Minneapolis Water Works Ultrafiltration Plant Makes a Big Splash in the Membrane World

By Jonathan Pressdee and Chad Hill

The quality of drinking water in the Minneapolis area has been significantly enhanced by a new membrane filtration plant now in operation in Columbia Heights. The largest potable ultrafiltration (UF) plant in the Western Hemisphere, which is also the second largest in the world, is now treating and supplying high-quality drinking water to area residents. With a current capacity of 70 million gallons per day (mgd) and ultimate capacity of 78 mgd, the Minneapolis Water Works’ Columbia Heights membrane filtration plant is second in size only to a 72 mgd membrane facility in Singapore. Both facilities were designed by Black & Veatch.

Growing interest in membrane filtration by communities around the world has spawned an increase in not only the number but also the size and sophistication of membrane facilities. With completion of the MWW UF plant, Black & Veatch has provided study, design, construction and startup services for the two largest membrane filtration facilities in the world treating potable water. The award-winning Chestnut Avenue Water Works extension project in Singapore features an immersed membrane system and continues to hold the world record in current operation capacity for potable water plants. The MWW plant further establishes membrane filtration as an economically viable technology. In fact, recent Black & Veatch projects in North America have shown membrane filtration to be not only affordable but even lower in cost than traditional filtration processes for Greenfield sites.

The decision to replace existing granular media filters with UF to further treat lime-softened, clarified, variable-quality water from the Mississippi River was prompted by multiple goals and considerations. These included the need to address future contamination threats, continue to comply with regulatory requirements and replace nearly century-old treatment sand filters. The new membrane filtration plant is producing low-turbidity water that is better than regulatory standards require, and it

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By the time this newsletter reaches your desk, spring will be in full swing and AMTA's 2006 activities will be in high gear. Our Biennial Conference, entitled “Desalination Comes of Age – The Answer for New Supplies” is shaping up to be landmark event. The conference will be held in Anaheim, CA, July 31 – August 2, 2006. As I write this in March, exhibit space is selling out quickly and registrations are already flowing in. In addition to AMTA’s usual comprehensive coverage of membrane technology advances and issues, a key focus area of the conference will be seawater desalination. The conference will also highlight AMTA’s long-standing affiliation with the International Desalination Association and its other affiliates around the world.

Attendees to the conference will have the opportunity to tour local desalination facilities including the Orange County Water District Ground Water Replenishment Project, the Long Beach Water Department NF Seawater WTP and West Basin MWD’s Water Reclamation Project and Desal Pilot Plant. There will also be three Pre-Conference Workshops offered on Sunday, July 30th: a concentrate disposal summit, a membrane plant operator forum & hands-on training & tour of Irvine Ranch Water Treatment Facilities, and a workshop on Metallurgy & Membrane Systems.

As I close, I hope you are enjoying the new look and feel of our newsletter. Special kudos to Robert Reiss, Janet Jaworski and Kelcia Mazana for their work in improving and upgrading the newsletter. Also, by the time you receive this newsletter, your 2006 AMTA ballot should be in the mail. Please take the time to vote for your Board of Directors.

See you in Anaheim!

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AMTA Solutions is published quarterly for the members of AMTA. AMTA Solutions is mailed to AMTA members and published on the AMTA website only.
With membrane technologies roaring forward in the market place, providing solutions to more and more treatment needs, it's no surprise that mergers and acquisitions would follow. With that said, I stopped to reflect the large number of corporate transitions we have seen in the past several years. The purchase of Advanced Membrane Systems by Layne Christensen highlighted what has seemed like an increasing level of activity. We all watched and wondered as US Filter was offered up for sale. Now solidly in the Siemens family for almost two years, the landscape appears relatively unchanged for the Memcor membrane group. Not soon after the US Filter deal came GE's merge of venerable desal firm Ionics. This year we have seen Pridesa, the Spanish desal company that had been leveraging its relationship with sister company American Water to enter the US desal market, get spun out of the RWE family and sold to Acciona, SA of Spain (now American Water and Thames are slated for sale by RWE as well). Finally, I was surprised and impressed with GE's acquisition of Zenon Environmental, firming up their position in water and membrane technologies. What all of these mergers and acquisitions mean to the municipalities using or considering membranes, in my mind, remains to be seen. However, it's clear that many companies see a future in membranes.

On another note, we continue to work hard to obtain non commercial, technical articles for publication. I believe we have done an admirable job of providing quality, meaningful information for our readership each quarter. However, you (yes, you!) should submit an article, asap. Please email articles to kdmazana@reissenv.com. Thanks in advance for your support.

Before beginning this article, I spent some time reflecting on the changes in membrane technology over the past thirty years. It is almost like comparing your first calculator or computer to what is now available. For those interested, my first calculator was actually a slide rule and my first electronic calculator took “D” size batteries and had about 2 hours of useful battery life. We have come a long way since then and so has membrane technology.

During my early days in the industry, the choices in membrane were limited. The water quality produced from these initial membranes was difficult to predict and frequently varied by a few percent from one production run to the next. Membrane system design calculations were completed differently by each OEM and, as a result, water quality was almost impossible to predict accurately. In general, we knew what water quality to expect but even the best water quality projections were rather loose and unreliable.

In recent years, most membrane manufacturers have developed water quality projection programs that are very precise. These new projection programs have allowed us to accurately predict the performance of a specific product and the resulting water quality under a given set of circumstances.

In addition, new and improved technology has provided the membrane manufacturers the ability to modify and further improve their products. The latest generation membranes offer a wide variety of separation characteristics that allow us to adjust and accurately predict the water quality we can obtain from a new membrane system.

This is a very exciting time to be part of this dynamic industry. With the careful selection of membranes, use of hybrid designs, and second stage pressure boost, we are able to control permeate water quality outcome better than we could have imagined just a few years ago. It is important that we take advantage of these new advances in membrane technology and tools to help us select the best product and design for our specific application.

If you have a tip or a suggestion for a future article please contact Ben Mohlenhoff at (772) 546-6292 or bmohlenhoff@aerexindustries.com.
a Dutch membrane manufacturing company. Each membrane unit comprises 28 fiberglass pressure vessels similar to those used in reverse osmosis systems, 28 feet in length. Each pressure vessel contains four membrane cartridges connected in series, and bypass channels within each cartridge allow for even flow distribution throughout the pressure vessel.

Integration of new complex treatment into existing treatment facilities presents challenges, and the Columbia Heights UF plant was no exception. Challenges that necessitated special attention included flow control and hydraulic balancing through the existing pretreatment process to meet the demands of the ultrafiltration system; treatment, recovery, and recycle of waste streams such as chemical cleaning waste, backwash water from the membrane units, and feed strainers and integrity test drain down water; construction of new chemical feed processes to replace existing facilities while maintaining plant operations; and ensuring ease of access for anticipated future maintenance activities such as replacement or repair of valves and membrane fiber.

Extensive piloting was conducted throughout the procurement, design, and post-construction phase of this project. Initial pilot testing was performed as part of the procurement process to identify the most economical membrane system that met strict performance goals. Membrane manufacturers were required

will protect MWW customers from waterborne disease by providing high-log removal of microbial pathogens such as Cryptosporidium.

Raw water is abstracted directly from the Mississippi River. The river receives numerous discharges in the watershed, including agricultural run off, power plant cooling water and effluent from sewage treatment plants. These threats have driven improvements to the treatment plant over the years. Notable treatment challenges include variable organic concentration, turbidity, and temperature. The annual snow melt period in the spring also creates treatment challenges for the pretreatment process due to rapid changes in raw water alkalinity and organic composition.

Previous study indicated that membrane filtration would provide better protection against contamination threats present in the watershed. Study team members also recognized that optimization of pretreatment would be necessary to successfully integrate membrane filtration. Such improvements included optimization of PAC dosing and use of potassium permanganate to control taste and odor.

Once the MWW decided to add membrane filtration, the utility prepared procurement documentation for the testing and purchase of filtration equipment. A panel of industry experts with membrane filtration technology was formed to provide input for the procurement documents and to review the pilot testing that accompanied the bidding process. Following pilot tests, extensive bench-scale tests, and a value engineering study, UF was selected as the most appropriate technology because it met the established criteria at an acceptable cost. Design of the Columbia Heights UF facility commenced in January 2001 following selection of Black & Veatch as the design engineer and Ionics (now part of GE Water Infrastructure) as the membrane equipment supplier.

At the Columbia Heights UF facility, the membrane filtration process is fed by five variable frequency-driven pumps. Water is distributed to four rows of membrane units; each row comprises nine ultrafiltration membrane units, each with a gross capacity of 2.2 mgd operating at a flux of 57 gfd (97 L/m²/h). Feed water to each membrane unit is pre-filtered by automatic backwash strainers of a candle filter design, which are periodically washed via a rotating wash arm. Strainers remain in service during backwashing, and each wash takes approximately two minutes.

The membrane units were manufactured by Ionics, Inc and use UF membrane cartridges manufactured by X-Flow,
to establish operating parameters at the start of the initial piloting phase. At the end of the optimization period, the membrane suppliers had to identify their operating parameters and conduct extended piloting without any further adjustments. For the Columbia Heights project, two membrane systems made the shortlist following the initial advertisement. The systems piloted were Koch and Ionics, using the X-flow membrane. The Ionics system performed best and was ultimately selected for installation at the Columbia Heights facility. Additional piloting was conducted following selection to further optimize system parameters.

A major fouling event occurred during the extended piloting phase. It is believed to have coincided with a major change in water quality due to snow thawing in the spring. This causes softening of the Mississippi River water source, and it has been postulated that the nature of organic species may have been altered at this time. An alternative chemical cleaning procedure has been developed to restore permeability caused by the fouling event. After successful piloting, adjustments were made to the design of the chemical feed and neutralization systems. Chemical feed system changes are relatively inexpensive when caught during the design phase of the project but can be very expensive to modify once the plant has been constructed. Long-term pilot trials can be quite beneficial for utilities with rapidly changing surface water quality.

The MWW intends to continue pilot testing throughout the life of this plant. A demonstration scale unit is planned to enable utility staff to conduct off-line testing. Such testing may encompass alternative chemical cleaning regimes, additional virus testing, and alternative membrane formulations as they become available to compare performance with the existing plant.

The Columbia Heights UF plant project team incorporated advanced design tools as well as filtration technology in the upgrade of the existing water treatment facilities, using innovative 3-D design, virtual reality software, and an effective internet-based communications approach. While the exterior was designed to aesthetically complement the historic existing facilities, the new building houses contemporary control, laboratory and educational facilities in addition to the 40 UF units and associated storage and feed equipment for membrane cleaning.

Clearly identifying the best treatment solution and effectively communicating the need for rate increases to citizens and political leaders enabled the MWW to raise funds and increase rates as necessary. The professionals involved in the massive planning, design, construction, and implementation effort also concluded that it is beneficial to: continue piloting after bid award, especially if the water source is of changeable nature; allow for flexible chemical cleaning regimes to address unexpected fouling events; maintain and enforce rigid protocols for membrane pilot testing to gather high quality data to accurately determine the best performing membrane filtration unit; and maintain close working relationships among the owner, contractor, and design engineer. They also demonstrated that 3-D design is an excellent tool for developing a well laid-out plant that facilitates operations and maintenance work and careful coordination with regulatory agencies enables smooth passage through the approval process.

Jonathan Pressdee is an Associate Vice President and Membrane Practice Leader with B&V Water, the water business of Black & Veatch Corporation. Currently based in the company’s Minneapolis office, Pressdee has 15 years experience in the water industry and holds a degree in Chemical Engineering from University College Swansea, University of Wales, UK. He can be reached at pressdeejr@bv.com.

Associate Vice President Chad Hill, P.E., served as the project director with Black & Veatch in Minneapolis. He has 19 years of project experience and is responsible for client services in upper midwestern United States. Hill earned his Masters degree from the University of Kansas, Lawrence, Kans.
Case History of a 3.4 MGD RO Plant Treating Brackish Groundwater

Edward H. Talton, Jr., PE, Reiss Environmental, Inc.

Abstract
An exponential increase in demand for high quality water to support population growth, economic expansion, and existing customers is being experienced in many areas in the United States. Utilities are actively investigating innovative water supply and treatment alternatives to meet this demand at a manageable cost. This paper provides an overview of the design requirements for a 3.4 million gallon per day (mgd) expansion of a reverse osmosis (RO) water treatment plant (WTP) using brackish groundwater from a coastal aquifer. The approach to effectively complete the plant design was as follows:

- Identify suitable quantity and quality source water
- Characterize the source water quality
- Define treatment requirements based on regulations and municipal standards
- Identify a suitable treatment process train
- Verify stability of the finished water in the distribution system
- Develop the basis of design for each unit treatment process
- Estimate the cost of the expansion and implementation schedule

This plant design consisted of the RO process, pretreatment, RO feed pumping, degasification, post treatment, and high service pumping systems. The process design included state-of-the-art low pressure membranes and an inter-stage turbo boost energy recovery device. The energy recovery device payback was less than 4 years. The plant began operations in November 2005.
• Develop the basis of design for each unit treatment process
• Verify stability of the finished water in the distribution system
• Develop the basis of design for each unit treatment process

Keywords
Reverse Osmosis; Water Treatment Plant Design; Brackish Water

Introduction
St. Lucie West Services District (SLWSD), Port St. Lucie, FL, provides potable water to residential and commercial customers in its service area. SLWSD operated a 2 mgd reverse osmosis (RO) water treatment plant (WTP) that was designed to be readily expandable to 4 mgd. The 2003 maximum daily flow was 1.6 mgd, or 80 percent of design capacity. Future growth projections necessitated expanding the RO WTP. SLWSD’s approach to expanding the WTP was to prepare a preliminary engineering report that identified a suitable supply source and treatment process train to provide a functional, reliable WTP which meets water quality regulations and standards. The preliminary engineering report was also used to support the permitting efforts with FL DEP. The approach to complete the plant design was as follows:

• Identify suitable quantity and quality source water
• Characterize the source water quality
• Define treatment requirements based on regulations and municipal standards
• Identify a suitable treatment process train
• Verify stability of the finished water in the distribution system
• Develop the basis of design for each unit treatment process

This paper summarizes the results of the design effort.

Capacity Requirements
The expanded capacity of the RO WTP was designed to meet SLWSD’s projected growth needs for at least a 10 year planning period. SLWSD had the foresight to construct the initial RO WTP to be readily expandable to a second phase capacity of 4 mgd and an ultimate capacity of 10 mgd. This expansion project primarily consisted of adding new RO trains or skids inside the building and related ancillary equipment.

Flow Projections
Projections indicated SLWSD’s service population would increase from 14,528 in 2003 to 24,750 in 2010 and 26,550 in 2020. The district’s customers typically use shallow wells for landscape irrigation and the District also reuses reclaimed water for irrigation. Therefore, per capita potable water usage is lower than typical Florida cities. Using the current per capita usage of 80 gallons per day, the average annual flow for SLWSD was projected to increase from 1.2 mgd in 2003 to 2.0 mgd in 2015, to 2.1 mgd in 2020.

WTP Expansion Phasing
The initial RO WTP plant included support structures, yard piping and processes with 4.0 mgd capacity, RO skids with 2.0 mgd capacity and buildings for 10 mgd capacity. The expansion was to include two additional RO skids. The new skids were designed for full design capacity without the original two trains in operation. The City planned to use the original 2.0 mgd RO trains for backup purposes only and use the untreated shallow well supply system for supplemental irrigation flow. Because the 10-year and 15-year projections are very close, 2.0 mgd versus 2.1 mgd, the plant expansion was sized to meet 15-year (year 2020) projection.

Peaking Factors and Design Flow
Treatment components were sized based on maximum daily flows. Finished water pumps were sized based on peak hourly flows. Based on the limited amount of potable water used for irrigation in the service area, SLWSD’s peaking factors are relatively low. The RO WTP has experienced maximum day flow factors of 1.5 and peak hourly flow factors of 2.5 compared to average daily flows. The RO WTP expansion design capacity was projected by multiplying maximum daily and peak hourly flow factors by the design year average daily flow. Using the 15-year average daily flow of 2.1 mgd the design maximum daily flow is 3.2 mgd and the design peak hourly flow is 5.3 mgd. The proposed treatment plant design capacity was increased to 3.4 mgd to provide water for in-plant uses.

Water Quality
Source Water Quality
SLWSD investigated a different source of supply to lessen the impact on local wetlands and which had lower suspended solids and was better suited for RO treatment compared to the existing shallow aquifer supply. Hydrogeological investigations identified the Floridan Aquifer as a more suitable source. While typically higher in hardness and total dissolved solids (TDS), this source had ample available supply, low impact on wetlands and very low suspended solids concentrations. The source was also successfully used for RO treatment in Martin County and the nearby City of Port St. Lucie. Consequently, water quality data from six of Port St. Lucie’s nearby Floridan Aquifer wells was used for the design of the RO WTP. To be conservative, the worst case well water quality was used for the basis of design, as summarized in Table 1. Ranges of water qualities are provided as well as quality from the worst case well in terms of total dissolved solids (TDS) and chloride. The TDS of 3,200 mg/L for the worst case well is significantly higher than the average of 2,400 mg/L for the six wells.

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General Electric Agrees to Acquire ZENON Environmental

Expands GE’s Water & Process Technologies Platform with the Addition of Best-In-Class Ultrafiltration Membrane Technologies

TREVOSE, PENNSYLVANIA AND OAKVILLE, ONTARIO (March 14, 2006) – GE Water & Process Technologies, a unit of General Electric Company (NYSE: GE) and ZENON Environmental Inc. (TSX: ZEN and ZEN.NVA; OTC: ZNEVF and ZNEAFL), announced today that they have signed an agreement in connection with the acquisition by way of Plan of Arrangement of ZENON by GE in an all cash transaction for Cdn $24.00 per share, valuing the transaction at approximately Cdn $760 million, or US $656 million. ZENON is a global leader in advanced membranes for water purification, wastewater treatment and water reuse to municipalities and industries worldwide.

Over its 26-year history, ZENON pioneered the use of ultrafiltration technology for water and wastewater treatment. The technology has become the technology of choice for water and wastewater plants, and its adaptation is spreading rapidly throughout the world.

“ZENON is a great strategic fit with GE,” said David Calhoun, GE Vice Chairman and President & CEO, GE Infrastructure. “With the synergies we create, we will have the potential to grow revenue in the municipal water segment at more than 30 percent for the next several years. Its best-in-class membrane technologies will allow GE to serve the fast-growing ultrafiltration segment of water and wastewater treatment, significantly expand our capabilities to help customers address pressing water scarcity issues and play a key role in the high-growth areas of the municipal water segment. With this terrific addition, we anticipate our water platform growing to nearly US $2.5 billion in revenue next year.”

Andrew Benedek, Chairman and CEO of ZENON Environmental, said, “This transaction will benefit both our customers and GE’s customers. Our advanced membranes and talented team, combined with GE’s technology, scale, strong global network and services expertise, will open up new global opportunities for our ultrafiltration technology.”

ZENON’s advanced membranes include membrane bioreactor (MBR) and hollow fiber technologies that offer low-cost filtration and disinfection in one step with low energy consumption. ZENON has an extensive patent portfolio that will enhance GE’s current water scarcity platform by providing pre-treatment technology for reverse osmosis desalination and reuse. ZENON’s technology in municipal water treatment will enhance GE’s presence with advanced technology products in this large global industry. ZENON’s technologies also will help GE provide the best life-cycle cost reduction for customers in customized service agreements.

Under the terms of the agreement, GE will acquire all of the issued and outstanding Common Shares of ZENON (ZEN – TSX) and the Non-Voting Class A Shares (ZEN.NVA – TSX) for Cdn $24.00 in cash. ZENON option holders will be eligible to receive Cdn $24.00 cash, less the exercise price of the respective option.

The transaction is to be effected by way of statutory “Plan of Arrangement” and will require the approval of ZENON’s securityholders. Management of ZENON anticipates that a management proxy circular regarding the Arrangement will be mailed to securityholders by the end of March 2006, with a meeting of the ZENON shareholders being held to approve the Plan of Arrangement in late April or early May 2006.

Assuming successful completion of the Arrangement, GE intends to amalgamate ZENON with a wholly owned subsidiary of GE.

The Board of Directors of ZENON, following the unanimous recommendation of a Special Committee of independent directors established to oversee the transaction and the negotiation thereof, has unanimously approved the Arrangement Agreement and is recommending the holders of ZENON Common and Non-Voting Class A Shares vote in favor of the Plan of Arrangement.

GMP Securities L.P. and J.P. Morgan Securities Inc. have acted as financial advisers to the ZENON Board and Special Committee and have also each provided an opinion to the Board and the Special Committee confirming the fairness of the offer to the holders of the Common Shares and Non-Voting Class A Shares of ZENON.

Andrew Benedek, Chairman and Chief Executive Officer, who, together with his affiliates, owns 6,148,160 shares, has entered into a support agreement agreeing to vote in favor of the Arrangement, subject to limited exceptions, including the termination of the Arrangement Agreement by ZENON.

Additional Information about the Transaction

The Arrangement is subject to customary regulatory approvals, as well as to approval by the holders of the ZENON Common Shares, Class A Non-Voting Shares and the holders of ZENON options and the approval of the Alberta Court.

Under the Arrangement Agreement, ZENON is prevented from pursuing any other takeover proposals, subject to certain exceptions including exceptions in connection with the fiduciary duties of the ZENON Board of Directors.
If the Arrangement does not occur under certain circumstances, ZENON has agreed to pay a break fee of three percent of the equity value of this agreement.

**About GE Water & Process Technologies**

GE Water & Process Technologies, a unit of General Electric Company, is solving some of the world's most pressing water challenges by providing industrial, agricultural and potable water, while lessening our dependence on fresh water sources. Technologies to accomplish this include desalination, advanced membrane, separation solutions, and water reuse and wastewater management and process technologies. GE delivers value to customers by improving performance and product quality, reducing operating costs and extending equipment life. For more information on GE Water & Process Technologies, visit www.gewater.com.

In Canada, GE has operations across the country, including 15 major manufacturing facilities, over 150 sales and service locations and more than 9,500 employees.

**About ZENON Environmental**

ZENON is a world leader in providing advanced membrane products and services for water purification, wastewater treatment and water reuse to municipalities and industries worldwide. Canada’s Top 100 Employers ranked ZENON in their top 100 list for the last six years. An S&P/TSX Composite company, ZENON Environmental Inc. trades on the Toronto Stock Exchange under the symbols ZEN and ZEN.NV.A; and on the OTC under the symbols ZNEVF and ZNEAF. Additional information is available at ZENON’s web site www.zenon.com.

**Caution Concerning Forward-Looking Statements**

This document contains “forward-looking statements” – that is, statements related to future, not past, events. In this context, forward-looking statements often address expected future business and financial performance, and often contain words such as “expects,” “anticipates,” “intends,” “plans,” “believes,” “seeks,” or “will.” Forward-looking statements by their nature address matters that are, to different degrees, uncertain. For GE, particular uncertainties arise from the behavior of financial markets, including fluctuations in interest rates and commodity prices, from future integration of acquired businesses, from future financial performance of major industries which we serve, including, without limitation, the air and rail transportation, energy generation, media, real estate and healthcare industries, from unanticipated loss development in our insurance businesses, and from numerous other matters of national, regional and global scale, including those of a political, economic, business, competitive and regulatory nature. These uncertainties may cause actual future results to be materially different than those expressed in the forward-looking statements. Neither GE nor ZENON undertakes to update our forward-looking statements.

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Legislative Updates

By: Eric Sapirstein, Legislative Advocate

A recent National Research Council report on the future of the Bureau of Reclamation is expected to be the subject of careful review when the House Committee on Resources and the Senate Committee on Energy and Natural Resources convene separate hearings into the study. The study entitled *21st Century Bureau of Reclamation* was initiated after a request by the Department of the Interior. The study found that the Bureau has a number of challenges most importantly managing and restoring an aged infrastructure of dams and related facilities and the ability to conduct research in a collaborative manner that will enable it to work with its limited resources. Among one of the few examples cited is the value of a separate research arm to conduct desalination research. While the report acknowledges the research is important, NRC suggests consideration of whether such an approach is as efficient compared to stakeholders conducting the research. These issues are expected to be closely scrutinized when the House and Senate committees review the report and hear the Bureau’s responses to suggestions that call for a close review of the kind of research it should conduct in the years ahead.

**Senate Subcommittee Hears Witnesses Praise Water Recycling Program; Cite Importance of Fixing Program**

The continuing concern over water scarcity in the west and the role of the Bureau of Reclamation set the agenda for a recent Senate Committee on Energy and Natural Resources’ Subcommittee on Water and Power hearing. At the March hearing, the subcommittee heard from the Bureau’s Commissioner, John Keys, that while the Bureau supports water recycling and other alternative water supply projects, the Bureau believes that it should have a more defined role rather than just providing assistance. In defending the Bureau’s current practices, Keys noted that a number of projects are being funded and that at least two projects are expected to be completed in the coming year. In response to Senators’ questions, the Bureau acknowledged that it has not supported any number of proposed projects, instead placing emphasis on its Water 2025 program as the key to responding to water supply needs throughout the west. The members expressed skepticism of the Bureau’s position on greater involvement in the process. Citing the importance of moving projects through completion rather than reinventing the review process, the Bureau, it was pointed out, did not seem to have a good track record in bringing projects to completion in a timely manner. As an example of this position, the recent authorization permitting the Bureau to review and approve water projects as part of CALFED had yet to yield one project that was identified as ready to proceed to construction. This position was held by the Bureau despite the position of a number of project sponsors that projects were ready to proceed.

In a separate panel discussion, witnesses drawn from local government and Congress’ own Congressional Research Service provided an overview of the existing Bureau programs to support alternative water supply needs. In a round of exchanges with the Subcommittee, the local government witnesses highlighted the importance of the federal government’s role in supporting project development through funding assistance. While the funding may be limited due to budgetary constraints, they indicated that the federal role validated the project and helped to secure necessary construction funding and public willingness to accept the costs of such projects. In response the Subcommittee members highlighted their concern that it is vital that projects not be submitted to endless reviews and reevaluations. They agreed that feasibility studies should not take many millions of dollars and several years, which has been the experience in other federal programs. Instead, the subcommittee indicated that it intends to take action on the issue in the coming months to provide for a reinvigorated program to support the development of alternative water supply projects. To this end, the subcommittee staff is expected to begin the process of developing legislative options to address the needs of western water users. As part of this effort, the Bureau of Reclamation announced during the hearing that it intends to provide legislative options for subcommittee consideration.

**Bureau of Reclamation Future to be Focus of House and Senate Hearings**

A recent National Research Council report on the future of the Bureau of Reclamation is expected to be the subject of careful review when the House Committee on Resources and the Senate Committee on Energy and Natural Resources convene separate hearings into the study. The study entitled *21st Century Bureau of Reclamation* was initiated after a request by the Department of the Interior. The study found that the Bureau has a number of challenges most importantly managing and restoring an aged infrastructure of dams and related facilities and the ability to conduct research in a collaborative manner that will enable it to work
The President's budget request for desalination programs follows through on early warnings that fiscal year 2007 program spending would be limited. Under the President's request for the Bureau of Reclamation, desalination program spending would be severely reduced. Under the request, desalination water research would effectively be eliminated providing only $25,000. Instead funding for such activities would be derived from the Administration's request for its Water 2025. This program would be supported at $14.5 million representing a $9 million increase over the amount Congress provided in fiscal year 2006. At the same time, support for the Science and Technology program that has provided assistance in desalination in past years is reduced by almost 50% to $8.5 million. The reductions while draconian are only the first step in a year-long process. Congress is now poised to begin its budget review process that will culminate in a final spending bill sometime later this fall. According to congressional budget writing staff, the effort to effectively eliminate support for these kinds of programs is unlikely to be adopted. However, they indicate that the federal deficit and the calls for action to constrain the growth of the budget may manifest itself in reduced spending for programs like desalination research or current year funding at best. Funding for desalination programs (Tularosa) is expected to receive continued support from Congress.

Fiscal Year 2007 Budget Tests Congressional Resolve

Congressional budget committees are expected to move quickly in the House and Senate to fashion spending bills to meet the October 1, deadline. However, the pressure to restore cherished spending programs, like desalination, is expected to slow the process down as Congress and the Administration attempt to find a middle ground that could serve as the basis of a final budget that Congress could pass.

Senate Committee on Energy and Natural Resources Chairman Pete Domenici (R-NM) staff have recently restated the chairman's goal of moving legislation through the Senate with the aim of finalizing a water technology research program by the end of the congressional session. The legislation, Energy-Water Efficiency Technology Research, Development, and Transfer Program Act of 2005 (S. 1860) is currently pending before the Senate. As approved by the Senate committee, the bill would provide for a new program of research and technology demonstration within the U.S. Department of Energy. Perhaps one of the key areas of interest to AMTA members is the bill's provision to focus attention on concentrate disposal challenges. Under the legislation, funding would be available to support technology demonstrations that could help to minimize the costs associated with concentrate disposal that in turn make desalination and general water treatment more expensive. Also included in the bill are provisions that would establish an advisory panel to help U.S. DOE define appropriate areas of research as well as identifying promising technologies that could benefit from federal assistance under the new program. Additionally, a directive to develop a technology roadmap that would help identify critical water supply technology research would be initiated. In collaboration with a number of federal agencies, including the Environmental Protection Agency and the Department of the Interior, DOE would develop the roadmap and submit it to Congress for consideration on how to direct future federal support in the research arena.

According to committee staff, the legislation remains a top priority. Once a few technical revisions are agreed to on the bill's provisions, the Senate is expected to consider and pass the bill to the House. House action is anticipated as similar legislation was introduced (H.R. 3182) several months ago. ■

Water Technology Legislation Remains Top Priority

The President's budget request for desalination programs follows through on early warnings that fiscal year 2007 program spending would be limited. Under the President's request for the Bureau of Reclamation, desalination program spending would be severely reduced. Under the request, desalination water research would effectively be eliminated providing only $25,000. Instead funding for such activities would be derived from the Administration's request for its Water 2025. This program would be supported at $14.5 million representing a $9 million increase over the amount Congress provided in fiscal year 2006. At the same time, support for the Science and Technology program that has provided assistance in desalination in past years is reduced by almost 50% to $8.5 million. The reductions while draconian are only the first step in a year-long process. Congress is now poised to begin its budget review process that will culminate in a final spending bill sometime later this fall. According to congressional budget writing staff, the effort to effectively eliminate support for these kinds of programs is unlikely to be adopted. However, they indicate that the federal deficit and the calls for action to constrain the growth of the budget may manifest itself in reduced spending for programs like desalination research or current year funding at best. Funding for desalination programs (Tularosa) is expected to receive continued support from Congress.

Congressional budget committees are expected to move quickly in the House and Senate to fashion spending bills to meet the October 1, deadline. However, the pressure to restore cherished spending programs, like desalination, is expected to slow the process down as Congress and the Administration attempt to find a middle ground that could serve as the basis of a final budget that Congress could pass. ■
New requirements under the S2DBPR apply to community and nontransient noncommunity water systems that use or deliver water that has been treated with a primary or residual disinfectant other than UV light. The new Rule includes:

- Individual Distribution System Evaluation (IDSE) Plan, Monitoring and Report requirements
- Compliance Monitoring using sites identified in IDSE
- Compliance based on Locational Running Annual Average (LRAA)
- Consecutive system requirements

Significant in this rule is that USEPA has incorporated requirements and compliance deadlines for combined distribution systems and consecutive systems. USEPA has defined these systems as follows:

**Combined Distribution System (CDS)** - Interconnected distribution system consisting of the distribution system of wholesale systems and consecutive systems that receive finished water

**Consecutive Systems** - PWS that receives some or all of its finished water from one or more wholesale systems

A Schedule Number has been assigned to each system for phasing in compliance with the S2DBPR Rule. USEPA has defined the Schedule Numbers as follows:

If your system serves a population of:
You are on schedule number:

<table>
<thead>
<tr>
<th>Population</th>
<th>Schedule Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥100,000</td>
<td>1</td>
</tr>
<tr>
<td>50,000-99,999</td>
<td>2</td>
</tr>
<tr>
<td>10,000-49,999</td>
<td>3</td>
</tr>
<tr>
<td>&lt;10,000 and not connected to a larger system</td>
<td>4</td>
</tr>
</tbody>
</table>

**Complying With IDSE Requirements**

The Implementation Schedule first calls for systems to conduct an Initial Distribution system Evaluation (IDSE) which will determine the locations of high DBP concentrations throughout your distribution system. You can comply with this requirement in one of four ways:

1. Develop a **Standard Monitoring (SM) Plan** which uses existing maps, water quality data and operational data to identify monitoring locations expected to have high DBP results, then conduct the Standard Monitoring at those locations for one year at the frequency identified in the S2 Rule. For systems with populations over 10,000, the frequency is every 60 days (every 2 months) at 8 or more sites, depending on population served. You must also continue to monitor under the S1DBPR during the period you conduct the Standard Monitoring. This can be a lot of data. Upon completion of the Standard Monitoring, the system must submit an IDSE report to the State that makes a recommendation on the locations for S2DBPR compliance monitoring.

2. Develop a **System Specific Study (SSS) Plan** which allows you to use existing monitoring results (if they meet criteria) or modeling to identify the locations of highest DBP concentrations. If insufficient samples have been collected under existing monitoring, you are required to make up additional sampling. The IDSE report for a SSS must make a recommendation and provide the basis and justification for locations for S2DBPR compliance monitoring. The State can reject the data submitted under a SSS, and the system must then conduct Standard Monitoring and submission of an IDSE Report.

3. Submit **40/30 Certification**, indicating that all Stage 1 DBPR compliance samples were ≤0.040 mg/L for TTHM and ≤0.030 mg/L for HAA5 AND there were no monitoring violations under Stage 1 DBPR.

4. Submit a **Very Small System Waiver (VSSW)** request. Applies only to systems serving <500 persons AND who have complied with Stage 1 DBPR monitoring requirements.
### IDSE Compliance Schedule

<table>
<thead>
<tr>
<th>Schedule Number</th>
<th>Population</th>
<th>Submit SM Plan or SSS Plan by:</th>
<th>Complete Standard Monitoring or SSS By:</th>
<th>Submit IDSE Report by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>≥100,000</td>
<td>Oct 1, 2006</td>
<td>Sept 30, 2008</td>
<td>Jan 1, 2009</td>
</tr>
<tr>
<td>2</td>
<td>50,000-99,999</td>
<td>April 1, 2007</td>
<td>Mar 31, 2009</td>
<td>July 1, 2009</td>
</tr>
<tr>
<td>3</td>
<td>10,000-49,999</td>
<td>Oct 1, 2007</td>
<td>Sept 30, 2009</td>
<td>Jan 1, 2010</td>
</tr>
<tr>
<td>4</td>
<td>&lt;10,000</td>
<td>April 1, 2008</td>
<td>Mar 31, 2010</td>
<td>July 1, 2010</td>
</tr>
</tbody>
</table>

Wholesale and consecutive systems comply at the same time as the system with the earliest compliance date in the combined distribution system (CDS).

There is no IDSE requirement for systems submitting the 40/30 Certification, a VSSP or if it is a NTNCWS serving less than 10,000 connections.

### Compliance Monitoring Requirements

After completion and submittal of the IDSE report, systems must update their DBP Monitoring Plan to reflect new locations and monitoring under S2DBPR, and submit this to the State prior to initiating compliance monitoring. You must conduct with S2DBPR according to the following schedule:

#### Compliance Monitoring Schedule

<table>
<thead>
<tr>
<th>Schedule Number</th>
<th>Population</th>
<th>You must comply with S2DBPR monitoring by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>≥100,000</td>
<td>April 1, 2012</td>
</tr>
<tr>
<td>2</td>
<td>50,000-99,999</td>
<td>October 1, 2012</td>
</tr>
<tr>
<td>3</td>
<td>10,000-49,999</td>
<td>October 1, 2013</td>
</tr>
<tr>
<td>4</td>
<td>&lt;10,000</td>
<td>October 1, 2014 if no Cryptosporidium monitoring is required or October 1, 2014 if Cryptosporidium monitoring is required</td>
</tr>
</tbody>
</table>

Wholesale and consecutive systems comply at the same time as the system with the earliest compliance date in the combined distribution system (CDS).
Case History of a 3.4 MGD RO Plant Treating Brackish Groundwater

**Finished Water Quality Goals**

The United States Environmental Protection Agency (EPA) has established water quality standards and monitoring requirements for drinking water supplies. The maximum contaminant levels are divided into primary and secondary standards. In Florida, the Department of Environmental Protection (FDEP) has primacy for drinking water regulations. FDEP's drinking water standards are based on the EPA primary and secondary standards with stricter limits for several contaminants. These standards were used to establish the finished water quality goals for this project.

Finished water quality goals were developed and compared to raw water quality to define treatment requirements. Finished water quality goals meet or exceed primary and secondary drinking water standards and provide an aesthetically pleasing and stable drinking water. To provide SLWSD customers with better water quality, goals for secondary standard parameters were set at 80% or less of the maximum contaminant levels (MCLs). Finished water quality goals are compared to raw water quality in Table 1. Parameters which did not meet the finished water quality goals are shown in bold. Contaminants requiring removal were sodium, chloride, total organic carbon (TOC), hydrogen sulfide, sulfate and TDS. Fluoride and pH needed to be increased during post treatment.

**Treatment Requirements**

The brackish groundwater with high chlorides and TDS made low pressure RO the applicable membrane treatment process. The existing plant was designed for RO and three nearby water treatment plants using the same Floridan Aquifer source also were using RO. RO readily removed hardness, sodium, sulfate and TOC from the source water. The hydrogen sulfide levels were removed via forced draft aeration or degasification. The existing plant had one forced draft aeration unit and the process is used statewide for hydrogen sulfide removal. Post treatment was designed to restore some hardness and meet pH, LSI and CCPP goals to prevent corrosion in the distribution system.

**Design of Treatment Process**

**Pretreatment**

Pretreatment of the groundwater was needed to prevent fouling of the low pressure RO membranes and sustain system productivity. The groundwater source was expected to have very low in turbidity (<0.5 NTU). Therefore, the only solids removal process was the standard micron cartridge filter included with every RO system to intercept intermittent slugs of solids. Other typical RO pretreatment processes included acid and antiscalant (scale inhibitor) addition.

**Sulfuric Acid Feed System**

A sulfuric acid feed system was provided upstream of the cartridge filters to dissolve any calcium carbonate particles present in the groundwater, as observed in similar Floridan Aquifer wells. The proposed SLWSD groundwater pH was expected to range from 7.1 to 7.8 units. Adjusting the pH to approximately 7.0 units dissolved the calcium carbonate particles. An in-line static mixer was included to blend the acid with the feed particles. An in-line static mixer was used to optimize the degasification process. The existing plant had one forced draft aeration unit and the process is used statewide for hydrogen sulfide removal. The existing RO trains were redundant, the existing acid feed system was expanded to provide the needed capacity.

---

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Units</th>
<th>Range of Well Water Quality</th>
<th>Design Raw Water Quality</th>
<th>Finished Water Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkalinity, Total</td>
<td>mg/L as CaCO$_3$</td>
<td>140-160</td>
<td>140</td>
<td>35-50</td>
</tr>
<tr>
<td>Aluminum</td>
<td>mg/L</td>
<td>&lt;0.020-0.139</td>
<td>&lt; 0.02</td>
<td>0.15</td>
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<tr>
<td>Barium</td>
<td>mg/L</td>
<td>0.024-0.14</td>
<td>0.053</td>
<td>1.6</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>800-1,750</td>
<td>1,750</td>
<td>150</td>
</tr>
<tr>
<td>Color</td>
<td>CPU</td>
<td>&lt;5</td>
<td>&lt; 5</td>
<td>10</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/L</td>
<td>0.013-0.1</td>
<td>0.016</td>
<td>0.8</td>
</tr>
<tr>
<td>Fluoride</td>
<td>mg/L</td>
<td>&lt;0.01-0.67</td>
<td>0.50</td>
<td>0.8</td>
</tr>
<tr>
<td>Hardness, Total</td>
<td>mg/L as CaCO$_3$</td>
<td>476-860</td>
<td>860</td>
<td>60-100</td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>mg/L</td>
<td>&lt;0.04-0.55</td>
<td>1.5</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/L</td>
<td>&lt;0.025-0.05</td>
<td>&lt; 0.025</td>
<td>0.24</td>
</tr>
<tr>
<td>Lead</td>
<td>mg/L</td>
<td>&lt;0.003-0.016</td>
<td>&lt; 0.001</td>
<td>0.005</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/L</td>
<td>&lt;0.005</td>
<td>&lt; 0.004</td>
<td>0.04</td>
</tr>
<tr>
<td>Nitrate (as N)</td>
<td>mg/L</td>
<td>0.01-0.068</td>
<td>0.014</td>
<td>&lt;00.1</td>
</tr>
<tr>
<td>pH</td>
<td>Units</td>
<td>7.1-7.8</td>
<td>7.1</td>
<td>8.0-8.5</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg/L</td>
<td>436-960</td>
<td>960</td>
<td>150</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>200-300</td>
<td>220</td>
<td>200</td>
</tr>
<tr>
<td>TOC</td>
<td>mg/L</td>
<td>&lt;1.3</td>
<td>1.95</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>1,800-3,200</td>
<td>3,200</td>
<td>450</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>&lt;0.019-0.019</td>
<td>0.15</td>
<td>0.2</td>
</tr>
<tr>
<td>Ammonia (as N)</td>
<td>mg/L</td>
<td>0.28-0.57</td>
<td>0.57</td>
<td>–</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/L</td>
<td>75-140</td>
<td>140</td>
<td>–</td>
</tr>
<tr>
<td>Conductivity</td>
<td>S/cm</td>
<td>3,100-5,400</td>
<td>5,400</td>
<td>–</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/L</td>
<td>70-120</td>
<td>120</td>
<td>–</td>
</tr>
<tr>
<td>Potassium</td>
<td>mg/L</td>
<td>22-37</td>
<td>29</td>
<td>–</td>
</tr>
<tr>
<td>Silica Dioxide</td>
<td>mg/L</td>
<td>14-18</td>
<td>14</td>
<td>–</td>
</tr>
<tr>
<td>Strontium</td>
<td>mg/L</td>
<td>12-22</td>
<td>22</td>
<td>–</td>
</tr>
<tr>
<td>Langlier Saturation Index</td>
<td>Units$^2$</td>
<td>–</td>
<td>0.10</td>
<td>0.05-0.10</td>
</tr>
<tr>
<td>CCPP</td>
<td>mg/L$^2$</td>
<td>–</td>
<td>4.9</td>
<td>positive</td>
</tr>
</tbody>
</table>

1 Data from the City of Port St. Lucie LTC Water Treatment Plant, 2003 Floridan Aquifer water quality data for the highest TDS well. Bold values exceed Finished Water Goal.

2 Calculated
Acid was stored in the existing 12,000 gallon tank.

**Antiscalant Feed System** – An antiscalant feed system was provided to prevent precipitation of calcium carbonate, calcium sulfate, strontium sulfate, barium sulfate and calcium fluoride. Two different projections resulted in a dose of approximately 2 mg/L of antiscalant for the 84% membrane system recovery. Using a dose of 2 mg/L and a recovery of 84%, approximately 7.5 gpd was required at design capacity. The existing antiscalant feed system was expanded and re-piped to add antiscalant to the process flow just after the in-line mixer and prior to the cartridge filters. Two new chemical feed pumps were added to the two existing 1.7 gph chemical feed pumps to achieve the needed capacity. The existing antiscalant tank had a capacity of 450 gallons which was enough capacity for the expanded system.

**Cartridge Filtration** – Following addition of acid and antiscalant, cartridge filtration was provided to remove particles that might damage the feed pump and plug the lead RO membranes. The three existing filter vessels remained and one new vessel was installed. Two of the three existing filter vessels had a capacity of 1.25 mgd each, and the third vessel had a capacity of 1.5 mgd, for a total capacity of 4.0 mgd. The new filter vessel was designed with a capacity of 2.4 mgd to provide firm capacity of 4.0 mgd. The new filter vessel was vertical, stainless steel unit with a 150 psi pressure rating, similar to the existing filters. The cartridge filters were designed for 90% removal of 5 micron particles.

**High Pressure RO Feed Pumps**
The total raw water demand was 4.05 mgd. The design RO feed pressure was calculated to be 276 psi. Approximately 40 psi was supplied by the well pumps, resulting in a total pressure provided by the high pressure pump of 236 psi (545 feet). Each treatment skid was fed by two pumps and one standby pump was provided, for a total of five pumps. Two pumps were equipped with variable frequency drives for modulating flow (recovery) or feed pressure. Each pump is an 8-inch short set vertical turbine with a 150 horsepower motor. The pumps draw from a common header and discharge back into a common header.

**RO System**
The RO system was designed based on state-of-the-art engineering practice, similar full scale facilities and a recently conducted pilot study for Port St. Lucie, FL on the same source of supply. The results of this pilot study showed that operating a RO system at 15 gallons per square feet per day (gfd) first stage average flux, a 10 gfd second stage flux and a recovery between 80 and 85% was successful with no observed fouling during the 3 month study. The pilot study demonstrated that addition of 2 mg/L of antiscalant and cartridge filtration were successful pretreatment with a raw water pH of 7.1 units.

Specific design criteria were then independently established to evaluate system design alternatives. Two antiscalant computer programs were used to evaluate limiting recovery and the need for acid addition at temperatures ranging from 70°F to 80°F and design water quality. Antiscalant projections indicated limiting recoveries from 89 to 94% for the design water quality. An 84% design recovery was selected based on these analyses and the pilot study.

Design criteria were a maximum first-stage average flux of 15 gpm per square foot (gfd) of membrane, and a minimum second stage flux of 10 gfd. In order to balance fluxes between the first and second stages, an inter-stage boost between the stages was considered. The inter-stage boost recovers excess pressure in the concentrate to boost the pressure in the second stage resulting in decreased first stage pressure. Residual concentrate pressures of 50 to 75 psi were required for deep well injection.

A maximum RO by-pass flow of 0.15 mgd was included to increase of the hardness and alkalinity in the blended stream and maintain the chloride goal of 150 mg/L. Blending feed water and permeate will result in a reduction of the number of calcite contactors necessary to provide stable water.

Three RO process designs were evaluated: simple (standard 2:1 array with no inter-stage boost), inter-stage boost and hybrid membranes. Membrane manufacturers considered for the alternative system designs included Toray, Koch (Fluid Systems) and Dow/Filmtec. Toray and Koch membranes were evaluated for the simple and inter-stage boost alternatives. Koch and Dow/Filmtec membranes were evaluated for the hybrid membrane alternative. As an example of the evaluation, the results for the alternative designs using Koch membranes at 84% recovery are summarized in Table 2.

Based on the results of the analysis it was recommended to provide an inter-stage boost for the RO system to conserve...
energy, balance fluxes and reduce permeate backpressure requirements. The payback for the inter-stage boost was approximately five years. Additionally, the inter-stage boost would aid system operation if source water quality declined in the future.

Other energy saving features included optimizing the hydraulic design including maximizing pump efficiency, variable speed drives and a lifecycle analysis of pipe sizing. The overall energy savings were $40,000 per year in 2003 dollars.

The selected RO design was two new skids, with a capacity of 1.7 mgd each. The high pressure piping was 316L stainless steel (SS), and the pressure vessels were rated for 300 psi. The pressure vessels were 8” diameter and accommodated seven 40” long membrane elements. The maximum surface area of each membrane element was 440 square feet. The skids were designed to allow the addition of 10% more pressure vessels to accommodate declining source water quality or lower recovery. The RO system basis of design is summarized in Table 3.

**Post Treatment**

Post treatment was provided to stabilize the finished water prior to distribution. Post treatment consists of alkalinity/hardness recovery, hydrogen sulfide removal, pH adjustment, disinfection and fluoridation. Post treatment processes included calcite addition, degasification, sodium hydroxide addition, chlorination using chlorine gas, and fluoridation using hydrofluosilicic acid.

**Calcite Addition** – Calcite (limestone or CaCO3) is added to RO finished waters to raise the hardness, alkalinity and pH in the product water. SLWSD has had excellent success stabilizing its existing RO WTP finished water with calcite contactors, therefore this process was utilized for the expansion. The addition of calcium and alkalinity is directly proportional to the carbon dioxide present in the water entering the calcite contactor. As described above, the RO system design included a 3% bypass to assist with alkalinity and hardness recovery. To improve reliability, the

| Table 2 | Evaluation of Alternative Designs Using Koch Membranes |
|-----------------|-----------------|-----------------|-----------------|
| **Parameter** | **Simple (2:1 Array)** | **Inter-stage Boost** | **Hybrid with Inter-stage Boost** |
| Membrane Element Model | TFC8821ULP-400 | TFC8821ULP-400 | TFC8832HR:575MAG/TFC8832HR:365 |
| - Stage 1 | | |
| Chloride (permeate), mg/L | 148 | 150 | 50 |
| Max. Feed Pressure, psi | 226 | 197 | 230 |
| Max Permeate Backpressure, psi | 70 | 40 | 30 |
| Interstage Boost, psi | 0 | 30 | 38 |
| Maximum Average System Flux, gfd | 14.4 | 14.4 | 14.9 |
| Min. Second Stage Flux, gfd | 10.1 | 10.0 | 11.6 |
| Array Configuration | 28:14 | 28:14 | 30:13 |
| Turbo Boost Capital Cost | - | $100,000 | $100,000 |
| Annual Power Cost | $180,000 | $160,000 | $185,000 |
| Annual Savings | - | $20,000 | - |

1. Design raw water quality represented worst case and was evaluated with 15% fouling factor.
calcite contactors were designed to be able to successfully adjust water quality without the 3% RO bypass.

The calcite contactor was sized to treat 60-70% of the permeate and bypass 30-40%. The expected hardness and alkalinity concentrations out of the calcite contactors were 54 mg/L as CaCO3 and 19 mg/L as CaCO3, respectively. Following blending with the calcite bypass and the RO bypass, the hardness and alkalinity of the blended stream is projected to be 72 mg/L as CaCO3 and 37 mg/L as CaCO3, respectively. Two new calcite contactors were added to the existing two contactors to accommodate the expansion from 2.0 to 3.4 MGD. The existing calcite contactors had a diameter of 8 ft and a loading rate of 6 gpm/sf. The new calcite contactors were designed with a diameter of 8 ft and a loading rate of 8 gpm/sf. The limestone bed depth is 3 ft to 4 ft. The addition of two 1-mgd contactors provided firm capacity with one contactor out of service.

**Degasification and Odor Control** – The treated water from the calcite contactors, the calcite bypass flow and the RO bypass flow are combined and directed to the degasifier to remove hydrogen sulfide. The degasifiers were designed to remove hydrogen sulfide to less than 0.2 mg/L. The existing RO WTP had one degasifier; the expansion added a second unit. An odor control system was added to reduce off-gas hydrogen sulfide concentrations.

**Sodium Hydroxide Feed System** – Sodium hydroxide is added to raise the pH and provide an LSI of 0.1 to 0.2. A dose of 30 mg/L was needed to raise the finished water pH from 5.5-6.5 units to around 7.7 units. In addition, sodium hydroxide is added to the wet scrubber used for odor control. The design dose was 12 mg/L. Two new chemical feed pumps were added to the two existing feed pumps for pH adjustment. Two additional new chemical feed pumps were added for the feed to the wet scrubber. The existing 4,000 gal storage tank was adequate for 30 days of storage and the existing 750 gal day tank was adequate for the expanded plant.

**Hydrofluosilicic Acid Feed System** – Fluoride is added to the water by SLWSD to improve dental health. Hydrofluosilicic acid is added in the chlorine contact chamber. The raw water contains naturally occurring fluoride, which is removed by the RO process. A goal of 0.8 mg/L of fluoride in the finished water was established in meet Florida regulations. Therefore, the hydrofluosilicic acid feed system was designed to dose 0.8 mg/L. Based on this design dosage and a hydrofluosilicic acid solution strength of approximately 23%, 12 gpd of hydrofluosilicic acid were required for 3.4 mgd design capacity. The existing feed system was adequately sized to handle the increased design flow, so no new equipment was needed.

**Disinfection** – The treated water is disinfected with chlorine to inactivate pathogens and provide a residual in the distribution system. The design dose was 5 mg/L, which resulted in chlorine use of 142 lb/day. The existing chlorine gas system was used because it was adequately sized. Chlorine is added to the treated water in the chlorine contact chamber.

**RO Cleaning System**

The existing cleaning system was adequately sized and retained for use with the expanded RO system. However, the pumping design was changed to maintain adequate flow in the RO skid during chemical cleaning. The circulation pump was designed to supply 40 gpm per pressure vessel which corresponds to 1040 gpm for one skid in Stage 1 (based on a maximum of 26 pressure vessels in the first stage). Chemical cleaning of the second stage requires only 520 gpm. In order to use the same pump to clean both stages, the piping on the pump discharge was teed off to have some of the flow pumped back to the cleaning solution tank.

**Project Costs**

The project costs for the 3.4 mgd RO WTP expansion are summarized in Table 4. Costs related to developing the source of supply and raw water transmission, and concentrate disposal are not included.

---

### Table 4

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Requirements</td>
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</tr>
<tr>
<td>Building Modifications</td>
<td>50,000</td>
</tr>
<tr>
<td>Chemical Feed Pumps</td>
<td>50,000</td>
</tr>
<tr>
<td>Static Mixer</td>
<td>40,000</td>
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<tr>
<td>Cartridge Filter</td>
<td>100,000</td>
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<tr>
<td>High Pressure Pumps</td>
<td>300,000</td>
</tr>
<tr>
<td>Membrane Skids w/Membranes</td>
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</tr>
<tr>
<td>Interstage Boost</td>
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<tr>
<td>Degasser and Odor Control</td>
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<tr>
<td>Calcite Contactors</td>
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<tr>
<td>Chlorination</td>
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<tr>
<td>Process Piping</td>
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<tr>
<td>Site Piping</td>
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<tr>
<td>Instrumentation and Control</td>
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<td>Electrical and Motor Control</td>
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<tr>
<td>Total</td>
<td>$3,650,000</td>
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</table>

**Conclusion**

The design of the 3.4 mgd RO WTP expansion provided a high quality supply of potable water for SLWSD using a brackish water coastal aquifer. The RO system was designed to handle the worst case raw water supply and included energy recovery to minimize operating costs. The cost of the WTP expansion was $3,650,000.

**Acknowledgements**

The author wishes to express his sincere gratitude to Jon C. Whitmer and other team members such as St. Lucie Services District personnel, C. Robert Reiss, Christophe Robert and Kelcia Mazana who contributed to the success of this project.

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**About the Author**

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Disposal of Desalting By-Product

To date, the drinking water industry has primarily focused on the use and management of freshwater supplies to meet demands. However, in several regions of the U.S., these supplies have been utilized and managed to their full capacity. Purveyors of potable water are now turning to supplies of lesser quality. These include brackish groundwater, brackish surface water, and seawater. Treatment of these waters for potable use requires membrane desalting technologies such as reverse osmosis (RO) and electrodialysis reversal (EDR).

RO and EDR are used in some capacity across the US and more heavily in the states of California, Florida, and Texas. These and other states have recently received heightened attention from the desalting industry due to increased emphasis on the use of seawater as a potable water supply. One impediment to the growing demand for membrane desalting technologies is the disposal of resulting by-product.

Desalination water treatment plants (DWTPs) produce by-product as they separate salts, minerals, and other dissolved constituents from the water. The separation of these constituents results in two flow streams: 1) a purified potable stream (permeate), and 2) a stream containing the separated dissolved constituents. The latter by-product stream is typically referred to by regulators as “concentrate” and sometimes inappropriately referred to as “brine”.

By-Product Disposal Alternatives

Desalting by-product is commonly disposed of through one of six practices: 1) sewer discharge, 2) surface water discharge, 3) irrigation, 4) deep well injection 5) evaporation ponds, 6) zero liquid discharge thermal processes. Each of these methods varies in complexity of permitting and costs, with sewer discharge commonly being the least complex and least costly and zero liquid discharge being the most complex and most costly.

Sewer Discharge is dependent on the ability of the wastewater treatment plant to accept high salinity discharge. The treatment plant outfall location may be affected by total dissolved solids restrictions or other limiting water quality concerns. A national pollution discharge elimination system (NPDES) permit is required and maintained by the WWTP owner.

Surface Water Discharge involves discharge to a point of outfall such as a bay, tidal lake, brackish canal, or ocean. The location and potential required by-product treatment prior to discharge are determined by state and regulatory agency water quality standards and bioassay toxicity testing. An NPDES permit is required and maintained by the DWTP owner.

Irrigation is sometimes used for by-product streams relatively lower in salinity. Saline tolerant vegetation and habitat are required. This is usually determined by site-specific soil and drainage characteristics. An NPDES permit is required and maintained by the DWPT owner if run-off from irrigation is possible.

Deep Well Injection is very common, especially with inland DWTPs. This method injects the by-product stream deep below ground under at least one overlaying, confining geologic layer. The by-product is permanently stored in the injection zone.

Evaporation Ponds may be used to reduce or eliminate by-product flows. This method of disposal is land-intensive and requires relatively dry climates. Dry salt is the waste product, and it must be characterized and disposed of accordingly as solid waste.

Zero Liquid Discharge Thermal Processes greatly reduce or eliminate the by-product liquid stream through thermal treatment processes. These processes are energy intensive and are very costly. Wastes must be characterized and disposed of accordingly.

Is Desalting By-Product from Drinking Water Production an Industrial Waste?

The answer to this question involves the synergy between the applications for membrane desalting and federal and state agencies responsible for developing laws and issuing National Pollution Discharge Elimination System (NPDES) permits.

At present, the Clean Water Act does not specifically address DWTP

1Brine is water with twice the concentration of dissolved solids as seawater. Most desalting by-products do not fit this definition. The word “brine” carries a negative connotation since it is also used to refer to some wastes from the petroleum industry.
by-products. As a result, DWTP by-products are addressed through a default classification: industrial waste. This results in a stringent and cumbersome set of regulations applied to an often benign by-product primarily composed of constituents from a natural water body, albeit in a form that is more concentrated. Furthermore, the term “industrial waste” is alarming to the public. Often, purveyors of potable water are required to spend excessive amounts of finance and efforts educating the public about the benign nature of this by-product. This expense transfers into higher water costs for the treatment process.

The absence of science-based regulations to address DWTP by-products has resulted in an uncertain regulatory environment. The latitude available to regulatory agencies when addressing the default classification of “industrial waste” greatly limits the ability to predict the outcome of any permitting effort and further limits the ability to accurately forecast costs, suitability, environmental compatibility, and other key planning level tasks. Of particular concern are the use of surface water discharge and the issuance of an NPDES permit. Because desalting by-product is inadequately addressed in NPDES law, surface water discharge is often the most problematic yet most applicable method of discharge for larger DWTPs, which are necessary to meet water deficits.

At present, state regulatory agencies have no choice but to address DWTP by-products through industrial waste regulations. These agencies would benefit from more specific regulatory guidance regarding desalting by-product.

**Florida Case Study**

The State of Florida recently passed legislation to streamline the permitting process for desalting by-product waters. Though incapable of amending the Clean Water Act to reclassify the by-product out of the industrial waste program, the state was able to change the name and create permitting forms that are better suited for by-product applications.

Florida now refers to “RO concentrate” as a “potable water treatment by-product,” which is still regulated under the industrial program as required by the Clean Water Act. However, the law’s objective is to improve the economics of permitting desalting by-product discharge to surface waters by improving public perception and creating permit applications and permits that are best suited for this type of by-product. Nevertheless, a strong case can and should be made to amend the Clean Water Act to provide for a new, separate classification for DWTP streams and how to deal with them.

This material has been prepared as an educational tool by the American Membrane Technology Association (AMTA). It is designed for dissemination to the public to further the understanding of the contribution that membrane water treatment technologies can make toward improving the quality of water supplies in the US and throughout the world.

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Stuart, FL 34994
Phone: 772-463-0820
Fax: 772-463-0860
E-mail: amtaorg@aol.com
AMTA was contacted by EPA and asked to participate as a stakeholder in the review of technical issues related to the management of drinking water treatment process residuals, which includes byproduct water from desalination. This review will support the EPA’s decision making for the Drinking Water Treatment Effluent Guidelines Rulemaking.

The Clean Water Act directs EPA to develop national industrial technology-based regulations to limit the amount of pollutants that are discharged to surface waters (usually called “effluent guidelines”) or to sewage treatment plants (called “pretreatment standards”). Pretreatment standards ensure that pollutants do not pass through or interfere with the safe and effective operation of these treatment plants. The Clean Water Act also directs EPA to develop national industrial technology-based regulations (called “new source performance standards”) for new facilities.

Furthermore, the Clean Water Act requires EPA to identify industries, not yet regulated by effluent guidelines, which may be discharging more than trivial amounts of toxic or “nonconventional” pollutants, such as nutrients. EPA published the 2004 effluent guidelines program plan (September 2, 2004; 69 FR 53705) and identified the “drinking water treatment point source category” as a candidate for effluent guidelines or pretreatment standards or both. It is important to note, however, that EPA has made no decisions about whether any national technology-based discharge controls are necessary for residuals produced by drinking water treatment facilities. More detailed investigations are warranted in order to support a final action. Consequently, EPA is conducting a rulemaking to evaluate whether EPA should establish any national technology-based discharge controls for this point source category. The Clean Water Act directs EPA to take final action by September 2007.

EPA’s goals for AMTA’s stakeholder review contributions include:

- Characterization of typical drinking water treatment residuals;
- Identification of pollutant parameters of concern;
- Potential pollution prevention and treatment technology options for drinking water treatment residuals;
- Evaluating 1993 and 1987 cost estimates developed by EPA and AWWA respectively for these technology options;
- Evaluate potential subcategorization options for the point source category; and
- Application of prevention and treatment technology options for the different point source subcategories.

AMTA has worked hard for over 10 years, making annual trips to Washington, D.C. to visit with law makers and EPA to convince them that only new rulemaking can impact the issues related to disposal of desalination by-product waters. This new effort by EPA and AMTA’s invitation to serve as a stakeholder demonstrates that our message has been heard. AMTA is dedicated to representing our members for this cause. If you are interested in receiving regular updates on this activity, please contact the Concentrate Committee Chairperson, Tom Seacord by emailing him at tseacord@carollo.com.
New Members

Since our last newsletter we have welcomed 62 new AMTA members!

Nadia Abbott
Severn Trent Services

Mark Abrahams
DelStar Technologies, Inc.

Tim Baldwin
McKim and Creed, PA

Chris Ballard P.E.
R.W. Beck

Chris Barlow
Kimley-Horn & Associates

Richard Berry
Superior Salt, Inc.

Bob Brayton
Aerex Industries, Inc.

Richard Broderick
Schlumberger Water Services

Robert A. Byers
Buckman Laboratories International, Inc.

Steve J. Cappos
Toray Industries, Inc.

Mike Caston
Startex-Jackson-Wellford-Duncan (SJWD) Water District

Doreen H. Chan
Southwest Florida Water Management District

Bill Conlon
Parsons Brinckerhoff (PB Water)

D. Timothy Cullen
DelStar Technologies, Inc.

Chad Dannemann
Severn Trent Services

Kevin Eberle
McKim and Creed, PA

Mo Eichman
City of Tipp City

David Elggren
Water & Power Technologies, Inc.

Michael A. Gisclair
Veolia Water Solutions & Technologies

Danny Gregory
South Blount County Utility District

Abhay Hanamsagar
Severn Trent Services

Taryn Harvey
Doosan Hydro Technology, Inc.

William Himebaugh
Water & Power Technologies, Inc.

Danny Holliday
Startex-Jackson-Wellford-Duncan (SJWD) Water District

Alejandro Jimenez
Pridesa America Corporation

Sheila Kapur
DelStar Technologies, Inc.

Steve Kasower
U.S. Bureau of Reclamation

Sunil W. Kommineni Ph.D.
Malcolm Pirnie, Inc.

James W. Laraway
Water & Power Technologies, Inc.

John Larmon
Harbin ROPV Industry Development Center

Street Lee
McKim and Creed, PA

Youqing Li
Harbin ROPV Industry Development Center

Jon Loveland
Malcolm Pirnie, Inc.

Eugene Lu
Matrix Membranes

Armen Mahdessian
Geo-Processors USA, Inc.

Mo Mahrous
Fluid Equipment Development Company

Scott McClelland
Sweetwater Authority

Marilyn McIlvaine
McIlvaine Company

Priscilla Ochoa P.E.
R.W. Beck, Inc.

Eli Oklejas Jr.
Fluid Equipment Development Company

Jim Ouellet
Mount Pleasant Water Works

Mark Prein
Prein & Newhof

Jon Reimink
Prein & Newhof

Gary O. Robinson
Myron L Company

Kathryn Robinson
Myron L Company

Claude P. Roulet
Schlumberger Water Services

Tammy Russo
National Water Research Institute

Luisa Sangines-Urarte
Alameda County Water District

Andrew L. Shea
Pridesa America Corporation

Charlotte G. Smith
Sweetwater Authority

Jim Smyth
Miller A. Truby
Toray Industries, Inc.

Joanne C. Truong
U.S. Navy, Naval Facilities Engineering Command Atlantic

Gil Turner
Aerex Industries, Inc.

Carl J. Yavra
Nathan Ver Huel
Prein & Newhof

Larry Vicars
Kimley-Horn & Associates, Inc.

Karl Voigt
Alameda County Water District

Al Wagner
Alameda County Water District

Wendy Wempe
Schlumberger Water Services

Jake White
NRS Consulting Engineers

David Yanke
R.W. Beck, Inc.
The first Joint Technology Transfer Workshop between AMTA and SCDA (South Central Desalting Association) was held on February 8th and 9th in Corpus Christi, Texas. The program was titled “Advances in Technology & Operator Training” and was attended by 168 registrants. This is a record attendance for an AMTA Technology Transfer Workshop. Topics covered include Membrane Technology Advances, Membrane Operations, and Energy Recovery Options and Applications. Speakers included Dr. Graham Juby of Carollo Engineers, Nikolay Voutchkov of Poseidon Resources, and Thomas Smith of San Antonio Water System, to name a few of the outstanding presenters. Feedback from those in attendance suggested the program ranks as one of the best workshops they have ever attended.

Lunch time speaker were Mr. Rod Pittman, Chairman of the Texas Water Development Board, and Ed Garaña, Water Director for the City of Corpus Christi. Both spoke on the role of membranes in meeting future water requirements. Mr. Pittman spoke about the future of desalination in Texas and the ways in which Texas is advancing desalination technologies. Mr. Garaña delivered a very engaging talk on Corpus Christi’s efforts to meet the objectives of Governor Perry’s Desalination Program.

A tour of the 9.5 MGD San Patricio Water Treatment Facility was offered on Tuesday and Wednesday afternoons. A reception was held at the USS Lexington and Afton Pumps and American Water Chemicals had an overflow crowd at their hospitality suite, teeming with networking opportunities.

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AMTA/SCDA Joint Technology Transfer Workshop

Article written by Judith Herschell, jherschell@whb-env.com
Help Wanted

Potable Water Treatment Facilities Supervisor (Grade V Operator)

Olivenhain Municipal Water District is a public agency providing water, wastewater services, recycled water, and hydroelectricity. The District also operates the Elfin Forest Recreational Reserve. Located in Encinitas, California, the District serves almost 60,000 customers in the communities of Olivenhain, Leucadia, Elfin Forest, Rancho Santa Fe, Fairbanks Ranch and 4S Ranch as well as portions of the cities of Encinitas, Carlsbad, San Diego, Solana Beach and San Marcos.

Olivenhain Municipal Water District is recruiting for the newly added position of Potable Water Treatment Facilities Supervisor (Grade V Operator) for its state-of-the-science ultrafiltration membrane water treatment plant. Qualified applicants must have a CA Water Treatment Operator T5 certification. Minimum 5 years water treatment/distribution experience required. Excellent benefits – annual salary range of $63,948 - $95,916 depending on experience. Open until filled.

To apply, submit a completed District employment application to: OMWD – Attn: HR, 1966 Olivenhain Rd., Encinitas, CA 92024. District employment applications are available at the District office and on-line at www.olivenhain.com. Resumes without applications will not be considered. For any questions about the position, contact Gabriela Saffiote at (760) 632-4210.

American Membrane Technology Association

611 S. Federal Highway, Ste. A
Stuart, FL 34994

Newsletter Advertisement is Available.

Please Contact AMTA for rates and availability.

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772-463-0820 • 772-463-0860 (fax)
amtaorg@aol.com

A form is available on the website at
www.membranes-amta.org/publications.html

Calendar of Events

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<tr>
<td>May 10-12, 2006</td>
<td>AMTA Technology Transfer Workshop, Atlanta, GA</td>
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<td>May 13, 2006</td>
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<td>SEDA – Membrane Operator Certification School, Naples, FL</td>
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<td>June 25-28, 2006</td>
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<td>AMTA Biennial Conference &amp; Expo &amp; Board Meetings, Anaheim, CA</td>
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<td>Nov. 15-16, 2006</td>
<td>AMTA Technology Transfer Workshop, Richmond, VA</td>
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<td>Nov. 17, 2006</td>
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Contact the following organizations for more information regarding their listed events:
AMTA • 772-463-0820, amtaorg@aol.com, www.membranes-amta.org
SEDA • 772-781-7698, administrator@southeastdesalting.com, www.southeastdesalting.com
IDA • 978-887-0410, paburke@idadesal.org, www.idaesal.org
AWWA • 800-926-7337, www.awwa.org/conferences/membrane