

Nutrient and Energy Optimization Study Plateau Utility District - Wartburg STP Wartburg, Tennessee

June 2024



Tennessee Association of Utility Districts

with funding from the **Tennessee Department of Environmental Conservation, State Revolving Fund Loan Program** and support from **Grant Tech, Inc., Plateau Utility District** and the **City of Wartburg**

Introduction

Tennessee Plant Optimization Program (TNPOP) assists water and wastewater utilities in achieving energy efficiency and nutrient optimization through low-and-no-cost measures. TNPOP is a free program operated by the Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources (DWR). The program provides resources to support water and wastewater operators in achieving optimization in energy use and nutrient removal for their facilities through low-and-no-cost measures.

Acknowledgements

The following study was made possible through funding from the Department of Environment and Conservation (TDEC), Tennessee Division of Water Resources (DWR) State Revolving Fund Loan Program with a TDEC/SRF/TAUD contract. The lead technician for this study was TAUD Senior Wastewater Specialist Dewayne Culpepper. Special ***Thank You*** to the Plateau Utility District General Manager Mike Monroe, Plateau Utility District - Wartburg WWTP operator Garret Starkey, Grant Weaver of Grant Tech, Inc., and TDEC's Karina Bynum.

Summary of Findings

Preceding the optimization effort described in this report, the Wartburg staff in 2017 (after attending TDEC's seminars on nutrient removal with Grant Weaver) implemented strategies to optimize treatment plant performance. As a result of the initial optimization efforts, Wartburg's oxidation ditch was already providing a high-quality effluent. A change in plant staff took place in late 2023 when lead operator Ray Freeman and his assistant/lab technician Alex Freeman left the facility. They were replaced by Plateau Utility District General Manager, Mike Monroe, and Operator Trainee, Garret Starkey, on September 29, 2023. During this time, the new management and operators benefited from the Tennessee Plant Optimization Program (TNPOP) through the extensive hands-on training regarding process control to achieve nutrient removal.

Beginning February 2022, a sixteen-month optimization effort resulted in a slight improvement in Nitrogen removal but otherwise little change in Phosphorus removal or conventional treatment. Effluent BOD remains around 5 mg/L and effluent TSS remains at 1 mg/L.

The staffing change seems to have had little impact on treatment. The total Nitrogen concentration in the treated effluent has held at a notably low value of under 3.0 mg/L. Effluent total Phosphorus has averaged 1.0 to 1.4 mg/L.

Electrical savings of approximately 10% appear to have been realized before the staffing change. This likely due to the adjustments made to the oxidation ditch aeration rotors during the course of the study.

To dial in performance, frequent in-house monitoring of effluent ammonia, nitrate, and orthophosphate were performed. Using these data, the on/off cycles of the aeration were changed in an effort to maintain ammonia-nitrogen removal while reducing nitrate-nitrogen concentration. As the influent hydraulic and organic loading changed as well as with the seasonal temperature changes, close process control monitoring and documented adjustments were made to optimize plant performance.

Utilizing the State of Tennessee's TNPOP program, the Wartburg WWTP personnel received guidance in adjusting the run times of three different aeration rotors to provide the highest quality treatment at the least possible cost. Several configurations of aeration on-off cycles for each of the 3 rotors were tried. In the past year, all parties involved learned the limitations of the process, equipment, and design of the plant and at the same time learned what adjustments optimized the biological process control to achieve lower TN and TP.

In conclusion, the Plateau Utility District Wartburg WWTP now has documented nutrient optimization abilities of the plant, design limitations and infrastructure improvement needs. On a normal daily basis, the WWTP achieves permit compliance with all effluent nutrient parameters (BOD, TSS, Ammonia NH₃) including the 12 – month rolling average for limits Total Phosphorus and Total Nitrogen. Plant performance is affected during severe weather events. TNPOP optimization program has so far shown successful improvements in consistency in total nitrogen nutrient reduction and compliant results with total phosphorus resulting in a high-quality treated effluent to help meet the goals of the TNPOP, protect public health and for the environment to enjoy.

Comments on Plateau Utility District Wartburg WWTP

The Plateau Utility District Wartburg WWTP was built in 2005 and has therefore been in continuous service for nearly twenty years. A beginning of project equipment review identified the following to be in need of attention: preliminary treatment equipment (screening), intermediate plant screw pumps & motors, and tertiary sand filtration units. Since there is limited screening and grit removal, the plant has experienced chronic problems with trash in the oxidation ditch, clarifiers and blinding of the tertiary filters.

The Wartburg sewer collection system has chronic Infiltration/Inflow problems resulting in a current moratorium from the State of Tennessee. I/I have a detrimental impact on the collection system components and the wastewater treatment process control causing violations with federal and state permits. The city has started a sewer evaluation project to identify problems in the collection system and then conduct a rehabilitation of those areas found needing repair.

Recommendations

In light of the above, the following shortcomings merit attention.

- An on-going investment in identifying and correcting Wartburg's significant collection system Inflow and Infiltration.
- Further improvements with the preliminary equipment, intermediate plant screw pumps & motors, and tertiary sand filtration units.
- By-pass arrangement ability to divert flow around tertiary sand filtration units so to perform maintenance of filters and handle flow hydraulic overload periods.
- An investment in in-line instrumentation and control systems to further optimize aeration rotor performance.

WWTP Plant Information

NPDES Permit No. TN0028622 - Plateau Utility District Wartburg STP
519 Wastewater Customers (taps) and a Major Prison housing 2441 offenders and 741 employees.
10 miles of gravity sewer
Inflow/Infiltration = 32%

The Plateau Utility District Wartburg STP is authorized to discharge treated domestic wastewater from Outfall 001 to the Crooked Fork Creek at mile 6.3. Discharge 001 consists of municipal wastewater from a treatment facility with a design capacity of **0.75 MGD**. The Permit link that shows all permit required parameters, monitoring, and limits:

https://dataviewers.tdec.tn.gov/dataviewers/f?p=2005:34308:9739345493380:::RIR:IREQ_PERMIT_NUMBER,IREQ_FILE_TYPE:TN0028622,Permit

Wastewater Treatment Plant characteristics

Built in 2005

Single Oxidation Ditches with a design capacity of 0.75 MGD.

The Ditch is followed by two clarifiers.

There are 4 sand filters for tertiary of treated effluent.

Disinfection is achieved with liquid bleach and dechlorination with a liquid agent.

Average Year-round Influent flow: **0.5 MGD**

Oxidation Ditch has a volume of 0.83 MG.

Oxidation Ditch has three 50 hp rotary aerators.

Oxidation Ditch Effluent flow splits to two clarifies.

Each Clarifier has a volume of 0.113 MG

WAS ?????? gallons 1 to 2 times / week based on the desired MLSS

Average 2021 -2022 wastewater parameters:

Average Influent Flow: 0.5 MGD; Max flow: >1.0 MGD

Average Influent BOD: 214 mg/L; Effluent BOD: 5.5 mg/L

Average Influent TSS: 192 mg/L ; Effluent TSS: < 1.0

Average Influent Ammonia as NH₃: 21.0 mg/L; Effluent Ammonia as NH₃: 0.3 mg/L

Average Effluent TN: 3.6 mg/L (2-Year Average) / 2022 Average = 2.56 mg/L

Average Effluent TP: 1.29 mg/L (2-Year Average) / 2022 Average = 0.975 mg/L

Operating Process Control Parameters:

Average MLSS: 3115 mg/L

Volatile Solids Content : 80%

Average MLVSS : 2492 mg/L

Average F/M: 0.044

Average SVI 135

WWTP Operator Information:

Wastewater Operations – General Manager, Plateau Utility District

Mike Monroe - Plateau Utility District

mmonroe@plateauutility.com

423-319-7791

Wastewater Treatment Plant Operator

Garret Starkey - 423-539-6998 - gstarkey@plateauutility.com

Wartburg Wastewater Treatment System Information (Initial Evaluation – January 2023)

The Plateau Utility District now is contracted to operate the Wartburg STP wastewater system, and monitors & samples three county school on-site treatment plants. The Plateau Utility District is under contract with the State of Tennessee Morgan County Correctional Complex to treat their wastewater. There is a dedicated line directly to the Wartburg STP.

The Plateau Utility District has one categorical industry that requires an Industrial Pretreatment Program. The Sewer Use Policy/Ordinance is current, well written and supports the Industrial Pretreatment Program. The Industrial Pretreatment Program is administered by the General Manager, Mike Monroe.

The Morgan County Correctional Complex (MCCC) has a dedicated sewer line pumped directly to the Wartburg STP and is sampled at the plant. There is no State mandated pretreatment program required for MCCC. The characteristics of the wastewater flow from the Prison consist of High BOD, Ammonia and TSS.

The Wastewater Treatment Plant was built around 2005. The collection system consists of 8 sewer lift stations. The plant has a stringent NPDES permit to comply with. There are several complex parameters to be sampled daily, weekly, monthly, quarterly, semi-annually and annually to comply with pretreatment, plant effluent and Bio-solids sections in the permit (see attached permit). The plant has nutrient limits for Total Nitrogen (9.7 mg/L - TN) and monitoring for Total Phosphorus (1.6 mg/L - TP). The plant was not designed for TN or TP removal when built. The current operation of the plant has recently been equipped for optimization using timers and soft-starts to control the rotors on-off aeration cycles in the oxidation ditch to achieve removal of TN and TP with some success. To achieve consistent future compliance with the NPDES permit will require upgrades to the plant to optimize the process. This will include addition of automatic controls (SCADA) to control process operation, control aeration rates and install on-line process sensors (DO sensors, ORP sensors and ammonia sensors) to control the biological process.

In 2019, The Wartburg WWTP had an upgrade on the bio-solids disposal facility and disinfection process.

The Plateau Utility District Wartburg WWTP is now 15 years old and in the stage for equipment upgrades and replacement. At the beginning of the current Tennessee Plant Optimization Program (TNPOP), the condition of the plant was evaluated. The preliminary equipment, plant pumps & motors, aeration motor and gear box need attention. The influent preliminary equipment consists of a spiral fine screen unit and vortex grit removal unit, and both are inoperable and need replacement. Since there is no screening and grit removal, the plant has experienced chronic problems with trash in the oxidation ditch, clarifiers and especially with the tertiary filters blinding them.

The Wartburg sewer collection system is like most of the cities having I/I Problems, 32%. There are sanitary sewer overflow violations resulting in a current moratorium from the State of Tennessee. The city has started a sewer evaluation project to identify problems in the collection system and then conduct a rehabilitation of those areas found needing repair.

June 2021, Plateau Utility District hired Ray Freeman, Grade IV certified operator, to operate the wastewater plant.

Plateau Utility District Wartburg WWTP Current Process Control

The Wartburg Wastewater Treatment Plant is a single channel oxidation ditch activated sludge plant with headworks that are not in service due to hydrogen sulfide deterioration beyond repair. The influent characteristic is mostly domestic waste with one manufacturing industry and a state prison. An approved pretreatment program is enforced.

The wastewater treatment receives an average flow of 0.50 MGD to the headworks for sampling and partial screened with makeshift hand cleaned bar screen catching only 10% of trash. The flow is then gravity fed to the single channel oxidation ditch. The influent flow entry point and the RAS entry point are side by side in the oxidation ditch (see attached plant schematic). The oxidation ditch aeration system consists of (3) 50 HP rotor aerators. Each of the aerators are controlled by timers, and each equipped with soft starts. There are no mixers in the aeration basins.

Current Biological Process Set-Up

Ray Freeman has been exploring and implementing optimization of the process since June of 2021 on his own to comply with permit limits for TN and TP. The current on/off aeration cycles for the 3 rotors are controlled by timers with No SCADA. The following is the ON/ OFF schedule for each rotor: (see picture on next page for rotor locations.)

ROTOR #1

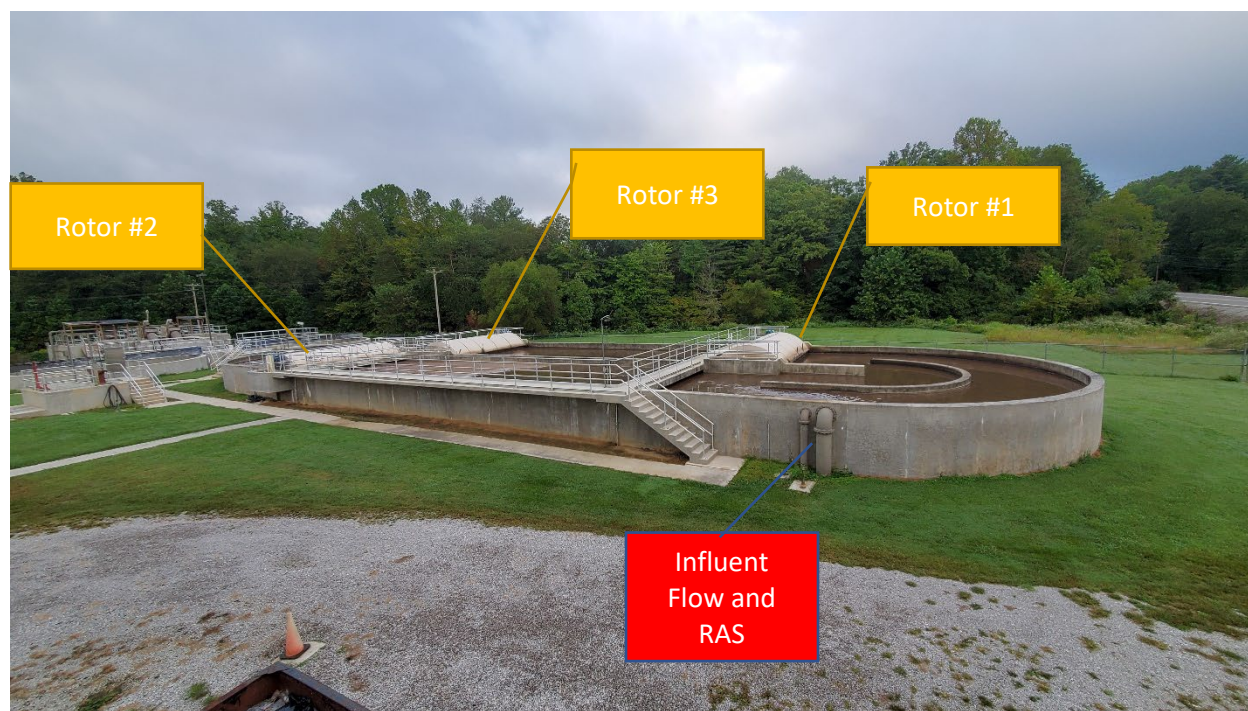
<u>Schedule</u>	<u>Time of day</u>	<u>Time, hrs</u>
On	4:15 am – 5:45 am	1.5
Off	5:45 am – 9:00 am	3.25
On	9:00 am – 12 pm	3.0
Off	12 pm – 12 am	12.0
On	12 am – 2 am	2.0
Off	2 am – 4:15 am	2.25

ROTOR #2

<u>Schedule</u>	<u>Time of day</u>	<u>Time, hrs</u>
On	9 am – 12 pm	3.0
Off	12 pm – 5:00 pm	5.0
On	5:00 pm – 7:45 pm	2.75
Off	7:45 pm – 9 am	13.25

ROTOR #3

<u>Schedule</u>	<u>Time of day</u>	<u>Time, hrs</u>
On	4:00 am – 5:15 am	1.25
Off	5:15 am – 5:00 pm	11.75
On	5:00 pm – 8: pm	3.0
Off	8 pm – 12 am	4.0
On	12 am – 1:45 am	1.75
Off	1:45 am – 4:00 am	2.25



After the treatment in the oxidation ditch, ***the MLSS exits from the bottom of the West end of the ditch and flows to a splitter box. The MLSS exiting from the bottom depth rather from the top of the ditch is unique compared to other designs.*** The splitter box splits the flow to 2 clarifiers where the biomass is settled. The settled biomass flows to an RAS pumpstation. There is no flow meter on the RAS/WAS. The RAS pumpstation can return the biomass to the oxidation ditch or to the digesters for wasting. Wasting is accomplished by manually turning a valve to divert sludge to the digester. The plant has 2 dewatering sludge boxes for sludge dewatering and disposal. industry. The average FM ratio is 0.044 and SVI is 135.

The clarified effluent gravity flows to a pumpstation then pumped to tertiary filters. Flow passes through the filters and gravity flows to disinfection and dechlorination. For the calendar year 2022, the average effluent TN was 2.56 mg/L and the average TP is 0.975 mg/L.

Operations Personnel TNPOP Training

When the TNPOP officially started on February 7, 2023, the wastewater treatment plant was staffed with two operators. Ray Freeman, Wastewater Treatment Plant Superintendent, is a competent, well-seasoned and highly skilled Grade IV certified operator. Alex Freeman, Rays Daughter, has been hired as intern while in transition with her college studies. All laboratory equipment and reagents for TP, TN, Ammonia as N, Total Alkalinity, Nitrate and Nitrate have been supplied by TAUD. Training to perform all analysis has been completed. The operators were supplied and/or already have portable DO and ORP equipment and trained to complete analysis/sampling. The implementation of TDEC EMOR is active.

On September 29, 2023, Ray and Alex resigned from Plateau Utility District. I contacted Mike Monroe, Manager of Plateau UD, and he stated Plateau UD / Wartburg plans to continue with the TNPOP program.

On 11/09/2023, we held an on-site meeting with Plateau Utility District Manager, Mike Monroe, and new wastewater operator trainee, Garrett Starkey. The fundamental elements of the State of Tennessee TNPOP program were reviewed, and Garrett was introduced to all training videos posted on the State of Tennessee TNPOP Web page. The current wastewater treatment plant process control and analytical wastewater laboratory analysis were reviewed and discussed regarding the intentions and goals for nutrient removal. All state and federal reports were reviewed and submitted by the Manager, Mike Monroe. Mike is very proficient with all required calculations and reporting procedures. The TNPOP continued during the transition of operators.

Official Wartburg WWTP TNPOP Process Review and Initial Process Adjustments

February 7, 2023

The official on-site meeting with Plateau Utility District Officials (contract operates the Wartburg STP), TAUD and Grant Weaver was conducted on February 7, 2023. Grant Weaver attended the meeting via Microsoft Teams. The current process control, historical & current NPDES compliance data was reviewed. It was determined that the current schedule, for rotor on – off aeration, for all three rotors is adequate for Total Nitrogen Removal. So, all agreed the focus should be on adjusting the process for Total Phosphorous (TP) removal. Recommended process control testing was discussed to check the ditch effluent MLSS for Ammonia, Nitrate, ortho phosphorous, ph and alkalinity. After a new process set up is established, ORP analysis will be conducted during aeration and off-aeration cycles in several areas of the ditch. The following information from Grant Weaver sums up the challenge to reduce TP.

02/09/2023 – Wartburg Summary Email from Grant Weaver.

Ray,
As always, was a real pleasure speaking with you.
I look forward to upcoming discussions.

Given the already excellent effluent nitrogen numbers, there is nothing more to be done there.
You are nearly as perfect as possible.

Phosphorus.
Fabulous wintertime numbers.
Not so great removal during summertime and fall.

Given my observation that this is a common situation at plants across the country ...
Given my observation that too much consecutive air-off time during warm water months makes for poor phosphorus removal ...
The challenge is to find the sweet spots: getting the right consecutive minutes of air-on / air-off time in summer to dial-in phosphorus removal.
Settings that are likely to be quite different for the winter optimums.

As you work through this, it is likely that nitrogen removal will decline.
Not a lot.
But some.
Once you find the sweet spots you may be able to bring effluent tN back down to 2 mg/L while keeping tP below 1.0.
But maybe not.
I'm guessing that all involved would gladly trade off a few mg/L of effluent tN in exchange for driving tP to an absolute minimum.

Looking forward to working with you, Dewayne and Karina on the Wartburg wwtp!
Grant

Wartburg WWTP TNPOP Process Review Meeting and Follow Up Process Adjustments - March 14, 2023

The follow up on-site meeting with Wartburg Utilities, TAUD and Grant Weaver was conducted on March 14, 2023. Grant Weaver attended the meeting via Microsoft Teams. The current process control, current NPDES compliance data was reviewed. Ray implemented a new schedule for rotor on – off aeration to rotor’s aeration controls. Ray extended the air on time to enhance TP uptake. Continuing process control testing to check the ditch effluent MLSS for Ammonia, Nitrate, ortho phosphorous, ph and alkalinity to monitor results from new aeration schedule. After a new process set up is established, ORP analysis will be conducted during aeration and off-aeration cycles in several areas of the ditch. A follow up meeting is planned on April 12th, 2023, to review process updates. The following is the new aeration schedule to be implemented.

Current Rotor Schedule				
Run Time	00:00 01:30	04:00-05:30	09:00-12:00	17:00-20:00
Rotor 1	✓	✓	✓	
Rotor 2			✓	✓
Rotor 3	✓	✓		✓

Wartburg WWTP TNPOP Process Review Meeting and Process Adjustments Review - April 12, 2023

The follow up on-site meeting with Wartburg Utilities, TAUD and Grant Weaver was conducted on April 12, 2023. Grant Weaver attended the meeting via Microsoft Teams. Dewayne Culpepper, TAUD, furnished a new HACH Multimeter to perform ORP measurements to replace a defective meter that belonged to Wartburg WWTP. The current process control and laboratory data was reviewed during the meeting. All agreed to stick with the new aeration rates that Ray implemented and continue to monitor all parameters as the wastewater temperature increases in the selector basin or Oxidation Ditch. The main focus is to enhance TP uptake.

Wartburg WWTP TNPOP Process Review Meeting and Process Adjustments Review – June 15, 2023

The follow up virtual meeting with Wartburg Utilities, TAUD and Grant Weaver was conducted on June 15, 2023. Grant Weaver and Dewayne attended the meeting via Microsoft Teams. Alex and Ray Freeman have been providing weekly detailed process control and laboratory analysis data. The current process control and laboratory data was reviewed during the meeting. Total Phosphorus data showed a gradual increase, so all agreed to change the schedule of on/off aeration rates with the focus to enhance TP uptake. The next meeting will be scheduled after changes have been implemented with several weeks of monitoring data to show results. The following is an email from Grant summarizing the meeting and new process control regarding the aeration on/off schedule.

06/15/2023 – Wartburg Summary Email from Grant Weaver.

Ray & Dewayne,

A few weeks ago, we asked Ray to provide more air-ON time thinking that the warmer water needed more air.

Seems it wasn't so.

As we discussed today, the increase in air-ON times seems to have made effluent phosphorus worse.

For the past few weeks, the settings have been ...

Two of three rotors air-ON for 4 hours and all three OFF for 4 hours.

Ray will decrease the air-ON times from the current settings to ...

Two rotors air-ON for approximately 4 hours and all three OFF for approximately 5 hours.

See attached data sheet.

Data collected and analyzed by Wartburg staff.

Grant

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – July 21, 2023

A follow up meeting with Ray Freeman was conducted on July 21, 2023, by phone call. Alex and Ray Freeman have been providing weekly detailed process control and laboratory analysis data. The current process control and laboratory data was reviewed during the meeting. After the last meeting on June 15, 2023, a new aeration cycle schedule was implemented using 5 hours on and 4 hours off. After monitoring for several weeks, starting out TP and TN data showed good results then in the past couple of weeks the TP has had a gradual increase to 3.36 mg/L. On 07/21/2023, all agreed to change the schedule of on/off aeration rates with the focus to enhance TP uptake. The following is the monitoring reports from Ray and Alex and email communications.

TNPOP Testing Averages

Week of: 6/19/2023

Phosphorus	PO ₄ ³⁻ -P	PO ₄ ³⁻
Influent - P846	10.4	31.9
Effluent - P843	0.319	0.978

Nitrate	NO ₃ -N	NO ₃ -
Influent - N835	1.37	6.08
Effluent - N835	1.91	8.45

Nitrite	NO ₂ -N	NO ₂
Influent - N839	1.05	3.44
Effluent - N839	0.005	0.017

Total Nitrogen	Influent	Effluent
N826	28.6	2.65

Weekly Averages	Influent	Effluent
Temperature	21.4	21.1
pH	7.32	6.90
DO	2.28	7.87
CBOD5	204.5	3.1
NH ₃	18.9	0.045

Mixed Liquor Averages		Results		
MLSS		2915		
MLVSS		2315		
SVI		219.5		
Volatiles		79.4		
Current Rotor Schedule				
Run Time	00:00-05:00	05:00-09:00	09:00-14:00	14:00-18:00
Rotor 1	✓		✓	

Rotor 2	✓		✓	
Rotor 3	✓		✓	

Run Time	18:00-21:00	21:00-00:00
Rotor 1	✓	
Rotor 2	✓	
Rotor 3	✓	

Notes:

- The rotor schedule was changed to add more air as shown above in the new rotor schedule. They are no longer rotating, but all three are running simultaneously and in 5-hour intervals throughout the day. Much more air than before!

TNPOP Testing Averages

Week of: 7/3/2023

Phosphorus	PO₄³⁻-P	PO₄³⁻
Influent - P846	9.13	28.0
Effluent - P843	0.392	1.20

Nitrate	NO₃-N	NO₃-
Influent - N835	0.356	1.58
Effluent - N835	2.21	9.77

Nitrite	NO₂-N	NO₂
Influent - N839	0.002	0.008
Effluent - N839	0.001	0.003

Total Nitrogen	Influent	Effluent
N826	32.1	3.51

Weekly Averages	Influent	Effluent
Temperature	22.4	21.3
pH	7.13	7.32
DO	2.47	7.88
CBOD5	229.0	3.8
NH ₃	21.4	0.060

Mixed Liquor Averages	Results
MLSS	3420

MLVSS	2835			
SVI	190.5			
Volatiles	82.9%			
Current Rotor Schedule				
Run Time	00:00-05:00	05:00-09:00	09:00-14:00	14:00-18:00
Rotor 1	✓		✓	
Rotor 2	✓		✓	
Rotor 3	✓		✓	

Run Time	18:00-21:00	21:00-00:00
Rotor 1	✓	
Rotor 2	✓	
Rotor 3	✓	

TNPOP Testing Averages

Week of: 7/10/2023

Phosphorus	PO ₄ ³⁻ -P	PO ₄ ³⁻
Influent - P846	9.61	29.5
Effluent - P843	2.65	8.12

Nitrate	NO ₃ -N	NO ₃ -
Influent - N835	0.335	1.48
Effluent - N835	4.73	21.0

Nitrite	NO ₂ -N	NO ₂
Influent - N839	0.019	0.061
Effluent - N839	0.061	0.200

Total Nitrogen	Influent	Effluent
N826	29.3	5.63

Weekly Averages	Influent	Effluent
Temperature	21.8	21.9
pH	7.12	7.17
DO	2.14	7.91
CBOD5	226.9	3.3

NH ₃	24.0	0.047
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Mixed Liquor Averages	Results
MLSS	2475
MLVSS	2065
SVI	169.7
Volatiles	83.4%

Current Rotor Schedule				
Run Time	00:00-05:00	05:00-09:00	09:00-14:00	14:00-18:00
Rotor 1	✓		✓	
Rotor 2	✓		✓	
Rotor 3	✓		✓	

Run Time	18:00-21:00	21:00-00:00
Rotor 1	✓	
Rotor 2	✓	
Rotor 3	✓	

07/25/2023 – Email from Ray and Alex

Hello, all!

Here are some recent findings in our testing at the plant in the last few weeks, and our Pace testing for our July monthly report. **TP has increased to 3.36 mg/L!**

After receiving the monthly results for July, the extended oxygen cycle we discussed during the last TNPOP meeting did not result in phosphorus or nitrogen reduction at the temperature (~22C)/MLSS/MLVSS(~2500) we held. On Friday I spoke with Dewayne Culpepper and discussed rising temperatures requiring me to drop the MLSS, somewhere around 1800 to 2000 is my target. We also discussed the ORP results, and they are not low enough. They were averaging somewhere around -20, but -120 is a more desired result that we will seek out. Due to this, we have also changed the rotor times to allow further denitrification/lower ORP results. The new schedule is also attached with everything else we have for you.

Talk to you soon!

Ray and Alex Freeman
Wartburg WWTP

Current Rotor Schedule as of 07/25/2023
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Run Time	00:00-04:00	04:00-07:00	07:00-09:00	09:00-12:00
Rotor 1	✓		✓	
Rotor 2			✓	
Rotor 3	✓			

Run Time	12:00-16:00	16:00-19:00	19:00-21:00	21:00-24:00
Rotor 1			✓	
Rotor 2	✓		✓	
Rotor 3	✓		✓	

The next meeting will be scheduled after changes have been implemented with several weeks of monitoring data to show results.

Wartburg WWTP TNPOP Process Review by phone – August 18th, 2023

By phone call, Ray gave an update on the process control and effluent laboratory analysis. The aeration schedule has been adjusted since 7/25 by lowering the time on schedule. The effluent analysis for TN is 2.0 and TP is < 2.0. He will have official results from THE contract lab soon to share.

Wartburg WWTP TNPOP Process Review and Process Adjustments

August 23 – September 29, 2023

08/23/2023 – Email from Ray and Alex

Hello again everyone,

Here are some fun updates from the last few weeks out here at the Wartburg plant. I’ve attached a few weeks of reports, and our current Pace testing reports to look over.

We’ve kept up with our latest rotor schedule that is on all of these reports, which has knocked down the air that we’re giving by about a third from the previous schedule. We found that the over-aeration did not decrease the nitrogen/phosphorus like we had hoped it would (rather, it increased it), but with decreasing the air by a good bit the nitrogen and phosphorus has gone back down to a better level. We have also reduced the MLSS from around 3500 as we had before

down to around 2000 incrementally. The plan is to hold the MLSS around 1800-2000 at the temperatures we are experiencing currently. As for ORP numbers, the lows are averaging around -70 and the highs are around +135 in the last few weeks.

Hope you're all doing well and enjoying the last few weeks of this very hot summer!

Thank you,

Ray and Alex Freeman
 Wartburg WWTP
 Wartburg, TN

TNPOP Testing Averages

Week of: 7/31/2023

Phosphorus	PO₄³⁻-P	PO₄³⁻
Influent - P846	11.5	35.1
Effluent - P844	3.05	9.36

Nitrate	NO₃-N	NO₃-
Influent - N835	0.535	2.37
Effluent - N835	2.13	9.43

Weekly Averages	Influent	Effluent
Temperature	24.5	23.1
pH	7.15	7.45
DO	1.65	7.78
CBOD5	204.2	3.6
NH₃	29.9	0.057

Mixed Liquor Averages	Results
MLSS	2285
MLVSS	1892
SVI	126
Volatiles	82.4%

Current Rotor Schedule				
Run Time	00:00-04:00	04:00-07:00	07:00-09:00	09:00-12:00
Rotor 1	✓		✓	
Rotor 2			✓	
Rotor 3	✓			

Run Time	12:00-16:00	16:00-19:00	19:00-21:00	21:00-24:00
Rotor 1			✓	
Rotor 2	✓		✓	
Rotor 3	✓		✓	

TNPOP Testing Averages

Week of: 8/7/2023

Phosphorus	PO₄³⁻-P	PO₄³⁻
Influent - P846	11.8	36.2
Effluent - P844	2.38	7.31

Nitrate	NO₃-N	NO₃-
Influent - N835	0.437	1.94
Effluent - N835	1.48	6.55

Weekly Averages	Influent	Effluent
Temperature	23.3	22.9
pH	7.16	7.42
DO	1.35	7.77
CBOD5	196.8	6.7
NH ₃	22.0	0.043

Mixed Liquor Averages	Results
MLSS	2172
MLVSS	1792
SVI	112
Volatiles	82.4%

Current Rotor Schedule				
Run Time	00:00-04:00	04:00-07:00	07:00-09:00	09:00-12:00
Rotor 1	✓		✓	
Rotor 2			✓	
Rotor 3	✓			

Run Time	12:00-16:00	16:00-19:00	19:00-21:00	21:00-24:00
Rotor 1			✓	
Rotor 2	✓		✓	
Rotor 3	✓		✓	

TNPOP Testing Averages

Week of: 8/14/2023

Phosphorus	PO₄³⁻-P	PO₄³⁻
Influent - P846	9.52	29.2
Effluent - P844	0.876	2.69

Nitrate	NO₃-N	NO₃-
Influent - N835	0.217	0.959
Effluent - N835	1.77	7.82

Weekly Averages	Influent	Effluent
Temperature	22.8	21.9
pH	7.30	7.25
DO	1.68	7.90
CBOD5	217.2	4.3
NH ₃	22.0	0.052

Mixed Liquor Averages	Results
MLSS	2505
MLVSS	2050
SVI	107.8
Volatiles	81.8%

Current Rotor Schedule				
Run Time	00:00-04:00	04:00-07:00	07:00-09:00	09:00-12:00
Rotor 1	✓		✓	
Rotor 2			✓	
Rotor 3	✓			

Run Time	12:00-16:00	16:00-19:00	19:00-21:00	21:00-24:00
Rotor 1			✓	
Rotor 2	✓		✓	
Rotor 3	✓		✓	

08/23/2023 – On-site Meeting with Ray

On August 29, 2023, Ray met me in Oak Ridge (his hometown) during the evening and we discussed the process and effluent analysis of the plant. **Also, Ray was delivered HACH TNT chemistries to replenish his supplies to conduct on-site process control analysis for process control. TAUD purchased the HACH TNT reagents.** During the meeting, Ray agreed that reducing the amount of air- on cycle time to try to help the process control to reduce Total Phosphorous (TP) has worked as seen in the previous analysis.

Ray stated that he will continue to keep his MLSS at this current set point and the on-off aeration cycles at the current settings until further notice.

09/29/2023 – Ray Resigns with Plateau Utility District

On September 29, 2023, I received notice that Ray and Alex resigned from Plateau Utility District. I contacted Mike Monroe, Manager of Plateau UD, and stated Plateau UD / Wartburg plans to continue with the TNPOP program. There is an operator in training and TAUD personnel have reached out to provide assistance to train new personnel. I plan to schedule an onsite visit in early November to continue the TNPOP Program.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – November 09, 2023

On 11/09/2023, we held an on-site meeting with Plateau Utility District Manager, Mike Monroe, and new wastewater operator trainee, Garrett Starkey. The fundamental elements of the State of Tennessee TNPOP program were reviewed, and Garrett was introduced to all training videos posted on the State of Tennessee TNPOP Web page. The current wastewater treatment plant process control and analytical wastewater laboratory analysis were reviewed and discussed regarding the intentions and goals for nutrient removal. All state and federal reports were reviewed and submitted by the Manager, Mike Monroe. Mike is very proficient with all required calculations and reporting procedures. Future meeting for process control adjustments is scheduled for 11/29/2023.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – November 21, 2023

On 11/21/2023, TAUD consulted with Garret Starkey via phone reviewing process control and lab analysis of Effluent TP, Effluent TN, and Effluent Nitrate. On- Off aeration rates were adjusted with the following schedule.

Wartburg WWTP Aeration Schedule as of 11/21/2023

<u>Aerator (1)</u>			<u>Aerator (2)</u>			<u>Aerator (3)</u>		
<u>On</u>	<u>Off</u>	<u>Total Hrs.</u>	<u>On</u>	<u>Off</u>	<u>Total Hrs.</u>	<u>On</u>	<u>Off</u>	<u>Total Hrs.</u>
12:00 am	3:00 am	3.0	-----			12:00 am	3:00 am	3.0
7:00 am	9:00 am	2.0	7:00 am	9:00 am	2.0	-----		
-----			1:00 pm	4:00 pm	3.0	1:00 pm	4:00 pm	3.0
-----			7:00 pm	9:00 pm	2.0	7:00 pm	9:00 pm	2.0
-----			-----			-----		
Total aeration time per aerator: 5.0					7.0	8.0		

Total overall ON aeration time: 10 hours per 24 hours

Total OFF time: 14 hours per 24 hours

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – November 29, 2023

On 11/29/2023, TAUD consulted with Garret Starkey on-site reviewing process control and lab analysis of Effluent TP, Effluent TN, and Effluent Nitrate. On- Off aeration rates were reviewed, and the process has shown great improvement on TP removal, so we agreed to continue with the current setup. TP crept up to 2 mg/L two weeks ago and since we adjusted DO schedule it has decreased to 1.3 mg/L. Since Garrett is a new operator in training, we reviewed and conducted each permit required analysis and process control test. Results from each test were calculated and discussed how each analysis related to the process control of the biological process. The following are results from the analysis conducted on 11/29/2023.

On-site Effluent Composite Sampling – (11/29)

Effluent Average BOD: 4.0 mg/L
Eff Ammonia NH³: 0.05 mg/L
Eff Nitrate: < 3 mg/l Eff. Nitrite: < 0.1 mg/L
Eff TP: 1.3 mg/L – (TNT Ortho method in TP reading)
Eff Alkalinity: 80 mg/L
Eff Ph: 7.4

Influent Grab Sample

Influent Alkalinity: 180 mg/L
Influent PH:7.2

Ditch Sampling – (11/29)

Ditch DO **when in ON-Aeration Cycle**: 5.0 mg/L
Ditch MLSS temperature : 15 C
Ditch MLSS 2700 mg/L – 80% Volatile solids = MLVSS 2160 mg/L
Ditch PH : 7.2 S.U.
Ditch MLSS 30-minute Settleometer: 600 mL/L
Ditch SVI: 200 mL/g
Ditch F/M Ratio : 0.04 (Using Average Parameters)

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – December 15, 2023

On December 15, 2023, I received updates from Garret that in house on-site composite TP sample result was 0.717 mg/L. On/off aeration rates implemented on 11/21/2023 continues.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – December 21, 2023

On December 21, 2023, I received updates from Garret that in house on-site composite TP sample result was 0.39 mg/L. On/off aeration rates implemented on 11/21/2023 continues. The plant is meeting all effluent requirements with low TN and TP results.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – December 29, 2023

On December 29, 2023, I received updates from Garret that in-house on-site composite TP sample result was 0.304 mg/L. On/off aeration rates implemented on 11/21/2023 continues. Average effluent ammonia NH_3 is 0.111 mg/L. The plant is meeting all effluent requirements with low TN and TP results.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – January 5, 2024

On January 5, 2024, I received updates from Garret that in-house on-site composite TP sample result was 0.166 mg/L. On/off aeration rates implemented on 11/21/2023 continues. Average effluent ammonia NH_3 is 0.10 mg/L. The plant is meeting all effluent requirements with low TN and TP results.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – January 12, 2024

On January 12, 2024, I received updates from Garret that in-house composite TP sample result was <0.300 mg/L. On/off aeration rates implemented on 11/21/2023 continues. Average effluent ammonia NH_3 is 0.047 mg/L.

Note: Due to extreme weather starting on 01/08, the plant process control was interrupted due to excessive flows from 2.9 inches of rain resulting in I/I, and two separate winter polar blasts, each having temperatures at 0 degrees. Contract lab sampling was performed during the process control interruption resulting in TN at 5.0 mg/l and TP at 2.0 mg/l. Once the process control was restored on 01/11/2024, the next day (01/12) TP results were lowered back down <0.3 mg/l.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – January 19, 2024

On January 19, 2024, I received updates from Garret that in-house on-site composite TP sample result was <0.200 mg/L. On/off aeration rates implemented on 11/21/2023 continues. Average effluent ammonia NH_3 is < 0.03 mg/L. The plant is meeting all effluent requirements with low TN and TP results.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – January 26, 2024

On January 26, 2024, I received updates from Garret that in-house on-site composite TP sample result was 0.53 mg/L. On/off aeration rates implemented on 11/21/2023 continues. Average effluent ammonia NH_3 is < 0.03 mg/L. The plant is meeting all effluent requirements with low TN and TP results.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – February 9, 2024

On February 9, 2024, I received updates from Garret that in-house on-site composite TP sample result was 1.12 mg/L. On/off aeration rates implemented on 11/21/2023 continues. Average effluent ammonia NH_3 is < 0.03 mg/L. The plant is meeting all effluent requirements with low TN and TP results.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – February 16, 2024

On February 16, 2024, I received updates from Garret that they have split samples to compare with contract Lab results. When results come back from the contract laboratory and compare with in house lab results will give us information on how well we are doing on in house procedures. The in-house on-site composite TP sample result was 0.735 mg/L. On/off aeration rates implemented on 11/21/2023 continues. Average effluent ammonia NH_3 is < 0.03 mg/L. The plant is meeting all effluent requirements with low TN and TP results.

Wartburg WWTP TNPOP On-Site Visit - Process Review and Process Adjustments Review – February 22, 2024

On February 22, 2024, TAUD met with Garret Starkey and Mike Monroe on-site reviewing process control and split sample on-site lab results **versus** contract lab analysis of Effluent TP, Effluent TN, and Effluent Nitrate. When comparing the results of split sample of TP, Wartburg's in house result was close, (0.735 mg/L vs 0.865mg/l), with the contract laboratories result. The TN compared results were also very close with Wartburg's Lab at 1.67 mg/l and contract lab at 1.57 mg/L.

On- Off aeration rates were reviewed, and the process has shown consistent removal rates of TP and TN so far during the winter. We all agreed to continue with the current aeration on/off cycle schedule. The following are results from the analysis conducted on 02/16/2024.

On-site Effluent Composite Sampling (02/16) Versus Contract Laboratory Results

Effluent Average BOD: < 4.0 mg/L

Eff Ammonia NH³ : < 0.03 mg/L

Eff Nitrate: 0.242 mg/l Eff. Nitrite: 0.096 mg/L

Eff TN: 1.67 mg/L

Eff TN: 1.57 mg/L

Eff TP: 0.735 mg/L (TNT TP reading)

Eff TP: 0.865 mg/l

Eff Alkalinity: 80 mg/L

Eff Ph: 7.0

Influent Grab Sample

Influent PH:7.2

TNPOP Summary to Date, February 26, 2024

As Spring approaches with warmer temperatures, we plan to continue with the current process control and monitoring plan, adjusting if necessary. In the meantime, data regarding energy usage compared to previous years usage will be generated. By utilizing the State of Tennessee's TNPOP program allowed the Wartburg WWTP personnel to adjust the process control in several configurations regarding aeration on-off cycles with different 3 rotors. In the past year, all parties involved learned the limitations of the process, equipment, and design of the plant and at the same time learned what adjustments optimized the biological process control to achieve lower TN and TP.

Wartburg WWTP TNPOP On-Site Visit - Process Review and Process Adjustments Review – April 4th, 2024

On April 4th, 2024, TAUD met with Garret Starkey on-site reviewing process control and most recent contract lab analysis of Effluent TP 0.9 mg/L, and Effluent TN 1.6 mg/L. On- Off aeration rates were reviewed, and the process has shown consistent removal rates of TP and TN so far during the winter. We all agreed to continue with the current aeration on/off cycle schedule. During the visit it was noted the return activated sludge pump was out of service and scheduled to be replaced that next morning when received from vendor.

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – April 26th, 2024

On April 26th, 2024, I received updates from Garret by phone. Contract Lab results sampled on 04/18 resulted in the TP at 0.69 mg/L and TN at 3.69. During that same week, the Eff Ammonia NH³ has continued to increase over the week to 2.0 mg/L To lower the Ammonia NH³, the aeration rate was increased by running the 3 aerators during the scheduled aeration ON cycles. The Eff Ammonia NH³ decreased to <0.5 within a couple of days. With winter limits for BOD and Ammonia NH³ coming to an end and summer compliance schedule limits of BOD (10.0 mg/L) and Ammonia NH³ (1.0 mg/L) starting May 1st, the air on/off schedule may need to be updated to increase the air on schedule for the east aerator.

After reviewing the current analysis data, the BOD and Ammonia NH³ results is a concern and is the reason for adjustments on the aeration schedule to adjust the process for summer compliance limits. The following new schedule was implemented on 04/26/2024.

Wartburg WWTP Aeration Schedule as of 4/26/2024

<u>Aerator (1)</u>			<u>Aerator (2)</u>			<u>Aerator (3)</u>		
<u>On</u>	<u>Off</u>	<u>Total Hrs.</u>	<u>On</u>	<u>Off</u>	<u>Total Hrs.</u>	<u>On</u>	<u>Off</u>	<u>Total Hrs.</u>
12:00 am	3:00 am	3.0	-----	-----	-----	12:00 am	3:00 am	3.0
7:00 am	10:00 am	3.0	7:00 am	10:00 am	3.0	7:00 am	10:00 am	3.0
12:00 pm	4:00 pm	4.0	12:00 pm	4:00 pm	4.0	12:00 pm	4:00 pm	4.0
7:00 pm	10:00 pm	3.0	7:00 pm	10:00 pm	3.0	7:00 pm	10:00 pm	3.0

Total aeration time per aerator: 13.0					10.0		13.0	

Total overall ON aeration time: 13 hours per 24 hours

Total OFF time: 11 hours per 24 hours

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – May 17th, 2024

On May 17th, 2024, I received updates from Garret by phone and email. After adjusting aeration schedule on 04/26/2024, the Ammonia NH³ decreased and stabilized at < 0.05 mg/L. On May 8th and 9th, the wastewater influent flow exceeded 2.0 MGD from heavy rain fall resulting in high inflow in the sewer collection system to the plant. During this event, the plant experienced a disruption in operation with a controlled bypassing event. TDEC was notified, as several other systems in the area were in the same shape from heavy flooding in the area. The following are in house laboratory results on 05/08/2024 before the heavy flows hit the plant:

On-site Effluent (Composite Sampling) test – (05/08/2024)

Effluent Average BOD: 4.0 mg/L
 Eff Ammonia NH³: < 0.05 mg/L
 Eff TP: 1.74 mg/L – (TNT Ortho method in TP reading)

Today, 05/17, as the plant operations return to normal (flow and the biological mass), Garrett and I discussed backing down the aeration ON time duration for ALL rotors from running from 12 noon – 4 pm by one hour to enhance the anaerobic zone for TP release. The rotors will now run from 1pm to 4 pm. Grant Weaver will be consulted on the adjustment and as well as other adjustments. This effort will be dictated by closely monitoring Ammonia NH³ levels for permit compliance.

On-site Effluent (Composite Sampling) test – (05/17/2024)

Effluent Average BOD: <4.0 mg/L
 Eff Ammonia NH³: < 0.02 mg/L
 Eff Nitrate: ---- mg/l Eff. Nitrite: < 0.1 mg/L
 Eff TP: 1.63 mg/L – (TNT Ortho method in TP reading)

Contract Lab Results – 05/22

TN: 1.96
 TP: 1.75
 TKN: 0.755

Wartburg WWTP Aeration Schedule as of 5/17/2024

<u>Aerator (1)</u>			<u>Aerator (2)</u>			<u>Aerator (3)</u>		
<u>On</u>	<u>Off</u>	<u>Total ON Hrs.</u>	<u>On</u>	<u>Off</u>	<u>Total ON Hrs.</u>	<u>On</u>	<u>Off</u>	<u>Total ON Hrs.</u>
12:00 am	3:00 am	3.0	-----			12:00 am	3:00 am	3.0
7:00 am	10:00 am	3.0	7:00 am	10:00 am	3.0	7:00 am	10:00 am	3.0
1:00 pm	4:00 pm	3.0	1:00 pm	4:00 pm	3.0	1:00 pm	4:00 pm	3.0
7:00 pm	10:00 pm	3.0	7:00 pm	10:00 pm	3.0	7:00 pm	10:00 pm	3.0

Total aeration time per aerator: 12.0					9.0	12.0		

Total overall ON aeration time: 12 hours per 24 hours

Total OFF time: 12 hours per 24 hours

Wartburg WWTP TNPOP Process Review and Process Adjustments Review – June 17th, 2024

On June 17th, 2024, I received updates from Garret by phone and email. After adjusting aeration schedule on 05/17/2024, the Ammonia NH³ continues to be stabilized at < 0.03 mg/L. Grant Weaver was consulted regarding changes to the aeration rates to enhance the anerobic zone to further reduce total phosphorus since the summer permit limits for effluent ammonia NH³ are being met. There is concern with the 30-minute Settleometer test with results of 800 ml/l. The following are contract lab results sampled on 06/12/2024: *Waiting on results*

Contract Effluent (Composite Sampling) test – (06/12/2024)

Wartburg WWTP Aeration Schedule as of 6/17/2024

<u>Aerator (1)</u>			<u>Aerator (2)</u>			<u>Aerator (3)</u>		
<u>On</u>	<u>Off</u>	<u>Total ON Hrs.</u>	<u>On</u>	<u>Off</u>	<u>Total ON Hrs.</u>	<u>On</u>	<u>Off</u>	<u>Total ON Hrs.</u>
----	----	0.0	12:00 am	3:00 am	3.0	12:00 am	3:00 am	3.0
7:00 am	9:00 am	2.0	7:00 am	10:00 am	3.0	7:00 am	10:00 am	3.0
1:00 pm	3:00 pm	2.0	1:00 pm	4:00 pm	3.0	1:00 pm	4:00 pm	3.0
7:00 pm	9:00 pm	2.0	7:00 pm	10:00 pm	3.0	7:00 pm	10:00 pm	3.0

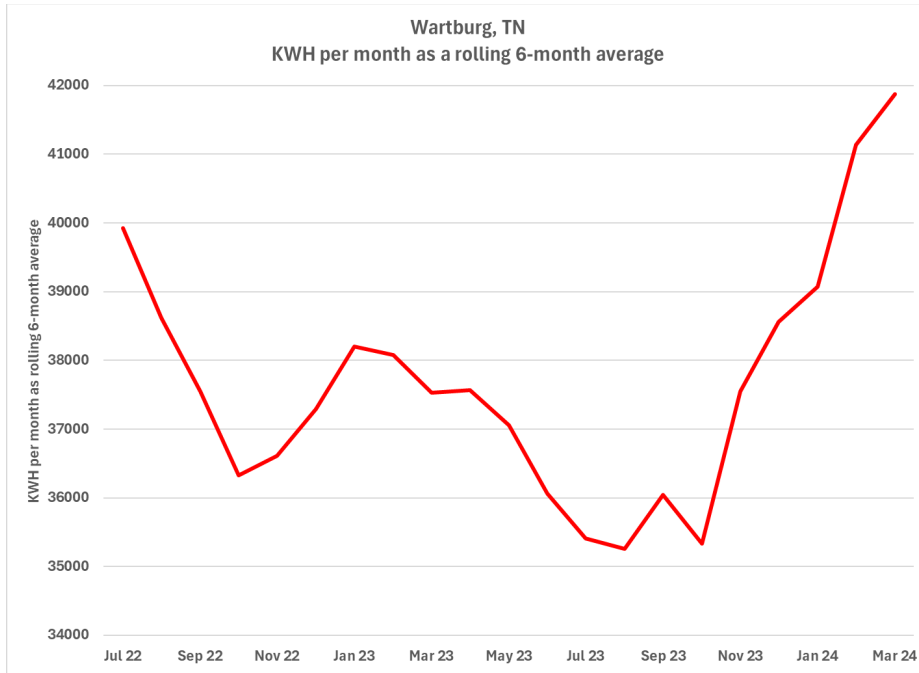
Total aeration time per aerator: 6.0					12.0		12.0	

Total overall ON aeration time: 12 hours per 24 hours

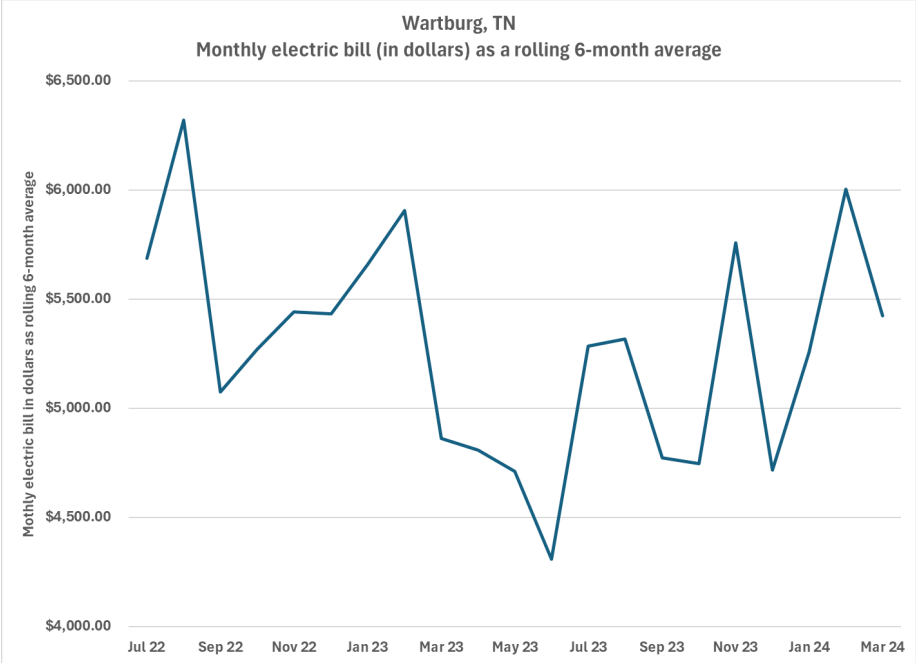
Total OFF time: 12 hours per 24 hours

Electrical Usage

The billing report that follows provides a two-year history of electrical use at Wartburg's municipal wastewater treatment plant. Electrical consumption trended downward until late 2023, coincident with a change in staff.



The dollar cost of electricity didn't trend the same as usage as illustrated by the graph below.



	Usage (KWH)	Bill (dollars)
Feb 22	48840	\$ 5,925.02
Mar 22	41480	\$ 5,456.41
Apr 22	44600	\$ 5,787.73
May 22	34600	\$ 4,758.87
Jun 22	32600	\$ 4,927.22
Jul 22	37440	\$ 5,687.66
Aug 22	41000	\$ 6,319.20
Sep 22	35080	\$ 5,075.13
Oct 22	37240	\$ 5,271.40
Nov 22	36320	\$ 5,443.57
Dec 22	36680	\$ 5,432.25
Jan 23	42880	\$ 5,660.86
Feb 23	40280	\$ 5,906.79
Mar 23	31800	\$ 4,863.55
Apr 23	37480	\$ 4,809.81
May 23	33240	\$ 4,710.71
Jun 23	30720	\$ 4,309.39
Jul 23	38920	\$ 5,284.18
Aug 23	39400	\$ 5,317.71
Sep 23	36520	\$ 4,772.73
Oct 23	33240	\$ 4,748.56
Nov 23	46520	\$ 5,757.15
Dec 23	36760	\$ 4,717.37
Jan 24	42000	\$ 5,257.99
Feb 24	51800	\$ 6,003.96
Mar 24	40920	\$ 5,423.66