WASTEWATER PLANT PERFORMANCE EVALUATION

April -- May, 2010

Frackville Area Municipal Authority
Frackville Sequencing Batch Reactor Facility

NPDES #PA0062219

Bureau of Water Standards & Facility Regulation
POTW Optimization Program

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Table of Contents

1 Optimization Report 1-1
1.1 Receiving Stream 1-2
1.2 Operational Strengths........ 1-3
1.3 Focus Points for Improvement:........ 1-3
1.4 Design/Process changes to consider: 1-6
1.5 WPPE Rating: 1-7
1.6 Re-evaluation: 1-7
2 Downstream Water Treatment 2-1
2.1 FPPE Review— 2-1
2.2 Water Chemistry— 2-3
2.3 Waterborne Pathogen Discussion— 2-4
2.4 Effect of TMDL on Ashland Water Filtration Plant 2-5

Attachments

Attachment A—Program Description
Attachment B—Frackville WPPE Team
Attachment C—Plant Description and Treatment Schematic
Attachment D—2010 Process Monitoring and Control Data and Discussion
Attachment E—Equipment Deployed
Attachment F—Equipment Placement Photos
Attachment G—Continuous Digital Monitoring Charts and Histograms
Attachment H—Pathogen Test Results (Method 1623 for *Giardia* and *Cryptosporidium*)
Attachment I—Process Monitoring Tests: Example WPPE Daily/Weekly Bench Data
Attachment J—Graphs: Process Monitoring Test Results
Attachment K—Tables of Sample Data from Bureau of Labs Testing
Attachment L—Recommended Process Control Tests, Observations, and Calculations
Attachment M—SBR-specific Process Control Issues
Attachment N—NPDES Effluent Discharge Limits
Attachment O—Biosolids Production Worksheet
Attachment P—Example Chesapeake Nutrient Reduction Worksheet
Attachment Q—Dissolved Oxygen Profile for ICEAS Basin 2

THIS PAGE INTENTIONALLY LEFT BLANK

1 Optimization Report

In early 2009, DEP staff asked the Chief Operator and staff of Frackville Area Municipal Authority's (FAMA) Frackville wastewater treatment facility to participate in a Wastewater Plant Performance Evaluation (WPPE), a new program that seeks to optimize effluent quality through process monitoring and control. The WPPE program is currently funded under an Environmental Protection Agency (EPA) grant for studying the effect of process optimization on the reduction of dangerous waterborne pathogens found at drinking water treatment facilities within a ten-mile distance downstream from municipal wastewater plant discharges. DEP staff employed continuous-recording nutrient and water chemistry probes and a portable wastewater laboratory to effect process optimization, following an initial evaluation of the candidate facilities.

On-site activities for the WPPE took place during April and May of 2010. DEP staff installed both the continuously monitoring digital probes and portable wastewater laboratory during the final week of March and began automatically collecting data recorded at fifteen-minute intervals, downloading probe data to a notebook computer set up in the facility's motor control center in the building that houses the centrifugal blowers. In addition, staff conducted a variety of process monitoring tests when on-site. This data generally confirmed the data already being recorded by plant staff in their process monitoring activities, and DEP staff also obtained aqueous samples from different sampling points in the treatment process on a weekly basis, delivering the samples to PA-DEP's Bureau of Laboratories facility in Harrisburg for supplemental routine analysis and to calibrate the digital instruments. Generally, staff attended the site two or three days per week during the WPPE. Specific sampling required under terms of the study grant was undertaken on three occasions, where 10-liter samples of final effluent, background receiving stream, and impacted surface waters downstream were analyzed using EPA Method 1623 for waterborne pathogens *Cryptosporidium* oocyst and *Giardia lamblia* cyst, two species of particularly noxious drinking water pathogens which must be removed by downstream potable water filtration facilities.

DEP staff completed on-site activities on June 4, 2010, and the last of laboratory reporting was completed by October. The WPPE examined the site history, its operations and operations data for the previous year through May, and looked for operations issues that might be improved in order to increase the water quality for downstream users. Findings and recommendations are summarized in this section, below.

Most daily findings and recommendations were communicated to the Operator-in-Charge when DEP staff was on site. During the WPPE, it was readily apparent that the facility is being operated in a satisfactory manner consistent with prescribed operating guidelines. Ongoing issues with malodor complaints from one or two neighboring residential properties are being addressed through aerobic digester upgrades that will enhance the aeration system for the digesters and provide covers for each tank, connected to an air recirculation system.

A description of the WPPE Program follows as Attachment A, with a listing of program participants in Attachment B. Descriptions of the Frackville plant, its design operational characteristics, and a schematic of the current flow configuration is attached at C, and

Attachment D summarizes operational data developed during the WPPE, with discussions of process monitoring and control conditions observed during the on-site activities or researched during file reviews and discussions with facility staff, other DEP personnel, or EPA regulators..

Minor process adjustments to the Intermittent Cycle Extended Aeration System (ICEAS) were recommended during the evaluation, including increasing the set point for blower output to increase dissolved oxygen content, along with recommendation to adjust settling cycles to maximize potential for denitrification. Lists of the monitoring equipment used, a schematic, and photos of the installation are provided in attachments E and F, with tables of test results and graphic representations following in attachments G through K. Attachment Q is a graphic representation of the Dissolved Oxygen profile for one of the ICEAS basins, while N lists the NPDES permit requirements, and O and P refer to biosolids production and nutrient reduction, respectively.

Attachment L lists recommended process control tests, observations, and calculations for SBR-type facilities. Attachment M lists some SBR-specific process control issues.

1.1 Receiving Stream

The FAMA plant discharges to the Little Mahanoy Creek, 06B, a tributary of the larger Mahanoy Creek Watershed located in the USGS Region 02050301, the Lower Susquehanna-Pennsylvania. Ultimately, discharged flows reach the Susquehanna River and subsequently impact aquatic life in the Chesapeake Bay. A 2008 renewal of the facility's National Pollutant Discharge Monitoring System (NPDES) Permit #PA0062219 included annual nutrient loading limits for Total Nitrogen (TN) and Total Phosphorus (TP). Mahanoy Creek is considered by the US EPA to be impaired by acid mine drainage and metals, and in 2007, a Total Maximum Daily Load (TMDL) was established for the entire watershed. The Little Mahanoy itself had, over the years, been impaired by high levels of total and fecal Coliform bacteria, likely the result of failing on-lot systems. The US-EPA TMDL report noted that the Little Mahanoy was but one of two creeks that did not suffer from Acid Mine Drainage (AMD,) although the TMDL for metals was applied to the Ashland Water Treatment Plant downstream.

During the studies that established the location of the ICEAS facility, public concern about placing a sewage treatment plant so relatively close to an adjacent community's drinking water filtration plant had generated controversy. Appeals of the project siting were taken to the Environmental Hearing Board which determined that the need for the sewage treatment works outweighed any potential adverse effect downstream, and the record noted that the Little Mahanoy has never overflowed into the Ashland Reservoir, the downstream potable water source, which was instead supplied by mountain spring water.

After learning that the downstream water source was protected by a concrete channel separating the Little Mahanoy from the Ashland Reservoir, DEP Staff considered canceling the WPPE; however, reversing course on a commitment to complete the evaluation would have had adverse impact on the word-of-mouth recommendation of plant owners and operators necessary for establishing and nurturing the nascent WPPE program.

Results of our evaluation are summarized below as Operational Strengths and Focus Points for Improvement. A third category of Design/Process Changes to Consider suggests process modifications that would require study and implementation by a professional engineer, the technical details of which are outside the professional qualifications of the WPPE evaluators.

1.2 Operational Strengths

The following items are Operational Strengths that were identified during the WPPE. These include strengths of both the operators and the facility itself.

- Operators conduct routine assessments of treatment facility on a regular basis. These assessments include process monitoring such as:
  - Measurement of dissolved oxygen concentrations at several points,
  - 30-minute sludge Settleability tests with results taken at 5-minute intervals,
  - Ammonia-nitrogen levels in mixed liquor supernatant,
  - Alkalinity, a measure of the chemical buffering capacity of the biomass and its ability to nitrify ammonia waste,
  - Digester conditions, including sludge press operations and cake solids.
- The facility has a certified laboratory for testing wastewater strength, gravimetric and volatile solids, and nutrient levels for process monitoring purposes. Most regulatory compliance samples are now sent to a contract lab, on a weekly basis, for obtaining most DMR data, and such lab features as the BOD_5 incubator are no longer used for lab work. The laboratory is well-organized for its current purposes and remains somewhat under-utilized.
- Waste sludge solids are gravity thickened and digested aerobically, then condensed on a belt filter press for disposal off-site. In 2009, the facility manufactured 183 dry ton of biosolids for soil amendment purposes.
- Maintenance records show that facility equipment maintained and operated in balance, with manual and digital records readily available for review.
- Facility generally has maintained continual NPDES compliance.
- Automatic samplers are located at the headworks and at the wet well for effluent discharge to the Little Mahanoy. This equipment is in serviceable working order and the final effluent sampler has a working calibration thermometer to assure correct holding temperatures.
- Operators are conscientious and workflow is coordinated according to plan.
- Operators have achieved certification for their system.
- Inflow/Infiltration control activities in the collection system are ongoing.
- Development of new commercial/institutional accounts will improve the facility's financial security.

1.3 Focus Points for Improvement:

The following items have been identified as focus points to assist in optimization efforts, and they are ranked "High," "Medium," and "Low" in terms of their importance to optimized functioning of the treatment facility. Focus points include both operational tactics and physical plant issues that can or do impact optimization efforts. These items generally demand more of the operator's attention and therefore require more of the operator's time to perform. The benefits are expected to be favorable by improving the plants discharge quality and thereby improving downstream water quality. The priority levels are defined as follows:

High- Major impact on plant performance on a repetitive basis and/or has been associated with a regulatory violation:

- Planned Digester Upgrade: Continue efforts to minimize malodor complaints by completing the digester upgrades scheduled for later this year;
- Annual Nutrient Loading: Be certain that Chesapeake Bay Nutrient Initiative data is reported correctly: data listed on the 2009/2010 Excel spreadsheet reported low monthly mass loading (MML) values for Total Nitrogen, because some total nitrogen loads were calculated for days on which no Total Kjeldahl Nitrogen (TKN) tests were performed. (These daily values calculated only the nitrate/nitrite-nitrogen loads.) This is discussed in more detail in Attachment D.

Medium- Minimal impact on plant performance on a repetitive basis;

- Digester Operation: As seen in Attachment O, the estimated production of biosolids is 131% for the facility if sludge is digested for a period of ten days; however, it appeared that the sludge press was operating more frequently in an effort to prevent the digesters from becoming overloaded, reducing the length of digestion to perhaps less than ten days holding time. This results in biosolids which may still contain too much volatile content. After the digester upgrade has been completed, re-examine the duration of digestion and whether or not the biosolids are sufficiently digested before further processing on the belt-filter press. Doing so may result in cost savings for treatment chemicals, energy, and labor, as well as assuring that pressed biosolids are sufficiently non-volatile for land reclamation and agricultural uses.
- Supplemental DMR Reporting: The report spreadsheets for the Supplemental DMR for 2009 and 2010 were provided to DEP staff for review. The calculations for monthly mass loading reported on this form were incorrect, and the operator-in-charge may have to submit report corrections to the DEP regional office to correct the records.

Low- Minimal impact on plant performance on a rare basis or has the potential to impact plant performance:

- Biomass enhancement: Although the facility appears to maintain adequate sludge age, it remains necessary to enhance biomass through introduction of "new" microorganisms on a regular schedule. Different formulations of bacterial infusoria may be found among a number of vendors, and some formulations may be customized to the needs of your particular facility, especially for the reduction of fats, oils, and greases that tend to float on the surface of the settled basins. Such material risks being carried forward into the effluent during decant cycles. Use of seed sludge from other activated sludge processes or digesters is not favored, because such biomass may be contaminated or inert and is generally unreliable.
- Ongoing Tank Maintenance: All tanks should be drained and cleaned at least once per year and be checked for cracks, leaks, corrosion, spalling, and diffuser damage. In basins of Frackville's size, it is not uncommon for inert material and grit to accumulate despite the use of grit removal in the plant headworks. During such downtime, we recommend that the railing posts be re-mounted so that the railings are truly protective.

- Cross-training of Personnel: Licensed wastewater operators should serve rotations through differing areas of operation, if they do not already do so. This is especially critical for laboratory practices: All staff should become proficient in recognizing qualities of healthy biomass versus adverse conditions, such as endogeny, filamentous organisms, slug loads, and toxicities. Process monitoring tests should include regular microscopy, analysis of oxygen uptake and respiration rates, and sludge inventory tests necessary for calculating sludge age, cell residence time, sludge volume index, or food-to-mass ratio. These data, taken as a whole, provide a solid foundation on which to base process control decisions; however, using any one process monitoring parameter by itself may not be sufficient to truly understand the condition of the system. Personnel should continue to build their skill sets through continuing education and practical operations exercises outside of their regular disciplines. Cross-training assures the Authority that their treatment team can deploy to any position on short-notice.
- Process Optimization as a Business Strategy: Optimization requires setting voluntary goals for treatment quality which are better than the minimum permit requirements. For example, although there may be no requirement to maintain low phosphorus loading to the receiving stream during the winter months, the facility may voluntarily set a limit and strive to meet it through continued dosing of ferric chloride, while carefully recording and reporting progress to the Authority and to the regulatory agencies.

  Operators should see their job not as "running a sewage treatment plant" but "manufacturing a high quality effluent and/or a Class A biosolids" for further utilization. It's a mindset that is adopted and cultivated through ongoing self-improvement and continuing education.
- Automated Recordkeeping: The Department is promoting the use of its electronic DMR reporting website (eDMR) at:

  http://www.portal.state.pa.us/portal/server.pt/community/edmr/17879

  This utility is, at present, entirely voluntary; however, as technology continues to develop, it is inevitable that all NPDES holders in the state will eventually be enrolled into the program. eDMR replaces the old paper system that employed pre-printed forms with direct data entry by means of secure websites. Using this will reduce the chance for common errors in reporting the monthly compliance data.
- Site Security: Recently, the PA Water and Wastewater Systems Operator's Certification Act has required that all licensed water and wastewater treatment operators complete a course on facility security as part of the routine continuing-education requirement. Staff can access a web-based course "Securing Drinking Water and Wastewater Treatment Facilities" through the DEP's eLearn website at http://www.padepelearn.com. Licensed operators can log on to the site and complete this course during the current licensing cycle, if they have not already done so.

  Although past incidence of unauthorized entry at FAMA's facilities is non-existent-to-remote, site security should be enhanced by locking doors to various buildings at all times, particularly after hours, and maintaining a controlled set of keys, use of remote-notification alarms, and other security devices to protect critical facility features. The perimeter fence by itself is a "good start," but the facility remains vulnerable to unauthorized entry. Consider adopting additional recommendations listed in the training course described above.

1.4 Design/Process changes to consider:

Process changes to consider are informal recommendations made as a result of the on-site evaluation, but they are voluntary considerations for the Authority and are not official recommendations or mandates by the Department of Environmental Protection. In some cases, it may be necessary to refer these matters to the Authority's consulting engineer for evaluation, and any changes made to flow patterns or treatment methodology must be approved by DEP as a Water Management Permit Amendment. The Authority is free to consider or reject these recommendations in the normal business of operating the facility. Nevertheless, we have prioritized these recommendations in order from most immediate consideration to longer-term consideration, based in part upon what will most quickly benefit plant operation and then upon what is most quickly feasible from a funding standpoint:

- Blower pacing can be improved by installing a Dissolved Oxygen probe in each SBR and using their signal to regulate variable-speed-drive (VSD) motors on the aeration blowers. Doing this will require establishment of set-points and then monitoring the system to optimize the range of blower response to oxygen demand of the system. Dissolved oxygen should be held within a range of 1.5-2.0 mg/L minimum to 3.5-4.0 mg/L maximum.
- Computer System: The centrifugal blowers that supply air to the ICEAS are currently controlled by a simple switching system, basically "on/off" according to computerized timers. With major advances in PLC (primary logic controller) technology and digital instrumentation in the last fifteen years, an upgrade of the control system for the blowers should be considered.
- Energy Consumption: An energy audit of the facility should be performed to optimize electric power consumption. While most attention needs to be paid to the blower system, other systems such as pumps, headworks, and support services should be evaluated for energy efficiency, including heating and lighting systems.
- Chesapeake Bay Tributary Strategy: Eventually, the nutrient reduction features of the ICEAS may have to be enhanced because of the Chesapeake Bay Tributary Strategy requirements for annualized TMDL (total maximum daily load) requirements. While at the present time the facility is in no danger of exceeding its annualized load, this may change as the facility approaches its design capacity. Operators may find it useful to employ Oxidation / Reduction Probes in addition to Dissolved Oxygen probes to control blower output and oxic/anoxic phases of operation. These probes would interface with an upgraded supervisory control and data acquisition (SCADA) system that replaces the obsolete technology currently in place.

  Ideally, the ICEAS cycles should be adjusted to include a period of anoxic mixing, whereby denitrification and biological phosphorus uptake may be maximized, so that nutrients are removed prior to effluent discharge.

1.5 WPPE Rating:

Background of the rating system for WPPE is described in Attachment A. As a result of our evaluation and our on-site interaction with the plant operators, we have assigned a facility rating of **Satisfactory**, because the plant routinely meets its compliance requirements and because the facility's management and operators conscientiously strive to improve plant performance and effluent quality.

1.6 Re-evaluation:

Presently, there are no plans to re-evaluate the facility for the WPPE Program, although we anticipate that re-evaluations may become part of the program if it matures. However, we would like to revisit the facility within three-year's time to see if changes were made as a result of this evaluation, if optimization strategy had been adopted, and if the facility status changed.

THIS PAGE INTENTIONALLY LEFT BLANK

2 Downstream Water Treatment

Little Mahanoy Creek is part of the larger Mahanoy Creek watershed. The Mahanoy Creek eventually flows to the Susquehanna River, slightly north of the village of Herndon in Jackson Township, Northumberland County, approximately between Hoover and White Islands and across the river from Dundore. The Borough of Ashland Water Filtration Plant is the nearest downstream potable water filtration plant to Frackville, approximately 4.7 stream miles downstream beside the Little Mahanoy, PWSID 3540030. However, it was learned early in the course of the WPPE that the intake for the Ashland water plant is actually separated from the Little Mahanoy by a concrete and earthen berm. This water plant draws its raw water from the Ashland Reservoir, an impoundment constructed in a small valley near the FAMA plant. The Frackville effluent does not appear to adversely affect water quality of the Ashland facility. Our pathogen tests included three sampling events at the nearest crossroad to the water plant, in the Little Mahanoy, also known as a trout-stocking location for the Fish and Boat Commission. In the opinion of one of our colleagues in the Filter Plant Program, there could be cross contamination of the reservoir outlet with the receiving stream in the event of a berm or sluiceway failure or during a flood; however, subsequent research demonstrated that no cross-contamination due to flooding had ever occurred, going back to the late 1950s.

2.1 FPPE Review—

The Borough of Ashland water system provides water to a population of about 4,200 through 1,650 metered service connections, and it withdraws about 0.415 MGD and up to 0.900 MGD from the Ashland Reservoir that is fed by four springs. The Ashland water plant began operation in 1994 using two Roberts package units employing adsorption clarifiers and mixed-media filters. Storage capacity for the clear well is 40,800 gallons, and a 33 ft. diameter, 48 ft. high water tank with a 300,000 gallon capacity is nearby with a maximum working storage capacity of 262,500 gallons. A 2009 FPPE report notes that three back-up wells can provide approximately 0.703 MGD of capacity should the 14.5 acre reservoir be out of service.

DEP conducted a Filter Plant Performance Evaluation (FPPE) at Ashland in May 2009. Settled water turbidities are consistently below the optimization goals of 1.0 NTU; filtered water turbidities, below 0.10 NTU. Particle counts on the operating filters remained below thresholds of 25 particles per milliliter for *Giardia*-sized particles (>2.0 µm/ml) except during brief periods following filter backwashes, when water was diverted during filter recovery periods. Actual assays for Method 1623 pathogens performed on samples taken during the FPPE showed there were no pathogens present in either the raw or finished water samples. The facility received a “satisfactory” rating during its latest evaluation.

Figure 2.1, below, is a schematic of the Ashland Water Filtration Plant. This schematic does not show the sluiceway that diverts Little Mahanoy Creek around the source water connection point to Ashland Reservoir; hence, the initial misunderstanding of the relationship between to the two entities. Plant production data follows as copied from the 2009 FPPE report.

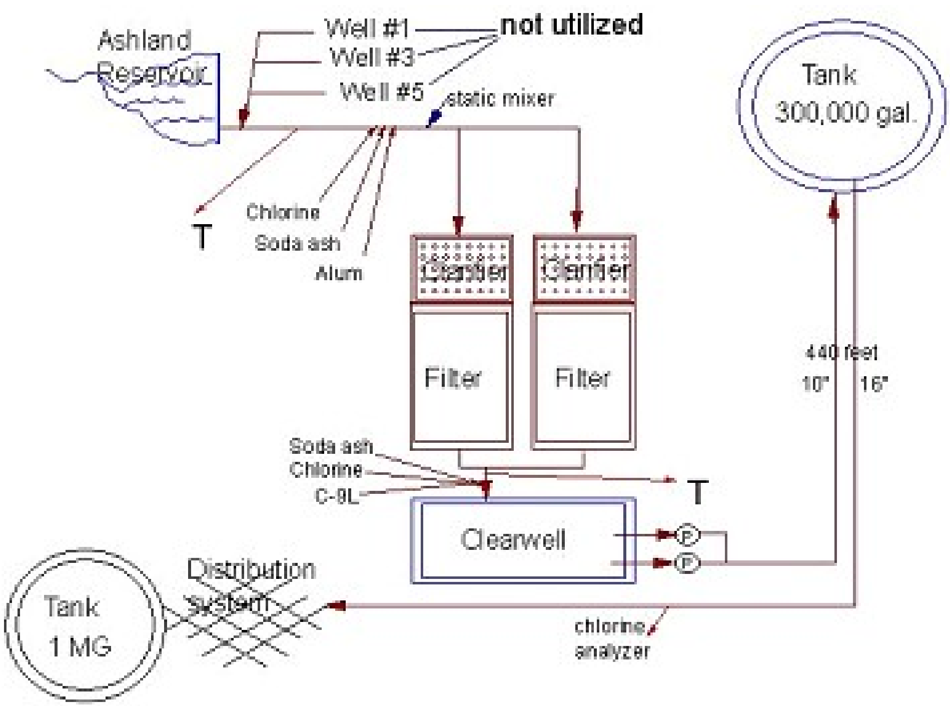


Figure 2.1: Flow Schematic for Borough of Ashland Water Filtration Plant

Plant Production
- Current Production: 425,000 gallons per day
- Time of Operation: 16-18 hours per day
- *Design Capacity: 900,000 gallons per day (625 gpm)
  **based on a filtration rate of 4 gpm-ft^2 and one unit in operation.*
- Pumps: (2) 50 HP finished water variable speed pumps
- Blowers: duplicate provided 25 HP (1765 rpm)
- Backwash: from storage tank

Source Water

The water treatment plant primarily receives its raw water from the Ashland Reservoir which has a capacity of 108 million gallons. The dam is an earthen embankment with a concrete core wall. The embankment is 69 feet high. The reservoir is fed by 4 major springs and rainfall located within the Little Mahanoy Creek watershed. This watershed is primarily located in Butler Township and includes a small area in neighboring New Castle Township. The total drainage area is 2.13 square miles and the reservoir surface area is 14.5 acres. A Water Allocation Permit (WA-139B) allocates 800,000 gallons per day from the reservoir.

	Capacity (MG)	Safe Yield
Ashland Reservoir	108	800,000 gpd
Well No. 1	---	208 gpm
Well No. 3	---	200 gpm
Well No. 5	---	80 gpm

** Well No. 5 is yielding 150 gpm. (Motor and discharge piping replaced).*

Approximately 85% of the watershed is forested, with some areas of urban or developed land amounting to 11%. Water storage comprises the remaining land use.

The source water protection assessment done by DEP's north east regional office in 2002 noted that the primary protection priority was control of contaminants entering the watershed and the reservoir through the Interstate 81 corridor, including potential spills along roads, winter maintenance activities, and stormwater runoff. The source water protection needs were classified as low risk of significant contamination.

2.2 Water Chemistry—

Combined filter finished water turbidities at Borough of Ashland typically have turbidities around 0.04 NTU, as well as rapidly recovering post-backwash turbidities, showing that the plant regularly produces low-turbidity water. Source water typically is less than 2.9 NTU 95% of the time in 2008, with a maximum turbidity of 18.6 NTU occurring in March of that year. Raw water pH was reported to be 6.6 during the last FPPE, with alkalinity of 14 mg/L.

WPPE examination of impacted Little Mahanoy Creek water 4.7 miles downstream from the FAMA outfall is summarized in the table below:

Downstream Little Mahanoy Creek, "Impacted" Waters Samples:

Sample #	250	258	270	279	288	296	305	311	320	329	
Date	4/1	4/7	4/15	4/20	4/27	5/4	5/5	5/11	5/18	5/25	
Time	13:30	12:45	9:19	15:32	15:42	14:39	11:25	10:48	11:03	11:50	Avg.
BOD	2.00	1.40	0.70	1.20	1.40	1.20	1.20	0.60	0.80	0.80	1.13
pH	7.5	7.5	7.5	7.8	7.4	7.2	7.6	7.3	7.5	7.2	7.5
Alkalinity	21.6	23.2	26.6	40.8	35.2	28	29.8	29.8	27.4	30	29.2
TDS	162	146	156	196	176	158	142	144	158	184	162
TSS	6	5	5	5	5	6	5	5	5	5	5.2
VSS	6	5	5	5	5	6	5	5	5	5	5.2
NH3-N			0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NO2-N					0.01	1.05	0.01	0.01	0.01	0.01	0.18
NO3-N	1.73				1.56	0.02	0.91	1.03	1.21	1.44	1.13
TKN	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Phos		0.094			0.20	0.303	0.198	0.266	0.239	0.362	0.237
Chloride	66.4	57.2	57.9	62.6	63.3	51.3	50.3	53	55	57.1	57.4
NO3-NO2	1.73				1.57	1.07	0.92	1.04	1.22	1.45	1.29
TN	2.73		1.00		2.57	2.07	1.92	2.04	2.22	2.45	2.13
Tot.Coli.	3,900	700	400	240	600	200	300	300	700	600	510
Fec.Coli.	440	20	20	20	20	50	10	20	10	20	26
Giardia	3	12					0				
Crypto	1	0					0				

Notes: Figures in RED denote quantities reported as "not detected" and are represented as the minimum amount detectable by the assay.
Pathogen samples outlined in blue were taken on initial site visit in January 2010.

Table 2.1: Little Mahanoy Creek Sample Test Results

In particular, the level of nutrient contamination in the Little Mahanoy is quite low, with nitrate-nitrogen averaging just 1.13 mg/L and both ammonia-nitrogen and nitrite-nitrogen undetectable in all but one sample. Total phosphorus concentration, likewise, averaged just 0.24 mg/L.

Figure 2.2, below, graphically depicts the nutrient levels found in samples taken downstream from the Frackville wastewater plant outfall.

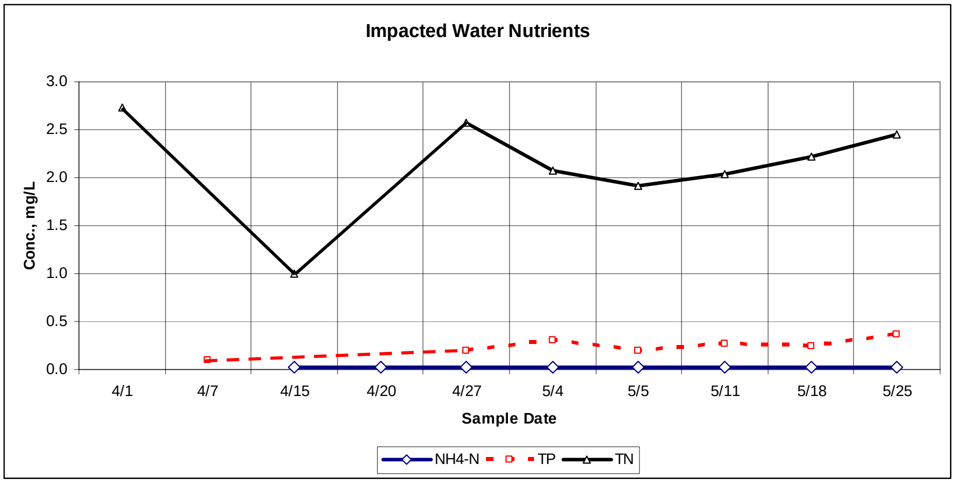


Figure 2.2: Histogram of Downstream Water Nutrient Concentrations (NH4-N undetected in all samples.)

One of the chief complaints about the Little Mahanoy Creek, leading to construction of the wastewater treatment plant, had been high levels of Coliform and fecal Coliform bacteria. In the samples studied, of ten total, one sample had fecal Coliforms count of 440 colonies per 100 ml, although the geometric mean for the set was 26 c/100ml.

2.3 Waterborne Pathogen Discussion—

Method 1623 Sampling was performed on three occasions during the Frackville WPPE. The first event occurred during the original site reconnaissance performed on January 15, 2009, although because of project scheduling, deployment for site optimization would not take place until March 31, 2010. The second and third sampling events occurred in the middle and at the end of the WPPE. The last sample set, taken in May, was interrupted because of a localized heavy rainfall event that rendered the background creek sample unusable due to high turbidity and excessive solids washed into the waterway from storm drains and overland flows. In any case, the samples resulted in the general observation that *Giardia* and *Cryptosporidium* were endemic to the waste stream but were not readily evident in either the background samples or the impacted samples, at least those taken at a distance greater than four miles from the wastewater plant outfall.

Figure 2.3 depicts the results of Method 1623 testing performed on impacted water samples taken during the Frackville WPPE. A more comprehensive accounting of waterborne pathogens is found in Attachment H, where the results for all sample sites are shown.

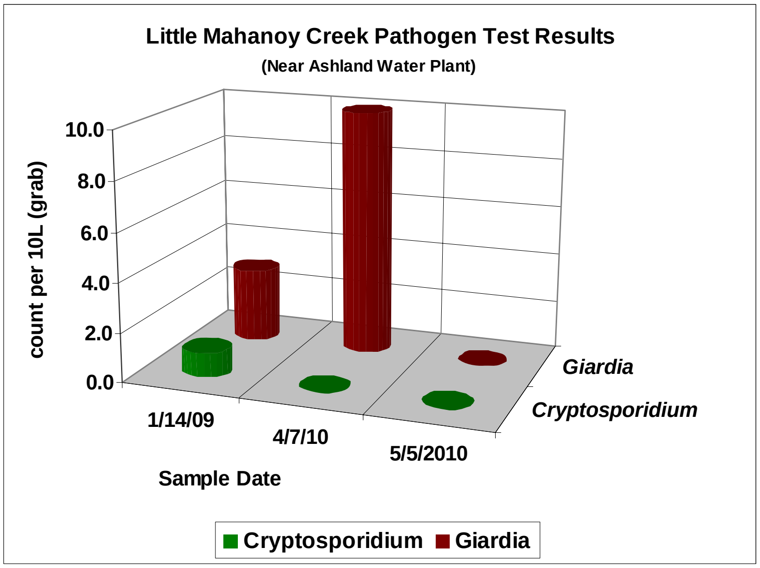


Figure 2.3: Waterborne pathogen test results for Little Mahanoy Creek near Ashland Water Plant

Giardia cyst count for impacted water samples was variable, but one sample averaged 1.09 cysts per liter. On that sample date, the Frackville plant's raw *Giardia* count was 52, or 4.7 cysts per liter, indicating the facility may indeed have public health impact close to five miles downstream.

While sampling for this project, DEP staff often observed fishermen along this stretch of Little Mahanoy Creek. The state does stock this cold water fisher with trout each springtime.

2.4 Effect of TMDL on Ashland Water Filtration Plant

Due to the adoption of TMDL for acid mine drainage and metals for the greater Mahanoy Creek watershed, the Ashland Water Filtration Plant has waste load allocations for its 19,000 gpd of filter backwash wastewater.

Ashland Area Municipal Authority
Water Treatment Plant (NPDES PA0063061)

Metal	Allowable Avg. (mg)	Avg. Flow (MGD)	WLA (lb/day)
Al	4.0	0.019	0.63
Fe	2.0	0.019	0.32
Mn	1.0	0.019	0.16

These are shown in the table at the left. The facility uses alum as a coagulant in the water sedimentation process. Data from the FPPE review suggest that with a 12.9% acid solubility and somewhat compromised filter bed expansion during backwash cycles, there is probably aluminum deposition on the filter media. In addition, aluminum is not routinely measured in drinking water, but some have suggested that typical water and wastewater treatment metals such as aluminum, iron, and manganese be routinely measured during these sampling events. Future NPDES permits for Ashland will likely limit these metals in its treated wastewater discharges in order to help clean up the AMD problems in the overall watershed.

THIS PAGE INTENTIONALLY LEFT BLANK

ATTACHMENTS

A—Program Description **A-1**
Description and goals 1
Process Optimization 1
Wastewater plant performance evaluation 1
Potential Benefits 2
Potential Obstructions to Success 3
B—Frackville WPPE Team **B-1**
Frackville Area Municipal Authority—Frackville Wastewater Treatment Plant 1
C—Plant Description and Treatment Schematic **C-1**
Figure C-1: Flow Schematic for FAMA Frackville ICEAS SBR plant 2
D—2010 Process Monitoring and Control for Frackville ICEAS-SBR Plant **D-1**
Equipment Deployment— 1
Laboratory Equipment— 1
Sampling and Off-site Analyses— 1
Interpretation of Data— **D-1**
Permit Modifications— 1
Solids Management— 1
pH/Temperature— 2
DO Findings— 3
DO Grab Testing— 3
Oxidation/Reduction Potential— 4
Nitrate- and Ammonia-Nitrogen— 4
Phosphorus Control— 6
Sludge Settleability Tests— 7
Oxygen Uptake Rate (OUR) and Specific Oxygen Uptake Rate (SOUR) Tests— 7
Microscopic Exam— 8
Settled Sludge SBR Blanket Level & Core Sampling— 9
Flow Measurement— 9
Power Consumption— 9
eDMR— 10
Inflow/Infiltration— 10
Pathogen Control— 10
Operations Regulations & Operator-in-Charge— 11
E—Equipment Deployed **E-1**
F—Equipment Placement Photos **F-1**
G— Continuous Digital Monitoring Charts **G-1**
Example Period Histograms for April & May 2010 5
H—Pathogen Test Results (Method 1623 for Giardia and Cryptosporidium) **H-1**
I—Process Monitoring Tests: Example WPPE Daily/Weekly Bench Data **I-1**
J—Graphs: Process Monitoring Test Results **J-1**
K—Tables of Sample Data from Bureau of Labs Testing **K-1**
L—Recommended Process Control Tests, Observations and Calculations **L-1**
M—SBR Specific Process Control Issues **M-1**
Example—F/M Calculation for SBR 1
SBR Effluent Sampling Issues. 2
N—NPDES Effluent Discharge Limits **N-1**
O—Biosolids Production Worksheet **O-1**
P—Example Chesapeake Nutrient Reduction Worksheet **P-1**
Q—DO Profile for ICEAS Basin 2 ..... **Q-1**

THIS PAGE INTENTIONALLY LEFT BLANK

A—Program Description

POTW Optimization Program
Description and goals

As part of an EPA-sponsored grant, the DEP has created a Wastewater Optimization Program to enhance surface water quality by improving sewage treatment plant performance beyond that expected by existing limits of the plants' National Pollutant Discharge Elimination System (NPDES) Permits.

The goal of this program is to encourage wastewater treatment facilities to voluntarily produce higher-quality effluent than mandated by the limits set in their NPDES permits and to optimize treatment in such a way that reduces contaminants and pathogens in surface waters that are consumed for drinking water following filtration at facilities downstream.

The initial focus will be to work with wastewater treatment facilities within ten miles upstream of these drinking water filter plant intakes. DEP will conduct Wastewater Plant Performance Evaluations (WPPEs) to assist municipal wastewater systems in optimizing their wastewater treatment plant processes as part of the Wastewater Optimization Program. Each evaluation is expected to last up to 2 months.

Process Optimization

- Purpose of Optimization: Set production goals as if running the process were an industry that makes a product: clean water and biomass.
- Goal-Setting: Voluntary meeting of limits that are better than the minimum required limits in the permit in order to reduce pathogen, nutrient, and emerging contaminant loadings to downstream drinking water facility intakes.
- Action Items: Break down optimization tasks into various activities or adjustments that should be done to improve routine operation.

This new program is modeled after DEP's Filter Plant Performance Evaluations (FPPEs) conducted at Drinking Water facilities.

This program is not part of the Field Operations, Monitoring and Compliance Section. Sample collection methods utilized during this evaluation generally do not conform with 40 CFR Part 136, therefore the data collected will not be used, and in some cases is not permitted to be used for determining compliance with a facility's effluent limits established in its NPDES permit.

Wastewater plant performance evaluation

- Department staff will consult with the plant operators to explain the program, the goals, the equipment used, and the expectations for participation.
- Upon arrival at the wastewater plant, Department staff will set up equipment, including meters capable of continuous, in-line monitoring for pH, Oxidation-Reduction Potential, Ammonia, Nitrates, Dissolved Oxygen, and other parameters.
- The Department will utilize the equipment to gather data on system performance, show the operator how to gather similar data, and explain the value of gathering the data. We'll

also explain how operators could choose to modify their treatment processes based on interpretation of the data collected.

- Although the Department may show operators how to achieve effective process control by using these process monitoring tools, the operators will continue to make all process control decisions, in conformance to their licensing requirements, and retain responsibility for those changes.
- The Department will also lend the facility additional laboratory equipment which will remain on site during the WPPE to assist in data collection and interpretation.
- During this time, the operator may need to spend more time performing routine testing at the treatment plant than was done previously. This will allow correlations to be made between process modifications and the process response.
- One major goal of the program is to provide the operator with the process monitoring knowledge and experience necessary to gather useful data and utilize it to make beneficial changes in the treatment process and the receiving stream long after the Department and its equipment have been removed.
- There is no charge for the Department's review of the treatment process, setup of all equipment, the process control monitoring that will take place, lending meters to the plant during the WPPE, data collection and explanation of potential effects that process modifications can have on the treatment process.
- The municipality will be responsible for providing laboratory bench space and 120 VAC power for the instrumentation. Any costs associated with process modifications (such as equipment upgrades, chemical purchases, etc.) that the municipality deems appropriate and beneficial as a result of the WPPE remain the responsibility of the municipality. The municipality reserves the right to cease participation in the WPPE at any time.
- Following the equipment set-up, the Department will observe the facilities and review operational practices, treatment processes, chemical treatment, operational data currently collected, and overall system performance.
- During the evaluation, the Department will review monitoring records, laboratory sheets, operations log sheets, and any drawings and specifications for the treatment facility. Also of interest is data currently collected and how it is utilized for daily process modifications. This information is usually available from existing reports.

Program evaluation team will consist of 1 to 2 people: Wastewater Optimization Program Specialists, PA licensed as a wastewater plant operators with operations and compliance assistance experience.

Potential Benefits

- Use of online process control monitoring equipment during the WPPE, use of hand held meters and portable lab equipment during the WPPE, and furthering the operators' knowledge of process control strategies and monitoring techniques,
- Producing a cleaner effluent discharge which minimizes impacts to the environment and downstream water users, and possible identification of process modifications that could result in real cost savings.
- Where the optimization goals may be more stringent than current requirements of your NPDES permit, they are completely voluntary. The WPPE objective is to optimize wastewater treatment plant performance in order to enhance surface water quality,

minimizing the effects of pathogen and nutrient loading to downstream drinking water plant intakes.

- Furthermore, pursuit of a good rating in the WPPE program may place the wastewater system in a better position to meet more stringent regulatory requirements in the future, should they occur. For example, regulatory changes over the last ten years have reduced the final effluent Total Chlorine Residual limits requiring dechlorination or optimization of treatment processes to reduce the levels of chlorine added to the process for disinfection. Facilities who have voluntarily maintained lower residuals than listed in their permit have found it easier to comply with the updated regulations.

Potential Obstructions to Success

Many factors may present obstructions to a successful plant optimization. Some of these are listed below:

- Inadequate use or interpretation of regular process monitoring test results
- Inadequate funding of facility operating expenses, including staff training, chemical and energy usage, equipment maintenance
- Miscommunication as to program goals and methodologies
- Obsolete, inadequate, or out-dated treatment equipment and methods

WPPE Rating System

WPPE Staff use the following categories to rate each facility, based on observations and data developed during the evaluation. The ratings are based on the facility's capabilities and the operators' skill levels to maintain optimal performance over the long term. Please note that while WPPEs may discover treatment problems or identify potential or actual violations of regulations, the rating system is not based upon regulatory compliance.

- **"Commendable"**

  Department staff has identified only minor operational, equipment, and / or performance problems that affect the plant's ability to maintain optimized performance. Plant personnel have already taken steps to improve overall facility performance, maintain high effluent quality, and consistently preserve the long-term reliability of the facility.

- **"Satisfactory"**

  Department staff has identified operational, equipment, engineering, and / or performance problems that may affect the facility's ability to maintain optimized performance. Facility personnel appear willing and capable of improving overall performance; however, one or more treatment processes showed areas of weakness in operational, equipment, and/or performance that, if corrected, will improve treatment performance and maintain the long-term reliability of the facility.

- **"Needs Improvement"**

  Department staff has identified considerable operational, equipment, and/or performance problems that are affecting the facility's ability to maintain optimized performance. Limitations are apparent that hinder improvement of overall filter plant performance. Areas of weakness affect the capability and dependability of the plant in producing a quality final effluent, increasing the potential for degradation of the receiving stream through increased nutrient and/or pathogen loading.

THIS PAGE INTENTIONALLY LEFT BLANK

B—Frackville WPPE Team

WPPE Team

Marc Neville, Water Program Specialist
DEP- RCSOB
400 Market St
Harrisburg, PA 17105
717-772-4019
mneville@state.pa.us

Robert DiGilarmo, Water Program Specialist
DEP – Cambria Office
286 Industrial Park Rd
Ebensubrg, PA 15931
814-472-1819
rdigilarmo@state.pa.us

Frackville Area Municipal Authority—Frackville Wastewater Treatment Plant

Municipal Wastewater Plant Representatives

Douglas Cleary, Chief Operator
Frackville Area Municipal Authority
1199 West Oak Street
Frackville, PA 17931
570-874-4421
fama2@verizon.net

THIS PAGE INTENTIONALLY LEFT BLANK

C—Plant Description and Treatment Schematic

The Frackville Area Municipal Authority (FAMA) operates a 1.4 MGD treatment facility that employs activated sludge in a sequencing batch reactor (SBR) process operated as a twin unit Intermittent Cycle Extended Aeration System (ICEAS) mode, with pretreatment screening and front-end chemical addition and also followed by disinfection using ultraviolet (UV) radiation. Currently, average daily flows are in the range of 0.7 to 1.1 MGD. The facility serves a collection system consisting of 19.9 miles of sewer and serving approximately 2,300 effluent domestic units (EDU) and two major industrial dischargers as well as a state prison that has its own pretreatment facility. 55% of the collection system was constructed at about the same time as the wastewater treatment facility. In the ICEAS process, biological oxidation, nitrification, denitrification, phosphorus removal and liquids/solids separation are achieved continuously in a single basin while maintaining continuous inflow. This continuous source of carbonaceous BOD provides a food source for denitrifying bacteria that convert nitrate-nitrogen back to nitrogen gas. The ICEAS does produce lower effluent nutrients than a conventional SBR aeration system.

Solids handling includes a pair of aerobic sludge digesters for reduction of volatile content in waste sludges prior to gravity de-watering and compaction on a 2-meter belt filter press. Each SBR basin has a maximum capacity of seven hundred thousand gallons (7 kgal.) The treatment scheme of FAMA’s plant follows as Figure C-1.

The plant headworks includes an automated bar screen and a Pista-grit chamber to remove solid waste, trash, and grit. From there, inflow enters a large underground wet well and is divided between the ICEAS basins, each of which is served by fine-bubble diffusers powered by centrifugal blowers. The plant currently employs a four-hour treatment cycle in each SBR: 120 minutes under aeration, 70 minutes of decant during which inflow continues, followed by 50 minutes of decant, during which the last twelve minutes of the cycle are devoted to sludge wasting to aerobic digesters. Each decant cycle averages about 30,000 gallons. Decanted effluent flows to a disinfection chamber where ultraviolet light bank assures inactivation of most pathogens prior to a final reaeration by use of a step cascade, followed by discharge to the Little Mahanoy Creek.

Solids handling is achieved by aerobic digestion in two tanks using coarse-bubble diffusers, followed by dewatering on a belt-filter press and disposal as fertilizer/biosolids used in mine reclamation activities. Current plans call for upgrading the solids handling by improving aeration in the digesters, adding digester covers to minimize odor, and further use of treated biosolids in agricultural activity. Material removed at the head of the plant is consolidated and disposed to landfill.

ICEAS cycles are electronically controlled using hardware that dates to the facility’s construction in 1994. Operators indicate that this control system is badly in need of upgrade to more modern digital technology, with blower upgrades or replacements a priority. Thus, our performance of a WPPE came at an opportune time, for the operators have been exposed to newer technologies that can be used to pace blower operation and achieve improved nutrient control in the plant effluent, a requirement under new and stringent nutrient limits on facilities discharging to the Susquehanna basin.

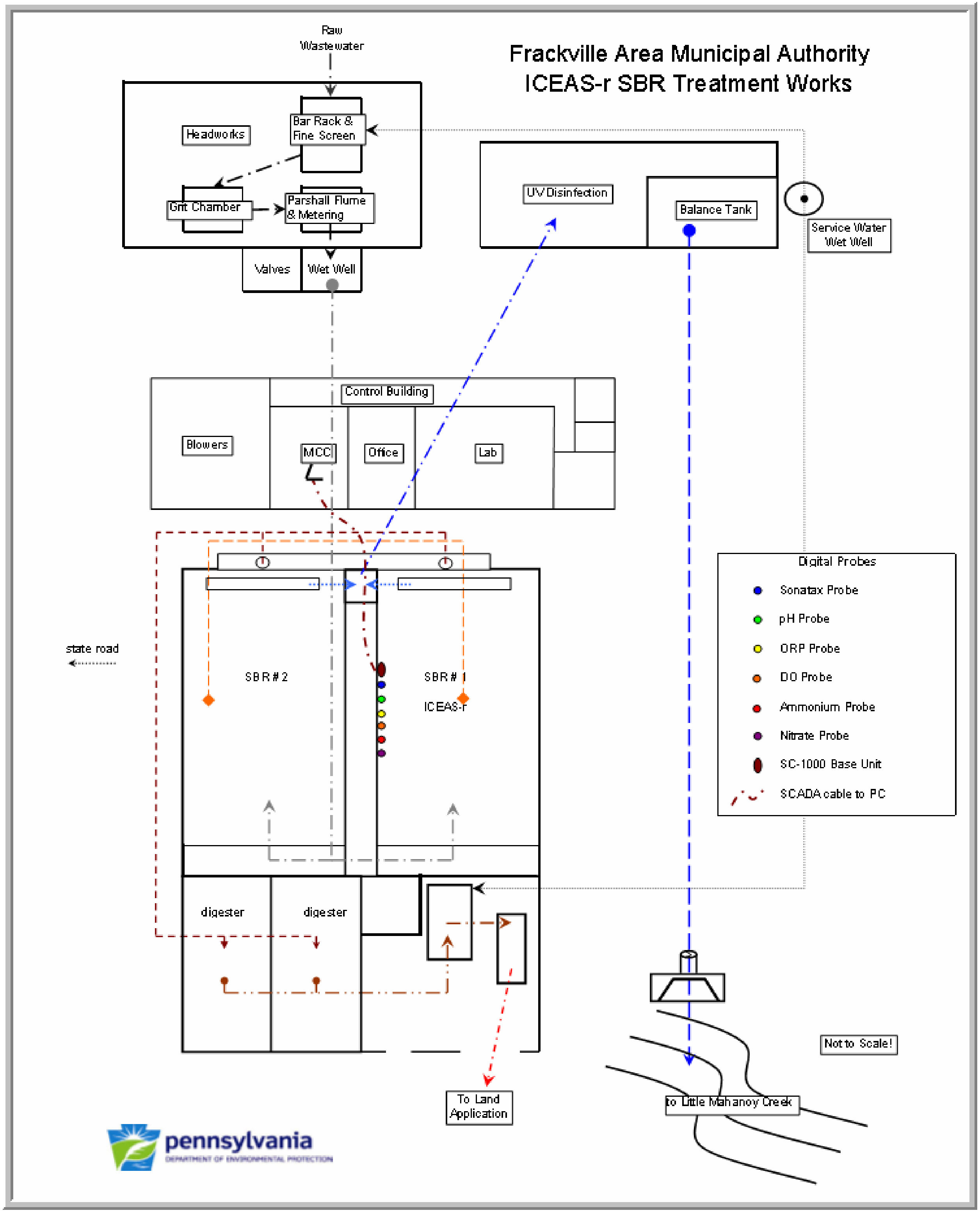


Figure C-1: Flow Schematic for FAMA Frackville ICEAS SBR plant.

D—2010 Process Monitoring and Control for Frackville ICEAS-SBR Plant

Equipment Deployment—
At the end of March 2010, DEP staff deployed 6 electronic probes to facility to monitor the sequencing batch reactors' activated sludge treatment process. SBR 1 was selected for dissolved oxygen (DO), oxidation/reduction potential (ORP), pH, nitrate-nitrogen (NO3-N), ammonia-nitrogen (NH3-N), and sludge level probes.

The probes were installed and calibrated, programmed to give readings every fifteen minutes to a laboratory computer for the duration of the study. The purpose of these probes was to monitor biomass for operational purposes, never for compliance purposes. The data generated allow operators to observe trends showing improved treatment efficiency over time and, in response to a wider array of data, make process control decisions that optimize effluent quality so that the facility emits even less pollution than the permit allows.

Laboratory Equipment—
DEP staff also deployed a portable wastewater lab for process monitoring, including: Solids inventory by Volume Percent (Albert West method), Settleometry for Sludge Volume Index (SVI) development, Microscopy with Digital Photography, and a Spectrophotometer for interpreting wet-chemistry tests for nutrients and metals.

Sampling and Off-site Analyses—
Weekly samples of the raw wastewater, final effluent, upstream (background) and downstream (impacted) waters were taken for analysis at our off-site laboratory in Harrisburg, to characterize the plant operating conditions by assaying several wastewater treatment parameters. Some of these test results were employed in recalibrating the electronic instruments. In addition, sampling and testing was performed on Mixed Liquor Suspended Solids and suspended solids concentrations for return or waste activated sludge. Other tests were performed on sludge press filtrate to characterize this internal side-stream flow. A table of test results for these samples follows in Attachment G.

<u>Interpretation of Data</u>—
Permit Modifications—
Observations or recommendations for improving treatment may entail modifications to facility physical plant or to flow patterns. If permanent modifications are contemplated, the facility operators should obtain the proper permits or permit modifications (Part II NPDES) prior to enacting any permanent changes.

Solids Management—
There are four general methods available for managing solids inventory in a wastewater treatment plant; typically, Mean Cell Residence Time (MCRT) is employed, although Food to Mass Ratio (F/M) is often substituted. Additional methods are Solids Retention Time (SRT) and Dynamic Sludge Age (DSA,) which are basically just MCRT using simpler calculations. Because an SBR plant has varying MLSS concentration, it is difficult to pin down calculations which require knowledge of the biosolids mass. Typically, operators should synchronize sampling for process monitoring test with specific times during the SBR cycles, or they should always account for the volume of mixed liquor at the time when the samples are drawn.

Measurement of sidewall depth (SWD) should be taken along with the samples. A discussion of this, using a sample of the F/M calculation for SBRs, follows in Attachment M.

A key point with Solids Management is to choose a parameter and then determine at what factor the facility best operates. For example, if the sludge settles best when the sludge age is 30-days, then the operator would adjust sludge wasting rates to achieve a steady state condition that holds at or around that particular sludge age. Regulating the "mass" side of the equation is easier than regulating the "food" part of the F/M Ratio, as most WWTPs do not employ flow control at the headworks or maintain equalization basins as backup storage.

For an SBR facility, it appears that operating based on the F/M Ratio appears to be the easiest way to determine a steady-state condition. During the WPPE, we employed the Chemical Oxygen Demand test (COD) as an analogue of the five-day Biochemical Oxygen Demand (BOD_5) or the Carbonaceous BOD_5 test (CBOD). The advantage of using COD is that the test takes just 2-hours of reaction time (versus 5 days) and the results can be easily compared with BOD numbers to determine a conversion factor that is then used in the F/M calculation. The COD test is relatively inexpensive but does present some storage and disposal issues, as some of the chemicals used in the test, hexavalent chrome and mercuric chloride, must be treated as hazardous waste.

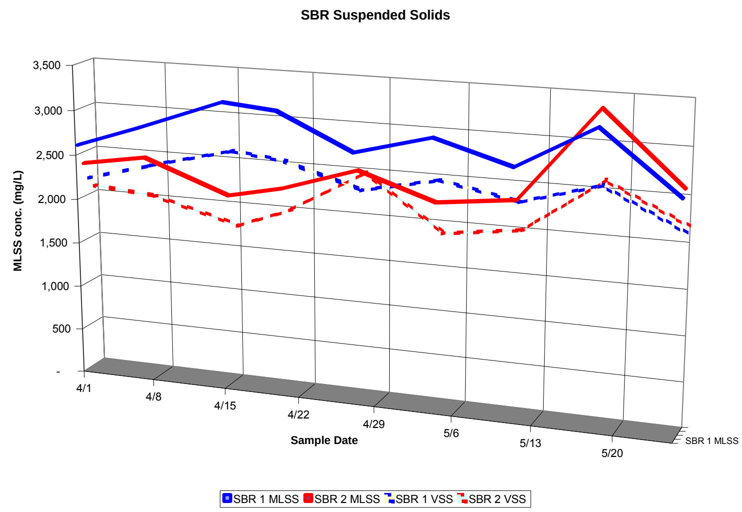


Figure D-1: Suspended and Volatile Solids

	Basin 1	Basin 2
avg	**2,960**	**3,140**
max	**2,370**	**2,000**
min	**3,670**	**4,070**
stdev	**420**	**450**
δ	**14.19%**	**14.33%**

The graph shown above depicts the variation of MLSS results over the duration of on-site evaluation. Generally, we tried to obtain solids samples near the end of the aeration/fill cycle; however, in practice this proved to be inconsistent because of on-site time limitations. A table, left, shows the statistical data from a year earlier, where synchronization of sampling time with side-wall depth produced a better correlation of data..

pH/Temperature—

A pH probe was installed in Unit 1 and recorded values generally between 6.6 to 7.0 standard units. Optimum pH range for nitrification is 7.0 to 8.5 standard units. Nitrifiers cease activity at pH below 6.0. Mixed liquor temperatures gradually increased with the progression of the spring season. The graph in Figure D-2 on the following page depicts both pH and

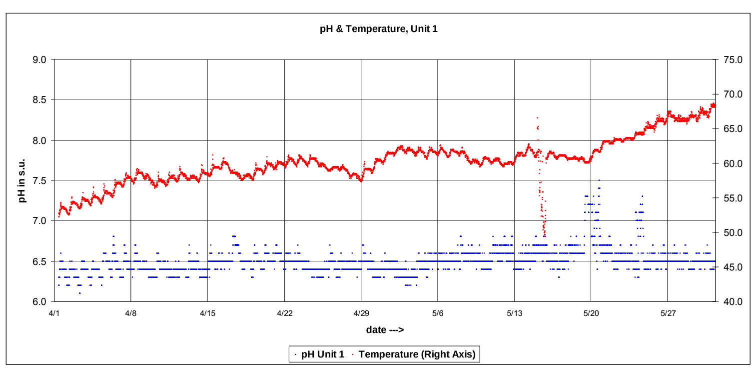


Figure D-2: Mixed Liquor pH and TemperatureHistogram

Temperature throughout the evaluation. All of the electronic probes employ thermocouples for reporting temperature, which is helpful when calibrating the probes.

Biological activity, of course, is temperature-dependent.

Dissolved Oxygen (DO) Measurements—
A dissolved oxygen (DO) probe was installed in Basin 1 to measure DO as a function of time. The intent was to look for patterns or trends in daily, weekly, and monthly intervals. Ideally, for activated sludge aeration plants, DO concentrations are maintained between 1.5 and 4.0 mg/L for oxic treatment zones. At Frackville, DO is usually within or slightly above this concentration range.

The dissolved oxygen histogram in Figure D-3 depicts Basin 1 conditions during April and May. DO is seen to vary in concentration as a function of the ICEAS cycles, but in May, the DO values were usually as high as seven mg/L while though organic load remained constant. 12% of the DO readings during this period fell within the recommended range for Dissolved Oxygen concentrations for activated sludge plants. DO above 4 mg/L represents wasted energy, and excessive aeration can shear floc and cause poor settling. Blower performance may be enhance by using variable speed motor controls to pace aeration output controlled using dissolved oxygen probes.

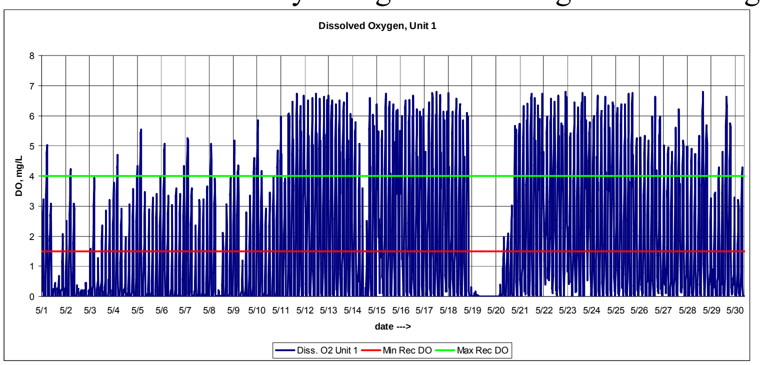


Figure D-3: SBR DO Histogram, green=max recommended DO

The small break in the record that occurred around May 19 was the result of a power loss to the decant arm, requiring operators to leave the basin in "storm mode," where aeration blowers remain off while flow continues through the process. During this period, the basin did become anaerobic, as seen in the oxidation/reduction probe histogram in Figure D-4, below. While this did not endanger operations, it might have done if the operators hadn't quickly established a temporary power source. Generally, activated sludge plants can go without aeration for about a day before truly adverse effects are seen.

DO Grab Testing—
Development of a dissolved oxygen profile is recommended at least once per year to characterize performance of the aeration grid and to diagnose potential air leaks and/or deficient spots where accumulation of inert solids may interfere with aerator performance. Use of a portable meter and dissolved oxygen probe allowed development of a DO Profile for Basin 2, where oxygen concentration was measured at depths of 12", 6', and 12', depicted graphically in Attachment Q. Oxygen concentrations were consistent throughout the basin, with no obvious air leaks or dead spots. Oxygen levels behind the influent wastewater baffle was much lower than in the remainder of the basin, despite the presence of aeration, a situation that could be remedied with valve adjustments.

Typically, operators should perform a DO profile of the aerators prior to cleaning and inspection of tanks at least once per year. Doing so allows operators to assure continued integrity of the aeration grid components and of the basin structures, and removal of settled inert solids will prevent loss of aeration efficiency.

Nitrate- and Ammonia-Nitrogen—
One of the features of the ICEAS is that nutrient concentration in the treated wastewater may be reduced naturally. The Frackville facility was designed to fully nitrify incoming ammonia nitrogen and provide some denitrification during its settling and decant cycles through continuous introduction of a carbon source.

The chart shown here demonstrates nitrate-nitrogen production in the ICEAS, where increases in nitrate production occur during aeration phases of the process. Nitrate peaks drop off during the settling and decant cycles, when denitrification is taking place. Nitrates for the period shown, April and May of 2010, show that averaged 0.9 mg/L with a maximum of 6.9 mg/L. (Nitrate content in conventional activated sludge plants may be two or three times higher.) Unfortunately, the ammonia-nitrogen probe deployed for the WPPE malfunctioned, so no automatic data was generated. Grab samples measurements of ammonia-nitrogen averaged 0.25 mg/L with a maximum of 0.79 mg/L. No samples were taken while the basin was temporarily set in "storm flow mode," and ammonia-nitrogen would have risen during that time. However, grab samples taken during that time did not demonstrate excessive ammonia-nitrogen.

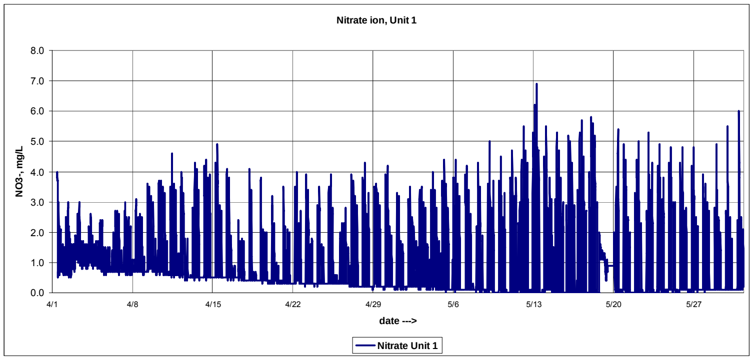


Figure D-5: NO3-N Histogram

Oxidation/Reduction Potential (ORP)—
Use of ORP probes in facilities employing biological nutrient removal (BNR) is essential. Nitrification and denitrification are effective according to defined ranges of bioelectrical charges in the outer membranes of bacteria. This is shown in the following table.

ORP (mV)	Process	Electron Acceptors	Condition
> +100	1	**O2**	**Aerobic**
≤ +100	2	NO3	Anoxic
≥ -100	2	NO3	Anoxic
< -100	3	**SO4**	**Anaerobic**

1= Nitrification

2= De-Nitrification

3= Methane Formation

Table D-1: Oxidation-Reduction Potential (ORP) Ranges for Bacterial Activity.

At Frackville, the ORP values generally remained in the positive millivolt (mV) range during all cycles, indicating superb nitrification taking place with some denitrification during the settling and decant cycles. Nitrification occurs above a charge of +100 mV. For denitrification to occur efficiently, it must occur under anoxic conditions where mechanical mixing of a carbon source with the activated sludge occurs. Within this zone, the charge drops below +100 mV as low as -100 mV, and denitrifying organisms consume carbon while converting nitrate-nitrogen to molecular nitrogen gas.

ORP values averaged +35mV plus or minus 89 mV in the example data from April and May with one significant exception. In the ICEAS, denitrification occurs mostly at the interface of the raw wastewater with the settling biomass. It is effective, but it is inefficient. Denitrification can be maximized by adding a cycle where the biomass is continually mixed using subsurface mixers while adding wastewater carbon to nitrate-rich mixed liquor.

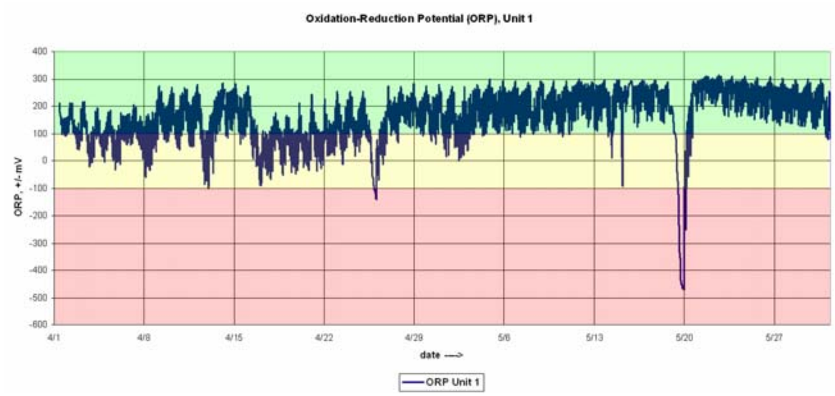


Figure D-4: Oxidation Reduction Potential for Basin 1, April/May

Total Nitrogen— Total nitrogen (TN) is the sum of total Kjeldahl nitrogen (organic and reduced nitrogen) and inorganic nitrate-nitrite nitrogen. It is derived by monitoring for total Kjeldahl nitrogen (TKN) and nitrate-nitrite individually and adding the results together. An acceptable range of TN in receiving waters is 2 mg/L to 6 mg/L, and the Chesapeake Bay Tributary Strategy estimates a 6 mg/L concentration in calculating the annualized loading requirements for each wastewater facility discharging to the Chesapeake Bay watershed. For Frackville, the annualized TN limit is 25,570 pounds, reported for yearlong period beginning at the end of the previous calendar year's growing. Frackville's annualized TN loading to the watershed is well under its permit limit, at 27%.

TKN Conc. mg/L	Nitrate + Nitrite mg/L	Day	Flow Volume MGD	Total Nitrogen Mass lbs	CB M l
		1	0.820		
		2	0.877		
		3	0.756		
		4	0.736		
		5	0.971		
1.7	1.1	6	0.796	18.9	
	0.5	7	0.725	3.2	
		8	0.700		
		9	0.812		
		10	0.672		
		11	0.656		
		12	0.710		
1.1	1.1	13	0.706	12.5	
	0.7	14	0.681	4.2	
		15	0.966		
		16	1.020		
		17	1.180		
		18	1.040		
		19	0.950		
1.0	0.7	20	0.881	12.7	
	0.5	21	0.838	3.7	
		22	0.833		
		23	1.140		
		24	2.110		
		25	1.510		
		26	1.290		
1.0	1.4	27	1.910	37.6	
	0.5	28	1.910	8.0	
		29	1.630		
		30	1.520		
		31	1.550		
		MXWKAV			
1.2	0.8	Avg	1.063	12.6	
1.0	0.5	Min	0.656	3.2	
1.7	1.4	Max	2.110	37.6	
4.8	6.6	Total	32.956	100.9	1
					6

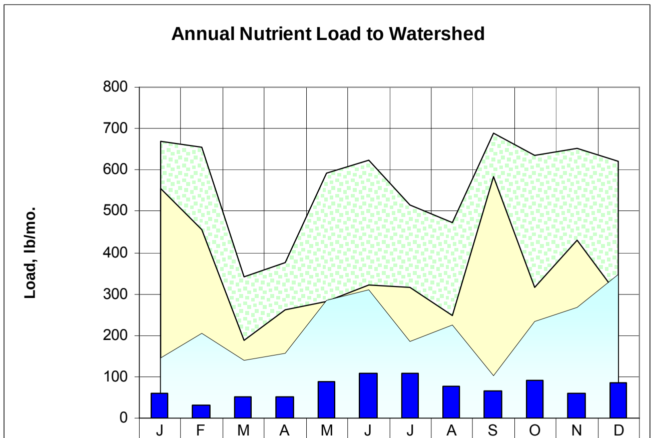
Figure D-6: Suppl. DMR Rept., Oct. 2009

During the evaluation, an error in the spreadsheet for the monthly DMR summary was discovered, whereby the monthly mass load (MML) for TN was under-reported. Since TN is the sum of both TKN and NO3-NO2-N, data for both test results needs be available for calculating the TN loading. This is illustrated in Figure D-6 at left. In addition, when calculating the monthly total nitrogen, the average mass loading is multiplied by the number of days in the month. For the example at left, the actual monthly mass load ("Total") was 634 lb.

Based on the lab samples analyzed at Bureau of Labs, from April and May, the average TN concentration during the WPPE was 4.27 mg/L.

The upstream background samples ranged from 1.16<>2.75 mg/L during this period, and the downstream impacted samples were between 1.30<>2.33 mg/L. Because the ability of nitrifying and denitrifying bacteria to process nitrogen varies seasonally, one would expect better treatment efficiencies during the growing season months when basin temperatures are favorable. In the graph shown in Figure D-7 below, the annualized TN load is shown in relation to its components, TKN and Nitrate-Nitrite. The smaller percentage of nitrate-nitrite is the result of denitrification that occurs during the settling/decant cycle, unique to the ICEAS configuration.

Since inflow is continuous throughout the ICEAS cycles, ammonia-nitrogen concentration will be slightly higher in ICEAS effluent than in a traditional SBR; however, the effect is usually negligible. Denitrification in the ICEAS occurs somewhat less efficiently than in dedicated denitrification processes such as modified Lutzak-Ettiger, because there is no cycle where mixing without aeration would keep carbon source, nitrate, and bacteria in constant contact with one another. A modification of the ICEAS that may increase denitrification efficiency would add such an anoxic mixing cycle to the overall scheme. This type of modification should be discussed with the Authority's consulting engineer.



	J	F	M	A	M	J	J	A	S	O	N	D
TN	668	655	340	377	591	625	516	473	689	634	651	621
TKN	555	456	188	262	283	321	316	247	584	316	430	296
NO3+NO2	145	206	140	157	284	311	186	225	103	233	268	347
P	60	32	50	50	90	107	109	77	66	91	60	86

Figure D-7: Nutrient Load annualized as Calendar-Year 2009, in lb/day

Phosphorus Control—

For total phosphorus (TP), the NPDES permit employs a 1.0:1.5:2.0 maximum concentrations limit for monthly average, weekly average, and daily grab, respectively. Final effluent TP averaged 0.689 mg/L for the BOL samples, while that of the background and impacted samples averaged 0.060 mg/L and 0.237 mg/L, respectively. Raw wastewater after preliminary treatment had strength of 2.82 mg/L, so phosphorus removal across the ICEAS achieved 76% removal. Effluent monthly mass loads for TP are displayed on the chart in Figure D-7 as columns.

One of the advantages of the ICEAS is that the process promotes biological uptake of phosphorus, thereby reducing an adverse reliance on chemical phosphorus removal that adds unwanted metal cations to the already-impaired Mahanoy Creek watershed. However, without a dedicated cycle for biological phosphorus uptake, biological uptake is never efficient. According to the 2009 annualized data, the facility's loading of TP was 687 lb. The annualized Chesapeake limit for the facility is 3,409 lb TP/yr, making the current loading of 26% well within the requirements.

For the calculation of monthly mass load for TP, the Supplemental DMR spreadsheet should calculate MML (or "Total") by multiplying the average daily load by the number of days in the month. Compare the TP values reported in Figure D-7 with those reported on the Supplemental

DMR: The October 2009 TP MML was 91 lb. compared to a reported MML of 23 lb. Any under-reported nutrient loading values should be corrected by submitting amended DMR data to the regional office.

Sludge Settleability Tests—

Weekly assessments of the biomass included sludge Settleability tests. The photograph below illustrates typical 30-minute settling characteristics for solids in the two basins. As seen in Figure D-8, the biomass sample taken from Basin 1 exhibits slower settling quality. With SBR plants, it is necessary to sample mixed liquor settleability at the same time during the aeration cycle, to account for changes in concentration as the SBR level rises and falls. This assures that mixed liquor samples will have relatively the same MLSS concentration during each sampling event. This may require to operator to conduct Settleability tests independently for each basin, because sludge quality changes if one basin sample is held too long and then compared with a fresh sample from the second basin. That in itself could alter the outcome of the Settleability tests. Attachment L contains some information on the unique sampling and testing issues that arise when operating SBRs. Note that the supernatant of these samples are very clear, with no straggler floc or bulking. This is a good sign that the biomass contains appropriate proportions of indicator organisms that aid in floc formation and settling, as confirmed by microscopic examination.

Figure D-8: Sludge Settleability Tests at 30 min, 5/12/09

Oxygen Uptake Rate (OUR) and Specific Oxygen Uptake Rate (SOUR) Tests—

Valuable measurements of biomass metabolism are the Oxygen uptake rate (OUR) and Specific oxygen uptake rate (SOUR or Respiration Rate) tests, which provide a quick analysis of biomass for its relative health and to indicate potential toxicity in wastewater. These tests demonstrate the rate at which oxygen is used by the bacteria in the activated sludge system and can indicate if the biomass is consuming BOD at a "normal" rate when operating in steady-state conditions. The OUR test measures relative oxygen consumption of a sample of mixed liquor; the SOUR test looks at oxygen consumption per unit of volatile suspended solids, the bacteria. An SOUR less than 12 mgO_2/hr/gm MLVSS can be indicative of endogenous respiration and can be accompanied by pin floc. A SOUR in the 12-20 range is usually indicative of a healthier biomass and improved settling. Weekly samples of the biomass were analyzed for OUR, with the biomass generally calculated at between 72% and 80% of the MLSS. In the example graph of OUR shown at right, from May 5, the biomass samples exhibit an

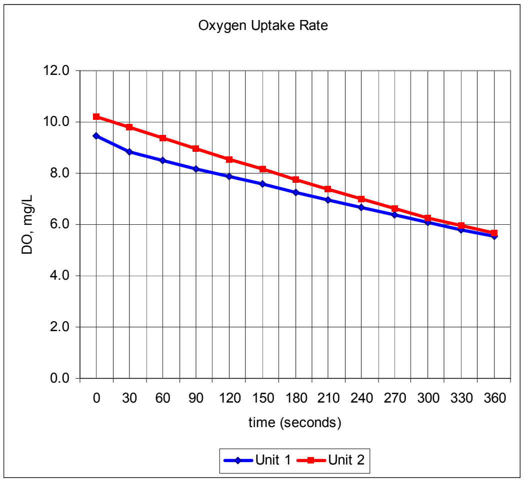


Figure D-9: OUR Graph

moderate rate of decline of oxygen in the sample, where the SOUR was estimated between 18 and 22 mg O_2/g VSS/hr. The biomass was in a generally healthy, steady-state condition near the top of bacterial growth curve, where the activated sludge organisms are considered to be most active. Microscope examination supported this conclusion because it demonstrated fairly active free-swimming and stalked ciliates, with a minimum of rotifers and no observed nematodes nor amoeboids.

Microscopic Exam—
During the WPPE, DEP staff frequently examined the mixed liquor and recorded photographs of typical slide images. Regular microscopy gives operators yet another tool for assessing the relative health, age, and Settleability of the biomass, and facilities that maintain records of plate counts can use this tool to determine steady-state growth conditions for activated sludge.

The photomicrographs shown below are representative examples of biomass found in the ICEAS basins.

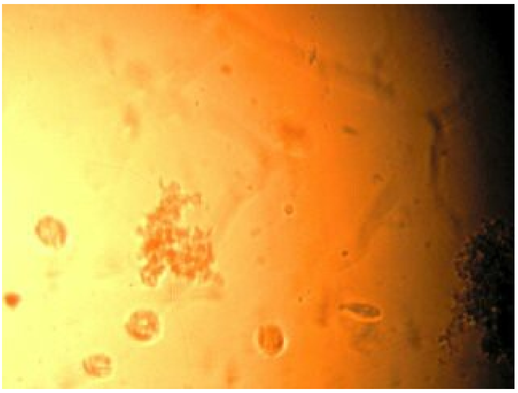


Figure D-10: Free-swimming Ciliates

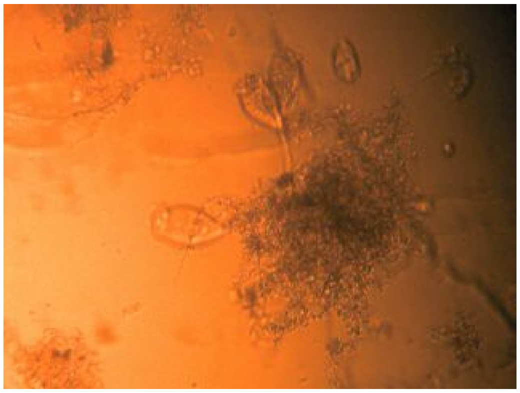


Figure D-11: Zoogleae

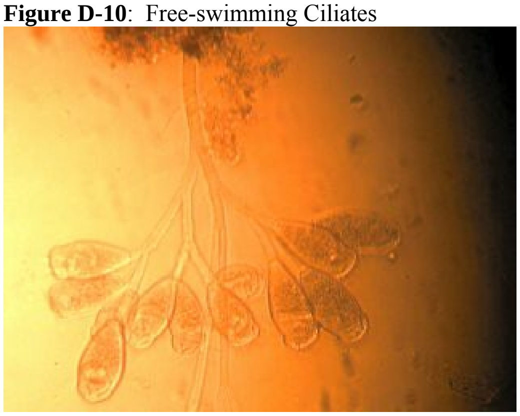


Figure D-12: Vorticellae

Figure D-13: Nematode

Indicator organisms are used as a determinant of relative sludge age: More free swimming ciliates than other, higher life forms usually indicate "young sludge" conditions, while the predominance of mostly rotifers and nematodes indicate "old sludge." The presence of equal numbers of free swimming ciliates and stalked ciliates usually suggests a biomass that exhibits good Settleability and peak growth conditions for treating wastewater. The photo D-13 shows part of a nematode found in a sample of a floating scum layer, where "old sludge" organisms tend to accumulate.

An important thing to remember is that process monitoring test results must be taken in their totality, to give the operator a good indication of the relative stability of the treatment system: for example, good Settleability and moderate SOUR and DO above 1.5 mg/L and the presence of free swimming and stalked ciliates together all indicate a healthy condition.

Settled Sludge SBR Blanket Level & Core Sampling—
Frackville does not routinely conduct process monitoring of the sludge blanket that forms in the ICEAS during settling and decant cycles; however, we have found that regular characterization of the actual settling, aside from sludge Settleability tests, may provide useful information and feedback for the operators.

For example, a rising sludge blanket over a short period of time may indicate plant upset in the near future and allow operators time to intervene. The data will give operators another record by which to observe and notate trends. The end result of trend analysis is to find a range within which the plant best operates and then control the operation to remain within that range.

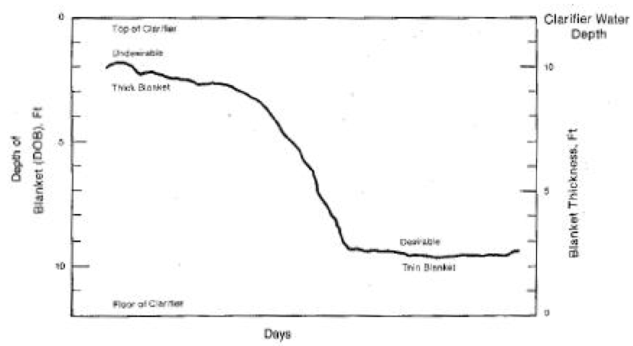


Figure D-14: Sludge settling chart: example of trend mapping

Another benefit of performing this test on the basins is that the operators will rapidly see if perhaps too much or too little polymer has been added to assist in sludge settling. One of the adverse effects of occasionally overdosing polymer in the basins was fouling of the electronic instrumentation, requiring more frequent maintenance.

Flow Measurement—
The facility has flow meters installed in the raw wastewater headworks at a Parshall flume and as a level sensor in the disinfection tank. Flow meter readings are taken at the same time each day and recorded, and continuous charts of changes in flow are recorded and analyzed by the operators. Because an SBR plant discharges treated effluent in batches but an ICEAS-SBR has continuous inflow, it is important to compare the records of both influent and effluent flow measurement and account for the presence of recycle flows such as filtrate from the sludge press. With improvements in microprocessor technology, operations guides generally recommend that chemical feed pumps and automatic samplers be flow-proportioned, as this provides a more accurate method of operation, reducing chemical consumption and cost.

Power Consumption—
This evaluation did not study past or present power consumption trends. Use of the digital DO probe to pace blowers for the ICEAS basins would be a good beginning, as are efforts to employ energy efficient motors, soft-start systems, and the like. The largest monetary cost to a treatment system is for providing power to blower systems. As technology advances, plant operators and owners can benefit from use of higher efficiency motors and better control systems.

US EPA offers, on their website, a simple utility program to calculate efficiency of motors used in treatment facilities, "Motor Master+ 4.0," which allows plant operators to assess motor efficiency and determine costs of replacements. This program is available from EPA's website, at

http://www1.eere.energy.gov/industry/bestpractices/software.html

Typically,

- Traditional fast cheap motor rewinds have an average loss of 20% efficiency each time the coil is repaired.
- Even with reliable repair shops, using OEM or OEM-equivalent materials, the efficiency loss is 1% or 2% each instance.
- EPA literature recommends that motors be replaced if:
  - Motor of any age has a rating less than 40 hp;
  - The cost of the rewind exceeds 65% of the price of a new energy efficient motor;
  - The motor was rewound before 1980.

During the WPPE, DEP staff did not evaluate the facility's emergency power generator, although it was noted that the plant operators run the generator on a regular basis according to the manufacturer's specifications. It is important that, when exercising a generator set, that both engine and generator are exercised; so that the operators can be assured that the treatment plant will continue to operate during interruptions of utility line power.

eDMR—
Presently, Frackville publishes its monthly discharge monitoring reports (DMR) using pre-printed forms. DEP has established an electronic reporting method that it recommends all NPDES holders use. The electronic DMR reporting system (eDMR) allows users to enter its monthly reports on a secure website, and its use reduces the possibility for transposition errors in data entry or other optical scanning errors. Furthermore, eDMR is equipped to perform many routine loading calculations. It is recommended that the operators begin using eDMR.

Inflow/Infiltration (I/I)—
Frackville has benefited from ongoing efforts to reduce I/I in the collection system. The recent Wasteload Management (Chapter 94) reports show that the efforts to mitigate and reduce I/I are an ongoing activity of the Authority, which is always sensible.

Pathogen Control—
The evaluation included analysis for specific waterborne pathogens, *Giardia lamblia* cyst and *Cryptosporidium* oocyst, in addition to total and fecal *Coliform* testing. These pathogens are responsible for severe lower gastrointestinal disease which can be chronic and even fatal for immune-compromised populations such as the elderly, infants, and people taking anti-rejection drugs or having certain chronic medical conditions. Following severe system-wide cryptosporidium outbreaks during the mid-1990s, the federal government began requiring surface water filtration plants to meet strict pathogen reduction goals. Since wastewater treatment facilities tend to contribute large concentrations of *Giardia* cyst to receiving surface waters, an effort has been made to analyze whether optimization may reduce these quantities. However, there was no overall correlation between facility optimization and waterborne pathogen reduction, although the final series of Method 1623 tests for *Cryptosporidium* and *Giardia* at the Frackville facility showed no pathogens found in any of three samples.

Subsequent investigation of the occurrence of waterborne pathogens at wastewater treatment facilities determined that the most effective method of killing these pathogens was to apply some combination of multiple disinfection methods such as UV light followed by ozonation or chlorination or barrier filtration, the sum of which would add significant capital costs to each treatment facility.

Operations Regulations & Operator-in-Charge—
Recent changes to the Operator Certification regulations have defined the concept of "Operator in Charge," who is the licensed operator responsible for making process control decisions. Many of the regulations changes provide stronger protections for plant operators and facility owners by establishing systematic criteria for assuring operator and owner responsibility. DEP recommends that licensed operators review the regulations carefully to understand their responsibilities under the regulations, as well as their rights and protections. Most significant is the provision that when operators have discovered and corrected a non-compliance, they report this in writing to the facility owner or Authority, documenting measures taken to resolve the noncompliance and efforts made to prevent a recurrence. It is also important for licensed operators to be certified for the type of treatment system they operate. Additional information on this may be found at DEP's website.

THIS PAGE INTENTIONALLY LEFT BLANK

E—Equipment Deployed
Digital, Continuously Monitoring Probes
Laboratory Equipment On-Loan

Digital, Continuously Monitoring Probes:
1 – Laptop computer with signal converter
1 – SC1000 SCADA Base Unit
1 – LDO probe
1 – pH probe
1 – ORP probe
1 – NH_4D probe w/Cleaning System
1 – Nitratax probes
1 – Solitax probes

Laboratory Equipment On-loan:
1 – Hach HQ40d handheld pH and LDO meter
1 – LBOD probe
1 – DR2800 spectrophotometer
1 – Wastewater Field Test Kit
1 – Raven centrifuge
1 – Raven Core Taker sampler
2 – Raven settleometers
1 – COD Heater Block
1 – Microscope with photographic/video capability

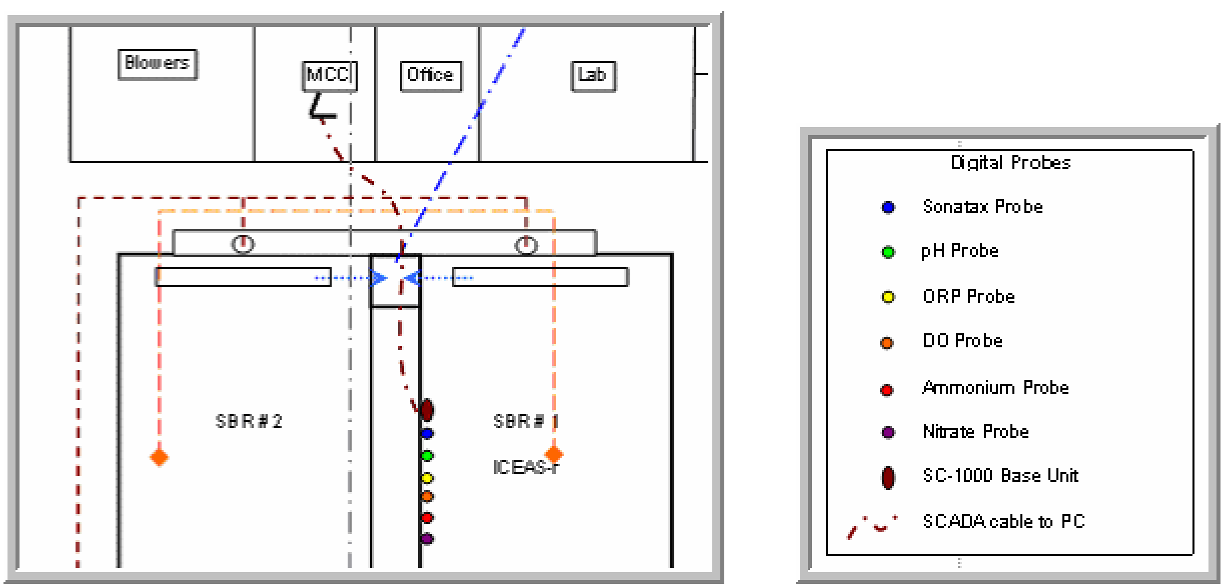


Figure E-1: SBR 1 Equipment Placement & Computer, with legend

THIS PAGE INTENTIONALLY LEFT BLANK

F—Equipment Placement Photos

Figure F.1: SC-1000 Base Unit

Figure F.2: ORP, pH, DO, and Sonatax Probes

Figure F.3: At low level, some instruments are above surface. Sludge blanket interface probe at lower right.

Figure F.4: Nitratax Probe Assembly at lower left.

Figure F.5: Probes on swing arms during aeration/fill cycle

Figure F.6: Probes during decant cycle, two are above water.

Figure F.7: Probe floats at high-level/start of decant cycle.

Figure F.8: Equipment staged for assembly and deployment.

Figure F.9: Upstream (Background) Sampling Point
Upstream (Background) Sampling Point

Figure F.10: Downstream (Impacted) Sampling Point.

Figure F-11: Frackville Process Monitoring Laboratory

Figure F-12: Example of touch-screen display on SC-1000

G— Continuous Digital Monitoring Charts

The following charts are examples of the data recorded from the continuous digital monitoring probes, set at 15-minute intervals. Additional data is available on the Data Disk.

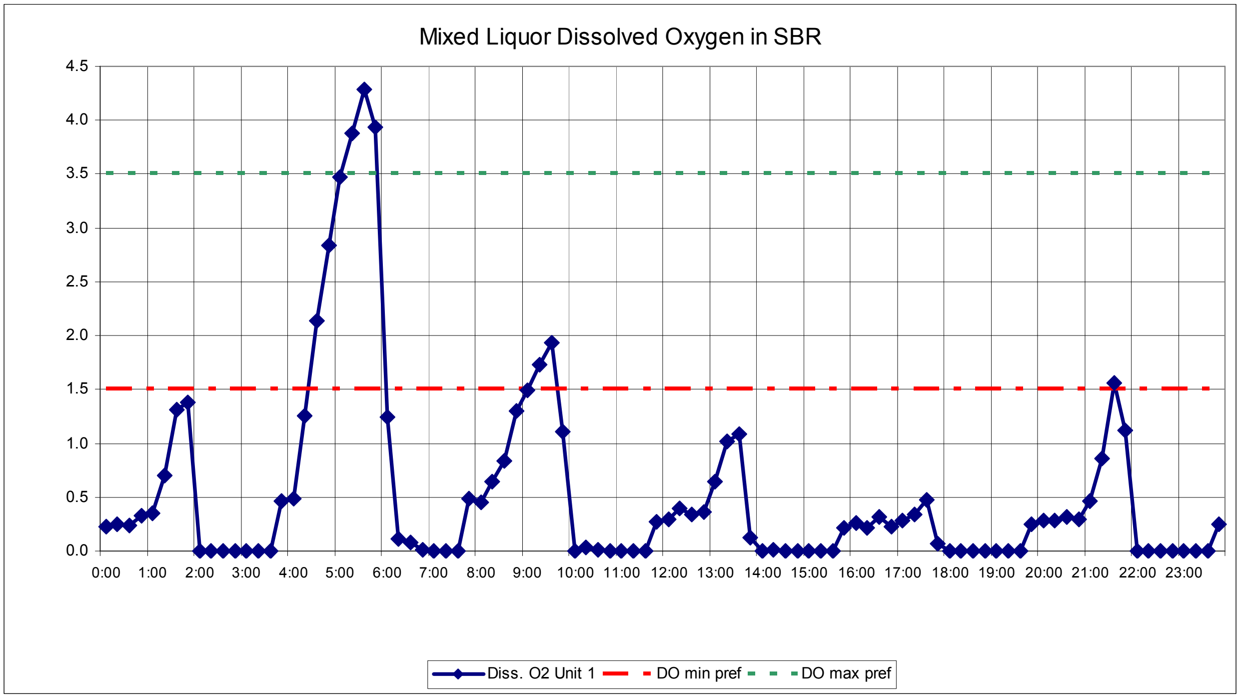


Figure G-1: Mixed Liquor Dissolved Oxygen Histogram, SBR 1, 4/23/2010

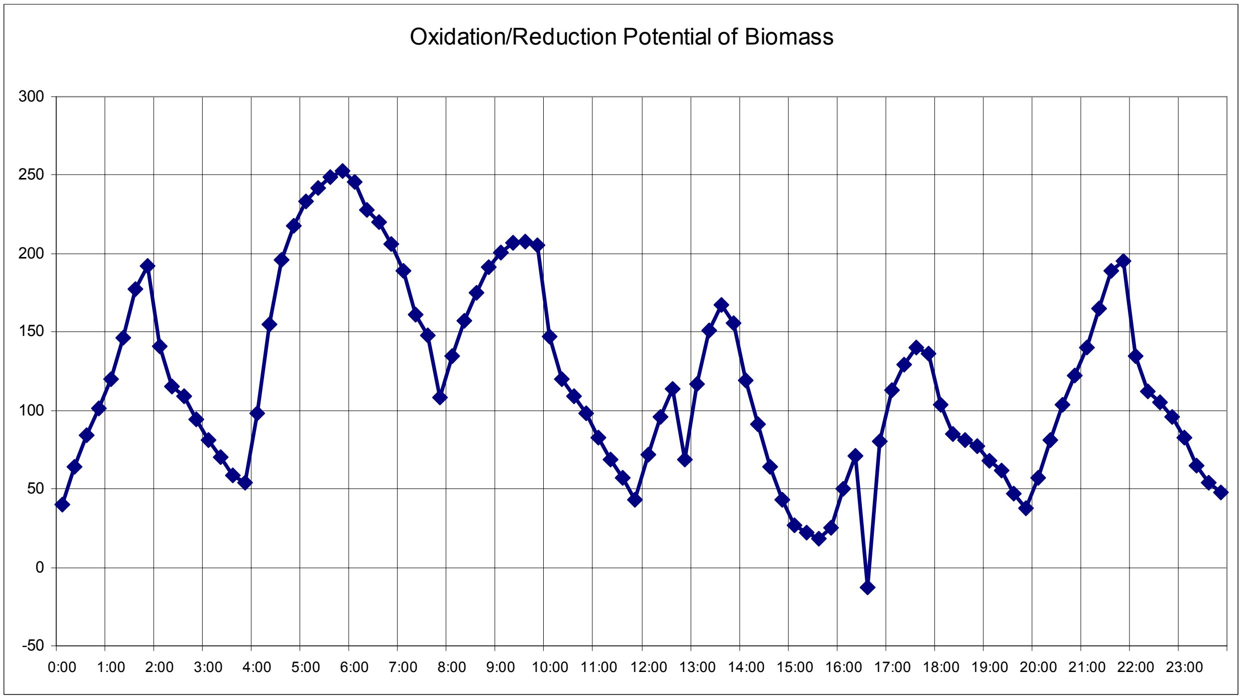


Figure G-2: Mixed Liquor Oxidation/Reduction Potential Histogram, SBR 1, 4/23/2010

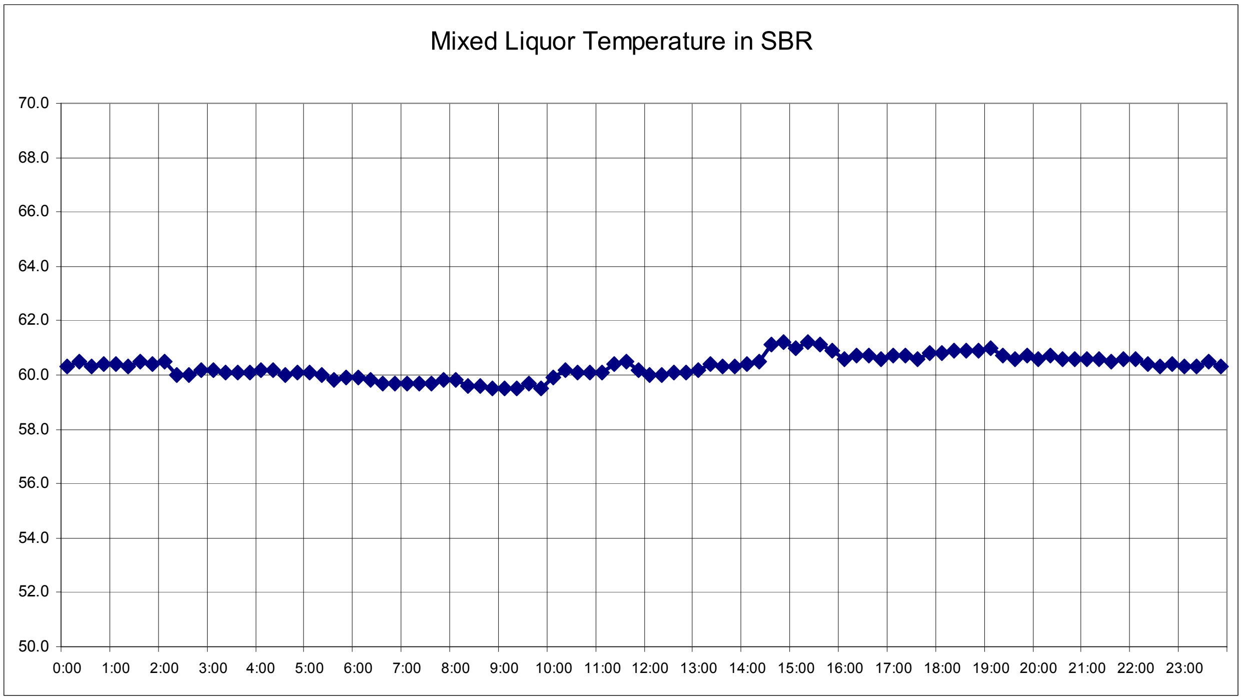


Figure G-3: Example Mixed Liquor Temperature Histogram, degrees F, for SBR 1, 4/23/2010

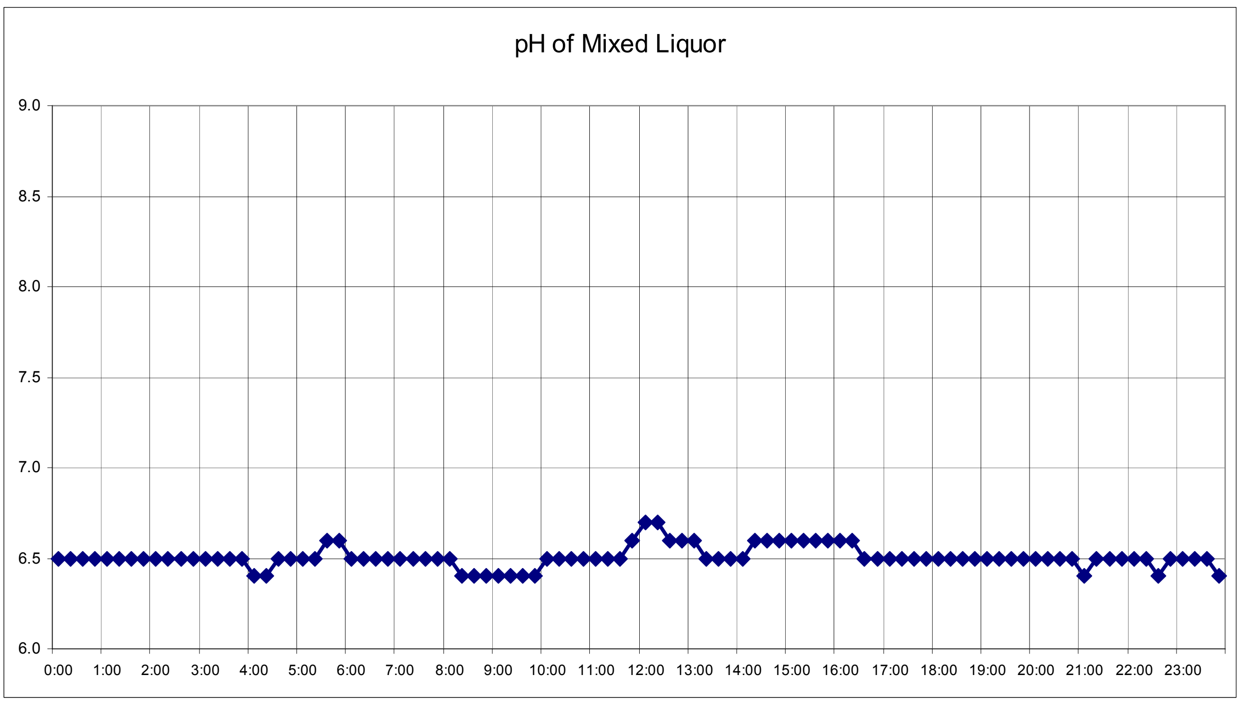


Figure G-4: Mixed Liquor Daily pH Histogram, SBR 1, 4/23/2010

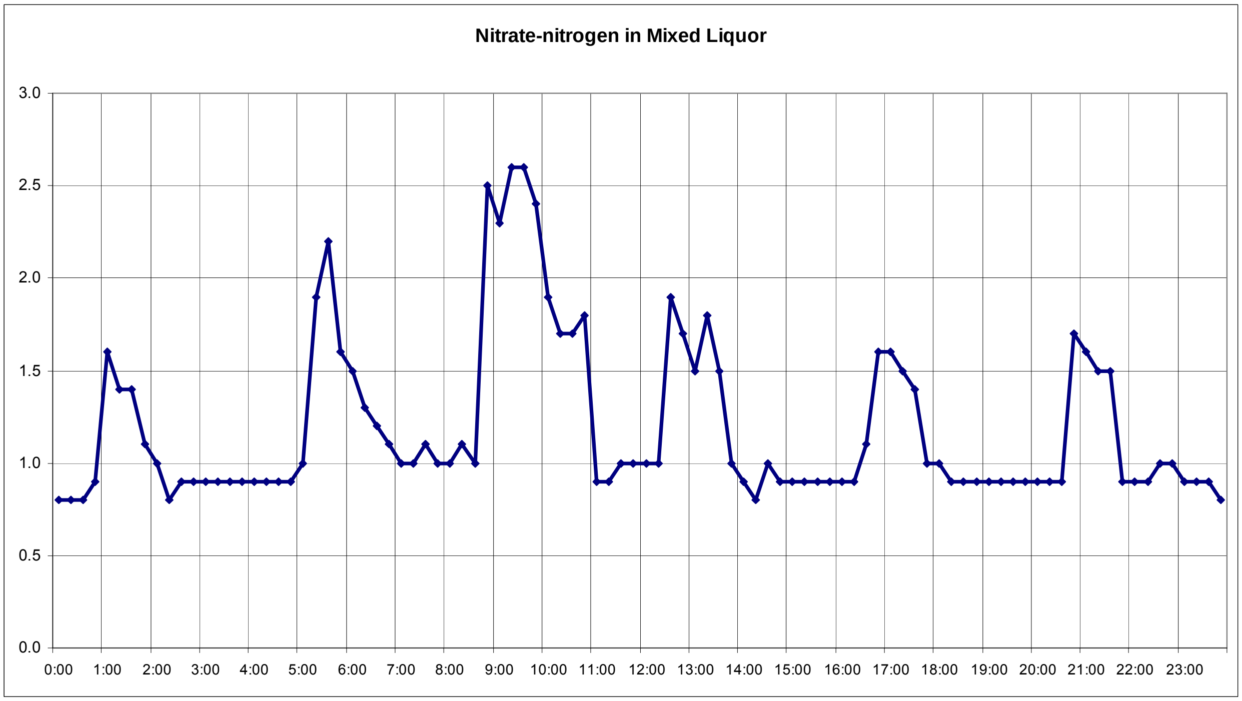


Figure G-5: Example Mixed Liquor Nitrate-nitrogen Concentration Histogram, SBR 1, 4/4/2010

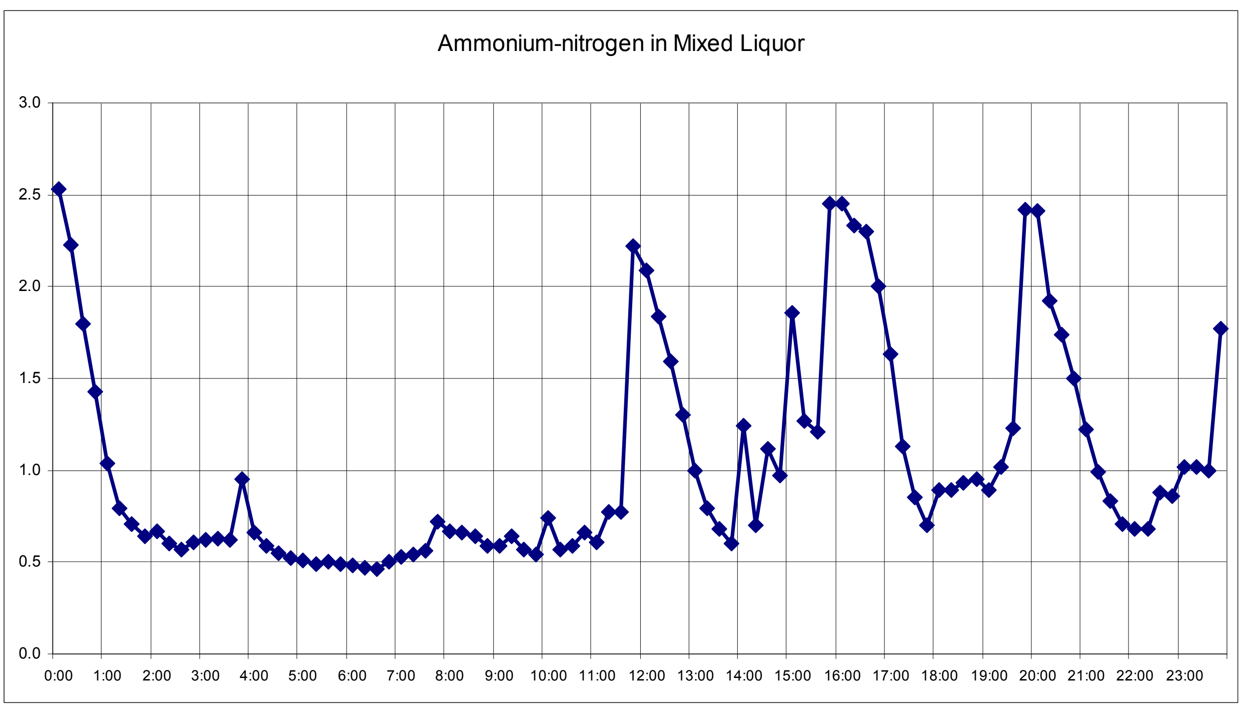


Figure G-6: Example Mixed Liquor Ammonium-nitrogen Concentration Histogram, SBR 1, 4/9/2010

Note on Figure G-7: When SBR is in aeration mode, probe detects zero depth to sludge blanket interface; during settling & decant cycles, probe detects sludge interface at about 13 ft. depth.

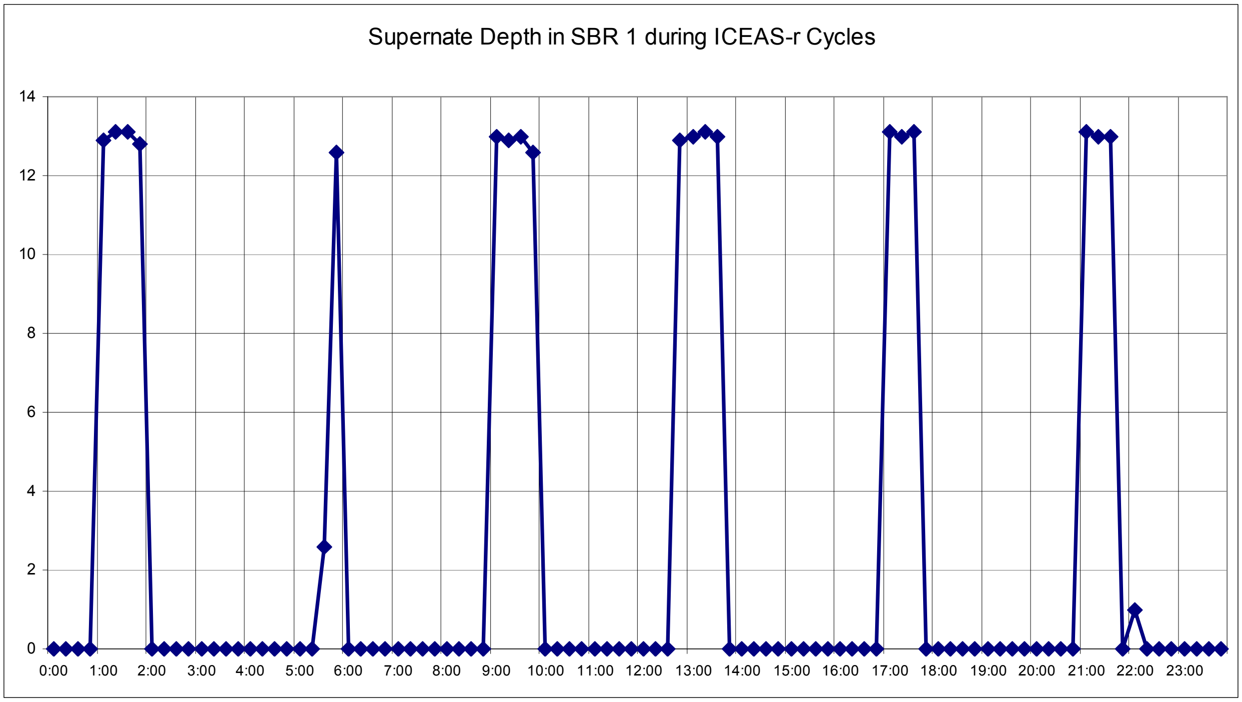


Figure G-7: Example Supernate Depth during ICEAS-r Cycles, SBR 1, 04/04/2010

Example Period Histograms for April & May 2010

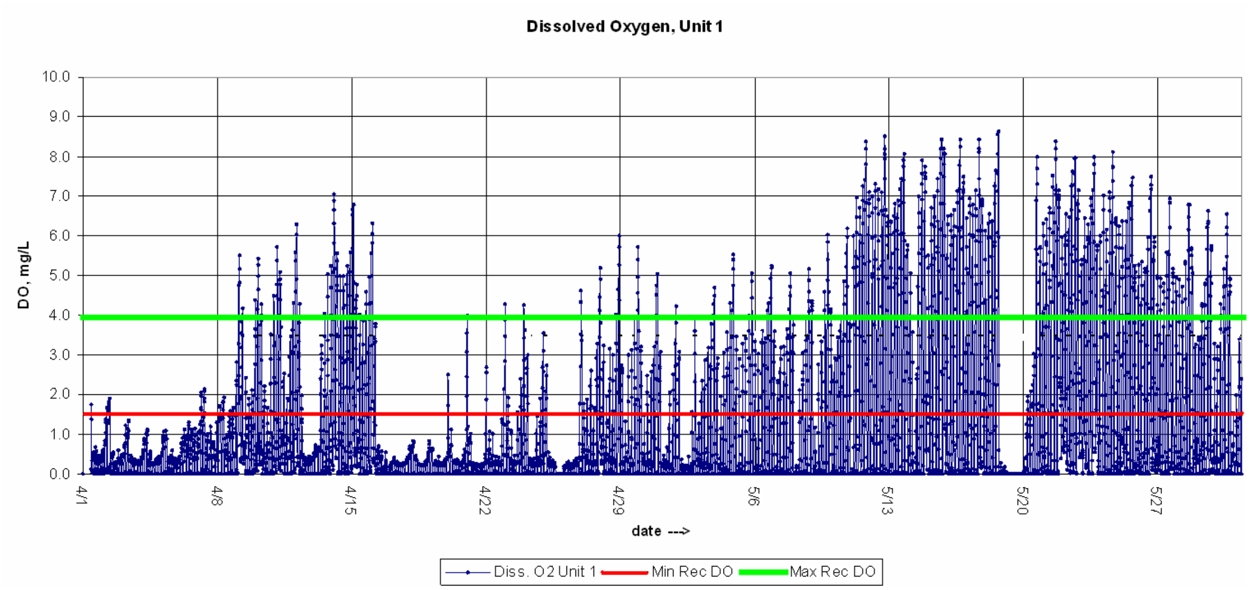


Figure G-9: Dissolved O2 Concentration, SBR 1, April & May 2010

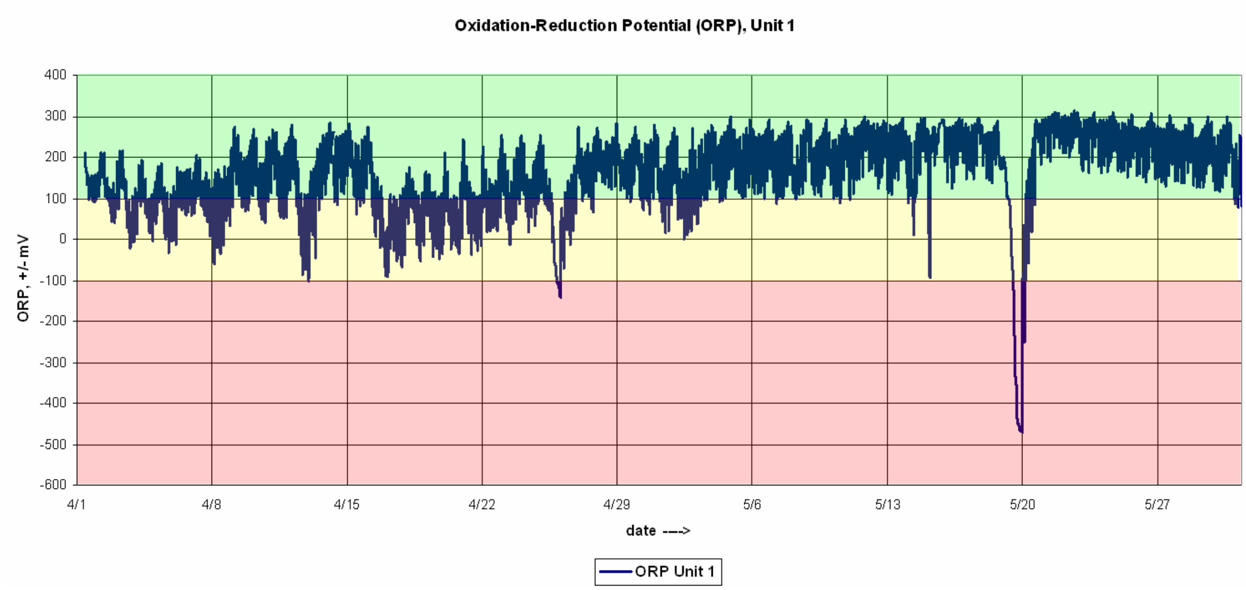


Figure G-10: Oxidation / Reduction in Biomass Membrane of Mixed Liquor, SBR 1, April & May 2010

Note on ORP: Green range depicts ideal nitrification; yellow range depicts ideal denitrification; red range depicts danger zone for septicity. Decant arm failure in late May required operators to set basin 1 to “storm flow” conditions overnight while temporary power supply was established. During this time, the ORP probe detected anaerobic conditions.

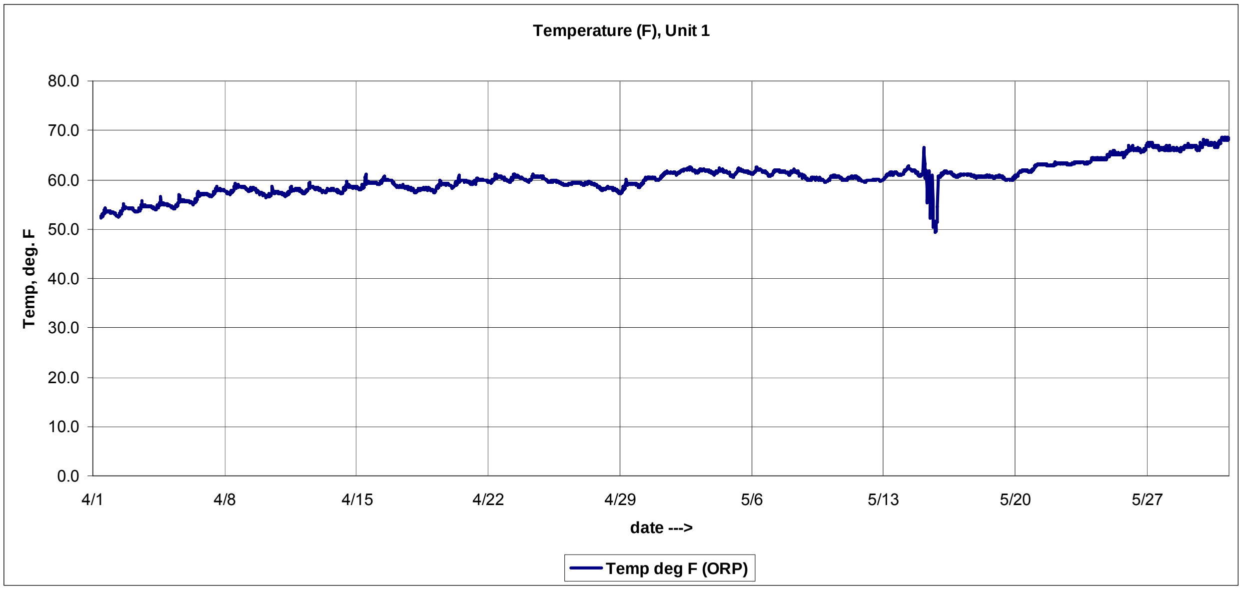


Figure G-11: Mixed Liquor Temperature in degrees Fahrenheit, SBR 1, April & May 2010

Note on temperature: Basin temperatures were recorded during Spring. The mixed liquor temperature will rise into the mid-eighties during summer and drop as low as fifty during winter.

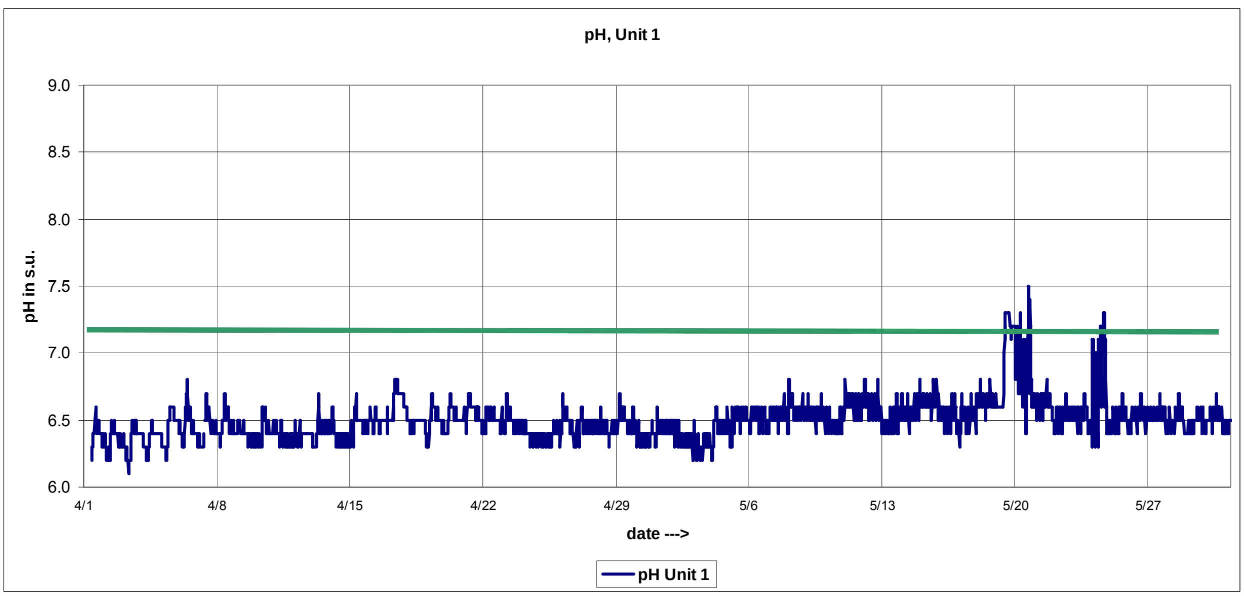


Figure G-12: Mixed Liquor pH, SBR 1, April & May 2010 (Line at pH 7.2 shows ideal set point)

Note on pH: Most SBRs can nitrify at pH ranges of 6.5 to 7.0 s.u. For biological nutrient control, *nitrosomonas* and *nitrobacter* prefer pH within a range from 7.5 to 8.5, and the in the process of nitrification, these facultative bacteria excrete acid which consumes alkalinity. Approximately 7.1 mg/L of alkalinity as $CaCO_3$ are consumed for each 1.0 mg/L of NH_3-N oxidized to NO_3. Therefore, it is important to have enough alkalinity available for nitrification to take place, or the biomass must be supplemented with additional buffer capacity. Frackville's pH is at the low end of the acceptable pH range and could be better.

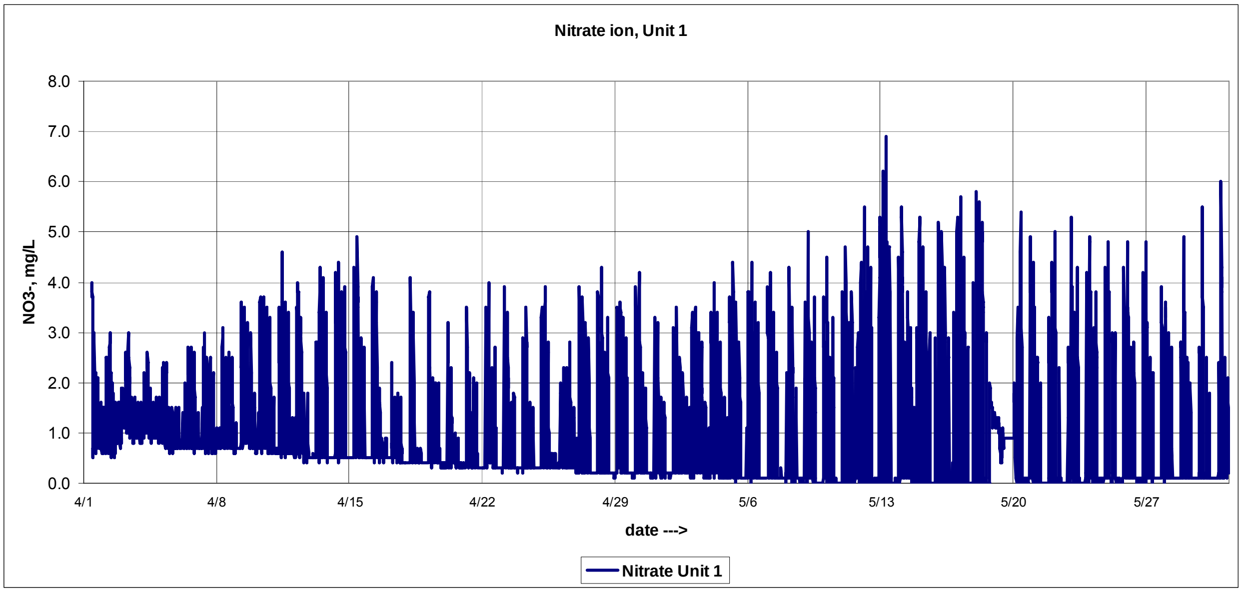


Figure G-13: Mixed Liquor Nitrate-nitrogen Concentration, SBR 1, April & May 2010

Note: Nitrate production varies according to availability of oxygen, carbon, and alkalinity. It peaks when ORP rises above 150 mV to 350 mV. During the settling and decant cycles, nitrification is curtailed and denitrification occurs on a small scale.

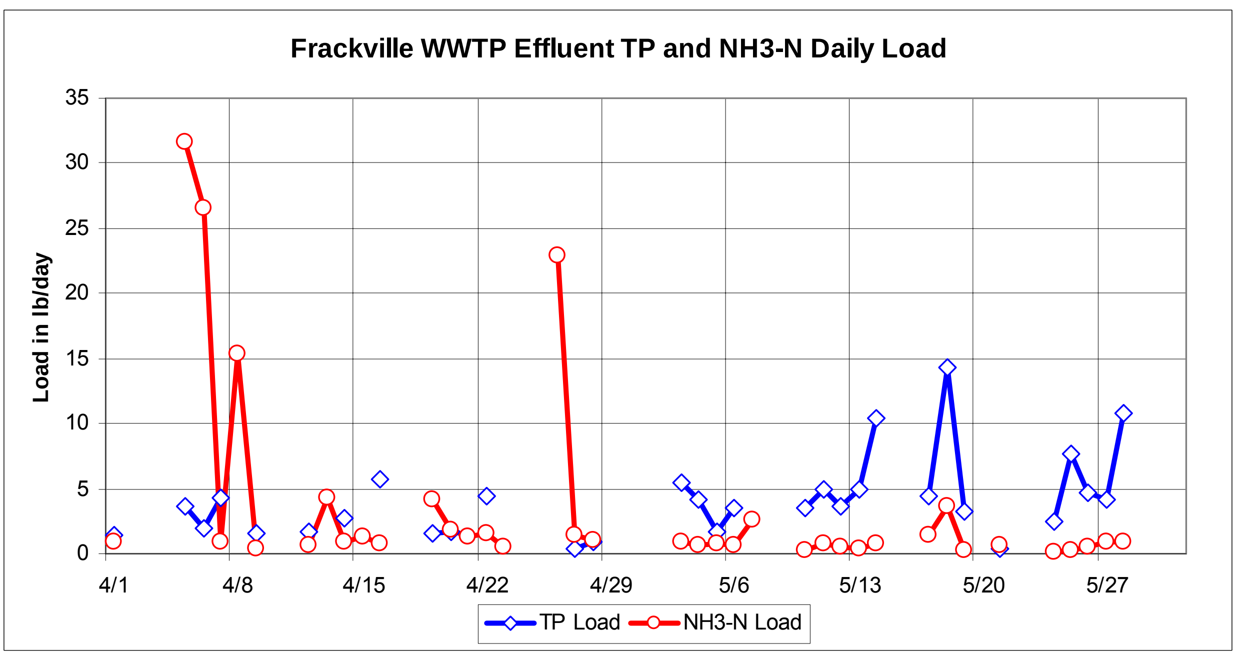


Figure G-14: Mixed Liquor Ammonium-nitrogen Concentration, SBR 1, April & May 2010

Note: The numbers reported here are calculated using data generated by the BOL sample test results, as there had been no working Amtax probe during the WPPE.

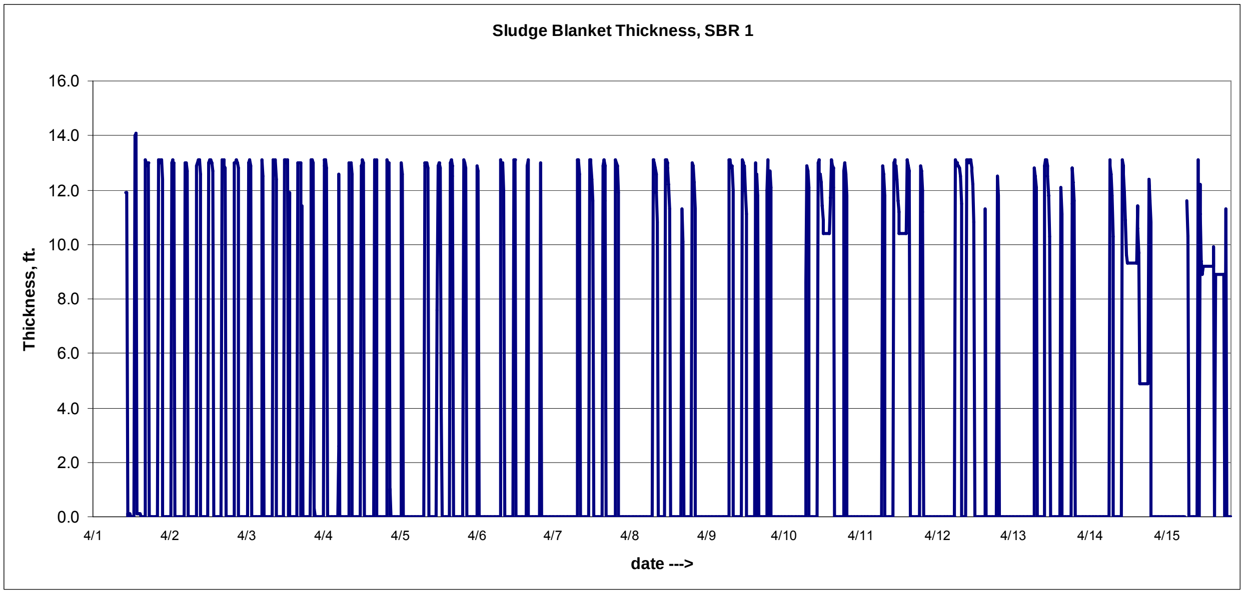


Figure G-15: Aeration / Settling-Decant Cycles, SBR 1, April 1 to April 15, 2010

Note: The chart in the above figure shows aeration/settling cycles of the ICEAS, where sludge "thickness" of the full range represents the aeration cycle. The charted minima represent the sludge thickness during the settling cycle, and the gaps are where the instrument was not submersed following the decant cycle. In other words, using the Sonatax probe on an SBR proved to be not very useful at all.

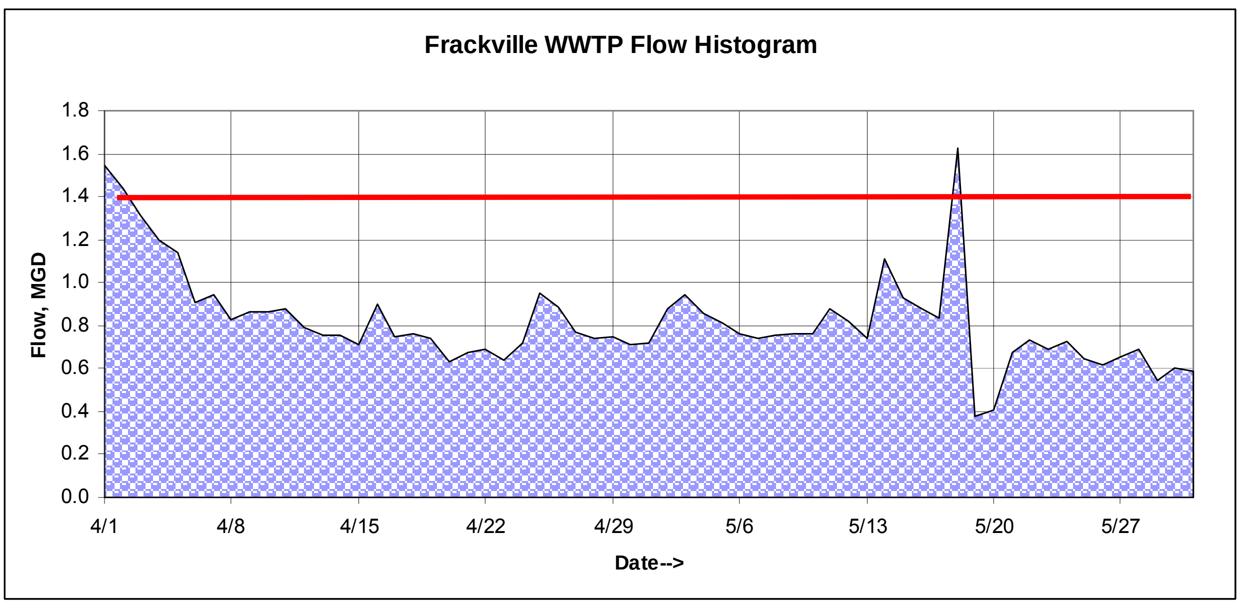


Figure G-16: Facility Effluent Flow Histogram, April & May2010

H—Pathogen Test Results (Method 1623 for Giardia and Cryptosporidium)

Tests for drinking water pathogen cysts, using EPA Method 1623, were performed on 3 sets of 10-liter samples taken on three separate days. Sampling points were

- Upstream/Background: Upstream of Outfall 001 for "background" purposes
- Effluent: Frackville final effluent at facility sampling point
- Downstream/Impacted: 4.7 miles downstream of Outfall 001 at the iron bridge over Little Mahanoy Creek, approximately near the water plant intake from the reservoir.

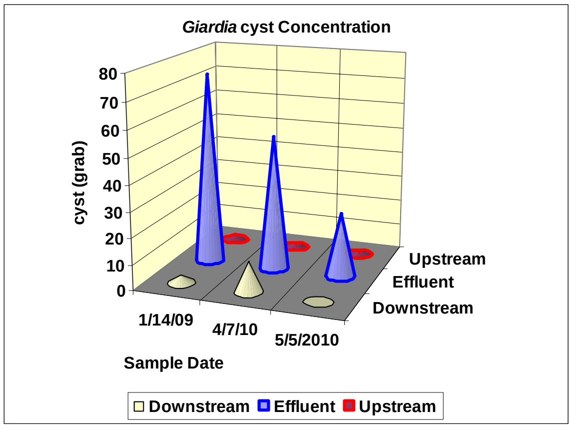
Giardia lamblia cysts were pronounced in the effluent samples from Frackville, although the test method could not determine the viability of these cysts, which may have been inactivated by exposure to ultraviolet (UV radiation.) We observed a mild decline in the number of *Giardia* cysts counted in effluent samples from winter conditions through early summer conditions; however, this was not a function of changes to the wastewater treatment so much as it had been due to changing viability of the cysts as water temperatures rose. In background sampling, very little *Giardia* had been found, and only the middle sampling event showed evidence of adverse impact by the relatively large dosing of effluent *Giardia* from plant effluent, probably due to inflow/infiltration in the collection system on a day having heavy localized rainfall.

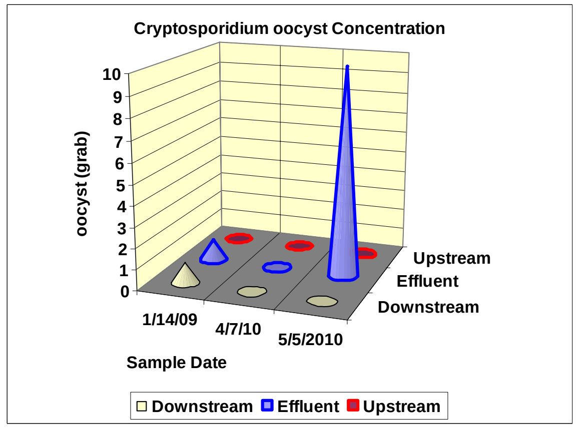
Most likely, this *Giardia* came from animal fecal sources within the collection system, and it occurred whether or not precipitation events preceded the sampling events. One might conclude that *Giardia* is relatively inherent in the facility's collection system, although such a statement does not confirm one way or another that the disease giardiasis is endemic but non-pathogenic in the Frackville population.

Cryptosporidium oocyst were found in plant effluent on two occasions, with a high concentration in the sample taken 5/4/10, the afternoon of a strong, localized thunderstorm. Yet both the upstream and downstream samples did not contain this pathogen. The oocyst did occur in the plant effluent sample in the sample taken 1/15/09, in dead of winter.

As we have found at other treatment facilities, *Giardia lamblia* cyst was more likely to be found in treated effluent than *Cryptosporidium*; however, the test method does not confirm pathogenicity, whether or not the cysts are capable of reproducing. The test uses fluorescent antibodies that merely detect potentially viable cysts. UV disinfection may inactivate these cysts without destroying their structural appearance, so they may be detected without our truly knowing if exposure to UV light had killed them.

Unfortunately, although treatment cycles in the SBR may have been adjusted during the WPPE, this had no bearing on the presence or reduction of Method 1623 pathogens. Therefore, the plant operators should be aware that these micro-organisms are endemic to the treated wastewater, and the





FRACKVILLE	LOCATION	GIARDIA	CRYPTO	DESCRIPTION
1/15/2009	UPS	2	0	Upstream/Background
1/15/2009	EFF	74	1	Plant Effluent
1/15/2009	DWS	3	1	Downstream/Impacted
4/7/2010	UPS	1	0	Upstream/Background
4/7/2010	EFF	52	0	Plant Effluent
4/7/2010	DWS	12	0	Downstream/Impacted
5/5/2010	UPS	1	0	Upstream/Background
5/4/2010	EFF	25	10	Plant Effluent
5/4/2010	DWS	0	0	Downstream/Impacted

I—Process Monitoring Tests: Example WPPE Daily/Weekly Bench Data

Frackville Area Municipal Authority STP Process Monitoring Data for
Tuesday, April 6, 2010

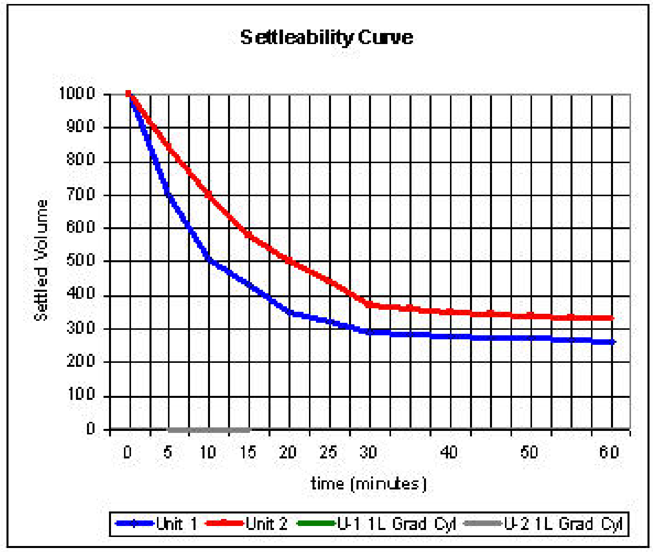
Raw WW	174	mg/L COD	1,321	lb/day	BOD5 Analog =	132 mg/L	=	1,004 lb/day
Flow at nc	0.910	MGD						

Settleability:

	Unit 1	Unit 2
0	1000	1000
5	700	840
10	510	700
15	430	580
20	350	500
25	320	440
30	290	370
	285	360
40	280	350
	275	345
50	270	340
	265	335
60	260	330

OUR

time	Unit 1 reading	Unit 2 reading
0	9.15	9.95
30	8.82	9.35
60	8.60	8.75
90	8.39	8.16
120	8.18	7.67
150	7.97	7.04
180	7.76	6.47
210	7.58	5.89
240	7.36	5.32
270	7.17	4.74
300	6.92	4.16
330	6.62	3.58
360	6.38	3.03
Slope	0.446	1.158
OUR	26.76	69.48
check		
Slope2		



Centrifuge solids by volume

Unit 1	Unit 2	
2.75	2.75	

pH checks

Unit 1	Unit 2	Eff
6.7	6.6	6.7

Parameter	AT1	AT2		Effluent	Digester
DO	1.7	0		7.1	
Temp	14.2	14.3		9.6	
SSV-30	290	370			
MLSS	1,630	2,310			
SVI	178	160			

Unit 1 Process Nutrients:			Dilution	Tube	Under/Ove
PO4-P	2.49	mg/L P	No dilution	HR	-
NH4-N	2.15	mg/L N	No dilution	LR	-
NO3-N		mg/L N	No dilution	HR	

Unit 2 Process Nutrients:			Dilution	Tube	Under/Ove
PO4-P	0.952	mg/L P	No dilution	HR	u
NH4-N	2.08	mg/L N	No dilution	LR	-
NO3-N	0.449	mg/L N	No dilution	LR	-

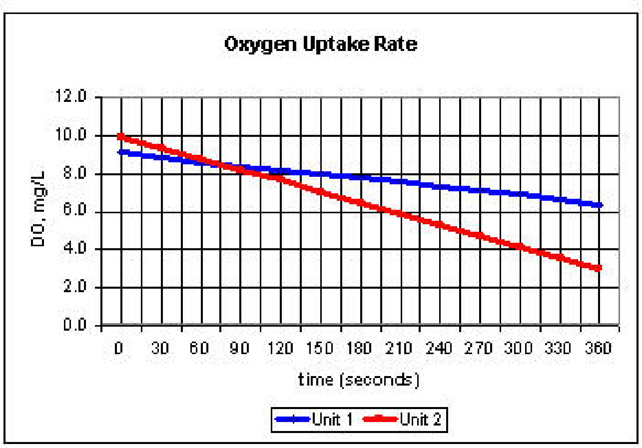
Effluent Nutrients:			Dilution	Tube	Under/Over
PO4-P	2.07	mg/L P	No dilution	HR	-
NH4-N	1.25	mg/L N	No dilution	ULR	-
NO3-N	0.313	mg/L N	No dilution	LR	

Settled Sludge Concentration

time	Unit 1	Unit 2
0	2.8	2.8
5	3.9	3.3
10	5.4	3.9
15	6.4	4.7
20	7.9	5.5
25	8.6	6.3
30	9.5	7.4
	9.7	7.6
40	9.8	7.9
	10.0	8.0
50	10.2	8.1
	10.4	8.2
60	10.6	8.3

Notes: PO4-P for Unit 1 on 4/1/10 was 4.71 mg/L using HR.

Blue numbers are entered
Red numbers are calculated



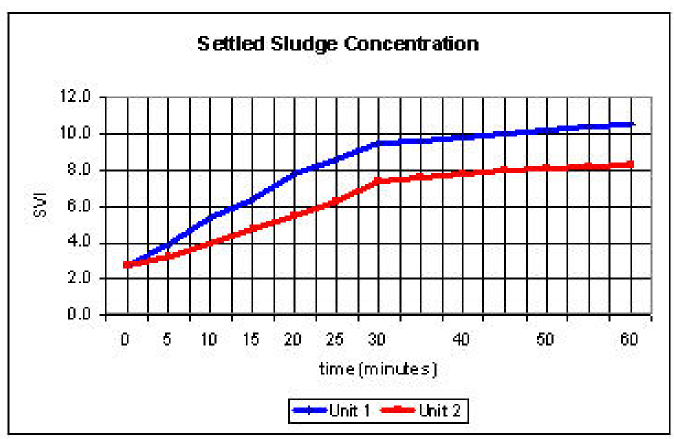


Figure I-1: Example of Process Monitoring Bench Testing Results.

Frackville Area Municipal Authority STP Process Monitoring Data for
Wednesday, May 26, 2010

Raw WW 432 mg/L COD 2,335 lb/day BOD5 Analog = 328 mg/L = 1,774 lb/day
Flow at nc 0.648 MGD

Settleability:

	Unit 1	Unit 2
0	1000	1000
5	970	950
10	950	850
15	930	780
20	890	700
25	870	620
30	820	550
	810	500
40	800	460
	770	430
50	740	400
	715	390
60	690	380

OUR

time	Unit 1 reading	Unit 2 reading
0	8.95	9.49
30	8.66	8.90
60	8.40	8.78
90	8.13	8.67
120	7.88	8.57
150	7.81	8.46
180	7.72	8.35
210	7.65	8.25
240	7.59	8.14
270	7.54	8.03
300	7.48	7.93
330	7.43	7.81
360	7.30	7.71
Slope	0.294	0.312
OUR	17.6	18.72
check	0.19	0.21
OUR man.	11.4	12.6

Centrifuge solids by volume

Raw	Unit 1	Unit 2	Eff
0.02	4.5	3.3	0

pH checks

INF	Unit 1	Unit 2	Eff
	6.8	6.7	

Parameter	Unit 1		Unit 2		Effluent	Digester
DO	3.22		3.86		6.44	
Temp	18.2		18.41		18.27	
pH	6.8		6.7			
OUR	17.6		18.72			
RR	8.5		#DIV/0!			
SSV-30	820		550			
MLSS	2,560					
VSS	2,074		-			
SVI	320		#DIV/0!			

Theoretical VSS/TSS %
81%

Settled Sludge Concentration

time	Unit 1	Unit 2
0	4.50	3.30
5	4.64	3.47
10	4.74	3.88
15	4.84	4.23
20	5.06	4.71
25	5.17	5.32
30	5.49	6.00
	5.56	6.60
40	5.63	7.17
	5.84	7.67
50	6.08	8.25
	6.29	8.46
60	6.52	8.68

Unit 1 Process Nutrients:			Dilution	Tube	Under/Ove
PO4-P	1.620	mg/L P	No dilution	HR	-
NH4-N	0.533	mg/L N	No dilution	ULR	-
NO3-N	1.14	mg/L N	No dilution	HR	

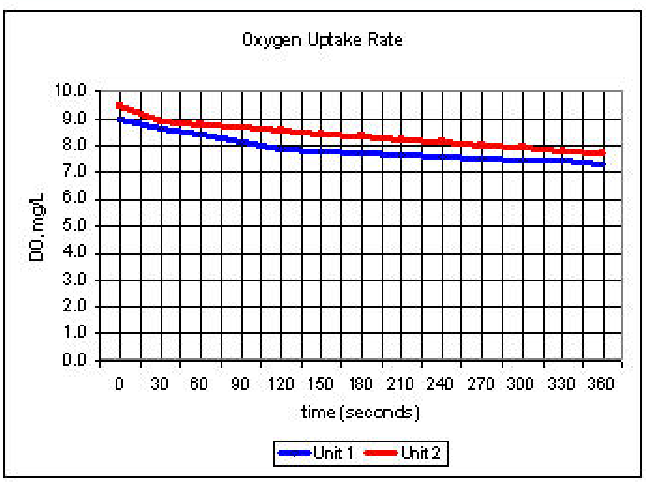
Unit 2 Process Nutrients:			Dilution	Tube	Under/Ove
PO4-P	1.450	mg/L P	No dilution	HR	-
NH4-N	0.049	mg/L N	No dilution	ULR	-
NO3-N	4.32	mg/L N	No dilution	LR	-

Raw WW Process Nutrients:			Dilution	Tube	Under/Ove
PO4-P	3.280	mg/L P	No dilution	HR	-
NH4-N	0.149	mg/L N	No dilution	LR	-
NO3-N		mg/L N	No dilution	HR	

Effluent Nutrients:			Dilution	Tube	Under/Ove
PO4-P	1.310	mg/L P	No dilution	HR	-
NH4-N	0.112	mg/L N	No dilution	ULR	-
NO3-N	2.87	mg/L N	No dilution	LR	

Notes: Sample SBR1 taken at start of aeration cycle; Sample SBR2 taken 10 minutes before start of settling cycle.
Effluent sample taken shortly after SBR1 was decanting (grab sample.)
Sludge press running today.

Blue numbers are entered
Red numbers are calculated or transferred from manual entry cells



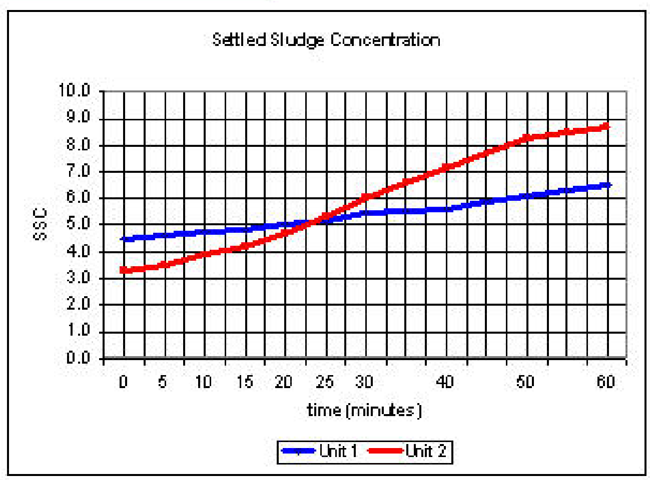


Figure I-2: Example of Process Monitoring Bench Testing, cont'd.

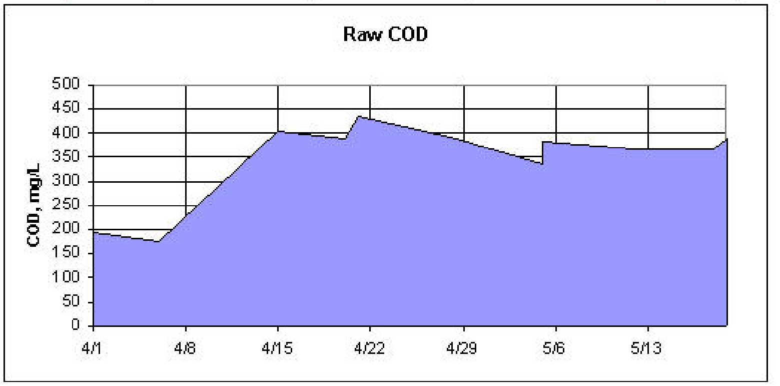
Frackville Area Municipal Authority STP Process Monitoring Data for
Wednesday, May 19, 2010

RawWW	390	mg/L COD	2,879	lb/day	BOD5 Analog =	296 mg/L	= 2,188 lb/day
Flow at nc	0.885	MGD					

Colorimetry Results from Spectrophotometer memory:

Date	INF COD	INF
4/1/10	123	LR
4/1/10	195	HR
4/6/10	174	
4/15/10	405	HR
4/15/10	208	LR
4/20/10	388	
4/21/10	436	
4/28/10	392	
5/5/10	336	
5/5/10	381	
5/12/10	368	
5/18/10	368	
5/19/10	390	

Date	INF COD
4/1/10	195
4/6/10	174
4/15/10	405
4/20/10	388
4/21/10	436
4/28/10	392
5/5/10	336
5/5/10	381
5/12/10	368
5/18/10	368
5/19/10	390



RawWW Process Nutrients:			Dilution	Tube	Under/Ove
PO4-P	3.59	mg/L P	No dilution	HR	-
NH4-N	13.2	mg/L N	No dilution	LR	-
NO3-N	0.978	mg/L N	No dilution	HR	

Unit 1 Process Nutrients:			Dilution	Tube	Under/Over
PO4-P	1.42	mg/L P	No dilution	HR	-
NH4-N	0.172	mg/L N	No dilution	ULR	-
NO3-N	1.59	mg/L N	No dilution	HR	

Unit 2 Process Nutrients:			Dilution	Tube	Under/Ove
PO4-P	1.15	mg/L P	No dilution	HR	-
NH4-N	0.124	mg/L N	No dilution	ULR	-
NO3-N	2.65	mg/L N	No dilution	LR	-

Effluent Nutrients:			Dilution	Tube	Under/Over
PO4-P	1.05	mg/L P	No dilution	HR	-
NH4-N	0.091	mg/L N	No dilution	ULR	-
NO3-N	2.69	mg/L N	No dilution	LR	

Figure I-3: Example of Process Monitoring Bench Testing, cont'd.

THIS PAGE INTENTIONALLY LEFT BLANK

J—Graphs: Process Monitoring Test Results

The following pages represent the samples collected by Department personnel over the project period. These samples are for informational use in identifying trends and effects of process modifications where applicable. These samples were not collected with the intentions of being used for compliance purposes.

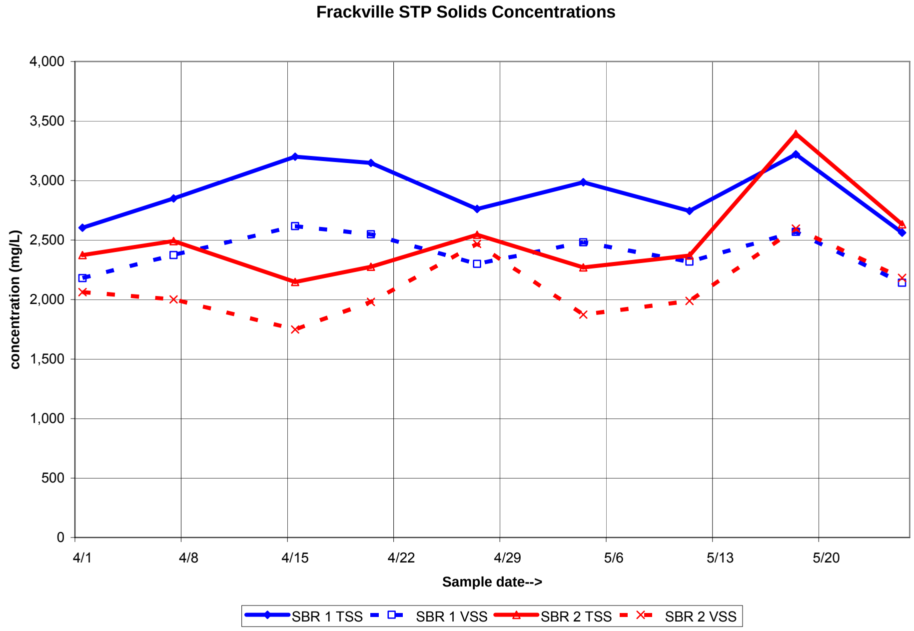


Figure J-1: Mixed Liquor Suspended Solids for BOL Samples

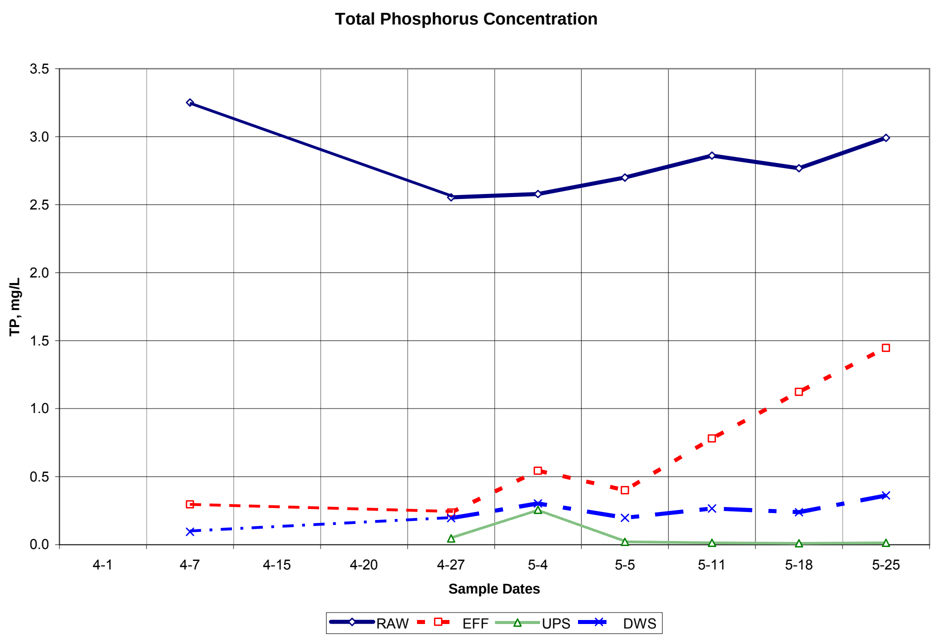


Figure J-2: Phosphorus Test Results for BOL Samples.

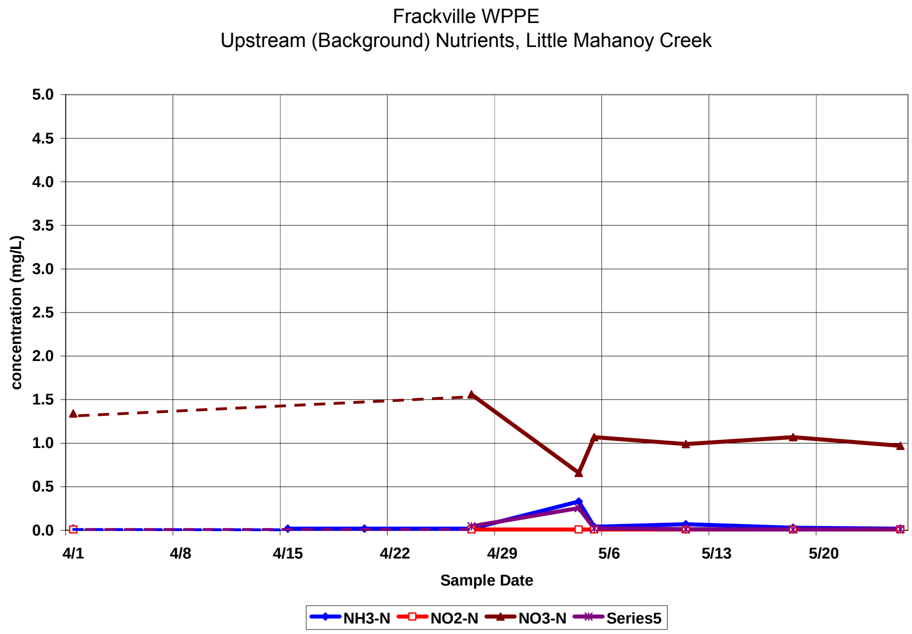


Figure J-3: Background Nutrient Concentrations found in BOL Samples

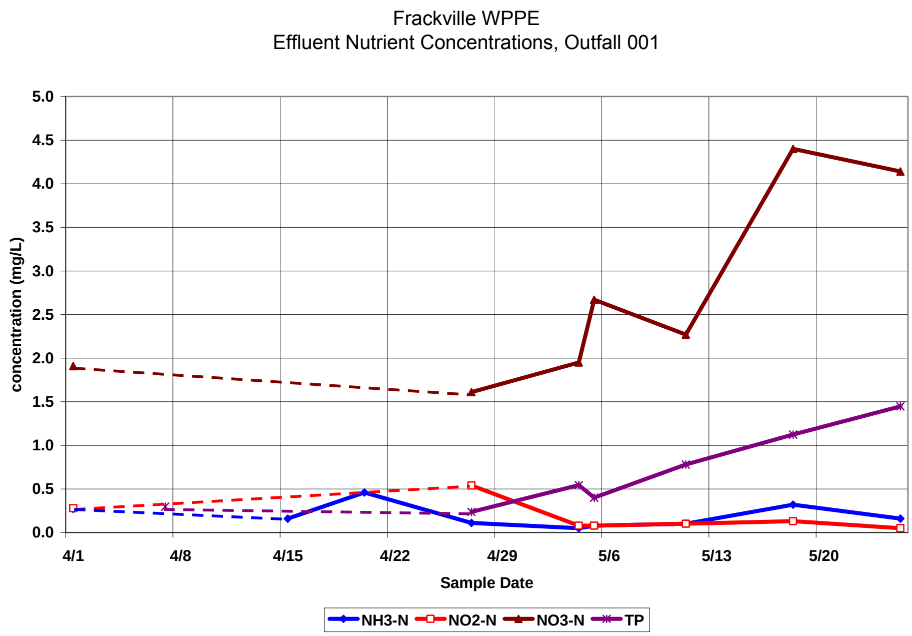


Figure J-4: Effluent Nutrient Concentrations found in BOL Samples

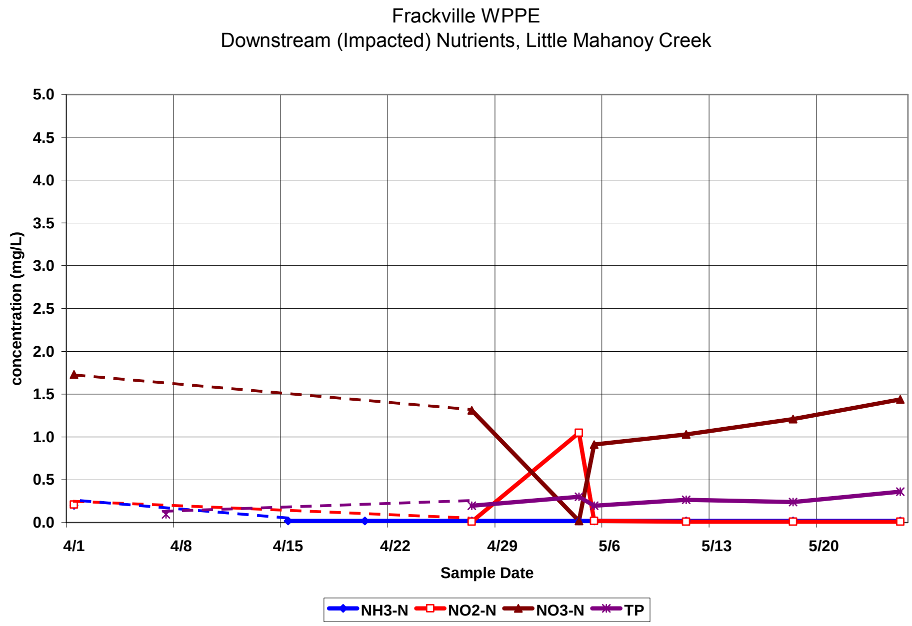


Figure J-5: Impacted Receiving Waters Nutrients found in BOL Samples

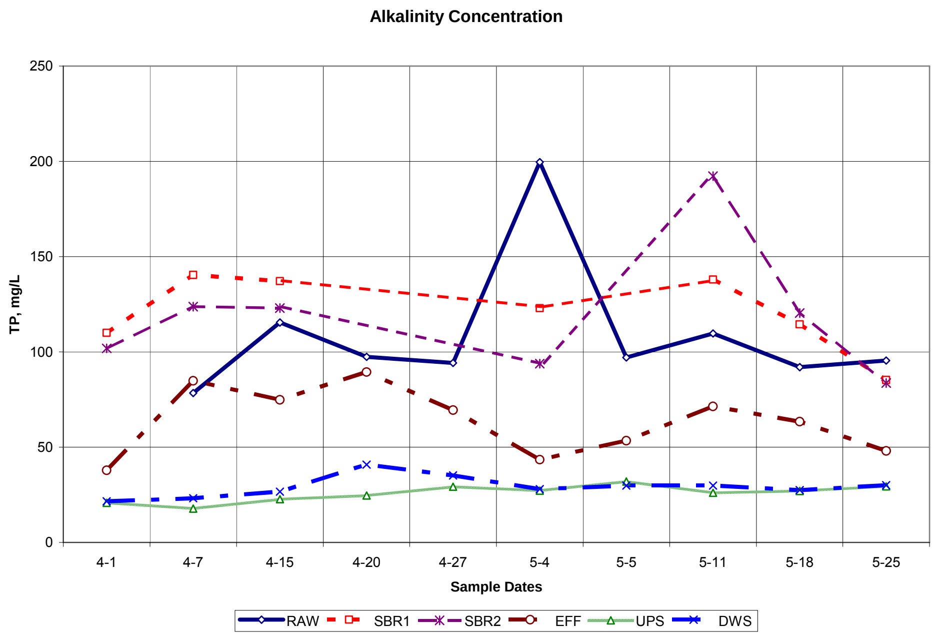


Figure J-6: Alkalinity Concentrations for various Sampling Points

THIS PAGE INTENTIONALLY LEFT BLANK

K—Tables of Sample Data from Bureau of Labs Testing

Raw Wastewater

Sample#	247	255	267	276	285	293	306	308	317	326
Date	4/1/2010	4/7/2010	4/15/2010	4/20/2010	4/27/10	5/4/2010	5/5/2010	5/11/2010	5/18/2010	5/25/2010
Time	12:40	13:12	11:00	11:42	13:13	12:15	11:53	11:35	10:16	9:50
Locus	INF	INF	INF	INF	INF	INF	INF	INF	INF	INF
Lab#	I2010008834	I2010009447	I2010010881	I2010011690	I2010012772	I2010013737	I2010013918	i2010014556	i2010015446	i2010016563
Field Temp										
Field DO										
Field pH										
BOD	98.50	228.00	199.00	205.00	137.00	137.00	154.00	167.00	255.00	214.00
CBOD										
COD	65.0	210.4	152.2	134.7	131.5	315.3	345.6	397.9	330.5	106.1
pH	6.8	6.9	7.1	7.1	7.0	7.7	7.1	7.0	7.0	7.2
ALK		78.4	115.4	97.4	94.2	199.6	97	109.6	92.0	95.4
TDS	272	250	224	300	248	378	226	276	258	238
TSS	78	204	190	122	126	100	88	122	106	130
VSS	66	142	146	110	108	96	98	136	102	118
NH3-N	3.5		12.8	12.5	7.22	11.93	16.14	11.07	13.0	15.5
NO2-N	0.18				0.15	0.08	0.01	0.33	0.39	0.01
NO3-N	2.40				0.63	0.04	0.04	0.74	0.09	0.04
TKN	10.9		23.8		20.39	22	24.42	23.45	22.4	24.8
TN	17.0				28.39	34.05	40.61	35.59	35.9	40.3
TP		3.252			2.554	2.579	2.699	2.861	2.768	2.982
Chloride	93.4	67.4	76.1	78.4	65.0	73.9	57	75.6	78.5	52.2

Final Effluent

Sample#	248	256	268	277	286	294	307	309	318	327
Date	4/1/2010	4/7/2010	4/15/2010	4/20/2010	4/27/10	5/4/2010	5/5/2010	5/11/2010	5/18/2010	5/25/2010
Time	12:45	13:20	10:59	11:48	12:55	12:27	11:48	11:27	10:27	9:56
Locus	EFF	EFF	EFF	EFF	EFF	EFF	EFF	EFF	EFF	EFF
Lab#	I2010008835	I2010009448	I2010010882	I2010011691	I2010012773	I2010013738	I2010013919	i2010014557	i2010015447	i2010016564
Field Temp										
Field DO										
Field pH										
BOD										
CBOD	--	1.10	2.10	3.00	1.40	1.7	1.2	1.2	2.60	1.50
COD										
pH	7.4	7.9	7.8	7.2	7.1	7.2	7.5	7.6	7.6	7.0
ALK	37.8	84.8	74.8	89.4	69.4	43.4	53.4	71.4	63.4	48.0
TDS	250	256	258	312	238	214	212	234	262	272
TSS	5	5	5	5	5	5	5	5	7	5
VSS	6	6	5	6	5	5	5	5	5	5
NH3-N	0.27		0.16	0.46	0.11	0.05	0.08	0.10	0.32	0.16
NO2-N	0.28				0.54	0.08	0.08	0.10	0.13	0.05
NO3-N	1.91				1.61	1.95	2.67	2.27	4.40	4.14
TKN	1.29		1.53		1.21	1.00	1.00	1.11	1.69	1.28
TN	3.75				3.47	3.08	3.83	3.58	6.54	5.63
TP		0.296			0.236	0.543	0.4	0.78	1.123	1.447
Chloride	93.9	75.8	76.7	89.4	69.9	65.6	68.7	72.5	73.7	71.2

Upstream/Background

Sample#	249	257	269	278	287	295	304	310	319	328
Date	4/1/2010	4/7/2010	4/15/2010	4/20/2010	4/27/10	5/4/2010	5/5/2010	5/11/2010	5/18/2010	5/25/2010
Time	13:15	11:41	8:56	10:33	15:24	15:20	10:35	11:11	10:35	10:05
Locus	UPS	UPS	UPS	UPS	UPS	UPS	UPS	UPS	UPS	UPS
Lab#	I2010008836	I2010009449	I2010010883	I2010011692	I2010012774	I2010013739	I2010013916	i2010014558	i2010015448	i2010016565
Field Temp										
Field DO										
Field pH										
BOD	0.40	0.80	0.20	0.70	1.50	16.2	1.3	0.6	0.90	1.20
CBOD										
COD										
pH	7.4	7.4	7.4	7.2	7.2	6.9	7.5	7.2	7.4	7.0
ALK	20.8	17.8	22.6	24.6	29.2	27.2	32	26	27.0	29.4
TDS	200	180	186	212	186	110	186	186	186	222
TSS	6	5	5	5	5	224	5	5	5	5
VSS	5	5	5	5	5	46	5	5	5	5
NH3-N	0.02		0.02	0.02	0.02	0.33	0.04	0.07	0.03	0.02
NO2-N	0.01				0.01	0.01	0.01	0.01	0.01	0.01
NO3-N	1.34				1.56	0.66	1.07	0.99	1.07	0.97
TKN	1.00		1.00		1.00	5.00	1.00	1.00	1.00	1.00
TN	2.37				2.59	6.00	2.12	2.07	2.11	2.00
TP					0.046	0.256	0.021	0.014	0.01	0.014
Chloride	83.7	71.7	65.9	66.3	67.8	26.8	70.1	70.5	65.3	76.6

Downstream/Impacted

Sample#	250	258	270	279	288	296	305	311	320	329
Date	4/1/2010	4/7/2010	4/15/2010	4/20/2010	4/27/10	5/4/2010	5/5/2010	5/11/2010	5/18/2010	5/25/2010
Time	13:30	12:45	9:19	15:32	15:42	14:39	11:25	10:48	11:03	11:50
Locus	DWS	DWS	DWS	DWS	DWS	DWS	DWS	DWS	DWS	DWS
Lab#	I2010008837	I2010009450	I2010010884	I2010011693	I2010012775	I2010013740	I2010013917	i2010014559	i2010015449	i2010016566
Field Temp										
Field DO										
Field pH										
BOD	2.00	1.40	0.70	1.20	1.40	1.2	1.2	0.6	0.80	0.80
CBOD										
COD										
pH	7.5	7.5	7.5	7.8	7.4	7.2	7.6	7.3	7.5	7.2
ALK	21.6	23.2	26.6	40.8	35.2	28	29.8	29.8	27.4	30.0
TDS	162	146	155	156	176	158	142	144	158	184
TSS	6	5	5	5	5	6	5	5	5	5
VSS	6	5	5	5	5	6	5	5	5	5
NH3-N	0.20		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NO2-N	0.21				0.01	1.05	0.02	0.01	0.01	0.01
NO3-N	1.73				1.31	0.02	0.91	1.03	1.21	1.44
TKN	1.00		1.00		1.00	1.00	1.00	1.00	1.00	1.00
TP		0.094			0.195	0.303	0.198	0.266	0.239	0.362
Chloride	66.4	57.2	57.9	62.6	63.3	51.3	50.3	53	55.0	57.1

SBR 1 Solids

Sample#	251	259	271	280	289	297	312	321	330
Date	4/1/2010	4/7/2010	4/15/2010	4/20/2010	4/27/10	5/4/2010	5/11/2010	5/18/2010	5/25/2010
Time	15:37	15:00	12:50	12:27	13:00	11:34	12:20	12:10	13:14
Locus	TSS1	SBR1	SBR1	SBR1	SBR1	SBR1	SBR1	SBR1	SBR1
Lab#	I2010008838	I2010009451	I2010010885	I2010011694	I2010012776	I2010013741	i2010014560	i2010015450	i2010016567
ALK	110.0	140.4	137.2			123	138	114.4	85.2
TSS	2,604	2,850	3,200	3,148	2,762	2,986	2,744	3,220	2,562
VSS	2,180	2,374	2,616	2,548	2,300	2,482	2,318	2,568	2,140

SBR 2 Solids

Sample#	253	260	272	281	290	298	313	322	331
Date	4/1/2010	4/7/2010	4/15/2010	4/20/2010	4/27/10	5/4/2010	5/11/2010	5/18/2010	5/25/2010
Time	14:15	14:05	10:48	15:06	14:13	11:19	14:21	14:45	14:48
Locus	TSS2	SBR2	SBR2	SBR2	SBR2	SBR2	SBR2	SBR2	SBR2
Lab#	I2010008840	I2010009453	I2010010886	I2010011695	I2010012777	I2010013742	i2010014561	i2010015451	i2010016568
ALK	101.8	123.8	123.0			93.8	192.2	120.4	83.6
TSS	2,374	2,492	2,148	2,276	2,544	2,270	2,370	3,392	2,632
VSS	2,062	2,002	1,748	1,980	2,468	1,874	1,988	2,596	2,182

SBR 1 Supernatant

Sample#	252	261	273	282	291	299	314	323	332
Date	4/1/2010	4/7/2010	4/15/2010	4/20/2010	4/27/10	5/4/2010	5/11/2010	5/18/2010	5/25/2010
Time	14:10	14:10	10:54	15:10	14:17	13:25	14:56	14:50	15:01
Locus	B1S	B1S	B1S	B1S	B1S	B1S	B1S	B1S	B1S
Lab#	I2010008839	I2010009452	I2010010887	I2010011696	I2010012778	I2010013743	i2010014562	i2010015452	i2010016569
BOD	5.40	6.70	4.40	5.90	4.10	5.7	3.3	1.70	1.50
pH	7.2	7.2	7.7	7.2	7.2	7.1	7.5	7.7	7.4
ALK	67.6	88.4	72.6	102.2	64.2	66.8	84	69.8	48.6
TSS	9	5	5	5	5	6	5	5	5
VSS	12	5	5	5	5	14	5	5	5
NH3-N	0.6	0.8	0.1	0.6	0.02	0.02	0.02	0.02	0.02
NO2-N	0.50				0.05	0.03	0.05	0.05	0.01
NO3-N	1.64				2.32	3.04	3.34	4.38	3.97
TKN	4		2		1.06	1.43	1.06	1.00	1.00
TP		0.419			0.180	0.671	1.127	1.414	1.514
Chloride	91.2	73.6	76.5	75.8	73.1	69.3	72.2	73.4	70.5

SBR 2 Supernatant

Sample #	254	262	274	283	292	300	315	324	333
Date	4/1/2010	4/7/2010	4/15/2010	4/20/2010	4/27/10	5/4/2010	5/11/2010	5/18/2010	5/25/2010
Time	15:17	14:50	12:53	12:30	13:05	12:34	12:27	11:57	13:11
Locus	B2S	B2S	B2S	B2S	B2S	B2S	B2S	B2S	B2S
Lab#	I2010008841	I2010009454	I2010010888	I2010011697	I2010012779	I2010013744	i2010014563	i2010015453	i2010016570
BOD	31.50	4.70	6.10	4.80	10.30	0.7	2.1	5.00	2.20
pH	7.4	7.3	7.5	7.2	7.3	7.3	7.8	7.6	7.3
ALK	60.6	80.2	79.2	94.0	70.0	38.6	80.4	64.2	46.2
TDS									
TSS	10	5	7	5	5	5	5	6	5
VSS	22	52	5	5	5	8	5	6	8
NH3-N	0.60	0.05	0.07	0.57	0.32	0.03	0.10	0.08	0.11
NO2-N	0.36				0.51	0.12	0.09	0.14	0.04
NO3-N	1.54				1.51	3.84	4.01	4.32	4.62
TKN	3.61		1.61		1.83	1.00	1.09	1.28	1.14
TP		0.538			0.386	1.095	1.227	1.065	1.405
Chloride	90.7	73.9	76.0	75.9	71.7	66.6	72	73.8	71.2

Sludge Press Filtrate

Sample #	263	275	284	316	325	334			
Date	4/7/2010	4/15/2010	4/20/2010	5/11/2010	5/18/2010	5/25/2010			
Time	13:10	10:38	12:23	13:04	11:36	13:34			
Locus	SPF	SPF	SPF	SPF	SPF	SPF			
Lab#	I2010009455	I2010010889	I2010011698	i2010014564	i2010015454	i2010016571	Average	Max	Min
BOD	488.00	418.00	718.00	146	60.10	203.00	338.85	718.00	60.10
pH	7.0	6.9	6.7	7.0	7.1	7.1	7.0	7.1	6.7
ALK	61.4	70.4	97.2	57	62.0	63.4	68.6	97.2	57.0
TDS	326	312	388	282	268	280	309	388	268
TSS	597	646	1594	692	812	784	854	1594	597
VSS	488	576	1280	658	660	634	716	1280	488
NH3-N	0.1	0.5		0.2	0.4	1.6	0.57	1.64	0.10
NO2-N				0.15	0.25	0.10	0.17	0.25	0.10
NO3-N				8.94	2.92	1.73	4.53	8.94	1.73
TKN		53.1		46.1	45.9	54.7	49.97	54.70	45.92
TP	20.513			17.426	19.025	22.372	19.834	22.372	17.426
Chloride	90.9	92.8	96.2	76.4	76.3	75.2	84.6	96.2	75.2

NOTES:

Items in RED denote non-detectable results reported as minimum detectable quantity for statistical purposes.
All Samples are Grab Samples unless otherwise noted.

THIS PAGE INTENTIONALLY LEFT BLANK

L—Recommended Process Control Tests, Observations and Calculations

The following is suggested for proper process control. The actual testing you do and how frequently you do it will be based upon your circumstances. If you are not sure, consult your engineer and state regulatory officials. It is important that you do testing on the influent wastewater so you can determine loadings and efficiencies of all treatment units. Influent testing also provides valuable information for chapter 94 reports as well. At a minimum you should test your influent wastewater each time you collect samples for effluent testing (NPDES Reporting). The operator should also note weather conditions on a daily basis Hi/Lo temperature and amount (if any) precipitation.

The following describes the parameters you should be monitoring (at a minimum) in regard to influent wastewater. Depending on your facility, additional parameters may need to be monitored especially if you facility treats industrial or trucked in waste.

Influent Wastewater Recommended Parameters	
$cBOD_5$	24 Hour Composite
Total Suspended Solids (TSS)	24 Hour Composite
Ammonia-Nitrogen (NH3-N)	24 Hour Composite
PO4	24 Hour Composite
pH	Grab
Temperature	Grab
Alkalinity	Grab
Flow (MGD)	Continuous monitoring
Visual/Aromatic Observations	Document unusual conditions

For monitoring the SBR's, the following are the monitoring parameters, calculations and observations you should institute. The frequency of these will depend on the variability of your waste-stream and other factors. Refer to section about process control issues when sampling, testing or performing calculations on an SBR

Dissolved Oxygen	Best done with continuous monitoring within the reactor. Calibration of DO sensors should be checked weekly.
Oxidation Reduction Potential (ORP)	Best done with continuous monitoring within the reactor.
Nitrate (NO3)	Best done with continuous monitoring within the reactor. Occasional grabs (to check calibration) during each cycle.
Nitrite (NO2)	Can be a grab sample at various intervals. If you are having problems maintaining chlorine residual excess nitrite can be a factor. Nitrite can be associated with incomplete nitrification or incomplete denitrification
Ammonia-Nitrogen (NH3-N)	Best done with continuous monitoring within the reactor. Occasional grabs (to check calibration) during each cycle.
	This test is essential for determining the lbs of solids you have under aeration. The use of a centrifuge spin can provide quick

MLSS & MLVSS	and reasonable estimates of solids under aeration. With an increase in MCRT, the MLVSS should decrease.
Mean Cell Residence Time	MCRT is a calculation. lbs of solids in the system ――――――――――― Solids leaving the system (WAS & Effluent)
Food to Microorganism Ratio	F/M is a calculation (be aware of SWD). FOOD (BOD) coming into system ――――――――――― lbs of solids under aeration
Sludge Volume Index (SVI)	SVI is a calculation 30 Minute Settleability Result ml/l ――――――――――― MLSS mg/l / 1000
Microscopic Examination	Microscopic observation of the biomass to determine the relative predominance of organisms and to spot troublesome filamentous organisms.
30 Minute Settleability	To help quantify the amount of sludge in the system and to determine settling characteristics. Must be used in conjunction with MLSS to determine SVI. Remember to account for your side water depth. Best taken towards the end of the React cycle.
Alkalinity	This can be a grab sample, should not drop below 50 mg/l at any point in the system especially for facilities that must nitrify. Would like to see 100 mg/l in effluent after complete nitrification.
pH	This can be done through continuous monitoring or through a grab sample. Alkalinity in more important. Drastic changes in pH will occur when alkalinity is consumed.
Temperature	The temperature will determine how lively your biological activity will be every 10 degree C change in temperature results in biological activity either doubling (warmer temps) or cutting in half (for colder temps).
Dissolved Oxygen Uptake Rate(DOUR)	Useful test for determining the respiration rate of the biomass. Can be used to determine treatability of waste.
Amount and concentration of sludge wasted from each SBR	We must be able to quantify the amount of sludge removed from the system in order to maintain a proper mass balance.
Recycle flows	This could include flows such as supernatant from aerobic digesters or filtrate from dewatering or thickening activity. These recycle flows can be high in nutrients (phosphorus and nitrogen) as well as BOD

M—SBR Specific Process Control Issues

Due to the fact an SBR processes wastewater in batches, there are some considerations with regard to process control. All treatment systems (including batch reactors are impacted by diurnal changes in flow and strength of wastewater. Operators must be familiar with these impacts. As previously mentioned, wet weather operations will present some of the biggest challenges.

The specific issue here is that the water level (mixed liquor) is variable based upon the mode, time of day and other factors. In a conventional flow through plant the water level always remains basically the same. In a batch reactor if you measure the MLSS at 8ft depth and then again at 12ft, the concentration of the MLSS will change. This will change all of the process monitoring tests that involve MLSS concentration, including the Settleability, OUR/SOUR, Centrifuge Solids by Volume, and calculations based on those data, such as SVI, WCR, even sludge age. The MLSS reading needs to correlate to the depth of the tank and must be taken during a time of mixing and/or aeration.

For example, when calculating Food to Mass (F/M) Ratio you would need to know the depth of the reactor and the MLSS in order to calculate the pounds of solids under aeration. The following example takes a hypothetical treatment plant and calculates the F/M Ratio:

Example—F/M Calculation for SBR

Details – 2 Unit SBR @50 ft long 15 ft wide and a maximum SWD of 14ft
Minimum discharge depth 8ft SWD
50 X 15 X 14 = 10,500 cubic feet (max) X 7.48 = 78,540 gal max
Total plant daily flow = 0.25 MGD, Influent BOD = 200 mg/l
0.25 X 200 X 8.34 = 417 lbs of BOD, ½ the flow going to each unit **208 lbs (F)** each

Unit 1 had a MLSS concentration of 3500 mg/l with a SWD of 12 ft
50 X 15 X 12 = 9000ft cu ft. X 7.48 = 67,320 gallons or .06732 million gallons
0.06732 X 3500 X 8.34 = **1965 lbs of solids under aeration (M)**
(F)208/(M)1965 = 0.11 F/M

Unit 2 had a MLSS concentration of 3000 mg/l with a SWD of 14 ft
50 X 15 X 14 = 10,500 cu ft. X 7.48 = 78,540 gal or .07854 million gallons
0.07854 X 3000 X 8.34 = **1965 lbs of solids under aeration(M)**
(F)208/(M)1965 = 0.11 F/M

The use of a centrifuge can help you estimate the MLSS concentration by correlating gravimetric solids (the weighing of dried, filtered solids) with volumetric solids by percent (the centrifugal solids result.) You can determine a range within which percent solids relates to MLSS and use a multiplication factor to reliably estimate what MLSS and VSS would be on days when the centrifuge test is the only test performed.

Desired F/M ratio for many SBR systems ranges between. 0.04 – 0.10. Please refer to your facility Operations and Maintenance Guide for specific F/M information for your system. Your engineer as well as the manufacturer will be able to provide you guidance in achieving the desired F/M. As the operator, you may determine the optimum F/M for your facility based on operational process control records and reports.

Some conventional activated sludge plants use a constant MLSS concentration as a means of process control. Since your side water depth (SWD) changes, you will have to maintain certain number of lbs under aeration as opposed to a constant MLSS.

SBR Effluent Sampling Issues.

Since an SBR discharges in batches, collecting a 24hour/effluent composite sample is a little more difficult. There will be times during the day that there is no discharge. Your sampling device should be tied to a flow meter that collects a sample after every “X” amount of gallons. For example, we could program the sampler to take a 100 ml sample for every 1000 gallons discharged. If you do not have a composite sampler that is tied to a flow meter, you need to get one. In the interim you could manually collect a composite sample by grabbing a sample during the start of the discharge cycle, the middle of the discharge cycle and one at the end of the discharge cycle (at a minimum) for each batch discharged for that day. Please refer to your facility NPDES permit for specific sampling requirements. Remember that your samples must be representative of the nature and volume of wastewater you are discharging. ALL samples for DMR reporting must be preformed by an accredited laboratory.

N—NPDES Effluent Discharge Limits

PA0062219, Sewage, Frackville Area Municipal Authority, 41 North Lehigh Avenue, P. O. Box 471, Frackville, PA 17931. This facility is located in Butler Township, **Schuylkill County**.

Design parameters of the WWTP are:

- Hydraulic Loading 1.4 million gallons per day (MGD)
- Organic Loading 2,335 pounds per day of BOD_5

The receiving stream, Little Mahanoy Creek, is in the State Water Plan Watershed 06B and is classified for: CWF. The nearest downstream public water supply intake for Ashland Area Municipal Authority is located on Little Mahanoy Creek 2 miles below the point of discharge. The effluent limits for Outfall 001 based on a design flow of 1.4 MGD.

Parameter	Average Monthly (mg/l)	Average Weekly (mg/l)	Maximum Daily (mg/l)
$CBOD_5$	10.0	15.0	20.0
Total Suspended Solids	30.0	45.0	60.0
NH_3-N			
(5-1 to 10-31)	2.5	3.5	5.0
(11-1 to 4-30)	7.5	11.0	15.0
Phosphorus as "P"	1.0	1.5	2.0
Dissolved Oxygen	A minimum of 6.0 mg/l at all times.		
Fecal Coliform			
(5-1 to 9-30)	200/100 ml as a Geometric Mean		
(10-1 to 4-30)	2,000/100 ml as a Geometric Mean		
pH	6.0 to 9.0 Standard Units at all times.		
NO_2 plus NO_3-N	11.0	16.0	22.0
Whole Effluent Toxicity	Less than 1.14 Chronic Toxicity Units		

Chesapeake Bay Tributary Strategy Nutrient Requirements

	Concentration (mg/l)	Mass (lbs)	
Parameter	Monthly Average	Monthly Load	Annual Load
Ammonia-N	Report	Report	Report**
Kjeldahl-N	Report	Report	
Nitrate-Nitrate as N	Report	Report	
Total Nitrogen	Report	Report	Report
Total Phosphorus	Report	Report	Report
Net Total Nitrogen		Report	25,570
Net Total Phosphorus		Report	3,409

Notes:

* This permit contains conditions which authorize the permittee to apply nutrient reduction credits to meet the Net Total Nitrogen and the Net Total Phosphorus effluent mass limits, under the Department of Environmental Protection's (Department) Trading of Nutrients and Sediment Reduction Credits Policy and Guidelines (Document No. 392-0900-001, December 30, 2006). The condition includes the requirement to report the application of these credits in Supplemental Discharge Monitoring Reports (DMRs) submitted to the Department.

* The compliance date for Net Total Nitrogen and Net Total Phosphorus will begin on October 1, 2010. Since these reporting requirements are annual loads, the reporting on compliance with the annual limitations will be required to be reported on the Supplemental DMR--Annual Nutrient Summary by November 28, 2011. This facility is required to monitor and report for Net Total Nitrogen and Net Total Phosphorus from the effective date of the permit until September 30, 2010.

** Total Annual Ammonia Load will be required to be reported on the Supplemental DMR--Annual Nutrient Summary by November 28, 2011.

In addition to the effluent limits, the permit contains the following major special conditions:

1. Whole Effluent Toxicity Testing and Chesapeake Bay Nutrient Requirements.

(Source: PA Bulletin Vol. 37, No. 40, pp. 5592-5593, October 6, 2007)

O—Biosolids Production Worksheet

Frackville Area Municipal Authority WWTP

Date:	**2009 DMRs**
Plant Name:	**Frackville**
Design Flow:	**1.4**
Design Loading:	**2,335**
Avg Daily Flow	0.997

Months	Actual Sludge Disposed
Jan	9.46
Feb	15.4
Mar	14.41
Apr	16.64
May	14.03
Jun	16.68
Jul	13.38
Aug	12.37
Sep	8.03
Oct	10.47
Nov	9.31
Dec	13.74
12	153.92

x 2000lbs/ton

307,840

actual lbs removed

BOD mass removed by STP

influent pounds BOD/day		1,256	lbs/day	*(as reported in Chapter 94 Report)*
effluent pounds BOD/day	–	20	lbs/day	*(use monthly avg loading value from permit)*
BOD mass removed by STP	=	1,236	lbs/day	*(from DMRs)*

pre-digestion sludge mass produced by STP

BOD mass removed by STP		1,236	lbs/day
sludge production factor *	x	0.65	
pre-digested sludge mass	=	803	lbs/day

** sludge production factors*

- extended aeration = .65
- oxidation ditches = .65
- conventional activated sludge = .85
- contact stabilization = 1.0

post-digestion sludge mass produced by STP **

***calculate only if plant has a digestor*

pre-digestion sludge mass		803	lbs/day
% of pre-digestion solids remaining	x	0.8	
post-digested sludge mass	=	643	lbs/day

solids reduction in digestors

- 0 days (no digestor)= 1
- 10 days = .9
- 15 days = .8 **default value**
- 20 days = .7
- >30 days = .65

estimated amount of sludge to be removed

sludge mass (pre or post)		643	lbs/day
days per year	x	365	days/yr
estimated sludge mass for disposal	=	234,599	lbs/yr

percentage of sludge mass for disposal

actual		307,840	lbs
estimated	/	234,599	lbs
		1.31219496	
	x	100	%
		131.2195	% Sludge Removal Percentage

Typical Range: 80% ± 20%

THIS PAGE INTENTIONALLY LEFT BLANK

P—Example Chesapeake Nutrient Reduction Worksheet

To review the calculation of annualized nutrient loading reports for the Chesapeake Bay Strategy Initiative, we have attached the following sample worksheet for calculating the total nitrogen and total phosphorus loadings.

These loadings are calculated based on a summation of each month's *monthly mass load* (MML) where the average loading is multiplied by the number of days in the month to obtain the total load for each month. At the end of the reporting period, usually in November, the month sums are added to obtain the annualized load. Additional worksheets provided on the accompanying CD/DVD include sheets for deducting nutrient credits traded with other entities.

Example: The facility conducted 10 Total Nitrogen tests in December 2009. For each day where a flow-proportional or timed-interval sample was tested, multiply the Total Nitrogen concentration by the MGD flow for the sample date. Then average all seven TN loadings. Multiply the product of this calculation by 31, the total number of days in the month. This value will then be added with the similar MML for the other 11 months to obtain the total nitrogen load emanating from the facility effluent.

(a) 19.89 lb/day x 31 day = 616.59 lb TN

(b) For the reporting year: $\sum MML_{TN} = \leq 25{,}570$ lb. TN, $\sum MML_{TP} = \leq 3{,}409$ lb. TP

3800-FM-WSFR0444 7/2009

CHESAPEAKE BAY SUPPLEMENTAL REPORT
NUTRIENT MONITORING

Facility Name: FAMA Frackville WWTP
Municipality: Butler Township County: Schuylkill
Watershed: 02050301

Month: 12 (Select number) Year: 2009
NPDES Permit No.: PA0062219 Outfall: 001
Renewal application due 180 days prior to expiration.
This permit will expire on: ______

DAY	FLOW MGD	Total P mg/l	Total P lbs/day	NH_3-N mg/l	NH_3-N lbs/day	TKN mg/l	TKN lbs/day	NO_2+NO_3 as N mg/l	NO_2+NO_3 as N lbs/day	Total N mg/l	Total N lbs/day
1	0.791	0.4	2.64	0.2	1.32	1.2	7.92	1.0	6.60	2.20	14.51
2	2.72	0.1	2.27	0.1	2.27			0.5	11.34		
3	1.52										
4	1.37										
5	1.25										
6	1.2										
7	1.1										
8	1.2	0.5	5.0	0.2	2.00	1.0	10.01	0.8	8.01	1.80	18.01
9	2.2	0.1	1.83	0.4	7.34			0.5	9.17		
10	1.55										
11	1.51										
12	1.2										
13	1.58										
14	1.57										
15	1.45	0.1	1.21	0.1	1.21	1.0	12.09	0.7	8.47	1.70	20.56
16	1.41	0.4	4.7	0.3	3.53			1.9	22.34		
17	1.34										
18	1.24										
19	1.13										
20	1.08										
21	1.03	0.4	3.44	0.1	0.86	1.0	8.59	1.3	11.17	2.30	19.76
22	0.945	0.5	3.94	0.1	0.79			1.6	12.61		
23	0.926										
24	0.881										
25	0.971										
26	1.49										
27	1.19										
28	1.16										
29	1.03	0.3	2.58	0.2	1.72	1.0	8.59	2.1	18.04	3.10	26.63
30	1.03	0.1	0.86	0.3	2.58			0.5	4.30		
31	0.966										
Avg	1.2913	0.29	2.85	0.20	2.36	1.04	9.44	1.09	11.20	2.22	19.89
Monthly Total Loads (lbs):			88		73		293		347		617

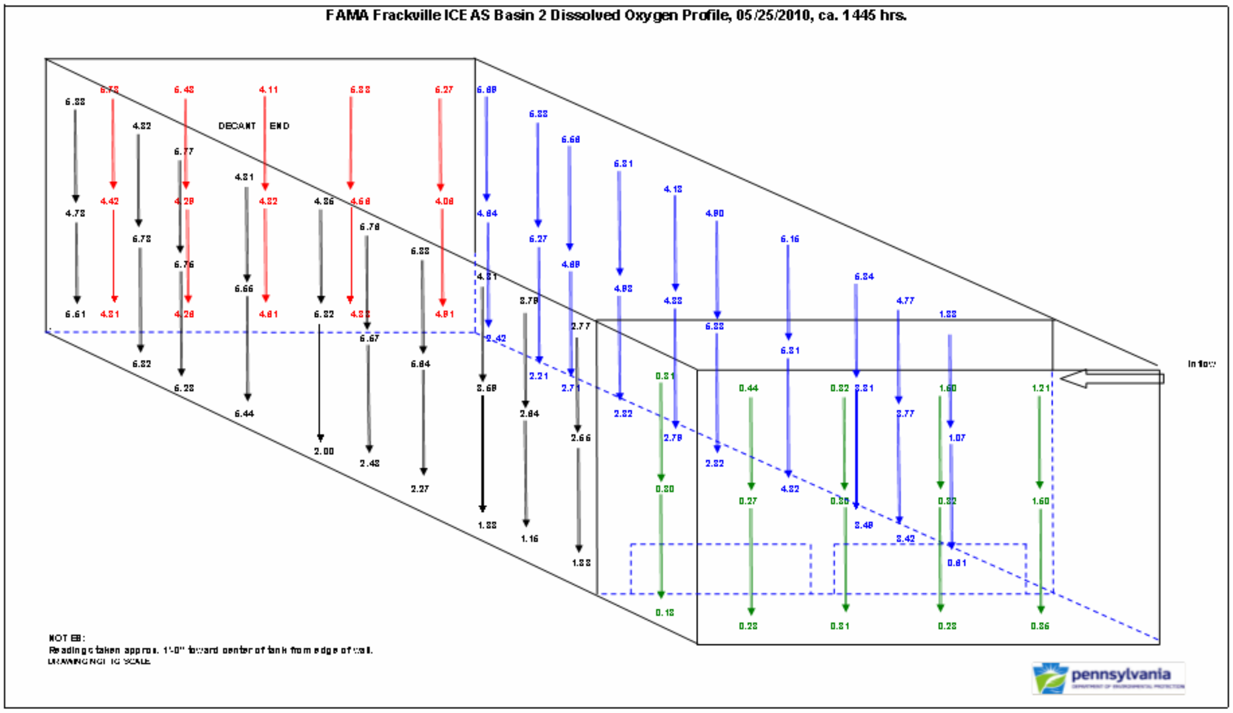
I certify under penalty of law that this document was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. See 18 Pa. C.S. § 4904 (relating to unsworn falsification).

Prepared By: ______ License No.: ______
Title: Operator Date: ______

THIS PAGE INTENTIONALLY LEFT BLANK

Q—DO Profile for ICEAS Basin 2

As part of the WPPE, DEP staff conducted a DO Profile of the ICEAS Basin #2. We recommend to operators that they create DO profiles of the aeration units on a regular basis, at least once per year. DO profiles can be used to determine if there exist "dead spots" within the tank where growth of adverse microlife such as filamentous bacteria may occur. A DO profile should be completed prior to annual maintenance of the tank, when the tank would be drained for cleaning, inspection, and repair.



Starting at top left corner, rotating clockwise around tank:

position	depth	DO, mg/L
1	a	5.73
1	b	4.42
1	c	4.31
2	a	5.43
2	b	4.29
2	c	4.26
3	a	4.11
3	b	4.32
3	c	4.61
4	a	5.38
4	b	4.56
4	c	4.38
5	a	5.27
5	b	4.06
5	c	4.91

position	depth	DO, mg/L	position	depth	DO, mg/L
6	a	5.69	11	a	4.90
6	b	4.64	11	b	5.88
6	c	2.42	11	c	2.82
7	a	5.38	12	a	5.15
7	b	5.27	12	b	5.31
7	c	2.21	12	c	4.32
8	a	5.56	13	a	5.84
8	b	4.69	13	b	3.81
8	c	2.71	13	c	3.49
9	a	5.71	14	a	4.77
9	b	4.98	14	b	3.77
9	c	2.82	14	c	3.42
10	a	4.13	15	a	1.83
10	b	4.88	15	b	1.07
10	c	2.79	15	c	0.61

position	depth	DO, mg/L
16	a	1.21
16	b	1.50
16	c	0.35
17	a	1.50
17	b	0.32
17	c	0.23
18	a	0.32
18	b	0.30
18	c	0.31
19	a	0.44
19	b	0.27
19	c	0.23
20	a	0.31
20	b	0.30
20	c	0.18

position	depth	DO, mg/L	position	depth	DO, mg/L
21	a	2.77	26	a	4.85
21	b	2.55	26	b	5.82
21	c	1.38	26	c	2.00
22	a	3.79	27	a	4.81
22	b	2.64	27	b	5.55
22	c	1.15	27	c	5.44
23	a	4.81	28	a	5.77
23	b	3.59	28	b	5.75
23	c	1.83	28	c	5.28
24	a	5.88	29	a	4.82
24	b	5.64	29	b	5.78
24	c	2.27	29	c	5.32
25	a	5.76	30	a	5.88
25	b	5.57	30	b	4.73
25	c	2.48	30	c	5.51