July • August 2012

UNDERWATER

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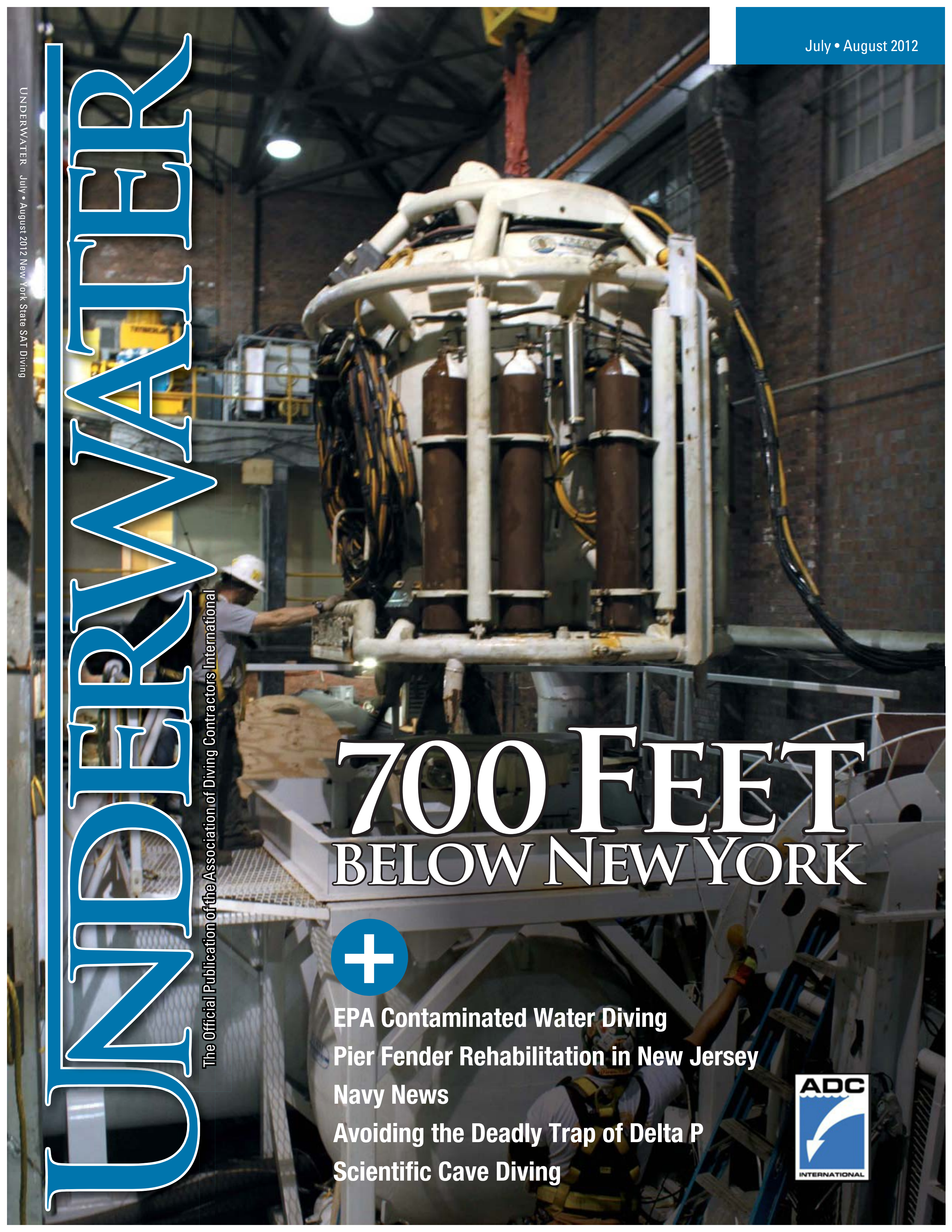
UNDERWATER July • August 2012 New York State SAT Diving



700 FEET BELOW NEW YORK

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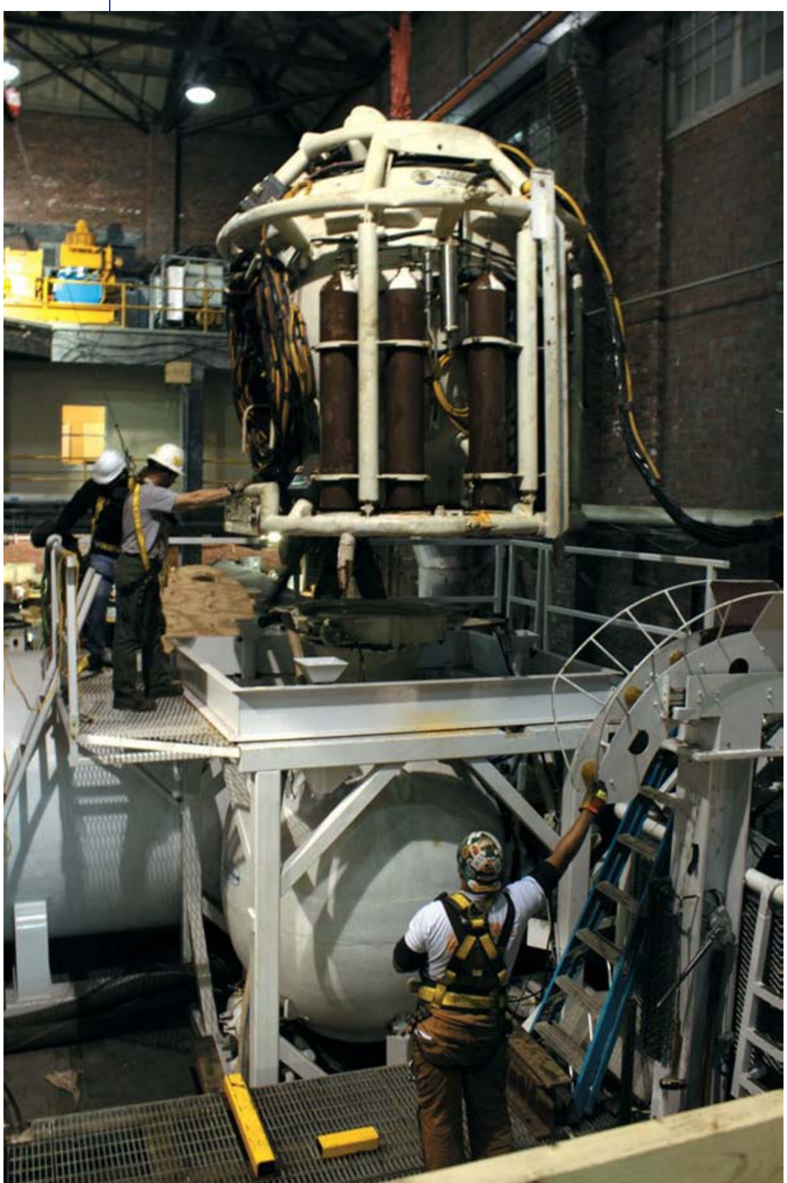
700 Feet below NEW YORK

Global Diving & Salvage Ventures Underground

BY AARON M. LAY



Bell being disconnected - going to work

WITHOUT QUESTION, AMERICA IS BLESSED with some of the best public water supplies in the world. And we use a lot of it. But as we're making our coffee, washing our clothes, or flushing our toilets, few of us ever stop to consider how our water gets to our spigots.

For the eight million residents of New York City, over half (800 million gallons per day) of their water begins *its* journey high in the Catskills Mountains at several different reservoirs. It finds its way to New Yorkers' taps by way of the Delaware Aqueduct, making it arguably one of New York City's most critical pieces of infrastructure. At 85 miles long, it's the world's longest underground tunnel. Built between 1939 and 1945, its aging framework has sprung a few leaks, and it's estimated between 10 and 36 million gallons are lost each day, depending on how much water the aqueduct is carrying. As part of its Water for the Future program, the New York Department of Environmental Protection (NYDEP) has been addressing the problem in stages.

Needless to say, vital maintenance on the aqueduct, which runs as deep as 2000 feet below ground, is no small task. Leading the underwater portion of this *massive*, multi-phase project that has spanned five years is Global Diving & Salvage Inc., headquartered in Washington State. Global's staff and crews are no strangers to unusual and challenging jobs, but this one probably takes the cake in terms of peculiarity. Mike Langen, Vice President of Marine Construction, Engineering and Technology, said of the project, "I don't expect to *ever* see a job quite like this one again." Langen's statement should not be considered as just so much hyperbole – he's saying this for good reason. And to understand why, we've got to head underground.

Considering when the Delaware Aqueduct was constructed, it stands as an impressive feat of engineering. Its 85 miles of tunnel wind through solid granite and limestone and travel underneath the Hudson River before arriving in Yonkers, New York where the water it carries is distributed to NYC residents. At one of 13 vertical access shafts that run perpendicular to the aqueduct (where it passes beneath the Hudson) is where Global set up shop. This shaft, Shaft 6, is the aqueduct's deepest – at 13 and a half feet wide and entirely filled with water, it plunges nearly 700 feet straight down.

Diving bell inside shaft

It is a tight fit

In the offshore sector, dives of 700 feet or greater are relatively common. But conducting saturation dives on land in 700 feet of water? In a 13-foot wide shaft? It's no wonder Langen doesn't expect to see a job like this one again. He spoke of the extraordinarily technical challenges this job brought to fore, "The logistics of working in a 13-foot diameter shaft were interesting, to say the least. We had to carefully plan all our work. Every tool and piece of equipment required for a particular task had to be put down the hole prior to the (dive) bell going down. Once the bell was in the shaft, we couldn't bring anything in or out. Our bell was 8-feet in diameter in a 13-foot shaft, so that doesn't leave a whole lot of space to work with. Each operation had to be meticulously planned to make sure we had all the right tools and equipment in place in order to have it all loaded and put down in the shaft prior to the bell going down and the divers getting to work. It was *always* a real challenge."

The first phase of Global's work in the shaft was primarily inspection-based to help lay the groundwork for eventual repair of the aqueduct's leaks. Among other tasks, this phase required crews to assess the integrity of a hemispherical door that isolated a small 5-foot wide by 7-foot tall, horizontal access tunnel, which connects the vertical shaft to the aqueduct. Langen adds, "When the aqueduct is flowing, head pressure inside can reach 1,200 feet. So, this door was intended to keep the aqueduct isolated from the access tunnel. In the interest

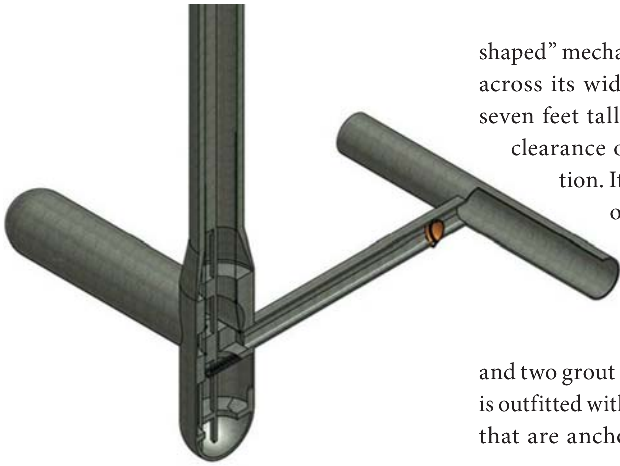
The old valve coming out

New valve ready to be sent down

of safety, they didn't want to dewater the shaft until they knew that the door and the access shaft were in good condition. The technical challenges of this part of the project required highly specialized tools, which had to be designed by the engineers at Global, including a track/fixture combination that allowed for the precise physical and sonar measurement of the horizontal drift to within 1/16th of an inch. Additionally, it could be fitted with a core drill allowing for concrete core samples to be taken at any engineer-determined location along the drift. A 'bridge' fitted with a crane arm was used to access the drift as well as to remove pieces of the piping and a 24-inch valve that had to removed."

Langen continues to elaborate on this part of the project, "We did non-destructive testing on the door including ultrasonic thickness testing as well as taking physical samples of the bronze door for chemical analysis." Crews also had to remove several pieces of the existing 24-inch bronze piping works within the shaft. Langen spoke of this process, "We removed a number of valves and piping from down in the lower shaft area, eventually removing a 24-inch (manually operated) bronze valve that was encased in concrete and replacing that with a 24-inch hydraulic stainless steel gate valve which will eventually connect to the dewatering piping, allowing them to open and close that valve from the surface." All of this piping was located below the bridge and away from the main lifting line. The bridge crane was used to move the sections of pipe and valves to where they could be rigged into the main lifting wire. The results of the testing were used to determine how the subsequent phases of the project were approached. Although the interpretation of the test results and the video inspection revealed that the bronze door was in fact functional to static head, and possibly full operational head, it was decided that a secondary bulkhead, or "plug," capable of withstanding the 2.5 million of pounds of force, be installed approximately 50 feet into the access tunnel to provide added safety to workers.

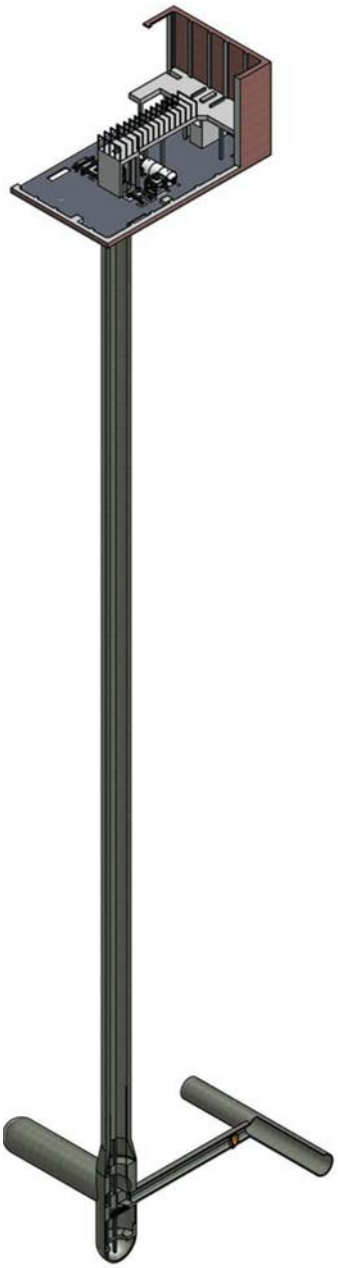
Like the rest of this project, getting this plug securely in place inside the access tunnel was highly involved and required an almost surgical precision. This "horseshoe



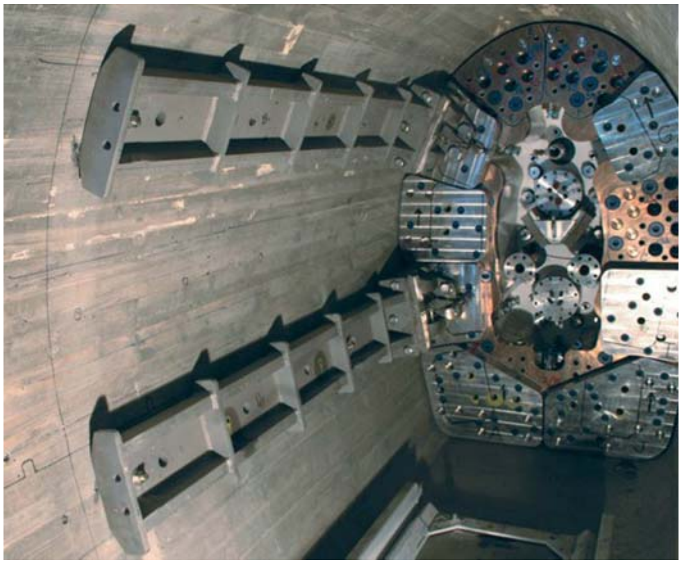
shaped" mechanical plug measures five feet across its widest diameter and is nearly seven feet tall and was designed with ¾" clearance on all sides during installation. It was machined from a series of stainless steel plates and is approximately four feet thick and weighs over 23,000 pounds. It features a mechanical seal and two grout actuated hydraulic seals and is outfitted with a series of restraining struts that are anchored along the walls of the shaft. Crews used a hydraulic lifting arm they dubbed "the claw" to precisely place different components of the plug, some of which weighed over 500 pounds apiece. Operated remotely from the surface, this arm provided seven degrees of motion. A purpose built tool was used to push the plug, mounted on rollers, which allowed crews to place the plug *exactly* where it needed to go in the drift. This plug will allow the shaft to be dewatered and outfitted with nine submersible pumps (over 15,000 horsepower), which will serve to drain the

Plug outside of mock up

Shaft 6, NY Mock Up in Seattle



Shaft-6 Assembly Bulkhead Install



Shaft 6, NY Plug Mock Up

System in the building

aqueduct at a rate of 80 million gallons per day to facilitate the forthcoming repairs to the aqueduct itself.

All the aforementioned spatial and environmental limitations Global had to contend with weren't the only obstacles in its path. Anytime a city the size of the Big Apple has its water supply compromised for *any* reason, there's bound to be some complications. Langen discusses this issue, "The single biggest thing we had to do was deal with the ability to get outages to take the aqueduct offline. In the beginning, nobody knew the condition of a lot of this equipment, so we didn't want to have it at full head pressure while the divers were down there working. So, they had to secure the aqueduct. The reservoirs downstream had to be filled to be able to continue supplying NYC with water. But there's only so much capacity to those reservoirs, enough to allow us 25-day windows of work, and that's what directed our schedule. There couldn't be more work planned than could be accomplished in 25 days. Weather could also impact the quality of the water being delivered from those reservoirs. Being able to get an outage long enough to go down and do the work we had to do could be *extremely* difficult at times. We had to balance all these factors with the operational requirements of the water department, and those were some of the biggest hurdles that we had to clear."

Langen reflects on Global's five-year involvement in the project, "For me, it was a one of a kind experience, and all these challenges made the job really interesting. Of course, working in 680 feet of water is a challenge, even with the *best* circumstances. The people we have had involved throughout the course of the job have been absolutely *outstanding*. The extremely high level of planning, attention to detail, and breadth of talent and effort required to do this kind of work is immense, and it's a real feat to accomplish.

Saturation Control Van

There's a great deal of pressure with this kind of work. Think about it, there are a lot of people at the end of the spigot who would not understand if no water came out of it."

Although Global's involvement in the project is nearing its end, NYDEP is moving full steam ahead and has current plans to break ground on a bypass tunnel in 2013. This three-mile tunnel will detour around the portion of the aqueduct that is leaking in Orange County, and other leaks in the aqueduct will be repaired inside the existing tunnel. The bypass is scheduled to be completed and reconnected to the Delaware Aqueduct by 2019.