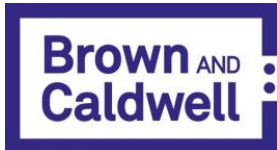


Laying the Foundation: Treatment Selection and Design of the City of Vancouver's First PFAS Treatment System



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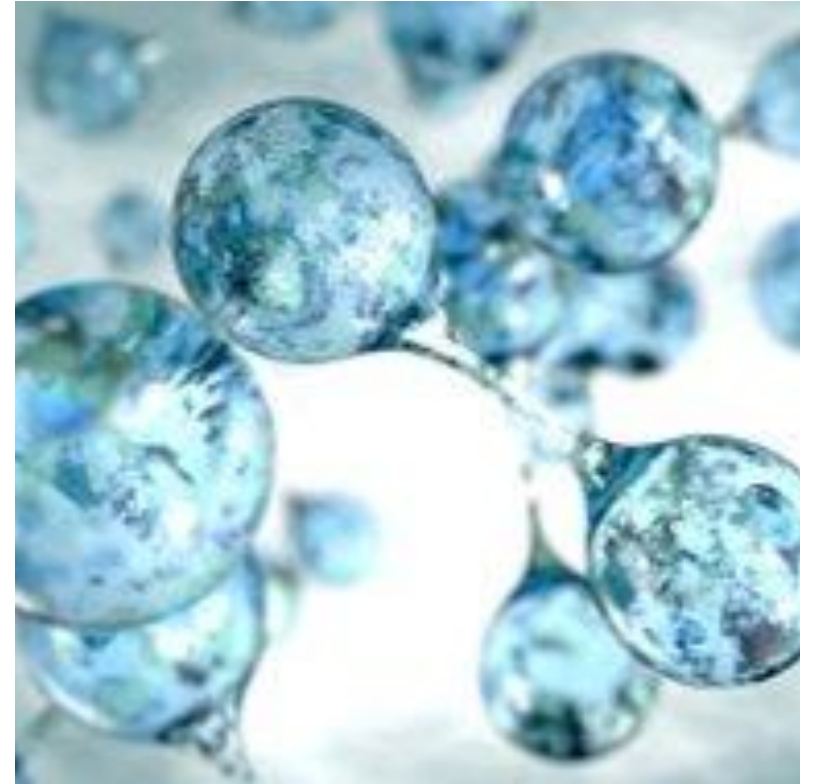
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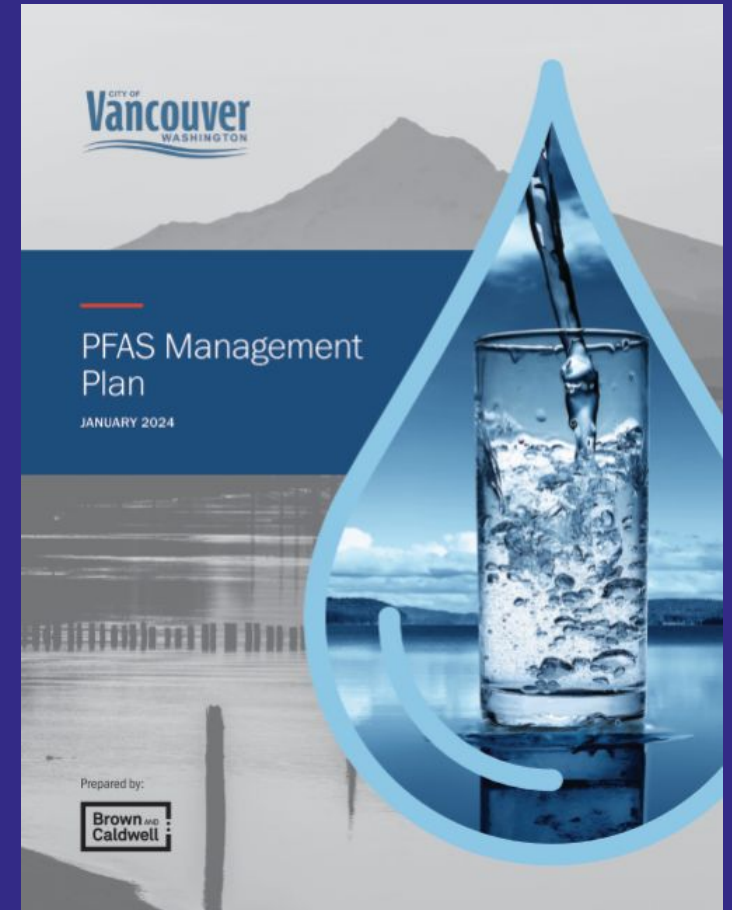
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Presentation Roadmap

- PFAS Overview
- Technology Selection and Decision Drivers
- Design Considerations

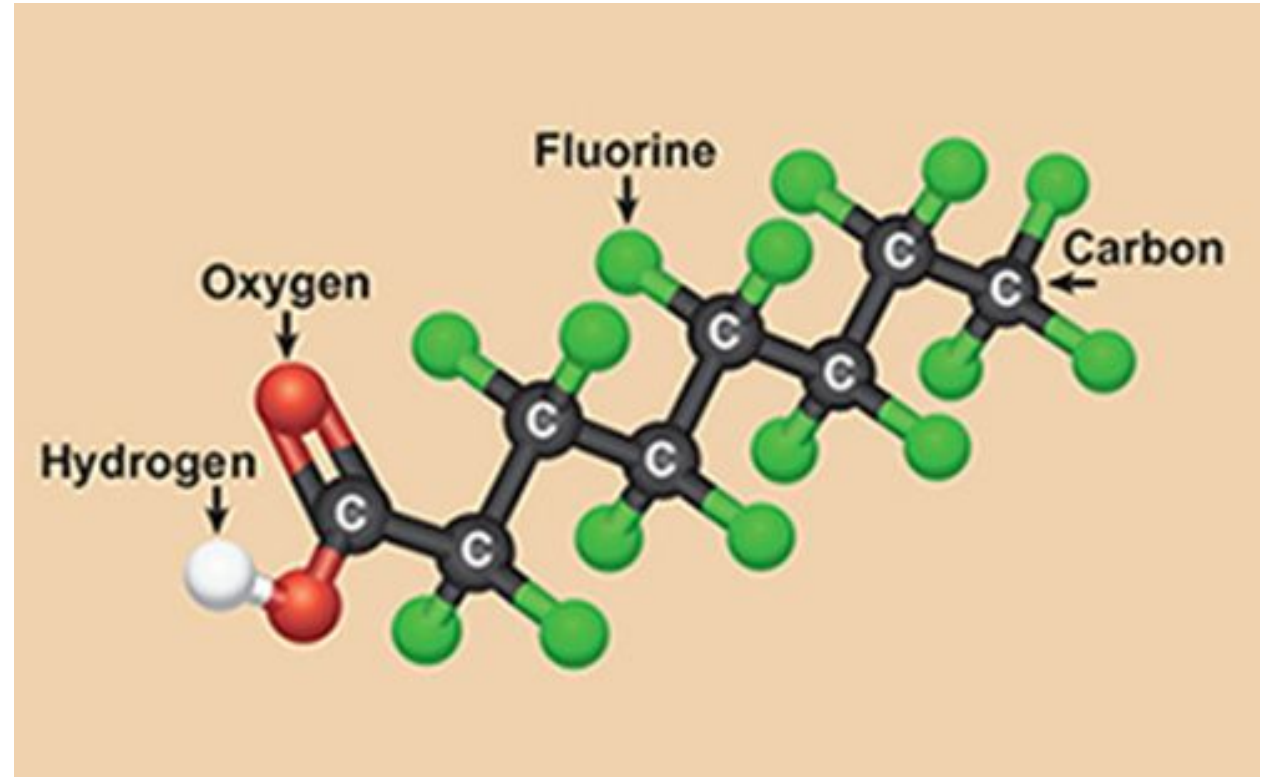


PFAS Overview



PFAS

- Per- and Polyfluoroalkyl Substances (PFAS) are fluorinated surfactants with chronic human health effects
- Extremely persistent and mobile in the environment
- Difficult to destroy



Final MCLs for PFAS

- Compliance
 - Running annual average with quarterly sampling
 - Samples collected at each EPTDS
 - Results below the PQL count as zero for the average
 - PFOA and PFOS have 2 significant figures, all else is 1 significant figure (important for rounding)

Compound	MCLG	MCL	Practical Quantitation Limit (PQL)	Individual MCL	Hazard Index
PFOA	0	4.0 ppt	4.0 ppt	X	-
PFOS	0	4.0 ppt	4.0 ppt	X	-
PFHxS	10 ppt	10 ppt	3.0 ppt	X	X
PFNA	10 ppt	10 ppt	4.0 ppt	X	X
HFPO-DA (GenX)	10 ppt	10 ppt	5.0 ppt	X	X
PFBS	-	-	3.0 ppt	-	X
Hazard Index	1 (unitless)	1 (unitless)	-	-	-

$$Hazard\ Index = \frac{GenX_{water}}{10} + \frac{PFBS_{water}}{2000} + \frac{PFNA_{water}}{10} + \frac{PFHxS_{water}}{10} < 1$$

What is the timeline?



City of Vancouver Discovers PFAS

- 3rd largest utility in state, serves about 277,000 people, 78,000 connections
- Supplied by three regional groundwater aquifers
- Includes 9 Wellfields (water stations), 40 wells, 50 booster pumps, and 1,100 miles of pipes
- ADD of 27 MGD
- PFAS detected in 2020-2021 sampling
 - PFAS Treatability Study
 - Bench- and pilot-scale testing
 - PFAS Management Plan



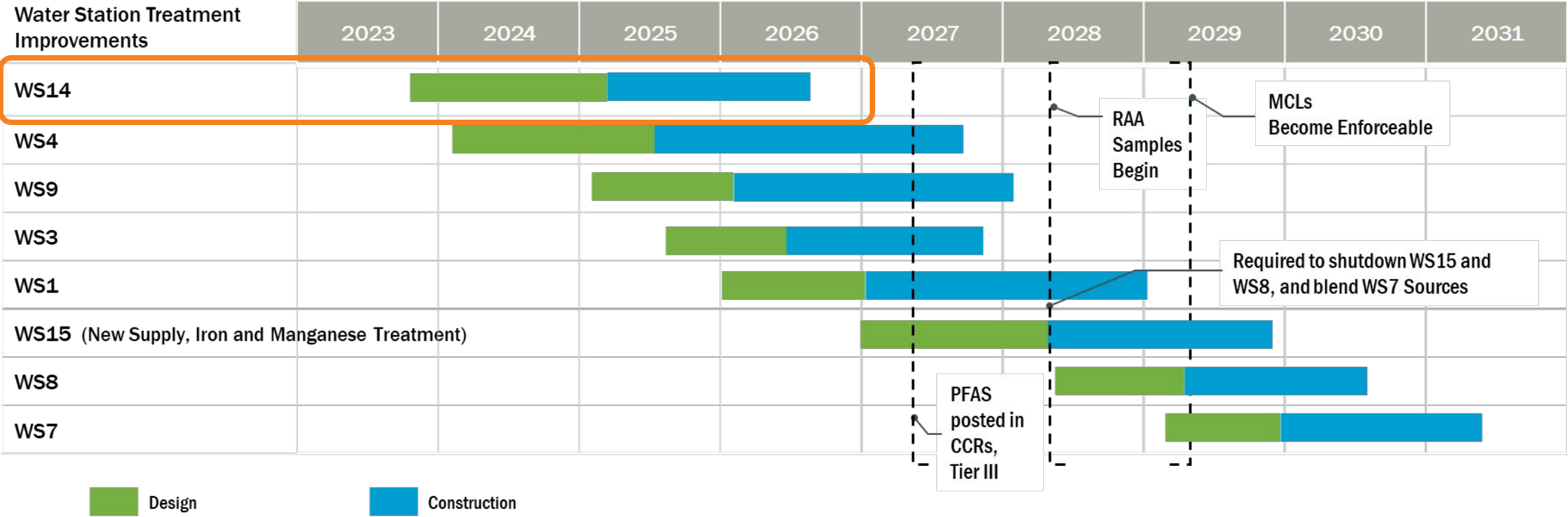
In 2023, Vancouver won 1st in the Best Tasting Water Competition for the Northwest.

We're Hiring!! Water Engineering Manager

City of Vancouver Water Stations Impacted by PFAS



Water Treatment Improvements Implementation Plan



Technology Selection and Decision Drivers

Current Best Available Treatment Technologies

Media Adsorption



Granular Activated Carbon (GAC)



Ion Exchange (IX)

Membrane Separation



Reverse Osmosis (RO),
Nanofiltration (NF)

These technologies have trade-offs

Granular Activated Carbon (GAC)

Ion Exchange (IX)

Pro S

- Established and widely used
- Removes many co-contaminants (TOC, color, T&O, VOCs)
- Can be reactivated
- More resilient to backwash and easier to recovery from a fouling issue

- Some resins have high selectivity for PFAS
- Shorter EBCT and smaller equipment footprint
- Typically more effective for short-chain PFAS

Con S

- Competitive adsorption by co-contaminants
- More frequent media change-outs
- Inefficient for removing short-chain PFAS (e.g., PFBS)

- Higher pressure loss, higher energy cost
- Typically has more pumping upgrades
- Requires pre-filtration due to fouling risk
- Other anions can compete (e.g., sulfate and nitrate) reduce IX resin efficiency
- Generally, IX media more expensive than GAC
- Disposal via incineration or landfill

How to select the right PFAS treatment solution?



- GAC vs IX

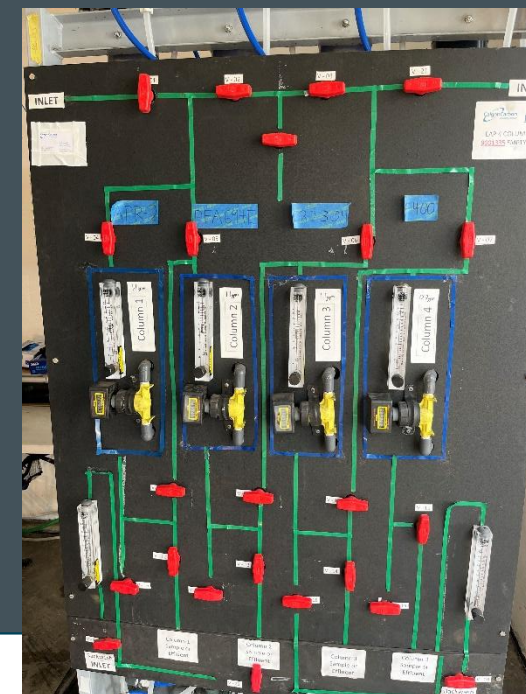
Technology
Trade-offs
Comparison

Preliminary
sizing
and
evaluation

- Capital and
O&M Cost
comparisons

- Bench-scale (RSSCT)
- Pilot
Testing

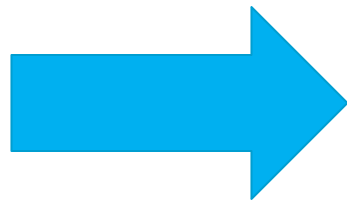
Testing



Options to Design with Flexibility for the Future

Uncertainties:

- Potential future changes in media options on the market (novel media; FLUORO-SORB[®], etc.)
- Media supply chain issues that could impact GAC or IX
- Potential future limitations on disposal of spent media
- Potential future changes in regulated compounds



- Consider adding design elements to switch GAC to IX, or IX to GAC

Design considerations for treatment selection flexibility

- Considerations depend starting technology
- Less cost impact for GAC to IX, and more cost impact for IX to GAC
- Operational flexibility



FIL-TREK® UFH Series

Design Feature Added To Transition from GAC to IX in Future	Implement Now	Consider for later
Upsize exterior pipe size for future IX	X	
Allocate tees and space for prefiltration	X	
Construct pad for prefiltration		X
Outlet screens with smaller slot size for IX media retention	X	
Pump upgrades for IX headloss		X

Design Considerations

Water Station 14

- 3,200 gpm facility
- 3.35 acre parcel
- Three wells and associated wellhouses
- Air stripper for pH control
- Two booster pumps
- OSHG for chlorination
- Fluoridation with sodium fluoride



Design Criteria



- 3 lead/lag pairs of 12 ft diameter vessels, 40 lbs of media

Parameter	Units	Design (3 Wells)	1 Well	2 Wells	Backwash Cycle (1 vessel pair offline)
Vessel pairs online	N/A	3	3	3	2
Maximum operating flow	gpm	3,200	1,100	2,200	2,256
Flowrate/vessel	gpm	1,067	367	733	1,128
Empty Bed Contact Time (EBCT)	min	9.6	28	14	9.1
Hydraulic Loading Rate	gpm/sf	9.4	3.2	6.5	10

GAC with flexibility to go to IX Design Criteria



Parameter	Units	GAC Design (3 Wells)	IX Design (3 Wells)
Vessel pairs online	N/A	3	2
Maximum operating flow	gpm	3,200	3,200
Flowrate/vessel	gpm	1,067	1,600
Empty Bed Contact Time (EBCT)	min	9.6	2
Maximum Hydraulic Loading Rate	gpm/sf	9.4	14

Controls/Automation - Vessel Flow Options

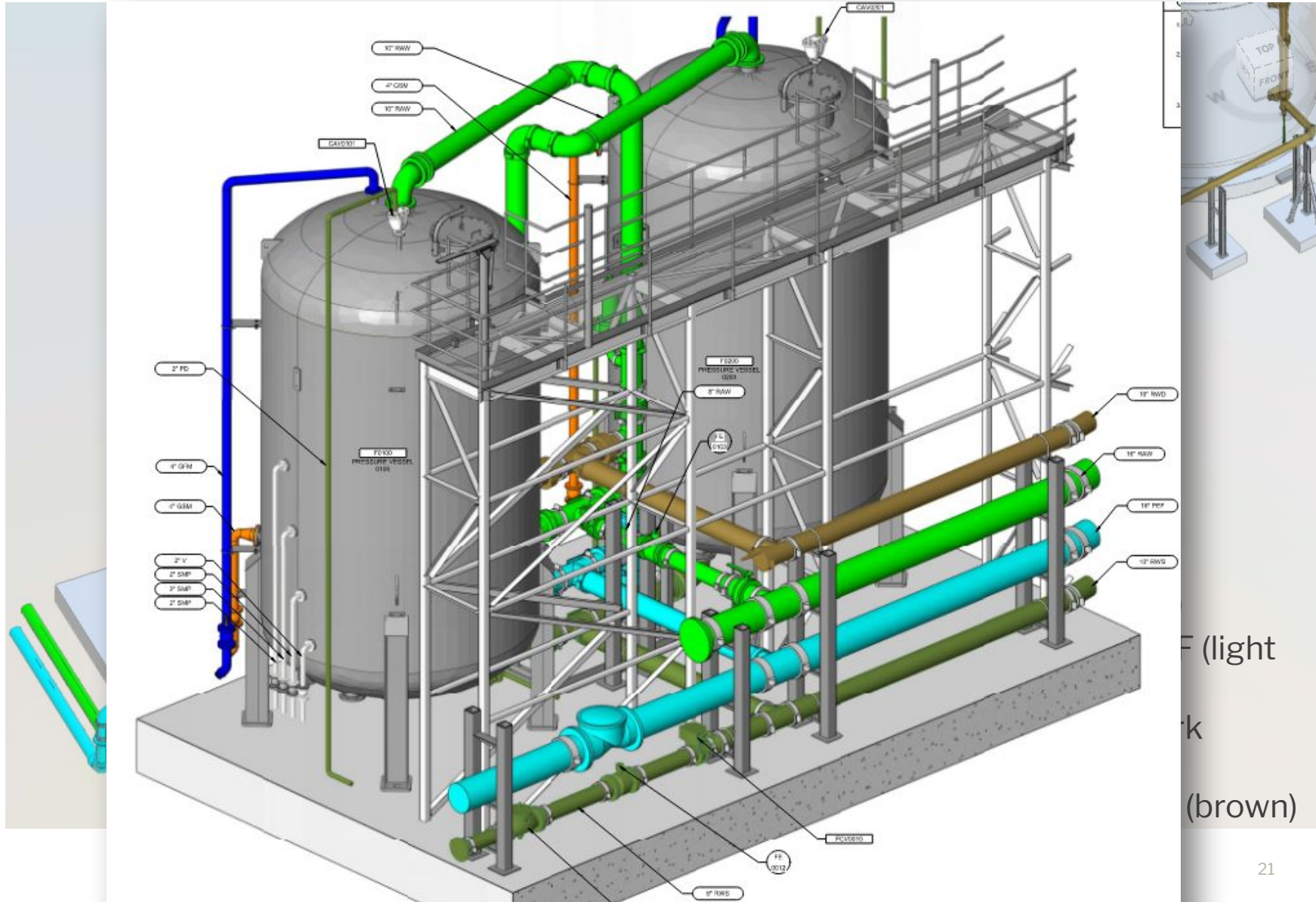
- 1. Manual: All Valves Manual, No Flowmeters**
- 2. All Automated: All Valve Automated and Flowmeters**
- 3. Hybrid: Manual Valves with Addtl Automated Throttling Valves and Flowmeters per Vessel Pair**



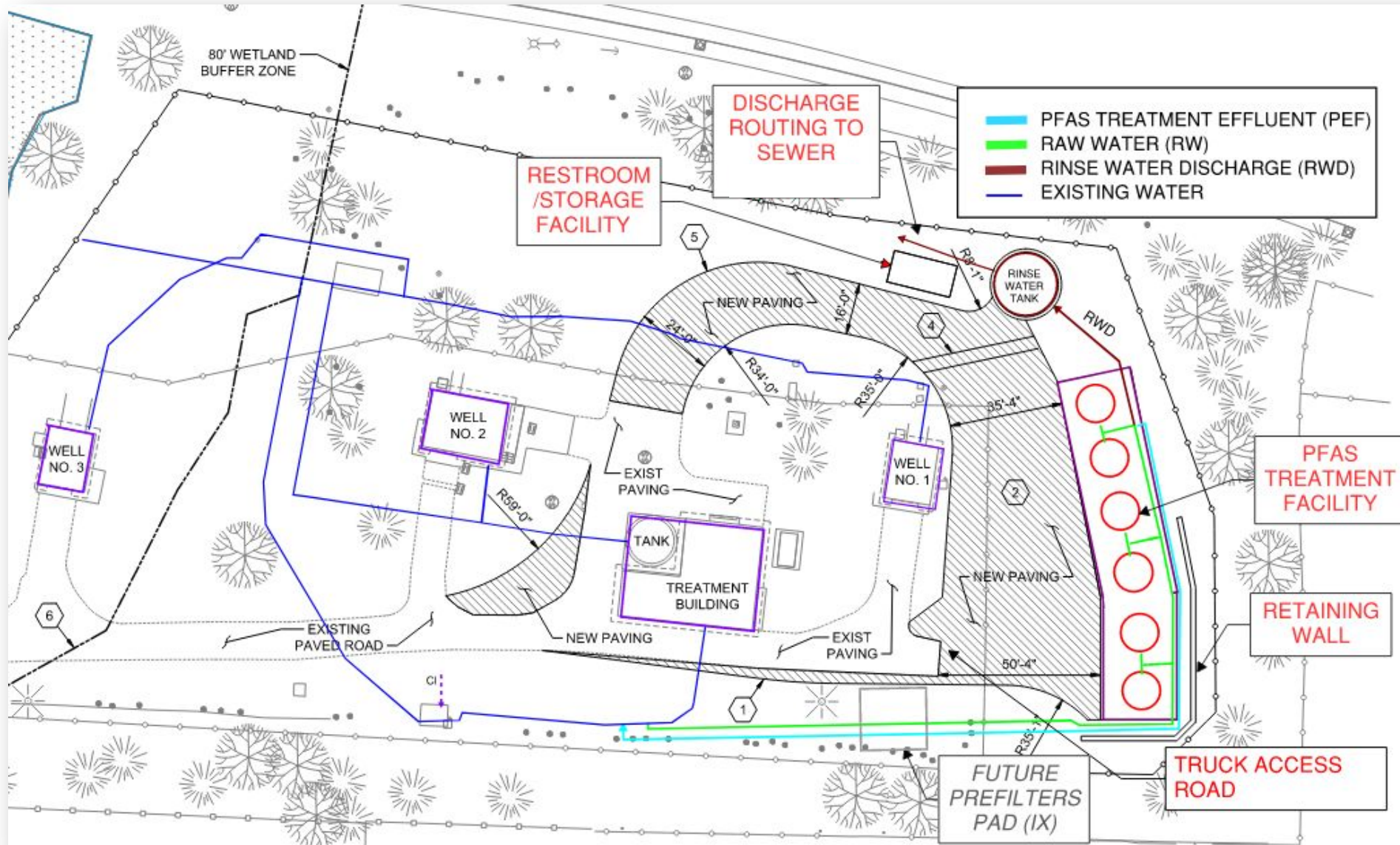
***Cost Adder for Automated Valves:
\$50,000 - \$150,000 per pair**

Laying the Foundation

- Automation
 - Flowmeters and control valves for each pair
 - Flowmeter and control on backwash supply
- Equipment Access
 - Boom lift access
- Rinse Water Tank
- Prechlorination
- Design Standards
 - Asset Tagging



Design Site Layout



Site Considerations

- Existing wetlands (0.22 and 0.01 acres)
 - Rated Category III
 - 50 ft buffer
- Infiltration testing revealed high groundwater levels
- No existing sewer
- Assessed different connection points
- Required coordination with Clark Regional Wastewater District
- Negotiate Letter of Discharge



SRF Funding

- Secured \$12.7M in SRF grant
- Developed SRF Compliance Plan
- Requirements
 - Build America Buy America (BABA) and American Iron and Steel (AIS)
 - PFAS Treatability Study (Brown and Caldwell, 2022) allowed for BABA waiver
 - Cultural Review for 106 Determination
 - Labor Compliance
 - Davis Bacon
 - Prevailing Wage
 - Disadvantaged Business Enterprise
 - DOH review
 - Contractor NTP by July 2025
 - Records retention for 6 years

Summary

Summary

- WS14 lays the foundation for the additional 5 PFAS design projects
- Design for future flexibility
- Tight timeline with permitting requirements requires advancement of design milestones quickly
- Bid close this week with facility start-up in 2026





Thank you.
Questions?

The logo for Brown and Caldwell is centered on the page. It consists of the company name in a dark blue, sans-serif font. The word "Brown" is on the top line, followed by "AND" in a smaller font size. The word "Caldwell" is on the bottom line. The entire text is enclosed within a dark blue rectangular border. To the right of the text, within the border, are two small dark blue circles stacked vertically.

Brown AND
Caldwell