City of Portland Water Bureau

1.3 MG Forest Park Low Tank

Presented by
Matt Hickey

Killing Two Birds with One Stone

Improving Water Quality with a New Reservoir

Project Team

- **Owner –** Portland Water Bureau
- **Prime Consultant –** Murray, Smith & Associates, Inc.
- **CFD Modeling** -- MWH
- **Structural Engineer –** Peterson Structural Engineers, Inc.
- **Prime Contractor –** Emery & Sons/Marion Construction
- **Tank Prestressor –** DN Tanks

MSA

PSE
Peterson Structural Engineers, Inc.

PORTLAND WATER BUREAU
FROM FOREST TO FAUCET

MWH

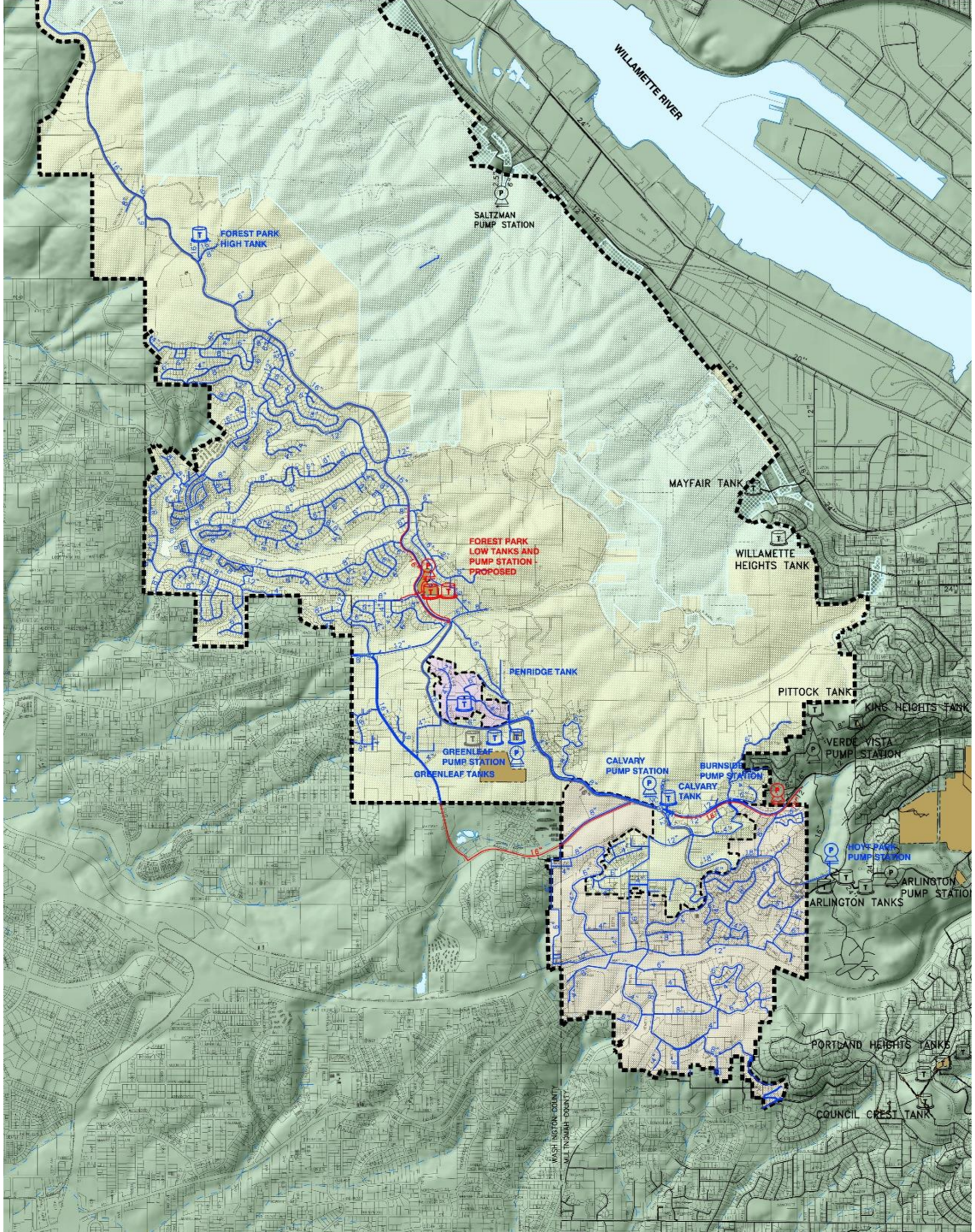
Emery & Sons Construction, Inc.
General Contractors
Underground Specialists

MARION CONSTRUCTION

DN TANKS

Presentation

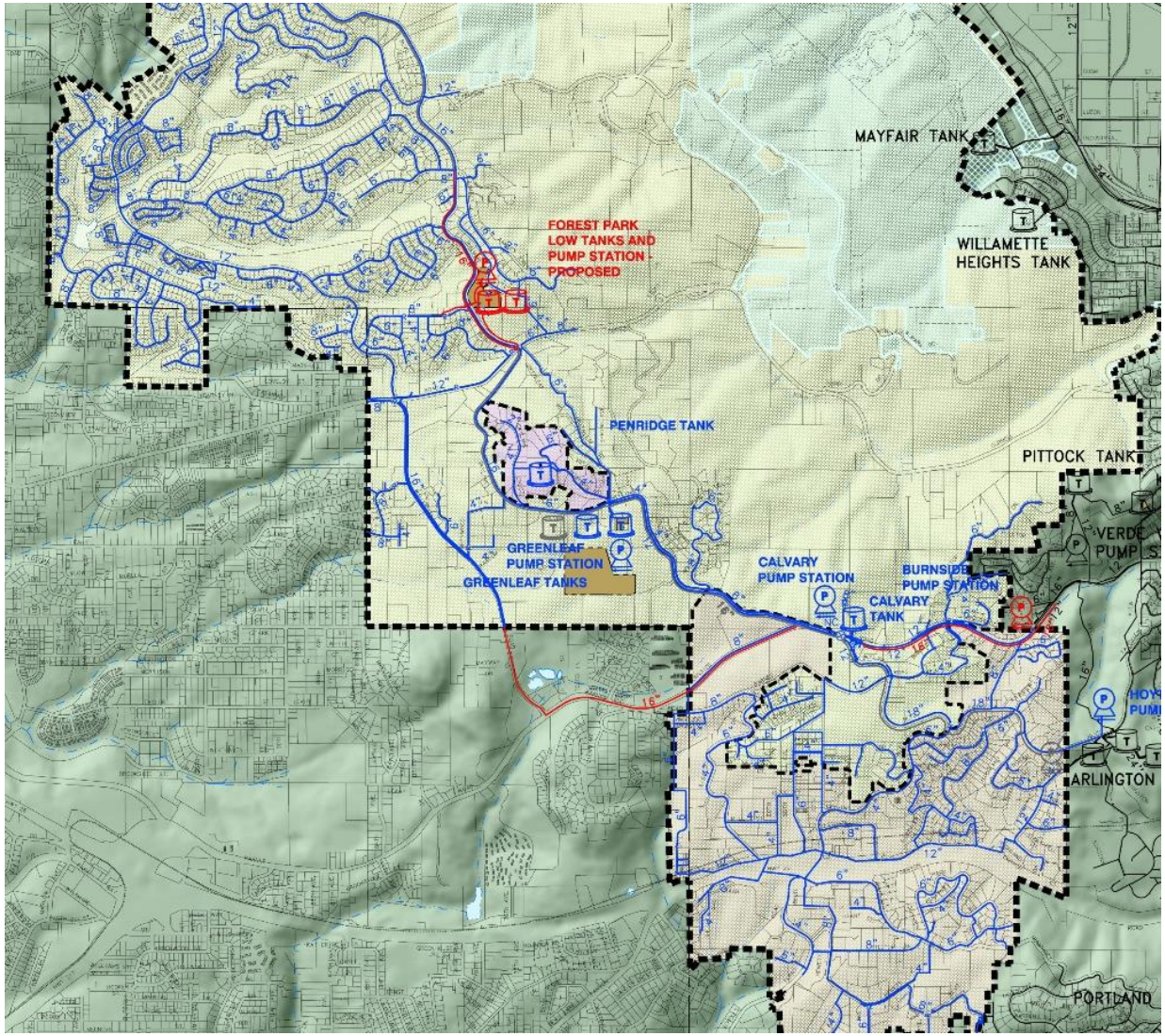
Outline



Project Background

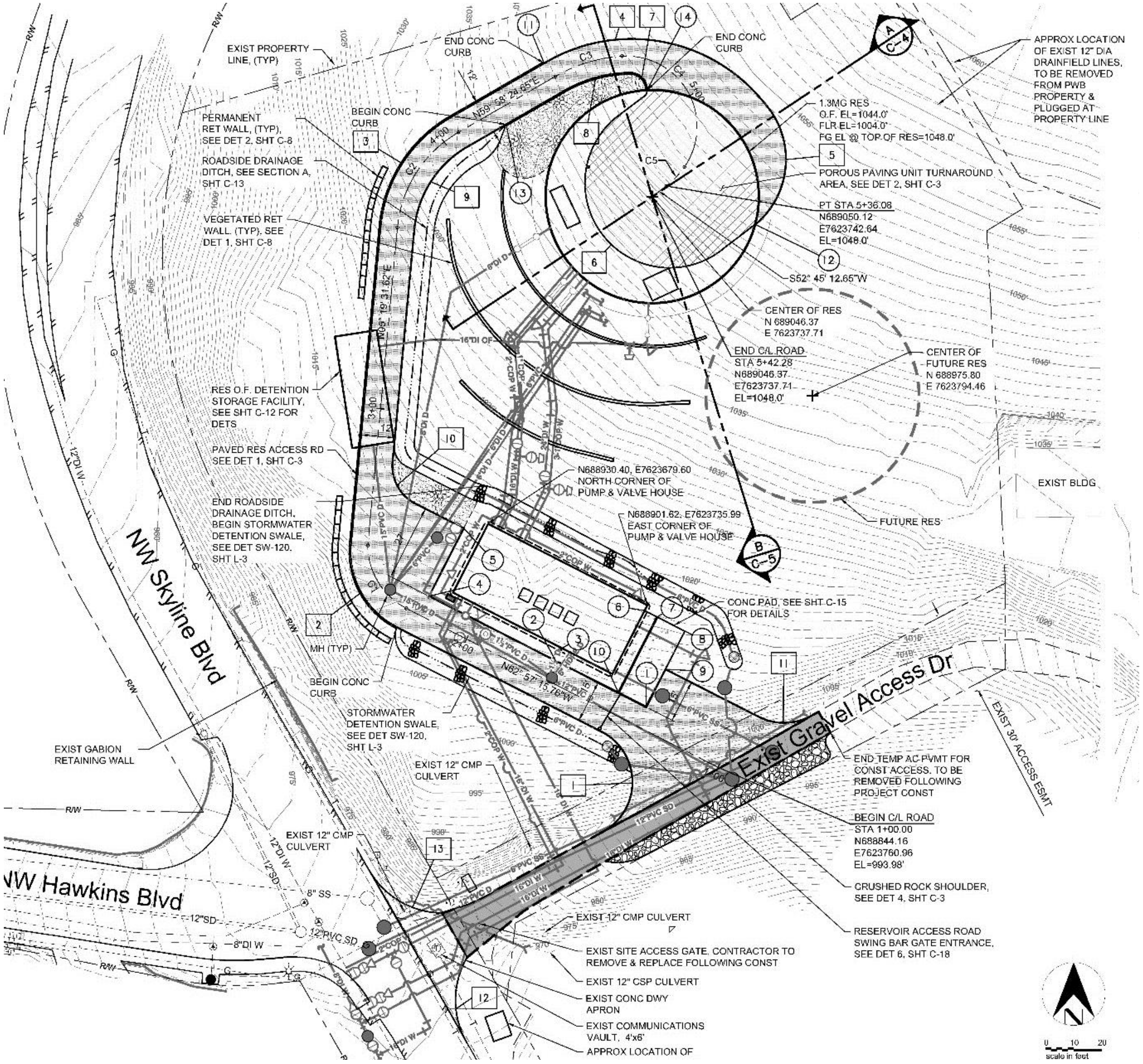
- Studies, 1987, 1992, 2007
- Additional storage
- Reduce pumping frequency
- Improve system pressures
- Redundancy
- Flexibility
- 2.6 MG needed

History - Siting



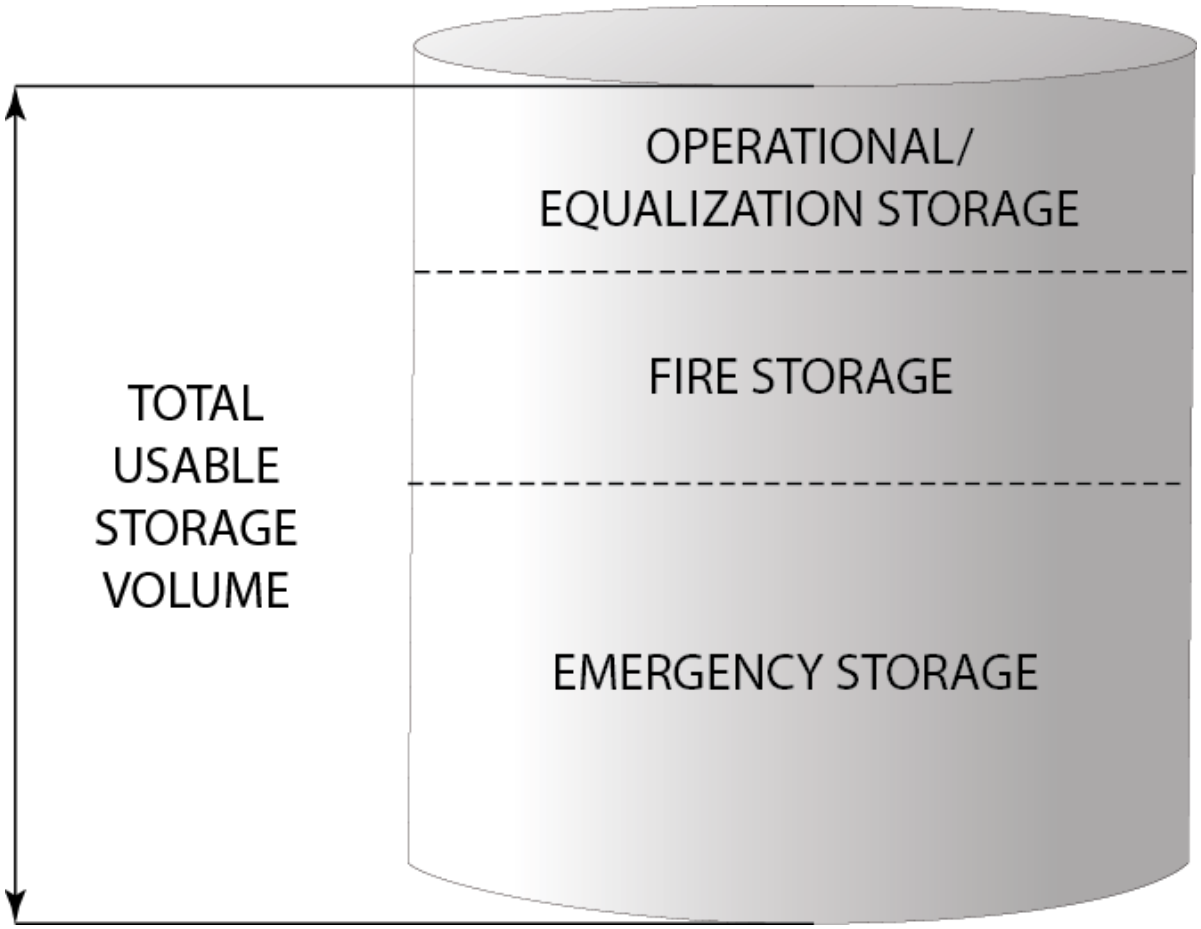
- Number of sites identified
- Alternatives analysis
- Condemnation process
- Purchased in 2003

Project Description



- 1.3 MG prestressed concrete, fully-buried reservoir
- Pump station building for future 3,300 GPM pumps
- Site piping
- Access road
- Drainage facilities
- In scenic overlay area in Northwest Skyline Road

Considerations in developing new storage

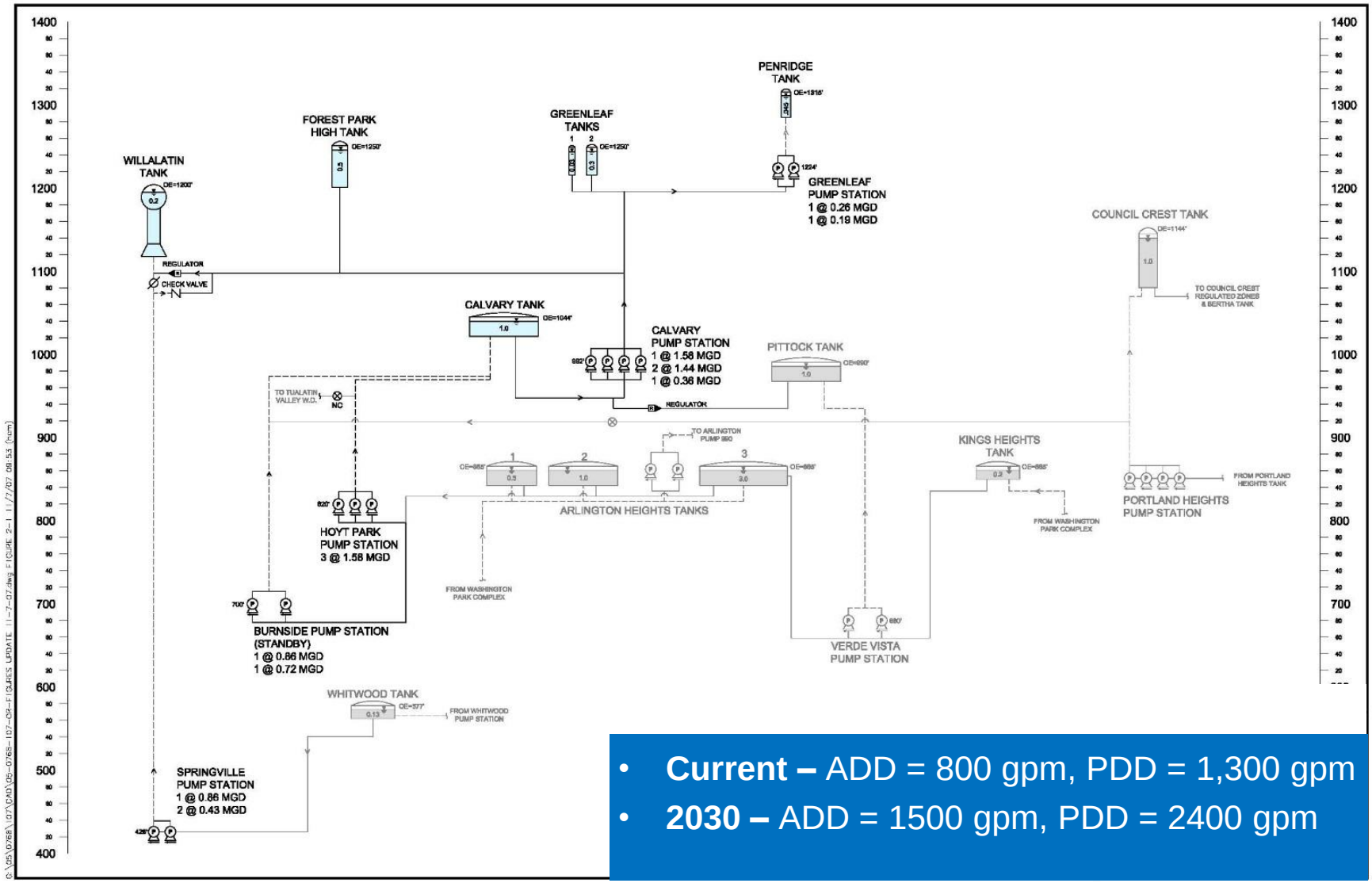


- Fire flow
- Maintain or improve water quality
- Improve system pressures
- Address seismic risk
- Reduce pumping to the zone

Design Criteria

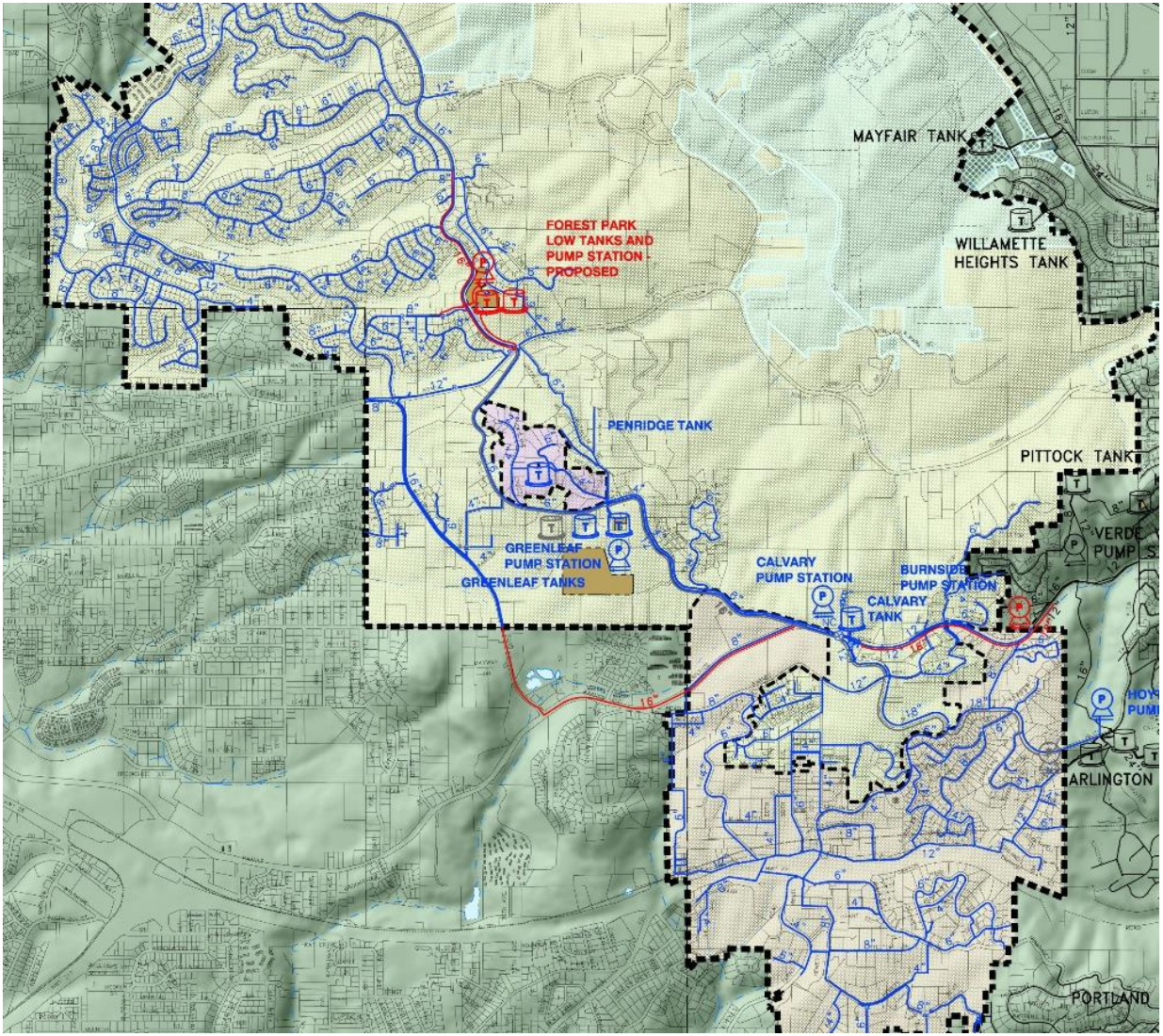
- Match Mt. Calvary Tank 1044 overflow elevation
- Round for mixing, water quality, and cost
- Round for seismic performance
- Fully buried to minimize visual impacts
- Screening improvements due to scenic overlay

Existing System Operations



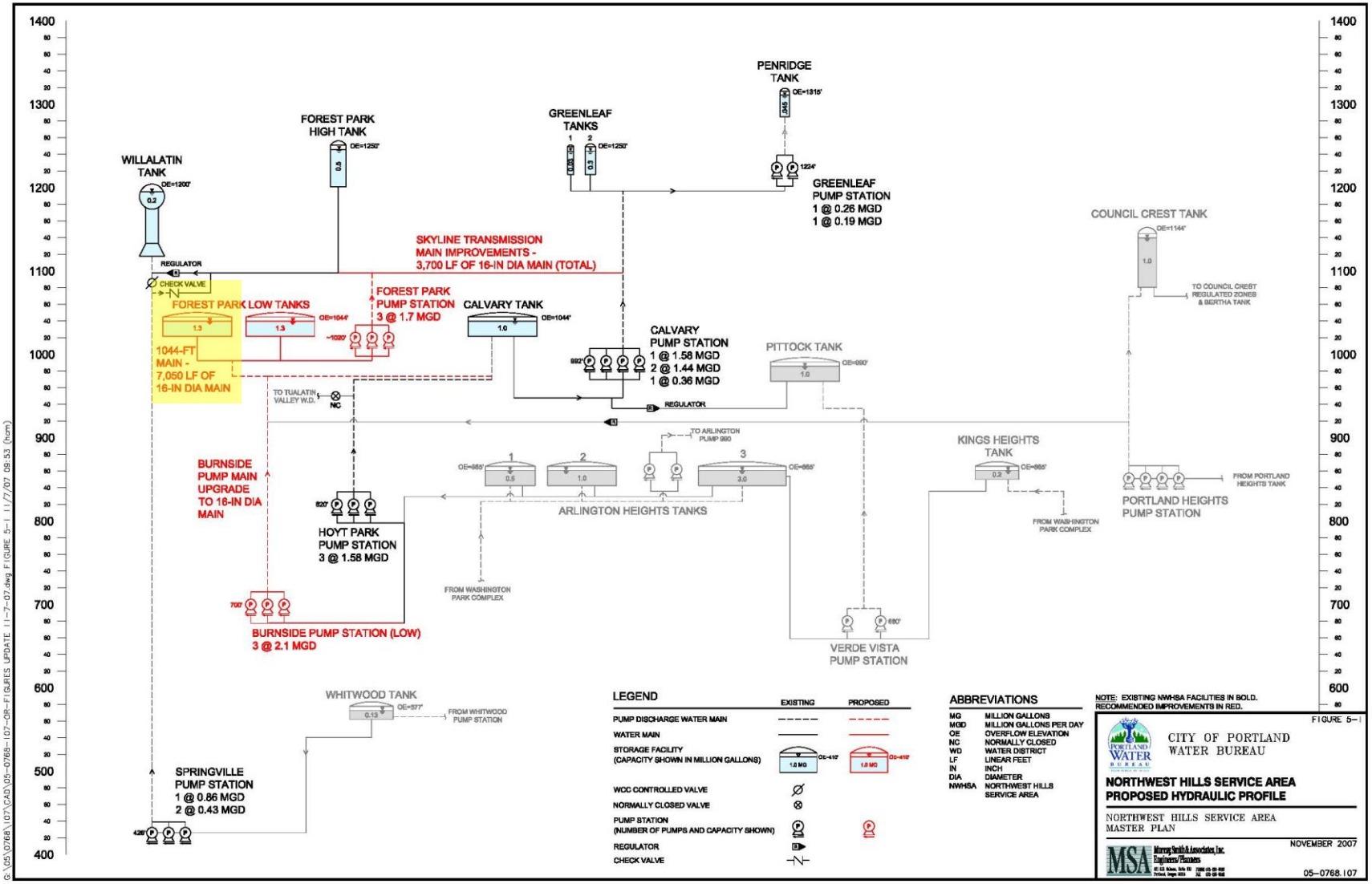
- **Current –** ADD = 800 gpm, PDD = 1,300 gpm
- **2030 –** ADD = 1500 gpm, PDD = 2400 gpm

Hydraulic & Operational Analysis

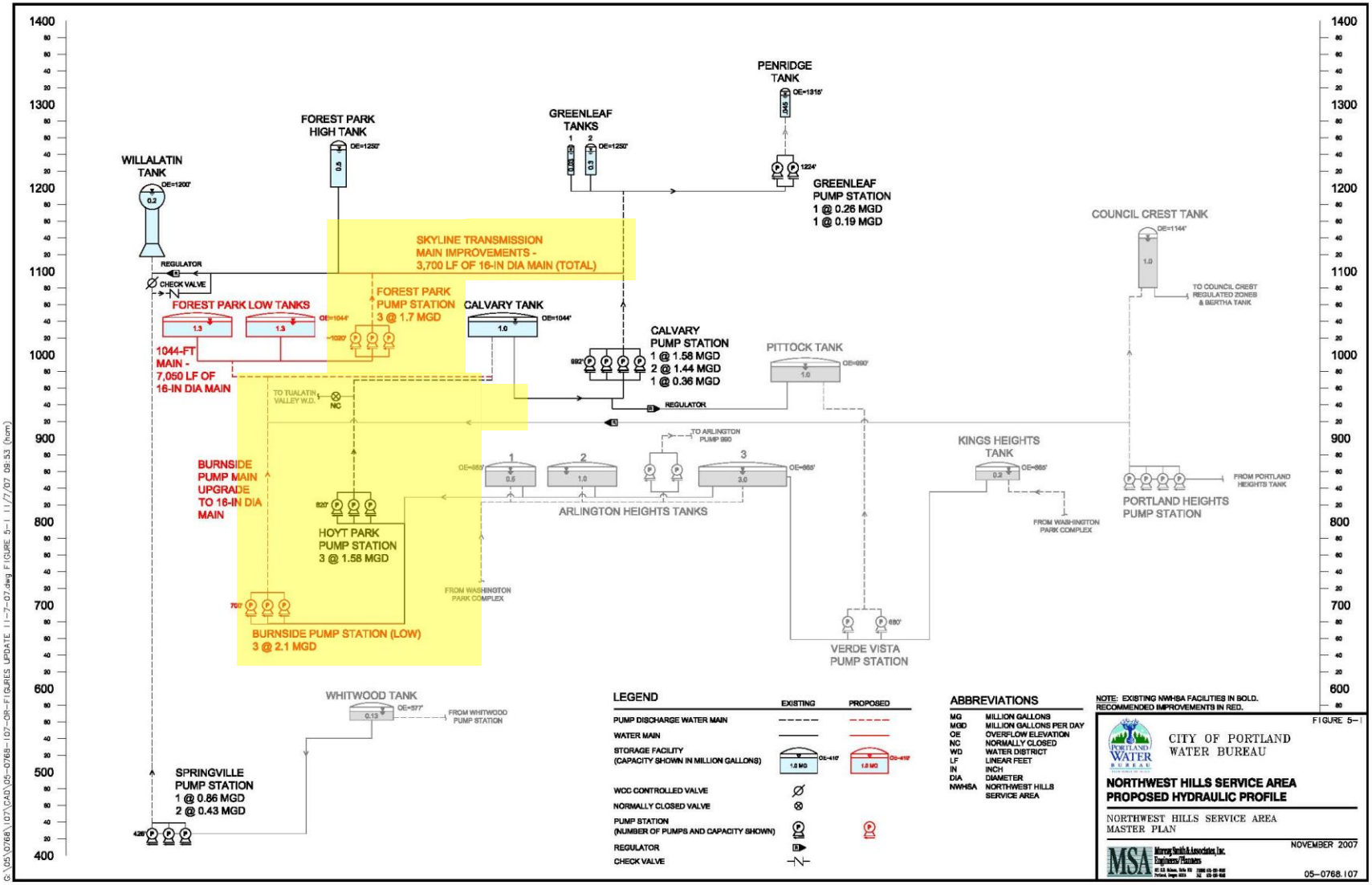


- Flow rates & demands
- Operating modes
- Water age
- CI residual
- Storage need
- Supply to tank

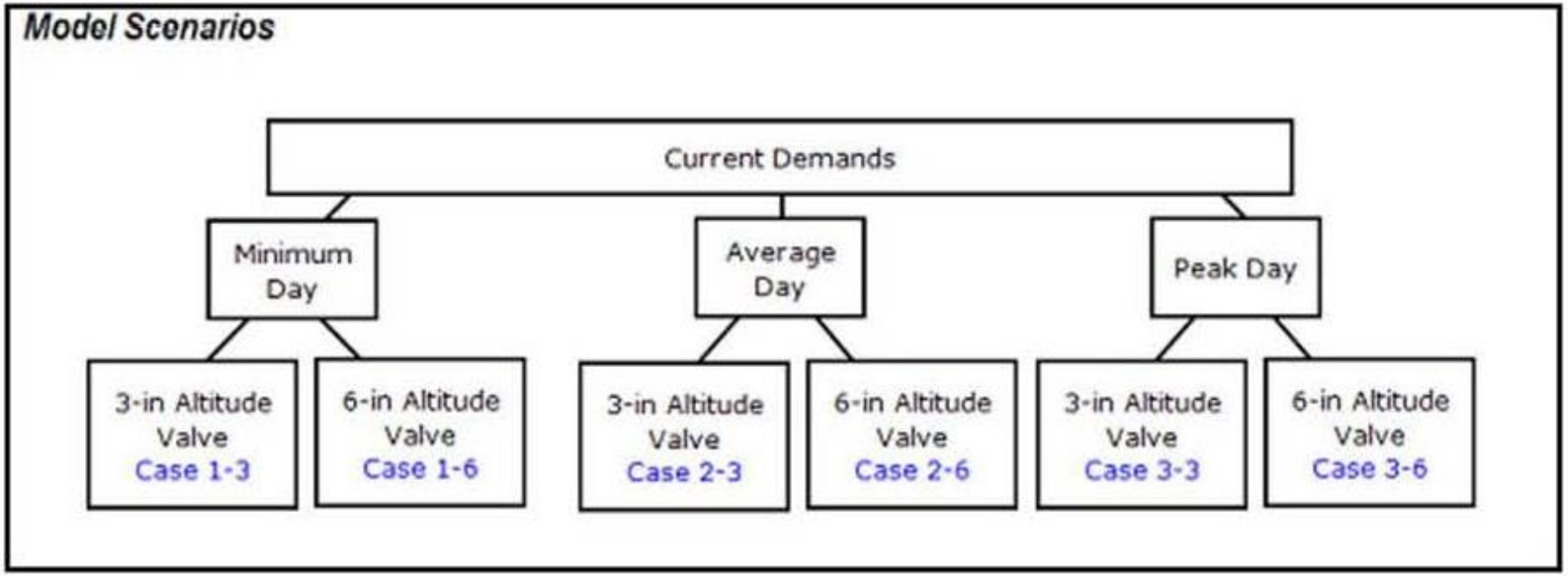
Proposed Upgrades



Hydraulic analysis – Future upgrades



Hydraulic System Analysis



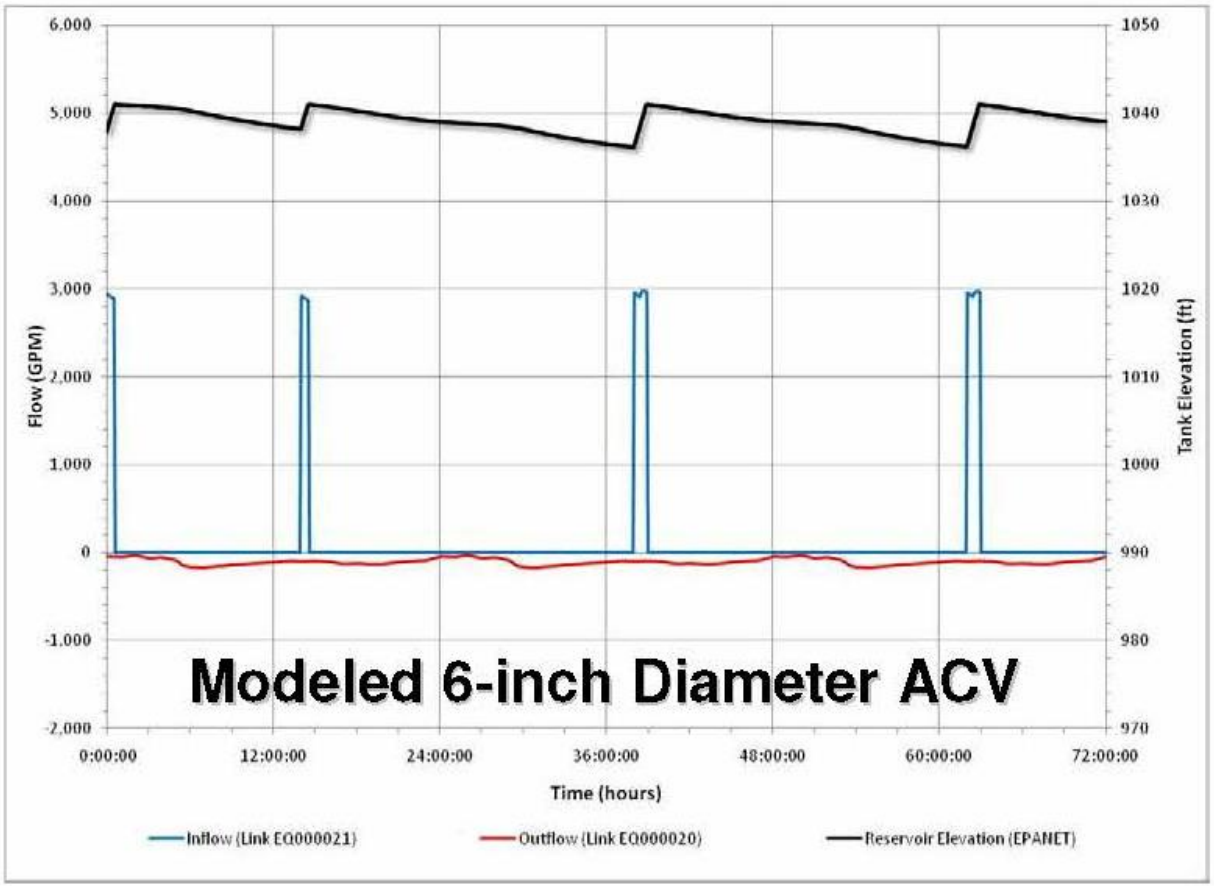
- More specific modeling scenarios
- Modeling to support CFD modeling
- Water quality considered throughout

Modeling Criteria & Scenarios

12-Inch Transmission Line Hydraulics Flow and Stage Summary

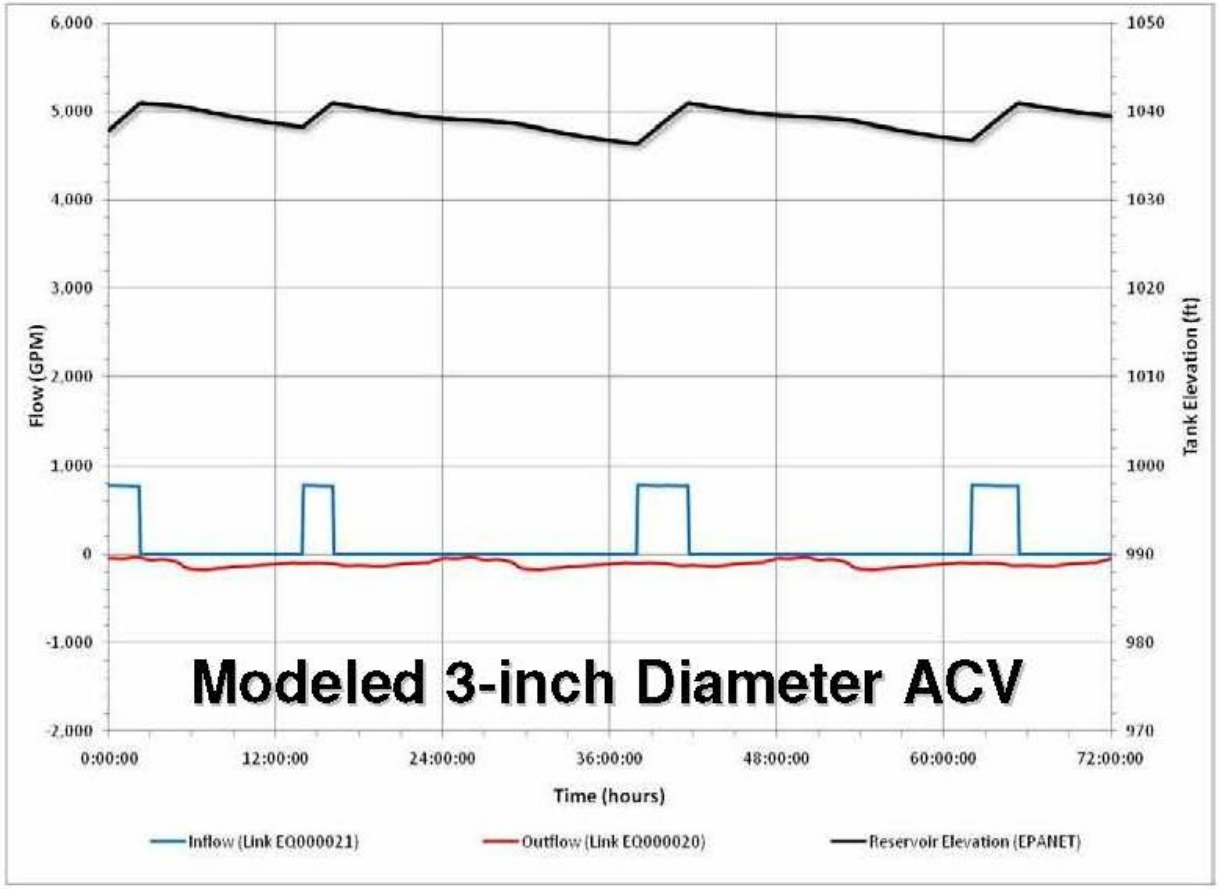
	Minimum Day Demand		Average Day Demand		Peak Day Demand	
	3-in ACV	6-in ACV	3-in ACV	6-in ACV	3-in ACV	6-in ACV
CFD Case ID	1-3	1-6	2-3	2-6	3-3	3-6
Sample Period (hrs)	72	72	72	72	72	72
Operational Scenario ID	1-3	1-6	2-3	2-6	3-3	3-6
Minimum Inflow Rate (gpm)	0	0	0	0	0	0
Maximum Inflow Rate (gpm)	787	2,983	795	2,993	786	3,013
Average Fill Time (hrs)	3.0	0.8	3.9	1.0	7.4	1.8
Average Drain Time (hrs)	17.8	19.8	17.2	19.7	14.5	19.1
# Fill/Drain (FD) Cycles (per day)	0.9	0.9	0.9	0.9	0.9	0.9
Minimum Tank Level (ft)	1,036.4	1,036.1	1,035.0	1,034.6	1,031.6	1,029.8
Maximum Tank Level (ft)	1,041.0	1,041.0	1,041.0	1,041.0	1,041.0	1,041.0
Tank Drawdown (%/FD cycle)	12.2	13.0	15.8	16.9	24.8	29.5

Modeling Scenarios – 6-inch valve simulation

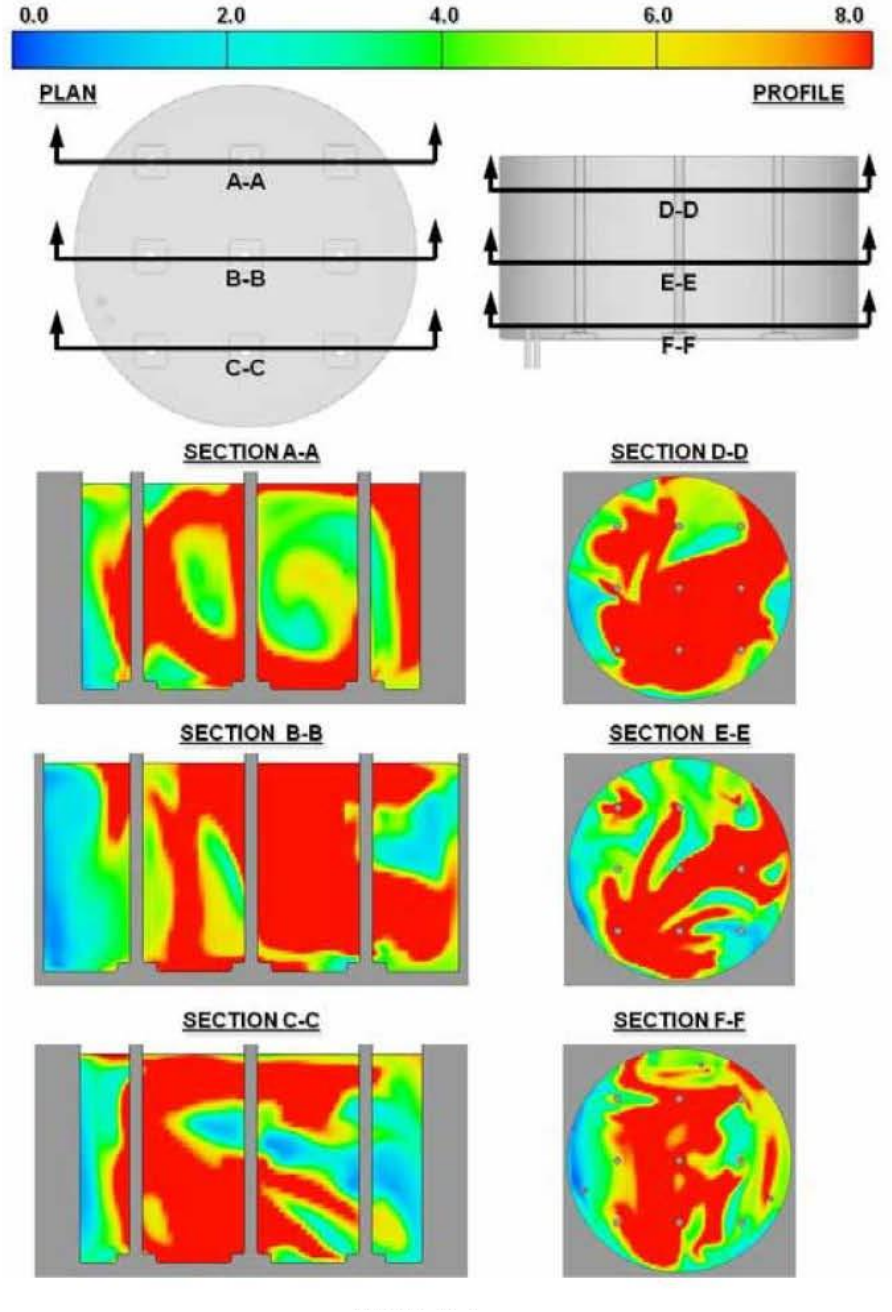


- Faster fill
- Lower transmission main pressures
- Forest Park High Tank never fills
- More pumps run to fill

Modeling Scenarios – 3-inch valve simulation



- Slower fill
- Better pressures in transmission main
- ACV opens at 2:00 each day
- Pump stations run of other tanks not based on Forest Park Low Tank

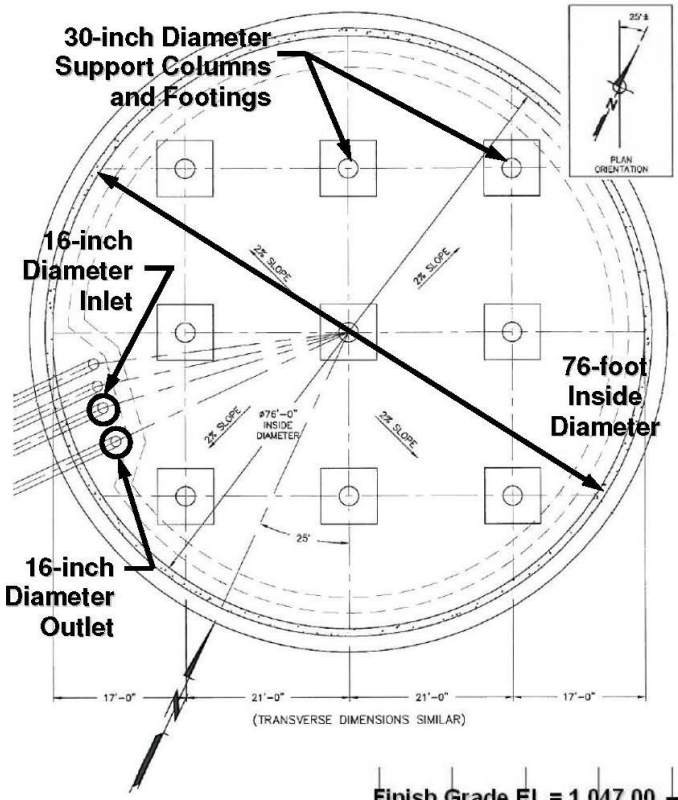


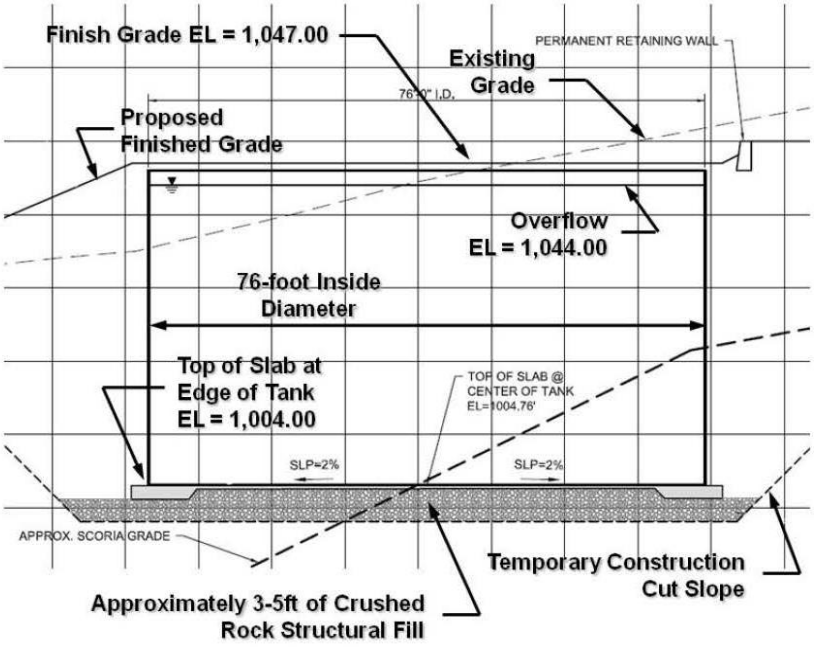
Goals for CFD modeling

- Flow & velocity distribution
- Turnover
- Eliminate stratification
- Determine average water age
- Evaluate operations
- Identify inlet layout
- Minimize short circuiting
- Minimize decay of chloramines and chlorine

Basis for CFD modeling

- Current and 2030 demands
- Assumed isothermal conditions – buried tank
- Tank configuration considerations
- Completely mixing contents

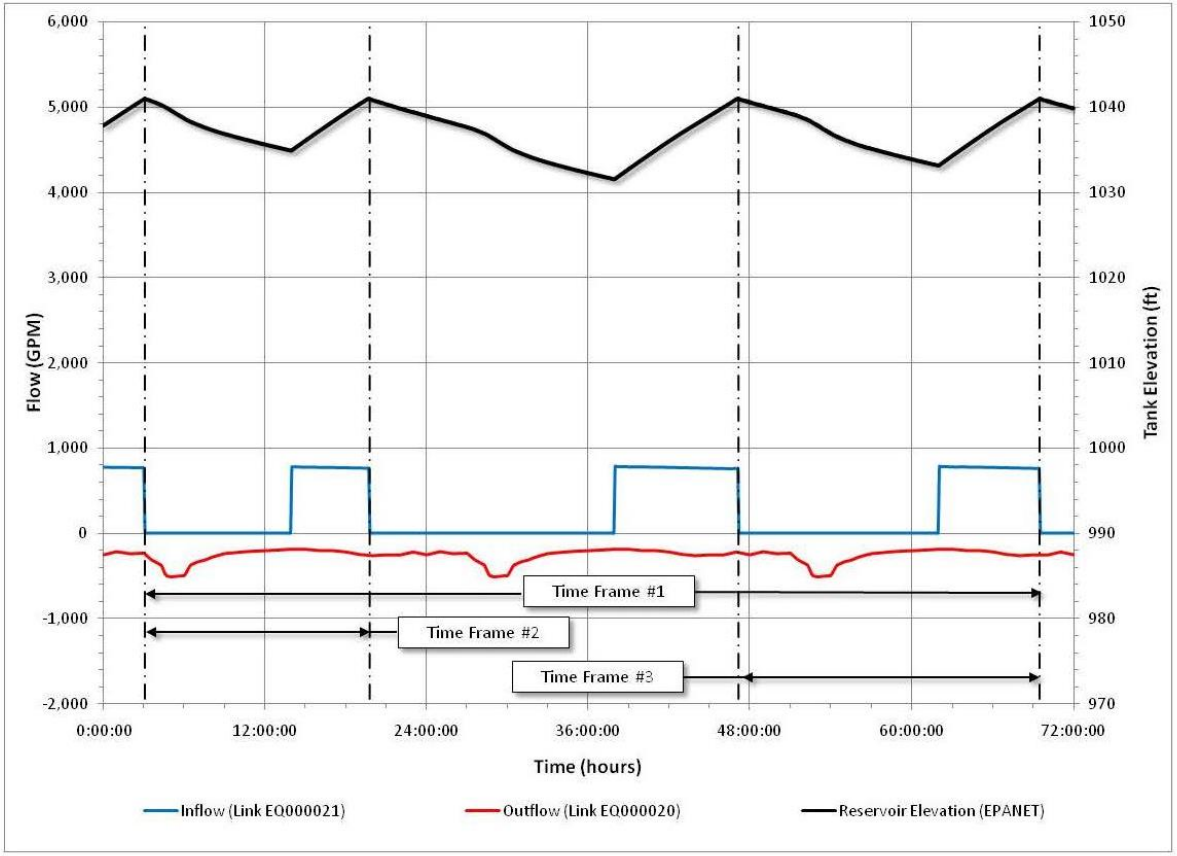




Use the “momentum”

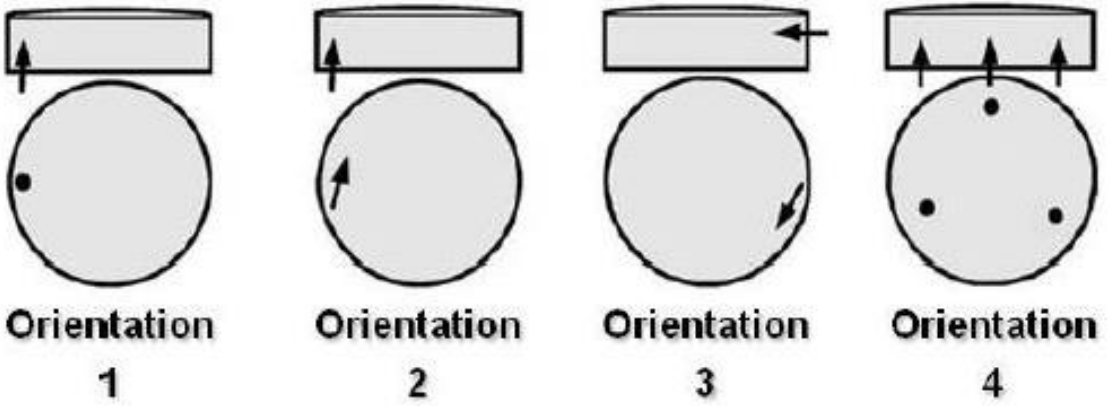
Basis for CFD modeling

- Passive mixing system
- Multiple inlet ports
- Momentum over 20 $ft.^4/s^2$

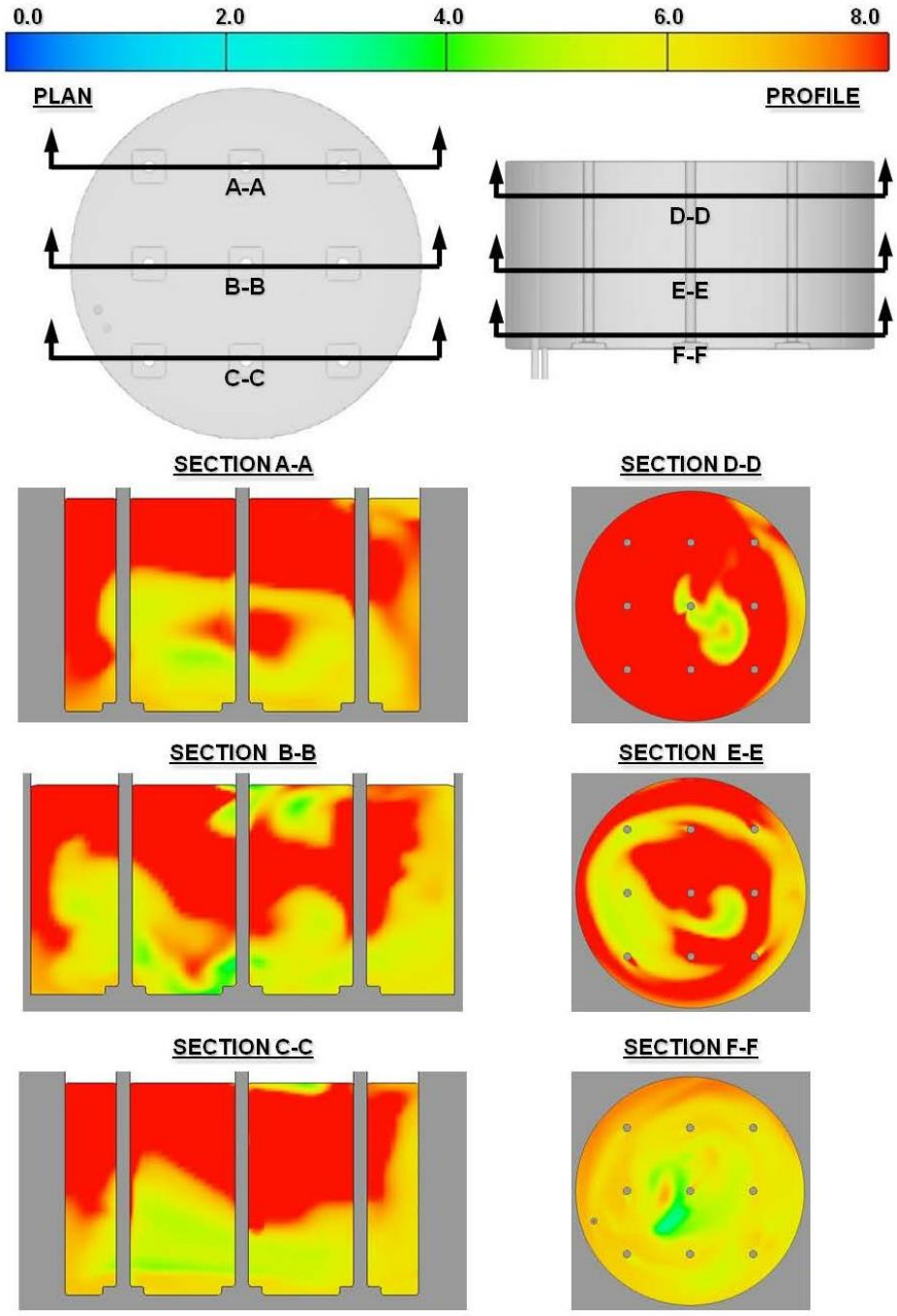


Sir Mix-A-Lot

Mixing System Configuration



- Initial layouts developed
- Initial sensitivity analysis conducted
- Two likely options selected
  - **Option 1 (Orientation 1):** Single vertical inlet near the wall
  - **Option 2 (Orientation 4):** 3 inlets oriented 120 degrees apart

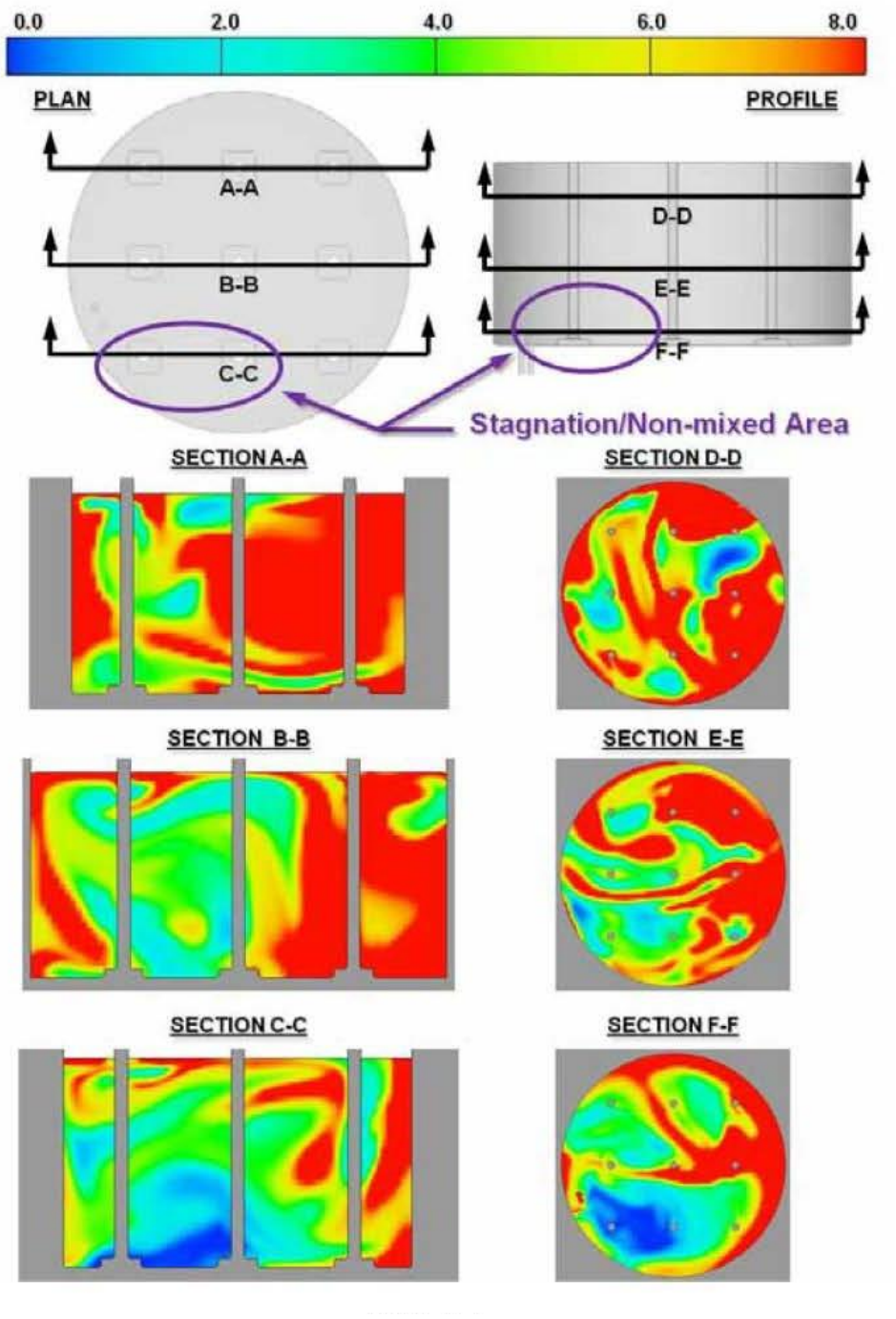


CFD results – thoroughly mixed

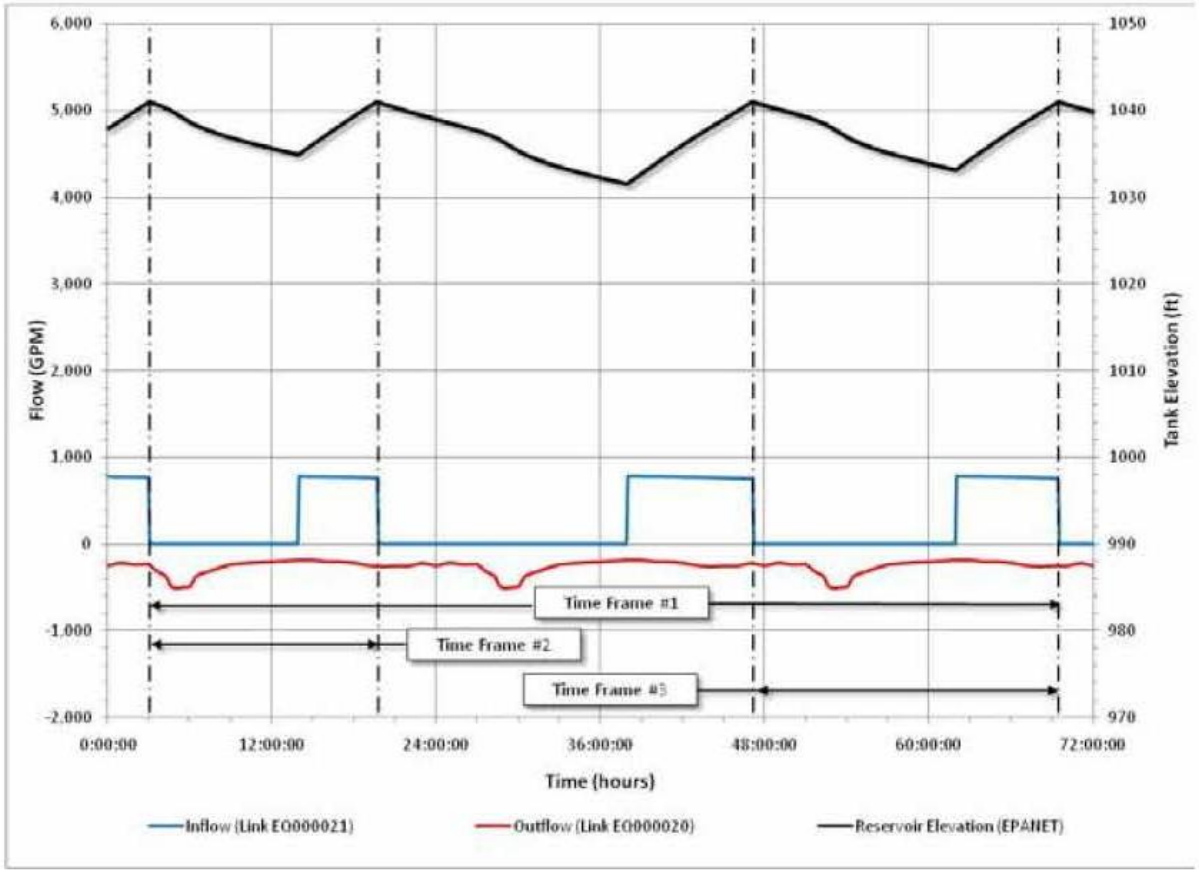
- 6-inch nozzle
- No dead zones
- No short circuiting
- No additional mixing devices needed
- Conducted sensitivity analysis

CFD results – not completely mixed

- 16-inch nozzle
- Lower degree of mixing
- Some dead spots

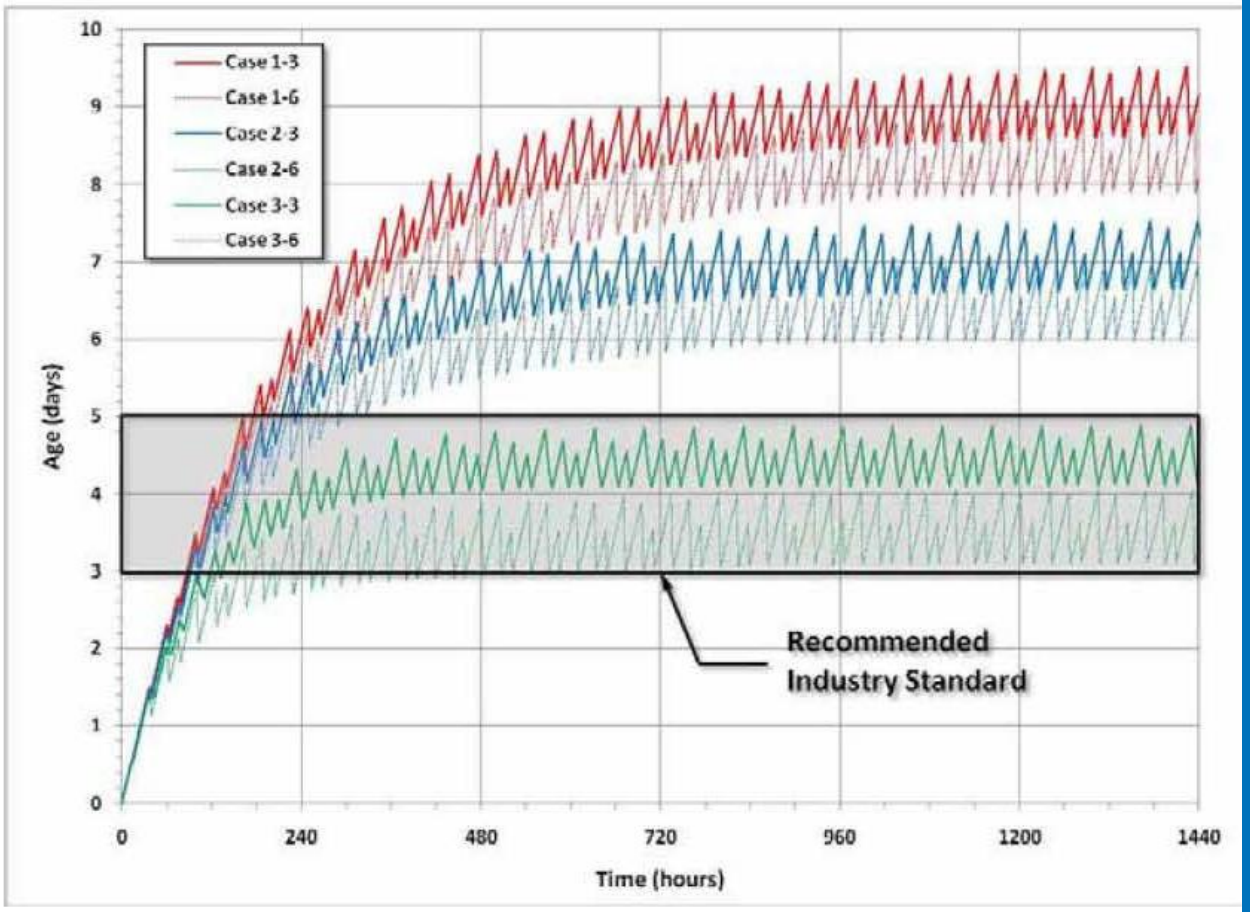


Tank turnover analysis – 3-inch ACV Simulation



- 12-16% for minimum demand and ADD
- 19-24% for PDD
- Guidelines 20-25%
- Short circuiting can still be an issue (last in - first out)

Water age analysis

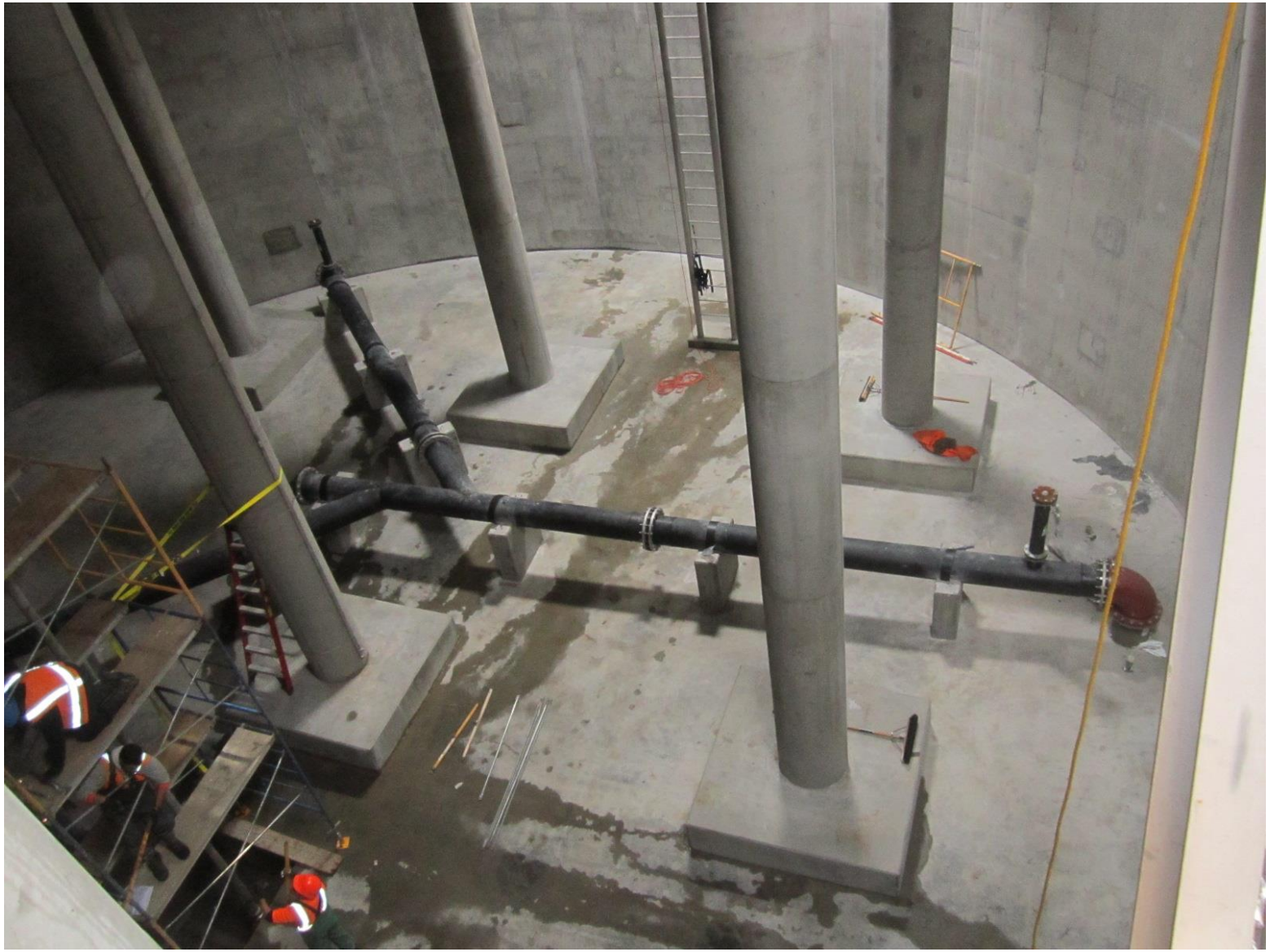


- Indicator of water quality
- Appropriate water age based on a number of variables
- 3-9 days ADD
- 3-5 days PDD
- Guidelines
  3-5 days
- Uniform water age if completely mixed

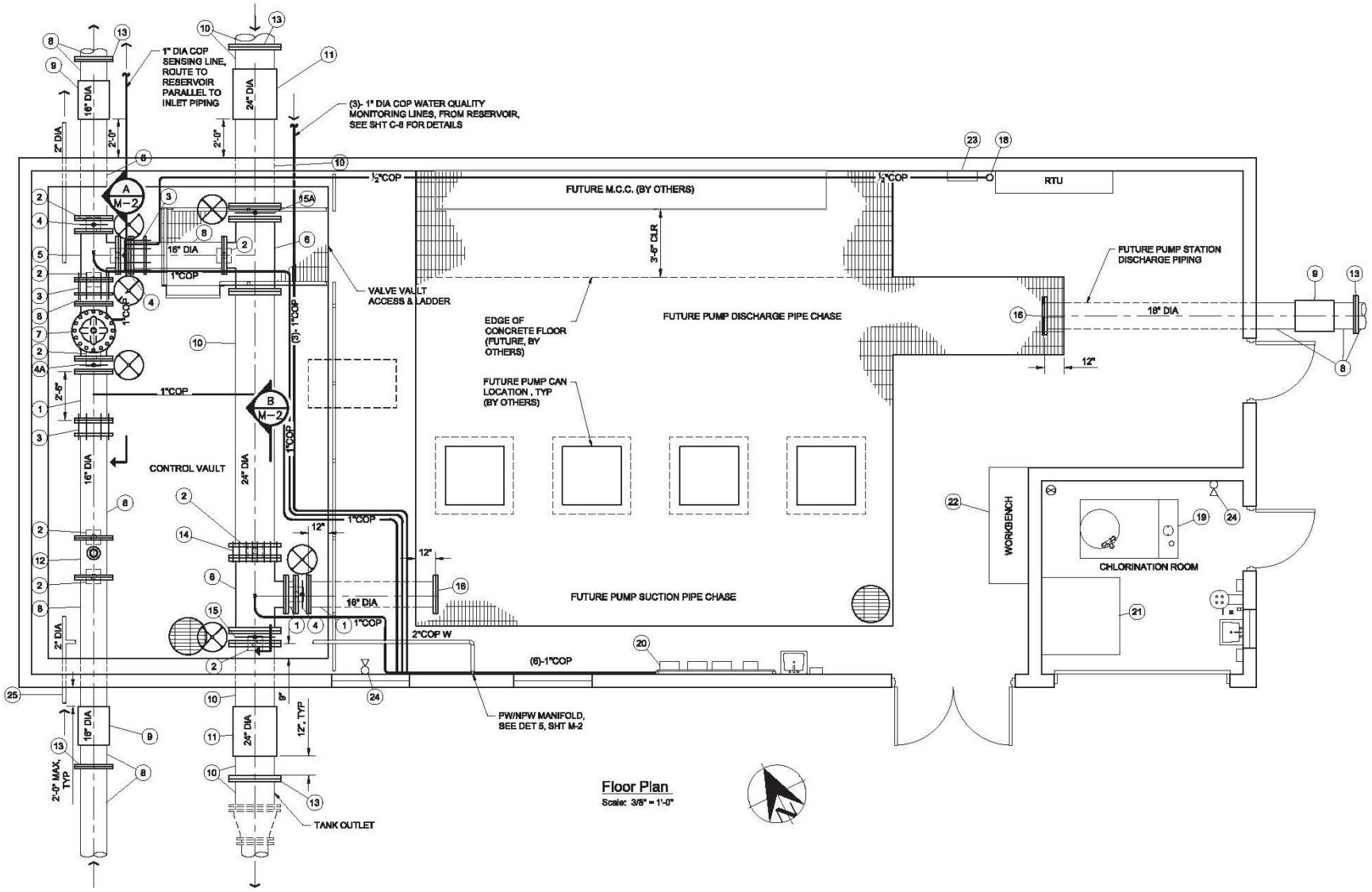
Recommendations – Chlorine monitoring & boosting

Reservoir configuration

Mixing system configuration



Site piping & valving configuration



Project challenges

Geotechnical conditions

Booster pump station

- Fully buried reservoir minimizes visual impacts
- Design minimizes stormwater run-off
- Stormwater treatment
- Partially buried pump station
- Drivable access to the top of the tank

That’s a wrap!

- Consider water quality when adding storage
- Siting, operations, sizing, and tank configuration
- Analysis needed
- Proper design and operations impact water quality

Q & A