RADLEY RUN MEWS SEWER ASSOCIATION

RADLEY RUN WASTEWATER TREATMENT FACILITY

EAST BRADFORD TOWNSHIP
CHESTER COUNTY
PENNSYLVANIA

NPDES Permit No. PA0036200

Intermittent Aeration Study

Pennsylvania
Department of
Environmental Protection

Bureau of Clean Water
Rachel Carson State Office Building
PO Box 8774
400 Market Street
Harrisburg, PA 17105-8774

2025

<u>Disclaimers</u>:

Pennsylvania Regulations at 25 Pa. Code § 91.12 state, inter alia, that "Employees of the Department [Department of Environmental Protection] may not act as consulting engineers for a party or recommend the employment of a particular consultant, gather the data for the design of [a] his treatment plant, prepare plans or act as an inspector on the construction of the project…". This report and any recommendations represent an interpretation of data collected during the project and the best professional judgement of Department staff. Permittees, in conjunction with certified wastewater operators and consulting engineers, should continue an independent investigation to determine the guidance and procedures necessary to optimize operations of the publicly owned treatment works (wastewater treatment facility and sanitary sewer collection and conveyance system).

The mention of a brand of equipment is in no way an endorsement for any specific company. The Pennsylvania Department of Environmental Protection (PADEP) Wastewater Technical Assistance Program (WWTAP) urges the facility owner / permittee to research available products and select those which are the most applicable for its situation and compatible with existing equipment.

The goal of the PADEP WWTAP is to improve receiving water quality through troubleshooting, training, and monitoring. Permittees are encouraged to achieve effluent quality above and beyond current permit requirements.

Additional data and results from the PADEP WWTAP for this project may be available upon request. Please contact the WWTAP staff listed in Appendix A of this report or the Pennsylvania Department of Environmental Protection Bureau of Clean Water at RA-EPWWTAPROVIDER@pa.gov / (717) 787-6744

Executive Summary:

From July through October 2025, staff from the Pennsylvania Department of Environmental Protection (PADEP) Bureau of Clean Water - Wastewater Technical Assistance Program (WWTAP) partnered with the Radley Run Mews Sewer Association (RRMSA) to improve the quality of the RRMSA wastewater treatment facility (WWTF) final effluent discharge to Plum Run, a water of the Commonwealth. RRMSA and staff from the PADEP Southeast Regional Office – Clean Water Program requested this WWTAP project with the goal of optimizing treatment at the WWTF to improve the quality of the final effluent discharge and address reported exceedances of the NPDES Permit discharge limits for Total Nitrogen.

WWTAP staff coordinated with RRMSA and the operator(s) at the WWTF to adjust the existing operations strategy from continuous (24-hour) aeration in the treatment system to a program of intermittent, or "on/off", aeration with mechanical mixing. Intermittent aeration has been used successfully at wastewater treatment facilities like the RRMSA WWTF to achieve biological nutrient removal (BNR) in the activated sludge treatment biomass and improve the quality of the facility's final effluent discharge.

In the BNR process, bacteria in the activated sludge biomass consume organic solids, proteins, and carbon sources (food) while converting ammonia to nitrate (nitrification) and nitrate to nitrogen gas (denitrification) that returns to the atmosphere. Nitrification requires a lot of oxygen during the aeration "on" cycle to make nitrate. Conversely, denitrification during the aeration "off" cycle requires very low concentrations of oxygen and mixing to keep the activated sludge biomass in contact with both nitrate and the organic components (food) in wastewater.

The benefits of intermittent aeration for BNR by the activated sludge treatment biomass include:

- Reduced electricity consumption because the WWTF aeration blowers do not have to be operated continuously.
- Removal of nitrogen and phosphorous in the final effluent discharge to achieve compliance with NPDES Permit requirements and reduce pollutants in downstream waters to support aquatic life, recreational uses, and source-water protection in waters of the Commonwealth.
- Intermittent aeration strategies do not require the significant capital investments required for the upgrade of the existing facility to comply with NPDES Permit effluent discharge limits.

These are wins for the host community served by the treatment facility, for the facility owners and operators, for the regulatory community, and especially for the downstream users of the waters contributing to the Delaware River Watershed.

For this project, WWTAP staff deployed a selection of continuous-monitoring submersible probes in the treatment system to collect water quality data in the activated sludge treatment tanks and final effluent discharge after disinfection. WWTAP staff also returned to the facility for weekly site visits to complete the following:

- Perform process control and water quality testing necessary at activated sludge treatment system,
- Ensure proper operation and maintenance (calibration & cleaning) of the probe system,
- Direct and assist facility operators in tasks to optimize the process, including maintenance of the anoxic mixing pumps and trials of different supplemental carbon sources, and
- Observe the general operation & maintenance of the treatment system.

Weekly reports and graphs of continuous-monitoring probe data and process control testing results from WWTAP were provided to RRMSA and Miller Environmental, the WWTF operator.
In July and early August, RRMSA installed timer systems on the WWTF aeration blower electrical controls and installed four (4) electric grinder pumps in the corners of aeration tank no. one. The

timer systems were set for repeating three hour on/off aeration cycles; with two hours of aeration (blowers on) followed by one hour of no aeration with mixing (blowers off and mixers on).

The intermittent aeration program was successful at reducing effluent nitrogen concentrations, but project stakeholders recognized that additional modifications to the WWTF were needed to support efficient BNR. In response, WWTAP staff, RRMSA, and WWTF operators consolidated treatment to one aeration tank, adjusted the activated sludge biomass inventory, and began adding supplemental organic/food sources to the anoxic mixing cycles. After these additional modifications were implemented by RRMSA and WWTF operator(s), WWTAP probe data indicated that the biomass responded with complete nitrification & denitrification, achieving effluent nitrate concentrations less than the (10) milligrams per liter (mg/L).

In the months following startup of the intermittent aeration program, biomass adjustments, and implementation of the organic carbon/food addition system, data collected by WWTAP monitoring systems indicate a greater than fifty (>50) percent reduction of final effluent nitrogen concentration and compliance with the WWTF NPDES Permit total nitrogen monthly average limit of 30 mg/L. Figure 1, below, includes a graph of WWTAP continuous monitoring probe nitrate-nitrogen data collected in the WWTF final effluent discharge during the project. Probes to monitor total nitrogen are unavailable, so nitrate-nitrogen probe data best represents total nitrogen.

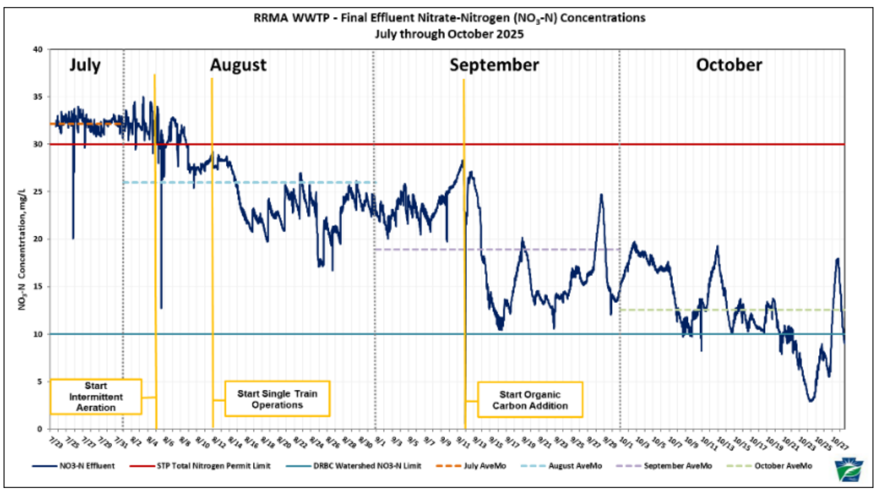


Figure 1) RRMSA WWTF final effluent discharge nitrate-nitrogen concentration data from WWTAP nitrate probe The Intermittent Aeration program, combined with management of the activated sludge biomass inventory and supplemental organic carbon (food) addition, drove efficient BNR in the aeration tank activated sludge biomass. Efficient BNR at the WWTF reduced final effluent Nitrogen & Phosphorous concentrations below the RRMSA NPDES Permit limits.

After WWTAP removed equipment from the facility in October, RRMSA continued to improve effluent discharge quality by implementing additional process control testing and making improvements to the operation and maintenance of the WWTF. Effluent sampling data reported by RRMSA indicates that the facility achieved a final effluent total nitrogen concentration of 3.5 mg/L in November 2025. Figure 2, included on page 3 of this report, includes the WWTF effluent sampling results for total nitrogen submitted by RRMSA with the monthly Discharge Monitoring Reports (DMRs).

This project effectively demonstrated that using intermittent aeration with anoxic mixing has been very effective in bringing BNR to conventional activated sludge wastewater treatment systems. Continued refinement of the intermittent aeration program will help RRMSA to save energy and capital, while supporting efficient treatment and NPDES Permit compliance.

RRMSA WWTF – Intermittent Aeration Project Summary

RRMSA is a privately managed community of approximately 100 residences with a population of around 200 people. RRMSA owns and manages the sanitary sewer system and wastewater treatment facilities through a sewer board. The RRMSA WWTF has a rated treatment capacity of up to 32,000 gallons per day (gpd) and consists of one comminutor with mechanical bar screen, one influent flow equalization tank, two activated sludge treatment trains that each include one aeration tank, one clarifier, and one sludge holding tank, and one ultraviolet (UV) final effluent disinfection system.

A review of monthly Discharge Monitoring Report (DMR) effluent sampling result data submitted by RRMSA indicates that the WWTF exceeded the 30 mg/L Total Nitrogen Monthly Average final effluent limit in the NPDES permit in 27 of the 43 months (January 2022 – July 2025) preceding start of the intermittent aeration program at the WWTF. Figure 2, below, includes a graph of final effluent total nitrogen monthly average concentrations reported by RRMSA for the WWTF for January 2022 through November 2025.

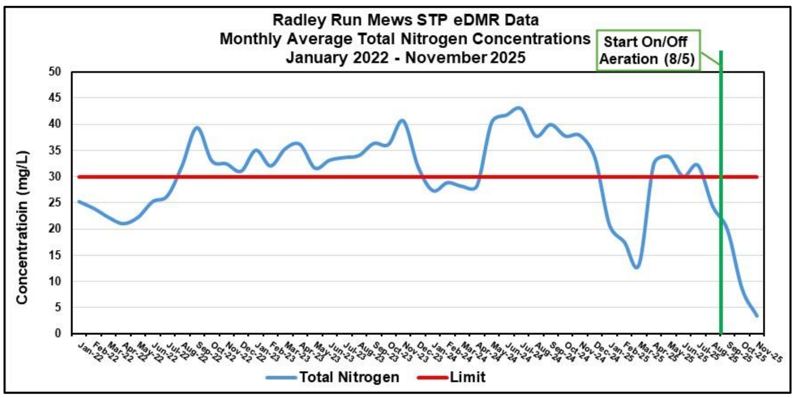


Figure 2) Graph of WWTF Final Effluent Monthly Average Total Nitrogen conc. data for January 2022 through November 2025.

Intermittent Aeration

During a site visit on April 28, 2025, WWTAP staff suggested converting the WTF to intermittent aeration to utilize the aeration tank as the point where both nitrification and denitrification occur. To achieve an Anoxic environment in the existing aeration tank required for denitrification, mixers must be installed in the tank to maintain bacterial contact with both influent carbon and nitrate, providing mixing while the aeration blowers are off. Following depletion of dissolved oxygen in the tanks, bacteria begin to utilize nitrate-nitrogen for respiration. The pre-existing operations strategy of 24-hour blower operations provides constant aeration and inhibits any anoxic periods from occurring in the activated sludge biomass. Constant aeration is not necessary and wastes energy.

Generally, successful BNR in activated sludge treatment facilities includes Nitrification & Denitrification. Nitrification is a biological process performed by bacteria that convert ammonia (NH_3-N) into nitrate (NO_3-N). This process demands oxygen for respiration. For every pound of ammonia that is removed through the nitrification process, 4.6 pounds of oxygen are consumed. Denitrification is a biological process performed by bacteria that converts the nitrate (NO_3-N) produced by nitrification to nitrogen gas (N_2). Denitrification requires low DO (>0.3 mg/L) and Oxidation/Reduction Potential (ORP) conditions in the aeration tank, as well as a source of organic carbon as “food” for the bacteria and mixing to ensure contact between the bacteria & nitrate.

WWTAP installed continuous-monitoring probes to collect data for DO, pH, ORP, and total suspended solids (TSS) in the treatment train #1 aeration tank. The data provided by these probes is important to ensure that the operations strategy creates conditions required for successful BNR, and to balance the inventory of activated sludge biomass in the WWTF. Probes to detect effluent ammonia-nitrogen and nitrate-nitrogen were installed in effluent discharge chamber after UV disinfection. Photographs of WWTAP continuous-monitoring probe deployment locations at the RRMSA WWTF are included in Attachment C of this report.

During this project, the data provided by the continuous-monitoring probes were used to help set the on/off aeration cycle duration using timers for WWTF aeration blower and mechanical mixer controls. The aeration blower timers were set for a repeating on/off aeration cycle with two hours standard aeration followed by one hour of no aeration with mixing. Successful nitrification occurs when DO concentrations in the biomass remained between 1 to 3 mg/L and ORP readings were greater than +100 mV during periods where aeration blowers are in operation. Successful denitrification occurs when probe data indicate DO concentrations less than 0.3 mg/L and ORP readings less than -100 mV in the activated sludge when the aeration is off & the mixing pumps are on.

Figure 3, below, includes a graph of WWTAP continuous-monitoring probe data for DO in the aeration tank. The aeration tank DO probe data indicates that the intermittent aeration treatment strategy created conditions where DO concentrations during aeration met the requirement for efficient nitrification (1-3 mg/L) without wasting energy, and the minimum DO concentrations during periods where aeration was off met the requirements for denitrification (target DO <0.3 mg/L).

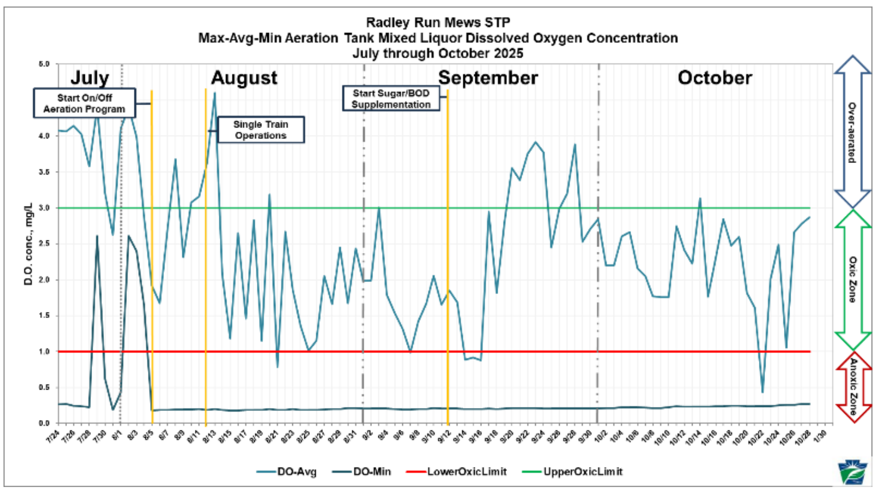


Figure 3) WWTF Aeration Tank Dissolved Oxygen (DO) concentration data from WWTAP DO probe.

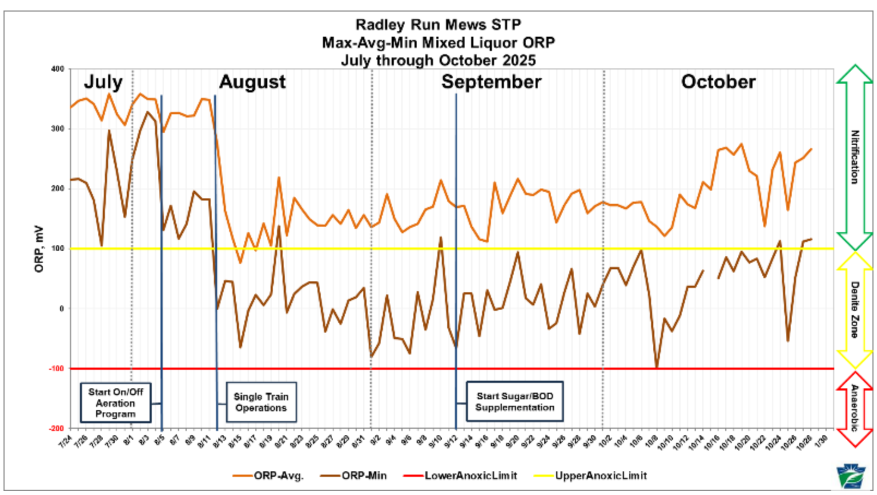


Figure 4) WWTF Aeration Tank Oxidation/Reduction Potential (ORP) data from WWTAP ORP probe.

Figure 4, above, includes a graph of the WWTAP continuous-monitoring probe data for ORP in the aeration tank. The aeration tank ORP probe data indicate that the intermittent aeration treatment strategy created conditions in the activated sludge biomass where the average ORP concentration during aeration met the requirement for efficient nitrification (>+100 mV), and during periods where aeration was off, the minimum DO concentrations (>0.3 mg/L) and ORP (-100 to +100 mV) met the requirements for complete denitrification.

Using intermittent aeration has thus far been extremely successful, with average total nitrogen concentration data reported by RRMSA post-implementation (September, October, & November 2025) of 10.6 mg/L, down from an average of 31.6 mg/L for the 12 months prior to the start of the project (July 2024 to July 2025). The graphs in Figures 5, 6, & 7, below, depict the reduction of Nitrate-Nitrogen and Total Phosphorous *(as* $(PO_{4-})^{-3}$*)* in final effluent through the course of the project.

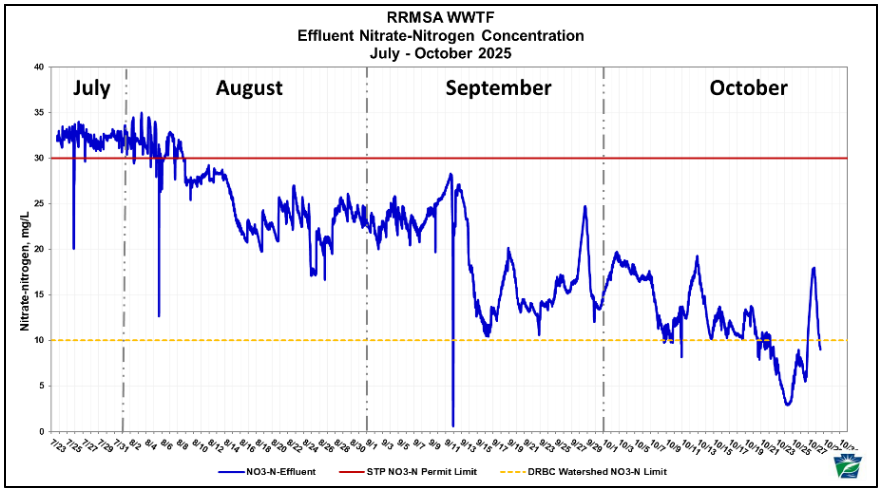
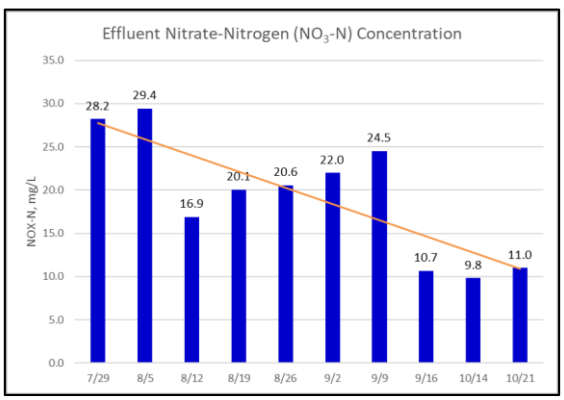
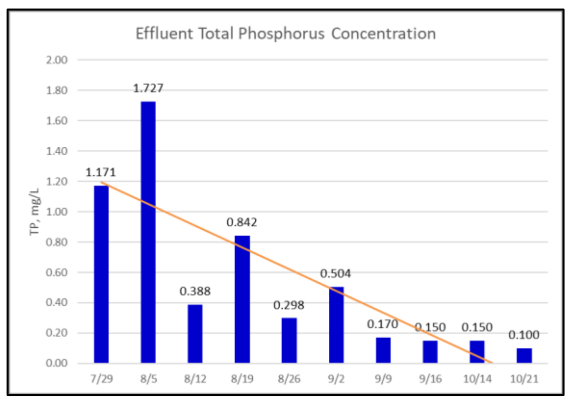


Figure 5) WWTF Final Effluent Nitrate concentration data from WWTAP Nitratax probe. The Intermittent Aeration program, combined with effective sludge inventory management and supplemental addition of sugar solution & animal feed drove BNR in the aeration tank activated sludge biota and reduction of final effluent nutrient concentrations below NPDES Permit effluent limits.





Figures 6 & 7) Graphs that include the results of weekly WWTAP bench testing for RRMSA WWTF Final Effluent Nitrate-nitrogen and Total Phosphorous concentration that depict the success of the Intermittent Aeration program to achieve reduction of final effluent nutrient concentrations.

The study at RRMSA has effectively demonstrated that using an intermittent aeration strategy works well to drive BNR (nitrification & denitrification) in conventional activated sludge systems without resorting to significant capital investments required for facility upgrades to install, operate, & maintain a more complicated wastewater treatment infrastructure.

This has been a Win-Win-Win for all participants. It is a win for users of the watershed as the water quality of WWTF effluent is improved, a win for the community and its infrastructure as operational costs will be reduced (cost savings on electricity), and a win for regulators, such as the EPA and DEP with improved permit compliance.

Additional Operational Challenges & Successes

Single-Train Operations and Sludge Inventory Management
Prior to the start of the project, PADEP completed a review of data submitted by RRMSA in monthly Discharge Monitoring Reports for the 2024 calendar year and determined that the facility was not removing enough sludge from the WWTF to maintain a healthy activated sludge biomass. WWTAP staff made this determination after completing the PADEP Sludge Calculation Worksheet. The results provided by the worksheet are an accepted method for determining whether a facility is adequately removing waste sludge to maintain a healthy treatment biomass. The PADEP requires the submission of the Sludge Calculation Worksheet when publicly owned wastewater treatment facilities with activated sludge treatment systems submit Annual Wasteload Management Reports (aka Chapter 94 reports). A completed PADEP Sludge Calculation Worksheet and a table of the eDMR and monthly biosolids summary report data used to complete the worksheet are provided in Attachment D of this report.

Additionally, WWTAP staff completed industry-standard process control testing during weekly site visits to monitor the condition of the WWTF activated sludge biomass. Initial solids concentration data from the WWTAP solids probe and process control testing results confirmed that the WWTF operators maintained an excessive solids inventory at the facility. The pre-existing operations strategy failed to properly waste solids from the treatment system, resulting in sub-optimal solids inventory, “old” sludge protozoa communities, and reduced ability of the WWTF activated sludge biomass to remove pollutants/nutrients that caused exceedances of NPDES Permit final effluent limits.

Continued refinement of the WWTF operations strategy will help RRMSA achieve efficient treatment and NPDES Permit compliance. Figure 8, below, includes a graph of WWTAP aeration tank solids probe data. This graph indicates that RRMSA and wastewater operators worked to remove (hauling & disposal) of sludges from the WWTF to “healthy” target solids concentrations.

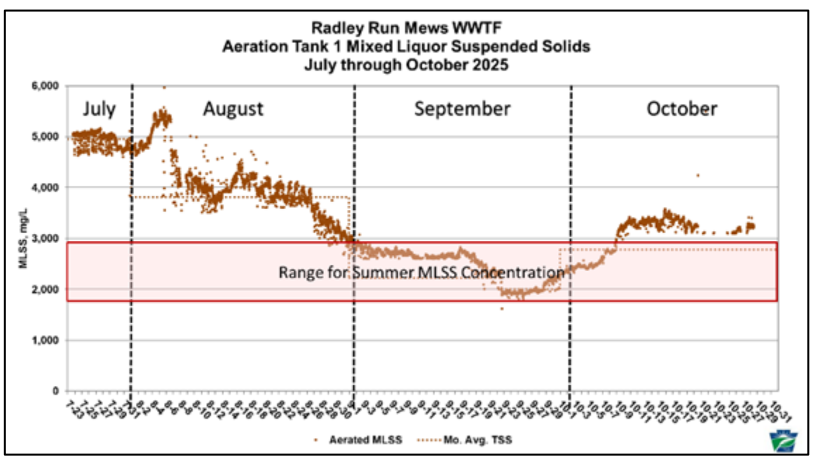


Figure 8) RRMSA WWTF Aeration Tank Mixed Liquor Suspended Solids (MLSS) concentration data. WWTF operators increased the volume of solids wasted daily and RRMSA contracted for removal of additional solids by a sludge hauler (McGovern) for offsite disposal.

After RRMA contracted to remove solids from the WWTF, and after WWTF operators increased wasting of activated sludge from the treatment system (settled sludge from the settling tank/clarifier), the activated sludge biomass appeared to be healthier and more robust. Figure 9, below, shows the lower sludge-by-volume percentages during the second half of the project. These values, between 2.75% and 3.50%, indicate a more acceptable activated sludge biomass solids concentration. After wasting away the old, endogenous mixed liquor and allowing a more robust, younger biomass to develop in its place, sludge quality improved in all areas.

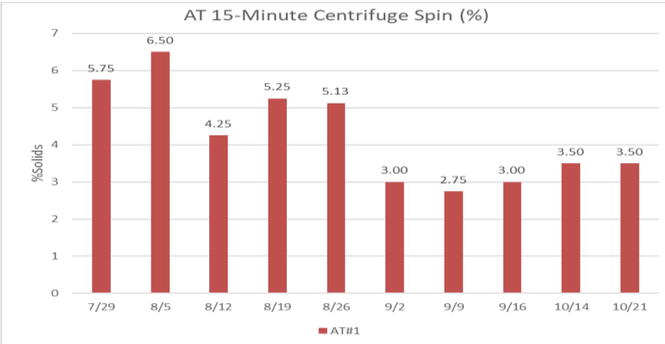


Figure 9) RRMSA WWTF Aeration Tank Mixed Liquor percent solids (%) data from WWTAP process control testing.

Total Phosphorous Removal

Biological phosphorus removal was not part of the scope of work; however, phosphorus data submitted by RRMSA has shown that there may be biological reduction of phosphorus as a result of the intermittent aeration process. Through the combination of the addition of an alum solution, an approved chemical additive for phosphorous removal at wastewater treatment facilities, with effective BNR through intermittent aeration, this facility may be achieving additional reductions of effluent total phosphorus concentrations. Post-implementation monthly average concentrations reported by RRMSA are lower (0.2 mg/L) than any result previously submitted for the WWTF. Additionally, the average total phosphorous concentrations of 0.3 mg/L (September, October, & November 2025) indicate a reduction from an average of 1.8 mg/L for the 12 months prior to the start of the project (July 2024 to July 2025). The data reported for July 2024 through July 2025 also includes 6 exceedances of the NPDES Permit final effluent limit of 2 mg/L for the Total Phosphorous monthly average concentration. Figure 9, below, includes a graph of final effluent total phosphorous monthly average concentrations DMR data by RRMSA for the WWTF for January 2022 through November 2025.

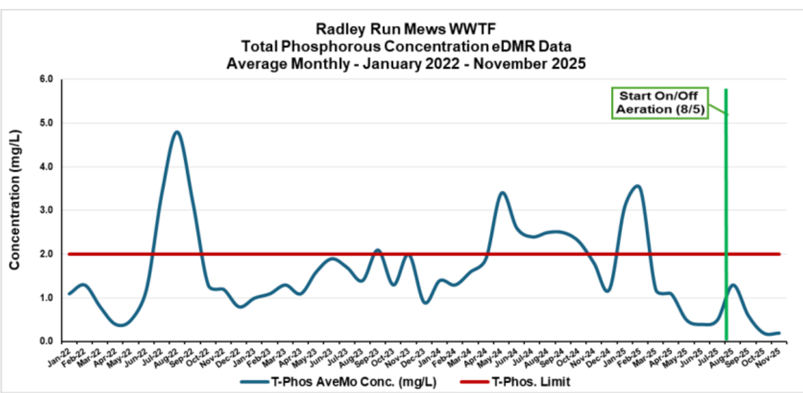


Figure 10) RRMSA WWTF Total Phosphorous concentration data for January 2022 through November 2025 (RRMSA WWTF Discharge Monitoring Report (DMR) data submitted by RRMSA).

Acknowledgements:

DEP gratefully acknowledges the contributions of Greg Pikul from RRMSA, Dean Miller and Dave Mohn from Miller Environmental (contract wastewater operators), Brian Sanders from Process Masters, for inviting participation in this study and for providing equipment and service upgrades necessary to make it successful. RRMSA and WWTF operators will work to resolve additional operational challenges observed during the project, but the framework for NPDES Permit compliance with the intermittent aeration program has been a success. Recommendations for continued improvement of the RRMSA WWTF are included as Attachment G of this report.

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LIST OF ATTACHMENTS

- ***Upon request, WWTAP* will *provide RRMSA with complete copies of all data & documentation generated during this project.***
- ***Additional WWTAP data & results for this project may be available upon request. Please contact the project manager listed in Appendix A of this report or the PADEP Bureau of Clean Water WWTAP at RA-EPWWTAPROVIDER@pa.gov / (717) 787-6744.***

Attachment A: RRMSA STP – Intermittent Aeration Study Project Team

PA Department of Environmental Protection	
PADEP WWTAP	
Erick Ammon – Project Manager Water Program Specialist Wastewater Technical Assistance Program Bureau of Clean Water PADEP - Rachel Carson State Office Building 400 Market St., POB 8774 Harrisburg, PA 17105-8774 (717) 772-8911 eammon@pa.gov	Jeremy Miller Wastewater Operations Treatment Advisor Wastewater Technical Assistance Program Bureau of Clean Water PADEP Northeast Regional Office 2 Public Square Wilkes-Barre, PA 18701-1915 (570) 830-3078 jermiller@pa.gov
Marc Austin Neville Water Program Specialist Wastewater Technical Assistance Program Bureau of Clean Water PADEP - Rachel Carson State Office Building 400 Market St., POB 8774 Harrisburg, PA 17105-8774 (717) 772-4019 mneville@pa.gov	
PADEP Southeast Regional Office	
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Radley Run Mews Homeowners Association	
Greg Pikul President Radley Run Mews Sewer Association gpikul@gmail.com 732-742-6152	Dean Miller WWTF Operator-in-Responsible-Charge Miller Environmental, Inc. Reading, PA 19602 (610) 376-9162 info@miller-env.com
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Attachment B: RRMSA WWTF On/Off Aeration Study – Project Outline

Project Outline

PADEP WWTAP Wastewater Treatment Evaluation &
On/Off Aeration Pilot Project
Radley Run Mews Sewage Treatment Plant
PA National Pollutant Discharge and Elimination System (NPDES) Permit No. PA0036200

Background:

On Aril 23rd, 2025, a wastewater operator outreach advisor from the Pennsylvania Department of Environmental Protection (PADEP), conducted a site visit at the Radley Run Mews Association Sewage Treatment Plant (STP) in Birmingham Township, Chester County, Pennsylvania.

On July 9th, 2025, PADEP WWTAP staff and representatives/contractors for RRMA met onsite to discuss a wastewater treatment evaluation (WTE) project to monitor STP treatment units during a pilot project for On/Off aeration in the activated sludge treatment system. The objectives of this project include monitoring wastewater treatment units at the STP during the On/Off aeration program to assist RRMA with NPDES Permit final effluent limit compliance and reduction of final effluent discharge nutrient loading to waters of the Commonwealth.

WWTAP Project Proposal:

WWTAP staff will install a selection of continuous monitoring equipment at the WWTP to optimize biological nutrient removal of the activated sludge treatment system and complete at least one (1) weekly site visit to clean & maintain probes and complete process control & bench testing.

After striking equipment, WWTAP will deliver a project report that will include; a summary of data & relevant findings during the WTE and On/Off aeration pilot study, recommendations for efficient WWTP operations, and a discussion regarding optimization of the activated sludge treatment system.

WWTAP Project Timeline:

Project duration is six (6) to ten (10) weeks from deployment to striking of WWTAP equipment.
WWTAP equipment deployment and setup is tentatively scheduled between July 22nd & 24th, 2025.

WWTAP Resource Requests for RRMA and the WWTP Certified Operator:

- WWTAP requests access to the facility at reasonable times (M-F 0700-1600).
- STP driveway space to park WWTAP trailer w/mobile laboratory equipment.
- Coordination to allow WWTAP collects at least seven (7) days of continuous monitoring data before starting the On/Off aeration program.
- Reliable power source(s) for WWTAP equipment.
- Access to 24-months of operating records, including laboratory & bench testing results.
- Availability of RRMA and Miller Environmental wastewater operations staff to regularly discuss project status and WWTAP continuous monitoring & process control data.

Figure 10) RRMSA WWTF – WWTAP Project Outline

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Attachment C: RRMSA WWTF Intermittent Aeration Study – Project Photos.

Figure 11: WWTAP pH, DO, ORP, and Solids continuous-monitoring probe installation in RRMSA WWTF Aeration Tank #1.

Figure 12: WWTAP pH, DO, ORP, and Solids continuous monitoring probe installation in RRMSA WWTF Aeration Tank #1.

Attachment C: RRMSA WWTF Intermittent Aeration Study – Project Photos. (cont'd)

Figure 13) WWTAP continuous monitoring probe placement (Hach AISE and Nitratax) at WWTF final effluent at UV disinfection discharge.

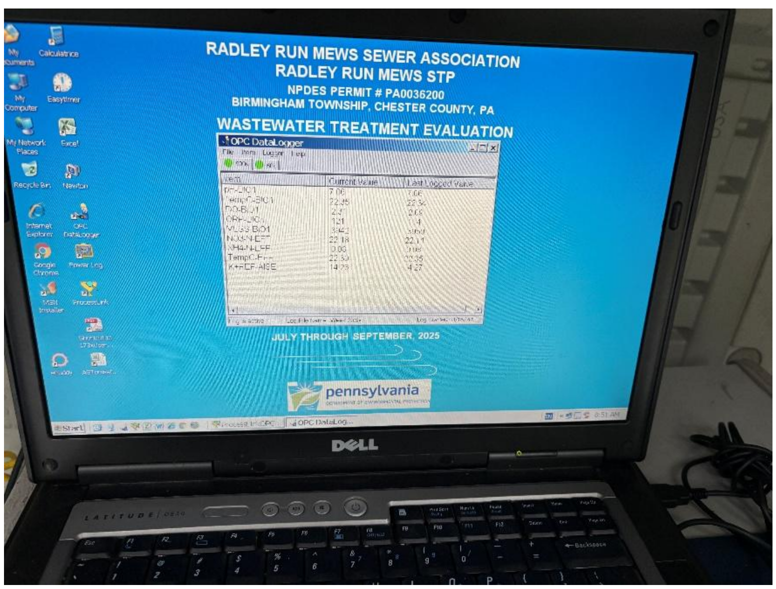

Figure 14) WWTAP continuous monitoring probe data live view at RRMSA WWTF. The live data view was installed for 24/7 continuous monitoring probe data review for RRMSA, WWTF operator(s), and project stakeholders.

Attachment D: RRMSA WWTF – 2024 Sludge Calculation Worksheet (PADEP)

SLUDGE GENERATION CALCULATION

Facility Name: RRMA STP
Permit Number: PA0036200
Date of Calculation: 7/15/2025

Required Information For Calculation

Average Daily Flow (mgd):	0.011	Digester Capacity (gal):	4,000
Influent BOD (mg/l):	261	%Solids of Outgoing Sludge:	2.3
Effluent BOD (mg/l):	2.4	Monitoring Period (days):	365

Wastewater Treatment Processes

Place an "X" in the box beside the corresponding treatment process. Select a maximum of Primary Clarification and one other treatment process.

Primary Clarification		Contact Stabilization		RBC	
Conventional Activated Sludge		SBR		ABF	
Extended Aeration	x	Trickling Filter		Small Plant with low SOR (<500 gpd/sq ft)	

Operational Information

BOD Removed (lbs/day):	24	TSS Removed (lbs/day):	15

Digester Information

Type of Digester

Place an "X" in the box beside the corresponding treatment process.

Aerobic Digestion	x	Anaerobic Digestion		None	

Sludge Feed Rate to Digesters (gpd):	246.532
Digester Hydraulic Detention Time (days):	16
Estimated Total Solids Reduction (%):	0.3

Sludge Generation

dry lbs/day	11	wet lbs/day	469
dry tons/monitoring period	1.97	wet tons/monitoring period	86
gal/day	56	gal/monitoring period	20540

Amount of Sludge Reported as Being Generated by the Facility

wet tons/monitoring period: 0

OR

dry tons/monitoring period: 0.768

Enter only one of the above values. The remaining value should be "0".

Is the amount reported by the generator within 15% of the calculated value? **NO**

NO explanation: **LESS THAN 15% RANGE**

What type of information was used to calculate the above information: eDMR Data

Dates used: 1/1/2024 TO 12/31/2024

Name of person performing the calculation: Ammon

Figure 15) PADEP Sludge Calculation Worksheet for the RRMSA WWTF (1/1/2024 – 12/31/2024)

Attachment D: RRMSA WWTF – 2024 PADEP Sludge Calculation Worksheet (cont'd.)

Table 1: 2024 Sludge Calculation Worksheet Data submitted by RRMSA with monthly eDMR data and Effluent Monitoring, Influent & Process Control, and Biosolids Supplemental Reporting Forms.

Month	Flow (MGD)	BOD_5 Inf (mg/L)	TSS Inf (mg/L)	$CBOD_5$ Eff (mg/L)	TSS Eff (mg/L)	Sludge Solids (%)	Sludge Hauled (gal)	Sludge Hauled (DryTons)
Jan-24	0.014	165	160	2	10	-	-	-
Feb-24	0.012	172	192	2	5.5	2.3*	4,000	0.384
Mar-24	0.012	115	126	2.2	4	-	-	-
Apr-24	0.015	162	208	2.3	10.5	-	-	-
May-24	0.009	453	706	2	4.8	-	-	-
Jun-24	0.010	198	310	2	5	-	-	-
Jul-24	0.009	687	1322	2	4	-	-	-
Aug-24	0.010	458	894	2	4	-	-	-
Sep-24	0.008	115	148	2	4	-	-	-
Oct-24	0.008	201	233	5.1	8.8	-	-	-
Nov-24	0.011	229	275	3.6	8	2.3	4,000	0.384
Dec-24	0.012	171	83	2	4.8	-	-	-
	Annual Average						**Annual Total**	
	0.011	**260.5**	**388.1**	**2.4**	**6.1**	**2.3**	**8000**	**0.768**

** % Solids Not Reported. Estimated value from 11/24 Biosolids Supplemental Reporting Form*

Attachment E: Recommended Process Control Testing for RRMSA WWTF

The following is a list of recommended process control tests & calculations for an activated sludge wastewater treatment facility of comparable size and design to the RRMSA WWTF (some are already being performed):

- Influent Temperature (daily)
- Monitor Nutrient Balance (1:5:100) for the WWTF (monthly with sampling)
  *Phosphorous: Nitrogen: BOD_5
- Influent/Effluent alkalinity (weekly)
  *Alkalinity is necessary to support nitrification, and it will be consumed in the process. If testing reveals little fluctuation in these values, testing can be occasional. WWTAP recommends this test if there is a problem with nitrification.
- Continuous monitoring of dissolved oxygen levels in Aeration Tank treatment units with procedures and/or automatic controls to adjust aeration rates and on/off aeration cycles.
- Aeration Tank mixed liquor pH (daily grab during aeration)
- Aeration Tank mixed liquor DO (daily grab during aeration)
- Aeration Tank mixed liquor ORP (daily grab during aeration)
- Aeration Tank mixed liquor MLSS & MLVSS (3 times per week)
- Microscopic examination of mixed liquor (2 times per week)
- 30 Min. Settleability (daily grab during aeration)
- Monitor and Adjustments to RAS and WAS Rates (daily)
- Calculate the Food to Microorganism Ratio (F:M Ratio) (2 x month with sampling)
- Calculate MCRT (sludge age) for the WWTF
- Calculate Lbs. of solids under aeration (2 x month with sampling)
- For the digestion process:
  - Monitor the lbs. of solids added to the system each day and the lbs. of solids removed (WAS),
  - Monitor the volatile content of solids (influent & effluent) and calculate reduction of volatile solids.
    - One common workflow involves monitoring volatile solids concentrations before (volatile solids of influent) and after (volatile solids of effluent) biological processes
  - Monitor the temperature & pH of the digesters daily
  - Thicken digesters as much as possible
  - Calculate Hydraulic Detention Time (HDT) of digesters
  - The decant from the aerobic digesters should be monitored as well. Internal recycle flows (e.g. digester decant) can contain significant concentrations of nutrients and impact BNR by the activated sludge biomass. The quantity and quality of the supernatant should be monitored. WWTAP recommends monitoring for BOD, Total Phosphorous, TSS, NH_3-N and pH.

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Attachment F: RRMSA WWTF - Costs for Continuous Monitoring Probe System for BNR

The equipment deployed at the RRMSA WWTF for this study was chiefly comprised of Hach products. In this attachment, the estimated cost for purchasing this equipment and maintaining it is listed, excluding installation costs. Modifications to the electrical control system to incorporate these probes would have to be contracted with an electrical engineer/contractor at additional cost. The costs listed here may not be current and do not include installation costs for physical and electrical work. Engineering costs for design and for regulatory approvals are not included.

Following is a table listing equipment needed for DO & ORP probe installation with a probe controller into one aeration tank:[1]

Item	Unit Price	Qty.	Subtotal
Hach LDO2 Probe (DO)	$3,400	1	$3,400
Hach pHD Digital ORP Sensor	$1,900.00	1	$1,900
Hach Pole Mount Set for 1" NPT Sensors	$825.00	2	$1,650
Hach SC4500+ (2 inputs)	$3,797.00	1	$3,797
	Total Hach Pricing:		**$10,747.00**

An annual budget for online data access/visualization applications and probe/sensor maintenance costs should be included for the probes and controllers. Professional service costs for replacement of seals, desiccant, and worn or broken parts are available. During professional service, the technician also updates any firmware and recalibrates the probes. Some of these costs are listed below:

Item	Unit Price	Qty.	Subtotal
Salt bridge (ORP Probe)	$134.00	1	$134.00
Equi-Transferrant Solution 500 mL (ORP Probe)	$113.00	1	$113.00
Zobell's ORP Buffer Solution, 500 mL (ORP Probe)	$89.20	1	$89.20
LDO Replacement Sensor Cap Kit (LDO Probe)	$380.00	1	$380.00
Hach SC4500+ Field Service Partnership	$354.00	1	$354.00
Hach SC4500+ MSM Sensor Registration	$3,148.00	1	$3,148.00
Hach SC4500+ Claros Subscription	$220.00	1	$220.00
	Total Hach Pricing:		**$4,438.20**

Current data monitoring and processing with the Hach Claros platform and Hach probe and controller warranty and service plan costs may be obtained from the manufacturer or vendor. The more expensive service plans, where a technician maintains the probes at the facility, reduces the probe maintenance and repair turn-around time from approximately three weeks to one or two days. This is an important consideration when a facility does not have back-up equipment in reserve.

[1] Costs are estimated based on current catalog pricing and are presented only for estimating purposes. Facility owners and operators should check and compare with equipment vendors as to the most appropriate equipment and pricing before drafting budgets. PADEP makes no endorsement of any particular brand of equipment.

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Attachment G: Recommendations for Continued Optimization of the RRMSA WWTF

Based on the outcome of the intermittent aeration program and additional discussions with RRMSA and the certified wastewater operator(s), the following recommendations are made for ongoing and future improvement of the WWTF:

1. Continue to follow the WWTF Intermittent Aeration operations strategy to comply with NPDES Permit requirements and improve water quality of the final effluent discharge to waters of the Commonwealth.
2. Investigate the purchase and installation of continuous-monitoring Dissolved Oxygen (DO) probes in the aeration tank(s) to optimize BNR through aeration cycles, reduce excess aeration (DO >4 mg/L) to the activated sludge biomass, and achieve energy savings.
3. If possible, investigate the purchase and installation of additional continuous monitoring probes for Oxidation/Reduction Potential (ORP) in the aeration tank. Continuous-monitoring ORP probes allow the operators to fine-tune the intermittent aeration cycle times and maintain an optimized period of anoxic mixing for efficient denitrification. See Attachment F for information on continuous-monitoring probes.
4. Maintaining efficient biological nutrient removal by the activated sludge biomass requires that the operators conduct robust process monitoring tests, including regular analyses for alkalinity concentration of aeration tank activated sludge, and nitrogen forms such as ammonium, nitrite, and nitrate at various points throughout the process. Enhanced process monitoring may require the purchase of additional laboratory equipment and test materials. See Attachment E for recommended process monitoring tests and their frequencies.
5. Continue to develop in-house monitoring and methods for tracking sludge wasting to the digester, including regular total solids testing, and measuring volumes of wasted sludge. Tracking sludge wasting will assist operators to quantify sludge wasting and other standard operating parameters for maintaining a healthy activated sludge biomass, such as food-to-microorganism ratio (F:M) and/or mean cell residence time (MCRT).
6. Continue to investigate collection of representative influent composite samples. Representative influent sampling will assist with adjustments to the supplemental organic carbon (Biochemical Oxygen Demand [BOD]) dosing rates.
7. If accumulation of rags and other detritus affects the performance of sensor probes, pumps, valves, and other equipment, do consider upgrading the plant headworks with an effective and efficient trash screening unit to remove this material. After such an upgrade, it would be prudent to clean out all downstream units to ensure removal of earlier deposits of rags, trash, and detritus. Manufacturers of underground package tank systems may have written maintenance schedules for such tasks.
8. Assure that cathodic protection of the tanks remains intact and replace any depleted anodes or broken cables. During tank maintenance, consider grinding and refinishing corrosion spots and use only approved finishes.

N.B.: These are only recommendations by WWTAP staff based upon experience with successful process control programs that have been implemented at other facilities with design and treatment technologies similar to the RRMSA WWTF. RRMSA will need to determine the feasibility of implementing any/all recommended process control testing in addition to what is currently completed by RRMSA representatives and WWTF operator(s).

Pennsylvania
Department of
Environmental Protection