

Hilldale Water District a Success with Using Nation's First Silicon Carbide Ceramic Ultrafiltration System to Purify Drinking Water

By
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In 2014 the Hilldale Water District (HWD) found itself confronting a set of challenges that many of the nation's small water systems experience. HWD is a relatively small rural water utility that serves a utility-certificated area that borders on the southeast side of Vicksburg, Mississippi, in Warren County. HWD discovered the aquifer which had served as its single source of water since the District's inception in 1965 was declining.

HWD was faced with rapidly declining and lower levels of ground water in its sole source for water supply, the relatively shallow Forest Hill Aquifer. HWD decided that the best option to ensure water resource sustainability was to drill a large well into the much deeper Sparta Aquifer. This Sparta Aquifer, unlike the Forest Hill Aquifer, is both widespread and abundant. However, water from the Sparta Aquifer, in HWD's Certificated Area, was discovered to be contaminated with large quantities of dissolved organic carbon (DOC) along with dissolved gases (carbon dioxide, hydrogen sulfide and methane), and is hot (103 degrees Fahrenheit). The Sparta Aquifer, as sourced, has poor drinking water quality, primarily resulting from high concentrations of DOC. This DOC gives the water a very evident unaesthetic brown color and can act as a precursor, via chlorination, to support the formation of Trihalomethanes (THMs) and Haloacetic Acids (HAAs), organic chemical compounds that are closely-regulated by the U.S. EPA.

To address the challenge of treating the Sparta source water, HWD's Board of Directors sought advice from their consulting engineer. After researching various promising technologies, the consulting engineer recommended pilot testing of a nanofiltration system and a ceramic ultrafiltration system in parallel. During piloting research to determine feasibility and best treatment strategies, HWD decided to blend, prior to any coagulation and filtration treatment, water from the Sparta Aquifer with water from the Forest Hill Aquifer. HWD soon realized, from the pilot testing, that by blending the two source waters it greatly improved effectiveness of the coagulation and associated filtration treatment in regards to both iron and DOC removal. High iron concentrations in the Forest Hill Aquifer's source water had long-presented HWD with treatment challenges. Another water quality treatment-related challenge with the water sourced from the Forest Hill Aquifer is the very high concentrations of calcium carbonate. By mixing these two aquifer source waters, the calcium carbonate was reduced, by dilution, by 50 percent. Using this combined source water and one treatment scheme, HWD realized it would achieve large cost savings and have the ability to produce product water essentially devoid any iron and with very minimal DOC.

After pilot-testing and a subsequent evaluation and assessment of the two competing filter technologies, the HWD Board of Directors decided to purchase and install the ceramic ultrafilter water treatment system (CUF®) as patented and manufactured by Purifics. A major factor favoring the CUF® is that the filter is composed of silicon

carbide, an extremely durable material having near diamond-like hardness. The special Purifics' patented-form of silicon carbide ceramic supports great water filtration. The CUF® has a forecasted significantly longer lifespan versus similar water filtering technologies made of less durable ceramics and certainly more so than filters made from plastic-polymeric materials. The CUF®, as augmented at HWD by incorporation of a novel coagulation process, effectively removes most all of the THM/HAA's precursors by greatly reducing the DOC, as well as the abundant iron and brownish color. If any heavy metals, bacteria, protozoans or viruses are ever present in the blended ground waters, then these contaminants will also be effectively removed. Notably the CUF® has not been compromised by high water temperatures from water sourced from the Sparta Aquifer, abrasive fine sand found in the Forest Hill Aquifer source waters, the chemical coagulant used, or the aggressive cleaning agents used in the in-place cleaning processes.

In comparing life cycle costs of the two technologies, HWD realized it would have to replace the membranes in any plastic-polymeric nanofiltration system every 3-5 years while the life expectancy of the CUF® system is forecast to be 25 years. Another huge cost savings benefit from the CUF® is that by removing the DOC in the ground water, chlorine demand was greatly reduced. According to General Manager, Bradley Barnes, chlorine usage was reduced from 80 pounds per day to 20 pounds per day, a reduction of 75%. This HWD treatment system (pictured in Figure 1.) represented a huge cost savings for the small water utility. HWD officials are impressed with the extremely small footprint of the one million gallon per day (MGD) treatment system.



Figure 1: The CUF® System at Hilldale Water District, Vicksburg, Mississippi

“I like the fact that Purifics was able to design an effective filter system that compliments coagulation treatment and removes both the iron and dissolved organic material from our well waters while taking up much less space and requiring very little operation and maintenance compared to other treatment systems.” said Mr. Barnes. “This helps in two ways: with the iron and organic material removed, the chlorine demand and usage went down, thereby saving HWD money; and both the iron and the DOC were reduced to levels well below EPA’s maximum contaminant levels.”

George Hunt, President of HWD's Board of Directors, noted the following: "A major concern of HWD with nearly all systems considered was the very expensive cost of operations and maintenance and the need to frequently replace other-type filters available at the time. The Purifics system's ceramic ultra-filters are being chemically cleaned in-place at HWD about every four weeks with otherwise uninterrupted operations and long-life expectancy that afford best lifecycle costs. The potable water produced exceeds the treatment requirements for every EPA and State-listed/monitored water quality standard."

Hilldale Water District was indeed a pioneer since no North American drinking water system had installed and operated a silicon carbide ceramic ultrafiltration system prior to the installation of the Purifics CUF® system in 2015. Since the Hilldale installation, Purifics has installed several similar units and is now in the process of supplying its seventh CUF® system, which is the Granisle Water Treatment Plant in British Columbia. Following Hilldale, a one MGD CUF® system was installed at the Artesian Water Company in Delaware in 2016 and has been operating successfully since.

In addition to the CUF® system, Hilldale also purchased a water treatment residual/solids dewatering system from Purifics called DeWRS. The technology used by DeWRS is a flat plate ceramic membrane that is capable of producing a 20% solids cake of the treatment's waste water stream. The combination of the CUF® system and DeWRS allows Hilldale to achieve Zero Liquid Discharge (ZLD).

Brian Butters, President of Purifics, noted that he "is pleased and gratified that the Hilldale Board of Directors provided the opportunity to demonstrate the efficiency and cost-effectiveness of the CUF® and DeWRS technologies. It was a market breakthrough for Purifics," said Butters.

Randall Williams, a Hilldale Board member and a research scientist, was skeptical of the unproven technology. He was insistent and instrumental in the conduct of appreciable pilot testing and evaluation, prior to purchase-commitment. He remains proud of the fact that HWD, a small rural water district in Mississippi, innovatively and successfully pioneered the first installation and operation of a silicon carbide ceramic ultra-filter, as enhanced with a novel coagulation scheme, to very effectively treat less-than desirable ground water quality. This treatment approach and technology is now fast becoming a preferred and accepted method of treating challenging source waters for drinking water. Williams noted, "Even after HWD researched, then pilot-evaluated and tailored the coagulation-aided treatment scheme to meet our needs, this best-available technology option still remained an appreciable technical and fiscal risk; as HWD would be the first potable water producer to employ this unique filtration technology. To date, the technology as a treatment scheme has consistently performed well, just as our pilot-testing indicated. The compact system requires very little maintenance and most all the operations are fully automated. And most importantly, it consistently produces copious amounts of outstanding quality drinking water."

Author bylines

Randall Williams is a board member serving Hilldale Water District, and a retired federal government scientist/engineer. In a near-four decade career, his initial work efforts were in environmental RDT&E. His research work later transitioned into military systems and operations. In late career he primarily served as an analyst, red-team leader, and strategist supporting the Office Secretary of Defense and National Intelligence Community. He served as a science advisor forward in several conflicts. He has led numerous national and international research panels, and named a technical member-at-large to NATO. He holds a B.S. (USM) and a M.S. (UF) in environmental sciences and engineering, respectively, plus appreciable post-graduate studies in strategic intelligence and military engineering.

Wade Miller has started two associations and managed four associations and foundations during the period 1985-2014. He is also a serial entrepreneur, having started nine different organizations. During a career that now spans five decades, he has provided consulting services to numerous government agencies, associations, consulting engineering firms, water technology equipment manufacturers, water utilities, and investment banking firms. He has specialized in strategic and business planning, mergers and acquisitions, and market assessment and entry strategies. Along the way, he authored seminal reports on urban water infrastructure for two presidential commissions. His education consists of a B.S. in chemistry and graduate training in marketing and finance.