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VIRTUAL WASTEWATER INPLT SESSION 1

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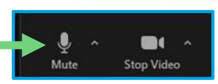
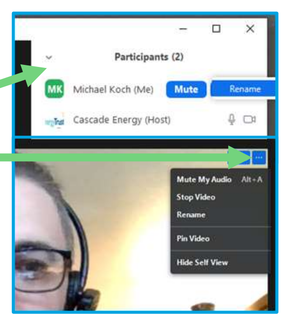
Using Zoom!

Mute yourself!
Have a question?
Use the chat feature.
Controls accessed at the bottom



Rename yourself
"Name (Company)"
Right click on your picture or 3 dots
OR
Controls accessed at the right after clicking 'Participants' at bottom.



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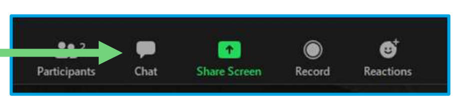

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Today's Trainers

Wendy Waudby

CascadeEnergy

Giulia Pollastri

CascadeEnergy

Eric Wahlberg

WasteWater Technology TRAINERS

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Thank You to Our Participants!

- ***Our Heroes….***
- **The Operators, Assistant Operators, Lab Technicians, Lab Analysts, Plant Electricians & Mechanics,**
- Who work tirelessly and continuously keeping our waters safe and people healthy!!!

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The heroes that stand between a city or town and a cherished body of water

> **"The British and American Medical Associations jointly concluded in 2005 that of any technology, modern wastewater treatment has had the greatest positive impact on public health and life expectancy."**

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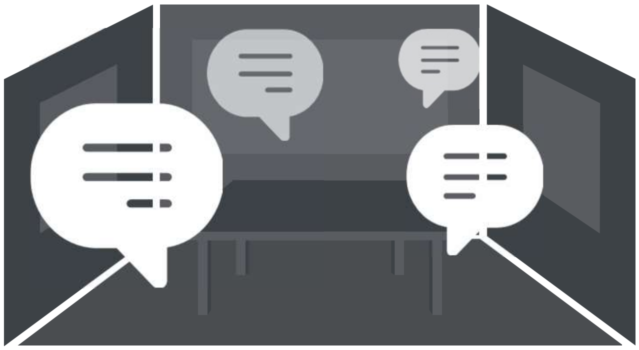
Introductions



Who are we kidding…..? ☺

POLL vault

Day 1: Introduction to Wastewater Energy Optimization

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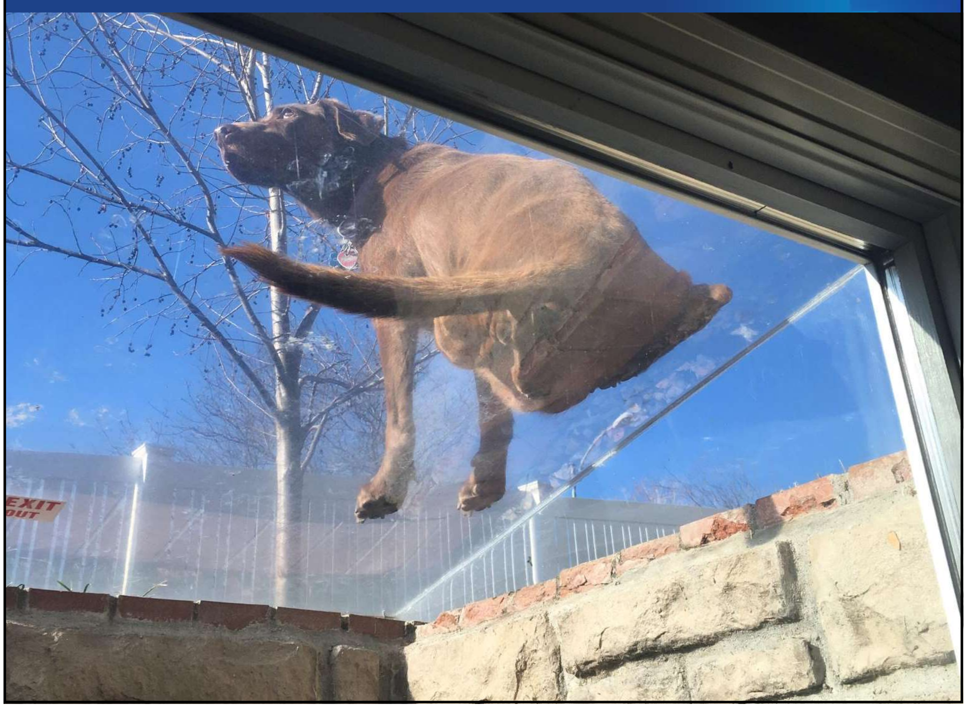

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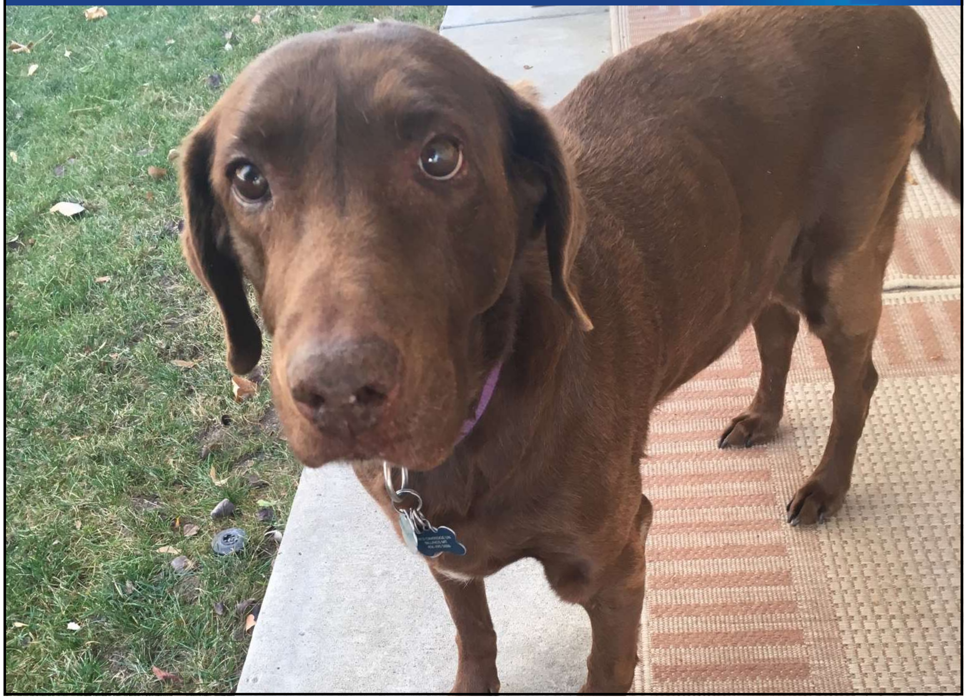

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Training Schedule Overview

Sessions 1 & 2	Sessions 3, 4, & 5	Sessions 6, 7, & 8
• Wastewater Energy Basics • Intro to Wastewater Tools • Process Energy Conservation • Pumping Systems • Non-Potable Water Systems • Follow the BOD	• More Energy Basics • Headworks • Primary Clarifiers • Aeration Energy • Sludge Quality & SRT • Fans and Odor Control	• Even More Energy Basics • RAS Flow Optimization • Thickening, Digestion, and Dewatering • Ancillary Systems • Disinfection

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Today's Agenda

- Welcome and Introductions
- Plant Process Energy Conservation
- Plant Energy Basics
- Break
- WW Treatment Efficiency Facts and Figures
- Non-Potable Water Systems
- Wrap-up
- Q&A

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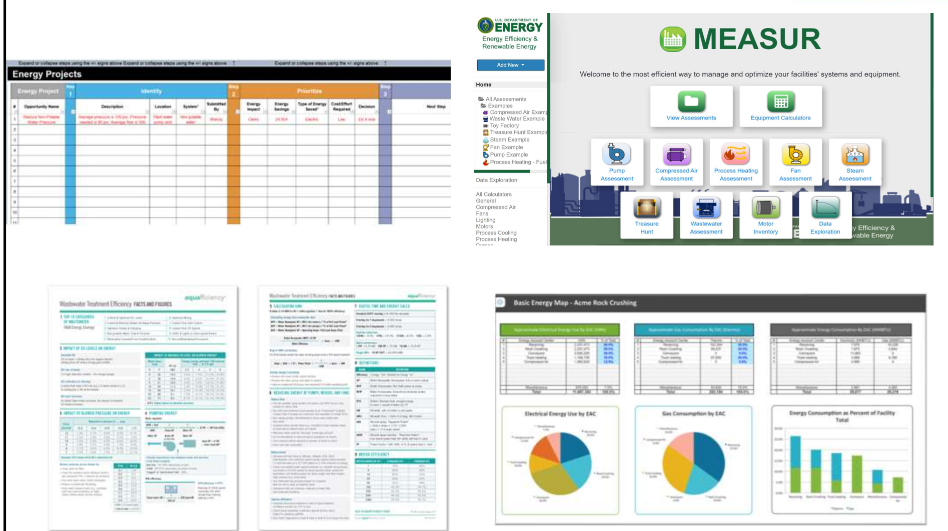
Supporting Materials



OPPORTUNITY REGISTER & THE TREASURE HUNT

Introduction to the Opportunity Register

Expand or collapse steps using the +/- signs above Expand or collapse steps using the +/- signs above ↑ Expand or collapse steps using the +/- signs above ↑

Energy Projects

Energy Project		Step 1	Identify				Step 2	Prioritize					Step 3	
#	Opportunity Name		Description	Location	System*	Submitted By		Energy Impact	Energy Savings	Type of Energy Saved*	Cost/Effort Required	Decision		Next Step
1	Reduce Non-Potable Water Pressure		Average pressure is 100 psi. Pressure needed is 80 psi. Average flow is 300	Plant water pump skid	Non-potable water	Wendy		Gems	24,954	Electric	Low	Do it now		
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														

Put your first waster here…

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Treasure Hunts

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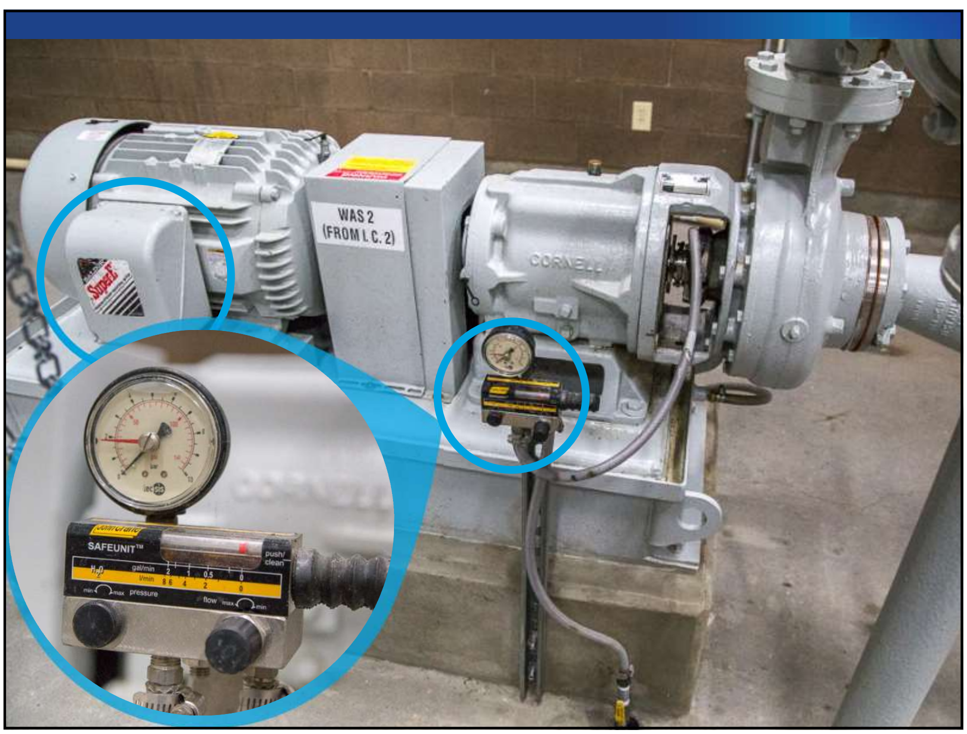
ACTIVATED SLUDGE
TASKMASTER
21

21


WAS 2
(FROM L C. 2)
CORNELL
SAFEUNIT
push/ clean
gal/min
l/min
pressure
flow

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ERIC

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During COVID Isolation…

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"It's only boring until you learn something about it. Knowledge makes things interesting."

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Heroes, Absolutely…but…

"The British and American Medical Associations jointly concluded in 2005 that of any technology, modern wastewater treatment has had the greatest positive impact on public health and life expectancy."

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Nine Signs of Stagnation

1. We've never done it that way.
2. We've always done it that way.
3. We're not ready for that, yet.
4. We're doing all right without it.
5. We tried it once, and it didn't work out.
6. It costs too much.
7. That's not our responsibility.
8. It just won't work.
9. Our facility is too small (big, hot, cold, different) for that.

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For Too Many, For Too Long, Operators Operate the Way They've Always Operated

"If you always do what you've always done, you'll always get what you've always got."

Henry Ford

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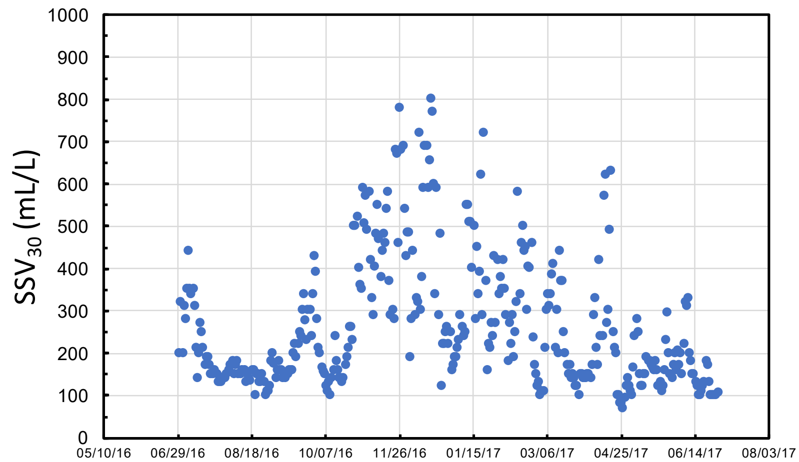
It's Not Working Here



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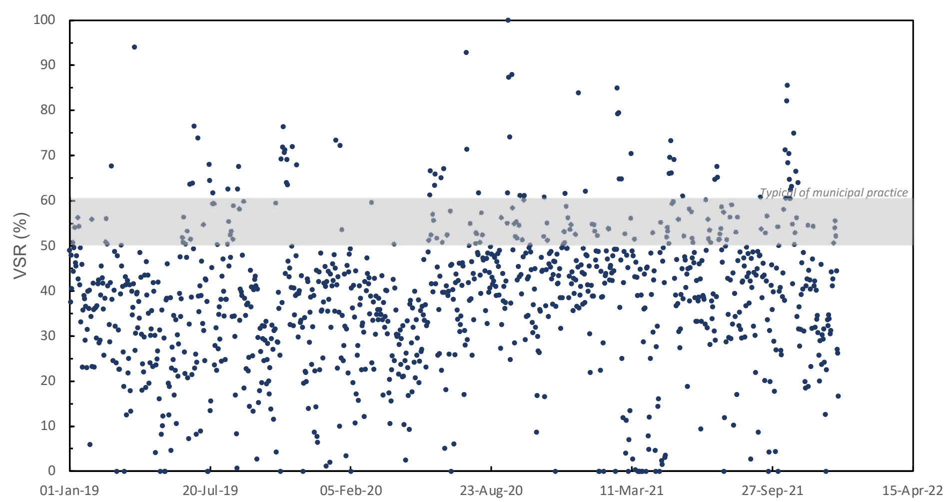
And It's Certainly Not Working Here
In a Word: Embarrassing



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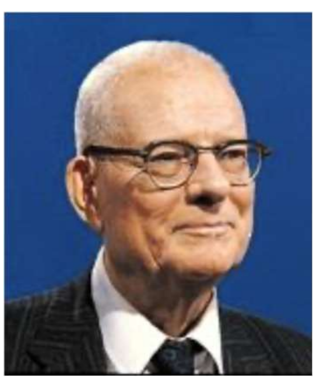
Still, To This Day, Many Operators Think They Can Operate Using "Sight and Smell"

"If you can't express something in the form of numbers, you don't really know much about it. If you don't know much about it, you can't control it. If you can't control it, you're at the mercy of chance."

W. Edwards Deming 1900—1993



"It's not enough to do your best. You must know what to do, then do your best."

"Doing Our Best" Means Two Things

1. **We meet all permits**
2. **We neither take for granted nor take advantage of the trust our ratepayers have in us to give them the biggest bang for their treatment buck**

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Code of Federal Regulations Title 40 Part 133
Secondary Treatment Standards

Biological treatment meeting these standards:

Parameter	30-day Average	7-day Average
BOD_5	30 mg/L	45 mg/L
$cBOD_5$	25 mg/L	40 mg/L
TSS	30 mg/L	45 mg/L
BOD and TSS removal (concentration)	Not less than 85%	
pH	6.0−9.0	

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Regulators Understand Wastewater and Wastewater Treatment are…

Biological treatment meeting these standards:

Parameter	30-day Average	7-day Average
BOD_5	30 mg/L	45 mg/L
$cBOD_5$	25 mg/L	40 mg/L
TSS	30 mg/L	45 mg/L
BOD and TSS removal (concentration)	Not less than 85%	
pH	6.0−9.0	

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HIGHLY VARIABLE

Biological treatment meeting these standards:

Parameter	30-day Average	7-day Average
BOD_5	30 mg/L	45 mg/L
$cBOD_5$	25 mg/L	40 mg/L
TSS	30 mg/L	45 mg/L
BOD and TSS removal (concentration)	Not less than 85%	
pH	6.0−9.0	

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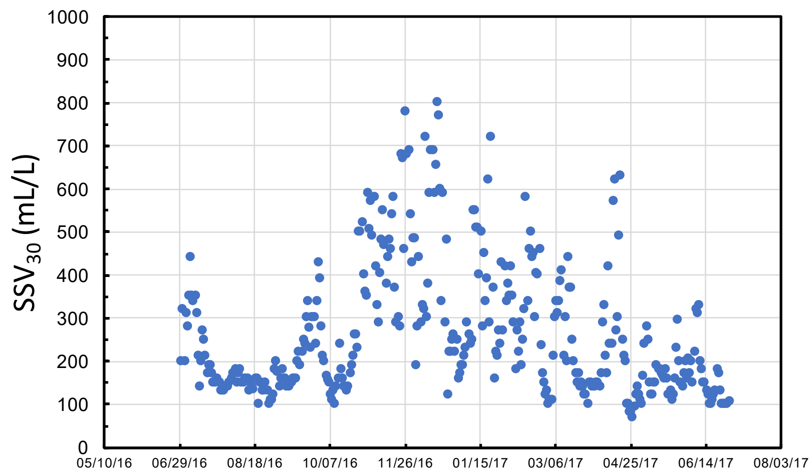
Performance Variability Stifles Control and Optimization—the Plant Controls Us



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Bottom Line:

Understanding variability tells us "what to do," then we can do our best.

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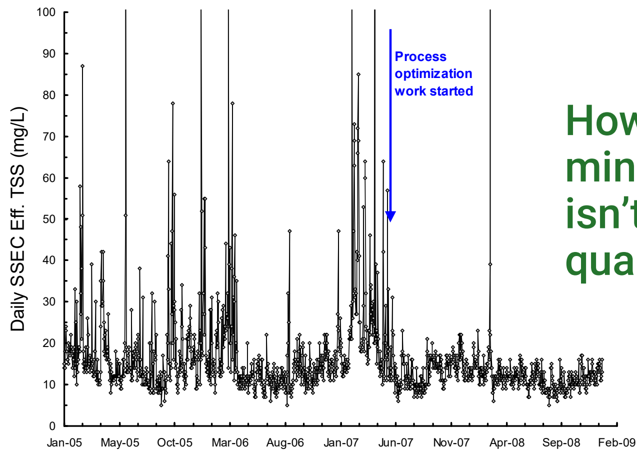
Minimizing Variability the First Step in Process Optimization and Energy Conservation



How can it be minimized if it isn't first quantified?

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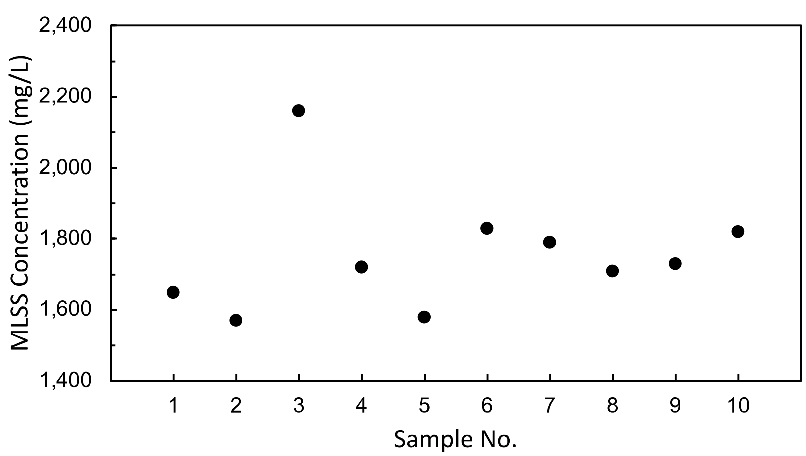
10 Mixed Liquor Samples Collected at Same Point, One Right After the Other



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Few Operators Use Statistics When Making Process-control Decisions

"Variability is what … allows us to interpret, model, and make predictions from data."

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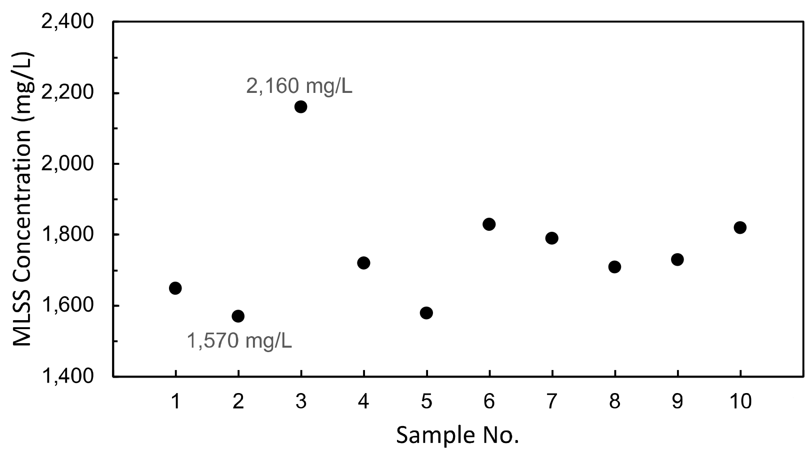
Making Informed Process-control Decisions Requires Quantifying Data Variability



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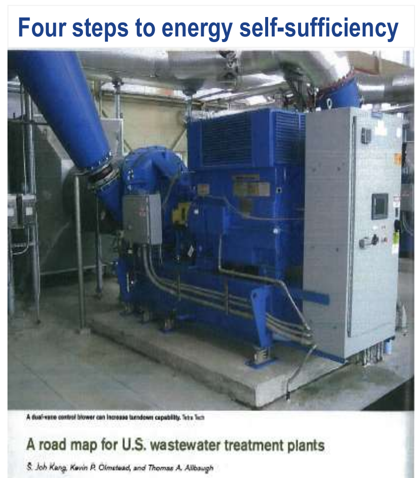
Kang, Olmstead and Allbaugh, *WET*, (DEC/2010)

1. Commitment to saving energy throughout organization
2. Energy generation
3. Process energy conservation
4. Assess and refine



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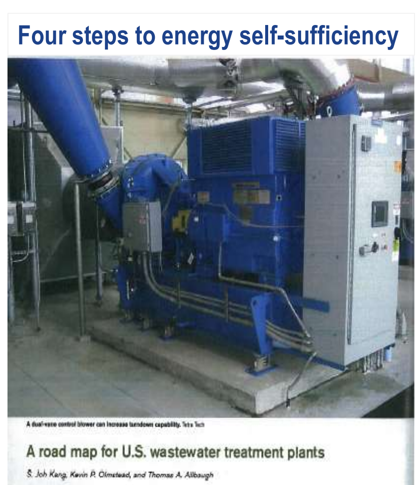
Very Different Than Energy Conservation

1. Commitment to saving energy throughout organization
2. Energy generation
3. **Process energy conservation**
4. Assess and refine



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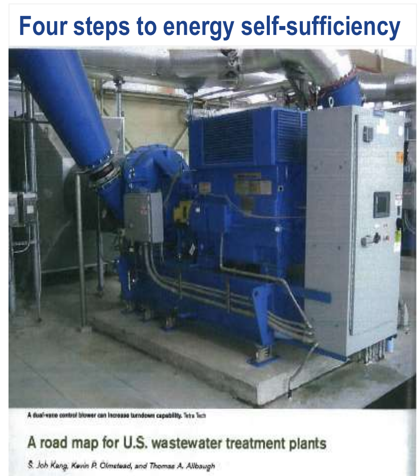
Process Energy Conservation Seven Focal Points

1. Primary Clarifiers
2. Reduce SRT
3. Denitrify
4. Increase Equipment Turndown Capability
5. Create Swing-zones
6. Side-stream Treatment
7. Combined Heat and Power Cash-back Incentives



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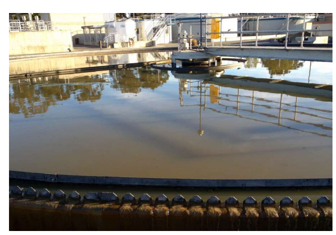
Primary Clarifiers—On the Agenda

1. Add if not existing
2. Maintain and document maximum performance
3. Chemically enhanced primary treatment (CEPT)



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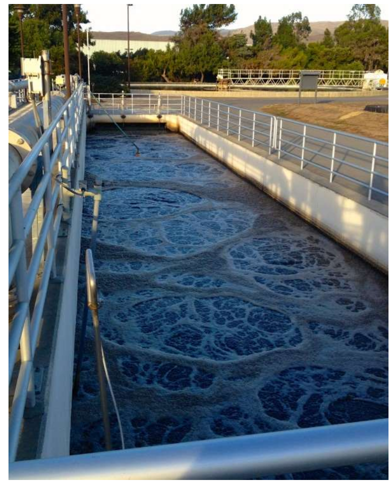
Reduce SRT—On the Agenda

1. Why SRT control is so important
2. Setting SRT_{TARGET}
   a. Meet effluent ammonia requirement or goal
   b. Maximize sludge quality
   c. Minimum that meets a. and b.



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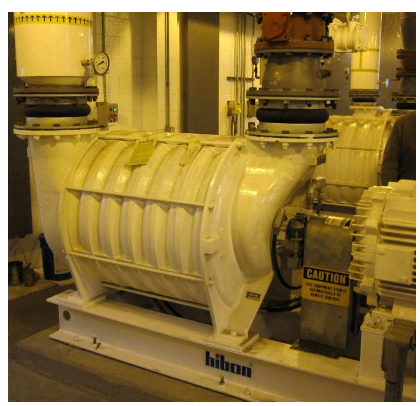
Equipment Turndown—On the Agenda

1. What's the right DO setpoint in aeration basins?
2. What's the right RAS flow rate?



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Next Session: Can't Generate Energy Without Anaerobic Digestion

1. Commitment to saving energy throughout organization
2. **Energy generation**
3. Process energy conservation
4. Assess and refine

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WASTEWATER PLANT ENERGY BASICS AND KPIs

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Billing Terminology

Watt	= Basic unit of electrical power
kW	= 1,000 Watts
kWh	= kW*Hours of Operation

Note A Watt is a pretty small unit, so we use kW.

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Units of Measure

Flow gal/min — $\frac{100 \text{ gallons}}{\text{minute}}$

POWER (demand) kW — 60 kW

Volume gallons

$$\frac{100 \text{ gal}}{\cancel{\text{min}}} * \frac{60 \cancel{\text{min}}}{\cancel{\text{hour}}} * \frac{24 \cancel{\text{hours}}}{\text{day}} = \frac{144{,}000 \text{ gallons}}{\text{day}}$$

ENERGY (consumption) kWh

$$60 \text{ kW} * \frac{24 \text{ hours}}{\text{day}} = \frac{1{,}440 \text{ kWh}}{\text{day}}$$

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Estimating Energy Cost

1. **POWER** (kW)
2. **HOURS** of operation per day
3. **RATE** per kWh ($/kilowatt-hour)

kWh/day = kW*Operating Hours/day

$$\text{Cost (\$/day)} = \frac{\cancel{kWh}}{day} * \frac{\$}{\cancel{kWh}} = \$/day$$

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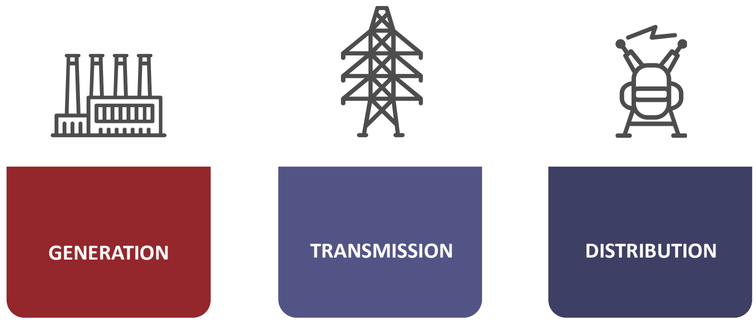
Why does the utility charge peak demand?



Reading Your Electricity Bill

ACME ELECTRIC February 2019

Account ID	0004 1234-56789 8	Invoice Number	123456789
Billing Dates	12/31/2018-1/31/2019 32 days of service	Current Charges	$29,760.80
		Due By	2/15/2019

METER # ABC123456, Schedule 81 Secondary

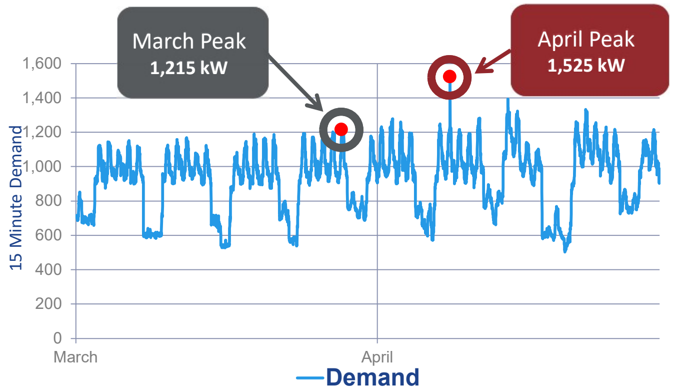
Service Description	
Basic Charge	560.00
System Usage Charge	593.85
Off-Peak Usage of 195446.000 kWh x $0.0335	6,547.44
On-Peak Usage of 295347.000 kWh x $0.0504	14,885.49
Demand Charge of 932.000 kW x $1.9500	1,817.40
Transmission Charge of 932.000 kW x $0.910	848.12
Distribution Facility Capacity Charge of 1017.00 kW x $2.0600	2,095.00
	$27,347.32
Taxes and Adjustments	
City Tax (1.5%)	410.21
Public Purpose Charge (3%)	820.42
108 Regulatory Adjustments	29.47
115 Energy Efficiency Funding	1,153.38
	$2,413.48

Period Ending	Avg Daily Temp	Avg kWh per day	Avg Cost per day
1/31/2019	71.5	15338	930.03
1/31/2018	73.1	15021	889.25

kWh use

kW demand

Peak Demand Example



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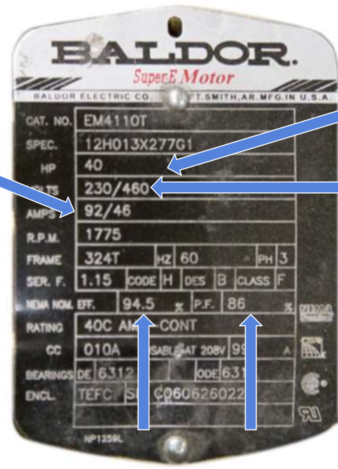
Motor Nameplates

Amps = Full Load Amps



HP = Max *Output @ Full Load*

Runs on 230 or 460 volts

EFF & P.F. = Motor efficiency and power factor @ ideal operating point

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Estimating Power

Estimating Power from Motor HP and Load Factor	
HP =	Motor HP from the nameplate (Motor horsepower)
Load Factor =	Estimated capacity/loading (~ Measured amps/Full Load amps) (0 – 1.0)
Motor Efficiency =	Motor efficiency rating from the nameplate (0 – 1.0)

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Estimating Power

Estimating from Motor HP & Efficiency and Load Factor
Power (kW) = $\frac{0.746 \times HP \times \text{Load Factor }\%}{\text{Motor Efficiency }\%}$

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Electricity Example – w/ Efficiency & Load Factor

Power (kW)

$= \frac{0.746 \times HP \times \textbf{Load Factor \%}}{\text{Motor Efficiency }\%}$

= (0.746 * **40** * **0.8**)/**0.945** = **25 kW**

Energy (kWh)

= kW * **Annual Operating Hours**

= **25** kW * **8,760 h** = **220,000 kWh**

Annual Energy Cost ($)

= kWh * **$/kWh**

= **220,000** kWh * **$0.10** = **$22,000**

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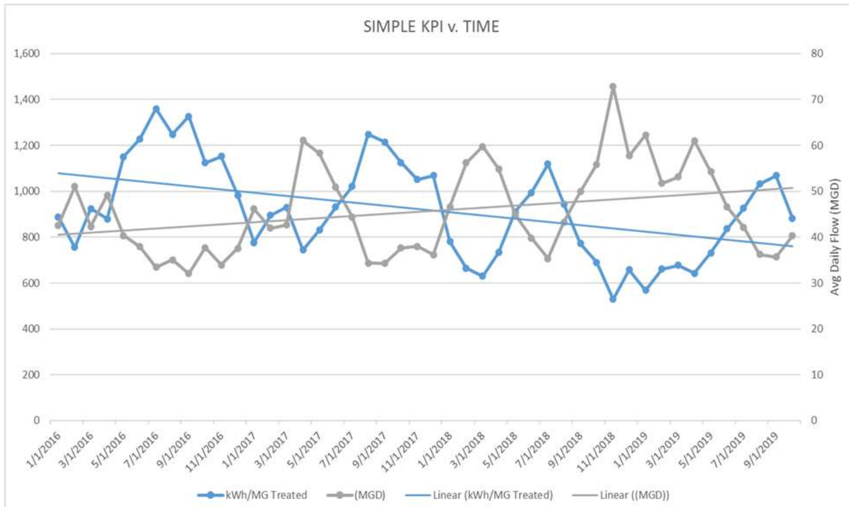
Key Performance Indicators (KPIs)



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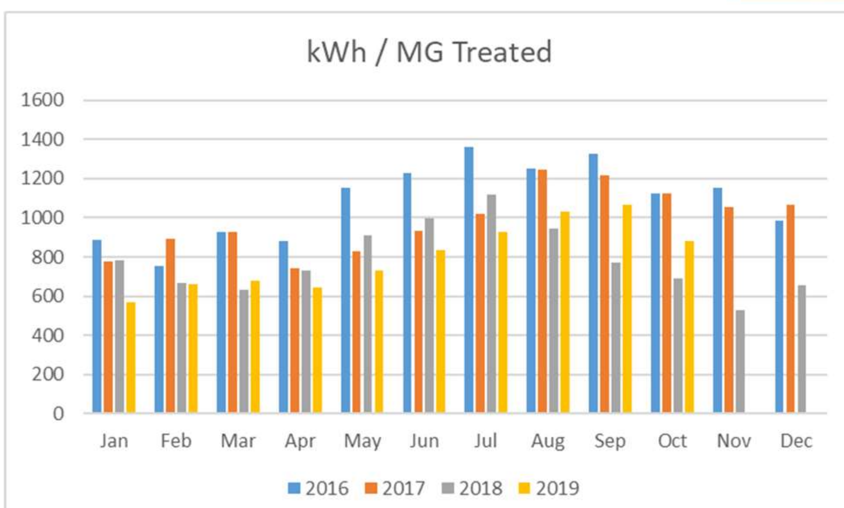
Year over Year KPIs



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BREAK

until 22 after the hour

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Back from the break…

Please share in chat:

- What is one thing you are doing at your facility right now that you consider is saving energy over the alternatives available?
- What is one thing you are doing at your facility right now that you consider is wasting energy?

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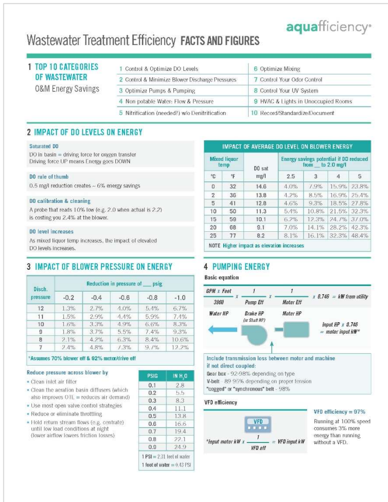
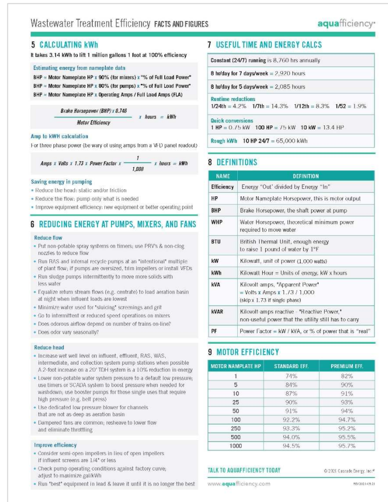
WW Treatment Efficiency Facts and Figures





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QUIZ - Wastewater Treatment Efficiency Facts & Figures

1. Your RAS pump runs continuously. The nameplate says 10 hp and 85% efficiency. Knowing nothing else, what would you estimate the annual energy consumption to be in this case?

Wastewater Treatment Efficiency **FACTS AND FIGURES**

5 CALCULATING kWh

It takes 3.14 kWh to lift 1 million gallons 1 foot at 100% efficiency

Estimating energy from nameplate data

BHP ≈ Motor Nameplate HP x 90% (for mixers) **x "% of Full Load Power"**

BHP ≈ Motor Nameplate HP x 80% (for pumps) **x "% of Full Load Power"**

BHP ≈ Motor Nameplate HP x Operating Amps / Full Load Amps (FLA)

$$\frac{\text{Brake Horsepower (BHP)} \times 0.746}{\text{Motor Efficiency}} \times \text{hours} = \text{kWh}$$

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QUIZ - Wastewater Treatment Efficiency Facts & Figures

1. Your RAS pump runs continuously. The nameplate says 10 hp and 85% efficiency. Knowing nothing else, what would you estimate the total energy consumption to be in this case?

BHP ≈ Motor Nameplate HP x 80% (for pumps) **x "% of Full Load Power"**

- Motor Nameplate HP = 10 hp
- Motor Efficiency = 85% = 0.85
- Assume % Full Load Power = 100% = 1

BHP = 10 hp * 0.80 * 1 = 8 BHP

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QUIZ - Wastewater Treatment Efficiency Facts & Figures

1. Your RAS pump runs continuously. The nameplate says 10 hp and 85% efficiency. Knowing nothing else, what would you estimate the total energy consumption to be in this case?

$$\frac{\text{Brake Horsepower (BHP)} \times 0.746}{\text{Motor Efficiency}} \times \text{hours} = \text{kWh}$$

- BHP = 8 BHP
- Motor Efficiency = 85% = 0.85
- Runs continuously = 8760 hours/year

$$\frac{8\,\text{hp} * \frac{0.746\,\text{kW}}{\text{hp}}}{0.85} * \frac{8760\ \text{hours}}{\text{year}} = \frac{61{,}500\ \text{kWh}}{\text{year}}$$

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QUIZ - Wastewater Treatment Efficiency Facts & Figures

2. Your electrician measures the actual average amperage on a 10 hp RAS pump that runs continuously. His reading is 8.7 amps and 460 volts. Estimate how much energy this pump uses in one year. Assume a power factor of 85%.

Wastewater Treatment Efficiency FACTS AND FIGURE

5 CALCULATING kWh

It takes 3.14 kWh to lift 1 million gallons 1 foot at 100% efficiency

Estimating energy from nameplate data

BHP ≈ Motor Nameplate HP x 90% (for mixers) x "% of Full Load Power"

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BHP ≈ Motor Nameplate HP x Operating Amps / Full Load Amps (FLA)

$$\frac{\text{Brake Horsepower (BHP)} \times 0.746}{\text{Motor Efficiency}} \times \text{hours} = \text{kWh}$$

Amp to kWH calculation

For three phase power (be wary of using amps from a VFD panel)

$$\text{Amps} \times \text{Volts} \times 1.73 \times \text{Power Factor} \times \frac{1}{1{,}000} \times \text{hours} = \text{kWh}$$

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QUIZ - Wastewater Treatment Efficiency Facts & Figures

2. Your electrician measures the actual average amperage on a 10 hp RAS pump that runs continuously. His reading is 8.7 amps and 460 volts. Estimate how much energy this pump uses in one year. Assume a power factor of 85%.

$$\text{Amps} \times \text{Volts} \times 1.73 \times \text{Power Factor} \times \frac{1}{1{,}000} \times \text{hours} = \text{kWh}$$

- Amps = 8.7 amps
- Volts = 460 volts
- Power Factor = 85% = 0.85
- Runs continuously = 8760 hours/year

$$8.7 \text{ amps} * 460 \text{ volts} * 1.73 * 0.85 * \frac{1}{1{,}000} * \frac{8760 \text{ hours}}{\text{year}} = \frac{51{,}500 \text{ kWh}}{\text{year}}$$

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NON-POTABLE WATER SYSTEMS

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An actual picture…

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Non-Potable Water Systems

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Non-Potable Water Tour

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Non-Potable Water Tour Discussion

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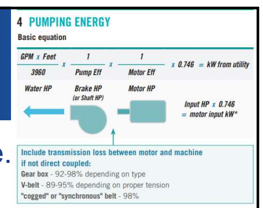
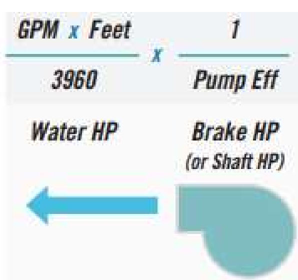
So What's the Big Deal?



Non-potable water reclaimed from the plant isn't free.
You are paying your utilities for it.

Pumping Power Equation:



Example:

- 500 gal/min @ 100 psi average (85 ON – 115 OFF)
- 100 psi = **231 feet**
- Brake hp = $\dfrac{(500\ \cancel{gal/min} * 231\ \cancel{ft})}{[3960\ \cancel{gal\ ft/(min}\ hp)]* 0.70)}$ = 42 hp

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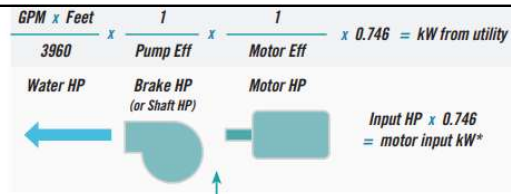
So What's the Big Deal?



Include transmission loss between motor and machine if not direct coupled:
Gear box - 92-98% depending on type
V-belt - 89-95% depending on proper tension
"cogged" or "synchronous" belt - 98%

Pumping energy:

- Brake hp x 1 / Motor Eff = Motor hp
- 42 hp / 94% motor eff = **44 hp**
- Input hp x 0.746 kW / hp = Motor kW
- 44 ~~hp~~ x 0.746 kW/~~hp~~ = **33 kW**
- 33 kW x 8760 hr/yr = **290,000 kWh/yr**

What's that cost you?

- 33 ~~kW~~ x $8.00/~~kW~~ x 12 months/yr = **$3,200/yr for demand (kW)**
- 290,000 ~~kWh~~/yr x $0.10/~~kWh~~ = **$29,000/yr for energy (kWh)**
- The free water costs **~$32,200 per year!**

Wait there is more cost!!

- If the "free water" you use returns to the headworks, then you are also paying for the retreatment…

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So What's the Big Deal?

Let's assume the following:

1. 250 gal/min of the 500 gal/min is returned to the influent (50%).
2. This particular plant has an average KPI of 2000 kWh/MG treated/yr.

What's that cost you?

- MG treated/yr = (250 ~~gal~~/~~min~~* 60 ~~min~~/~~hr~~ * 8760 ~~hr~~/yr)/ (1,000,000 ~~gal~~/MG)
  = **131 MG treated/yr**
- kWh/yr= 2000 kWh/~~MG treated~~ * 131 ~~MG treated~~/yr
  = **263,000 kWh/yr**
- **$/yr = $0.10/~~kWh~~ * 263,000 ~~kWh~~/yr = $26,300/yr**

The final cost for the "free water"?

Annual Cost of 500 gal/min @ 100 psi = $32,200 + $26,300 = $58,500/yr

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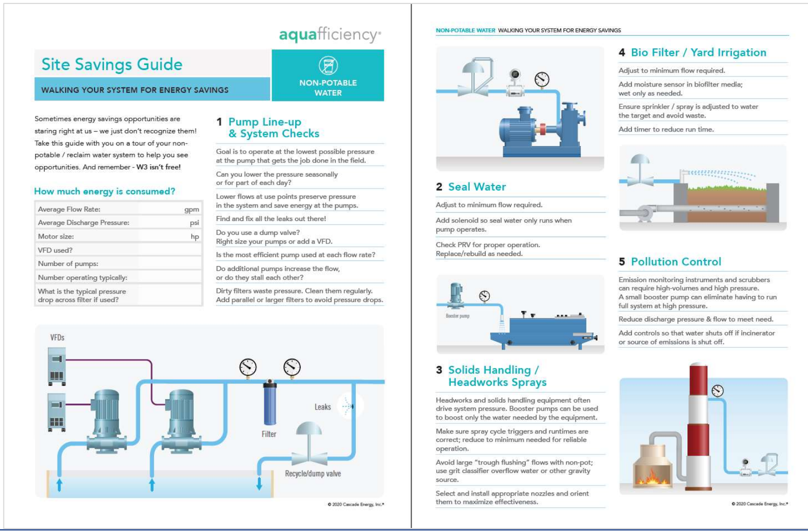
Non-Potable Water Site Savings



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Site Savings Guide

WALKING YOUR SYSTEM FOR ENERGY SAVINGS

NON-POTABLE WATER

Sometimes energy savings opportunities are staring right at us – we just don't recognize them! Take this guide with you on a tour of your non-potable / reclaim water system to help you see opportunities. And remember - **W3 isn't free!**

How much energy is consumed?

Average Flow Rate:	gpm
Average Discharge Pressure:	psi
Motor size:	hp
VFD used?	
Number of pumps:	
Number operating typically:	
What is the typical pressure drop across filter if used?	

1 Pump Line-up & System Checks

Goal is to operate at the lowest possible pressure at the pump that gets the job done in the field.

Can you lower the pressure seasonally or for part of each day?

Lower flows at use points preserve pressure in the system and save energy at the pumps.

Find and fix all the leaks out there!

Do you use a dump valve? Right size your pumps or add a VFD.

Is the most efficient pump used at each flow rate?

Do additional pumps increase the flow, or do they stall each other?

Dirty filters waste pressure. Clean them regularly. Add parallel or larger filters to avoid pressure drops.

VFDs

Leaks

Filter

Recycle/dump valve

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NON-POTABLE WATER WALKING YOUR SYSTEM FOR ENERGY SAVINGS

2 Seal Water

Adjust to minimum flow required.

Add solenoid so seal water only runs when pump operates.

Check PRV for proper operation. Replace/rebuild as needed.

Booster pump

3 Solids Handling / Headworks Sprays

Headworks and solids handling equipment often drive system pressure. Booster pumps can be used to boost only the water needed by the equipment.

Make sure spray cycle triggers and runtimes are correct; reduce to minimum needed for reliable operation.

Avoid large "trough flushing" flows with non-pot; use grit classifier overflow water or other gravity source.

Select and install appropriate nozzles and orient them to maximize effectiveness.

4 Bio Filter / Yard Irrigation

Adjust to minimum flow required.

Add moisture sensor in biofilter media; wet only as needed.

Ensure sprinkler / spray is adjusted to water the target and avoid waste.

Add timer to reduce run time.

5 Pollution Control

Emission monitoring instruments and scrubbers can require high-volumes and high pressure. A small booster pump can eliminate having to run full system at high pressure.

Reduce discharge pressure & flow to meet need.

Add controls so that water shuts off if incinerator or source of emissions is shut off.

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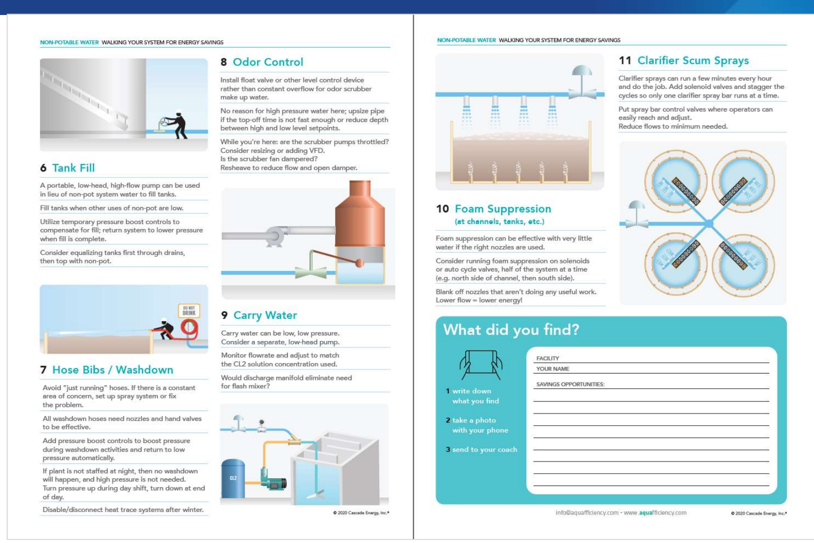
Non-Potable Water Site Savings



NON-POTABLE WATER WALKING YOUR SYSTEM FOR ENERGY SAVINGS

6 Tank Fill

A portable, low-head, high-flow pump can be used in lieu of non-pot system water to fill tanks.

Fill tanks when other uses of non-pot are low.

Utilize temporary pressure boost controls to compensate for fill; return system to lower pressure when fill is complete.

Consider equalizing tanks first through drains, then top with non-pot.

DO NOT DRINK

7 Hose Bibs / Washdown

Avoid "just running" hoses. If there is a constant area of concern, set up spray system or fix the problem.

All washdown hoses need nozzles and hand valves to be effective.

Add pressure boost controls to boost pressure during washdown activities and return to low pressure automatically.

If plant is not staffed at night, then no washdown will happen, and high pressure is not needed. Turn pressure up during day shift, turn down at end of day.

Disable/disconnect heat trace systems after winter.

8 Odor Control

Install float valve or other level control device rather than constant overflow for odor scrubber make up water.

No reason for high pressure water here; upsize pipe if the top-off time is not fast enough or reduce depth between high and low level setpoints.

While you're here: are the scrubber pumps throttled? Consider resizing or adding VFD. Is the scrubber fan dampered? Resheave to reduce flow and open damper.

9 Carry Water

Carry water can be low, low pressure. Consider a separate, low-head pump.

Monitor flowrate and adjust to match the CL2 solution concentration used.

Would discharge manifold eliminate need for flash mixer?

CL2

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NON-POTABLE WATER WALKING YOUR SYSTEM FOR ENERGY SAVINGS

10 Foam Suppression (at channels, tanks, etc.)

Foam suppression can be effective with very little water if the right nozzles are used.

Consider running foam suppression on solenoids or auto cycle valves, half of the system at a time (e.g. north side of channel, then south side).

Blank off nozzles that aren't doing any useful work. Lower flow = lower energy!

11 Clarifier Scum Sprays

Clarifier sprays can run a few minutes every hour and do the job. Add solenoid valves and stagger the cycles so only one clarifier spray bar runs at a time.

Put spray bar control valves where operators can easily reach and adjust. Reduce flows to minimum needed.

What did you find?

1 write down what you find

2 take a photo with your phone

3 send to your coach

FACILITY

YOUR NAME

SAVINGS OPPORTUNITIES:

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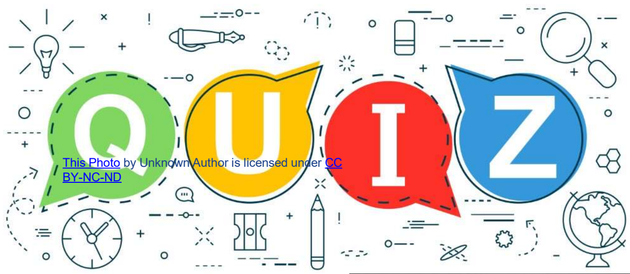

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Closing

Homework:

1. Complete the facility survey if you haven't already
2. Complete a non-potable water walk, if applicable

SEE YOU NEXT WEEK!

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