Merrimack Village District PFAS Treatment Design

Granular Activated Carbon, Ion Exchange Expansion

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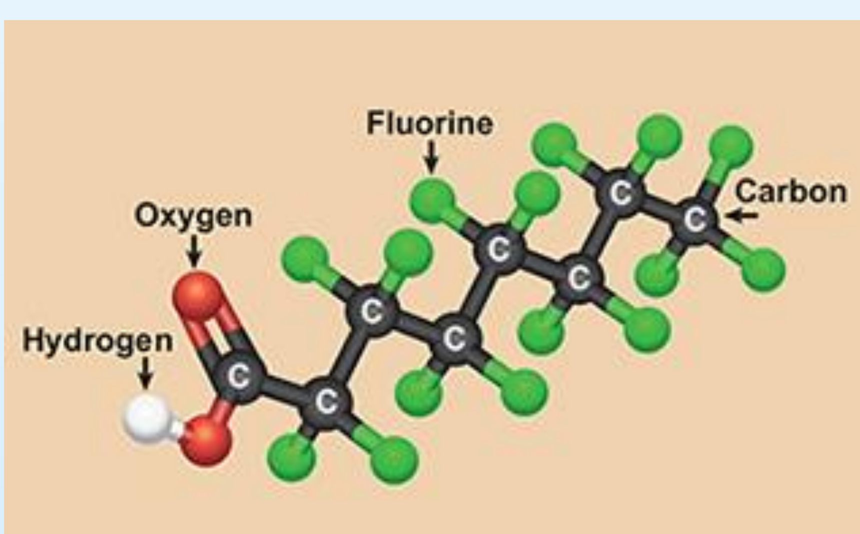
INTRODUCTION

Polyfluoroalkyl substances (PFAS) are a family of man-made chemical compounds commonly used in applications like household appliances, non-stick coating, and firefighting foam. They are long-lasting in the environment because they do not breakdown naturally in nature. There are health concerns due to PFAS accumulating in our blood. In the Merrimack Village District (MVD) contamination of PFAS was caused by Saint Gobain's use of PFAS resulting in an aerial dispersion of these contaminants through a smokestack.

The objective of this project was to design a water treatment plant capable of achieving the necessary removal of all contaminants of interest from the raw water of Wells 4 & 5. We explored a wide range of treatment options, created a conceptual process flow diagram, and finally drafted a cost estimate.



Above: PFOA chemical compound. These carbon-fluorine bonds are some of the strongest bonds found, making these substances referred to as "forever chemicals".

WATER QUALITY DATA

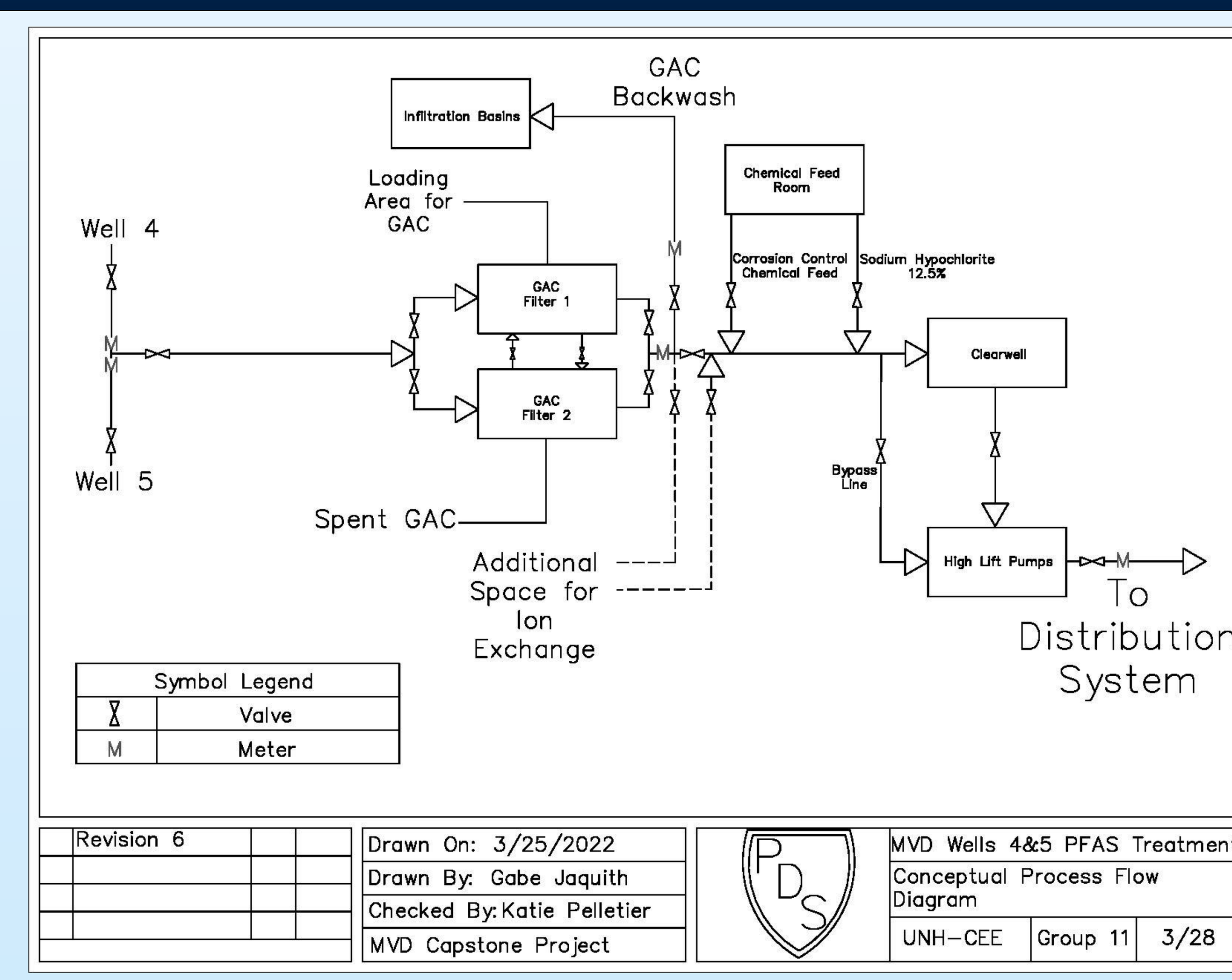
PFAS	MCL	Well 4 Average	Well 5 Average	Well 4 Max	Well 5 Max
PFOA (ppt)	12	68.3	49.1	130	79
PFOS (ppt)	15	3.1	0.8	38.5	40
PFOA+PFOS (ppt)		71	50	141	79
Co-contaminants					
Turbidity (NTU)	1	<0.05	<0.05	<0.05	<0.05
Copper (ppm)		0.111	<0.01	0.184	<0.01
Iron (ppm)		<0.05	<0.05	<0.05	<0.05
Manganese (ppm)		<0.01	<0.01	<0.01	<0.01
Lead (ppm)	0.015	<0.01	<0.01	<0.01	<0.01
Sodium (ppm)		57.9	100	61.4	111
Chloride (ppm)		101	198	111	229
Nitrate (ppm)	10	3.7	1.8	4	2.1
Alkalinity (ppm)		19	22	22	24
Hardness (ppm)	100	55.5	77.2	62.4	83.3
pH		5.96	6.09	6.85	7.01

Highlighted: Contaminants of interest

TREATMENT METHOD(s)

The top two methods of PFAS treatment we found that would be the best fit for this case would be GAC and ion exchange. GAC was a less expensive option than ion exchange, and it successfully removed the longer chain and some short chain PFAS of interest. GAC is the most widely used technique to remove PFAS contaminants and the carbon may be recycled for a future use. The decision to design the facility with provisions for the future addition of resin as the research for PFAS is new and evolving. It is possible that in the future, short chain PFAS may be required to remove. Leaving room for an ion exchange system following the GAC would result in removal of the shorter PFAS contaminants.

RESULTS



The flow diagram provides a basic overview of how the proposed treatment facility would operate. Through the diagram, we have illustrated the proposed treatment process and other key elements like backwashing and chemical feed.

COST

The capital cost we estimated to be $4,290,000. We incorporated the clear well and high lift pump cost of $237,600. The yearly operation and maintenance cost we estimated to be $334,000. We included the maintenance of our chemicals, energy usage of high lift pumps, and removal of the activated carbon at the end of its life.

GAC Lead/Lag System

GAC Vessels

Provisions for Ion Exchange with Resin in Future

Resin Vessels

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