TECHNICAL MEMORANDUM

# Business Case Evaluation: Traditional Versus Design-Build-Finance-Operate-Maintain (DBFOM) Delivery Methods for Biosolids Processing Facility Focusing on Thermal Drying Technology

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| DATE: | November 23, 2015 |

## Introduction

To support the Miami-Dade Water and Sewer Department (WASD) implementation strategy for the biosolids processing facility (BPF) development, a business case evaluation (BCE) that incorporates analysis of risks transferred and retained in traditional and Design-Build-Finance-Operate and Maintain (DBFOM), delivery methods have been developed. This BCE (referred to as a value for money analysis) is a life-cycle cost analysis that includes risk transfers to the private sector that occur in the DBFOM option. This technical memorandum (TM) describes the methods and approaches used to define the options evaluated, cost and financing assumptions used, inputs to the risk transfer analysis, and BCE results.

It is important to highlight that this BCE is only intended to serve as an alternative analysis to compare delivery alternatives described in the Technical Design Memorandum. It was prepared by CH2M HILL Inc. (CH2M) in its role as the Owner's Representative for the biosolids project. The Owner's Representative is not a registered Municipal Advisor as called for in Section 975 of the Dodd-Frank Wall Street Reform and Consumer Protection Act and this alternative analysis does not represent advice regarding specific municipal securities. Since some options under consideration would involve the sales of municipal bonds, we believe that a registered Municipal Advisor could likely provide additional useful input to WASD's decisions in this matter.

The basis of design memorandum developed for the BPF at WASD's South District Wastewater Treatment Plant (SDWWTP) included the evaluation of six potential technology solutions. This analysis does not address the potential option for a thermal drying facility at the Central District. For this BCE, thermal drying (with waste heat use) technology is assumed to be used. The thermal drying option was among the most promising in terms of technology characteristics, and is considered more amenable than other technologies for delivery through either traditional or DBFOM approaches. A thermal drying facility could be built and started with minimal interruption to existing operations, and thermal drying technology is amenable to the use of waste heat from the existing cogeneration facility at the SDWWTP.

Life-cycle cost opinions for traditional and DBFOM options over a 20-year study period are included in this BCE.

## Evaluation Period

A 20-year study period has been used to conduct the value for money analysis. Two primary considerations were used in identifying this period. The normal lifespan for the biosolids process equipment is 20 years,

which is a likely timeframe for a private delivery arrangement if a DBFOM approach is selected. In addition, as detailed later in this memorandum, 20 years is likely a reasonable time to assume financing would be arranged for either a public or private delivery option.

# Assumptions for Traditional Public Delivery

The option of traditional delivery and finance in a value for money analysis is referred to as the public sector comparator. This section defines the cost and financing assumptions used to develop the life-cycle cost estimates for the traditional delivery option for the processing facility.

## Cost Estimate

To develop a life-cycle cost estimate for the traditional delivery option, capital and operating cost estimates have been developed.

### Capital Cost Estimate

The Owner's Representative TM Biosolids Processing Facility: Predictions of Design/Construction and Operating Costs (Attachment 1) identified a construction cost range of $51 million to $83 million for the option of a thermal drying facility (with waste heat use) at the SDWWTP site, with capacity to dry biosolids from the SDWWTP and CDWWTP. That option is chosen for the basis of capital and operating cost estimates in this BCE. The approximate midpoint of the construction cost range (rounding up) is $70 million, which this BCE is based on. Capital cost estimates as defined in this TM are the combination of estimated design/construction cost and other associated up-front costs such as legal and administrative costs. Refer to Attachment 1 for more detail on the projected ranges of design/construction costs for this project.

### Operation and Maintenance Cost Estimate

Based on currently available information on wastewater flow projections developed as part the Ocean Outfall Study for WASD, an average daily solids production of 400 wet tons per day (WTPD) is assumed, which results in 146,000 wet tons per year. For traditional public delivery, net annual operation and maintenance (O&M) costs are estimated to be $5.5 million in current year dollars rounded to the nearest $0.5 million, based on the following assumptions:

- Daily O&M cost for WASD operation = $40 per wet ton x 400 WTPD = $16,000 per day
- Dried Biosolids produced = 400 WTPD x 0.23 = 92 dry tons per day/0.92 solids = 100 tons per day of dried biosolids
- Estimated revenue for WASD dried biosolids product sales = $10 per ton x 100 tons per day = $1,000 per day
- Estimated net O&M cost for WASD operation = $16,000 - $1,000 = $15,000 per day.

## Financing Assumptions

### Bond Rate and Term

Based on recent borrowing by WASD for Series 2013 bonds (WASD, 2014), an average interest rate of 5.0 percent is assumed for the municipal bond borrowing the traditional delivery/finance option. A term of 20 years is assumed. The expected useful life for the facilities that would comprise most of these facilities is 20 years. When determining the financing term for municipal bonds, the life expectancy of the facilities being financed is one of the primary considerations.

### Issuance Costs

For this preliminary analysis, bond issuance costs of 1.5 percent of the borrowed amount are assumed for the traditional delivery option.

# Assumptions for DBFOM Option

For the DBFOM option, ownership of the facility retained by WASD. Under this type of contract, WASD would be contracting to receive a given level of service at a set price, whereas under the traditional option described in the preceding section, WASD would be contracting for construction of a specific facility that the county would presumably operate.

This section defines the cost and financing assumptions used to develop the life-cycle cost estimates for this DBFOM option.

## Capital and Operating Cost Assumptions

### Borrowing Rate and Term

The capital cost for private finance has traditionally been higher than financing available through the municipal bond market because privately raised capital typically does not enjoy tax-exempt status and private financiers typically expect a higher rate of return on the capital they offer for infrastructure financing. Based on these considerations, an interest rate of 9.0 percent is assumed for the preliminary value for money analysis. Many private equity financing sources would expect to realize even greater returns than 9.0 percent for a finance-only deal. The 9.0 percent rate assumes that some teams would provide a discount from the highest level of private finance rates to secure the full, long-term concession that includes the opportunity to provide construction and operation services and the possibility of a blend of public and private financing to implement the facilities.

A borrowing term of 20 years is assumed. This is consistent with the estimated service life of most facilities that would be developed and the anticipated term for the long-term concession. It also is consistent with the term assumed for the traditional public delivery and finance option.

### Issuance Costs

It is assumed that there are no issuance costs associated with the private delivery and finance option. Since the DBFOM arrangement would be a direct negotiated arrangement between WASD and a private team for the full value of the concession period with the concessionaire expected to provide capital financing, there would be no need for WASD to hire an underwriting team to sell shares related to financing or secure a credit rating for transaction.

### Operation and Maintenance Cost Estimate

Based on opportunities for operating cost savings through reduced labor costs and opportunities for bulk purchase of input commodities, such as energy and chemicals, it is assumed for this preliminary value for money analysis that O&M costs for the DBFOM option will be lower than O&M costs for the traditional public delivery option. In addition, it is assumed that the private delivery option will have a greater opportunity to realize revenues from the sale of biosolids processing by-products. Overall, it is assumed that net operating costs for the DBFOM option will be 83.0 percent of those identified with the traditional public delivery option. Specific supporting assumptions used to develop the 83.0 percent estimate include:

- Daily O&M cost for DBFOM operation = 0.90 x $16,000 per day = $14,400 per day (DBFOM efficiency affords 10.0 percent O&M cost reduction from traditional public delivery option)

- Estimated revenue for DBFOM operation = $20 per ton x 100 tons per day = $2000 per day (DBFOM access to wider and more diverse markets for dried biosolids would result in higher unit prices and revenues)
- Estimated Net O&M cost for DBFOM operation = $14,400 - $2,000 = $12,400 per day (which is 83.0 percent of the $15,000 per day net O&M cost for public operation)

Refer to Attachment 1 for the O&M cost estimates on which these assumptions are based.

# Risk Transfer Opportunities

A preliminary identification and screening of potential risk transfer considerations that would be relevant for WASD's biosolids processing facility was conducted. The potential risk transfer factors considered include:

- **Cost Risk**
  - Capital cost (bid climate uncertainty and change orders) – Risk that capital cost will exceed the initial estimate as a result of higher bids than estimated and change orders during project delivery/execution.
  - Cost of municipal borrowing uncertainties – Risk that interest rates for borrowed funds will be higher.
- **Operating risk** –Risk that assets will not be properly operated or that operating costs will be higher than projected/forecasted with traditional public delivery.
- **Maintenance risk** – Risk that assets will not be adequately/properly maintained or that maintenance costs will be higher than projected/forecasted with traditional public delivery.
- **Variable demand risk** – Uncertainty related to the level of demand and resulting revenue in traditional public delivery.
- **Performance risk** – Uncertainty related to asset performance in traditional public delivery.
- **Security risk** – Risks related to security considerations for the public delivery entity.
- **Technology risk** – Uncertainty related to capability of technologies employed to provide the level of service required to meet the required outputs. Generally most relevant when a system depends on new or unproven technologies. Regarded to be low in this case because thermal drying is a proven technology.
- **Credit reduction risk** – Potential additional risk of higher borrowing rates for other capital projects planned by WASD in light of cumulative public debt burden of the current project plus existing outstanding debt when additional debt is incurred in the future for other capital projects

From this preliminary list, the initial screening identified the two cost risk factors as the ones definitely relevant to the BCE for WASD biosolids processing facility:

- **Cost Risk**
  - Capital cost (bid climate uncertainty and change orders)
  - Cost of municipal borrowing uncertainties

Other potential risk factors identified, such as operations risk and variable demand risk, could be relevant considerations for traditional public delivery of the biosolids facilities evaluated in this BCE. As such, the value for money results reported in this memorandum may be conservatively stated; that is, some of these additional factors might present opportunities where risk could be transferred to a private entity through

DBFOM contracting provisions, while traditional public delivery could result in additional operating costs or reduced operating revenues.

The subsections below identify factors used in developing the risk transfer opportunity assumptions included in this analysis for the two factors.

## Capital Cost: Bid Climate and Change Orders

While the DBFOM option is assumed to incorporate a fixed price for the design and construction components of the costs, the traditional municipal delivery option would be subjected to market bidding conditions and, during execution, would be subjected to change orders executed in response to changing conditions, and unexpected elements. It is not uncommon for water and wastewater utilities to experience change orders in the 15.0 to 20.0 percent range for major construction projects. A 20.0 percent factor has been incorporated into this analysis to address uncertainties related to change orders and initial construction bidding climate.

## Cost of Municipal Borrowing Uncertainty

While the DBFOM option is assumed to incorporate a fixed price for the capital component of the costs, the financing cost for the traditional municipal delivery option would be subject to bond market fluctuations and consideration of WASD's credit rating and evaluation at the time bonds are issued for the project.
A 0.5 percent interest rate differential is incorporated into the BCE to reflect potential uncertainties in the interest rate that would be secured for the bonds for this project.

Key inputs to the BCE analysis are summarized in Table 1. For this preliminary analysis, a 5.0 percent discount rate, equal to the cost of capital for WASD in its most recent revenue bond offerings, has been used to calculate the net present value (NPV) of life-cycle costs for the traditional and DBFOM options.

Table 1. Summary of Key Financing and Cost Assumptions and Risk/Discount Factors
*WASD Thermal Biosolids Drying Facility at South District Wastewater Treatment Plant*

| | | Traditional Delivery | DBFOM with Guaranteed Price |
|---|---|---|---|
| Base Assumptions | Base Design/Construction Cost | $70,000,000 | $70,000,000 |
| | Term (Years) | 20 | 20 |
| | Interest Rate | 5.0% | 9.0% |
| | Issuance Cost (% of Capital Cost) | 1.5% | 0.0% |
| | First Year O&M | $5,500,000 | $4,565,000 |
| | Escalation Rate O&M | 3.0% | 3.0% |
| Risk/Discount Factors | Bid Climate/Change Order Differential | 20.0% | 0.0% |
| | Bond Interest Differential | 0.5% | 0.0% |
| | Private O&M as % of Traditional | 83.0% | NA |

# Results

This section provides BCE results, which includes NPV of the life-cycle costs for the direct capital and operating costs over the 20-year study period. In addition, the value for money analysis incorporates the net present value of the two risk transfers to the private section identified in the preceding section. As shown in Figure 1, the incorporation of reasonable assumptions for the risk factors identified as relevant for this draft BCE analysis results in net present value of costs for the traditional option that is slightly higher than for the DBFOM option. The NPV of costs for the traditional option is $175 million compared with costs of $168 million for the DBFOM option, so roughly a 4.0 percent differential over the 20-year study period. This

differential is within the current cost estimating accuracy range, which as a Class 5 estimate is approximately +100.0 percent to -50.0 percent of actual cost

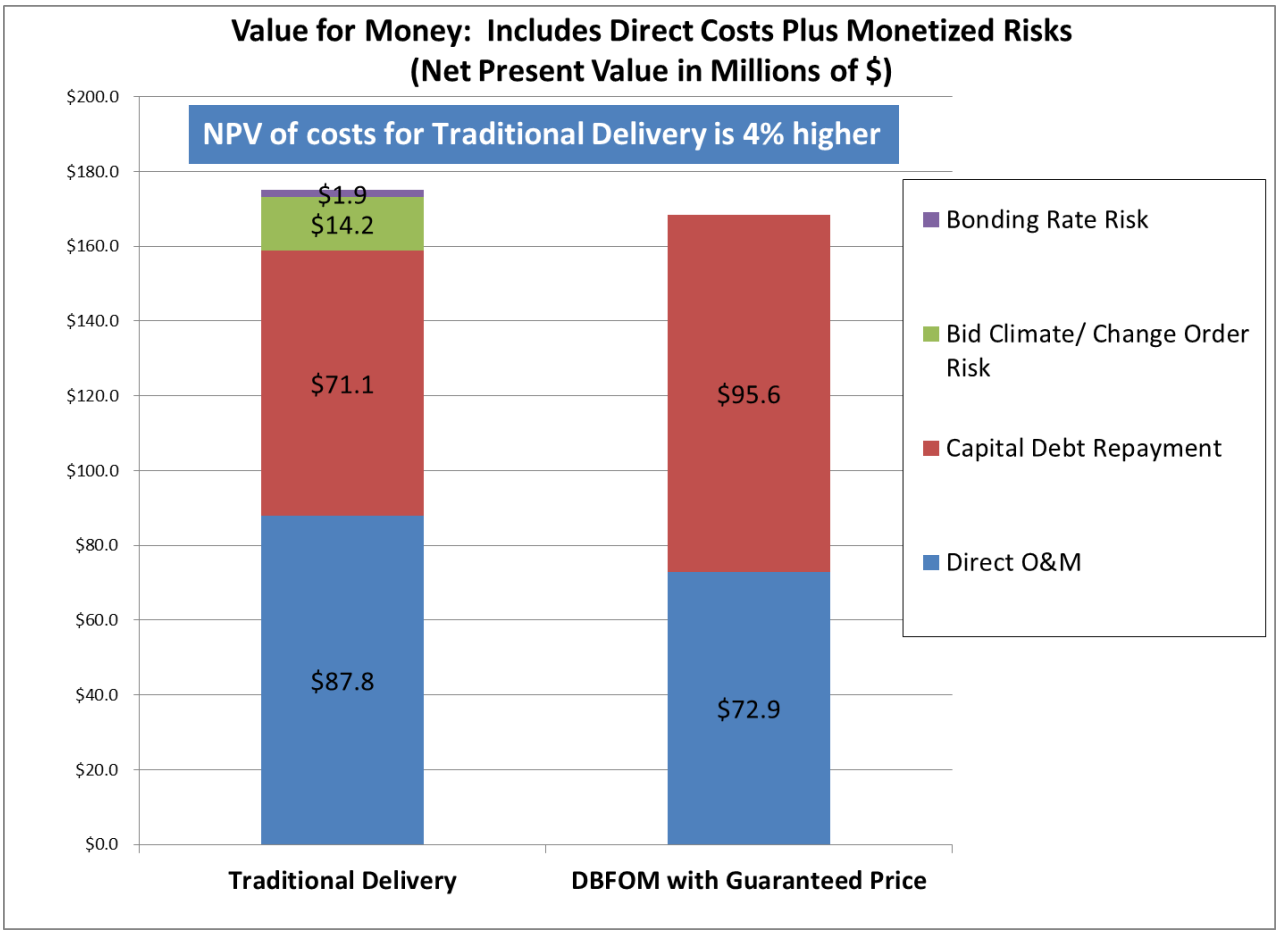


Figure 1. Value for Money Analysis

*WASD Thermal Biosolids Drying Facility at South District Wastewater Treatment Plant*

## Additional Considerations

When the results of the draft value for money analysis are within the cost estimating accuracy range of the cost estimates shown in the Results Section, the development of a recommended strategy may depend on other ancillary considerations.

Some considerations that would suggest additional benefits of implementing a traditional delivery and finance approach include:

- **Reserve account requirement** - Use of municipal bonding typically requires an agency to set aside funds in debt service reserve accounts, often a full year's debt service payment. Such a requirement could tie up more than $5 million in WASD revenues over the 20-year period that bonds are outstanding.
- **Annual coverage requirement** - An agency issuing traditional municipal bonds needs to raise rates to customers to produce current year net operating revenues that provide a coverage factor of 1.5 or higher, even though technical requirements are often lower (often in the range of 1.2 or 1.25 times debt service). Based on the current traditional option financing assumptions and project costs, the need to support coverage could result in a requirement to raise rates to customers to produce more than $2.5 million per year to meet this requirement; the funds raised each year could be used the following year to reduce future debt financing needs or cover some system operating costs.

- **Support for strong WASD credit rating** - Implementing the biosolids facility through private financing may preserve municipal bonding capability and support strong credit ratings for WASD. Since WASD's capital improvement plan (CIP) calls for significant capital investments during the next 20 years to support three significant capital initiatives, reducing the amount of public borrowing may be important to preserving WASD's strong credit rating, which is key to maintaining access to municipal borrowing at competitive interest rates. Figure 2 includes the NPV of an additional 0.5 percent interest rate for $1 billion in capital borrowing by WASD.

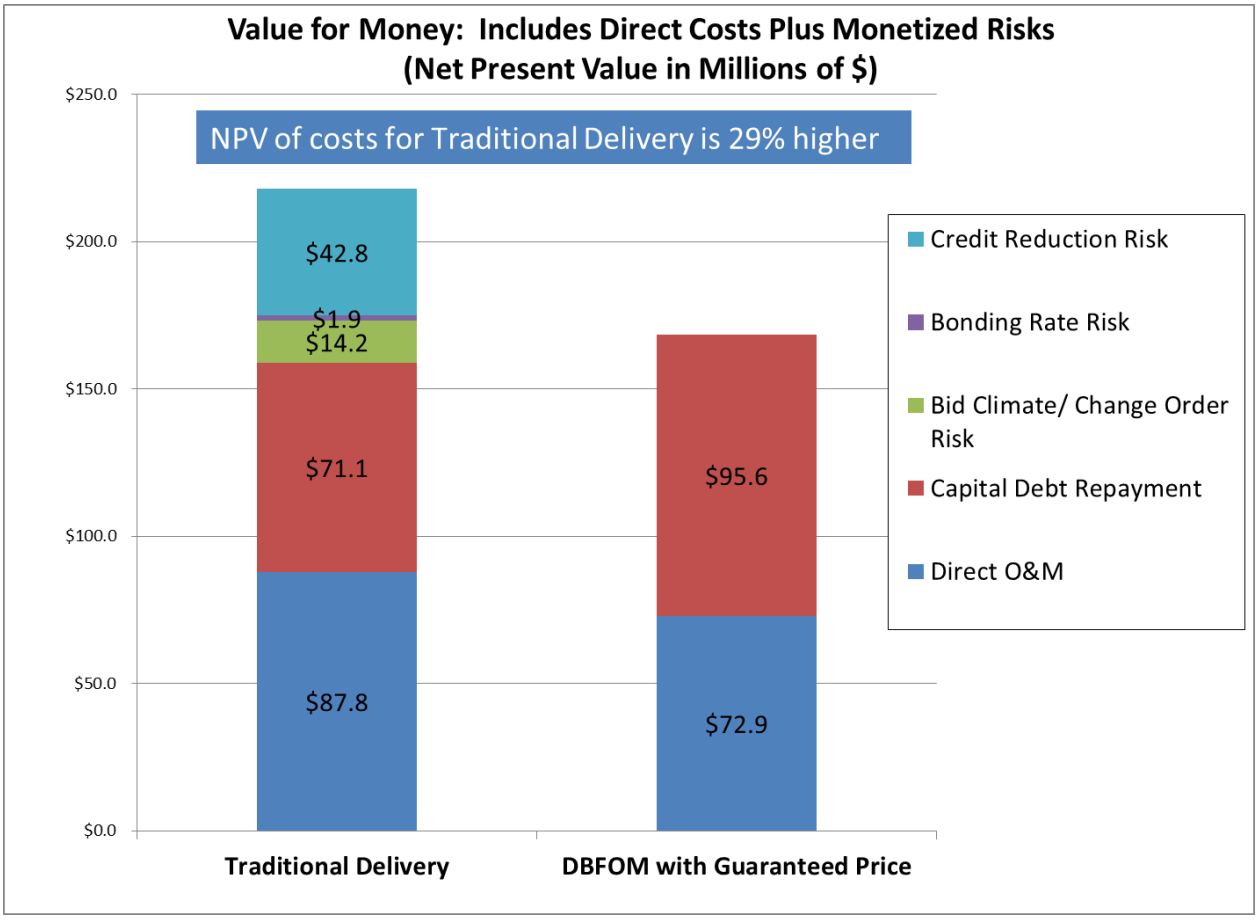


Figure 2. Value for Money Analysis including Credit Reduction Risk
*WASD Thermal Biosolids Drying Facility at South District Wastewater Treatment Plant*

As shown, the added NPV of costs to WASD's rate payers of a 0.5 percent increase in interest rates could be approximately $43 million for $1 billion in other WASD borrowing. Since the $70 million capital borrowing for the biosolids drying facility by itself is not likely to result in a reduction in WASD's credit rating or increase interest rates for other capital borrowing, this factor was not included in the baseline findings shown in this memorandum. But, as shown in Figure 2, there is a strong benefit for WASD in maintaining competitive credit ratings/interest rates. Given the magnitude of its overall CIP, finding opportunities to reduce direct municipal borrowing will likely be part of the strategy to keep WASD and other local government agencies interest rates competitive.

- **Support for strong credit ratings for other area jurisdictions -** Reducing public borrowing by WASD may be important in preserving credit ratings for other overlapping Miami-area jurisdictions, such as school districts that intend to issue municipal debt for schools, roads, or other pressing community priorities. Since the credit rating agencies consider total outstanding and planned municipal debt of agencies that

draw on a common population and economic base for repayment of debt, the credit rating implications could include such entities.

- **Staffing impacts** – By implementing the DBFOM option, WASD could likely reduce the need for additional staff to oversee construction of new facilities and operate the facilities. The staff needed to oversee a DBFOM contract would be significantly less, reducing the need for additional office space and other related ancillary costs that result from adding staff by WASD.

An additional benefit of implementing a traditional delivery and finance approach is that WASD may have more direct control over the implementation of facilities through a traditional construction management/delivery approach, although there also are options to embed close coordination with WASD within a DBFOM structure.

Additional considerations identified as part of this preliminary BCE analysis tend to strongly favor the DBFOM option, as WASD could avoid some notable ancillary costs with the DBFOM option that would likely need to be incurred with traditional municipal finance options.

# Summary of Findings and Recommendations

Primary findings of this preliminary BCE for the biosolids processing facility based on thermal drying technology include:

- The estimated NPV of lifecycle costs for traditional delivery are greater than for the DBFOM option ($174 million versus $168 million). This difference is within the accuracy range of current cost estimates, which are at a Class 5 level of development.
- There are additional considerations, such as not having to raise revenues to satisfy reserve fund requirements or coverage requirements and staffing impacts, which further tip the advantage toward the DBFOM option. These additional considerations have not been monetized in the NPV results shown in this memorandum.

Recommended follow-up steps include:

1. Broader review of the framework and assumptions used in this preliminary analysis and results, as appropriate, with WASD staff.
2. Refinement to definition of the solution – There is a possibility that the specific technical solution will be revised based on feedback WASD has received. For example, there is a possibility that provision for offsite biosolids processing may be incorporated into the solution. If so, the analysis could be updated to reflect revisions to costs or other assumptions that would result from such changes.
3. Revisit the assumptions and results when more refined capital and O&M cost estimates are available for the preferred technical solution.

# Reference

Miami-Dade Water and Sewer Department (WASD). 2014. Single Audit Reports for the Year Ending September 30, 2014, page 20. WASD is a department of Miami-Dade County.

# Attachment 1
# Technical Memorandum - Biosolids Processing Facility: Predictions of Design/Construction and Operating Costs

TECHNICAL MEMORANDUM

# Biosolids Processing Facility: Predictions of Design/ Construction and Operating Costs

PREPARED FOR: Miami-Dade Water and Sewer Department

PREPARED BY: CH2M HILL, Inc.

DATE: November 10, 2015

## Introduction

Design, construction and operating cost estimates for two recommended technologies for implementation at the Biosolids Processing Facility (BPF) or facilities (BPFs) 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 design of the BPF(s) 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 Design-Build-Finance-Operate-Maintain (DBFOM) Providers who would implement the BPF(s).

The BDM recommends that the Miami-Dade Water and Sewer Department (WASD) consider two general process technologies for implementation at the BPF by DBFOM Providers. These two processes are composting and thermal drying. Within these two general types of processes, there are many potential variations of technologies that could be used, such as types of composting or drying equipment, composting and drying process configurations, materials handling systems, operational approaches, control strategies, levels of odor control, and others.

One key aspect of the overall cost for the facilities is site location. WASD desires that a new BPF consisting of composting and/or thermal drying technologies be located at the South District Wastewater Treatment Plant (SDWWTP) site, and has proposed that all or a portion of the SDWWTP site area currently used for composting can be incorporated into the DBFOM Provider's solution. At the choice of the DBFOM project provider, another BPF consisting only of thermal drying technology may be located at the Central District WWTP (CDWWTP) site. The financial considerations for use of the site(s) will be identified as the DBFOM procurement process moves forward.

The WASD intends to implement this project using DBFOM delivery, wherein the project design, construction, and operating costs are part of one DBFOM contract, which is the focus of this TM. Design and construction costs are lumped together and referred to as construction cost, making up the largest component of the project's capital cost. Other components of capital cost include financing, land acquisition, legal, administration, technical services, and DBFOM oversight. These other components of capital cost are not addressed in this TM but are considered in the Business Case Evaluation (BCE).

## Basis of Design

The quantities and characteristics of the material that will be sent to the BPF(s) will depend on two factors. First, 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 at SDWWTP will be reduced with improved dewatering. Also, both the total mass and volatile solids content of the biosolids are expected to decrease (in proportion to raw biosolids produced) with

improved digestion at both WWTPs. These upgrades are planned to be in service by 2020. Finally, quantities of biosolids delivered to the BPF(s) will change when the West District Wastewater Treatment

Plant (WDWWTP) is put into service and flows redirected from the North District Wastewater Treatment Plant (NDWWTP) and the Central District Wastewater Treatment Plant (CDWWTP) to the WDWWTP. The WDWWTP is anticipated to start up in 2026.

The BPF(s) will be designed to process up to 102 dry tons per day (DTPD, average day basis), that corresponds to 2025, just before the WDWWTP is projected to start operation. The maximum projected quantity of biosolids in terms of wet material to be delivered to the BPF(s) is 465 wet tons per day (WTPD), which is projected to occur in 2019, just before the dewatering improvements are expected to be online. In design year 2035, the expected amount of material that will be treated at the BPF is 81 DTPD, equivalent to 354 WTPD.

# Biosolids Transport from CDWWTP to SDWWTP

## Purpose

At a project workshop held October 15, 2014 at the WASD offices, a request was made to perform a conceptual evaluation of two different approaches for transporting biosolids from the CDWWTP to a new BPF that will be located at the SDWWTP (at that time only the SDWWTP site was being considered for a BPF). These two approaches are: 1) trucking of digested, dewatered cake, and 2) 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 a BPF at SDWWTP goes into service, the biosolids could be transported there from the CDWWTP for further treatment. Pumping of liquid biosolids is similar to the current method used to transport solids from the NDWWTP to the CDWWTP; except the materials currently pumped are raw primary and waste activated sludge (WAS).

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

## Assumptions

At this stage of design, several assumptions have been made to facilitate the comparison and include:

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 biosolids 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 CDWWTP to the SDWWTP 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 dewatered solids is based on total contracted cost from current WASD haulers minus the disposal tipping free. Current tipping fees were obtained from area providers. The highest estimated hauling cost was used from several different contract prices available to WASD.

l. If the CDWWTP material is pumped to the SDWWTP, costs for dewatering capacity increases at the SDWWTP and 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 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.

## Central District WWTP Digested Biosolids Production

Data covering January 2009 through December 2013 from WASD for the CDWWTP were analyzed to determine the peak day flows of digested biosolids. To estimate peak day flows in the future, a 1 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, digested biosolids flow in 2035 of 1.5 million gallons per day (mgd). Solids concentrations leaving the digesters at the CDWWTP are expected to range from 1.1 percent to 3.8 percent, with an average of 2.2 percent.

Pumping rather than gravity flow would 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, Inc. (CH2M) 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 head loss, 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 CDWWTP will initially be approximately 234 WTPD. This amount will increase annually to approximately 270 WTPD until approximately 2026 when it is assumed that the WDWWTP will begin treating wastewater and a portion of the flow to the CDWWTP will be diverted to the WDWWTP. After 2026, the amount of material produced at the CDWWTP will be approximately 165 WTPD. The average amount of biosolids to be transported in this scenario over the project life is estimated to be approximately 238 WTPD.

For the purposes of the economic comparison, design and construction 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.

## 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 also would 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 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.


Figure 1. Potential Biosolids Pipeline Alignment

*WASD Biosolids Processing Facilities*

## Advantages and Disadvantages

The primary advantage of piping biosolids (compared to trucking) is that piping biosolids 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
*WASD Biosolids Processing Facilities*

| Advantages | Disadvantages |
|---|---|
| Operations not visible to general public<br>Relatively simple operation requiring typical wastewater equipment | Pipelines are buried and physical condition can be difficult to assess |
| 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 Construction 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 Estimated Construction Costs for Biosolids Pumping and Piping Facilities
*WASD Biosolids Processing Facility*

| Item | Quantity | Unit Cost | Total Estimated Construction Cost |
|---|---|---|---|
| **Estimated Construction Costs** | | | |
| 16-in Class 53, Lined DIP | 109,500 Linear Feet | $ 450 per Linear Foot | $49,280,000 |
| Biscayne Bay Crossing | 4,000 | $1,500 per Linear Foot | $ 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 Construction Cost | | | $76,850,000 |

Table 3. Summary of Operating Costs for Biosolids Pumping and Piping Facilities
*WASD Biosolids Processing Facility*

| Item | Quantity per year | Unit Cost | Total Estimated Annual Cost |
|---|---|---|---|
| **Operating Cost** | | | |

| | | | |
|---|---|---|---|
| Pumping | 230,000 kwh | $0.08 per kwh | $ 18,400 |
| Cleaning and Maintenance | 1 | $225,000 per Year | $225,000 |
| Subtotal Annual Cost | | | $243,500 |

Note:

Kwh = kilowatt hour

# 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 a new BPF at the SDWWTP. The one-way 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 cost that would be incurred to construct the pipeline. This approach also has 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 Hauling Biosolids
*WASD 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 Construction and Operating Costs

Since dewatering facilities that would be used in this alternative are common to both alternatives, there are no anticipated 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 application 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
*WASD Biosolids Processing Facility*

| Item | Quantity | Unit Cost | Total Estimated Annual Cost |
|---|---|---|---|
| **Operating Costs** | | | |
| Hauling | 86,870 Wet Tons per Year | $ 18 per Wet Ton | $1,542,000 |

| | | | |
|---|---|---|---|
| Maintenance | 1 | $ 50,000 per Year | $ 50,000 |
| Subtotal Annual Cost | | | $1,592,000 |

## Comparison of Alternatives

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 annualized construction and operating costs) 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 under the scenario of hauling all biosolids from CDWWTP to a BPF at the SDWWTP. Therefore, the basis of design will be to continue to haul biosolids between the two WWTPs via truck when necessary. It is recommended that the trucking activity be assigned to the DBFOM Provider in the BPF contract.

# Design/Construction Costs

The level of design and estimate of design/construction costs (also referred to herein as “construction costs”) for the BPF(s) are considered conceptual at this point. They are based on the required size of the facility and use construction cost information from other similar facilities on a unit (e.g., cost per dry ton of processing capacity) basis to estimate construction costs for the BPF. The value of land on which the facilities will be sited is not included in the construction cost estimates.

There are two basic scenarios on which construction costs for the BPF(s) are estimated:

1. A BPF is constructed only at the SDWWTP based on composting, thermal drying, or a combination thereof, and all biosolids produced at the CDWWTP are hauled to the SDWWTP by truck as digested, dewatered cake. The BPF in this scenario is sized for total biosolids production at both the CDWWTP and SDWWTP. There may be some redundancy incorporated into the planned capacity of this BPF since it will be sized for total biosolids production.
2. Two BPFs are constructed, one at the SDWWTP and one at the CDWWTP. The BPF at the SDWWTP may still consist of both composting and/or drying technologies, but will be sized based on SDWWTP biosolids production only. The BPF at CDWWTP will consist only of thermal drying technology and will be sized for CDWWTP biosolids production only. There may be some cross-redundancy incorporated into the capacity of these two BPFs, and each BPF will include equipment to receive some biosolids imported from offsite.

The average-day processing capacity of the BPF(s) will change over the years according to biosolids projections from Figures 4 and 5 of the BDM. Figure 4 from the BDM showing projected biosolids production in terms of dry tons per day (DTPD) is shown again below for reference.

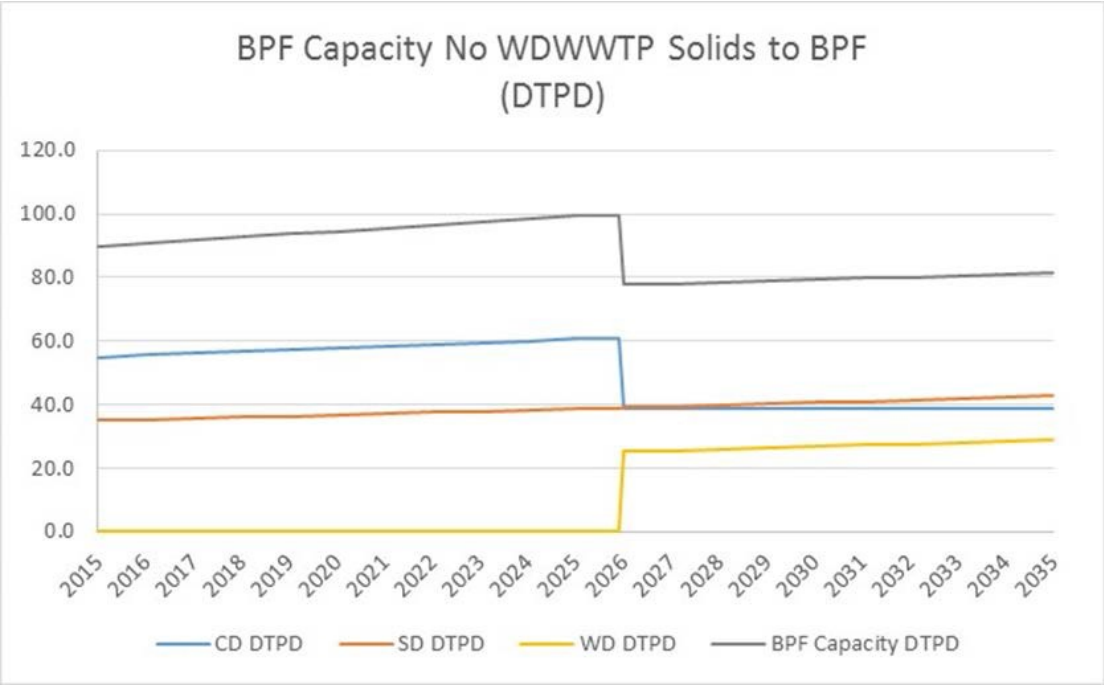


Figure 2 - Estimated Capacities of BPFs Based on Biosolids Production in Dry Tons per Day (DTPD)

*The composting cost estimates shown below are based on the first scenario, represented by the grey line in Figure 2.*

# Composting at SDWWTP

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 DBFOM Provider 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 likely be to use a metal- or fabric-roofed, covered compost area and maintain the existing aeration system. On the other hand, if the DBFOM 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.

# Basis for Conceptual Unit Costs- Composting

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 WASD BPF if composting is to be used exclusively. By developing a unit cost on a DTPD basis from this facility, and prorating it to the design capacity of the BPF, a rough estimate of construction cost for the BPF has been developed. This represents what the potential costs for the BPF 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 million or $825,000 per DTPD of capacity.
- Therefore, consider a range of $700,000 to $900,000 per DTPD for the construction costs of the new composting facilities for WASD 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 million to $92 million.

If the DBFOM Provider decides that the existing compost turning and screening equipment are acceptable and that no changes are needed to the existing 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 major improvements under this scenario.

Conceptual level estimates for the buildings are $12 million to $16 million. For odor control using a site-constructed biofilter, estimated construction costs range from $1.5 million to $4 million. The total construction cost for an upgraded composting facility using this approach is estimated to be in the range of $14 million to $20 million.

# Thermal Drying

If the DBFOM Provider elects to utilize thermal drying, then the drying facility (if located at only the SDWWTP) or facilities (if located at both the CDWWTP and SDWWTP) would be all new. The only resource from WASD 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. For the scenario of one drying facility at the SDWWTP, the dewatered biosolids would arrive from the CDWWTP by truck and be unloaded into truck-receiving hoppers. If the DBFOM Provider elects to construct drying facilities at both the CDWWTP and SDWWTP, truck-receiving hoppers will still be needed at each facility in the event that solids need to be imported from other facilities for drying. At the DBFOM Provider's option, biosolids produced at the same WWTP as the drying facility would likely be conveyed (by conveyor or pumped) rather than trucked from dewatering facilities to the new thermal drying facility at that site.

Based on other projects using thermal drying across the United States, the expected range of cost for the construction of this system would be $500,000 to $800,000 per daily dry ton of processing capacity.

In Scenario 1 (one thermal drying facility at SDWWTP only), the expected total capacity of the thermal drying facility would be 102 DTPD (465 WTPD). The construction cost for a thermal drying facility at the SDWWTP designed to process all biosolids produced by the CDWWTP and SDWWTP would be in the range of $51 million to $82 million.

In Scenario 2, two drying facilities (one at SDWWTP and the other at CDWWTP), each of the drying facilities would be of smaller size with a capacity more closely matched to the biosolids production of the WWTP where it would be located. At the SDWWTP, the thermal dryer would have a projected capacity of 43 DTPD, and its estimated construction cost would be in the range of $22 million to $35 million.

In Scenario 2 at the CDWWTP, the required capacity of a thermal dryer to process all biosolids produced at the CDWWTP would start at 55 DTPD and increase to 63 DTPD until 2026 when the WDWWTP is built, and then reduce to 39 DTPD due to transfer of wastewater from CDWWTP to the WDWWTP. If the CDWWTP drying facility is built to accommodate the maximum expected CDWWTP biosolids processing rate of 63 DTPD, its construction cost could range from $32 million to $50 million. A somewhat smaller thermal dryer at the CDWWTP could be justified based on its eventual biosolids projection of 39 DTPD, but the additional biosolids production that exceeds 39 DTPD in the interim years would need to be managed by either transporting those biosolids to the SDWWTP or to land application or landfill sites.

The total construction and operating costs for drying will likely be higher for Scenario 2 than for Scenario 1. Construction costs for Scenario 2 will be higher because of the additional equipment items and additional redundancy incorporated into two drying facilities versus one drying facility. Costs to operate thermal drying facilities in Scenario 2 will be higher than Scenario 1 because the staffing to operate two facilities in Scenario 2 will be more than to operate one larger facility in Scenario 1. However, construction of a separate dryer at the CDWWTP in Scenario 2 would substantially reduce the need to haul dewatered biosolids from CDWWTP to SDWWTP for drying, thereby saving an estimated $1 million annually in transport costs. So the overall operations cost for Scenario 2 would likely be lower than Scenario 1. In summary, the difference in total costs between the two scenarios is within the uncertainty range of current estimates and projections, and therefore insignificant to this evaluation.

In conclusion, there is uncertainty in the sizing of thermal drying facilities, depending on whether one or two drying facilities are built, and whether they are sized for total biosolids production, or instead, for a base loading production with excess biosolids to be handled by other means such as land application or landfilling.

If complex waste heat recovery equipment is built for the thermal drying facility or facilities, the estimated cost ranges shown above for thermal drying could increase by 2-5 percent of the totals.

# Operating Considerations

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

## 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 $87 to $217 per dry ton, assuming the feed biosolids average approximately 23 percent total solids concentration. Operating costs include

labor, power, equipment, other utilities, and supplies. Cost data provided by WASD 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, so the operating cost estimate for composting in this case was increased to the range of $30 to $50 per wet ton, or $130 to $217 per dry ton of biosolids processed.

## 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 heat, then the dryer operator must pay 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, is used, then the DBFOM 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, initial cost of the heat recovery equipment, and the operation and maintenance costs associated with that equipment.

Currently at the SDWWTP, the digester and landfill gas available is planned for use by the existing Cogeneration Facility. Thus, if a DBFOM 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 DFOM Provider will have to provide a dryer that utilizes low or medium-range temperature in its operations.

The dryer configuration and heat source selection for a thermal drying facility or facilities will be made by the DBFOM Provider based on the costs and efficiencies of the systems that it plans to use. For thermal drying system at either the CDWWTP or SDWWTP, potential heat sources that may be used are limited to Cogeneration waste heat and natural gas. It will be up to the DBFOM Provider to ascertain the availability and location of natural gas for potential fuel at both the CDWWTP and SDWWTP. If the DBFOM Provider intends to use alternative energy sources such as wind or solar, then it will need to identify how these sources will be used and document whether their impact on 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. In thermal drying, most of the material handling is mechanized and does not require operators to be involved continually. Because thermal drying is a high-temperature, short-retention-time process, it is very important to measure and control each step in the process. Tracking the amount of water removed is important in terms of final product quality. While fewer staff are needed to operate thermal drying compared with composting systems, the staff to operate a thermal dryer are typically trained at a higher level than composting system operators. Computer monitoring systems for thermal drying systems are also 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 only natural gas is used, the estimated operating cost range is $40 to $70 per wet ton, or $174 to $304 per dry ton, assuming the current (2015) commodity price for natural gas, and that the feed solids average 23 percent total solids concentration.
2. If waste heat is recovered and used in the thermal drying process to supplement natural gas use, estimated operating costs range from $30 to $60 per wet ton, or $130 to $260 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 (and depending on how much waste heat is available); however, there also is 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 DBFOM Providers.

# Summary of Cost Considerations

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

Table 6. Summary of Conceptual Costs
*WASD Biosolids Processing Facility*

| BPF Process | Construction Cost Range ($Million) | Operation and Maintenance Cost Range (O&M, $ per wet ton) |
|---|---|---|
| Scenario 1 – BPF based on one composting facility at SDWWTP: | | |
| Composting at SDWWTP (minimal reuse of existing facilities) | 71 - 92 | 20 - 50 |
| Composting at SDWWTP (maximum reuse of existing facilities) | 14 - 20 | 30 – 50 |
| Scenario 1 – BPF based on one thermal drying facility at SDWWTP: | | |
| Thermal Drying with only natural gas (no waste heat) | 51 - 82 | 40 – 70 |
| Thermal Drying (with combination of waste heat and natural gas) | 53 - 84 | 30 - 60 |
| Scenario 2 – BPF based on thermal drying facilities located at both the CDWWTP and SDWWTP: | | |
| Thermal Dryer at CDWWTP | 32 – 50 | 30 – 70 |
| Thermal Dryer at SDWWTP | 22 – 35 | 30 - 70 |
| Total Thermal Drying Cost for Scenario 2:[a] | 54 – 85 [a] | 30 – 70 [a] |

[a] In Scenario 2, the estimated total construction cost range is the sum of estimated construction costs for thermal dryers at CDWWTP and SDWWTP, but the estimated O&M cost range is shown on a unit cost basis, and therefore is the same cost range for the individual WWTPs as for the two combined WWTPs.