RECLAMATION

Managing Water in the West

San Luis Drainage Feature Re-evaluation

Feasibility Report

Appendix H

Evaluation of Enhanced Evaporation Technologies

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region
Sacramento, California

November 2007

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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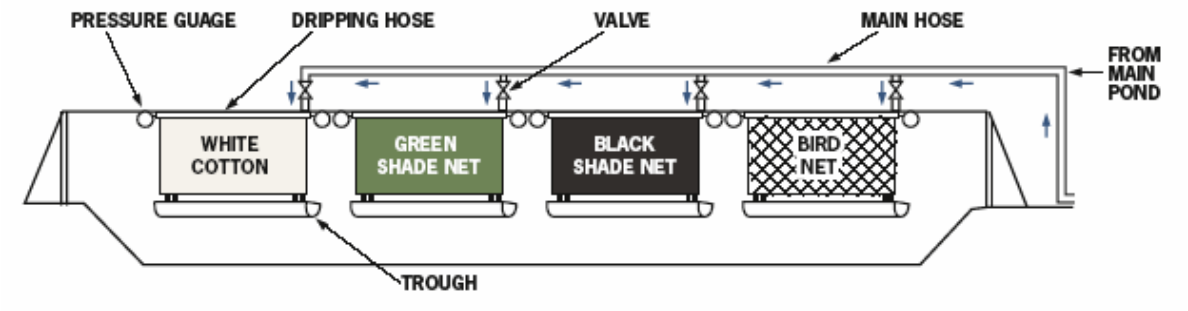
Appendix H—Evaluation of Enhanced Evaporation Technologies

Introduction

Over the past decade, Reclamation has participated in a number of enhanced evaporation research studies aimed at increasing the efficiency of concentrate disposal methods, particularly for inland desalination and irrigation drainage projects. These studies included the testing described below involving net systems, spray evaporators, and a re-circulating evaporator.[1]

Net Systems [2]

This study, created to support Reclamation's El Paso Salt-Gradient Solar Pond project, was conducted to see what type of netting would enhance the evaporation process most efficiently. The study looked at four different types of material – white cotton, green shade, black shade, and bird netting. The test setup shown below flowed brine over the top of the netting and let it drip down into a trough, concentrating along the way with the aid of increased surface area. The most efficient of these was the polypropylene bird netting with 90% open area.



Strong Points: Relatively effective and inexpensive except for O&M costs.

Potential Problems: Potential roosting site for birds, difficult to maintain, and susceptible to damage by high winds.

Note: Another EES system that uses netting is the WAIV (Wind-Aided Intensification of eVaporation) system developed by the Lesico Group in Israel.

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[1] Jorgensen, Erik. Feasibility of Membrane Concentrate Disposal (using Enhanced Evaporation Systems) **AMTA Solutions**. Spring 2005, pg. 4-7.

[2] Swift, Andrew, et al. Experimental Study of the Performance of Four Types of Netting used to Enhance Salinity-Gradient Solar Pond Brine Reconcentration, **Solar Engineering 1992**. Vol. 1, pg. 645-650.

Mechanical Spray Evaporators [3]

This study, performed at the Salton Sea in southern California, was conducted to quantify the evaporation performance and to measure the operating costs of a Turbo-Mist Model S30P mechanical spray evaporator and a Super Polecat evaporator.

These spray evaporators are designed to reduce the particle size of a water droplet (60 to 500 microns) so that the water is able to volatilize quickly while in the air, leaving only the salt to fall to the ground.

The units were tested in two different modes of operation – first in single pass using Sea water at 45,000 mg/L TDS and secondly in batch mode where the feedwater was re-circulated through the sprayers until it was near saturation for sodium chloride, which is about 1.195 to 1.20 specific gravity. During testing, the units experienced large amounts of mist digestion, frequent maintenance, and the need for pretreatment to remove algae and gypsum. Both units enhanced evaporation 1.44 times compared to natural evaporation.

[3] Weghorst, Paul. Salton Sea Salinity Control Research Project – Final Report, U.S. Bureau of Reclamation, August 2004.

Strong Points: Very effective for evaporating low saline waters, e.g. acid mine drainage.

Potential Problems: High power consumption, maintenance problems due to mist digestion of fine particulate matter, and air pollution during periods of high winds.

Fan Sprayers [4]

This technology, developed by the California Department of Water Resources, is an integral part of the IFDM (Integrated on-Farm Drainage Management) program that has been pilot tested at Red Rock Ranch in the San Joaquin Valley over the past couple of years. The testing involved the use of various evaporative surfaces, nozzles, materials, and equipment to evaporate agriculture drainage water, recover the salts, and control the salt drift from the sprayers.

Strong Points: Proven effective for evaporating hypersaline waters

Potential Problems: Requires pumping power, potential long-term maintenance problems, and fine particulate matter may contribute to air pollution during periods of high winds.

[4] Begaliev, A.G. and Faria, Jose. Solar Evaporator for Integrated on-Farm Drainage Management (IFDM) System at Red Rock Ranch, San Joaquin Valley, California. March 2006.

SolarBee® Pond Circulator [5]

This study, which was also performed at the Salton Sea, was conducted to evaluate the evaporation performance of the SolarBee pond circulator – a solar-powered machine that was developed primarily for the purpose of cleaning up and maintaining wastewater and freshwater reservoirs. The SolarBee works by drawing water from the pond bottom and spreading it along the surface in a near laminar fashion; thereby keeping the pond continuously mixed, controlling algae, and keeping the overall pond temperature higher.

The testing showed the SolarBee to be most effective in enhancing evaporation at night, with an overall performance of 130% enhancement when operated continuously 24 hours a day.

Strong Points: Solar powered for 24 hr/day operation, most effective for enhancing nighttime evaporation, and effective for algae control.

Potential Problems: Minimal evaporation benefits during the daytime (compared to natural evaporation) and potential maintenance problems if used in hypersaline ponds.

[5] Jorgensen, Erik. Feasibility of Membrane Concentrate Disposal (using Enhanced Evaporation Systems) **AMTA Solutions**. Spring 2005, pg. 4-7.

Conclusions

Of the commercially available EES technologies, the SolarBee is the only one that may have application in the SLDFR project, since it can be used in an environmentally acceptable manner to enhance the evaporation process as well as to prevent algae growth in the lower salinity concentrating ponds. The use of any of the other commercially available EES technologies, such as a mechanical spray evaporator or WAIV-type net system, would be limited to:

1. periods of relatively calm wind conditions because of the risk they present to increased air pollution and overspray resulting in damage to crops growing nearby, or

2. after fall harvest and then only if the spray is well contained.