

## **APPENDIX 5E: Energy Alternatives Selection**

DRAFT

**Project Name:** 2050 Facilities Plan

**HNTB Project No.** 61129

**MMSD Project No.** M03037P01

**MMSD File Code:** M03037P01.P3100

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**Date:**

July 28, 2017 (Final Draft)

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## 2050 Facilities Plan

### Energy Reduction Alternatives for 2050 FP Review

#### 1. PURPOSE

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One of the goals of the Milwaukee Metropolitan Sewerage District (MMSD) Energy Plan (Energy Plan Goal No. 4) was that its implementation plan should be refined in conjunction with the 2050 Facilities Plan (FP). The purpose of this technical memorandum (TM) is to document the evolution of this goal under the 2050 FP. This TM describes the energy reduction alternatives that were initially recommended by the Energy Plan, identifies the selection refinement process, and presents the final list of alternatives that were selected to be assessed as part of the 2050 FP.

#### 2. BACKGROUND

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An Energy Plan (Contract No. M03072P01) dated January 2015 was prepared by CH2MHill, which outlined several potential energy reduction alternatives that could help MMSD meet the following 2035 Vision energy goals:

- Meet a net 100% of energy needs with renewable energy sources
- Meet 80% of energy needs with internal, renewable sources

The Energy Plan identified 92 potential alternatives, 43 of which were determined to be the most likely to be effective. A technology review was completed on the 43 alternatives as part of the Energy Plan (documented in TM 3 of the Energy Plan). These are identified in Attachment A of this TM.

The Energy Plan recommended that 28 alternatives be evaluated as part of the 2050 FP:

- 4 of the 19 alternatives that were evaluated as part of the Energy Plan were recommended for further evaluation as part of the 2050 FP (shown in column B of Attachment A)
- 24 alternatives that were not evaluated as part of the Energy Plan but were identified to be evaluated by the 2050 FP (shown in column E of Attachment A)

### 3. PRELIMINARY RECOMMENDATION OF ENERGY REDUCTION ALTERNATIVES

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On March 9, 2015, MMSD held an Energy Plan review meeting with the 2050 FP project team to determine which of the recommended Energy Plan alternatives should be evaluated as part of the 2050 FP. At that meeting, MMSD identified those alternatives that were currently being evaluated by MMSD, those that MMSD planned to evaluate outside of the 2050 FP project, and those that it recommended should be evaluated as part of the 2050 FP. The information presented by MMSD at the March 9, 2015 meeting is shown in columns F – H in Attachment A.

The breakdown of MMSD's preliminary energy reduction alternative status/recommendations presented at the March 9, 2015 meeting was as follows:

- 30 energy alternatives currently being evaluated by MMSD
- 1 energy alternative to be evaluated by MMSD
- 36 energy alternatives to be evaluated as part of the 2050 FP. Note: Three of these are being concurrently evaluated by MMSD, so are also included in the count of 30 in the 1<sup>st</sup> bullet

After further discussions during the March 9, 2015 meeting, the 2050 FP project team and MMSD selected 24 energy reduction alternatives that were to be reviewed as part of the 2050 FP, noted as follows:

- 7 alternatives that were identified for implementation in the Energy Plan (increased from 4 alternatives)
  - Energy Plan Alternatives 2, 6, 9b, 12, 22, 24 and 34
- 8 alternatives that were evaluated in TM 3 of the Energy Plan and were not recommended for additional evaluation (remained at 8 alternatives)
  - Energy Plan Alternatives 4, 9a, 17, 23, 29, 31, 44b, and 78
- 4 alternatives that were not evaluated in the Energy Plan but were recommended to be evaluated as part of the 2050 FP (decreased from 24)
  - Energy Plan Alternatives 54, 55, 75 and 82

- 5 new alternatives (alternatives that were not included in Energy Plan)

#### 4. FINAL DOCUMENTATION OF ENERGY REDUCTION ALTERNATIVES REVIEW

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During the course of the development of the 2050 FP subsequent to the March 9, 2015 meeting, the list of recommended alternatives was updated to reflect the final decisions regarding which alternatives were to be evaluated as part of the 2050 FP.

Table 5E-1 indicates the final recommendation/status of each alternative that was selected at the March 9, 2015 meeting (note that alternatives 9a/9b and 54/55 were subsequently combined into one alternative so there are only 22 alternatives listed below). The final breakdown of these recommendations is as follows:

##### *Energy Reduction Alternatives to be evaluated in the 2050 FP*

- **4** alternatives to be addressed by analyses as part of Appendix 6B, WRFs and Biosolids:
  - Energy Plan Alternatives 54/55 – supplement biosolids processing
  - Energy Plan Alternative 75 – identify drying technologies that offer higher efficiencies
  - New Alternative – consider alternative dryer air filtration process or modify operation of existing electrostatic precipitators
  - New Alternative – SSWRF energy audit
- **3** alternatives to be evaluated as part of Appendix 6E, in Systemwide Analysis FG3, Energy Plan Additional Analysis:
  - Energy Plan Alternative 31 – heat recovery from effluent
  - Energy Plan Alternative 34 – large bubble mixing for JIWRf channels
  - Energy Plan Alternative 78 – hydropower at SSWRF using either preliminary influent or primary clarifier influent

##### *Status of other Energy Reduction Alternatives*

- **9** alternatives require no further review
- **6** alternatives are covered by active MMSD capital projects

**TABLE 5E-1: FINAL STATUS OF ENERGY REDUCTION ALTERNATIVES ORIGINALLY SELECTED AT MARCH 9, 2015 MEETING TO BE EVALUATED IN 2050 FACILITIES PLAN**

Energy Reduction Alternatives Selected at March 9, 2015			Final Status / Comments
Energy Plan Alternative # / Name	To be Addressed in 2050 FP Appendix 6B	To be Addressed in 2050 FP Appendix 6E	
<b>Alternatives that were originally identified in the Energy Plan</b>			
2. Optimized influent flow split between WRFs	--	--	Discussed and omitted since MMSD already does this and wet weather considerations outweigh any energy savings potentials. Not addressed at this time.
4. Bypass JIWRf High-Level Screw Pumps	--	--	Discussed and omitted since current operating procedures make implementation unlikely. Not addressed at this time.
6. Optimize pumping energy using PLC for RAS/WAS	--	--	Use control logic to control energy in pump operation. Addressed in projects J06065C02 & J02013.
9a/9b. Optimized waste heat pressure control by modifying damper on the waste heat boiler or dryer waste heat dampers	--	--	Existing dampers are not currently designed to throttle for maintaining duct pressure. Currently approximately 10% of waste heat is exhausted. Include as component of biosolids management upgrades.
12. Increase belt press feed solids to increase cake solids	--	--	Increase feed solids from 3.2% to save drying energy. Addressed in project J04037 – 2050 FP will assist if needed.
17. Use waste heat to heat biological process at JIWRf	--	--	Discussed and omitted since the decrease in energy is insignificant. Not addressed at this time.

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Energy Reduction Alternatives Selected at March 9, 2015			Final Status / Comments
Energy Plan Alternative # / Name	To be Addressed in 2050 FP Appendix 6B	To be Addressed in 2050 FP Appendix 6E	
22. Recover heat from dryer exhaust	--	--	Heat may be used to preheat polymer solution and belt press feed sludge to increase dewatered cake solids. Heat may be recovered from dryer exhaust (eliminated in Energy Plan due to presence of chaff and dust in dryer exhaust) or from quench chamber drain water. Deemed low priority based upon initial review by 2050 FP team (evaluated by AES Engineering in the recent past). Not addressed at this time.
23. Capture more heat from existing IC engines	--		Deemed low priority. Would only offset winter heating requirements. Not included as standalone analysis in our evaluations. Not addressed at this time.
24. Jones Island Aeration Control Using DO and Ammonia/Nitrate Probes	--	--	Discussed and omitted since MMSD is already evaluating. Not addressed at this time.
29. South Shore based flow UV disinfection with renewable energy	--	--	Use of wind, solar photovoltaic or hydropower to power UV disinfection for base flow up to 100 mgd. Standalone alternative not addressed at this time. Sizing of solar panel system addressed in South Shore Energy Systems Alternative Analysis, included potential UV system.
31 Heat recovery from effluent		√	Energy may be used to offset space heating/cooling or process heating requirements Systemwide Analysis FG3, Energy Plan Additional Alternatives in Appendix 6E documents initial efforts and heat available.

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Energy Reduction Alternatives Selected at March 9, 2015			Final Status / Comments
Energy Plan Alternative # / Name	To be Addressed in 2050 FP Appendix 6B	To be Addressed in 2050 FP Appendix 6E	
34. Large bubble mixing for JIWRf channels		√	Provide large bubble mixing for PE, ML and RAS Channels. Note MMSD is also currently evaluating this alternative.  Systemwide Analysis FG3, Energy Plan Additional Alternatives in Appendix 6E documents detailed analysis.
44b. Send excess heat to nearby industries, commercial buildings, and residences	--	--	Discussed and omitted since MMSD would first need to commit to biosolids plan that increased digester production. Recommend MMSD revisit after 2050 FP biosolids recommendations finalized.  Not addressed at this time.
54/55. Supplement biosolids processing	√		Supplement biosolids processing and distribution through alternative drying/processing technologies. Target approximately 7,000-8,000 dry tons per year of digested sludge to address current Milorganite production (45,000 DT/y) versus sales (38,000 DT/y)  Addressed in WRF FG1, Milorganite® Quantity and Quality Alternative Analysis in Appendix 6B.
75. Identify alternative drying technologies that offer higher efficiencies	√		Analysis should provide high level comparison between drum drying and other drying technologies (heat energy, electric energy, ancillary systems required, dust, safety, product quality, etc.)  Addressed in WRF FG2, Alternative Biosolids Processing and Disposal Systems Alternative Analysis in Appendix 6B.

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Energy Reduction Alternatives Selected at March 9, 2015			Final Status / Comments
Energy Plan Alternative # / Name	To be Addressed in 2050 FP Appendix 6B	To be Addressed in 2050 FP Appendix 6E	
78. Hydropower at South Shore using either preliminary treatment influent or primary clarifier influent		√	Install turbine to harness hydropower resulting from hydraulic drop between facilities. Likely available only during dry weather flow. Systemwide Analysis FG3, Energy Plan Additional Alternatives in Appendix 6E documents initial efforts.
82. Install jockey pump within ISS PS for dewatering tunnel	--	--	Operation of jockey pump lowers peak electric power demand associated with dewatering tunnels. Prior Symbiont effort examined new power supply system with VFDs reduces energy consumption. Not addressed at this time as not anticipated to be economically feasible.
<b>New alternatives (identified at March 9, 2015 meeting)</b>			
Consider alternative dryer air filtration process, or modify operation of existing electrostatic precipitators	√		Wet electrostatic precipitators have a rheostat, which may be used to reduce electrical power draw. Stack testing could be performed to ensure compliance with particulates. ESP flush down water could also be sampled. Addressed in WRF R11, Condition and Performance of Dryer Emissions Control Systems Alternative Analysis in Appendix 6B.
Evaluate modifying existing induced draft fans in D&D with VFDs	--	--	Addressed in project J04046.



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Discharge scum to digesters	--	--	Provide receiving and digester feed facilities to accept primary scum from JI and SS. Consider receiving commercial grease trap waste.  Addressed in project S04010. Upon further evaluation and consultation with VWM, idea is not feasible for JIWRf.
SSWRF use of effluent pumping to create mixing for chlorination	--	--	Provide more mixing for chlorination to eliminate the need for effluent pumping to create mixing in the Parshall flumes.  Addressed in project S02008.
SSWRF Energy System Audit	√		Work with MMSD on development of SSWRF energy analysis by season – are additional IC engines justified (beginning of larger effort)  Addressed in WRF FG4, Increase SSWRF Renewable Energy Use Alternative Analysis in Appendix 6B.

**ATTACHMENT A**

**ENERGY PLAN ALTERNATIVES:**

**ORIGINAL ENERGY PLAN RECOMMENDATIONS AND MARCH 9, 2015 MMSD  
RECOMMENDATIONS**

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**TABLE A1: DOCUMENTATION OF ORIGINAL ENERGY PLAN RECOMMENDATIONS AND MARCH 9, 2015 MEETING RECOMMENDATIONS**

Alt No.	Energy Alternative Name (N = 66)	Alternative Recommendation/Status per Energy Plan					MMSD status/recommendation presented at March 9, 2015 meeting		
		A. Evaluated--to be Implemented by MMSD (N = 15)	B. Evaluated--to be Further Evaluated by 2050FP (N = 4)	C. Total Evaluated and Recommended (N = 19)	D. Evaluated but not Recommended (N = 24)	E. Not Evaluated--Recommended to be Evaluated in 2050 FP (N = 24)	F. MMSD is Evaluating (N = 30)	G. MMSD will Evaluate (N = 1)	H. 2050 FP will Evaluate (N = 36)
1	Optimize Biosolids Transfer between Plants for Energy Generation and Use				X		X		
2	Optimize Influent Flow Split Between Plants			X			X		X
3	Purchase More Green Energy from We Energies				X		X		
4	Bypass Jones Island WRF High-Level Screw Pumps				X				X
5a	Decrease Number of Idle Aeration Basins Online at Jones Island				X		X		
5b	Decrease Number of Idle Aeration Basins Online at South Shore	X		X			X		
6	Optimize Pumping Energy Using Programmable Logic Controller Logic (Return Activated Sludge/Waste Activated Sludge Pumps)	X		X			X		
7	Use Chemically Enhanced Primary Treatment to Reduce Aeration Energy and Increase Primary Sludge/Digester Gas				X		X		
8	Modify/Optimize Activated Sludge Process—South Shore Step Feed	X		X			X		
9a	Optimize Waste Heat Pressure Control with Waste Heat Boiler Damper			X					X
9b	Optimize Waste Heat Pressure Control with Dryer Control Modifications	X		X					X
10	Increase SRT to Reduce Solids Processing Energy				X		X		

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11	Decrease Activated Sludge Solids Retention Time at South Shore	X		X			X		
12	Increase Belt Press Feed Solids Concentration to Increase Cake Solids	X		X			X		
13a	Improve Plant-wide HVAC Control at Jones Island		X		X		X		
13b	Improve Plant-wide HVAC Control at South Shore				X		X		
14	Automate Real-time Energy Optimization Control and Monitoring	X		X				X	
15a	Improve Jones Island Primary Treatment Efficiency	X		X			X		
15b	Improve Primary Clarifier Operations/Removal Efficiency by Installing Inlet Baffling at Jones Island		X	X			X		
17	Use Waste Heat to Heat Biological Process at Jones Island				X				X
18	Install High-efficiency Plant Lighting	X		X			X		
19a	Maximize South Shore Digestion: No. 1 Base Scenario (Optimized Digestion; no Co-digestate)	X (COMBINED)			X		X		
19b	Maximize South Shore Digestion: HSW Accepted to Meet 4 MW Power Production			X			X		
20	Solar Power Electricity Generation				X		X		
21	Wind Energy Generation				X		X		
22	Recover Heat from Dryer Exhaust	X		X					X
23	Capture more Waste Heat from Internal Combustion Engines				X				X

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24	Implement Jones Island Aeration Control using Dissolved Oxygen and Ammonia/Nitrate Probes	X		X			X		X
25	Implement South Shore Aeration Control using DO and Ammonia/Nitrite Probes		X	X			X		
26	Install Turbine Waste Heat Landfill Gas Duct Burners				X		X		
29	Implement South Shore WRF Renewable Energy Powered UV Disinfection for 100 mgd Base Flow				X				X
31	Large-scale Effluent Heat Recovery Using Heat Pumps				X		X		X
32	Thermal Energy Generation/Recovery in Collection System (large scale)					X			X
34	Change Jones Island Channel Mixing to Large Bubble Mixers		X	X			X		
41	Install Variable Frequency Drives for Pumps, Fans, and other Equipment	X		X			X		
44a	Send Excess Heat to Nearby Industries, Commercial Buildings, and Residences: Captured Heat to Nearby Industry				X		X		
44b	Send Excess Heat to Nearby Industries, Commercial Buildings, and Residences: Use Heat Onsite				X				X
45	Anaerobic Sludge Pretreatment and Conditioning Methods					X			X
46	Ostara/ANITA™ Mox – Biosolids Bundle Project #3					X			X
47	Algae Bioreactor for Biofuel Production (large scale)					X			X

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48	Change Anaerobic Digestion Operation (i.e., from mesophilic to thermophilic or acid-gas)					X			X
49	Consolidate Process Facilities					X			X
50	Low Energy Ammonia Removal (e.g., ANAMMOX) – Mainstream at SSWRF and JIWRf					X			X
51	Algae Bioreactor for P Removal					X			X
52	Microbial Fuel Cells					X			X
53	Anaerobic Secondary Treatment					X			X
54	Solar Drying					X			X
55	Composting (including numerous composting technologies)					X			X
56	Geothermal Energy (large scale)					X			X
57	Geothermal Energy from Lake Michigan or River Coupled with Heat Pumps (large scale)					X			X
58	Hydroelectric Energy from Lake Michigan Wave Action (large scale)					X			X
59	Drying Gasification to Produce Synthetic Gas (syngas)					X			X
60	Pyrolysis of Excess Milorganite for Heat Energy Recovery and Create Biochar					X			X
64	Install High-Efficiency Motors for Pumps, Fans, and Other Equipment at Jones Island WRF				X		X		
73	Increase Natural Light in Buildings				X		X		

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75	Install new JIWRF Milorganite Dryers that use Less Energy					X			X
76	Dry Weather Load Equalization					X			X
77	Consolidate or Downsize Non-process / Administrative Facilities					X			X
78	Large-scale hydrokinetic Turbines/Micro-hydropower				X				X
79	Hydroelectric Energy from River Flow (large scale)					X			X
82	Use Smaller Pumps for Dewatering ISS between Rain Events and Diversions					X			X
85	Alternative Method of Powering Effluent Pumps					X			X
92	Throttle Back Influent Gates					X			X
95	Increase Jones Island WRF Landfill Gas Volume	X		X			X		