AWP Case Study

Municipal RO Water Treatment Plant Upgrade

Client Overview

Client Name: **Water Control Improvement District**
Industry: **Drinking water treatment system**
Location: **Hebbronville, Texas, U.S.A**
Client Type: **Municipality**

PROJECT SUMMARY:

The Water Control Improvement District faced an urgent challenge: reducing arsenic levels in the municipal water supply from **0.031 mg/L to 0.005 mg/L** to meet the Texas Commission on Environmental Quality's (TCEQ) maximum contaminant level (MCL) for drinking water. Because arsenic is classified as a primary health-based contaminant, addressing this issue was both a regulatory necessity and a critical public health priority.

At the time of assessment, the district operated three water treatment plants, each utilizing Electrodialysis Reversal (EDR) technology with three EDR trains per plant. However, only one of the plants remained operational. The other two facilities were offline, leaving the district heavily dependent on a single system. This presented significant risks: any failure at the functioning plant could result in regulatory noncompliance, supply disruption, and community impact.

ALPHA'S STRATEGY: TRANSITION FROM EDR TO REVERSE OSMOSIS (RO)

To resolve these issues, **Alpha Water & Power** recommended replacing the outdated and high-maintenance EDR systems with a modern **Reverse Osmosis (RO) system**. The transition was driven by several key factors:

- **High Cost and Complexity of EDR Systems:**
  EDR technology required multiple hazardous chemicals for both pretreatment and post-treatment. These chemicals increased both capital (CAPEX) and operating expenses (OPEX) while creating safety risks due to bulk on-site storage. In addition, EDR systems produced higher volumes of wastewater, straining local sewer infrastructure.

- **Limited Vendor Options:**
  The district's EDR systems were supplied exclusively by Ionics, Inc., a vendor with monopolized control over parts and services. This created costly and challenging maintenance conditions with limited flexibility.

- **Declining Water Quality & Regulatory Pressure:**
  Water analyses revealed elevated Total Dissolved Solids (TDS) and arsenic levels, both beyond acceptable thresholds. A more robust and sustainable treatment technology was needed to meet TCEQ requirements and restore long-term reliability.

PROPOSED SOLUTION: REVERSE OSMOSIS SYSTEM

Alpha designed and installed a new **RO system** to replace the failing EDR infrastructure. RO technology offered clear advantages:

- **Lower Chemical Usage:**
  RO requires minimal, non-hazardous, NSF-approved chemicals, ensuring safety and compliance.
- **Higher Efficiency and Lower OPEX:**
  With higher recovery rates and less waste generation, RO reduces disposal costs and requires less maintenance, minimizing downtime.
- **Cost-Effective and Scalable:**
  Supported by a broad vendor network, RO systems provide competitive pricing for membranes, pumps, and vessels, lowering lifecycle costs and simplifying upgrades.
- **Proven and Accepted Technology:**
  RO is widely approved by TCEQ and highly effective at removing contaminants such as arsenic, nitrates, fluoride, and radium.

SOLUTION PROVIDED:

Alpha Water delivered a full **engineering, procurement, and construction (EPC)** package for a new RO water treatment facility. The plant was designed to process **700 gallons per minute (GPM) of feed water**, producing **560 GPM of permeate water** at an **80% recovery rate**.

Turnkey Scope of Work

- Comprehensive consulting, design, and engineering services
- TCEQ permitting support and coordination
- Supply and installation of treatment equipment
- Full automation and controls integration
- Site supervision, commissioning, and operator training
- Complete demolition of existing EDR infrastructure

- Annual maintenance service program

System Installation

A **1 MGD RO system** was installed, incorporating:

- A Clean-in-Place (CIP) skid
- Complete equipment, piping, electrical, and controls integration
- Delivery of a fully functional, regulatory-compliant treatment plant

Annual Maintenance Program

Alpha also implemented a comprehensive maintenance plan to ensure long-term system reliability and efficiency:

- Furnishing of filters and chemicals
- Scheduled quarterly inspections and routine servicing
- 24/7 remote troubleshooting and alarm monitoring
- On-call labor support as needed

This program enables operators to:

- Optimize antiscalant dosing
- Reduce membrane cleaning frequency
- Increase recovery rates
- Detect operational issues early

RO SYSTEM DESIGN CRITERIA:

In compliance with **TCEQ Title 30 TAC §290.45(b)(1)**, public water systems serving more than 250 connections must maintain a combined production capacity of at least **0.6 GPM per connection**.

The Hebbronville district (JHCWCID #2) serves **1,813 active connections**, requiring a minimum of **1,087.8 GPM**. Alpha's RO plant was designed to exceed this threshold by producing **1 MGD of finished water**, ensuring both compliance and future capacity needs.

PRIMARY TREATMENT OBJECTIVE

The central goal was to significantly improve raw water quality by reducing:

- **Arsenic**
- **Total Dissolved Solids (TDS)**

This was accomplished in accordance with **TCEQ Title 30 TAC §290.105(b)**, which establishes secondary drinking water standards for contaminants that impact both health and aesthetics.

DESIGN FLOW RATES:

Description	Design Conditions
Feed water flow rate to RO	879 GPM
Permeate water flowrate	673.8 GPM
Blend flow rate	42.6 GPM
Total Blended finished water flow rate	716.4 GPM
Reject water flowrate	162.6 GPM
Overall recovery rate	77.7%
Feed water TDS (mg/L or PPM)	1467.77 mg/L

RO SYSTEM ARRAY CONFIGURATION:

Number of Trains	--	1
Passes	--	Single pass
Stages	--	2-staged
Array Size	--	18x9-6m
Membrane Manufacturer	--	LG
Membrane Model Number	Stage-1 & 2	LG BW 400 ES
Membrane Diameter x Length	inches	8x40
Membrane Active Area	ft2/element	400

FINISHED WATER QUALITY TARGET GOALS :

Description	Finished Water Quality (Select Primary and Secondary drinking water standards per 30 TAC (290.105) (b))
Arsenic, mg/l	<0.01 mg/l (or 10 ppb)
Total Dissolved Solids, PPM	< 1000 PPM
Sulfates, mg/l	Not to exceed 300 mg/l
Chlorides, mg/l	Not to exceed 300 mg/l
Fluorides, mg/l	Not to exceed 2.0 mg/l
pH	> 7.0

SCOPE OF WORK

Alpha Water & Power delivered the project from start to finish through a structured, turnkey process:

- Needs Assessment: Conducted site surveys, water quality testing, and data analysis in collaboration with the client.
- Design & Engineering: Developed detailed system designs including membrane selection, process flow diagrams (P&ID), CAD modeling, and automation integration.
- Manufacturing: Fabricated the RO skid with custom controls and performed factory acceptance testing.
- Installation: Executed demolition of existing EDR equipment, followed by installation of the new RO system, piping, and electrical connections.
- Commissioning: Started up the system, verified performance, and resolved initial operating issues.
- Training & Handover: Provided operator training, O&M manuals, and ongoing technical support.

Key Technologies

- **Water Treatment Process:** Reverse osmosis (RO) membrane filtration reduced arsenic and total dissolved solids (TDS) to levels compliant with TCEQ secondary drinking water standards.
- **Pretreatment:** Antiscalant dosing and cartridge filtration (1–5 micron) protected membranes from scaling, fouling, and particulates.
- **RO Treatment:** Automated startup based on tank levels, with finished water stored on-site and reject water discharged safely to the city sewer.
- **Post-Treatment:** Chlorination ensured safe residual disinfection, while a corrosion inhibitor protected the distribution system. All treatment chemicals used were NSF-approved for drinking water.
- **Automation & Controls:** A SCADA/HMI package enabled fully automated operation, real-time monitoring of pressures, flows, tank levels, TDS, and pH, as well as alarm notifications. Operators could also access system data remotely, with Alpha providing additional remote support under the maintenance program.

System Components

Remote Monitoring Package

The system includes a remote monitoring package that allows operators to track performance and receive alarm notifications in real time. Through a secure cellular modem, users can access the system from any smart device or PC. Key features include:

- Real-time visibility into operating parameters such as flow, pressure, TDS, and tank levels
- Remote adjustment of select system settings
- Alarm notifications for rapid response
- Remote troubleshooting capabilities, reducing the need for on-site intervention

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RO Skid

The reverse osmosis system was delivered as a **fully skid-mounted, pre-piped, and pre-wired unit**, factory tested prior to shipment. The skid included:

- Prefilter cartridge housing
- Fiberglass pressure vessels
- Spiral-wound thin-film composite LG membranes

- High-pressure membrane feed pump
- Programmable Logic Controller (PLC) with full instrumentation and controls

The system was designed for an **80% recovery rate** and included an on-board blending feature to allow controlled mixing of raw water with permeate water.

Clean-in-Place (CIP) Skid

To maintain membrane performance and extend service life, the system incorporated a hard-piped **CIP skid** with:

- CIP pump and 1,750-gallon polyethylene cleaning solution tank
- Recirculation pump, pressure gauge, and flow sensor
- All necessary instrumentation and controls

The CIP system allows for periodic cleaning to prevent scaling, fouling, and bacterial growth. A **permeate flush function** automatically rinses the membranes with fresh water upon shutdown, further protecting against organic buildup.

Chemical Feed Systems

To safeguard system performance and water quality, the plant included dedicated chemical feed systems:

- **Antiscalant Feed System** – Dual chemical pumps (one duty, one standby) with a 330-gallon tote and injector quill. Automatically activated during RO startup, this system prevents scaling and optimizes recovery.
- **Corrosion Inhibitor Feed System** – Ensures long-term protection of the distribution network.

Both systems were fully integrated with the central control panel and included low-level alarm switches for enhanced operator oversight.

Instrumentation

Instrument	Manufacturer/Type	Locations	Display
Conductivity/ Temperature	GF Signet	Feed, Product, Reject conductivities	Transmitter
		Feed, Product Water temperatures	
Pressure Transmitters	IFM, or Equal	Pre-filter inlet, pre-filter outlet, Pump Discharge, membrane feed, interstage, reject, combined permeate @ common header	HMI
Flow Meters	Signet/Paddlewheel	Reject, Product	HMI
PH monitor	Signet	product	Transmitter

Project Results

Metric	Before AWP	After AWP
Water Recovery Rate		80%
Regulatory Compliance 1.Arseni removal rate 2.%Salt rejection rate	0.031 mg/L 2223.1 mg/L	0.005 mg/L (91.9% removal rate) 101.88 mg/L (97.2%)
Downtime or Maintenance Events	6/month	1/month

FINISHED WATER QUALITY SUMMARY BASED ON LABORATORY ANALYSIS:

CONSTITUENTS	FEED WATER (759.9 GPM)	RO PERMEATE (542.2 GPM)	FINAL FINISHED BLENDED (582.2 GPM)
Calcium, mg/l	4.13	<1.00	<1.00
Sodium, mg/l	432	14.1	52.6
Chlorides, mg/l	346	10.9	31.1

Fluoride, mg/l	2.74	<0.20	0.622
Aluminum, mg/l	<0.05	<0.05	<0.05
Sulfates, mg/l	310	<1.00	21.1
Arsenic, mg/l	0.037	0.003	0.007
Nitrate-N, mg/l	<1.0	<1.00	<1.00
Nitrite-N, mg/l	<1.0	<1.00	<1.00
Copper, mg/l	<0.01	<0.01	<0.01
Lead, mg/l	<0.001	<0.001	<0.001
Total iron, mg/l	<0.05	<0.05	<0.05
Manganese, mg/l	<0.01	<0.01	<0.01
Total Dissolved Solids, mg/l	848 (Note 1_	63.0	108
Conductivity, us/cm	2520	69.6	247
Total Alkalinity, mg/L as CaC03	360	<20.0	24.0
Silica, mg/l	20.2	0.991	2.64
Zinc, mg/l	<0.010	<0.01	<0.01
pH, standard units	8.03	6.07	7.48

Lessons Learned & Future Outlook

- Scalability: e.g., design allows for future expansion by 50%
- Innovation: e.g., integrated AI fault detection
- Client Plans: e.g., phase 2 planned for brine reuse system

AWP Contact

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