NYSERDA FLEXTECH REPORT

COUNTY OF ONONDAGA

CFA# 11528, Brewerton WWTP

October 23, 2012

Contents

APPENDICES

SECTION 1: EXECUTIVE SUMMARY

Johnson Controls (JCI) and CDM Smith (engineering consultant) surveyed the Brewerton Waste Water Treatment Plant (WWTP), owned and operated by the County of Onondaga, relative to the energy saving potential of separating the blower systems for aeration and digesters and adding DO controls. Recommended changes included new variable speed turbo blowers for the aeration tanks, new variable speed, positive displacement (PD) blowers for the digesters, and DO and level controls. 760,823 kWh of electric savings and average of 158 kW peak demand savings were identified, for a total annual operating savings of $82,539. Implementation cost for the proposed measures is estimated at $2.5M with a simple payback of 30.0 years. This measure replaces aging equipment as well as saving energy. It should be considered as part of an overall plant rehabilitation project where there is additional opportunity to save energy through equipment upgrades and process modification.

SECTION 2: BACKGROUND

Onondaga County manages over 200 facilities consisting of libraries, stadiums, public colleges, civic centers, county offices, police stations, correctional facilities, a justice center, a forensic science center, a public safety center, a convention center, municipal parking garages, recreation centers, wastewater treatment facilities, and water treatment and pumping facilities. In 2003, the County contracted with an Energy Services Corporation (ESCO) to audit and implement energy-related capital improvements at 25 of the County's largest energy consuming facilities for which NYSERDA provided Technical Assistance (Flex Tech) incentives. These energy audits identified numerous energy efficiency and conservation measures (ECMs) including; lighting replacements, motor replacement, variable speed drive installations, and HVAC controls upgrades.

In 2011 a lighting audit was performed on 13 of the County buildings for which an application for NYSERDA Flex Tech incentives was submitted.

And currently the County is using FlexTech incentives to fund retro-commissioning at several of its facilities. The Jamesville Maintenance Facility is among those.

As a part of Onondaga County's American Recovery and Reinvestment Act, Energy Efficiency and Conservation Block Grant, this project will perform Energy Audits of County facilities not previously audited in 2003 and will not include lighting measures. The facilities to be included in this PON 1746 Scope of Work were not a part of the 2003 energy audit either because they were not one of the 25 largest County energy consuming facilities or because the facility had not been constructed or was not commissioned or operational at the time. A complete listing of facilities is given below.

Brewerton WWTP

2011 Energy Use

						2011 ELECTRIC								
Dept.	Description	Floor Area (ft2)	$/yr	Btu/yr	Btu/sf/yr	Account #	Service Class	Elec. Use (kWh)	Elec. Use Cost	Avg. Use Rate	Avg. Demand (kW/mo)	Avg. Demand Charge ($/mo)	Avg. Demand Rate ($/kW)	Total Elec. Cost
WEP	Brewerton WWTP, Guy Young Road, Brewerton, NY 13029 (315) 676-3432	16,470	$370,952	10,538,060,712	639,834	42376-06105	SC3	3,087,624	$270,782	$ 0.088	525	$ 8,348	$ 15.90	$ 370,952

Electric account is with National Grid and the County pays a system benefits charge. There are no fossil fuels used at this site.

SECTION 3: PROJECT DESCRIPTION

Provide engineering services for preliminary design of aeration system upgrades at the Onondaga County Brewerton Wastewater Treatment Plant (WWTP). The project tasks will focus on analyzing the existing plant data and determining process modifications necessary to improve the energy efficiency of the existing aeration systems. The work at the Brewerton WWTP will be limited to evaluating options for improving energy efficiency of the blowers and controls, which supply air to the aeration, digestion and sludge thickening processes. The objective of this phase of the work is to identify the appropriate improvements to the aeration processes and generate a preliminary design package that can be used to estimate the construction cost of the upgrades and be used as the basis for final design.

TASK #1 WWTP DATA GATHERING, ANALYSIS & DEVELOPMENT OF THE BASIS OF DESIGN

Scope: Conduct a data analysis of the 2008 to 2010 WWTP Discharge Monitoring Reports (DMRs) and available process control data. It is assumed that primary effluent BOD, TSS, ammonia, nitrogen and phosphorous concentrations and dissolved oxygen levels and MLSS concentrations in the aeration tanks are available as well as solids concentration of the sludge in the digester and thickened sludge holding tank. These data will be used as the basis of design, along with daily and monthly flow rates from the DMRs to generate loadings to the aeration systems at the Brewerton WWTP.

Review available WWTP operating procedures for the aeration system and develop control logic which will serve as the basis of design for the dissolved oxygen systems. Available as-built drawings or construction specifications will be reviewed to identify existing equipment, sizes, layouts, locations and other pertinent design information.

Perform a site visit to the WWTP to confirm the general configuration of equipment and space available for new equipment. Detailed measurements to confirm the accuracy of existing as-built drawings will not be performed at this time.

TASK #2 PRELIMINARY BLOWER DESIGN FOR THE BREWERTON WWTP

Scope: Based on the data analysis above, determine preliminary sizing and layouts of the blowers necessary to replace the existing equipment at the Brewerton WWTP. Work will include an evaluation of blower technologies and sizing of the recommended blowers. Preliminary layouts of the blowers, piping, valves and appurtenances will be prepared. Modification of the existing blower system will be evaluated. The work will be limited to the following:

1. Installation of four new blowers with VFDs and a PLC based dissolved oxygen (DO) control system, including the following evaluation

a. Evaluate a separate blower and air delivery system to the digesters and sludge holding tank and a separate system for the aeration tanks
b. Evaluate two types of blower technologies (high speed turbo and positive displacement) or a combination of the blower technologies using capital costs and estimated energy savings as the guidelines for performing the evaluation.

The design will be limited to the sizing of an equipment maintenance pad suitable for mounting the blowers, pipe modifications to split air flow between aeration tanks and digester/sludge holding tanks, and valves or other appurtenances necessary to accommodate the new blowers.

The electrical system will be analyzed to determine a methodology for supplying power to the new aeration blowers. Suitability of reusing an existing MCC will be evaluated and power requirements to the blowers will be established.

During final design, which is outside this scope of work, it will be necessary to analyze the power system to determine if changes to the generator startup sequence will be required and to verify that the plant's utility power supply is adequate for any additional load.

TASK #3 UTILITY ANALYSIS AND SAVINGS

Scope: Historical utility data will be gathered and analyzed. Existing equipment use patterns will be used to create a model that matches the historical usage and demand. The replacement equipment and control sequence will be utilized to modify the model for the post retrofit condition and the consumption of the two scenarios compared.

TASK #4 DISSOLVED OXYGEN CONTROL SYSTEM AT THE BREWERTON WWTP

Scope: A site inspection will be performed to determine whether the existing air distribution piping is consistent with available as-built or construction drawings. Locations for dissolved oxygen probes and motor operated control valves will be identified. Routes for power and control wiring will also be identified. System controls will be analyzed at the conceptual level in terms of the number of dissolved oxygen probes and whether a cascade or parallel flow control algorithm will be used.

The SCADA interface will be used for monitoring the blower system and providing a dissolved oxygen setpoint. All other control will be resident in the blower control package, except where the existing blowers will continue to be used. A new master control panel will be installed for control of the existing blowers.

TASK #5 PRELIMINARY PROJECT COST ESTIMATES

Scope: Upon completion of the preliminary design, a quantity takeoff and cost estimate will be prepared of equipment, piping, valves and associated appurtenances. Quotes for equipment and materials suppliers will also be included for backup of the project construction cost.

Scopes of work write-ups will be prepared for specific trades and packaged with the preliminary layouts and equipment cuts for Contractor walk-thrus for cost proposals.

CDM Smith will also prepare a proposal for professional engineering services for preparation of the final design, NYSDEC review/permitting assistance and services during construction. Scope and budget allowances will be included where the final design and construction scope cannot be fully identified.

Meetings

Two meetings or workshops with the County will be attended by project staff from JCI as well as the consultant. It is assumed that the project manager will attend each meeting and specialty staff will be required for only one of the meetings. Two meetings or conference calls are included for the purposes of coordinating work efforts of JCI and CDM Smith for the purposes of developing the preliminary design and developing the scope and budget for the final design and construction phases of the work.

SECTION 4: PROJECT RESULTS AND RECOMMENDATIONS

TASK #1 WWTP DATA GATHERING, ANALYSIS & DEVELOPMENT OF THE BASIS OF DESIGN

General

A data analysis was performed to estimate the oxygen requirements for process air and mixing for the aeration system, digesters and thickened sludge holding tank at Onondaga County's Brewerton Wastewater Treatment Plant (WWTP) as part of the blower evaluation project. This information was be used to evaluate the replacement of the existing four blowers with new blowers. Flow, BOD5, TSS and TKN were evaluated using WWTP operational data from January 2008 through February 2012. The oxygen air requirements were estimated for average, maximum month and maximum day (95^{th} percentile) loading conditions from this data. As the WWTP does not have primary clarifiers, the raw wastewater is conveyed directly to the aeration tanks after preliminary treatment.

The data reviewed specifically included

- Plant Influent and Effluent BOD Data, State Reports Jan 2008-Feb 2012
- Plant Influent and Effluent TSS Data, State Reports Jan 2008-Feb 2012
- Plant Influent and Effluent TKN Data, State Reports Jan 2008-Feb 2012
- Thickened Sludge Trucked Waste Volume Jan-Dec 2011
- Thickened Sludge Solids Concentration Jan-Dec 2011
- Digester Solids Concentration Data Jan-Dec 2011
- Digester Temperature Data Jan-Dec 2011
- Aeration Tank MLSS Data Jan-Dec 2011

Wastewater Flows and Organic Loadings

The average daily design flow (ADDF) and permitted flow capacity is 3 million gallons per day (MGD). Current average daily flow (ADF) is less than the 3 MGD design flow, thus loads were evaluated based upon both current data (2008 to 2012) and design conditions. The wastewater flows and loads to the aeration tank for the current and original design conditions are summarized in Table 1.

Table 1 Wastewater Flows & Organic Loading		
	Current Flows and Loads (1)	Permit/Design Flows & Loads (2)
Average Daily Flow (MGD)	1.98	3.0
Max Day Flow (MGD)	2.95	4.48
Max Day Peaking Factor	1.49	
Average BOD (lbs/day)	2,566	3,897
Max Day BOD (lbs/day)	4,008	6,087
Max Day BOD Peaking Factor	1.56	
Average TSS (lbs/day)	2,742	4,165
Max Day TSS (lbs/day)	4,674	7,099
Max Day TSS Peaking Factor	1.70	
Average TKN (lbs/day)	388	589
Max Day TKN (lbs/day)	467	709
Max Day TKN Peaking Factor	1.20	

(1) Based on 2008-2012 plant wastewater data
(2) Based on ADDF=3.0 MGD. Max flow and loads are based upon peaking factors established from review of operational data from 2008 to 2012

SPDES Permit

The existing SPDES permit is based on a 30 day average flow loading of 3 mgd, and requires seasonal nitrification to achieve an ultimate oxygen demand (UOD) of 2,775 lbs/day. Due to percent removal requirements, the WWTP generally nitrifies year-round.

From the data reviewed, the average effluent BOD and TSS concentrations are below 15 mg/L. The average daily flow from the data reviewed was 1.98 mgd, max month flow was 2.57 mgd and the max day flow was 2.95 mgd, which is below the design flow of 3.0 mgd.

The summary of plant data from the State Reports can be found in Appendix A.

Air Requirements

The actual oxygen requirements (AOR) of the aeration tanks were calculated at the average, minimum, and max day conditions for both the current plant loads and the permit/design (ADDF =3 MGD) loads. Oxygen is required for carbonaceous and nitrification removal as the plant is currently operated in nitrification mode year round.

The plant influent data includes loads from the decant of the sludge thickening process and other internal recycles as the influent sampling point is located downstream of the internal recycle return point. The current SPDES requirements are assumed to also represent the future conditions, thus the calculations assume current effluent limits will remain unchanged.

Aeration equipment shall be capable of maintaining a dissolved oxygen (DO) concentration of 2.0 mg/l at all times based upon requirements in the "Recommended Standards for Wastewater Facilities" (10 States Standards).

Table 2 Actual Oxygen Demands

	Current (lbs/day)	Permit/Design (lbs/day)
Average Day Carbonaceous AOR	2,540	3,850
Max Day Carbonaceous AOR	4,100	6,210
Average Day Nitrogenous AOR	990	1,510
Max Day Nitrogenous AOR	1,340	2,040
Average Day Total AOR	3,530	5,360
Max Day Total AOR	5,440	8,240

Table 3 summarizes the airflow requirements to achieve the AORs summarized in Table 2 assuming a diffuser submergence of 12 feet, fine bubble tube diffusers and an oxygen transfer efficiency provided by the diffuser manufacturer.

Table 3 Process Air Flow Requirements

	Current Average Day SCFM	Current Max Day SCFM	Average Design Day SCFM	Max Design Day SCFM
Aeration Tanks	3,200	4,900	4,300	6,700

In addition to the process air requirements for aeration, there are minimum mixing requirements which are required to completely mix the tank. There may be cases where the mixing requirements govern the airflow requirements (i.e. the air flow value for minimum mixing is higher than the air flow required to achieve oxygen demands (AOR) for the process). Based on preliminary review of the data, this is assumed to be the case for aerobic digestion. Table 4 summarizes the air requirements to maintain minimum mixing of the aeration, aerobic digesters and thickened sludge holding tanks based upon tank volume and typical air flow rates for mixing per tank area and volume.

Table 4 Mixing Air Requirements	
	Air Flow – CFM
Aeration Tanks	460
Aerobic Digesters	2,300 (1,150 per digester)
Thickened Sludge Holding Tank	200
Total	**2,960**

Assumptions: Aeration Tank Mixing = 0.06 CFM/sq. ft. of tank surface
Aerobic Digester Mixing = 30 CFM/1000 cu. ft. digester volume
Thickened Sludge Holding Tank Mixing = 60 cfm/1000 cu. ft tank volume

Summary

It is recommended that new aeration blowers be sized to accommodate a range of flow rates summarized in Table 5 below. These flow rates are designed for mixing and process air and are designed to provide a DO concentration of 2.0 mg/L in each aeration tank. Discharge pressures were evaluated as part of the blower evaluation and included in Task #2. Currently the WWTP operates the blowers between 8 and 12 psi discharge pressure. Blower discharge pressure varies due to varying levels of sludge in the aerobic digesters and sludge holding tank and the air flow set points and headloss through the system at varying air flow rates. During the site visit on April 27, 2012, the discharge pressure was 10 psi and the air flow was 5,770 cfm.

Table 5 Air Flow Ranges (SCFM)				
	Minimum Day (1)	**Current Average Day**	**Current Max Day**	**Permit/Design Max Day (2)**
Aeration	1,900	3,200	4,900	6,700
Digesters (3)	300	2,300	2,300	2,300
Thickened Sludge Holding Tank (3)	0	200	200	200
Total	4,400	5,700	7,400	9,200

(1) Minimum day air flow requirements are based upon the 5th percentile of loads from the data from 2008 to 2012. For the digesters, min air flow is based upon 2 feet of liquid in digesters and for thickened sludge holding tank it is based upon an empty tank.
(2) Using 3.0 MGD design ADDF and peaking factors based on current loading. These air requirements would be sufficient to satisfy SPDES permit requirements and accommodate future growth, flows and loads.
(3) Assumed mixing limited. VS destruction across digester is unknown.

TASK #2 PRELIMINARY BLOWER DESIGN FOR THE BREWERTON WWTP

JCI and CDM Smith have evaluated blower options for Onondaga County's Brewerton WWTP based upon the pre-defined scope. High speed direct drive turbo blowers and positive displacement blowers to supply process air and mixing air to the aeration tanks, digesters and sludge holding tank were evaluated. As discussed in the June 21, 2012 meeting, and based upon a preliminary review of air requirements, a separate air delivery system for the aeration tanks and for the digesters/sludge holding tank was evaluated to allow for improved control. Since the liquid level in the digester and thickened sludge holding tank varies, the blower discharge pressure varies. Given the limited control of air flow currently available at the WWTP and the varying blower discharge pressure, it is difficult for the operators to efficiently run the aeration system to the aeration tanks, aerobic digesters and thickened sludge holding tank. Current dissolved oxygen (DO) levels in the aeration tanks are much higher than the typical 2.0 mg/l at many times, thus a new blower and DO control system could significantly reduce energy consumption. To improve performance, new controls and the following blowers are recommended:

- The aeration tanks would be serviced by 3-50% direct drive turbo blowers (2 duty, 1 standby), with the standby also servicing the aerobic digesters and thickened sludge holding tank if necessary in a backup situation.
- The two aerobic digesters would each have their own dedicated positive displacement blower, for a total of 2. The blower servicing the south digester will also provide air to the thickened sludge holding tank.

Blower Sizing

The blowers described below have been selected and sized to provide the required air flow under the average and maximum design day AORs, and have sufficient turndown under minimum loading conditions to optimize available energy savings. This approach should result in a system that achieves process requirements to meet permit limits and minimize electrical usage.

Table 6 summarizes the air flow requirements which were detailed in Task 1.

Table 6 – Summary of Air Flow	
Aeration Tank Min Air Flow	1,900 scfm
Aeration Tank Avg. Air Flow	3,200 scfm
Aeration Tank Max. Air Flow	4,900 scfm
Aeration Design Max Air Flow	6,700 scfm
Digesters/Sludge Holding Tank Minimum Air Flow	300 scfm (150 scfm per digester)
Digesters/Sludge Holding Tank Maximum Air Flow	2,500 scfm (1,150 scfm per digester plus 200 scfm for thickened sludge holding tank)

Aeration Blowers

Per the county's interest in using direct drive turbo blowers for the aeration system and the efficiency of these blowers, we have used APG-Neuros and HSI turbo blowers for our analysis. Turndown is accomplished through the use of variable frequency drives (VFDs). The direct drive turbo blowers for this project can turn down to 38 percent of maximum air flow.

The blowers have been sized for the air volume required for the warmest expected temperature (100 degrees F). Changes in inlet air temperature or ambient pressure will change the density of the compressed air. The greater the air density, the higher the pressure rise is across the compressor. As a result, greater horsepower is needed to compress cold air than an equal volume of warm air. Therefore, motors for these blowers have also been sized based on the coldest expected winter temperature. The required horsepower was approximated by multiplying the ratio of the summer and winter temperatures times the horsepower required for the warm weather conditions. Discharge pressure for the blowers was calculated using the criteria and assumptions listed in Table 7.

Table 7 – Pressure Losses for Aeration Tanks	
Ambient pressure, psia (El. 380)	14.5
Inlet losses, psig	0.3
Static Pressure (12' Diffuser Depth), psig	5.2
Pressure at top of dropleg (estimated, confirm with diffuser manufacturer during design), psig	6.0
Piping losses (psig), (assumed, need to verify with detailed piping calcs during design)	0.7
Allowance for dirty diffusers, psig (assumed)	0.4
Discharge side losses, psig	1.9
Blower Inlet Pressure, psia	14.2
Blower Discharge Pressure, psia	21.6 (7.1 psig)

Based upon the flows and loads analyzed and summarized in Task 1, the aeration blowers need to provide air from 1,900 scfm to 6,700 scfm at 7.1 psi, based upon the existing diffuser oxygen transfer efficiency.

Digester and Thickened Sludge Holding Tank Blowers

Positive displacement blowers were selected to provide air for mixing and process to the north and south aerobic digesters and the thickened sludge holding tank. Positive displacement blowers were selected because they are better suited to handle varying discharge pressures that are inherent to the operation of the digesters and thickened sludge holding tank due to the varying liquid levels in the tanks. Centrifugal type blowers (direct drive turbo, single stage, multi-stage) are not an appropriate selection for aerating tanks where liquid levels vary substantially.

Blower discharge pressures were calculated based on the criteria and assumptions outlined in Table 8.

Table 8 – Pressure Losses for Digesters and Thickened Sludge Holding Tank	
Ambient pressure, psia (El. 380)	14.5
Inlet losses, psig	0.3
Static Pressure – Max (13’ diffuser depth), psig	5.6
Static Pressure – Min (assume 2’ water depth over diffusers), psig	0.9
Pressure at top of dropleg, max, psig (assume, confirm with diffuser manufacturer during design)	6.2
Piping losses (psig), (assumed, need to verify with detailed piping calcs during design)	0.7
Blower Inlet Pressure, psia	14.2
Max Blower Discharge Pressure, psia	21.4 (6.9 psig)
Min Blower Discharge Pressure at min liquid depth	Approx. 1.8 to 2.0 psig

The digester blowers need to provide air flow from 150 scfm at approximately 1.8 psig to 1,150 scfm at 6.9 psig per digester based upon liquid levels varying from 2 feet to 15 feet. Air flow rates of up to 200 scfm are required for the thickened sludge holding tank. The turndown of the Roots PD blowers evaluated can accomplish a minimum air flow of about 300 scfm at 1.8 psig, which will provide a little more air than necessary when the liquid depth in the tank is at 2 feet, however this condition is not expected to occur frequently, and thus the minimum air flow of 300 scfm is deemed acceptable.

Blower Selection

Based on these calculations, a total of three blowers in a 2 duty, 1 stand-by arrangement are recommended for aeration and two duty blowers are recommended for the digesters and sludge holding tank. The stand-by aeration blower will also serve to provide back-up air for the digesters/thickened sludge holding tank.

- Three APG-Neuros NX150-C060 (150 hp)
- One Roots 418 RAM (75 hp) for south digester and thickened sludge holding tank and one Roots 418 RAM (60 hp) for north digester

It should be noted that the aeration blower size would decrease to 100 hp if the current maximum day air flow is used rather than the design maximum day air flow, however, the WWTP would then not be able to meet the permit requirements if the flows and loads increased to those included in the SPDES permit. The larger 150 hp blowers were selected so that the WWTP could meet its SPDES permit and have capacity for future flows and loads up to an average 3.0 mgd.

Relative to the process air required, the approximate capacity of each blower based upon the manufacturer's blower curve is as follows:

- APG-Neuros NX150-C060 at 7.1 psig: 1,264 to 3,333 scfm
- Roots 418 RAM at 1.8 to 6.9 psig: 300 to 1,700 acfm

Much of the time, one NX150 blower is capable of providing sufficient air to the aeration tanks. The blower curves received from HSI were also reviewed and a HSI direct drive turbo blower model Frame 4 is capable of providing similar capacity to the APG-Neuros NX150 blower.

A copy of blower cut sheets and blower curves are included in Appendix B.

Blower and Piping Layouts

Onondaga County Department of Water Environment Protection (OCDWEP) requested that the blowers be installed in structural containers (walk-in enclosures) and mounted on concrete pads due to the desire to reuse the space in the existing blower room for other functions. Initially the preference by OCDWEP was to install the blowers in the gallery, however there were concerns about dampness impacts to the control system and the potential for a pipe to break and flood the gallery and damage equipment, thus the decision to install the blowers outside in walk-in type enclosures was made during the meeting with OCDWEP on July 25, 2012. The existing pipe will be utilized with new piping required to connect from the digester blowers to the existing digester piping and new pipe to connect from the aeration blowers to the existing air header in the gallery below. Appendix C shows the proposed location for the blowers and the new piping required. Piping layouts were developed assuming an in-line velocity of 2,500 feet per minute or less to minimize head loss and noise. Thus the following new pipe is required

- Aeration blower header from blowers to connection with existing 30" air header: 24" diameter, approximate length of 80 feet
- North Digester blower header from blower to connection with existing pipe at digester: 10" air header, approximate length of 100 feet
- South Digester blower header from blower to connection with existing pipe at digester: 10" air header, approximate length of 80 feet

Blower Controls

Both the aeration and aerobic digester blowers will be variable speed. The aeration blowers will be varied based on the process requirements via signals from DO probes in each basin. The operation of the aerobic digester blowers will be based on mixing requirements via tank level sensors, and subsequently volume. The digesters will also have a DO probe which will override the mixing requirements in the event that DO drops below an operator setpoint (anticipated to be 2 mg/l). It is expected that the level in the tank and the mixing requirements for a given volume in the tank will govern most of the time.

Blower Energy

Energy usage for the existing and the proposed blowers was estimated to determine the approximate energy savings of the new blower system. For the new aeration blower system, a variety of operational conditions were analyzed to determine oxygen requirements, air flow rate, and required blower horsepower to estimate the energy usage in a typical year. Each condition was weighted as to the fraction of time during a typical year those conditions are expected; for example, the maximum day is expected to occur one day out of the year (rounded up to 1%), the maximum month is expected to occur 30 days out of 365 days, or 8% of the year, and so on. Based on those operating requirements and the blower curves supplied by APG-Neuros for a 150 hp turbo blower the power requirements for current conditions are as follows.

Table 9 - Annual Power Requirements for Aeration using Neuros NX150-C060 blowers

	Airflow (scfm)	Fraction of Operation in Typical Year	Number of Blowers Operating	Total Blower Horsepower (1)	Wire to Air (kW) (2)	Weighted Wire Power (kW) (3)	Wire Power (kWh per year) (4)
Max Day	4,900	1% (87.6 hours)	2	179	150	1.5	13,140
Max Month	4,200	8% (700.8 hrs)	2	153	128	10.2	89,702
Avg. Day	3,200	82% (7183.2 hrs)	1	123	103	84.5	739,870
Min Month	2,200	8% (700.8 hrs)	1	80	67	5.4	46,954
Min Day	1,900	1% (87.6 hrs)	1	70	58	0.6	5,081
Total		**100% (8,760 hours)**				**102.2 (avg annual kW)**	**895,000**

(1) Assumed operation at standard conditions (68 deg F, 14.2 psia, 36% RH)

(2) Wire to air kW accounts for losses within the blower system. The assumed VFD efficiency is 89%. For example, based upon an avg. day AOR of 3,530 lbs/day from Table 2, an avg. day air flow of

3,200 scfm was calculated (Table 6) and the blower curves in the appendix were used to determine 123 hp was required at the design conditions to achieve 3,200 scfm. 123 hp converted to kW is 91.7 kW and accounting for efficiency losses of 89%, 103 kW is needed to operate the blower at this design point. Since it was estimated average conditions occur 82% of the year (7183 hours), the annual kWh for this condition is 103kW x 7183 = 739,870 kWh/year.

(3) The weighted wire power is the fraction of operation in a typical year multiplied by the wire to air kW. 150 kW for 1% of the year is equivalent (in kWh) to 1.5 kW continuous for the whole year. 102.2 is the average kW for the year (895,000 divided by 8,760).

(4) Wire power in kWh/year is the weighted wire power times 8,760 hours/year

The aerobic digester blowers will include a 60 hp variable speed positive displacement (PD) blower for the north digester and a 75 hp variable speed PD blower for the south digester and thickened sludge holding tank. The digester blower performance for Roots is summarized in Table 10.

Table 10 - Annual Power Requirements for Digesters and Thickened Sludge Holding Tank (Roots 711 U-RAI)

	Airflow (scfm)	Fraction of Operation in Typical Year	Digester Operating Depth	Total Blower Horsepower	Wire to Air (kW) (1)	Weighted Wire Power	Wire Power (kWh per year)
South – Max	1350	30%	15’ (6.9 psig)	55	45	13.4	
South – Avg	710	60%	7.5’ (3.7 psig)	15	12	7.3	
South – Min	300	10%	4’ (2.0 psig)	10	8	0.8	
North – Max	1150	10%	15’ (6.9 psig)	48	39	3.9	
North – Avg.	575	20%	7.5’ (3.7 psig)	12	10	2	
North- Min	300	70%	4’ (2.0 psig)	10	8	5.6	
TOTAL						**33.0**	**289,100**

(1) Assumed VFD efficiency 92%. Max. wire power = (45+39) = 84 kW.

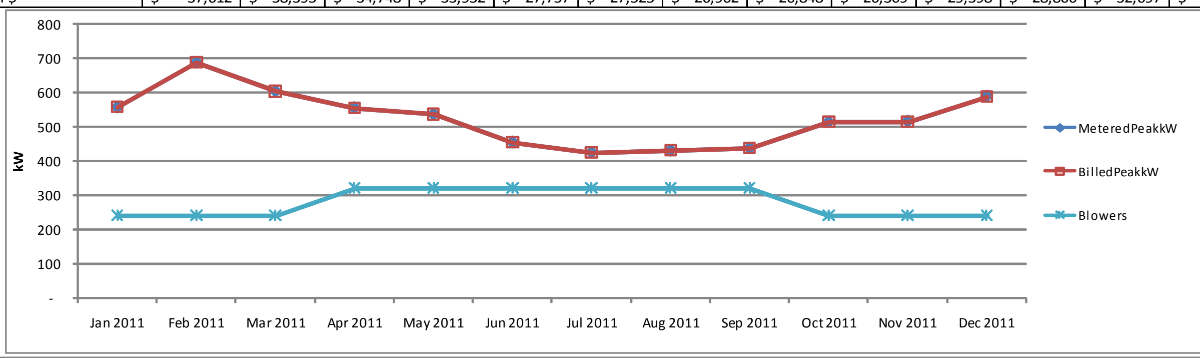
TASK #3 UTILITY ANALYSIS AND SAVINGS

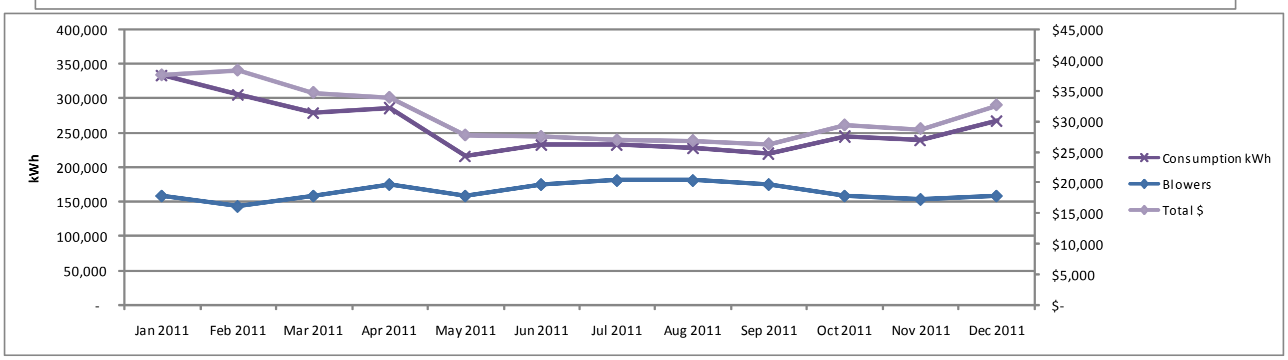
2011 Plant Utility Data

Account #	42376-06105
Description	Brewerton WWTP
Service Class	SC3

Demand Rate	$ 15.90 /kW
Demand Charge	$ 100,208
Flat Customer Charge	$ 3,122
kWh Charge	$ 267,660
kWh Rate	$ 0.08669 /kWh
Blended Rate	$ 0.12015 /kWh

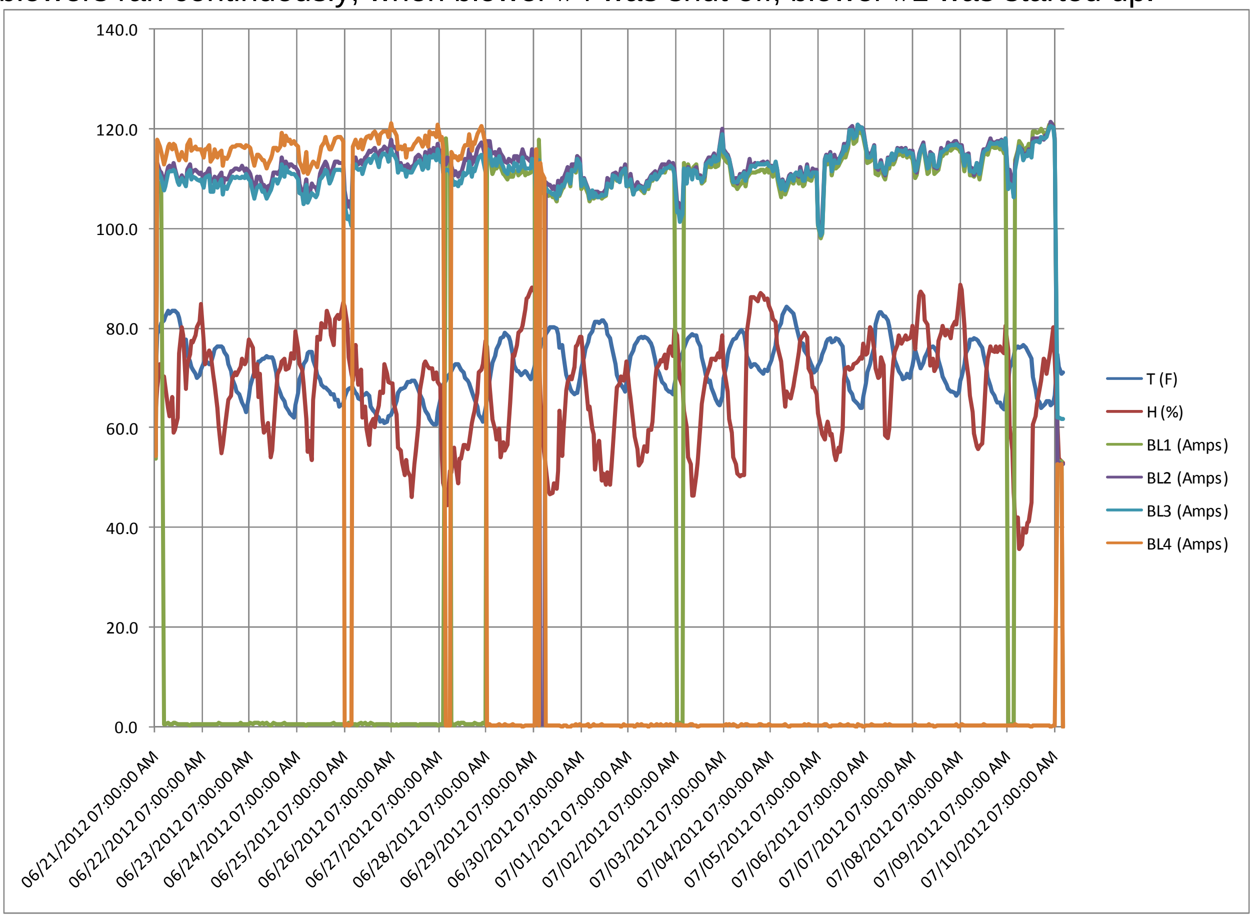
	Jan 2011	Feb 2011	Mar 2011	Apr 2011	May 2011	Jun 2011	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Nov 2011	Dec 2011	Total
MeteredPeakkW	557	688	603	555	536	454	424	430	437	514	515	589	6,302
BilledPeakkW	557	688	603	555	536	454	424	430	437	514	515	589	6,302
Consumption kWh	333,883	306,208	279,294	286,587	216,202	233,180	232,295	228,107	219,990	245,094	238,991	267,793	3,087,624
UtilityCharges	$ 16,494	$ 19,028	$ 17,083	$ 15,806	$ 14,082	$ 12,776	$ 12,270	$ 12,420	$ 12,395	$ 13,896	$ 13,690	$ 15,759	$ 175,699
SupplierCharges	$ 21,118	$ 19,368	$ 17,665	$ 18,127	$ 13,675	$ 14,749	$ 14,693	$ 14,428	$ 13,914	$ 15,502	$ 15,116	$ 16,938	$ 195,292
LatePmtCharges	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total $	$ 37,612	$ 38,395	$ 34,748	$ 33,932	$ 27,757	$ 27,525	$ 26,962	$ 26,848	$ 26,309	$ 29,398	$ 28,806	$ 32,697	$ 370,990





Blower Logging Data

The blower amps, and inlet temperature and humidity were logged for a two week period. Additionally the air flow at each of the air flow measuring stations was recorded manually on the hour over the same period. The blowers are activated manually and the air flow quantities in each branch are set at the discretion of the operator. The control valves in each branch adjust automatically to maintain the air flow set points. The data indicates very minor fluctuations in air flow or amp draw. In this period three blowers ran continuously; when blower #4 was shut off, blower #1 was started up.



Breakdown of Electric Consumption - 2011

Estimate of Blower kWh and Demand kW

Voltage	470	(measured)
Current	113.1	(measured avg.)
pf	87%	(nameplate)
kW	80.1	

Blowers are turned on and off manually at the operators discretion. The operator indicated they run 2 blowers continuously in the winter and a third blower occasionally. In the summer they run 3 blowers continuously and a fourth occasionally. The table below represents an approximation of that operating scenario.

	WINTER								SUMMER							
BLOWER	MON	TUE	WED	THU	FRI	SAT	SUN	TOT	MON	TUE	WED	THU	FRI	SAT	SUN	TOT
1ST	24	24	24	24	24	24	24	168	24	24	24	24	24	24	24	168
2ND	24	24	24	24	24	24	24	168	24	24	24	24	24	24	24	168
3RD	8	8	8	8	8	8	8	56	24	24	24	24	24	24	24	168
4TH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8
					Total Fan Hours per Week			392						Total Fan Hours per Week		512

In the table below Jan. is taken as the minimum month and July the maximum for kWh. The other months are proportioned based on their relative average outdoor temperatures.

	Jan 2011	Feb 2011	Mar 2011	Apr 2011	May 2011	Jun 2011	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Nov 2011	Dec 2011	Total	Cost	
Days	31	28	31	30	31	30	31	31	30	31	30	31	365		
AVG. T	21	24	33	49	63	69	76	72	66	53	47	36			
kW	240	240	320	320	320	320	320	320	320	320	240	240	3,524	$ 56,037	
kWh	139,052	141,374	148,339	160,722	171,558	176,201	181,619	178,523	173,880	163,818	159,175	150,661	1,944,923	$ 168,602	
Avg. kW	293.7													$ 224,639	Blowers

Estimate of Influent Pump kWh

Influent pumps start/stop automatically and vary their speed based on influent flow rate. The operator indicated that one pump operates continuously and the second and third pumps will come on during wet weather events (rain, thaws) for an equivalent runtime of one week each. The table below represents an approximation of that operating scenario.

PUMP	1ST	2ND	3RD	Totals	
Horsepower	75	75	75		(nameplate)
Avg. Loading	70.0%	100.0%	100.0%		(estimated)
Efficiency	93.6%	93.6%	93.6%		(nameplate)
kW	41.84	59.78	59.78	42.5	(avg.)
Hours/year	8760	168	168	9,096	
kWh	366,544	10,042	10,042	386,629	

Below, the demand kW is represented as an average monthly. The kWh is the remainder each month after the other components are considered. Adjustments where made until the total kWh below came close to the annual estimate for these motors in the table above.

	Jan 2011	Feb 2011	Mar 2011	Apr 2011	May 2011	Jun 2011	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Nov 2011	Dec 2011	Total	Cost	
Days	31	28	31	30	31	30	31	31	30	31	30	31	365		
kW	66.0	60.9	29.4	90.4	21.3	55.8	47.6	45.8	34.6	40.2	18.7	21.9	532	$ 8,466	
kWh	49,079	40,914	21,875	65,086	15,821	40,168	35,388	34,104	24,884	29,892	13,470	16,308	386,989	$ 33,547	
														$ 42,014	Influent Pumps

Estimate of Misc. Motors and Lights

This table represents an estimate of the relatively constant load of the small motors and lights.

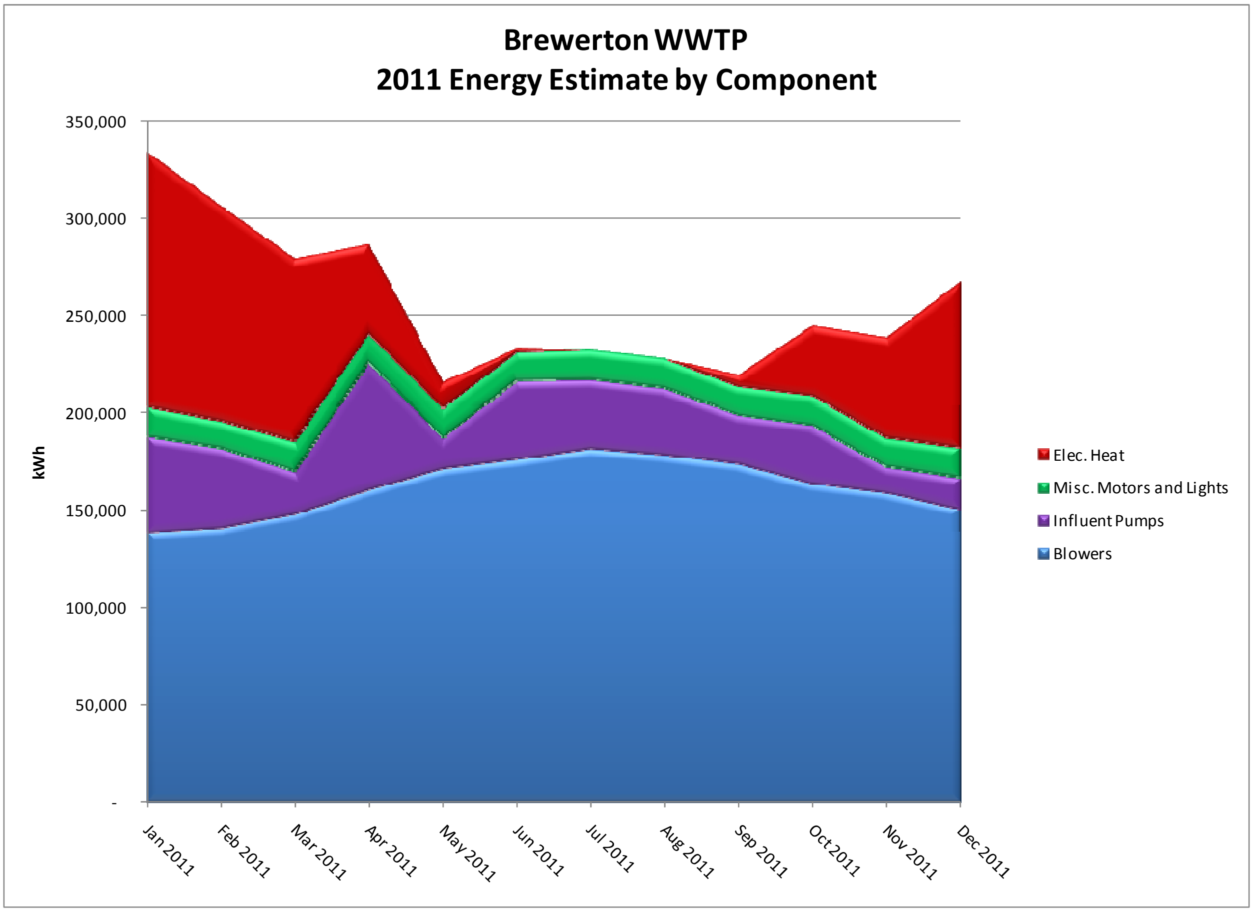
	Jan 2011	Feb 2011	Mar 2011	Apr 2011	May 2011	Jun 2011	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Nov 2011	Dec 2011	Total	Cost	
Days	31	28	31	30	31	30	31	31	30	31	30	31	365		
kW	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	247	$ 3,921	
kWh	15,288	13,808	15,288	14,795	15,288	14,795	15,288	15,288	14,795	15,288	14,795	15,288	180,000	$ 15,604	
														$ 19,524	Misc. Motors and Lights

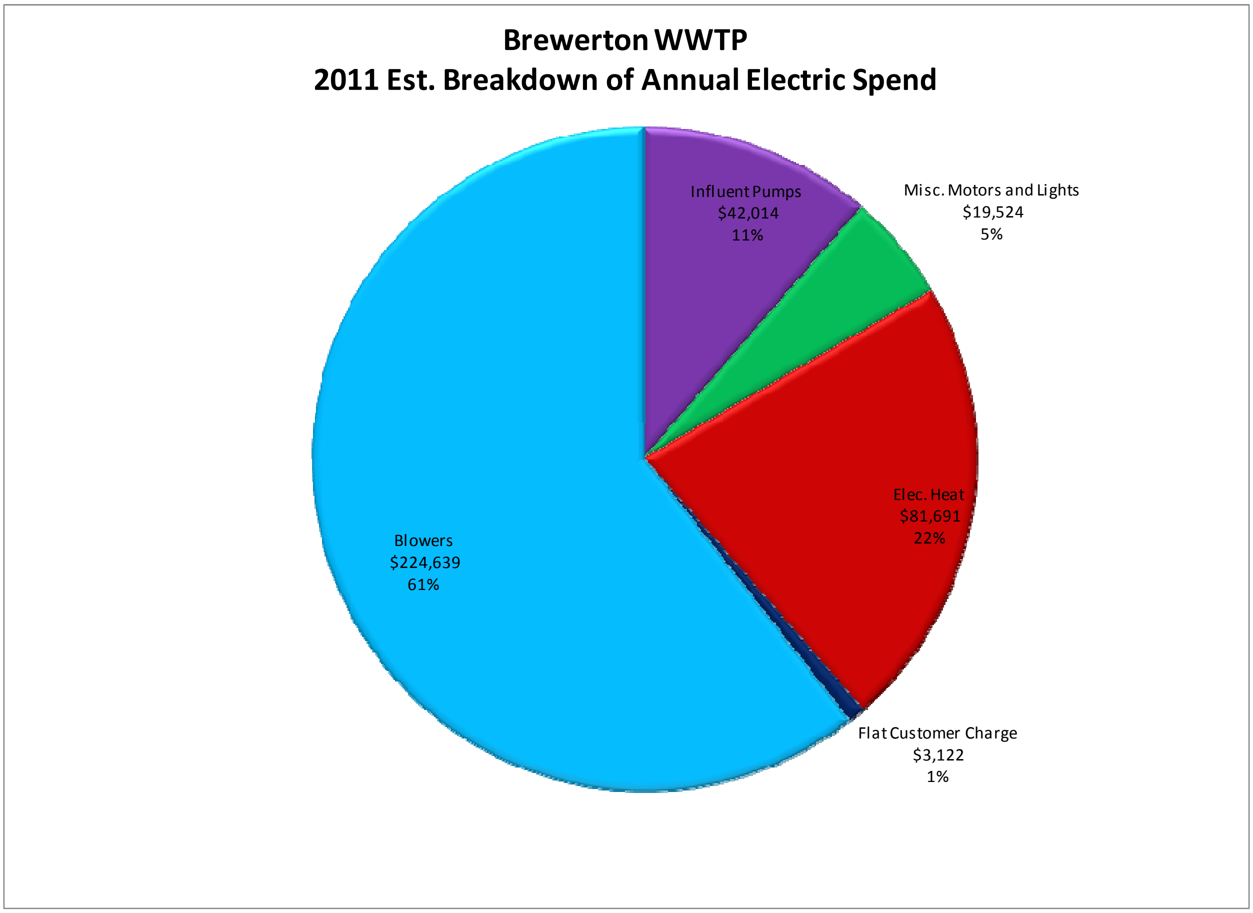
Estimate of Electric Heat

Electric Heat kWh is proportioned to heating degree days.

	Jan 2011	Feb 2011	Mar 2011	Apr 2011	May 2011	Jun 2011	Jul 2011	Aug 2011	Sep 2011	Oct 2011	Nov 2011	Dec 2011	Total	Cost	
Days	31	28	31	30	31	30	31	31	30	31	30	31	365		
HDD	1,359	1,147	977	479	141	21	-	2	67	376	537	891	5,997		
kW	230.0	366.3	232.9	123.9	173.8	57.7	35.5	43.6	61.3	132.5	235.6	306.0	1,999	$ 31,784	
kWh	130,464	110,112	93,792	45,984	13,536	2,016	-	192	6,432	36,096	51,552	85,536	575,712	$ 49,907	
														$ 81,691	Elec. Heat

6,302	$ 100,208	kW demand
3,087,624	$ 267,660	kWh consumption
	$ 3,122	Flat Customer Charge
	$ 370,990	


Brewerton WWTP
2011 Energy Estimate by Component
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
kWh
Jan 2011
Feb 2011
Mar 2011
Apr 2011
May 2011
Jun 2011
Jul 2011
Aug 2011
Sep 2011
Oct 2011
Nov 2011
Dec 2011
Elec. Heat
Misc. Motors and Lights
Influent Pumps
Blowers


Brewerton WWTP
2011 Est. Breakdown of Annual Electric Spend
Influent Pumps
$42,014
11%
Misc. Motors and Lights
$19,524
5%
Elec. Heat
$81,691
22%
Blowers
$224,639
61%
Flat Customer Charge
$3,122
1%

Comparison of Annual Energy Consumption and Cost

In Table 11 below the calculation of average annual kW and maximum annual kW is shown for reference and is not used in the calculation of energy cost savings. The average kW for 2011 is estimated from operator information (when he ran the blowers and how many), and fitting that within the actual utility usage data and measured fan kW. The average kW for the proposed condition is based on estimates of run time at various loading.

Although ambient air temperature is mentioned as a factor, there are other parameters affecting the operator's decision to turn on a third or fourth blower, such as biological loading, the levels of the digester tanks, the level of the sludge holding tank, or odor control. Since there is just one, manually controlled air system, and the plant is unmanned on the weekends, the operator must be proactive in his decisions. The demand charge for the plant will be determined by whether a fourth blower was ever run during that month.

In the proposed condition the air systems for the digesters and sludge holding tank will be separate from that serving the aeration tanks. The blowers will have variable speed drives and be automatically controlled for DO and tank levels. Fan curves are utilized to estimate kW at various loading. The amount of time at any particular loading is estimated from historical influent data. Variations in loading are not predictable simply from outside temperature or calendar month. We can't predict for any particular month what the kW savings will be, but we can be sure that all kWh savings will be accompanied by kW savings.

Table 11 – Comparison of Annual Energy Consumption for Blower Operation

	Annual Average		Annual Maximum			
	Aeration Blower Power (kW)	Digester Blower Power (kW)	Aeration Blower Power (kW)	Digester Blower Power (kW)	Annual kWh	Annual Cost (3)
Existing (1)	293.7		320		1,944,923	$224,639
Proposed (2)	102.2	33.0	150	84	1,184,100	$142,100
Difference	**158.5**		**86**		**760,823**	**$82,539**

(1) Existing system uses common blowers for aeration, aerobic digesters and thickened sludge holding tank mixing. Based on 2011 data.

(2) See Task #2 for details of kWh calculations. Annual cost is calculated using a blended rate of $0.12/kWh based on 2011 data. This is justified because the blowers are by far the largest single load and they operate continuously.

TASK #4 DISSOLVED OXYGEN CONTROL SYSTEM AT THE BREWERTON WWTP

General

The existing aeration blowers and plant SCADA system used for monitoring and control of the aeration system were evaluated. This task discusses the electrical and control requirements for providing more efficient turbo blowers for the aeration system and separate positive displacement blowers for the aerobic digesters.

Electrical Power to Existing Aeration Blowers

The existing four aeration system blowers within the blower room inside the Control Building are driven by 480 volt, 3 phase, 125 horsepower Toshiba, premium efficiency, induction motors. Each blower is fed from its own vertical section within MCC-11 and configured as a reactive start to limit the inrush current to the motors upon startup with a run contactor switching in after the motor is up to full speed.

Existing Aeration Blower Monitoring and Control

The existing aeration blowers are monitored for bearing temperatures, bearing vibrations, motor amperage and air flow from blower instrumentation and local control panels within the blower room.

Existing Plant SCADA System

The facility currently has an existing PLC based SCADA system consisting of four Allen Bradley PLC's networked together using an Ethernet protocol via Category 5 and fiber optic cable throughout the plant. The existing Allen Bradley SCADA system consists of one PLC-5/20 processor and one SLC-50/5 model in the Control Building. Another PLC-5/20 is located in the Raw Building and the fourth PLC is a SLC-50/5 in the Chemical Building to run the Iron Salts system.

Aeration Blower Electrical and Controls Modifications

Aeration Blower Electrical Modifications

The basis of design for the aeration basin blowers is centered around providing three 150 horsepower turbo blowers with integral outdoor enclosures containing variable frequency drives and PLC's to replace the existing four 125 horsepower blowers in the Control Building. The existing blowers will remain in operation while the new blowers and electrical distribution equipment is installed. The 480 volt electrical supply for the new turbo blowers will be provided from individual breakers within a new 480 volt switchboard to be installed within the Control Building electrical room. New 3" rigid metal conduit and new 500 kcmil power cables will be installed between the new switchboard breakers through the tunnel to the new outdoor blower skids to be located near the aeration tanks.

The new blower switchboard will be fed from a new breaker retrofitted into the existing main switchgear currently designated as 52-F3 (spare). The existing spare 52-F3 breaker in the main switchgear will be replaced with a new 1600 amp breaker. After the new blower system is up and operational the existing four blowers can be disconnected and the existing panelboard loads connected to MCC-11 can be transferred over to the new panelboard. See Appendix D for new one-line diagram and illustration of power interconnections.

Aeration Blower Controls Modifications

The control modifications required for the new turbo blowers include installing a new blower Master Control panel within the existing control room inside the Control Building. Modification of existing aeration system control equipment including replacing the orifice plate flow meters within the aeration piping with new thermal mass flow meters, adding new dissolved oxygen probes at the aeration tanks, aerobic digesters, and thickened sludge holding tank and replacing existing pneumatic actuated butterfly valves with electrically actuated valves will be required.

The new turbo blowers will be provided with a new NEMA 12 Master Control Panel (MCP) which will include a programmable logic controller, operator touch screen and all components required for operation of the upgraded aeration system. The MCP will require a 120VAC source of power from an available 20 amp, 1 pole breaker out of the new panelboard within the new blower switchboard in the Control Building electrical room. The MCP will be network interfaced to control and monitor the three new blower skids and associated instrumentation using communication cable in conduit interconnected between all devices. Monitoring and alarming of the new turbo blowers will also be interfaced into the existing plant SCADA system by providing an additional Category 6 cable from the MCP to either the existing Ethernet switch (if additional ports are available) or by providing a new Ethernet switch within the existing PLC cabinet within the Control Building. Modifications to the existing SCADA PLC and HMI software will be provided to integrate the new blowers into the system.

The existing orifice plate flow meters will be replaced with new thermal mass flow meters as these have less pressure drop across them than the existing orifice plate flow meters. The new thermal mass flow meters will have new signal wiring and conduit installed to them for connection to the new MCP.

New Dissolved Oxygen Probes (DO) will be strategically located within the aeration tanks and digesters with new signal wiring and conduit routed back to the MCP for controlling the blowers based upon dissolved oxygen concentration in the tanks.

New butterfly valves will be installed within the aeration piping with new signal wiring and conduit installed for connection to the new MCP.

Aerobic Digester Blower Electrical and Controls Modifications

Aerobic Digester Blower Electrical

The intent for aeration to the aerobic digesters is to separate them from the existing aeration blowers in the Control Building. New dedicated positive displacement blowers will be installed near the aeration tanks in outdoor enclosures. One blower will be dedicated to Aerobic Digester No.1 (north) and the second blower will be dedicated to

Aerobic Digester No.2 (south) and the thickened sludge holding tank. If either of these blowers is out of service, the back-up turbo blower from the aeration system blowers will provide air to the digester. The valve near the digester on the existing air piping will be normally closed, but when air is provided by the back-up turbo blower, this valve will be opened and the valve directly downstream of the positive displacement blower out of service will be closed. Power requirements for each digester blower will require a 480 volt, 3 phase, 60 hertz, 150 amp service for blower number 1 and a 175 amp service for blower number 2.

Power for the digester blowers will be obtained from the new blower switchboard in the Control Building with a new 150 amp breaker for blower number 1 and a 175 amp breaker for blower number 2 installed within the new switchboard. The new breakers, new 2/0 AWG power cable and 2" conduit would need to be installed from the new switchboard through the aeration pipe gallery and out to the blowers.

Aerobic Digester Blower Controls

The control philosophy for the new digester blowers will be to provide an air flow setpoint to the blowers and adjust the blowers using variable frequency drives. The air flow setpoint to the aerobic digesters will be based upon the sludge level in the digester. To measure sludge level within the digesters new radar level instruments will be installed at the digesters and the thickened sludge holding tank with new signal wire and conduit connected back to the MCP located in the Control Building. The air flow setpoint signal to the blower VFD's will be from communication wiring from the MCP in the Control Building. To maintain the desired air flow to the blower VFD a new thermal mass flow meter will be installed in the piping with conduit and communication wiring to the MCP. When the blower is placed into automatic mode, the new flow meter will be used as the feedback to maintain the air flow output from the blower. A DO probe will be installed in each digester and the thickened sludge holding tank and will override the air flow set point if DO decreases below the operator adjustable setpoint (assume 2 mg/l initially), thus a minimum amount of air and a minimum dissolved oxygen level will be maintained in the digester at all times. Modifications to the existing PLC and the plant HMI software will be required for monitoring and alarming of the new digester blowers.

TASK #5 PRELIMINARY PROJECT COST ESTIMATES

Cost Estimate

Table 12 - Partial Equipment List

Equipment	Manufacturer/ Supplier	Model	Part No.	Quantity	List Price
Turbo blowers	APG-Neuros	NX150-C060		3	$372,000
PD blowers	Roots	418 Ram		2	$48,295
DO probes for aeration tanks	Hach			4	$28,900
DO probes for digesters & sludge holding tank	Hach			3	$21,675
Electrically actuated modulating butterfly valves				9	$80,500
Electrically actuated open/close butterfly valves				2	$1,600
Thermal Mass Flow Meters (4-10”, 2-8”, 1-30”, 1-4”)				7	$25,316
Master Control Panel (MCP)				1	$55,000
1200 Amp Switchboard	Eaton	IFS		1	$77,601
1600AF switchgear breaker	Square D	NW Masterpact		1	TBD

Total estimated installed cost $2,477,000
Material $1,486,200
Labor $990,800

This construction cost includes engineering, project management, plus labor and material for 3 turbo blowers, 2 PD blowers all located outside near the clarifiers/aeration tanks, 5 walk-in type enclosures, concrete base pads, conduit, wiring back to the control room where the switchgear and electrical feeds are located, 260 feet carbon steel pipe, VFDS, MCPs, programming, 9 butterfly control valves, 7 DO probes, 7 thermal mass flow meters, 3 level instruments.

APPENDIX A, SUMMARY OF WWTP OPERATIONAL DATA

Summary of Flows, Temperature, pH and Concentrations for Brewerton WWTP from January 2008 to February 2012

	FLOW MGD	Infl Temp deg C	Effl Temp deg C	Infl pH min	Infl pH max	Effl pH min	Effl pH max
Average	1.98	13.8	13.9	7.5	7.5	7.3	7.4
Average of Instantaneous Max	3.19						
Max - 95th percentile	2.95	18.7	19.4	7.7	7.7	7.5	7.5
Max Month - 90th Percentile	2.57	18.3	19.0	7.6	7.7	7.5	7.5
Min Month - 10th Percentile	1.43	9.6	9.3	7.2	7.4	7.2	7.3
Min - 5th percentile	1.36	9.0	8.9	7.2	7.3	7.1	7.2

Summary of Mass Loads for Brewerton WWTP from January 2008 to February 2012

Data	Current Avg. Load (lbs/day)	Current Max Day Load (lbs/day)	Max Day Peaking Factor	Current Max Month Load (lbs/day)	Max Month Peaking Factor	Current Min Month Load (lbs/day)	Min Month Peaking Factor	Current Min Day Load (lbs/day)	Min Day Peaking Factor	Avg. Conc. (mg/L)	Design Avg. Load (lbs/day)	Design Max Day Load (lbs/day)
Flow	1.98	2.95	1.49	2.57	1.30	1.43	0.73	1.36	0.69		3.00	4.48
BOD Influent	2,566	4007.67	1.56	3,346	1.30	1,856	0.72	1,723	0.67	155.76	3,897	6,087
BOD Effluent	243	613.88	2.53	516	2.12	73	0.30	61	0.25	14.75	369	932
TKN Influent	388	466.78	1.20	447	1.15	330	0.85	320	0.82	23.54	589	709
TKN Effluent	70	160.74	2.31	142	2.04	17	0.24	14	0.20	4.23	106	244
TSS Influent	2,742	4674.37	1.70	3,830	1.40	1,786	0.65	1,621	0.59	166.47	4,165	7,099
TSS Effluent	169	414.64	2.46	314	1.86	56	0.33	49	0.29	10.25	256	630

Notes:
Avg Load (lbs/day) - calculate by taking flow and conc times 8.34 for each day and then average the loads - see mass loadings tab
Avg concentrations (mg/l) is calculated by taking load divide by flow and 8.34

Brewerton WWTP, INVENTORY OF EXISTING EQUIPMENT

	MOTOR									BLOWER/PUMP					
DESCRIPTION	MFR	MODEL	SERIAL	HP	NOM. EFF	P.F.	YEAR	VSD	MFR	CATALOG	SERIAL	YEAR	COST	NOTES
AERATION BLOWER #1	TOSHIBA	B1252VL63USH	61102625	125	95.4%	87.0%	2009		GARDNER DENVER	857-ADOO	911434X	1991		Never less than 2, usually 3, frequently 4
AERATION BLOWER #2	TOSHIBA	B1252VL63USH	61102623	125	95.4%	87.0%	2009		LAMSON	857-2-0-0-5-0-AD	911436	1991		
AERATION BLOWER #3	TOSHIBA	B1252VL63USH	60703785	125	95.4%	87.0%	2009		LAMSON	857-2-0-0-5-0-AD	911491	1991		
AERATION BLOWER #4	TOSHIBA	B1252VL63USH	61102624	125	95.4%	87.0%	2009		LAMSON	857-2-0-0-5-0-AD	911490	1991		Out of service
RETURN ACTIVATED SLUDGE PUMP #1	US MOTORS	H23389	B01A3180178R-2	20	91.0%	83.5%	1999	X	GOULDS	10X8-17	B267C663-1	2011		One runs continuously
RETURN ACTIVATED SLUDGE PUMP #2	US MOTORS	H23389	B01A3180178R-3	20	91.0%	83.5%	1999	X	GOULDS	10X8-17	B267C663-2	2011		
RETURN ACTIVATED SLUDGE PUMP #3	US MOTORS	H23389	B07-97071815-001R-1	20	91.0%	83.5%	1999		GOULDS	10X8-17	B267C662-1	2011		One runs continuously
RETURN ACTIVATED SLUDGE PUMP #4	TECO	AEHE	JX4732090004	20	92.4%		1999		GOULDS	10X8-17	B267C662-2	2011		
TANKER LOADING PUMP #1	TECO	OPTIM HE PLUS	69A2070048	20	93.0%		2001		HAYWARD GORDON	XCS5-B	285476-1	2001		One runs 2 hrs/wk
TANKER LOADING PUMP #2	TECO	OPTIM HE PLUS	69A2070047	20	93.0%		2001		HAYWARD GORDON	XCS5-B	285476-2	2001		
SLUDGE TRANS. PUMP #1	RELIANCE		1MA456486-G3-EY	7.5			1974					1974		5-7 hrs/wk
SLUDGE TRANS. PUMP #2	RELIANCE			7.5			1974					1974		5-7 hrs/wk
AIR COMPRESSOR	INGERSOLL RAND	32036006		10	89.5%									
INFLUENT PUMP #1	MARATHON	9F-444TSTDS4102AN-W	MU404000-6/12-01	75	93.6%	79.5%	2001	X	YEOMANS	1210522-4B	9807640	2001		One runs continuously. 2nd and 3rd pump needed for high flows (assume 1 wk/yr)
INFLUENT PUMP #2	MARATHON	9F-444TSTDS4102AN-W	MU404000-6/12-02	75	93.6%	79.5%	2001	X	YEOMANS	1210522-4B	9807640	2001		
INFLUENT PUMP #3	MARATHON	9F-444TSTDS4102AN-W	MU404000-6/12-03	75	93.6%	79.5%	2001	X	YEOMANS	1210522-4B	9807640	2001		
EFFLUENT WATER PUMP #1	BALDOR	EJMM3711T	F0502144310	10	91.7%	92.0%		X	GOULDS	5BRIL5C0P5	3656			One runs continuously.
EFFLUENT WATER PUMP #2	BALDOR	EJMM3711T	F0512190580	10	91.7%	92.0%		X	GOULDS	5BF1L9C0	3656			
DECANT SUBMERSIBLE PUMP #1				5										4 hrs/wk
DECANT SUBMERSIBLE PUMP #2				5										4 hrs/wk
SUBMERSIBLE SLUDGE PUMP #1								X	FLYGT	3102				
SUBMERSIBLE SLUDGE PUMP #2								X	FLYGT	3102				
DRUM MOTOR	SEW-FURODRIVE	DFT90L4-KS	850278534.01.01.001	2					SEW-FURODRIVE					96 hrs/wk
FLOCULATOR MOTOR		DFT17D4-KS	850278535.01.01.001	0.5										32 hrs/wk
PLANT WATER BOOSTER PUMP	MARATHON	7VF-184TTFS6810AN-L	MB596070-06/21-01	5	89.5%	89.0%								96 hrs/wk
POLYMER PUMPS (2)	BALDOR	5902205	F0010200721	0.5	55.0%	69.0%								32 hrs/wk
CLARIFIER	US MOTORS	DD056916		0.5										
CLARIFIER	US MOTORS		6119/Y07Y156R071F	0.5	72.0%									

APPENDIX B, CALCULATION PROCEDURE FOR OXYGEN DEMAND

CLIENT: JCI Brewerton	JOB NO. 2121	COMPUTED BY: P. Vavonese
PROJECT NAME: Diffused Aeration	CHECKED BY: A. Saikkonen	DATE COMPUTED: 6-14-12
FACILITY NAME: Brewerton WPCP	DATE CHECKED: 6-19-12	
DETAIL Current Average and Max Day Existing Tube Membrane Diffusers	REVISION NO. 3	DATE REVISED: 6-28-12 and 7/31/12 by NOV

1.0 PURPOSE/OBJECTIVE

This procedure estimates oxygen demand and air requirements and sizes centrifugal and positive displacement blowers and mechanical aerators for activated sludge. For this calculation, aerobic digester requirements were no included.

2.0 PROCEDURE

Input from the user on site conditions (found in section 5.1.1; note that all numbers in parentheses below refer to the sections in which data or calculations are provided in this file) is used to calculate correction factors that account for the influence of process water characteristics, temperature and pressure on the oxygen transfer coefficient and saturation value under standard clean water conditions (5.2.1).The ratio of field oxygen transfer rate to standard oxygen transfer rate (5.2.2), combined with information on the standard oxygen transfer efficiency for the diffusers based on manufacturer information (5.2.3), is used to calculate the field oxygen transfer efficiency (5.2.4). Air requirements are then estimated from the field oxygen transfer efficiency and the average oxygen demand, with an allowance for diffuser fouling (5.2.5).

3.0 REFERENCES AND DATA SOURCES

The procedure used to calculate air requirements and size blowers is based on procedures contained in:

*(1) WEF/ASCE. **1988.** Aeration. WEF Manual of Practice FD-13/ASCE Manuals and Reports on Engineering Practice No. 68.*
*(2) Mueller, J., W.C. Boyle, and H.J. Popel. **2002.** Aeration: Principles and Practice. CRC Press.*
*(3) EPA. **1989.** Fine Pore Aeration Manual. EPA/625/1-89/023.*

The relationship between temperature and dissolved oxygen concentration is from:

*APHA. **1999.** Standard Methods for the Examination of Water and Wastewater, 20th Edition. Washington DC: American Public Health Association.*

Good references for basic properties of air and water:

*(1) CRC. **2004.** Handbook of Chemistry and Physics. 85th Edition. CRC Press.*
*(2) Perry, R.H. and D.W. Green. **1997.** Perry's Chemical Engineers' Handbook. 7th Edition. McGraw Hill.*

3.2 Data Sources

As provided by personnel at Brewerton WWTP

4.0 ASSUMPTIONS AND LIMITATIONS

4.1 Unit Conversions

$MGD := 1000000 \cdot \frac{gal}{day}$

$MG := 1000000gal$

4.2 Standard Conditions

The following correspond to US practice standard conditions, wherein tap water is the standard type of water, 20 deg C is the standard water temperature, chloride concentration is 0 g/L, barometric pressure is 1 atm, and air flow occurs at 20 deg C and 36% relative humidity. Eurpopean practice standard conditions are the same with the exception of air flow, which is at 0 deg C and 0% relative humidity. Standard conditions are from Mueller et al. (2002).

$T_{StandardWater} := 20$ Standard water temperature (degree C)

$T_{StandardWaterK} := (T_{StandardWater} + 273.15) \cdot K$ Standard water temperature (degree Kelvin)

$T_{StandardAir} := 20$ Standard air temperature (degree C)

$T_{StandardAirR} := (1.8T_{StandardAir} + 32) + 460$ Standard air temperature (degree Rankine)

$P_{Standard} := 14.7 \cdot psi$ Standard atmospheric pressure

$RH_{Standard} := 36 \cdot \%$ Standard relative humidity

$\rho_{Air} := 0.075 \frac{lb}{ft^3}$ Density of air at standard conditions (20 degree C & 36% RH)

$\%O_2 := 0.232$ % of oxygen by weight in air at standard conditions

$\gamma_{Water} := 62.4 \frac{lbf}{ft^3}$

5.0 CALCULATION

5.1 Site Conditions

5.1.1 Input by User

Note: Temperatures have to be in degrees Celsius. Elsewhere, any system of units may be used.

5.1.1.1 Input Needed to Calculate Oxygen Demand

$Q_{Avg} := 1.98MGD$	Average daily flow
$Q_{Min} := 1.3 \cdot MGD$	Minimum daily flow
$Q_{Peak} := 2.95MGD$	Peak Max day Flow
$V_{Aer} := 0.8MG$	Aeration volume - used to calculate F/M
$MLSS := 2300 \cdot \frac{mg}{L}$	Mixed liquor suspended solids in aeration - used to calculate F/M based on operating data.
$BOD_{In} := 164.79 \cdot \frac{mg}{L}$	Average influent BOD - used to calculate F/M from BOD removed
$BOD_{Eff} := 14 \cdot \frac{mg}{L}$	Average effluent BOD - used to calculate F/M from BOD removed
$TKN_{In} := 25 \cdot \frac{mg}{L}$	Average influent TKN - used to calculate effluent soluble organic nitrogen
$NH3_{Eff} := .4 \cdot \frac{mg}{L}$	Average effluent ammonia - used to calculate nitrogen available for nitrification (Average for 2011 is 0.4 mg/L NH3 effluent. Average TKN for 2008-2011 is 4.2 mg/L)
$NO3_{eff} := 4.2 \frac{mg}{L}$	Average effluent nitrate - used to calculate oxygen saved by denitrification
$\%Vol := 0.8$	% of waste and effluent solids that is volatile. Default is 0.8. Used to find nitrogen needed for growth of heterotrophic microorganisms.
$\%N := 0.088$	% of volatile fraction of waste and effluent solids that is N. Default is 0.088. Used to find nitrogen needed for growth of heterotrophs.
$\%SolON_{Eff} := 0.015$	Soluble organic N leaving aeration as a % of TKN in raw wastewater. Default is 1.5%.
$PF_{BODMaxDay} := 1.56$	Peaking factor for maximum day to average influent BOD. Default value is 1.85. Used to calculate peak BOD removed.
$PF_{TKNMaxDay} := 1.2$	Peaking factor for maximum day to average influent TKN. Default value is 1.85, assuming TKN varies in direct proportion to BOD.
$Y := 0.95 \cdot \frac{lb}{lb}$	Yield (lb solids per lb BOD removed) (operational data from table 3-1 with SRT of 8.4 days)

5.1.1.2 Input Needed to Calculate Air Requirements Based on Oxygen Demand

Needed for both diffused and mechanical aeration:

$T_{Wastewater} := 13.93$ — Wastewater temperature (deg C) - affects saturation DO, OTR_f

$T_{Ambient} := 25$ — Ambient temperature (deg C) - affects power required for PD blowers

$Elevation := 380 \cdot ft$ — Elevation of facility - used to calculate ambient pressure

$Submergence := 12ft$ — Diffuser submergence; diffusers are generally installed as close to the basin floor as possible -- typically within 9 in of the highest point on the floor (EPA 1989).

$C_{ds} := 0 \cdot \frac{mg}{L}$ — Chloride concentration - used to calculate saturation DO.

$C_0 := 2.0 \cdot \frac{mg}{L}$ — Design steady state DO. Default is 2 mg/L

$\beta := 0.95$ — Relative O_2 saturation compared to clean water = C_s(*wastewater*)/C_s(*clean water*). Default is 0.95.

$\theta := 1.024$ — Temperature correction for α, assumed to be 1.024 unless tests show a different factor

Needed for diffused aeration only:

Note: Alpha for diffused aeration is calculated in section 5.3.1 below based on SRT.

$T_{AirSummerMax} := 38$ — Summer max air temperature (deg C). Default is 38C (100F) - used to calculate maximum airflow requirements.

$T_{AirWinter} := -23$ — Winter minimum air temperature (deg C). Default is -18C (0F).

$RH_{Ambient} := 95\%$ — Actual relative humidity. Default is 85%.

$f_{edDiffused} := 0.33$ — Equivalent depth factor; 0.26 to 0.34 for coarse bubble and 0.21 to 0.44 for fine bubble

$P_{InletLosses} := 0.3 \cdot psi$ — Blower inlet pressure losses, usually assumed to be ~ 0.3 psig

$P_{DischargeLosses} := 1.9psi$ — Blower discharge losses, about 1.9 psig but will depend on distance between blowers and aeration tanks.

$SOTE_{DiffuserUnit} := 0.9 \cdot \frac{\%}{ft}$ — Diffuser unit SOTE, % per foot of diffuser submergence. Depends on diffuser type, layout, air flow, and submergence. 0.9% SOTE is the manufacturer value for tube style membrane diffusers in a rolling pattern

$SRT := 8.4 \cdot day$ — Used to calculate alpha for diffused aeration. (taken from operational data

$F_{\alpha} := 1$ — Allowance for diffuser fouling

5.2 Oxygen Demand

5.2.1 Calculated from User Input

Find food to microorganism ratio (used to find unit oxygen demand):

$$F := (BOD_{In} - BOD_{Eff}) \cdot Q_{Avg}$$

$$F = 2492 \cdot \frac{lb}{day}$$

$$M := V_{Aer} \cdot MLSS$$

$$M = 15356 \cdot lb$$

$$\boxed{\frac{F}{M} = 0.162 \cdot \frac{1}{day}}$$

5.2.2 Carbonaceous oxygen demand

5.2.2.1 Compute average and peak BOD removed

$$BOD_{rAvg} := (BOD_{In} - BOD_{Eff}) \cdot Q_{Avg}$$

$$\boxed{BOD_{rAvg} = 2492 \cdot \frac{lb}{day}}$$

$$BOD_{rPeak} := (PF_{BODMaxDay} \cdot BOD_{In} - BOD_{Eff}) \cdot Q_{Avg}$$

$$\boxed{BOD_{rPeak} = 4017 \cdot \frac{lb}{day}}$$

5.2.2.2 Compute oxygen demand per pound BOD removed

Oxygen demand per pound of BOD is assumed to be a function of SRT. Ratio of oxygen required is equal to 0.8+(0.027xSRT)

$$O2_{BOD} := 1.02$$

5.2.2.3 Compute average and peak oxygen demand

$$OD_{CarbAvg} := O2_{BOD} \cdot BOD_{rAvg}$$

$$\boxed{OD_{CarbAvg} = 2541 \cdot \frac{lb}{day}}$$

$$OD_{CarbPeak} := O2_{BOD} \cdot BOD_{rPeak}$$

$$OD_{CarbPeak} = 4097 \cdot \frac{lb}{day}$$

5.2.3 Nitrogenous oxygen demand

5.2.3.1 Find soluble organic nitrogen exiting aeration tank

$$ON_{SolEff} := \%SolON_{Eff} \cdot TKN_{In} \cdot Q_{Avg}$$

$$ON_{SolEff} = 6 \cdot \frac{lb}{day}$$

5.2.3.2 Find nitrogen used for growth of carbonaceous removing organisms

$$OD_{NitCarb} := \%Vol \cdot \%N \cdot Y \cdot BOD_{rAvg}$$

$$OD_{NitCarb} = 167 \cdot \frac{lb}{day}$$

5.2.3.3 Find average and peak nitrogen available for nitrification

$$NH3_{NitAvg} := TKN_{In} \cdot Q_{Avg} - ON_{SolEff} - OD_{NitCarb} - NH3_{Eff} \cdot Q_{Avg}$$

$$NH3_{NitAvg} = 234 \cdot \frac{lb}{day}$$

$$NH3_{NitPeak} := TKN_{In} \cdot PF_{TKNMaxDay} \cdot Q_{Avg} - ON_{SolEff} - OD_{NitCarb} - NH3_{Eff} \cdot Q_{Avg}$$

$$NH3_{NitPeak} = 316 \cdot \frac{lb}{day}$$

5.2.3.4 Find oxygen required for nitrification

Assuming 4.25. lb O2 required per lb of NH3-N nitrified

$$O2_{Nit} := 4.25 \cdot \frac{lb}{lb}$$

$$OD_{NitAvg} := O2_{Nit} \cdot NH3_{NitAvg}$$

$$OD_{NitAvg} = 993 \cdot \frac{lb}{day}$$

$OD_{NitPeak} := O2_{Nit} \cdot NH3_{NitPeak}$

$OD_{NitPeak} = 1344 \cdot \frac{lb}{day}$

5.2.4 Total average and peak oxygen demand

$OD_{TotAvg} := OD_{CarbAvg} + OD_{NitAvg}$

$OD_{TotAvg} = 3534 \cdot \frac{lb}{day}$

$OD_{TotPeak} := OD_{CarbPeak} + OD_{NitPeak}$

$OD_{TotPeak} = 5441 \cdot \frac{lb}{day}$

Note: Maximum oxygen demand can be more accurately determined from computer simulations using historical plant data on flows, BOD, and TKN.

5.3 Air Requirements for Diffused Aeration

5.3.1 Calculated from User Input

$T_{WastewaterK} := (T_{Wastewater} + 273.15) \cdot K$ Wastewater temperature (Kelvin)

$T_{AmbientK} := (T_{Ambient} + 273.15) \cdot K$

$T_{AirSummerK} := (T_{AirSummerMax} + 273.15)K$ Summer max air temperature (Kelvin)

$T_{AirSummerMaxR} := (1.8 \cdot T_{AirSummerMax} + 32) + 460$ Summer max air temperature (Rankine)

$T_{AirWinterK} := (T_{AirWinter} + 273.15)K$ Winter air temperature (Kelvin)

$T_{AirWinterR} := (1.8 \cdot T_{AirWinter} + 32) + 460$ Winter air temperature (Rankine)

$P_{Ambient} := P_{Standard} \cdot \left(1 - \frac{Elevation}{30000 \cdot ft}\right)$

$P_{Ambient} = 1.001 \times 10^{5} Pa$

Barometric pressure calculated as a function of elevation; equation from Mueller et al. Aeration: Principles and Practice 2002 p. 26

$P_{BlowerInlet} := P_{Ambient} - P_{InletLosses}$

$P_{BlowerInlet} = 14.214 \cdot psi$

Blower inlet pressure = ambient pressure - blower inlet losses

$P_{Vapor}(T) := \left(0.00000007 \cdot T^4 + 0.00000313 \cdot T^3 + 0.00020431 \cdot T^2 + 0.00657480 \cdot T + 0.08865719\right) \cdot psi$

Water vapor pressure from a 4th-order fit to tabular water vapor pressure data vs. temperature (deg C)

$P_{VaporStandard} := P_{Vapor}\left(T_{StandardWater}\right)$

$P_{VaporStandard} = 0.338 \cdot psi$

$P_{VaporWastewater} := P_{Vapor}\left(T_{Wastewater}\right)$

$P_{VaporWastewater} = 0.231 \cdot psi$

$P_{VaporSummerMax} := P_{Vapor}\left(T_{AirSummerMax}\right)$

$P_{VaporSummerMax} = 0.951 \cdot psi$

$P_{VaporWinter} := P_{Vapor}\left(T_{AirWinter}\right)$

$P_{VaporWinter} = 0.027 \cdot psi$

$P_{Static} := \gamma_{Water} \cdot Submergence$

$P_{Static} = 5.2 \cdot psi$

Pressure above diffusers.

$\alpha_{Diffused} := .6$

Relative rate of O_2 transfer = K_La (*wastewater*)/K_La (*clean water*); range is 0.40 - 0.45 for non-nitrifying systems and 0.55 - 0.65 for nitrifying systems for fine bubble and 0.85 for coarse bubble

5.3.2 Calculate Correction Factors

5.3.2.1 Calculate Temperature Correction, τ

$$X(T) := C_{ds} \cdot \left(0.031929 - 19.428 \cdot \frac{K}{T} + 3867.3 \cdot \frac{K^2}{T^2}\right) \cdot \frac{L}{gm}$$

$$C_S(T) := \exp\left[\left[-139.34411 + \left(157570.1 \cdot \frac{K}{T}\right) - \left(66423080 \cdot \frac{K^2}{T^2}\right) + \left(12438000000 \cdot \frac{K^3}{T^3}\right) - \left(862194900000 \cdot \frac{K^4}{T^4}\right) - X(T)\right]\right] \cdot \frac{mg}{L}$$

Saturation dissolved oxygen as a function of temperature (in K); equation from APHA (1999), p. 4-139.

$$C_S(T_{StandardWaterK}) = 9.09 \cdot \frac{mg}{L}$$

$$C_S(T_{WastewaterK}) = 10.32 \cdot \frac{mg}{L}$$

$$\tau := \frac{C_S(T_{WastewaterK})}{C_S(T_{StandardWaterK})}$$

Temperature correction factor for oxygen concentration = $C_S(\textit{Wastewater})/C_s(\textit{Standard})$

$$\boxed{\tau = 1.135}$$

5.3.2.2 Calculate Altitude Correction, Ω

$$D_{Equivalent} := f_{edDiffused} \cdot Submergence$$

$$D_{Equivalent} = 3.96 \cdot ft$$

$$P_{EquivalentDepth} := \gamma_{Water} \cdot D_{Equivalent}$$

$$P_{EquivalentDepth} = 1.716 \cdot psi$$

$$\Omega := \frac{P_{Ambient} + P_{EquivalentDepth} - P_{VaporWastewater}}{P_{Standard} + P_{EquivalentDepth} - P_{VaporWastewater}}$$

$$\boxed{\Omega = 0.988}$$

Altitude correction factor for oxygen concentration; approximately equal to $P_{Ambient}/P_{Standard}$ up to a submergence of 20 ft

5.3.2.3 Calculate Depth Correction, C_{SC}

$$C_{SC} := \left(\frac{P_{Standard} - P_{VaporWastewater} + P_{EquivalentDepth}}{P_{Standard} - P_{VaporWastewater}}\right) \cdot C_S(T_{StandardWaterK})$$

$$\boxed{C_{SC} = 10.17 \cdot \frac{mg}{L}}$$

Spatial average DO saturation concentration at infinite time, standard temperature, and altitude; equation from WEF MOP FD-13, p. 16

5.3.3 Calculate OTRf/SOTR, OTEf/SOTE Ratio

$$RATIO := \left(\frac{\beta \cdot \tau \cdot \Omega \cdot C_{SC} - C_0}{C_{SC}}\right) \cdot \alpha_{Diffused} \cdot F_{\alpha} \cdot \theta^{T_{Wastewater} - 20}$$

$RATIO = 0.452$

5.3.4 Calculate Diffuser SOTE

$$SOTE_{Diffuser} := SOTE_{DiffuserUnit} \cdot Submergence$$

$SOTE_{Diffuser} = 0.108$

5.3.5 Calculate Field OTE

$$OTE_{Field} := SOTE_{Diffuser} \cdot RATIO$$

$OTE_{Field} = 0.049$

5.3.6 Estimate Air Requirements

$$SCFM_{Average} := \frac{OD_{TotAvg} \cdot 1.1}{OTE_{Field} \cdot \%O_2 \cdot \rho_{Air}}$$

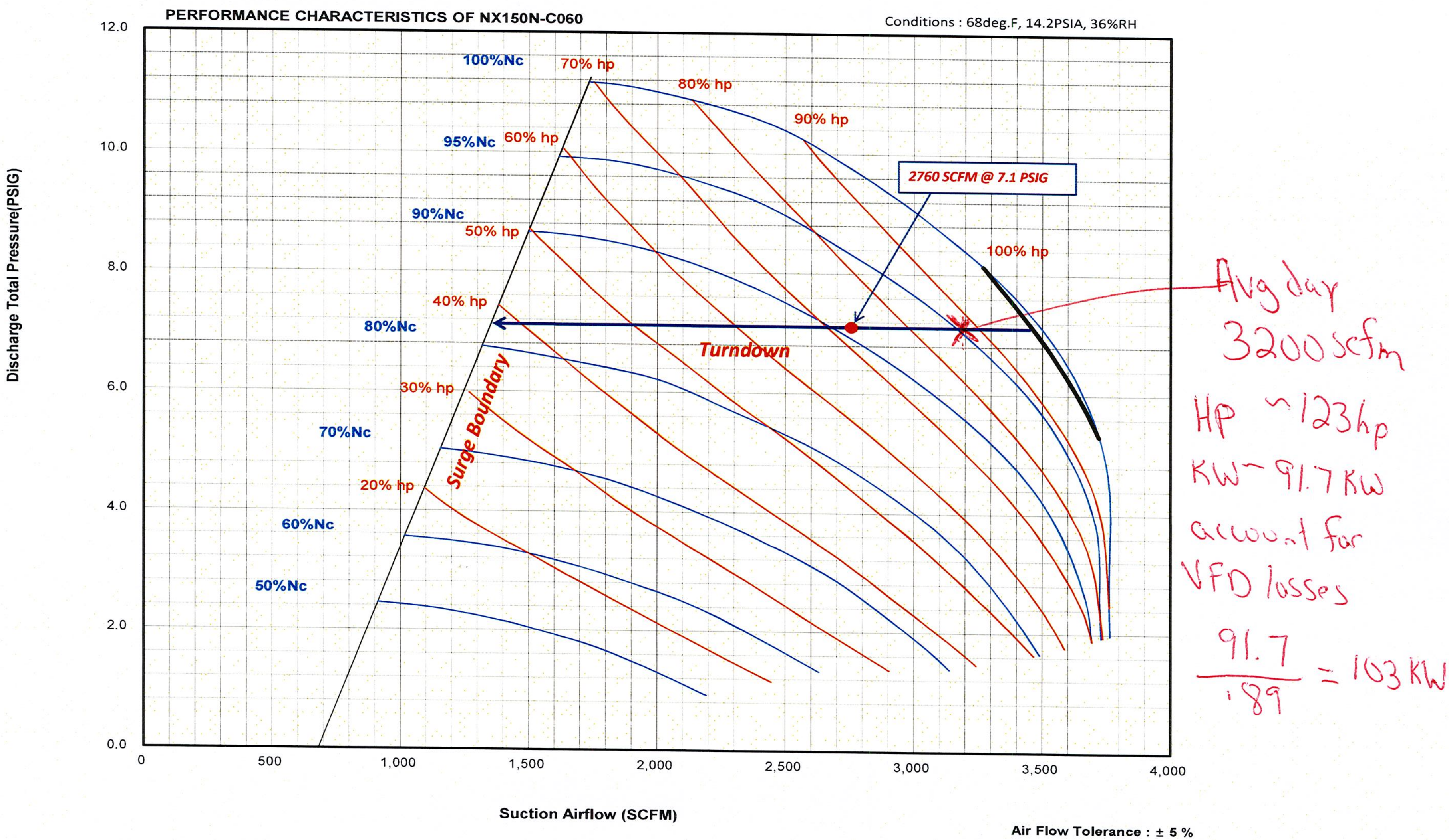
$SCFM_{Average} = 3180.8 \cdot \frac{ft^3}{min}$

$$SCFM_{Maximum} := \frac{OD_{TotPeak} \cdot 1.1}{OTE_{Field} \cdot \%O_2 \cdot \rho_{Air}}$$

$SCFM_{Maximum} = 4896.6 \cdot \frac{ft^3}{min}$

Brewerton NY WWTP - APG - Neuros Turbo Blower - Performance Curves

Std. Spec. V6.9



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APPENDIX C, BLOWER CUT SHEETS AND CURVES

Rev 1.3

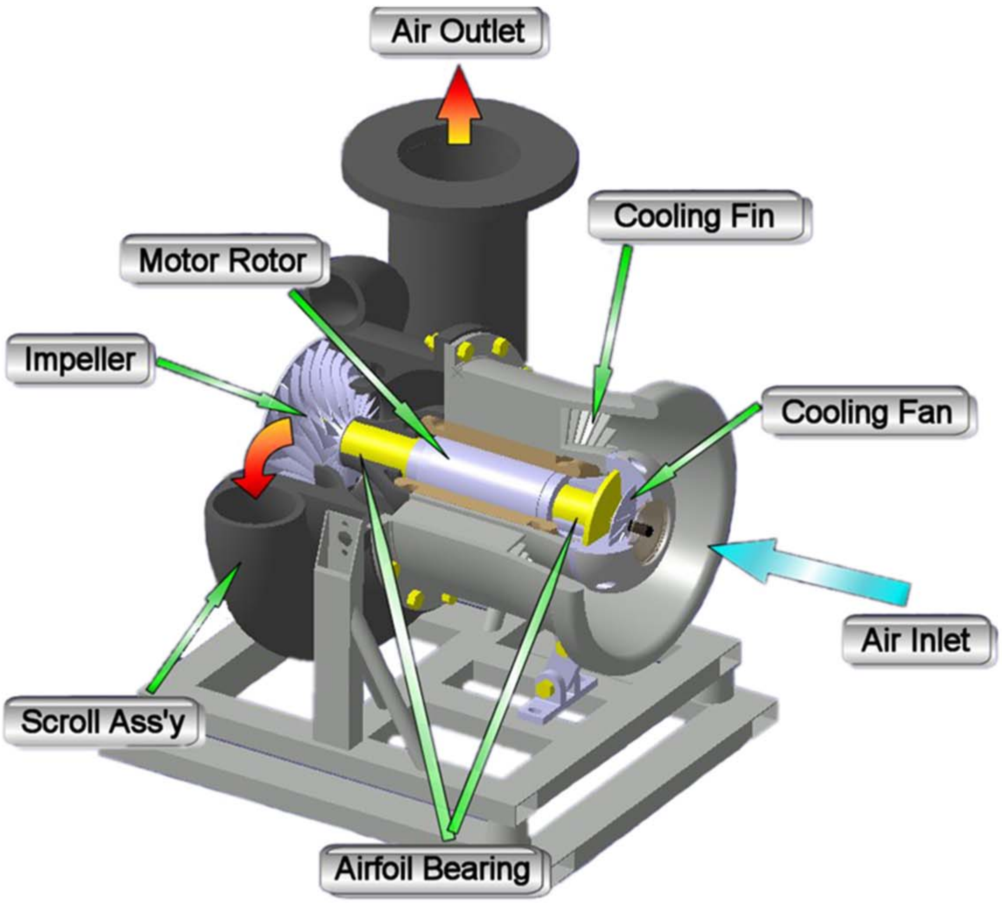
APG-Neuros Turbo Blower Scope of Supply Proposal

Brewerton NY WWTP

CDM Smith

Prepared By APGN Inc. *dba* APG-Neuros

Date
July 3, 2012
Proposal Reference # 558-070312-CM



APG-Neuros Turbo Blower Core

Brewerton NY WWTP - APG- Neuros Turbo Blower - Performance Data

Design Conditions

Application	Option 1	Option 2	Option 3	
Blower Installation Location	Indoor	Indoor	Indoor	
Working Fluid	Air	Air	Air	
Elevation	400	400	400	Feet
Inlet Pressure	14.488	14.488	14.488	PSIA
Inlet Temperature	100	100	100	Deg. F
Relative Humidity	95	95	95	%

Design Conditions

Maximum Design System Flow Rate	3642	5518	2760	SCFM
Minimum Design System Flow Rate	1540	1540	1540	SCFM
Discharge Pressure	7.1	7.1	7.1	PSIG
Flow Rate per Blower	2365	3585	2760	SCFM
Number of Blowers - Duty	2	1	2	Units
Number of Blowers - Stand-By	1	1	1	Units

Available Blower Performance

Model	**NX200-C070**	**NX350-C100**	**NX150-C060**	
Rate Motor Output Power	200	350	150	HP
Maximum Air Flow @ Duty Discharge Pressure per Blower	4177	5518	3333	SCFM
Minimum Air Flow @ Duty Discharge Pressure per Blower	1383	1407	1264	SCFM
Turndown from Maximum Flow	66.9%	74.5%	62.1%	%
Shaft Power @ Design Conditions per Blower	**89.4**	**143.1**	**114.5**	**bhp**
Wire-to-Air Power @ Design Condition per Blower	**74.7**	**119.6**	**95.7**	**kW**
Discharge Temperature @ Design Condition	184	188.7	192.2	Deg. F
Maximum Discharge Pressure	13.329	17.92	11.392	PSIG
Rise-to-Surge	6.229	10.82	4.292	PSIG

Notes

Maximum Noise Level @ 3 feet	80	80	80	dBA
Dimensions per Blower, L / W / H	83/39/65	83/55/80	61/30/53	Inches
Weight per Unit	2693	4268	1848	lbs.
Heat Rejection inside Blower Room	0	0	0	kW
Cooling Requirements	0	0	0	kW
Input Voltage/Phase/Frequency	480/3/60	480/3/60	480/3/60	V/Phase/Hz
Full Load Amperage	221	364	166	Amps
Inlet Flange Size (Optional, does not apply to louvered inlet)	16	18	16	Inches
Discharge Flange Size	12	12	12	Inches

Note:

Performance data is measured at core inlet with a Tolerance of ± 5 % on flow values and ± 2 dBa on noise level

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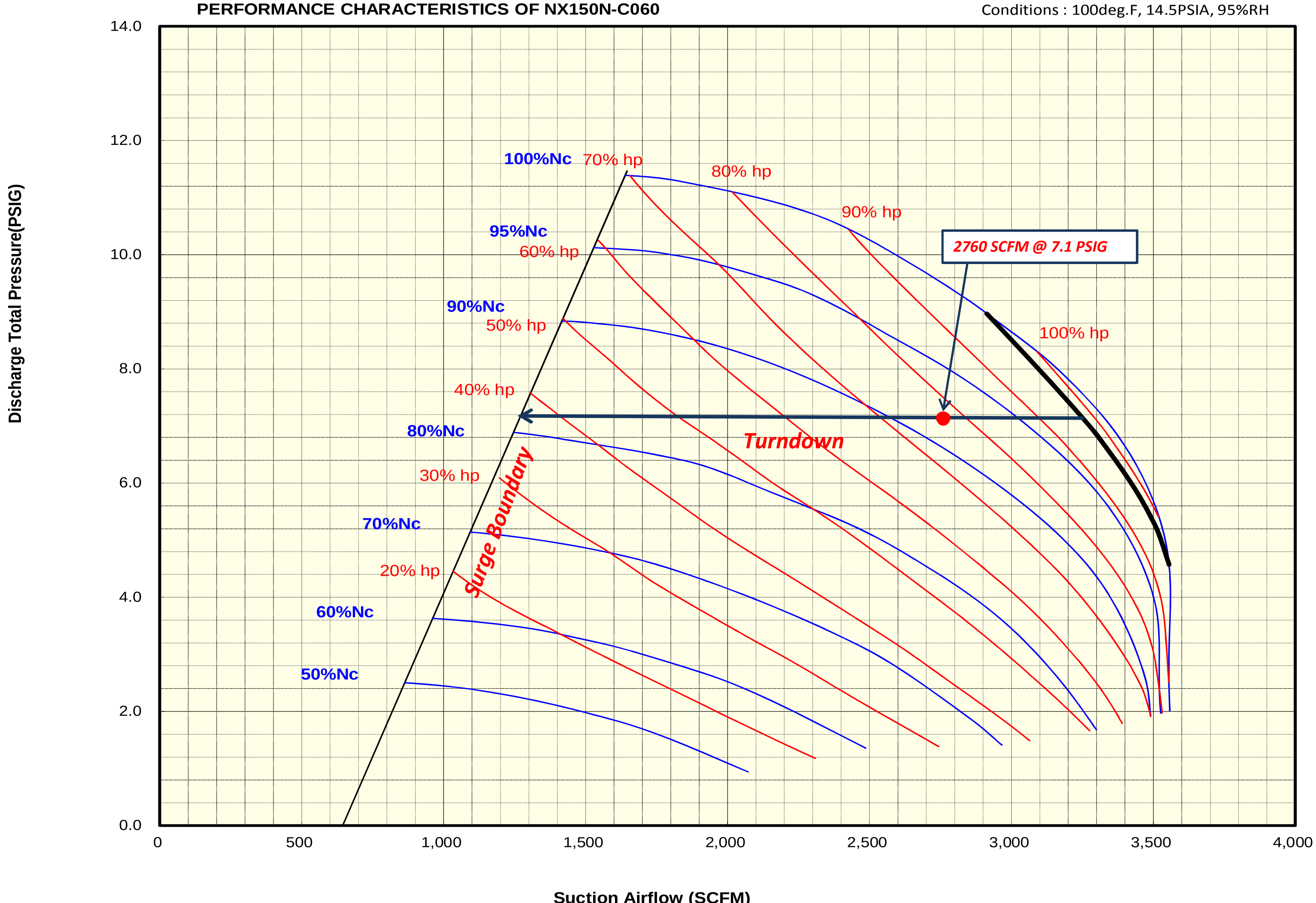
Std. Spec. V6.9

PERFORMANCE CHARACTERISTICS OF NX150N-C060

Conditions : 100deg.F, 14.5PSIA, 95%RH



Air Flow Tolerance : ± 5 %

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APG - Neuros Turbo Blower - Blower Components

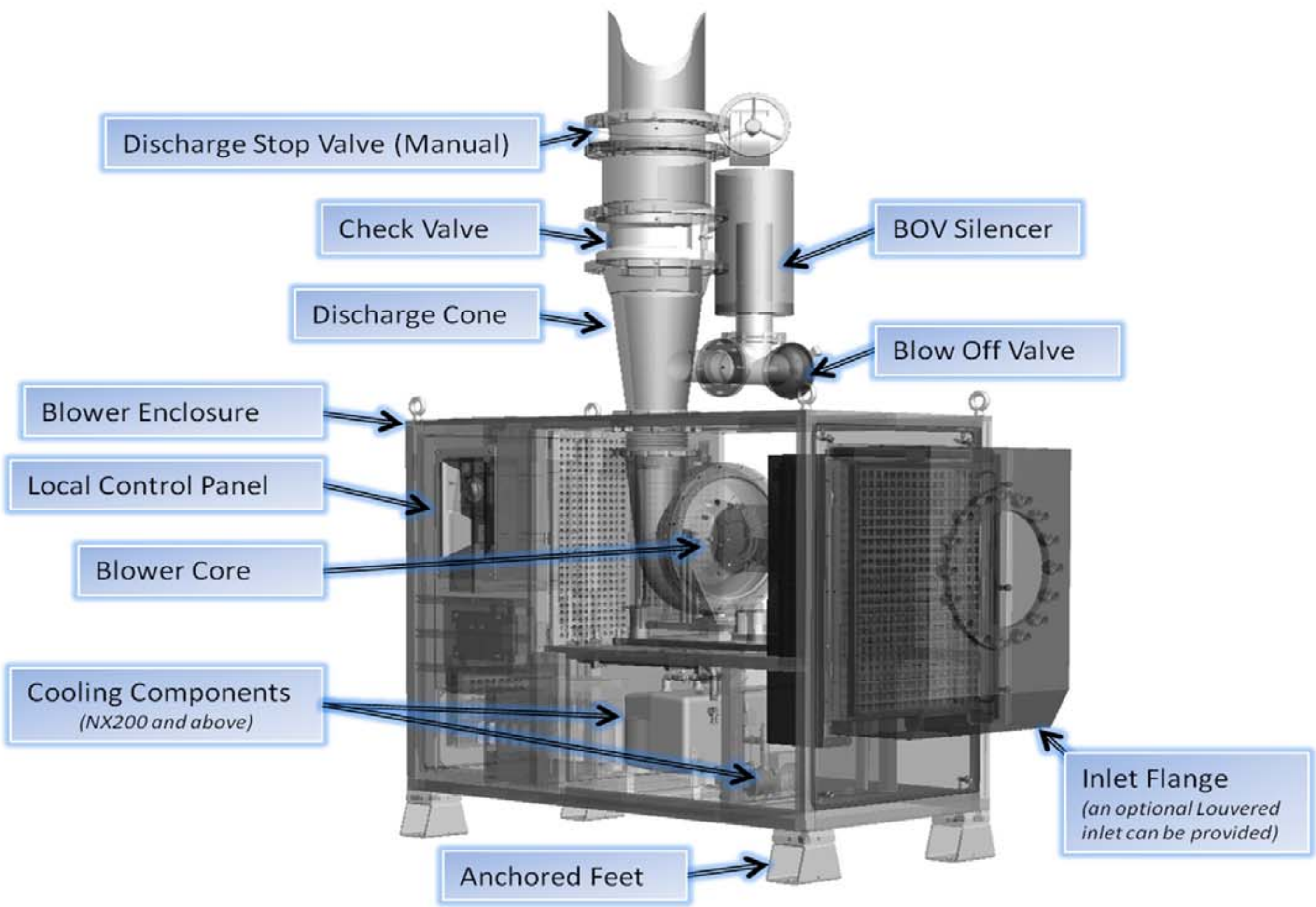

*Image is not project specific.

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Brewerton NY WWTP - APG - Neuros Turbo Blower - Scope of Supply

APG-Neuros Inc., agrees to sell to the Buyer, the equipment designated as Included in the scope of supply below, subject to the Seller's General Terms and Conditions of Sales available upon request and special conditions outlined herein in this proposal.

1. Standard Turbo Blower Equipment *(Included)*

1.1 Blower Package

1. Blower Core with Permanent Magnet Synchronous Motor, Air Bearing and Forged Impeller
2. High Performance Variable Speed Drive / Inverter
3. Local Control Panel for Control and Monitoring, **A-B MicroLogix Case 2 PLC based**
4. Remote Control capability via Ethernet, LAN or Hard wiring
5. Built in Standard Sound Enclosure with Louver Intake
6. Temperature Sensors for motor, bearing, inlet and discharge air flow
7. Pressure Sensors for discharge conditions
8. Pressure Sensor and alert for air filter condition
9. Built in Flow Calculation
10. Built in Speed Measurement
11. Internal Expansion Joint
12. Internal vibration and dynamic effect Absorption Mounts
13. Line Input Reactor to maintain high power factor
14. Sinewave (Sinus) Filter
15. Built in Air Filter to within ten micron filtration

1.2 Standard Ship Loose Accessories

1. One (1) Saehan Type Wafer Discharge Check Valve **
2. One (1) DK T.M.I Discharge Butterfly Valve **
3. One (1) Maxi Joint EPDM Discharge Duct Expansion Joint **
4. One (1) Discharge Cone**
5. One (1) Blow-off Valve to blow off air flow during start / shutdown
6. One (1) Blow-off Silencer

***Sizes as indicated on the performance data sheet.*

2. Optional Equipment

2.1 Computers and Software *(Not Included unless specified in Price sheet)*

A. Master Control Panel to operate multi-blowers

1. Complete standalone computer system, built with its own state of the art technology microprocessor in a self contained enclosure.
2. MCP operates based on input and output signals to control on line blowers and other flow equipment based on command point

2.2 Harmonic Filters *(Not Included unless specified in Price sheet)*

1. Meets IEEE 519 standards for <8% THD or 5%THD
2. Can be Included inside the blower enclosure or as a standalone unit.

2.3 Vibration Sensor *(Not Included unless specified in Price sheet)*

1. Vibration sensor comes with transmitter and display screen

2.4 Enclosure Options *(Not Included unless specified in Price sheet)*

1. Outdoor Enclosure Installed Under Canopy***
2. Completely Outdoor Enclosure with no Canopy
2. Inlet Flange

**** Canopy design can be provided or is to be pre-approved by Seller*

4. Standard Documentation *(Included)*

A. Submittal Information: PDF Electronic File

1. Bill of Material
2. Installation Drawings
3. Electrical and Control Drawings
4. Operation and Maintenance Manual
5. Commissioning Instructions

B. Standard Tests

1. Standard Blower Package Functional Acceptance Test ***included***

2. PTC-10 Factory Performance Test - available for additional cost upon request

3. Optional Functional tests with Plant LC - available for additional cost upon request

4. Optional Aeration System Control functional system test - available for additional cost upon request

For any Factory witnessed testing or additional tests, please contact APG-Neuros for a price quote.

5. Spare parts (on site)

A. One set of spares

1. One (1) set of Air Filter Elements

6. Quality Assurance and Control and Product certification

A. Neuros Quality Assurance program is ISO 9001 certified on the basis of Neuros Co. Ltd.

B. Neuros Turbo Blower is UL / CSA certified

C. Turbo Blower UL 1450 or UL508A certification is supplied as an option.

D. Turbo Blower is CE certification is supplied as an option.

7. Start-up and Factory Testing Service:

Unless inlcuded in the Price, start-up and operator training is available at US $2,000 per day plus travel and living expenses billed at cost, plus 10%. Advance notification of 15 working days is required for scheduling.

8. Proposal Validity and Seller Terms and Conditions

A. Unless otherwise specified elsewhere in the Sales Agreements, the prices in this proposal are valid for ninety (90) days from the issue date on the cover page.

B. This proposal, unless otherwise specified herein this document, is subject to the Seller's General Terms and Conditions of Sales available upon request.

9. Payment Terms:

Payments shall be made as follows:

15% upon issuance of shop drawings

75% at delivery to Jobsite or offer to ship based on agreed upon schedule

10% upon Start-up, no later than 90 days after Delivery

All invoices are paid Net 30 Days

1.5% Interest charge per month will be added to past due accounts.

Letter of Credit listing draw of payments against above deliverables will apply for Sales outside US and Canada.

100 % of invoice amount shall be payable by bank wire transfer without deduction and to be paid Net 30 days after invoice date.

Payment shall not be dependent on the buyer being paid by any third parties or equipment acceptance by owner.

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Brewerton NY WWTP - APG - Neuros Turbo Blower - Scope of Supply

10. Submittals or Shop Drawings:

Submittal package will be provided within 4 to 6 weeks after acceptance of the Purchase Order by APG-Neuros.

11. Shipment:

Shipping terms, unless otherwise stated in price details, shall be ExWorks Factory

Shipment will be made within 12 to 16 weeks after acceptance of Purchase Order by APG-Neuros or 16 weeks after approval of Submittals, which ever occurs last.

Add Five percent (5%) escalation to Price for each partial or full quarter that shipment is extended beyond one year after order acceptance.

12. Warranty

A. Standard Warranty (INCLUDED)

Non pro-rated One (1) year from commissioning date or Eighteen (18) months from delivery, whichever occurs first.

Warranty will begin upon successful completion of start-up and certification for full-scale operation by APG-Neuros, or Eighteen (18) months after shipment, whichever occurs first. Under no circumstances will the warranty begin upon "beneficial use", completion of the project, or acceptance of the equipment as determined by the Engineer or End User.

B. Extended Warranty (OPTIONAL - Not Included)

Warranty extension available included in Maintenance Cost Guarantee program described in Item C below.

C. Maintenance Cost Guarantee (OPTIONAL - Not Included)

All inclusive maintenance and warranty cost coverage beyond first year is available at additional cost.

13. Technical and Spares Support

Technical service personnel as required to support start-up and technical service is available at additional cost.

14. Items Not Included:

Installation, main starters, anchor bolts, interconnecting pipe, Electrical & Control Items outside Blower Package, fittings, bolts, nuts, gaskets, wiring, valves, taxes and duties, or any other items not specifically listed above.

APGN Inc.
1270 Michele-Bohec, Blainville, QC, J7C-5S4
Tel: 450-939-0799 Fax: 450 939 2115
www.apg-neuros.com

Brewerton NY WWTP - APG - Neuros Turbo Blower - Price

Budgetary Price (U.S. Dollars, 2012 Economy Year)

Tuesday, July 03, 2012

Standard Equipment Scope of Supply Price:

Application	Option 1	Option 2	Option 3
Total Quantity, Units	3	2	3
Model	NX200-C070	NX350-C100	NX150-C060
Design Condition, per Blower, SCFM	2365	3585	2760
Design Discharge Pressure, PSIG	7.1	7.1	7.1
Motor Rating, HP	200	350	150
Total Base Price	[redacted]	[redacted]	**$372,000**

Notes

Unless otherwise specified else where in this proposal,

Shipping and Handling	**ExWork Factory**
Taxes and Duties are	**Not included**
Start Up and Training	**Not included**

Rev 1.3

APG-Neuros Turbo Blower Scope of Supply Proposal

Brewerton NY WWTP

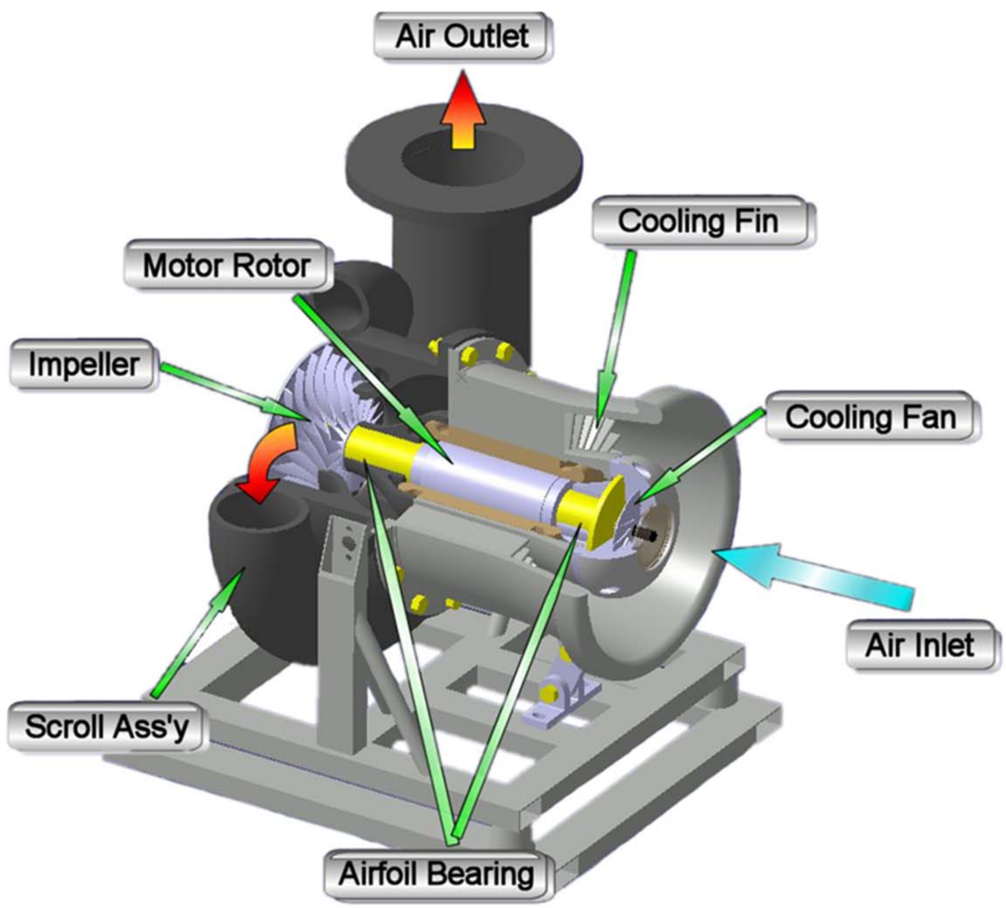
CDM Smith

Prepared By APGN Inc. *dba* APG-Neuros

Date

August 1, 2012

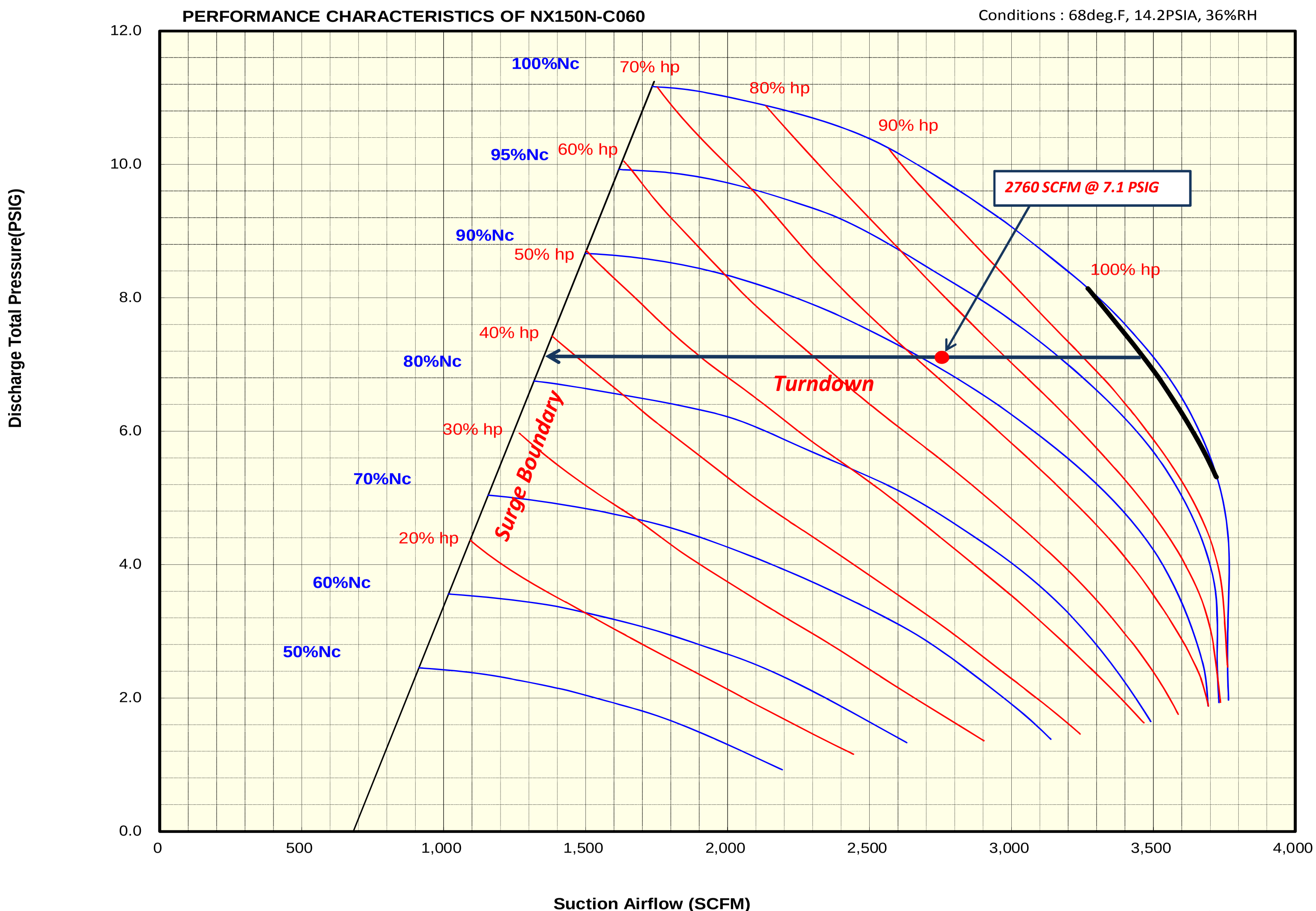
Proposal Reference # 558-070312-CM



APG-Neuros Turbo Blower Core

Brewerton NY WWTP - APG - Neuros Turbo Blower - Performance Curves

Std. Spec. V6.9



Air Flow Tolerance : ± 5 %

APGN Inc.
1270 Michele-Bohec, Blainville, QC, J7C-5S4
Tel: 450-939-0799 Fax: 450 939 2115
www.apg-neuros.com

QUOTATION

GP Jager

PO Box 937 Royersford PA 19468
(610) 495-9700 Ext. 104
(610) 495-9710 FAX
E-Mail: JohnP@ramequipment.com
web site: www.ramequipment.com

Attention: Randy Ott
Reference: Brewerton NY

Quote # : 44363-1
Date: 8/3/2012

QTY				
1	Blower:	**Roots Blower 418RAM**		
		Airflow: 300/1150 ACFM	Discharge Pressure:	6.9 psig
		Gas: Air	Specific Gravity:	1.0
		Inlet Pres: 14.4 psia	Inlet Temperature:	100 deg (F)
		Speed: 900/2892	Brake Horsepower:	48.37
	Blower Connections	Inlet: 8" flg	Discharge:	8" flg
1	Base:	Elevated Steel Base		
1	Drive:	V-Belt Drive		
1	Drive Guard:	Enclosed OSHA Style		
1	Relief Valve	Kunkle 337-3" set @ 8.5 psig (BHP=55.2)		
1	Inlet Filter:	8" w/paper filter		
1	Inlet Silencer:	8" w/supports		
1	Discharge Silencer:	6" w/supports		
1	Motor:	60HP 1800RPM 460/3/60		
1	Slide Base:	Adjustable		
1	Layout & Mount:	Yes		
3	Flexible Connectors:	R&M Series 500 or Equal		
1	Crating:	domestic		
	Accessories:			
1	Check Valve:	Wafer Type 6"		
1	Press Gauge:	Dischagre Pressure Gauge 2.5" dial liquid filled		
1	Lubrication	First Fill of Blower Oil Only		
1	Paint & Assembly:	Fully Assembled & Painted R&M Standard		
1	Engineering:	Sets of Submittals, O&M Manuals R&M Standard		
1	85dBa Galvanized Outdoor Sound Enclosure			

Price for One (1) Blower Package: $ 22,907

Adders/Options

Freight Not Included
Start Up By Others
R&M Standard Start Up will be billed at $ 600.00 per day plus all travel expenses

TO SUBMIT OUR PROPOSAL

John P. Pumo, Jr.

TERMS: Net 30
QUOTATION VALID: For 60 Days

QUOTATION

GP Jager

PO Box 937 Royersford PA 19468
(610) 495-9700 Ext. 104
(610) 495-9710 FAX
E-Mail: JohnP@ramequipment.com
web site: www.ramequipment.com

Attention: Randy Ott
Reference: Brewerton NY

Quote # : 44363-2
Date: 8/3/2012

QTY				
1	Blower:	**Roots Blower 418RAM**		
	Airflow:	300/1350 ACFM	Discharge Pressure:	6.9 psig
	Gas:	Air	Specific Gravity:	1.0
	Inlet Pres:	14.4 psia	Inlet Temperature:	100 deg (F)
	Speed:	900/3297	Brake Horsepower:	55.9
	Blower Connections Inlet:	8" flg	Discharge:	8" flg
1	Base:	Elevated Steel Base		
1	Drive:	V-Belt Drive		
1	Drive Guard:	Enclosed OSHA Style		
1	Relief Valve	Kunkle 337-3" set @ 8.5 psig (BHP=63.6)		
1	Inlet Filter:	8" w/paper filter		
1	Inlet Silencer:	8" w/supports		
1	Discharge Silencer:	8" w/supports		
1	Motor:	75HP 1800RPM 460/3/60		
1	Slide Base:	Adjustable		
1	Layout & Mount:	Yes		
3	Flexible Connectors:	R&M Series 500 or Equal		
1	Crating:	domestic		
	Accessories:			
1	Check Valve:	Wafer Type 8"		
1	Press Gauge:	Dischagre Pressure Gauge 2.5" dial liquid filled		
1	Lubrication	First Fill of Blower Oil Only		
1	Paint & Assembly:	Fully Assembled & Painted R&M Standard		
1	Engineering:	Sets of Submittals, O&M Manuals R&M Standard		
1	85 dBa Galvanized Outdoor Sound Enclosure			

Price for One (1) Blower Package: $ 25,388

Adders/Options

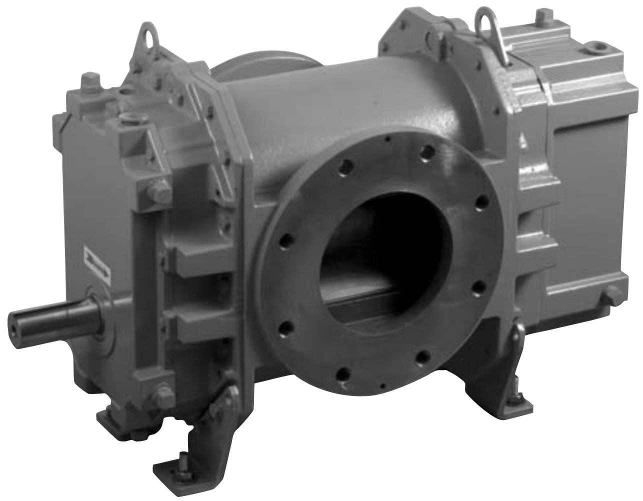
Freight Not Included
Start Up By Others
R&M Standard Start Up will be billed at $ 600.00 per day plus all travel expenses

TO SUBMIT OUR PROPOS/

John P. Pumo, Jr.

ROOTS™ RAM™
Rotary Positive Blowers
Frames 404 thru 624

RAM™ stands for Reliability, Availability and Maintainability. Today, more than ever, ROOTS is committed to supplying our customers with reliable products manufactured with state-of-the-art CNC machine tools. Production and inventory are being scheduled and controlled to ensure these units will be available when you need them. Design improvements such as repositionable rugged steel mounting feet and die-cast aluminum drive end covers and gear covers help to reduce installation costs and make normal maintenance easier.



BASIC BLOWER DESCRIPTION
RAM™ rotary blowers are heavy-duty units designed with integral-shaft ductile iron impellers having an involute profile. The headplates and rigid, one-piece casing are grey iron, while the drive end cover and gear cover are aluminum. Carburized and ground alloy steel spur timing gears are taper mounted on the shafts, secured with a locknut. Cylindrical roller bearings are used on all units.

Piston rings reduce air leakage through the shaft openings in the headplates, and lip-type oil seals prevent lubricant from entering the air chamber. A hydrodynamic seal on the drive shaft prevents shaft seal oil leaks.

RAM rotary blowers incorporate thrust control, with splash oil lubrication at both ends of the blower.

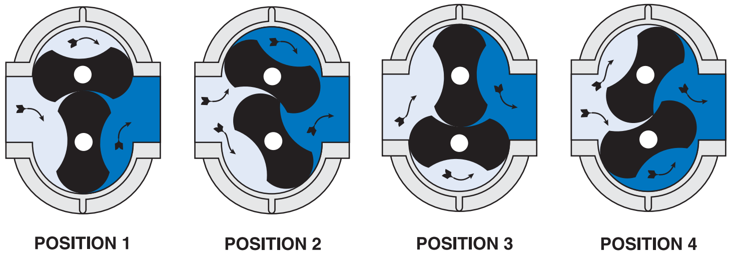
All frame sizes are designed with detachable rugged steel mounting feet which permit in-field adaptability to either vertical or horizontal installation requirements.

The top shaft is extended for drive on side outlet blowers, and either shaft can be extended for drive on top or bottom outlet blowers.

WARRANTY PERIOD
Twenty-Four (24) months from date of original unit start-up or 30 months from date of original shipment, whichever occurs first.

DESIGN AND CONSTRUCTION FEATURES
1. Horizontal and vertical configurations available
2. Improved volumetric efficiency and reduced operating temperatures
3. Alloy steel timing gears
4. Cylindrical roller bearings
5. Piston ring air seals
6. Lip-type, hydrodynamic oil seals,
7. Splash oil lubrication

OPERATING PRINCIPLE



Two figure-eight lobe impellers mounted on parallel shafts rotate in opposite directions. As each impeller passes the blower inlet, it traps a definite volume of air and carries it around the case to the blower outlet, where the air is discharged. With constant speed operation the displaced volume is essentially the same regardless of pressure, temperature or barometric pressure. Timing gears control the relative position of the impellers to each other and maintain small but definite clearances. This allows operation without lubrication being required inside the air casing.

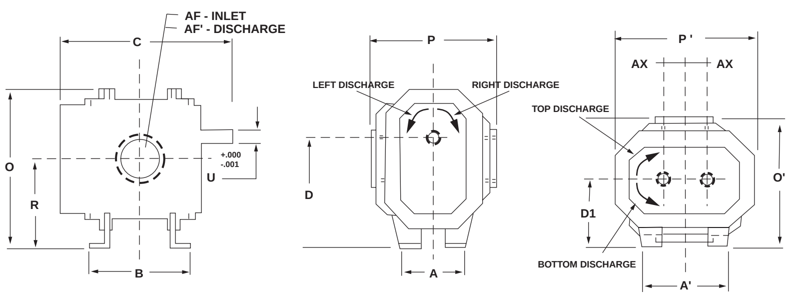
DRESSER Roots

PERFORMANCE TABLE

FRAME SIZE	SPEED RPM	4 PSI CFM	4 PSI BHP	6 PSI CFM	6 PSI BHP	8 PSI CFM	8 PSI BHP	10 PSI CFM	10 PSI BHP	12 PSI CFM	12 PSI BHP	15 PSI CFM	15 PSI BHP	18 PSI CFM	18 PSI BHP	MAX. VACUUM "Hg	MAX. VACUUM CFM	MAX. VACUUM BHP
404	1750	149	3.6	139	5.3	130	7.0	123	8.7	116	10.4					14.0	115	5.9
	2950	281	7.0	271	9.8	262	12.6	255	15.4	248	18.2	239	22.4			15.0	240	10.9
	4000	396	8.3	386	14.2	378	17.9	370	21.6	364	25.3	355	30.9	347	37.0	16.0	353	15.9
406	1750	225	5.4	210	8.0	198	10.5	187	13.0	177	15.6					14.0	173	9.0
	2950	426	10.5	411	14.7	398	18.9	387	23.1	377	27.3	363	33.6			15.0	365	16.4
	4000	601	15.0	586	20.1	574	26.0	562	31.9	552	37.0	539	46.5	526	54.0	16.0	531	23.6
409	1750	338	8.5	315	12.0	296	15.8	279	20.0	264	23.5					14.0	259	13.5
	2950	638	15.2	615	21.5	596	27.8	579	34.1	564	40.4	544	49.8			15.0	546	24.4
	4000	900	24.0	878	30.0	859	38.1	842	46.8	827	55.0	806	67.9	788	79.0	16.0	795	35.1
412	1750	450	11.0	420	16.0	394	21.0	372	26.0	352	32.0					14.0	343	17.7
	2950	849	19.9	819	28.3	794	36.6	772	45.0	752	53.4	724	66.0			15.0	728	32.3
	4000	1199	28.8	1169	39.9	1144	51.0	1121	62.2	1101	73.3	1074	90.0			16.0	1059	46.5
418	1750	675	16.5	630	24.0	592	31.7	559	39.0							14.0	515	26.5
	2950	1275	29.5	1230	42.1	1192	54.7	1159	67.3							15.0	1092	48.4
	4000	1800	42.9	1755	59.7	1717	73.4	1684	93.1							16.0	1590	69.7
616	1170	718	16.9	672	24.9	633	32.9	599	40.9	568	49.0					13.0	579	25.9
	1750	1176	26.2	1130	38.2	1091	50.1	1056	62.0	1025	73.9					14.0	1013	42.0
	3000	2162	48.9	2116	68.7	2077	88.5	2043	108.3	2012	128.0	1970	157.7			16.0	1946	81.7
624	1170	1077	25.4	1008	37.5	950	49.5	899	61.5							13.0	869	39.0
	1750	1764	39.9	1695	57.8	1637	75.7	1585	93.6							14.0	1519	63.4
	3000	3244	77.6	3175	107.3	3117	137.0	3065	166.7							16.0	2920	124.6

Notes: 1. Pressure ratings based on inlet air at standard pressure of 14.7 psia, standard temperature of 68° F, and specific gravity of 1.0.
2. Vacuum ratings based on inlet air at standard temperature of 68°F, discharge pressure of 30" Hg and specific gravity of 1.0.

OUTLINE DRAWING & DIMENSIONAL TABLE



NOTES:
1. All dimensions are in inches.
2. Do not use for construction.

VERTICAL CONFIGURATION
(Horizontal Air Flow)

HORIZONTAL CONFIGURATION
(Vertical Air Flow)

FRAME SIZE	A	A'	B	C	Drive Shaft Location D	Drive Shaft Location D1	O	O'	P	P'	R	U	Keyway	AF Inlet Diameter	AF' Discharge Diameter	AX	Approx. NetWt (lbs)
404	8.00	11.00	8.75	18.50	11.25	7.50	16.63	13.50	12.00	15.25	9.00	1.500	.375 x.188	3.0 NPT	3.0 NPT	2.25	200
406	8.00	11.00	10.75	20.50	11.25	7.50	16.63	13.50	12.00	15.25	9.00	1.500	.375 x.188	4.0 NPT	4.0 NPT	2.25	230
409	8.00	11.00	13.75	23.50	11.25	7.50	16.63	13.00	11.00	15.25	9.00	1.500	.375 x.188	4.0 NPT	4.0 NPT	2.25	270
412	8.00	11.00	16.75	26.50	11.25	7.50	16.63	13.00	11.00	15.25	9.00	1.500	.375 x.188	6.0 FLG	6.0 FLG	2.25	330
418	8.00	11.00	22.75	32.50	11.25	7.50	16.63	13.00	11.00	15.25	9.00	1.500	.375 x.188	8.0 FLG	8.0 FLG	2.25	410
616	10.00	16.00	20.75	32.44	15.00	9.00	22.00	16.25	14.50	20.00	12.00	2.000	.500 x.250	8.0 FLG	8.0 FLG	3.00	650
624	10.00	16.00	28.75	40.44	15.00	9.00	22.00	16.25	14.50	20.00	12.00	2.000	.500 x.250	10.0 FLG	10.0 FLG	3.00	775

Dresser, Inc.

DRESSER
Roots

Dresser ROOTS
2135 Hwy 6 South
Houston, TX 77077
PH: 281-966-4700
FX: 281-966-4309
Toll Free: 1-877-363-ROOT(S)

Dresser ROOTS - Connersville
900 West Mount Street
Connersville, IN 47331
PH: 765-827-9200
FX: 765-827-9266

Dresser ROOTS - Holmes Operation
PO Box B7
Off St. Andrews Rd
Turnbridge, Huddersfield
England HD1 6RB
PH: +44-1484-422222
FX: +44-1484-422668

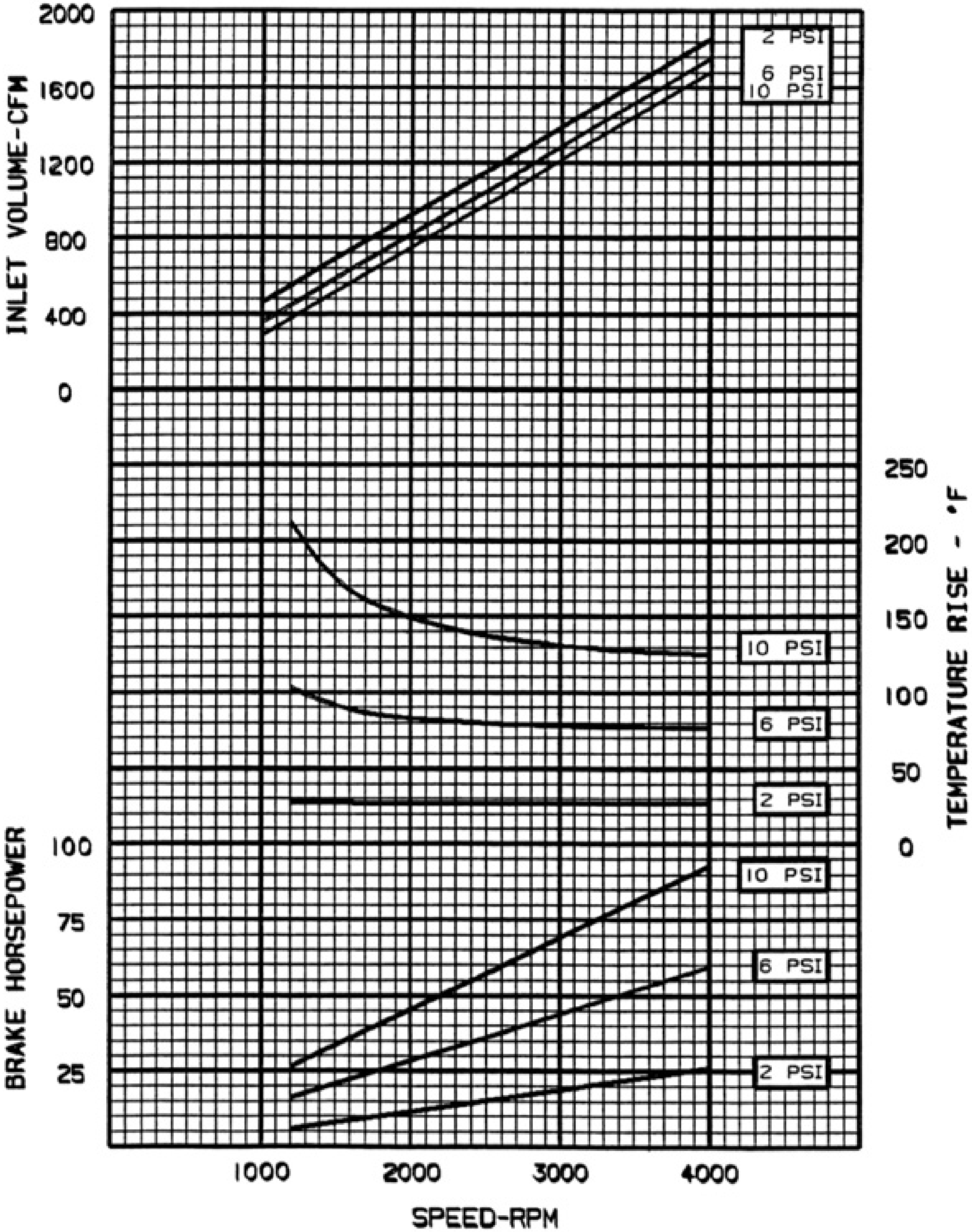
website: www.rootsblower.com • email: ROOTS@dresser.com

S-28F98
February 2004

DRESSER INDUSTRIES, INC.
ROOTS DIVISION
900 WEST MOUNT STREET
CONNERSVILLE, INDIANA 47331
PRINTED IN U.S.A.

PERFORMANCE BASED ON
INLET AIR AT 14.7 PSIA & 68°F
MAY, 1997

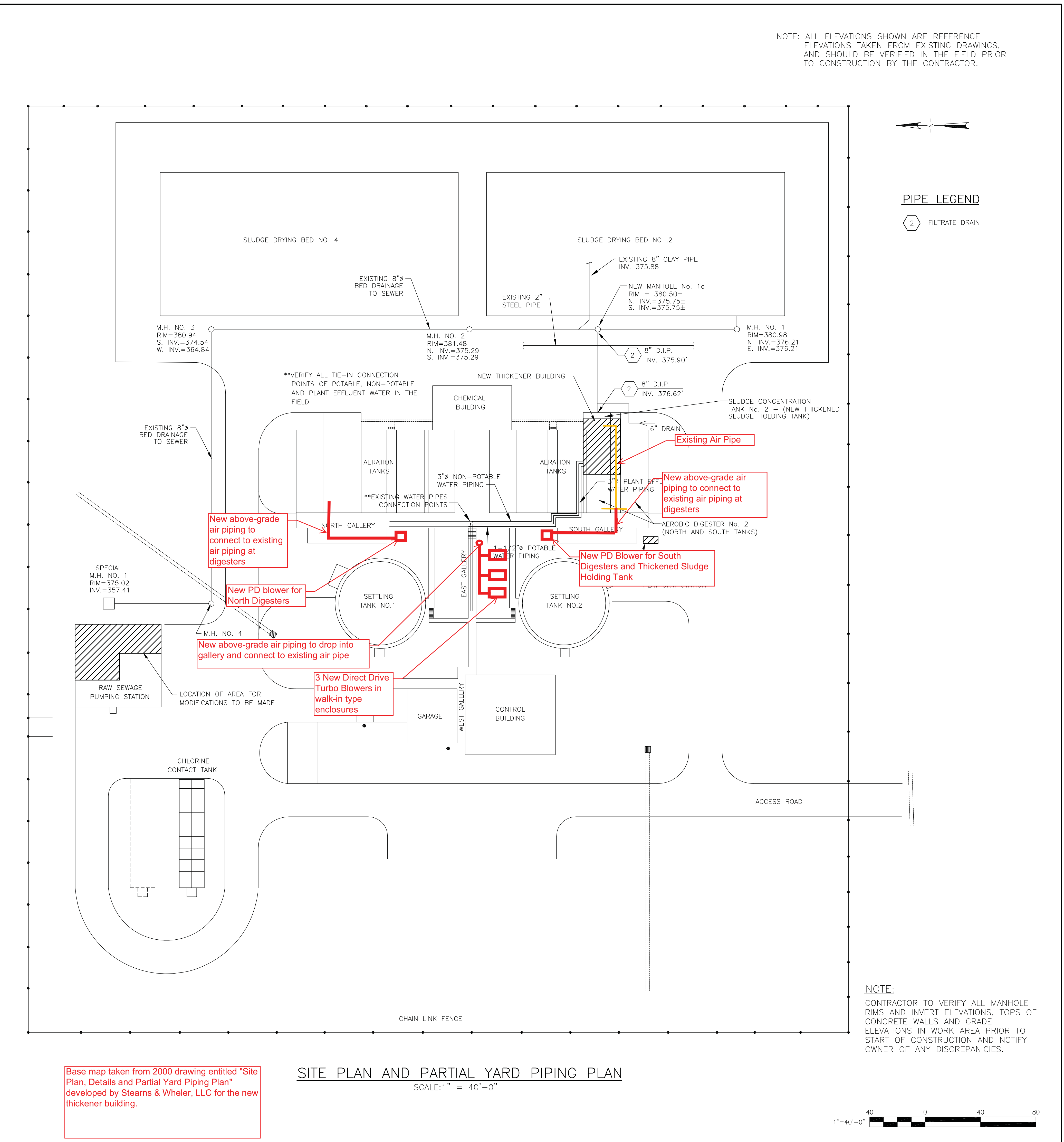
PRESSURE PERFORMANCE
FRAME 418 RAM BLOWER
MAXIMUM PRESSURE RISE=10 PSI
MAXIMUM SPEED=4000 RPM

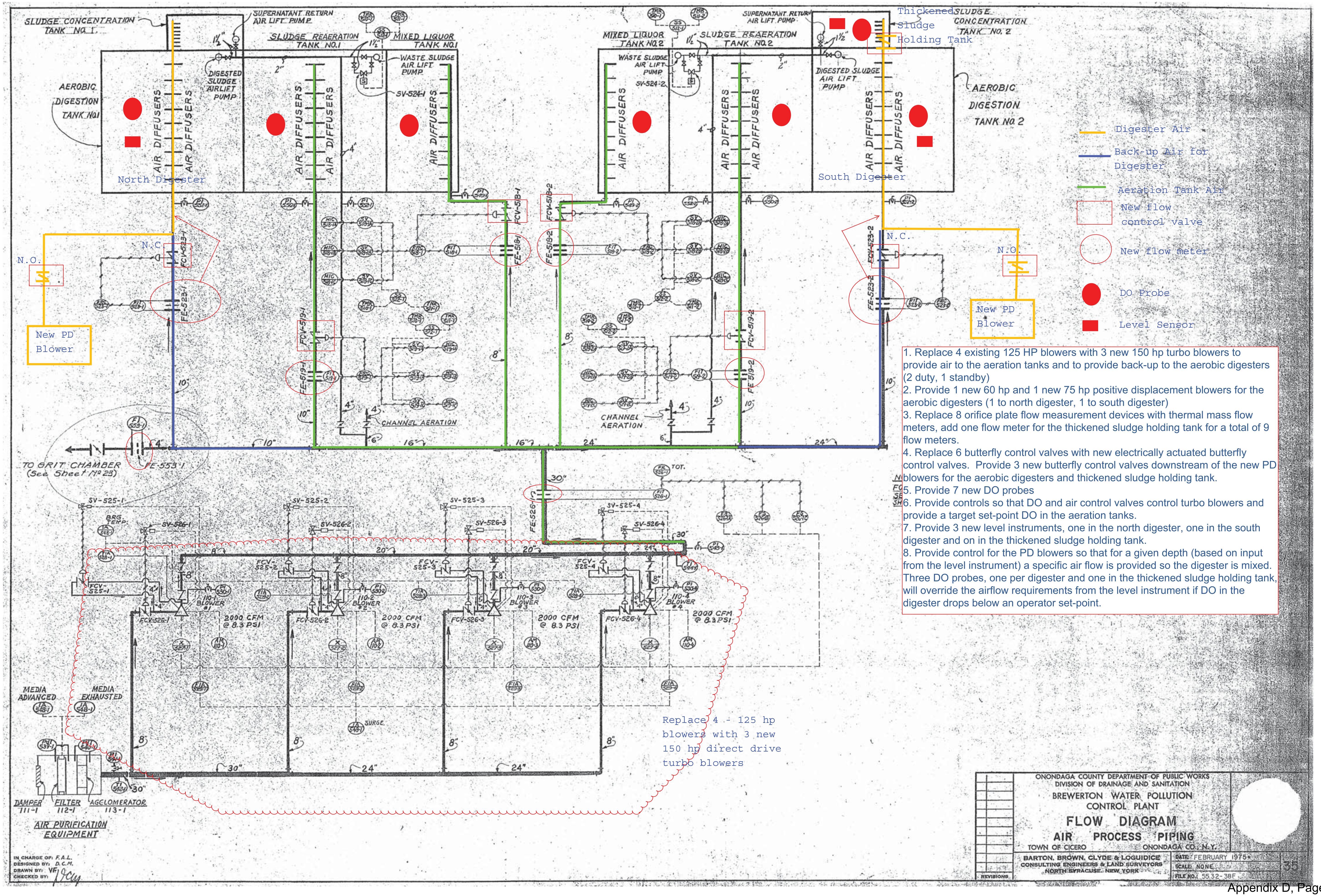


/PARTS2/CRVE

PC-28-418R

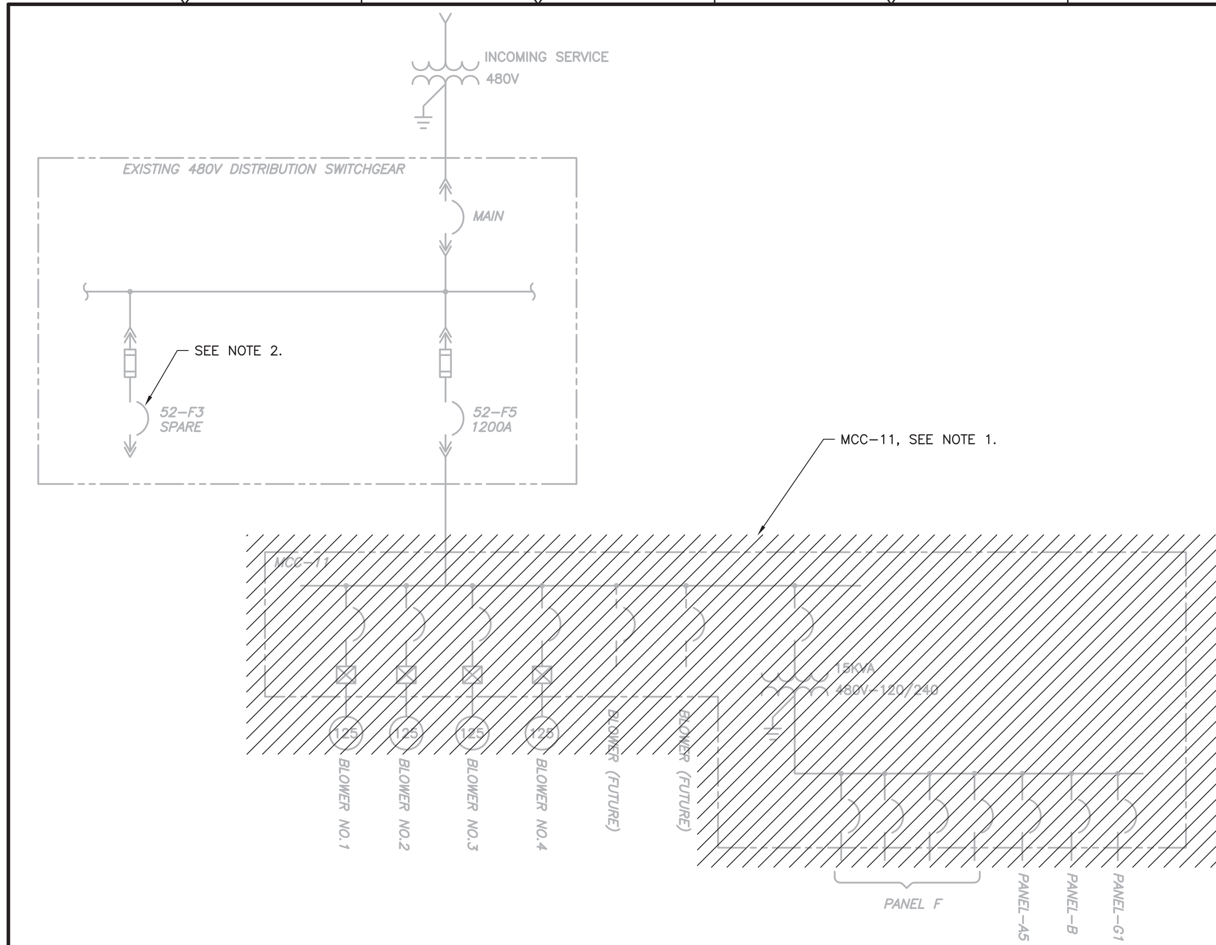
APPENDIX D, SITE PLAN AND PIPING DIAGRAM


NOTE: ALL ELEVATIONS SHOWN ARE REFERENCE ELEVATIONS TAKEN FROM EXISTING DRAWINGS, AND SHOULD BE VERIFIED IN THE FIELD PRIOR TO CONSTRUCTION BY THE CONTRACTOR.
PIPE LEGEND
2 FILTRATE DRAIN
SLUDGE DRYING BED NO .4
SLUDGE DRYING BED NO .2
EXISTING 8"ø BED DRAINAGE TO SEWER
EXISTING 8" CLAY PIPE INV. 375.88
NEW MANHOLE No. 1a RIM = 380.50± N. INV.=375.75± S. INV.=375.75±
EXISTING 2" STEEL PIPE
M.H. NO. 3 RIM=380.94 S. INV.=374.54 W. INV.=364.84
M.H. NO. 2 RIM=381.48 N. INV.=375.29 S. INV.=375.29
M.H. NO. 1 RIM=380.98 N. INV.=376.21 E. INV.=376.21
8" D.I.P. INV. 375.90'
8" D.I.P. INV. 376.62'
**VERIFY ALL TIE-IN CONNECTION POINTS OF POTABLE, NON-POTABLE AND PLANT EFFLUENT WATER IN THE FIELD
NEW THICKENER BUILDING
CHEMICAL BUILDING
SLUDGE CONCENTRATION TANK No. 2 – (NEW THICKENED SLUDGE HOLDING TANK)
EXISTING 8"ø BED DRAINAGE TO SEWER
6" DRAIN
Existing Air Pipe
AERATION TANKS
AERATION TANKS
3"ø NON-POTABLE WATER PIPING
3"ø PLANT EFFL. WATER PIPING
New above-grade air piping to connect to existing air piping at digesters
**EXISTING WATER PIPES CONNECTION POINTS
NORTH GALLERY
SOUTH GALLERY
AEROBIC DIGESTER No. 2 (NORTH AND SOUTH TANKS)
New above-grade air piping to connect to existing air piping at digesters
1-1/2"ø POTABLE WATER PIPING
New PD Blower for South Digesters and Thickened Sludge Holding Tank
SPECIAL M.H. NO. 1 RIM=375.02 INV.=357.41
New PD blower for North Digesters
SETTLING TANK NO.1
EAST GALLERY
SETTLING TANK NO.2
M.H. NO. 4
New above-grade air piping to drop into gallery and connect to existing air pipe
3 New Direct Drive Turbo Blowers in walk-in type enclosures
RAW SEWAGE PUMPING STATION
LOCATION OF AREA FOR MODIFICATIONS TO BE MADE
GARAGE
WEST GALLERY
CONTROL BUILDING
CHLORINE CONTACT TANK
ACCESS ROAD
CHAIN LINK FENCE
NOTE:
CONTRACTOR TO VERIFY ALL MANHOLE RIMS AND INVERT ELEVATIONS, TOPS OF CONCRETE WALLS AND GRADE ELEVATIONS IN WORK AREA PRIOR TO START OF CONSTRUCTION AND NOTIFY OWNER OF ANY DISCREPANICIES.
Base map taken from 2000 drawing entitled "Site Plan, Details and Partial Yard Piping Plan" developed by Stearns & Wheler, LLC for the new thickener building.
SITE PLAN AND PARTIAL YARD PIPING PLAN
SCALE:1" = 40'-0"
40 0 40 80
1"=40'-0"



1. Replace 4 existing 125 HP blowers with 3 new 150 hp turbo blowers to provide air to the aeration tanks and to provide back-up to the aerobic digesters (2 duty, 1 standby)
2. Provide 1 new 60 hp and 1 new 75 hp positive displacement blowers for the aerobic digesters (1 to north digester, 1 to south digester)
3. Replace 8 orifice plate flow measurement devices with thermal mass flow meters, add one flow meter for the thickened sludge holding tank for a total of 9 flow meters.
4. Replace 6 butterfly control valves with new electrically actuated butterfly control valves. Provide 3 new butterfly control valves downstream of the new PD blowers for the aerobic digesters and thickened sludge holding tank.
5. Provide 7 new DO probes
6. Provide controls so that DO and air control valves control turbo blowers and provide a target set-point DO in the aeration tanks.
7. Provide 3 new level instruments, one in the north digester, one in the south digester and on in the thickened sludge holding tank.
8. Provide control for the PD blowers so that for a given depth (based on input from the level instrument) a specific air flow is provided so the digester is mixed. Three DO probes, one per digester and one in the thickened sludge holding tank, will override the airflow requirements from the level instrument if DO in the digester drops below an operator set-point.

APPENDIX E, ELECTRICAL ONE-LINE AND PANEL SCHEDULES



SINGLE LINE DEMOLITION

DIAGRAM 1 / –

NTS

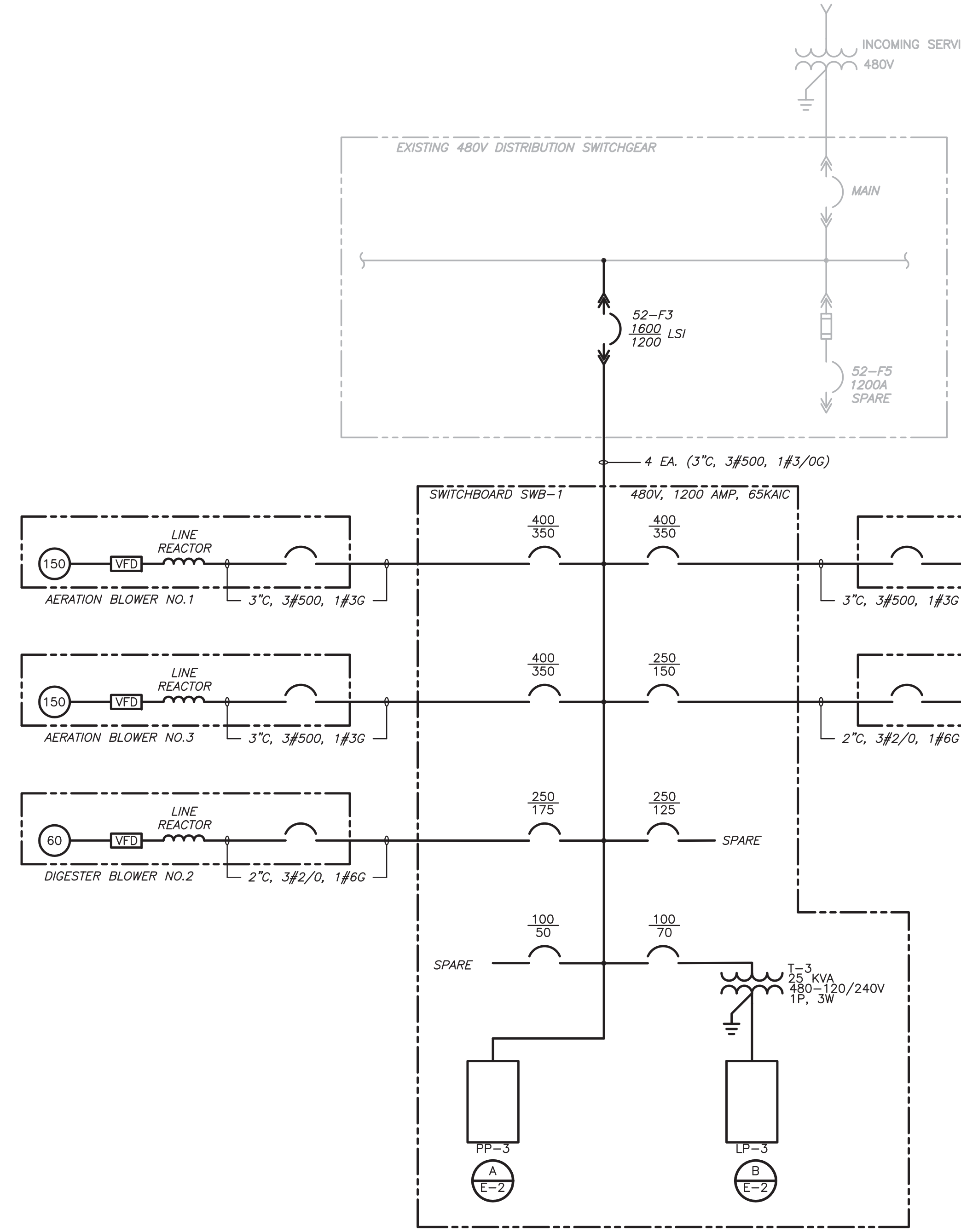
FEEDER BREAKER 52-F5 TO MCC-11

SPARE FEEDER BREAKER 52-F3 TO BE RETROFITTED WITH NEW BREAKER

EXISTING MAIN 480V SWITCHGEAR

ELEVATION

NTS



NEW WORK SINGLE LINE

DIAGRAM 2 / –

NTS

NOTES:

1. MCC-11 DEMOLITION WORK SHALL NOT OCCUR UNTIL NEW AERATION, DIGESTER BLOWERS AND AUXILIARY EQUIPMENT ARE INSTALLED AND OPERATIONAL.

2. EXISTING BREAKER TO BE REPLACED WITH NEW 1600AF/1200AT BREAKER.

WARNING
IT IS A VIOLATION OF SECTION 7209, SUB-DIVISION 2 OF THE NEW YORK STATE EDUCATION LAW FOR ANY PERSON UNLESS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR TO ALTER IN ANY WAY PLANS, SPECIFICATIONS, PLATES OR REPORTS TO WHICH THE SEAL OF A PROFESSIONAL ENGINEER OR LAND SURVEYOR HAS BEEN ATTACHED.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: W. AYERS
DRAWN BY: W. AYERS
SHEET CHK'D BY: J. MORROW
CROSS CHK'D BY:
APPROVED BY: X
DATE: AUGUST 2012

CDM Smith
Camp Dresser & McKee
Salina Industrial Powerpark, One General Motors Drive
Syracuse, NY 13206
Tel: (315) 434-3200

JOHNSON CONTROLS INC.
ONONDAGA COUNTY DEPT. OF WATER ENVIRONMENT PROTECTION, BREWERTON WATER POLLUTION CONTROL PLANT AERATION UPGRADES

AERATION BLOWERS ELECTRICAL SINGLE LINE DIAGRAM

PROJECT NO. 2121-92168
FILE NAME: E001SDDI
SHEET NO. E-1

PRELIMINARY - NOT FOR CONSTRUCTION

125 **AMP MAIN LUG ONL'** | **PANELBOARD PP-3** | LOCATION: **CONTROL BLDG.**
125 AMP BUS RATING **36** POLES | **65** KA SHORT CIRCUIT RATING | ENCLOSURE RATING: **NEMA 1** ,
480 VOLTS **3** PHASE **3** WIRE **60 Hz.** | ELECTRONIC GRADE: **NO** | MOUNTING: **SURFACE**

CIRCUIT NO.	DESCRIPTION	LOAD KVA PHASE A	PHASE B	PHASE C	BREAKER AMPS/ POLES	NOTES	CIRCUIT NO.	DESCRIPTION	LOAD KVA PHASE A	PHASE B	PHASE C	BREAKER AMPS/ POLES	NOTES
1	CONTROL VALVE NO.1				20 /3	3,7	2	CONTROL VALVE NO.2				20 /3	
3							4						
5							6						
7	CONTROL VALVE NO.3				20 /3		8	CONTROL VALVE NO.4				20 /3	
9							10						
11							12						
13	CONTROL VALVE NO.5				20 /3		14	CONTROL VALVE NO.6				20 /3	
15							16						
17							18						
19	CONTROL VALVE NO.7				20 /3		20	CONTROL VALVE NO.8				20 /3	
21							22						
23							24						
25	CONTROL VALVE NO.9				20 /3		26	CONTROL VALVE NO.10				20 /3	
27							28						
29							30						
31	CONTROL VALVE NO.11				20 /3		32	CONTROL VALVE NO.12				20 /3	
33							34						
35							36						
	TOTAL PHASE KVA THIS SIDE	0	0	0				TOTAL PHASE KVA THIS SIDE	0	0	0		
								TOTAL KVA PER PHASE	0	0	0		
								TOTAL THREE PHASE KVA		0			

480V POWER PANEL PP-3

DIAGRAM (A) E-1

NTS

125 AMP MAIN BREAKER | **PANELBOARD LP-3** | LOCATION: **WITHIN SWB-1**
125 AMP BUS RATING **30** POLES | **22** KA SHORT CIRCUIT RATING | ENCLOSURE RATING: **NEMA 1** ,
120/240 VOLTS **1** PHASE **3** WIRE **60 Hz.** | ELECTRONIC GRADE: **NO** | MOUNTING: **SURFACE**

CIRCUIT NO.	DESCRIPTION	LOAD KVA LINE 1	LINE 2	BREAKER AMPS/ POLES	NOTES	CIRCUIT NO.	DESCRIPTION	LOAD KVA LINE 1	LINE 2	BREAKER AMPS/ POLES	NOTES
1	SPARE			30 /2	5,7	2	SPARE			30 /2	
3					5,7	4					
5	SPARE			20 /2		6	SPARE			20 /2	
7						8					
9	DO PROBES - NORTH BASINS			20 /1		10	DO PROBES - SOUTH BASINS			20 /1	
11	FLOW METERS - NORTH BASINS			20 /1		12	FLOW METERS - SOUTH BASINS			20 /1	
13	LEVEL TRANSMITTERS - NORTH BASINS			20 /1		14	LEVEL TRANSMITTERS - SOUTH BASINS			20 /1	
15	PANEL "F" EXISTING LOAD			20 /1		16	PANEL "F" EXISTING LOAD			20 /1	
17	PANEL "F" EXISTING LOAD			20 /1		18	PANEL "F" EXISTING LOAD			20 /1	
19	EXISTING PANEL "A5"			20 /1		20	EXISTING PANEL "B"			20 /1	
21	EXISTING PANEL "G1"			20 /1		22	BLOWER MCP			20 /1	
23	SPARE			20 /1		24	SPARE			20 /1	
25	SPACE					26	SPACE				
27	SPACE					28	SPACE				
29	SPACE					30	SPACE				
	TOTAL LINE KVA THIS SIDE	0	0				TOTAL LINE KVA THIS SIDE	0	0		
							TOTAL KVA PER LINE	0	0		
							TOTAL KVA	0			

PANELBOARD LP-3

DIAGRAM (B) E-1

NTS

WARNING
IT IS A VIOLATION OF SECTION 7209, SUB-DIVISION 2 OF THE NEW YORK STATE EDUCATION LAW FOR ANY PERSON UNLESS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR TO ALTER IN ANY WAY PLANS, SPECIFICATIONS, PLATES OR REPORTS TO WHICH THE SEAL OF A PROFESSIONAL ENGINEER OR LAND SURVEYOR HAS BEEN ATTACHED.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: W. AYERS
DRAWN BY: W. AYERS
SHEET CHK'D BY: J. MORROW
CROSS CHK'D BY:
APPROVED BY: X
DATE: AUGUST 2012

CDM Smith
Camp Dresser & McKee
Salina Industrial Powerpark, One General Motors Drive
Syracuse, NY 13206
Tel: (315) 434-3200

JOHNSON CONTROLS INC.
ONONDAGA COUNTY DEPT. OF WATER ENVIRONMENT PROTECTION, BREWERTON WATER POLLUTION CONTROL PLANT AERATION UPGRADES

ELECTRICAL PANELBOARD SCHEDULES

PROJECT NO. 2121-92168
FILE NAME: E002SDDT
SHEET NO.
E-2

PRELIMINARY - NOT FOR CONSTRUCTION

APPENDIX F, PROJECT SUMMARY SHEET

PROJECT SUMMARY SHEET

Customer's Name and Address: Onondaga County
600 S. State St.
Syracuse, NY 13202
Customer Contact and Title: Lee A. Klosowski, Dir. Energy & Sustainability
Telephone Number: (315) 435-3451

STRATEGY OF ENERGY SAVINGS

				Energy Savings								
				Electric Consumption		Annual Elec. Demand		Natural Gas		Total***	Estimated	Simple
Site	FIM #	FIM Name	Status*	kWh	$	kW **	$	therms	$	$	Cost	Payback
Brewerton WWTP	1	Blower Upgrade and Controls	R	760,823	$ 82,539	86				$ 82,539	$ 2,477,000	30.0

* Measure Status: Implemented (I); Recommended (R); Further Study Recommended (RS)
** Represents the difference in annual maximums. The difference in average kW over the year is 158.5 kW. It can not be determined what the demand will be in any one particular month.
*** Based on a blended rate of $0.12/kWh which represents a more conservation savings estimate.