RECLAMATION Managing Water in the West

February 2013
Research and
Development Office
Update 2013-02

The Knowledge Stream

Research Update

Treating Concentrate in Desert Wetlands

An innovative, environmentally sustainable, cost-effective method to treat concentrate in inland areas

Bottom Line

Treating the saline concentrate from water treatment plants with a wetlands system and then blending it with wastewater effluent for surface water discharge will benefit the city of Goodyear's reclaimed water quality, as well as provide a source of water appropriate to restore riparian habitats in the Gila and Salt Rivers.

Better, Faster, Cheaper

Vertical flow wetlands can treat concentrate to meet applicable water criteria for most metals while creating and restoring wetland habitat. Regulating wetlands can be used in a variety of concentrate management scenarios.

Principal Investigator

Tom Poulson
Civil Engineer
tpoulson@usbr.gov
623-773-6278

R&D Contact

Miguel Rocha
Science and Technology
Program Coordinator
mrocha@usbr.gov
303-445-2841

Collaborators

CH2M Hill

City of Goodyear, Arizona

City of Phoenix, Arizona

Problem

Managing concentrate produced by reverse osmosis (RO) membrane treatment is a significant challenge. The concentrate can include salts, metals, and nutrients at levels that exceed water quality standards and must be removed or diluted before being discharged to surface waters. In an inland area such as central Arizona, few pragmatic alternatives exist to handle this concentrate. Thermal driven evaporation processes are commonly used at industrial facilities, but have high energy and carbon footprints. While deep well injection has been used in some states such as Florida, this has never been successfully permitted in Arizona. Solar evaporation ponds, though proven, have large land requirements and are not always practical when dealing with large concentrate volumes.

In the future, RO facilities in the greater Phoenix, Arizona, metro area may produce up to 80 million gallons per day (mgd) of potable water, producing 12 mgd of saline concentrate as a byproduct. Currently, the city of Goodyear, a nearby suburb, discharges their concentrate to the 157th Avenue Water Reclamation Facility (WRF), and they plan to increase their RO treatment capacity in coming years. However, the RO concentrate degrades the effluent quality (with total dissolved solids of about 2,000 milligrams per liter [mg/L]), which is too high to use this reclaimed water for irrigation at parks, schools, and local baseball fields.

Solution

Wetlands have a proven capacity to remove pollutants such as nutrients and metals while creating and restoring wetland habitat. Using wetlands is a way to re-use this concentrate in an inland area, and to treat water for irrigation. Reclamation's Science and Technology Program funded a pilot system using vertical flow wetlands, where untreated concentrate is piped into the bottom of the wetland.

Bins held wetlands in the pilot-scale project.

The concentrate diffuses up through a gravel and rock bed. Peat moss or green waste (compost) serves as the media for the wetland plants and micro-organisms to grow. These microbes consume the oxygen, creating an anaerobic zone. The microbes then reduce the sulfates to sulfides, which link to the heavy metals (i.e., arsenic and selenium), forming metal sulfide compounds that precipitate out of the water. Other methods of removal are through plant uptake, sorption, and physical settling. The treated water then travels up through the wetland to a manifold where it exits.

— continued

— continued

Application

To test this approach, we constructed a pilot-scale facility at the city of Goodyear's Bullard Water Campus. If successful, the regulating wetlands will provide riparian habitat along the Gila River and also allow the city to use the reclaimed water from the 157th Avenue WRF for local irrigation.

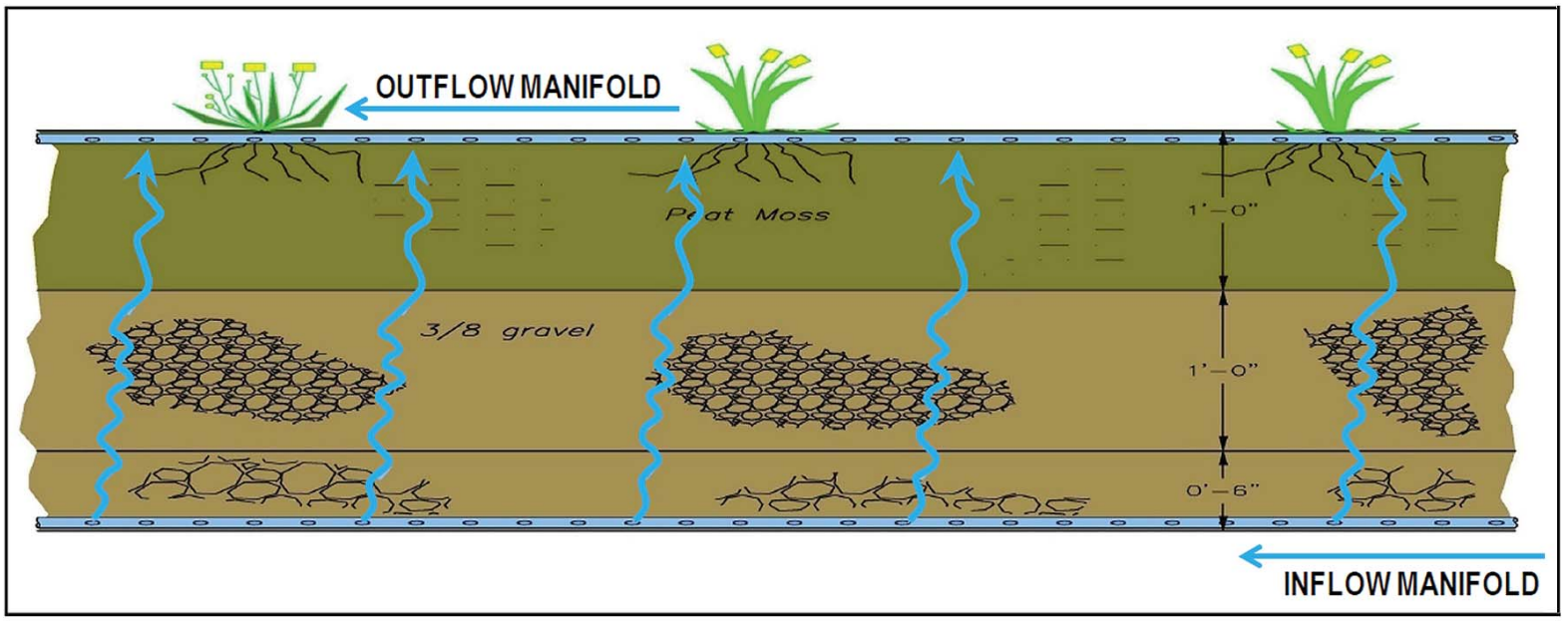
In this pilot system, the wetlands were grown in bins. Each bin was 8 feet wide and 24 feet long (192 square feet of surface area) and contained various media, plant types, and hydraulic configurations. All bins were planted with a variety of wetland plant species native to central Arizona and the southwestern United States.

The pilot system helped determine how hydraulic and mass loading rates, type of media beds, and plant species affected performance, thereby establishing preliminary engineering criteria for a full-scale system.

These vertical flow wetlands can reduce heavy metal contaminants in the concentrate to non-detectable levels. Results from this pilot system indicated that the wetlands could reduce concentrations of arsenic from greater than 30 to less than 10 micrograms per liter (µg/L), selenium from greater than 20 to less than 1 µg/L, and chromium from greater than 45 to less than 5 µg/L—all well within water quality standards. Nitrate-nitrogen concentrations were also reduced from approximately 55 mg/L to less than 1 mg/L. Preliminary estimates and monitoring of contaminants accumulation indicate that the green waste (compost) would need to be replaced every 20 years and the media removed to a landfill.

"This idea of managing concentrate through natural means is a complete shift in thinking from conventional concentrate management. Instead of using lots of energy and highly engineered systems, we can use natural means to process the concentrate, removing the harmful constituents and returning the benign salts back to nature, with the added bonus of water for the desert environment."

Tom Poulson,
Civil Engineer/Planner, Reclamation



Schematic of vertical flow wetlands.

Future Plans

This research paved the way for a full-scale concentrate management system using wetlands in an inland desert area. The city of Goodyear plans to develop a full-scale system.

More Information

Comparative Analysis of Innovative Concentrate Management Systems

www.usbr.gov/research/projects/detail.cfm?id=3699