Technical Memorandum

Date: April 12, 2021

To: Brian Helminger, Director, Heart of the Valley Metropolitan Sanitary District

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From: Mike Gerbitz, PE

Re: **Executive Summary of Capacity Analysis**
2020/1 Master Planning

Abbreviations

AA	annual average
BOD	5-day biochemical oxygen demand
District	Heart of the Valley Metropolitan Sanitary District
HOVMSD	Heart of the Valley Metropolitan Sanitary District
MD	maximum day
mgd	million gallons per day
mg/L	milligrams per liter
MM	maximum month
NH3-N	ammonia nitrogen
Permit	WPDES permit
ppd	pounds per day
TKN	total kjeldahl nitrogen
TM	technical memorandum
TSS	total suspended solids
TP	total phosphorus
WRRF	water resource recovery facility or wastewater treatment facility

Purpose

The purpose of this Technical Memorandum (TM) is to summarize the findings of a capacity analysis of the Heart of the Valley Metropolitan Sanitary District (HOVMSD) water resource recovery facility (WRRF).

Background

Loadings to the WRRF have been increasing steadily since approximately Year 2015, outpacing the rate of service area population growth. The HOVMSD retained Donohue (Year 2019) to review historical flows and loadings, forecast future flows and loadings, and assess the potential to re-rate the WRRF to better accommodate service area growth and rising influent loadings.

Rated Capacity

Every WRRF possess two capacities: [1] the capacity approved by a regulating agency and [2] its true capacity. The capacity approved by a regulating agency is commonly referred to as the "rated capacity." The true capacity often exceeds the rated capacity. Regulators understand this difference and may increase or decrease the rated capacity if there are compelling reasons and evidence to do so. This is referred to as "re-rating" a WRRF.

The capacity of the HOVMSD WRRF was established by the most recent Facility Plan (circa Year 2005). It has not been re-rated to increase or decrease this capacity. The current rated WRRF capacity is delineated below.

Population

Planning for the WRRF as it is currently configured was completed circa Year 2005. The planning period was 20 years. The end of the planning period is Year 2028. The estimated population for the WRRF service area was 67,827. Table 1 shows the anticipated population distribution between the municipal entities.

Table 1 – Design Population

Entity	Design Population
Combined Locks	3,473
Darboy	25,098
Kaukauna	18,969
Kimberly	6,898
Little Chute	13,389
Total	67,827

Flows and Loadings

Table 2 shows the flows and loadings the WRRF is *rated* to treat. These flows and loadings correspond to the design year population presented in Table 1.

At the time of planning, the Permit did not include total maximum daily load (TMDL) limits for total suspended solids (TSS) or total phosphorus (TP). The current Permit includes effluent TSS and TP limits that are more stringent than those at the time the WRRF was planned (circa Year 2005). Because the existing WRRF cannot consistently comply with these more stringent TSS and TP limits, the HOVMSD will be adding tertiary effluent filtration with cloth media disk filters. These filters will be sized to treat the peak-hour secondary treatment flow rate (26 mgd).

Table 2 – Design Flows and Loadings

Parameter	AA	MM	NMD	PH
Flow (mgd)	8.5	11.9	26.4	60
BOD (ppd)	12,209	14,651		
TSS (ppd)	13,565	16,278		
NH3-N (ppd)	1,600	1,920		
TP (ppd)	339	407		

Notes
AA = Annual average
MM = Maximum month
NMD = Normal maximum day
PH = Peak hour

Current and Future Population

Figure 1 shows the current and projected future service area populations. The exponential projection assumes the population will grow at an annual % equivalent to that of the last two decades (1%). The linear projection assumes future decades will the same number of people the last two decades added. The solid horizontal red line corresponds to the design year population. The projected populations do not reach the design population until approximately Year 2045 – 2055.

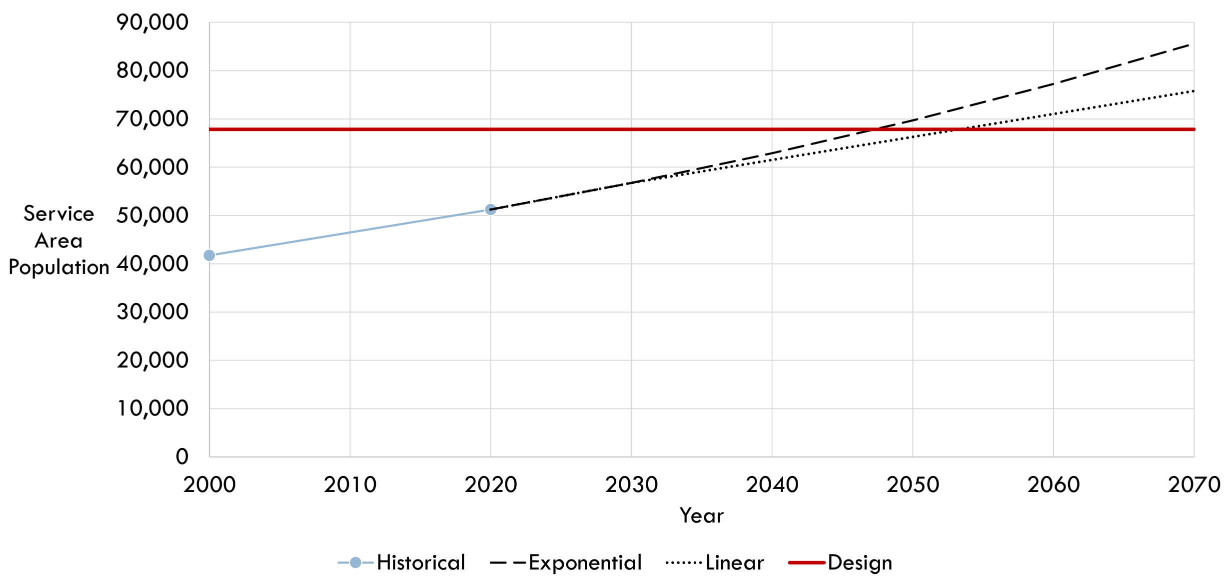

Figure 1 – Historical and Projected Service Area Populations

Table 3 shows the design population and the estimated Year 2020 population for the service area based on population estimates published by the Wisconsin Demographic Services Center (WDSC). The Darboy Sanitary District (Darboy) population is estimated using the HOVMSD-provided number of customers and the average people per customer throughout the balance of the HOVMSD service. The present-day population is roughly 75% of the design population.

Table 3 – Design Year and Estimated Present-Day Populations

Entity	Design Population	Current Population Estimate	% of Design Population
Combined Locks	3,473	3,592	
Darboy	25,098	12,194	
Kaukauna	18,969	16,363	
Kimberly	6,898	7,137	
Little Chute	13,389	11,947	
Total	67,827	51,233	75.5%

Historical Flows and Loadings

Flows

Figure 2 shows historical average influent flows. An ultrasonic flow meter measured influent WWRF flows throughout the entire timeframe. A laser flow meter was installed in 2019. The laser meter is more accurate than the ultrasonic meter. On average, laser-measured flows are 11% higher than ultrasonic-measured flows. Laser flows prior to 2019 are estimated by applying the average laser meter bias (111%). Historical average flows are consistently less than the rated average flow capacity (horizontal red line).

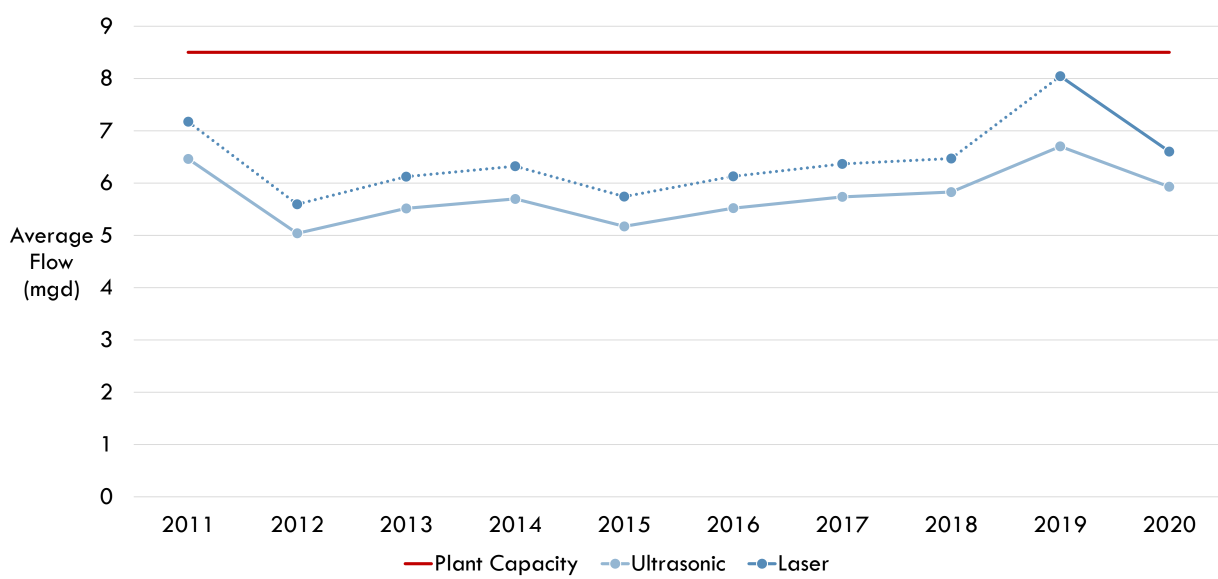

Figure 2 – Historical Average Influent Flows

Figure 3 shows historical maximum month influent flows. Laser flows prior to 2019 are estimated by applying the average laser meter bias (111%). Maximum month flows are consistently below the rated maximum month flow capacity (horizontal red line). Two estimated laser values exceed the rated capacity; however, these excursions may be attributed to the simple method used to estimate laser flows.

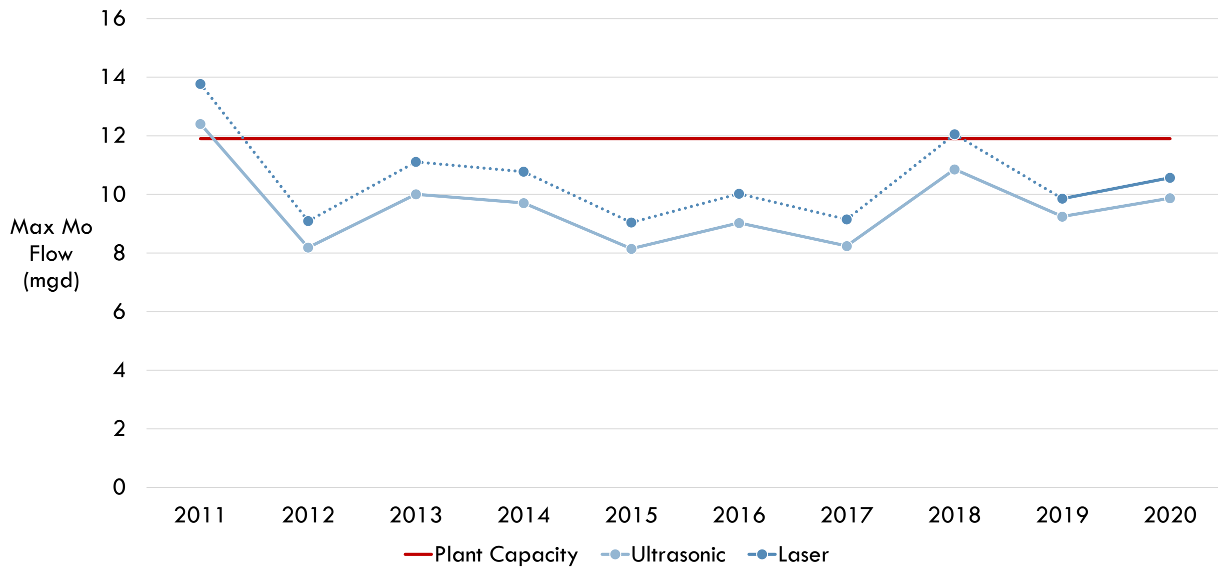

Figure 3 – Historical Maximum Month Influent Flows

Loadings

Figure 4 shows historical average influent 5-day biochemical oxygen demand (BOD) loadings. Figure 5 shows historical maximum month influent BOD loadings. The solid horizontal red lines represent the rated WRRF capacities.

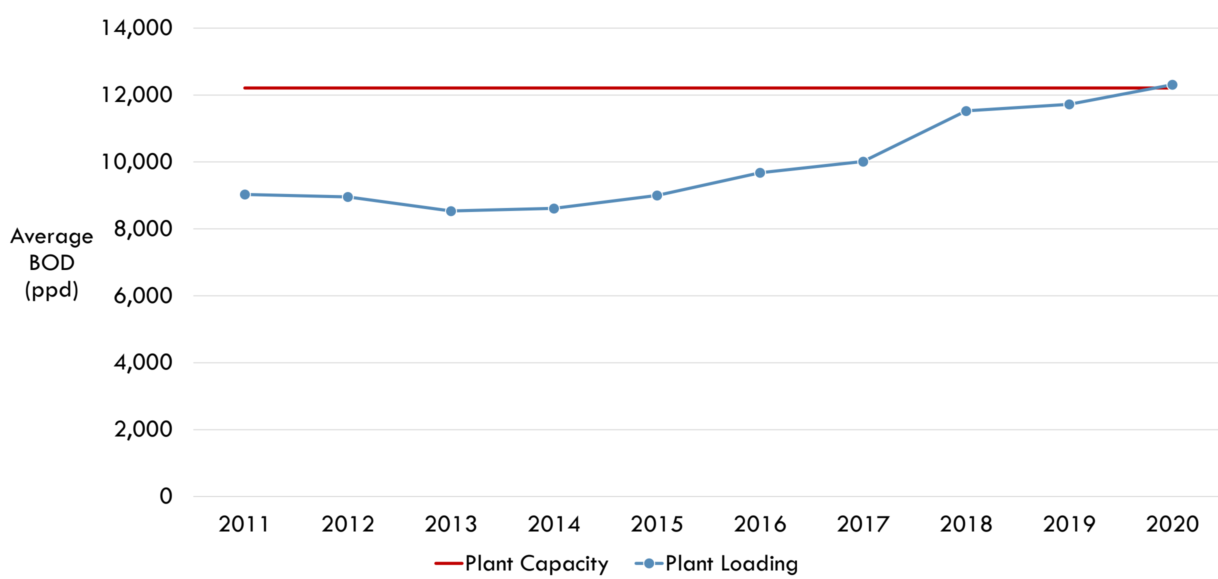

Figure 4 – Historical Average Influent BOD Loadings

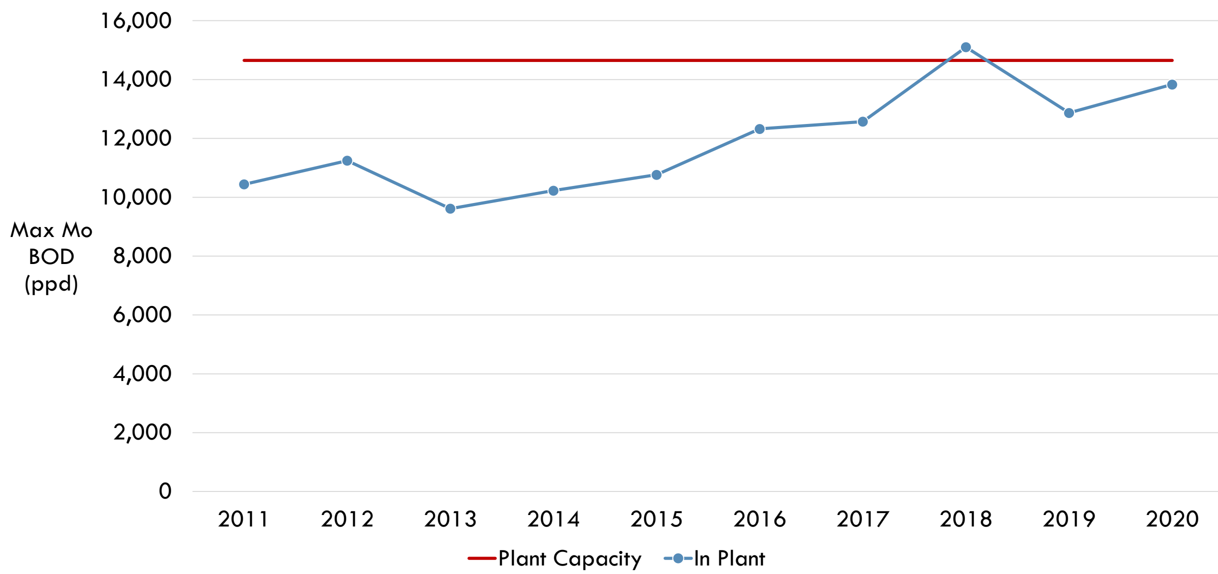

Figure 5 – Historical Maximum Month Influent BOD Loadings

Figures 4 and 5 reveal that influent BOD loadings have increased steadily since 2015. Figure 6 shows that these loading increases, both average and maximum month, exceed the increases that would be expected from the growing service area population. The dashed lines represent influent BOD loadings *assuming* per capita loadings after Year 2015 are consistent with those prior to that. Historical BOD loadings outpace those attributed solely to service area population growth after Year 2015. The difference in BOD loadings (actual – expected) in Year 2020 equates to roughly 16,000 residents that do not live within the service area.

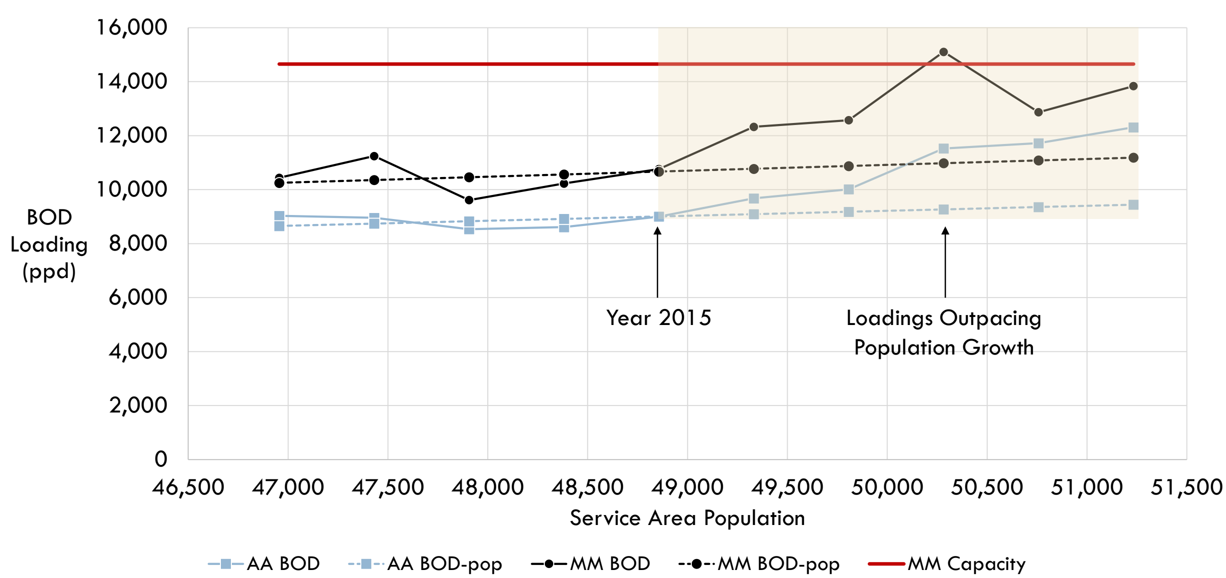

Figure 6 – Actual and Expected Influent BOD Loadings

Figure 7 shows historical average influent TSS loadings. Figure 8 shows historical maximum month influent TSS loadings. The solid horizontal red lines represent the rated WRRF capacities. All historical loadings are consistently and considerably below their corresponding design ratings.

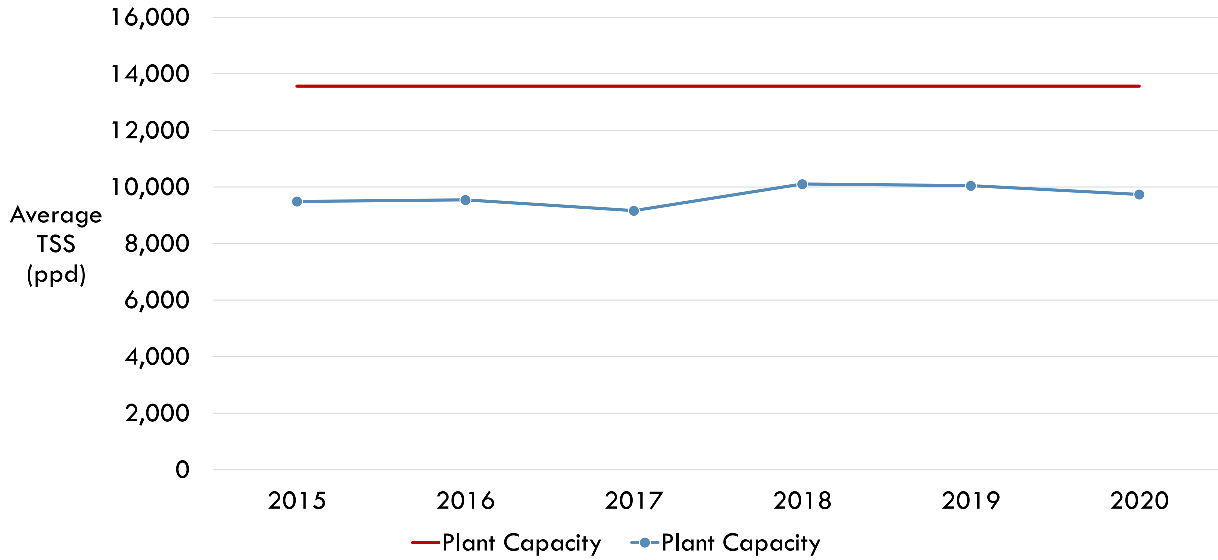

Figure 7 – Historical Average Influent TSS Loadings

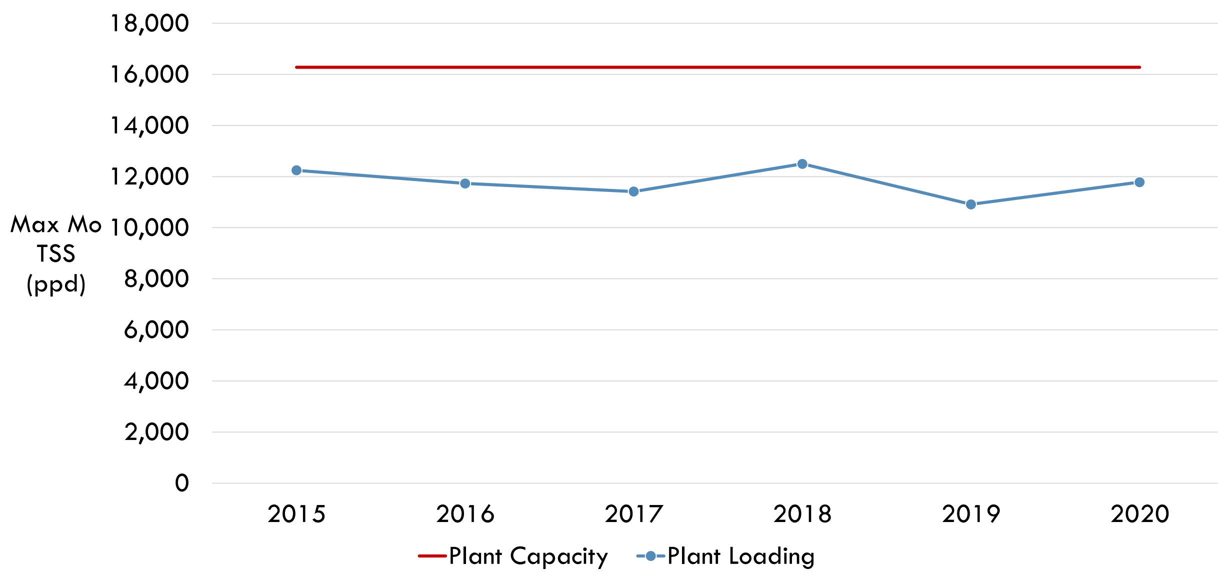

Figure 8 – Historical Maximum Month Influent TSS Loadings

Figure 9 shows historical average influent total Kjeldahl nitrogen (TKN) loadings. Figure 10 shows historical maximum month influent TKN loadings. The solid horizontal red lines represent the rated WRRF capacities. The original design basis did not explicitly define TKN loadings, only ammonia. For the purposes of this analysis, the design TKN capacities are the same as the design NH3-N capacities.

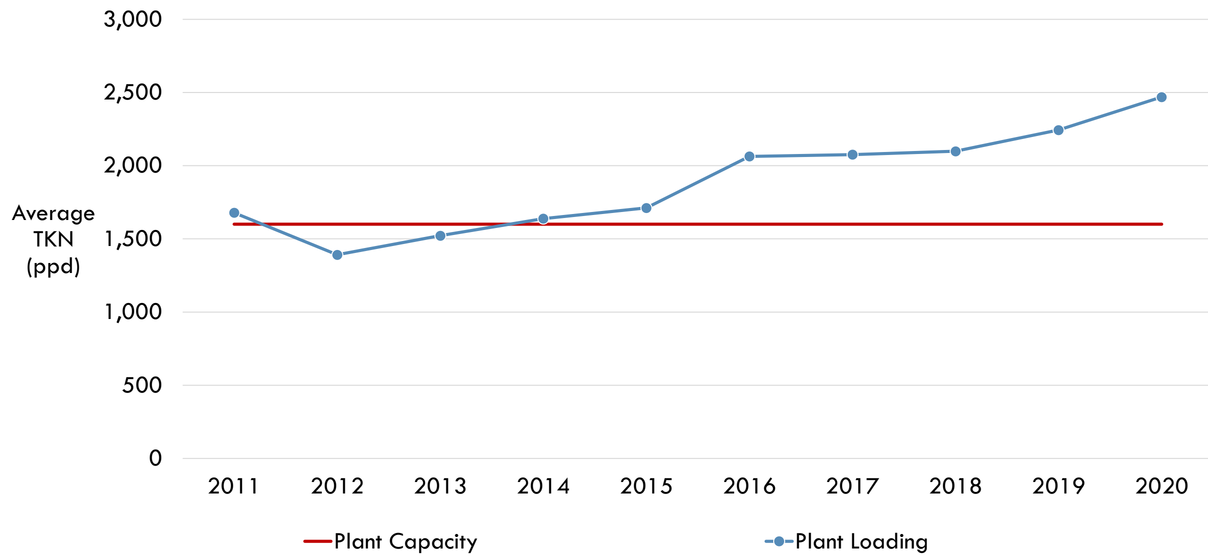

Figure 9 – Historical Average Influent TKN Loadings

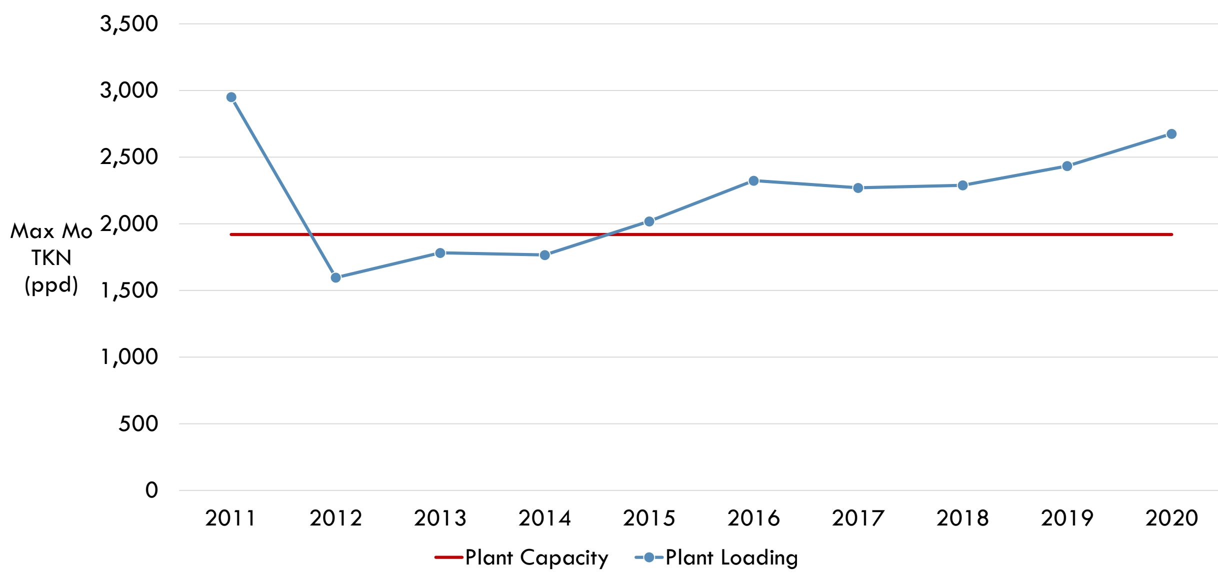

Figure 10 – Historical Maximum Month Influent TKN Loadings

Figures 9 and 10 reveal that influent TKN loadings have increased steadily since 2015. Figure 11 shows that these loading increases, both average and maximum month, exceed the increases that would be expected from the growing service area population. The dashed lines represent influent TKN loadings *assuming* per capita loadings after Year 2015 are consistent with those prior to that. Historical TKN loadings outpace those attributed solely to service area population growth after Year 2015. The difference in TKN loadings (actual – expected) in Year 2020 equates to roughly 26,000 residents that do not live within the service area.

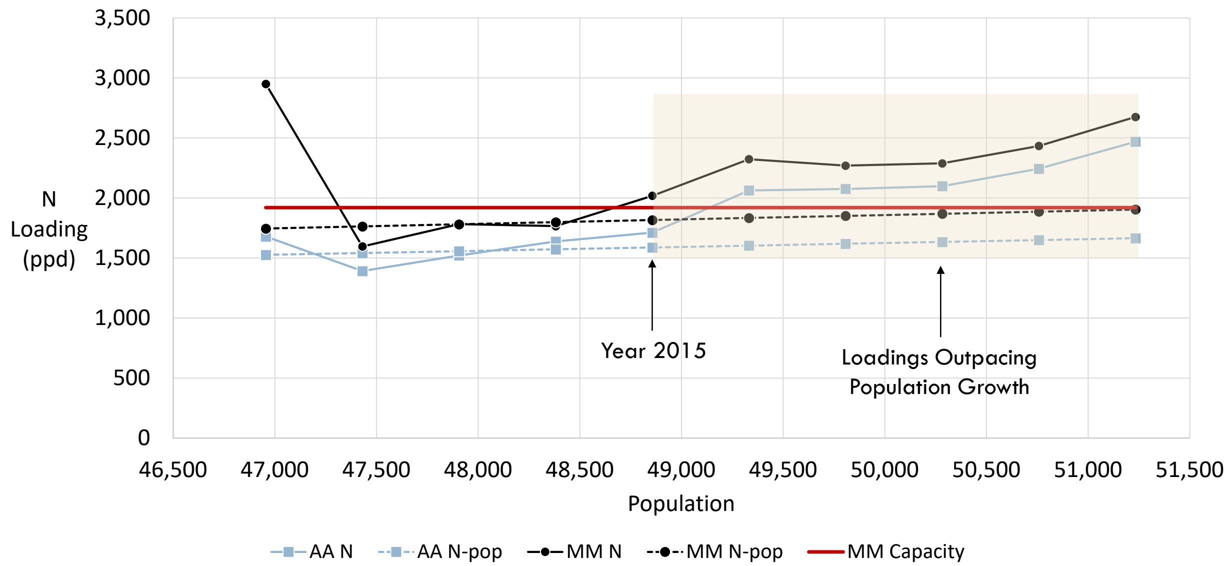

Figure 11 – Actual and Expected Influent TKN Loadings

Figure 12 shows historical average influent TP loadings. Figure 13 shows historical maximum month influent TP loadings. The solid horizontal red lines represent the rated WRRF capacities. All historical loadings are consistently and considerably below their corresponding design ratings.

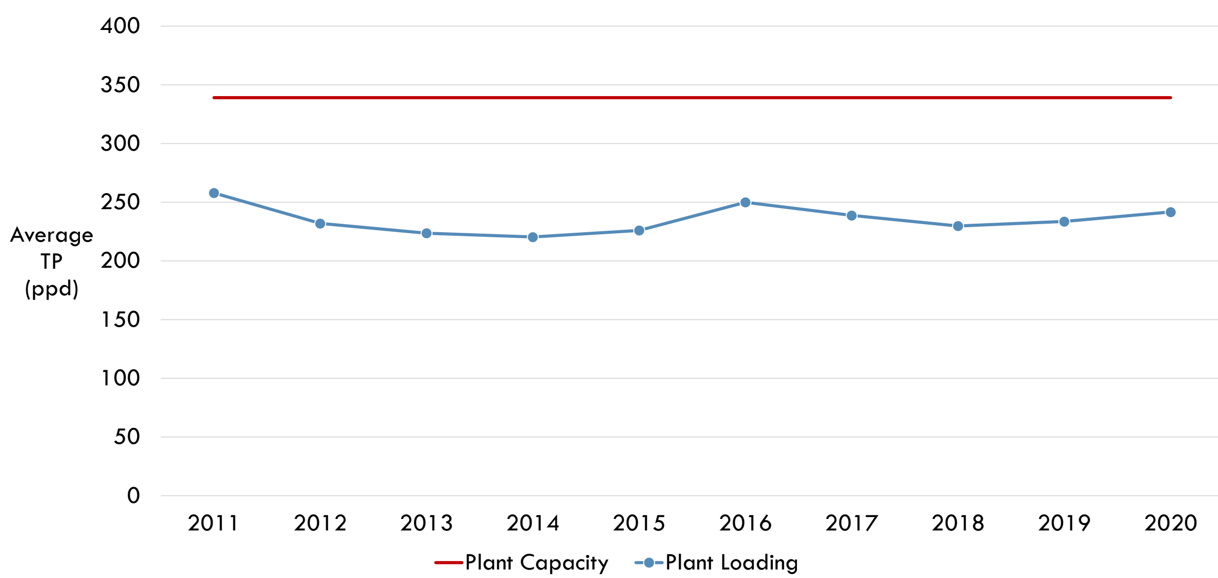

Figure 12 – Historical Average Influent TP Loadings

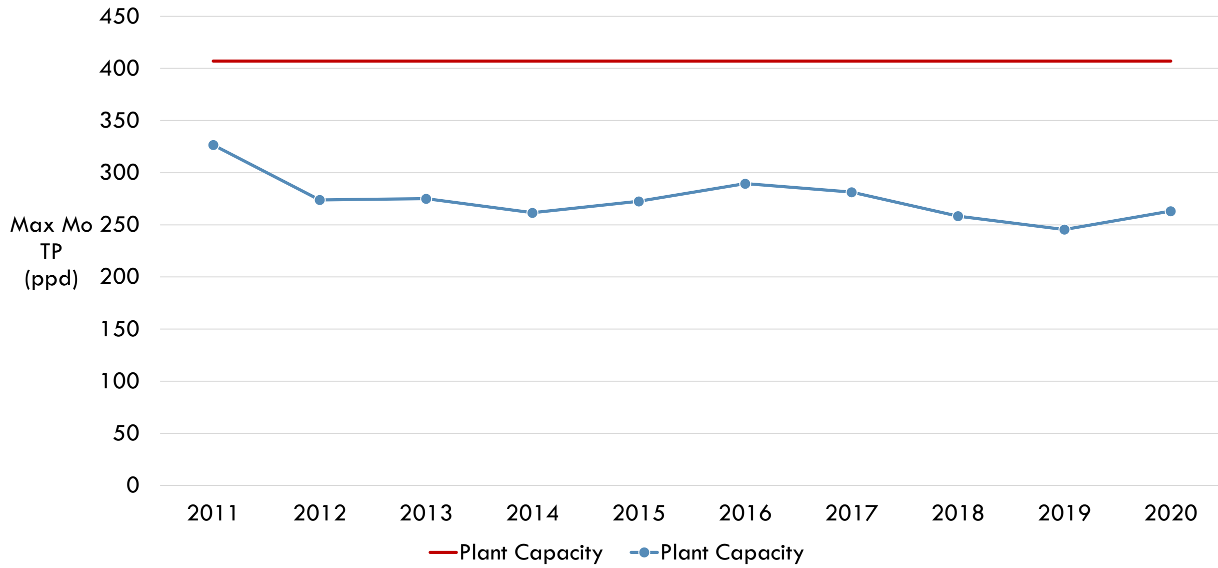

Figure 13 – Historical Maximum Month Influent TP Loadings

Historical Effluent Performance

Figure 14 shows historical effluent BOD concentrations. The horizontal red line is the monthly average permit limit. The dashed red line through the data points is a 30-day rolling average. The rolling average is consistently and considerably below the permit limit.

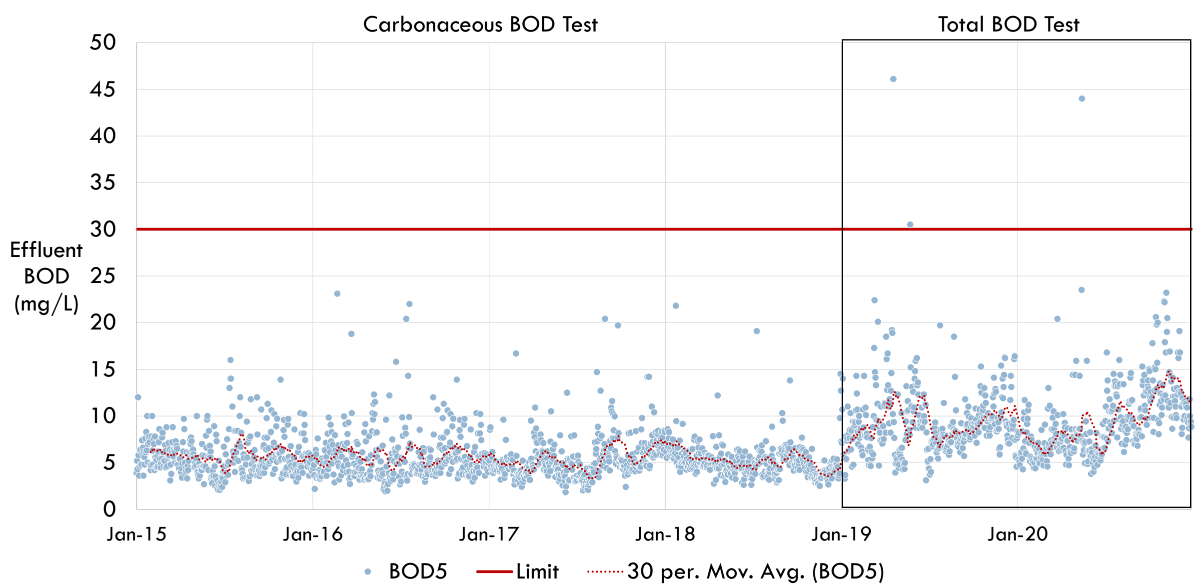

Figure 14 – Historical Effluent BOD Concentrations

Figure 15 shows historical effluent TSS loadings. The horizontal red line is the monthly mass limit. The jagged black line through the data points is a 30-day rolling average. The rolling average regularly exceeds the mass limit. The District is designing an effluent filtration system to address this compliance issue. The existing WRRF, without effluent filtration, is incapable of consistently meeting this recent limit.

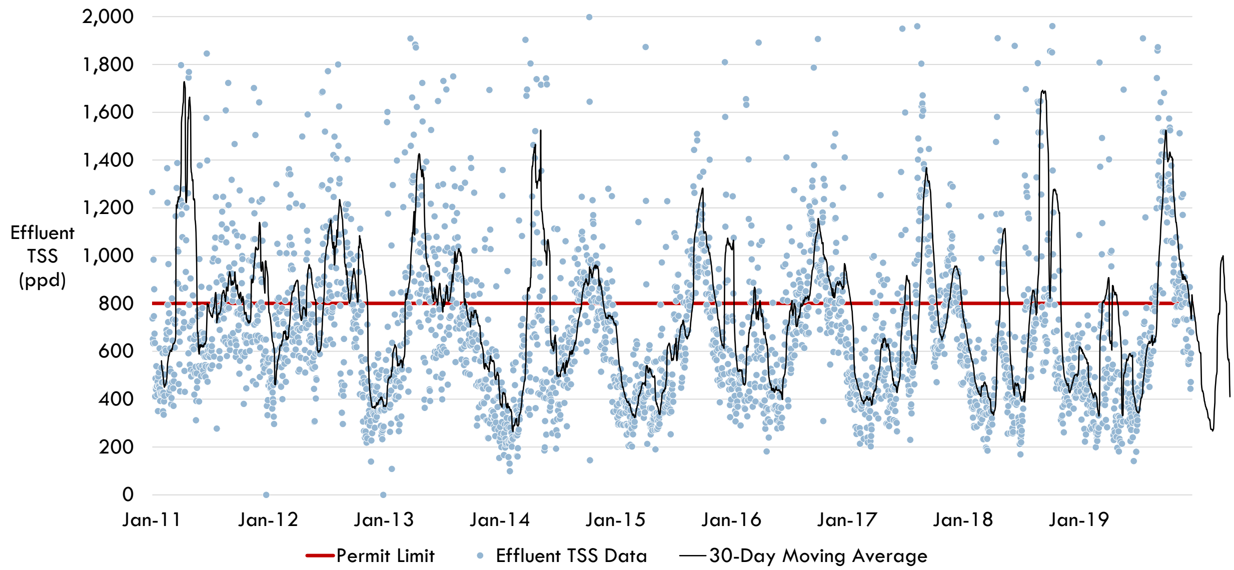

Figure 15 – Historical Effluent TSS Loadings

Figure 16 shows historical effluent NH3 concentrations. The horizontal red line is the permit limit. The dashed red line through the data points is a 20-day rolling average, which corresponds to a rolling monthly average. The rolling average is consistently and considerably below the permit limit.

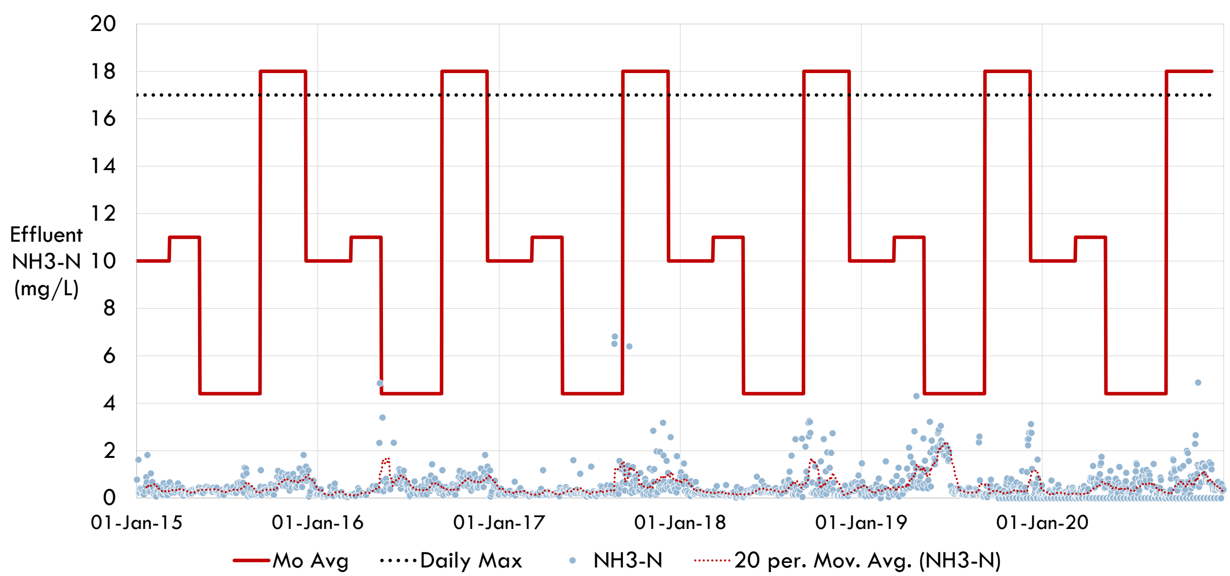

Figure 16 – Historical Effluent NH3 Concentrations

Figure 17 shows historical effluent TP loadings. The horizontal red line is the impending 180-day mass limit. The jagged black line through the data points is a 180-day rolling average. The rolling average regularly exceeds the mass limit. The District is designing an effluent filtration system to address this compliance issue. The existing WRRF, without effluent filtration, is incapable of consistently meeting this impending limit.

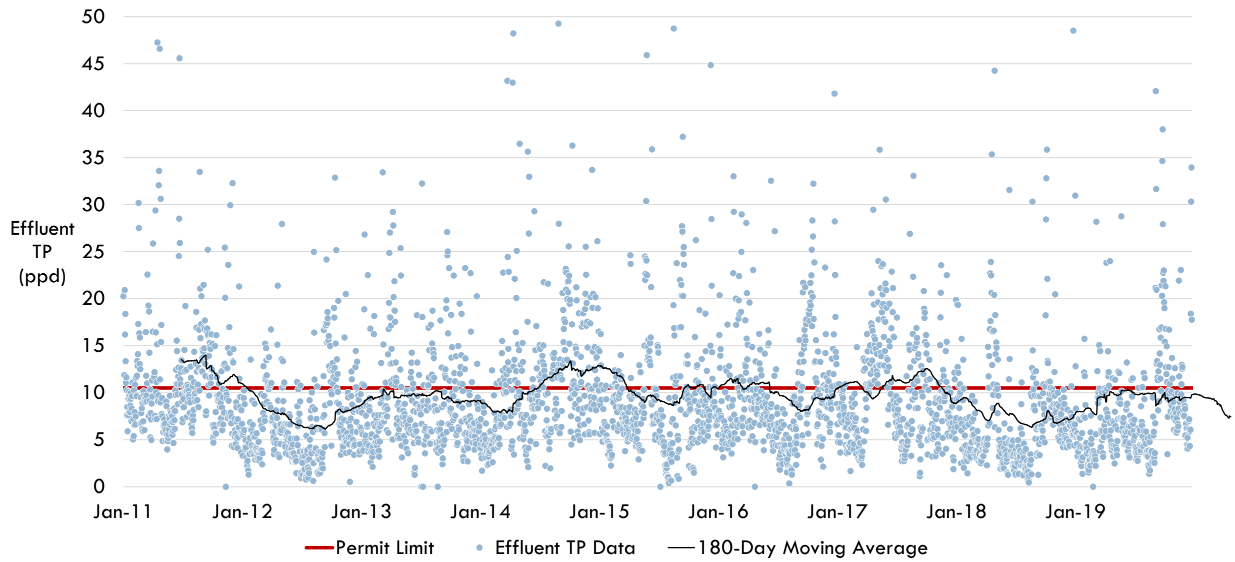

Figure 15 – Historical Effluent TP Loadings

Capacity

Liquid Train

With the exception of disinfection, all liquid train processes possess adequate hydraulic capacity. The disinfection system possesses the same capacity that was previously approved by the Wisconsin Department of Natural Resources (WDNR); however, the peak-hour detention time does not satisfy the current requirement stated in NR 110 (30 minutes). The effluent filtration project will increase the detention volume to meet the peak-hour requirement.

The Biostyr process is the only liquid train unit process that is operating at loadings beyond its design capacities, which were used to establish the rated capacities for the WRRF. Figures 16 and 17 show average and maximum month BOD loadings to Biostyr, respectively. Average loadings are consistently and considerably less than the design capacity. Maximum month loadings have reached the design capacity on multiple occasions. Average Biostyr loadings are less than the design capacity because the upstream Actiflo system is removing a higher fraction of the influent BOD than the original design assumed it would.

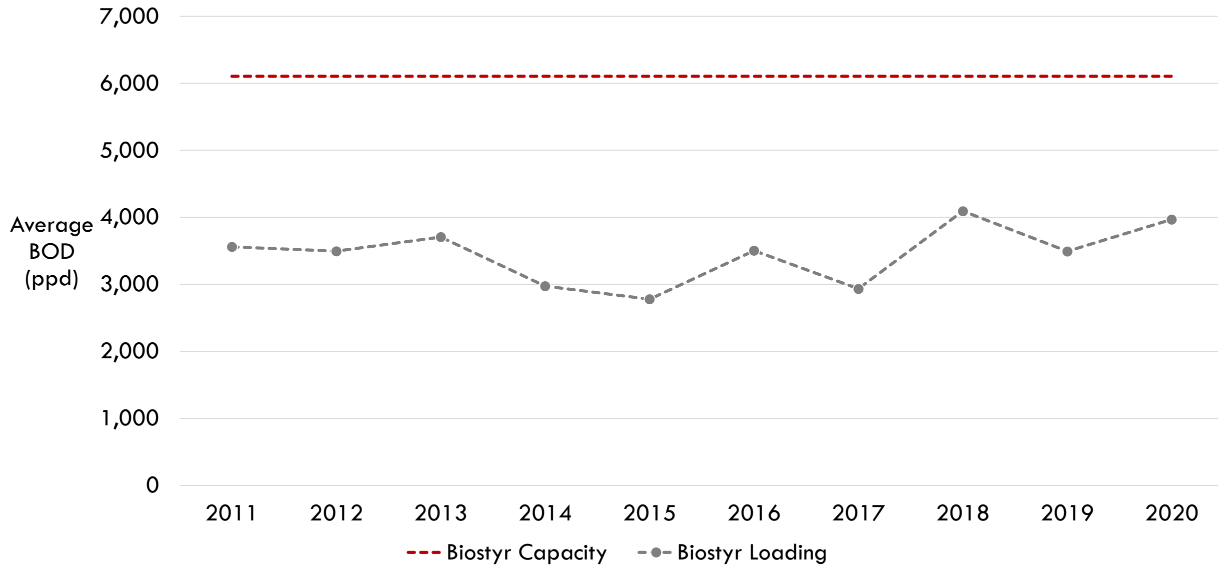

Figure 16 – Historical Average BOD Loadings to Biostyr

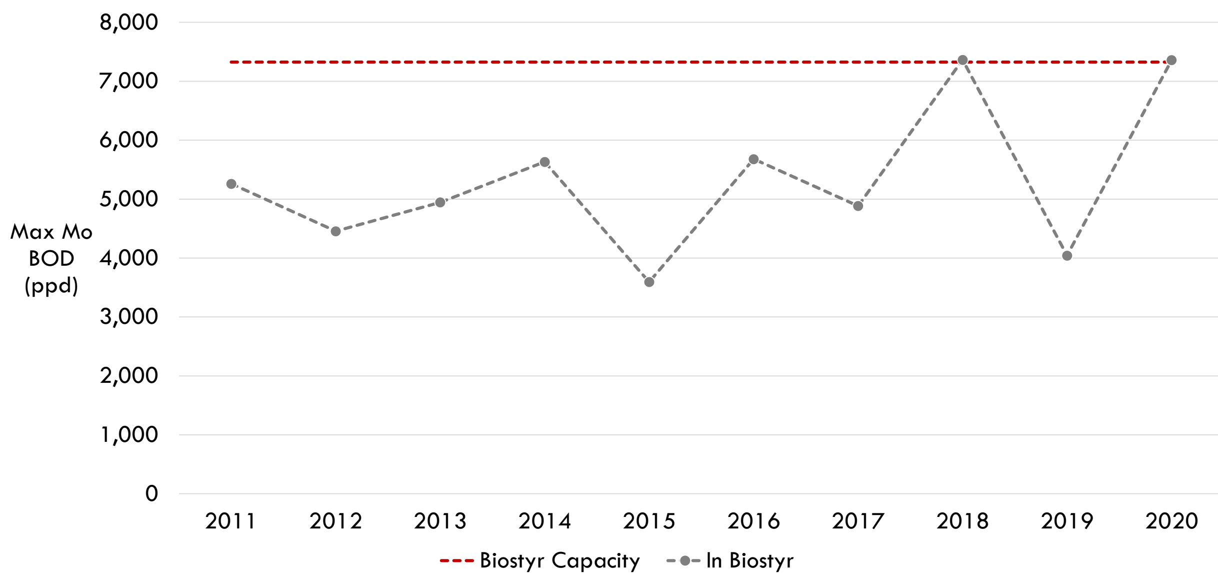

Figure 16 – Historical Maximum Month BOD Loadings to Biostyr

Figures 17 and 18 show average and maximum month TSS loadings to Biostyr, respectively. Average and maximum month TSS loadings to Biostyr have reached or exceeded their respective design capacities. Influent TSS loadings are consistently less than the rated capacity of the WRRF. The relatively high Biostyr loadings reveals that the Actiflo system is removing a smaller fraction of the influent TSS than the original design assumed.

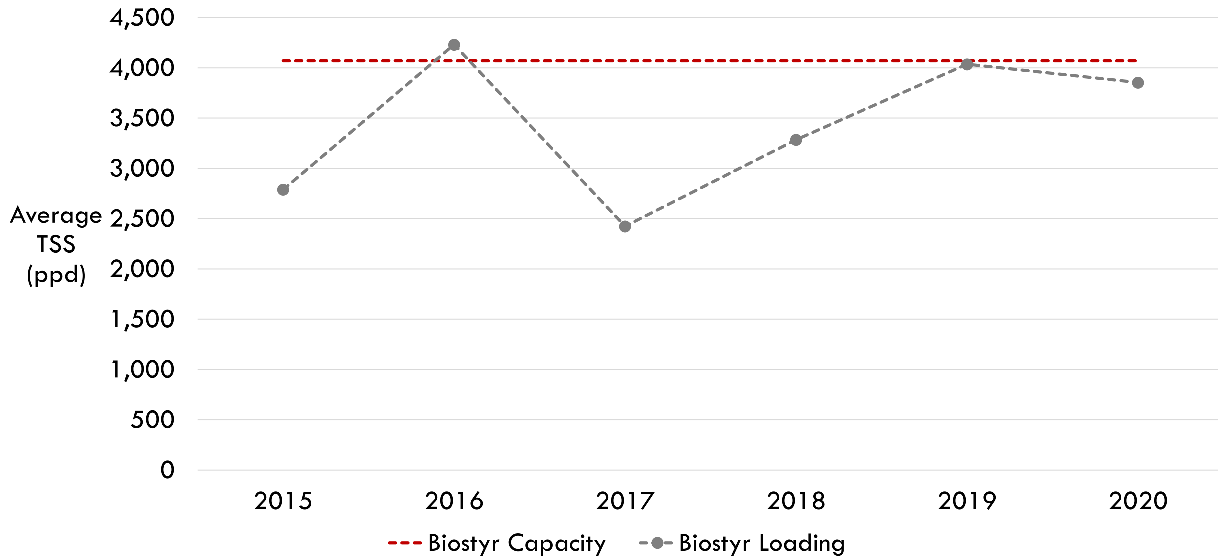

Figure 17 – Historical Average TSS Loadings to Biostyr

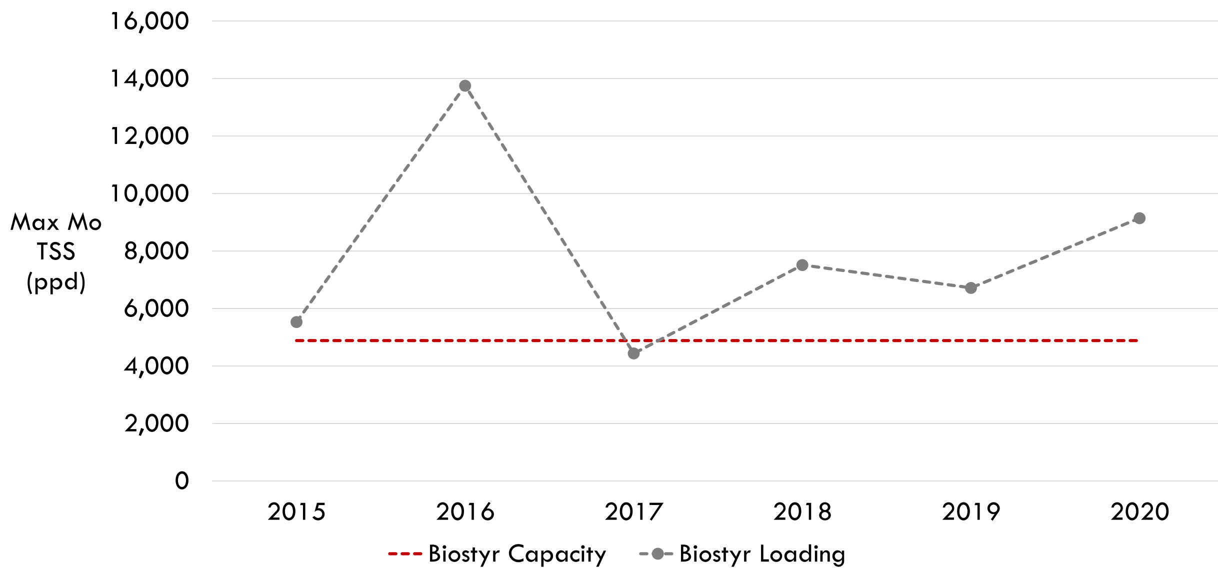

Figure 17 – Historical Maximum Month TSS Loadings to Biostyr

Figures 19 and 20 show average and maximum month TKN loadings to Biostyr, respectively. Average and maximum month TSS loadings to Biostyr have reached or exceeded their respective design capacities. Data from 2015 – 2019 was not available. The District collected a large amount of nitrogen data in 2020. The regression lines show anticipated loadings from 2015 – 2019.

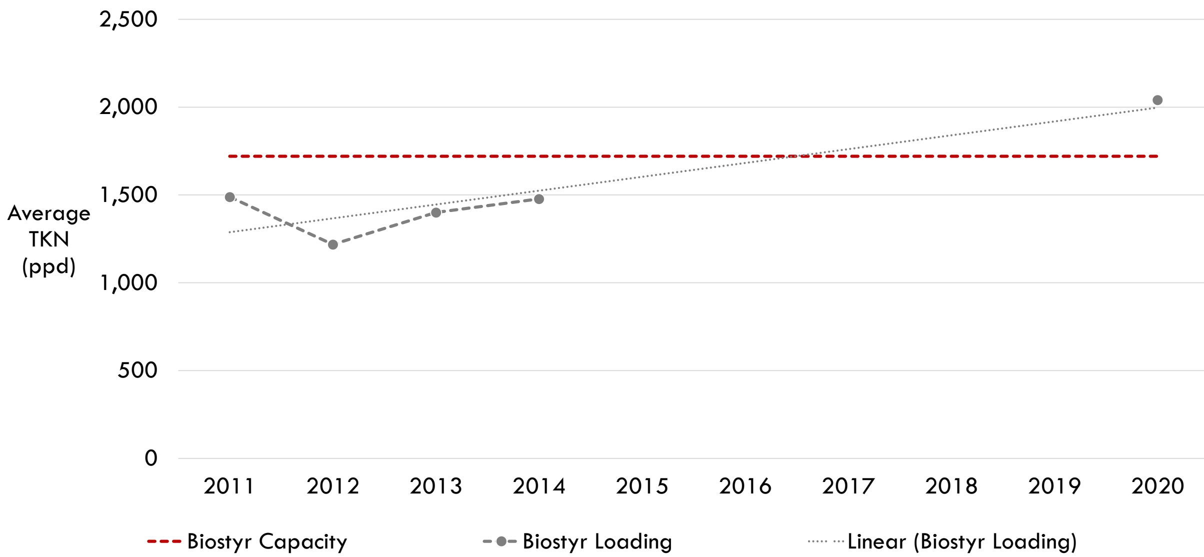

Figure 19 – Historical Average TKN Loadings to Biostyr

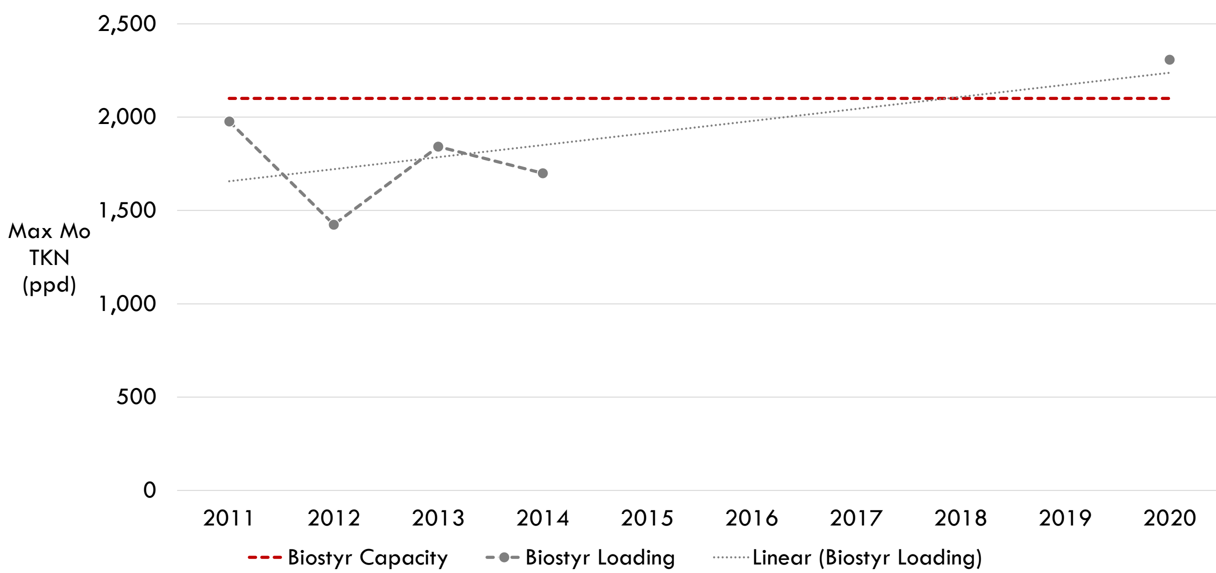

Figure 20 – Historical Maximum Month TKN Loadings to Biostyr

<u>Solids Train</u>

The main solids train unit processes include dissolved air flotation thickening, autothermal thermophilic aerobic digestion (ATAD), post-ATAD nitrification reactor, and solids storage. These processes are operating within their design capacities. The ATAD and post-ATAD reactors are operating very near and, at times, above those rated capacities.

<u>Capacity Findings</u>

The disinfection system is undersized. The District is addressing this shortcoming as part of its current effluent filtration project.

Recent BOD and TKN loadings exceeded their respective WRRF capacities. Recent BOD, TSS, and TKN loadings reached or exceeded their respective Biostyr capacities. The BOD and TKN capacity issues are largely attributed to relatively high loadings from sources other than the service area population.

Outagamie Landfill

The Outagamie Landfill is one source that has added large BOD and TKN loadings since 2015. The landfill intends to add pre-treatment. The District should continue to monitor these pre-treatment efforts and understand its expected future BOD and TKN loadings.

Next Steps

The effluent filtration project will allow the WRRF to comply with recent or impending low-level TSS and TP effluent requirements. No further action is required related to TSS and TP.

Despite the WRRF operating at BOD and TKN loadings at or above their rated capacities, the WRRF has continued to produce permit-compliant effluent. Historical performance suggests there is a low probability of an effluent BOD or NH3 violation at loadings similar to those of the recent past. This also suggests that the WRRF and, more specifically, Biostyr has more capacity than the original design assumed. In other words, true capacities exceed rated capacities. The steps below are aimed at [1] determining the true capacities and [2] evaluating a low-cost alternative to increase the Biostyr capacities.

1. Perform cold- and warm-weather stress testing to determine the *true* capacities of the Actiflo/Biostyr system.
2. If stress testing shows that more capacity is required, then pilot test alternative Biostyr media. An alternative media has the potential to improve BOD and TKN capacities.
3. Determine a path forward in the context of a) expected future loadings from the Outagamie Landfill, b) the results of stress testing, and c) the cost-benefit of changing Biostyr media.