RECLAMATION Managing Water in the West

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The Knowledge Stream
Research Update

Using Salt-Loving Plants to Treat Concentrates

Long-term testing for halophyte irrigation for concentrates from a desalination treatment using slowsand filtration and reverse osmosis.

Bottom Line

We can treat Colorado River water by managing salts through a combination of RO treatment and using the concentrate to irrigate salt-tolerant crops for agriculture and landscapes.

Better, Faster, Cheaper

This is a low-cost, environmentally friendly treatment that produces high quality water. SSF can be used by rural areas, for example on Native American reservations.

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Collaborators

Northwest Water Providers Partners

- **Metropolitan Domestic Water Improvement District**
- **Flowing Wells Irrigation District, Marana Water**
- **Oro Valley Water**

Tucson Water

University of Arizona

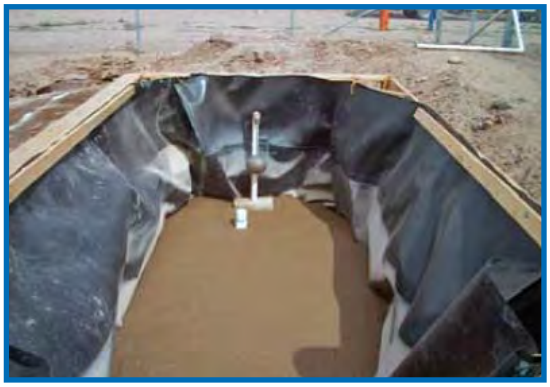
Problem

Increasingly stringent water quality treatment regulations, along with the long-term impacts of increased salinity in the Colorado River have caused water providers in the arid regions of the Western United States (U.S.) to focus on treatment technologies that will avert long-term problems. Local water quality concerns with Central Arizona Project (CAP) water have delayed full use of CAP water in Pima County, Arizona.

Current problems with arsenic, perchlorate, and salinity in Phoenix, Arizona; Las Vegas, New Mexico; southern California; and El Paso, Texas, offer compelling evidence that finding long-term water treatment solutions is critical to sustaining our Nation's future water supplies. Developing a low-cost, environmentally friendly treatment that produces high quality water will pay dividends for generations. This technology can be transferred to many cities and towns across the Western U.S.

Solution and Results

Reclamation's Science and Technology Program teamed up with the University of Arizona at the Marana Pilot Project to study all parts of a reverse osmosis (RO) treatment for CAP water—from pretreatment to managing the brine (the concentrate left after extracting treated water). Each of these areas was aggressively investigated through field site operations, data acquisition and monitoring, performance evaluation, technology assessment, and systems analysis. A long-term test was conducted at Reclamation's Mobile Treatment Facility, which has been in operation at the Cortaro Marana Irrigation District/ Central Arizona Water Conservation District turnout in Marana, Arizona, since 2007.



Slowsand filter after draining water.

Pretreatment

RO, an effective desalination treatment, requires high quality pretreatment to operate economically. Pretreating raw (or source) water is absolutely necessary to preserve the RO membrane integrity, prevent fouling of the membranes, and extend membrane life. Typically, this is done with chemicals, which can introduce unwanted byproducts, or with expensive filtration processes. The

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Slowsand filter after being filled up.

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Marana Pilot Project tested slowsand filtration (SSF) as an inexpensive pretreatment for RO. A slowsand filter consists of a tank containing a fine sand on top of a layer of gravel. Raw water flows in from the top and percolates by gravity through the sand. Organic material is removed by a biological layer called "schmutzdecke," which forms at the top of the sand layer. When the now clean water reaches the bottom of the filter, it is collected through a drain consisting of a perforated pipe under the gravel.

SSF and microfiltration (MF) was compared as pretreatment technologies for desalination by RO. These two pretreatment alternatives were studied previously, leading to a conclusion that both methods performed adequately but that, land permitting, SSF was much less expensive. However, as RO membrane post mortems indicated that SSF may have left clay particles on the RO membranes, MF pretreatment was reevaluated.

Side-by-side comparison of the pretreatment options suggests that MF is capable of outperforming SSF based on silt density index values in reactor effluents. Results suggest that the quality of MF-treated water may be superior to that SSF effluent for downstream RO separation of water-soluble components.

Treatment

The long-term RO performance was monitored over a period to compare interseasonal effects and establish limits to membrane life. It was found that very high recoveries, on the order of 99 percent, are feasible when RO is carried out using a presoftened water in combination with the deployment of the vibratory shear enhanced process.

Concentrate Management

Managing the "waste" stream from RO is difficult and expensive. Ways were examined to eliminate the need for evaporation ponds—which present environmental concerns due to high concentrations of certain constituents—by growing salt-loving plants (halophytes) and using the concentrate to raise fish.

Salt Loving Plants

Halophytes can be harvested for additional value. It was found that Atriplex lentiformis (a halophyte) can be irrigated with RO concentrate from CAP water in Tucson, Arizona. These plants can be used for livestock feeding, as the proximate analyses show Atriplex lentiformis to be comparable to conventional forage in protein and other digestables, but higher in salt. The halophytes, were irrigated with varying volumes of concentrate to measure the maximum amount of concentrate that could be used to grow the halophytes. Drainage below the root zone can be managed to provide for aquifer protection; the study indicates that lining to prevent water movement to the deeper aquifer may not be necessary.

Atriplex lentiformis

Fish

The concentrate can also be used to help raise food fish. A number of bench top bio-assays was conducted to determine viability of aquaculture species (shrimp and Tilapia) on concentrate. Survivability and growth rate on both RO and VSEP concentrate are being evaluated.

"The Marana Pilot Project demonstrates the ability of local utilities, academia, and the Federal Government to work together to produce real-world innovations. It has proven that SSF can be an effective and cost-saving pretreatment for RO of CAP water. It has also shown that unsightly evaporation ponds can be replaced attractive plantings, converting a troublesome waste product into a useful resource."

Eric Holler
Tucson Field Office Manager, Reclamation's Lower Colorado Region

More Information

Water Consumption, Irrigation *Efficiency, and Nutritional Value of Atriplex lentiformis Grown on Reverse Osmosis Brine in a Desert Irrigation.* Agriculture , Ecosystems, and Envrionment Journal, 140 (2011) 473 – 483.

Yoklic, Martin, Wendell Ela, and Robert Arnold. 2011. *Long-term testing near Tucson, Arizona for concentrate management using halophyte irrigation; with associated slowsand filtration (SSF) and reverse osmosis (RO) treatment.* Final Report. Bureau of Reclamation, Tucson Office and University of Arizona. Available at:

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