

Environmental Regulations and Technology

Use and Disposal of Municipal Wastewater Sludge

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Site access is a key factor in public acceptance. Land application requires transport of sludge over good roads that are passable in most or all seasons. Trucking sludge through residential neighborhoods may generate public concern about traffic congestion, sludge spills, and dripping of sludge on the streets. Steps can be taken to assuage these concerns—for example, scheduling truck traffic at hours that will neither conflict with rush-hour traffic nor disturb sleeping residents, and washing trucks before they leave the site. One community fined trucks that dripped sludge, which has proven effective in reducing sludge spills.

3.3.8 Transportation Requirements

Transportation is a major expense in most land application systems. In agricultural application, where the sludge is often destined for many parcels of land, trucks are usually the most economical means of transport. For liquid sludge, tank trucks are commonly used. Even dewatered sludge requires watertight closed trucks. Open trucks with a tarp or similar covering can be used for composted and dried sludge. For dedicated land disposal sites pipeline transport may be possible. All transportation options are highly energy dependent, and none is cheap. The most appropriate mode of transport depends on the nature of the sludge and the distance to its destination.

3.3.9 Energy Usage

Except for transportation, energy usage in land application is low.

3.3.10 Regulatory Approval

Federal regulations pertaining to land application of sludge are contained primarily in 40 CFR 257 – Criteria for Classification of Solid Waste Disposal Facilities and Practices. Many states also regulate sludge land application – some more stringently than the Federal government. Other requirements are contained in 40 CFR 761 and in hazardous waste rules under the Resource Conservation and Recovery Act.

In 40 CFR 257, land application is considered to be a form of solid waste disposal, as are landfilling and sludge lagooning. The same regulations, in several general sections, apply to all three practices.

- **Floodplains.** Land application sites, landfills, and lagoons may be located in a floodplain; however, they must not “restrict the flow of the base flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.” A base flood is a 100-year flood.
- **Surface Waters.** Discharges that would violate Sections 402, 404, and 208 of the Clean Water Act are prohibited.
- **Ground Water.** Facilities must not “contaminate an underground drinking water source beyond the solid waste boundary.” States may establish an alternative boundary for a facility if such a change would not contaminate drinking water

resources. EPA is currently examining more stringent controls on land application to protect particularly vulnerable and valuable groundwater resources such as irreplaceable aquifers.

- **Public Health.** Waste cannot cause a risk of infection by the enteric organisms which are concentrated in the sludge. For this reason, controls on pathogenic organisms are required.

To protect public health, sewage sludge or septic tank pumpings that are applied to the land or incorporated into the soil must be treated by a “*Process to Significantly Reduce Pathogens*” (PSRP) prior to application or incorporation (see Table 6). The success of a PSRP can be determined by measuring the reduction in the number of organisms present. A one-log (90 percent) reduction in the number of pathogens present, or a two-log (99 percent) reduction in indicator bacteria (fecal coliforms) can be used to show that an unlisted process attains equivalent pathogen reduction. Also to protect public health, *public access* to the facility must be controlled for at least 12 months, and *grazing by animals* whose products are consumed by humans must be prevented for at least one month unless “*Processes to Further Reduce Pathogens*” (PFRP) are used (see Table 7).

Food-Chain Crops

Food-chain crops are: tobacco, crops grown for human consumption, and feed for animals whose products are consumed by humans. Land application of sludge for growth of food-chain crops is subject to additional requirements, and to restraints imposed by good practices and state regulations. For example, to prevent nitrate contamination of ground water, the usual practice is

Table 6. Regulatory Definition of Processes to Significantly Reduce Pathogens

(PSRP)

Aerobic Digestion: The process is conducted by agitating sludge with air or oxygen to maintain aerobic conditions at residence times ranging from 60 days at 15°C to 40 days at 20°C, with a volatile solids reduction of at least 38 percent.

Air Drying: Liquid sludge is allowed to drain and/or dry on underdrained sand beds, or on paved or unpaved basins in which the sludge depth is a maximum of 9 inches. A minimum of 3 months is needed, for 2 months of which temperatures average on a daily basis above 0°C.

Anaerobic Digestion: The process is conducted in the absence of air at residence times ranging from 60 days at 20°C to 15 days at 35°C to 55°C, with a volatile solids reduction of at least 38 percent.

Composting: Using the within-vessel, static aerated pile, or windrow composting methods, the solid waste is maintained at minimum operating conditions of 40°C for 5 days. For 4 hours during this period the temperature exceeds 55°C.

Lime Stabilization: Sufficient lime is added to produce a pH of 12 after 2 hours of contact.

Other Methods: Other methods of operating conditions may be acceptable if pathogens and vector attraction of the waste (volatile solids) are reduced to an extent equivalent to the reduction achieved by any of the above methods.

Table 7. Regulatory Definition of Processes to Further Reduce Pathogens

(PFRP)

Composting: Using the within-vessel composting method, the solid waste is maintained at operating conditions of 55°C or greater for three days. Using the static aerated pile composting method, the solid waste is maintained at operating conditions of 55°C or greater for three days. Using the windrow composting method, the solid waste attains a temperature of 55°C or greater for at least 15 days during the composting period. Also, during the high temperature period, there will be a minimum of five turnings of the windrow.

Heat drying: Dewatered sludge cake is dried by direct or indirect contact with hot gases, and moisture content is reduced to 10 percent or lower. Sludge particles reach temperatures well in excess of 80°C, or the wet bulb temperature of the gas stream in contact with the sludge at the point where it leaves the dryer is in excess of 80°C.

Heat treatment: Liquid sludge is heated to temperatures of 180°C for 30 minutes.

Thermophilic aerobic digestion: Liquid sludge is agitated with air or oxygen to maintain aerobic conditions at residence times of 10 days at 55°C to 60°C, with a volatile solids reduction of at least 38 percent.

Other methods: Other methods or operating conditions may be acceptable if pathogens and vector attraction of the waste (volatile solids) reduced to an extent equivalent to the reduction achieved by any of the methods.

Any of the processes listed below, if added to a PSRP, further reduce pathogens.

Beta ray irradiation: Sludge is irradiated with beta rays from an accelerator at dosages of at least 1.0 megarad at room temperature (ca. 20°C).

Gamma ray irradiation: Sludge is irradiated with gamma rays from certain isotopes, such as ⁶⁰Cobalt and ¹³⁷Cesium, at dosages of at least 1.0 megarad at room temperature (ca. 20°C).

Pasteurization: Sludge is maintained for at least 30 minutes at a minimum temperature of 70°C.

Other methods: Other methods or operating conditions may be acceptable if pathogens are reduced to an extent equivalent to the reduction achieved by any of the above add-on methods.

to apply sludge at a rate that just satisfies the nitrogen requirement of the crop to be grown on a site. Similarly, some states protect surface waters against phosphorus contamination by limiting application rates to the phosphorus needs of the crops. Key Federal regulations affecting land application to food-chain crops focus on pathogen reduction, cadmium limitations, and PCB content.

If the sludge will not contact the edible portions of the crop, pathogen reduction to PSRP levels is acceptable. However, if crops for direct human consumption are grown within 18 months of sludge application, sludge must be treated with a PFRP. These processes destroy pathogenic bacteria, viruses, and protozoa, as well as parasites, in most cases by exposing the sludge to elevated temperatures over a period of time.

Food-chain application is also subject to regulations designed to prevent excessive human exposure to cadmium. Annual cadmium applications to sites growing tobacco, root crops, and leafy vegetables are limited to 0.5 kg/ha/yr. Cadmium application to sites growing other crops are limited to 1.25 kg/ha/yr until 1987, when the limit will drop to 0.5 kg/ha/yr. The cumulative application of cadmium is also limited, based on soil pH and soil cation exchange capacity. In general, soil pH must be at least 6.5 or greater at the time of planting, and EPA recommends that pH be permanently maintained at or above 6.2. Future regulations may reflect greater flexibility in this requirement.

Alternatively, if the crop is exclusively animal feed, cadmium applications need not be limited, but pH must be consistently maintained at or above 6.5. Thus the production of animal feed is ideal at dedicated land disposal facilities. However, such facilities do require a facility operating plan which demonstrates how the animal feed will be distributed to preclude ingestion by humans and which describes measures to safeguard the public health from the hazards of cadmium entering the food chain. Also, future property owners must be notified, by means of a stipulation in the land record or property deed, that the property has received solid waste at high cadmium application rates and that food-chain crops should not be grown.

Sludges containing greater than 10 mg/kg but not more than 50 mg/kg of PCBs must ordinarily be incorporated into the soil when applied to land used for producing animal feed, including pasture crops for animals raised for milk. Sludges containing greater than 50 mg/kg of PCBs must be treated under the strict requirements of 40 CFR 761.60 which allows only incineration (in compliance with Part 761.70) or disposal in a chemical waste landfill (defined under Part 761.65). These requirements are separate from hazardous waste requirements specified under RCRA. Substitute methods of disposal may be approved by EPA Regional Offices.

Sludges that contain high concentrations of metals and thus qualify as hazardous wastes are controlled under provisions of the Resource Conservation and Recovery Act (see subsection 2.3.4).

3.3.11 Cost Factors

Land application may be a low-cost sludge use option. Capital expenditures are frequently low, particularly if the municipality does not need to buy land. *Capital costs* include:

- Trucks
- Sludge storage facilities
- Dewatering/drying equipment
- Stabilization/composting equipment
- Spreading equipment
- A small amount of land on which to set up or store the equipment and facilities.

Dewatering, drying, and composting may all require high capital expenditures, but are often not used in land application.