WASTEWATER PLANT PERFORMANCE EVALUATION

23 August through 20 October, 2011

Portland Borough Authority
Portland Wastewater Treatment Facility

NPDES #PA0064297

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Water Standards & Facility Regulation
POTW Optimization Program

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Abstract
Since the time of its commissioning two years ago, the Portland Borough Authority's new membrane bioreactor wastewater treatment plant on Demi Road in the borough has been underperforming with regard to biological nutrient removal. DEP field staff, working with the contract operator company, Portland Contractors, Inc., requested assistance of DEP's operator outreach program to assist in identifying issues that may interfere with the promised performance of this new facility. DEP Operator Outreach staff from the Cambria Office visited the facility and identified some problems associated with retention time, loading, and collection system management, any of which may be causing high effluent total nitrogen concentrations. He requested that personnel from the POTW Optimization Program to evaluate the performance by conducting a Wastewater Plant Performance Evaluation (WPPE) on site for six to eight weeks. Following the evaluation, he returned to the site to assist with implementation of changes recommended during the evaluation. As a result of process improvements, the facility has achieved compliance with its nutrient concentration limits.

The WPPE identified underloading as the principal cause for failure to denitrify. The facility, designed for 0.105 MGD flow, has consistently received an average flow of 0.027 MGD, requiring operators to run only one of two membrane bioreactor units and that at rates well below the recommended operating guidelines. Other factors that complicate this problem include:

- Insufficient natural flushing of the collection system, allowing waste to begin substantially decaying inside the sewers;
- Insufficient instrumentation for process monitoring and control, combined with a SCADA program that interrupts wastewater treatment until on-site operator intervention to re-set alarms has occurred;
- Defective or improperly installed motorized valve to the aeration grid, resulting in frequent SCADA interruptions;
- Insufficient facilities for providing supplemental nutrition required for biological nutrient removal;
- Inadequate process monitoring due to lack of sufficient laboratory equipment for performing routine activated sludge tests;
- Insufficient linkage between recordskeeping and analysis of data for trend development and process control implementation.

In short, "turn-key" does not necessarily mean "complete." The contracted operators work hard to assure facility performance and maintain permit compliance, but this cannot be done without having the proper and effective tools for completing the job.

The report concludes that several modifications will be necessary in order for this facility to reach its full potential as a vanguard of modern wastewater treatment in Pennsylvania. It is troubling that a technology having so much promise is hampered by unavailability of tools and equipment that would make it achieve its promise.

Project Summary

The purpose of a Wastewater Plant Performance Evaluation (WPPE) is to educate operators in finding ways to optimize plant performance in ways that do not entail major capital improvements and can be done without requiring permit or facility upgrades.

On-site activities for the WPPE took place for eight weeks in late summer and early autumn. 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 one-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 supplemented the data already being recorded by plant staff in their monitoring activities, as 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.

DEP staff commenced on-site activities on August 23, 2011, and completed its site work October 18, 2011. The last of the laboratory reporting was completed November 14, 2011. The WPPE examined the site history, its operations and operations data for the previous year through September, and searched 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 or in written notes left for the operator to review. The operators were encouraged to check the instrument computer often to observe instrument-recorded values and to review test results. Additionally, the operators were asked to perform some of the process monitoring tests using DEP equipment and materials provided for the study. The contract operator most associated with the daily operations at Portland, was especially pleased with the performance of the Hach DREL-

2800 spectrophotometer and its test-in-tube kits for wastewater nutrient analysis.

A description of the WPPE Program follows as Attachment A, with a listing of program participants in Attachment B. Descriptions of the Portland MBR facility, 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.

Portland Borough WWTF Data:

Design Average Daily Flow:	0.105	MGD
Design Average Daily BOD Load:	219	Lb/day
3-yr Average Daily Flow:	0.020	MGD
3-yr Average Daily BOD Load (est)	66.32	Lb/day
WPPE ADF (8/22--10/19):	0.027	MGD
WPPE ADL (8/22--10-19):	66.0	Lb/day

<u>MBR Set Points</u>

Air Pulse	frequency	10	min
	duration	5	min
Diffuser Cleaning			
	duration	10	min
Sch1			
Start	1000	hrs	
Sch2			
Start	2200	hrs	
After intermittent Pulse:			
	duration	3	min
	(disabled)		

<u>MBR Air Supply:</u>

Conditions:		SCFM/Cart	MBR	
LoFloAlarm	Set point	0.15	113	scfm
LoFloMode		0.35	263	scfm
MedFloMode		0.38	285	scfm
HiFloMode		0.53	398	scfm
HiFloAlarm		0.60	450	scfm
Intermittent&Diffuser CleaningFlow SP		0.25	188	scfm

Table 1.1: Operating Parameters for Portland WWTF

Statement of the Problem

Portland Borough WWTP is a 2-year old, 0.105 MGD municipal wastewater treatment facility constructed for BNR using PLC-driven MBR technology. Portland's WWTP was issued its first NPDES Discharge Permit in July 2008. The borough's collection system and pump station was built concurrently.

Since its commissioning in mid-2009, the facility has experienced difficulty achieving its nutrient reduction permit limits and has also encountered excessively high (for domestic wastewater) influent ammonia-nitrogen. Due to annual average daily flows well-below the permitted flow, the facility operators have mothballed one MBR unit and operated the other exclusively, which may induce added wear on the second unit. The operator would like to reduce permit violations, achieve the nutrient reduction numbers promised in the initial engineering report, and develop a strategy for operating within the AADF conditions actually occurring than theoretically stated.

Operational Strengths

Portland's facility has many operational strengths, owing to its newness, the technology employed, and the dedication of its workers. Some of these are listed below:

- As designed, the facility MBR achieves better water quality in its effluent than many conventional activated sludge plants;
- The collection system is remarkably tight, resulting in virtually no inflow/infiltration.
- The SCADA system that supervises operation of the MBR treatment cycles assures 24/7/365 process monitoring within defined set-points while maintaining security of the system against equipment failure. It has the capability of being augmented to provide a higher quality of record keeping than is found at many facilities of this size.
- UV disinfection ensures effluent quality by avoiding the use of halogens and sulfides that degrade the finished product.
- Aeration blowers are significantly muffled to prevent noise pollution;
- Aerobic digestion and reed bed disposal for waste solids reduces costs associated with solids production while requiring minimum operator intervention to function normally.
- Fine screening of raw wastewater to remove macro-particles and rubbish significantly reduces the overall loading to the facility.
- State-of-the-art submersible pumps require less ongoing maintenance than more conventional dry well pumps.
- Use of variable speed drive motor controls, soft-start motors, and timers helps conserve electrical energy, reducing carbon emissions at power generation sources.
- Membrane vacuum filtration in place of conventional gravity settling clarifiers achieves water purification without having to worry about biological plant upsets that ash or bulk solids.
- Operators are conscientious and strive to assure effluent quality at a minimum of labor cost to the Borough and the ratepayers.

Focus Points for Improvement

Because of the problems as stated by the operators, above, DEP's WPPE program review has identified focus points for improvement. Some of these points suggest upgrades and additional instrumentation or laboratory equipment; others, additional labor requirements. And, while perhaps beyond the scope of the study, also listed are goals that would help the facility achieve its promise, although achieving them are not within the purview of operations staff or, perhaps, even of the facility owner.

High

- Equip the anoxic tank with a secondary carbon source to promote biological denitrification, as intended. Discussed in other parts of this report, an ongoing problem with the facility is that it has insufficient carbon available to drive the BNR process. As discussed by Portland Operations staff in meetings with the facility owner, this will require an insulated, heated shed be placed in close proximity to the Anoxic Tank and equipped with metering pumps, mixers, and heated discharge lines. Ideally, the system would be capable of holding a skid-mounted 210-gallon tote-drum. The DEP provided the operators with a source for a high-grade carbon source, waste molasses, listed in Attachment I.
- Develop a schedule and periodically flush portions of the collection system where material is known to rot in the line because of long detention time or insufficient flow. This is critical to reducing the amount of raw wastewater ammonia-nitrogen and hydrogen sulfide (a corrosive) that occur when material simply sits.
- Continue adding Magnesium chloride or similar agent to the Anoxic Tank location as a source of Alkalinity, buffering capacity to promote the biological denitrification process. This may entail providing additional space in the proposed chemical shed, especially using heated delivery lines, as $Mg(OH)_2$ cannot drop below 50 degrees F.
- Equip the existing SCADA system with remote access capability, so that the MBR plant does not remain shut down after certain alarms but can be re-started from a remote location following power failures, system trips, or mishaps. While it is useful to have an operator appear on-site following after-hours system stops, in order to check equipment for damage, in some cases the SCADA needs only restarting, something that should not require an on-site presence. Adding this capability will reduce the time that flow backs up in the Anoxic Tank when a full-stop alarm is waiting to be re-set.
- Check the membrane filters in MBR#2 to see if they are reaching the end of their useful service life. Due to the fact that only one of two process tanks has been employed, while the other has been idle, the

membranes may have been subject to harsher conditions than if use f the two MBR tanks had been alternated over time.

Medium

- Maintain an inventory of spare parts. During the WPPE, an unscheduled chemical clean of the MBR was required, but a plastic flow-metering device broke due to continued exposure to bleach solutions. The cleaning could not take place until a replacement had been special-ordered and sent overnight from the broker. Had the spare parts been available, valuable time and treatment efficiency would not have been lost, setting the optimization efforts back another week.

  New facilities often do not have the spare parts and miscellaneous equipment that is accumulated over years of operation. It may be necessary to purchase an initial stock of spare parts and the tools required to install them, rather than to rely on the availability of materials on a "just in time" basis. A poster from the system manufacturer, hanging in the control building, notes the importance of stocking spare parts.
- Equip the wastewater laboratory with general activated sludge monitoring tools similar to those used during the WPPE; at a minimum, the facility should have
  - Solids centrifuge. (Raven Products Corp. makes a relatively low-priced one for wastewater applications;)
  - BOD probe for DO meter & bottles for performing oxygen uptake rate tests on mixed liquor samples;
  - Microscope for viewing activated sludge flora;
  - Spectrophotometer for colorimetric wastewater chemistry;
  - Water test kits for domestic wastewater; with augmentations for detecting commonly occurring commercial and industrial pollutants.

  At present, the lab is equipped with a pH probe and dissolved oxygen test kit, as well as the minimum-required filtering equipment needed for monitoring the membrane filter unit. Additional equipment that is useful includes:
  - Portable dissolved oxygen and pH meter and probes, as the tests are more accurate if measured *in situ* rather than at the lab bench, and portability would allow for monitoring of DO of the receiving stream, the pump station, and at the digester;
  - COD reactor block and test kits, for regular testing of raw wastewater strength;
  - Influent wastewater sample compositor, used for obtaining 24-hour composite samples of raw wastewater at the head of the

plant or anywhere in the collection system, to appropriately characterize the wastewater strength. Composite samples produce more reliable data than do grab samples. Use of timed sample aliquots allows operators to determine the time of slug loads or illegal discharges to the sewer.

- Implement a schedule of alternating the MBR aeration tanks. This will reduce wear on a system continuously in service, and it will prevent unknown damage from occurring to the system that has been idle for three years. The idle system, MBR #1, should occasionally be operated to assure that it is capable of performing under full load in the event that the other system becomes inoperable.
- Portland Contractors, the facility operator, provides continuous education training opportunities for its employees in order for them to maintain licensure. Many operators train once or twice on a subject and do not revisit the material in a formal training situation later on. It may be beneficial for plant operators to attend review courses on activated sludge microlife to keep abreast of new developments as well as to reinforce current knowledge.

Low

- Equip the laboratory with a working desk computer for process monitoring spreadsheets, data repository, and word processor, with associated print capabilities, and train personnel to record data electronically.
- Provide an operations software program for recording operational data, reports, graphs, and projections, instead of relying solely upon hand-written records and log books. There are many vendors available of software suitable for this purpose, including Allmax “Operator-10”, RTW’s “Activated Sludge Operations Toolset”, or similar.
- Periodically seed activated sludge with prepared microlife infusoria to enhance microlife population with increased genetic diversity. This may contribute to overall treatment efficiency.
- Install a dedicated work bench for equipment maintenance and repair. This work should not be performed in the laboratory, because lab equipment cannot withstand rough-service conditions such as dirt, vibration, or rapid temperature change.
- Develop a “punch list” of minor site improvements that may be incorporated into future planning and budget. This list would include completion of some outfitting tasks such as provision of voice telephony in the office area, weather stripping the entry doors, motorizing the main entry gate, provision of a guide rail along the south side of the driveway (beside the steep hill,) and construction of a exterior stair along the

south end of the control building (which would prevent slips/falls on wet grassy hillside.)

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 facility has achieved nutrient reduction and implemented many of the recommendations to bring the plant back into compliance. These actions included installation of facilities for additional chemical treatment, acquiring appropriately-sized pumps to control recycle rates at the established plant flows, and continuing to work with DEP Technical Assistance personnel to resolve remaining problems associated with flows and loading below the original design capacity.

The facility owner's and the operators' response to the additional needs of the facility have been notable, determining the facility's course of compliance for years to come.

ATTACHMENT A—WPPE 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

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ATTACHMENT C—SITE SCHEMATIC & EQUIPMENT DIAGRAM

Portland's Wastewater Treatment Plant (WWTP) consists of an activated sludge treatment process modified for biological nutrient removal (BNR) and using Membrane Bio-reactor (MBR) technology in place of the conventional aeration tank / secondary clarifier combination. In an MBR, aeration (carbon oxidation and nitrification) occur within one vessel, which includes an array of vacuum-filtering membrane sheets in place of traditional gravity settling as a mode of clarification. To operate effectively, the membrane system requires a higher mixed liquor suspended solids (MLSS) concentration than conventional clarifier plants. At Portland, the minimum MLSS is 8,000 mg/L, and the average operating MLSS has been 11,100 mg/L during the evaluation.

Wastewater entering Portland WWTP from the collection system is preliminarily screened for solids and inerts removal, after which wastewater falls into an Anoxic Mixing Tank. This tank holds approximately 7,500 gallons of mixed liquor maintained at maximum dissolved oxygen (DO) no greater than 0.2 mg/L, mixed to ensure adhesion of wastewater particles to biomass. In this tank, growth and development of facultative nitrogen-using bacteria is encouraged as a means of removing nitrate ion by converting it biologically to molecular nitrogen gas, which diffuses into the atmosphere.

The treatment scheme at first seems reversed, but provision of source wastewater to the anoxic tank, where biological nitrogen removal occurs, yields a source of carbonaceous material that drives the BNR process. Carbonaceous waste adsorbs to the bacteria cell surfaces, where it is utilized under anoxic conditions to remove nitrate ion from continually recycled activated sludge (coming from the MBR aeration tank,) by converting it biologically to molecular nitrogen, which evolves back into the atmosphere.

Flow of activated sludge mixed liquor is pumped by submerged lift pumps to one of two MBR tanks, each of which is equipped with an MBR array and subsurface aerators. In these 10,000-gallon tanks, the activated sludge biomass is aerated and mixed, while adsorbed carbonaceous and nitrogenous waste is converted to CO_2, NO_3^- ion, water, and (of course) more bacteria. Other constituents of wastewater, including reduced sulphur and organic polyphosphates, are oxidized to sulphate ion and orthophosphate ion. While the majority of the mixed liquor from this tank recycles back to the anoxic tank for denitrification, the in-situ membrane array periodically filters effluent water at a rate of thirty to fifty gallons per minute over intervals set by the computer program that supervises the operation.

Filtered water (effluent) is pumped to an ultra-violet light array (UV) in the control building, where exposure of pathogenic bacteria to UV energy disrupts biological processes, killing these cells and disinfecting the effluent prior to freshening and discharge to the Delaware River via an in-stream distribution grid.

Solids handling is presently a manual process. The plant operators waste activated sludge to an aerobic digester according to prescribed schedule, usually three to five minutes every second day, at a rate of about 490 gpm. The aerobic digester is periodically decanted to a pair of reed beds, and solids are either sent there or hauled off-site for dewatering at another facility supervised by the contractor. The treatment scheme is depicted below:

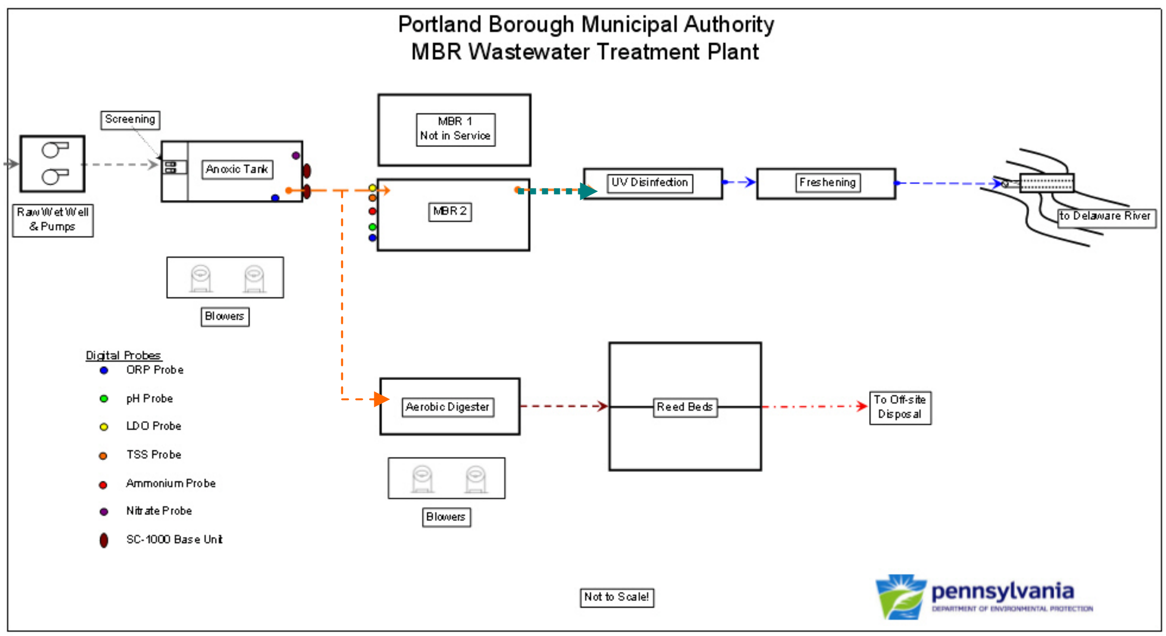

Figure C-1: Schematic of Portland WWTP

The MBR employs arrays of micro-filtration membranes in the aeration tanks and removes effluent through vacuum filtration. MBRs produce a higher-quality effluent than conventional clarifiers and sand filters. The process is controlled by a SCADA system computer that assures high treatment efficiency without risking damage to the membrane sheets. The manufacturer recommends certain process monitoring tests be performed to assure integrity of the membrane system; however, these tests are not comprehensive for the activated sludge process.

Currently, because the average daily flow at Portland is only about 0.030 MGD, only one of the two aeration tanks and MBRs is in service. Each tank is rated for flows of 0.0525 MGD.

The Facility Operations and Maintenance (O&M) Manual emphasizes care and maintenance of the vacuum membrane system, noting setpoints, operational ranges, required cleaning schedules, and bench tests that assure filterability of the mixed liquor. Chemical cleaning is recommended when transmembrane pressure (TMP) increases by 1.0 psi at operational flows or if the membrane permeability drops below 10 gfd/psi. The maximum TMP is listed as 3.0 psig. Operational ranges for the mixed liquor are 8,000 mg/L to 15,000 mg/L. Aeration diffusers should also be cleaned at a minimum for 10 minutes per day.

Since its opening in mid-2009, the Portland MBR has required two acid cleanings and several hypochlorite cleanings. The operators have experimented with different chemicals to achieve the most effective membrane cleanings, and it was learned that the most significant fouling of the membranes came from biological slime deposition rather than from metals precipitates. Cleanings using muriatic or citric acids were far less effective than cleanings using hypochlorite solution. Operators noted that the membranes in MBR 2 have been in service full-time for since April 2009. DEP staff noted that in biological wastewater treatment, certain types of bacteria will under stress produce significant amounts of polysaccharide slime to protect themselves from an irritant, be it pH anomalies, toxins, or competing organisms. DEP staff observed that the membranes may be near the end of their useful life and may need to be replaced.

ATTACHMENT D— FIELD OPERATIONS NARRATIVE

WPPE equipment described in Attachment E was deployed at the Portland Borough WWTP on August 17, 2001, following a discussion of operational and compliance history by Portland Contractors president and DEP staff from the Operatior Outreach Program. The monitoring equipment consisted of seven in-situ, continuously recording digital chemical probes, a pair of linked SCADA computers, a recording computer, and a portable wastewater laboratory used for conducting process monitoring tests and probe calibrations.

At the time, the MBR SCADA had recently been relocated to the laboratory from a sled-mounted unitized blower, pump, and PLC module in the chemical room. It was felt that the computer would run better, with less frequent problems, in a climate-controlled, relatively dust-free location.

Performance Issues

The facility had experienced NPDES permit violations for Total Nitrogen. The permit conditions list year-round discharge limit of 10 mg/L concentration and 8.8 lb/day monthly average loading, with a 20 mg/L instantaneous maximum (imax) concentration for TN. Ammonia-nitrogen is listed as 1.5 mg/L monthly average concentration and 3.0 mg/L imax, with a 1.3 lb/day monthly average loading. The chief complaint of the operators is that the facility does not denitrify effectively. Corollary complaints are that the facility often experiences slug loads of material high in ammonia-nitrogen, and this is thought to overwhelm the treatment system.

Following is a table of removal efficiencies for the Portland facility, based on chemical concentrations averaged over the course of the WPPE. As seen here, the facility has a 99% removal rate for biochemical oxygen demand (BOD5), a quantification of the organic matter in the wastewater. Ammonia removal from head to effluent was 89%, with removal of organic nitrogen (TKN) at 97%. Total Nitrogen removal, however, was only 82%, perhaps indicating inefficiencies in the denitrification processes that occur under anoxic conditions.

Removal Efficiencies

Chem	conc	loading
BOD	99.3%	99.3%
NH3	89.1%	89.5%
TP	87.2%	87.4%
TN	82.0%	82.2%
TKN	96.7%	96.7%

Table D-1: Treatment Removal Efficiencies

DEP staff from the Operator Outreach Program, stated that the raw wastewater ammonia nitrogen issue is related to insufficient flushing of the collection system, because there exists none of the inflow/infiltration (I/I) usually observed in older sewers having less structural integrity than the newly installed Portland sewers, usually providing flushing and dilution effects. This high ammonia nitrogen is the result of material decaying anaerobically within the sewer, before it reaches the treatment plant. Some anaerobic bacteria use nitrogen instead of oxygen as a proton receiver during intracellular respiration. This reduces organic nitrogen from proteins to aqueous ammonia. In Portland's case, some ammonia nitrogen concentrations rapidly approached 95% of total Kjeldahl nitrogen concentration, a measure of organic nitrogen in the wastewater.

Plant records and our evaluation subsequently demonstrated that the facility produced soluble nitrate in expected proportion, but that biological nitrogen reduction was not occurring consistently in the Anoxic Tank. This was chiefly due to a lack of available carbonaceous waste in the inflow, needed to drive the denitrifying processes. Quite simply, the Portland collection system and its customer connections do not provide enough waste concentration or flow to sustain the biological nutrient removal process. Additional carbon must be available in order for facultative bacteria to convert nitrate to molecular nitrogen.

A corollary factor affecting plant performance has been the relative lack of flow anticipated by what should have been a joint venture among adjacent municipalities to provide the treatment facility with enough wastewater to meet its minimum design operating parameters. During discussions with Borough representatives, it was learned that there were to have been additional connections from the surrounding township to provide the intended flow. Portland WWTP was designed for an average daily flow of 105,000 gpd but receives on average only a quarter of that. Plant operators have downscaled some of the pumping equipment to accommodate this, but the system delivered simply does not receive enough hydraulic or waste loading to operate effectively.

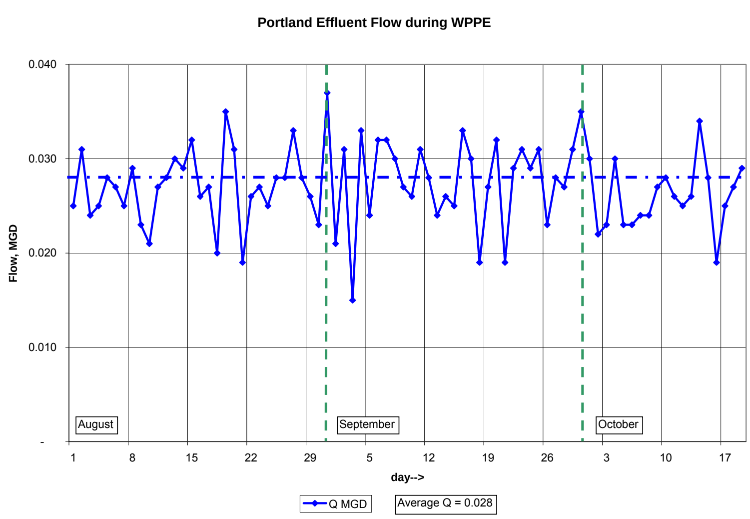

Figure D-1: Flow during WPPE averaged 28,000 gal/day

Nitrifying bacteria require suitable pH buffering and consume alkalinity. It was also recommended that the pH of the mixed liquor in the anoxic tank be buffered to approximately 7.2 to 7.5 s.u. in order to optimize the biological denitrification and to provide enough alkalinity to maintain the process. This would require the addition of buffering chemical salts such as calcium carbonate (lime,) sodium bicarbonate, or magnesium hydroxide. In response, operators began adding magnesium hydroxide (65% $Mg(OH)_2$ suspension) to the anoxic tank. This improved alkalinity throughout the treatment process.

Operators stated that they have experimented with the addition of granulated sucrose (sugar) to the anoxic tank, and this has helped in the reduction of nitrate; however, bulk addition of five to ten pounds of sugar per day as a single dose provides insufficient carbon to drive the chemical reactions over the course of a day. This addition amounts to an occasional slug load.

DEP staff suggested that the carbon addition be attenuated so that sugar is fed at a constant rate to the anoxic tank over the course of each day. To do this, additional chemical addition and pumping facilities may be necessary. Staff recommended that waste molasses would be an effective substitute carbon source, rather than prohibitively-expensive methanol, granulated sugar, or other wastes. (Starch wastes were also submitted as a recommendation; however, starch waste does not absorb to bacteria as readily as molasses.) One recommended source for waste molasses is provided in Attachment I.

Operations Testing and Trending

Over the course of the evaluation, operating conditions were observed and recorded. Test results generally supported the salient points made in the report. DEP staff demonstrated use of the portable lab equipment to the operators and asked them to participate by running comparative tests alongside those they were routinely performing. It was surprising that, aside from influent and effluent nutrient tests, mixed liquor viscosity, and other required daily tests, the facility operators did not routinely perform activated sludge process monitoring at the facility. MLSS samples were collected and sent to another facility for analysis, and weekly composite samples for compliance purposes were collected and sent to an independent commercial lab. The O&M Manual for the facility contained no information on routine activated sludge process monitoring tests.

These tests include solids inventory assays, in-process nutrient tests, oxygen uptake rate for mixed liquor, microscopy, and regular assessments of raw wastewater composite samples. Because the MBR does not rely on gravity settling, and mixed liquor is maintained at high concentrations relative to conventional activated sludge plants, sludge Settleability tests and resultant sludge volume index are irrelevant. However, other PM tests are useful, and one of the purposes of the activated sludge PM tests is to develop records to trend data that show ranges where the facility operates best and alerts operators to gradual changes that could affect the health and effectiveness of the living biomass that treats the wastewater.

Following is a recommended schedule of process monitoring and control tests for activated sludge wastewater treatment facilities having annual average daily flow less than 1.0 MGD:

Operator Sample collection guidelines Plant Flow: Less than 1.0 MGD

Sample Parameter	Sample Location	Sample Type	3/Week	1/Week	2/Month
Raw Influent *					
BOD5 and TSS	Influent	Grab			x
Alkalinity	Influent	Grab			x
COD	Influent	Grab			x
NH3-N	Influent	Grab			x
pH	Influent	Grab		x	
Flow	Influent	Totalizer	Daily		
* Frequency of sampling may need to be increased or decreased depending on plant size or conditions					
Aeration Basin					
MLSS / MLVSS (or centrifuge, with coorelated data from periodic MLVSS values	Aeration Tank	Grab			x
Dissolved Oxygen	Aeration Tank	In Situ		x	
Settleability (SV30)	Aeration Tank	Grab	x		
pH	Aeration Tank	Grab		x	
Microscopic Evaluation	Aeration Tank	Grab			x
Return Activated Sludge, SS	RAS line	Grab			x
Computation of SVI, F/M, sludge age, and/or MCRT	-	-	As data collected		
Secondary Clarifier					
Sludge blanket depth	As appropriate	In situ		x	
Waste Activated Sludge, SS and VSS	Waste Line	Grab			X
Final Effluent					
Alkalinity	Effluent	Grab			x
Parameters, sample types, and frequencies required by permit					

Table D-2: Suggested sampling frequencies

These parameters and frequencies are the minimum for facilities with flows rated less than 1.0 MGD. Operators are encouraged to sample more frequently as necessary to gather enough data to effectively make informed process control decisions. Although the plant flow is small, testing frequency should for many factors should be three times per week rather than once per week, until steady-state operating conditions have been achieved. Also, depending on the chemical makeup of the wastewater, whether or not septages and hauled-in wastes are received, additional analyses may need to be performed to provide adequate treatment. Although Portland does not employ clarifiers, information on concentration of recycle activated sludge (RAS) and waste activated sludge (WAS) is important in determining many calculated operating parameters.

Following the initial assay of operations, DEP staff and the plant operators attempted minor adjustments in measured increments to look for improvement that could be traced to specific actions. Generally, when making adjustments to an activated sludge process, results of an adjustment do not manifest for at least one sludge-age day. (Sludge age is discussed below.) It is important not to make too many changes to the process before observing how the first change works out. Unless inaction poses immediate danger to life or environmental health, changes to wastewater operation are to be made with deliberation. (One engineer likens the process to steering a supertanker: such a ship does not "turn on a dime;" rather, ships make slow, graceful arcs around the compass.)

Measures of Sludge Age

Sludge age is a quantification of time representing the duration of transit for a particle of activated sludge to pass from the plant headworks, through the treatment process, to a point where it is either recycled or wasted. One of basic sludge age parameters often discussed is Solids Retention Time (SRT.) Others similar to this are Mean Cell Residence Time (MCRT) and Sludge Age (AGE.) Using the biweekly mixed liquor suspended solids values for samples sent by the operators to another facility for testing, it is possible to determine an SRT for Portland:

SRT (days) = Solids in plant (lb.) ÷ Solids wasted (lb. per day)

E.G.: On 9/16/11, the operator received a solids value of 10,125 mg/L and wasted for 3 minutes that day, using a 100% rate on the feed-forward pump, or 403 gal./min.:

SRT = 1,912 lb. Solids in plant ÷ 102 lb./day Solids wasted = 21 days

All sludge age calculations rely on the rate at which solids leave the treatment system, typically through wasting, although also through the plant effluent during times of process breakdowns. The more complex an age calculation becomes depends on the availability of reliable data on how, when, and where solids leave the process.

DEP staff provided a solids centrifuge with its portable lab so that operators may develop understanding of a solids inventory unique to the facility and determine its relative sludge age. This AGE number is recorded and trended over time to determine the plant's "sweet spot," and then operations is directed toward maintaining the biomass in a "steady state" condition where AGE does not change more than a sludge-age day within a 24-hour cycle. Using solids percent-by-volume and the capacity of the various process tanks, it is possible to determine a sludge inventory for the plant, based on "sludge units (SU.)" Sludge units are determined by:

MBR SU = % solids (v/v) x tank volume (gal.), and
ANX SU = % solids (v/v/) x ANX tank volume factor x Tank depth from SCADA

E.G. 13.5% x 12,891 gal = 174,029 SU in MBR 2
And 12.0% x 1,424 sf-gal/cf x 7.3 ft. (depth reading) = 124,742 SU in Anoxic Tank
TSU = 121,500 + 124,742 = 298,771 SU

The wasting rate was determined to be 403 gpm, using the 100% rate of the feed-forward pump. At Portland, waste sludge is diverted from the MBR to the digester for a few minutes.

E.G. WSU = 403 gpm x 3 min. x 12.0% = 14,508 SU/day

It is important for operators to waste sludge on a regular basis. DEP staff recommended that wasting occur as a daily event, rather than occasional, in an effort to drive the biomass to a steady-state condition. Sludge age is calculated by dividing the amount of sludge wasted from the system (WSU) into the amount of sludge held in the plant (TSU). Since the first quantity may be characterized as a rate (SU per day) and the second is a fixed amount (SU), dividing one into the other results in a quantity (days:)

AGE = TSU ÷ WSU
298,771 / 14,508 = 20.59 ≈ 21 days

The equation works only if wasting occurs during the calculation period. (One cannot divide a number by zero.) Typically, the Portland operators were wasting sludge every other day. Therefore, the Portland operators could base their sludge age records on a 48-hour period by halving the WSU, which would double the sludge age.

The point of trending data and analyzing it for operations is that a facility needs only data relative to its operation. By recording data and calculations on a regular basis, then developing trends through use of graphics (histograms, concentration or loading versus time,) operators may determine the ideal operating parameters for their facility and for specific seasons at that facility. These become benchmarks for continued operation, and operators become accustomed to observing beneficial and adverse trends in the data, taking steps accordingly to avert plant upsets or permit violations.

Testing for Bioactivity in Activated Sludge Microlife

Oxygen Uptake Rate (OUR) Test, (sometimes called Soluble OUR or SOUR,) is an important relative measure of the activity of the biomass that has been overlooked at Portland. DEP staff recommended to the operators that they incorporate this test into routine PM testing. It employs a BOD probe and 310-ml. bottle and a DO meter to chart the DO level of a mixed liquor sample over a maximum ten-minute period. A line is then drawn among the graphed DO readings at 30 to 60 second intervals, and a slope is calculated for that line. DEP staff demonstrated this to the operators, showing relative oxygen uptake by the bacteria as it processes the waste. For example, the graphic below shows a series of OUR curves for varying samples of mixed liquor (only one of which was taken at Portland:)

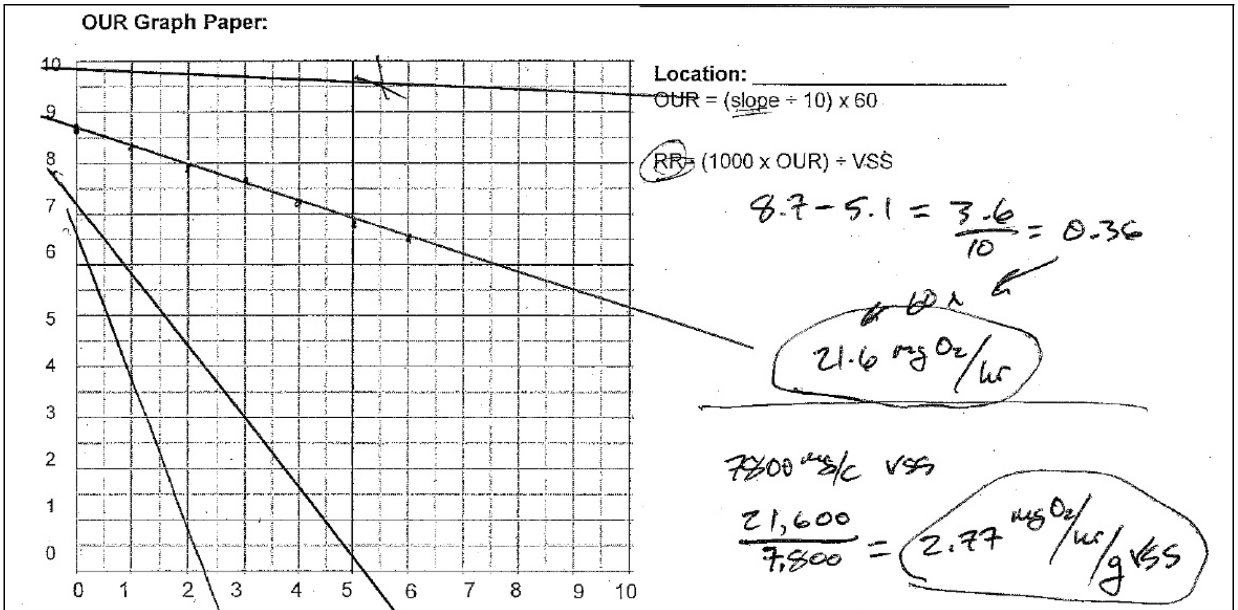

Figure D-2: Sample OUR Graph & Linear Curves

After the successive DO readings are plotted, in this case at 60-second intervals, and the line is drawn interpolating the points, the OUR at 10-minutes is subtracted from that of Zero time, in this case, 5.1 from 8.7, to give the total decline. To determine the slope of the line, divide the total decline, 3.6, by ten minutes to get 0.36. (Note, the actual linear slope is negative, but for our purposes, that's not necessary.) If all the oxygen in the sample is depleted in under ten minutes, as seen in two of the lines on the lower part of the graph, then simply divide the starting DO at time Zero by the number of minutes (estimating the decimal) to determine the slope.

Next, multiply the slope by 60. The result is reported in "milligrams of molecular oxygen consumed per hour." This is the OUR.

To make more sense of the number, if the Volatile Suspended Solids (VSS) of the MLSS is available, calculate the respiration rate per gram of VSS: In the example, VSS were 7,800 mg/L, where VSS represents the "living biomass" portion of all the material in the Suspended Solids. Multiply the OUR by 1,000 and divide by the VSS to obtain the Respiration Rate (RR) in "milligrams of molecular oxygen per hour per gram of microorganisms."

This test is important because plant operators must know if their biomass is in a healthy condition. To rapid a decline in the OUR line usually means that the biomass hasn't enough oxygen to fully process the wastewater. More air may be necessary, or the inflow rate has to be reduced. A very flat OUR line suggest that the biomass may not have enough waste to process, that the DO is too high (too much aeration,) or that something toxic in the raw wastewater has diminished the bioactivity of the microorganisms.

Another useful test for bioactivity is simple microscopy. Part of the DEP lab included a high-school level microscope useful for observing indicator organisms living among the clumps of bacterial mass that compose the microlife. Operators observe and sometimes count the relative number of certain protists and multicellular organisms as a way of qualitatively characterizing sludge age and to predict whether or not activated sludge conditions are favorable or disfavorable to the goal of making quality effluent.

The simplest example of microscopy is depicted here in photographs made at Portland. They depict actual sludge conditions at the time the photos were recorded:

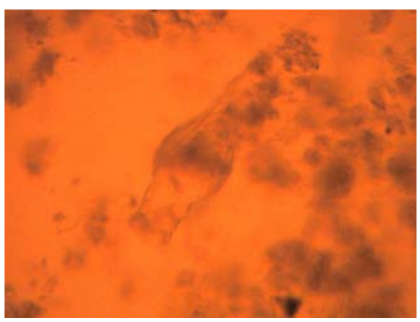

Figure D-3: Rotifer in MBR#2

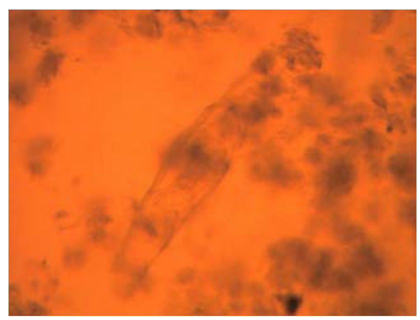

Figure D-4: Rotifer capturing food

Figure D-5: Zoogleal Mass in ANX

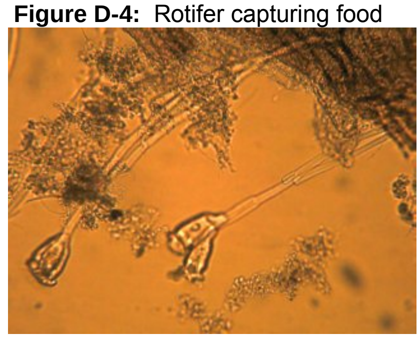

Figure D-6: Stalked Ciliates not found

At Portland, with MLSS concentrations generally in the 12,000 mg/L range, the biomass appearance was more consistent with that of clarifier recycle found in more conventional facilities. Often, rotifers were observed in samples from the aerated MBR, usually a predictor of "old sludge" conditions. However, as seen in the photo in D-5, the zoogleal mass in the anoxic tank

ANX contained no observable indicator organisms. Reasons for this may be that the anoxic detention time is not favorable to their growth (technology differences between convention activated sludge treatment and the BNR-based MBR facility,) or that there is insufficient food to support the population. Figure D-6 depicts stalked ciliates that were not observed at the Portland facility. Activated sludge without readily identifiable indicator organisms usually experiences unhealthy growth conditions. The problem may be solved by balancing the Food to Mass equation, through increases in flow and carbon sources, or by nutrient balancing (not a significant problem in domestic wastewater sources,) or by seeding the facility with biologically active supplements that provide additional genetic diversity that fosters biomass growth and development.

Oxidation/Reduction Potential (ORP)

ORP probes were placed in both the Anoxic Tank and in MBR#2 to record oxidation-reduction potentials in each of those processes. ORP can be used by the operators to assess and control periods of aerobic or anoxic treatment conditions for nitrification and denitrification. The following table depicts ORP values at which nitrogen conversions occur:

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-3: Oxidation Reduction Potential (ORP) ranges for bacterial activity

ORP readings are typically used in conjunction with the DO readings to identify the effectiveness of a given biological treatment process and the condition of each zone. At times during the evaluation the DO levels reached 0 mg/L. Had we not been monitoring with the ORP, we would not have known what stage of the biological process was in, i.e. nitrification, denitrification, anoxic, or anaerobic.

Attachment F includes ORP probe histograms during the WPPE. Typically, under aeration, the ORP was above 150 mV, and in the anoxic tank, the values averaged -190 mV. Denitrification is effective in that latter range. The table values below -200 mV show that anaerobic conditions promote formation of reduced sulfides and fermentation by-products. That is not a factor in the operation of the Portland facility.

Phosphorus Removal

Portland's WWTP was issued its NPDES Discharge Permit in July of 2008. The permit requires that nutrient limits be met year-round, although past practice has shown that biological nutrient removal is less efficient during periods of cold weather. The nutrient limits are listed in Attachment H. The phosphorus limit of 2.0 mg/L monthly average concentration / 1.8 ppd average monthly load is met through addition of Aluminum sulfate solution to the Anoxic Zone Tank near the discharge end. Phosphorus forms a colloidal precipitate with aluminum that is carried through the process to be wasted with biosolids and applied to the reed beds.

Effluent phosphorus concentrations during the WPPE averaged 1 mg/L, with loading values averaging 0.2 lb/day. Comparatively, the influent phosphorus concentrations during the WPPE averaged 8 mg/L, with loading values averaging 1.8 lb/day. Treatment efficiency averaged 87%.

A Biochemistry Lesson: Mechanics of Nitrogen Conversion:

Portland Borough's collection system, being of recent construction, has experienced high ammonia-nitrogen because hydraulic flow through the system has not quickly moved organic waste solids to the treatment plant. Essentially, material in the lines have been decomposing anaerobically. Bacteria that cannot use oxygen as electron acceptors during intracellular respiration are adapted to use nitrogen and sulfur, instead. When carbon, nitrogen, and sulfur in aqueous solution accept electrons, they are then able to capture hydrogen protons from hydronium ion, a chemical form of water in some aqueous environments:

e.g. $R_3\text{-N:} + H_3O^+ \rightarrow R_2N: + H_2O + R^+$, where R= any small hydrocarbon

$R_2\text{-N:} + H_3O^+ \rightarrow RNH_2 + H_2O + 2R^+$

$R\text{-}NH_2 + H_3O^+ \rightarrow NH_3\uparrow + H_2O + 3R^+$

(Ammonia either leaves aqueous solution as a gas, or it associates with H_20 to become NH_4^+ ion in aqueous solution, often written as NH_4OH)

Waste particles adhere to the cell surface of anaerobic bacteria and are digested and slowly absorbed into the cells. In a special structure known as mitochondrion, intracellular respiration takes place, breaking down simple organic molecules such as amino acids from protein into useful forms, generating methane, ammonia, and hydrogen sulfide gas. The chemical reactions produce energy that is used by the cells to do all of the things that maintain life and reproduction. An example of the anaerobic reaction is shown below:

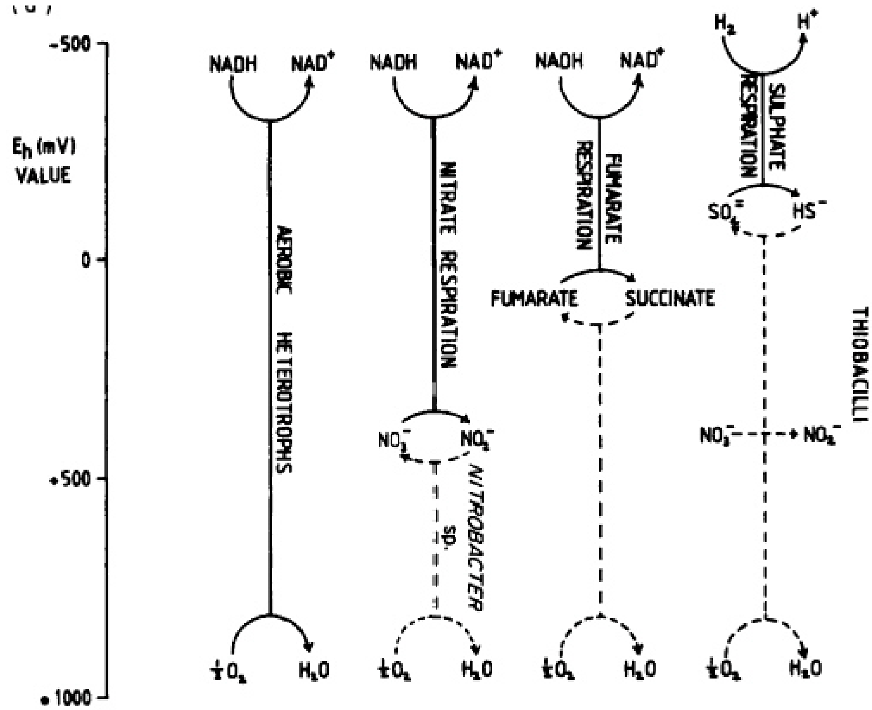

Figure D-3: Examples of Intracellular Respiration electron acceptors

Ammonia-nitrogen, found in the raw wastewater as 80% to 90% of total Kjeldahl nitrogen (TKN,) is readily nitrified in the aerobic process. It should not usually present a problem in treatment unless the biological treatment becomes inefficient. Nitrite ion is an intermediate oxidized form that persists long enough to be quantified but generally does not contribute to the total nitrogen (TN) load to the receiving waters.

Removing nitrate ion, the oxidized form of aqueous nitrogen, is the reason for Portland configuration that employs an anoxic mixing zone. The biochemical reactions responsible for conversion of aqueous nitrate ion to molecular nitrogen gas occur within the mitochondria of facultative anaerobic bacteria during cellular respiration:

$$6NO^{3-} + 5CH_3OH\ 3N_2 + 5CO_2 + 7H_2O + 6OH^-$$

These are slow-growing bacteria populations in activated sludge treatment. It is estimated that carbon-consuming, aerobic bacteria reproduce every hour, but nitrogen-reducing bacteria reproduce only once every day. In order to increase the efficiency of their metabolism, they must be maintained in an anoxic condition, where the tank dissolved oxygen remains below 0.2 mg/L on average and, preferably, below 0.1 mg/L and within a Redox range of –150 millivolts.

As shown in the equation, a carbon source is necessary to supplement the reaction. At Portland, this carbon source is assumed to be the raw wastewater itself; however, because the facility is underloaded, there is insufficient carbon to drive the reaction. Portland's staff has found that adding granulated table sugar (sucrose) has enabled the denitrification reaction to occur; however, like the methanol shown in the equation, this carbon source could become an expensive proposition. Therefore, it was suggested to employ waste sugar sources such as molasses or waste starch such as potato wash water. Small modifications will be necessary to make this possible.

Optimum pH values for denitrification are between 7.0 and 8.5.

The denitrification reaction also produces approximately 3.0 to 3.6 pounds of alkalinity (as $CaCO_3$) is produced per pound of nitrate converted, thus partially mitigating the lowering of pH caused by nitrification in the mixed liquor.

Maintaining Anoxic Conditions for Nutrient Removal

At the Portland anoxic tank, DEP staff found that the influent wastewater falls freely from the screening equipment to the liquid surface. This small amount of cascading water is sufficient to introduce dissolved oxygen into the tank, causing facultative bacteria to quickly revert to using oxygen instead of nitrogen forms as electron acceptors. This works against the purpose of the anoxic zone. For that reason, it may be beneficial to fabricate an inflow-line extension that Introduces the raw wastewater at a point below the surface of the liquid in the tank. This can be done using a collection hopper behind the fine screen equipment and a flexible discharge hose that can be extended below the average tank surface. There may be some times that influent wastewater overflows at the hopper, but most of the raw wastewater will continue to be introduced without adding dissolved oxygen. (See figure D-3, below.) Square overflow weirs could be cut into the side of the box, also.

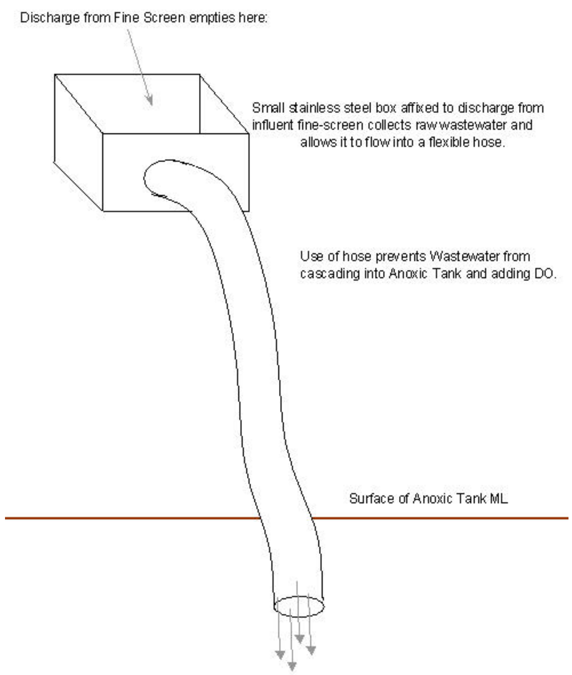

Figure D-3: Influent flow modification scheme

At the time of the WPPE, operators were recirculating treated water from the effluent reaeration tank back to the head of the plant, to accommodate the lack of hydraulic flow through the facility. They used a small pump with an attached garden hose. This water had been feeding to the screening unit, but on our suggestion, it was relocated to discharge into the Anoxic tank subsurface. However, there is one problem with this: Should the power source for the pump fail, then there is a chance that mixed liquor could siphon back to the effluent reaeration tank, meaning solids could get into the river. We suggested that a small check valve be applied to the pump.

Technical Assistance continued:

During the winter of 2011/2012, DEP staff returned frequently to the site to assist with adjustments and improvements to the process. The facility operator secured equipment to feed Magnesium hydroxide to the facility while reducing the recycle rate by pinching off a butterfly valve. Mechanical defects in the automatic valve for the aeration tank, which hindered performance of membrane filtration by shutting down the supervisory program, were also corrected. At the time of this update, the facility operator planned to downsize the recycle pump to address the need for slower recycle rates without risking impeller damage due to a pinched valve.

DEP monitoring equipment for nutrients was reinstalled at the facility during February and March 2012 to obtain data used to guide operators in achieving steady-state conditions and compliance with nutrient limits. The histogram in Attachment F, Figure F-16, shows achievement of compliance, where average nitrate-nitrogen concentrations have dropped below 10 mg/L to an average less than half that limit.

ATTACHMENT E—EQUIPMENT DEPLOYED

Digital, Continuously Monitoring Probes:
1 – Laptop computer with signal converter
2 – SC1000 SCADA Base Unit
1 – LDO probe
1 – pH probe
2 – ORP probe
1 – NH4D probe w/Cleaning System
1 – Nitratax probes
1 – Solitax probes
Including all mounting appurtenances and supplies

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

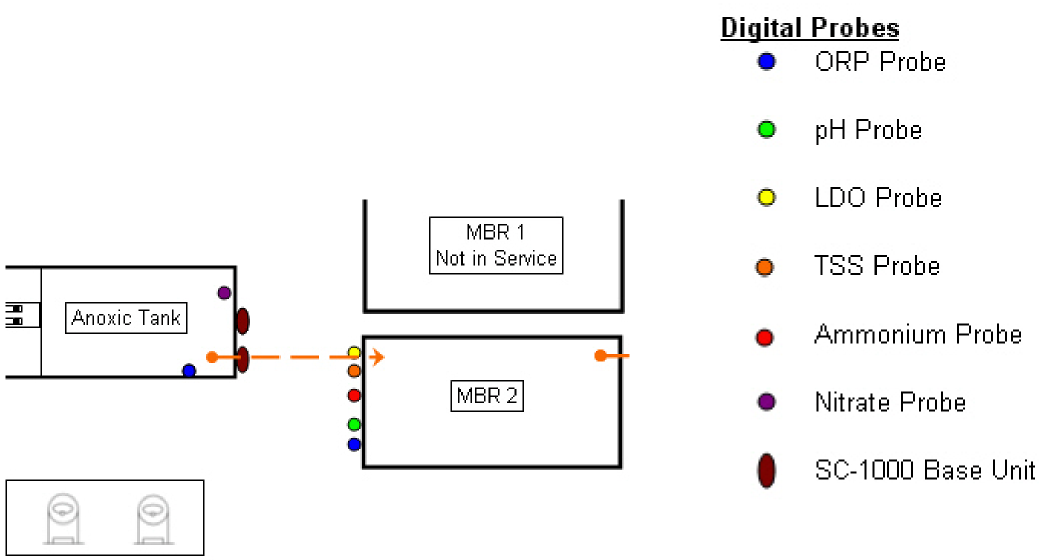

Figure E-1: MBR 2 and Anoxic Tank Equipment Placement & Computer, with legend

ATTACHMENT F—SELECTED DATA CHARTS

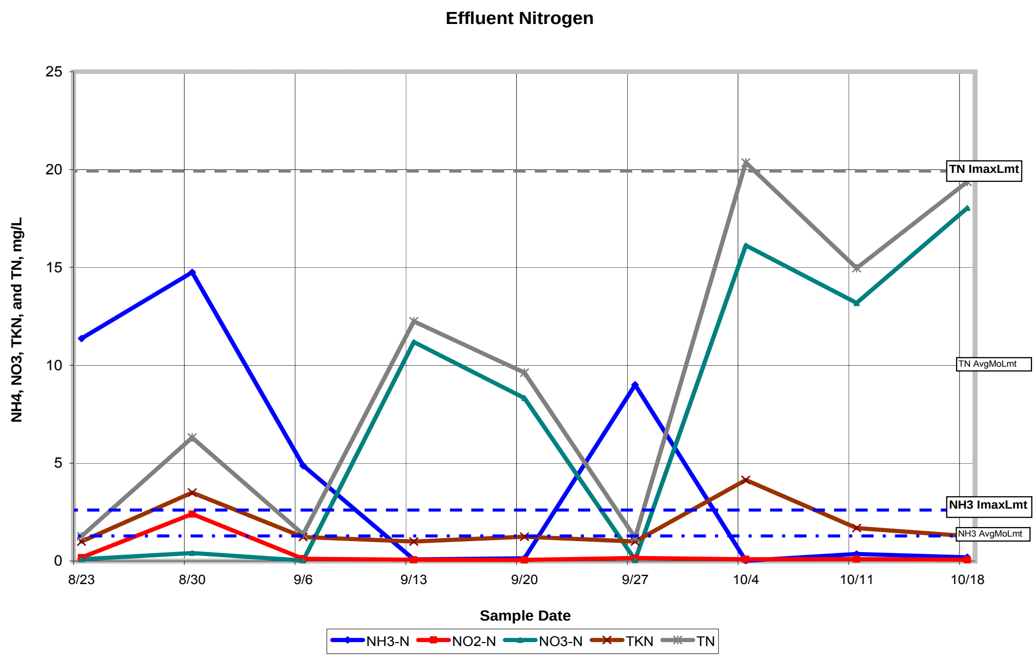

Figure F-1: Effluent Nitrogen Concentrations, BOL Samples

Note: The ammonia-nitrogen concentration value exceeded the imax limit four times, at the beginning of the study and on 9/27. The monthly effluent total nitrogen exceeded the weekly maximum once, on 10/4/11. Effluent TN was largely a function of effluent nitrate ion, which tracks almost one to one in the graph.

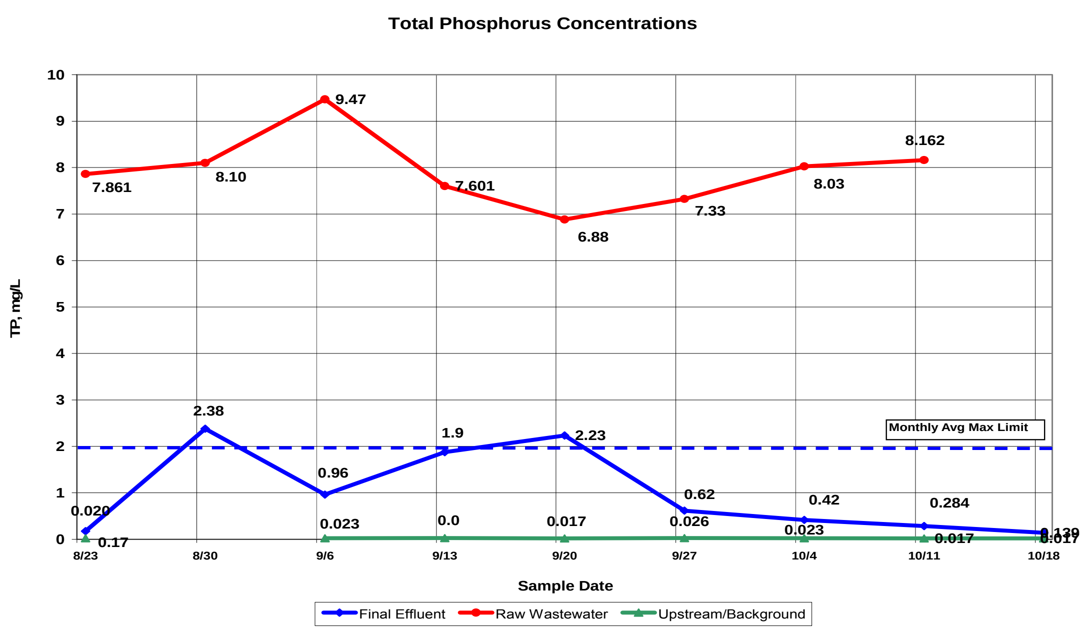

Figure F-2: Effluent Phosphorus Concentration, BOL Samples

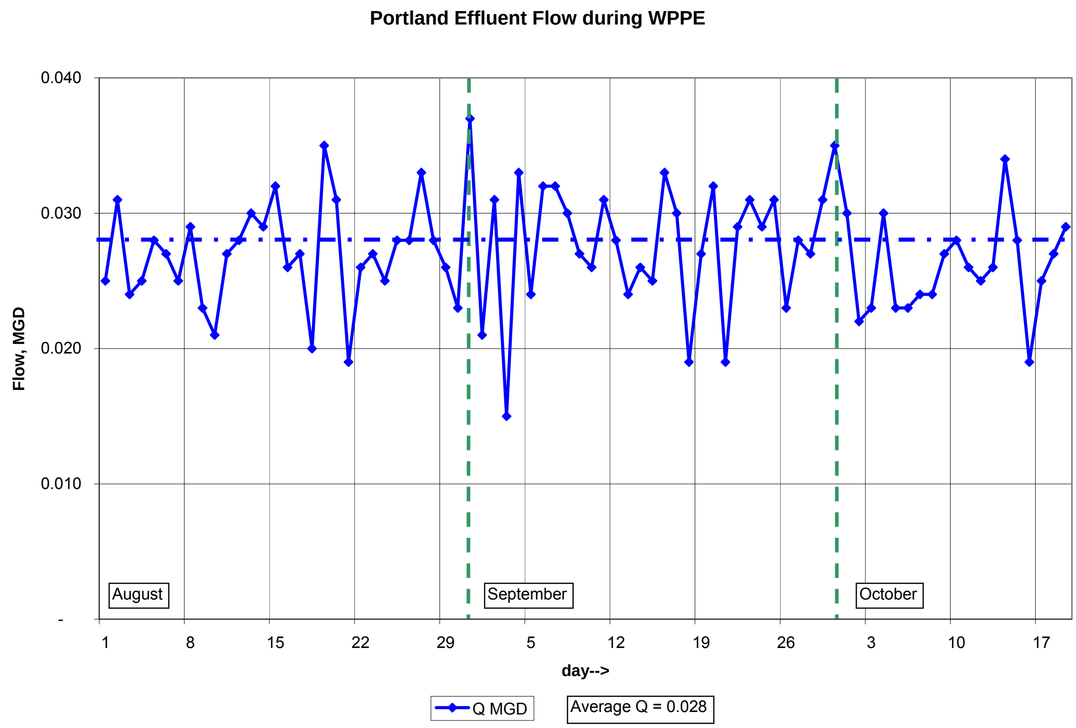

Figure F-3: Metered Effluent Flow, August 1 through mid-October

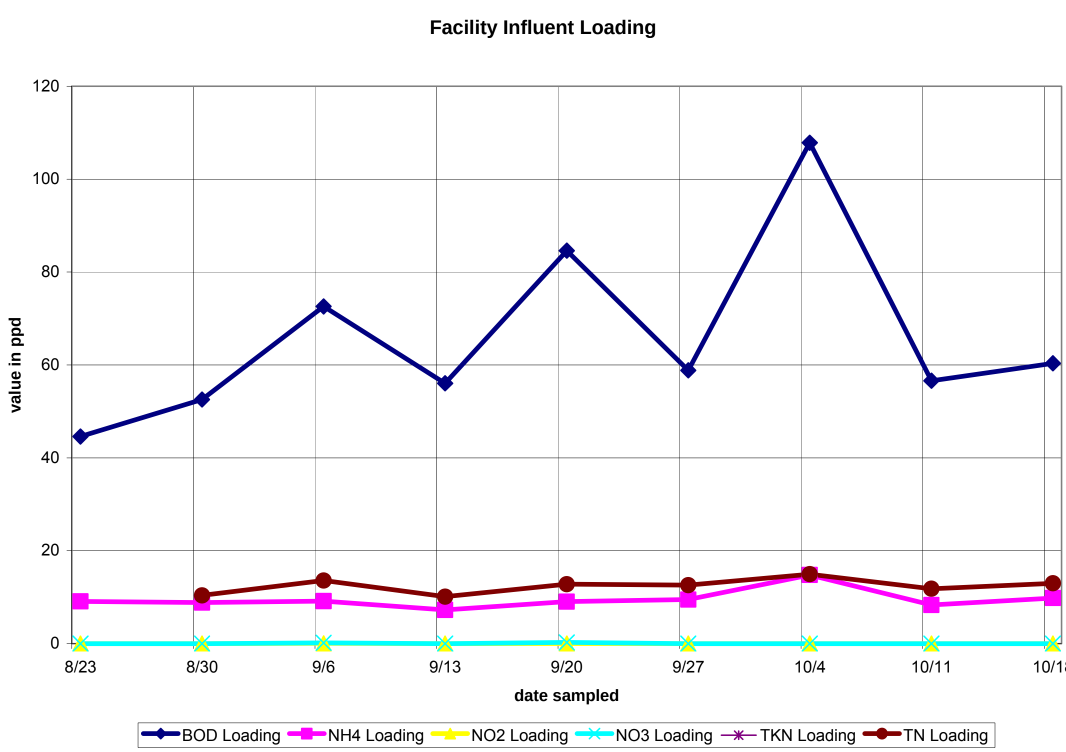

Figure F-4: Facility Influent Loading in lb./day, based on composite samples

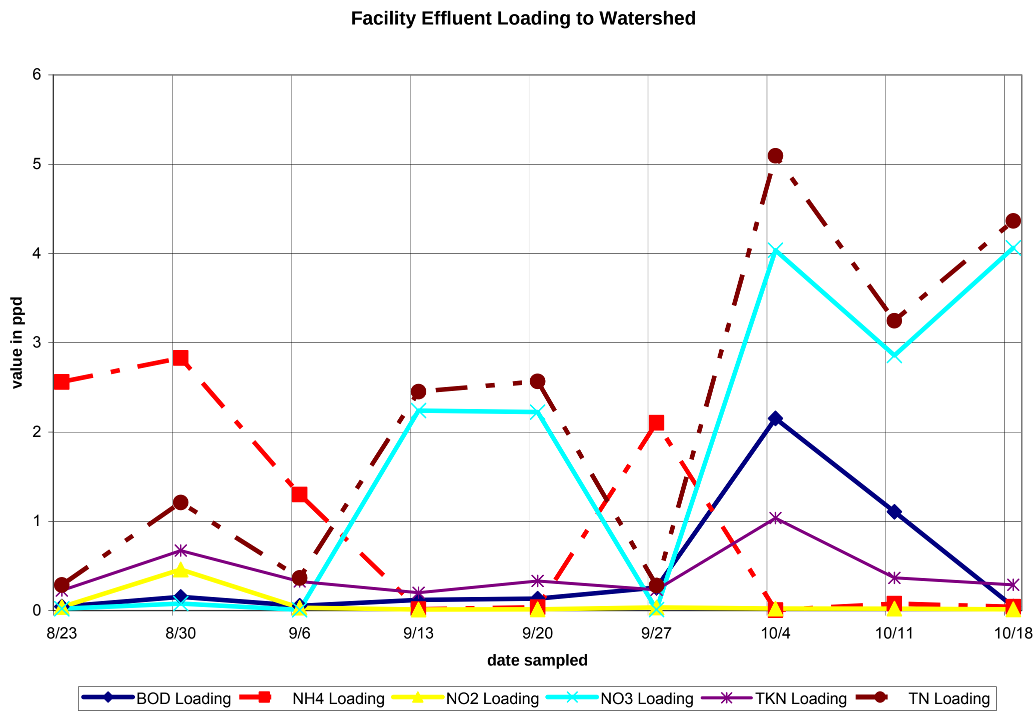

Figure F-5: Facility Effluent Loading to watershed, in lb./day, based on composite samples

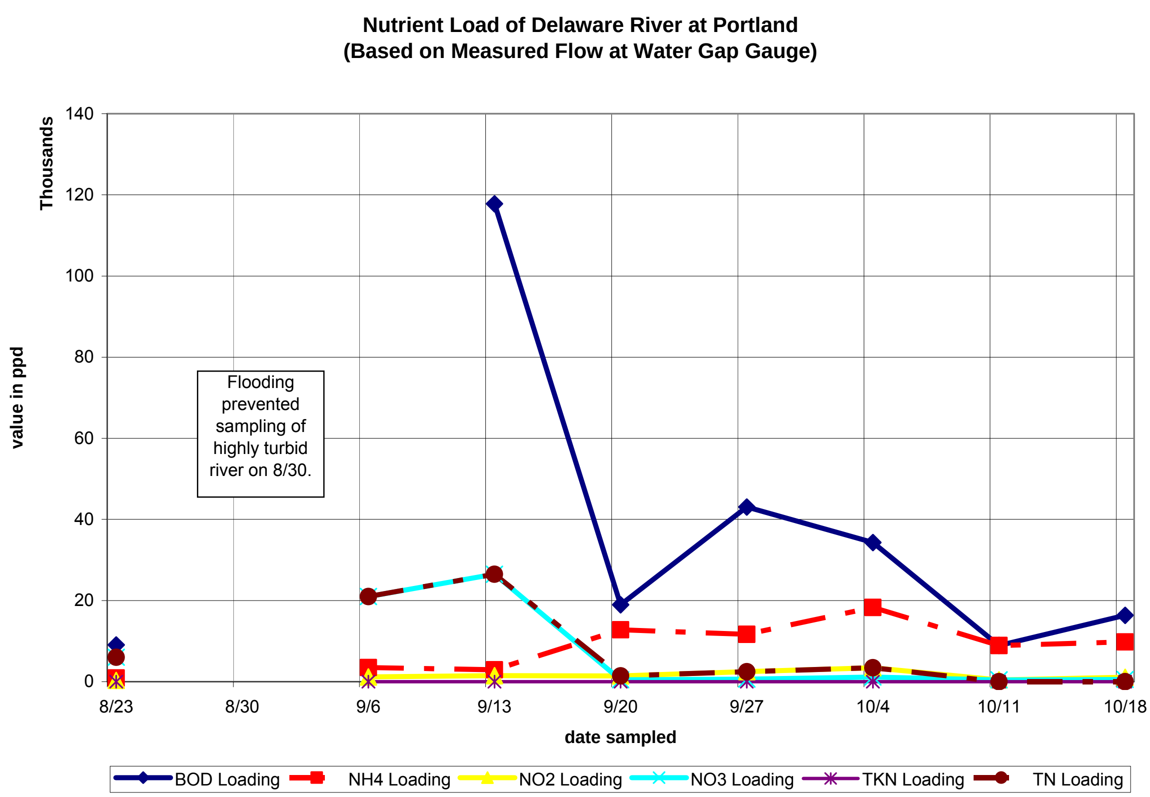

Figure F-6: Calculated Nutrient Load in Delaware River, in lb./day, based on flow at Water Gap

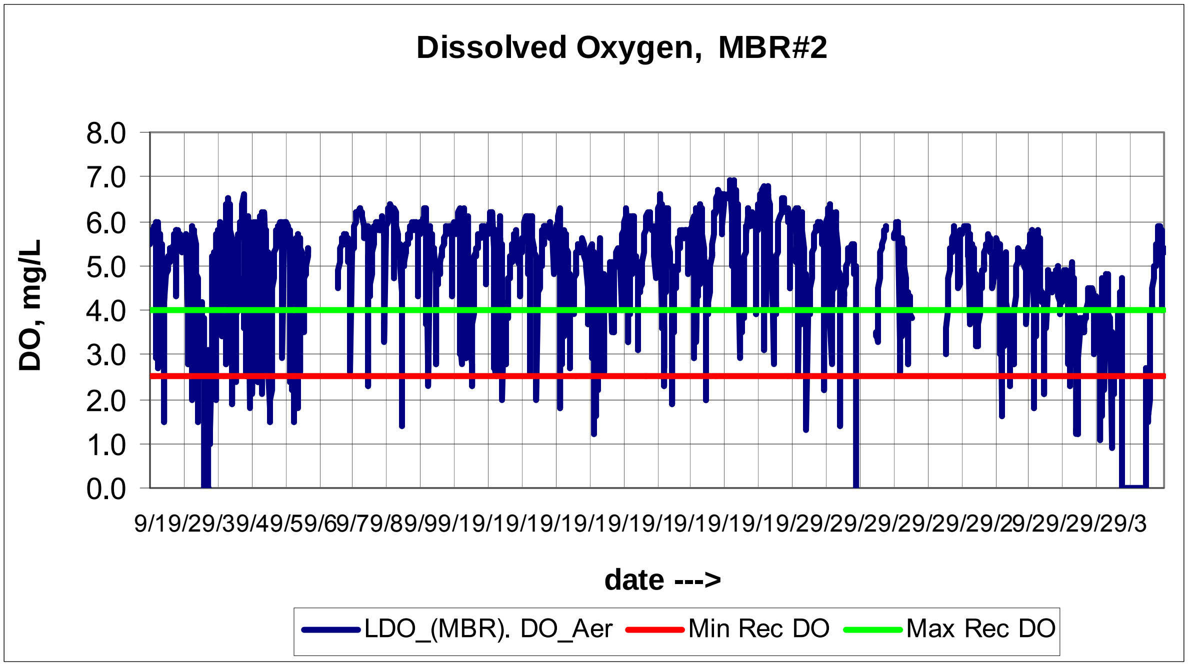

Figure F-7: MBR#2 Dissolved Oxygen Histogram, September 2011: Note range excursions.

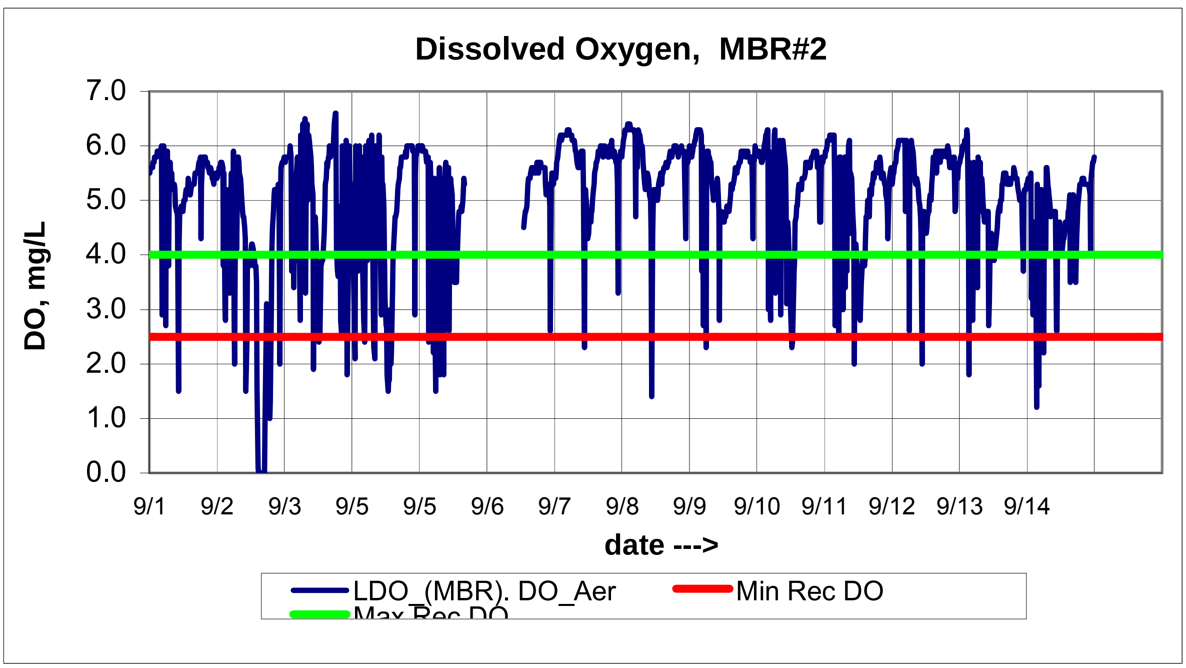

Figure F-8: MBR#2 Dissolved Oxygen Histogram, September 1 to 15, 2011

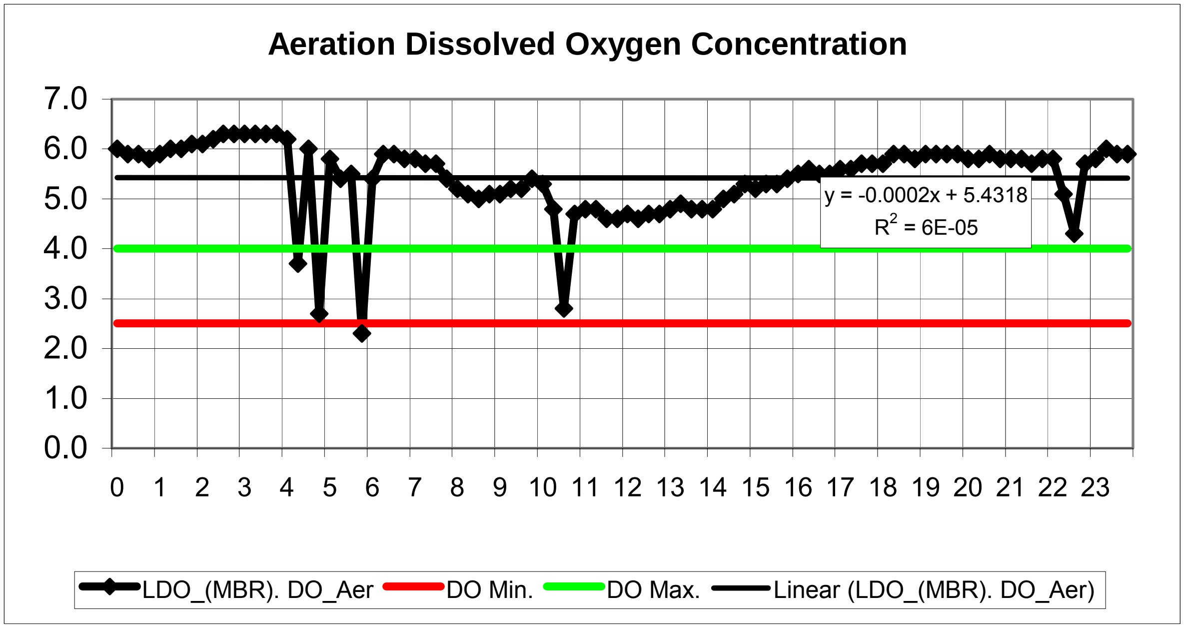

Figure F-9: MBR#2 Dissolved Oxygen Histogram, September 9, 2011

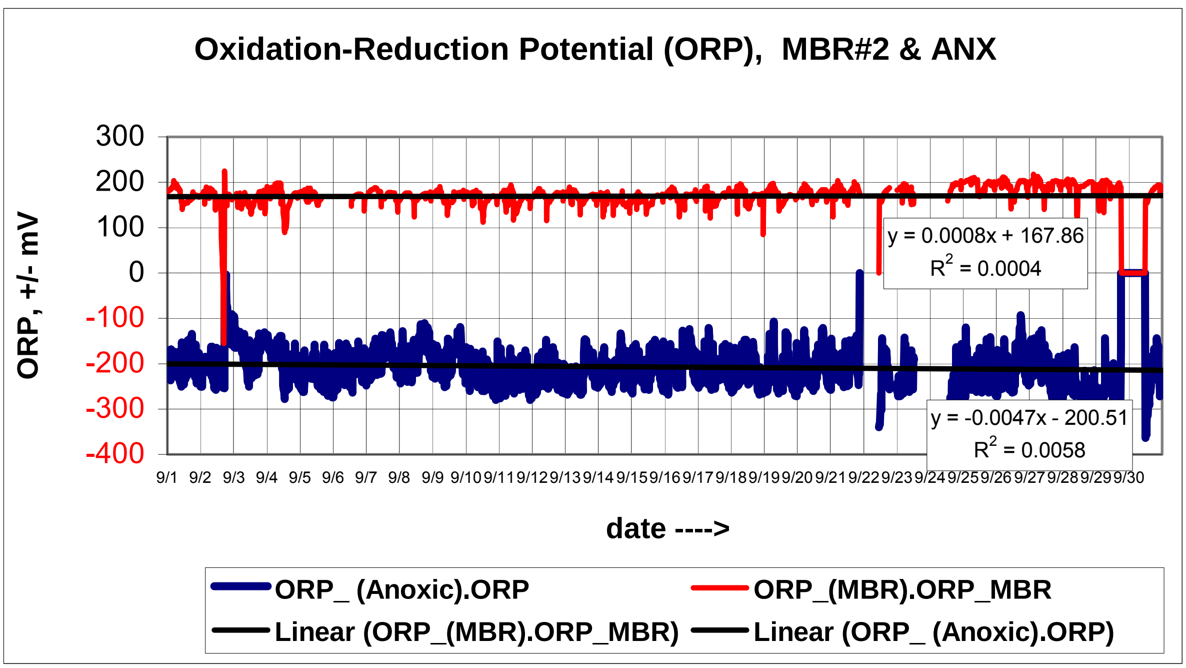

Figure F-10: Comparative Histogram: MBR and ANX Oxidation/Reduction Potentials, September 2011.

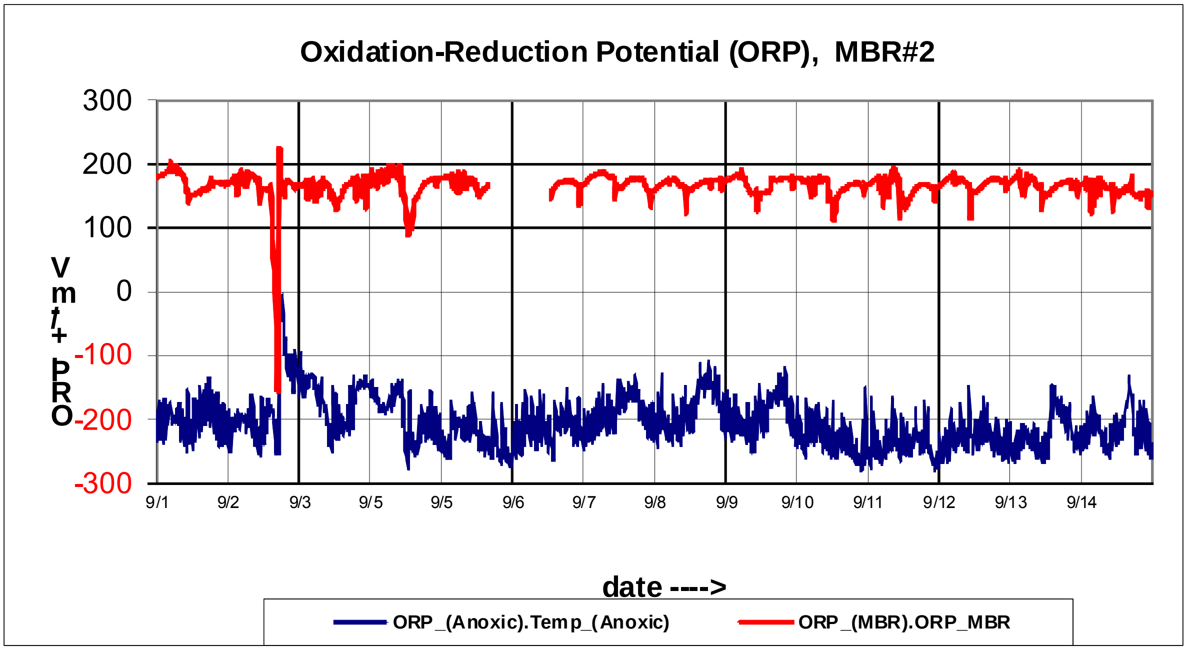

Figure F-11: Comparative Histogram: MBR & ANX Redox Potentials, Sept. 1 to 15, 2011

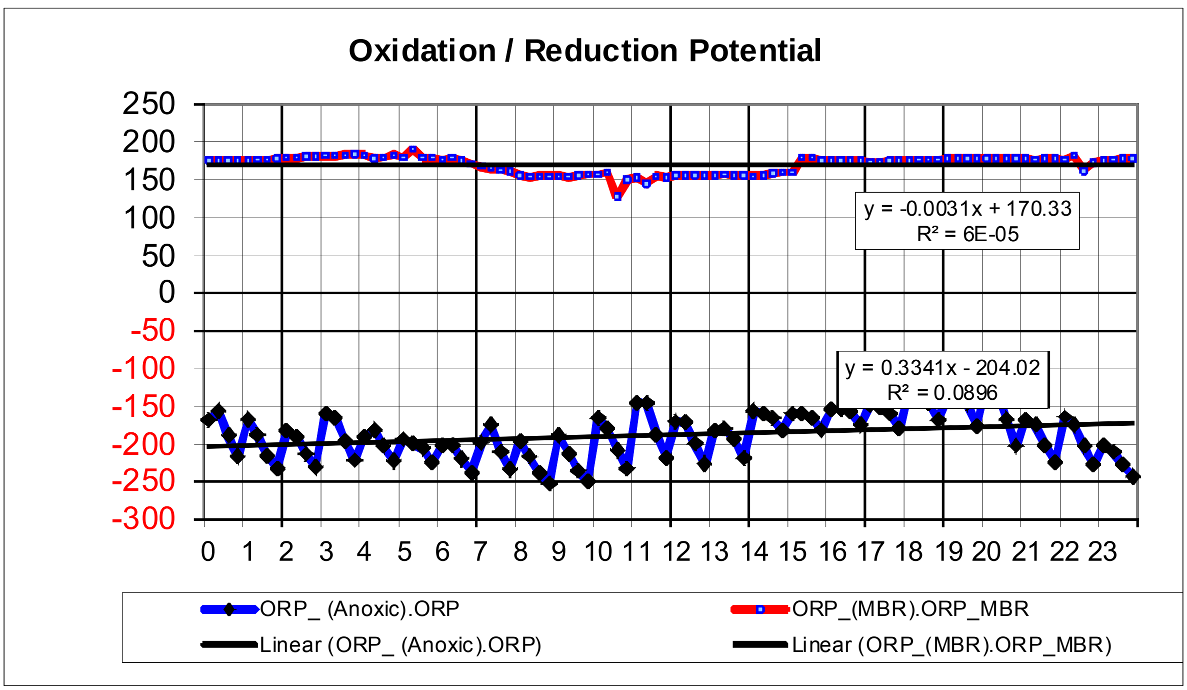

Figure F-12: Comparative Histogram: MBR & ANX Redox Potentials, Sept. 9, 2011

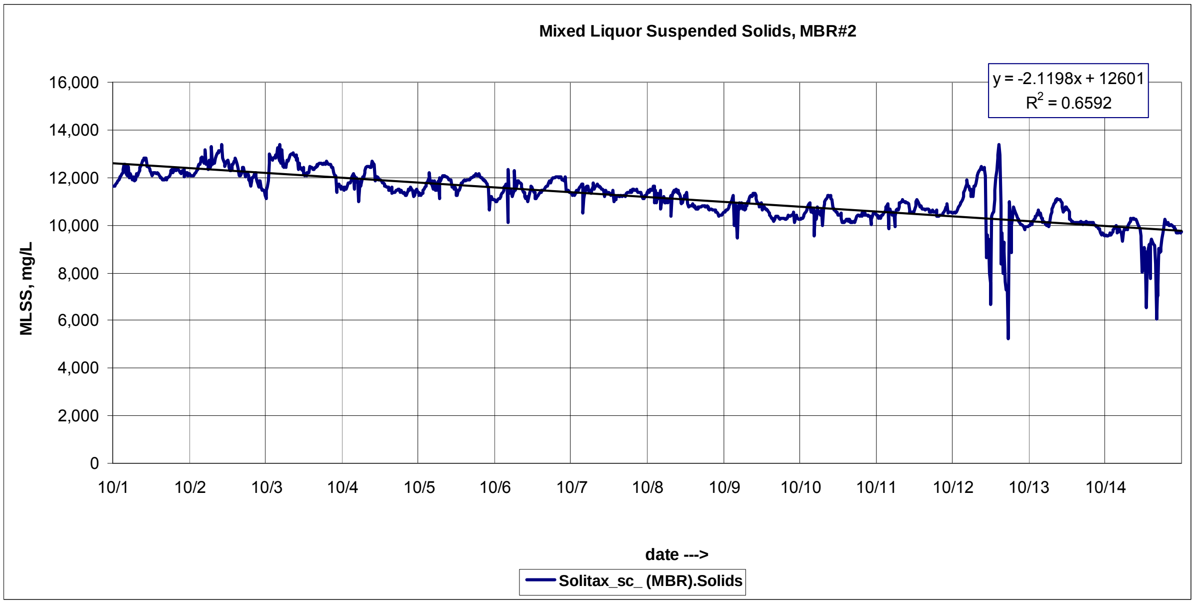

Figure F-13: MBR#2 Total Suspended Solids histogram, October 1-15, 2011, shows solids gradually coming under control as a result of testing data and recommendations.

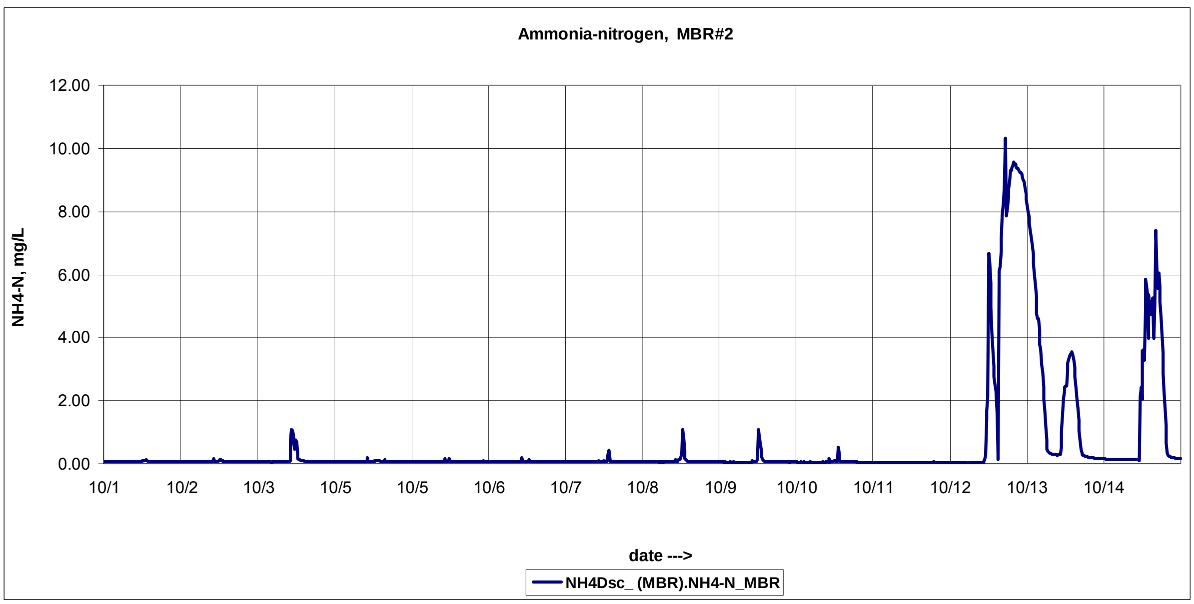

Figure F-14: MBR#2 Ammonia-nitrogen Concentration histogram, October 1-15, 2011, demonstrating a significant spike in concentration from 10/12 to 10/15. These occurred during system shut-downs due to a malfunctioning automatic valve on the aeration lines, a problem under repair in mid-month

Figure F-15: Histogram

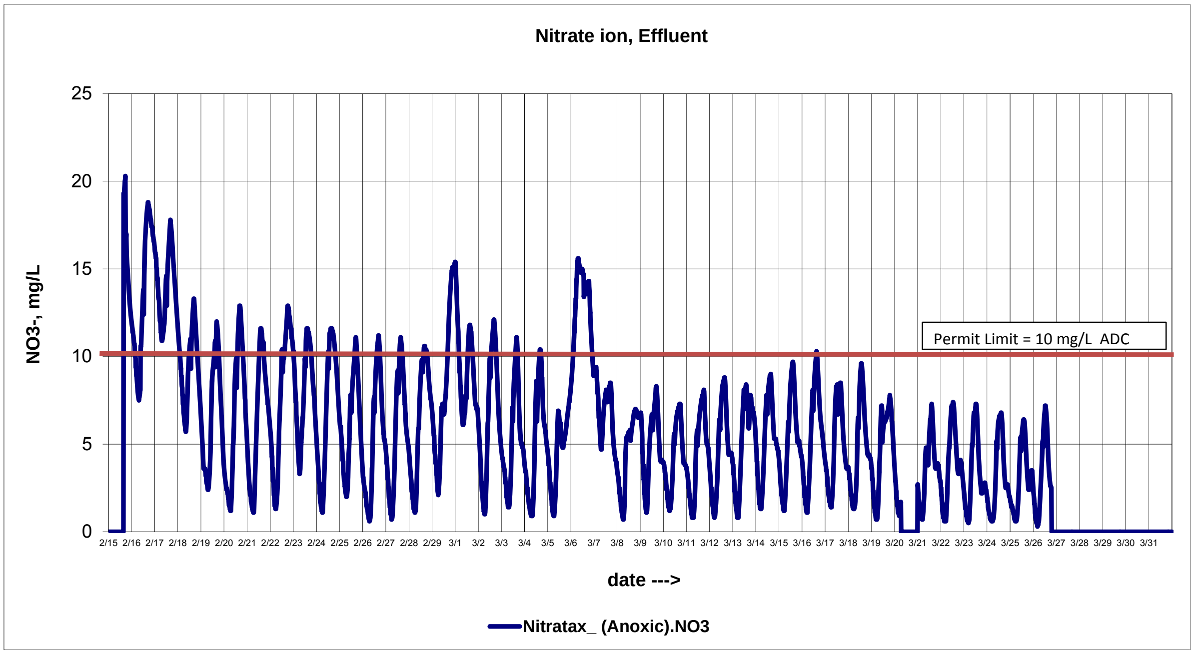

Figure F-16: Nitrate Histogram for February/March 2012, showing improvements since implementation of recommendations regarding carbon and alkalinity addition and slowing of recycle rate. The histogram shows that increases in the frequency of adding sucrose as a carbon source brought the average daily concentration well under the 10 mg/L permit limit.

ATTACHMENT G—SITE PHOTOGRAPHY

Figure G-1: Portland Treatment System: Anoxic Tank (left); MBRs (right); Freshening (upper right)

Figure G-2: Portland Aerobic Digester with Reed Beds to right.

Figure G-3: MBR Blowers

Figure G-4: UV System

Figure G-5: Chemical Feed

Figure G-6: Screening

Figure G-7: PLC Control Panel

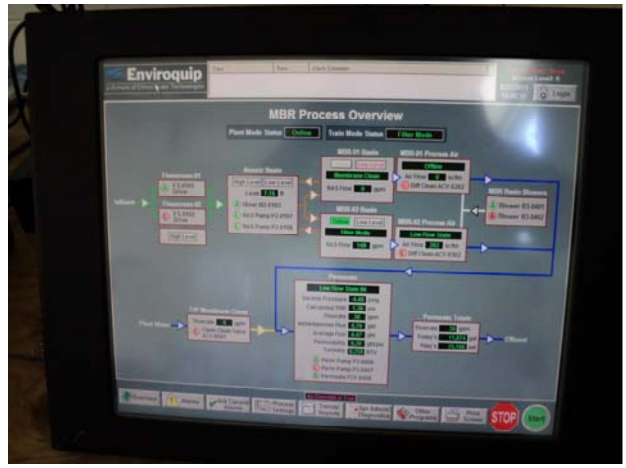

Figure G-8: SCADA Computer & Display

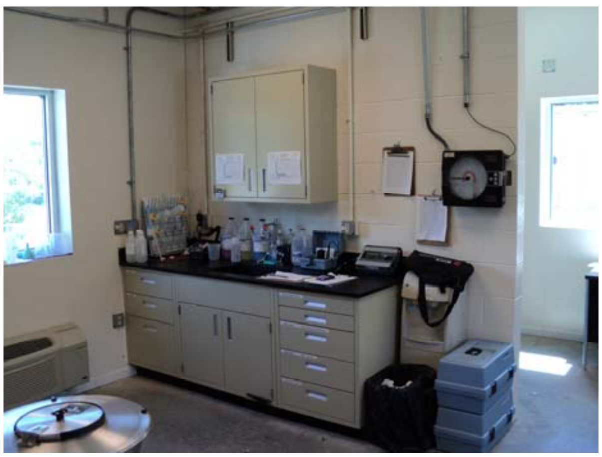

Figure G-9: Laboratory Bench & Chart Recorder

Figure G-10: WPPE Bench & Data Workstations

Figure G-11: Effluent Sampler

Figure G-12: Recycle Sludge Valve


Figure G-13: Hach SCADA Equipment Mounted in Process Tanks


Figure G-14: Anoxic Tank Instrument Mounts


Figure G-15: Hach Probe Mounts in MBR 2

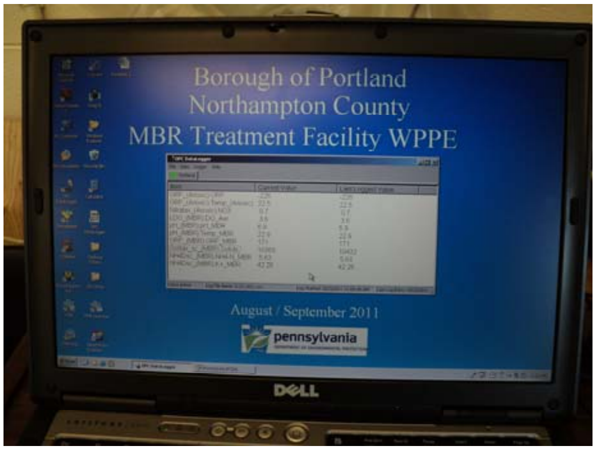

Figure G-16: Digital Probe Display in Lab

Figure G-17: Controllers & Probes

Figure G-18: Anoxic Tank Instrument Mounts

Figure G-19: Problematic Automatic Valve

ATTACHMENT H—NPDES PERMIT PARTICULARS

3800-PM-WSWM0012 Rev. 7/2007
Permit

Permit No. PA-0064297

PART A - EFFLUENT LIMITATIONS, MONITORING, RECORDKEEPING AND REPORTING REQUIREMENTS

I. **For Outfall** 001, **Latitude** 40°55'04", **Longitude** 75°05'16", **River Mile Index** _______, **Stream Code** __________

which receives wastewater from publicly owned treatment plant

a. The permittee is authorized to discharge during the period from August 1, 2008 through July 31, 2013.

b. Based on the anticipated wastewater characteristics and flows described in the permit application and its supporting documents and/or amendments, the following effluent limitations and monitoring requirements apply (see also Additional Requirements, Footnotes and Supplemental Information).

Discharge Parameter	Effluent Limitations						Monitoring Requirements	
	Mass Units (lbs/day) (1)		Concentrations (mg/L)				Minimum (3) Measurement Frequency	Required Sample Type
	Monthly Average	Weekly Average	Minimum	Monthly Average	Weekly Average	Instantaneous Maximum (2)		
Flow							Continuous	Recording Instr.
$CBOD_5$	8.8	13.1		10.0	15.0	20.0	1/Week	8 Hr. Comp.
Total Suspended Solids	8.8	13.1		10.0	15.0	20.0	1/Week	8 Hr. Comp.
NH_3-N	1.3			1.5		3	1/Week	8 Hr. Comp.
Total Nitrogen	8.8			10.0		20.0	1/Week	8 Hr. Comp.
Phosphorus	1.8			2			1/Week	8 Hr. Comp.
Total Dissolved Solids				500			1/Week	8 Hr. Comp.
pH			6.0 to 9.0 Standard Units at All Times				Daily	Grab
Fecal Coliform				50/100 ml		**	1/Week	Grab
Dissolved Oxygen			Minimum of 6.0 mg/L at all times				Daily	Grab

**Not greater than 1000/100 ml in more than 10% of the samples tested.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):

Outfall 001

Figure H-1: Effluent Discharge Parameters

PART C

I. OTHER REQUIREMENTS

SPECIAL CONDITIONS

ONE: No storm water from pavements, area ways, roofs, foundation drains or other sources shall be directly admitted to the sanitary sewers associated with the herein approved discharge.

TWO: The approval herein given is specifically made contingent upon the permittee acquiring all necessary property rights by easement or otherwise, providing for the satisfactory construction, operation, maintenance and replacement of all sewers or sewerage structures associated with the herein approved discharge in, along, or across private property, with full rights of ingress, egress and regress.

THREE: If, in the opinion of the Department, these works are not so operated or if by reason of change in the character of wastes or increased load upon the works, or changed use or condition of the receiving body of water, or otherwise, the said effluent ceases to be satisfactory or the sewerage facilities shall have created public nuisance, then upon notice by the Department, the right herein granted to discharge such effluent shall cease and become null and void unless within the time specified by the Department, the permittee shall adopt such remedial measures as will produce an effluent which, in the opinion of the Department, will be satisfactory for discharge into the said receiving body of water.

FOUR: Analysis for Carbonaceous Biochemical Oxygen Demand (CBOD5) shall be done in accordance with methods specified in the current edition of Standard Methods for the Examination of Water and Wastewater.

FIVE: Collected screenings, slurries, sludges, and other solids shall be handled and disposed of in compliance with 25 Pa. Code, Chapters 75, and in a manner equivalent to the requirements indicated in Chapters 271, 273, 275, 283, and 285 (related to permits and requirements for landfilling, land application, incineration, and storage of sewage sludge), Federal Regulation 40 CFR 257, Pennsylvania Clean Streams Law, Pennsylvania Solid Waste Management Act of 1980, and the Federal Clean Water Act and its amendments.

The permittee is responsible to obtain or assure that contracted agents have all necessary permits and approvals for the handling, storage, transport, and disposal of solid waste materials generated as a result of wastewater treatment.

SIX: The effluent limitations for Outfall 001 were determined using an effluent discharge rate of 0.105 MGD.

Figure H-2: Special Conditions

NPDES PERMIT NO: PA0064297

In compliance with the provisions of the Clean Water Act, 33 U.S.C. Section 1251 *et seq.* ("the Act") and Pennsylvania's Clean Streams Law, as amended, 35 P.S. Section 691.1 *et seq.*,

Borough of Portland

P. O. Box 476

Portland, PA 18351

is authorized to discharge from a facility known as **Borough of Portland Wastewater Treatment Facility** located in the **Borough of Portland**, **Northampton County** to the **Delaware River** in Watershed **1F** in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts A, B and C hereof.

THIS PERMIT SHALL BECOME EFFECTIVE ON **August 1, 2008**

THIS PERMIT SHALL EXPIRE AT MIDNIGHT ON **July 31, 2013**

Figure H-3: Validity Dates

ATTACHMENT I—SUPPLEMENTAL CARBON SOURCES

Bulk molasses waste can be obtained in tote-drum quantities from:

Allenwood Molasses Inc.
230 Columbia Ave.
P.O. Box 1
Allenwood, PA 17810

(570) 538-1638

Attn: Lynn McCormick, Owner, tel. (570) 713-9629

This vendor has provided material used at other DEP WPPE sites for augmenting BNR carbon requirements.

ATTACHMENT J—SAMPLING DATA

The following spreadsheet pages summarize sampling data from the Portland WPPE. Sampling sites typically include:

- Influent wastewater to secondary processes (after screening and grit removal)
- Effluent from the last process in the treatment train, usually post-disinfection
- Background receiving stream, typically an upstream sample of the waterway into which the facility discharges
- Impacted receiving stream, the downstream waterway which may affected by the quality of the plant effluent (NOTE: Because the Portland facility employs a mid-river discharge, the effluent flow was significantly less than that of the river, and due to the unavailability of access to a suitable downstream sampling site about 100 meters downstream of the discharge, no impacted samples were taken.)
- Activated sludge mixed liquor, used for calibration of the TSS probe and also to assess the buffering capacity (alkalinity) of the mixed liquor

Supplemental sampling was performed at two other locations specific to the project:

- Returned Anoxic Sludge (RAS) mixed liquor sample from the discharge end of the Anoxic Mixing Tank, used to assess alkalinity and for TSS calibration, if needed.
- Filtrate or Permeate, taken after the membrane filters but prior to disinfection, used to assess filter performance and compared to effluent discharged to receiving stream.

Note on flow data:

- Metered effluent data was used for determining plant and effluent loading values, using the flow for the day the sample was taken
- River flows were calculated using USGS data from a flow metering station at Delaware Water Gap, the closest such metering facility to the actual facility discharge.

Portland MBR WWTF--BOL Test Results

Raw Wastewater

Sample #	436	441	447	454	459	465	471	477	483				
Date	8/23/2011	8/30/11	9/6/11	9/13/2011	9/20/11	9/27/11	10/4/11	10/11/11	10/18/2011				
Time	13:45	13:00	13:26	14:20	11:52	13:15	13:00	12:38	12:00				
Locus	INF	INF	INF	INF	INF	INF	INF	INF	INF				
Lab#	I2011024523	I2011025200	I2011025673	I2011026279	I2011027062	I2011027920	I2011028789	I2011029554	I2011030441	Average	Max	Min	Std. Dev.
Field Temp		18.7	18.4	18	18.4	15.2	17.2	18.4	22.1	18.3	22.1	15.2	1.9
Field DO		1.2	1.7	0.6	1.6	0.2	6.5	7.9	1.0	2.6	7.9	0.2	2.9
Field pH		6.5	6.9	6.8	7.4	6.8	3.7	0.8	8.4	5.9	8.4	0.8	2.5
BOD	198.00	274.00	272.00	280.00	317.00	252.00	431.00	261.00	268.00	283.67	431.00	198.00	63.41
CBOD	198.00	274.00	272.00										
COD		0.0	0.0	475.0		515.5	650.0	523.7	463.6	375.4	650.0	0.0	263.5
pH	7.7	7.6	7.4	7.6	7.6	7.5	7.6	7.6	7.5	7.6	7.7	7.4	0.1
ALK	309.8	309.8	313.0	302.0	271.0	271.6	304.6	284.0	292.6	295.4	313.0	271.0	16.4
TSS	138	462	274	104	234	98	204	206	236	217	462	98	110
VSS	136	264	426	110	210	154	206	190	196	210	426	110	93
NH3-N	40.4	46.1	34.33	36.3	33.93	40.65	59.03	38.43	43.62	41.4	59.0	33.9	7.7
NO2-N	0.01	0.01	0.18	0.01	0.06	0.01	0.01	0.01	0.01	0.03	0.18	0.01	0.06
NO3-N	0.04	0.04	0.67	0.04	0.98	0.04	0.04	0.04	0.04	0.21	0.98	0.04	0.35
TKN		54.08	50.04	50.5	46.91	53.82	59.70	54.42	57.68	53.4	59.7	46.9	4.2
TN		100.19	85.04	50.57	47.95	53.87	59.75	54.47	57.73	63.7	100.2	48.0	18.7
TP	7.861	8.10	9.47	7.601	6.88	7.33	8.03	8.162	7.317	7.860	9.468	6.883	0.739
Chloride	406.0	59.9	36.1	55.6	35.4	40.9	45.6	39.6	45.9	85.0	406.0	35.4	120.7
TDS		444	398	432	364	334	416	410	390	399	444	334	36

Final Effluent

Sample #	437	442	448	455	460	466	472	478	484				
Date	8/23/11	8/30/11	9/6/11	9/13/2011	9/20/11	9/27/11	10/4/11	10/11/11	10/18/2011				
Time	13:46	13:10	13:16	14:25	11:56	13:20	13:10	13:00	12:14				
Locus	EFF	EFF comp	EFF comp	EFF	EFF	EFF	EFF	EFF	EFF				
Lab#	I2011024524	I2011025201	I2011025674	I2011026280	I2011027063	I2011027921	I2011028790	I2011029555	I2011030442	Average	Max	Min	Std. Dev.
Field Temp	0.0	22.0	0.0	22.4	21.0	22.3	20.0	20.6	19	16.4	22.4	0.0	9.3
Field DO	0.0	7.4	0.0	7.9	6.4	6.8	7.2	7.1	7.2	5.6	7.9	0.0	3.2
Field pH	0.0	7.1	7.1	7.2	7.5	7.1	8.4	6.2	7.5	6.4	8.4	0.0	2.5
BOD					0.50	1.10	8.60	5.10	0.20	3.10	8.60	0.20	3.65
CBOD	0.20	0.80	0.20	0.60						0.45	0.80	0.20	0.30
COD													
pH	7.9	8.1	8.2	7.8	8.2	8.1	7.7	8.1	7.6	8.0	8.2	7.6	0.2
ALK	81.6	133.6	140.6	163.2	154.4	108.2	102.2	128.0	104	124.0	163.2	81.6	26.8
TSS	5	5	5	5	5	5	5	5	5	5.0	5.0	5.0	0.0
VSS	6	5	10	5	5	26	5	18	5	9.4	26.0	5.0	7.6
NH3-N	11.37	14.75	4.87	0.1	0.14	9.01	0.02	0.36	0.19	4.5	14.8	0.0	5.8
NO2-N	0.18	2.40	0.12	0.06	0.05	0.15	0.09	0.1	0.06	0.4	2.4	0.1	0.8
NO3-N	0.09	0.41	0.03	11.19	8.33	0.05	16.13	13.18	18.04	7.5	18.0	0.0	7.5
TKN	1.00	3.50	1.22	1.00	1.24	1.00	4.14	1.69	1.28	1.8	4.1	1.0	1.2
TN	1.27	6.31	1.37	12.25	9.62	1.20	20.36	14.97	19.38	9.6	20.4	1.2	7.6
TP	0.17	2.38	0.96	1.9	2.23	0.62	0.42	0.284	0.139	1.0	2.4	0.1	0.9
Chloride	0.0	45.2	60.7	38.10	54.3	35.8	49.3	41.1	47.3	41.3	60.7	0.0	17.3
TDS	442	512	398	390	418	360	466	436	438	429	512	360	45
Sample #	437	442	448	455	460	466	472	478	484				
Lab#	B2011008642	B2011008987	B2011009277	B2011009572	B2011010326	B2011011042	B2011011642	B2011012094	B2011012643	Average	Max	Min	Std. Dev.
Field Temp		22.0	22.1	22.4	21.0	22.3	20.0	20.6	19	21.2	22.4	19.0	1.2
Field DO		7.4	7.8	7.9	6.4	6.84	7.2	7.1	7.2	7.2	7.9	6.4	0.5
Field pH		7.1	7.1	7.2	7.5	7.1	8.36	6.2	7.5	7.3	8.4	6.2	0.6
Total Col.				20						20	20	20	
Fecal Col.	0.20	0.20	0.20	20	20	20	20	10	20	12	20	0	10

Portland MBR WWTF--BOL Test Results

Upstream/Background

Sample #	440		443	453	461	467	476	482	488				
Date	8/23/2011	8/30/2011	9/6/2011	9/13/2011	9/20/2011	9/27/2011	10/4/2011	10/11/2011	10/18/2011				
Time	13:51	11:41	12:02	12:10	11:27	18:27	11:31	12:16	12:00				
Locus	UPS	UPS	UPS	UPS	UPS	UPS	UPS	UPS	UPS				
Lab#	I2011024527	I2011009449	I2011025672	I2011026284	I2011027064	I2011027925	I2011028794	I2011029559	I2011030446	Average	Max	Min	Std. Dev.
River Q cfs	5,590	53,500	21,600	27,300	8,780	11,400	21,200	8,270	10,100	18,638	53,500	5,590	15,025
River time	14:00	11:45	12:00	12:15	11:30	18:30	11:30	12:15	12:00				
River MGD	3,615	34,599	13,969	17,655	5,678	7,372	13,710	5,348	6,532	12,053	34,599	3,615	9,717
Field Temp	19.2	flooded	19.2	0	16.1	14.6	16.6	16	15.4	14.6	19.2	0.0	6.1
Field DO	8.4	flooded	8.6	0	8.2	8.65	7.2	7.1	9.62	7.2	9.6	0.0	3.0
Field pH	6.9	flooded	6.8	0	7	6.9	9.78	9.41	7.1	6.7	9.8	0.0	3.0
BOD				0.80	0.40	0.70	0.30	<0.20	0.30	0.50	0.80	0.30	0.23
CBOD	0.30												
COD													
pH	7.1		7.3	7.2	7.5	7.5	7.1	7.3	7.4	7.3	7.5	7.1	0.2
ALK	22.8		17.6	20.6	24.2	21.8	17.4	24.2	23.2	21.5	24.2	17.4	2.7
TSS	5		19	8	5	5	6	5	5	7	19	5	5
VSS	26		12	5	5	6	5	5	5	9	26	5	7
NH3-N	0.03		0.03	0.0	0.27	0.19	0.16	0.20	0.18	0.14	0.27	0.02	0.10
NO2-N	0.01		0.01	0.01	0.03	0.04	0.03	0.01	0.02	0.02	0.04	0.01	0.01
NO3-N	0.20		0.18	0.18	0.01	0.01	0.01	0.01	0.01	0.08	0.20	0.01	0.09
TKN	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
TN	1.21		1.19	1.19	1.04	1.05	1.04	1.02	1.03	1.10	1.21	1.02	0.08
TP	0.020		0.023	0.0	0.017	0.026	0.023	0.017	0.017	0.021	0.026	0.017	0.004
Chloride	12.1		9.1	8.30	11.2	8.4	7.1	9.7	8.5	9.3	12.1	7.1	1.6
TDS	80		62	64	88	48	72	72	56	68	88	48	13

MBR 2 Solids

Sample #	438	444	449	456	462	468	473	479	485				
Date	8/23/2011	8/30/2011	9/6/2011	9/13/2011	9/20/2011	9/27/2011	10/4/2011	10/11/2011	10/18/2011				
Time	13:49	16:22	13:30	14:32	12:07	12:10	13:14	12:43	12:00				
Locus	MBR	MBR	MBR	MBR	MBR	MBR	MBR	MBR	MBR				
Lab#	I2011024525	I2011025202	I2011025675	I2011026281	I2011027065	I2011027922	I2011028791	I2011029556	I2011030443	Average	Max	Min	Std. Dev.
Field Temp	23	22.2	22.4	22.5	21.2	22.3	20	20.6	19.3	21.5	23.0	19.3	1.3
Field DO	4.4	4.4	5.4	5.0	4.6	4.8	7.22	7.1	4.8	5.3	7.2	4.4	1.1
Field pH	6.9	7.1	7.1	7.2	7.1	7.1	4.76	4.4	7.1	6.5	7.2	4.4	1.1
BOD													
CBOD													
COD													
pH													
ALK	344.8	381.0	440.6	607.2	497.2	542.0	449.6	582.8	547.8	488.1	607.2	344.8	90.4
TSS	10,180	8,712	10,772	11,348	12,060	15,108	13,368	10,832	10,624	11,445	15,108	8,712	1,873
VSS	8,196	6,792	7,388	7,324	9,832	9,736	10,056	7,220	6,616	8,129	10,056	6,616	1,383
NH3-N													
NO2-N													
NO3-N													
TKN													
TP													
Chloride													
TDS													

Portland MBR WWTF--BOL Test Results

Anoxic Tank Solids

Sample #	439	445	450	457	463	469	474	480	486				
Date	8/23/2011	8/30/2011	9/6/2011	9/13/2011	9/20/2011	9/27/2011	10/4/2011	10/11/2011	10/18/2011				
Time	13:51	16:24	13:33	14:35	12:09	12:12	13:16	12:44	12:00				
Locus	RAS	RAS	RAS	RAS	RAS	RAS	RAS	RAS	RAS				
Lab#	I2011024526	I2011025203	I2011025676	I2011026282	I2011027066	I2011027923	I2011028792	I2011029557	I2011030444	Average	Max	Min	Std. Dev.
Field Temp	22.5	21.7	21.9	22.1	20.8	21.7	20.2	19.9	18.5	21.0	22.5	18.5	1.3
Field DO	0	0.4	0.2	0.2	0.4	0.08	7.4	7.3	0.8				
Field pH	6.9	7	6.9	7.1	7.2	7.2	0.7	0.52	7.3	5.6	7.3	0.5	2.9
BOD													
CBOD													
COD													
pH													
ALK	331.8	360.8	430.4	591.6	558.6	470.0	447.2	546.2	523.8	473.4	591.6	331.8	89.7
TSS	9,528	4,276	10,008	12,156	9,212	10,880	10,900	7,884	7,540	9,154	12,156	4,276	2,343
VSS	6,847	6,292	7,096	8,808	9,036	7,996	7,620	7,540	4,396	7,292	9,036	4,396	1,398
NH3-N													
NO2-N													
NO3-N													
TKN													
TP													
Chloride													
TDS													

Sample #			452	458	464	470	475	481	487				
Date	8/23/2011	8/30/2011	9/6/11	9/13/11	9/20/11	9/27/11	10/4/11	10/11/11	10/18/2011				
Time			14:36	14:45	12:15	13:28	12:50	12:50	12:16				
Locus			FIL	MFP	MFP	MFP	MFP	MFP	MFP				
Lab#			I2011025677	I2011026283	i2011027067	I2011027924	I2011028793	I2011029558	I2011030445	Average	Max	Min	Std. Dev.
Field Temp			21.2	22.6	20.8	21.5	20.3	20.3	18.7	20.8	22.6	18.7	1.2
Field DO			0.0	4.6	4.4	4.7	7.2	7.4	3.6	4.6	7.4	0.0	2.5
Field pH			7.0	7.2	7.1	7.2	4.9	5.2	7.3	6.6	7.3	4.9	1.0
BOD			0.70	0.30	0.30	0.50	1.70	2.90	0.20	0.94	2.90	0.20	1.00
CBOD													
COD													
pH			7.7	7.9	7.8	7.7	7.3	7.5	7.6	7.6	7.9	7.3	0.2
ALK			133.4	159.6	119.2	103.8	90.8	116.8	103.6	118.2	159.6	90.8	22.8
TSS			<5	<5	<5	<5	<5	<5	<5	#DIV/0!	0	0	#DIV/0!
VSS			10	<5	<5	<5	<5	8	<5	9	10	8	1
NH3-N			0.08	0.08	0.12	0.12	0.54	0.1	0.18	0.17	0.54	0.08	0.16
NO2-N			0.03	0.05	0.02	0.02	0.07	0.04	0.05	0.04	0.07	0.02	0.02
NO3-N			10.75	11.33	10.28	11.73	16.69	15.6	17.98	13.48	17.98	10.28	3.17
TKN			1.06	<1.00	1.16	<1.00	3.33	1.22	1.18	1.59	3.33	1.06	0.97
TN			11.84	12.38	11.46	12.75	20.09	16.86	19.21	14.94	20.09	11.46	3.69
TP			0.63	2.00	0.89	0.86	0.18	0.21	0.17	14.941	20.090	11.460	3.686
Chloride			44.3	38.2	49.2	37.5	44.6	37.8	47.4	0.7	2.0	0.2	0.7
TDS			396	396	482	380	474	456	426	43	49	38	5
Lab#			B2011009277	B2011009573	B2011010327	B2011011043	B2011011643	B2011012093	B2011012644				
Total Col.													
Fecal Col.			20	<20	20	<20	<20	<20	<10				

NOTES:

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

Portland MBR WWTF--BOL Test Results

Portland MBR WWTF--Calculated Plant and Effluent Nutrient Loadings, with Background Loadings

Flow Data for Portland Borough WWTF

Date	8/23/2011	8/30/2011	9/6/2011	9/13/2011	9/20/2011	9/27/2011	10/4/2011	10/11/2011	10/18/2011
Flow	0.027	0.023	0.032	0.024	0.032	0.028	0.03	0.026	0.027

Final Effluent

Sample #	8/23/2011	8/30/2011	9/6/2011	9/13/2011	9/20/2011	9/27/2011	10/4/2011	10/11/2011	10/18/2011	Average	Max	Min	Std. Dev.
CBOD	0.20	0.80	0.20	0.60	0.50	1.10	8.60	5.10	0.20	1.92	8.60	0.20	2.94
lb/day	0.05	0.15	0.05	0.12	0.13	0.26	2.15	1.11	0.05	0.45	2.15	0.05	0.72
NH3-N	11.37	14.75	4.87	0.08	0.14	9.01	0.02	0.36	0.19	4.53	14.75	0.02	5.78
lb/day	2.56	2.83	1.30	0.02	0.04	2.10	0.01	0.08	0.04	1.00	2.83	0.01	1.21
NO2-N	0.18	2.40	0.12	0.06	0.05	0.15	0.09	0.10	0.06	0.36	2.40	0.05	0.77
lb/day	0.04	0.46	0.03	0.01	0.01	0.04	0.02	0.02	0.01	0.07	0.46	0.01	0.15
NO3-N	0.09	0.41	0.03	11.19	8.33	0.05	16.13	13.18	18.04	7.49	18.04	0.03	7.49
lb/day	0.02	0.08	0.01	2.24	2.22	0.01	4.04	2.86	4.06	1.73	4.06	0.01	1.74
TKN	1.00	3.50	1.22	1.00	1.24	1.00	4.14	1.69	1.28	1.79	4.14	1.00	1.18
lb/day	0.23	0.67	0.33	0.20	0.33	0.23	1.04	0.37	0.29	0.41	1.04	0.20	0.27
TN	1.27	6.31	1.37	12.25	9.62	1.20	20.36	14.97	19.38	9.64	20.36	1.20	7.63
lb/day	0.29	1.21	0.37	2.45	2.57	0.28	5.09	3.25	4.36	2.21	5.09	0.28	1.80

Upstream TN Calcs — River flow calculated using gauge reading at Delaware Water Gap and nearest time to sampling time.

Sample #	8/23/2011	8/30/2011	9/6/2011	9/13/2011	9/20/2011	9/27/2011	10/4/2011	10/11/2011	10/18/2011	Average	Max	Min	Std. Dev.
BOD	0.30			0.80	0.40	0.7	0.30	0.20	0.3	0.43	0.80	0.20	0.23
lb/day	9,045			117,794	18,942	43,040	34,303	8,921	16,342	35,484	117,794	8,921	38,467
NH3-N	0.03		0.03	0.02	0.27	0.19	0.16	0.20	0.18	0.14	0.27	0.02	0.10
lb/day	904		3,495	2,945	12,786	11,682	18,295	8,921	9,805	8,604	18,295	904	5,853
NO2-N	0.01		0.01	0.01	0.03	0.04	0.03	0.01	0.02	0.02	0.04	0.01	0.01
lb/day	301		1,165	1,472	1,421	2,459	3,430	446	1,089	1,473	3,430	301	1,033
NO3-N	0.20		0.18	0.18	0.01	0.01	0.01	0.01	0.01	0.08	0.20	0.01	0.09
lb/day	6,030		20,970	26,504	474	615	1,143	446	545	7,091	26,504	446	10,547
TKN	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
lb/day	30,150		116,500	147,243	47,355	61,486	114,342	44,604	54,474	77,019	147,243	30,150	42,695
TN MinPoss	0.20		0.18	0.18	0.03	0.04	0.03	0.00	0.00	0.08	0.20	0.00	0.09
lb/day	6,030		20,970	26,504	1,421	2,459	3,430	0	0	7,602	26,504	0	10,255
TN MaxPoss	1.21		1.19	1.19	1.04	1.05	1.04	1.02	1.03	1.10	1.21	1.02	0.08
lb/day	36,481		138,635	175,219	49,249	64,560	118,916	45,496	56,109	85,583	175,219	36,481	51,560

INF WW

Sample #	8/23/2011	8/30/2011	9/6/2011	9/13/2011	9/20/2011	9/27/2011	10/4/2011	10/11/2011	10/18/2011	Average	Max	Min	Std. Dev.
BOD conc.	198.00	274.00	272.00	280.00	317.00	252.00	431.00	261.00	268.00	283.67	431.00	198.00	63.41
ppd	44.59	52.56	72.59	56.04	84.60	58.85	107.84	56.60	60.35	66.00	107.84	44.59	19.52
NH3-N	40.39	46.10	34.33	36.26	33.93	40.65	59.03	38.43	43.62	41.42	59.03	33.93	7.75
ppd	9.10	8.84	9.16	7.26	9.06	9.49	14.77	8.33	9.82	9.54	14.77	7.26	2.10
NO2-N	0.01	0.01	0.18	0.01	0.06	0.01	0.01	0.01	0.01	0.03	0.18	0.01	0.06
ppd	0.00	0.00	0.05	0.00	0.02	0.00	0.00	0.00	0.00	0.01	0.05	0.00	0.02
NO3-N	0.04	0.04	0.67	0.04	0.98	0.04	0.04	0.04	0.04	0.21	0.98	0.04	0.35
ppd	0.01	0.01	0.18	0.01	0.26	0.01	0.01	0.01	0.01	0.06	0.26	0.01	0.10
TKN		54.08	50.04	50.52	46.91	53.82	59.70	54.42	57.68	53.40	59.70	46.91	4.16
ppd		10.37	13.35	10.11	12.52	12.57	14.94	11.80	12.99	12.33	14.94	10.11	1.58
TN mg/L		54.13	50.89	50.57	47.95	53.87	59.75	54.47	57.73	53.67	59.75	47.95	3.86
TN ppd		10.38	13.58	10.12	12.80	12.58	14.95	11.81	13.00	12.40	14.95	10.12	1.61

NOTE: If a sample reads below the detection limit, the Total Nitrogen is calculated as the maximum possible value for the data set. In reality, the TN value is somewhere between the summation of actual values obtained for all constituents, as minimum, and the summation of both actual values and the detection limits for those values which are reported to be not present. For example, on 8/23/11, the effluent TN is a value between 11.64 mg/L and 12.64 mg/L, where TKN was not detected to 1.00 mg/L.

Portland MBR WWTF--BOL Test Results

Portland MBR WWTF--Contribution of Portland Nutrient Loading to Delaware River

Percent Contribution of Portland WWTP Loading to Delaware River   River flow calculated using gauge reading at Delaware Water Gap and nearest time to sampling time

Sample #	8/23/2011	8/30/2011	9/6/2011	9/13/2011	9/20/2011	9/27/2011	10/4/2011	10/11/2011	10/18/2011	Average	Max	Min	Std. Dev.
BOD EFF	0.05	0.15	0.05	0.12	0.13	0.26	2.15	1.11	0.05	0.45	2.15	0.05	0.72
BOD RIV	9,045			117,794	18,942	43,040	34,303	8,921	16,342	35,484	117,794	8,921	38,467
BOD load %	0.0005%			0.00010%	0.00070%	0.00060%	0.00627%	0.01240%	0.00028%	0.0030%	0.0124%	0.0001%	0.0047%
NH3-N EFF	2.56	2.83	1.30	0.02	0.04	2.10	0.01	0.08	0.0427842	1.00	2.83	0.01	1.21
RIV	904		3,495	2,945	12,786	11,682	18,295	8,921	9,805	8,604	18,295	904	5,853
NH3-N load %	0.2831%		0.0372%	0.0005%	0.0003%	0.0180%	0.0000%	0.0009%	0.0004%	0.0426%	0.2831%	0.0000%	0.0981%
NO2-N EFF	0.04	0.46	0.03	0.01	0.01	0.04	0.02	0.02	0.01	0.07	0.46	0.01	0.15
RIV	301		1,165	1,472	1,421	2,459	3,430	446	1,089	1,473	3,430	301	1,033
NO2-N load %	0.0134%				0.0009%	0.0014%	0.0007%	0.0049%	0.0012%	0.0038%	0.0134%	0.0007%	0.0050%
NO3-N EFF	0.02	0.08	0.01	2.24	2.22	0.01	4.04	2.86	4.06	1.73	4.06	0.01	1.74
RIV	6,030		20,970	26,504	474	615	1,143	446	545	7,091	26,504	446	10,547
NO3-N load %	0.0003%		0.0000%	0.0085%	0.4695%	0.0019%	0.3530%	0.6407%	0.7457%	0.2774%	0.7457%	0.0000%	0.3153%
TKN EFF	0.23	0.67	0.33	0.20	0.33	0.23	1.04	0.37	0.29	0.41	1.04	0.20	0.27
RIV	30,150		116,500	147,243	47,355	61,486	114,342	44,604	54,474	77,019	147,243	30,150	42,695
TKN load %	0.0007%		0.0003%	0.0001%	0.0007%	0.0004%	0.0009%	0.0008%	0.0005%	0.0006%	0.0009%	0.0001%	0.0003%
TN EFF min	0.06	1.21	0.37	2.25	2.57	0.05	5.09	3.25	4.36	2.13	5.09	0.05	1.86
RIV min	6,030		20,970	26,504	1,421	2,459	3,430	0	0	7,602	26,504	0	10,255
TN min load %	0.0010%		0.0017%	0.0085%	0.1807%	0.0019%	0.1485%			0.0571%	0.1807%	0.0010%	0.0840%
TN EFF max	0.29	1.21	0.37	2.45	2.57	0.28	5.09	3.25	4.36	2.21	5.09	0.28	1.80
RIV max	36,481		138,635	175,219	49,249	64,560	118,916	45,496	56,109	85,583	175,219	36,481	51,560
TN max load %	0.0008%		0.0003%	0.0014%	0.0052%	0.0004%	0.0043%	0.0071%	0.0078%	0.0034%	0.0078%	0.0003%	0.0031%

Portland Operating Data during WPPE, from 8/22/11 to 10/19/11:

Portland August	2011 Q		EFF	EFF	EFF	EFF	EFF	EFF	EFF	MBR	Solids	FPT	WAS	WAS	WAS	SRT	Reed1	Reed2	Hauled
Date	Day	MGD	pH	NO3-N	NO3	NH4	DO	PO4	P	MLSS	lb.	ml.	min/hr	gpd	ppd	days	gal.	gal.	gal.
22	Mon	0.026	7.55	1.0		0.4	6.93	0.95	0.31	10,625	1,684	31	3	1,230	109	15			
23	Tue	0.027	7.57	3.0		0.2	6.18	0.98	0.32										
24	Wed	0.025	7.53	4.0		0.2	6.92	0.87	0.28				3	1,230	110				
25	Thur	0.028	7.39	3.8		0.2	7.05	2.43	0.80										
26	Fri	0.028	7.51	7.0		0.2	8.27	2.26	0.74	10,875	1,723	31	3	1,230	110			4,848	
27	Sat	0.033	7.46	4.0		0.6	7.6	3.30	1.10										
28	Sun	0.028	7.49	6.0		0.2	6.18	3.80	1.20				3	1,230	110				
29	Mon	0.026	7.60	10.0		10	6.8	11.60	3.80				15	6,150	551				9,500
30	Tue	0.023	7.64	4.0		0.2	8.11	6.10	2.00										
31	Wed	0.037	7.68	3.0		0.2	8.32	3.00	0.98	8,625	1,367	34					3,927		
1	Thur	0.021	7.65	3.0		0.2	7.98	3.1	1.00										
2	Fri	0.031	7.56	7.0		0.4	7.36	5.1	1.70										
3	Sat	0.015	7.82	4.0		0.8	7.49	8.4	2.70				3	1,230	104	20			
4	Sun	0.033	7.67	2.0		1.2	7.66	10.0	3.30										
5	Mon	0.024	7.65	10.0		0.2	7.42	2.3	0.76	10,125	2,027		3	1,230	104	20			
6	Tue	0.032	7.64	1.4		0.4	6.11	2.3	0.74										
7	Wed	0.032	7.68	6.0		0.3	6.87	12.6	4.10				3	1,230	104	20			
8	Thur	0.030	7.72	3.0		0.4	6.13	6.6	2.20										
9	Fri	0.027	7.81	7.0		0.4	6.28	7.0	2.30				3	1,230	104	21			
10	Sat	0.026	7.69	6.0		1.0	6.32	11.3	3.70										
11	Sun	0.031	7.74	2.0		0.4	6.98	12.4	4.00				3	1,230	104	20			
12	Mon	0.028	7.68	4.8		0.4	6.65	11.1	3.60	10,125	2,364	28							
13	Tue	0.024	7.76	<1.0		0.4	7.43	6.6	2.15										
14	Wed	0.026	7.78	1.4		0.2	7.54	11.5	3.80										
15	Thur	0.025	7.75	4.0		0.2	6.78	10.6	3.50			30							
16	Fri	0.033	7.80	3.0		0.5	6.46		4.48	10,125	2,787		3	1,230	104	25			
17	Sat	0.030	7.63	7.0		0.6	8.80	1.9	5.95										
18	Sun	0.019	7.36	3.0		0.2	8.50	1.3	4.40				3	1,230	104	27			
19	Mon	0.027	7.52	1.0		0.2	6.41	5.33	5.33										
20	Tue	0.032	7.57	6.0		0.4	6.90	2.48	2.48				3	1,230	104	27	3,927	3,928	
21	Wed	0.019	7.45	8.0		0.6	8.36	2.65	0.86										
22	Thur	0.029	7.45	3.6		0.4	6.45	>3.30	>1.10			30	3	1,230	117	26			
23	Fri	0.031	7.48	5.0		0.4	6.55	9.7	4.13										
24	Sat	0.029	7.42			0.8	9.56	9.6	3.10				3	1,230	117	26			
25	Sun	0.031	7.27	4.0		0.6	9.58	3.7	1.20										
26	Mon	0.023	7.37	4.0		0.6	7.56	3.5	1.10				5	2,050	218	15			
27	Tue	0.028	7.48	2.8		0.4	7.55	5.8	1.90										
28	Wed	0.027	7.49	9.39		0.2	8.30	5.8	1.20				3	1,230	131	25			
29	Thur	0.031	7.47	6.0		0.2	8.62	3.8	1.20	12,750	3,296	25							
30	Fri	0.035	7.52	7.0		0.4	6.23	7.9	2.60				5	2,050	218	15	3,927	3,927	
1	Sat	0.030	7.41	10.0		1.2	8.75	7.3	2.37										
2	Sun	0.022	7.21	7.0		0.6	7.95	1.87	0.61				5	2,050	216				
3	Mon	0.023	7.35	3.4		2.2	8.58	4.3	1.40				10	4,100	432				
4	Tue	0.030	7.38	1.80		0.40	6.87	3.6	1.20	12,625	3,159	26	5	2,050	208	15.2			
5	Wed	0.023	7.30	6.60		0.20	7.62	1.44	0.47				10	4,100	417				
6	Thur	0.023	7.33	7.78		0.60	7.34		0.54				5	2,050	208				
7	Fri	0.024	7.30	5.00		0.60	8.46	2.23	0.73	11,750	2,352	26	10	4,100	417	5.6		4,860	
8	Sat	0.024	7.40	9.85		0.70	8.94		0.22				10	4,100	384				
9	Sun	0.027	7.40	<1.0		0.80	8.14	3.12	1.00				10	4,100	384				
10	Mon	0.028	7.42			0.60	6.19		0.55										
11	Tue	0.026	7.43	16.10		0.20	6.17		0.34	10,700	2,320	30	10	4,100	361	6.4			
12	Wed	0.025	7.62	8.60		2.40	6.65		1.02				5	2,050	180	12.9			
13	Thur	0.026	7.76	17.10		1.00	7.48		1.50	10,400	2,255	23							
14	Fri	0.034	7.65	0.57		0.40	7.15		1.17				5	2,050	180	12.5			
15	Sat	0.028	7.41	2.50		2.00	6.9	1.28	0.42				6	2,460	209	10.8			
16	Sun	0.019	7.33	3.30		1.00	9.9	0.88	0.29										
17	Mon	0.025	7.56	9.65		0.40	7.45		0.258										
18	Tue	0.027	7.54	10.40		0.40	7.2		0.33	10,000	2,252	28							
19	Wed	0.029	7.56	11.60		0.30	8.84	1.24	0.4				2	820	68	32.9		3,297	
	Total	1.603				41.8													
	Avg.Daily	0.027	7.5	5.6		0.7	7.5	5.1	1.82	10,727	2,299	28.5	5.3	2,156	203	19	3,927	4,172	
	Max	0.037	7.8	17.1		10.0	9.9	12.6	5.95	12,750	3,296	34.0	15.0	6,150	551	33	3,927	4,860	
	Min	0.015	7.2	0.6		0.2	6.1	0.9	0.22	8,625	1,367	23.0	2.0	820	68	6	3,927	3,297	
	Std.Dev.	0.004	0.2	3.5		1.3	1.0	3.6	1.48	1,164	575	3.1	3.3	1,335	130	7	-	673.7	

Portland MBR Data during WPPE, from 8/22/11 to 10/19/11:

MBR#2 Permeability Records

	Permeate	Air at	Air at	Suction	Suction	TMP	TMP	Perm	Perm
8/22-10/19	Current Fl	Low Flow	Med. Flow	PSI	PSI	Start	Stop	Start	Stop
Date	gpm	SCFM	SCFM	Start	Stop			%	%
22	30	262		-3.44	-4.25	0.37	1.17	30	5.8
23	30	262		-3.12	-4.24	0.05	1.13	85	5.9
24									
25									
26									
27									
28									
29									
30									
31									
1	30	262		-3.61	-4.5	0.4	1.4	94.4	4.8
2	30	263		-3.07	-3.25	0.05	0.2	100	33.01
3	30	265		-3.28	-3.38	0.21		34.11	
4	120	254		-4.61	-4.18	0.91	1.87	57.8	17.86
5	30	261		-3.08	-3.34	0.07	0.27	100	25.78
6	30	265		-3.12	-3.32	0.05	0.24	100	27.4
7									
8	54	286		-3.14	-4.85	0.24	1.77	100	6.9
9	30	262		-3.14	-4.23	0.05	1.14	100	5.8
10	30/50	265	285	-3.19	-4.63	0.13	1.56	100	7.68
11	30	265		-3.14	-4.07	0.06	0.98	100	6.75
12	2	264	284	-3.26	-3.7	0.12	0.76	100	8.6
13	30	262		-3.13	-4.14	0.05	1.04	98	6.5
14	30		263	-3.11	-4.27	0.05	1.22	53	5.54
15									
16	30	266		-3.09	-3.27	0.08	0.22	60	30.71
17	30	280		-3.16				33	0.38
18	50		286	-3.14	-3.57	0.10	0.48	100	23.3
19									
20	30	264			-3.25		0.27		
21	30				-4.16		1.06		
22									
23	30	265		-3.12	-4.14	0.05	1.09	100	6.3
24	30	263		-3.24	-3.48	0.05	0.4	85	16.8
25	50			-3.00	-3.57		0.52		21.6
26	30	263		-3.39	-3.40	0.05	0.29	100	24.0
27	30	262		-3.42	-3.48	0.32	0.44	54	15.0
28	30	262		-3.45	-3.46	0.28	0.37	100	17.8
29	30	260		-3.05	-3.74	0.05	0.62	100	10.95
30	30	262		-3.23	-4.66	0.05	0.46	100	4.6
1	30	262		-4.56		1.34		5.06	
2	50		237	-5.5		2.39		4.62	
3	30	262		-3.43	-5.48	0.05	2.36		2.8
4									
5									
6	30	262		-3.28	-4.46	0.05	1.14	100	5.8
7									
8	30	264		-3.34	-4.56	0.39	1.18		5.65
9									
10	30	266		-3.39	-6.09	0.06	2.74	100	2.42
11									
12									
13									
14									
15									
16									
17									
18									
19									
Total									
Average	34	264	271	-3.38	-4.04	0.27	0.95	79	12
Max	120	286	286	-3.00	-3.25	2.39	2.74	100	33
Min	2	254	237	-5.50	-6.09	0.05	0.20	5	0
Std Dev	18	6	21	0.53	0.68	0.49	0.65	31	9