How to Fix the Water Pressure for a Subdivision Built Next to a Ground Storage Tank

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Jeremy Cook, P.E. URS Corporation

Lance Livesay, City of Fairborn

One Water

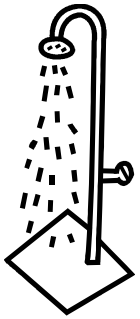
Rona Hills Tank

- Built in 1970; last painted in 1993; last inspected in 2003
- 2 million gallon ground storage tank
- Located at an elevation of approximately 1000’
- Well-suited to serve the city’s average elevation of 837’
- Nearby condominium complex slightly downhill of the tank had historical pressure of about 40 psi

- 80 ft in diameter
- 54 ft SWD

New Growth

- In the late 1990's/early 2000's, the area started to experience new residential growth
- Homes were being located closer and closer to the tank
- Upscale homes with two to three levels, multiple bathrooms, and other water using devices
- Pressure at the street met OEPA requirements but not the aesthetic desires of the customers



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Finding a Solution

- The 2003 Master Plan outlined a recommendation to establish a new high pressure zone
- Project was added to the city's capital improvement plan
- In 2007, URS was hired to evaluate and later to design the Rona Village Area High Pressure Zone
- The City also needed to replace the Kauffman Ave Sewage Pump Station. URS designed both projects to be bid as one package to reduce construction administration costs.

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NEW KAUFFMAN AVE PS
EX. KAUFFMAN AVE PS
Wright-Patterson Air Force Base
W Lindberg Dr
Kauffman Ave
W Parkwood Dr
S Central Av
RONA BPS

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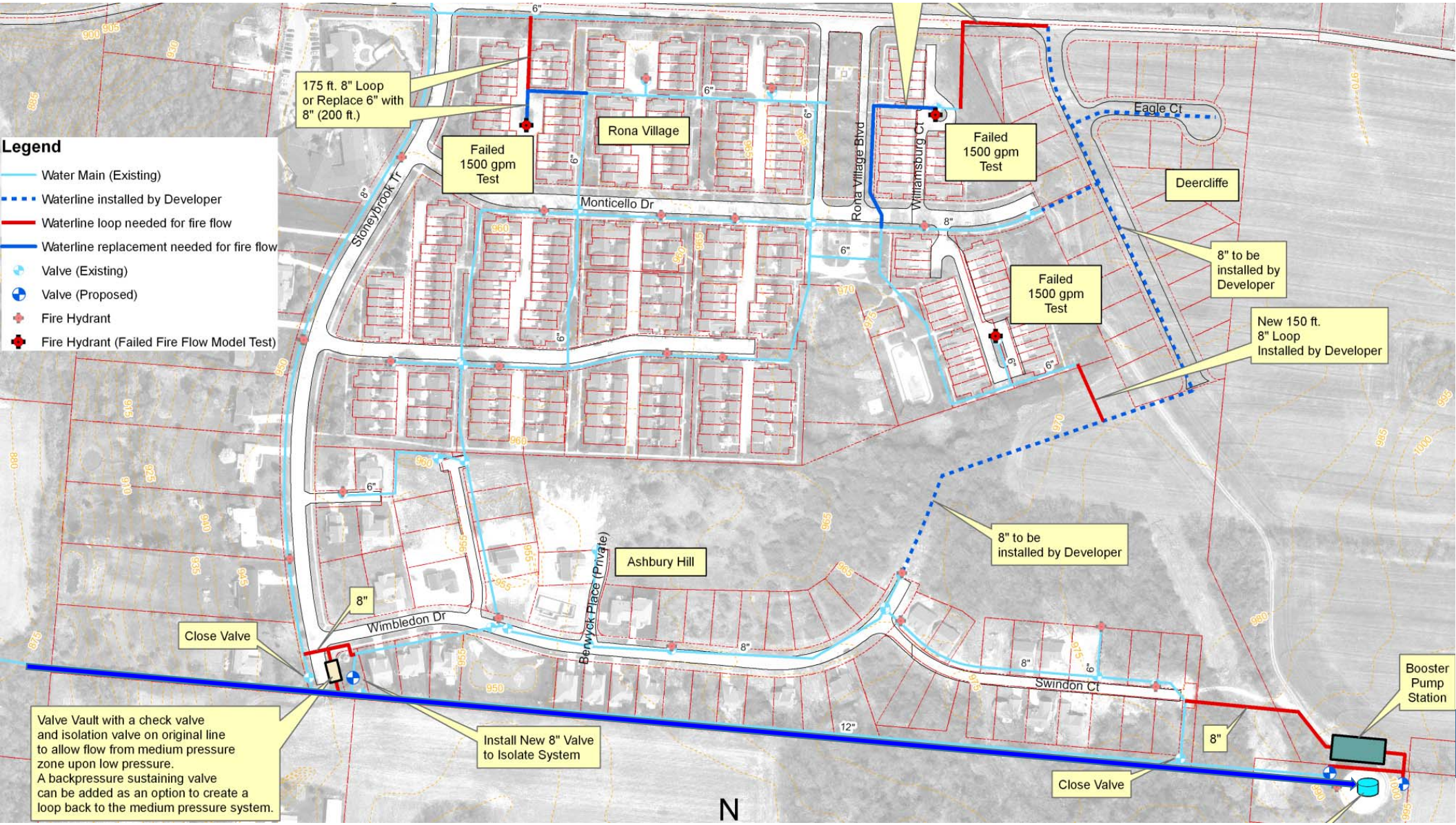
Legend
Water Main (Existing)
Waterline installed by Developer
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175 ft. 8" Loop or Replace 6" with 8" (200 ft.)
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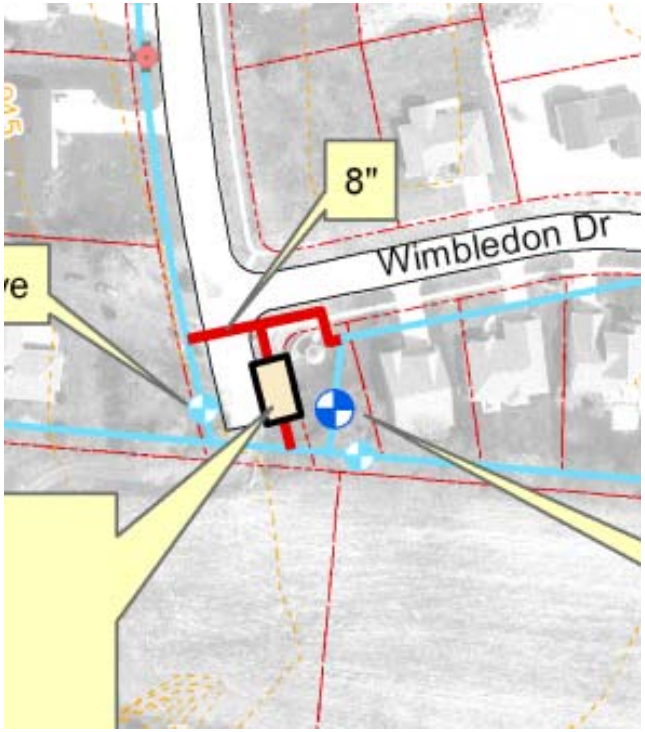
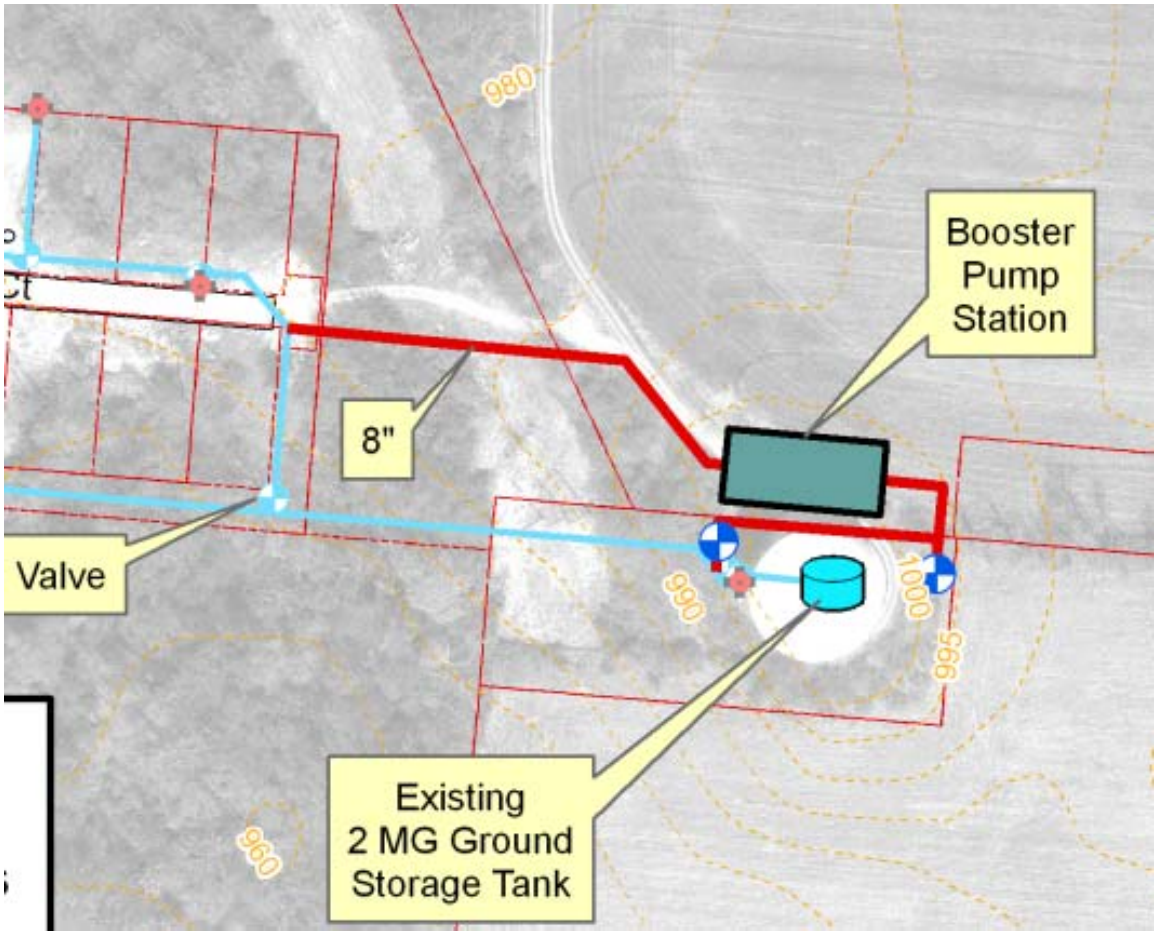
Install New 8" Valve to Isolate System
Close Valve
N

New High Pressure Zone



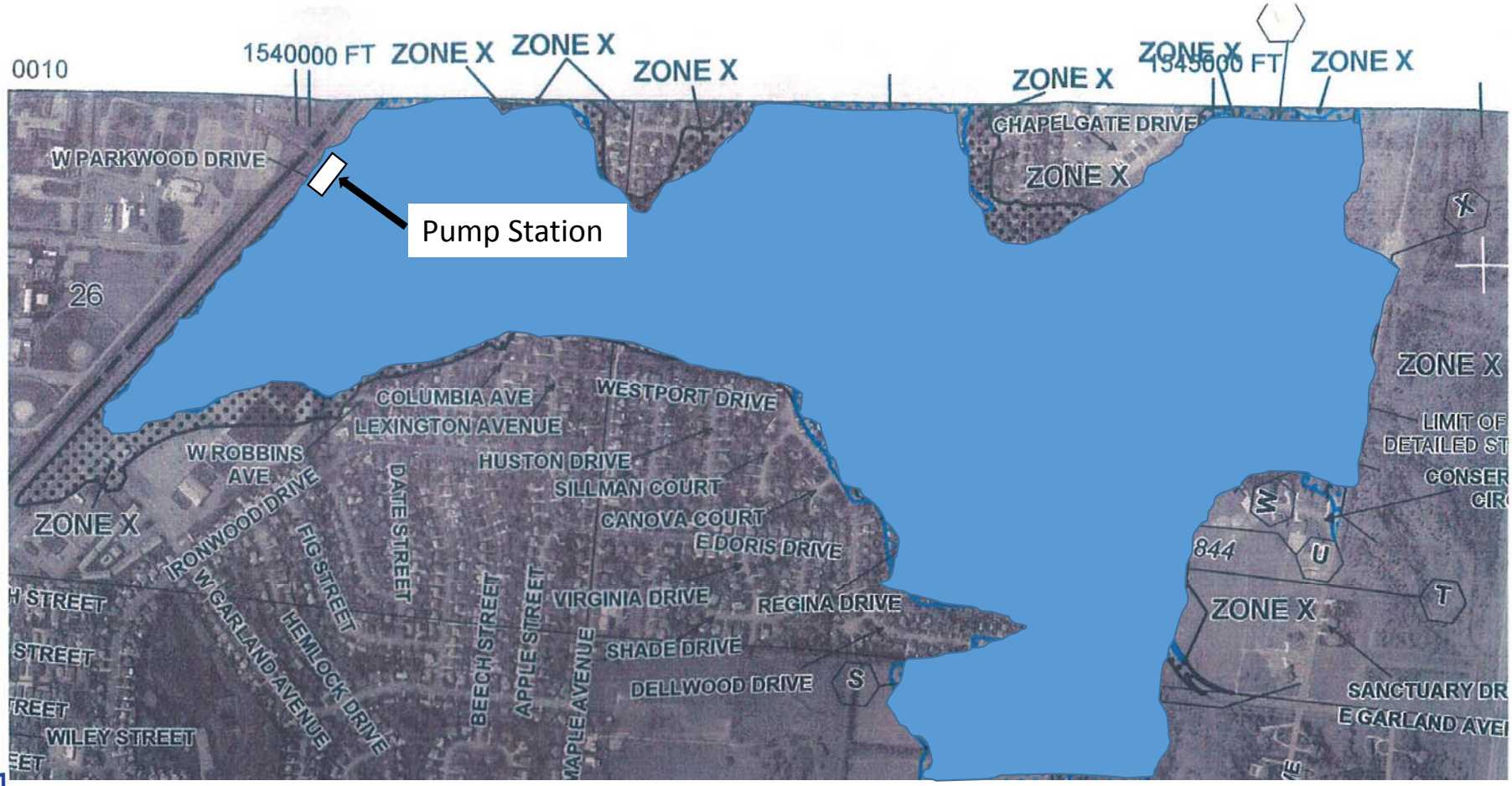


Design Considerations

- Location:
  - Outer edge of distribution system (dead end)
  - Adjacent to existing elevated tank
- Elevating the existing tank or constructing a new elevated tank would obviously not be cost-effective to serve a small subdivision
- Pump Control Options
- Average and peak demand calculations
- Fire flows
- Standby Power
- Building Construction

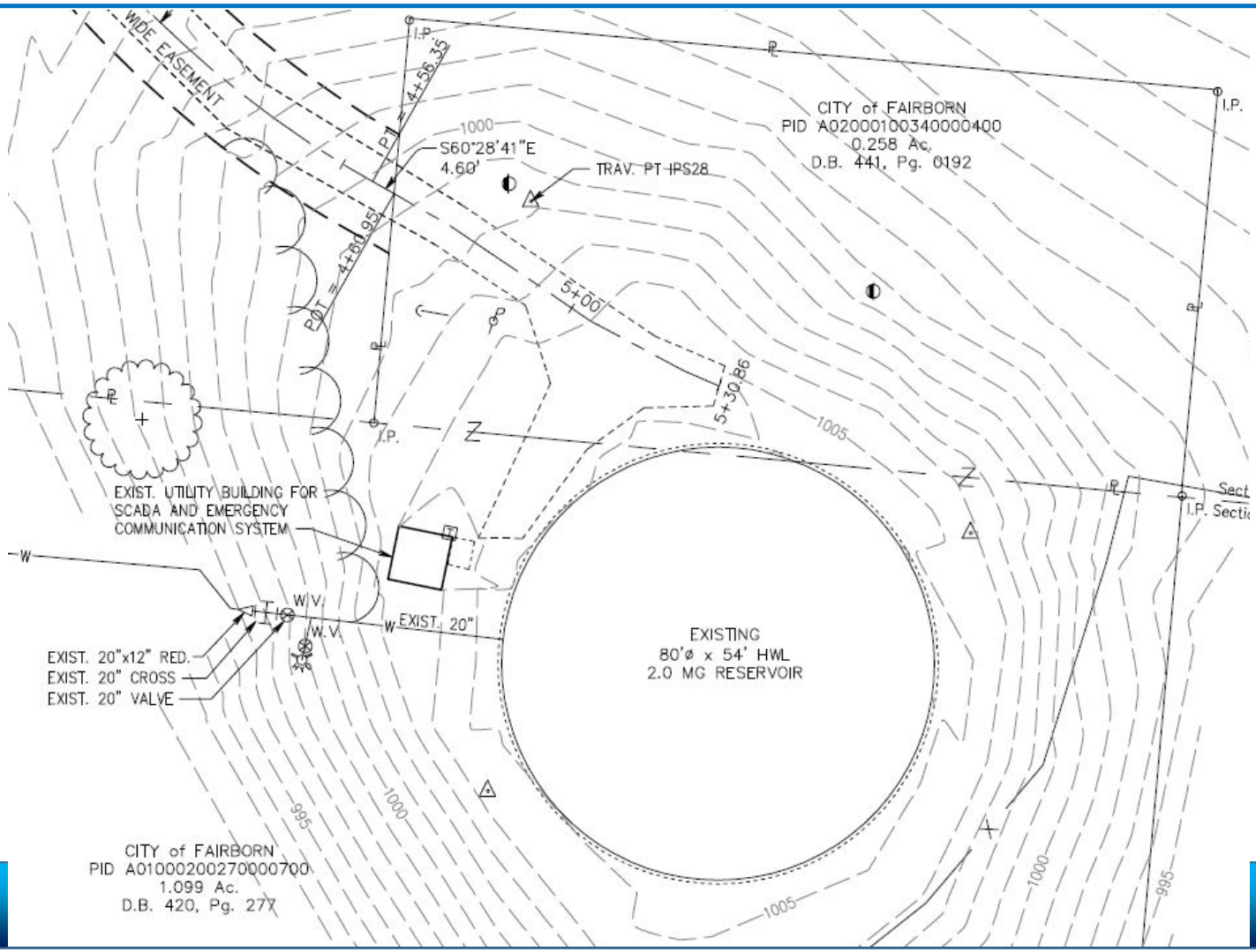

TEL: 713-796-9000


KOHLER. POWER SYSTEMS 400

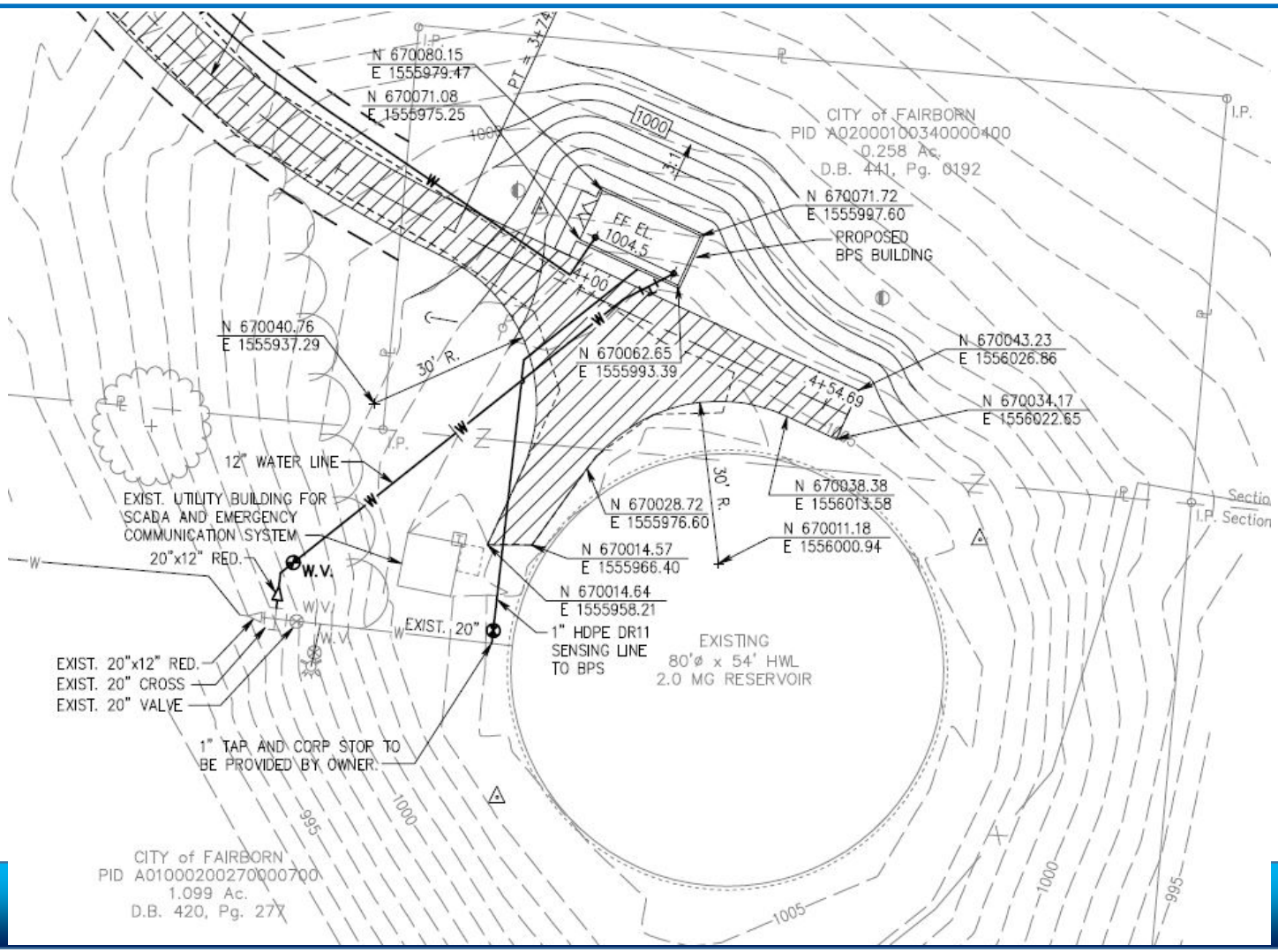

0010
1540000 FT
ZONE X
ZONE X
ZONE X
ZONE X
ZONE X
1545000 FT
ZONE X
W PARKWOOD DRIVE
Pump Station
CHAPELGATE DRIVE
ZONE X
26
ZONE X
COLUMBIA AVE
WESTPORT DRIVE
LEXINGTON AVENUE
W ROBBINS AVE
HUSTON DRIVE
SILLMAN COURT
CANOVA COURT
E DORIS DRIVE
ZONE X
IRONWOOD DRIVE
DATE STREET
FIG STREET
W GARLAND AVENUE
HEMLOCK DRIVE
BEECH STREET
APPLE STREET
MAPLE AVENUE
VIRGINIA DRIVE
REGINA DRIVE
SHADE DRIVE
DELLWOOD DRIVE
WILEY STREET
844
ZONE X
SANCTUARY DR
E GARLAND AVE

Closed Sanitary Sewer Overflow

Existing Site Plan



Proposed Site Plan



Calculating Design Flows

- Average demand:
  - 500 EDUs x 400 (gpd)/EDU = 200,000 gpd or 139 gpm
- Peak day factor of 2.0 and an additional peak hour factor of 1.75
  - Peak hour demand is 700,560 gpd or 487 gpm
- Need to consider fire flows
  - State Insurance Services Office and AWWA publications: Single family homes require 1,000 gpm and condominiums require 1,500 gpm
  - WaterGEMS was used to perform the fire flow analysis

Table 1 | Flow Projections for Rona Village BPS

Area	EDUs	Description
Rona Village	250	Condominiums
Stoneybrook Trail	8	Single Family Homes
Stoneybrook Trail	43	Church
Stoneybrook Trail	43	Nursing Home
Ashbury Hill	96	Single Family Homes
Ashbury Hill 2nd Phase	30	Single Family Homes
Deercliffe	30	Single Family Homes
Total	500	EDUs

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Four BPS Design Options Considered

Option 1: Constant speed pumps/large expansion tank

Option 2: VFDs/smaller expansion tank

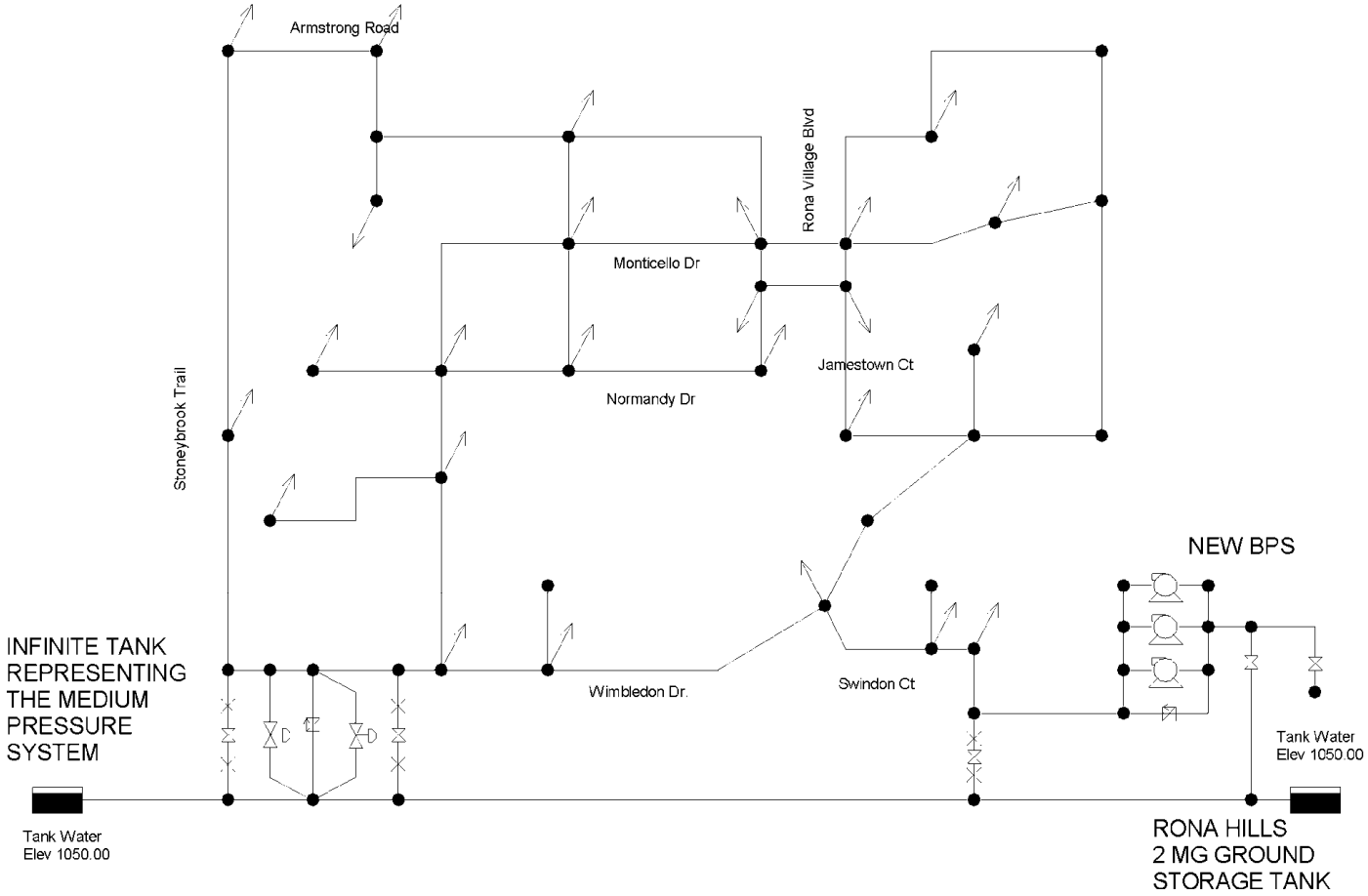
Option 3: Constant speed pumps/recirculation loop (separate suction line from tank)

Option 4: VFDs/recirculation loop (suction connected to existing tank inlet piping)

Fire Flow Options Considered

- Problem - dead ends on 6” lines failed fire flow test
- Solutions
  - Option 1: Provide separate pumps for fire flow and peak hour flow
    - Advantages: Simple
    - Disadvantages: More pumps; one large fire pump; more power
  - Option 2: Use Medium Pressure Zone
    - Provide a bypass line with a check valve around the booster pumps
    - Advantages: Reduced building footprint and lower power costs
    - Disadvantages: None

Pipe-Flo Model (Engineered-Software)



Advantages/Disadvantages of Options 1 & 2

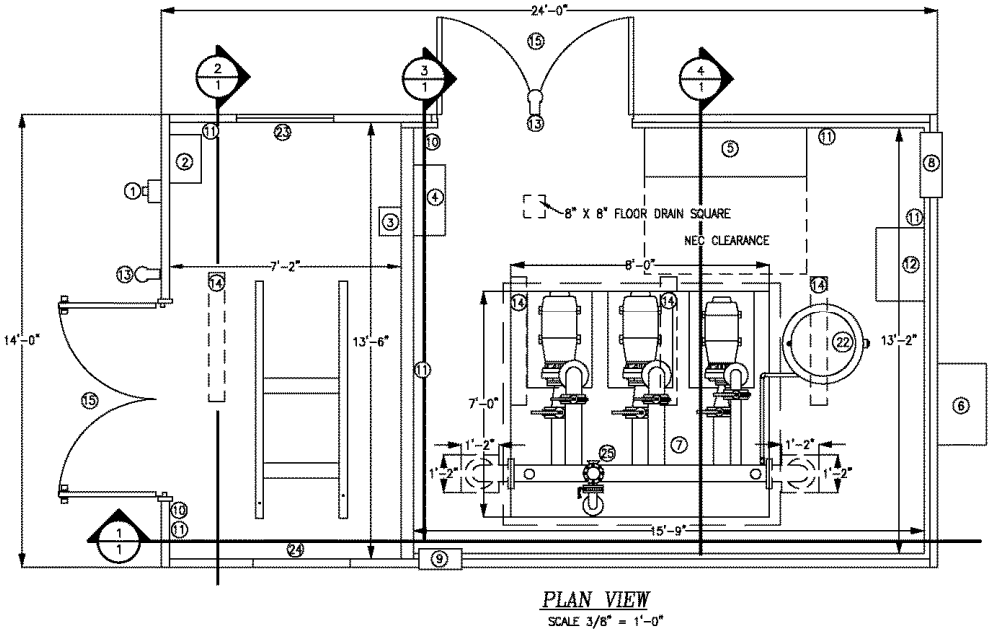
Option 1: Constant speed pumps/large expansion tank

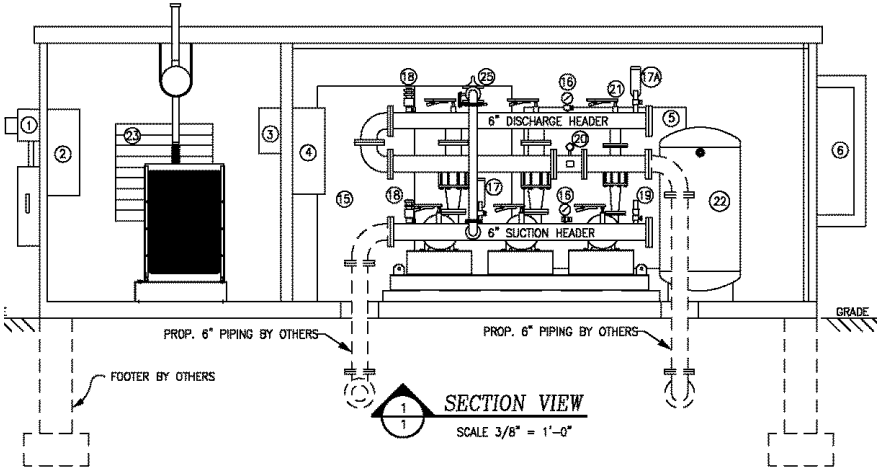
- Advantages: Simple controls
- Disadvantages: Expansion tank - TSS requires 10X pump capacity (5,000-gal)
- Only 1,700-gallons with Pressure Sustaining Valve (still quite large)
- Without loop to the medium pressure zone, fire flow pumps are required

Option 2: VFDs/smaller expansion tank

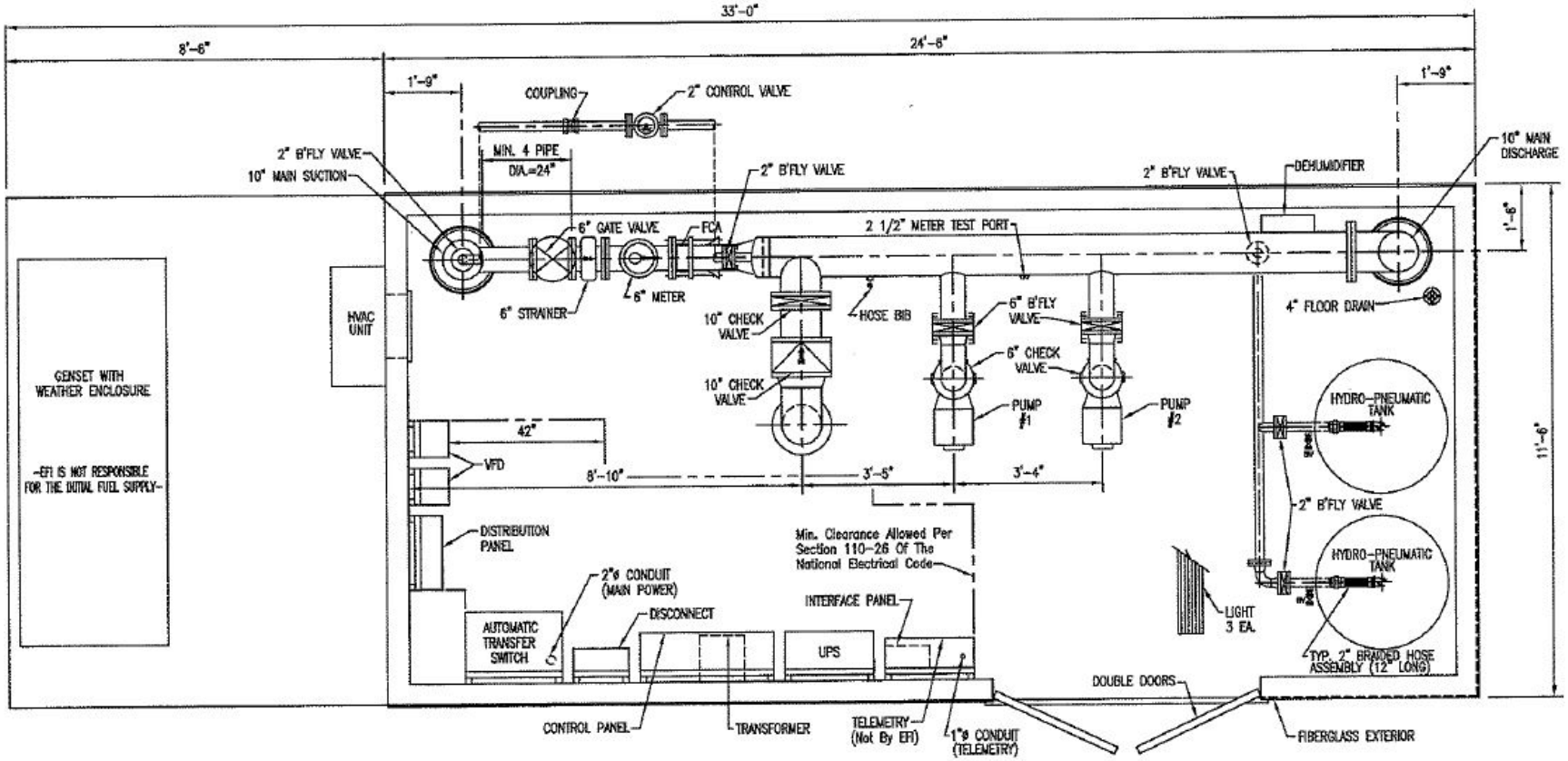
- Advantages: VFDs reduce expansion tank size and lower power costs
- Disadvantages: Requires more controls and still requires a bladder tank (only 200-gallons)
- Fire flow pumps still required

BPS with Expansion Tank & Generator





BPS with Expansion Tank &



PLAN

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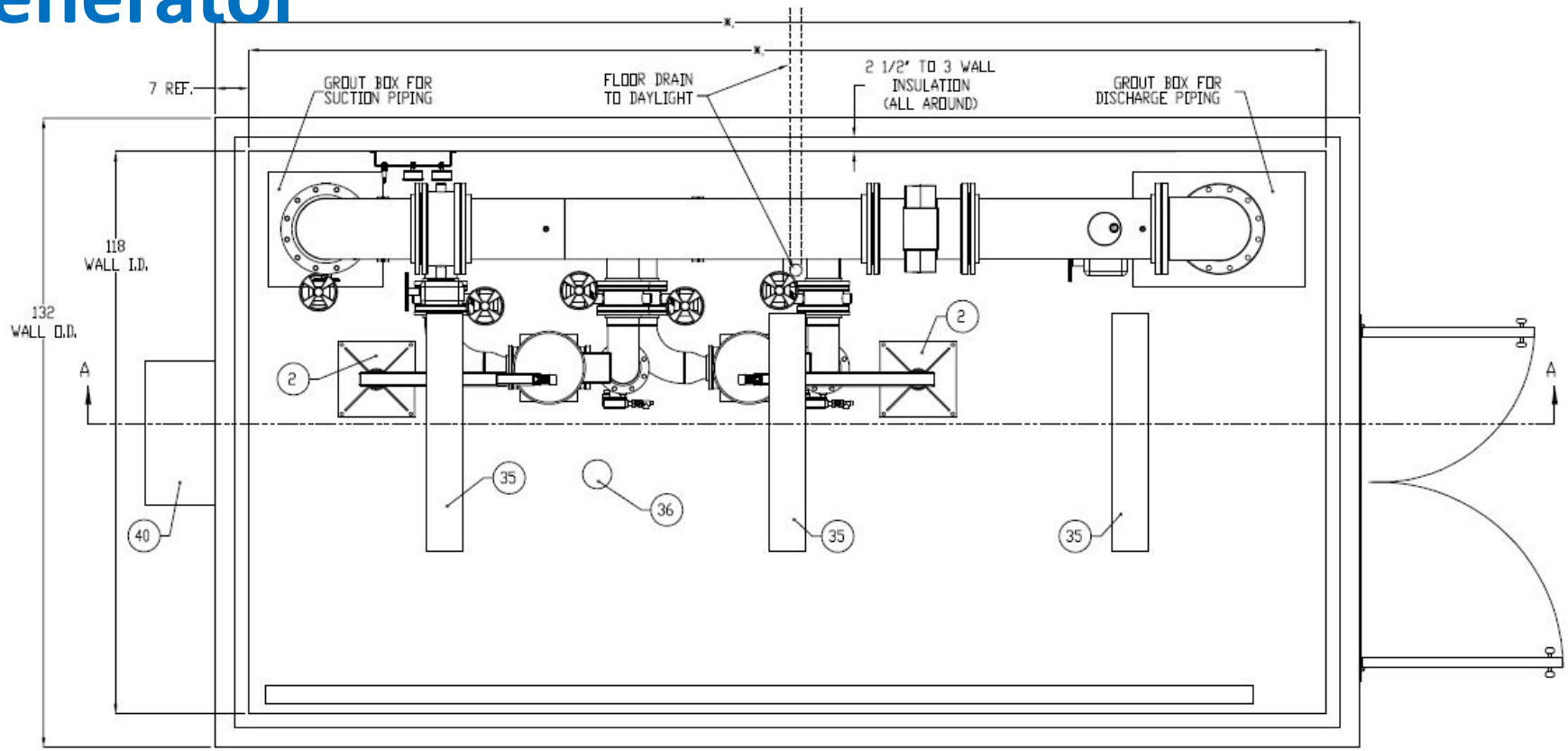
BPS with VFDs without Generator



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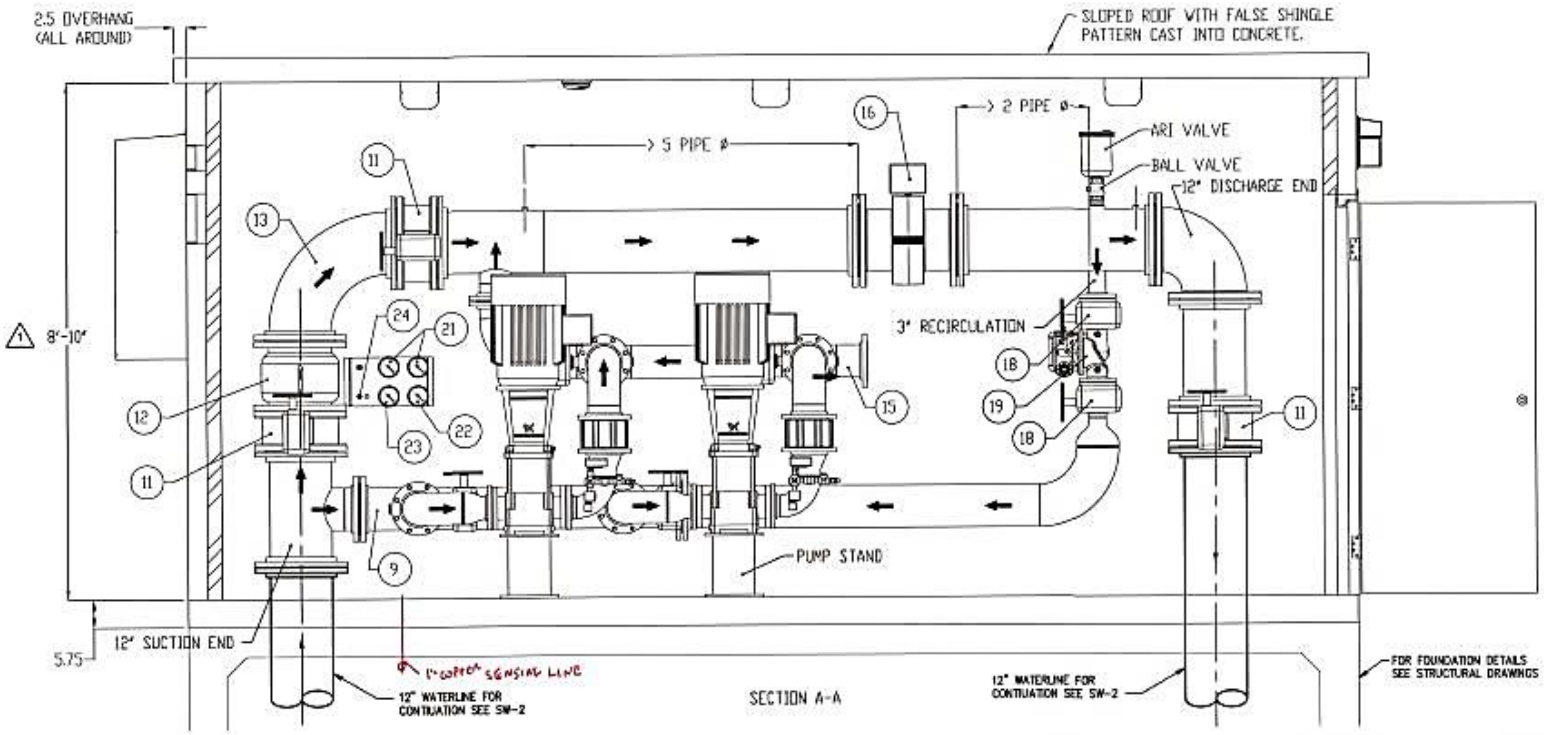


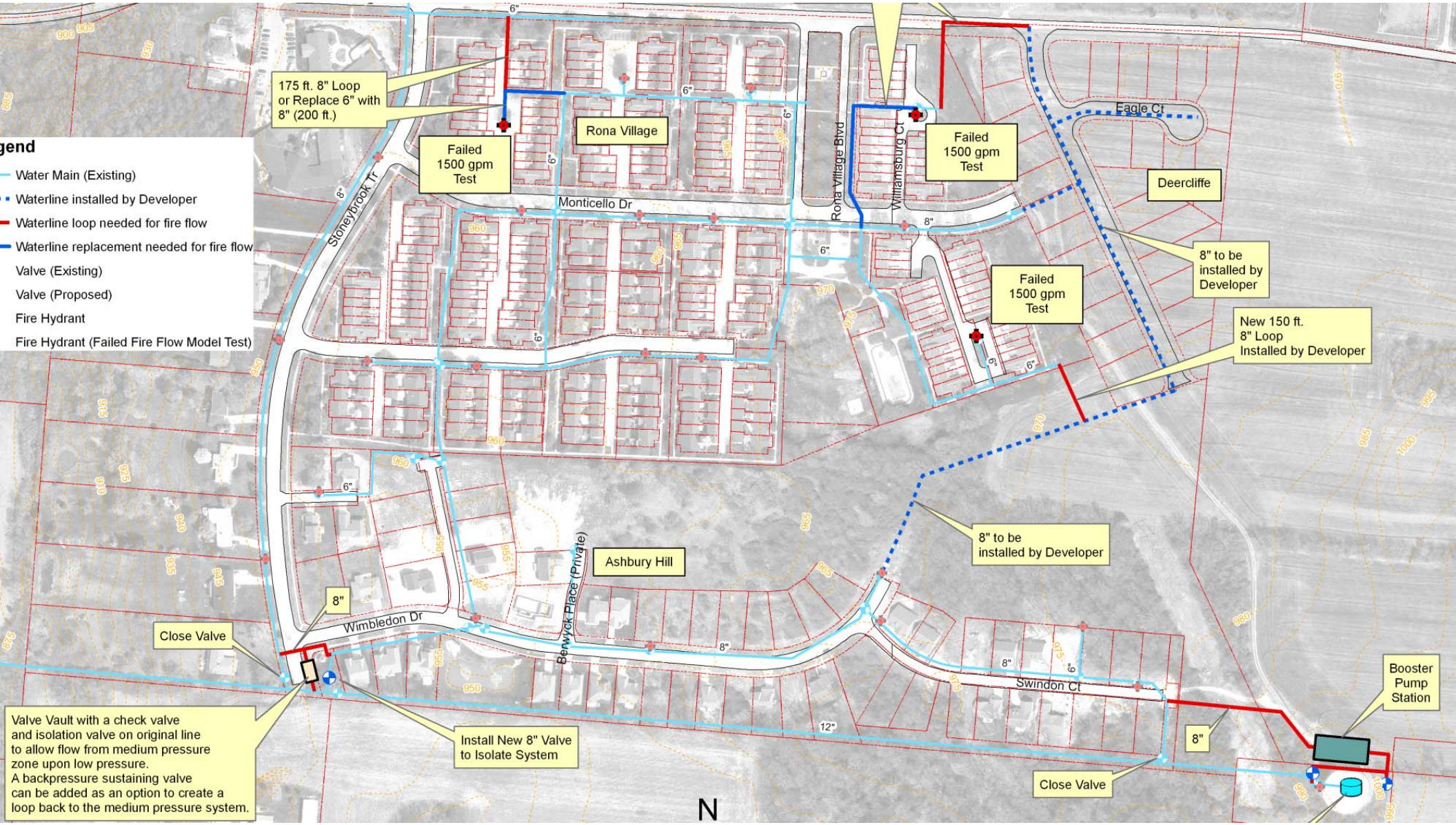
Advantages/Disadvantages of Options 3 & 4

Option 3: Constant speed pumps/recirculation loop (separate suction line from tank)

- Advantages: Simple controls; No expansion tank; Increases tank turnover; Fire flows can be provided by medium pressure zone and no standby power
- Disadvantages: Higher construction cost as well as power costs

Option 4: VFDs/recirculation loop (suction connected to existing tank inlet piping)

- Advantages: Same as Option 3 with lower power costs
- Disadvantages: Reduced tank turnover (however, the amount of recirculation can still be increased by adjusting the PSV and VFDs to increase recirculation, if needed)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N

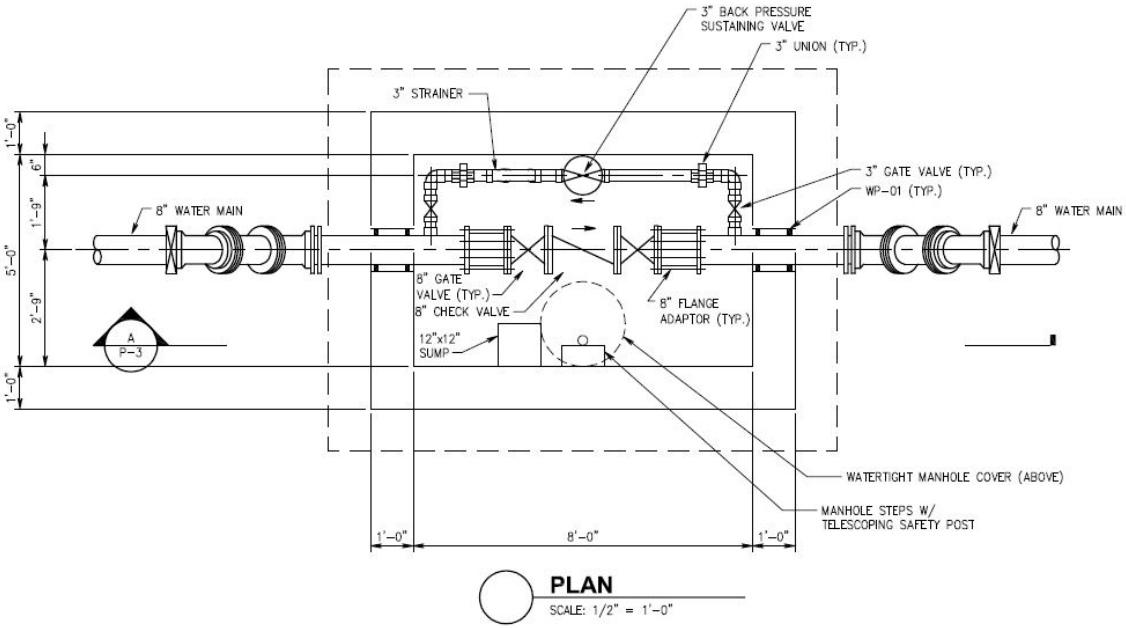
Calculating Surge Pressure

$$\Delta H = a * \Delta v / g \quad + Hs$$

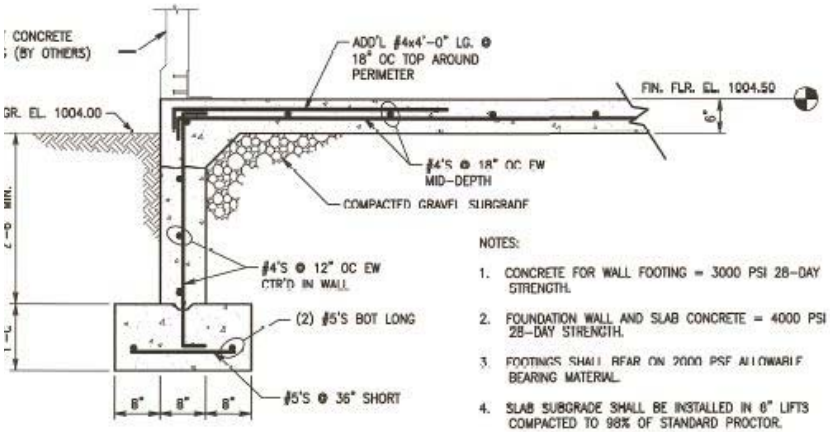
where "a" is the speed of sound in water feet per second (ft/s), v is the velocity (ft/s), "g" is the acceleration of gravity (32.2 ft/s^2), and "Hs" is the static head on pump discharge or surge relief valve.

a	Surge (psig) for Ductile Iron Pipe					
3500			Pipe Diameter, inches			
Static Head, ft		Flow Rate, gpm	6	**8**	10	12
60		300	186	116	84	66
		600	346	206	141	106
		800	453	**266**	180	133
		1200	666	386	256	186

Design Details



PLAN
SCALE: 1/2" = 1'-0"



NOTES:

1. CONCRETE FOR WALL FOOTING = 3000 PSI 28-DAY STRENGTH.
2. FOUNDATION WALL AND SLAB CONCRETE = 4000 PSI 28-DAY STRENGTH.
3. FOOTINGS SHALL BEAR ON 2000 PSF ALLOWABLE BEARING MATERIAL.
4. SLAB SUBGRADE SHALL BE INSTALLED IN 6" LIFTS COMPACTED TO 98% OF STANDARD PROCTOR.

1 PRECAST BUILDING FOUNDATION DETAILS
SCALE: 3/4"=1'-0"

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CAUTION

Startup Issues:

Pressure Relief Valve

- Stayed open all the time
- Plastic from factory (or shop) was stuck in valve

HVAC

- Electrician forgot to power up unit
- City bought portable dehumidifier due to condensation

ENR news:

- 41,000 lb, 125 kW nat. gas generator on top of precast concrete bldg
- Flood-tight doors and hatches
- Forcemain splits into two different directions (tricky hydraulics)

Flood Conditions Impact Pump Station Design

The Kauffman Ave. Pump Station, in Fairborn, Ohio, was two years in the making. What seemed like a straightforward pump station equipment and generator building became more complex when the city of Fairborn confirmed that, due to its location in a flood-prone area, the building had to be designed to allow only 2 in. of water seepage in any 24-hour period. In addition, they required a 5-year warranty. Norwalk Concrete Industries (NCI), an Easi-Set licensed producer, worked with Easi-Set, Concrete Sealants and PS doors to come up with a solution that was within budget yet still met specifications and building code requirements for anchoring the building and for dry, flood-proof design. "The design itself was a challenge because we had never attempted a building with these characteristics," says Robb Smithson, the NCI project manager and engineer. "Some products required long lead times so decisions had to be finalized early in order to meet deadlines."

The 77,300-lb precast concrete building is 12 ft wide x 20 ft long x 11 ft tall. It is insulated and includes an upgraded electrical package. Not conforming to industry standards, it includes a flood-proof, watertight door and special anchoring to withstand flood waters. Atop the roof rests a 4,100-lb generator.

The 77,300-lb building was designed for flood conditions up to 5 ft 6 in. and includes a flood-proof watertight door. It supports a roof-mounted 4,100-lb generator.

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2012 Construction Costs

- Engineer's Estimate:
  - $700,000 for Rona BPS
  - $860,000 for Kauffman Ave PS
  - Total $1.56M
- Low bid awarded to Danis Construction:
  - $490,000
  - $868,000
  - Total $1.36M (12.8% below estimate)

Public Interface

- Started interaction early with letters to all residents
  - Explained the benefits of the project while reminding them that higher pressure could impact bad plumbing
- Updates were posted weekly on City's website
- Danis Construction Field Superintendent had great customer service skills so most concerns were handled at his level

Challenges Encountered

- "Not In My Yard" – Right of Way & Easements
  - One resident tried to stop construction by parking vehicles in right of way work area
- Super Dry Weather Impeded Restoration
  - credited a nearby customer's water bill for watering

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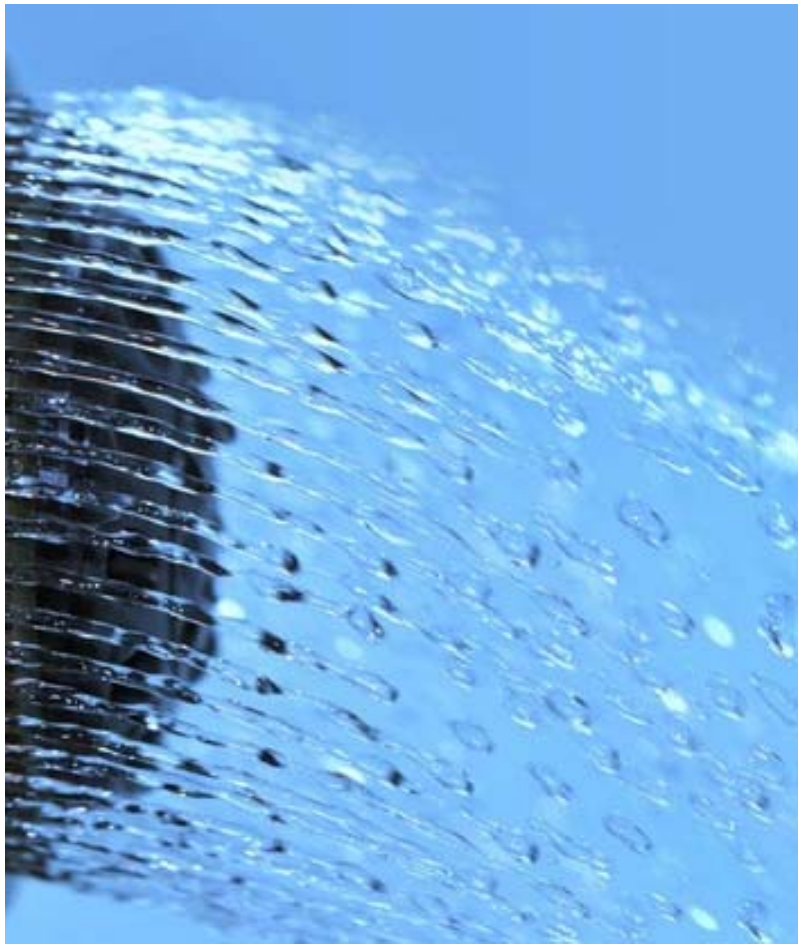
Operation

- VFD's are set to maintain 50 psi at the Booster Station
- Typical pressure following the project – 65 psi
- Verified through hydrant testing

End Result

- Happy Customers
  - Door to door survey conducted
  - Results were overwhelmingly positive



Next Steps

- Perform fire flow tests
- If needed, loop area mains to further improve flow
- More houses can be built and the associated water lines will create more loops

Questions?

Contact:

- Jeremy Cook, P.E. URS Corporation
- Lance Livesay, City of Fairborn
  Water Plant Manager


06/27/2012 03:02

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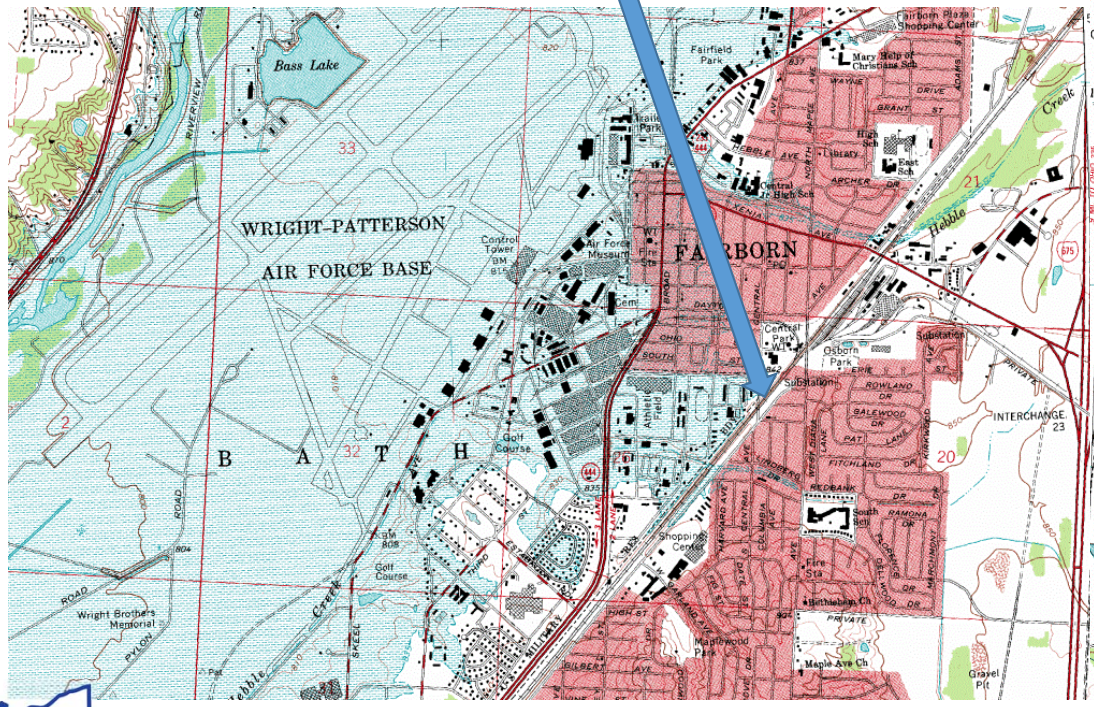
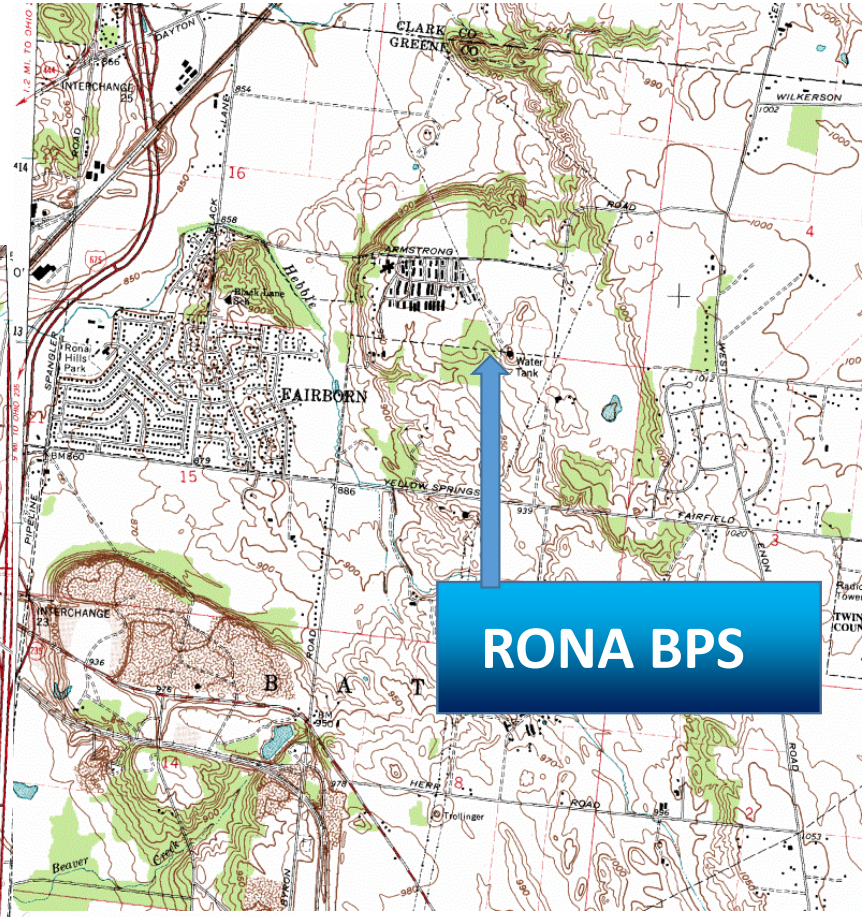
KAUFFMAN AVE PS





RONA BPS

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