Comparison of Class A and Class B Private Biosolids Stabilization Technologies

Gerald W. Foess and Douglas Fredericks

Concerns over the long-term reliability of land application of Class B biosolids are causing many utilities to examine alternatives for effectively disposing of biosolids. Most wastewater treatment plants in Florida rely upon private contractors to dispose of residual biosolids in either a liquid or cake form. Currently, the predominant disposal method is application of digested biosolids on agricultural land. However, many utilities are re-evaluating this method because of two major concerns: (1) the ability of existing digestion systems to consistently meet Class B pathogen reduction requirements under 40 CFR 503; and (2) the uncertain long-term availability of suitable agricultural land within reasonable haul distances.

In this study, the costs of three Class A and two Class B pathogen reduction technologies were compared at various system capacities. The results described were derived from recent biosolids management planning efforts conducted for wastewater utilities in Broward County and Fort Pierce. The purpose of the study is to compare the costs of various sludge management alternatives and provide general guidance to utility managers who are examining options to their current means of biosolids management.

Biosolids Management Alternatives

Figure 1 is a schematic representation of the systems evaluated and their respective products and markets. The systems shown are divided into Classes A and B, according to the alternate levels of pathogen reduction defined under the Part 503 regulations. Class A systems must meet more stringent requirements, enabling Class A biosolids to be applied not only to agricultural land but also to public access areas, such as private lawns and home gardens. Class B biosolids are almost exclusively applied to agricultural land and are prohibited from public access areas.

Brief descriptions of some key features of each management system alternative follow.

Digestion. Conventional digestion performed on raw or thickened sludge produces a liquid product that is intended to be Class B with respect to pathogen reduction. Historically, aerobic digestion has been the technology of choice in Florida for plants of less than about 10 MGD capacity, while anaerobic digestion has proven more economical for larger plants. Only aerobic digestion was analyzed in this study. Aerobically digested biosolids were assumed to be dewatered and trucked to agricultural land for ultimate use. A haul distance of 100 miles and covered storage of three months were assumed. In addition, it was assumed that the landowner would be paid a fee of $20/year per usable acre to ensure long-term biosolids application rights.

Alkaline Stabilization. Versions of this process are available to achieve either Class A or Class B disinfection. In the Class B process, alkali (lime or cement kiln dust) is added to dewatered raw sludge to meet a specified pH and contact period. By adding additional lime and/or supplemental heat to meet stricter pH/time/temperature criteria, a Class A product can also be produced. Alkaline stabilized sludge ranges from a wet-cake consistency to a moist, soil-like consistency depending on the specific process used.

Both Class A and Class B lime stabilization systems were evaluated. In each case the products were assumed to be utilized on agricultural land as described above for digested sludge, except that no land lease cost was charged against the Class A product because it was considered to have more inherent value.

Thermal Drying. This process uses applied heat to force moisture to evaporate from dewatered sludge and produces a dried, pathogen-free product suitable for beneficial use. Two rotary direct drying and two indirect steam drying systems were evaluated.

Thermally dried product is in the form of small granules or pellets. In this study, the product was assumed to be marketed in bulk to users such as golf courses and citrus growers, who currently use similar products primarily imported to Florida from other states. Thermally dried product was assigned a value of $40/ton, which included a deduction for marketing and distribution costs.

Composting. The composting process uses a mixture of dewatered raw or digested sludge and dry amendment material (yard waste in this study) under controlled environmental conditions to produce a disinfected, humus-like product. The three composting systems evaluated included a horizontal agitated reactor, a horizontal non-agitated reactor, and an aerated static pile system (nonproprietary).

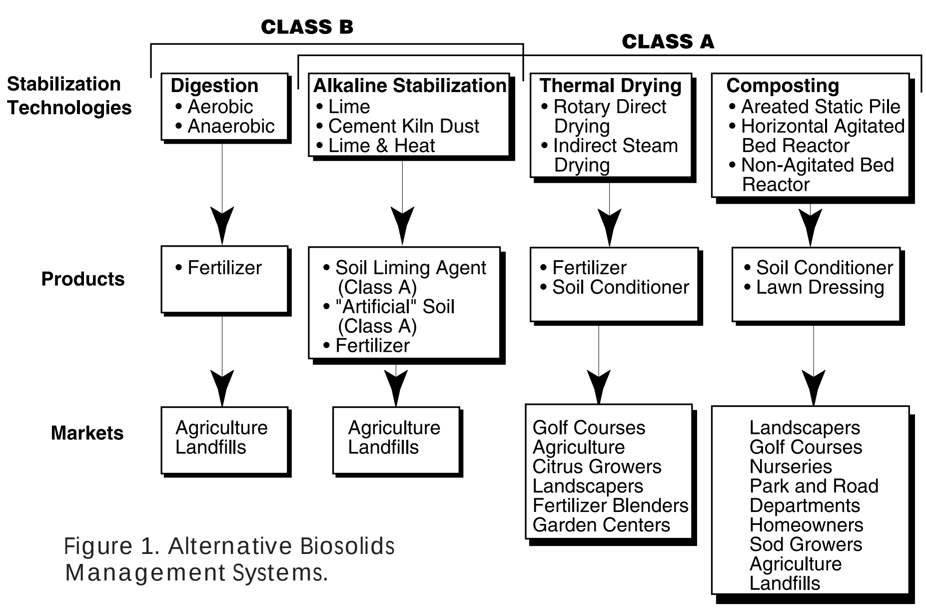


Figure 1. Alternative Biosolids Management Systems.

Compost was assumed to be marketed as a soil conditioner in competition with such products as peat, soil, and mulch. Yard waste and finished compost were valued at $5/cubic yard and $1.50/cubic yard, respectively.

Comparison of Alternatives

Cost Comparison. Capital and operating costs were developed for each biosolids management alternative at various system capacities. To allow the overall costs of the alternatives to be more easily compared, they were converted to dollars per dry ton of raw solids.

Figure 2 shows the cost comparison for the major alternatives at a system capacity of 35 dry tons/day (dtpd), which equates to about a 45 MGD wastewater treatment plant. The costs shown are representative of the various process

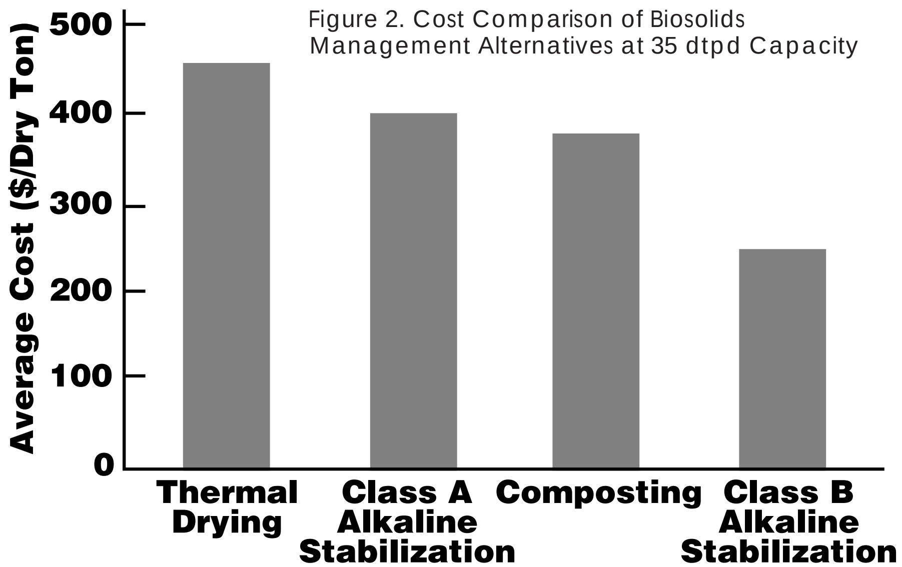


Figure 2. Cost Comparison of Biosolids Management Alternatives at 35 dtpd Capacity

Note: Cost includes capital, O&M, and final distribution; capital costs amortized over 20 years at 6 percent interest.

options within the thermal drying, composting, and alkaline stabilization categories.

Costs were also developed for system capacities of 65 and 95 dtpd and it was found that thermal drying exhibited the most favorable economies of scale. The cost per ton for thermal drying successively decreased about 10 percent at each of these levels, whereas the cost reduction was only about 5 percent for alkaline stabilization and composting.

Odor control costs are included in Figure 2; however, dewatering costs are not included because dewatering was a common process in each management alternative. The only condition under which dewatering may not be economical or required is with digestion/land application systems having a haul distance of less than about 15 miles.

These results showed that land application of Class B biosolids with a 100-mile, one-way haul distance is significantly less costly than any of the Class A alternatives for the size range investigated. Unit costs for all of the alternatives would increase for smaller systems, but it is expected that land application of Class B biosolids would continue to show a similar advantage over Class A alternatives in the smaller size range.

For plants of less than 10 MGD that opt for land application of Class B biosolids, aerobic digestion and lime stabilization will be the principal competing stabilization alternatives. These two alternatives were separately compared at a system capacity of 2.5 dtpd, equivalent to about a 3 MGD plant. The results, depicted in Figure 3, show that Class B lime stabilization is significantly less expensive than aerobic digestion.

Agricultural Land Availability

The fact that agricultural application of Class B biosolids is much less costly than the Class A alternatives is meaningless unless suitable agricultural land is available within a reasonable haul distance. Assessment of land availability was not part of this study, but existing practice and general statistics suggest significant land application opportunities. According to the 1993 *Florida Statistical Abstract*, Florida has more than 24 million acres of farmland, with 56 of 67 counties having more than 250,000 acres. More than half of the counties have population densities of less than 75 per square mile, indicating a rural character.

Class B biosolids usually would not be applied to row crops but are generally suitable for citrus groves, turf farms, sugar cane, and pasture land. Land requirements vary depending on the crop type and limiting nutrient (nitrogen or phosphorus), but are approximately 150 to 600 acres/dtpd of biosolids (usable land, excluding buffers, wet areas, etc.). In South Florida, the chief obstacle to land application is a high seasonal groundwater table, which may require drainage to lower the water table or provision of biosolids storage facilities.

Experience indicates that most educated farmers want biosolids and many are willing to pay for the product. The biosolids application fee of $20/acre/year used in this study was essentially an incentive payment to the farmer to provide a long-term, exclusive lease and thereby minimize the uncertainty of this management alternative. Municipalities would also have the option of purchasing their own land.

Conclusions

1. Among the Class A stabilization technologies, thermal drying was the most costly at a system capacity of 35 dtpd, followed by alkaline stabilization and composting, respectively; however, thermal drying exhibited a greater economy of scale and, therefore, became more cost competitive as system capacity increased.

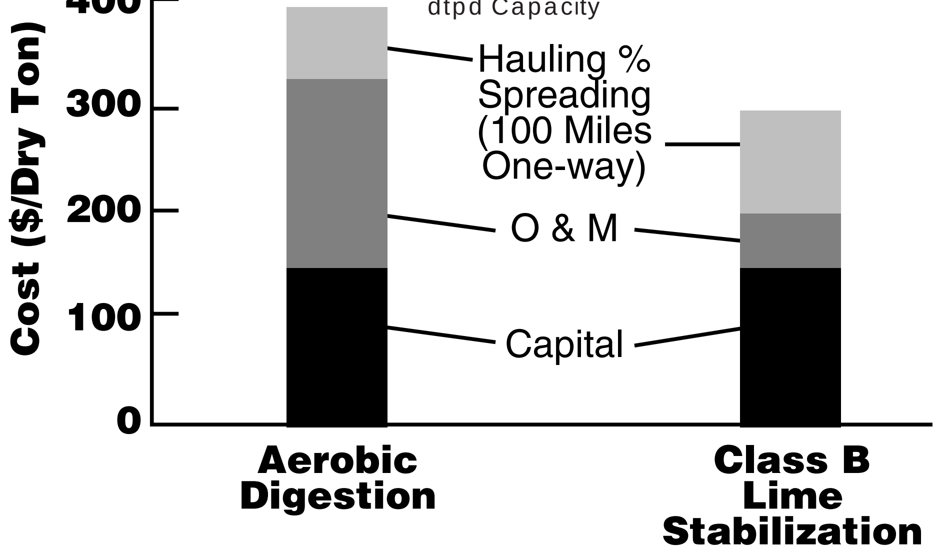
2. Class B lime stabilization, followed by agricultural application at a 100-mile, one-way haul distance, was significantly less costly than any of the major Class A biosolids management alternatives.

3. The long-term reliability of agricultural land application can be enhanced if a utility purchases or leases its own land.

4. Florida has abundant agricultural land, but a seasonal high groundwater table may require drainage or temporary storage of biosolids and rigid adherence to agronomic application rates.

5. For a small system of 2.5 dtpd, Class B lime stabilization was significantly less expensive than aerobic digestion.

Figure 3. Cost Comparison of Class B Lime Stabilization and Aerobic Digestion at 2.5 dtpd Capacity



Gerald W. Foess, Ph.D., P.E., is wastewater and residuals technology coordinator with CH2M HILL, Deerfield Beach. Douglas Fredericks is a senior wastewater engineer with CH2M HILL, Tampa.

Molybdenum in Sludge—What's Happening and How Does It Affect Us?

Lynn Green and Tina Helmling

Molybdenum was virtually an unknown metal prior to the establishment of concentration limits under the EPA 40 CFR, Part 503 rule for sludge products suitable for beneficial use, or "biosolids." These limits were greeted with intense criticism by the industry and concern over the technical basis. EPA's reaction on February 25, 1994, was to suspend all molybdenum concentration limits, with the exception of the "ceiling limit" for land application, pending further review.

Despite the suspension of most molybdenum limits, some generators have been unable to meet the ceiling limit of 75 mg/kg, thus prohibiting the production of biosolids suitable for beneficial use. More important, other molybdenum limits will soon be reestablished by EPA and are likely to be the limiting factor in determining whether a generator can meet the exceptional quality limits and be exempted from site life restrictions and other constraints which translates to savings in capital and operating costs. The wastewater industry must determine the sources and corrective measures necessary to reduce the quantity of molybdenum which finds its way into our collection systems.

Background

The EPA 40 CFR, Part 503 rule promulgated on February 19, 1994 established four molybdenum limits for beneficial use: 503.13(b)(1), Pollutant ceiling concentration of 75 mg/kg prior to land application; 503.13(b)(2) Cumulative loading rate of 16 lb/ac for land application; 503.13(b)(1) "Exceptional quality" pollutant limit of 18 mg/kg for distribution & marketing; and 503.13(b)(3) Annual loading limit of 0.8 lb/ac/yr for biosolids distributed and marketed, which do not meet the Table 3 limits.

Following the promulgation of Part 503, EPA was petitioned by numerous groups to reconsider these molybdenum limits in light of concerns as to the technical basis utilized to develop the limits. The second, third, and fourth limits were based on the land application risk assessment pathway for protection of livestock which consume plants grown on sludge-amended soils. High levels of molybdenum can cause a chronic disease in animals called molybdenosis. The risk assessment appeared to be flawed due to the basis of the crop uptake rate calculations. The calculations were based on data for sludges which were extremely high in molybdenum content and not representative of typical wastewater treatment plant sludges.

An estimated 50 percent of all treatment facilities would be unable to meet the limit of 18 mg/kg for exceptional quality sludges. Heat drying facilities appeared to be most impacted by the limit and would either be shut down or required to blend with other materials to produce a marketable product. The Water Environment Federation requested that EPA stay the 18 mg/kg molybdenum limit to avoid major financial impacts on the industry while the basis of the limits was reassessed. EPA did take action on February 25, 1994, to stay the molybdenum limits pending further review.

Molybdenum Characteristics And Sources

A naturally occurring metal, molybdenum is found in nature in the form of the mineral molybdenite (MoS_2). Molybdenum is obtained from mined ores and is a by-product of copper mining. It is essential to human, animal, and plant life in trace amounts.

Molybdenum is used in many commercial and industrial applications. Yet it has been difficult to positively identify and pinpoint those sources contributing to wastewater collection systems. One problem is that information on the amount of molybdenum contained in some products may be proprietary and unavailable. The major uses of molybdenum include pigmentation, metallurgy, catalysis, fertilization, lubrication, and corrosion inhibition. Businesses which utilize molybdenum or materials and products with molybdenum based compounds may contribute significant amounts of molybdenum compounds to a wastewater treatment facility.

Sodium molybdate is the base material for the production of both organic and inorganic chrome pigments and dyes. Molybdic oxide is used in the production of steels and stainless steels; molybdenum metal is used for gas scrubbers, power generation, and coal gasification. Molybdenum based catalysts are utilized in a wide range of reactions, including the hydrodesulfurization and denitrification of crude oils during refining, ammonium production, and in analytical air quality testing. Molybdenum is an important trace element for enzymes which fix nitrogen and promote normal plant growth; it is also used as a soil additive. Molybdenum disulfide is used in many industrial grade lubricants to significantly reduce wear, friction, and sustain lubrication of machine components. Sodium molybdate is used as a corrosion inhibitor in solutions of antifreeze, paints, finishes, and in the treatment of water for industrial cooling systems.

Presently the most likely source of molybdenum in wastewater systems has been determined to be from cooling towers used to supplement standard air conditioning and refrigeration in large office buildings and not from major industrial contributors. Corrosion inhibitors are usually added to cooling systems not only to control corrosion but to prevent scaling, mineral deposition, and bacteria and algae growth.

Analytical Concerns

The accurate analysis of molybdenum in a biosolids matrix has proven to be a difficult process. Careful sample collection, handling, and preparation are also important factors in producing accurate and precise results. Currently no standard methods exist for the analysis of biosolids, although Part 503 regulations cite as a sample preparation and testing method reference *Testing Methods for Evaluating Solid Waste: Physical/Chemical Methods*, USEPA Pub. SW-846, November 1986 with Revision I (December 1987), which presents several testing methodologies for molybdenum detection. These are the flame atomic absorption (AA), inductively coupled plasma (ICP), and graphite furnace atomic absorption (GFAA) methods.

The flame atomic absorption method has been found to have a high detection limit, high atomization temperature, poor signal resolution, and memory effects caused by some graphite tubes. The inductively coupled plasma and graphite furnace atomic absorption spectroscopy methods have been utilized with some success, although laboratories using the ICP method have reported problems with low molybdenum emission intensity, poor signal, and background interference with other metals, such as iron and aluminum. This can be corrected by using a different wavelength. Due to their analysis sensitivity, the ICP and GFAA methods have been used extensively and are the recommended procedures for analysis of molybdenum.

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Lynn Green, P.E. is a project engineer and Tina Helmling is a staff engineer with Black & Veatch, Tampa.