District Energy Roadmap

Eric Dundee, Executive Director

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Madison Metropolitan
Sewerage District

Where we have been…

Madison Metropolitan Sewerage District

2020 ENERGY MANAGEMENT MASTER PLAN

FINAL | December 2021

Energy Tracking

Electric Energy	2020		2021		2022		2023		2024	
	kWh/ Day	% of Total	kWh/ day	% of Total	kWh/ day	% of Total	kWh/ day	% of Total	kWh/ Day	% of Total
Commercial Service Purchased from MG&E	62,809	69.1%	64,571	73.7%	64,577	72.4%	66,639	73.8%	67,195	72.1%
Wind Power Purchased from MG&E	40	0.0%	40	0.0%	99	0.1%	99	0.1%	98	0.1%
Generated from Digester Gas	18,838	20.7%	15,903	18.2%	16,387	18.4%	15,802	17.5%	18,624	20.0%
Avoided Purchase Due to Blower Gas Engine	9,185	10.1%	7,060	8.1%	8,076	9.1%	7,722	8.6%	7,264	7.8%
Total Used & Avoided	**90,873**		**87,574**		**89,139**		**90,262**		**93,180**	
Average cost of purchased power ($/kWh)	$ 0.0881		$ 0.0873		$ 0.0981		$ 0.1085		$0.1109	
Estimated total monthly value of energy used	$244,135		$232,468		$266,084		$297,757		$314,239	
Estimated monthly value of renewable energy	$75,396	30.9%	$61,062	26.3%	$73,319	27.6%	$77,928	26.2%	$87,632	27.9%

Energy Tracking

Thermal Energy	2020		2021		2022		2023		2024	
	therms/ Day	% of Total	therms/ day	% of Total	therms/ day	% of Total	therms/ day	% of Total	therms/ Day	% of Total
Generated from Natural Gas	757	30.2%	584	25.4%	587	24.1%	360	17.4%	360	16.3%
Generated from Digester Gas	201	8.0%	387	16.8%	440	18.1%	350	17.0%	357	16.2%
Recovered from Gas Engines	1,545	61.7%	1,332	57.9%	1,407	57.8%	1,353	65.6%	1,487	67.5%
Total hot water energy used	**2,503**		**2,303**		**2,434**		**2,063**		**2,204**	
Average cost of purchased gas ($/therm)	$ 0.3591		$ 0.5451		$ 0.8372		$ 0.6940		$0.5854	
Estimated total monthly value of gas used*	$36,552		$50,914		$82,642		$58,062		$52,311	
Estimated monthly value of renewable energy	$25,498	69.8%	$37,999	74.6%	$62,714	75.9%	$47,942	82.6%	$43,775	83.7%
Total Energy Use	**2020**		**2021**		**2022**		**2023**		**2024**	
	$ per Month	% of Total	$ per month	% of Total	$ per month	% of Total	$ per month	% of Total	$ per month	% of Total
Total Estimated Value of Energy Used	$280,687		$283,382		$348,726		$355,819		$366,550	
Estimated Value of Renewable Energy Used	$100,893	35.9%	$99,060	35.0%	$136,034	39.0%	$125,870	35.4%	$131,407	35.8%

* Conversion of natural gas to heat is assumed to be 75% efficient and heat recovered from the gas engines is assumed to be 40%.

Note – due to rounding, numbers may not add exactly.

Avg Home = 1.5 therms/day

District = 4,500 therms/day

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W4 System Improvements

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W4 System

Why this project is important

This project replaces aging and deteriorated equipment critical to the District's W4 system, which allows the utility to use treated effluent for various non-potable plant processes. This system allows the District to avoid approximately $2 million in city water costs annually.

Additional facts

- W4 water, which is disinfected and strained effluent, is utilized in various ways across the plant, including as wash water, sludge storage tank cooling, and in some toilets.
- This system saves approximately 300 million gallons of potable water annually.
- Two chlorination systems, installed in 2006 and 2014, will be consolidated into a single system.

Phase	Timing	Estimated Cost (2025 CIP)
Design/ Permitting	Bid: Late 2025	$1.5 million

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Generational projects

2040

Biosolids

Liquid Processing

Heat & Power

Liquid Processing Improvements: Phase 2

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Liquid Processing Improvements Phase 2

Flow & Loadings 2050

- Population from 408K (2020) to 558K (2050).
- Annual ave flows (MGD) from 42.8 (2022) to 57 (2050)
- Annual ave loadings to the right. Addressing loadings is the crux of this project.

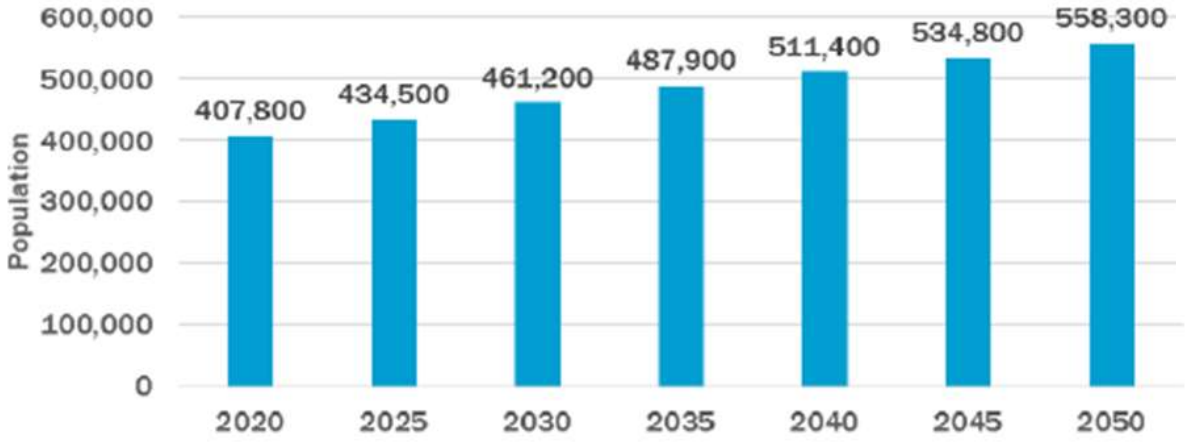


Figure 3-1. NSWWTP population projections

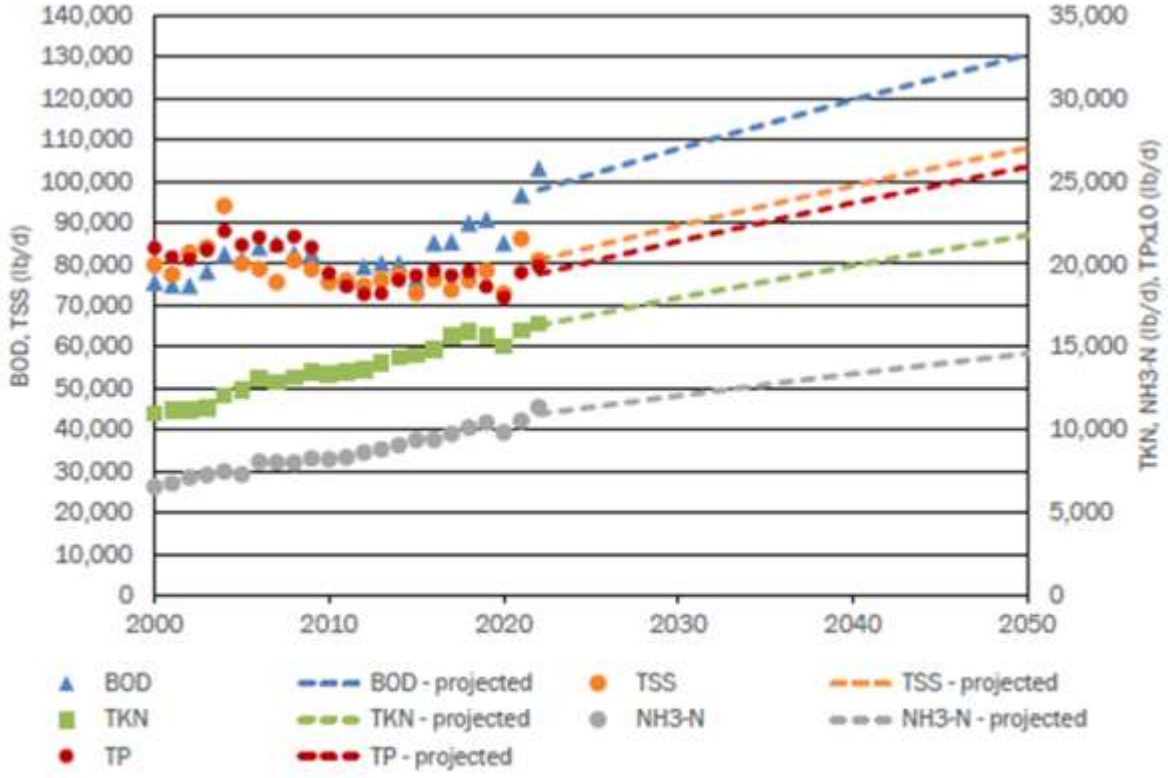
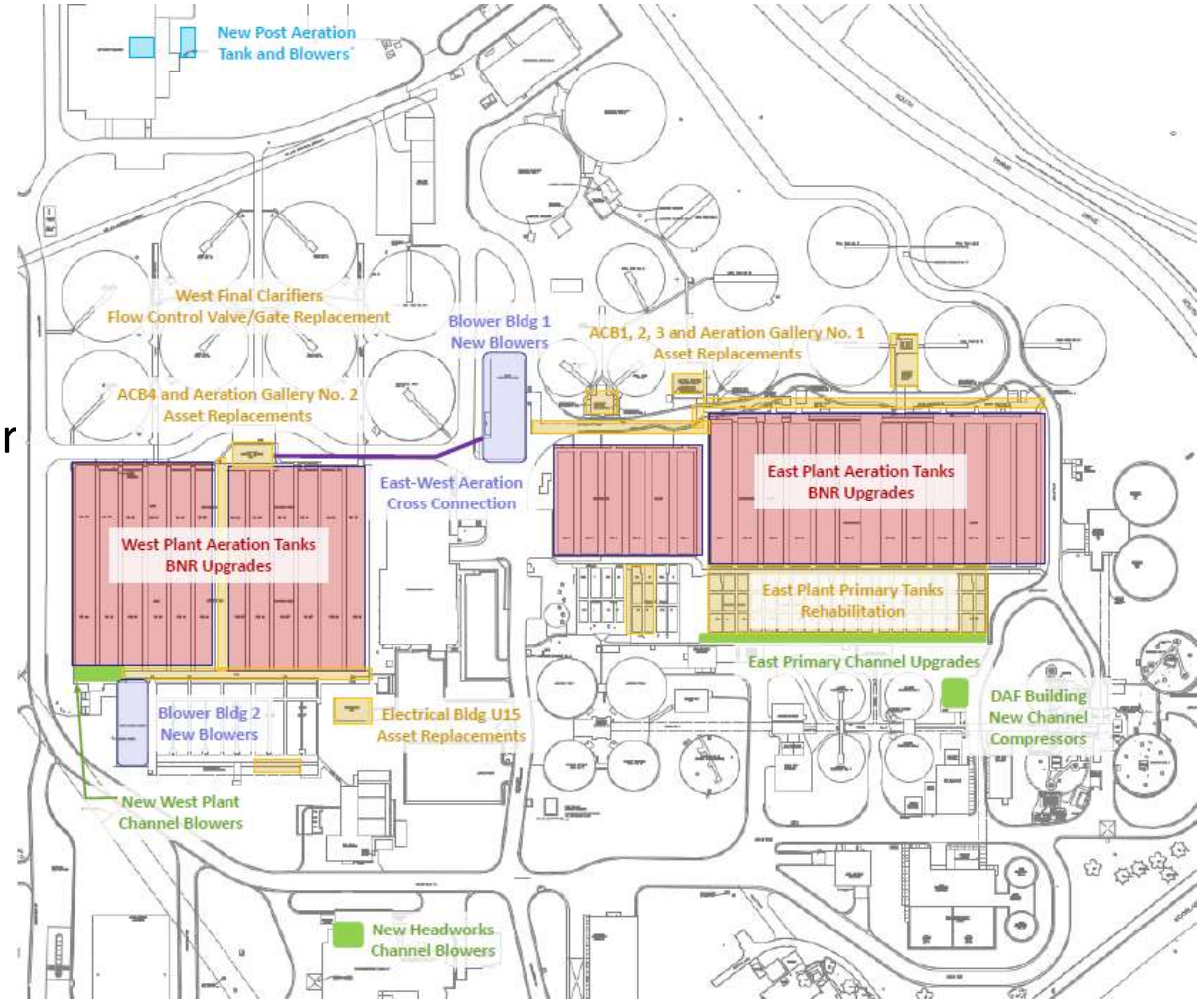


Figure 3-3. NSWWTP historical and future projected annual average loadings

Liquid Processing Improvements Phase 2

Major components/recap major decisions

- BNR system selected is hybrid –low or high DO
- High-speed turbo blowers + silicone tube diffusers
- Process controls, instrumentation + equipment
- Replace some aeration piping + add interconnection between East and West plants
- Associated Electrical + HVAC upgrades
- Replace East primary influent aeration with pulsed air mixing
- Dedicated smaller blowers for headworks channel, west primary influent channel & west mixed liquor channels.
- Post-aeration tank
- Refurbish nine east plant primary clarifiers
- Asset replacement
- *No additional primary tank and no 5th plant required*



Liquid Processing Improvements Phase 2

Energy efficiencies

- Overall savings due to change to hybrid BNR system :
  - Energy usage reduced (~18%) when running in low DO
  - Or (~7-11%) if operational switch to high DO
- Blower Selection:
  - High Speed turbo blowers – more efficient than single stage geared
- Blower Configuration
  - Cross-connection of blowers more efficient
  - Separate low pressure blowers for headworks, east and west primary influent channels and west mixed liquor channel more efficient than supplying air from process blowers
  - East primary influent channel mixing strategy
- Blower control system -will minimize system operating pressure
- Diffuser selection and arrangement
  - Silicon tube diffusers
  - Low energy configuration

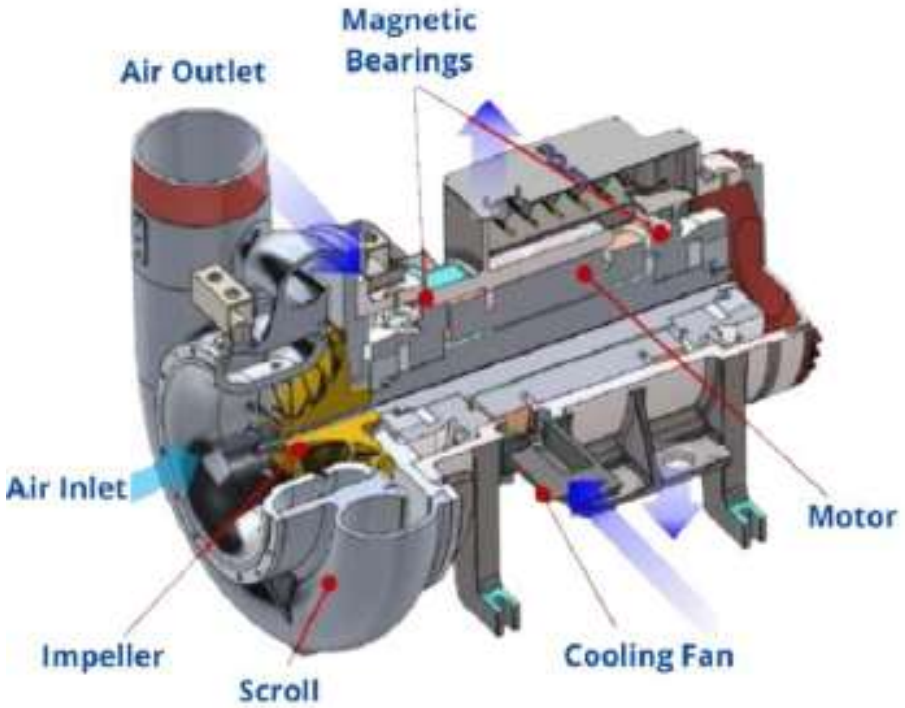


Figure 5-3. Example of Tube Membrane Diffusers.
(OTT Magnum FLEXSIL)

Heat and Power Facility Plan

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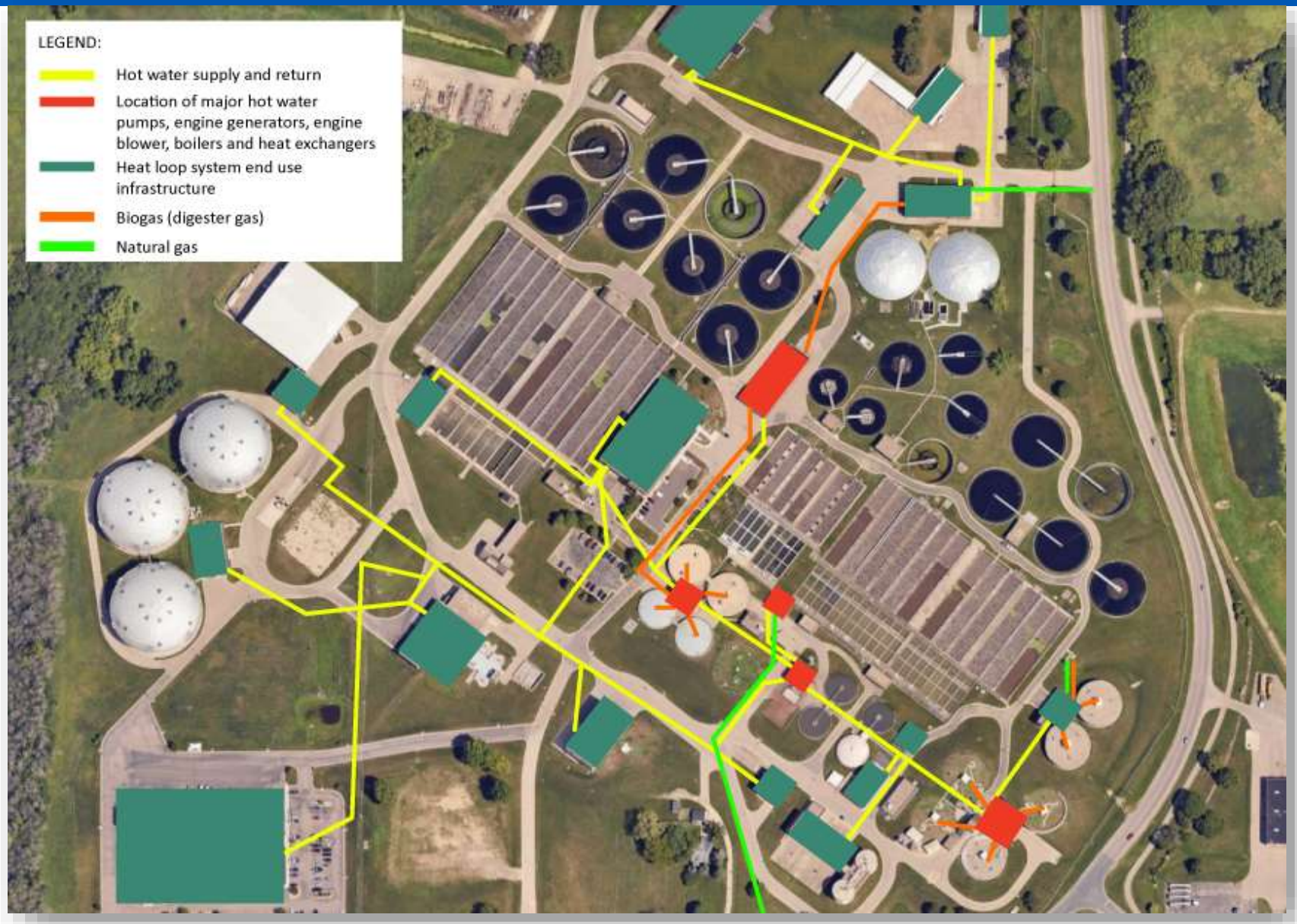
Introduction



Simplified schematic of the existing heat loop system at the Nine Springs Wastewater Treatment Plant

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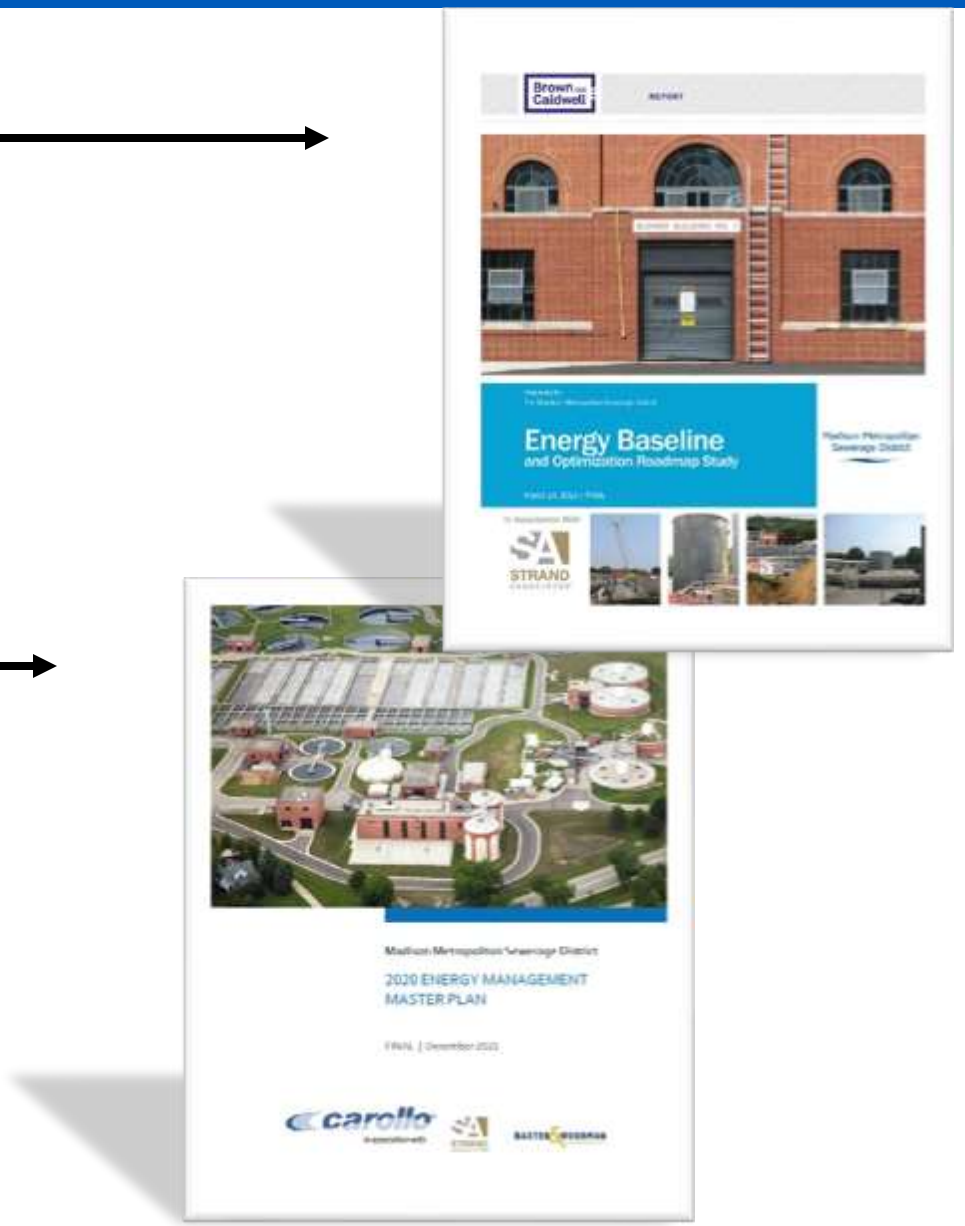
Project background

- ✓ **The 2014 Energy Baseline and Optimization Roadmap study:**
  - Focused on how to reduce energy usage
  - Focused on how to improve utilization of digester gas
  - Focused on how to generate more energy
  - Did not focus on assessing the age and condition of existing infrastructure

- ✓ **The 2020 Energy Management Master Plan:**
  - Identified critical aging infrastructure related to energy utilization
  - Identified multiple pathways for infrastructure replacement
  - Recommended rehabilitation, replacement, or upgrade of the aging assets while reducing energy usage, operational cost and energy-related environmental footprint



Project direction

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Use biogas to generate electricity at greater efficiency

Process biogas to renewable natural gas (RNG) to pipeline quality that can be sold to others

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Biosolids Facility Plan

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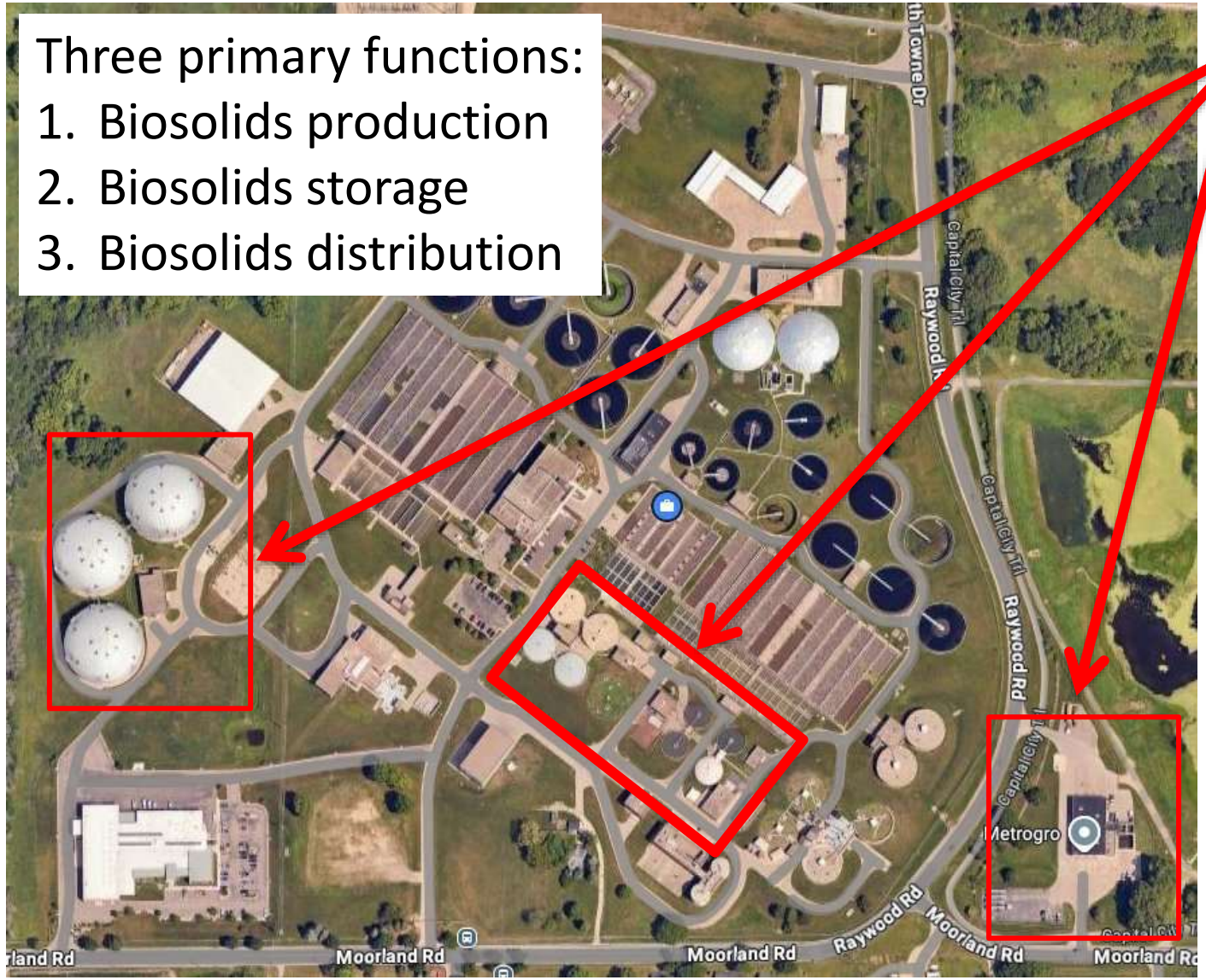
Biosolids Overview



MMSD Biosolids Facilities

Examine the costs, benefits, and management difficulties of four disposal strategies:

1. Status quo (Liquid B)
2. Pursuing liquid Class A
3. Pursuing Class A thermo-dried product
4. Consider non-land application/disposal

District Property Opportunity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Questions?