MVD's PFAS Journey
Chapter One

Introduction

On February 26, 2016, a representative from Saint-Gobain Performance Plastics (SGPP) in Merrimack, New Hampshire notified the Drinking Water and Groundwater Bureau (DWGB) of the New Hampshire Department of Environmental Services (NHDES) that perfluorooctanoic acid (PFOA) had been detected at 30 parts per trillion (ppt) at a tap within the SGPP facility. Given that SGPP's water is supplied by the Merrimack Village District (MVD), NHDES immediately contacted MVD to let them know of the detection and the need to sample all their wells for PFOA and related compounds. Thus, began MVD's experience with per- and poly-fluorinated alkyl substances (PFAS), which has dominated MVD's attention since 2016, and will continue to be a major financial, treatment and testing issue for many years to come.

MVD Vital Statistics

MVD supplies water to most of the Town of Merrimack and serves about 25,000 residents through about 6,800 service connections. It is a groundwater system with six active wells installed in sand and gravel aquifers, although there are emergency connections with surface water systems to both the north (Manchester Water Works) and the south (Pennichuck Water Works). Information on the MVD wells is summarized in **Table 1.**

TABLE 1 – MVD WELLS

Well	Capacity	Issues	Status
MVD-1	0 gpm (was 400 gpm)	Screen failure	Decommissioned 2005
MVD-2	1,100 gpm	None, largest, best quality well	On line, permitted for 1,500 gpm
MVD-3	800 gpm	Elevated Fe & Mn	On line, use limited due to elevated Fe/Mn
MVD-4	410 gpm*	PFAS $\geq$ 70 ppt	Off line per DES until WTP constructed
MVD-5*	625 gpm*	PFAS $\geq$ 70 ppt	Off line per DES until WTP constructed
MVD-6	1,500 gpm	VOC contamination	Off line since 1988
MVD-7	500 gpm	Elevated Fe & Mn	On line, w/Fe/Mn WTP
MVD-8	750 gpm	Elevated Fe & Mn	On line, w/Fe/Mn WTP
*Rates if only one well pumped. Wells 4 & 5 are 300 ft apart and operated together at 420 gpm (sustainable yield) to 870 gpm (peak short term yield)			

Prior to 2016, all MVD wells received treatment for corrosion control (lime & a blended phosphate) and disinfection (calcium hypochlorite tablets). Due to high iron and manganese concentrations in Wells #7 & #8, an iron and manganese removal water treatment plant (WTP) was constructed and put on line in 2016.

The MVD distribution system consists of 166 miles of 4" – 20" piping and is divided into two pressure zones, with one storage tank in the main zone, and two tanks (one off-line) in the high-pressure zone. All wells discharge into the main pressure zone, so a booster pump station (Turkey Hill BPS) feeds the high-pressure zone.

Demands follow a typical pattern with the highest use in the summer months. Current and projected water demand in the MVD service area is summarized in **Table 2**.

TABLE 2 – CURRENT & PROJECTED DEMAND

	Current (2008 – 2014)	Projected (2030)
Annual Avg Day Demand	2.2 – 2.3 mgd	2.9 mgd
Summer Avg Day Demand	2.7 – 3.2 mgd	4.1 mgd
Max Day Demand	4.3 – 5.4 mgd	5.9 mgd

With all six active wells operating, the existing supplies can meet the existing max day demand but additional supply is needed to meet the projected future max day demand. Locating and developing additional supply capacity is just one of the many projects that MVD had either completed, in process, or in the planning stage prior to the discovery of PFAS. The need for these other projects did not disappear with the discovery of PFAS in the MVD system. Rather, a busy, proactive agenda was greatly disrupted by the need to deal with a new, and largely unknown water quality issue.

Journey into the World of PFAS

Much has been written and presented on PFAS in the last four years and it is not the intent of this article to be a treatise on PFAS, but some brief description is in order for context. Per- and poly-fluorinated alkyl substances are a class of chemicals used to make everyday products resistant to stain, heat, oil, grease and water. They consist of a chain of carbon atoms with fluorine atoms bonded to them. Depending on the number of carbon atoms they are often categorized as "long or short chain" compounds. PFAS chemicals are extremely soluble, stable and resistant to break down due to the very strong nature of the carbon-fluorine bond. This makes them very mobile once they have been released into the environment and very difficult to treat. They are often referred to as "forever compounds".

So…what happened at MVD after that phone call from NHDES that PFOA had been detected in the MVD water system? All MVD wells were immediately sampled and tested for PFAS. Initial efforts focused on PFOA and PFOS but other long and short chain compounds were detected as well. The initial sampling effort indicated some level of contamination in all MVD wells (**Table 3**). Based on this result, MVD authorized Underwood Engineers (UE) to evaluate treatment for PFAS removal. Technologies reviewed included ion exchange with synthetic resins, adsorption with granular activated carbon (GAC), reverse osmosis and advanced oxidation. GAC adsorption was by far the most prevalent and effective treatment for PFOA and PFOS, although it was reportedly less effective on the short chains compounds.

TABLE 3 – INITIAL PFAS TESTING RESULTS – MARCH 2016

	PFOA/PFOS Concentration (ppt)					
Date	**MVD Well**					
	MVD-2	**MVD-3**	**MVD-4**	**MVD-5**	**MVD-7**	**MVD-8**
3/31/16	27/ND	N/A*	90/5.6	56/ND	26/ND	9.7/ND
*Off line for cleaning. Subsequent tests showed PFAS contamination.						

Figure 1 shows the MVD system, supply sources, and their relative locations to the Merrimack SGPP facility.

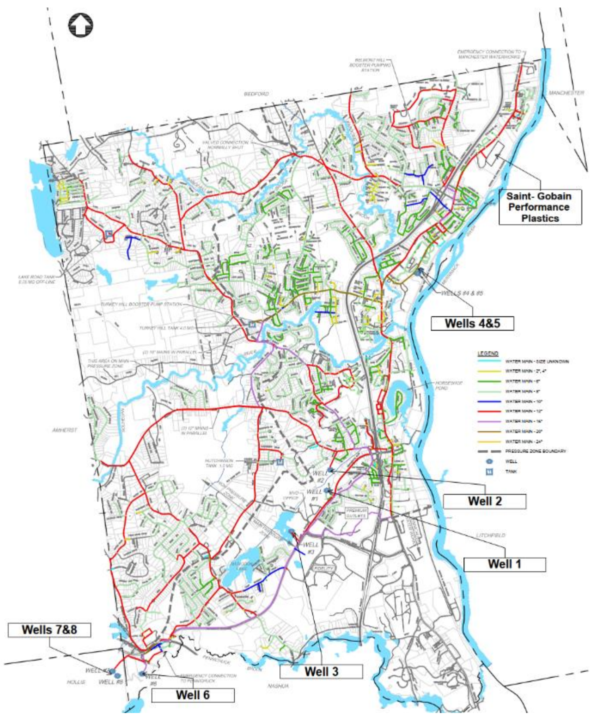

Figure 1 – MVD System and Supply Sources

A major challenge in 2016 was the lack of a standard for any PFAS chemical. A valid standard is critical as it provides a benchmark, both for systems to treat to, and for regulators to regulate to. The only PFAS standards in 2016 were Provisional Health Advisory Levels (HAL's) set by EPA for short term acute exposure; 400 ppt for PFOA and 200 ppt for PFOS. The MVD levels were well below these concentrations, however similar contamination events in NY and VT, and subsequent studies had led to NY setting an interim PFOA standard of 100 ppt while VT set it at 20 ppt. At public meetings instituted by NHDES in Merrimack to discuss the contamination, some MVD users insisted that the only acceptable standard for these man-made contaminants was non-detection. Given this wide disparity there was much pressure put on EPA to come up with a meaningful consistent standard. In May of 2016 EPA set a HAL for lifetime exposure of 70 ppt for PFOA, PFOS, or PFOA + PFOS if both were present. NHDES quickly enacted emergency rule making to adopt this 70 ppt standard as an Ambient Groundwater Quality Standard (AGQS) which is enforceable as an MCL in NH. In June of 2016, NHDES informed MVD that until treatment is in place, Wells #4 and #5, which are operated together as a single source, must be deactivated, locked out and tagged since the levels exceeded the AGQS of 70 ppt.

In response, MVD initiated the following steps:

- Began the process of negotiating a settlement agreement with SGPP to provide funding for treatment of Wells #4 & #5 and other PFAS related costs
- Authorized UE to:
    - Complete a 30% Preliminary Design of a GAC based PFAS WTP for Wells #4 & #5
    - Initiate fast track design, bidding and construction of a booster pump station to allow water from Pennichuck Water Works (PWW) to be pumped to the hydraulic grade line (HGL) of the MVD system for emergency use if needed to replace the lost capacity of Wells #4 & #5 (existing connection could not meet MVD HGL).

While SGPP agreed to fund the 30% Well #4 & #5 WTP Preliminary Design effort, it was a long process to come to an agreement over what their final financial liability would be. After a nearly two-year process, a settlement agreement was reached in March of 2018 in which SGPP agreed to pay $3.35 Million of the projected $5.1 Million total project cost. This allowed MVD to authorize final design of the WTP.

MVD was under a great deal of pressure from users to not only treat Wells #4 & #5, but also to treat the remaining active MVD wells (#2, #3, #7, & #8) with a goal of non-detection of all PFAS compounds. In July of 2018, MVD authorized UE to conduct a feasibility analysis and provide conceptual cost opinions to treat Wells #2, #3, #7, & #8 for non-detection of PFAS. Once again, GAC was determined to be the best treatment alternative. Iron and manganese treatment for Well #3 was also included as these constituents would interfere with GAC treatment of PFAS. Since the PFOA and PFOS concentrations in these wells was less than 70 ppt, this was a non-regulatory need. Therefore, to reduce cost to the degree possible, the conceptual designs utilized single vessel treatment, with room for expansion, instead of the redundant treatment vessels required for Wells #4 & #5. In December of 2018 a report was issued with a $14.5 million conceptual cost opinion for PFAS treatment of Wells #2, #3, #7, & #8. MVD users used these costs to develop petitioned warrant articles to raise and appropriate this amount which passed overwhelmingly at the March 2019 MVD Annual Meeting, and Preliminary Design was authorized in April of 2019.

In January of 2019, NHDES, based on direction from the legislature, had proposed new PFAS standards for PFOA and PFOS, and introduced standards for two other PFAS compounds, perfluorohexanesulfonic acid (PFHxS), and perfluorononanoic acid (PFNA). The concentrations of these compounds in Wells #2, #3, #7, & #8 was well below these levels. However, based on new risk analysis studies on infants and lactating mothers, NHDES dramatically lowered the proposed standards in July of 2019 (**Table 4)** to some of the lowest PFAS standards in the nation.

TABLE 4 – PFAS STANDARDS (ppt)

PFAS Compound	May 2016	Proposed	Proposed
PFOA	70	38	12
PFOS	70	70	15
PFOA + PFOS	70	No Std	No Std
PFHxS	No Std	85	18
PFNA	No Std	23	11

Enactment of these standards will make removal of PFOA in all MVD wells a regulatory need, requiring redundant treatment vessels to be incorporated into the design. **Figure 2** shows the PFOA concentrations in Wells #2, #3, #7, & #8 relative to the proposed standards. UE's designs were altered to include redundant vessels and a preliminary estimate was that this would increase the construction costs by at least $3 million.

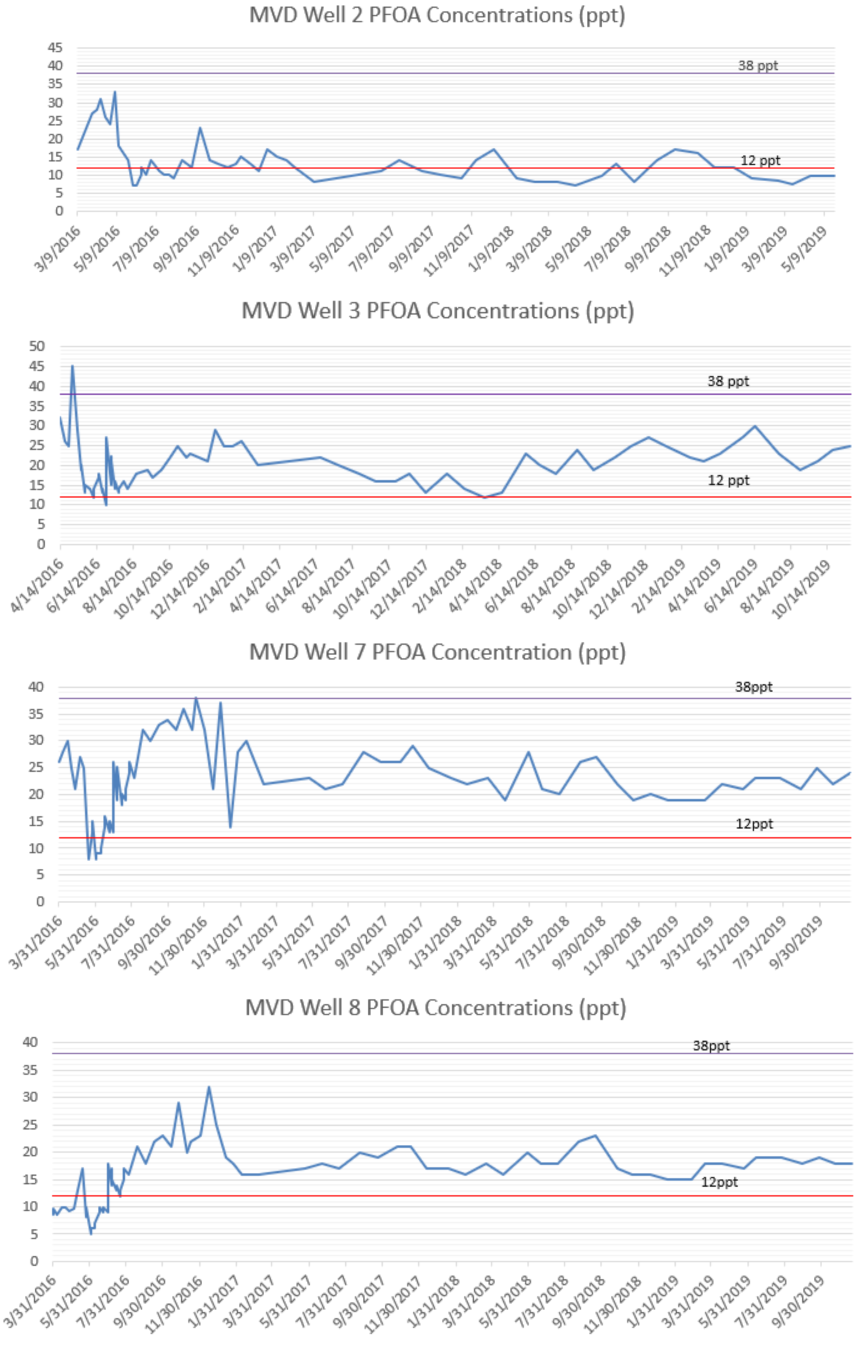

Figure 2 – PFOA Concntrations Relative to Proposed Standards

At the time of the writing of this article in March of 2020, the major milestones achieved by MVD in their continuing PFAS journey are listed below:

- Designed and constructed an emergency booster pump station to allow water from PWW to be pumped into any part of the MVD system (operational February 2017)
- Reached a settlement agreement with SGPP in March 2018 for partial funding of a PFAS removal WTP for Wells #4 and #5, as well as other PFAS related costs.
- Had 58 private well users connected to the MVD system to replace contaminated wells.
- Designed and initiated construction of a WTP for Wells #4 and #5 utilizing GAC contactors. Substantial completion is expected by the late summer of 2020. See **Figures 3 & 4** for photos of the construction.
- Completed final design of a PFAS removal addition utilizing GAC contactors to the Wells #7 & #8 Iron & Manganese Removal Facility. Expected to be operational by July 2021.
- Completed preliminary design of PFAS removal facilities for Wells #2 and #3. Expected to be operational by July 2022.
- Secured over $14 million in grant and loan funding through the NHDES SRF program and the Drinking and Groundwater Trust Fund for PFAS related infrastructure.

Figure 3 – Well 4 & 5 Access Road

Figure 4 – Well 4 & 5 WTP Structure

It has been a little over four years since the detection of PFAS in the MVD system. The approximate capital cost for treatment of all the MVD wells is over $18 million and estimates of operation and maintenance costs range from $150,000 to as much as $450,000 per WTP, per year depending on how frequently GAC must be changed out. While MVD's PFAS journey has already been a long hard road, and there is far to go, they have risen to the challenge of both mitigating and funding the PFAS contamination of their groundwater supplies.

Each of the three WTP's are due to be online over the next three years. Chapter 2 of the MVD PFAS Experience will appear in the Fall Journal and will address design issues as well as the construction and operation of the system.

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