Murray, Smith & Associates, Inc.

OVER THE TOP:

High Flow/Low Head Efficient Pumping at Wastewater Treatment Plants

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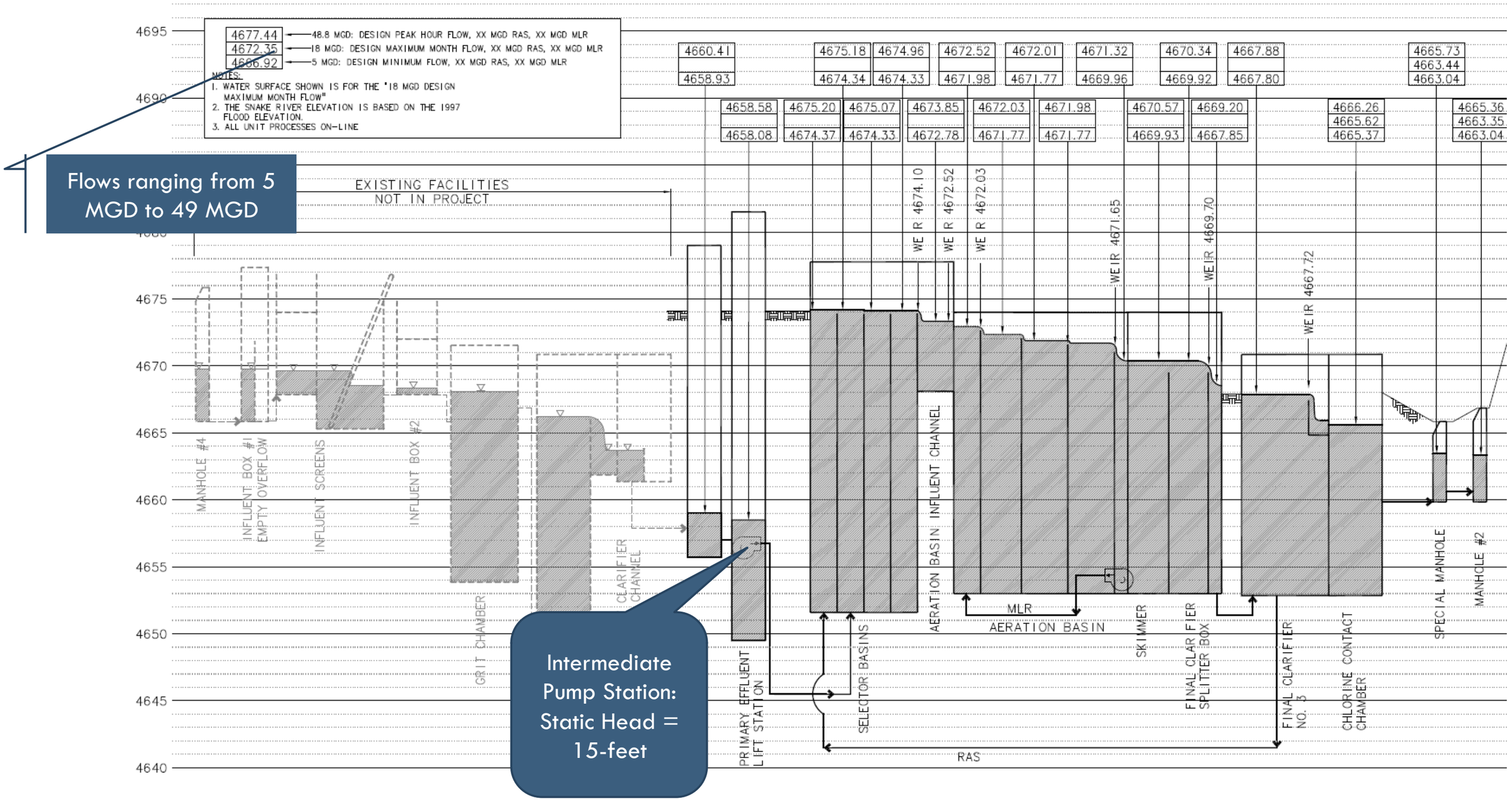
Overview

- **High Flow/Low Head Pumping: Rough Definition**
- Pump Selection
- Case Study: Intermediate Pump Station

High Flow/Low Head Pumping Definition

- Total sewer flow at a wastewater treatment plant (WWTP)
  - Location where all flows from a municipality enter a plant
  - Pumping head conditions up to approximately 40-feet
- Focus on dilute wastewater streams
  - Sludge pumping excluded

Example Hydraulic Profile at a WWTP



Flows ranging from 5 MGD to 49 MGD

Intermediate Pump Station: Static Head = 15-feet

Overview

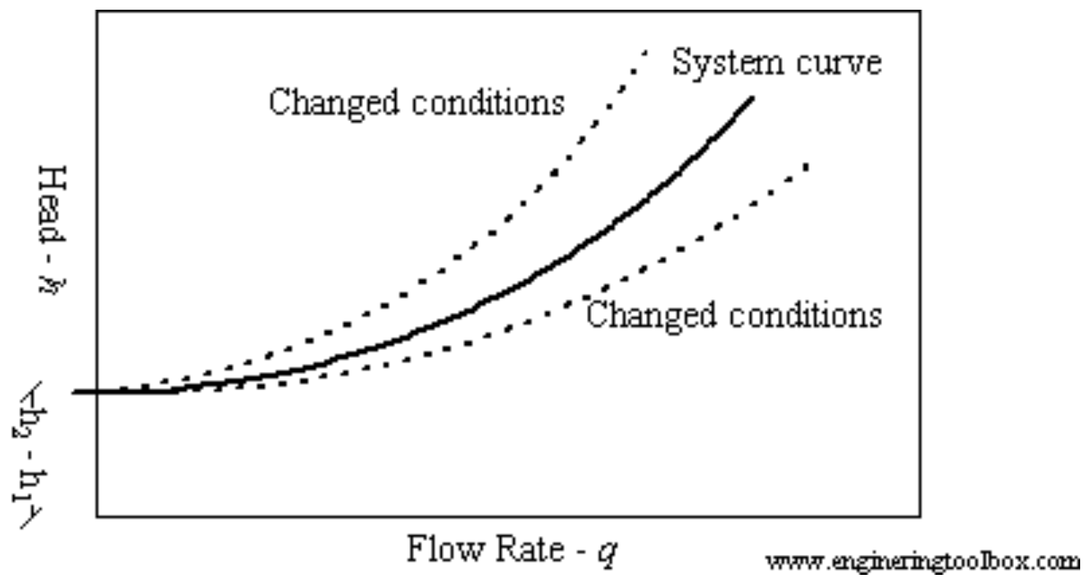
- High Flow/Low Head Pumping: Rough Definition
- **Pump Selection**
- Case Study: Intermediate Pump Station

Pump Selection by Application

Common Types	Typical Applications
Nonclog, Recessed Impeller, Screw Centrifugal, Chopper, Vertical Turbine Solids Handling	Dilute Process Streams: Intermediate Pump Station, RAS, WAS, Unthickened Primary Sludge, Secondary Scum, Anaerobic Digester Circulation, others
Positive Displacement	Sludge Pumping
Others (Air Lift, Archimedes Screw Pump)	Various Applications

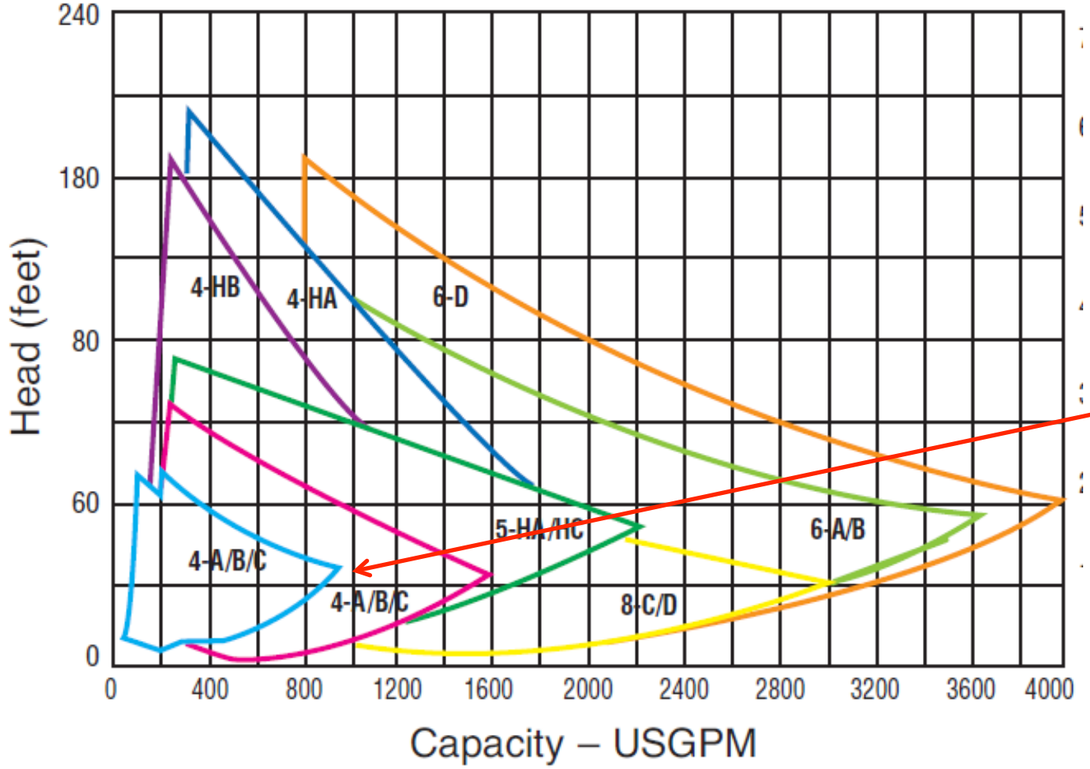
Analyze System Hydraulics

Q		VELOCITY	h(f)	H(f)	H(s)	TDH		VELOCITY	h(f)	H(f)	H(s)	TDH	exit losses		TDH	Flow
(gpm)		(ft/s)	(ft/100ft)	(ft)	(ft)	(ft)		(ft/s)	(ft/100ft)	(ft)	(ft)	(ft)			(ft)	(gpm)
0		0.00	0.000	0.00	-7.62	-7.62		0.00	0.000	0.00	26.47	26.47	0.00		18.9	0
200		0.42	0.007	0.00	-7.62	-7.62		0.25	0.002	0.00	26.47	26.47	0.00		18.9	200
400		0.83	0.026	0.00	-7.62	-7.62		0.50	0.007	0.01	26.47	26.48	0.00		18.9	400
600		1.25	0.054	0.00	-7.62	-7.62		0.76	0.014	0.01	26.47	26.49	0.01		18.9	600
800		1.67	0.093	0.00	-7.62	-7.62		1.01	0.024	0.02	26.47	26.51	0.02		18.9	800
1000		2.09	0.140	0.00	-7.62	-7.62		1.26	0.036	0.04	26.47	26.53	0.02		18.9	1000



Secondary Pump Selection by Pump Curve Data

- Select pumps from manufacturers that best fit system hydraulics
  - Each manufacturer has different best efficiency ranges



Can this pump supplier provide an efficient pump at the flow and head condition for my system?

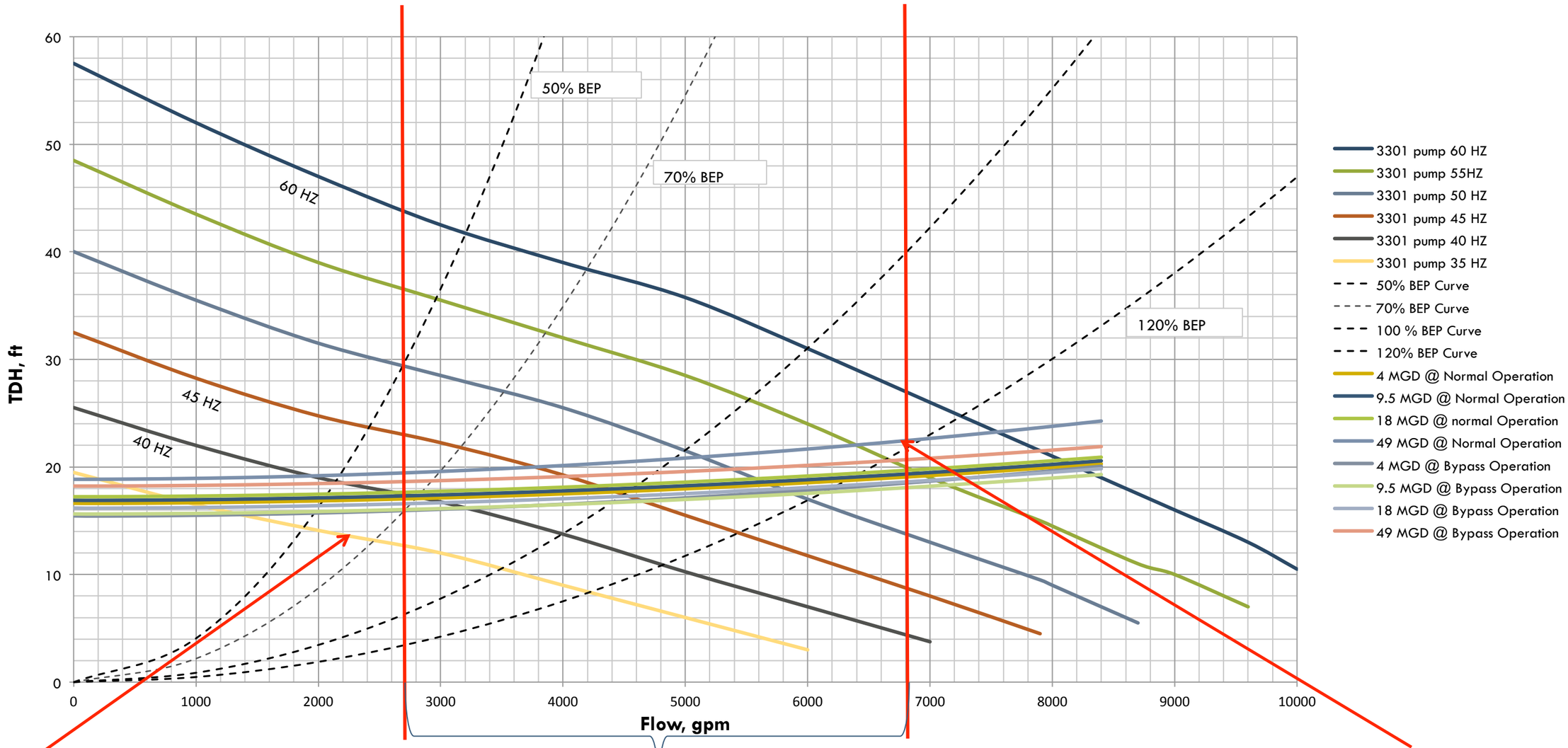
Variable Frequency Drives (VFDs)

- VFDs allow for a wide range of flow conditions and more efficient operation
- However, correct pump and motor selection are critical when operating with a VFD

VFD Considerations for Pump Selection

- Select design point to the right of the Best Efficiency Point of a pump
- Understand the minimum speed limitation of a motor
- Motor must be rated for VFD operation

Design for Entire Range of Expected Operation

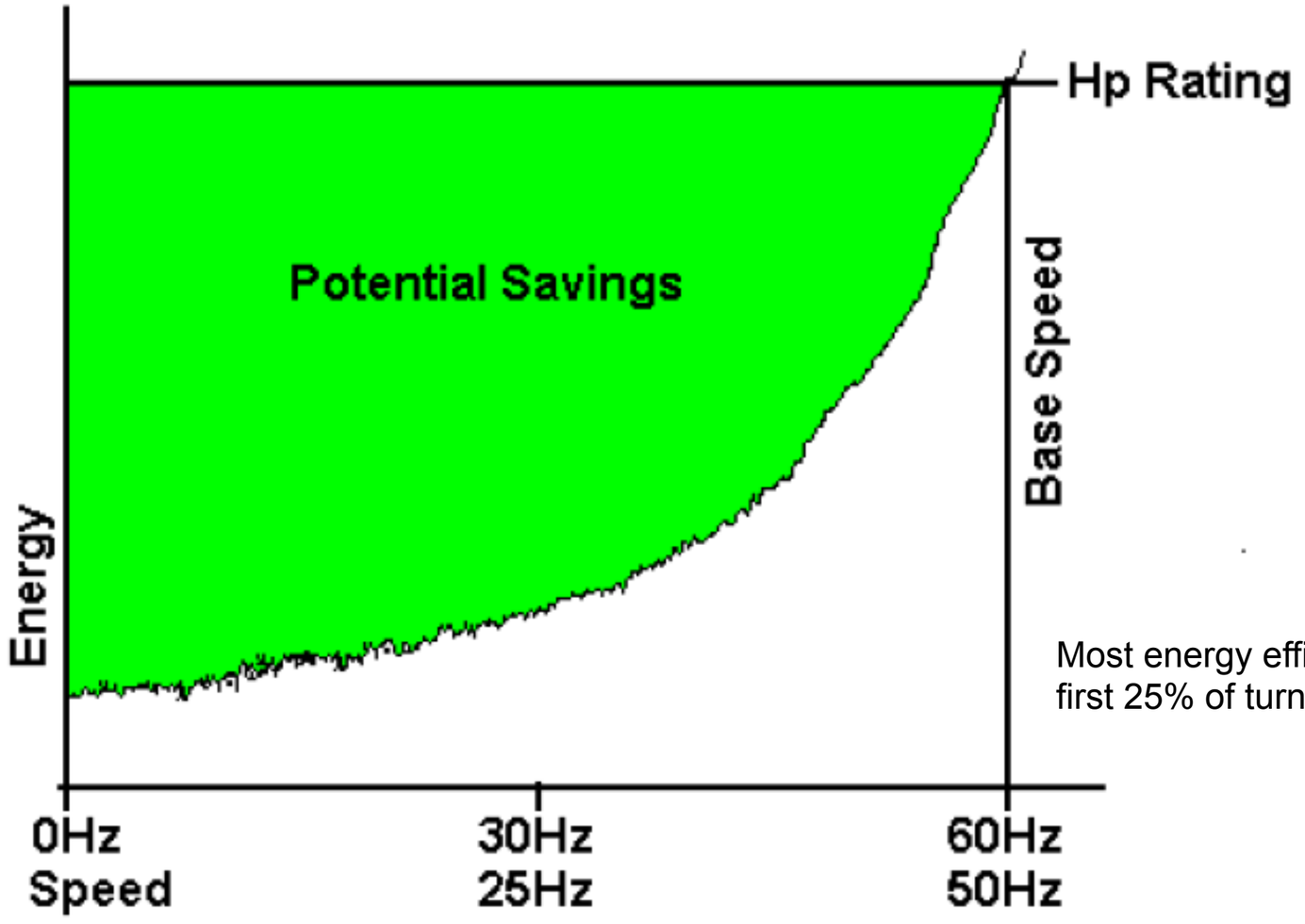


Minimum motor speed accommodates operational range

Full Operational Range of Pump

Design Point selected right of BEP

Cost Benefit of VFD Operation



Most energy efficiency gain occurs in first 25% of turn-down

VFD Capital Cost Comparison

- 20HP VFD w/filter — $4,500 (filter = $300)
- 20HP SS — $3,000

- 5HP VFD w/filter — $2,200 (filter = $220)
- 5HP SS — $2,900

- VFDs become more expensive relative to soft starts as size increases. List pricing from Rockwell

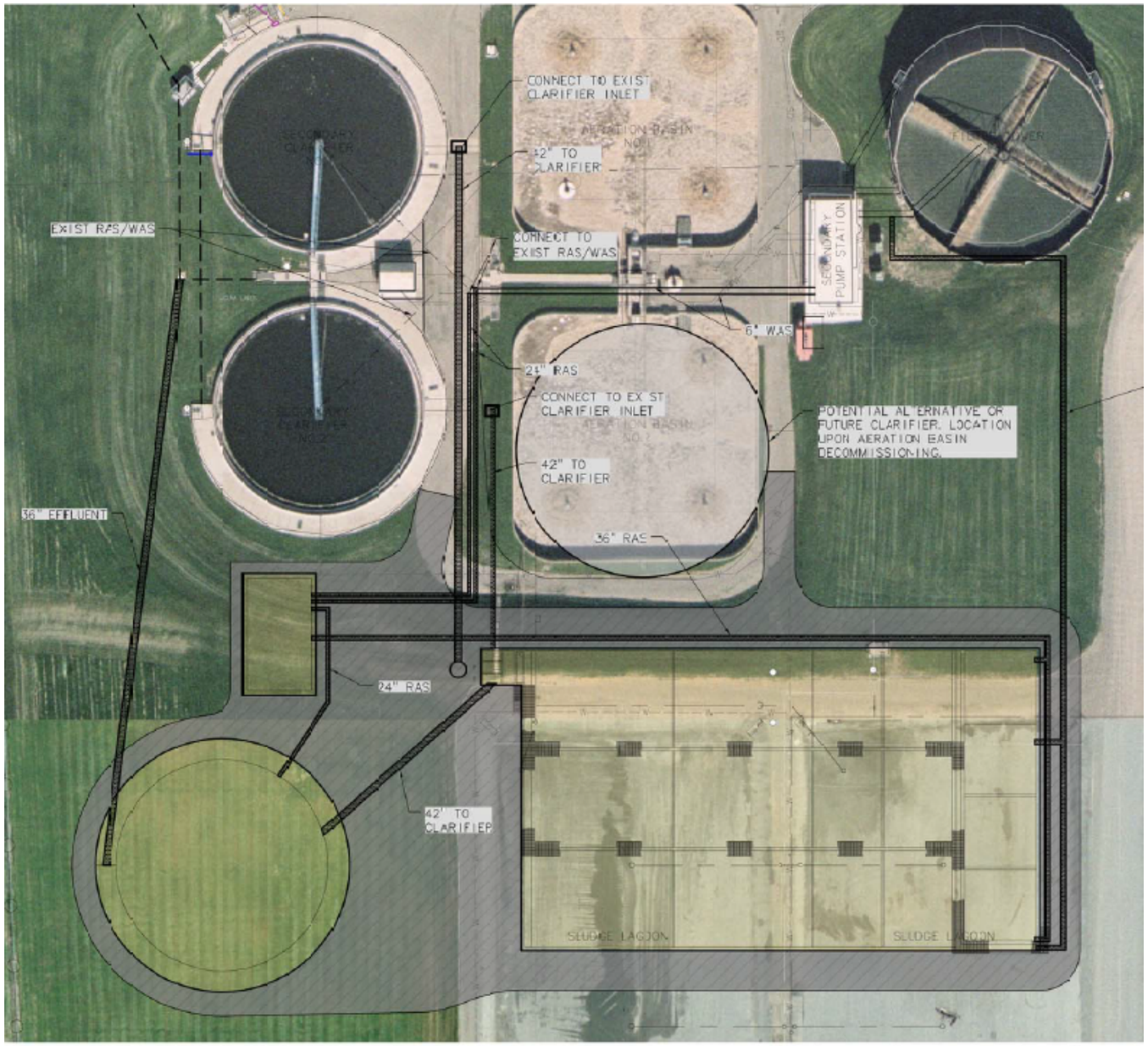
Overview

- High Flow/Low Head Pumping: Rough Definition
- Pump Selection
- **Case Study: Intermediate Pump Station**

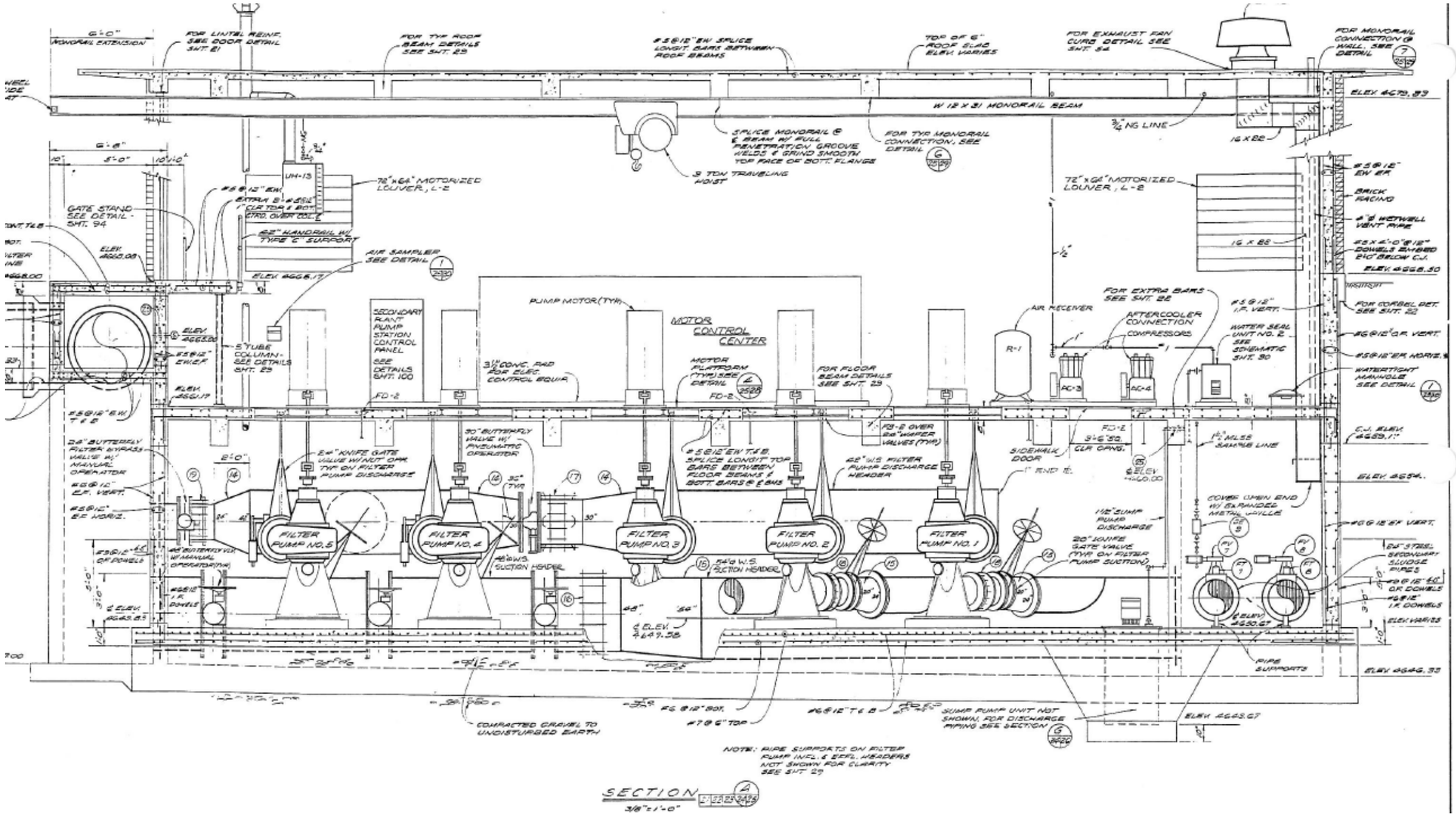
City of Idaho Falls: Primary Effluent Pumping

- Need: Pump effluent from the primary clarifier to the secondary treatment process.

Secondary System Adjustments



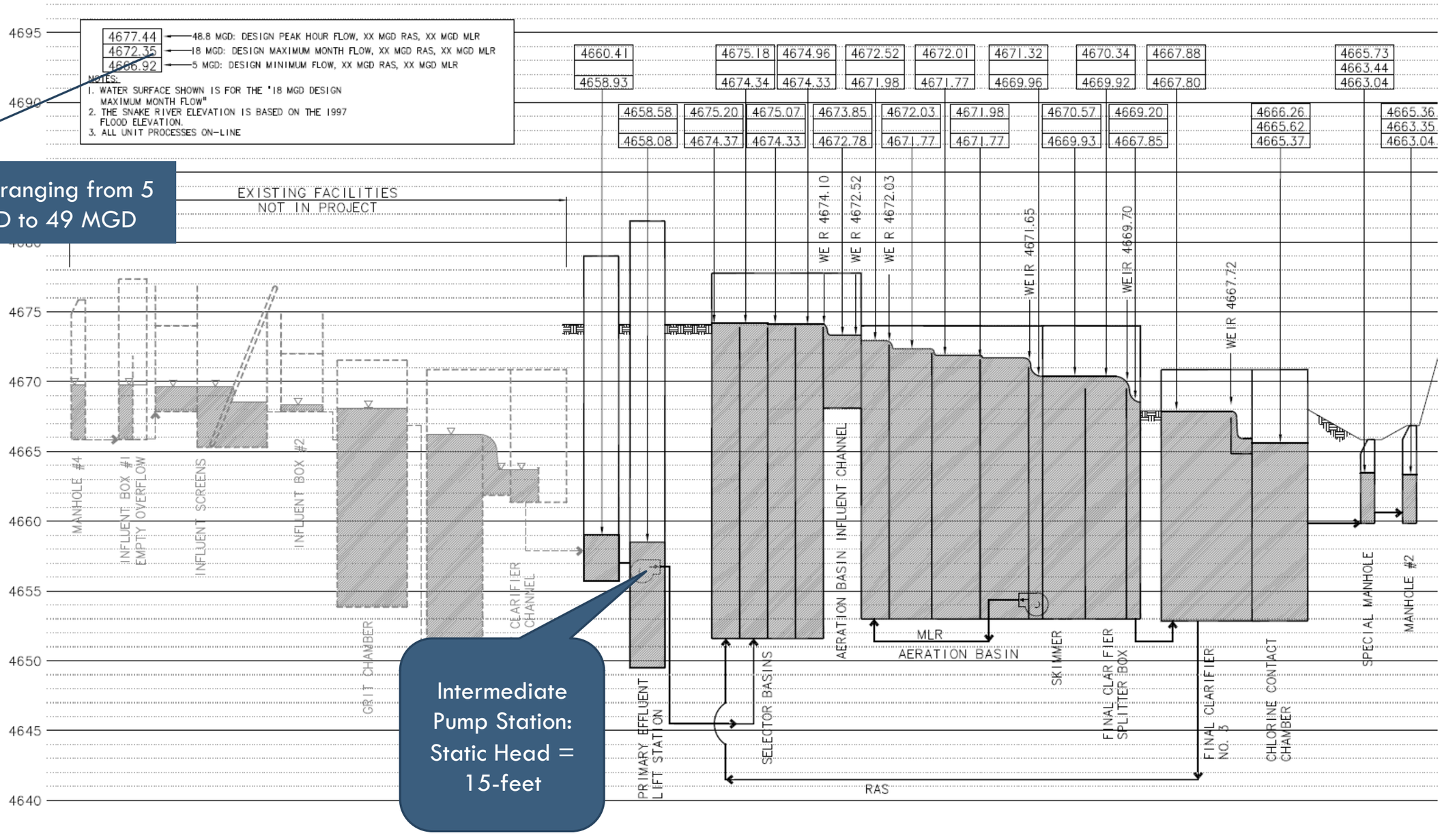
Upgrade Existing Pump System?



SECTION
3/8"=1'-0"

Intermediate Pump Station Design

Flows ranging from 5 MGD to 49 MGD



Intermediate Pump Station: Static Head = 15-feet

Retrofit Cost Comparison

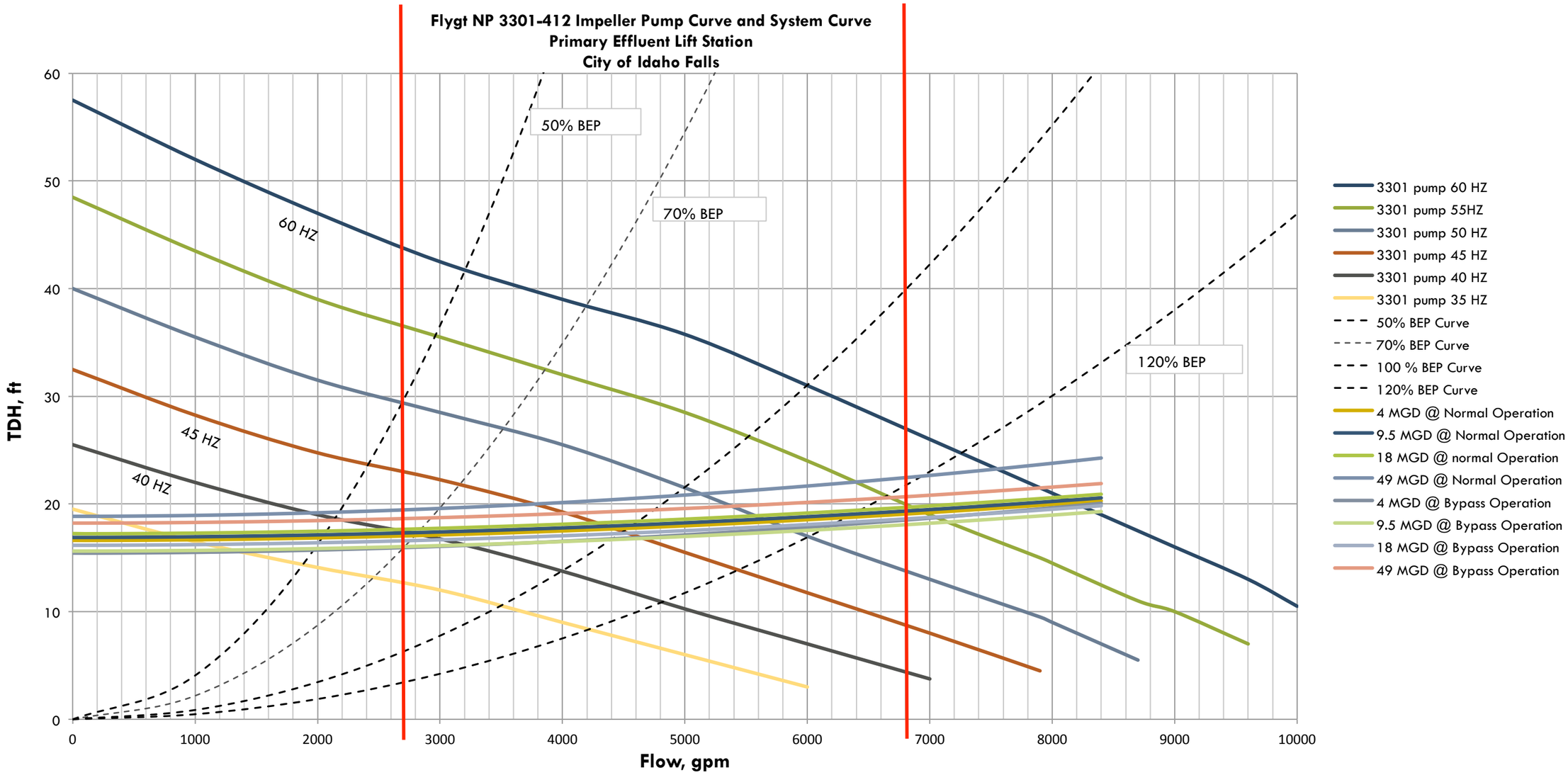
Option	Preliminary Probable Cost
Retrofit Existing Pumps	$1,349,000
Construct New Submersible Pump Station	$756,000

Select Pump Type for the Application

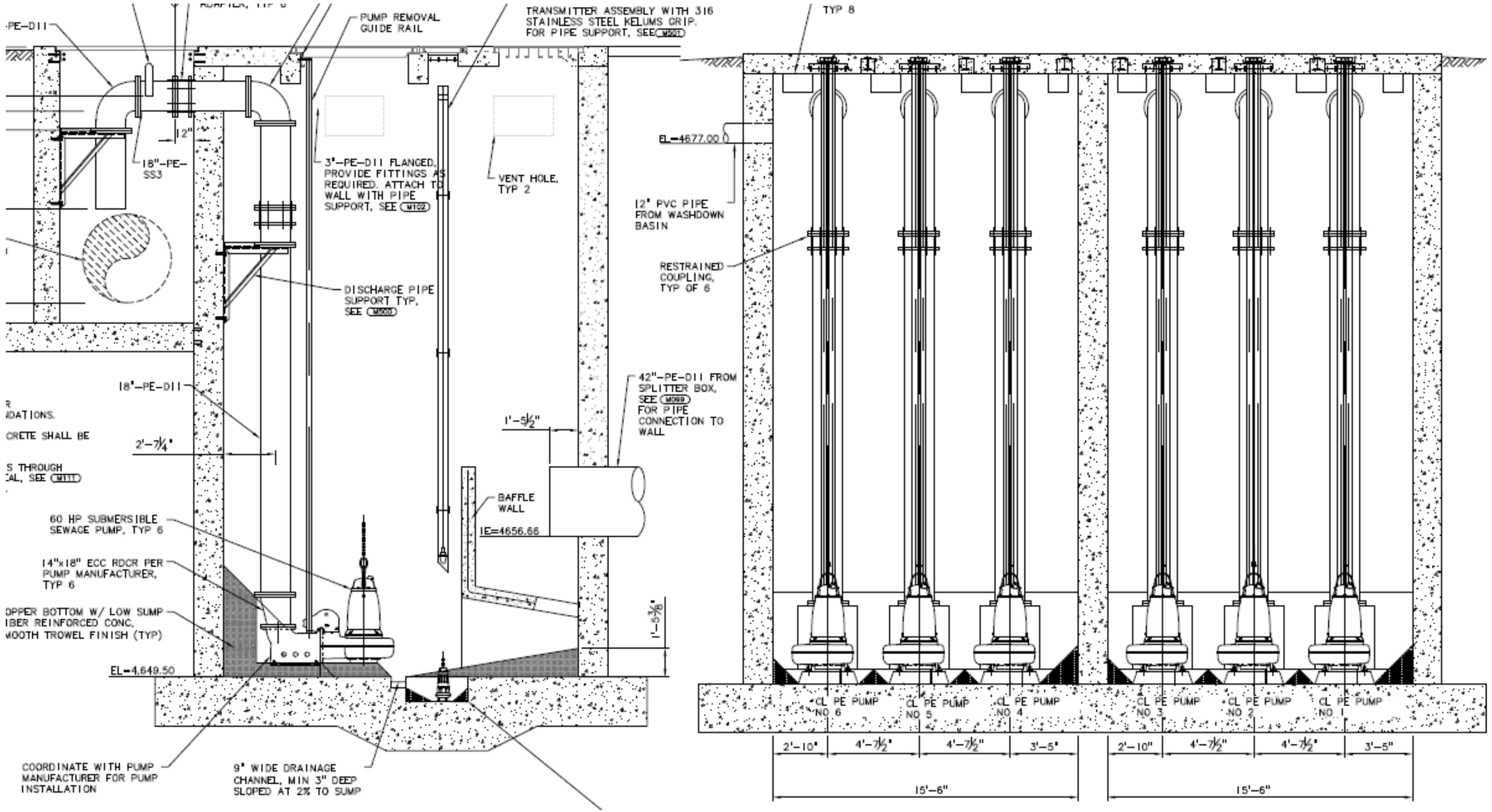
Common Types	Applications
Nonclog mixed flow impeller, Vertical Turbine Solids Handling	Dilute Process Streams: Intermediate Pump Station

Upstream primary clarifier and grit removal systems reduce solids handling requirements of the pumps.

Select Pumps to Fit System Hydraulics



System Design



Pumping Efficiency Cost Savings

Cost Scenario	Continuous Power Demand (hp)	Annual Power Cost
Existing Pumping System and Secondary Treatment System Power Demand (including aeration)	960	$314,000
New Submersible Pumping System Including Secondary Treatment System Demand	615	$201,000

Assumed power cost at $0.05/kW-hr

Pumping Efficiency Cost Savings

- Old pumps are constant speed pumps
- New pumps incorporate VFDs in an efficient range for the selected pump
- New process efficiency in overall system design

Take Home Message

- There are large efficiency gains available when pumps are selected correctly:
  - substantially reduce annual power costs
  - limit maintenance on pumping systems
  - energy incentive programs encourage pump system upgrades
- Every pumping situation is different. There is no one-size fits all solution for pump systems.

Acknowledgements

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Questions?

Murray, Smith & Associates, Inc.