Story by Danielle Supercinski

# Alternative water sources

## Desalination model provides life-cycle costs of facility

Desalination can provide an alternative source of potable water for many communities, and agricultural economists are evaluating the construction and operation costs associated with all components required for an operating plant.

Through the Rio Grande Basin Initiative, a team of agricultural economists from the Texas AgriLife Extension Service and Texas AgriLife Research have developed the Microsoft® Excel® spreadsheet model DESAL ECONOMICS©. The team consists of Dr. Ronald Lacewell, Dr. Edward Rister, Allen Sturdivant and several graduate students in the Texas A&M University Department of Agricultural Economics who work hand-in-hand on these efforts. This program is designed to analyze and provide life-cycle costs for an entire facility, including up to 12 individual functional expense areas.

"To our knowledge, and from a literature search, this life-cycle cost capability to individually look at the well field, the main facility, other components, and/or the entire facility appears unique among economic and financial cost models directed at desalination facilities," said Sturdivant, AgriLife Extension associate at Weslaco. "DESAL ECONOMICS© is custom-built and useful for analyzing any desalination facility, regardless of size or location."

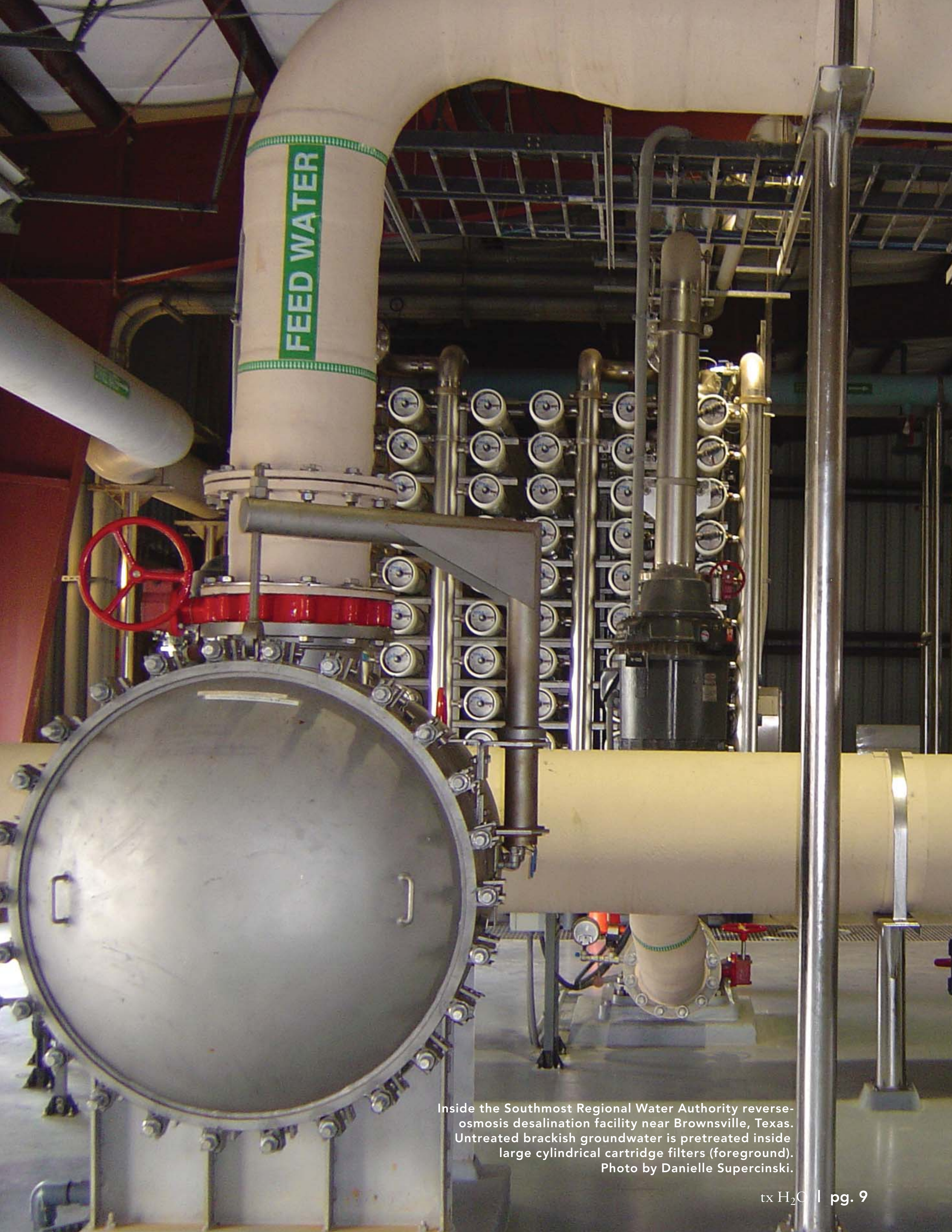
Having a flexible design and the solid economics and financial methodology embedded in DESAL ECONOMICS© permits this type of complete analysis, he said. In addition, the agricultural economists have built a related economic and financial model, CITY $H_2O$ ECONOMICS©, on the same methodological platform and design standards as DESAL ECONOMICS©, but created to analyze conventional surface water treatment facilities. The models allow experts to analyze which technology and/or facility design and asset configuration provides the lowest long-term cost of potable water supplies.

Using these newly developed models, the team conducted case studies to determine the economic and financial life-cycle costs of building and operating four water treatment facilities in South Texas. One facility was the Southmost Regional Water Authority Regional Desalination Plant near Brownsville. Sturdivant said their specific results are only applicable to the Southmost facility, but do provide useful information regarding life-cycle costs for other desalination facilities.

"Though the case study provides a snapshot evaluation for the Southmost facility, DESAL ECONOMICS© has broad applicability," he said. "It really has its strength in providing information in the planning and design stages of future facilities – particularly when there are multiple alternatives amongst key facility characteristics affecting costs being considered."

The Southmost facility treats brackish groundwater and provides an alternative water supply for southern Cameron County.

"Potable water from desalination is currently limited in the Valley, representing only about 3 percent of the region's supplies," Sturdivant said. "However, within the immediate service area, the 7.5 million gallons per day Southmost facility is capable of providing upwards of 40 percent of the total municipal and industrial potable water needs." ⇨




Inside the Southmost Regional Water Authority reverse-osmosis desalination facility near Brownsville, Texas. Untreated brackish groundwater is pretreated inside large cylindrical cartridge filters (foreground). Photo by Danielle Supercinski.

As part of conventional surface-water treatment, raw water is treated to remove any disease-causing organisms, silt, or grit, and to improve the taste. Information from the sedimentation tank and the McAllen South Water Facility is used as input for the CITY $H_2O$ ECONOMICS© model. Photo by Danielle Supercinski.

The life-cycle costs addressed in DESAL ECONOMICS© (and CITY $H_2O$ ECONOMICS©) include initial investment, annual operating costs, downstream reinvestment costs, capital replacement, and inflation through time, he said. By design, life-cycle costs are different than typical accounting department costs and serve a different purpose.

"There are initial investments going into the land, concrete, and construction of desalination plants; then there are operating costs incurred year after year that may go up as inflation impacts factors of production. Also, as the facility deteriorates, you are going to have capital reinvestment," Sturdivant said.

These case studies suggest the life-cycle costs of producing potable water are equivalent for groundwater desalination and conventional treatment. While desalination can be efficient as an alternative source for water in rural areas, energy costs are higher when compared to conventional treatment.

"Energy is a much larger proportion of cost on desalination than it is in the conventional treatment, so sensitivity of total costs is higher," Sturdivant said. "In the base analysis, if you look at all of the money spent building the facility and operating it over 50 years, energy is 26 percent of the total cost of the Southmost desalination facility. It is only 10 percent to 15 percent, however, of total costs for conventional treatment of Rio Grande surface water."

This problem has always been one of the drawbacks of desalination, he said.

"Engineers continue to look at trying to find ways to develop more efficient membranes to reduce the energy use in desalination," Sturdivant said. "Energy use means two things: First, with this brackish groundwater facility, they have to extract the water out of the ground, so there is a lot of pump energy required. Second, pumps within the desalination facility push the water through the membranes, which filter out the salts. This process pressurizes water up to 180 psi, which is where the largest energy use occurs. In addition, energy costs are highly dependent on the location, as power rates can vary greatly from region to region, state to state, and country to country."

"There has been a lot of development with membranes, and they are getting more energy efficient," said Rister, professor and associate department head for the Department of Agricultural Economics at Texas A&M. "You could probably track energy use over time on the membranes and would see that it has come down substantially in recent years."

Energy costs excluded, the cost per thousand gallons of water for desalination has dropped dramatically over the past 20 years.

"Looking back in the 1900s, the cost per thousand gallons of water was $5 or more, and now our case study results indicate the costs are $1.95," Rister said. "That speaks well to the work being done by engineers and technical specialists."

He said putting in a desalination plant instead of extending the traditional treatment network of piping can be economical, depending on location.

"Rather than trying to construct a pipeline from a big city or a conventional treatment plant to a distant rural community, which would be vastly expensive and not economical, they have the option of putting in a small desalination plant using brackish water," Rister said.

The agricultural economists agreed that pumping brackish water locally and putting it through a modular desalination plant — which can pump a million gallons a day or more — can be a method of drought-proofing for rural communities. The per-unit cost does not increase very much between 1 million or 8 million gallons, they said; it stays about the same. ⇨

"The chemical costs to treat surface water and the cost of purchasing water rights are increasing, which is making conventional treatment more expensive," Rister said. "Then, you have membranes becoming more efficient so it has reached the point where desalination has its place."

The DESAL ECONOMICS© model case study by the Texas AgriLife agricultural economists is specific for South Texas.

"Even though this analysis is concentrating on South Texas, when we look at Texas overall, there are serious water issues; we have limited surface water alternatives in many parts and a huge brackish water supply," Rister said. "When you talk about going from 22 million Texans to 40 million Texans during the next 30 years or so and the amount of extra potable water we are going to need, desalination appears to look like a good option to consider."

However, a downside of desalination when not located near the Gulf or an ocean is the concentrate discharge issue.

"For inland locations, it has to be deep-well injection for concentrate-waste disposal," Sturdivant said. "The economic feasibility of many of these facilities or locations is site-specific, and depending on that location, there may or may not be a competitive advantage."

Rister said that evaluating such issues is a strength of using the DESAL ECONOMICS© model. Their model was built so that one could look at the total facility, or individual components or cost centers, such as well field and concentrate-waste discharge. "You can see costs by function (component), helping to identify the major issues to consider in making them more economical, but a constant in all cases is discharge must be addressed," he said.

While numerous factors and costs must be considered prior to constructing, operating, and maintaining a desalination facility, the agricultural economists and their DESAL ECONOMICS© model have made it easier for a community or water supplier to review costs for desalination plants of the future.

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"Having the ability to objectively compare different water-supply projects and make capital investment decisions will become more important over time as populations increase, input costs rise, and water supplies become relatively scarcer," Sturdivant said. "As such, sound analyses of finance and economics should be considered an extension of engineering-related tasks for capital-project alternatives involved in a region's water-resource planning."

Water quality of individual pressure vessels is closely monitored. Inside each vessel, pressures reach 180 psi to separate salts from water. Photo by Danielle Supercinski.