CASE STUDY

Designing an Innovative Retrofit to Meet Tightened Discharge Limits

When a Colorado water/wastewater utility had to reduce its total dissolved solids, it chose design-build delivery and a first-of-its-kind treatment process to save time and money while meeting strict compliance standards.

Challenge

An ever-expanding population, changing environmental regulations and drought are increasing the demand for water. To better manage water resources, lessen the supply-demand gap and establish a sustainable path toward water security, direct and indirect water reuse is playing an increasingly significant role in how water resources are handled in the United States and around the globe.

The Cherokee Metropolitan District operates a 4.8 million-gallon-per-day (MGD) wastewater treatment facility that discharges to the Upper Black Squirrel Creek Alluvial Aquifer, southeast of Colorado Springs, Colorado. The plant serves nearly 40,000 customers.

Project Stats

Client
Cherokee Metropolitan District

Location
Colorado Springs, Colorado

40K
customers served

$45M
approximate project value

$6M
cost savings through value engineering

The facility was originally designed to meet groundwater standards established through preliminary effluent limitations for nitrates and biological oxygen demand. Three months before the new facility was put online in 2010, the District was notified that a 400 mg/L limit for total dissolved solids (TDS) would be added to its discharge permit. The original facility was not designed to reduce TDS and regularly discharged above this limit.

The District's wastewater effluent is not discharged to surface water, such as a river or creek, but is placed in rapid infiltration basins (RIBs), which act as infiltration ponds that allow water to seep back into the aquifer used for drinking water. After a few years of operation, the state initiated a compliance period for the substantial modifications needed to allow the new facility to meet TDS limits.

Solution

The utility chose to implement the improvements using a progressive design-build project delivery approach, which integrates design and construction to create a single point of accountability, which saves time and money. This mode of delivery was ideal because the District's team wanted to partner with a firm that could handle both design and construction to avoid risk gaps. The drivers behind the decision to utilize design-build delivery included:

1. Collaboration: The utility preferred a collaborative approach that would allow it to provide input into various elements of the project, including treatment process selection and equipment selection.
2. Speed: The District's compliance schedule could not be achieved with traditional design-bid-build delivery.
3. Value: The utility wanted to select the team that provided the highest overall value, as measured by its qualifications, including a combination of cost and non-cost factors.
4. Innovation and Creative Technical Solution: The District knew that the most effective solution would involve an innovative combination of treatment processes.

Updating an existing wastewater plant to reduce TDS is a challenging problem. The District selected a joint venture of Burns & McDonnell and Garney Construction in a competitive progressive design-build procurement process because of the companies' shared and individual experience in wastewater treatment, potable water treatment, membrane applications and progressive design-build delivery.

The team started preliminary design in October 2019 and broke ground on this $45 million improvements project in January 2021. Slated for completion in 2023, the project will provide a sustainable reduction in TDS to bring the facility into compliance with its discharge permit.

At the outset, our team studied the facility and the underlying process issues. After examining piloting data, it was clear that TDS reduction could be achieved with a reverse osmosis (RO) treatment application added after the existing sequencing batch reactor (SBR) process.

Following the current SBR process — in which wastewater is treated by a sequencing batch reactor, then discharged to an equalization tank — it was noted that the water quality coming off the equalization tank of the SBR system would require multiple steps of filtration before it would be suitable as RO feed water.

Our team explored the option of tertiary filtration followed by microfiltration after the SBR. We also reviewed the alternative of changing the secondary process to a membrane bioreactor (MBR) so that no additional filtration would be needed. The option of converting SBRs to MBRs was selected based on the merits of reducing treatment steps, simplifying operations and reducing costs.

The MBR process requires less secondary process volume, which allows the entire treatment to occur in two of the existing four process trains. A high-recovery RO (HRRO) system was also explored in place of traditional RO. The HRRO has a recovery rate above 90%, which allows for the use of evaporation ponds for brine disposal rather than the higher-risk option of deep well injection.

Results

This is the world's first municipal MBR and HRRO treatment plant, and Colorado's largest municipal MBR. We worked with the utility to engineer an optimal design solution that met process and treatment needs while adhering to budget and time constraints. The District is on track to meet its compliance deadline, and in collaboration with the project owner, we have reduced costs by more than $6 million through value engineering.

One of the biggest keys to the design's success is the detailed process and treatment equipment knowledge that made the conversion of SBRs to MBRs seamless. We also brought our depth of advanced treatment technologies experience to the project,

and leveraged both to meet the project's goals. This provided the District with a clear understanding of the performance, limitations and risks of the treatment equipment, and how the equipment components operated together as a single system.

The use of a single point of accountability for the project has yielded fewer than normal change orders, optimizing labor and maximizing material cost savings.

Project Highlights

- World's first municipal MBR and HRRO treatment plant.
- Colorado's largest municipal MBR.
- Sequence batch reactor (SBR) to membrane bioreactor (MBR) conversion.
- High-recovery reverse osmosis (HRRO) process to reduce TDS.
- Optimized and reused existing infrastructure for cost savings and more sustainable solution.
- Progressive design-build project delivery.

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