TEXAS Biosolids Quarterly

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This volume covers the site selection process for beneficial land application of treated sewage sludge (biosolids) and domestic septage and discusses in detail the various considerations to be taken into account while selecting a Class B beneficial land application site.

Site Selection for Beneficial Land Application of Biosolids

Introduction

Land application is spreading, spraying, injecting, or incorporating biosolids onto or just below the surface of the land, to take advantage of biosolids' soil-enhancing qualities. Generally, there are four types of land application: home garden and landscapes, agricultural lands, forest lands, and drastically disturbed lands (land reclamation).

Site characteristics greatly affect the potential environmental impacts of biosolids application; consequently, site selection is an important aspect of all land application systems. The site must be conveniently located and suitable for the type of biosolids being considered. Careful identification, evaluation, and ultimate selection of land application sites help prevent future environmental problems, reduce monitoring requirements, minimize overall program costs, and moderate or eliminate adverse public reaction. Poor site selection may result in environmental problems and public resistance. Before selecting a site, the user should know the estimated present and future quantity, physical characteristics, and chemical quality of the biosolids. Also, site operators should have a working knowledge of federal and Texas Natural Resource Conservation Commission (TNRCC) regulations (under 30 TAC Section 312) that apply to the project under consideration.

Site Selection

Site selection is a two-step process. The first step is to identify potential sites by review of all available information, including knowledge of local conditions. The second step involves detailed investigation of the potential sites and selection of an environmentally and economically sound site. The objective of site investigation is to minimize the probability of off-site contamination via groundwater, surface water, or atmospheric emissions and the associated risk to the public and the environment.

Initial Screening

The initial screening process involves obtaining an estimate of the land area required, identifying potential sites, and conducting a preliminary review that eliminates sites unsuitable due to physical, environmental, social, or political conditions. The number of potential sites depends upon local conditions, quality of biosolids being used, and the method of application.

Estimation of Land Area Required. An initial estimate of the area required for land application is obtained by dividing the total quantity of sludge by an assumed application rate. This will provide an estimate of total acreage needed. Initial values of 5 to 10 dry tons/acre/year can be considered as estimates for forested and agricultural lands. These numbers can be modified during later stages of the design process, when other site-specific factors have been determined.

Potential Site Identification. After estimation of total acreage required, potentially available land areas within a radius of approximately 30 miles of the treatment plant should be targeted, including crop lands, forests, parks, golf courses, strip-mined areas, and other arable lands. Once the potentially available land areas are located, consulting with local experts—such as the Natural Resources Conservation Service (NRCS) technicians, County Agriculture (Ag) Extension agents, private agronomists and agribusiness owners—can provide valuable information about agronomic and other conditions at potential sites. These experts will have knowledge about the area surrounding potential sites, including the condition and use of public roadways leading to sites.

Preliminary Review. Not all available land will be ideally suited for application of biosolids because of site characteristics. The technical characteristics can be reviewed before field investigation is required. Several excellent resources are available to help in this review. The majority of counties in Texas have a published soil survey, which can be found in local NRCS offices, County Ag Extension offices, and public libraries. Soil surveys can provide screening of potentially unsuitable areas, such as steep areas having sharp relief and slopes greater than 8 percent; soils with less than two feet of depth; perched or shallow water tables; and soils of high permeability. The soil surveys contain detailed information about soils and soil horizons including depth to bedrock, infiltration rates, soil pH ranges, slopes in the terrain, potential productivity, and plant communities typically found at individual sites. The list of potential sites can be narrowed down to those deserving field investigation.

After the potential sites are identified, ownership should be determined. The county courthouse, city hall, county recorder, title insurance company, or a real estate broker are often useful resources for property ownership, size of tracts, and related information. Once the landowners of the potential sites are located, they should be contacted to discuss information about the program's potential benefits and constraints.

In this issue...

continued

Detailed Technical Investigation

Once it has been established that enough suitable land is available, then a detailed investigation identifies the best sites based on socio-geographic factors (land use, local ordinances, aesthetics, etc.) and technical factors (climatology, topography, soils, etc.). Limiting criteria can be set for each factor with the understanding that they would be reexamined if excessive amounts of land were excluded from consideration.

Current Land Use. Knowledge of current land use patterns in an area indicates how much land is potentially suitable and/or available for land application. However, an area almost exclusively devoted to production of human food crops restricts the periods when biosolids can be applied to the land (refer to 30 TAC §312.82 (b) (3) (A)-(F)). Application of biosolids may restrict public access for a period of time (refer to 30 TAC §312.82 (b) (3) (G)-(H)). Areas with hay crops, pastures, small grains, and row crops make it possible to apply biosolids throughout much of the year.

Ag Extension Service bulletins in county Ag Extension offices report the results of demonstrations conducted with farmers and ranchers in the local area. These bulletins contain information about varieties and yields of crops that are suited to local conditions. (The term "local conditions" encompasses more than soils and climates; it also includes availability of markets, harvesting equipment, transport, and supplies necessary to produce crops economically.) The County Ag Extension Agent can interpret the results of soil tests, help in selecting crops that most efficiently use the nutrients supplied by biosolids, and calculate the agronomic loading rate that meets the nutrient requirements of the selected crop.

Future Land Use. Projected land use plans, where they exist, may also eliminate certain areas from consideration for biosolids application. If the site is located near a densely populated area or in a residential/commercial development area, extensive application control measures are suggested to overcome concerns and minimize potential aesthetic problems.

Regional planners and planning commissions should be consulted early in the process to determine the future use of the potential land application sites and adjacent properties. Often a real estate broker will have community or area-wide maps indicating the tract of land, present owners, and property boundaries. The county recorder or title insurance company is another useful source of information on property ownership, size of tracts, and related information.

Zoning Compliance. Local ordinances will affect the placement and operation of the land application system. The major ordinances affecting beneficial land use include those dealing with the public roads, public health, and nuisances. It is important to give an opportunity to any interested citizen(s) to participate in planning the beneficial land use program. The more the public participation, the easier it is for the public to understand and accept beneficial land use programs. Community concern over aesthetics such as odor, fugitive dust, and noise is a key factor in the site selection (refer to 30 TAC §312.44 (k)). Disruption of local scenic recreational facilities, environmentally sensitive areas, historic landmarks, and similar places (refer to 30 TAC §312.44 (a)) may generate a strong local opposition to a biosolids management program. The community concern over unsightly appearance can be allayed (1) by minimizing deposition of solids on vegetation and surface ponding of water, and (2) by regular harvesting and removal of the cover crop.

Buffer Zones. Buffer zones (refer to 30 TAC §312.44 (d)) are required around land application sites to provide a set-back from residences, water supplies, surface waters, roads, parks, playgrounds, etc. The zones can be increased by site operators to mitigate concerns and gain acceptance by adjacent property owners. The buffer zones can also be reduced or eliminated if–

- ▲ an agreement to that effect is signed by the owner(s) of the established institution, business, occupied residences, or adjacent property; and
- ▲ this documentation is provided to the Executive Director of the TNRCC before issuance of the registration.

Climate. Climate strongly affects the overall feasibility as well as the ultimate design of a land application system. Climate affects the timing of biosolids applications, run-off intensity, groundwater recharge, and maintenance of soil pH. Temperature affects organic waste decomposition and growth and development of vegetative cover. Factors such as humidity, air velocity, temperature, and the amount of rainfall control the rate of evaporation of free water from soil surfaces. The greater the natural precipitation, the less the adsorptive capacity of a land application system. For cases where application rates are governed by nitrogen uptake rates, a limited growing season will require long periods of storage or alternative methods of winter disposal. Storage considerations must also include periods of inclement weather and frozen ground when biosolids cannot be applied (refer to 30 TAC §312.44 (b) and (i) (3&6)).

Climatic data for most locations in the U.S. can be obtained from the various publications of the National Oceanic and Atmospheric Administration (NOAA) and are available in monthly and 10-year summaries. Federal Emergency Management Administration (FEMA) maps containing information about the location of floodplains can be found through the assistance of Ag Extension and NRCS offices.

Topography. Topography influences surface and subsurface water movement, the extent of contact between biosolids and soil particles, soil formation processes, and soil erosion. Slope characteristics such as steepness, length, and shape are important factors in determining the amount of runoff and erosion. Erosion is minimal on flat surfaces, but with increasing slope the potential for erosion increases. Generally, gentle slopes have less runoff than steep ones, especially for permeable soils. Rapid surface runoff accompanied by soil erosion can remove soil-biosolids mixtures and transport them to surface waters. Regardless of slope, conservation practices such as reduced tillage systems, terraces, strip cropping, and retention of crop residues on the soil surface wherever possible will minimize runoff from biosolids-amended soils.

Drainage. Two general landscape drainage systems exist: the open and the closed system. The open drainage system of most humid and subhumid areas permits the movement of sediment and soluble material from a given site to the watercourse and then to the major sediment loads in streams and rivers. The use of vegetated buffer zones will minimize the loss of nutrients from the sites.

By contrast, in the closed drainage system of some arid and semiarid areas, essentially all rainfall and nutrients within the basin are trapped in the system and are not transmitted to major streams. Excess water is ponded and then evaporates or percolates through the soils. These systems generally contribute little to the movement of nutrients outside their perimeter. A closed or a modified closed drainage system, with slopes less than 4 to 6 percent, is preferred. Steeper gradients may be acceptable where management application methods reduce erosion hazards (refer to 30 TAC §312.44 (i) (4)). Slope data may also be obtained from United States Geological Survey (USGS) topographic maps. In flat areas these maps are plotted with one-foot contour intervals. The U.S. Soil Conservation Service soil surveys also delineate soils by slope.

Soil Texture, Permeability, and Infiltration. On land used for biosolids applications, the soil functions as a natural filter and as a medium for the biological and chemical reactions that recycle nutrients in the

biosolids. The suitability of a site is a function of the physical, chemical, and mineralogical constituents of the soil. Soil texture is one of the most important aspects of site selection because it influences infiltration rate, subsoil percolation rate, moisture holding capacity, and adsorption reactions for trace elements. Medium textured soils, ranging from sandy loams to silty clay loams, are generally suitable for biosolids application. Coarse textured soils such as sands and gravel can accept large quantities of water without runoff, but nutrient holding capabilities are often low.

In most soils the clay fraction represents only about 10 to 40 percent of the total soil. However, clays are plate shaped and have a relatively large surface area. These characteristics, along with organic matter, control most of the physical and chemical reactions in the soil. Clays, being electrically charged particles, have structures and properties that permit their large surface areas to hold nutrients and heavy metals. Nitrogen in the form of nitrate, on the other hand, is not held to these surfaces and is highly mobile. However, proper site management practices would allow plants to uptake nitrates and help prevent leaching of nitrates into groundwater. Soil reactions near neutral (pH values 6.5-7.5) are important for the immobilization of heavy metals and phosphates that occur in biosolids. Soils with low pHs (<5.5) must be amended with lime prior to applications of biosolids to raise pH.

Fine textured soils transmit water slowly. Even though they have the same volume of pore space as coarse textured soils, pores in fine textured soils are very small. When evaluating a site for biosolids application on fine textured soil, infiltration rate and permeability should be considered carefully. Failure to achieve rapid infiltration could result in surface ponding and temporary anaerobic conditions, increasing the risk of odors.

In contrast to fine textured soils, coarse textured soils have many large interconnecting pores, which allow water to move rapidly through the soil. Unless the coarse textured material is underlain by a finer textured zone, water carrying suspended soluble components from biosolids and wastewater can move downward to groundwater and may cause contamination of a public or private water supply. Infiltration and permeability rates tend to increase with increased organic matter content. Organic matter improves soil aggregation and porosity and allows water to be transmitted more rapidly. In addition, organic matter in the surface of soils helps prevent crusting, particularly in silty soils. Biotic factors, such as burrowing by insects and animals or old root channels in recently cleared forests, permit water and potential pollutants to move rapidly through the surface soil.

Soil survey reports represent the general information available on soils, but soils at a proposed site may have somewhat different characteristics. Therefore, it is recommended that a detailed field investigation be made of the soils found at the site. Once again local experts—such as the Natural Resources Conservation Service (NRCS) Technician, County Agriculture (Ag) Extension Agent, and private agronomists and agribusiness owners—can provide assistance with collecting soil samples, selecting soil testing laboratories, locating sources for maps, and completing technical information in the TNRCC site registration application. These sources are familiar with using soil sampling tools and processing samples for shipment to the lab and can help calculate acreage from maps, complete soil data tables, and draw and label sites on the required USGS Topographic Maps.

Groundwater and Surface Water Constraints. The movement of water into and through groundwater depends on local and regional geology. Bedrock characteristics can influence the direction and speed of groundwater movement and determine whether a pollutant might be carried long distances with minimal biological or chemical renovation. For example, limestone bedrock can be interlaced with a complex pattern of relatively open fractures and solution channels that act as open pipelines.

Evaluation of hydrogeologic conditions associated with a specific site should include consideration of the following:

- depth to the water table,
- distance to surface waters (refer to 30 TAC §312.44 (c)),
- seasonal water table fluctuations,
- groundwater velocity and direction of travel,
- present and potential use of groundwater and surface water bodies,
- existing surface and groundwater quality,
- interrelationship between bodies of groundwater and surface water, and
- ecology of surface water bodies.

The number, size, and nature of surface water bodies on or near a potential biosolids application site are significant factors in site selection due to potential contamination from site runoff and/or flood events.

Final Site Selection

Since modes of transportation and distances are important to the economics of biosolids utilization, it is desirable to choose sites as close as practical to the biosolids generator. After excluding unsuitable sites, remaining ones can be evaluated on the basis of the following criteria:

- Total farm acreage available on each farm and types of crops historically grown.
- Public acceptance of both the option(s) and site(s) selected.
- Anticipated design life, based on assumed application rate, land availability, and projected heavy metal loading rates.
- Prevailing soil types present and their suitability for biosolids additions, field slopes, and general site topography.
- Proximity of the site to an established school, institution, business, occupied residential structure, or public right of way.
- Proximity of the site to—an irrigation conveyance canal, solution channel, sinkhole, or other conduit to groundwater; a public or private water supply well; the intake of a public water supply, spring, or similar source; a public water supply treatment plant; or a public water supply elevated or ground storage tank.
- Prevailing wind direction for minimization of odor complaints.

Site Acquisition

Site acquisition represents the most critical step in the implementation of a land application project. Application of biosolids to agricultural land can usually be accomplished without direct purchase or lease acquisition of land. Well-prepared programs for public education and participation early in the planning stages normally identify numerous farmers willing to cooperate with the biosolids generators in a land application program.

A written contract between the landowner and the biosolids applicator is recommended. The principal advantage of a written contract is to ensure that both parties understand the agreement before applying the biosolids. Often oral contracts are entered into with the best of intentions, but the landowner and applicator have different notions of the rights and obligations of each party. In some cases the contract may serve as evidence in disputes about the performance of either the applicator or the landowner.

Common Contract Types. There are various types of contractual agreements between biosolids producers and landowners. Broadly speaking they fall into two general categories: (1) outright purchase of land, which

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gives the generator direct control over the quantity and frequency of biosolids application as well as the crops grown on the land; and (2) lease of the land, in which the farmer has control over land use. The most common contractual agreements between biosolids generators and farmers contain one of the following provisions:

- ▲ the generator transports and spreads the biosolids at no expense to the farmer;
- ▲ the generator not only transports and spreads the biosolids but also pays the farmer a nominal sum per load, usually when the sites are close to the treatment facility; or
- ▲ the farmer pays a nominal fee to the generator when the biosolids are of good quality and there is a local demand for them.

Disturbed and forested lands may be available for land application of biosolids without purchase or leasing.

Summary of Ideal Site Conditions

In summary, the ideal site conforms to the following conditions:

- ▲ 750 feet from an established school, institution, business, or occupied residential structure;
- ▲ 200 feet from a solution channel, sinkhole, or other conduit to groundwater;
- ▲ 500 feet from a public water supply well, 150 feet from a private water supply well, and 10 feet from an irrigation conveyance canal;
- ▲ minimal slope (less than 8 percent);
- ▲ deep, fertile, moderately well-drained soil with a neutral to slightly alkaline pH;
- ▲ flat, open, and easily accessible from dependable public roads; and
- ▲ managed intensively to produce high crop yields and recycle large amounts of biosolids.

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For more information about land application of biosolids, please contact the Sludge and Transporter Review Team at (512) 239-4710.

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