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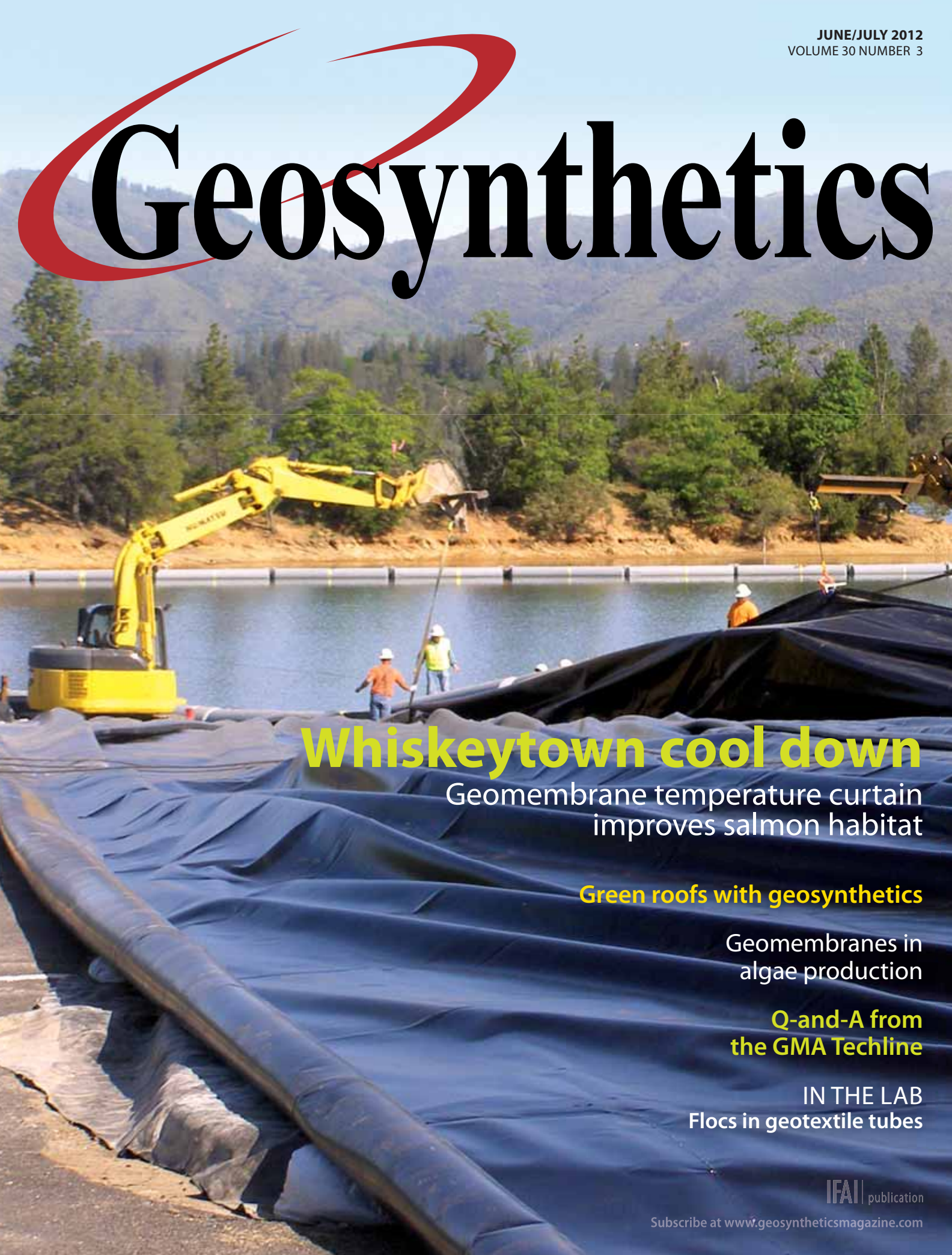
Geosynthetics



Whiskeytown cool down

Geomembrane temperature curtain improves salmon habitat

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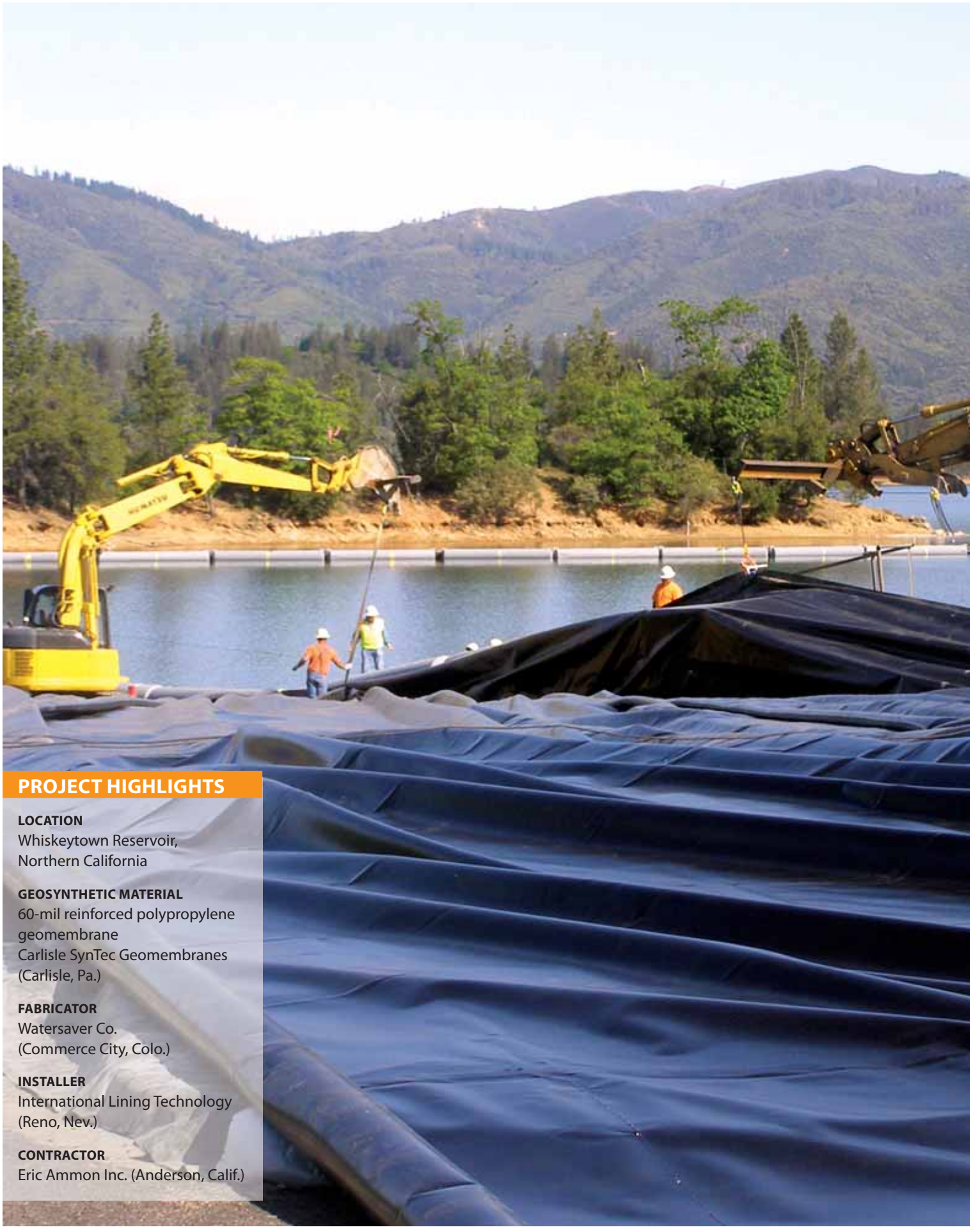

PROJECT HIGHLIGHTS

LOCATION
Whiskeytown Reservoir,
Northern California

GEOSYNTHETIC MATERIAL
60-mil reinforced polypropylene geomembrane
Carlisle SynTec Geomembranes (Carlisle, Pa.)

FABRICATOR
Watersaver Co.
(Commerce City, Colo.)

INSTALLER
International Lining Technology (Reno, Nev.)

CONTRACTOR
Eric Ammon Inc. (Anderson, Calif.)

The Whiskeytown Reservoir in Northern California received a new geomembrane separation curtain designed, fabricated, and installed to lower water temperatures and save salmon.

At the Whiskeytown Reservoir

Geomembrane curtain improves salmon habitat

By Bob Gee, Greg Morris, and Stanford W. Slifer

Introduction

In California's Central Valley, geomembrane temperature curtains provide an example of how geosynthetic materials can help stabilize environmental conditions along water diversion systems.

Located in the Whiskeytown Reservoir, about 10 miles west of Redding in Northern California's Shasta County, one of these curtains makes it possible to selectively withdraw cold water needed for successful salmon spawning and divert it to the Sacramento River run, an area where chinook salmon are considered an endangered species. Originally installed in 1993, the curtain was replaced in 2011 with a newer model estimated to last at least 15 years.

Bob Gee is a mechanical engineer for the U.S. Bureau of Reclamation's Northern California office.

Greg Morris is a chief engineer with the U.S. Bureau of Reclamation.

Stanford W. Slifer is the president of Watersaver Co.–a division of CDI, based in Commerce City, Colo.

Geosynthetics editorial intern, Jessica Bies, also contributed to this article.

FIGURE 1 Map of the Whiskeytown project area

Courtesy of National Geographic

History

The Whiskeytown Reservoir is just one part of a complex water reclamation system known as the Central Valley Project.

Located in the Shasta and Trinity River Division, the Whiskeytown Reservoir holds water that is on its way east toward the Sacramento River. The water takes a circuitous route, passing through several different tunnels, reservoirs, dams, and power plants before it is discharged into the upper reaches of the Sacramento River **(Figure 1)**.

Prior to the construction of three flexible temperature-control curtains in 1993, water diverted from the Trinity River would increase 5 to 7 C (10 to 13 F) in temperature before it reached the Sacramento River.[1] This increase raised the temperature above the 12 C (53.6 F) maximum temperature limit imposed on the river by the National Marine Fisheries Service. Salmon eggs and larvae require lower temperatures of 5.5 to 13.3 C (42

1 www.usbr.gov/pmts/hydraulics_lab/pubs/PAP/PAP-0847.pdf

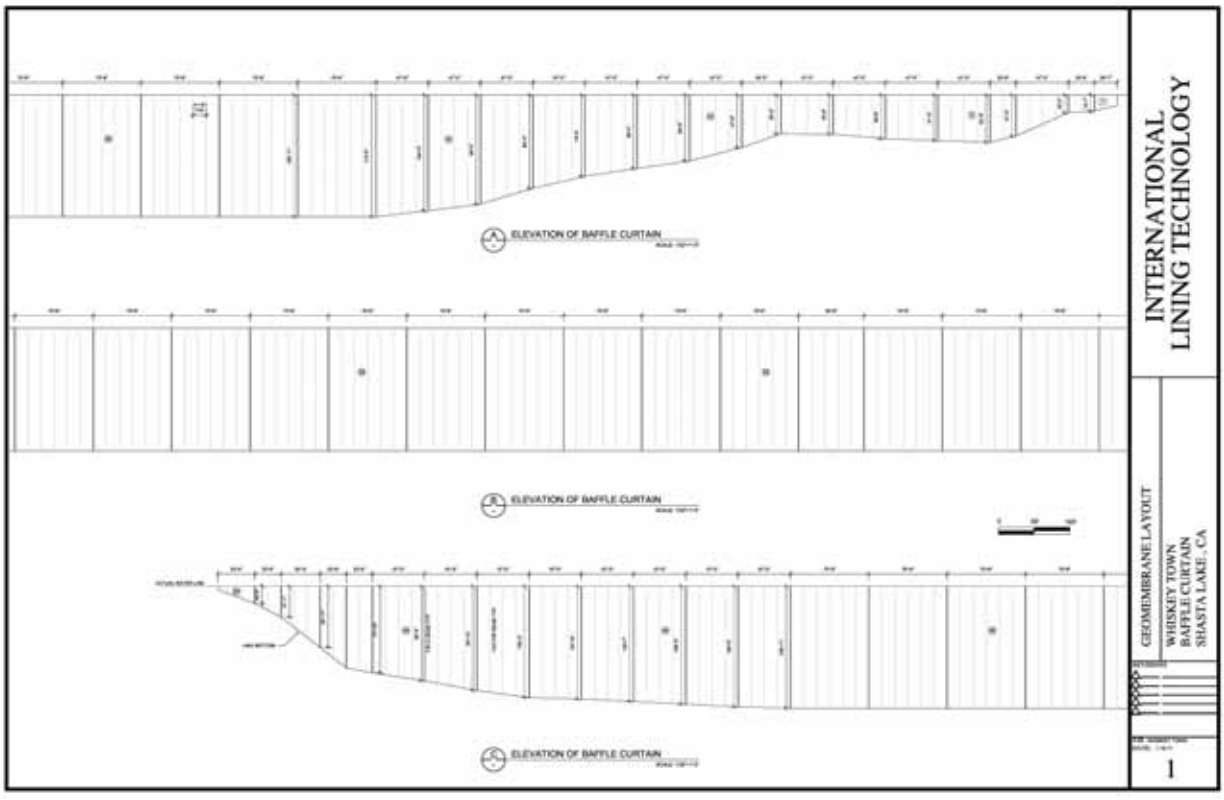

DIAGRAM 1 Take-off for the temperature curtain

Courtesy of Watersaver Co.

to 56 F) to live and any increase in water temperature can endanger their survival.

The geosynthetic curtains, installed in 1993 and located in various positions along the water division, were intended to lower the water's temperature before it was diverted back toward the Sacramento River and the chinook salmon's spawning grounds. Historically, the curtains have lowered water temperatures by 2 to 3C degrees, but the poor condition of the curtain located in the Whiskeytown Reservoir required a change last year.[2]

The original curtains were made of Hypalon®—a synthetic rubber known for its long life span and capable of surviving harsh environments. According to Bob Gee, a mechanical engineer with the Bureau of Reclamation, after 17 years of service this curtain in Whiskeytown was riddled with holes. "The holes were caused by the curtain rubbing against chains linking buoys holding the top of the curtain to anchors on the lake bottom," Gee said.[3]

"It just had deteriorated," said Brian Person, manager for the Bureau of Reclamation's Northern California office. "It was time for a replacement."

Project

The old curtain was removed in the fall of 2010 and the new curtain was installed and made operational in 2011.

Redesigned using a 60-mil, reinforced polypropylene geomembrane, commonly installed in wastewater lagoons, industrial waste ponds, or fish hatcheries, it took almost 260,000ft^2 to complete this job. Because of the deterioration of the Hypalon curtain, the Bureau of Reclamation decided to use polypropylene instead, hoping that it would better withstand the rubbing against the chains.

Welding the panels together was also difficult. According to Gee, just finding

2 www.usbr.gov/pmts/hydraulics_lab/pubs/PAP/PAP-0847.pdf
3 www.fabricatedgeomembrane.com/?p=1843

Central Valley Project

Encompassing 35 counties, California's Central Valley Project provides electrical power and water to farms, homes, and factories located within a 500-mile north-south stretch.

One of the largest water conservation developments in the U.S., it was constructed to protect the Central Valley Basin from water shortages and floods. Approved by President Roosevelt in 1935, the project continued through the 1940s and '50s and eventually grew to involve various federal and state government agencies but was headed by the Bureau of Reclamation, a branch of the U.S. Department of the Interior.

The era of large dam building had waned by the 1960s and during the next several decades the Central Valley Project would become the focus of numerous political and environmental debates. By 1969, the chinook salmon and steelhead trout populations began to decline, prompting environmentalists and anglers to seek widespread change.

In 1992, the Central Valley Project Improvement Act was passed, reallocating 800,000 acre-feet of water from farmers for the restoration of Central Valley fisheries, despite strong objections from local politicians. About the same time, the National Marine Fisheries Service imposed a 12 C (54 F) maximum temperature limit on the upper Sacramento River.

One of the biggest threats facing chinook salmon is loss of habitat. While an estimated 16 million salmon populated U.S. waters before human settlement, today less than 2% of salmon have survived. While many fingers point to the U.S. government's excessive utilization of hydroelectric and irrigation programs, today's developments in dam design and management plus innovations such geosynthetic materials can mitigate these effects.

–Jessica Bies, Geosynthetics *editorial intern*

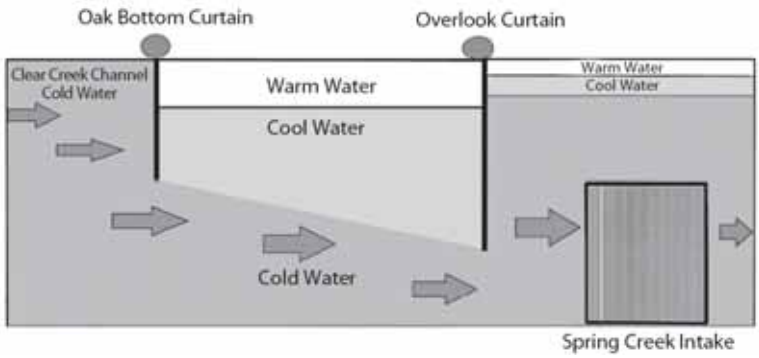

DIAGRAM 2 Thermally stratified water flow

Courtesy of the National Park Service

FIGURE 2 Assembly of the curtain on the shoreline

Photo: Bureau of Reclamation

an open area ashore large enough for assembly of the curtain was difficult. "Working with the National Park Service, we were able to utilize a parking lot at a beach prior to the summer recreation season," Gee said. "It measures 2,400 feet in length and reaches depths of approximately 100 feet. The curtain was hot-spliced on the reservoir shoreline and assembled as one continuous sheet of polypropylene."

To help save space, the fabricated curtain was floated out into the water even as the panels were being completed. A conveyor system was used to help clamp the curtain into 20-foot-long metal floats and deploy it into the reservoir without dragging it along the ground. While some of the original float-

FIGURE 3 Shoreline fabrication

Photo: Bureau of Reclamation

ing tanks were reusable, many needed to be replaced or repaired. Other existing components, such as lake anchors, chains, cables, and surface stabilizing tanks were inspected prior to installation and some were also reused.

Once finished, the curtain was anchored to the bottom of the reservoir by 800-lb weights. Designed to float vertically, the curtain stretches 2,400ft from shoreline to shoreline.

How it works

Located in the headwaters of the Whiskeytown Reservoir is what is known as a "plunge zone."[4] Cold water diverted from the upstream Lewiston Reservoir enters Whiskeytown after it is discharged through the Carr Powerhouse. The cold water plunges beneath the surface water and travels downstream, producing stratified water flow. Another geosynthetic curtain, located near the discharge point, prevents the cold water from mixing with the warmer water in the reservoir and keeps it moving toward the lower end of the reservoir.

When it reaches the base of the reservoir, the water passes under the recently replaced curtain and through an intake. Because the reservoir is thermally stratified and the curtain is designed to leave a 30-ft gap between the bottom of the curtain and the bottom of the lake, it is possible to draw in only the cold water. After the water moves through the intake, it continues on through a tunnel and on toward the Sacramento River.

FIGURE 4 Crane setting a float onto the frame Photo: Bureau of Reclamation

FIGURE 5 800-lb metal weights (foreground) used to secure the curtain Photo: Bureau of Reclamation

Conclusion

The $3 million Whiskeytown geomembrane curtain replacement project was completed in June 2011, a month ahead of schedule.

According to Gee, the new 2,400-foot-long curtain should last at least 15 years.

4 www.usbr.gov/pmts/hydraulics_lab/pubs/PAP/PAP-0848.pdf

>> For more, search **geomembrane** at www.geosyntheticsmagazine.com

FIGURE 6 Geomembrane curtain was clamped in the metal floats before being deployed

Photo: Watersaver Co.

Historically, the curtain has reduced water temperatures by 2-3C degrees during late summer and early fall to facilitate salmon spawning. The new curtain is expected to yield similar results and be more durable than the previous one.

The success of the thermal curtains installed in the Shasta and Trinity River Division in 1993 and the recent replacement of the Whiskeytown curtain are a prime example of how geosynthetics can help rectify environmental problems caused by water reclamation systems. The Whiskeytown curtain makes it possible for power plants and salmon to exist within the same water system. As more demands are placed on our natural resources, more innovative solutions such this one are required.

FIGURE 7 The floats and the curtain were deployed using a conveyor system

Photo: Watersaver Co.

Go with the flow

Located in the Shasta and Trinity River Division, Whiskeytown Reservoir is just one stop in a system that diverts water from the Trinity River Basin into the upper Sacramento River. The water takes a complicated path through a total of two tunnels and three reservoirs including the one in Whiskeytown.

This is the path the water takes:

1. Water from the Trinity River Basin is collected in the Lewiston Reservoir.
2. The water leaves Lewiston Reservoir through the Clear Creek tunnel and travels towards the Judge Francis Carr power plant located in the northern reaches of the Whiskeytown Reservoir.
3. Water from the Carr power plant discharges into the headwaters of the Whiskeytown Reservoir, plunging down and creating a thermally stratified flow.
4. The cold water travels along the bottom of the Whiskeytown Reservoir until it is pulled under the thermal curtain and into the Spring Creek uptake and tunnel.
5. Water flows through the Spring Creek tunnel to the Spring Creek power plant
6. Water from the Spring Creek power plant is discharged into the Keswick Reservoir.
7. Water leaves the Keswick Reservoir and enters the upper Sacramento River near Redding.

Still confused? Check out our online interactive map to get a look at the project site and the surrounding area: http://g.co/maps/z5cz6

–*Jessica Bies,* Geosynthetics *editorial intern* G

FIGURE 8 Metal floats in place and curtain ready to be anchored to the river bottom by 800-lb weights Photo: Bureau of Reclamation

FIGURE 9 The conveyor system used for pulling the curtain out into the reservoir during the installation process is visible in this picture. Photo: Bureau of Reclamation