

# Pioneering Water Reuse System

Necessity, once again, is the mother of invention.

**T**he small New Mexico village of Cloudcroft holds more than one important distinction. At an elevation of 9,000 feet, it is home to the nation's highest golf course. But it is the cutting edge way that Cloudcroft is addressing a serious water shortage that really makes it stand out. The local population agreed to implement an integrated water conservation and indirect potable reuse project that uses advanced membrane technology to supplement the existing raw water source consisting of spring and well water with treated wastewater effluent.

Faced with a drought that necessitated trucking in 20,000 gallons of water up the mountain each day during the peak summer tourism season, the 1,000 local residents quickly let go of any concerns about using recycled wastewater. From the state's \$10-million initiative to promote innovative water conservation,

osmosis (RO) system to treat wastewater flows that ultimately exceed drinking water quality standards. For the most part the treated effluent is discharged into a man-made reservoir rather than pumped into a larger body of water such as an aquifer, river, lake, or ocean. What makes Cloudcroft unusual is that this reservoir serves as a raw water source for the town's drinking water treatment system. Essentially, Cloudcroft is noteworthy for implementing a system that shortens the distance—and traces an obvious path—from the wastewater treatment discharge point to the intake point of the potable water treatment system.

The purified wastewater constitutes up to 50 percent of the drinking water supply. The effluent from the reclaimed wastewater treatment plant (RWTP) is pumped into the reservoir, where it is mixed with well and spring waters. Prior to intake into the potable water treatment system, the reservoir water is stored an average of 30 days for natural treatment by diffusion and sunlight. The use of an artificial reservoir, and the blending with well and spring waters, classifies the Cloudcroft integrated water treatment system as an "indirect planned potable reuse" system.

While the public has general concerns about water reuse, water engineers recognize that wastewater also contains pathogens and other so-called Emerging Pollutants of Concern (EPOC), including pharmaceutically-active substances, endocrine disrupters, and personal care products. For these reasons, it was felt that a multiple membrane barrier solution was a good choice.

Livingston Associates, (Alamogordo, NM) performed the engineering design for the project. The key elements of the system are the MBR and RO membranes supplied by Koch Membrane Systems ([www.kochmembrane.com](http://www.kochmembrane.com)). These membranes, which will be installed in the reclaimed wastewater treatment plant, will make the effluent discharged into the reservoir safe for human consumption. The integrated water treatment process also includes an ultrafiltration (UF) system to treat the reservoir water (a mix of RWTP effluent and well and spring water), an increasingly common treatment method for treating surface water.

## Second Generation MBR

The project involves the conversion of the original wastewater treatment plant (WWTP) to an MBR process. The MBR is designed for an average flow of 100,000 gpd, with room for an additional 100,000 gpd in the future. The pre-existing 200,000-gal equalization basin (EQ) is being retrofitted for the MBR process by being divided into two compartments: a 100,000-gal basin for flow equalization and the remaining 100,000-gal basin for the MBR.

Raw wastewater influent will enter the system and pass through a one-mm rotating drum screen located at the existing headworks. The screened influent will flow by gravity to the EQ basin, before being pumped into the anoxic basin. From there, the flow enters the aeration basin to receive aerobic treatment, and then enters the four membrane chambers that house PURON™ submerged membrane modules from Koch.

The MBR system will produce a high quality effluent with a turbidity of typi-



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the village received \$600,000 in 2004 to help fund the village's new \$2-million water reuse system.

The state-of-the-art system employs a second-generation membrane bioreactor (MBR) and a gravity-fed reverse

cally less than 0.2-NTU (or 1.0-mg/L TSS). The filtrate will be disinfected with chloramines and pumped to a new 75,000-gal water storage tank at the RWTP site.

The PURON technology is a second generation submerged MBR system that employs hollow fibers. A key advantage of the PURON system is the use of a single header with hollow fibers that are fixed only at the bottom. The sealed upper ends of the fibers are allowed to float freely. The free floating membrane tip eliminates the build-up of hair and fibrous materials that can clog the upper end of membrane fibers in MBR designs that employ both a top and bottom header. Solids and particulates, including bacteria, are rejected by the membrane and remain on the outside, while permeate is drawn through the membrane to the inside of the fibers. Outside-to-inside technology such as this provides optimal solids management and a high flow-rate, while using up to 50 percent less energy than other MBR systems.

Another advantage of the PURON design is the introduction of air scour at the center of the fiber bundle, right where it is needed. Compressed air creates bubbles that shake the membranes and scour the outside of the hollow fibers, removing accumulated debris. The unique air scour design is a tremendous improvement over older technology since it minimizes sludging around the membrane and reduces energy consumption.

The high-strength fibers in the PURON modules also overcome the fiber breakage problems typical of first generation systems that utilize non-braided fibers. The free-floating tips of the hollow fibers in the single header design also place less mechanical stress on the fibers compared to double-header designs.

Unlike flat sheet membranes that do not support backflushing, the PURON modules resist fouling and maintain flux by introducing a small portion of the filtrate back through the fiber pores from the inside-out at timed intervals. PURON hollow fibers provide significantly higher membrane surface area, and therefore higher filtration capacity

within the same module footprint, compared to flat sheet membrane designs.

The MBR is the first step in a multiple physical-barrier approach to reclaimed water repurification. The high-quality MBR permeate will be pumped uphill into a 75,000-gal storage tank. From there, some of the water will be diverted for non-potable reuse (i.e., to irrigate the golf course and high school athletic fields).

Each day, 100,000 gal will flow downhill about 2.5 miles to the water treatment facilities (WTF) that house the RO system. The force of gravity produces approximately 175 psi of residual pressure at the terminus of the four-in. waterline—the pressure required to operate the RO system.

The RO system is a single train, three-stage, one-pass system with five pressure vessels set up in a 2:2:1 array that contains Magnum® 8822HR membranes, also from Koch. These high-rejection, low-pressure thin-film composite membranes have been successfully utilized in a number of reuse applications, and they have been shown to be effective in rejecting many emerging contaminants while achieving water recovery of about 80 percent.

The RO system will produce an average of 80,000 gpd of permeate, with a total dissolved solids (TDS) content of about 50-mg/L from a feed quality of around 1,000 mg/L TDS.

Permeate from the RO system will receive peroxide and UV disinfection, and will be discharged into a one-MG lined and covered reservoir. From there, the reservoir water will flow into a 750,000-gal covered and lined reservoir, where it will blend with existing spring and ground waters. A portion of the RO permeate will be used for

aquifer recharge during times of low water demand.

The concentrate from the RO process will be diverted to a 250,000-gal open and lined reservoir along with UF backwash water. This water is to be used for road dust control, construction, snow making for the ski area, gravel mining operations, forest fire fighting, and other beneficial purposes.

The final stage of the integrated water treatment is the ultrafiltration of reservoir water containing RO permeate, well, and spring water.

Each day, about 180,000 gal of blended water will be treated through the UF system. The permeate from the UF system will be filtered by granular activated carbon before receiving additional disinfection using sodium hypochlorite. The disinfected water will then go into the water distribution system.

Because the high-quality (low TDS) water from the RO process is to be used for blending, the overall water quality in the distribution system is expected to improve when Cloudcroft begins using reclaimed water.

And that just goes to show that it is not where the water has been that counts, but where it is going. The integrated membrane system, and its multiple physical-barriers, provide protection that will give the residents and tourists in Cloudcroft the confidence to enjoy high-quality, high-tech water as pure as a mountain stream.

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