Minimizing Disposal of a Reusable Resource

A California utility's desalter brine and concentrate recovery permitting experience

By Carl W. Spangenberg

Two membrane facilities operated by the same water district generate concentrate waste streams that are handled in distinctly different manners. Here we investigate the steps and methods used by California's Irvine Ranch Water District (IRWD) on the permitting and concentrate recovery methods for the Irvine Desalter Project (IDP) and the Deep Aquifer Treatment System (DATS).

Table 1. Concentrate Flow & Water Quality

Concentrate	Flow	Water Quality
IDP-PTP	0.67 mgd	TDS: 3,500 mg/L Mn: 266 µg/L Silica: 184 mg/L
DATS	0.65 mgd 0.16 mgd*	TDS: 900 mg/L Color: 2,500 to 3,000 color units

*With concentrate recovery

Table 2. Selected Concentrate Disposal Options & Key Permits/Actions

Concentrate	Disposal Method	Concentrate Recovery	Required Permits/Actions	Disposal Costs[a]
IDP-PTP	Ocean Outfall	No	• Addendum No. 3, Order No. 2001-08 NPDES Permit No. CA01070611, Waste Discharge Requirements for SOCWA to ACOO • SOCWA Project Committee Interagency Agreement Amendments • Coastal Commission Ruling • Required Acute and Chronic Toxicity Testing • Reviewed Every Five Years	$153,000[b]
DATS	Sewer	Yes	• OCSD Class I Industrial Waste Discharge Permit • No Toxicity Testing Required • Renewable Every Two Years	$445,000[c] $67,000[d]

a: Annual disposal and wastewater treatment costs, excludes pumping costs
b: Cost for 2007/08 fiscal year
c: Prior to implementation of concentrate recovery, cost for 2006/07 fiscal year
d: After implementation of concentrate recovery, cost for 2007/08 fiscal year

IDP Primary Treatment Plant (PTP)

The IDP-PTP removes moderately high levels of total dissolved solids (TDS) and nitrates pumped from the principal aquifer within the Irvine groundwater basin. A full-scale reverse osmosis (RO) plant was put into operation in 2006 and can treat up to five wells that are 1,000 ft deep and deliver 5.9 million gal per day (mgd) of raw water to the treatment plant. Approximately 2.7 mgd is treated by RO operated at 75.5% recovery, 15.4 gal per sq ft per day (gfd), feed pressures up to 300 psig and blended with the remaining raw bypass water.

A total of 434 membrane elements are used at the IDP-PTP facility. Water production levels vary according to fluctuations in the raw water feed. Targeted constituent levels in the product water include a TDS of 420 mg/L and nitrates less than 10 mg/L as nitrogen.

DATS

The goal of the DATS is to remove high color (300 color units) caused by natural organic matter from groundwater pumped from the Santa Ana River Basin below five color units. A full-scale nanofiltration (NF) plant was constructed utilizing a design/build approach, with operation of the facility initiated in February 2002.

The DATS facility is an 8-mgd NF plant designed to operate at 98% recovery, 16 gfd at operating pressures up to 125 psig. It includes two deep wells approximately 2,000 ft deep; water collection; and membrane treatment, concentrate recovery and concentrate disposal facilities. A total of 1,398 membrane elements are used for the DATS facility.

Concentrate Disposal Options

The water quality of the concentrate from the IDP-PTP and the DATS are significantly different; this was the secondary factor dictating the ultimate disposal method of these resources, with brine line capital costs being the primary factor.

The IDP-PTP concentrate contains a TDS level of 3,500 mg/L, Mn of 266 µg/L and silica of 184 mg/L, whereas the DATS contains high color in excess of 2,000 color units with a TDS of 900 mg/L that is close to that of drinking water. The differences in water quality between the DATS and IDP-PTP concentrates are significant (see Table 1): The DATS concentrate is more amenable for concentrate recovery due to low TDS levels and the removal of color as the primary constituent controlling post-concentrate treatment, in comparison to the higher TDS, Mn and silica levels being the controlling, more difficult and costly constituents to remove in the IDP-PTP concentrate.

IDP-PTP Concentrate

Two alternatives were identified in the early part of 2000 for the IDP-PTP concentrate:

1. Construction of a regional brine line connecting these two concentrate wastes and other brine disposal wastes within the region with its terminus downstream of the Orange County Sanitation District's (OCSD) Plant No. 1 for ultimate disposal to the ocean. The estimated cost of construction for this regional brine line, with average flows from both current and future membrane facilities around 4.32 mgd, was $33 million in 2004 dollars and would require construction of approximately 24 miles of pipelines of various sizes crossing a minimum of four cities in highly developed and utilized thoroughfares.

Concentrate flow would be generated from four IRWD membrane facilities (existing IDP-PTP and DATS, plus two future facilities), two desalting facilities in the city of Tustin, three future shallow groundwater dewatering facilities owned by the city of Irvine and one facility owned by the Transportation Corridor Agency. Major jurisdictional hurdles that would need to be overcome to make this brine disposal line a realization included the city of Irvine, city of Santa Ana, city of Tustin, Caltrans, OCSD, California Coastal "Commission" and Santa Ana Regional Water Quality Control Board.

2. Construction of a dedicated 5-mile brine line at a cost of $4.4 million for the IDP-PTP concentrate at an average discharge rate of 0.68 mgd that would convey the concentrate to a newly constructed ocean outfall pump station at the Los Alisos Water Recycling Plant. This ocean outfall pump station would discharge excess treated wastewater and concentrate via an existing land outfall directly to the South Orange County Wastewater Authority (SOCWA) Aliso Creek Ocean Outfall (ACOO) that is blended with other wastewater effluents prior to discharge to the ocean.

Jurisdictional hurdles included the city of Irvine and city of Lake Forest (pipeline routing through two cities), SOCWA, San Diego Regional Water Quality Control Board (ocean outfall permit addendum) and the California Coastal Commission.

DATS Concentrate

Given the low salt levels in the DATS concentrate as noted in Table 1, only one alternative was evaluated: connection to an existing sewer located in the city of Santa Ana with eventual treatment and disposal at the OCSD Plant No. 1, located in Fountain Valley, Calif. In order to minimize the quantity of concentrate discharged to OCSD and to maximize recovery of the concentrate from the DATS, IRWD performed pilot and demonstration scale testing from 2004 to 2006 to allow recovery of the concentrate. This resulted in the construction of a concentrate recovery NF fourth train, at a cost of $1.2 million, that increased the recovery of the DATS from 92% to 98% in 2007 with a payback of two years based on savings of concentrate disposal and treatment alone.

Selected Disposal Options

The concentrate disposal options implemented at the IDP-PTP and the DATS are summarized in Table 2 along with the key permits that were obtained from identified jurisdictions. The key reasons for the selected concentrate disposal options for each membrane facility included jurisdictional hurdles, capital costs, ease and timing of securing required permits and ability for concentrate to be treated and recovered for potable use.

The ocean disposal method to the SOCWA ACOO for the IDP-PTP concentrate was based on:

- Lower capital costs vs. disposal via a regional brine line to the OCSD facility ($4.4 million vs. $33 million);
- Multi-agency agreements required to construct the regional brine line vs. a single point of contact with SOCWA; and
- Limitations of the IDP-PTP concentrate silica levels for application of concentrate recovery.

A combination of concentrate recovery and discharge to OCSD sewer for disposal and treatment was selected for the DATS concentrate based on:

- Demonstration of the treatment and recovery of concentrate due to color removal being the factor controlling treatment, not solubility of salts;
- Payback of two years for concentrate treatment facility; and
- Sewer connection point being adjacent to the DATS facility.

Editor's Note: The information in this article originally was presented by the author at the 2010 AMTA Annual Conference. MT

Carl W. Spangenberg, P.E., is senior engineer for the Irvine Ranch Water District. Spangenberg can be reached at spangen@irwd.com.