

WATER DESALINATION REPORT

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2012 Desal Year in Review

This first, six-page issue of 2013 takes a look back at some of the desal and reuse highlights covered in *WDR* during the past year. It was another interesting year in which we tracked new projects and evaluated new technologies while considering the *Top Ten Desal Disasters* [42] and *Top Ten Desal Successes* [45].

During 2012, *WDR* followed the latest industry trends and offered our answer to the question, “What’s next in Desal?” [5]. We watched the growth of interest in desal technologies in the oil and gas industry [39], and the continued interest in forward osmosis [18]. We also examined algal bloom strategies, whether RO pilot studies are still necessary [6], and how TEPs factor in membrane biofouling [28].

Subscribers can read the articles recapped here—referenced by [bracketed] issue number—in their entirety at our searchable website: www.desalination.com.

CARLSBAD. FINALLY.

WDR has followed the Carlsbad SWRO project for fourteen years, and 2012 was no exception. During the past year, more than 20 issues included a story on the project.

In January, the San Diego County Water Authority began finalizing the draft water purchase agreement (WPA) that would govern its purchase of desalted water from Poseidon for the next 30 years [4]. Numerous board meetings were held to consider the WPA [23] and details of the agreement, including a breakdown of the project’s water price [31] and the project’s structure [32, 36, 38], which were gradually made public. Despite some delays, the WPA was finally presented to the board for a vote that was held at its last meeting of the year [41, 45].

WDR noted the occasion of the board’s overwhelming approval of the WPA by devoting an entire issue [46] to the event, including anecdotes from the project’s most visible proponents and opponents. Only a few weeks earlier, we had included the project as one of the *Top Ten Desal Disasters* on the basis of its interminable development history [42], noting that, “Carlsbad has every opportunity of becoming a great plant.” We remain hopeful that this will be the case.

Even as the year ended, the project continued to make news. On 24 December, Dickstein Shapiro LLP—Poseidon’s primary legal advisor—announced that financing, which included \$755 million in investment grade tax-exempt bonds and \$167 million in private equity, had closed.

Concurrent with the closing, Poseidon said that it had given a ‘notice to proceed’ to the Kiewit/Shea joint venture that will engineer, procure and construct the project. On 2 January 2013, IDE announced that Kiewit/Shea had, in turn, awarded it a contract to design and supply SWRO equipment, while Poseidon signed a contract directly with IDE to operate the plant for 30 years.

Construction is to begin immediately, and the plant is expected to be in commercial operation in 2016.

One week after securing project financing, Poseidon also took the long-overdue step of hiring a public outreach firm. The company said that San Diego-based Southwest Strategies would manage community relations throughout the construction period.

OTHER US SWRO ACTIVITY

California’s permitting procedures are often blamed for Carlsbad’s long development timetable. In May, *WDR* interviewed the lead environmental consultant on the project, who outlined the State’s complex regulatory framework [19].

It was a rocky year for those planning to use SWRO to provide a new, alternative water supply solution for the Monterey Peninsula. Over the past few years, a regional project had cleared several major hurdles and secured widespread support. However, local water agencies could not agree on a single plan [3]. While CalAm reviewed its options [6] and proceeded to develop a SWRO/ASR project [22], the agencies tried to settle their differences in court [29] and new “developers” began to appear with various dubious alternatives [33]. SPI was called in to review the alternatives [37]. By December, CalAm had settled its dispute with the County [48]. Meanwhile, the 2016 deadline for having an alternative supply in place approaches.

A consortium of six San Francisco Bay Area water agencies continued to evaluate the environmental implications of a regional desal plant site along the Delta [43], and West Basin’s SWRO demo plant continues operation as two local power plants have expressed interest in hosting a full-scale plant that could be constructed by 2017 [22].

The Guadalupe-Blanco River Authority issued an RFQ for consultants interest in conducting a study for a SWRO and power plant in what could be the US’ first IWPP [16, 31, 35]. The invitation drew responses from 16 firms, and the selection process will take place this month [39, 41, 43].

In December, the Pacific Institute released a report that evaluates the cost of seawater desal in California [47].

WEATHER SIDELINES 4 OF OZ'S 'BIG SIX'

Construction and operating costs of Australia's Big Six seawater desal plants continued to draw attention, especially after rains replenished many of the country's reservoirs. It was announced that the Sydney Water Desal Plant would cut production until its reservoir dropped to a 70 percent 'trigger' level [10, 11, 26].

With the Queensland reservoirs at 95+ percent of capacity, the Gold Coast Desal Plant was placed in hot standby and a study was announced to evaluate alternatives for its future use [24, 30]. SA Water said that its Adelaide Desal Plant would be placed on 'standby mode' whenever cheaper water sources were available [39], and the Victorian Government said that its brand new plant's production would not be required for the first year that it was operational [40].

Western Australia's drought continued [30] through 2012 and Water Corporation's Ben Jarvis matter-of-factly told the press, "That's why we built the first desalination plant and the second desalination plant and are currently expanding that" [30]. Seawater desal now provides approximately 50 percent of Perth's water supply, and all of the desalted water is produced using renewable energy [40].

Australia's largest and most expensive plant—the Victorian Desal Plant near Melbourne [24]—made news throughout the year. Labor disputes and severe weather during the plant's 2010-2011 construction delayed the plant's startup and cost the developers hundreds of millions of dollars [8, 31]. However, the plant made first water at the end of June [27], began production tests [35], received Preliminary Commercial Acceptance [40, 43] and was able to meet its full, 450 ML/d (119 MGD) production goal by the end of the year [47].

In May, Sydney Water announced that it had sold its 250 ML/d (66 MGD) SWRO plant for \$2.3 billion to private buyers in a 50-year lease agreement [20, 21, 30], while Victoria's State Government was found to have increased water rates prematurely and had to return \$230 million in 'over-recovered' funds that were to have been used to pay for its new SWRO plant operations [24, 25, 43].

SA Water's Adelaide Desal Plant was not without controversy, and a payment dispute between SA Water and AdelaideAqua, the Acciona Agua-Trility-Abigroup consortium that designed and constructed the \$1.82 billion plant, was settled in June [23]. The state-of-the-art plant

included some unique design features, including the use of its elevation as a means to recover energy from concentrate as it was discharged to the sea [25], schemes to increase its pretreatment water recovery to nearly 100 percent, and the use of a novel, two-pass hybrid membrane configuration to optimize energy efficiency [26].

In late October, AdelaideAqua announced that the plant was able to produce its full 300 ML/d (80 MGD) of capacity [42], and on 12 December, the plant's control and custody were formally handed over from the construction team to the operations team to start the 24-month operational proving period.

Meanwhile, BHP Billiton called off its plans for the country's seventh large-scale SWRO plant to support its Olympic Dam mine expansion north of Adelaide [34].

Despite the slowdown in large-scale seawater desal, Australia recognizes the importance of investing in desal technology. The National Centre of Excellence in Desalination continued to fund new research projects, award scholarships [21] and sponsor technical workshops [6].

SEAWATER DESAL IN MENA, ASIA

Kuwait PTB outlined its plans for ten new large-scale seawater desal plants [13]. It issued an RFP for the development of the Al Khirran IWPP about the same time that it opened bids for the Az-Zour North IWPP [7]. International Power, using Sidem's MED technology, was the selected bidder. But in July, the National Assembly said that it would scrap the project due to a political dispute, and the government is deciding whether or not it will go ahead with the project [26].

Meanwhile, Babcock Borsig was awarded a contract to refurbish three existing MSF units at Kuwait's Shuwaikh plant [23].

With the help of MIGA, the World Bank's political risk insurance arm, Abengoa (formerly Befesa) received the necessary project finance support to proceed with a SWRO plant in Accra, Ghana [44], and Saudi Arabia's SWCC selected Doosan's MSF technology for its 550,000 m³/d (145.3 MGD) Yanbu Phase 3 desal project [45].

An RFP for Oman's Ghubrah IWP was issued to seven prequalified bidders in March [13]. Five bids were received [30] and a Sumitomo-Malakoff-Cadagua team was selected to develop the SWRO project [45]. ILF/Golden Sands was awarded a contract to develop a strategy to decommission the existing MSF units to make way for the new plant [37].

Although Oman's existing Barka 1 IWPP employs MSF technology, ACWA Power Barka received approval to expand the plant using SWRO technology [29]. The EPC contract for the expansion was awarded to Abengoa [30], and the groundbreaking was held in November [45].

In February, Saudi Arabia's Marafiq issued an RFP addendum adding a second 75,000 m³/d (19.8 MGD) SWRO plant alongside the first plant [8] in Jubail, with the first plant to be operational in June 2014 [26]. Saudi Binladin/Acciona Aqua won the EPC contract to furnish the first UF/SWRO [38], and a second project of similar design could be offered to the same contractors, though details are not finalized [47].

At the World Water Forum, the Palestinian Authority campaigned for support to build a SWRO plant in Gaza [12]. Financial commitments have been made by Arab states and France, and the EIB is financing technical assistance [43].

Hitachi Zosen was given a notice to proceed with the addition of two MSF units at Qatar's Ras Abu Fontas desal plant [38].

Aqualyng and BEWG said they would increase SWRO production in China's Hebei Province where they already have constructed one plant [14], and Hong Kong's WSD solicited EOIs to conduct a SWRO planning study [26, 29].

THE CARIBBEAN AND LATIN AMERICA

Trinidad's Petrotrin Refinery opened the year by resurrecting bidding exercises for a desalinated water supply that had been previously conducted in 2008 and 2009 [2]. An invitation to bid for a SWRO was released in January. By September, it appeared that a decision was near [37]. Inevitably, a bid extension was granted while Petrotrin made up its mind [39]. By early December, a BOO contract for a 4.2 MGD (15,897 m³/d) mobile UF/BWRO was awarded to GE Water to meet increased process water demands at the expanded refinery [47].

Consolidated Water prevailed in a lawsuit with the BVI government over the payment for operating the Baughers Bay SWRO plant [16], and in addition to its proposed development of a SWRO project in Rosarito, Mexico [31], announced that it would supply desalted seawater for a project in Bali, Indonesia [32].

In November, the local Hafeez Karamath Ltd group of companies announced that it had acquired 100 percent ownership in Desalcott (Desalination Company of Trinidad and Tobago), the special purpose company created in partnership with GE Water in 1999 to build, own and operate

the 24 MIGD (28.8 MGD) Point Lisas SWRO plant [45]. The plant, which has undergone expansions, is still the Western Hemisphere's largest SWRO plant. GE's divestiture did not signal a lack of desal interest, only a change in focus [47].

A boiler failure at a WAPA power plant resulted in the shut down of the MEDs on St Thomas, in the US Virgin Islands. Seven Seas Water was able to supply containerized SWROs to restore production in record time [20]. A few months later, the Hovensa Refinery on St Croix was shuttered and its MED units decommissioned, closing another chapter in the Caribbean's reliance on thermal desalination. The capacity was replaced with SWRO units provided by Seven Seas.

Although most of the desal-related activity in South America had focused on mining-related projects in Chile and Peru, 2012 saw some non-mining desal activity. Ecuador's new Refinería del Pacifico prepared plans to construct a SWRO plant for potable and utility water [2], Unitek supplied a UF/SWRO/EDI system for a Chilean regasification facility [30], and a rural community in northern Chile selected a SWRO system from Nirosoft for its potable water supply [33].

Most recent desal plants in South America have employed membrane technology, however a new power plant in Chile selected IDE's MVC distillers [6].

OIL & GAS INDUSTRY TURNS TO DESAL

As the seawater desal market leveled off, desal technology providers began looking to the upstream oil and gas industry as the emerging market with the most opportunities. Both membrane and evaporative systems are being applied with increasing frequency [39], and oilfield-produced water disposal, brine minimization, frac'ing and reuse were all hot desal topics in 2012.

WDR looked at the similarities and differences in the water and oil industries as desal companies scrambled to develop technical solutions and marketing strategies to pursue the huge potential market [11]. In April, we compared the performance, energy requirements and costs of various oilfield brine concentration options [14].

In March, Oasys released the results of its FO system's performance in concentrating oilfield brine [10]. Select Energy, an oilfield services company, soon announced that it had partnered with Oasys to gain access to the MBC technology [12] and followed up by partnering with Fountain Quail for its mobile clarification and evaporator technology [34]. In September, *WDR* profiled Fountain Quail's oilfield water recycling facility in South Texas [35].

IDE, whose evaporators have been used in steam flood applications, also began to turn its attention to the oilfield [34], while Nirosoft furnished multiple BWRO units for a produced water project in Colombia [39], and GE Water said it would team with memsys clearwater to jointly develop membrane distillation applications in the shale/coal seam gas markets [26].

Canada's oil sands have provided a growing market for evaporators in SAGD applications since 1998, and GE Water continued its success last year [12, 36]. Purestream Technology received a recycling permit for its mobile VC evaporator system in Texas oil and gas operations [33].

Water Standard maintained its focus on upstream oil and gas opportunities and developed a SWRO optimization technology adapted for low-salinity EOR projects [19]. Weeks later, it announced that Mitsui acquired a minority ownership position in the firm [22], and by the start of the fourth quarter, the company had been awarded two contracts: one for the conceptual development of a CEOR project by Shell, and a FEED contract for another CEOR project by Petronas [39].

Advanced Hydro, a 2011 Technology Idol participant, partnered with GeoPure HydroTechnologies, and said that it will build membrane systems for use in the oilfield that employ its polydopamine antifouling coating [32].

Koch Membranes introduced a new membrane targeting the offshore sulfate removal market [10] and Pentair X-Flow's UF membranes filtered produced water on three Chinese oil platforms [39], while FEDCO has begun developing a line of pumping equipment that meets oil industry standards [25].

Although the upstream oil and gas market seems to hold the most promise, there was also activity in the downstream market as evidenced by Osmoflo's tenth win of a modular desal system for an LNG facility [15].

BRACKISH DESAL ON THE RISE

Although seawater desal projects seem to garner the most attention, the number of brackish desal projects is increasing at a more rapid rate, and a review showed that brackish projects were less affected by the recent market slowdown [11].

Saudi Arabia's NWC issued an RFP for 25 new groundwater treatment plants and the construction of BWRO plants at three existing water plants [26], and Tunisia's SONEDE awarded nine BWRO plants and one EDR plant in three separate packages in September. The bids had been under review since December 2010, and the award was delayed by the Arab Spring events [37]. And, in November, Degremont

announced that it had been awarded two contracts to supply 33 modular BWRO units at 14 inland sites in Saudi Arabia [45].

Texas' record-breaking drought continues and more communities are beginning to consider BWRO projects as an alternative to reservoirs. During his re-election campaign, the State Land Commissioner declared that "desal is part of Texas' water future" [28]. San Antonio Water System began work on a large-scale system [14, 41].

The City of Odessa, Texas, issued an RFP for a new BWRO facility [16, 24, 30], as the State held workshops on how to streamline the BWRO approval process [33]. Meanwhile, a West Texas golf course used BWRO to produce fresh water to maintain its fairways and greens [35]. Also in Texas, a chemical plant turned to Nalco to develop a hybrid IX/NF system that would improve its water treatment system recovery and reduce concentrate volumes to enable it to meet a new, more stringent discharge requirement [30].

CH2M Hill designed a system employing both BWRO and IX to treat water from different aquifers for Florida's Lee County. In an interesting twist, RO concentrate will be used to regenerate the IX [40].

Salts are not the only dissolved solids that require removal. Mesa Consolidated Water District installed a new NF system to deal with the high color in the groundwater that results from ancient redwood forests that are buried in the area [2], and OSMO SISTEMI used BWRO to remove nitrates from Italy's Marche Region water supply [23].

Australia's National Water Commission prepared a report to aid local water authorities that are considering desalting brackish groundwater [9], and *WDR* interviewed the facility manager of Reclamation's Brackish Groundwater Desal Research Center in March [13].

REUSE

A National Academies report on the current state of water reuse was released in early January [2]. The report assessed the state of reclamation technology and reviewed its social, legal and regulatory issues and costs. A committee of experts, led by Rhodes Trussell, prepared *Water Reuse: Potential for Expanding the Nation's Water Supply Through Reuse of Municipal Wastewater*, which also includes a proposed 14-point research agenda.

Other 2012 reports that addressed reuse challenges included a white paper issued by the National Water Research Institute entitled *Direct Potable Reuse: Benefits for Public Water Supplies, Agriculture, the Environment and Energy Conservation* [3]; a report that compared the cost of MF/

RO and EDR as alternative reuse technologies [8]; and an updated edition of Guidelines for Water Reuse that was issued by USEPA/USAID [43].

In January, the Orange County Water District broke ground on a 30 MGD (113,550 m³/d) expansion of the GWRs [3]. The plant was commissioned in 2008 after 30 years of water reuse research had been conducted at the site [14]. In December, the plant celebrated the production of 100 billion gallons (378.5 million m³) of high-quality water reclaimed by MF/RO and advanced oxidation [48]. Research at the facility continues, and in November, the plant began replacing existing RO membranes with new, higher-performance elements [45].

The City of San Diego completed a two-year study on its water reuse alternatives. It looked at alternatives to the City's current practice of treating its municipal wastewater to primary effluent standards before discharging into the Pacific Ocean [23]. During a public survey, the residents overwhelmingly supported both seawater desal and water reuse as alternative water supplies, even if they increased water rates [34]. Now, the politicians must approve additional investments to plan and develop the program.

The City of Brownwood received a loan from the TWDB to continue development of a direct potable reuse plant [38].

WDR also looked at several facilities that use membrane technologies to reuse treated effluent. One of the plants reviewed was the expansion and upgrade of the Los Angeles County Sanitation District's Vander Lans treatment facility, which will recover and reuse 92 percent of plant effluent [36]. *WDR* also covered the expansion and upgrade of the Scottsdale, Water Campus [35], and the membrane cleaning practices at the UAE's Ajman Sewage Treatment Plant [33].

COMPANY NEWS

MECO supplied its VC watermakers, designed to meet extreme weather conditions, on offshore oil production facilities in Russia and the Arabian Sea [2].

Since first introducing its nanocomposite SWRO membrane in 1999, NanoH₂O has developed several new products [16] and installed its elements at more than 50 sites on six continents [17]. In April, it closed a deal that provided over \$60 million in additional equity funding and credit facilities to make it one of the most highly funded new water technology companies in the industry [18].

Toray introduced a new BWRO membrane product with improved permeability and salt rejection [10], and LANXESS introduced several new BWRO elements [27].

Construction of Israel's Sorek project was ahead of schedule last year and the IDE/Hutchison consortium developing the project said that it would produce water in August 2013 [3]. Most of the 16-inch diameter, vertical pressure vessels were in place at the start of the year and by September, most of the marine works for the intake and outfall were complete [37].

Isobarix, an ERD supplier, said that the three-year-old company had reached the 'break-even' point in sales [44].

Modern Water was awarded a contract to furnish its second seawater FO system in Oman, which will produce potable water [35], and Dow Water announced that it would build an RO membrane manufacturing plant in China [23].

Siemens was the most interesting M&A story of 2012. Siemens' current desal profile is actually quite limited: it owns Memcor, builds a few modular BWRO units and is developing a highly touted but far-from-commercial ED/CEDI seawater desal process. However, in 2001 it had at least 16 business centers with desal products and expertise. Its fall from being a (the?) dominant water industry player was chronicled in numerous issues [30, 34, 35, 44].

Other 2012 acquisitions and mergers covered include:

- Germany's MANN+HUMMEL acquired Fluid Brasil, an RO and UF system supplier [2].
- Mahle Group acquired InnoWa Membrane [5].
- Lahmeyer International acquired Pöyry environment GmbH [10].
- DHV and Royal Haskoning announced their intention to merge [10], and completed the deal in July.
- Pentair announced it would merge with Tyco Flow Control [14], completing the deal later in the year.
- Mitsui acquired a minority ownership position in Water Standard [22].
- GE Water introduced its newly acquired IPER ERD technology [26].
- Victaulic acquired MTS Valves & Technology's desal businesses [36].
- ACWA Power International completed the acquisition of NOMAC from Sogex Oman [39].
- Parker Hannifin acquired Sea Recovery from Danfoss A/S [41].
- Doosan Heavy Industries acquired DAF technology, water assets and process engineering expertise from Enpure [45].
- Desalco acquired GE Water's shares of Trinidad's Point Lisas Desal Plant [45].
- Demont has acquired the desal businesses of SOWIT and Reggiane [48].

NEW TECHNOLOGY

After almost 40 years of lurking in the research laboratories, membrane distillation is beginning to show some promise as a commercial technology. In separate projects, researchers in Australia and Qatar have moved from the lab into the real world [15, 23] to conduct tests. One company, memsys, has signed agreements with GE Water to work together in the shale/coal seam gas markets [26] and with Concord Enviro in the sugar industry [41].

MIT researchers, in collaboration with KFUPM, demonstrated a new humidification-dehumidification process that targets the concentration of oilfield brines using a carrier gas extraction process and a bubble column dehumidifier [48].

In April, HTI's new spiral-wound FO membrane went into full production [17], even as the company began to develop a new 'cyclonic swirl' technology aimed at reducing the effects of internal concentration polarization [29].

Ever since the University of Manchester's Andre Geim identified graphene as the next 'miracle material' and won the 2010 Nobel Prize in Physics, researchers have been looking for ways to use its unique properties in filtration and desalting applications [5]. Using molecular dynamic simulations, MIT researchers predicted permeability rates significantly higher than diffusive membranes [28].

The US Office of Naval Research awarded separate contracts to MECO [8] and Pall [33] to develop UF/SWRO units for use in challenging coastal waters, and GE Water announced a non-thermal brine concentrator for the beverage industry [29].

Desalitech was awarded a contract to pilot test its closed circuit desal process to increase RO recovery when treating reclaimed water [13]. The company also announced a cash infusion from Liberation Capital to expand its business [21].

Suns River completed the first phase of pilot tests on its solar distillation pilot [38], and a non-toxic coating that is said to control intake pipe macrofouling was introduced by CMP Coatings [47].

PEOPLE

Mark Donovan has been appointed senior process engineer for GHD, based in the company's Irvine, California, office. He was formerly with Hatch and may be contacted at mark.donovan@ghd.com.

Hydranautics has announced the appointment of **Jayesh Shah** as its new global marketing manager. He has fourteen years of water treatment and membrane filtration experience. He is based in Mumbai, India, and may be contacted at jshah@hydranautics.com.

Patrick Regan has joined Desalitech as vice president of global sales and marketing. He was formerly a global account executive with GE. He will be based in New Jersey and may be contacted at Patrick.Regan@Desalitech.com.

Bruce Alderman has been appointed as Desalitech's director of sales. He previously worked for Veolia Water Solutions and Technologies as a Business Development Director. He will be based in Philadelphia and may be contacted at Bruce.Alderman@Desalitech.com.

Bill Musiak, formerly with Pentair X-Flow, has been appointed as Koch Membrane Systems' North American commercial director for water and wastewater. He is based in Wilmington, Massachusetts, and may be contacted at William.Musiak@kochmembrane.com.

Chris King, formerly of GE Power & Water, has been appointed as Koch Membrane Systems' water and wastewater business development director for Africa and Eastern Europe. He will be based in Scotland and may be contacted at kingc@kochmembrane.com.

Matias Amor Pintado, formerly with Zenon/GE Water, has been appointed to Koch Membrane Systems' newly created position of regional manager-Iberia, and will be responsible for managing the company's commercial activities in Spain, Portugal, Andorra and Gibraltar. He will be based in Spain and may be contacted at AmorM@kochmembrane.com.

JOBS

Sales & Marketing Positions – Genesys North America (GNA) is a vital part of the Genesys group of companies (www.genesysro.com), manufacturers of specialty antiscalant, flocculant and cleaning chemicals for RO, NF and UF membrane treatment. GNA is looking to appoint an experienced water treatment professional with knowledge of the membrane desal industry to grow the business in the US. Contact schesters@genesysro.com to express your interest.

2013 FELICITATIONS

WDR wishes its readers a healthy and prosperous New Year.