# Water Softening Improvements

## at the City of Harrison Water Treatment Plant

2024 CSEAO Winter Conference

December 6, 2024

HARRISON OHIO

fishbeck

Engineers | Architects | Scientists | Constructors

# System Overview

- Source:  Groundwater
- Supply:  Seven production wells
  - Ohio wellfield (4 wells)
  - Indiana wellfield (3 wells)
  - Firm capacity 4.46 MGD
    Total capacity 5.76 MGD
- Previous Water Treatment Plant Operations:
  - Did not include softening
  - Iron/Manganese removal by chemical oxidation and pressure filtration
  - 2.93 MGD treatment capacity

# Project Need

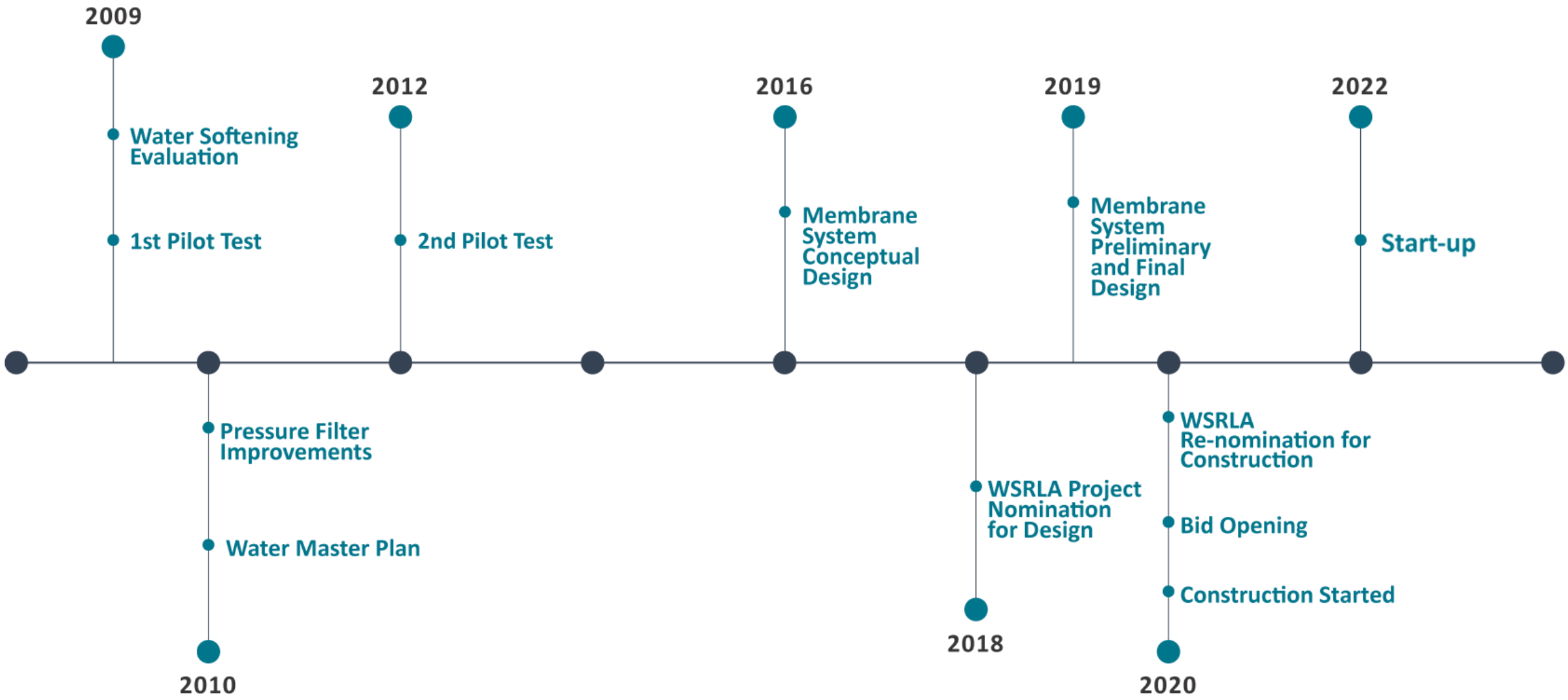
| Hardness (mg/L as CaCO3) | Description | Effect(s) |
|---|---|---|
| 0 – 50 | Extremely soft | Corrosive. Skin feels slimy when wet. |
| 50 – 100 | Very soft | Can be corrosive. |
| 100 – 150 | Soft to moderately hard | Often acceptable to most users. |
| 150 – 300 | Hard | Staining, scaling of plumbing fixtures. |
| > 300 | Very hard | Scum in the bath and shower, scaling on cookware and in water heaters/boilers, and requires more laundry detergent. |

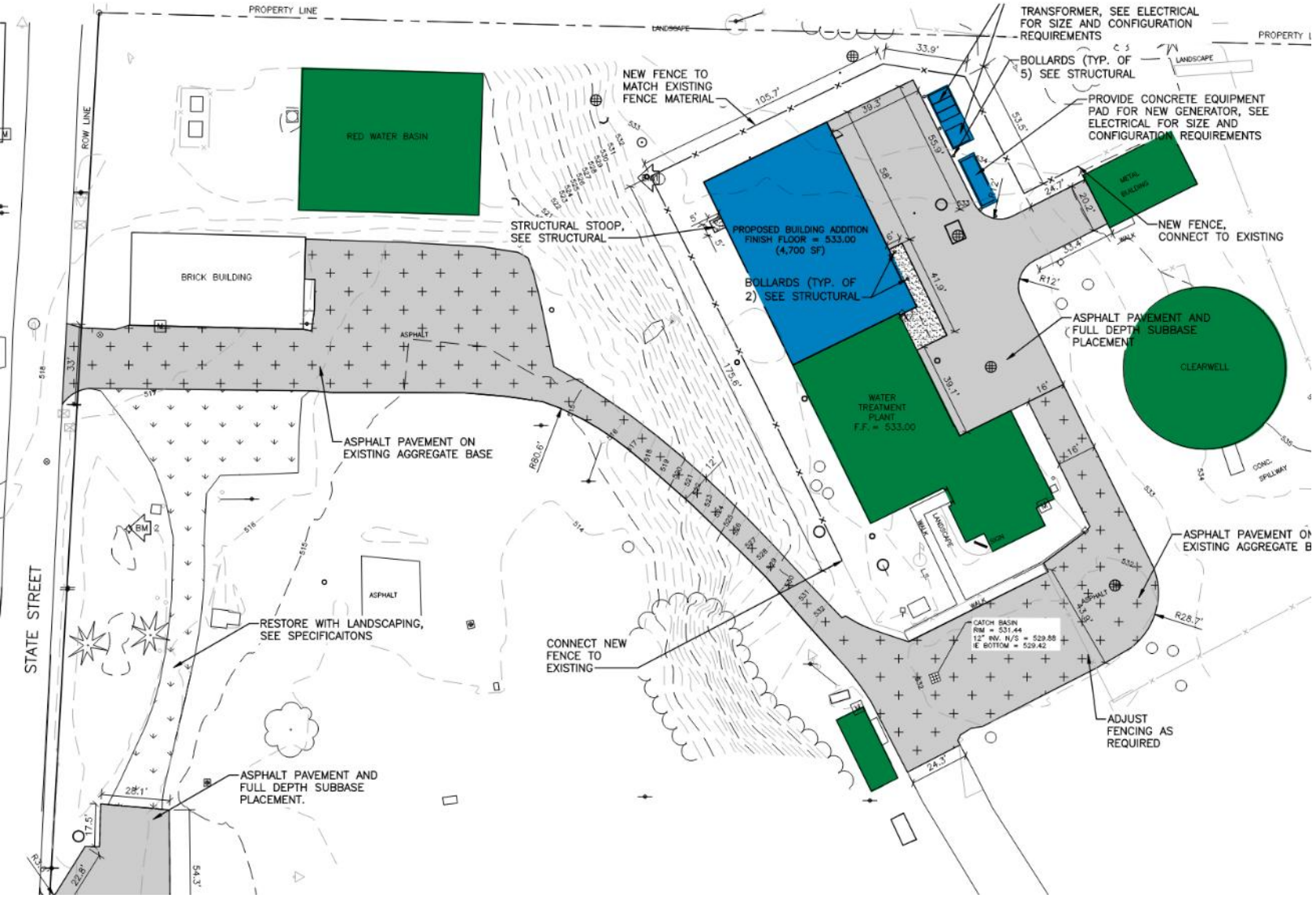
Harrison water hardness is 320–490 mg/L “very hard”

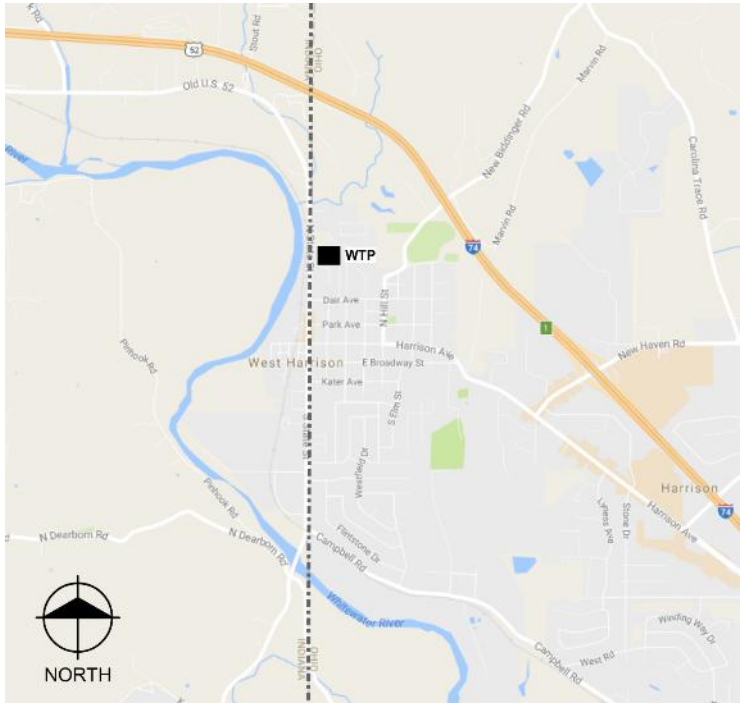
# Hard Water Consequences

- Why add membrane softening?
  - Causes scum in bath/shower and fixtures
  - Causes scaling on cookware and in water heaters/boilers
  - Complexes with soap, reducing laundering effectiveness
  - Soap can’t interact with dirt on clothing, forming undesirable precipitates

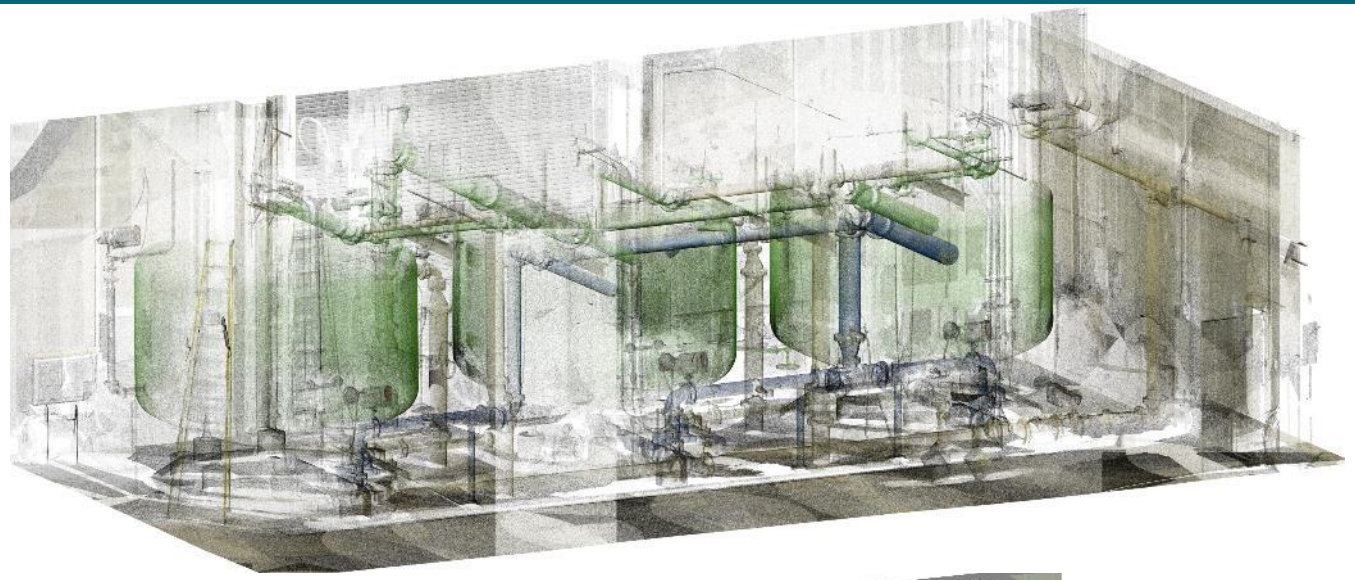
# Project Timeline

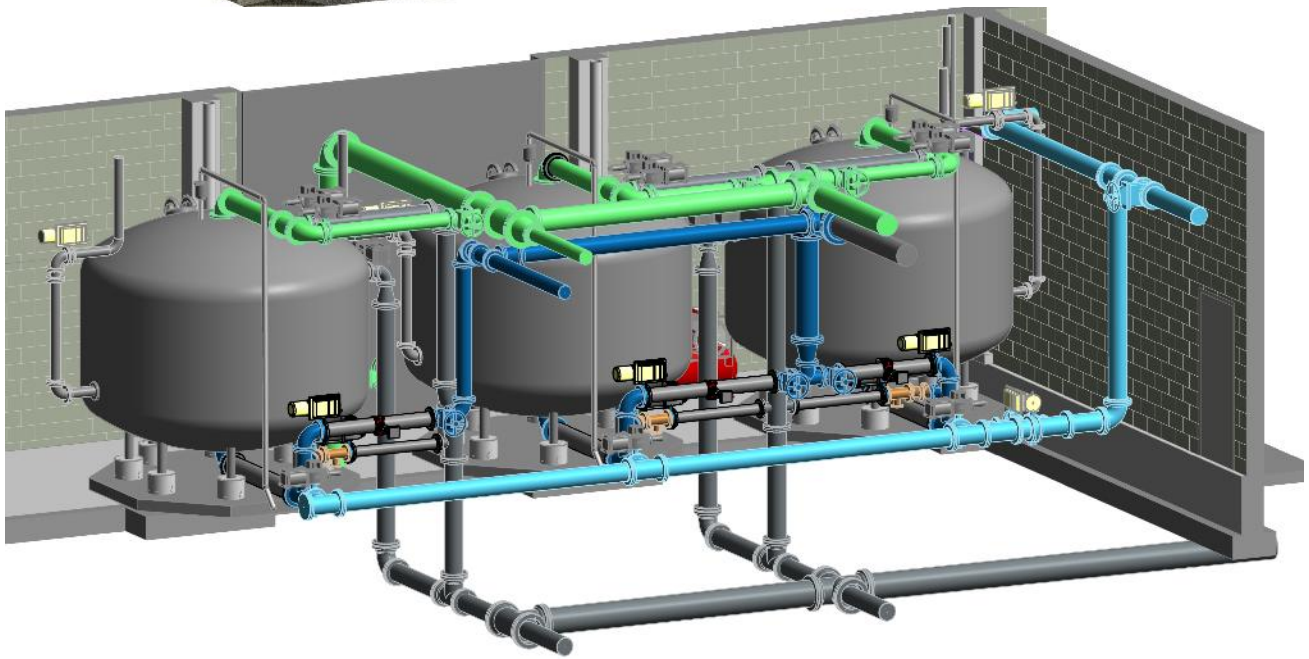





*Site Location*

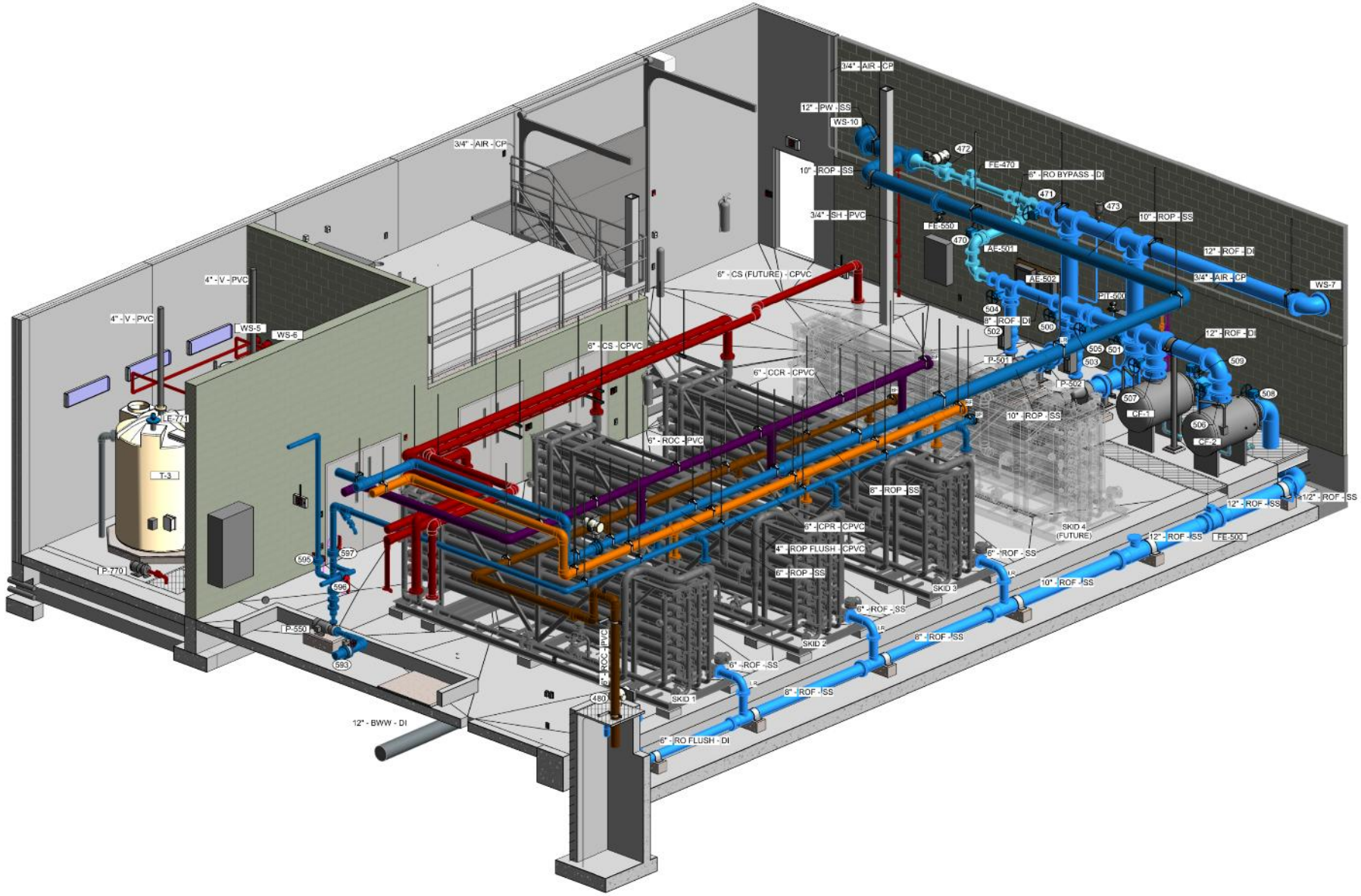




*40 scans of existing facility were performed*

# Creation of As-Built Model

*Laser Scanning*
*Scan-to-BIM*



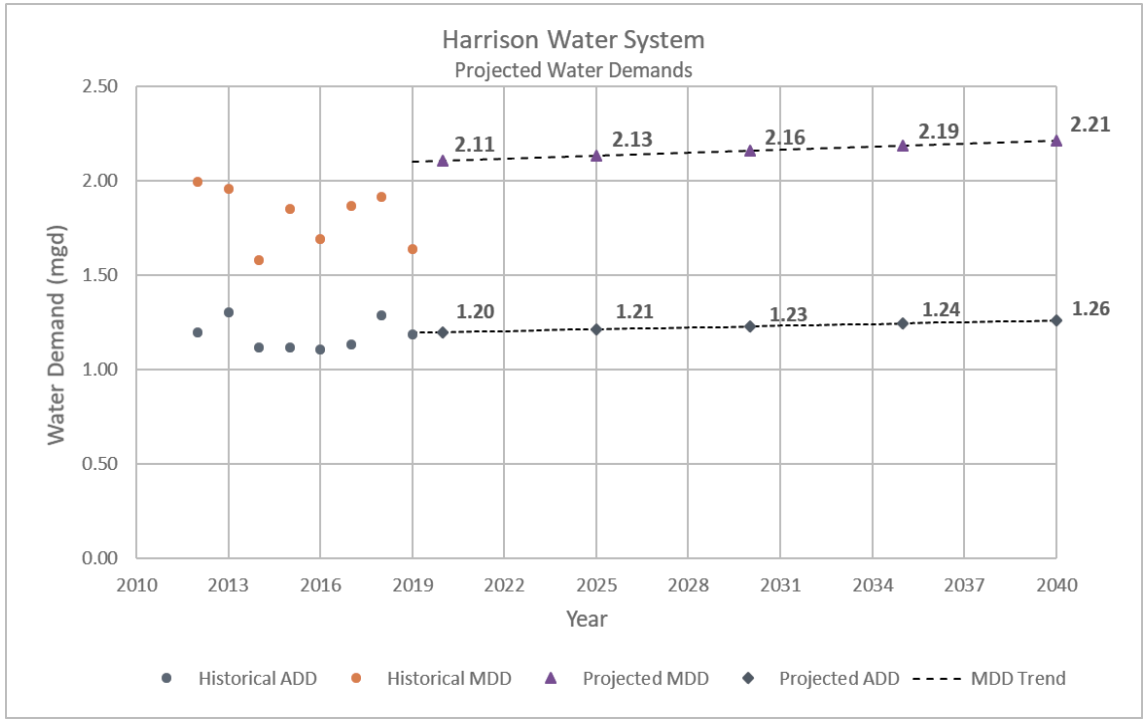

*Revit 3D model*

# Building Addition Model

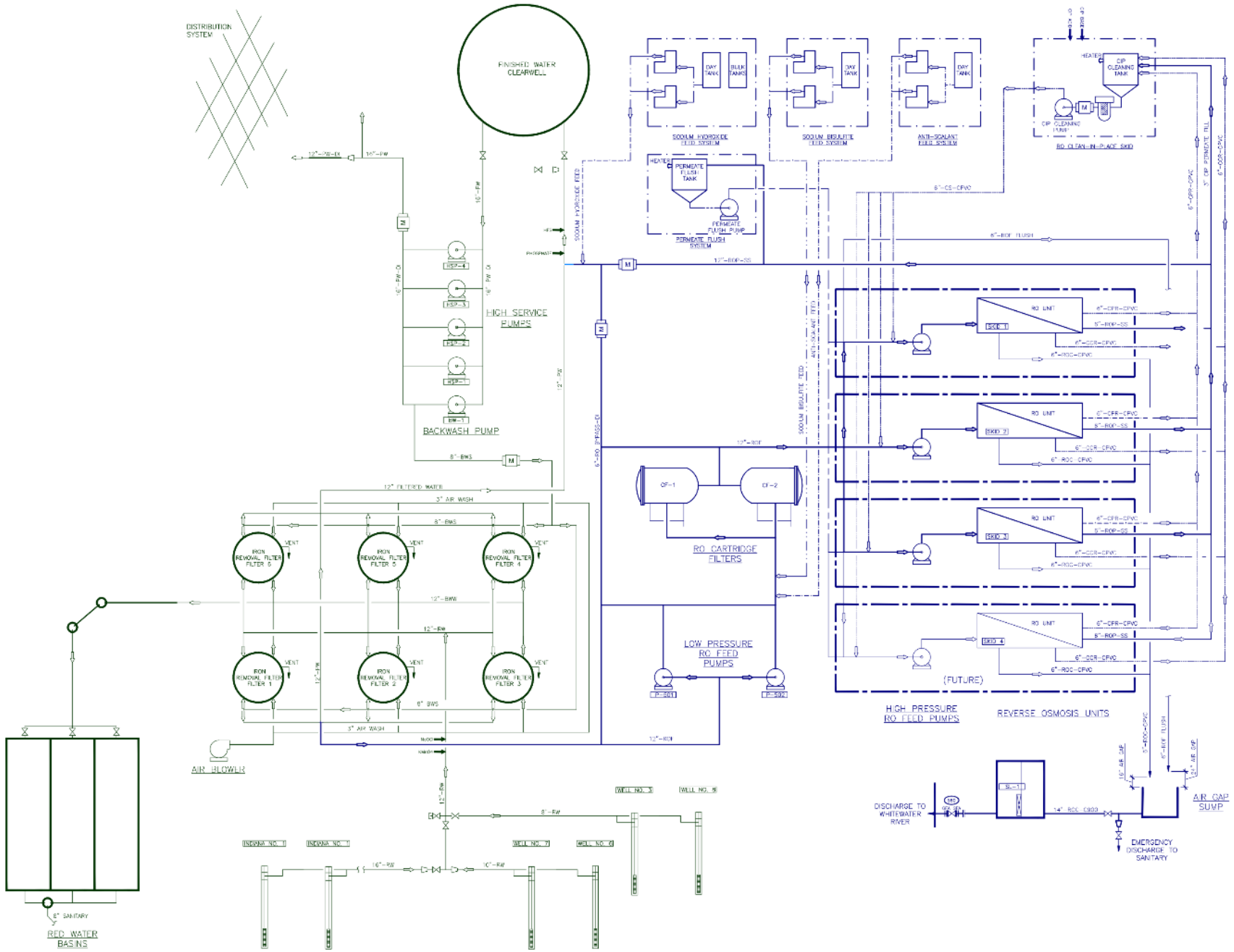
*Autodesk Revit*
*BIM 360*
*Autodesk Navisworks*

# Treatment Basis of Design

- Filtration
  - 2.93 MGD at a filtration rate of 3.0 gpm/sf
- Softening Capacity
  - 2.4 MGD initially, 3.2 MGD future
- Recovery Rates
  - Membrane Recovery: 75–80%
  - Discharge to Whitewater River: 20-25%
- Concentrate Volume
  - Average Day: 300,000 gallons/day
  - Maximum Day: 530,000 gallons/day
- Finished Water Goals
  - Target Hardness between 120–140 mg/L as $CaCO_3$




*Projected Water Demands*




# System Design

# Pretreatment Improvements

- Valves and actuators upgraded
- Meters replaced
- Media replaced
- Controls upgraded
- Validation Steps
  - Filter run SDI profiles
  - Filter to waste SDI profiles

*Existing filter piping, valves and actuators*

# Low Pressure RO Feed Pumps

- Boost filter effluent pressure
- Bypass control valve
- Cartridge filter headloss

# Chemical Addition

- Antiscalant
- Sodium bisulfite
- Feed points at static mixer
- Fed prior to cartridge filters
- Continuous monitoring

*Photo credit: Avista Technology — iron fouled membrane*

# Chemical Feed Room

- **Antiscalant and Sodium Bisulfite**
  - Converted Tote
  - Day Tank on Scale
  - Watson Marlow  Qdos Pod
- **Sodium Hydroxide**
  - Two Bulk Tanks
  - Day Tank on Scale
  - Watson Marlow  Qdos Pod


# Cartridge Filters

- Lead/Standby – 100% duty
- Located off-skid
- Horizontal vs. vertical

# Cartridge Filters

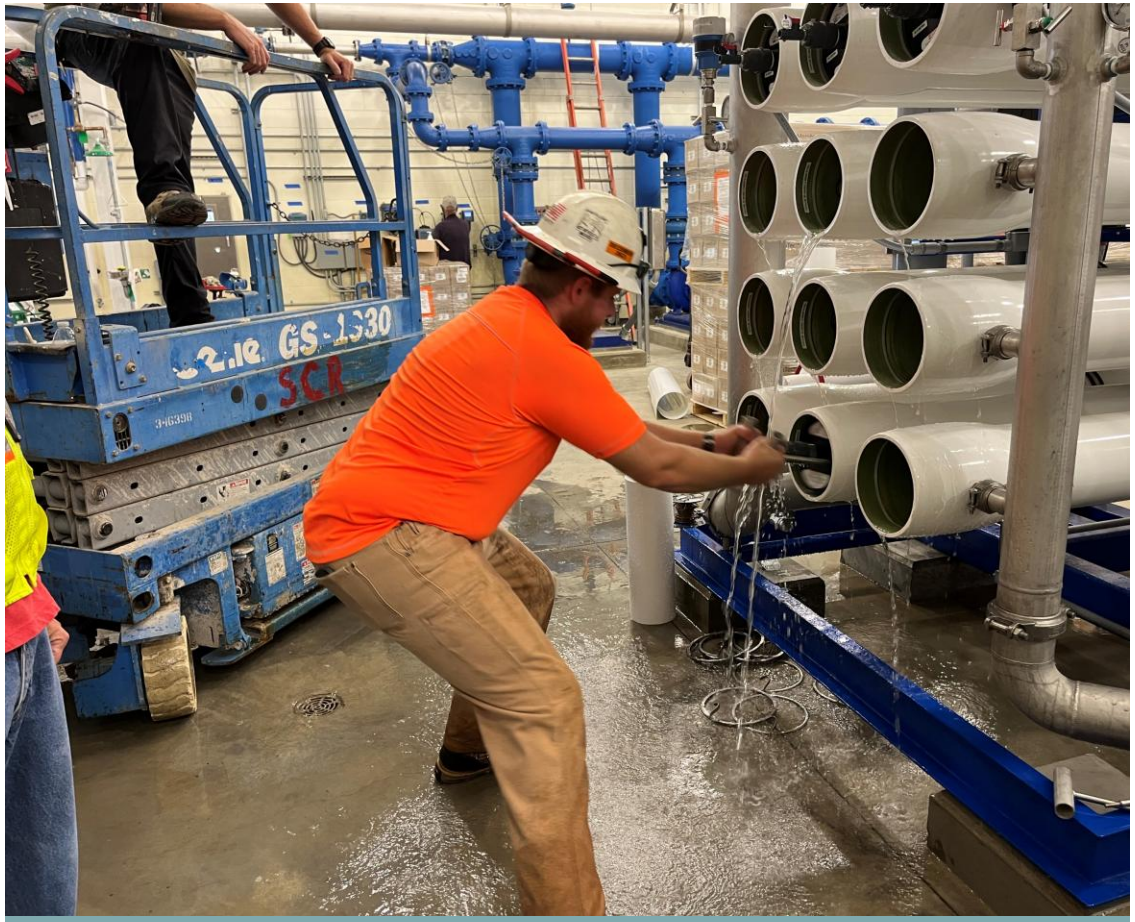
- Density Rating: 5 µm
- Max Loading Rate:
  - 3.5 gpm/10-inch
  - 1.7 gpm/10-inch (both online)
- Manufacturer:
  - Fil-Trek MP Series
- Filters: 118 each SOE
- O-rings: EPDM

# Membrane Elements

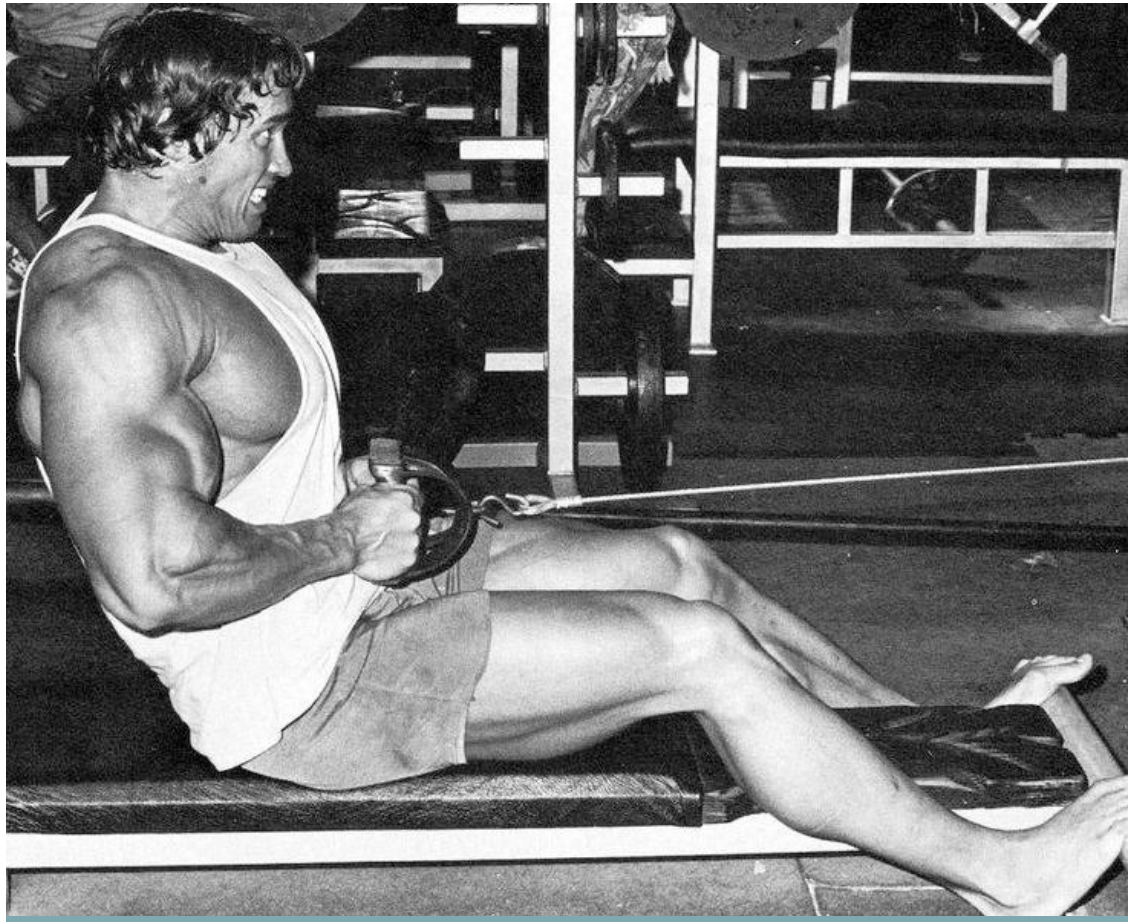
- **Active Area:**
  - 400 sf/element
- **Feed Spacer:**
  - 34 mil
- **Listed Manufacturers:**
  - Dupont, FilmTec BW30XFRLE-400/34
  - Toray, Model TMG20D-400

*Dupont FilmTec RO element*

# Initial Membrane Element Loading




*Start of Day*



*Later That Day*

# RO Feed Flush

- Automated
  - Pre-flush when skid comes online
- Flushes non-optimum feed water
- Allows chemistry to stabilize

# RO Skids

- Configuration:
  - 12:6 with 7 elements/vessel
- Max Overall Flux:
  - 12 gfd
- Design Recovery: 75-80%
  - 10/22: Started Up 75%
  - 6/23: Increased to 80%

# High Pressure RO Feed Pump

- **High Pressure RO Feed Pumps**
  - Vary speed to maintain steady permeate flow
- **Design Point**
  - Maximum recovery
  - 5-year conditions
  - 20% fouling factor
  - Permeate header pressure
  - Concentrate header pressure

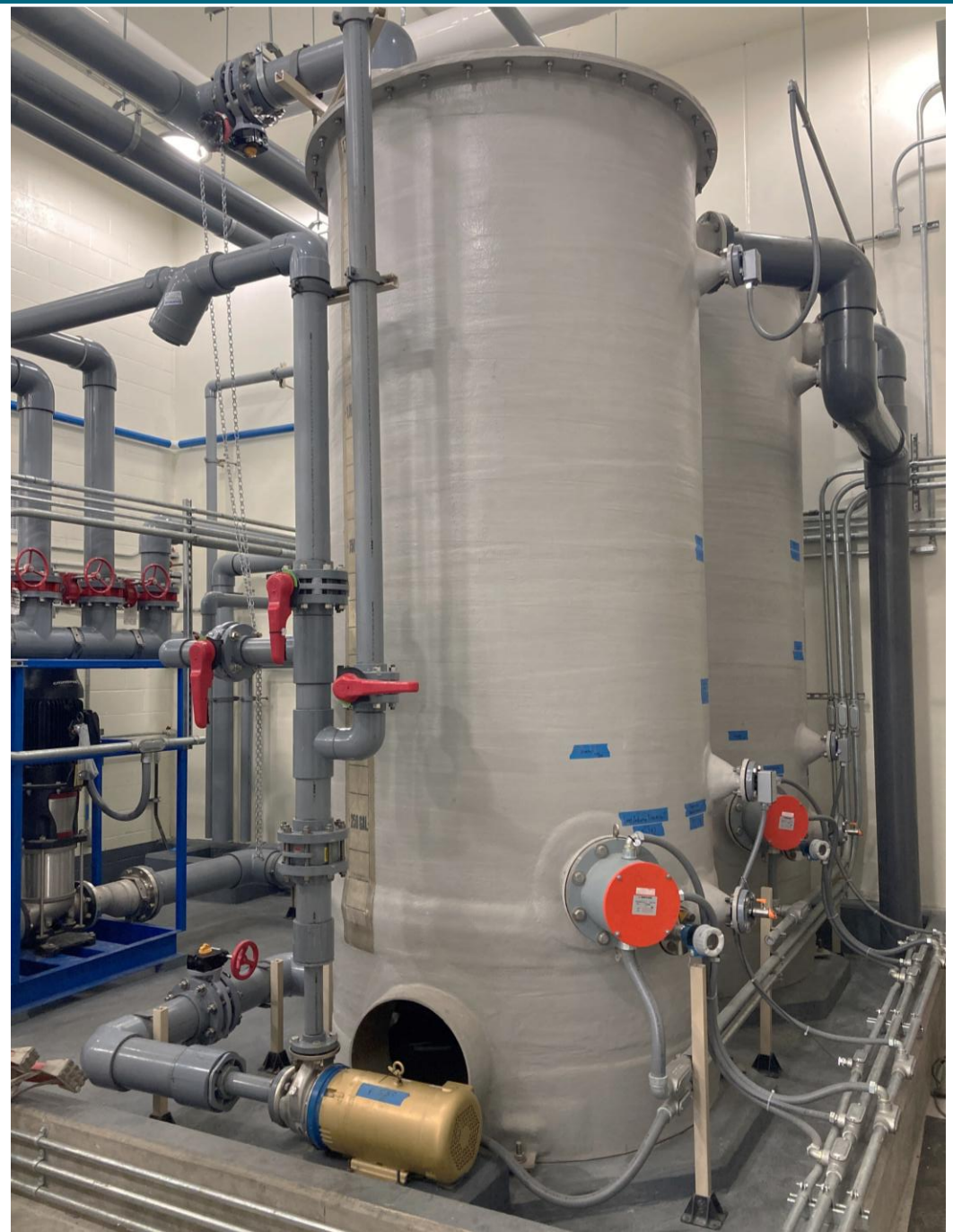

# CIP System Criteria

- Clean stages independently
- Right-size CIP pump w/ VFD
- Flexibility: liquid vs. powder
- Right-size CIP tank
- Dedicated CIP supply piping
- FRP tank
- CIP cartridge filter
- Double block and bleed

# CIP Cleaning Chemical Room

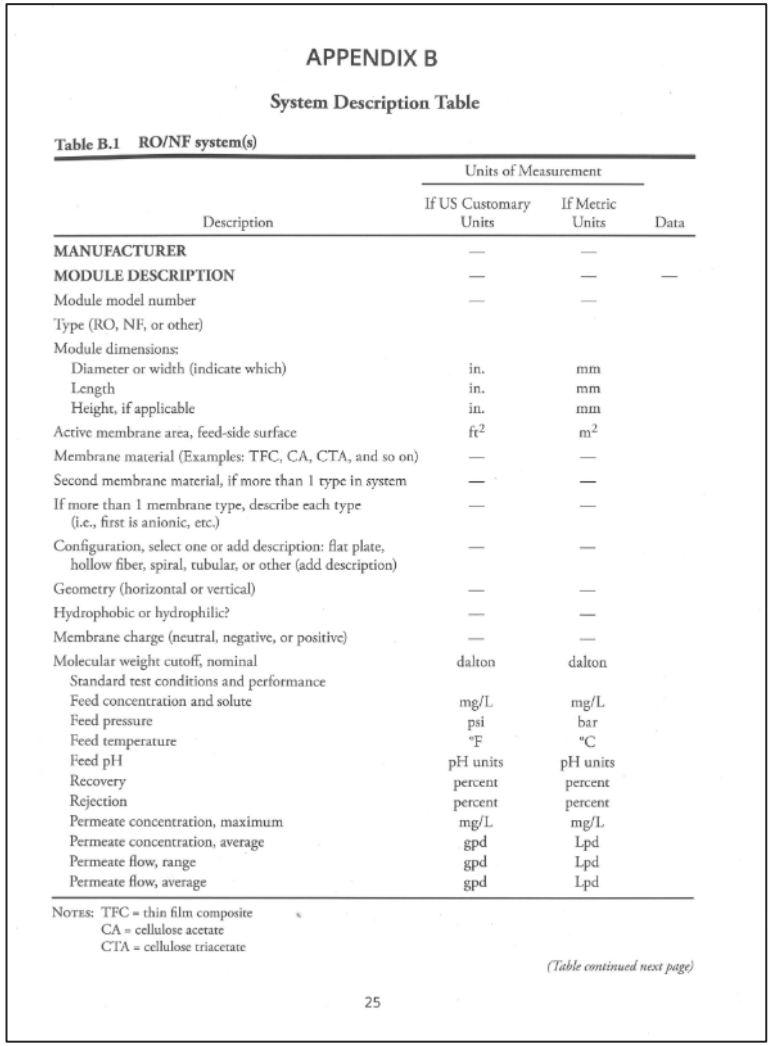
# Permeate Flush System

- Permeate Flush Tank
  - Exchange skid volume
- Permeate Flush Pump w/ VFD
  - 10 gpm/vessel at 30 psi
- Dual Function



# Bid Evaluation

- System Description
  - Skid dimensions
  - Array configuration
  - Scope of supply
  - Element manufacturer & model
- Performance Projections
  - at 0, 3, and 5 years



APPENDIX B

System Description Table

Table B.1 RO/NF system(s)

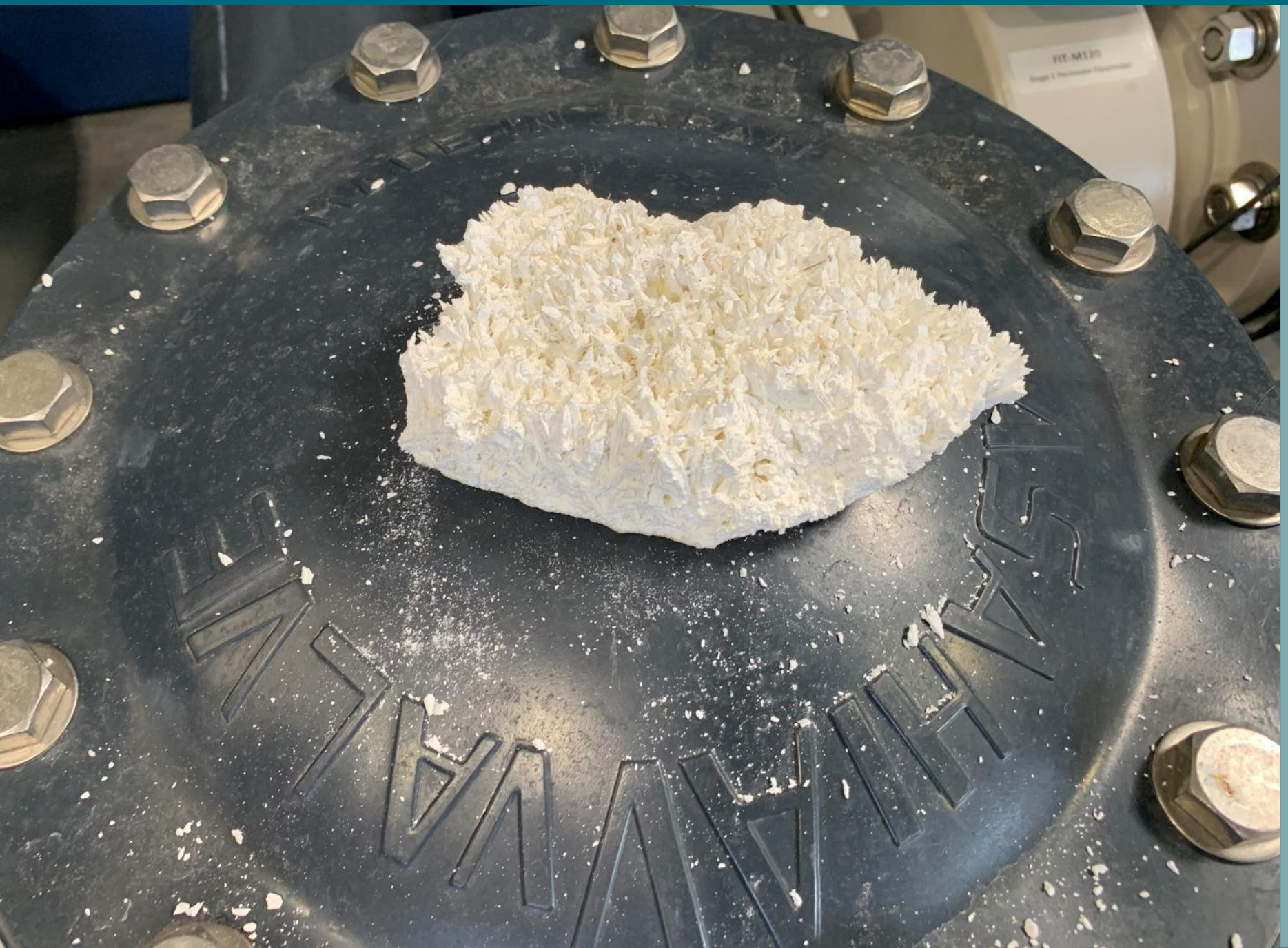
| Description | Units of Measurement: If US Customary Units | Units of Measurement: If Metric Units | Data |
|---|---|---|---|
| MANUFACTURER | — | — | |
| MODULE DESCRIPTION | — | — | — |
| Module model number | — | — | |
| Type (RO, NF, or other) | | | |
| Module dimensions: | | | |
| Diameter or width (indicate which) | in. | mm | |
| Length | in. | mm | |
| Height, if applicable | in. | mm | |
| Active membrane area, feed-side surface | $ft^2$ | $m^2$ | |
| Membrane material (Examples: TFC, CA, CTA, and so on) | — | — | |
| Second membrane material, if more than 1 type in system | — | — | |
| If more than 1 membrane type, describe each type (i.e., first is anionic, etc.) | — | — | |
| Configuration, select one or add description: flat plate, hollow fiber, spiral, tubular, or other (add description) | — | — | |
| Geometry (horizontal or vertical) | — | — | |
| Hydrophobic or hydrophilic? | — | — | |
| Membrane charge (neutral, negative, or positive) | — | — | |
| Molecular weight cutoff, nominal | dalton | dalton | |
| Standard test conditions and performance | | | |
| Feed concentration and solute | mg/L | mg/L | |
| Feed pressure | psi | bar | |
| Feed temperature | °F | °C | |
| Feed pH | pH units | pH units | |
| Recovery | percent | percent | |
| Rejection | percent | percent | |
| Permeate concentration, maximum | mg/L | mg/L | |
| Permeate concentration, average | gpd | Lpd | |
| Permeate flow, range | gpd | Lpd | |
| Permeate flow, average | gpd | Lpd | |

NOTES: TFC = thin film composite
CA = cellulose acetate
CTA = cellulose triacetate

(Table continued next page)



*ANSI/AWWA B114 – System description table*

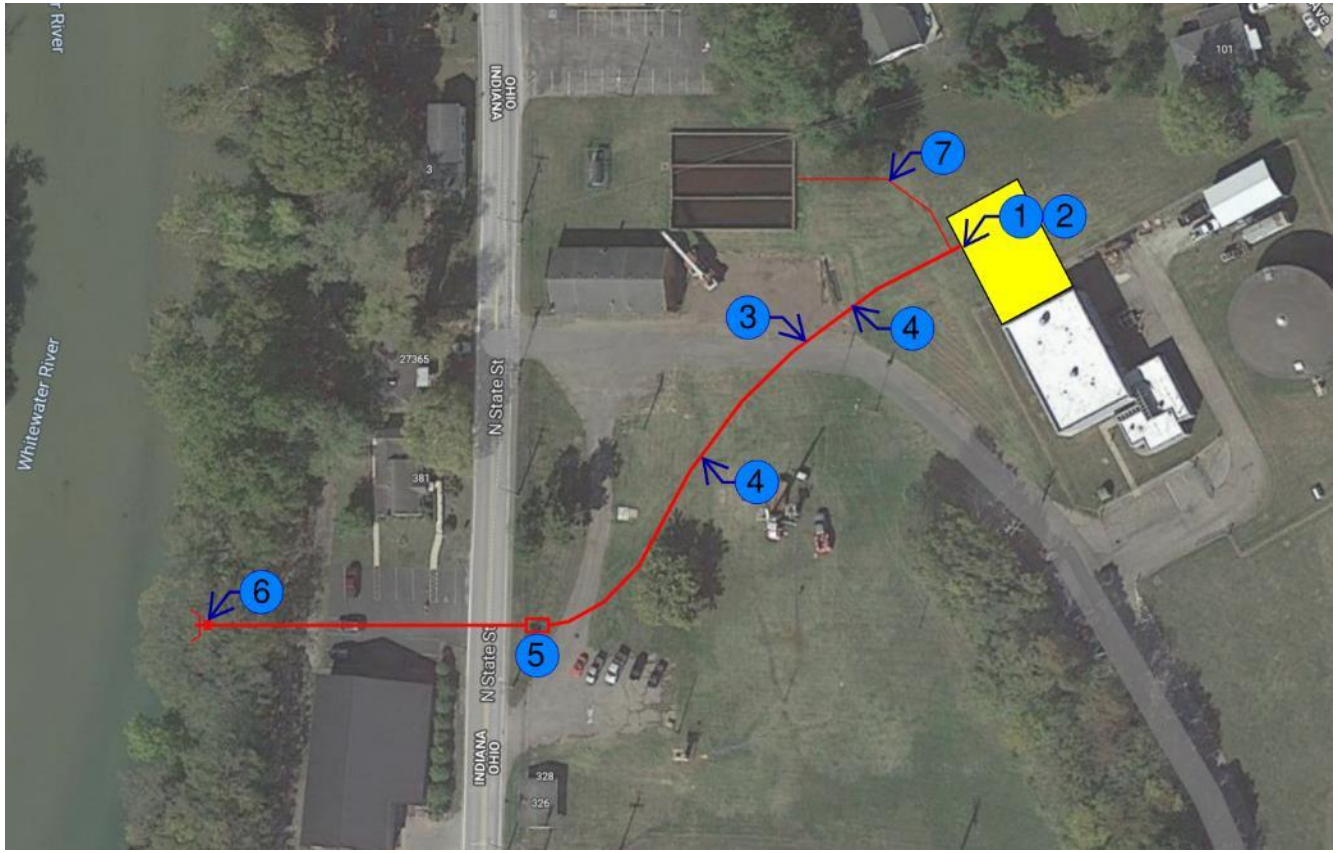


# Concentrate Disposal Challenges

*Wet Well = Scaling Pit*
*Long Pipe = Plugged Pipe*

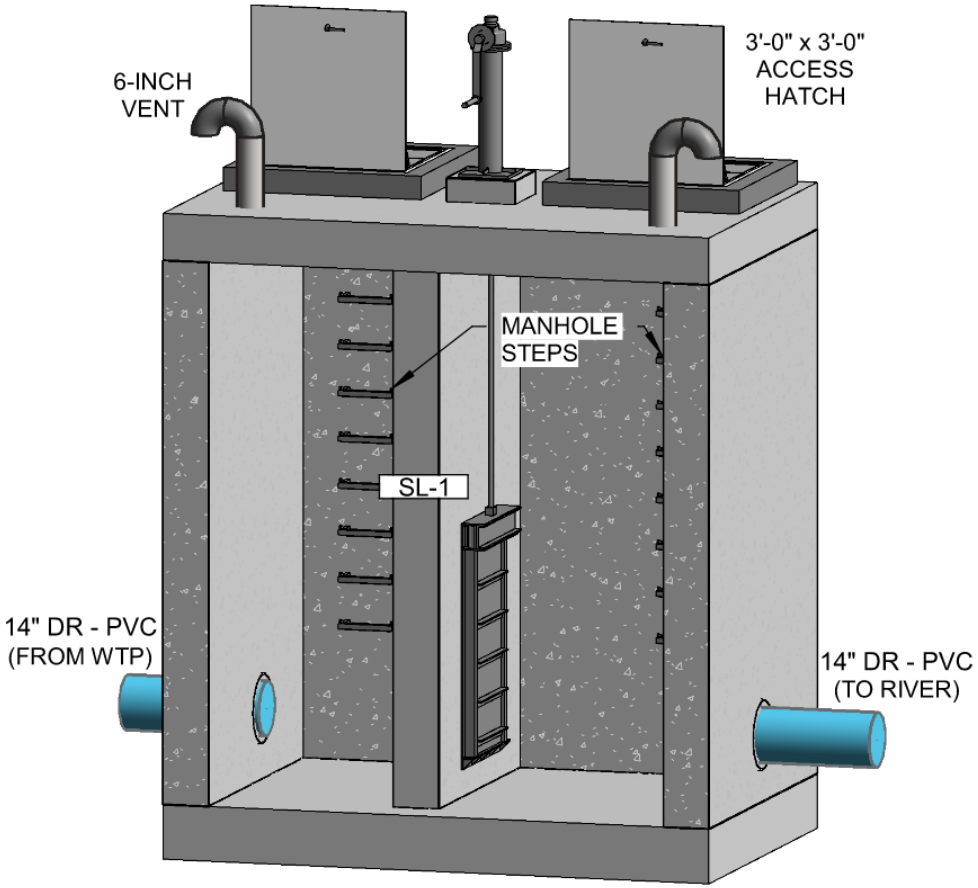
# Concentrate Management

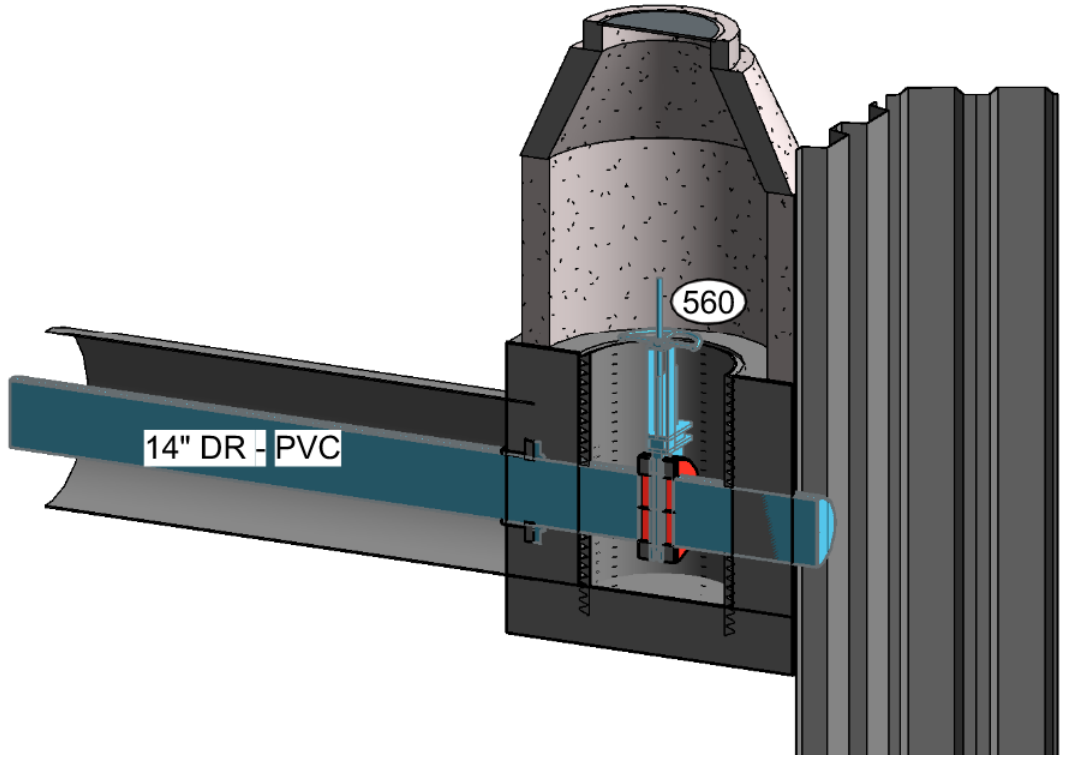
1. Air gap sump
2. RO feed flush
3. C900 pipe
4. Clean outs
5. Slide gate structure
6. Outfall knife gate
7. Emergency discharge to sanitary system



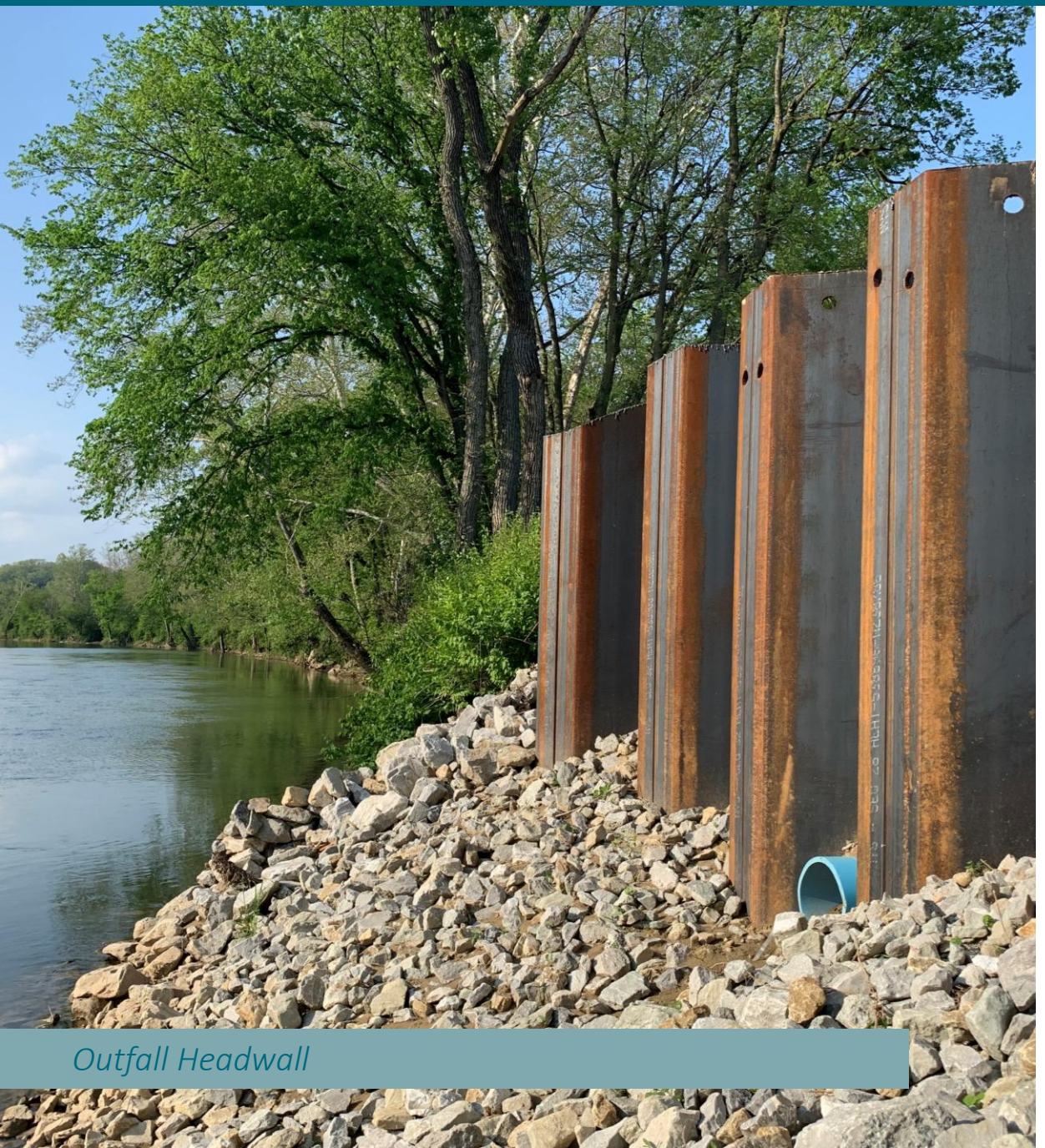

*Concentrate disposal to Whitewater River*

# Whitewater River Outfall

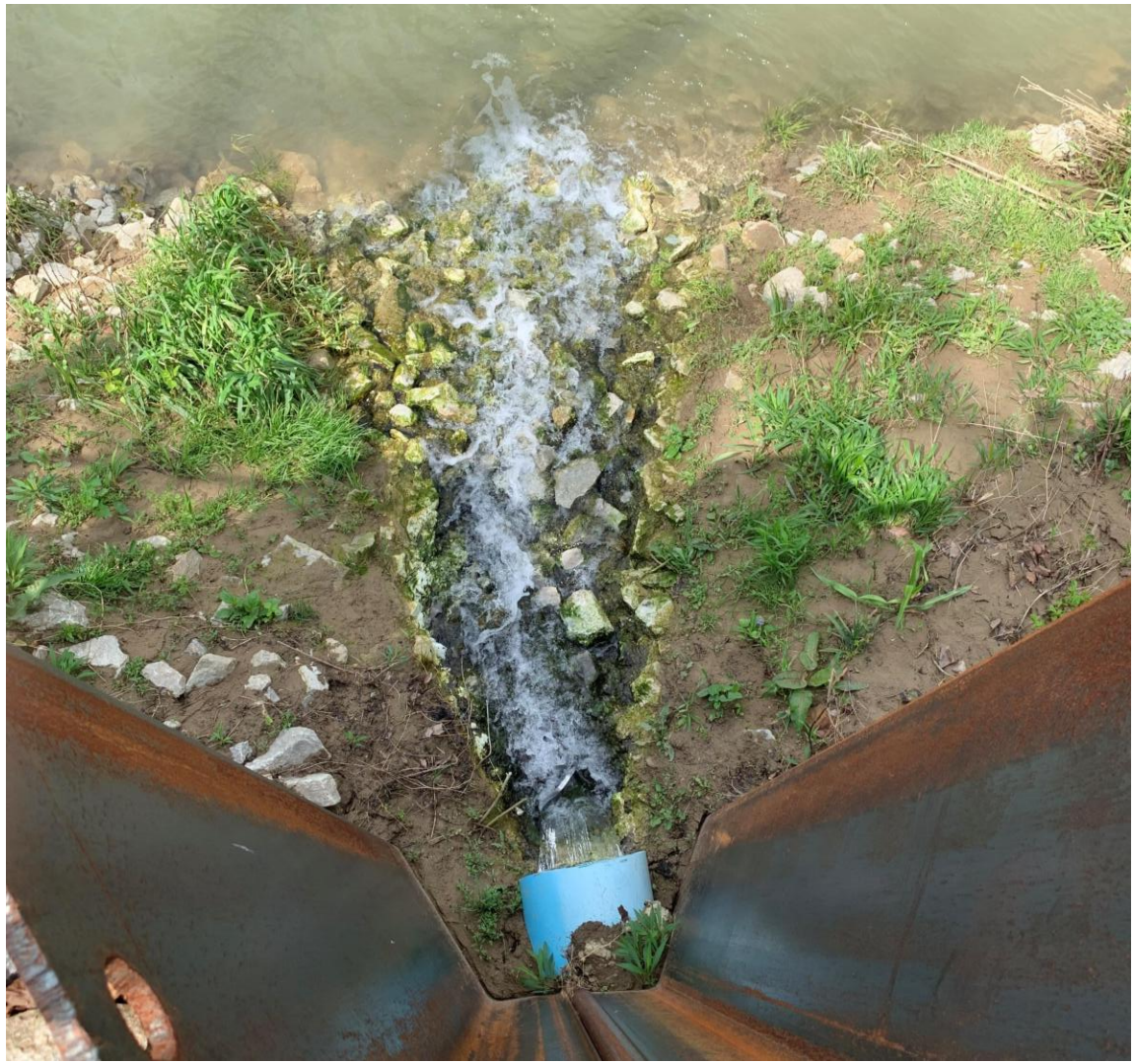


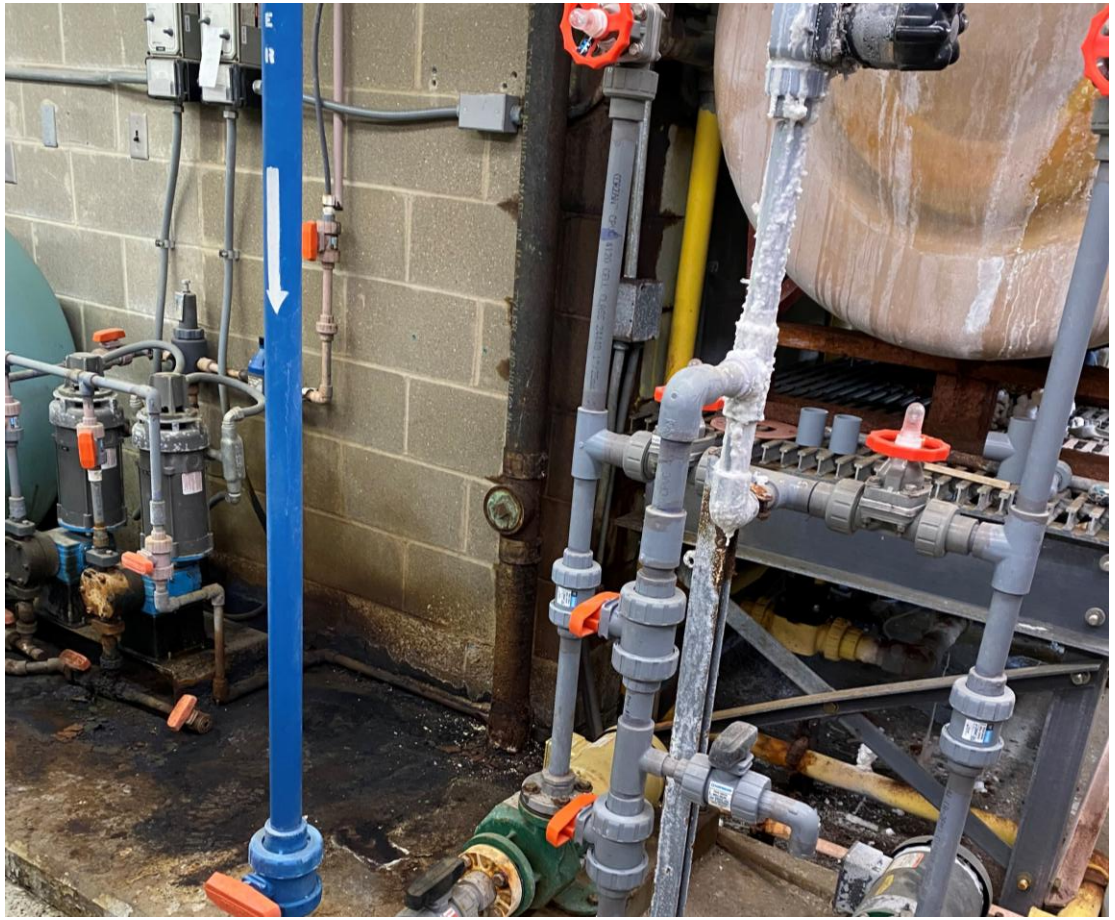
# Whitewater River Outfall



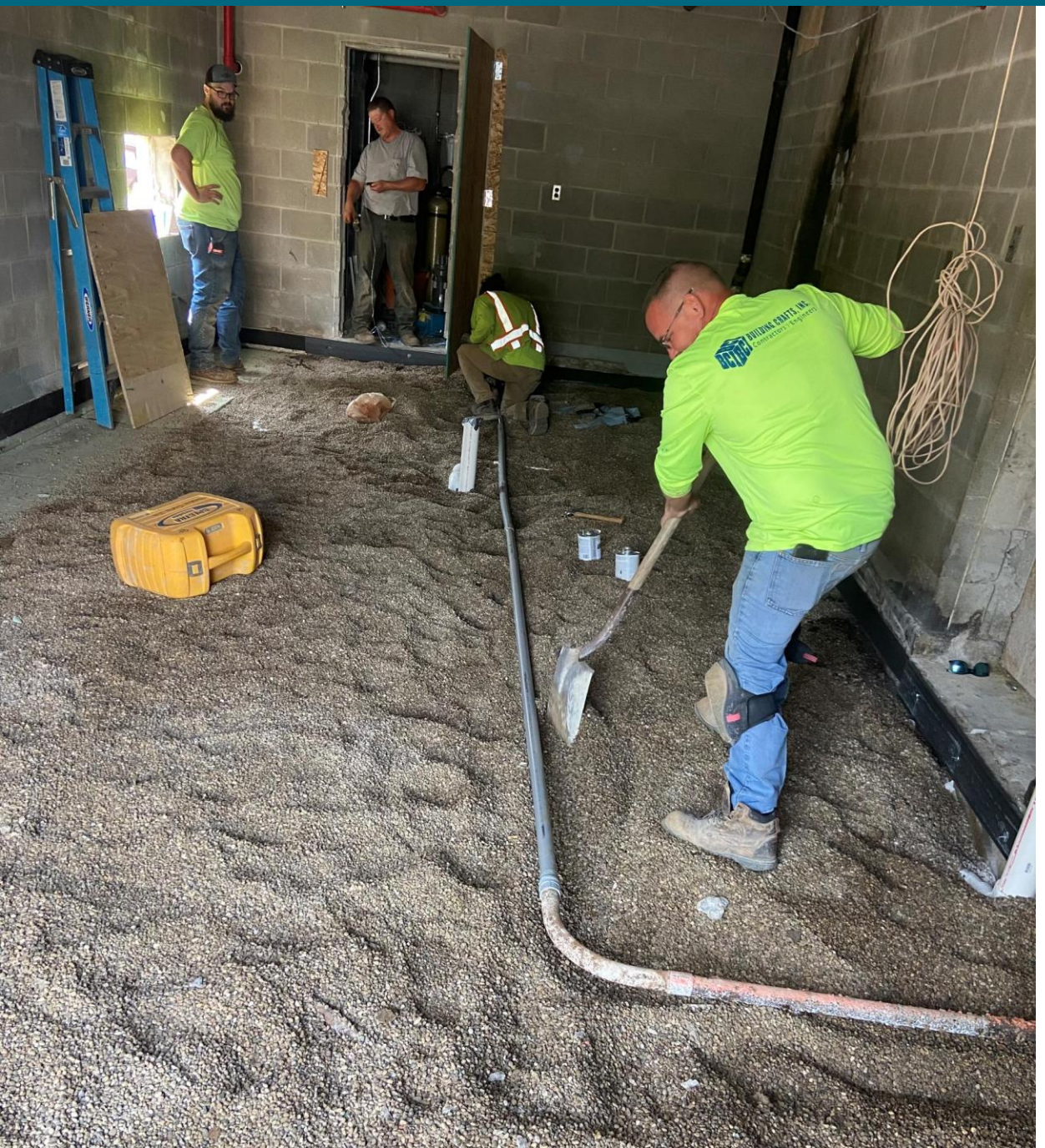
*Outfall Headwall*



# Chemical Room Improvements

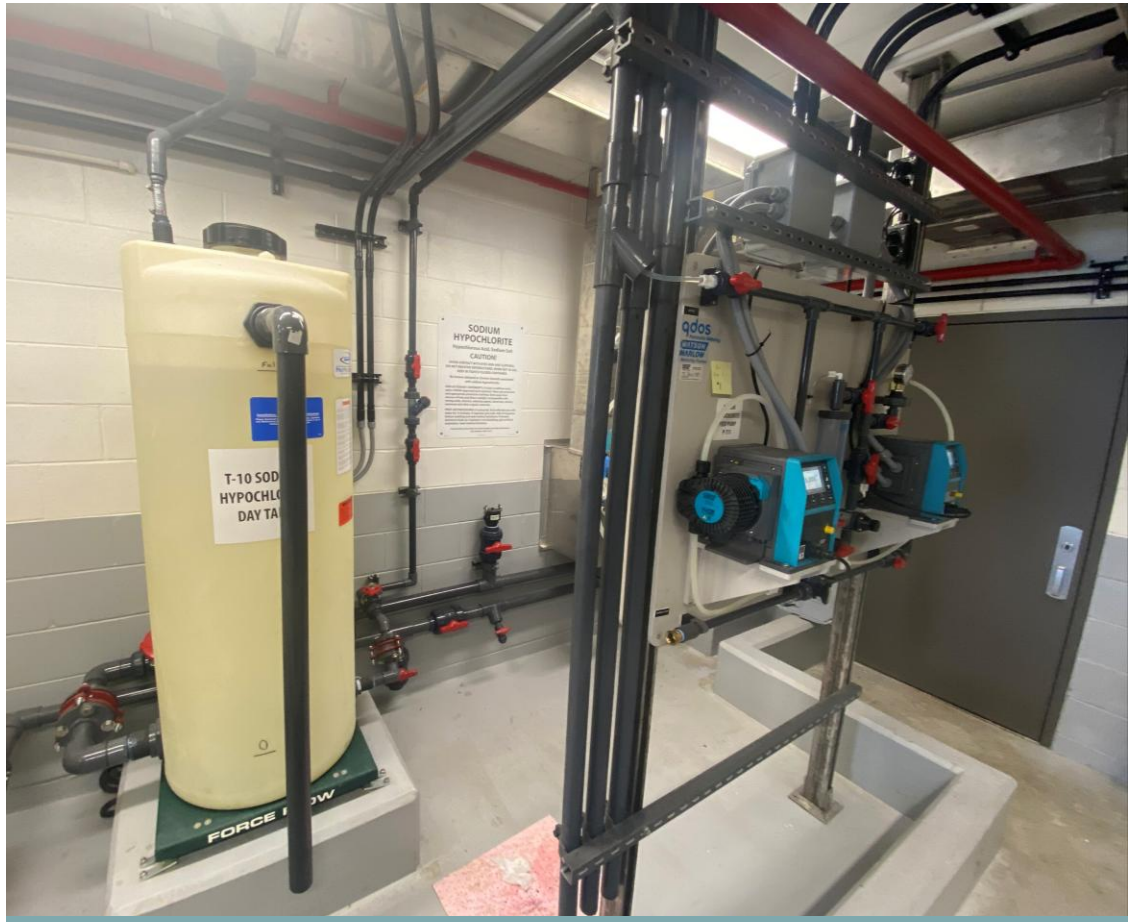


# Slab/Curb Replacement



# Chemical Room Improvements

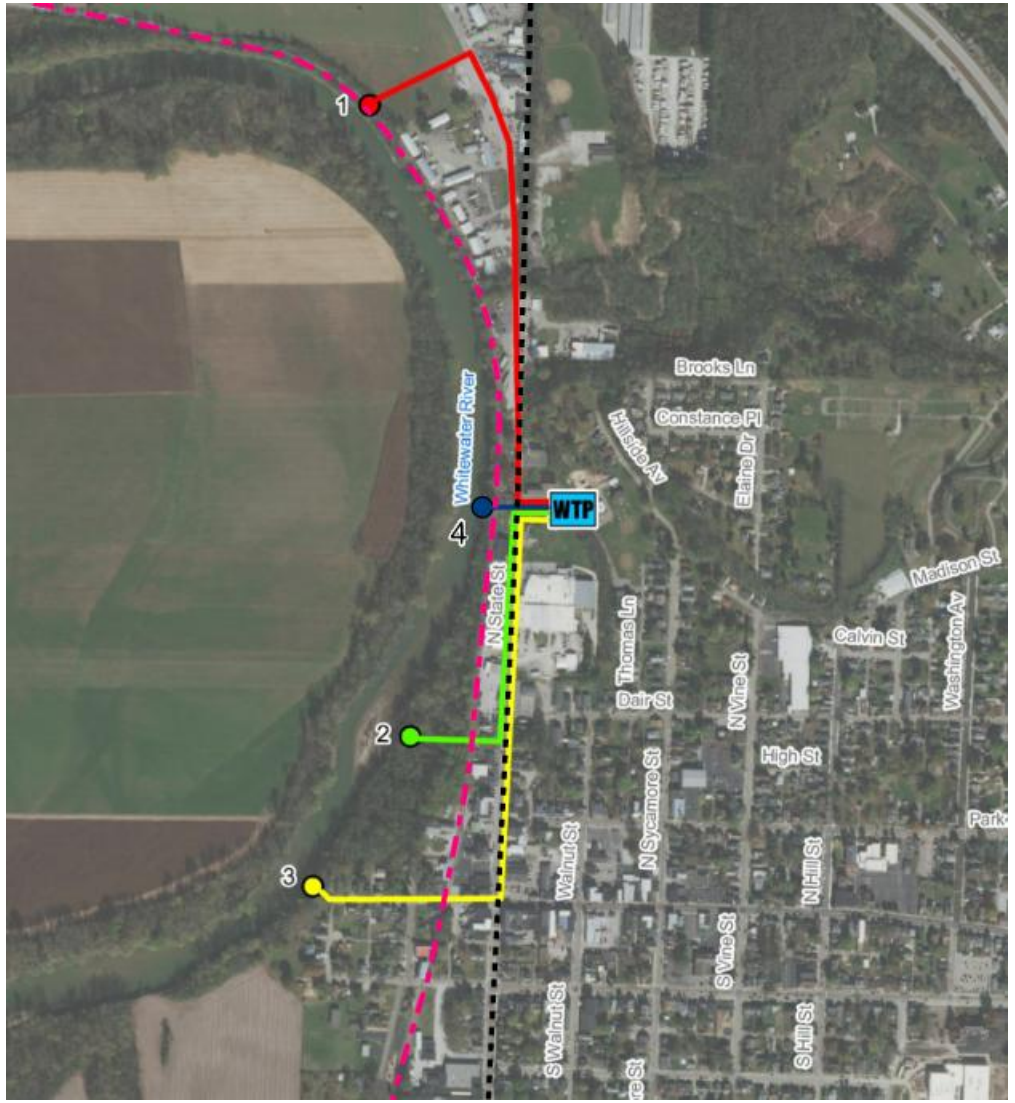

*Hydrofluosilicic Acid*




*Sodium Hypochlorite*

# Permits

- USACE – Section 401 WQC Regional Permit
  - IDNR
- NPDES
  - Antidegradation application
  - Raw water analysis
- OEPA – Plan approval
- Genesee & Wyoming railroad permit

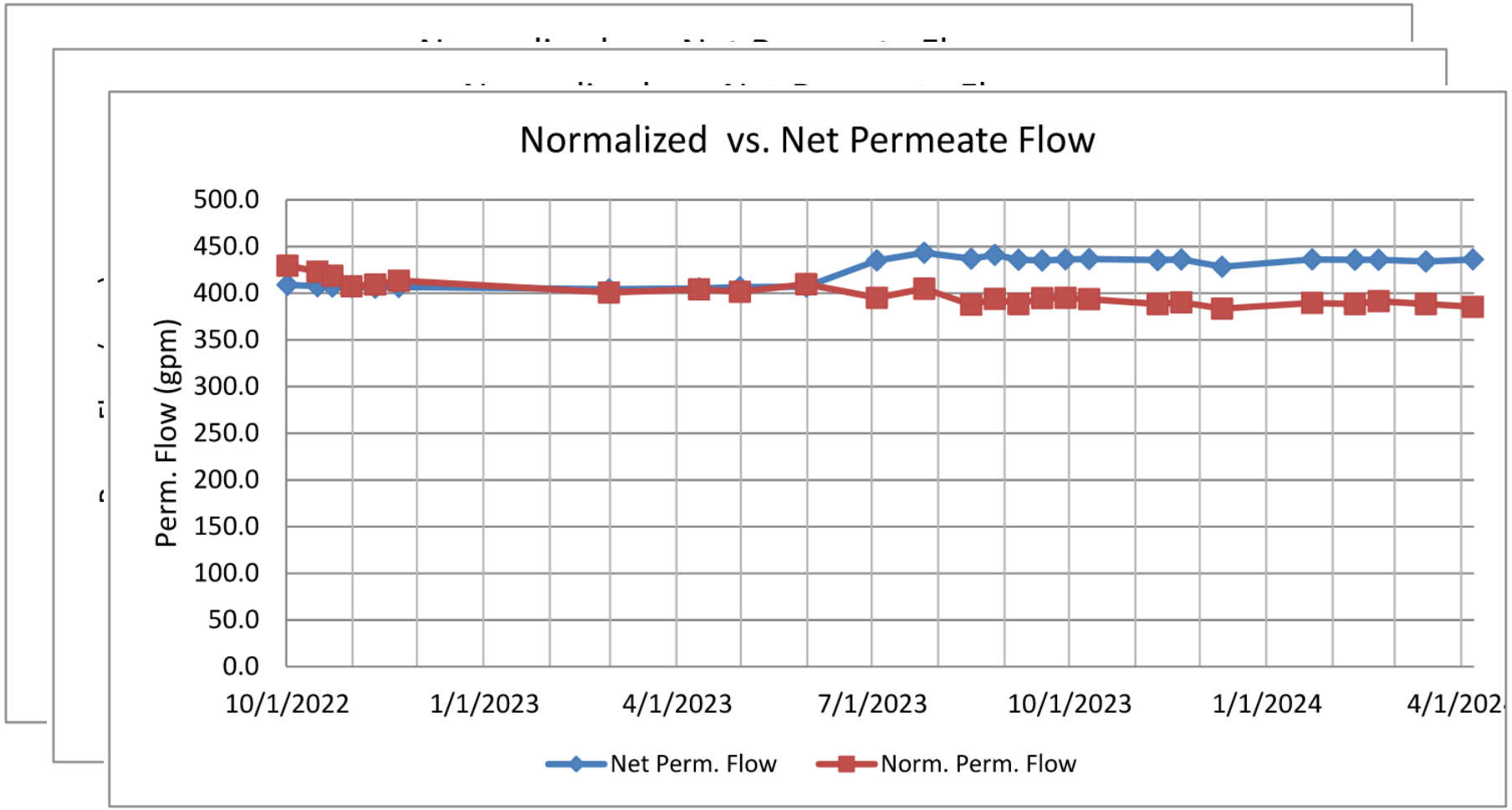



# Genesee & Wyoming Railroad Permit

- Right of way
- Shutoff valves
- Casing pipe
- Minimum separation

# System Performance

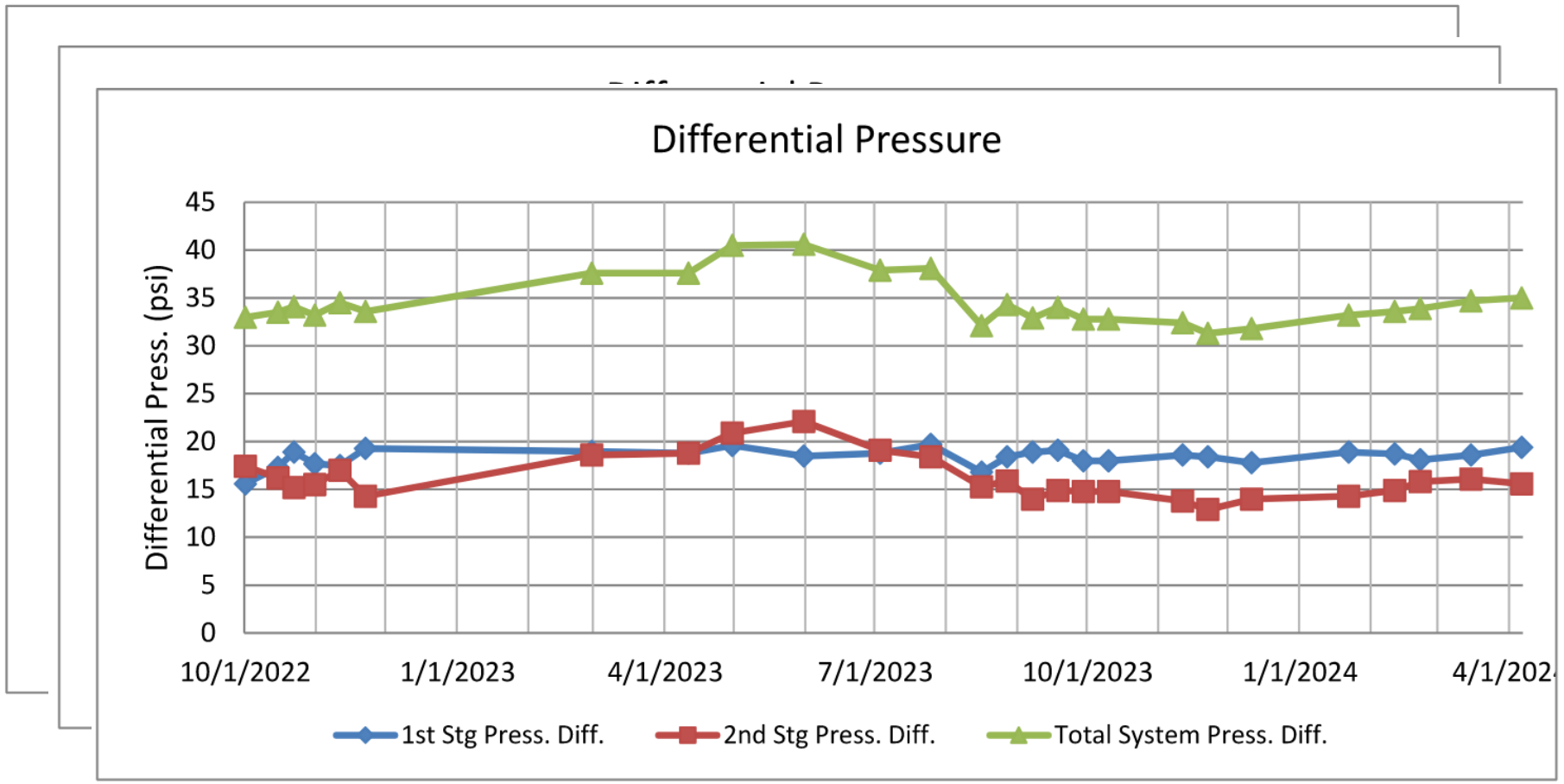
- Online for 1 year 8 months
- Skid No. 1
  - 1st CIP performed 11/2023
- Skid No. 2
  - 1st CIP performed 9/2023
- Skid No. 3
  - 1st CIP performed 8/2023
- Cleaning Regiment
  - RoClean L403 and RoClean L211
  - 2% heated solution
- Additional Cleanings
  - Second CIP's  8/2024




# System Performance:

# Flow

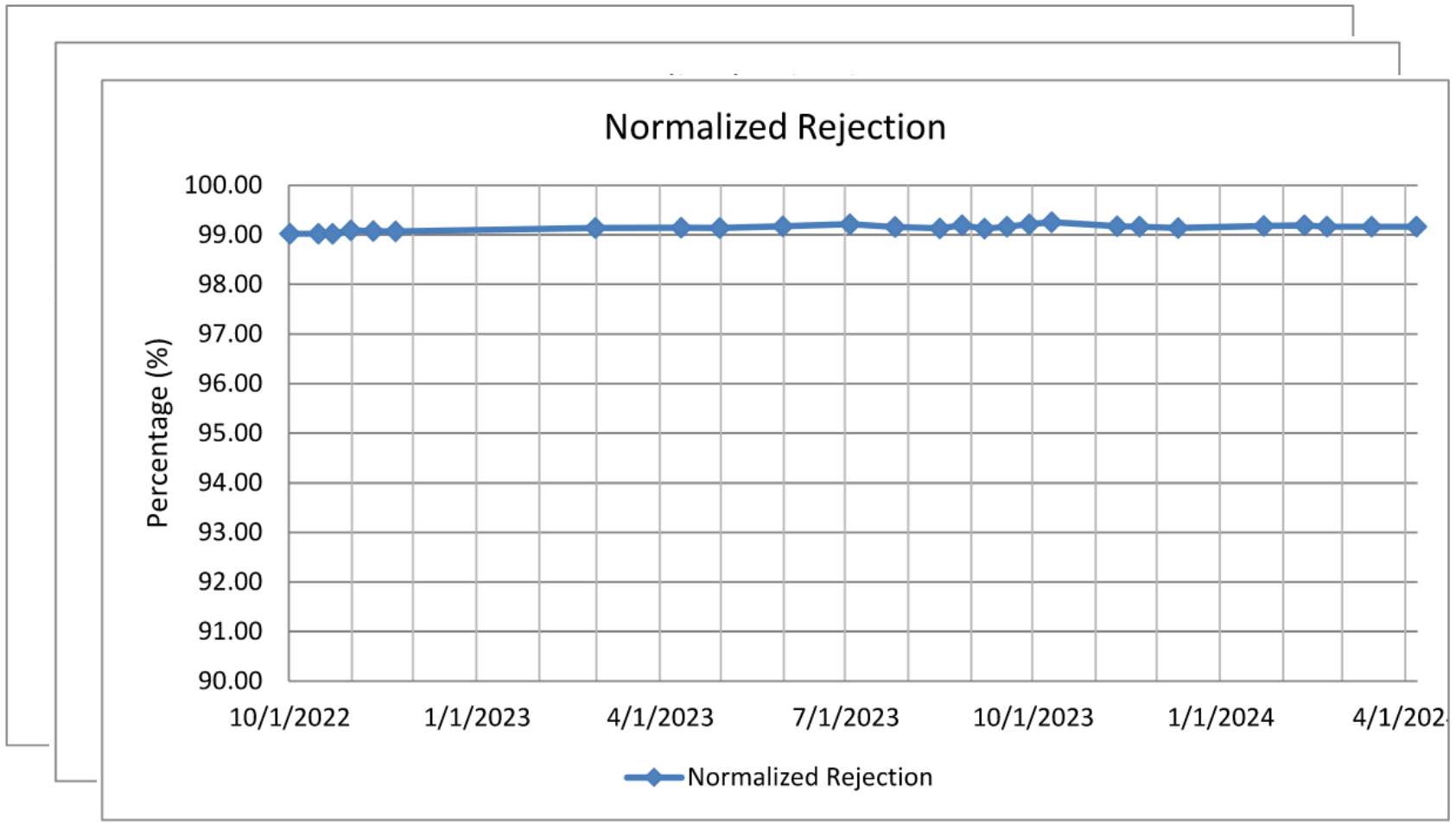
*Skid No. 3*




# System Performance:

# Differential Pressure

*Skid No. 3*




# System Performance:

# Rejection

*FilmTec BW30XFRLE-400/34i*
*Minimum Salt Rejection: 99.1%*

## *Skid No. 3*

# Funding

- **How we are funded**
  - Water Supply Revolving Loan Account (WSRLA)
- **Process to get funded**
  - March 1st for project nominations
    - Design: Application submitted February 2018
      - Conceptual design/general plan for water treatment
      - Basis of design
      - Inorganic raw water analyses for wells
    - Construction: Application submitted February 2019, re-nomination February 2020
      - Capability assurance assessment
- **Interest rate City received**
  - Design – 0% over 5 years, $700,000
  - Construction – 0.53% over 20 years, $6,689,000


# Water Supply Expansion

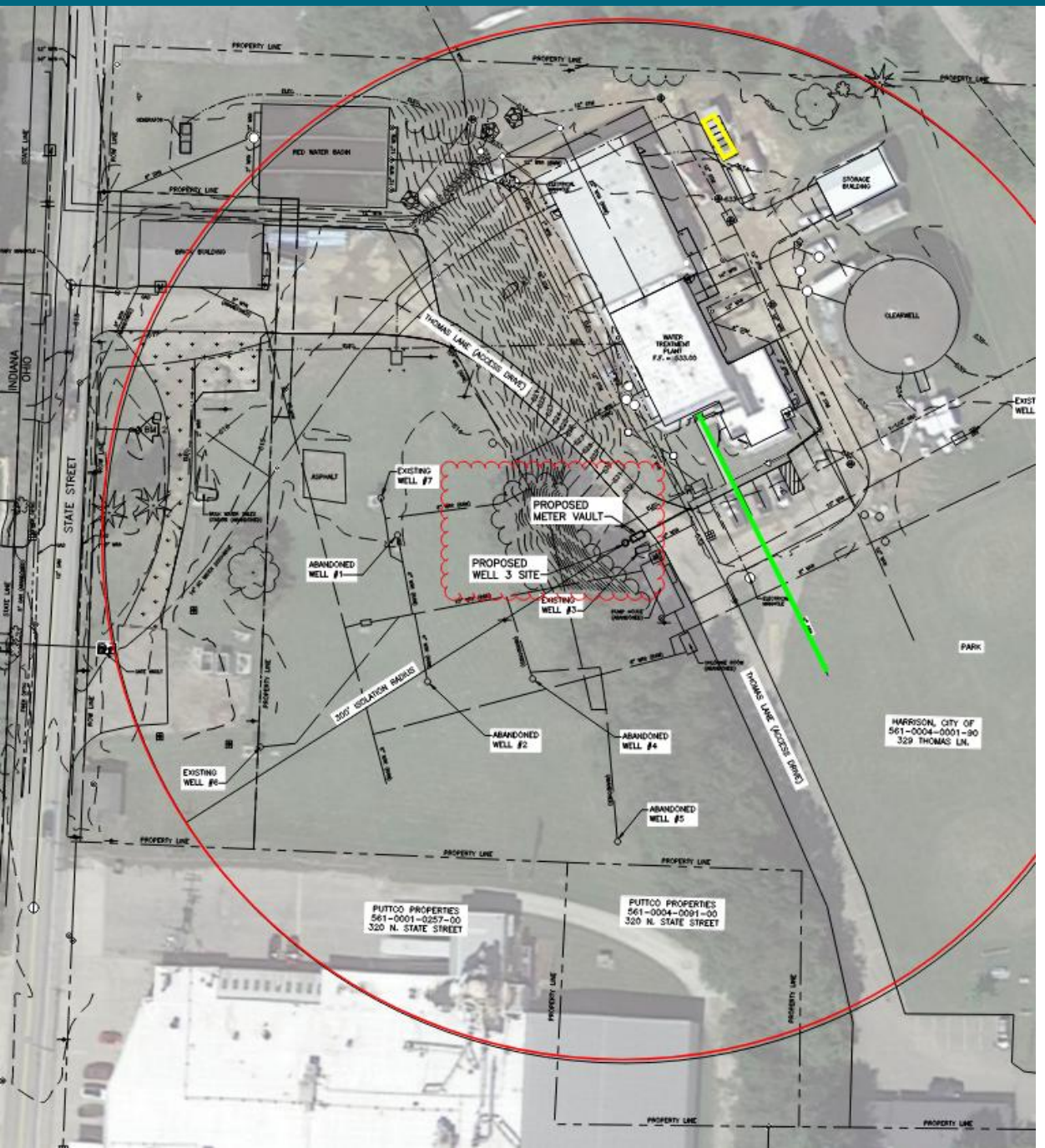
*Prior Water Supply:*

*Four Ohio Wells: 3,5,7 & 8*

*Two Indiana Wells: 1 & 2*

# Ohio Well No. 3

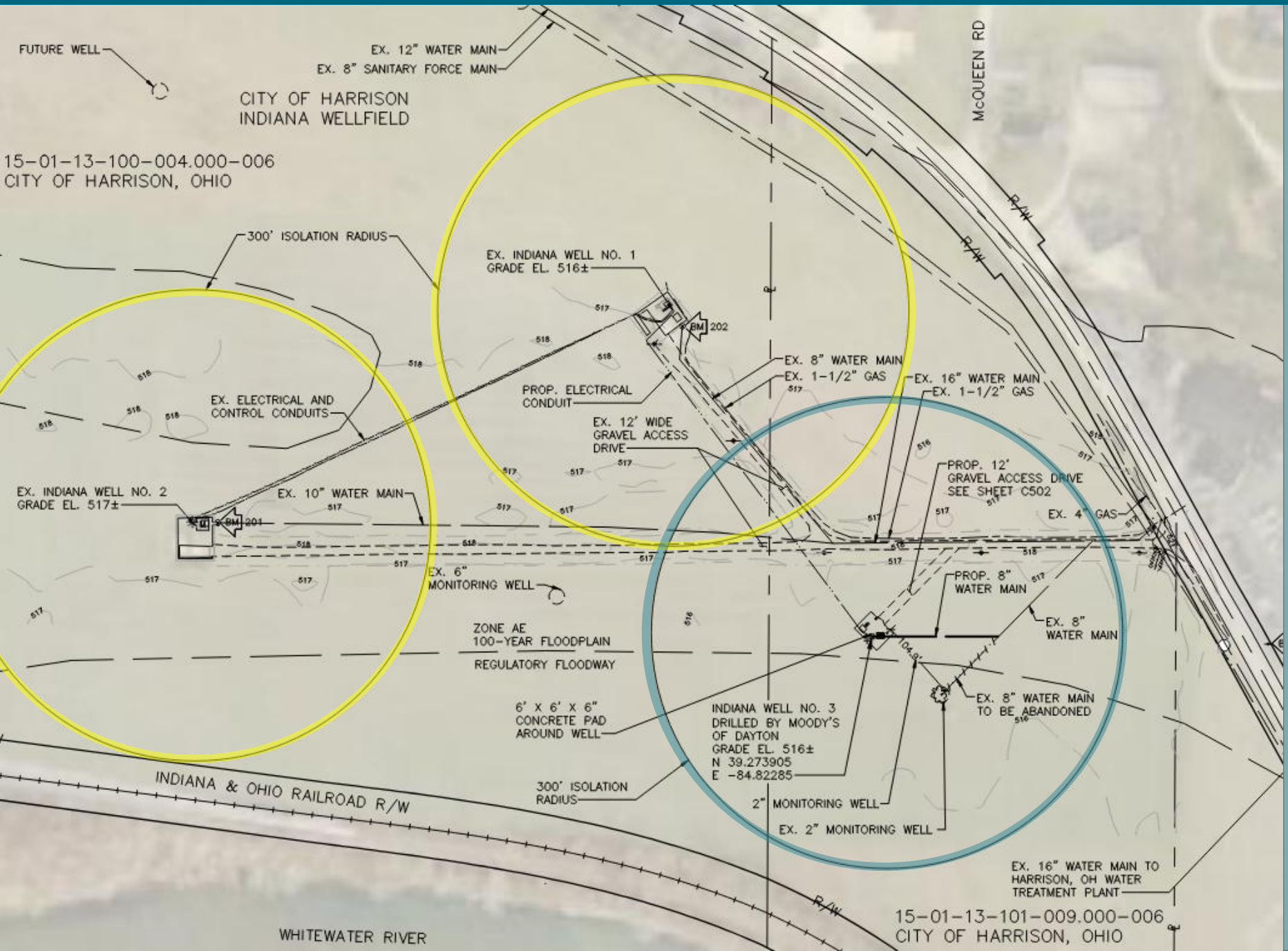
- Originally installed in 1973
- Declining production
- Rehabilitation and lining considered
- Isolation radius considerations
- OEPA not receptive to issuing a variance for a new well




# Ohio Well No. 3

Multiple potential sources of contamination within the 300-foot isolation radius

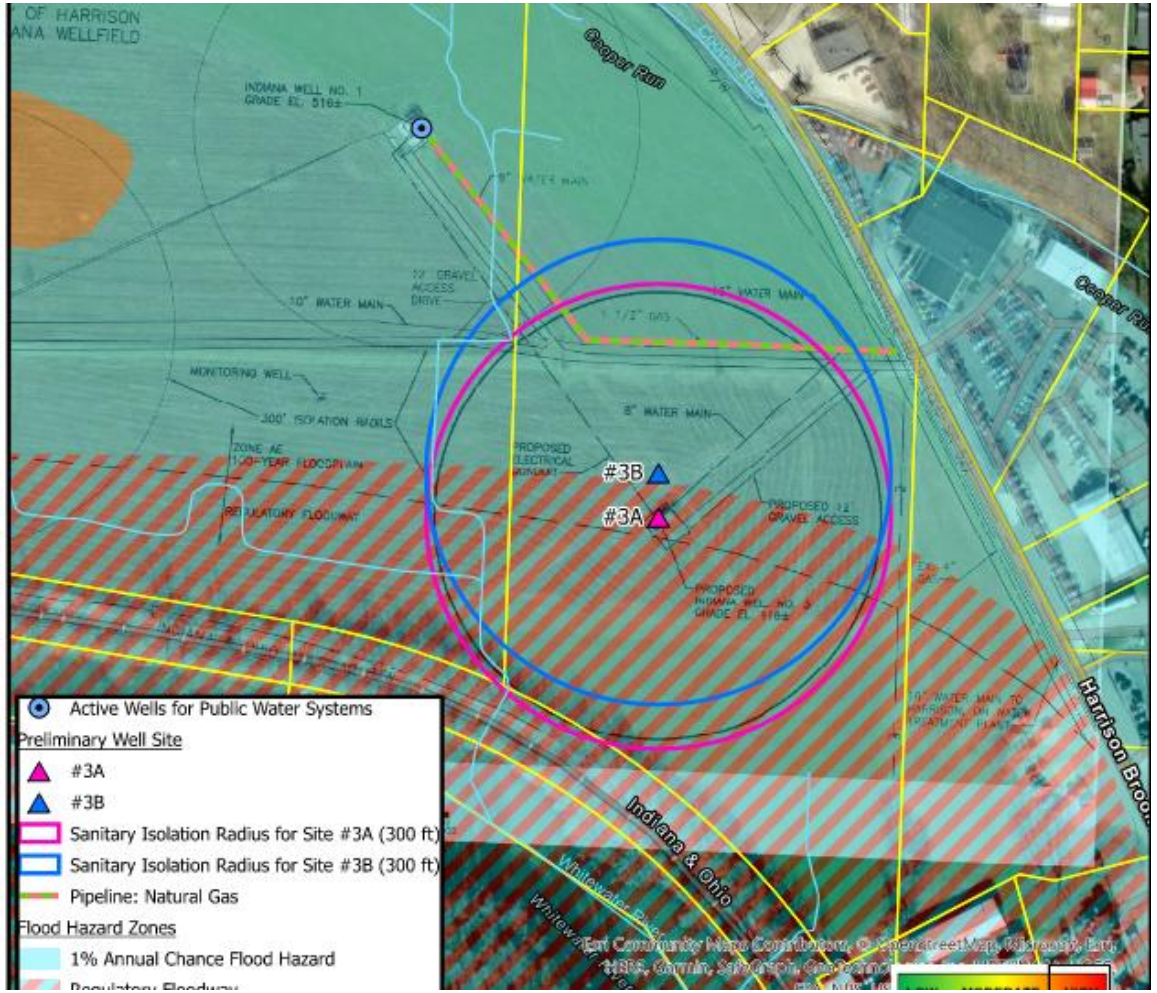
- Sanitary sewer lateral serving the plant
- Emergency generator with diesel fuel storage tank
- Chemicals for water treatment
- Industrial property to the southwest




# Indiana Wellfield

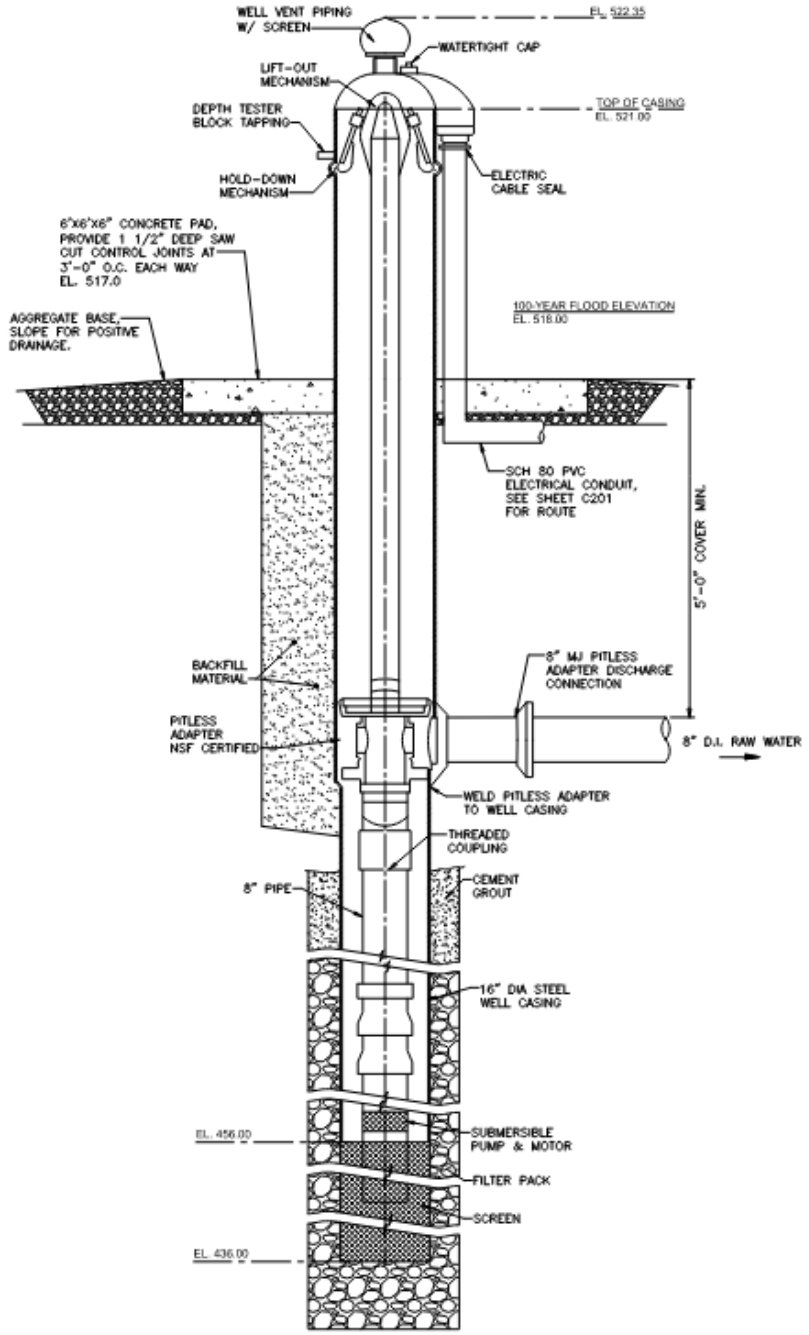
# Indiana Wellfield

- Well No. 3 planned for the southeast corner
- Location shifted north to avoid the floodway of the Whitewater River and a lightly used railroad line
- Also avoided the road and a sanitary force main to the northeast
- Isolation radius contained within City property

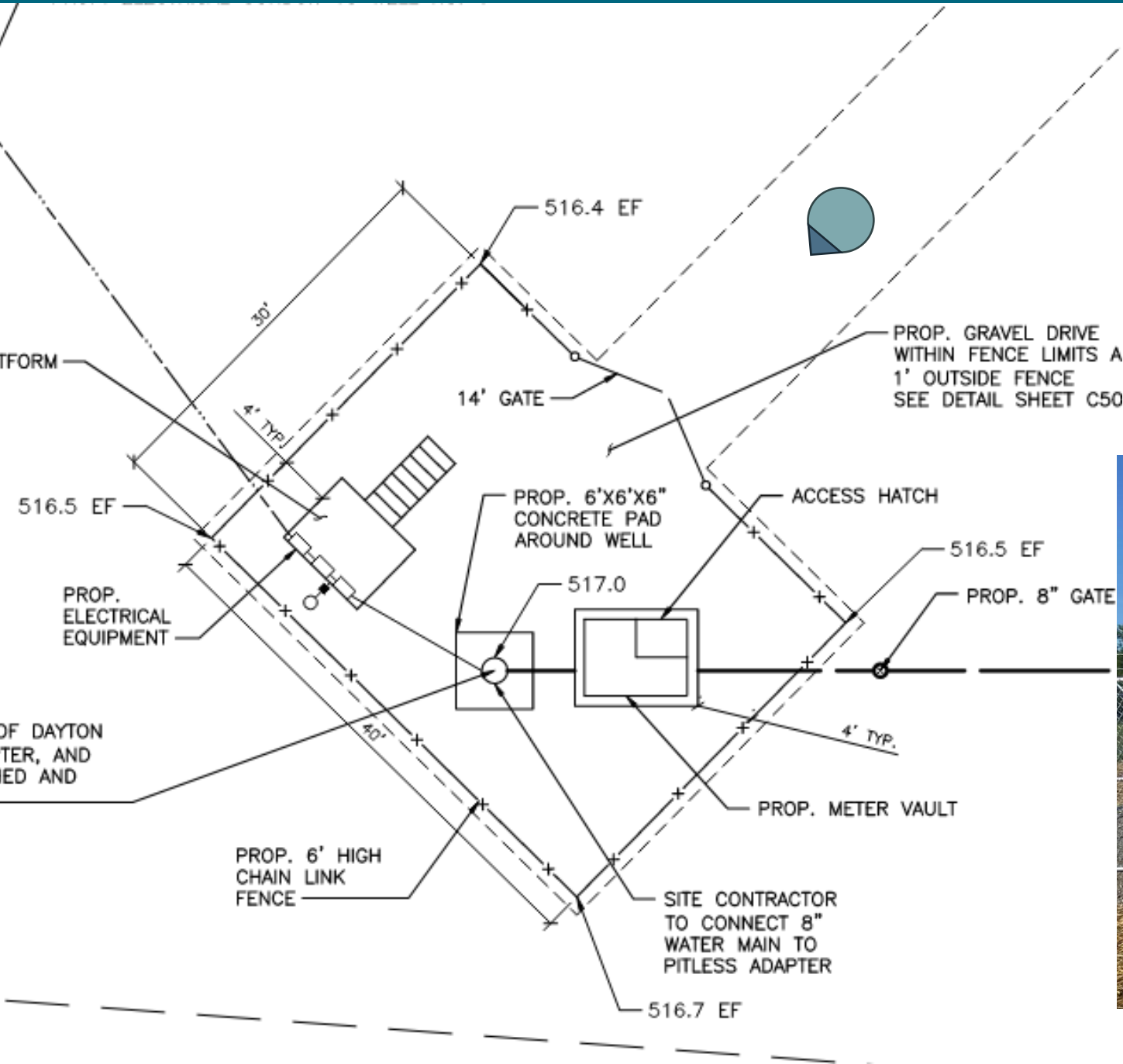


# Well Profile

- Provided for OEPA permit submittal
- Filter pack provided around the well screen
- Annular space grouted
- Pitless adapter
- Surrounding grade sloped away from the well
- Top of casing required to be at least three feet above the flood elevation



# Well Profile




# Thank You

*City of Harrison:*
*Jim Leslie,*
*Public Works Director*

*Terry Knueven,*
*Water Superintendent*

*General Contractor:*
*Building Crafts*

*Contact Information:*
*Brian Phillips*
*bdphillips@fishbeck.com*

# Thank You

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Engineers | Architects | Scientists | Constructors