WASTEWATER PLANT PERFORMANCE EVALUATION

November 18, 2009 – January 26, 2010

Masontown Municipal Authority-Bessemer (Cats Run) STP

Water Pollution Control Facility

NPDES #PA0023892

Bureau of Water Standards & Facility Regulation
POTW Optimization Program

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Disclaimers:
The mention of a particular brand of equipment is in no way an endorsement for any specific company. The Department urges the permittee to research available products and select those which are the most applicable for its situation.

The goal of the Department's Wastewater Optimization Program is to improve water quality at drinking water intakes by optimizing upstream wastewater plant effluent quality. This often times involves permittees achieving effluent quality above and beyond any permit requirements.

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1. Executive Summary

The Pennsylvania Department of Environmental Protection (DEP) conducted a Wastewater Plant Performance Evaluation (WPPE) of the Masontown Municipal Authority's (MMA) Bessemer wastewater treatment facility from November 2009 through January 2010, at the invitation of Mr. Joe Kirk, following a routine visit. A WPPE is an evaluation of existing operations and practices followed by small-scale operational changes meant to optimize effluent quality. The purpose for optimizing effluent quality is to reduce pathogens and nutrients at drinking water intakes directly downstream of the subject facility, with an overall goal of improving surface water quality.

The WPPE was performed by staff of DEP's Operations Monitoring and Training Division, Bureau of Water Standards and Facility Regulation (BWSFR). The WPPE program is conducted under terms of a federal grant administered by the United States Environmental Protection Agency (USEPA).

The following items summarize some of the important findings identified during the WPPE:

- Plant operations appear be optimal with solids levels at approximately 3500-5000 mg/l during the winter months. As the temperatures increase, it may be necessary to reduce solids levels to maintain nitrification.
- Dissolved Oxygen (DO) above 3.5 mg/L in the aeration tanks essentially represents wasted energy. It is optimal to maintain DO levels no less than 1.5 mg/L during the aeration phase to ensure that nitrification is occurring in the aeration basins.
- It may be advantageous to purchase an updated pH and DO meter. Some DO sensors utilize luminescent measurement of DO instead of membrane sensors which are prone to fouling when utilized in the mixed liquor. An Oxidation Reduction Potential (ORP) probe will allow the operator to continue monitoring ORP which will minimize nitrates in the effluent and minimize blower run time. On-line DO and ORP monitors, if connected to a controller for the blower motors would further maximize treatment and minimize power consumption.
- Solids control is very important to the extended aeration process. A sampling plan similar to one described in Attachment C which, while requiring manual collection, will assist the operator in making process control decisions in the absence of having on-line monitoring equipment. The solids removal process will require continued monitoring due to the lack of sludge digestor at this site.
- Effluent Nitrate levels were reduced over the project period, through modification of aeration cycles, benefiting the receiving stream and downstream water users.
- There were 2 significant rain events (near 2") during the course of the WPPE which increased influent flows.
- Modification of the aeration cycles has resulted in an approximate 68% reduction in nitrate levels. Values during the beginning of the project were in the 25-30 mg/l range and near the end of the project dipped to as low as 4 mg/l. The operator's attention to detail and desire to improve effluent quality, along with the use of the on-line monitoring equipment, were responsible for the reductions.

The following items have been identified as focus points to assist in optimization efforts. Operators should review the focus points and are encouraged to incorporate them into their daily operating procedures when feasible. While some of these items will require more of the operator's time to perform the outcome is expected to be favorable by improving the plants discharge quality and thereby improving downstream water quality. Focus points are listed in order of importance.

- Purchasing a meter capable of monitoring DO utilizing luminescent technology and ORP will allow the operator to continue optimizing the treatment process.
- Continue monitoring Mixed Liquor Suspended Solids (MLSS) levels and % solids, along with settleability testing to identify when solids removal is necessary. The % solids and settleability should be conducted at least twice per week with MLSS tests preferably performed biweekly.
- Upon gathering data necessary to determine appropriate solids levels in the plant, the operator should continue to schedule solids removal as necessary to achieve levels in line with calculated removal estimates. This would involve an increase of approximately 11% more solids removal.
- Without the luxury of a sludge digester to remove solids from the secondary treatment process, the facility would benefit from the installation of on-line processing equipment to monitor Total Suspended Solids and DO. This would allow the operator to quickly make adjustments in the treatment process and identify times when solids removal is necessary.
- Continue to record and trend data to troubleshoot periods of reduced performance.
- While monitoring for DO in the aeration basins, take the handheld meter to the basin and insert the probe in the contents of the aeration tank. This provides the most accurate DO reading possible reducing external interferences.
- Using centrifuge measurements along with total solids testing of the mixed liquor to identify solids levels within the treatment process will help establish healthy levels that provide the maximum nitrification efficiency. Refer to Attachment C for suggested process control testing frequencies.
- Try to maintain the Sludge Volume Index (SVI) levels in the aeration tanks to a range between 50 -100 which should allow for optimum treatment conditions and settling characteristics. Levels during the WPPE were in the 75 (+/- 10) range. Levels much over 100 could lead to decreased settling in the clarifiers.
- Closely monitor power usage to correlate the amount of blower usage, plant nitrification efficiency, and electrical costs which may prove beneficial in minimizing power consumption.
- DO profiling of the east aeration basin revealed a dead zone in the northeast corner of the basin. This may indicate clogged diffusers or an accumulation of grit or other inert material. Further evaluation and follow-up should be considered by MMA. Repairing diffusers may improve nitrification efficiency and reduce power consumption. In addition, it would be valuable for MMA to perform a similar DO profile in the west aeration tank to examine the performance of the air diffusers.

2. Background

The Masontown Municipal Authority's (MMA) Bessemer wastewater treatment plant is a 0.20 MGD conventional activated sludge, extended aeration treatment process. The service area includes Masontown Borough and German Township, Fayette County and the waste stream is comprised mostly of domestic sewage with no large industrial users. An ultraviolet light system is used for disinfection of the treated wastewater before being discharged to Cats Run. The MMA discharge is located approximately 3.5 miles upstream of its drinking water intake. Due to the proximity of the discharge and intake this wastewater plant was selected to participate in a Wastewater Plant Performance Evaluation.

The Pennsylvania Department of Environmental Protection (DEP) has undertaken a new project in its Bureau of Water Standards and Facility Regulation (BWSFR) to improve the quality of surface waters used for drinking water by optimizing sewage treatment plant operations to reduce pathogens and nutrients in the effluent from the wastewater treatment plant. BWSFR's optimization program is called the Wastewater Plant Performance Evaluation (WPPE) and is modeled on the successful program for drinking water filtration plants that has been operating for the past twenty plus years, the Filter Plant Performance Evaluation (FPPE) program. The WPPE program is fully explained in Attachment A.

DEP contacted MMA with a request to deploy and operate the instrumentation at their Bessemer wastewater treatment plant (WWTP) located in Masontown Borough, Fayette County, for a period of two months in order to assess current plant operations and provide the operator with process monitoring data to make process modifications improving effluent quality and downstream surface water quality at the MMA drinking water intake.

DEP utilized on-line probes installed within the secondary treatment processes. In addition, DEP brought, to the facility's laboratory, instruments and test kits that were used during the evaluation and available for the plant operator's use. This equipment supplements the on-line continuous monitoring and provides operators with the opportunity to utilize test equipment used in making process control adjustments. The goal is to familiarize operators with process control testing that can be performed to trend their plant data which will assist them in making decisions to optimize their treatment process.

The Department recommends that the Authority review the report and the plant operator continue to maintain and improve plant performance through the use of regular process monitoring and control and data trending to ensure the facility is capable of producing effluent water quality that exceeds current and planned future concentration and loading limits. On-line monitoring equipment for dissolved oxygen, oxygen reduction potential, and total suspended solids could be used to optimize the wastewater treatment process at Masontown. The process modifications identified in this report, based on the operator's data trending, could provide reduced blower usage and associated electrical cost savings that may provide a payback period desirable to the MMA. This issue will prove more important as rate caps expire and the cost of electrical usage increases.

Attachment B lists the WPPE team and participating members of the MMA.

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3. Masontown Municipal Water Works Drinking Water Plant

Plant Description

The following information was gathered from the most recent Masontown Filter Plant Performance Evaluation report. Samples collected during the FPPE indicated 1 *Giardia* cyst and 0 *Cryptosporidium* oocysts present in the raw water sample and 0 *Giardia* and *Cryptosporidium* present in the filtered water sample.

The Masontown water treatment plant obtains raw water from the right bank of the Monongahela River in Fayette County. Constructed in 1909, the plant has undergone several upgrades and currently consists of treatment with polyaluminum chloride for coagulation, two ClariCone clarifiers for flocculation and clarification, four dual-media filters, and disinfection (Figure 1). Presently, the Masontown Municipal Waterworks plant provides water to about 3,700 consumers through 1,875 metered service connections. The plant has a daily production of 0.54 MGD.

At Masontown, the filtration plant obtains raw water from the Monongahela River through a 16 inch screened intake that extends approximately 150 feet from the shore. The raw water is pumped to the plant via one of two pumps (one pump is operated at a time and staff alternate the pumps weekly). The intake area is within the Maxwell pool, which has a normal pool elevation of 763 feet. Upstream of the intake, the Monongahela River drains a large watershed that contains areas of active and abandoned coal mines, roads, communities with sewage treatment plants, residential areas with on-lot sewage systems, and other activities that impact water quality characteristics.

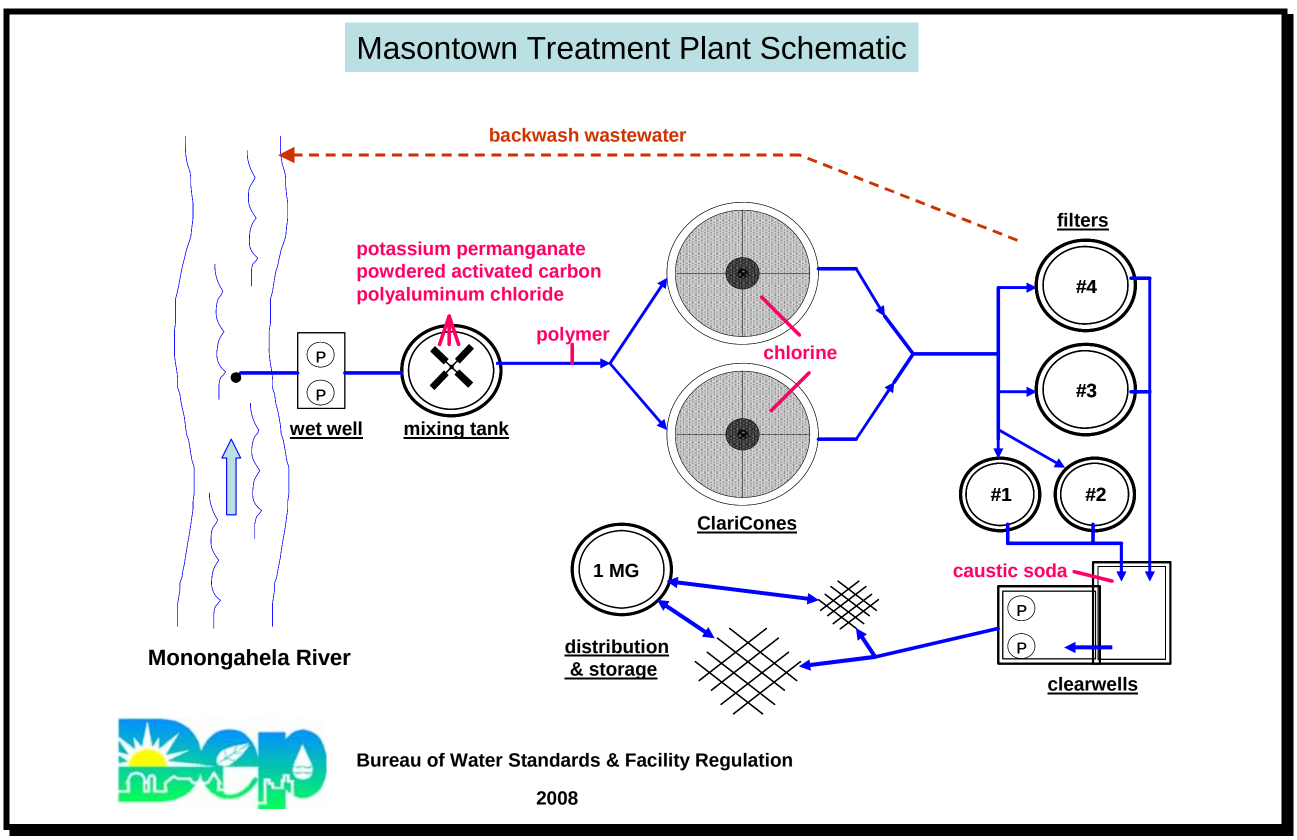

Figure 1. Masontown water treatment plant schematic

Raw water from an intake along the bottom of the Monongahela River is pumped to the plant. Potassium permanganate, powdered activated carbon, and coagulant are added at the mixing tank, which contains a vertical shaft paddle. The coagulated water is treated with a polymer before entering one of 2 ClariCone units. The water enters the bottom of the units at an angle to cause a rotation, to facilitate flocculation and formation of a sludge blanket for particle removal. The clarified water above the sludge blanket is chlorinated, combined from both units and piped to the 4 dual media filters. The filtered water is treated with caustic soda in the clearwell. Finished water from the clearwell is pumped into the distribution/storage system.

Raw Water Sampling Results

Figures 2 and 3, graphically depict the sample results collected downstream of the MMA wastewater plant discharge at the drinking water intake. All downstream samples were collected from the raw water tap at the drinking water plant before any chemical treatment had occurred.

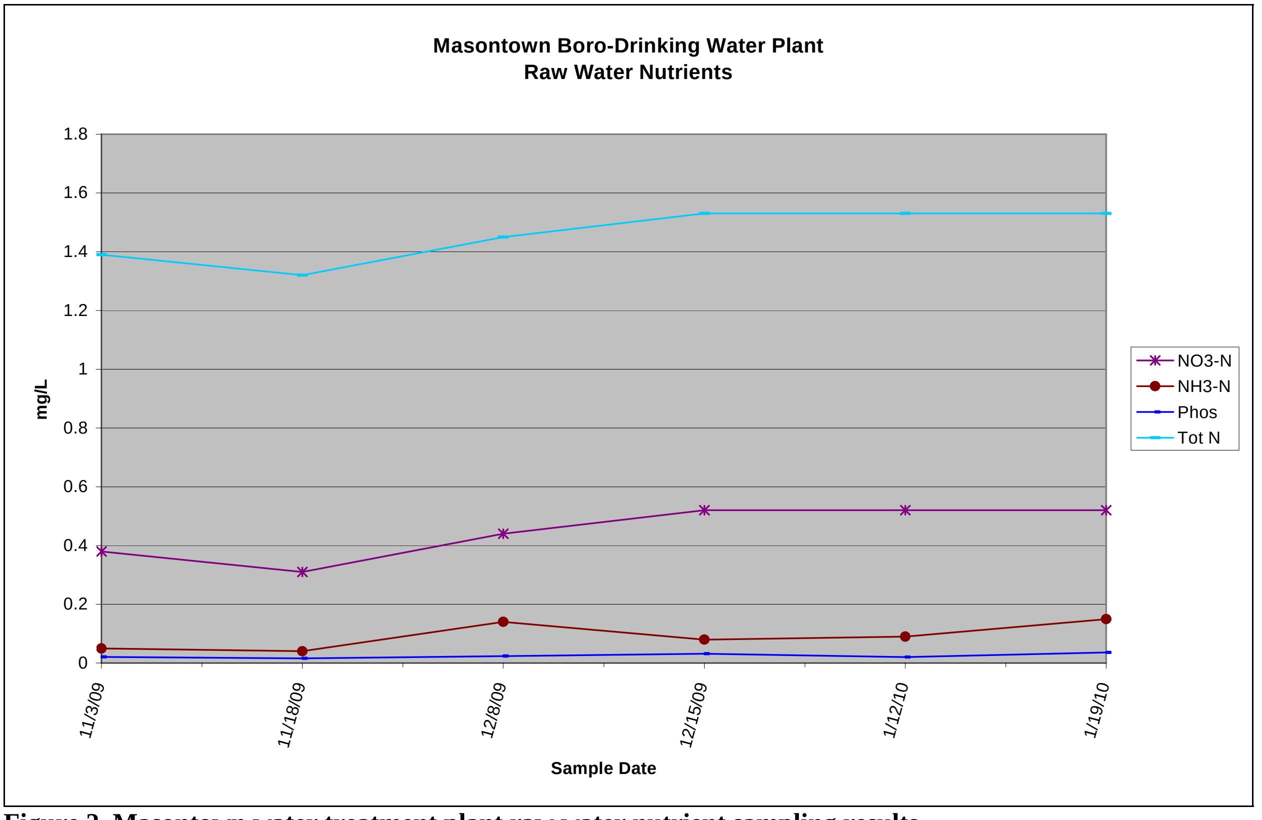

Figure 2. Masontown water treatment plant raw water nutrient sampling results

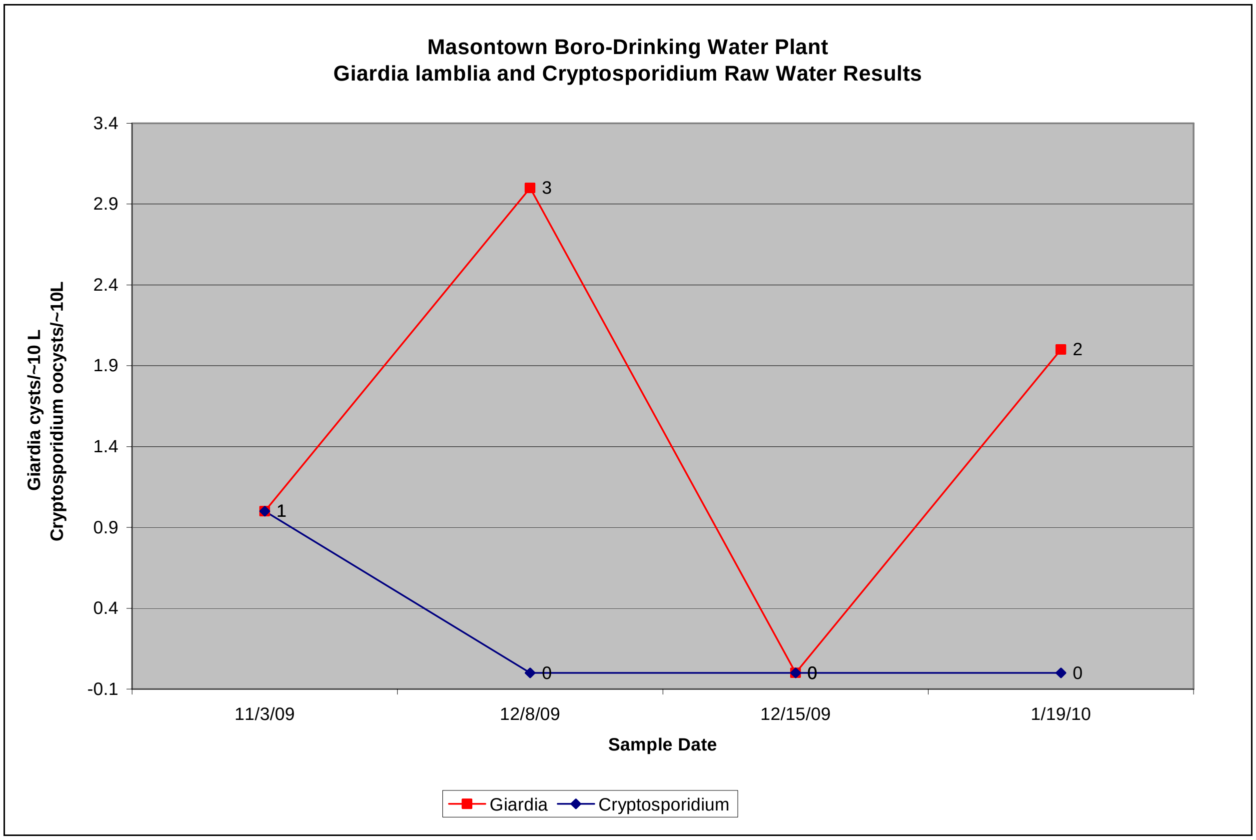

Figure 3. Masontown water treatment plant raw water *Giardia* lamblia/*Cryptosporidium* results

Historical raw water sampling for *Cryptosporidium* and *Giardia* was consistent when compared with the most results collected during the WPPE. Figure 4 compares the pathogen sample data collected during Filter Plant Performance Evaluations dating to 2000 through the most recent WPPE data collected in 2009-2010. Figure 5 compares Alkalinity, Sulfates, Total Dissolved Solids (TDS), and pH over the last five years. The pH and alkalinity had minor fluctuations whereas there are some fluctuations with the Sulfates and TDS. The cause of the fluctuations in the Sulfates and TDS values is beyond the scope of this project.

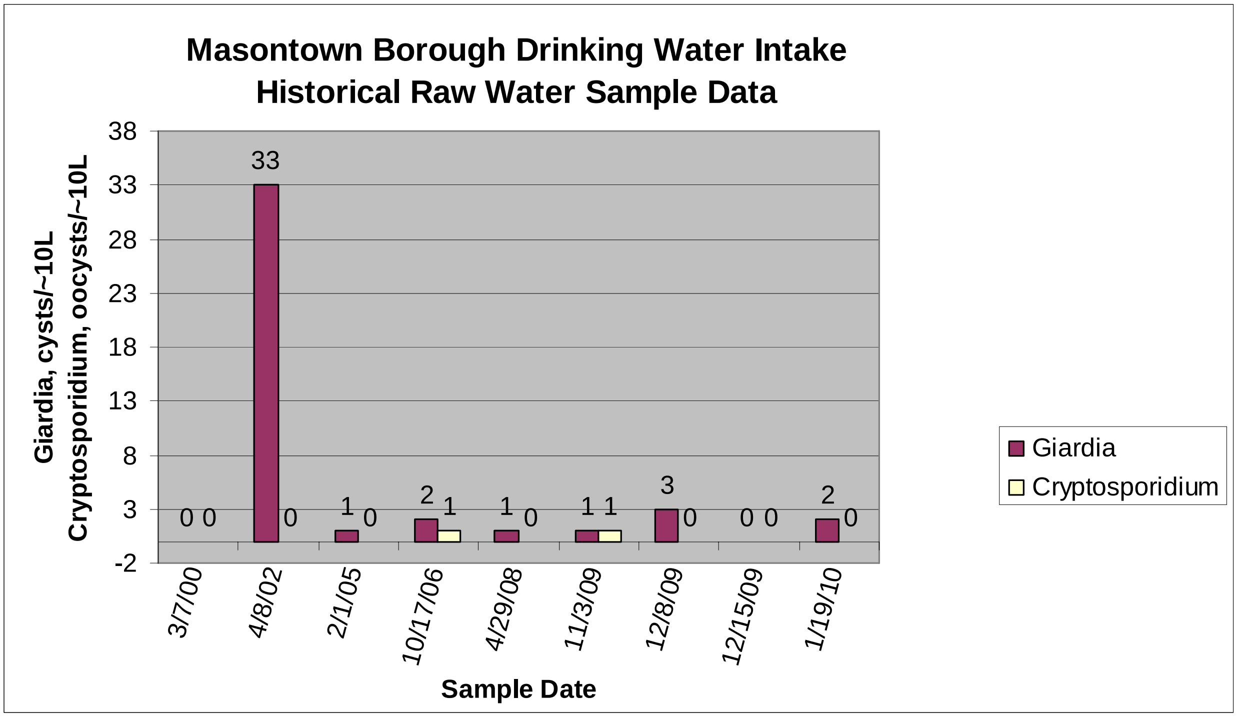

Figure 4. Historical raw water data, *Giardia/Cryptosporidium*

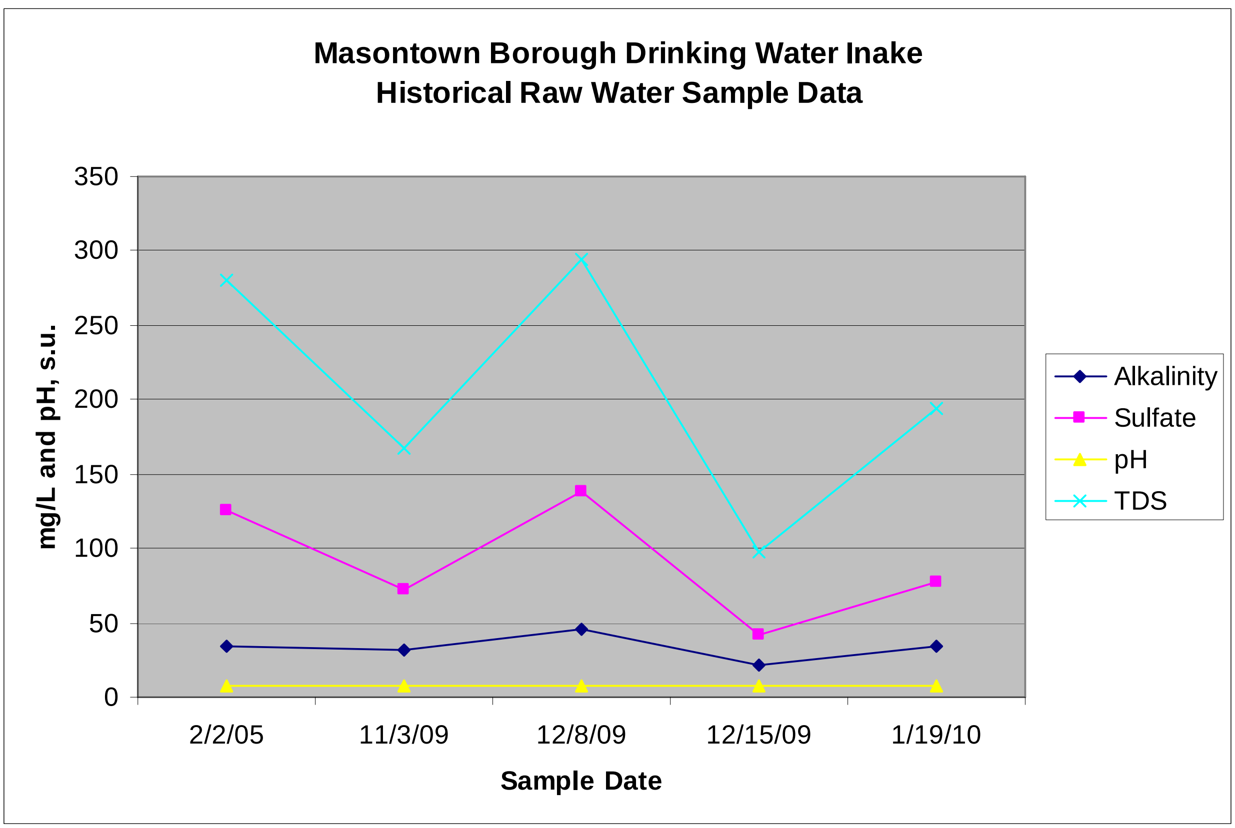

Figure 5. Historical raw water data, TDS/Sulfate/pH/Alkalinity

Discussion

The distance between the Masontown-Cats Run STP discharge and the Masontown Borough drinking water plant raw water intake is approximately 3.5 miles. This includes approximately 1.5 stream miles of Cats Run and 2.0 stream miles of the Monongahela River. While the raw water sampling results did not provide any direct correlation to the positive optimization results at the Masontown-Cats Run STP, the large dilution factor in the Monongahela River is believed to have a direct impact on the raw water results. In addition, there may be some vertical and horizontal stratification because of temperature and side waste stream influence. Nevertheless, the optimization efforts at the Masontown wastewater plant provided reductions in nutrients discharged to the surface water Cats Run which does contribute to the raw water utilized by the Masontown drinking water plant. These results are further discussed in the Process Control section.

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4. Initial Observations

Plant Description

MMA's WWTP treats domestic sewage from its collection system servicing Masontown Borough and German Township. The plant is currently rated at 0.20 MGD. The Masontown sewage treatment plant was originally constructed in 1968 as an activated sludge treatment facility. Due to excess influent flows related to Inflow and Infiltration (I&I) issues, a permit was issued in 2001 to construct a flow equalization tank and storm flow retention tank at the wastewater plant. Construction for the upgrade was completed in 2002. According to the most recent Wasteload Management Report (Chp. 94), the collection system includes no large industrial users and predominantly domestic sewage customers. The facility is currently not required by the USEPA to have an Industrial Pretreatment Program.

The Masontown sewage treatment plant is located in Masontown Borough east of State Route 166 off of South Water Street. NPDES Permit No. PA0023892 establishes the operations and monitoring requirements for treated sewage at the Masontown sewage treatment plant. The MMA WWTP discharges treated effluent to Cats Run, designated as a warm water fishery. Cats Run is in the 19C- watershed- Ohio Basin. The discharge from the MMA plant represents approximately 93% of the stream flow within Cats Run, considering stream flows of .0212 cfs and plant flow of 0.20 MGD. Stream flow data was gathered from the DEP Water Quality pollution report. Following the discharge to Cats Run, the stream flows approximately 1.5 miles to its confluence with the Monongahela River. The Masontown water intake is on the Monongahela River approximately 2.0 miles below the confluence with Cats Run.

A wastewater treatment plant process description and treatment schematic are depicted in Attachment D.

This site was chosen for the WPPE because of its proximity to the Masontown drinking water intake which is located approximately 3.5 miles directly downstream of the MMA outfall. MMA's overall operating efficiency appears to be good with few violations of its operating permit within the past two years. Following deployment of the WPPE equipment, the instrumentation was used to collect data that will supplement current operations by providing the operator with additional process data to be used when making decisions on modifying treatment plant operations with the ultimate goal of improving effluent quality.

Background samples were collected on November 3, 2009 and a summary of the results for all sampling is listed in Attachment E.

Figure 6, below plots the MMA wastewater plant and outfall to Cats Run along with the Masontown drinking water intake.

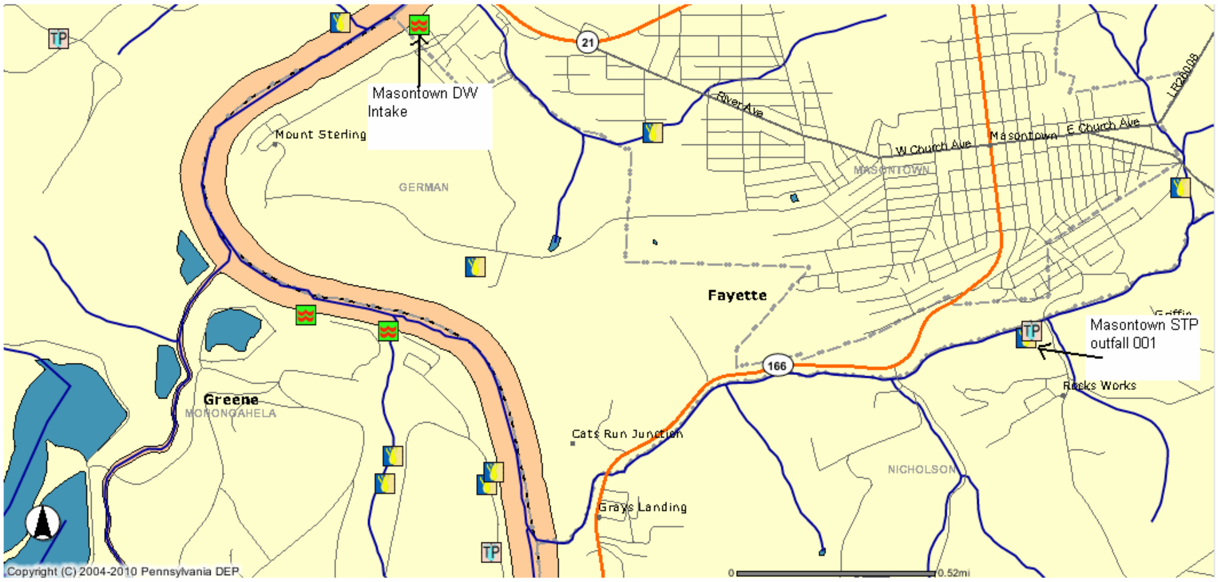

Figure 6. Masontown WWTP and Drinking water intake

Past Performance

A review of plant records showed that there have been no permit violations from this facility in the past two years.

During file review, the Department reviewed the facility's NPDES Permit, its Part II Permit, Water Quality Protection Report, monthly Discharge Monitoring Reports (DMR), Chapter 94 Report, as-built drawings, and available daily process monitoring records.

DMRs for all of 2008 through April 2009 were reviewed in order to develop an understanding of the facility's daily operating ranges. For 2008, the annual average flow was 0.19 MGD and the peak monthly average flows of 0.27 MGD were recorded in February and March 2008. For 2009, the annual average flow was 0.18 MGD and the peak monthly average flow of 0.27 MGD occurred in May 2009. These records indicate that the collection system is impacted by inflow/infiltration during wet weather events. Rainfall tends to increase flows at the plant rather quickly indicating sources of inflow within the collection system. The construction of the equalization and storm surge tanks have helped alleviate the excess hydraulic loads to the treatment plant and discharges of raw sewage to surface waters from combined sewers and storm surge tank overflow.

The MMA WWTP appears to consistently produce effluent of a good quality and the results of this project along with the review of DMRs for calendar years 2008 and 2009 supported this conclusion, see Tables 1 and 2 below.

Masontown- Cats Run STP
2008 DMR Data

Date	Flow Avg. Mon	Flow Max Daily	pH min	pH max	Fecal Avg Mon	TSS Avg Mon	TSS Avg Wkly	Influent BOD-load Avg Mon	Influent BOD-conc Avg Mon	Effluent CBOD-5 Avg Mon	Effluent CBOD-5 Avg Wkly	(Dry tons) Biosolids removed	Avg % solids
Jan	0.177	0.224	6.5	6.8	0	5.4	9	247	167	7.6	14.7	0.976	1.56
Feb	0.270	0.41	6.7	6.9	2	1.5	6	271	120	4.3	7	1.813	1.59
Mar	0.266	0.32	6.8	7	2	9.5	12	242	109	6.3	11	0.652	1.25
Apr	0.170	0.305	6.9	7.2	0	8.2	13	198	140	6.5	11.7	0.987	1.48
May	0.248	0.33	6.8	7.1	2	1.3	5	212	102	3.7	5.3	1.09	1.45
Jun	0.194	0.388	7	7.2	0	8.5	14	182	112	3.4	4.7	0	
Jul	0.179	0.299	6.7	7	0	3.4	10	137	92	3.9	6	1.03	1.65
Aug	0.135	0.193	6.8	7	0	4.5	6	205	182	4.8	9.3	0.788	1.05
Sep	0.114	0.147	6.5	7.1	0	1.3	5	180	189	6.5	12	4.817	1.668
Oct	0.102	0.149	6.3	6.9	1	14.6	31	116	136	2.7	5	0.365	1.25
Nov	0.112	0.175	6.4	7.1	6	7.9	14.3	103	110	7.9	14.3	0.704	1.35
Dec	0.258	0.4	6.4	6.8	2	13.2	17	224	104	4.3	6	2.299	1.31

Table 1. Masontown WWTP 2008 DMR data summary

Masontown- Cats Run STP
2009 DMR Data

Date	Flow Avg. Mon	Flow Max Daily	pH min	pH max	Fecal Avg Mon	TSS Avg Mon	TSS Avg Wkly	* Influent BOD-load Avg Mon	** Influent BOD-conc Avg Mon	Effluent CBOD-5 Avg Mon	Effluent CBOD-5 Avg Wkly	Biosolids removed	Avg % solids
Jan	0.237	0.335	6.5	6.8	0	6.5	9			3.3	9	0.85	1.63
Feb	0.209	0.355	6.5	6.7	0	3.5	9			2	4	1.042	1
Mar	0.145	0.233	6.4	6.8	0	1.4	7			0	0	2.71	1.04
Apr	0.185	0.282	6.4	6.7	0	0	0			1.5	6	1.662	1.07
May	0.267	0.436	6.7	6.9	4	8	19			1	4	1.763	
Jun	0.196	0.284	6.7	6.9	2	2.6	8			0	0	1.426	
Jul	0.151	0.188	6.4	6.7	1	3.8	15			0	0	0.755	0.725
Aug	0.139	0.25	6.4	6.6	0	1.5	6			0	0	1.71	1.64
Sep	0.102	0.116	6.3	6.5	10	7.4	22			0.8	4.1	1.57	1.5
Oct	0.157	0.252	6.4	6.7	1	6.3	9			2.8	11	2.369	1.76
Nov	0.118	0.166	5.6	6.6	2	13.5	29			1.5	6	0.99	1.49
Dec	0.188	0.319										0	

Table 2. Masontown WWTP 2009 DMR data summary

Current Performance

During the period of the evaluation, the Department observed that the facility was operating satisfactory with nitrification occurring within the aeration basins. There was low alkalinity and pH in the plant effluent, 2.2mg/L and 5.9 s.u. respectively, indicating that the nitrification process was utilizing almost all alkalinity from within the raw wastewater. Targets values for alkalinity and pH are at least 50mg/L alkalinity in the effluent and a pH of 7.5 s.u. in the aeration basins. Upon identifying the low levels, the operator was able to start using hydrated lime to supplement the alkalinity in the aeration basins. This immediately brought up the alkalinity and pH to desired levels. Upon reviewing some initial monitoring data gathered through this project the operator was able to identify adjustments in the aeration cycles that could lead to periods of anoxic conditions where the aeration basins could be used to denitrify the wastewater. Upon making these modifications the nitrate levels dropped almost immediately from near 25 mg/l to less than 10 mg/l. This was a significant accomplishment for this treatment plant without having any digestors to continuously maintain the solids levels in the treatment process.

Flow into the treatment facility averaged 0.175 MGD and BOD concentrations averaged 152 mg/L over the course of the WPPE. This equates to an average BOD loading of 222 lbs/day. The flows were approximately 80% of the design flow and approximately 67% of the permitted organic loadings that the plant is designed to treat. Several oxygen uptake rate (OUR) tests were performed with results indicating healthy biological activity.

At the start of the WPPE on November 3rd the following data was collected:

Parameter	East Tank	Anticipated Values
F/M ratio	0.04	0.05-0.1
Hydraulic Retention Time	36.5 hrs	18-24 hrs
Sludge Age	13 days	15-30 days
Sludge Volume Index (SVI)	138	50-150

The F/M ratio appeared to be slightly on the low side but the biomass appeared to be healthy with full nitrification occurring and approximately a 98% reduction in BOD and 92% reduction in Total Suspended Solids. The sludge age was on the low side of expected values but this is attributed to the wasting of solids that occurred on November 12, just a week prior to the start of the WPPE, and an influent flow of only 0.124 MGD. The SVI was in the expected range and stayed there over the course of the WPPE apparently due to the operators' removal of solids based on settleability and centrifuge testing. The operational records maintained on site are very thorough and were essential in optimizing operations over the course of the WPPE.

The operator's assistance and eagerness to understand the process modifications were refreshing and contributed to the projects success.

Headworks

The facility headworks provide for removal of nondegradable solids through use of a manual barscreen. This study did not include an assessment of the quantity or nature of solids removed at this point.

According to the facility's most recent Chapter 94 reports, the facility is not projected to exceed its hydraulic and organic operating capacity. Inflow-infiltration is considered to be significant and there is not much growth anticipated within the service area. Figures 7 and 8 depict the 2008 and 2009 flows including monthly average and design values. A summary of daily flow measurements for October 2009 through January 2010 is listed in Attachment F.

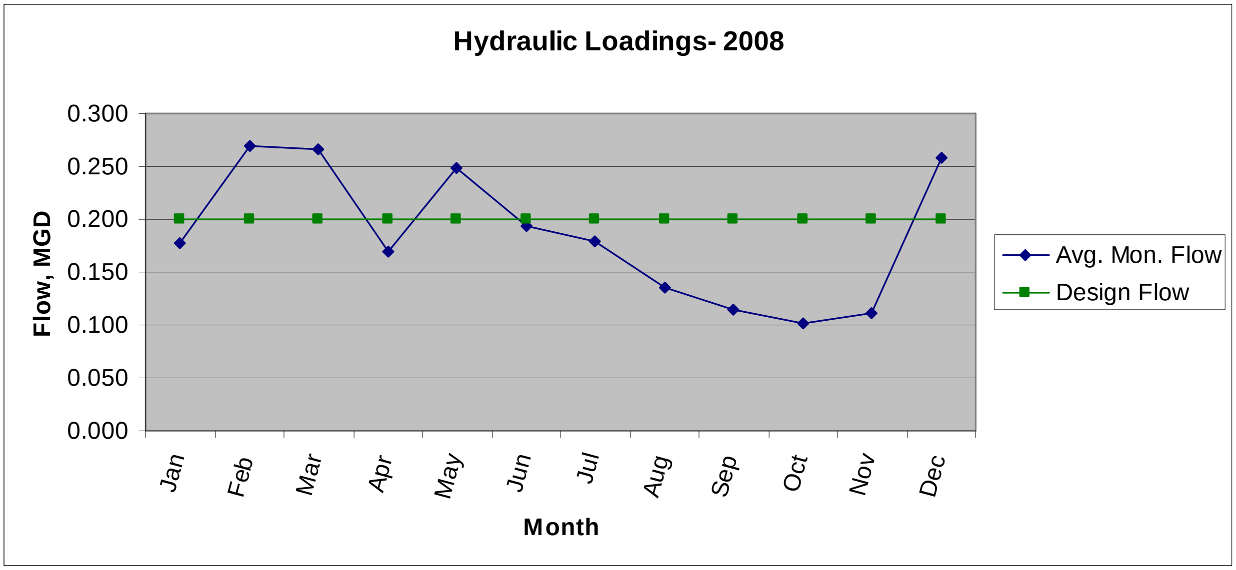

Figure 7. 2008 Hydraulic Loadings

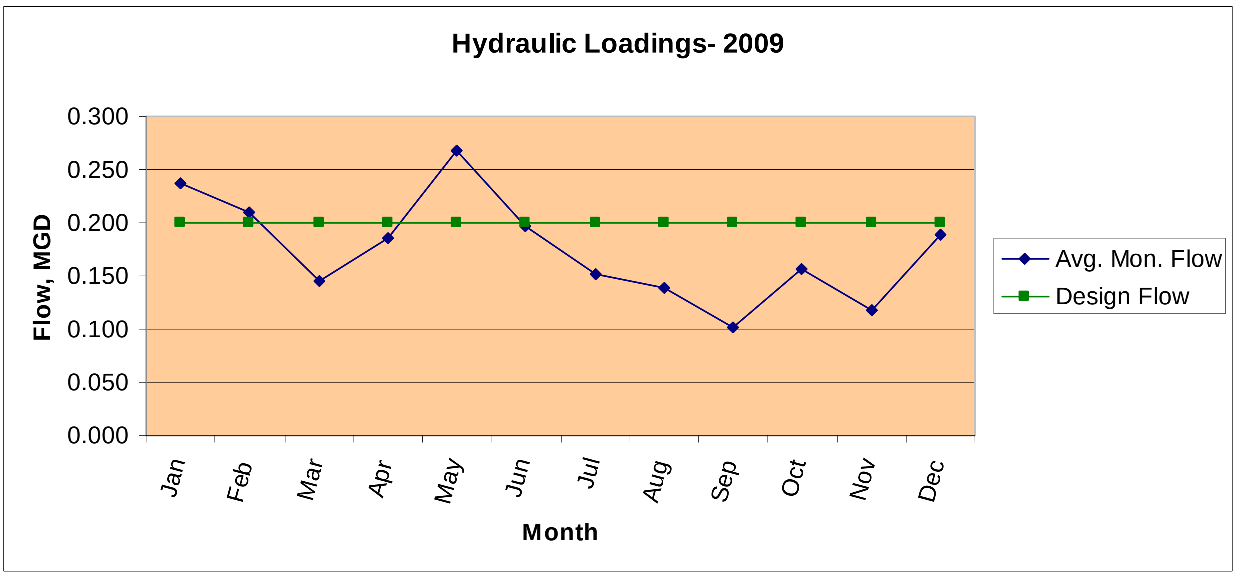

Figure 8. 2009 Hydraulic Loadings

Flow Equalization

MMA currently utilizes a storm flow retention tank which has a 1.2 million gallon capacity to equalize flows from rain events. Within the storm flow tank, a 40,000 gallon equalization tank provides a consistent flow to the treatment units. This process was not examined in detail during the WPPE. Visual inspection of the storm flow retention tank and flow equalization tanks showed good air dispersion throughout the diffusers and both appeared to be operating within normal design parameters.

Aeration

Two secondary aeration tanks having a total capacity of 256,000 gallons provide the bulk of treatment at the facility. These tanks are configured for extended aeration. Fine bubble diffusers are used for air distribution in both units. For the WPPE, the Department installed instruments in the east aeration basin. Flow is split at the influent distribution box with a slightly higher flow entering the west aeration tank. Aeration within the east aeration tank is rather consistent throughout the tank except for a dead spot in the north west corner near the bottom of the tank. This is explained further in the section on DO Profile. The WPPE confirmed that nitrification is occurring in both aeration tanks, and through the manipulation of aeration cycles, denitrification is also occurring.

Secondary Settling

Each aeration tank discharges to an attached secondary settling tank, or clarifier. Here, activated sludge solids settle by gravity and are withdrawn using mechanical return sludge pumps, for reintroduction to the aeration tanks. Both settling tanks have an approximate capacity of 13,500 gallons each. The return sludge pumps are variable speed and can be adjusted as desired to maintain optimal conditions in the settling tanks and aeration basins.

Bio-solids removal

The MMA plant does not have a sludge digestor for conventional removal of solids accumulated within the treatment process. To remove accumulated solids, the operator must turn off the sludge return pumps for approximately 4 to 6 hours to allow solids to accumulate within the clarifiers. After that, vacuum trucks remove solids from the waste line prior to being deposited on the sand filtration beds. Solids can be removed from each clarifier independently to maintain a solids loading in each treatment train as desired by the operator. MMA currently has plans to install a sludge “bagger” system at their Big Run STP, located near the drinking water plant. Once that has been completed, MMA will continue to haul liquid sludge from the Cats Run STP clarifiers but it will be transported to the Big Run plant resulting in savings due to reduced transportation costs.

Disinfection

The MMA facility employs ultraviolet light for disinfection of the treated wastewater. The operator monitors UV intensity levels to identify times for bulb cleaning and ensuring maximum disinfection. Following disinfection, the effluent falls through a V-notch weir prior to discharge. The outfall at Cats Run is approximately 50 yards from this final process.

5. Equipment Installation & Calibration

On November 17 and 18, 2009, DEP staff arrived at MMA to diagram the instrument layout and install the on-line probes and associated communication lines between probes and SC1000 control unit.

The on-line monitoring equipment is described as having microprocessor technology built into each probe. Each probe has sufficient memory to retain several days' worth of readings. The SC1000 base units are microprocessor-driven routing and transit units, working in conjunction with detachable display units. The display units are used to calibrate the attached instruments, in addition to relaying information to other microprocessors. The technology allows plant operators to observe and track operational trends that can be interpreted using readily available literature, reinforcing an operator's process control decisions and showing him/her, in real time, the results of process changes that affect plant performance. The entire system is capable of being combined with a SCADA operations and monitoring system.

The equipment utilized in this WPPE contains a portable notebook computer for displaying the continuous signals from the digital probes. This is an enhancement, as the SC1000 units installed also support displays that provide graphical depiction of trends collated from the data recorded by the probes.

This WPPE utilized a sufficient number of probes to allow for monitoring equipment to be installed in both aeration tanks.

The installations were:

- 1 Hach SC1000 base unit
- DO, ORP, pH, Nitrate, and Ammonia sensors in the east aeration tank

Attachment G shows a diagram of where the continuous monitoring probes were installed.

Continuous Digital Monitoring

The installation at this facility was set to log all measured parameters at 15 minute intervals. Data collected from the probes is transferred via digital signal to a SC1000 base unit which then transferred the data to a laptop computer to log the values in spreadsheet format. A summation of all logged data is provided in electronic format on a CD provided along with this report. The continuous logging function allowed the operator to view live data representing the current operating conditions of the wastewater plant. With this data the operator was able to make on the spot adjustments to the treatment process which effectively optimized the treatment process. The continuous monitoring digital probes provide the plant operators with graphical output that allows them to see how the tested parameters fluctuate during a variety of conditions.

Laboratory Equipment

As part of the WPPE, the use of on-line probes was supplemented with less expensive portable laboratory equipment for obtaining "snapshots" of plant conditions using relatively simple test methods. This equipment was also utilized to verify the quality of data being collected with the digital probes.

In addition to the digital on-line probes, the following laboratory equipment was utilized:

- Raven Products centrifuge, settleometers, and clarifier core-taker for sampling and testing according to sludge inventory methods developed by Al West and cited in Activated Sludge Manual of Practice No. OM-9
- Portable LDO and pH/temperature instruments;
- Portable spectrophotometer and packaged wastewater lab, for colorimetric analyses of water and wastewater parameters;

The purpose of this equipment is to supplement the digital recording probes with a variety of lab tests that can be performed by plant operators to track solids inventory, health and condition of the biomass, and relative strength of incoming wastewater. This equipment may be purchased through various vendors and can provide sufficient test data for an operator to make process control decisions, even in the absence of the digital, on-line continuous monitoring equipment.

The purpose of the additional testing is to provide an operator with data needed to develop Mean Cell Residence Time (MCRT), Food to Mass Ratio (F/M), or Sludge Age (AGE) methods of managing activated sludge treatment facilities.

MMA has limited laboratory glassware on hand but does routinely conduct settleability and centrifuge testing on the mixed liquor. The operator indicates he performs all the required testing for process control and effluent testing as required.

The purpose in bringing the lab equipment was to make it available for the operators use and to perform process control testing to include monitoring: pH, DO, NO3, NH3, Phos, clarifier sludge blanket depth, and OUR tests.

There were a significant number of process control tests performed during the WPPE, some representative spreadsheets of the output data are included at Attachment H.

6. Process Monitoring

Beginning on November 18, 2009 and lasting until January 26, 2010 the Department continuously obtained digital data from the on-line probes installed at MMA.

Attachments I and J include graphs of monthly and daily data, respectively, collected by the digital probes. These graphs were developed by DEP using MS Excel.

During the project, the operator adjusted the aeration cycle on/off set points to maximize treatment efficiency and reduce nitrate levels in the effluent. These adjustments were made effectively by monitoring the on-line monitoring equipment to show the results of those adjustments. Rising ammonia levels indicated the need for longer periods of aeration while minimal drops in the nitrate levels indicated the need for increased anoxic periods. The operator was able to effectively interpret the data and adjust the treatment cycles in such a manner that the effluent nitrate levels were reduced by approximately 68%. In addition to denitrification, the operator was able to reduce blower motor run times effectively reducing the utility bills at the same time.

It is vital for plant operators to perform regular process monitoring tests to assay the condition of their facility and to look for trends that both support process control decision-making as well as predict future plant performance under changing conditions. The manufacturer of the centrifuge equipment, sludge settleometers, and core-taker suggests that their equipment be employed on a daily basis in order to monitor the health of the facility. Likewise, use of the digital spectrophotometer and accompanying portable wastewater lab chemical test kits will allow an operator to assay any number of chemical parameters for process monitoring and control purposes. Even those facilities who employ an independent contractor for operations and/or compliance reporting do need to regularly conduct process monitoring tests of their facility systems. Once this data is collected it should be trended to identify the optimal set points for various parameters including DO, MLSS, waste rates and pH to name a few. When future situations arise the operator can refer to the trending data to identify the conditions during a previous similar situation and see what remedial actions were taken to rectify the issue. Without having trending data, an operator is starting at square one for each occasion where the plant experiences an abnormal condition. Trending is also very important when more than one operator runs a treatment plant or even more importantly when a secondary operator only occasionally operates the plant.

Shown below in Figure 9 is a graphical representation of Dissolved oxygen versus time in the east aeration tank for December 13th. This was 5 days after the operator made initial adjustments to the aeration cycles. Note the off periods were extended to periods of approximately 45 minutes; those periods were modified further over the course of the project. As anticipated, the off cycles began producing anoxic periods for denitrification conditions to be favorable. The on-off cycles are controlled by timers used to operate the blower motors and the operator makes manual changes to the timer settings for process control changes.

Interpretation of Data

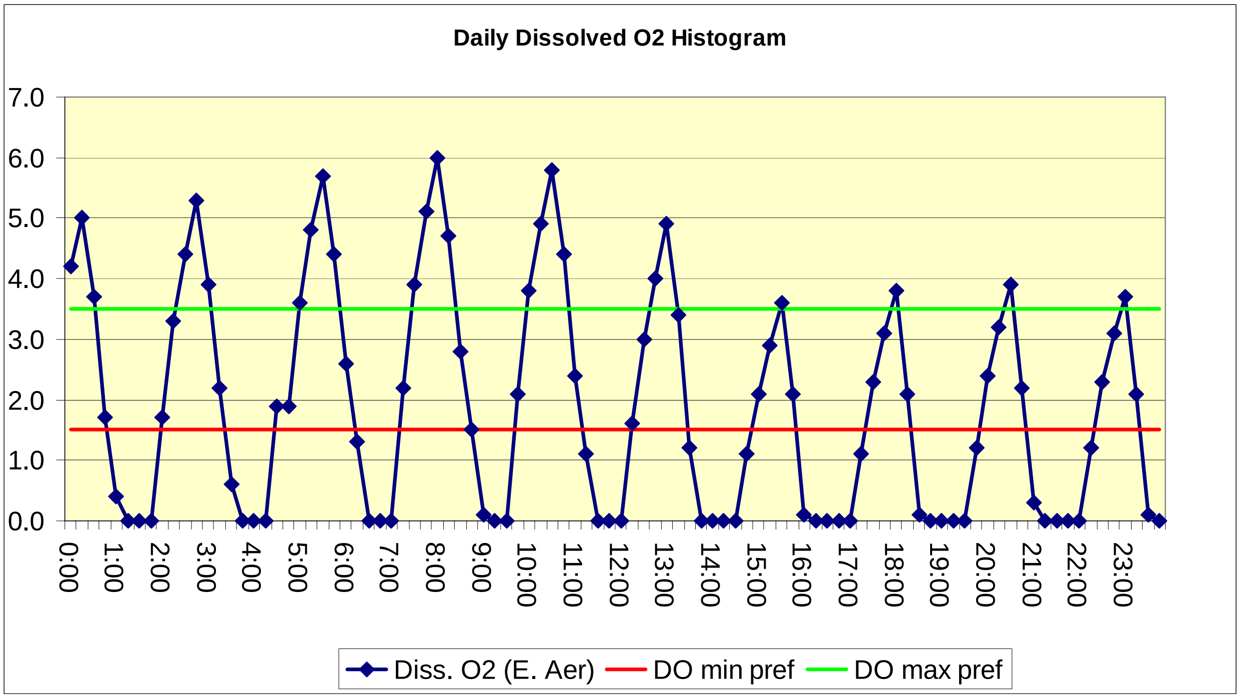

Figure 9: DO vs. time, December 13, 2009

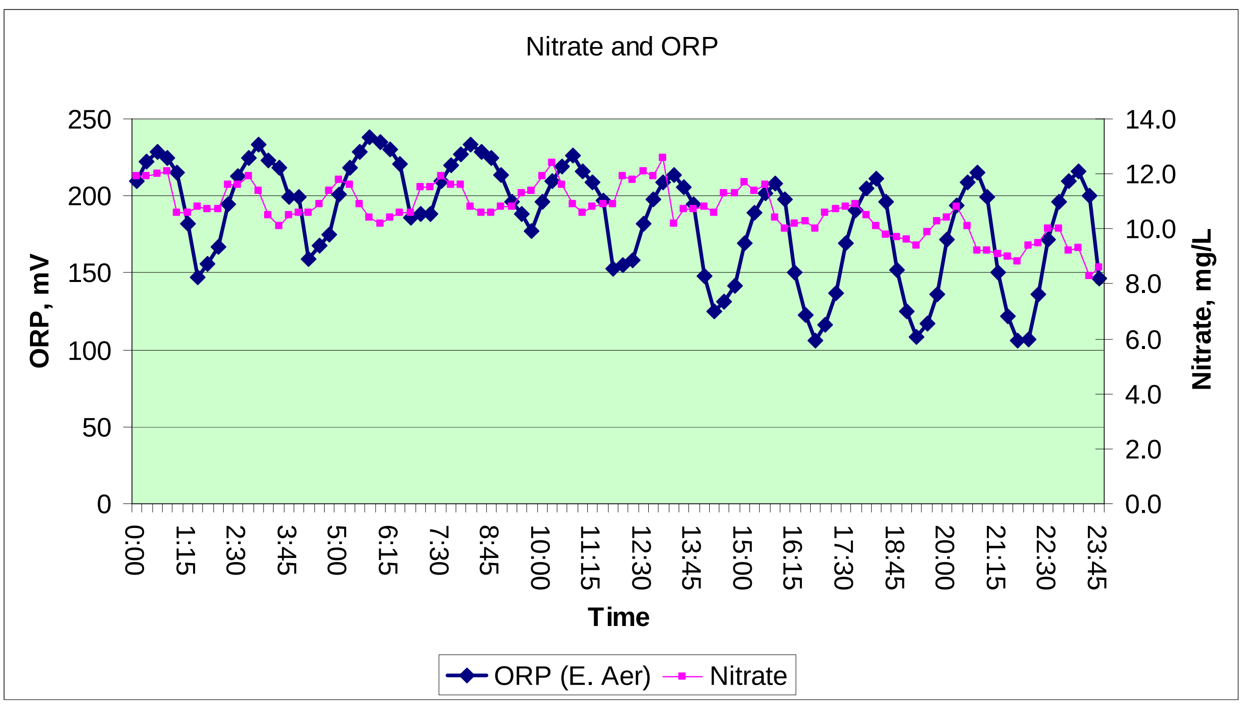

Figure 10. Nitrate and ORP, December 13, 2009

Figure 10 shows ORP levels during this same period decreasing to approximately 100mV where denitrification can occur. While providing periods of anoxic activity can be advantageous for nitrate reduction, reducing costs, and improved settling; extended periods can lead to a complete loss of nitrification and the need to reseed the wastewater plant. This process modification requires close monitoring on behalf of the operator.

During this project, beginning on December 7th, the operator modified the on-off aeration cycles as follows:

Date	Aerator on time (min)	Aerator off time (min)
Pre 12/7	35	25
12/7	60	30
12/8	120	60
12/9	90	90
12/10	60	90
12/14	60	80
12/16	60	90
12/28	60	105
1/11	60	100

Table 3. Aerator on-off times for optimizing denitrification

At the start of the project the Total Nitrogen results were in the 25-30 mg/L range. Over the course of the project, with the manipulation of the aeration cycles, the TN levels were reduced to levels around 10 mg/L. On December 13, in the figure above, the TN levels approached 8 mg/L. The graph also shows the as the ORP trended lower so did the TN levels. At times when the overall ORP levels trended upward or remained elevated the resulting TN levels trended in the same manner.

Oftentimes during the late spring when water temperature rises, the concentration of MLSS needs to be lowered from the levels that sustained the plant through cold weather. Treatment efficiency rises as a function of temperature, and fewer MLSS are needed to accomplish the same amount of waste treatment as may be necessary during winter months. Regular sludge wasting is a vital part of maintaining a healthy biomass. The operator at MMA bases his need to waste on ½ hour settleability, centrifuge tests results, and visual observations collected at the wastewater plant. Additionally, gravimetric tests should be performed routinely to establish associated MLSS levels that result in the maximum performance for that particular time of year. The levels of the various tests resulting in the maximum system performance generally change with seasonal variations which reinforces the need to trend the data and keep records of the results. While these methods are effective in identifying when to adjust the levels of biomass, the solids removal operations allow for the actual changes in the MLSS levels. At this facility, the operator cannot waste solids with any frequency due to the lack of a sludge digestor. There are 2 sludge drying beds on site but they are insufficient in size to effectively perform that function. The operator removes solids by pumping from the clarifiers to a tanker truck where they are hauled to another treatment facility for further processing.

In order to maintain a healthy biomass and an optimally performing treatment system, sludge wasting is usually performed daily or several times per week. If solids are wasted from the process less frequently and in large volume then large amounts of nitrifying bacteria will be removed from the process all at once. Through the use of gravimetric MLSS tests, centrifuge testing, and other laboratory test an operator can adjust the solids levels in the aeration basins to anticipate the changes in operating conditions as the weather changes from warmer to colder and vice versa. Instead of wasting solids over a few days to transition the operation from winter to spring conditions, an operator would be better to withdraw waste solids to establish a desired MCRT, gradually reaching a solids concentration where biomass growth rate is nearing the peak of log growth, where treatment efficiency is optimal, and the potential for negative indicators such as filamentous organisms are reduced.

It is generally best to maintain a consistent solids management plan that includes wasting solids based on process control testing that includes monitoring the food to mass ratios (F/M), mean cell residence time (MCRT), sludge volume index (SVI), and mixed liquor suspended solids (MLSS). Generally, choosing a method such as a targeted F/M or MCRT and sticking with it produces the most consistent effluent quality.

Figure 11, below, depicts the MLSS levels in the east aeration basin over the course of the project. The solids levels were increased due to decreasing temperatures in the treatment units. Figure 12, shows the MLSS during the same timeframe with higher levels than that in the east tank, most likely attributed to the more flow entering the west aeration basin and the variability in the return sludge pump settings. One of the return sludge pumps was on a manual setting over most of the project due to electrical problems which were corrected the week of January 18. Through experience, the operator has determined that the plant operates best around 5000 mg/L over the winter months.

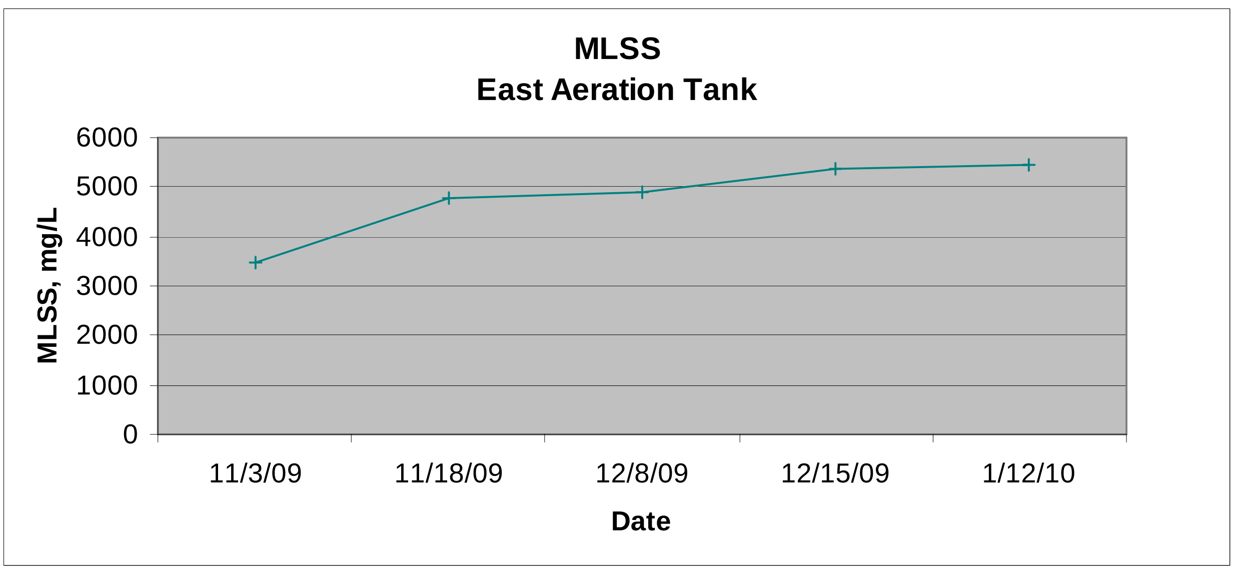

Figure 11. Mixed liquor suspended solids-East Aeration

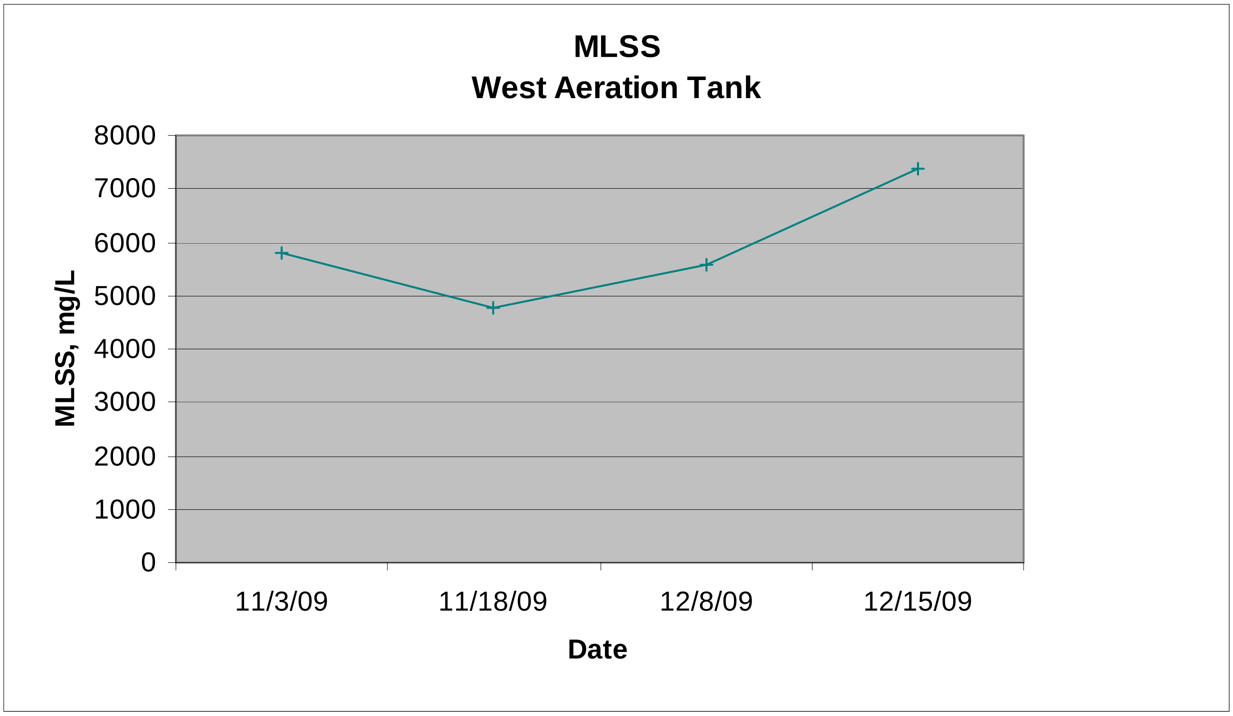

Figure 12. Mixed liquor suspended solids-West Aeration

Figure 13, below, shows how nitrate levels are reduced with corresponding reductions in DO. DO is necessary for nitrification to occur and, upon achieving full nitrification, as the DO levels are diminished the resulting respiration utilizing the residual nitrate in the wastewater produces an almost immediate drop in concentrations as measured by the nitrate analyzer.

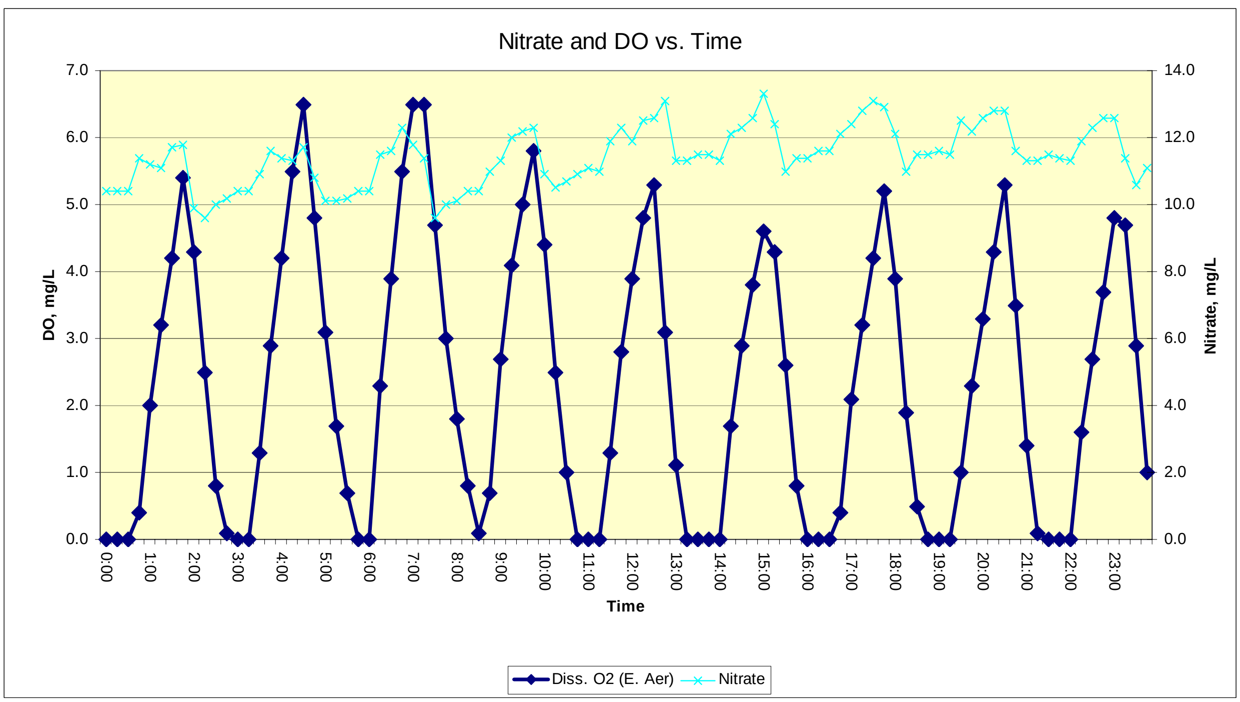

Figure 13. Nitrate Levels

Ammonia levels over the course of the project consistently remained below 0.5 mg/L, a non-detectable level for the monitoring equipment in use. The complete nitrification was essential in allowing the denitrification operations to occur. Although the west treatment train was not connected for on-line monitoring over the duration of the project, manual samples collected from that train verified that nitrification and denitrification were occurring in both trains.

The resulting effluent samples analyzed by the Bureau of Labs confirmed the results. Reductions in effluent nutrient levels are graphically depicted on Figure 14, below. While there were some spikes in the effluent data, after modifying the aeration cycles the overall trend was a reduction in both nitrate and phosphorus. The results on the chart are from samples collected of the plant effluent and tested at the Department's Bureau of Laboratories. Through the use of the on-line equipment, bench testing, and adjusting solids levels the operator was able to adjust the treatment process in an effective manner that reduced overall nutrient levels without any capital expenditures.

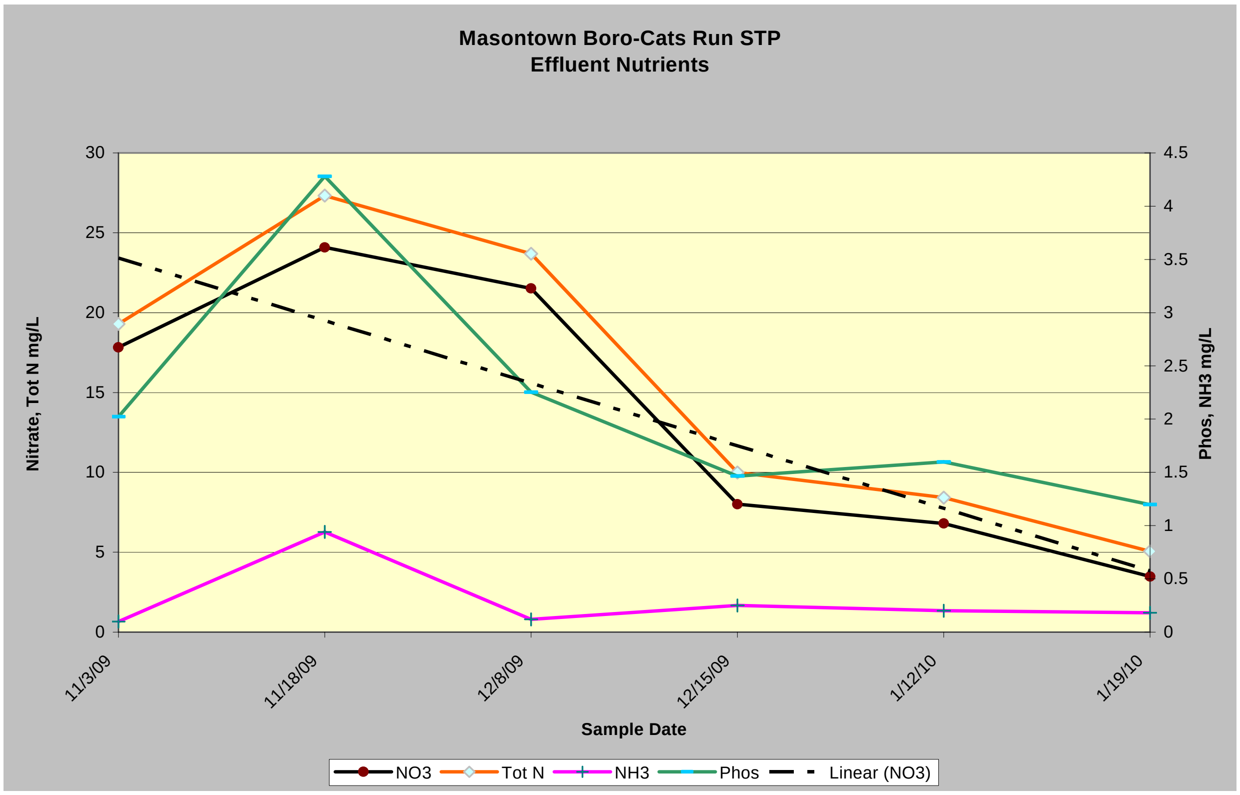

Figure 14. Effluent nutrient reduction over the course of the WPPE

Figure 15, below, shows the *Cryptosporidium* oocyst levels in twelve samples taken during four events over ten weeks. Effluent concentrations varied slightly from 0 to 9 oocysts/~10L through the period, while upstream and downstream concentrations were negligible. During this project, there appears to be no scientific conclusion that can be drawn regarding the plant operations and reductions in *Cryptosporidium* oocyst levels.

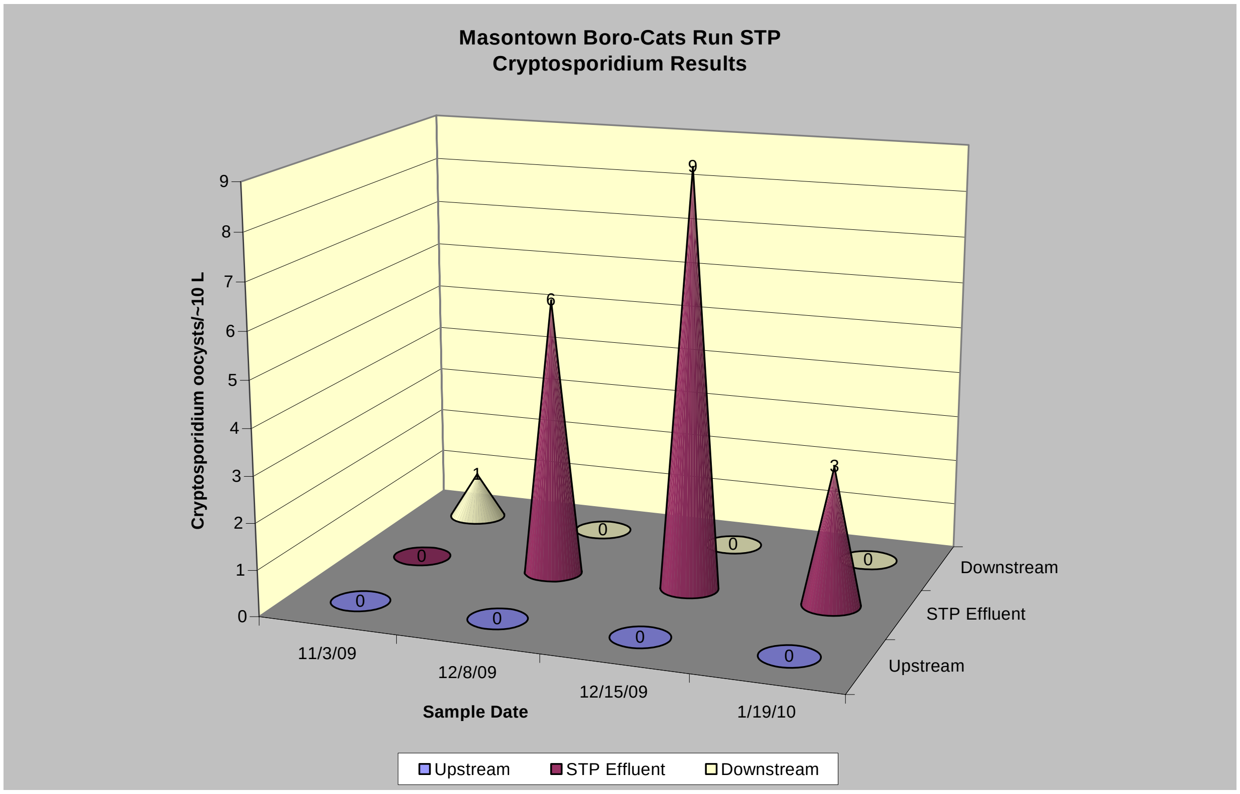

Figure 15. *Cryptosporidium oocyst* levels

In figure 16, the level of *Giardia lamblia* cysts found in 10L samples is shown. In this illustration, the treatment plant produced a much higher quantity of giardia cyst than was present in the upstream and downstream samples, where concentrations were negligible. There is no explanation available for the increased Giardia levels present in the December 15th sample. The high number of giardia does not indicate that the disease causing organism is endemic in the population of the service area; neither does the test indicate whether or not the organisms have been inactivated by disinfection methods. MMA does utilize ultraviolet light for disinfection which is generally the most effective means of inactivating pathogenic protozoa and destroying pathogenic bacteria.

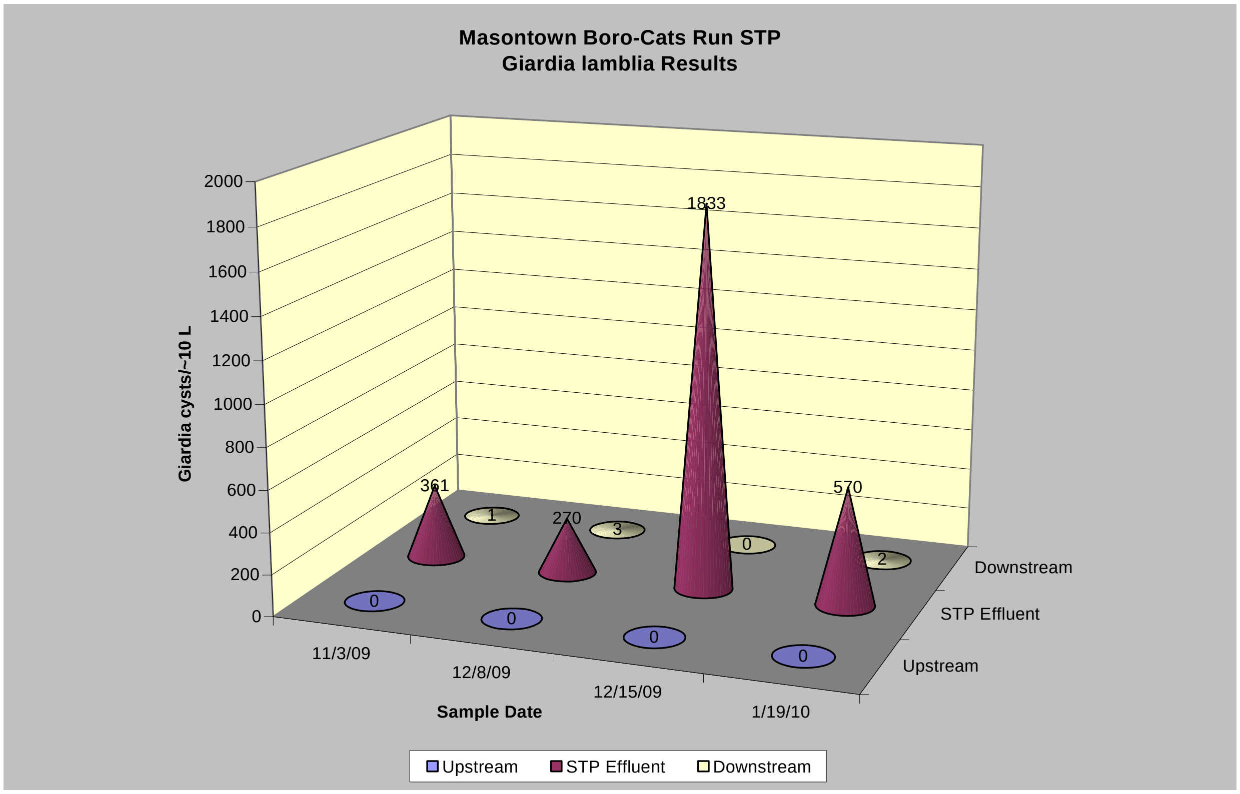

Figure 16. ***Giardia lamblia*** **cyst levels**

The following is a chart depicting the relationship between Cryptosporidium oocysts and Total suspended solids.

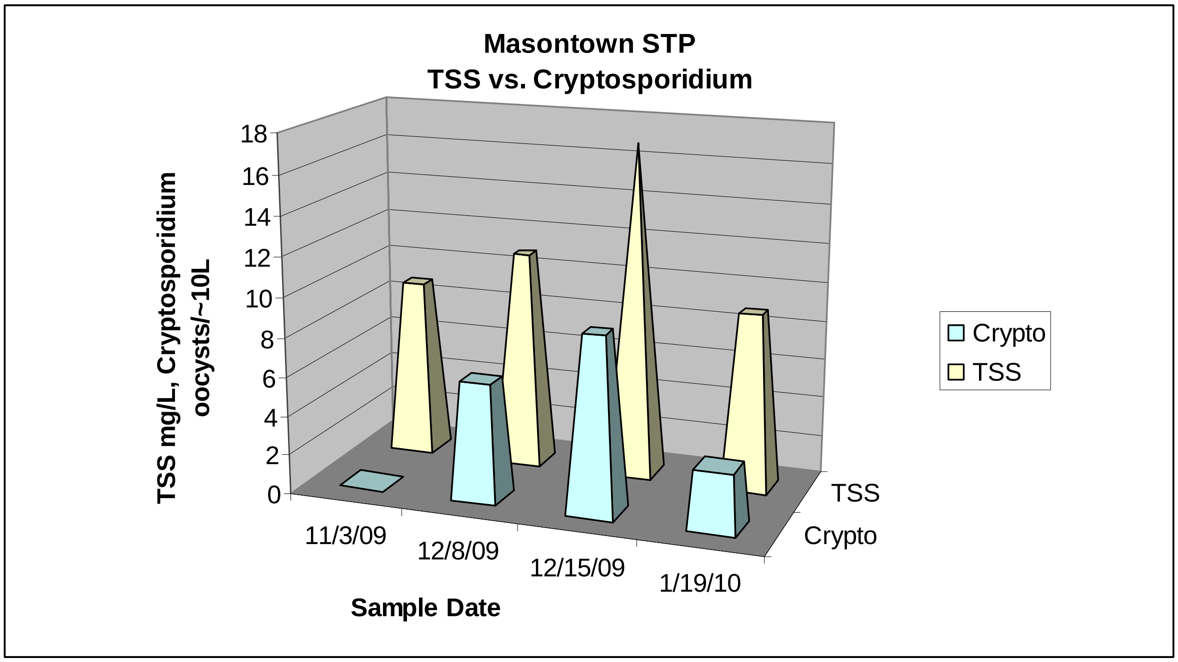

Figure 17. ***Cryptosporidium/TSS comparison***

While there has not been a defined reduction of pathogens from the treatment plant effluent, there may be some relation between Total Suspended Solids and Crypto levels especially since pathogenic and parasitic organisms such as these tend to accumulate in suspended solids or colloidal material. If the treatment plant is working properly, without excessive ashing of solids in the effluent, one can infer that the incidence of pathogenic organisms will be low or null. During the evaluation, there was no excessive solids carry-over into the disinfection tank or the effluent line. In general the levels of Giardia and Crypto appear to fluctuate relative to the levels of TSS in the effluent.

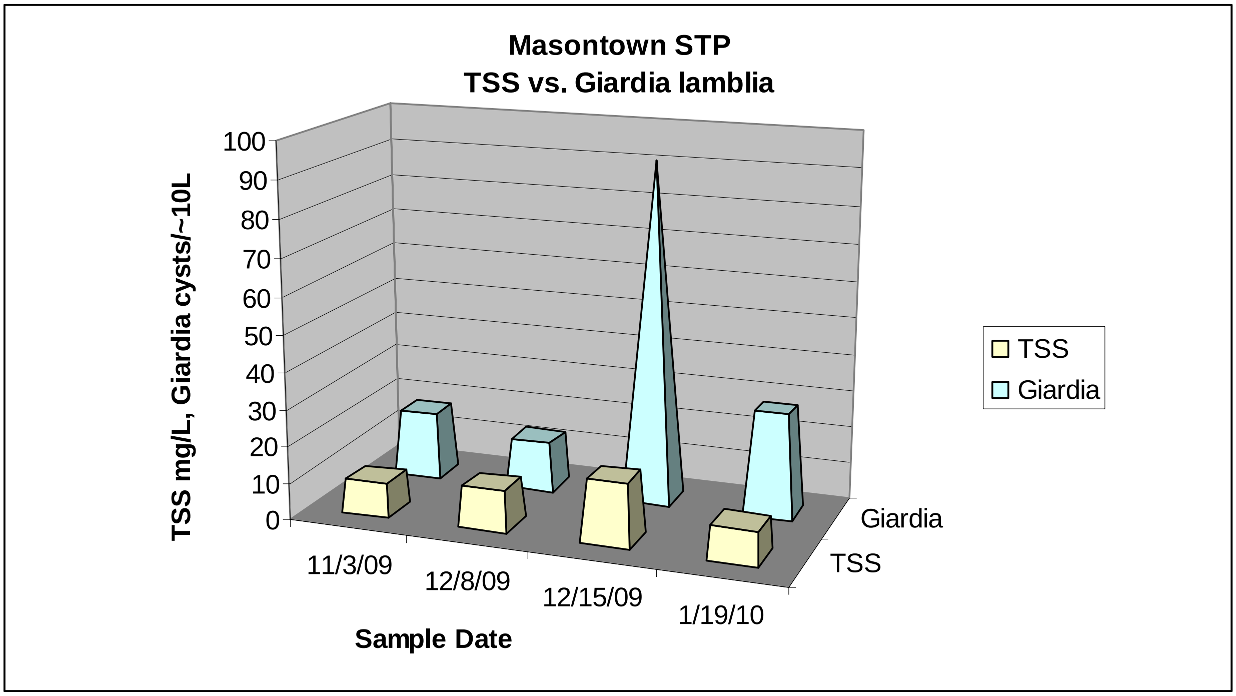

Figure 18. ***Giardia lamblia/TSS comparison***

In order to more effectively assess the level of pathogens, and the effect of annual weather patterns on them, an effective statistical population would necessarily include many samples per location, taken over the course of the entire year. The study would have to account for temperature and weather variability, seasonal activity of host wildlife in the area, changes in stream flow and chemistry, and other factors.

Field Sampling

Initial background samples were collected on November 3, 2009:

Location	Sample Number	Analyses
Upstream of Outfall 001 at South Water Street bridge over Cats Run	0331835	Method 1623, Total Solids, and Conventional Pollutants
Chlorine contact tank discharge	0331834	Method 1623, Total Solids, and Conventional Pollutants
Downstream of Outfall 001 at Masontown drinking water intake, raw water tap	0331836	Method 1623, Total Solids, and Conventional Pollutants

Table 4. Initial sampling locations and analyses

As indicated above, on several occasions, grab samples were collected for Method 1623 pathogens (*Cryptosporidium* and *Giardia lamblia*) from the treated plant effluent at the discharge weir, upstream at the South Water Street bridge over Cats Run, and downstream at the drinking water intake for MMA.

At various times during the WPPE, samples were collected of the wastewater plant and receiving stream; these samples were submitted to the Department's Bureau of Laboratories for analysis. The mixed liquor was sampled for suspended solids, and volatile solids. The influent, effluent, upstream, and downstream samples were checked for conventional sewage pollutants, total dissolved solids, specific conductivity, sulfates, and chlorides. The effluent, upstream, and downstream were also sampled for *Cryptosporidium* and *Giardia lamblia*.

A summary of these results is fully listed in Attachment E. I addition, the laboratory results for all samples collected during the WPPE has been provided separately on a CD-ROM disc that accompanies this report.

7. Process Control

Permit Modifications

Any modifications to the permitted treatment process may require an amendment to the Water Management Permit. If you are unsure whether a permit modification is necessary contact the DEP regional office that supports your wastewater facility prior to making any modifications.

General

The objective of Process Monitoring and Testing is to develop regular monitoring procedures for the individual treatment facility. Typically, an operator chooses to maintain a facility according to mean cell residence time (MCRT) or food-to-mass (F/M) ratio. The objective of these broad parameters is to find a level where plant performance is optimal for the current conditions (including season, amount of precipitation, loading variations, industrial or commercial contributors) and then adjust the treatment processes in order to maintain a steady-state. For example, if an operator runs a facility according to constant Food to Mass ratio of 0.35, and plant loading (the "food" value) is either naturally constant (based on collection system) or can be sufficiently buffered (using flow equalization tanks), then their objective in maintaining constant F/M is to assure that the biomass (the "mass" value, or the amount of MLSS in the system) can be adjusted through wasting in order to keep the ratio at or near a constant 0.35.

Mean Cell Residence Time is a method by which the operator adjusts solids retention to achieve a steady sludge age. MCRT incorporates a regularly tested solids inventory with adjustments to the wasting rates and an accounting for the expected growth rate due to plant loading. The end result of such operation is an MCRT of X-number days, usually in the range of 10-13 days for nitrifying wastewater plants.

Guidance manuals generally suggest that an operator choose a parameter and then operate the facility accordingly. Operators have found that doing so maintains conditions in an optimized state whereby the chance of plant upsets is mitigated or controlled.

Solids Tracking

At present, the Masontown facility tracks sludge solids in the two aeration tanks by performing ½ hour settleability and centrifuge tests as deemed necessary by the operator. Total Solids tests are performed 1-2 times per month on each treatment train. Solids levels increased over the course of the WPPE and were scheduled for removal upon reaching approximately 5000 mg/L. A core taker was present on site and is routinely used by the operator to ascertain the solids blanket depth in the clarifiers. The core sampler can also be used to identify conditions occurring in the chlorine contact tank. When solids have accumulated in the chlorine contact tank/disinfection tank they will denitrify over time causing the solids to rise to the surface and be washed out with the treated effluent having negative effects on effluent quality. There was no accumulation of solids noted on the chlorine contact tank during the WPPE.

To develop and maintain a complete solids inventory, the clarifier solids needs be regularly assayed in a consistent method. During a WPPE, DEP provides, on loan, a clarifier core-taker sampler that is used to determine the level of the sludge blanket and which can be used to sample the entire clarifier for a percent solids number that, with measurements of the return and waste sludge values, may be used to determine an operational MCRT. This method only involves the core taker and a centrifuge to spin the solids samples. A clarifier spin cycle that runs six samples, or three with duplicates, takes approximately 15 minutes to complete.

The MCRT method is described in earlier versions of WPCF's Activated Sludge Manual of Practice No. OM-9 and in other sources. Calculation of a sludge inventory using undefined sludge units allows an operator to derive an MCRT value for his/her facility, and this can be done on a daily, semi-weekly, or weekly basis.

The Department utilized gravimetric solids tests, ½ hour settleability tests, and centrifuge tests to track changes in the mixed liquor suspended solids. In addition, a sludge blanket monitoring system was installed in the clarifier to track changes in sludge blanket levels. Once calibrated the blanket level monitor will effectively measure changes in feet of sludge blanket as an indicator to be used in conjunction with other solids testing to maximize treatment effectiveness.

Solids monitoring is very important in a wastewater treatment plant. If the MLSS concentrations are too low then there won't be enough nitrifying bacteria present for nitrification to occur and MLSS concentrations to high can cause problems with clarifier operations and suspended solids levels in the effluent. MLSS target levels are usually adjusted seasonally as the temperature plays an important part in nitrification.

DO findings

The DO readings at this facility follow a typical diurnal pattern with peaks occurring in the morning hours prior to the facility receiving an increase in flows due to residents starting their day. The flows then decrease over the daytime hours and begin to creep up in the evening until starting the cycle over the next day. Optimal DO range for activated sludge plants is usually between 1.5 mg/L and 3.5 mg/L. Any DO over 3.5 mg/L usually represents wasted energy, because the biomass functions adequately within this prescribed range. At MMA, the facility could benefit from continuous monitoring of DO, insofar as the operator may interconnect a DO probe with their blower system in order to achieve demand-based aeration which is a much more cost effective operation when considering utility costs.

ORP

ORP can be used by the operators to control periods of anoxic or aerobic treatment conditions, as described earlier, for the removal of nitrates. The following table depicts general ORP values at which denitrification occurs; the operators may wish to pursue the use of timed intervals as a method to optimize nitrate removal, even in the absence of dedicated treatment units where denitrification would occur.

General values for ORP used to determine which biological condition exists within a particular treatment unit:

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 5. ORP Chart

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 near 0 mg/L. Had there not been monitoring of the ORP, the exact stage of biological treatment process would not have been known, i.e. nitrification, denitrification, anoxic, aerobic, or anaerobic conditions.

DO Profile

A dissolved oxygen (DO) profile, shown in Figure 19 below, was developed in December to characterize mixing in the East aeration tank. For this, a Hach 40d digital meter and LDO portable probe were used. DO was recorded at several locations in the aeration tanks, at varying depths. Recordings were made approximately 2 ft from the edge of the tank at three depths: 1 ft, 6ft, and 12ft along the length of the tanks.

Results of this analysis show that, for the most part, mixing within the east tank is complete and DO remains fairly consistent throughout the process. However, this test suggests that the diffuser in the bottom of the north-west corner in the east aeration tank will need more attention due to its diminished oxygen distribution.

Operators at similar facilities have found that performing a DO profile on a regular basis helps to characterize weak spots in the aeration grid and identify dead zones that may be caused by occluded diffuser outlets or by faulty baffling. Performing a DO profile every six months at this facility should be sufficient. Studying the DO profile over time also allows the operator to see the effects of loading on the tanks, and data may be used to identify the need for aeration balancing and/or the need for cleaning of diffusers.

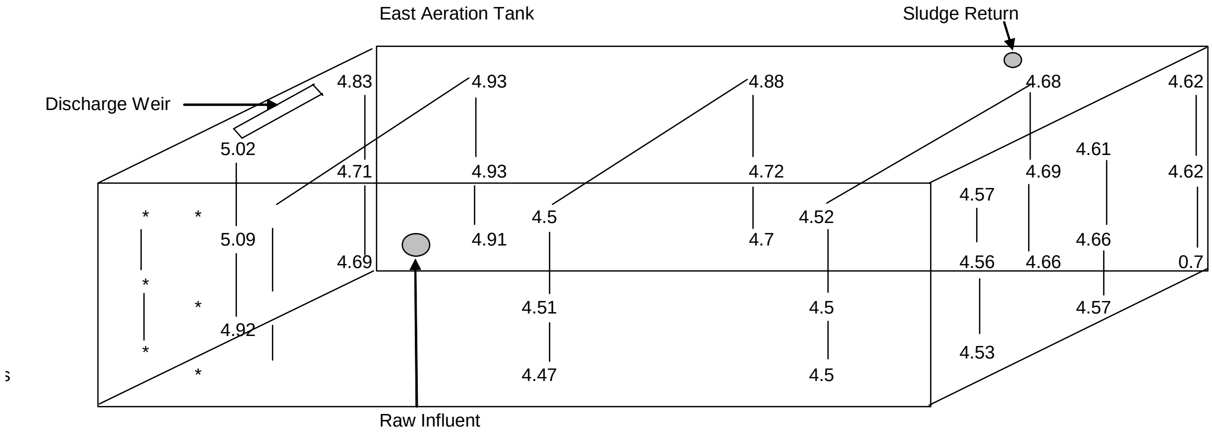

Figure 19. DO Profile of the Masontown east aeration unit

DO Grab Testing

During the course of the study, DO grab samples were collected at various locations in the aeration tanks for process control purposes and to validate on-line monitoring equipment. These samples were also used to perform OUR and Specific Oxygen Uptake Rate (SOUR) testing on both basins to analyze biomass health and food supply.

After the on-line monitoring equipment has been removed the DO within the aeration tanks can be tracked and trended using this same grab sample method to ensure sufficient oxygen is available for nitrification to occur.

Nitrate and Ammonia Nitrogen

Use of the nitrate and ammonium ion probes at the MMA plant showed relatively low ammonia and high nitrate concentrations at the onset of the WPPE. Since nitrification and BOD removal were occurring and the facility was constructed in a manner allowing the aeration blowers to be controlled individually, modification of the treatment process was possible.

With extended aeration processes, ammonia-nitrogen tends to be quickly converted to nitrite and nitrate. Nitrate is a pollutant-of-concern in wastewater effluent because nitrate acts as a fertilizer, increasing algal growth that leads to eutrophication of streams and lakes and, ultimately, the mortality of higher life forms. Nitrates have also been indicated as damaging to human health, having both immediate and long-term effects.

The study has shown that MMA may benefit from adopting flow and aeration configurations that favor denitrification, without excessive capital expense. The current configuration of the raw influent entering the bottom of each tank assists in providing some mixing that is essential for nitrification to occur. Should that not provide enough mixing then another source would be adding submersible pumps in the corners of the aeration basins and piping the flow up and then back down into an adjacent corner of the tank. A general rule of thumb for sizing these pumps is 1HP for each 15,000 GAL of tankage, in this case approximately 8.5HP pumps for each tank. The use of “on/off aeration” for several periods per day could significantly reduce the nitrate concentrations in the plant’s effluent and additional cost savings benefits are also possible. Attachment K shows a comparison of running 1 blower to that of needing 2 blowers. The potential cost savings of lower blower motor run times due to reduced solids values and reduced overall run time due to utilizing on/off aeration methods could lead to savings of over $750 per year.

pH, Temperature

Upon completion of the WPPE, the plant's operating pH and temperatures were normal for the times and conditions observed. Generally, the optimum pH for nitrification is in the 7.5 to 8.5 s.u. range. In MMA's case, pH values of 5.5 to 6.0 are typical. There was no chemical addition for pH adjustment at the onset of the WPPE. However after several days of pH monitoring the low pH values were confirmed and the operator implemented the addition of hydrated lime to increase pH and alkalinity. The alkalinity at the onset of the project was approximately 25 mg/L which indicates insufficient alkalinity present for nitrification to effectively occur. The nitrification process consumes approximately 7.2 lbs of alkalinity for each pound of ammonia converted to nitrate. The operator should continue to monitor the pH in the aeration basins on a daily basis and add lime as necessary to maintain healthy levels.

Clarifier Blanket Level & Core Sampling

Two methods of analyzing the clarifier blanket were employed at the MMA plant: use of the continuous-monitoring sonar device, and use of the core-taker sampler. Currently, the operator monitors the clarifier sludge blanket levels on a daily basis. This process control measure is essential and should continue to determine at what plant conditions the best effluent is produced by the clarifiers. Rising sludge blanket can indicate trouble a day or two out; falling sludge blanket could indicate over wasting or short-circuiting.

The Department used the continuous sonar method to look for fluctuations in blanket levels, but none were found. There were changes in the blanket level throughout the course of the day but these are to be expected.

Flow Measurement

The MMA totalizer readings were utilized for flow readings during the WPPE.

Laboratory Tests

A significant part of the WPPE includes sampling on-site using a centrifuge, pH and DO meters, LBOD probe, and a spectrophotometer. Also, the clarifier sludge blankets are monitored to define the blanket depth and clarity.

A centrifuge is utilized to perform percent solids analysis on the mixed liquor, return activated sludge, clarifier contents, and waste activated sludge. When these parameters are monitored over a period of time, one can draw a correlation between the suspended solids levels and percent solids test results. Once this correlation is established you can utilize the centrifuge to identify the solids levels in the aeration basins within 15 minutes, the duration of the test.

A centrifuge was utilized for developing quick information on solids inventory and biomass condition. This equipment includes settleometers, which mimic clarifier performance, and a core-taker that is used to determine both clarifier sludge blanket level and percent solids of a representative sample, used in determining total plant inventory. According to supplemental information provided by Raven, it is possible to determine a sludge age, similar to use of MCRT, for tracking overall plant performance. Doing so includes maintaining a running sludge solids inventory of all processes and tanks, including aeration, clarifiers, return and waste sludge volumes, and inflow and effluent solids. It is also recommended that the sludge solids by percent volume be calibrated to sludge solids by gravimetric analysis.

During the evaluation period, the Department also provided a hand-held dissolved oxygen probe and pH probe for use in field testing of the aeration tank mixed liquor. The preferred method of determining process DO is to immerse the DO probe into the aeration tank or effluent stream and to read the DO after the meter stabilizes.

To verify the accuracy of the digital probes, a field spectrophotometer kit was provided that included test materials for several water quality parameters. During the WPPE, this kit was used to determine nitrate and ammonia nitrogen levels throughout the plant and verify the on-line process monitoring equipment.

Attachment H contains examples of the Process Control Testing worksheets prepared during the WPPE.

Method 1623 Pathogen Test Results:

Date	Sample Location	Weather	Sample Number	*Giardia* cysts/~10 L	Crypto oocyst/~10 L
11/3/09	Upstream at S. Water St. bridge over Cats Run		0331835	0	0
11/3/09	Effluent		0331834	361	0
11/3/09	Downstream at MMA DW intake		0331836	1	1
12/8/09	Upstream at S. Water St. bridge over Cats Run		0331847	0	0
12/8/09	Effluent		0331846	270	6
12/8/09	Downstream at MMA DW intake		0331848	3	0
12/15/09	Upstream at S. Water St. bridge over Cats Run		0331855	0	0
12/15/09	Effluent		0331854	1833	9
12/15/09	Downstream at MMA DW intake		0331856	0	0
1/19/10	Upstream at S. Water St. bridge over Cats Run		0331871	0	0
1/19/10	Effluent		0331870	570	3
1/19/10	Downstream at MMA DW intake		0331872	2	0

Table 6. Method 1623 test results

Table 6, above shows the pathogen test results for *Giardia* and *Cryptosporidium*. The effluent samples from the plant consistently indicate the presence of Giardia lamblia cysts and Cryptosporidium oocysts in the effluent.

The instream waste concentration (IWC) is based on plant design flow and the Q7-10 flow of Cats Run. The Q7-10 flow is the lowest average, consecutive 7-day flow that would occur with a frequency or recurrence interval of one in ten years (from SRBC website). The Q7-10 flow and IWC are used in the Department's NPDES permitting process. The IWC for MMA is 93%, considering stream flows of .0212 cfs and plant flow of 0.20 MGD. This would indicate that during relatively dry conditions the MMA discharge flow would represent 93% of the stream flow. The stream flow of Cats Run was not measured during the WPPE. The volume of the Monongahela River is much greater than that of Cats Run and the resulting waste concentration is much less where the drinking water plant withdrawals its surface water.

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8. Conclusions

Considerations for Operational Modifications

The following are possible modifications that could be made at the WWTP and are based on the data collected during this study and current operating practices commonly utilized at other WWTP's across the Commonwealth. These modifications are presented for the operators benefit but should only be instituted while cautiously observing the effects on the overall treatment efficiency. Since the WWTP process is a biological process, changes made on a particular day may not be visible until at least 24-48 hours later, or more. The responsibility for instituting changes and their outcomes remains with the Operator in Responsible Charge at the WWTP where the changes are made.

DO control

Currently, the plant has the ability to modify DO levels in the aeration tank without manually starting and stopping blower motors controlling air flow to other tanks and/or opening and closing valves on other tanks. Future modifications to the plant could include installation of on-line process monitoring equipment to monitor DO, ORP, and TSS. If the data were used to control the blower motors with combined with soft-start and variable-speed drive capability then utilizing a feedback loop between the motor starters and on-line DO probes, the operator could efficiently regulate aeration capacity to support nitrification and denitrification. These efforts could save thousands of dollars over the long term on electric energy costs. MMA's engineer may be able to develop a depreciation and payback term for such equipment changes.

Meanwhile, continuing the on-off aeration should continue to trigger the denitrification process. While there are many benefits to these operating methods, there is more demand for operator oversight and some additional testing, i.e. DO, ORP, TSS levels, that will be essential for effective nitrification and denitrification to continue. Together, all this could reduce the need for adding lime to the mixed liquor, since the denitrification process devours nitrate and creates alkalinity as a byproduct.

Optimum Levels for Nitrification

Nitrifying bacteria (autotrophic aerobes) convert NH3 to NO3 consuming inorganic carbon, DO, and alkalinity.
Optimal conditions for nitrification are:

MCRT:	10 to 13 days
Wastewater Temperature:	60 - 95°F
MLSS:	2,000 to 3,500 mg/L (colder temperatures may require increased MLSS levels)
DO level:	> 1.5 mg/L (4.6 lbs per lb of NH3 converted to NO3)
pH:	7.5 to 8.5 s.u.
Sufficient Alkalinity to provide 7.2 lbs per pound of NH3 converted to NO3	

Table 7. Optimum nitrification indicators

Unfortunately, all plants have their individual characteristics based on influent flow, plant design, and operating procedures. While these levels are generally used in the nitrification process, individual plants may find necessary to deviate from these general values.

Power Consumption

Electrical usage is commonly the highest expense when operating a wastewater treatment facility. As described in the DO control section above, there could be cost savings realized through the use of on-line process monitoring equipment. The equipment is utilized to assist the operator in identifying the current conditions of the plant and make timely process control changes to the motor run times based on the DO readings so as to not operate equipment when unnecessary.

Electricity deregulation is a concern for everyone across the state and it is anticipated that all homes and businesses will see increases in utility bills. The utilization of automated equipment to operator blower motors and assist the operator in maintaining solids levels in the aeration basins should effectively reduce electrical consumption of the motors by requiring a shorter run time.

Electricity charge at this facility is based on variable kilowatt hour pricing. An estimate of the demand charge was used to calculate an estimated electrical usage for the blower motors. The kW demand on the utility bill minus an allowance factor of 5, multiplied by 60 provides a number of hours of demand. Those demand hours are charged at 5 cents each. This can be used to calculate a demand charge. Performing this calculation for the months of November and December 2009 provided demand charges of $124.50 and $192.00 respectively. By dividing that demand charge by the associated demand for that month and averaging the two values provides an approximate average demand charge of $2.73 kW. This value was used in calculating costs of operating the motors for the blowers at the plant.

The blowers at this facility are controlled via timers on the aeration unit blowers and on based on tank levels for the equalization and storm surge tanks. Due to changes in weather and rainfall accordingly the usage of the motors for the equalization and storm surge tanks can vary extensively as evidenced on the two utility bills used in this calculation. December had much more rainfall than November resulting in higher tank levels and therefore more blower motor run time. The cost savings example here assumes only operating 1 blower motor for each unit at one time so as to provide the most conservative cost savings. Approximately $2 per day is saved by operating the blowers in the modified configuration which has significantly reduced nitrate levels in the effluent. Assuming that rate over a year should provide a cost saving of $730. This money could be used to provide the operator with additional meters that can be used to more effectively monitor the treatment process. The meters that would assist the operator include luminescent dissolved oxygen and oxidation reduction potential. Often meters can be packaged together to include pH, LDO, and ORP probes. Savings such as that described above would pay for a meter in approximately one year’s time. Attachment K shows the power usage calculation.

Pathogen control

Disinfection for fecal coliform reduction is currently performed utilizing ultraviolet light disinfection. No solids accumulation was identified in the disinfection tank during the course of the WPPE. Chlorine disinfection is not used at this facility.

Laboratory methods

Mixed liquor suspended solids tests are usually conducted once weekly. Generally this practice would be acceptable for monitoring the biomass. During spring and fall times of year when the temperatures are changing it may be beneficial to monitor the MLSS more frequently, at least twice weekly. Also, once the MLSS test is complete, volatilizing any solids remaining in the muffle furnace will provide data on ML volatile suspended solids, which allows for the calculation of the mean cell residence time (MCRT). Generally, MCRTs in the 10 - 13 day range allow for optimum nitrification of the wastewater.

Use of the centrifuge, settleometers, and core-taker would allow the operators to develop a sludge inventory based on sludge units (SLU), which is a product of both solids-by-volume percent and process volume or total flow. Developing such a sludge inventory also allows the operators to determine a sludge age (AGE) for the process, which on a daily basis is used similar to the MCRT as an operational guideline.

In either case, whether using AGE or MCRT, it is beneficial to plant operators to find an ideal operational setpoint and then adjust the process to maintain the plant at or near that setpoint. It is somewhat like flying by instruments instead of using visual flight rules. Intuition, experience, and visual observations do help, but they only go so far.

Inflow/Infiltration

As are many POTWs in the Commonwealth, the collection system is impacted by inflow and infiltration. A maximum daily flow of 0.414 MGD indicates that some I/I does exist and could adversely affect operations. Continued maintenance on the collection system is needed to reduce these impacts. MMA should maintain an aggressive policy to find and disconnect wildcat connections, storm drains and downspout connections, and root infiltration in its collection system. If manhole cap inserts are not in use, they should be installed to reduce inflow.

Solids Management and Inventory Control

The solids management and inventory control program is based primarily on ½ hour settleability tests and centrifuge testing performed on mixed liquor samples. Additionally, gravimetric tests should be performed at least twice per month to correlate the settleability and centrifuge tests to actual suspended solids analysis. With these three pieces of information the operator can quickly identify the loadings on the treatment units allowing them to waste solids at the most opportune times.

The current practices include wasting solids after they are allowed to settle in the clarifiers for approximately 4 to 6 hours. While the operator makes this practice work for the current plant setup it would be more operator friendly and easier to operate if a sludge digester were installed for solids disposal. Ultimately, it appears that a sludge “bagger” system will be installed at the MMA-Big Run STP at which point liquid sludge will be hauled from the Cats Run STP to the Big Run STP.

MLSS / % Solids comparison charts were prepared for the operators use since a centrifuge is available and currently being used for testing at the plant. The operator can use the attached charts to estimate MLSS levels after performing a % solids test which should give a good indication of solids levels and help with deciding when to waste solids. These charts would need to be updated regularly to ensure changes in plant conditions are considered, especially seasonal considerations.

Figures 20 and 21, below, depict the mixed liquor suspended solids (MLSS) levels at MMA in relation to the respective centrifuge solids reading. By plotting the data and inserting a best fit line, one can use a centrifuge solids reading to effectively estimate the MLSS reading. To utilize the chart, find the % solids result along the x axis and draw a line vertically to the black line to find the approximate MLSS result.

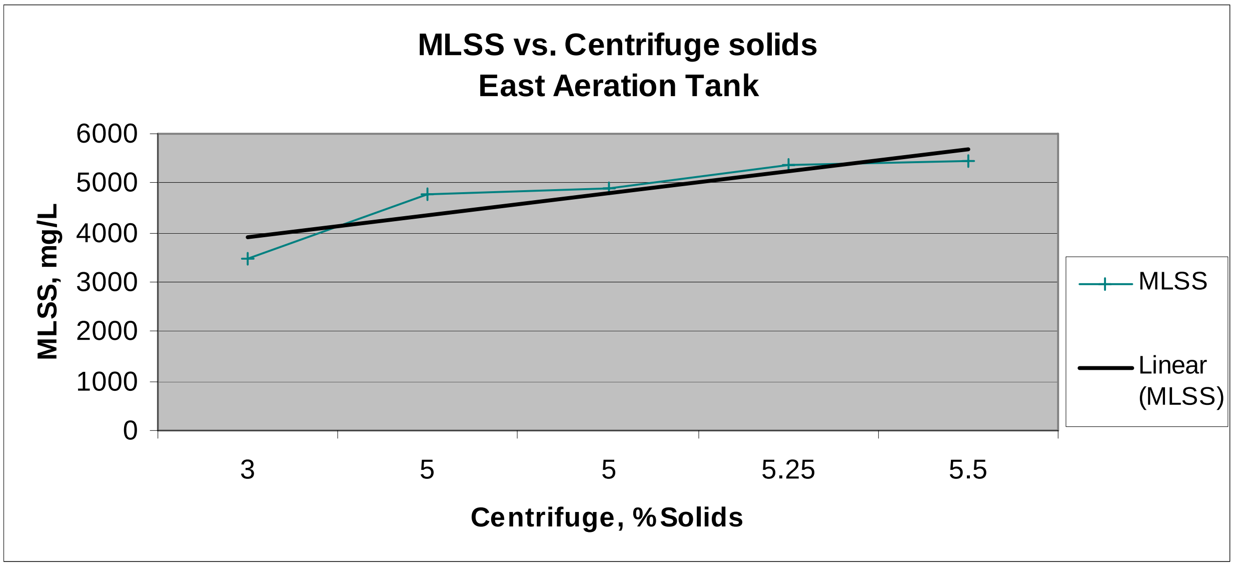

Figure 20. MLSS vs. Centrifuge solids comparison chart for the east aeration tank

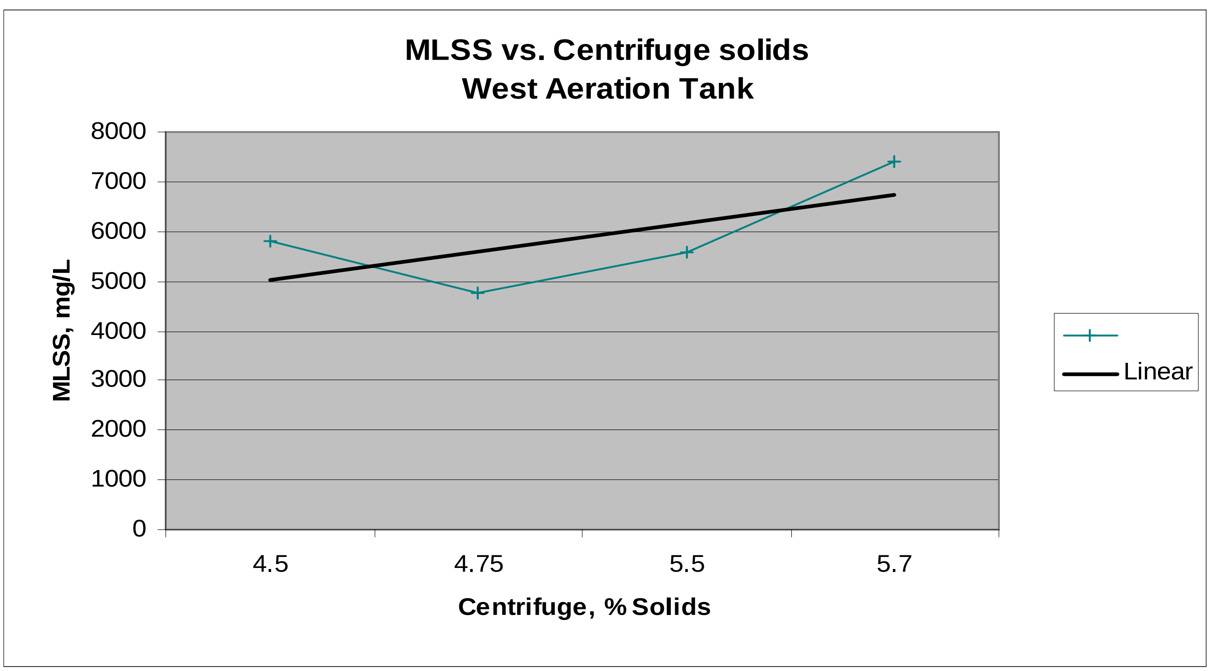

Figure 21. MLSS vs. Centrifuge solids comparison chart for the west aeration tank

The following spreadsheets were prepared utilizing data from the 2008 Chapter 94 report and the 2008/2009 DMRs. For purposes of these sludge removal calculations, the 2009 influent loading was assumed to be equal to that of 2008.
These estimations were prepared using information provided in the US EPA Handbook, Retrofitting POTWs, July 1989 Edition, EPA/625/6-89/020. The estimated values are deemed to be within +/- 15 % of actual values. Target values are therefore 85 -115 %.

Date: **2008 DMRs**

Plant Name: **Masontown-Cats Run**

Design Flow: **0.2**

Design Loading: **333**

Avg Daily Flow: 0.185

Months	Actual Sludge Disposed
Jan	0.976
Feb	1.813
Mar	0.652
Apr	0.987
May	1.09
Jun	0
Jul	1.03
Aug	0.788
Sep	4.817
Oct	0.365
Nov	0.704
Dec	2.299
0	15.521

x 2000lbs/ ton

31,042.00 actual lbs removed

BOD mass removed by STP

influent pounds BOD/day		193	lbs/day	*(as reported in Chapter 94 Report)*
effluent pounds BOD/day	–	7.7	lbs/day	*(use monthly avg loading value from permit)* *(from DMRs)*
BOD mass removed by STP	=	185.3	lbs/day	

pre-digestion sludge mass produced by STP

BOD mass removed by STP		185.3	lbs/day
sludge production factor *	x	0.65	
pre-digested sludge mass	=	120.445	lbs/day

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

post-digestion sludge mass produced by STP **

***calculate only if plant has a digestor*

pre-digestion sludge mass		120.445	lbs/day
% of pre-digestion solids remaining	x	1	
post-digested sludge mass	=	120.445	lbs/day

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

estimated amount of sludge to be removed

sludge mass (pre or post)		120.445	lbs/day
days per year	x	365	days/yr
estimated sludge mass for disposal	=	43,962.43	lbs/yr

percentage of sludge mass for disposal

actual		31,042.00	lbs
estimated	/	43,962.43	lbs
		0.706103	
	x	100	%
		70.6103	%

Sludge Removal Percentage

Figure 22. 2008 Sludge removal estimation

The 2008 sludge removal estimation in Figure 22 estimates the sludge removal at 71% of the approximate value that should be removed from a wastewater plant of this type with the given loadings. Again, the target values should be somewhere between 85-115% so the goal should be to increase solids removal at the wastewater plant.

Date: **2009 DMRs**

Plant Name: **Masontown-Cats Run**

Design Flow: **0.2**

Design Loading: **333**

Avg Daily Flow: 0.175

Months	Actual Sludge Disposed
Jan	0.85
Feb	1.042
Mar	2.71
Apr	1.662
May	1.763
Jun	1.426
Jul	0.755
Aug	1.71
Sep	1.57
Oct	2.369
Nov	0.99
Dec	0
0	16.847

x 2000lbs/ ton

33,694.00

actual lbs removed

BOD mass removed by STP				
influent pounds BOD/day		193	lbs/day	*(as reported in Chapter 94 Report)*
effluent pounds BOD/day	–	2	lbs/day	*(use monthly avg loading value from permit)* *(from DMRs)*
BOD mass removed by STP	=	191	lbs/day	
pre-digestion sludge mass produced by STP				
BOD mass removed by STP		191	lbs/day	
sludge production factor *	x	0.65		
pre-digested sludge mass	=	124.15	lbs/day	
post-digestion sludge mass produced by STP **				
***calculate only if plant has a digestor*				
pre-digestion sludge mass		124.15	lbs/day	
% of pre-digestion solids remaining	x	1		
post-digested sludge mass	=	124.15	lbs/day	
estimated amount of sludge to be removed				
sludge mass (pre or post)		124.15	lbs/day	
days per year	x	365	days/yr	
estimated sludge mass for disposal	=	45,314.75	lbs/yr	
percentage of sludge mass for disposal				
actual		33,694.00	lbs	
estimated	/	45,314.75	lbs	
		0.7435548		
	x	100	%	
		74.35548	%	Sludge Removal Percentage

** sludge production factors*

extended aeration = .65

oxidation ditches = .65

conventional activated sludge = .85

contact stabilization = 1.0

solids reduction in digestors

10 days = .9

15 days = .8 **default value**

20 days = .7

>30 days = .65

Figure 23. 2009 Sludge removal estimation

The 2009 sludge removal estimation in Figure 23 estimates the sludge removal at 74% of the approximate value that should be removed from a wastewater plant of this type with the given loadings. In this example the influent loading value was unavailable, so the value from 2008 was utilized. There is an increase in solids removal from the previous calendar year and there were no solids visible in a cursory review of an area within 20 yards downstream of the effluent discharge.

Through increased monitoring, the operator should be able to identify when solids removal is necessary and increase the amount of solids removed from the wastewater plant to levels that more closely align with expected values. The benefit will be a cleaner effluent, including reduced BOD and TSS levels.

Attachment A— Program Description

POTW Optimization Program

Description and goals

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

The goal of this program is to reduce pathogen, nutrient, and emerging contaminant loadings to downstream drinking water facility intakes. The initial focus will be to work with wastewater treatment facilities within five miles upstream of these 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.

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, on-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. Process modification will be discussed to 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.

Attachment B— WPPE Team

Municipal Authority of Masontown-Wastewater Treatment Plant

WPPE Team

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Attachment C— Suggested Sampling Frequencies

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	As permitted	Totalizer	Daily		
* Frequency of sampling may need to be increased or decreased depending on plant size or conditions					
Aeration Basin					
MLSS / MLVSS	Aeration Tank	Grab			x
Centrifuge Testing	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					
Modified from its original version					
Reference: Texas Commission on Environmental Quality, Guidance Document RG-002(Revised), October 2002					

Table 8. 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. Depending on the chemical makeup of the wastewater, additional analyses may need to be performed to provide adequate treatment. This sampling may coincide with some sampling required by the NPDES permit but does not reduce the sampling required by said permit.

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Attachment D—Treatment Schematic

Process Description:

MMA's treatment train is depicted in Figure 24, below, showing a conventional activated sludge, extended aeration treatment process. Plant headworks include a storm surge tank, flow equalization tank and a manual bar screen or comminutor. The bar screen is utilized at this site to remove debris from the system instead of grinding it to smaller pieces that can potentially clog pumps and cause unnecessary wear on plant equipment. Two aeration tanks provide for 256,000 gallons of capacity. Secondary settling is provided in two clarifiers. The clarifiers have a 200 sq ft surface area and 9 ft depth for a 13,500 gallon capacity each, 27,000 gallons total. The disinfection processes utilizes one tank with ultraviolet disinfection to destroy pathogens prior to discharge to the receiving stream. Additional chemicals used at this facility include lime added to the aeration basins for pH adjustment and alkalinity control and polymer is sometimes added to the aeration basins to aid in settling at the clarifiers. MMA's final outfall into Cats Run employs a standard, shoreline point discharge and headwall.

Waste sludge is disposed of in either of two methods. Generally, solids are allowed to settle and accumulate in the clarifiers for approximately 4 to 6 hours, with the returns off, and then pumped out of the piping at the sludge drying beds. Another possible method would be to transfer solids to the sludge drying beds, allow adequate time to dry, and manually removed and disposed of off site. Due to the limited size of the drying beds the second method is not practical and is seldom if ever used.

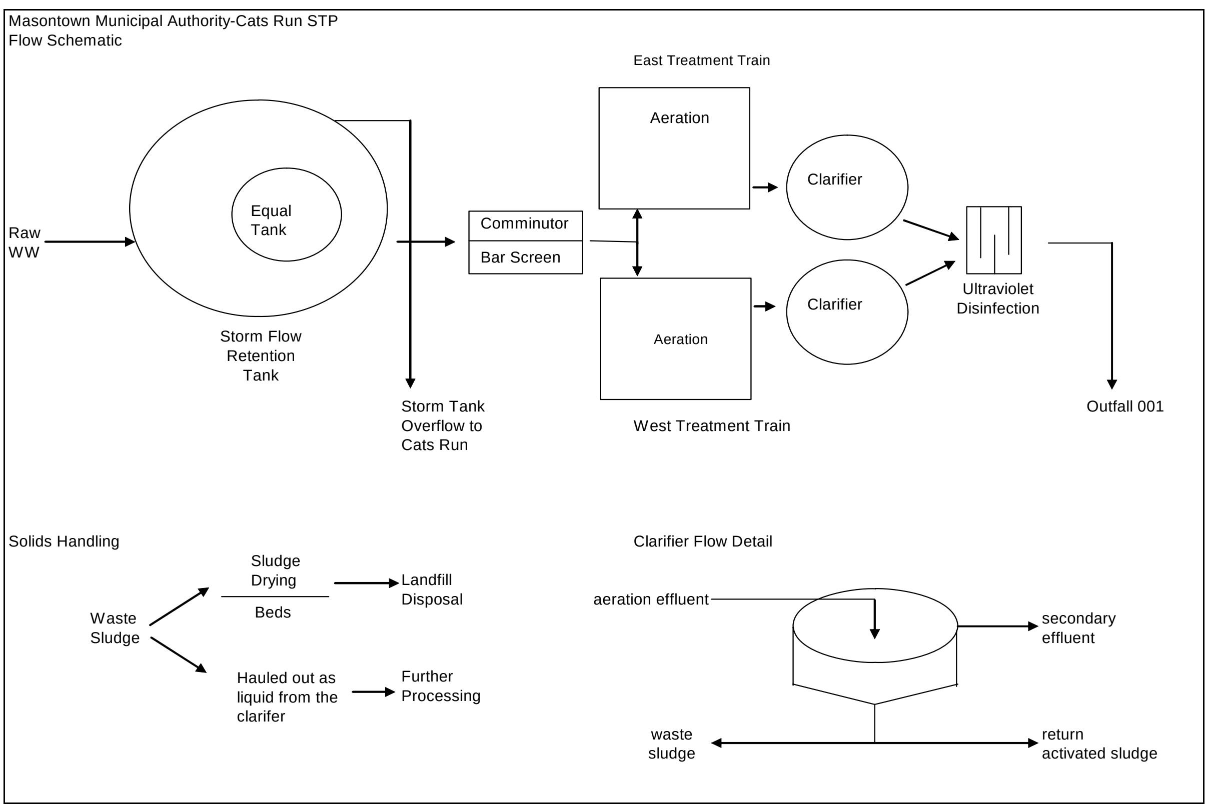

Figure 24. Masontown-Cats Run sewage treatment plant process flow schematic

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Attachment E— Laboratory Sampling Results

Municipal Authority of Masontown Laboratory Sample Results

Upstream, Downstream, Effluent, Mixed Liquor Suspended Solids

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

Municipal Authority of Masontown, DEP Laboratory sample results

Effluent, Upstream, and Downstream

Lab Resutls-Masontown Boro- Cats Run STP

	11/3/09	11/18/09	12/8/09	12/15/09	1/12/10	1/19/10
Effluent-Sample #	0331834	0331840	0331846	0331854	0331862	0331870
CBOD	0.9	4.4	6.3	3.5	2.9	2.8
TSS	9	21	11	17	10	9
Alkalinity	23.2	2.2	99.6	79.4	83.2	73.4
NO2-N	0.02	0.02	0.02	0.03	0.02	<.01
NO3-N	17.82	24.09	21.52	8	6.8	3.48
NH3-N	0.1	0.94	0.12	0.25	0.2	0.18
TKN	1.46	3.22	2.15	1.96	1.59	1.56
Phos	2.022	4.28	2.253	1.465	1.597	1.197
TOT N(TKN+NO3+NO2)	19.3	27.33	23.69	9.99	8.41	5.05
Fecal Coliform	<20	20	60	20	<20	<20
Spec Cond	564	646	812	520	666	811
TDS	414	452	576	328	426	506
Ratio TDS:Spec Cond	0.73	0.70	0.71	0.63	0.64	0.62
Sulfate	85.5	98.9	121	62.5	67	67.4
Chloride	57.2	63.6	64.7	52.6	98.5	182.1
pH	6.8	5.9	7.5	7.6	7.2	7.3
Crypto	0		6	9		3
Giardia	361		270	1833		570

Upstream-Sample #	0331835	0331841	0331847	0331855	0331863	0331871
BOD	0.3	<.2	1.1	1.1	<.2	0.5
TSS	<5	<5	<5	8	<5	11
Alkalinity	0	0	0	0	0	0
NO2-N	<.01	<.01	<.01	<.01	<.01	<.01
NO3-N	0.35	0.18	0.39	0.72	0.48	0.9
NH3-N	0.02	<.02	<.02	0.06	<.02	0.1
TKN	<1	<1	<1	<1	<1	<1
Phos	<.01	<.01	<.01	0.013	<.01	0.013
TOT N(TKN+NO3+NO2)	1.36	1.19	1.4	1.73	1.49	1.91
Fecal Coliform	<20	<20	<20	<20	<10	<20
Spec Cond	1020	1225	1031	838	1155	857
TDS	902	1104	932	710	1040	696
Ratio TDS:Spec Cond	0.88	0.90	0.90	0.85	0.90	0.81
Sulfate	501.4	683	565	420	579.1	395
Chloride	21	19.3	22	20.2	24.3	44.9
pH	4.2	3.8	4.1	4.5	3.6	4.6
Crypto	0		0	0		0
Giardia	0		0	0		0

Downstream-Sample #	0331836	0331842	0331848	0331856	0331864	0331872
BOD	8.5	<.2	2.2	1.2	1.4	1.7
TSS	8	<5	<5	14	<5	24
Alkalinity	32	25.6	46.2	21.6	32	34
NO2-N	0.01	<.01	0.01	<.01	0.01	0.01
NO3-N	0.38	0.31	0.44	0.52	0.52	0.52
NH3-N	0.05	0.04	0.14	0.08	0.09	0.15
TKN	<1	<1	<1	<1	<1	<1
Phos	0.021	0.016	0.024	0.032	0.02	0.036
TOT N(TKN+NO3+NO2)	1.39	1.32	1.45	1.53	1.53	1.53
Fecal Coliform	60	10	110	990	20	500
Spec Cond	249	274	440	142.9	299	294
TDS	168	180	294	98	182	194
Ratio TDS:Spec Cond	0.67	0.66	0.67	0.69	0.61	0.66
Sulfate	72.1	83.2	138	41.9	73.5	77.5
Chloride	6.8	8.5	12.9	5.4	18.4	16.6
pH	7.5	7.4	7.6	7.2	7.4	7.3
Crypto	1		0	0		0
Giardia	1		3	0		2

Table 9. Masontown sample data

Municipal Authority of Masontown, DEP Laboratory sample results

Mixed Liquor Suspended Solids, Return Activated Sludge, and Influent

Lab Resutls-Masontown Boro- Cats Run STP

	11/3/09	11/18/09	12/8/09	12/15/09	1/12/10	1/19/10
MLSS- East - Sample #	0331837	0331843	0331849	0331857	0331865	0331873
BOD	1.8					
MLSS	3462	13180	4796	4896	5382	5428
MLVSS	2470	10830	3524	3524	4140	4320
MLSS/MLVSS ratio:	71.3%	82.2%	73.5%	72.0%	76.9%	79.6%
Alkalinity	90.4					
NO2-N	1.74					
NO3-N	13.62					
NH3-N	0.23					
TKN	188.36					
Phos	31.819					
TOT N(TKN+NO3+NO2)	203.72					
pH	6.7					
Chloride	7.1					
MLSS- West - Sample #			0331852	0331860	0331868	0331876
MLSS			5800	4758	5566	7392
MLVSS			3688	3744	4352	4676
MLSS/MLVSS ratio:			63.6%	78.7%	78.2%	63.3%
RAS- East- Sample #	0331838	0331844	0331850	0331858	0331866	0331874
MLSS	4704	5306	6424	7036	6326	5308
MLVSS	3104	4132	4468	5224	5036	4272
MLSS/MLVSS ratio:	66.0%	77.9%	69.6%	74.2%	79.6%	80.5%
RAS- West- Sample #			0331853	0331861	0331869	0331877
MLSS			7156	7270	6680	6668
MLVSS			4780	5768	5628	4840
MLSS/MLVSS ratio:			66.8%	79.3%	84.3%	72.6%
Influent -Sample #	0331839	0331845	0331851	0331859	0331867	0331875
BOD	1.5	263	186	89.7	162	59.9
COD	140.1	445.8	89.7	171.4	97.8	98.1
BOD/COD ratio:		170%	48%	191%	60%	164%
TSS	392	150	146	84	148	74
Alkalinity	162.2	157.6	182.4	128	161.4	124.6
NO2-N	0.01	0.07	0.03	0.16	0.06	0.14
NO3-N	<.04	<.04	0.08	1.23	0.37	2.29
NH3-N	21.68	27.26	24.64	11.09	18.19	10.25
TKN	35.56	45.98	37.11	18.77	29.87	17.23
Phos	4.822	6.203	4.411	2.801	4.042	2.371
TOT N	35.61	46.09	37.22	20.16	30.3	19.66
Chloride	59.5	155	64.5	52.4	92.6	125.9
pH	7.3	7	7.5	7.4	7.4	7.4

Table 10. Masontown sample data

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Attachment F— 2009 Flow Data, October through January

Masontown-Cats Run Flow Readings S-SNOW

October 2009

Day	MGD	Rainfall
1	0.110	
2	0.113	0.2
3	0.121	
4	0.120	
5	0.112	
6	0.105	0.1
7	0.099	
8	0.092	0.9
9	0.141	1.3
10	0.251	0.1
11	0.252	
12	0.210	
13	0.178	
14	0.156	0.3
15	0.156	0.6
16	0.176	0.1
17	0.181	0.2
18	0.181	
19	0.171	
20	0.156	
21	0.140	
22	0.131	
23	0.127	0.7
24	0.153	0.3
25	0.178	
26	0.169	
27	0.156	0.6
28	0.182	0.05
29	0.187	
30	0.182	
31	0.171	0.3
Average	**0.157**	**0.411**
Max	0.252	1.300
Min	0.092	0.050
Total		5.75

November 2009

Day	MGD	Rainfall
1	0.166	
2	0.164	
3	0.149	
4	0.139	0.1
5	0.113	
6	0.139	
7	0.105	
8	0.122	
9	0.119	
10	0.112	
11	0.103	
12	0.125	
13	0.124	
14	0.116	
15	0.115	
16	0.116	
17	0.115	
18	0.101	
19	0.105	0.4
20	0.115	
21	0.115	
22	0.104	
23	0.100	0.1
24	0.113	
25	0.108	0.1
26	0.105	0.15
27	0.108	
28	0.105	
29	0.103	0.45
30	0.111	0.1
Average	**0.118**	**0.200**
Max	0.166	0.450
Min	0.100	0.100
Total		1.4

December 2009

Day	MGD	Rainfall
1	0.115	
2	0.115	0.5
3	0.123	
4	0.125	
5	0.126	0.09
6	0.125	
7	0.114	
8	0.089	1.8
9	0.304	
10	0.319	
11	0.265	
12	0.240	
13	0.238	0.5
14	0.232	
15	0.219	
16	0.181	
17	0.145	
18	0.144	S
19	0.143	S
20	0.144	0.2
21	0.145	
22	0.148	
23	0.151	
24	0.151	0.2
25	0.190	0.3
26	0.312	
27	0.314	
28	0.279	S
29	0.233	S
30	0.201	S
31	0.189	0.1
Average	**0.188**	**0.461**
Max	0.319	1.800
Min	0.089	0.090
Total		3.69

January 2010

Day	MGD	Rainfall
1	0.191	S
2	0.181	S
3	0.169	S
4	0.159	S
5	0.150	S
6	0.144	S
7	0.144	S
8	0.144	S
9	0.144	S
10	0.143	S
11	0.126	S
12	0.115	
13	0.115	
14	0.115	
15	0.118	
16	0.135	
17	0.209	0.61
18	0.314	
19	0.238	
20	0.203	
21	0.222	0.5
22	0.246	0.1
23	0.249	0.03
24	0.241	1.8
25	0.374	
26	0.414	
27		
28		
29		
30		
31		
Average	**0.192**	**0.608**
Max	0.414	1.800
Min	0.115	0.030
Total		3.04

Table 11. Masontown Flow Data

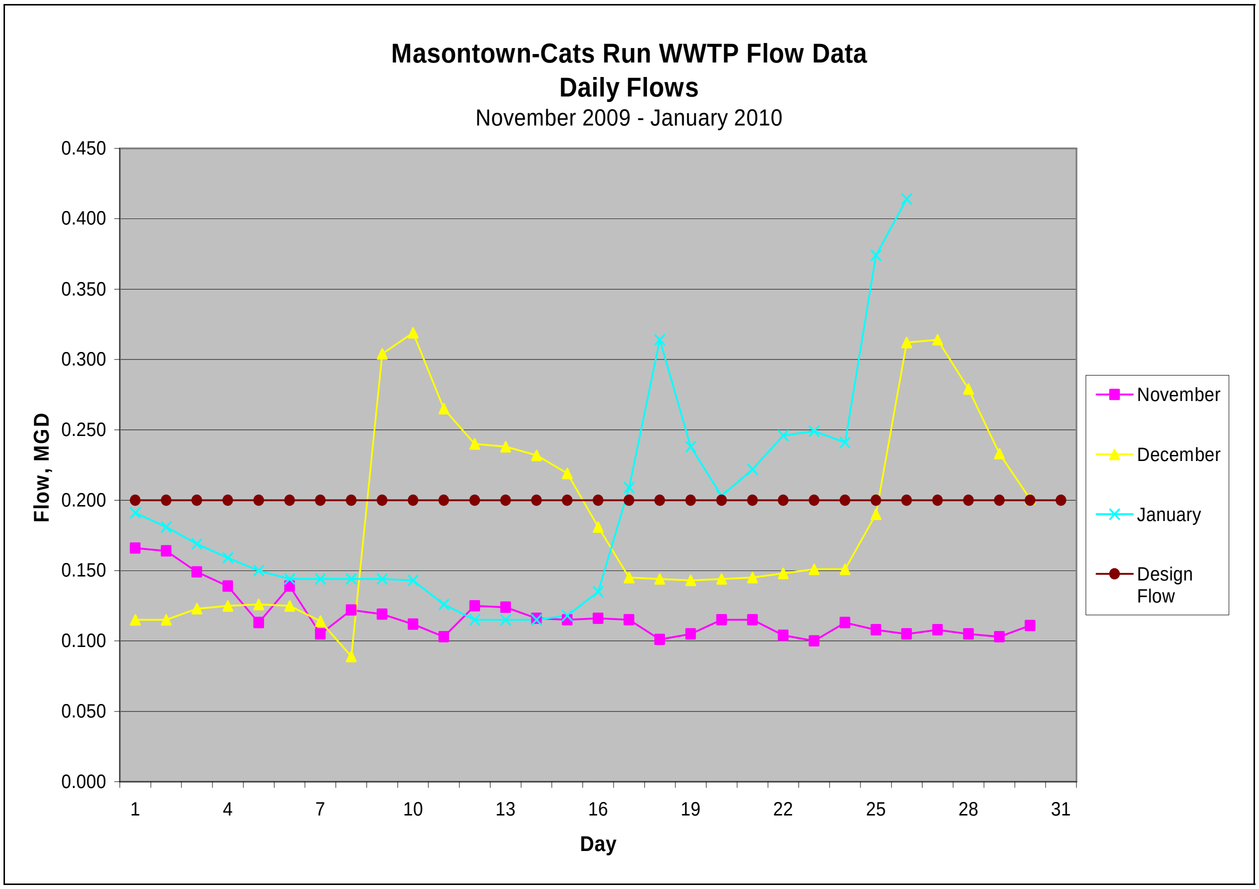

Figure 24.b. Masontown-Cats Run sewage treatment plant process flow schematic

Attachment G—Equipment Deployed

Continuous monitoring

Table of equipment

1 – Laptop computer with 485 to 232 signal converter
1 – SC1000
1 – LDO probe
1 – pH probe
1 – ORP probe
1 – NH_4D probe
1 – Nitratax probe
1 – Sonatax probe

Laboratory

Table of equipment

1 – Hach HQ40d handheld pH and LDO meter
1 – LBOD probe
1 – DR2800 spectrophotometer
1 – Raven centrifuge
1 – Raven Core Taker sampler
2 – Raven settleometers
1 – COD Heater Block
1 – Microscope with photographic/video capability

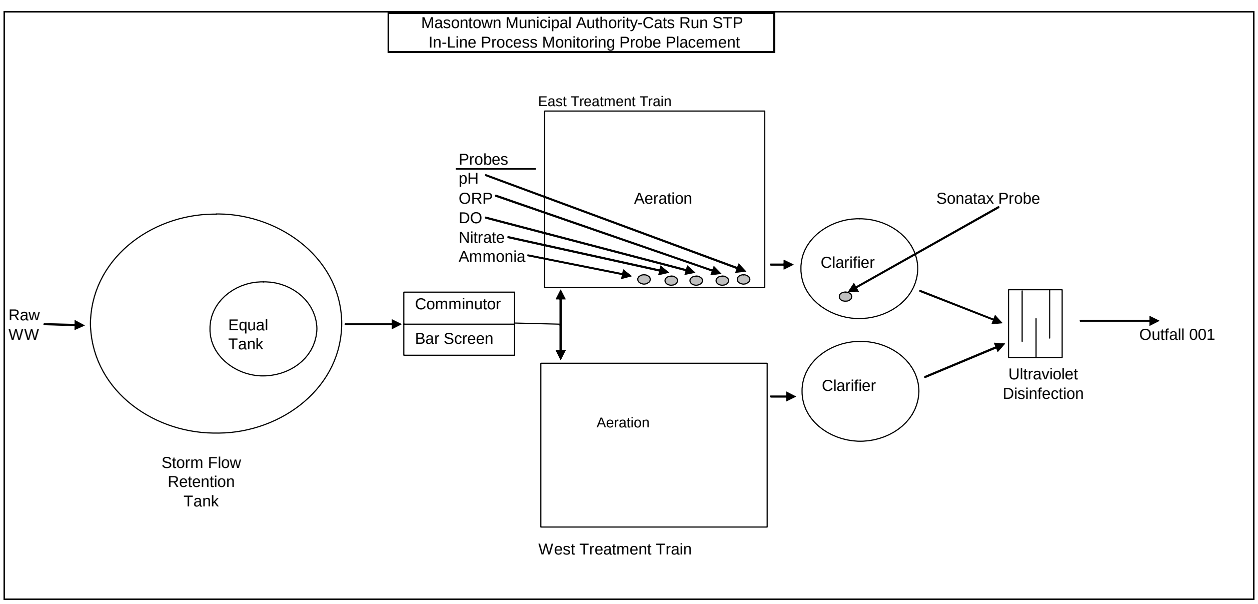

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Figure 25. Locations of on-line process monitoring equipment

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Attachment H— Process Control Test Results

Masontown- Cats Run STP
Bench Sheet

Date: 12/15/2009 Time:

Lab Tech: DiGilarmo

Raw Wastewater (INF)		
COD		mg/L
Total Flow	0.219	MGD
Flow to E- Aer	0.099	MGD
Flow to W- Aer	0.120	MGD
Influent TSS	84.00	mg/L

BOD	89.70	mg/L

Settleometer Data

Loc	W-Aer	W clar	W RAS	W WAS	E -Aer	E -Clar	E RAS	E WAS
Spin Solids	4.75		6.50		5.00		6.25	
Tank vol.	0.128	0.014			0.128	0.014		
SLU								

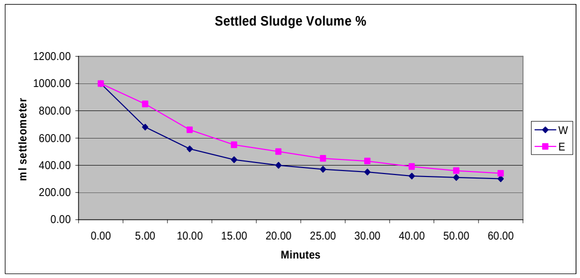
Loc	W-Aer	W-Aer	E-Aer	E-Aer
time	SSV	SSC	SSV	SSC
0.00	1000.00	4.75	1000.00	5.00
5.00	680.00	6.99	850.00	5.88
10.00	520.00	9.13	660.00	7.58
15.00	440.00	10.80	550.00	9.09
20.00	400.00	11.88	500.00	10.00
25.00	370.00	12.84	450.00	11.11
30.00	350.00	13.57	430.00	11.63
40.00	320.00	14.84	390.00	12.82
50.00	310.00	15.32	360.00	13.89
60.00	300.00	15.83	340.00	14.71

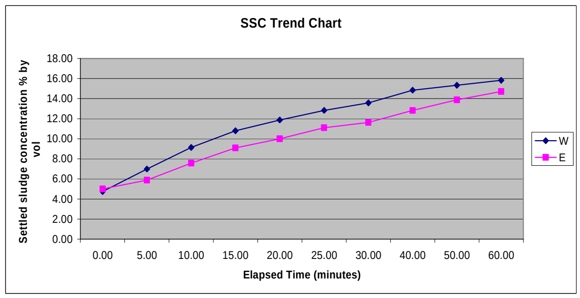
SSC=[(Spin%) x 1000] ÷ SSV

WCR=TSS ÷ Spin%

	W- Aer	E- Aer
TSS	4758.00	4896.00
WCR	1001.68	979.20
MLVSS	3744.00	3524.00
RAS solids	7270.00	7036.00
RAS flow, mgd		0.0800

	W-Aer		E-Aer		E-Clar	
SVI	73.56		87.83		490	gpd/sf, surface overflow rate
Sludge Age	60.19	days	75.70	days	43.38	lbs/day/sf, loading rate
HRT	25.50	hours	31.17	hours	3.29	hours
F/M Ratio	0.02		0.02			





RAS & WAS flow calculations:

	N RAS	N WAS	S RAS	S WAS
Time to fill bucket:				
Volume of Bucket:				
gal/min				
MGD				

Bench Tests	INF	W- Aer	E- Aer	W Clar	E Clar	Effl		
Nitrate		8.73	10.20					
Phosphate-P								
Ammonia-N		0.09	0.07					
Iron								
Chloride								
Ca+ hardness								
Aluminum								
Alkalinity								
Blanket Depth								

Notes: 0.10 0.08

clarifier loading rate assumes, RAS at 0.08 MGD (75% of forward flow through each treatment train)
clarifier loading rate incorrect if RAS solids is blank
clarifier surface area = 201 sq ft
More flow goes to the west side aeration than the east (assume 55/45 ratio)

Table 12. Masontown bench sheet

Masontown- Cats Run STP
Bench Sheet

Date: 12/15/2009 **Time:**

Lab Tech: DiGilarmo

OUR Testing

Location: E- Aer

OUR = slope x 60

slope = 1.48 / 10

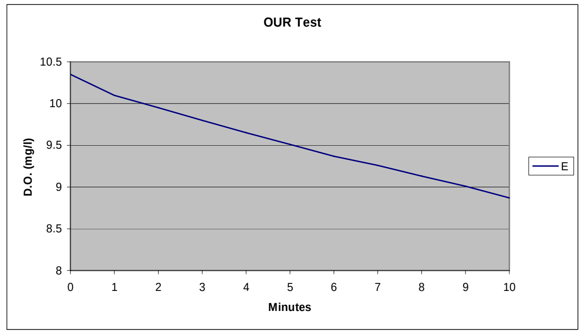
OUR = 1.48 / 10 x 60

OUR = 8.88

RR= (1000 x OUR) ÷ VSS
= 1000 / 3524.00 x 8.88

RR = 2.52

Time	D.O.
0	10.35
1	10.1
2	9.95
3	9.8
4	9.65
5	9.51
6	9.37
7	9.26
8	9.13
9	9.01
10	8.87



Location: W- Aer

OUR = slope x 60

slope = 1.35 / 10

OUR = 1.35 / 10 x 60

OUR = 8.1

RR= (1000 x OUR) ÷ VSS
= 1000 / 3744.00 x 8.1

RR = 2.16

Time	D.O.
0	10.29
1	10.17
2	10.03
3	9.89
4	9.75
5	9.61
6	9.48
7	9.36
8	9.23
9	9.1
10	8.94

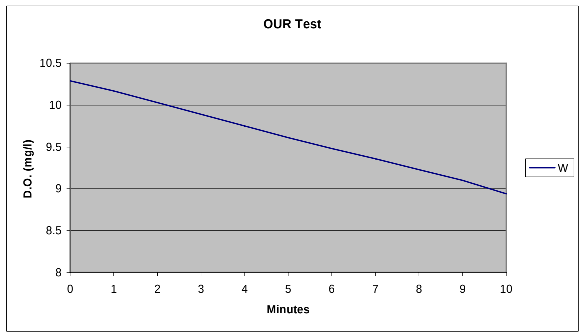


Table 13. Masontown bench sheet

Attachment I—Graphs: Monthly Monitoring Examples

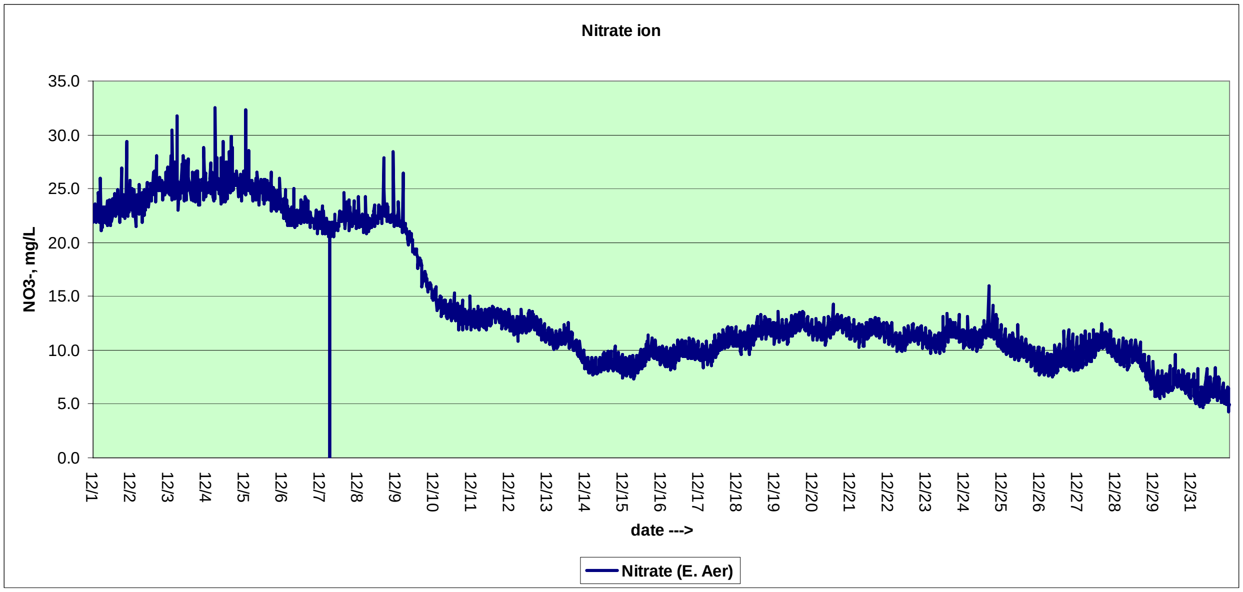


Figure 26. Nitrate values during the month of December 2009

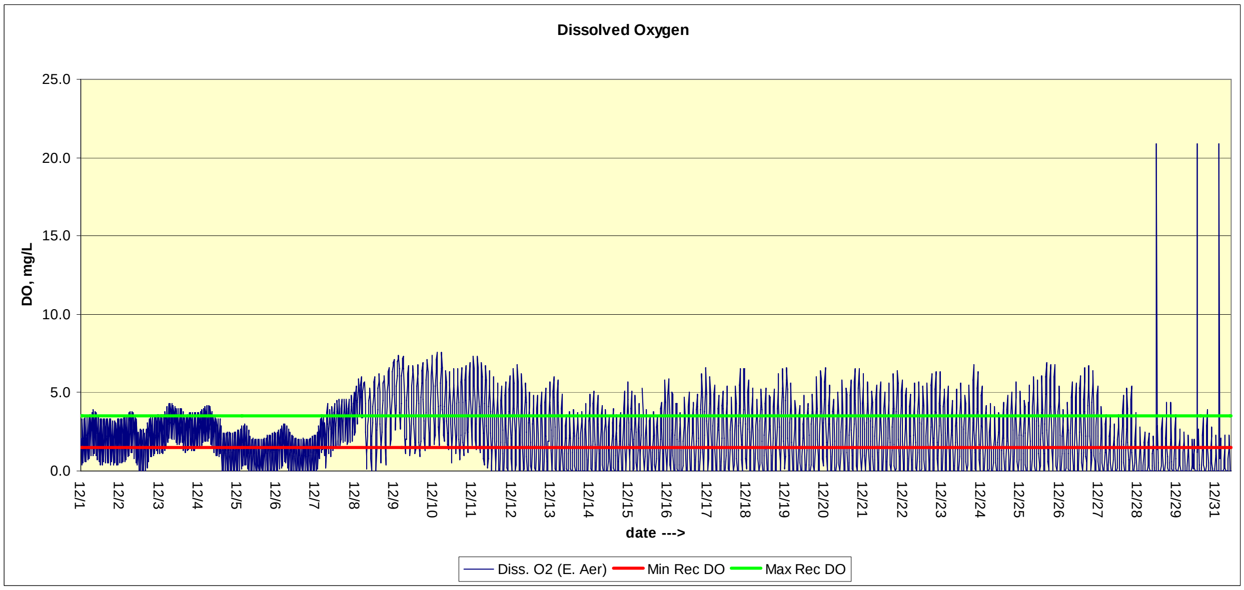


Figure 27. DO values during the month of December 2009

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Attachment J—Graphs: Daily Monitoring Examples

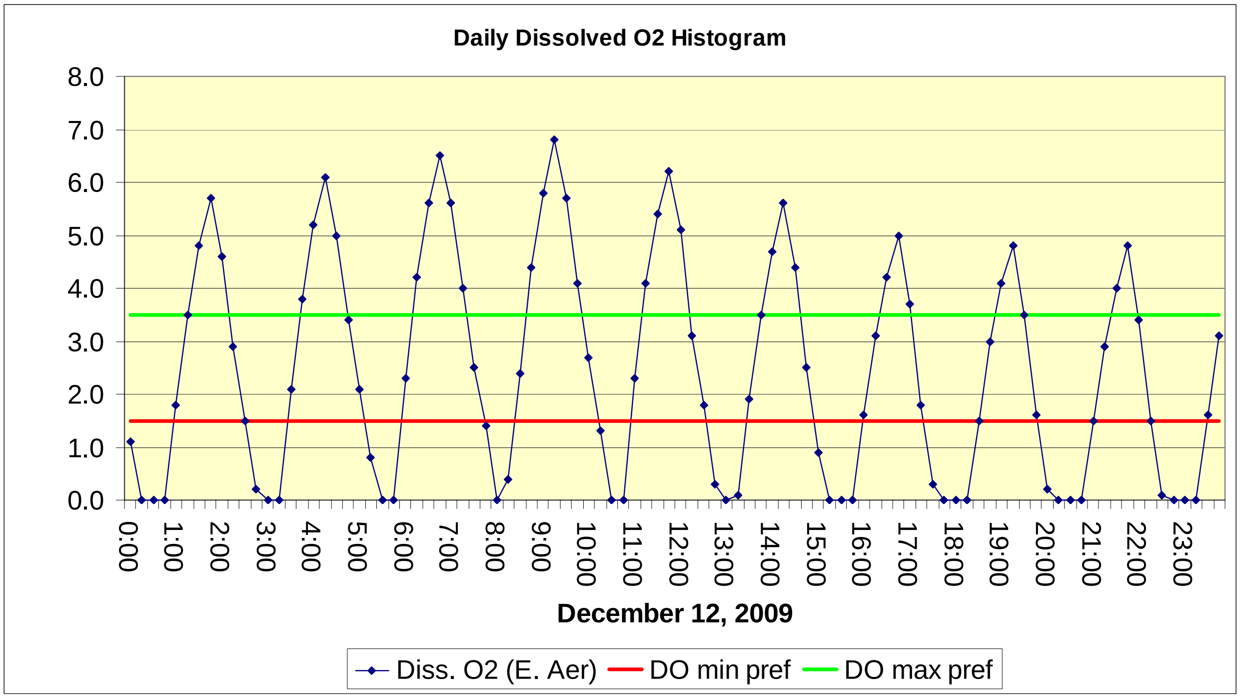

Figure 28. DO values, December 12, 2009

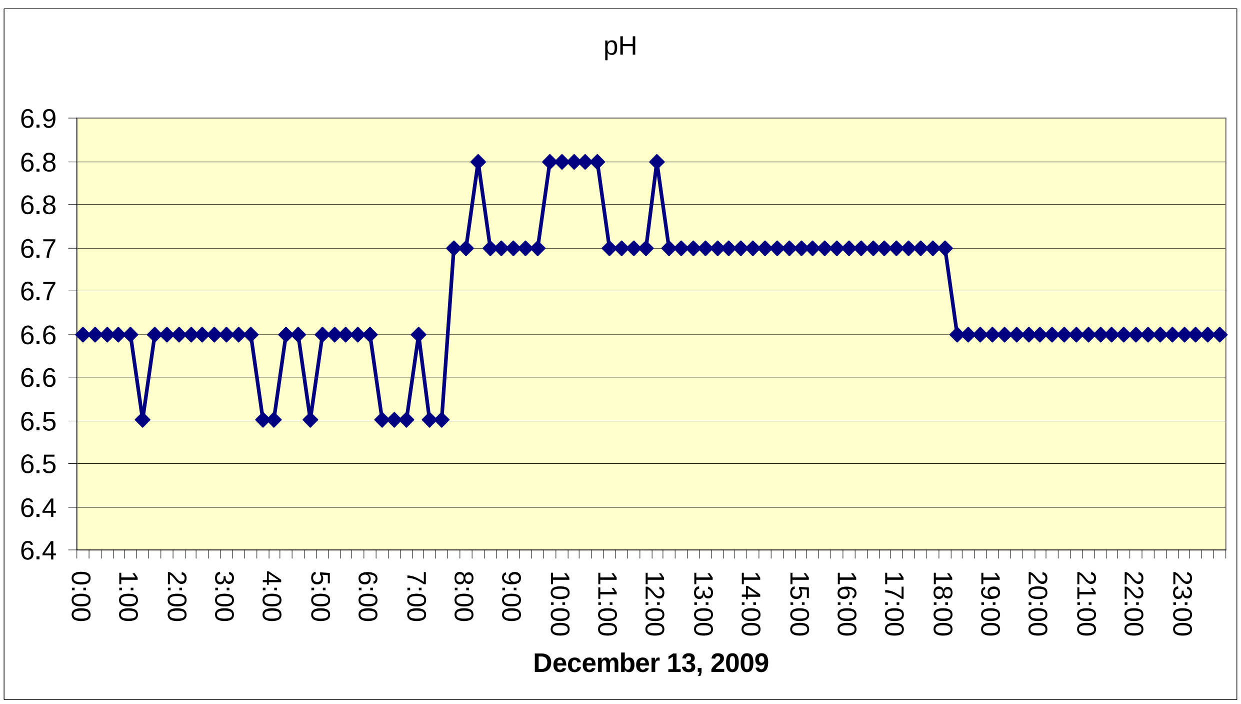

Figure 29. pH values, December 13, 2009

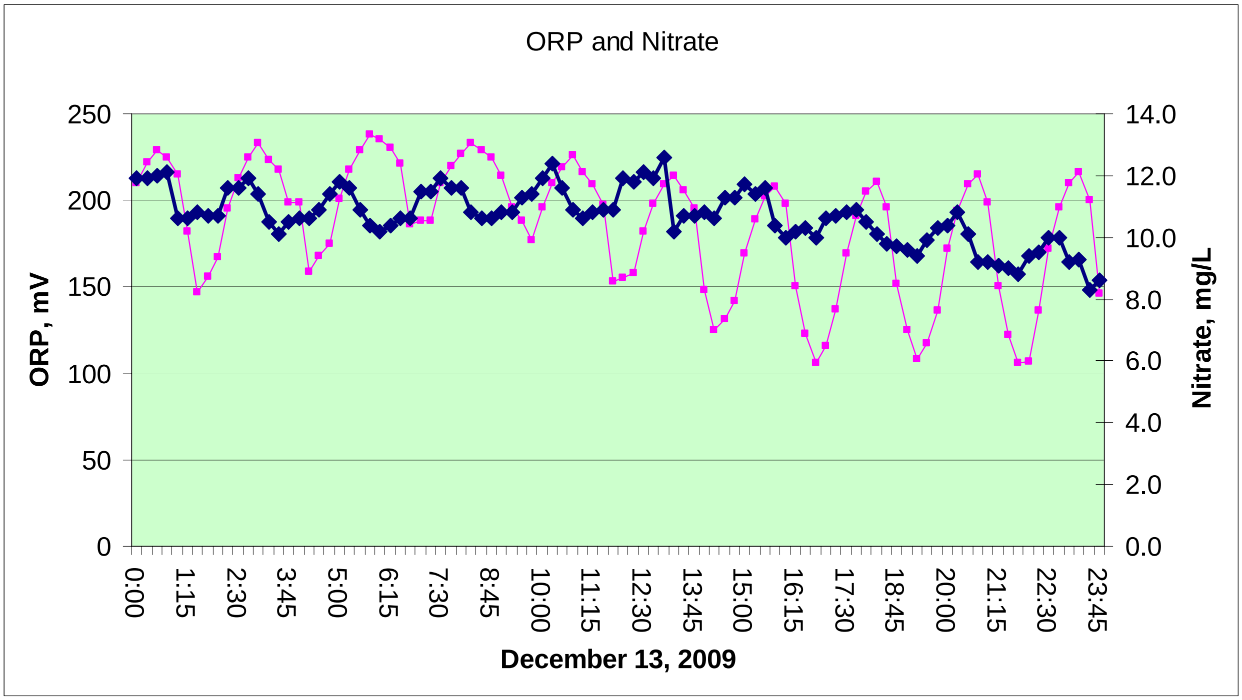

Figure 30. ORP and Nitrate values, December 13, 2009

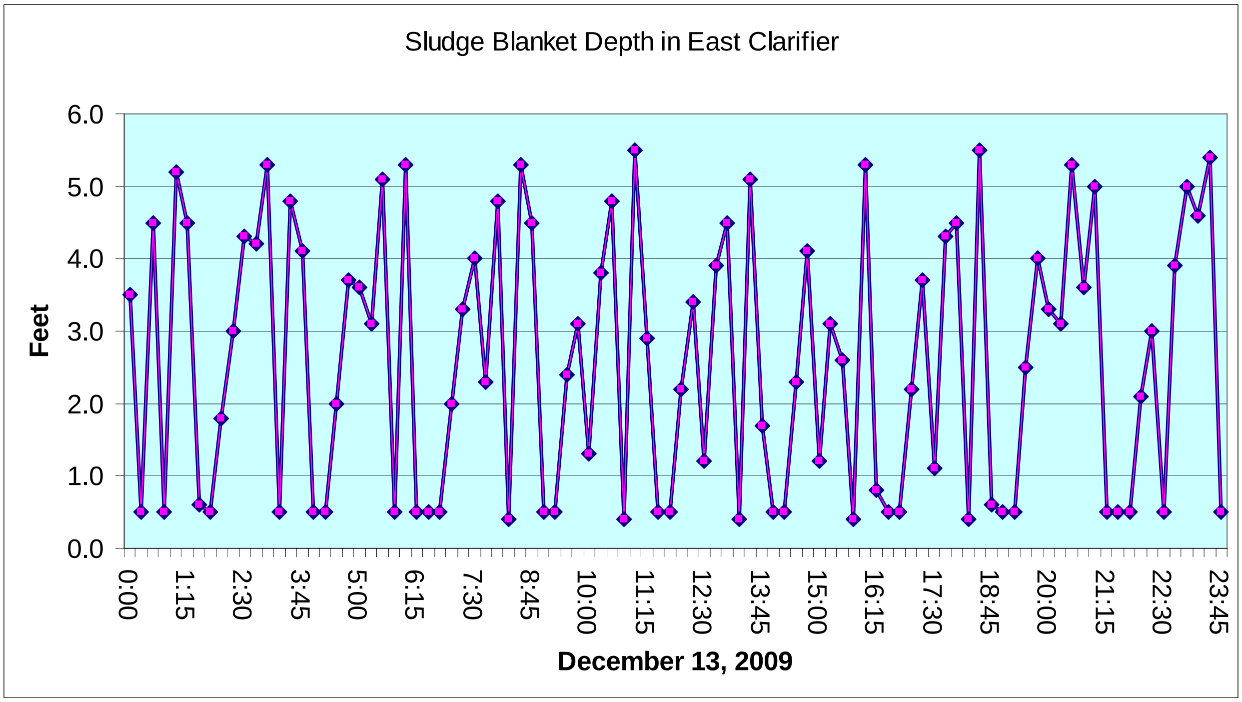

Figure 31. Sludge blanket depth in the east clarifier

Attachment K— Power usage

This example shows the duty cycle for aeration blower run times prior to the start of the WPPE. Power consumption estimate calculated utilizing 1 motor for each of the aeration, storm, and equalization tanks.

Motor Description	Motor HP*	Motor kw	Efficiency*	Virtual kW	Duty cycle* (hours/day)	Electricity charge* (¢/kwh)	Demand charge* ($/kw)
Storm water tank	30	22	92.4%	24	24	5.5	2.73
Aeration	15	11	91.0%	12	12	5.5	2.73
EQ tank	5	4	87.5%	4	24	5.5	2.73

	# of motors*	Annual kwh Cost	Annual Demand Cost	Daily Electricity Cost	Annual Electricity Cost
Storm water tank	1	**$11,670**	**$793**	$34	**$12,463**
Aeration	1	**$2,962**	**$403**	$9	**$3,365**
EQ tank	1	**$2,054**	**$140**	$6	**$2,193**
				DAILY	ANNUALLY
			Total Costs	*$49*	*$18,022*

Winter example where stormwater and EQ blowers run continuously

Table 14. Masontown power consumption estimate

This example shows a reduction in the duty cycle for aeration blower run times utilizing on/off aeration methods as modified over the course of the WPPE.
Power consumption estimate calculated utilizing 1 motor for each of the aeration, storm, and equalization tanks.

Motor Description	Motor HP*	Motor kw	Efficiency*	Virtual kW	Duty cycle* (hours/day)	Electricity charge* (¢/kwh)	Demand charge* ($/kw)
Storm water tank	30	22	92.4%	24	24	5.5	2.73
Aeration	15	11	91.0%	12	9	5.5	2.73
EQ tank	5	4	87.5%	4	24	5.5	2.73

	# of motors*	Annual kwh Cost	Annual Demand Cost	Daily Electricity Cost	Annual Electricity Cost
Storm water tank	1	**$11,670**	**$793**	$34	**$12,463**
Aeration	1	**$2,222**	**$403**	$7	**$2,625**
EQ tank	1	**$2,054**	**$140**	$6	**$2,193**
				DAILY	ANNUALLY
			Total Costs	*$47*	*$17,281*

Winter example where stormwater and EQ blowers run continuously

Cost savings by aeration blower running less saves approx $2/day or $730/year

Table 15. Masontown power consumption estimate

Attachment L—Equipment Placement Photographs

WPPE at
Masontown Municipal Authority-Cats Run STP

Figure 32. DO, ORP, and pH probes installed in east aeration tank

Figure 33. LDO, ORP, pH, and NH4D probes installed in east aeration tank

Figure 34. Nitrate, Ammonium, pH, LDO, and ORP probes installed in North aeration tank

Figure 35. Centrifuge, heater block, DR2800 setup area

Figure 36. Computer setup and equipment storage area

Figure 37. Outfall 001 at Cats Run