

# Factoring Energy Savings into a Plant Upgrade

WWOA – 46<sup>th</sup> Annual Conference  
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Presented by:  
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- Project background
- Identifying energy reduction opportunities
- Energy reduction elements
- Focus on Energy incentive grant

# Project Background

- Village of Plover WWTF
  - Serves population of 12,000
  - Current average flow of 1.2 MGD
  - Last major upgrade in 1987
    - Digesters 1999



<http://www.ploverwi.gov>

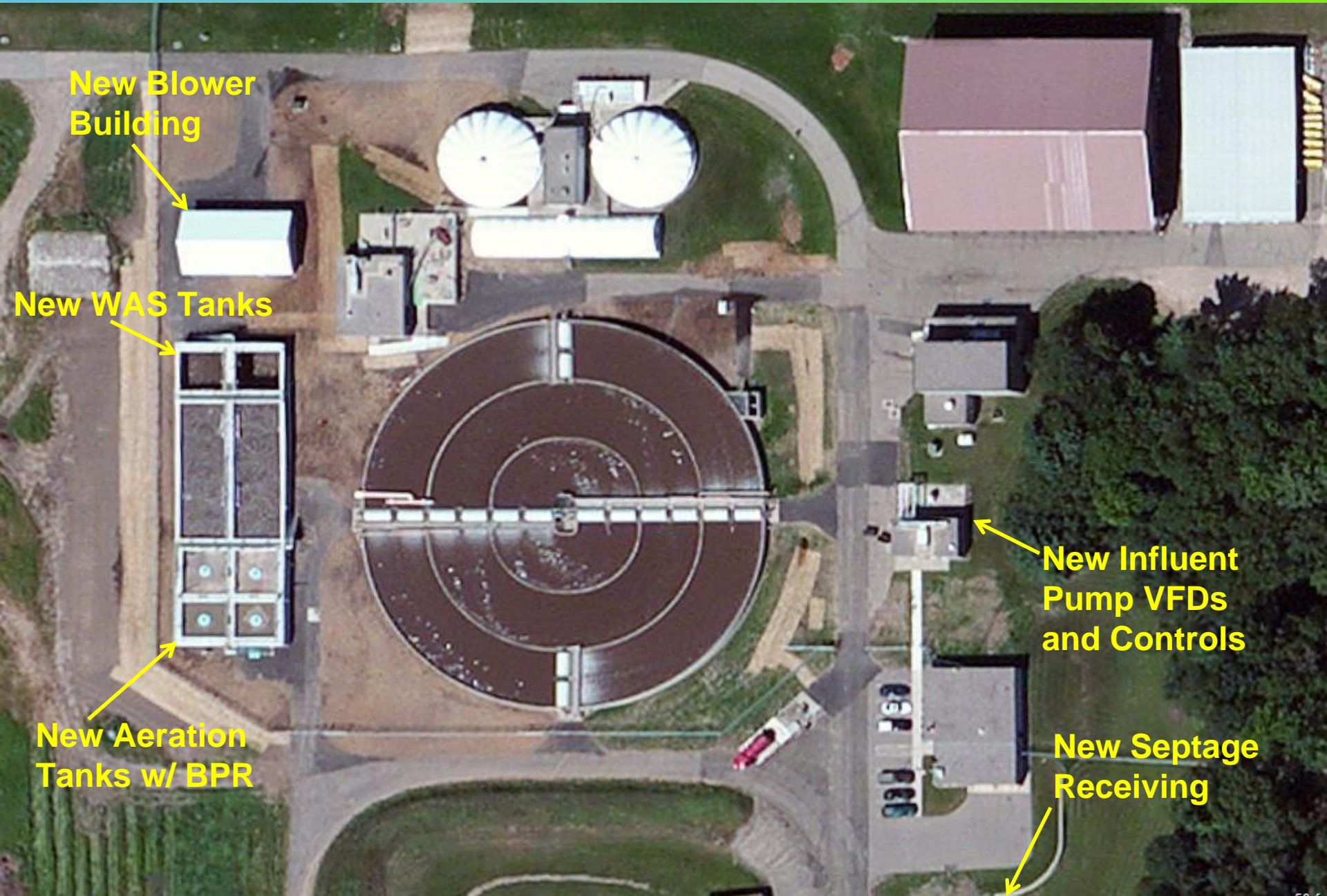
Village of  
**Plover**  
Wisconsin



- Project drivers
  - Capacity for industrial growth
  - New ammonia limits
- Project timeline
  - Facility planning – January 2009
  - Design – May 2009
  - Bidding – September 2009
  - Construction - January 2010 to July 2011



# Background – Main Project Elements



**New Blower Building**

**New WAS Tanks**

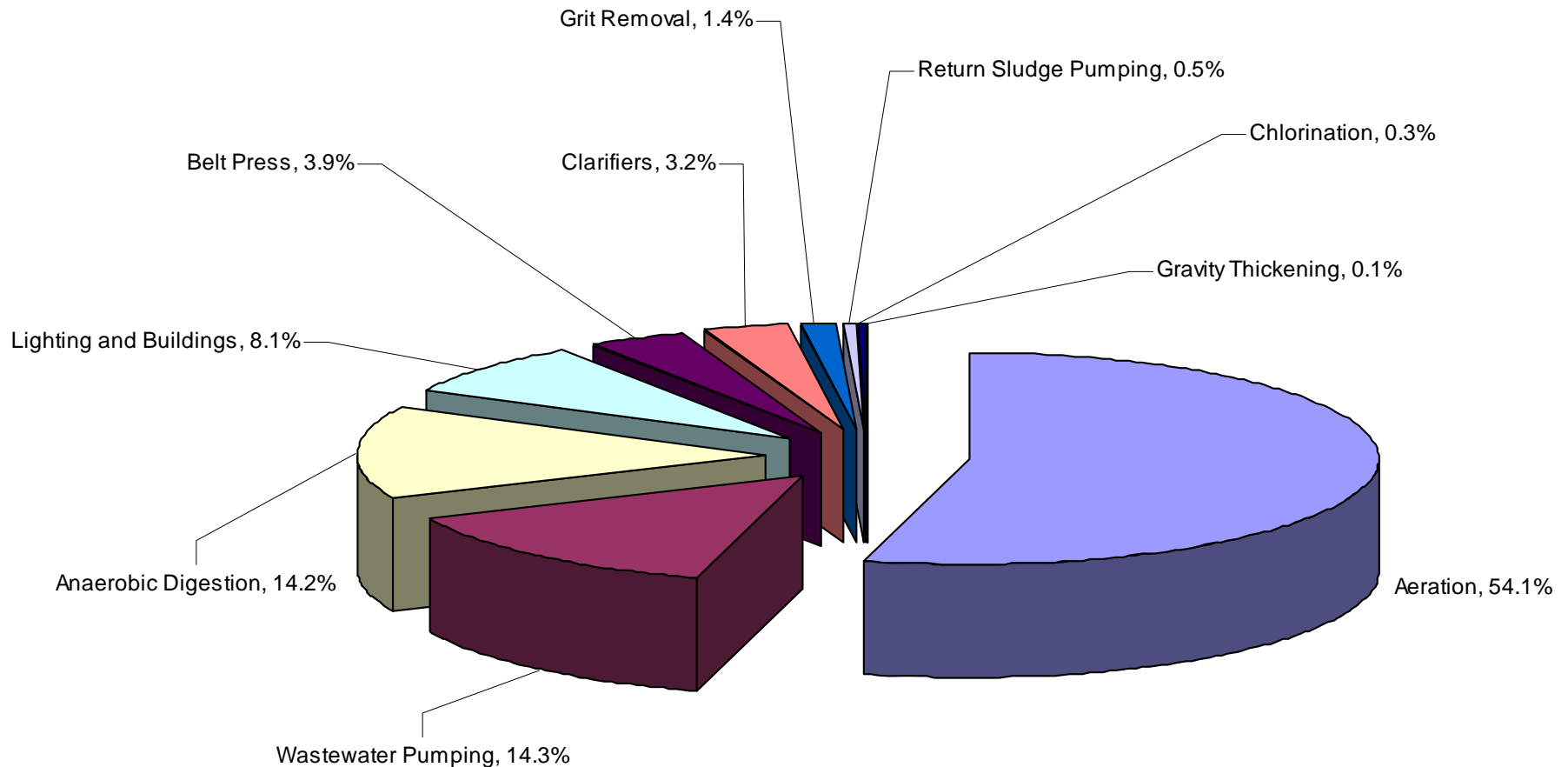
**New Aeration Tanks w/ BPR**

**New Influent Pump VFDs and Controls**

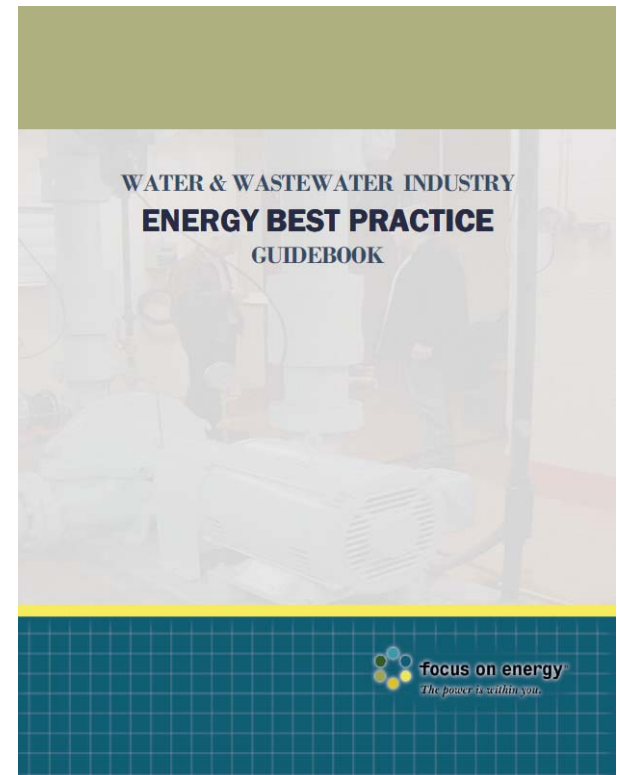
**New Septage Receiving**

# Identifying Energy Reduction Opportunities

- Typical energy usage at WWTFs



- Creation of the “long list”
  - Energy Best Practice Guidebook from Focus on Energy
    - Technical Best Practices
      - Water and Wastewater
      - General Facility



- Identified opportunities
  - Influent pumps (self explanatory upgrades)
    - Adding VFDs
    - Automated level control
  - Activated Sludge
    - Fine pore aeration
    - Turbo compressors
  - Oxidation ditch aerators (self explanatory upgrades)
    - Adding VFDs
  - WAS holding tanks
    - Fine pore aeration
    - Tri-lobe PD blowers with VFDs
    - Automated controls for anoxic cycling
  - Demand-side energy management
  - Digester blower replacement

# Energy Reduction Opportunities

- Activated sludge
  - Fine pore aeration
  - 20 ft side-water depth
  - Anaerobic zones for phosphorus removal
  - Optical dissolved oxygen probes



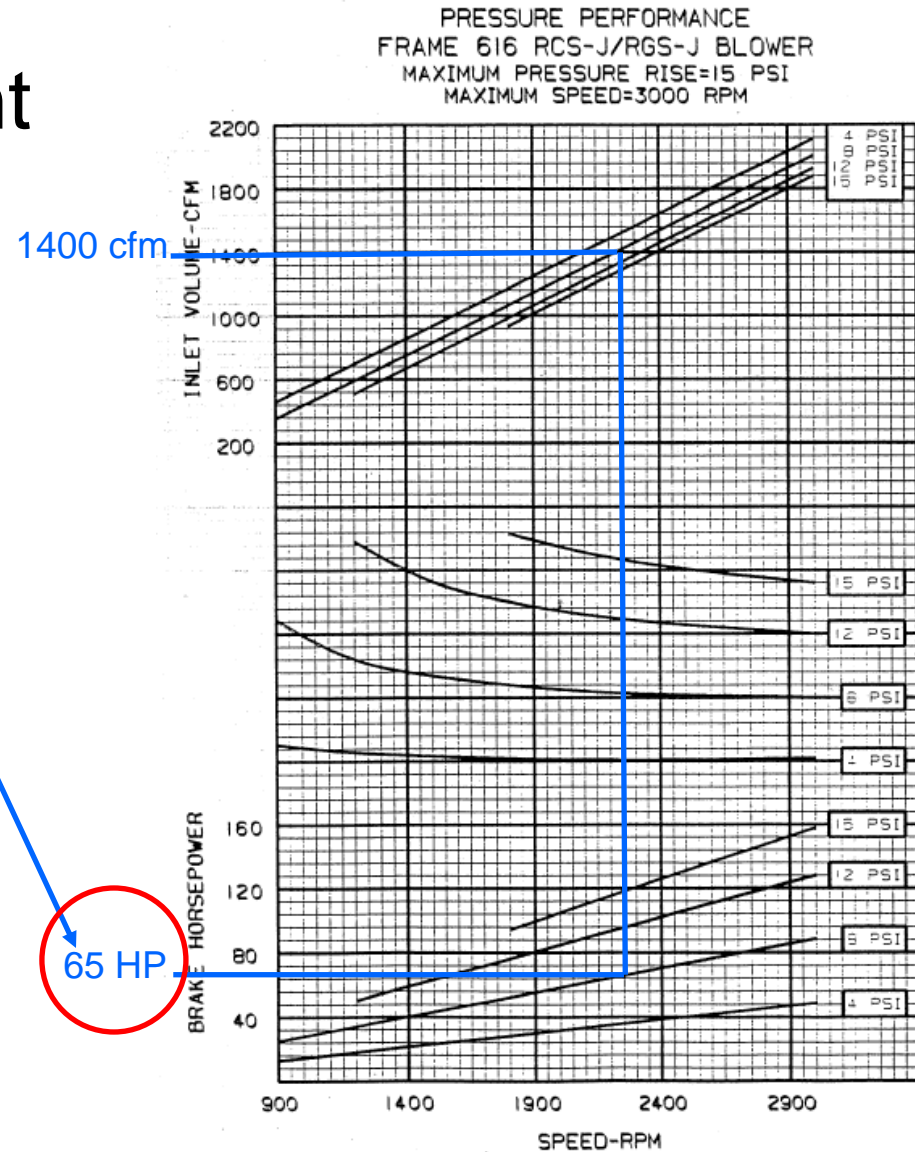
- Activated sludge
  - Turbo compressors - 3 APG Neuros Units
  - 150 HP, 2,500 cfm each
  - D.O. setpoint control



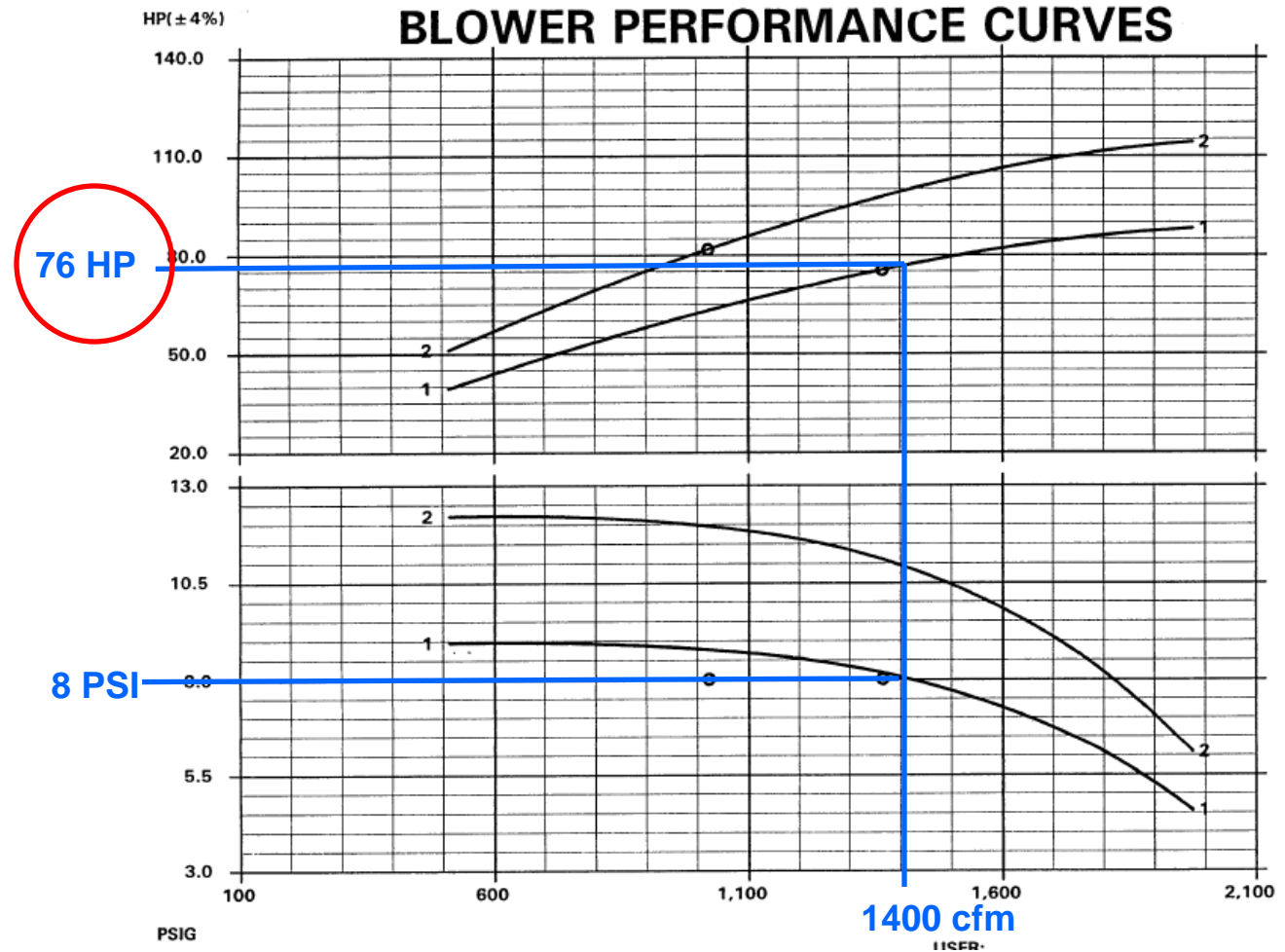
- Activated sludge
  - Efficiency comparison between:
    - Positive displacement
    - Multi-stage centrifugal
    - Single stage turbo



- Positive displacement
  - Break horsepower doesn't account for speed reducer and motor efficiencies

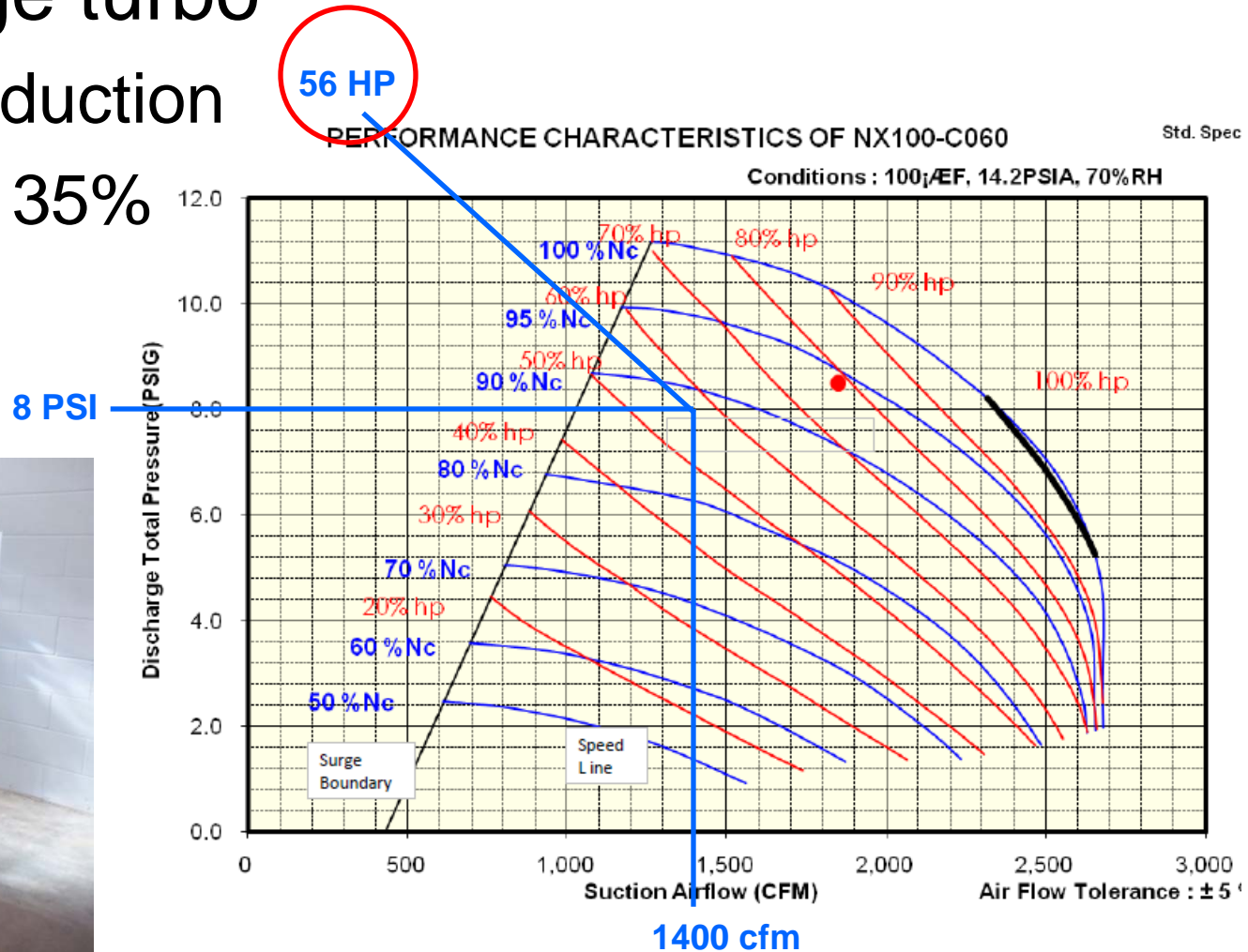


- Multi-stage centrifugal



# Energy Reduction Opportunities

- Single stage turbo
  - Energy reduction of 25% to 35%

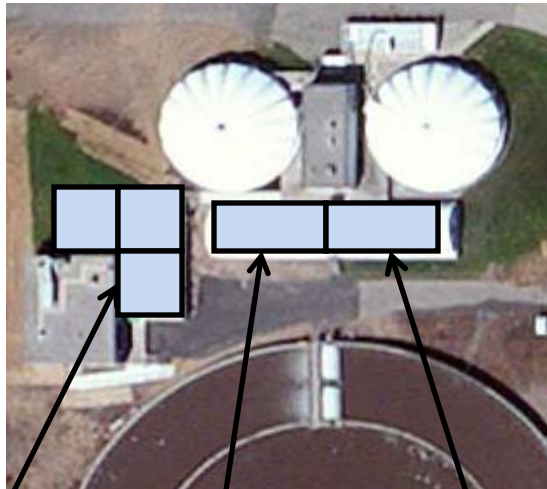


- WAS holding tanks
  - Part of aerobic digestion upgrades
    - Increase WAS storage volume
    - Increase digestion capacity
    - Increase digested sludge storage volume



- Aerobic Digestion Process

Original Operation

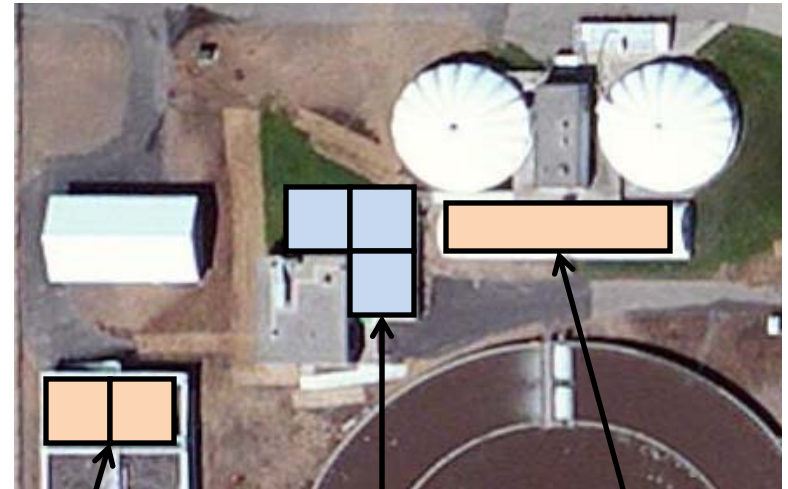


Aerobic  
Digesters

WAS  
Holding

Digested  
Sludge  
Storage

Upgraded Operation



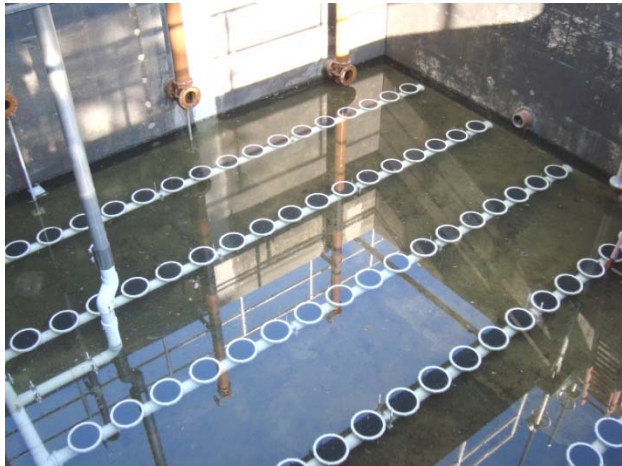
WAS  
Holding

Aerobic  
Digesters

Digested  
Sludge  
Storage

# Energy Reduction Opportunities

- WAS holding tanks
  - Fine pore aeration
  - 20 ft side-water depth
  - Tri-lobe positive displacement blowers



# Energy Reduction Opportunities

- Tri-lobe positive displacement blower
  - 61 BHP, 66 HP (92% Eff)

## Technical data:

Package: EB 420C  
 Blower: OMEGA 53P  
 Motor power: 75.0 hp  
 Operating voltage: 460V/60Hz

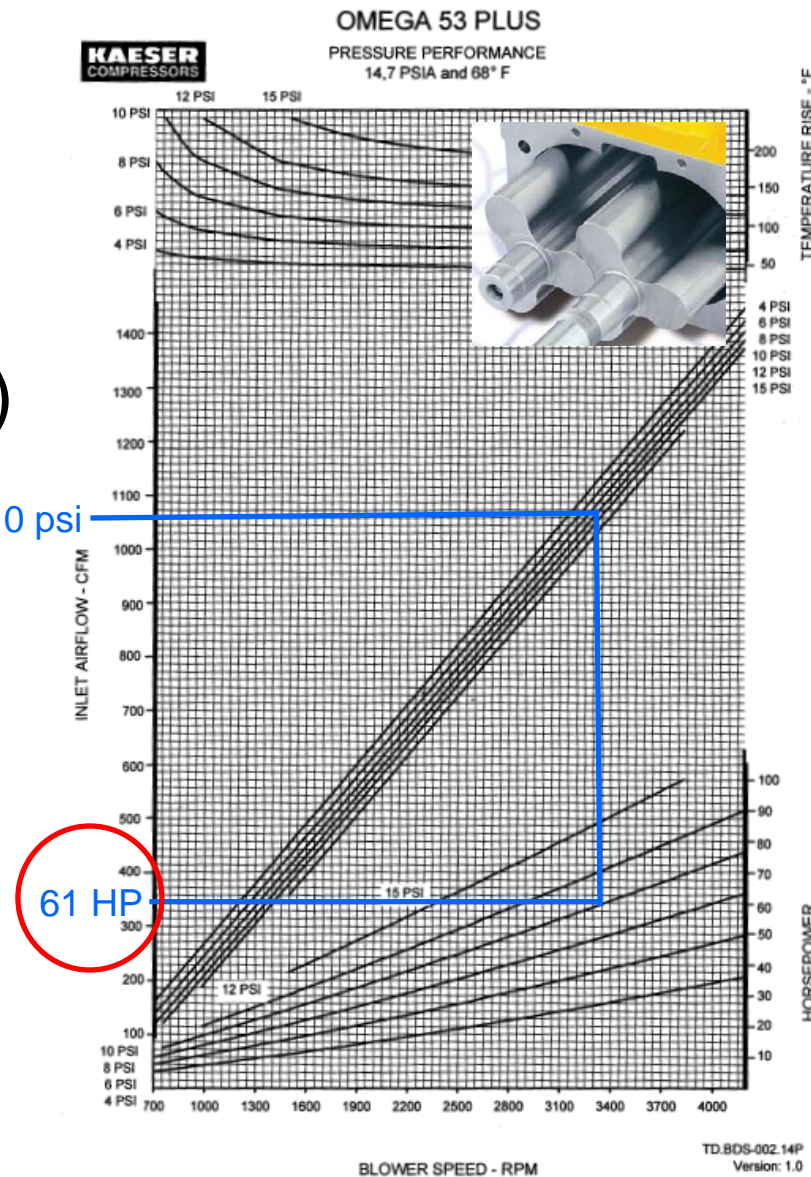
NOTE: ACCESSORIES SHOWN ARE INTENDED FOR AIR USE ONLY.

Blower speed: 3330 rpm  
 Connection ANSI: 6"  
 % of maximum speed: 79  
 Volumetric efficiency: 0.86

## Performance data:

	max. load	design point
Pressure difference $\Delta P$ :	12.6 psig	10.3 psig
Inlet flow Q1*:	1042 icfm	1059 icfm
Inlet air flow Q1 (standard): Standard conditions 14.7 psia, 68°F and 0 % RH		965 scfm
Discharge temperature*:	268 °F	235 °F
Motor shaft power:	78.8 bhp	65.9 bhp
Blower shaft power*:		60.9 bhp

1060 cfm @ 10 psi



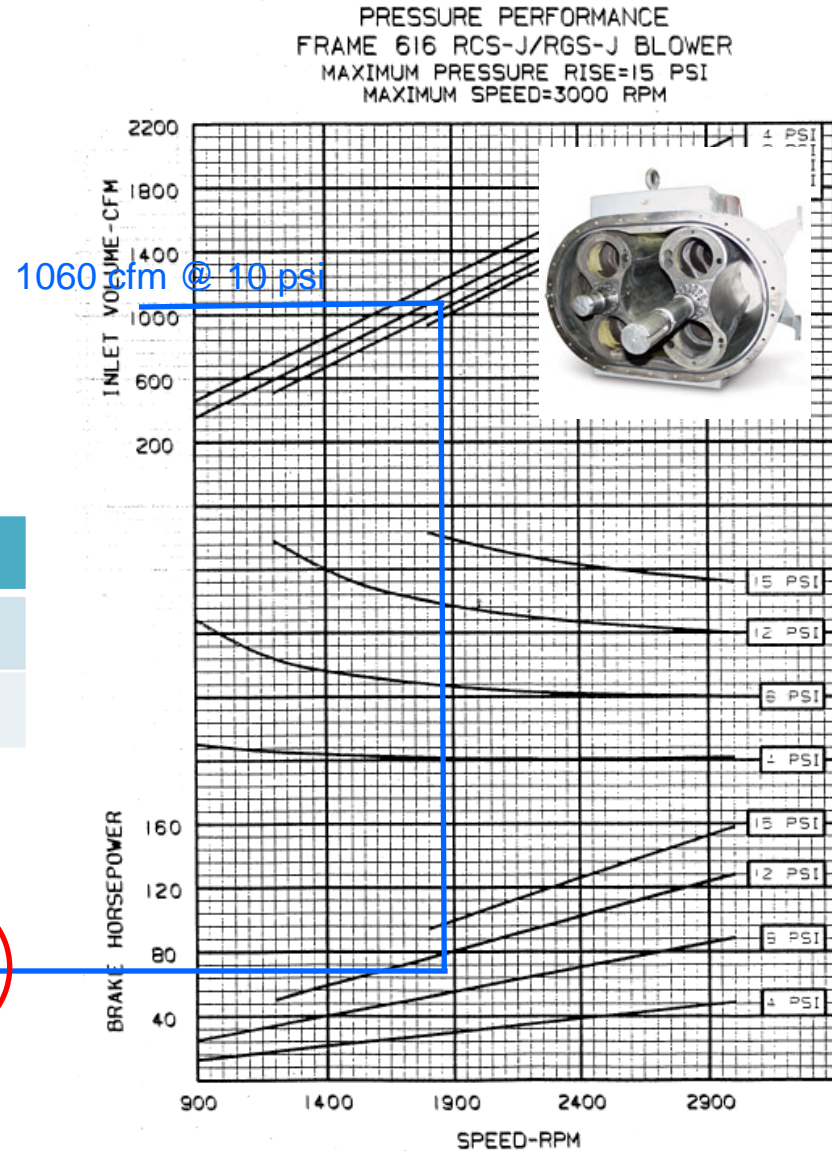
# Energy Reduction Opportunities

- Dual-lobe positive displacement blower
  - 70 BHP, 76 HP (92% Eff)

Lobe Type	BHP	Motor Shaft HP
Dual-lobe	70	76
Tri-lobe	61	66

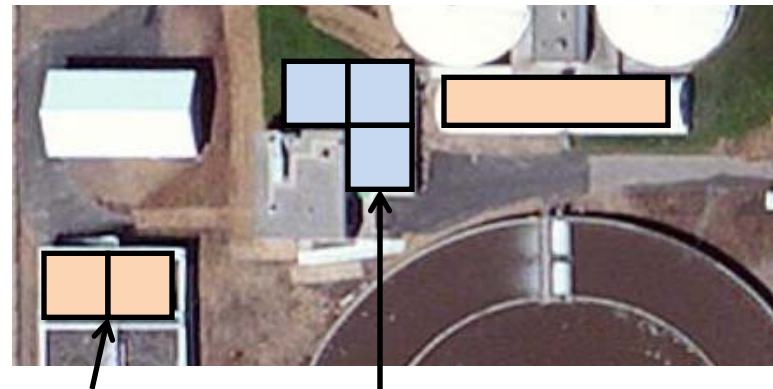
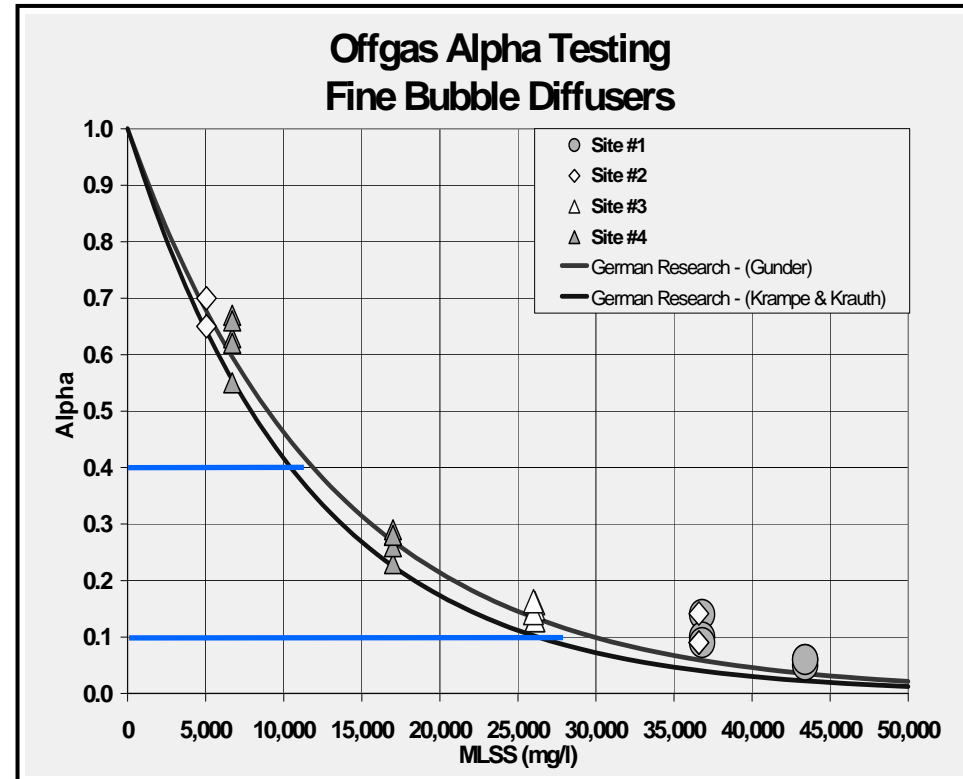
Tri-lobe provides 15% power reduction

70 HP



# Energy Reduction Opportunities

- WAS holding tanks
  - Process energy reduction
    - Increased alpha in first stage (WAS holding tanks)
    - High rate of digestion at lower energy
    - Secondary benefit of reduced digestion demand in second stage



First Stage

Second Stage

## Automated controls for anoxic cycling

- Aeration ON
    - Oxygen is utilized for electron acceptor
    - Ammonia is nitrified to nitrate
    - Alkalinity is consumed
    - pH decreases
  - Aeration OFF
    - Nitrate is utilized as electron acceptor
    - Nitrate is denitrified to nitrogen gas
    - Alkalinity is recovered
    - pH increases
- Significant blower energy savings
  - 50/50 aerobic to anoxic cycles ideal
  - Typically 3 to 4 hour increments

# Demand-Side Energy Management

# Energy Reduction Opportunities

- Demand-side energy management
  - Facility is already highly automated
  - Incorporate power monitoring into SCADA automatic control logic



# Energy Reduction Opportunities

- Demand-side energy management
  - Is this worth the effort?
    - Monthly demand cost = \$12.08 per kW
    - Demand costs are 33% of monthly bill
    - A 70 kW reduction over 12 months = \$10,000 in savings



- Demand-side energy management
  - Establish kW ceiling for high kW alarm
  - Large HP items get maximum speed setpoints during on-peak hours.
    - Aeration blowers, mechanical aerators, digester blowers
  - Non-essential items get shut off if kW ceiling is reached
    - WAS holding blowers
  - On-peak and off-peak D.O. setpoints

# Energy Reduction Opportunities

Real-Time Display Client - [Main]

File Edit View Window Options Help

Alarm Acknowledge

## EnergyVIEW Dashboard

**MCC 10**

KW: 38.2  
KWH Max: 94.7  
KWH Min: 0.0

**MCC 20**

KW: 1.7  
KWH Max: 4.8  
KWH Min: 0.0

**MCC 55**

KW: 148.2  
KWH Max: 155.7  
KWH Min: 0.0


**MCC 60-1**

KW: 97.1  
KWH Max: 142.1  
KWH Min: 0.0

**MCC 60-1E**

KW: 59.6  
KWH Max: 103.0  
KWH Min: 0.0

Ethernet



	Power Cost \$/Hour	KW
Current \$	\$ 22.01	305
Daily Max	\$ 24.38	338
Daily Min	\$ 8.51	0

**1. Track and Trend Energy Real-time**  
**2. Record 15 minute and daily peak demand**  
**3. Report hourly, daily and monthly usage**

Real-time Power Use Trend

Real-time Power Cost Trend

Daily KWH MCC Report

Monthly KWH MCC Report

Yearly KWH MCC Report

KWH Trend Historical

Chemical Data Entry

QC Data Entry

**MCC Peak Demand Alarm**

MCC 55 Demand Limit (140 KW) ●

MCC 60 Demand Limit (240 KW) ○

**Daily Total KWH**

Charlotte kWmeter

2850

1 hp = 0.745 kw    1 hp/yr = 6437 kwh x \$0.07

**MCC 80**

KW: 112.6  
KWH Max: 157.9  
KWH Min: 0.0

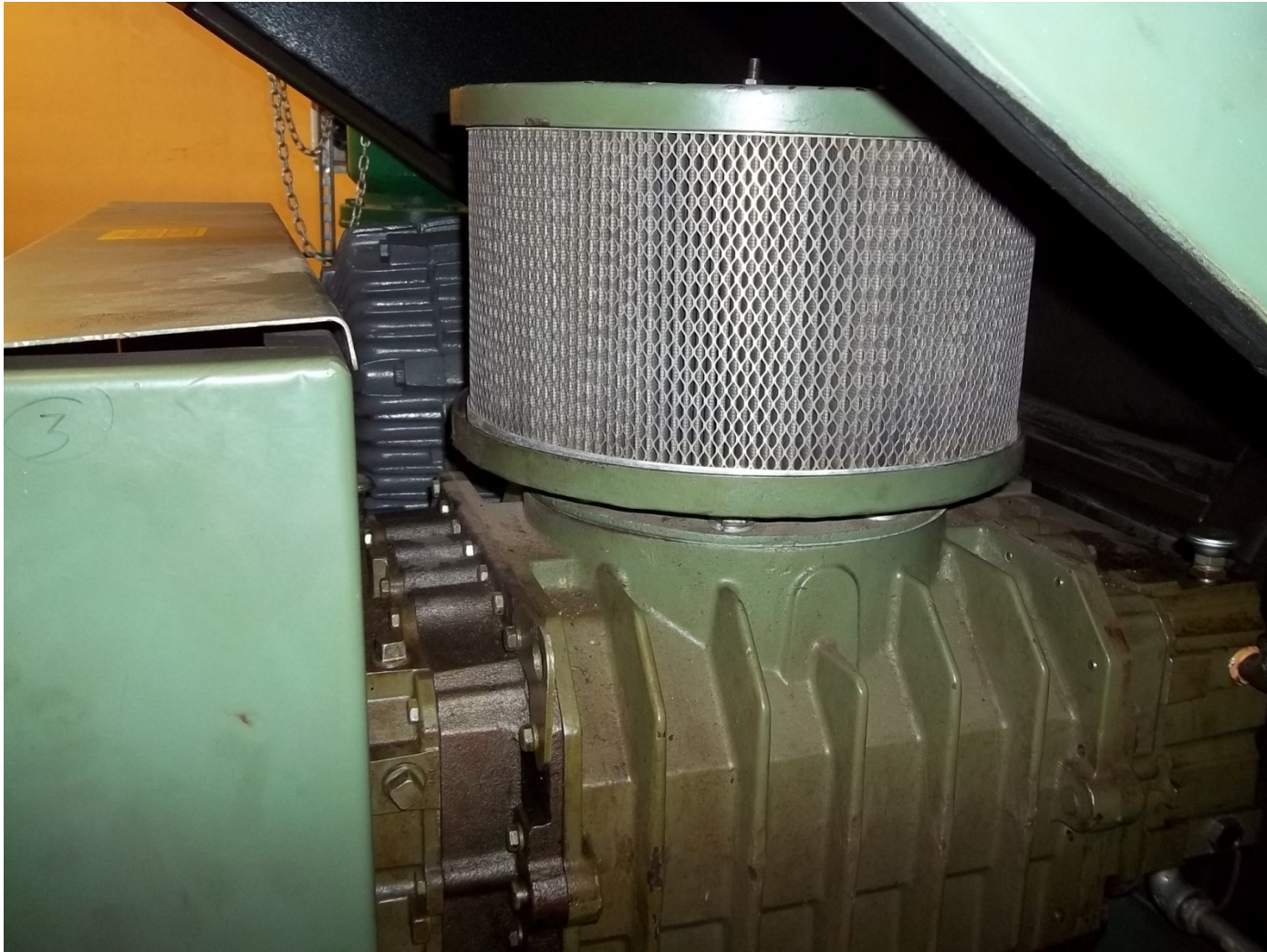
ALARM

Connected    February 9, 2012 11:32:43 AM

# Digester Blower Replacement Project

- 3 aerobic digesters
- Three 100 hp dual lobe Roots PD blowers
- Installed 1999
- One blower dedicated to each digester
- Each blower operated by VFD
- Max turn down is 58% of full speed
  - Second digester normally has excess O<sub>2</sub> levels at min blower speed

# Existing Blower



- Seized up June 12, 2011
- Burning belts caused a small contained fire
- Damage to filter assembly and motor
- Blower badly damaged

- Rebuild bare blower
  - \$8,200 estimated
  - No energy saving
- Replace bare blower with new OEM
  - \$11,400
  - No energy saving
- Replace unit with tri-lobe blower
  - \$22,000 installed
  - Significant energy saving

## New Blower Advantages

- Tri-lobe design is more efficient
- Size blower to meet final digester demand
- Meet the aeration requirements with 60 hp blower vs. 100 hp blower.
- Greater turndown to match demand
  - **TURN DOWN TO 33% FULL SPEED**

- Contacted FOE
- Calculated annual savings
  - 777,139 KWH
  - 9.4 KW system demand
  - \$5,815
- Grant \$4,280
- 4 year payback

# New Blower



- Old blowers peak demand 77 BHP
- Replace 100 hp motors with 75 hp motors
  - Downsize motors to meet blower HP demand
  - Save ~2.5 amps motor magnetizing current
  - Save about \$950 per year per motor

# Motor Replacement



75 hp motor installed

# Focus on Energy Incentive Grant

- Incentive grant program
  - VFD grant \$50/HP
    - Equipment must have 2,000 hrs operation
  - Custom project grant
    - \$0.06/kWh usage savings
    - \$200 per kW demand savings
  - Grant can cover up to 30% of project cost
  - Simple payback must be over 1.5 years and under 10 years

# Focus on Energy Incentive Grant

- Applied for VFD incentives and custom incentives – received \$136,000

Description	Average kW Savings	Peak kW Savings	Estimated Cost of Upgrades	Estimated Energy Savings	Payback Period (years)
Raw Wastewater Pump VFDs and Automated Controls	10	23	\$55,000	\$6,300	9
Fine Pore Aeration and Turbo Compressors for Activated Sludge	135	36	\$428,000	\$80,000	5
Oxidation Ditch Aerator VFDs	20	16	\$58,000	\$13,700	4
WAS Holding Tank Fine Pore Aeration, Blowers, Automated Controls	29	17	\$194,000	\$22,900	8
Demand-Side Energy Management	0	70	\$62,000	\$7,200	9
Aerobic Digester Blower	9	83	\$23,000	\$5,800	4
<b>Totals</b>	<b>203</b>	<b>245</b>	<b>\$823,000</b>	<b>\$136,000</b>	<b>6</b>

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