

# CORPS' PONDENT

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**Spirit Lake Outlet Tunnel team plans to repair movement to tunnel floor**



# Mountain on the move

## Spirit Lake Outlet Tunnel team plans to repair movement to tunnel floor

By Diana Fredlund, Public Affairs Office

**W**hen mountains move, humans can only watch and figure out how to work with the changes.

A massive avalanche of rock and debris choked Spirit Lake when Mount St. Helens erupted May 18, 1980, changing the jewel-like lake forever. The avalanche completely blocked the natural outlet where Spirit Lake flowed into the North Fork Toutle River and on into the Toutle, Cowlitz and Columbia rivers.

The avalanche created a dam of sediment, ash and fragmented rock, with heavier, less porous materials below and more erodible pumice and ash from pyroclastic flows above it. Snow and rain continued to feed Spirit Lake, but without an outlet, the water level rose dangerously close to the more easily erodible material.

“The natural dam is strong enough to withstand the weight of water in Spirit Lake until it reaches the top layer,” said Chris Budai, Spirit Lake Outlet Tunnel project manager. “If water levels were

to rise into the more porous pumice and ash, it could erode the entire dam and possibly send tons of material and water downstream.”

In the worst-case scenario, communities like Castle Rock, Kelso and Longview in the Cowlitz River Valley would be flooded by more than 60 feet of water and debris. “The U.S. Forest Service needed to find a way to stabilize the lake level and the Federal Emergency Management Agency tasked the Corps with finding it,” Budai said.



Mount St. Helens erupted in southwestern Washington May 18, 1980

Mount St. Helens and Spirit Lake are located within the Gifford Pinchot National Forest in southwestern Washington. In 1982, President Ronald Reagan declared a state of emergency and FEMA requested that the U.S. Army Corps of Engineers develop and execute a solution to Spirit Lake's water level problem.

"The first step was to design an interim plan to maintain the lake's water level until a long-term solution could be developed," Budai said. The Corps established a temporary pumping facility on Spirit Lake in November 1982, which operated until the Spirit Lake Outlet Tunnel was completed in 1985.

It wasn't as easy as moving equipment in and getting repairs started, however.

In 1982 President Reagan and Congress created the Mount St. Helens National Volcanic Monument within the Gifford Pinchot National Forest. An important objective of the legislation was to protect natural features and allow the environment to develop naturally, according to Peter Frenzen, staff scientist for the Monument.

"Spirit Lake and the surrounding area are very remote now, since roads and infrastructure were destroyed in the blast. As the best known and most studied eruption of the 20th century, we believe it's important to learn about how nature manages its own recovery," Frenzen said. "It does create some challenges, but within the bounds of public safety we need to preserve this important natural laboratory."

"It definitely posed a challenge when the Corps began constructing the outlet tunnel in 1984," Budai said. "For example, we couldn't protect the slopes

at the tunnel intake with shotcrete when we excavated it."

Shotcrete is a concrete mix that is "shot" through a pressurized hose, allowing the material to adhere to a variety of surfaces. Instead of using shotcrete, the slopes were protected with chain link fabric and rock bolts, but the rock was exposed to freezing and thawing conditions that caused a rapid deterioration of the rock slope, Budai said.

"Fragments of rock would break off and build up behind the chain link fabric and eventually fall onto the intake air grating that allows the tunnel to function properly. Additionally, ash, pumice and other volcanic material that surrounded the intake was a constant source of material that fell on the air grates and blocked air flow into the tunnel."

Engineers modified the intake air grating to allow this debris to drop into the shaft and then wash out through the tunnel, eliminating the problem.

The intake shaft drops water about 40 feet into an 8,465-foot long, 11-foot diameter tunnel that the Corps constructed through Harry's Ridge, which borders Spirit Lake. The water flows into South Coldwater Creek, Coldwater Creek and the North Fork

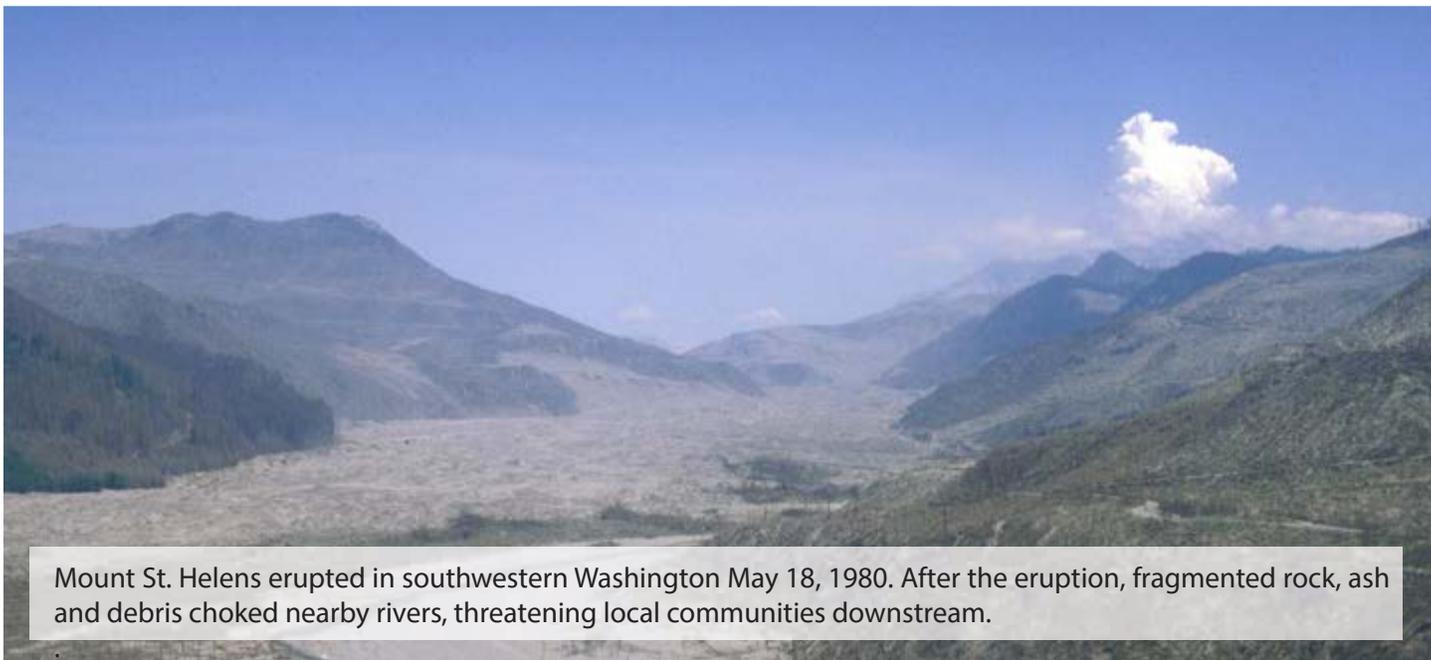


(MSH) Mount St. Helens erupted in southwestern Washington May 18, 1980. The eruption forever changed the jewel-like Spirit Lake, seen here prior to May 1980.

Toutle, Toutle and Cowlitz rivers as it flows to the Columbia River.

Geologists knew there were some areas along the tunnel's path that could exert additional pressure on the tunnel. These areas are known as shear zones, where the pressures could cause the ground to move if the tunnel was not adequately supported; they also contained soft, clay gouge material that flows under pressure.

"The tunnel had to be designed to withstand these varying stresses," Budai said. "We knew routine monitoring would be important so we could react if we detected any changes in the tunnel."



Mount St. Helens erupted in southwestern Washington May 18, 1980. After the eruption, fragmented rock, ash and debris choked nearby rivers, threatening local communities downstream.

Since its completion in 1985, the Corps has repaired the tunnel many times; most were small repairs to restore tunnel integrity.

A more significant repair was performed in 1997, when tunnel movement due to pressure build-up in a shear zone caused a partial failure of some tunnel supports. Pressure build-up from that same shear zone has caused gradual movement in an area near the 1997 repairs, causing the tunnel to constrict. For nearly 30 years the annual inspections showed only a gradual constriction in the tunnel's diameter, which engineers monitored but decided no action was necessary; in October 2014 Budai found that was no longer true.

"Our inspection in October found one part of the tunnel's floor had moved upward by about a foot and a half, increasing the possibility of a tunnel collapse," Budai said. "Another concern is the decreased water capacity due to the constriction." Decreased

capacity means less water can flow without pressurizing the tunnel – the expansion and contraction that occurs if water completely fills the smaller tunnel. Pressurization can be seen when water flows out of a bottle that's tipped nearly vertical, causing a back-and-forth motion. In a concrete structure like the Spirit Lake Outlet Tunnel, that can cause damage and failure, since it can rapidly erode the tunnel rock and undermine the tunnel supports.

Budai and her team knew the soft clay material was being forced upward into the tunnel. "The movement is much like that of toothpaste being squeezed from a tube," Budai said. "The pressure from the material above the tunnel was forcing the soft material up into a weaker section of the tunnel."

When sharing her findings with the Forest Service, Budai emphasized the need to move quickly. During an inspection six months later, Budai found the floor had moved upward another six inches, reinforcing the need

to repair the tunnel before the next flood season in January 2016.

Because the Monument is managed by the Forest Service, the Gifford Pinchot National Forest first needed to secure funding from its national headquarters. As soon as the situation was discovered, senior leaders from the Forest Service and the Corps met to discuss the needed repairs and formulate a funding strategy.

Budai and her team began designing the repair plan. "Under normal circumstances a Corps project moves through the design, review, and contracting phases in 12 to 18 months," Budai said. "Our accelerated schedule includes design and review in about six weeks. The construction contract is expected to be awarded by early August; work is scheduled to begin in September 2015 and finish by February 2016."

Fast-tracking the repair project means it receives a higher priority for resources while still conducting all the



quality assurance checks every project undergoes. “We are ensuring all design and review actions are fully in place. It means our team is focusing almost exclusively on the Tunnel Outlet Project for a while in order to get the work done on time.”

“It’s important to remember these are interim repairs, designed to provide us time to make more extensive, long-term repairs,” Budai said.

“The Forest Service is the lead agency in all of this work. We have an excellent team of Forest Service and Corps employees working together to ensure all aspects of the project

fit current and future requirements.” The long-term project will require formal studies to ensure the repair work meets all regulations, she added.

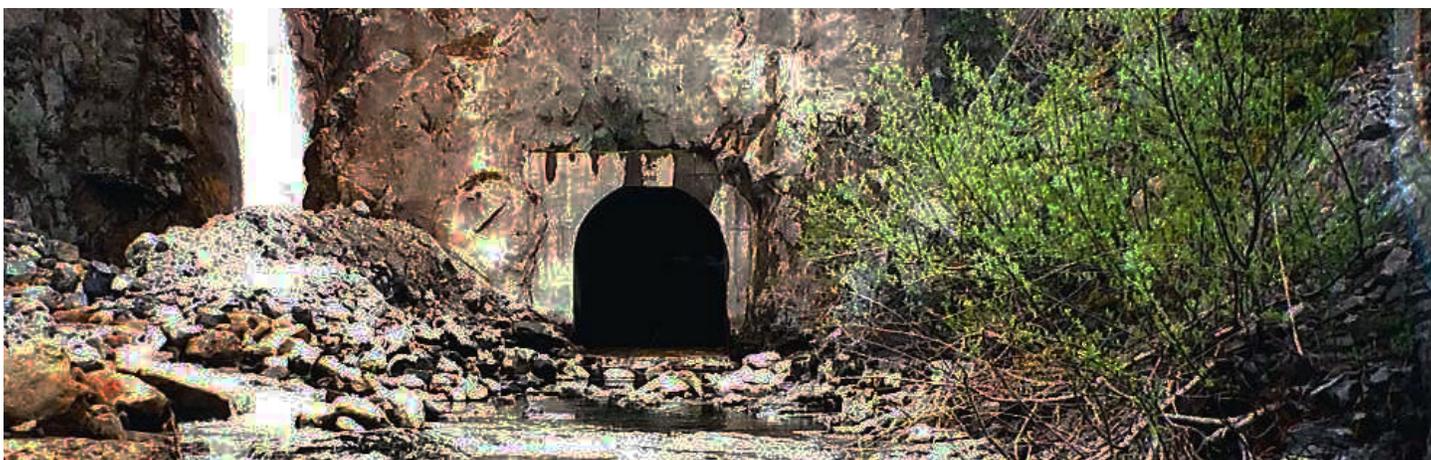
Water continues to flow into Spirit Lake and thanks to a team of Corps and Forest Service scientists, engineers and biologists, the lake will continue to flow safely through the tunnel and continue its way to the ocean.

“The cooperation among the agencies is outstanding,” Frenzen said. “The tunnel has controlled the level of Spirit Lake for 30 years, and our goal is to make necessary short-term repairs while investigating how best to manage Spirit

Lake’s water level sustainably into the future.”

Mountains move on their own schedule and many were surprised in 2004 when Mount St. Helens erupted again. The Spirit Lake Outlet Tunnel was designed to withstand landslides and mudflows from future eruptions.

It’s possible today’s team members won’t be working on the project the next time Mount St. Helens erupts – but they’re doing all they can to ensure future teams will have options for managing the level of Spirit Lake long into the future. 



To construct the Spirit Lake Tunnel Outlet, the Corps used a mammoth tunnel boring machine to dig through Harry’s Ridge to create a new outlet for the lake after the natural outlet was blocked by the eruption

Corps of Engineers Photos

