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Threat and Hazard Identification and Risk Assessment (THIRA) Guidance for Railroads

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SJSU SAN JOSÉ STATE UNIVERSITY

MTI MINETA TRANSPORTATION INSTITUTE

THREAT AND HAZARD IDENTIFICATION AND RISK ASSESSMENT (THIRA) GENERIC GUIDANCE FOR RAILROADS

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Daniel C. Goodrich

MINETA TRANSPORTATION INSTITUTE

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THREAT AND HAZARD IDENTIFICATION AND RISK ASSESSMENT (THIRA) GUIDANCE FOR RAILROADS

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16. Abstract

Climate change creates new challenges for all critical transportation infrastructure, especially for railroads with an open system that is continuously exposed to the elements. A Threat and Hazard Identification and Risk Assessment (THIRA) is a necessary first step for an organization to understand the challenges and develop strategies for adaptation to them. In many cases the railroad sector is uniquely positioned to also mitigate greenhouse gas emissions through mitigation steps. This guide will assist railroad risk managers and emergency managers to evaluate the risks and determine how best to respond to them, through preparation, mitigation or adaptation. The THIRA is the first step in understanding the scope of the climate change challenges faces by railroads.

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INTRODUCTION

The first step in ensuring a safely operating railroad is the development of a comprehensive threat and hazard inventory and risk assessment (THIRA). This is followed by the creation of a comprehensive emergency plan using the Incident Command System (ICS) following the National Incident Management System. This document provides guidance for the creation or updating of the THIRA by a railroad to account for climate change. Companion documents provide guidance on using ICS on the railroad for climate change related events, developing or revising an emergency operations plan for a railroad to include climate change related activities, and developing or updating an emergency operations center that is prepared to manage climate change related events.

Understanding existing hazards and associated risks is critical for developing appropriate mitigation steps to lessen or eliminate future harm, and to plan for response to hazards that cannot be fully mitigated. For example, a railroad may have plans, equipment, and trained personnel to respond to the forecast of a snowstorm, which is a frequently experienced event. It can only plan for the anticipated but not experienced effects of infrequent catastrophic events, which may not be fully understood until the event has occurred. The better the organization understands the existing hazards and potential risks in its operating area, the better it can plan for preventing or managing the risks. The THIRA is the first step in comprehensive emergency management for any organization, public or private.

Motivations for THIRA

Private sector corporations and public sector organizations may have slightly different motivations for risk management. The private sector organization is answerable to stockholders who wish to maximize the return on their investment. Any investment that will impact the organization's financial "bottom line" must show its financial value in terms of return on investment. How will this investment in risk mitigation avoid harm and its related costs, including liability and negligence losses? A public sector organization is answerable to stakeholders, including taxpayers, who want to lessen their exposure to the costs of risk occurrences, especially those that can be avoided. An investment must show its value when compared to other activities that the scarce tax-sourced resources could be spent on, including liability and negligence costs.

An example from Amtrak demonstrates the elements of evaluating the value of investments in resilience. Starting in 2015, Amtrak undertook a multi-year research program to better understand the risks and hazards specific to its Northeast Corridor (NEC) operations from Boston to Washington, D.C. In 2015 it conducted its pilot vulnerability assessment in Wilmington, Delaware. In 2017 the Northeast Corridor Sea Level Rise Modeling and Vulnerability Assessment developed sea level and storm surge projections for tracks, stations, and other infrastructure running along waterways, including the Atlantic Ocean, the Delaware River, and Delaware Bay. In 2019 the Wharton School of Business at the University of Pennsylvania developed a Climate Resilience Case Study for Amtrak's NEC covering 21 business processes. Also in 2019, Amtrak quantified its climate impacts using the damage done to its facilities by named storms from 2006-2019. They estimated that

by 2030 they would have $220 million in losses. In 2020 metrics were created to use vulnerability measures to prioritize capital projects. In 2021 the climate Risk and Vulnerability Assessment was conducted, including “temperature changes, precipitation, wind, severe storms and sea level rise” (Amtrak, 2022, p. 3). This research led to the creation of the NEC Climate Resilience Strategic Plan in 2021 to integrate adaptation measures into all NEC future planning (Amtrak, 2022).

Both private sector corporations and public agencies also must consider reputational risk. The *Harvard Business Review* noted the importance of brand recognition and its relation to customer loyalty and future growth. An organization that is known for providing a quality service will generally have a higher return on investment. Whether the railroad is seeking lucrative contracts or the public agency is seeking economic development activity, having a reputation as a safe, secure, and reliable organization is critical (Eccles, Newquist and Schatz, 2007). For example, one Silicon Valley emergency manager received a visit from the top executives of a technology company that was considering locating there. They wanted an introduction to the city’s plans for managing earthquakes and floods, two natural hazards that have occurred in the area. A tour of the emergency operations center and a review of the city’s emergency operations plan reassured them, but as they were leaving, the Chief Financial Officer said that what drew him to the city was an article in the *Boston Globe* identifying it as the best prepared city in the United States for hazard response. This company’s relocation resulted in the addition of several thousand jobs to the local economy and millions of dollars of taxable business property to the local tax rolls.

While the motivations differ slightly between the public and private sectors, the goals are the same: minimize the impact of risk to the organization’s financial balance sheet and its public reputation, especially risks from predictable sources, and enable it to get back to serving its customers.

THREAT AND RISK

The terms threat and risk are often used interchangeably, but they are two different things. A threat is the likelihood of a known or reasonably anticipated event in a certain area, such as the threat of the occurrence of a natural hazard. Risk is the likelihood that something unwanted will happen. There is the threat of earthquakes in the Cascadia subduction zone in the Pacific Northwest or the threat of a Category 5 hurricane in Gulf Coast states. In both cases, the risk of the events is high because of known factors about geology and meteorology in those areas.

Again, the private and public sectors approach threat and risk evaluation slightly differently. The private sector is more concerned with quantifiable factors regarding the likelihood of an event occurring and its financial and reputational impacts. The public sector is more focused on knowing the hazards that exist, the likelihood that they will occur and what the community impacts will be. Thus, the Project Management Academy has a four-step process recommended to businesses:

The 4 step Project Management Institute Risk Management Process

1. Identify the risks

2. Analyze the risks

3. Identify strategies for managing the risk event

4. Monitor and control the risks

(Project Management Academy, 2024).

The Federal Emergency Management Agency has a slightly different set of THIRA evaluation steps required for public agencies but beneficial for all agencies. The evaluation is focused on achieving the specific capabilities required by the Federal Emergency Management Agency (FEMA) for public agencies and beneficial to any organization.

The 4-step FEMA Threat and Hazard Inventory and Risk Assessment (THIRA) Process

1. Identify threats and hazards of concern: what does the agency need to prepare for?

2. What is the context for threats and hazards: time, place, and magnitude based on expert judgement, probability analysis, and statistics?

3a. What are the organization's current capabilities?

3b. What gaps exist between the organization's current capabilities and the capability targets set by FEMA?

4. How can the organization close the current gaps in its capabilities? This would

lead to decisions about planning, equipping, training, and exercising as a follow-on process.

(FEMA, 2018, p. 8)

Every state and all large urban areas that are part of the Urban Area Security Initiative (UASI) program have developed a THIRA on which to base their resiliency investments and federal grant requests. Railroad companies can access these evaluations through local or state Office of Emergency Management staff members. Railroad security and emergency management staff members can begin the railroad's THIRA process with a review of the completed THIRAs for their territories of concern and augment the public agency analysis with railroad-specific concerns.

Because railroads work closely with the federal government and are regulated by federal agencies, FEMA's THIRA approach is recommended as the process, or at least an adjunct process, for railroad organizations planning for climate change (FEMA, 2024). While many Class 1 railroads have long had a robust risk management plan, other railroad organizations may have fewer resources to invest in risk management plan updates. The THIRA process limits the corporate resources that are needed to achieve a workable risk management plan, which can be kept up to date regularly by a few staff members with easily obtained training.

FEMA offers its THIRA training through an on-line independent study process, "Threat & Hazard Identification & Risk Assessment & Stakeholder Preparedness Review," which is available for free at https://teex.org/class/awr401/ . A more advanced two-day program is also available through an in-person course offered by the TEEX training consortium around the country. An annual schedule is published at https://teex.org/class/mgt310/ . A list of critical infrastructure-related information from federally funded resources is available in Attachment 1.

CLIMATE CHANGE

Most railroads are well aware of the hazards present along their operating corridors. Their current risk assessments reflect the mitigation steps that have been taken to prepare for seasonal and cyclical hazard events that have been experienced or studied along their routes. The Association of American Railroads has published a Freight Railroads and Climate Resiliency Fact Sheet, 2023 that details the many steps taken by American railroads to adapt to or mitigate the effects of climate change (AAR, 2023b), focusing on both infrastructure and operations. It accompanies a larger detailed report on railroad climate change responses (AAR, 2023a).

American railroads have been operating transcontinental service since 1869, taking trains across all types of terrain and climatic conditions. Companies have invested in equipment specific to operating in various conditions. For example, Union Pacific has a special car for removing snow from the tracks that is stored at the Dunsmuir station in northern California, near Mount Shasta, and other companies have developed water cars to carry water along rail lines to protect the railroad's infrastructure and right of way from the effects of wildfires (AAR, 2023b).

Climate change is causing all organizations to reevaluate their threat or risk plans to recognize new climate-related threats in unexpected areas. For example, for many years Californians said that their state was America's disaster theme park (Wilson, 1994), but proudly asserted that while they had every natural hazard, they did not have hurricanes because of the cold ocean temperatures that cannot hold the strength needed for a tropical storm to make landfall (Sternfeld, 2023). However, in August 2023 "the National Weather Service issued its first ever tropical storm watch" for Southern California as Hurricane Hilary spun north from Mexico. Significant flooding in the Los Angeles metro area and in San Francisco impacted train operations. Wetter weather is projected in coming years as a warmer atmosphere holds more moisture, "meaning stronger storms and wetter wet periods" (Lee, 2023).

INTRODUCTION TO THIRA

The Threat and Hazard Inventory and Risk Assessment (THIRA) is the first step in climate change adaptation and emergency management program development. This understanding of the threats and risks will form the basis for developing the emergency operations plan (EOP) and the emergency operations center (EOC) facility documentation. Specific information for conducting these next steps is provided in companion guidance documents.

The fictional ABC Railroad operates in multiple states, encompassing multiple climate regions, from sea level coastal to alpine to desert. This example THIRA has been created for its California Region operations. The examples and guidance are readily transferrable to real railroads in all regions.

Existing THIRA reports have focused on natural, technological, and human-caused hazards and threats, evaluated based on recorded information. Historically, earthquakes and hurricanes are the natural disasters that have caused the greatest property damage and loss of life. However, in the 21st century the increase in global temperatures related to carbon dioxide and other greenhouse gas (GHG) emissions has added a new dimension to risk analysis. Many weather-related hazards are accelerating due to the warming of the planet. Heat waves are more frequent and hotter, wildfires are more frequent and intense, and storms are more intense (Zhong and Collins, 2024). Going forward, THIRAs must include the recorded and estimated impacts from heat on the other hazards, and the related emergency plans should consider adaptation and mitigation measures for both the hazard and the impact on its virulence from heat. For example, strategies for dealing with hot weather that have been used in traditionally hot areas, like the American southwest, may have to be applied to infrastructure in areas farther north that have not previously been subjected to extended periods of high temperatures (Association of American Railroads, 2023a).

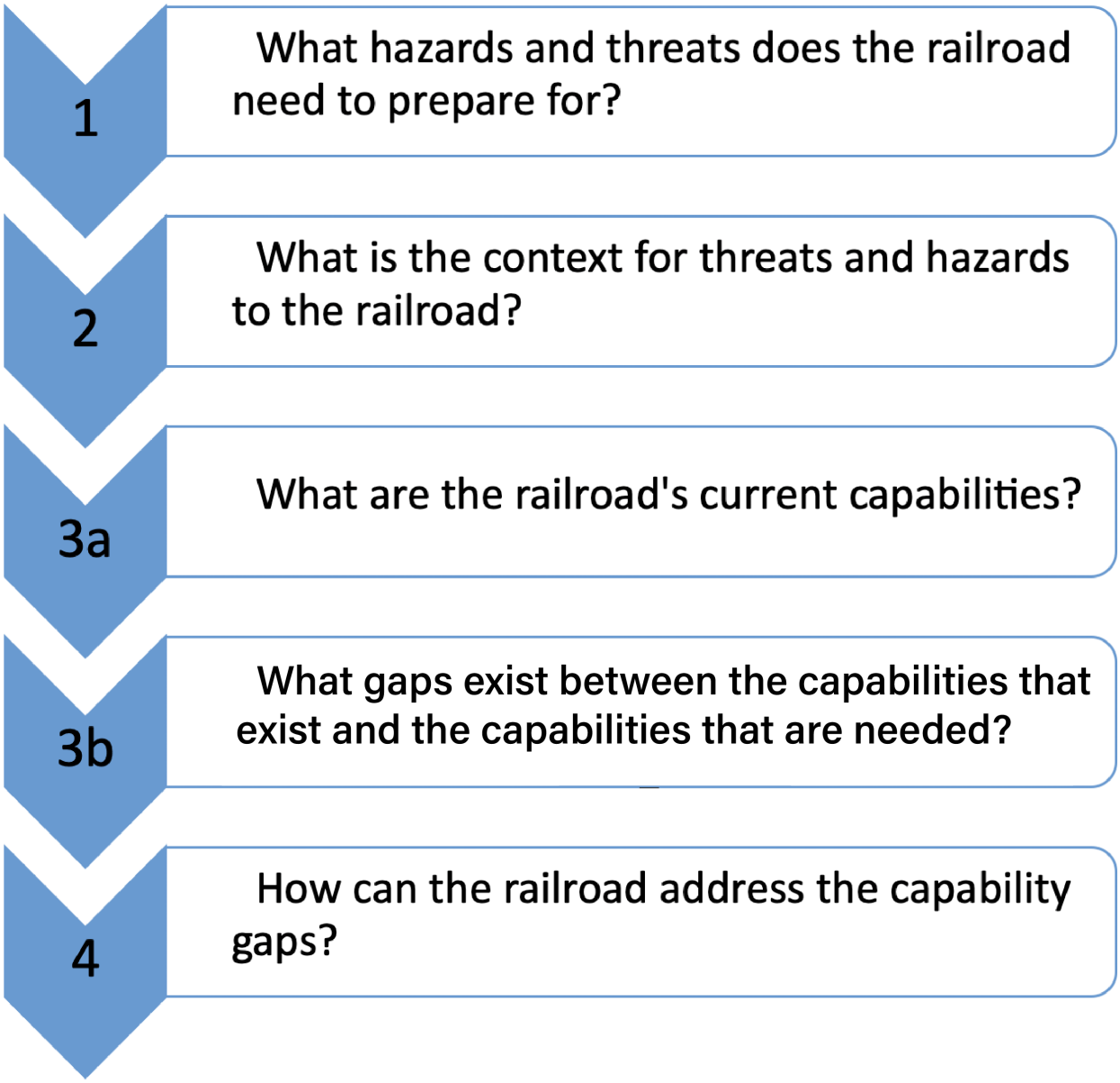

Figure 1. THIRA Evaluation Rubric. Source: FEMA, THIRA 3rd edition, 2018, p. 8.

Fictitious Example Railroad

ABC, a Class 1 railroad, part of the nation's Transportation Critical Infrastructure, is a private corporation regulated by the Federal Railroad Administration (FRA). It carries all types of freight in a variety of purpose-built cars, including tankers, flat bed cars, box cars, hoppers, cattle cars, and intermodal container cars. Within California, the railroad has two major north-south routes, one that travels from the Oregon border to the Mexican border, much of which runs along the Pacific coast, and another that travels from Long Beach to Ogden, Utah, by way of the Central Valley and Sierra Nevada Mountains. There are two west-east routes, one from Oakland to Chicago, and one from Long Beach to Houston. ABC Railroad provides freight service, and rents part of the track to local

commuter heavy rail in the San Jose, Los Angeles, and San Diego areas. Amtrak shares parts of the coastal and southern tracks.

Rail facilities include stations, flat yards for switching cars, sidings, freight terminals, and maintenance yards. Along the way there are signals, radio and telegraph lines, and telephone and cellphone facilities. As the Federal Emergency Management Agency (FEMA) notes, "The Transportation Systems Sector is a vast, open network of interdependent systems that moves …millions of tons of goods annually" (FEMA. 2013). The open nature of the system means that hazards abound, from natural to technological and human threats.

ABC Railroad service in California puts the rail lines in proximity to creeks and rivers, requiring trains to cross bridges over rivers and lakes, ravines, and mountain terrain. Many California rivers are prone to flooding during wet winter seasons, and recently the Los Angeles basin has experienced heavy summer rains from Mexican hurricanes. There are many identified earthquake faults that impact the state, including the San Andreas Fault that runs northwest from the desert at the Mexican border to the San Francisco Bay Area, the cause of the 1906 earthquake there. The Mojave Desert, Los Angeles Basin, the Bay Area, and the northern Pacific Coast are seismically active. Seismic activity may result in additional hazards such as liquefaction and landslides.

Example THIRA Step 1: What does ABC Railroad need to prepare for?

Table 1 depicts the principal natural, technological, and human-caused hazards that have been identified in California and highlights the most significant threat in each category. Developing data on climate change suggest that many of these weather-based hazards will intensify over time, causing greater damage to railroad property, further disrupting services and impacting life safety for railroad staff.

Table 1. Threats and Hazards by Category: California

Natural	Technological	Human-Caused
Drought	Aviation accident	Active shooter
Earthquake **	Dam failure **	Armed assault
Epidemic/pandemic	Hazardous materials	Biological attack
Floods	Levee failure	Chemical attack
Heat wave, sustained	Pipeline accident	Cyberattack against data
Hurricane/monsoon	Radiological accident	Explosive attack
Sea level rise	Train accident	Improvised explosive device attack
Space weather	Transportation accident	Nuclear terrorism
Tornado	Urban conflagration	Physical attack on system**
Wildland interface fire	Utility disruption	Radiological attack
Winter storms		

****** Most significant event in each category, based on likelihood and vulnerability.
Source: Department of Homeland Security, 2015, p. 4-5.

The threats and hazards are identified through literature review and discussion with subject matter experts. These include the National Weather Service, US Geological Survey, state geologists, state and local fire officials, utility professional groups, Federal Bureau of Investigation, Department of Energy, state departments of transportation, and local public health officials. All states and most counties have developed a THIRA, which could be a useful starting point for an organization developing its first THIRA or evaluating another type of risk analysis assessment.

Example THIRA Step 2: What is the context of the hazards for the railroad's operating area

The THIRA analyst should evaluate the various threats and hazards that have been identified in the already created state or county THIRAs for the area being assessed. Proximity to the hazard, likelihood/frequency of the hazard and likely impact of the hazard should be considered. FEMA then defines the context as the time, place and magnitude of the identified hazard event (FEMA, 2018), based on the judgement of event-specific experts—for example, state forestry department for wildfires, probability analysis of the identified hazards, and statistics regarding the incidence of that hazard historically. THIRA analysts would then engage climate change experts to evaluate the impacts of rising sea levels, increasing average daily temperatures in the service area and intensified storms on the likelihood/frequency of the identified events. A last consideration is whether future threats must be added to the list that are driven by climate change, such as hurricane impacts in coastal Southern California, or track buckling in the Great Plains from increased temperatures.

A hazard that has been evaluated by local THIRA creators as unlikely to occur and have little impact on the community would not warrant an investment in THIRA analysis. Conversely, an infrequent hazard with a significant impact should be planned for, such as earthquakes in California or hurricanes in New York City. Such impactful events provide a good model for the organizational response to less catastrophic events with fewer cascading events following them. For example, having a written emergency response plan based on the Incident Command System (ICS) that focuses on one specific hazard offers the framework for railroad response to any emergency event. Event-specific annexes can be added to the revised emergency plan to address the unique requirements for response to other events, such as flooding, tornadoes or wildfires.

Once the THIRA is complete, the organization can use it for the creation of the ICS-based response plan. The emergency planner must consider for each significant hazard what specialized personnel, equipment, and activities would be needed for an effective response. For example, in an earthquake, flood, or hurricane structural engineers would be needed to evaluate the safety of buildings and bridges. Each major hazard that will be planned for should be evaluated for likelihood, severity, and impact, and then considered in light of the specialized training and supplies unique to this event. For example, most emergencies will require an infrastructure safety evaluation before normal railroad operations are resumed. Many climate-related emergencies require providing care and shelter and medical care for railroad personnel in offices, stations, and the field. Beyond those categories are the special needs of differing hazards and threats.

Another important factor is vulnerability. Are some portions of the population likely to be more impacted than others by climate change events on railroad property? Is the agency prepared to address those special needs? Are some employees in closer proximity to the hazard than others? If so, can they be moved to a safer location or can their facility be effectively retrofitted in advance of the event? How will these changes be paid for? Are they cost effective? Will they reduce the risk of harm to the target population? A cost-benefit analysis might suggest building a new facility rather than retrofitting, given the changes in demand for broadband and electricity access. Would the at-risk population be likely to decrease as work processes change and employees doing those tasks will diminish in number?

For each hazard and threat, an agency should consider the likelihood of the event occurring, the vulnerability of the organization to the event, and the consequences for the organization. So, for example, agencies in northern California need not worry about hurricanes, with 56-degree ocean temperatures, but they might need to be concerned about sea level rise and greater rains from storms that develop in a hotter atmosphere. Examples of this step of analysis can be found in Annex B of the 2019 National Threat and Hazard Identification and Risk Assessment: Overview and Methodology.

Example THIRA Step 3a: What are ABC Railroad's current capabilities?

Table 2 depicts the transportation-related core capabilities identified in the National Preparedness Goal (2015), which requires the participation of the whole community, including the private sector. The goal addresses the five mission areas of prevention, protection, mitigation, response, and recovery. It requires the overarching activities of planning, public information, and operational coordination. Capabilities are then listed by mission area.

Table 2 lists the core capabilities related to the transportation sector and evaluates ABC Railroad's current level of capability for the three most damaging types of events.

Table 2. National Preparedness Goal (2015) Core Capabilities- Response

Capability	Natural Hazard: Earthquake	Technological Hazard: Dam failure	Human-caused Hazard: Physical attack on system
Planning	E	D	E
Public information and warning	E	E	E
Operational coordination	D	D	D
Infrastructure systems	E	E	E
Intelligence and information sharing	E	E	E
Interdiction and disruption	NA	NA	D
Screening, search, and detection	D	N	D
Access control and identity verification	NA	NA	D
Cyber security	D	NA	D
Physical protective measures	D	D	D
Risk management for protection programs and activities	E	E	E
Supply chain integrity and security	D	D	E
Community resilience	D	D	D
Long-term vulnerability reduction	D	D	D
Risk and disaster resilience assessment	D	D	D
Threats and hazards identification	E	E	E
Critical transportation	E	E	E
Environmental response/health and safety	E	D	E
Fire management and suppression	E	NA	E
Logistics and supply chain management	E	E	E

Mass care services	E	D	D
On-scene security/protection/law enforcement	E	E	E
Operational communications: interoperability with local first responders	D	D	D
Situational awareness	D	D	D
Economic recovery	E	E	E

Key: Exists (E), Developing (D), Needs (N), Not Applicable (NA)

Many of the capabilities that are developing or not yet addressed are in the Association of American Railroads' best practices activities list.

Example THIRA Step 3b: What level of capability does ABC Railroad need to be prepared for in its emergency planning?

ABC Railroad needs to evaluate the probable hazards for each of its service areas and develop appropriate plans, stockpiles, and employee training to manage each hazard. Issues to consider when weighing the level of effort are probability of occurrence, level of loss to the railroad likely to be created by the event, and the presence of vulnerable populations/habitats in the area likely to be impacted. For example, the derailment and subsequent hazardous materials fire on the Norfolk Southern Railroad in East Palestine, Ohio in 2023 impacted a community with many elderly and child residents. It abutted agricultural fields (Smart, Yan and Watson, 2023). Consideration of such factors in advanced emergency planning might have led to a different strategy for managing the derailed hazardous materials tanker cars, having fewer long-term impacts on the people and environment.

The Association of American Railroads has collected some best practices for managing hazards that include a variety of capabilities.

Table 3. AAR Best Practices for Climate Change Capability

Hazard	Climate Adaptation
Temperature increases	Build and install track to prevent temperature variations from damaging steel tracks—track buckling and sun kinks—use technologies from hot areas more widely as heat increases across the system. Operate the system with awareness of track heat conditions. Operating at reduced speeds may be needed to reduce stress to rails in high-heat situations. Use MxV rail researchers' computer software to assess and manage heat risks more effectively
Flooding from intensifying rainfall, flash floods, sea-level rise, and stronger hurricanes/ tropical storms	Highwater detection technology warns operators to stop trains to assess conditions before passing through flooded areas.

	Drone inspection of bridges. Develop contingency plans to protect workers and freight. Inspect and reinforce bridges, replace ballast; park rail cars of heavy materials or ballast on bridges before a flood to prevent them being swept away; clear debris from culverts and ditches. Conduct 24/7 weather monitoring to manage system operations, use national storm information dashboards. Rerouting plans to help cargo to avoid flooding. Use the period between the warning of bad weather and its arrival to relocate locomotives; remove sensors, signals, and switches to dry areas and reinstall after the storm is over to speed recovery. In flood-prone areas, raise track, bridges, and signals. In recovery, use drones to monitor safety of employees; use ground-penetrating radar to assess conditions under the track. Plan to use rail infrastructure to help communities: deliver relief supplies, move evacuees, remove debris from the community.
Winter storms and bomb cyclones	Snow drifts cover tracks, freeze air brake hoses, and affect steel rails, so plan for avalanche response, snow removal and rail equipment repairs.
$23 billion/year spent on freight rail winter weather preparation	Pneumatic cannons to disperse overhead snow, snow sheds over tracks to divert snow. Smart sensors along tracks to look for defects. Private weather forecasts to foresee winter weather and allow for operational changes like diversions to other routes. Snow fighting equipment like plows and blowers; Jordan Spreader cars remove snow 20 feet from track; rotary snowplows throw snow off tracks. Centralized command centers for coordinated decisions—change schedules, reroute trains. Example: Chicago Transportation Coordination Office. Rapid response teams to remove snow and replace equipment, reroute trains to another company's track—need pre-made agreement. Locomotives with air dryers for brake systems and heated headlights; heaters to prevent switches from freezing; auxiliary power to keep engines warm when stopped; extra locomotive in consist during cold weather to maintain air pressure for the brakes. CREATE (Chicago Region Environmental and Transportation Efficiency) public-private partnership model—example of projects that mitigate climate change impacts for winter and year round.
Wildfires	GPS mapping for tracks to assess vulnerabilities. Fire prevention programs to clear brush from along tracks. Fire trains with water and tools deployed along tracks, moved to wildfire areas. Replace wooden infrastructure with steel and concrete where possible.

	Prepare for landslides and mudslides in wildfire damaged areas after first post-fire rains—sensors, track clearance plan, restoration plan.
Earthquakes	Sensors along the track to warn train crews.
	Coordinate with earthquake early warning systems (EEW) for automatic train shut offs like Japan.
	Rapid repair capabilities pre-staged in seismically active regions.
All Hazards	Enhanced customer communication.
	When warned of impending impacts, reroute trains, move business personnel, move equipment and cargo out of danger areas.
	Stockpile repair supplies and equipment, generators, fuel, ballast for rapid repairs of grade crossing and tracks; pre-position inspectors, engineers, and maintenance workers to speed recovery.
	Damage assessment and debris removal, divers to inspect bridges, drones and helicopters in dangerous places.
	Coordinate with local first responders, community emergency operations centers.
	Rapid repair based on pre-positioned heavy equipment to remove debris and downed trees, replace damaged track, ties, and bridges; power and telephone utility coordination to restore operations.
	Restart operations at reduced speeds, replenish supplies; document lessons learned and update plans.
	Community support—relief supplies in and debris out; participate in post-event after action meetings.

Source: Association of American Railroads, 2023a.

Individual railroads have started additional activities in cooperation with local agencies to mitigate damage from climate-related disasters. The 2018 Camp Fire in California that destroyed the town of Paradise was caused by a downed power line. Pacific Gas and Electric Company was held as the responsible party and experienced a large financial settlement. This event made energy companies aware of the need for more aggressive forest management and brush removal, leading to new cooperation with adjacent landowners. For example, in Nevada there is interagency cooperation between Nevada Energy and the local railroads to ensure that brush is removed along the power line routes that generally parallel the railroad property. While the railroads are removing the brush from their rights-of-way, the energy company is paying a local fire company to remove brush along the adjacent utility rights-of-way, cooperatively enhancing wildfire safety. In other areas, railroads are engaged in netting and seeding operations to prevent slope erosion from rain after a wildfire.

Across the various threats, there are common capability needs for a railroad. In every event, the focus of ABC Railroad is providing critical transportation services to the communities in the state, so its internal structures must be capable of supporting the continuation of critical transportation services in all circumstances. ABC Railroad has an existing emergency

response plan that has supported the community demands for critical transportation services to date. However, this planning needs to be re-evaluated in light of the impacts of climate change.

ABC Railroad leadership has recognized that as climate change increasingly impacts weather, the need for a more robust operational coordination system internally that meets the requirements of the National Infrastructure Protection Program (NIPP) and the Incident Command System (ICS)/National Incident Management System (NIMS) grows. As the principal provider of critical supply chain transportation services in the state, and a key provider of the international freight land-bridge to Europe[1], ABC Railroad must interface with local governments, special districts, state agencies, and federal agencies during emergencies and disasters, so regularly using the standard operational coordination systems (ICS/NIMS) will smooth internal and external decision-making and communication.

The infrastructure of the ABC Railroad system must also be re-engineered and retrofitted to withstand the expected new impacts of climate change. Different parts of the United States will experience different hazards and impacts. Coastal areas where ABC Railroad operates will see more storms that generate increased wave action, leading to coastal erosion that may undermine tracks along the coast. Such erosion has been seen in the LOSSAN corridor between Los Angeles and San Diego in California (Los Angeles Times Editorial Board, 2024). Rail lines in low lying areas may see flooding of the tracks and washouts of the track bed caused by stronger storms or sea level rise, as was experienced by the Long Island Rail Road in The Rockaways during Hurricane Sandy (Alan, 2022). Such rights of way may have to be elevated on a bridge or relocated. Wildfires may burn railroad infrastructure, requiring greater vegetation removal and the use of fire trains, as was seen in California (Union Pacific, 2020), Texas (TRA Newswire, 2024), Montana, and Canada (Franz, 2023) in the 2020s. Changes in the heat and cold cycles may occur due to climate change, as hotter temperatures move farther north. This may require a change in track metallurgy and replacements of tracks in impacted areas.

ABC Railroad should undertake a survey of its facilities to ensure there is a plan being executed to continuously improve the resilience of ABC Railroad's facilities and operations. Guidance is available in the Association of American Railroads' Freight Rail and Climate Resiliency report (Association of American Railroads, 2023a), as shown in Table 3 above. Areas that it calls out for special attention include temperature shifts that can cause track buckling, impacts from flooding, and winter stressors. For a western railroad, wildfires have become an increasing concern, requiring brush clearance along hundreds of miles of track to prevent damage to rail technology and infrastructure. Fire trains that "carry thousands of gallons of water" should be acquired and deployed into wildfire areas for use protecting bridges and track facilities. Other mitigation measures are included in the AAR's report (AAR, 2023a).

Rosen (2023) has noted the erosion along the railroad's coastal route, requiring the imminent replacement of track, and in some cases the future rerouting of the line, as sea front cliffs slide. The corridor from Los Angeles to San Diego, known as the LOSSAN,

1. Containerized ocean freight shipments that travel across a large body of land for a significant part of the trip, using rail transport (CWI Logistics, 2019).

lies in proximity to the Pacific Ocean and is experiencing the impacts of winter storms' stronger waves, leading to cliff failure, undermining of track bed, and related infrastructure failure. "The 351-mile LOSSAN rail corridor in Southern California, the second busiest in the United States, is under siege" (Rosen 2023, n.p.) from these recurring climate change impacts. It is also a critical section of the military's STRACNET strategic rail corridor, which runs through the Marine Corps' Camp Pendleton and serves the Naval complex in San Diego.

Earthquakes are also a persistent concern along the west coast, where the Cascadia subduction zone, volcanoes, and land-based faults coexist with large population centers like Seattle, Portland, San Francisco/San Jose, Los Angeles/Long Beach, and the Inland Empire. ABC Railroad could retrofit its facilities to withstand the design level of earthquake-related shaking, and prepare for possible landslides along its routes.

Example THIRA Step 4: What gaps exist between the capabilities that ABC Railroad has and the capabilities that it needs?

A review of example ABC Railroad Table 2 indicates that Operational Capability, Operational Communication, and Situational Awareness are still in development mode across all threat categories, and that the dam failure and physical attack categories have the additional deficiency of mass care planning. Table 4 depicts an approach to improving the level of capability across the developing areas.

Table 4. FEMA Core Capabilities – Threats and Proposed Actions

Core Capability	Threat	Action
Planning	Dam failure	Obtain maps from dam owners, complete an EOP annex for dam failure response and recovery.
Operational Coordination	All threats	EOP update; comprehensive SSI GPS infrastructure maps—pipelines, utilities, hazmat, sensitive populations; participate in community exercises.
Interdiction and disruption	Physical attack	Plan coordination with local law enforcement agencies, write an EOP annex for physical attack on rail facilities; participate in community exercises.
Screening, search, and detection	Earthquake	Work with owners of EEW systems to connect to the rail control center; investigate installing automatic train shut offs like Japan; test along-the-track sensors annually; participate in community exercises.
	Dam failure	Work with dam owners to connect the railroad control center to the dam's warning center; add Dam Failure Annex to the EOP; participate in community exercises.
	Physical attack	Work with local law enforcement to ensure that railroad alarms contact their communications center; review EOP to ensure that physical attacks are addressed; participate in community exercises.

Access control and identity verification	Physical attack	Work with local law enforcement to ensure that railroad alarms contact their communications center; review EOP to ensure that physical attacks are addressed; participate in community exercises.
Cybersecurity	Earthquake	Continue developing mitigation measures for cyber systems to withstand shaking and power loss; participate in community cyber security exercises.
	Physical attack	Protect cyber systems from physical intrusion.
Physical protective measures	All threats	Continue developing systems to protect personnel and equipment from all forms of damage; ensure that all systems have back-up power, redundant systems.
	Earthquake	Install seismic safety devices like shut off valves, furniture restraints; hold duck and cover drills for personnel.
	Dams	Install water barriers for sensitive equipment; raise devices above flood levels; map areas that will flood in a dam failure; install mitigation devices for flooding.
Supply chain integrity and security	Earthquake and dam failure	Map routes impacted by these hazards and develop alternate routes for cargo; plan and exercise personnel responses; develop communication plan for customers.
Community resilience	Earthquake and dam	Collaborate with community emergency managers on expectations of railroad personnel and resources after a disaster; write joint EOPs on railroad response and recovery roles; participate in community exercises.
Long term vulnerability reduction	All threats	Examine facilities and equipment in light of known threats and hazards, especially those related to climate change and sea level rise; make a long-term plan for mitigating, relocating or removing vulnerable personnel, equipment and facilities where possible, or raising or otherwise protecting what cannot be moved.
Environmental response/health and safety	Dam failure	Examine the terrain subject to dam failure-caused flooding. Consider any hazardous conditions that will impact railroad personnel, equipment and facilities—hazmat, rockslides, mudslides. Coordinate with dam owners for early warning and rapid notification of failure; make an evacuation plan for personnel and essential equipment. Participate in community dam failure exercises.
Risk and disaster resilience assessment	All threats	Evaluate threats and hazards; consider surroundings that exacerbate risk and remove them or relocate the endangered personnel, equipment, or facilities. Collaborate with local communities to keep the THIRAs up to date.
Mass care	Dam failure and physical attack	Need EOP annex for railroad's transportation role; tie railroad maps to dam inundation maps; participate in community exercises.
Operational Communications	All threats	Need plan in EOP for alternative systems of communication among rail entities and with community first responders; ensure disaster communications capability with public safety in communities along the tracks.

Situational awareness	All threats	Need plan in EOP for alternative information gathering; ensure tie to state emergency operations center, business emergency operations center, local emergency operations centers for situational awareness sharing; tie into any statewide dashboards or web-based information sharing systems, like WebEOC.

ABC Railroad has tracks that are in proximity to multiple large reservoirs and dams. If the dams failed catastrophically, as in an earthquake or winter storm, the tracks could be undermined, or even washed away. In one case, both tracks and a rail yard would be under six feet of water for several hours to several days, depending on the weather and king tides. Mud and debris would be deposited on the remaining tracks. Electrical equipment could be damaged or destroyed by the water. Freight services could be delayed for days to weeks, depending on the level of damage and time to repair the infrastructure. Access to the railroad facilities could also be limited for days to weeks as roadways and track sections were cleared. The impact on the freight system could be local, regional or international, depending on how much track was lost and how available alternate routes were. Adopting the mitigation steps in Table 3 and Table 4 would minimize damage and disruption.

Example THIRA Step 5: How can ABC Railroad address the capability gaps?

ABC Railroad should undertake a review and revision of its emergency response system, recognizing changes in technology and in Earth's climates. The review needs to include the railroad's various internal components, such as operations, maintenance, security, financial services, executive management, and labor. A second-level review needs to include participation by public safety, environmental, non-governmental, and emergency managers from cities, counties and states along the railroad's operating system, as well as ancillary and multi-modal service providers, like trucking companies and electrical utilities. This two-way planning effort will inform the railroad of what resources and support may be expected from these partners, and inform the partners about the railroad's capabilities and unique operating systems.

Advanced planning of these interactions will enable the most effective cross-disciplinary responses. This can be accomplished by participation in active full-scale exercises, but also through discussion-based exercises, like tabletop exercises, seminars, or workshops, which require less of an investment in staff time and resources. Exercises provide for two-way learning, as rail staff members learn more about partner capabilities, and partners learn more about rail systems. Serving as an evaluator or exercise staff member is another way for railroad staff members to benefit from participation in all types of exercises.

One focus of emergency planning is on aligning the ABC Railroad's emergency response structures and systems with the ICS/NIMS standards for ease of coordination among public, private, and non-governmental agencies in responding to an emergency. The 2023 derailment and environmental disaster in East Palestine, Ohio (Sarisohn, 2023; Daleo, 2023) clearly demonstrates the value of planned and tested multi-agency response across the public, private, and non-governmental sectors. The EOP development guidance document advises railroads to consider the actions described in Table 4.

A second focus should be the experienced and anticipated impacts of climate change across the railroad's open operating system. The railroad is subject to all climate types, thus requiring accommodation for both intense heat and its associated impacts, like heavier rains, more intense wildfires, and new seasonal cycles for vegetation growth. Natural hazards need to be re-evaluated for their seasonal and cyclical impacts, and appropriate adaptation steps must be taken for both the built infrastructure and the operational systems. More steel and concrete and less wood in railroad infrastructure will reduce losses and speed recovery (Association of American Railroads, 2023a). More frequent mowing, avalanche clearing, and storm water management system maintenance will be required in the warming world.

Funding for emergency planning, training, equipping, and exercising is a critical part of climate adaptation and of updating the emergency plan based on the THIRA. Resources may have to be shifted from existing maintenance and operations activities to accommodate the warmer world's impacts on railroad property and operations. Investments in new sensors and more sensors may be required, maintenance crews' time may have to be reallocated. Planned upgrades to other elements of railroad systems may have to be deferred until climate adaptation work is completed.

At the end of the planning process, all emergency information stored system-wide and regionally must be updated, especially up-to-date contact information for the states through which the railroads travel, including cellphone and computer-based communications. States typically have a 24/7 emergency communications center that can contact needed emergency responders expeditiously, so it is the first point-of-contact in any emergency. ABC Railroad should develop a regular working relationship with the states so that railroads are included in the state and regional planning process for emergency exercises, and in their implementation.

New emergency planning initiatives will prepare ABC Railroad for the hotter and wetter world developing from climate change, regardless of its cause. Developing new schedules and systems for maintenance and adaptation are investments in ABC Railroad's ability to both serve its customers and meet the needs of shareholders.

CLOSING THE LOOP

NIMS requires the planning/operations/equipping/training/exercising (POETE) approach to capability development. Once the climate change driven EOP revision is complete, the other elements of the POETE phases should be reviewed and acted on to ensure complete capabilities into the future. Table 5 demonstrates how ABC Railroad might "close the loop" on capability development for the climate-adapted emergency management structure.

Table 5. POETE- Closing the Loop

Term	Definition*	Action
Planning	Development of policies, plans, procedures, mutual aid agreements, strategies, and other publications; also involves the collection and analysis of intelligence and information	Meet with partners— internal and external; document emergency information and plans.
Operations	Individual teams, an overall organizational structure, and leadership at each level in the structure	Revise the EOC checklists and systems to support the new emergency plan.
Equipping	Equipment, supplies, and systems that comply with relevant standards	Identify deficiencies for adaptation and emergency response functions; plan for funding the needed equipment, supplies, and systems, including computer monitoring of the earthquake early warning system.
Training	Content and methods of delivery that comply with relevant training standards	Develop a cadre of trainers to deliver required ICS/NIMS courses to appropriate staff members
Exercising	Exercises and actual incidents that provide an opportunity to demonstrate, evaluate, and improve the ability of core capabilities to perform assigned missions and tasks to standards	ABC Railroad is encouraged to use all planned events as exercise opportunities, and to collaborate with states to enhance exercise participation opportunities. Make professional videotape of full-scale exercises as described in the case study below, to share with other agencies along the rail line, using a virtual webinar to allow for questions and answers.

*Source: FEMA, THIRA, 3rd edition, p. 30.

The first step is to review and revise the EOP using the climate change guidance, which will cover the Planning and Operations elements of POETE. This includes defining the EOC structure and functions. Staff can make recommendations for any changes to the current facilities, systems, sensors, or other equipment that may be needed to achieve full functionality of the EOC and EOP. For example, Amtrak and Caltrain operations centers have designated computer workstations in their emergency communications centers to monitor the earthquake early warning system. Emergency response training should become an ongoing activity, from awareness level for executives and train control center staff, through field level ICS classes for both train crews and maintenance staff. EOC staff will need overall and section training. Some training is available through FEMA's independent studies, but rail-specific in-person classes are more effective, when available.

Exercising is a critical part of POETE. Running an EOC is a seldom-used skill for most organizations. Therefore, a regular cycle of exercises is needed to ensure that staff members are confident in their abilities to manage a real event. The only way to confirm the functionality of the EOP and to prove the value of the training is to hold tabletop and functional exercises for each shift of EOC staffing, involving the field-level staff in concurrent simulations. An exercise plan with a regular cycle of events should be created and implemented, as required by NIMS and described in the climate change exercise guidance.

Completion of the POETE activities, including an ongoing cycle of exercises, will ensure that ABC Railroad is ready to respond to the new challenges of climate change, as well as the traditional hazards and risks found in existing all-hazards THIRAs.

CASE STUDY 1: BENEFIT OF AN EXERCISE ON THE RAILROAD

The San Jose Metropolitan Medical Task Force (MMTF)[2] sponsored a facilitated exercise for public safety agencies on the railroad with partners Amtrak, Caltrain, and Altamont Corridor Express. The rail yard that served as the site for the exercise is owned by Union Pacific, which also owns much of the track that the three passenger rail providers operate on. The goal was to better equip the public safety professionals to respond to accidents involving railroad equipment.

San Jose is a major rail terminus, with large rail yards where petroleum products, bleach, and chemical raw materials for industry are switched or placed on sidings. Topics of the training exercise included improvised explosive devices, response to serious injuries in the rail yard, and hazardous materials on the railroad. Public safety participants were amazed when, in the middle of the hazardous materials discussion, a single tanker car of chlorine slid past the exercise point on its own. Railroad personnel explained to the astounded public safety personnel that this was the usual way to rearrange cars for consists, as the car glided into another tanker car and coupled.

Rail car orientation

While the hazardous materials discussion was entertaining, the most popular learning station, and the one with the most unique lessons, was the rail car orientation station. Each participating rail company ran its cars on electricity, but each car was distinctly designed. For example, the Caltrain car was a two-story car with narrow aisles and a sharp turn to descend the stairs from the upper level. Fire department emergency medical services crews practiced how they could extricate a patient from an upper floor, realizing that a backboard could not be used, and a sked or improvised cloth sling would be needed to get a person around the curve and down the stairs. Practicing with a dummy demonstrated how difficult the extrication would be. The doctor who was a subject matter expert for the exercise, and the medical director for many Bay Area fire departments, commented that he often rode Caltrain and had never before considered how he would manage the care of patients on the top level in a rail accident, or how they could be safely removed from their seats.

Fire department first responders learned even more powerful lessons for emergency response. None of them knew anything about rail car operation or construction, even though many were veterans of the fire service with twenty or more years on the job. When asked how they would make entry to a rail car in an accident, they said they would use the ax to break a window. Rail staff explained that the windows are Lexan, bullet proof, and impervious to axes. They showed the fire personnel the marking that indicates an emergency entrance window, and how to remove the gasket and then the pane of Lexan from the space, allowing for safe entry and egress. They also learned that the cars are

2. The MMTF program was created in 1996 after the 1995 Murrah Building bombing in Oklahoma City. It is a terrorism response unit, has been folded into the Urban Area Security Initiative (UASI) program in the 122 largest cities and regions in the United States.

unibody construction, meaning that severe damage to the car's outer shell could cause it to collapse. They also learned that shooting out the air brake line would apply the brakes due to loss of pressure, and that the wheels were powered by extremely high voltage electrical lines that could instantly kill anyone who touched them.

Learning together

Learning about how the railroads operate the yard, and how the cars themselves are constructed, provided life safety lessons for the police, fire, and emergency medical services personnel who participated in the exercise. It gave rail personnel a chance to meet the public safety members in a learning environment, not a high-pressure accident scene. In this calmer atmosphere, they were able to explain railroad systems and answer questions to equip the first responders with critical knowledge for use in real disasters.

Out of ten very well received exercises, the rail exercise was the most highly rated by both the rail staff doing the teaching and the first responder learners. It proved the truth of the statement, "You don't want to exchange business cards at the disaster." The informal meeting created respect and goodwill between these two groups of professionals who never before had a chance to exchange knowledge.

Not all partner first responder agencies are able to participate in the full-scale exercise, but the benefit can be extended by providing a professional video of the exercise. It can be distributed through a virtual meeting with a question and answer time, or as a DVD for first responders to watch at local training events.

CASE STUDY 2: HURRICANE KATRINA AND LOST OPPORTUNITY

Railroads cross most populated areas of the United States. Amtrak provides service along the coasts and across the continent. In an emergency, the rail assets can be used to deliver supplies and materials for first responders and to remove residents from harm's way. For these services to be delivered rapidly, there must be pre-event planning and collaboration between the railroad management and state and local emergency managers. This can be facilitated by transportation sector organizations, by business emergency operations centers, or through public-private partnerships. When there is no pre-event collaboration, the onset of a disaster is too late to develop the systems and communications links needed to make the railroad an effective part of the disaster response team.

Railroad as an evacuation asset

One example of such a lost opportunity was in New Orleans during the run-up to Hurricane Katrina in 2005. While many stories have been written about the failed evacuation of the city in advance of the hurricane making landfall, few stories have been written about the successful evacuation of 80% of the area's population (Cooper and Block, 2007). In advance of hurricane season, the state and local emergency managers met with the American Red Cross chapter to develop a hurricane evacuation map. Many residents had their own vehicles and relatives in the area who could shelter them. Others had adequate resources to stay at a hotel. Still others were moved through the Brother's Keeper program, a plan developed by the clergy of New Orleans to have church members inventory their neighborhoods for people without cars and make a plan to move those people if an evacuation were required, using the unified hurricane map (Wilkins, 2006). The hurricane season of 2005 was active in New Orleans before Katrina. The American Red Cross chapter itself had evacuated four times that season. There were numerous community-wide planning meetings with multiple levels of government over the summer to plan for evacuations (Wilkins, 2006). One missing member was the transportation sector, the lynchpin to successful evacuations.

Many stories have been told about why people did not leave the New Orleans area after the hurricane evacuation notice was finally issued by Mayor Ray Nagin. Some people did not have the money at the end of the month to fill their vehicles' gas tanks. Some people had elderly relatives who refused to leave, so they stayed with them. Some were first responders and their families who stayed out of a sense of duty. Some were tourists who had no way to leave and nowhere to go, the airport having been closed, and rental cars generally unavailable. Some people had always gone to the Superdome in previous hurricanes, seeing the short trip as less disruptive and expensive than an out-of-town evacuation trip. Some were elderly, staying in nursing homes and board and care homes whose staff members provided a few days of medication and left them to see to their own families. Based on past experience, they expected to be back in two or three days to again care for the elderly residents (Cooper and Block, 2007).

Of course, the problem was not the hurricane's wind and rain, but the wind-driven barge that rammed the wall of the Industrial Canal and let the water in. Other locally owned canal

levees failed because of poor maintenance caused by poor financial management by the elected oversight boards. These levees collapsed under the pressure of the swollen lake (Cooper and Block, 2007).

The highway department had a coordination plan with Mississippi to make I-10 one way north, away from the coast, and that road carried contraflow traffic. Roads going west and north were all part of that evacuation map drawn in the summer of 2005. But no one saw the other corridor to safety, the railroad. Every day the famous City of New Orleans train leaves for the trip north to Memphis and Chicago. Coach seats and private rooms are available for the 19-hour trip. Nearby stops are available at Hammon, Louisiana and McComb, Mississippi. When Hurricane Katrina was traveling to New Orleans, the tourists had no interest in taking the jazz music tour up the Mississippi River on Amtrak, so the train was empty. When a local Amtrak employee saw the empty cars and realized that people who wanted to leave might be without transportation resources, he called the New Orleans City Hall with the idea of offering free rides out of harm's way to interested residents. By then, the emergency operations center had been relocated to the airport and the mayor had decamped to the Hyatt Hotel with some political advisers, so no one answered the phone. Thus, failure to plan is planning to fail, and the train left its namesake city empty.

Lost Opportunity

With all the pre-event planning in New Orleans that summer of 2005, no one brought in the railroad. Because they were not part of the evacuation plan, there was no coordinated plan for notification of the local governments or the community when evacuation capacity was being offered for free. Amtrak offered regular service between New Orleans and Hammond, Mississippi for $20, so even a paid ticket might have been possible for people who could not afford to fill the gas tank, or who did not have a car. The missing factor was information. People who needed to leave simply did not know that the train was available. The government never coordinated with the railroad as an evacuation route, so it was not used in the Hurricane Katrina disaster.

Pre-event planning between the railroad and the community could lead to beneficial uses of railroad capacity. Freight rail companies have flat cars and box cars that could be used to move school buses and heavy equipment out of harm's way in advance of a storm. They could prioritize rescue and recovery supplies on returning to service in the disaster area. The local government agency could host a town hall to make the residents and businesses aware of the railroad as an asset in times of emergency, benefiting both the community and the railroad.

CASE STUDY 3: RAIL IS THE ONLY WAY IN

There are parts of the country where the train is the only transportation access. Even in urban areas there can be remote spots without roads. In the San Francisco Bay Area, Niles Canyon is just such a spot. Lying between Livermore and Fremont, two fast-developing cities, Niles Canyon is a mountain area that has a single road for access. In an emergency exercise, the City of San Jose's emergency planners could not find a safe route to the railroad track in Niles Canyon that serves the Altamont Corridor Express (ACE) rail service that runs between Stockton in the Central Valley and Silicon Valley's Diridon Station in San Jose.

Real storm-related emergencies

While the exercise's emergency was imaginary, in January of 2023 a real event occurred on the Niles Canyon segment of the ACE run when two landslides hit the tracks in 24 hours. Although the rail line parallels SR 84, there is no direct access from the road to the single track, which is on the opposite side of a creek from the road, at the base of the hillside. Due to landslide concerns following a strong winter storm, Caltrans had kept SR 84 closed for a few days, but Union Pacific, the owner of the railroad track, kept the train route open. The train was carrying 230 passengers and crew when the mud and debris blocked the tracks. The only way to evacuate the passengers was by having another train travel to the site and tow the damaged train back to a previous station, where they were safely loaded onto the platform.

This event demonstrates the limits of access in remote areas. This train was only slightly damaged by the landslide, so it was able to be towed back to the previous station (Gary, 2023). However, in 2016 in the same area, a train had two cars derailed by a landslide, injuring nine people. The train was pushed off its track into a "swollen creek," sliding down a 40-foot embankment into Alameda Creek and partially submerging. Passengers had to climb out of the train, where some in the first car were in 55-degree creek water. Several concrete ties were destroyed, and it was the next day before the train could be pulled out of the creek by a very large crane (Cabanatuan, 2016).

Limited access to portions of a train track's route means that careful preparations have to be made for emergencies. Only the tracks give access to emergency assistance, which may be limited, depending on how the emergency occurs and the state of the tracks. In the Niles Canyon derailments, the tracks were not damaged, but in a wildfire or flood there could be damage that would limit access to the disaster site.

Railroad as a disaster response asset

Train access may also be an asset when the disaster occurs in a remote area and does not involve a train. Some railroads have created special cars for response to remote wildfires that carry thousands of gallons of water and large tools (Franz, 2023; Inside Track, 2020). Railroads have rail-based snow removal equipment that travels along the tracks, clearing the way for other trains.

The key to successful emergency response by trains is pre-event planning with regional

and state partners. When all parties consider the opportunities and challenges faced by entities responding to a hazard or threat, creative uses of resources can be developed. Communication plans are essential to the success of such plans, as the donor has to know who to call, and the requestor has to know how to make the request. Emergency operations plans of both the rail organization and its public and private partners can provide the information needed to ensure that railroad resources are used appropriately, efficiently, and effectively.

ACRONYMS AND GLOSSARY

ACE	Altamont Corridor Express
Caltrain	Commuter rail line serving San Francisco, San Mateo County, and Santa Clara County
CHP	California Highway Patrol
Caltrans	California Department of Transportation
CREATE	Chicago Region Environmental and Transportation Efficiency project
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
ICS	Incident Command System
LOSSAN	Los Angeles to San Diego rail corridor
MMTF	Metropolitan Medical Task Force
NIMS	National Incident Management System
POETE	Planning, Operations, Equipping, Training, and Exercising
SJFD	San Jose Fire Department
SCC	Santa Clara County
THIRA	Threat and Hazard Inventory and Risk Assessment

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ATTACHMENT 1: PRIVATE SECTOR RESOURCES FOR CLIMATE CHANGE

DHS CISA (Cybersecurity & Infrastructure Security Agency): Extreme Weather and Climate Change
Email: Extreme.Weather@CISA.DHS.GOV
Website: https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/extreme-weather-and-climate-change

DHS CISA's Transportation Systems Sector page: https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/critical-infrastructure-sectors/transportation-systems-sector

EPA Air and Transportation page:

Key Issues, Websites and Programs related to Transportation, Air Pollution, and Climate Change | US EPA
https://www.epa.gov/transportation-air-pollution-and-climate-change/key-issues-websites-and-programs-related .

Public/Private Analytic Exchange Program (AEP). Extreme Weather Implications:
https://experience.arcgis.com/experience/a1ec0d1276064ae387c863f2a14b11e1/

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