ROCKY RIDGE ESTATES

WASTEWATER TREATMENT FACILITY

MIDDLE SMITHFIELD TOWNSHIP, MONROE COUNTY, PENNSYLVANIA

WQM Permit 4594405

WASTEWATER TREATMENT EVALUATION

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pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
WASTEWATER TECHNICAL ASSISTANCE PROGRAM

2022

Executive Summary

During December 2021 and January 2022, technical assistance staff from the Department of Environmental Protection's Bureau of Clean Water, Operations Section, conducted an instrument-based analysis of the performance of the wastewater treatment facility at Cresson Properties' Rocky Ridge Estates, a small community of manufactured housing located in Middle Smithfield Township of Monroe County, near Stroudsburg, Pennsylvania. This report summarizes findings and impressions regarding the operation and maintenance of the facility and includes recommendations listed below. DEP staff were invited by the facility's contract operator, Portland Contractors, LLC, to assess whether or not the existing PureStream package sequencing batch reactor facility as operated was capable of treating domestic sewage with suspended matter, activated sludge, to meet more stringent effluent standards that require biological nutrient removal (BNR). After evaluating the facility condition and operation, DEP's evaluators concluded that the facility as presently configured will require significant capital investment within the next permit cycle to adequately treat its waste stream.

Recommendations:

Based on the results of the field evaluation, the following recommendations are offered for both short- and long-term improvements to facility operation and, where applicable, process improvements:

Short-term:

1. Employ dissolved oxygen (DO) probes to control aeration blowers through the use of variable frequency drives in order to maintain an oxic dissolved oxygen range between 1.5 mg/L and 3.5 mg/L for adequate nitrification of ammonia and to assure rapid depletion of dissolved oxygen during denitrification. A control feedback using real-time measurement connected to VFD control of the blowers is essential to prevent oxygen-poisoning of denitrification, necessary to meet total nitrogen limits of 10 mg/L.
2. Evaluate the facility headworks and consider replacing the basic PureStream bar rack with a fine-screen automatic trash removal system. Detritus and trash flushed into the collection system finds its way past the rudimentary bar rack and damages pumps, aeration diffusers, control devices, and probes downstream in the treatment unit. Further, the treatment unit should be emptied and cleaned of all trash and detritus that has built up over time, before any such new screening system is implemented.
3. Have the facility electrician secure loose wiring and open junction boxes.
4. Secure loose lid frames accessing underground tanks, per recent inspection directives.
5. Have the facility engineer evaluate the condition of the existing pumping stations and sand mounds for functional integrity. This appears not to have been done in a long time.
6. Implement recommended process monitoring and control testing at the facility, providing the operators with modern tools to assess the health of the biomass, and develop an operating strategy for achieving steady-state treatment conditions. The recommended process monitoring and control tests are discussed in Attachment F.
7. To achieve better denitrification, install a dedicated secondary carbon source and automate it to deliver the necessary food only during the anoxic mix phase, when it is needed by the denitrifying bacteria. The carbon source may be commercially prepared solutions such as Micro-C, a citrate, or methanol or glycerol; however, it may also be possible to locate and secure waste from food manufacturers, such as waste sugar, whey powder, or fruit juice to provide this carbon. Ideally, this material should be temperature-controlled to prevent fermentation and to reduce nuisance insects.
8. To achieve and maintain steady-state operating conditions, it is necessary to regularly waste sludge from the bioreactor (SBR) and to dispose of it on a regular basis.

Suspended solids concentrations at this facility were excessively high for its influent waste loading, suggesting that sludge wasting is not performed regularly enough to maintain a healthy biomass.

9. When necessary, bioaugmentation with commercial bacteria preparations may enhance the relative health of the biomass. During the evaluation, the biomass appeared to be largely in endogenous, declining state, with low activity, probably due to the facility being underloaded.
10. It is recommended that the facility conduct its sampling using a 24-hour automatic sampler instead of 8-hour manually composited sampling. Although this community is residential, modern work schedules and lifestyles suggest that waste is generated around the clock, and the present characterization of the waste stream may be inadequate. The facility should employ composite samplers for both raw wastewater and treated effluent.
11. Develop and post standard operating procedures for non-licensed operators.
12. Develop and implement a maintenance and preventative maintenance plan for the facility.
13. Develop and implement a sludge management plan for the facility.
14. Because the facility is privately held and does not participate in municipal Act 537 planning, it is not required to file an annual Municipal Wasteload Management Report. It is recommended that the regulator require that this facility report at least the five-year Chapter 94 workbook and the annual sludge disposal report, to better characterize the hydraulic and organic loading to this facility, including monthly precipitation and annual sludge disposal. Chapter 94 reports can serve as an annual report on the health of the collection and treatment system, providing insight into projected growth, or decline, of the community.
15. Three years of monthly operational reports and data should be maintained on site, at the treatment facility. Also, sludge management regulations require keeping five years' worth of biosolids removal records.
16. Regularly remind residents of the community to avoid flushing prohibited items into the collection system. This includes not only trash and plastics but also "flushable" wipes, infant and adult diapers, discarded household chemicals and prescription drugs.
17. Assure control of inflow and infiltration to the collection system not only in the sewer system but also in the lateral connections. This includes prohibitions against connecting roof drains to the sewer system. Regular mailings may include such recommendations.

Long-term:

1. The facility owner should ask their engineer to consider extensive upgrades or replacement of the bioreactor within the next five-to-ten years.
2. The steel treatment unit by PureStream appears to require significant maintenance. According to the operator, one wall of the unit had previously collapsed due to corrosion. When asked, no one could provide any information on the cathodic protection for this tankage, and it is likely that the sacrificial anodes have never been replaced. Because of this, it is recommended that the facility engineer re-evaluate the structural integrity of this treatment unit. During required down-time for what may be extensive maintenance, the steel tank should be stripped, reinforced, and refinished. The operator and the evaluator both expressed concern that the tank may already be leaking underground, although the condition of the tank could not be assessed during the study.
3. Like most treatment facilities, Rocky Ridge has built on existing treatment units over the years. The underground tanks used to store treated effluent prior to discharge to the

mounds should be evaluated for integrity and for leaks. This is also recommended for the wasted sludge holding facility.

4. The facility engineer should evaluate whether installation of an aerobic digester may be of benefit at this facility. An aerobic digester would reduce the mass of wasted material, limiting some of the expense of sludge hauling for disposal.
5. The existing SBR and its constituent parts are controlled by timers. It may be beneficial to evaluate and employ other forms of automation, such as the use of dissolved oxygen and oxidation/reduction potential probes to control the SBR cycles. During the evaluation, operations staff commented on problems with the existing control panel that has been much altered since its original installation.
6. If this existing bioreactor is to be replaced, it is recommended that alternative processes be considered on their merits. These bioreactors include:
   a. Sequencing batch reactor
   b. Modified Ludzack Ettinger (MLE) with dedicated oxic and anoxic treatment zones
   c. “Mini” membrane bio-reactor unit that employs reverse osmosis (RO) technology to withdraw filtered effluent from a suspended growth bioreactor following biological treatment: the benefit of such a system is its reduced footprint that allows for conversion of unused tankage to storage of wastewater and treated effluent.

Wastewater Treatment Evaluation:

Rocky Ridge Estates is a manufactured housing community in Monroe County and has a wastewater treatment system that has evolved over time from community septic systems to a package plant sequencing batch reactor. It is a non-point discharger, meaning that the treated secondary effluent is pumped to drain fields where it percolates into the groundwater. The facility is permitted by Water Quality Management Permit 4594405-T1, as amended. Presently, the facility is operated by Portland Contractors which provides operations services.

The facility’s operating permit is shown in Attachment E, following. Special conditions for groundwater dischargers apply. These include provisions for frequency of monitoring at once per week for all but flow, which is continuously measured. Permit limits are based on tests conducted once per month, and groundwater monitoring is required semi-annually.

Staff from Portland Contractors solicited assistance from DEP’s technical assistance program in 2021 to determine if the facility could achieve proper denitrification to reduce its total nitrogen discharge to the groundwater. DEP staff installed several monitoring probes in the bioreactor to measure

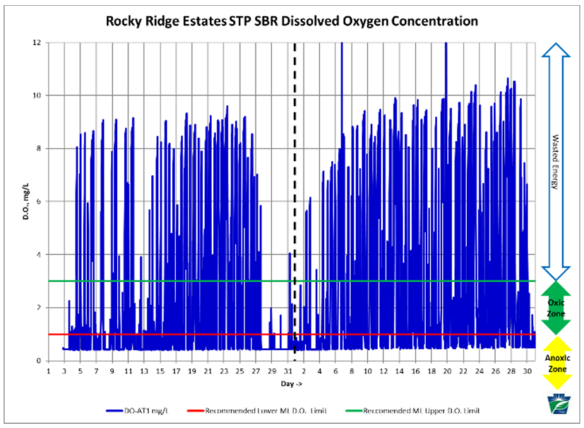
- pH,
- dissolved oxygen,
- oxidation/reduction potential,
- total suspended solids,
- ammonia-nitrogen, and
- nitrate-nitrogen
- total organic carbon

A simplified process flow schematic and probe placement diagram follows as Attachment B.

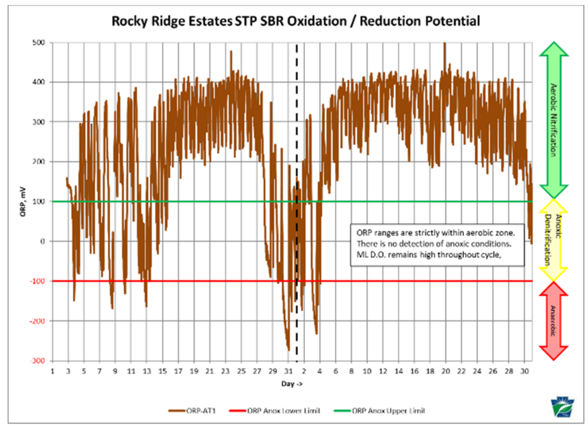
Attachment A lists the study participants. Attachment C shows trend graphs of the probe output during the evaluation. Attachment D includes record photographs.

In addition, DEP provided additional water chemistry and process monitoring tests, including alkalinity, settled sludge volume, volumetric solids, nitrite, and phosphorus. These tests, also including microscopy, were performed weekly during the two months on site.

At the outset of the evaluation, operators were adding sugar as a carbon source to the bioreactor to enhance denitrification; however, the feed pump was not connected to the SBR control panel, so it had been adding sugar water constantly rather than only during the anoxic phase of treatment. This sugar addition ceased during the evaluation, largely because the dissolved oxygen present during the so-called anoxic period had precluded any denitrification. This is evidenced by the ORP probe chart, below, that shows ORP was within anoxic denite range only about a third of the time over the evaluation period:



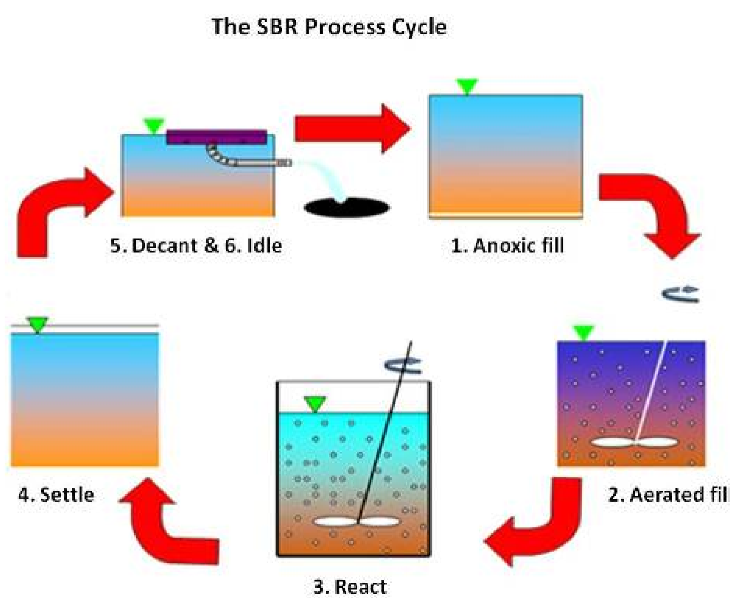
Dissolved oxygen graph showing excessive oxygenation



ORP graph showing limited denitrification

Nutrient Reduction Goals:

Nitrate has been a pollutant of concern in groundwater sources for drinking water wells. The Delaware River Basin Commission has been recommending nitrate limits of 10 mg/L for point-source discharges, and more recent attention has turned to groundwater discharges. Ammonia-nitrogen discharged to sand mounds is likewise a concern, because naturally occurring soil bacteria will convert ammonia to nitrate. Nitrate has been implicated in human health concerns. It acts on hemoglobin in red blood cells to form methemoglobin, reducing the oxygenation of organs and tissues.[1] Exposure to nitrate also increases the risk of thyroid



[1] Kross BC, Ayebo AD, Fuortes LJ. Methemoglobinemia: nitrate toxicity in rural America. Am Fam Physician. 1992 Jul;46(1):183-8. PMID: 1621630

disease[2] and may lead to certain types of cancers of the colon[3], as well as a very specific birth defect called neural tube disorders caused early in pregnancies.[4] Nitrates may also be implicated in diabetes, miscarriages, and acute respiratory infections. The medical science on the effects of nitrates continues to develop.

The SBR at Rocky Ridge has six phases of treatment: Anoxic Fill, Aerated Fill, Aerobic React, Settle, Decant, and Idle. Sludge wasting usually occurs in the idle phase. The anoxic fill phase allows food to adsorb to the bacteria in the suspended solids, and in the presence of a nitrate-rich, anoxic environment, adsorbed food is metabolized by denitrifying bacteria. Then, in aerated fill phase, carbonaceous waste is processed, and ammonia is converted to nitrate. During settling and decant, a clear water supernate develops and is then drawn off to a cistern that feeds the leach fields.

Denitrification appears to occur first, but the process takes place after carbonaceous and ammonia waste have been metabolized. For denitrification to work, there must be no dissolved oxygen present in the water, only bound oxygen in the form of nitrates, sulfates, and carbon dioxide. Certain facultative bacteria can use that bound oxygen to perform life functions.

Unfortunately, at Rocky Ridge's PureStream SBR, the concentration of dissolved oxygen in the water is much higher than is necessary for aerobic processes. This excess oxygen persists and interferes with denitrification. It is recommended that the dissolved oxygen for aerobic processes not exceed 4 mg/L for nitrification. A range of 1.5 mg/L to 3.5 mg/L is usually sufficient when denitrification is also considered.

Anoxic conditions require the dissolved oxygen concentration be reduced to 0.3 mg/L or lower. The technology of the dissolved oxygen probes is limited at the lower end of the scale, where any reading below 0.5 mg/L may be zero. To better understand the effective ranges for denitrification, ORP probes are used, where anoxic process are favorable between 100 mV and -100 mV. In practice, the denite "sweet spot" occurs between 0 mV and -50 mV, although experience may be different among differing treatment technologies.

Excessive dissolved oxygen at Rocky Ridge could be controlled by using variable frequency motor drives (VFD) to regulate aeration blower speeds. Rocky Ridge employs rotary lobe blowers, a type of blower well-suited to this control. Use of dissolved oxygen probes in the bioreactor, sending a 4 mA to 20 mA signal to the VFD, allow for established set points to control blower function, reducing excess aeration. This would greatly improve the potential of this facility to efficiently treat nitrogenous wastes.

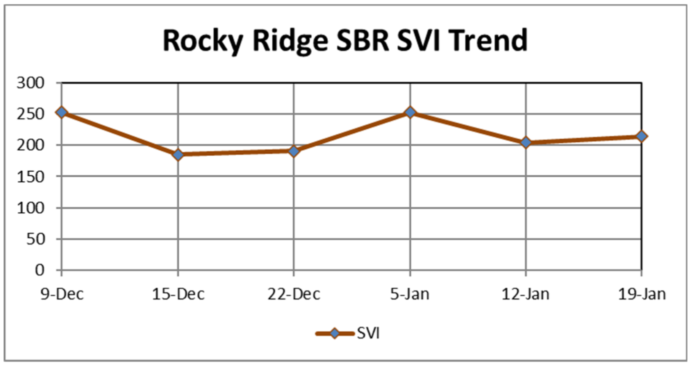
[2] Epidemiology: May 2010 - Volume 21 - Issue 3 - p 389-395 (Nitrate converts to nitrite *in vitro* which becomes nitrosamines, leading to a host of health issues.)

[3] Schullehner J, Hansen B, Thygesen M, Pedersen CB, Sigsgaard T. Nitrate in drinking water and colorectal cancer risk: A nationwide population-based cohort study. Int J Cancer. 2018 Jul 1;143(1):73-79. doi: 10.1002/ijc.31306. Epub 2018 Feb 23. PMID: 29435982.

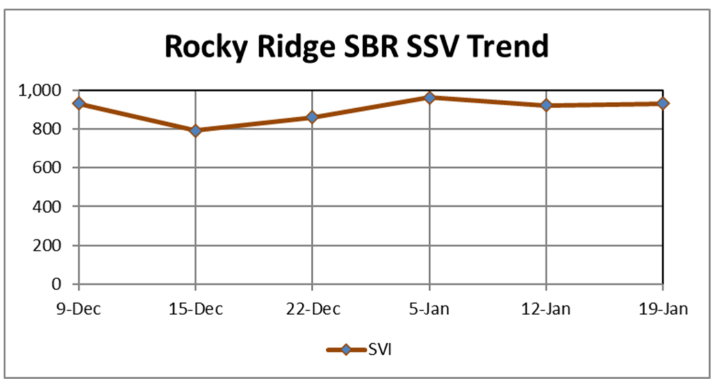
[4] Epidemiology: July 2004 - Volume 15 - Issue 4 - p S184; The Lancet, Volume 14, 100286, March 1, 2022

Process Monitoring:

During the evaluation, DEP staff conducted routine process monitoring tests during most weekly visits. It was observed that operations staff was performing minimal process monitoring on site and that the facility relies mainly on settleability testing and some colorimetric testing for nitrogen. Recommended process monitoring tests are listed in Attachment F. Updates of probe and laboratory outputs were regularly sent by email to Portland Contractors, with discussions by phone or on site, in person. During the evaluation, DEP staff conducted weekly monitoring tests for solids-by-volume, sludge settleability, nutrient testing, and microscopy. The solids-by-volume test using a centrifuge allows the operator to determine solids in fifteen minutes instead of using the two-to-three-hour gravimetric test on filtered samples.[5]



The purpose of the portable laboratory that DEP deploys is to allow plant operators to learn process monitoring tests; however, at Rocky Ridge, visits by the operators and by DEP staff seldom coincided. A full battery of tests may easily occupy two to three hours of an operator's time, and this is not usually possible given contract time limits. Nevertheless, DEP staff observed that limited routine testing allowed the SBR process to operate inefficiently and unpredictably. High solids concentrations meant that sludge settleability was impaired, and sludge volume indices were typically more than the recommended value of 100 for activated sludge treatment. Staff also observed that the facility went through long periods of sludge settling that, while assuring that supernate was produced even during periods of reduced settleability, overall sludge quality was reduced.



Given the low loading and the high solids concentrations, the SBR would be operating in an extended aeration, low Food-to-Mass ratio condition. One would expect that 30-minute settleability, a measure of how well the solids settle in preparation for decanting (and more importantly, that solids should settle below the range of the decant mechanism,) to be in the 400 ml/cc range. Here, during the evaluation, settled sludge volume remained high at thirty minutes.

[5] This is the Albert West Method that has been around since the early 1970s. A correlation between volumetric and gravimetric testing may be done periodically to determine a weight-to-concentration ratio (WCR) that assigns a concentration value to each 1% of volumetric solids. The West Method originally posited that 1% = 1,000 mg/L. WCR factors in variability caused by density effects of sludge age, and the value used at Rocky Ridge was 860 mg/L for every 1%. Thus, sludge volume index (SVI) could be calculated from the settleability and the centrifuge tests.

Causes for poor settleability are 1) excessive solids concentration, or 2) presence of filamentous bacteria and their exogenous polysaccharide slime. In low loading conditions such as at Rocky Ridge, one may expect to find Nocardia in the mixed liquor. But this did not appear to be the case: sludge settling was impacted here by high solids concentration. This is usually the result of not wasting sludge often enough.

It was found by the operators that the decant and the wasting pumps were not working correctly and had been impacted by trash and detritus fouling the impellers. Pumps were replaced in January, allowing for improved solids control.

DEP staff also ran water chemistries for alkalinity, nutrients, ammonia, and chemical oxygen demand.[6] These tests are used to check the probe performance. For example, the ammonia probe when placed in mixed liquor instead of clear water tends to read high due to "matrix interferences," or the collective effects of other material in the bioreactor. Although not analytically precise, the ammonia probe is useful in this case for trending: is ammonia increasing, holding steady, or decreasing with time.

For most of the study, ammonia-nitrogen tests on the effluent showed that the facility nitrified very well. Results ranged from 0.3 mg/L to 1.0 mg/L. Raw wastewater ammonia-nitrogen tested between 20 and 40 mg/L. In the mixed liquor, where raw wastewater ammonia would have been present, the ammonia probe ranged from 1 mg/L to 7 mg/L, with a spike to 21 mg/L around New Year when the facility suffered a blower failure that required drive belts to be replaced. Correspondingly, mixed liquor nitrate during that ammonia spike was very low, because ammonia was not being oxidized.

Nitrite, an intermediate product of nitrification, tested below 0.2 mg/L, indicating that nitrification was working well.[7] This is one of the benefits of having the bioreactor installed below grade and protected by a large structure: temperature variations in winter are not drastic at Rocky Ridge, maintaining mixed liquor well above the five-degree Celsius temperature limit where nitrification usually fails.

Influent phosphorus ranged from 6 mg/L to 14 mg/L, depending on the volume and dilution of the wastewater in the surge tank. Effluent phosphorus test results range from 0.9 mg/L to 5 mg/L. Phosphorus discharged to groundwater is not as significant a problem as nitrate, but

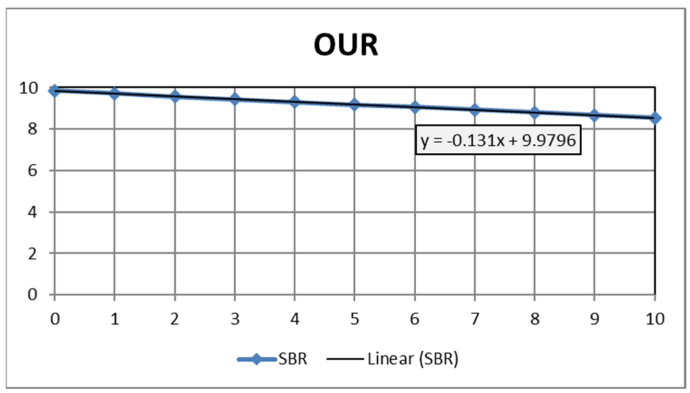
[6] DEP used the Hach TNT-Plus chemistries, colorimetric analyses quantified using a spectrophotometer. These tests were chosen for relative ease of use and for rapid quantification.

[7] Nitrite is the intermediate product of nitrification formed by ammonia-oxidizing bacteria (AOB). In facilities that disinfect effluent using chlorine or hypochlorite, high nitrite concentrations will inhibit disinfection by rapidly forming chloramines, resulting in high fecal coliform counts. Since Rocky Ridge STP discharges to drain fields, this is not a problem; however, testing for nitrite is also diagnostic for potential problems with nitrification. For example, AOB acidify the mixed liquor, lowering pH. If pH drops too low, below 7 generally and 6.5 in particular, nitrification is inhibited to the point of stopping altogether.

because phosphorus is a nutrient required by the biomass for growth and efficient wastewater treatment, it is worth monitoring.

Tests and probe output for pH of the mixed liquor showed that it generally remained between 6.5 s.u. and 7.2 s.u. Nitrification is sensitive to pH. The biological process yields an acid as a byproduct, which in the absence of sufficient alkalinity may cause nitrification to stop below 6.5 s.u. Ideally, the mixed liquor should be buffered with alkalinity to between 7 s.u. and 8 s.u. Testing showed that alkalinity was on the low-end of adequate. The recommended concentration for alkalinity as calcium carbonate is 100 mg/L. At Rocky Ridge, the effluent alkalinities were mostly in the 90 to 100 range. pH in the bioreactor tended to be lower, though. Sometimes, it may be necessary to add alkalinity in the form of lime or bicarbonate to increase the buffering capacity. At Rocky Ridge, nitrification sometimes appeared to be on the edge of failing, although it did not, except for the blower outage. In Attachment G, there is a discussion on how to calculate a facility's alkalinity demand and dose, based on tests of the ammonia-nitrogen in the raw wastewater.

Phosphorus tests ranged from 1 mg/L to 5 mg/L for the effluent samples tested. Because of the mound discharge, there is no limit on phosphorus at this facility.



Oxygen uptake rate testing was done on fresh mixed liquor samples. Generally, this diagnostic test provides information that may be confirmed by other process monitoring tests. At Rocky Ridge, OUR test results, and calculated respiration rate results, showed that the facility tends to be underloaded or overaerated. Influent testing for organics and solids showed that the waste stream can be very concentrated; however, flows to the facility during the period averaged about ten to twelve thousand gallons per day, about half of design flow. The TOC probe, measuring an analog of biochemical oxygen demand, averaged 160 mg/L over the entire evaluation.

For a period between November and December, where flow averaged 9,400 gallons per day, the organic loading may have been about 18 lb./day. During onsite activities, the flow averaged about 12,000 gpd but the organic loading was lower, at 12.3 lb./day, which may indicate presence of inflow or infiltration (I/I) in the collection system. The facility is rated for 22,000 gpd and an organic loading of 44 lb./day. Approximately 28% to 41% percent loading was occurring.

Microscopy notes show that the mixed liquor contained decent amounts of crawling and stalked ciliates, moderate numbers of rotifers, some free-swimming ciliates, no nematodes and few amoeboids as indicator organisms. This suggests that the biomass had a mature sludge age, probably in the extended aeration, low F/M range. There were no filamentous bacteria initially, although some were present moving into January, although they appeared to die off after the aeration blower failed during New Year's week.

General Facility Operation

Operation of the SBR portion of the treatment facility requires investments of time, money, and labor to produce a quality effluent. In this case, the facility permit defines quality effluent has having total nitrogen of less than ten milligrams per liter, among others, all listed in the Attachments, following. Typical ammonia concentrations in domestic wastewater range in thirty- to forty mg/L range. Some nitrogen is used by bacteria to make amino acids and proteins, but most ammonia and organic nitrogen in the wastewater is converted to nitrate. A facility not attempting to remove nitrate would expect about the same concentration of nitrate in the effluent as ammonia in the raw wastewater.

Suspended growth systems, activated sludge, itself requires the operator to marshal optimal conditions for growth and reproduction to successfully treat wastewater. Achieving and maintaining a healthy biomass requires ongoing attention and expense. As it presently exists, the bioreactor at Rocky Ridge needs serious preventative maintenance. Lack of reliable preliminary treatment to capture and remove trash and debris from the incoming wastewater will continue to cause pump failures and interfere with aeration and decant facilities. Better screening would envision fine-screen trash removal. Use of a comminutor may only create problems with rag material reknitting further downstream, damaging pumps and controls. Accumulations of grease within the bioreactor should be discouraged. Part of this requires educating the sewer system's customers; part of it requires vigilant maintenance. The latter is a question of time and money.

Excessive dissolved oxygen in the bioreactor, due to uncontrolled blower output, can be reduced using instrumentation feedback, as discussed. To optimize denitrification, aeration must be limited to the aerobic cycle. Also needed are sufficient bound oxygen in the form of nitrate and organic carbon as either influent wastewater or as supplemental carbon. If using the latter, the addition of carbon should be restricted by the SBR programming or timers to only the Anoxic Fill period.

Instead of waiting for pumps to fail, personnel should regularly pull pumps to check for rags and detritus, at least until there exists a better way to remove trash from the waste stream.

Although some operators eschew frequent process monitoring testing, such lab work is necessary for understanding how the facility behaves when working as intended, so that awareness anticipates plant upsets through acquired ability to observe and predict operational trends seen in test results. Unfortunately, providing adequate time and resources for good process monitoring is an expense that must be budgeted.

It is recommended that sampling of influent and effluent for compliance testing by an outside laboratory be done using 24-hour automated composite samplers. The manually composited, 8-hour sample is obsolete by today's standards, because it does not effectively characterize all of the flows to and from the facility.

Any facility seeking to successfully control nutrients should develop an operational strategy that encodes best practices in standard operating procedures that may be used by anyone asked to operate the plant. Facilities are designed to be operated at established set points—Food-to-Mass Ratio or Cell Residence Time—under steady-state conditions that may vary seasonally. If Rocky Ridge is sometimes underloaded, it may be necessary to recalculate the operational strategy to meet the present needs of treatment rather than those of a theoretical future. Since incoming waste load may not be controllable, the operator can achieve steady-state conditions through judicious wasting of activated sludge from the process. This requires ongoing attention to process monitoring and control.

The facility owner and operator should have a structured preventative maintenance program to service equipment before problems occur. Such a program entails understanding the equipment in use, maintaining it on schedule, and keeping sufficient spare parts on hand when needed.

While influent alkalinity appears adequate most of the time, there will be periods when additional alkalinity is required for nitrification. Likewise, the operation may require some stockpiling of supplemental carbon for denitrification. Using both will require use of day tanks, mixers, and feed pumps. Attachment G includes information on calculating alkalinity demand based on the total Kjeldahl ammonia (TKN) or just the ammonia-nitrogen loading in the raw wastewater. For each pound of TKN converted to nitrate, approximately 7.2 pounds of alkalinity as $CaCO_3$ are required. Experience has shown that the alkalinity demand of a wastewater in the bioreactor may require concentrations much higher than those usually recommended as final effluent concentrations.[8]

Although not required to file a Municipal Wasteload Management Report, it is suggested that the owner and operator complete the annual Chapter 94 loading spreadsheet and sludge production worksheet that are appended to this report as Attachment H. Doing so provides a planning tool to predict future loading so that treatment capacity is monitored. The operators should characterize the influent wastewater using 24-hour flow-proportioned composite sampling, eschewing 8-hr. manual or automatic composites. Average monthly organic and hydraulic loading should be tracked on the spreadsheet, along precipitation measured on-site or at the nearest airport or weather station. The spreadsheet has programming that will compare the organic and hydraulic loading to the corresponding design values, determining peak loading factors based on operational history. Checking sludge hauling manifests for volume and percent solids will provide information on sludge generation. This can be compared to estimated sludge production based on organic loading in the Chapter 94 spreadsheet or by estimating sludge generation based on population of the community, with the resulting estimate being within 80% to 120% of the sludge hauled offsite in any given year.


View of Corroded Finish on Tank

Condition of the Bioreactor

The PureStream package plant is a self-contained modular steel tank that contains a surge tank (equalization tank,) a bioreactor, and, usually, a sludge holding tank. Portland Contractors informed DEP staff that a steel wall had collapsed in the plant and was removed, thus expanding the bioreactor space while sludge storage was relocated to one of the underground vaults from an earlier treatment

[8] The effluent requirement is usually 100 mg/L as concentration. However, if the influent TKN is 42 mg/L, then the alkalinity demand in the bioreactor will be 302 mg/L. If the average flow is 12,000 gpd, the alkalinity demand will be 30 lb./day. Subtract from this demand the alkalinity already present in the wastewater. For example, if the alkalinity is 250 mg/L, then the native alkalinity is 25 lb./day, meaning that the operator would have to make up a deficit by adding 5 lb./day of alkalinity to maintain healthy nitrifiers.

system. The bioreactor space would have been designed for 22,000 gallons, a day's worth of projected flow. Removal of the wall would have expanded the space previously designated as sludge storage or possibly effluent filtration, raising the capacity to about 30,000 gallons. This would have exacerbated the problems caused by chronic underloading, as the biomass increase would have adversely affected the design Food-to-Mass ratio.

The manufacturer ships these package plants with sacrificial anodes as part of a cathodic protection system to protect against corrosion. The anode, illustrated at the right, is not permanent. It may last up to thirty years, depending on the size of the anode. There is no evidence at Rocky Ridge STP of a preventative maintenance program that would monitor the condition of cathodic protection on the tank. No one at the site knew of the last time the cathodic protection was checked or serviced. No OEM operations and maintenance manual could be located on site for reference.

Sacrificial Anodes

The steel tank also has an epoxy-based finish. At Rocky Ridge, the steel tank may have moderate to severe corrosion. Accumulated corrosion within the package plant begs the question of what is unseen. It may be necessary for the facility engineer to thoroughly inspect the steel tankage for corrosion and repair it.

Another photo shows the sections of wall that had collapsed and had been removed. There is much pitting and corrosion on the steel that may suggest similar damage throughout the tankage that is buried to grade level.

The presence of the enclosing building and the burial of the tank, installed on a concrete pad below grade, has afforded long life to this package plant. Even during winter, the temperature inside the building remains above freezing, although the effects of high humidity are observed in the room.

Removed Tank Divider Sections

The operator expressed some concern that when the steel is refinished, pinholes and leaks may be discovered, requiring patching and other work. Corroded areas will have to be ground to bare steel or sand-blasted prior to refinishing. Overhauling this tankage would also require rental of temporary treatment tanks such as those used in the fracking industry.

Other parts of the overall treatment works may warrant evaluation by the engineer. This could be an opportunity to replace the existing facility with more modern equipment adequately sized to existing and projected loading and better suited to biological nutrient removal.

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ATTACHMENT A: STUDY PARTICIPANTS

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info@cressonpoint.com

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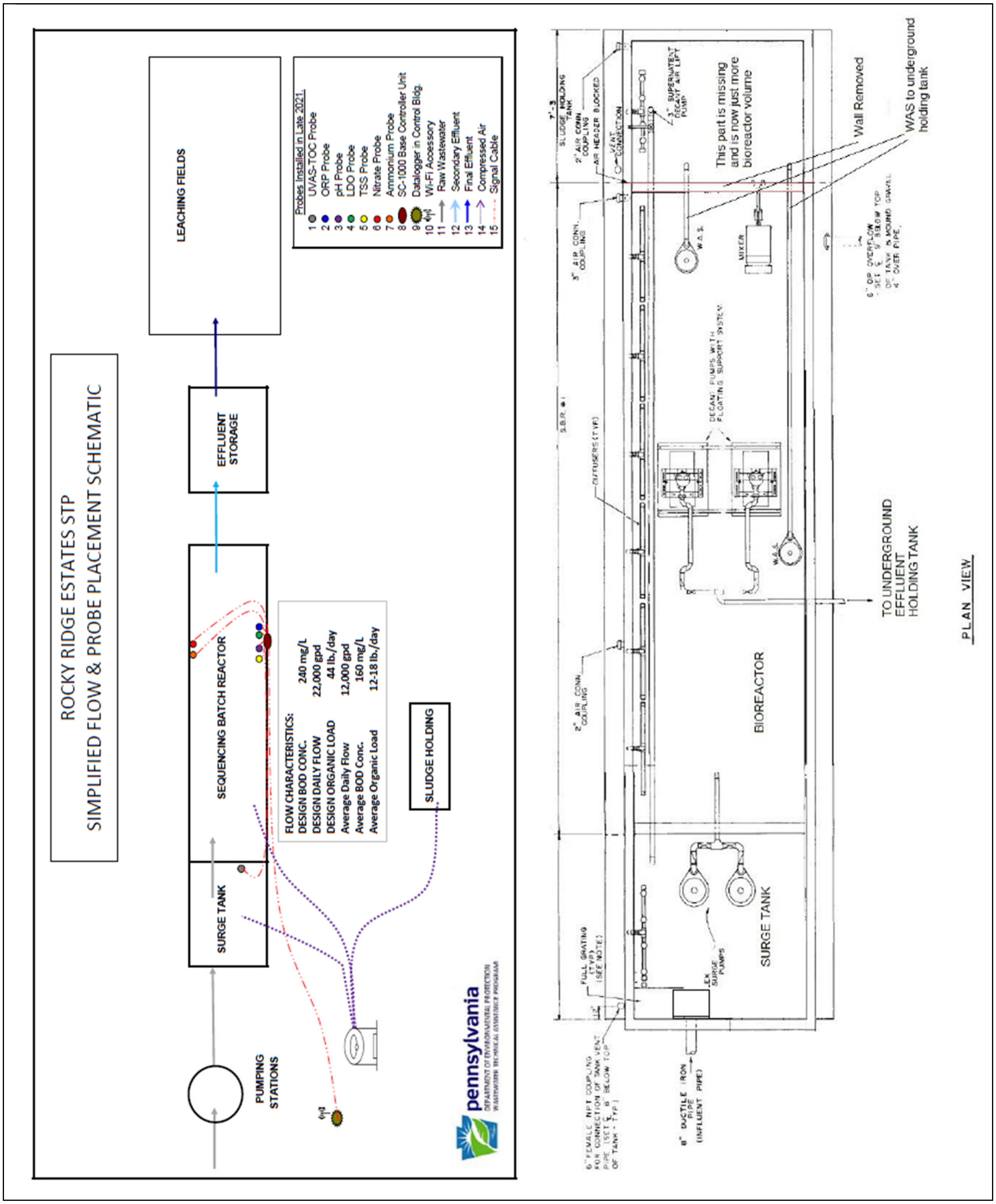
ATTACHMENT B: PROCESS SCHEMATIC & BIOREACTOR PLAN



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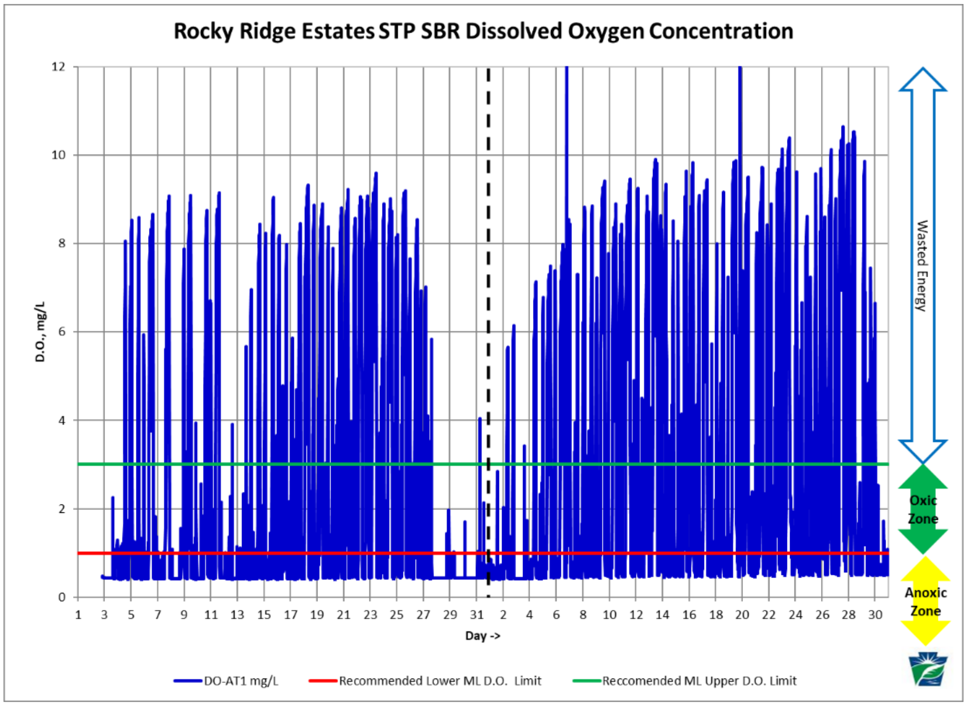
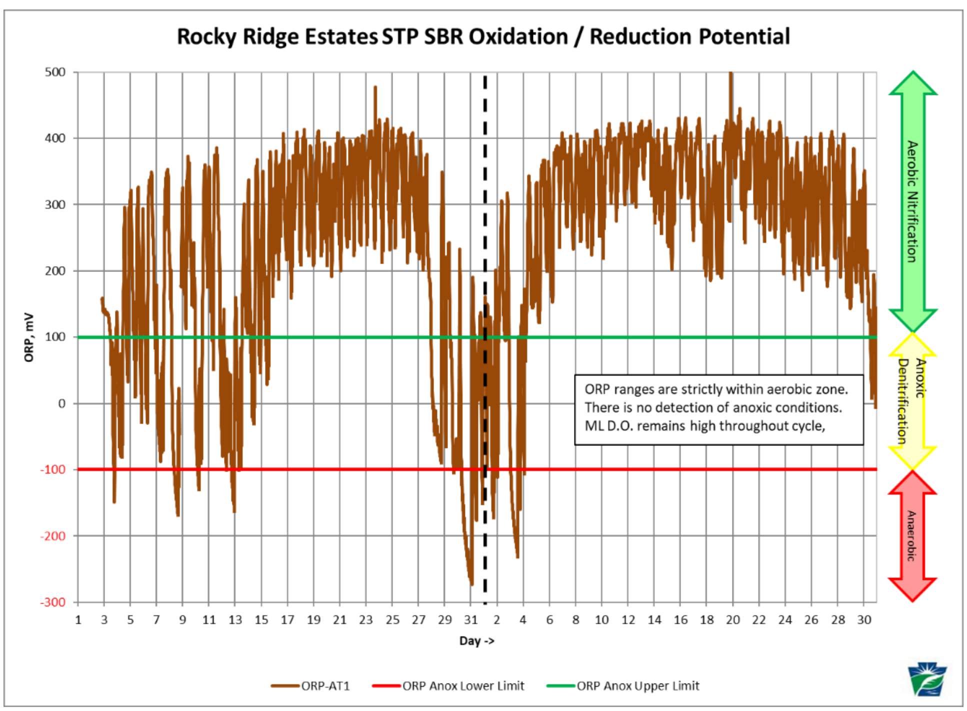
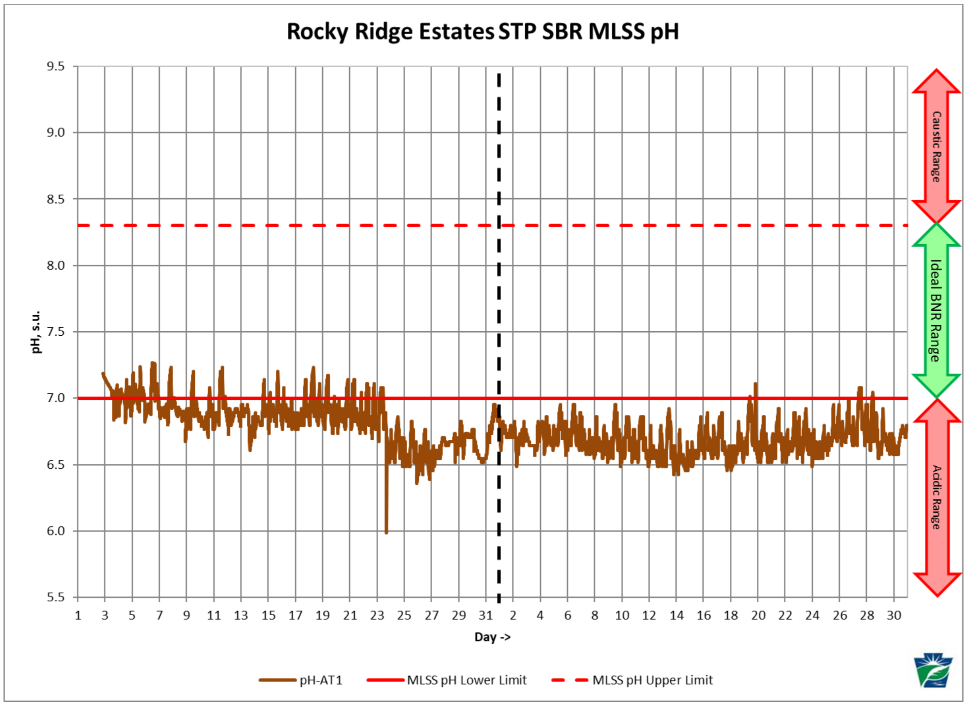
ATTACHMENT C: FULL PERIOD RECORD GRAPHS



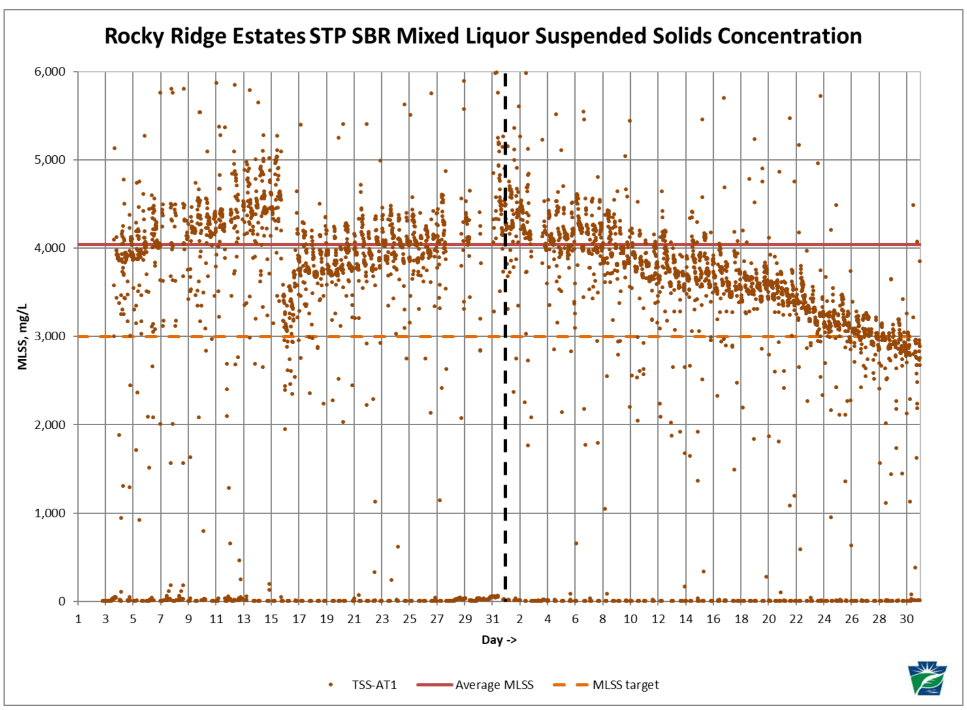
Generally, dissolved oxygen levels are not controlled: DO in excess of 3 mg/L in a BNR oxic process is merely wasted energy; however, high oxygen entering anoxic process serves to “poison” denitrification



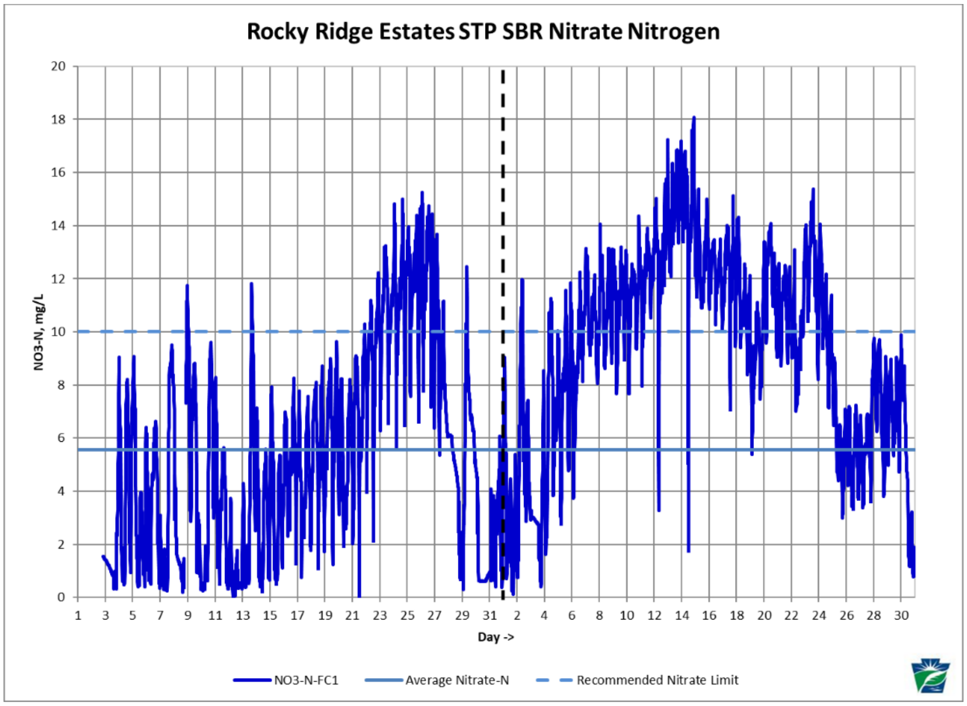
ORP exceeding +100 mV during anoxic treatment (the minimum values on the graph) means that the conditions remain oxic and therefore unfavorable to denitrification. Minimum values less than -100 mV represent non-anoxic anaerobic conditions favoring formation of products of fermentation.



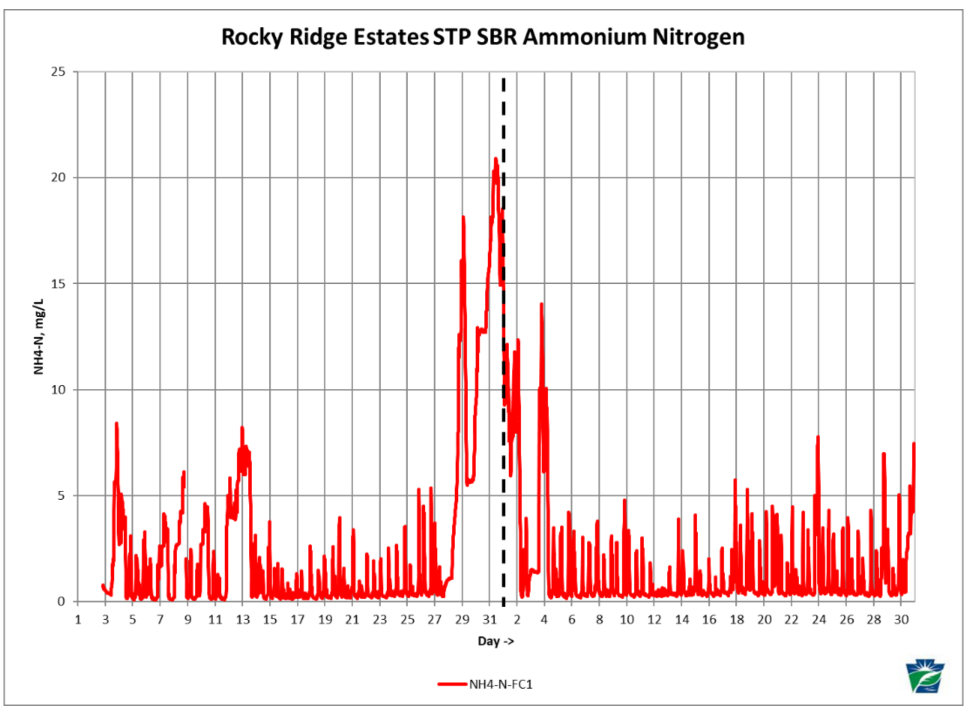
pH values below 7.0 during oxic nitrification demonstrate unbuffered acidification caused by formation of nitrous acid by ammonia-oxidizing bacteria (AOB). If pH drops below 6.5 s.u. during nitrification, the AOB become dormant and nitrification stops. Low pH calls for better regulation of carbonate buffering during oxic processes.



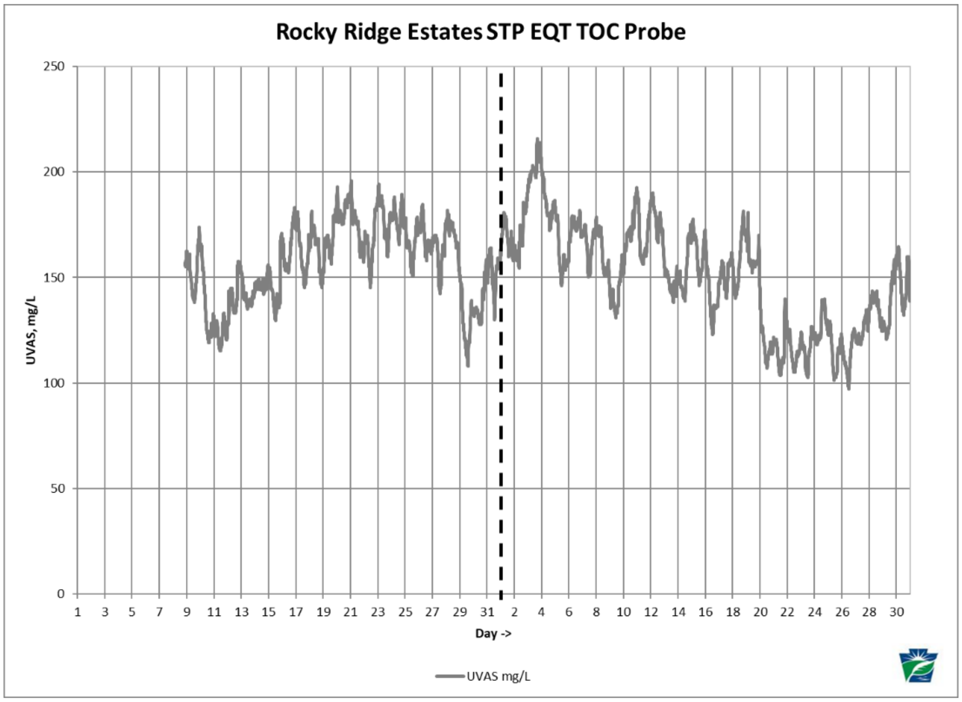
Mixed liquor suspended solids (biomass) is generally too concentrated at this facility, suggesting that sludge wasting may be insufficient. There is not enough incoming organic loading to support this concentration of biomass. Wasting sludge is the only real control the operator has for balancing Food/Mass Ratio.



Nitrate monitoring in the SBR shows that, while some denitrification is taking place, nitrate tends to exceed the recommended 10 mg/L target value for groundwater discharges. The average nitrate during the study period was 5.8 mg/L, but peaks above 10 mg/L occurred frequently. The record shows that nitrate was not being produced during the week preceding New Year 2022 while the aeration blower was non-functional.



Ammonium values in this graph are for trending only. The ammonia peaks between 12/27 and 1/4 represent a period when the aeration blower was out of service and unmonitored, corresponding to the lack of nitrate formation in the preceding graph.



The total organic carbon (TOC) probe monitors the raw wastewater surge tank for slug loads and for general diurnal effects. Calibrated to represent five-day biological oxygen demand (BOD5), this record reflects a dearth of organic loading, averaging 159 mg/L for the period, with a maximum of 196 mg/L. In terms of loading, based on average daily flow of c. 10,000 gpd during the period, the average daily organic load was 12.3 lb./day, just 28% of the design daily load at 44 lb./day.

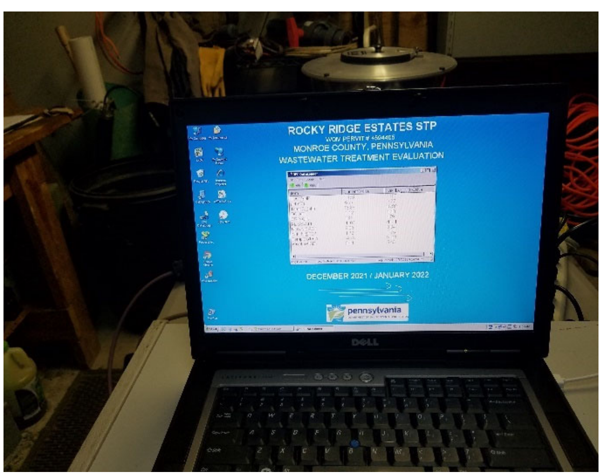
ATTACHMENT D: RECORD PHOTOGRAPHS


TOC Probe at Surge Tank


Set of Six Probes in Bioreactor


Tankside Controller & Probes

Probe Controller & Data Server



Data-logging Computer


Supplemental Carbon Day Tank

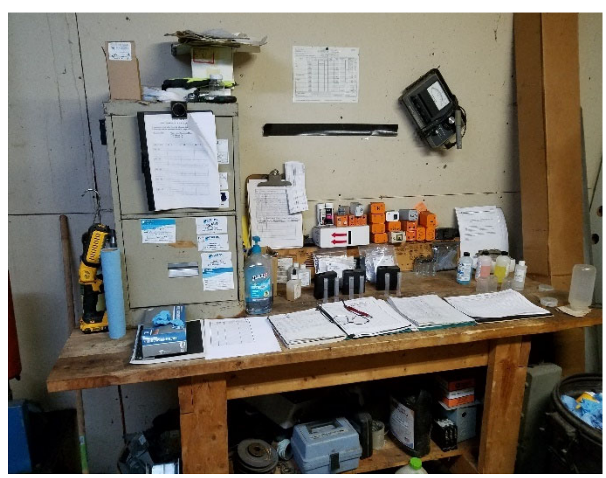

View of SBR Bioreactor


Surge Tank Lift Pumps & UVAS Probe


Effluent Storage


Leach Fields

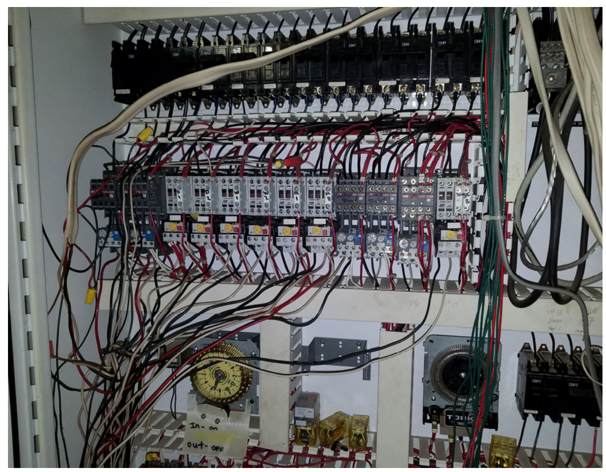

Unreliable Bar Rack


Operator’s work space & test kits

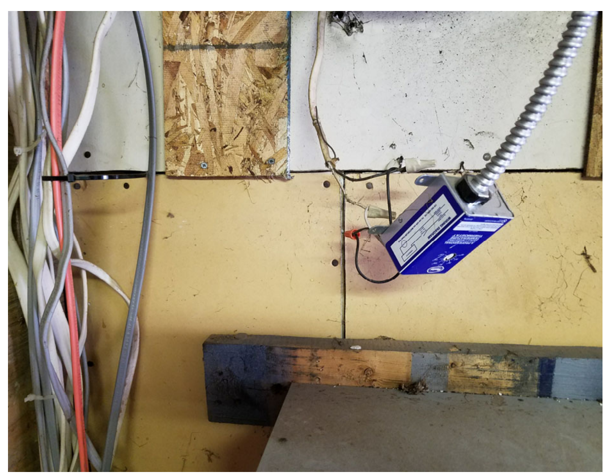

Decant Pumps & Nocardia Foam


Surge Tank showing corrosion


Aeration Blowers


Inside of Control Panel


Melted 120 VAC Receptacle


Dodgy Wiring in Control Bldg.

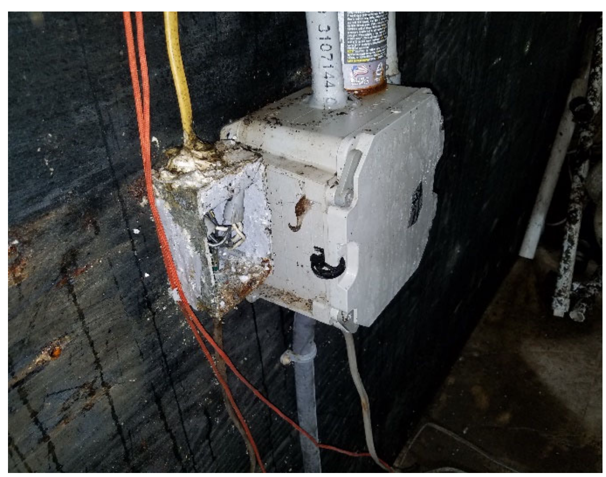
Dodgy Wiring, cont'd.

Unsecured Lid Assemblies in yard

Unsecured pipe in yard

Open junction box in SBR building

Open junction box in SBR building



Open junction box in SBR building

ATTACHMENT E: WATER QUALITY MANAGEMENT PERMIT

3800-PM-WSFR0015 1/2011
Permit

pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF POINT AND NON-POINT SOURCE MANAGEMENT

WATER QUALITY MANAGEMENT PERMIT

PERMIT NO. 4594405-T1
AMENDMENT NO.______
APS ID. 850645
AUTH. ID. 1038977

A. PERMITTEE (Name and Address): CLIENT ID#: 298023
Cresson Point Properties, LLC
P.O. Box 53
Ashfield, PA 18212

B. PROJECT/FACILITY (Name):
Rocky Ridge MHP

C. LOCATION (Municipality, County): SITE ID#: 446488
Middle Smithfield Township, Monroe County

D. This permit approves the operation/transfer of sewage facilities consisting of:
A Sequencing Batch Reactor (SBR) wastewater treatment facility discharging effluent to seven (7) sand mound treatment beds.

Pump Stations: ____	Manure Storage:	Sewage Treatment Facility:		
Design Capacity: ____ GPM	Volume: ____ MG	Annual Average Flow:	0.022	MGD
	Freeboard: ____ Inches	Design Hydraulic Capacity:	0.022	MGD
		Design Organic Capacity:	44	lb/day

E. APPROVAL GRANTED BY THIS PERMIT IS SUBJECT TO THE FOLLOWING:

1. Transfers: Water Quality Management Permit No. 4594405 dated September 12, 1995 and conditions, supporting documentation and addendums are also made part of this transfer.
2. Permit Conditions Relating to Sewerage are attached and made part of this permit.
3. Special Conditions 1-7 are attached and made part of this permit.

F. THE AUTHORITY GRANTED BY THIS PERMIT IS SUBJECT TO THE FOLLOWING FURTHER QUALIFICATIONS:

1. If there is a conflict between the application or its supporting documents and amendments and the attached conditions, the attached conditions shall apply.
2. Failure to comply with the rules and regulations of DEP or with the terms or conditions of this permit shall void the authority given to the permittee by the issuance of this permit.
3. This permit is issued pursuant to the Clean Streams Law Act of June 22, 1937, P.L. 1987, as amended 35 P.S. §691.1 *et seq.* Issuance of this permit shall not relieve the permittee of any responsibility under any other law.

PERMIT ISSUED: October 23, 2014

BY: /s/

TITLE: Michael J. Brunamonti, P.E.
Clean Water Program Manager
Northeast Regional Office

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ATTACHMENT F: RECOMMENDED MONITORING TESTS & FREQUENCIES

PROCESS CONTROL TESTS FOR DOMESTIC WASTEWATER TREATMENT FACILITIES

Activated Sludge Facility: Conventional, Complete Mix, Step Feed, or Extended Air
Less than and including 1.0 MGD (Page1 of 1)

SAMPLE PARAMETER	SAMPLE LOCATION	SAMPLE TYPE	3/WEEK	1/WEEK	2/MONTH
Raw Influent*					
BOD_5 and/or COD	Influent	Grab			X
TSS/VSS, NH_3-N, and pH	Influent	Grab			X
* Frequency of sampling may need to be increased or decreased depending on plant size or conditions.					
Aeration Basin					
MLSS/MLVSS (or centrifuge, with correlated data from periodic MLVSS values)	RAS line and effluent	Grab			X
Dissolved oxygen	Effluent	In situ		X	
Settleability (SV30)	Effluent	Grab	X		
pH	Effluent	Grab		X	
Microscopic examination	Effluent	Grab			X
Computation of SVI, F/M ratio, sludge age, and/or MCRT, as desired	Effluent	—	As data collected		
Secondary Clarifier					
Sludge blanket depth	As appropriate	In situ		X	
Final Effluent					
Parameters, sample types, and frequencies as required by permits.					

The table reproduced above lists suggested sampling frequencies for facilities of capacity up to 1.0 MGD. This represents the minimum monitoring requirements; however, experience suggests that process monitoring tests be performed more frequently when a facility is experiencing any changes. These changes include any process changes made by the operators and any changes due to unavoidable circumstances, such as slug loading or equipment service interruptions. Generally, the higher the level of treatment, the more process control testing is necessary. For example, denitrification operations require additional process monitoring when compared to nitrification operations.

A solids-by-volume centrifuge test may be an adequate, quick substitute for the gravimetric total suspended solids test. The centrifuge test does in 15 minute what otherwise takes up to four hours. If used, centrifuge solids tests are done more frequently and are backed up with gravimetric solids tests done monthly at an outside lab to maintain centrifuge calibration (Weight-to-Concentration Ratio, or WCR.) Microscopy, Settleability, and water chemistry should be done on the mixed liquor at least twice per week until the operators have reasonable understanding of a 4-season set of reference data to which they may refer in future years. Whenever process or treatment methods change, the test data set would need to be reproduced. Also, whenever the facility experiences plant upset conditions more frequent process-monitoring and control testing should be performed by the operators, until conditions stabilize.

Process Monitoring testing is often not the same as those performed by contract laboratories in that approved test methods are not utilized. Compliance testing refers to those analyses used by certified laboratories for reporting parameters required by the NPDES permit. Over the years, many small treatment facilities began to contract compliance testing to certified environmental laboratories. This eased the burden on operators, and it saved the facility owner the cost of maintaining certification of its own laboratory. However, over time, many facilities ceased to perform regular process monitoring tests, as well. It is important for operators to know the condition of their facilities, the sludge solids inventory, and the qualities of the treatment solids (i.e., quantity and quality of "bugs") to effectively optimize operations.

DEP's WWTAP has adopted the process monitoring tests recommended by US-EPA and the professional trade organization, Water Environment Federation (WEF.) These tests include the following:

- Centrifuge solids test: percent volume/volume measurement of activated sludge solids for activated sludge-type plants: Calculations stemming from this data include solids inventory (expressed as "sludge units" (SLU).)
- Clarifier blanket level: a core-sampling of the clarifier contents provides a proportional quantity of mixed liquor and supernatant that can be used for developing awareness of how much mixed liquor is detained in the effluent clarifier, representing part of the overall sludge inventory.
- Settleometry test: 30- and 60- minute activated sludge settling rates in wide half-gallon or 1-liter, calibrated vessels: Settled sludge volume (SSV) is expressed in standard 30-minute intervals and used to calculate Settled Sludge Concentration (SSC) which is a qualitative measure of how well the activated sludge settles in the clarifier, mimicking clarifier performance in terms of supernatant quality as well. Using WCR, it is also possible to calculate and track Sludge Volume Index (SVI).
- Oxygen Uptake Rate (a.k.a. Soluble Oxygen Uptake Rate): By measuring the rate of dissolved oxygen depletion in a sample of mixed liquor, one may demonstrate the relative effect of BOD loading on the biomass, how quickly this material will be metabolized by the activated sludge organisms. Expressed in "milligrams Oxygen per hour," when mixed liquor volatile suspended solids concentration is known or can be extrapolated, then one may determine the actual Respiration Rate, in mg. Oxygen per hour per gram of activated sludge. OUR and RR are also useful for comparing the relative health of the biomass under toxic conditions, should there be undesirable contaminants in the raw wastewater, or anoxic conditions, should the aeration be insufficient to treat the incoming waste load using the available amount of oxygen.
- Raw Wastewater and Effluent Chemical Oxygen Demand (COD): an analog of the 5-day Biochemical Oxygen Demand test, COD can be determined in about three hours and give operators a quick assessment of relative strength of wastewater and/or the amount of material remaining in treated effluent, thereby providing an analog of treatment efficiency.
- Nutrient Tests: A portable wastewater laboratory provided during the WTE consists of materials for conducting various colorimetric analyses for nutrients such as ammonia-nitrogen, nitrite, nitrate, organic nitrogen, phosphorus, etc. to determine whether the facility is removing or treating nutrients. For process monitoring purposes, nutrient test strips provide ample, low-cost, low-trouble test results. They are available in most supplier catalogs (USA Blue Book, Hach, Grainger, et al.)
- Alkalinity testing to determine the buffering capacity of the mixed liquor or the final effluent.

The objective of all this testing is to develop a unique profile for the facility useful in developing operations trends, showing conditions that become predictive of how the facility responds to various beneficial or adverse conditions that could affect effluent quality and treatment efficiency. Once sufficient data exists, operators should have a cogent understanding of how the facility responds to process adjustments and what they must do to maintain it in good condition.

Typically, operators should determine an overall treatment strategy for their facility, using standard industry calculations for:

- Food to Mass Ratio (F/M)
- Mean Cell Residence Time (MCRT)
- Sludge Age or Dynamic Sludge Age

These values can be determined using the equipment described above. These calculations provide set-points unique to the facility that can be adjusted either through changes in sludge wasting rates or aeration capacity, assuming that the concentration of waste in the wastewater is a variable that operators cannot control.

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ATTACHMENT G: CALCULATING ALKALINITY DEMAND

Typically, alkalinity in effluent should be 50 mg/L or match that of the receiving stream; however, because of bioavailability of alkalinity at the pH range needed by nitrifying bacteria, this concentration should be higher in the Aeration Tanks, 100 mg/L up to 220 mg/L.

Alkalinity demand should be calculated. Since each 1 mg/L of ammonium in the secondary influent requires 7.14 mg/L alkalinity as $CaCO_3$[9], multiply the influent (or raw) TKN (total Kjeldahl nitrogen, which is organic nitrogen and ammonium nitrogen, combined)[10] concentration in mg/L X 7.14 mg/L alkalinity to determine a minimum amount of alkalinity needed for ammonia removal through nitrification. Then determine the influent alkalinity concentration already present and subtract this from the alkalinity demand you just calculated for your influent ammonium.

Example:
32 mg/L Influent TKN x 7.14 mg/L alkalinity per 1 mg/L TKN = 228 mg/L alkalinity required

If the secondary influent already has 56 mg/L of alkalinity, then the net alkalinity demand is:

228 mg/L alkalinity needed to treat – 56 mg/L alkalinity in Influent = 172 mg/L alkalinity demand

To convert this to an actual chemical dose, you will have to multiply the net demand concentration by the Influent flow rate:

If the average flow is 0.035 MGD, then the amount of alkalinity required would be

172 mg/L x 0.035 MGD x 8.34 lb./gal = 50 lb./day.

To convert this to a chemical dose, you will have to determine the available alkalinity in the chemical. For example, 1 lb. hydrated lime has 0.74 lb. alkalinity[11]. This means that to provide 50 lb./day alkalinity as $CaCO_3$, you need to divide this by the ratio of chemical to alkalinity:

50 ÷ 0.74 = 68 lb./day of hydrated lime

Figure adding 1-½ fifty-pound bags added over 24 hours, not all at once. Using the 100-gallon day tank, the feed rate would be

75 lb./day ÷ 24 hours = 3-1/8 lb./hr. (100 gal. per day = c. 4.2 gal./hr.)

Keeping track of the alkalinity demand over time should help when determining the size and capacity of the chemical feed pump and the size of the line needed.

---

[9] To account for bioavailability of alkalinity at the desired MLSS pH of 7.2 to 7.5, substitute 8 mg/L for 7.14 mg/L. This increased the alkalinity required but is also more realistic, since 7.14 mg/L is the **minimum** required.

[10] If you can't test for TKN, substitute a test for ammonia-nitrogen and multiply the result by 1.25 to approximate the combination of organic nitrogen and ammonium nitrogen, together.

[11] See the table on the next page.

Supplemental Alkalinity Buffering Compounds

Compounds	**Alkalinity-Ratio, ppm/ppm $CaCO_3$**
Soda Ash	1.06
Acetate	0.82
Hydrated Lime	0.74
Quick Lime	0.56
Bicarbonate	1.68
Caustic soda	0.80
Magnesium hydroxide	0.50

ATTACHMENT H: CHAPTER 94 LOADINGS WORKBOOK & SLUDGE GENERATION WORKSHEET

Following are hyperlinks to DEP's Chapter 94 Loadings Workbook and the Sludge Generation Worksheet:

Loadings: Chapter 94 Workbook

Sludge Generation: Operator Tools

Chapter 94 Workbook, Loadings Worksheet:

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PADEP Chapter 94 Spreadsheet
Sewage Treatment Plants

		Reporting Year:	
Facility Name:		**Permit No.:**	
		Persons/EDU:	3.5

Existing Hydraulic Design Capacity:		MGD		**Existing Organic Design Capacity:**		lbs BOD5/day	
Upgrade Planned in Next 5 Years?		**Year:**		**Upgrade Planned in Next 5 Years?**		**Year:**	
Future Hydraulic Design Capacity:		MGD		**Future Organic Design Capacity:**		lbs BOD5/day	

Monthly Average Flows for Past Five Years (MGD)

Month					
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
Annual Avg					
Max 3-Mo Avg					
Max : Avg Ratio					
Existing EDUs					
Flow/EDU (GPD)					
Flow/Capita (GPD)					
Exist. Overload?					

Monthly Average BOD5 Loads for Past Five Years (lbs/day)

Month					
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					
Annual Avg					
Max Mo Avg					
Max : Avg Ratio					
Existing EDUs					
Load/EDU					
Load/Capita					
Exist. Overload?					

Projected Flows for Next Five Years (MGD)

New EDUs					
New EDU Flow					
Proj. Annual Avg					
Proj. Max 3-Mo Avg					
Proj. Overload?					

Projected BOD5 Loads for Next Five Years (lbs/day)

New EDUs					
New EDU Load					
Proj. Annual Avg					
Proj. Max Avg					
Proj. Overload?					

Show Precipitation Data on Hydraulic Graph?

Total Monthly Precipitation for Past Five Years (Inches)

Month					
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

Illustration only, not an automated worksheet: Use hyperlinks to download this workbook.

Sludge Generation Worksheet:

Solids Management (Sludge) Calculator

This worksheet calculates the expected sludge volume that should be produced by various treatment processes over a one-year period. Enter data into green cells - hit the Tab key to move between cells. Red cells are calculated.

Facility Name: ____ Permit No.: ____

Enter Date *Enter Date*

Evaluation Period: ____ to ____

Design Flow: ____ MGD Actual Annual Average Flow: ____ MGD

Type of Biological Treatment Process: ____ Treatment Factor: ____

Type of Digestion Process: ____ Digestion Factor: ____

Total Population Served by Treatment Plant: ____

Average Annual Influent BOD5 Load (per Ch. 94 Report): ____ lbs/day

Average Annual Influent BOD5 Load (Expected based on Population): ____ lbs/day *(Population x 0.17)*

% of Influent BOD5 Load per Ch. 94 Report / Influent Load Expected: ____ *(Influent Load per Ch. 94 Report / Influent Load based on Population)*

Average Annual Effluent Concentration of ____ : ____ mg/L

Average Annual Pounds (lbs) of BOD5 Discharged: ____ lbs/day *(Actual Flow x Effluent BOD5 Concentration x 8.34)*

Influent BOD5 Load per Person per Day (based on Ch. 94): ____ *(Influent BOD5 Load per Ch. 94 Report / Population - 0.17 to 0.22 is typical)*

Pounds of BOD5 Removed (based on Ch. 94): ____ lbs/day *(Influent BOD5 Load per Ch. 94 Report - BOD5 Discharged)*

Pounds of BOD5 Removed (based on Population): ____ lbs/day *(Influent BOD5 Load Expected based on Population - BOD5*

Sludge Removed from Treatment Plant (Previous Year): ____ Dry Tons = ____ Dry lbs

Sludge Production and Wasting Calculations

	Based on Chapter 94 Report		*Based on Population*
	BOD5 Removed / Day (lbs)		BOD5 Removed / Day (lbs)
X	Treatment Factor	X	Treatment Factor
	Daily Solids Production (lbs)		Daily Solids Production (lbs)
X	Digestion Factor	X	Digestion Factor
	Daily Digested Solids (lbs)		Daily Digested Solids (lbs)
X 365	Days per Year	X 365	Days per Year
	Solids Generated / Year (lbs)		Solids Generated / Year (lbs)
-	Solids Actually Wasted / Year (lbs)	-	Solids Actually Wasted / Year (lbs)
	Difference (lbs)		Difference (lbs)
	% of Expected Volume Wasted *(85 - 115% is generally acceptable)*		% of Expected Volume Wasted *(85 - 115% is generally acceptable)*
	Percent Solids of Wasted Solids		Percent Solids of Removed Solids
	Volume of Solids to Remove Annually (gallons)		Volume of Solids to Remove Annually (gallons)
-	Volume of Solids Actually Removed Annually (gallons)	-	Volume of Solids Actually Removed Annually (gallons)
	Difference (gallons)		Difference (gallons)

Illustration only, not an automated worksheet: Use hyperlinks to download this workbook.

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