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Divers Go Deep for Denver Water Dam Upgrades

For a month at a time, a team of divers lived inside a compression chamber and worked underwater to repair Denver (Colo.) Water's 105-year-old Cheesman Dam. The dam, located on the South Platte River about 50 miles southwest of Denver, needs important upgrades to maintain dam safety, provide a viable water supply, and ensure smooth operations. For almost a decade leading up to the project, Denver Water engineers used blueprints and photos as old as the dam itself to carefully outline a construction plan for the unique underwater work.

"Denver Water historically has been very good about keeping records," said Mike Miller, Denver Water's engineering manager for the project. "But you also have to understand how the [company] built things 100 years ago and what equipment [it] used."

Denver Water's Jeff Martin, the project engineer, added, "For [the dam] being 100 years old, we couldn't be more proud of this facility. It's considered the workhorse of Denver Water's system and has been for many years."

To keep that workhorse laboring well into the next century, crews have begun work on a two-year, $18.3-million project to upgrade the dam's outlet works valve system, which was installed when the dam was built in 1905, and to set up new underwater trash racks to prevent debris from clogging the valves. Crews are also installing new upstream control slide gates and a control building and are updating the dam's electrical systems.

Most of the construction at the site took place during the past summer, using divers from Seattle, Wash.–based Global Diving & Salvage. A large working barge served as the divers' home base and contained equipment, a decompression chamber, the life support system, and many other necessities for the project. Four divers lived in a compression chamber attached to the working barge for 30-day intervals, where they took turns working in pairs underwater (at depths up to 215 feet). One pair worked while the other pair slept, ate, and recovered for the next shift.

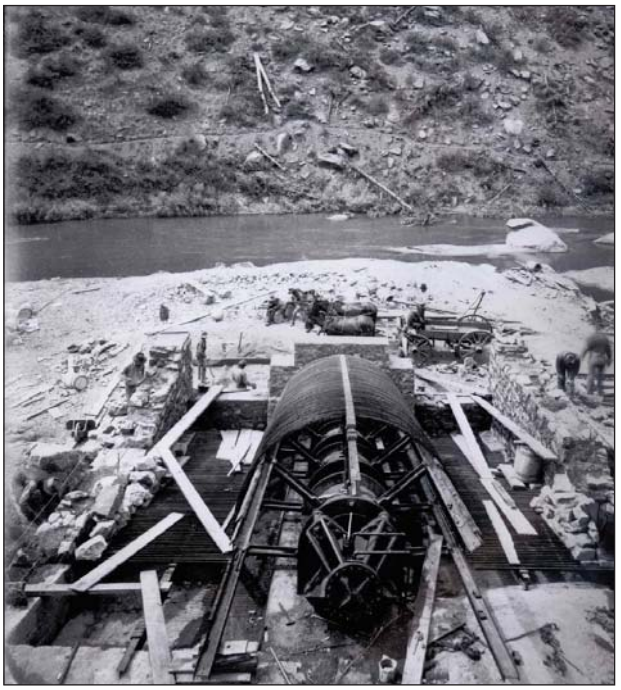
The divers record all their work with helmet-mounted cameras so Denver Water will have an accurate real-time depiction of the underwater job.

Still, the work didn't begin when divers stepped into their suits. Most of the design work leading up to the actual repair work was done in-house by Denver Water civil, mechanical, and electrical engineers. Denver Water needs the water in Cheesman Reservoir all

PHOTOS COURTESY OF DENVER WATER

Earlier this year, a 250-ton crane was placed on this working barge in Cheesman Reservoir. The barge served as the divers' home base and housed them during their 30-day work intervals.

Denver Water engineers used old blueprints and original construction photos to compile construction documents that would accurately reflect the work underwater divers needed to do to rehabilitate the 105-year-old Cheesman Dam, located about 50 miles southwest of Denver.



Early construction photos helped today's engineers determine what was built where.

year long and cannot risk draining it to study or work on the dam. So engineers used sonar to study the dam and surrounding topography and took advantage of the plummeting water levels during the 2002 drought to document all they could about the suddenly exposed structure.

In addition to sonar and drought-time studies, engineers used original hand-drawn blueprints of Cheesman, century-old black-and-white photographs, and any subsequent drawings of work that had been done to help prepare for the major upgrade project.

"You have to look at the cross-section of the different levels to find all the features," Miller said. "Once you pull out the drawings, you have to figure out if the original features of the dam are still there. How was the facility originally built? What are the new existing conditions?"

Figuring out the nuances between how new structures will be built and how they were built a century ago can be challenging. One 1899 photo shows a 4-foot-tall mine cart being pushed by a man into a tunnel at the dam's mid-level, with a flat area jutting out from the tunnel. But in another photo, the flat area appeared to be missing. That kind of discrepancy was challenging for the engineers. Was that ledge still there? If so, would it support a trash rack?

Engineers also had to study the geology of the surrounding rock and understand the excavation techniques crews used back then. "You can blast out a tunnel now a lot more accurately than they could in the 1890s," Miller said. "Back then, they followed the geologic discontinuities in the rocks to construct a tunnel."

Engineers found that Cheesman's first construction workers used early versions of air compressors and dynamite to excavate the rock. They blasted tunnels with a slight curve that followed the geology of the rock because that was easier for them to do than blasting in a straight line, Miller said. But that slightly curved tunnel created a challenge for present-day divers. The new trash rack, gate, and spool were built for a straight tunnel, so divers had to expand the diameter of the tunnel by blasting underwater. Then they had to cut the roof with wire saws to smooth out the bands and allow the spools to fit as designed.

"That was the biggest struggle—what conditions really exist? How have conditions changed?" Miller said. "You have to use a lot of judgment as you interpret site conditions and complete your design."

The clear, accurate, and updated drawings were crucial in helping divers work more efficiently. "The most important thing is having a good handle on how the structures were built and what conditions they encountered back then," Miller said. "That's so necessary when you're doing rehab on old projects. That way, you don't have too many surprises."

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