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City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.12
BIOSOLIDS MANAGEMENT

FINAL DRAFT
December 2015

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City of Oxnard

Public Works Integrated Master Plan

WASTEWATER

PROJECT MEMORANDUM 3.12
BIOSOLIDS MANAGEMENT

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BIOSOLIDS MANAGEMENT

1.0 INTRODUCTION

The purpose of this project memorandum (PM) is to define and summarize the available solids end use and treatment alternatives that were considered as part of this Public Works Integrated Master Plan's (PWIMP's) analysis of solids disposal and beneficial use options. Options were considered to satisfy Scenario 2 (Energy Efficiency, as described in *PM 3.7.1-Wastewater System - Treatment Alternatives*), as well as the Oxnard Wastewater Treatment Plant (OWTP) and the City of Oxnard (City) goals. Scenario 2, defined in PM 3.7.1, focuses on incorporating projects that promote energy efficiency at the OWTP (e.g., introduction of FOG to the digesters and installation of photovoltaic cells on rooftops).

1.1 PMs Used for Reference

The alternatives outlined in this PM are made in concert with recommendations and analyses from other related PMs:

- PM 3.1 – Wastewater System – Background Summary.
- PM 3.5 – Wastewater System – Condition Assessment.
- PM 3.7.1 – Wastewater System – Treatment Alternatives.

2.0 BACKGROUND

The City of Oxnard owns and operates the OWTP and the associated wastewater collection system. The City provides wastewater treatment to Oxnard and several surrounding communities (see *PM 3.1 - Wastewater System - Background Summary* for details). The solids handling facilities at the OWTP currently consist of two gravity thickeners for primary sludge thickening, two dissolved air flotation thickeners (DAFTs) for waste activated sludge (WAS) thickening, three anaerobic digesters, and four belt filter presses (BFPs) for dewatering.

Sludge thickening processes concentrate solids and reduce the hydraulic load on downstream digesters, thereby minimizing required digestion volume. The main purpose of anaerobic digestion is to stabilize primary and secondary sludge, reducing pathogens, odors, and volatile solids. Because the digestion process reduces the mass of volatile solids in the sludge, the quantity of solids requiring dewatering and hauling is also reduced. Maximizing volatile solids destruction and minimizing solids loads on the dewatering and hauling operations are necessary to control associated operating costs. Anaerobic digestion also produces digester gas as a byproduct of the microbial processing of volatile solids.

This digester gas, which typically consists of approximately 60-percent methane can be cleaned and used for onsite cogeneration systems or other beneficial uses. The City currently operates their cogeneration system utilizing all of the onsite produced digester gas, in addition to some natural gas.

Anaerobically digested sludge is sent to the dewatering belt filter presses to increase solids concentration from 1 - 3 percent to 19 - 20 percent on average. Removing water reduces the volume of biosolids that must be hauled to the Toland Landfill in Ventura County for final disposal. The biosolids are either directly landfilled, or dried in a dryer to approximately 70 percent solids and used as alternative daily cover (ADC) at the landfill.

As shown in Table 1 (below) and described in *PM 3.5 - Wastewater - Condition Assessment*, the gravity thickeners, DAFTs, anaerobic digesters, and BFP structures and equipment are at or near the end of their useful life. Furthermore, regulations could potentially limit currently practiced solids disposal methods and certain land application options. For these reasons, the City is considering alternative solids management strategies that achieve long-term goals within the plant's available footprint.

Table 1 OWTP Solids Handling Equipment and Year of Installation
Public Works Integrated Master Plan
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Criteria	Equipment	Condition	Year Installed
Gravity Thickening (primary solids)	2 - 59-foot diameter thickeners; Polymer and ferric chloride system for thickening, thickened sludge pump station	3 - 5	2 GT – 1980
Dissolved Air Flotation (secondary solids thickening)	2 - 25-foot diameter thickeners; Polymer system for thickening	3 - 4	2 units - 1990
Anaerobic Digestion	3 digesters, 2 at 90-foot diameter and 1 at 110-foot diameter; Heat exchanger, mixer, recirculation pumps, fixed cover, gas collection system, digested sludge pumping	3 - 5	90-foot dia.– 1980 110-foot dia. – 1990
Belt Filter Press (Dewatering)	4 - 2.2-m units; Polymer system for sludge conditioning	3 - 5	4 BFPs – 1990
Cogeneration	3 - 500-kW generators; Waste heat recovery system	3 - 5	1980

Note:
(1) Source: OWTP (WW-1), Operation and Maintenance Manuals (WW-7 to WW-12), and comments from Mark Moise.

As described in *PM 3.5 - Wastewater - Condition Assessment*, the condition of each asset was evaluated on a one-through-five ranking scale, based on the International

Infrastructure Management Manual (IIMM). In the IIMM, condition is expressed in terms of the amount of repair needed to bring an asset to “like new” condition. The definitions for the one-through-five condition ranking system from the IIMM are presented in Table 2.

Table 2 Asset Condition Ranking
Public Works Integrated Master Plan
City of Oxnard

Score(1)	Description(1)	Required Rehabilitation Percentage(1,2)
1	Very Good	0%
2	Good	1-10%
3	Fair	11-20%
4	Poor	21-50%
5	Very Poor	>50%

Notes:
(1) Adapted from the International Infrastructure Management Manual.
(2) Percentage of asset requiring rehabilitation: The percentage of the asset value needed to return the asset to a condition ranking of one.

In addition to the OWTP's goals stated in *PM 3.7.1 - Wastewater System - Treatment Alternatives*, the City has a Sustainability mission:

> *“To develop policies and programs that nurture a balanced connection between natural resource conservation, economic vitality, and a quality of life that meets the needs of current and future residents of the City of Oxnard*.”

This mission is supported by the Community Energy Action Plan (EAP), which provides a road map for enhancing energy efficiency throughout the City's residential, commercial, and industrial communities. As part of the EAP, the City has decided to participate in Southern California Edison's (SCE) Energy Leader Partnership (ELP) Program and pursue the “Gold Level” which targets a 10 percent kWh reduction for City Government facilities.

A 10 percent kWh reduction target would significantly help the City achieve California Air Resources Board’s (CARB’s) recommended 15 percent reduction in *community* greenhouse gas (GHG) emissions for all sectors combined. As part of the Oxnard Climate Action and Adaptation Plan, the City intends to examine all sectors for community GHG reduction opportunities, including land use, transportation, vehicle miles traveled, local generation and use of alternative energy, and solid waste management. The EAP identified the OWTP as the City's largest power consumer in 2010, and targeted the plant for a reduction in power consumption. The EAP called for the OWTP and MRFs to increase on-site electricity generation by 2020, offsetting purchased electricity.

Another major goal of the City is diversion of materials going to the landfill, in order to meet current and future Assembly Bills (AB) 939 and 341 and other diversion-related requirements. The City is also considering a compressed natural gas (CNG) fueling station for City vehicles, which would be fueled by biogas generated at landfills or the OWTP.

3.0 OPTIONS FOR SOLIDS END USE OR DISPOSAL

Biosolids contain nitrogen, phosphorous, micronutrients and energy that can be harnessed through various processes and end uses. Currently, dewatered cake is hauled for disposal at the landfill, so there is no recovery of these resources. The PWIMP will compare disposal options and more beneficial use alternatives relative to resource recovery objectives and compliance with existing and potential future regulations. Options for beneficial use of the solids depend on material quality, solids treatment, and management methods relative to the Code of Federal Regulations Title 40 Chapter I Subchapter O Part 503 (40 CFR 503) and California's General Order (GO). See *PM 3.1 - Wastewater System - Background Summary* for a more detailed description of 40 CFR 503 requirements.

The level of treatment the solids require will ultimately be based on the selected end use alternative. The end use options considered for the City of Oxnard are summarized in Table 3 and include:

- Landfill Disposal: Direct landfill of solids, use of biosolids as an alternative daily cover (ADC), or ash disposal resulting from thermal conversion of solids (either by fluidized bed incineration, gasification, or pyrolysis).
- Land application of biosolids meeting Class A or Class B requirements under 40 CFR 503.
- Production of marketable products from biosolids.
- Exporting solids to an off-site, regional solids processing facility and/or facility operated via public-private partnership (PPP).

Table 3 Comparison of End Use and Disposal Options
Public Works Integrated Master Plan
City of Oxnard

Option	Estimated Remaining Life	Reason	Issue/Driver
Landfill Disposal			
Direct Disposal ADC Ash	Uncertain Uncertain Indefinite	Organics & GHGs Organics & GHGs Small volume, no organics	CalRecycle plans to eliminate organics from landfills
Land Application			
Class B Class A	Uncertain Indefinite with successful marketing	Perception is poor quality for Class B, less so for Class A	Counties implementing bans; Limited sites in proximity to the plant

Table 3	Comparison of End Use and Disposal Options Public Works Integrated Master Plan City of Oxnard		
Option	**Estimated Remaining Life**	**Reason**	**Issue/Driver**
Marketable Products			
Compost Dried Biosolids	Indefinite with successful marketing	Growing demand for local compost & fertilizer	Local, sustainable, phosphorous need
Other Opportunities			
Regional Solids Processing Facility	Indefinite	Planned as long term	Diversification
PPP	Indefinite	Planned as long term	Diversification

While impossible to know exactly what will change in the future, there is regulatory pressure to divert organics from landfills. This may result in further restrictions on direct disposal of biosolids in landfills or using them as ADC. Hence, it appears that these options may not be viable long-term. Landfill disposal of inorganic ash is less problematic due to its relatively small volume and elimination of organics.

There is considerable public opposition to land application of Class B solids in California. The numerous injunctions throughout the state that restrict or prohibit Class B land application threaten this option for beneficial use within California. Many agencies in Southern California contract with haulers that transport Class B solids to nearby states for land application because this practice is still accepted in Arizona, the Midwest, and many other states.

Land application of Class A products is generally more acceptable to the public and has a more positive outlook in California. There are a few counties that have restricted all land application of biosolids, regardless of Class. Outside of those counties, land application of Class A solids is typically acceptable due to lower odors and higher levels of stabilization compared to Class B products.

Public perception of biosolids drives the viability of these end use alternatives and this perception can shift with time. Due to public pressure, biosolids-derived soil amendments cannot currently be used for cultivation of certified organic foods. On the other hand, wastewater agencies around the country have started successful public outreach and media relations programs that highlight the benefits of Class A biosolids-derived soil amendments. In those communities, branded soil amendments have been accepted by the public. Long term, reliable options for biosolids include collaborating with industry partners and developing marketable products in conjunction with efforts to educate the public and engage community stakeholders.

4.0 PROCESS ALTERNATIVES FOR SOLIDS TREATMENT

This section describes various solids treatment processes necessary to produce the end-use products summarized in Table 3. For the purposes of developing solids treatment alternatives, it is assumed that the solids treatment and handling operations (i.e., gravity thickeners, DAFTs, anaerobic digesters, and BFPs) will undergo repair and/or replacement to meet existing and anticipated future level of treatment requirements under Scenario 1 and satisfy wastewater treatment goal number one as described in *PM 3.7.1 - Wastewater System - Treatment Alternatives*. Projects to optimize operations and maintenance are included in Scenario 1 as are projects that adopt newer technologies in place of aging equipment (e.g., replacing gravity thickeners with co-thickening at the DAFTs and replacing the BFPs with centrifuges).

4.1 Baseline (Landfill, ADC, and Land Application)

The baseline consists of continuing existing solids treatment operations onsite. These processes allow for continued transport of biosolids to the Toland Landfill (where they are either added to the landfill or dried in an onsite dryer to be used as ADC) or land application of the biosolids as a Class B soil amendment.

This alternative would not improve (i.e., decrease) energy use onsite, but could offset energy consumed by others for the production of synthetic fertilizer if the Class B biosolids are land applied.

4.2 Thermal Drying

Thermal drying is a well-established solids treatment technology resulting in a Class A product. Thermal drying reduces the moisture content of biosolids using direct or indirect auxiliary heat to increase the evaporation rate. Either digested or undigested biosolids can be dried. While drying undigested solids leaves more of the fuel and fertilizer value in the dried product (pellet), there are greater public perception and odor issues as a result of the drying process and rewetting of the final product.

The most common energy sources to provide heat for thermal dryers are natural gas, digester gas, landfill gas, fuel oil, and waste heat from nearby combustion sources. There are two general categories for thermal drying: direct and indirect.

Direct drying uses forced convection to transfer heat to biosolids. This process involves circulating heated air over the biosolids, accelerating the evaporation process, and drying the biosolids. The exhaust gas is condensed to remove moisture and particulate matter. The resultant gas, along with odors, is typically combusted in a regenerative thermal oxidizer. Direct dryers are generally used in larger WWTPs. Direct dryer alternatives include rotary drum, fluidized beds, and belt dryers.

Indirect drying uses conduction to transfer heat to biosolids. This process involves contacting biosolids directly with a heated surface. Heat mediums, such as oil or steam, are used to heat surfaces that evaporate moisture from the biosolids. Exhaust vapors are condensed and typically drawn through an odor control system before direct discharge to atmosphere. Indirect dryers are typically used in smaller WWTPs. Indirect dryer alternatives include auger drying, disk paddle/screw drying, and multiple-stage tray drying.

In drying systems that produce pellets, such as rotary drums and multiple stage tray dryers, fines and oversized particles in the dried biosolids are screened. Fines and crushed oversized particles are typically recycled back to the dryer as seed material for the agglomeration phase where the particles are formed before entering the dryer.

Dryer technologies and dried pellet-storage systems have the potential to explode or catch fire. Manufacturers include safety measures to prevent such events, such as inert purge blankets, pressure reliefs, and various safety interlocks included with the dryers. Similar precautionary equipment is available for dried-product storage systems.

There is limited opportunity for energy production using heat recovery from a dryer. Depending on dryer type, waste heat from other processes (e.g., engine heat recovery) could be used to supplement the heat demand of dryers. Although dryers can require considerable input of fuel, the product (i.e., dried solids) can be used as a biogenic fuel source for use in coal or coke-fired power plants or cement kilns for example.

4.2.1 <u>Thermal Dryer Selection</u>

Rotary drum and fluidized bed dryers were considered since many large municipal WWTPs in the U.S. use thermal drying technology.

4.2.1.1 Rotary Drum Dryer (Direct Drying)

Rotary drum drying systems recycle a significant portion of product to mix with the dewatered cake in a mixer. Dewatered cake coats pellets before being dried in a rotating drum. Heated air comes in contact with the biosolids and evaporates water, producing a dry hard pellet. The granules or pellets are then graded into different size categories. Those that do not fit the product specifications are crushed and recycled back into the dryer system. The pellets that meet the specifications are either recycled as seed material for pellet formation or cooled and stored prior to distribution.

A rotary drum dryer system for the City would be fueled by biogas and/or natural gas and the dryer exhaust heat could be recovered to provide additional hot water supply for OWTP. The rotary drum dryer system would not use the cogeneration engines exhaust gases as a heat supply because it has oxygen content above 10 percent. Oxygen levels in the dryer must be maintained below 5 percent to reduce the ignition potential of the solids. Rotary drum dryers operate at approximately 900 °F and dry the solids to approximately 95 percent solids.

4.2.1.2 Fluidized Bed Dryer (Hybrid - Direct and Indirect Drying)

In fluidized bed dryers, moisture removal is achieved predominantly by convective heat transfer. A natural gas or biogas fired furnace heats oil or other heating media. The oil is pumped into a heat exchanger where the heat is transferred to the fluidizing air. The heated fluidizing air comes into direct contact with the cake solids, causing the water to evaporate. Fluidized bed dryers are equipped to produce a high-quality biosolids product consisting of uniform, hard, spherical pellets similar in appearance (with the exception of color and odor) to commercial inorganic fertilizer products.

Dewatered biosolids are pumped directly into the dryer. An extrusion and cutting system is used to form pellets for the drying process. Heated, fluidized air is blown through the bed of the dryer. Once the pellets are dried, they are discharged from the fluidized bed. The pellets are separated from the air stream and conveyed to storage.

Air from the dryer is conveyed to a bag house to remove particulate matter. The solids from the bag house are collected and mixed with a stream of cake solids fed to the dryer. The remaining air is condensed and recycled to heat the fluidization air.

4.3 Compost Offsite (Co-Compost with Green Waste)

Composting is a stabilization process normally performed after biosolids are dewatered and after subsequent mixing with a bulking agent (e.g., green waste). The bulking agent raises the initial solids content of the mixture and provides a carbon source for the organisms and bulk porosity important for maintaining aerobic conditions. High temperatures achieved during the microbial decomposition reduce pathogenic organisms in the solids. When composting is complete, the compost material is typically screened to retrieve a portion of the bulking agent. The product is then allowed to cure for several days and the resulting humus-like material can be used as a soil amendment. As identified in the 40 CFR 503 regulations, composting operations can meet either Class A or Class B pathogen reduction requirements dependent upon time and temperatures met during the process.

In general, compost products are considered the most acceptable beneficial use products available to the public. This is because compost products are associated with food, yard, and agricultural wastes that the public is more familiar with, and so are more likely to accept biosolids compost. In addition, biosolids compost does not have an objectionable odor or sludge-like appearance.

Due to the limited land available on-site, existing off-site composting operations at a City-run Contracted Materials Recovery Facility (MRF) are considered.

This alternative would not improve (i.e., decrease) energy use onsite; however, if the composted product (Class A or B biosolids) is land applied, it will offset fossil-fuel based energy consumption from the production of synthetic fertilizer that would otherwise be used as a soil amendment to improve soil health. Land applying composted biosolids also contributes to carbon sequestration and improves water retention in the soil below. Soil amendments are also being examined for their potential to assist with recovery of forest lands from fire damage and to prevent future fires, which would result in a potential reduction in black carbon emissions.

4.4 Fluidized Bed Incineration

Fluidized bed incineration (FBI) is a well-established sludge treatment technology in the U.S. It is the preferred technology for new incineration systems because they are more energy efficient, easier to control, and produce fewer air emissions than multiple hearth furnaces (MHFs). Fluidized bed incinerators are refractory-lined steel cylinders with three distinct zones: 1) a windbox, 2) the bed section typically composed of sand, and 3) the freeboard. Combustion air is preheated and introduced into the windbox, which distributes air to an orifice plate. The plate separates the windbox from the fluidized bed, provides structural support for the sand bed, and is comprised of air distribution tubes. Fluidizing air is passed through the tubes to the bed section, which fluidizes the sand. Dewatered cake is fed into the fluidized sand bed, the water in the solids is evaporated, and the combustible matter is oxidized in seconds. Oxidation gas and water from this process flow upward into the freeboard where the gas combusts and completes the process.

The operating temperature range for the freeboard is 650 to 850 degrees Celsius. A high-pressure spray system is located in the freeboard zone to control process temperatures.

Air from the incineration process is recycled to preheat the combustion air. Prior to discharging the air to the atmosphere, it is treated to remove pollutants. Federal regulations for incinerators may become more stringent in the future and could impact the cost of emissions control technologies and the overall viability of incineration. Carbon is injected upstream of a baghouse filter to remove mercury from the air stream. The air is conveyed to the baghouse filter where the mercury-containing carbon is removed as it passes through the filter. These steps are followed by a tray scrubber and wet electrostatic precipitator to remove the particulate matter (ash). The ash can either be used as a cement substitute, or may need to be disposed of at a landfill (depending on the ash contents). The air is condensed to remove moisture and clean air is discharged to the atmosphere.

Energy and heat recovery from an FBI system would typically consist of a waste heat recovery boiler to generate steam that is used to turn either process equipment (such as pumps or blowers) or a generator. Based on discussions with vendors, for a facility the size of the OWTP, it may not be cost effective to incorporate energy recovery/generation. Inherent to the FBI system is recirculation of the heated air to reduce energy input required for operation. This reduction in energy is included in the overall energy required for operation of the FBI system.

4.5 Gasification

Gasification of sludge/biosolids is an emerging technology. There was only one installation in the U.S. (in Sanford, Florida) processing wastewater sludge, however it is no longer in operation due to the manufacturer filing for bankruptcy. The Sanford installation was intermittently operated between 2010 and mid-2014, during which they tested and optimized the gasification process. The process involved applying a controlled amount of air (to supply a small amount of oxygen) to control the heat to a fuel rich sludge providing a temperature-controlled environment (greater than 800 degrees Celsius). Most of the volatile portion of the sludge is converted into synthesis gas, also called “syngas.” However, complete combustion is not realized in the gasifier because gasification operates in an oxygen-starved environment. An estimated 80 percent of the solids are converted to syngas. The remaining ash has little value and is usually disposed of similar to incinerator ash, though there were studies evaluating its use as a fertilizer.

Dewatered sludge is fed into a dryer to reduce the moisture content to approximately 10 percent. Dried solids are conveyed into the gasifier at a controlled rate to optimize syngas production. The majority of the volatile content of the solids is converted to syngas and conveyed to a thermal oxidizer where it is blended with air and burned. The heated flue gas from the thermal oxidizer is used to heat the solids dryer. Flue gas is conveyed through a baghouse filter and scrubber prior to atmospheric discharge. In addition, flue gas from the solids dryer is conveyed to an odor control system prior to atmospheric discharge.

While the syngas produced in a wastewater solids gasification process has a high fuel value, it can be utilized to dry the solids prior to the gasification unit. Because of this, there is little remaining recoverable energy, and the unit is actually a net user of power since electrical power is used for dewatering, conveyance, and odor control. However, there is potential for it to be energy neutral.

4.6 Pyrolysis

Pyrolysis is an emerging technology with two demonstration facilities in the U.S., one located at the Encina Wastewater Authority (EWA) and one at the Los Angeles County Sanitation District (LACSD). The process is similar to gasification in that it involves applying a controlled amount of heat to sludge except that it operates in an oxygen free environment. Because it operates in this type of environment, there is little or no combustion. The incomplete combustion of the sludge produces a biochar, a pyrolysis oil (i.e., "bio-oil"), and a gas similar to syngas created with gasification. The biochar, bio-oil, and biogas from pyrolysis can be used to fuel a waste-to-energy facility or as a fuel alternative for cement kilns. In addition, the biochar can be used as an organic fertilizer/soil amendment.

Similar to the gasification process, dewatered cake is dried to 90 percent solids and fed into the pyrolysis system. The cake is subjected to high temperatures (less than 700 degrees Celsius) in the absence of oxygen - biochar, bio-oil, and biogas are created from this process. The air pollution control system for pyrolysis would consist of equipment similar to a gasification process.

When considering the energy efficiency for this alternative, EWA has observed multiple benefits through the addition of the pyrolysis process to their existing anaerobic digestion process. By co-digesting the bio-oil with sewage sludge they have observed an increase in biogas production by 25 to 30 percent, a reduction in the mass of the dewatered sludge by approximately 8 times through use of the pyrolysis process, and the resulting biochar has concentrated nutrients for use as an organic soil amendment (offsetting the use of fossil-fuel energy intensive synthetic fertilizer).

5.0 ADDITIONAL CONSIDERATIONS

5.1 Public-Private Partnerships (PPP)

The City may consider PPPs for the operation and management of the selected solids treatment alternative. Public-private partnerships are contractual arrangements making use of private partner resources to finance public projects and enable municipalities to outsource the management and operation of portions of or all of their wastewater or biosolids processing system. For example, the private partner may provide:

- Treatment supplies (e.g., chemicals).
- Design and construction services.
- Maintenance of a portion of the collection and/or treatment system under a contract in compliance with all applicable federal, state, and local environmental regulations.
- Meter reading, billing, and customer service.

The risks and rewards are shared while providing access to additional capital resources and the public partner maintains ownership of the assets, controls the management of the assets, and establishes user rates.

An example project for which the City may consider a PPP is the addition of a pyrolysis system onsite at the OWTP. As this is an emerging technology in the wastewater sector, the OWTP staff could benefit from contracting with an experienced private partner to install, operate, and manage the pyrolysis system. Since there are benefits of operating this system alongside anaerobic digestion, the private partner could work closely with public partner (i.e., OWTP) staff to optimize management of both systems. The terms of the contract would clarify the responsibilities of the private partner. An example entity the City may consider for a PPP with pyrolysis system experience could be Anaergia Inc. Anaergia is a private company currently managing two demonstration pyrolysis system projects at EWA and LACSD, and they are currently in a PPP with Victor Valley Wastewater Reclamation Authority supporting their Omnivore™ digester system.

5.2 OWTP Location and Biosolids Processing Layout

If the OWTP remains in its existing location, recommendations for optimizing biosolids related facility locations within the OWTP site are provided in Section 3 of *PM 3.7.1 - Wastewater System - Treatment Alternatives*.

5.3 Alternative Biogas Utilization

The OWTP currently uses the biogas it produces to generate electricity and heat onsite through its cogeneration system. This electricity and heat is beneficially used by OWTP facilities, thereby offsetting purchased electricity and heat. If the OWTP produces biogas in excess of the facility's demand (e.g., through receipt of fats, oils, and grease) or would like to consider other ways to utilize the biogas, there are two other options that may be viable and good options for satisfying potential future restrictive air emissions limits on stationary combustion units:

- Processing the biogas into a compressed natural gas (CNG) to be used as a transportation fuel.
- Processing the biogas into a pipeline grade fuel for injection into a natural gas pipeline.

While the technology and expertise for processing biogas into transportation fuel already exists, newly developed regulations and goals geared toward greenhouse gas (GHG) emissions reductions are providing newfound incentives for implementing these types of projects making them more feasible in California. Not only do these projects produce a renewable fuel with low carbon content, they also offset the use of and dependence on fossil fuel consumption and reduce emissions of GHGs and local air pollutants.

Digester gas to CNG fuel projects consist of anaerobic digesters, a gas conditioning system, a compressor system, a gas storage system, and a fueling station, as well as a fleet of vehicles or trucks nearby that can make use of the fuel. Nearby industries (e.g., the New Indy Containerboard Company that manufactures and supplies recycled containerboard to the corrugated box industry) are ideal candidates for using CNG in their distribution vehicles.

Standards and incentives are also being developed in California for the processing and injection of biogas into existing natural gas pipelines. The City should determine if there are nearby Southern California Gas Company pipelines and discuss the advantages (e.g., reducing or eliminating onsite stationary combustion) and disadvantages (e.g., current costly interconnection fees and digester gas sampling/testing requirements) of injecting conditioned biogas into a pipeline. The California Public Utilities Commission is leading the effort to examine barriers to injecting conditioned biogas in order to make this a more viable option in the future.

6.0 ADVANTAGES AND DISADVANTAGES OF SOLIDS TREATMENT ALTERNATIVES

Table 4 summarizes the advantages and disadvantages of the solids treatment and management alternatives discussed above. Table 4 also ranks each alternative against the goals and objectives for the PWIMP, as noted in Section 2 of *PM 3.7.1- Wastewater System - Treatment Alternatives*. The City should consider the future viability of each disposal or end use option, the OWTP site flexibility, the constructability of each alternative, and the flexibility of each alternative relating to future conditions and the regulatory environment. While Table 2 currently shows composting offsite and pyrolysis in a better position to satisfy wastewater treatment goals, the City should consider a suite of options and include diversification in their solids portfolio to avoid risk.

Table 4 Advantages and Disadvantages of Solids Treatment and Management Alternatives
Public Works Integrated Master Plan
City of Oxnard

	Baseline (Landfill)	Baseline (ADC)	Baseline (Land Application)	Thermal Drying	Compost (Offsite)	FBI	Pyrolysis	Gasification
Goal 1: Compliant, reliable, flexible system	Low	Low-Moderate	Low-Moderate	Moderate	High	Moderate	Low	Low
Goal 2: Economic sustainability	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Moderate	Low
Goal 3: Mitigate/adapt to climate change	Low	Low	Low	Low-Moderate	Moderate	Moderate	Moderate	Moderate
Goal 4: Resource sustainability	Low	Low	Moderate	Moderate	High	Moderate	Moderate-High	Moderate
Goal 5: Energy efficiency	High	High	High	Low	High	Low-Moderate	Moderate-High	Moderate
Advantages	No impact to OWTP footprint Low $	No impact to OWTP footprint Low $ Beneficial use of product	No impact to OWTP footprint for Class B Low $ for Class B Beneficial use of product Offset use/production of synthetic fertilizer	Marketable pelletized product Reduces solids volume and hauling costs Beneficial use of product	No impact to OWTP footprint Low $ Marketable product (more publicly accepted) Beneficial use of product	Potential net energy recovery (unlikely) Reduces solids volume and hauling costs Potential beneficial use of product (ash in cement)	Potential net energy recovery Marketable product (biochar) Reduces solids volume and hauling costs Beneficial use of product(s) - biochar, biogas, bio-oil	Potentially energy neutral Reduces solids volume and hauling costs Potential beneficial use of product (ash in cement)
Disadvantages	Option threatened by regulatory and public perception drivers No beneficial use of product	Option threatened by regulatory and public perception drivers	Class B land application option threatened by regulatory and public perception drivers Limited land application sites	Marketing of pelletized product requires public buy-in and public relations efforts Potential hazard (explosive dust particles) Increase in energy use Product quality desired by end user can drive additional upstream processes Additional footprint Med $$ (capital, O&M)	Can be difficult to site and permit if public is against compost process May require additional emissions measurement	Additional process and equipment to operate/maintain Can be difficult to site and permit if public is against process Air pollution control requirements/costs Existing and future limiting regulations Additional footprint High $$$ (capital, O&M)	Additional process and equipment to operate/maintain New application of technology - only two demonstration facilities in operation Additional footprint High $$$ (capital, O&M)	Additional process and equipment to operate/maintain (including pre-drying) Installation in U.S. is no longer in operation Additional footprint $$$ (capital, O&M)

* An alternative is ranked "high" if it satisfies the goal, "moderate" if it partially satisfies the goal, and "low" if it does not satisfy the goal.