Chapter 9: Alternative Analysis

9.1 Introduction

The development and evaluation of alternatives are key elements in the facilities planning process. The purpose of this chapter is to evaluate alternatives for modifications to Jones Island Wastewater Treatment Plant (JIWWTP) and South Shore Wastewater Treatment Plant (SSWWTP). The purpose of implementing these alternatives is to control combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs). Biosolids management alternatives are also evaluated in this chapter.

Based upon the water quality modeling done for the 2020 Facilities Plan (2020 FP) and shown in Appendix 4A, 9B, 9C and 9E of the 2020 FP, the discharges from MMSD's two wastewater treatment plants (WWTPs) do not have a significant negative impact on receiving water quality, as illustrated by the following:

- The JIWWTP discharges into Lake Michigan in the area known as the outer harbor. This area was modeled for water quality using the monitoring points in the lake/estuary as detailed in Appendix 9B, 9C and 9E of the *Facilities Plan Report*. As shown in these appendices, the water quality of the outer harbor meets all water quality standards for almost the entire year. For example, the models show the following water quality of the outer harbor at the closest point to the JIWWTP discharge (model assessment point OH – 11):

TABLE 9-1
OUTER HARBOR ASSESSMENT POINT OH-11
DAYS PER YEAR MEETING WATER QUALITY MEASURES

Water Quality Parameter	Existing 2000	Revised 2020 Baseline
Fecal Coliform Geomean Standard	363	363
Fecal Coliform Max Day Standard	358	359
Phosphorus Guideline	365	365
Dissolved Oxygen Standard	365	365

- The yearly pollutant loading analysis (shown in Section 9.6.11 of the *Facilities Plan Report*) shows the very small impact JIWWTP has on the total loadings to the Lake/Estuary watershed.
- The impact of SSWWTP on the water quality assessment point closest to the SSWWTP outfall (assessment point LM-17 as detailed in Appendix J of Chapter X of the Southeastern Wisconsin Regional Planning Commission (SEWRPC) Planning Report No. 50, *A Regional Water Quality Management Plan Update for the Greater Milwaukee*

Watersheds) shows that the water quality of Lake Michigan in the vicinity of the SSWWTP outfall is excellent and meets all water quality standards. Thus, improving effluent quality of SSWWTP is not a recommendation of this facilities plan.

- The effluent quality of JIWWTP and SSWWTP has been exemplary during wet weather high treatment flow events.[a]

Thus, improving effluent quality of JIWWTP and SSWWTP during wet weather events is not a recommendation of this facilities plan.

Sections 9.2 through 9.5 review and evaluate the individual treatment technologies that deal with technologies to expand the capacity of JIWWTP and SSWWTP to increase CSO and SSO control that were considered in the *State of the Art Report* (SOAR). The technologies that are evaluated include conventional activated sludge treatment, physical-chemical treatment, blending. Inline storage system (ISS) pumping options are also evaluated. These are evaluated in parallel with the system level evaluations conducted in Chapter 9 of the *Facilities Plan Report*.

Sections 9.6 through 9.10 develop and evaluate biosolids management alternatives. The screening alternatives include the continued production of Milorganite®, the use of "glass furnace technology" (GFT), land application, landfill, incineration, and composting. The Recommended Plan alternatives include Milorganite®, GFT, and landfill.

The SOAR screening of alternatives for treatment and biosolids management used 2020 Baseline flows/wasteloads based on population and land use projections. The evaluations for the Recommended Plan alternatives in this chapter use Revised 2020 Baseline flows and wasteloads that have been reduced based on lower, more realistic future population and land use projections for the MMSD service area. The wasteloads also reflect the relocation of a major industrial customer (LeSaffre Yeast), which occurred in December 2005.

The alternatives evaluated in this chapter result in the Recommended Plan for treatment facilities, which is presented in Chapter 10 of this report.

9.2 State of the Art Report - Individual Treatment Technologies

9.2.1 Point Source Indicators used in Analysis

As stated in Chapter 3, *Point Source Technologies* of the SOAR, the analysis of the point source technologies is based on model simulations using the 64.5-year period of record (January 1940 through June 2004). The approach used in the SOAR analysis defines a production function for each individual technology. The SOAR analysis of the point source technologies is based on four point source indicators:

- SSO volume removed
- SSO events eliminated
- CSO volume removed
- CSO events eliminated

[a] See discussions in Section 4.5.2 and data shown in Tables 4-15 to 4-20 of Chapter 4 of this report and in Appendix 4J of this report for information on wet weather effluent quality.

The analysis of all treatment options was also based upon the need to meet all current Wisconsin Pollutant Discharge Elimination System (WPDES) permit requirements, and all four of these options meet those permit requirements. The performance of the MMSD's two WWTPs is exemplary and, as shown in Chapter 4 of this report, the WPDES permit requirements are met essentially 100% of the time.

9.2.2 South Shore Wastewater Treatment Plant Treatment Options

The treatment technologies that were reviewed for implementation at SSWWTP in the SOAR are discussed below. The maximum possible gravity flow to SSWWTP is approximately 450 to 500 million gallons per day (MGD) based on the conveyance capacity of the metropolitan interceptor sewer (MIS) system tributary to SSWWTP.[b] In this range, conveyance enhancements are not required, nor is there a need for a dedicated force main to pump flow from the ISS to SSWWTP. Options that would increase conveyance system flow capacity to SSWWTP were considered but proved to be too expensive (relative to other options that were analyzed) and were not analyzed further. Thus, treatment capacity expansion of up to 500 MGD was considered under the various options evaluated.[c]

The Capacity Analysis of SSWWTP Project that is recommended in Chapter 8 of the *Facilities Plan Report* may determine that the existing capacity of SSWWTP is greater than 300 MGD. If so, SSWWTP will require less additional treatment capacity to meet the recommendations of this report. Therefore, the capacities of the technologies reviewed at SSWWTP were limited to an additional capacity that reasonably matches the available flow capacity of the interceptor sewer system that conveys wastewater to SSWWTP.

Conventional Activated Sludge Treatment

Increasing treatment plant capacity by adding conventional activated sludge treatment process at SSWWTP to treat additional peak flows would entail additional influent screening, grit removal, primary clarification, activated sludge treatment, secondary clarification, disinfection, effluent pumping and a second outfall pipe in parallel with the existing outfall pipe. Costs for this technology set were developed with both chlorine and ultraviolet (UV) disinfection; the technology with UV disinfection was less expensive. This technology set is a viable option, but is more expensive than other treatment technologies reviewed due to the number of treatment unit processes and facilities required and the need to add additional lakefill in Lake Michigan to accommodate all of the additional facilities.

In addition, there are concerns about the peaking factor of the secondary treatment system from average day flows to maximum day flows. The peaking factor of the SSWWTP biological activated sludge plant is currently about 3:1 (peak day 300 MGD and average day 100 MGD). Expanding SSWWTP to more than 300 MGD activated sludge capacity would require the plant to meet an even higher secondary treatment peaking factor. If SSWWTP were expanded to provide a full 450 MGD of secondary capacity, the peaking factor for the plant would be 450/100 or 4.5. This is an extremely high peaking factor for an activated sludge plant and would create concerns in terms of the ability to keep a viable biological treatment mass that could function effectively during a wet weather event. Measures would have to be taken to assure that the increased biological mass needed for these infrequent wet weather episodes would be

[b] Per analysis in Appendix 3A of the *State of the Art Report*.

[c] The force main and additional conveyance enhancements are discussed in Section 9.1.4 of the *Conveyance Report*.

available for effective treatment. These measures would have to include operational measures to feed normally unused biological treatment mass with wastewater to keep it viable, and other measures to assure that the peaking factor required is available. This technology was not included in the alternative analysis due to these factors.

Physical-Chemical (ballasted flocculation) Treatment

The physical-chemical system is based upon a conceptual design developed in a project that evaluated treatment of wet weather flows (the *Technology Evaluation Project*).(1) The final report was not complete as of the drafting of this chapter, but the draft analysis was used to develop the 2020 FP assessment for facilities required and planning level costs. The physical-chemical technology, also referred to as high-rate treatment, involves the addition of a ballasting agent and chemicals to enhance settling of solids in the wastewater. As presented in this section, the technology is a separate unit process that provides treatment of intermittent high wet weather flows with a smaller footprint than conventional activated sludge treatment. There are a number of physical-chemical systems in use around the world specifically for municipal wet weather treatment

The system evaluated in the SOAR was the ACTIFLO® system, manufactured by Kruger, based upon a cost effectiveness evaluation in the *Technology Evaluation Project*. Physical-chemical treatment is an acceptable method for full secondary treatment based upon existing Wis. Admin. Code Chapter Natural Resources (NR) 110.

The physical-chemical system evaluated for the 2020 FP includes additional influent screening, additional grit removal, all of the facilities required for an ACTIFLO® system, and additional disinfection. Costs were developed with both chlorine and UV disinfection. The UV disinfection option was selected for additional analysis because of the potential for better bacterial reduction. The physical-chemical facilities also included additional effluent pumping and an addition to the existing Lake Michigan outfall to handle the additional total plant flow (physical-chemical treated effluent combined with the biological activated sludge system effluent before discharge).

This technology is less expensive than conventional activated sludge treatment because the physical-chemical system needs fewer unit processes and facilities than the conventional system and has a much smaller footprint. No additional lakefill is required for this alternative. This technology was included in the alternatives analysis due to its cost effectiveness and suitability for quick start up and short-term operational capabilities, as discussed in Section 9.3.

Blending

A blending system at SSWWTP was considered in the SOAR. It would entail additional influent screening and grit removal, a connection to the primary clarifiers, and use of the existing bypass channel from the primary clarifiers. Additional UV disinfection, additional effluent pumping, and an outfall expansion were also included to allow for the blended flow to be combined with the biological secondary activated sludge system effluent before discharge. Additional chlorine disinfection was not considered due to the lack of available land along the existing bypass channel. It was assumed that at the higher wastewater flows, wasteload concentration (mg/l total suspended solids) would decrease so as not to overload the primary clarifier mechanisms and sludge pumping.

Blending is not currently allowed at SSWWTP per MMSD's WPDES permit.(2) This technology is less expensive than other treatment alternatives because of the very limited treatment (screening, grit removal and disinfection) upgrades needed. However, due to current WPDES permit requirements and future regulatory concerns, this technology was not considered further.[d]

Physical-Chemical (chemical flocculation) Treatment

An alternative technology to the physical-chemical (ballasted flocculation) technology discussed earlier is physical-chemical treatment using chemical flocculation. This process uses primary clarifiers and newly developed chemical feed schemes and process modifications. This technology was added to the technology list after the initial technologies were developed and discussed in the SOAR. Chemical flocculation uses existing primary clarifiers and a process by which wastewater is conditioned with chemicals, typically metal salts and/or polymers, to improve liquid/solid separation within the existing primary clarification process. The key feature of this technology is the use of the existing SSWWTP primary clarifiers as the wet weather physical-chemical treatment system by adding a chemical feed system to the clarifiers. This process is patterned after a similar system being constructed in Seattle, WA.(3)

The proposed modifications include additional influent screening, additional grit removal, chemical feed and flocculation facilities, and conversion of some of the existing primary facilities to chemical flocculation. No modifications of the secondary treatment facility (activated sludge process) would be required. The system would be designed to process up to 450 MGD on a peak wet weather day, with about 300 MGD being treated with the existing process flow pattern (preliminary treatment, primary clarifiers, activated sludge and chlorine disinfection). Any flow above 300 MGD from the additional preliminary and converted dedicated chemical flocculation primary clarifiers would be routed to a dedicated UV disinfection system, monitored, and then recombined with the secondary process effluent for discharge into Lake Michigan. The process would also include additional effluent pumping and an outfall expansion to handle the additional total plant flow. This alternative offers significant gains in capacity with minimal new construction and potentially better biochemical oxygen demand (BOD) and total suspended solids (TSS) removal over other physical-chemical technologies according to preliminary tests at SSWWTP conducted in the spring of 2006. Another benefit is that this alternative would use equipment commonly operated by the plant staff rather than new unit operations that would be rarely used and therefore be less familiar to the operators.

Physical-chemical secondary treatment complies with Wis. Admin. Code NR 110.22 (Physical-Chemical Treatment).

This technology is recommended as an alternate option to the physical-chemical (ballasted flocculation) system that is part of the Recommended Plan. However, due to the innovative nature of this process, implementation must be preceded by a demonstration project at SSWWTP. This demonstration project is discussed in Chapter 11, *Implementation Plan* of the *Facilities Plan Report*.

[d] Refer to Section 9.6.5 of the *Facilities Plan Report* for a detailed discussion of permit requirements and regulatory concerns.

9.2.3 Jones Island Wastewater Treatment Plant Treatment Options

The review of treatment technologies at JIWWTP in the SOAR noted that additional treatment capacity is limited by the amount of available land. An estimate of available land was made, which considered land that could be available without severely impacting the Milwaukee Harbor Commission facilities adjacent to JIWWTP. It was estimated that approximately 17.6 acres immediately south of the existing primary clarifiers at JIWWTP could be used for additional treatment. This land would have to be purchased from the Harbor Commission at a very high cost per acre, projected to 2007 costs based on costs developed during the last purchase of Harbor Commission land in 1980.(4) This area is sufficient to add 100 MGD of treatment using activated sludge technology or as much as 500 MGD of treatment using physical-chemical treatment.

Conventional Activated Sludge Treatment

Additional conventional activated sludge treatment system at JIWWTP would entail additional influent screening, grit removal, primary clarification, activated sludge treatment, secondary clarification, disinfection, and effluent pumping. This construction would consist of a "south" plant to complement the existing east and west plants as described in Chapter 4 and 5 of this report. Costs were developed with both chlorine and UV disinfection; the technology with UV disinfection was less expensive. As stated above, due to the size of the system and the limited amount of land available near JIWWTP, this system was limited to 100 MGD. Even at this size, the costs for this type of system are much higher than the costs for a physical-chemical system due to the number of facilities required.

In addition, there are concerns regarding the ability of such a system to react quickly to large increases of flows on wet weather event days. The peaking factor of the JIWWTP biological activated sludge plant is currently about 3:1 (peak day 300 MGD and average day 100 MGD). Expanding JIWWTP to more than 300 MGD activated sludge capacity would require the plant to meet an even higher secondary treatment peaking factor. The issue of activated sludge peaking factor is discussed in the previous section, and the issues presented for SSWWTP also apply at JIWWTP. This technology was not included in the alternative analysis due to these factors.

Physical-Chemical (ballasted flocculation) Treatment

The physical-chemical system at JIWWTP is also based upon the conceptual design developed for the *Technology Evaluation Project*.(5) The physical-chemical system evaluated for the 2020 FP includes additional influent screening, additional grit removal, all facilities required for an ACTIFLO® system, additional disinfection, and additional effluent pumping. Costs were only developed with UV disinfection, which has a much smaller footprint than chlorine disinfection, due to the limited land availability for additional treatment. This technology was found to be less expensive than the conventional activated sludge treatment technology because the physical-chemical system needs fewer facilities than the conventional system and has a smaller footprint. This technology was included in the alternatives analysis (as discussed in Chapter 9, Section 9.6 of the *Facilities Plan Report)* for the Recommended Plan 10-year level of protection alternative due to its cost effectiveness.

The physical-chemical (chemical flocculation) process considered for SSWWTP could also be considered for JIWWTP. The demonstration project recommended for SSWWTP would also need to be implemented at JIWWTP to determine the specific performance aspects of physical-chemical (chemical flocculation) at JIWWTP. Because the physical-chemical (chemical flocculation) process is less expensive at SSWWTP, it is assumed that it would also be less expensive at JIWWTP.

Blending

An expanded blending system at JIWWTP would entail additional influent screening, additional grit removal, a new connection to the ISS Pump Station, an additional bypass channel, additional disinfection, and additional effluent pumping. Costs were developed with both chlorine and UV disinfection; the technology with UV disinfection was less expensive. Blending is currently allowed at JIWWTP up to 60 MGD per the WPDES permit.(6) As discussed in Chapter 5 of this report, the current capability for blending at JIWWTP is about 100 MGD. This technology is less expensive than other treatment alternatives. However, due to current WPDES permit requirements and existing and future regulatory concerns, expansion of the current blending rate was not considered further.[e]

9.2.4 Inline Storage System Pumping Options

The 2020 Baseline assumption for the future operation of the existing ISS Pump Station is 80 MGD firm capacity to JIWWTP and 40 MGD firm capacity to SSWWTP. The SOAR included technologies for additional pumping to JIWWTP and SSWWTP. Additional pumping to JIWWTP would involve expanding the cavern of the existing ISS Pump Station to install additional pumps and additional piping to deliver the increased pumped flow capacity to JIWWTP. Also, consideration was given to the analysis of "firm" capacity per Wisc. Admin. Code NR 110 (Sewerage Systems) with one redundant pump over and above the number of pumps needed for the planned firm capacity, along with all other appurtenances to pump additional flow from the tunnel system.

Additional pumping to SSWWTP would also require the construction of a dual 48" force main from the ISS Pump Station to SSWWTP. Without a force main, the opportunity to pump to SSWWTP is limited due to the location at which the existing South Shore force main (SSFM) pumps wastewater from the tunnel to the MIS system at South 6th Street and West Oklahoma Avenue (discussed in more detail in the SOAR).

Additional pumping to JIWWTP is preferred over pumping to SSWWTP because it is less expensive and is more effective in reducing SSO and CSO volumes and events. The JIWWTP can operate at maximum day flow for a long time, but the nature of the combined sewer collection system feeding the plant does not deliver the flow over a long time frame (flow to JIWWTP peaks quickly but is only maintained at that peak rate for a short period of time). Pumping to JIWWTP allows the ISS to pump wastewater to use the capacity available at JIWWTP throughout a wet weather event. Furthermore, because flows at SSWWTP use all available plant capacity for an extended period after the peak of the event is seen at JIWWTP, there is little opportunity to use additional pumping capacity to SSWWTP. Finally, the required force main from JIWWTP to SSWWTP appears to be extremely expensive to construct, estimated at $227 million in SOAR Appendix 3A. Therefore, additional ISS pumping to JIWWTP was considered in the alternatives analysis, but additional pumping to SSWWTP was not considered further. The recommended plan is to maintain 40 MGD pumping capacity to SSWWTP.

The recommended additional ISS pumping to JIWWTP could be accomplished in many ways. The technology evaluated and priced for the 2020 FP is one of many systems that could be constructed. As discussed in Chapter 5, United Water Services (UWS) modified the motor cooling system on the ISS pumps in 2006; this is expected to improve the reliability of the pumps and increase their output by up to 10%. Recent data indicate that two of the three ISS pumps now can pump at the rate of 47 MGD, rather than the 40 MGD assumed in this analysis. In addition, MMSD initiated a project in November 2006 for a Conceptual Design to Upgrade the JIWWTP ISS Pump Station (Project J01009). This project, as discussed in Chapter 8, includes review of the existing ISS Pump Station as well as evaluation of the 2020 FP proposed capacity upgrade. This project will include a preliminary engineering study to provide a more in-depth analysis of alternatives to expand the ISS Pump Station.

Another project that is recommended in conjunction with the ISS Pump Station expansion is the installation of a second force main from the ISS Pump Station to the South 6th Street and Oklahoma Avenue site. This facility would provide additional redundancy and a way to direct all dry weather flow to SSWWTP to allow for maintenance at JIWWTP. This potential facility is discussed in more detail in Chapter 9 of the *Conveyance Report*.

9.3 Preliminary Treatment Alternatives

9.3.1 State of the Art Report Findings

All point source technologies were compared for their ability to reduce SSOs and CSOs. The findings are shown in the Figures 9-1 to 9-4.

These figures indicate that treatment and ISS pumping were the most cost effective technologies for SSO volume removal and elimination of SSO events. Deep tunnel storage was the most cost effective technology for CSO volume removed, with combined sewer separation also considered for complete elimination of CSOs. All treatment alternatives discussed in this chapter are SSO control alternatives. The CSO volume removal technologies and alternatives analysis are discussed in Chapter 9 of the *Facilities Plan Report*.

9.3.2 Treatment Technologies Identified for Further Analysis

The treatment technologies identified based on the analysis from the SOAR are:

- Physical-chemical treatment at SSWWTP (either ballasted or chemical flocculation)
- Physical-chemical treatment at JIWWTP (ballasted flocculation)
- Additional ISS pumping to JIWWTP

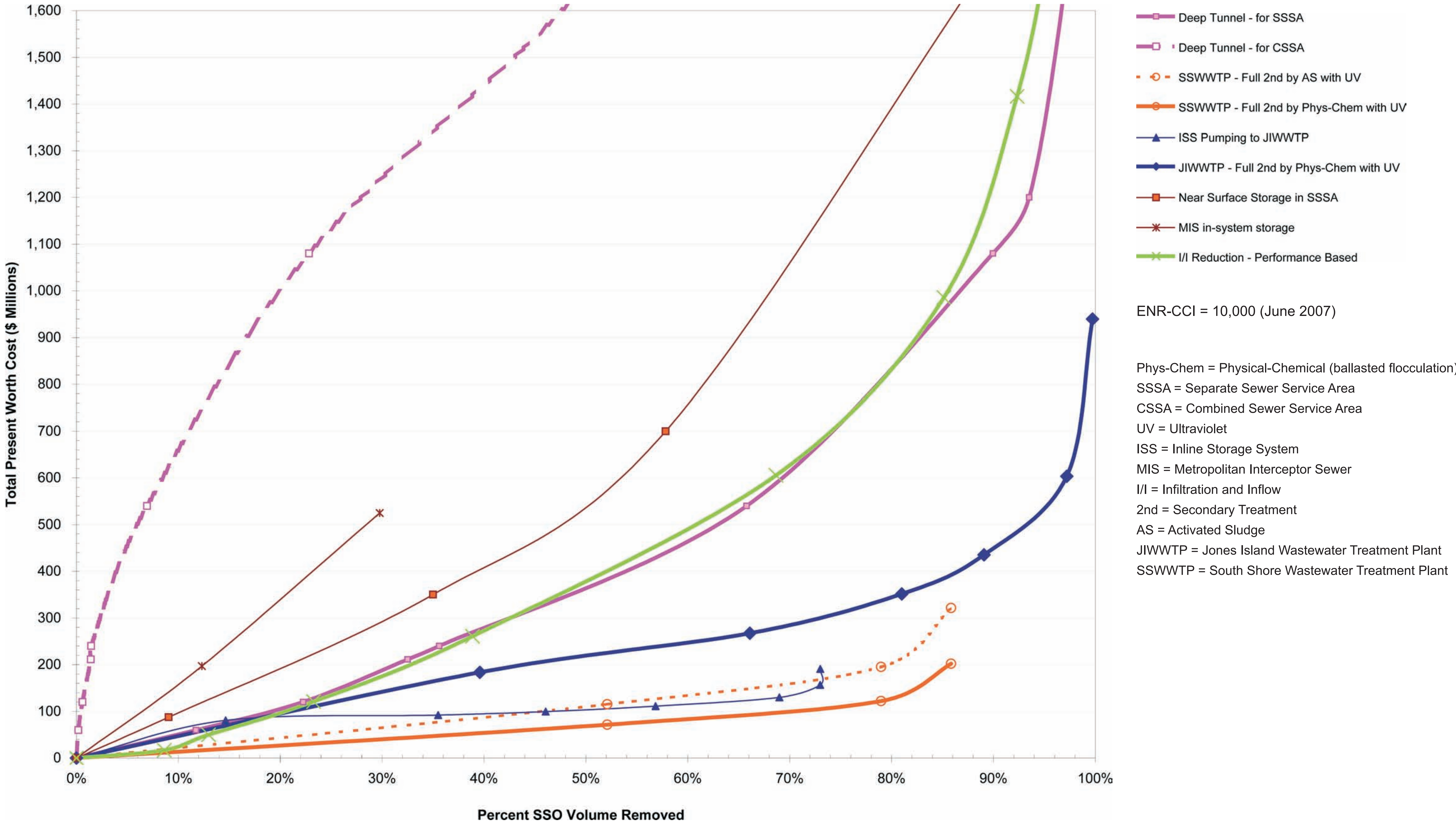

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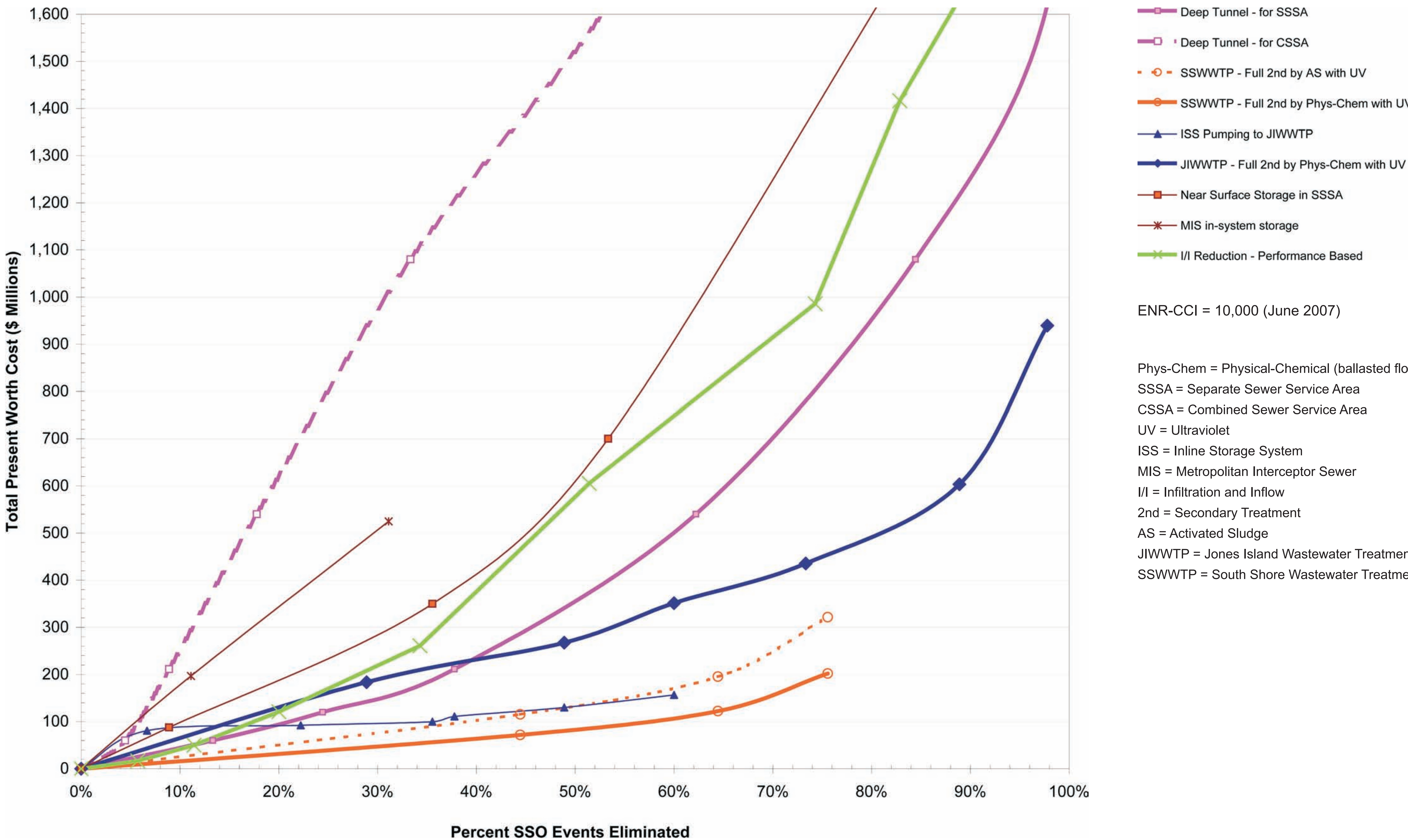
FIGURE 9-1
SSO VOLUME COST BENEFIT CURVES
2020 TREATMENT REPORT
5/14/07 TR_9.0001.07.05.14.cdr



ENR-CCI = 10,000 (June 2007)

Phys-Chem = Physical-Chemical (ballasted flocculation)
SSSA = Separate Sewer Service Area
CSSA = Combined Sewer Service Area
UV = Ultraviolet
ISS = Inline Storage System
MIS = Metropolitan Interceptor Sewer
I/I = Infiltration and Inflow
2nd = Secondary Treatment
AS = Activated Sludge
JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

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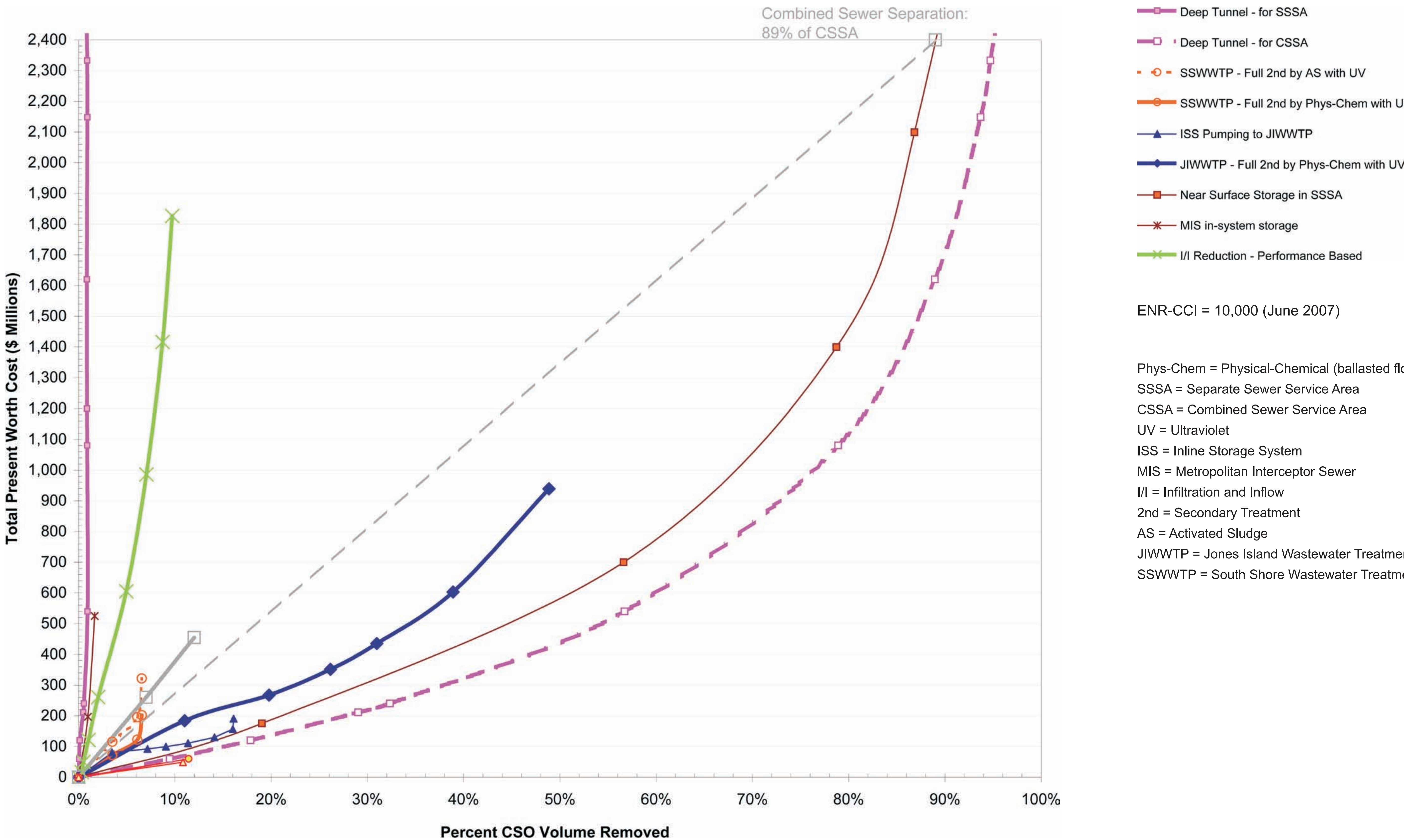
FIGURE 9-2
SSO EVENTS COST BENEFIT CURVES
2020 TREATMENT REPORT
5/14/07 TR_9.0002.07.05.14.cdr



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Phys-Chem = Physical-Chemical (ballasted flocculation)
SSSA = Separate Sewer Service Area
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I/I = Infiltration and Inflow
2nd = Secondary Treatment
AS = Activated Sludge
JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

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FIGURE 9-3
CSO VOLUME COST BENEFIT CURVES
2020 TREATMENT REPORT
5/14/07
TR_9.0003.07.05.14.cdr

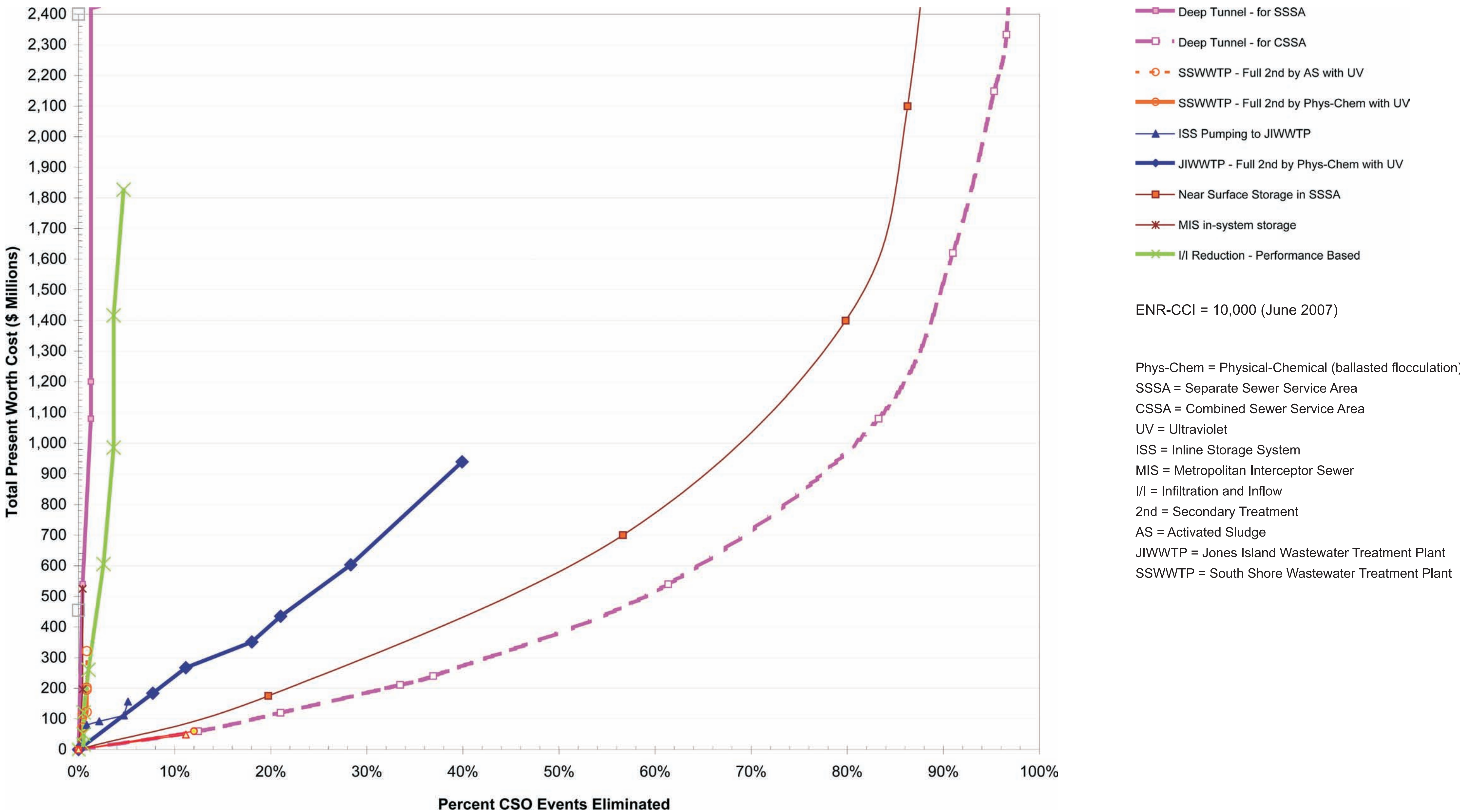

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FIGURE 9-4
CSO EVENTS COST BENEFIT CURVES
2020 TREATMENT REPORT
5/14/07 TR_9.0004.07.05.14.cdr

9.4 Alternatives Analysis

9.4.1 Screening and Preliminary Alternatives

The treatment technologies identified as feasible alternatives in the 2020 FP analysis were combinations of the technologies listed above. Appendix 9A of the *Facilities Plan Report* considered all the technologies in the alternatives developed and evaluated to eliminate CSOs and/or SSOs.

The detailed preliminary alternatives analysis is discussed in Section 9.4 of the *Facilities Plan Report*. The preliminary alternatives were based upon the 2020 Baseline population and land use. They include the following:

- A - 2020 Baseline (No Further Action) - No additional actions beyond future committed projects and the common package implementation as defined in Chapter 8 of the *Facilities Plan Report*
- B - Meet Regulatory Requirements (all alternatives include 2020 Baseline elements)
  - B1 - Meet all discharge and nonpoint regulations
  - B1 (MMSD-Only) - Meet all discharge and nonpoint regulations (MMSD components only)
  - B2 - Minimize MMSD overflows
- C - Meet Water Quality Objectives (all alternatives include 2020 Baseline elements)
  - C1 - Maximize compliance with water quality criteria
  - C2 - Maximize compliance with water quality criteria and enhance habitat, aesthetics and community values

The Alternative B options incorporated additional treatment technologies to meet regulatory requirements and therefore they are the focus of the discussion in this section. The variations in the alternatives are listed in Table 9-2 and discussed in more detail in Section 9.4 of the *Facilities Plan Report*.

The main focus of the Alternative B variations is SSO control because MMSD is currently in compliance with the requirements of its WPDES permit with regard to CSO control. Further, MMSD will continue to be in compliance with permit conditions for CSO control unless there is a drastic change in CSO policy at the federal level or in CSO control requirements in the WDNR-issued permit.

Future population growth necessitates additional treatment facilities in order to comply with the prohibition against SSOs under the projected level of protection (LOP). Note that all of the treatment elements for this alternative are facilities, with the exception of blending at JIWWTP, which is an operational practice. There are no common element treatment programs, operational improvements, or policies (POPs). As discussed in detail in Section 9.6 of the *Facilities Plan Report*, 5- and 10-year levels of protection are evaluated.

TABLE 9-2
ALTERNATIVE B VARIATION DESCRIPTIONS

	B1	B1-MMSD ONLY	B2
Driver	Compliance of all regulated entities with regulations governing discharge of municipal overflow and nonpoint pollution to watersheds.	MMSD compliance with all regulations governing discharge of overflows.	Maximize use of MMSD facilities to reduce total overflow. All regulated entities meet nonpoint regulations.
Description	Develop FPOPs to comply with existing SSO, CSO, and nonpoint pollution regulations.	Develop FPOPs to comply with existing SSO and CSO regulations.	Operate all existing and committed MMSD facilities to reduce total overflows (both SSO and CSO) to the maximum extent. Develop and implement FPOPs to comply with nonpoint regulations.
Measures	Projected frequency of allowable overflows (SSO and CSO), and meets percent reduction requirements for nonpoint pollution using applicable measures.	Projected frequency of allowable overflows (SSO and CSO).	Projected frequency of allowable overflows (SSO and CSO), and meets percent reduction requirements for nonpoint pollution using applicable measures.
Endpoints	Number of CSOs and SSOs per year during the period after the FPOPs have been implemented to meet regulatory requirements. Nonpoint pollution reduction activities will meet regulatory requirements.	Number of CSOs and SSOs per year during the period after the FPOPs have been implemented to meet regulatory requirements. MMSD CSO control will meet the "presumptive" approach per regulations.	Number of CSOs and SSOs per year during the period after the FPOPs have been implemented to meet maximum event and volume reduction possible. CSO control will meet the "presumptive" approach per regulations.

FPOPs = Facilities, Programs, Operational Improvements, and Policies

The analysis estimated the most cost effective additional treatment technology combinations (i.e., additional capacities of treatment and pumping) to achieve the 5- and 10-year LOP alternatives discussed in the *Facilities Plan Report*, Section 9.6. The recommended combination of technologies determined by the MACRO model was then verified with MOUSE model runs to determine if the selected technology set met the selected criteria under detailed wet weather event conditions. This step was repeated until the most cost effective successful combination of technologies required to meet the desired LOP was determined.

The preliminary alternatives were developed with the 2020 Baseline population and land use projections. The Recommended Plan alternatives, which are discussed in Section 9.6 of the *Facilities Plan Report*, used the Revised 2020 Baseline population and land use projections.

9.4.2 Treatment Technology Combination for 5-Year Level of Protection

The technological analysis performed in the SOAR, coupled with the analysis of the screening and preliminary alternatives associated conveyance modeling, showed that the most cost effective method to reduce SSOs to a 5-year LOP is the following combination of facilities:

- Additional 100 MGD pumping capacity from ISS to JIWWTP (assumed to be three additional 50 MGD pumps, one redundant) for a total firm capacity of 180 MGD to JIWWTP
- Additional 150 MGD physical-chemical treatment capacity at SSWWTP using either:
    - Ballasted flocculation technology
    - Chemical flocculation technology (potentially less expensive option)

The cost estimates for the additional ISS pumping to JIWWTP are shown in Table 9-3.[f] The two treatment technologies are shown in Table 9-4. The data used to develop these estimates are provided in Appendix 9A, *Treatment Recommended Plan Alternatives Cost Estimates* of this report.

TABLE 9-3
COST FOR ADDITIONAL INLINE STORAGE SYSTEM PUMPING TO JONES ISLAND WASTEWATER TREATMENT PLANT FOR 5-YEAR LEVEL OF PROTECTION

Facilities	Percent of Subtotal	100 MGD Firm Capacity Costs ($ M)
ISS Pump Station		$63.6
Channel		0.3
Subtotal		**$64.0**
Contingencies	25%	16.0
Total Estimated Construction Cost		**$80.0**
Engineering and Administration	35%	28.0
Capital Costs		**$108.0**
Annual Operation and Maintenance Costs, Present Value	5.125% Discount Rate at 20 years	11.0
Total Present Value		**$119.0**

Notes:
These costs do not include salvage values.
The sum of the rounded components may not equal the total due to rounding.

[f] All costs presented in this chapter were escalated using the Engineering News Record Construction Cost Index (ENR-CCI), which is projected to be 10,000 in 2007 unless indicated otherwise.

Facilities	Percent of Subtotal	Physical-chemical (ballasted flocculation) (150 MGD) Costs ($ M)	Physical-chemical (chemical flocculation) (150 MGD) Costs ($ M)
Treatment (physical-chemical)		$39.6	$14.4
Disinfection – UV		12.8	12.8
Yard Piping		4.5	3.8
Effluent Pumping		5.4	5.4
Outfall		9.9	9.9
Subtotal		**$72.3**	**$46.3**
Electrical and I&C	15%	10.8	7.0
Piping	1%	0.7	0.5
Yard work	0.10%	0.1	0.1
Demolition		0.1	0.0
Subtotal		**$84.0**	**$53.8**
Mobilization/Demobilization	7%	6.0	3.8
Subtotal		**$90.0**	**$57.6**
Contingencies	25%	22.5	14.4
Total Estimated Construction Cost		**$112.5**	**$72.0**
Engineering and Administration	35%	39.5	25.0
Provision for Demonstration Plant Costs			1.5
Capital Costs		**$152.0**	**$99.0**
Annual Operation and Maintenance Costs, Present Value	5.125% Discount rate at 20 years	21.0	17.0
Total Present Values		**$173.0**	**$116.0**

I&C = Instrumentation and Control
MGD = Million Gallons Per Day
UV = Ultraviolet Disinfection

NOTES:
These costs do not include salvage values.
The sum of the rounded components may not equal the total due to rounding.

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TABLE 9-4

COST FOR ADDITIONAL TREATMENT CAPACITY TO SOUTH SHORE WASTEWATER TREATMENT PLANT FOR 5-YEAR LEVEL OF PROTECTION

9.4.3 Treatment Technology Combination for 10-Year Level of Protection

The technological analysis performed in SOAR, coupled with the analysis of the screening and preliminary alternatives, showed that the most cost effective method to reduce SSOs to a 10-year LOP is the following combination of facilities:

- Additional 120 MGD firm pumping capacity from ISS to JIWWTP
- Additional 150 MGD treatment capacity at SSWWTP
- Additional 140 MGD treatment capacity at JIWWTP

The cost estimates for the first 100MGD of additional ISS pumping and the additional treatment capacity at SSWWTP are the same as those listed in Section 9.4.2. The cost estimate for the additional treatment capacity at JIWWTP (including the additional 20 MGD of ISS pumping) is shown in Table 9-5.

9.5 Recommended Treatment Alternatives

The recommended treatment technology combination is that for a 5-year LOP as listed in Section 9.4.2. Additional details regarding the recommended treatment technologies are discussed below along with considerations for implementation of the Recommended Plan. Figures 9-5 through 9-7 show the proposed facilities at JIWWTP, the ISS Pump Station and SSWWTP respectively.

9.5.1 Additional Inline Storage System Pumping to Jones Island Wastewater Treatment Plant

The recommendation for this technology is due to the need for a firm pumping capacity of 180 MGD to JIWWTP. As stated in Section 9.2.4, the Conceptual Design to Upgrade JIWWTP ISS Pump Station Project (J01009) is expected to review the existing ISS Pump Station as well as the recommendations in this report to determine the best approach to reach the recommended pumping capacity. Less additional pumping capacity may be needed if the existing ISS pumping capacity can be restored to original design capacity.

9.5.2 South Shore Wastewater Treatment Plant Additional Treatment Capacity

The key recommendation for this technology is the need to increase SSWWTP treatment capacity to handle wet weather flows up to 450 MGD (300 MGD current treatment capacity plus the additional recommended 150 MGD of physical-chemical treatment capacity). As stated in Section 9.2.2, the recommended Capacity Analysis of SSWWTP Project may determine that less additional treatment capacity is needed to reach the recommended maximum capacity. Section 9.4.2 presented both physical-chemical options (ballasted flocculation and chemical flocculation) for additional treatment capacity. Though the cost for physical-chemical (chemical flocculation) appears to be significantly lower than physical-chemical (ballasted flocculation), additional evaluations must be conducted at SSWWTP to determine if the technology should be recommended over physical-chemical (ballasted flocculation). A physical-chemical (chemical flocculation) demonstration project is recommended to clearly understand the challenges of operation before a technology is selected.

Facilities	Percent of Subtotal	Physical-chemical (ballasted flocculation) (140 MGD) Costs ($ M)
Treatment (physical-chemical)		$38.8
Disinfection – UV		11.9
Yard Piping		8.9
Effluent Pumping		3.8
Subtotal		**$63.5**
Electrical and I&C	15%	10.0
Piping	1%	0.6
Yard Work	0.10%	0.1
Demolition		0.1
Piles		2.1
Subtotal		**$76.0**
Mobilization/Demobilization	7%	5.5
Land		8.0
Subtotal		**$89.5**
Contingencies	25%	22.5
Total Estimated Construction Costs		**$112.0**
Engineering and Administration	35%	39.0
Capital Costs		**$151.0**
Present Value for additional 20 MGD Pumping from the ISS Pump Station to JIWWTP		**11.0**
Annual Operation and Maintenance Costs, Present Value	5.125% Discount Rate at 20 years	20.0
Total Present Value		**$182.0**

I&C = Instrumentation and Control
ISS = Inline Storage System
JIWWTP = Jones Island Wastewater Treatment Plant
MGD = Million Gallons per Day
UV = Ultraviolet

NOTES:
These costs do not include salvage values.
The sum of the rounded components may not equal the total due to rounding.

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TABLE 9-5
COST FOR ADDITIONAL TREATMENT CAPACITY TO JONES ISLAND WASTEWATER TREATMENT PLANT FOR 10-YEAR LEVEL OF PROTECTION

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FIGURE 9-5
JONES ISLAND WASTEWATER TREATMENT PLANT PROPOSED FACILITIES SITE PLAN
2020 TREATMENT REPORT
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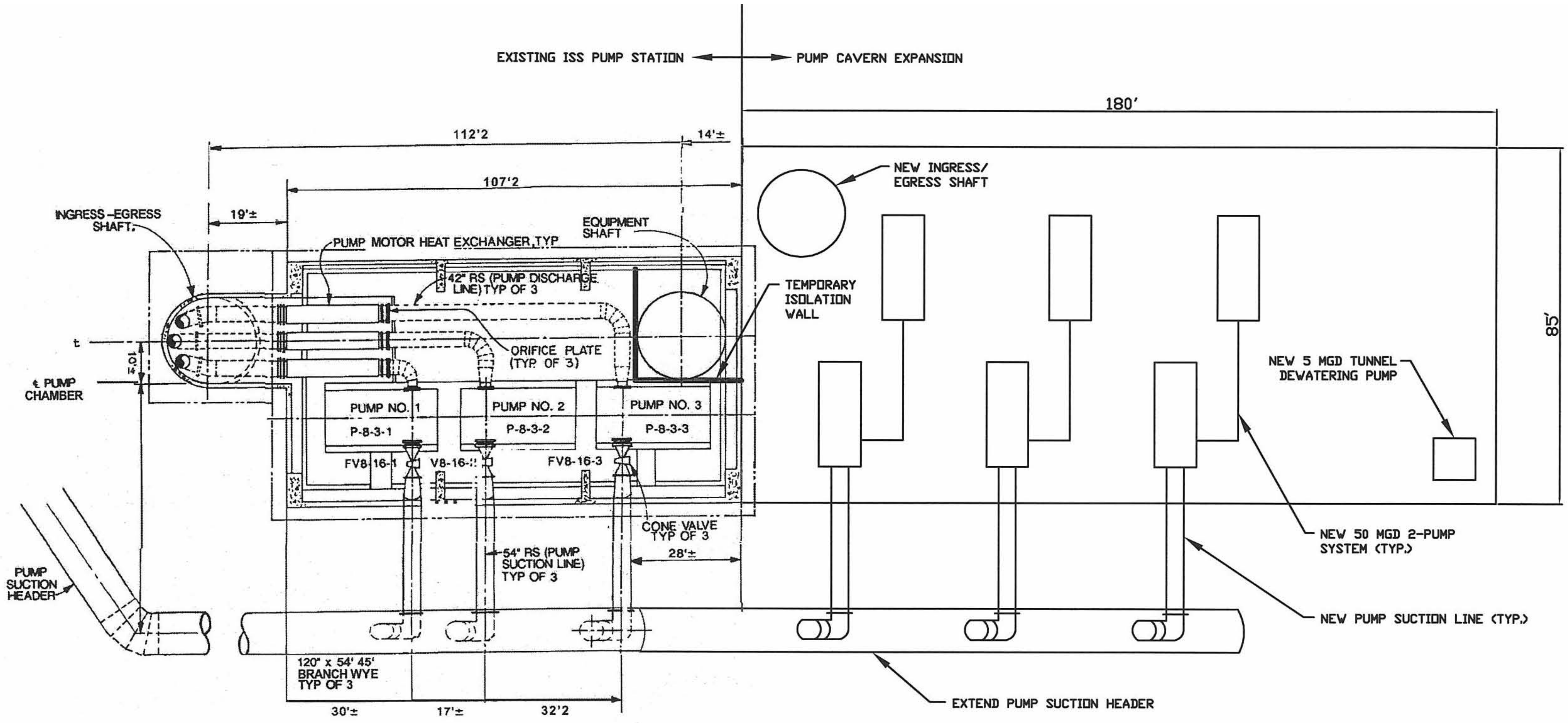

SOURCE FOR EXISTING ISS PUMP STATION FIGURE: MMSD, INLINE STORAGE SYSTEM O & M MANUAL : PART 2 UNIT PROCESS OPERATIONS VOL.1 INLINE PUMP STATION (1 MARCH, 1995)

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FIGURE 9-6
ISS PUMP STATION
PROPOSED FACILITIES SITE PLAN
2020 TREATMENT REPORT
5/14/07 TR_9.0006.07.05.14.cdr

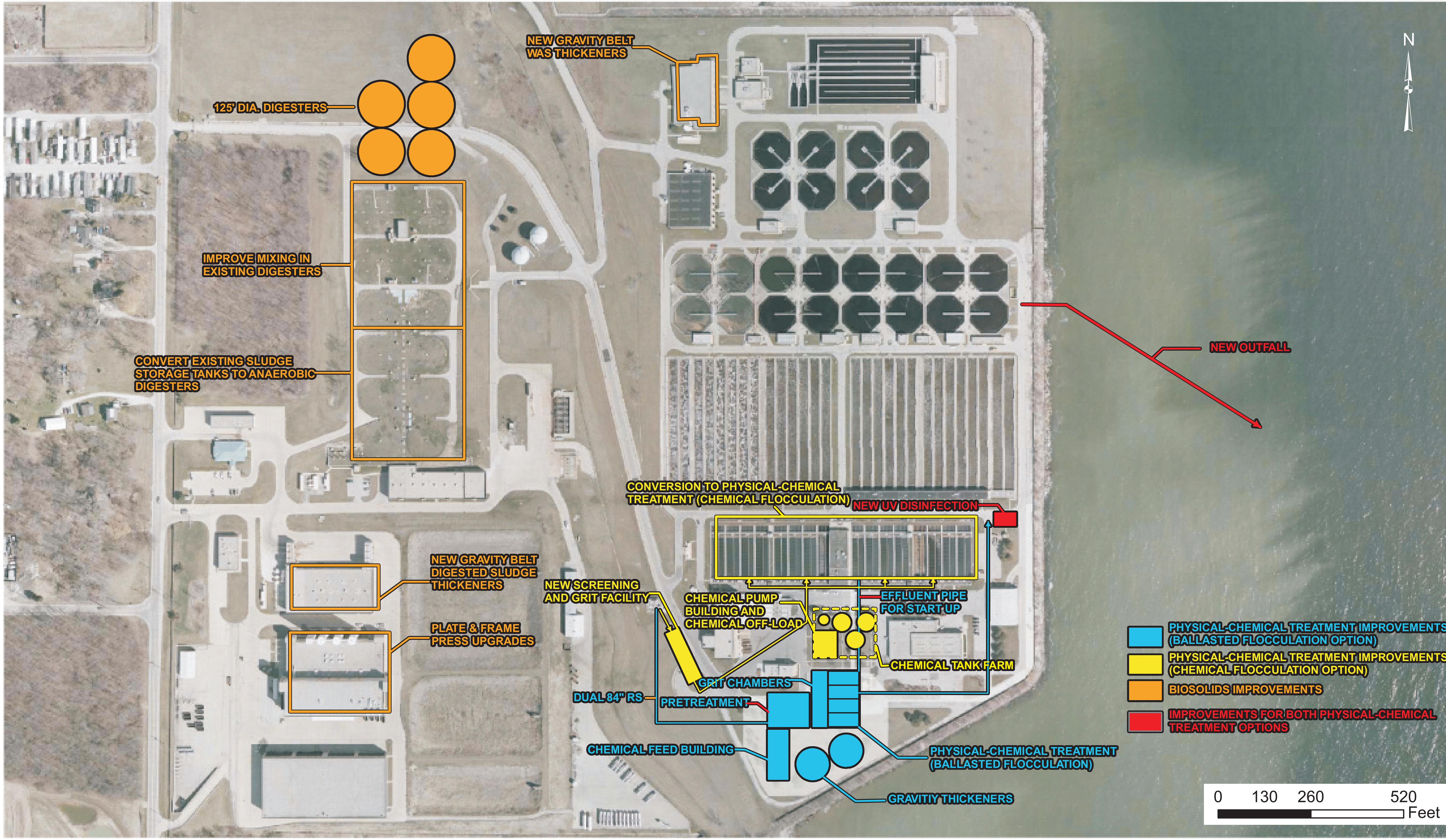

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FIGURE 9-7
SOUTH SHORE WASTEWATER TREATMENT PLANT
PROPOSED FACILITIES SITE PLAN
2020 TREATMENT REPORT
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9.5.3 Considerations in Implementation

As stated above, more evaluation and studies are needed before the recommended technologies are implemented. A demonstration project involving full scale operation of a physical-chemical (chemical flocculation) system is recommended for SSWWTP to assure that this proposed optional technology will perform adequately and produce physical-chemically treated effluent that meets MMSD permit requirements during wet weather.

At JIWWTP, additional treatment capacity is not part of the Recommended Plan, but increases to capacity using existing facilities should be considered. In addition to the physical-chemical (chemical flocculation) demonstration project at SSWWTP, an analysis on the potential use of physical-chemical (chemical flocculation) treatment at JIWWTP could be considered as an alternative to blending once the Primary Clarifier Mechanisms Project (J01008) is completed. Also, the use of blending at JIWWTP is allowed per MMSD's WPDES permit and the 2020 FP recommends continuing this practice as permitted. Therefore, this treatment option needs to be available during wet weather events. Blending use is discussed in more detail in Section 9.6 of the *Facilities Plan Report*.

9.6 Biosolids Analysis Introduction

Biosolids management is an important part of the wastewater treatment process. The current MMSD biosolids program, discussed in Chapter 4, *Treatment Assessment – Existing Condition*, consists of the production of Milorganite® and Agri-Life®. The MMSD's two treatment plants produce an average of over 150 tons of untreated biosolids (from primary and secondary treatment) each day. After processing, an average of over 120 tons per day (over 44,000 tons per year) of biosolids remain in the form of Milorganite®, Agri-Life®, and chaff from Milorganite® production.(7) The cost to manage biosolids represents approximately 45% of the total MMSD operating budget.(8) Selection of a reliable cost effective method of biosolids treatment and disposal significantly affects the overall costs of wastewater treatment. In addition, proper biosolids disposal is important to the public, from its beneficial reuse possibilities to its potential impact on the environment if not properly disposed.

The biosolids portion of this chapter presents the following:

- Screening alternatives, which compare various stand-alone biosolids disposal technologies (Section 9.7)
- A Milorganite®/Glass Furnace Technology sensitivity analysis (Section 9.8)
- Recommended Plan alternatives, which compare various combinations of the technologies preferred in the screening alternatives analysis (Section 9.9)
- The Recommended Biosolids Management Plan (Section 9.10)

In the analyses presented in Sections 9.7 to 9.10, consideration is given to the energy systems at both wastewater treatment plants. Energy and biosolids need to be considered together because the two are intimately connected. In the analysis of future biosolids production, Milorganite® production is typically matched to the waste heat (defined in Section 4.2.2 in Chapter 4) availability from the electricity generating turbines that exist at JIWWTP. As a result, the total tons of Milorganite® that can be made (on average) for a given sludge production are dependent on the influent waste loads to JIWWTP, the various unit processes that process the biosolids, the dryness of the dewatered cake, the efficiency of the turbine, and the plant electrical load on that day. Conditions can change so that on one day, for a given solids load which requires drying, there is excess waste heat from the turbines, while on another day there is insufficient waste heat. The glass furnace system uses the same dryers, so heat balance is also a key consideration for that technology.

Integral to the biosolids analysis are the options for electrical power supply at JIWWTP. The biosolids analysis is influence by a number of factors, including: base plant electric load, peak plant electric load, frequency and duration of peak electric loads, and usage of any generated waste heat. Options considered in this facilities planning effort included the following:

- Providing two new redundant transmission level service (138,000 Volts or higher) connections and abandoning the use of turbines
- Providing a single transmission level service connection, one new turbine and abandoning the two existing turbines
- Providing a single new turbine and maintaining one existing turbine available for peak shaving, while retaining the existing Dewey and Harbor electrical services
- Providing a single non-transmission level service line (at a similar voltage to the existing Dewey power supply), while retaining the existing Dewey and Harbor electrical services and abandoning the two existing turbines

9.6.1 2020 Baseline Influent Wasteloads and Biosolids Production

The 2020 Baseline influent wasteload projections at the two treatment plants were determined based on current influent flows and wasteloads and projected land use and population growth. The 2020 Baseline biosolids production was determined from these projected influent wasteloads. Chapter 5, *Treatment Assessment – Future Condition* of this report discusses the development of the 2020 Baseline projections in more detail. The influent wasteloads and corresponding biosolids production presented in Section 9.7, *Biosolids Screening Alternatives Evaluation*, are larger than the values presented in Section 9.9, *Recommended Plan Alternatives*, and Section 9.10, *Recommended Biosolids Plan*. The development of the two sets of biosolids production values are explained in more detail below.

Biosolids Production Development for Screening Alternatives

The 2020 Baseline influent flows and wasteloads were developed using an average of 1999 - 2003 Discharge Monitoring Reports (DMR) and Daily/Weekly Operating Reports (DWOR) influent flows and wasteloads as the current values and adding the original population and land use projections for the MMSD service area to the current values.

To understand how biosolids production was developed for the screening alternatives from these 2020 Baseline influent wasteload projections, some background information is provided.

Biosolids are produced from two unit processes:

1) Primary Clarification
2) Activated Sludge

The primary clarifiers capture a portion of the influent suspended solids (measured as TSS). Historically, the primary clarifiers have captured about 50 to 60% of the total influent suspended solids.(9) The solids captured in the primary clarifier (primary sludge or PSD) have a high volatile solids content, which makes them easy to digest in the anaerobic digesters. The digestion process removes about 50% of the volatile solids, producing methane gas as a byproduct of the process. There is a net reduction of about 35% in the total mass of primary sludge undergoing the anaerobic digestion process.

Secondary or waste activated sludge (WAS) is produced from the biological activity that removes the soluble organic and fine particulate material (measured as biochemical oxygen demand or BOD) in the secondary treatment process. As the microorganisms consume the organic material, they produce more microorganisms. To maintain a proper balance between organic material and microorganisms, most of the new growth needs to be removed in the form of WAS.

The WAS contains most of the nitrogen required to meet Milorganite®'s nutrient specification of a minimum of 6% nitrogen content. For that reason, all of the WAS produced at JIWWTP and most of the WAS produced at SSWWTP is currently sent directly into the Milorganite® production process and does not receive any additional treatment (such as digestion) at SSWWTP.

The 2020 Baseline biosolids production was calculated based on the development of PSD and WAS production factors.[g] Based on existing DWOR information, current PSD and WAS production factors were estimated for JIWWTP and SSWWTP. Because primary clarification captures more TSS than BOD, the PSD production factor was determined as a ratio between influent TSS and PSD produced at each WWTP. The PSD factor estimated for each WWTP was then applied to the projected 2020 Baseline influent TSS at that plant to determine the 2020 Baseline PSD projection. Because the amount of WAS produced is based on treatment plant biological activity, the WAS production factor was determined to be a ratio between the influent BOD and the WAS produced at each WWTP. The WAS factor estimated for each WWTP was then applied to the projected 2020 Baseline influent BOD at that plant.

Biosolids Production Development for Recommended Plan Alternatives

Following the evaluation of the screening alternatives, the 2020 Baseline influent wasteloads were further refined for the evaluation of the Recommended Plan alternatives. Refinements included:

- The use of a more representative average of 1999 through 2003 flows and wasteloads for the current influent flows and wasteload, which disregarded questionable influent data
- Revisions to the land use and population growth projections for the MMSD service area to more realistic values for the incremental increase to 2020 values
- Inclusion of the relocation in late 2005 of the LeSaffre Yeast Company, a major industrial wasteload contributor

This refinement is referred to as the Revised 2020 Baseline.

Projected biosolids production values (based upon the Revised 2020 Baseline) were also recalculated for the Recommended Plan alternatives using the updated influent wasteloads and an improved biosolids production calculation method. The new calculation method consisted of total plant biosolids mass balances for JIWWTP and SSWWTP. The mass balances account for

[g] See Appendix 9B, *Biosolids Screening Alternatives,* Wasteload Projections for more information.

all biosolids production at each WWTP, consider biosolids transfer between plants, and were calibrated using treatment plant records.[h] This method is a significant improvement over the biosolids production calculation method used for the screening alternative analysis.

The 2020 Baseline biosolids production estimates were sufficient for evaluating the screening alternatives because only a relative comparison was required. (The goal of the screening alternatives evaluation, as discussed in Section 9.7, was to determine which technologies were appropriate for incorporation into the Recommended Plan alternatives analysis.) Thus, the screening alternatives, which exhibit high cost estimate projections based upon the 2020 Baseline biosolids loads, were not revised to incorporate the refined biosolids production numbers. The Recommended Plan alternatives and final Recommended Biosolids Plan presented in Sections 9.9 and 9.10 are based on the Revised 2020 Baseline population and land use.

9.6.2 Cost Development

Several tools were used to estimate the costs to manage biosolids. Costs to produce Milorganite® and Agri-Life® were obtained from MMSD and UWS cost analyses.[i] These 2004 (the most recent production costs available to the 2020 technical team) costs are summarized in Table 9-6.

All of the biosolids alternatives evaluated use some components of the Milorganite® and Agri-Life® programs. Consequently, the unit costs from MMSD and UWS cost analyses were used in the operation and maintenance (O&M) cost development where applicable. Other O&M cost information was obtained from equipment and system suppliers and outside facilities operators. Engineering judgment and experience were used to refine researched cost information and to estimate costs where external sources were not available.

Some important criteria must be noted regarding the estimated O&M costs for the screening and Recommended Plan alternatives. First, the O&M costs are total O&M costs, not additional O&M costs beyond existing (2006) MMSD O&M costs. Second, the O&M costs used for the screening alternatives (Section 9.7) were based upon best available data (2004 MMSD O&M costs.[j] Finally, the O&M costs used for the Recommended Plan alternatives (Section 9.9) were based upon these (2004) MMSD O&M costs escalated to 2007 costs using the ENR Construction Cost Index, but with projections of electricity and natural gas prices that were inflated to 2009 rates to account for higher energy inflation. The sensitivity analysis (Section 9.8) discusses these issues in detail.

When available, capital costs for recently constructed systems were used to develop the estimated capital costs for similar biosolids systems proposed in this chapter. Proposals from various equipment and system suppliers were solicited and, where necessary, engineering judgment was also applied.

[h] See Appendix 9F, *Biosolids Recommended Plan Alternatives,* Mass Balances for more information.
[i] See Appendix 9C, *Historic MMSD Data* for more information.
[j] See Appendix 9C, *Historic MMSD Data* for more information.

TABLE 9-6
YEAR 2004 MILORGANITE® AND AGRI-LIFE® PRODUCTION COSTS

	JIWWTP	SSWWTP	
Production Parameter	**Milorganite®**	**Liquid Agri-Life®**	**Cake Agri-Life®**
Tons Processed[1]	56,040	4,665	2,168
Tons Sold/Applied/Disposed[1]	49,086	5,473	2,649
Manufacturing or Processing Cost/Ton[2]	$388.49	$234.00	$368.30
Marketing/Packaging or Application/Disposal Cost/Ton[2]	60.93	306.62	116.46
Gross Cost/Ton	449.52	540.63	484.76
Less: Net Revenue/Ton[2]	(116.21)	0.00	0.00
Net Cost/Ton	**$333.21**	**$540.63**	**$484.76**

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

1) Each solids disposal option includes an amount of water or moisture; therefore, to compare costs between options all tons have been converted to a 100% dry basis. In addition, credit has been given for solids removed during the digestion process at SSWWTP.
2) Costs included in this analysis consist of operating expenses directly charged to solids utilization by UWS, MMSD operating cost centers and MMSD administrative support. The MMSD and Hurtado Consulting summarized these costs in August 2005 (see Reference 10 at the end of this chapter, along with Appendix 9C, *Historic MMSD Data*).

Further information on the cost estimating methodologies used for the biosolids analysis is presented in Sections 9.7 and 9.9.

9.7 Biosolids Screening Alternatives Evaluation

This section presents biosolids screening alternatives, which were developed to evaluate the technologies available for the treatment of sludge at MMSD's two wastewater treatment plants. Each screening alternative, except for the existing condition, consists of one sludge treatment technology. The analysis of the screening alternatives presented here will be used to assemble Recommended Plan alternatives (Section 9.9), from which a Recommended Biosolids Plan will be made (Section 9.10).

9.7.1 Selection of Screening Alternatives and Evaluation Parameters

Each technology selected for evaluation was chosen based on the technology's proven history and applicability to MMSD's biosolids program. Six screening alternatives, each composed of one technology (except for the existing condition), were created:

1) Maintaining existing Milorganite® and Agri-Life® biosolids programs

2) Preparing a glass aggregate product by oxidizing and melting dried biosolids using a glass furnace technology (GFT) system
3) Disposing of all biosolids into a landfill as a dewatered cake
4) Applying a Class A dewatered cake (approximately 35% solids) biosolid to land as a fertilizer and soil amendment
5) Burning all sludge in a fluid bed incinerator
6) Composting biosolids to produce a compost product.

Each of the screening alternatives was evaluated in terms of the following parameters:

- Cost (present value and capital)
- Energy use
- Sensitivity to natural gas and electricity prices
- Operational experience
- Land and site considerations and requirements
- Flexibility to work with other biosolids disposal methods
- Sensitivity to regulatory limits
- Treated biosolids volume
- Marketability of final product
- Beneficial reuse of biosolids
- Community acceptance

A present value cost analysis was completed for each alternative using projected future wasteloads as described below. A summary of each screening alternative is provided in Section 9.7.4.

9.7.2 Projected Future Influent Wasteload

The present value cost analysis performed for each screening alternative was based on the 2020 Baseline condition influent wasteloads to the two treatment plants.[k] The wasteloads were determined using the methods discussed in Chapter 5 of this report the future influent wasteload for the screening alternatives reflects SEWRPC's population and land use growth projections and steady industrial wasteload input. Table 9-7 summarizes the design, current (as of 2003 when the analysis of screening alternatives was done), and predicted future flows and influent wasteloads used for the biosolids screening alternatives analysis.(10,11)

[k] See Appendix 9B, *Biosolids Screening Alternatives,* Wasteload Projections for more information.

TABLE 9-7
TREATMENT PLANT INFLUENT FLOWS AND LOADS USED FOR SCREENING ALTERNATIVES

	Design[1]			CURRENT (1999 – 2003)[2]			2020 Baseline[3]		
Plant	Flow (MGD)	BOD (lb/day)	TSS (lb/day)	Flow (MGD)	BOD (lb/day)	TSS (lb/day)	Flow (MGD)	BOD (lb/day)	TSS (lb/day)
JIWWTP	123	299,000	314,000	102	270,306	226,076	104	281,559	239,505
SSWWTP	113	224,000	266,000	101	150,382	199,875	132	200,974	260,273
Total	**236**	**523,000**	**580,000**	**203**	**420,688**	**425,951**	**236**	**482,533**	**499,778**

BOD = Biochemical Oxygen Demand
lb/day = Pounds per Day
SSWWTP = South Shore Wastewater Treatment Plant
JIWWTP = Jones Island Wastewater Treatment Plant
MGD = Million Gallons per Day
TSS = Total Suspended Solids

1) From JIWWTP and SSWWTP Part 2, Volume 1 Operation Manuals, Plant Summary.
2) 1999 through 2003 UWS Daily Wastewater Operating Reports (DWORs) values. Summary presented in Appendix 9B, Biosolids Screening Alternatives – Wasteload Projections.
3) Appendix 9B, Biosolids Screening Alternatives – Wasteload Projections.

9.7.3 Future Sludge Production

As described in Section 9.6, PSD and WAS are produced as wastewater is treated at JIWWTP and SSWWTP. Currently, domestic wastewater has a higher percentage of suspended solids (which can be captured as primary sludge in the primary clarifiers) than in industrial wastewater. Because domestic flow is expected to increase while industrial flow stays constant, future sludge is expected to be composed of a higher proportion of primary sludge than current sludge.

Table 9-8 summarizes projected 2020 Baseline sludge production used for the screening alternatives and compares it to design and current (2003) sludge production.

TABLE 9-8
SLUDGE PRODUCTION USED FOR SCREENING ALTERNATIVES

	Design[1]		Current (Year 2003)[2]		2020 Baseline[3]	
Treatment Plant	WAS (lb/day)	PSD (lb/day)	WAS (lb/day)	PSD (lb/day)	WAS (lb/day)	PSD (lb/day)
JIWWTP	218,000	232,000	145,600	141,500	180,536	173,879
SSWWTP	165,000	182,000	53,600	194,300	70,780	199,831
Total	**383,000**	**414,000**	**199,200**	**335,800**	**251,316**	**373,710**

JIWWTP = Jones Island Wastewater Treatment Plant
PSD = Primary Sludge
WAS = Waste Activated Sludge
lb/day = Pounds per Day
SSWWTP = South Shore Wastewater Treatment Plant

1) From JIWWTP and SSWWTP Part 2, Volume 1 Operation Manuals, Plant Summary.
2) 2003 DWOR values.
3) Appendix 9B, Biosolids Screening Alternatives – Wasteload Projections.

A higher primary sludge ratio presents a potential for greater energy recovery through anaerobic digestion, but also creates lower sludge nutrient value, which is not beneficial for Milorganite® production.

It is important to note that the screening alternative analysis was performed using the total treatment plant sludge production described above in Table 9-8, which was based on the 2020 Baseline wasteloads, the best available information at the time. The sludge production numbers were later revised to reflect the relocation of LeSaffre Yeast and to reflect more realistic population growths reflected in the Revised 2020 Baseline population and land use.

For example, after LeSaffre Yeast left the MMSD service area in December 2005, influent BOD to JIWWTP dropped by 24% (averages for January 1 to March 3, 2005 compared to the same timeframe in 2006) and WAS production dropped by 20% (averages for January 1 to March 8, 2005 compared to the same timeframe in 2006).(11) This loss is reflected in the future influent wasteload and biosolids production projections presented in Section 9.9, *Recommended Plan Alternatives.*

9.7.4 Screening Alternatives Summaries

Screening Alternative 1 – Maintain Existing Milorganite® and Agri-Life® Programs

Description

This screening alternative maintains the current Milorganite® and Agri-Life® programs with minor modifications and takes advantage of existing facilities. Biosolids are distributed to the programs in a similar proportion to current practice (85% Milorganite® and 15% Agri-life®). With this screening alternative, all primary sludge is assumed to be digested at SSWWTP after being thickened. All Agri-Life® will be transported as dewatered cake.

The JIWWTP existing Dewatering and Drying facilities are suitably sized to handle future loads. To handle future sludge loads at SSWWTP, two sludge storage tanks will need to be converted to anaerobic digesters and additional gravity belt thickeners (GBTs) are recommended to replace the existing dissolved air flotation units for thickening prior to digestion. Thickening the sludge prior to digestion condenses the sludge so that new digesters do not have to be constructed. Additional storage area for dewatered cake will have to be constructed (to provide for a total of six months of cake storage). Figures 9-8 and 9-9 provide schematics of the Screening Alternative 1 JIWWTP and SSWWTP biosolids production processes.

Turbine Operation

The sludge drying process currently uses waste heat from the turbine generators located at JIWWTP. These turbine generators were installed in the mid-1970s and rehabilitated in the mid-1990s. By modern standards, the turbine generators are considered inefficient because current turbines create more electricity per amount of natural gas burned. The inefficiency, however, results in waste heat that is used for sludge drying needs. Prior to the start-up of the dewatering and drying facility (D&D) in 1994, the vacuum filter sludge dewatering system produced sludge cake that averaged approximately 12% solids, compared to the current dewatered cake that averages between 16 and 17% solids. The higher moisture combined with the higher sludge production from years past resulted in a much higher need for waste heat.

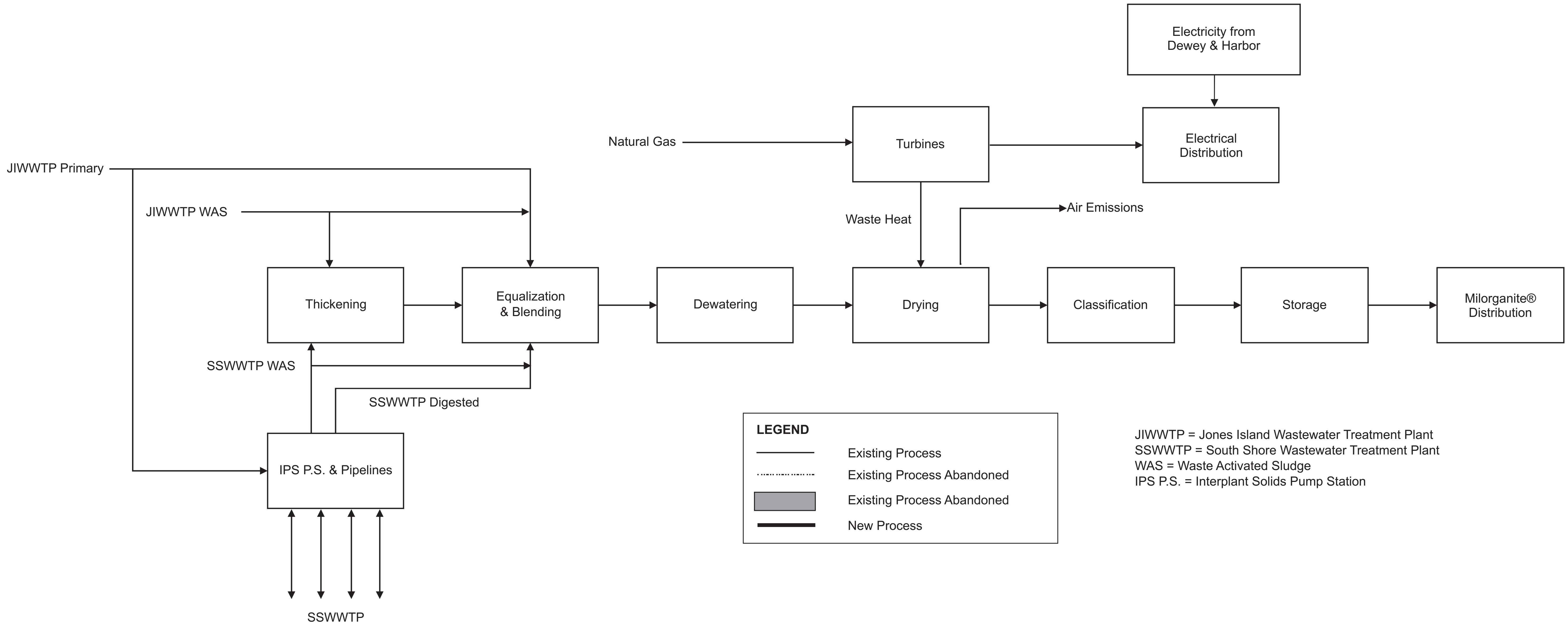

FIGURE 9-8
BIOSOLIDS SCHEMATIC AT JIWWTP FOR SCREENING ALTERNATIVE 1 – MAINTAIN EXISTING MILORGANITE® AND AGRI-LIFE® PROGRAMS
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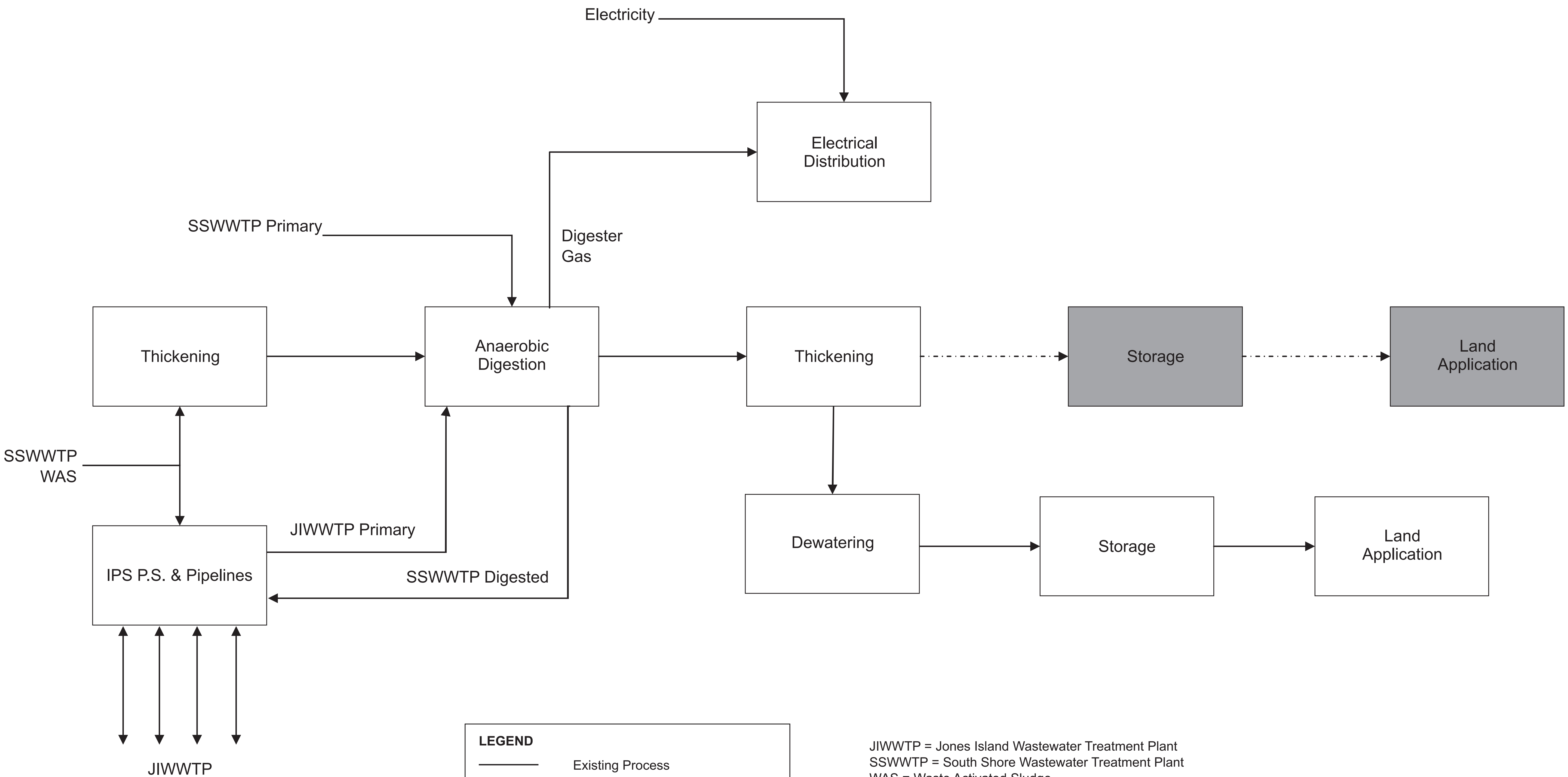

LEGEND

- Existing Process
- Existing Process Abandoned
- Existing Process Abandoned
- New Process

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-9
BIOSOLIDS SCHEMATIC AT SSWWTP FOR SCREENING ALTERNATIVE 1 – MAINTAIN EXISTING MILORGANITE® AND AGRI-LIFE® PROGRAMS
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The turbines require increasing maintenance due to their age.[l](12) Spare parts are becoming difficult to obtain and turbine replacement will likely be required during the 2020 planning period. In addition, not all of the waste heat is currently used in the sludge drying process.[m] As shown in Figure 4-4, approximately 30% of the heat is released through the turbine stack.

An alternative to future turbine replacement is to operate without the turbines and purchase electricity to operate the treatment plant and purchase natural gas to dry the solids in the dryers. Relying solely on WE Energies' power supply carries some risk due to potential power interruptions or brief power fluctuations that can cause sensitive equipment to fail. For example, a momentary "blip" in power can cause variable speed drives to fail and therefore the entire drying process to fail. Restarting the dewatering and drying (D&D) facilities after this type of failure is both time consuming and risky due to the latent heat in the dryer and the time that dried material is in contact with this heat.

The MMSD has a scheduled capital improvement project, J04013, to replace the majority of the variable frequency drive (VFD) units, which will thereby reduce the impacts of momentary power outages on the facility operation. The newer generation VFDs should reduce the amount of equipment that will be impacted by short-term voltage drops. The remaining impacts of power supply "blips" and potential power interruption, however, still warrant consideration when proposing complete reliance on purchased electrical power.

Two reliable sources of power are required at a treatment plant to meet Wisc. Admin. Code NR 110 emergency power requirements.(13) If the turbines were not available as a backup or supplemental power supply, the Dewey power supply alone (as a back up supply) will not meet treatment plant and inline storage pumping needs if the inline pumping capacity to JIWWTP is increased as recommended (see Section 9.5.1). The Harbor power supply would also have to be upgraded and the treatment plant power distribution system would have to be upgraded to distribute power so that all facilities have two power sources. At present, some equipment is powered directly from the turbines, thus this equipment would require rewiring and other new systems if the turbines are no longer used.

If the turbines were abandoned, one alternative could be a new, third power supply from WE Energies The third supply would be sized to power up to half of the plant and the three supplies (the Dewey supply, the Harbor supply and the new supply) would be configured so that half the plant is operating on one supply, half the plant is operating on another supply, and the third supply would serve as a backup to the other two supplies.(14)

[l] See Appendix 9C, *Historic MMSD Data* for more information.
[m] Year 2000 and later – see energy balance shown in Figure 4-4 in Chapter 4 of this report.

Some of the advantages and disadvantages of operating without the turbines are as follows:

Advantages

- Lower overall energy use (no heat loss through the turbine stacks)
- No turbine and gas compressor maintenance
- Elimination of the two turbine air emission sources
- Costly turbine replacement can be avoided
- Simplified dryer operation

Disadvantages

- Possible air permitting issues since the current permit limits the quantity of natural gas that can be used in the dryer to a level that is not sufficient to dry all wastewater sludge.
- Less reliable power – so would need to:
    - Improve electrical infrastructure
    - Address safety concerns over potential loss of power in the dryers (fire and explosion risk if dryers cannot be powered quick enough) and other potential issues such as temporary loss of influent pumping and disinfection
- Complete reliance on WE Energies for power, which makes MMSD subject to electricity price increases with no alternative power supply available

Cost Analysis

A present value analysis was performed for both options (with and without turbines) for maintaining existing Milorganite® and Agri-Life® programs.[n]

A number of capital investments would be required with either of these options. Table 9-9 summarizes the anticipated capital costs.

[n] See Appendix 9D, *Biosolids Screening Alternatives,* Cost Estimates for more information.

TABLE 9-9
SCREENING ALTERNATIVE 1 - MAINTAIN EXISTING MILORGANITE® AND AGRI-LIFE® PROGRAMS

CAPITAL COST SUMMARY

Facility	With Turbines ($ M)	Without Turbines ($ M)	Comments
JIWWTP Dewatering and Drying	$98.5	$98.5	Improvements required for worn equipment
JIWWTP Powerhouse/ Electrical Feed	97.2	49.9	Turbines are replaced or electrical supply is improved
SSWWTP Thickening	5.0	5.0	Additional thickening capacity required to handle primary sludge
SSWWTP Digesters	8.5	8.5	Digester mixing improvements and conversion of two sludge storage units to digesters
Interplant Solids Pumping	2.7	2.7	Improvements required for worn equipment
New Locomotive	2.5	2.5	Locomotive required for transporting Milorganite®
Cake Storage	6.4	6.4	Additional area to allow for a total of 6 months dewatered cake storage
Total	**$220.8**	**$173.5**	

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

Notes:
Capital costs include construction cost plus 25% for contingencies and 30% for technical services and administration.
The sum of the rounded components may not equal the total due to rounding.

The operation and maintenance costs for this screening alternative are well documented by UWS and MMSD at current sludge production rates. Table 9-10 summarizes these O&M costs.

TABLE 9-10
SCREENING ALTERNATIVE 1 - MAINTAIN EXISTING MILORGANITE® AND AGRI-LIFE® PROGRAMS
ANNUAL OPERATION AND MAINTENANCE COSTS

Facility	With Turbines ($ M)	Without Turbines ($ M)
JIWWTP Thickening	$2.6	$2.6
JIWWTP Dewatering and Drying	23.4	23.4
JIWWTP Chaff Processing	1.9	1.9
JIWWTP Electrical and Gas Purchase[1]	13.3	18.3
Interplant Solids Pumping	0.2	0.2
SSWWTP Natural Gas Credit[2]	(1.6)	(1.6)
SSWWTP Thickening	3.8	3.8
SSWWTP Digesters	2.1	2.1
SSWWTP Dewatering	3.5	3.5
Disposal	11.4	11.4
Product Revenue	(13.1)	(13.1)
Total	**$47.5**	**$52.5**

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

1) Electrical purchase is considered for the entire treatment plant. Gas purchase with turbines is for turbine operation. Gas purchase without the turbines is for sludge drying.
2) Cost of natural gas at SSWWTP that will no longer have to be purchased due to increased digester gas production

The two tables above show that although the capital cost to install new turbines is higher, the overall operating cost to operate with turbines is lower than without them due to the relatively high cost of electrical power.

The net present value of these two alternatives is $805 million if the turbines are replaced and $819 million if operating without the turbines.[o]

Advantages and Disadvantages

The advantages and disadvantages of this screening alternative are summarized below.

[o] See Appendix 9D, *Biosolids Screening Alternatives- Cost Estimates* for more information.

Advantages

- Lowest present value of alternatives evaluated
- Second lowest capital cost of alternatives evaluated
- With turbines, provides the option of natural gas or electrical purchase and makes O&M cost less sensitive to energy prices
- Proven operational experience; capital and O&M costs fairly certain
- Fits into existing WWTP footprint
- Two biosolids options provides flexibility
- Moderate biosolids volume reduction achieved
- Milorganite® and Agri-Life® programs are proven biosolids reuse alternatives
- Community has a high acceptance for Milorganite®

Disadvantages

- Without turbines, O&M cost sensitive to changes in natural gas and electricity costs
- High energy use (gas for turbines or drying)
- Potential future land application phosphorus limits could severely limit Agri-Life® program
- Biosolids disposal requires marketing
- Demand for Milorganite® and Agri-Life® is sometimes less than supply

Screening Alternative 2 – Glass Furnace Technology (GFT)

Description

In this screening alternative, all organics in the biosolids are oxidized (converted to heat energy) and the inert portion of the biosolids is melted in a furnace to produce a glass aggregate product. While this process is not technically an incinerator, the process will likely be required to follow the U.S. Environmental Protection Agency's (USEPA) Part 503 Biosolids Rule for sludge incineration. A manufacturer of this process has indicated that its process will comply with all requirements.

All primary sludge produced from both treatment plants is thickened and anaerobically digested at SSWWTP to minimize the total solids that must be handled in the glass production process.

Under this screening alternative, SSWWTP WAS and digested sludge are pumped to JIWWTP, where they are thickened along with JIWWTP WAS. The thickened sludge is dewatered and dried at the JIWWTP Dewatering and Drying facilities and the dried solids are pneumatically conveyed to a new glass furnace technology (GFT) facility located adjacent to the existing Power House.

The GFT process uses pure oxygen and the pure oxygen facility is located adjacent to the glass furnace facility. Waste heat (created from the oxidation of the organics) from the GFT facility is then recycled to dry the biosolids. The net energy balance is such that the waste heat from the furnace is essentially equal to the drying needs of the biosolids, thus only a small amount of natural gas is needed in the drying process. Due to the lack of supplemental heat required, the use of turbines for electricity generation and waste heat is no longer practical.

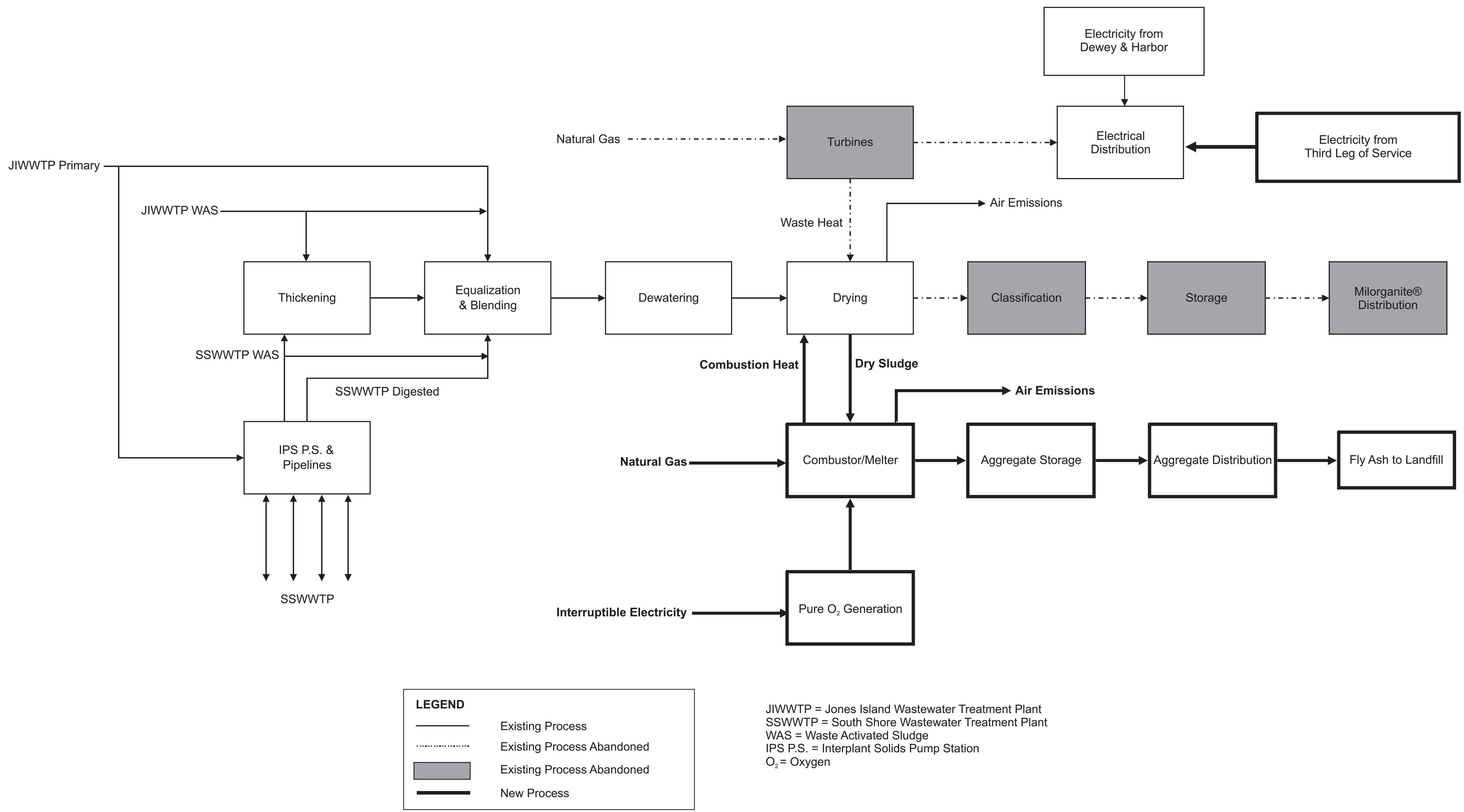
The glass aggregate is classified as a beneficial product in the state of Illinois with application pending in Wisconsin and can be used for pipe trench backfill or as filler in some asphalt products. Development of a market for the glass aggregate would be a consideration in implementation of this technology.

The alternative includes four new GBTs at SSWWTP and requires that two of the existing sludge storage tanks be converted to primary digesters, for a total of eight primary digesters. Thickening the sludge prior to digestion condenses the sludge such that new digesters do not have to be constructed. Digested sludge storage is not required.

The alternative assumes the JIWWTP Dewatering and Drying facilities will undergo a major rehabilitation in 10 years. The GFT combustion of the biosolids produces enough heat to dry the incoming sludge.[p] With no need for waste heat from the turbines, onsite electrical power generation is not cost effective and the JIWWTP turbines would be abandoned. The electrical supply and power distribution at JIWWTP would be upgraded to maintain two reliable sources of power as described for Screening Alternative 1.

Figures 9-10 and 9-11 provide schematics of the new biosolids process and those processes that would no longer be used.

[p] See Appendix 9H, *Glass Furnace Technology, Minergy Proposals* for more information.



JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station
O_2 = Oxygen

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FIGURE 9-10
BIOSOLIDS SCHEMATIC AT JIWWTP FOR SCREENING ALTERNATIVE 2 – GLASS FURNACE TECHNOLOGY

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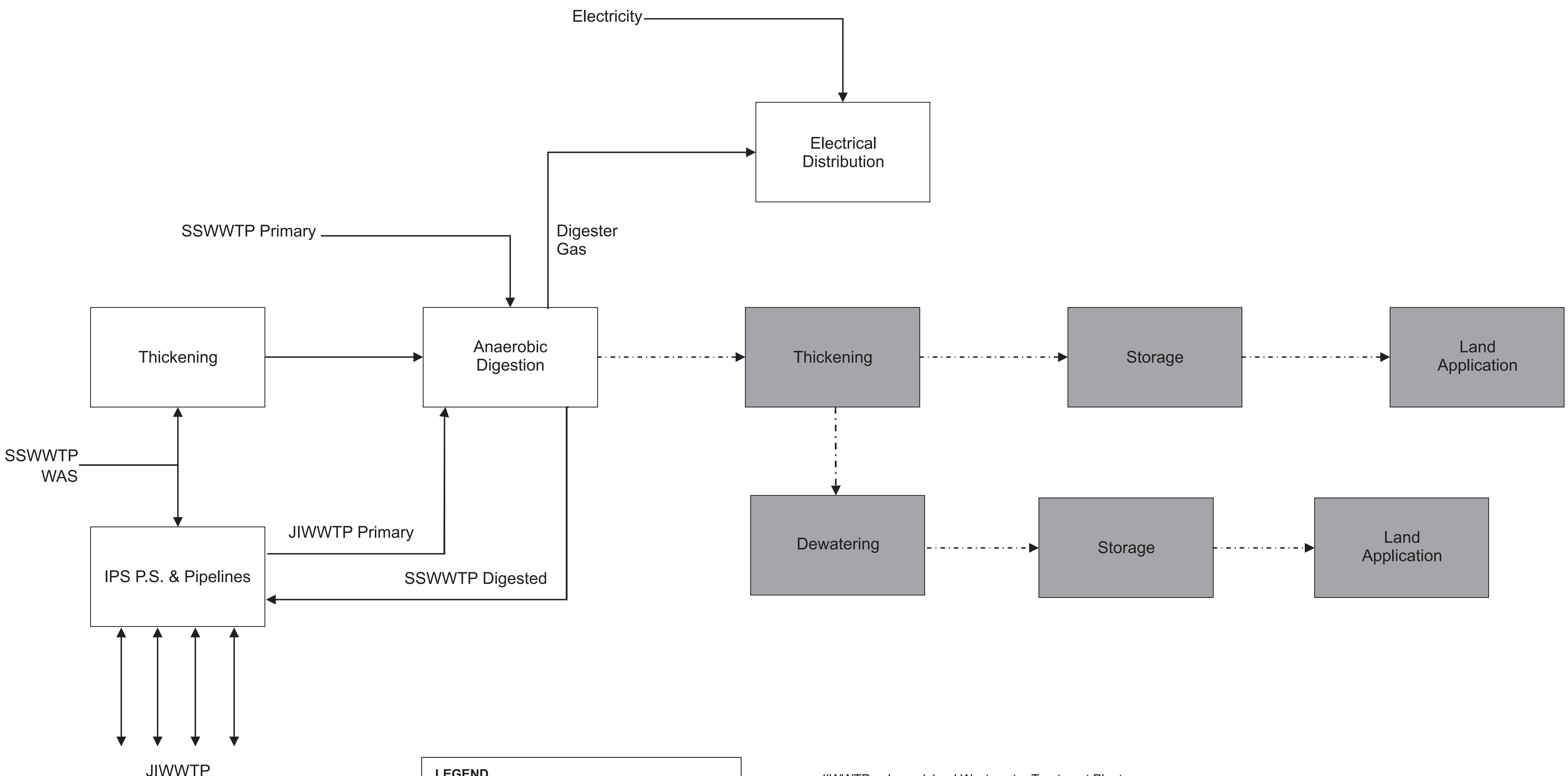


LEGEND

- Existing Process
- Existing Process Abandoned
- Existing Process Abandoned
- New Process

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

FIGURE 9-11
BIOSOLIDS SCHEMATIC AT SSWWTP FOR SCREENING ALTERNATIVE 2 – GLASS FURNACE TECHNOLOGY

Cost Analysis

Capital investment is required in several areas, as summarized in Table 9-11.

TABLE 9-11
SCREENING ALTERNATIVE 2 - GLASS FURNACE TECHNOLOGY
CAPITAL COST SUMMARY

Facility	Cost ($ M)	Comments
JIWWTP Dewatering and Drying	$98.5	Improvements required for worn equipment
JIWWTP Powerhouse/ Electrical Feed	54.1	Improvements to electrical supply and distribution
SSWWTP Thickening	3.1	Thickening required for primary sludge
SSWWTP Digesters	8.5	Digester mixing improvements and conversion of two sludge storage units to digesters
Interplant Solids Pumping	2.7	Improvements required for worn equipment
Glass Furnace Facility	82.4	New facilities required for plasma furnace and associated oxygen generation systems
Total	**$249.3**	

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

Notes:
Capital costs include construction cost plus 25% for contingencies and 30% for technical services and administration.
The sum of the rounded components may not equal the total due to rounding.

This screening alternative essentially replaces the turbines with a glass furnace process that oxidizes sludge as a source of heat for sludge drying. Because the existing Milorganite® processes (JIWWTP thickening and blending and SSWWTP thickening and digestion) remain largely unchanged, eth O&M costs for these processes are well documented and summarized in Table 9-12. The glass furnace O&M costs, also summarized in Table 9-12, are provided by the manufacturer and have not been verified.

TABLE 9-12
SCREENING ALTERNATIVE 2 - GLASS FURNACE TECHNOLOGY
ANNUAL OPERATION AND MAINTENANCE COSTS

Facility	Annual Cost ($ M)
JIWWTP Thickening	$3.0
JIWWTP Dewatering and Drying	27.5
JIWWTP Glass Furnace Process	5.2
JIWWTP Electrical and Gas Purchase[1]	10.8
Interplant Solids Pumping	0.3
SSWWTP Natural Gas Credit[2]	(1.5)
SSWWTP Thickening	0.8
SSWWTP Digesters	2.0
Product Revenue	(0.2)
Total	**$47.9**

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

1) Electrical purchase is considered for the entire treatment plant. A small amount of gas purchase is required to start the plasma furnace.
2) Cost of natural gas at SSWWTP that will no longer have to be purchased due to increased digester gas production.

The net present value of this screening alternative is $840 million.[q]

Advantages and Disadvantages

Some of the advantages and disadvantages of the glass furnace technology are as follows:

[q] See Appendix 9D, *Biosolids Screening Alternatives - Cost Estimates* for more information.

Advantages

- Second lowest present value of alternatives evaluated.
- Median capital cost of alternatives evaluated
- Relatively simple operations. Functionality demonstrated at other Wisconsin facilities (for non-municipal biosolids applications).
- Fits into existing WWTP footprint.
- Has flexibility to work with other biosolids disposal methods.
- Allows use of existing stack.
- Reduction in air emissions (nitrogen oxides-NOx) as compared to operating the existing turbines.
- Significant reduction in biosolids volume.
- Considered a beneficial reuse (Appendix 9H, *Glass Furnace Technology,* Minergy Proposals).
- Community likely to accept, although may not be as popular as Milorganite®.

Disadvantages

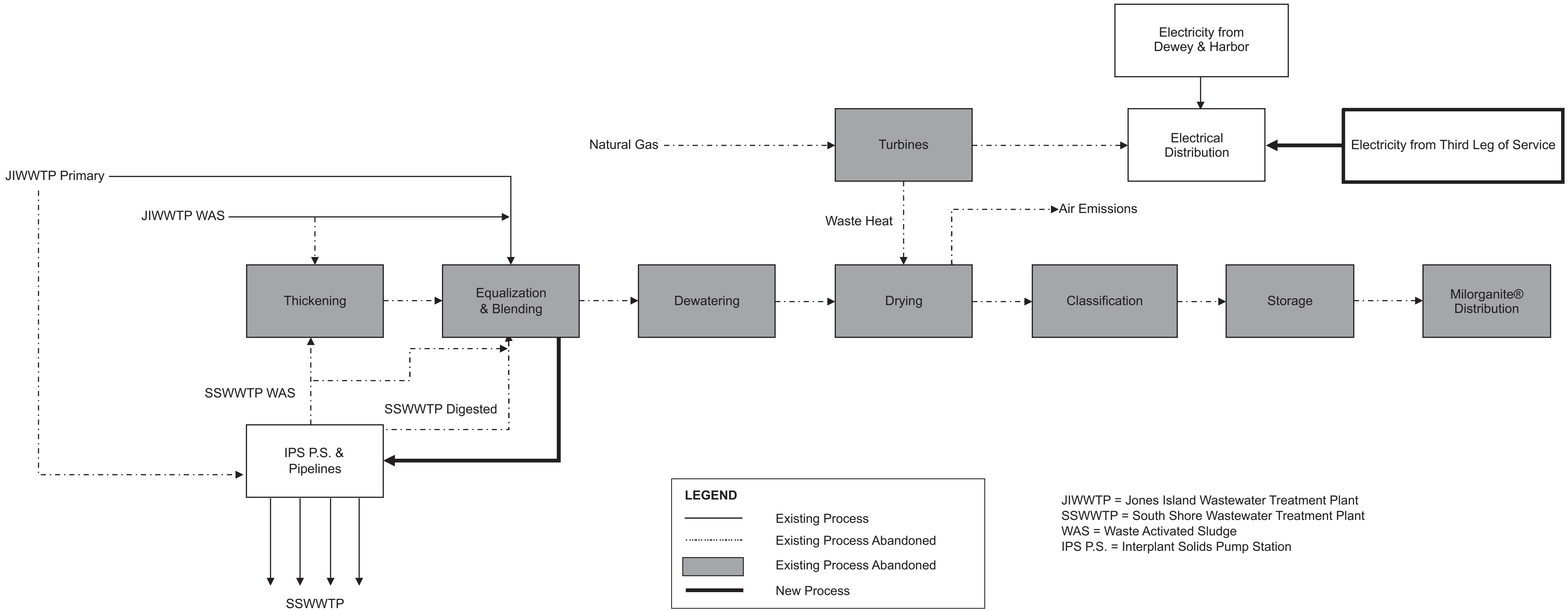
- O&M cost sensitive to changes in electricity cost; short term and long-term maintenance costs unknown due to limited experience.
- A small increase in mercury production as a result of the combustion of dried sludge.
- Exclusive reliance on WE Energies and its price structure for electricity since turbines to be abandoned.
- Relatively unknown technology; only one installation on municipal biosolids in the U.S. (little operational history; no operational history on air pollution control system).
- Second highest energy use (electricity needed for oxygen generation).
- Air pollution control process produces ammonia air emissions, which are not quantified.
- Process will produce a small amount of hazardous air emissions, including mercury that will be controlled with air emissions control systems included in the alternative.
- Requires market development for new product.
- An additional 2 to 3 MGD of cooling water would have to be discharged to Lake Michigan.

Screening Alternative 3 –Landfill

Description

In this screening alternative, Milorganite® and Agri-Life® production is eliminated and all biosolids are disposed of at a landfill as a dewatered cake. The JIWWTP sludge (WAS and PSD) is blended and pumped to SSWWTP where it is thickened along with SSWWTP WAS. The thickened sludge and SSWWTP primary sludge are then fed to the anaerobic digesters. The sludge is anaerobically digested at mesophilic temperatures to produce a Class B biosolids product, as currently required for Agri-Life®. The digested sludge is thickened and dewatered in plate and frame presses. Prior to dewatering, the sludge is conditioned with polymer only (no lime is required).

This screening alternative would require a number of process changes. All JIWWTP biosolids treatment processes, along with the turbines, would be taken out of service and possibly demolished. To handle future sludge loads at SSWWTP, all existing sludge storage tanks would have to be converted back to anaerobic digesters and additional digesters would be required to handle the full biosolids load. The SSWWTP dewatering facilities would have to be expanded. No long-term cake storage is required because it is assumed that the landfill is available year-round. Sludge trucking to the landfill would be continuous. Figures 9-12 and 9-13 provide schematics of the existing JIWWTP and SSWWTP biosolids production processes under this screening alternative.



LEGEND

- Existing Process
- Existing Process Abandoned
- Existing Process Abandoned
- New Process

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-12
BIOSOLIDS SCHEMATIC AT JIWWTP FOR SCREENING ALTERNATIVE 3 – LANDFILL
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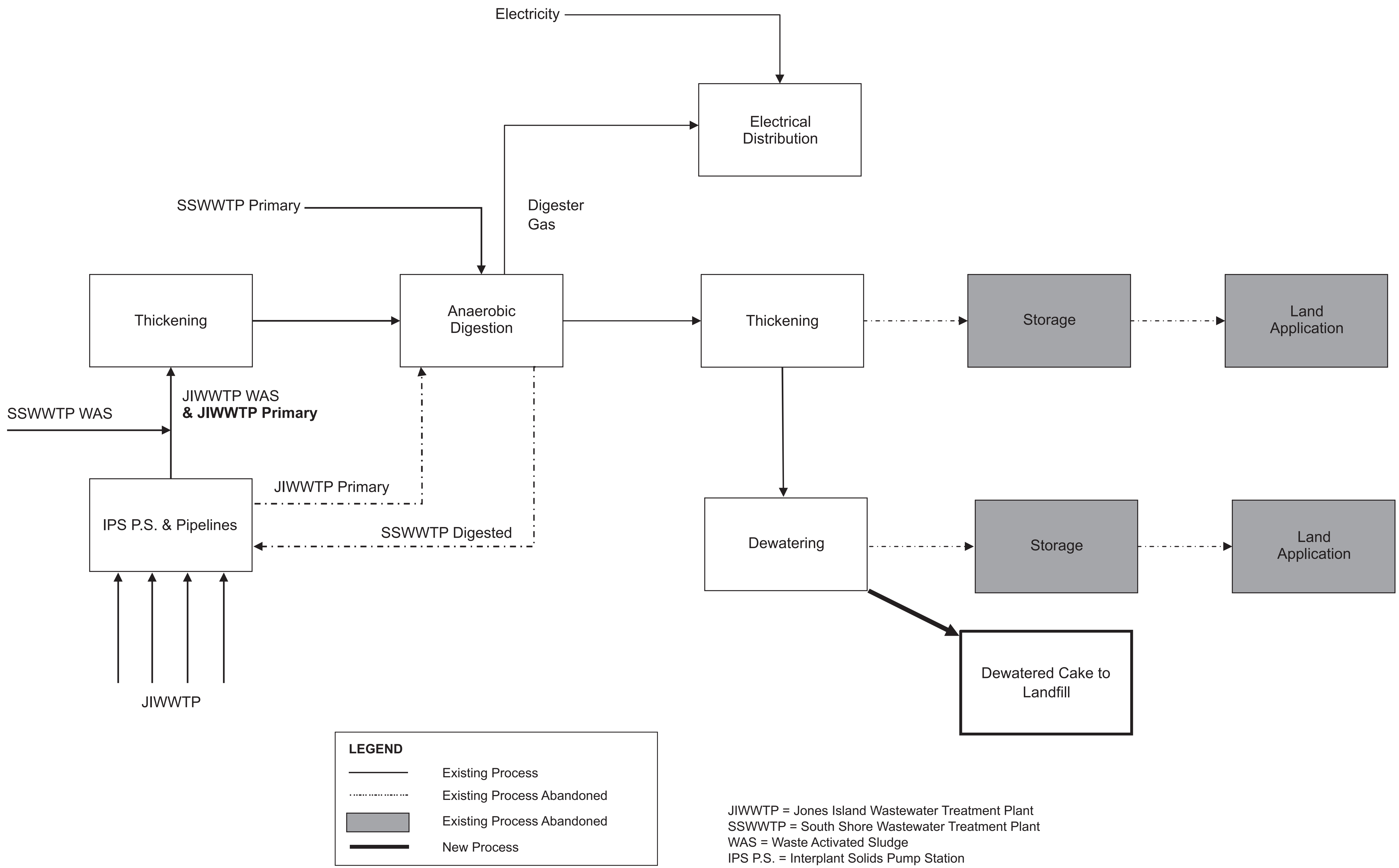

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FIGURE 9-13
BIOSOLIDS SCHEMATIC AT SSWWTP FOR SCREENING ALTERNATIVE 3 – LANDFILL
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Cost Analysis

A present value analysis was performed for the screening alternative in which all biosolids are disposed of in a landfill as dewatered cake.

To treat the biosolids, capital investments would be required in several areas. Table 9-13 summarizes the capital costs.

TABLE 9-13
SCREENING ALTERNATIVE 3 – LANDFILL
CAPITAL COST SUMMARY

Facility	Cost ($ M)	Comments
JIWWTP Dewatering and Drying	$42.3	Facility taken out of service and eventually demolished
JIWWTP Powerhouse/ Electrical Feed	49.9	Electrical supply is improved
SSWWTP Thickening	11.5	Additional thickening required to handle added primary sludge
SSWWTP Dewatering	16.2	Additional dewatering required to handle all sludge
SSWWTP Digesters	14.7	Digester mixing improvements, conversion of two sludge storage units to digesters and add more digesters
Interplant Solids Pumping	1.6	Improvements required for worn equipment. Pumping now only one way
Total	**$136.2**	

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

Notes:
Turbines are abandoned.
Capital costs include construction cost plus 25% for contingencies and 30% for technical services and administration.

Table 9-14 summarizes the O&M costs for this screening alternative.

TABLE 9-14
SCREENING ALTERNATIVE 3 - LANDFILL
ANNUAL OPERATION AND MAINTENANCE COSTS

Facility	Cost ($ M)
JIWWTP Electrical and Gas Purchase[1]	$6.5
SSWWTP Natural GasCredit[2]	(4.8)
SSWWTP Thickening	21.2
SSWWTP Digesters	4.2
SS Dewatering	23.4
Disposal	11.9
Total	**$62.4**

JIWWTP = Jones Island Wastewater Treatment Plant SSWWTP = South Shore Wastewater Treatment Plant

Note:
The sum of the rounded components may not equal the total due to rounding.

1) Electrical purchase is considered for the entire treatment plant.
2) Cost of natural gas at SSWWTP that will no longer have to be purchased due to increased digester gas production.

The net present value of this alternative is $906 million.[r]

Advantages and Disadvantages

The advantages and disadvantages of this screening alternative are summarized below.

[r] See Appendix 9D, *Biosolids Screening Alternatives- Cost Estimates* for more information.

Advantages

- Lowest capital cost of alternatives evaluated
- Median present value of alternatives evaluated
- Involves proven technologies
- Elimination of dryer system operation and maintenance requirements
- Low energy requirement which reduces reliance on the purchase of electricity
- Increases land available for other facilities at JIWWTP, fits into footprint of SSWWTP
- Has flexibility to work with other biosolids disposal methods
- Reduction in air emissions (no turbines, no dryers)
- Not susceptible to changes in land application requirements (phosphorus limits)

Disadvantages

- O&M cost sensitive to changes in electricity cost
- Operation involves high truck traffic (25 trucks per day on average)
- Would be restricted by proposed WDNR organics to landfills limits
- Increases treated biosolids volume
- Long term contract from landfill may not be available
- Not considered a beneficial re-use
- May not be as popular as beneficial reuse alternatives

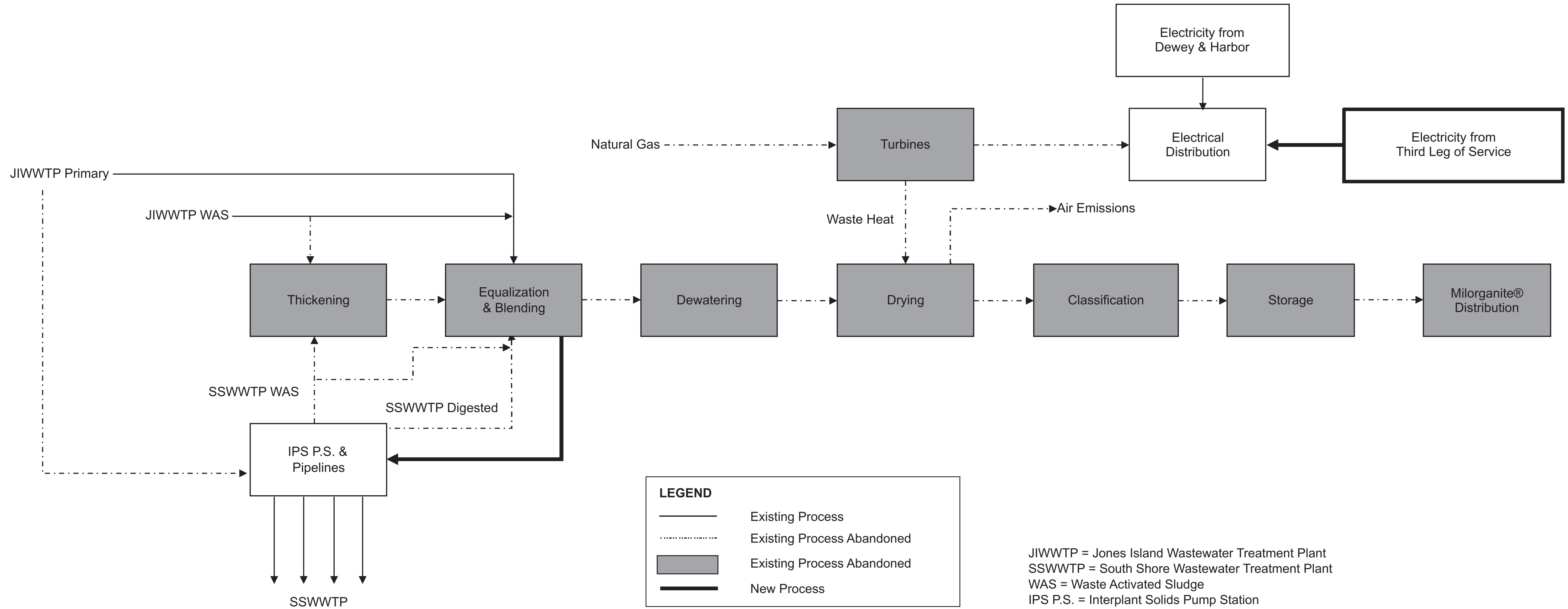
Screening Alternative 4 –Land Application

Description

This alternative disposes of all biosolids by producing a Class A production which is applied to land as a fertilizer and soil amendment through a land application program. The JIWWTP sludge (WAS and PSD) are blended and pumped to SSWWTP, where they are thickened along with SSWWTP WAS. The thickened sludge and SSWWTP primary sludge are fed to a two-stage thermophilic-mesophilic digestion process, producing Class A biosolids.[s] The digested sludge is thickened and dewatered in plate and frame presses. Prior to dewatering, the sludge is conditioned with polymer only (no lime is required).

This screening alternative would require a number of process changes. All JIWWTP biosolids treatment processes, along with the turbines, would be taken out of service and possibly demolished. To handle future sludge loads at SSWWTP, all existing sludge storage tanks would have to be converted to anaerobic digesters and additional digesters would be required to handle the full biosolids load. The SSWWTP dewatering facilities would have to be expanded. Six months of cake storage is required to allow for staging, which requires approximately 14 acres of land. Remote storage sites close to the land application sites were chosen to balance the truck traffic at SSWWTP and to allow for the purchase of land at a lower capital cost. Figures 9-14 and 9-15 provide schematics of the existing JIWWTP and SSWWTP biosolids production processes for this screening alternative.

[s] Per USEPA Part 503 Biosolids Rule, in order to be considered Class A, biosolids have to receive more treatment to reduce pathogens than Class B biosolids – see Chapter 6 of this report for more information.



JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-14
BIOSOLIDS SCHEMATIC AT JIWWTP FOR SCREENING ALTERNATIVE 4 – LAND APPLICATION

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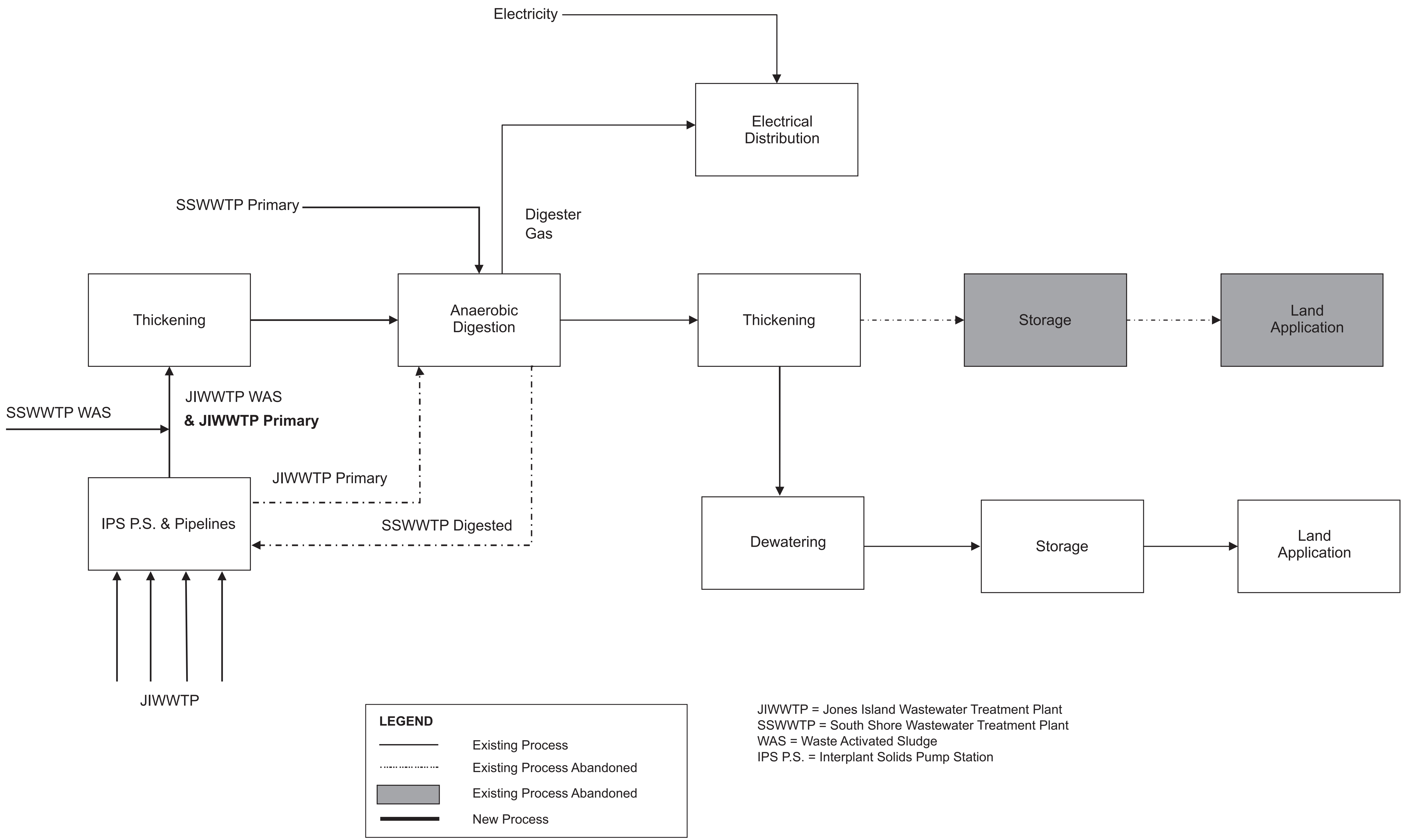

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FIGURE 9-15
BIOSOLIDS SCHEMATIC AT SSWWTP FOR SCREENING ALTERNATIVE 4 – LAND APPLICATION
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Cost Analysis

A present value analysis was performed for the screening alternative in which all biosolids are applied to land as a soil conditioner. To treat the biosolids, capital investments would be required in several areas. Table 9-15 summarizes the capital costs.

TABLE 9-15
SCREENING ALTERNATIVE 4 - LAND APPLICATION
CAPITAL COST SUMMARY

Facility	Costs ($ M)	Comments
JIWWTP Dewatering and Drying	$42.3	Facility taken out of service and eventually demolished
JIWWTP Powerhouse/ Electrical Feed	49.9	New electrical supply to JIWWTP
SSWWTP Thickening	12.1	10 new gravity belt thickeners
SSWWTP Dewatering	17.2	3 new plate and frame presses
SSWWTP Digesters	19.9	Upgrades to existing digesters for mixing
Cake Storage/ Loading	136.2	New roll-offs, straddle carriers, front end loaders, storage building and facilities
Interplant Solids Pumping	1.6	Upgrades to existing equipment
Total	**$279.2**	

JIWWTP = Jones Island Wastewater Treatment Plant SSWWTP = South Shore Wastewater Treatment Plant

Notes:
Turbines are abandoned
Capital costs include construction cost plus 25% for contingencies and 30% for technical services and administration.

Table 9-16 summarizes the O&M costs for this screening alternative.

TABLE 9-16
SCREENING ALTERNATIVE 4 - LAND APPLICATION
ANNUAL OPERATION AND MAINTENANCE COSTS

Facility	Cost ($ M)
JIWWTP Electrical and Gas Purchase[1]	$6.5
SSWWTP Natural Gas Credit[2]	(4.8)
SSWWTP Thickening	21.2
SSWWTP Digesters	4.2
SSWWTP Dewatering	23.4
Disposal	15.7
Total	**$66.2**

JIWWTP = Jones Island Wastewater Treatment Plant SSWWTP = South Shore Wastewater Treatment Plant

Notes:
The sum of the rounded components may not equal the total due to rounding.

1) Electrical purchase is considered for the entire treatment plant.
2) Cost of natural gas at SSWWTP that will no longer have to be purchased due to increased digester gas production.

The net present value of this alternative is $1,095 million.[t]

Advantages and Disadvantages

The advantages and disadvantages of this screening alternative are summarized below.

Advantages

- Involves proven technologies
- Elimination of dryer system operation and maintenance requirements
- Low energy requirement reducing reliance on the purchase of electricity.
- Increases land available for other facilities at JIWWTP, fits into footprint of SSWWTP
- Has flexibility to work with other biosolids disposal methods
- Reduction in air emissions from existing operations (the air emissions from turbines, and dryers will be eliminated)
- Considered a beneficial reuse
- Likely to be accepted by the community (but to a lesser degree than Milorganite)

Disadvantages

- Highest present value of alternatives evaluated
- Second highest capital cost of alternatives evaluated
- O&M cost sensitive to changes in electricity cost
- Operation involves high truck traffic (25 trucks per day on average)
- Susceptible to changes in land application requirements (specifically phosphorus limits)
- Increases treated biosolids volume since biosolids would not be dried, incinerated or melted before disposal
- Requires marketing to find land for application

Screening Alternative 5 - Fluid Bed Incineration

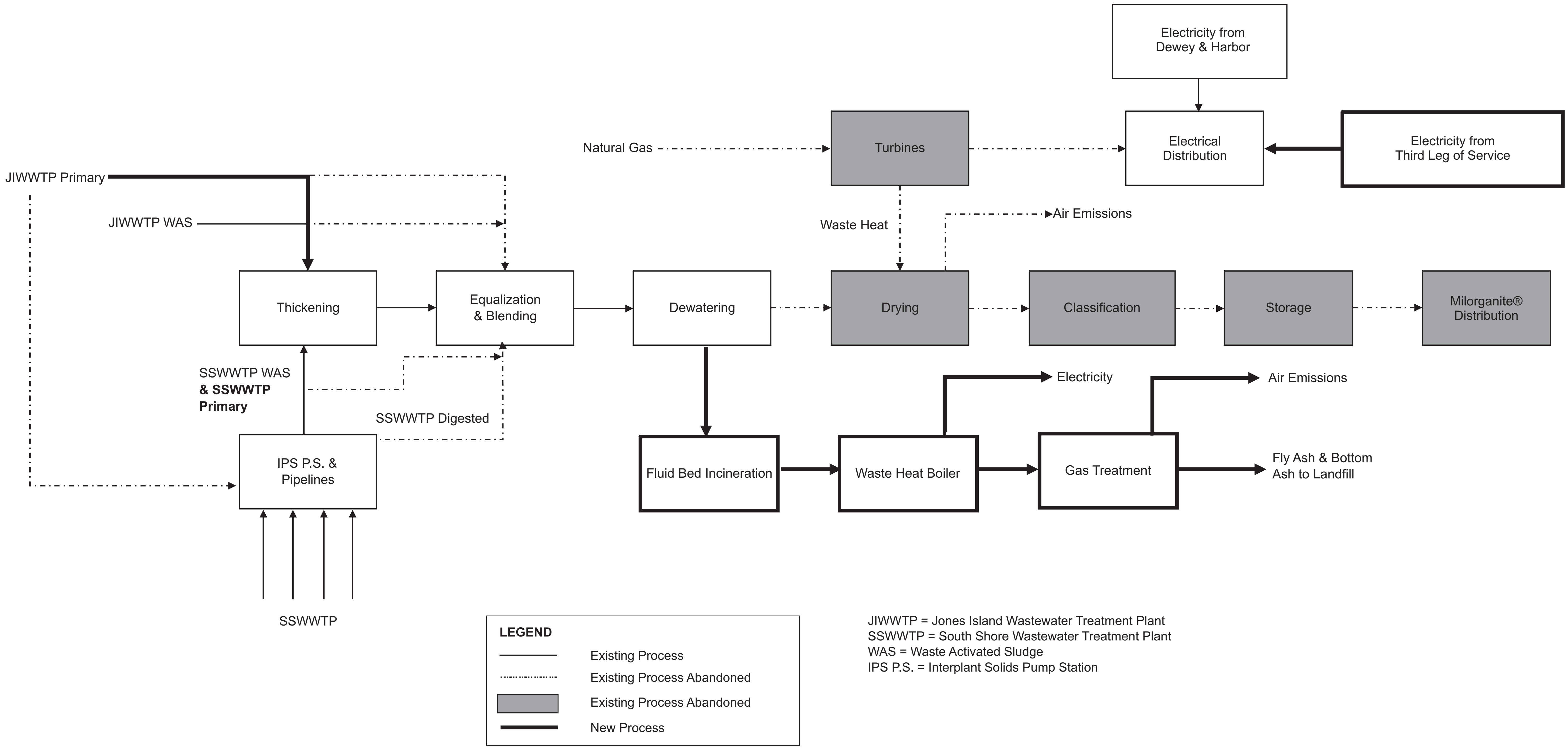
Description

In this screening alternative, all biosolids are burned in a fluid bed incinerator. A fluid bed incinerator uses a sand bed and fluidizing air heated to high temperatures (1400-1500 degrees Fahrenheit) to combust the biosolids. The byproducts of the process are combustion gases and ash. The SSWWTP sludge is pumped to JIWWTP, where it is thickened along with JIWWTP sludge. High solids centrifuges are used to dewater the sludge prior to incineration. Existing belt filter presses do not produce sufficiently dry enough sludge cake for the incineration facility to be self-sustaining. The ash from the incinerator is assumed to be landfilled.

The alternative assumes the JIWWTP turbine facility is taken out of service and possibly demolished with electrical feed upgrades at JIWWTP to provide full redundancy. The SSWWTP thickening and digesting equipment is also abandoned.

Figures 9-16 and 9-17 provide schematics of this screening alternative.

[t] See Appendix 9D, *Biosolids Screening Alternatives - Cost Estimates* for more information.



JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-16
BIOSOLIDS SCHEMATIC AT JIWWTP FOR SCREENING ALTERNATIVE 5 – FLUID BED INCINERATION
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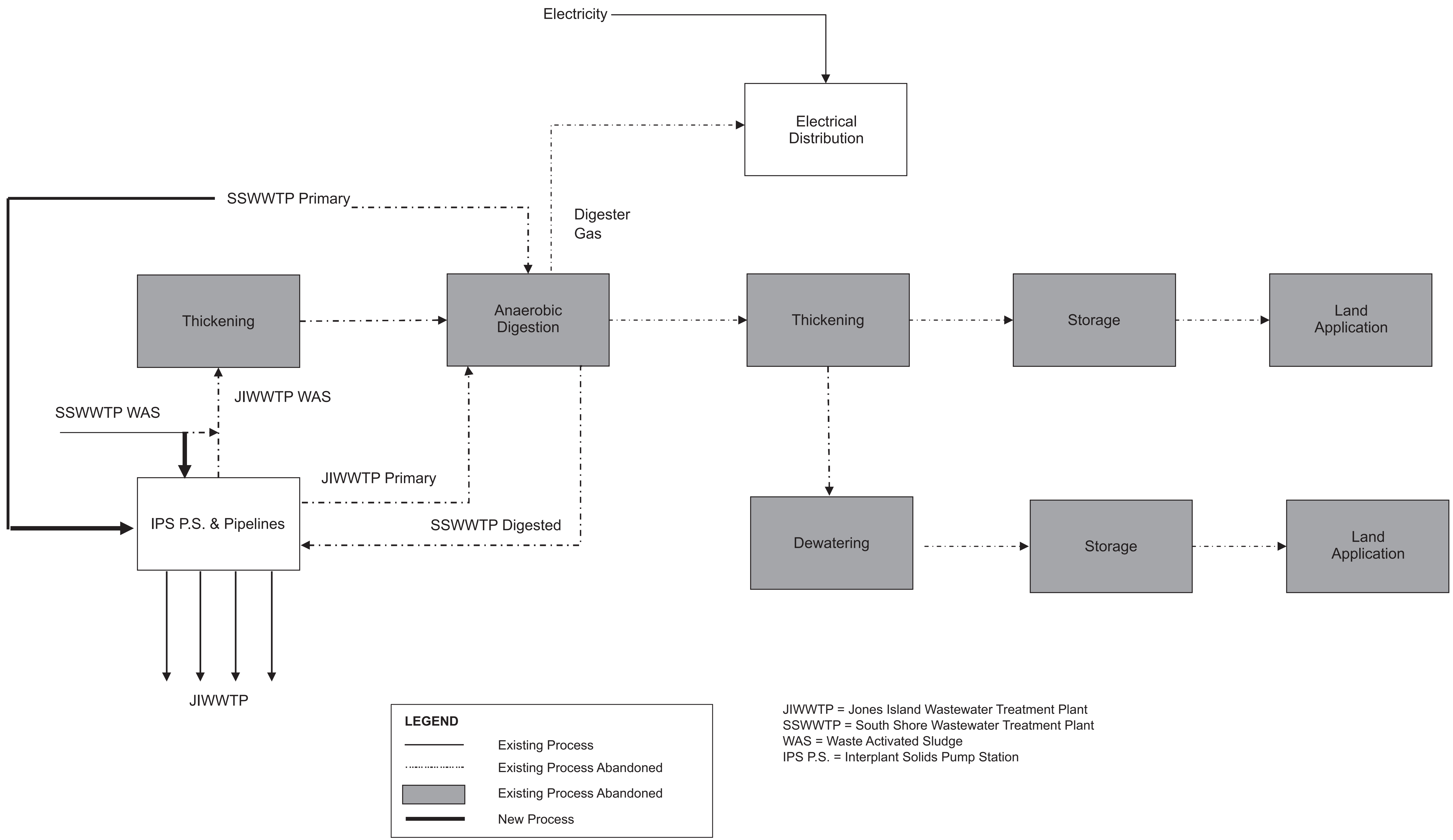

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-17
BIOSOLIDS SCHEMATIC AT SSWWTP FOR SCREENING ALTERNATIVE 5 – FLUID BED INCINERATION

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Cost Analysis

The Metropolitan Council Environmental Services (MCES) in St. Paul, Minnesota recently placed a fluid bed incineration facility online. A site visit was made to this facility in May 2005 to collect costs for their 398 ton per day facility. These costs were scaled down to a 313 ton per day facility for Milwaukee. Additional costs were added for supplemental work that will be required by MMSD that was not incurred by the MCES plant, such as upgrading the JIWWTP sludge thickening system and interplant solids pumps.

Capital investment is required in several areas as shown in Table 9-17.

TABLE 9-17
SCREENING ALTERNATIVE 5 – FLUID BED INCINERATION
CAPITAL COST SUMMARY

Facility	Cost ($ M)	Comments
JIWWTP Powerhouse/ Electrical Feed	$49.9	Modifications required to provide redundant reliable dual power supply
JIWWTP Thickening	3.1	Required to handle all sludge
Interplant Solids Pumping	1.6	Replace old and outdated equipment
Incinerator	422.4	New facilities including dewatering, chemical feed and fluid bed incineration
SSWWTP Digester Facilities	10.6	Demolition of existing facilities
Total	**$487.6**	

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

Note:
Capital costs include construction costs plus 25% for contingencies and 30% for technical services and administration.

Table 9-18 summarizes the O&M costs for this screening alternative.

TABLE 9-18
SCREENING ALTERNATIVE 5 - FLUID BED INCINERATION
ANNUAL OPERATION AND MAINTENANCE COSTS

Facility	Annual Cost ($ M)
JIWWTP Thickening	$7.7
JIWWTP Dewatering and Drying	6.7
JIWWTP Incinerator	8.0
JIWWTP Electrical & Gas Purchase[1]	9.2
Interplant Solids Pumping	0.2
SSWWTP Natural Gas Credit[2]	1.9
Disposal	1.1
Total	**$34.8**

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

Note:
The sum of the rounded components may not equal the total due to rounding.

1) Electrical purchase is considered for the entire treatment plant.
2) Cost of natural gas at SSWWTP that will no longer have to be purchased due to increased digester gas production.

The net present value for this screening alternative is $915 million.[u]

Advantages and Disadvantages

Some of the advantages and disadvantages of the fluid bed incineration technology are as follows:

[u] See Appendix 9D, *Biosolids Screening Alternatives* - Cost *Estimates* for more information.

Advantages

- Proven technology in use at St. Paul, MN and Green Bay, WI and many other locations
- Elimination of digestion system operation and maintenance requirements
- Lower energy use/cost (power generation with energy derived from combustion of organics in biosolids)
- Reduces sensitivity to changes in power costs because power costs are a lower percentage of total O&M costs
- Reduction in volatile organic compounds (VOC) and NOx emissions compared to existing operations.
- Provides the greatest reduction to treated biosolids volume
- No marketing of final product required

Disadvantages

- Second highest present value of alternatives evaluated
- Highest capital cost of alternatives evaluated
- O&M cost sensitive to changes in electricity cost due to removal of onsite power generation capability
- May be difficult to obtain construction approval due to air permitting issues
- Has less flexibility to work with other biosolids disposal methods
- No current beneficial reuse for ash product
- Not likely to be widely accepted by the community

Screening Alternative 6 - Composting

Description

This alternative disposes of all biosolids through a composting program. The JIWWTP primary sludge and WAS are pumped separately to SSWWTP where they are thickened. Thickened JIWWTP primary sludge is combined with SSWWTP primary sludge and fed to the anaerobic digesters. The sludge is digested in a single stage mesophilic digester, producing a Class B product. The digested sludge is then combined with thickened JIWWTP and SSWWTP WAS, and then the blended sludge is dewatered in plate and frame presses. Prior to dewatering, the sludge is conditioned with polymer only (no lime is required). The dewatered cake is mixed with other waste materials (wood chips, etc) to make a good nutrient balance and then the material is allowed to compost. Composting requires a long reaction time to allow microorganisms to stabilize the biosolids, eventually producing a Class A product.

The land required for composting exceeds the MMSD-owned land at SSWWTP. To allow for composting, land near SSWWTP would have to be purchased and access constructed to allow public to pick up compost. Figure 9-18 shows the new amount of land required and where new facilities would be constructed. Recent development activity around SSWWTP suggests that use of this land for composting would not be popular with the community and with development investors.

This screening alternative would have a high capital cost to purchase the land and to provide new facilities to dewater the sludge and handle the amendments required to make a good compost product. Due to the high capital cost and the new land requirements, this alternative was dropped from further evaluation.

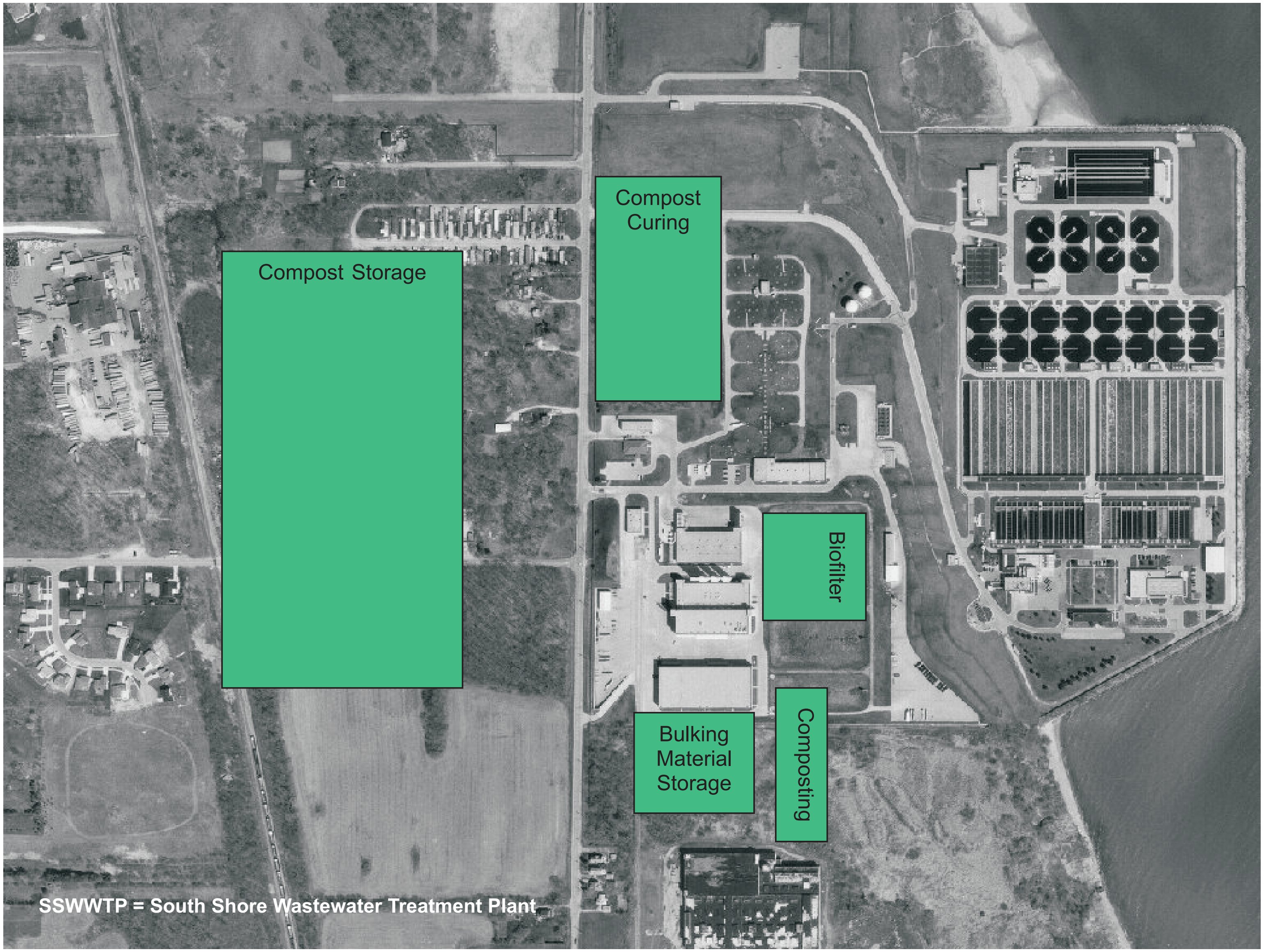

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FIGURE 9-18

FACILITIES AND LAND REQUIREMENTS AT SSWWTP FOR SCREENING ALTERNATIVE 6 – COMPOSTING

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Technology Evaluation

The advantages and disadvantages of the above screening alternatives were compared to determine which alternatives were worthy of further development. The costs of the alternatives are summarized below in Table 9-19.

TABLE 9-19
SCREENING ALTERNATIVES COST SUMMARY

Screening Alternative	Capital Cost ($ M)	Annual O&M Cost ($ M)	Present Value ($ M)
Maintain Existing Milorganite® and Agri-Life® Programs (new turbines)	$221	$48	$805
Maintain Existing Milorganite® and Agri-Life® Programs (abandon turbines)	174	53	819
Glass Furnace Technology	249	48	840
Landfill	136	62	906
Land Application	279	66	1,095
Fluid Bed Incineration	488	35	915

O&M = Operation and Maintenance

Notes:
All estimates are facilities planning level estimates, accurate to +50%/-30%.
Capital costs include construction cost plus 25% for contingencies and 30% for technical services and administration.

The first three Screening Alternatives - Milorganite®/Agri-Life® (with and without new turbines) and glass furnace technology - have present values that are considered equal given the accuracy of facilities planning estimates (+50%/-30% cost accuracy), involve reliable technologies (although the glass furnace technology is less proven than the others), provide flexibility for working with other biosolids disposal methods, involve a beneficial reuse of biosolids, and are likely to have high community acceptance, although, again, community acceptance for glass furnace technology is more uncertain. For these reasons, these screening alternatives will be incorporated into the Recommended Plan alternatives analysis.

The incineration and landfill screening alternatives have very similar present values. Landfill is more likely to be accepted by the public than fluid bed incineration and it is a technology with which MMSD is already very familiar. As such, landfill will be advanced to the Recommended Plan alternatives analysis, while incineration will not be pursued further.

Due to the high capital cost of an all land application biosolids program and due to the fact that there is a limited amount of land available that can reasonably accept biosolids, land application is not feasible as a standalone technology. However, MMSD is familiar with the technology, there is an existing market for the product, and the current program has been relatively successful and cost effective (as illustrated by the existing conditions alternative above). As such, land application may be considered as a supplement to another technology in the Recommended Plan alternatives analysis.

9.8 Milorganite® and Glass Furnace Technology Sensitivity Analysis

9.8.1 Introduction

One of the major activities completed in the biosolids alternatives analysis was the comparison of the existing MMSD Milorganite® production process with a relatively new process – the GFT system (marketed by "Minergy," a subsidiary of WE Energies).

It was necessary to compare the two processes in depth due to the factors that influence the costs within each option, including:

- Annual tons of biosolids processed
- Energy use – both electricity and natural gas
- Energy inflation – comparison of inflation rates for natural gas and electricity
- Value, or sales price, of either Milorganite® or the GFT residuals
- Value of any emission credits available for the cessation of Milorganite® production from shutting down the existing JIWWTP gas turbines

Based upon these issues, a sensitivity analysis was conducted to better understand the factors involved with each of the technologies. The following is a summary of the results of the All GFT/All Milorganite® cost evaluations and sensitivity analyses.

9.8.2 Base Case Assumptions

At the end of this section, Table 9-20 summarizes the assumptions used for the base case. These are the costs for each system before any changes were made under the sensitivity analysis. This analysis was based upon 2007 costs and assumed that all capital projects were built in 2007 and then operated for 20 years.

The base case for comparison between the All GFT and All Milorganite® alternatives assumed a total Milorganite® production of 42,000 tons per year dry solids. This estimate of total Milorganite® production for 2006 was developed by MMSD during meetings in early 2006, before actual data regarding the loss of LeSaffre Yeast were available. Although the total Milorganite® production estimate of 42,000 used for the base case did include the estimated impact of the loss of the LeSaffre Yeast waste load, actual operating data collected later in 2006 indicated that yearly Milorganite® production will be less due to the loss of this waste load. The analysis presented in Section 9.9 used the further reduced Milorganite® production estimate developed from actual operating data.

The interest rate for a capital improvement loan was assumed to be 2.875%. This interest rate is not the current rate of 5.125% recommended by the WDNR. However, 2.875% was used at the direction of MMSD to reflect its current cost for capital using the state of Wisconsin revolving loan fund.

Both alternatives assumed a base electrical load of 12.5 MW and a peak demand that included the base electrical load times 1.25 for 12 months a year plus an on-peak demand for three tunnel pumps operating four months of the year. This estimated electrical load was meant to reflect current JIWWTP electrical loads. Future additional electrical loads from the proposed installation of additional inline pumps (as discussed in Section 9.5) were not considered in this analysis.

Energy rates were based on information provided by WE Energies. The electrical rates included an 8% increase on 2006 rates that is expected in the near future. The natural gas price included delivery charges and was based upon the average of the New York Mercantile Exchange (NYMEX) natural gas futures market available in the spring of 2006 (the NYMEX web site typically contains up to four years of future gas price data – the values used were the averages of the four years available in the spring of 2006 (2007 to 2011) for natural gas futures rates).

Due to the large fluctuations in the price of natural gas in recent years, the base case was run assuming different natural gas prices. At the time of the sensitivity analysis, the natural gas rates were approximately $8.25/DTherm (a $1/DTherm delivery cost would be added) and they decreased from there into the future. The NYMEX futures have decreased since the sensitivity analysis was conducted.

The capital costs for the GFT alternative were provided by the GFT vendor (Minergy) on a design-build basis and were included in the calculations without modification. Performing the work in this manner may lower the overall construction cost, but raises the risk to MMSD by not requiring all construction details be designed before the bidding of the contract. The MMSD must determine if a design-build project of this nature can be done under current state law. Another possible form of delivery of a GFT system could involve a sole source procurement of the GFT system.

The cost analyses that were performed included only the differentiators between the two alternatives, so common items, like the improvements to JIWWTP dewatering and drying (as mentioned in Chapter 8 of this report) were not included in the cost analyses. Capital costs for the alternatives screening analysis are higher than those used in this sensitivity analysis because they include all biosolids costs, not just the differentiating costs between Milorganite and GFT.

9.8.3 Sensitivity Analysis

Table 9-21 at the end of Section 9.8, summarizes the variables adjusted during the sensitivity analysis. In general, four variables were modified:

- Energy (the cost of electricity and natural gas and their inflation rates relative to general inflation)
- Milorganite® sales volume (in tons per year), with unsold Milorganite® going to landfill to reflect the loss of a sales customer
- Milorganite® sales price to reflect the effect of marketplace competition (reduced sales price)
- Emission credits (based upon JIWWTP existing turbine shut down) from reduced emissions from an all-GFT system

Large variations were assumed in each of these to better demonstrate the effect of a change.

9.8.4 Results

Appendix 9E, *Milorganite and Glass Furnace Sensitivity Analysis* calculations provide a summary of the calculations used in this sensitivity analysis. Refer to that appendix for additional information.

Milorganite® Volume

The present value is relatively insensitive to the total volume of Milorganite® sold when the total volume produced is held constant. This is due to a relatively low cost for landfill of dried sludge.

Energy Prices

The relative present value of each alternative is fairly sensitive to energy prices. If both natural gas and electrical energy prices are assumed to inflate at the same rate, then the relative value of the two alternatives remains unchanged. If the price of natural gas increases at a rate grater than that for electricity, the relative cost of Milorganite® compared to GFT goes up much faster. If the price of natural gas is assumed to increase at an annual rate that is nearly double that of electricity, then the price difference between the two alternatives exceeds 10%, with the GFT process having a lower present value.

The GFT process is more sensitive to electrical rates than natural gas rates. The GFT process captures energy through the combustion of the organic content of dried sewage sludge and this excess heat is used to dry incoming sludge (thus requiring less natural gas for drying). The GFT process requires high purity oxygen, which requires electrical energy above the normal plant electric load. However, the energy increase required for oxygen generation is much less than the energy gained from the dried sewage sludge combustion. Even when the inflation in electrical rates was essentially double the rate of inflation for natural gas, there was less than a 10% difference in the relative cost of the two alternatives.

The result is that the Milorganite® process is much more sensitive to overall energy prices than the GFT process.

Milorganite Sales Price

The cost effectiveness of Milorganite® is sensitive to the Milorganite® sales price, while of course, the GFT process is unaffected. The cost effectiveness is also sensitive to the sales price for Milorganite®. The historical trend shows the sales price of Milorganite® has kept pace with inflation. However, with the loss of LeSaffre Yeast, the nitrogen content of the JIWWTP waste activated sludge has decreased. This decrease is substantial enough to raise concerns over meeting Milorganite®'s 6% nitrogen specification. If the 6% nitrogen product cannot be made, it is expected possible that to result in a lower price per ton of Milorganite® may result. (Note: The MMSD will commission a marketing study in 2007 to evaluate the market and sales impact of a less than 6% nitrogen product.) Until that study is completed, the likelihood of a price reduction and the relative impact of that possibility are unknown.

Information from WE Energies noted that the pilot GFT facility near Neenah, Wisconsin has procured and tested a dried sludge from Louisville, Kentucky, which has a 5% nitrogen guarantee. The price they pay per ton for the Louisville product is approximately 60% of the price paid for Milorganite®.

Air Emission Credits

A combustion turbine is recommended for Milorganite® production for safety reasons (reduced chance of power outage and the safety issues associated with loss of power in the dryers) and because the overall cost of electricity is cheaper if the waste heat is used. With a GFT system, there is no need for combustion turbines because the GFT process produces the waste heat required for sludge drying. The existing turbines are emitters of NOx and VOCs. Other industries may be willing to purchase these emission credits. The GFT vendor claimed that MMSD could be paid $500,000 annually for those credits; however, the market and value for emission credits in southeast Wisconsin or in the Midwest is speculative. The MMSD should not assume in this evaluation it would receive these credits or that they would be marketable without first confirming that this can be achieved. These possible credits could significantly reduce the present value of the GFT alternative but the present value of the two alternatives is would still be considered equal with less than a 5% difference in present value.

9.8.5 Conclusions of the Sensitivity Analysis

The base case costs and results of the sensitivity analyses are presented in Table 9-22.

The base case present value for the two alternatives is considered to be essentially equal with less than a 2% difference. It should be noted that the cost accuracy for facilities planning is +50/-30 %. The net present value of the two alternatives is therefore considered equal. The relative value of the two alternatives is affected by both energy prices and Milorganite® sales price.

While both electric and natural gas rates are predicted to increase at relatively similar rates, their costs are subject to rapid changes resulting from unforeseen events such as hurricanes or other natural disasters.

The Milorganite® sales price will be evaluated by MMSD as part of a planned 2007 marketing study. The results of that study will not be available in time for the conclusion of this facilities planning effort.

1.	**Cost of Capital**	**Annual rate**	**2.85%**	
2.	**Life of Investments**	**Years**	**20**	
3.	**Nominal Milorganite® Production**	**Tons / year**	**42,000**	
	Chaff	Tons / year	4,200	
	Milorganite® to Landfill	Tons / year	0	
4.	**Capital Cost Escalation Factor**		**0.00%**	
5.	**General Inflation Rate**		**3.00%**	
6.	**Electrical Energy Inflation Rate**		**0.00%**	
7.	**Natural Gas Inflation Rate**		**0.00%**	
8.	**Milorganite® Revenue Inflation**		**0.00%**	
9.	**Discount Rate**		**5.13%**	
10.	**Natural Gas Cost**			
	2008 All-in Burner Tip		$9.25	
	2009 All-in Burner Tip		$9.25	
	2010 All-in Burner Tip		$9.25	
	2011 All-in Burner Tip		$9.25	
11.	**Electric Cost Structure — Milorganite® Case**			
	1st Year Escalation Factor		8.00%	
12.	**Electric Cost Structure — No Transmission Level Service**		**Future (2008)**	**Current**
	On-peak demand rate	$/kW	$11.21	
	Customer demand rate	$/kW	$0.82	
	On-peak energy rate	$/kWHr	$0.07	
	Off-peak energy rate	$/kWHr	$0.03	
	Facilities charge	$/month	$567.00	
13.	**Electric Cost Structure — GFT Case Transmission Service Schedule**			
	On-peak demand rate	$/kW	$10.21	$9.45
	Customer demand rate	$/kW	$0.00	
	On-peak energy rate	$/kWHr	$0.07	$0.06
	Off-peak energy rate	$/kWHr	$0.03	
	Facilities charge	$/month	$567.00	
14.	**Interruptible Rate**			
	On-peak demand rate	$/kW	$4.85	$4.49
	Customer demand rate	$/kW	$0.00	
	On-peak energy rate	$/kWHr	$0.06	$0.05
	Off-peak energy rate	$/kWHr	$0.03	$0.03
	Facilities charge	$/month	$864.00	

GFT = Glass Furnace Technology
kW = Kilowatt
kWHr = Kilowatt Hour

TABLE 9-20
KEY ASSUMPTIONS FOR BASE CASE

Analysis	Description	Milorganite® Tons/year	Chaff Tons/year	Landfill Tons/year	GFT Tons/year
Base	Base	42,000	4,200	0	46,200
Base 2	Same as base except NG at $7.25/Dtherm + $0.00 for transport				
Base 3	Same as base except tunnel pumps operated more frequently				

Analysis	Description	Milorganite® Tons/year	Landfill Tons/year	GFT Tons/year	Other
T1 (tons)	More Milorganite®	45,000	5,000	50,000	Base Case
T2	Less Milorganite®	39,000	7,200	46,200	Base Case
T3	Lowest Milorganite®	36,000	10,200	46,200	Base Case

Analysis	Description	Natural Gas	Electricity	Other
E1 (energy)	Estimate based on available data	NYMEX thru 2011 Inflate at 1.5% per year after	Use 2008 rate thru 2011 Inflate at 0.5% per year after	Base Case
E2	Higher inflation on E1	NYMEX thru 2011 Inflate at 3.0% per year after	Use 2008 rate thru 2011 Inflate at 1.5% per year after	Base Case
E3	Gas inflates less than electricity	NYMEX thru 2011 Inflate at 0.5% per year after	Use 2008 rate thru 2011 Inflate at 1.5% per year after	Base Case
E4	Higher inflation on E3	NYMEX thru 2011 Inflate at 1.5% per year after	Use 2008 rate thru 2011 Inflate at 3.0% per year after	Base Case

Analysis	Milorganite®	GFT
S1	Sale price per ton reduced 10%	Base case
S2	Sale price per ton reduced 40%	Base case

Analysis	Milorganite®	GFT
C1 (credit)	Base Case	Sell $500,000 per year NOx credits

Dtherm = Deckatherm (measurement of heat equivalent energy)
GFT = Glass Furnace Technology
NOx = Nitrogen Oxide
NG = Natural Gas
NYMEX = New York Mercantile Exchange

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TABLE 9-21
SUMMARY OF VARIABLES FOR SENSITIVITY ANALYSES
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	Milorganite®	GFT	Percent Change	Assumptions
Base Case				
Base 1	$202	$205	1.6%	NG — $9.25/Dtherm; Electricity — 2008 Rates; General Inflation — 3%; Natural Gas and Electricity Inflate — 0%
Base 2	$183	$203	11.5%	Same as Base 1 except natural gas at $7.25/Dtherm+$1.00 transport
Base 3	$259	$209	-19.2%	Same as Base 1 except natural gas at $11.25/Dtherm+$1.00 transport
Base 4	$202	$215	6.4%	Same as Base 1 except tunnel pumping during on-peak, 12 mo/yr
Milorganite® Sales				
T1	$202	$207	2.3%	More Milorganite® made and sold (45,000 tons/year with 5,000 tons/year chaff to landfill)
T2	$209	$205	-2.0%	Less Milorganite® sold (same amount made as base case — 39,000 sold, 7,200 to landfill)
T3	$217	$205	-5.4%	Lowest Milorganite® sold (42,000 made, 36,000 sold and 10,200 to landfill)
Energy Rates *(NG Prices @ $9.25 through 2011, Base Case electric rates through 2011, vary inflation rates after 2011)*				
E1	$192	$207	7.8%	Inflate natural gas 1.5% per year, inflate electricity 0.5%
E2	$207	$214	3.6%	Inflate natural gas 3.0% per year, inflate electricity 1.5%
E3	$183	$212	15.8%	Inflate natural gas 0.5% per year, inflate electricity 1.5%
E4	$192	$223	16.2%	Inflate natural gas 1.5% per year, inflate electricity 3.0%
Sales Price *(Sales price may vary due to lower nitrogen content, general inflation rate still applies)*				
S1	$211	$205	-2.8%	Milorganite® sales price reduced 10%
S2	$244	$205	-16.0%	Milorganite® sales price reduced 40% (sales price equal to Louisville Green)
Credit Analysis *(A credit of $500,000 per year applied for NOx sales)*				
C1	$202	$197	-2.3%	Accounts for potential sales of Milorganite® air emission offsets

Dtherm = Deckatherm (measurement of heat equivalent energy)
GFT = Glass Furnace Technology
NOx = Nitrogen Oxide
NG = Natural Gas

NOTE:
All estimates are facilities planning level estimates, accurate to +50%/-30%.

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TABLE 9-22

ALL GLASS FURNACE TECHNOLOGY OR ALL MILORGANITE® SENSITIVITY ANALYSIS PRESENT VALUES $M

9.9 Recommended Plan Alternatives

This section presents the Recommended Plan biosolids alternatives, which follow from the comparison of biosolids disposal technologies presented in Section 9.7. The Recommended Plan alternatives include both single technology and combined technology alternatives. The analysis presented here will be used to recommend a final alternative for biosolids handling.

Cost analyses for the Recommended Plan biosolids alternatives include three significant changes in assumptions from the Screening Alternatives cost analyses:

- The estimate of engineering and administrative costs has been increased from 30% to 35% of estimated construction costs based upon MMSD direction in October 2006
- The biosolids mass quantities have been revised to reflect the Revised 2020 Baseline (versus the original 2020 Baseline)
- The O&M costs include the "base case" assumptions as discussed in Section 9.8.2, meaning that the utility rates for electricity and natural gas used in the analysis are inflated future projections

The O&M costs shown in this section reflect the total MMSD O&M costs, not the incremental cost. This means that the costs reflected in this section are not additional costs to be added on to existing MMSD biosolids management costs. The reason the costs were done in this fashion is that it allows for a more complete and accurate comparison of alternative costs.

9.9.1 Selection of Recommended Plan Alternatives and Evaluation Parameters

Each Recommended Plan alternative was selected based on the screening alternatives analysis and the ability of the technology or combination of technologies to satisfy the needs of MMSD's biosolids program. After the screening analysis presented in Section 9.7, the 2020 technical team further analyzed the following alternatives: landfill, glass furnace technology, Milorganite®, and land application (only when combined with another technology). Two technologies, fluid bed incineration and composting, were eliminated from further consideration based upon the advantages and disadvantages of each process as stated in Section 9.7. The main reason for elimination of compost was the land requirements at SSWWTP. The main reason for the elimination of incineration is the GFT process carried forward an "incineration – like" technology with potentially less potential negative environmental impacts regarding air emissions, and with lower capital and present worth costs. The remaining screening technologies were used to develop the following six Recommended Plan alternatives for further analysis:

1) Disposing of all biosolids to a landfill as a dewatered cake
2) Glass Furnace Technology
3) Milorganite® biosolids program to produce less than 6% nitrogen product
4) Combining Milorganite® production with land application
5) Combining Milorganite® production with Glass Furnace Technology
6) Combining Milorganite® production with landfill disposal

As with the screening alternatives, each of these alternatives was evaluated in terms of the following parameters:

- Cost (present value and capital)
- Sensitivity to natural gas and electricity prices
- Operational experience
- Energy use
- Sensitivity to regulatory limits
- Marketability of final product
- Beneficial reuse of biosolids
- Community acceptance

A present value cost analysis was completed for each alternative using projected future wasteloads as described below. A summary of each alternative follows.

9.9.2 Projected Future Influent Wasteloads

The present value cost analyses performed for each Recommended Plan alternative was based on the revised projected 2020 Baseline influent wasteloads to the two treatment plants. The wasteload were determined using the methods discussed in Chapter 5, *Treatment Assessment – Future Condition*. The future influent wasteloads for the Recommended Plan alternatives reflect the revised estimation of population and land use growth projections for the 2020 FP and steady industrial wasteload input. Table 9-23 summarizes the design, current, and predicted future flows and influent wasteloads used for the biosolids Recommended Plan alternatives analysis.

TABLE 9-23
TREATMENT PLANT INFLUENT FLOWS AND LOADS USED FOR RECOMMENDED PLAN ALTERNATIVES

	Design[1]			Current (1999-2003)[2]			Revised 2020 Baseline[3]		
Plant	Flow (MGD)	BOD (lb/day)	TSS (lb/day)	Flow (MGD)	BOD (lb/day)	TSS (lb/day)	Flow (MGD)	BOD (lb/day)	TSS (lb/day)
JIWWTP	123	299,000	314,000	101.5	264,000	225,000	98.8	232,000	220,000
SSWWTP	113	224,000	266,000	101.6	149,000	193,000	115.7	171,000	223,000
Total	**236**	**523,000**	**580,000**	**203.1**	**413,000**	**418,000**	**214.5**	**403,000**	**443,000**

BOD = Biochemical Oxygen Demand
lb/day = Pounds per Day
SSWWTP = South Shore Wastewater Treatment Plant
JIWWTP = Jones Island Wastewater Treatment Plant
MGD = Million Gallons per Day
TSS = Total Suspended Solids

1) From Jones Island O&M Manual, Section 400 and South Shore O&M Manual, Section 400
2) Average of 1999-2003 Daily Monitoring Reports (DMRs) and UWS Daily Wastewater Operating Reports (DWORs) recorded values.
3) Flows developed from Conveyance Modeling - 10 yr simulation using Revised 2020 Baseline Conditions. Loads based on current (1999-2003) values with estimated future incremental load increases added and LeSaffre Yeast loads subtracted.

The SSWWTP is predicted to have a larger increase in flow than JIWWTP due to projected population and land use growth. The JIWWTP receives most of MMSD's industrial flow.

9.9.3 Future Sludge Production

Future sludge production values for the Recommended Plan alternatives analysis were determined from mass balance analyses.[v] The 2020 FP mass balances used the projected flows and wasteloads (presented in Table 9-23) along with known and estimated treatment process parameters to track the movement of flow, TSS, and BOD through the unit processes at the two wastewater treatment plants. The JIWWTP and SSWWTP mass balances were created for each Recommended Plan alternative for average day and maximum month conditions.[w]

Recommended Plan alternative operation and maintenance costs were based on the sludge loads in the average day mass balances. Recommended Plan alternative capital costs for SSWWTP digestion and post-digestion thickening and dewatering were based on the flows and sludge loads in the maximum month mass balances. Peak day WAS flows to size SSWWTP WAS thickening facilities were estimated from the average day mass balance values multiplied by peak to average day ratios determined for other mass balances.

9.9.4 Recommended Plan Alternative Summaries

Recommended Biosolids Plan Alternative 1 - Landfill

Description

In this alternative, Milorganite® and Agri-Life® production are eliminated and all biosolids are disposed of at a landfill. The JIWWTP sludge (WAS and PSD) is combined and pumped to SSWWTP, where it is thickened along with SSWWTP WAS. The thickened sludge and SSWWTP primary sludge are then fed to the anaerobic digesters. The sludge is anaerobically digested at mesophilic temperatures to produce a Class B biosolids product (as currently required for Agri-Life®). The digested sludge is thickened and dewatered in plate and frame presses before being hauled to a landfill. Prior to dewatering, the sludge is conditioned with polymer only (no lime is required). The JIWWTP and SSWWTP schematics for this alternative are shown in Figures 9-19 and 9-20.

As described for the landfill screening alternative in Section 9.7, this alternative would require a number of process changes. All JIWWTP biosolids treatment processes, along with the turbines, would be taken out of service and possibly demolished. To make up for the loss of the turbines, the electrical service to JIWWTP would be upgraded with two independent supplies of transmission level service from WE Energies to maintain two reliable sources of power.

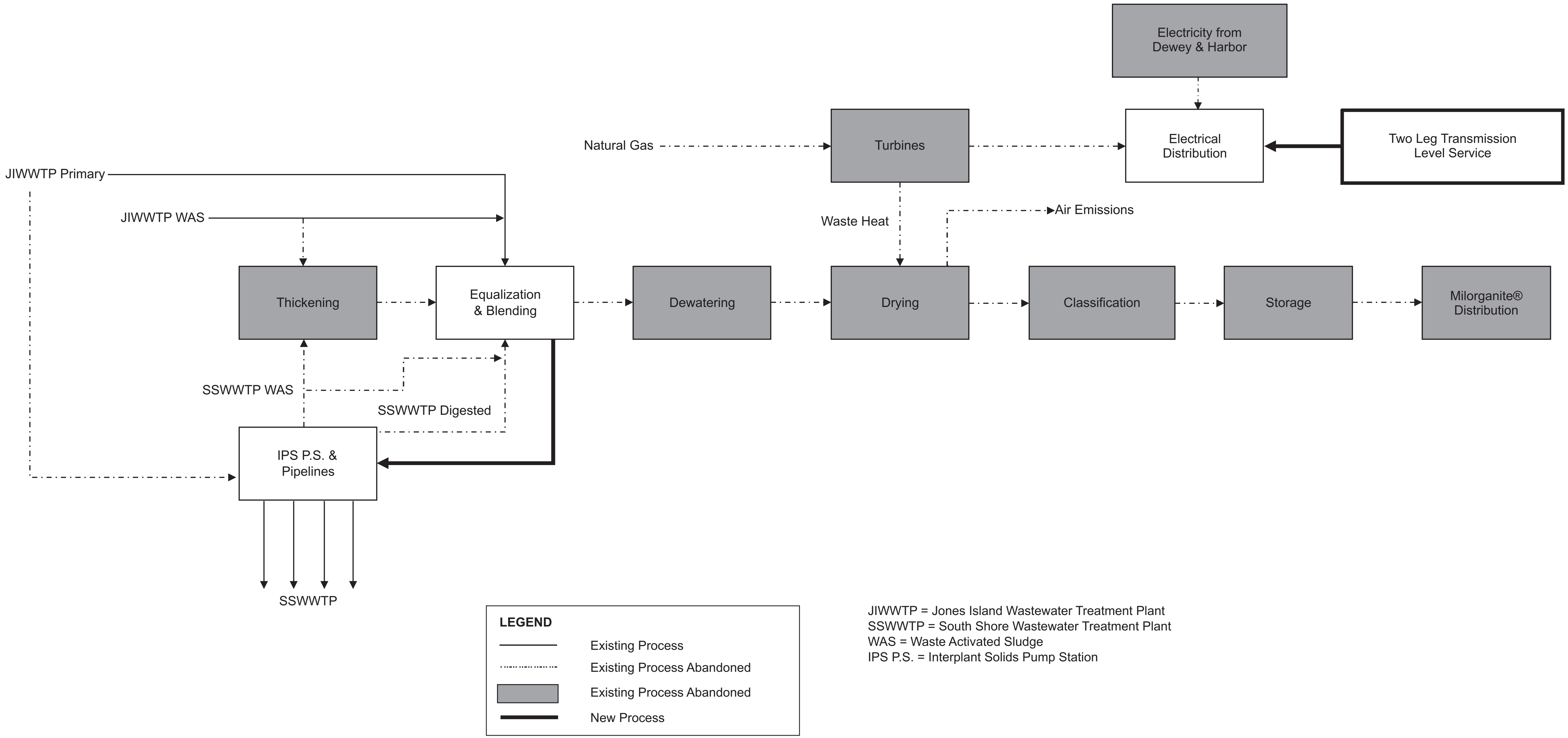
To handle future sludge loads at SSWWTP, the existing dissolved air floatation units used for pre-digestion WAS thickening would be replaced with 16 new three-meter GBTs at SSWWTP to thicken JIWWTP WAS and primary sludge and SSWWTP WAS. It is assumed that the four existing GBTs at JIWWTP would be moved to SSWWTP, so that only 12 new GBTs would be purchased. The existing thickening building would be expanded to house some of the new GBTs. The six existing mesophilic digesters would be rehabilitated with new mixing systems, all six existing sludge storage tanks would be converted back to anaerobic digesters, and ten additional digesters would be built. The SSWWTP digested sludge thickening facilities would

[v] See Appendix 5C, *MMSD System Future 2020 Condition Mass Balance Analysis* for more information.
[w] See Appendix 9F, *Biosolids Recommended Plan Alternatives - Mass Balances* for more information.

be expanded with four new two-meter GBTs and the SSWWTP dewatering facilities would be rehabilitated by the replacement of worn parts. No long-term cake storage would be required because it is assumed that the landfill is available year-round. Sludge trucking to the landfill would be continuous. Improvements would also be required for the interplant solids pumps and pipeline to ensure reliable service throughout the planning period.

This alternative has an estimated capital cost of $288 million, annual O&M cost of $34.2 million, and present value of $710 million.[x] These costs are shown in more detail in Tables 9-24 and 9-25.

[x] See Appendix 9G, *Biosolids Recommended Plan Alternatives - Cost Estimates* for more information.



JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-19
BIOSOLIDS SCHEMATIC AT JIWWTP FOR RECOMMENDED PLAN ALTERNATIVE 1 – LANDFILL
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TR_9.0019.07.05.14.cdr

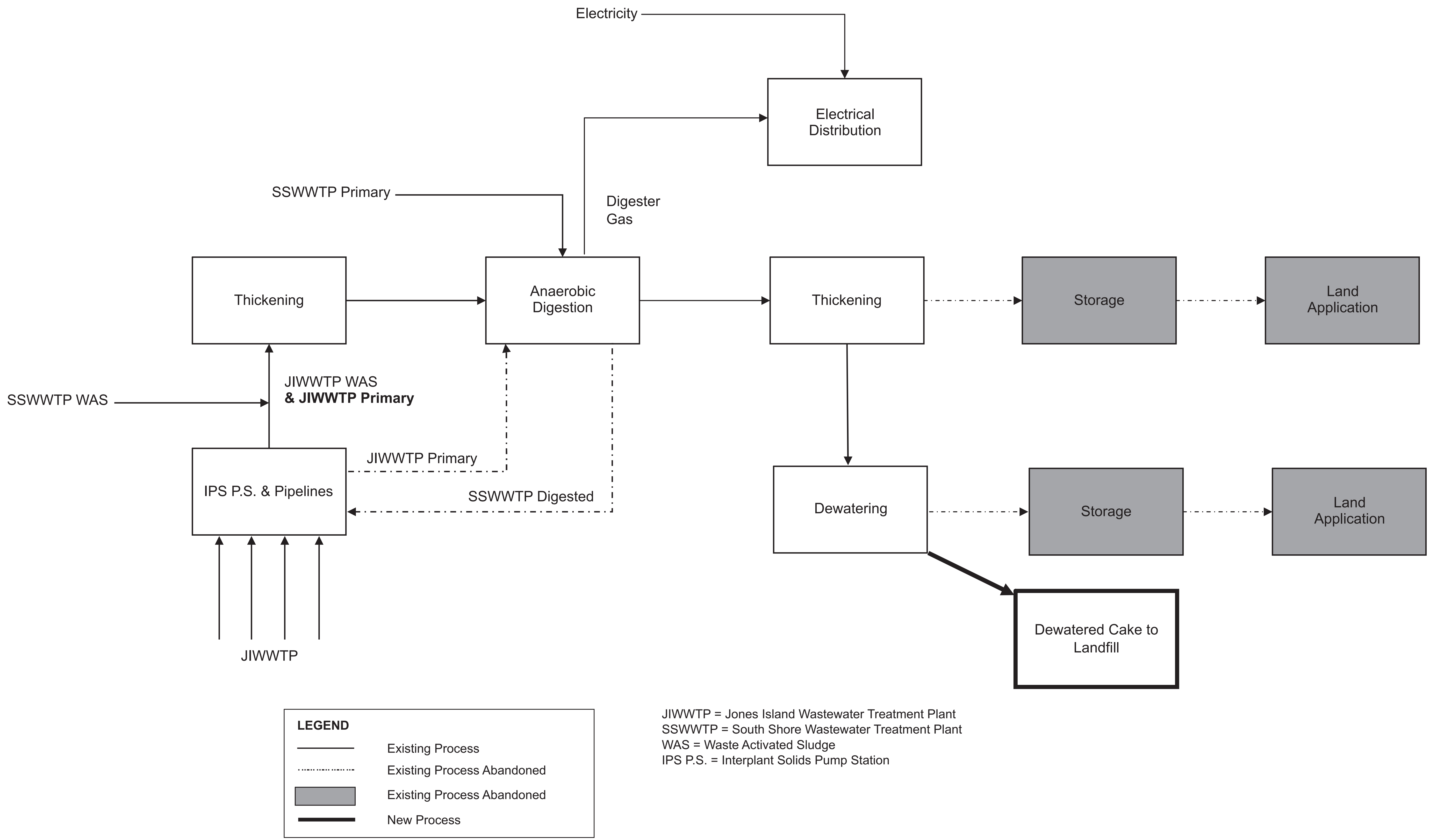

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FIGURE 9-20
BIOSOLIDS SCHEMATIC AT SSWWTP FOR RECOMMENDED PLAN ALTERNATIVE 1 – LANDFILL
2020 TREATMENT REPORT
5/14/07 TR_9.0020.07.05.14.cdr

General Description

All treatment plant sludges are digested, dewatered using plate and frame presses and then taken to either a landfill or land applied. The sludge is a Class B and is digested through a single-stage mesophilic digestion system. Construction requires 16 new GBTs for SSWWTP WAS thickening, 10 new digesters, and 4 new GBTs for digested sludge thickening.

Biosolids Load		
Influent Sludge	82,700	
Finished Biosolids	42,400	

Raw Sludge Influent Load Distribution		
Milorganite®	0%	
Glass Furnace Facility	0%	
Landfill	100%	
ENR Index	10,000	(assumed Milwaukee 2007)
Interest Rate per Year	5.125%	

Summary of Capital Costs	
JIWWTP Electrical Service Upgrades	$27,980,000
JIWWTP Dewatering and Drying Facility Demolition	$47,250,000
Interplant Solids Pipeline Upgrades	$1,740,000
SSWWTP New Gravity Belt WAS Thickeners	$18,730,000
SSWWTP Digester Rehabilitation	$219,780,000
SSWWTP New Gravity Belt Digested Sludge Thickeners	$4,240,000
SSWWTP Dewatering Upgrades	$5,360,000
Salvage Value	-$36,610,000
Total Capital Cost	**$288,470,000**

Summary of Annual Operation and Maintenance Costs

Total Annual Cost $34,160,000

Life Cycle Analysis	
Number of Years	20
Present Worth Factor	12.331

Present Worth of Total Annual Operation and Maintenance Costs **$421,230,000**

Summary of Non-Annual Operation and Maintenance Costs

NONE

Present Worth of Total Non-Annual Operation and Maintenance Costs **$0**

TOTAL PRESENT WORTH **$710,000,000**

ENR = engineering news record
GBT = gravity belt thickener
WAS = waste activated sludge
JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

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TABLE 9-24
CAPITAL COSTS FOR RECOMMENDED PLAN ALTERNATIVE 1 – LANDFILL
2020 TREATMENT REPORT
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Total 2020 MMSD Sludge Production (dt/yr)	**82,700** (raw solids)
Total Annual Operating and Maintenance Cost	**$34,160,000**

JIWWTP Energy Costs

Item/Process	**Annual Cost ($/yr)**
Natural Gas — Turbine Fuel	$0
Natural Gas — Direct Firing of Dryers	0
Natural Gas — GFT NOx Control and Startup	0
Natural Gas — Other Plant Facilities	5,450,000
Firm Electricity — Base Power Load	2,960,000
Firm Electricity — Demand Charges	2,250,000
Interruptible Electricity — Base Power Load	0
Interruptible Electricity — Demand Charges	0
Turbine Operation and Maintenance	0
Subtotal	**$10,660,000**

SSWWTP Natural Gas Credit

Additional amount of solids destroyed in digestion	23,235 tons/year
Additional amount of energy recovered from digestion process	150,267 Dtherm/year
Value of additional energy recovered in terms of cost of equivalent gas purchase	**-$1,390,000**

Landfill Annual Operating and Maintenance Costs

% of Sludge to Landfill	100%
Annual Sludge Volume (dt/year)	82700 (raw)

Item/Process	**Process Unit Cost ($/dt)**	**Process Contribution Cost ($/dt raw)**	**Annual Cost ($/yr)**
IPS Pipeline Sludge Transfer (includes SSWWTP energy)	$3.20[1]	$1.80	$150,000
SSWWTP WAS Thickening (energy included)	82.40	55.30	4,570,000
SSWWTP Digestion (energy included)	36.40	36.40	3,010,000
SSWWTP DS Thickening (energy included)	82.40	47.20	3,900,000
SSWWTP Dewatering (energy included)	115.00	65.90	5,450,000
SSWWTP Landfill System Staffing	per year	11.20	930,000
Cake Trucking and Landfilling	145.30	83.20	6,880,000
Subtotal		**$301.00**	**$24,890,000**

Dtherm = Deckatherm (measurement of heat equivalent energy)
DS = Digested Sludge
dt = Dry Tons
GFT = Glass Furnace Technology
IPS = Interplant Solids Pipeline
NOx = Nitrogen Oxide
O&M = Operation and Maintenance
JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
yr = Year

NOTE:
1) Average of costs to pump WAS, primary sludge, and digested sludge

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TABLE 9-25
O&M COSTS FOR RECOMMENDED PLAN ALTERNATIVE 1 – LANDFILL

Advantages and Disadvantages

The advantages and disadvantages of this alternative are summarized below.

Advantages

- Second lowest present value of all alternatives evaluated
- Year round availability of biosolids disposal
- No sludge storage required
- Landfill receives benefit from biosolids (helps to stabilize the landfill site in 20 years vs. 40 years)
- Digester gas production is high
- Significantly reduced air emissions compared to existing operations (no emissions from turbines and sludge drying)
- Low energy reliance
- Low O&M costs

Disadvantages

- Reliance on third party landfill operators – which places both pricing and availability at risk (landfill costs have not historically increased at extreme rates, although costs to truck to the landfill are dependent on historically volatile gas prices)
- Potential WDNR regulations limiting organic input to a landfill indicated by landfill operator
- High traffic volume at SSWWTP due to truck hauling (approximately 15 to 20 trucks per day)
- Not considered a beneficial reuse (although does have beneficial results in that the landfill can be closed sooner due to the ability of microorganisms contained in digested sludge to decompose organics in landfill)
- May not be as popular as beneficial reuse alternatives
- Reliance on a single biosolids technology

Other Comments

1) The possibility exists that landfill space limitations could be an issue in the future
2) Many alternatives exist in digester design to improve solids destruction and energy capture (egg shaped, two stage, thermophilic and mesophilic digestion, etc.), which can take place smaller footprint than the digesters proposed
3) Likely to produce more electricity at SSWWTP than is required to run the plant

Recommended Biosolids Plan Alternative 2 - Glass Furnace Technology

Description

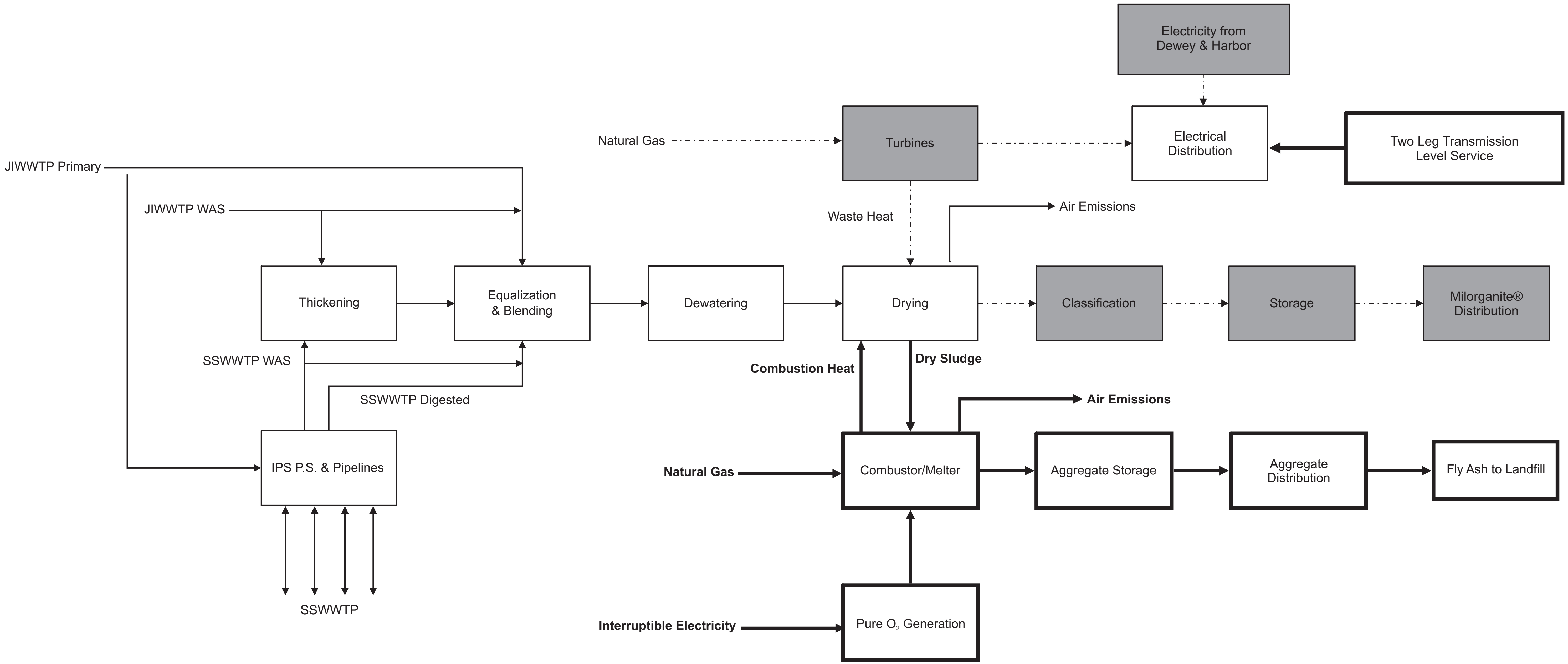
In this alternative, all sludge is processed in a newly constructed plasma furnace to produce a glass aggregate product. In this process, the organic content of the sludge is oxidized (producing heat energy) and the inorganic component is melted into a glass aggregate. All primary sludge produced from both treatment plants is anaerobically digested at SSWWTP to minimize the total solids that must be handled in the glass production process. The digested sludge does not have to meet Class B requirements. The SSWWTP WAS and digested sludge are pumped to JIWWTP, where some of the WAS from SSWWTP and JIWWTP is thickened. The thickened WAS, unthickened WAS, and digested sludge are dewatered and dried at the JIWWTP Dewatering and Drying facilities and the dried solids are sent to a new glass furnace facility. Waste heat from the glass furnace facility – obtained through the combustion of the organics in the dried sludge - is used to dry the incoming sludge. The glass furnace process includes the plasma furnace, a high purity oxygen system and an exhaust gas (air emissions) treatment system. The JIWWTP and SSWWTP schematics for this alternative are shown in Figures 9-21 and 9-22.

This alternative includes seven new three-meter GBTs at SSWWTP to replace the existing dissolved air floatation units used for pre-digestion WAS thickening (when SSWWTP WAS cannot be pumped to JIWWTP). The six existing mesophilic digesters would be rehabilitated with new mixing systems, all six existing sludge storage tanks would be converted back to anaerobic digesters, and five additional digesters would be required to handle the full biosolids load. Digested sludge storage would not be required.

Projects required at JIWWTP include a major rehabilitation of the Dewatering and Drying facilities to ensure continued reliable operation. Overhaul of this facility is common to all of the alternatives that include its continued use. A glass furnace facility, including a plasma furnace, oxygen supply, and building(s) would be constructed. The combustion of the sludge in the plasma furnace would produce enough heat to dry the vast majority of the incoming sludge and thus the turbine waste heat would no longer be needed. With no need for waste heat, onsite electrical power generation is not cost effective and the JIWWTP turbines would be either abandoned or demolished. The electrical supply and power distribution at JIWWTP would be upgraded to include two independent supplies of new transmission level service from WE Energies to maintain two reliable sources of power. Improvements would also be required for the cooling water pumping system and interplant solids pumps and pipeline to ensure their reliable service throughout the planning period.

This alternative has an estimated capital cost of $335 million, annual O&M cost of $31.5 million, and present value of $724 million.[y] These costs are shown in more detail in Table 9-26 and 9-27.

[y] See Appendix 9G, *Biosolids Recommended Plan Alternatives - Cost Estimates* for more information.



LEGEND

Solid line	Existing Process
Dotted line	Existing Process Abandoned
Gray box	Existing Process Abandoned
Heavy line	New Process

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station
O_2 = Oxygen

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FIGURE 9-21
BIOSOLIDS SCHEMATIC AT JIWWTP FOR RECOMMENDED PLAN ALTERNATIVE 2 – GLASS FURNACE TECHNOLOGY
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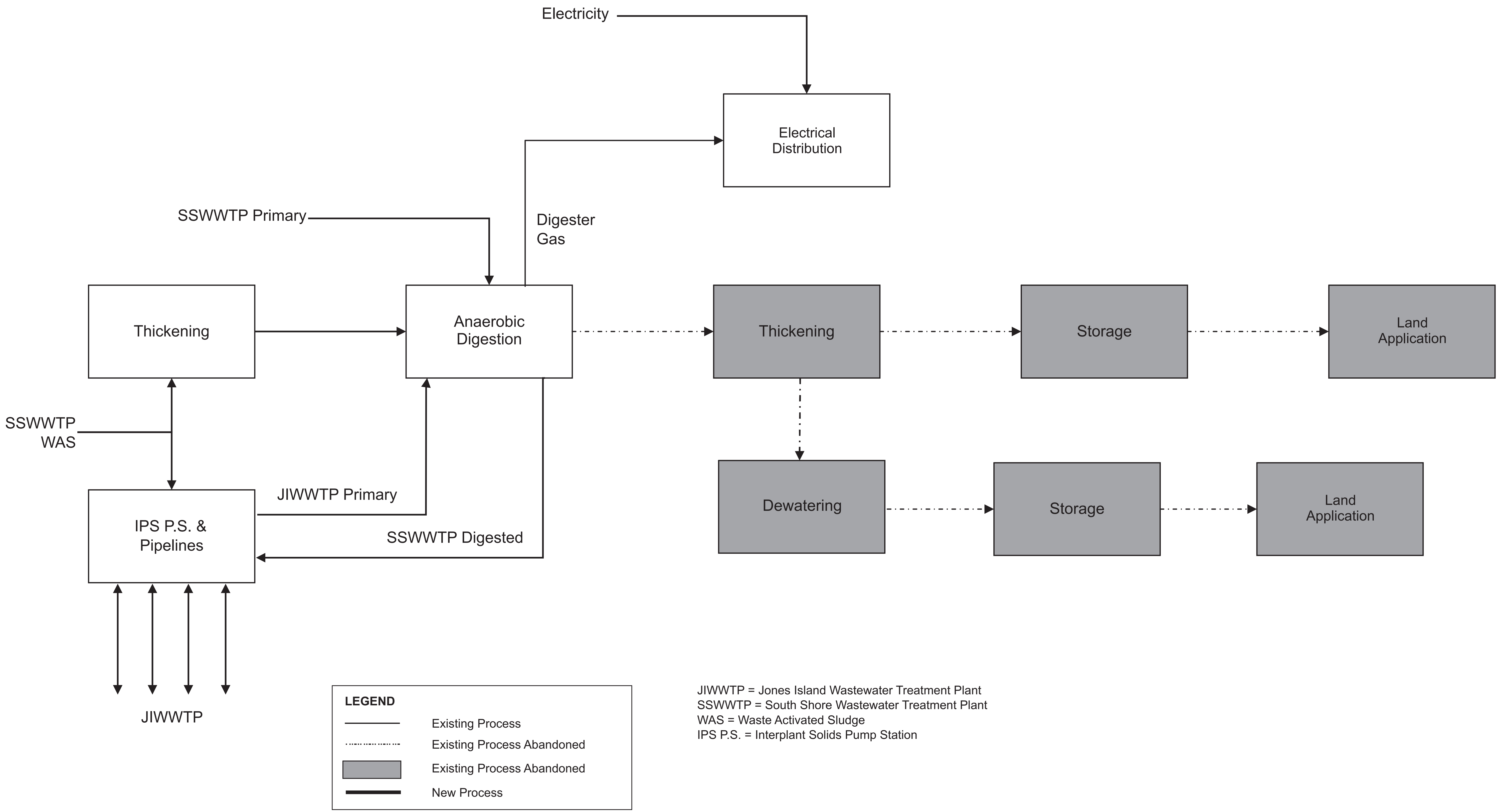

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-22
BIOSOLIDS SCHEMATIC AT SSWWTP FOR RECOMMENDED PLAN ALTERNATIVE 2 – GLASS FURNACE TECHNOLOGY
2020 TREATMENT REPORT
5/14/07 TR_9.0022.07.05.14.cdr

General Description

All treatment plant primary sludge is digested and then combined with all of the raw secondary sludge before feeding to the existing Milorganite® dryers. The dried product is then fed to the glass furnace process to be converted to energy and glass aggregate. Construction requires 2 - 80 tpd glass furnace units, 7 new GBTs for SSWWTP WAS thickening, and 5 new digesters.

Biosolids Load		
Influent Sludge	81,000	
Finished Biosolids	16,700	

Raw Sludge Influent Load Distribution		
Milorganite®	0%	
Glass Furnace Facility	100%	
Landfill	0%	

ENR Index	10,000	(assumed Milwaukee 2007)
Interest Rate per Year	5.125%	

Summary of Capital Costs	
JIWWTP Electrical Service Upgrades	$27,980,000
JIWWTP Cooling Water Pump Upgrades	$600,000
JIWWTP Dewatering and Drying Facility Upgrades	$114,740,000
JIWWTP New Glass Furnace Process	$67,580,000
JIWWTP New Glass Furnace Buildings	$16,440,000
Interplant Solids Pipeline Upgrades	$2,870,000
SSWWTP New Gravity Belt WAS Thickeners	$7,580,000
SSWWTP Digester Rehabilitation	$117,430,000
Salvage Value	-$20,010,000
Total Capital Cost	**$335,210,000**

Summary of Annual Operation and Maintenance Costs

Total Annual Cost	$31,510,000	

Life Cycle Analysis		
Number of Years	20	
Present Worth Factor	12.331	

Present Worth of Total Annual Operation and Maintenance Costs	**$388,560,000**

Summary of Non-Annual Operation and Maintenance Costs

Process	**Cost**	**ENR Index**	**Year**	**Present Worth**
Major unit refractory replacement	$370,000	9,700	10	$230,000
Fabric filter bag replacement	$64,000	9,700	5	$50,000

Present Worth of Total Non-Annual Operation and Maintenance Costs	**$320,000**
TOTAL PRESENT WORTH	**$724,000,000**

ENR = engineering news record
GBT = gravity belt thickener
WAS = waste activated sludge

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
tdp = Tons Per Day

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TABLE 9-26

CAPITAL COSTS FOR RECOMMENDED PLAN ALTERNATIVE 2 – GLASS FURNACE TECHNOLOGY

Total 2020 MMSD Sludge Production (dt/yr)	**81,000** (raw solids)
Total Annual Operating and Maintenance Cost	**$31,510,000**

JIWWTP Energy Costs

Item/Process	**Annual Cost ($/yr)**
Natural Gas — Turbine Fuel	$0
Natural Gas — Direct Firing of Dryers	$3,140,000
Natural Gas — GFT NOx Control and Startup	$90,000
Natural Gas — Other Plant Facilities	$5,450,000
Firm Electricity — Base Power Load	$4,560,000
Firm Electricity — Demand Charges	$2,710,000
Interruptible Electricity — Base Power Load	$800,000
Interruptible Electricity — Demand Charges	$1,000
Turbine Operation and Maintenance	$0
Subtotal	**$16,750,000**

SSWWTP Natural Gas Credit

Additional amount of solids destroyed in digestion	10,375 tons/year	
Additional amount of energy recovered from digestion process	150,267 Dtherm/year	
Value of additional energy recovered in terms of cost of equivalent gas purchase		**-$1,390,000**

Landfill Annual Operating and Maintenance Costs

% of Sludge to Glass Furnace Facility	100%
Annual Sludge Volume (dt/year)	81,000 (raw)
Annual Biosolids to Glass Furnace Facility	57,900

Item/Process	**Process Unit Cost ($/dt)**	**Process Contribution Cost ($/dt raw)**	**Annual Cost ($/yr)**
JIWWTP Thickening	$53.00	$13.80	$1,120,000
JIWWTP Dewatering/Drying	$191.30	$139.80	$11,320,000
JIWWTP Sodium Hydroxide for GFT SO_2 Control	$6.20	$4.40	$360,000
JIWWTP Ammonia for GFT NOx control	$0.50	$0.30	$20,000
JIWWTP Liquid O_2 Tank and Vaporizer Rental	per year	$0.32	$30,000
JIWWTP GFT Liquid Oxygen Usage	$2.10	$1.50	$120,000
JIWWTP GFT Equipment Maintenance	$8.20	$5.90	$480,000
JIWWTP GFT Ash Disposal	$0.60	$0.40	$30,000
JIWWTP GFT Staffing	per year	$7.63	$620,000
IPS Pipeline Sludge Transfer (includes SSWWTP energy)	$3.20[1]	$2.00	$160,000
SSWWTP WAS Thickening (energy included)	$82.40	$0.50	$40,000
SSWWTP Digestion (energy included)	$36.40	$22.90	$1,850,000
Subtotal		**$199.45**	**$16,150,000**

DS = Digested Sludge
dt = Dry Tons
Dtherm = Dekatherm
GFT = Glass Furnace Technology
IPS = Interplant Solids Pipeline
JIWWTP = Jones Island Wastewater Treatment Plant
NOx = Nitrogen Oxide
O&M = Operation and Maintenance
O_2 = Oxygen
SO_2 = Sulfur Dioxide
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
yr= Year

NOTE:
1) Average of costs to pump WAS, primary sludge, and digested sludge

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TABLE 9-27
O&M COSTS FOR RECOMMENDED PLAN ALTERNATIVE 2 – GLASS FURNACE TECHNOLOGY

Advantages and Disadvantages

Some of the advantages and disadvantages of the glass furnace alternative are as follows:

Advantages

- Year round availability of biosolids disposal; significant reduction in volume of biosolids
- No sludge storage required
- Considered a beneficial reuse
- Some air emissions reduction compared to existing operations (emissions from turbines are eliminated but still have dryers)
- Captures energy from dried sewage sludge

Disadvantages

- Third highest present value of all alternatives evaluated
- High reliance on WE Energies and its price structure for electricity (already projected to increase due to future infrastructure improvements)
- Some air emissions increase; specific air emissions unknown at this time; possible that New Source Review required under Clean Air Act
- Significant capital investment
- Relatively new technology – only one other U.S. municipal sludge facility
- Unknown long-term maintenance requirements and costs
- Must find use for aggregate or has to go to landfill.
- An additional 2 to 3 MGD of cooling water must be discharged to Lake Michigan
- May need detailed guarantee.
- May require sole source procurement to have effective implementation.
- Reliance on a single biosolids technology
- May require sole source or design-build to be cost effective. Unsure if MMSD policy allows this.

Recommended Plan Alternative* 3 - *Maintain Existing Milorganite® Program

Description

This alternative discontinues the Agri-Life® program and continues the Milorganite® program to convert all of the sludge to a Milorganite® fertilizer product that contains less than 6% nitrogen (estimates for annual average are slightly less than 5% as shown in Appendix 9F, *Biosolids Recommended Plan Alternatives – Mass Balances*). This product may not generate as much revenue as a 6% nitrogen product, but with the recent decrease in influent solids, it is easier to produce on a continuous basis. However, the use of all sludge to produce Milorganite® may result in production of product that may not meet certain product specifications regarding the dust level in the product. This issue has been raised by MMSD and UWS staff based upon full-scale tests of the drying system in August 2006.

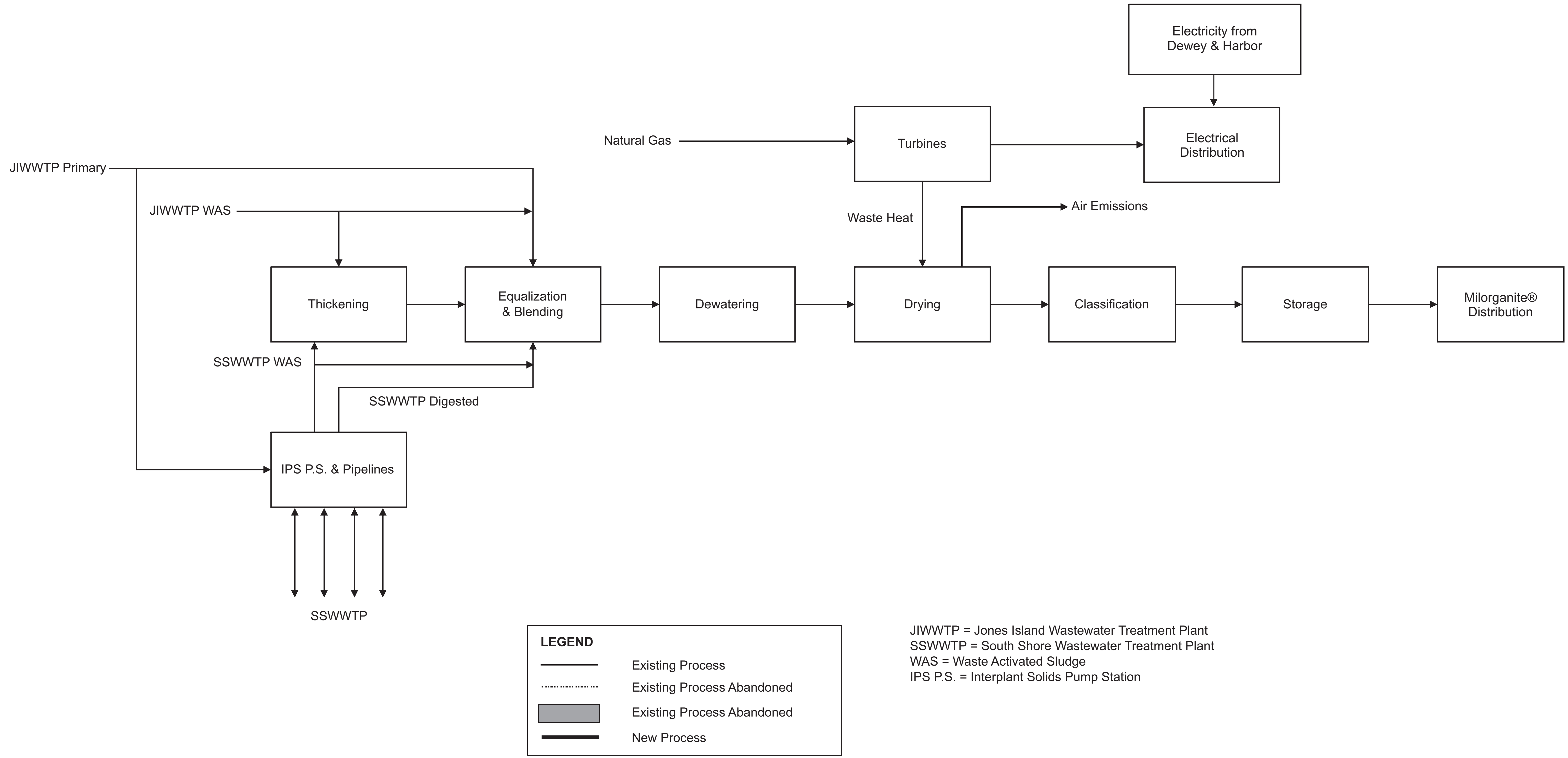
This alternative takes advantage of existing facilities with minor modifications at both JIWWTP and SSWWTP. The electrical service at JIWWTP would be upgraded through the addition of one turbine. One of the existing turbines would be maintained to handle peak loads and to provide a backup to the new turbine. These two improvements will allow JIWWTP to maintain two reliable sources of power and to meet the state requirements for reliable power. The new turbine would be housed in a new, separate building. The JIWWTP and SSWWTP schematics for this alternative are shown in Figures 9-23 and 9-24.

The existing JIWWTP Dewatering and Drying facilities are suitably sized to handle future loads but, as previously indicated, upgrades are needed to ensure reliable service. A new locomotive is also included for JIWWTP in this alternative for the transportation of finished Milorganite®.

To handle future sludge loads at SSWWTP, seven new three-meter GBTs would be installed at SSWWTP to replace the existing dissolved air floatation units used for pre-digestion WAS thickening (when SSWWTP WAS cannot be pumped to JIWWTP). To ensure reliable digester operation, the six existing mesophilic digesters would be rehabilitated with new mixing systems, all six existing sludge storage tanks would be converted back to anaerobic digesters, and five additional digesters would be required to handle the projected biosolids load. Digested sludge storage is not required. This alternative would also include improvements to the interplant solids pipeline to ensure the reliable transfer of sludge between JIWWTP and SSWWTP. The improvements include pipeline cathodic protection and 12 new transfer pumps.

This alternative has an estimated capital cost of $246 million, annual O&M cost of $37.8 million, and present value of $712 million.[z] These costs are shown in more detail in Tables 9-28 and 9-29.

[z] See Appendix 9G, *Recommended Plan Alternatives - Cost Estimates* for more information.



JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-23
BIOSOLIDS SCHEMATIC AT JIWWTP FOR RECOMMENDED PLAN ALTERNATIVE 3 – MAINTAIN EXISTING MILORGANITE® PROGRAM
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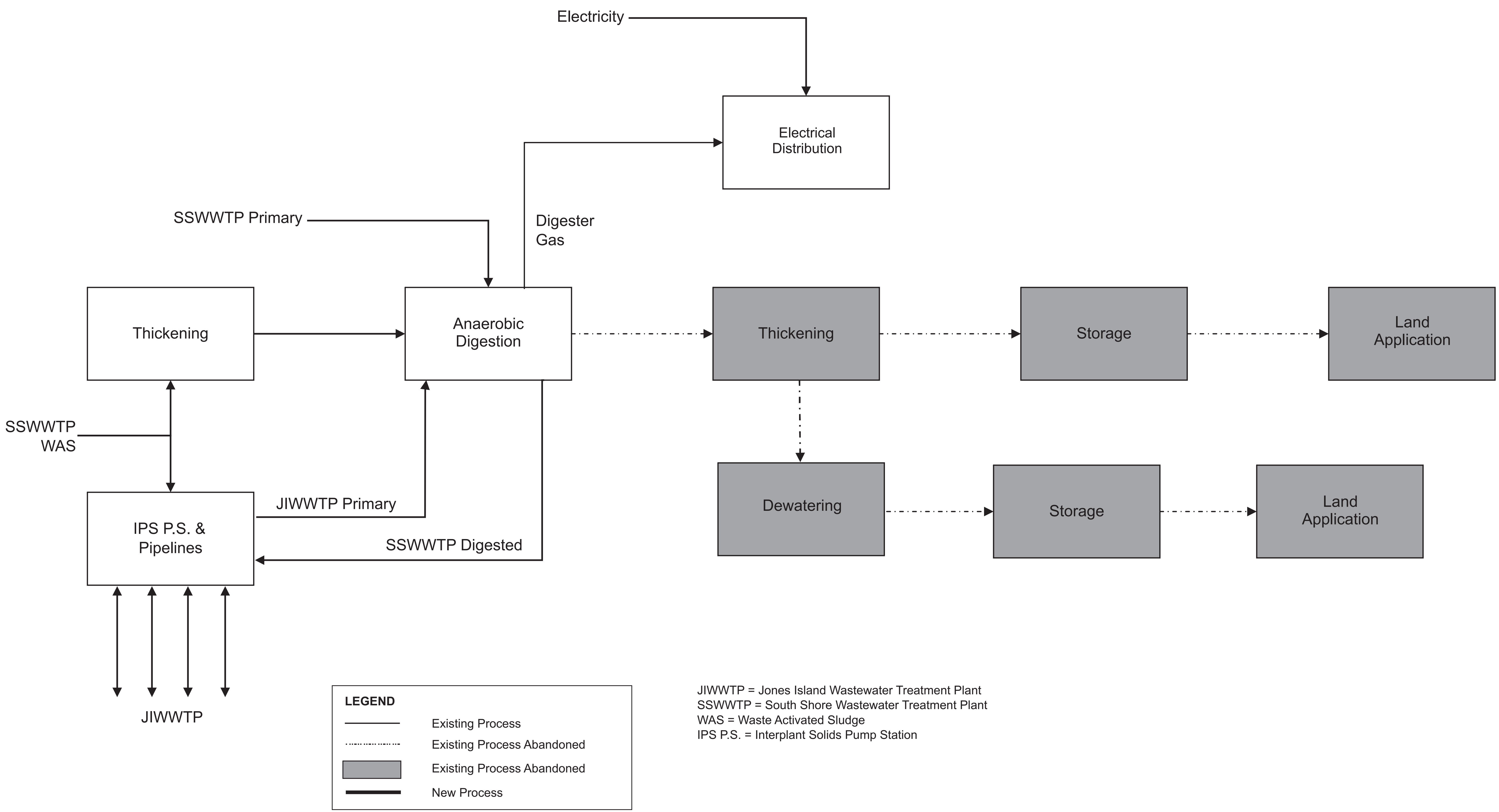

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-24
BIOSOLIDS SCHEMATIC AT SSWWTP FOR RECOMMENDED PLAN ALTERNATIVE 3 – MAINTAIN EXISTING MILORGANITE® PROGRAM
2020 TREATMENT REPORT
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TR_9.0024.07.05.14.cdr

General Description

All treatment plant primary sludge is digested and then combined with the raw secondary sludge to produce a classic Milorganite®. With the loss of LeSaffre Yeast, the blended sludge is expected to have a Nitrogen content of approximately 5%, which is less than the current 6% N guarantee. Construction requires 7 new GBTs for SSWWTP WAS thickening, and 5 new digesters.

Biosolids Load			
Influent Sludge	81,000		
Finished Biosolids	53,800		
Raw Sludge Influent Load Distribution			
Milorganite®	0%		
Glass Furnace Facility	100%		
Landfill	0%		
ENR Index	10,000	(assumed Milwaukee 2007)	
Interest Rate per Year	5.125%		
Summary of Capital Costs			
JIWWTP Electrical Service Upgrades			$16,460,000
JIWWTP Cooling Water Pump Upgrades			$3,500,000
JIWWTP Dewatering and Drying Facility Upgrades			$114,740,000
JIWWTP New Glass Furnace Process			$3,050,000
JIWWTP New Glass Furnace Buildings			$2,870,000
Interplant Solids Pipeline Upgrades			$7,580,000
SSWWTP New Gravity Belt WAS Thickeners			$117,430,000
SSWWTP Digester Rehabilitation			-$19,170,000
Salvage Value			**$246,460,000**
Total Capital Cost			$16,460,000
Summary of Annual Operation and Maintenance Costs			
Total Annual Cost	$37,780,000		
Life Cycle Analysis			
Number of Years	20		
Present Worth Factor	12.331		
Present Worth of Total Annual Operation and Maintenance Costs			**$465,870,000**
Summary of Non-Annual Operation and Maintenance Costs			
NONE			
Present Worth of Total Non-Annual Operation and Maintenance Costs			**$0**
TOTAL PRESENT WORTH			**$712,000,000**

ENR = engineering news record
GBT = gravity belt thickener
WAS = waste activated sludge
JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

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TABLE 9-28

CAPITAL COSTS FOR RECOMMENDED PLAN ALTERNATIVE 3 – MAINTAIN EXISTING MILORGANITE® PROGRAM

2020 TREATMENT REPORT

Total 2020 MMSD Sludge Production (dt/yr)	81,000 (raw solids)
Total Annual Operating and Maintenance Cost	**$37,780,000**

JIWWTP Energy Costs

Item/Process	Annual Cost ($/yr)
Natural Gas — Turbine Fuel	$10,540,000
Natural Gas — Direct Firing of Dryers	$5,120,000
Natural Gas — GFT NOx Control and Startup	$0
Natural Gas — Other Plant Facilities	$5,450,000
Firm Electricity — Base Power Load	$7,000
Firm Electricity — Demand Charges	$0
Interruptible Electricity — Base Power Load	$0
Interruptible Electricity — Demand Charges	$0
Turbine Operation and Maintenance	$1,290,000
Subtotal	**$22,400,000**

SSWWTP Natural Gas Credit

Additional amount of solids destroyed in digestion	10,375 tons/year	
Additional amount of energy recovered from digestion process	150,267 Dtherm/year	
Value of additional energy recovered in terms of cost of equivalent gas purchase		**-$1,390,000**

Milorganite® Annual Operating and Maintenance Costs

% of Sludge to Milorganite®	100%
Annual Sludge Volume (dt/year)	81,000 (raw)
% sold	100%

Item/Process	Process Unit Cost ($/dt)	Process Contribution Cost ($/dt raw)	Annual Cost ($/yr)
JIWWTP Thickening	$53.00	$13.80	$1,120,000
JIWWTP Dewatering/Drying	$191.30	$139.80	$11,320,000
JIWWTP Chaff Processing	$443.30	$16.70	$1,350,000
Milorganite® Warehouse/Shipping	$27.20	$19.90	$1,610,000
Milorganite® Marketing	$81.70	$59.70	$4,840,000
IPS Pipeline Sludge Transfer (includes SSWWTP energy)	$3.20[1]	$2.00	$160,000
SSWWTP WAS Thickening (energy included)	$82.40	$0.50	$40,000
SSWWTP Digestion (energy included)	$36.40	$22.90	$1,860,000
Milorganite® Land Application	$135.10	$0.00	$0
Milorganite® Sales Revenue	-$77.90	-$68.30	-$5,530,000
Subtotal		**$207.00**	**$16,770,000**

dt = Dry Tons
Dtherm = Dekatherm
GFT = Glass Furnace Technology
IPS = Interplant Solids Pipeline
JIWWTP = Jones Island Wastewater Treatment Plant
NOx = Nitrogen Oxide
O&M = Operation and Maintenance
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
yr= Year

NOTE:
1) Average of costs to pump WAS, primary sludge, and digested sludge

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TABLE 9-29
O&M COSTS FOR RECOMMENDED PLAN ALTERNATIVE 3 – MAINTAIN EXISTING MILORGANITE® PROGRAM

Advantages and Disadvantages

The advantages and disadvantages of this alternative are summarized below.

Advantages

- Third lowest present value of all alternatives evaluated
- Year round availability of biosolids disposal.
- No sludge storage required.
- Considered a beneficial reuse.
- Process with which MMSD is familiar and comfortable.
- Milorganite® trademark name helps sales.
- Options still available to landfill or land apply dried sludge.
- Known commodity (capital and O&M costs fairly certain).
- Low capital cost – takes advantage of huge investment in existing infrastructure.
- No new air permitting issues, unless change in law occurs.

Disadvantages

- May not be able to meet current 6% nitrogen guarantee (closer to 5%) based upon 2006 data.
- High energy requirement (turbines and dryers).
- High air emissions (although new turbine will reduce from current).
- Other sludge drying facilities coming online (Chicago and Nashville). These may have an impact on the market for dried biosolids and sales revenue.
- Milorganite® that is not 6% nitrogen may have a lower sales price than traditional Milorganite® 6% nitrogen product.
- Need to address potential dust issue
- Reliance on a single biosolids technology.

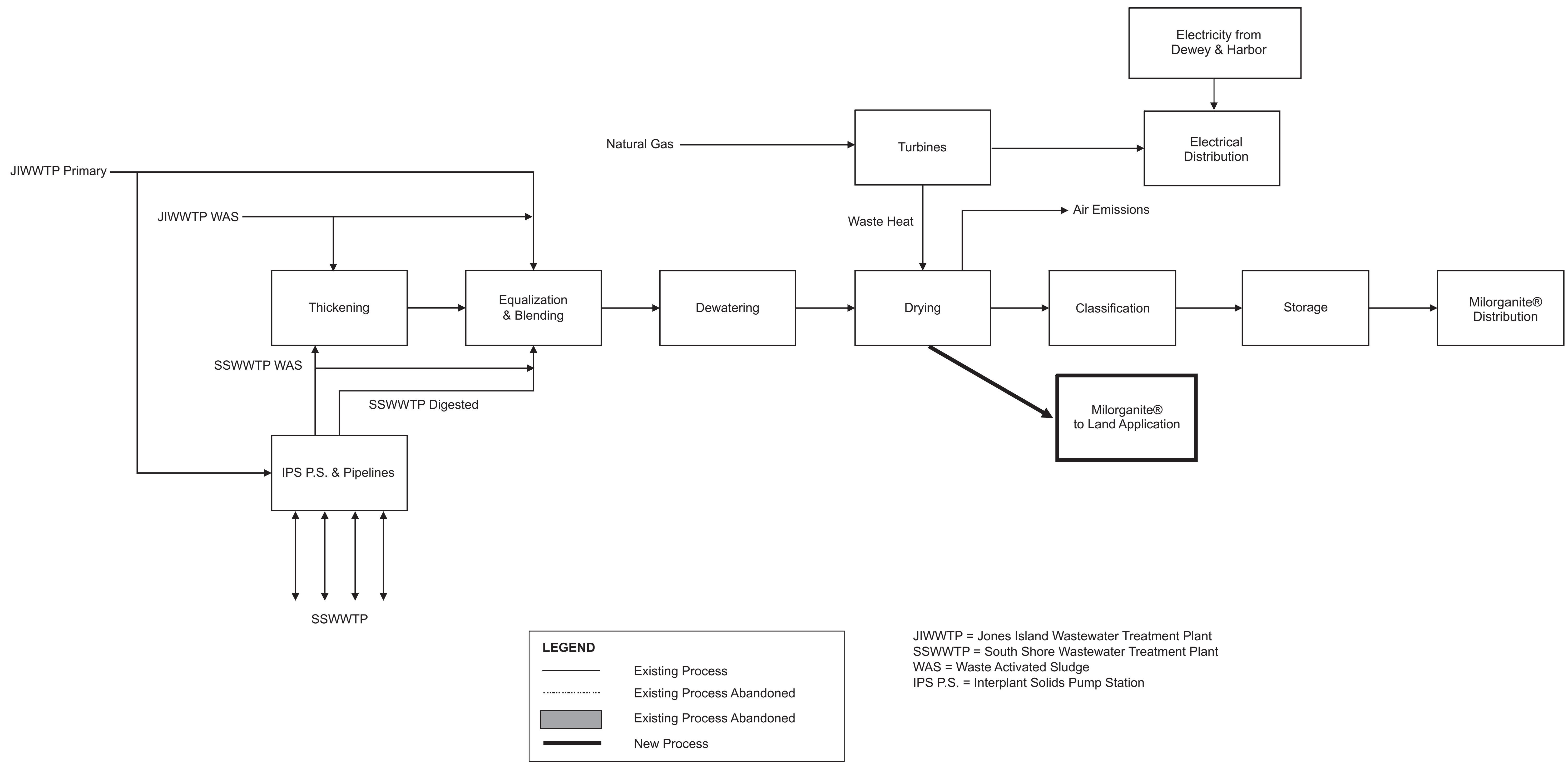
Other Comments

1) Need to evaluate use of combustion turbines versus buying all electricity and firing dryers on natural gas only.
2) If staying with a turbine, need to evaluate use of second turbine to shave peaks.
3) Concern about nitrogen balance and understanding of system dynamics

Recommended Plan Alternative 4 - Combine Milorganite® Program with Land Application

Description

This alternative combines a Milorganite® program to produce as much 6% nitrogen product as possible with a land application program to recycle the Milorganite® that does not meet the 6% nitrogen requirement. Approximately 45% of the Milorganite® produced would meet the nitrogen criterion and be suitable for traditional sales, though this amount will vary depending on the quality of influent biosolids. This alternative may be able to better address the dust issue noted in the discussion of Alternative 4. The JIWWTP and SSWWTP schematics for this alternative are shown in Figures 9-25 and 9-26.



JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-25
BIOSOLIDS SCHEMATIC AT JIWWTP FOR RECOMMENDED PLAN ALTERNATIVE 4 – COMBINE MILORGANITE® PROGRAM WITH LAND APPLICATION

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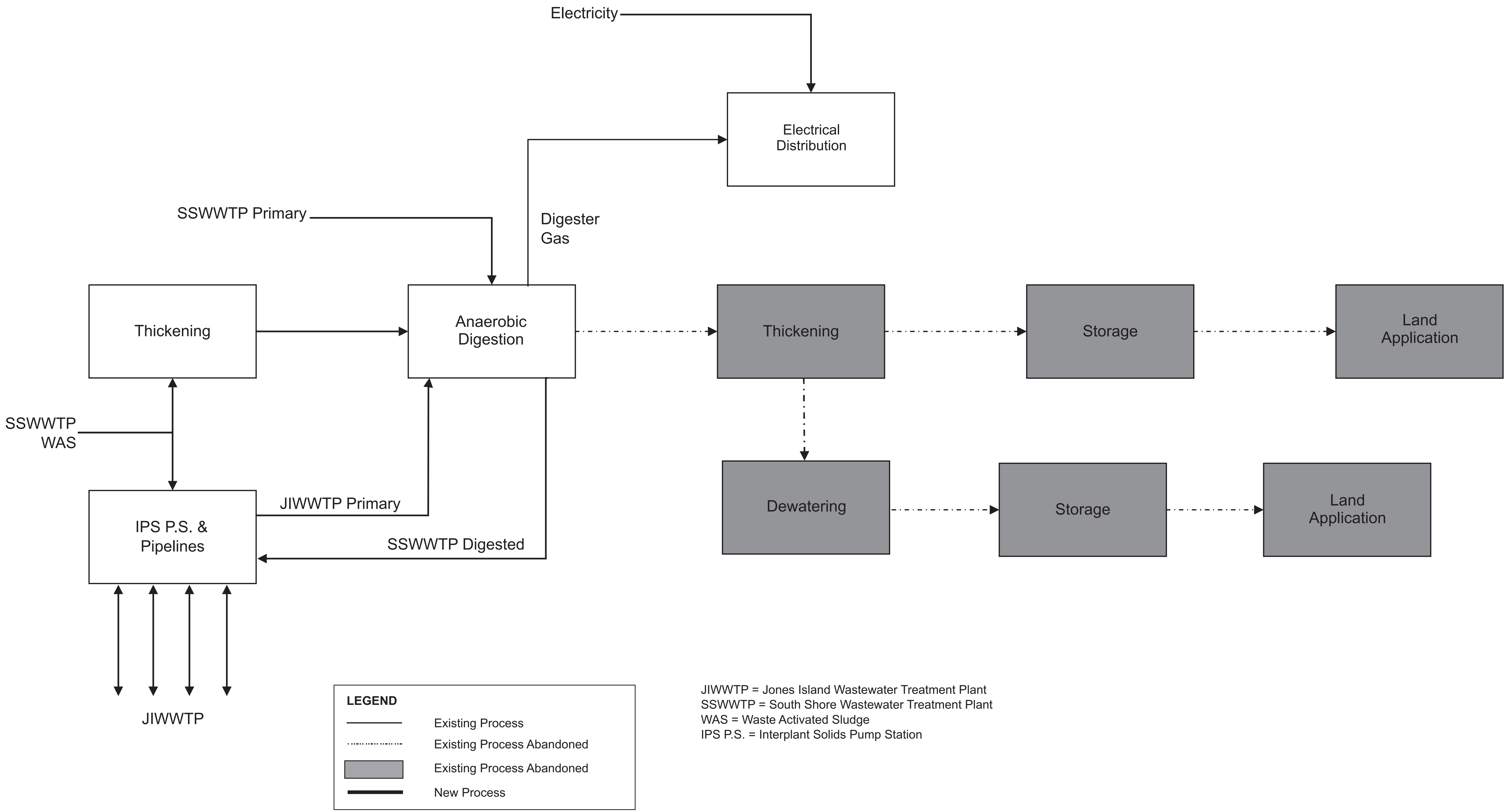

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-26

BIOSOLIDS SCHEMATIC AT SSWWTP FOR RECOMMENDED PLAN ALTERNATIVE 4 – COMBINE MILORGANITE® PROGRAM WITH LAND APPLICATION

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The capital improvements necessary to implement this alternative are identical to the improvements described for Recommended Plan Alternative 3 because they both process all of the influent biosolids into a Milorganite® product. The JIWWTP improvements include a new turbine, Dewatering and Drying facilities upgrades, and a new locomotive. Similarly, the SSWWTP improvements previously described would include new GBTs, significant digester upgrades, and interplant solids pipeline equipment upgrades.

This alternative has an estimated capital cost of $246 million, annual O&M cost of $40.5 million, and present value of $746 million.[aa] These costs are shown in more detail in Tables 9-30 and 9-31.

Advantages and Disadvantages

The advantages and disadvantages of this alternative are summarized below.

Advantages

- Year round availability of biosolids disposal.
- No sludge storage required.
- Considered beneficial reuse.
- Process with which MMSD is familiar and comfortable.
- Milorganite® trademark name helps sales.
- Options available to landfill or land apply dried sludge.
- Known commodity (capital and O&M costs fairly certain).
- Low capital cost – takes advantage of huge investment in existing infrastructure.
- No new air permitting issues, unless change in law occurs.

Disadvantages

- Highest present value of all alternatives evaluated
- May need to develop segregated markets (one for a 6% nitrogen product and one for a lower nitrogen product).
- High energy requirement (turbines and dryers).
- High air emissions (although new turbine will reduce from current).
- Other sludge drying facilities coming online (Chicago and Nashville). These may have an impact on the market for dried biosolids and sales revenue.
- Material that is not 6% nitrogen may be difficult to sell given traditional Milorganite® product.

Other Comments

1) Need to evaluate use of combustion turbines versus buying all electricity and firing dryers on natural gas only
2) If staying with a turbine, need to evaluate use of second turbine to shave peaks
3) Concerns exist about Milorganite® nitrogen balance and understanding of system nitrogen balance with regard to Milorganite nitrogen content

[aa] See Appendix 9G, *Biosolids Recommended Plan Alternatives - Cost Estimates* for more information.

General Description

All treatment plant primary sludge is digested and then combined with raw secondary sludge for the production of classic Milorganite®. The blend of raw secondary and digested sludge is adjusted to make as much Milorganite® meeting the 6% Nitrogen guarantee as possible, with the remaining sludge made into a blend that does not meet the guarantee. The 6% is sold at current prices while the rest is sold at below market or land applied. Construction requires 7 new GBTs for SSWWTP WAS thickening and 5 new digesters.

Biosolids Load		
Influent Sludge	81,000	
Finished Biosolids	53,800	
Raw Sludge Influent Load Distribution		
Milorganite®	100%	
Glass Furnace Facility	0%	
Landfill	0%	
ENR Index	10,000 (assumed Milwaukee 2007)	
Interest Rate per Year	5.125%	
Summary of Capital Costs		
JIWWTP Turbine Upgrades		$16,460,000
JIWWTP Turbine Building		$3,450,000
JIWWTP Dewatering and Drying Facility Upgrades		$114,740,000
JIWWTP New Locomotive		$3,050,000
Interplant Solids Pipeline Upgrades		$2,870,000
SSWWTP New Gravity Belt WAS Thickeners		$7,580,000
SSWWTP Digester Rehabilitation		$117,430,000
Salvage Value		-$19,170,000
Total Capital Cost		**$246,410,000**
Summary of Annual Operation and Maintenance Costs		
Total Annual Cost	$40,500,000	
Life Cycle Analysis		
Number of Years	20	
Present Worth Factor	12.331	
Present Worth of Total Annual Operation and Maintenance Costs		**$499,410,000**
Summary of Non-Annual Operation and Maintenance Costs		
NONE		
Present Worth of Total Non-Annual Operation and Maintenance Costs		**$0**
TOTAL PRESENT WORTH		**$746,000,000**

ENR = Engineering News Record
GBT = Gravity Belt Thickener
JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated sludge

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TABLE 9-30

CAPITAL COSTS FOR RECOMMENDED PLAN ALTERNATIVE 4 – COMBINE MILORGANITE® PROGRAM WITH LAND APPLICATION

Total 2020 MMSD Sludge Production (dt/yr)	81,000 (raw solids)
Total Annual Operating and Maintenance Cost	**$40,500,000**

JIWWTP Energy Costs

Item/Process	Annual Cost ($/yr)
Natural Gas — Turbine Fuel	$10,540,000
Natural Gas — Direct Firing of Dryers	$5,120,000
Natural Gas — GFT NOx Control and Startup	$0
Natural Gas — Other Plant Facilities	$5,450,000
Firm Electricity — Base Power Load	$7,000
Firm Electricity — Demand Charges	$0
Interruptible Electricity — Base Power Load	$0
Interruptible Electricity — Demand Charges	$0
Turbine Operation and Maintenance	$1,290,000
Subtotal	**$22,400,000**

SSWWTP Natural Gas Credit

Additional amount of solids destroyed in digestion	10,375 tons/year	
Additional amount of energy recovered from digestion process	150,267 Dtherm/year	
Value of additional energy recovered in terms of cost of equivalent gas purchase		**-$1,390,000**

Milorganite® Annual Operating and Maintenance Costs

% of Sludge to Milorganite®	100%
Annual Sludge Volume (dt/year)	81,000 (raw)
% sold	45%

Item/Process	Process Unit Cost ($/dt)	Process Contribution Cost ($/dt raw)	Annual Cost ($/yr)
JIWWTP Thickening	$53.00	$13.80	$1,120,000
JIWWTP Dewatering/Drying	$191.30	$139.80	$11,320,000
JIWWTP Chaff Processing	$443.30	$16.70	$1,350,000
Milorganite® Warehouse/Shipping	$27.20	$19.90	$1,610,000
Milorganite® Marketing	$81.70	$26.90	$2,180,000
IPS Pipeline Sludge Transfer (includes SSWWTP energy)	$3.20[1]	$2.00	$160,000
SSWWTP WAS Thickening (energy included)	$82.40	$0.50	$40,000
SSWWTP Digestion (energy included)	$36.40	$22.90	$1,860,000
Milorganite® Land Application	$135.1	$49.40	$4,000,000
Milorganite® Sales Revenue	-$155.80	-$51.30	-$4,160,000
Subtotal		**$240.60**	**$19,490,000**

dt = Dry Tons
Dtherm = Dekatherm
GFT = Glass Furnace Technology
IPS = Interplant Solids Pipeline
JIWWTP = Jones Island Wastewater Treatment Plant
NOx = Nitrogen Oxide
O&M = Operation and Maintenance
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
yr = Year

NOTE:
1) Average of costs to pump WAS, primary sludge, and digested sludge

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TABLE 9-31

O&M COSTS FOR RECOMMENDED PLAN ALTERNATIVE 4 – COMBINE MILORGANITE® PROGRAM WITH LAND APPLICATION

Recommended Plan Alternative 5 - Combine Milorganite® Program with Glass Furnace Technology

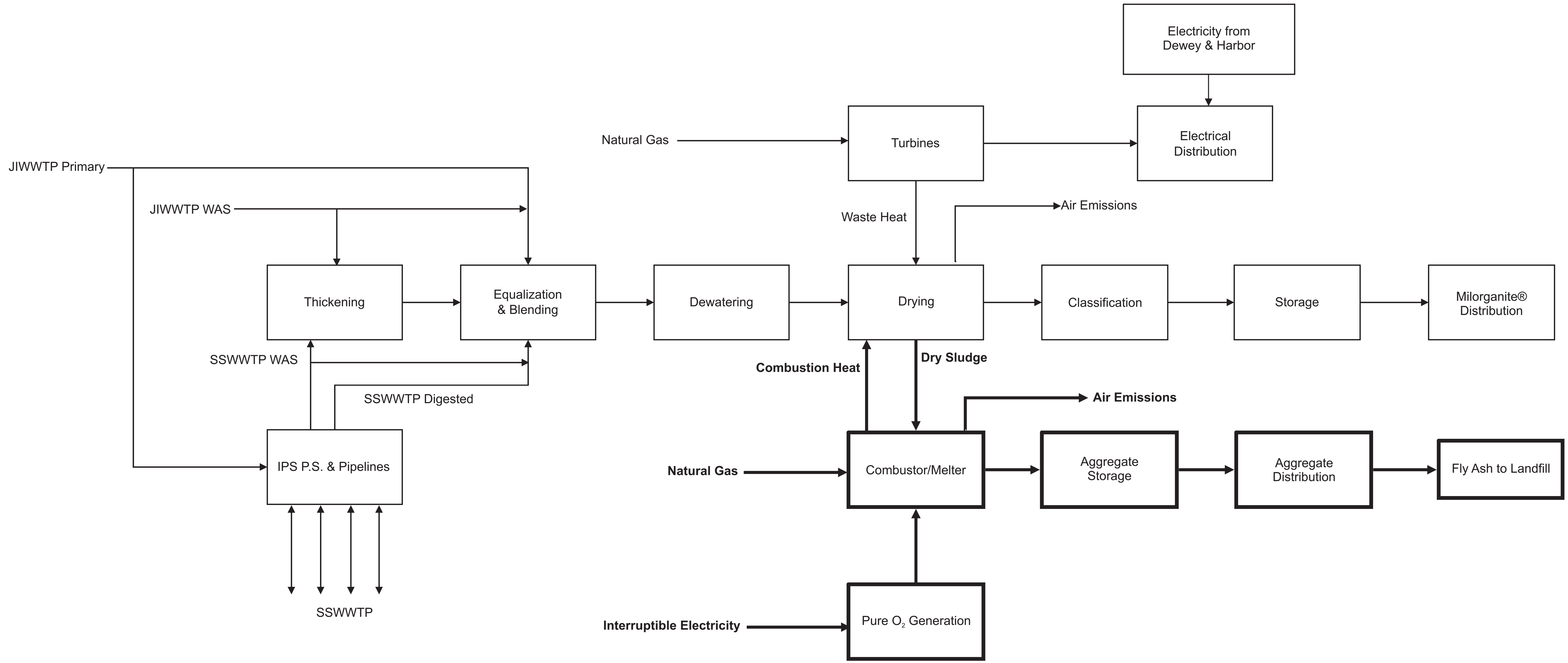
Description

This alternative combines a Milorganite® program with a glass furnace technology facility to treat the biosolids load. This alternative will use the Milorganite® program to produce Milorganite® for sale or for further processing in the glass furnace facility. Approximately 45% of the Milorganite® produced will be sold with the remaining 55% processed in a glass aggregate facility. This approach combines two compatible technologies to take advantage of the benefits of each. The capital improvements necessary to implement this alternative include similar improvements to those described in the alternatives that only included each respective technology. The JIWWTP and SSWWTP schematics for this alternative are shown in Figures 9-27 and 9-28.

In addition to the glass aggregate facility installation, improvements at JIWWTP include a new turbine, cooling water pumping system upgrades, Dewatering and Drying facilities improvements, and a new locomotive. The SSWWTP improvements include seven new GBTs for WAS thickening prior to anaerobic digestion. To ensure reliable digester operation, the six existing mesophilic digesters would be rehabilitated with new mixing systems, all six existing sludge storage tanks would be converted back to anaerobic digesters, and five additional digesters would be required to handle the projected biosolids load. Pumping and cathodic protection improvements would also be necessary for the interplant solids pipeline to ensure its continued reliable operation.

This alternative has an estimated capital cost of $287 million, annual O&M cost of $32.7 million, and present value of $691 million.[bb] These costs are shown in more detail in Tables 9-32 and 9-33.

[bb] See Appendix 9G, *Biosolids Recommended Plan Alternatives - Cost Estimates* for more information.



LEGEND

- Existing Process
- Existing Process Abandoned
- Existing Process Abandoned
- New Process

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station
O_2 = Oxygen

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FIGURE 9-27
BIOSOLIDS SCHEMATIC AT JIWWTP FOR RECOMMENDED PLAN ALTERNATIVE 5 – COMBINE MILORGANITE® PROGRAM WITH GLASS FURNACE TECHNOLOGY
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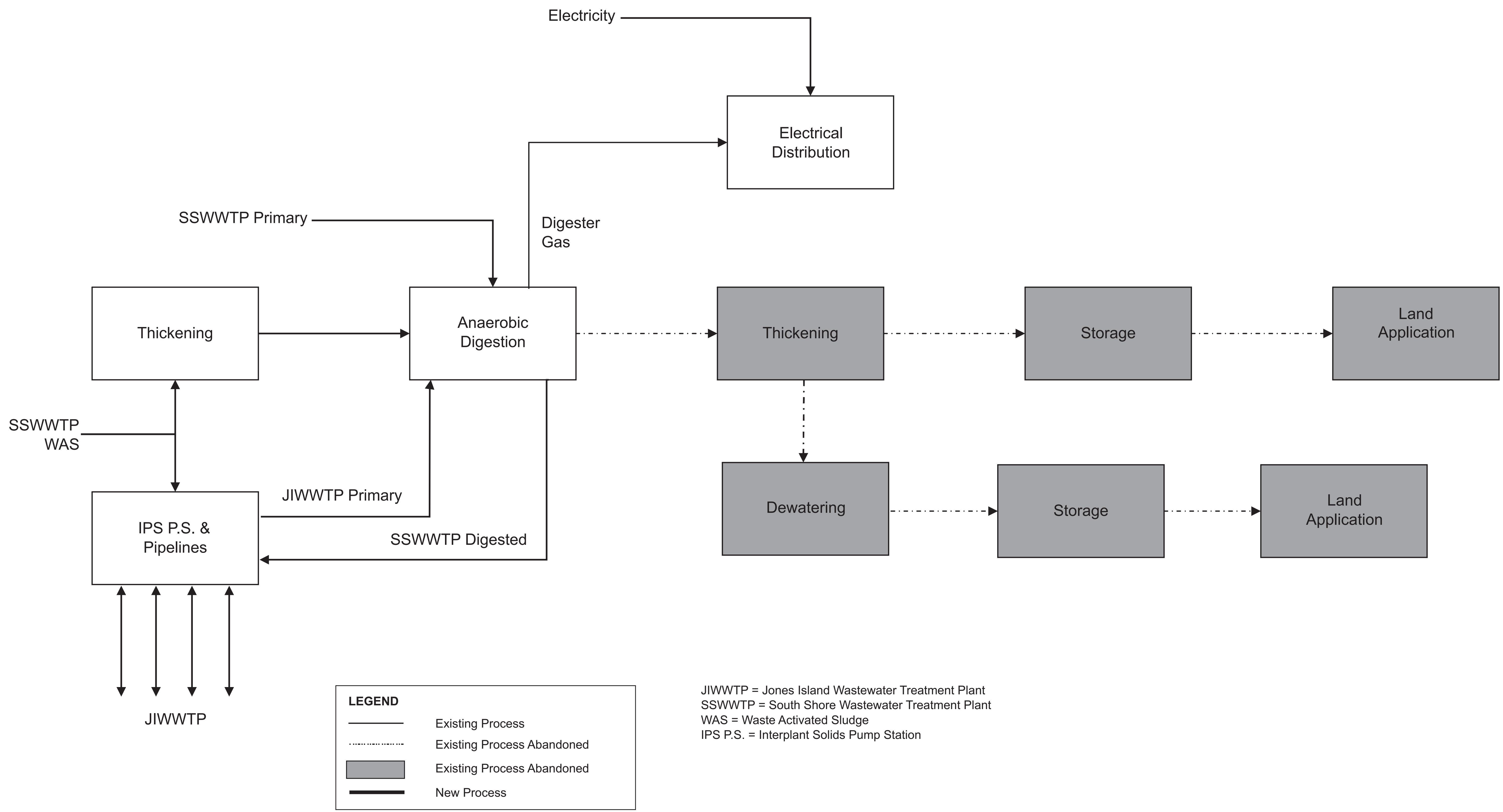

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-28
BIOSOLIDS SCHEMATIC AT SSWWTP FOR RECOMMENDED PLAN ALTERNATIVE 6 – COMBINE MILORGANITE® PROGRAM WITH GLASS FURNACE TECHNOLOGY
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General Description

All treatment plant primary sludge is digested and then combined with raw secondary sludge. The sludge blend is controlled to produce some classic Milorganite® meeting the 6% Nitrogen guarantee while the remaining blend is dried and fed to the Glass Furnace to capture energy and glass aggregate. Construction requires 7 new GBTs for SSWWTP WAS thickening and 5 new digesters.

Biosolids Load		
Influent Sludge	81,000	
Finished Biosolids	33,700	

Raw Sludge Influent Load Distribution		
Milorganite®	33%	
Glass Furnace Facility	67%	
Landfill	0%	

ENR Index	10,000	(assumed Milwaukee 2007)
Interest Rate per Year	5.125%	

Summary of Capital Costs	
JIWWTP Turbine Upgrades	$16,460,000
JIWWTP Cooling Water Pump Upgrades	$600,000
JIWWTP Dewatering and Drying Facility Upgrades	$114,740,000
JIWWTP New Locomotive	$3,050,000
JIWWTP New Glass Furnace Process	$32,650,000
JIWWTP New Glass Furnace and Turbine Buildings	$11,400,000
Interplant Solids Pipeline Upgrades	$2,870,000
SSWWTP New Gravity Belt WAS Thickeners	$7,580,000
SSWWTP Digester Rehabilitation	$117,430,000
Salvage Value	-$19,560,000
Total Capital Cost	**$287,220,000**

Summary of Annual Operation and Maintenance Costs

Total Annual Cost	$32,740,000

Life Cycle Analysis	
Number of Years	20
Present Worth Factor	12.331

Present Worth of Total Annual Operation and Maintenance Costs	**$403,720,000**

Summary of Non-Annual Operation and Maintenance Costs

Process	**Cost**	**ENR Index**	**Year**	**Present Worth**
Major unit refractory replacement	$185,000	9,700	10	$120,000
Fabric filter bag replacement	$32,000	9,700	5	$30,000
Fabric filter bag replacement	$32,000	9,700	10	$20,000

Present Worth of Total Non-Annual Operation and Maintenance Costs	**$170,000**
TOTAL PRESENT WORTH	**$691,000,000**

ENR = Engineering News Record
GBT = Gravity Belt Thickener
JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge

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TABLE 9-32

CAPITAL COSTS FOR RECOMMENDED PLAN ALTERNATIVE 5 – COMBINE MILORGANITE® PROGRAM WITH GLASS FURNACE TECHNOLOGY

Total 2020 MMSD Sludge Production (dt/yr)	**81,000** (raw solids)
Total Annual Operating and Maintenance Cost	**$32,740,000**

JIWWTP Energy Costs

Item/Process	Annual Cost ($/yr)
Natural Gas — Turbine Fuel	$10,540,000
Natural Gas — Direct Firing of Dryers	$1,230,000
Natural Gas — GFT NOx Control and Startup	$50,000
Natural Gas — Other Plant Facilities	$5,445,016
Firm Electricity — Base Power Load	$7,000
Firm Electricity — Demand Charges	$0
Interruptible Electricity — Base Power Load	$470,000
Interruptible Electricity — Demand Charges	$1,000
Turbine Operation and Maintenance	$1,290,000
Subtotal	**$19,030,000**

SSWWTP Natural Gas Credit

Additional amount of solids destroyed in digestion	10,375 tons/year	
Additional amount of energy recovered from digestion process	150,267 Dtherm/year	
Value of additional energy recovered in terms of cost of equivalent gas purchase		**-$1,390,000**

Milorganite® Annual Operating and Maintenance Costs

% of Sludge to Milorganite®	33%
Annual Sludge Volume (dt/year)	26,730 (raw)
% sold	100%

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TABLE 9-33 SHEET 1 OF 2

O&M COSTS FOR RECOMMENDED PLAN ALTERNATIVE 5 – COMBINE MILORGANITE® PROGRAM WITH GLASS FURNACE TECHNOLOGY

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Item/Process	Process Unit Cost ($/dt)	Process Contribution Cost ($/dt raw)	Annual Cost ($/yr)
JIWWTP Thickening	$53.00	$13.80	$1,120,000
JIWWTP Dewatering/Drying	$191.30	$139.80	$11,320,000
JIWWTP Chaff Processing	$443.30	$16.70	$1,350,000
Milorganite® Warehouse/Shipping	$27.20	$19.90	$1,610,000
Milorganite® Marketing	$81.70	$26.90	$2,180,000
IPS Pipeline Sludge Transfer (includes SSWWTP energy)	$3.20	$2.00	$160,000
SSWWTP WAS Thickening (energy included)	$82.40	$0.50	$40,000
SSWWTP Digestion (energy included)	$36.40	$22.90	$1,860,000
Milorganite® Land Application	$135.1	$49.40	$4,000,000
Milorganite® Sales Revenue	-$155.80	-$51.30	-$4,160,000
Subtotal		**$240.60**	**$19,490,000**

Glass Furnace Facility Annual Operating Costs	
% of Sludge to Glass Furnace Facility	67%
Annual Sludge Volume (dt/year)	54,270 (raw)
Annual Biosolids to Glass Furnace Facility	33,900

Item/Process	Process Unit Cost ($/dt)	Process Contribution Cost ($/dt raw)	Annual Cost ($/yr)
JIWWTP Thickening	$53.00	$2.10	$120,000
JIWWTP Dewatering/Drying	$191.30	$116.20	$6,310,000
JIWWTP Sodium Hydroxide for GFT SO_2 Control	$6.20	$3.90	$210,000
JIWWTP Ammonia for GFT NOx control	$0.50	$0.30	$20,000
JIWWTP Liquid O_2 Tank and Vaporizer Rental	per year	$0.48	$30,000
JIWWTP GFT Liquid Oxygen Usage	$2.10	$1.30	$70,000
JIWWTP GFT Equipment Maintenance	$8.20	$5.20	$280,000
JIWWTP GFT Ash Disposal	$0.60	$0.40	$20,000
JIWWTP GFT Staffing	per year	$11.39	$620,000
IPS Pipeline Sludge Transfer (includes SSWWTP energy)	$3.20[1]	$2.10	$110,000
SSWWTP WAS Thickening (energy included)	$82.40	$0.80	$40,000
SSWWTP Digestion (energy included)	$36.40	$33.50	$1,820,000
Subtotal		**$177.67**	**$9,650,000**

dt = Dry Tons
GFT = Glass furnace Technology
IPS = Interplant Solids Pipeline
JIWWTP = Jones Island Wastewater Treatment Plant
NOx = Nitrogen Oxide
O_2 = Oxygen
O&M = Operation and Maintenance
SO_2 = Sulfur Dioxide
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
yr = Year

NOTE:
1) Average of costs to pump WAS, primary sludge, and digested sludge

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TABLE 9-33 SHEET 2 OF 2

O&M COSTS FOR RECOMMENDED PLAN ALTERNATIVE 5 – COMBINE MILORGANITE® PROGRAM WITH GLASS FURNACE TECHNOLOGY

Advantages and Disadvantages

The advantages and disadvantages of this alternative are summarized below.

Advantages

- Lowest present value of all alternatives evaluated
- Year round availability of biosolids disposal
- No sludge storage required
- Considered beneficial reuse
- Process flexibility – can process solids as Milorganite or with GFT, and can also recover energy at SSWWTP with digestion process
- Maintains a higher quality dried sludge (6% nitrogen) that is easier to market and MMSD can retain the highest revenue per ton
- Moderate energy use because GFT technology captures a lot of energy
- Large reduction in some air emissions due to less natural gas use in the one new efficient turbine.
- Lower O&M cost due to lower energy requirement

Disadvantages

- Reliance on WE Energies for peak demand electricity
- Potential difficulty in maintaining 6% nitrogen in Milorganite® (although less of an issue than for the all Milorganite® alternative)
- Significant capital investment
- GFT is relatively new technology – only one other U.S. municipal sludge facility
- Long-term maintenance requirements and costs unknown for GFT
- Must find use for glass aggregate or has to go to landfill (more manageable quantity than Recommended Plan Alternative 2)
- 2020 biosolids loadings are slightly beyond the limits of nameplate capacity for GFT system so additional disposal option may be required
- GFT air emissions include some new air emission sources; new source review may be required to permit under the Clean Air Act

Other Comments

1) Need to evaluate turbines versus purchase of electricity and firing dryers on natural gas only
2) If go with turbines, a second turbine could be beneficial to eliminate higher costs for peak electricity demands (or maintain one of existing turbines for peak shaving)
3) A combination alternative allows for increased flexibility to protect against loss of industrial wasteloads
4) The stated capacity of the GFT system is 100 tons per day. At the Revised 2020 Baseline biosolids loading, the system may be required to process 106 tons per day, 330 days per year. The vendor who supplied the quote for the GFT system stated that they have enough contingencies in their sizing to handle this additional amount should it occur.

Recommended Plan Alternative 6 - Combine Milorganite® Program with Landfill Disposal

Description

This alternative combines a Milorganite® program with a landfill program to treat the influent sludge load. Approximately 46% of the finished biosolids will be Milorganite® product with the remaining 54% being sent to a landfill after thickening and dewatering at SSWWTP. The same percentage of raw sludge is processed into Milorganite® in this alternative as in Recommended Biosolids Plan Alternative 5. However, Milorganite® makes up a slightly larger percent of finished biosolids in this alternative than in Recommended Biosolids Plan Alternative 5. This due to the fact that the Milorganite® in this alternative contains a lower percentage of digested sludge (to make up for the fact that all of the landfilled solids are digested) than the Milorganite® in Recommended Plan Alternative 5 (where only about 87% of the solids sent to Minergy have been digested), and thus less of the raw solids sent to Milorganite are lost during digestion in this alternative compared to Recommended Biosolids Plan Alternative 5. This results in Milorganite® making up a higher percentage of finished biosolids in this alternative, than in Recommended Plan Alternative 5.

This approach combines two proven technologies to take advantage of the benefits of each. The capital improvements necessary to implement this alternative include similar improvements to those described in the screening alternatives for the individual technologies. The JIWWTP and SSWWTP schematics for this alternative are shown in Figures 9-29 and 9-30.

Improvements at JIWWTP include one new turbine, Dewatering and Drying facilities improvements, and a new locomotive. The SSWWTP improvements include seven new GBTs for WAS thickening prior to anaerobic digestion. To ensure reliable digester operation, the six existing mesophilic digesters would be rehabilitated with new mixing systems, all six existing sludge storage tanks would be converted back to anaerobic digesters, and seven additional digesters would be required to handle the projected biosolids load. The SSWWTP digested sludge thickening facilities would be expanded with two new two-meter GBTs and two new one-meter GBTs and the SSWWTP dewatering facilities would be rehabilitated. No long-term cake storage would be required since it is assumed that the landfill is available all year-round. Sludge trucking to the landfill would be continuous. Pumping and cathodic protection improvements would also be necessary for the interplant solids pipeline to ensure its continued reliable operation.

This alternative has an estimated capital cost of \$289 million, annual O&M cost of \$35.6 million, and present value of \$728 million.[cc] These costs are shown in more detail in Tables 9-34 and 9-35.

[cc] See Appendix 9G, *Biosolids Recommended Plan Alternatives - Cost Estimates* for more information.

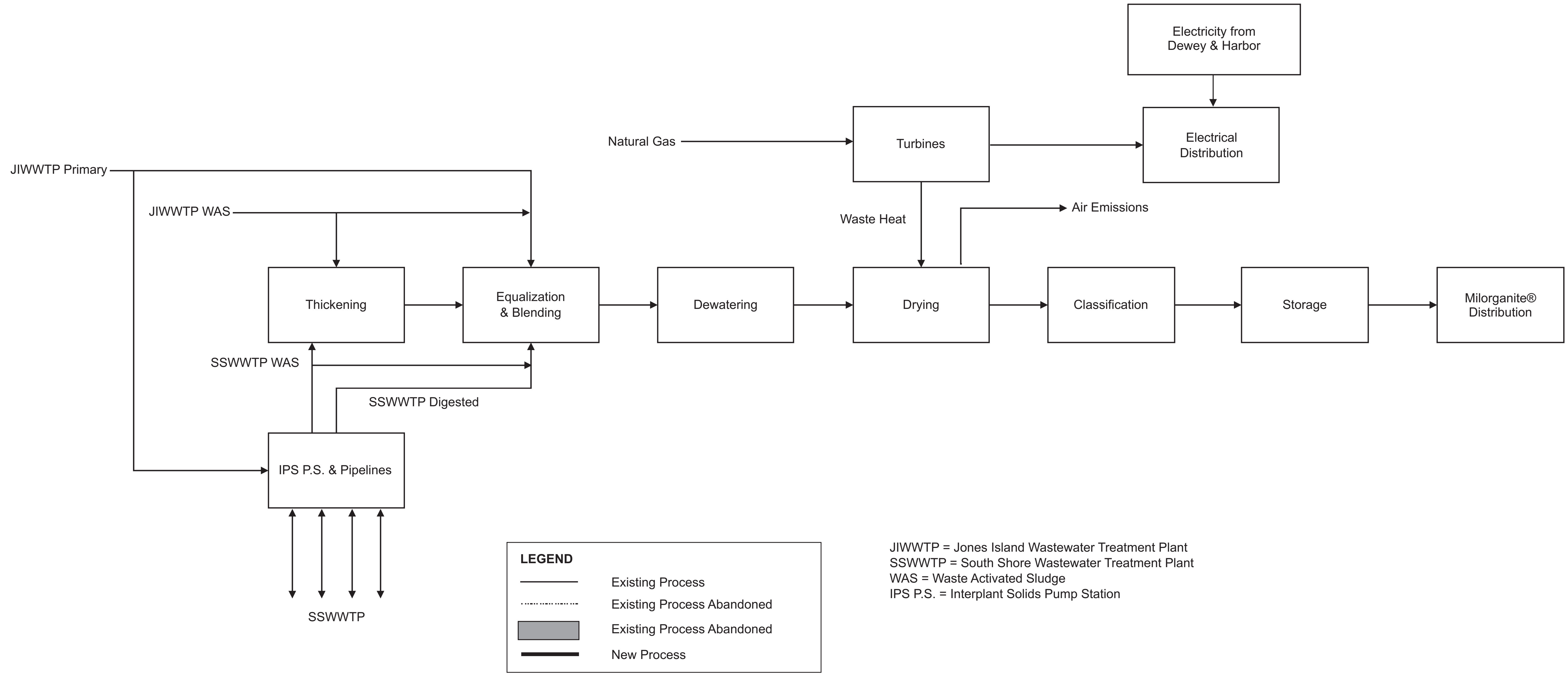

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FIGURE 9-29
BIOSOLIDS SCHEMATIC AT JIWWTP FOR RECOMMENDED PLAN ALTERNATIVE 6 – COMBINE MILORGANITE® PROGRAM WITH LANDFILL DISPOSAL
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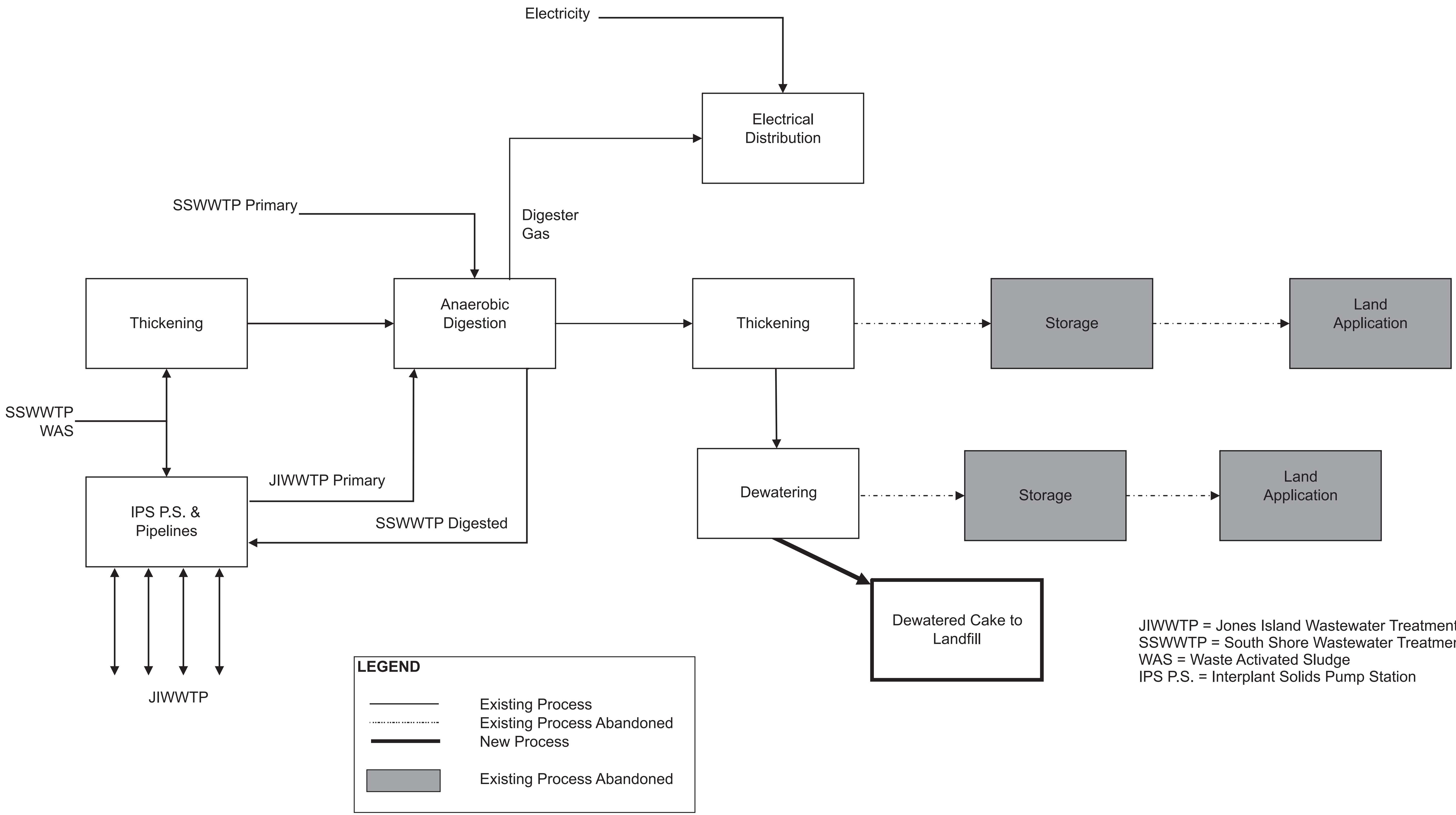

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
IPS P.S. = Interplant Solids Pump Station

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FIGURE 9-30
BIOSOLIDS SCHEMATIC AT SSWWTP FOR RECOMMENDED PLAN ALTERNATIVE 6 – COMBINE MILORGANITE® PROGRAM WITH LANDFILL DISPOSAL

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General Description

A combination of Milorganite® and either landfill or land application of dewatered digested sludge. Milorganite® is made from a blend of raw WAS and digested sludge at a ratio that allows the Milorganite® 6% Nitrogen guarantee to be maintained. All remaining treatment plant sludges are digested and cake pressed. Dewatered cake is either land applied or landfilled. Landfill costs are used since they are less than land application.

Biosolids Load		
Influent Sludge	82,300	
Finished Biosolids	52,600	
Raw Sludge Influent Load Distribution		
Milorganite®	33%	
Glass Furnace Facility	0%	
Landfill	67%	
ENR Index	10,000 (assumed Milwaukee 2007)	
Interest Rate per Year	5.125%	
Summary of Capital Costs		
JIWWTP Turbine Upgrades		$16,460,000
JIWWTP Turbine Building		$3,400,000
JIWWTP Dewatering and Drying Facility Upgrades		$114,740,000
JIWWTP New Locomotive		$3,050,000
Interplant Solids Pipeline Upgrades		$2,870,000
SSWWTP New Gravity Belt WAS Thickeners		$7,580,000
SSWWTP Digester Rehabilitation		$158,310,000
SSWWTP New Gravity Belt Digested Sludge Thickeners		$3,420,000
SSWWTP Dewatering Upgrades		$5,360,000
Salvage Value		-$26,030,000
Total Capital Cost		**$289,160,000**
Summary of Annual Operation and Maintenance Costs		
Total Annual Cost	$35,620,000	
Life Cycle Analysis		
Number of Years	20	
Present Worth Factor	12.331	
Present Worth of Total Annual Operation and Maintenance Costs		**$439,240,000**
Summary of Non-Annual Operation and Maintenance Costs		
NONE		
Present Worth of Total Non-Annual Operation and Maintenance Costs		**$0**
TOTAL PRESENT WORTH		**$728,000,000**

ENR = Engineering News Record
WAS = Waste Activated Sludge
JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

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TABLE 9-34
CAPITAL COSTS FOR RECOMMENDED PLAN ALTERNATIVE 6 – COMBINE MILORGANITE® PROGRAM WITH LANDFILL DISPOSAL

Total 2020 MMSD Sludge Production (dt/yr)	81,000 (raw solids)
Total Annual Operating and Maintenance Cost	**$35,620,000**

JIWWTP Energy Costs

Item/Process	Annual Cost ($/yr)
Natural Gas — Turbine Fuel	$10,540,000
Natural Gas — Direct Firing of Dryers	$0
Natural Gas — GFT NOx Control and Startup	$0
Natural Gas — Other Plant Facilities	$5,450,000
Firm Electricity — Base Power Load	$7,000
Firm Electricity — Demand Charges	$0
Interruptible Electricity — Base Power Load	$0
Interruptible Electricity — Demand Charges	$0
Turbine Operation and Maintenance	$1,290,000
Subtotal	**$17,290,000**

SSWWTP Natural Gas Credit

Additional amount of solids destroyed in digestion	12,734 tons/year	
Additional amount of energy recovered from digestion process	150,267 Dtherm/year	
Value of additional energy recovered in terms of cost of equivalent gas purchase		**-$1,390,000**

Milorganite® Annual Operating and Maintenance Costs

% of Sludge to Milorganite®	33%
Annual Sludge Volume (dt/year)	27,159 (raw)
% sold	100%

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TABLE 9-35 SHEET 1 OF 2

O&M COSTS FOR RECOMMENDED PLAN ALTERNATIVE 6 – COMBINE MILORGANITE® PROGRAM WITH LANDFILL DISPOSAL

Item/Process	Process Unit Cost ($/dt)	Process Contribution Cost ($/dt raw)	Annual Cost ($/yr)
JIWWTP Thickening	$53.00	$37.10	$1,010,000
JIWWTP Dewatering/Drying	$191.30	$186.40	$5,060,000
JIWWTP Chaff Processing	$443.30	$22.20	$600,000
Milorganite® Warehouse/Shipping	$27.20	$26.50	$720,000
Milorganite® Marketing	$81.70	$79.60	$2,160,000
IPS Pipeline Sludge Transfer (includes SSWWTP energy)	$3.20	$1.70	$50,000
SSWWTP WAS Thickening (energy included)	$82.40	$0.40	$10,000
SSWWTP Digestion (energy included)	$36.40	$2.20	$60,000
Milorganite® Land Application	$135.1	$0.00	$0
Milorganite® Sales Revenue	-$155.80	-$151.80	-$4,120,000
Subtotal		**$204.30**	**$5,550,000**

Landfill Annual Operating and Maintenance Costs

% of Sludge to Landfill	67%
Annual Sludge Volume (dt/year)	55,141 (raw)

Item/Process	Process Unit Cost ($/dt)	Process Contribution Cost ($/dt raw)	Annual Cost ($/yr)
IPS Pipeline Sludge Transfer (includes SSWWTP energy)	$3.20[1]	$0.70	$40,000
SSWWTP WAS Thickening (energy included)	$82.40	$6.90	$380,000
SSWWTP Digestion (energy included)	$36.40	$36.40	$2,010,000
SSWWTP DS Thickening (energy included)	$82.40	$47.20	$2,600,000
SSWWTP Dewatering (energy included)	$115.00	$65.90	$3,630,000
SSWWTP Landfill System Staffing	per year	$16.79	$920,000
Cake Trucking and Landfilling	$145.30	$83.20	$4,590,000
Subtotal		**$257.09**	**$14,170,000**

DS = Digested Sludge
dt = Dry Tons
GFT = Glass Furnace Technology
IPS = Interplant Solids Pipeline
JIWWTP = Jones Island Wastewater Treatment Plant
NOx = Nitrogen Oxide
O&M = Operation and Maintenance
SSWWTP = South Shore Wastewater Treatment Plant
WAS = Waste Activated Sludge
yr = Year

NOTE:
1) Average of costs to pump WAS, primary sludge, and digested sludge

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TABLE 9-35 SHEET 2 OF 2

O&M COSTS FOR RECOMMENDED PLAN ALTERNATIVE 6 – COMBINE MILORGANITE® PROGRAM WITH LANDFILL DISPOSAL

Advantages and Disadvantages

The advantages and disadvantages of this alternative are summarized below.

Advantages

- Year round ability to dispose of biosolids
- No sludge storage required
- Milorganite® is considered beneficial reuse
- Process flexibility – can process solids as Milorganite or landfill the solids, and can also recover energy at SSWWTP with digestion process
- Maintains a higher quality dried sludge (6% nitrogen) that is easier to market and MMSD can retain the highest revenue per ton
- Moderate energy use since running fewer dryers
- Major reduction in air emissions (one new efficient turbine, reduced loadings through dryers)
- Lower O&M cost due to lower energy requirement

Disadvantages

- Second highest present value of all alternatives evaluated
- Landfill operators have control over pricing and availability for over half the biosolids quantity produced
- Potential WDNR regulations limiting organic input to a landfill
- High traffic volume at SSWWTP due to truck hauling
- Landfill not considered a beneficial reuse
- Landfill probably not perceived well by public

Other Comments

1) Need to evaluate turbines versus purchase of electricity and firing dryers on natural gas only
2) If go with turbines, a second turbine could be beneficial to eliminate peaks (or maintain one of existing turbines for peaking)
3) A combination alternative allows for increased flexibility to protect against loss of industrial wasteloads

9.10 Interim Recommended Biosolids Plan

9.10.1 Recommended Plan Alternatives Cost Summary and Interim Recommended Plan

A change from the existing biosolids operations is being investigated only to better position MMSD to reliably process and dispose of biosolids in the most cost effective manner. The existing biosolids program of Milorganite® and Agri-life®, with landfill as a backup has sufficient capacity to process current and future loads with only the anaerobic digestion process at SSWWTP requiring any expansion to meet Revised 2020 Baseline loads (refer to Chapter 5 of this report for additional discussion on the capacity of existing facilities to meet future loads).

Table 9-36 summarizes the capital, O&M and present value cost for the Recommended Plan Alternatives evaluated in Section 9.9.

TABLE 9-36
BIOSOLIDS ALTERNATIVES COST SUMMARY ($ M)

Alternative	Capital	Operation and Maintenance	Present Value	% of Lowest Cost Alternative
1. Landfill	$288	$34.2	$710	103%
2. Glass Furnace Technology	335	31.5	724	105%
3. Maintain Existing Milorganite® Program	246	37.8	712	103%
4. Combine Milorganite® Program with Land Application	246	40.5	746	108%
5. Combine Milorganite® Program with Glass Furnace Technology	287	32.7	691	100%
6. Combine Milorganite® Program with Landfill Disposal	289	35.6	728	105%

Notes:
O&M impact from the Recommended Plan alternatives is estimated at approximately $10 to $18 million per year above current O&M costs. See discussion presented earlier in Section 9.9 for more details.
These costs are facilities planning level estimates and have an accuracy of +50%/-30%.
Capital costs include construction cost plus 25% for contingencies and 35% for technical services and administration.

The present value for each of these alternatives is considered equal given the accuracy of facilities planning estimates (+50%/-30% cost accuracy). Thus, there is no strong financial present value basis for making a 2020 FP recommendation.

The 2020 FP does not recommend Alternative 1 because it relies on essentially a single biosolids technology for handling biosolids with little option to process biosolids by an alternative means. However, the 2020 FP recommends that MMSD maintain current thickening and plate and frame dewatering capabilities at SSWWTP, regardless of which alternative is selected, to allow landfill as a backup to any other technology selected.

The 2020 FP recommends that MMSD continue with existing operations for an interim period, and use the interim period to continue to evaluate the other potential biosolids options and to fully understand the impacts of the loss of LeSaffre Yeast. Chapter 11, the *Implementation Plan,* will identify the analyses that will be necessary to be completed before the determination of a final Recommended Plan.

Throughout the interim period, the following additional analyses are recommended for completion, which will allow for a better assessment of the remaining future biosolids options:

- Review of 2006 and future years of JIWWTP and SSWWTP wasteload data to better characterize the impact of the loss of the LeSaffre waste load. This additional data will be vital for the recommended *Evaluation of Milorganite® Nitrogen Balance* study.
- A Milorganite® marketing study addressing the marketing of a less than 6% nitrogen product.
- An overall assessment report on energy (recommended in Section 9.10.2 and in Chapter 8, *Common Treatment Programs, Facilities, Operational Improvements, and Policies* of this report).
- Additional study of the potential new options (such as GFT).

With this additional detailed information, the costs, advantages, and disadvantages of moving forward with a new biosolids program versus continuing the current program can be better understood and quantified. During this extended evaluation period, more detailed consideration can be given to combining Milorganite® production with other potential alternatives evaluated in this chapter.

These issues will be more fully discussed in Chapter 11, *Implementation Plan*.

The recommendation to continue with the existing biosolids program for this interim period while further evaluating future biosolids management options is based on the following key non-monetary factors:

- The change in wasteload and wasteload composition (in particular mass loading and nutrient content) resulting from the relocation of the LeSaffre Yeast outside of the MMSD service area is not fully understood based upon 2006 data and a major change in the MMSD's biosolids management program at this time is not advisable until this change is more fully understood.
- The future operation and maintenance costs (particularly the future costs for natural gas and electricity) for all of the biosolids program alternatives are uncertain and thus do not provide a solid basis for a major change in the MMSD's biosolids management program at this time.
- Taking additional time to assess new potential biosolids programs avoids the risk of implementation of any new option too quickly without fully understanding the long-term impacts of the change.
- The additional evaluation allows MMSD to continue with improvements common to all remaining future biosolids program options (see Section 9.10.2, Interim Recommendations below) without risking premature investment in new facilities that

might not ultimately be effective at efficient biosolids management (due to insufficient data while planning, as discussed above).

- Continuing current biosolids management provides the greatest certainty in that Milorganite® and other operational costs are well understood based on past experience. The additional planning time provides an opportunity to increase the confidence level of the operational cost estimates for the other biosolids alternatives through more detailed analyses.
- The GFT alternative, in combination with Milorganite®, will continue to be evaluated as a possible future alternative. More information must be gathered regarding the costs, implementation issues and guarantees involved in the implementation of this relatively new process.
- Milorganite® can continue to be made; taking full advantage of the huge investment of public capital that has been made in Milorganite® production facilities in relatively recent years and the Milorganite® branding that has been established for nearly 80 years.
- The beneficial re-use of MMSD biosolids can continue.
- The facilities required for landfilling and land applying biosolids can still be available as a backup to the Milorganite process. This results in additional biosolids management flexibility with minimal short-term capital expenditures.

The specific evaluations to be conducted in the interim period to move towards the development of a final biosolids management plan are described in the next section. Currently recommended facility and operational improvements are also discussed.

9.10.2 Interim Recommendations

In order to develop a final biosolids management program, a number of additional analyses are recommended for completion in the interim period. These analyses are described below.

There are a number of proposed improvements that are common to all of the remaining biosolids alternatives. These improvements are also described below. The MMSD should move forward with the implementation of these recommended improvements as it works on selecting a final biosolids management plan.

Detailed Engineering and Other Analyses

Conduct Milorganite® Marketing Study Assuming 5% or Less Nitrogen Content

With the relocation of LeSaffre Yeast, the average Milorganite® nitrogen content has decreased. For many years, Milorganite® has been marketed with a guaranteed 6% nitrogen content. To adequately process all biosolids with existing facilities, the average nitrogen content in Milorganite® will likely average below 6%. The market implications of the lower nitrogen content need to be understood. The MMSD plans to begin a marketing study in the early part of 2007 and continuation with that plan is recommended.

Evaluation of Milorganite® Nitrogen Balance

Maintaining the nitrogen guarantee of Milorganite® is desirable to maintain the price that buyers are willing to pay and the overall sales volume. There needs to be more detailed data taken on a routine basis to track the overall nitrogen flow through the treatment plant and through the biosolids process. In addition, there is an unexplained increase in Milorganite® nitrogen over the sum of its constituents. A full understanding of this nitrogen balance will help MMSD and its wastewater treatment plant operators better manage the use and blend of biosolids to ensure the nitrogen guarantee is met. Thus, additional data is recommended to be gathered on a routine basis on all nitrogen forms and their concentrations in all steps of the Milorganite® production process.

Overall Assessment Report on Energy and Energy Management and Power Supply/Power Generation

Energy and biosolids need to be considered together because the two are intimately connected. Energy costs make up a significant percentage of the costs to process biosolids.

Drying sludge to produce Milorganite® at JIWWTP is extremely energy intensive. The dryers typically operate on waste heat from the power generating turbines at JIWWTP and on the direct firing of purchased natural gas. The energy economics of sludge drying are dependent on the dryness of the dewatered cake (dryer feed), the efficiency of the turbine that is supplying waste heat, the plant electrical load on any given day (which is met by operating the turbine), and the cost of natural gas.

The cost to remove water from the cake feed before sending it to the dryer (which is primarily the chemical cost for sludge thickening) needs to be balanced with the cost of evaporating water from the cake in the dryer. The cost of purchasing natural gas to operate a turbine to supply waste heat to the dryers (and power JIWWTP) has to be balanced against the costs of not operating a turbine (i.e. purchasing natural gas to operate the dryers directly and purchasing electricity to operate the rest of JIWWTP). These comparisons are greatly complicated by the fact that the future costs of electricity and natural gas are difficult to predict.

In addition to these issues, the turbines at JIWWTP will likely need to be replaced during the 2020 planning period. The turbines date to the late 1960s and are inefficient when compared to new turbines. At current (year 2006) biosolids production levels, there is substantially more waste heat generated from the JIWWTP turbines than required for sludge drying as shown in Figure 4-4 in Chapter 4 of this report. This excess waste heat represents energy purchased (in the form of natural gas) for which no benefit is received. The turbines require increasing maintenance due to their age.[dd](15) Spare parts are becoming difficult to obtain.

An overall assessment report on energy requirements/energy management and power supply/power generation at JIWWTP is necessary and recommended to determine what should be done to replace the aging turbines, how to most efficiently operate the dryers (a critical element of the biosolids management program), and, correspondingly, how all energy should be managed at JIWWTP.

Several options exist for future power supply. Selecting the best option requires consideration of base plant electric load, peak plant electric load, frequency and duration of peak electric loads, and usage of any generated waste heat. Options considered in this facility planning effort that should be further evaluated include the following:

- Providing two new redundant transmission level service connections and abandoning the use of turbines

[dd] See Appendix 9C, *Historic MMSD Data* for more information.

- Providing a single new turbine and maintaining one existing turbine available for peak shaving, while retaining the existing Dewey and Harbor electrical services
- Providing a single transmission level service connection and one new turbine

It may be possible to achieve lower operating costs by not operating the turbines, purchasing all plant electrical power, and operating Milorganite® dryers on direct firing of natural gas. Transmission level electrical service is available close to JIWWTP and consideration should be given to providing dual transmission level service connections to JIWWTP and abandoning turbine operation.

Turbine investment may be more beneficial, however, because it provides a more reliable power supply source and because of the improved safety aspects from having the more reliable power source. With the continued production of Milorganite®, the purchase of at least one new turbine to supply enough electricity to meet base treatment plant loads should be considered. At that power output, the turbine will generate enough waste heat to operate three to four dryers, which is enough to produce approximately 25,000 tons per year of Milorganite®. Natural gas would be purchased to provide sludge drying heat that is not satisfied by turbine waste heat. One of the two existing turbines could be retained and used for peak shaving, operating whenever tunnel storage pumping is required during on-peak hours. To remain in compliance with air permitting requirements, it is anticipated that one of the existing turbines would have to be decommissioned. Once decommissioned, it would be used for parts, etc. to keep the other turbine in operation.

There are two additional factors to consider with regards to future power supply and energy management as well. One of these factors is that options exist to build a pipeline and purchase natural gas directly from the gas pipeline operator, ANR. This would allow gas to be purchased at a lower cost and at a higher pressure (eliminating the need for the turbine gas compressors). Another factor to consider is that if transmission level service were provided along with a turbine, MMSD would have increased ability to sell power generated by the turbine according to market rates.

All of these factors are recommended for evaluation in sufficient detail to determine which energy management/power supply option at JIWWTP is best suited for MMSD over the long term and what implications this energy management plan will have for the MMSD biosolids program.

Development of a Final Biosolids Management Plan for the 2020 FP

A final biosolids management plan should be developed as the studies recommended above are completed. Once this information is known, Recommended Biosolids Alternatives 2-6, and any other options that are identified, can be modified as appropriate and reevaluated to select a final biosolids plan.

Facilities Improvements

Maintenance of Jones Island Wastewater Treatment Plant Dewatering and Drying Facilities

The existing sludge Dewatering and Drying equipment will continue to be used for the production of Milorganite®. The Dewatering and Drying equipment is subject to high amounts of wear due to the abrasive nature of Milorganite® and the chemical addition required for sludge dewatering. As a result, there is a continuous need to repair and replace worn equipment. It is estimated that capital expenditures over the next 20 years would be about $115 million.

New Milorganite® Locomotive

The existing locomotive that is used to move and locate railcars for filling has reached the end of its useful life and should be replaced. Because Milorganite® will still be produced; consideration must be given to replacing the locomotive with another locomotive (as assumed in the cost estimates) or an alternative system.

Interplant Sludge Pumping and Pipeline Improvements

The interplant solids pipeline pumps located at JIWWTP and SSWWTP have reached the end of their useful lives. The transfer of solids between the two treatment plants is a critical part of overall sludge management and energy management. Consideration must be given to replacement of the pumps and continued maintenance of the interplant solids pipeline system.

New Gravity Belt Thickeners for South Shore Wastewater Treatment Plant Sludge

There are two potential uses for new GBTs at SSWWTP. The highest priority is the continued replacement of the centrifuges used for digested sludge thickening prior to feeding the solids to the plate and frame presses. MMSD has installed two GBTs at SSWWTP in recent years to replace the aging, high maintenance, and high energy consuming centrifuges. Additional consideration should be given to the installation of more GBTs for this purpose.

One significant benefit of these GBTs is that they assure the South Shore plate and frame presses continue to serve their original design intent as a back up or emergency solids disposal system in the event that the JIWWTP Dewatering and Drying facility is not available to process biosolids. The decision to replace the SSWWTP centrifuges with GBTs needs to consider this issue.

A second use for GBTs is for the thickening of waste activated sludge. Raw waste activated sludge is typically conveyed to JIWWTP for use in either Milorganite® production or in the glass furnace process. However, there are times when either the interplant sludge pump station is not in service or JIWWTP is unable to receive SSWWTP sludge. During those periods, SSWWTP waste activated sludge must be thickened and fed to the anaerobic digesters. The dissolved air floatation thickeners that are currently used for this purpose are reaching the end of their useful life. A recent project recommended the replacement of SSWWTP dissolved air floatation thickeners with GBTs. This option should continue to be evaluated.

Upgrade and Maintain South Shore Wastewater Treatment Plant Plate and Frame Presses

A current project (2005 Review of United Water Services Plant Requested Projects) evaluated the South Shore plate and frame presses and the cost to upgrade them for future use.([16]) The estimated cost to perform this work is approximately $5 million, which is a relatively small component when compared to the total capital expenditures that will be required to implement a comprehensive biosolids plan. Retaining these plate and frame presses gives MMSD a landfill and land application option for disposal of biosolids. While circumstances requiring the landfill of sludge are not anticipated at this time, retaining this option would be beneficial should future conditions require the use of landfill.

As for the GBTs, the original design intent for the plate and frame press was to provide MMSD with a back up or emergency biosolids operational mode that would allow landfill of sludge cake. Maintenance of these presses is critical to assure that this operational mode is available.

South Shore Wastewater Treatment Plant Digester Rehabilitation

Increased primary sludge production is expected even at current treatment plant flows due to the recommended improved JIWWTP primary clarifier performance (see the subsection, *Maximize Operation of Primary Clarifiers*, below).

Maximizing solids destruction in the anaerobic digester is critical to obtaining the necessary energy to generate electricity at SSWWTP (the increased volatile solids destruction produces methane that is used to generate electricity) and to minimize the remaining solids handling costs (increased solids destruction results in fewer solids that require further processing). The feed solids to the SSWWTP digesters are, for the most part, primary sludge. The existing mixing system limits solids destruction to 50% to 55% volatile solids destruction, whereas up to 55% to 60% volatile solids destruction is possible with primary sludge. In addition, poor mixing allows solids to settle in a digester, reducing digester volume and further limiting solids destruction. This issue is discussed in more detail in Chapter 4, Section 4.2.4 of this report.

All alternatives include the upgrade of the digester mixing system in the existing digesters as well as the conversion of the sludge storage units back to anaerobic digesters. The work entails updating the sludge heating systems, sludge pumping systems, and gas mixing systems.

The existing digesters and sludge storage units provide sufficient capacity to process existing (2006) sludge production; however, up to five new digesters could be required for predicted revised 2020 Baseline sludge loads, should they materialize and to meet NR 110 requirements for digester sizing at those future sludge loads. The NR 110 requirements are conservative and additional study and discussions with WDNR regarding the required digester capacity are recommended.

Operational Improvements

Maximize Operation of Primary Clarifiers

The JIWWTP primary clarifiers have been operated in a manner that allows some carryover of BOD and TSS to the activated sludge system. This has been done in an effort to produce more waste activated sludge, with its higher nitrogen content, and less primary sludge, with its lower nitrogen content. The result of this effort has been an increase in Milorganite® production but also an increased aeration requirement to oxidize the additional BOD sent to the activated sludge process.

Table 9-37 provides a comparison of the actual capture efficiency with that of a typical primary clarifier and the original design intent of the JIWWTP primary clarifiers.

TABLE 9-37
COMPARISON OF ACTUAL JONES ISLAND WASTEWATER TREATMENT PLANT PRIMARY CLARIFIER CAPTURE EFFICIENCY TO TYPICAL CAPTURE EFFICIENCY AND DESIGN INTENT

Parameter	2006 Performance [1]	Typical Primary Clarifier [2]	Original Design Intent [3]
TSS	40%	65%	70%
BOD	20%	30%	35%

BOD = Biochemical Oxygen Demand
TSS = Total Suspended Solids

1) Based on mass balance estimate of average performance using measured sludge flows and wastewater samples taken around the primary clarifier.
2) From Water Environment Federation MOP 11, Primary Clarifier section.
3) From Jones Island Primary Clarifier Operations portion of the O&M Manual.

Operation of the primary clarifiers at design performance requires the completion of the committed project J01008 – Upgrade Primary Clarifier Mechanisms.[ee] The benefits from running the primary clarifiers at design removal rates include the following:

- A 30% to 40% reduction in BOD load to the activated sludge system, with a corresponding reduction in aeration requirements
- Increased primary sludge production, which is anaerobically digested at SSWWTP, increasing digester gas production
- Reduced waste activated sludge production with a corresponding reduction in sludge handling costs

9.10.3 Biosolids Interim Recommendations Summary

Table 9-38 summarizes the recommended elements of the current biosolids plan and shows the capital costs associated with each element. All of these elements are recommended, regardless of whether or not Milorganite® production is combined with another biosolids technology in the final recommended plan.

Once a final recommended biosolids plan is completed, it should be used to develop a focused preliminary engineering effort for the various recommended projects. Through preliminary engineering analysis, the project elements can be refined and expanded to include all of the detailed elements required to optimize the final recommended plan to provide a fully functioning biosolids and energy management program.

[ee] See Section 8.2.1 of Chapter 8 for more information.

Recommended Element	Capital Cost ($ M)	Comment
Detailed Engineering and Other Studies		
Marketing Study for Lower %N Milorganite®	$0.0	Study would be conducted by the Milorganite® Marketing Department
Evaluation of Milorganite® Nitrogen Balance	0.0	Additional analytical lab costs not expected to be significant
Overall Planning Report on Energy and Energy Management	0.3	Preliminary Engineering Study estimate
Development of Final Recommended Biosolids Plan for 2020 FP	See Note 1	Development schedule to be determined
Facilities Improvements		
Maintenance of JIWWTP Dewatering and Drying Facility	$115.0	A project that will be implemented in stages over the next 20 years
New Milorganite® Locomotive	3.0	Replaces existing locomotive that is beyond its useful life
Interplant Solids Pumping and Pipeline Improvements	3.0	Involves pumps at both SSWWTP and JIWWTP and the pipeline cathodic protection system
New Gravity Belt Thickeners for SSWWTP Waste Sludge Thickening	7.7	Recommended in a tech memo as part of the 2003 Plant Requested Projects
Install 3 new 2-meter gravity belt thickeners	See Note 2	For preparation of sludge prior to feed to plate and frame presses – upgrades already in progress
Upgrade and Maintain SSWWTP Plate and Frame Presses	5.0	Included as part of 2005 Plant Review Project (Project J06015P06)
SSWWTP Digester Rehabilitation	117.0	An increase in primary sludge production is expected due to planned improvements to JIWWTP primary clarifier performance. Includes improved digester mixing, conversion of existing sludge storage units to active digesters and the construction of 5 new 3.5 MG digesters
Total Facilities Capital Costs	**$251.0**	
Operational Improvements		
Maximize Operation of Primary Clarifiers	0.0	This clarifier mechanism project is an existing project. No other capital expenditure is required.
Total	**$251.0**	

JIWWTP = Jones Island Wastewater Treatment Plant
SSWWTP = South Shore Wastewater Treatment Plant

NOTES:
1) Costs and schedule for this effort will be determined in the future.
2) The costs for this upgrade are assumed to be a part of the ongoing treatment upgrades as discussed in Chapter 10, Table 10-2.

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TABLE 9-38
RECOMMENDED INTERIM BIOSOLIDS PROJECTS

References

(1) CH2M Hill, DRAFT *Technology Evaluation & Preliminary Engineering for High-Rate Treatment of Wet-Weather Flows Conceptual Design* (August 2006)

(2) Milwaukee Metropolitan Sewerage District, WPDES Permit No. WI-0036820-02-0, (April 1, 2003)

(3) Brown and Caldwell, *Technical Memorandum to King County, Subject: Chemically Enhanced Primary Clarification – Basis of Design* (November 18, 2005)

(4) Milwaukee Metropolitan Sewerage District, *Jones Island Facility Plan: Environmental Assessment Vol. 2* (June 1, 1980)

(5) CH2M Hill, DRAFT *Technology Evaluation & Preliminary Engineering for High-Rate Treatment of Wet-Weather Flows Conceptual Design* (August 2006)

(6) Milwaukee Metropolitan Sewerage District, WPDES Permit No. WI-0036820-02-0, (April 1, 2003)

(7) 2006 Mass Balance Analysis, located in 2020 project files

(8) Milwaukee Metropolitan Sewerage District, *Cost Recovery Procedures Manual*, Annual Report (January 2005)

(9) United Water Services, *Daily/Weekly Operating Report* (2002-2003)

(10) Hurtado Consulting, *Biosolids Operating Costs* memorandum (August 13, 2005), located in 2020 project files

(11) United Water Services, *Daily/Weekly Operating Report* (2005 and 2006)

(12) John Jankowski, MMSD, e-mail correspondence to Alan Scrivner, 2020 technical team, subject: JIWTP Turbines (January 15, 2007)

(13) Department of Natural Resources, *Wisconsin Administrative Code*, Volume 11, Chapter NR 110 (Revisor of Statutes Bureau, May 2001)

(14) Alan Scrivner, AES Engineering, Inc., *Memorandum: Jones Island Electrical Power Supply* (February 22, 2006), located in 2020 project files

(15) John Jankowski, MMSD, e-mail correspondence to Alan Scrivner, 2020 technical team, subject: JIWTP Turbines (January 15, 2007)

(16) Pat Carnahan, Symbiont, Review of United Water Services Plant Requested Projects for 2005, Jones Island and South Shore Wastewater Treatment Plants (December 2006)