

# ***Out with the Old and In with the New! Replacement of Diatomaceous Earth Filtration***

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# Agenda

## Carson City, NV

- Overview of Water Supply
- Overview of Quill WTP
- Project Drivers

## Solving the Problem

- Alternative analysis
- Technology selection
- Design Challenges and Decisions





# Carson City Water Supply Overview

- Multiple sources of supply
- Quill Water Treatment Plant
  - 30 years old
- Treats water from 3 surface water sources
  - Ash Creek
  - Kings Creek
  - Marlette Lake Water System



# Quill WTP Overview

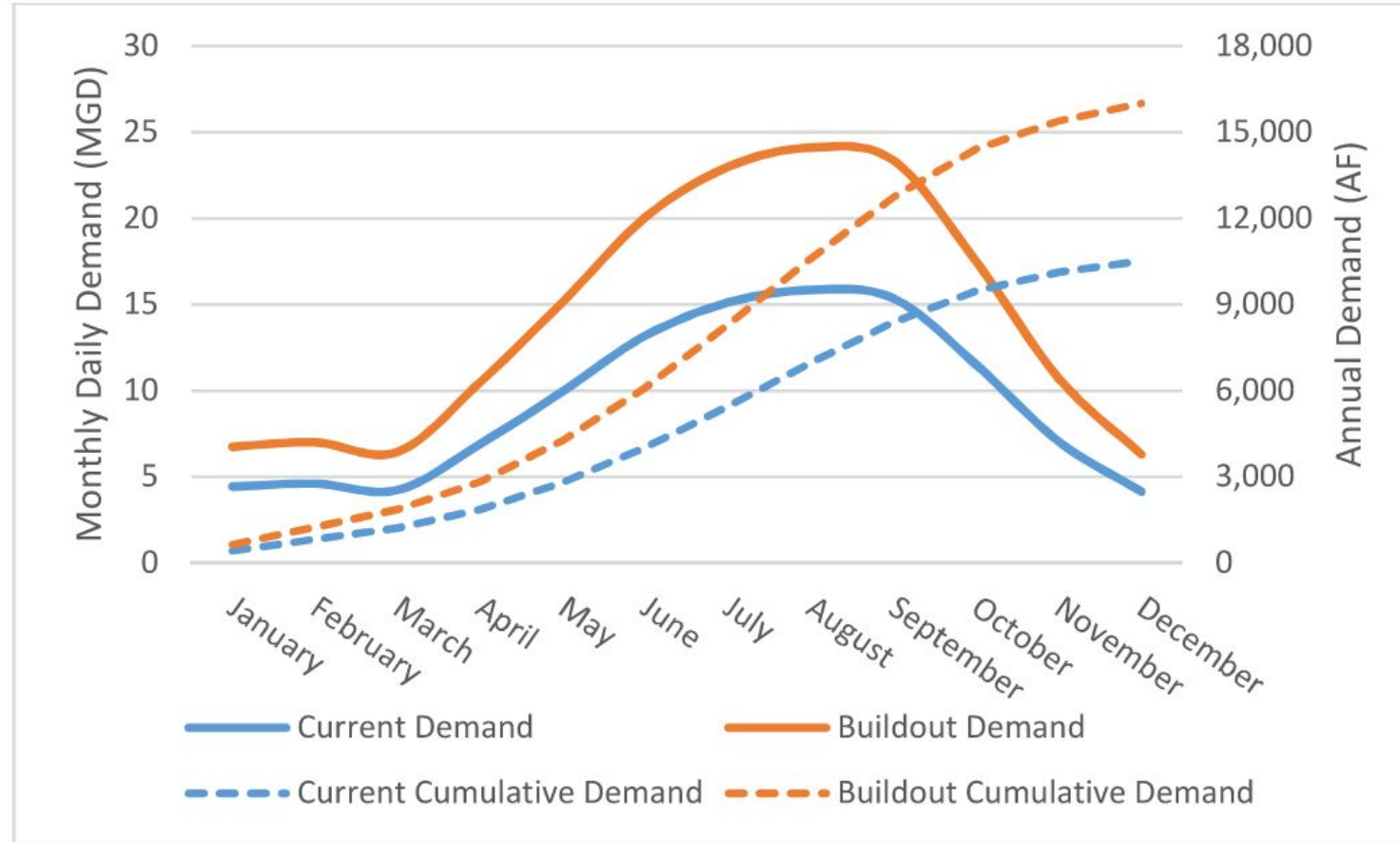
- Settling Pond 1 (1,450,000 gallons)
- Settling Pond 2 (500,000 gallons)
- Diatomaceous Earth Filtration
  - Design filter loading rate of 1.0 gpm/ft
  - Rated capacity of 4.6 MGD
- Sodium Hypochlorite Disinfection
  - 500,000-gallon chlorine contact tank with an approved baffling factor of 0.5
- Quill Storage Tank
- Booster Pumps to Ash Storage Tank





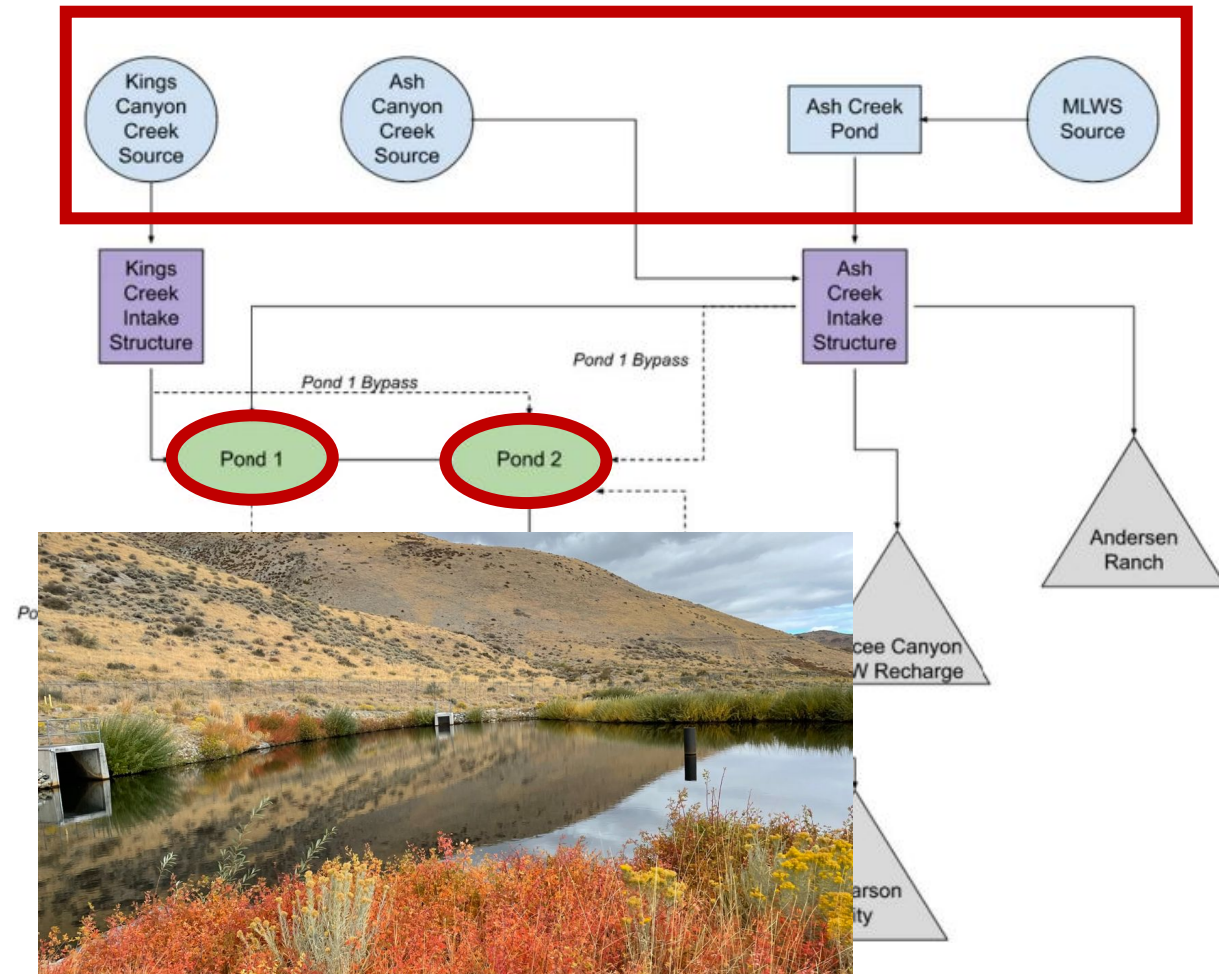
# Project Drivers: Capacity

- Growing population requires increase in current total demand
- Groundwater supply
  - Contaminant issues
  - Maximum utilization rate
- Regional intertie
  - Own by others with no plans for expansion
- Carson River induction wells
  - Water rights allocation limitations
- Quill WTP will need to be expanded



# Project Drivers: Deficiencies at the Quill WTP

- Water Quality
  - In 2017 the Quill WTP surface water sources were placed in Bin 2 (LT2) due to the detection of *Cryptosporidium* in water samples.
  - WQ of surface water sources have worsened (algae, organics and turbidity)
  - Uncovered settling ponds
  - Inability to clean Pond 2 without taking the plant offline contribute to higher organics and turbidity into the plant



# Water Quality Blends

- Different blends of the three sources to achieve additional capacity.
- DE Filters lack operational flexibility to handle water quality fluctuations.

Water Source	Minimum (NTU)	Average (NTU)	95 <sup>th</sup> Percentile (NTU)	99 <sup>th</sup> Percentile (NTU)	Maximum (NTU)
Kings Creek	0.2	1.3	2.5	8.0	121
Ash Creek	0.2	5	13.1	37.4	348
MLWS	0.1	1.7	3.3	5.5	42

Higher demand will result in more water from Ash Creek and MLWS

Water Source	Minimum (mg/L)	Average (mg/L)	95 <sup>th</sup> Percentile (mg/L)	99 <sup>th</sup> Percentile (mg/L)	Maximum (mg/L)
Kings Creek	0.5	0.9	1.5	2.1	2.3
Ash Creek	0.5	1.9	3.3	3.8	3.8
MLWS	0.7	2.7	4.9	5.0	5.0

Concern is higher organics



# Project Drivers: Deficiencies at the Quill WTP

- Filter Operations
  - Old DE filtration technology is labor intensive
  - DE Filters can no longer run at design loading rate
  - During low water quality, filters may need to be backwashed two times per day.
  - Aging infrastructure
    - Leaks in pressure vessels
    - US Filter is no longer in business so hard to find replacement parts
- Disinfection
  - Limited chlorine contact to achieve disinfection during high flow





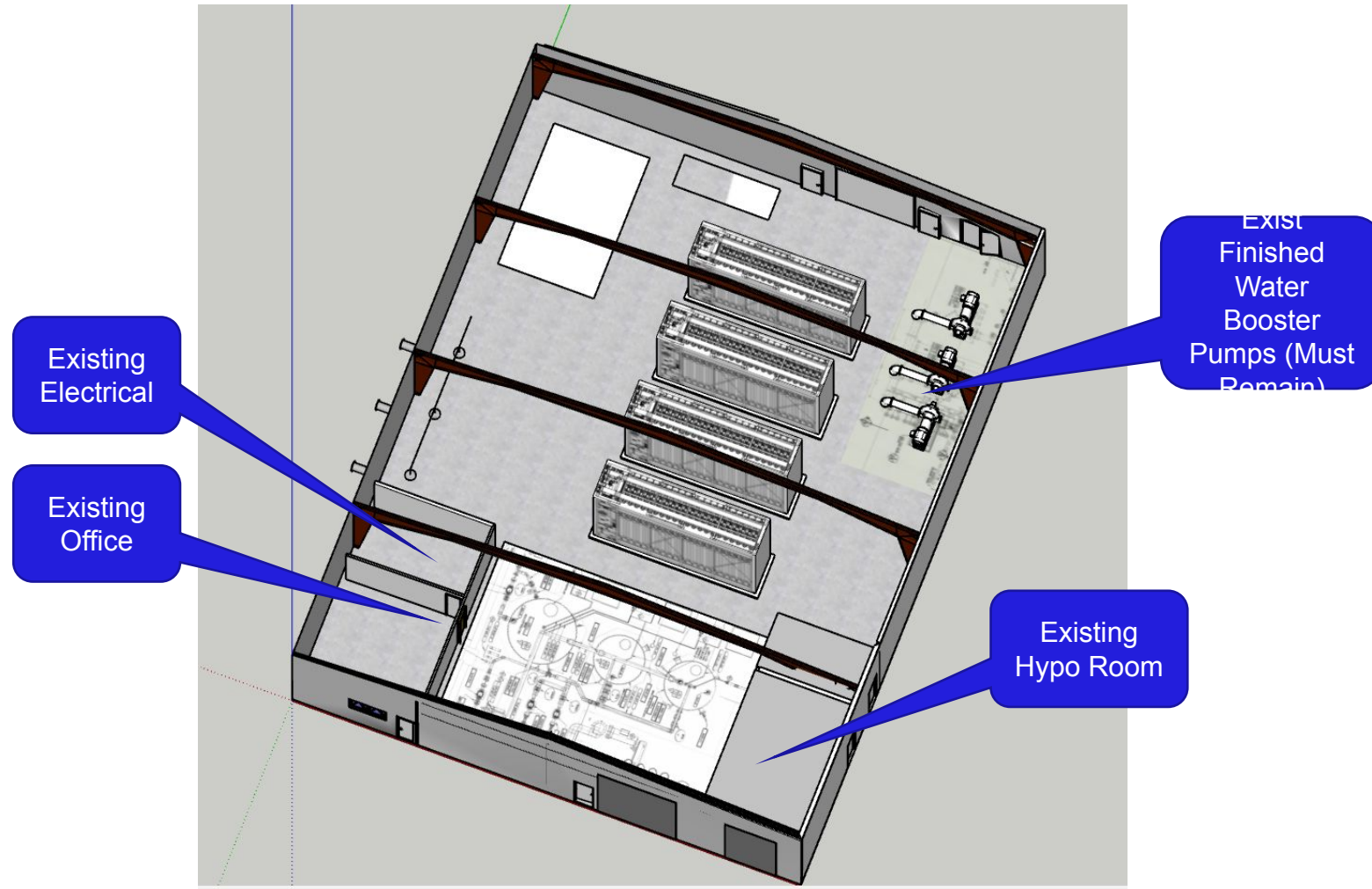
# Alternative Analysis





# Treatment Goals

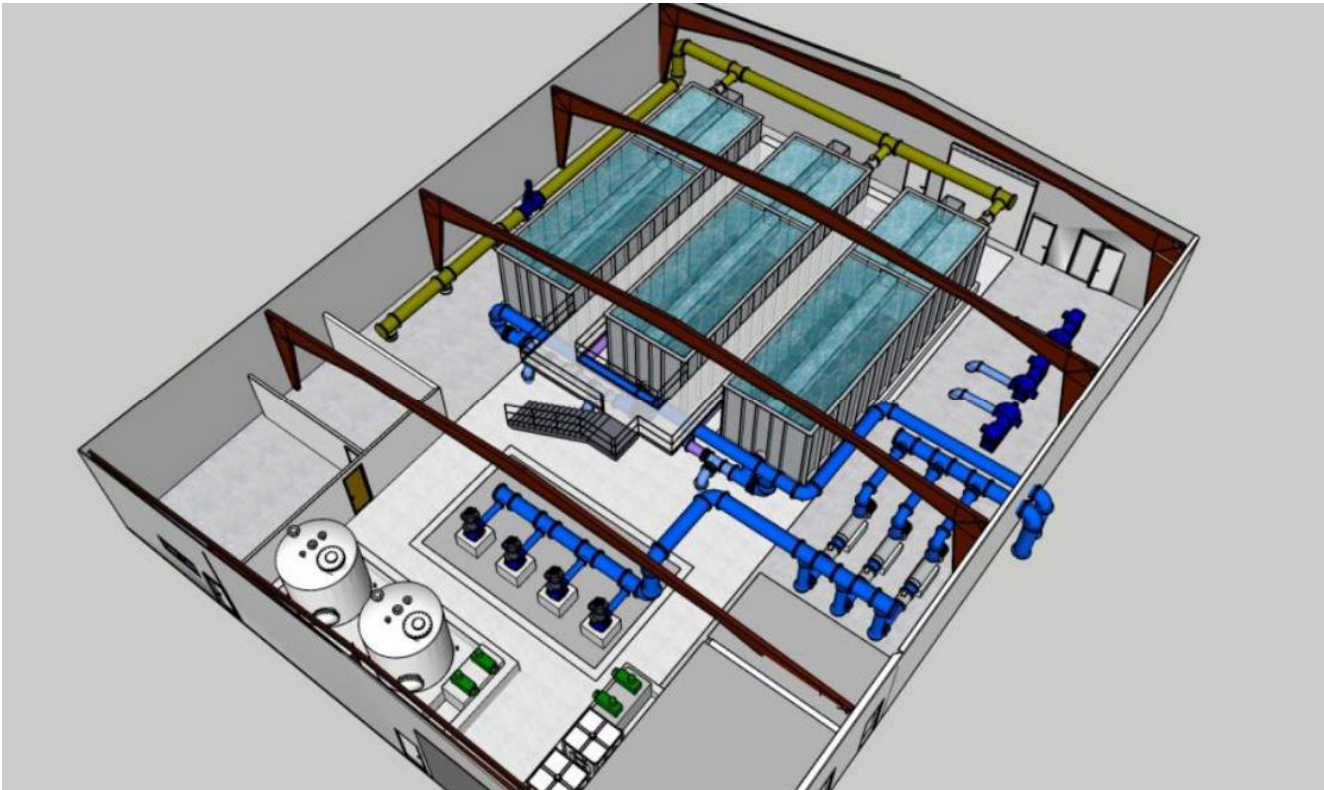
- Immediate capacity is 6 mgd
- Ultimate buildout is 8.3 mgd
- Achieve/exceed disinfection requirements
- More operational flexibility in treating raw water source blends
- Fit into existing building





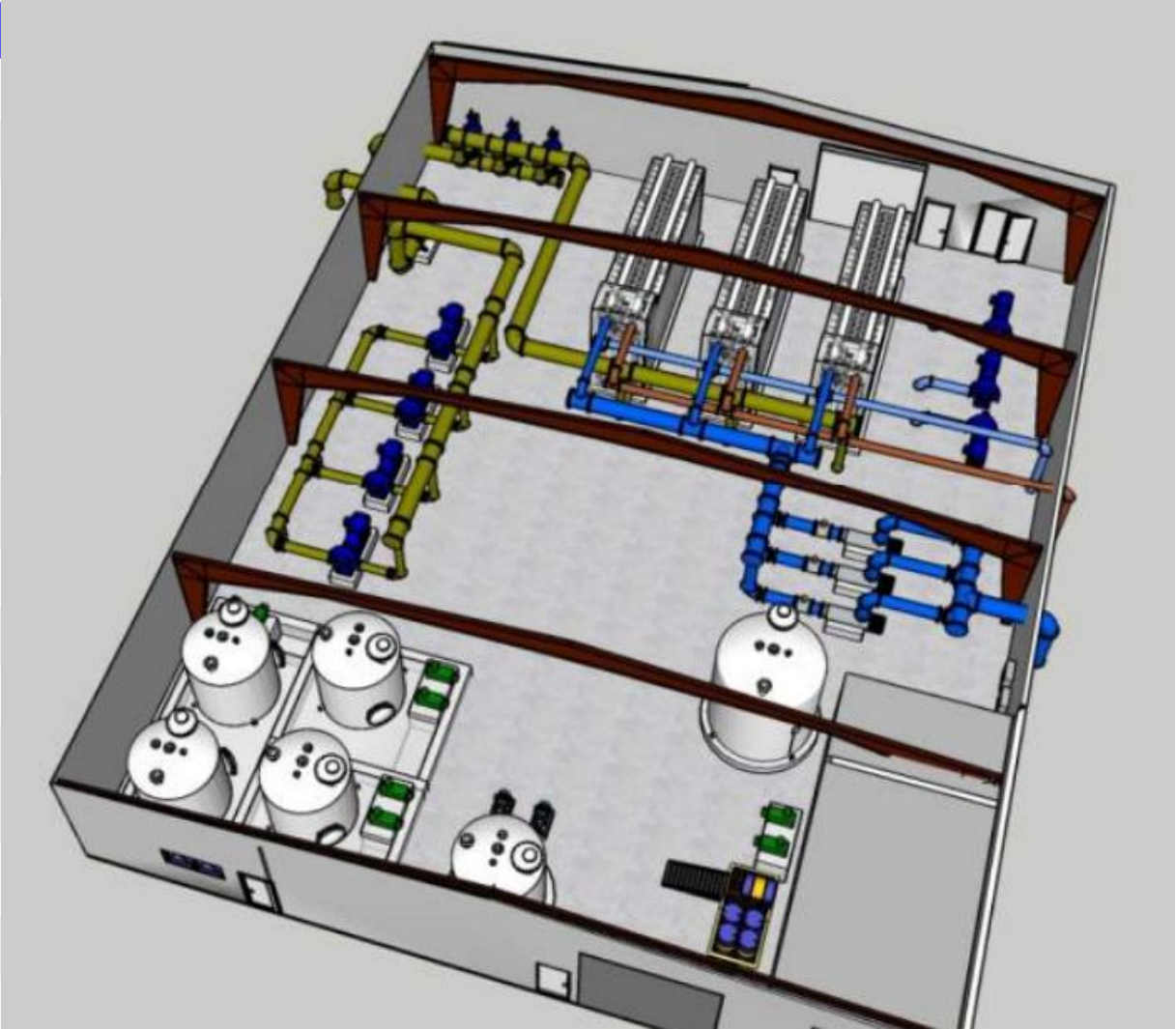
# Filtration Alternative 1: Packaged Filtration

Design Criteria	
Packaged System Gross Treatment Capacity	4200 gpm (6.0 MGD)
Number of Trains	3
Adsorption Clarifier Loading Rate	10 gpm/ft2
Adsorption Clarifier Water Flush Rate	1400 gpm (10 gpm/ft2)
Adsorption Clarifier Air Flush Rate	1425 scfm (10 scfm/ft2)
Filter Loading Rate	5 gpm/ft2
Backwash Method	Air & Water
Low Rate Backwash Water Loading Rate	5 gpm/ft2
High Rate Backwash Water Loading Rate	15 gpm/ft2
Number of Blowers	3
Airwash Loading Rate	3.4 scfm/ft2
Airwash Flow Rate	950 scfm
Tank Dimensions	39 ft 10 in long x 11 ft 11 in wide x 10 ft 1 in tall



# Filtration Alternative 2: Microfiltration

Design Criteria	
Membrane Net Filtrate Capacity	4200 gpm (6.0 MGD)
Pressurized Membrane Type	8-inch rack
Number of Membrane Modules Per Rack	110
Number of Racks	3
Recovery	95.8%
Instantaneous Flux	40 gfd
Backwash Interval	26 minutes
Enhanced Flux Maintenance (EFM) Interval	1 day
Clean-In-Place (CIP) Interval	30 days
CIP/Neutralization Storage	3000 gallon
Number of strainers	3 (2 duty, 1 standby)
Number of feed pumps	3 (2 duty, 1 standby) horizontal split case centrifugal pumps
Number of reverse filtration pumps	2 close-coupled end suction centrifugal pumps
Number of blowers	2
Instantaneous air flow per treatment train	354 scfm





## Disinfection: Addition of UV

- Virus inactivation achieved with chlorine contact
- UV required to provide inactivation of *Cryptosporidium* and *Giardia*

	Parameter	Package Filtration	Micro-filtration
Giardia	Total Removal / Inactivation	3.0	
	Min Removal by Filtration	2.5	2.5
	Min Inactivation by Disinfection	0.5	0.5
Virus	Total Removal / Inactivation	4.0	
	Min Removal by Filtration	2.0	0.0
	Min Inactivation by Disinfection	2.0	4.0
Crypto	Total Removal / Inactivation	4.0	
	Min Removal by Filtration	3.0	>2.0*
	Min Inactivation by Disinfection	1.0	0.0

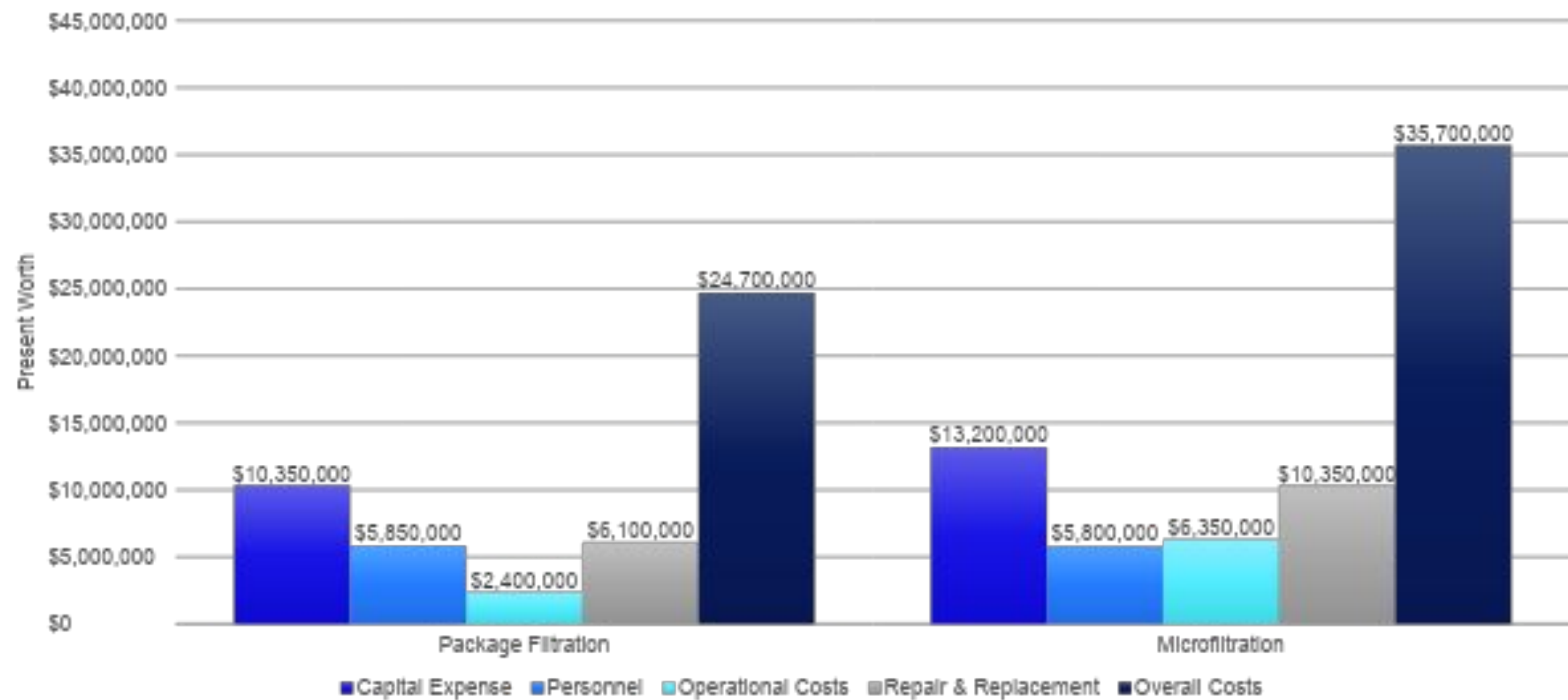
\*Package filtration (conventional filtration) requires an additional 1.0 Log. Through challenge testing, it is possible for microfiltration to provide the total 4.0 Log removal required.

# Non-Monetary Ranking of Filtration Alternatives

	Weight Percentage	Adjusted Weight Percentage	Package Filtration			Microfiltration		
			Score	Weighted Score	Adjusted Weight Score	Score	Weighted Score	Adjusted Weight Score
Environmental Impact								
Energy Consumption	2.7%	3.5%	4	0.11	0.14	1	0.03	0.03
Carbon Footprint	1.0%	1.2%	3	0.03	0.04	2	0.02	0.02
NEPA	1.7%	2.2%	3	0.05	0.07	3	0.05	0.07
Construction Impacts & Constructability								
Good Neighbors: Noise, truck Traffic, etc	3.0%	3.0%	2	0.06	0.06	3	0.09	0.09
Plant Downtime	9.3%	9.2%	3	0.28	0.28	4	0.37	0.37
Constructability	6.3%	6.2%	2	0.13	0.12	2	0.13	0.12
Space Constraints	6.7%	6.6%	3	0.20	0.20	2	0.13	0.13
Reliability								
Established technology	7.6%	7.5%	4	0.30	0.30	3	0.23	0.22
Scalable / expandable	6.7%	6.6%	4	0.27	0.26	3	0.20	0.20
Treatment flexibility / adaptability	8.4%	8.2%	3	0.25	0.25	3	0.25	0.25
Regulatory compliance / “safety factor”	10.9%	10.7%	3	0.33	0.32	5	0.54	0.53
Operations & Safety								
Operational intensity	7.0%	6.9%	2	0.14	0.14	4	0.28	0.28
Number of operators	8.6%	8.4%	3	0.26	0.25	3	0.26	0.25
Safety risks	11.8%	11.6%	3	0.35	0.35	3	0.35	0.35
Complexity / frequency of maintenance	8.4%	8.2%	4	0.34	0.33	2	0.17	0.16
Weighted Score				3.1	3.1		3.1	3.1
Weighted Percentage				61.8%	61.9%		62.1%	61.6%



# Monetary Evaluation of Filtration Alternatives



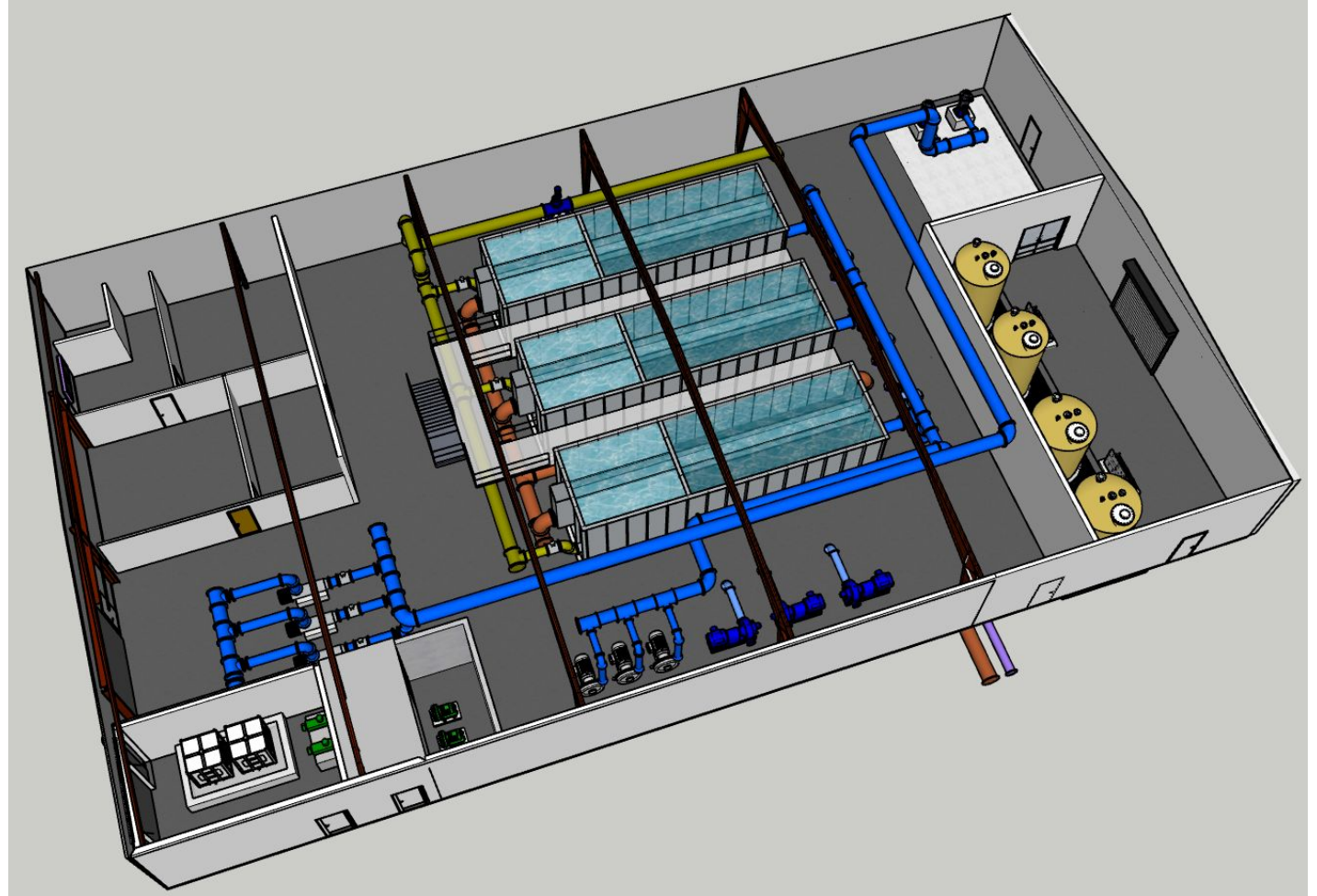
# Design





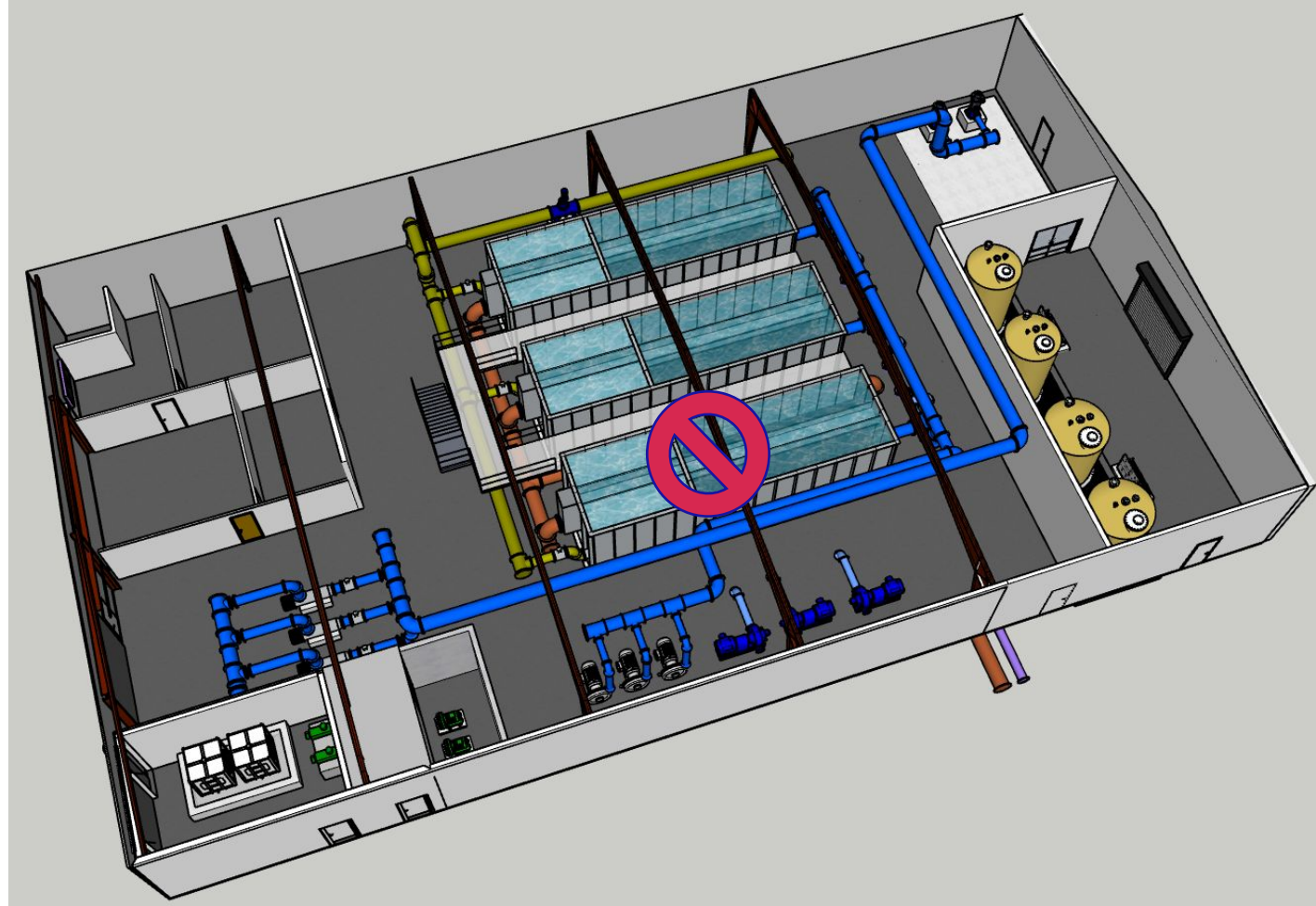
# Design Challenges and Decisions

- New equipment to fit within existing building
  - Pre-select package filtration and UV vendors to incorporate into design during 60%
  - Use of 3D modeling to visualize accessibility after installation of new equipment
- Decisions
  - Expansion of building to maintain accessibility around new and existing equipment
  - Expansion of building to allow increased hypochlorite storage



# Design Challenges and Decisions

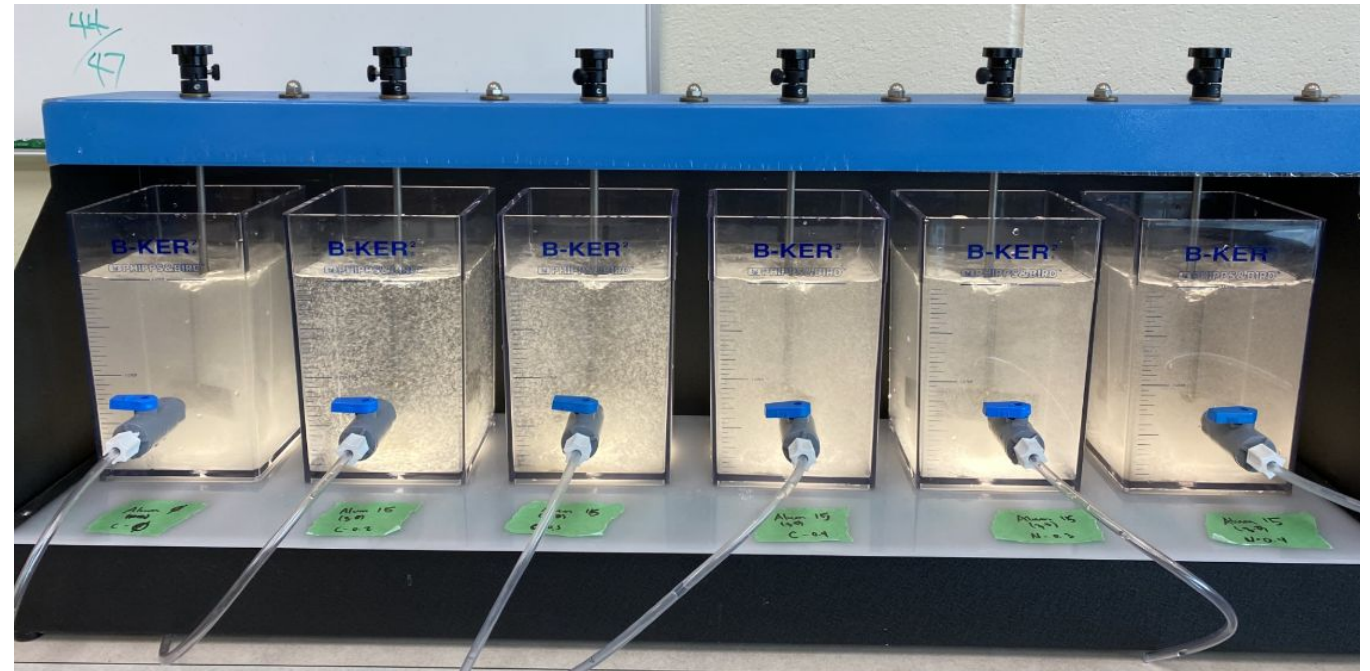
- Costs
  - Funding sources drove up costs due to BABA and AIS requirements
  - Funding sources contributed to inability to prepurchase and lock in costs during design
- Decisions
  - Eliminate filter train and include in later phase with the raw water diversions to allow expanded capacity





# Design Challenges and Decisions

- Coagulant Selection and Sizing
  - Jar test various coagulants and polymers on various raw water blends
  - ACH and PACI performed similarly in terms of turbidity and organics at the optimized jar with coagulant and polymer.
- Decisions
  - ACH selected due to lower impact to pH and alkalinity in the finished water
  - Desktop study to be completed to look at impact to distribution system

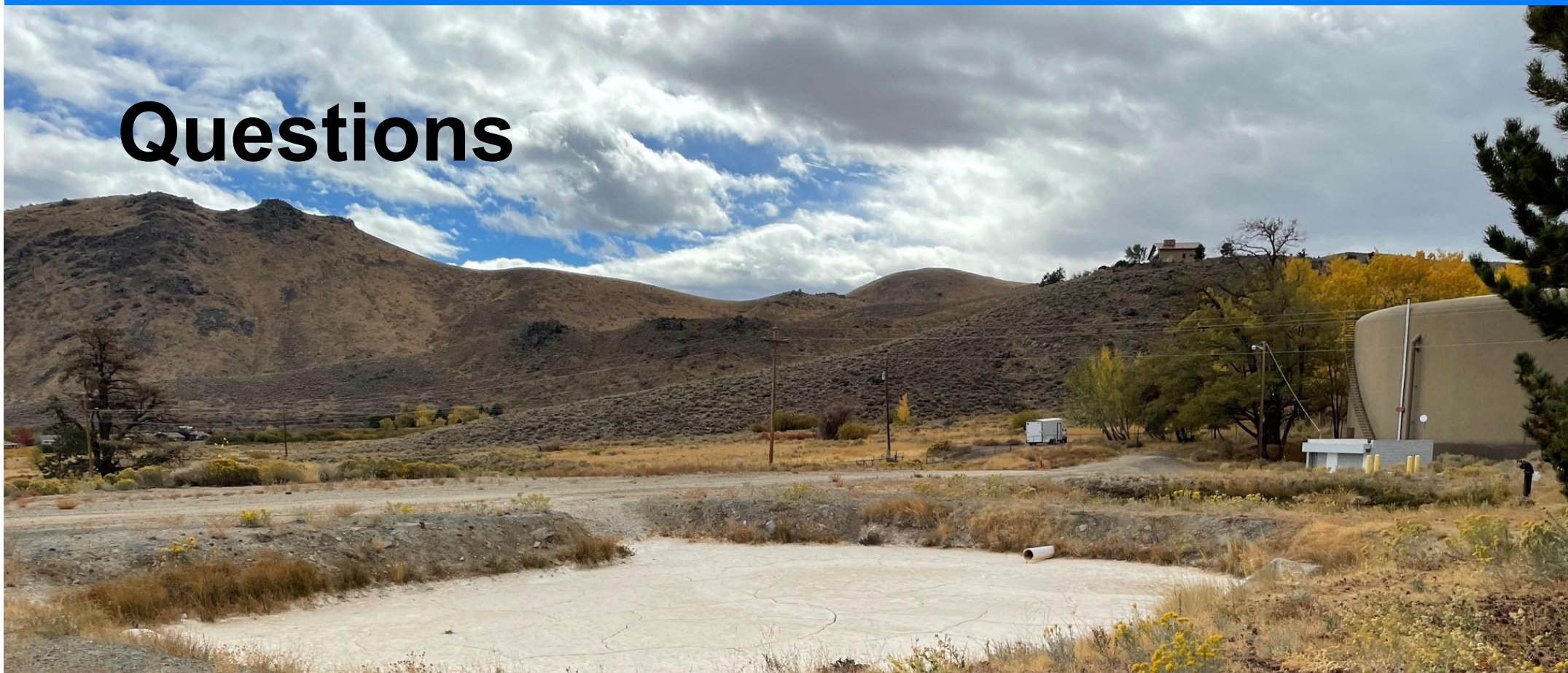


# Conclusions

- Changing raw water sources can present challenges in an aging DE filtration system.
- Non-monetary and monetary evaluations are both important to evaluate when comparing alternatives.
- 3D visualization early in design are useful for making layout decisions around accessibility.
- Funding sources can impact construction costs if not identified early.
- Jar testing during design help inform decisions on coagulant selection and sizing for changing sources.



# Questions



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