T E C H N I C A L   M E M O R A N D U M

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Prepared for

Miami-Dade Water and Sewer Department (WASD)

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Executive Summary

The Miami-Dade Water and Sewer Department (WASD) is the largest water and sewer utility in the southeastern United States, serving nearly 2.3 million residents, employing nearly 2,763 workers, and providing direct service to more than 440,000 customers with a total annual operating budget of $796 million. WASD provides water and wastewater service to the unincorporated areas of Miami-Dade County, wholesale water service to 15 municipalities, and wholesale wastewater service to 13 municipalities.

Alternatives Evaluation

WASD is considering design-build-finance-operate-maintain (DBFOM) as the delivery option for a regional Biosolids Processing Facility (BPF) to be located at the South District Wastewater Treatment Plant (SDWWTP), which is at the south end of the County near South Miami-Dade Landfill and Black Point Marina. This regional facility will incorporate the handling and processing of biosolids produced by WASD's three wastewater treatment plants (WWTPs): North District WWTP (NDWWTP), Central District WWTP (CDWWTP), and South District WWTP (SDWWTP). The BPF will allow WASD to produce a higher quality biosolids product that has greater flexibility where the material is reused or disposed, thereby lowering disposal costs. It will also provide a solids treatment alternative that is less affected by inclement weather, thus improving the operations.

The NDWWTP generates primary sludge and waste activated sludge (WAS), which are conveyed through the interfacility sludge force main to the CDWWTP for processing. The combined NDWWTP and CDWWTP sludge is anaerobically digested at the CDWWTP to meet Class B biosolids stabilization criteria, dewatered by centrifuges, and trucked to land application or landfill sites. The SDWWTP produces WAS that is anaerobically digested, centrifuge dewatered, and air dried on asphalted drying beds as a certified fertilizer product by third-party vendors. The Class B material is either land applied or landfilled. Weather permitting, Class B dewatered biosolids are composted to meet Florida DEP Class AA stabilization criteria. The Class AA compost is sold, but currently less than 10 percent of the SDWWTP solids are composted. The three WWTPs generated an annual average amount of about 90 dry tons per day of biosolids in 2015.

WASD authorized CH2M HILL, Inc. (CH2M) to evaluate 11 biosolids processing alternatives that would manage biosolids produced by WASD's three WWTPs.

CH2M analyzed the technologies involved, conducted economic analyses including the triple bottom line (TBL) criteria, and considered alternative project delivery methods. The evaluation included life-cycle cost comparisons of the base case (no additional biosolids handling upgrades), thermal hydrolysis (a digestion pretreatment process), composting, thermal biosolids drying technologies, and combinations thereof at the SDWWTP and CDWWTP. The evaluation addressed capital costs, operation and maintenance (O&M) costs, staffing requirements for treatment, marketing/disposal options, and biosolids volume reduction. Available areas at the CDWWTP and SDWWTP were considered as potential sites for a future, regional BPF.

Recommendations

The evaluation resulted in the following recommendations:

- The TBL evaluation concluded that several alternatives involving the thermal hydrolysis process (THP) and thermal drying for a consolidated BPF are viable, and they all received high TBL scores. It is in WASD's best interest to have both technologies competitively bid in an open market.

- The regional BPF is to be located at a county-owned site. The recommended site is the SDWWTP. THP and/or thermal drying systems are the two recommended technologies that could be located as a consolidated BPF at the SDWWTP site.
- At the CDWWTP, continue with mandatory improvements and land apply Class B biosolids until a consolidated Class AA BPF is built at SDWWTP. Class B biosolids from the CDWWTP may also be received and disposed or reused at other locations in accordance with all regulatory requirements.

The two recommended technologies, THP and thermal drying, require relatively small footprints (compared to composting), which gives WASD the flexibility to better space plan for future wastewater regulatory requirements and capacity needs. These two technologies can also benefit from the available renewable energy sources (biogas and waste heat) at the SDWWTP.

Procurement Process

The procurement process is being conducted under State legislation for Public-Private Partnerships (Section 287.05712, Florida Statutes) and is intended to consist of a Request for Qualifications requiring an evaluation of proposals by a County Competitive Selection Committee (Step 1) for certain planning, development, design, and financing services for the project. A Request for Proposal will then be issued to the top three firms, which will require the submittal of certain cost, schedule, and other information for the negotiation and possible award of a Comprehensive Agreement (Step 2) that may include the final design, permitting, construction, financing, and operation and maintenance of the project.

WASD is in the process of retaining financial and legal consultants to evaluate the feasibility of this project.

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Acronyms and Abbreviations

°F	degrees Fahrenheit
AADF	annual average daily flow
Btu/hr	British thermal units per hour
BPF	Biosolids Processing Facility
CD	Central District
CDWWTP	Central District WWTP
CH2M	CH2M HILL, Inc.
CHP	combined heat and power
CWAS	conditioned waste activated sludge
DB	Design-Build
DBFOM	design-build-finance-operate-maintain
DG	digester gas
DS	digested solids
DSC	dewatered solids cake
DT	dry tons
dtpd	dry tons per day
ft^3/day	cubic feet per day
FOG	fats, oil, and grease
gal/day	gallon(s) per day
gpm	gallons per minute
kW	kilowatt
lbs/day	pound(s) per day
lbs/MG	pound(s) per million gallons
mgd	million gallon(s) per day
ND	North District
NDWWTP	North District WWTP
O&M	operation and maintenance
OOL	Ocean Outfall Legislation
PSD	primary sludge
RFQ	Request for Qualification
SD	South District
SDWWTP	South District WWTP
THP	thermal hydrolysis process
TM	technical memorandum
TS	total solids
TWAS	thickened waste activated sludge

VSS	volatile suspended solid
WAS	waste activated sludge
WASD	Miami-Dade Water and Sewer Department
WDWWTP	West District WWTP
WS	wet solids
WT	wet tons
WWTP	wastewater treatment plants

SECTION 1

Introduction

The Miami-Dade Water and Sewer Department (WASD) contracted CH2M HILL, Inc. (CH2M) to evaluate technical alternatives for the Biosolids Processing Facility (BPF). In 2015, WASD performed an initial screening of more than 40 solids stabilization technologies, and based on WASD's preferences and assumptions at the time, it was decided to exclude all pre-digestion alternatives from CH2M's 2015 alternatives analysis (CH2M, 2015a). This technical memorandum provides a more detailed evaluation of CH2M's previously recommended post-digestion processes, thermal drying and composting, and a pre-digestion alternative, thermal hydrolysis, based on the triple bottom line criteria approach.

WASD authorized an evaluation of 11 biosolids processing alternatives that would manage biosolids produced by WASD's three wastewater treatment plants (WWTPs). As part of the analysis, CH2M analyzed the technology process evaluations, financial economic analysis (including the triple bottom line), and project delivery procurement approach. The purpose of this technical memorandum (TM) is to address the alternatives being considered for processing biosolids generated by the Central District WWTP (CDWWTP) and South District WWTP (SDWWTP) and conduct evaluations of 11 biosolids management alternatives to include the following aspects:

1. Develop life-cycle cost comparisons of thermal hydrolysis (a digestion pretreatment process), composting, thermal biosolids drying technologies, and combinations thereof.
2. Prepare a comparison of the three technologies or combinations thereof, to include: capital costs, operation and maintenance (O&M) costs, staffing requirements for treatment (assume onsite facilities), marketing/disposal options (Appendix A), and biosolids volume reduction.
3. Consider available space at the CDWWTP and SDWWTP as potential sites for a future centralized regional BPF.
4. Include a triple bottom line evaluation approach, which is an accounting framework based on social, environmental, and economic criteria as they apply to the different technologies being considered.

Section 1 describes the background and scope of work including a description of alternatives evaluated.

1.1 Background

WASD owns and operates three regional WWTPs: North District WWTP (NDWWTP), CDWWTP, and SDWWTP. The NDWWTP generates primary sludge and waste activated sludge (WAS), which are conveyed through the wastewater collection system to the CDWWTP for processing and disposal. The combined NDWWTP and CDWWTP sludge is anaerobically digested at the CDWWTP to meet Class B biosolids stabilization criteria, then dewatered by centrifuges, and then transported by truck to be applied to agricultural land or landfilled.

The SDWWTP produces WAS and is anaerobically digested and centrifuge dewatered, and then further processed on air drying beds, depending on seasonal weather conditions. Weather permitting, Class B dewatered biosolids are air dried to reduce water content or composted to meet Florida DEP Class AA stabilization criteria. The Class B material is either land applied or landfilled. The Class AA material has traditionally been sold to a third-party broker at an average price of $12 per ton for resale to soil blenders, but that practice has decreased significantly in the past 2 years such that less than 10 percent of the solids produced was managed in this manner. The three WWTPs generated an annual average amount of about 90 dry tons per day (dtpd) of biosolids in 2015.

WASD evaluated the use of processes to generate a high-quality Class AA product for future biosolids management or other beneficial use product for which a market is available (i.e., biofuel) and, in 2013, WASD authorized a project for developing a new evaluation and procurement process, including technology and delivery options, for managing biosolids produced by the CDWWTP and SDWWTP. At the time, WASD decided to only consider proven technologies for processing biosolids after the dewatering facilities, to avoid interference with the current operation of the existing treatment plants.

In 2015, WASD requested CH2M to prepare a draft Request for Qualification (RFQ) based on composting and heat-drying technologies, and WASD issued the RFQ for comments from interested vendors so that alternative technologies could be presented and considered. Based on industry response to the draft RFQ, WASD decided that it should consider alternative technologies during the RFQ process (CH2M, 2015a) and WASD tasked another consultant (AECOM) with an analysis of the viability of thermal hydrolysis process (THP) as an alternative technology as related to capital program improvements to anaerobic digestion, sludge thickening, and dewatering (AECOM, 2016). Based on the complex interactions between existing and proposed biosolids unit processes, CH2M was tasked to further evaluate incorporation of THP as part of the entirety of WASD's biosolids program. The results of that evaluation are described in this TM.

The WASD-preferred delivery alternative type for the proposed BPF is a concession. WASD authorized this evaluation of 11 biosolids processing alternatives that would manage biosolids produced by the CDWWTP and SDWWTP to consider different combinations of technical alternatives for biosolids processing, adding THP to the previously selected technologies, composting and thermal drying.

1.2 Scope of Work

WASD tasked CH2M with developing and evaluating 11 alternatives for managing biosolids produced by the CDWWTP and SDWWTP. In December 2016, CH2M worked with WASD to develop the basis of triple bottom line criteria and relative importance for this project's objectives. This evaluation includes a recommendation of up to three alternatives that best meet WASD objectives and criteria. This technical memorandum summarizes the alternatives evaluation. Included in this technical memorandum are triple bottom line criteria of the THP, composting, thermal biosolids drying technologies, and combinations thereof, to compare with the baseline alternatives of conventional anaerobic digestion, dewatering, and existing biosolids disposal routes at the CDWWTP and SDWWTP. This technical memorandum also includes:

1. Comparisons of the three technologies or combinations thereof, to include:
    a. Staffing requirements for treatment (assume onsite facilities), marketing/disposal options, and production volume.
    b. Implications of the Federal Food Safety Act under the U.S. Department of Agriculture on the local and national land application of biosolids and biosolids derived fertilizer (Appendix A).
2. Preliminary site layouts at the CDWWTP and SDWWTP as potential sites for the future BPF.
3. A review of the market potential and pricing ranges for Class AA THP cake, Class AA dried biosolids, and Class AA biosolids compost will be included in this task (Appendix A).
4. A discussion and evaluation of triple bottom line (social, environmental, and economic) aspects of the alternatives. The triple bottom line framework evaluates performance in a broader perspective to create greater business value.

CH2M also evaluated the alternatives based on a 20-year project life cycle that assumes startup will occur in 2020 and facilities will operate for 20 years until design year 2040.

1.3 Alternatives Evaluated

This section provides descriptions of the 11 biosolids management alternatives evaluated in this TM, including the nomenclature for each alternative. The Consent Decree required improvements were added to the alternatives at SDWWTP (S-1) and CDWWTP (C-1) as base cases to compare alternatives.

1.3.1 Alternatives at Central District Wastewater Treatment Plant

C-1. Base Case at CDWWTP – Continue with sludge thickening, anaerobic digestion, and sludge dewatering improvements, and dispose of or land apply Class B biosolids cake as part of the Consent Decree improvements.

C-2. Thermal Hydrolysis Process (THP) at CDWWTP – Implement THP prior to anaerobic digestion at CDWWTP, then market Class AA THP biosolids as a soil amendment.

C-3. Thermal Drying at CDWWTP – Implement thermal drying on biosolids cake at CDWWTP, then market the dried biosolids product as a Class AA biosolids fertilizer or soil amendment

1.3.2 Alternatives at South District Wastewater Treatment Plant

S-1. Base Case at SDWWTP – Continue with anaerobic digestion, sludge thickening, and sludge dewatering improvements and dispose of or land apply Class B biosolids cake as part of Consent Decree improvements.

S-2. Thermal Hydrolysis Process (THP) at SDWWTP – Implement THP prior to anaerobic digestion at SDWWTP, then market Class AA THP biosolids soil amendment.

S-3. Composting at SDWWTP – Implement composting process on biosolids cake at SDWWTP, then market the compost product as a Class AA biosolids soil amendment.

S-4. Thermal Drying at SDWWTP – Implement thermal drying on biosolids cake at SDWWTP, then market the dried biosolids product as a Class AA biosolids fertilizer or soil amendment.

S-5. Thermal Hydrolysis Followed by Thermal Drying at SDWWTP – A combination of S-2 and S-4, then market the dried biosolids product as a Class AA biosolids fertilizer or soil amendment.

1.3.3 Combined Alternatives

C-S-1. Composting at SDWWTP (with CDWWTP Biosolids) – Truck biosolids cake from CDWWTP to SDWWTP, implement composting process on combined CDWWTP and SDWWTP biosolids cake at SDWWTP, and market the compost product as a Class AA biosolids soil amendment.

C-S-2 Thermal Drying at SDWWTP (with CDWWTP Biosolids) – Truck dewatered biosolids cake from CDWWTP to SDWWTP, implement thermal drying on combined CDWWTP and SDWWTP biosolids cake at SDWWTP, and market the dried biosolids product as a Class AA biosolids fertilizer or soil amendment.

C-S-3. THP at CDWWTP and SDWWTP Followed by Thermal Drying at SDWWTP – Implement digestion THP at CDWWTP and SDWWTP. Truck THP biosolids from CDWWTP to SDWWTP, dry THP biosolids from both plants at SDWWTP, and market the dried biosolids product as a Class AA biosolids fertilizer or soil amendment.

The alternatives will be described in Section 4 starting with the CDWWTP's three alternatives, followed by the SDWWTP's five alternatives, and then followed by the three alternatives that involve transporting CDWWTP biosolids to a central BPF at the SDWWTP, which are called combined alternatives.

Section 2 describes WASD's existing WWTPs that produce biosolids and their current status.

Existing Biosolids Processing Facilities

This section describes the WASD WWTPs and their contributions to biosolids production.

2.1 North District Wastewater Treatment Plant

Located in the northeast section of Miami-Dade County at 2575 NE 151 Street, the NDWWTP serves the northern portion of the county. The plant is permitted to treat an annual average daily wastewater flow of 112.5 million gallons per day (mgd) to secondary treatment standards with basic disinfection. It is a pure oxygen-activated sludge treatment plant with primary and secondary clarification, which discharges its effluent via ocean outfall and deep injection wells. The NDWWTP transfers all solids to the CDWWTP via WASD's wastewater collection system. Primary and waste-activated solids produced by the NDWWTP are pumped to the CDWWTP's solids treatment train (beginning with gravity thickeners) or mixed with the influent wastewater to the CDWWTP for treatment. The NDWWTP solids contribution to CDWWTP is shown in Figure 2-1.

2.2 Central District Wastewater Treatment Plant

Located in Virginia Key, the CDWWTP serves the central portion of the county, including Miami Beach and Key Biscayne. The facility has a permitted capacity to treat an annual average daily wastewater flow of 143 mgd. The pure oxygen-activated sludge treatment plant has two independently operated process trains that discharge chlorinated effluent to the ocean. The biosolids removed in the treatment process are pumped to gravity sludge thickeners. The concentrated sludge is then pumped to anaerobic sludge digesters. After the digestion process, the biosolids are dewatered prior to Class B land application (when weather and site availability permit) or disposed in a landfill when there are no available land application sites. Figure 2-1 presents the solids processing facilities at CDWWTP as a schematic diagram.

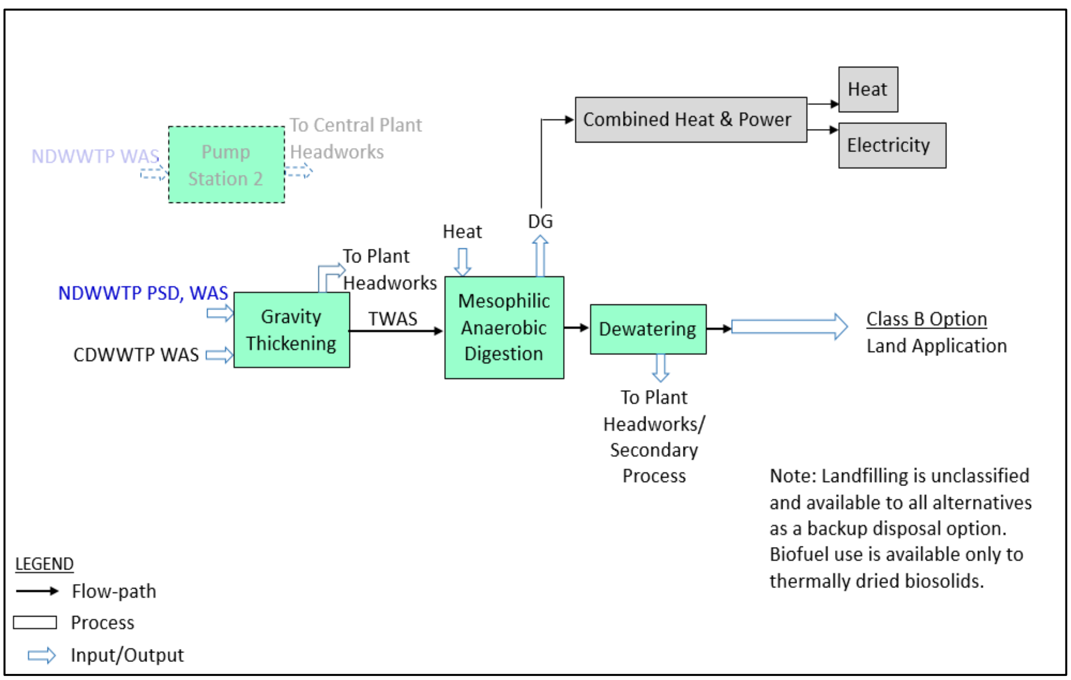

Figure 2-1. Central District Wastewater Treatment Plant Solids Process Schematic Diagram

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Figure 2-2 shows a site layout highlighting the area that could be designated for a potential BPF at the CDWWTP. The designated area is approximately 3.9 acres.

Figure 2-2. Site Layout at the Central District Wastewater Treatment Plant

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2.3 South District Wastewater Treatment Plant

Located in the southeast section of the county at 8950 SW 232 Street, the SDWWTP serves the southern and southwest portions of the county. It is permitted to treat an annual average daily wastewater flow of 112.5 mgd with secondary treatment processes, followed by high-level disinfection and filtration, prior to deep well injection. The sludge removed during treatment is processed onsite through gravity thickeners, anaerobic digesters, and dewatered by centrifuges prior to (1) Class B land application, (2) composting, or (3) landfill disposal. A portion of the residuals is composted onsite at the SDWWTP using the aerated static pile process, after which the compost product qualifies for Class AA marketing and distribution. Figure 2-3 shows the solids processing facilities at SDWWTP as a schematic diagram. Figure 2-4 shows a site layout highlighting the area that can be partially designated for a potential BPF at the SDWWTP. The designated area is approximately 18 acres.

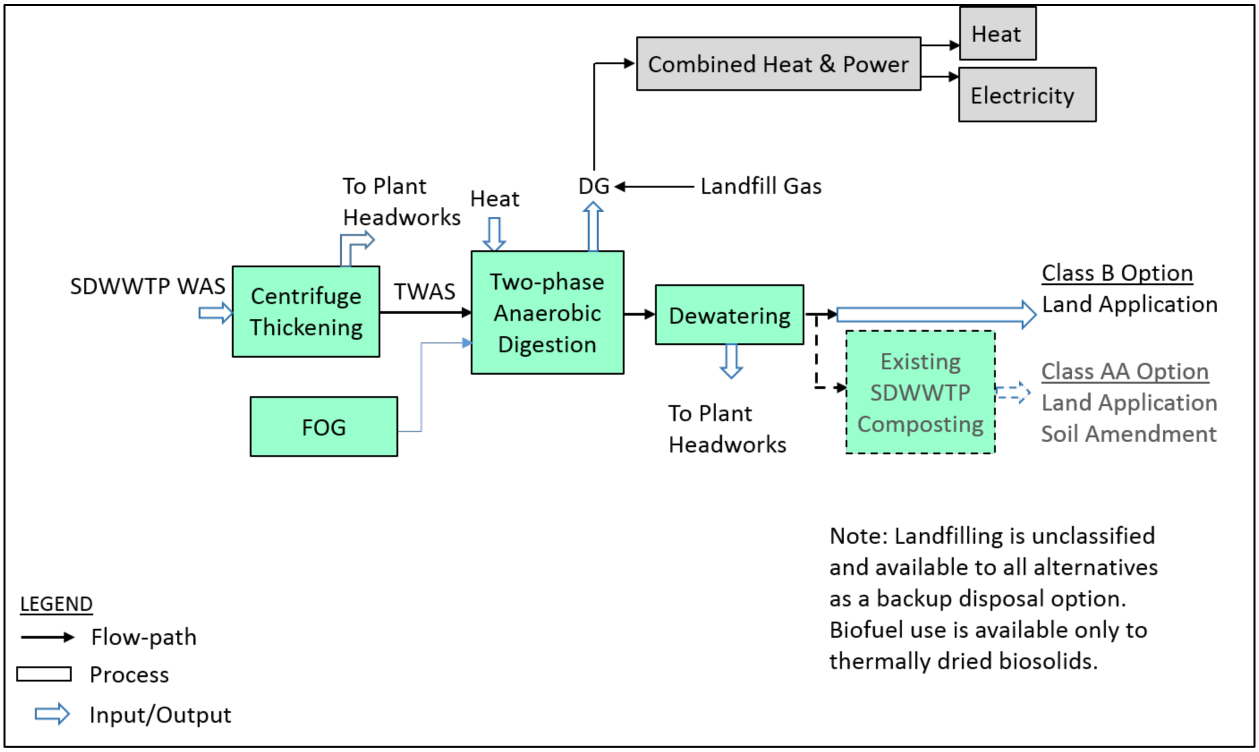

Figure 2-3. South District Wastewater Treatment Plant Solids Process Schematic Diagram
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

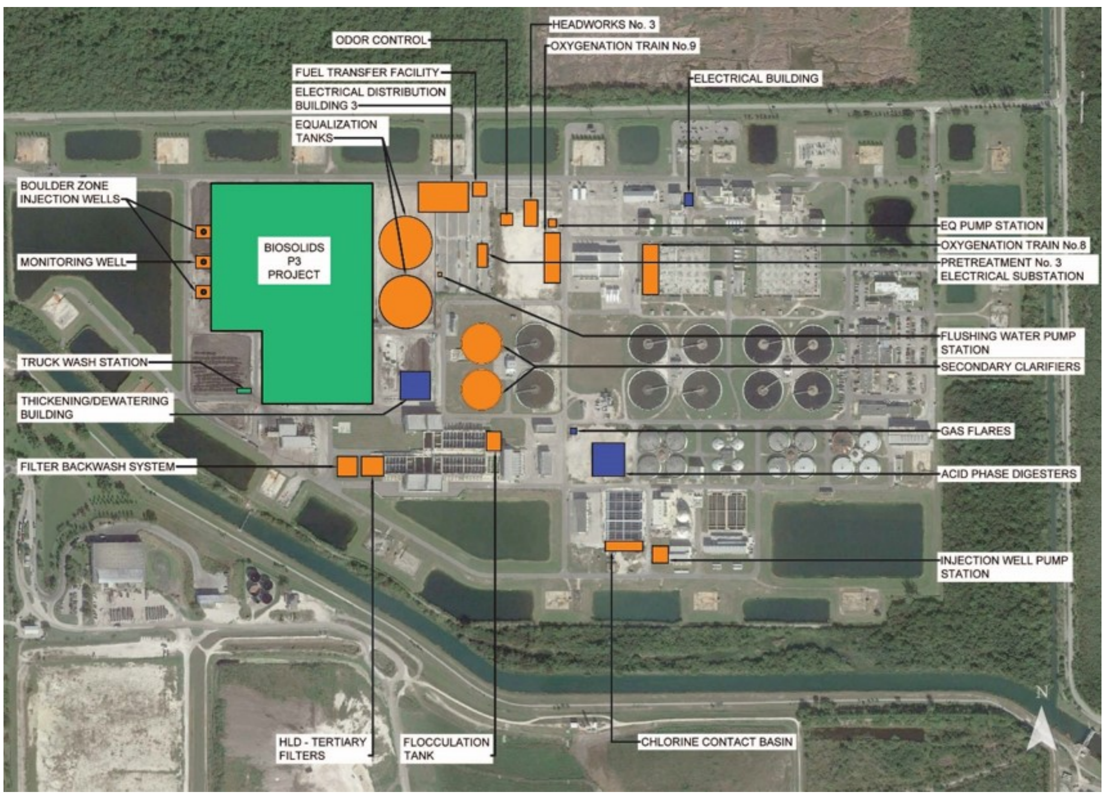

Figure 2-4. Site Layout South District Wastewater Treatment Plant
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternative

2.4 Future West District Wastewater Treatment Plant

WASD is planning a new WWTP (the West District WWTP [WDWWTP]), which is expected to begin operation in 2026. After the WDWWTP begins operating, the biosolids produced are expected to be managed separately from the CDWWTP and SDWWTP biosolids that are the subject of this TM. When the WDWWTP comes online, WASD's wastewater collection system will be reconfigured so that a significant portion of wastewater that currently flows to the NDWWTP and the CDWWTP will instead be conveyed to the WDWWTP. Therefore, the NDWWTP and CDWWTP wastewater flow projections decrease after the WDWWTP starts up in 2026, and the biosolids projections reflect this decrease in wastewater flows and loads.

Section 3 describes the solids estimates that form the design basis of each alternative.

SECTION 3

Solids Estimates that Form the Basis of Design

The most recent wastewater process models were performed as part of the Ocean Outfall Legislation (OOL) Program and the modeling alternatives have been used to update the estimates and projections for solids production from the CDWWTP and SDWWTP.

The alternatives have been developed using the same set of estimates and projections for wastewater solids, feeding the processes being considered for each alternative. Since THP is a pre-digestion process, estimates and projections for the THP alternatives must be based on raw, thickened solids feeding THP and digestion at the CDWWTP and SDWWTP. The alternatives involving composting and thermal drying technologies are based on digested and dewatered solids projections, which differ based on whether THP is being implemented or conventional single-stage mesophilic anaerobic digestion is used without THP (in the case of the CDWWTP), or two-phase (acid-gas) mesophilic anaerobic digestion is used (in the case of the SDWWTP).

Section 3.1 summarizes the raw solids projections for the CDWWTP and SDWWTP that are common to all alternatives being evaluated.

3.1 Raw Wastewater Solids Projections for the Central District Wastewater Treatment Plant

Wastewater solids projections for the CDWWTP were developed for years 2020, 2025, and 2040 during the projected 20-year life cycle of the project:

- Projected startup is in 2020 with a 20-year length of operation.
- Maximum flow and load projections in 2025, which is 1 year before the WDWWTP comes online, and involves diverting some wastewater flows from the CDWWTP. Therefore, 2025 is the design year for sizing this alternatives evaluation.

Projections are based on annual average daily flows (AADF) for 2020, 2025, and 2040. Table 3-1 presents the raw wastewater flows and solids to thickening projections for the 3 years. Plant data, the most recent Biowin wastewater process model calibrated data (CH2M, 2015b) and the most recent flow projections from the OOL Task Authorization 7 *Pump Station Peak Flows Update 2035 Average Flows* (CH2M, 2016) technical memorandum were used to develop the projections shown in Table 3-1.

Table 3-1. Projections of Raw Wastewater Flows and Solids at Central District Wastewater Treatment Plant in 2020, 2025, and 2040

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CDWWTP 2020 (with NDWWTP Sludge) Data

Growth	1.08		Source: WASD, 2013
AADF CD Influent 2020	**128.7**	mgd	Calculated Based on 2014-2015 Data Plus Growth (No Climate Change, Sea Level Rise)
AADF ND Influent 2020	**95.6**	mgd	Calculated Based on 2014-2015 Data Plus Growth (No Climate Change, Sea Level Rise)

		Annual Average			Max Month			Max Week	
	gal/day	lbs/day	TS	gal/day	lbs/day	TS	gal/day	lbs/day	TS
PSD+WAS to thickening,	3,171,300	**285,000**	**1.08%**	4,624,900	**446,900**	**1.16%**	5,120,500	**511,000**	**1.20%**
PSD to Thickening	710,900	**63,884**	1.08%	1,036,700	**100,175**	1.16%	1,147,800	**114,544**	1.20%
WAS to Thickening	2,460,400	**221,116**	1.08%	3,588,200	**346,725**	1.16%	3,972,700	**396,456**	1.20%

CDWWTP 2025 (with NDWWTP Sludge) Solids Data Inputs to Central Alternatives Flow and Mass Balance, and to the combined Central and South Alternatives Flow and Mass Balance

Growth	1.08		Source: WASD, 2013
AADF CD Influent 2025	**135.3**	mgd	Calculated Based on 2014-2015 Data Plus Growth (No Climate Change, Sea Level Rise)
AADF ND Influent 2025	**100.5**	mgd	Calculated Based on 2014-2015 Data Plus Growth (No Climate Change, Sea Level Rise)

	Annual Average					Max Month			Max Week
	gal/day	lbs/day	TS	gal/day	lbs/day	TS	gal/day	lbs/day	TS
PSD+WAS to thickening,	3,333,800	**299,600**	**1.08%**	4,861,900	**469,800**	**1.16%**	5,383,100	**537,200**	**1.20%**
PSD to Thickening	747,300	**67,157**	1.08%	1,089,800	**105,308**	1.16%	1,206,700	**120,416**	1.20%
WAS to Thickening	2,586,500	**232,443**	1.08%	3,772,100	**364,492**	1.16%	4,176,400	**416,784**	1.20%

CDWWTP 2040 (with NDWWTP sludge) Data

AADF CD Influent 2035	113	mgd	Source: CH2M, 2016
AADF ND Influent 2035	100	mgd	Source: CH2M, 2016
Growth	1.08		Source: WASD, 2013
AADF CD Influent 2040	**119.1**	mgd	Calculated (No Added Flow for Climate Change and Sea Level Rise)
AADF ND Influent 2040	**105.4**	mgd	

	Annual Average			Max Month			Max Week		
	gal/day	lbs/day	TS	gal/day	lbs/day	TS	gal/day	lbs/day	TS
PSD+WAS to thickening	3,172,500	**285,100**	**1.08%**	4,627,000	**447,100**	**1.16%**	5,122,500	**511,200**	**1.20%**
PSD to Thickening	783,300	**70,392**	1.08%	1,142,400	**110,390**	1.16%	1,264,800	**126,217**	1.20%
WAS to Thickening	2,389,200	**214,708**	1.08%	3,484,600	**336,710**	1.16%	3,857,700	**384,983**	1.20%

Notes:
CD = Central District
SD = South District
gal/day = gallons per day
lbs/day = pounds per day
WAS = waste activated sludge
lbs/MG = pounds per million gallons
ND = North District
TS = total solids
PSD = primary sludge

3.2 Raw Wastewater Solids Projections for the South District Wastewater Treatment Plant

Wastewater solids projections for the SDWWTP were developed from a calibrated Biowin model using 2015 data and applied to years 2020, 2025, 2035, and 2040 during the projected 20-year life cycle of the project:

- Projected startup in 2020, length of operation 20 years
- Biowin modeling design year of 2035
- Design year of 2040 used in this alternatives evaluation (maximum flow and load projections)

The projections are based on AADF for years 2020, 2025, 2035, and 2040. Table 3-2 presents the raw wastewater flows and solids projections for the 4 years. Plant data, the most recent Biowin wastewater process model results for 2035, and the most recent flow projections from the OOL TA 7 *Pump Station Peak Flows Update 2035 Average Flows* (CH2M, 2016) technical memorandum were used for developing the projections shown in Table 3-2.

Table 3-2. Projections of Raw Wastewater Flows and Solids at South District Wastewater Treatment Plant in 2020, 2025, 2035, and 2040
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SDWWTP 2020 Inputs (Based on Biowin):									
AADF Plant Influent 2035	131	mgd		Source: CH2M, 2016					
Growth	1.08			Source: WASD, 2013					
AADF SD Influent 2020	110	mgd							
Max Month and Max Week Multiplier = Same as 2015 Biowin Calculated									
	Annual Average			Max Month (1.24 x Average_L)			Max Week (1.42 x Average_L)		
	gal/day	lbs/day	TS	gal/day	lbs/day	TS	gal/day	lbs/day	TS
To Thickening	2,017,500	198,550	1.18%	2,307,200	246,200	1.28%	2,373,100	281,900	1.42%
SDWWTP 2020 Biowin Based Data, Solids to Thickening Per Flow Treated:									
Average	1,805	lbs/MG	1.18%	Assumed Linear Change between 2015 and 2035					
SDWWTP 2025 Solids Inputs (Based on Biowin) used for the Combined Central and South Alternatives Flow and Mass Balance:									
AADF SD Influent 2035	131	mgd		Source: CH2M, 2016					
Growth	1.08			Source: WASD, 2013					
AADF SD Influent 2025	117	mgd							
Max Month and Max Week multiplier = same as 2015 Biowin calculated									
	Annual Average			Max Month (1.24 x Average_L)			Max Week (1.42 x Average_L)		
	gal/day	lbs/day	TS	gal/day	lbs/day	TS	gal/day	lbs/day	TS
To Thickening	2,098,300	203,000	1.16%	2,304,400	251,700	1.31%	2,341,700	288,300	1.48%
SDWWTP 2025 Biowin Based Data, Solids to Thickening Per Flow Treated:									
Average	1,735	lbs/MG	1.16%						
SDWWTP 2035 Inputs from Biowin:									
AADF SD Influent 2035	131	mgd		Source: CH2M, 2016					
Max Month and Max Week multiplier = same as 2015 Biowin calculated									
	Annual Average			Max Month (1.24 x Average_L)			Max Week (1.42 x Average_L)		
	gal/day	lbs/day	TS	gal/day	lbs/day	TS	gal/day	lbs/day	TS
To Thickening	2,237,500	209,000	1.12%	2,275,600	260,000	1.37%	2,269,100	299,000	1.58%
Produced Cake, Calculated									

Table 3-2. Projections of Raw Wastewater Flows and Solids at South District Wastewater Treatment Plant in 2020, 2025, 2035, and 2040

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

SDWWTP 2035 Biowin data, Solids to Thickening Per Flow Treated:									
Average	1,595	lbs/MG	1.12%						
SDWWTP 2040 Solids Inputs to Alternatives for SDWWTP Only Flow & Mass Balance:									
AADF Plant Influent 2035	131	mgd	Source: CH2M, 2016						
Growth	1.08		Source: WASD, 2013						
AADF Plant Influent 2040	138	mgd	Calculated (No Added Flow for Climate Change and Sea Level Rise)						
Max Month and Max Week Multiplier = Same as 2015 Biowin Calculated									
SDWWTP 2040 Biowin Based Data, Solids to Thickening Per Flow Treated:									
Average	1,595	lbs/MG	Assumed Same as 2035 (No Change from 2035 to 2040)						
	Annual Average			Max Month (1.24 x $Average_L$)			Max Week (1.42 x $Average_L$)		
	gal/day	lbs/day	TS	gal/day	lbs/day	TS	gal/day	lbs/day	TS
To Thickening	2,356,300	220,100	1.12%	2,388,500	272,900	1.37%	2,371,500	312,500	1.58%

Note:

SD = South District

Alternatives C-S-1, C-S-2, and C-S-3 are based on trucking dewatered solids from the CDWWTP to the SDWWTP and building one centralized BPF at the SDWWTP site (i.e., combined alternatives). In this alternatives evaluation, 2025 is the design year for sizing the composting/drying (as this year has the highest combined maximum month solids loadings). Startup is projected in 2020 with length of operation of 20 years.

SECTION 4

Alternatives Descriptions

This section includes descriptions and process flow schematics for each of the 11 alternatives evaluated in this technical memorandum. The alternatives are listed and described starting with the CDWWTP, then the SDWWTP, and followed by the three combined alternatives that evaluate a centralized regional BPF that would manage biosolids from both the SDWWTP and CDWWTP.

4.1 Central District Wastewater Treatment Plant Alternatives

There are three alternatives that evaluate a BPF treating biosolids produced by the CDWWTP. With each of these three alternatives, biosolids produced at the SDWWTP would be handled separately and, presumably, by one of the alternatives described under Section 4.2. The solids inputs for the alternatives flow and mass balances are shown in Table 3-1. The design year for sizing is 2025 and the facility is projected to startup in 2020 and operate for 20 years.

The number of required digesters and rehabilitation work varies for each alternative. Therefore, the capital cost for the digesters' rehabilitation (complete cluster rehabilitation and partial cluster rehabilitation depending on the alternative) is included in the estimated capital cost tables. The conventional mesophilic digesters' rehabilitation construction costs have been calculated based on the August 2016 bid for three digesters' rehabilitation work at the CDWWTP (Plant 2, Cluster 1). One cluster consists of four digesters around a central building housing digestion heating, mixing, and pumping equipment. The additional capital cost for the expansion of the existing thickening, dewatering, and combined heat and power (CHP) facilities beyond the scope of the current slated/approved work (i.e., Consent Decree) has been included in the capital cost and net present value tables. For each of the alternatives, costs related to yard piping, site civil, site electrical, and site instrumentation have been distributed to each process (except for the digestion, which costs were calculated as explained above and already include site civil, yard piping, electrical, instrumentation costs) based on the percent participation of the specific process cost to the overall alternative cost (digestion excluded).

4.1.1 Alternative C-1: Base Case at Central District Wastewater Treatment Plant

The Consent Decree program mandates a base level of biosolids-processing improvements at each WWTP (Alternative C-1). For the CDWWTP, those improvements include:

- Replace existing gravity sludge thickening with thickening centrifuges
- Refurbish existing anaerobic digesters (Plant 2, Digester Clusters 1, 2, and 3)
- Replace existing dewatering centrifuges with new dewatering centrifuges
- Dispose or land apply Class B biosolids cake to permitted agricultural sites

Figure 4-1 is a process flow schematic of Alternative C-1.

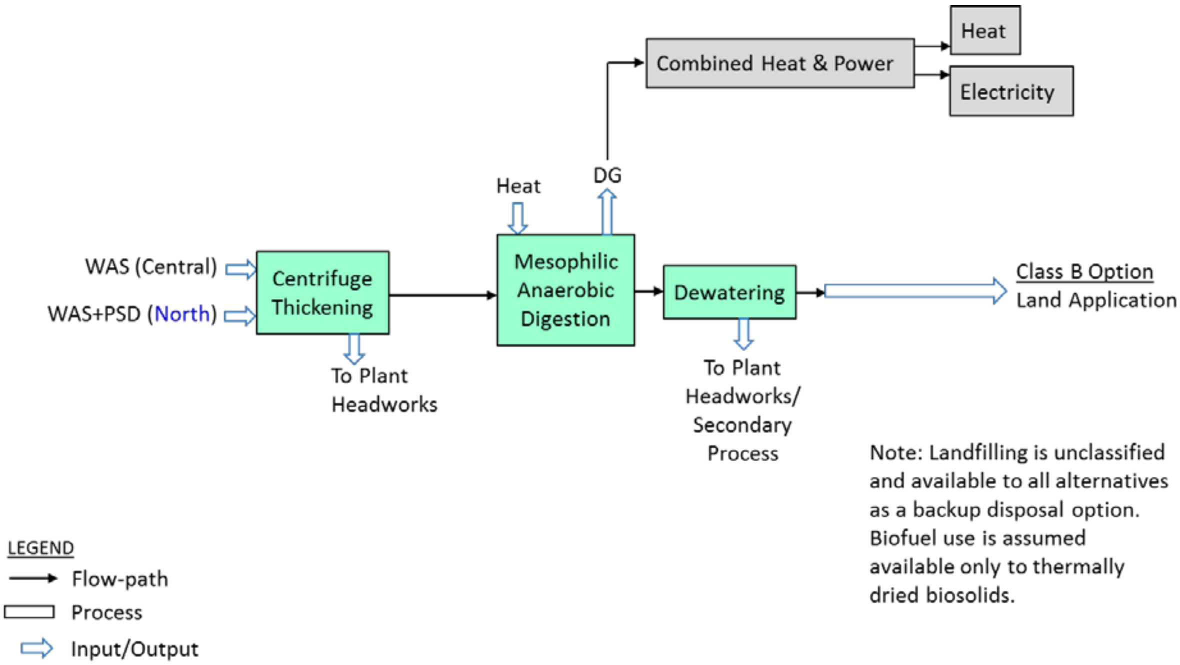

Figure 4-1. Alternative C-1: Base Case at Central District Wastewater Treatment Plant
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance of processes that comprise Alternative C-1 are summarized in Table 4-1.

Table 4-1. Central District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative C-1 Consent Decree (Base Case) Only
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
WAS Thickening				
Technology Used	Centrifuge			
Capture	95%			
TWAS Out (lbs/day)		284,600	446,300	
TWAS Out TS	5.5%			
Anaerobic Digestion				
Tanks In Service	11			3 clusters complete rehabilitation
Digester Feed VSS	82%			
Overall digester VSR	50%			
DG production (ft^3/day)		1,750,400	2,744,800	
DS Out (lbs/day)		167,900	263,300	
DS Out TS		3.2%	3.2%	
SRT [≥20 Days Average, 15 Days Max Month]		24	15	

Table 4-1. Central District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative C-1 Consent Decree (Base Case) Only
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
Dewatering				
Technology Used	Centrifuge			
Capture	95%			
DSC Out (dry tons/day)		79.8	125.1	
DSC Out TS	24%			
DSC Out (wet tons/day)		333	521	
BIOGAS - Utilization; Fuel to CHP (24/7 operation)				
DG to CHP (ft^3/day)		1,750,400	2,744,800	
Engine Thermal Efficiency	33.0%			No exhaust gas heat recovery
Available Heat for Other Uses (Btu/hr)		1,822,000	9,918,400	
Engine Electrical Efficiency	27.6%			
Power Generation (kW)		3,490	5,480	

Notes:
Btu/hr = British thermal units per hour
ft^3/day = cubed feet per day
gpm = gallons per minute
kW = kilowatt
lbs/day = pounds per day
VSS = volatile suspended solids

A summary breakdown of the estimated capital costs for Alternative C-1 is shown in Table 4-2. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-2. Estimated Capital Cost for Alternative C-1. Base Case (Consent Decree Improvements) at CDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	**Cost (2020$)**
Centrifuge Thickening	$9,533,000
Mesophilic Anaerobic Digesters	$134,965,000
Dewatering	$0
Combined Heat and Power Facility	$24,034,000
Estimated Capital Cost	$168,532,000

Note:

Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-2 includes cost estimates for the centrifuge thickening and CHP facilities, because the sizing calculations for these facilities required expansion for one more unit of each respective equipment in comparison to the Consent Decree design. The dewatering facility provided as part of the Consent Decree is adequate, so there is no additional cost for dewatering. The cost for the anaerobic digestion facility has been calculated as described in Section 4.1. Alternative C-1 has higher anaerobic digestion costs than other alternatives, because more digestion volume is required to meet the Class B requirements of Alternative C-1, than is required when other processes are used to meet Class AA requirements, such as THP in Alternative C-2 and thermal drying in Alternative C-3.

4.1.2 Alternative C-2: Thermal Hydrolysis Process at Central District Wastewater Treatment Plant

Alternative C-2 includes design elements at the CDWWTP that comprise the base case Alternative C-1 and also implements THP prior to digestion at CDWWTP. When accomplished as a batch process, THP provides the time-temperature relationship required to meet Class AA biosolids requirements, which opens the door to market Class AA THP biosolids as soil amendment without site restrictions.

The installation of THP adds screening and pre-dewatering processes after thickening and subsequently reduces the hydraulic loading to the anaerobic digestion process, which substantially reduces the size of anaerobic digestion facilities. THP has higher solids content in the dewatered biosolids due to volatile solids reduction and ultimately much less volume of cake solids requiring subsequent handling. The THP facility would operate year-round and produce Class AA biosolids, which would be marketed as Class AA biosolids. Figure 4-2 is a process flow schematic of Alternative C-2.

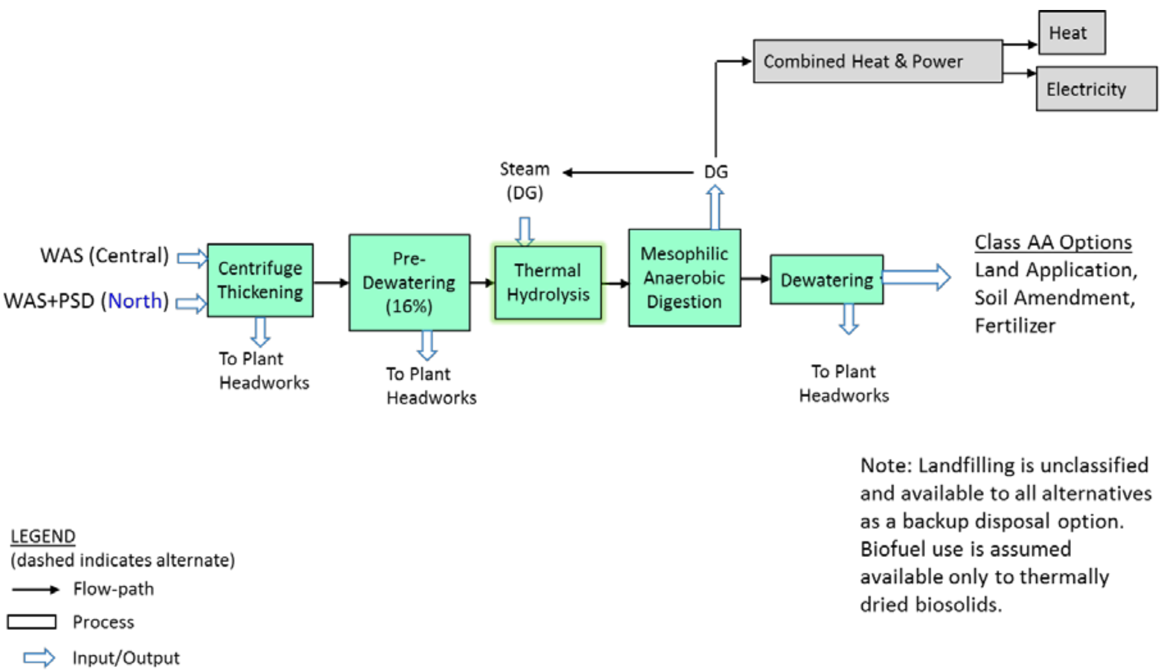

Figure 4-2. Alternative C-2: Thermal Hydrolysis Process at Central District Wastewater Treatment Plant
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and flow-mass balance of the processes that comprise Alternative C-2 are summarized in Table 4-3. A 6% increase in dry solids from 24% TS to 30% TS would be expected with THP.

Table 4-3. Central District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative C-2 Thermal Hydrolysis
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		Annual Average	Max Month	Notes
WAS Thickening				
Technology Used	Centrifuge			
Capture	95%			
TWAS Out (lbs/day)		284,600	446,300	
TWAS Out TS	5.5%			
TWAS Pre-Dewatering				
Technology Used	Centrifuge			
Capture	95%			
TWAS Out (lbs/day)		270,400	424,000	
TWAS Out TS	16.0%			
Thermal Hydrolysis				
CWAS Out TS	13%			
CWAS Out (lbs/day)		270,400	424,000	
Anaerobic Digestion				
Tanks In Service	5			1 cluster complete and 1 cluster partial rehabilitation
CWAS diluted In TS	10%			
Digester Feed VSS	82%			
Overall digester VSR	60%			
DG production (ft^3/day)		1,995,500	3,129,100	
DS Out (lbs/day)		137,400	215,400	
DS Out TS		5.1%	5.1%	
SRT [≥15 days average, 12 days max month]		21	13	
DS Dewatering				
Technology Used	Centrifuge			
Capture	95%			
DSC Out (dry tons/day)		65.2	102.3	
DSC Out TS	30%			
DSC Out (wet tons/day)		217	341	
BIOGAS - Utilization; Fuel to Boilers and CHP (24/7 Operation)				
DG to CHP (ft^3/day)		1,557,100	2,441,700	

Table 4-3. Central District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative C-2 Thermal Hydrolysis
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
DG to hi P Steam Boiler (ft^3/day)		438,400	687,400	
Engine Thermal Efficiency	33.0%			No exhaust gas heat recovery.
Available Heat for Other Uses (Btu/hr)		12,678,100	19,880,400	
Engine Electrical Efficiency	27.6%			
Power Generation (kW)		3,110	4,870	

Note: CWAS = conditioned waste activated sludge

A summary breakdown of the estimated capital costs for Alternative C-2 is shown in Table 4-4. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-4. Estimated Capital Cost for Alternative C-2. Thermal Hydrolysis at CDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	**Cost (2020$)**
Centrifuge Thickening	$8,023,000
Screening and Pre-Dewatering	$50,523,000
Thermal Hydrolysis	$99,676,000
Mesophilic Anaerobic Digesters	$73,628,000
Dewatering	$0
Combined Heat and Power Facility	$0
Boiler Building	$29,929,000
Estimated Capital Cost	$261,779,000

Note:

Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-4 includes cost estimates for the centrifuge thickening facility, because the sizing calculations required expansion for one more centrifuge in comparison to the Consent Decree design. The cost of the centrifuge thickening for Alternative C-2 is slightly less than for Alternative C-1 because the cost markups for centrifuge thickening are slightly different between the two alternatives. Consent Decree program dewatering and CHP facilities are adequate in this alternative and therefore have no additional cost. Alternative C-2 has screening and pre-dewatering processes and a high-pressure steam boilers building that are required for THP, as well as the thermal hydrolysis process, so those facilities are added to the Base Case. The cost for the anaerobic digestion has been calculated as described under Section 4.1.

4.1.3 Alternative C-3: Thermal Drying at Central District Wastewater Treatment Plant

Alternative C-3 includes the design elements at the CDWWTP that comprise the base case Alternative C-1. The solids thickening, anaerobic digestion, and dewatering process of Alternative C-3 are also identical in configuration and sizing to Alternative C-1.

The primary additional feature of Alternative C-3 is a new and completely enclosed thermal biosolids drying facility, utilizing belt-drying technology that can operate at 200 to 300 degrees Fahrenheit (°F) on waste heat from biogas cogeneration facilities. The thermal drying facility would operate year-round and convert all Class B dewatered biosolids into dried biosolids product, which would be marketed as a Class AA biosolids soil amendment. Figure 4-3 is a process flow schematic of Alternative C-3.

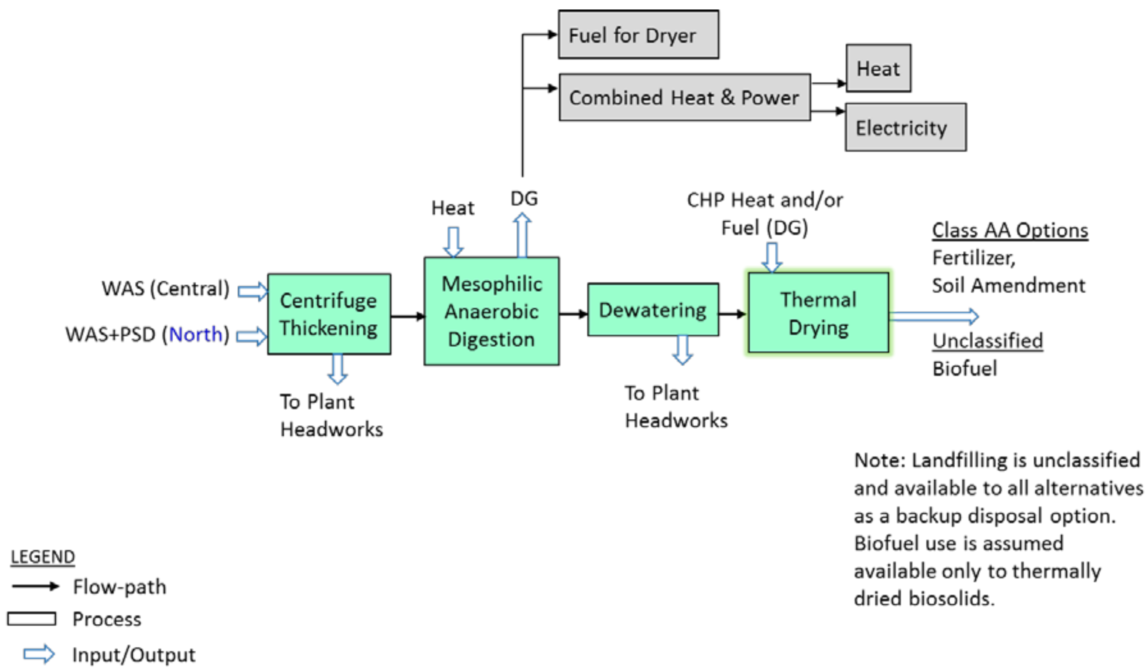

Figure 4-3. Alternative C-3: Thermal Drying at Central District Wastewater Treatment Plant
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance of the processes that comprise Alternative C-3 are summarized in Table 4-5.

Table 4-5. Central District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative C-3 Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
WAS Thickening				
Technology Used	Centrifuge			
Capture	95%			
TWAS Out (lbs/day)		284,600	446,300	
TWAS Out TS	5.5%			

Table 4-5. Central District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative C-3 Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
ANAEROBIC DIGESTION				
Tanks In Service	9			2 clusters complete and 1 cluster partial rehabilitation
Digester Feed VSS	82%			
Overall Digester VSR		50%	50%	
DG production (ft^3/day)		1,750,400	2,744,800	
DS Out (lbs/day)		167,900	263,300	
DS Out TS		3.2%	3.2%	
SRT [≥15 Days Average, 12 Days Max Month]		19	12	
DS DEWATERING				
Technology Used	Centrifuge			
Capture	95%			
DSC Out (dry tons/day)		79.8	125.1	
DSC Out TS	24%			
DRYING				
Technology Used	Direct Belt			
Capture	100%			
Dryer Out (dry tons/day)		79.8	125.1	
Dryer Out TS	90%			
Dryer Out (wet tons/day)		89	139	
Dryer thermal Efficiency (Btu/lb H2O evaporated)	1,300			
BIOGAS – DRYER Utilization; Fuel to CHP, and BOILER (24/7 operation)				
DG to Dryer (ft^3/day)		1,070,100	1,678,100	
DG to Boiler (ft^3/day)		412,200	412,200	
DG to CHP (ft^3/day)		268,100	654,500	
Engine Thermal Efficiency	33.0%			No exhaust gas heat recovery.
Available Heat for Other Uses (Btu/hr)		2,182,700	5,329,200	
Engine Electrical Efficiency	27.6%			
Power Generation (kW)		535	1,310	

A summary breakdown of the estimated capital costs for Alternative C-3 is shown in Table 4-6. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-6. Estimated Capital Cost for Alternative C-3. Thermal Drying at CDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	Cost (2020$)
Centrifuge Thickening	$8,147,000
Mesophilic Anaerobic Digesters	$118,616,000
Dewatering	$0
Combined Heat and Power	$0
Boiler Building	$6,102,000
Thermal Drying Building	$178,595,000
Estimated Capital Cost	$311,460,000

Note: Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-6 includes cost estimates for the centrifuge thickening facility, because the sizing calculations required expansion for one more centrifuge in comparison to the Consent Decree design. The cost of centrifuge thickening for Alternative C-3 is lower than for Alternative C-1, because the cost markups for centrifuge thickening are slightly different between the two alternatives. Consent Decree program dewatering and CHP facilities are adequate in this alternative and therefore have no additional cost. Alternative C-3 has the drying facility cost added to the Base Case, as well as an additional Boiler Building required for digester heating (the produced digester gas is not sufficient for both dryer fuel and CHP digester heat generation). The cost for the anaerobic digestion has been calculated as described under Section 4.1.

4.2 South District Wastewater Treatment Plant Alternatives

There are five alternatives that evaluate a BPF treating biosolids produced only by the SDWWTP. The solids inputs for these alternatives flow and mass balance are shown in Table 3-2. Design year for sizing is 2040, facility is projected to startup in 2020 and operate for 20 years. With each of these five alternatives, biosolids produced at the CDWWTP would be handled separately by one of the alternatives described in Section 4.1. To arrive at an estimate of total life-cycle cost for biosolids management under the alternative scenarios in this section, one of the following five alternatives for SDWWTP would need to be combined with one of the three alternatives for CDWWTP.

The number of required digesters and rehabilitation work varies for each alternative. Therefore, the capital cost for the digesters' rehabilitation (complete cluster rehabilitation and partial cluster rehabilitation depending on the alternative) is included in the estimated capital cost tables. The conventional mesophilic digesters' rehabilitation construction costs have been calculated based on the August 2016 bid for three digesters' rehabilitation work at the CDWWTP (Plant 2, Cluster 1). One cluster consists of four digesters around a central building housing digestion heating, mixing, and pumping equipment. The acid phase digesters' construction cost has been calculated based on the July 2015 BODR (CH2M, 2015c). For all other facilities (i.e., thickening, dewatering, CHP) only the additional capital cost for the expansion of these facilities beyond the scope of the current slated/approved work (i.e., Consent Decree) has been included in the capital cost and present value tables. The additional capital cost for the expansion of the existing thickening and dewatering facilities beyond the scope of the current slated/approved work (i.e., Consent Decree) has been included in the capital cost and net present value tables. For each of the alternatives, costs related to yard piping, site civil, site electrical, and site instrumentation have been distributed to each process (except for the digestion which costs were calculated as explained above and already include site civil, yard piping, electrical, instrumentation costs) based on the cost ratio of each process relative to the overall alternative cost (digestion excluded).

4.2.1 Alternative S-1: Base Case at South District Wastewater Treatment Plant

The Consent Decree program mandates a base level of biosolids-processing improvements at each WWTP. For the SDWWTP, those improvements include:

- Replace existing gravity sludge thickening with thickening centrifuges
- Refurbish existing anaerobic Digester Clusters 1 and 2, and make minor improvements to Digester Cluster 3.
- Convert from simple mesophilic digestion to acid-gas (two phase) digestion
- Install new fats, oil, and grease (FOG) receiving facility that heats and feeds FOG directly to anaerobic digesters
- Upgrade existing combined heat and power (cogeneration) facilities
- Replace existing dewatering centrifuges with new dewatering centrifuges
- Air dry or compost dewatered biosolids as weather conditions permit
- Land apply Class B biosolids cake on permitted agricultural sites, use it for feedstock at merchant composting facilities, and market whatever Class AA biosolids compost is produced to soil blenders.

Figure 4-4 is a process flow schematic of Alternative S-1.

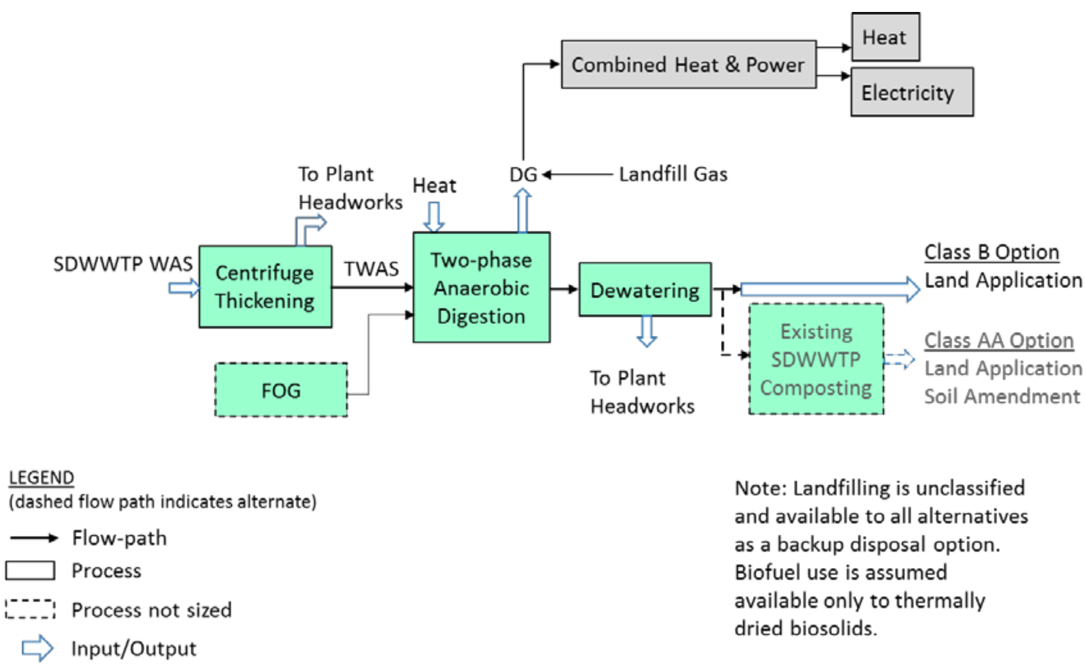

Figure 4-4. Alternative S-1: Base Case at South District Wastewater Treatment Plant

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance for the processes that comprise Alternative S-1 are summarized in Table 4-7.

Table 4-7. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-1 Consent Decree (Base Case) Only
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
WAS Thickening				
Technology Used	Centrifuge			
Capture	95%			
TWAS Out (lbs/day)		209,100	259,300	
TWAS Out TS	5.5%			
ANAEROBIC DIGESTION				
Tanks In Service (in addition to the acid phase)	7			2 clusters complete, and 1 cluster partial rehabilitation (for 2 emergency plus 2 storage)
Digester Feed VSS	85%			
Overall Digester VSR (two-phase Digestion Upgrade)	50%			
DG Production (ft^3/day)		1,332,400	1,652,100	
DS Out (lbs/day)		120,300	149,100	
DS Out TS		3.2%	3.2%	
SRT [≥20 Days Average, 15 Days Max Month]		20	16	
DEWATERING				
Technology Used	Centrifuge			
Capture	95%			
DSC Out (dry tons/day)		57.1	70.8	
DSC Out TS [based on CDWWTP 2015 data]	20%			
DSC Out (wet tons/day)		286	354	
BIOGAS - Utilization; Fuel to CHP (24/7 operation)				**% of total for Average:**
DG to CHP (ft^3/day)		1,332,400	1,652,100	65%
LG to CHP (ft^3/day) at 500 cfm		720,000	720,000	35%
Engine Thermal Efficiency	49.9%			With exhaust gas heat recovery
Available Heat for Other Uses (Btu/hr)		15,584,500	19,822,600	
Engine Electrical Efficiency	39.1%			
Power Generation (kW)		5,370	6,350	

A summary breakdown of the estimated capital costs for Alternative S-1 is shown in Table 4-8. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-8. Estimated Capital Cost for Alternative S-1. Base Case (Consent Decree Improvements) at SDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	Cost (2020$)
Centrifuge Thickening	$9,597,000
Two-phase Anaerobic Digestion	$136,075,000
Solids Dewatering	$9,597,000
Combined Heat and Power	$0
Estimated Capital Cost	$155,269,000

Note:

Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-8 includes cost estimates for the centrifuge thickening and dewatering facilities, because one more equipment unit in each process is needed, compared to the Consent Decree design. The Consent Decree CHP facility is adequate for this alternative, so CHP has no additional costs. The cost for the anaerobic digestion facility has been calculated as described in Section 4.2. Alternative S-1 has higher anaerobic digestion costs than other alternatives because more digestion volume is required to meet the Class B requirements of Alternative S-1 than is required when other processes are used to meet Class AA requirements, such as THP in Alternative S-2 and thermal drying in Alternative S-3.

4.2.2 Alternative S-2: Thermal Hydrolysis Process at South District Wastewater Treatment Plant

Alternative S-2 includes design elements at the SDWWTP that comprise the base case Alternative S-1 and also implements THP prior to digestion at CDWWTP. When accomplished as a batch process, THP provides the time-temperature relationship required to meet Class AA biosolids requirements, which opens the door to market Class AA THP biosolids as soil amendment without site restrictions.

The installation of THP adds screening and pre-dewatering processes after thickening and subsequently reduces the hydraulic loading to the anaerobic digestion process, which substantially reduces the size of anaerobic digestion facilities. THP has higher solids content in the dewatered biosolids due to volatile solids reduction, and ultimately much less volume of cake solids requiring subsequent handling. The THP facility would operate year-round and produce Class AA biosolids product, which would be marketed as Class AA biosolids. Figure 4-5 is a process flow schematic of Alternative S-2.

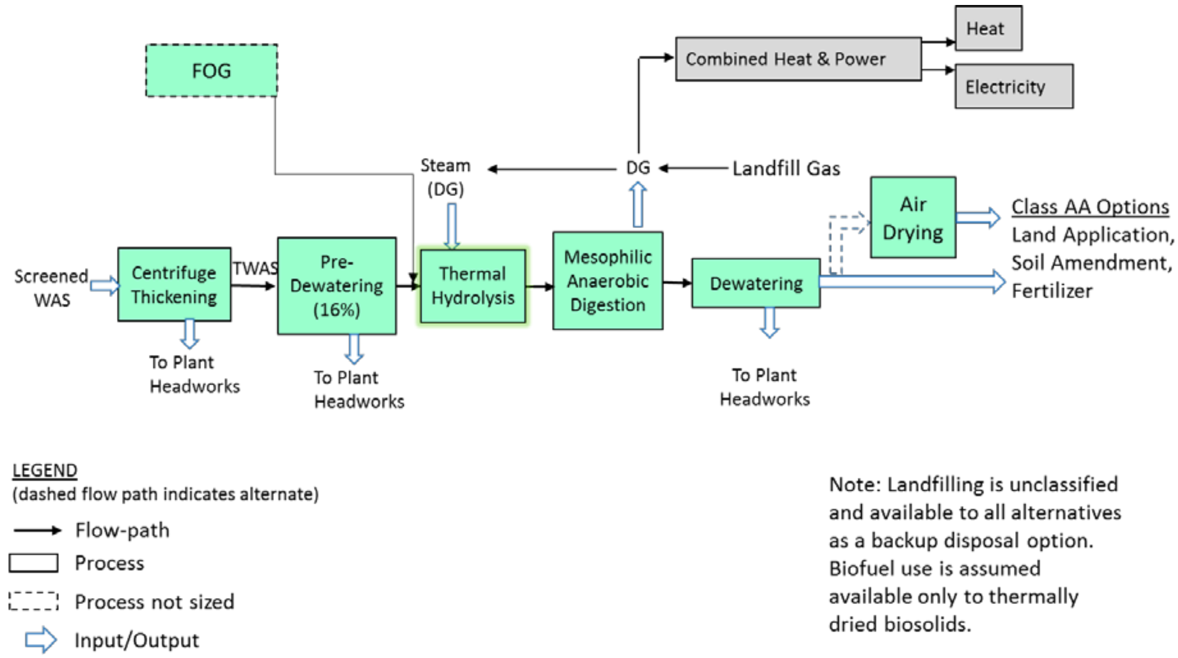

Figure 4-5. Alternative S-2: Thermal Hydrolysis at the South District Wastewater Treatment Plant
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance of the processes that comprise Alternative S-2 are summarized in Table 4-9. An increase in the percent total solids of the dewatered cake is expected in comparison to the Base Case because of the THP.

Table 4-9. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-2 Thermal Hydrolysis
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
WAS Thickening				
Technology Used	Centrifuge			
Capture	95%			
TWAS Out (lbs/day)		209,100	259,300	
TWAS Out TS	5.5%			
TWAS Pre-Dewatering				
Technology Used	Centrifuge			
Capture	95%			
TWAS Out (lbs/day)		198,600	246,300	
TWAS Out TS	16%			
Thermal Hydrolysis				
CWAS Out TS	13%			
CWAS Out (lbs/day)		198,600	246,300	

Table 4-9. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-2 Thermal Hydrolysis
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
Anaerobic Digestion				
Tanks In Service	3			1 cluster complete, and 1 cluster partial rehabilitation (for 2 emergency plus 2 storage)
CWAS In diluted TS	10%			
Overall digester VSR		53%	53%	
DG production (ft^3/day)		1,329,600	1,648,600	
DS Out (lbs/day)		110,000	136,400	
DS Out TS		5.5%	5.5%	
SRT [≥15 days average, 12 days max month]		17	14	
DS DEWATERING				
Technology Used	centrifuge			
Capture	95%			
DSC Out (dry tons/day)		52.2	64.8	
DSC Out TS	28%			
DSC Out (wet tons/day)		186	231	
BIOGAS - Utilization; Fuel to CHP, and HI P BOILER (24/7 operation)				% of total for Average:
DG to hi P Steam Boiler (ft^3/day)		51,600	68,400	3%[1]
DG to CHP (ft^3/day)		1,278,000	1,580,200	62%
LG to CHP (ft^3/day) at 500 cfm		720,000	720,000	35%
Engine Thermal Efficiency	49.9%			With exhaust heat recovery
Available Heat for Other Uses (Btu/hr)		12,860,500	10,052,900	
Engine Electrical Efficiency	39.1%			
Power Generation (kW)		4,930	4,630	

[1] Remaining THP steam is generated at the high pressure steam boilers either with the use of dual burner (connected to CHP exhaust gas, and to DG) or by pumping the boiler hot water through the CHP exhaust gas recovery system and then to the high pressure steam boiler.

A summary breakdown of the estimated capital costs for Alternative S-2 is shown in Table 4-10. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-10. Estimated Capital Cost for Alternative S-2. Thermal Hydrolysis at SDWWTP Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	**Cost ($2020)**
Centrifuge Thickening	$8,489,000
Screening and Pre-Dewatering	$49,780,000
Thermal Hydrolysis	$95,574,000
Mesophilic Anaerobic Digesters	$73,628,000
Dewatering	$0
Boiler Building	$22,817,000
Combined Heat and Power	$0
Estimated Capital Cost	$250,288,000

Note:

Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-10 includes cost estimates for the centrifuge thickening facility, because one more centrifuge is needed for this alternative in comparison to the Consent Decree design. The cost of centrifuge thickening for Alternative S-2 is less than for Alternative S-1 because the cost markups for centrifuge thickening are slightly different between the two alternatives. Consent Decree program dewatering and CHP facilities are adequate for this alternative, and therefore have no additional cost. Alternative S-2 has screening, pre-dewatering processes and high pressure steam boiler building that are required for THP, as well as the thermal hydrolysis process and are added to the Base Case. The cost for the anaerobic digestion has been calculated as described under Section 4.2.

4.2.3 Alternative S-3: Composting at South District Wastewater Treatment Plant

Alternative S-3 includes all the design elements at the SDWWTP that comprise the base case Alternative S-1. The solids thickening, anaerobic digestion, and dewatering process of this Alternative S-3 are also identical in configuration and sizing to Alternative S-1.

The primary additional feature of Alternative S-3 is a new and completely enclosed biosolids composting facility, utilizing the aerated-static pile process with full odor control. The new and enclosed composting facility would operate year-round and convert all Class B dewatered biosolids into compost product, which would be marketed as a Class AA biosolids soil amendment. Figure 4-6 is a process flow schematic of Alternative S-3.

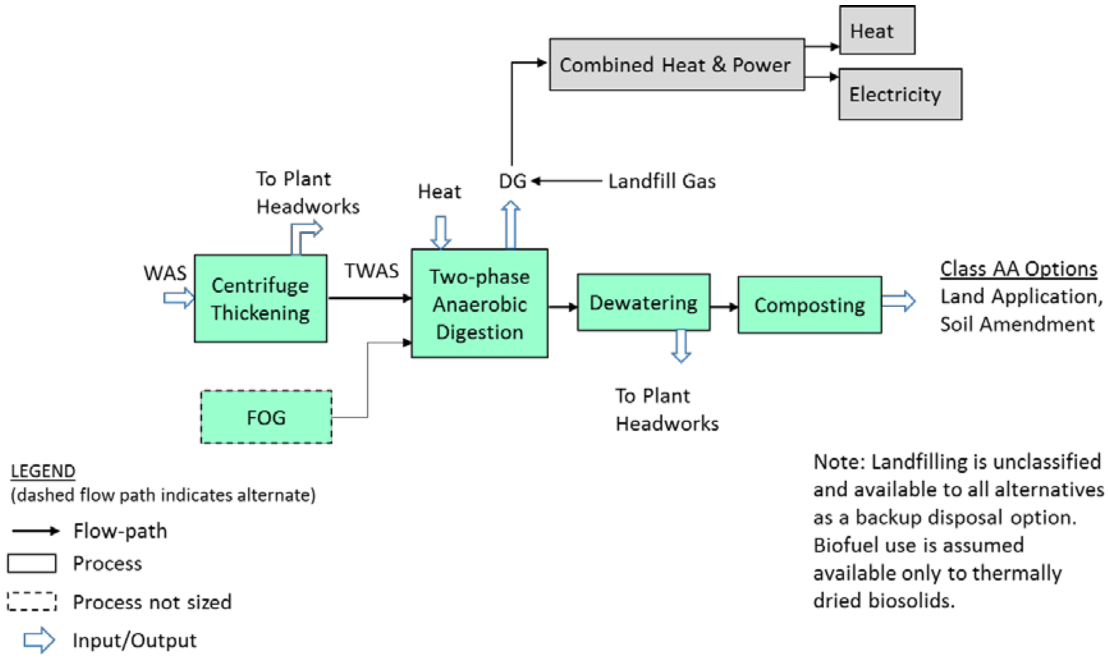

Figure 4-6. Alternative S-3: Composting at South District Wastewater Treatment Plant
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance of the processes that comprise Alternative S-3 are summarized in Table 4-11.

Table 4-11. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-3 Composting at SDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
WAS Thickening				
Technology Used	centrifuge			
Capture	95%			
TWAS Out (lbs/day)		209,100	259,300	
TWAS Out TS	5.5%			
Anaerobic Digestion				
Tanks In Service (in addition to the acid phase)	7			2 clusters complete, and 1 cluster partial rehabilitation (for 2 emergency plus 2 storage)
Digester Feed VSS	85%			
Overall digester VSR	50%			
DG production (ft^3/day)		1,332,400	1,652,100	
DS Out (lbs/day)		120,300	149,100	
DS Out TS		3.2%	3.2%	

Table 4-11. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-3 Composting at SDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
SRT [≥20 days average, 15 days max month]		20	16	
DS Dewatering				
Technology Used	Centrifuge			
Capture	95%			
DSC Out (dry tons/day)		57.1	70.8	
DSC Out TS [based on SDWWTP 2015 data]	20%			
DSC Out (wet tons/day)		286	354	
BIOGAS - Utilization; Fuel to CHP (24/7 operation)				% of total for Average:
DG to CHP (ft^3/day)		1,332,400	1,652,100	65%
LG to CHP (ft^3/day) at 500 cfm		720,000	720,000	35%
Engine Thermal Efficiency	49.9%			With exhaust gas heat recovery
Available Heat for Other Uses (Btu/hr)		6,208,000	8,747,400	
Engine Electrical Efficiency	39.1%			
Power Generation (kW)		5,370	6,350	

A summary breakdown of the estimated capital costs for Alternative S-3 is shown in Table 4-12. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-12. Estimated Capital Cost for Alternative S-3. Composting at SDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	**Cost (2020$)**
Centrifuge Thickening	$7,967,000
Acid-Mesophilic Anaerobic Digesters	$136,074,000
Solids Dewatering	$8,004,000
Composting Facility	$189,073,000
Combined Heat and Power	$0
Estimated Capital Cost	$341,118,000

Note:
Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-12 includes cost estimates for the centrifuge thickening and dewatering facilities, one more unit of each respective equipment is needed for this alternative, compared to the consent decree design. The consent decree program CHP facility is adequate for this alternative and therefore has no additional cost. The cost for the anaerobic digestion facility has been calculated as described in Section 4.2.

Digestion requirements are the same as for the Base Case. The composting facility to meet Class AA requirements is the major additional cost of this Alternative S-3.

4.2.4 Alternative S-4: Thermal Drying at South District Wastewater Treatment Plant

Alternative S-4 includes all the design elements at the SDWWTP that comprise the base case Alternative S-1. The solids thickening, anaerobic digestion, and dewatering process of this Alternative S-4 are also identical in configuration and sizing to Alternative S-1.

The primary additional feature of Alternative S-4 is a new and completely enclosed thermal biosolids drying facility, utilizing belt-drying technology which can operate at 200 to 300°F on waste heat from biogas cogeneration facilities. The thermal drying facility would operate year-round and convert all Class B dewatered biosolids into dried biosolids product, which would be marketed as a Class AA biosolids soil amendment. Figure 4-7 is a process flow schematic of Alternative S-4.

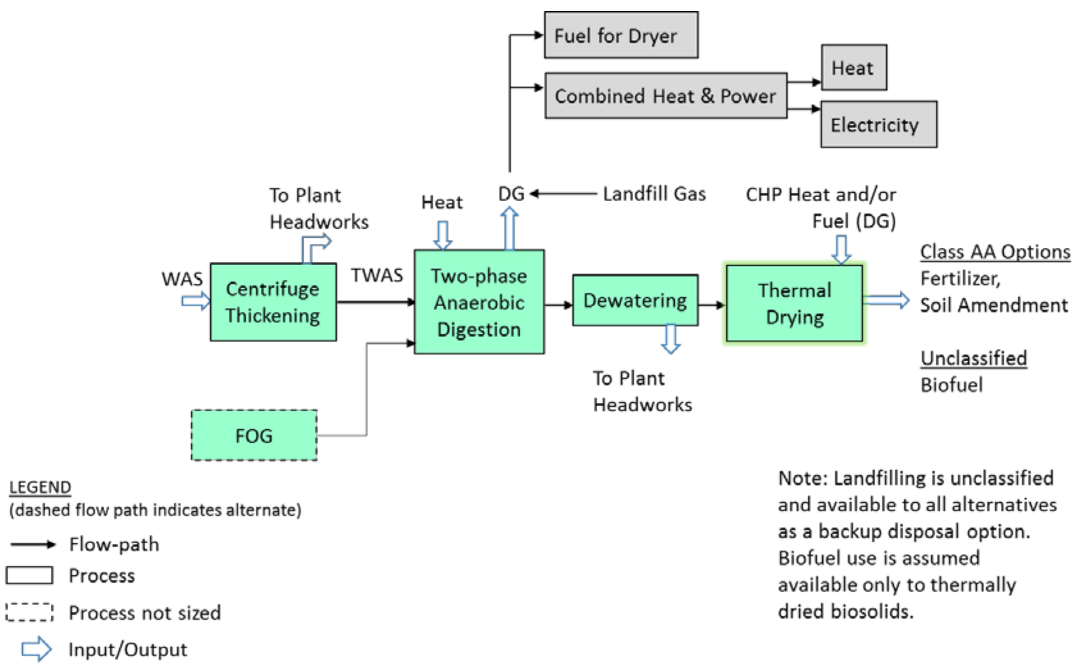

Figure 4-7. Alternative S-4: Thermal Drying at South District Wastewater Treatment Plant
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance of the processes that comprise Alternative S-4 are summarized in Table 4-13.

Table 4-13. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-4 Thermal Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	Annual Average	Max Month	Notes
WAS THICKENING			
Technology Used	Centrifuge		
Capture	95%		

Table 4-13. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-4 Thermal Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
TWAS Out (lbs/day)		209,100	259,300	
TWAS Out TS	5.5%			
Anaerobic Digestion				
Tanks In Service (in addition to acid phase)	5			2 clusters complete rehabilitation (includes 1 emergency plus 1 storage)
Digester Feed VSS	85%			
Overall digester VSR	50%			
DG production (ft^3/day)		1,332,400	1,652,100	
DS Out (lbs/day)		120,300	149,100	
DS Out TS		3.2%	3.2%	
SRT [≥15 Days Average, 12 Days Max Month]		15	12	
DS Dewatering				
Technology Used	Centrifuge			
Capture	95%			
DSC Out (dry tons/day)		57.1	70.8	
DSC Out TS [based on CDWWTP 2015 data]	20%			
Drying				
Technology Used	Direct Belt			
Capture	100%			
Dryer Out (dry tons/day)		57.1	70.8	
Dryer Out TS	90%			
Dryer Out (wet tons/day)		63	79	
Dryer Thermal Efficiency (BTU/lb H2O evaporated)	1,300			
BIOGAS - Utilization; Fuel to DRYER, and CHP (24/7 Operation)				% of total for Average:
DG to Dryer (ft^3/day)		781,900	1,123,100	38%
DG to CHP (ft^3/day)		550,600	529,000	27%
LG to CHP (ft^3/day) at 500 cfm		720,000	720,000	35%
Engine thermal efficiency	49.9%			With exhaust heat recovery
Available Heat for Other Uses (Btu/hr)		856,100	685,100	
Engine Electrical Efficiency	39.1%			

Table 4-13. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-4 Thermal Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	Annual Average	Max Month	Notes
Power Generation (kW)	2,990	2,930	

A summary breakdown of the estimated capital costs for Alternative S-4 is shown in Table 4-14. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-14. Estimated Capital Cost for Alternative S-4. Thermal Drying at SDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	Cost (2020$)
Centrifuge Thickening	$8,594,000
Acid-Mesophilic Anaerobic Digesters	$107,435,000
Solids Dewatering	$8,594,000
Thermal Drying Building	$171,634,000
Combined Heat and Power	$0
Estimated Capital Cost	$296,257,000

Note:

Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-14 includes cost estimates for the centrifuge thickening and dewatering facilities, because one more equipment unit is needed for each process compared to the Consent Decree design. The cost of centrifuge thickening for Alternative S-4 is less than for Alternative S-1 because the cost markups for centrifuge thickening are slightly different between the two alternatives. The Consent Decree program CHP facility is adequate for this alternative and therefore shows no additional cost. Alternative S-4 has the drying facility cost added to the Base Case. The cost for the anaerobic digestion has been calculated as described under section 4.2.

4.2.5 Alternative S-5: Thermal Hydrolysis Followed by Thermal Drying at South District Wastewater Treatment Plant

Alternative S-5 includes the design elements at the SDWWTP that comprise case Alternative S-2, followed by a drying facility similar to Alternative S-4.

The thermal drying facility would operate year-round and convert all dewatered biosolids into dried biosolids product, which would be marketed as a Class AA biosolids soil amendment. Figure 4-8 is a process flow schematic of Alternative S-5.

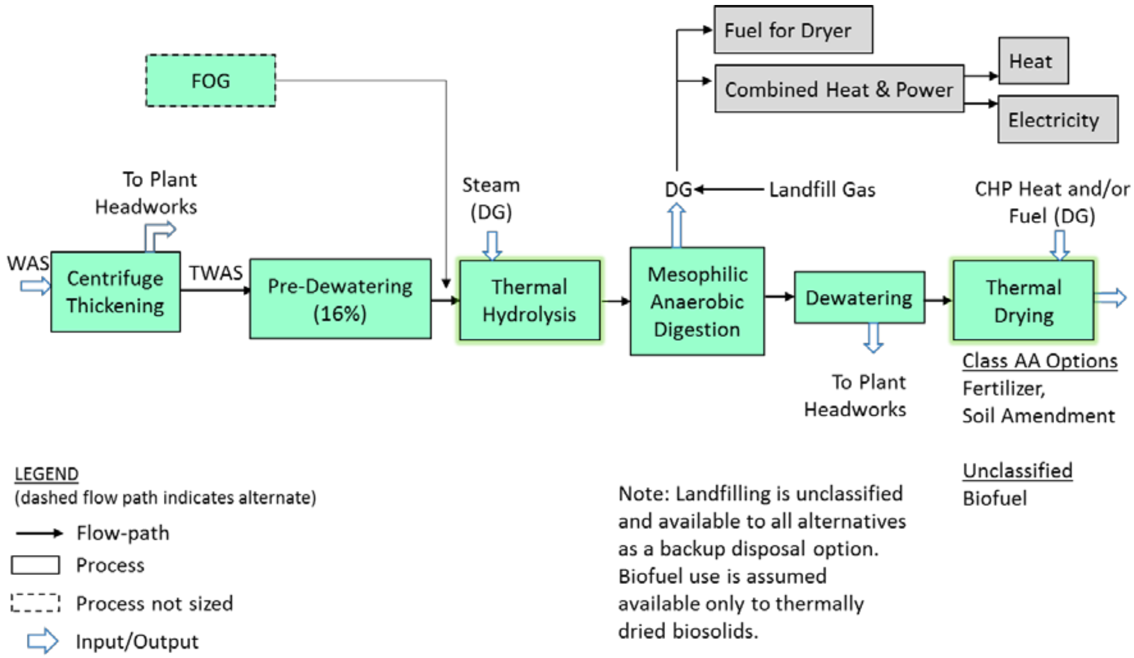

Figure 4-8. Alternative S-5: Thermal Hydrolysis Followed by Thermal Drying at South District Wastewater Treatment Plant

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance of the processes that comprise Alternative S-5 are summarized in Table 4-15.

Table 4-15. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-5 Thermal Hydrolysis and Drying

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		Annual Average	Max Month	Notes
WAS Thickening				
Technology Used	Centrifuge			
Capture	95%			
TWAS Out (lbs/day)		209,100	259,300	
TWAS Out TS	5.5%			
TWAS Predewatering				
Technology Used	Centrifuge			
Capture	95%			
TWAS Out (lbs/day)		198,600	246,300	
TWAS Out TS	16%			
Thermal Hydrolysis				
CWAS Out TS	13%			
CWAS Out (lbs/day)		198,600	246,300	
Anaerobic Digestion				

Table 4-15. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-5 Thermal Hydrolysis and Drying

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process		**Annual Average**	**Max Month**	**Notes**
Tanks In Service	3			1 cluster complete, and 1 cluster partial rehabilitation (for 2 emergency plus 2 storage)
CWAS In diluted TS	10%			
Digester Feed VSS	85%			
Overall digester VSR	53%			
DG production (ft^3/day)		1,329,600	1,648,600	
DS Out (lbs/day)		110,000	136,400	
DS Out TS		5.5%	5.5%	
SRT [≥15 Days Average, 12 Days Max Month]		17	14	
DS Dewatering				
Technology Used	centrifuge			
Capture	95%			
DSC Out (dry tons/day)		52.2	64.8	
DSC Out TS	28%			
Drying				
Technology Used	Direct Belt			
Capture	100%			
Dryer Out (dry tons/day)		52.2	64.8	
Dryer Out TS	90%			
Dryer (wet/day)		58	72	
Dryer Thermal Efficiency (BTU/lb H2O evaporated)	1,300			
BIOGAS - Utilization; Fuel to CHP, and HI P BOILER (24/7 operation)				**% of total for Average:**[(1)]
DG to Dryer (ft^3/day)		256,800	699,800	11%
DG to hi P Steam Boiler (ft^3/day)		402,500	145,600	18%[(2)]
DG to CHP (ft^3/day)		670,300	803,200	29%
LG to CHP (ft^3/day) at 500 cfm		720,000	720,000	31%
NG to CHP (ft^3/day)		243,800	243,800	11%
Engine Thermal Efficiency	49.9%			With exhaust heat recovery
Available Heat for Other Uses (Btu/hr)		11,262,300	12,242,700	
Power Generation (kW)		4,320	4,690	

Table 4-15. South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Alternative S-5 Thermal Hydrolysis and Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	Annual Average	Max Month	Notes

(1) Biogas utilization was selected such that to provide the best balance of biogas distribution between dryer, high pressure steam boiler, and CHP to meet all needs (and required steam pressures) and minimize the use of NG.

(2) Remaining THP steam is generated at the high pressure steam boilers either with the use of dual burner (connected to CHP exhaust gas, and to DG) or by pumping the boiler hot water through the CHP exhaust gas recovery system and then to the high pressure steam boiler.

A summary breakdown of the estimated capital and O&M costs for Alternative S-5 is shown in Table 4-16. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-16. Estimated Capital Cost for Alternative S-5. Thermal Hydrolysis Followed by Thermal Drying at SDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	Cost (2020$)
Centrifuge Thickening	$8,291,000
Screening and Pre-Dewatering	$48,382,000
Thermal Hydrolysis	$93,088,000
Mesophilic Anaerobic Digesters	$73,628,000
Dewatering	$0
Thermal Drying Building	$119,082,000
Boiler Building	$22,273,000
Combined Heat and Power	$0
Estimated Capital Cost	$364,744,000

Note:

Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-16 includes cost estimates for centrifuge thickening, because one more centrifuge is required, compared to the Consent Decree design. The cost of the centrifuge thickening for Alternative S-5 is less than for Alternative S-1 because the cost markups for centrifuge thickening are slightly different between the two alternatives. The Consent Decree program CHP facility is adequate for this alternative and therefore shows no additional cost. Alternative S-4 also has the screening, pre-dewatering, high-pressure steam boiler, thermal hydrolysis, and drying facilities costs added to the Base Case. The 6% increase in dry solids from expected with THP compared to the Base Case resulted in a smaller thermal drying facility than Alternative S-4. The cost for the anaerobic digestion has been calculated as described under Section 4.2.

4.3 Combined Alternatives

There are three alternatives that evaluate a BPF treating biosolids produced by both the CDWWTP and the SDWWTP. With each of these three alternatives, dewatered biosolids produced at the CDWWTP would be hauled by truck to the SDWWTP and combined with SDWWTP biosolids, then either composted (Alternative C-S-1) or thermally dried (Alternative C-S-2) at a centralized regional BPF.

In Alternative C-S-3, biosolids would undergo thermal hydrolysis at the CDWWTP and SDWWTP, then the dewatered CDWWTP biosolids would be hauled by truck to the SDWWTP and thermally dried in a centralized thermal dryer facility at the SDWWTP. The solids inputs for these alternatives flow and mass balance are shown in Tables 3-1 and 3-2. Design year for sizing composting/drying is 2025 (as this year has the highest combined maximum month solids loadings), facility is projected to startup in 2020 and operate for 20 years.

The number of required digesters and rehabilitation work varies for each alternative. Therefore, the capital cost for the digesters' rehabilitation (complete cluster rehabilitation and partial cluster rehabilitation depending on the alternative) is included in the estimated capital cost tables. The conventional mesophilic digesters' rehabilitation construction costs have been calculated based on the August 2016 bid for three digesters' rehabilitation work at the CDWWTP (Plant 2, Cluster 1). One cluster consists of four digesters around a central building housing digestion heating, mixing, and pumping equipment. The acid phase digesters' construction cost has been calculated based on the July 2015 BODR (CH2M, 2015c). For all other facilities (thickening, dewatering, CHP, pre-dewatering and screening, THP, boilers, drying, composting) only the additional capital cost for the expansion of these facilities beyond the scope of the current slated/approved work (i.e., Consent Decree) has been included in the capital cost and net present value tables. For each of the alternatives, costs related to yard piping, site civil, site electrical, and site instrumentation have been distributed to each process (except for the digestion process, in which costs were calculated as explained above) based on the percent participation of the specific process cost to the overall alternative cost digestion excluded).

4.3.1 Alternative C-S-1: Composting at South District Wastewater Treatment Plant (with Central District Wastewater Treatment Plant Biosolids)

Alternative C-S-1 includes all the design elements at the CDWWTP and SDWWTP that comprise the base case Alternatives C-1 and S-1, respectively. The solids thickening, anaerobic digestion, and dewatering processes of this alternative are also identical in configuration and sizing to the base case alternatives.

The primary additional feature of Alternative C-S-1 is a new, completely enclosed, and larger biosolids composting facility utilizing the aerated-static pile process and full odor control. Similar to Alternative S-3, the enclosed composting facility would receive dewatered biosolids cake from both the CDWWTP and SDWWTP, operate year-round, and convert all Class B dewatered biosolids into compost product, which would be marketed as a Class AA biosolids soil amendment. Figure 4-9 is a process flow schematic of Alternative C-S-1.

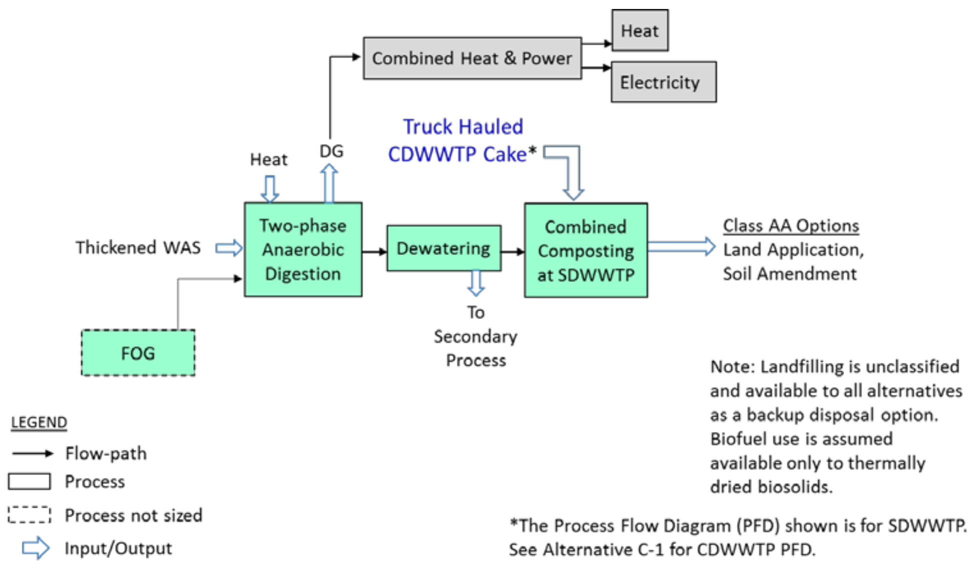

Figure 4-9. Alternative C-S-1: Composting Combined Biosolids at South District Wastewater Treatment Plant
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance of the processes that comprise Alternative C-S-1 are summarized in Table 4-17.

Table 4-17. Central and South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Combined Alternative C-S-1 Composting
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	**Central District WWTP**				**South District WWTP**			
		Annual Average	**Max Month**	**Notes**		**Annual Average**	**Max Month**	**Notes**
WAS Thickening								
Technology Used	Centrifuge				Centrifuge			
Capture	95%				95%			
TWAS Out (lbs/day)		284,600	446,300			192,900	239,100	
TWAS Out TS	5.5%				5.5%			
Anaerobic Digestion								
Tanks In Service	11				7			See C-1 and S-3 alternatives for digesters' rehabilitation work
Overall Digester VSR	50%				50%			
DG production (ft^3/day)		1,750,400	2,744,800			1,228,900	1,523,700	
DS Out (lbs/day)		167,900	263,300			110,900	137,500	
DS Out TS		3.2%	3.2%			3.2%	3.2%	
SRT [≥20 Days Average, 15 Days Max Month]		24	15			22	18	
Dewatering								
Technology Used	Centrifuge				Centrifuge			
Capture	95%				95%			
DSC Out (dry tons/day)		79.8	125.1			52.7	65.3	
DSC Out TS	24%				20%			

Table 4-17. Central and South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Combined Alternative C-S-1 Composting

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	**Central District WWTP**				**South District WWTP**			
		Annual Average	**Max Month**	**Notes**		**Annual Average**	**Max Month**	**Notes**
DSC Out (wet tons/day)		333	521			264	327	
BIOGAS - Utilization; Fuel to CHP (24/7 operation)								
DG to CHP (ft^3/day)		1,750,400	2,744,800			1,228,900	1,523,700	
LG to CHP (ft^3/day) at 500 cfm		N/A	N/A			720,000	720,000	
Engine thermal efficiency (Caterpillar)	33.0%			No exhaust gas heat recovery	49.9%			With exhaust gas heat recovery
Available Heat for Other Uses (Btu/hr)		1,822,000	9,918,400			5,385,500	7,727,800	
Engine Electrical Efficiency	27.6%				39.1%			
Power Generation (kW)		3,490	5,480			5,060	5,960	

A summary breakdown of the estimated capital costs for Alternative C-S-1 is shown in Table 4-18. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-18. Estimated Capital Cost for Alternative C-S-1. Combined Composting at SDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	**Cost (2020$)**
Centrifuge Thickening	$16,074,000
Mesophilic Anaerobic Digesters	$271,039,000
Solids Dewatering	$7,923,000
Combined Heat and Power	$19,831,000
Composting Facility	$389,378,000
Estimated Capital Cost	$704,245,000

Note:

Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-18 includes cost estimates for the CDWWTP and SDWWTP centrifuge thickening facilities, because one more unit in each process is needed compared to the Consent Decree design. The Consent Decree program dewatering facility is adequate for the CDWWTP but not for the SDWWTP. Therefore, a cost estimate for the SDWWTP dewatering facility is included above. The Consent Decree program CHP facility is adequate for the SDWWTP but not for the CDWWTP. Therefore, a cost estimate for the CDWWTP is included above.

The cost for the anaerobic digestion facility has been calculated as described in Section 4.3. Alternative C-S-1 has higher anaerobic digestion costs than other alternatives, because more digestion volume is required to meet the Class B requirements of Alternative C-S-1, than is required when drying or thermal hydrolysis and drying are implemented in the following two alternatives. The major additional cost in this alternative is for the centralized composting facility located at the SDWWTP.

4.3.2 Alternative C-S-2: Thermal Drying at South District Wastewater Treatment Plant (with Central District Wastewater Treatment Plant Biosolids)

Alternative C-S-2 includes the design elements at the CDWWTP and SDWWTP that comprise the base case Alternatives C-1 and S-1, respectively. The solids thickening, anaerobic digestion, and dewatering processes of this alternative are also identical in configuration and sizing to the base case alternatives.

The primary additional feature of Alternative C-S-2 is a new, completely enclosed, and larger biosolids thermal drying facility based on low-temperature belt dryers. Similar to Alternative S-4, the enclosed drying facility would receive dewatered biosolids cake, operate year-round, and convert all Class B dewatered biosolids into compost product, which would be marketed as a Class AA biosolids soil amendment. The thermal drying facility in this alternative is larger than the drying facility in Alternative S-4, because it would receive and process dewatered biosolids from both the CDWWTP and SDWWTP. Figure 4-10 is a process flow schematic of Alternative C-S-2.

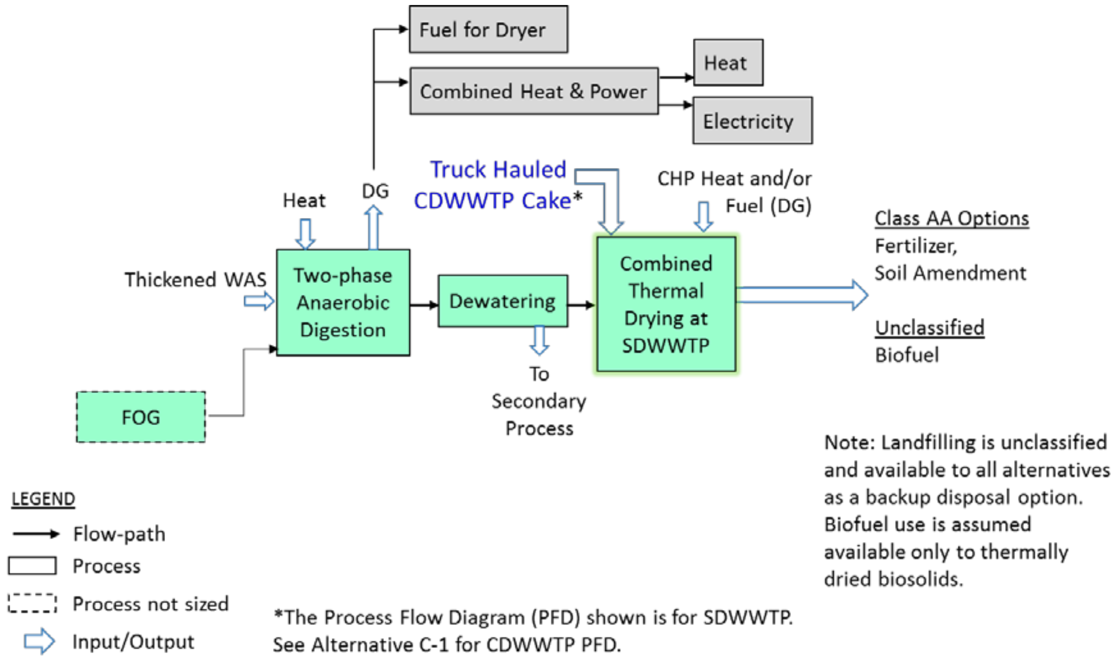

Figure 4-10. Alternative C-S-2: Thermally Drying Combined Biosolids at South District Wastewater Treatment Plant
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance of the processes that comprise Alternative C-S-2 are summarized in Table 4-19.

Table 4-19. Central and South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Combined Alternative C-S-2 Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	**Central District WWTP**				**South District WWTP**			
		Annual Average	**Max Month**	**Notes**		**Annual Average**	**Max Month**	**Notes**
WAS Thickening								
Technology Used	Centrifuge				Centrifuge			
Capture	95%				95%			
TWAS Out (lbs/day)		284,600	446,300			192,900	239,100	
TWAS Out TS	5.5%				5.5%			
Anaerobic Digestion								
Tanks In Service	11				5			See C-1 and S-4 alternatives for digesters' rehabilitation work
Overall Digester VSR	50%				50%			
DG Production (ft^3/day)		1,750,400	2,744,800			1,228,900	1,523,700	
DS Out (lbs/day)		167,900	263,300			110,900	137,500	
DS Out TS		3.2%	3.2%			3.2%	3.2%	
SRT [≥15 Days Average, 12 Days Max Month]		24	15			16	13	
DS Dewatering								
Technology Used	Centrifuge				Centrifuge			
Capture	95%				95%			
DSC Out (dry tons/day)		79.8	125.1			52.7	65.3	
DSC Out TS	24%				20%			
Drying								

Table 4-19. Central and South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Combined Alternative C-S-2 Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	**Central District WWTP**				**South District WWTP**			
		Annual Average	**Max Month**	**Notes**		**Annual Average**	**Max Month**	**Notes**
Technology Used					Direct Belt			
Dryer Out (dry tons/day)						132.5	190.4	
Dryer Out TS					90%			
Dryer Out (wet tons/day)						147	212	
Dryer Thermal Efficiency (Btu/lb H2O Evaporated)					1,300			
BIOGAS - Utilization; Fuel to DRYER, and CHP (24/7 Operation)								
Blend[a] to Dryer (ft^3/day)		N/A	N/A			2,048,900	2,654,900	
DG/Blend[a] to CHP (ft^3/day)		1,750,400	2,744,800			371,900	353,100	
LG to Blend/Sphere (ft^3/day) at 500 cfm		N/A	N/A			720,000	720,000	
NG to Boiler, for Dig HEX (ft^3/day)		N/A	N/A			53,900	53,900	
Engine Thermal Efficiency	33.0%			No exhaust gas heat recovery	49.9%			With exhaust gas heat recovery
Available Heat for Other Uses (Btu/hr)		1,822,000	9,918,400			0	0	
Engine Electrical Efficiency	27.6%				39.1%			
Power Generation (kW)		3,490	5,480			1,110	1,110	

Note:

[a] Blend refers only to and consists of DG, LG, and NG.

A summary breakdown of the estimated capital costs for Alternative C-S-2 is shown in Table 4-20. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-20. Estimated Capital Cost for Alternative C-S-2. Combined Thermal Drying at SDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	**Cost (2020$)**
Centrifuge Thickening	$15,684,000
Mesophilic Anaerobic Digesters	$242,400,000
Solids Dewatering	$7,732,000
Thermal Drying Building (includes Boilers)	$329,356,000
Combined Heat and Power	$19,684,000
Estimated Capital Cost	$614,856,000

Note:

Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-20 includes cost estimates for the CDWWTP and SDWWTP centrifuge thickening facilities, because these facilities required one more unit of each respective equipment in comparison to the Consent Decree design. The cost of centrifuge thickening for Alternative C-S-2 is slightly less than for Alternative C-S-1 because the cost markups for centrifuge thickening are slightly different between the two alternatives.

The Consent Decree program dewatering facility is adequate for the CDWWTP but not for the SDWWTP. Therefore, cost estimate for the SDWWTP dewatering facility is included. The Consent Decree program CHP is adequate for the SDWWTP but not for the CDWWTP. Therefore, cost estimate for the CDWWTP CHP is included.

The cost for the anaerobic digestion facility has been calculated as described in Section 4.3. Major additional cost is for the centralized drying facility located at the SDWWTP. This cost includes the boilers that are required for this alternative.

4.3.3 Alternative C-S-3: Thermal Hydrolysis Process at Central and South District Wastewater Treatment Plant Followed by Thermal Drying at South District Wastewater Treatment Plant

Alternative C-S-3 implements THP prior to digestion at the CDWWTP and the SDWWTP. The thermally hydrolyzed, digested, and dewatered biosolids cake from the CDWWTP will be hauled by truck to a centralized thermal drying facility located at the SDWWTP. Alternative C-S-3 also incorporates a new and completely enclosed thermal biosolids drying facility at the SDWWTP utilizing belt-drying technology, similar to Alternative S-5. The thermal dryer in Alternative C-S-3 will be larger than the dryer in Alternative S-5, because it is sized to dry the thermally hydrolyzed, digested, and dewatered cake solids from both the CDWWTP and the SDWWTP.

The thermal drying facility would operate year-round and convert all dewatered biosolids from CDWWTP and SDWWTP into dried biosolids product, which would be marketed as a Class AA biosolids soil amendment. Figure 4-11 is a process flow schematic of Alternative C-S-3.

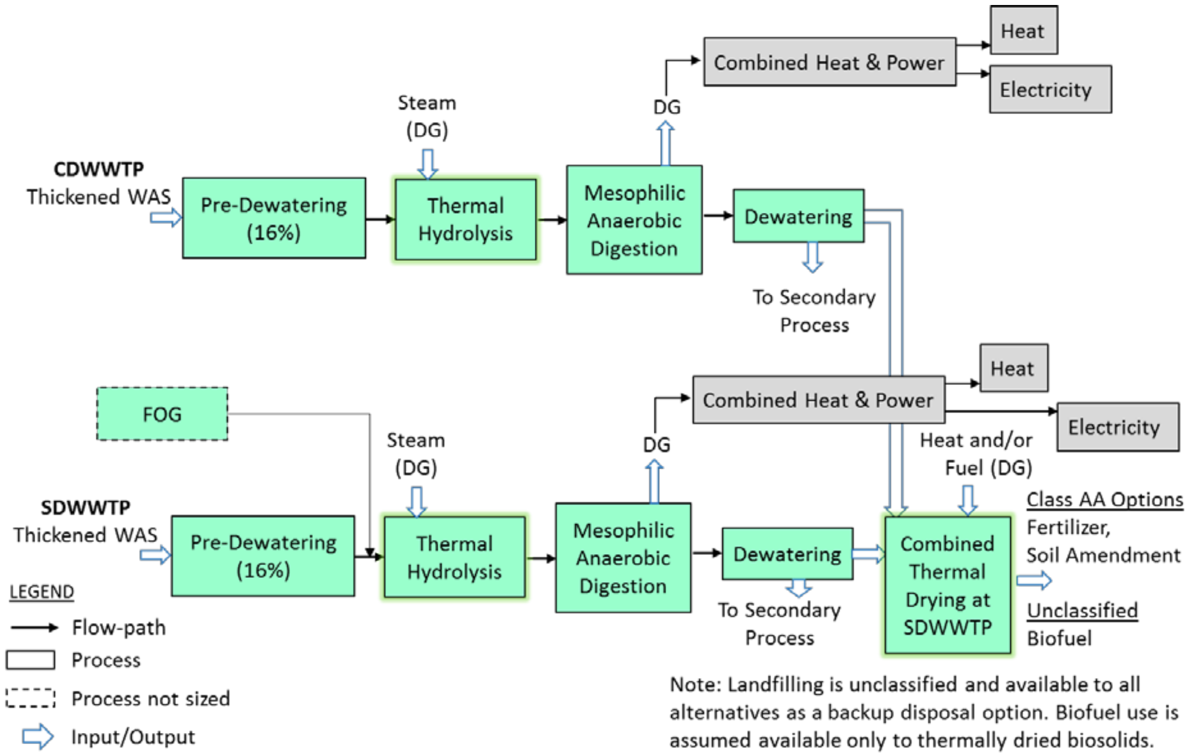

Figure 4-11. Alternative C-S-3: THP at Each Wastewater Treatment Plant followed by Thermally Drying Combined Biosolids at South District Wastewater Treatment Plant

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

The considered design criteria and the flow-mass balance of the processes that comprise Alternative C-S-3 are summarized in Table 4-21.

Table 4-21. Central and South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Combined Alternative C-S-3 Thermal Hydrolysis and Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	**Central District WWTP**			**South District WWTP**		
		Annual Average	**Max Month**		**Annual Average**	**Max Month**
WAS Thickening						
Technology used	Centrifuge			Centrifuge		
Capture	95%			95%		
TWAS Out (lbs/day)		284,600	446,300		192,900	239,100
TWAS Out TS	5.5%			5.5%		
TWAS Predewatering						
Technology Used	Centrifuge			Centrifuge		
Capture	95%			95%		
TWAS Out (lbs/day)		270,400	424,000		183,200	227,200
TWAS Out TS	16%			16%		
Thermal Hydrolysis						
CWAS Out TS	13%			13%		
CWAS Out (lbs/day)		270,400	424,000		183,200	227,200
Anaerobic Digestion						
Tanks In Service	5			3[(1)]		
CWAS In Diluted TS	10%			10%		
Overall Digester VSR	60%			53%		
DG Production (ft^3/day)		1,995,500	3,129,100		1,226,300	1,520,500
DS Out (lbs/day)		137,400	215,400		101,500	125,800
DS Out TS		5.1%	5.1%		5.5%	5.5%

Table 4-21. Central and South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Combined Alternative C-S-3 Thermal Hydrolysis and Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	**Central District WWTP**			**South District WWTP**		
		Annual Average	**Max Month**		**Annual Average**	**Max Month**
SRT [≥15 days average, 12 days max month]		21	13		18	15
DS Dewatering						
Technology Used	Centrifuge			Centrifuge		
Capture	95%			95%		
DSC Out (dry tons/day)		65.2	102.3		48.2	59.7
DSC Out TS	30%			28%		
Drying						
Technology Used				direct belt		
Capture				100%		
Dryer Out (dry tons/day)					113.4	162
Dryer Out TS				90%		
Dryer Out (wet tons/day)					126	180
Dryer Thermal Efficiency (Btu/lb H2O Evaporated)				1,300		
BIOGAS - Utilization; Fuel to CHP, and HI P BOILER (24/7 operation)						
Blend(2) to Dryer (ft^3/day)		N/A	N/A		1,279,000	1,708,400
DG/Blend(2) to hi P Steam Boiler (ft^3/day)		438,400	687,400		328,900	383,400
DG/Blend(2) to CHP (ft^3/day)		1,557,100	2,441,700		433,000	231,600,000

Table 4-21. Central and South District Wastewater Treatment Plant - BPF Design Criteria Consideration for Combined Alternative C-S-3 Thermal Hydrolysis and Drying
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Process	**Central District WWTP**			**South District WWTP**		
		Annual Average	**Max Month**		**Annual Average**	**Max Month**
LG to Blend[2]/Sphere (ft^3/day) at 500 cfm		N/A	N/A		720,000	720,000
NG to Blend[2] (ft^3/day)		N/A	N/A		94,600	258,500
Engine Thermal Efficiency[3]	33.0%			49.9% [4]		
Available Heat for Other Uses (Btu/hr)		12,678,100	19,880,400		2,885,300	2,885,300
Engine Electrical Efficiency	27.6%			39.1%		
Power Generation (kW)		3,110	4,870		1,110	1,110

Note:

[1] See C-2 and S-2 alternatives for digesters’ rehabilitation work

[2] Blend refers only to the South plant and consists of DG, NG, and LG.

[3] No exhaust gas heat recovery

[4] With exhaust gas heat recovery

A summary breakdown of the estimated capital and O&M costs for Alternative C-S-3 is shown in Table 4-22. In Section 5, these capital costs are included with the estimated annual O&M costs and converted to a Net Present Value cost estimate for each alternative.

Table 4-22. Estimated Capital Cost for Alternative C-S-3. THP at each WWTP followed by Combined Thermal Drying at SDWWTP
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Construction/Process Area	**Cost (2020$)**
Centrifuge Thickening	$15,197,000
Screening and Pre-Dewatering	$92,475,000
Thermal Hydrolysis	$180,145,000
Mesophilic Anaerobic Digesters	$147,256,000
Dewatering	$0
Thermal Drying Building	$180,305,000
Combined Heat and Power	$0
Boiler Building	$48,960,000
Estimated Capital Cost	$664,338,000

Note:

Each line item cost includes construction markups, engineering, and administrative costs, plus contingencies amounting to approximately 40% of the total capital cost.

Table 4-22 includes cost estimates for the CDWWTP and SDWWTP centrifuge thickening facilities, because one more unit of each respective equipment is needed for this alternative compared to the Consent Decree design. The cost of the centrifuge thickening for Alternative C-S-3 is slightly less than for Alternative C-S-1 because of the differences in cost markups between the two alternatives.

Consent Decree program dewatering and CHP facilities are adequate for both the CDWWTP and SDWWTP in this alternative and therefore show no additional cost. This alternative includes THP facilities at both the CDWWTP and SDWWTP. Therefore, the costs for the screening, pre-dewatering and high pressure steam boilers processes required by THP have been included in this alternative in addition to the THP process cost itself.

The cost for the anaerobic digestion facility has been calculated as described in Section 4.3. Additional cost is for the centralized drying facility located at the SDWWTP. The increase in cake dry solids that will occur with THP results in a smaller thermal drying building than Alternative C-S-2.

SECTION 5

Comparison of Alternatives Summary

Section 5 summarizes the comparison of the 11 biosolids management alternatives described in this TM. Section 5.1 will address the triple bottom line criteria of social, environmental, and economic aspects.

5.1 Triple Bottom Line (TBL) Evaluation

The triple bottom line evaluation criteria address social, environmental, and economic aspects used to evaluate and compare the 11 alternatives in this TM. The evaluation is based on non-monetary criteria and reflects an emphasis on reliability, the regulatory environment, risk assessment, and future flexibility. Given the potential for a long-term contract of 20 years, these social, environmental, and economic aspects are salient and justify consideration. In a December 2016 workshop, WASD and CH2M weighted non-monetary criteria in terms of their relative importance, using a forced-weighting process. The descriptions and resulting weights of the non-monetary criteria are shown in the last column of Table 5-1.

Table 5-1. Descriptions of Non-Monetary Criteria that Comprise the Triple Bottom Line
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Criteria Number and Type	Evaluation Criteria	Criteria Description	Relative Weight %
1 - Environmental	Carbon Footprint Considerations	Propensity of each alternative to increase emissions of greenhouse gases (GHGs), either directly or indirectly through fossil fuel consumption, relative to the other alternatives. Greater propensity for higher GHG emissions results in lower score.	13.9
2 - Environmental	Impacts on Soil and Water	Relative propensity for facility operations to create adverse impacts on soil or water. Higher potential for adverse impacts result in lower score.	16.7
3 - Environmental	Air Emissions Impacts and Risks	Relative propensity for biosolids product to create air emissions that might pose public health or regulatory problems. Higher potential for air emission issues results in lower score.	8.3
4 - Environmental	Regulatory and Permitting Impacts and Risks	Extent to which existing facilities can be permitted and will comply with existing regulations and anticipated regulatory climate.	11.1
5 - Social	Traffic, Roads, and Public Safety	Possibility of each alternative to create public health or safety issues relative to the other alternatives, such as road and traffic hazards. Greater possibility of creating issues results in lower score.	8.3
6 - Social	Facility and Product Odors	Likelihood of each alternative to experience emit odors from the operating facilities and from the final biosolids product.	19.4
7 - Social	Beneficial uses of Biosolids Product	Likelihood of biosolids product from each alternative to be successfully marketed and distributed, without considering costs. Higher likelihood of developing reliable markets results in higher score.	11.1
8 - Social	Other Community Impacts (Aesthetics and Noise)	Likelihood of each alternative to encounter environmental or permitting problems, relative to the other alternatives. Higher likelihood of problems results in lower score.	11.1

The 11 alternatives were evaluated based on the non-monetary criteria noted in Table 5-1. Resulting from considerable discussion at the December 16, 2016 workshop, each of the alternatives was assigned raw scores ranging from 1 to 5 based on the capability of that alternative to satisfy each of the selected criteria, per the criteria definitions presented in Table 5-1.

Results of the non-monetary evaluation are shown in Table 5-2. The first part of Table 5-2 shows the raw scores assigned to each of the alternatives based on satisfying each of the stated criteria. The second part of Table 5-2 shows the scoring results after criteria weightings have been applied.

Table 5-2. Alternatives Non-Monetary Scores

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

	Weight	**13.9%**	**16.7%**	**8.3%**	**11.1%**	**8.3%**	**19.4%**	**11.1%**	**11.1%**	**100.0%**
	Criteria Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
	Criteria Name Alternative Name	**Carbon Footprint Considerations**	**Impacts on Soil and Water**	**Air Emissions Impacts and Risks**	**Regulatory and Permitting Impacts and Risks**	**Traffic, Roads and Public Safety**	**Facility and Product Odors**	**Beneficial uses of Biosolids Product**	**Other Community Impacts (aesthetics, noise)**	**Raw Score**
1	S1- SDWWTP Base Case	1	1	4	3	1	2	1	1	14
2	S2- SDWWTP THP	3	3	3	2	3	4	3	3	24
3	S3- SDWWTP Composting	4	3	2	4	2	3	4	2	24
4	S4- SDWWTP Drying	2	4	2	3	4	5	5	4	29
5	S5- SDWWTP THP + Drying	4	4	2	3	4	5	5	4	31
6	C1- CDWWTP Base Case	1	1	4	3	1	2	1	1	14
7	C2- CDWWTP THP	3	3	3	2	3	4	3	3	24
8	C3- CDWWTP Drying	2	4	2	3	4	5	5	4	29
9	CS1- Combined CD/SD Composting at SDWWTP	4	3	2	4	1	3	4	2	23
10	CS2- Combined CD/SD Drying at SDWWTP	2	4	2	3	2	5	5	4	27
11	CS3- THP at CD & SD + Combined Drying at SDWWTP	2	4	2	3	3	5	5	4	28

Table 5-2. Alternatives Non-Monetary Scores

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

	Criteria Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
	Criteria Name Alternative Name	**Carbon Footprint Considerations**	**Impacts on Soil and Water**	**Air Emissions Impacts and Risks**	**Regulatory and Permitting Impacts and Risks**	**Traffic, Roads and Public Safety**	**Facility and Product Odors**	**Beneficial uses of Biosolids Product**	**Other Community Impacts (aesthetics, noise)**	**Weighted Score**
1	S1- SDWWTP Base Case	0.14	0.17	0.33	0.33	0.08	0.39	0.11	0.11	1.67
2	S2- SDWWTP THP	0.42	0.50	0.25	0.22	0.25	0.78	0.33	0.33	3.08
3	S3- SDWWTP Composting	0.56	0.50	0.17	0.44	0.17	0.58	0.44	0.22	3.08
4	S4- SDWWTP Drying	0.28	0.67	0.17	0.33	0.33	0.97	0.56	0.44	3.75
5	S5- SDWWTP THP + Drying	0.56	0.67	0.17	0.33	0.33	0.97	0.56	0.44	4.03
6	C1- CDWWTP Base Case	0.14	0.17	0.33	0.33	0.08	0.39	0.11	0.11	1.67
7	C2- CDWWTP THP	0.42	0.50	0.25	0.22	0.25	0.78	0.33	0.33	3.08
8	C3- CDWWTP Drying	0.28	0.67	0.17	0.33	0.33	0.97	0.56	0.44	3.75
9	CS1- Combined CD/SD Composting at SDWWTP	0.56	0.50	0.17	0.44	0.08	0.58	0.44	0.22	3.00
10	CS2- Combined CD/SD Drying at SDWWTP	0.28	0.67	0.17	0.33	0.17	0.97	0.56	0.44	3.58
11	CS3- THP at CD & SD + Combined Drying at SDWWTP	0.28	0.67	0.17	0.33	0.25	0.97	0.56	0.44	3.67

The non-monetary evaluation results have led to the following conclusions:

- Two alternatives involving thermal drying facilities at each WWTP (C-3 and S-4) rated highest among the 11 alternatives. Separate thermal drying facilities at each WWTP scored well against other separate plant alternatives in terms of odor and traffic control, low environmental impact, reliability, and acceptability of the final biosolids product.
- The base case alternatives involving only the processes required by the Consent Decree were lowest in the non-monetary evaluation among the 11 alternatives in terms of non-monetary scores. These alternatives do not produce a Class AA biosolids product, which limits the beneficial use of biosolids and poses greater risks to WASD in terms of sustainability and future compliance with regulations.
- The alternatives involving biosolids composting scored the next lowest to the base case alternatives in terms of non-monetary rankings. Reasons for the low non-monetary scores of composting include larger site requirements for composting, the need for bulking agent, the higher volume of product, and odor concerns about the composting process at a County owned WWTP.
- The alternatives involving only THP facilities with no post-processing of dewatered biosolids (S-2 and C-2) ranked the next lowest among the 11 alternatives in terms of non-monetary evaluations. Reasons for the lower rankings of these alternatives include greater technology risk (only one THP facility is currently operating in the U.S.), and uncertainty about the marketability of the dewatered biosolids product of THP and digestion. However, THP ranked substantially higher than the base case for these non-monetary criteria and THP ranked among the top alternatives based on monetary criteria.
- The alternatives involving both THP and thermal drying (S-5 and C-S-3) ranked better than alternatives involving only THP facilities (S-2 and C-2). While all four of these alternatives produce a Class AA biosolids product, combining THP with drying has several advantages, including generating more biogas as fuel for drying, increasing the energy potential of biogas, and reducing the energy requirement for drying because the THP-enhanced biosolids cake contains less water than anaerobically-digested solids.

Regarding the economic criteria, Table 5.3 shows the O&M costs, capital costs, and Net Present Value (NPV). For this TBL analysis, the economic component of the TBL is represented by the NPV of costs over the life of the study period, which represents a reasonable method to assess the economic impact of the options. In the cost estimates presented in Table 5-3, the expected accuracy range of capital costs are from -30% to +50% of the indicated value, and the expected accuracy range of the O&M costs are from -25% to +25% of the indicated value. The O&M costs were estimated using the average biosolids loadings from the design year, considering an annual escalation factor of 3%. The NPV's assume a 3% net discount rate, which takes into account a 5% projected annual discount rate and 2% projected, annual inflation rate.

Table 5-3. Alternatives Costs

Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Alternative	**Total, Annual O&M Cost (2020$)**	**Total Capital Cost (2020$)**	**Net Present Value (20 years, 3%, 2020$)**
Alternatives for Biosolids from CDWWTP Only			
C-1 Mandated Improvements	$24,748,000	$168,532,000	$536,720,000
C-2 THP	$23,606,000	$261,779,000	$612,977,000
C-3 Drying	$20,231,000	$311,460,000	$612,446,000

Table 5-3. Alternatives Costs
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Alternative	Total, Annual O&M Cost (2020$)	Total Capital Cost (2020$)	Net Present Value (20 years, 3%, 2020$)
Alternatives for Biosolids from SDWWTP Only			
S-1 Mandated Improvements	$23,747,000	$155,269,000	$508,564,000
S-2 THP	$13,694,000	$250,288,000	$454,020,000
S-3 Composting	$15,540,000	$341,118,000	$572,314,000
S-4 Drying	$13,844,000	$296,257,000	$502,221,000
S-5 THP-Drying	$13,773,000	$364,744,000	$569,651,000
Alternatives for Biosolids from both CDWWTP and SDWWTP (Combined Alternatives)			
C-S-1 Composting	$37,412,000	$704,245,000	$1,260,841,000
C-S-2 Drying	$35,790,000	$614,856,000	$1,147,321,000
C-S-3 THP - Drying	$35,554,000	$664,338,000	$1,193,292,000

Based on the triple bottom line criteria, the evaluation concluded that all alternatives except the base case and composting scenarios are considered acceptable for WASD to implement. The alternatives also were evaluated based on their relative life-cycle costs. The relative triple bottom line scores of the alternatives are summarized in Table 5-4, with the highest non-monetary score assigned a score of 100%, and the highest estimated NPV assigned a score of 100%. Other non-monetary scores and relative NPV's are assigned a percentage of the top score according to their relative ratios of the top score. The normalized TBL score is calculated by first dividing the non-monetary score by the monetary score (therefore, the lower the NPV, the higher the TBL score), then assigning the highest TBL scores in each category a normalized score of 100%, with the other alternatives scored as ratios of the highest score.

Table 5-4. Normalized Triple Bottom Line Summary
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Alternative	Non-Monetary Criteria[a]	Monetary Criteria[b]	Triple Bottom Line[c]
Alternatives for Biosolids from CDWWTP Only			
C-1 Mandated Improvements	44%	88%	50%
C-2 THP	82%	100%	82%
C-3 Drying	100%	100%	100%
Alternatives for Biosolids from SDWWTP Only			
S-1 Mandated Improvements	41%	89%	44%
S-2 THP	77%	79%	92%
S-3 Composting	77%	100%	72%
S-4 Drying	93%	88%	100%
S-5 THP-Drying	100%	99%	95%
Alternatives for Biosolids from both CDWWTP and SDWWTP (Combined Alternatives)			
C-S-1 Composting	82%	100%	76%

Table 5-4. Normalized Triple Bottom Line Summary
Basis of Design Update for Biosolids Processing Facilities - Evaluation of 11 Biosolids Management Alternatives

Alternative	Non-Monetary Criteria[a]	Monetary Criteria[b]	Triple Bottom Line[c]
C-S-2 Drying	98%	91%	100%
C-S-3 THP - Drying	100%	95%	98%

Notes:

[a] Higher non-monetary scores are better than lower non-monetary scores.

[b] Higher monetary scores represent higher NPV; therefore, lower monetary scores are better than higher monetary scores.

[c] The TBL score is calculated by dividing non-monetary scores by monetary scores, then normalizing the best (highest) TBL score to 100%, with the other TBL scores in that category normalized to ratios of 100%.

Based on the screening process evaluation of the 11 alternatives that accounted for both monetary and non-monetary concerns (in addition to other considerations detailed in Section 5.2), design-build-finance-operate-maintain (DBFOM) providers offering THP and/or thermal drying systems should be considered for a centralized regional BPF at the SDWWTP. The THP and/or thermal drying systems can produce end products that meet the requirements for Class AA material and both are used in the industry. This conclusion is based on the following factors.

1. Although thermal drying was ranked first based on the triple bottom line criteria, the scores between thermal drying and THP, and between thermal drying and THP combined with thermal drying, were relatively close. Furthermore, vendors of all technologies will have an opportunity to submit their best price as a part of the DBFOM procurement process. By considering these two different technologies, there is a competitive market among various equipment providers and WASD can potentially identify an appropriate balance of technologies for biosolids processing in the future. The THP and drying technologies offer DBFOM providers flexibility while using technologies that are proven processes with a higher probability of operating success based on similar installations, while taking advantage of available renewable energy resources (such as digester gas, landfill gas, natural gas, and waste heat from cogeneration).
2. The combined alternatives (involving a central biosolids processing facility to serve both CDWWTP and SDWWTP) involving THP and thermal drying are more desirable in general than any of the separate-plant alternatives, primarily because those combined alternatives offer consolidated operations and avoid the need to build additional facilities at the CDWWTP beyond the Consent Decree mandates. In general, it is recommended to minimize future capital investments in the CDWWTP (aside from the Consent Decree mandates), because of WASD's plans to transfer a significant portion of wastewater that is now being treated at the CDWWTP to the new WDWWTP.
3. It appears to be in WASD's best interest to continue with the Consent Decree mandated improvements at CDWWTP and haul dewatered Class B biosolids to SDWWTP for further processing to meet Class AA standards. Alternatively, hauling dewatered Class B biosolids from CDWWTP to another processing facility besides the SDWWTP may also be considered as long as it is done in accordance with all regulatory requirements. While a thermal drying facility at CDWWTP received the highest TBL score among CDWWTP alternatives, the proximity of CDWWTP to the most developed areas of the County, concerns about odors and air emissions from drying operations, and the need to minimize capital expenditures are all factors that discourage building additional biosolids facilities at the CDWWTP. The recommended method for transporting biosolids from the CDWWTP to the BPF or other acceptable biosolids processing facility is via trucks. Using this approach, the CDWWTP digesters and dewatering facilities would be rehabilitated and constructed with upgrades to meet the Consent Decree mandate. Dewatered cake would be loaded into trucks for transport to the centralized regional BPF at SDWWTP or other acceptable biosolids processing facility to process and manage the solids.

5.2 Other Considerations for Siting Biosolids Processing Facility (Limitations and Advantages)

In reference to the future BPF, there are other factors considered during the selection of alternatives at each treatment plant. The following presents a list of considerations for CDWWTP and a centralized regional BPF at SDWWTP.

1. CDWWTP Considerations
    a. Reducing treatment capacity at CDWWTP (routing flows to WDWWTP)
    b. Land limitations due to OOL and Consent Decree Capital Improvement projects
    c. Vulnerability to sea level rise
    d. New facilities must present no increase in odor potential
    e. Plant located close to sensitive areas (i.e., Biscayne Bay, Downtown, Fisher Island, and Key Biscayne)
    f. Plant located near a densely populated area
2. Centralized Regional BPF at SDWWTP Considerations
    a. SDWWTP increasing flow capacity due to OOL Program
    b. Availability of land at the SDWWTP
    c. Renewable energy available (natural, landfill and digester gas)
    d. Heat available from cogeneration system for further processing
    e. Nearby backup disposal option (South Dade Landfill)
    f. Reduced logistics for a single processing facility
    g. Lower land use density in South Miami-Dade County at present

5.3 Recommendations

5.3.1 Biosolids Processing Facility

Based on the evaluation of biosolids management alternatives for WASD, the recommendations are summarized as follows:

- BPF is to be located at a county-owned site (i.e., SDWWTP).
- At the CDWWTP, continue with mandatory improvements and land apply Class B biosolids until a consolidated Class AA BPF is built at SDWWTP. Class B biosolids from the CDWWTP may also be received and disposed at other locations so long as it is done in accordance with all regulatory requirements.
- THP and/or thermal drying systems are the two recommended technologies that could be located as a consolidated BPF at the SDWWTP site as shown in Figure 2-4. The triple bottom line evaluation in Section 5.1 concludes that the alternatives involving THP and thermal drying for a consolidated BPF are viable. Additionally, since THP had the same score of 100% as thermal drying technology based on the triple bottom line scores shown on Table 5-4 for Combined Alternatives, it is in WASD’s best interest to have both technologies competitively bid in an open market.

The two recommended technologies require relatively small footprints (compared to composting at a County owned WWTP), which gives WASD the flexibility to use excess land in the future. These two technologies can benefit from the available renewable energy sources (biogas and waste heat) at the SDWWTP.

5.3.2 Project Delivery Approach

The contract to implement this project depends on Miami-Dade County's preferences and procurement requirements. A full-service, DBFOM contract that includes completing the preliminary planning, design engineering, permitting, construction, operations, and financing is the anticipated approach. As the procurement process progresses, the contract type, and services to be included will be further defined by Miami-Dade County and CH2M. A RFQ will be issued as Step 1 in the procurement process, followed by a shortlisting of qualified DBFOM providers. Step 2 will involve issuing a Request for Proposal that includes detailed information that is sufficient to result in a well-defined, competitive proposal.

SECTION 6

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Appendix A
Biosolids Product Marketing Report

DISCLAIMER: This Appendix A – Biosolids Market Feasibility Study was completed in December 2016, while this TM - Basis of Design Update for Biosolids Processing Facilities was revised and updated several times in 2017, subsequent to the Biosolids Market Feasibility Study. In the event of discrepancies between the content of Appendix A and the updated TM, the updated TM will govern.

Biosolids Market Feasibility Study

Prepared for

Miami-Dade Water and Sewer Department (WASD)

December 9, 2016

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Acronyms and Abbreviations

CDWWTP	Central District Wastewater Treatment Plant
CH2M	CH2M HILL, Inc.
dt/yr	dry ton per year
dwb	dry weight basis
EPA	U.S. Environmental Protection Agency
F.A.C	Florida Administrative Code
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FOB	free on board
MSA	Metropolitan Statistical Area
NDWWTP	North District Wastewater Treatment Plant
RAA	R. Alexander Associates, Inc.
SDWWTP	South District Wastewater Treatment Plant
THP	thermal hydrolysis process
TS	total solids
WASD	Miami-Dade Water and Sewer Department
wt/yr	wet ton per year
WDWWTP	West District Wastewater Treatment Plant
WWTP	wastewater treatment plant

Executive Summary

Miami-Dade Water and Sewer Department (WASD) requested that CH2M HILL, Inc. (CH2M) evaluate the requirements and options for future biosolids processing. All processing options are required to produce Class AA biosolids products. Three Class AA biosolids product options are being considered:

1. Biosolids compost
2. Thermally dried biosolids
3. Dewatered biosolids cake produced by a thermal hydrolysis process (THP)

CH2M worked with subconsultant R. Alexander Associates, Inc. (RAA) to complete market research to evaluate potential WASD biosolids product markets, their value(s), and overall marketability (distribution), primarily within the Florida horticultural and fertilizer industries. Other potential markets, such as biofuel for cement kilns, are also considered.

Biosolids Volumes and Processing

WASD currently operates three wastewater treatment plants, specifically the North District Wastewater Treatment Plant (NDWWTP), Central District Wastewater Treatment Plant (CDWWTP), and South District Wastewater Treatment Plant (SDWWTP). A fourth facility, the West District Wastewater Treatment Plant (WDWWTP) is projected to come on line in 2026. The biosolids volumes and characteristics produced from these plants and considered for this market research study are noted in Table ES-1.

Table ES-1. Biosolids Volumes and Characteristics
Biosolids Market Feasibility Study

	CDWWTP wt/yr	**CDWWTP dt/yr**	**SDWWTP wt/yr**	**SDWWTP dt/yr**
Quantities Generated				
2015	85,410 wt/yr	20,075 dt/yr	75,920 wt/yr	12,775 dt/yr
2029 Projections	98,185 wt/yr	23,068 dt/yr	64,415 wt/yr	14,673 dt/yr
2035 Projections	60,225 wt/yr	14,126 dt/yr	66,430 wt/yr	15,586 dt/yr
Nutrient Content		*(< 2015 average >)*	Class AA versus Class B product	
Total Nitrogen, dwb	5.8%		3.9% / 3.4%	
Total Phosphorous, dwb	2.5%		2.0% / 1.4%	
Total Potassium, dwb	0.13		0.1% / 0.13%	

Notes:
dt/yr = dry ton per year
dwb = dry weight basis
wt/yr = wet ton per year

The SDWWTP has been operating a biosolids composting operation that does not use a bulking agent. Plant staff windrow the dewatered biosolids and turn it using a Brown Bear to accelerate natural, solar drying and assist in aeration. The finished product typically contains 60 percent or more total solids (TS) that is screened through a 3/8-inch screen to produce a Class AA product. Most of this product is marketed by the South Dade Soil & Water Conservation District. The District had been purchasing the product from the WASD for $12 per ton, and had been reselling it for up to $65 per ton, delivered to farmers in the region (who are primarily located south of Miami). Negativity from food processors regarding the use of biosolids, and difficulties within the citrus industry related to pest control have hurt product sales to such a degree that in early 2016 the South Dade Soil & Water Conservation District had to severely cut back staffing (as well as active WASD compost marketing).

Biosolids in Florida are regulated under the Department of Environmental Protection by Chapter 62-640 Florida Administrative Code (F.A.C.) regulations. These regulations allow for the production of Class AA biosolids products. These products must meet specific pathogen and vector attraction reduction requirements set forth by U.S. Environmental Protection Agency' 40 CFR Part 503 regulations and the Exceptional Quality heavy metal limits (on a monthly average). WASD has historically proven that it can meet these standards at its SDWWTP composting facility when weather conditions allow the composting process to be completed.

Market Area

Miami-Dade County is included in the Miami-Fort Lauderdale-West Palm Beach Metropolitan Statistical Area (MSA), which is home to 6,012,331 people as of 2015. The large population bases within the MSA support a large number of landscape and garden center businesses, as well as golf courses, all of which use fertilizers and soil amendments. A large number of fertilizer companies exist within the state, with the largest numbers in Central Florida (Hillsborough and Polk counties). Further, considerable agricultural acreage exists within a reasonable trucking distance of Miami. Although densely populated, both Miami-Dade (61,567 acres) and Palm Beach (383,617 acres) counties still possess substantial harvested agricultural acreage.

Large population bases exist within a feasible trucking distance from Miami, including a substantial number of horticultural (ornamental) businesses which can utilize a variety of biosolids products. Whereas, denser soil type products are typically shipped less than 50 miles from their source, compost may be competitively shipped to a distance of 75 to 100 miles, and high quality granulated biosolids fertilizer to a distance of 250 to 300 miles. Nursery and landscaping industries in Florida, sometimes referred to as environmental horticulture, are numerous and represent markets for biosolids. A 2012 study indicated that the economic impact of the environmental horticulture industry in Florida is approximately $16.3 billion dollars (University of Florida, 2012).

Biosolids Product Experience

Considerable experience exists with both the composting and thermal treatment (into fertilizer) of biosolids in Florida. Currently, good acceptance of thermally dried biosolids and composted biosolids products exist in the central and southern Florida marketplace. Merchant facilities exist that process biosolids through composting and lime stabilization. Drying and granulation of biosolids is being completed by and for individual communities. Both compost and thermally dried biosolids have been extensively marketed in Florida but there are no current THP facilities. As such, there is no experience with marketing of THP biosolids product in Florida.

A significant amount of experience exists in and around the Miami metropolitan area with the use of biosolids compost and fertilizer products. The biosolids market study results indicate the following product experience:

- **Opportunities for Increased Biosolids Product Use Exists**b. Despite the current market, there are opportunities to expand the market, given that less than 40 percent of the companies surveyed mentioned that they have or are currently using biosolids-based products. The market penetration rate with biosolids products is deceptively low because many fertilizer and nursery products contain biosolids products and do not advertise it.

- **Milorganite and Dried/Granulated Biosolids Products are Widely Used.** The majority of biosolids product experience in Florida is with Milorganite and other dried and granulated biosolids products. Several garden centers and resellers carry or could obtain Milorganite for resale, while several large fertilizer blenders identified that they were using bulk biosolids granules manufactured in Florida for use in their fertilizer blends.
- **No Experience Using Class AA THP Biosolids in Soil Blends.** Biosolids compost is used in nursery and landscape soil mixes, but no one had any direct experience with the use of Class AA THP biosolids usage in soil blending. This was expected since there is currently no facility producing THP biosolids product in Florida. Lower quality (dusty) biosolids fertilizer products are being successfully marketed and distributed in most cases, but there are exceptions. For example, the Reedy Creek facility appears to be paying shipping costs to distribute its dried biosolids product. It also appears that markets for dried and granulated products have not been fully developed in Florida, probably because the fertilizer markets have been robust.

Recommendations

Based on background research, benchmarking conducted with utilities throughout Florida, and biosolids industry organizations conducted as part of this market study, five key recommendations are provided.

1. Marketing efforts for a WASD composted product should be concentrated in horticulture (e.g., landscape, nursery, golf course) and agricultural sectors in the three county Miami MSA.
2. Properly dried and granulated biosolids products, low in dust and useable in blended fertilizers, will be easier to market and possess a greater market value. A nutritionally rich thermally dried product, containing a significant amount of dust, should also be marketable, with the proper effort. However, the dustier and more variable dried product will possess a lower value and require more local markets to be developed. Use of a thermally dried biosolids product as an energy source, combusted at cement kilns, is also feasible. However, these markets have not yet been developed, because fertilizer markets have been more lucrative, and likely will remain so, since the cement kilns contacted have shown no interest in paying for biosolids as fuel.
3. Knowing that the location of the potential WASD processing facility puts its product at a distance disadvantage to competing products, WASD or its biosolids contractor will have to concentrate on developing local markets first. However, Miami-Dade County is somewhat confined, as there is limited territory for distribution to the south, west, and southwest of the county. Therefore, much of the potential WASD Class AA products will need to be transported to markets to the north of Miami-Dade County. These markets to the north must still be developed, but have more outlets and greater market potential than areas to the south of Miami-Dade County.
4. Concentrating sales into environmental horticulture, possibly even packaging and blending biosolids products, should significantly raise the products' value, allowing them to be shipped farther. If concentrating on agricultural sales, efforts should be made to expand markets north and west of Miami. Marketing a THP treated biosolids to soil blenders will likely be difficult, at least in the short-term, because of inexpensive base materials (e.g., muck soils) available in the region. However, WASD could consider the development of its own soil blending operation, similar to the TAGRO project in Washington, using any of its biosolids products as the base. This concept would require additional research and significant ongoing effort. Partnering with an existing topsoil supplier in the region may even be a viable option.
5. It is possible that the WASD could manage product marketing in-house, if it dedicates the proper resources to develop the program and hires the appropriate technical staff. However, opportunities exist for a private contractor to process and market potential biosolids products, even if the facility is located at a WASD wastewater treatment plant. Most of these companies possess practical

experience in market development in Florida. Contacts made as part of the market study indicated that companies have identified their willingness to create Class AA biosolids products (and market them) for the WASD at rates similar, or less than, those which the WASD is currently paying to process.

Biosolids Product Market Values

Although potential product values are greater based on product purchases by the end users, it is suggested that the speculative market values to WASD, as noted in Table ES-2 be used when evaluating production of the three biosolids products.

Table ES-2. Biosolids Product Market Values
Biosolids Market Feasibility Study

Product	Value
Compost	$10.00 per ton
Thermally Dried	$15.00 per ton (assumes low bulk density and dusty product)
THP Cake	$0.00 to (-) $20.00 per ton (assumes product not further processed after production)

Marketing of the THP cake, and/or soil products derived from it, will be the most difficult to establish because markets for these products have not been developed for them in South Florida. For that reason, it is assumed that distribution of the THP product will involve a net cost (rather than revenue) until a sufficient market demand has been established.

SECTION 1

Introduction

Miami-Dade Water and Sewer Department (WASD) requested that CH2M HILL, Inc. (CH2M) evaluate the requirements and options for future biosolids processing. All processing options are required to produce Class AA biosolids products. Three product options (specifically compost, thermally dried biosolids, and dewatered biosolids cake produced by a thermal hydrolysis process [THP]) are being considered.
CH2M worked with subconsultant R. Alexander Associates, Inc. (RAA) to complete market research to evaluate potential WASD biosolids product markets, their value(s), and overall marketability (distribution) within the Florida horticultural and fertilizer industries.

SECTION 2

Methodology

Desktop research was initially conducted to identify key biosolids product information. Further data collection (using the survey research method) was then completed to obtain specific information related to the south Florida biosolids regional market.

To complete this market study, the following data collection and analysis tasks were completed:

Task 1 - Evaluate feedstock data, volumes, and characteristics. This task involved identifying biosolids production volumes and current processing methods, and evaluating product analytical data.

Task 2 - Complete market research. The study team contacted 34 potential biosolids end users and distributors to gather marketing and product quality data. Population and distance analysis were conducted as part of this task. Market research included conducting telephone surveys of Florida regional horticultural and fertilizer industry staff to collect qualitative and quantitative data. Staff familiar with data collection using survey research methods and biosolids derived product sales conducted the surveys.

Task 3 – Collect data from existing Florida biosolids distribution and marketing programs. This task involved interviewing 12 biosolids processing entities (representing 14 processing facilities) to obtain data on types, volumes, product characteristics. and marketing/distribution success.

Market research databases were also accessed as part of this task. Data obtained from the databases are provided in Appendix A. Persons surveyed or interviewed are noted in Appendix B.

SECTION 3

Background

CH2M and RAA started the project by completing a feedstock evaluation (Task 1). This provided critical biosolids data and information on current management practices and regulations. A summary of the information collected follows.

3.1 Current/Future Biosolids Quantities

WASD currently operates three wastewater treatment plants, specifically the North District Wastewater Treatment Plant (NDWWTP), Central District Wastewater Treatment Plant (CDWWTP), and South District Wastewater Treatment Plant (SDWWTP). A fourth facility, the West District Wastewater Treatment Plant (WDWWTP) is projected to come on line in 2026. Currently, only the CDWWTP and SDWWTP produce biosolids.

The CDWWTP plant processes solids from the NDWWTP and CDWWTP and produces Class B biosolids that in 2015 averaged 23 percent in total solids (TS) content. This facility is expected to reach its peak production of biosolids (23,068 dry tons /year) in 2026. The level will decrease when the WDWWTP becomes operational. The biosolids generated at the CDWWTP are primarily land applied onto agricultural land after dewatering to 23 percent to 24 percent TS.

The SDWWTP produces digested Class B biosolids which are dewatered by centrifuge to an average of 20 percent TS content. Some of the dewatered biosolids are solar dried as weather permits; some of the dried solids are composted without a bulking agent. During the wet season, dewatered biosolids cake is hauled away to land application or offsite, merchant composting facilities. If land application or composting outlets are not available, biosolids are landfilled. The composted biosolids qualifies as Class AA product via pathogen testing. The average TS content of the Class AA product is 58 percent, while that of the Class B, solar-dried product is 49 percent, and the Class B dewatered cake is 20 percent without any additional drying or composting. Current and anticipated production levels are noted in Table 3-1.

Table 3-1. Biosolids Data
Biosolids Market Feasibility Study

	CDWWTP wt/yr	CDWWTP dt/yr	SDWWTP wt/yr	SDWWTP dt/yr
Quantities Generated				
2015	85,410 wt/yr	20,075 dt/yr	75,920 wt/yr	12,775 dt/yr
2029 Projections	98,185 wt/yr	23,068 dt/yr	64,415 wt/yr	14,673 dt/yr
2035 Projections	60,225 wt/yr	14,126 dt/yr	66,430 wt/yr	15,586 dt/yr
Nutrient Content (2015 Average)			Class AA versus Class B product	
Total Nitrogen	5.8% dwb		3.9% / 3.4%	
Total Phosphorous	2.5% dwb		2.0% / 1.4%	
Total Potassium	0.13 dwb		0.1% / 0.13%	

Notes:
dt/yr = dry ton per year
dwb = dry weight basis
wt/yr = wet ton per year

3.2 Biosolids Infrastructure

The SDWWTP has been operating a biosolids composting operation that does not use a bulking agent. Plant staff windrow the dewatered biosolids and turn it using a Brown Bear to accelerate natural, solar drying and assist in aeration (Figures 3-1 and 3-2). The finished product typically contains 60 percent or more total solids (TS) that is screened through a 3/8-inch screen to produce a Class AA product. Most of this product is marketed by the South Dade Soil & Water Conservation District. The District had been purchasing the product from the WASD for $12 per ton, and had been reselling it for up to $65 per ton, delivered to farmers in the region (who are primarily located south of Miami). Negativity from food processors regarding the use of biosolids, and difficulties within the citrus industry related to pest control have hurt product sales to such a degree that in early 2016 the South Dade Soil & Water Conservation District had to severely cut back staffing (as well as active WASD compost marketing).

There are no covers or enclosures over the biosolids drying or composting operations to keep rainfall out. Therefore, SDWWTP composting operations are severely curtailed in wet weather. Wet product is heavy, expensive to ship, and difficult to spread. Therefore, solar drying and composting are consistently operated only during the dry season (November through March), and operated sporadically during the remainder of the year. As a result, the majority of biosolids leaving the SDWWTP are still in the form of Class B, digested and dewatered (20 percent% TS) to partially dried (approximately 40 percent to 50 percent TS) biosolids cake (Figure 3-3). Whereas the dried and composted biosolids were previously marketed (generating a small income), they are now primarily being landfilled.

Figure 3-1. Windrow Turning at the SDWWTP Composting Facility

Figure 3-2. South Plant Class AA Cake Drying (Windrow)
Biosolids Market Feasibility Study

Figure 3-3. South Plant Class B Cake Drying
Biosolids Market Feasibility Study

3.3 Class AA Biosolids Regulation

Biosolids in Florida are regulated under the Florida Department of Environmental Protection (FDEP) by Chapter 62-640 Florida Administrative Code (F.A.C.) regulations. These regulations allow for the production of Class AA biosolids products. These products must meet specific pathogen and vector attraction reduction requirements set forth by U.S. Environmental Protection Agency 40 CFR Part 503 regulations and the "exceptional quality" heavy metal limits (on a monthly average). WASD has historically met these standards at its South District composting facility when weather conditions allow the composting process to be completed.

Meeting these parameters and licensing the product as a fertilizer with the Florida Department of Agriculture and Consumer Services (FDACS) allows the finished products to avoid additional regulations related to compost distribution and marketing. The compost product, once it meets Class AA “exceptional quality” standards, is essentially unregulated, allowing for broad commercial and retail usage. The State of Florida requires that the distributed product be properly stored and cause no nuisances. Further, if licensed as a fertilizer, the products can be distributed for use in south Florida watersheds (e.g., Lake Okeechobee, St. Lucie River, and Caloosahatchie River) which otherwise restrict the usage of Class B biosolids products. Based on discussions with the FDEP Biosolids Coordinator (Maurice Barker), a THP biosolids product that meets Class AA standards would be regulated like other Class AA biosolids products (e.g., compost) with respect to off-site storage and usage.

SECTION 4

The Market Area

4.1 Population Statistics and Information

Miami-Dade County is located in the southeastern part of Florida, and is the southeastern most county on the United States mainland. According to a 2015 census report, the county had a population of 2,693,117, making it the most populous county in Florida and the seventh-most populous county in the United States (U.S. Census Bureau, 2015). It is Florida's third-largest county in terms of land area, with 1,946 square miles.

Miami-Dade County is included in the Miami-Fort Lauderdale-West Palm Beach Metropolitan Statistical Area (MSA), as defined by the U.S. Office of Management and Budget. The MSA comprises Miami-Dade, Broward, and Palm Beach counties, Florida's three most populous counties, with principal cities including Miami, Fort Lauderdale, Pompano Beach, West Palm Beach, and Boca Raton. The three-county MSA is also referred to as the Miami metropolitan area. With 6,012,331 inhabitants as of 2015, the Miami metropolitan area is the most populous metropolitan area in Florida and the second most populous metropolitan area in the southeastern United States (U.S. Census Bureau, 2015).

4.2 Geographical Characteristics

South Florida has a subtropical climate, with most of its rain in the summer (wet season) and a dry winter (dry season). The wet season, which is hot and humid, lasts from May through most of October. The hurricane season largely coincides with the wet season, and officially runs from June 1 through November 30. The dry season is from late October through late April. During the height of the dry season (from January through March), south Florida is often very dry, and brush fires and water restrictions often occur..

In addition to its sea-level elevation, coastal location, and subtropical latitude, the area owes its warm, humid climate to the Gulf Stream, which moderates climate year-round. A typical summer day has temperatures from the high 70°F to the mid-90°F, and is humid. During winter, the air is more dry, and daytime temperatures across South Florida rise to the mid- to high-70°F. Minimum temperatures during the winter season are generally in the mid-50°F. On average, coastal South Florida is frost free, although there can be a frost inland a few times each decade (National Weather Service, 2016).

The South Florida climate allows for long growing seasons, which can extend the use of soil products. Whereas, vegetable farmers can often grow two to three crops per year (on raised planting beds), in the height of the summer only minor landscaping related work is practiced because of the heat. Agricultural and ornamental horticultural work is limited during the rainy season. The sandy soils, which are predominant in the region, can greatly benefit from the addition of biosolids-based products, as they are often droughty and low in cation exchange capacity (or nutrient holding ability). Further, Miami-Dade County is somewhat geographically confined as there is limited territory for which to distribute potential products south, and much of the land west and southwest is in the Florida Redlands and in the Everglades, neither of which constitute a significant market for biosolids. This means that much of the potential WASD Class AA products will need to be transported to markets, which must be developed to the north of its location.

4.3 Regional Market Demographics

In order to provide additional market insight, a population and distance analysis was completed for southern Florida, and preliminary business demographic data (related to horticultural and fertilizer markets) was obtained and evaluated. This data provided an understanding of the current marketplace, as well as potential sales potential and logistics for fertilizer, soil, and fertilizer-containing products.

As shown in Table 4-1, very large population bases exist within a feasible trucking distance from Miami, including a substantial number of horticultural (ornamental) businesses (Table 4-2) which can utilize a variety of biosolids products. Whereas, denser soil type products are typically shipped less than 50 miles from their source, compost may be competitively shipped to a distance of 75 to 100 miles, and high quality granulated biosolids fertilizer to a distance of 250 to 300 miles. These distances are greatly dependent upon competitive factors. The large population bases in the Miami MSA positively impact the number of landscape and garden center businesses, as well as golf courses, which exist. It should be noted that the nursery and landscaping industries in Florida, sometimes referred to as environmental horticulture, are massive. A University of Florida study (Florida Nursery Crops and Landscaping Industry Outlook) estimated the economic impact of the environmental horticulture industry in Florida as approximately $16.3 billion dollars in 2010 (Khachatryan and Hodges, 2012).

Table 4-1. Population and Distance Analysis
Biosolids Market Feasibility Study

City	County	Distance[a] (Miles)	Drive Time[a] (Hours: Minutes)	City[b] Population	County[b] Population
Miami	Miami-Dade	--	--	441,003	2,693,117
Fort Lauderdale	Broward	27	0:36	178,590	1,896,425
West Palm Beach	Palm Beach	70	1:15	106,779	1,422,789
Immokalee	Collier	115	1:50	24,154	357,305
Fort Pierce	St. Lucie	125	2:00	44,484	298,563
Naples	Collier	125	2:00	21,512	357,305*
Okeechobee	Okeechobee	128	2:10	5,608	39,469
Fort Myers	Lee	152	2:20	74,013	701,982
Key West	Monroe	160	3:30	25,755	77,482
Sebring	Highlands	168	2:50	10,497	99,491
Melbourne	Brevard	173	2:42	80,127	568,088
Sarasota	Sarasota	230	3:30	55,118	405,549
Orlando	Orange	233	3:30	270,934	1,288,126
St. Petersburg	Pinellas	265	4:00	257,083	949,827
Tampa	Hillsborough	280	4:10	369,075	1,349,050
Total				**1,964,732**	**10,859,137**

Notes:
*Duplicate county is only counted once
[a]Source: MapQuest
[b]Source: U.S. Census Bureau (2015)

Table 4-2. Horticultural Market Demographics
Biosolids Market Feasibility Study

County	Landscape Contractors	Retail / Wholesale Nurseries	Golf Courses	Landscape Equipment & Supplies	BULK Topsoil	Materials Mulches	Garden Centers	Total
Broward	483	12	76	26	8	7	71	683
Collier	113	9	139	8	1	3	19	292
Hendry	1	0	1	0	0	0	4	6
Lee	274	11	155	11	2	11	23	487
Miami-Dade	306	68	40	9	11	4	56	494
Monroe	69	0	8	0	2	0	15	94
Palm Beach	518	68		24	6	13	41	670
Totals	1,764	168	419	78	30	38	229	2,726

Source: Power Finder USA ONE DVD 2016

This research also illustrates that a large number of fertilizer companies (Table 4-3) exist within Florida, with the largest numbers in central Florida (Hillsborough and Polk counties). That stated, a thermally dried and properly granulated biosolids product could feasibly be marketed the required 250 to 300 mile distances to reach these end users, whereas a THP or compost product alone (with a 50 to 100 mile maximum) could not. This is primarily because of the product's weight (bulk density) and perceived value (fertilizer products have the highest). Fertilizer companies typically use granulated biosolids as is, or to blend with other fertilizer components. A lower quality, thermally dried product, one that is not well granulated and/or is very dusty in nature, would possess a much lower innate value, since its physical characteristics would not allow it to be used as a traditional fertilizer, or fertilizer component. It would more likely be used in soil blends and marketed at lower prices.

Table 4-3. Fertilizer Market Demographics
Biosolids Market Feasibility Study

Counties	Manufacturers	Mixers	Wholesale	Retail	Totals
Brevard	0	0	3	0	3
Broward	1	0	7	3	11
Charlotte	1	0	2	0	3
Collier	4	0	8	2	14
DeSoto	0	0	0	0	0
Glades	1	0	2	0	3
Hardee	4	0	5	0	9
Hendry	2	1	6	2	11
Highlands	4	1	7	3	15
Hillsborough	11	1	24	7	43
Indian River	0	2	3	1	6

Table 4-3. Fertilizer Market Demographics
Biosolids Market Feasibility Study

Counties	Manufacturers	Mixers	Wholesale	Retail	Totals
Lee	2	0	9	2	13
Manatee	2	1	6	1	10
Martin	1	0	4	0	5
Miami-Dade	1	0	3	2	6
Monroe	0	0	0	0	0
Okeechobee	0	1	4	1	6
Osceola	0	0	1	0	1
Palm Beach	3	3	11	4	21
Pinellas	1	0	5	2	8
Polk	11	4	20	5	40
Sarasota	1		4	1	6
St. Lucie	1	2	2	3	8
Totals	**51**	**16**	**136**	**39**	**242**

Source: Power Finder USA ONE DVD 2016

Further, considerable agricultural acreage exists within a truckable distance (Table 4-4) from Miami. Although densely populated, both Miami-Dade (61,567 acres) and Palm Beach (383,617 acres) counties still possess substantial harvested agricultural acreage. Miami-Dade County’s major crop acreage is in vegetable production (29,703 acres), orchards (21,977 acres), and nursery stock (12,584 acres). Palm Beach County's crop acreage is dominated by sugar cane (285,304 acres), but also has large acreage in vegetable (60,762 acres) and sod (15,007 acres) production.

However, higher quality thermally dried product is likely the only biosolids-based product that could be marketed outside of the Miami metropolitan area of Miami-Dade, Broward, and Palm Beach counties. Interestingly, higher value crops are grown in the area, which favors the use of compost products, but unprocessed (fresh) fruits and vegetables are often less likely to use biosolids-based products. Historically, regional citrus (located primarily in Central Florida) and vegetable farmers (located in Central Florida and Homestead) have used biosolids-based compost and fertilizer products.

Table 4-4. Regional Agricultural Census Data
Biosolids Market Feasibility Study

		Florida	Broward	Collier	Hendry	Lee	Miami -Dade	Monroe	Palm Beach
Farms	Number	47,740	615	319	406	844	2,954	28	1,409
Land in Farms	Acres	9,548,342	14,497	123,608	495,734	87,125	139,310	476	513,943
Farms by Size									
1 to 9 Acres		11,742	474	136	76	307	2,045	16	850
10 to 49 Acres		21,013	102	100	126	364	697	10	418
50 to 179 Acres		8,764	16	31	71	96	119	1	58
180 to 499 Acres		3,528	15	19	41	39	58	1	33
500 to 999 Acres		1,259	7	9	38	20	25	--	14
1,000 Acres or more		1,434	1	24	54	18	10	--	36
Total cropland	Farms	24,544	377	168	207	393	2,732	13	739
	Acres	2,744,064	4,292	66,948	262,438	22,816	64,904	130	440,747
Harvested cropland	Farms	21,011	353	137	175	339	2,680	10	672
	Acres	2,184,485	3,085	30,096	192,555	20,038	61,567	103	383,617
Selected Crops Harvested									
Corn for grain	Acres	39,330	--	(D)	--	--	(D)	--	84
Corn for silage	Acres	27,715	--	(D)	--	--	--	--	(D)
Wheat for grain, all	Acres	15,456	--	(D)	(D)	--	--	--	--
Winter wheat	Acres	15,456	--	--	(D)	--	--	--	--
Oats for grain	Acres	4,631	--	--	--	--	--	--	--
Sorghum for grain	Acres	3,541	--	--	--	--	--	--	--
Sorghum for silage	Acres	8,385	--	(D)	--	--	--	--	--

Table 4-4. Regional Agricultural Census Data
Biosolids Market Feasibility Study

		Florida	Broward	Collier	Hendry	Lee	Miami -Dade	Monroe	Palm Beach
Soybeans for beans	Acres	19,409	--	--	--	--	(D)	--	--
Dry edible beans	Acres	28	--	--	--	--	--	--	--
Cotton, all	Acres	105,420	--	--	--	--	--	--	--
Forage	Acres	398,231	907	468	223	3,045	(D)	(D)	665
Rice	Acres	(D)	--	(D)	--	--	--	--	(D)
Sugarcane for sugar	Acres	401,491	--	--	79,624	--	669	--	285,304
Vegetables	Acres	251,011	--	13,881	11,234	4,952	29,703	--	60,762
Potatoes	Acres	35,251	--	(D)	--	(D)	5	--	--
Sweet Potatoes	Acres	5,988	--	--	--	(D)	(D)	--	(D)
Land in Orchards	Acres	579,068	--	15,966	100,720	9,745	21,977	(D)	1,068
Nursery Stock	Acres	51,657	1,032	562	918	2,028	12,584	(D)	3,285
	Sq.Ft (Under glass)	65,221,237	148,928	1,066,240	--	665	--	--	624,366
Sod Harvested	Acres	62,120	--	--	(D)	_	1	--	15,007

Notes:

D = *Information w*ithheld to avoid disclosing *data* for individual farms

Source: USDA, National Agricultural Statistics Service (2016)

SECTION 5

Processing Options

CH2M evaluation a variety of biosolids management processing technologies. Through the technical review process, the following three processing options (alone or in combination) were deemed as the most plausible:

- Composting,
- Drying and Granulation
- THP processing with Soil Blending

The market research study focuses on the products that would result from these processing options.

5.1 Technology Options and Product Characteristics

Any of the three processing options and biosolid products could be produced at a WASD owned and operated facility or through a contractor. A contractor could construct a facility to process just WASD biosolids, or develop a merchant facility which processes biosolids for various communities. Currently, merchant facilities exist in Florida; these facilities process biosolids through composting and lime stabilization. Drying and granulating biosolids is being completed by and for individual communities. Both compost and thermally dried biosolids have been extensively marketed in Florida. Currently no THP processing facilities exist in Florida, so there is no experience with marketing of THP biosolids product in Florida.

5.1.1 Compost

Biosolids composting has been successfully practiced in the United States since the late 1970s.
The process involves blending dewatered biosolids with carbonaceous materials, such as wood chips or ground brush, to supply carbon and provide porosity for aeration to provide oxygen to the microbes. The composting process enhances the degradation process which consumes and stabilizes the organically-based materials, turning them into a versatile soil amendment (see Figure 5-1). During the process, the composting mass roughly reduces 40 to 50 percent in weight and volume, losing significant amounts of moisture (as water vapor) and cellulosic carbon (as carbon dioxide). However, because of the addition of carbon to the biosolids, for use as a bulking agent in the process, roughly 1 cubic yard of biosolids will produce 1 cubic yard of compost. The composting process can transform Class B biosolids into a Class AA product with no EPA or FDEP use restrictions. The finished product could not be used in certified organic production, but could be used in the production of other crops for human consumption, including fresh produce. Biosolids compost has been used extensively by the Florida citrus industry, as well as in landscaping and nursery production. Compost can also be used in environmental applications, such as mine land reclamation, forestry, and storm water management. Figure 5-1 describes the characteristics of a high quality general use compost product.

- pH - 6.0 - 8.5
- Electrical Conductivity - maximum 5 dS/m (mmhos/cm)
- Moisture Content - 30 to 60 percent, wet weight basis
- Organic Matter Content - 30 to 65 percent, dry weight basis
- Particle Size - 98 percent pass through 3/8-inch screen or smaller (dry weight basis)
- Stability (Carbon Dioxide Evolution Rate) - < 5 mg CO_2-C per g OM per day

- Maturity (Seed Emergence and Seedling Vigor) - Minimum plant growth must be 80 percent of the control plants growth
- Physical Contaminants (inerts) - < 0.1 percent (dry weight basis)
- Chemical contaminants, mg/kg (ppm): meet or exceed EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels.
- Biological contaminants select pathogens fecal coliform bacteria, or salmonella, meet or exceed EPA Class A standard, 40 CFR § 503.32(a) level requirements

Figure 5-1. Generic High Quality Compost Specifications
Biosolids Market Feasibility Study

5.1.2 Fertilizer (Thermally Dried)

Thermal treatment of biosolids has been successfully done in the United States since the 1920s, starting in Milwaukee, Wisconsin. However, its use as a mainstream biosolids management technique likely started in the 1990s, with both large and small cities adopting the technology. The process entails drying biosolids to a minimum TS content of 90 percent using various technologies. Certain technologies primarily dry (dehydrate) the biosolids for landfilling, land application and/or burning as a fuel. However, other technologies dry and granulate it in order to generate a marketable fertilizer or fertilizer component. Often, the term pelletization is used when discussing thermally treating biosolids, but this is a misnomer, as only a small amount of biosolids are actually extruded into pellets. This is primarily because the fertilizer industry is not accepting of the pellet's shape and size, but rather they require a very dry, hard, and somewhat spherical granule for fertilizer blending (see Figure 5-2). Therefore, when choosing thermal treatment technology, a clear vision of available markets and program goals is of primary importance. Biosolids fertilizer value is primarily driven by its nitrogen content and the acceptability of its physical attributes.

- Consistent nutrient analysis
- No less than 95 percent total solids
- No/Minimal objectionable odors
- Uniform granular/rounded shape
- Uniform size, with granules being sized at approximately, 1.0, 2.0, 2.5 or 3.0mm, depending on the market being approached
- Dust free (minimal dust, under 1 percent by weight)
- Product must have a minimum bulk density of 45 pounds per cubic foot
- Chemical contaminants, mg/kg (ppm): meet or exceed EPA Class A standard, 40CFR § 503.13, Tables 1 and 3 levels.
- Biological contaminants select pathogens fecal coliform bacteria, or salmonella, meet or exceed EPA Class A standard, 40 CFR § 503.32(a) level requirements

Figure 5-2. Generic Biosolids Granule Specifications
Biosolids Market Feasibility Study

There are providers that sell but do not operate drying and granulation (or pelletization) technology. However, there are biosolids management companies that specialize in operating these same technologies. There are also technology providers that will only design and build facilities if they are contracted to operate them. The greatest factor impacting the development of a thermal drying treatment system is the overall cost, as thermal drying is typically the most expensive biosolids management alternative. The capital and operating costs of thermal drying are typically recovered through lower handling costs and the market value of dried biosolids. However, the energy costs for operating the facilities is substantial.

5.1.3 THP with Soil Blending

Using dewatered Class AA biosolids as an ingredient in the production of blended landscaping soils is a newer management technique which is picking up momentum nationally. This is probably because it allows wastewater treatment plants to diversify their biosolids product into horticultural (non-agricultural) markets with a limited construction investment. The process uses Class A dewatered biosolids and blends it with native soil, and/or a variety of other ingredients such as sawdust, bark, and sand. The blending process is typically done using readily available commercial soil blending and screening equipment. The management technique is not patented, and construction investments would be much lower than that of other technologies (e.g., composting, drying/granulation) which produce non-agricultural products. However, since this technique is rather new, product (types and formulations) and market development research is essential prior to further development.

The Tacoma Grow (TAGRO) program in Washington, which started in 1992, is the most well-known soil blending program in existence in North America. However, similar programs also exist in Vancouver, British Columbia (Canada), and a new one is underway through the District of Columbia's Water and Sewer Authority. These programs have been operated by wastewater treatment plant (city/municipal) staff, or contracted out to biosolids management companies. The processing is typically done at the treatment plant, where the biosolids are generated, but could also be done off-site. It should be noted that biosolids are typically less than 50 percent of the blended soil mix (volume basis), and can be as low as 25 percent. Therefore, this management technique creates more volume of material to distribute. However, the product(s) can be sold (to recover some of the production costs) and not merely distributed at full cost to the generator. Also, because the product’s characteristics are significantly different than typical biosolids products with which users may be familiar, new markets would have to be created and the marketplace educated. It should be noted that South Florida has a unique landscape soils industry, whereas much of it is first derived from mined 'muck' soils, which are dark in color and relatively inexpensive to harvest for use. This situation has reduced the overall value of landscape soils in South Florida. Acceptable characteristics of these soils have not been established, and acceptability of soil blends with biosolids cake are greatly dependent upon their specific application.

5.2 Competing Products/Facilities

Several facilities in Florida produce Class AA biosolids products. Table 5-1 provides summarized data pertaining to both production and marketing issues at these facilities. As shown in Table 5-1, most biosolids processors are successfully managing the sale of their products. Interest exists for processing WASD biosolids at rates similar, or less than, those which the WASD is currently paying. Opportunities exist for shipping the biosolids to existing merchant facilities, and there is also a possibility that an established vendor could develop a facility specifically for the development of soil blends using WASD biosolids.

Table 5-1. Biosolids Management Facility Data
Biosolids Market Feasibility Study

Facility	Production Data	Markets/Distribution
City of Bonita Springs	Operate a small Andritz drying facility since 2007, producing under 1,000 dt/yr of product. No expansion is currently planned. The nutrient content of the product was not disclosed.	The sales price of the product to the primary buyer (name not disclosed) is low and sold through an RFP process.
Emerald Coast Utilities Authority - Pensacola	Operate 2 small Komline-Sanderson dryers and a composting facility. Composting facility was needed to deal with yard trimmings and helps diversify biosolids management. Dried product is very dusty and produces 400-500 t/month of 6-5-0 fertilizer product. Produces 30,000 t/yr of compost. Use a building canopy for dried product storage.	Sell all dried product to Mannco for $15/t, freight on board (FOB). They resell to agriculture and sod industries. Compost was being used on landfill and is now sold for $4 to $10 per cubic yard, based on volume purchased.
City of Hollywood	Operate a Schwing-Bioset lime stabilization process at the city's wastewater treatment plant. Operate five other facilities in the state, including merchant facilities, and more are under design.	Sister company ages and markets the product. Food Safety Modernization Act pathogen issue has not affected their sales. Sell primarily to grazing land, orange groves, golf courses and sod producers. Soil amendment sold to sod farms, plant nurseries and for use on state projects. Would not disclose pricing (quoted $45/ton, delayed and spread to farmers in 2013).
JFE Brighton Composting Facility - Okeechobee	Operate a McGill composting to produce 100,000 t/yr for an incoming feedstock facility. Are composting some Miami biosolids, which is received from WMI. Do not have much excess capacity, but could expand. Located 2 hours from WASD. They claim they could build and operate a facility for WASD for a tip fee under $50/wt.	All compost (100,000 CY/yr) is sold to Harvest Quest which sells almost all of it into the citrus industry (once it is treated with their microbial inoculants). Doing more with golf courses too. Did not indicate sales pricing.
Lee County Composting Facility	Compost 60,000 wt/yr of biosolids, producing approximately 30,000 wt of compost. They compost for Lee county cities, and also process some from Naples and Ft. Myers. Have limited excess capacity, and expanded just 2 years ago. Yard waste is their bulking agent.	Selling primarily to citrus groves ($10/t, FOB), and a little retail ($10/CY, FOB). Own fleet of 12 trucks that manage yard waste and compost shipping. Food Safety Modernization Act concerns are not a problem for them. Think product is underpriced, but allows them to sell to a small number of larger customers.
Palm Beach County	Closed their composting facility (2014) to build a dryer, operated by NEFCO. Produce 25,000 dt/yr of a 4-3-0 fertilizer product. Any off-spec product is recycled (very small amount), but could be land applied.	Primarily market to fertilizer blenders, and agriculture. They produce a 1.8-2.2mm hard granule that fertilizer blender like. High value end users pay up to $100/t, delivered, low value could just pay shipping $15-$25/t, delivered. Sell all product. Low value ag sales (pasture) are untapped.
Reedy Creek WWTP – Orlando	Harvest Power is processing at the Reedy Creek facility using a Komline-Sanderson dryer. Produce approximately 80 dt/week.	Stated that the facility produces a 5-5-0 fertilizer product, which is dusty. Product is currently distributed (and delivered) to farmers for free.

Table 5-1. Biosolids Management Facility Data
Biosolids Market Feasibility Study

Facility	Production Data	Markets/Distribution
City of Sarasota	Shut down their Purac composting facility several years ago, because it was old and worn out. Then they sent it to the landfill and pelletizer, and now to Synagro for composting.	Now process at Synagro's Charlotte Cty. composting facility; 540 wt/month at 20% TS. Stated that the tip fees are $57/ton.
Southeast Soil, LLC (owned by Compost USA) – Okahumpka	Operate 2 sites; in Okahumpka and Lake Panasoffkee. Operate windrow facilities, and currently only have excess capacity at the Lake Panasoffkee facility. Tip fee is $30 wt at gate.	SE Soils was C&C Peat, a large peat and nursery soils company that expanded into composting. Most compost has been used in their own nursery and landscape soils. Pure compost sold for $8/CY, FOB. Golf courses, sod and farms are starting to buy compost too.
Synagro	Operate a 6,000 t/yr Andritz drying facility in Pinellas County. and 10,000 incoming t/yr composting facility in Charlotte Cty. They suggested that they could process WASD biosolids for $25-40/ton.	Ship less biosolids granules into Florida, because citrus was their biggest market. Marketing all of their products, but with regulatory and ag challenges (P reductions, citrus psylild) , it is just a little harder.

Research Findings

This market research study evaluated marketing opportunities and values for biosolids compost, thermally dried, and THP biosolids used in soil blending. Study results related to biosolids end-user market information, product experience, and opportunity/value in ornamental and agricultural industries are presented in this section.

6.1 End-User Market Information

The Miami metropolitan area possesses a huge urban population which is being serviced by a large environmental horticulture industry. Further, a large agricultural industry also exists within a truckable distance. During market research, 34 end users and product distributors were surveyed, including fertilizer blenders and brokers, product spreaders, soil blenders, garden centers, and agricultural and horticultural product distributors. Company contact lists and response information are provided in Appendixes A and B.

Because of the short project schedule, much of the biosolids end use data were obtained from producers, distributors, and resellers of related products. Farmers and landscapers were not contacted directly, but past experience in the marketplace confirms that farmers, landscapers, and soil blenders routinely use biosolids compost products.

6.2 Biosolids Product Experience

A significant amount of experience with the use of both biosolids compost and fertilizer products exists in and around the Miami metropolitan area but there are opportunities. The biosolids market study results indicate the following product experience:

- **Opportunities for Increased Biosolids Product Use Exists.** Despite the current market, there are opportunities to expand the market, given that less than 40 percent of the companies surveyed mentioned that they have or are currently using biosolids-based products. The aforementioned penetration rate with biosolids products is deceptively low because many fertilizer and nursery products contain biosolids products.
- **Milorganite and Dried/Granulated Biosolids Products Widely Used.** The majority of biosolids product experience was with milorganite and other dried and granulated biosolids products. Several garden centers and resellers carry or could obtain milorganite for resale, while several large fertilizer blenders identified that they were using bulk biosolids granules manufactured in Florida for use in their fertilizer blends.
- **No Experience Using Class AA THP Biosolids in Soil Blends.** Biosolids compost is used in nursery and landscape soil mixes, but no one had any experience with the use of Class AA THP biosolids usage in soil blending. This was expected since there is currently no facility producing THP biosolids product in Florida. Lower quality (dusty) biosolids fertilizer products are being successfully marketed and distributed in most cases, but there are exceptions. For example, the Reedy Creek facility appears to be paying shipping costs to distribute its dried biosolids product. If also does not appear that markets for dried and granulated products have not been developed in Florida, probably because the fertilizer markets have been robust.

6.3 Opportunity/Value

Opportunities exist for WASD to market a composted and a thermally dried biosolids product possessing a variety of characteristics. A finer, dustier product would likely be marketed at $1 to $15 per ton to companies that spread products on agricultural land. Some interest may also exist with sod producers and farmers themselves for this product, depending on the nutrient content and existing fertilizer pricing. These direct customers would likely pay twice as much for the product. Higher quality granules are being delivered to fertilizer blenders for $65 to $100 per ton. All of the thermally dried products can be marketed within this marketplace, if a concerted effort is given. A product that possesses better physical properties (uniform sizing, little dust) also has good long-term potential in landscape, turf, and retail applications. While marketing these products to cement kilns in Florida, as a fuel source, these markets do not usually generate income for the producer. Further, because of permitting changes required for using biosolids as an energy source, end users would likely require large on-going volume sources (5,000 or 10,000 ton minimum) in order to consider its usage.

Several biosolids composting facilities are successfully marketing their products throughout central and southern Florida to agricultural and environmental horticulture enterprises. A WASD composted product should also be highly marketable, especially if marketing efforts are concentrated north. Prices for un-amended biosolids compost to agriculture range from $2 to $10 per ton, freight on board (FOB), and prices to environmental horticulture range from $4 to $10 per cubic yard, FOB (assume 2 cubic yards per ton) – nearly double that of agriculture. Unblended compost prices are somewhat depressed, probably because the low cost of muck soils and because of problems in the citrus industry. Compost prices do appear to be down (25 to 50 percent) from similar research obtained in Florida. However, blended and amended compost products are being marketed at higher prices ($20 to $30 per cubic yard, FOB), with peat-based nursery soil products being marketed at even higher prices. Certainly, WASD (or its agent) should be able to market a traditional compost product at the values mentioned above or higher, if the product is of good quality. Successful market development for composted and thermally dried biosolids products will require WASD to work with a company or companies experienced with marketing biosolids products or develop an internal marketing team to reach markets north of Miami.

No firm data were obtained pertaining to the marketing of THP biosolids based soils. Further, because muck soil is marketed at commodity prices ($10 to $15 per cubic yard) and compost prices are repressed (see Table 6-1), marketing the product to the soil blending industry as an ingredient to topsoil will be more difficult. Understanding the value of a variety of existing soil products in the South Florida marketplace is helpful when considering what products may be used (economically) within it. Further, the THP product is denser than compost, which will make it less shippable. It would likely be easier for the WASD to produce and market the finished blended soils. However, that would require great commitment. But, again, even the price of blended landscape soils is somewhat repressed.

Table 6-1. Expected Wholesale Biosolids Products Market Value
Biosolids Market Feasibility Study

Product	Value
Compost	$2.00 to $10.00 per ton – agriculture $8.00 to $20.00 per ton – horticulture
Dried/Granulated	$35.00 to $65.00 per ton - high quality granules $1.00 to $15.00 per ton - low bulk density, dusty product
Soil	$10.00 to $15.00 per cubic yard - muck soil $16.00 to $25.00 per cubic yard - blended / manufactured soils
THP Cake	$0.00 to (-) $20.00 per ton (shipping costs included)

Note:
Cost shown indicate picked-up prices in large truckload volumes (20 tons to 25 tons, 30 to 50 CY)
THP cake values may be improved. Additional product development and market research is necessary to confirm this.

6.4 Market Impacts

There are specific issues currently negatively impacting the use of biosolids-based products in the Florida marketplace. They are:

1. Passage of the Food Safety Modernization Act - This act was passed by the U.S. Congress on December 21, 2010, and signed into law by President Obama on January 4, 2011. Implementation started in November 2015. The Food Safety Modernization Act covers produce safety, preventive controls for human and animal food, and foreign supplier verification. The regulation could change the way raw manures and other organic amendments (including biosolids) are used in fresh fruit and vegetable production, placing lengthy 'days to harvest' restrictions on the use of those which have not been treated for pathogen reduction. The manure related pathogen concerns outlined in these regulations are likely creating concern in the Florida marketplace regarding the usage of biosolids-based products, even though the Class AA products are treated for pathogen destruction. Although the regulation does not disallow the use of biosolids, it does allow growers groups and purchasers to implement such restrictions.
2. Citrus Production Reduction due to Asian Citrus Psyllid (*Diaphorina citri* Kuwayama) Infestation- This insect has become the most important insect pest of Florida citrus due to the presence of citrus greening disease, also known as huanglongbing which is spread by the psyllid. This disease is said to have reduced the 2016 citrus crop yield by 40 to 50 percent, which is causing many citrus farmers to cease operation. This is significant because various biosolids products have been used successfully in citrus crop production.
3. Nutrient Limits from the Lake Okeechobee and Estuary Recovery Plan Impact Biosolids Use – This plan was created at the direction of former Governor Bush, the South Florida Water Management District and the FDEP to better manage nutrient application. As such, the FDACS revised its fertilizer content standards for use in urban settings. The rule requires that all fertilizer products labeled for use on urban turf or lawns and sports turf be limited to the amount of nitrogen and phosphorous necessary to support healthy turf maintenance. The rule protects water quality by restricting phosphorous and nitrogen application rates in fertilizers for urban turf and lawns. The rule requires the directions for use to limit the amount of phosphate and nitrogen which can be applied in a single application, as well as annual totals. These rules can affect the usage of biosolids products because they limit the application of nitrogen to 1 lb of total nitrogen/1,000 square feet to be applied at any one time and a maximum of 0.25 lbs P_2O_5/1,000 square feet per application (not exceeding 0.5 lbs P_2O_5/1,000 square feet per year). P_2O_5 application rates above these levels would require a soil sample of the application site to justify an increased application.

The end users in the marketplace are already adjusting to these circumstances, and as will the biosolids management industry. Although problematic, especially in the short-term, these circumstances will not likely devastate biosolids product usage. The fact that these circumstances are occurring simultaneously, simply makes their management more complicated.

SECTION 7

Conclusions

Good acceptance of thermally dried biosolids and composted biosolids products exist in the central and southern Florida marketplace. That stated, several biosolids thermal drying and composting facilities have ceased operation in Florida; primarily because of economic considerations. Biosolids composts have been successfully used in nursery and landscape soil mixes and agriculture (e.g., citrus) for many years and have been accepted in the marketplace where produced.

Marketing efforts for a WASD-composted product should be concentrated in the three county Miami metropolitan area, into horticulture (e.g., landscape, nursery, golf course), and as necessary, agriculture. Properly dried and granulated biosolids products, low in dust and useable in blended fertilizers, will be easier to market and possess a greater market value. That stated, a nutritionally rich thermally dried product, containing a significant amount of dust, should also be marketable, with the proper effort. However, it will possess a lower value, so more local markets will be required to be developed.

Based on 2015 Annual Sludge Report data, the CDWWTP biosolids are more nutrient rich, with more than 5 percent total nitrogen content, making them a more attractive feedstock than the biosolids generated at the SDWWTP for a thermally dried fertilizer product. However, other biosolids quality issues, such as odor and hair content, are also relevant when considering drying and granulation, and therefore must be considered. Use of a thermally dried biosolids product as an energy source, combusted at cement kilns, is probably also feasible. However, these markets have not yet been developed, because fertilizer markets have been more lucrative. This market requires a very dry product, though it may be dusty, and nutrient content is much less relevant.

Knowing that the location of the potential WASD processing facility puts its product at a distance disadvantage to competing products, WASD or its surrogate will have to concentrate on developing local markets first. Since Miami-Dade County is somewhat confined to distribute potential products south and as much of the land west and southwest is in the Redlands and in The Everglades, potential WASD Class AA products will need to be transported to markets which must be developed to the north of its location.

Further, concentrating sales into environmental horticulture, possibly even packaging and blending products, should significantly raise the products value, allowing it to be shipped farther. If concentrating on agricultural sales, efforts should be made to expand markets north and west of Miami. Marketing a THP treated biosolids to soil blenders will likely be difficult, at least in the short-term, because of inexpensive base materials (e.g., muck soils) available in the region. That stated, WASD could consider the development of its own soil blending operation, similar to TAGRO, using its THP product as the base. This concept would require additional research, and significant on-going effort, and partnering with an existing topsoil supplier in the region may even be a viable option.

It is possible that the WASD could manage product marketing in-house, if it dedicates the proper resources to develop the program and hires the appropriate technical staff. However, it must be noted that opportunities do exist for a private contractor to process and market potential biosolids products, even if the facility is located at a WASD wastewater treatment plant. Further, since significant interest exists with private biosolids management companies to process the WASD biosolids, this concept should be further evaluated. Most of these companies possess practical experience in market development in Florida, Contact with said companies has identified their willingness to create Class AA biosolids products (and market them) for the WASD at rates similar, or less than, those which the WASD is currently paying to process. Opportunities exist both for shipping the biosolids to existing merchant biosolids management facilities, as well as contacting with a vendor that would develop a facility specifically for the WASD.

All issues considered, it is suggested that the following speculative market values be used when evaluating production of the three biosolids products:

Table 7-1. Potential Value for Biosolids Product Options
Biosolids Market Feasibility Study

Product	Value
Compost	$10.00 per ton
Thermally Dried	$15.00 per ton (of low bulk density and low dust product)
THP Cake	$0.00 to (-) $20.00 per ton (of a product not further processed after production)

The THP cake is a signed a low speculative value because markets have not been developed for it in South Florida, and because it is generally considered a 'less finished' product.

SECTION 8

References

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USDA-ARS-BARC, Environmental Microbial & Food Safety Lab and Sustainable Agricultural Systems Lab - Patricia D. Millner, Ph. D., Research Microbiologist.

Appendix A
Project Contact List and Potential End Users

Project Contact List and Potential End Users

Company Name	City	Phone	Contact
A1A Sod Sand & Soil, Inc.	Homestead	305-245-4445	Andy Diaz / Valdo
Aglime Sales, Inc.	Babson Park	863-638-1481	Ray Bassett
Agricultural Innovations	Plant City	813-393-6300	Don Long
Andersons Plant Nutrient	Clewiston	863-983-2103	Mike Willis
Atlas Peat & Soil	Boynton Beach	561-734-7300	Brian Lulff
Bushel Stop	Pompano Beach	954-975-4660	Al Richardson
Diamond R Fertilizer	Fort Pierce	772-464-9300	Kathy
Diamond R Fertilizer	Okeechobee	863-763-2158	Matt Davis
EPS Organics	Miami	305-885-1200	Maria De La Portilla
Florida Fertilizer	Wauchula	863-773-4159	Larry Coker
Grower’s Outlet of Lake Worth	Lake Worth	561-433-4744	Albert Brown
Harrell’s Inc.	Lakeland	863-687-2774	Jim Moon
Harvest Quest	Okeechobee	216-401-7039	Shane Donnelly
Jeny Sod Nursery	Miami	305-596-5610	George Morales
Lighthouse Garden Center	Miami	303-271-7190	Ketlyne Alexis
Nutri-Source, Inc.	Windermere	407-876-1130	Mike Litvany
Lance Palmer Spreader Service	Arcadia	863-990-112	Lance Palmer
Odum’s Inc.	Loxahatchee	561-402-7736	Nalio
Olimar Sand & Gravel	Miami	305-477-7428	Silva Olivar
Piri Nursery & Landscaping	Hialeah	786-313-00441	Jenny Sanchez
Pro-Plus Golf Services	Bowling Green	863-375-2487	Jim Lyle (Christy)
Nu-Way / Rite-Way Recycling	Jupiter	561-935-9298	Patricia
Reliable Peat Company	Winter Garden	352-326-5432	Jack Reiner
Roland Trucking	Key Largo	322-559-0581	Gill Rowland
Site 1	Kissimmee	407-870-8600	Terry
Solce Fertilizer	Palmetto	841-721-7777	John Wright
South Dade Soil & Water Conservation District	Florida City	781-255-8820	Bill Townshend
South Florida Spreader Service	Fort Pierce	772-3770-3538	Matt McBride
Sunrise Mushroom, Co.	Pompano Beach	954-942-0747	Michael Ewing
True Value of West Kendell	Miami	305-603-8660	Alejandro Chediak
USA Sod & Landscaping	Miami	305-485-8422	Virgelio Lopez
Williams Soils & Sod	West Palm Beach	561-967-1591	Georgina Randell

Company Name	City	Phone	Contact
PROCESSORS			
City of Bonita Springs	Bonita Springs	239-495-4247	Jake Hepokski
Emerald Coast Utilities Authority	Pensacola	850-969-6690	Gerry Piscopo – Thermal Drying
Emerald Coast Utilities Authority	Pensacola	850-969-3393	Randy Rudd – Composting
City of Hollywood / Schwing Bioset	Winter Haven / Sebring	863-287-7421	Chad Meadows
City of Hollywood / Schwing Bioset	Naples	239-596-0104	Tom Welch
JFE Brighton Composting Facility	Okeechobee	863-532-8819	Steve Crawford
JFE Brighton Composting Facility/McGill Composting	Cary, NC	919-990-3188	Noel Nyons
City of Largo	Clearwater	727-518-3201	Richard Meshaben
Lee County Composting Facility	Felda	299-533-8000	Howard
Merrill Brothers, Inc.	Kokomo, IN	765-438-7374	Ted Merrill
Palm Beach County / NEFCO	Quincy, MA	617-851-6297	Manuel Irujo
Reedy Creek WWTP / Harvest Power	Orlando	321-307-5844	Gary Aguinaga
City of Sarasota	Sarasota	941-365-2200, ext. 6266	Roger Markranz
Southeast Soil, LLC	Lake Panasoffkee	407-496-2872	Matt Beigler
Southeast Soil, LLC	Okahumpka	352-360-8013	Steve Cook
Synagro	Bartow	800-573-5538	Terry Wiseman
Synagro	Baltimore, MD	443-489-9083	Bob Pepperman

Appendix B
End User Information

Table B-1. End User Information
Biosolids Market Feasibility Study

Business	City, State	Contact	Phone	Business	Markets	Other
A1A Sod Sand & Soil, Inc.	Homestead	Andy Diaz / Valdo	305-245-4445	Landscape supplies	Retail sales	Do not handle biosolids products, sells horse manure compost for $20 CY, P-U. Sell grower soil mix with yard waste compost for $30/CY, P-U and several mulches.
Aglime Sales, Inc	Babson Park	Ray Bassett	863-638-1481	Agricultural supplies	Ag	Still marketing WPB granules , buy from NEFCO (6-3-0) for under $40/ton. Typically sells for $80/t, del'd. Concentrates sales on citrus and pasture land. Also sells dolomitic and calcitic lime, gypsum and sulfur. Many citrus farmers have been hurt by Psyllid, but South Florida groves have not been hit as bad as Central Florida groves. They are not impacted by P restrictions or Food Safety Modernization Act.
Agricultural Innovations	Plant City	Don Long	813-393-6300	ag consultant, organic farmer, ag product producer	Ag	Familiar with biosolids products, was going to resell in past (but did not). Stated that citrus industry is suffering, down 25-40%.
Andersons Plant Nutrient	Clewiston	Gary Aguinaga	321-307-5844	Fertilizer Blender	Ag & turf	Produce all liquid fertilizers in Florida, so no interest in biosolids ferts.
Atlas Peat & Soil	Boynton Beach	Brian Lulff	561-734-7300	Landscape supplies	Nursery and landscape supplies	Wholesale and retail sales of peat and a variety of bulk products. Well known blending company, peat and nursery bark supplier. Sell compost for $22/CY, natural topsoil for $12.30/CY and overburden soil for $9/CY, all P-U.
Bushel Stop	Pompano Beach	Al Richardson	954-975-4660	Landscape supplies	Retail, landscapers, nurseries	Sell various bulk landscape products, and many soil mixes. Sell muck soil/sand mix for $24/CY, P-U, 'Overburden' (soil) for $21/CY, but no compost at this location (Delray carries compost). Sell Milorganite for $22/bag.
Diamond R Fertilizer	Fort Pierce	Bruce Matthews	772-464-9300	Fertilizer Blender	Ag	Do not do any blending. But carry bagged Milorganite (50lb bags sold for $14/CY, P-U.
Diamond R Fertilizer	Okeechobee	Matt Davis	863-763-2158	Fertilizer Blender	Ag	Uses granules from PBC, it is hard and not dusty. Pay $65/ton, del'd for the 6-3-0 product
Diamond R Fertilizer	Winter Garden	Scott Maxwell	407-656-3007	Fertilizer Blender	Ag	Uses 1000's of tons of biosolids granules - 6-4-0 - not from Florida, purchased for whole year (call Jan/Feb 2013). Would not discuss pricing.
EPS Organics	Miami	Maria De La Portilla	305-885-1200	Landscape supplies	Retail, landscapers, nurseries	Manage yard waste, and produce products from it. Produce various blended products, but do not handle any biosolids.
Florida Fertilizer	Wauchula	Larry Coker	863-773-4159	Blender	Ag	Use 8,000 t/a of biosolids granules. 99% of what they do is in the ag market. Use biosolids because it is a cheap filler, but tough to store. Contracted to buy all of WPB's products but reneged because it was to odorous to use. Would like the product oiled to reduce dust. Likes Largo sized granule 150-200 SGN and ThermoFlite 1,2, or 3mm is OK as long as it is consistent. Could buy everything and pay $30-40/t for biosolids.
Grower's Outlet of Lake Worth	Lake Worth	Albert Brown	561-433-4744	Nursery supplies	Nurserymen	Sells plants and some bulk products. Sells yard waste compost for $24/CY, P-U, carries no biosolids products.
Harrell's Inc	Lakeland	Jim Moon	863-687-2774	Blender	Turf, retail products	Uses approximately 2,800-2,900 t/a of biosolids granule from various sources - mainly Synagro / Pinellas Cty facility 5-4-0. Use as a filler w/nutrients. Is paying $40-$50/t, pick-up. Use more biosolids in golf and nursery products. Used to use Milorganite. Need a low dust, low odor product that has a consistent 150-200 SGN (1.5-2.0 mm).
Harvest Quest	Okeechobee	Shane Donnelly	216-401-7039	Compost broker	Ag, turf	All compost is sold to Harvest Quest which adds a microbe package then sells the adjusted product into marketplace; primarily citrus. Hope to expand more into golf turf sales in the future. Produce approximately 110,000 cubic yard (CY) / annum. Sell all of their product. (Sold for $30/ton, delivered)
Jeny Sod Nursery	Miami	George Morales	305-596-5610	Landscape supplies	Retail and landscapers	Sell sod and various soil and mulch products. Sells bulk topsoil/sand blend for $18/CY, P-U and a potting soil for $20/CY, P-U. Do not sell fertilizer or biosolids products. Sells bagged mulch.
Lighthouse Garden Center	Miami	Ketlyne Alexis	303-271-7190	Garden center	Retail	Sell plants and other garden products, plus some bulk products. Do not sell mulch, but sell topsoil for $20CY and a compost/topsoil mix for $25/CY, P-U. Blend with horse manure compost.

Table B-1. End User Information
Biosolids Market Feasibility Study

Business	City, State	Contact	Phone	Business	Markets	Other
Noble Spreading Service	Bowling Green	Cecil Noble	863-781-0329	Spreader	Agriculture	Do not spread biosolids or compost, but do spread dry fertilizers and lime. Do not resell bulk products, only spread.
Nu-Way Recycling	Jupiter	Patricia	561-935-9298	Landscape supplies	Landscapers	Manage yard waste, and produce products from it. Also sells muck soil for $10/CY, P-U, and 'black topsoil' for $30/CY, P-U.
Nutri-Source, Inc.	Windermere	Mike Litvany	407-876-1130	Ag supplier, broker, manages citrus groves	Ag, primarily citrus	Been marketing biosolids compost and granules for many years, but has lost various sources because of facilities shutting down. Sells biosolids granules from Ocala (K-S system) and West Palm Beach (NEFCO technology). Ocala - 5-3-0 - he pays $1/ton and places trailers at the site. WPB - 6-3-0 - he pays $40/ton and the facility has adequate storage. He has been hurt by difficulties in citrus industry (Psyllid has killed much of the acreage). Stated that Food Safety Modernization Act has generated hesitation about using biosolids and manure in ag, while the golf industry has been hurt by economic conditions (courses have closed), and the P reduction regs around Lake Okeechobee.
Odum's Inc.	Loxahatchee	Nalio	561-402-7736	Landscape supplies	Retail and landscapers	Sell various bulk landscape products, including horse manure compost for $17/CY, P-U, and a muck soil/sand mix for $16/CY, P-U. Can deliver in tri-axels (10 CY) truckloads.
Olimar Sand & Gravel	Miami	Silva Olivar	305-477-7428	Landscape supplies	Retail and landscapers	Sells sand and soil, does no specialty blending with 'organics'. Sell a 50/50 mix of sand and soil for $22/CY, P-U.
Lance Palmer Spreader Service	Arcadia	Lance Palmer	863-990-1612	Spreader	Ag	Spreads bulk materials, primarily fertilizer and lime. Tried spreading dewatered biosolids in past, but couldn't spread with current equipment. Could spread dried biosolids. Quote spreading rates on a per ton basis.
Piri Nursery & Landscaping	Hialeah	Jenny Sanchez	786-313-00441	Landscape supplies	Retail sales	Sell no soil amendments, just topsoil for $15/CY, P-U. (Primarily Spanish speakers)
Pro-Plus Golf Services	Bowling Green	Jim Lyle / Christy	863-375-2487	Brokers / uses Largo product	Golf courses	Sell primarily to golf courses, so needs a high quality product (1 or 2mm size, low dust and odor, consistency), sells primarily in bulk form and lends out spreaders to apply. Sell various golf products including liquid fertilizers. Has been selling Largo biosolids product in bag and bulk form (6-3-0 product) for 3-4 yrs; called WIN max 6-3-0 organic. Bagged through a 3rd party company. Sell for $300/ton, del'd in 1 ton sacks.
Reliable Peat Company	Winter Garden	Jack Reiner	352-326-5432	Landscape and nursery supplies	Nursery supplies	Major nursery mix and peat supplier, sells all in bulk (no packaging). Uses compost, but no biosolids compost. They are not opposed to it, just none available locally anymore. Pricing is a major issue for them, pay approximately $8/CY, del'd for yard waste compost. Resells compost for $16/CY and garden mix for $21/CY, P-U.
Roland Trucking	Key Largo	Gill Rowland	305-664-7721	Landscape supplies	Trucker	Lots of independent truckers in Miami, so tough for him to come up and compete. Lots of traffic in Miami too; he works mainly south of Miami. Haul bulk landscape products, but doesn't do much redistribution of materials. He has not worked with biosolids products, but is open-minded.
Site 1	Kissimmee	Ted Merrill	765-438-7374	Landscape supplies	Homeowners and profs	Do not do any blending, resell bagged products. Do not carry any Milorganite (but can get) and trying to sell less P fertilizers. Have a company custom blend for them, but only for large orders. Carry no bulk products.
Solce Fertilizer	Palmetto	John Wright	941-721-7777	Fertilizer broker	Fertilizer blenders	Brokers barge loads of DAP/MAP/urea/muriate. These products are sold for high value, but low margin. Considering diversifying into others fertilizer products - lower volumes, but higher margin. Keep in touch about granulated product, must be high quality granule.
South Dade Soil & Water Conservation District	Florida City	Bill Townshend	781-255-8820	Landscape supplies	Ag	Marketed Miami biosolids products for several years, also sells PBC granules from Hwy 60 and south. Selling little now because of Psyllid and problem and Food Safety Modernization Act concerns. Concentrated sales of citrus, avocado and mango south of Miami.
South Florida Spreader Service	Fort Pierce	Matt McBride	772-370-3538	Spreader	Ag	Spreads bulk materials, primarily fertilizer and lime, but also some chicken litter. Could spread dried biosolids, charge by the ton ($8/t is typical).

Table B-1. End User Information
Biosolids Market Feasibility Study

Business	City, State	Contact	Phone	Business	Markets	Other
Sunrise Mushroom, Co.	Pompano Beach	Michael Ewing	954-942-0747	Landscape supplies	Retail and landscapers	Ship aged mushroom soil from their closed production facility in Delray for $15/CY, P-U.
True Value of West Kendell	Miami	Alejandro Chediak	305-603-8660	Garden products	Retail	Do not carry Milorganite or any bulk products.
USA Sod & Landscaping	Miami	Virgelio Lopez	305-485-8422	Landscape supplies	Retail and landscapers	Sell sod and various bulk materials, but no fertilizer or biosolids products. Sells black muck soil for $15/CY, P-U and potting soil for $22/CY, P-U.
Williams Soils & Sod	West Palm Beach	Georgina Randell	561-967-1591	Landscape supplies	Retail and landscapers	Sell sod and various soil and mulch products. Sells bulk black topsoil for $25/CY, P-U. Do not sell fertilizer or biosolids products.

Table B-2. Biosolids Facilities
Biosolids Market Feasibility Study

Business	City	Contact	Phone	Product(s)	Usage market(s)	Other
City of Bonita Springs	Bonita Springs	Jake Hepokski	239-495-4247	Biosolids fertilizer manufacturer	Sell to broker, resell to fertilizer blenders	Operate Andritz system, producing under 1,000 tons/annum. Started in 2007, contract sell at low price through RFP. Wouldn't give pricing or name of contractor, but stated that they receive little for the product.
Emerald Coast Utility Authority	Cantonment	Gerry Piscopo	850-791-5818	Biosolids fertilizer manufacturer	Broker buys all (sod and ag use)	Located near Pensacola, operate 2 K-S dryers. Bid out sales of product - currently getting $15/t (PU) from Mannco; they sell to sod and into agriculture. Produce 13,140 tons/annum of 6-5-0 product that is very dusty. Pleased with technology, 99% TS. Building canopy building to store product.
Emerald Coast Utilities Authority	Pensacola	Randy Rudd	850-969-3393	Biosolids composter	Sod farms, nurseries, state & DEP projects	Use Harvest Quest system and microbe package to produce compost. Use a 45 day composting cycle. Produce 30,000 t/annum of product. Now that they compost, they can more easily do maintenance on the dryers. Composting was key to yard waste recycling; operate on a 10 acre site.
City of Hollywood / Schwing Bioset	Winter Haven / Sebring	Chad Meadows	863-287-7421	Lime stabilization	Ag - pasture, citrus, and golf and sod	Marketer of lime stabilized biosolids, Hollywood product primarily sold into Central Florida agriculture. Food Safety Modernization Act has not been a problem for them. Sold at $15-$25/ton, plus delivery. Product is aged to reduce moisture content and allow easy application (and lower odor).
City of Hollywood / Schwing Bioset	Naples	Tom Welch	239-596-0104	Lime stabilization	Marketing arm sells	More Schwing Bioset facilities are being developed in Florida. They are building a regional facility in Okeechobee, and have a new facility in Orlando. They add less lime now so pH changes in soil are less of an issue.
JFE Brighton Composting Facility	Okeechobee	Steve Crawford	863-532-8819	Biosolids composter	Primarily citrus industry	McGill Environmental operates the facility, and the facility uses their indoor aerated static pile system.
JFE Brighton Composting Facility / Mcgill Composting	Cary. NC	Noel Lyons	919-990-3188	Biosolids composter	Primarily citrus industry	All compost is sold to Harvest Quest which adds a microbe package then sells the adjusted product into marketplace; primarily citrus. Hope to expand more into golf turf sales in the future. Produce approx. 110,000 CY / annum. Sell all of their product.
City of Largo	Clearwater	Rich Mashaben	727-518-3201	Biosolids fertilizer manufacturer	Golf courses, through a broker	Produce a 8-3-0.5 (92% TS) product, and produce approx. 2,000 tons/year. It is all sold to a broker for $51/t (Pro-Plus Golf Srvs.). Have 2 - 365 ton silos; use an Andritz dryer.
Lee County Composting Facility	Felda	Howard	299-533-8000	Biosolids composter	Primarily sell to citrus	Expanded site 2 years ago, now managing 60,000 wt/yr of incoming biosolids. Produce 30,000 tons/year of compost. Food Safety Modernization Act is not a problem for them, participate in STA program (for QA/QC). Concentrate sales with large groves (2-6,000 ton/year customers). Own a fleet of trucks (12) to manage incoming materials and finished product. Sells to large volume groves for $10/t, P-U , and retail customers for $10 per cubic yard, P-U.
Merrill Brothers, Inc.	Kokomo, IN	Ted Merrill	765-438-7374	Solar dried biosolids	Not sure, Ag - cattlemen	Developer of solar/greenhouse drying facilities, and will be setting up and operating one in 2017 (hopefully) in Pasco County. Turn biosolids in greenhouse until 60% TS, then goes to belt dryer to pasteurize (2 pass belt) and further dry (to 80 TS+)
Palm Beach County / NEFCO	Quincy, MA	Manuel Irujo	617-851-6297	Biosolids fertilizer manufacturer	Primarily selling to fertilizer blenders, some to ag	Operate PBC drying facility, producing 25,000 tons/year of product. Use their own technology and produce a good low dust granule, with a 4-3-0 nutrient content. Low value markets can pay $15-$25/ton, delivered and high value markets $100/ton delivered. Stated that granules are somewhat commoditized in Florida, but they are marketing their full volume and believe that markets can grow.
Reedy Creek WWTP / Harvest Power	Orlando	Gary Aguinaga	321-307-5844	Biosolids fertilizer manufacturer	Farmers	Anaerobically digestate, then dry and granulate biosolids and food waste mix. Operate a K-S dryer, which produces a dusty 5-5-0 product. A trucking firm is collecting the product for free and hauling it to farmers. Produce 80 tons/week. In past, sold for $20/ton to turf farms and citrus.
City of Sarasota	Sarasota	Roger Markranz	941-365-2200, ext. 6266	Biosolids composter	Dryer shut down	Composted for many years, but didn't want to invest into aging facility (Purac system). After composting operation ceased, biosolids was going to the landfill, but now Synagro manages it at their Charlotte County windrow composting facility. Thinks they pay $57/t tip fee.
Southeast Soil, LLC	Lake Panasoffkee	Matt Beigler	407-496-2872	Biosolids composter	Use in nursery soils, little to golf, sod and ag	They have some capacity left at their Sumner County site, and would probably charge a $30/ton tip fee (plus fgt) to manage Miami biosolids. Site manages approx. 150,000 ton/year of biosolids on a 40 acre site.

Table B-2. Biosolids Facilities
Biosolids Market Feasibility Study

Business	City	Contact	Phone	Product(s)	Usage market(s)	Other
Southeast Soil, LLC	Okahumpka	Steve Cook	352-360-8013	Biosolids composter	Primarily use in nursery soils	Their Okahumpka site is at capacity. Sold C&C Peat to Compost USA, now it's called Southeast Soils. Operated peat and soil blending company, put their own biosolids compost into their mixes (FertiComp Potting Soils), for several years now. Sell at $8/CY, FOB if sold unblended. They see the Food Safety Modernization Act as an issue.
Synagro	Bartow	Terry Wiseman	800-573-5538	Biosolids composter and dried fertilizer	Citrus in past, fertilizer blenders now	Operate drying facility in Pinellas County, producing 6,000 tons/year of a 5-4-0 product. Use the Andritz technology. 2016 has been a good sales year, but marketing is becoming more of a challenge. Fertilizer prices are down, and nutrient restrictions are affecting sales. Less granules from other states are being sold into Florida now (Psyllid problem reducing citrus acreage).
Synagro	Baltimore, MD	Bob Pepperman	443-489-9083	Biosolids composter and dried fertilizer	Sod farms, Ag - pastures and citrus	Their Charlotte County composting facility is 2 years old, and it produces approx. 10,000 tons/year of product. They are moving all of their product, and the facility is at incoming biosolids capacity now. Sales are more of a challenge (more effort). They would likely charge Miami $25-$40/ton, plus freight to manage their biosolids. They do see Food Safety Modernization Act as an issue, but believe that it is manageable.