LAND APPLICATION SUSTAINABILITY STUDIES WITH CLASS B BIOSOLIDS AND NOVEL APPROACHES FOR OBTAINING CLASS A BIOSOLIDS

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A) SUSTAINABILITY STUDIES

Both Class B biosolids are known to contain pathogens including bacterial and viral pathogens and protozoan parasites. Over the past 10-15 years a variety of potential hazards associated with Class B biosolids have been identified (Case Study). Many of these issues involved the potential for infection from pathogens associated with the organic residues. These pathogens of concern are listed in Table 1. However, in addition to pathogens, other potential hazards have centered on non-pathogenic issues such as antibiotic resistant bacteria, endotoxin and prions.

Case Study. The University of Arizona, National Science Foundation studies on biosolids and land application.

During the period 1999 through 2014 the University of Arizona was funded by the National Science Foundation to conduct studies on "Water Quality" and "Water and Environmental Technology." One of the focal areas of research included studies on potential hazards associated with Class B biosolids and land application of such material. Table 2 highlights some of the studies undertaken. Many of the topics evaluated were highly controversial with the general public because of the concern for potential microbial infections and/or illness due to pathogens found within Class B biosolids. Particularly worrisome for the public was the potential for infections to occur within communities off-site, following transport of pathogens as bioaerosols, or transport via leaching into underground aquifers. However, research studies on both issues showed very limited transport by either route. Hence, exposure via such mechanisms was low, and subsequently, risks to human health were also low. Other biological concerns included the potential for disease from endotoxin, *S. aureus* and infectious proteins known as prions. However, it was shown that neither *S. aureus* nor prions survived wastewater treatment. Finally, note that regrowth of *Salmonella* did not occur following land application, indicating that site restrictions following land application would allow for inactivation of biosolid associated pathogens without secondary regrowth. Overall, the studies indicate that the risk of adverse health effects from biosolid amended soil is low. However, diligence is necessary and the fate and transport of all emerging microbial contaminants still needs to be evaluated.

Table 1. Pathogens commonly found in Class B biosolids.

Class B biosolids
E.coli 0157:H7
Salmonella
Campylobacter jejuni
Listeria monocytogenes
Cryptosporidium
Enterovirus
Adenovirus
Norovirus

Table 2. Microbial issues associated with land application of biosolids.

ISSUE	CONCERN	OUTCOME OF STUDY	REFERENCES
Occurrence of *Staphylococcus aureus* in biosolids	Community infections from *S.aureus* associated with biosolids amended soil	*S. aureus* does not survive wastewater treatment	Rusin *et al*., 2003
Aerosolized bacteria and virus	Offsite community infections from bioaerosols	Limited microbial transport via bioaerosols and negligible risk to offsite communities	Brooks *et al*., 2005a & b; Tanner et al., 2005
Endotoxin	Community exposure to aerosolized endotoxin due to endotoxin associated with biosolids	Most aerosolized endotoxin derived from soil	Brooks *et al*., 2006; Brooks *et al*., 2007
Groundwater contamination	Groundwater contamination with viruses following transport through soil and vadose zone	Very limited transport of viruses because viruses sorb to biosolids	Chetochine *et al*., 2006
Antibiotic resistant bacteria (ARB)	Presence of antibiotics in biosolids will increase the numbers of ARB in soil with subsequent transfer of resistance to pathogens	No increase in soil ARB	Brooks *et al*., 2007
Salmonella	*Salmonella* regrowth in biosolids and soil following land application	*Salmonella* only regrows in Class A biosolids under saturated conditions. No regrowth in amended soil	Zaleski *et al*., 2005a&b
Prions	Prion infection of animals and humans following land application of prions	Prions do not survive wastewater treatment	Miles *et al*., 2012

B) NOVEL APPROACHES FOR OBTAINING CLASS A BIOSOLIDS

Class A and B biosolids are the result of different levels of treatment of wastewater. Class A biosolids contain no detectable levels of pathogens, whereas Class B biosolids are known to contain variable concentrations of bacterial and viral pathogens. The requirements for Class A and B biosolids are shown in Table 3.

Table 3. Part 503 Pathogen Density Limits.

Standard Density Limits (Dry Weight)
Pathogen or Indicator
Class A
Salmonella <3 MPN/4g total solids or
Fecal coliforms <1000 MPN/g and
Enteric viruses <1 PFU/4g total solids
Class B
Fecal coliform density <2,000,000 MPN/g total solids

There are several designated process defined by the U.S. Environmental Protection Agency to attain Class A status (Processes to Further Reduce Pathogens: PFRPs), including: composting, heat drying and thermophilic aerobic digestion. Here we describe two novel approaches for obtaining Class A biosolids, that are being evaluated at the University of Arizona.

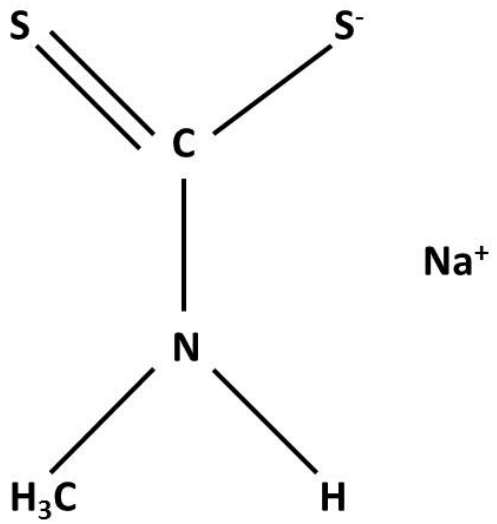
i) Class A Pelletized Fertilizer

Top Choice Organic is a Class A Exceptional Quality pelletized fertilizer and soil conditioner. It is produced by Metro Water in Nashville, TN and then marketed by Mannco Environmental Services. Essentially the product consists of anaerobically digested sewage which is subsequently dewatered via centrifugation, then heat dried. Top Choice is an unusual Class A product in that it has a high nitrogen content of 5% total N. The overall nutrient content is 5-3-0. An additional attractive feature of the product is that it consists of dark colored pellets 1 mm to 4 mm in diameter, that are easy to handle, and, in fact they are similar to urea granules. Also there is the additional advantage that there are no biosolid odors associated with the product.

At the University of Arizona we are now in the second year of a field trial evaluating Top Choice Organic as a fertilizer for the growth of cotton.

ii) Treatment of Class B Biosolids with Sodium Metam

Sodium metam is a soil fumigant used extensively as a pesticide in the U.S.



Sodium methylaminomethanedithioate

It is an economical and safe alternative to methyl bromide, and once incorporated into soil it quickly decomposes to methylisothiocyanate, a gaseous product with nematocidal, fungicidal, herbicidal and insecticidal activity. It is used for a variety of crops including potatoes, carrots and beets, as well as ornamentals.

We have been investigating the use of Metam sodium with Magna Grow for the production of Class A biosolids. It is highly effective against *Ascaris* ova and human pathogenic viruses. The Magna Grow process involves the addition of metam sodium and increasing the pH to 12 for 24 hours. The metam is lost to the atmosphere during the process, and the high pH kills both helminthes and viruses, and also meets vector control requirements. During this time, the *Ascaris* ova are killed and the enteric viruses reduced to less than 1 per 4 grams. The results of our studies have been used for the recent submission of approval by the USEPA as a Class A process for biosolids. We are currently conducting research to reduce the treatment time to 12 hours or less.

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