Cache Creek Desalination Facility

LOCATION: Yolo County, California

OWNER: Yoche Dehe Wintun Nation

ENGINEER: HydroScience Engineers, Inc.

Project Overview

Located in rural Capay Valley, California, and owned by the Yoche Dehe Wintun Nation, the Cache Creek Casino Resort is served by dedicated on-site water, wastewater, and recycled water facilities designed with state-of-the-art technology to help fulfill the Tribe's commitment to environmental stewardship. As part of this commitment, recycled water is used for golf course irrigation, toilet flushing, and decorative water features.

Local groundwater is high in salts and hardness, so salt management is a key challenge. A new desalination facility was recently constructed to improve irrigation suitability of the recycled water for use on the resort's 18-hole championship golf course. The Tribe desalinates the groundwater before it enters the resort as potable water rather than treating the recycled water itself. A major benefit of this approach is that the water is both softened and desalinated in a single step without the use of ion-exchange softeners that increase recycled water salinity.

The new desalination facility started operation in early 2009 and uses Electrodialysis Reversal (EDR) for softening and desalination and an enhanced reverse osmosis process known as Vibratory Shear Enhanced Process (VSEP) to concentrate the brine for offhauling by truck. The facility produces 650,000 gpd of softened potable water. Recycled water salts are reduced by 62% with less than 5% treatment reject water. This highly efficient system has helped the Tribe to maximize recycled water usage, use less groundwater, and demonstrate the viability of desalination as part of an overall water supply and reclamation strategy.

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Purpose

This document provides information in support of our nomination of this project for the 2009 WateReuse Symposium Desalination Facility Award *(Category 3)*.

Introduction

The Cache Creek Casino Resort is located among the rolling hills of rural Capay Valley, California, about 70 miles north of San Francisco. It is owned and operated by the Yoche Dehe Wintun Nation (Tribe). The resort includes gaming and restaurants, a 467 room hotel, spa and pool facilities, entertainment venues, and an 18-hole championship golf course. Due to its remote location, the resort has its own on-site water, wastewater, and recycled water facilities to address all water needs. In accordance with the Tribe's commitment to be good stewards of the land, these facilities have been designed with state-of-the-art technology to maximize water quality and water reuse and minimize impact on the surrounding environment. The Tribe's water and wastewater approach is part of a larger effort to utilize green approaches and technology throughout resort operations, including an award-winning refuse recycling program, a 750 KW on-site fuel cell power generation facility, and a 250 KW on-site photovoltaic array.

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Recently the Tribe implemented a desalination project to reduce salts in the recycled water to improve its suitability for irrigating the golf course. Due to the self-contained nature of this resort, an opportunity existed to take a unique approach to controlling salts in the recycled water by desalinating the potable water before it enters the resort. This provided numerous water quality and efficiency benefits, as will be described in further detail below.

This document discusses project significance, key components, water flows, water quality, and benefits to the resort and the community.

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The Cache Creek Casino Resort. *Located in scenic Capay Valley, California, and owned by the Yoche Dehe Wintun Nation, the Cache Creek Casino Resort (1–3) is served by dedicated on-site water, wastewater, and recycled water facilities (4). In accordance with the Tribe's sustainability initiatives, these facilities were recently improved so that recycled water could be used more broadly across the resort grounds. Today, recycled water is used to irrigate a championship 18-hole golf course (5) as well as for toilet flushing, dust control, and decorative water features.*

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Key Project Participants

The key participants to the Cache Creek Casino Resort Desalination Project are as follows:

- Owner: Yoche Dehe Wintun Nation, Brooks, CA
- Design Engineer: HydroScience Engineers, Inc., Sacramento, CA
- Contractor: Manito Construction, Inc., Pleasanton, CA
- Operator: HydroScience Operations, Inc., Stockton, CA

The Tribe was supported in this endeavor by HydroScience Engineers, Manito Construction, and HydroScience Operations.

Background

The Cache Creek Casino Resort is located in Yolo County, California, approximately 50 miles west of Sacramento and 70 miles north of San Francisco, within the rural Capay Valley **(FIGURE A)**. The Tribe owns and operates the resort and other casino facilities which are located on land held in trust by the Federal Government. The Tribe also owns adjacent land not held in trust. The Yocha-De-He Golf Course, irrigated with recycled water, is located on both fee and trust land **(FIGURE B)**.

The resort's water supply consists of local groundwater drawn by two on-site wells and treated at a Water Desalination Treatment Facility (WDTF) prior to distribution. The wastewater treatment system consists of a membrane bioreactor (MBR) wastewater treatment plant (WWTP) producing high quality tertiary effluent suitable for reuse in accordance with the State of California Code of Regulations Title 22, Water Recycling Criteria, as enforced by the California Department of Public Health (CDPH), for use on areas with unrestricted access, including public golf courses.

Recycled Water Program

The Tribe's water supply and treated wastewater disposal strategy includes a strong emphasis on recycling. This is driven by the need to manage effluent disposal, augment the water supply, and enhance environmental stewardship. All effluent produced by the MBR wastewater treatment plant meets Title 22 disinfected tertiary criteria for unrestricted reuse. Current reuse applications at the resort include:

1. Toilets within the Casino;
2. Construction dust suppression;
3. Yocha-De-He Golf Course Irrigation; and
4. Decorative water feature.

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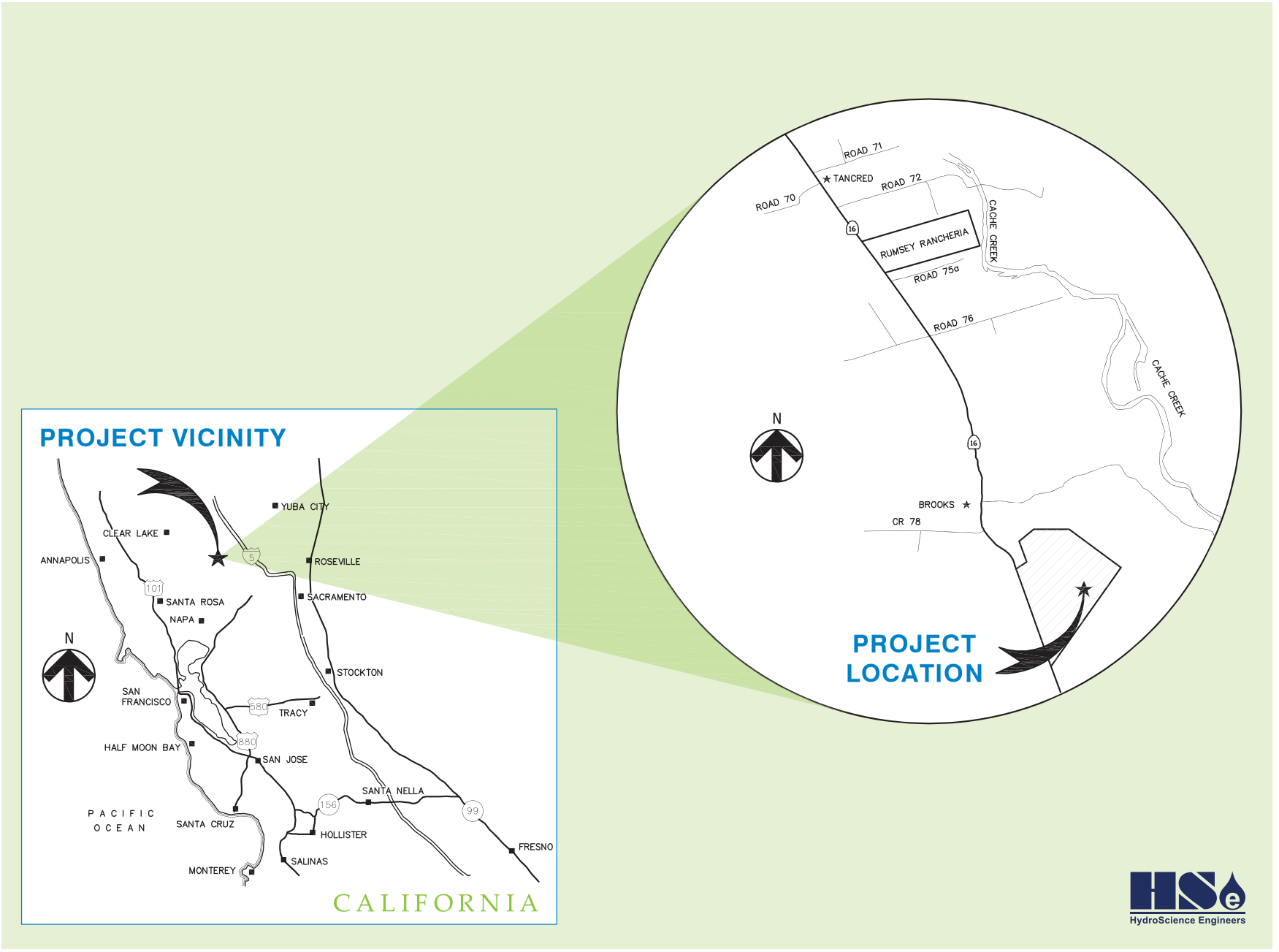
FIGURE A—Cache Creek Casino Resort Desalination Project Location



HydroScience Engineers

FIGURE B—Aerial View of the Cache Creek Casino Resort Desalination Project

Due to its location off of trust land, the golf course falls under State of California jurisdiction and is regulated under Waste Discharge Requirements (WDR) Order No. R5-2006-0121, issued by the State of California Regional Water Quality Control Board (RWQCB). Toilet flushing and dust suppression reuse applications occur on trust land and therefore fall under federal (EPA) jurisdiction, but they are supplied with the same Title 22 quality recycled water.

The current annual average recycled water usage at the resort is 230,000 gallons per day (gpd), with the ability to produce up to 475,000 gpd. Due to the use of an MBR process, the recycled water is very high quality, with a turbidity never exceeding 0.2 nephelometric turbidity units (NTU).

Project Need

The groundwater in the Capay Valley utilized as the resort's primary water source is relatively high in total dissolved solids (TDS) and hardness. Driven primarily by hospitality needs, the resort previously relied on ion-exchange water softeners to reduce hardness in the source water to a level acceptable to patrons. A well-known disadvantage of this approach is that sodium and chlorides are elevated in the potable water and wastewater streams (and thus the recycled water) as a result of the ion-exchange process and the need to recharge the media. **TABLE 1** below summarizes the water quality prior to installation of the desalination facility. The additional salts added by the softeners to the potable water had a ripple effect on the operation of the entire system, exacerbated by the closed, self-contained nature of the resort's water systems. Impacts included:

The groundwater in the Capay Valley utilized as the resort's primary water source is relatively high in TDS and hardness, presenting challenges for reuse applications in the resort.

1. Reduced irrigation suitability at the golf course, due to the sensitivity of the turf grass to high chlorides and TDS. A greater degree of blending with raw surface water from Cache Creek was required.
2. Compliance with WDR limitations for application of recycled water at the golf course requires a high degree of surface water blending.
3. Increased maintenance of toilet flushing valves due to high TDS.
4. Aesthetics issues where recycled water was used (salt deposits).

TABLE 1—Average Water Quality Prior to Desalination Project

	TDS (mg/L)	Sodium (mg/L)	Chloride (mg/L)
Groundwater	540	85	110
Potable water supply to resort after softening by ion exchange	570	175	115
Recycled water supply	1,380	378	423

Solution

Due to the impacts described above, it became clear that a new solution to the salinity problem was needed. This solution should allow the resort to continue to provide acceptable water quality to its patrons while accommodating the needs of the golf course in a way that maximizes water reuse, minimizes groundwater and surface water use, and provides suitable water quality for the turf. Achieving all these goals would not only address water needs holistically, but would further the Tribe's overall objective of environmental stewardship.

The following alternatives were developed and evaluated:

- Alternative A: Continue to use the ion-exchange process, but off-haul all regeneration brine and dispose of it offsite.
- Alternative B: Desalinate the recycled water.
- Alternative C: Desalinate the potable water.

Alternative A was implemented on a trial basis beginning in 2007 to determine if this approach could reduce salt concentrations sufficiently to meet golf course WDR limitations. This option was relatively inexpensive to implement and provided immediate results in the wastewater stream. Approximately 1.5 truckloads per day of regeneration brine were off-hauled for disposal at the East Bay Municipal Utility District (EBMUD) WWTP in Oakland, CA. Although recycled water TDS was reduced by this approach, the reduction was not sufficient to achieve target water quality.

Desalination of the recycled water (Alternative B) was then evaluated. However, because the resort required soft water for potable water needs, the ion-exchange softeners would have to remain in service, ultimately increasing the workload of the downstream desalination process. This was deemed a highly inefficient approach that would unnecessarily increase construction and operating costs, energy usage, and brine production. This alternative was therefore rejected.

Desalination of the potable water (Alternative C) was ultimately selected as the best alternative to address all of the project goals. Given the unique closed, self-contained nature of the resort's water systems, desalination of the potable water would have a direct beneficial effect on the salinity levels in the waste stream and therefore the recycled water. This approach would have the secondary benefit of softening the potable water to acceptable levels without the need to use ion-exchange softening.

Water Desalination Treatment Facility

The Tribe evaluated numerous desalination approaches and technologies for the project. A key issue was disposal of the brine generated by conventional RO technologies. Because the resort is located far from potential ocean discharge locations or large municipal sewer systems, long-distance off-haul of the brine would be needed. The Tribe therefore selected a two-stage TDS removal and brine concentration process to minimize the off-haul costs and the environmental impact of hauling. A unique combination of treatment technologies were selected to achieve the desired results. A process flow diagram of the system is shown in **FIGURE C**.

Treatment Technologies

The initial desalination step consists of an Electrodialysis Reversal (EDR) system. An EDR system was selected over conventional reverse osmosis (RO) primarily due to potential fouling from elevated levels of silica in the source water. Unlike RO, EDR systems allow silica to pass through to the product water. This eliminates the potential for membrane fouling and prevents the introduction of high silica concentrations to the brine, which could impact the brine concentration process. EDR is a demineralization process that transfers ionic species from the water through cation and anion membranes using direct current (DC).

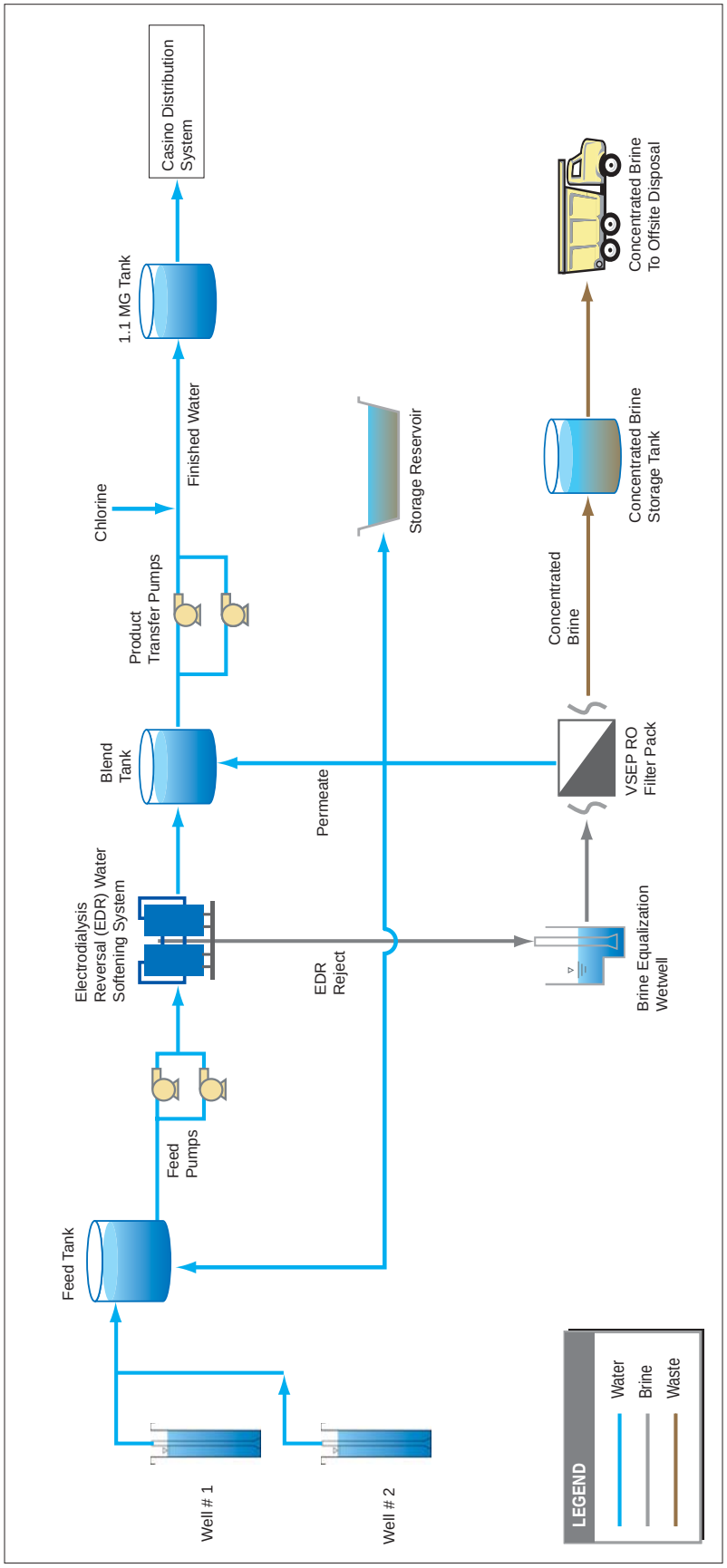


FIGURE C—Process Flow Diagram

***Water desalination facility**. Chemicals are delivered to the WDTF at outdoor connections (6). Source water is pressurized through the desalination plant via these feed pumps (7). First stage EDR demineralization system (8) with the reject concentrated by the VSEP RO system (9). The concentrated brine is stored in a tank for off-haul disposal (10).*

TABLE 2—Current Average Water Quality

	TDS (mg/L)	Sodium (mg/L)	Chloride (mg/L)
Groundwater	540	85	110
Potable water (EDR product water)	210	41	56
Recycled water supply	537	143	173
Percent reduction (2007 vs. 2009)	61%	62%	59%

Brine concentration is achieved by a Vibratory Shear Enhanced Process (VSEP). VSEP is an enhanced form of RO that applies a vibratory shear force to the membranes to minimize fouling while operating at a lower pressure and achieving higher recovery rates compared to traditional cross flow membrane systems.

The combination of these two technologies provides highly efficient TDS removal in a very small footprint.

Facility Overview

The WDTF was completed and commissioned in early 2009. The entire facility is contained within a relatively small building 45 feet wide and 180 feet long. As shown in **FIGURE C**, water is pumped from two existing groundwater wells to the WDTF, where it is treated in the EDR. Process water from the EDR passes through a blend tank and is subsequently disinfected with chlorine prior to distribution to the resort. EDR reject is concentrated in the VSEP process. The brine is discharged to a storage tank for off-haul, and the product water is returned to the main process stream. VSEP product water is typically blended with EDR product water, but also can be discharged upstream of the EDR or sent to a storage reservoir if water quality dictates.

The WDTF has an existing softening and brine concentration capacity to treat a peak flow of approximately 650,000 gpd.

Facility Performance

The facility has met all water quality objectives at a high level of treatment efficiency, as shown in **TABLE 2**. This process has reduced recycled water salts by an average of up to 62 percent. Overall percent recovery, which represents the amount of water produced compared to the total amount treated, is extremely high for this type of process at greater than 95 percent. For comparison, a conventional single-stage RO system treating this water would only obtain about 80% recovery. Brine off-haul rates average only two truck trips per day.

This process has reduced recycled water salts by an average of up to 62 percent.

Project Benefits

The project has proven to be highly successful and has resulted in numerous added benefits to the resort, tribal community, and surrounding environment:

- Significant reduction in recycled water TDS from an average of 1,400 mg/L to 540 mg/L, increasing its suitability for irrigation.
- Reduced groundwater and surface water usage, reducing the impact on these sources and reserving a greater quantity of water for other uses in the community and for sustaining the environment.
- Reduced treated wastewater discharge to the environment.
- Reduced maintenance effort in the resort due to reduced TDS and corrosivity in the water supply.

Furthermore, the project serves as a successful demonstration of the viability of desalination as part of an overall water supply and reclamation strategy.