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Case Studies

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Applying basic principles to real world situations: *Case Studies*

Case study presentation agenda

- Describe "as found" case study configurations
- Look for indicators of energy reduction opportunities (prescreening method)
- Apply the MEASUR software to as found data
- Describe changes made to improve the situation

Welches Point Wastewater Lift Station (Milford, Connecticut)

- This case study is based on work done by ITT Flygt for the town of Milford

- Case study technical contact:
- Gunnar Hovstadius (retired)
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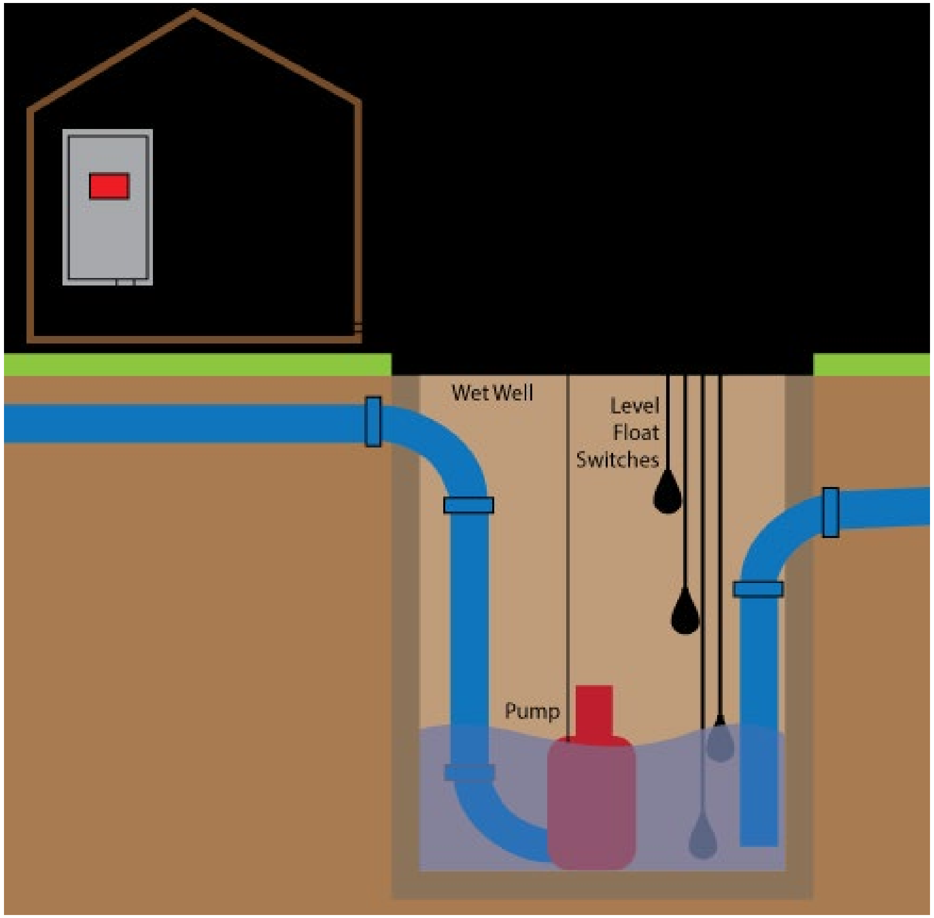
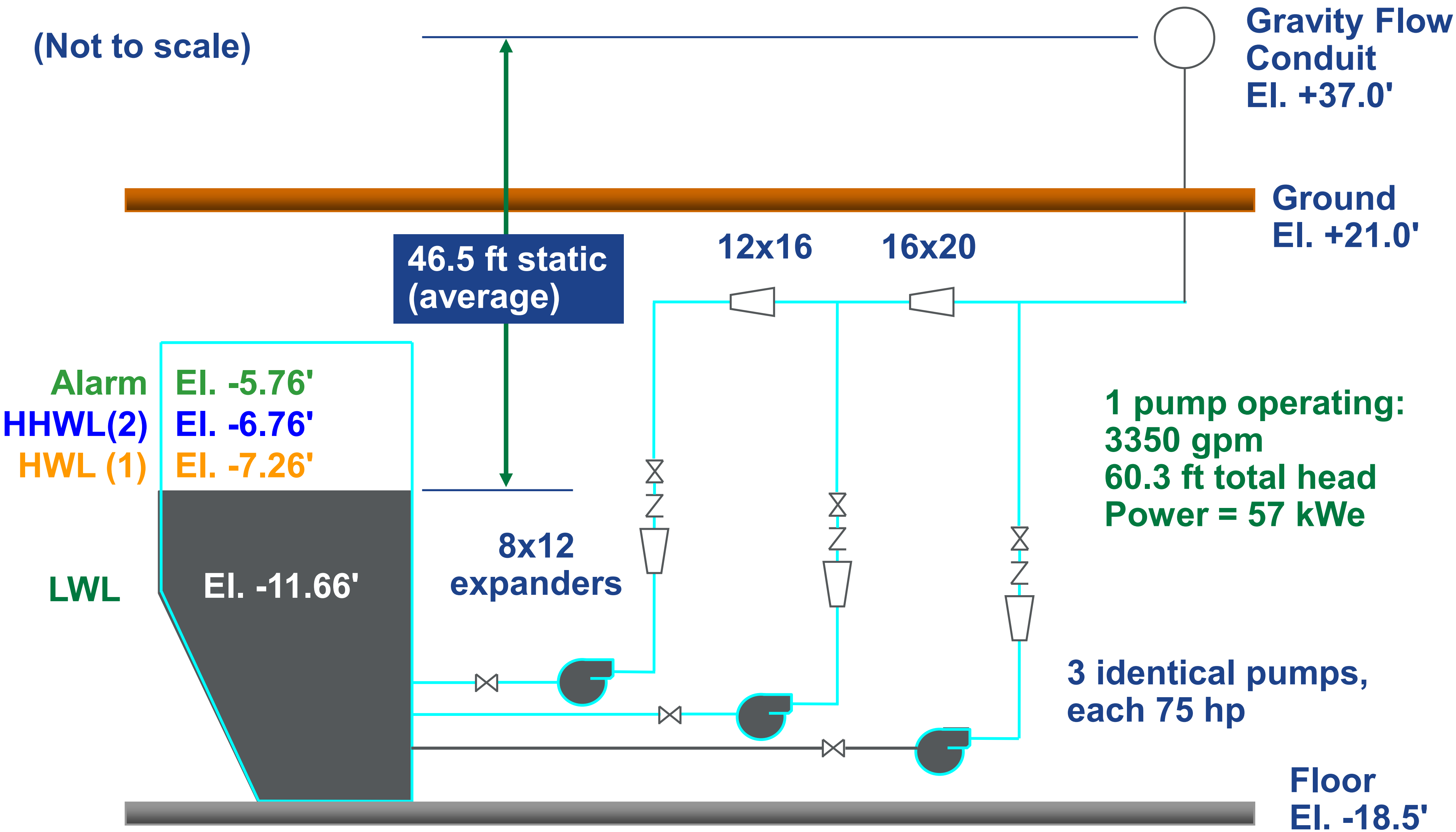
- Email:gunnarh@msn.com

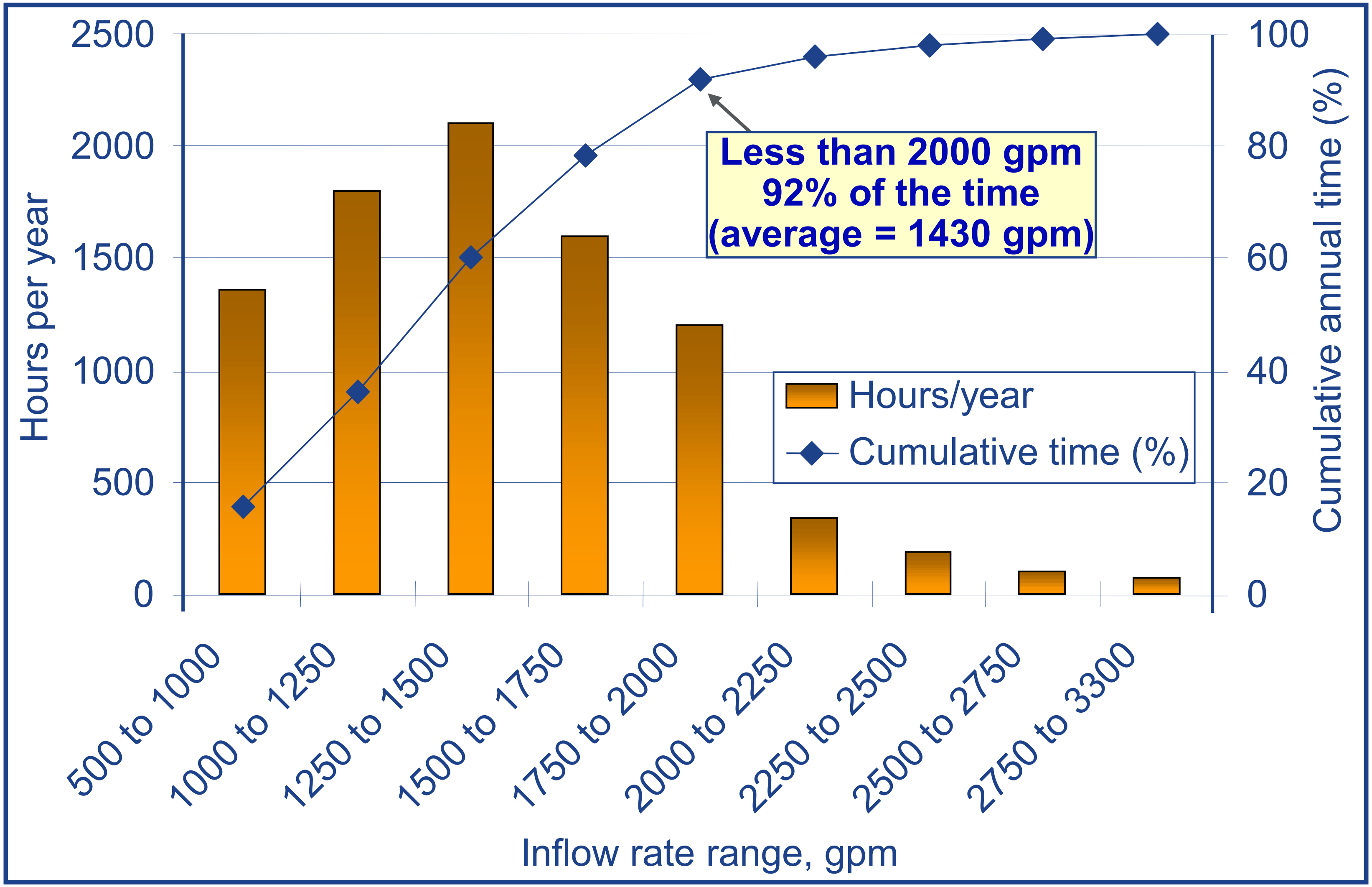
- Case study prepared by Don Casada, Diagnostic Solutions



The Welches Point Lift Station cycles pump(s) on/off (run 43% of time) to control wet well level



The pump design capability greatly exceeds the normal operational requirement



NOTE: Average pump flow rate = 3350 gpm

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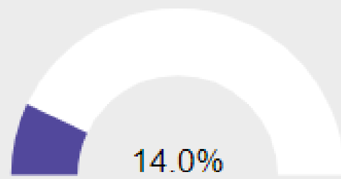
Putting the box around the pump and motor for the existing flow and head condition

Pump Type	End Suction Sewage	
Pump Speed	1170	rpm
Drive	Direct Drive	
Fluid Type	Water	
Fluid Temperature	68	°F
Specific Gravity	1	
Kinematic Viscosity	1	cSt
Stages	− + 1	
Line Frequency	60 Hz	
Rated Motor Power	75	hp
Motor RPM	1170	rpm
Efficiency Class	Standard Efficiency	
Rated Voltage	460	V
Full-Load Amps Estimate Full-Load Amps	92.3	A
Operating Hours	3740	hrs/yr
Electricity Cost	0.082	$/kWh
Flow Rate	3350	gpm
Head Calculate Head	60.3	ft
Load Estimation Method	Power	
Motor Power	57	kW
Measured Voltage	460	V

Putting the box around the pump and motor for the existing flow and head condition

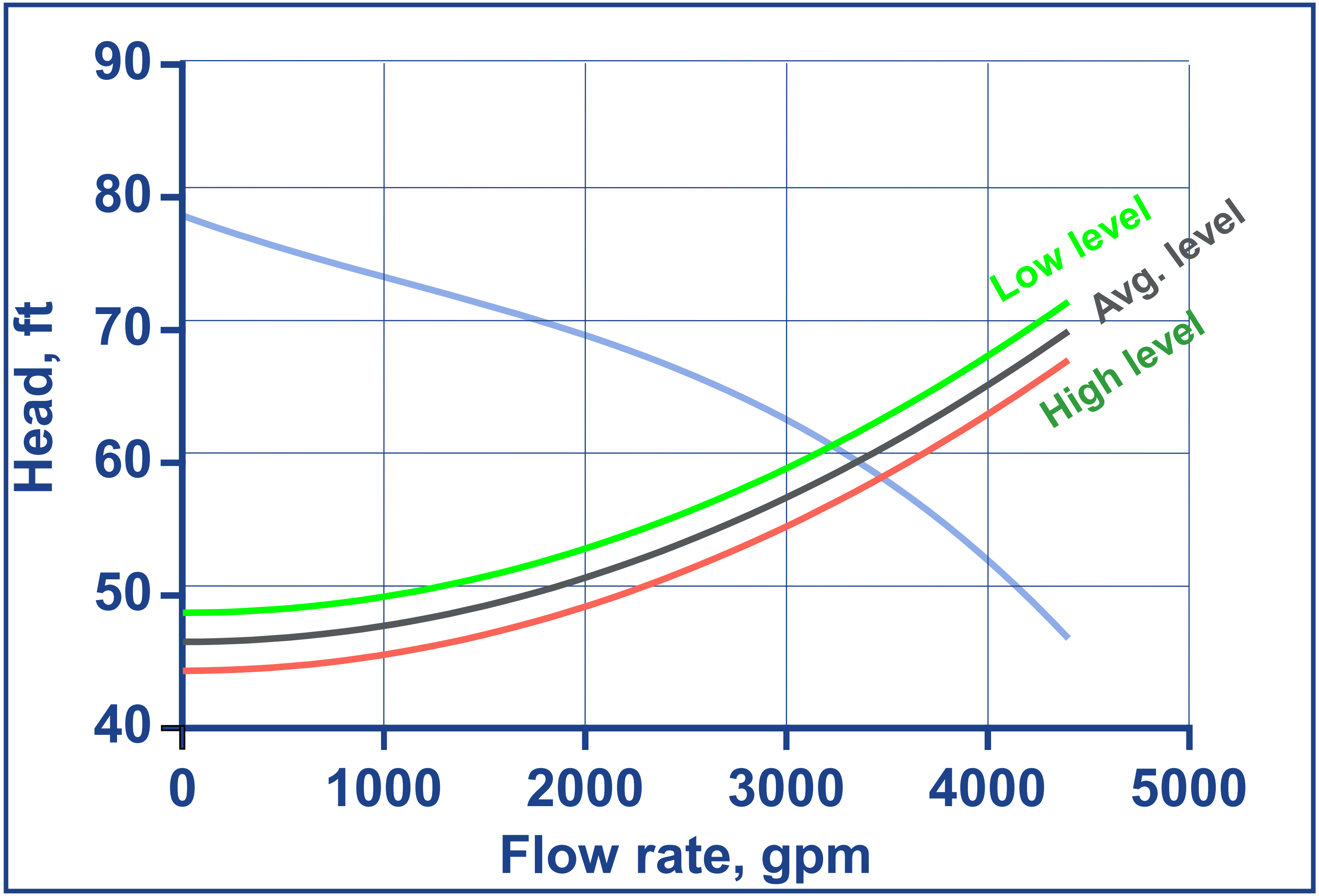
RESULTS | SANKEY | HELP

	Baseline	Optimal Pump
Percent Savings (%)	— —	
Pump efficiency (%)	72.3	83.5
Motor rated power (hp)	75	75
Motor shaft power (hp)	70.6	61.1
Pump shaft power (hp)	70.6	61.1
Motor efficiency (%)	92.4	92.4
Motor power factor (%)	82.2	81.2
Percent Loaded (%)	94	81
Drive efficiency (%)	100	100
Motor current (amps)	87	76
Motor power (kW)	57	49.3
Annual Energy (MWh)	**213**	**184**
Annual Energy Savings (MWh)	**—**	**29**
Annual Cost	**$17,481**	**$15,119**
Annual Savings	**—**	**$2,361**

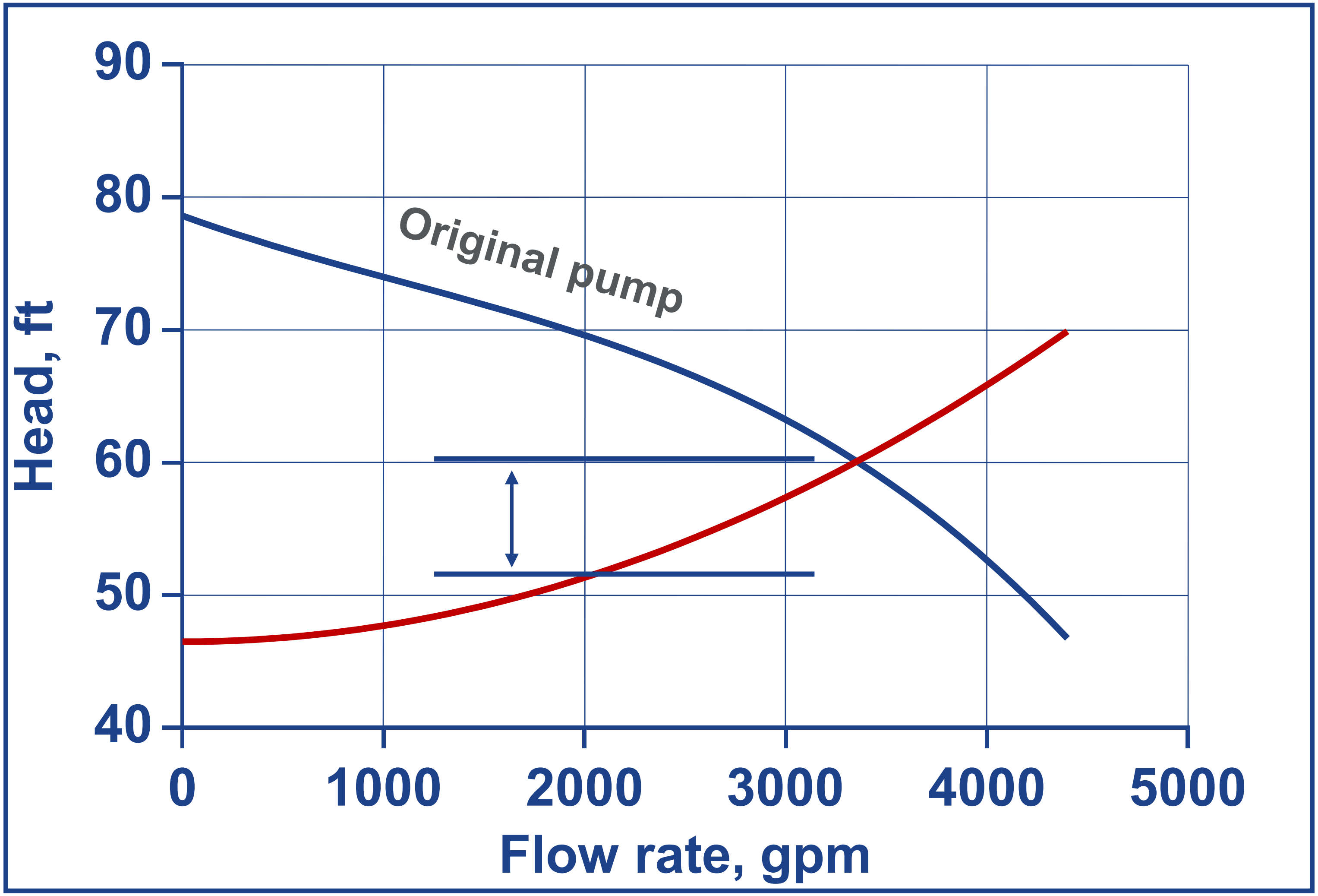
Optimization Rating = (72.3/83.5)100 = 86.6%

Existing equipment is not bad

Existing pump & system head-capacity curves



Excessive frictional head losses occur when higher than necessary flow rates occur



The system curve tool can be used to determine head at alternate flow rates

System Curve

Fluid Specific Gravity	1
System Loss Exponent, C	1.9

Point 1

Flow Rate	3350 gpm
Head	60.3 ft

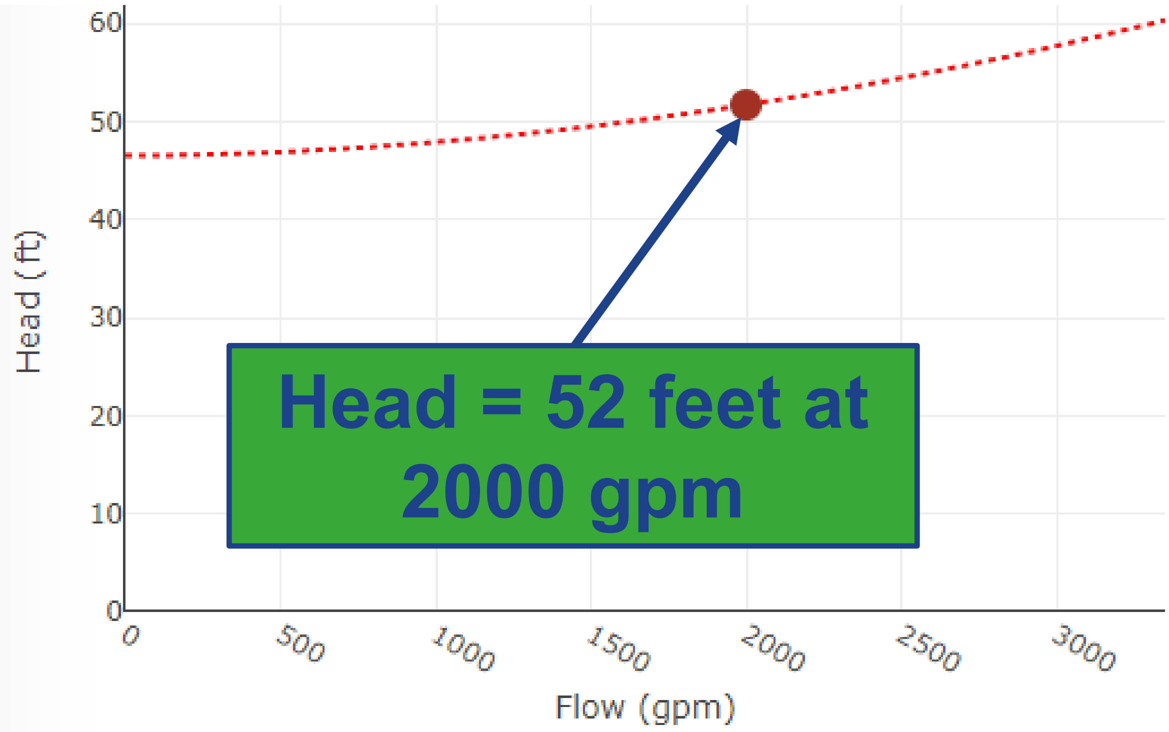
Point 2

Flow Rate	0 gpm
Head	46.5 ft

System Curve

Head = 46.5 + (0.00000277 × $flow^{1.9}$)

Key	Flow (gpm)	Head (ft)
●	2,000	52



The station processes 752 million gallons/yr; What if we pumped at lower flow rates?

Average running flow rate hours and associated head

Flow rate	Hours/year	Run fraction	Head (ft)
3350 gpm	3741	0.427	60.3
2500 gpm	5013	0.572	54.4
2000 gpm	6267	0.715	51.7
1500 gpm	8356	0.954	49.5

Optimized pump at 2500 gpm

Operating Hours	5013 hrs/yr
Electricity Cost	0.082 $/kWh
Flow Rate	2500 gpm
Head Calculate Head	54.4 ft
Load Estimation Method	Power
Motor Power	33.97 kW
Measured Voltage	460 V

Savings = $17,481 - $13,964 = $3,517/yr

RESULTS SANKEY HELP

	Baseline	Optimized Pump at 2500 gpm
Percent Savings (%)	— —	
Pump efficiency (%)	82	82
Motor rated power (hp)	75	75
Motor shaft power (hp)	41.9	41.9
Pump shaft power (hp)	41.9	41.9
Motor efficiency (%)	91.9	91.9
Motor power factor (%)	74.7	74.7
Percent Loaded (%)	56	56
Drive efficiency (%)	100	100
Motor current (amps)	57	57
Motor power (kW)	34	34
Annual Energy (MWh)	**170**	**170**
Annual Energy Savings (MWh)	**—**	
Annual Cost	**$13,964**	**$13,964**
Annual Savings	**—**	**$00**

Optimized pump at 2000 gpm

Operating Hours	6267	hrs/yr
Electricity Cost	0.082	$/kWh
Flow Rate	2000	gpm
Head	51.7	ft
Calculate Head		
Load Estimation Method	Power	
Motor Power	26.1765	kW
Measured Voltage	460	V

Savings = $17,481 - $13,452 = $4,029/yr

RESULTS | SANKEY | HELP

	Baseline	Optimized Pump at 2000 gpm
Percent Savings (%)	— —	
Pump efficiency (%)	82	82
Motor rated power (hp)	75	75
Motor shaft power (hp)	31.8	31.8
Pump shaft power (hp)	31.8	31.8
Motor efficiency (%)	90.7	90.7
Motor power factor (%)	67.5	67.5
Percent Loaded (%)	42	42
Drive efficiency (%)	100	100
Motor current (amps)	49	49
Motor power (kW)	26.2	26.2
Annual Energy (MWh)	**164**	**164**
Annual Energy Savings (MWh)	**—**	
Annual Cost	**$13,452**	**$13,452**
Annual Savings	**—**	**$00**

Optimized pump at 1500 gpm

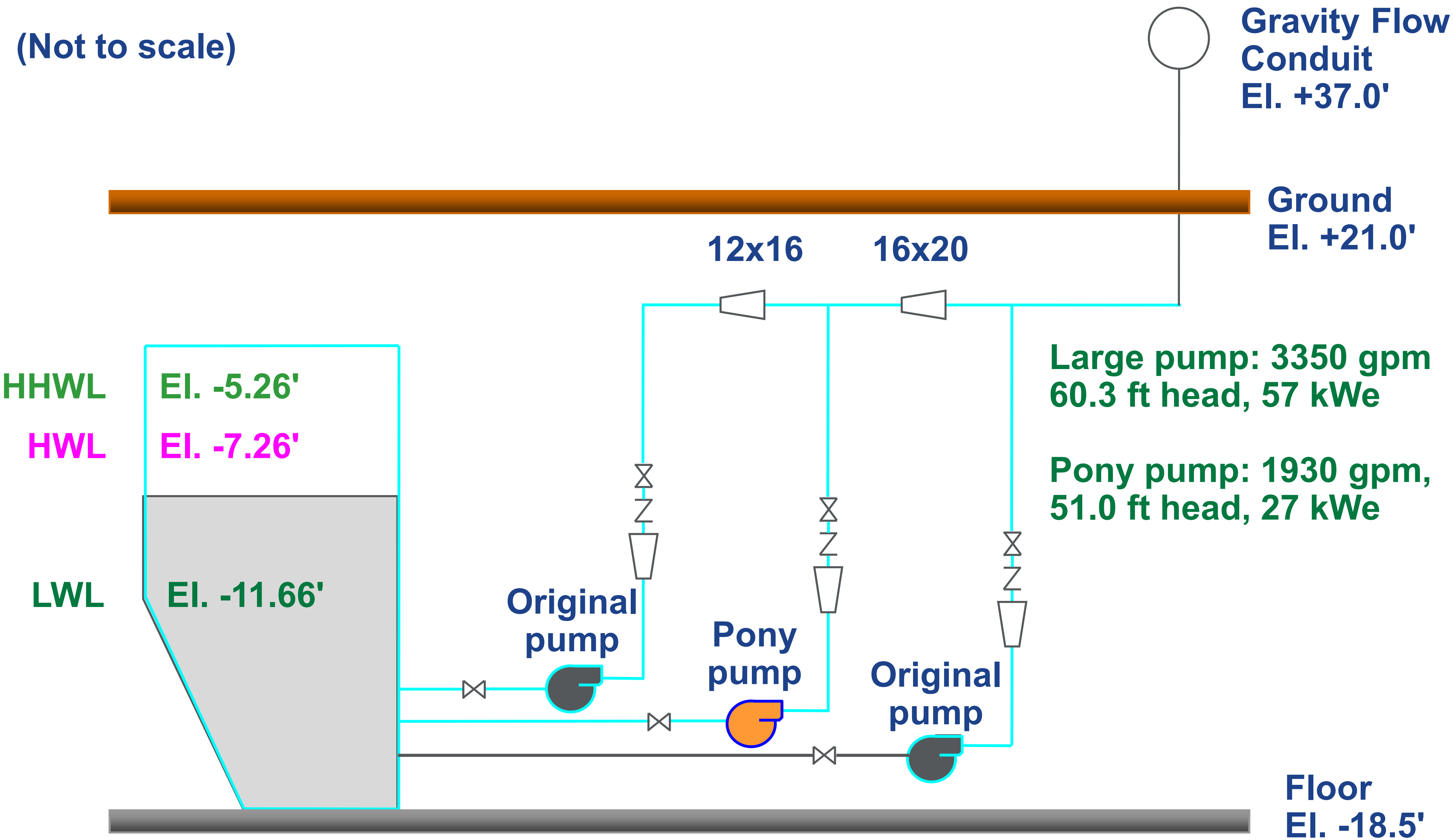
Operating Hours	8356	hrs/yr
Electricity Cost	0.082	$/kWh
Flow Rate	1500	gpm
Head Calculate Head	49.5	ft
Load Estimation Method	Power	
Motor Power	19.315	kW
Measured Voltage	460	V

Savings = $17,481 - $13,234 = $4,247/yr

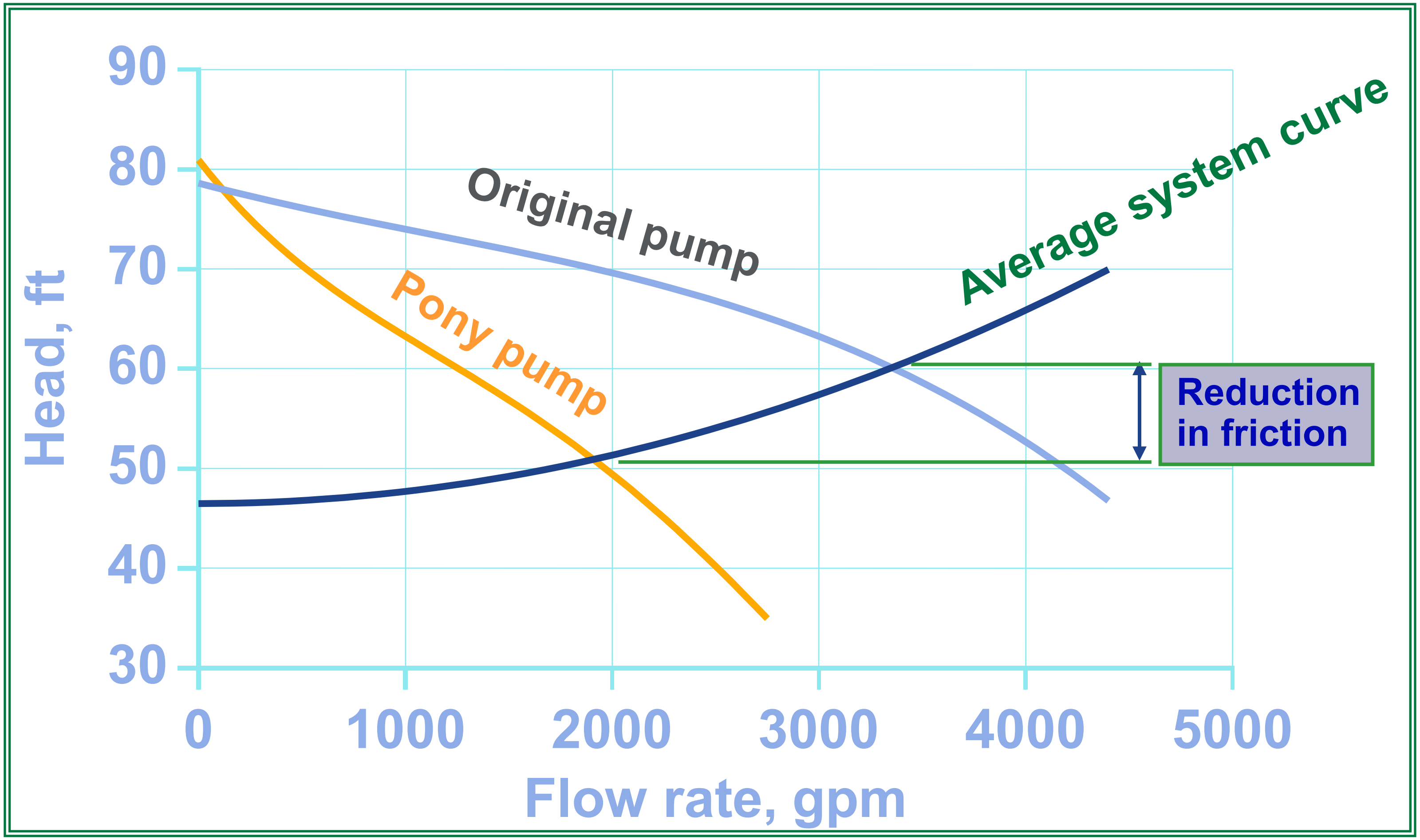
RESULTS | SANKEY | HELP

	Baseline	Optimized Pump at 1500 gpm
Percent Savings (%)	— —	
Pump efficiency (%)	82	82
Motor rated power (hp)	75	75
Motor shaft power (hp)	22.9	22.9
Pump shaft power (hp)	22.9	22.9
Motor efficiency (%)	88.3	88.3
Motor power factor (%)	57.8	57.8
Percent Loaded (%)	30	30
Drive efficiency (%)	100	100
Motor current (amps)	42	42
Motor power (kW)	19.3	19.3
Annual Energy (MWh)	**161**	**161**
Annual Energy Savings (MWh)	**—**	**00**
Annual Cost	**$13,234**	**$13,234**
Annual Savings	**—**	**$00**

Lift station after replacing one large pump with smaller “pony” pump



The pony pump operates efficiently at lower flow rate, eliminating 2/3 of the frictional losses



Note: The sizing of the original pump, the availability of adequate spare capacity, and nature of the system made use of a variable speed drive less attractive for this particular system.

After making the design change:

Replacement pump comparison

BASELINE

Pump Type	End Suction Sewage
Pump Speed	1170 rpm
Drive	Direct Drive
Fluid Type	Water
Fluid Temperature	68 ℉
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 1
Line Frequency	60 Hz
Rated Motor Power	75 hp
Motor RPM	1170 rpm
Efficiency Class	Standard Efficiency
Rated Voltage	460 V
Full-Load Amps	92.3 A

REPLACE PUMP

Pump Efficiency Optimize Pump	79.6 %

The efficiency of your pump has been calculated based on your system setup. Either directly modify your efficiency or click **"Optimize Pump"** to estimate your pump efficiency based on a different pump type.

Pump Speed	880 rpm
Drive	Specified Efficiency
Drive Efficiency	100 %
Fluid Type	Water
Fluid Temperature	68 ℉
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 1
Line Frequency	60 Hz
Rated Motor Power	35 hp
Motor RPM	880 rpm
Efficiency Class	Specified
Efficiency	86 %
Rated Voltage	460 V
Full-Load Amps Estimate Full-Load Amps	49.2 A

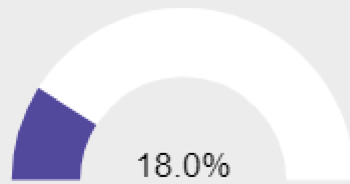
BASELINE

Operating Hours	3741 hrs/yr
Electricity Cost	0.082 $/kWh
Flow Rate	3350 gpm
Head Calculate Head	60.3 ft
Load Estimation Method	Power
Motor Power	57 kW
Measured Voltage	460 V

REPLACE PUMP

Operating Hours	6482 hrs/yr
Electricity Cost	0.082 $/kWh
Flow Rate	1930 gpm
Head Calculate Head	51 ft
Implementation Costs	$

RESULTS | SANKEY | HELP

	Baseline	Replace Pump
Percent Savings (%)	— —	 18.0%
Pump efficiency (%)	72.3	79.6
Motor rated power (hp)	75	35
Motor shaft power (hp)	70.6	31.2
Pump shaft power (hp)	70.6	31.2
Motor efficiency (%)	92.4	86.3
Motor power factor (%)	82.2	78.3
Percent Loaded (%)	94	89
Drive efficiency (%)	100	100
Motor current (amps)	87	43
Motor power (kW)	57	27
Annual Energy (MWh)	**213**	**175**
Annual Energy Savings (MWh)	**—**	**38**
Annual Cost	**$17,485**	**$14,338**
Annual Savings	**—**	**$3,147**

What if you don’t have room to ADD a pump?

- In this case, the excess redundancy allowed a pump to simply be replaced; in some systems, that option may not exist (e.g., space considerations)
- In such situations, a *<u>properly selected</u>* variable speed driven pump can provide nearly the same benefits (although with a higher capital cost) while maintaining required redundancy
- Replacing a functional pump may not be cost effective; but replacing a failed pump with a new design may

Y-12 Plant (Oak Ridge, TN) Demineralized water system

- This case study is based on work done by the Y-12 plant in Oak Ridge, Tennessee, a DOE defense facility.

- Case study technical contact:
- Don Casada—Qualified PSAT Instructor
- Diagnostic Solutions, LLC
- Email:doncasada@diagsol.com

Demineralized and tower water pumping station for the Fusion Energy complex

Let's investigate a really oversized pump – system operations have changed

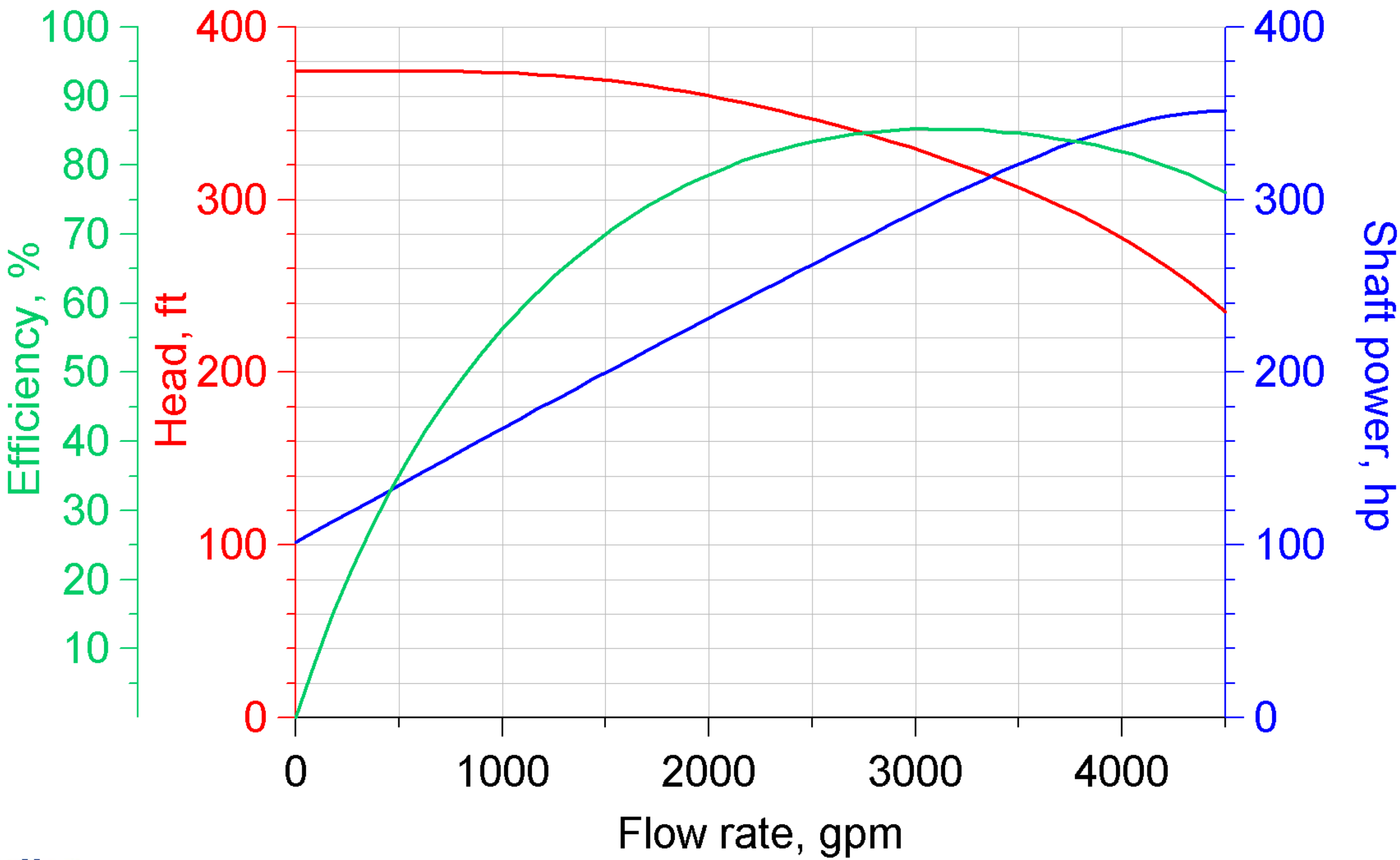
Application:

Demineralized water pumps (for process cooling)

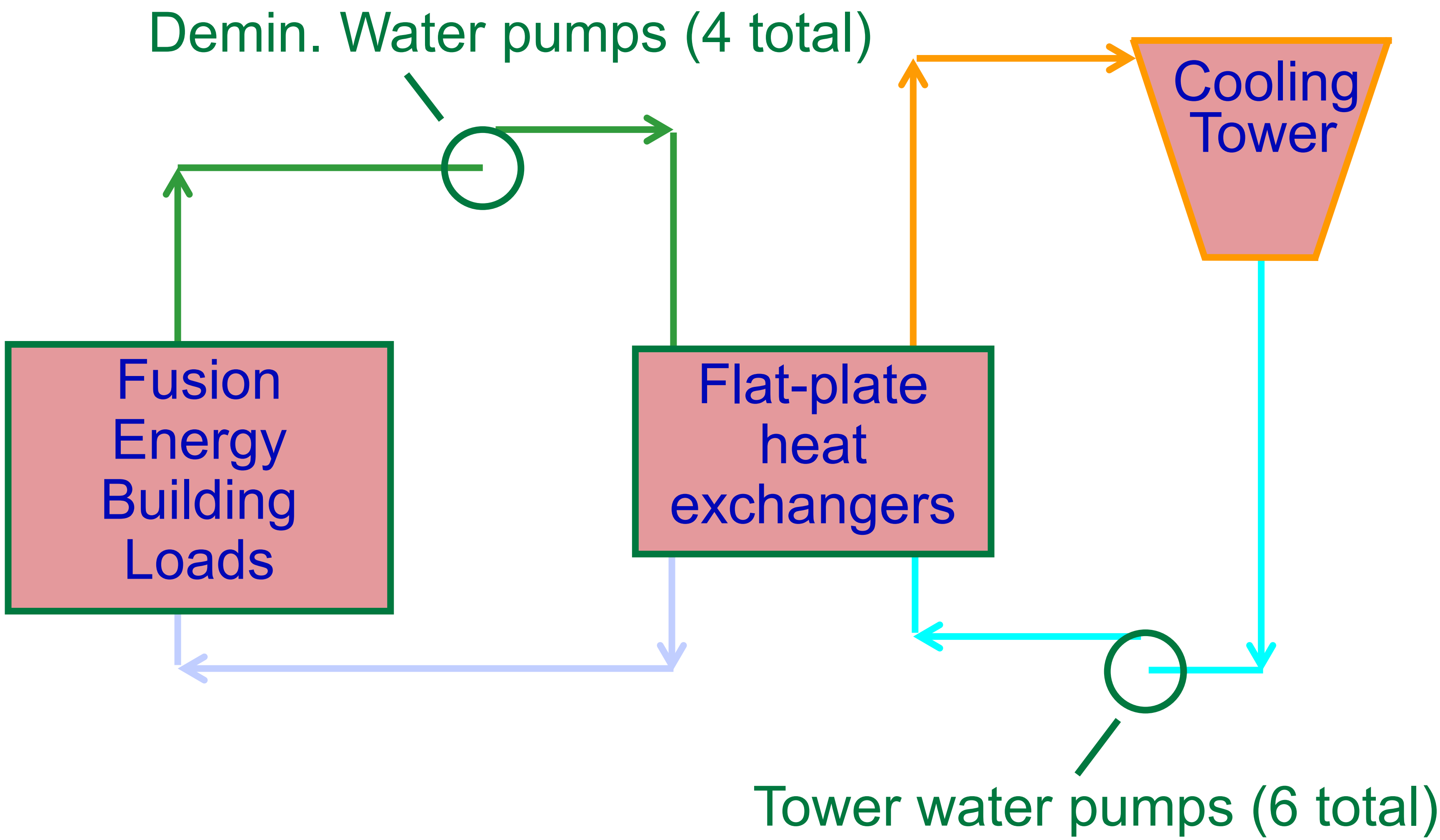
Original pump and motor design (4 parallel pumps):
3700 gpm @ 292 ft head, 1785 rpm pump
350 hp, 2300 V, 1785 rpm motor

Current system requirements:
1200 gpm @ 140 ft head (conservatively high)

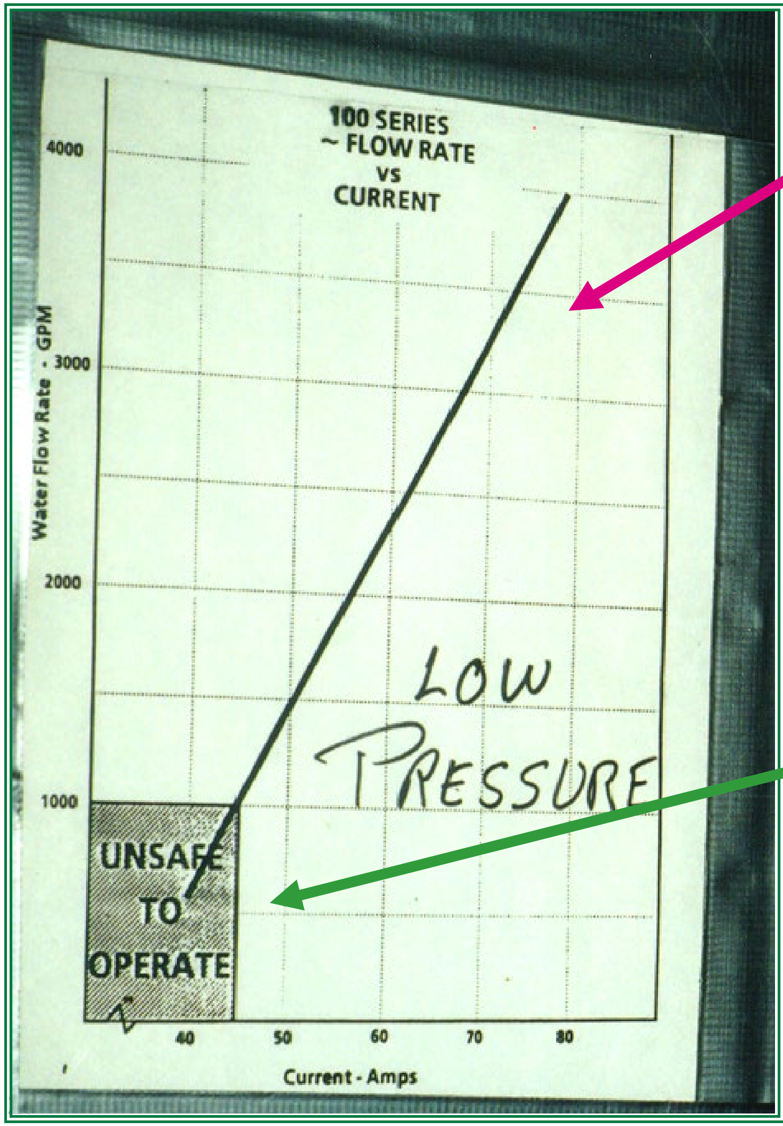
Installed pump performance curves



Simplified flow diagram



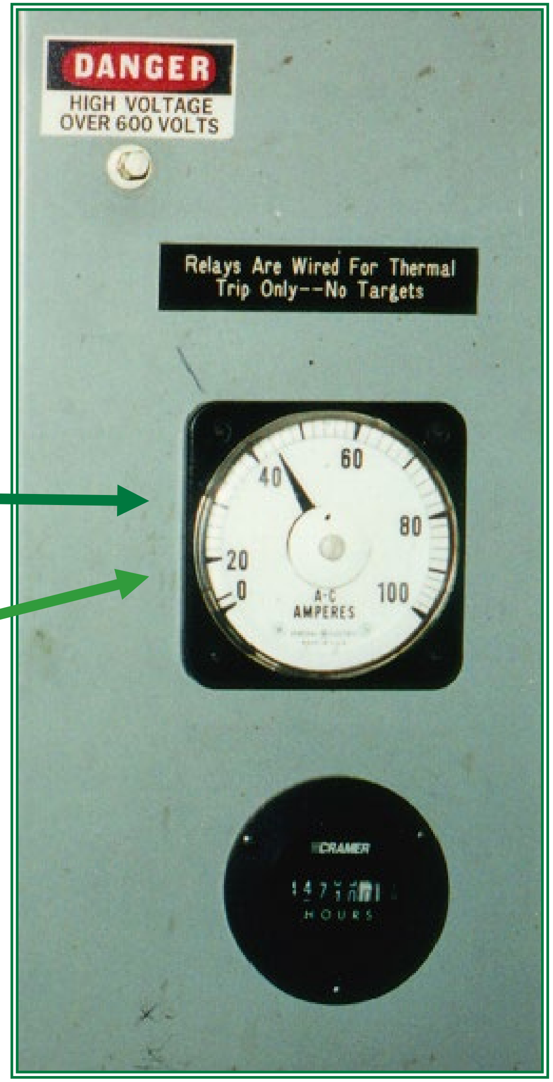
Operators can't always accommodate outdated engineering (i.e., changed facility demands)



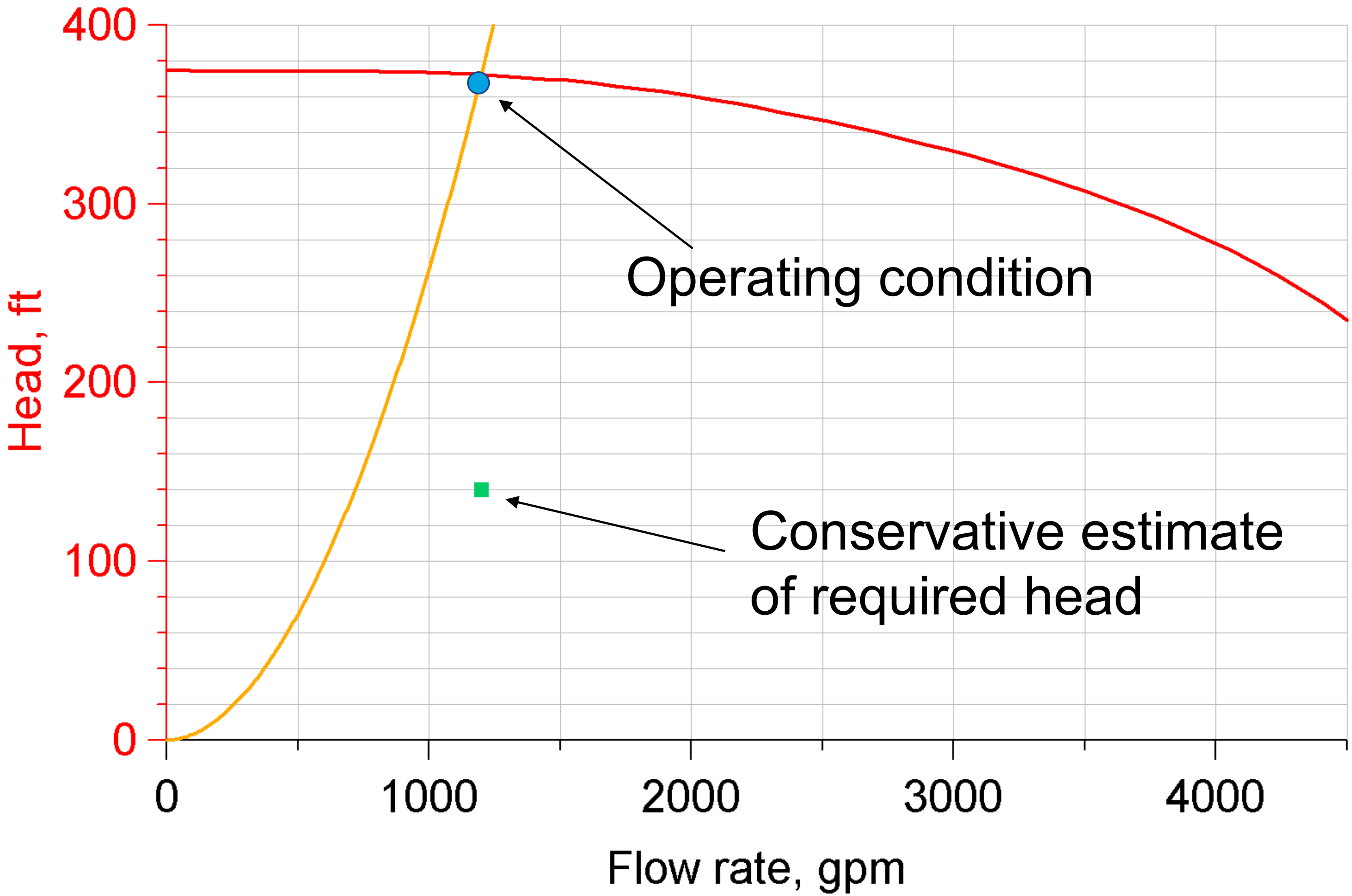
Sign on motor control center cabinet based on maintenance experience

Ammeter on the same cabinet (typical operating condition)

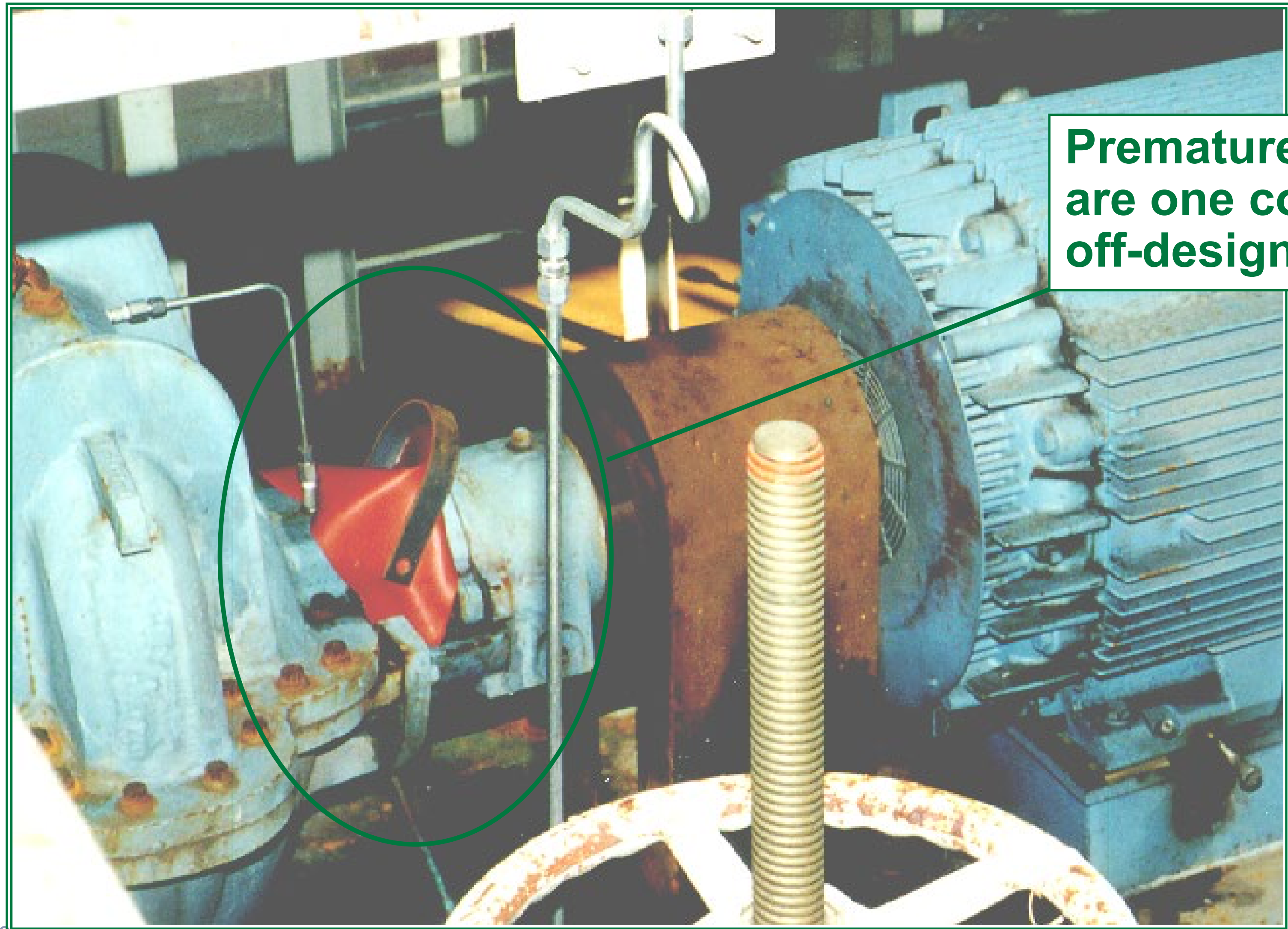
Normal condition was "unsafe"



Even a conservative estimate clearly showed the effects of throttling/bypass losses



Off-design operation of pumps will result in increased operating AND maintenance costs



Premature seal failures are one consequence of off-design operation

Applying the MEASUR tool to the measured conditions showed significant potential savings

Pump Type	API Double Suction
Pump Speed	1785 rpm
Drive	Direct Drive
Fluid Type	Water
Fluid Temperature	68 °F
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 1
Line Frequency	60 Hz
Rated Motor Power	350 hp
Motor RPM	1785 rpm
Efficiency Class	Standard Efficiency
Rated Voltage	2300 V
Full-Load Amps	79 A

Estimate Full-Load Amps

Applying the MEASUR tool to the measured conditions showed significant potential savings

Operating Hours	8760	hrs/yr
Electricity Cost	0.054	$/kWh
Flow Rate	1200	gpm
Head Calculate Head	367	ft
Load Estimation Method	Power	
Motor Power	154	kW
Measured Voltage	2370	V

Applying the MEASUR tool to the measured conditions showed significant potential savings

RESULTS | SANKEY | HELP

	Baseline	Optimal Pump
Percent Savings (%)	— —	29.0%
Pump efficiency (%)	57.3	80.5
Motor rated power (hp)	350	350
Motor shaft power (hp)	194.2	138.2
Pump shaft power (hp)	194.2	138.2
Motor efficiency (%)	94.1	94.5
Motor power factor (%)	80.1	72.3
Percent Loaded (%)	55	39
Drive efficiency (%)	100	100
Motor current (amps)	47	37
Motor power (kW)	154	109.1
Annual Energy (MWh)	**1,349**	**955**
Annual Energy Savings (MWh)	**—**	**394**
Annual Cost	**$72,848**	**$51,583**
Annual Savings	**—**	**$21,265**

Ultimate goal

Conservative estimate of required head – 140 Feet

BASELINE

Pump Type	API Double Suction
Pump Speed	1785 rpm
Drive	Direct Drive
Fluid Type	Water
Fluid Temperature	68 ℉
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 1

Line Frequency	60 Hz
Rated Motor Power	350 hp
Motor RPM	1785 rpm
Efficiency Class	Standard Efficiency
Rated Voltage	2300 V
Full-Load Amps	79 A

OPTIMAL PUMP - 140 FEET HD

Pump Type	API Double Suction
Pump Efficiency	80.45 %

Known Efficiency

The efficiency of your pump has been calculated based on your **flow rate** and selected **pump type**. Click **"Known Efficiency"** to use the efficiency calculated by your system setup.

Pump Speed	1785 rpm
Drive	Specified Efficiency
Drive Efficiency	100 %
Fluid Type	Water
Fluid Temperature	68 ℉
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 1

Line Frequency	60 Hz
Rated Motor Power	75 hp
Motor RPM	1785 rpm
Efficiency Class	Standard Efficiency
Rated Voltage	2300 V
Full-Load Amps	17.7 A

Estimate Full-Load Amps

Conservative estimate of required head – 140 Feet

BASELINE

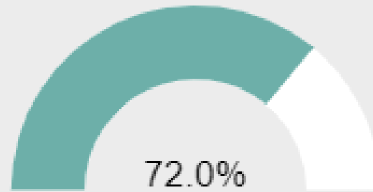
Operating Hours	8760 hrs/yr
Electricity Cost	0.054 $/kWh
Flow Rate	1200 gpm
Head Calculate Head	367 ft
Load Estimation Method	Power
Motor Power	154 kW
Measured Voltage	2370 V

OPTIMAL PUMP - 140 FEET HD

Operating Hours	8760 hrs/yr
Electricity Cost	0.054 $/kWh
Flow Rate	1200 gpm
Head Calculate Head	140 ft
Implementation Costs	$

Conservative estimate of required head – 140 Feet

RESULTS | SANKEY | HELP

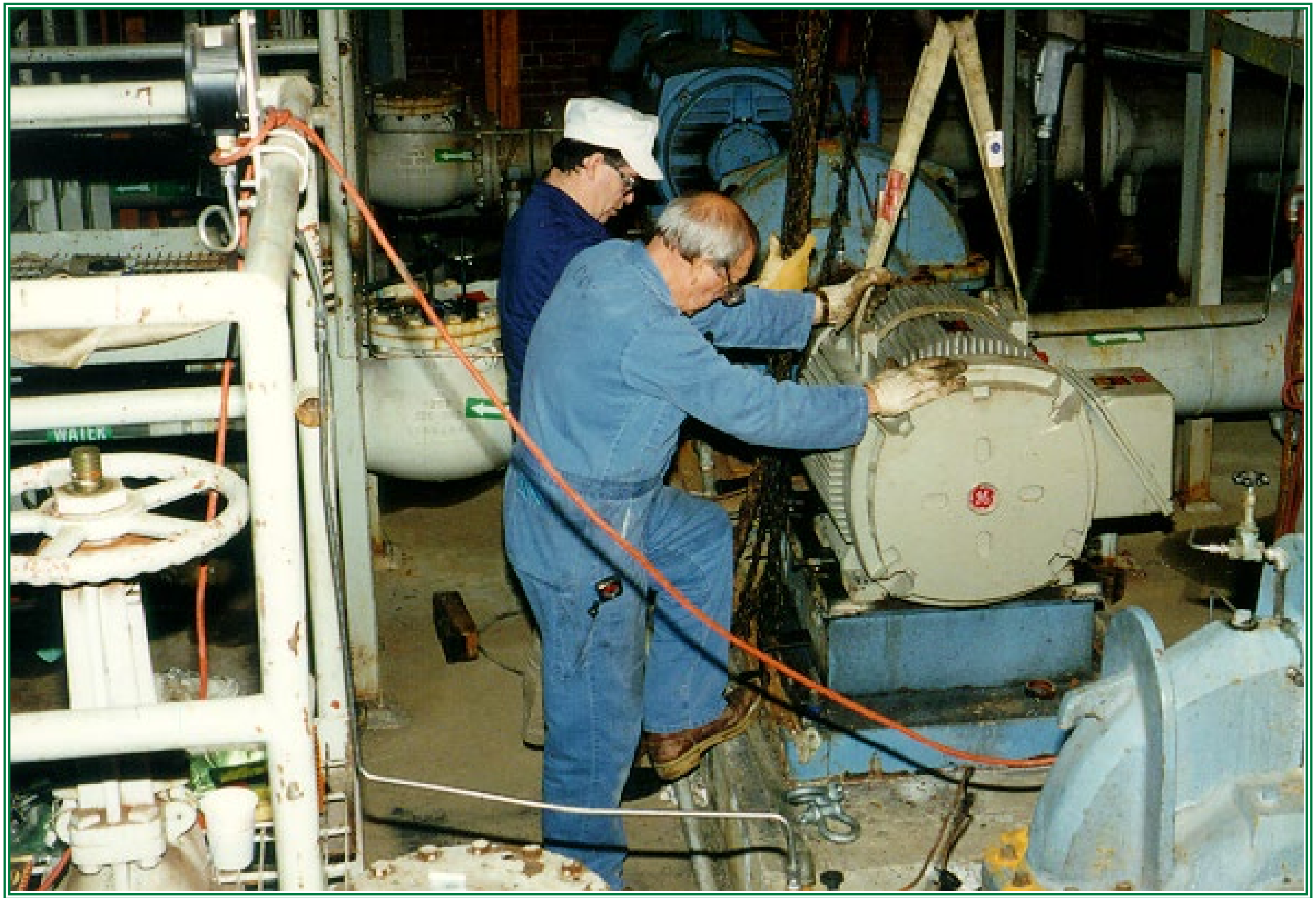
	Baseline	Optimal Pump - 140 Feet Hd
Percent Savings (%)	— —	
Pump efficiency (%)	57.3	80.5
Motor rated power (hp)	350	75
Motor shaft power (hp)	194.2	52.7
Pump shaft power (hp)	194.2	52.7
Motor efficiency (%)	94.1	92.2
Motor power factor (%)	80.1	81.6
Percent Loaded (%)	55	70
Drive efficiency (%)	100	100
Motor current (amps)	47	13
Motor power (kW)	154	42.6
Annual Energy (MWh)	**1,349**	**373**
Annual Energy Savings (MWh)	**—**	**976**
Annual Cost	**$72,848**	**$20,168**
Annual Savings	**—**	**$52,680**

We considered some options

- Trim the pump impeller
- Get a new, smaller pump
- Add a variable speed drive

But what we finally decided
was a little unconventional

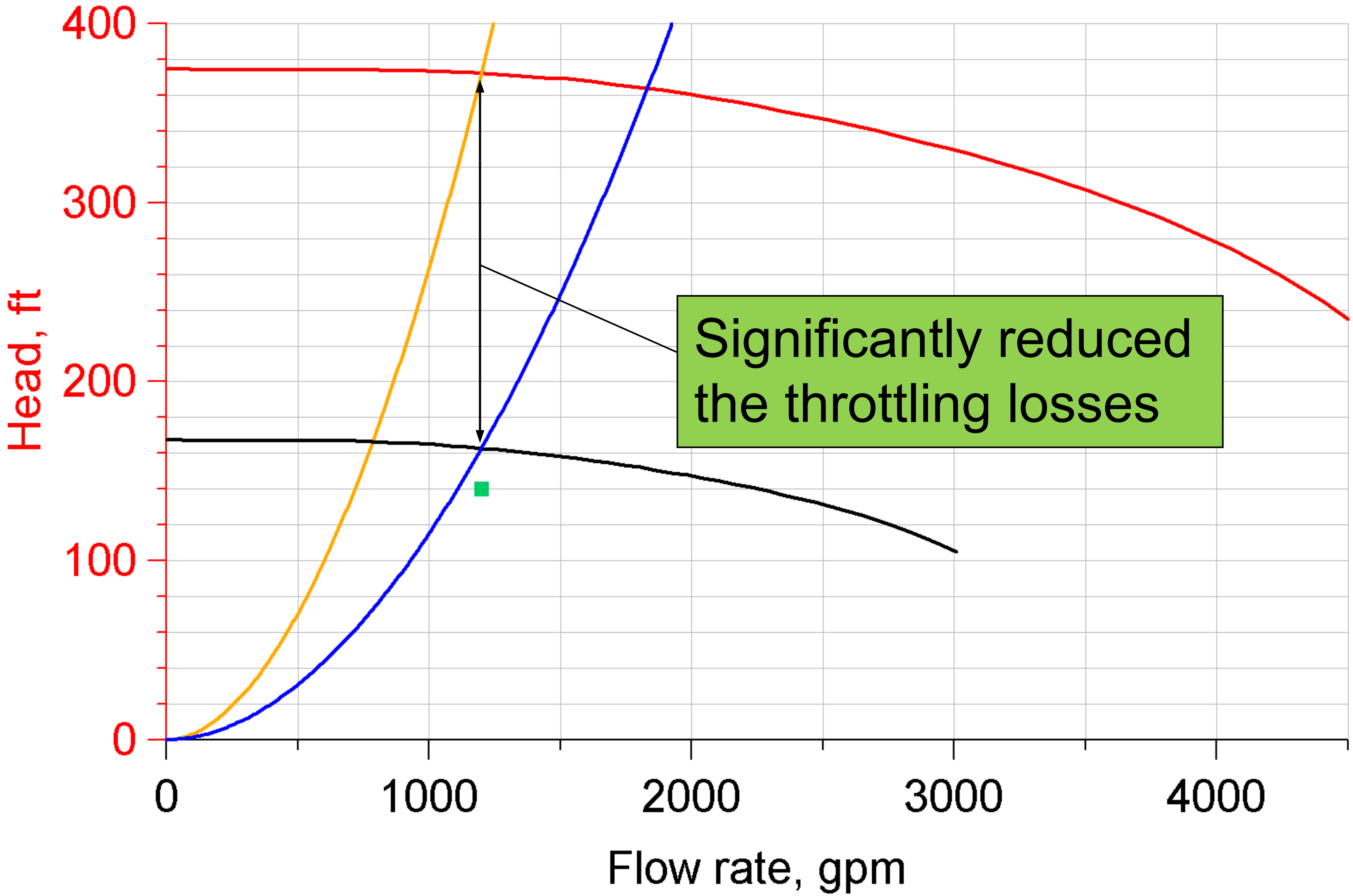
A 125 hp, 6-pole (1190 rpm) motor was installed on an existing demineralized water pump



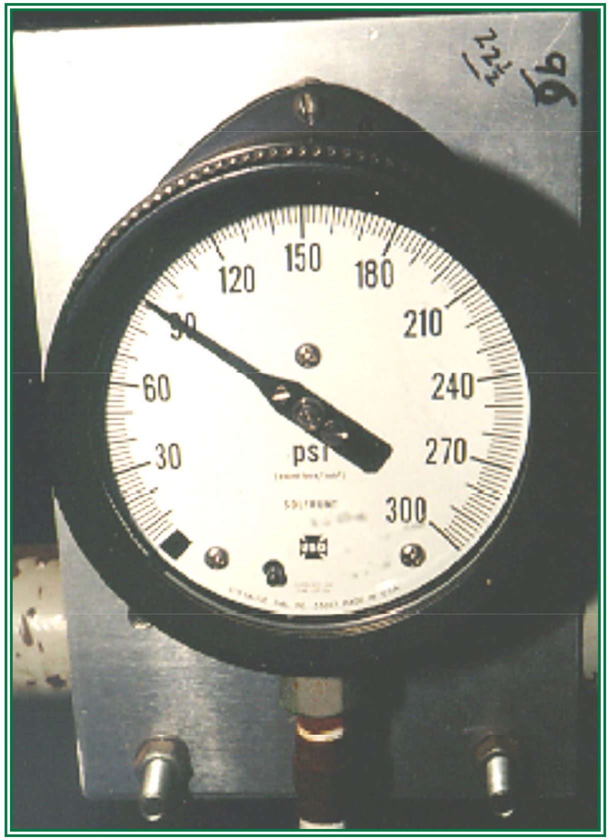
$$n_s = \frac{120 \times \text{Frequency}}{\text{No of Poles}}$$

A motor with a broken foot was replaced

Operation of the pump at reduced speed eliminated much of the throttling losses



By slowing the motor down, the operating head was dramatically reduced, even at the same flow rate



Discharge gauges on identical parallel pumps; left gauge is for a pump driven by a 4-pole motor, right gauge is for the pump with a 6-pole motor. Note: suction is ~ 25 psig.

Before and After the Motor Change

BASELINE

Pump Type	End Suction ANSI/API
Pump Speed	1785 rpm
Drive	Direct Drive
Fluid Type	Water
Fluid Temperature	68 °F
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 1
Line Frequency	60 Hz
Rated Motor Power	350 hp
Motor RPM	1785 rpm
Efficiency Class	Standard Efficiency
Rated Voltage	2300 V
Full-Load Amps	79 A

REPLACE MOTOR (6-POLES)

Pump Efficiency	62.3 %

Optimize Pump

The efficiency of your pump has been calculated based on your system setup. Either directly modify your efficiency or click **"Optimize Pump"** to estimate your pump efficiency based on a different pump type.

Pump Speed	1190 rpm
Drive	Specified Efficiency
Drive Efficiency	100 %
Fluid Type	Water
Fluid Temperature	68 °F
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 1
Line Frequency	60 Hz
Rated Motor Power	125 hp
Motor RPM	1190 rpm
Efficiency Class	Energy Efficient
Rated Voltage	478 V
Full-Load Amps	142.72 A

Estimate Full-Load Amps

Before and After the Motor Change

BASELINE

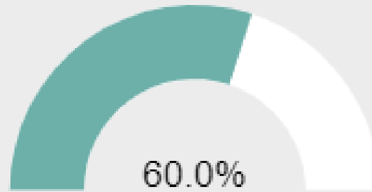
Operating Hours	8760	hrs/yr
Electricity Cost	0.054	$/kWh
Flow Rate	1200	gpm
Head Calculate Head	367	ft
Load Estimation Method	Power	
Motor Power	154	kW
Measured Voltage	2370	V

REPLACE MOTOR (6-POLES)

Operating Hours	8760	hrs/yr
Electricity Cost	0.054	$/kWh
Flow Rate	1200	gpm
Head Calculate Head	162	ft
Implementation Costs		$

Before and After the Motor Change

RESULTS | SANKEY | HELP

	Baseline	Replace Motor (6-Poles)
Percent Savings (%)	— —	
Pump efficiency (%)	57.3	62.3
Motor rated power (hp)	350	125
Motor shaft power (hp)	194.2	78.8
Pump shaft power (hp)	194.2	78.8
Motor efficiency (%)	94.1	94.7
Motor power factor (%)	80.1	-518.8
Percent Loaded (%)	55	63
Drive efficiency (%)	100	100
Motor current (amps)	47	-03
Motor power (kW)	154	62
Annual Energy (MWh)	**1,349**	**543**
Annual Energy Savings (MWh)	**—**	**806**
Annual Cost	**$72,848**	**$29,349**
Annual Savings	**—**	**$43,500**

Dollar and energy savings:

- Annual electricity cost reduction from this change are almost $50,000 (other changes made to the system)
- Reduction in annual electrical energy is > 900,000 kWhr
- The motor/starter/cable capital cost was $12,000
- Capital cost repaid in about 3 months

There were some important tangential benefits

- Seal face speed is reduced, seal life thereby extended
- Pump is more hydraulically stable, which means fewer maintenance problems are expected
- Noise levels are reduced - both in the pump house and in the main Fusion building (hearing protection is no longer required)

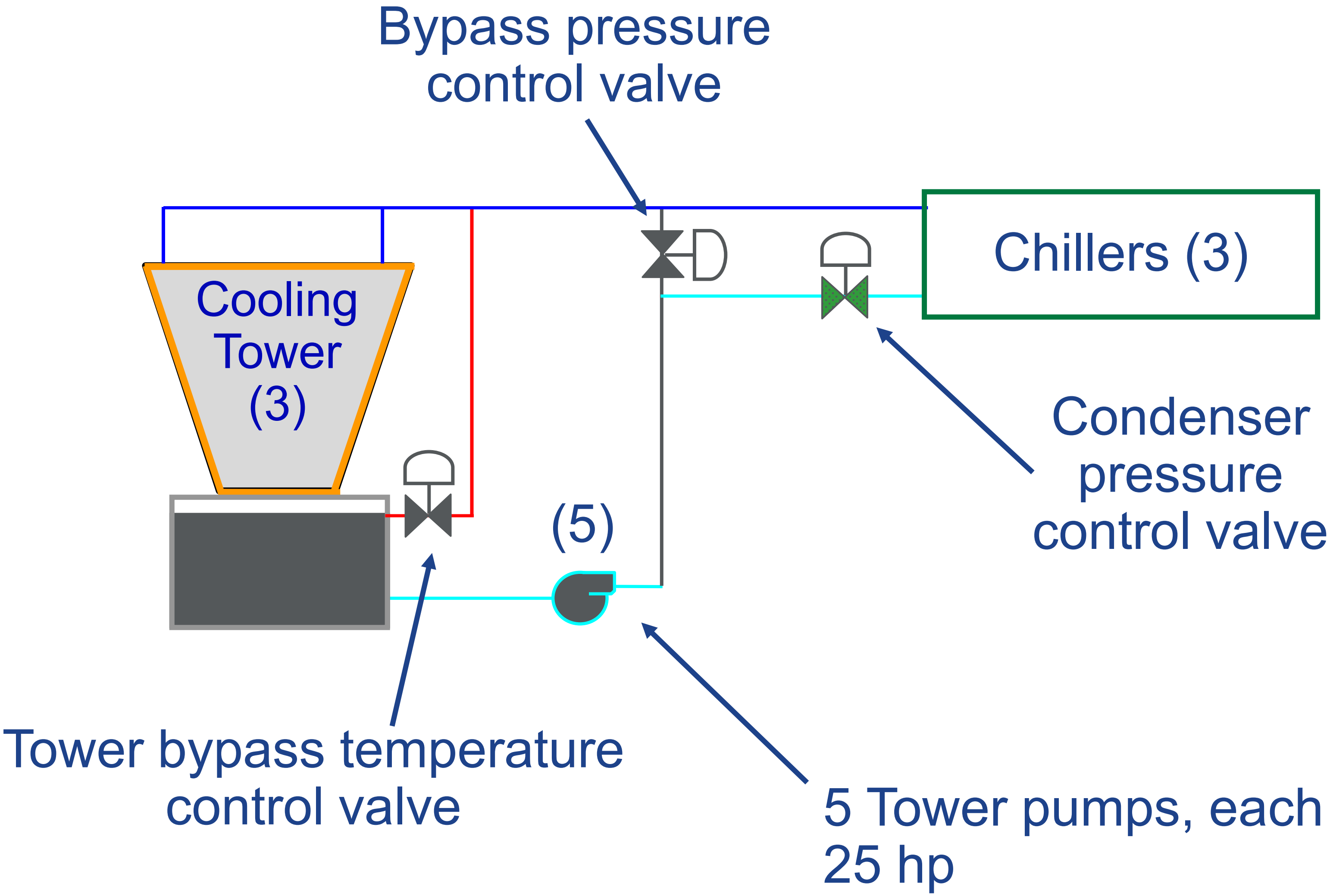
Y-12 Plant: 9767-12 tower water pumps Multiple parallel pumps: A good idea…..

WHEN PROPERLY CONTROLLED

The temptation is to run more pumps than are needed, defeating the very reason for having multiple pumps.

This case study is based on work done by the Y-12 plant in Oak Ridge, Tennessee, a DOE defense facility.
Case study technical contact:
Don Casada—Qualified PSAT Instructor
Diagnostic Solutions, LLC
Email:doncasada@diagsol.com

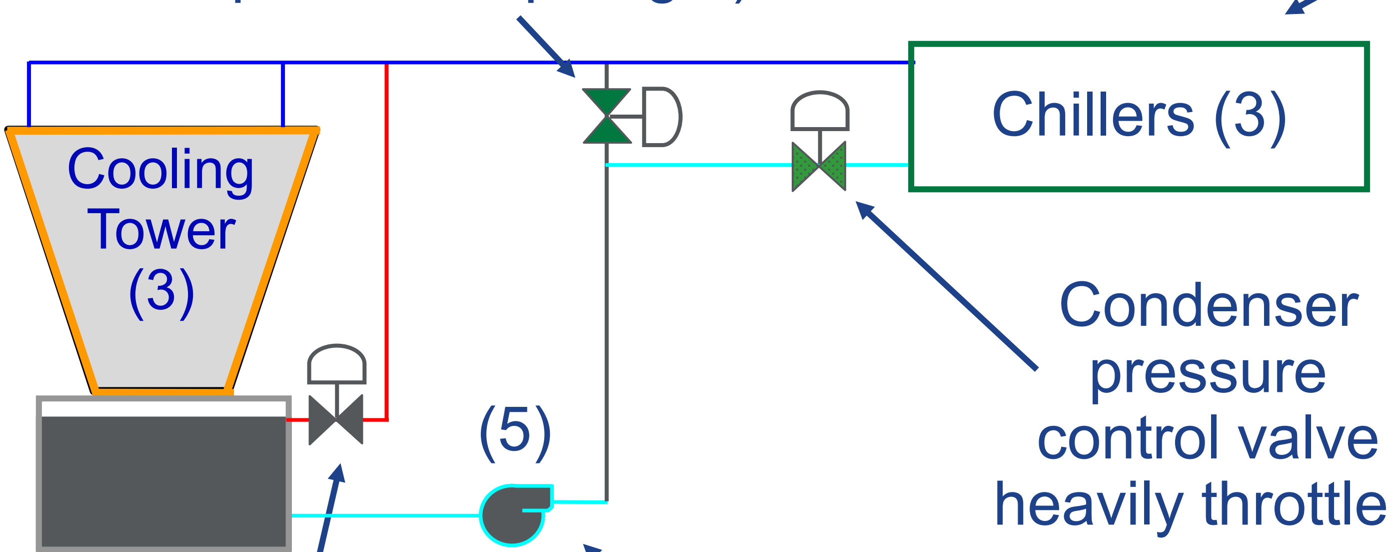
Simplified flow diagram of the tower water portion of the chilled water system



As found conditions: One chiller in operation, but 3 or 4 tower pumps running

Bypass pressure control valve failed open (ruptured air operator diaphragm)

Only one chiller running



Condenser pressure control valve heavily throttled

Tower bypass temperature control valve was open (under manual control)

3-4 of the 5 pumps normally in operation

Initial corrective actions were simple

- Closed manual isolation valve
- Repaired diaphragm in failed open bypass valve, eliminating bypass flow
- Turned off all but one or two tower pumps (depending on time of the year)
- Savings: about 30 kWe ($14,000 per year)

A further look revealed additional energy reduction opportunities

Measured performance with only one original pump running (box around the pump & motor)

BASELINE

Pump Type	End Suction ANSI/API
Pump Speed	1750 rpm
Drive	Direct Drive
Fluid Type	Water
Fluid Temperature	68 °F
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 2
Line Frequency	60 Hz
Rated Motor Power	25 hp
Motor RPM	1775 rpm
Efficiency Class	Energy Efficient
Rated Voltage	460 V
Full-Load Amps	28.8 A

OPTIMAL PUMP

Pump Type	End Suction ANSI/API
Pump Efficiency	83.49 %

Known Efficiency

The efficiency of your pump has been calculated based on your **flow rate** and selected **pump type**. Click **"Known Efficiency"** to use the efficiency calculated by your system setup.

Pump Speed	1750 rpm
Drive	Specified Efficiency
Drive Efficiency	100 %
Fluid Type	Water
Fluid Temperature	68 °F
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 2
Line Frequency	60 Hz
Rated Motor Power	15 hp
Motor RPM	1775 rpm
Efficiency Class	Energy Efficient
Rated Voltage	460 V
Full-Load Amps	18.39 A

Estimate Full-Load Amps

Measured performance with only one original pump running (box around the pump & motor)

BASELINE

Operating Hours	8760 hrs/yr
Electricity Cost	0.054 $/kWh
Flow Rate	820 gpm
Head	53.4 ft
Calculate Head	
Load Estimation Method	Current
Motor Current	22.9 A
Measured Voltage	480 V

OPTIMAL PUMP

Operating Hours	8760 hrs/yr
Electricity Cost	0.054 $/kWh
Flow Rate	820 gpm
Head	53.4 ft
Calculate Head	
Implementation Costs	$

Measured performance with only one original pump running (box around the pump & motor)

RESULTS | SANKEY | HELP

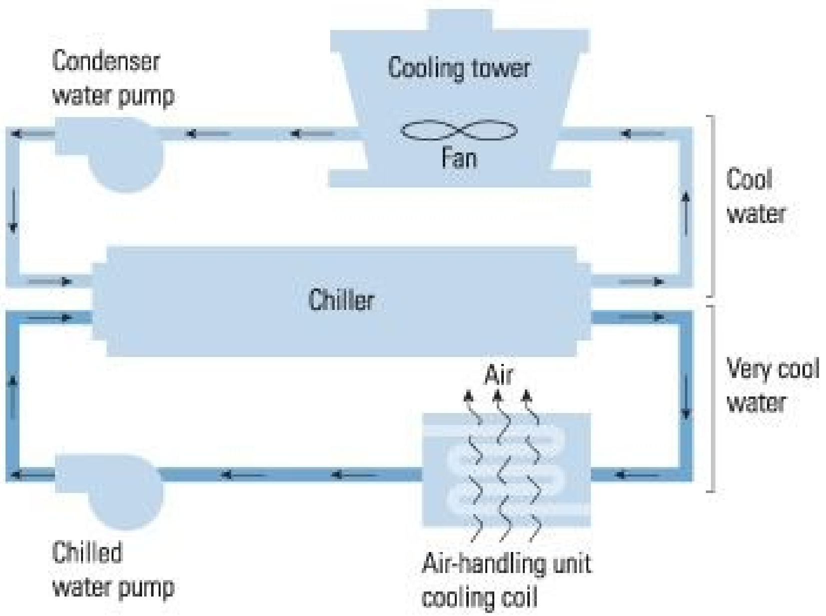
	Baseline	Optimal Pump
Percent Savings (%)	— —	35.0%
Pump efficiency (%)	55.3	85.7
Motor rated power (hp)	25	25
Motor shaft power (hp)	20	12.9
Pump shaft power (hp)	20	12.9
Motor efficiency (%)	93.2	92.8
Motor power factor (%)	84.1	71
Percent Loaded (%)	80	52
Drive efficiency (%)	100	100
Motor current (amps)	23	18
Motor power (kW)	16	10.4
Annual Energy (MWh)	**140**	**91**
Annual Energy Savings (MWh)	**—**	**49**
Annual Cost	**$7,572**	**$4,910**
Annual Savings	**—**	**$2,662**

Potential Savings ~$2.7k

Stepping back to consider what is really required (the *Ultimate goal*)

A general rule of thumb for chillers: 3 gpm tower water flow per ton of cooling

(10° F rise in tower water for an 80% efficient chiller)



Courtesy: E SOURCE; adapted from EPA

Reduce flow to 600 gpm @ 40 feet

BASELINE

Pump Type	Vertical Turbine
Pump Speed	1750 rpm
Drive	Direct Drive
Fluid Type	Water
Fluid Temperature	68 °F
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 2

REDUCE FLOW TO 600 GPM

Pump Type	Vertical Turbine
Pump Efficiency	85.66 %

Known Efficiency

The efficiency of your pump has been calculated based on your **flow rate** and selected **pump type**. Click **"Known Efficiency"** to use the efficiency calculated by your system setup.

Pump Speed	1750 rpm
Drive	Specified Efficiency
Drive Efficiency	100 %
Fluid Type	Water
Fluid Temperature	68 °F
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 2

BASELINE

Line Frequency	60 Hz
Rated Motor Power	25 hp
Motor RPM	1775 rpm
Efficiency Class	Energy Efficient
Rated Voltage	460 V
Full-Load Amps	28.8 A

REDUCE FLOW TO 600 GPM

Line Frequency	60 Hz
Rated Motor Power	7.5 hp
Motor RPM	1775 rpm
Efficiency Class	Energy Efficient
Rated Voltage	460 V
Full-Load Amps	9.39 A

Estimate Full-Load Amps

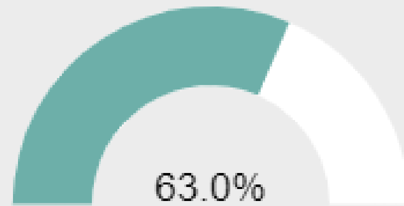
Reduce flow to 600 gpm @ 40 feet

BASELINE		
Operating Hours	8760	hrs/yr
Electricity Cost	0.054	$/kWh
Flow Rate	820	gpm
Head Calculate Head	53.4	ft
Load Estimation Method	Current	
Motor Current	22.9	A
Measured Voltage	480	V

REDUCE FLOW TO 600 GPM		
Operating Hours	8760	hrs/yr
Electricity Cost	0.054	$/kWh
Flow Rate	600	gpm
Head Calculate Head	40	ft
Implementation Costs		$

Reduce flow to 600 gpm @ 40 feet
Replace with optimal pump

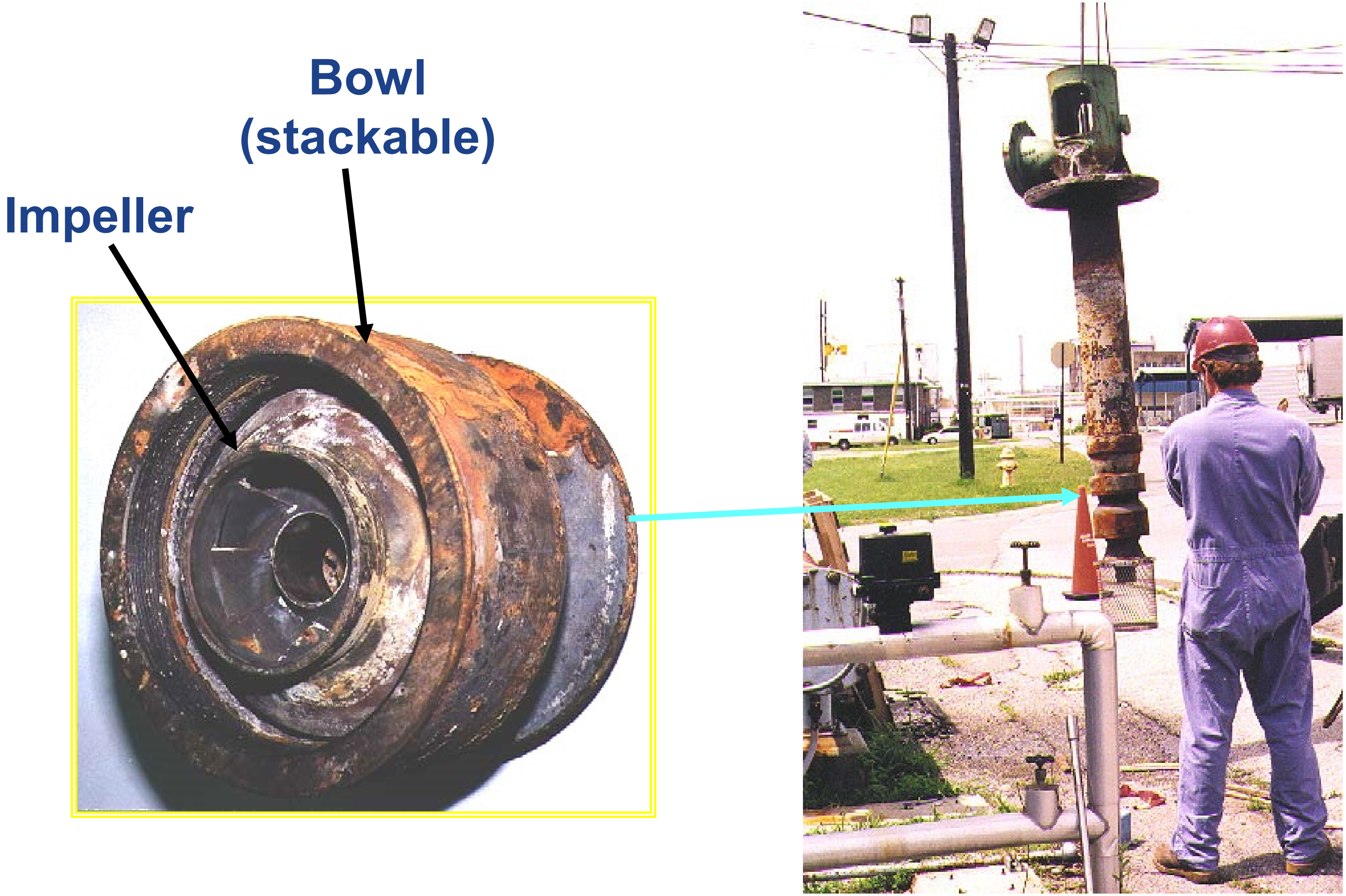
RESULTS | SANKEY | HELP

	Baseline	Reduce Flow to 600 GPM
Percent Savings (%)	— —	
Pump efficiency (%)	55.3	85.7
Motor rated power (hp)	25	08
Motor shaft power (hp)	20	07.1
Pump shaft power (hp)	20	07.1
Motor efficiency (%)	93.2	90
Motor power factor (%)	84.1	82.3
Percent Loaded (%)	80	94
Drive efficiency (%)	100	100
Motor current (amps)	23	09
Motor power (kW)	16	05.9
Annual Energy (MWh)	**140**	**51**
Annual Energy Savings (MWh)	**—**	**89**
Annual Cost	**$7,572**	**$2,773**
Annual Savings	**—**	**$4,799**

A great opportunity, but a familiar story….

NO CAPITAL FUNDS

Turning maintenance problems into energy savings….



Before and after

Next slide:

Baseline: 2-stage pump (600 gpm @ 40 ft)

Modification: 1-stage pump (600 gpm @ 45.6 ft)

(saves about $3,900/year)

Convert 2-stage pump to 1-stage pump

BASELINE

Pump Type	End Suction ANSI/API
Pump Speed	1750 rpm
Drive	Direct Drive
Fluid Type	Water
Fluid Temperature	68 ℉
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 2

1-STAGE PUMP

Pump Efficiency	73 %

Optimize Pump

The efficiency of your pump has been calculated based on your system setup. Either directly modify your efficiency or click **"Optimize Pump"** to estimate your pump efficiency based on a different pump type.

Pump Speed	1750 rpm
Drive	Specified Efficiency
Drive Efficiency	100 %
Fluid Type	Water
Fluid Temperature	68 ℉
Specific Gravity	1
Kinematic Viscosity	1 cSt
Stages	− + 1

BASELINE

Line Frequency	60 Hz
Rated Motor Power	25 hp
Motor RPM	1775 rpm
Efficiency Class	Energy Efficient
Rated Voltage	460 V
Full-Load Amps	28.8 A

1-STAGE PUMP

Line Frequency	60 Hz
Rated Motor Power	25 hp
Motor RPM	1775 rpm
Efficiency Class	Energy Efficient
Rated Voltage	460 V
Full-Load Amps	28.8 A

Estimate Full-Load Amps

Convert 2-stage pump to 1-stage pump

BASELINE

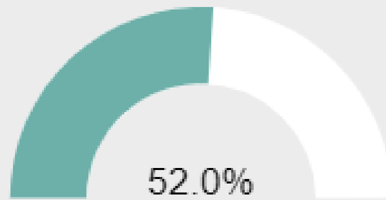
Operating Hours	8760	hrs/yr
Electricity Cost	0.054	$/kWh
Flow Rate	600	gpm
Head Calculate Head	40	ft
Load Estimation Method	Current	
Motor Current	22.9	A
Measured Voltage	480	V

1-STAGE PUMP

Operating Hours	8760	hrs/yr
Electricity Cost	0.054	$/kWh
Flow Rate	600	gpm
Head Calculate Head	45.6	ft
Implementation Costs		$

Convert 2-stage pump to 1-stage pump

RESULTS | SANKEY | HELP

	Baseline	1-Stage Pump
Percent Savings (%)	— —	
Pump efficiency (%)	30.3	73
Motor rated power (hp)	25	25
Motor shaft power (hp)	20	09.5
Pump shaft power (hp)	20	09.5
Motor efficiency (%)	93.2	91.7
Motor power factor (%)	84.1	62.4
Percent Loaded (%)	80	38
Drive efficiency (%)	100	100
Motor current (amps)	23	15
Motor power (kW)	16	07.7
Annual Energy (MWh)	**140**	**67**
Annual Energy Savings (MWh)	**—**	**73**
Annual Cost	**$7,572**	**$3,643**
Annual Savings	**—**	**$3,930**

Pump system management

- Motor management programs have become relatively common
- Include repair/replace decision processes
- Opportunities with pumps are an order of magnitude greater than motors
- Consider a pump management program with contingency maintenance plans

The End for Case Studies