



SAN DIEGO WATER AGENCY UPGRADES AGING AQUEDUCT

Critical Water Supply Tunnel Sliplining a Success Thanks to Careful Planning, Collaboration

By Bijan Khamanian

Through a design-build alternative delivery method, San Diego County Water Authority undertook the rehabilitation of its First Aqueduct Treated Water Tunnels located in Escondido, California.

The timely rehabilitation of the First Aqueduct is part of the Water Authority’s proactive asset management program. An essential element of providing safe and reliable water supplies is assessing the agency’s 310 miles of

large-diameter pipeline and making the upgrades necessary to continue serving the region. That work, funded through water bills paid by residents and businesses across the county, sustains the region’s \$245 billion economy and quality of life.

“The First Aqueduct delivered imported water to our region for the first time more than 70 years ago, and it remains critical to water supply reliability for our region to this day,” said Gary Croucher, chair of the Water Authority’s Board of Directors. “Coordination across Water Authority departments and collaboration with our member agencies allowed us to complete this extraordinarily com-

plex project and ensure these pipelines operate for generations to come.”

Through a lengthy statement of qualifications and approval process, the agency awarded the project to Michels Trenchless Inc. and Stantec. The initial design package identified several methods for relining these tunnels. Welded in place steel plates, sliplining with FRP, cured in place pipe and spray on liners.

Phase One — Sliplining

The Michels/Stantec design-build team quickly eliminated all but the sliplining option for Phase One. Some of the project requirements do not allow for slow-moving construction methods. Welding,

coating, contract grouting, etc. take too long and would result in a 3 to 4 year process (shutdowns limited to three per winter).

The goal was to try to complete the tunnel rehabilitation work from December to March and demobilize entirely from the site by the end of April.

shoe concrete tunnel. The 70-year-old structure was relined using 63-in. (1,600 mm) ID fiberglass reinforced polymer mortar (FRPM) Hobas pipe. The tunnel was more than 385 ft (117 m) deep under the peak elevation, resulting in an estimated 155 psi (10.5 bar) external hydrostatic head. The design allowed for zero infiltration for the entire run to

completion of additional work outside of the tunnels while the aqueduct was in operation. The work also included a seismic retrofit of the Oak Hills downstream bifurcation structure, where the flow from the 63-in. pipe was split to twin 42-in. siphons downstream of the tunnel.

As one of the longest-pushed slipline projects in a dry host pipe, and to reduce



Project requirements:

1. Non-tunnel work could be completed between flow shutdowns, as the tunnel could not be taken out of service during construction.
2. A maximum of three, 10-day, shutdown periods (24/7) during the winter season of dry time is allowable in the tunnel.
3. Construction was only allowed in winter when the water usage was less than in summer, enabling conveyance systems to go offline.
4. The pipe was installed by jacking a full pipe string from the access pit in a single drive.
5. 100 psi internal Pressure Rated Pipe
6. 160 psi external pressure rating
7. Standalone structural system
8. NSF61 potable water rating
9. Placement of special temporary diversion pressure fittings between the shutdowns to enable the flow to be put back into the downstream aqueduct.

The Oat Hills portion of the project consisted of more than 3,600 lf (1,120 m) of existing 72-in. (1,830 mm) ID horse-

maintain the highest purity of the precious drinking water source.

To add to the strict shutdown schedule, several 2023 winter atmospheric rivers hit during the project's construction at Oat Hills. The excessive precipitation induced further stress on the construction schedule.

Selecting the Right Pipe

The Michels/Stantec team elected to use Hobas FRPM pipe. The pipe demonstrated a 100-plus-year design life per ASTM D3681 long-term strain corrosion test procedure for fiberglass reinforced polymer mortar pipes. FRPM pipes offer a multigenerational solution, a low carbon footprint and a sustainable option compared with pipes that require replacement or renewal every 30 to 50 years.

To ensure the rapid installation of the pipe inside the host tunnel, the Michels team picked 20-ft (6 m) joints for the task and completed the slipline portion of the project in just over three months from December 2022 to March 2023 in a single winter season. The project completion date of June 30, 2023, allowed for

the anticipated higher-than-normal jacking loads, the original Michels design used wheeled casing spacers for the entire run. After further study, it was determined that based on Hobas' high jacking capacity, much simpler spacers with polypropylene shoes would also work and this revision was made to the design.

The team used an Akkerman SL100 sliplining frame and power system to expedite the installation and increase the number of pipes placed daily. During the second shutdown, with the machine and spacers in place, the lining process took 55 hours to complete, with just under 3,600 lf placed in the system, and completion of the first lift of the annular grout install—the balance of the grout installed during shutdown three.

The project was a complete success, thanks to careful planning by the contractor, consultant and all suppliers and subcontractors in conjunction and cooperation with the Water Authority to make this a showcase for similar projects in the future.

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