Cost Effectively Maintaining and Rehabilitating an 80-MGD Pump Station for Energy Efficiency

NEWEA Energy Efficiency & Asset Management Conference
April 12, 2018

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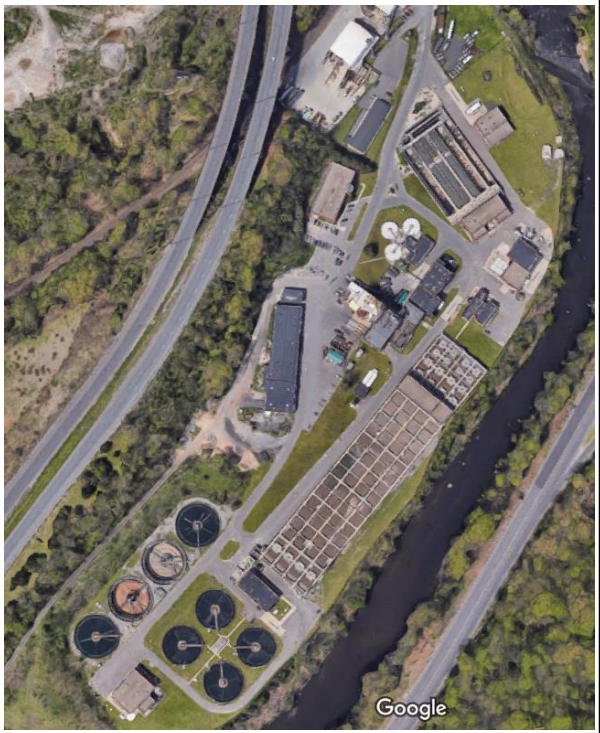
Outline

- Waterbury WPCF
- Energy Efficiency Study
- Project Introduction
- Rehabilitation of Influent Pumps
- Procurement Strategy
- Implementation / Results
- Control System Improvements
- Discussion

Waterbury WPCF

- **Last Major Plant Upgrade in 2000**
- **Processes**
  - Influent Screening
  - Grit Removal
  - **Influent Pumping**
  - Primary Sedimentation
  - Activated Sludge
  - **RAS Pumping**
  - Secondary Sedimentation
  - UV Disinfection
- **Flows:**
  - ~ 22 MGD Current Average Flow
  - ~ 27 MGD Average Design Flow
  - ~ 80 MGD Peak Flow
  - Bypass
    - » CSO if > ~80 MGD;
    - » Primary Treatment > ~50 MGD
- **NEWEA Award 2017 (Wastewater Utility)**



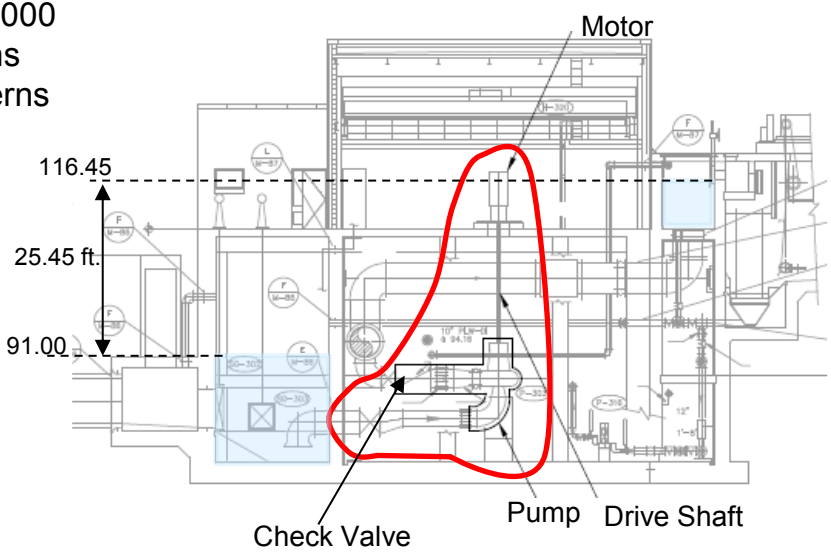
Energy Efficiency Study

- **JK Muir Completed Study in December 2015**
  - Actual Performance Testing
- **$101,568 Utility Grant**
  - Influent Pumps (4) – This Project
  - RAS Pumps
- **Rebuild/Rehabilitate Pumps - Return to Factory Curves**
  - Replace wear rings, wear plates
  - Rebuild worn surfaces
  - Bearings
- **Interior Ceramic Epoxy Coating**
  - Data to support improved efficiency
  - Not Quantified for grant

EVERSOURCE

Project Introduction

- **History**
  - 4 Influent Pumps
  - Only Seal Repairs since 2000
  - Historic Vibration Concerns
  - Historic Air Binding Concerns
- **Goals**
  - Execute Grant
  - Improve Pump Efficiency
  - Reduce Energy Costs
  - Maintain Capacity
  - Investigate Vibration
  - Rehabilitate System:
    - Pump
    - Motor
    - Drive Shaft
    - Check Valve



Rehabilitation of Influent Pumps

- **4 Influent Pump Systems**
  - ITT AC Pump
    - 19,500 gpm (28 MGD)
    - 39 feet
  - 250 HP WEG motor
  - 30-inch Check Valve

Procurement Strategy

- **Timeline**
  - **March – June 2016**: Design Project
    - » Allowance for unknown repairs ($100k)
  - **August 2016**: Bid Project
    - » Engineer's Estimate: $730,000
    - » Lowest Bidder: $620,000
  - Construction Period: **January – December 2017**
    - » 4 Pumps ~ 3 Months each
  - Final Completion: **March 9, 2018**

Photos - Before

Photos - After

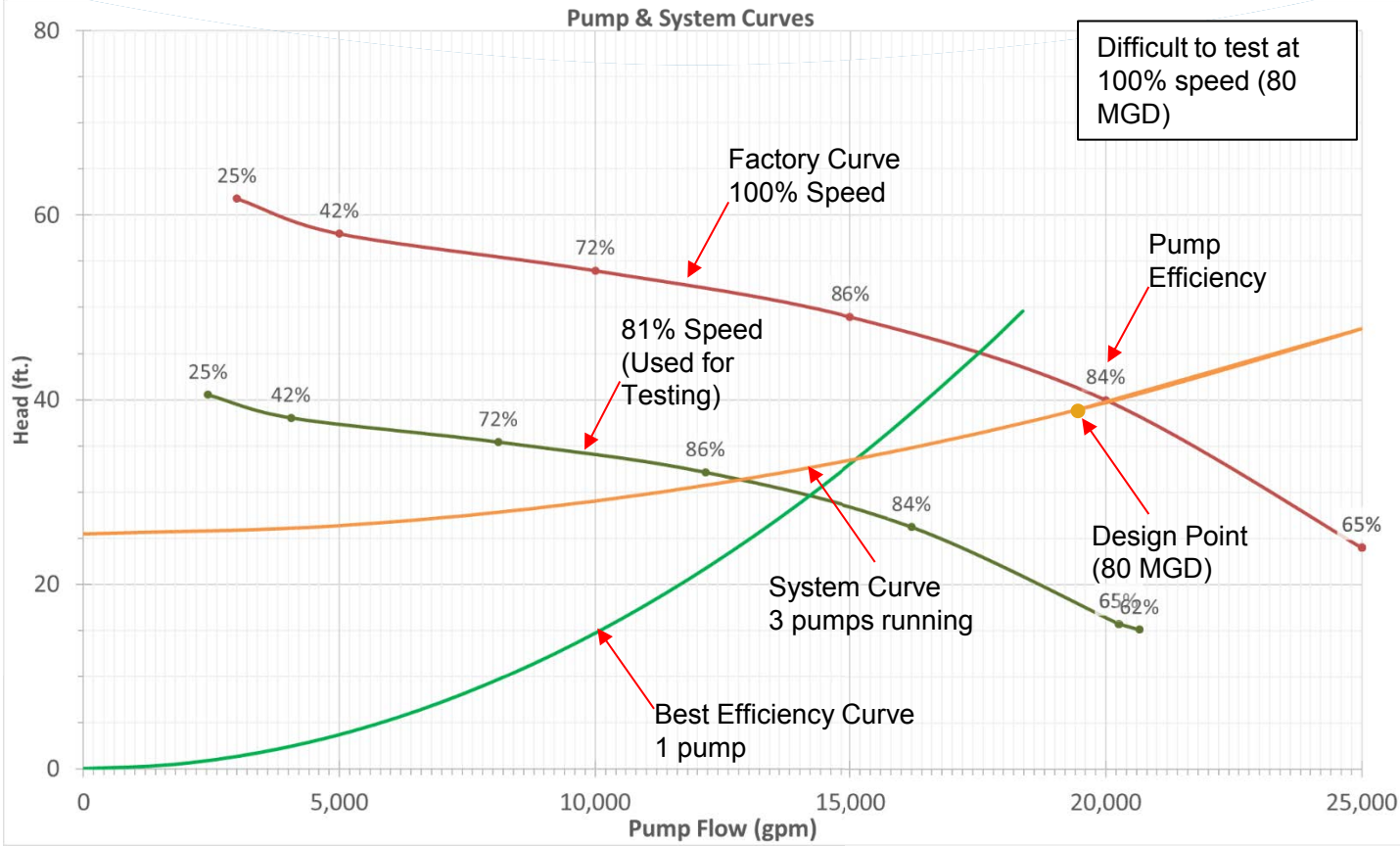
Performance and Vibration Testing

Performance Monitoring
(Constant Level & Speed)

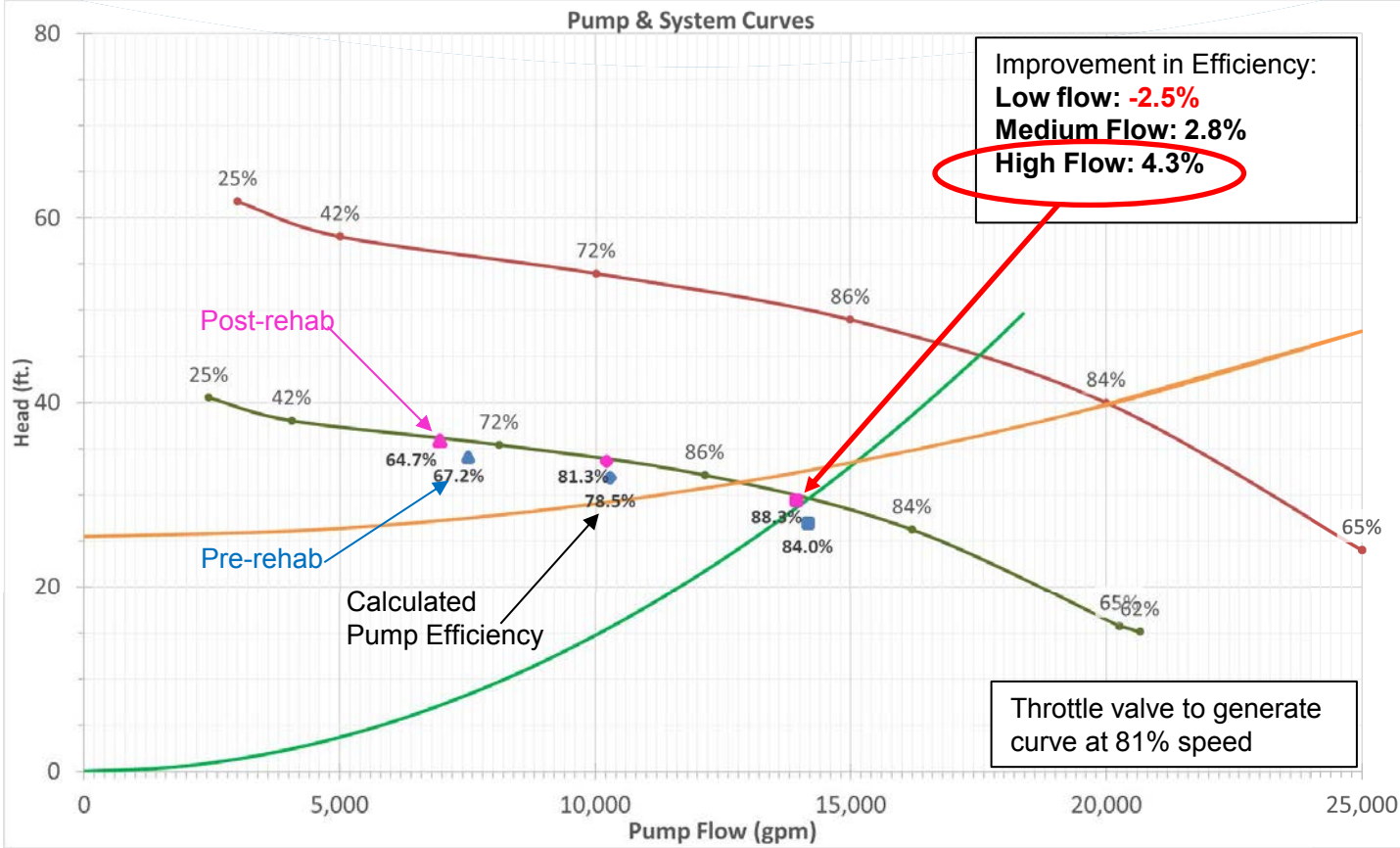
- **Pre- and Post-Rehabilitation Tests**
- **Performance**
  - Flow (MGD)
  - Pressure (psi)
    - » influent
    - » effluent
  - Motor Power
  - Est. Efficiency
- **Vibration**
  - Motor
  - Shaft
  - Pump

Vibration Monitoring
Motor (Shaft and Pump)

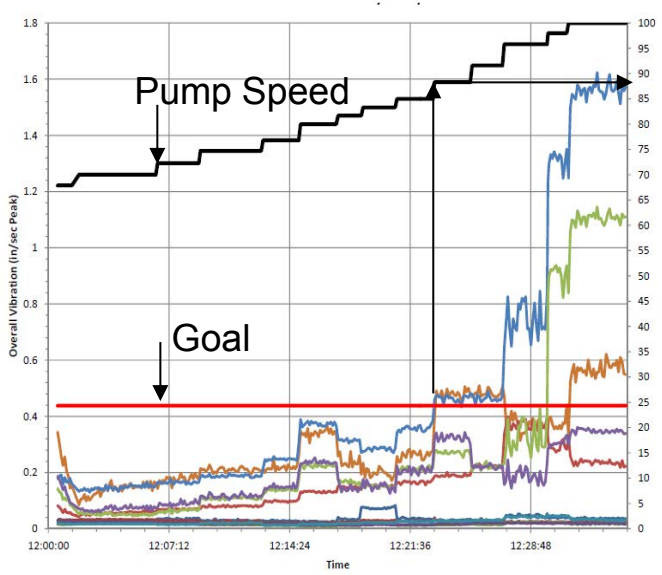
Results


Pump & System Curves
Difficult to test at 100% speed (80 MGD)
Factory Curve 100% Speed
Pump Efficiency
81% Speed (Used for Testing)
System Curve 3 pumps running
Design Point (80 MGD)
Best Efficiency Curve 1 pump
25%
42%
72%
86%
84%
65%
25%
42%
72%
86%
84%
65%
62%
Head (ft.)
Pump Flow (gpm)
0
20
40
60
80
0
5,000
10,000
15,000
20,000
25,000

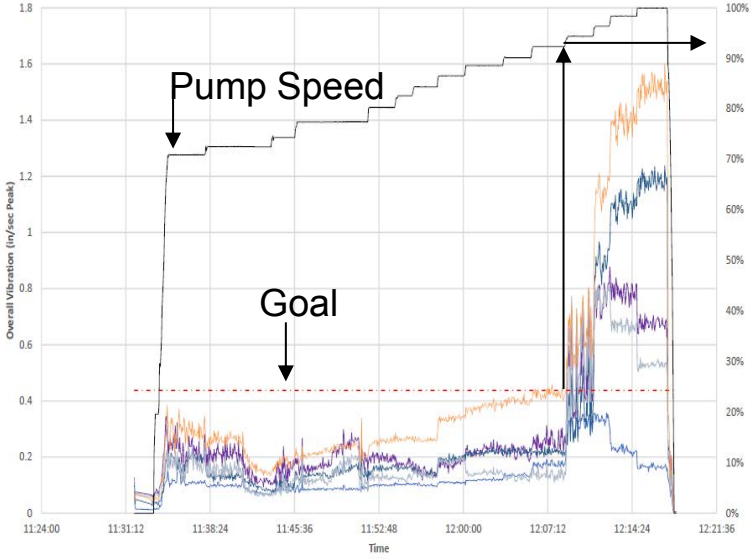
Performance Results



Vibration Results



Pre-Rehabilitation



Post-Rehabilitation

Conclusion: Vibration High at High Speed, but Some Improvement

Pump Rehabilitation Project

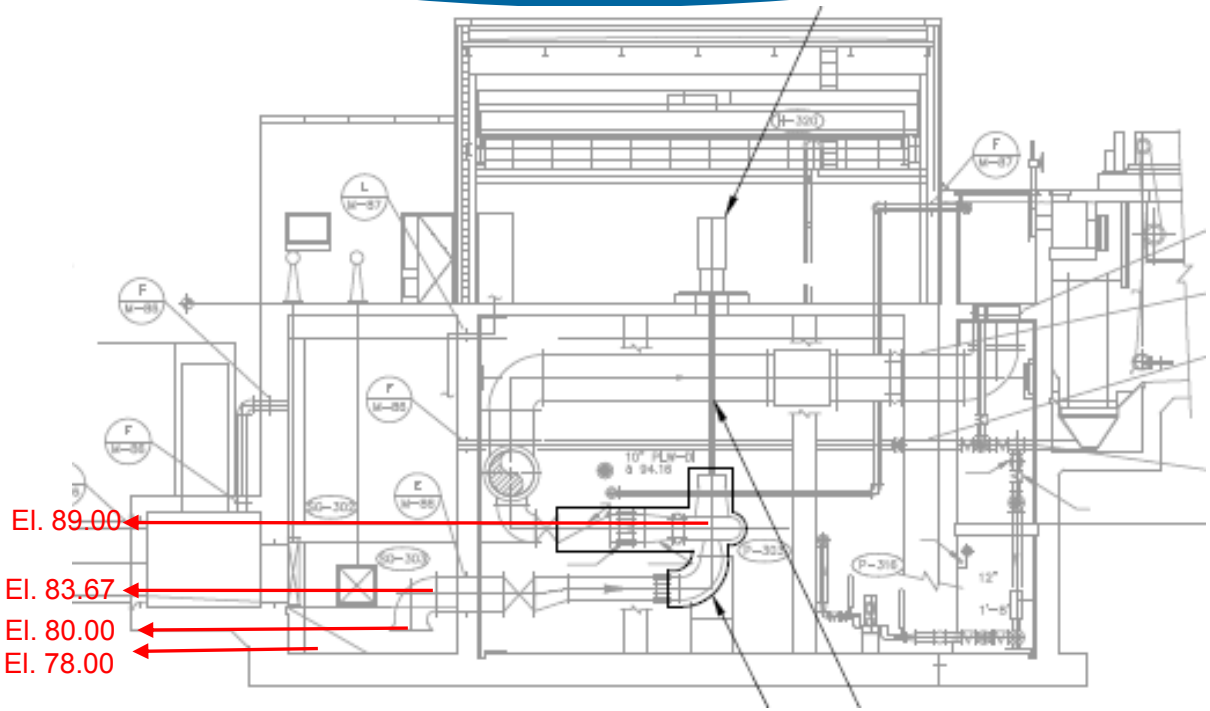
- **Success!**
  - Project Under Budget
- **Estimated Savings**
  - Annual:
    - ~300,000 kWh*
    - ~$45,000**

* JK Muir Estimate
** Assuming $0.15/KWH

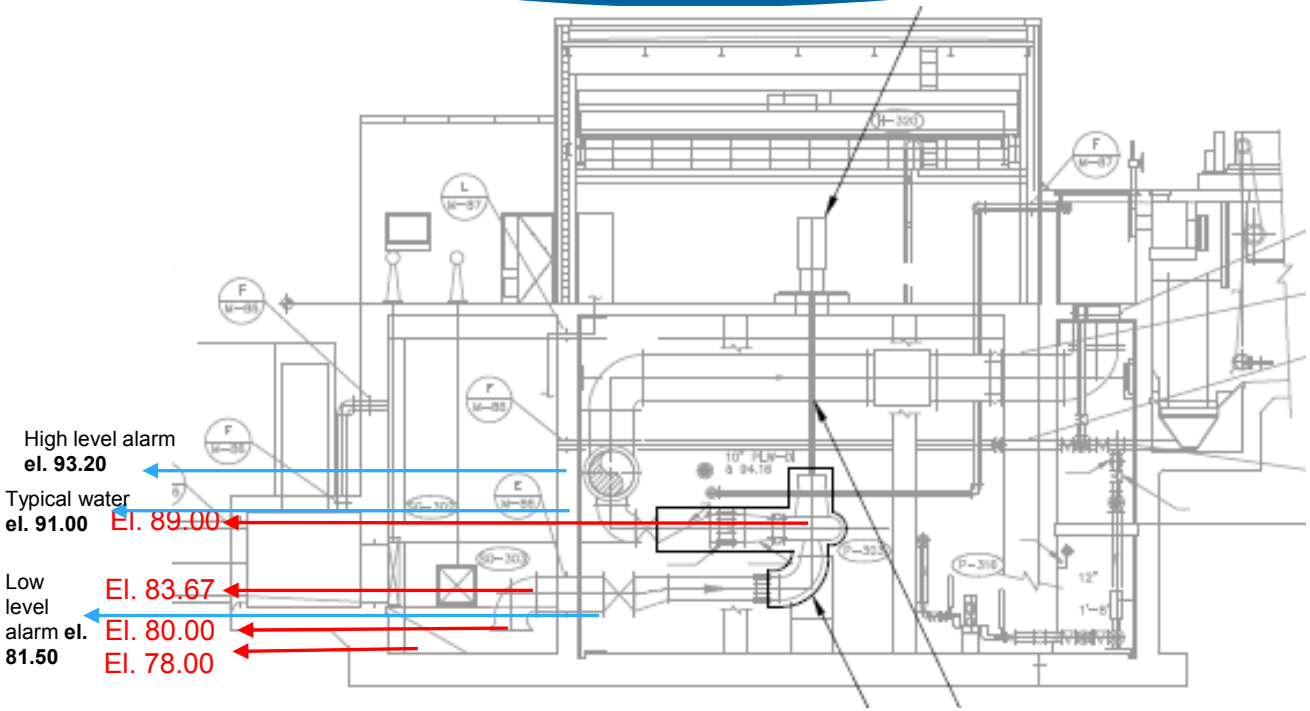
But Wait – There is More!

- **Other Part of Puzzle?**
- **Vibration**
  - Avoid High Speeds - Modify Controls ? $
  - Structural Study & Design ? $$$?
- **Air Binding**
  - Avoid Low Wet Well Levels – Modify Controls $

Air Binding of Lag Pumps



Air Binding of Lag Pumps



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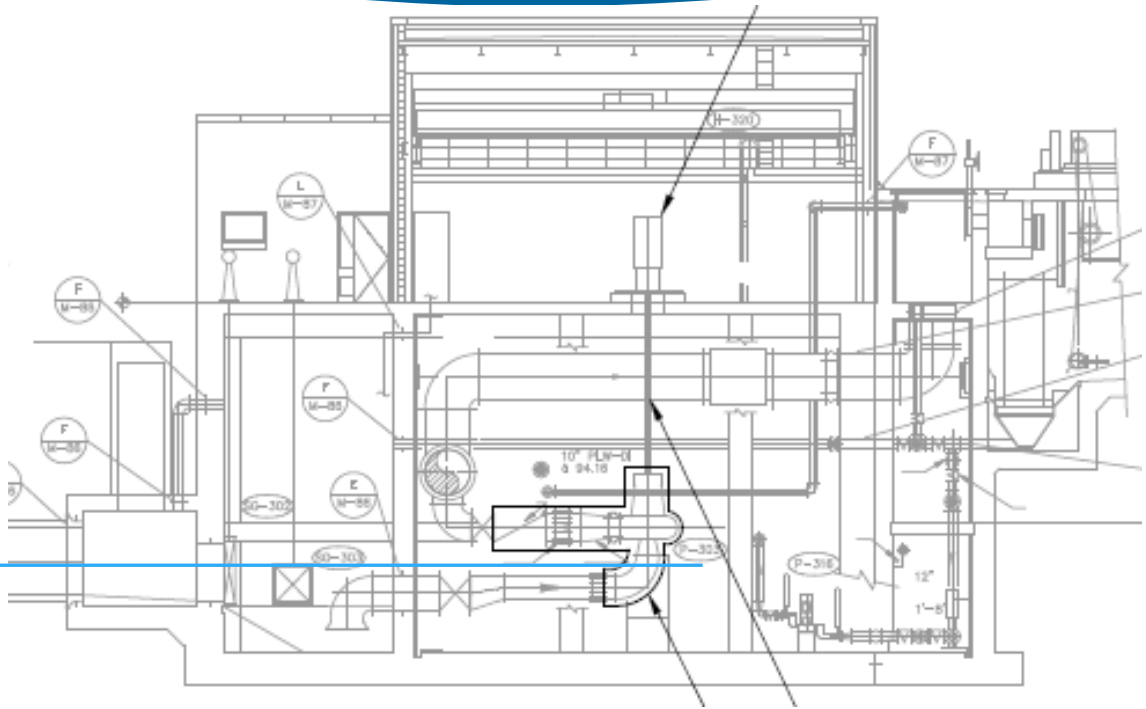
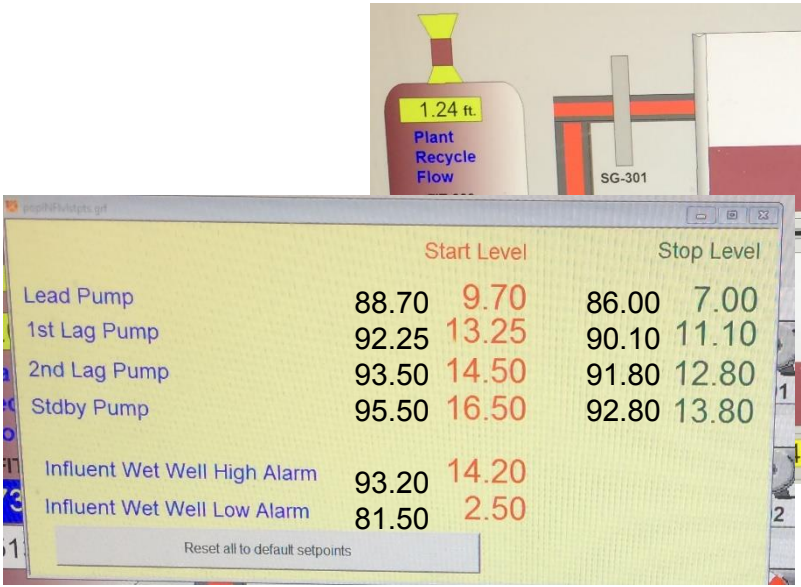
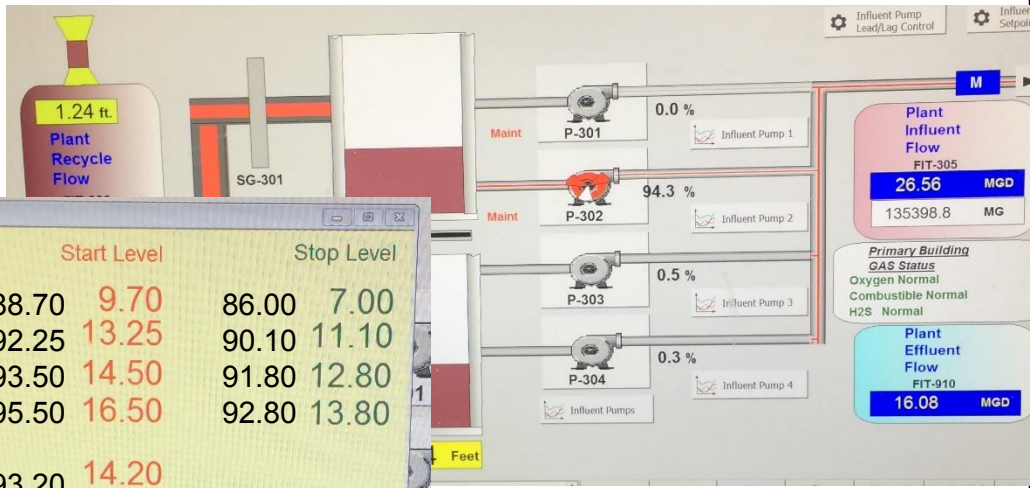


Typical Overnight Low Flow Water **el. 85+/-**

Control System Changes

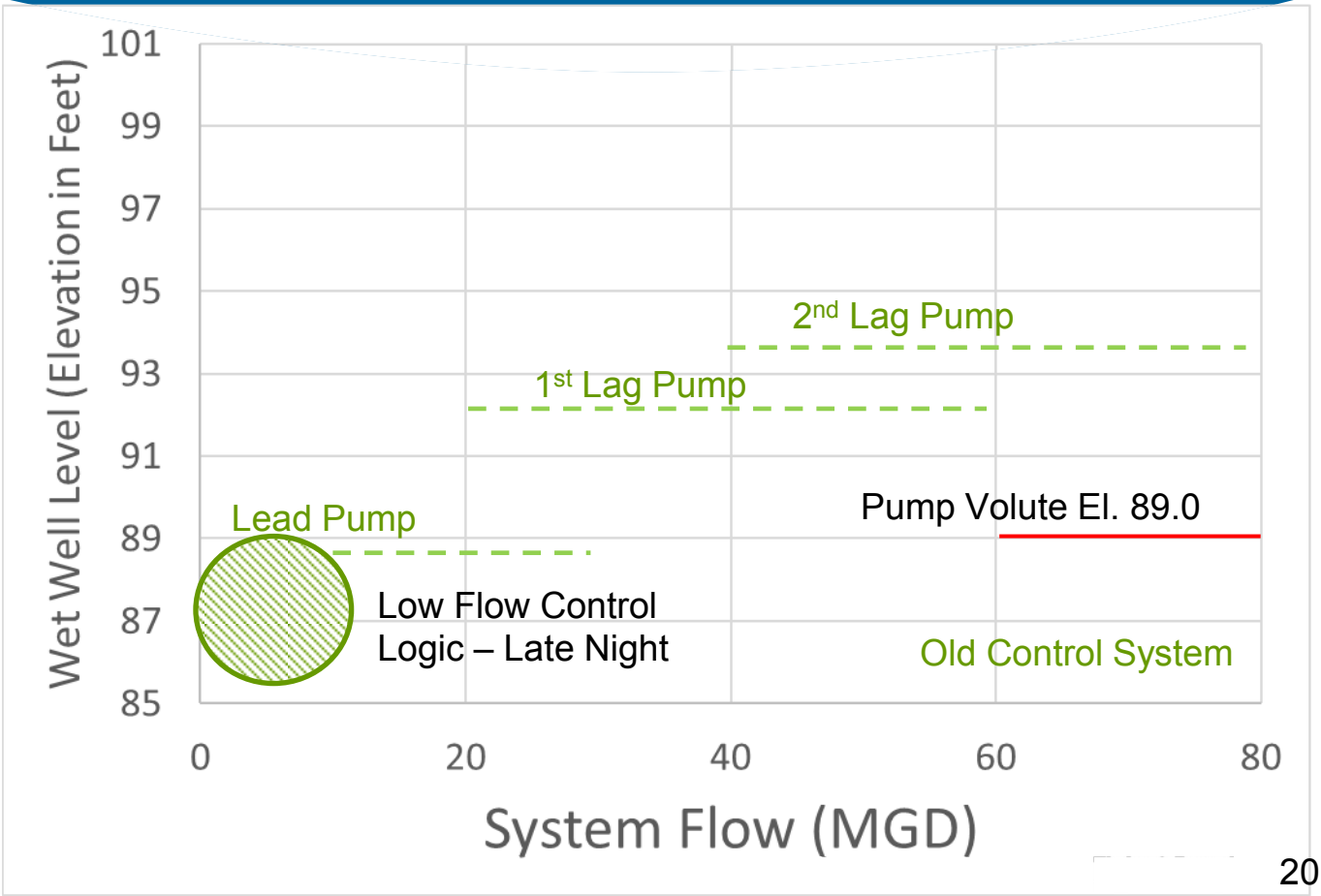
- Avoid High Pump Speeds
- Avoid Low Wet Well Levels



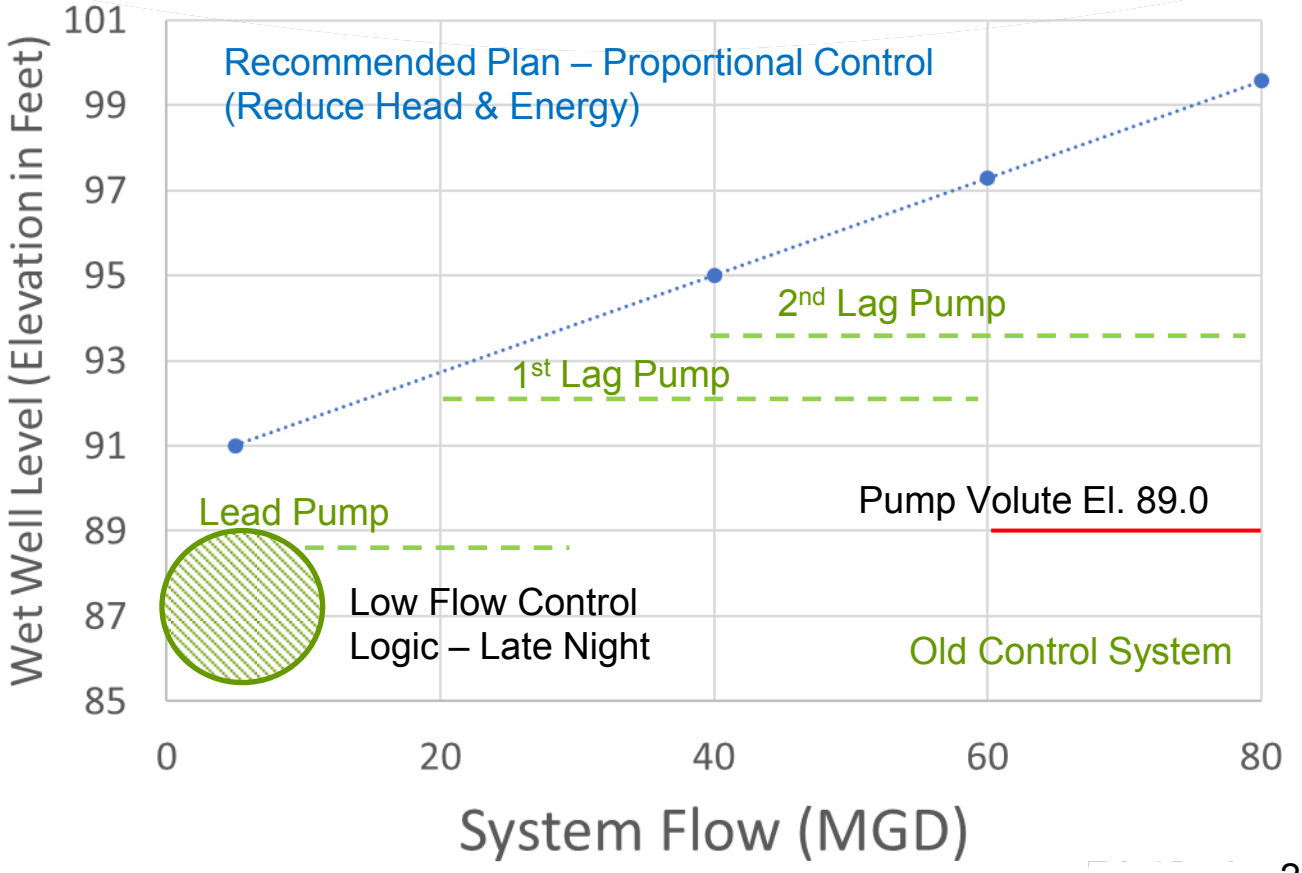


Low Flow Controls Logic Hidden

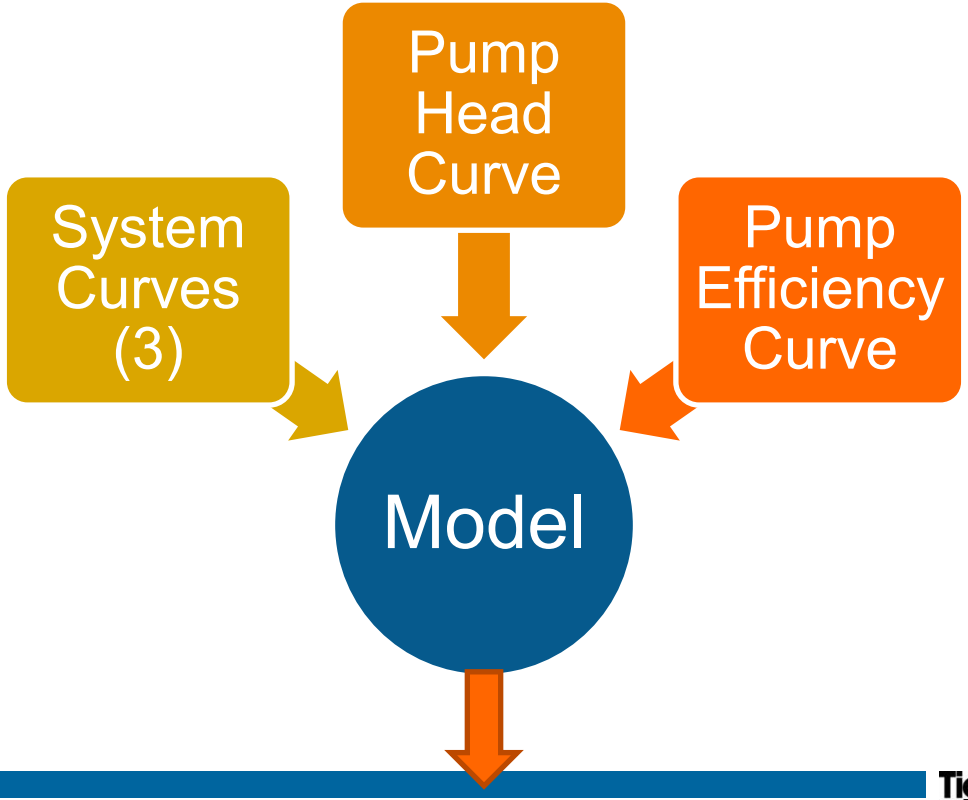
Wet Well Level vs. Flow



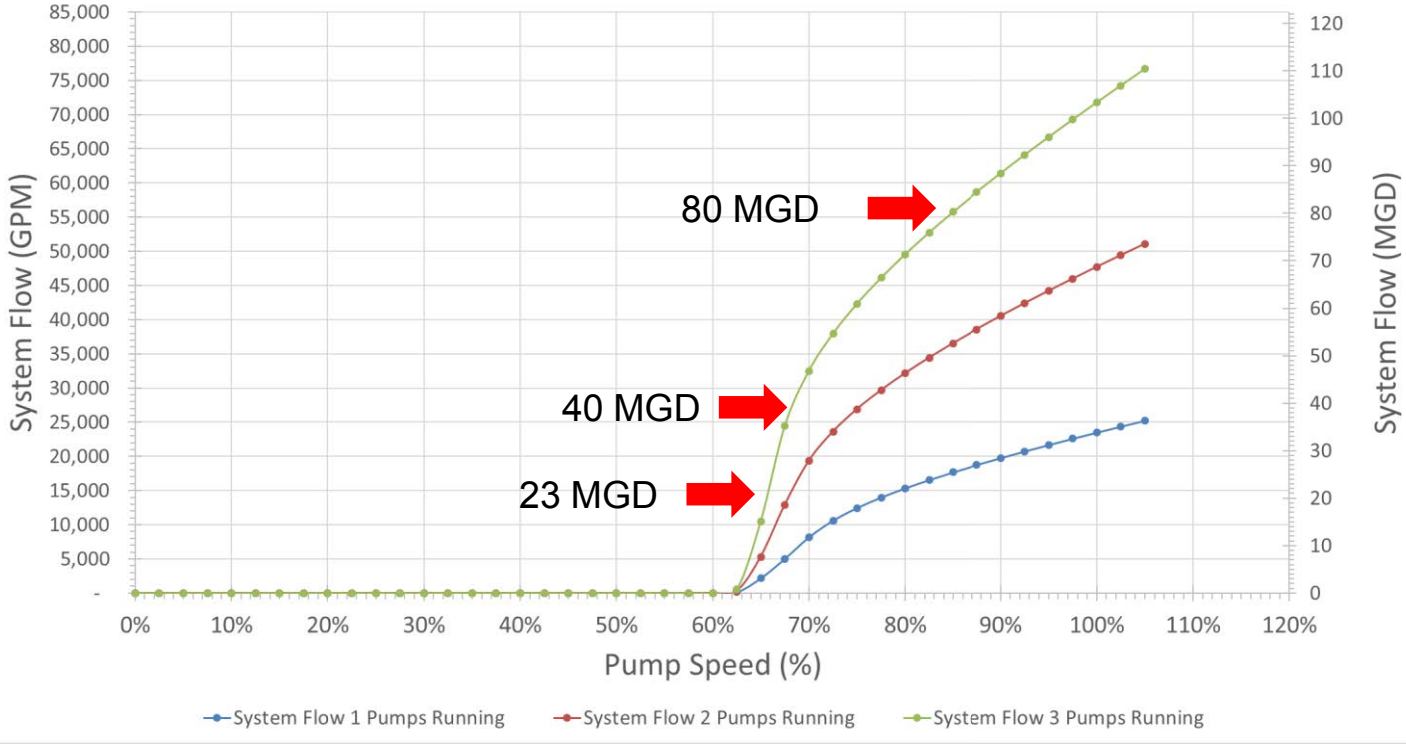
Wet Well Level vs. Flow



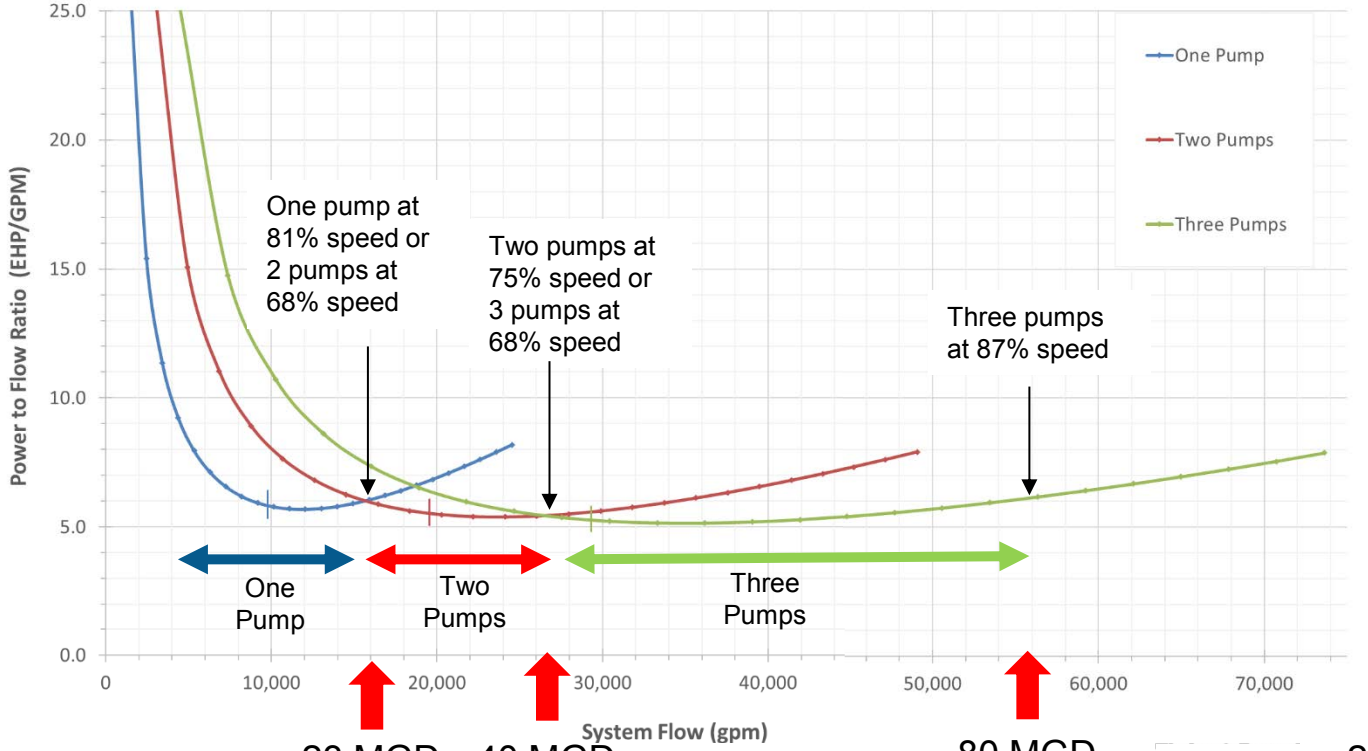
Pump Optimization Model



Recommended Plan
Flow vs Speed



What is the Most Efficient Operating Strategy?



Impact of Control System Changes

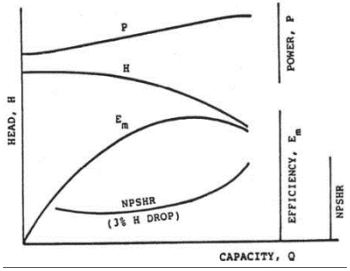
- Put Lag Pumps on Sooner
- Run at Higher Wet Well Levels
- Avoid High Speed & Vibration
- Increase Pump Station Capacity
- Estimated Annual Energy Savings
  - 147,000 KWH*
  - $22,000 **

* Estimated by Tighe & Bond

** Assume $0.15 / KWH

Pump Optimization Tool

- **Can be used to analyze any centrifugal pump station.**
- **Pump Curves**
  - Flow v Head,
  - Flow v Efficiency
  - Flow v NPSHR
- **System Curves**



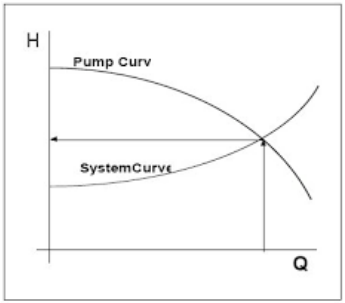
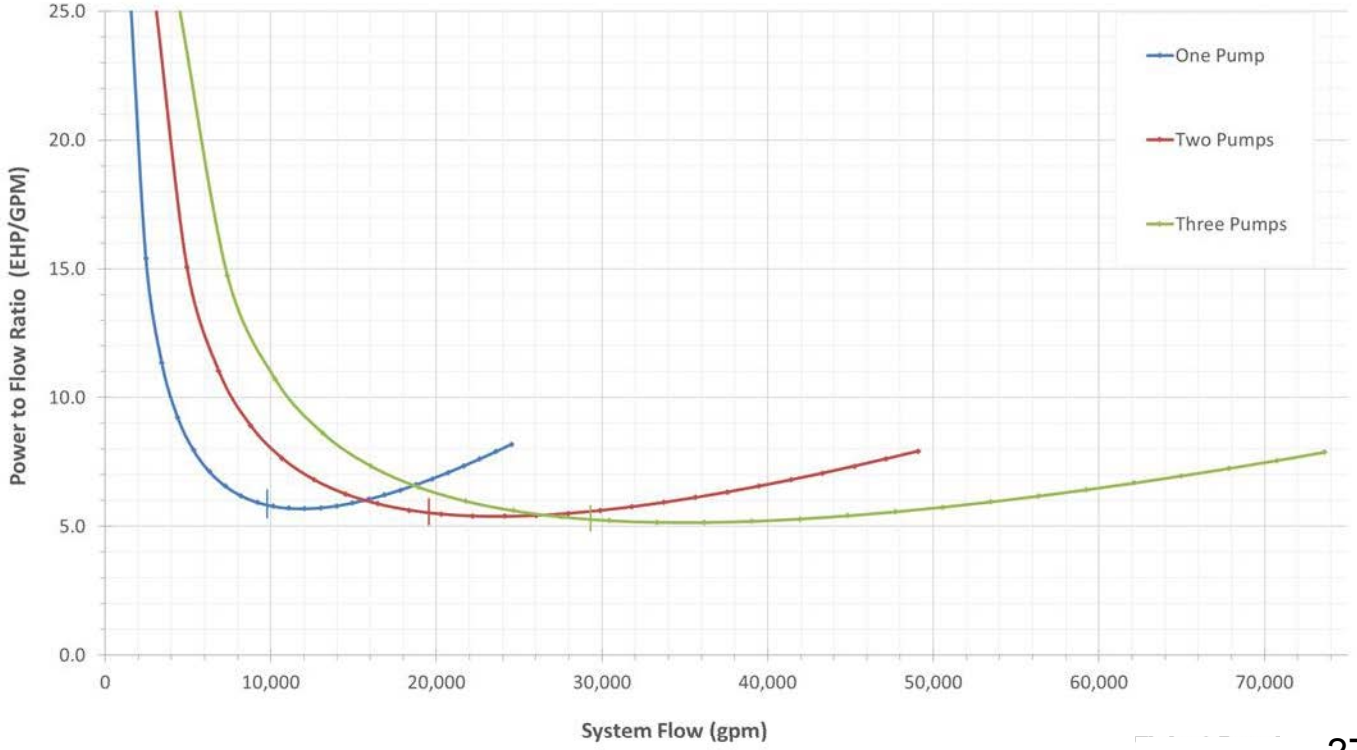


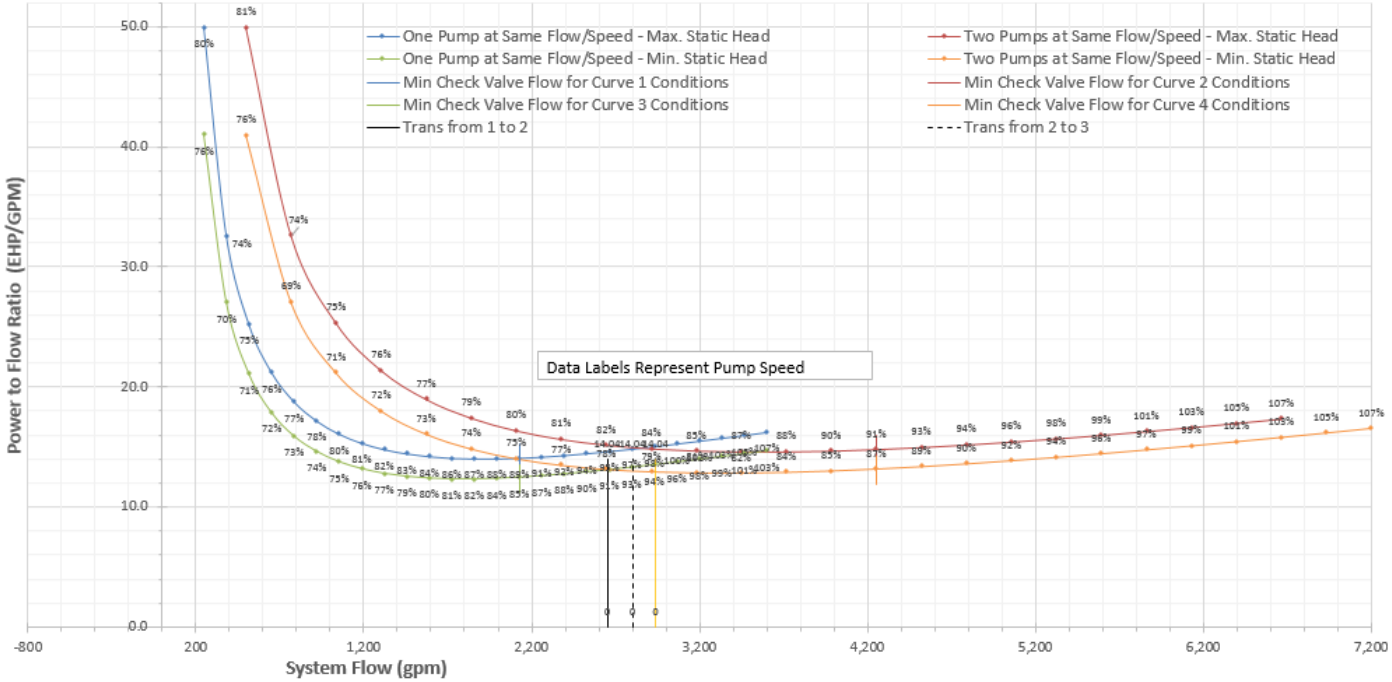
Figure 8

Low Head – Very Short Force Main (Waterbury)



Medium Head – Long Force Main (Middletown)

Medium Head - Medium Force main



THANK YOU

QUESTIONS?

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NEW ENGLAND PUMP & VALVE

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