

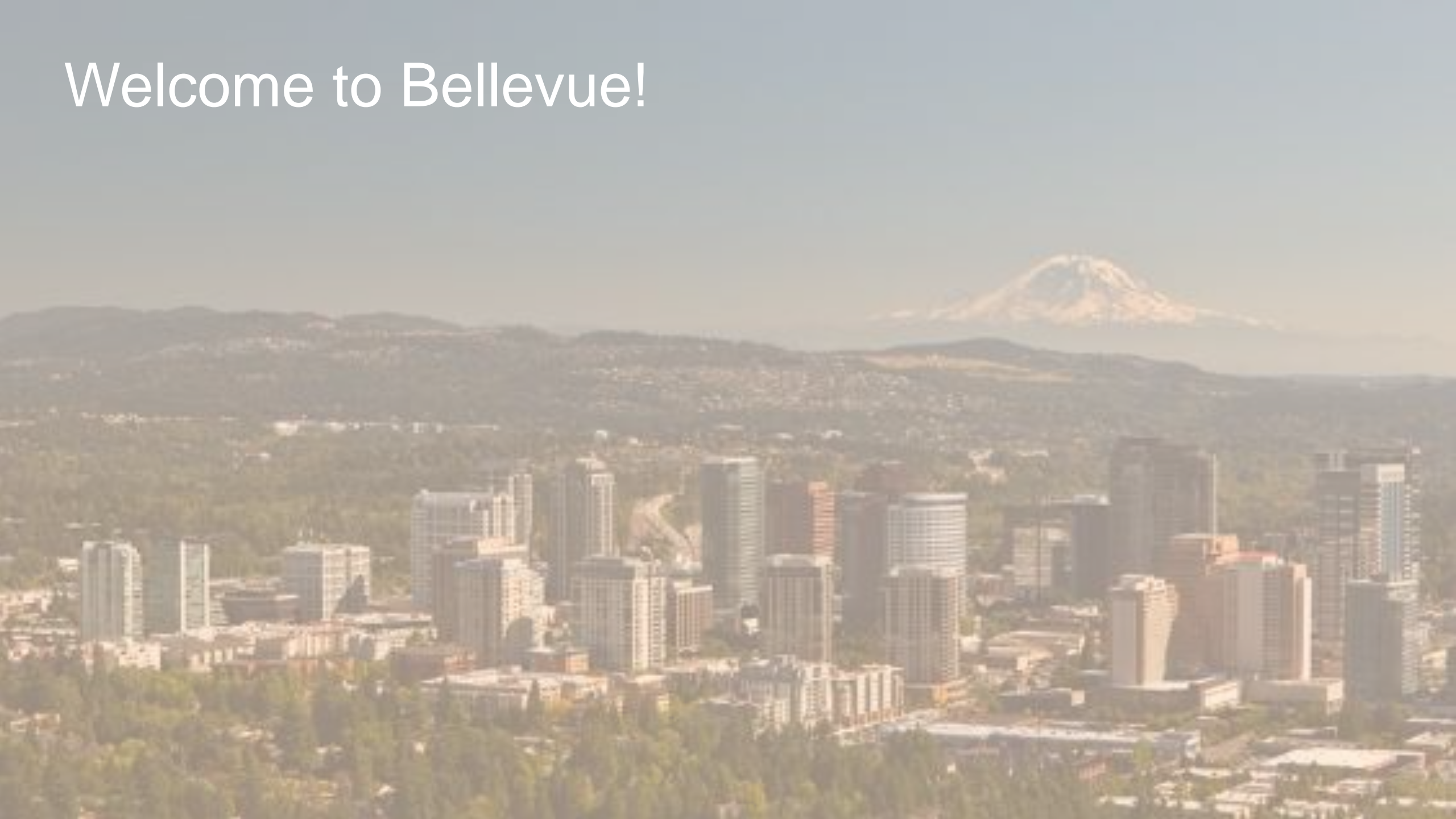
Using Hydraulic Modeling to Support Operational Decisions & To Solve Water Quality Challenges

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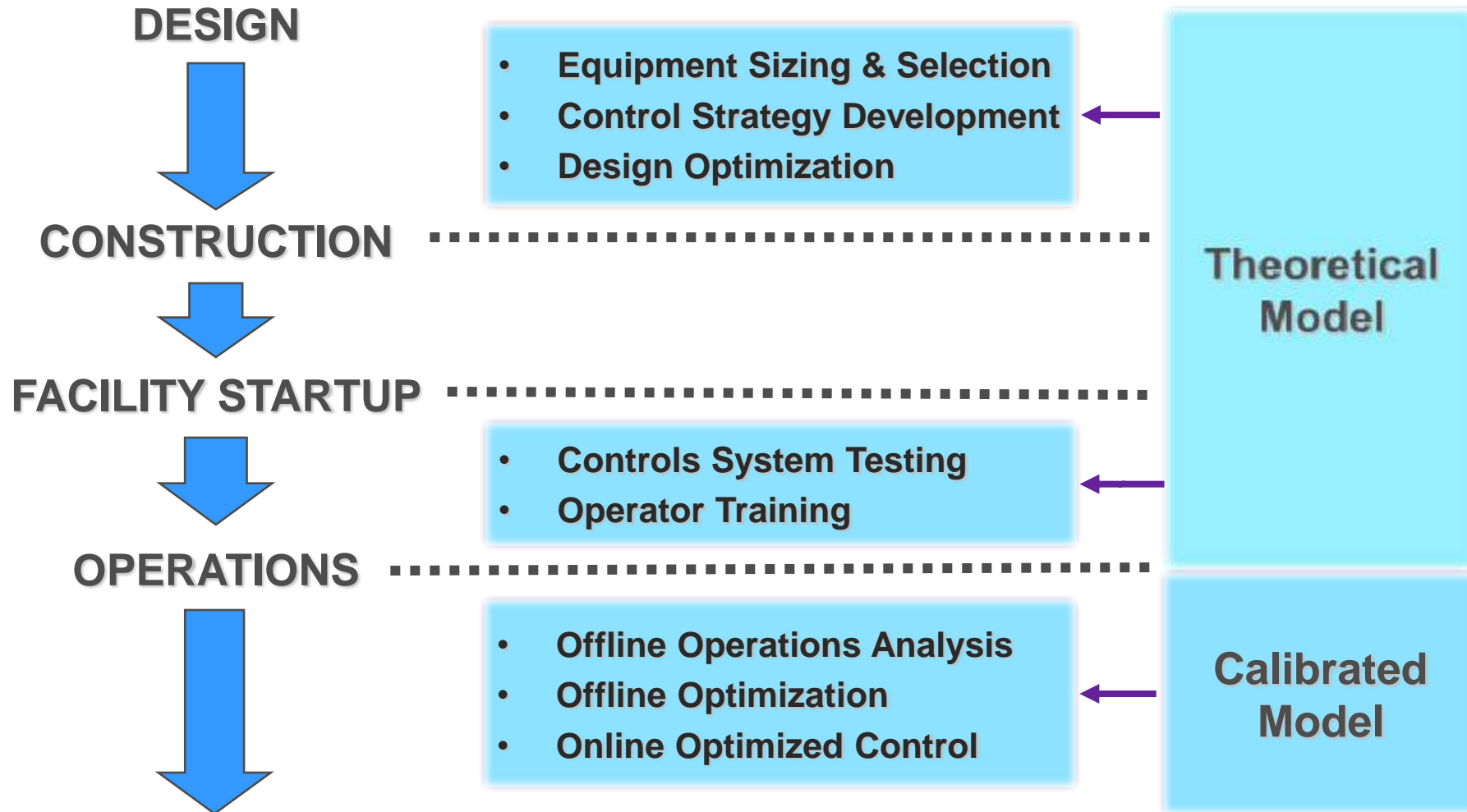
Welcome to Bellevue!



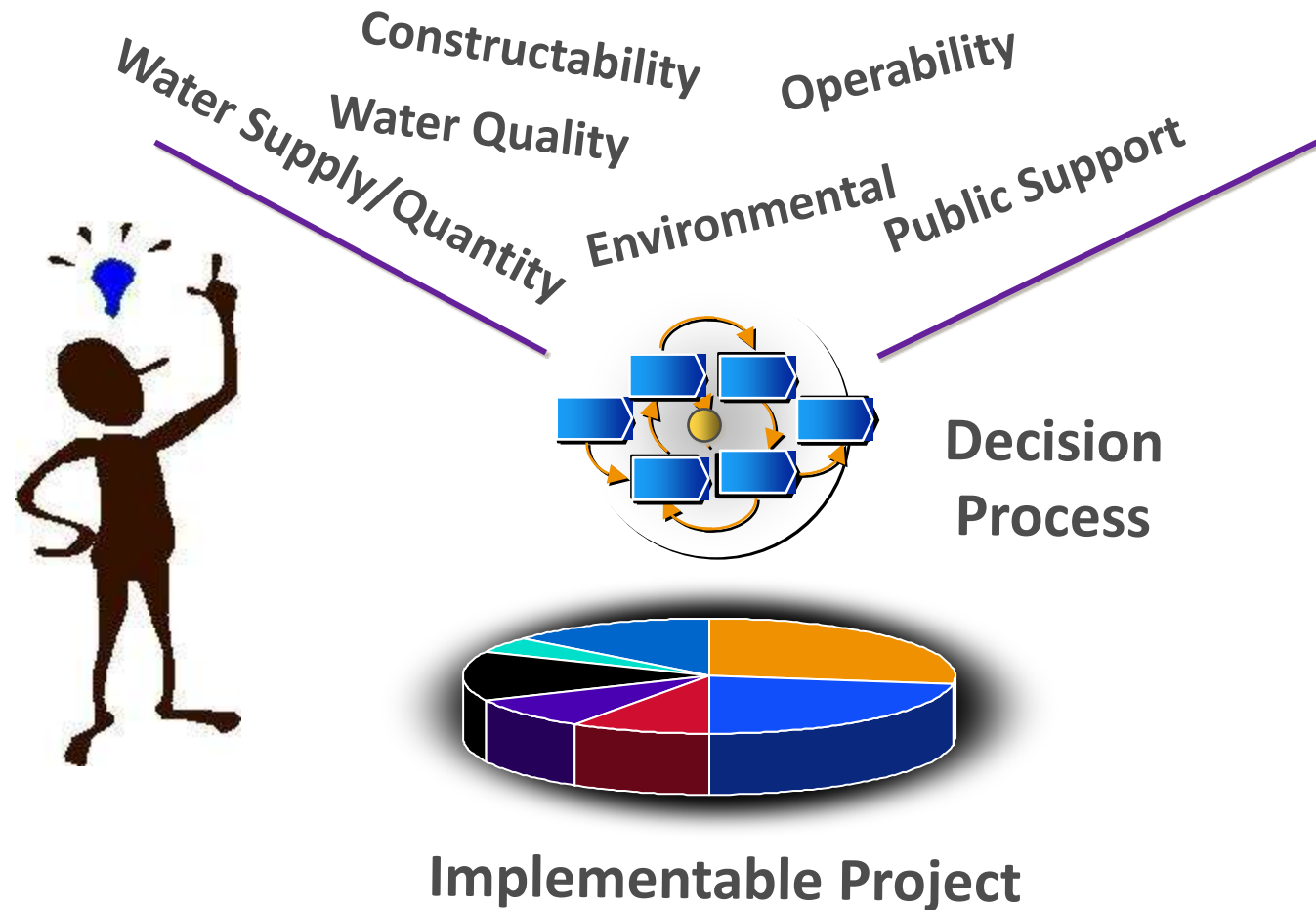
Outline

- Hydraulic Modeling Application
- Problem Definition
- Approach to Identifying and Evaluating Solutions
- Recommendations and Implementation

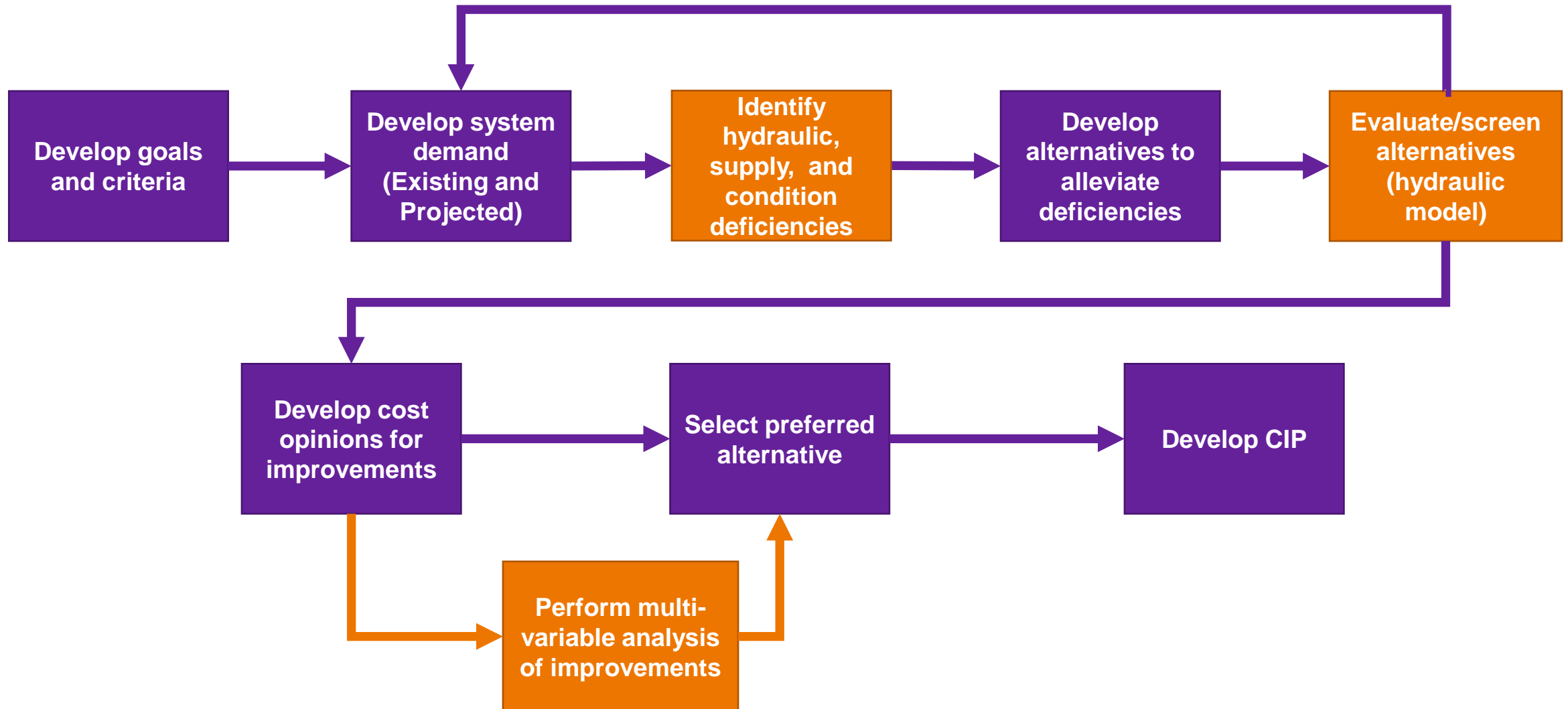
Hydraulic Modeling: Multitude of Applications!!!



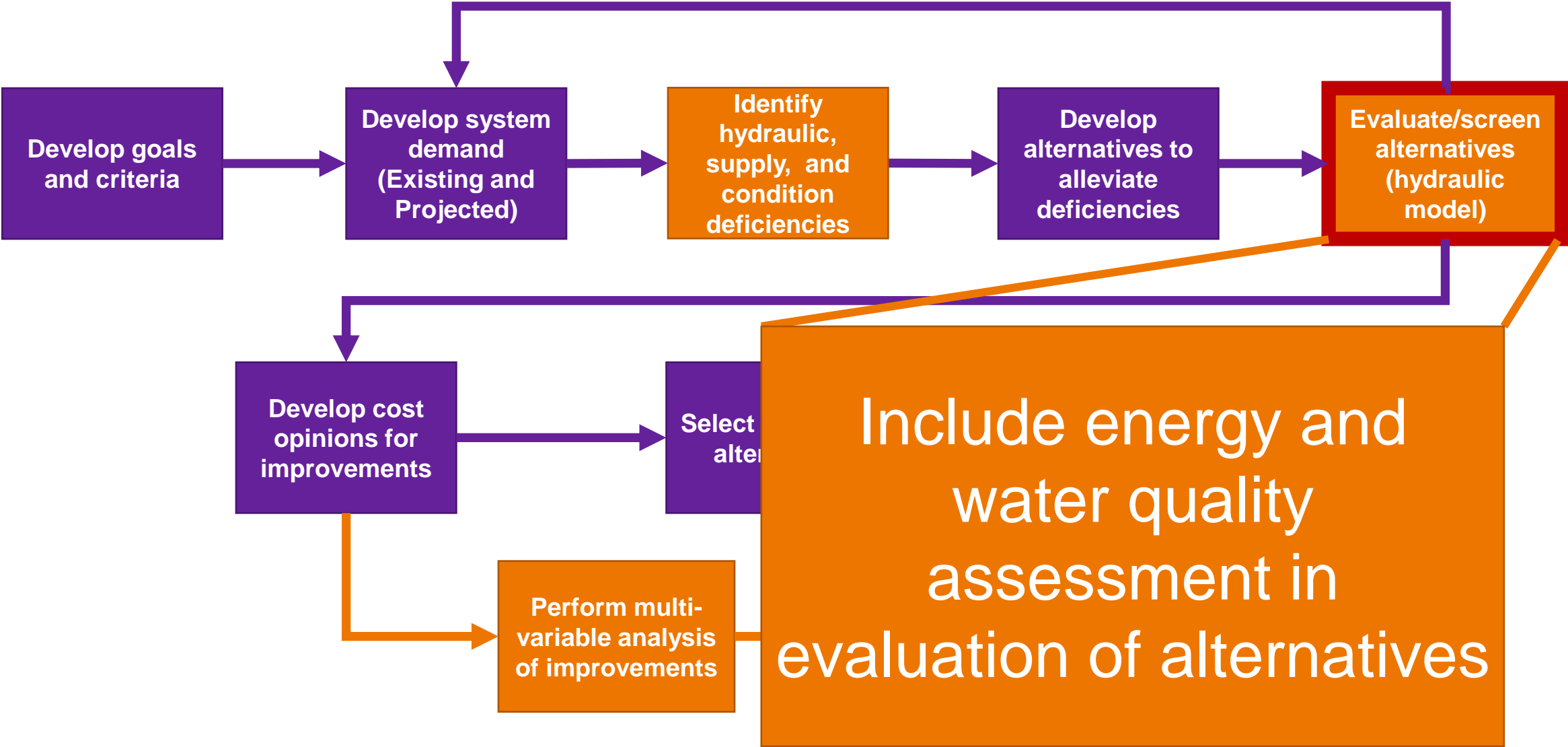
What Should Hydraulic Modeling Consider



Traditional Modeling Revisited



Current Generation of Modeling



Problem Definition

- Low chlorine residual
- Flushing initiated
- Isolation and dumping of
- Main breaks
- Chlorine

Why did this
?

How do
it from



again

Goals of Analysis

- Identify most probable cause for low chlorine residual
 - Forensic evaluation of sampling data
 - Couple with hydraulic modeling of conditions leading up to event
- Prevent future occurrences
 - Update operating protocols
 - Identify capital improvements

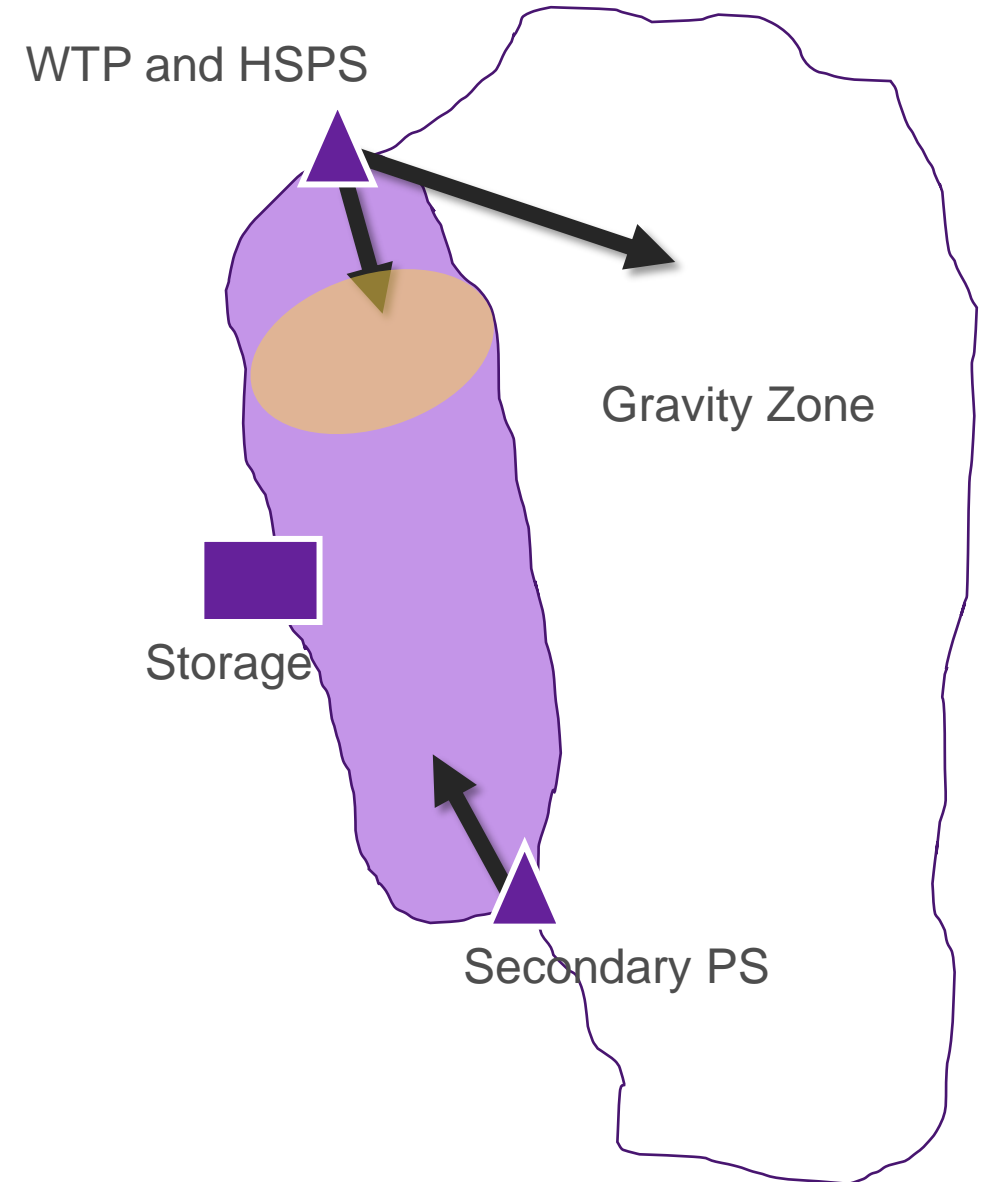


Analysis Approach

- Review background information leading up to event
 - Chlorine residual data (historical and event data)
 - Operational data
 - Tank operation
 - Pump Station Operation
- Simulate distribution system observed and modified operation
- Assess tank mixing and options for improving
- Assess operation for Surge Impacts

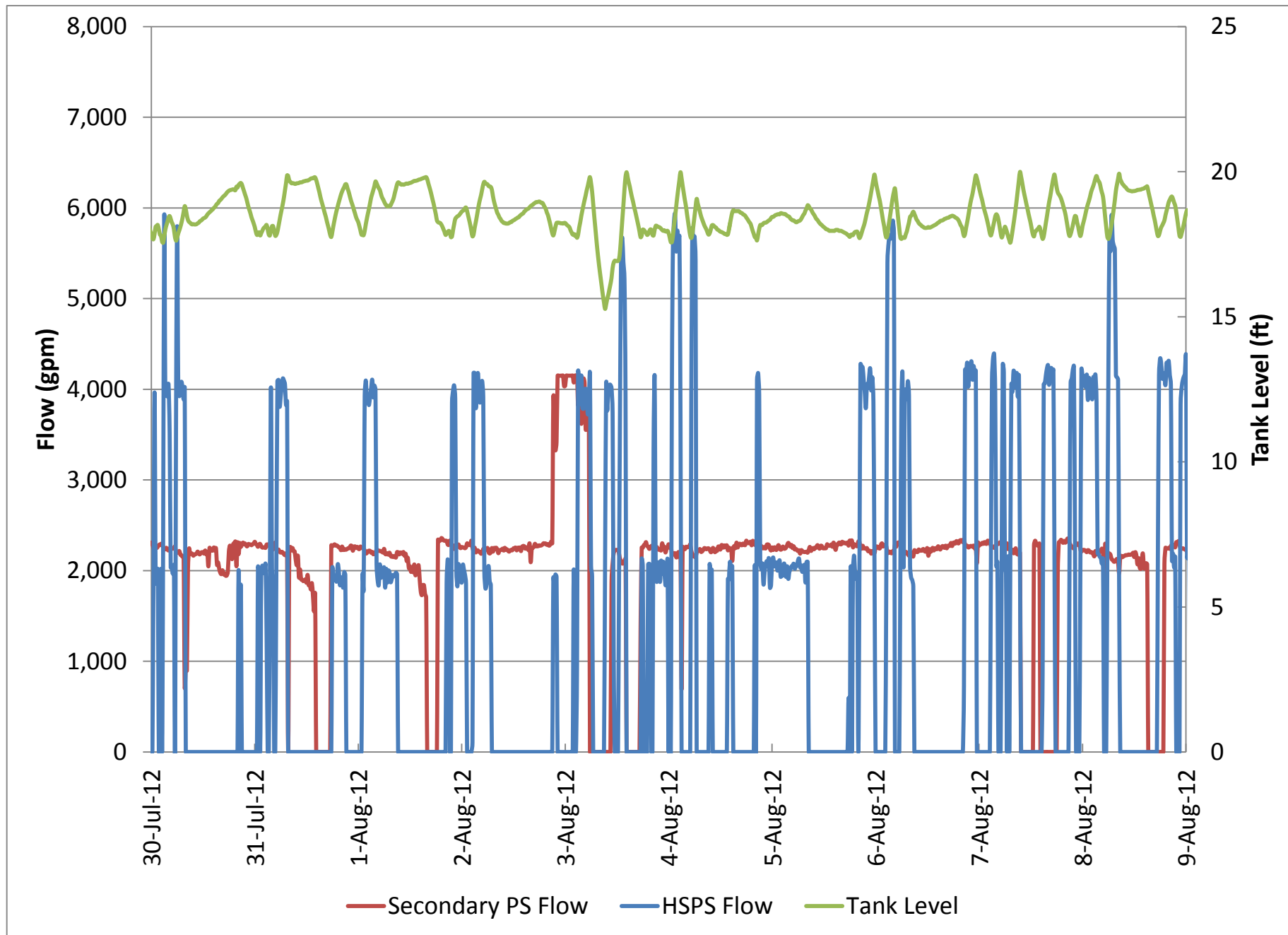
System Background

- Mostly gravity fed system
- Zone has two points of supply
 - HSPS
 - Secondary Pump Station
- Floating storage within the zone

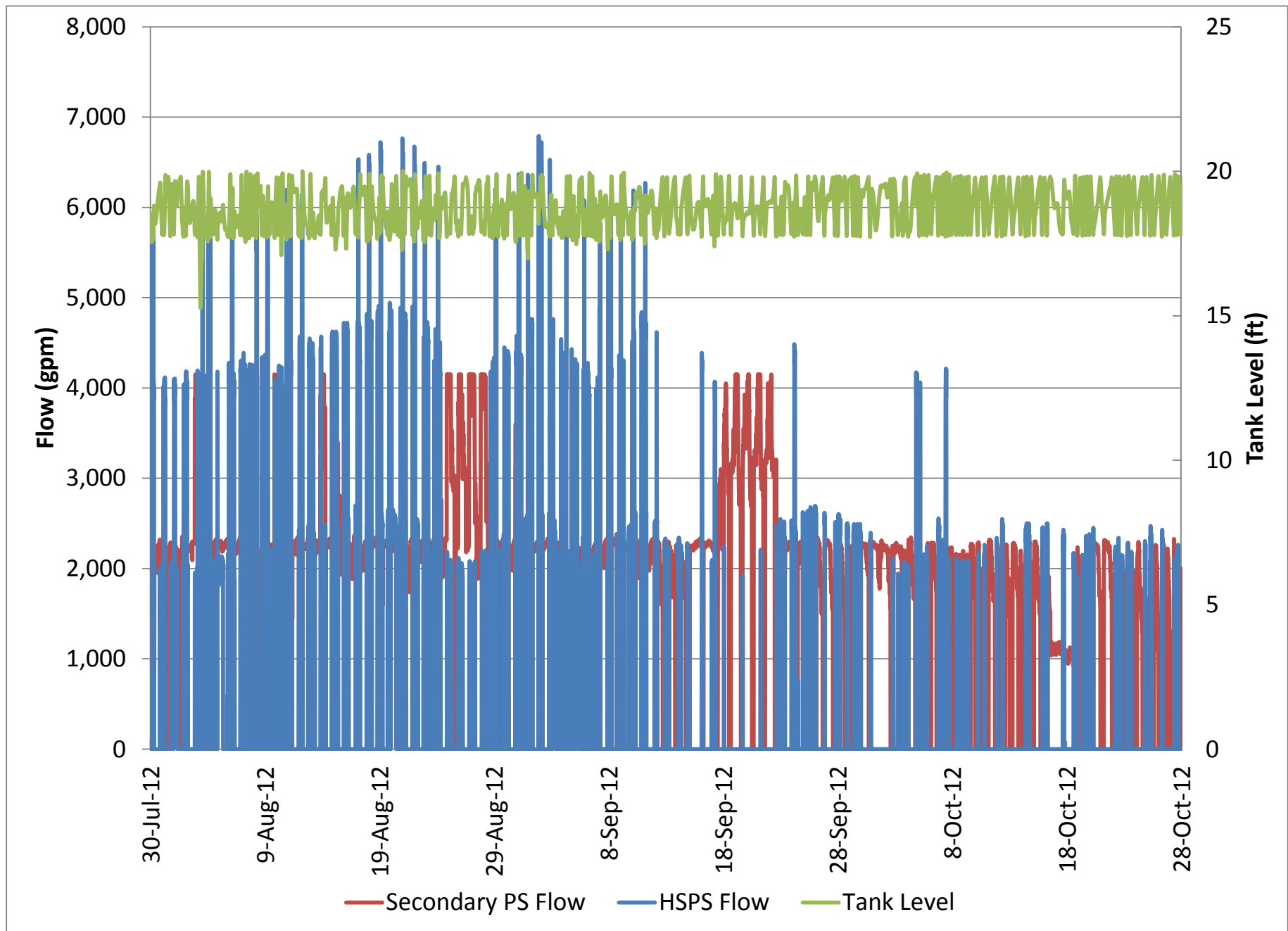


Operational
Data-

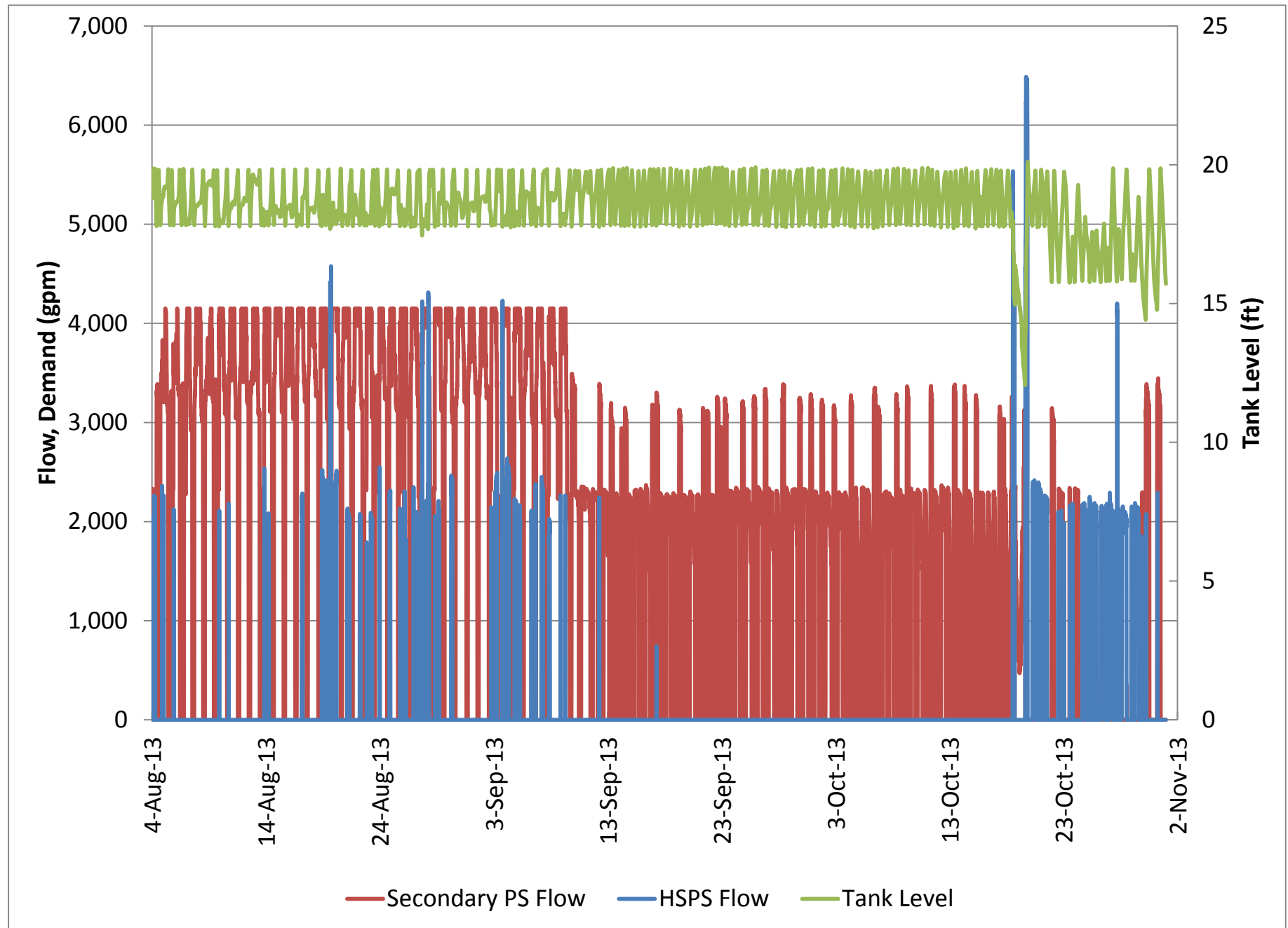
Trend
Evaluation

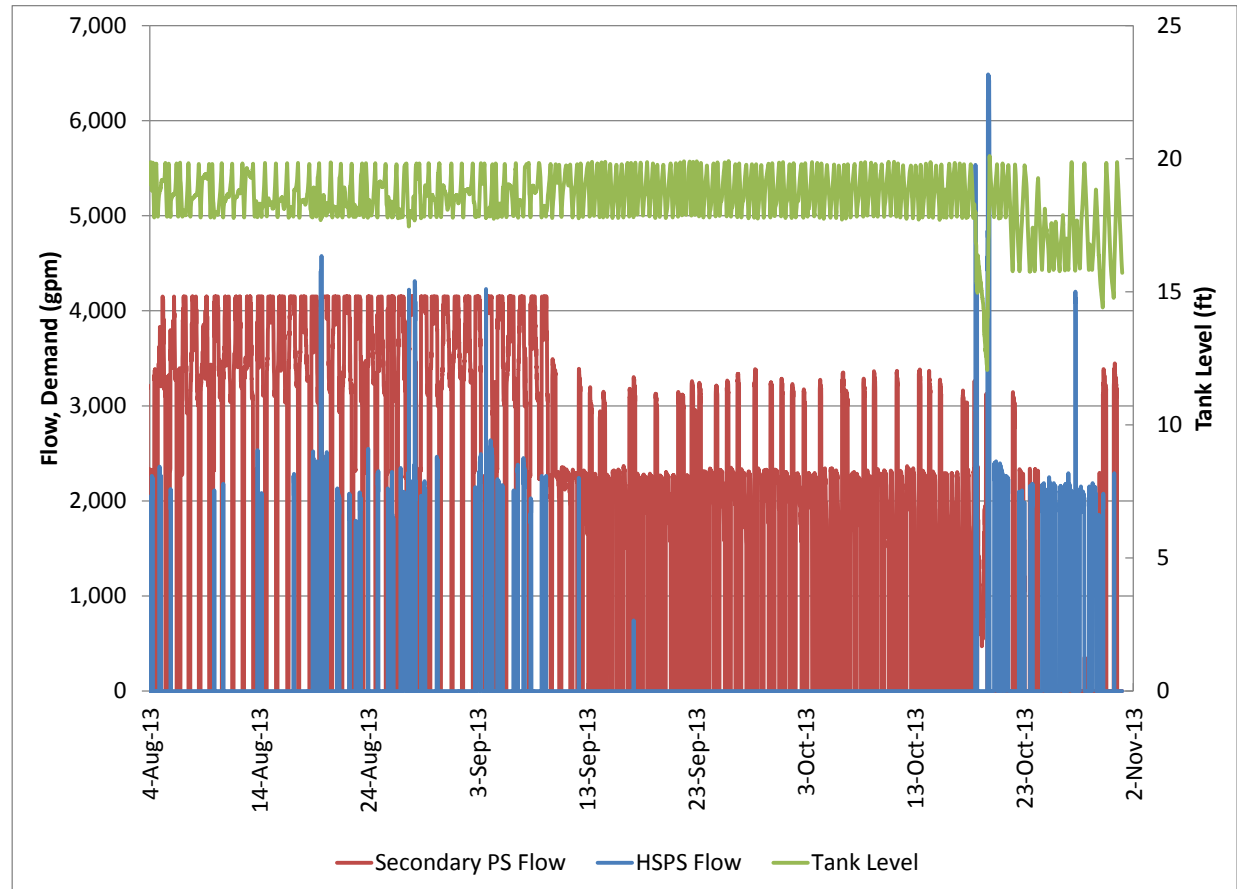
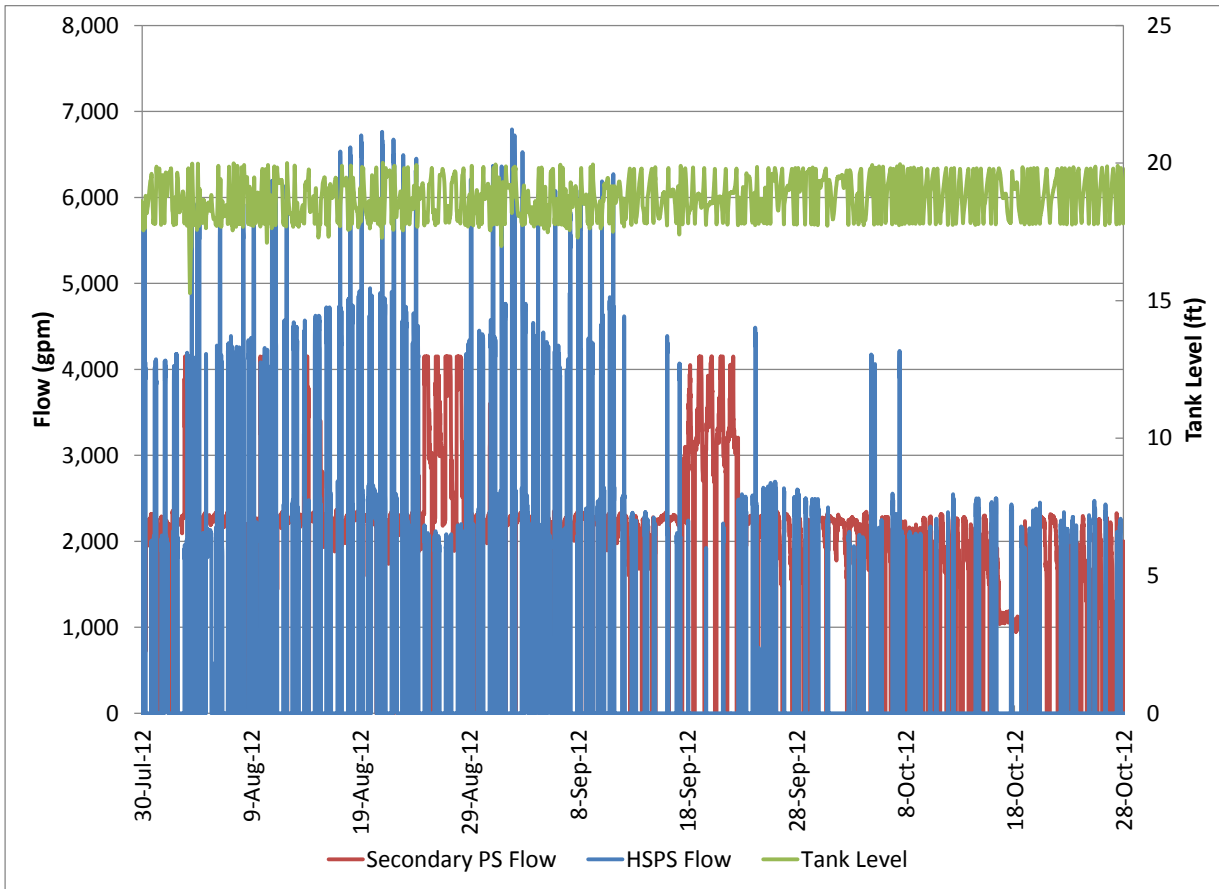


Operational Data- Year 1



Operational Data- Year 2





Observations from Data Review

- Operation of one pump station creates water quality concern
- Periodic lower chlorine residual follows the same trend of PS operation

• Action

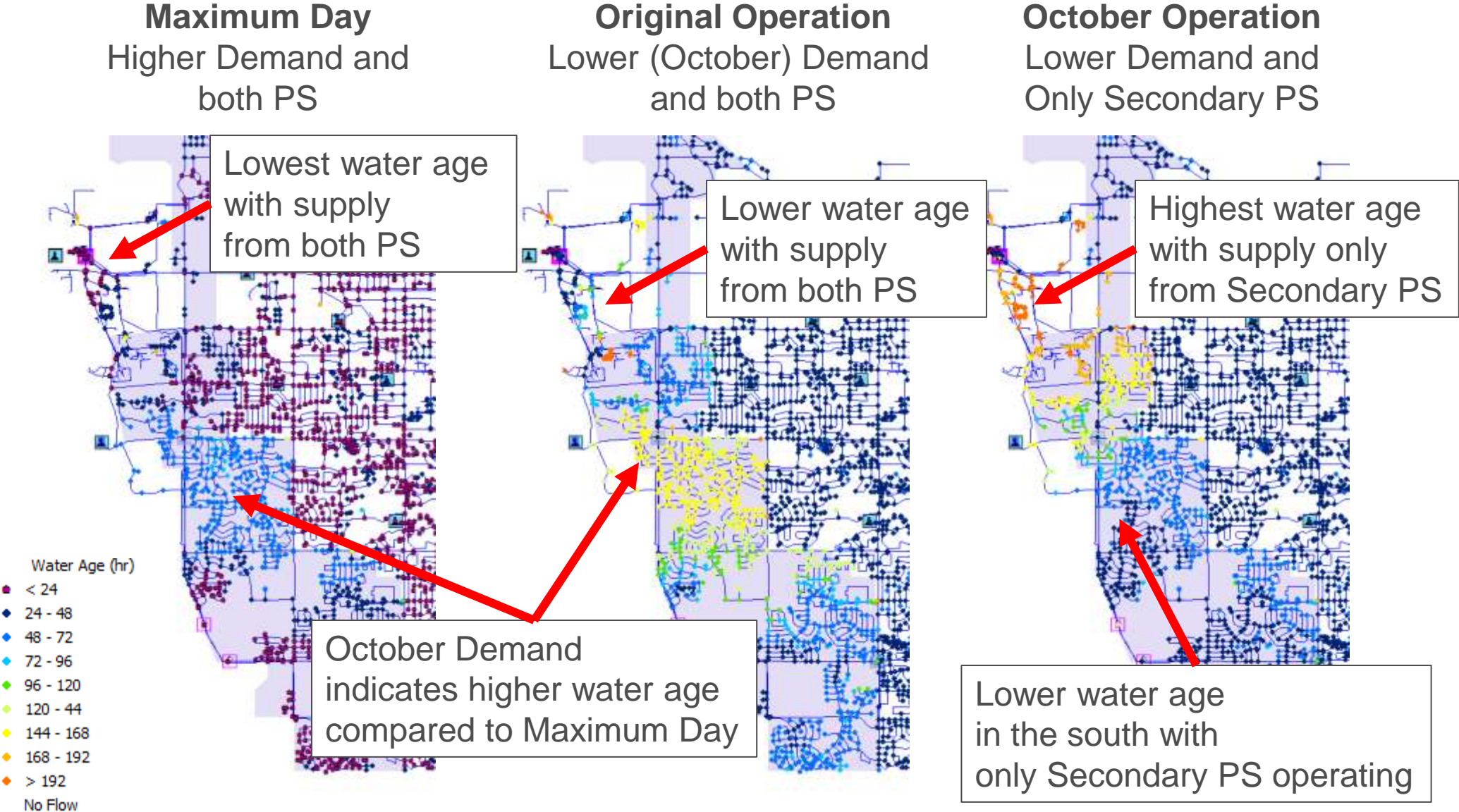
- Modify Operation
 - Pump Start Level
 - Rotating PS Operation
 - Range of demand scenarios
- Evaluate Tank Mixing Options

• Assess

- Water Age
- Pressure Impacts
- Tank Turnover, operational/capital improvements

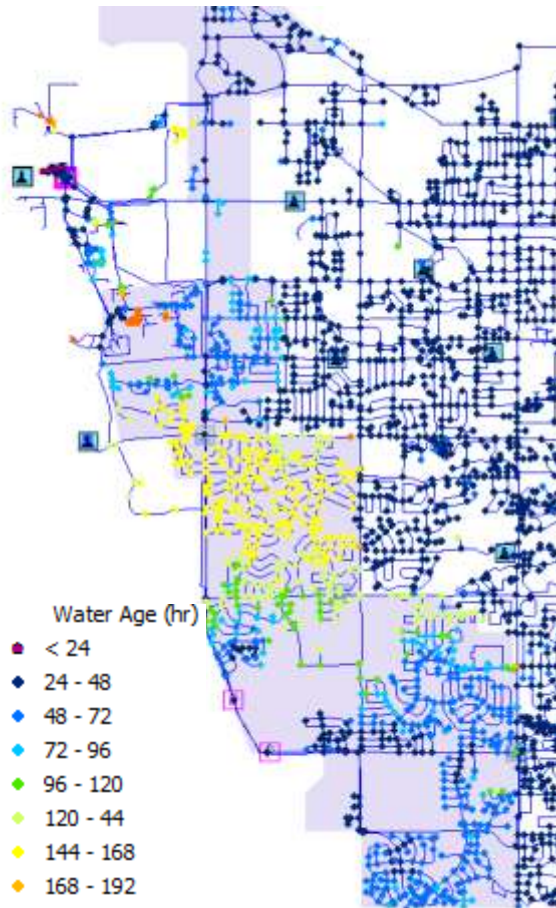
Scenario Results: Water Age

Baseline Comparison of Average Water Age

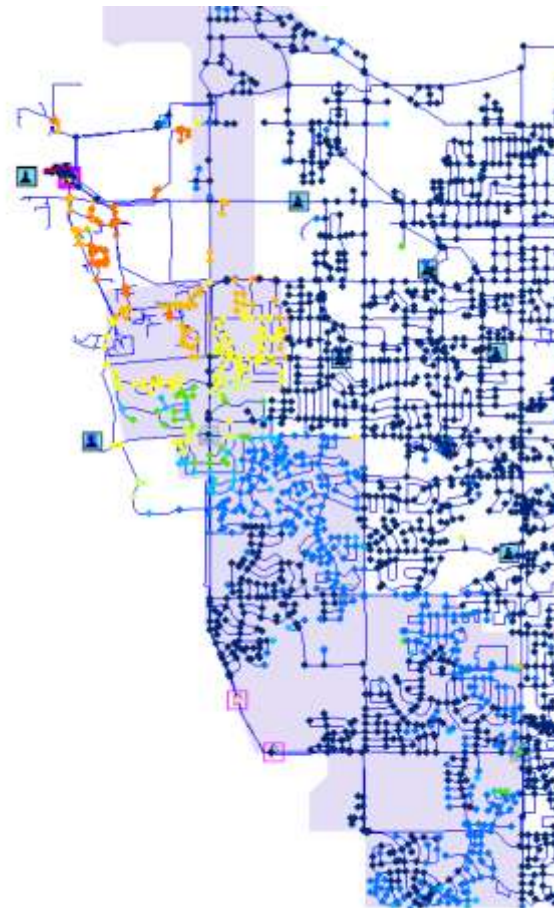


Water Age Comparison with Modified Operation

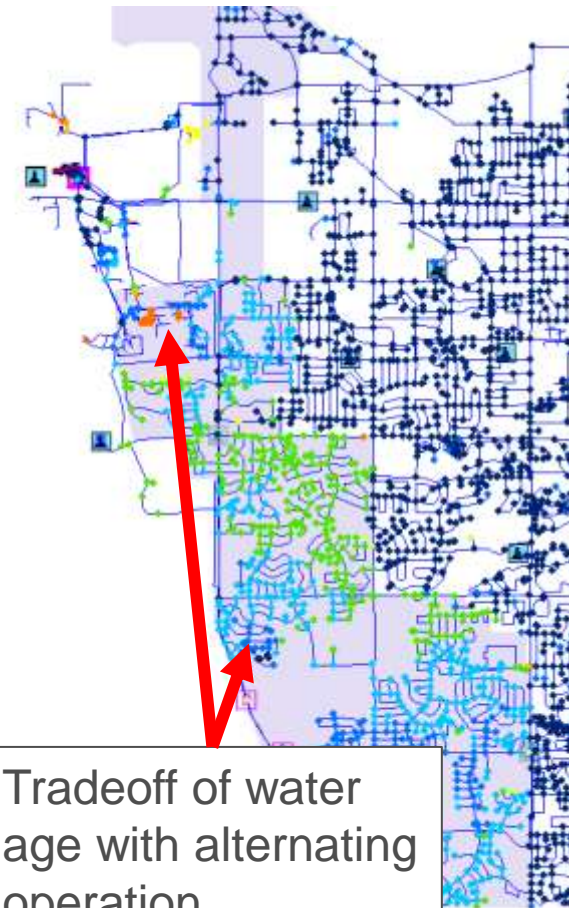
Original Operation
Lower Demand and
both PS



October Operation
Lower Demand and
Only Secondary PS



Modified Operation
Lower Demand and
Rotating HSPS & Secondary PS

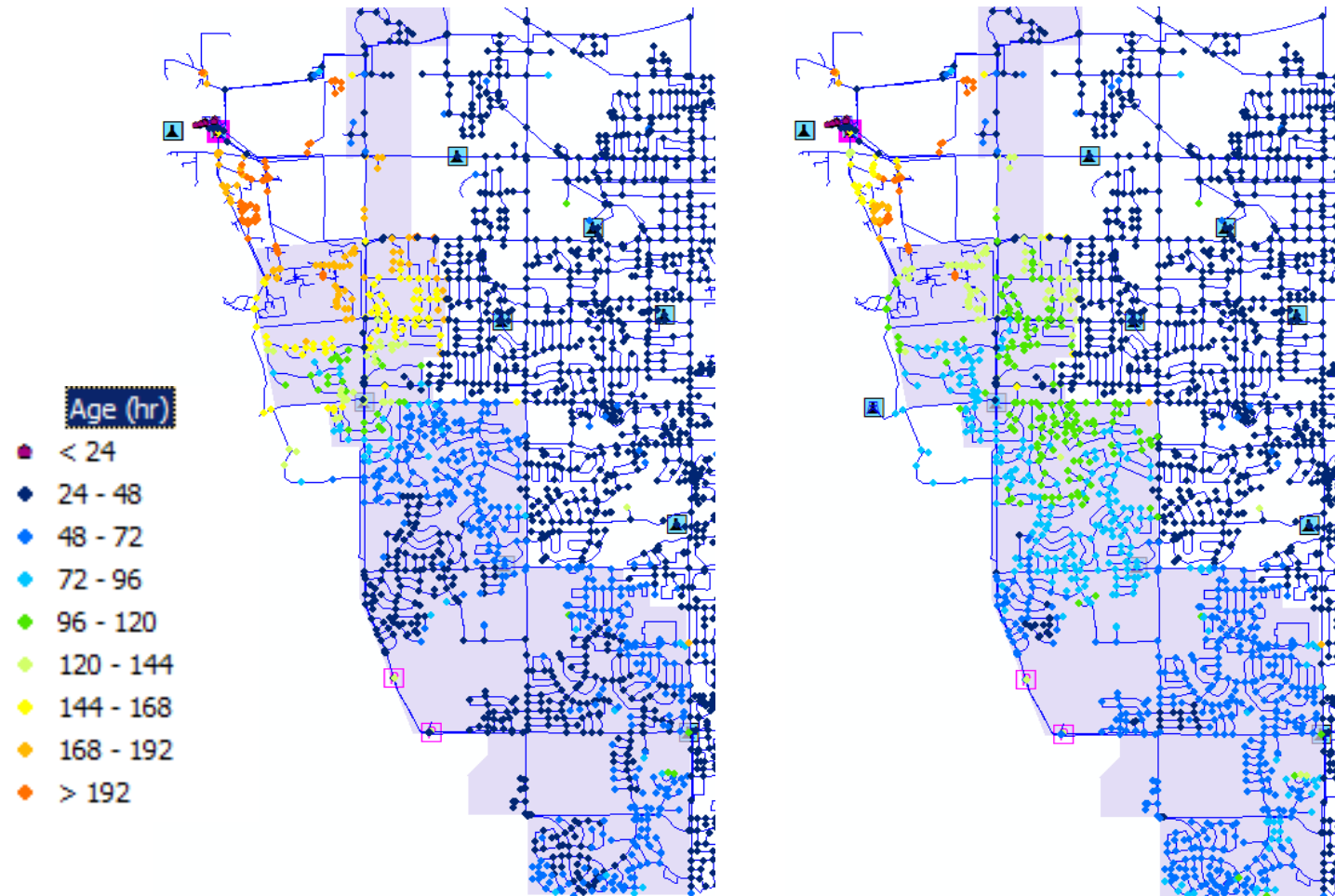


Tradeoff of water age with alternating operation

Lower Operating Range Comparison-Water Age

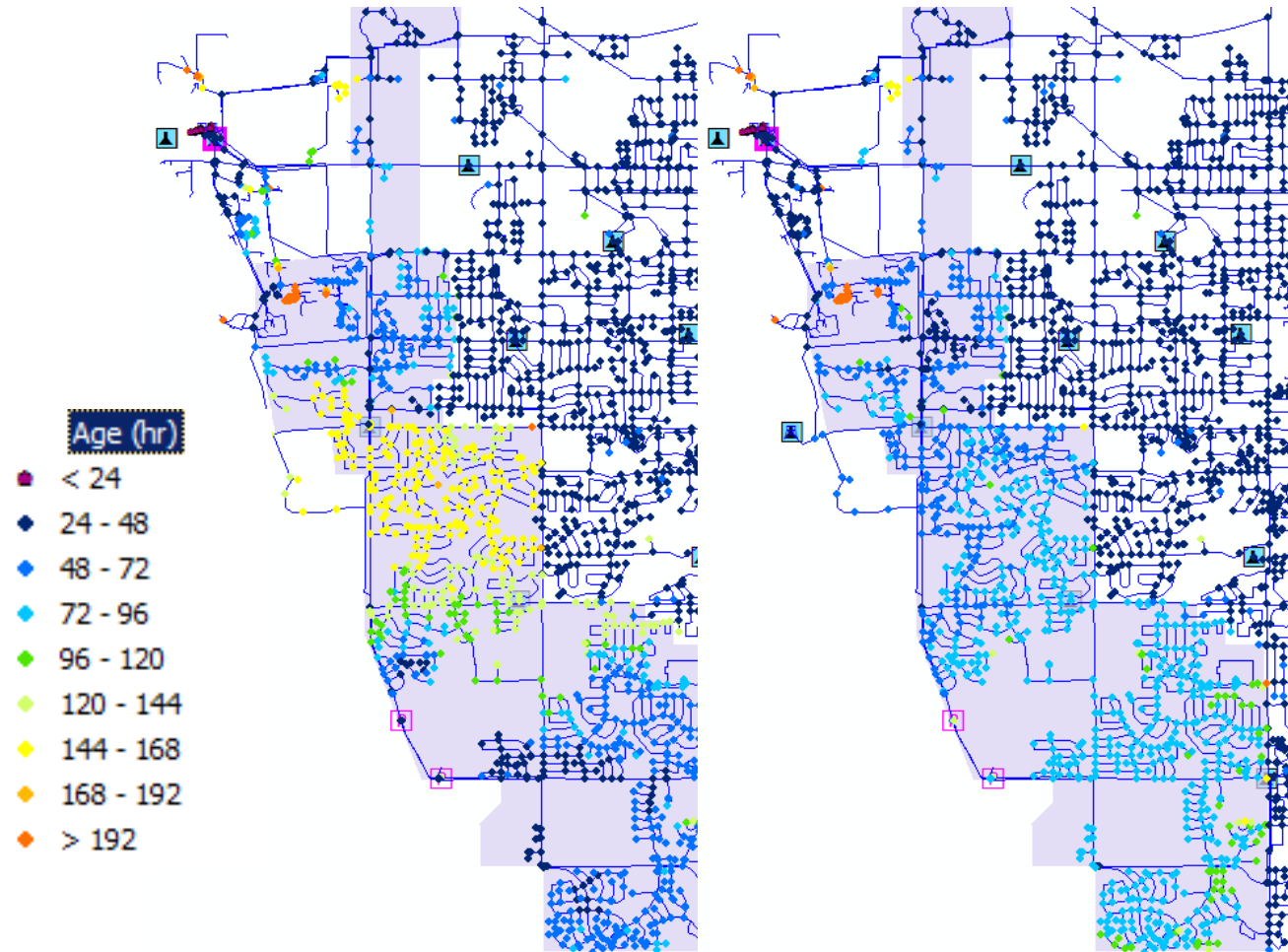
Secondary PS Only, 18 ft LL

Secondary PS Only, 12 ft LL



Lower Operating Range Comparison-Water Age

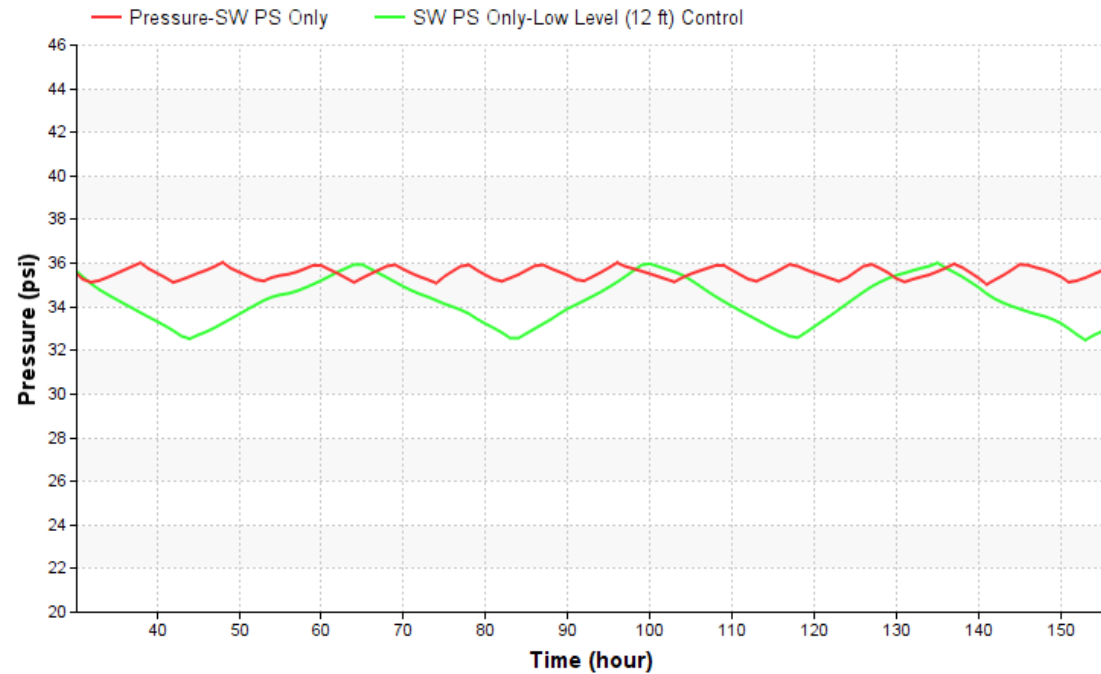
Rotating PS Operation 18 ft LL Rotating PS Operation 12 ft LL



Scenario Results: Pressure

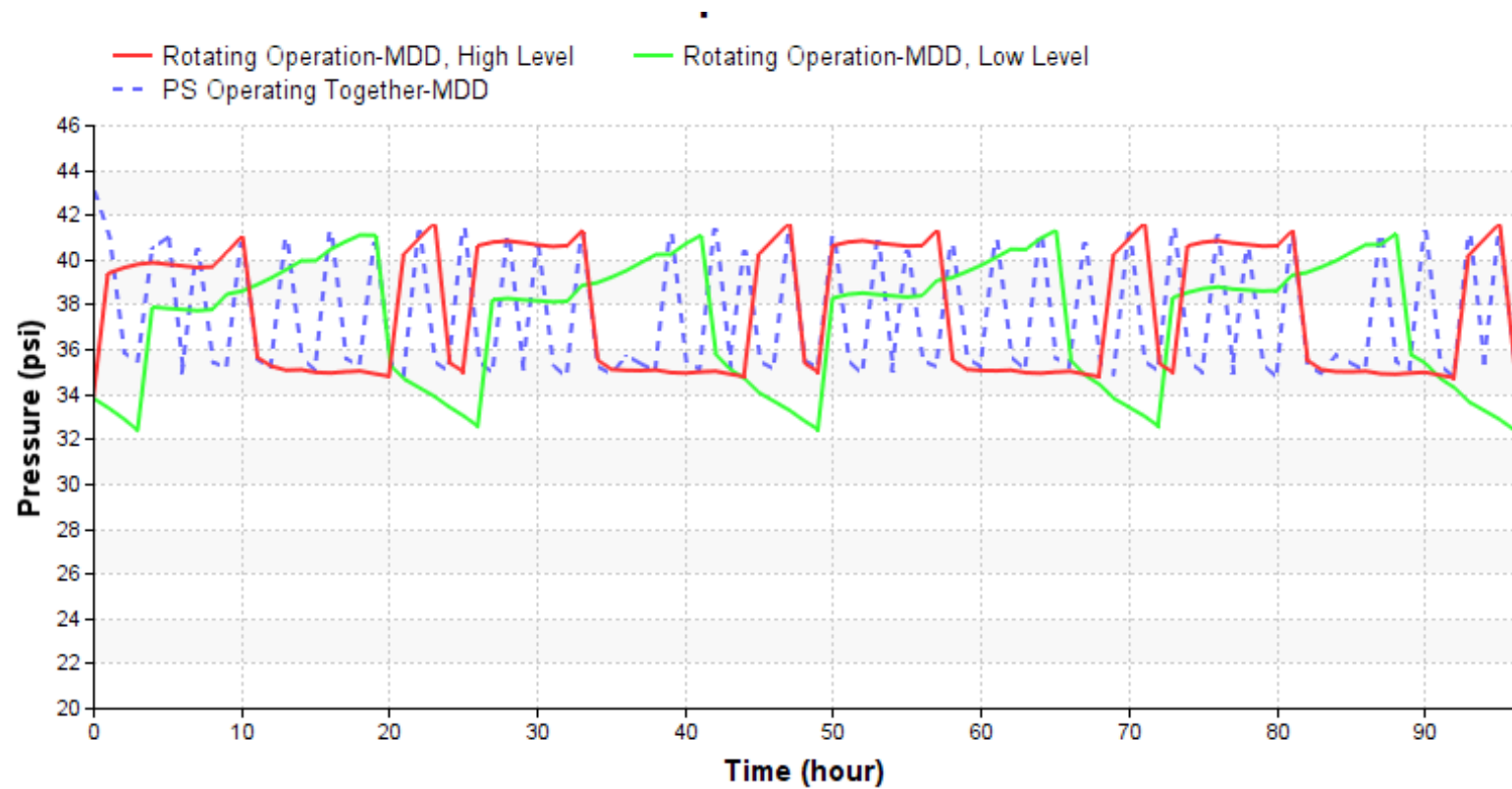
Lower Operating Range- Pressure

- Reduction in observed pressure is about 3 psi at location of concern building for lowering tank operating level for October demand level
- Pressures maintained above 30 psi



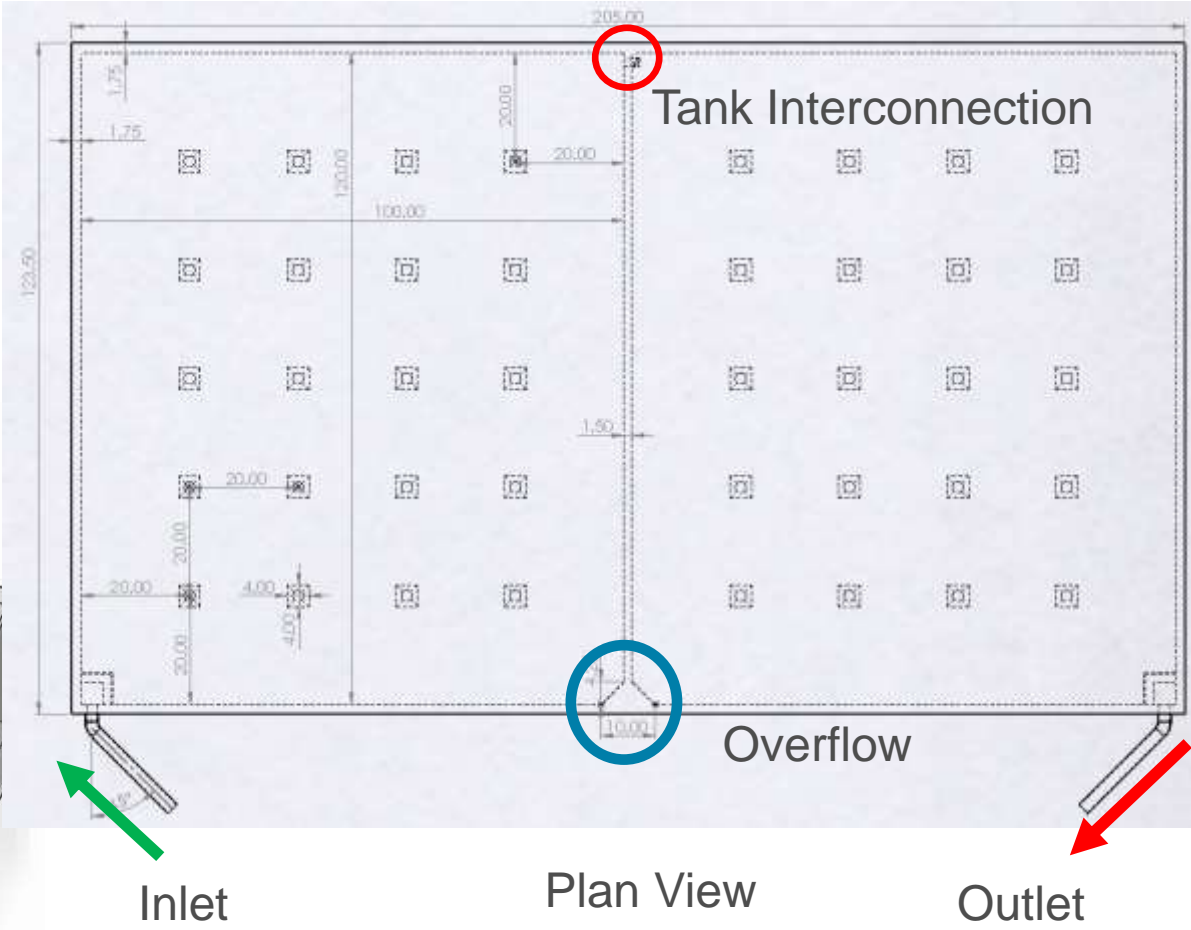
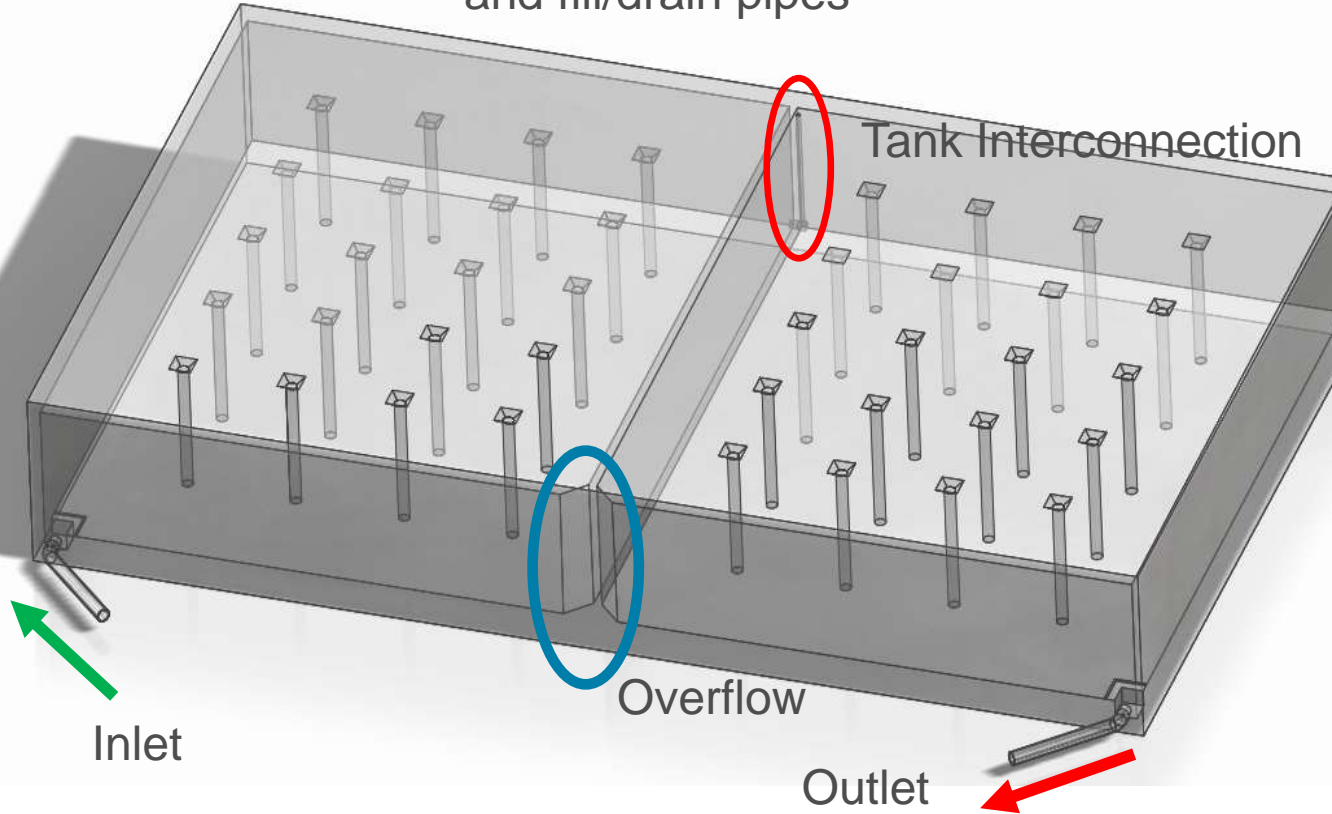
Lower Operating Range-Pressure under MDD

- Similar reduction in pressure (3 psi) under MDD conditions as observed for October demand conditions



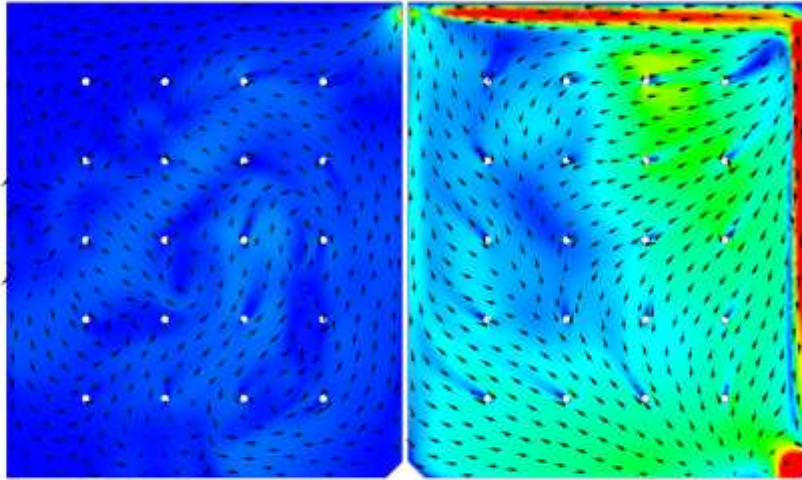
CFD Analysis: Tank geometry

Oblique View Showing Columns and fill/drain pipes



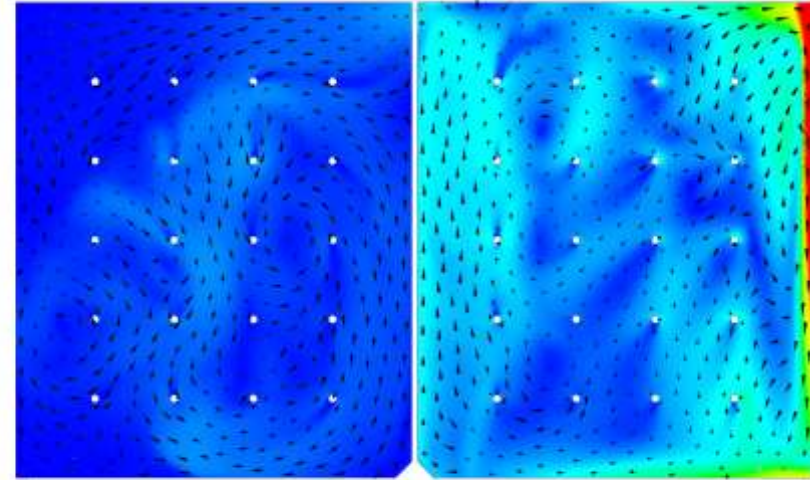
CFD Results: 18 ft fill, Plan View Velocity

Velocity
0.06
0.04
0.03
0.01
0.00
[ft s⁻¹]



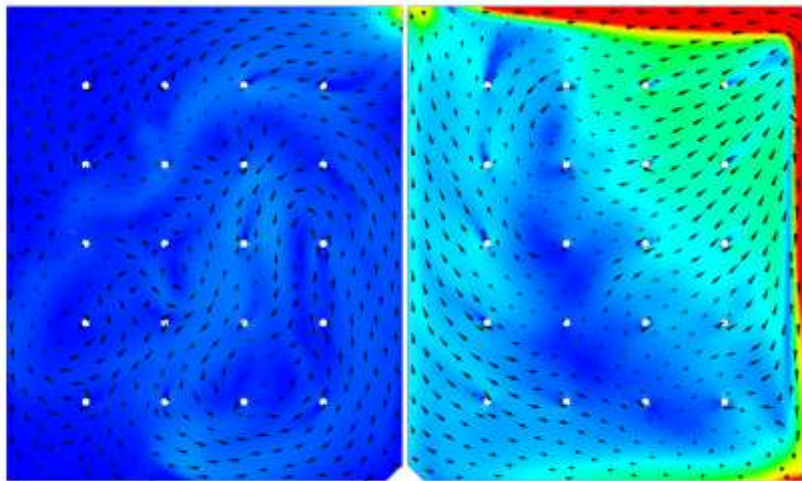
5290

Velocity
0.06
0.04
0.03
0.01
0.00
[ft s⁻¹]



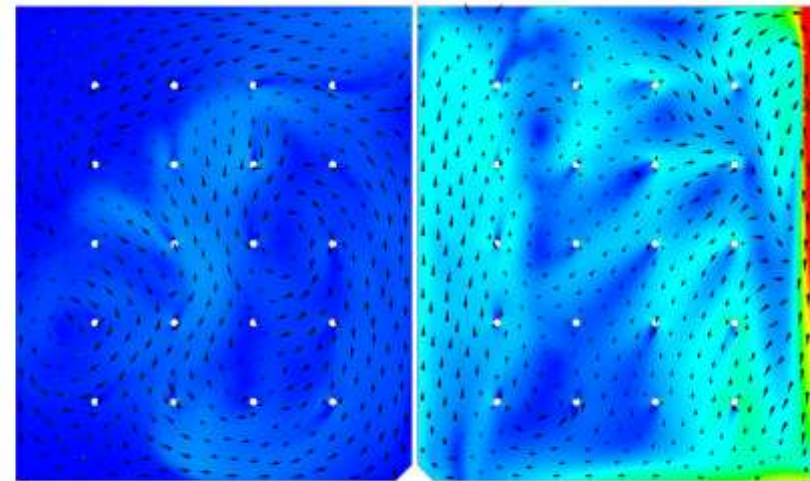
5295

Velocity
0.06
0.04
0.03
0.01
0.00
[ft s⁻¹]



5300

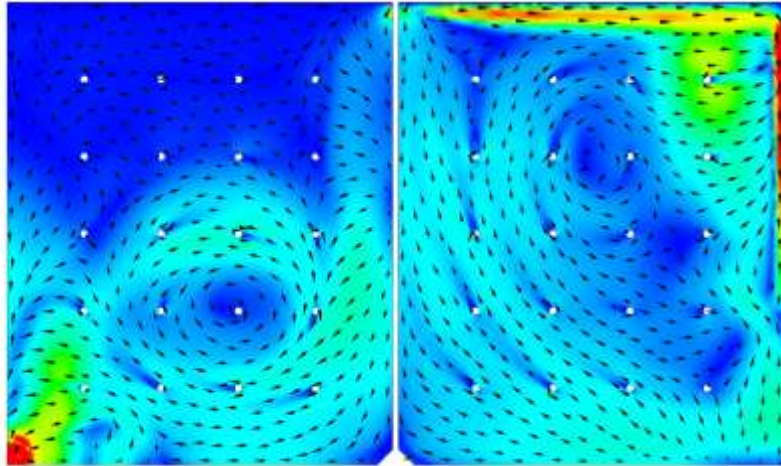
Velocity
0.06
0.04
0.03
0.01
0.00
[ft s⁻¹]



5305

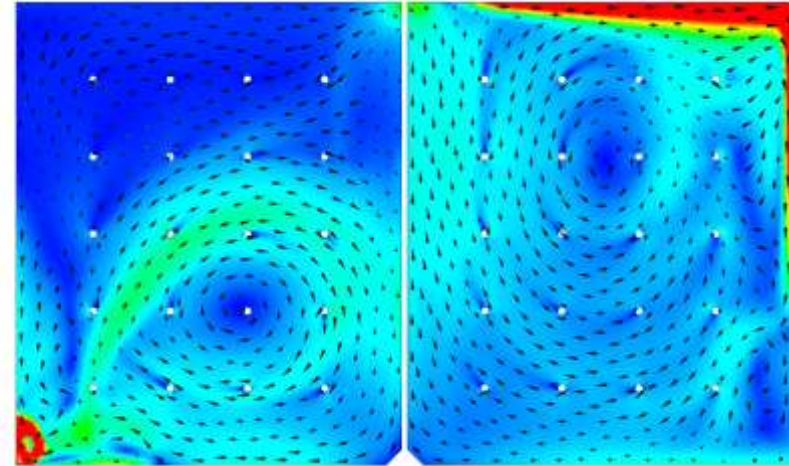
CFD Results: 12 ft fill, Plan View Velocity

Velocity
0.06
0.04
0.03
0.01
0.00
[ft s⁻¹]



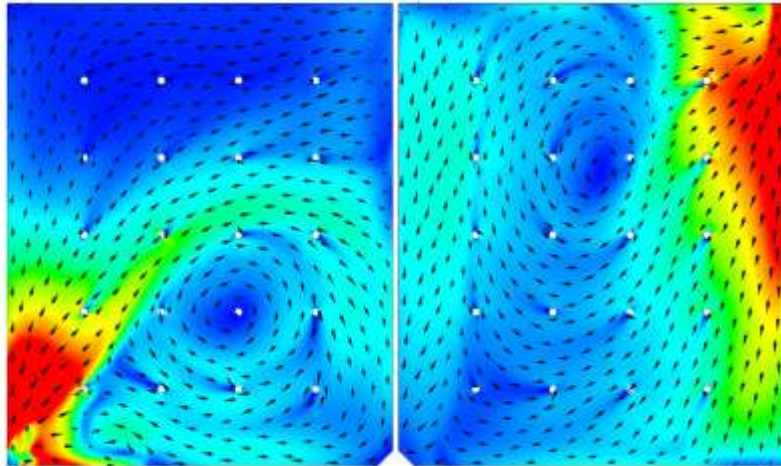
5290

Velocity
0.06
0.04
0.03
0.01
0.00
[ft s⁻¹]



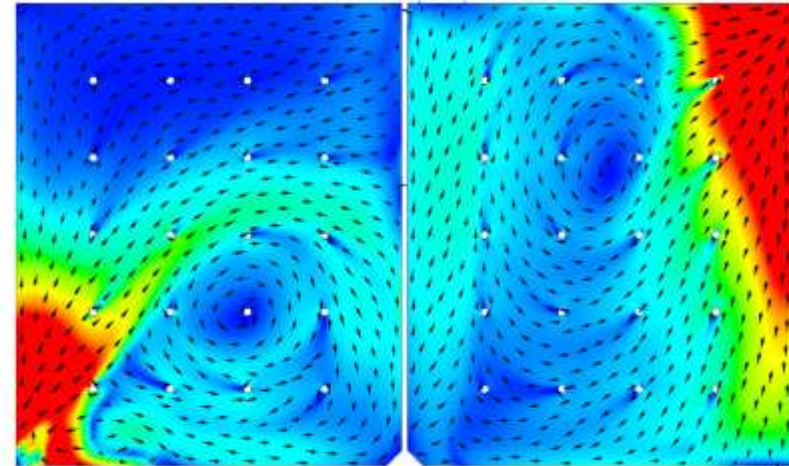
5295

Velocity
0.06
0.04
0.03
0.01
0.00
[ft s⁻¹]



5300

Velocity
0.06
0.04
0.03
0.01
0.00
[ft s⁻¹]



5305

CFD Analysis

- Some benefit for operating at lower level
- Additional improvement could be gained with infrastructure upgrades
 - Additional point for tank discharge
- Operation of one side of tank during low demand

Recommendations

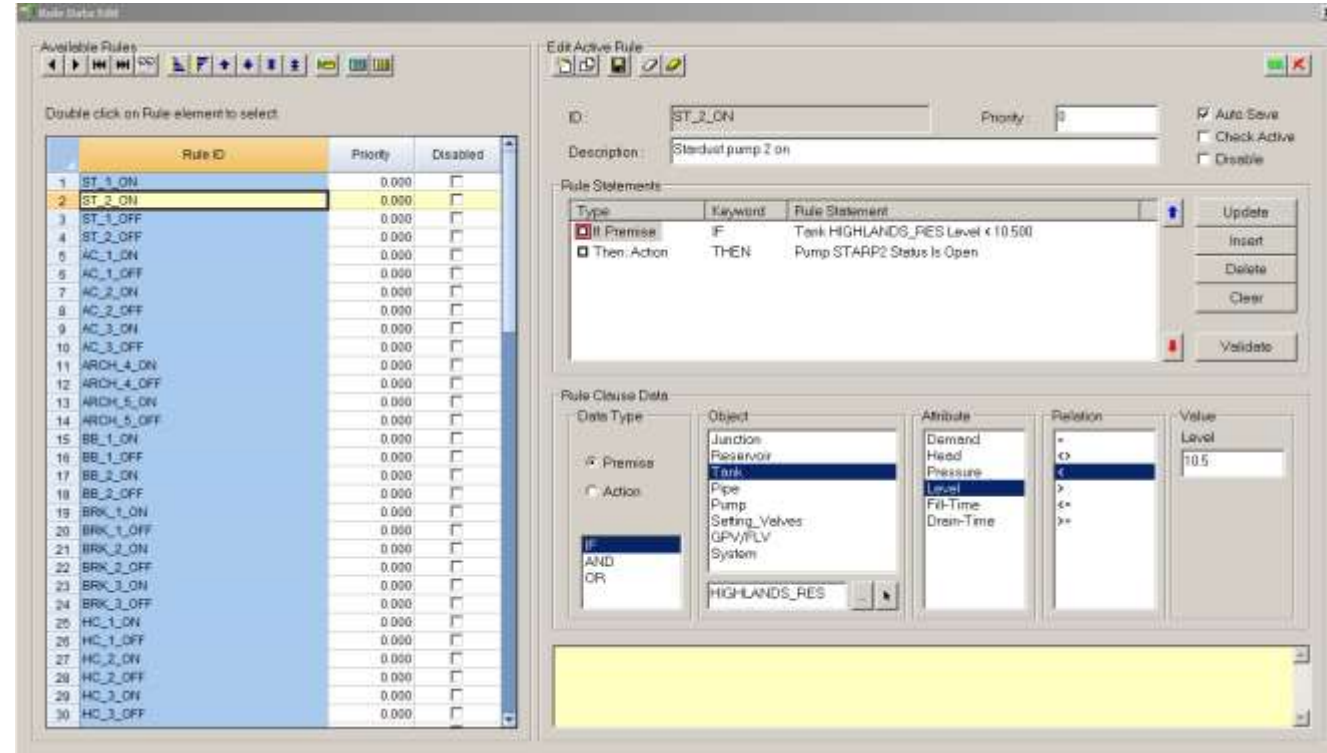
- Implement operating controls to rotate pump operation
 - Time of day controls for energy management
- Operate Tank at Lower Level
 - Sufficient storage maintained at low level, especially in shoulder season and low demand time
- Develop operating protocol for target discharge pressures when tank is out of service
 - Prevent main breaks

How to get started with an operational model

- Build hydraulic model
 - GIS or best available information to capture accurate information
- Allocate demand based upon meter locations and records
 - Demand drives the model performance and water flow through the system
- Engage Operations staff to build confidence in the model
 - Realistic operation for “normal” conditions plus those unique scenarios

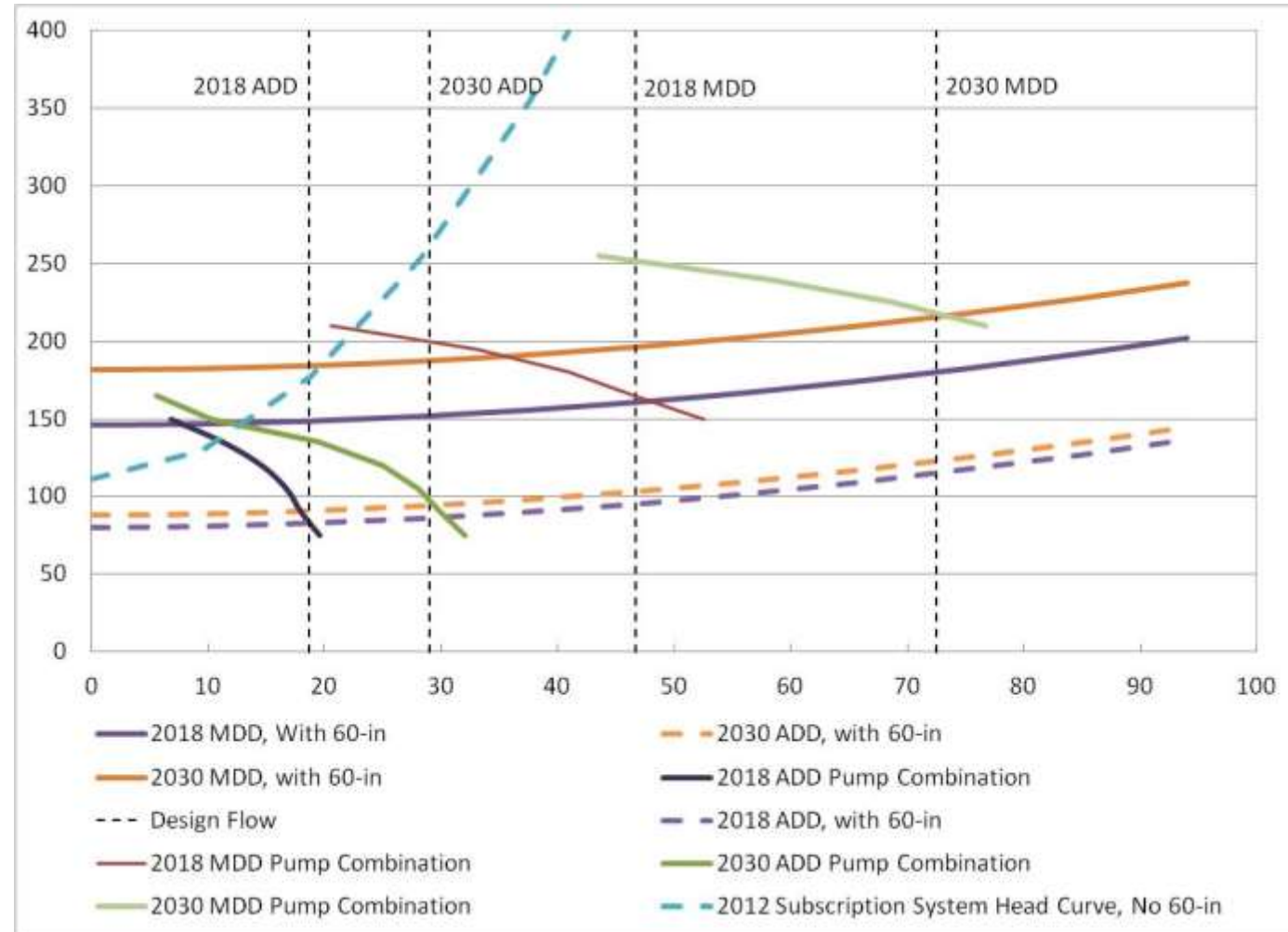
How to get started with an operational model

- Develop controls that simulate operation
 - Automated controls
 - Operator governed controls
- Calibrate model under EPS conditions
 - Flow
 - Pressure
 - Tank Level
- Assess/validate model for range of demand conditions
 - Confidence in performance for *any* situation
- User friendly tool **with detailed documentation** so others can pick it up and duplicate results



What you can use your model for.....

- Evaluating changes in operation
 - Improvements
 - Impacts
- Evaluating new facilities and setting desired operating points
 - Pump Operating Envelope
 - VFD Settings
 - PRV Settings (zone balancing)
- Water Quality
 - Water age as a water quality indicator
 - Chlorine residual, using bulk and wall decay information developed for **your** system



Thank You!

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