pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Point and Non-Point Source Management
Technical Assistance Program

ENHANCED TECHNICAL ASSISTANCE EVALUATION

Berlin Borough Sewage Treatment Plant

Berlin Borough, Somerset County

NPDES #PA0021822

The Pennsylvania Department of Environmental Protection (DEP) conducted an Enhanced Technical Assistance Evaluation (ETAE) of the Municipal Authority of the Borough of Berlin (Berlin) wastewater treatment plant (WWTP) from May through July 2012. An ETAE 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 nutrients in the final effluent, with an overall goal of improving surface water quality. The ETAE was performed by staff of DEP's Bureau of Point and Non-Point Source Management (BPNSM), Technical Assistance Section.

Berlin owns a sewage treatment plant (treatment plant) and collection system that serves the Borough of Berlin under National Pollutant Discharge Elimination System (NPDES) Permit No. PA0021822 (Berlin Borough Sewage Treatment Plant). The treatment plant is located in Berlin Borough, Somerset County and serves a primarily residential service area with one industrial user, Snyder of Berlin that contributes approximately 80% of the organic loading. Operations at the treatment plant are by contract operator.

The current treatment plant consists of a muffin monster/barscreen, four aeration tanks with mixing and sparge ring aeration, three final clarifiers, one chlorine contact tank, two primary sludge digesters, and two secondary sludge digesters. The treatment plant has a current design flow limit of 0.80 MGD and a design loading of 1,800 lbs/day of BOD. The treatment plant discharges into a Cold Water Fishery (CWF), Buffalo Creek, which is a tributary of the Ohio River Basin. The collection system does not contain any pump stations and was not part of this evaluation.

Operational Strengths

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

- Berlin Borough and its operators have made several improvements to the wastewater plant that were necessary to modify plant operations for nitrification and denitrification resulting in an average reduction of 91.5% Total Nitrogen with an average effluent Total Nitrogen of 4.5 mg/l.
- Modified operations at the wastewater plant are estimated to save at least $28,000 per year in electrical consumption.
- Operators have repaired plant sampling equipment and modified the sampling schedule to ensure accurate data is collected

Focus Points for Improvement

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

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

Medium- Minimal impact on plant performance on a repetitive basis

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

High:

- Berlin must continue their open communications with Snyder of Berlin to ensure that process changes at Snyder plant are relayed to the Berlin operator so needed process changes can occur quickly.
- To continue the current operational schema, Berlin should consider installing operational monitoring equipment similar to that utilized during the ETAE. Use of such equipment will allow the operators to accurately monitor and adjust the treatment process. Operating a treatment plant to reduce nitrate requires much more attention than a conventional activated sludge facility.
- Berlin should consider installing an alarm system to alert operators to various process conditions. A unit such as this could be combined with the equipment identified above to further automate and improve the treatment process efficiency.
- Repair of air lines leading to aeration basins
- During the ETAE, there were several instances of power loss at the plant. Power loss to the clarifiers led to plugging of the return lines in addition to loss of all aeration and return sludge flow. Several hours of continual power loss will lead to a loss of treatment and the need to report to the local DEP Clean Water Program inspector.[BKS1]

Medium:

- The Berlin operator should work with the engineer to identify and address issues with process piping at the plant that prevent efficient operations.
- Currently there are DO probes in the first two aeration basins. The probes appear to be out of calibration and the displays are inaccurate.
- Modification of the air delivery system to separate the aeration basins and primary digestors. This will allow the digestors to aerate while operating the basins in the modified settings for optimum treatment.

Low:

- The water lines that spray on the surface of the clarifiers should be adjusted to more effectively move the surface contents toward the skimmer hoppers

- The surface spray system for the aeration tanks is nearly inoperable. Any instance of foam in the aeration tanks cannot be controlled with the existing system.

Discussion

At the beginning of the ETAE, the Berlin treatment plant was being operated as an extended aeration treatment facility. In this fashion the treatment process is designed to remove ammonia from the effluent discharge. During the process of nitrification there is a reduction in pH and associated alkalinity as part of the conversion of ammonia to nitrate. Berlin was deficient of alkalinity and was to begin supplementing alkalinity with the installation of a magnesium hydroxide chemical feed system. In this manner they would be able to provide nitrification and maintain the balance of alkalinity and pH.

As part of the ETAE, Department staff reviewed the current operating data from the treatment plant and examined the treatment process, associated units, and available operating data. Upon review, the Department offered the operator the idea of operating the treatment plant in an on/off aeration configuration. This would provide nitrification, but then take the process further with denitrification. The treatment plant would realize the reduction in nitrates through denitrification and other benefits including the recovery of oxygen and alkalinity.

The existing treatment plant was designed with mixers and sparge ring diffusers for the introduction of air; both units can be operated independently. The ability to operate the mixing and aeration separately was key to experimenting with the on/off aeration schema. Upon beginning the ETAE the units were in a continuous aeration mode and were nitrifying well while adding supplemental alkalinity in the form of magnesium hydroxide. The process removed the ammonia but, as designed, resulted in high nitrate levels.

The next phase of the ETAE included the operator changing from continuous aeration to on/off aeration, two hours on and one hour off. The effect was rather immediate and reduced the nitrate levels to less than 5 mg/l. The nitrification process itself is fueled by a soluble carbon source; in this instance the high organic BOD loading of the Snyder wastewater.

The Snyder pretreatment system includes starch reduction facilities, a dissolved air flotation unit for solids removal, and a lagoon for the reduction of BOD. Since the treatment plant was being operated for nutrient reduction, the carbon source was desirable to fuel the denitrification process. Therefore, the Department suggested that Berlin’s operator request Snyder’s to cease operating the lagoon, used to reduce Snyder’sBOD, and send the wastewater from the starch and DAF units directly to the treatment plant. With this modification to the Snyder treatment process, Snyder’s has reduced electrical costs, by not aerating its treatment lagoon, and Berlin has improved effluent quality by using Snyder’s wastewater as a carbon source. There have been minimal undesirable events under normal operating conditions.

The extended aeration process with periods of anoxic conditions is expected to operate well both during the summer months and throughout the colder months, with operator modifications to the treatment process. Generally, in order for operators to maintain treatment during the colder weather they increase the Mean Cell Residence Time (MCRT) and MLSS levels; this is due to the reduced growth rate of the bacteria at colder temperatures. In addition, over the winter months, while treatment is more complicated and demands more attention, the NPDES effluent limits for Ammonia are relaxed (see permit limits in Appendix G).

The facility already has long Hydraulic Retention Times (HRTs) and MCRTs compared to expected values. The average HRT over the course of the evaluation was 41 hours and the average MCRT was 43 days. The MCRTs were estimated using the measured value for MLSS and assuming 75% volatile solids. The RAS volatile solids were measured during the Jun 28 sampling event and comparative ratios were used to estimate the other sample results. The long MCRTs improve treatment and will certainly help during colder weather. The winter MCRTs may be even higher when MLSS levels are increased and would be conducive to maintaining the same level of treatment as that of the summer months.

Oxidation Reduction Potential—Also referred to as ORP, measures the ability of the wastewater to oxidize waste material. The ORP levels at Berlin ranged between -445 mv to 280 mv. While some values were lower than expected, none caused the process to enter an anaerobic state. The negative values generally indicate periods of anoxic activity favorable to denitrification while the positive values generally represent aerobic conditions. Monitoring ORP is essential for denitrification operations.

Energy Consumption—During the ETAE several procedures were enacted to reduce electrical usage and costs. In wastewater plant operations, electricity is usually the largest cost. After monitoring the DO levels for a period of time, it was determined that the levels were much higher than necessary over the night time hours, 6.0-7.0 mg/L. (Excessive over aeration can lead to floc shear and poor settling.) The blower run times were modified to provide periods of aerobic conditions and anoxic conditions with the use of a timer. Current settings are two hours on and one hour off. This on/off aeration provides approximately eight hours of off aeration over the course of the day. This is approximately 1/3 of the aeration blowers' previous usage. The spreadsheets in Appendix G identify the cost breakdown for each motor based on the original and modified operations schema.
The overall energy savings as a result of the ETAE is estimated to be nearly $28,000 per year.

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, please contact the DEP regional office that supports your wastewater facility prior to making any modifications.

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 Enhanced Technical Assistance Evaluation is to reduce nutrients in wastewater plant discharges. This often times involves permittees achieving effluent quality above and beyond any permit requirements.

Attachment A— ETAE Team

Borough of Berlin Wastewater Treatment Plant

ETAE Team

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

Thomas J. Brown, Water Program Specialist
DEP – Ebensburg Office
286 Industrial Park Rd
Ebensubrg, PA 15931
814-472-1878
thbrown@pa.gov

Municipal wastewater plant representatives

Mike Garrity, Operator
Municipal Authority of the Borough of Berlin
700 North Street
P.O. Box 115
Berlin, PA 15530-0115

Chet Cyga, Operator
Municipal Authority of the Borough of Berlin
700 North Street
P.O. Box 115
Berlin, PA 15530-0115

Attachment B— Plant Description and Treatment Schematic

Berlin currently operates an activated sludge treatment plant capable of being operated in several different modes including: contact stabilization, step feed, and extended aeration. It is currently being operated in the extended aeration mode utilizing on/off aeration with periods of mixing for reducing of nitrate in the treated effluent.

Operations—Berlin retains the services of a contract operating firm for daily operations and maintenance of the treatment plant.

Headworks—The headworks include a muffin monster and manual bar screen prior to the aeration basins.

Influent Sampling—The influent samples were collected manually by grab sample. This does not allow for accurate representation of influent BOD strength which is necessary for optimum plant operation and reporting in the Department's Annual Wasteload Management Report (Chp 94 Report). During the ETAE the operator was able to repair a composite sampler which will be utilized to collect 24 hour composite samples.

Aeration—There are four aeration tanks, with a total approximate capacity of 0.58 MG. Submerged mixers and sparge ring diffusers provide both air and mixing in the aeration basins. These units have the capability of being operated separately which was the main process modification occurring during the ETAE and allowed for the reduction of nutrients in the effluent. With the installation of a simple timer, the operator was able to cycle the blower motors on and off to provide for periods of aerobic and anoxic conditions. This process is a key step in allowing nitrification and denitrification to occur.

Clarifiers—There are three clarifiers, two original units and one newer unit. All three units operate utilizing draft tubes for the return activated sludge. One of the original units routinely clogs and causes additional work for the plant operator. The operator is currently returning sludge from the newest clarifier utilizing the waste sludge line at the bottom of the clarifier which is working well according to the operator. The spray lines on the clarifier surface should be adjusted to direct flow to the skimmer hoppers instead of pointing straight down. The operator and/or authority would have to work with the engineer to evaluate the piping system for modifications prior to changing the methods used to return sludge in the older clarifiers.

Disinfection—The disinfection process is achieved utilizing gas chlorination. This system appeared to be effective and was not evaluated.

Discharge—Final effluent flows from the chlorine contact tank and V notch weir to its discharge location at Buffalo Creek. The operator uses a 24hour composite sampler to collect effluent samples and was also used during the ETAE. Effluent samples are now collected on days which provide representative sampling.

Solids Handling—Solids are wasted from the clarifiers to sludge digestors. There are two sludge digestors with a total capacity of approximately 126,000 gallons. Solids are pumped from these digestors to two secondary tanks before being dewatered in a belt filter press. Piping constraints limit operational changes while pressing sludge solids. The operator and authority should work with the facility engineer to fully identify and address these issues that complicate pressing, wasting, and returning sludge. Maintaining an appropriate mass balance of sludge in the treatment process is the most elemental job of the operator.

Performance Track Record: Past Performance—The plant has experienced violations over the past 18 months including Total Suspended Solids, and Fecal Coliform.

Current Performance—As of the completion of the ETAE, the facility is currently meeting all permitted effluent limits and reducing Total Nitrogen to approximately 4.5 mg/l. Several process modifications including the modification of the aeration and mixing cycles were key aspects of the plants operational improvements.

Attachment C— Equipment Deployed

Digital, Continuously Monitoring Probes

Laboratory Equipment On-Loan

Digital, Continuously Monitoring Probes:

1 – Laptop computer with signal converter, 2 – SC1000s, 2 – LDO probes, 1– pH probe,

2 – ORP probes, 1 – NH_4D, 1 – Nitrate Probe, 1 – Solitax probe

Laboratory Equipment On-loan:

1 – Hach HQ40d handheld pH and LDO meter, 1 – DR2800 spectrophotometer, TNTplus test vials for measuring Nitrate-LR, Ammonia-LR, Alkalinity, Digital Reactor Block, Phosphorus-Total-HR

Figure E.1 Locations of ORP probes and SC1000

Attachment D— Continuous Digital Monitoring Charts

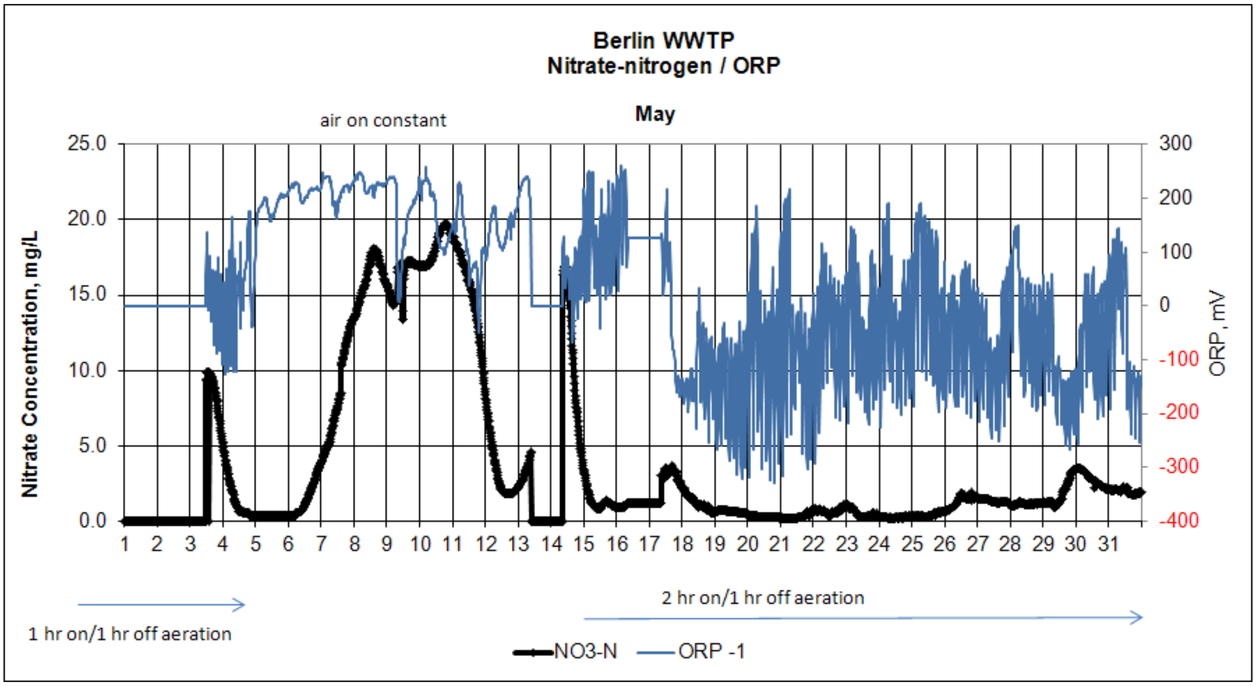

Figure G.1: This figure shows how on/off aeration is necessary for the reduction of nitrate and therefore Total Nitrogen in the effluent. While the aeration is on, nitrification is occurring and upon cycling the air off, denitrification can occur which reduces the nitrate levels.

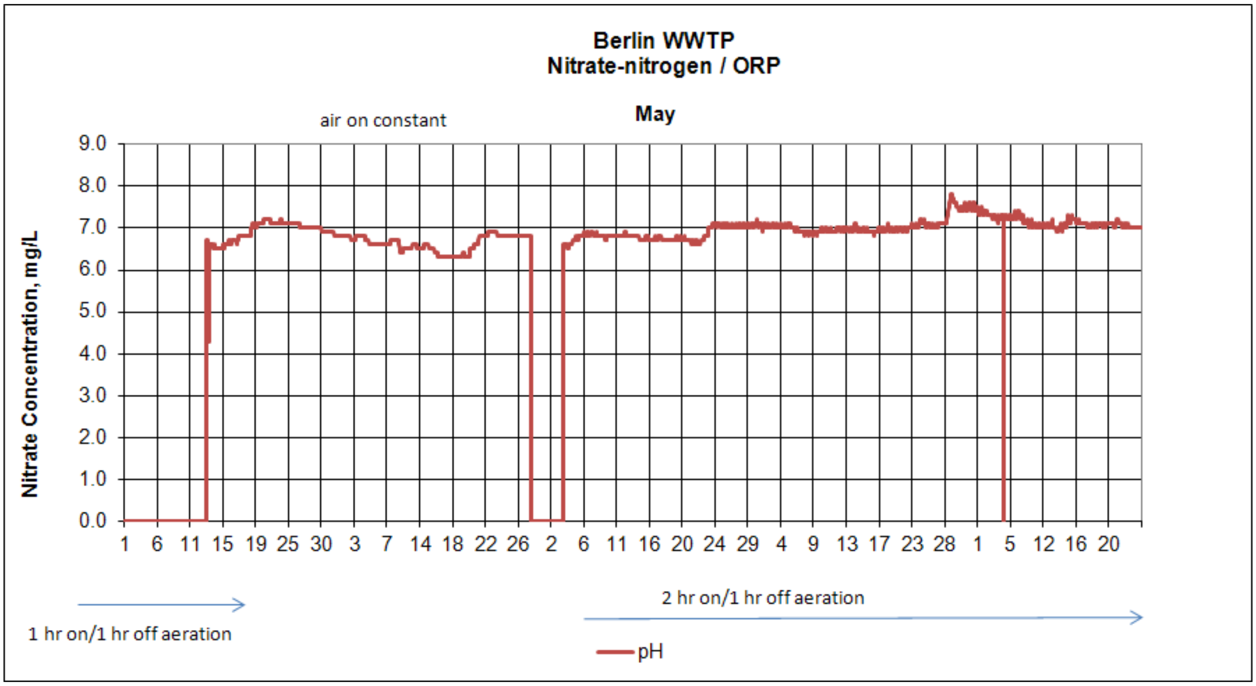

Figure G.2: This figure identifies the need for supplemental alkalinity while nitrification is occurring. Upon beginning the on/off aeration and establishing effective denitrification, the pH recovers and the need to supplement alkalinity is negated.

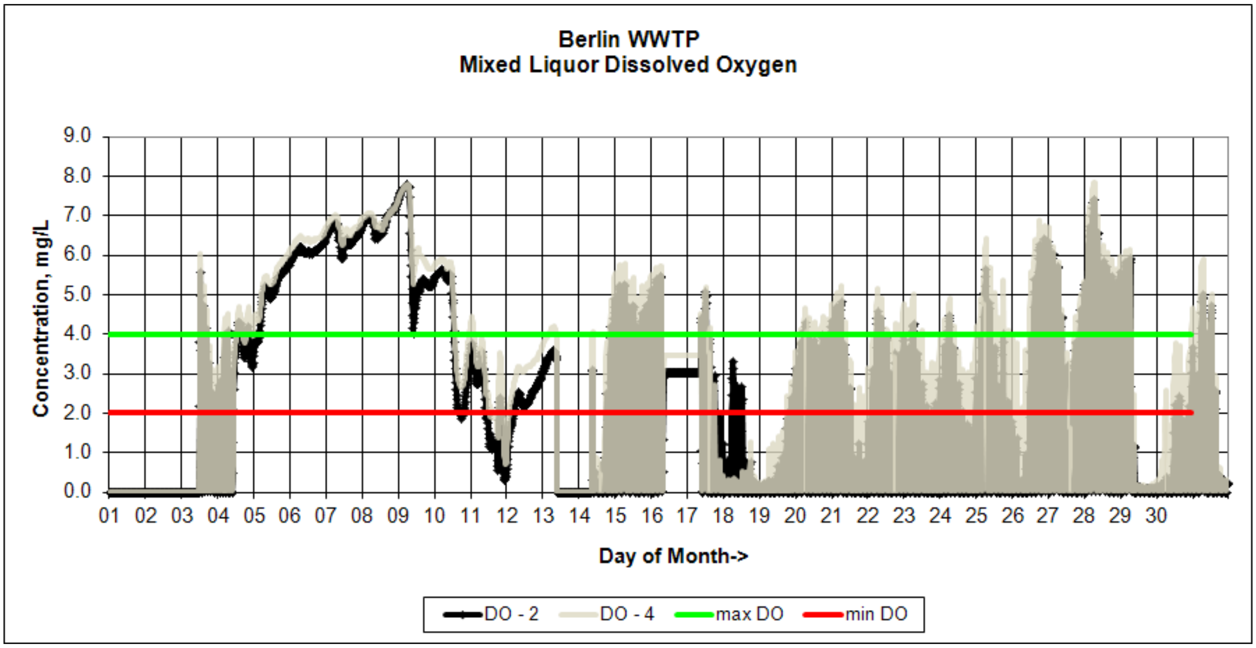

Figure G.3: The Dissolved Oxygen data shows the effects of continual aeration from the 4th to the 10th. The DO levels climbed to excess levels, above 4 mg/L which utilizes energy but does not provide additional treatment. The aspects of on/off aeration limits the excess DO levels and could also be controlled better with DO process monitoring equipment tied back to the blower units.

Attachment E—Tables of Data from Bureau of Labs Testing

The following tables summarize all sample data collected during the ETAE.

Berlin Boro Samples

Date	Sample Type	BOD	TSS	NH3	TKN	TOT N	Phos	NO2	NO3	Alk	pH	Chloride	VSS
24-May	Inf-comp	1144	886	19.87	63.08	63.13	4.395	*0.01*	*0.04*	187	6.9	88	
	Eff-grab	4.4	10	2.01	2.19	2.24	0.952	*0.01*	*0.04*	130.6	7.9	70	
31-May	Inf-comp	1067	1628	20.78	72.37	72.42	4.975	*0.01*	*0.04*	185.6	6.9	95	
	Eff-comp	36.5	52	2.83	8.61	8.71	1.431	0.02	0.08	138.6	8.0	65.9	
20-Jun	Inf-comp	230	390	15.75	34.93	34.98	3.201	*0.01*	*0.04*	149.4	7.0	66.6	
	Eff-comp	3.4	14	0.22	1.8	4.75	0.173	0.06	2.89	104.8	8.0	56	
28-Jun	Inf-comp	670	892	24.46	46.7	46.75	4.487	*0.01*	*0.04*	179.6	7.0	63.1	
	Eff-comp	5.8	8	0.51	2.1	2.3	1.098	0.02	0.18	127.4	8.0	56	
	MLSS		4960							193.4			4094
	RAS		5130										4524

Sample results in italics are at MDL

Table J.1: DEP, BOL testing results

Attachment F—Electrical Costs / Power Savings

Motor Description	Motor HP*	Motor kw	Efficiency*	Virtual kW	Duty cycle* (hours/day)	Electricity charge* (¢/kwh)	Demand charge* ($/kw)
Aeration tank Blower	150	112	92.4%	121	24	8.0	
Return sludge	15	11	89.5%	13	24	8.0	0.00
Waste Sludge	10	7	92.0%	8	2	8.0	0.00
Sludge Press	7.5	6	90.2%	6	2	8.0	0.00
	# of motors*	Annual kwh Cost	Annual Demand Cost	Daily Electricity Cost	Annual Electricity Cost		
Aeration tank Blower	1	**$84,870**	**$0**	$233	**$84,870**		
Return sludge	1	**$8,762**	**$0**	$24	**$8,762**		
Waste Sludge	1	**$474**	**$0**	$1	**$474**		
Sludge Press	1	**$362**	**$0**	$1	**$362**		
0	1	**$0**	**$0**	$0	**$0**		
0	1	**$0**	**$0**	$0	**$0**		
				DAILY	ANNUALLY		
			Total Costs	***$258***	***$93,994***		

Figure L.1 Estimated annual electrical costs for blower motors based on original plant operations prior to the ETAE

Motor Description	Motor HP*	Motor kw	Efficiency*	Virtual kW	Duty cycle* (hours/day)	Electricity charge* (¢/kwh)	Demand charge* ($/kw)
Aeration tank Blower	150	112	92.4%	121	16	8.0	
Return sludge	15	11	89.5%	13	24	8.0	0.00
Waste Sludge	10	7	92.0%	8	2	8.0	0.00
Sludge Press	7.5	6	90.2%	6	2	8.0	0.00
	# of motors*	Annual kwh Cost	Annual Demand Cost	Daily Electricity Cost	Annual Electricity Cost		
Aeration tank Blower	1	**$56,580**	**$0**	$155	**$56,580**		
Return sludge	1	**$8,762**	**$0**	$24	**$8,762**		
Waste Sludge	1	**$474**	**$0**	$1	**$474**		
Sludge Press	1	**$362**	**$0**	$1	**$362**		
0	1	**$0**	**$0**	$0	**$0**		
0	1	**$0**	**$0**	$0	**$0**		
				DAILY	ANNUALLY		
			Total Costs	***$180***	***$65,704***		

Figure L.2 Estimated annual electrical costs for blower motors based on modified plant operations as a result of the ETAE. Estimated yearly cost savings of $ 28,000.00.

Attachment G—NPDES Effluent Discharge Limits

Berlin Borough Sewage Treatment Plant
NPDES PA0021822

Discharge Parameter	Effluent Limitations						Monitoring Requirements	
	Mass Units (lbs/day)		Concentrations (mg/L)					
	Average	Maximum	Minimum	Monthly Average	Weekly Average	Maximum	Minimum Measurement Frequency	Required Sample Type
$CBOD_5$ (05/01 – 10/31)	100.0	150.0		15	22.5	30	1/week	8-hr comp
$CBOD_5$ (11/01 – 4/30)	167.0	250.0		25.0	37.5	50	1/week	8-hr comp
Total Suspended Solids	200.0	300.0		30.0	45.0	60.0	1/week	8-hr comp
Ammonia – N (05/01 – 10/31)	20.0	30.0		3.0	4.5	6.0	1/week	8-hr comp
Ammonia –N (11/01 – 04/30)	50.0	75.0		7.5	11.3	15.0	1/week	8-hr comp
Total Residual Chlorine				0.1		0.3	30/month	Grab
Dissolved Oxygen			6.0				1/week	Grab
pH			6.0			9.0	1/week	Grab
Fecal Coliform 5/1 - 9/0			200/100 ml as a geometric average, not greater than 1,000/100 ml in more than 10% of the samples tested				1/week	Grab
10/1 - 4/30			2000/100 ml as a geometric average				1/week	Grab

Table M.1. BERLIN NPDES effluent limitations