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By Lake H. Barrett, Jr.

Advanced Surface Water Treatment Plant's

Enhanced Coagulation Treatment Process

Requires Tough Protective Coatings

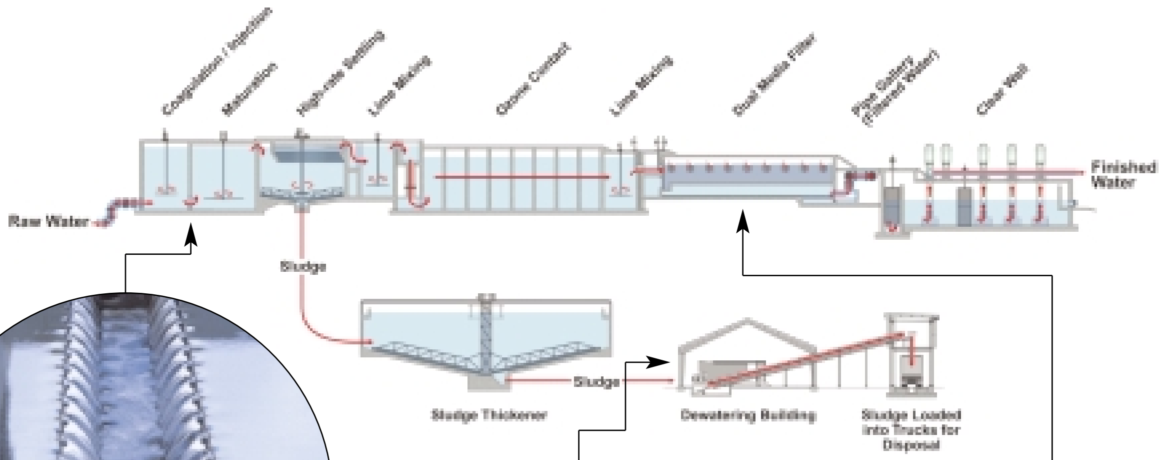
By the late 1990s, Florida's largest wholesale water supplier, Tampa Bay Water (the Utility), was facing a quandary all too familiar to managers of the nation's drinking water infrastructure. The contract creating Tampa Bay Water required that the utility replace 68 million gallons per day (mgd) of groundwater with new, alternative sources. Water usage in the tri-county region (Hillsborough, Pasco and Pinellas counties and the cities of Tampa, St. Petersburg and New Port Richey) had soared from 177.7 mgd in 1980 to 218.5 mgd in 1995. By 1998 that number had jumped to 232.36 mgd, and was projected to continue rising as the region grew. The Utility had to develop new sources to replace the groundwater lost to permit reductions and to meet the region's continuing growth.

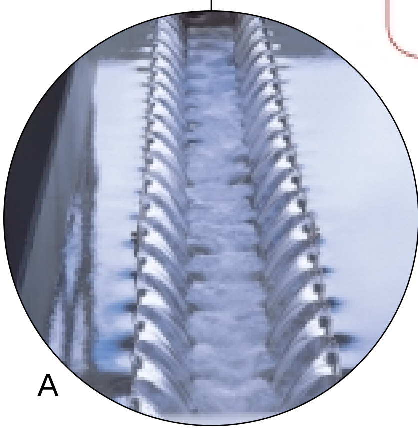
For years, the Tampa Bay region relied on groundwater to meet its drinking water needs. However, in the early 1990s, the region was required by contractual mandate to reduce groundwater pumping at 11 long-producing wellfields in order to help the surrounding environment rest and recover. New non-groundwater sources were needed.

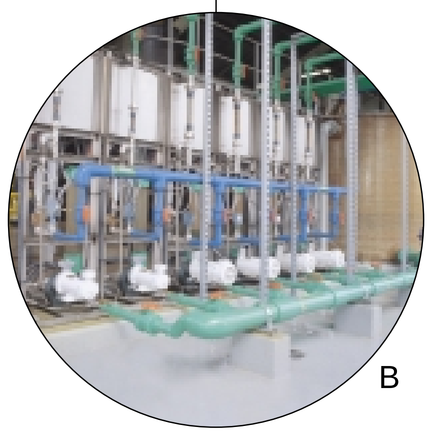
After years of studying water supply options, the Utility developed a $610 million Master Water Plan blueprint to meet the long-term drinking water needs for more than two million customers in the Tampa Bay region. In 1998, the first configuration of projects was approved. A key component of the Master Water Plan's first phase was a strategy to deliver surface water. Therefore, a surface water treatment plant (SWTP) was proposed.

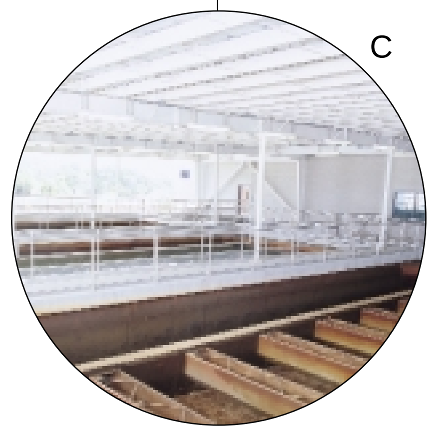
In March 2000, the Utility entered into a $144 million, 15-year design/build/operate (DBO) agreement with a team led by USFilter Operating Services, Houston, to

Tampa Bay Water's Surface Water Treatment Plant









A: *Protective linings act as secondary containment for the submerged concrete.* ***B:*** *Protective linings act as secondary containment for the concrete flooring, and color-coordinated coatings protect the exposed steel piping.* ***C:*** *Corrosion-resistant coatings cover the structural steel canopy.*

carry out the design and construction of the new state-of-the-art surface water treatment plant and to provide for its day-to-day operation. Owned by regional utility Tampa Bay Water, the plant is among the most technologically sophisticated in the world.

The Utility's first surface water plant also is the nation's largest DBO water project. The new 66-mgd regional treatment plant began operation in September 2002. Located on 435 acres in Hillsborough County, the SWTP operates 24 hours a day, seven days a week. Tampa Bay Water officials estimate that this public/private partnership over the 15-year term of the contract will save the region an estimated $80 million.

Role of High-Performance Coatings in Plant Design

USFilter turned to the global, full-service consulting, engineering and construction firm of CDM, Tampa, Fla., as its design partner. Because of the accelerated schedule for the project, the CDM design team was required to produce complete water treatment plant design drawings for submittal to permitting agencies in less than six months.

From the notice to proceed, the SWTP was up and running in about 28 months, including design, permitting and construction, according to Project Manager and CDM Vice President Richard D. Moore, P.E.

"That's about half of the time to implement a conventional design/build/operate project of this magnitude," Moore said.

CDM design engineers faced the formidable challenge of protecting diverse plant operation surfaces and substrates spread over 20 acres, including carbon steel, concrete (both pre-cast and poured-in-place), concrete masonry units (CMU), ductile iron and alloy steel.

During construction, CDM design engineers turned to Tnemec Company, Inc., Kansas City, Mo., for answers to this challenge. Because of the sophisticated water treatment technologies designed for the plant, Moore noted that the design team looked for the most reliable high-performance coatings systems for the 50,000 square feet of the plant's multiple surfaces.

Technological Sophistication

Plans called for the use of the high rate ballasted Actiflo flocculation process. This process is particularly advantageous when treating large flow rates with variable raw water quality—the conditions anticipated for the regional water treatment plant. The facility treats water from the Hillsborough and Alafia rivers as well as the Tampa Bypass Canal to standards that exceed the current EPA Safe Drinking Water Act requirements for potable water.

It is the largest Actiflo plant for municipal water in the United States. The plant also utilizes ozone as the primary disinfectant and granular activated carbon as a medium for the biological filtration, providing advanced treatment.

The process uses sulfuric acid to lower the pH of the raw water and ferric sulfate to coagulate the water. Fine grain sand and polymer are added to the water in the injection tank (See diagram at left).

The water then moves into the maturation tank for further mixing that allows the sand and flocculant particles (floc) to join together before passing into the settling tank. In the settling tank, the floc and raw water are completely separated. The sand's weight forces the floc to fall to the bottom, allowing the treated water to rise to the top for further treatment. Lamella tube settlers are used to improve the separation. At this point, the pH level of the water is lower than normal. Lime is added to help adjust the water's pH level back to normal and prepare the water for disinfection.

Floor coatings and overlayments protect the concrete flooring seen here in the pilot plant, located in the operations building. The pilot plant is a miniature of the entire plant operation; every process can be tested here for performance.

Tampa Bay Surface Water Treatment Plant Facts

- The plant treats 66 million gallons of water a day, enough to fill 94 Olympic-size pools or 1.06 billion cups of water.
- The weight of the water produced in one day at the plant is equal to the 54 million pound concrete base of the Statue of Liberty.
- Approximately 15,000 cubic yards of concrete were used to build the plant, equivalent to a 46-mile sidewalk.

U.S. Drinking Water Infrastructure Needs

- A recent American Water Works Association (AWWA) study on the nation's drinking water infrastructure found that the nation must invest an additional $250 billion to replace aging drinking water infrastructure over the next 30 years.
- The AWWA report finds that spending on pipe replacement must triple over the next 30 years in order for the nation to maintain a high quality drinking water infrastructure.
- The American drinking water infrastructure network spans 700,000 miles, more than four times longer than the National Highway System.
- A recent study by Water Infrastructure Network (WIN), a coalition of industry, engineering, professional and environmental groups, predicts that total expenditures for drinking water and wastewater infrastructure over the next twenty years may range from $492 billion to $820 billion.
- The EPA's Clean Water and Drinking Water Infrastructure Gap Analysis report released last year, under a "no revenue growth" scenario, estimates a total capital payments gap of $122 billion for clean water and $102 billion for drinking water over the next 20 years.

Ozone gas then is added as the primary disinfectant. It destroys the microorganisms including bacteria, viruses and protozoa that may be left in the water. Ozone also oxidizes any remaining organic particles that may be left in the water.

After disinfecting the water, the pH is raised again with lime to prepare it for the filtration process. The water moves from the ozone tank to the biologically active filtration area. During the biologically active filtration process, "good bacteria" oxidize the remaining organic molecules. Layers of sand and granular activated carbon then filter out any remaining particles.

After the biologically active filtration process, the water moves to a storage area (or clearwell) for a second disinfection process. Chloramine is added to maintain the residual chlorine in the distribution process and to ensure that the water supply remains free of bacteria.

After leaving the surface water plant, the water moves to a blending facility where it is merged with treated water from the nearby groundwater plant. Then, the combined water is piped to Tampa Bay Water's member governments.

The plant is fully automated. At the control station, changes in water quality and any changes in the process are monitored continuously. If a problem occurs, an alarm will sound, identifying the problem area. The automated controls allow the operators to react quickly and make any necessary changes.

Coating Solutions

Tnemec consultants specified four categories of coatings systems needed to protect the wide variety of substrates throughout the treatment plant, including protective linings, exterior masonry and steel coatings, corrosion resistant coatings and floor coatings and overlayment systems.

Protective linings included novolac epoxies, vinyl esters, amine epoxies, elastomeric aromatic urethanes and modified aliphatic amine epoxy mortars. These coatings were specified for the interior of the settling, maturation, coagulation and injection tanks, and on submerged concrete in the gravity thickener tank, recycle surge basin and influent box. They were selected to resist corrosive industrial and municipal wastewater and hydrogen sulfide gas permeation as well as abrasion, cavitation and chemical exposure.

Exterior masonry and steel coatings included zinc-rich primers, epoxies, aliphatic urethanes, acrylics, water-based acrylics, saline water repellants, sealers and stains. These were specified for all piping and pumps, exterior concrete, CMU, containment areas and in the maintenance and storage buildings. These coatings and water repellants were chosen because of their ability to resist atmospheric corrosion in a coastal environment and to improve the long-term aesthetics of the facility.

Corrosion resistant coatings included polyamines, amido-amines and cyclo-aliphatic epoxies as well as fiber-reinforced polymers. These were specified for all interior and exterior pipe galleries, filters, submerged steel, walls and ceilings of the operations building. These corrosion-resistant coatings were required to protect against the numerous processing chemicals used in this facility.

Floor coatings and overlayments included resinous floor epoxies applied to the maintenance area, chemical storage area, gravity thickener room, control rooms and bathrooms. These coatings and overlayments were selected to decrease maintenance costs, provide slip-resistant surfaces, increase cleanability and provide a pleasing work environment.

Throughout the plant, wherever there were piping and valves, a tough polyurethane overcoat for UV protection was specified. Because of the many colors available, Tampa Bay Water was able to coat the piping infrastructure with seven colors, one for each process in the treatment cycle.

"Because of the plant's enhanced coagulation treatment process, it was extremely important to have the right

Color-coordinated, exterior steel coatings were used to protect and label the exposed piping seen here in the pipe gallery.

coatings to protect the plant's extensive concrete and steel substrates against this low pH water environment, which is aggressive and borderline corrosive," USFilter Plant Manager David Hackworth said.

Therefore, a great diversity of coatings was needed. Besides chemical and corrosion resistance, the coatings needed to adhere to both the steel and concrete substrates immersed in potable water.

"The integrity and excellence of coating systems is critical to the efficient operation of this state-of-the-art, sophisticated facility," Hackworth said. "It's one more thing we don't have to worry about."

About the Author:
Lake H. Barrett, Jr., is the director of water and wastewater operations at Tnemec in Kansas City, Mo. He holds a Bachelor's degree from Penn State University and is pursuing a Master's degree in management. He is an active member of SSAC, NACE, ASME, AWWA and WEF.

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