IMPLEMENTING SOLUTIONS FOR EMERGENCY ROUTING

January 2024

FHWA-HOP-22-030

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16. Abstract

Following major disasters, emergency response and recovery activities are dependent on the expeditious movement of utility service vehicles and other trucks, emergency supplies, medicine, food, fuel, and infrastructure repair materials into affected areas. Immediately before, during, and after a declared emergency, an increased number of oversize/overweight loads need expedited permits to travel to the affected area. The Fixing America's Surface Transportation Act (FAST Act) required the creation of an Emergency Route Working Group (ERWG) to provide recommendations for the implementation of noteworthy practices for expeditious State approval of permits for vehicles involved in emergency response and recovery. FHWA study teams pursued research and feasibility studies to enhance permit automation and emergency routing and consider necessary standardization and communication. This report summarizes research and activities for developing solutions per the recommendations of the ERWG.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1,000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2,000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2,000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	2.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AMBER	America's Missing: Broadcast Emergency Response
API	application programming interface
CAP	Common Alerting Protocol
CFR	Code of Federal Regulations
CMIP	Common Management Information Protocol
CMO	convoy movement order
COG	collaborative operating group
CSV	comma-separated value
CVSA	Commercial Vehicle Safety Alliance
CSRIC	Communications Security, Reliability, and Interoperability Council
DMC	defense movement coordinator
DOD	Department of Defense
DOT	department of transportation
EAS	Emergency Alert System
EOC	emergency operations center
ERWG	Emergency Route Working Group
FAST	Fixing America's Surface Transportation Act
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GIS	geographic information system
HTML	hypertext markup language
IFTA	International Fuel Tax Agreement
IPAWS	Integrated Public Alert and Warning System
IRP	International Registration Plan
LRS	linear referencing system
MAP-21	Moving Ahead for Progress in the 21st Century Act
NBI	National Bridge Inventory
OS/OW	oversize/overweight
PPP	power projection platforms
QA/QC	quality assurance/quality control
SNMP	Simple Network Management Protocol
TC-AIMS II	Transportation Coordinators' Automated Information for Movements System II
TMC	traffic management center
USDOT	U.S. Department of Transportation
VDOT	Virginia Department of Transportation
VoIP	Voice over Internet Protocol

EXECUTIVE SUMMARY

EMERGENCY ROUTE WORKING GROUP RECOMMENDATIONS AND RESEARCH PROGRAM

Program Background

Following major disasters, emergency response and recovery activities are dependent on the expeditious movement of utility service vehicles and other trucks, emergency supplies, medicine, food, fuel, and infrastructure repair materials into the affected area. Responses to disasters rely on the timely receipt of equipment and workers that may be traveling through multiple States. Immediately before, during, and after a declared emergency, an increased number of oversize/overweight (OS/OW) loads need expedited permits to travel to the affected area.

Section 5502 of the Fixing America's Surface Transportation (FAST) Act (Pub. L. No. 114-94, 129 Stat. 1312) required the U.S. Department of Transportation (USDOT) to create an Emergency Route Working Group (ERWG) to provide advice and recommendations to the Secretary of Transportation on noteworthy practices for expeditious State approval of special permits for vehicles involved in emergency response and recovery, to respond to emergencies more quickly.

The ERWG provided a report that included seven recommendations, summarized below:

1. Incentivize States to modernize their permitting systems to provide for automated permitting so that permits are available 24/7.
2. Fund a study that examines a multi-State emergency route scenario for vehicles involved in emergency response and recovery.
3. Encourage the development of a preclearance process that preidentifies a set of vehicles that are part of response and recovery.
4. Study the feasibility of setting up a nationwide alert system to notify State and local authorities of emergency response convoy movements through their region.
5. Coordinate the development of an online resource with all relevant permitting and regulatory compliance information that can be accessed by those participating in emergency response and recovery operations.
6. Collaborate with external stakeholders to identify opportunities to reduce impediments to utility service vehicle movements for emergency response and recovery efforts.
7. Inform Congress that expanding coverage of the section 1511 provision in the Moving Ahead for Progress in the 21st Century Act (Pub. L. No. 112-141) to emergencies declared by a governor of a State would positively affect emergency response and recovery efforts.

Overview of Research Program

Based on the ERWG recommendations, Federal Highway Administration (FHWA) staff pursued research and feasibility studies to enhance permit automation and emergency routing and consider necessary standardization and communication. The following research studies are summarized in this report.

- Multi-State Emergency Route Scenario Study of Vehicle Delay
- Assessment of Automated Permit Systems
- Research on the National Bridge Inventory (NBI)
- Resources on Federal Regulations Related to Emergency Response
- Research on Preclearance Processes
- Feasibility Study of Nationwide Emergency Vehicle Alert System
- Assess Feasibility of Emergency Routing Web tool

UNDERSTANDING THE EFFECTS OF EMERGENCY ROUTING DELAYS THROUGH CASE STUDIES

Estimating the delays that emergency response vehicles and equipment responding to natural disasters in other States may encounter provides an understanding of the costs and effects of those delays on emergency response activities. To accomplish this, FHWA conducted a multi-State emergency route scenario study. This study reviewed five natural disaster scenarios in different parts of the country and estimated permitting and enforcement delays for emergency vehicles.

The emergency response vehicles and equipment included in this study are those involved in power restoration, including bucket trucks, digger derricks, pole trucks, and transformers, as well as temporary housing units, fuel trucks, and mobile cranes. For each natural disaster scenario, each vehicle type was subject to a number of potential delays, including delays from receiving International Registration Plan (IRP), International Fuel Tax Agreement (IFTA), and OS/OW permits; undergoing weight inspections; and navigating toll booths.

The scenarios looked at different numbers of vehicles, types of vehicles, origins, destinations, and pass-through States, yet each revealed commonalities regarding delays. For vehicles hauling large equipment, OS/OW permit delays were the largest contributors to delays. Recommendations for reducing delays for emergency response vehicles and equipment include:

- Encourage and assist States in implementing automated permitting systems for OS/OW permits.
- Encourage State departments of transportation (DOTs) to include information on how to obtain IRP, IFTA, and OS/OW permits during off-hours on their websites.
- Encourage State DOTs to expedite weight and roadside safety inspections for emergency response vehicles.
- Encourage State DOTs to implement cashless tolling or waive tolls for emergency response vehicles.
- Extend strategies used by ambulances and firetrucks for bypassing traffic congestion, such as shoulder use, to utility and other vehicles responding to disasters.

SOLUTION 1: AUTOMATED PERMIT SYSTEMS

Permits are often required from multiple States for OS/OW vehicles. Obtaining permits for an entire route may be delayed by a single State that does not have automated permitting systems. Delays in obtaining OS/OW permits—particularly during nonbusiness hours, over holidays, or when permitting offices are busy—can delay the movement of vehicles engaged in emergency response and recovery. Improving permit automation is one potential solution.

To study this solution, FHWA conducted an "Assessment of Automated Permit Systems," which assessed the current state of and provided a baseline for automated permitting across the United States, and "Research on the National Bridge Inventory (NBI)," which evaluated the NBI for bridge clearance data that could help enhance automated permitting.

Assessment of Automated Permitting Systems

The first step in this process was to understand the current state of permit automation across the country. FHWA conducted an assessment of automated permitting systems. Approximately 36 States currently have automated permitting systems for OS/OW vehicles. These systems allow fleet managers to apply and receive permits online for vehicles exceeding the legal weight or legal dimensional envelope. FHWA will use this information to continue working with States and encourage implementation of automated permitting and permit harmonization.

Preliminary Research on the National Bridge Inventory

The NBI is a database that stores condition and inventory data for bridges across the United States. The ERWG report noted the need for additional bridge clearance data fields in the NBI to enhance permit automation. The current NBI database has six fields that provide information on horizontal and vertical clearances over and under the bridges. FHWA has published updated specifications for the NBI that include new/revised clearance fields.

FHWA studied how NBI data fields relate to vertical and horizontal clearances of dual carriageways underneath structures and how these could enhance the ability to develop multi-State emergency route maps. Findings of the review include:

- Further research could be done to better understand the data needs for emergency routes and the interface with OS/OW permitting systems.
- Coordination with State DOTs could identify relevant clearance fields in State DOT bridge management databases that could provide more real-time clearance information to road users on a statewide basis.
- Minimum and maximum vertical clearance fields in the NBI could be used to provide the trucking industry with the expected range of clearance values along the route, particularly if visually presented through multi-State emergency route maps.

SOLUTION 2: FACILITATE UNDERSTANDING OF REGULATIONS AND REQUIREMENTS

Responses to disasters rely heavily on the timely receipt of equipment and workers from other States, such as when electric utilities send trucks, equipment, and staff to restore energy infrastructure after a hurricane. Staff at these companies may have limited experience moving their equipment across State lines and may be unfamiliar with the State and Federal requirements for doing so. Emergency responders may encounter obstacles that add time and expense when efficient delivery of resources is critical.

To address this, FHWA developed a comprehensive document called *Resources for Commercial Vehicles Involved in Emergency Response* to help emergency responders plan their trips, comply with relevant regulations, and understand regulatory relief that may be available. The regulations and requirements reviewed in the resource document include the following:

- Size and weight regulations (23 U.S.C. 127 and 23 CFR part 658)
- IRP requirements
- IFTA requirements
- Motor carrier identification number requirements (USDOT Number) (49 Code of Federal Regulations (CFR) part 390)
- Hours-of-service regulations (HOS: 49 CFR part 395)
- Other Federal Motor Carrier Safety regulations (49 CFR parts 390–399)
- Federal hazardous materials regulations (49 CFR parts 100–180)

The *Resources for Commercial Vehicles Involved in Emergency Response* document also provides a checklist to aid in planning trips, preparing to travel to a destination, and following procedures needed for successful delivery of disaster relief supplies and services.

SOLUTION 3: PRECLEARANCE PROCESS

The FHWA works closely with the Military Surface Deployment and Distribution Command Transportation Engineering Agency to improve support of military mobilization and to provide States with adequate coordination procedures to support military deployments. As highlighted in the ERWG report, the established procedures for the U.S. military can inform potential preclearance processes for nonmilitary vehicles responding to emergencies., In response to ERWG's recommendation, FHWA conducted "Research on Preclearance Processes," which is summarized in this report.

The major phases of a typical military deployment are outlined in the 2005 FHWA publication *Coordinating Military Deployments on Roads and Highways: A Guide for State and Local Agencies*. Understanding the responsibilities and communication channels for military convoy deployment can provide a strong foundation for analyzing the feasibility of a preclearance process for nonmilitary emergency response and recovery vehicles. The following components of these phases could benefit the movement of nonmilitary OS/OW vehicles:

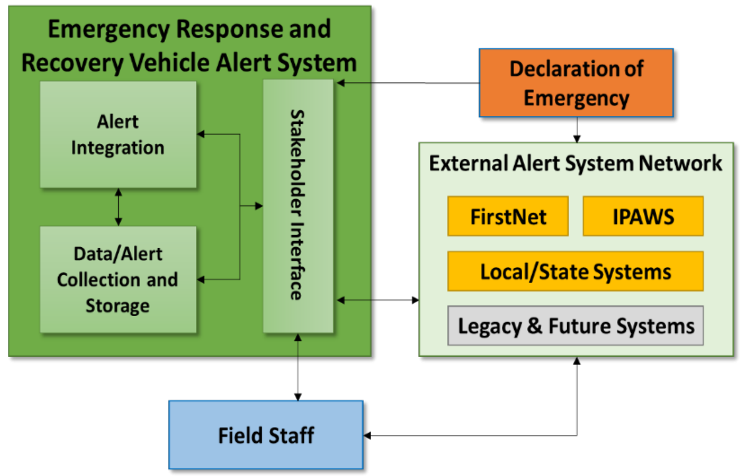
- Establish a coordinated communication process.
- Define an emergency responder point of contact.

- Identify a State point of contact.
- Develop a preclearance registry of standard emergency response and recovery vehicles.

SOLUTION 4: NATIONWIDE EMERGENCY RESPONSE VEHICLE ALERT SYSTEM

Studying the feasibility of setting up a nationwide Emergency Response Vehicle Alert System (Alert System) takes the first step at addressing the ERWG recommendation to study the feasibility of setting up an alert system to notify State and local authorities of emergency response and recovery convoy movement through their region. The feasibility study reviewed existing similar alert and emergency communication systems and provided a high-level concept for a new system (figure 1).

The concept included high-level system specifications, operational scenarios, and options for deployment. The system would leverage existing national and regional systems, data centers, and other elements.



IPAWS = Integrated Public Alert and Warning System.
Source: FHWA.

Figure 1. Illustration. Conceptual framework for alert system.

The data flow of the alert system would be as follows:

- A declaration of emergency is put in place at a particular location by its governing agency, typically the president's or governor's office.
- This declaration is then shared with External Alert Systems and Networks and the nationwide Vehicle Alert System.
- Data flows through three key components of the system:
  - The stakeholder interface
  - The data/alert collection and storage component
  - The alert integration component

The alert system then shares actionable alerts with selected field staff (e.g., law enforcement, emergency responders, and emergency convoys from remote locations) through approved and registered devices (e.g., smartphones, tablets).

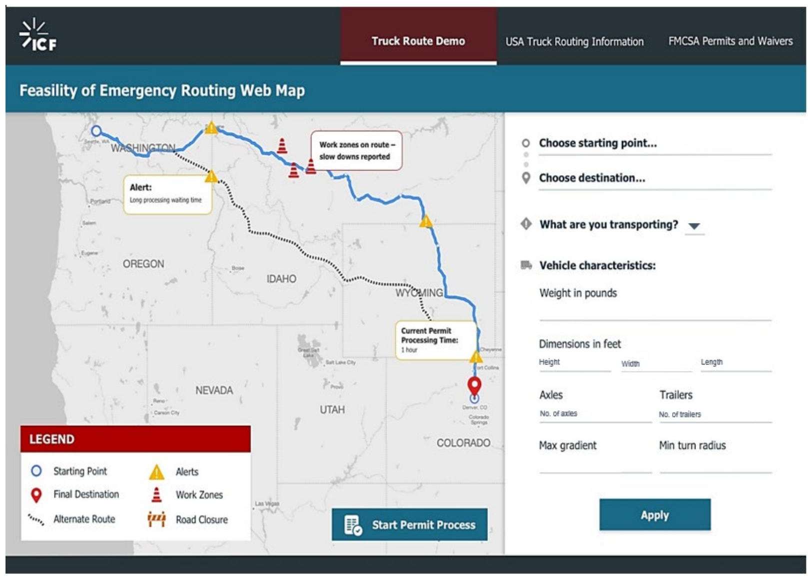
While the system would be based on commercial standards, this conceptual framework is flexible and can evolve as technology advances and new software, hardware, and standards are made available. This framework serves as a starting point for more detailed design in future iterations. The alert system's development and deployment should be accomplished through phases that follow a systems engineering approach.

SOLUTION 5: EMERGENCY ROUTING WEB TOOL

This study addresses the ERWG's recommendation for a Web tool that can improve how information is shared to drivers of emergency response convoys through specific regions. The Web tool would provide information needed during predeployment, deployment, redeployment, and return of responders to and from declared emergencies. This tool would provide access to current and consistent information that would allow emergency convoys to better plan their trips and reroute if needed.

This high-level feasibility study provides insight into four alternatives to develop a tool, and the data needs and challenges associated with each alternative. Following an Agile process, each alternative builds on the capabilities and requirements of the previous one, allowing this to be a phased project. The alternatives are as follow:

- Alternative 1—a database in table format from which drivers can query States and receive links that could provide information by State.
- Alternative 2—an interactive map, built from the static database from Alternative 1.
- Alternative 3—an interactive map that provides as much real-time information as available and with routing capability.
- Alternative 4 (figure 2)—a one-stop interactive Web-based tool that handles all permitting from both the State and driver perspective, along with an interactive map and routing capabilities.



Source: FHWA.

Figure 2. Screenshot. Web tool Alternative 4.

The alternatives range in complexity and would require substantial investment and collaboration with States and the private sector to implement. FHWA is currently working with the American Association of State Highway and Transportation Officials (AASHTO) and the Commercial Vehicle Safety Alliance (CVSA) to develop an emergency declarations website that provides current information on emergency and disaster declarations and permit requirements during an emergency. If an emergency routing Web tool were to be implemented, a first step would be determining the lead agency and the key stakeholders to be involved in developing a concept of operations. An alternative is that State agencies and AASHTO could take a lead in piloting a regional model with support from USDOT. Because Alternative 4 requires extensive State data and integration with State systems, this could be a candidate for a regional pilot by a group of States, which could set a model to eventually be scaled up to the national level.

RECOMMENDATIONS FOR NEXT STEPS

The findings of this research suggest a framework of potential solutions and next steps that could be taken to improve emergency routing. Some of these steps build on activities that FHWA or other partners are already undertaking and may be more readily implemented to make near-term progress toward the objective of the ERWG. These include the following actions:

- Continue to help States understand the benefits of improved emergency routing through dissemination of the results of FHWA's research and that of other stakeholders.
- Continue to encourage and assist States in implementing automated permitting systems for OS/OW permits, permit harmonization, and multi-State issuance of permits.
- Finalize website for emergency declarations with AASHTO and CVSA.
- Provide information to stakeholders that help them navigate the regulatory and permitting environment.
- Encourage and promote information dissemination on FHWA and other websites.
- Continue to work with State DOTs to encourage and implement cashless tolling.
- Continue to encourage the deployment and adoption of public and private sector systems to streamline and automate vehicle and driver inspections.

A midterm solution could be achieved with additional planning and investment for the following:

- Help public and private sector entities to use noteworthy practices in emergency routing, including employing and applying relevant military procedures.
- Develop an inventory of equipment and standardized vehicle envelopes for expedited emergency permitting on specific predesignated routes.

Some of the solutions suggested by this research would require significant additional planning and investment of staff, funding, and other resources. These longer term initiatives include the following:

- The emergency alert system would require a more extensive investment, such as specifying a full concept of operations, including significant outreach to stakeholders outside USDOT.
- Working with other agencies and AASHTO to build a Web routing and mapping tool to assist with emergency routing and permitting.

CHAPTER 1. INTRODUCTION

BACKGROUND

Emergency response and recovery activities in the United States are dependent on the expeditious movement of utility service vehicles and other trucks, emergency supplies, medicine, food, fuel, and infrastructure repair materials into affected areas. Emergencies can require responders' coordination throughout the country. Responses to disasters rely heavily on the timely receipt of equipment and workers from other States, such as when electric utilities send trucks, equipment, and staff to restore energy infrastructure after a hurricane.

Emergency responders have determined a need to pre-position and move equipment, clear debris, fix downed power lines, and rebuild infrastructure during and after disastrous events. Immediately before, during, and after a declared emergency, an increased number of oversize/overweight (OS/OW) loads need expedited permits to travel to affected areas. Equipment or vehicles may be traveling long distances and need to move through multiple States, including pass-through States where emergencies have not been declared.

Emergency responders may encounter obstacles that add time and expense when efficient delivery of resources is critical. For instance, it may be difficult to obtain OS/OW permits to move equipment and supplies on short notice.

Below are some of the regulations that can affect trucks and drivers traveling across State lines to support emergency response and recovery efforts. This section provides a summary of the requirements, who must comply, what drivers need to do, and what types of emergency permits may be available. The regulations and requirements reviewed in this section include the following:

- Size and weight regulations (23 U.S.C. 127 and 23 CFR part 658)
- International Registration Plan (IRP) requirements
- International Fuel Tax Agreement (IFTA) requirements
- Motor carrier identification number requirements (USDOT Number) (49 CFR part 390)
- Hours-of-service regulations (HOS: 49 CFR part 395)
- Other Federal Motor Carrier Safety regulations (49 CFR parts 390–399)
- Federal hazardous materials regulations (49 CFR parts 100–180)

This is not an exhaustive list of relevant regulations, but instead discusses some of those most pertinent to the movement of emergency response vehicles. Noncompliance with these requirements can cause delays in deploying emergency response and recovery vehicles across State lines.

EMERGENCY ROUTE WORKING GROUP

Section 5502 of the Fixing America's Surface Transportation (FAST) Act (Pub. L. No. 114-94, 129 Stat. 1312) required the creation of an Emergency Route Working Group (ERWG) to provide recommendations for the implementation of noteworthy practices for expeditious State approval of permits for vehicles involved in emergency response and recovery in consideration of whether:

- Impediments currently exist that prevent expeditious State approval of special permits for vehicles involved in emergency response and recovery.

- It is possible to preidentify and establish emergency routes between States through which infrastructure repair materials could be delivered following a natural disaster or emergency.

- A State could predesignate an emergency route as a certified emergency route if a motor vehicle that exceeds the otherwise applicable Federal and State truck length or width limits may safely operate along such route during periods of declared emergency and recovery from such periods.

- An online map could be created to identify each predesignated emergency route, including information on specific limitations, obligations, and notification requirements along that route.

In response to section 5502, USDOT established the ERWG through the Federal Advisory Committee Act on July 25, 2016, to develop the report on recommendations for the Secretary of Transportation. The ERWG had 21 members and included representation from:

- State highway transportation departments or agencies
- Relevant modal agencies within USDOT
- Emergency response or recovery experts
- Relevant safety groups
- Entities affected by special permit restrictions during emergency response and recovery efforts (e.g., gas and the electric utility organizations)

Additional information on the ERWG, including the charter, membership roster, and meeting minutes, can be accessed at https://ops.fhwa.dot.gov/fastact/erwg/index.htm.

RECOMMENDATIONS FROM THE EMERGENCY ROUTE WORKING GROUP

As required in Section 5502(b) of the FAST Act, the ERWG provided the Secretary of Transportation advice and recommendations for implementing practices to expedite State approval of permits for vehicles involved in emergency response and recovery. The ERWG Report is available on the FHWA website at: https://ops.fhwa.dot.gov/freight/technology/emergency_routing/index.htm.

The ERWG made the following recommendations to the Secretary of Transportation:

1. Incentivize States to modernize their permitting systems to provide for automated permitting so that permits are available 24/7. This would reduce delays in obtaining the necessary permits to move OS/OW vehicles in response to an emergency.
2. Fund a study that examines a multi-State emergency route scenario for vehicles involved in emergency response and recovery. This study would test different scenarios for

emergency response and identify how delays in permitting (overlength, overwidth, IRP, IFTA), differences in regulations between States, and vehicle routing would affect response times during an emergency. This study would be incorporated in a Federal Government national exercise program.

3. Encourage the development of a preclearance process that preidentifies a set of vehicles that are part of response and recovery. This process should preidentify a convoy and provide the convoy with certain privileges that include expedited inspection or pass-through permission at weigh stations.
4. Study the feasibility of setting up a nationwide alert system (like America's Missing: Broadcast Emergency Response [AMBER] alerts) to ensure that State and local authorities are aware of the movement of emergency response convoys through their region. This should include predeployment, deployment, redeployment, and return of responders to and from declared emergencies. Enforcement officials will more easily be able to take steps to expedite these vehicles through weigh station inspections or during other roadside inspections if they know in advance that they are coming. This will ensure that once an emergency is declared in one region, surrounding regions are notified, consistent with the severity of the emergency.
5. Coordinate the development of an online resource with all relevant permitting and regulatory compliance information that can be accessed by those participating in emergency response and recovery operations (building on https://transportation.gov/emergency). In addition to providing original content, the website would provide a resource that would integrate links to other sources as well. Items that could be included in this resource are an interactive map, traffic information, permitting information, links to permitting websites, 24/7 contact information for State departments of transportation (DOTs), and other items. The website would be a one-stop shop for utilities, freight carriers, emergency management professionals, and other responders to use during emergencies.
6. Collaborate with external stakeholders to identify opportunities to reduce impediments to the movement of utility service vehicles for emergency response and recovery efforts.
7. Currently, Moving Ahead for Progress in the 21st Century Act (MAP-21), Section 1511 extends the States' authority to issue special permits to vehicles with divisible loads that are delivering relief supplies during a presidentially declared emergency or major disaster under the Robert T. Stafford Disaster Relief and Emergency Assistance Act.[1] Expanding the coverage of the MAP-21, Section 1511 provision to emergencies declared by a governor of a State would positively affect emergency response and recovery efforts. This final recommendation is outside the direct control of the Secretary of Transportation.

[1]See Pub. L. No. 93-288, 42 U.S.C. 5121 et seq., the Robert T. Stafford Disaster Relief and Emergency Assistance Act at: https://www.fema.gov/sites/default/files/documents/fema_stafford_act__2021vol1.pdf.

PURPOSE OF THIS DOCUMENT

This report summarizes research and activities for developing solutions to each recommendation listed above. This report serves as a compilation of the seven research studies performed as part of this program.

The purpose of the research was to further define the problem of emergency routing, quantify the costs of delays in the movement of emergency response and recovery vehicles, and conduct further research to establish potential solutions to reduce delays in the movement of vehicles during emergencies.

DOCUMENT ORGANIZATION

The remainder of the report is organized as follows:

- Chapter 2 provides an overview of the research conducted as a result of the ERWG recommendations.
- Chapter 3 describes the effects of emergency routing delays.
- Chapter 4 presents the results from efforts to automate permits.
- Chapter 5 provides information to facilitate understanding of regulations and requirements.
- Chapter 6 summarizes how a preclearance process could be used to preidentify a set of vehicles that are part of response and recovery.
- Chapter 7 summarizes the feasibility of an alert system to notify State and local authorities of emergency response and recovery convoy movements.
- Chapter 8 describes the proposed Alert System.
- Chapter 9 summarizes the feasibility of a Web tool that can improve how information is shared to drivers of emergency response convoys through specific regions.
- Chapter 10 outlines next steps.

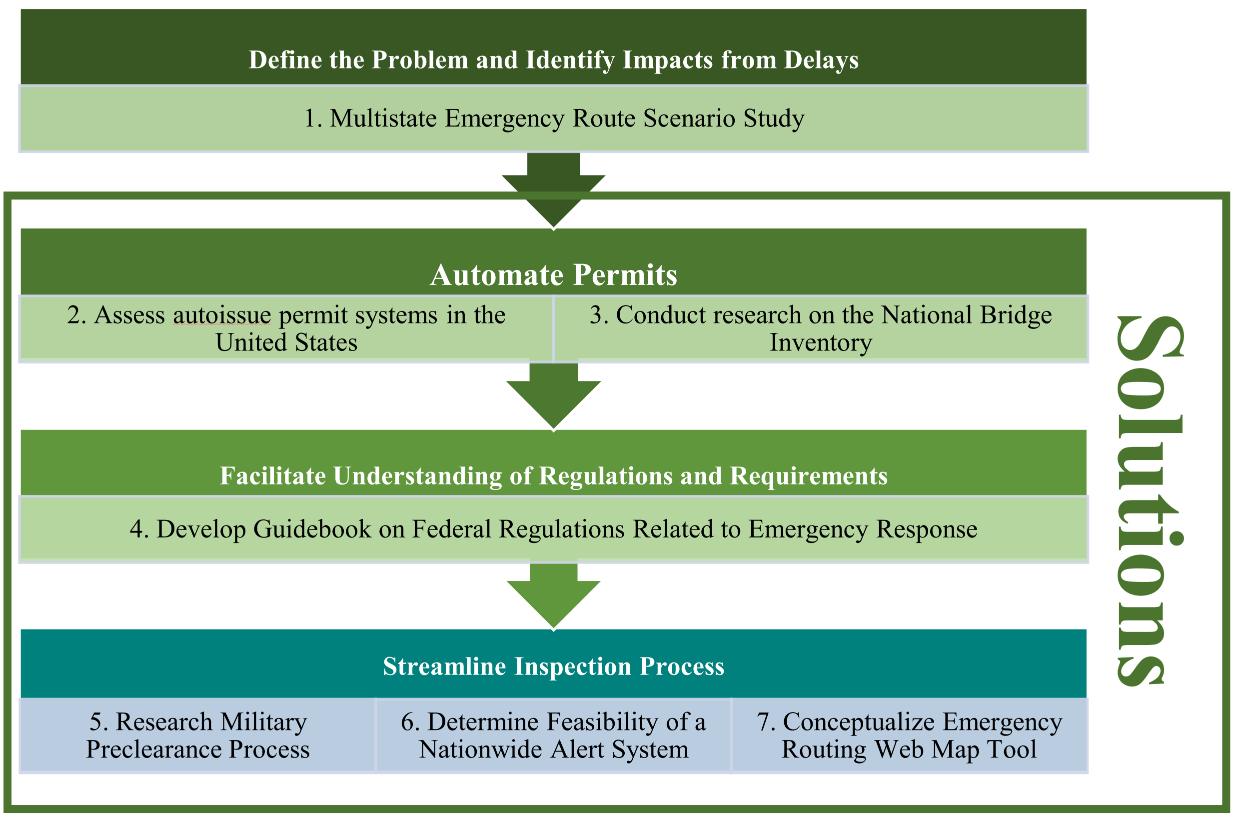
CHAPTER 2. OVERVIEW OF RESEARCH

This research addresses the recommendations made by the ERWG (listed in chapter 1) through the development of seven studies that identify effects and challenges in emergency routing delays, assess current situations, and provide potential solutions. These research studies are summarized below. Figure 3 illustrates how these research studies are linked to the program's outcomes.

- **Multi-State emergency route scenario study:** This study involved developing scenarios and a methodology to estimate delays for emergency vehicles associated with permitting and enforcement activity. The scenario analysis estimated what types of delays occur, how many vehicles are affected, how delays affect vehicle routes and transit time, and what effects these delays have on emergency response and recovery. The scenarios included East Coast Tropical Storm (Hurricane Sandy, October 29, 2012), Florida Hurricane (Hurricane Michael, October 10, 2018), Midwest Tornado (Joplin, MO, tornado, May 22, 2011), West Coast Wildfire (Tubbs Fire in Northern California, October 2017) and Colorado Flood (Colorado Front Range Flood, September 11, 2013).
- **Assessment of automated permit systems in the United States:** This study assessed the current state of and provided a baseline for automated permitting across the United States. Automated permitting significantly streamlines the permitting process. As permits are often required from multiple States for OS/OW vehicles, obtaining permits for an entire route may be delayed by a single State that does not have automated permitting systems. Manual permit processing procedures can cause significant delays, especially if an emergency occurs over a weekend or holiday. Approximately 30 States currently have an automated permitting system for OS/OW vehicles that allows a fleet to apply and receive a permit online for a defined dimensional envelope.
- **Research on the National Bridge Inventory (NBI):** This study examined NBI fields related to bridge clearance, factors for adding new NBI fields, data collection and processing requirements, additional costs to FHWA and State DOTs, and other efforts that could be undertaken.
- **Resources on Federal regulations related to emergency response:** This study provided information to assist the movement of large-scale relief equipment during emergencies. Responses to disasters rely heavily on the receipt of equipment and manpower from other States, such as when electric utilities send trucks, equipment, and staff to restore energy infrastructure after a hurricane. Staff at these companies may have limited experience moving their equipment across State lines and may be unfamiliar with the State and Federal requirements for doing so. Emergency responders may encounter obstacles that add time and expense when efficient delivery of resources is critical. The resources included in this study can help emergency responders (and the agencies that support them) plan their trips, comply with relevant regulations, and understand the regulatory relief that may be available to them.
- **Research on military preclearance processes:** This study analyzed existing preclearance processes followed by the U.S. military when moving large vehicle convoys on public highways to assess the feasibility of a similar preclearance process for civilian emergency

response and recovery vehicles. A process could be applied to nonmilitary vehicles responding to an emergency to preidentify a convoy and provide the convoy with certain privileges that might include expedited inspection or pass-through permission at weigh stations.

- **Feasibility study of nationwide alert system:** This study provided a high-level feasibility assessment for setting up a nationwide alert system to ensure State and local authorities are aware of the movement of emergency response convoys through their region. Alerts would cover predeployment, deployment, redeployment, and return of responders to and from declared emergencies. This type of system would allow enforcement officials to easily be able to take steps to expedite these vehicles through weigh station inspections or during other roadside inspections. This could ensure that once an emergency is declared in one region, surrounding regions are notified consistently with the severity of the emergency.
- **Assess feasibility of emergency routing Web tool:** This study provided a high-level feasibility assessment for setting up a Web tool that can improve how information is shared to dispatchers and drivers of emergency response convoys through specific regions. The Web tool would provide the necessary information needed for drivers to travel to and from declared emergencies. The tool could provide links from which drivers and dispatchers can obtain the following emergency information, including State 511 websites, permitting websites, emergency and disaster declarations, and Federal Motor Carrier Safety Administration (FMCSA) declarations.



Source: FHWA.

Figure 3. Diagram. Link between project solutions.

CHAPTER 3. EFFECTS OF EMERGENCY ROUTING DELAYS

The multi-State routing study was conducted in response to one of the recommendations of the ERWG to estimate the effects of delays on vehicles responding to an emergency. The following summarizes the approach and findings from the emergency routing scenario analysis, setting the stage for the solutions presented in chapters 4–9.

INTRODUCTION

The goal of the multi-State routing study was to estimate the effect of delays that vehicles responding to natural disasters in other States may encounter. While natural disasters are complex and unpredictable, this study provided examples of emergency routing scenarios that could occur based on real-life natural disasters and the emergency responses that followed.

This study used a set of scenarios and a methodology to estimate the length and effect of delays associated with permitting and enforcement activity for these vehicles. The scenario analysis estimated what types of delays could occur, how many vehicles could be affected by each type of delay, how the delays could affect transit time, and what types of effects these delays could have on emergency response and recovery efforts. This study was limited to quantifying the costs associated with equipment delays and did not attempt to quantify the effects of delays on deaths or injuries resulting from the disasters. By realistically describing problems associated with the routing of emergency response and recovery vehicles, this study helps educate stakeholders on the nature of the problem and its effects.

METHODOLOGY

Below is a summary of the methodology used to develop the estimated effects. For a complete description of each step of the methodology, data, and assumptions, see the *Multi-State Emergency Route Scenario Study of Vehicle Delays* report available at: https://ops.fhwa.dot.gov/publications/fhwahop21020/fhwahop21020.pdf.

Step 1: Develop Natural Disaster Scenarios

Disaster scenarios were chosen that represent different geographic areas in the United States, different types of natural disasters, and disaster events of varying scale to ensure this analysis covered a wide range of emergency routing scenarios. The five natural disasters chosen were as follows:

1. Tropical storm along the East Coast, based on Hurricane Sandy (2012).
2. Hurricane in Florida, based on Hurricane Michael (2018).
3. Tornado in the Midwest, based on an EF–5 tornado in Joplin, Missouri (2011).
4. Wildfire on the West Coast, based on the Tubbs Fire in Northern California (2017).
5. Flood in Colorado, based on a 1,000-year rainfall event in Colorado (2013).

The development of these scenarios was based on information from after-action reports created by Federal, State, county, and local governments. Information was collected for each natural disaster scenario to describe the event and its effects, emergency response efforts, emergency response vehicle inventory, and number of out-of-State emergency response vehicles required.

Step 2: Identify Vehicles and Estimate Their Origins

Information was collected on the types of vehicles and equipment and estimates were made for vehicle origins and the pass-through States.

- Utility service vehicle: bucket truck
- Utility service vehicle: digger derrick
- Tractor semitrailer: flatbed/specialized for delivering utility poles
- Tractor semitrailer: flatbed for delivering transformers
- Tractor semitrailer: flatbed for delivering temporary housing units
- Tractor semitrailer: hazardous material tank truck for delivering fuel
- Mobile crane

Step 3: Develop a Baseline Routing Scenario (No Delays)

Using the origin, pass-through, and destination States, a baseline routing scenario was established assuming movement of equipment without delays from permits, weigh stations, and tolls.

Step 4: Identify Delay Scenarios and Estimate the Effects of Delays on Total Transit Time

Delay scenarios were identified and incorporated into each baseline routing scenario. Estimates were made to determine the amount of transit time each delay added to each vehicle for the following:

- IRP and IFTA registration temporary trip and fuel permit transactions
- OS/OW permit transactions
- Tolls
- Weight and roadside safety inspections

In addition to the above delays, a weekend scenario was created to account for delays in obtaining IRP, IFTA, and OS/OW permits that vehicles may encounter because of issuing offices without automated permitted systems being closed on the weekend.

Based on each vehicle's configuration and route, delays were incorporated into each baseline routing scenario to calculate the total added transit time and the total transit time for each vehicle traveling along each route in all five scenarios.

Step 5: Identify the Effects of Delays

Finally, the effects of the delays were identified in terms of the number of States affected, the number of people affected, and the size of the response effort:

- The effects of delayed bucket trucks, digger derricks, pole trucks, and transformers were calculated to include the costs to the utilities and the customers.
- The effects of delayed fuel trucks were quantified in terms of the number of residential generators, ambulances, and firetrucks that could have been filled by the fuel being transported.
- The effects of delayed temporary housing units were quantified based on the number of people who could have been housed in each unit.
- The effects of delayed mobile cranes were quantified based on the cost and effect of delay on other emergency response activities.

NATURAL DISASTER SCENARIOS

East Coast Tropical Storm

Scenario Description

The East Coast Tropical Storm scenario was based on Hurricane Sandy, which made landfall in New Jersey on October 29, 2012, and had significant effects on the New York metropolitan region and affected 24 other East Coast States.[2] An estimated 8.5–8.6 million customers lost power as a result of the storm, 2.5 million of which were in New Jersey alone.[3,4] Additionally, acute fuel shortages in New York and New Jersey required the delivery of 9.3 million gallons of fuel to both States.[5] Due to the number of States affected by the storm, power restoration crews often needed to respond in their State before moving across State lines to areas that were more significantly affected, such as New York and New Jersey. Approximately 67,000–70,000 mutual assistance personnel from 80 utilities across the country (as far as California) were deployed to restore power.[6,7]

This scenario represented a storm with heavy rainfall, storm surge, flooding, and hurricane-force winds that significantly affected multiple East Coast States, causing widespread power outages and infrastructure and property damage. Major response efforts included search and rescue; clearing fallen trees, debris, and snow; restoring power; delivering fuel; draining flooded areas; providing medical care; and providing temporary housing for those displaced. Debris clearance, power restoration, and fuel delivery were three critical efforts that required large numbers of personnel, equipment, and vehicles. The number of each type of vehicle traveling from each of the origin States in this scenario is detailed in Table 1, along with the baseline travel time for the route.

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[2] U.S. Department of Homeland Security, Federal Emergency Management Agency, *Hurricane Sandy FEMA After-Action Report,* Washington, DC: USDOE, 2013.

[3] U.S. Department of Homeland Security, *Hurricane Sandy FEMA After-Action Report.*

[4] U.S. Department of Energy, Energy Information Administration, "Electricity restored to many in the Northeast, but outages persist," *Today in Energy* (blog), November 9, 2012, https://www.eia.gov/todayinenergy/detail.php?id=8730.

[5] U.S. Department of Homeland Security, *Hurricane Sandy FEMA After-Action Report.*

[6] U.S. Department of Homeland Security, *Hurricane Sandy FEMA After-Action Report.*

[7] U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability, *Overview of Response to Hurricane Sandy-Nor'Easter and Recommendations for Improvement,* Washington, DC: USDOE, 2013. https://www.energy.gov/sites/prod/files/2013/05/f0/DOE_Overview_Response-Sandy-Noreaster_Final.pdf.

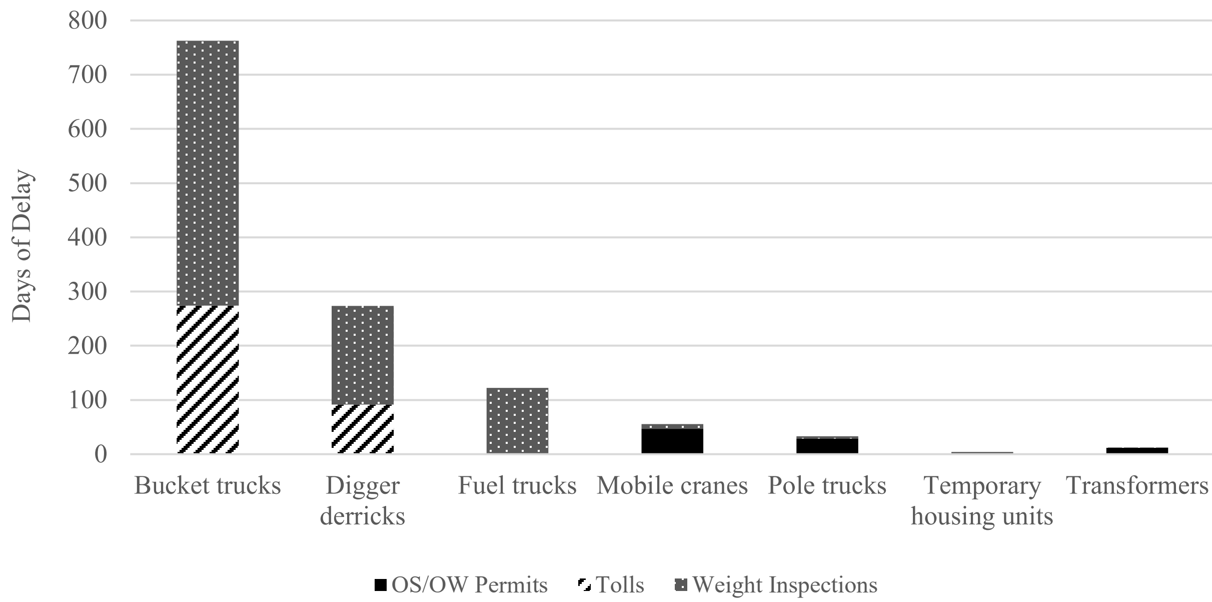
Table 1. East coast tropical storm baseline routing scenario.

Number of Vehicles Traveling	Origin State	Baseline Transit Time (Hours)
• Bucket trucks: 438 • Digger derricks: 146 • Pole trucks: 4 • Transformers: 1 • Fuel trucks: 98 • Mobile cranes: 6	California	50
• Bucket trucks: 877 • Digger derricks: 292 • Pole trucks: 7 • Transformers: 1 • Fuel trucks: 196	Indiana	13
• Temporary housing units: 114 • Mobile cranes: 12	Maryland	5
• Bucket trucks: 877 • Digger derricks: 292 • Pole trucks: 7 • Transformers: 1 • Fuel trucks: 196 • Mobile cranes: 12	Tennessee	17
• Bucket trucks: 877 • Digger derricks: 292 • Pole trucks: 7 • Transformers: 1 • Fuel trucks: 196 • Mobile cranes: 18	Texas	33
• Bucket trucks: 877 • Digger derricks: 292 • Pole trucks: 7 • Transformers: 1 • Fuel trucks: 196 • Mobile cranes: 12	Vermont	6

Delays

In the Tropical Storm scenario, weight inspections added the most transit time to each applicable vehicle, followed by toll delays (Figure 4). Both of these delay types accounted for a relatively higher proportion of delay time in this scenario compared with the other scenarios. This was because some vehicles in this scenario were traveling from as far as California and were therefore subject to a greater number of weight inspections. Additionally, more bucket trucks and digger derricks were required in this scenario compared with the others, and these were the only vehicle types that were subject to toll delays.

While the transformers in this scenario were subject to fewer cumulative delays than other vehicles, the one transformer being transported from Vermont, the closest State to New Jersey in this scenario, experienced a delay of 5 days due to waiting for an OS/OW permit to be issued from another State. This was the longest delay time by both delay type and vehicle type in this scenario.



OS/OW = oversize/overweight.

Source: FHWA.

Figure 4. Chart. Cumulative days of delay encountered by all vehicles in the weekday tropical storm scenario.

Effects of Delays

The East Coast Tropical Storm scenario was the largest of the scenarios in this study in terms of the number of States affected, the number of people affected, and the size of the response effort. As a result, the effects of delayed equipment were significant. Table 2 details the economic effects from the delayed bucket trucks, digger derricks, pole trucks, and transformers. The additional labor costs incurred by out-of-State utilities was over $5 million. The economic costs to the approximately 175,000 residential and 8,000 commercial customers that would have had their power restored was over $4 million and $67.8 million, respectively. For industrial utility customers, the economic cost was almost $30 million for the approximately 922 industrial utility customers that would have had their power restored without delays.

When an additional day of delay was added to each vehicle to account for delays in receiving the necessary IRP, IFTA, and OS/OW permits due to permitting offices being closed on a weekend (i.e., the weekend scenario), the number of residential, commercial, and industrial customers that would have had their power restored during that time increased to over 551,000, 26,000, and 2,000, respectively. The resulting economic costs increased to $48.4 million for residential customers, $818.2 million for commercial customers, and $359.9 million for industrial customers. Additional costs to utilities increased to $28.1 million.

Table 2. Monetary effects of delayed power restoration vehicles in the tropical storm scenario.

Scenario	Total Cost to Utilities	No. of Residential Customers Affected	Total Cost to Residential Customers	Number of Commercial Customers Affected	Total Cost to Commercial Customers	Number of Industrial Customers Affected	Total Cost to Industrial Customers
Weekday	$5,032,918	175,117	$4,015,467	8,295	$67,876,314	922	$29,877,453
Weekend	$28,143,881	551,280	$48,403,612	26,113	$818,200,813	2,900	$359,902,658

In addition to these costs, extended power outages resulted in increased public health and safety risks, especially for elderly populations. These populations might be reliant on at-home electrical medical equipment, such as oxygen tanks, or more susceptible to either heat stroke or hypothermia when heating, ventilation, and air conditioning systems are down.[8] An estimated 2,500,000 customers lost power in New Jersey as a result of Hurricane Sandy,[9] equating to a high-risk population of approximately 95,000 people in this scenario.

Fuel deliveries in emergency response situations are needed for a variety of reasons, including fueling emergency response vehicles, vehicles transporting people and supplies, and backup generators when the power is out.[10] Service stations can deplete their fuel supplies in 2 days, and this timeframe may be even shorter in an emergency, making it pertinent that fuel deliveries arrive promptly.[11] Delays in fuel deliveries can have ripple effects, including further increasing the costs in Table 2 due to power restoration vehicles running out of fuel. The 979 fuel trucks in this scenario were delayed by a range of 1 to 8 hours in the weekday scenario and were transporting a total of 9.3 million gallons of fuel, which is enough to fuel 516,667 generators, 232,500 ambulances, or 143,077 firetrucks.

The 114 temporary housing units being transported from Maryland to New Jersey in this scenario experienced a minimal delay of 1 hour per vehicle, and therefore did not have a significant effect on those waiting for a more permanent housing situation.

Finally, the 58 mobile cranes were delayed by a range of 1 hour to almost 2.5 days. The total additional rental costs incurred were over $210,000, and the costs of disruption to other emergency response activities were over $631,000.

[8] Klinger Chaamala, Owen Landeg, and Virginia Murray, "Power Outages, Extreme Events and Health: A Systematic Review of the Literature from 2011-2012," *PLOS Currents Disasters*, PMID: 24459613, January 2, 2014. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3879211/.

[9] National Oceanic and Atmospheric Administration, National Centers for Environmental Information, *Coastal Flood Event Report*, Storm Events Database, https://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=416939.

[10] American Trucking Association, "When Trucks Stop, America Stops," Washington, DC: ATA, 2015. https://www.trucking.org/sites/default/files/2019-12/When%20Trucks%20Stop%20America%20Stops.pdf.

[11] American Trucking Association, "When Trucks Stop."

Florida Hurricane

Scenario Description

The Florida Hurricane Scenario was based on Hurricane Michael, which hit the Florida Panhandle, particularly Panama City Beach to Mexico Beach, on October 10, 2018, and continued to southwest Georgia. Over 400,000 people lost power (100 percent of customers in portions of the Florida Panhandle and southwest Georgia), and 375,000 were evacuated from Florida.[12]

This scenario was similar to the East Coast Tropical Storm scenario, yet with significant effects primarily occurring in Florida. Major response efforts included search and rescue, clearing fallen trees and debris, restoring power, providing medical care, and providing temporary housing for those displaced. Table 3 includes the total number of vehicles traveling to Florida from each origin State, as well as the baseline transit time for each route.

Table 3. Florida hurricane baseline routing scenario.

Number of Vehicles Traveling	Origin State	Baseline Transit Time (Hours)
• Temporary housing units: 871	Alabama	5
• Bucket trucks: 140 • Digger derricks: 47 • Pole trucks: 15 • Fuel trucks: 10 • Mobile cranes: 2	Illinois	15
• Bucket trucks: 140 • Digger derricks: 47 • Pole trucks: 15 • Fuel trucks: 10 • Mobile cranes: 1	Massachusetts	25
• Bucket trucks: 140 • Digger derricks: 47 • Pole trucks: 15 • Transformers: 2 • Fuel trucks: 10 • Mobile cranes: 3	Mississippi	8
• Bucket trucks: 140 • Digger derricks: 47 • Pole trucks: 15 • Fuel trucks: 10 • Mobile cranes: 1	Nebraska	29

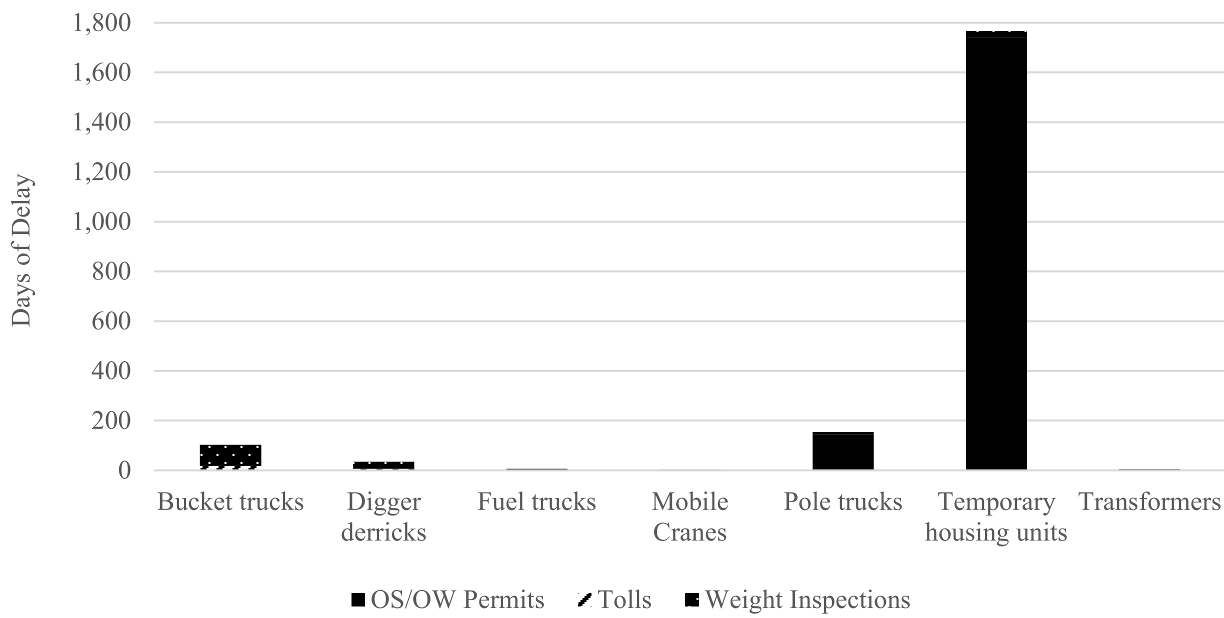
[12]Florida State Emergency Response Team, *Hurricane Michael: After Action Report and Improvement Plan,* Tallahassee, FL: FSERT, 2019.

Table 3. Florida hurricane baseline routing scenario. (continuation)

Number of Vehicles Traveling	Origin State	Baseline Transit Time (Hours)
• Bucket trucks: 140 • Digger derricks: 47 • Pole trucks: 15 • Fuel trucks: 10 • Mobile cranes: 2	Texas	18

Delays

As shown in Figure 5, OS/OW permit transactions made up the majority of delays in this scenario. All vehicles were routed through a State that did not have automated OS/OW permitting. Therefore, an additional 2 days of transit time were added for each vehicle that required an OS/OW permit. Additionally, all vehicles in this scenario traveled from States that were just over a 1-day drive away or less, which resulted in a smaller cumulative delay from weigh station stops than the previous scenario.



OS/OW = oversize/overweight

Source: FHWA.

Figure 5. Chart. Cumulative days of delay encountered by all vehicles in the weekday hurricane scenario.

Effects of Delays

The effects resulting from the delayed power restoration vehicles in this scenario are shown in Table 4. Responding utilities incurred an additional $1.1 million in labor costs, while the extended power outage costs to residential, commercial, and industrial utility customers were more than $1.6 million, $36.9 million, and $32.3 million, respectively. The weekend scenario increased utility costs to $5.1 million and resulted in delayed power restoration for over 99,000 residential customers, over 4,000 commercial customers, and over 500 industrial customers. The resulting economic costs were $9.7 million for residential customers, $164 million for commercial customers, and $72.4 million for industrial customers.

Table 4. Effects of delayed power restoration vehicles in the hurricane scenario.

Scenario	Total Cost to Utilities	Number of Residential Customers Affected	Total Cost to Residential Customers	Number of Commercial Customers Affected	Total Cost to Commercial Customers	Number of Industrial Customers Affected	Total Cost to Industrial Customers
Weekday	$1,166,016	24,835	$1,667,323	3,608	$36,925,198	1,534	$32,396,800
Weekend	$5,134,334	99,072	$9,735,480	4,693	$164,565,768	521	$72,437,728

An estimated 400,000 customers lost power in Florida as a result of Hurricane Michael,[13] resulting in a high-risk population of approximately 15,200 people in this scenario. The 50 fuel trucks in this scenario were each delayed by 1 to 4 hours. The 475,000 gallons of fuel being transported by these vehicles were enough to fuel 26,389 generators, over 11,875 ambulances, or over 7,308 firetrucks.

The 871 temporary housing units were each delayed by just over 2 days, predominantly due to the OS/OW permitting delays. This resulted in a delay of 3,484 people being placed in more permanent housing by an additional 2 days. Finally, the 10 mobile cranes were delayed by a range of 1 hour to almost 2.5 days. The total additional rental costs incurred were just over $14,500, and the costs of disruption to other emergency response activities were over $43,000.

Midwest Tornado

Scenario Description

The Midwest Tornado scenario was based on a tornado that landed in Joplin, Missouri, on May 22, 2011. Compared with the hurricane and tropical storm, the tornado had more localized effects, with a ¾-mile-wide and 6-mile-long path of damage through the City of Joplin.[14] Due to the scale of destruction and the fact that a regional hospital was destroyed, the city's resources were overwhelmed and required assistance from nearby States. Approximately 18,000 people lost power, and 8,000 buildings were damaged or destroyed. There were 1,100 responders from out-of-State, and 14,000 police cars, ambulances, and firetrucks were sent to Joplin from Illinois, Kansas, and Oklahoma, among other States.

This scenario represented a tornado with effects focused on a local community yet required assistance from other States. Major response efforts included search and rescue, providing medical care, providing shelter for those displaced, debris removal (including in search and

[13]Florida State Emergency Response Team, *Hurricane Michael.*

[14]U.S. Department of Homeland Security, Federal Emergency Management Agency, *The Response to the 2011 Joplin, Missouri, Tornado: Lessons Learned Study,* Washington, DC: FEMA, 2011. https://kyem.ky.gov/Who%20We%20Are/Documents/Joplin%20Tornado%20Response,%20Lessons%20Learned%20Report,%20FEMA,%20December%2020,%202011.pdf.

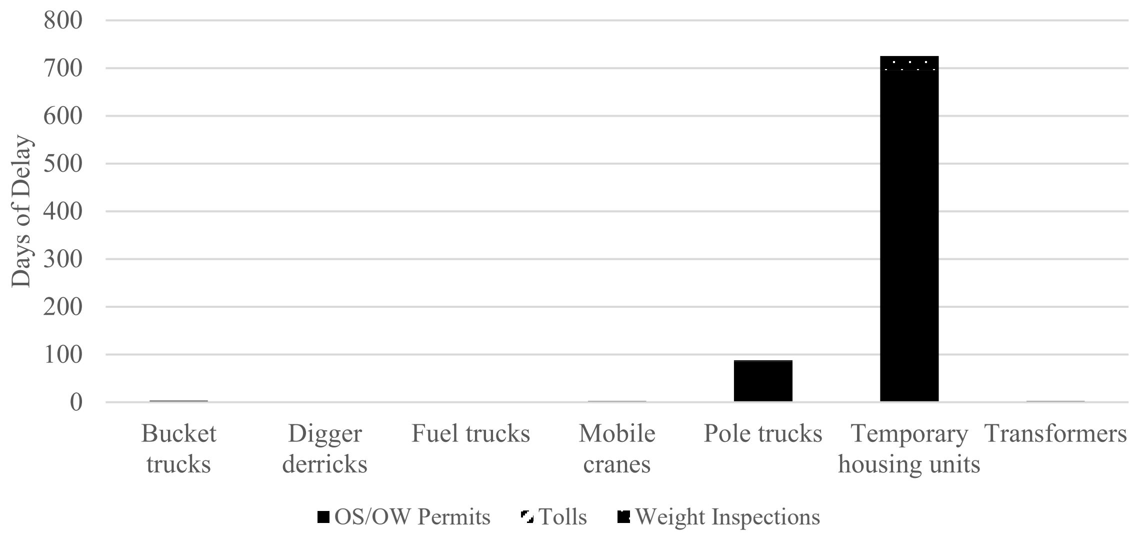
rescue operations), and restoring power. All vehicles in this scenario traveled to Joplin, Missouri, from the relatively nearby States listed in Table 5.

Table 5. Midwest tornado baseline routing scenario.

Number of Vehicles Traveling	Origin State	Baseline Transit Time (Hours)
• Temporary housing units: 348	Alabama	13
• Bucket trucks: 6 • Digger derricks: 2 • Pole trucks: 9 • Fuel trucks: 1	Colorado	13
• Bucket trucks: 6 • Digger derricks: 2 • Pole trucks: 9 • Fuel trucks: 1 • Mobile cranes: 1	Illinois	7
• Bucket trucks: 6 • Digger derricks: 2 • Pole trucks: 9 • Transformers: 1 • Fuel trucks: 1	Kansas	6
• Bucket trucks: 6 • Digger derricks: 2 • Pole trucks: 9 • Fuel trucks: 1	Nebraska	10
• Bucket trucks: 6 • Digger derricks: 2 • Pole trucks: 9 • Fuel trucks: 1	Oklahoma	5

Delays

The cumulative delays in the Midwest Tornado scenario were similar to the cumulative delays in the Florida Hurricane scenario. OS/OW permit transactions accounted for the majority of delays for applicable vehicles (Figure 6). Weight inspections contributed less to each vehicle's total transit time, given that all responding vehicles were traveling from States that were less than a 1-day drive away.



OS/OW = oversize/overweight

Source: FHWA.

Figure 6. Chart. Cumulative days of delay encountered by all vehicles in the weekday tornado scenario.

Effects of Delays

Delays in power restoration vehicles arriving in Missouri cost responding utilities an additional $370,116 (table 6). The economic cost to residential, commercial, and industrial customers was over $947,000, $16 million, and $838,000, respectively. The weekend scenario increased the additional costs to utilities to over $713,000, and the economic costs to residential, commercial, and industrial customers to over $1.7 million, $29.3 million, and $12.9 million, respectively.

Table 6. Effects of delayed power restoration vehicles in the tornado scenario.

Scenario	Total Cost to Utilities	Number of Residential Customers Affected	Total Cost to Residential Customers	Number of Commercial Customers Affected	Total Cost to Commercial Customers	Number of Industrial Customers Affected	Total Cost to Industrial Customers
Weekday	$370,116	6,135	$947,355	291	$16,016,551	7	$838,499
Weekend	$713,478	10,383	$1,735,489	491	$29,336,217	54	$12,913,068

An estimated 18,000 customers lost power in Missouri as a result of the 2011 tornado,[15] resulting in a high-risk population of approximately 684 people in this scenario. The five fuel trucks in this scenario were each delayed by 1 to 2 hours. The 50,000 gallons of fuel being transported by these vehicles were enough to fill 2,778 generators, 1,250 ambulances, or 769 firetrucks; however, given the minimal delay time, the effects of delayed fuel trucks were minimal.

[15]U.S. Department of Homeland Security, *The Response to the 2011 Joplin, Missouri, Tornado.*

The 348 temporary housing units in this scenario were each delayed by just over 2 days, leaving up to 696 displaced people without a more permanent housing situation for an additional 2 days.

Finally, the one mobile crane was delayed by 2 days, resulting in an additional rental cost of approximately $7,700. The additional cost of disruption to other emergency response activities was over $23,000.

West Coast Wildfire

Scenario Description

The West Coast Wildfire scenario was based on the Tubbs Fire that burned for about 3 weeks in Sonoma and Napa Counties in Northern California in October 2017.[16] Approximately 110,000 acres were burned, 100,000 people were evacuated, and 6,686 buildings were destroyed in Sonoma County.[17] This scenario represented a wildfire that affected a large area within a State. Major response efforts included containing the fire, providing temporary shelter for those displaced, providing medical care, debris removal, and power restoration. Table 7 details the total number of vehicles that traveled from each origin State to Sonoma County, California, in this scenario, as well as the baseline transit time for each vehicle type along each route.

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[16]County of Sonoma, *October 2017 Complex Fires: Emergency Operations Center After Action Report & Improvement Plan,* Sonoma, CA: County of Sonoma, 2018. https://sonomacounty.ca.gov/Main%20County%20Site/Administrative%20Support%20%26%20Fiscal%20Services/Emergency%20Management/Documents/_Documents/Sonoma-County-2017-Wildfires-EOC-AAR-FINAL-CORRECTED-6JUN2018.pdf.

[17]County of Sonoma, *October 2017 Complex Fires.*

Table 7. West coast wildfire baseline routing scenario.

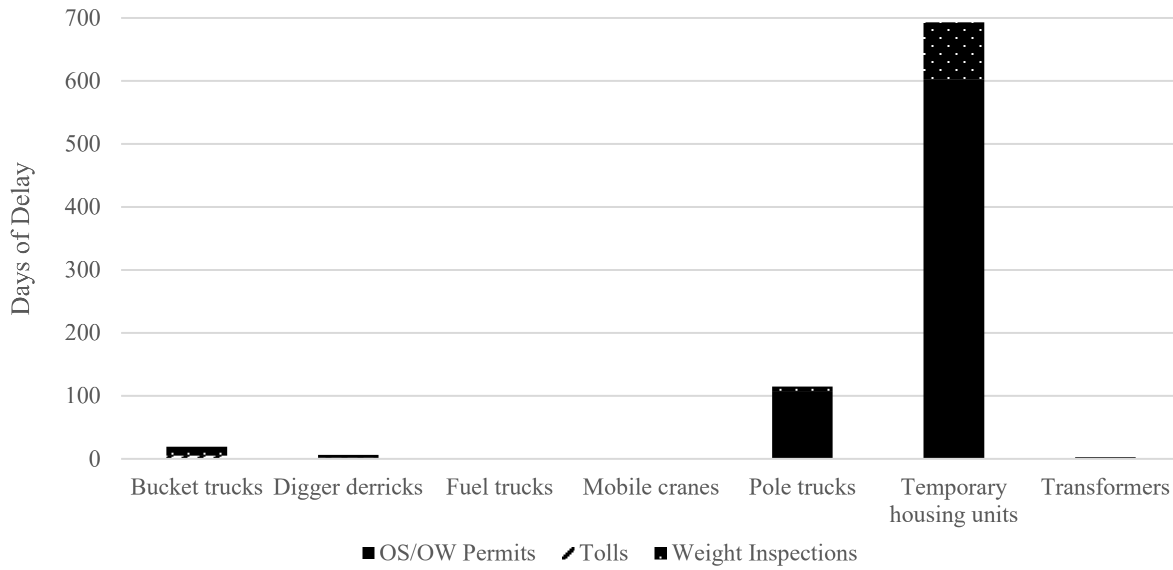
Number of Vehicles Traveling	Origin State	Baseline Transit Time (Hours)
• Temporary housing units: 151	Alabama	42
• Bucket trucks: 18 • Digger derricks: 6 • Pole trucks: 11 • Fuel trucks: 1	Kansas	29
• Temporary housing units: 151	Maryland	46
• Bucket trucks: 18 • Digger derricks: 6 • Pole trucks: 11 • Fuel trucks: 1	Minnesota	35
• Bucket trucks: 26 • Digger derricks: 9 • Pole trucks: 16 • Fuel trucks: 2 • Mobile cranes: 1	New Mexico	24
• Bucket trucks: 26 • Digger derricks: 9 • Pole trucks: 16 • Transformers: 1 • Fuel trucks: 2	Oregon	12

Delays

Similar to the Florida Hurricane and Midwest Tornado scenarios, delays from OS/OW permit transactions contributed the most to cumulative delay time (figure 7).

Because OS/OW permitting was not automated, an additional 2 days were added to the transit time for pole trucks, fuel trucks, and transformers traveling between States.

Although toll delays made up only a small fraction of cumulative delays, the 22 bucket trucks and digger derricks that were delayed from tolls in this scenario contributed a total of 7 days to cumulative delay time.



OS/OW = oversize/overweight

Source: FHWA.

Figure 7. Chart. Cumulative days of delay encountered by all vehicles in the weekday wildfire scenario.

Effects of Delays

As shown in Table 8, utilities paid an additional $560,918 in labor costs in this scenario due to delayed power restoration vehicles. The cost to customers from the delays that otherwise would have been avoided was $1.1 million for residential customers, $18.8 million for commercial customers, and $8.2 million for industrial customers. The cost to utilities increased to over $1.2 million in the weekend scenario, and the costs to utilities increased to $2.8 million, $36.1 million, and $15.9 million for residential, commercial, and industrial customers, respectively.

Table 8. Effects of delayed power restoration vehicles in the wildfire scenario.

Scenario	Total Cost to Utilities	Number of Residential Customers Affected	Total Cost to Residential Customers	Number of Commercial Customers Affected	Total Cost to Commercial Customers	Number of Industrial Customers Affected	Total Cost to Industrial Customers
Weekday	$560,918	10,270	$1,115,249	486	$18,851,863	54	$8,298,118
Weekend	$1,236,650	19,278	$2,800,725	775	$36,184,321.97	86	$15,927,431

An estimated 500,000 customers lost power in California due to the Tubbs Fire, resulting in a high-risk population of approximately 1,900 people in this scenario. The five fuel trucks were delayed by a range of 2 to 6 hours, and the 50,000 gallons of fuel they were transporting were enough to fuel 2,778 generators, 1,250 ambulances, or 769 firetrucks.

The delays experienced by the 301 temporary housing units left up to 1,204 people without a more permanent housing situation for a near additional 2.5 days.

Finally, the one mobile crane was delayed by just under 1 day, resulting in an additional rental cost of almost $3,000, and an additional cost of disruption to other emergency response activities of approximately $8,700.

Colorado Flood

Scenario Description

The Colorado Flood scenario was based on the 1,000-year rainfall event that resulted in flash floods and mudslides along Northern Colorado's Front Range in September 2013.[18,19] While Boulder County suffered the worst effects, the State experienced 200 miles of flooding spanning 18 counties, with over 17 inches of rainfall in some areas.[20] The flooding resulted in power outages for 10,113 customers, and gas service was suspended for 4,977 customers. Additionally, 18,000 people were evacuated, 17,882 structures were either damaged or destroyed, 150 to 200 miles of roadway were damaged, and an estimated 26,000 gallons of oil were spilled.

This scenario represented flash floods that affected a large area within a State. Major response efforts included search and rescue, providing temporary shelter for those displaced, providing medical care, clearing wooded areas to allow for the passage of land-based rescue vehicles and

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[18]Colorado Division of Homeland Security & Emergency Management, *After Action Report: State of Colorado 2013 Floods and Black Forest Fire*, Denver, CO: Colorado Department of Public Safety, 2015. https://dhsem.colorado.gov/sites/dhsem/files/documents/Colorado%202013%20Floods%20and%20Black%20Forest%20Fire_%20AAR_IP_Final_6_30_15%20%281%29.pdf.

[19]U.S. Department of Homeland Security, Federal Emergency Management Agency, *Integrated Incident Command: Colorado Floods 2013,* Washington, DC: FEMA, 2014. https://www.hsdl.org/?view&did=758185.

[20]Colorado Division of Homeland Security & Emergency Management, *After Action Report.*

the landing of air-based transports, and power restoration. Included in table 9 is the number of each vehicle type traveling from the determined origin States, as well as the baseline transit time for vehicles along each route.

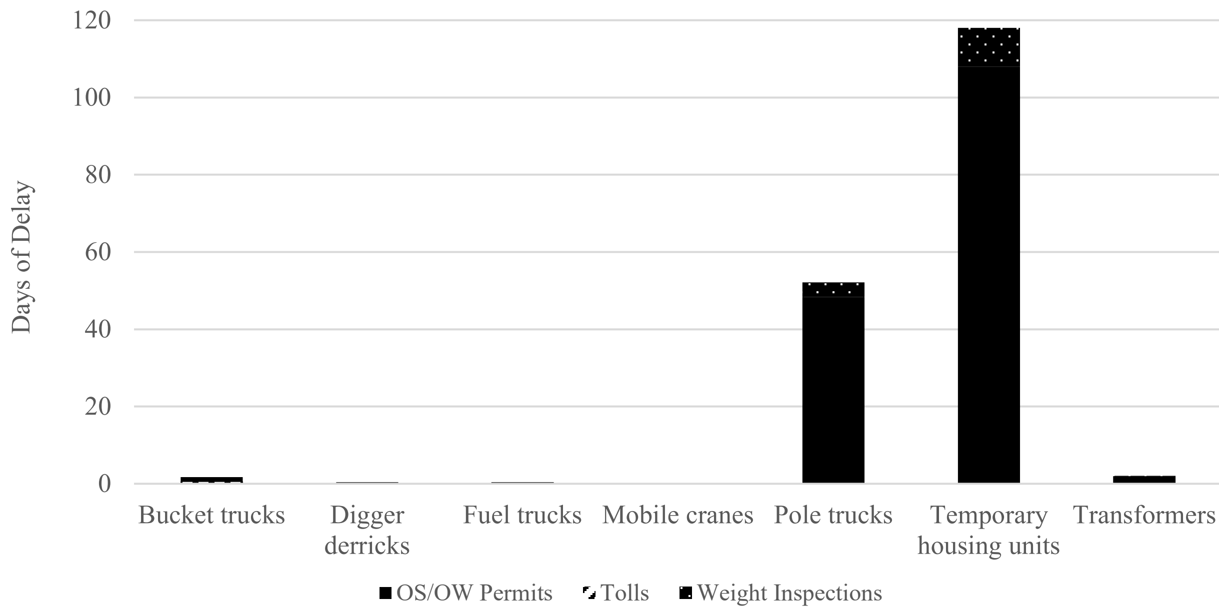
Table 9. Colorado flood baseline routing scenario.

Number of Vehicles Traveling	Origin State	Baseline Transit Time (Hours)
• Bucket trucks: 4 • Digger derricks: 1 • Pole trucks: 11 • Transformers: 1 • Fuel trucks: 1	Kansas	42
• Temporary housing units: 54	Maryland	27
• Bucket trucks: 4 • Digger derricks: 1 • Pole trucks: 11 • Fuel trucks: 1	Montana	11
• Bucket trucks: 4 • Digger derricks: 1 • Pole trucks: 11 • Fuel trucks: 1	South Dakota	11
• Bucket trucks: 4 • Digger derricks: 1 • Pole trucks: 11 • Fuel trucks: 1	Texas	15
• Bucket trucks: 4 • Digger derricks: 1 • Pole trucks: 11 • Fuel trucks: 1 • Mobile cranes: 1	Utah	10

Delays

Except for the temporary housing units coming from Maryland, all vehicles in this scenario traveled from States that were less than a 1-day drive away from Colorado. While most vehicles traveling either did not need an OS/OW permit or traveled through States with automated permitting, the majority of the cumulative delay time was still attributed to OS/OW permit transactions, and in particular, to the temporary housing units (figure 8). This was due to the large number of temporary housing units being transported to Colorado relative to other vehicle types.

Toll delays contributed a total of a half day of delay in this scenario since there was only one route with tolls and only two bucket trucks that experienced the toll delay.



OS/OW = oversize/overweight

Source: FHWA.

Figure 8. Chart. Cumulative days of delay encountered by all vehicles in the weekday flood scenario.

Effects of Delays

The delays to power restoration vehicles in this scenario resulted in an additional $221,523 to responding utilities (table 10). The economic costs to residential customers, commercial customers, and industrial customers were over $451,000, $7.6 million, and $3.3 million, respectively. The weekend scenario increased the costs to utilities to over $527,000 and the economic costs to residential customers, commercial customers, and industrial customers to $1.1 million, $19.8 million, and $8.7 million, respectively.

Table 10. Effects of delayed power restoration vehicles in the flood scenario.

Scenario	Total Cost to Utilities	Number of Residential Customers Affected	Total Cost to Residential Customers	Number of Commercial Customers Affected	Total Cost to Commercial Customers	Number of Industrial Customers Affected	Total Cost to Industrial Customers
Weekday	$221,523	4,184	$451,198	198	$7,626,938	22	$3,357,187
Weekend	$527,991	8,596	$1,176,275	407	$19,883,431	45	$8,752,188

An estimated 10,000 customers lost power in Colorado due to the 2013 floods,[21] resulting in a high-risk population of approximately 380 people in this scenario. The five fuel trucks were each delayed by a range of 1 to 2 hours. The 50,000 gallons of fuel they were transporting were enough to fuel 2,778 generators, 1,250 ambulances, or 769 firetrucks; however, given the small delay time, the effects of delayed fuel trucks were minimal. The delay experienced by the 54 temporary housing units resulted in 216 people lacking a more permanent housing situation for an additional 2 days. Finally, the one mobile crane was delayed by 2 hours, resulting in minimal additional rental and disruption costs totaling less than $1,000.

CONCLUSION

Findings

The goal of this study was to quantify the cost of delays that emergency response vehicles and equipment responding to natural disasters in other States might encounter in transit to their destination and to estimate the effects of those delays on emergency response activities.

Though each of the five scenarios in this study were unique in terms of the numbers of out-of-State emergency response vehicles and origin and destination of the vehicles, using the same vehicle types in each scenario revealed commonalities among each scenario. OS/OW permit transaction delays were the largest contributors of delays, both in terms of the additional transit time added to each vehicle as well as the resulting cumulative delay time across all vehicles. While all vehicles traveling were subject to weight inspections, and the likelihood of encountering a weight inspection increased as vehicles traveled farther distances, the large amount of delay time attributed to OS/OW permit transactions was particularly significant given that not all vehicles in this study were required to receive OS/OW permits. Across each scenario, OS/OW permit transactions added more time to an individual vehicle's total transit time than did weight inspections.

While many vehicles in this study were delayed by 1 or 2 days, the cumulative effects were significant. Monetary effects to utilities and their customers ranged from hundreds of thousands of dollars to millions of dollars. Adding just 1 additional day of delay to each vehicle significantly increased the monetary effects to utilities and their customers. Therefore, reducing the delay in obtaining OS/OW permits could contribute to the largest reduction in costs and effects associated with routing emergency response vehicles across State lines. The effects of delayed emergency response vehicles go beyond the monetary effects to utilities and their customers. Extended, widespread power outages also resulted in increased public health and safety risks in the affected community that were more difficult to quantify. Lack of electricity to power signalized intersections, ITS devices, and other electrified infrastructure elements can be a major cause of traffic delays in disaster areas, affecting emergency response times for all response vehicles, not just OS/OW vehicles. In general, past experience show that solutions including temporary stop signs and law enforcement direction at intersections are not effective.

Community risks could be lessened through rapid restoration of power. In addition to the previously discussed effects, other public health and safety effects can include:

[21] Colorado Division of Homeland Security & Emergency Management, *After Action Report.*

- An increased reliance on at-home generators, which may be improperly used and can lead to carbon monoxide poisoning
- Food and water safety issues due to lack of refrigeration, running water, and sewage services
- The inability to call for help due to downed communication services[22]

There are also a variety of equipment delays that can cause problems in effective emergency response:

- Delays in fuel trucks can result in fuel shortages for generators, private vehicles, and emergency response vehicles.
- Delays in temporary housing units can result in those who have lost their homes or have otherwise been displaced as a result of a natural disaster to be without a permanent shelter for a longer period of time, causing additional stress for displaced families, as well as on temporary shelters and the resources required to sustain them.
- Delays in mobile cranes can result in further delays to emergency response activities if they are required to clear debris blocking critical roadways and infrastructure.

Recommendations

While every community hit by a natural disaster will inevitably experience some of the discussed effects, costs, and risks, recommendations for reducing these effects are outlined below:

- Encourage and assist States in implementing automated permitting systems for OS/OW permits.
- Encourage State DOTs to include information on how to obtain IRP, IFTA, and OS/OW permits during off-hours on their websites.
- Encourage State DOTs to expedite weight and roadside safety inspections for emergency response vehicles or defer inspections until after the emergency.
- Encourage State DOTs to implement cashless tolling or allow reimbursement of tolls for emergency response vehicles.

Given that research has shown that reducing delays in obtaining OS/OW permits would likely result in the greatest reduction in costs and other effects associated with routing emergency response vehicles across State lines,[23] the need for all States to implement and use the full functionality of automated permitting systems is urgent. Manual permit systems can delay issuance of permits by as much as a week, and these delays can be exacerbated due to road closures on the permitted route that the State permitting authority or driver was unaware of.

Full routing and permitting automation functions include the ability of the permitting system to issue valid, routed OS/OW permits without human intervention. The dimensional envelope for this self-issue function is under the control of the State jurisdiction; however, encouragement

[22]Chaamala et al., "Power Outages, Extreme Events and Health."
[23]Laurence O'Rourke, Emily Klotz, and Jeff Purdy. *Multi-State Emergency Route Scenario Study of Vehicle Delays*, FHWA-HOP-21-020, Washington, DC: FHWA, 2022.

related to automated systems would ideally include urging States to broaden the parameters of the system settings to the greatest extent practicable. Several States that have automated permitting systems set system constraints at such a low level that only minimal efficiencies can be realized. Some States choose not to turn on the self-issue aspect of the automated system, which can be particularly impactful to those seeking an emergency permit at night, over the weekend, and during holidays. The focus of all OS/OW stakeholders in the emergency response domain ideally will focus on changing these choices during times of emergency response moves, at minimum.

Overweight divisible loads that are authorized by permit to move cargo in emergency response would obtain their permits through the same automated OS/OW systems. The weight aspect is seen by most as applying simply to the gross weight of the vehicle, but as the stakeholder community continues working to find solutions that will expedite emergency response, finding acceptable axle weight limits for common axle configurations that can be agreed to among the States could significantly decrease delay in delivery of supplies arriving where they are needed. Reaching consensus on such overweight axle weight tolerances has the added benefit of potentially being applied to trucks hauling debris from the emergency site as well. Removal of debris, in some cases, is directly relevant to providing emergency services and restoring power and water, which factor into both emergency response and recovery as well as community health and wellbeing.

Routing discussions address State and national networks and many highway attributes associated with each, but firmly established static emergency routes can be problematic. For example, construction that was already underway when an emergency occurs may result in a route that is in such a state of disrepair that continued use is no longer possible. In addition, restricted-weight bridges are not attributes listed in routing preferences, nor are toll roads, many of which are not owned by State transportation agencies. These considerations should be addressed in a long-term solution focused on emergency routing. They also provide additional justification for automated permitting systems, which do have restricted travel locations, including construction and weight restricted bridges, calculated into the determination of route and, in most cases, may be done in a matter of seconds, further reducing delay caused by unexpected highway conditions.

One factor in congestion delays in transporting very large loads is a lack of enforcement personnel to escort the load(s). Enforcement personnel resources have rapidly decreased in recent years, and this has had an effect on timely delivery within a disaster area. One solution might be advanced training for private certified escort vehicles.

Although not explored in this study, congestion delays contribute to delays in routing emergency response vehicles to their destination, and reductions in delay would likely result from the above solutions.

FHWA's Transportation Systems Management and Operations strategies and Incident Management Strategies available at: https://ops.fhwa.dot.gov/tim/, offer methods for mitigating congestion delays that can be implemented for emergency response vehicles, including:

- Allowing emergency response vehicles to travel on shoulders, in high-occupancy vehicle, toll, and other managed lanes and bypass ramp meters.

- Utilizing dynamic lane assignment for the dedicated use of emergency response vehicles.
- Employing signal preemption, which interrupts normal traffic operations to give emergency response vehicles the right-of-way over nonemergency response vehicles.
- Working with law enforcement officials to escort emergency response vehicles through congested urban areas.

While these strategies may already be in use for traditional emergency response vehicles, such as ambulances and firetrucks, these practices are not typically available for some vehicles in this study, such as bucket trucks and pole trucks. Therefore, extending these strategies to more vehicle types could further assist in reducing delays and their associated effects.

The continued certainty of future natural disasters requires continued advancement of solutions for emergency response and recovery. Enhancing resilience supports the goals of the National Highway Freight Program to improve the safety, security, efficiency, and resiliency of the transportation system and the Nation.

CHAPTER 4. AUTOMATED PERMIT SYSTEMS

Permits are often required from multiple States for OS/OW vehicles. Obtaining permits for an entire route may be delayed by a single State that does not have an automated permitting system. Manual permit processing procedures can cause significant delays, especially if an emergency occurs over a weekend or holiday. For vehicles responding to an emergency, obtaining single-trip permits for OS/OW vehicles may be the most significant source of delay.

Delays in obtaining OS/OW permits, particularly during nonbusiness hours, over holidays, or when permitting offices are very busy, can delay the movement of vehicles engaged in emergency response and recovery. For those responding to an emergency, the capability to have access to an online system that can autoissue permits and is operational 24 hours per day, 7 days per week can prevent significant delays in obtaining permits.

The next section assesses automated permitting systems in the United States, followed by a section that evaluates bridge clearance data in the NBI that can help enhance automated permitting.

ASSESSMENT OF AUTOMATED PERMIT SYSTEMS

Based on the recommendation of the ERWG to encourage the adoption of automated permitting systems, FHWA assessed automated permitting systems. A key source of delay is that emergencies do not only happen during the weekday when permitting offices are open. Emergencies can happen over the weekend or on holidays. In some cases, it may be difficult to get a permit if one needs to get a manual intervention from the permitting official. In some cases, there are emergency numbers available to reach permitting officials during nonbusiness hours, but people may not always know about them or know how to get the help they need to obtain permits outside of business hours. An effective solution is permit automation that can provide autoissued permits. These systems allow a user to log on to a website, obtain a permit, and print it out.

The first step in the assessment process was to understand the current state of permit automation across the country. Permit automation can be defined in different ways. Automation can occur in:

- Accepting information online
- Analyzing the route
- Processing
- Issuing permits

Table 11 shows information available as of the beginning of 2020 for State automated permit systems. Approximately 36 States had automated permitting systems for OS/OW vehicles. These systems allow a fleet manager to apply and receive a permit online for vehicles exceeding the legal weight or dimensional envelope.

The table below shows the specific thresholds (width, height, length, weight) for which systems can autoissue permits. In general, dimensions and vehicle weights closer to the Interstate systems standards are more likely to be able to use automated permitting across multi-State routes. The heaviest and most oversize loads are riskier, and all States with automated permit systems set a threshold for permit automation that requires manual intervention for extreme loads.

FHWA examined which States met or exceeded the common threshold of 14-ft high, 14-ft 6-inches wide, 110-ft long, and 150,000 lb. There are at least 20 States that meet this threshold, but most East Coast States do not autoissue permits to this threshold. Multi-State cross-country routes are significantly restricted by States that do not meet the threshold. For instance, the States around Florida do not meet this threshold.

Table 11. U.S. jurisdiction oversize/overweight automated thresholds, 2020.

State	Auto Issue Permits	Width	Height	Length	Weight
AK	No	-	-	-	-
AL	No	-	-	-	-
AR	Yes	14 ft	14 ft	90 ft	120,000 lb
AZ	Yes	14 ft	16 ft	120 ft	250,000 lb
CA	No	-	-	-	-
CO	Yes	14 ft	15 ft 3 inches	110 ft	150,000 lb
CT	No	-	-	-	-
DE	No	-	-	-	-
FL	Yes	16 ft	18 ft	150 ft	Tractor-Trailer, 199,000 lb; Crane, 140,000 lb
GA	Yes	16 ft	16 ft	100 ft	150,000 lb
HI	No	-	-	-	-
IA	Yes	11 ft	14 ft 6 inches	120 ft	120,000 lb
ID	Yes	18 ft	16 ft	120 ft	250,000 lb
IL	Yes	16 ft	17 ft	200 ft	299,000 lb
IN	Yes	16 ft	3 inches less than lowest VC on route – 15 ft	110 ft	120,000 lb
KS	Yes	16 ft 6 inches	15 ft	126 ft	120,000 lb
KY	Yes	8 ft 6 inches	13 ft 6 inches	Legal	120,000 lb
LA	Yes	16 ft	15 ft 6 inches	125 ft	232,000 lb
MA	Yes	12 ft	13 ft. 6 inches	80	130,000 lb
MD	Yes	13 ft	14 ft. 6 inches	90 ft	200,000 lb
ME	Yes	16 ft 1 inches	16 ft	125 ft	177,000 lb (depends on axles/spacings)
MI	No	-	-	-	-

VC = vertical clearance.; - = not applicable.

Table 11. U.S. jurisdiction oversize/overweight automated thresholds, 2020. (continuation)

State	Auto Issue Permits	Width	Height	Length	Weight
MN	Yes	14 ft 6 inches	14 ft 6 inches	110 ft	36,000 lb tandem; 54,000 lb tridem
MO	Yes	16 ft	16 ft	150 ft	160,000 lb
MS	Yes – Daylight	16 ft	15 ft 6 inches	120 ft	180,000 lb
	Yes – 24-hour movement	12 ft	13 ft 6 inches	99 ft	150,000 lb
MT	Yes	18 ft	17 ft	150 ft	175,000 lb noninterstate, 250,000 lb interstate
NC	No	-	-	-	-
ND	Yes	18 ft	17 ft	200 ft	250,000 lb
NE	Yes	16 ft 1 inches	16 ft	150 ft	180,000 lb
NH	Yes	15 ft	13 ft 6 inches	110 ft	149,999 lb
NJ	Yes	No trigger	15 ft	100 ft	250,000 lb
NM	Yes	16 ft	15 ft 5 inches	120 ft (trailer not > 90 ft)	170,000 lb (no axle width > 8 ft 6 inches)
NV	No	-	-	-	-
NY	Yes	16 ft	13 ft 11 inches	99 ft 11 inches	Load effect over 150% of an HS 20 vehicle[1]
OH	Yes	14 ft	14 ft 6 inches	No limitation	160,000
OK	Yes	16 ft	15 ft	110 ft	200,000 lb, as long as profile matches OL-1 drawing[2]
OR	No	-	-	-	-
PA	Yes	16 ft	-	160 ft	201,000 lb
RI	No	-	-	-	-
SC	No	-	-	-	-

Table 11. U.S. jurisdiction oversize/overweight automated thresholds, 2020. (continuation)

State	Auto Issue Permits	Width	Height	Length	Weight
SD	Yes	14 ft	18 ft	100 ft	130,000 lb
TN	Yes	16 ft	14 ft 6 inches	-	150,000 lb
TX	Yes	20 ft	18 ft 11 inches	125 ft	254,300 lb
UT	Yes	14 ft	14 ft 6 inches	105 ft	125,000 lb.
VA	Yes	14 ft	14 ft	100 ft	115,000 lb
VT	No	-	-	-	-
WA	Yes	16 ft	16 ft	125 ft	200,000 lb
WI	Yes	14 ft	14 ft 6 inches	125 ft	250,000 lb
WV	Yes	16 ft	15 ft	150 ft	250,000 lb
WY	No	-	-	-	-

- = not applicable.
[1]This is the term used by the American Association of State Highway and Transportation Officials to describe normal moving traffic loading conditions up to 18-wheeler loading. This loading assumes a 16,000-lb wheel load and therefore a 32,000-lb axle load.
[2]Refers to the permitted configurations for standard overweight permit trucks issued by the Oklahoma DOT. See https://www.odot.org/bridge/lpb/pdfs/brd_ol-1_truck_standards.pdf for more details.

PRELIMINARY RESEARCH ON THE NATIONAL BRIDGE INVENTORY

Introduction

The ERWG report noted the need to add data fields to the National Bridge Inventory (NBI) to enhance permit automation and provide needed standardization. Providing these additional data fields would enhance the ability of the Federal Government to develop multi-State emergency route maps for emergency response and recovery vehicles and equipment. The new data fields relate to vertical and horizontal clearances of dual carriage ways underneath structures.

The purpose of this section is not to present a comprehensive study or feasibility analysis, but rather to examine the need to add new NBI fields, provide summary information on factors that may affect addition of new NBI fields, data collection and processing requirements, additional support needed for State DOTs, additional costs incurred by FHWA and State DOTs, existing initiatives within FHWA, and likely efforts that could be undertaken.

National Bridge Inventory Database

FHWA's NBI is a database that stores condition and inventory data for approximately 621,000 highway bridges across the United States. The National Bridge Inspection Standards (NBIS) define highway bridges as all structures located on all public roads, on and off Federal-aid highways, including tribally owned and federally owned bridges, private bridges that are connected to a public road on both ends of the bridge, temporary bridges, and bridges under construction with portions open to traffic.

A bridge is defined as a structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between under copings of abutments or spring lines of arches, or extreme ends of openings for multiple boxes; it includes multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

The NBIS provides two methods for determining the interval at which bridges receive routine, underwater (UW), and nonredundant steel tension member (NSTM) inspections where most condition and inventory data is collected.

Method 1 is a simplified assessment of risk that classifies each bridge into one of three categories – reduced interval, regular interval, and extended intervals. Method 2 is a more rigorous method that classifies each bridge, or a group of bridges, into risk categories with associated inspection intervals:

- Routine Inspection:
    - Method 1 – not to exceed 12 months, 24 months, or 48 months
    - Method 2 – not to exceed 12 months, 24 months, 48 months, or 72 months
- Underwater Inspection:
    - Method 1 – not to exceed 24 months, 60 months, or 72 months
    - Method 2 – not to exceed 24 months, 60 months, or 72 months
- NSTM Inspection:
    - Method 1 – not to exceed 12 months, 24 months, or 48 months
    - Method 2 – not to exceed 12 months, 24 months, or 48 months

The bridge data are submitted by States and updated in the NBI database annually. NBI data are provided by States and are used for bridge asset management, safety, compliance evaluations, and reporting purposes. The NBI database is informed by the bridge inspections performed by the States based on the inspection intervals determined for each bridge.

Findings of Preliminary Research on the National Bridge Inventory

Review of National Bridge Inventory

This review focused on the following aspects of the NBI:

- Existing NBI fields related to vertical and horizontal clearances of dual carriage ways underneath structures

- Adequacy of existing NBI fields to enhance permit automation, map emergency routes, and provide needed standardization

- Additional national and regional databases to supplement existing NBI fields of vertical and horizontal clearances

National Bridge Inventory Fields for Vertical and Horizontal Clearances of Dual Carriage Ways Underneath Structures

The May 6, 2022, update to the NBIS incorporated new Specifications for the National Bridge Inventory (SNBI) by reference. The SNBI will be fully implemented by March 15, 2028, in accordance with the memorandum "Implementation of the Specifications for the National Bridge Inventory issued May 25, 2022.

The new NBI specifications include new/revised clearance fields, such as roadway maximum usable vertical clearance; roadway minimum vertical clearance; roadway minimum horizontal clearance, left; and roadway minimum horizontal clearance, right. These clearance items are reported for the highway features associated with each bridge. Features have a many-to-one relationship with a bridge so there may be multiple highway features with different clearance values requiring analysis. A description of these fields is presented in table 13.

Table 12. Additional clearance fields included in the draft National Bridge Inventory specifications.

NBI Field	Description
Item B.H.12—Highway Maximum Usable Vertical Clearance	• Used to report the minimum vertical clearance measured over the 10-ft-wide envelope of the traveled part of the highway that provides for the maximum usable clearance envelope, rounded down to the nearest tenth of a foot. • These data may not represent the absolute minimum clearance over the highway feature. Refer to Item B.H.13 (Highway Minimum Vertical Clearance) for the absolute minimum clearance. • These data may be different than the posted vertical clearance due to agency vertical clearance posting policies and procedures. • These data are not sufficient for permit routing as the location of the 10-foot-wide envelope that provides for the maximum usable clearance is not reported. • Reporting this item is optional for highway features below the bridge that do not carry NHS routes as identified in Item B.H.03 (NHS Designation).
Item B.H.13—Highway Minimum Vertical Clearance	• Used to report the minimum vertical clearance measured over the highway feature, rounded down to the nearest tenth of a foot. • These data may be different from the posted vertical clearance due to agency vertical clearance posting policies and procedures.
Item B.H.14—Highway Minimum Horizontal Clearance, Left	• Used to report the minimum horizontal clearance on the left of the highway feature rounded down to the nearest tenth of a foot. • This item is measured from the left edge line of the highway (excluding shoulders, turn lanes, acceleration, or deceleration lanes) in the direction of travel to the nearest substructure unit, rigid barrier, oncoming traffic lane, or toe of slope that is steeper than 1 to 3 (vertical to horizontal). • This item is applicable when the highway feature is located below the bridge.
Item B.H.15—Highway Minimum Horizontal Clearance, Right	• Used to report the minimum horizontal clearance on the right of the highway feature rounded down to the nearest tenth of a foot. • This item is measured from the right edge line of the highway (excluding shoulders, turn lanes, acceleration, or deceleration lanes) in the direction of travel to the nearest substructure unit, rigid barrier, oncoming traffic lane, or toe of slope that is steeper than 1 to 3 (vertical to horizontal). • This item is applicable when the highway feature is below the bridge.
Item B.H.16 – Highway Maximum Usable Surface Width	• Used to report the maximum usable surface width for a highway feature that passes below or is carried on the bridge, rounded down to the nearest tenth of a foot. • This item is measured perpendicular to the centerline of the highway (including paved or stabilized shoulders).

Source: Federal Highway Administration (FHWA). *Specifications for the National Bridge Inventory*. ID: FHWA-HIF-22-017. Washington DC: 2022.

Supplemental Databases: An Example of Virginia Department of Transportation's Permitting Process and Use of Clearance Data

The Virginia Department of Transportation (VDOT) was reviewed as an example of how State bridge clearance dimension data can be used to support oversize vehicle permitting. VDOT uses the AASHTOWare® Bridge Management™ as the resource for the vertical and horizontal clearance data and has standard query and reporting tools for managing and manipulating data in the database. The State agency determined that permitting decisions required more information than currently reported in the NBI database and that using the minimum clearance dimensions across multiple roadways was overly restrictive in decisionmaking. VDOT collects additional data to support oversize vehicle permitting. To provide timely information on bridge clearances to the trucking community, VDOT collects clearance information for up to two carriageways for "each" distinct travelway beneath a structure.

VDOT now collects bridge data using field inspections and updates its bridge inventory and management database, as needed, after each safety inspection. The State agency populates its database every time an inspection occurs and submits the data to FHWA for NBI data population purposes once per year. VDOT's bridge inventory and management database contains State fields to capture the minimum horizontal and vertical clearances under each applicable roadway beneath a structure; the fields are checked and updated as needed at each inspection cycle at prescribed intervals (typically 24 months). VDOT may also perform intermittent updates to the database contingent on incidents or other unusual circumstances such as bridge strikes, temporary maintenance events such as painting, permanent changes such as increased paving thickness beneath the bridge, or high-water events.

To map Virginia data to the NBI database, VDOT developed a Linear Referencing System (LRS), which can be purchased commercially, to display roadway centerlines. Using a data integration project, VDOT aligned selected fields from its NBI data to display on the LRS (i.e., route name, begin measure, end measure). The integrated data can be used to create a route event in a geographic information system (GIS) (by creating a GIS layer), enabling display of data for specific bridges along the desired route.

Observations and Future Research

There is a need to use data from other agencies, such as State DOTs, in conjunction with NBI data to help provide more comprehensive data on bridge clearances. Below are some suggestions to consider:

- Further research can be done to better understand the data needs for emergency routes and the interface with OS/OW permitting systems.
- Coordination with State DOTs can identify relevant clearance fields in State DOT bridge management databases that could provide more real-time clearance information to road users on a statewide basis.
- Minimum and maximum vertical clearance fields in the NBI could be used to provide the trucking industry with the expected range of clearance values along the route, particularly if visually presented through multi-State emergency route maps for emergency response and recovery vehicles and equipment.

CHAPTER 5. FACILITATE UNDERSTANDING OF REGULATIONS AND REQUIREMENTS

This section presents the findings from the study that seeks to provide information that can facilitate the large-scale movement of relief equipment during an emergency. FHWA assembled the information presented here based upon the recommendation of the ERWG to minimize impediments to expeditious State approval of special permits for vehicles involved in emergency response and recovery.

INTRODUCTION

Responses to disasters rely heavily on the timely receipt of equipment and workers from other States, such as when electric utilities send trucks, equipment, and staff to restore energy infrastructure after a hurricane. Staff at these companies may not have experience moving their equipment across State lines and may be unfamiliar with the State and Federal requirements for doing so. Emergency responders may encounter obstacles that add time and expense when efficient delivery of resources is critical.

FHWA has developed a document called *Resources for Commercial Vehicles Involved in Emergency Response* that summarizes some of the regulations that can affect trucks and drivers traveling across State lines to support emergency response and recovery efforts. This document provides a summary of the requirements, who must comply, what drivers need to do, and what types of emergency permits may be available. The regulations and requirements reviewed in the document include the following:

- Size and weight regulations (23 U.S.C. 127 and 23 CFR part 658)
- IRP requirements
- IFTA requirements
- Motor carrier identification number requirements (USDOT Number) (49 CFR part 390)
- Hours-of-service regulations (HOS: 49 CFR part 395)
- Other Federal Motor Carrier Safety regulations (49 CFR parts 390–399)
- Federal hazardous materials regulations (49 CFR parts 100–180)

The *Resources for Commercial Vehicles Involved in Emergency Response* is available on the FHWA website at: https://ops.fhwa.dot.gov/publications/fhwahop21009/fhwahop21009.pdf.

UNDERSTANDING EMERGENCY AND DISASTER DECLARATIONS, WAIVERS, AND EMERGENCY PERMITS

Regulatory and permit relief is often provided for the transportation of needed services and supplies in times of emergency. This can come in many forms, including declarations, waivers, blanket permits, immediate waivers, and emergency permits. This relief is provided by different Federal and State agencies and may apply to different types of relief supplies, vehicles, or roadway types (interstates, State highways, etc.). The terminology and meaning of different types of relief (temporary emergency permitting, waiver, blanket permit, etc.) may not always be clear to those operating vehicles for emergency response and recovery operations. The *Resources for*

Commercial Vehicles Involved in Emergency Response clarifies the different types of relief provided, whom it applies to, and some of the terminology used. Through a better understanding of the terminology used, emergency response and recovery managers can better use the available relief.

Emergency Declarations Overview

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Pub. L. No. 93-288, 42 U.S.C. 5121 et seq.) provides authority to issue disaster relief and emergency assistance in the form of national emergency and major disaster declarations. Generally known as the Stafford Act, it authorizes the President to provide financial and other forms of assistance to eligible State and local governments. The Stafford Act describes the declaration process, the types and extent of assistance that may be provided, and assistance eligibility requirements.

The *Resources for Commercial Vehicles Involved in Emergency Response* explains the process for emergency and major disaster declarations as defined in 42 U.S.C. 5122.

- A major disaster declaration is used for events of the highest severity in damage. It is initiated through the Federal Emergency Management Agency (FEMA) with a request by a State governor to the President, in accordance with the Stafford Act and its implementing regulations. The governor bases the request on a finding that the situation is of such severity and magnitude that an effective response is beyond the State, local, and tribal government capabilities and that Federal assistance is necessary to supplement the efforts and available resources from the State.

- A national emergency declaration is reserved for less severe instances. The process for requesting an emergency declaration is similar to the process for requesting a major disaster declaration, except the time in which to submit an emergency declaration request generally is shorter. The request must be submitted within 5 days after the need for assistance becomes apparent, but no longer than 30 days after the incident has occurred.

Procedural information regarding the Stafford Act declaration process is available from FEMA at https://www.fema.gov/disaster/how-declared.

Types of Waivers, Permits, and Exemptions

The *Resources for Commercial Vehicles Involved in Emergency Response* explains several different types of regulatory and permitting relief, including the following:

- Immediate waiver
- Nonwaivable regulation
- Special overweight divisible load permit
- Emergency blanket permits
- Exemptions
- Hazardous materials emergency special permits
- Toll waivers
- Weigh station bypass

Some of this relief is provided by States and some by Federal agencies. The definitions and terminology associated with these waivers, special permits, emergency blanket permits, and other mechanisms used to provide relief are described in the resource document.

TRIP PLANNING

Emergency responders, including utility convoys, face many challenges in planning and implementing response and recovery operations. The *Resources for Commercial Vehicles Involved in Emergency Response* provides a checklist to help aid in trip planning for emergency responders, preparing to travel to a destination, and providing disaster relief supplies and services. The questions posed in this checklist allow for drivers and fleets to think over and discuss if they have obtained the needed vehicle registration, identification, and/or permits. In addition, the checklist can help fleet managers to think through the trip procedures they need to use.

CASE STUDIES

Important lessons can be learned by examining how other agencies have overcome past challenges and the circumstances they have faced. The *Resources for Commercial Vehicles Involved in Emergency Response* provides other resources that emergency responders can use to improve emergency logistics. Each of these case studies provides at least one relevant takeaway for those trying to improve emergency routing, including:

- **Be aware of relevant State legal exemptions:** Examples are provided of State legal exemptions. Many States provide similar exemptions to facilitate emergency routing.
- **Take advantage of the provision of information about waivers:** During Hurricane Sandy, permitting offices provided information to vehicle operators and managers to understand what waivers were available to them.
- **Understand related convoy procedures used by others:** Examples are provided of procedures for military convoys, utility convoys, and commercial carrier convoys.
- **Consider commercial technology and services if applicable:** Commercial permitting services and weigh station bypass technology applications could be relevant in some cases.

CHAPTER 6. PRECLEARANCE PROCESS

INTRODUCTION

The ERWG report included the recommendation that the Secretary should encourage the development of a preclearance process that preidentifies a set of vehicles that are part of response and recovery. This process could allow for coordinated approval of a convoy of emergency response vehicles and provide the convoy of preidentified vehicles with certain privileges, including expedited inspection or pass-through permission at weigh stations. The ERWG report also included recommendations for States to designate emergency corridors that could accommodate certain widths and lengths of oversize vehicles, based on common dimensions of OS/OW vehicles used in emergency response, and corridors that size- and weight-conforming vehicles could use with standardized permits.

The Preclearance Processes Study, summarized here, analyzed existing processes followed by the U.S. military to assess the feasibility of a preclearance process for emergency response and recovery vehicles. The study described how military vehicles are precleared and suggests how such a system could be applied to nonmilitary vehicles responding to an emergency.

Military Convoy Deployment Processes

There are three major phases of a typical military deployment, as outlined in the 2005 FHWA publication, *Coordinating Military Deployments on Roads and Highways: A Guide for State and Local Agencies*. This study addresses the components of these three phases that relate to the movement of OS/OW vehicles, which require special permission (e.g., permits) to travel on public roadways. These components could be applied to the movement of nonmilitary OS/OW response and recovery vehicles.

MILITARY CONVOY PROCEDURES

The expeditious movement of military equipment on the National Highway System is central to the Department of Defense's (DOD's) enduring mission of providing military forces needed to deter war and to protect the security of the Nation.[24] These operations are executed through various modes of transportation, including shipment by rail, maritime, air, and on-road transportation. The military organizes equipment and personnel into convoys for travel on public roads and communicates with States to protect the public's safety and minimize disruption of civilian transportation while the military convoys are in transport. Cooperation between the military and Federal, State, and local government agencies is essential for safe and successful military convoy deployments.

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[24]U.S. Department of Defense, Summary of the 2018 National Defense Strategy of the *United* States of America: Sharpening the American Military's Competitive Edge, Washington, DC: DOD, 2018. https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.

Convoy Communications Phase

Convoy vehicles with dimensions and weights that are within the legally allowed OS/OW thresholds do not need OS/OW permits to travel on public roadways and do not necessarily need permission from or coordination with States to travel on public roadways as part of a convoy. Because convoy movement can affect civilian travel, clear responsibilities within the military and Federal, State, and local government agencies provide channels of communication to share information, plan, and operate military convoy deployments.

State Defense Movement Coordinators

State Defense Movement Coordinators (DMCs) are appointed National Guard positions within the office of the State Area Command. DMCs are a vital link between the military and States because they are responsible for processing military vehicle convoys at the State level. DMCs operate the State Movement Coordination Center, which receives and approves convoy movements on public roadways and resolves any conflicts between different convoy requests. Once a convoy has been established, the DMC creates a route for the convoy, identifies OS/OW vehicles, and provides a Convoy Movement Order (CMO). DMCs communicate with each other when a CMO moves through multiple States. The DMC in the State (or installation) where the convoy was initially planned notifies the DMCs in all other States that the CMO travels through. The DMCs coordinate with their State permitting officer to obtain permits for OS/OW vehicles.

State Departments of Transportation

The States work with the military to help confirm that the desired routes are passable for the type and amount of equipment to be moved as part of the convoy. Individual States issue permits to the military for vehicles using the public roadway system, and a State permitting officer is designated to coordinate with the DMC to confirm that height and weight clearance information is accurate and current for the areas that a military vehicle plans to pass through (or might alternately pass through) as part of a contingency route.

Traffic Management Centers

Traffic management centers' (TMCs') primary responsibility is to monitor normal traffic conditions and operations, including special events, such as military convoys and their implications for travel conditions. After the DMCs provide notification to the State of military convoys, the States will typically notify the TMC. The goal is that during convoy movement, the TMC is aware of the convoy's preferred route and which vehicles are part of the convoy. As TMC operators monitor traffic, they communicate with the DMC about traffic patterns and anticipated delays based on slowing traffic. Convoy movement typically does not change TMC operations, but TMC information is valuable to convoy leaders, and this information can help the DMC and other convoy planners to determine whether the route should be changed under certain traffic circumstances.

Emergency Operations Centers

Emergency operations centers (EOCs) are physical or virtual locations that support emergency responses by convening decisionmakers and providing them with consistent and current information to support their development of a coordinated response. Federal, military, and civilian agencies all use EOCs to control aspects of emergencies and to communicate with each other. Plans and contacts for EOCs need to be established and maintained routinely in order for the responsible parties to be prepared and capable to respond to an emergency.

Convoy Planning Phase

The U.S. military maintains an internal computer system, the Transportation Coordinators'—Automated Information for Movements System II (TC-AIMS II) to manage military convoy movements. DMCs use TC-AIMS II to receive and approve convoy movement requests, route convoys, and issue CMOs. CMOs are required by DMCs to include requests for special hauling permits for OS/OW vehicles included in the convoy. Vehicles that are OS/OW may significantly influence the convoy's route and effect on the public roadways, including safety for civilian travelers along the public roadways. Identifying OS/OW vehicles and determining the convoy route is necessary to determine how the existing process operates and how it could be improved.

Identifying Oversize/Overweight Convoy Vehicles

Length, width, and weight of largest or heaviest vehicles in each convoy is used to determine the need for special routing instructions for convoy vehicles and to ensure that vertical and horizontal clearance of potential obstacles and roadway weight limitations on the planned route are met. TC-AIMS II includes a catalog of sizes and weights of military vehicles. The large inventory of vehicles in the Joint Equipment Characteristic Database includes different variations of a single vehicle type (size and weight of an unarmed versus an armed vehicle of the same class or model). Some military bases have weigh-in-motion scales and scanners that can determine vehicle height and width, but this technology is limited in deployment and is not currently used for any preclearance process for OS/OW vehicles.

Determining Convoy Route

TC-AIMS II contains a routing tool that automatically plans convoy movements. Once a convoy has been identified by the DMC for deployment, the DMC enters the convoy into TC-AIMS II. The TC-AIMS II can plan a route (and contingency routes) based on its catalog of the sizes and weights of the military vehicles in the convoy. If the convoy includes any OS/OW vehicles and moves through multiple States, the other DMCs in those States that the convoy is passing through are notified automatically by the TC-AIMS II system so that those DMCs can obtain the appropriate permits for the convoy.

Certain military bases are designated power projection platforms (PPP). Routes from these PPP to seaports can be especially vital to military readiness and response. The U.S. Transportation Command, the functional combatant commander responsible for coordinating transportation for all modes, conducts PPP route studies with support from FHWA to analyze the routes from the military base to specific, designated seaports to load personnel and equipment onto ships.

These studies identify three tiers of vehicle types: (1) vehicles that meet OS/OW requirements and do not need additional permits so they could travel on the public roadway immediately; (2) vehicles that do not meet OS/OW requirements but are only slightly outside the requirements and could obtain a permit but would need to wait to travel on the public roadway pending permit approval; and (3) vehicles that do not meet OS/OW requirements and would not be eligible for a permit because they could not be transported on the public roadway without damaging infrastructure.

The goal of these studies is to identify vehicles in the second tier that would require OS/OW permits from States and coordinate with States to maintain an updated list of those vehicles.

Identifying Facilities Requiring Preclearance

The State coordinates with the DMC and regional and district State offices to confirm that the needs of the convoy can be met by the public roadway system, especially for OS/OW vehicles. The DMCs work with the State permitting officer to identify whether a route is passable (regarding height and weight clearance requirements) and whether the planned or contingency routes would require OS/OW permits. It is the DMCs' responsibility to work with the State permitting officer to obtain these permits.

Convoy Planning Factors

Some of the other factors that influence how the convoy will be planned, operated, and controlled by DMCs and DOD offices include:

- Possible routes—Primary and alternate routes for use by convoys based upon network capacity and restrictions applicable to bridges, tunnels, and highways for the types and volumes of vehicles
- Route conditions—Updated information on work zones, incidents, abnormal delays, lane closures, and toll facilities
- Traffic congestion—Identification of high-traffic congestion areas and their peak periods to allow effective scheduling to avoid congestion
- Weather conditions—Identification of areas with weather problems such as fog, high winds, flooding, heavy snow, and ice will affect convoy operations
- Rest/refuel stop locations—Identification of rest/refuel stops that can accommodate convoys
- Communications—Identification of protocols for communication among military commanders, convoy commanders, DMCs, law enforcement, and other State officials

For toll highway, bridges, and tunnels, DMCs coordinate with the toll authority, and a convoy representative is assigned to clear the convoy at toll facilities. When possible, toll tickets or electronic passes are obtained before the convoy departs from its point of origin. When this is not feasible, the convoy representative arrives at the toll facility in advance to coordinate passage and arrange for the uninterrupted movement of the convoy through the toll facility. Certain toll authorities, especially at tunnels, may provide an escort through the toll facility.

Convoy Movement Phase

By the time the convoy leaves the installation, the DMCs typically have obtained all OS/OW permits and attached them to the CMO. Only in cases of great urgency can convoy movements begin without prior written permits from the State and local authorities. Even in urgent cases, all requests should be confirmed in writing at a later time. Military convoy movement tries to minimize traffic disruption to the public, often by separating multiple convoy departures by 30 minutes or more and limiting the size of convoys to 20–30 vehicles, when possible. Convoys deploying from the same installation might take different routes depending on vehicle sizes and weights and roadway restrictions. Military convoys are not exempt from the same rules as the public while on a public roadway.[25]

Organizing Convoy Vehicles for Movement

Vehicles in a convoy are organized into groups to manage command and control of the convoy, which may, in total, range from a 6-vehicle march unit to a 300-vehicle column.

Each element of the convoy has three parts: the head, the main body, and the trail. The head is the first vehicle of the column, serial, or march unit and carries the pacesetter, who keeps track of time and speed, and the officer who directs the convoy along the proper route. The main body refers to most vehicles in the convoy element that travel between the head and the tail. The tail is composed of the last vehicles of the march column, serial, or march unit that are responsible for recovery, maintenance, and medical support.

Identifying Convoy Vehicles

Convoys are identified by convoy control numbers, which are assigned based on where the convoy originates and identify the convoy throughout its movement. The convoy is clearly marked with "Convoy Follows" and "Convoy Ahead" signs on the first and last vehicle of each convoy element, respectively.

RELEVANCE OF MILITARY PROCEDURES TO NONMILITARY EMERGENCY RESPONSE VEHICLES

Military convoys need to be prepared for possible deployments with minimal advance notice. A number of the procedures used by military convoys can be applied to nonmilitary emergency response and recovery vehicle movement. Understanding the responsibilities and communication channels for military convoy deployment provides a strong foundation for analyzing the feasibility of a preclearance process for nonmilitary emergency response and recovery vehicles.

Coordinated Communication Process

Communication, coordination, and infrastructure requirements are challenges that should be addressed by State DOTs and the relevant DOD offices when analyzing the feasibility of a preclearance process. The widespread responsibilities and numerous, separate parties involved in nonmilitary emergency response create additional challenges and barriers for a potential preclearance process. Military convoy deployment movement and the offices and personnel associated with them have established procedures and defined structures that support communication between the military and States. Any preclearance process for nonmilitary

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[25] FHWA, *Coordinating Military Deployments on Roads and Highways: A Guide for State and Local Agencies.* FHWA-HOP-05-029. Washington, DC: FHWA, 2005. p. 29. https://ops.fhwa.dot.gov/publications/fhwahop05029/, accessed December 18, 2023.

emergency vehicle response should try to replicate the streamlined, coordinated communication process and clear responsibility of vehicle coordinators, vehicle operators, and State and local transportation agency officials.

Emergency Responder Point of Contact

The U.S. military is a large, established, and well-organized entity that is represented with the State by the DMC. The various organizations that might respond to an emergency will probably not be organized as a single entity when approaching the State. Many different utility companies might be separately responding to an emergency, and other commercial freight vehicles that are aiding in that emergency response might be operating under different organizational structures, which could make it difficult for all operators to communicate with a State in advance efficiently and clearly. Identifying a representative that could coordinate emergency vehicle OS/OW permits with the State, similar to the DMC during military convoy movements, could support nonmilitary emergency vehicles.

State Point of Contact

Emergency response and recovery vehicles might not be able to plan their response to comply with State designated timeframes for permit approval, even for States with automated OS/OW permitting processes. Identifying a representative at the State as a point of contact for OS/OW permits, similar to the designated State permitting officer that is available during military convoy movements, could support nonmilitary emergency vehicles. This individual could be automatically notified when any OS/OW vehicle with a permit would be planning to travel through their State.

Preclearance Registry of Standard Emergency Response and Recovery Vehicles

Elements of military procedures that are applicable to civilian emergency convoys could be useful to States in streamlining their OS/OW permitting procedures and possibly developing preclearance processes. It could be possible to maintain a registry or catalog of OS/OW vehicles used during emergencies to support permitting procedures. Emergency response and recovery vehicle owners and operators could register for the preclearance process, with standard size and weight dimensions of the vehicle. Emergency response vehicles that are registered for preclearance could request an expedited emergency permit along predesignated routes that meet specific vehicle envelope size. This registry could be supported by funds from a vehicle preregistration fee. Further investigation of the feasibility of a national database of standard vehicle types for preclearance by States may be helpful.

CHAPTER 7. FEASIBILITY OF SETTING UP A NATIONWIDE EMERGENCY RESPONSE VEHICLE ALERT SYSTEM

INTRODUCTION

The Feasibility of Setting Up a nationwide Emergency Response Vehicle Alert System (Alert System), summarized in this report, takes the first step into addressing the ERWG recommendation to study the feasibility of setting up an alert system to notify State and local authorities of emergency response recovery convoy movement through their region. With such a system in place, enforcement officials will more easily be able to take steps to expedite these vehicles through weigh station inspections or during other roadside inspections if they know in advance that they are coming. Once an emergency is declared in one region, surrounding regions will be notified consistently with the emergency severity.

EXISTING ALERT SYSTEMS AND THEIR USES

Overview of Alert Systems

The Feasibility Study provides an overview of alert systems in the United States that are used to provide information and warn the public to increase the probability that people take decisions/actions that will lead to their safety. The Feasibility Study summarizes the ways to disseminate information, from traditional television and radio broadcasts to new technologies, such as smartphones and social media platforms.

Several alert systems are available, with various levels of coverage, including nationwide, statewide, regional, and local. Although existing systems can range in their comprehensiveness, variability, and restrictions, each system is designed to bring about a coordinated response to the situation at hand. The following subsections highlight relevant examples of such systems and their applications.

Integrated Public Alert and Warning System

The Integrated Public Alert and Warning System (IPAWS) is a Federal, State, and local alert system that sends notices regarding weather, missing and exploited children, and presidential alerts in selected areas or national alerts if the alert is nationally applicable.

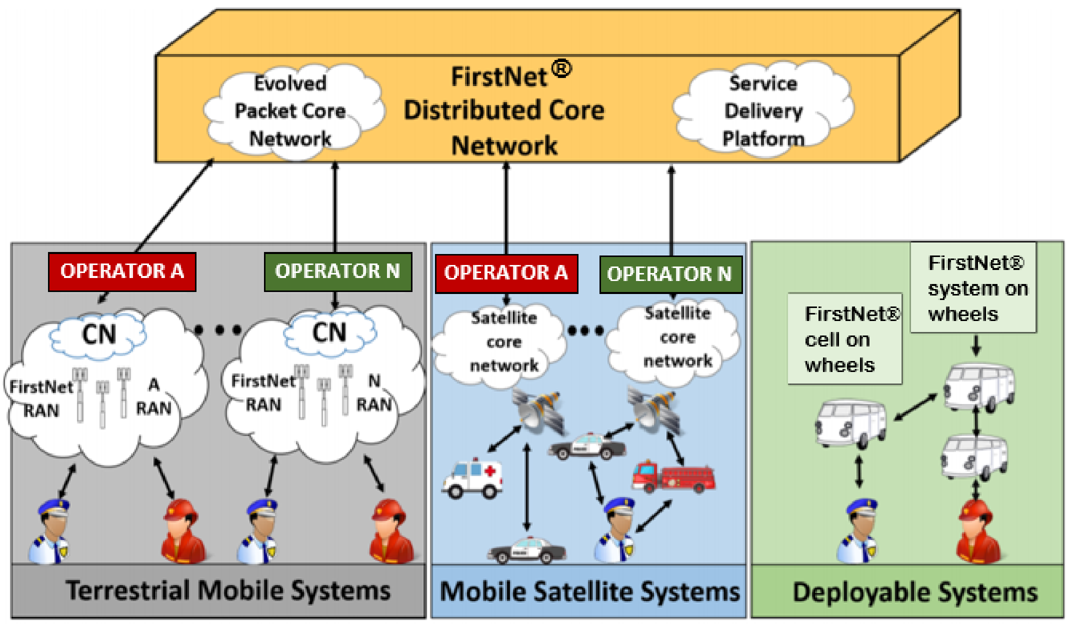
The Emergency Alert System (EAS) is a national public warning system commonly used by State and local authorities to send warning/emergency information, such as weather and AMBER alerts, via broadcast, cable, satellite, and wireline communications.

The Wireless Emergency Alerts system (WEA), formerly known as Commercial Mobile Alert Service, quickly and efficiently provides the public with life-saving information.

WEA is part of IPAWS and is designed to leverage wireless communication technologies for message dissemination. WEA is a new channel in IPAWS that augments other public alert and warning channels such as television, radio, the Internet, sirens, and public electronic highway signage.[26]

FirstNet®

FirstNet is an independent authority within the U.S. Department of Commerce in operation since 2012 (FirstNet information can be found at https://firstnet.gov/network). Its mission is to develop, build, and operate a nationwide wireless broadband network for first responders. FirstNet is currently being built and deployed through a public-private partnership between the Federal Government and AT&T. The FirstNet system includes a distributed core, terrestrial mobile system, mobile satellite system, and deployable systems (figure 9). The FirstNet broadband data network provides emergency first responders with a high-speed network dedicated to public safety services.



CN = core network; RAN = radio access network.
Source: National Institute of Standards and Technology, "Public Safety Communications Research Public Safety LTE," Emil Olbrich, Washington, DC: NIST, 2013. Republished courtesy of the National Institute of Standards and Technology.

Figure 9. Illustration. High-level architecture of FirstNet.

[26]U.S. Department of Homeland Security, Science and Technology Division, *Wireless Emergency Alerts - System Enhancement Recommendations*. Washington, DC: Department of Homeland Security, 2013.

CHAPTER 8. PROPOSED NATIONWIDE EMERGENCY RESPONSE AND RECOVERY VEHICLE ALERT SYSTEM

BACKGROUND

Large-scale incidents often affect multiple agencies and States. A critical consideration is the ability of public agencies to help large out-of-State vehicles or equipment respond to the area of an emergency. These vehicles and equipment must travel through various jurisdictions and different roadway designations with a multitude of facility restrictions. Delays, such as obtaining necessary permits from multiple States, being pulled over for inspections, and travel time restrictions, affect the timeliness of emergency response.

The proposed Alert System seeks to help improve emergency response by:

- Notifying law enforcement of multi-State emergency response and recovery vehicle movements
- Providing an alert system that can function across carriers, devices, agencies, jurisdictions, and systems
- Reducing the latency and increasing the coverage of emergency response alerts
- Supporting in-vehicle dissemination of alerts to drivers of emergency response vehicles
- Supporting fleet management operations by providing current information regarding waivers and restrictions along routes

Fulfilling these main objectives can increase awareness of key stakeholders involved in emergency response and recovery efforts. While stakeholders might differ by State depending on the activity/action being requested (e.g., maintenance versus operations), the Alert System envisions the participation of all relevant stakeholders, with potential ones listed in table 13.

Table 13. List of potential stakeholders.

Stakeholder Group	Examples
Federal	• Federal Emergency Management Agency (FEMA) • Federal Highway Administration (FHWA) • Federal Motor Carrier Safety Administration (FMCSA) • Department of Defense (DOD)
State	• Governor's office • state emergency control center • State departments of transportation (DOTs) • American Association of State Highway and Transportation Officials (AASHTO) • 511 system • State traffic management center • State-owned utilities • National guard

Table 14. List of potential stakeholders. (continuation)

Stakeholder Group	Examples
Local/Regional	• Local government (city, county) • Local emergency control center • Regional traffic management center • Local emergency responders (police, fire)
Law Enforcement	• Local police • State highway patrol • Commercial motor vehicle safety enforcement • Weigh stations
Associations and Advocacy Groups	• Commercial Vehicle Safety Alliance (CVSA) • Specialized Carriers and Rigging Association • American Trucking Associations
Maintenance	• Highway Operations and Maintenance Staff • System (Hardware/Software) Maintenance Staff
Responders and Utilities	• Utility providers • Utility drivers and response teams • Commercial vehicles (drivers and operators)
Private Sector	• Vendors (hardware/software) • Service/data providers

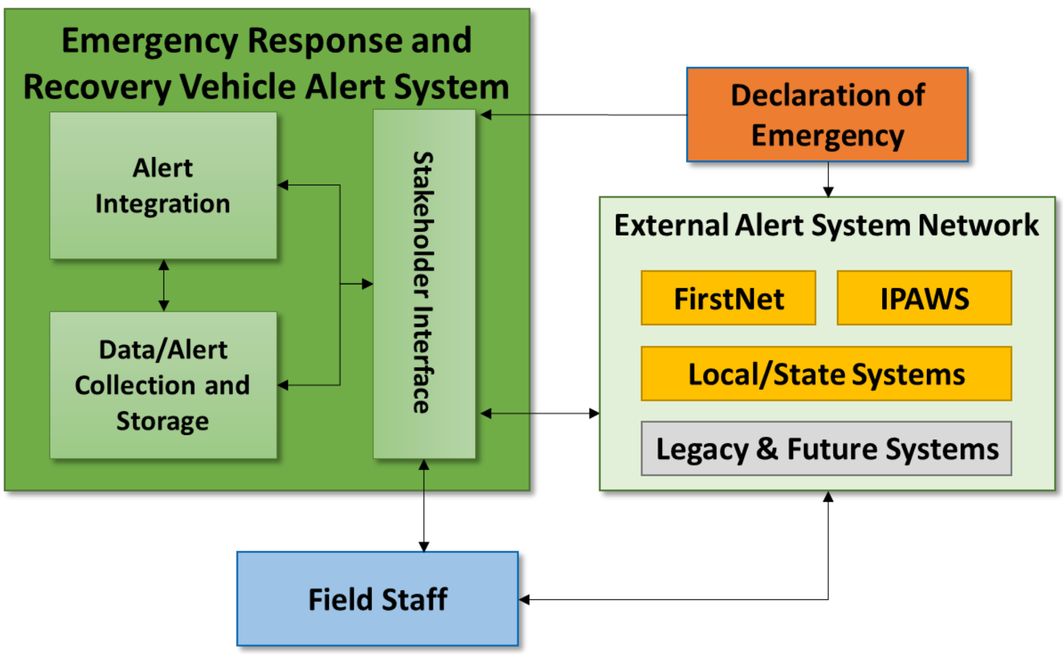
The following subsections describe the proposed Alert System and its components.

High-Level Conceptual Framework

This research proposes a high-level conceptual framework for the Alert System, shown in figure 10. The Alert System leverages existing/legacy national and regional systems, data centers, and other elements that may be in different geographical locations, such as cell-site equipment, antennas, and backhaul equipment that are required to enable wireless communications with devices using the public safety broadband spectrum. The data flow of the proposed nationwide Alert System would be as follows:

1. A **declaration of emergency** is put in place at a particular location by its governing agency, typically the president's or governor's office.
    a. The governor's office of emergency management is immediately notified and in turn immediately notifies State and local law enforcement agencies and the State OS/OW permitting agency. These entities immediately implement established emergency procedures to assure the safe and expeditious movement of emergency response and relief vehicles.
2. This declaration is then shared with **External Alert Systems and Networks** (i.e., existing/legacy Federal and State/local communication and alert dissemination systems and networks) and the nationwide Alert System (through its **Stakeholder Interface**).
3. In the nationwide Alert System, the data flows through three key components:
    a. The **Stakeholder Interface** serves as a data broker and is responsible for managing its interaction with stakeholders. The Alert System leverages external alert systems and networks to collect and disseminate alerts and emergency information. This component also shares alerts with field staff.

   b. The Stakeholder Interface shares the information received with the **Data/Alert Collection and Storage** component, which is responsible for ingesting (cleaning and validating) and storing all data received and produced by the Alert System.
   c. The ingested data are then shared with the **Alert Integration** component, which integrates all data into a single, actionable alert/notification. The Alert Integration component also monitors for changes in the alerts' status to not replicate alerts and overload field staff with notifications.
4. The Alert System then shares actionable alert(s) with selected **field staff** (e.g., law enforcement, emergency responders, and emergency convoys from remote locations) through approved and registered devices (e.g., smartphones, tablets). The alert can be disseminated in a variety of forms, including telephones (wireline and Voice over Internet Protocol (VoIP)), wireless phones (voice and text), emails, in-application notifications, and any other communication systems related and solely dedicated to State and local authorities. The alerts may contain different sets of information, ranging from those related to emergency response (e.g., OS/OW permits and restrictions) to transportation information (e.g., road traffic and weather condition).



IPAWS = Integrated Public Alert and Warning System.
Source: FHWA.

Figure 10. Diagram. High-level conceptual framework of the Emergency Response and Recovery Vehicle Alert System.

Although the proposed system is based on commercial standards, this conceptual framework is flexible and can evolve as technology advances and new software, hardware, and standards are made available. This serves as a starting point for more detailed design in future iterations.

High-Level Functional System Requirements

The proposed nationwide Alert System's key objective is to increase awareness of the movement of emergency response vehicles and convoys through their region. This section presents high-level functional system requirements that would achieve this through a Web-based alert system that targets State and local authorities. These proposed system requirements are not meant to be exhaustive or to set specific thresholds; instead, they highlight topics that should be considered and further defined during a more rigorous planning stage.

General Specifications

The following are general specifications for software and equipment that form part of the proposed Alert System:

1.1. **Industry Standards for Equipment:** All equipment provided shall comply with industry standards, where applicable.
1.2. **Industry Standards for Software:** All software provided shall comply with industry standards, where applicable.
1.3. **FCC Compliance:** All systems shall be capable of complying with regulations and noteworthy practices for communications as established by the Federal Communications Commission (FCC). Examples of these include the FCC's Communications Security, Reliability, and Interoperability Council (CSRIC) IV's Work Group 3 (WG3) EAS Security Subcommittee Report noteworthy practices.
1.4. **System Compatibility:** The Alert System shall be compatible with all major operating systems and Web browsers.
1.5. **Security:** The Alert System shall include malware and antivirus protection for all servers and workstations in the system.
1.6. **Periodic Updates:** The Alert System shall support periodically scheduled malware and antivirus updates.
1.7. **Uptime:** The Alert System shall meet uptime of 99.995 percent or better.
1.8. **Processing Time:** The Alert System shall process all data and generate alerts in under 30 seconds.
1.9. **Alert Delivery Time:** The Alert System shall notify devices and external systems selected to receive the alert(s) within 60 seconds of the alert being generated.

Stakeholder Interface

The following are system requirements that relate to the user interface of the Alert System:

2.1. **Ease of Use:** The Alert System shall require the user to navigate the least number of screens, but not more than three screens, to create and send an alert.
2.2. **Preview:** The Alert System shall display a preview of the alert in the format in which it will be displayed to the recipient before sending the alert for each distribution channel selected.
2.3. **Distribution Channels:** Alert distribution channels available to the alert generator shall be configurable by the Alert System administrator for each user or user group.

2.4. **Alert Dissemination:** The Alert System shall disseminate alerts generated by the *Alert Integration* component to selected devices in near realtime.
2.5. **Alert Templates:** The Alert System shall allow the authorized user to preprogram a minimum of 100 template messages and group them into situation types to respond quicker.
2.6. **Geographic Bookmarks:** The Alert System shall allow the authorized user to preprogram a minimum of 50 bookmarks for specific locations/polygons to respond quicker.
2.7. **Template/Bookmark Availability:** All preprogrammed elements shall be available for all Collaborative Operating Groups (COGs)[27] configured in the Alert System without requiring copying.
2.8. **Access Information:** The Alert System shall require a unique user login information (name and password, as defined by the user) for each user accessing the Alert System.
2.9. **Access Control:** The Alert System shall allow an administrator to set levels of permissions to access the system's components, such as limiting access to a specific COG or changing templates to specific personnel.
2.10. **Status Report:** The Alert System shall monitor, log, and report to staff any system discrepancy that may require troubleshooting and maintenance.
2.11. **Remote Support:** The Alert System shall allow staff to provide ongoing remote maintenance and support.
2.12. **Backup and Recovery:** The Alert System shall allow backups of all key data, as established and defined by the management staff.
2.13. **Interface with Others:** The Alert System shall interface with other operations, management, and monitoring systems using standard protocols, such as Simple Network Management Protocol (SNMP) or Common Management Information Protocol (CMIP).

Collect and Store Data/Alerts

The following are system requirements that relate to how the message should be displayed to the receiver:

3.1. **Collect Alert:** The Alert System shall accept alerts from other systems/networks.
3.2. **Validate Alert:** The Alert System shall confirm that all collected data undergo a predefined cleansing and validation process that outputs data that meet predetermined data quality standards.[28]
3.3. **Store Alert:** The Alert System shall have the capability to store all alerts collected and generated for a minimum of 3 years.

[27] A COG is a Federal, State, local, tribal, or territorial alerting authority that applies for authorization to use IPAWS and is designated by IPAWS as a Collaborative Operating Group or "COG." A COG may have members from multiple organizations (e.g., a regional mutual aid organization).

[28] The data quality standard should ensure that all data are correct and useful.

Alert Integration

The following are system requirements that relate to how collected alerts and data should be integrated:

4.1. **Alert Format:** The Alert System shall integrate all collected and generated data to create clear and actionable alerts in a compliant format with the Common Alerting Protocol (CAP).[29]
4.2. **Alerts Wired Phones:** The Alert System shall send alerts to wired phones via wireline and VoIP.
4.3. **Alerts Wireless Phones:** The Alert System shall send alerts to wireless phones via text and voice messaging.
4.4. **Alerts Email:** The Alert System shall be able to send alerts via emails.
4.5. **Alerts Others:** The Alert System shall send alerts to other communication systems related and solely dedicated to State and local authorities.
4.6. **Time:** The Alert System shall support a master timing source from an agency (local time source) or external (Internet or radio) source.
4.7. **Location:** The Alert System shall generate messages using subcounty Federal Information Processing Standard codes.
4.8. **Tower Check:** The Alert System shall check selected polygons to confirm that at least one tower is included in the activation area.
4.9. **Notification:** The Alert System shall provide the alerts in visual (e.g., text), audible (e.g., sound alerts), and sensible (e.g., vibration) forms.
4.10. **Text Colors:** The Alert System shall broadcast alerts in colors that are visible to a visually impaired or colorblind user.

[29]The CAP is a digital format for exchanging emergency alerts that allows a consistent alert message to be disseminated simultaneously over many different communications systems. CAP is a standard of the Organization for the Advancement of Structured Information Standards.

OPERATIONAL SCENARIOS

The following tables describe two common uses of the Alert System: (1) when alerts are generated and disseminated from within the same jurisdiction (table 14), and (2) from outside of the jurisdiction (table 15). Note that the flow/process may change once the Alert System is better defined.

Table 14. Alert notification within jurisdiction.

Short Description	This use case provides a synopsis of the scenario in which an emergency declaration is put in place, and all responders and resources are coming from within the alert's jurisdiction. For this use case, we will assume that a rural agency within a State has declared a state of emergency due to wildfires in its area. This has prompted different oversize/overweight (OS/OW) heavy equipment, utility, and water convoys from within the State to mobilize toward the emergency.
Goal	OS/OW convoys move more efficiently throughout the roads, given better awareness from enforcement staff in areas where these convoys would traverse through.
Constraints	Complete awareness would be dependent on the number of registered devices in the field.
Geographic Scope	Corridors with long stretches of divided highways with limited and long distances between services, limited communications and power, and lack of alternate routes. For instance, rural corridors that may already be subject to heavy freight travel.
Actors	• Devices on targeted vehicles (field staff) • Back office • External networks/systems • Satellite service providers or third-party service providers
Main Flow	1. The governor for the State declares the wildfires a State emergency and asks for all counties in the State to provide support by sending resources. 2. The official declaration of emergency is sent to the Alert System for processing and dissemination. 3. The Alert System integrates this emergency alert with any other active alert and outputs a single alert that provides clear and actionable guidance to field staff. 4. The Alert System sends this alert to the national system, which shares the alert with its network of devices within the specified geographical limits (i.e., counties within the State).
Alternate Flow(s)	4a. The Alert System sends the alert directly to selected and connected devices.
Postconditions	• Field Staff is informed of an upcoming change in vehicle volume and advisories in their area. • Local agencies are provided with current alert information and guidance on travel restrictions.

Table 15. Alert notification from outside the jurisdiction.

Short Description	This use case provides a synopsis of the scenario in which an emergency declaration is put in place, and a portion of the responders and resources are coming from outside the jurisdiction of the alert. For this use case, we will continue with the example of a rural agency within a State declaring a state of emergency due to wildfires in its area. After failed efforts to contain the wildfire, the rural agency and the State have reached out to neighboring States for help. This has prompted different OS/OW heavy equipment, utility, and water convoys from outside the State to mobilize toward the emergency, passing several State borders and checkpoints.
Goal	OS/OW convoys move more efficiently throughout interstate and local roads, given better awareness from enforcement staff in areas where these convoys would traverse through.
Constraints	Complete awareness would be dependent on the number of registered devices in the field.
Geographic Scope	Interstate corridors with long stretches of divided highways with limited and long distances between services, limited communications and power, lack of alternate routes, and several checkpoints (e.g., weigh stations) and borders along the route.
Actors	• Devices on targeted vehicles and weigh stations (field staff) • Back office • External networks/systems • Satellite service providers or third-party service providers
Main Flow	1. The governor for the State declares the fires a state of emergency and asks neighboring State agencies and private sector (e.g., utilities) for assistance by sending resources and personnel. 2. The official declaration of emergency is sent to the Alert System for processing and dissemination. 3. The Alert System integrates this emergency alert with any other active alert and State guidance related to the movement of OS/OW vehicles. The Alert System outputs a single alert that provides clear and actionable guidance to field staff and even drivers of the OS/OW vehicles (through third-party systems). 4. The Alert System sends this alert to FirstNet and third-party systems, which shares the alert with its network of devices and registered users within the specified geographical limits (i.e., States bordering the State with the emergency).
Alternate Flow(s)	4a. The Alert System sends the alert directly to selected and connected devices.
Postconditions	• Field Staff is informed of an upcoming change in vehicle volume and advisories in their area. • Local and neighboring agencies are provided with current alert information and guidance on travel restrictions.

RECOMMENDATIONS FOR DEPLOYMENT

Potential Next Steps

This document provides an initial conceptual framework for the Alert System and offers insight into the high-level requirements and level of effort such a system may entail. The next step will focus on further advancing the systems engineering process by identifying clear and detailed users' needs and system requirements that lead to a functional and efficient system design. This will enable developers to estimate the cost of deploying an Alert System.

Next steps will also focus on identifying barriers that need to be addressed (obstacles that may arise) throughout the system's planning, design, testing, and deployment phases. Examples of these include:

- Leveraging or integrating existing and future State plans, systems, and hardware
- Allowing agencies and their staff to opt-in and opt-out
- Identifying factors affecting opt-in/opt-out decisions
- Identifying critical aspects of the available network, such as coverage (rural and nonrural), cybersecurity, reliability, redundancy, features available, site hardening (e.g., strengthening and protecting critical infrastructure from disasters), and cost.
- Identifying who is going to be the system owner (e.g., Federal agency, AASHTO, private industry). The successful development of this system is heavily dependent on identifying its champion.

The following should be taken into account when designing the Alert System:

- Evolving and progressing as the capabilities of smartphones and other mobile broadband devices improve and newer technologies become available
- Adopting existing technologies for alerts and warnings that coexist with legacy systems and technologies
- Using more precise geotargeting that leverages locational information from smartphones in order to deliver more accurate and relevant alerts
- Preparing for deployment of an alert system by training originators about the capabilities and shortcomings of the alert system and how to write effective messages; this can include understanding local area coverage, as cellular networks can vary from one region to another, especially in rural areas

High-Level Estimation of Development and Deployment Effort

The Alert System's development and deployment should be accomplished through phases that follow a systems engineering approach. This can be done through the following three distinct phases:

- **Phase 1. Planning and Concept Development:** This phase can take between 12 and 18 months and focus on developing the necessary planning and preliminary, structured conceptual design of the Alert System. The structured concept will include active engagement with stakeholders to identify specific user needs and systems requirements, as well as developing plans that address needs for performance measurement (e.g., targets, capabilities associated with performance monitoring and performance management), human use, data management, safety, security, training, institutional/financial support, outreach and training, and other topics the deploying agency may consider useful to plan.
- **Phase 2. Design/Build/Test:** This phase can take between 24 and 48 months. In this phase, the deployment concept is designed in detail, built, and tested before operation. The detailed design should be done based on the needs, requirements, and development plan in Phase 1. During this phase, the development team should also collect the necessary information/data to develop a baseline for performance measurement.
- **Phase 3. Deploy and Maintain:** This phase can take 18–24 months to test the deployed system, applications, and technologies through a real-world operational demonstration. During this phase, the development team will measure the system's performance and its effect on emergency response, following the plan and baseline defined in Phases 1 and 2, respectively.

Each of the proposed phases will entail a different level of effort and cost. As of the drafting of this report, the project team estimates that the Phase 1 budget will likely be between $1.5 and $3 million. This is based on previous experiences planning for big technological deployments in other locations within the United States. Phases 2 and 3 cost estimates will need to be determined based upon Phase 1 results for scope, concepts, and other variables, such as external circumstances and the cost of the technology.

CHAPTER 9. EMERGENCY ROUTING WEB TOOL

INTRODUCTION

This section provides a high-level summary of the "Feasibility Study of an Emergency Routing Web Tool" assessment for setting up a Web tool that can improve how information is shared to drivers of emergency response convoys through specific regions. The Web tool could provide the necessary information needed for drivers to travel to and from declared emergencies. This information would be provided during predeployment, deployment, redeployment, and return of responders to and from declared emergencies. This will assist by providing access to current and consistent information that allows emergency convoys to better plan their trip and reroute if needed. This section provides insight into the different alternatives to achieve such a tool, and the data needs and challenges that each alternative would entail.

WEB TOOL ALTERNATIVES

There are four alternatives for a Web tool. The alternatives range from links to advanced interactive maps and tools that would require substantial investment and collaboration with States and private sector to implement. Following an Agile process, each alternative builds on the capabilities and requirements of the previous one, allowing this to be a phased project. The alternatives are as follow:

- Alternative 1—a database in table format from which drivers can query States and receive links that could provide useful information by State
- Alternative 2—an interactive map, built from the static database from Alternative 1
- Alternative 3—an interactive map that provides as much real-time information as available and with routing capability
- Alternative 4—a one-stop interactive Web-based tool that handles all permitting from both the State and driver perspective, along with an interactive map and routing capabilities

If an emergency routing Web tool is to be implemented, an important first step should be to determine the lead agency and the key stakeholders to be involved in developing a concept of operations. Because of the multiple agencies involved, this project would likely be led by a department-level office.

There is also the option for State agencies and AASHTO to take a lead in piloting a regional model with support from USDOT. Because Alternative 4 requires extensive State data and integration with State systems, this could be a candidate for a regional pilot by a group of States, which would set a model to eventually be scaled up to the national level.

Alternative 1: Database of Information

Description

Alternative 1 will give emergency vehicle drivers the ability to query desired States that they might traverse through en route. After States have been queried, corresponding static emergency information will appear in the form of a dynamic table. This information could provide links to applicable State websites that provide emergency-related information.

Figure 11 provides a mockup visualization of this alternative:

State	Resource Type	Link
Alaska	State 511	http://511.alaska.gov/alaska511/mappingcomponent
Florida	IFTA	https://www.flhsmv.gov/driver-licenses-id-cards/commercial-motor-vehicle-drivers/international-fuel-tax-agreement
Florida	IRP	https://www.flhsmv.gov/driver-licenses-id-cards/commercial-motor-vehicle-drivers/international-registration-plan/
Nationwide	Permitting	https://ops.fhwa.dot.gov/freight/sw/permit_report/index.htm
Washington	State 511	https://www.wsdot.wa.gov/about/news/511/home

IFTA = International Fuel Tax Agreement; IRP = International Registration Plan.

Source: FHWA.

Figure 11. Screenshot. Alternative 1 mockup.

Needs and Requirements

As a starting point, the tool should provide links from which drivers and dispatchers can obtain the following emergency information by State. While the development of the product (i.e., a table that allows query) has an overall low complexity, the process to obtain the data needed can be complex. Development of this alternative will rely on the following:

1. Collect the following data:
    a. State 511 website links
    b. State permitting website links
    c. State emergency declaration links
    d. FMCSA declaration links
    e. Any other additional data element identified during the conceptualization phase
2. Conduct quality assurance/quality control (QA/QC) of State emergency resource forms/links to make sure they are correct and relevant.
3. Format links into a table that will reside in a database.
4. Connect to database.
5. Develop dashboard.
6. Conduct QA/QC of dashboard.
7. Deploy dashboard and data source.

Risks

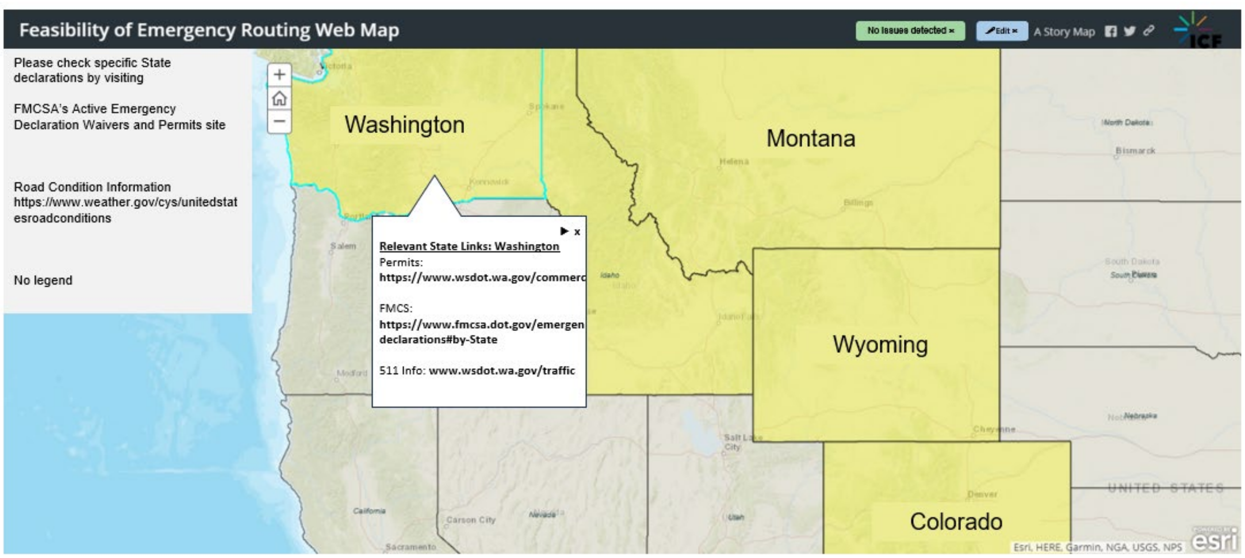
Given the development process, how the information is expected to be provided, and the identified limitations of this alternative, the most significant risk is providing inaccurate/outdated information. With links to multiple sites, there is a high probability of inconsistencies in the effect of emergency declarations. State emergency declarations may be posted to different State websites depending on the type of disaster and will vary by nature of the emergency. Clear disclaimers will need to be provided for information linked from other sources.

The database will need to be routinely updated to provide the correct permit links to the user. Similar action is necessary for State contacts and emergency resources. Updates, or validation of information, can be important for improving accuracy during emergency events.

Alternative 2: Interactive Map Based on Static Information

Description

Alternative 2 couples the static information generated in Alternative 1 with GIS software to allow users the ability to use a dynamic Web map containing data relevant to emergency information and vehicle permits. Similar to the previous alternative, users will query specific States that an emergency vehicle might need to traverse through on its route. However, Alternative 2 is more visual, and users can click on an individual State and receive the corresponding State emergency information. Figure 12 presents a mockup of how the tool could look under Alternative 2.



Source: FHWA.

Figure 12. Screenshot. Alternative 2 mockup.

Needs and Requirements

Alternative 2 builds on the data collection effort from Alternative 1. The information needed to develop the tool is the same as Alternative 1. These data will, however, need to be associated with a specific State in GIS format. Development of this alternative will rely on the following:

1. Collect the following data:
    a. State 511 website links
    b. State permitting website links
    c. State emergency declaration links
    d. FMCSA declaration links
    e. Any other additional data element identified during the conceptualization phase
2. Conduct QA/QC of State emergency resource forms/links to make sure they are correct and relevant.
3. Format links into a comma-separated values (CSV) table format.
4. Convert CSV table to GIS format (i.e., shapefile, feature class).
5. Upload GIS file to ArcGIS Online.
6. Create custom Web map that will feature the GIS layer.
7. Create custom dashboard using Web map.
8. Conduct QA/QC of ArcGIS Online Dashboard.
9. Embed ArcGIS Online Dashboard into an interagency website.

Risks

Alternative 2 also shares the same risks as in Alternative 1. The most significant risk is providing inaccurate/outdated information. With links to multiple sites, there is a high probability of inconsistencies in the effect of emergency declarations. Clear disclaimers will need to be provided for information linked from other sources.

It will be necessary for the database to be routinely updated to provide the correct permit links to the user. Similar action is necessary for State contacts and emergency resources.

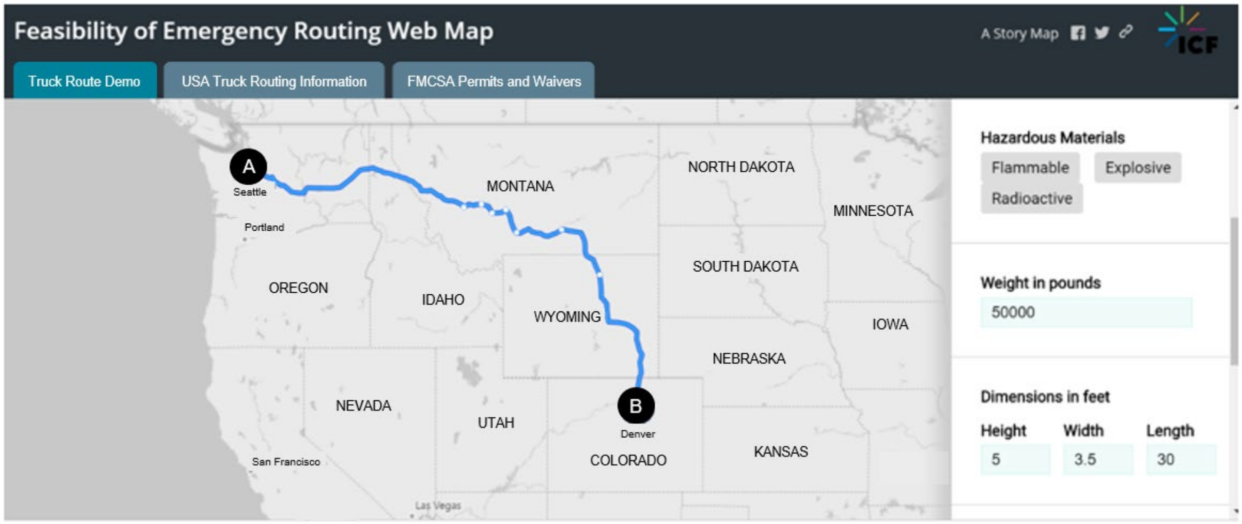
Alternative 3: Interactive Map Based on Dynamic Information

Description

In contrast to the previous alternatives, Alternative 3 would include a truck-routing element in addition to a database of various State emergency resource links. A truck-routing application programming interface (API) would need to be custom developed with the parameters necessary to guide trucker drivers through legal routes.

Detailed information on route, load posting, and bridge and tunnel clearance, among other hazard elements, would be considered in identifying potential routes. Within the proposed custom truck-routing API, truckers would be able to define truck characteristics such as dimensions, weight, hazardous materials, and any special needs.

If a specific State is found to be included within a projected route, the corresponding State on the route will be highlighted within the tool. Once a route has been successfully queried, corresponding links to State emergency information will additionally appear in the Web application. Figure 13 presents a mockup of the tool under Alternative 3.



Source: FHWA.

Figure 13. Screenshot. Alternative 3 mockup.

Needs and Requirements

In addition to the data needs from Alternatives 1 and 2, this alternative will also rely on vehicle and trip information. Truck-related information needs include:

- Dimensions
- Weight
- Cargo
- Special requirements
- Origin address
- Destination address
- Route specific information (load posting, bridge and tunnel clearance, among other hazard elements)
- Private sector map data and routing systems

Alternative 3 presents the State emergency resource information with a mapping interface, building on the work previously described in Alternative 2. However, in order to provide truck routing suggestions to users, a custom truck-routing API would have to be developed as there is not a single comprehensive and accurate map of the national network.

The development of the custom API needs to be done in close coordination with States and the private sector, since the API would also need to integrate the routing used by all States and would require State-by-State confirmation of the National Network. The routes would need to be identified by the States and be updated regularly as conditions change—particularly information related to bridges and infrastructure affected during disruptive events.

Alternative 3 would require more time and effort to build and maintain because many aspects of the API would need to be custom developed, preferably following an Agile development process. The API would also need to integrate the routing software and policies developed by all States across the country. This research could possibly require significant time and effort.

OS/OW loads would not be able to use this truck-routing API and would be required to go through individual State permitting offices to obtain permits and assigned routes. This truck-routing API will likely not have complete information that States use for routing OS/OW loads including the following attributes.

- Current bridge weight and height information for OS/OW loads
- Tunnel restrictions
- Other roads that are designated truck routes by State DOTs and local road agencies
- Hazardous material restrictions
- Work zone restrictions
- Weather restrictions
- Emergency road closure restrictions

Alternative 3 has a mid to high level of complexity, with the biggest efforts being the data collection, the custom truck-routing API configuration, and the development of the interface(s) for the application. The development of this alternative will rely on the following:

1. Collect the following data:
    a. State 511 Website links
    b. State Permitting Website links
    c. State Emergency Declaration links
    d. FMCSA declaration links
    e. Transportation network/infrastructure data
    f. Any other additional data element identified during the conceptualization phase
2. Develop a truck-routing API that integrates various State routing systems into a single, combined national truck-routing API
3. Conduct QA/QC of State emergency resource forms/links to make sure they are correct and relevant
4. Format links into a national emergency resource database that will feed data to the application
5. Develop custom Web application—build interactive application that houses two containers: the mapping portion that displays the route and the dynamic hypertext markup language (HTML) table that changes based on routing query

6. Conduct QA/QC of Web application
7. Embed Web application into an interagency website
8. Develop a detailed and robust operations and maintenance plan that includes continuous updates to account for changes in infrastructure conditions and truck routes

Risks

Alternative 3 introduces new risks that are associated with its new capabilities. Because of these risks, this alternative may not be a viable option. The risks include:

- There could be issues with providing routing suggestions (e.g., there might be errors in the route.). The route provided may place trucks onto roads where the type of vehicle is not allowed. The route may also lack accurate information on bridge weight limitations and structure clearances. Improper routing may result in damage to infrastructure. Commercial motor vehicle crashes from improper routing may also result in injuries or fatalities.
- There is a risk of not providing the most up-to-date information if the database is not routinely updated to provide the correct permit links to the user.
- If the custom API is developed as a silo, without leveraging existing APIs, there is a probability that the custom API be limited in capabilities in early stages as it gains maturity. For instance, it may limit the user in the route selection by providing only one route and may not provide other viable routes. It could take significant effort and various iterations (versions) of the custom API to address this limitation.
- Several States vary in how frequently they update their 511 data. For instance, some State DOT 511 road restrictions are updated every 15 minutes. If there is an emergency where a bridge is damaged, lowering weight allowed across a bridge, the truck driver would be required to rely on the updated 511 map and not the route provided by the API.

Alternative 4: One-Stop Interactive Web Tool

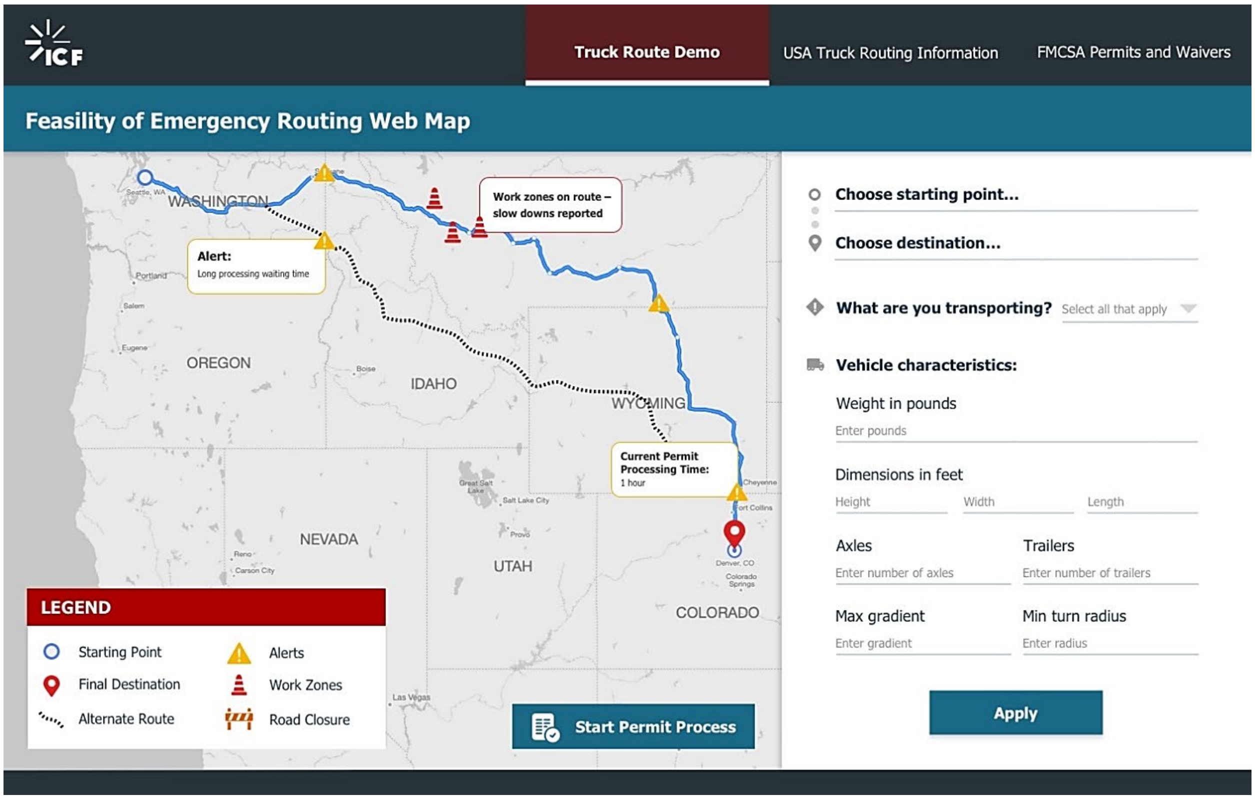
Description

Alternative 4 would be an interactive Web tool that serves as a one-stop shop, including routing, requesting, and processing permits. This alternative is currently not feasible. States use a range of proprietary systems, and a national system would need to be able to interface with all State systems. A number of States currently do not have automated permitting systems, and there would need to be a process for automating all the data, information, and procedures the States currently use. This would require States to agree on a standard national permit application form. This would also require States to continuously provide updated network data, specifically bridge information and any infrastructure affected by disrupting events within the State.

Instead of filling out a permit application form for each State that a truck driver will need to traverse through, the user would fill out one form that applies to all States on the route. Having a one-stop shop would help expedite the permitting process for emergency response vehicles. By utilizing a Web mapping and permit application, users could query their route based on the truck API, as well as fill out any required emergency routing forms.

Figure 14 illustrates a mockup of this alternative.

Using a customized truck-routing API solution previously mentioned in Alternative 3, the truck driver/dispatcher will be able to identify potential routes based on the provided information (e.g., dimensions, weight, cargo, origin, destination, and any other special needs associated with the vehicle). Once a route has been queried, all corresponding forms relating to State emergency information will be provided for the user.



Source: FHWA.

Figure 14. Screenshot. Alternative 4 mockup.

Needs and Requirements

This section provides insights into what is needed to build Alternative 4, including data, software, and considerations for development of the tool.

In addition to all the data detailed in the previous alternatives, Alternative 4 requires detailed information on the permitting processes for each State. All forms will need to be standardized nationally so that a user does not have to fill out different individual forms when moving through multiple States.

Alternative 4 builds heavily on the capabilities and needs of Alternative 3. The software needs are similar to the previous alternatives. However, there are new software needs that are associated with the added capabilities of Alternative 4.

Alternative 4 will rely more heavily on Web development efforts than Alternative 3. In addition to utilizing the truck API to identify potential routes based on user-provided truck information, the user will also be able to view and fill out corresponding forms relating to State permits. An HTML-based form will be developed for users to enter their information in the online form. Accordingly, there will need to be a backend database that will store all form information that users enter. An example database platform here would be PostgreSQL or an equivalent, secured storage space. Through utilizing PHP Web programming, an HTML form can be directly connected to a database like PostgreSQL. This information will be made readily available to State DOTs, so they are aware of every driver with emergency materials on the road.

Truck-Routing API—This system would use the same truck-routing API as Alternative 3 (see description in Alternative 3 "Software Needs" where this technology is outlined). This system would need to be built using routing data and integrated with systems used by all States.

Development of Alternative 4 will rely on the following steps:

1. Obtain a list of State contacts for:
    a. State 511 resources
    b. State Permitting resources
    c. State Emergency Declaration resources
    d. FMCSA declaration resources
    e. Transportation network and infrastructure data
    f. Any other additional data element identified during the conceptualization phase
2. Develop a truck-routing API that integrates State routing systems into a single, combined national truck-routing API.
3. Coordinate with States to gather ideas on developing standard formatting for resources listed above.
4. Develop custom forms.
5. Obtain State feedback on forms.
6. Publish forms.
7. Develop a custom Web application that houses two containers: the mapping portion to display the route, and the dynamic HTML form portion to display emergency resource forms.
8. Conduct QA/QC of Web application.
9. Embed Web application into new national website created through a collaboration of all States, AASHTO, and USDOT.

Risks

Being the most advanced of all the alternatives, Alternative 4 provides the most risks. In addition to all the risks listed before, this alternative also has the following:

- There could be issues with using a third-party truck-routing API, or by providing routing suggestions (e.g., there might be errors in the route and may not be the most efficient or even viable option).
- States generally have their own preferences and methodology when it comes to emergency resource policy. For instance, States often route OS/OW permit applications through their bridge office for review, so the system would need to provide for the State to process the applications through their own procedure.
- States may be reluctant to rely on a national OS/OW permitting system, and it may not be plausible to standardize national permitting forms.
- Making future changes to the application will include collaboration with every State involved in the permitting forms and reviews.

CONCLUSION

The following are a set of recommendations for consideration when deciding next steps for the development of this Web tool. Depending on the alternative that is pursued, there will need to be extensive collaboration between USDOT, States, and AASHTO.

- Alternative 1 would be the least time consuming and would require the least cost to develop of the four alternatives. While it does not provide mapping capabilities, this alternative would still be useful to truck drivers in identifying emergency resources across their intended route.
- Alternative 2 would be a slightly more complex than Alternative 1 but would have similar functionality. The output for Alternative 2 would include a corresponding interactive map that could be useful for truck drivers. By selecting States on the map, users will be able to identify emergency resources across their intended route.
- Alternative 3 would include the development of a new truck API and corresponding dynamic HTML tables containing links to emergency resources across their intended route. This alternative would include more development time and cost than Alternatives 1 and 2, as it includes a large Web development effort.
- Alternative 4 would create a national permitting and routing system that could help expedite the permitting process for emergency response vehicles. However, this option could not be implemented under the current permitting and routing process. There is no way of accurately estimating how long it would take to coordinate with States to develop a standard formatting for emergency resources, finalize and publish the forms, custom develop a Web application, and publish to a new national standardization website created through a collaboration of all States, AASHTO, and USDOT. There are many unknowns in this alternative, and it would be significantly more expensive and time consuming than the other alternatives.

Table 16 provides a brief description of all the alternatives and their associated level of development complexity, cost, and research and State coordination requirements. Table 17 provides a summary of the high-level estimate of cost and time needed for the development of each alternative, excluding maintenance and operation cost.

Table 16. Summary of alternatives.

Development Option	Application Development Complexity	Development Cost	Research and State Coordination	Highlights and Key Characteristics
Alternative 1	Low	Low	Med	Users query a dynamic table for specific State emergency form information.
Alternative 2	Med	Med	Med	Users query an interactive Web map tool via online mapping software to find specific State emergency form information.
Alternative 3	High	High	Med	Users query a custom Web application that includes a custom truck-routing API and dynamic HyperText Markup Language tables.
Alternative 4	Very High	Very High	Very High	Alternative 4 is a one-stop shop for requesting routes, processing permits, and providing routing options for emergency response vehicles.

Table 17. Cost and time summary of alternatives.

Development Option	Estimated Development Cost	Estimated Time Required
Alternative 1	$120k to $160k	900 hours
Alternative 2	$180k to $240k	1,100 hours
Alternative 3	$800k to $1.5M	7,000 hours
Alternative 4	$2M to $2.5M (planning alone)	10,000 hours (planning alone)

Each alternative builds upon the capabilities and requirements of the previous one, which would allow for phased development of the Web tool following an Agile process.

Next steps in developing an emergency routing Web tool would be to determine the lead agency and the key stakeholders (e.g., USDOT modal administrations, other Federal agencies, State agencies, AASHTO, and the private sector) to be involved in developing a concept of operations. There is also the option for State agencies and AASHTO to take a lead in piloting a regional model with support from USDOT.

Advance coordination among the States will be a prerequisite to reaching agreement on acceptable gross weights, axle weights, and axle spacings that may be operated on specified routes during emergencies. Permits for identified vehicles responding with emergency relief meeting the agreed-upon weights and spacings could be issued without requiring bridge analysis or district approval.

FHWA is currently working with AASHTO and CVSA to develop an emergency declarations website that provides current information on emergency and disaster declarations and permit requirements during an emergency. The website will be an online resource for overweight divisible loads for relief supplies. It would provide information on the changes to permittable weights, the contact information for each State's overweight permitting office, and access to up-to-date emergency declarations. This will provide some of the functions that are outlined in Alternative 1 of this study and could be built upon in the future.

CHAPTER 10. NEXT STEPS

The findings of this research suggest a framework of potential solutions and next steps that can be taken to improve emergency routing. Some of these steps build on activities that FHWA or other partners are already undertaking and may be accelerated to make near-term progress toward the objective of the ERWG. These include the following actions:

- Continue to help States understand the benefits of improved emergency routing through dissemination of the results of FHWA's research and that of other stakeholders.
- Continue to encourage and assist States in implementing automated permitting systems for OS/OW permits, permit harmonization, and multi-State issuance of permits. FHWA can encourage State DOTs to include information on how to obtain IRP, IFTA, and OS/OW permits during off-hours on their websites. FHWA can encourage States to expand the universe of vehicles and loads that have access to autoissue permits. This involves encouraging the expansion of the size and weight thresholds covered by automated permitting systems.
- Continue to provide information to stakeholders that helps them navigate the regulatory and permitting environment. FHWA has prepared the *Resources for Commercial Vehicles Involved in Emergency Response* to inform vehicle operators of the regulatory requirements and types of waivers available. This resource document contains a checklist for vehicle operators that will facilitate emergency routing. The document provides information on OS/OW permits, IRP permits, IFTA permits, FMCSA Safety regulations, such as the hours-of-service requirements, as well as other considerations.
- Encourage and promote information dissemination on FHWA and other websites. FHWA is currently rolling out an Emergency Routing website that can serve as a clearinghouse for noteworthy practices in emergency routing. In addition, AASHTO and FHWA are working with the CVSA on a website that will contain all of the emergency declarations. Continue to coordinate with and encourage public and private sector organizations that are providing useful information to facilitate emergency routing.
- Continue to work with State DOTs to encourage and implement cashless tolling or allow reimbursement of tolls for emergency response vehicles.
- Continue to encourage the deployment and adoption of public and private sector systems to streamline and automate vehicle and driver inspections.

A midterm solution could be achieved with additional planning and investment for the following:

- Help public and private sector entities to use noteworthy practices in emergency routing, including employing and applying relevant military procedures. These include vehicle preclearance processes, convoy management, and advance planning for emergency operations.
- Work with AASHTO and States on development of an inventory of equipment and standardized vehicle envelopes for expedited emergency permitting on specific predesignated routes.

Some of the solutions suggested by this research would require significant additional planning and investment of staff, funding, and other resources. These longer term initiatives include the following:

- The Alert System would require a more extensive investment. To pursue this, a full concept of operations would need to be initiated, including significant outreach to stakeholders. After such a system is more fully specified, a minimum viable system could be piloted that could ultimately be built out as a fully functional system.
- A more complete Web routing and mapping tool could be developed to assist with emergency routing and permitting. This research has defined different levels at which this concept could be implemented. Providing a higher level system with routing and permitting capability would likely require additional significant planning and investment. FHWA has been working with AASHTO and CVSA to develop an emergency declarations website that could be built upon in the future.

The continued certainty of future natural disasters requires advancement of solutions for emergency response and recovery. Enhancing resilience supports the goals of the National Highway Freight Program to improve the safety, security, efficiency, and resiliency of the transportation system and the Nation. FHWA will continue to encourage automated, harmonized, and multi-State issuance of permits and other systems to improve emergency routing.

U.S. Department of Transportation
Federal Highway Administration
Office of Operations
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Office of Operations Website
https://ops.fhwa.dot.gov

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