San Luis Obispo County
Los Osos Wastewater Project Development

TECHNICAL MEMORANDUM

SOLIDS HANDLING OPTIONS

FINAL
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1.0 INTRODUCTION

The purpose of this technical memorandum (TM) is to evaluate solids handling options for the proposed Los Osos Wastewater Treatment Facility (WWTP), as discussed in the Viable Project Alternatives Fine Screening Analysis (Carollo Engineers, August 2007). This TM is intended to provide further information on potential solids handling options in order to support the Environmental Impact Review Process and to further aid decision analysis.

Previous studies have evaluated different collection systems and treatment trains for the Los Osos WWTP. In the Fine Screening Analysis, the average solids loading for different liquids treatment processes were reported as 4,000 lbs dry solids/day for a gravity collection system and 1,000 lbs dry solids/day for a septic tank effluent pumping/gravity (STEP/STEG) system. A TM to examine septage receiving alternatives was prepared in conjunction with this TM. The septage receiving alternatives combined with the different liquids treatment processes yield multiple solids estimates, ranging from 570 to 5,400 dry lbs/day of solids to be treated. For comparison purposes across a range of potential estimates, only the two average loads from the Fine Screenings Analysis were developed in this TM. These are intended to represent typical small and typical large scenarios sufficient for comparison of solids handling options.

2.0 REGULATORY ISSUES

The Rough Screening Analysis Report (Carollo, March 2007) provided a detailed description of the regulatory issues affecting biosolids. A summary of these regulatory issues are presented here to aid the analysis and to highlight potential constraints regarding metals content.

Biosolids must comply with all requirements of the Federal 40 CFR 503 regulations and either site-specific waste discharge requirements or the California General Order to be land applied. Local ordinances also affect biosolids land application, and local agencies such as environmental health, planning, or public works may have discretionary authority to regulate a project. Solids handling processes are also subject to federal, state, and local air emissions controls.

2.1 Federal Regulations

Various technologies are used to treat sewage sludge to meet EPA's 503 requirements for "superior" quality Class A or "good" quality Class B biosolids standards. With class-dependent restrictions, biosolids may be land applied to agricultural lands, forests, public contact sites, and reclamation sites. By offsetting treatment requirements (such as digestion or chemical treatment) with application restrictions (such as crop harvesting and site access limitation), Class A and Class B standards are designed to be equally protective of human health and the environment. Public perception and/or biosolids reuse, however, are major drivers for higher levels of treatment.

Biosolids are regulated by pollutant limits and class-specific pathogen and vector attraction reduction requirements. Pathogen reduction is defined as the reduction of disease-causing organisms, including certain bacteria, protozoa, viruses and viable helminth ova. The following sections summarize the regulations pertaining to the two classes of pathogen reduction.

2.1.1 Class A

Class A biosolids are subject to a stricter pathogen reduction standard and less stringent land application requirements and management practices than Class B. This class is typically attained through use of a Process to Further Reduce Pathogens (PFRP). Class A biosolids have varying degrees of public acceptance based on the final form they take. Ranging from humus-like compost to lime-treated sludge, the various forms can differ both in appearance and potential odor emissions.

Biosolids that meet the Class A standards and have concentrations of metals lower than the most stringent limits are called Exceptional Quality (EQ) biosolids. While not defined by regulations, EQ biosolids that take a form more acceptable to the general public such as compost or pellets are called “biosolids products.” These products are used in a wider variety of applications including bulk and bagged commercial and residential landscaping.

There are six alternatives to meet pathogen reduction requirements for Class A biosolids as described in 40 CFR Part 503.32. All six alternatives described in Part 503.32 require that either a specific process be used or testing be conducted to ensure adequate disinfection. The alternatives are summarized in Table 1. Vector attraction reduction requirements must also be met, however they are addressed separately in Part 503.33.

PFRPs are defined by the Appendix of the 503 sludge regulations and include the following processes that will be discussed herein for the project:

- Digestion.
- Drying.
- Composting.

If properly managed, the biosolids treatment listed above meet all regulatory requirements for pathogens (fecal coliform or Salmonella sp. bacteria and enteric viruses and viable helminth ova). However, some alternatives meet the requirements because of the process used, and involve minimal testing. The “Other Processes” and “Unknown Processes”

Table 1	Alternatives for Class A Pathogen Reduction Los Osos Wastewater Project Development San Luis Obispo County
Alternative	**Description**
Thermal treatment processes.	Biosolids must be subjected to one of four time-temperature regimes.
High pH, high temperature processes.	Biosolids must meet specific pH, time, temperature, and air-drying requirements.
Other processes.	Process must reduce enteric viruses and viable helminth ova, and maintain operating conditions used to obtain the reduction.
Unknown processes.	Biosolids are tested for pathogens at the time of use or disposal or in preparation for use or disposal.
PFRP processes.	Biosolids are treated using one of seven listed Processes to Further Reduce Pathogens.
Equivalent PFRP processes.	Biosolids are treated in an accepted process that is equivalent to a PFRP.

require testing of each batch of biosolids for pathogens, which is an expensive and time-consuming process.

2.1.2 Class B

Class B biosolids can be produced through any of the defined Processes to Significantly Reduce Pathogens (PSRP). Facilities are responsible for self-monitoring and record-keeping with respect to quantity and quality of the sludge processed and biosolids produced. Sludge quality parameters include inorganic pollutants, pathogen reduction, and vector attraction reduction requirements. In addition to pollutant loading restrictions, land application restrictions for Class B biosolids apply to the timing of application with regard to public contact, animal forage, and production of crops for human consumption.

In addition to pathogen reduction requirements, a vector attraction reduction “option” must also be implemented. Vector attraction is the characteristic of sewage sludge that attracts rodents, birds, flies, mosquitoes, or other organisms capable of transporting infectious agents such as pathogens. There are several ways to reduce vector attraction: 1) the sludge is treated to reduce the volatile material by digestion or composting; 2) the sludge is stabilized with chemical addition usually by lime; or 3) the sludge is stored/disposed in a manner that reduces or prevents contact with vectors, such as incorporating the sludge into the soil soon after application.

2.2 State Regulations

2.2.1 General Order

The California ruling "General Waste Discharge Requirements for the Discharge of Biosolids to Land for Use as a Soil Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities (General Order)" supplements the EPA Part 503 rule with additional requirements for handling and application. The General Order does not apply to operations applying less than ten dry tons of Class A biosolids per acre per year. Most significantly, the General Order stipulates that:

- The application of Class B biosolids containing a moisture content of less than 50 percent is prohibited.
- Biosolids less than 75 percent moisture shall not be applied during periods when the surface wind speed exceeds 25 miles per hour as determined by the nearest calibrated regional weather station.
- Biosolids application projects less than 40 acres are deemed Non-Chapter 15 WDRs with a Category III threat to water quality rating and a Category b complexity rating. Biosolids projects consisting of more than 40 acres are deemed a Category II threat and Category b complexity rating.
- To obtain coverage under the General Order, a notice of intent and appropriate fee must be submitted to the RWQCB. A single permit cannot cover more than 2,000 net acres available for application. In other words, a facility of greater than 2,000 acres would need to be permitted as multiple reuse projects.
- Sites will be assessed for nitrate contamination.
- Long-term storage will need to be permitted separately.
- Irrigation water runoff is prohibited for 30 days after application if vegetation in the application area and along the path of runoff does not provide 33 feet of unmowed grass or similar vegetation to prevent the movement of biosolids from the application site.
- Biosolids shall not be applied in amounts exceeding the Risk Assessment Acceptable Soil Concentration.
- All biosolids shall be transported in covered vehicles capable of containing the designated load.
- The discharge shall avoid the use of haul routes near residential land uses to the extent possible.

2.2.2 AB 939

The California State Assembly Bill 939 mandates a phased reduction in waste sent to landfills. For many jurisdictions, the need to show reduction in waste sent to landfills often drives WWTPs to strive for "diversion credits," which they earn when they show a beneficial use of their biosolids (thereby diverting from the landfill). In the CIWMB database, San Luis Obispo County data last updated in 1999 shows sewage solids as comprising 0.0 percent of a total tonnage of 160,000 per year of landfilled commercial waste. This number would increase if the Los Osos WWTP were to send biosolids to the landfill, but the biosolids sent would be a very low percentage of the county's total waste. Therefore, mandates or credits stemming from AB 939 will not likely drive the decision to landfill or reuse biosolids.

2.3 Local Regulations

Many counties in California have recently developed or are currently developing ordinances for biosolids land application. The counties whose regulations could have a significant impact on the project are San Luis Obispo County, Monterey County, Santa Barbara County, Ventura County, Kings County, and Kern County. Of these, only Kern County has implemented a complete ban of all biosolids land application as of this date.

San Luis Obispo County has an ordinance that only allows Class A - Exceptional Quality biosolids to be land-applied and limits total biosolids application to land to no greater than 1,500 cubic yards per year. Santa Barbara County does not currently have an ordinance regulating biosolids, but it also does not have any large scale land application. Similar to Santa Barbara County, Ventura County does not currently have an ordinance regulating biosolids, but it also does not have any large scale land application. The Ventura Regional Sanitation District is proposing a dryer at their landfill, but they will likely limit its users to Ventura County agencies. Kings County adopted an ordinance that banned Class B land application in 2003 and only allows Class A EQ composted biosolids to be land applied as of the beginning of 2006.

2.4 Air Quality

Air quality is also a key concern in San Luis Obispo County and is highly regulated. Biosolids drying or composting technologies installed at the Los Osos WWTP may need to be permitted and to use Best Available Control Technology (BACT). A new air quality permit would need to be obtained for a waste gas flare in any scenarios using anaerobic digestion.

3.0 DISPOSAL/END USE OPTIONS

The following section recapitulates end use alternatives for the Los Osos WWTP biosolids as described in previous planning reports and identifies reuse potential feasibility constraints independent of processing technology.

3.1 Disposal

As discussed in the Rough Screening Analysis Report (2007), nearby landfills that may accept the biosolids include the Cold Canyon and Chicago Grade Landfills. Cold Canyon would require that the biosolids be dewatered to at least 50 percent total solids. Biosolids may be placed in a landfill as cover material for beneficial reuse or as strict disposal. Landfilling of biosolids is often a backup alternative to land application, typically during the wet season. Requirements for biosolids placed in a landfill depend on the intended reuse or disposal.

3.1.1 Cover Material

According to California Integrated Waste Management Board (CIWMB) regulations, biosolids may be reused as an alternative daily cover material, provided the biosolids meet the performance standards for cover material. This use, however, cannot exceed 25 percent of the landfill cover material. Biosolids, either alone or blended with soil, processed green material, or stabilization agents (such as lime, lime kiln dust, or cement kiln dust), are acceptable, provided public contact with the biosolids is prohibited.

3.1.2 Co-disposal

Co-disposal occurs when biosolids are mixed with municipal solid waste and buried in a sanitary landfill. No attempt is made to reuse the nutrient content of the biosolids, and this method is strictly disposal as a waste product. Co-disposal is regulated in California by the CIWMB and local enforcement agencies. Biosolids containing less than 50 percent solids must be discharged to a lined Class III landfill or a Class II waste management unit.

3.1.3 Commercial Composting

Alternatively, the biosolids could be sent to a processing facility such as McCarthy Family Farms in Kings County. The solids can be received at sub - Class B condition and would be processed at the farm to Class A or B quality for land application.

3.2 Bulk/Bagged Distribution

Biosolids can be bulk distributed for land application or can be bagged for distribution to the local community if compliant with Class A Exceptional Quality requirements. Bagged distribution of the Los Osos Community's biosolids would require Los Osos to implement a process that would produce a marketable product. These products are used as a fertilizer or soil amendment in landscaping, parks, nurseries and home gardens. For example, the nearby Morro Bay-Cayucos Wastewater Treatment Plant gives the public bagged material made from treated biosolids generated from the treatment plant mixed with wood chips and green waste from the local community. The finished compost product must meet both Federal and State regulations and the San Luis Obispo Environmental Health Department regulations. The compost is tested after the composting process to ensure that it meets the

Federal and State standards for metals and pathogens and is tested annually for over 160 different constituents. The compost is marketed as a soil amendment, especially as a top dressing or mulch.

The Los Osos WWTP would need to address metals limits before deciding to produce bulk or bagged biosolids of Class B or Class A Exceptional Quality. Metals typically concentrate in septic tanks because they tend to partition and settle with solids. Because the WWTP may accept a sizeable fraction of septage in either the gravity collection or STEP/STEG system scenarios, metals concentrations could exceed those in the Pollutant Concentration limits established for the fewest restrictions on application. A small treatment plant in Quincy, California, recently found that septage receiving at just 0.5 percent of the total plant influent caused their metals concentrations in biosolids to exceed those allowable for Class A or Class B Pollutant Concentration limits. Another town for comparison is Santa Maria, California, who also receives septage but does not have any concerns with the metals concentrations in their biosolids. Santa Maria has a strict policy to only accept domestic septage. Given the residential nature of the Los Osos community, metals may not be a problem. Nevertheless, limited testing of local septage is recommended before decisions are made regarding biosolids reuse.

Table 2 shows ranges and design criteria typical for septage as determined by the USEPA. These are given in mg/L of septage, and the 503 regulation's Pollution Concentration limits are given as mg/kg dry, finished biosolids. These concentrations cannot be directly compared but are presented here for further consideration.

Table 2 Design Concentrations for Metals in Septic Tanks
Los Osos Wastewater Project Development
San Luis Obispo County

Constituent	EPA Design Value (1)		Pollutant Limits(2)
	Average (mg/L)	Range (mg/L)	Limit (mg/kg)
Copper	4.84	0.01 - 261	1,500
Lead	1.21	<0.025 - 118	300
Mercury	0.005	0.0001 - 0.742	17
Zinc	9.97	<0.001 - 444	2,800

Notes:

(1) From U.S. EPA, 1994. *Guide to Septage Treatment and Disposal*. EPA Office of Research and Development. Washington, D.C. EPA/625/R-94/002.

(2) From EPA Part 503 Rule for Pollutant Concentration Limits for EQ and PC Biosolids, given in mg pollutant/kg biosolids on a dry-weight basis, Table 3, Section 503.13.

4.0 DIGESTION

If the Los Osos WWTP were to incorporate digestion, the benefits would be to reduce the amount of biosolids, to produce a more marketable biosolids product, and/or to capture methane gas for the purpose of cogenerating electricity and heat.

The Fine Screenings Analysis Report identified aerobic digestion as the most suitable digestion technology for the project based on cost. Because aerobic digestion does not yield methane gas, however, conventional anaerobic digestion was evaluated in this study to determine the potential benefit of using digester gas.

4.1 Technology

Conventional mesophilic anaerobic digestion operates at a temperature range of 30 to 40 degrees C (35 degrees C optimum). This process presents the most versatility, provides better stability and offers reduced cost in the operation and maintenance of the digesters as compared to aerobic digestion. Additionally, the production of methane from the anaerobic digesters can provide the facility with the ability to recover energy in the form of co-generation or steam or hot water generation.

There are several drawbacks to anaerobic digestion that result in it rarely being implemented at plants smaller than 5 million gallons per day (mgd). The process requires comparatively higher operational control than aerobic digestion and requires a highly stable environment, meaning a consistent quantity and quality of solids. Anaerobic digestion is also typically not implemented at plants using extended aeration processes, such as the Biolac or oxidation ditch processes being considered for the Los Osos WWTP. This is because much of the “easy” digestion occurs during extended aeration, which reduces the methane production and overall benefit of the anaerobic digestion process. Like aerobic digestion, conventional anaerobic digestion does not provide the disinfection needed for Class A biosolids without extended residence times, which require excess digester volume.

Anaerobic digestion is a two step process. First, all of the solid organic matter present in the waste solids must be hydrolyzed (broken down into smaller organic molecules). These smaller organic molecules are known as volatile fatty acids. The second step, which is carried out by a separate population of microorganisms, is the conversion of the volatile fatty acids to methane and carbon dioxide.

Advanced digestion technologies involve separating the two digestion phases into two or more separate reactor vessels. One of the benefits of separating the digestion into acid-phase and methane-phase reactors is improved performance degrading solids that have had a long solids residence time (SRT) in upstream biological treatment processes, such as the Biolac or oxidation ditch processes being considered for the Los Osos WWTP. Drawbacks of separated digestion, however, include potentially increased cost, reliance on fossil fuels to flare the low-energy gas produced in the acid-phase digester, and increased operational complexity. For these reasons, conventional anaerobic digestion was assumed for this analysis.

4.2 Feasibility of Using Digester Gas

Table 3 shows the potential methane gas production for the two collection scenarios. The electricity produced was calculated assuming the gas was collected and burned by an internal combustion cogeneration engine that would produce heat for the digester and electricity for the treatment plant. Regardless of the beneficial use of the gas, a waste gas flare would need to be constructed capable of burning 100 percent of the gas production in the event of engine failure.

Table 3 Gas Production Estimates
Los Osos Wastewater Project Development
San Luis Obispo County

Parameter	Unit	4,000 dry lbs solids/day	1,000 dry lbs solids/day
Volatile solids	lb/day	2,800	700
Volatile solids destroyed	lb/day	1,400	350
Gas produced(1)	cubic feet/day	22,400	5,600
Heat value produced(2)	BTU/day	12,320,000	3,080,000
Electricity produced(3)	kWh/day	986	246
Solids remaining	lb/day	2,600	650

Notes:
(1) Estimated gas production based on 16 cubic feet gas/lb VS destroyed.
(2) Estimated heat value based on 550 BTU/cubic foot gas.
(3) Estimated electricity based on 12,500 kWh/BTU typical of smaller facilities.

The gas estimates result in electric production capacities of 41 and 10 kW for the two scenarios. Most engines manufactured specifically to use digester gas are not made for applications this small. Microturbines are an option, but these must operate at constant capacity and thus require installing expensive gas storage or wasting gas when it is produced in excess. Veolia North America manufacturers a 65 kW reciprocating engine/generator, one of the smaller engine options for digester gas applications. Because the Veolia 65 kW can be turned down or up as needed, it was assumed for cost purposes in this analysis.

4.3 Facility Footprint

Conventional anaerobic digesters are sized based upon volatile solids loading and SRT. Assuming a slow loading rate of 100 lb VS/10^3 cubic feet digester volume and an SRT of 15 days minimum, two digesters would be necessary with a volume of 28,000 cubic feet each for the 4,000 lbs/day scenario, and 7,000 cubic feet for the 1,000 lbs/day scenario.

These would allow for the minimum 15 days SRT with one digester out of service and up to 30 days SRT when both digesters are in service. These capacities do not include sufficient volume for Class A detention times. The digester for the 4,000 lbs/day scenario may have a base diameter of 37 feet and a height of 25 feet. The digester for 1,000 lbs/day scenario may have a base diameter of 20 feet and a height of 20 feet. The digesters, the required support facilities housing digester feed and mixing pumps and heat exchangers, the waste gas flare, and a concrete pad for the cogeneration system would likely require a footprint of 14,000 square feet for the 4,000 lbs/day scenario and 8,000 square feet for the 1,000 lbs/day scenario.

4.4 Visual Impacts

The visual impacts of anaerobic digestion are potentially the highest among alternatives being considered. As stated above, the digesters would have an approximate height of 25 feet each for the 4,000 lbs/day scenario and 20 feet each for the 1,000 lbs/day scenario. The waste gas flare for either scenario would be required to have a height of approximately 20 feet, or taller if required based upon air dispersion modeling. In total, the plant skyline would be increased with a digester, a digester building, a cogeneration building, and a waste gas flare.

4.5 Odor Impacts

An anaerobic digester waste gas flare would be permitted based on design rated heating capacity [in British thermal units (btu)/hour] and sulfur content. Air dispersion modeling would determine if the flare needed to be taller than the typical 20 feet height. A scrubber may be required before combustion if sulfur levels are too high. Anaerobic digesters typically cause odor complaints only when they are chemically imbalanced. Due to inevitable changes in loading and operational patterns, intermittent odor issues are likely.

4.6 Truck Traffic

Digestion would reduce the amount of solids that would need to be carried offsite by approximately 35 percent, based on 50 percent destruction of the volatile solids, which are estimated to comprise 70 percent of the total solids. Truck trips were calculated in the Fine Screening Report based on a typical biosolids hauling truck with 40,000 lbs (or 20 cubic yard) capacity. Given no solids treatment other than dewatering to approximately 18 percent total solids, four trips were assumed per week in the 4,000 lbs/day (gravity sewer) scenario, and one trip per week in the 1,000 lbs/day (STEP/STEG) scenario. Digestion could decrease those trips to 2.5 per week and 0.63 per week respectively.

4.7 Costs

Budgetary capital construction costs estimates for anaerobic digestion include for each scenario two digesters, a digester mixing building, mixing and heating equipment, a waste gas flare, fuel conditioning, and a reciprocal engine with heat recovery system. These costs are $6,000,000 for the 4,000 lbs/day scenario and $3,900,000 for the 1,000 lbs/day scenario. These costs include estimates for sitework, piping, and electrical wiring. Costs also include a 30 percent estimating contingency, 8 percent sales tax on material costs, which are assumed to be half of the construction costs, 12 percent for general conditions, and 15 percent for contractor overhead and profit. These are construction cost estimates only, and do not include permitting costs, CEQA costs, design costs, and other project implementation costs.

5.0 SLUDGE DRYING

Sludge drying is a process that dries solids and further reduces volatile solids content, potentially to Class A standards. Sludge drying could be used to produce a product for bulk/bagged distribution or for landfilling with significantly reduced volume. Previous studies addressed mechanical heat drying technology and eliminated it as an economically viable option, but the purpose of this memorandum is to extend considerations to environmental impacts and benefits.

Assuming that the sludge to be dried at the Los Osos WWTP has been mechanically dewatered to 18 percent solids and will be dried to 75 percent solids, 4,223 lbs of water must be evaporated for every 1,000 dry lbs solids treated. The thermal energy required to evaporate water is typically given at 1,800 BTU/lb. This equates to 2,775,000 MBTU/year for a heat dryer at a WWTP treating 1,000 lbs dry solids/day. Natural gas releases 0.117 lbs CO_2 for every 1,000 BTU burned. Neglecting inefficiency in the heat dryer, the CO_2 emissions amount to 162 tons/year.

As shown in Table 6 in Section 7.4, drying saves 3.28 tons CO_2/year in reduced truck trips versus dewatering alone for the 1,000 lbs/day scenario. The CO_2 measure of heat drying is therefore 162 tons CO_2/year spent versus 3.28 tons CO_2/year saved. This reflects a typical conclusion that absent a waste heat source from a nearby power plant or manufacturing facility, heat drying results in more CO_2 emissions per year than other solids handling alternatives.

Solar sludge drying, however, allows for reduced truck hauling with minimal fossil fuel expenditure. There have been advances in solar drying technologies that make this a feasible option.

5.1 Technology

Previously, the barriers to drying sludge in greenhouses were difficulty maintaining proper air circulation and difficulty keeping the sludge aerobic throughout its profile. Recent advances have been made in air circulation and odor control as well in automatic mixing. Specifically, newer manufacturers use automatic air control sensors and a robotic locomotive for continuously stirring the sludge.

In order to attain Class A quality with undigested sludge, the final dried product would need to have a minimum content of 90 percent total solids. This is possible in a solar greenhouse but creates dust problems incompatible with the National Fire Protection Association. With digested sludge, Class A quality can be attained with 75 percent solids. Therefore, the sludge drying option would likely be combined with digestion or would be dried to only Class B standards.

In the Solia™ sludge drying process by Kreuger, fans are used to continuously renew the air in the greenhouse. A mechanical windrow turner generates the material in windrows to improve moisture removal and to mix fresh sludge with the partly dried sludge, improving granulation. The sludge is arranged in windrows to enhance exothermic aerobic fermentation, which provides pathogen kill even in winter months.

5.2 Facility Footprint

A wet sludge storage silo is used for sludge equalization and to regulate feed rate to the greenhouses. This consists of a stainless steel silo with a bottom feed system into the progressive cavity feed pumps.

The greenhouse consists of a peripheral wall to protect the structure during sludge handling, and exterior panels of twin layer no-drip polycarbonate. The floor in the greenhouse consists of a concrete slab. Table 4 shows the footprint and general design criteria for a solar sludge drying system as configured by Kreuger. The 4,000 lbs/day scenario requires two adjacent greenhouse “bays”, whereas 1,000 lbs/day scenario only requires one.

5.3 Visual Impacts

As described above, the solar sludge drying system would consist of a wet sludge storage silo and a greenhouse, with one or two bays depending on the collection scenario. Because the greenhouses are architecturally similar to horticultural greenhouses, the visual impacts of this technology are similar to those of agricultural operations and are largely tied to the dimensions of the structure and the silo.

5.4 Odor Impacts

The greenhouse would foster aerobic degradation similar to that found in compost. Ammonia may be generated at levels of 10 to 150 parts per million (ppm), and volatile organic carbons may be generated at < 5ppm. Sulfur compounds would be almost absent at < 0.2 ppm. Additional odor control is an option provided by the manufacturer.

5.5 Truck Traffic

Drying would reduce the volume of solids significantly. Truck trips were calculated in the Fine Screening Report based on a typical biosolids hauling truck with 40,000 lbs (or 20

Table 4 Solar Sludge Drying Design Criteria
Los Osos Wastewater Project Development
San Luis Obispo County

Parameter	Unit	4,000 lbs/day (Gravity Collection System)	1,000 lbs/day (STEP/STEG System)
Initial Dryness	%	18	18
Final Dryness	%	75	75
Final Quantity of Dried Cake	lb/day	5,333	1,333
Mixer Operation Time	hours/day	15.7	2.8
Mixer Operation Time (Days/week)	days/week	7	7
Windrow Width	feet	6.6	6.6
Number of Windrows per Bay	number	6	6
Number of Bays	number	2	1
Total Number of Windrows	number	12	6
Bay Width	feet	49.4	49.4
Total Width	feet	98.8	49.4
Total Length Windrows	feet	3,433	858.3
Reserved Service Length	feet	26.2	26.2
Minimum Required Length	feet	312.3	169.3
Total Length	feet	324	180
Effective Area	square feet	28,271	7,068
Total Area	square feet	32,016	8,893

cubic yard) capacity. Given no solids treatment other than dewatering to approximately 18 percent total solids, four trips were assumed per week in the gravity sewer scenario and one trip per week in the STEP/STEG scenario. Drying to 75 percent solids content could decrease those trips to less than once per week and less than once per month, respectively.

5.6 Costs

Budgetary capital construction cost estimates for the solar drying system provided by Kreuger with the facilities and equipment described above are $3,400,000 for the 4,000 lbs/day scenario and $2,200,000 for the 1,000 lbs/day scenario. These costs include estimates for sitework, piping, and electrical wiring. Costs also include a 30 percent estimating contingency, 8 percent sales tax on material costs, which are assumed to be half of the construction costs, 12 percent for general conditions, and 15 percent for contractor overhead and profit. These are construction cost estimates only, and do not include permitting costs, CEQA costs, design costs, and other project implementation costs.

6.0 COMPOSTING

Compost will generally be rich in organic matter; meet state and federal health and safety standards; be free of weed seeds, odor, and foreign matter; be cured/mature; have a near neutral pH; be low in soluble salts; and have a moisture content of 50 percent or less.

A composting operation provides no volume reduction (volume actually increases due to the bulking amendment) but it does provide a potentially marketable end product. Biosolids compost products can be used in the following areas:

- Commercial resale.
- Roadbed fill.
- Roadside stabilization.
- Runoff control.
- Landfill cover.
- Land reclamation/Environmental remediation.
- Horticulture.
- Grounds keeping turf amendment.
- Golf courses/country clubs.
- Farm soil amendment.
- Parks and recreation.
- Residential landscaping.

6.1 Technology

Composting is a stabilization process normally performed after sewage sludge is dewatered and after subsequent mixing with a bulking agent, which raises the initial solids content of the mixture and provides a carbon source for the organisms and bulk porosity important for maintaining aerobic conditions. Bulking agents consist of wood shavings or other green waste, and their availability and cost are a significant part of composting feasibility. High temperatures achieved during the microbial decomposition reduce pathogenic organisms in the biosolids. When composting is complete, the compost material is typically screened to retrieve a portion of the bulking agent. If needed, the product then cures for several days and the resulting humus-like material can be used as a soil amendment.

Composting operations can meet either Class A or Class B pathogen reduction requirements dependent upon time and temperatures achieved during the process. In lieu of providing the required carbon source through the bulking agent, organic municipal solid waste, or green waste, has been successfully substituted to provide a percentage of the carbon source. When another waste is mixed with the sludge the combined process is known as co-composting.

There are three basic types of composting processes:

- Aerated static pile (ASP) composting.
- Windrow composting.
- In-vessel composting.

Of the different methods, in-vessel composting offers the most process and odor control. Given that the composting site has not been established, these features were assumed to be desirable and in-vessel composting was assumed for this analysis.

For in-vessel systems, biosolids and bulking agents are initially mixed before entering the reactor. The first stage, called primary composting, occurs in the enclosed containers. A certain quantity of feedstock is fed to the system daily, while an equal volume of finished compost is removed from the opposite end. Aerobic conditions are maintained by blowing or drawing air through the reactor and/or by mixing the biosolids to bring them in contact with air. A typical primary composting period is 25 days.

The second composting stage can occur in aerated static piles or windrows. For aerated static piles, aerobic conditions are maintained by blowing air through the pile, or drawing air into it, using a blower. This is done using a slotted floor installation or by building the pile on top of shredded material. For windrow composting aerobic conditions are maintained by turning or mixing the biosolids to bring them in contact with air. A typical secondary composting period is also 25 days.

6.2 Facility Footprint

For the 4,000 lbs/day scenario, the footprint for the primary composting stage with in-vessel systems is estimated to be 4,000 square feet. This would include seven SV Composter™ stationary in-vessel units, as provided by Engineered Compost Systems. This area is for the aeration system and vessels only. It does not include access area in front of the vessels. For the secondary composting stage, assuming covered or uncovered aerated static piles, approximately 5,600 square feet will be required. The total footprint including access for the 4,000 lbs/day scenario is estimated to be 20,000 square feet.

For the 1,000 lbs/day scenario, the footprint for primary composting is estimated to be 3,000 square feet. This would include seven CV Composter™ containerized in-vessel units, as provided by Engineered Compost Systems. Because the CV Composter™ vessels are explicitly configured for roll-off truck access, this area includes the access area in front of the vessels. For secondary composting, assuming covered or uncovered aerated static piles, approximately 2,000 square feet will be required. The total footprint including access for the 1,000 lbs/day scenario is estimated to be 10,000 square feet.

6.3 Visual Impacts

The visual impacts of composting would include, at a minimum, several enclosures and large areas of windrows or piles. While the tipping and mixing process could be housed inside a building with a biofilter for scrubbing process air, the likely scenario is the continuous visual presence of heavy duty front-loading and lifting vehicles.

6.4 Odor Impacts

Primary composting in-vessel allows for excellent odor and emissions control. Secondary composting could also be conducted in-vessel or with a covered aerated static pile. Smaller land requirements allow aerated static pile composting to be enclosed easier. Enclosing the pile would be beneficial because of the local climate and will also allow for an odor control system to minimize off-site odors.

6.5 Truck Traffic

Compost is unique among the options presented because it results in significantly increased volume. The impact of increased volume depends on how far it is hauled upon leaving the plant site, which ultimately depends on the end use and end users. If compost were to be hauled away in a similar manner as dewatered or dried biosolids (i.e., in bulk in 40,000 lb capacity trucks), it would require almost eight trips per week for the 4,000 lbs/day scenario and almost two trips per week for the1,000 lbs/day scenario.

6.6 Costs

Budgetary capital construction cost estimates for the composting equipment described above from Engineered Compost Systems are $2,800,000 for the 4,000 lbs/day scenario and $1,500,000 for the 1,000 lbs/day scenario. These estimates do not include enclosure for secondary composting, which may or may not be necessary. These estimates include ECS in-vessel composting system (vessels, aeration, aeration control and monitoring), leachate management design, heavy-duty compost mixer, biofiltration, process design, equipment start-up, operator training and ongoing technical support, as well as estimates for sitework, piping, and electrical wiring. Costs include a 30 percent estimating contingency, 8 percent sales tax on material costs, which are assumed to be half of the construction costs, 12 percent for general conditions, and 15 percent for contractor overhead and profit. These are construction cost estimates only, and do not include permitting costs, CEQA costs, design costs, and other project implementation costs.

The County could save significant costs if process control and odor concerns are not significant enough to warrant in-vessel primary composting.

7.0 SUMMARY

Decisions regarding solids handling are largely independent of other process decisions for the Los Osos WWTP. The decision for biosolids reuse or disposal should, however, be linked to septage receiving decisions, due to the potential impact of increased metals in the septage sludge on the quality of the biosolids and their ability to meet Pollutant Concentration Limits.

Biosolids disposal options for hauling off-site include landfill disposal or sending biosolids to another facility for further processing. All of the options presented in this TM could be compatible with hauling off-site, with the exception of composting. Digestion to Class B quality will reduce the amount of solids to be disposed and would likely allow for more reliable and less expensive disposal contracts. Solar drying would significantly reduce the amount of wet cake to be disposed but may be limited to 50 percent dryness to be compliant with landfill dust requirements. Composting would not be logical treatment for hauling off-site for disposal due to the increased bulk weight of composted biosolids.

Regarding options to produce biosolids for reuse via bulk or bagged distribution, anaerobic digestion alone would not produce Class A biosolids without extended residence times. Solar drying would not produce Class A biosolids without digestion as an upstream process. Composting would produce Class A biosolids as a stand-alone process but would rely on a continuous supply of a bulking agent, such as green waste.

7.1 Facility Footprint

Table 5 shows a summary of the estimated footprint for the three options. If Class A biosolids were desired, solar drying would be conducted in conjunction with digestion, but the footprint below indicates individual processes only.

Table 5 Facility Footprint Summary
Los Osos Wastewater Project Development
San Luis Obispo County

	4,000 lbs/day (Gravity Collection System)	1,000 lbs/day (STEP/STEG Collection System)
Digestion (square feet)	14,000	8,000
Solar Drying (square feet)	32,000	9,000
Composting (square feet)	20,000	10,000

7.2 Visual Impacts

The digestion process would likely have the largest impact on the skyline of the facility, because it requires not only the digester tanks (of 20 foot height minimum), but also one or two support buildings and a waste gas flare. The solar sludge drying option would have a visual appearance of a typical agricultural operation, with one or more greenhouses and a wet sludge silo. The composting option could have a varying visual effect, depending on the level of enclosure selected. Composting would likely have a low profile but visual impact due to the containers, piles, and constant presence of earth-moving equipment.

7.3 Odor Impacts

An anaerobic digester waste gas flare would be permitted based on design rated heating capacity (in btu/hour) and sulfur content. A scrubber may be required before combustion if sulfur levels are too high. Process variations would likely cause intermittent odor issues.

Solar sludge drying and composting would likely create similar odors. Varying degrees of odor control are available for either of these technologies, and their need would be a function of proximity to neighbors. With composting, enclosing the secondary aerated static piles would help to contain odors and would also protect against climate conditions.

7.4 Truck Traffic

Table 6 shows the summary of the number of truck trips required for each option. This summary does not address actual use of the end-product, as many unknowns exist as to market and distribution patterns for beneficial biosolids products. The actual end-uses would therefore create distinction not only in number of trips per week, which is strictly a function of end-product volume, but also distance traveled.

Table 6 Truck Traffic Summary
Los Osos Wastewater Project Development
San Luis Obispo County

Alternative	4,000 lbs/day Trips per week	4,000 lbs/day Total Annual CO_2 Emissions from Trucking (tons)(1)	1,000 lbs/day Trips per week	1,000 lbs/day Total Annual CO_2 Emissions from Trucking (tons)(1)
Dewatering only	4	16.3	1	4.1
Digestion	2.5	10.2	0.6	2.4
Solar Drying	1	4.1	0.2	0.82
Composting	8	32.7	2	8.2

Note:
(1) Emissions based on a baseline 40-mile round trip to Cold Canyon Landfill, truck fuel economy of 5.65 miles/gallon, and 22.2 lb CO_2/gallon diesel burned.

As another means of comparison, an estimate of the annual carbon dioxide (CO_2) loading from the truck traffic was made based on trips per week. This estimate relies on the assumption that the 40,000 lb load trucks run on diesel fuel and have a fuel economy of 5.65 miles to the gallon. A baseline distance of 40 miles round-trip was selected for comparison, but actual distance traveled will be different for each option depending on final end-use. This type of information is developed in further detail in the Greenhouse Gas Technical Memorandum.

7.5 Costs

Table 7 provides a summary of the budget-level capital construction cost estimates associated with each technology. As stated above, solar drying would be combined with digestion if Class A biosolids were desired. The values below indicate individual processes only. These are construction cost estimates only, and do not include permitting costs, CEQA costs, design costs, and other project implementation costs.

Table 7 Estimated Construction Costs Summary[1,2]
Los Osos Wastewater Project Development
San Luis Obispo County

	4,000 lbs/day (Gravity Collection System)	1,000 lbs/day (STEP/STEG Collection System)
Anaerobic Digestion	$6,000,000	$3,900,000
Solar Drying	$3,400,000	$2,200,000
Composting	$2,800,000	$1,500,000

Notes:

(1) Costs are based upon vendor quotes and engineering estimates developed March 2008.

(2) Total construction costs do not include design, construction management, and legal/administration costs.