Montecito Sanitary District & Montecito Water District
Enhanced Recycled Water Feasibility Analysis

Technical Memorandum 4
EVALUATION OF MSD PERFORMANCE AND CAPACITY

DRAFT | November 2022

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This document is released for the purpose of information exchange review and planning only under the authority of Farzaneh Shabani, June 14, 2022, CA PE No. 6944.

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Abbreviations

AAF	average annual flow
ADWF	average dry weather flow
aSRT	aerobic solids retention time
CBOD	carbonaceous biochemical oxygen demand
CCT	chlorine contact tanks
City	City of Santa Barbara
CT	contact time
DAF	dissolved air flotation
DPR	Direct Potable Reuse
gpd	gallons per day
gpm	gallons per minute
hr	hour
IPR	Indirect Potable Reuse
IPS	influent pumping station
lb	pound(s)
m	meter
MG	million gallons
mg/L	milligrams per liter
mgd	Million gallons per day
mL/L	Milliliter per liter
MLSS	mixed liquor suspended solids
MSD	Montecito Sanitary District
MWD	Montecito Water District
NPR	Non-Potable Reuse
OOS	out of service
PFD	process flow diagram
ppd	pounds per day
PWWF	peak wet weather flow
TM	technical memorandum
TS	total solids
TSS	Total Suspended Solids
TWAS	thickened waste activated sludge
RAS	return activated sludge
scfm	standard cubic feet per minute
sf	square feet
SRT	solids residence times

WAS	waste activated sludge
WEF	Water Environment Federation
WWTP	wastewater treatment plant

Technical Memorandum 4

EVALUATION OF PERFORMANCE AND CAPACITY

4.1 Introduction

This project will provide guidance to Montecito Water District (MWD) and Montecito Sanitary District (MSD) for implementation of recycled water and the beneficial use of treated wastewater from the community of Montecito. The project seeks to identify the best method of maximizing wastewater reuse capabilities thus producing a new local drought proof water supply for the community and reducing the discharge of treated wastewater to the ocean. The analysis will consider local and regional partnerships, non-potable and potable reuse alternatives, and various treatment methods and technologies. The potential options included in the study are as follows:

1. **Montecito Non-Potable Reuse (NPR)** – local project producing tertiary quality water for irrigation of large landscapes in Montecito.
2. **Carpinteria Indirect Potable Reuse (IPR)** – regional project producing purified water involving a partnership with neighboring special district(s) and the use of the Carpinteria Groundwater Basin.
3. **Montecito Direct Potable Reuse (DPR)** – local project in Montecito producing purified water and utilizing raw water augmentation at the Montecito Water District water treatment facility.
4. **Santa Barbara DPR** – regional project producing purified water and involving a partnership with the City of Santa Barbara (City) and raw water augmentation at the City's regional water treatment facility.

Figure 4.1 shows the potential regional partners.

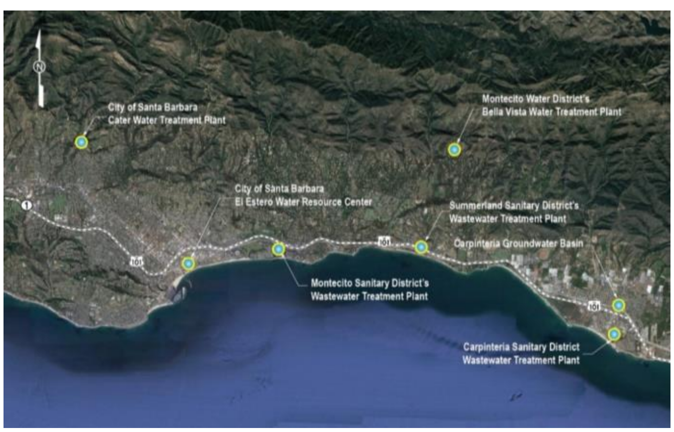

Figure 4.1 Potential Regional Partners

The focus of this technical memorandum (TM) is to provide a description of the existing MSD wastewater treatment plant (WWTP), an evaluation of the WWTP process performance, and a capacity assessment of the WWTP. As part of the performance assessment, recommended capacity rating criteria were developed for each unit process. The recommended capacity criteria were used along with steady-state process modeling and state-point analysis to develop average annual flow (AAF) and peak wet weather flow (PWWF) capacity for liquid stream unit processes. According to the TM 1, the average dry weather flow (ADWF) and PWWF at MSD will be 0.7 million gallons per day (mgd) and 7.76 mgd respectively. Since PWWF does not impact solids handling facilities, only AAF capacity was developed for them. Capacity limitations were identified when unit processes had less capacity than the anticipated flow and load projections.

4.2 Existing Facility Description

MSD serves the unincorporated area of Montecito in the Santa Barbara County. The influent to the plant is mostly residential sewer with some industrial sewer. The plant was originally built between 1961-1969 and it was upgraded in 1983 to achieve a permitted capacity of 1.5 mgd. MSD currently consists of the following main process areas:

1. Grinding and influent pumping station (IPS).
2. Biological treatment.
3. Chlorination and dechlorination.
4. Solid processing.

Figure 4.2 shows the process flow diagram (PFD). Numbers on the PFD are approximate flows during current average conditions. Appendix 4A.1 includes the design criteria for these processes.

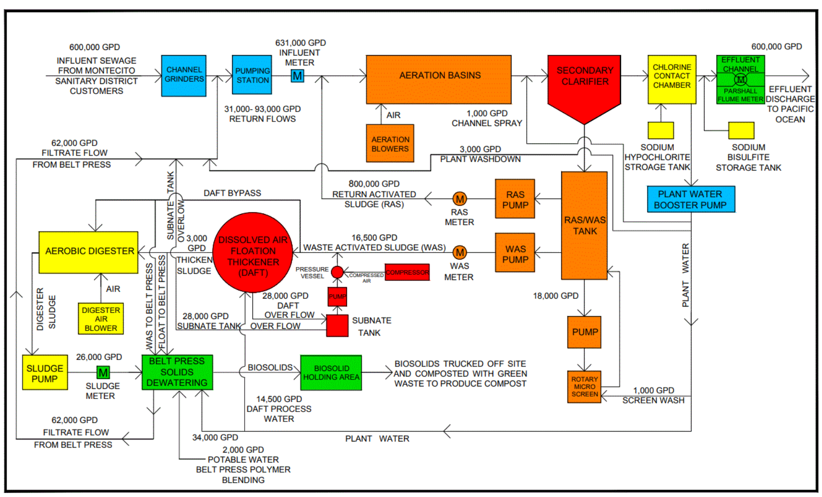

Figure 4.2 Process Flow Diagram

4.2.1 Grinding and IPS

There are two macerator grinders in the influent channel. The combined capacity of the two grinders are approximately 3.5 mgd. The influent flows through the grinders and into a wet well, where it is lifted by influent pumps to the aeration basins and flow by gravity thereafter through the WWTP. Three Flygt raw sewage influent pumps are located in the influent pump room.

4.2.2 Secondary Treatment Process

The secondary treatment process at MSD is an extended air activated sludge process to reduce carbonaceous biochemical oxygen demand (CBOD) to meet permit requirements as summarized in Table 4.1.

Table 4.1 MSD Effluent Limitations

Parameter	Units	Effluent Limitations(1)		
		Average Monthly	Average Weekly	Maximum Daily
Carbonaceous Biochemical Oxygen Demand (5-day @ 20° C) (CBOD)(2)	mg/L	25	40	85
	lbs/day	310	500	1,100
Total Suspended Solids (TSS)(2)	mg/L	30	45	90
	lbs/day	380	560	1,100
Oil and Grease	mg/L	25	40	75
	lbs/day	310	500	940
Settleable Solids	mL/L	1.0	1.5	3.0
pH	s.u.	6.0 to 9.0(3)		
Turbidity	NTU	75	100	225

Abbreviations:
mg/L = milligrams per liter.
mL/L = milliliter per liter.

Notes:
(1) NPDES Permit: Order No. R3-2022-0010, NPDES No. CA0047899
(2) The average monthly percent removal for CBOD and TSS shall not be less than 85 percent.
(3) When the Discharger continuously monitors effluent pH, levels shall be maintained within specified ranges 99 percent of the time. To determine 99 percent compliance, the following conditions shall be met:
- The total time during which pH is outside the range of 6.0 to 9.0 shall not exceed 7 hours and 26 minutes in any calendar month;
- No single excursion from the range of 6.0 to 9.0 shall exceed 30 minutes;
- No single excursion shall fall outside the range of 6.0 – 9.0; and
- When continuous monitoring is not being performed, standard compliance guidelines shall be followed (i.e., between 6.0 to 9.0 at all times, measured daily).

The aeration tanks are fully aerated, and the plant currently operates at long solids residence times (SRT) typically greater than 20 days. Although it is not required for the permit, the plant achieves full nitrification.

The secondary treatment process consists of two aeration basins, four rectangular clarifiers, return activated sludge (RAS) and waste activated sludge (WAS) pump stations and aeration system. The recycle streams from the solids processing (DAF subnatant and belt press filtrate) are returned to the head of the plant and combined with the influent. The combined influent is pumped to two aeration basins for biological treatment. The mixed liquor suspended solids (MLSS) from the aeration basins is settled in the final clarifiers. Most of the settled sludge (or RAS) is returned to the aeration basins while excess sludge (WAS) is sent to the solids processing facilities.

4.2.3 Disinfection and effluent discharge

There are two chlorine contact tanks (CCT). The effluent from the secondary clarifiers split between the two tanks and sodium hypochlorite is added in the mixing chambers at the inlet of each CCT. The CCT effluent is dechlorinated by adding Sodium Bisulfite, before being discharged to the ocean through the 1,500 ft outfall.

4.2.4 Solids Processing

The solids processing consists of dissolved air flotation (DAF), aerobic digestion, belt press for dewatering (and drying beds for backup to the mechanical process). The WAS is thickened in the DAF using compressed air, which floats the solids to the top of the DAF. The float, or solids collected at the surface of the DAF (thickened WAS (TWAS)) is pumped to the aerobic digester. The subnatant from the DAF is low in solids and is returned to the headworks where it is combined with the influent.

The aerobic digester stabilizes the sludge with long detention times and aeration, and it is compartmentalized, so half of it can be taken out of operation for maintenance. The digester is also equipped with capabilities to decant thicken by turning off aeration, allowing solids to settle, and returning the supernatant back to headworks.

Th digested sludge is normally dewatered by the belt press system. The belt press is operated every 1-2 weeks for 8 hours. During emergencies or if maintenance is being performed, the digested sludge can be dried on the drying beds.

4.3 Performance Evaluation

The historical load and performance of each unit process between 2017-2021 was compared to typical anticipated performance. When the original process design criteria were not available for comparison, the Water Environment Federation (WEF) Manual of Practice No. 8 (MOP-8) industry standards were used for comparison. The performance of each unit process provides a benchmark for assessing capacity. In some cases, historical performance confirms that original design criteria are appropriate for assessing unit process capacity. In others, above or below average performance warrants adjusting original design criteria for assessing capacity. For each unit process, recommended design criteria are identified for use in the capacity assessment.

Table 4.2 summarizes the results of the performance evaluation for the MSD.

Table 4.2 MSD Process Performance Data and Criteria for Capacity Analysis

Process Area	Design Parameter	Units	Design Capacity or Rating	Source	Average Performance from September 2016- October 2021	MOP-8 or Typical Values	Recommended Criteria for Capacity Assessment
IPS	PWWF	mgd	3 x 2.3 mgd	O&M manual	0.62 mgd ADWF 6.9 mgd PWWF	Sufficient firm capacity (i.e., 1 unit out of service (OOS)) to pump PWWF	Sufficient firm capacity (i.e., 1 unit OOS) to pump PWWF. The maximum capacity with 1 unit OOS is 4.6 mgd
Aeration Basins	Aerobic SRT	days	-	-	24[1]	Variable depending on treatment objectives and desired safety factor	Minimum of 15 days
	90th Percentile SVI	mL/g	-	-	62	150	Maximum SVI of 86
	MLSS	mg/L			3,070[2]	1,500 – 3,500	Maximum of 3,850
	Process Aeration	scfm	3 x 1,550 scfm blowers Normal operation 1+2	O&M manual	1,780	Variable	Firm capacity at peak day load

Commented [BR1]: List out rated max flow rates for each pump for a total of 2.3 mgd

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Process Area	Design Parameter	Units	Design Capacity or Rating	Source	Average Performance from September 2016- October 2021	MOP-8 or Typical Values	Recommended Criteria for Capacity Assessment
Secondary Clarifiers	Surface Overflow Rate at AAF	gpd/sf	-	-	161[3]	400 – 600	182
	Surface Overflow Rate at Peak Day Flow	gpd/sf	-	-	1,042[3,4]	600 – 1,200	Maximum of 398
	Average Annual Solids Loading Rate	ppd/sf	-	-	10.1[2]	20 – 30	14.6
	Peak Day Solids Loading Rate	ppd/sf	-	-	43.2[3,5]	30 – 40	Maximum of 31
RAS Pumps	Flow Rate	mgd	2 x 1,350 gpm	O&M manual	0.9	Sufficient firm capacity (i.e., 1 unit OOS) to pump 100 percent of MMF or minimum required by state point analysis	Sufficient firm capacity (i.e., 1 unit OOS) to pump 100 percent of MMF or minimum required by state point analysis

Process Area	Design Parameter	Units	Design Capacity or Rating	Source	Average Performance from September 2016- October 2021	MOP-8 or Typical Values	Recommended Criteria for Capacity Assessment
DAF	Solids Load average (maximum month)	lbs/sf/hr	-	-	0.17 (0.4)	0.4 – 1	0.4
	Percent Solids Capture	Percent	-	-	98[6]	90 – 95	Maximum of 95
	TWAS Concentration	Percent	-	-	3.6	3 – 4	Maximum of 3.6
Aerobic Digester	TS in digested sludge - average	mg/L	-	-	27,254		Maximum of 30,000
	TS reduction	Percent	-	-	23		Variable
	HRT - average	days			34.7	Variable	40-60 days if targeting time and temperature requirements for Class B biosolids. If not needed or met through other means, 14 days storage is recommended so that the dewatering belt press can be taken out of service for maintenance

Process Area	Design Parameter	Units	Design Capacity or Rating	Source	Average Performance from September 2016- October 2021	MOP-8 or Typical Values	Recommended Criteria for Capacity Assessment
Belt Press	Solids Loading Rate average (maximum month)	lbs/hr/m	-	-	380	500	Maximum of 500
	Cake	% TS	-	-	18.8		18.8
	Average Runtime	hours/ week	-	-	6		18[7]

Abbreviations:
gpd = gallons per day.
gpm = gallons per minute.
hr = hour
lbs = pounds.
m = meter.
OOS = out of service.
ppd = pounds per day.
scfm = standard cubic feet per minute.
sf = square feet.
TS = total solids.

Notes:
(1) Assumed to be same as effluent temperature.
(2) Excluding January 2018 – June 2019, when MLSS was much higher than typical values due to unusually high influent solids load.
(3) Assuming all clarifiers were in service.
(4) The 1,042 is based on the February 2017 storm events. The peak day flow SOR was 398 gpd/sf, if 2/17/2017 and 2/18/2017 events were excluded.
(5) The 43.2 ppd/sf is based on the February 2017 storm events. The peak day SLR was 27.3 ppd/sf, if 2/17/2017 and 2/18/2017 events were excluded.
(6) The necessary flow data around the DAF system for calculation of the percent removal is not available. Based on the estimated flows from the PFD, the average percentage removal is 98 percent.
(7) Based upon operational experience at MSD.

4.3.1 Influent Pump Station

The IPS capacity is assessed based on having sufficient firm capacity (i.e. capacity with one unit out of service) to pump observed PWWFs. The IPS has a firm capacity of 4.6 mgd. PWWFs (i.e., the observed maximum instantaneous daily influent flow) seen at the plant exceeded the IPS firm capacity 9 times during the past five years. During those periods, the plant would have been required to operate all of the influent pumps. The District also owns a portable engine driven pump that could be used if additional capacity is needed.

4.3.2 Aeration Tanks

4.3.2.1 Aerobic SRT

Total SRT is defined as the total mass of solids in the aeration tanks divided by the total mass of the solids leaving the system in the WAS and secondary effluent. It is a measure of the average sludge age. The aerobic solids retention time (aSRT), which is equal to total SRT at MSD, reflects the portion of the total MLSS that is under aerobic conditions.

The total SRT and aSRT required to meet effluent limits depends on the treatment objectives With CBOD and TSS limits, an SRT of 3 days would be sufficient for an activated sludge process. However, the aeration tanks are currently operating at an aSRT of approximately 24 days, on average, which is significantly higher. While operating at a long SRT is not required for meeting CBOD and TSS limits, there are other benefits including:

- Consistent removal of CBOD and TSS, and also ammonia. Although MSD does not have ammonia limits, removing ammonia likely has benefits in meeting any toxicity requirements in the permit.
- Reduced odor potential. Since the plant does not have primary treatment, operating with a longer SRT has the benefit of stabilizing organic material and reducing the odor potential in the aerobic digester and dewatering process.
- Improved settleability. Operating at SRTs greater than 20 days has likely resulted in the very good settleability the plant currently experiences. Most plants that operate at lower SRTs (i.e. 2-4 days) experience settleability issues and use selectors to mitigate it.
- Process monitoring and control is simplified. When operating at shorter SRTs, there is more variability in process parameters, and process monitoring and control upgrades will be critical to maintain target SRTs, MLSS, wasting, and DO within an acceptable range.

While operation at longer SRTs has benefits, it also reduces the secondary process capacity. An aSRT of 15-days under maximum month loading conditions was selected for the capacity assessment. This is lower than the average 24-day aSRT seen in the historical plant data, yet sufficient to achieve the permit limits and realize the other benefits noted above. Operating with a 15-day aSRT allows MSD to maximize the capacity of the existing secondary process without compromising performance. To be able to operate with a 15-day aSRT, it is recommended to implement automated aeration controls to ensure dissolved oxygen concentrations stay within the target range.

4.3.2.2 MLSS Concentration

The MLSS concentration impacts the SRT and treatment capacity of the aeration basins. Higher concentrations correspond to longer SRTs and improved nitrification performance. Higher MLSS concentrations also increase solids loading on the secondary clarifiers, so there are limits to how high the MLSS concentration can be. The historic MLSS concentration averaged 3,070 mg/L, which is within typical industry values. The capacity of the secondary process is optimized at an MLSS concentration of 3,850 mg/L. At concentrations above 3,850 mg/L, the plant is at risk of overloading the secondary clarifiers during wet weather events.

4.3.2.3 SVI

A key performance parameter in aeration basins is assessing whether well-settling sludge is being generated. The SVI represents the volume of solids in a mixed liquor sample after 30 minutes of settling. In general, the lower the SVI, the faster the solids settle. The SVI is important as it directly affects the capacity of the downstream clarifiers. Higher SVI can require that the aeration tanks maintain a lower MLSS concentration to avoid clarifier overload. A lower MLSS concentration results in a lower SRT and reduced overall secondary capacity. The “reasonable worst-case” SVI of a well-designed and operated extended air activated sludge system is around 150. The 90th percentile SVI, which is typically used as a “reasonable worst-case” at the MSD aeration basins was 86, indicating fast settling sludge at MSD. This 90th percentile value was used as the criteria for analysis based on historical performance. If for some reason settleability is not as good in the future, it will impact the calculated capacity.

4.3.3 Secondary Clarifiers

4.3.3.1 Overflow Rates

Overflow rates were assessed to ensure adequate solids capture. The average overflow of the secondary clarifiers, which were 161 and 1,042 gpd/ sf during AAF and peak day flow respectively, was within or lower than the typical industry range both for AAF and peak day flow conditions, indicating that the clarifiers are not over loaded. Recommended overflow criteria for the capacity analysis were based on the recommended MLSS concentration of 3,850 mg/L and the 90th percentile SVI of 86 mL/g. This results in a recommended capacity criteria of 182 and 398 gpd/sf for AAF and peak day flow day conditions, respectively.

4.3.3.2 Solids Loading

The solids loading rate at both AAF and peak day flow conditions, which were 10.1 and 27.3 ppd/sf, fell within the typical range of industry values, except for the 2 large storm events in February 2017. Recommended solids loading rate criteria for the capacity analysis was also based on the recommended MLSS concentration of 3,850 mg/L and the 90th percentile SVI of 86 mL/g. This results in a recommended capacity criteria of 14.6 and 31 ppd/square foot (sf) for average and max day conditions, respectively.

4.3.4 RAS Pump Station

The RAS pump station capacity is assessed based on having sufficient firm capacity to pump observed maximum monthly flows. The RAS pump station has a firm capacity of 1.9 mgd (with one unit OOS). This is ample capacity for a plant this size.

4.3.5 DAF

4.3.5.1 Solids Loading

Solids loading rate is the primary parameter used in DAF design and operation. Generally, solids loading is lower than typical industry values, and that the DAF is not operating under a stressed condition. The selected criterion for performance evaluation falls in the center of this typical range.

4.3.5.2 DAF Percent Solids Capture

Percent solids capture is calculated as the mass of TWAS divided by the mass of WAS. It is desirable for this to be as close to 100 percent as possible to minimize the amount of solids that are returned back to the headworks and processed again through the liquid stream process. These solids effectively reduce the secondary process capacity, and could negatively impact process performance if present in excess. There is no data available for the flows around the DAF system, but the average suspended solids concentration in the thickened sludge (DAF float) was 35,380 mg/L while the subnatant (recycle returned to the headworks) was 59 mg/L. The exact capture can't be calculated as the volume of plant water added to the process has not been confirmed. Based on current estimates, it is believed the process is performing very well with a capture of 98 percent.

4.3.5.3 TWAS Concentration

The percent solids of the TWAS from the DAF averaged 3.6, which is in the middle of the range of typical industry values for the DAF performance with respect to solids capture and TWAS concentration. Polymer is used to assist in achieving good performance.

4.3.6 Aerobic Digesters

4.3.6.1 Volatile Solids

The main purpose of an aerobic digester is to store and further stabilize the sludge prior to dewatering and disposal. Prior to being fed to the digester, the TWAS is already well stabilized from the long SRT of the activated sludge process, it is not very meaningful to use volatile or total solids reduction as a measure of digester performance. The average VS reduction was XX percent, which is within typical range for aerobic digestion of the sludge from extended air activated sludge process.

The Digesters are currently operated at an average TS concentration of 27,254 mg/L, which is slightly less than 3 percent and approaching the high end of what can be sufficiently mixed in an aerobic digester. Typically, digesters have difficulty mixing above 3 percent. The long detention times in the digesters (35 day average) coupled with the long SRT from the activated sludge process) have minimized any odor potential. If the plant needs to meet Class B requirements for land application, detention time requirements must be met (40 days at 20 deg C or 60 days at 15 deg C) or pathogen reduction must be demonstrated through testing. If MSD does not dispose biosolids through land application, a minimum of two weeks of detention time is recommended. This provides sufficient time for additional stabilization, and allows the plant to take the belt press out of service for up to two weeks to perform maintenance when needed.

Since MSD disposes of the biosolids through XX, etc…

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Commented [FS5R3]: VS in WAS or TWAS? Double check and back calculation % VS reduction in the digester

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4.3.7 Belt Press Dewatering

Loading rates are determined based on the make and model of the belt Press (US Filter 2000-14 series) The loading rate seems to be 380 lb/hr/m, while typical rates for this machine are 500 lb/hr/m. The belt press is running at typical solids loading rate for this machine.

The belt press is run once every 1-2 weeks for 8 hours. This translates to an average usage of 6 hours per week. Because the belt press is not run continuously, it is ultimately at the discretion of operations to set the maximum hours per week it can be run. Staff have indicated they are able to operate the belt press up to 18 hours per week.

4.3.8 Chlorine Contact Chambers

4.3.8.1 Theoretical Contact Time

Theoretical contact time (CT) ensures that the effluent water is adequately disinfected before being discharged to the ocean. The CCCs provides 30 minutes contact time at 1.5 mgd indicating the CCCs have long contact times except during extreme storm events. For effluent discharge, effective chlorination only needs ~10 minutes of contact time. For water reuse, the discussion is a bit more nuanced, noting the following:

- Regulations require a 90-minute modal contact time to obtain virus credits under Title 22 of the California Code of Regulations;
- Regulations allow for a much shorter contact time, such as 10 minutes based upon a t10[1] analysis, as long as the chlorination is free chlorine, which is anticipated for the WWTP due to complete nitrification;
- Regulations for Title 22 require filtration ahead of chlorine disinfection. Accordingly, an MBR option at the WWTP would include the opportunity to disinfect with free chlorine and have some flow be reused as needed for non-potable applications. Note for the MBR option, the peak MBR flow is 1.53 mgd, resulting in ~30 minutes of contact time.

4.4 Capacity Evaluation

Capacities were estimated for each unit process and are dependent on a range of parameters including flow, influent WW characteristics, treatment objectives, process configurations, operational setpoints, and desired redundancy. As part of the performance assessment, original design capacity, historical loading rates, and performance were reviewed and recommended capacity rating criteria were developed for each unit process. Capacities are based on the recommended rating criteria summarized in Table 4.2.

4.4.1 Assumptions

The AAF and peak day capacity was estimated for all liquid and solids stream facilities. The general approach for estimating peak day capacity is summarized below:

- Applied recommended criteria is summarized in Table 4.2.
- Assumed all units are in service.
- IPS capacity was based on firm capacity with one-unit OOS and booth Muffin Monster grinders in service.

[1] t10 is a tracer test in which the time for 10% of the seeded tracer to pass to the effluent of the contactor is demonstrated.

- Since pump station capacity is driven by peak day conditions, the equivalent AAF capacity was based on a peaking factor of 5.7.
- Aeration tanks and secondary clarifiers were assigned the same peak day capacity as both processes are integral to each other, and depend on several factors including the SRT, MLSS concentration, SVI, temperature, and flow distribution. The equivalent AAF was also based on a peaking factor of 5.7.
- The Chlorine Contact Basin capacity must have a minimum contact time of 10 minutes for all potential applications.
- Peak day flows are not meaningful in assessing solids handling capacity, therefore peak day ratings were not provided for those processes.
- For the secondary process and solids handling facilities, max month loading conditions during AAF flow conditions were simulated with a process model to determine the influent AAF when key limiting criteria (identified in Table 4.2) such as solids loading rate or HRT were met. The max month influent conditions used for COD, BOD, and TSS concentration were 940, 460, and 407 mg/L, respectively. See Appendix B for discussion on how those influent criteria were established.
- A Biowin model, Version 6.2 was used to simulate max month loading conditions. The model was calibrated to 2017-2021 data and Appendix B describes the calibration effort and results.

4.4.2 MSD Capacity Ratings

Table 4.3 present the estimated capacity for each unit process at the MSD based on the recommended criteria in Table 4.2 and the assumptions in Section 4.4.1.

Table 4.3 MSD Unit Process Capacity Ratings

Process	Maximum Day Capacity (mgd)	AAF Capacity (mgd)
IPS (mgd)	4.6	0.8[2]
Muffin Monster Grinders	3.5	0.6[2]
Secondary Processes (1)	4	0.7
Chlorine Disinfection (3)	4.5	0.8
DAF	-	0.8
Digesters(4)	-	2 Weeks
Dewatering (5)	-	0.7

Notes:
(1) Secondary processes include aeration tanks and secondary clarifiers.
(2) AAF Capacity is 1.6 and 2.1 mgd for IPS and 1.2 and 1.6 mgd for Muffin Monster grinders at PF 2.9 and 2.2 respectively
(3) Chlorination capacity based upon chlorine contact time minimum of 10 minutes. Disinfection to NPDES standards possible at lesser contact times but demonstration testing is recommended for very short contact times.
(4) Digester capacity is based on providing sufficient storage for maintaining the dewatering equipment (2 weeks). If time and temperature requirements must be met for land application, 40 to 60 days of storage will be required, which will reduce the rated AAF capacity.
(5) Based on operating XX hours per week. If operating hours are increased or decreased, rated capacity will change.

All processes meet the projected AAF of 0.7 mgd. All of the liquid stream facilities meet or exceed projected maximum daily flows per TM1 if the largest of two storm events in 2017 are excluded from the analysis. A discussion on the estimated capacity for the secondary treatment processes and solids handling is provided in the sections below.

Commented [FS10]: Estimate the average annual flowrates for the 2 weeks detention time in the digesters. Run for max month load

Commented [FS11]: Estimate the average influent based on 18hr operation of the BP (~1.8 mgd). Check with model

4.4.2.1 Secondary Treatment Processes (Aeration Tanks and Secondary Clarifiers)

The secondary process capacity noted in Table 4.3 is based on a 15-day SRT and a wet weather peaking factor of 5.7. To better understand the impact SRT and wet weather peaking factors have on the capacity, a range of scenarios were considered.

Currently, the plant is operated at an aSRT of 24.0 days. Simulations for capacity were performed at a 15-day and 20-day aSRT. These simulations indicated that there will be insufficient capacity for projected flows at a 20-day aSRT and a peaking factor of 5.7. Thus, capacity was determined using a 15-day aSRT, which is sufficient to achieve permit limits.

The secondary clarifier capacity is based on its ability to settle sludge which is dependent on the MLSS concentration and SVI or site-specific settling characteristics. State point analysis was performed for 90th percentile SVI based on plant data. State point analysis was used to estimate the PWWF capacity over a range of recommended MLSS and settleability conditions. The PWWF capacity was converted to an equivalent AAF capacity using PWWF/AAF peaking factors of 5.7, 2.9 and 2.2. The 5.7 and 2.9 peaking factors correspond to the 2 storm events during the February of 2017 and were taken into consideration in this analysis. Also, the analysis was performed at a peaking factor of 2.2, which is based on the assumption that future flows at MSD will be equalized at 1.53 mgd.[2] Therefore, it was important to understand Figure 4.3 shows the aeration basin and secondary AAF capacity over a range of SRT, settleability, and MLSS concentration, assuming all units are in service.

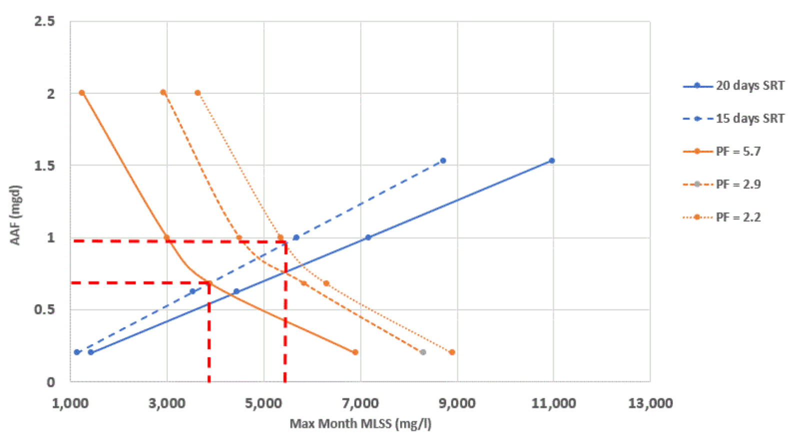

Figure 4.3 MSD Secondary Treatment Capacity

[2] 1.53 mgd is the peak day flow, if excluding the February 2017 storm events. Refer to TM 1 for further information.

The recommended capacity rating is 0.7 mgd AAF at 15 days aSRT and assuming PF of 5.7, which represents a target MLSS concentration of approximately 3,850 at a 15-day aSRT. If the settleability were degraded, then the capacity will be reduced. If the secondary process were maintained at the current aSRT of 24 days, the estimated capacity will be reduced and not meet the projected flow and loads.

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Appendix 4A

MSD TECHNICAL DATA

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Table 4A.1 MSD Technical Data

Plant Area	Sub Area	Parameter	Value
Headworks	IPS	Number of Units	2 Duty, 1 Standby
		Type	Flygt
		Total Capacity	6.9 mgd
		Firm Capacity	4.6 mgd
	Grinders	Number of Units	2
		Type	Muffin Monsters
		Total Capacity	7.0 mgd per O&M, 7.5 mgd per operational experience
	Flow Measurement	Number of Units	2
		Type	
		Total Capacity	
		Firm Capacity	
Secondary Treatment	Aeration Basins	Number of Tanks	2
		Shape	Rectangular
		Sidewater Depth	15 feet
		Total Volume	0.78 MG
	Aeration Blowers	Number of Units	3
	Final Sedimentation Tanks	Number of Tanks	4
		Shape	Rectangular
		Length, Each	80 feet
		Width, Each	12 feet
		Surface Area, Total	3,840 sf
		Number of WAS Pumps	1
		WAS Pump Capacity, Total	0.1 mgd
		WAS Pump Capacity, Firm	0.1 mgd
		Number of RAS Pumps	1 Duty, 1 Standby
		RAS Pump Capacity, Total	3.8 mgd
		RAS Pump Capacity, Firm	1.9 mgd

Plant Area	Sub Area	Parameter	Value
Solids Handling	DAF	Number of Units	1
		Shape	Circular
		Surface Area, Each	200 sf
		minimum Air/Solids Ratio	0.04 lbs of air/lbs of WAS
		Number of Pressurization Pumps	1 Duty
		Pressurization Pump Capacity, Firm	0.43 mgd
		Pressurization Pump Pressure	60 psi
	Aerobic Digestion	Number of Digester Tanks	1
		Surface Area	840 ft^2
		Sidewall Depth	18 feet
		Total Volume	0.1 MG
	Belt Press Solids Dewatering	Number of Units	1
		Maximum Weekly Runtime	8 hours per week

Appendix 4B

INFLUENT CHARACTERISTICS AND PROCESS MODEL CALIBRATION

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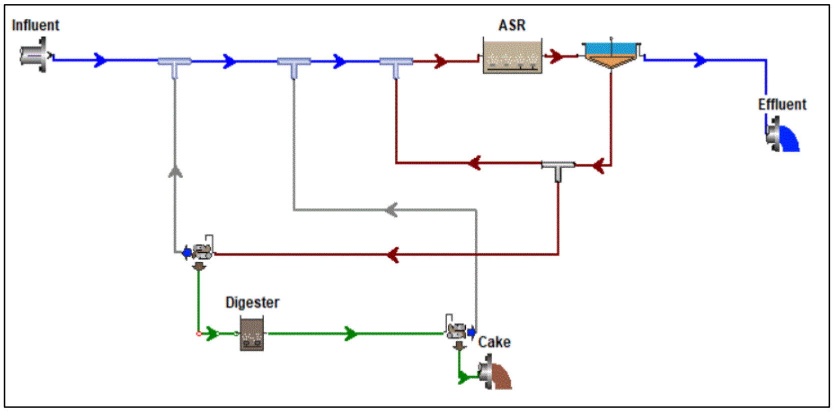
A process model of MSD's WWTP was built using the latest version of Biowin (6.2). Biowin is a commercially available software package that is commonly used to simulate municipal treatment plant operation and performance. A graphical illustration of the flow sheet is provided below.



The model was set up to reflect the volume and dimensions of the aeration tanks, secondary clarifiers, and aerobic digester. The average influent flows and loads from 2017-2021 were used as model inputs, and the WAS flows, TWAS flows, and thickener and dewatering performance was also adjusted to match historical data. The table below summarizes the historical data and model results for two scenarios; one where the influent COD matched historical data, and one where the influent COD was adjusted to better match the sludge production throughout the plant.

Table 4B.1 Historical Data and Model Results

Item	MSD Data 2017-2021 Avg	Model Simulation Match Influent COD	Model Simulation Match Sludge Production
Influent			
Flow, mgd	0.62	0.62	0.62
COD, mg/L	954	954	512
$CBOD_5$, mg/L	233	468	250
TSS, mg/L	398	412	237
TSS, lb/d	2,060	2,100	1,280
NH_3, mg/L	40	40	40
Aeration Basins			
MLSS, mg/L	3,300	6,800	4,100
MLVSS, mg/L	2,900	5,500	3,000
Process Air, scfm	1,780	3,200	2,200

Item	MSD Data 2017-2021 Avg	Model Simulation Match Influent COD	Model Simulation Match Sludge Production
Secondary Effluent			
TSS, mg/L	6	6	6
NH_3, mg/L	0.2	0.2	0.2
WAS			
Flow, mgd	13,840	13,840	13,840
TSS, mg/L	6,160	11,300	6,800
TS, lb/d	720	1,300	790
Thickened WAS or Digester Feed			
Flow, gpd	3,000	3,000	3,000
TSS, mg/L	33,800	49,500	29,900
TS, lb/d	840	1,240	750
Digested Sludge			
Flow, gpd	3,000	3,000	3,000
TSS, mg/L	27,300	42,500	26,100
TS, lb/d	790	1,070	650
Belt Press Cake			
% TS	18.8	18.8	18.8
Cake-Dry, lb/d	720	1,000	620

When using the average influent COD, the model predicts 40 to 80 percent more sludge production and process air usage than the plant's operating data shows. When using a lower influent COD, the model predicts values that would be expected for a mostly domestic wastewater. In addition, the model predictions for sludge production and air usage match up with the operating data. This suggested the possibility that the influent samples were not representative of the actual influent characteristics, or that there is an issue with the COD analysis for the samples. Non-representative samples could be captured if the samples are not flow composites, if they are taken from an area in the wet well where solids have accumulated, or if there is any sort of contamination.

A few other observations suggest the COD data may not be accurate or representative:

- For typical municipal wastewater characteristics, the influent BOD_5 and TSS concentrations are within 5-10 percent of each other. During the data review period, the average influent CBOD5 was 233 mg/L, which is significantly lower than expected based on the average influent TSS of 398 mg/L.
- For typical municipal wastewater characteristics, the COD/BOD_5 ratios range from 1.8 to 2.2. For the MSD data, with the average influent COD of 954 mg/L and a CBOD5 of 233, this ratio is 4:.1. High COD/BOD_5 ratios are often indicative large industrial contributions in the service area, however, that was unlikely given what was known about the community in the service area.

- Effluent COD averaged 232 mg/L, which is significantly higher than expected for a WWTP that operates a long-SRT activated sludge process. More typical values are in the 50 to 100 mg/L range. A significant industrial discharger could explain this observation, however it was unlikely given the service area.

After discussing the data and observations with MSD staff, it was decided to run a four- weeks long QA/QC test on MSD's influent to verify the influent's water quality. The QA/QC special sampling was performed during the March 2022, and provided significant value to the analysis. The table below summarizes the detailed results of the QA/QC testing.

Table 4B.2 QA/QC Testing Results

Date	INFL-001 BOD (mg/L)	INFL-001 CBOD (mg/L)	INFL-001 COD (mg/L)	INFL-001 SOLUBLE COD (mg/L)	INFL-001 TSS (mg/L)	INFL-001 VSS (mg/L)	Time or Flow Composite
02/27/22	384	255	1094	358	444	411	Time
03/01/22	303	195	1438	912	378	351	Flow
03/03/22	357	250	1235	844	357	332	Flow
03/06/22	264	195	1093	550	305	298	Time
03/08/22	246	174	1276	950	271	256	Time
03/10/22	224	178	1046	406	310	297	Time
03/13/22	222	166	920	692	214	208	Time
03/15/22	201	130	774	368	277	260	Time
03/17/22	264	221	838	414	252	231	Time
03/20/22	218	178	1214	478	281	268	Time
03/22/22	355	226	774	496	292	283	Time
03/24/22	254	206	898	460	268	258	Time
Average	274	198	1,050	577	304	288	-

The following were the key takeaways from the QA/QC test:

- The influent BOD and TSS results were consistent with the overall solid balance and the model predictions.
- The influent COD was still quite high compared to the influent BOD and TSS. MSD lab noted that there have been issues with the COD test kits being used. Sometimes, multiple analysis of the same sample would result in different COD values. It was concluded that the COD analysis was the likely issue and that the District would further investigate the accuracy of the COD analysis.

In order to complete the capacity analysis for the existing process, as well as the future potential MBR system (see TM 6), the TSS and BOD from the QA/QC test was used as the basis for the analysis. Historical COD data was assumed to be erroneous and was not used.

The table below summarizes the historical influent data and the recommended parameters to use for the capacity assessment and MBR analysis. Since biological processes are sized on max month conditions, the recommended parameters selected reflect max month load conditions.

Table 4B.3 Historical Influent Data and Recommended Parameters for Capacity Assessment

Item	MSD Data 2017-2021 Average	March 2022 Testing	Recommended Average Annual Conditions	Recommended Max Month Conditions (1)
Influent COD, mg/L	954	1094	590	885
Influent CBOD5, mg/L	233	198	289	434
Influent BOD_5, mg/L		274		
Influent TSS, mg/L	398	311	278	417

Notes:
(1) Calculated as the recommended average annual conditions times a 1.5 peaking factor. Peaking factor selected reflects historical mass load peaking factor for influent CBOD5 and TSS.