

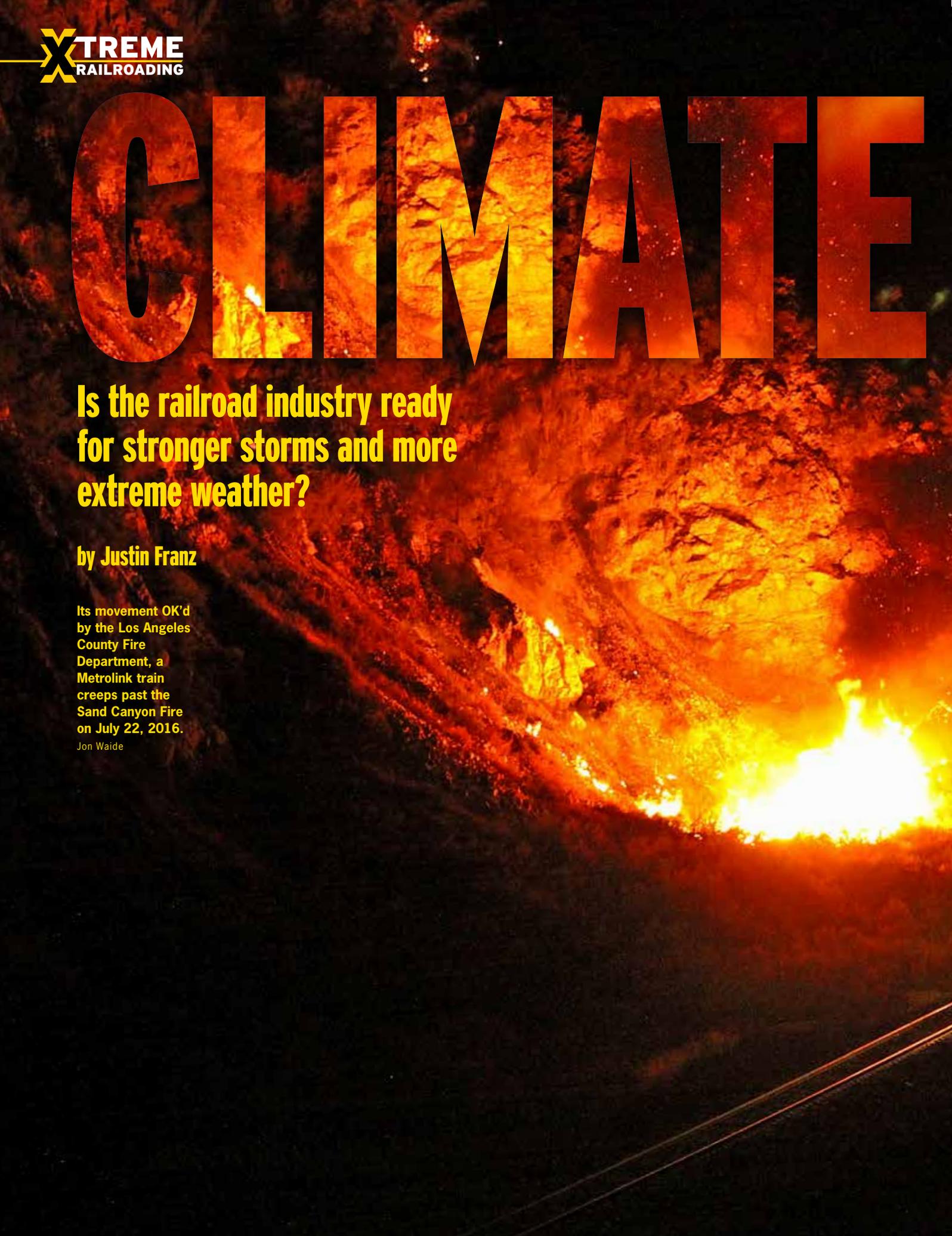
# CLIMATE

**Is the railroad industry ready for stronger storms and more extreme weather?**

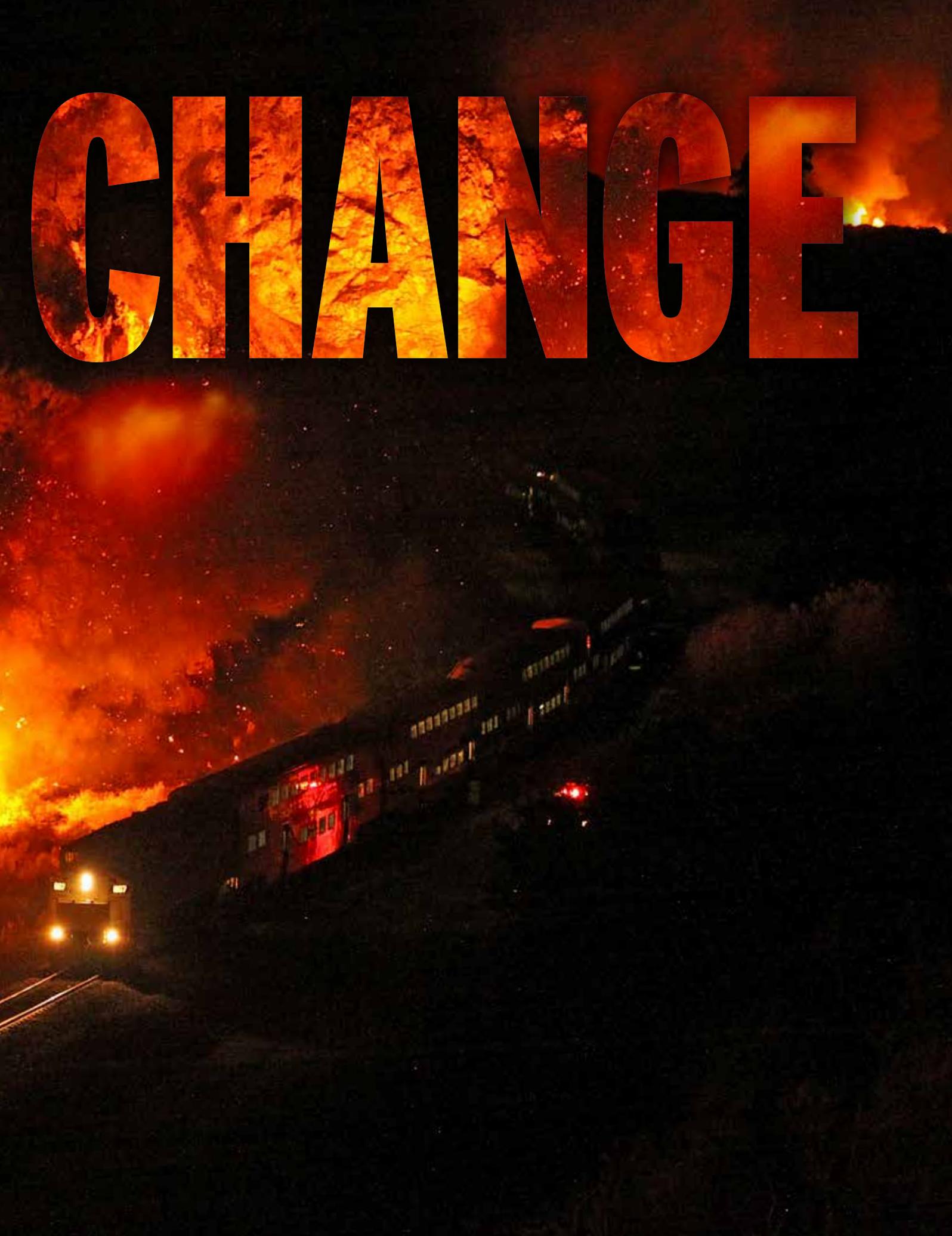
**by Justin Franz**

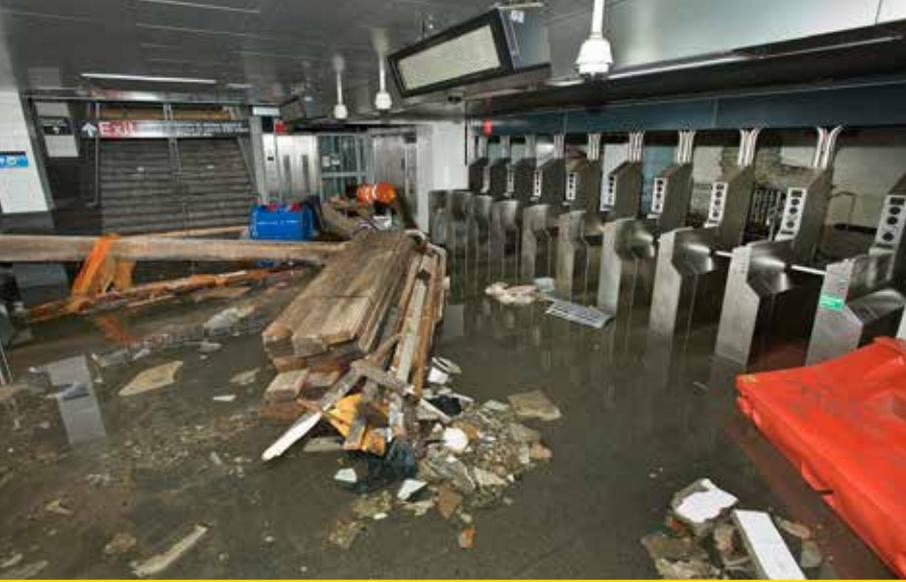
Its movement OK'd by the Los Angeles County Fire Department, a Metrolink train creeps past the Sand Canyon Fire on July 22, 2016.

Jon Waide

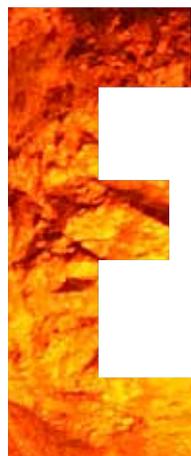


# CHANGE





**Hurricane Sandy's impact in New York, clockwise from top right: An empty Grand Central Terminal; a pump train works under the East River; flooding at Harmon Yard; a boat is removed from Metro-North tracks; the flooded South Ferry subway station. Metropolitan Transportation Authority**



very weekday, more than 5 million people ride the New York City subway, one of the busiest transit systems on earth. Twenty-four hours a day, seven days a week, 365 days a year, hundreds of trains connect 469 stations in the city's five boroughs on 24 lines.

But at 2:18 a.m. on Monday, Oct. 29, 2012 — as a massive hurricane swirled off the

east coast — the entire New York City subway system came to a screeching halt. It was only the second time in the system's 108-year history that it was shuttered due to a storm.

Later that day, Hurricane Sandy made landfall, pummeling the Northeast with wind, rain, and waves. As the storm hit New York City, tunnels flooded and roadbeds washed away. The 1.9-mile Montague Tube connecting Lower Manhattan with Brooklyn was inundated with 27 million gallons of seawater and was closed for 53 days. The Greenpoint Tube connecting Brooklyn with Queens was shuttered for

10 days after flooding with 3 million gallons of water. Heavy winds and waves destroyed a 3.5-mile stretch of the A Line across the Rockaway Flats, disrupting service for seven months. In the end, Hurricane Sandy caused more than \$4.75 billion in damage to the subway system.

Railroads and transit systems have been battling the elements for as long as they have moved people and goods. But stronger storms, like Hurricane Sandy, and extreme weather events have pushed the industry to the mat on more than one occasion in recent years.

A year before Hurricane Sandy, in August 2011, Hurricane Irene slammed into New England, shutting down more than half of the Vermont Rail System for three weeks after washouts and flooding devastated the railroad.

In summer 2012, record-breaking temperatures across the country resulted in numerous rail-buckling derailments, forcing the Federal Railroad Administration to issue a warning about "sun kinks."

In March 2014, BNSF Railway's main line to the Pacific Northwest was closed twice in one week after a series of avalanches blocked the tracks on Montana's Marias Pass. The slides came at the height of one of the coldest and harshest winters

the region had seen in decades and brought the Class I road to a halt in the northern part of the country [See "BNSF's Winter to Remember," August 2014, and "Railroading in Avalanche Alley," December 2015].

Eighteen months later, the same BNSF route along Glacier National Park was closed again, after a massive wildfire threatened to burn down a double-track bridge, a wooden snow shed, and the entire town of Essex, Mont. The fire was one of hundreds that burned across the western United States in summer 2015, during one of the biggest wildfire seasons in recorded history. They scorched more than 10 million acres in what one U.S. Forest Service official ominously called "the new normal."

With bigger storms and extreme weather events as "the new normal" — and scientists warning the trend is not about to slow down anytime soon — is the railroad industry ready to deal with the impacts?

## **BIG STORMS, MORE OFTEN**

In the months after Hurricane Sandy blasted the Northeast, a Bulletin of the American Meteorological Society, prepared with the help of National Oceanic and Atmospheric Administration scientists, reported that, compared to 1950, climate-change-related increases in sea level



**As part of repairs in the aftermath of Hurricane Irene, which shut down some lines for three weeks, a Vermont Rail System train takes on rocks in Brandon, Vt., for repair of a storm-damaged embankment along the right-of-way in September 2011.** Kevin Burkholder

had doubled the probability of flooding similar to that seen during the storm. It also stated that storms and flooding like Hurricane Sandy could become an annual occurrence in the future.

Such statistics are why the authors of the National Climate Assessment — a report produced in 2014 by the U.S. Global Change Research Program with the help of more than 300 experts — believe shifting weather patterns will have a major impact on transportation systems in the future. In some ways, they already do.

“Climate change is already impacting the rail industry in countless ways,” says Michael Kuby, an Arizona State University professor who helped write the transportation section of the assessment.

Among the obvious impacts are washouts and damage from flooding related to extreme rainstorms and rising sea levels. Kuby says even conservative estimates have the ocean level rising 1 to 4 feet by 2100, which could impact low-lying rail lines. Rising sea levels can also contribute to stronger storms that will spread their impact further inland, much as Hurricane Irene did in Vermont in 2011 when more than 200 miles of state-owned rail lines had to be repaired due to washouts, according to the climate assessment.

Other potential impacts include extreme temperatures that can result in “sun kinks,” when rails get so hot they buckle. Extreme winds can batter and damage lineside infrastructure like catenary, signals, or communication towers. Massive wildfires brought on by extreme drought can destroy bridges, snow sheds, and even wooden cross ties. Extreme winter storms can dump massive amounts of snow on rail lines that block the tracks or trigger avalanches that destroy in-

frastructure. Rail lines can even warp if the permafrost on which they are built begins to melt. (Rail lines have been built on permafrost in Canada and Alaska, and a large portion of the Qinghai-Tibet Railway in China.)

“The warming of the climate is changing weather patterns,” Kuby says, “and that’ll have big impacts on the transportation industry.”

### REPAIRING AND PREPARING

The vulnerabilities of the Metropolitan Transportation Agency system to extreme weather were first revealed in August 2007, when a massive rainstorm in the middle of the morning rush hour flooded sections of the New York City subway and brought service to a sudden stop. After that, the agency fortified flood-prone infrastructure, but even those improvements couldn’t handle Hurricane Sandy and its 13.8-foot storm surge. One lesson from the 2007 flood that did prove useful during Sandy was the effort to move trains and equipment to higher ground and out of harm’s way. Of MTA’s thousands of railcars, only 19 were dam-



**A Canadian Pacific hi-rail utility truck passes under the downtown skywalk as it wades through receding floodwaters in downtown Davenport, Iowa, after storms in July 2014.** Darrell D. Wendt



**In September 2014, almost two years after Hurricane Sandy, New York's Metropolitan Transportation Authority completed repairs on the subway Montague Tube between Brooklyn and Manhattan. Work continued around the clock for 13 months and cost about \$250 million — still \$60 million under budget.** Metropolitan Transportation Authority

aged during the storm. The same could not be said for nearby NJ Transit, which did not move its equipment to safe haven. Nearly a third of its fleet was flooded, resulting in more than \$120 million in damages.

Projjal Dutta, MTA's director of sustainability, says Hurricane Sandy "upped the ante" and pushed the agency to redouble its efforts to prepare for climate change. Since then, MTA has implemented a storm resiliency program that includes raising substations, using marine-grade cabling in tunnels so it is not impacted by floods, and even sealing manhole covers so water does not flow into the subway system.

But MTA was not alone in suffering at the hand of the second-most expensive hurricane in American history. Hurricane Sandy impacted railroads and transit agencies up and down the eastern seaboard, including Amtrak's Northeast Corridor.

"Climate change [and extreme weather] was on our radar because we've had some bad storms and flooding in the past, but Superstorm Sandy was a wake-up call for us," says Karen Gelman, Amtrak's infrastructure planning manager for the Northeast Corridor.

During the storm, four of Amtrak's six century-old tunnels between New York and New Jersey flooded with seawater for the first time. Elsewhere, signals, mechanical rooms, and emergency call boxes were damaged by wind and water. A substation in Kearny, N.J., also flooded and was out of service for more than two weeks.

While the tunnels under the Hudson were back in service faster than the substation, they suffered damage that wasn't obvious at first, according to Amtrak spokesman Craig Schulz. The water was pumped out within a matter of days, but the salt left

behind has had a major impact on the longevity of the tunnels, and in the four years since they have been shut down on multiple occasions. "Even though the water is gone, the salt that remained has been eating away at the concrete bench walls in these tunnels," Schulz says. "It's imperative that these tunnels be rebuilt."

Rebuilding the Hudson tunnels is easier said than done. More than 95,000 people travel through them every weekday. To complete long-term repairs, each portal would have to be closed for upward of a year, reducing capacity by 75 percent. U.S. Sen. Charles Schumer, D-N.Y., likened the prospect of shutting the tunnels down one at a time to a "transportation Armageddon" for New York and the surrounding region.

Amtrak officials say the solution is building a new tunnel under the Hudson as part of the multi-billion-dollar Gateway Project to increase Northeast Corridor capacity in and out of New York City. If construction begins soon enough, officials and supporters say, the new tunnel would be in service before the old ones need to be shut down and rebuilt.

The railroad is also looking beyond New York in planning for the effects of climate change. Soon after Hurricane Sandy, Amtrak began to study the topic. In 2014, it released a climate change vulnerability assessment that looked at infrastructure along the Northeast Corridor and its routes to Albany, N.Y.; Harrisburg, Pa.; and Springfield, Mass. Then the report outlined climate change scenarios that scientists say are possible within the next century. (For example, the report noted that by 2100, Rhode Island was likely to face a 2-to-6-foot sea level increase, and Providence was likely to experience a storm surge of 7 to 10 feet.)

In 2015, Amtrak began a pilot study to see how climate change will impact a 10-mile stretch of the Northeast Corridor around Wilmington, Del. That section of railroad was selected because of the variety

**A BNSF Railway coal train tiptoes through Mississippi River floodwaters on its way to Ameren Missouri's Rush Island Power Plant, near Festus, Mo., on May 21, 2010.** Drew Mitchem



**Above, a Hoboken-bound NJ Transit train passes ongoing repair work as service is restored on the Montclair-Boonton Line, two weeks after Hurricane Sandy. At right, a year after the storm, restoration continued on the Hoboken Terminal waiting room.** Above, Christopher Blaszczyk; right, Michael William Sullivan



of infrastructure it hosts, Gelman says, including bridges, stations, and a critical locomotive maintenance facility. Officials hope to complete the study by the end of 2016. Once it is done, Gelman says the railroad plans on expanding it.

“We want to take the lessons we’ve learned from this study and apply them to the rest of the Corridor,” she says.

The study will also outline ways the railroad could fortify the corridor. But like any major infrastructure project, it will cost money, and Gelman says it’s unlikely Amtrak could undertake the projects by itself. One possible way to protect the roadbed would be the construction of seawalls, a project Gelman says would benefit more than just the railroad.

“This isn’t something Amtrak can do alone,” she says, “and we’re going to have to work with the cities and states that could be impacted as well. It would need to be a cooperative effort.”

NJ Transit has also spent millions of dollars rebuilding and creating a stronger net-

work. Shortly after the storm, the agency established the NJ Transit Resilience Program to help lead the recovery. Four years later, its mission has changed, according to Senior Program Director Eric Daleo. “We’ve turned the corner from recovery and we’re now looking at how to make our system more resilient in future storms,” he says.

In the four years since Hurricane Sandy slammed the Northeast, NJ Transit has tackled a number of projects, including rebuilding the Raritan River Bridge and

refurbishing the Hoboken Terminal and yard. It is also building elevated signal systems and putting signal boxes on stilts so they will not be flooded. The signals have also been retrofitted so that sensitive circuit boards and electronics can easily be removed in advance of a hurricane.

Daleo says NJT’s low-lying Hoboken Terminal suffered some of the worst damage on its system. However, with the help of a \$146 million grant from the Federal Transit Administration, NJT is filling in an



**Northbound Canadian National train M34561-06, a daily Champaign, Ill.-Winnipeg, Manitoba, freight, passes through Rantoul, Ill., in a blizzard dropping wind chill to the minus-50-degree range. CN has developed operational readiness plans for extreme weather in both summer and winter.** Eric Coleman

old canal to build six additional tracks that will be higher than the Federal Emergency Management Agency's base flood elevation. Daleo says the elevated tracks will protect equipment and help NJT service resume faster following a storm.

The agency is also working with the Stevens Institute of Technology to develop a forecast and warning system focused on the Hoboken Yard. Daleo says the system will be able to predict what areas of the yard will flood. He adds that if it proves successful, it could be implemented elsewhere.

"It's going to be so detailed," he says, "that it will tell us which signals are going to be more prone to high water from the incoming storm, so that we can focus on removing the guts of those specific signals first."

## ANTICIPATING THE EXTREME

Freight railroads are also preparing for the impacts of climate change. Association of American Railroads spokeswoman Kristin Clarkson says the industry is uniquely prepared to deal with extreme conditions.

"With the rail industry being an outdoor business that operates in all different types of weather conditions and terrain, monitoring and responding to the environment is a 24/7 focus of freight railroads in the country," Clarkson says. "They are constantly identifying and responding to environmental fluctuations such as shifts in water levels, increases or decreases in rain or snowfall, and changes to the average temperature."

Canadian National spokesman Mark Hallman says his company is actively preparing for rising seas and extreme weather. To protect the railroad's infrastructure, it has stabilized more slopes in recent years and is monitoring particularly vulnerable areas. The railroad also has redesigned fueling stations to withstand extreme weather. Hallman says the railroad also has numerous emergency plans for events like bridge washouts.

"CN has also prepared extreme weather readiness plans for both summer and winter," Hallman says, "including procedures for train speed, train length and weight, inspections, rail replacements, distressing and fire-prevention and response."

CSX Transportation spokeswoman Melanie Cost says the company has extreme weather-preparedness procedures and winter weather action plans that outline how the railroad responds to major storms. CSX has also decentralized its train dispatching to mitigate the risk of an extreme weather event disrupting the entire network.

"Protecting employees and maintaining service to customers as long as is safely possible are CSX's priorities when facing extreme weather," Cost says. "Safety is always the company's first priority and is the foundation for all decisions made in preparation for and during extreme weather events."

CSX and other railroads in the Southeast had to roll out their extreme weather plans in October 2016 when Hurricane Matthew,



a Category 4 storm, caused damage from Florida to Virginia. North Carolina was the hardest hit, receiving more than a foot of rain, causing flooding and washouts that crippled the rail industry for days.

Railroads like Union Pacific, Canadian Pacific, and Kansas City Southern also say they are preparing for the impacts of climate change, although some note it's impossible to be ready for everything.

Fire may be one of the most challenging events to prepare for. UP and BNSF saw this in August 2016, when a small grassfire on Cajon Pass exploded into a 37,000-acre inferno in a matter of hours, forcing both railroads to close their routes through the area. This came at the height of yet another extreme fire season in California, which has been crippled by a historic five-year drought.

While the fire closed BNSF's route for 30



**UP 7379 leads a northbound freight up the Palmdale Cutoff through California's Cajon Pass on Aug. 21, 2016. The Blue Cut fire had erupted here five days earlier, consuming a bridge and closing the line for several days.** Elrond Lawrence

hours, a Union Pacific bridge was destroyed and trains didn't return to that route for another four days. UP spokesman Justin Jacobs says that while fires are unpredictable, advance planning can create a more effective response. "The biggest advantage is having open lines of communication with the local community and officials so we can respond effectively and safely," he says.

Despite the challenges, some railroad officials see positives in mounting a response to climate change. Hallman says CN has embraced more sustainable practices and

taken advantage of "climate change opportunities" to upgrade its locomotive fleet with units featuring the latest regulatory requirements that frequently results in fuel savings. Railroads are also among the most energy-efficient forms of freight transportation, and Hallman says that's a selling point to environmentally conscious customers.

The biggest impact climate change will have on railroads may not be to its infrastructure but its traffic base, says Kuby, the Arizona State University professor. Changes in energy consumption could alter commodity needs and freight traffic patterns, he says. For example, hotter summers could result in more energy consumption as people try and stay cool, and that might mean railroads will be moving more energy-related commodities. Another possible change is where

commodities originate. Kuby says climate change will have a huge impact on agriculture and forestry, and while trainloads of grain come out of the Midwest today, decades from now they may originate further north in a new grain belt.

Kuby says predicting what the railroads will haul in the future may be harder than predicting what will happen to their rails and rights-of-way. But it's possible the changes will benefit the industry.

"Rail is a very energy efficient form of transportation, and it's at least 10 percent more efficient per ton-mile than trucking," Kuby says. "Rail stands to benefit in the future when we start to make carbon emitters pay for their emissions. The rail industry could start carrying things that we can't even think of right now, and it should be cognitive of that and plan for it." I