Potential Uses of Biosolids Fact Sheet

Biosolids are nutrient-rich organic materials from the treatment of domestic wastewater in a wastewater treatment facility. Biosolids are a beneficial resource, containing essential plant nutrients and organic matter when recycled as a fertilizer and soil amendment. In the U.S., to protect human health and the environment, wastewater solids must be treated to meet the Environmental Protection Agency's (EPA's) Part 503 regulatory requirements if they are to be recycled as biosolids.

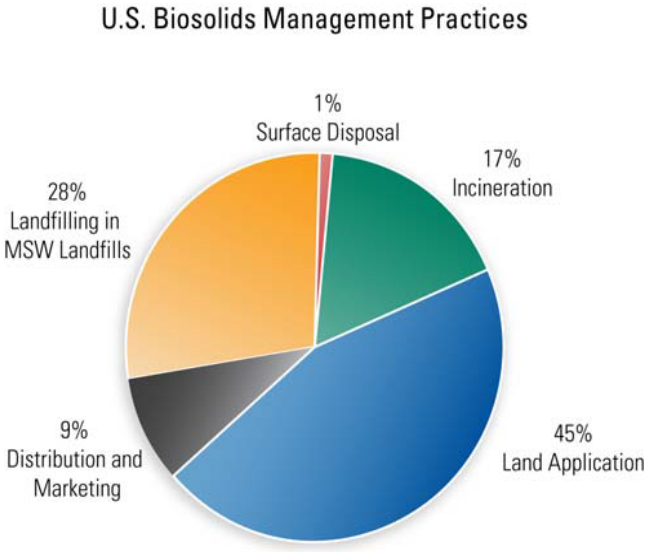
Terminology

The term ***sludge*** is generally used for residuals before applicable stabilization processes and before the Part 503 criteria have been met. Sludge should be used in tandem with a specific process descriptor (*e.g.*, *primary sludge*, *waste activated sludge*, *secondary sludge*, etc.)

The term ***biosolids*** is generally used after applicable beneficial recycling criteria have been achieved, *i.e.*, at the outlet of the stabilization process. Common stabilization processes include: aerobic digestion, autothermal thermophilic aerobic digestion (ATAD), anaerobic digestion, composting, alkaline stabilization, thermal drying (flash, rotary, fluid bed, paddle, hollow-flight, disc, and infrared dryers), thermophilic pozzolanic fixation, acid oxidation/disinfection, and heat treatment/acid digestion.

Biosolids Use Survey

The Northeast Biosolids & Residuals Association (NEBRA) July 2007 report – National Biosolids Regulation, Quality, End Use & Disposal Survey estimates that more than 7 million dry tons of solids are generated annually for use or disposal by the wastewater treatment facilities nationwide. Several biosolids management options are available under the Part 503 regulations. The chart below illustrates current biosolids management practices.



"Biosolids Management: Options, Opportunities & Challenges", NACWA

Benefits

The benefits of biosolids are dependent on several factors. However, generally the benefits include:

- Valuable source of organic matter, which assists in the improvement of soil structure;
- Rich nutrient fertilizer, nitrogen, and phosphorus;
- Valuable on cropland;
- Good iron fertilizer, better than commercial fertilizers for iron;
- Groundwater protection – organic nitrogen in sludge is much less likely to cause groundwater pollution than chemical nitrogen fertilizers; and
- Reduced landfill disposal.

AGRICULTURAL LAND APPLICATION

Recycling biosolids to agricultural land completes natural nutrient cycles and enables farmers to improve the economics of crop production. Also, recycling to land can make a contribution in reducing greenhouse gas emissions, compared with landfilling, and will mitigate climate change impacts. The enactment of Part 503 regulation in the U.S. fostered a surging interest in land application, not only of treated biosolids, but also of all sorts of organic residues. Most programs for land application of residuals started as projects for land renovation and alternative disposal for wastes rather than soil amendment. Their success rehabilitating depleted soils and barren land

demonstrated their effectiveness as a soil amendment.

Fertilizer/Soil Conditioner for Human Crops Production

The utilization of biosolids on land for enhancement of crop production is an age-old practice. Prior to the invention of chemical fertilizers to enhance crop production, farmers depended solely on various organic products and wastes. These organic wastes and products included farm animal litters and manures, household biodegradable wastes, and even human manure in some societies. Unlike other soil amendment use, biosolids application to agricultural land has been used for a number of years and is subject to extensive regulatory programs in place. Biosolids usually are applied at rates designed to supply crops with adequate nitrogen. They also contain other nutrients (phosphorus and micro-nutrients) that reduce fertilizer requirements. Before modern times, organic residuals were usually applied directly to the land without processing, although some residuals may have been composted. After the invention of mineral fertilizers, the utilization of organic residuals as soil amendments decreased.

Fertilizer for Animal Crops Production

The main potential use for biosolids is as a fertilizer and/or soil conditioner to assist with the growth of animal crop production and to help improve and maintain the structure of the soil. Biosolids contain a range of valuable nutrients such as nitrogen, phosphorus, iron, calcium, magnesium, and various other macro- (*e.g.*, oxygen and carbon) and micro-nutrients that are essential for plant growth. Many of these nutrients are also essential components in the healthy diet of animals in order to maintain growth and for food production. These are some of the more substantial examples of beneficial use of biosolids for animal crop production:

NONAGRICULTURAL LAND APPLICATIONS

Forestry

A relatively new use of land-applied biosolids is for applications to forestland. This use had been difficult to achieve due to technological limitations in spreading biosolids evenly through heavily forested areas. However, various residuals, including pulp and paper mill sludges, ash, industrial residues, biosolids, and wastewater, are utilized to enhance growth in forest ecosystems.

Land Reclamation

Biosolids have several characteristics that make them suitable for reclaiming and improving disturbed and marginal soils. The organic matter in biosolids improves the soil physical properties by improving aggregate formation, reducing plasticity and cohesion, and increasing water-holding capacity. Biosolids increase soil cation exchange capacity, supply plant nutrients, and buffer soil pH.

Mine Sites Reclamation

The most widespread reclamation use of biosolids has been for repairing land damaged by mining. They have been used to reclaim surface-mined areas, abandoned mine lands, coal refuse piles, smelter wastes, and other disturbed lands. Amendment of mine soils with biosolids has been shown to increase soil organic matter, cation exchange capacity, soil nutrient levels, and to promote soil ecosystem recovery. Depending on the amendments added, biosolids can serve many purposes, including pH control, metal control, and fertilization. Their adaptability allows them to conform to the specific characteristics of any reclamation site.

Horticulture and Landscaping

The use of biosolids for horticulture and landscaping is similar to land application and agricultural application, but with a different intent. The biosolids product, often compost, is used for soil conditioning rather than as a replacement fertilizer. Generally the biosolids product is sold in smaller bags from the treatment facility, through municipal outlets, or through retail establishments. Alternately, the material is used in bulk by consumers or by the municipality itself. Biosolids improve the manageability, water retention, and tilth of troublesome soils. Landscaping and horticultural uses of biosolids products often relate to maintenance of athletic or recreational facilities such as golf courses. Compost is perhaps the most popular biosolids-based product for landscaping uses, as compost is primarily a soil conditioner, not a fertilizer.

ENERGY RECOVERY – RENEWABLE ENERGY RESOURCES

Biosolids contain organic material and thus have a fuel value that potentially can be realized from incineration practice (see chart on page 1). Harnessing the fuel value of biosolids requires construction and operation of a combustion unit. The ability to control emissions and to generate electricity from the combustion and heat recovery from biosolids presents a strong argument for the consideration of biosolids combustion as a beneficial use of the material. The advantages of biosolids combustion include: reduction of volume of solids for disposal, pathogen destruction and oxidation of toxic organics, immobilization of heavy metals, sustainable technology, cost-effectiveness, and efficient air quality protection.

Thermal Energy Recovery – Heat Generation

Utilization of unused energy such as industrial waste heat is one of important measures to save energy consumption for global warming mitigation and to reduce domestic and industrial heat waste. Thermal energy of raw or treated wastewater residuals is used for air conditioning of buildings in wastewater treatment plants and for regional air conditioning. This is to utilize the characteristic that sewage is warmer in winter and cooler in summer than outdoor air temperature. The waste heat from sewage sludge incineration and melting facilities can also be used for heating facilities and buildings. Moreover, the excess heat from the incineration of sludge can be used to produce steam for electricity generation. Many treatment plants throughout the world anaerobically digest their sludge, producing methane to generate power via gas engines or turbines. The increased cost of power and increased interest in renewable energy sources is making this approach more attractive to water authorities.

Energy Recovery – Incineration

Incineration of biosolids can be carried out by a range of technologies including rotary kilns, fixed hearth, moving hearth, circulating fluidized bed, etc. The most common technology for mono-incineration of biosolids is the fluidized bed sewage sludge incinerator (FBSSI). In a typical FBSSI, biosolids are combusted in a fluidized bed of hot sand, in a vertical cylindrical combustion chamber.

Energy Recovery – Gasification

Plasma gasification presents significant environmental benefits over conventional thermal technologies due to its conversion efficiency and the concentrated syngas stream that is produced. Due to the high combustion temperature of the gasification reactor and the high temperature of the exit gas, there is virtually no reforming of combustion by-products to form organic compounds of environmental concern such as polycyclic aromatic hydrocarbons, dioxin/furans, or phenols. As the concentrated syngas exits the gasifier, a variety of proven technologies are available to remove impurities or sequester compounds of interest.

Biosolids as Biofuels

Biosolids are rich in energy. Unprocessed biosolids have the heat value of a low-grade coal. Biogas from anaerobic digestion, which is approximately 60% methane, can be cleaned to create a biomethane product with an equivalent heat value of natural gas. Initiatives from EPA, Department of Energy, and the manufacturers have led to the development of more efficient engines that are designed for use with biogas. The increased efficiency and rising electric power costs are making co-generation more viable for medium-sized facilities. Developments in microturbines and fuel cells are rapidly making co-generation potentially economically viable for smaller treatment facilities.

Electric power is only one benefit from cogeneration. Heat can be recovered from the power-producing systems and used in a variety of ways. For example, dryer manufacturers have recently developed lower temperature systems that can use this recovered heat to dry biosolids. Other uses for the heat include building and process heating. There are numerous other methods in which biosolids can be used as biofuels. Heat recovery at incineration facilities is a common practice that takes advantage of the fuel value of biosolids. Improvements in dewatering and incineration technologies have allowed incineration facilities to be net exporters of energy. Heat can be recovered for generating steam to produce electric power, or for heating facilities.

Another method is the use of dried biosolids as a substitute for coal. Dried biosolids have been used as a substitute for coal in electric power production in Europe and in cement production in both Europe and the U.S. Several U.S.-based power utilities are currently investigating the impacts of using dried biosolids as a coal substitute.

COMMERCIAL USES OF BIOSOLIDS

Efforts to "market" biosolids generally refer to the sale of large amounts to commercial consumers. Biosolids also may be sold in bulk and in smaller quantities to homeowners and gardeners. They could be used as an alternative to commercial fertilizers and soil conditioners, or they could be used in conjunction with these types of products. Biosolids also have the added benefit compared to commercial products in that they contain a significant amount of organic matter (approximately 40% to 60%), which improves soil structure by increasing soil aeration and the water-holding capacity of the soil.

Milorganite – Milwaukee

One of the U.S.'s oldest and most recognized biosolids recycling programs is conducted by the city of Milwaukee. Since the 1920's, this city has been producing a granular, heat-dried biosolids product called Milorganite. Milorganite is sold in bulk to fertilizer manufacturers. Forty-pound bags of Milorganite are sold to the retail market for distribution by nurseries and garden centers and 50-pound bags are marketed commercially to the turf and landscape industry for use at schools, parks, and golf courses. Besides being sold throughout the U.S., Milorganite has been sold in Japan, Puerto Rico, Canada, Venezuela, and India. Approximately 50,000 tons of Milorganite are produced per year.
URL:
http://v3.mmsd.com/NewsDetails.aspx (Enter keyword Milorganite)

Additional Commercial Uses of Biosolids

MetroGro – Madison, Wis.

The city of Madison produces an anaerobically digested biosolids product, called MetroGro, which is marketed to local agriculture. Every year, about 30 million gallons of MetroGro are sold to fertilize 3000 to 4000 acres of farmland. MetroGro is delivered to the farm sites in 6000-gallon semi-tanker trucks and the biosolids are applied using 3500-gallon application vehicles, which inject the product into the soil. MetroGro is applied primarily to fertilize corn, soybeans, and alfalfa.
URL:
http://www.madsewer.org/Metrogro.htm

GroCo – Seattle

Seattle's two wastewater treatment facilities produced 20,000 dry tons of wastewater residuals. Their sludge is used to create a class B biosolids cake that is used on agricultural land and forests (reclaiming logged areas and scars left by logging roads). A portion of their biosolids is sold to a private contractor who composts and produces a general-use soil conditioner called GroCo. Seattle's "Mountains to Sound Re-Greening Program" involves hundreds of volunteers in the restoration and revegetation of logging roads no longer needed along the scenic Interstate 90 corridor from Puget Sound to the east side of the Cascades. GroCo is being used to restore and revegetate the unsightly, barren scars left by many old logging roads.
URL:
http://www.kingcounty.gov/environment/wastewater/Biosolids/GardenCompost.aspx

Potential Uses

There are many potential uses of biosolids and specific opportunities, including:

- Agricultural land application
  - o Fertilizer/soil conditioner for human crops production
  - o Fertilizer for animal crop production – pastures
- Non-agricultural land application
  - o Forest crops (land restoration and forestry)
  - o Land reclamation (roads, urban wetlands)
  - o Reclaiming mining sites
  - o Landscaping, recreational fields, and domestic use
- Energy recovery – Energy production
  - o Heat generation, incineration, and gasification
  - o Oil and cement production
  - o Commercial uses