



FIRE



HURRICANES



FLOODS



DROUGHT



HAZARDS AHEAD

**BUILDING A MORE
RESILIENT
FUTURE**

SEARCHING FOR SOLUTIONS: AN ENR SERIES

Every year there is a new natural disaster added to the lists of worst disasters the U.S. has experienced: Hurricane Harvey, the Camp Fire, historic floods in Nebraska. Even the best engineer can't design for 100% safety during cataclysmic events. But engineers, architects, contractors, land-use planners and others in the construction industry can, and are, taking steps to help communities be more resilient — the ability to adapt and become better prepared to meet, and recover from, the next catastrophe. They are working in places like Ellicott City, Md., to help the historic city adapt to repeated flooding. They are working in Fort Collins, Colo., to help mitigate the multiple threats of drought, heat, flood and fire. And they are working in Paradise, Calif., to help the town chart a path forward after the deadly 2018 inferno. Throughout this year, ENR will examine how the industry is contributing to solutions with stories about the places and the people who are preparing for the hazards ahead.

DEFENDING THE LINE



**FACED WITH MORE WILDFIRES AND
GROWING POPULATIONS, COMMUNITIES
LIKE PARADISE, CALIF., WORK TO
MITIGATE FIRE RISK** By Pam Radtke Russell

On the morning of Nov. 8, flaming pine needles rained down on the homes of Paradise, Calif., blown from the Camp Fire, still 2.5 miles away. The embers set fire to roofs, attics, landscaping, decks and any other fuel in their path.

Within four hours, most of the town's homes and buildings were in ashes. Surrounding communities, including Magalia, Pugla and Concow, where the fire hit first in the early morning, were decimated. The fire killed 85 people and destroyed 18,800 structures in Butte County, 14,000 of which were in Paradise. The town's water system was irreparably damaged as meters and plastic pipes heated and melted, releasing benzene into the water and allowing in deadly bacteria.

It was the worst fire in California history—topping the previous No. 1, the 2017 Tubbs Fire that killed 22 people and destroyed 5,800 structures in Napa and Sonoma counties.

Today, six months after the Camp Fire, Paradise looks much as it did just days after the fire roared through. Most debris has yet to be cleared and little is recognizable except standing fireplaces and the occasional concrete wall. In the town's 18 sq miles, only about 1,300 structures are still standing.

To some, it's hard to imagine how the community will recover. But on March 28, Paradise issued its first permit to rebuild a home, and has since issued a few more. There are 40 permits pending. "It's not a question of if the town will be rebuilt, it's a question of how soon we get people back safely," says Marc Mattox, the town's public works director. The town is also working with a community planner to develop a long-term recovery plan with a focus on safety.

"Safety is a threshold residents won't cross," says Barry Long, architect and managing principal at long-term disaster-recovery specialist Urban Design Associates, which is working to develop the plan. Residents won't go home until the community is safe, he adds.

The rebuilt town will be made more resilient by hardening structures to meet California's wildfire-urban interface building code, which requires fire-resistant materials and reduced landscaping in high fire hazard areas such as Paradise. But more is likely to be done, including improving evacuation routes,

communications systems and water supply, and further tightening building codes to reduce available fuel sources in the next fire, Mattox and Long say.

Paradise is not the only town facing wildfire threat. In California alone, there are 190 communities designated by the California Dept. of Forestry and Fire Protection as very high fire severity zones, and many more areas have been designated fire severity zones.

Nationwide, people are moving into high fire hazard areas—also known as the wildfire-urban interface (WUI)—at a rate faster than any other area, according to the U.S. Forest Service. The service says that between 1990 and 2010, homes in the WUI grew by 41%, to 43.4 million from 30.8 million—putting more people and property in harm's way and creating more fuel for fires.

This is happening at the same time that large wildfires are becoming more common and costly as temperatures rise and drought dries out brush and trees. Wildfires are burning more than twice the area they did in 1970, and the average fire season is 78 days longer, according to Forest Service data.

"There are other hazards we've planned for. We plan for floods, we plan for other natural disasters, but planning for wildfires is something we've never done," says Doug Green, fire safety manager for both

Bend and Sisters, Ore. Both cities are working with the Community Planning Assistance for Wildfire Program (CPAW). Green says wildfire resilience is a three-legged stool of land management, vegetation management and building codes.

"This always used to be a fringe topic," says Molly Mowery of Wildfire Planning International, which, along with Headwaters Economics, created the CPAW. The Forest Service- and grant-funded program works with about 30 communities nationwide, bringing together foresters, land-use planners, economists and wildfire risk modelers who collaborate with community leaders, land managers and city officials to reduce wildfire risk. "Climate change, more humans in wildfire areas—these trends are going in the wrong direction," Mowery says. "Wildfires can no longer be something that emergency services and rescue services take care of."

The cleanup of Paradise has been slow as workers remove hazardous materials by hand. Only then can heavy equipment be allowed in to clear the lots. Cal-Recycle is managing the cleanup effort, and has awarded contracts for debris removal, disposal and



PHOTO BY SCOTT BLAIR/FORENR

HARDENING
Laborers frame a house using steel to add a layer of resilience in a Santa Rosa subdivision that burned down in 2017.

“[THE CAMP FIRE] WASN'T A FIRE FRONT. IT WAS RAINING MATCHES. THAT'S WHAT YOU HAVE TO DEFEND YOURSELF FROM.”

—BARRY LONG, URBAN DESIGN ASSOCIATES

testing. ECC Construction and SPSPG Partners (a joint venture including Pacific States Environmental Contractors, Goodfellow Brothers Construction and Sukut Construction) were awarded contracts worth about \$600 million each to clear the lots in Paradise and dispose of the waste. Ceres Environmental Services will be paid about \$300 million to clear burned lots in Butte County outside of Paradise and dispose of the waste, says Lance Klug, a spokesman for CalRecycle. TetraTech was awarded a \$250-million contract to test contaminated soils on burned homesites, an award that was challenged unsuccessfully by Arcadis on a bidding technicality.

“We’re several months behind schedule right now,” says John Farrow, CEO and president of Santa Rosa-based Farrow Construction, a residential and commercial builder that will work the Paradise cleanup. “We should have been clearing already. We’re at least two years out from having a meaningful number of homes being erected.”

Most of the homes in Paradise were built long before California’s wildland-urban interface building code went into effect in 2008. The WUI code requires homes in high fire hazard areas to be built with, among other things, interior sprinklers; a fine mesh on attic vents to keep embers out; tempered glass, which can with-

stand temperature changes and is stronger than standard glass; and fire-resistant walls, roofs and other exterior materials. The code also requires the removal of flammable materials and landscaping near homes and businesses.

“The residents we’ve talked to do, by and large, want to build back, but they understand that you can’t build under the old building codes,” Long says. “We have to be smarter when we build back. And this is part of resiliency.”

But even meeting the WUI code doesn’t guarantee that homes won’t burn. The majority of homes that burned in the 2017 Southern California Thomas Fire had fire-resistant exteriors and fire-resistant roofs.

Nothing Is Fireproof

“No building material is completely fireproof,” says Julio Ramirez, Purdue University civil engineering professor and director of the Natural Hazards Engineering Research Infrastructure center.

Traditional fire prevention measures, such as cutting a fire buffer, also wouldn’t have helped Paradise.

“There are all kinds of ‘silver bullets.’ But you have to understand that [the Camp Fire] wasn’t a fire front. It was raining matches. That’s what you have to defend yourself from,” Long says.

Commercial buildings and mini storage, built with masonry and metal and surrounded by asphalt rather than trees or landscaping, fared best, he says. After guiding residents out of town, Mattox and his fellow public works employees took shelter in a grocery store in Paradise because it had a large parking lot. The building did not catch fire. However, just a mile away,



a Safeway with another huge parking lot burned to the ground.

The town is looking at how to make evacuation routes safer by clearing vegetation close to roads. The morning of the fire, only one of the four routes out of town was passable. Paradise is working with the Federal Emergency Management Agency’s Hazard Mitigation Grant program and state agencies to help pay for the improvements.

Other suggestions to make the town more resilient include consolidating the town hall with fire and police into one building, requiring enclosed garages so cars left behind don’t become fuel, moving electric distribution lines underground and requiring fire-resistant fencing.