Basis of Design
Biosolids Processing Facility
Miami-Dade County Water and Sewer Department

South District Wastewater Treatment Plant (SDWWTP) Biosolids Processing Facility: Design-Build-Operate Engineering and Technical Support Services (E06-WASD-14)
Work Order 12

MIAMI-DADE COUNTY

CH2MHILL®

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Basis of Design Memorandum - Biosolids Processing Facility

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1 Technical Memorandum – Biosolids Processing Facility: Predictions of Capital and Operating Costs

Executive Summary

This Basis of Design Memorandum (BDM) for the Biosolids Processing Facility (BPF) presents the recommended technologies, sizing, and approach that will be considered for the implementation of the BPF for the Miami-Dade Water and Sewer Department (WASD). The BDM will be used to support the qualification and selection process for a service provider who will enter into a public/private partnership (P3) with WASD to provide the facilities, operations, and financing for a BPF to handle the biosolids produced by the WASD South District Wastewater Treatment Plant (SDWWTP) and the Central District Wastewater Treatment Plant (CDWWTP).

The CDWWTP also receives, digests, and dewaters the solids produced by the North District Wastewater Treatment Plant (NDWWTP). A new wastewater treatment facility is planned for construction in approximately 2025 to 2030. This facility, called the West District Wastewater Treatment Plant (WDWWTP), will receive some flows that are presently treated at the NDWWTP and CDWWTP, in addition to serving currently unsewered areas in western Dade County.

Current operations at the CDWWTP and SDWWTP process sludge onsite through gravity thickeners and anaerobic digesters. At the CDWWTP, digested biosolids are dewatered and then sent to Class B land application when weather and site availability permit, or disposed in a landfill when there are no available land application sites. At the SDWWTP, digested sludge is dewatered by centrifuges prior to (1) Class B land application, (2) composting, or (3) landfill disposal (including a portion of the solids mixed with grit removed from the influent with subsequent landfill disposal of the mixture). Some residuals are composted onsite at the SDWWTP using the aerated static pile process, after which the compost product qualifies for Class AA marketing and distribution.

The BPF will be designed to accept and process all dewatered solids produced at the SDWWTP and the CDWWTP. Currently, the CDWWTP also treats the solids generated by the NDWWTP; therefore, the BPF could initially process all solids from the WASD until the WDWWTP is constructed per the compliance plan to address the requirements of Chapter 2008-232 Laws of Florida Wastewater Disposal/Ocean Outfalls. The WASD may continue to operate the solids processing systems at the CDWWTP and use the BPF to process solids from the SDWWTP. Regardless of this decision, the guaranteed minimum and maximum amount of solids to be processed will be established with the selected P3 provider. It is assumed that once it begins operation, the new WDWWTP will process and manage the solids produced at that facility separately and not send material to the BPF.

The required location of the BPF is on the SDWWTP site, including approximately 4.5 acres of the existing property that can be made available as a potential site for the BPF if thermal drying is used. If a composting process is used, the operation will be performed at the SDWWTP within the current composting system boundary, consisting of approximately 25 acres of land. If composting is used, WASD and the P3 will negotiate to determine the value and intended uses of the infrastructure and equipment being provided by WASD and used by the P3.

The BPF will be designed for a 20-year service life, and the design year for the facility will be 2035. The required design year capacity of the BPF was estimated using the 2013 Ocean Outfall Compliance Plan growth projections and historical solids production rates (WASD, 2013). Based on 6 years of operating data, the SDWWTP and CDWWTP produce dewatered cake at approximately 0.39 to 0.41 dry ton per million gallons treated (DT/MG). Both the CDWWTP and SDWWTP have several projects planned to improve digester performance and other solids handling upgrades. With these improvements, the volatile solids reduction (VSR) achieved in the digesters is estimated to increase to at least 56 percent. Solids production and therefore sizing of the BPF is based on these improvements being in place and performing as intended.

The historical performance of the CDWWTP centrifuges shows they produce approximately 23 percent dry solids, and the centrifuge dewatering process at the SDWWTP produces 16 to 17 percent solids. WASD plans to implement dewatering improvements to the SDWWTP by 2020, thus averaging 23 percent dry solids from

dewatered cake at both WWTP's. The resultant required capacity in the design year in dry tons per day (DTPD) from the CDWWTP and SDWWTP for the BPF is summarized in Table E-1. It also shows the anticipated total wet ton per day (WTPD) production, assuming that the dewatering improvements at SDWWTP begin operating between 2020 and 2025. These projections are also based on the WDWWTP being in service in 2030, with the assumption that all solids generated at the WDWWTP are treated and re-used or disposed separately from the BPF. The peak-capacity year for wet material to be delivered to the BPF is approximately 2020, just before the planned dewatering improvements go on-line, at which time approximately 465 WTPD is projected to be processed. There is expected to be excess capacity at the BPF after the dewatering system at the SDWWTP is upgraded.

TABLE E-1
Projected Solids Production – CDWWTP and SDWWTP*
WASD Biosolids Processing Facility

Date	CDWWTP Including NDWWTP Solids (DTPD)	SDWWTP (DTPD)	Combined CDWWTP and SDWWTP Production (DTPD)	Combined CDWWTP and SDWWTP Production (WTPD)
2015	55.0	35.0	90.0	442
2020	57.8	36.8	94.6	465
2025	60.8	38.7	99.4	423
2029	63.2	40.2	103.5	440
2030	38.7	40.6	79.3	338
2035	38.7	42.7	81.4	346

Note:

*Projections assume that SDWWTP dewatering improvements are online by 2025 and WDWWTP is online by 2030.

Table E-2 includes an estimate of the minimum amount of biosolids that must be processed in the initial stages of operation. The quantities in this table are based on the lowest monthly average production over the last 6 years from each WWTP.

TABLE E-2
Minimum Estimated Solids Production – CDWWTP and SDWWTP
WASD Biosolids Processing Facility

Date	CDWWTP Including NDWWTP Solids (DTPD)	CDWWTP Including NDWWTP Solids (WTPD)	SDWWTP Solids (DTPD)	SDWWTP Solids (WTPD)
2015	35	150	27	160

If CDWWTP solids are handled separately during the early stages of operation, the BPF would have to process approximately 27 DTPD (approximately 160 WTPD) for the SDWWTP. If solids from both WWTPs are processed, then the minimum capacity would be approximately 62 DTPD (approximately 310 WTPD). WASD will need to establish a schedule for CDWWTP operations or transport in the RFP upon which P3 providers will based their proposals.

There were six general technologies for solids stabilization screened for the BPF: (1) anaerobic digestion, (2) aerobic digestion, (3) composting, (4) thermal drying, (5) chemical stabilization, and (6) high-temperature combustion/oxidation. Digestion, anaerobic or aerobic, is not in the BPF scope and was eliminated as a possible alternative because CDWWTP and SDWWTP currently operate anaerobic digesters producing class B biosolids. Chemical stabilization and high-temperature processes are not applicable to WASD because of staff concerns with chemical handling and safety, lack of familiarity with these processes, and less operational experience; therefore, they were eliminated from the possible alternatives.

The two preferred and recommended technologies are composting and thermal drying. Several variations of composting will be considered for the BPF. Because of the abundant rainfall in South Florida, a cover over composting and curing areas is required to maintain consistent compost quality.

The thermal drying process is based on one of the following principles:

- The materials to be dried are directly exposed to the heat source (direct drying systems)
- The heat is transferred from one form, such as heated oil or fluid, to the material through a conducting medium (indirect drying systems)

Both general types of thermal drying technologies will be considered as viable alternatives for the BPF. Heat sources that may be used for thermal drying include heat from combustion of natural gas and waste heat from the Cogeneration Facility at the SDWWTP. The WASD intends to identify and use the most cost-effective and sustainable of these technologies for the new BPF.

The contract vehicle for implementing this project is highly dependent on Miami-Dade County's (County's) preferences and procurement requirements. Currently, a full-service, P3 contract (planning steps, design engineering, permitting, construction services, operations, and financing) is envisioned as the approach. As the procurement process moves forward, the contract type and services to be included will be further defined.

1 Introduction/Background

The WASD is the County Department charged with providing drinking water and wastewater services to its citizens. As a department of Dade County (the County), WASD follows the County's purchasing and procurement rules.

WASD provides sewer service to most of the County. The sewer system consists of over 1,000 gravity sewer collection basins, four major gravity interceptors, over 1,000 pumping stations including five major booster stations, transmission mains, and three regional wastewater treatment plants (WWTPs) owned and operated by WASD. The three WWTPs include the NDWWTP, CDWWTP, and SDWWTP.

Other public and private entities, called Volume Sewer Customers (VSCs), are interconnected to WASD facilities and convey sewage to the regional plants. The wastewater transmission systems for the three WWTPs are interconnected. This provides WASD with some capability to direct sewage flows between service areas from one plant to another. WASD can exercise this option during storm events, emergencies, and planned shutdowns to balance flows between the three plants to optimize capacity. The three WWTPs are further described as follows:

- **NDWWTP:** Located in the northeast section of the County at 2575 N.E. 151st 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. The pure oxygen activated treatment plant with primary and secondary clarification discharges effluent via ocean outfall and deep injection wells. Solids produced by the NDWWTP are pumped to the CDWWTP, where they are mixed with the influent wastewater to the CDWWTP for treatment.
- **CDWWTP:** Located on 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 treatment plant has two independently operated process trains that discharge chlorinated effluent to the ocean. Similar to the NDWWTP, effluent is discharged by gravity during low flow periods and pumped the remainder of the time. 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.

- **SDWWTP:** Located in the southeast section of the County at 8950 S.W. 232nd 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. A total of 17 deep injection wells are installed for the disposal of treated effluent from the plant. The sludge removed in the 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.

The general relationship and locations of these treatment facilities is shown on Figure 1.

In the future, as flows and loads increase in WASD’s wastewater system, a fourth WWTP (WDWWTP) will be added. The WDWWTP is further described in the next section.

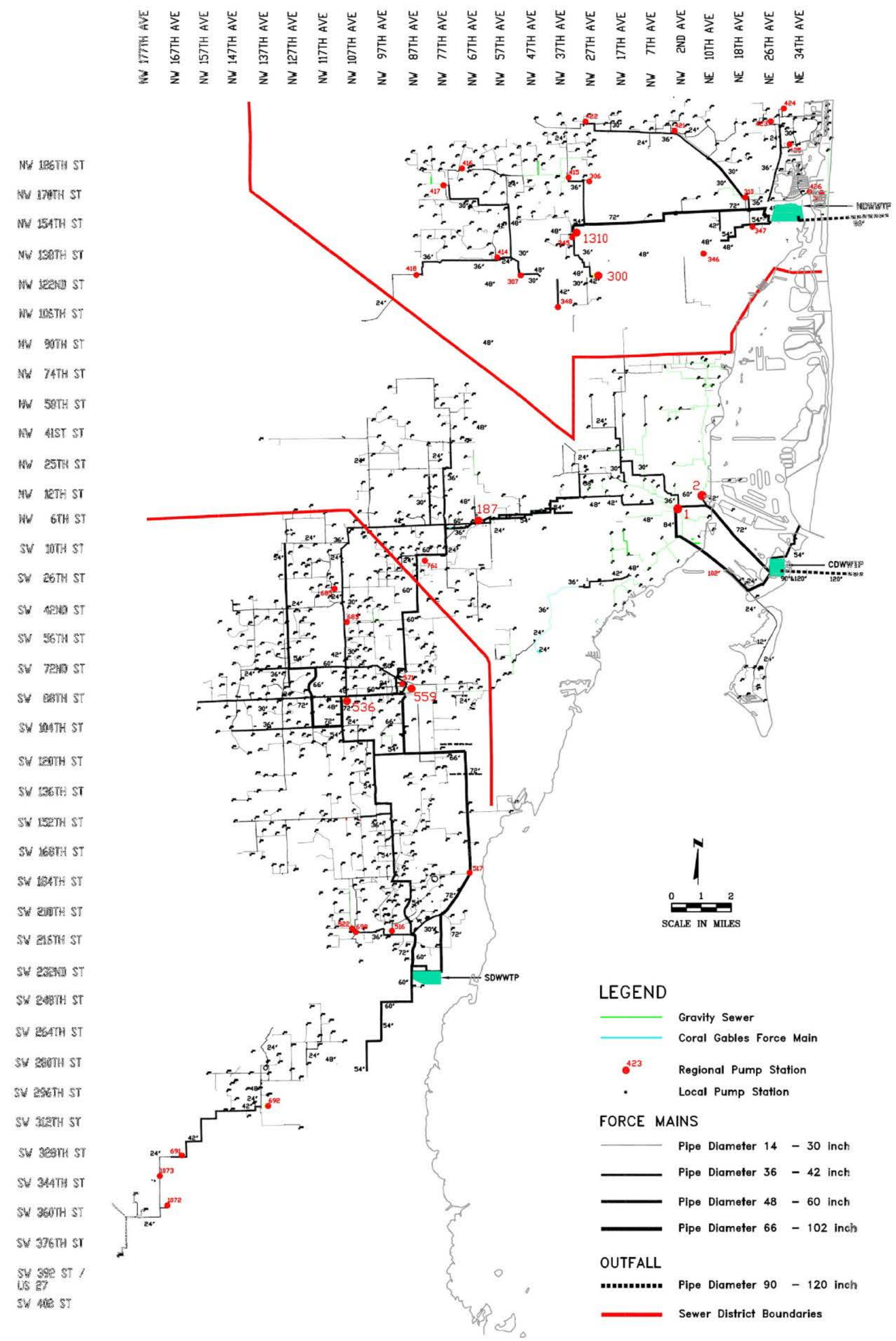

FIGURE 1
MDWASD Service Area
MDWASD Biosolids Processing Facility

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2 Program Overview

In June 2013, the WASD developed a compliance plan to address the requirements of Chapter 2008-232 Laws of Florida Wastewater Disposal/Ocean Outfalls (Section 403.086 (9), Florida Statutes and Amendment CS/SB 444). The recommended alternative in that plan includes a new WDWWTP with an average daily flow capacity of 102 mgd, reduced daily flow capacities at the NDWWTP of 85 mgd and at the CDWWTP of 83 mgd, and a design flow capacity at the SDWWTP of 131 mgd. The total system average daily capacity is projected to be 401 mgd. Biosolids produced at the CDWWTP and SDWWTP are expected to be processed and then land applied, distributed as compost, or disposed in a landfill, depending on the quality of the material produced. Processing alternatives for the biosolids include anaerobic digestion and dewatering, thermal drying or composting, as described herein.

The current WASD biosolids program functions well most of the time; however, there are issues that present challenges to biosolids management for WASD. These challenges include poor equipment conditions in the solids processing trains at each WWTP, peak wet-weather flow concerns, the vulnerability of operations to inclement weather, changing regulations, workforce changes, and limited capital and operating budgets.

The digestion and dewatering facilities at the CDWWTP and SDWWTP can produce Class B biosolids when they are functioning as designed. WASD expects continuing social and regulatory pressure on Class B land application programs, and is evaluating the use of processes to generate higher-quality Class A or Class AA products for future biosolids management, or other beneficial use products if a market is available (such as biofuel). WASD previously investigated approaches to implementing a biosolids program based on biosolids processing technologies capable of producing and reusing a Class AA product. In this investigation, information was collected on potential emerging and sustainable technologies capable of processing biosolids to a Class AA product (CDM 2007 and 2009).

The biosolids programs rely heavily on the anaerobic digestion and centrifuge dewatering processes at both the CD and SD WWTPs. If there are equipment failures in either of these processes, removing the biosolids from the WWTPs is challenging and could affect effluent quality. The solids stream treated via composting at the SDWWTP can produce higher quality, Class AA material; however, it is a large, open-air process that is detrimentally affected by wet weather. During rainy months the composting operation cannot produce Class AA material.

The BPF is under consideration by the WASD to improve the quality of the biosolids products produced, reduce the risk of operational challenges caused by weather or staffing changes, and to control the cost of operating the biosolids management program.

Currently, the WASD is assessing delivery alternatives for the BPF such as design-build (DB), design-build-operate (DBO), and design-build-operate-maintain-finance (DBOMF) through a P3. As the first step in a two-step selection process, the County will issue an Request for Quotation (RFQ) to obtain statements of qualifications from respondents interested in being considered for inclusion on a pre-qualified shortlist for providing planning, permitting, engineering, design, construction, operation, and financing to WASD for the SDWWTP and the CDWWTP BPF. Upon completing Step 1, Evaluation of Qualifications, the prequalified firms will be invited to Step 2, Evaluation of Proposals, and will submit proposals for this work. The BPF is required at the SDWWTP in order for the CDWWTP, NDWWTP, and SDWWTP to operate efficiently and cost effectively, and to remain in compliance with discharge permit requirements.

Delivery alternatives will be addressed in the RFQ and Request for Proposals (RFP). There are numerous technical alternatives for biosolids processing, as well as many vendors and suppliers in the biosolids management field; therefore, the County has developed technical criteria by which to request alternatives, and establish a common basis by which to evaluate the technologies and costs of each proposed alternative.

Through this procurement, the WASD will evaluate and select preferred technologies, identify qualified providers of these technologies, and identify project delivery methods that include financing and operations to find a cost-effective approach that can be implemented to manage costs and resources. The service provider selected will be capable of permitting, designing, constructing, operating, and financing the BPF. An option for BPF operation to return to WASD's control will be included as part of this procurement. This option would potentially be exercised if the Agreement term expires and is not renegotiated, if the P3 provider does not meet the contractual obligations identified in the Agreement, or for WASD's convenience. The performance requirement details will be established during the RFP and contract negotiation stages.

Performance will be monitored by WASD, and the P3 provider will be required to submit monthly operations and maintenance (O&M) reports summarizing O&M activities that occurred during the month including, but not limited to, the following:

- Daily production statistics including wet tons, percent solids, and dry tons of biosolids received; wet tons, percent solids, and dry tons of Class AA product; and the amount of Class B or unclassified material production and its destination(s)
- Summary of regular maintenance, unplanned maintenance, and equipment repairs made during the month
- Remarks on any other issues or activities affecting operations or maintenance that occurred during the month

WASD reserves the right to observe and inspect the BPF, or portions thereof, following adequate notice of intent to the P3 provider.

During the initial project scoping, WASD determined that the new BPF would be designed to accept digested and dewatered solids produced at the CDWWTP (which includes solids from the NDWWTP) and the SDWWTP. WASD staff will continue to operate the solids treatment and dewatering facilities at these WWTPs. The entity selected to provide the BPF will be responsible for collecting solids as they discharge from the dewatering equipment, providing appropriate short-term storage at the WWTPs to account for variations in production, transporting them from the CDWWTP or SDWWTP to the new BPF, and then processing the solids at the new BPF to produce a reusable, Class AA material for distribution and marketing.

The BPF will be located at the SDWWTP within the site limits established on Figure 2. When implemented, the WDWWTP will process its biosolids onsite and will not send material to the BPF for processing.

BPF implementation will be coordinated with other projects planned for both the CDWWTP and SDWWTP. These projects are part of the Consent Decree between the County, the United States of America, the State of Florida, and the Florida Department of Environmental Protection (FDEP) for improvements to the County's wastewater collection and treatment system (United States of America, 2013). The Consent Decree projects include work on thickening, digestion, and dewatering facilities at the CDWWTP and SDWWTP (refer to the Miami-Dade County website for more information on the Consent Decree projects). Specifically, the dewatering improvements at these facilities include new solids dewatering facilities at the SDWWTP (Project 1.8, construction planned from 2016-2019) and the CDWWTP (Project 2.16, construction planned from 2018-2020).

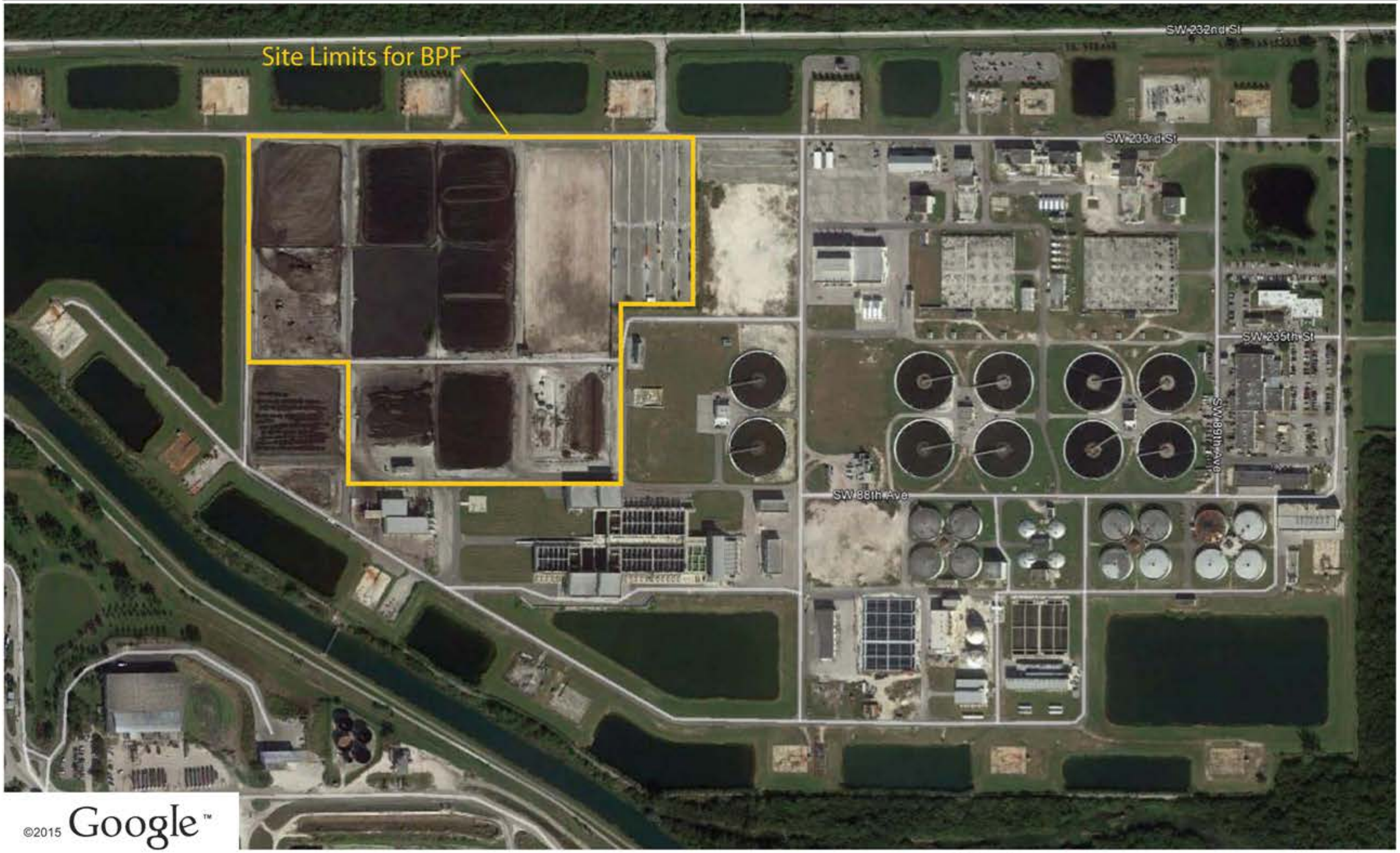

FIGURE 2
SDWWTP Site Plan
MDWASD Biosolids Processing Facility

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3 Design Criteria

3.1 System Capacity

The BPF will accept and process all dewatered solids produced at the SDWWTP and the CDWWTP. Currently, the CDWWTP also treats the solids generated by the NDWWTP; therefore, the BPF may initially process all solids from the WASD until the WDWWTP is constructed. Table 1 includes a summary of the current and anticipated hydraulic capacity of these facilities and data from the last 6 years of operations.

TABLE 1
Wastewater Flows – Total WASD Service Area
WASD Biosolids Processing Facility

Treatment Facility	Average Daily Flow 2009 – 2014 (mgd)	Present Design Flow (mgd)	Future Design Capacity 2035 (mgd)
NDWWTP	--[a]	112.5	85
CDWWTP	118.4	143	83
SDWWTP	95.8	112.5	131
WDWWTP	N/A	N/A	102

Note:

[a] Since solids from this facility are treated at the CDWWTP, influent flow data were not analyzed for the NDWWTP.

The required design year capacity of the BPF was estimated using the 2013 Ocean Outfall Compliance Plan projections and historical solids production rates (WASD, 2013). Based on 6 years of recent operating data, the SDWWTP and CDWWTP produce dewatered cake at approximately 0.39 to 0.41 (DT/MG) treated. However, WASD is planning several projects at both the CDWWTP and SDWWTP that will improve digester operations, increase volatile solids reduction, and improve dewatering. These projects are included in the Consent Order Capital Projects Plan and will all be implemented by 2020. Solids production is based on a population growth of approximately 1 percent and with the assumption that the WDWWTP will be in service and treating all of the solids produced at that new facility onsite after its startup. The resultant required capacities in various years in DTPD for the BPF is summarized in Table 2. The maximum capacity needed, in terms of dry solids, occurs in approximately 2029, at 101.5 DTPD, just before the WDWWTP goes into service. If the BPF is constructed at this capacity, there will be excess capacity in the years 2030 and beyond.

TABLE 2
Projected Dry Solids Production
WASD Biosolids Processing Facility

Date	CDWWTP Including NDWWTP Solids (DTPD)	SDWWTP (DTPD)	Combined CDWWTP and SDWWTP Production (DTPD)
2015	55.0	35.0	90.0
2020	57.8	36.8	94.6
2025	60.8	38.7	99.4
2029	63.2	40.2	103.5
2030	38.7	40.6	79.3
2035	38.7	42.7	81.4

The wet quantity of material produced depends on the efficiency of the dewatering processes at both the CDWWTP and SDWWTP. Based on historical performance, the CDWWTP centrifuges produce approximately 23 percent dry solids and the centrifuge dewatering process at the SDWWTP produces 16 to 17 percent solids. WASD plans to upgrade the dewatering equipment at the SDWWTP, improving the future efficiency of dewatering by late 2020. Table 3 shows the projected total mass of material in WTPD, assuming that dewatering improvements are implemented by 2020. Table 3 summarizes the estimated quantity of wet material that will be sent to the BPF. Note that the peak year for wet material to be delivered to the BPF is approximately 2019, just before the planned dewatering improvements go on-line, at which time approximately 465 WTPD is projected to be processed. There is expected to be excess capacity at the BPF at when the dewatering system at the SDWWTP is upgraded.

TABLE 3
Projected Wet Solids Production[a]
WASD Biosolids Processing Facility

Date	CDWWTP Including NDWWTP Solids (WTPD)	CDWWTP Percent TS (%)[b]	SDWWTP (WTPD)	SDWWTP Percent TS (%)[c]	Combined CDWWTP and SDWWTP Solids (WTPD)
2015	234	23.5	208	16.8	442
2020	246	23.5	157	23.5	403
2025	258	23.5	165	23.5	423
2030	165	23.5	173	23.5	338
2035	165	23.5	181	23.5	346

Notes:

[a] Based on dry solids as shown in Table 2.

[b] Average percent Total Solids for the CDWWTP has historically been 23% and is not expected to exceed 23% regardless of process improvements to sludge thickening and dewatering at CDWWTP.

[c] Historical average percent Total Solids for the SDWWTP has been approximately 16% and is expected to increase to 23% when the new dewatering facility is operational by 2025.

Figure 3 presents the estimated future annual average solids production from the CDWWTP, SDWWTP, and combined using the parameters included in Table 2.

FIGURE 3
Projected Annual Average Dry Solids Production for the CDWWTP, SDWWTP, and Combined
WASD Biosolids Processing Facility

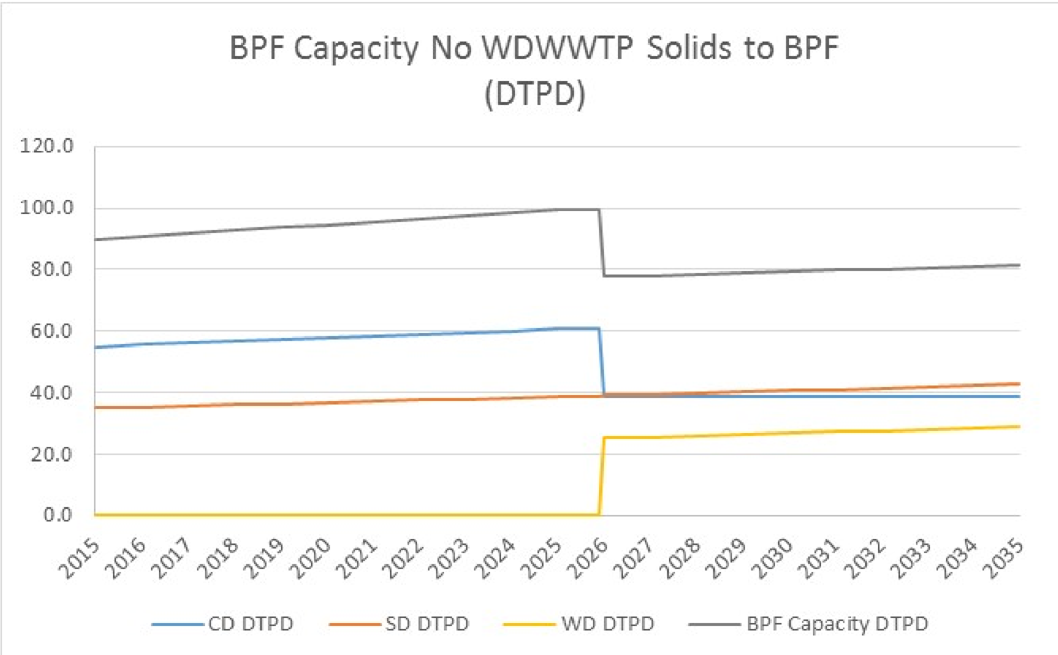
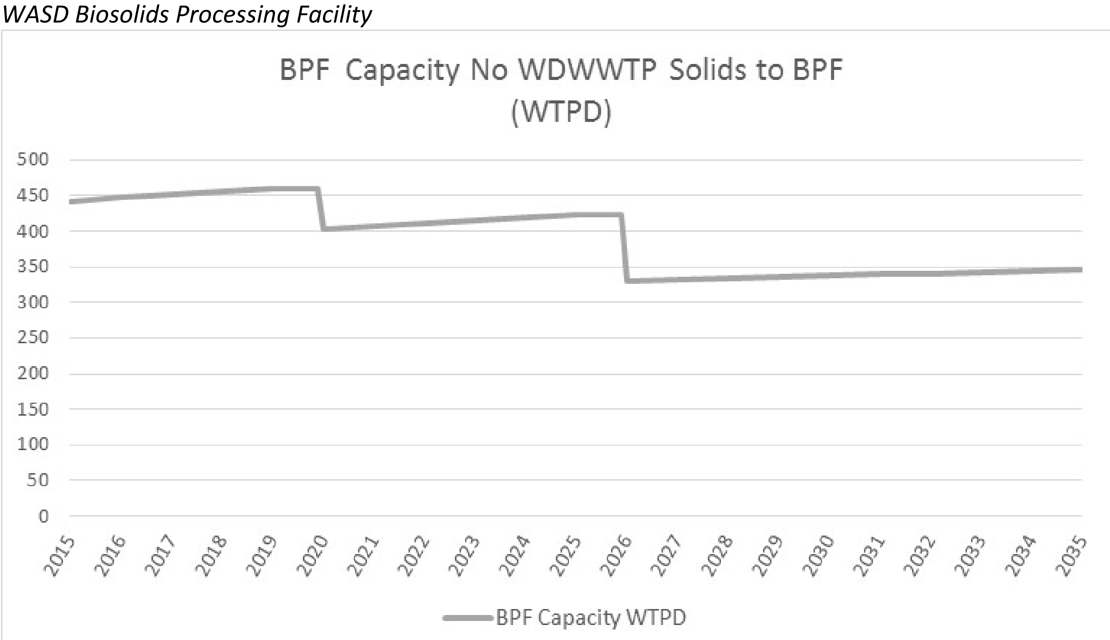


Figure 4 presents the projected wet solids production, assuming that dewatering improvements at the SDWWTP increase cake solids to the same level as that produced by the CDWWTP and that they are in place by 2022. Data for this graph are included in Table 3.

FIGURE 4
Projected Annual Average Wet Solids Production for the CDWWTP, SDWWTP, and Combined
WASD Biosolids Processing Facility



Peaking factors calculated from current operating data will be used to size equipment and process units. To address the 2035 design conditions, solids data from the CDWWTP and SDWWTP were analyzed to calculate the annual average day conditions compared to peak day, peak 2 week, and peak month solids production. The peaking factors used to address design conditions, other than annual average, are summarized in Table 4.

TABLE 4
Peaking Factors[a]
WASD Biosolids Processing Facility

Cake Production Peak Factor (Max Day/Annual Average)	Cake Production Peak Factor (Max 2 weeks/Annual Average)	Cake Production Peak Factor (Max Month/Annual Average)
1.76	1.31	1.19

Note:

[a] Derived from most recent 5-year operating records.

The BPF may only be required to process solids from the SDWWTP, while the operation at the CDWWTP continues until contractual agreements expire and solids processing from the CDWWTP is transitioned to the BPF. Initially the solids production rates will be lower than in the design year of 2035. The minimum amount of solids processed was estimated based on production data over the past 6 years. The minimum amount of biosolids that must be processed in the initial operating stages is presented in Table 5. These quantities are based on the lowest monthly average production over the last 6 years from each WWTP.

TABLE 5
Minimum Estimated Solids Production – CDWWTP and SDWWTP
WASD Biosolids Processing Facility

Date	CDWWTP Including NDWWTP Solids (DTPD)	CDWWTP Including NDWWTP Solids (WTPD)	SDWWTP Solids (DTPD)	SDWWTP Solids (WTPD)
2015	35	150	27	160

Initially, the BPF may process only approximately 27 DTPD (approximately 160 WTPD) if CDWWTP solids are handled separately. If solids from both WWTPs are processed, the minimum capacity would be approximately 62 DTPD (approximately 310 WTPD). The decision as whether to continue to handle CDWWTP solids separately, or to combine them at the BPF will be made by WASD prior to the RFP being issued. The minimum and maximum amount of solids that will be treated at the BPF will be set in the final contract.

3.2 Product Alternatives and Quality

WASD would like to produce at least one product that meets and exceeds the regulatory requirements found in Chapter 62-640, “Biosolids,” of the Florida Administrative Code for Class AA reusable material. Because there is a significant amount of agricultural land in the County area, it is preferred that one end-product be suitable for land application, such as a soil amendment or fertilizer, and be available for distribution and marketing. By producing material that meets this highest quality standard, WASD is committed to protecting public and environmental health to the maximum extent possible. Further, WASD’s goal for the BPF is to create a product that presents the lowest risk based on liability, costs, safety, and other criteria, in terms of long-term operations. The P3 provider will also have the capability to produce a second end-product that can be safely reused or disposed of should the Class AA processing system fail or if markets for this product are unavailable. The technology used and characteristics of the second end-product shall be such that it offers flexibility for distributing this second product the market(s) for the primary product are unavailable.

Available solids quality data were reviewed and summarized for the material produced at both the CDWWTP and SDWWTP. Table 6 show the concentration of various chemical constituents in the biosolids compared with current regulatory limits, as determined by averaging information from both facilities over the period of 2009 to 2012. A ceiling limit is the maximum allowable concentration of a pollutant in biosolids that can be applied to land. The pollutant limit sets a lower pollutant concentration threshold which, when achieved, relieves the person who prepares biosolids and the person who applies biosolids, from certain requirements related to recordkeeping, reporting, and labeling. Historical data shows that average pollutant concentrations in the biosolids are below pollutant concentrations and all maximum concentrations are below regulatory ceiling limits.

TABLE 6
Chemical Characterization of Biosolids Compared to Regulatory Limits
WASD Biosolids Processing Facility

Pollutant	Historical Average (mg/kg)	Historical Maximum (mg/kg)	Ceiling Limit (mg/kg)	Pollutant Limit (mg/kg)
Arsenic	5.7	21.0	75	41
Cadmium	4.8	15.4	85	39
Mercury	0.9	2.6	57	17
Nickel	28.8	43.5	420	420
Selenium	9.6	15.0	100	100
Molybdenum	23.0	46.0	75	-
Chromium	66.1	122.5	-	-
Zinc	1372.8	2538.2	7500	2800
Copper	452.4	600.2	4500	1500
Lead	49.4	334.9	840	300

Note:

Chemical Characterization based on data from 2009 - 2012

The nutrient data for the material currently produced by the CDWWTP and SDWWTP are summarized in Table 7.

TABLE 7
Nutrient Concentrations in WASD Biosolids
WASD Biosolids Processing Facility

Pollutant	SDWWTP Ave (mg/kg)	SDWWTP Max (mg/kg)	CDWWTP Ave (mg/kg)	CDWWTP Max (mg/kg)
Nitrogen	3.3	10.3	5.72	10.70
Phosphorus	1.8	3.9	2.14	3.70
Potassium	0.1	0.3	0.14	0.74

Note:

Chemical Characterization based on data from 2009 - 2012

3.3 Siting

According to WASD, approximately 4.5 acres of the existing SDWWTP property can be made available as a potential site for the BPF for thermal drying. The area currently used for composting at the SDWWTP may be used by P3 providers who want to offer composting as a treatment technology. No other sites will be considered.

3.3.1 Solids Transport from CDWWTP to SDWWTP

In order to centralize solids processing at the SDWWTP, it will be necessary to transport the solids produced at the CDWWTP to the new BPF. At the project review workshop held October 15, 2014 at the WASD offices, a request was made to analyze, at a conceptual level two transportation alternatives; trucking of dewatered cake, similar to the existing operation compared to installing a new, dedicated dual piping system to transport digested, liquid biosolids to the SDWWTP, where they could be combined with the solids from the SDWWTP, dewatered and sent to the BPF. In Attachment 1, the conceptual analysis is presented in a separate technical memorandum (TM) entitled "Predictions of Capital and Operating Costs." Trucking is the recommended method to transport solids from the CDWWTP to the BPF.

4 Process Screening and Evaluation

In biosolids processing, there are many technologies and operational approaches that can be used to produce a specified reusable end-product. Some of the technologies, such as anaerobic digestion, have been in use for decades. Other technologies are emerging that have demonstrated success in some locations; however, they do not have a track record in commercial applications that would warrant significant consideration. Further, some technologies are more applicable to certain size facilities, or facilities using certain liquid stream treatment processes. Finally, the process of anaerobic digestion at the WASD facilities is already in use, supports other processes and equipment, and will continue to be used. Because it is established and functions well in the overall biosolids processing trains, discontinuing anaerobic digestion use was not considered.

The purpose of screening technologies is to go from the large set of available alternatives to a "shortlist" of those that warrant more detailed consideration. For this process, WASD performed an initial screening to identify technologies that are either applicable or not applicable to WASD's goals. Technologies not applicable to WASD's goals were discussed so the WASD and CH2M HILL understands and agrees to the reason(s) they were not considered further. Factors that make those technologies not applicable to WASD include the following:

1. Lack of demonstrated operating track record at similar sized facilities
2. Processes that could not be operated by WASD personnel in the future should WASD decide, or be required, to take over operations
3. Processes that could not produce a high-quality Class AA biosolids product for reuse

Following the initial screening, technologies that were not eliminated in the first screening were further analyzed. The process is described in this section.

4.1 Initial Screening

During the scope definition workshop, CH2M HILL presented a range of treatment solutions that could be applied to the biosolids from WASD's wastewater facilities. This range of alternatives is shown in Figure 5. As shown, there are six general categories under the heading of solids stabilization. Given the size requirements, type of facilities that are currently in use, and desired end-products, many of these technologies in the initial screening step were removed from further consideration.

Digestion processes, either anaerobic or aerobic, is not in the BPF scope because WASD already uses anaerobic digestion, which will continue to be used at both the CDWWTP and SDWWTP. Initially the list was narrowed to composting, thermal drying, chemical stabilization, and high-temperature combustion/ oxidation, based on applicability to the existing conditions. Figure 6 shows the remaining technologies described in more detail.

Based on the WASD staff preferences, chemical stabilization and high-temperature combustion or oxidation processes are not applicable to WASD because of concerns with chemical handling and safety, lack of familiarity with these processes, and less operational experience. Since there is a possibility that WASD staff could eventually operate the facilities, processes using high temperatures and pressures were not considered. There is also a concern that these systems will have higher capital and operating costs. Figure 7 presents the remaining processes to be considered in more detail after this screening.

Generally, composting and thermal drying are the two preferred technologies for consideration. For composting and thermal drying technologies, the variations described in this section are applicable to WASD, and it is WASD's intent to identify and use the most cost-effective and sustainable technology for the new BPF. The P3 providers will be encouraged to select the technological variation they believe best suits the application for WASD.

FIGURE 5
Possible Range of Alternatives
WASD Biosolids Processing Facility

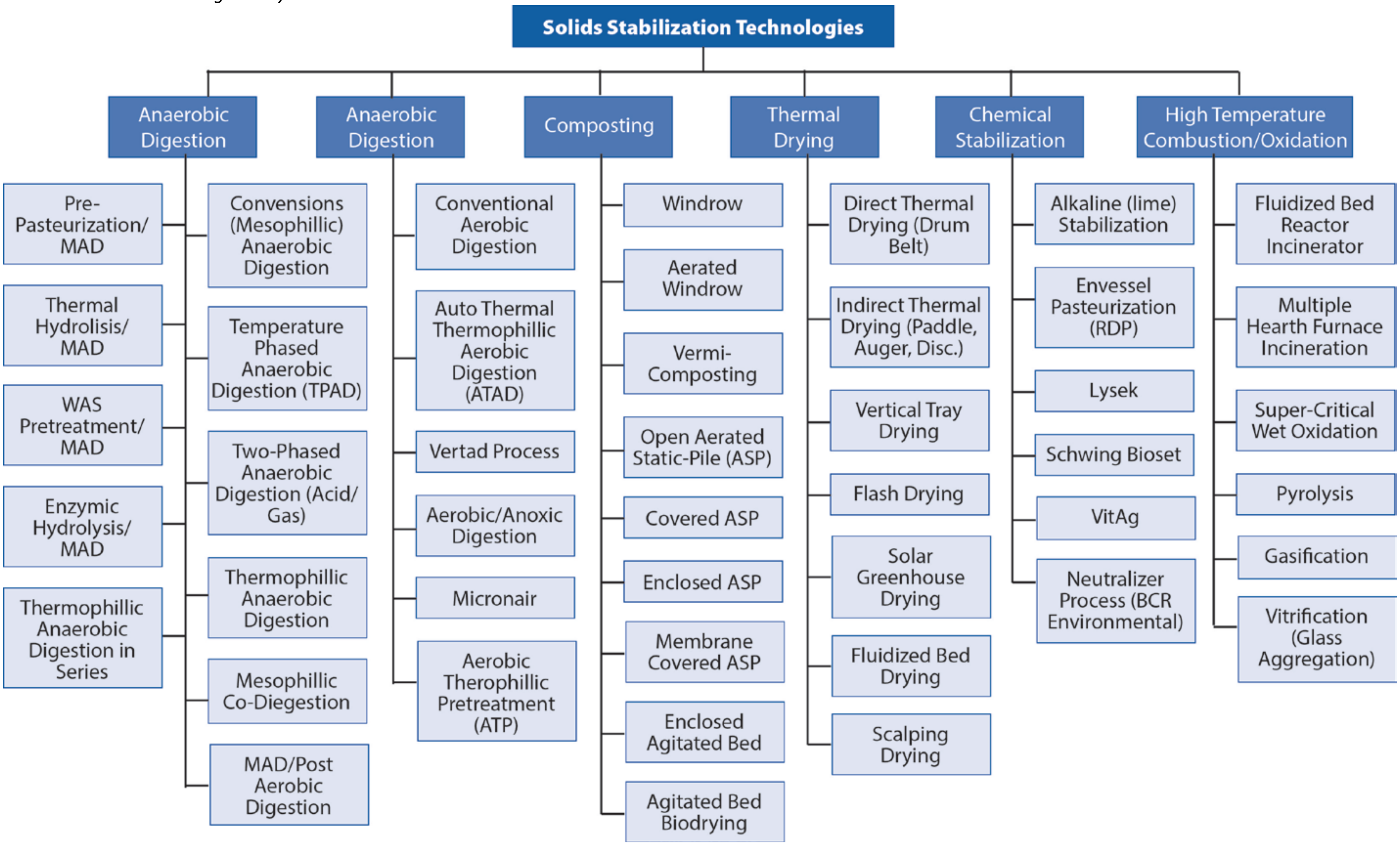


FIGURE 6
Results of Initial Screening
WASD Biosolids Processing Facility

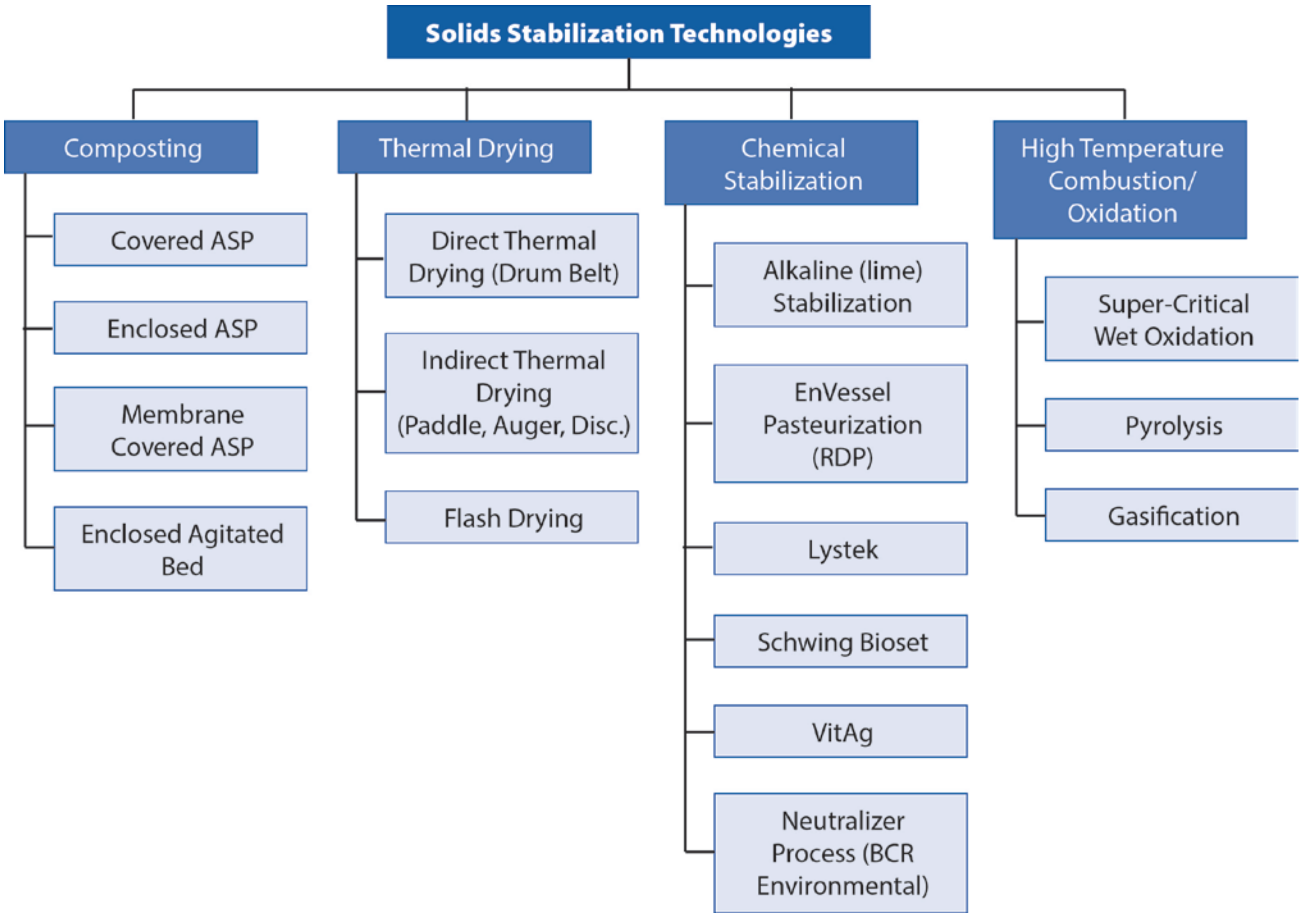
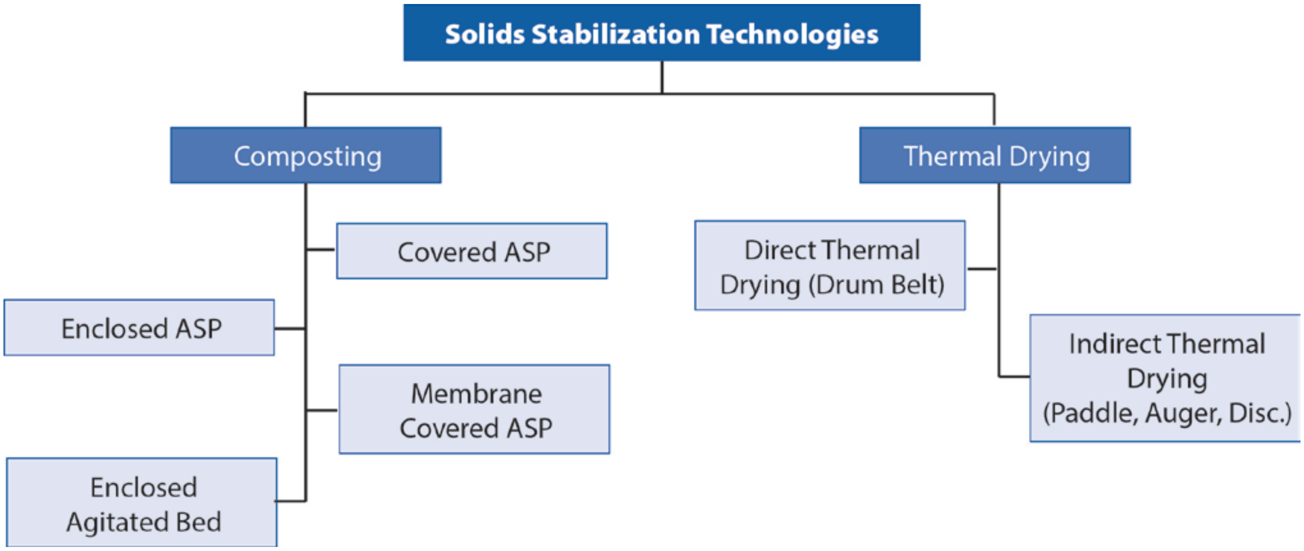


FIGURE 7
Alternatives for Detailed Consideration
WASD Biosolids Processing Facility



4.1.1 Composting

There are several variations available for implementing a composting approach. One major variation is the use of mixing during the composting process. Aerated static pile (ASP) processes are based on constructing compost piles in a prescribed manner and aerating them over the composting period. They employ fixed aeration systems, such as aerated trenches or pipes with blowers. Because of aeration, the compost pile is not physically mixed over the composting period. Covered and fully enclosed variations use large structures either open on the sides (covered) or with walls (enclosed) to protect the compost operation from the elements. Because of the abundant rainfall in South Florida, a cover is required for good operations. Covered membrane systems use large “tarps” made of water-shedding fabric that allow air passage, but contain the pile. Finally, agitated bed systems use fixed aeration systems and a mixer that continuously mixes the compost pile to keep the material uniform, minimize clumps, and maintain porosity for aeration. The mixer causes these systems to be more complex than ASP composting facilities.

4.1.2 Thermal Drying

The major differences in thermal drying technology follow:

- In direct drying systems the materials to be dried (biosolids in this case) are directly exposed to the heat source
- With indirect drying the heat is transferred from one form, such as heated oil or fluid, to the material through a conducting medium

An example of direct drying is a belt dryer in which dewatered biosolids are distributed evenly on a moving surface that passes near a heat source, such as heated air from a waste heat source or low temperature burner that allows the biosolids to be heated and dried. An example of indirect drying is a system where the biosolids are mixed with an auger that contains a circulating hot fluid. The heat is transferred through the mixer and the heat source is not directly exposed to the biosolids.

There is waste heat available at the SDWWTP from the Cogeneration Facility that uses internal combustion engines to produce electricity. This waste heat is available in two forms; medium-grade heat at approximately 190 degrees Fahrenheit (°F) and high-grade heat at 470 °F. The internal combustion engines use digester gas produced at the SDWWTP and landfill gas from the nearby solid waste disposal facility (South Dade Landfill). The Cogeneration Facility is designed to use all of the gas produced from those two sources and the waste heat produced by the engines is available for other uses. The high-grade heat is available in a closed-loop, hot oil system. The medium-grade heat is available from a recirculating hot water system. Currently, the high-grade heat is used to operate an adsorption chiller for the facility and the medium-grade heat is used to heat the anaerobic digesters. The amount of high-grade heat allocated to the absorption chiller is 1.8 mmBTU/hr and the medium-grade heat currently allocated to the existing anaerobic digesters is approximately 3.1 mmBTU/hr. Any unused heat is dissipated into the atmosphere or the effluent stream.

The predicted 2015 gas usage by the cogeneration facility is approximately 590 standard cubic feet per minute (scfm) from the digesters and 575 scfm from the landfill for a total gas flow of 1,165 scfm. At these gas flows, the heat balance estimates available heat to be 37.8 mmBTU/hr. During the startup and early months of operation, the availability of these quantities of gas has been problematic. Thus, the actual production of electricity and waste heat has been less than predicted. Assuming the predicted quantity of heat is available from the two gas sources (37.8 mmBTU/hr), approximately 14.1 mmBTU/hr of electrical energy equivalent is produced; 13.6 mmBTU/hr of waste heat is available and system losses account for the remaining 10.1 mmBTU/hr. The 13.6 mm BTU/hr would be split 7.9 mmBTU/hr to the high-grade system and 5.7 mmBTU/hr to the medium-grade system. At these production and use levels, after the chiller and digester heat demands are satisfied, the amount of potentially available high-grade waste heat is approximately 6.1 mmBTU/hr and medium grade heat is approximately 2.6 mmBTU/hr.

The design heat balance in the year 2035 for the cogeneration system is based on using 900 scfm of both digester gas and landfill gas for a total gas flow of 1,800 scfm, representing approximately 58.3 mmBTU/hr total available heat to the cogeneration engines. Accounting for losses in the cogeneration equipment, this converts to 21.7 mmBTU/hr of electricity and 20.9 mmBTU/hr of waste heat. The 20.9 mmBTU/hr would be split with 8.7 mmBTU/hr going into the high-grade heat system and 12.2 mmBTU/hr going to the medium-grade system. Assuming that heat consumption does not change, the available heat would be 6.9 mmBTU/hr in the high-grade system and 9.1 mmBTU/hr in the medium-grade system.

Table 8 summarizes the estimated available waste heat for startup and the design year. At startup there will be 4 cogeneration engines. A fifth engine will be added as gas production increases, which is estimated to be in 2020.

TABLE 8
Anticipated Waste Heat Availability
WASD Biosolids Processing Facility

Condition	Waste Heat Produced (mmBTU/hr)[a]	Waste Heat Used (mmBTU/hr)	Total Available Waste Heat (mmBTU/hr)	Available High-Grade Waste Heat (mmBTU/hr)	Available Medium-grade Waste Heat (mmBTU/hr)
Initial Startup, 2015	13.6	4.9	8.7	6.1	2.6
Design Year, 2035	20.9	4.9[b]	16.0	6.9	9.1

Notes:

[a] mmBTU/hr = million British thermal units per hour

[b] Assuming no changes to digestion and gas production systems from 2015.

If a P3 provider chooses to use this heat in their process, it will be their responsibility to provide the equipment and systems to collect and use it.

4.2 Project Capital Cost Considerations

A key part of the project delivery approach using a P3 provider model is the business case evaluation. A critical component of that evaluation will be the estimated capital and operating costs. At the point where there are two main technologies being considered, a conceptual order-of-magnitude cost for construction and operations is required to allow WASD to assess the financial aspects of the project. The P3 providers will provide detailed costs with their final proposals. Until then, WASD will continue planning for delivery of the design, construction, and operation of the BPF based on a P3 provider arrangement. Because anticipated capital and O&M costs vary significantly and are dependent on decisions that have yet been made, costs are addressed in a separate TM entitled “Predictions of Capital and Operating Costs” enclosed as Attachment 1. This TM can be updated as needed as cost information is received from P3 providers and the design is refined.

Minimal details are currently available to develop more detailed capital and operating costs; therefore, this initial summary of cost represents a very broad range of potential costs. As the project moves forward and P3 providers become more involved, the cost estimates will become more exact and the potential for variation will be reduced. Capital and operating cost ranges presented in the following paragraphs are based on trucking as the means of transporting solids from the CDWWTP to the BPF at the SDWWTP.

Phasing of some project elements may be appropriate to control expenses and to match expected solids production rates from the CD and SD WWTPs. The phasing decisions will be made by the selected P3 provider based on capacity and growth rates provided in this BDM. The cost estimates presented in this section apply to a constructed facility operating at full capacity. The maximum capacity to be provided is approximately 102 DTPD.

4.2.1 Composting

The capital cost for composting facilities is highly dependent on how much of the existing SDWWTP composting operation is incorporated into the new composting system. Further, WASD will have to decide how the existing facilities will be transferred to the selected P3. For example, the facilities could be made available at no cost to the P3, assuming that this will result in the lowest cost alternative for WASD. Or, the facilities could be leased to P3, which would more accurately reflect the true cost for implementing the BPF, but could result in higher costs. Finally, WASD could transfer ownership of the facilities to the P3 so that the solids handling site and equipment is completely in the control of the P3. This approach would require that a value of the total asset be established and that value incorporated into the overall cost for composting.

The range of alternatives for implementing composting goes from a relatively simple upgrade of the existing facility to a full, new state-of-the-practice facility. The relatively simple upgrade would include covering the composting areas with a roof to reduce the weather-related impacts on the system. This approach could be implemented at a fairly low cost, assuming as much of the existing composting equipment and facilities would be re-used. At the other end of the spectrum, if the P3 has to completely construct the composting process with new aeration equipment, solids handling, odor control and site support infrastructure (roadways, lighting, stormwater systems, etc.) then the costs would be similar to those experienced at other, new “greenfield” composting facilities.

4.2.2 Thermal Drying

If thermal drying is implemented, this system will be completely new since this technology has not been used at the SDWWTP. WASD will provide the site via some form lease or sale transfer, just as under the composting alternative. Since the footprint of thermal drying is much smaller, WASD could maintain the composting operation and provide approximately a 4.5 acre area for a thermal drying facility. The design concept for this process configuration is based on having at least two thermal dryer units, with the facility sized to meet maximum month design conditions with all dryers in service and average day design conditions with one dryer out of service. The thermal drying facilities would have air pollution control equipment to comply with air pollution control regulations. The dewatered material would arrive from the CDWWTP by truck and be unloaded into feed hoppers. Material from the SDWWTP would be conveyed from the dewatering facilities at that site. It will be the P3 provider's choice whether to combine SDWWTP cake solids with the CDWWTP cake solids prior to thermal drying.

Dried product would be stored onsite for up to 5 days prior to being trucked offsite for use. Dried product storage capacity for at least 5 days at design conditions will be provided to account for poor weather, transport problems, or similar issues.

4.2.3 Biosolids Transport

In the TM "Predictions of Capital and Operating Costs" two alternatives were evaluated for transporting the biosolids produced at the CDWWTP to the new BPF. Based on this planning-level evaluation, it was decided that trucking would be used. The P3 provider shall be responsible for this operation.

4.3 Operating Cost Considerations

The operational resources needed for the two technologies are significantly different. Composting is "low-tech" with a minimal amount of complex equipment that requires high-level maintenance. Conversely, thermal drying is fairly complex requiring high temperature and material handling system management that processes solids much more quickly.

4.3.1 Composting

Composting is labor intensive requiring construction and tear down of compost piles. The staff should understand the concepts and theories being applied. Equipment used is typical of light earthwork machinery. Composting requires a much larger area than thermal drying; therefore, there is a high amount of vehicle/equipment traffic at this size of facility. The operating costs include a significant rolling stock/fuel-based component. Composting requires electricity to power the aeration systems, and, depending on the composting system used, electric motors may power portions of the material handling system. It is possible to automate portions of the process. Compost time and temperature monitoring can be implemented. The amount of time at a given temperature can be recorded in the plant data system and used to show compliance with the time/temperature requirements. Odor control can represent a significant operating cost depending on the type of system(s) needed and the level of odor control required. Operating costs include labor, power, equipment, other utilities, and supplies.

4.3.2 Thermal Drying

Thermal drying requires a source of heat to operate the dryer. The type of dryer technology employed will depend on the heat source used. Heat can be provided directly by the combustion of natural gas or other fuels. Dryers that use this approach are typically the indirect type, where the heat is used to warm another media that is then exposed to the biosolids. Often these dryers run at relatively high temperatures. The other potential heat source to operate the dryer is "waste heat," provided it is available. Waste heat by definition is the heat produced from some other source that is typically not used in the main process. It is usually allowed to flow to a heat sink, such as the atmosphere, via cooling towers. As noted, SDWWTP waste heat is available from the engine casings and exhaust systems of the cogeneration engines.

With the extent of these heat sources unconfirmed, the potential cost range for operations is relatively broad. Operating costs will vary significantly depending on the source of heat used in the thermal drying process and whether waste heat can be used. Staffing is typically less with thermal drying than with composting, since thermal drying systems are more automated. Most of the material handling is mechanized and does not require operators to be involved continually. Because thermal drying is a higher temperature, shorter retention time process, it is very important to measure and control the thermal drying step. Tracking the amount of water removed is important in terms of final product quality. While fewer staff are needed with thermal drying systems, they are typically more highly trained than composting system operators and computer monitoring systems are more complex.

Because of the many potential variables, an estimated operating cost range for dryer operations was developed. The costs included in this estimate are labor, equipment, utilities, and supplies. Two alternatives were investigated: (1) using only natural gas from the local utility as the heat source, and (2) using the available low-temperature heat from the Cogeneration Facility supplemented with natural gas

At this level of design, the operating costs for thermal drying are estimated to be slightly higher than composting if waste heat is not used, and slightly lower if it is; however, there is also considerable overlap in operating costs. Establishing the firm cost for operations will be part of the proposal process involving the P3 providers.

5 Recommendations

There are various processes that could be applied to the BPF for WASD. Based on the screening process that accounted for both monetary and non-monetary concerns, it was concluded that P3 providers offering composting or thermal drying systems would be considered. These systems can produce end-products that meet the requirements for Class AA material, are in wide use in the industry, and do not require highly specialized operating staffs. This decision is based on the following factors:

- Operating track record of these systems in similarly sized applications
- Ability of WASD staff to operate these technologies (should this become necessary over the course of operations)
- Ability to produce a high-quality reusable product that can be sold to several markets such as agriculture, fertilizer production, bio-fuel production and others

By selecting at least two different technologies, WASD can achieve competition among various equipment providers and potentially identify an appropriate balance of technologies to employ for biosolids processing in the future. These two technologies offer the P3 providers flexibility while limiting the technologies to reliable and proven processes that have a high probability of operating success based on similar installations.

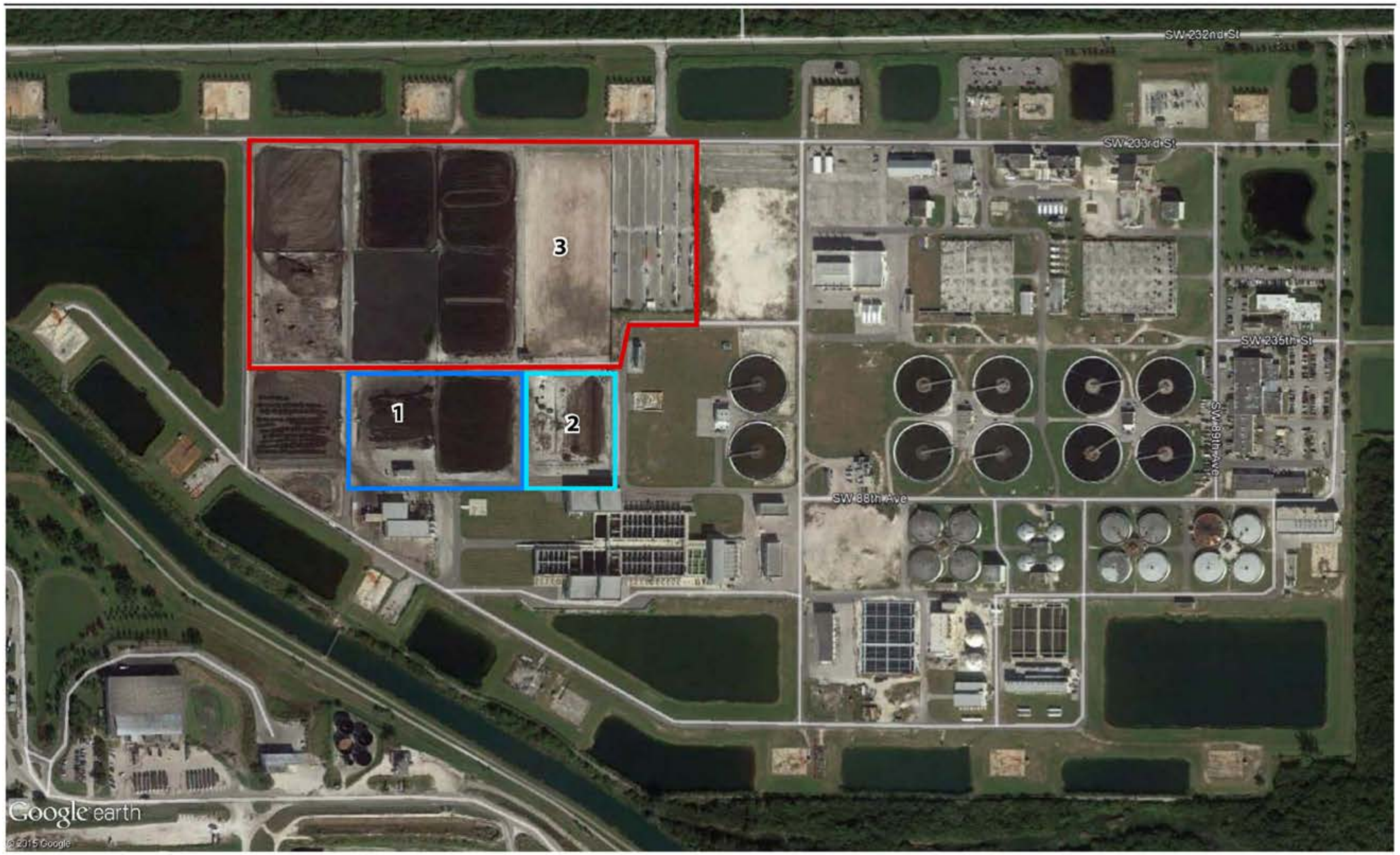
The recommended method for transporting biosolids from the CDWWTP to the BPF is via truck. Using this approach the CDWWTP digesters and dewatering facilities would continue operation with upgrades as needed. Dewatered cake would be loaded into trucks for transport to the BPF, where there will be unloading, storage and handling facilities for these solids.

5.1 Recommended Technologies

Thermal drying and composting are the two recommended technologies. Thermal drying would have a much smaller footprint than composting, and could be located on the SDWWTP site as shown in Figure 8. Composting onsite would require use of most of the existing composting area and improvements. The composting improvements include enclosures or covers to allow operation during rainy season, revisions to the aerations systems, and upgrades for the instrumentation and controls.

5.2 Recommended Project Delivery

The contract vehicle for implementing this project is highly dependent on the County’s preferences and procurement requirements. A full-service P3 contract that provides for completing the planning steps, design engineering, permitting construction services, operations, and financing is the recommended and anticipated approach. As the procurement process progresses, the contract type, and services to be included will be further defined by the County and CH2M HILL, and an RFP will be issued with more detailed information.



1. Proposed Thermal Drying P3 Site: 4.5 acres
2. Proposed Sludge Thickening/Dewatering Site: 2.3 acres
3. Proposed Composting P3 Site: 25.1 acres

FIGURE 8
Composting and Thermal Drying at the SDWWTP
MDWASD Biosolids Processing Facility

CH2MHILL.

WBG081214073037SPB

6 References

CDM. 2007. *Final Biosolids Master Plan Report*. Prepared for Miami-Dade County Water and Sewer Department. September.

CDM. 2009. *Memorandum: Miami-Dade Water and Sewer Department T.A. 3 – Biosolids Master Plan, Review of Responses to WASD's "Biosolids Processing Technologies" RFI*. February 19.

Miami-Dade Water and Sewer Department. 2013. *Ocean Outfall Legislation Compliance Plan*. Chapter 2008-232 Laws of Florida Wastewater Disposal/Ocean Outfalls (Section 403.086 (9), Florida Statutes and Amendment CS/SB 444). June 28.

United States District Court. 2013. Consent Decree. In the United States District Court for the Southern District of Florida. United States of America, the State of Florida Department of Environmental Protection, and the State of Florida, Plaintiffs, v. Miami-Dade County, Florida, Defendant. Case: No. 1:12-cv-24400-FAM. June 6.

Attachment 1

Technical Memorandum - Biosolids Processing Facility: Predictions of Capital and Operating Costs

Technical Memorandum - Biosolids Processing Facility: Predictions of Capital and Operating Costs

PREPARED FOR:	Miami-Dade County Water and Sewer Department
PREPARED BY:	CH2M HILL
DATE:	November 14, 2014

1. Introduction

Capital and operating cost estimates for the two recommended technologies for implementation at the Biosolids Processing Facility (BPF) are discussed in this technical memorandum (TM). The purpose of this TM is to provide this information in a format that can be readily updated as the design of the BPF moves from a conceptual level, as described in the Basis of Design Memorandum (BDM), to more detailed levels that will be supported by the business case evaluation (BCE) with inputs from the proposals submitted by potential public/private partnerships (P3) who would implement the BPF.

The BDM recommends that the Miami-Dade Water and Sewer Department (MDWASD) consider two general process technologies for implementation at the BPF by P3 providers. These two processes are composting and thermal drying. Within these two general types of processes, there are many potential variations of the technology that could be used, such as types of composting or drying equipment, dryer configurations, material handling systems, operational approach, control strategy, level of odor control, and others.

One key aspect of the overall cost for the facilities is the site location. MDWASD desires that the new BPF be located at the South District Wastewater Treatment Plant (SDWWTP) site. They have proposed that all or a portion of the site area currently used for composting, can be incorporated into the P3 providers solution. The financial considerations for use of the site will be identified as the procurement process moves forward.

1.1 Basis of Design

The quantity and characteristics of the material that will be sent to the BPF will depend on two factors. First, the quantity will change when the West District WWTP (WDWWTP) is put into service and flows redirected from the NDWWTP or CDWWTP to the WDWWTP. This is anticipated to occur in 2030. Second, the characteristics of the material will change when the digestion and dewatering processes are upgraded at the SDWWTP and CDWWTP. Primarily, the moisture levels in the biosolids will be reduced with improved dewatering. Also volatile solids content of the biosolids is expected to decrease with improved digestion. These upgrades are planned to be in service by 2020. The BPF will be designed to process up to 102 dry tons of solids per day (DTPD) which corresponds to the design year of 2030, just before the WDWWTP is projected to start operation. The maximum projected quantity of biosolids in terms of wet material is 465 WTPD, which is projected to occur in 2019, just before the dewatering improvements are expected to be on line. In the design year of 2035 the expected amount of material that will be treated at the BPF is 81 DTPD, equivalent to 354 WTPD.

1.2 Biosolids Transport From CDWWTP to SDWWTP

1.2.1 Purpose

At the project workshop held October 15, 2014 at the MDWASD offices, a request was made to perform a conceptual evaluation of two different approaches for transporting biosolids from the CDWWTP to the new BPF that will be located at the SDWWTP. These two approaches are trucking of digested, dewatered cake and pumping of digested liquid in new pipelines directly to the BPF. Trucking is the method currently used in which digested, dewatered biosolids are loaded into trucks and removed from the site. Presently, this material is hauled to a land application site or to a landfill for disposal. When the BPF goes into service the biosolids would be transported there for further treatment. Pumping of liquid biosolids is somewhat similar to the current method used to transport solids from the NDWWTP to the CDWWTP; except that currently the materials pumped are raw primary and waste activated sludge (WAS).

The purpose of this evaluation is to determine whether the pumping alternative is a reasonable alternative to trucking and may warrant additional investigation. If the equivalent costs of pumping are lower or equal to those for trucking, then the pumping and pipeline alternative will need to be investigated in greater detail.

1.2.2 Assumptions

At this stage of design, several assumptions have been made in order to facilitate the comparison. They are listed below.

a. Existing collection system will not be used. A new full-length, parallel pipe system between the CDWWTP and SDWWTP will be used.

b. Digested sludge will be pumped. No raw primary or undigested WAS will be pumped to the BPF.

c. Existing Bay-crossing force main will not be used for sludge due to concerns about risk of failure and leakage.

d. Parallel force mains from the CD to the SD WWTP are proposed to provide a high factor of safety and redundancy.

e. The Biscayne Bay crossing will be made by tunneling methods.

f. Crossing of major intersections and similar points of conflict will be made using tunneling techniques.

g. No alternative routes for the pipeline have been investigated at this level.

h. No topographic surveys or data were collected.

i. Costs are conceptual-level based on the pipeline alignment taken from aerial photos.

j. Peaking factor for sludge pumping based on typical flows anticipated.

k. Cost for hauling of dewatered solids based on total contracted cost from current MDWASD haulers minus the disposal tipping free. Current tipping fees were obtained from area providers. The highest estimated hauling cost was used from the several different contract prices available to MDWASD.

l. Costs for dewatering capacity increases at the SDWWTP, if CDWWTP material is pumped to the SDWWTP, are covered by the budgets for projects at both the CDWWTP and SDWWTP. They are not included in the cost comparison because they are common to both trucking and piping.

m. Costs are compared on an annualized basis over 20 years at a discount rate of 3 percent.

n. Pipeline will be designed to pump the anticipated maximum day flow. Peak flows may occur if equalization in the solids processing facilities is not available. If this occurs the backup pumps would be used.

1.2.3 CD Digested Biosolids Production

Data covering the period January 2009 through December 2013 from MDWASD for the CDWWTP were analyzed to determine the peak day flows of digested sludge. To estimate peak day flows in the future, a one percent growth rate was used over the 20-year project life, similar to the flow projections for the NDWWTP, CDWWTP and SDWWTP. Peak day flows were used as the design basis because higher peaks, such as peak hour events, are not expected with the equalization in the thickeners and digesters. Using this approach results in an anticipated maximum day flow in 2035 of 1.5 mgd. Solids concentrations leaving the digesters at the CDWWTP range from 1.1 percent to 3.8 percent, with an average of 2.2 percent.

Pumping will be needed to convey the biosolids to the BPF. The starting and ending elevations of the pipeline are approximately equal given the topography of the area. Therefore the head on the pumps will be dynamic head due to fluid friction. Sludge pumping is challenging and the approach used to estimate the friction uses the method outlined in standard texts and CH2M HILL design guidelines. This approach uses multiplying factors to adjust calculated fresh water friction factors to those applicable to sludge pumping at approximately 2 percent. Using this approach, the total dynamic head required was estimated to be approximately 420 feet in the design year. The average headloss, based on the amount of material produced at the midpoint of the project is approximately 240 feet.

The quantity of material to be hauled from the CD WWTP will initially be approximately 234 wet tons per day (WTPD). This amount will increase annually to approximately 270 WTPD until approximately 2030 when it is assumed that the WDWWTP will begin treating sewage and a portion of the flow to the CDWWTP will be diverted to the WDWWTP. After 2030, the amount of material produced at the CDWWTP will be approximately 165 WTPD. The average amount of material, over the project life is estimated to be approximately 238 WTPD.

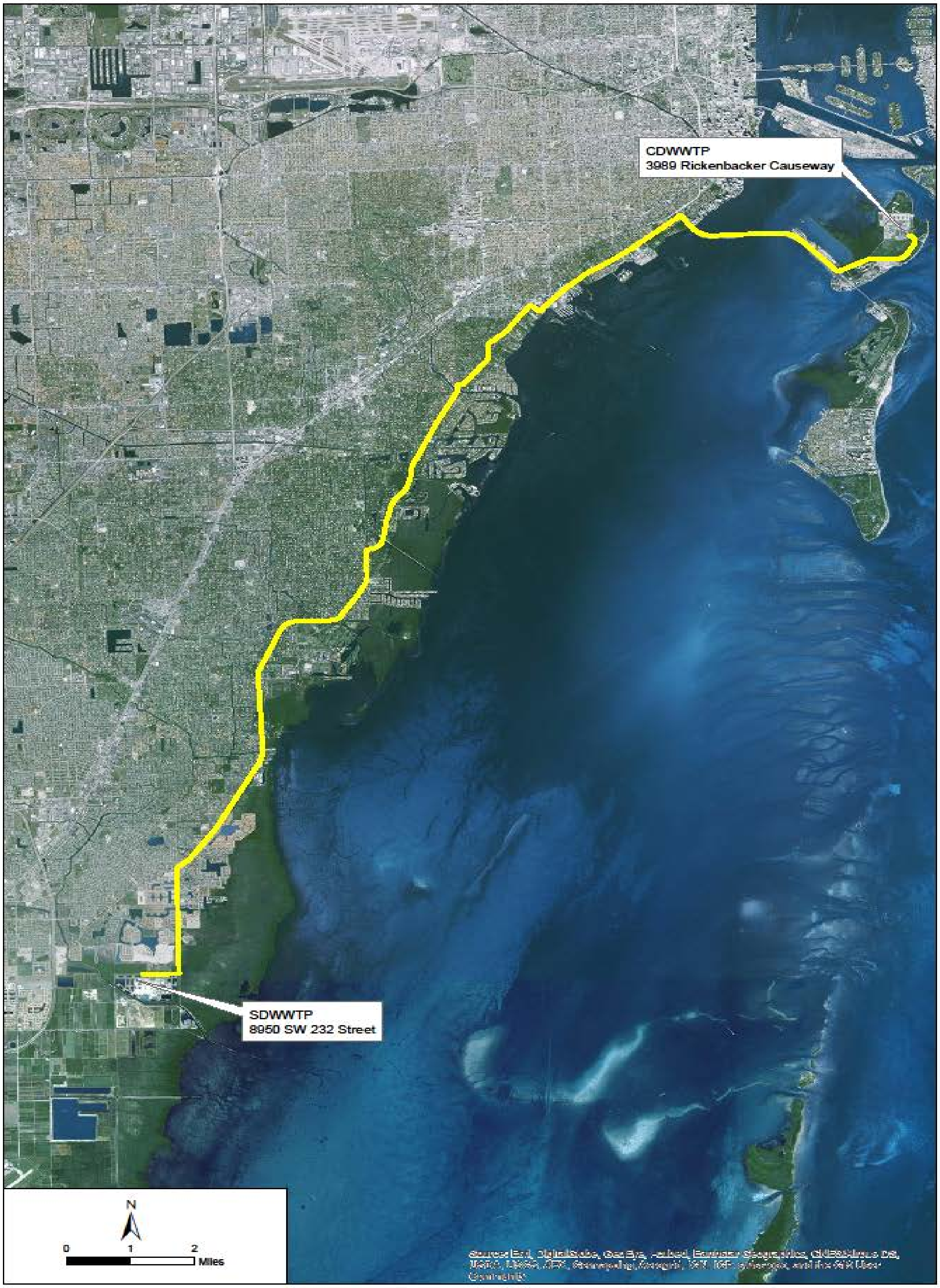
For the purposes of the economic comparison, capital costs for the full pipeline, capable of handling the 2035 flows are used. Annual costs are based on anticipated biosolids production at the mid-point of the project, in 2025.

1.2.4 Description of Pipeline Alternative

Overview

The pipeline route used for this comparison is presented in Figure 1.There will be two, 16-inch diameter parallel lines, each capable of transporting the full 1.5 mgd sludge flow. They will be equipped with air/vacuum (A/V) relief valves at high points as needed. The A/V valves would be installed in watertight vaults to prevent accidental release of biosolids. The pipeline appurtenances would also include facilities to access the lines for cleaning. Pipe pigging capabilities will be provided to allow periodic cleaning of the lines. Tunneled crossings of the Biscayne Bay, major streets and roads, and other potentially sensitive areas would be used to reduce environmental impacts. This preliminary route was selected to avoid major highways and similar transportation facilities. However, given the nature of the service area, it would still require construction in highly developed areas.

New pumps would be installed at the CDWWTP on the digester effluent to send the flow to the SDWWTP. At the SDWWTP, a storage tank would be needed to equalize the flow and allow the material to be combined with the digested biosolids from the SDWWTP for subsequent dewatering. Since sludge pumping requires high pressure systems, an intermediate pumping facility is included to provide a higher degree of confidence that the system will function well.



Legend

Figure 1 – Potential Biosolids Pipeline Alignment

Advantages and Disadvantages

The primary advantage of piping biosolids compared to trucking is it reduces the public visibility of the operation. Once the pipeline is constructed, most people would not be aware that the facilities are being used to transfer solids. However, this approach also has some significant disadvantages. Table 1 summarizes the advantages and disadvantages of the piping alternative.

TABLE 1
Advantages and Disadvantages of Piping Biosolids
MDWASD Biosolids Processing Facilities

Advantages	Disadvantages
Operations not visible to general public	Pipelines are buried and physical condition can be difficult to assess
Relatively simple operation requiring typical wastewater equipment	
Transport of material can be done around the clock	Buried pipelines are subject to damage by excavating equipment and settlement
Operations personnel are familiar with these types of systems	Piping of sludge over long distance can be problematic due to solids concentrations and potential for formation of methane in the pipeline
Lower energy consumption with pumping	Route under Biscayne is environmentally sensitive and subject to public scrutiny
	Significant changes to the dewatering facilities at the SDWWTP would be required
	If spills occur they can be difficult to contain and clean up

Estimated Capital and Operating Costs

The facilities that would be constructed to implement this alternative and their associated estimated construction cost are summarized in Table 2.

TABLE 2
Summary of Capital Costs for Biosolids Pumping and Piping Facilities
MDWASD Biosolids Processing Facility

Item	Quantity	Unit Cost	Total Estimated Construction Cost
		CAPITAL COSTS	
16-in Class 53, Lined DIP	109,500 LF	$ 450/LF	$49,280,000
Biscayne Bay Crossing	4,000	$1,500/LF	$ 6,000,000
Major Intersections/Canals	5	$ 100,000 Each	$ 500,000
Side Street Crossings	90	$ 20,000 Each	$ 1,800,000
Pumping Facilities	2	$1,000,000 Each	$ 2,000,000
Contingency	1	30%	$17,270,000
	SUBTOTAL CAPITAL COST		**$76,850,000**

TABLE 3
Summary of Operating Costs for Biosolids Pumping and Piping Facilities
MDWASD Biosolids Processing Facility

Item	Quantity per year	Unit Cost	Total Estimated Annual Cost
		OPERATING COST	
Pumping	230,000 KwHr	$0.08 per KwHr	$ 18,400
Cleaning and Maintenance	1	$225,000 per year	$225,000
SUBTOTAL ANNUAL COST			**$243,500**

1.2.5 Description of Trucking Alternative

Overview

This alternative would continue the current practice of hauling dewatered biosolids with trucks from the CDWWTP. Instead of hauling to a land application site or a landfill, the material would be taken to the new BPF. The haul route is approximately 21 miles, depending on the roadways used.

Advantages and Disadvantages

The primary advantage of trucking biosolids compared to pumping/piping is that it avoids the significant capital cost that would be incurred to construct the pipeline. This approach also has some significant disadvantages, such as the visibility of the trucks, potential for accidents when hauling and consumption of fuel. Table 4 summarizes the advantages and disadvantages of the piping alternative.

TABLE 4
Advantages and Disadvantages of Piping Biosolids
MDWASD Biosolids Processing Facilities

Advantages	Disadvantages
Operation similar to existing program	Trucks are visible and are noticed by the public
Relatively simple operation requiring loading and trucking already in place	
Capacity is flexible because if necessary, more trucks can be added.	Haul route is through developed areas that are fairly congested.
	Trucks consume significant amount of diesel fuel
	Potential for liabilities due to accidents while hauling

Estimated Capital and Operating Costs

Since dewatering facilities that would be used in this alternative are common to both alternatives, there are no anticipated capital construction costs for the trucking alternative. Operating costs were estimated based on the volume to be hauled and the hauling cost calculated from current contracts with land applications and disposal companies. To estimate the hauling costs, current contract fees were analyzed to determine the breakdown of unit costs between hauling and disposal.

The estimated cost for disposal was then applied to the quantity of material that will be produced. Table 5 summarizes the annual operating costs.

TABLE 5
Summary of Operating Costs for Biosolids Hauling
MDWASD Biosolids Processing Facility

Item	Quantity	Unit Cost	Total Estimated Annual Cost
		OPERATING COST	
Hauling	86,870 WT per year	$ 18 per WT	$1,542,000
Maintenance	1	$ 50,000 per year	$ 50,000
SUBTOTAL ANNUAL COST			**$1,592,000**

1.2.6 Comparison of Alternatives

In order to assess the economics, a 20-year design life with a discount rate of 3 percent was used. Costs were compared on an annual basis. Based on the calculations presented above, the equivalent annual cost for the piping/pumping alternative (including both the capital recovery and operating expenses) over the 20 year project life is $3,105,000 per year. The annual cost for the trucking alternative is $ 1,592,000.

The continued use of trucking appears to be less costly than the pumping/piping alternative by $1,514,000 per year. Therefore, the basis of design will be to continue to haul biosolids via truck. This effort can be assigned to the P3 in the BPF contract.

2 Capital Costs

At the point of completion for the basis of design memorandum, the level of design and estimate of capital costs are considered conceptual. They are based on the required size of the facility and use cost information from other similar facilities on a unit (e.g., cost per dry ton of processing capacity) basis to estimate the capital cost for construction.

2.1 Composting

The range of potential construction costs for a composting facility depends significantly on the amount of existing equipment and facilities currently in use at the SDWWTP, which are incorporated into the upgraded composting facility. If the P3 simply “takes over” the existing operation, it is possible that only basic improvements would be needed, such as covers for the composting and curing areas to reduce the impact of rain and inclement weather on the composting operation. The design concept for this approach would be to use a metal- or fabric-roofed, covered compost area and maintain the existing aeration system. On the other hand, if the P3 provider decides that existing composting processes need to be upgraded, then new composting equipment, aeration facilities and materials handling equipment could be needed. To account for potential hurricane wind loads in South Florida, all facilities and structures will need to meet local building codes, thus the estimated costs for these types of structures in South Florida are likely to be higher than other, similar facilities not designed for severe wind loads.

Odor control would need to be included for any type of new or upgraded composting facility. The instrumentation and control system would need to be adequate for both real-time monitoring and recordkeeping, such as recording time and temperature as needed to meet pathogen-reduction requirements.

2.2 Basis for Conceptual Unit Costs

Inland Empire Regional Composting Authority, located in southern California, currently operates the largest enclosed aerated static pile system in the United States. It is similar in size to the proposed MDWASD BPF if composting is to be used exclusively. By developing a unit cost on a dry-ton-per-day (DTPD) basis from this facility, and prorating it to the design capacity of the BPF, a rough estimate of capital cost for the BPF has been developed. This represents what the potential costs for the BFP would be if an all-new composting system were constructed. Approximate costs for a new BPF based on composting are derived from the Inland Empire composting facility as follows:

- Inland Empire Composting Facility: 115-DTPD facility with construction cost of approximately $95,000,000, or $825,000 per DTPD of capacity.
- Therefore, consider a range of $700,000 to $900,000 per DTPD for the capital costs of the new composting facilities for MDWASD BPF, to account for different construction conditions and site development needs.
- If an essentially all-new composting facility is constructed at the SDWWTP at a future capacity of 102 DTPD (465 WTPD), the construction cost for the BPF using composting would be in the range of $71,000,000 to $92,000,000.

If the P3 provider decides that the turning and screening equipment available is acceptable and that no changes are needed in the aeration system, then the improvements to the composting operation would be significantly less costly. Covers or open-frame buildings over the drying and composting areas and odor control would be the major improvements under this scenario. Conceptual level estimates for the buildings are $12,000,000 to $16,000,000. For odor control using a site-constructed biofilter, estimated construction costs range from $1,500,000 to $4,000,000. The total construction cost for an upgraded composting facility using this approach is estimated to be in the range of $14,000,000 to $20,000,000.

2.3 Thermal Drying

If the P3 provider elects to utilize thermal drying, then the facility would be all new. The only resource from MSWASD that is expected to be used is the land for the site.

The design concept for this process configuration is based on building and operating at least two thermal dryer units, with the facility sized to meet maximum month design conditions with all dryers in service and average day design conditions with one dryer out of service. The thermal drying facilities would have air pollution control equipment to comply with air pollution control regulations. The dewatered biosolids would arrive from the CDWWTP by truck and be unloaded into feed hoppers. At the P3 provider's option, biosolids from the SDWWTP would likely be conveyed rather than trucked from dewatering facilities to the new thermal drying facility at that site. It will be the P3 provider's choice whether to combine SDWWTP cake solids with the CDWWTP cake solids prior to thermal drying or to dry them separately and combine the two streams after the drying process.

Based on other projects using thermal drying across the United States, the expected range of cost for the capital construction of this system would be $500,000 to $800,000 per daily dry ton of processing capacity. At the expected future capacity of 102 DTPD (465 WTPD), the construction cost for the BPF at the SDWWTP using thermal drying would be in the range of $51,000,000 to $82,000,000. If complex waste heat recovery equipment is needed, these costs could increase slightly.

3 Operating Considerations

The operational resources needed for the two technologies are significantly different. Composting is "low-tech" with a large amount of rolling stock and a minimal amount of complex equipment that requires high-level maintenance. Conversely, thermal drying is fairly complex, with more sophisticated equipment and operational requirements that must withstand high temperatures, and material handling systems that must process solids much more quickly.

3.1 Composting

For composting, constructing and tearing down compost piles is labor intensive and requires staff trained in the process who understand the concepts and theories being applied. Equipment used is typical of light earthwork machinery. Composting requires a much larger land area than thermal drying; therefore, there is a fairly high amount of vehicle/equipment traffic at this size of facility. The result is that operating costs include a significant rolling stock/fuel-based component. Composting requires electricity to power the aeration systems, and, depending on the composting system used, electric motors may power portions of the material handling system. It is possible to automate portions of the process. Because composting relies on time and temperature, a system using probes placed into the pile can be implemented. The amount of time at a given temperature can be recorded in the plant data system and used to show compliance with the time/temperature requirements. Odor control can represent a significant operating cost depending on the type of system(s) needed and the level of odor control required.

Based on operations at similar-sized facilities, excluding recovery of investment, operating costs for composting systems typically range from $20 to $50 per wet ton, or $100 to $250 per dry ton, assuming that the feed biosolids average approximately 20 percent total solids concentration. Operating costs include labor, power, equipment, other utilities, and supplies. Cost data provided by MDWASD for the operation of the composting process at the SDWWTP for 2013 indicate that unit operating costs for composting were approximately $40 per wet ton.

3.2 Thermal Drying

Operating costs for thermal drying depend strongly on the source of heat to operate the dryer. If purchased fuels are used to provide the heat, then the dryer operator pays for this heat source based on the commodity price of the fuel. If “waste heat” from another source, such as the engine casings and exhaust systems of the cogeneration engines at the SDWWTP is used, then the P3 provider is limited to using medium-grade or low-grade heat, and the feasibility of recovering this heat depends on the amount of heat available, capital cost of the heat recovery equipment, and the operation and maintenance costs associated with that equipment. Currently, all of the digester and landfill gas available at the SDWWTP is planned for use by the existing Cogeneration Facility. Thus, if a P3 provider elects to use a high-temperature drying process, it will have to purchase the fuel to heat the material. If waste heat from the Cogeneration Facility is used instead, then the P3 provider will have to provide a dryer that utilizes low or medium-range temperature in its operations. The dryer configuration and heat source selection will be made by the P3 provider based on the costs and efficiencies of the systems that it plans to use. For any thermal drying system at the BPF, the potential heat sources that may be used are limited to Cogeneration waste heat and natural gas. If the P3 provider intends to use alternative energy sources such as wind or solar, then they should identify how these sources will be used and document whether they increase or decrease the project costs.

With the amount of potential heat sources for a thermal drying system unconfirmed, the potential cost range for operations is relatively broad. Operating costs will vary significantly depending on the source of heat used in the thermal drying process and whether onsite waste heat can be used. Staffing is typically less with thermal drying than with composting, since thermal drying systems are more automated. Most of the material handling is mechanized and does not require operators to be involved continually. Because thermal drying is a higher temperature, shorter retention time process, it is very important to measure and control the thermal drying step. Tracking the amount of water removed is important in terms of final product quality. While fewer staff are needed with thermal drying systems, they are typically more highly trained than composting system operators and computer monitoring systems are more complex. Managing and monitoring the air pollution control system is critical and requires appropriately trained staff.

The operating costs included in this estimate are labor, equipment, utilities, and supplies. Two alternative approaches were investigated: (1) using only natural gas from the local utility as the heat source, and (2) using the available low-temperature heat from the Cogeneration Facility supplemented with natural gas. The estimated operating cost range for each of these two cases follows:

1. If waste heat is not used, the estimated operating cost range is $40 to $70 per wet ton, or $200 to $350 per dry ton, assuming that the feed solids average 20% total solids concentration

2. If waste heat is recovered and used in the thermal drying process, estimated operating costs range from $20 to $50 per wet ton, or $100 to $250 per dry ton

At this level of design, the operating costs for thermal drying are estimated to be slightly higher than composting if waste heat is not used, and perhaps slightly lower than composting if the available waste heat is used; however, there is also considerable overlap in estimated operating costs among the different options. Establishing a firm cost range for operations will be part of the proposal process involving the P3 providers.

4 Summary of Cost Considerations

Table 6 summarizes the conceptual capital and operating costs for the two processes that are being considered. Annual operating and maintenance costs are based on a design capacity of 102 DTPD.

TABLE 6
Summary of Conceptual Costs
MDWASD Biosolids Processing Facility

BPF Process	Capital Cost Range ($ x 10^6)	Operation and Maintenance Cost Range ($/WT)
Composting (minimal reuse of existing facilities)	71 - 92	20 - 50
Composting (maximum reuse of existing facilities)	14 - 20	20 – 50
Thermal Drying (with no waste heat use)	51 - 82	40 – 70
Thermal Drying (with waste heat use)	51 - 82	20 - 50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