Controlling Your Own Water Destiny
How the City of Clearwater Addressed the Politics and Implementation Of Florida’s First Arsenic-Removal-Prior-to-Membranes Facility

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In 1999, the city of Clearwater initiated a study to determine its water supply future. The city examined whether it could economically sustain its water production facilities for the long term and, in so doing, reduce its reliance on regional supplies while providing its rate payers a buffer against future regional water rate increases. The answer was yes.

Clearwater has produced water from its local wellfield since the 1920s. Due to increased mineralization, notably iron and chlorides, over time officials abandoned certain wells and shifted production away from the coast and southern portion of the city. This shift in production has reduced the amount of water produced from the city’s own wells to approximately 3 million gallons per day (mgd). To cover its additional water needs, Clearwater bought approximately 12 mgd from Pinellas County, whose water is supplied by Tampa Bay area reservoirs to meeting a total average demand of about 15 mgd.

The cost of water has increased slightly over time, and the city was buying water at a cost of $1.79 per 1,000 gallons; however, due to increased capital and operations changes, the price of water is destined to increase in the near future. Increases in regular water costs are forecast to be as high as $2.78 per 1,000 gallons in 2010.

Water Supply Conditions in Clearwater

The city of Clearwater is located in Pinellas County in west-central Florida. The city serves a population of about 108,000 with approximately 36,000 customers. The water supply system includes three ground storage reservoirs.

- Reservoir 1 is located in the central portion of Clearwater; contains pumping facilities, disinfection facilities, and a 5-million-gallon (mg) storage tank; and produces approximately 1.4 mgd.
- Reservoir 2 is located closer to Tampa Bay; contains pumping facilities, disinfection facilities, and a 5-mg storage tank; and produces 0.7 mgd.
- Reservoir 3 is located in the northern portion of the city; features pumping facilities, disinfection facilities, and two 5-mg storage tanks; and produces approximately 1.0 mgd.

The city was producing approximately 6 mgd from its own wellfield, with pumping reduced significantly over the subsequent years. In 1996, SDI and CDM prepared a wellfield management plan that included provisions for control of chlorides by controlling pumping rates and dispersing wells. That plan also concluded that treatment would be necessary to sustain future production.

In 1999, Clearwater requested that McKim & Creed perform a study to determine if the city could produce its own water supplies while maintaining costs below that of purchased water. That same year, the city submitted a Water Use Permit (WUP) renewal application to the Southwest Florida Water Management District for continued use of its wellfield.

City Looks for Ways To Control Its Own Water Destiny

With water costs rising, the city began exploring ways to control its own water destiny. In 1988 Briley, Wild & Associates studied Clearwater’s water supply situation and reported that reverse osmosis (RO), or membrane treatment, was an option; however, if no additional treatment was provided, the city would need to purchase additional water from regional supplies. During this time period, the city wanted to reduce its reliance on regional supplies and implement a long-term solution that would avoid the permit requirement and increase production from local wellfields, while meeting anticipated regulations.

The city looked around the city to build treatment facilities to produce quantities higher than 3 mgd. The district also required the city to continue monitoring chloride levels, as well as any impacts to adjacent legal users as withdrew quantities were increased.

The McKim & Creed report, published in 2000, identified membrane technology as the most cost-effective method of treating well-source water within city limits. The report also focused on methods to control trihalomethanes (THMs) in the city’s water supply (at that time, Tampa Bay Water had not yet decided on using monochloramines for disinfecting the regional supply).

The city could use membrane technology to remove salts and reduce organics at two of its reservoir sites and blend at the third site to meet forthcoming Clean Water Act regulations on THM formation in drinking water that were to go into effect in December 2002. McKim & Creed also reported that the city could boost its water production from 3 mgd to 5 mgd with membrane technology, at a cost of $1.68 per 1,000 gallons. Additionally, membrane technology would enable the city to retain production from its wellfield while managing increased chlorides concentration.

The $1.68 per 1,000 gallons was based on the contingency that the city construct an $8.2 million facility, with anticipated operations and maintenance costs of $1.2 million annually. Those estimated costs were revised during construction, with construction costs reduced to $8.1 million and operating costs projected to be $1.0 million, which lowered the unit cost to $1.51 per 1,000 gallons.

The new facility was designed to provide 3 mgd, combined with 2 mgd from the remaining well field. Reservoirs 2 and 3, for a total city production of 5 mgd. The remaining 10 mgd required to meet city customer demands will be purchased from Pinellas County.

Regional Solution Considered

While the city was exploring ways to become more self-sufficient in terms of water production, Tampa Bay Water was reviewing options for increasing regional supply to offset future demands. Tampa Bay Water was driven by time; the agency needed to get additional production facilities online within about a year, due to regional permit limitations in light of forecast demand.

Once the city had decided to build an RO water facility, Tampa Bay Water offered to take control of the city’s water production facilities once the plant was built. This was unacceptable, since the city would still end up paying regional water rates of $1.79 per 1,000 gallons and higher, which directly impacted its customers. Clearwater’s goals were to reduce the impact of future regional water rate hikes and increase production from local wellfields, while meeting anticipated regulations.

Tampa Bay Water then proposed a design-construction agreement whereby Tampa Bay Water would, for a guaranteed price, design and build the facility, which would both be maintained, owned, and operated by the city. This effort was supported by water management district co-funding, and Clearwater and Tampa Bay Water agreed to come to terms on a guaranteed maximum price by February 2001.

Initial discussions with Tampa Bay Water revealed that Reservoir 1 would be the best location to build the treatment plant, since the city already had plans to rehabilitate and modify four well sites serving this facility, and sufficient area existed to accommodate the additional footprint. A project group was established—including representatives from Tampa Bay Water, city staff, consultants, and a

Clearwater citizen interested in the project— and charged with developing the framework for the design-construction agreement. The group discussed a number of issues, including destination and anticipated characteristics of the concentrate from the plant, review of well operational reports and the potential to achieve additional production of 2 mgd from city wells, siting of facilities, public involvement, and costs. One key issue was understanding the nature and effects of the concentrate stream and where this flow should go. Options included: 1) a reject water injection well, 2) gulf or bay disposal, and 3) recycling this flow at the city’s wastewater treatment plant(s).

The team visited Dunedin’s membrane plant to review operation and learn from Dunedin’s experience. The first two options were costly and presented potential problems with permitting. Since evaluations of the ability for the city’s wastewater treatment plant to acceptably operate with concentrate flow blend-ed with the raw wastewater flow proved positive, the decision was made to send the concentrate to the city’s wastewater treatment facilities. The city had the opportunity to transfer this flow to either its Marshall Street Advanced Pollution Control Facility (APCF) or Northeast APCF, and plans were made to
install concentrate pipelines to both facilities in the event of future capacity issues. The city's wastewater collection system was studied to ensure that sufficient current and future capacity existed at the plants, and a necessity study concluded that there would not be adverse impacts on the wastewater treatment plants' permit compliance by receiving the increased concentrate.

Wellfield reports were studied to determine which wells should be reactivated, which should be recycled, and the details on the agreement between the city and their consultant's geologists and laboratory staff. The knowledge of the geology in the wellfield area is an overriding cause of concern. The geology station was attended by a professional geologist provided explanations with a chlorides concentration anticipated to be 250 mg/L, increasing to 500 mg/L or greater over a 25-year time frame. These concentrations are less than expectations forecasted from the deeper basalt backwater sources and the surficial water sources, would result in a more stable finished water from the membrane treatment.

To provide a stable finished water for city customers, with an alkalinity of 80 to 100 and a pH of between 7.8 to 8.2, while higher than traditional water sources, would result in a more stable finished water source and minimize impacts to the distribution system. At the same time that Clearwater was preparing to alter the water quality by implementing the membrane treatment at facility Reservoir 1, the other city water source was altered as a result of Tampa Bay Water’s development of new water sources.

To address possible impacts and to develop design guidelines to minimize those impacts, pipe loop studies were conducted, two projects in a proposed water from a pilot unit. The studies determined that a target pH of 7.8 to 8.2, while higher than traditional water sources, would result in a more stable finished water source and minimize impacts to the distribution system. Thus, post-treatment process design studies showed that the treated water was suitable for use in the new facility.

The membranes that were selected for use in the new facility are the Osmonics DESAL® AG4040i spiral wound polyamide (PA) elements, which are designed to handle the relatively low TDS levels present, but are capable of treating the increased TDS levels anticipated over time. The design operating pressures are expected to be in the 175 psi range. Revised TDS levels are expected to be in the 80 percent range. Blended water flow occurs downstream of the membrane.

One area of concern for the city was to mitigate the impact the new treatment process would have on the existing, aged distribution system. The membranes are the Osmonics DESAL® AG4040i spiral wound polyamide (PA) elements, which are designed to handle the relatively low TDS levels present, but are capable of treating the increased TDS levels anticipated over time. The design operating pressures are expected to be in the 175 psi range. Revised TDS levels are expected to be in the 80 percent range. Blended water flow occurs downstream of the membrane.

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Power consumption was projected to be 4,700 kilowatt-hours per day at $0.05 per kilowatt-hour, for an annual cost of $90,000, or $0.08 per 1,000 gallons. Costs for cleaning and cartridge filter replacement were expected to be $0.03 per 1,000 gallons. Additional costs for membrane replacement funding, pumping of concentrate, and other miscellaneous expenses brought the total operating cost with capital recovery to $1.46 per 1,000 gallons, which is below the originally estimated cost of $1.68 per 1,000 gallons.

The original RO water treatment plant design data submitted to the Pinellas County Department of Health (PCDOH) identified design flow of 3.66 mgd and future flow of 5.00 mgd. The new construction authorized under the permit issued by the PCDOH allowed for the new water treatment facilities to have an existing permitted capacity of 3 mgd, with a future design capacity of 5 mgd. Specific Condition Number 11 classified the water plant as a Category 1 Class A water treatment plant, requiring a Class C or higher operator 24 hours a day for 7 days per week, with the lead/chief operator being a Class A.

City operations staff met with the PCDOH to request a reclassification from a Category 1 Class A facility to a Category 1 Class B facility. A letter was sent with this request, explaining that, although designed for expansion for up to 5 mgd, the plant will initially have an influent flow of 3.66 mgd and a finished water flow of 3.0 mgd. The level of automation was also described and included the following:

- An in-plant Supervisory Control and Data Acquisition (SCADA) system programmed with set points for automatic RO shutdown and process control.
- Wells that are controlled and monitored by the in-plant SCADA system, using a matrix for individual well and flow control to the plant.
- An external SCADA system that monitors the citywide SCADA with alarms and dial-up notification to the on-call operator.

Based on this information, the city of Clearwater formally requested, and received, the reclassification of this facility from a Category 1 Class A facility to a Category 1 Class B facility. When the facility is expanded to above 5 million gallons, the city will re-evaluate the classification and permit.

Contracting Equipment Separately From Construction Reduces Cost, Establishes Relationship with Vendor

A unique aspect of this project was the contracting methodology utilized. The city solicited bids from manufacturers for the membrane equipment and separate bids for general construction services. The ROEM was responsible for building, delivering, and testing all filter systems, membranes, and chemical feeds, and for providing staff training. The general contractor was responsible for building the facility and all associated piping, blend tanks, backwash tanks, and pumping equipment.

Contracting for equipment and construction services in this manner offered several advantages to the City, including:

- Reduced “mark-up” on the purchase price of the equipment by buying directly from the ROEM.
- The ability for the city to be directly involved in selecting the ROEM.
- The ability to evaluate ROEMs on the basis not only of price, but also process design support, maintenance support, experience, and company strength.
- The opportunity for the city to establish a direct working relationship with the ROEM for future support of the RO systems and training.
- Compression of the overall schedule by getting a head start on equipment procurement.

This project delivery method came with disadvantages as well, which included a higher degree of coordination required by the city and McKim & Creed, and a higher level of schedule coordination and communication with, and between, the ROEM and the general contractor. To address these issues, Clearwater required the ROEM to provide a process guarantee for one year of operation, during which the ROEM conducts all testing to ensure the equipment meets the city’s water quality requirements. Additionally, the city

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had the ability to obtain and review drawings and preliminary submittals from the vendor prior to completing the design and bidding the general construction package, which further reduced potential conflicts.

Clearwater conducted a two-step selection process for the ROEM. The first step was issuing a Request for Qualifications to solicit qualifications statements and preliminary equipment proposals. The ROEMs' Statements of Qualifications were evaluated for company qualifications and background, relevant experience, financial capability to meet the project requirements, and the technical and operational support capabilities. From the original ROEM submittals, four firms were selected to receive the Request for Proposals (RFP) from the city. The RFP solicited not only prices for the treatment equipment, but also process details, along with expected operational costs of the proposed equipment. The proposals were evaluated for technical merits, process performance, capital cost, and operational costs. The top-ranked proposers were selected and a contract for equipment purchase was finalized. The successful proposer for the RO equipment was Osmonics Inc.

The water treatment plant facility construction, including the installation of the equipment being supplied directly by Osmonics, was bid as a separate contract. The successful bidder for this work was Westra Construction Company Inc. The raw water pipelines and the concentrate force main were installed under a separate contract that utilized an existing unit-priced contract for similar pipeline work, in order to expedite this portion of the overall improvements program. The well rehabilitation work was contracted directly with the city by Hausinger Inc.

Current Status

The three primary components associated with this project were:

- Wellfield improvements.
- Construction of raw water piping and concentrate disposal piping.
- Construction of the water plant.

The initial wellfield improvements were completed in 2002. Existing wells have been video logged, cleaned, and fitted with new casing liners. The antiquated SCADA system, which was limited to well monitoring, has been upgraded with a system that allows both control and monitoring.

Two new wells have been added to the wellfield system and two previously abandoned wells have been reactivated, expanding water production capability. Water production has increased with additional efforts being made to continue increasing production of groundwater to meet targeted levels.

Pipeline construction was completed in 2002 to connect the new wells and the reactivated wells with the raw-water pipe system. A concentrate force main was also completed in 2002 to connect the lift station serving the water treatment plant to the existing gravity sewer system.

Approximately 20 percent of the raw water delivered to the new facility is rejected as either filter backwash or concentrate from the membrane treatment. This discharge water is transported, via the new reject water force main, to the city's Northeast Advanced Pollution Control Facility for treatment and disposal, with the capability to also divert some portion of flow to the Marshall Street Facility.

Construction on the RO plant began in October 2002 and was completed in November 2003. The grand opening ceremony of the facility was held on December 16, 2003, and the facility has been operating continuously since that time. Currently, the operating costs of the facility are about $930,000 per year, which includes about $500,000 per year to purchase chemicals, cartridge filters, and electricity to operate the facility.

This is Florida's first arsenic-removal-prior-to-membranes facility, one of the first in the U.S. to comply with the EPA's new arsenic standard, enabling the city of Clearwater to proactively manage its own water destiny.