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Acronyms

2 CFR ..... 2 CFR Part 200
AASHTO .... American Association of State Highway Transportation Officials
ACEC..... American Council of Engineering Companies
ACM..... alternative contracting method
AECOM ..... AECOM Technical Services
ADT ..... average daily traffic
AFWA ..... Anti-Fraud, Waste, and Abuse
AICP ..... American Institute of Certified Planners
APA ..... American Planning Association
ATC ..... alternative technical concepts
BCA ..... benefit-cost analysis
BRIC ..... Building Resilient Infrastructure and Communities
C&CB..... Capability and Capacity Building
CDBG-DR .. Community Development Block Grant – Disaster Recovery
CDC..... Centers for Disease Control and Prevention
CDOT ..... Colorado Department of Transportation
CO ..... Colorado
CUSEC ..... Central U.S. Earthquake Consortium
CFR ..... Code of Federal Regulations
CIA..... Critical Issue Area
CIPR..... Cyber Incident Response Plan
CM at Risk . Construction Manager at Risk
CM/GC..... Construction Manager / General Contractor
COOP ..... continuity of operations or Continuity of Operations Plan
COP ..... common operating picture
CPFF ..... cost-plus-fixed-fee
CPI..... Consumer Price Index
CPWR..... Center for Construction Research and Training
CRPG ..... Community Resilience Planning Guide
CSN..... Colorado State Network
CUSEC ..... Central U.S. Earthquake Consortium
DAR ..... Damage Assessment Report
DB..... design-build
DBF ..... design-build-finance
DBFM ..... design, build, finance, and maintain
DBFOM..... design, build, finance, operate, and maintain
DBB ..... design-bid-build
DDIR..... Detailed Damage Inspection Report
DHS ..... Department of Homeland Security
DHSEM..... (Colorado) Division of Homeland Security and Emergency Management
DOT ..... Department of Transportation
EOC ..... emergency operations center
ER..... Emergency Relief
F5 ..... Fujita Scale 5
F&A..... Facilities and Administration
FAR ..... Federal Acquisition Regulation
FAST ACT . Fixing America's Surface Transportation Act
FBI ..... Federal Bureau of Investigation
FDOT ..... Florida Department of Transportation
FEMA..... Federal Emergency Management Agency
FFCRA..... Families First Coronavirus Response Act
FHWA ..... Federal Highway Administration
FY..... fiscal year
GAAP..... Generally Accepted Accounting Principles
GAGAS..... Generally Accepted Government Auditing Standards
GB ..... Guide Brief
GIS ..... geographic information system
GSA ..... U.S. General Services Administration
GSAR ..... General Services Administration Regulation
IAP..... Incident Action Plan
IC..... Incident Commander
ICC ..... incident command center
ICS ..... incident command system
ICRA..... Infection Control Risk Assessment
IDIQ ..... indefinite delivery, indefinite quantity
IFB..... Invitation for Bids
INVEST..... Infrastructure Voluntary Evaluation Sustainability Tool
ITS..... Intelligent Transportation System

LEED ..... Leadership in Energy and Environmental Design
LPA..... local public agency
M..... Richter Magnitude Scale
MnDOT ..... Minnesota Department of Transportation
MOU ..... Memorandum of Understanding
MPO ..... Metropolitan Planning Organization
MTA..... New York Metropolitan Transportation Authority
MTP..... metropolitan transportation plan
MVSA ..... multi-variate statistical analysis
NABTU ..... North American Building Trade Unions
NASEM..... National Academies of Sciences, Engineering, and Medicine
NCEI..... (NOAA) National Centers for Environmental Information
NCHRP..... National Cooperative Highway Research Program
NEPA..... National Environmental Policy Act
NIEHS..... National Institute of Health, National Institute of Environmental Health Sciences
NIH ..... National Institutes of Health
NIOSH ..... National Institute for Occupational Safety and Health
NIST ..... National Institute of Standards and Technology
NOAA ..... National Oceanic and Atmospheric Administration
NRC..... National Research Council
NTE ..... not-to-exceed
NYC..... New York City
OEM ..... Office of Emergency Management
OIG ..... Office of Inspector General
OMB ..... Office of Management and Budget
OPR..... Office of Primary Responsibility
OSHA ..... Occupational Safety and Health Administration
P3 ..... Public-Private Partnership
PAB ..... Planning Accreditation Board
PAPPG ..... Public Assistance Program and Policy Guide (FEMA)
RE..... renewable energy
ReSCO ..... Resilience-Service Company
RFP ..... Request for Proposals
RFQ..... Request for Qualifications
RnR ..... Risk and Resilience
RoI ..... Return on Investment
ROW..... right of way
SARS-CoV-2 severe acute respiratory syndrome coronavirus 2
SEPTA..... Southeastern Pennsylvania Transit Authority
STA..... state transportation agency
STTL ..... state, territory, tribal, local
TAMPS ..... transportation asset management plans
TIP..... Transportation Improvement Plan
TRB ..... Transportation Research Board
TxDOT..... Texas DOT
UC Davis ... University of California, Davis
UCLA..... University of California at Los Angeles
UK..... United Kingdom
USACE ..... US. Army Corps of Engineers
U.S.C. ..... U.S. Code
WASHTO .. Western Association of State Highway and Transportation Officials
WHO..... World Health Organization
WTP..... Worker Training Program (NIEHS)

Icon Key

Reports from the field

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Abstract

Concurrent, regional emergencies and disasters cause long-term disruptions to transportation infrastructure. Many state/territory departments of transportation (DOTs) have established procedures on how to address emergency projects. However, increasingly frequent events involving emergencies across multiple regions demonstrate the need for DOTs to plan for prioritizing and managing several projects impacting critical corridors. *NCHRP Legal Research Digest 49: Emergency Contracting: Flexibilities in Contracting Procedures During an Emergency* provides a legal analysis for emergency contracting. However, DOT emergency procedures typically focus on a single emergency. When significant numbers of infrastructure assets are compromised including critical corridors, DOTs need guidelines on how to bring major segments of the system back online. While *Best Practices in Accelerated Construction Techniques* [NCHRP Project 20-68A (07-02)] offers case studies on emergency projects, a programmatic approach will facilitate emergency contracting at scale. *NCHRP Synthesis 438: Expedited Procurement Procedures for Emergency Construction Services* recommends research guidance and identifies the need to coordinate multi-agency DOT plans pre-emergency. It also recommends investigating alternative contracting methods as sources for on-call emergency design and construction services. The objective of this research, therefore, is to develop a contracting strategies guidebook for the administration of concurrent, regional emergencies and disasters. The primary audience is DOTs and other transportation agencies such as Metropolitan Planning Organizations (MPOs) administering multiple projects over one or more wide region(s) involving multiple, impacted critical corridors.

Summary

The primary deliverable of NCHRP 08-107 applied research is the *Contracting Strategies Guidebook for the Administration of Concurrent, Regional Emergencies and Disasters* (Guidebook). The goals of the applied research and its key delivers include the following: provide relevant information, strategies, and tools to transportation professionals including state and territorial departments of transportation (DOTs) and metropolitan planning organizations (MPOs), to effectively plan and administer work to restore essential traffic for surface transportation; and plan, design, and build resilient recovery projects. This research is distinguished from studies that contemplate emergencies and disasters involving a single corridor by focusing on strategies that address multiple, severely damaged, critical transportation corridors across a broad geographic region and multiple jurisdictions.

A framing question for this applied research is whether today's transportation professional is equipped, organized, and properly resourced to administer a $500 million or $10 billion rapid response and resilient recovery operation successfully? Do they have the necessary tools to contemplate and materially decrease post-disaster recovery time, risks, and costs? Do they have resources to evaluate opportunities to capture durable gains for the DOT, the community and travelling public, and the taxpayer? This applied research explores these and other key questions and provides recommendations to meaningfully improve outcomes shaped through effective processes and procedures, controls, and actions. It guides the user through important administrative steps to get ready for, respond to, and recover from concurrent, regional emergencies and disasters.

Transportation organizations are carrying significant embedded risks in their built infrastructure assets and systems. Similarly, administrative risks are sometimes reinforced within DOT governance and operational models that are typically designed to operate efficiently during "blue skies," as well as to support minor or moderate shocks (also described as emergencies, disasters, or events such as major earthquakes or hurricanes). The inability of these systems to withstand significant scale and magnitude shocks not only undermines transportation assets, but also has destabilizing effects on people and communities, the local and regional economy, and the environment.

To focus this broad topic area, this report considers critical issues to address gaps in the current bodies of knowledge and practice that together present compelling challenges. The applied research examines three phases of the resilience lifecycle: readiness, rapid response, and resilient recovery. All of these phases provide the opportunity to use administrative controls, including procurement, contracting, and project delivery methods, to yield important gains for transportation professionals who wish to unlock the power of improving system outcomes and reduce risks for the transportation agency.

NCHRP 08-107 used several data collection methods. The literature review formed a picture of the current research in transportation administration, disaster resilience, and concurrent, regional emergencies. Case studies were conducted in Washington State, the central U.S. earthquake region (New Madrid Seismic Zone), the greater Miami metropolitan area, Colorado, and the U.S. Virgin Islands. The case studies provided the fulcrum through which the critical issue areas were analyzed, and shaped many of the research questions and recommendations captured in this Final Report (Report) and presented in the Guidebook.

Applied research included a multi-variate statistical analysis (MVSA) to identify statistically significant relationships between procurement and contracting methods and compliance with Federal rules involving project delivery. Research included a Disaster Practitioner Cadre Survey (survey) of over 100 emergency management and disaster resilience professionals, most of whom have spent an average of 7 or more years responding to disasters of all scales. The survey provided outstanding trend data, as well as a snapshot of the strengths and weaknesses in rapid response and resilient recovery that were observed after hundreds of disasters over the last two decades. In addition, technical experts in emergency management were convened at an optional symposium that took place during a residency of FEMA's Emergency Management Executive Academy (Cohort IV) that delved into consequences and cascading impacts associated with multi-hazards, including human-caused events. Reports from the field capture interview feedback from transportation administrators who found themselves in key executive and management roles following concurrent, regional emergencies, and offer candid advice to peers to help bring Guidebook content to life for the user. This qualitative feedback is also included in this Report.

Together, NCHRP 08-107 applied research methods yielded 8 critical issue areas in relation to concurrent regional emergencies and disasters:

- DOT Emergency Plan Coordination
- Scope and Scale
- Prioritization and Capacity
- Flexible Arrangements
- Innovative Delivery
- Audit and Other Risks
- Policy and Funding
- Other Relevant Considerations
    - Social Dimensions
    - Cyber Incidents
    - Pandemics and COVID-19

The findings of the applied research emphasize the importance of using time available during normal operating conditions (also described as "blue skies") to plans for concurrent, regional emergencies and disasters. Over and over again, the research pointed to a few critical success factors such as:

- ✓ Building cooperative relationships with key partners, and emergency plans that contemplate, not just life-safety operations, but the monumental task of reconstruction at scale;
- ✓ Using incident command system (ICS) and adapting it to response and recovery phase needs;
- ✓ Putting professional services and construction contracts in place pre-shock to quickly restore essential traffic with fair and clear contract terms;
- ✓ Adopting enabling legislation and using innovative delivery to improve coordination and recovery times where transportation professionals are experienced in using these methods effectively;

- ✓ Anticipating and mitigating threats to supply chains such as inadequate supply, route disruptions and schedule impacts of long-lead items;
- ✓ Engaging the right resources to meaningfully consider social dimensions in all phases of disaster resilience and promote community participation in planning so decisions are made with community benefit in view;
- ✓ Providing contract direction on resilient engineering standards and specifications for above-minimum resilience requirements;
- ✓ Defining and using benefit-cost analysis, design alternatives, and bid alternative to evaluate feasible asset resilience;
- ✓ Leveraging readiness and resilient recovery phase to deliver co-benefits for people and communities, environmental sustainability, and economic stability and growth; and
- ✓ Understanding and complying with the rules of engagement that govern Federal disaster funding, such as flexibility for emergency procurement actions, which are essential for maximizing eligibility for funding and driving down audit risks.

Concurrent, regional emergencies and disasters need to be treated as a high-stakes threat. The consequences of failing to take timely action to prepare for concurrent, regional emergencies and disasters are clear—longer recovery times with adverse social, economic, and environmental impacts to communities, higher costs to the taxpayer, and lost opportunities to durably improve, adapt, and strengthen systems. Having robust administrative procedures in place to quickly stabilize and restore essential traffic and optimize the resilient reconstruction of surface transportation infrastructure assets is mission-critical following concurrent, regional emergencies and disasters. This Report outlines research findings for transportation professionals facing enormous obstacles with concrete and clear-eyed recommendations and tools and resources to better equip them to successfully procure, contract, and deliver hundreds of millions or billions of dollars in urgently needed network restoration and resilient reconstruction.

1 Introduction

The need to address the gap in emergency administrative procedures for concurrent, regional emergencies and disasters became evident following the Loma Prieta Earthquake in 1989 and Northridge Earthquake in 1994, following major disruptions after the September 11th attacks of 2001 and again following Hurricane Katrina in 2005 and Superstorm Sandy in 2012. Each of these events caused billions of dollars in damages to transportation infrastructure owned by hundreds of political jurisdictions across the US. Transportation agencies in these impacted regions experienced unprecedented levels of disaster damage to infrastructure systems, roadways, and structures, requiring urgent stabilization and emergency repairs to restore service, and at the same time, begin planning the way forward on significant system repairs and resilient reconstruction. Figure 1-1 displays transportation asset flooding as a result of Superstorm Sandy.

Figure 1-1: Battery Park Underpass in Manhattan, a major throughway in the city, flooded with seawater during Hurricane Sandy (NYC Department of Transportation, used with permission)

The need to provide guidance for emergency administrative procedures following concurrent, regional emergencies and disasters was then reinforced by the flooding in Colorado in September 2013, which damaged transportation infrastructure across the state's North Front Range of the Southern Rocky Mountains. The flood impact area was unprecedented, spanning almost 200 miles north to south by approximately 50 miles east to west, damaging over 400 miles of Federal Highway Administration (FHWA) on-system roadways and adjacent areas, and impacting over 120 bridges and structures. See Figure 1-2 and Figure 1-3. Floodwaters blocked access to mountain communities, and over 6500 stranded survivors were airlifted to safety as temperatures dipped below freezing. The Colorado Department of Transportation (CDOT) needed to immediately assess over 1000 structures for safety, close unstable roadways, and begin emergency repairs to restore essential traffic over a large portfolio of projects across

a widespread region with limited or no communications as well as award and monitor a portfolio of local agency recipient emergency projects.

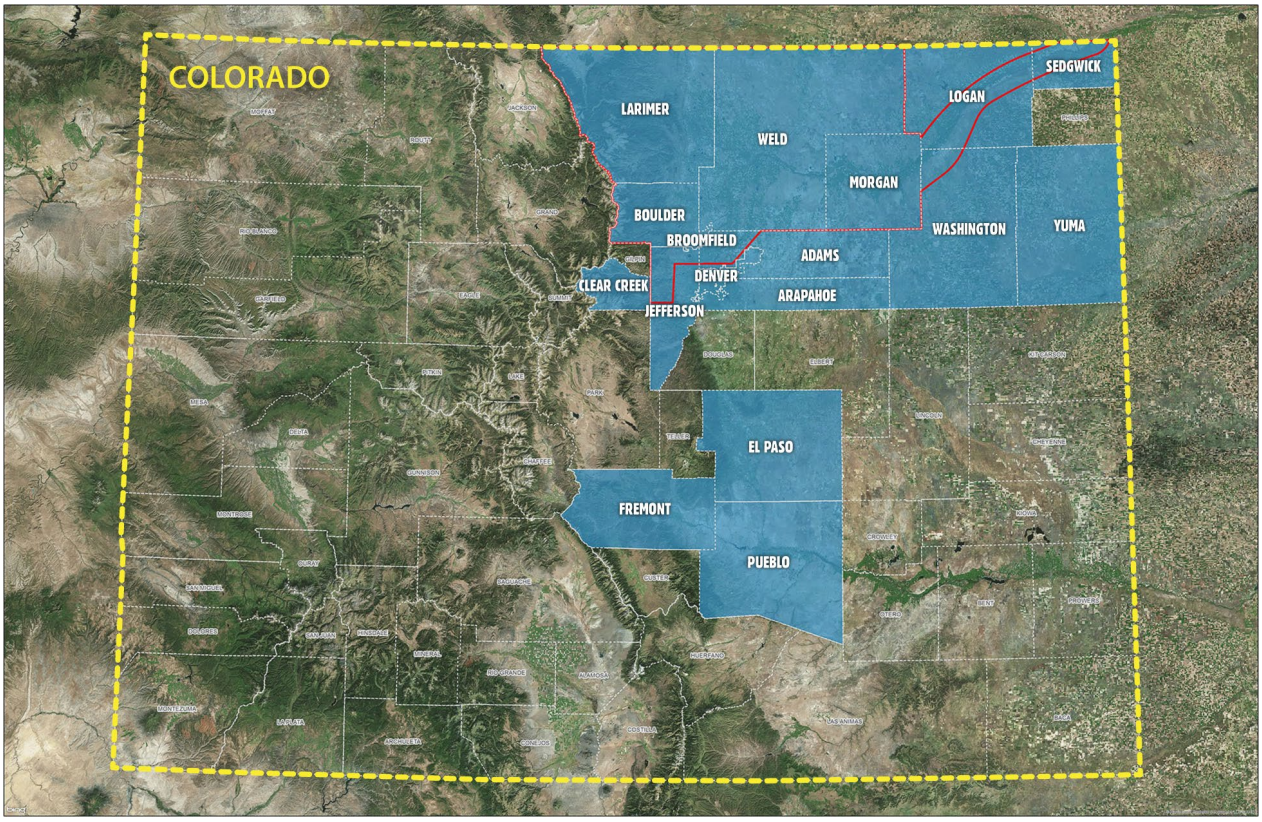


Figure 1-2: Impact scale of the Colorado 2013 flood (CDOT, used with permission)

Figure 1-3: Temporary repairs on U.S. 34 following the 2013 Colorado Flood (CDOT, used with permission)

Developed with the support of the National Cooperative Highway Research Program (NCHRP), the Report and the applied research's primary deliverable, the Guidebook, are designed to help transportation administrators and other professionals take actionable steps to reduce risks, time, and costs and to improve project delivery outcomes when faced with the responsibility of stabilizing and rapidly restoring essential traffic and resiliently reconstructing hundreds of millions or billions of dollars in transportation infrastructure assets.

Concurrent, regional emergencies involve disasters that cross regional and jurisdictional boundaries and impact more than one critical corridor or structure. Sometimes they are caused by a single, extreme shock. Other times, they are the result of successive or concurrent shocks impacting a single area, as seen in the

U.S. Virgin Islands following Hurricanes Irma and Maria or involve damages from multiple earthquakes, floods, fires, or tornadoes. Similarly, the unprecedented global impacts of the virus responsible for the 2020 pandemic, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and the resulting primary disease (referenced herein as COVID-19) have introduced startling new challenges for the transportation industry. Mitigating the impacts of the COVID-19 on the life-safety of transportation personnel, the traveling public, and the financial health of the industry present a clarion call to prepare for the unexpected.

There are many types of events that can cause localized disruptions to transportation systems caused by a variety of hazards for which there is a strong body of available research. Depending on the severity of the event(s) and impacts, the State, Tribal, Territory, Local (STTL), and/or Federal authorities may declare and emergency or a disaster. At times, a single or multiple events can be of such severity, scale, and distribution that they cause concurrent, widespread damage and disruption to surface transportation systems across one or more regions. This aggregation of incidents that causes regionwide or multi-region disruption is the subject of NCHRP 08-107 applied research. The Report and the applied research's primary deliverable, the Guidebook, deliver information, recommendations, and tools to promote organizational agility and successfully deliver a large portfolio of surface transportation projects through the nexus of administrative procedures and controls, including procurement and contracting strategies.

1.1 Applied Research Objective

The Report presents findings of applied research, NCHRP 08-107, and its primary deliverable, the Guidebook. These center around the needs of transportation professionals who are charged with effectively implementing administrative systems that facilitate robust readiness, rapid response, and resilient recovery of surface transportation infrastructure when faced with the unique demands of concurrent, regional emergencies.

The research contemplates the most effective administrative strategies to quickly and safely get surface transportation assets back in service and resiliently restored in alignment with project/corridor prioritization objectives despite complex and dynamic post-disaster conditions.

Objective

NCHRP 08-107 Applied Research Findings encourage transportation professionals to take action before and after concurrent, regional emergencies to unlock the benefits of utilizing administrative actions to control risks, shorten corridor downtime, realize cost savings, maximize disaster funding and optimize compliance, and improve returns on investment (RoIs) through resilient recovery. These actions can amplify co-benefits for people and communities, the regional economy, and environmental sustainability.

Figure 1-4 shows the nexus of the three key focus areas of this applied research—administration, including procurement and contracting, surface transportation corridors, and concurrent, regional emergencies and disasters.

To focus this broad topic area, the research considers critical issues to address gaps in the current bodies of knowledge and practice that together present compelling challenges. The Report and this applied research's primary deliverable, the Guidebook, are organized to be concise, useful, and actionable. The Report describes methods and recommendations based on known and anticipated risks and effective practices. It also presents tools and resources that can be readily applied or customized for locally relevant conditions to help users move from problem identification and planning to successfully delivering a large portfolio of projects.

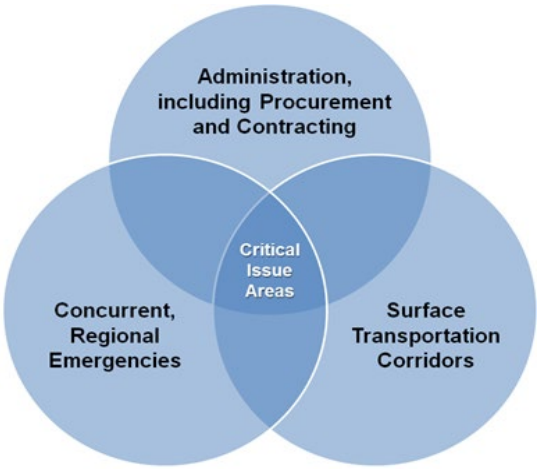


Figure 1-4: NCHRP 08-107 applied research nexus

1.2 NCHRP 08-107 Research Scope and Methods

Having robust administrative procedures in place to quickly stabilize and restore essential traffic and optimize the resilient reconstruction of surface transportation infrastructure assets is mission critical following concurrent, regional emergencies.

The goals of NCHRP 08-107 applied research is to offer relevant information, strategies, and tools that will help state and territorial departments of transportation (DOTs) and Metropolitan Planning Organizations (MPOs) achieve effective administrative practice. This research is distinguished from studies that contemplate emergencies involving a single corridor by focusing on strategies that address multiple, severely damaged, critical transportation corridors across a broad geographic region and multiple jurisdictions.

This applied research discusses the importance of an effective handoff by emergency managers, who direct lifesaving activities, such as evacuations and road closures, and manage traffic information and incidents during the life-safety operations phase, to the recovery incident command who is charged with rapidly restoring and resiliently reconstructing surface transportation assets. In many cases, finance and administration section personnel provide critically important continuity during the transition between resilience phases that move from an exigent life-safety focus to rapid response and resilient recovery. The Report and the Guidebook explore three resilience phases—readiness, rapid response, and resilient recovery.

A great deal of the Report's and the Guidebook's content on disaster phases are included in the readiness phase. Often described in emergency management circles as "preparedness," the readiness phase identifies activities that can be undertaken during normal conditions without severe weather or major shocks or stressors to the system (also described as "blue skies") to materially improve post-emergency and disaster administrative and project delivery outcomes. Actions undertaken and integrated within the

transportation agency's culture within the readiness phase will yield the most demonstrable gains in avoiding and mitigating damages and disruptions to transportation systems.

In addition to content on the readiness, the Report and the Guidebook focus on the rapid response and resilient recovery phases. In emergency management circles, work to restore infrastructure after life-safety work has been accomplished is typically described as "recovery" work. However, because this research is focused on administrative procedures, recovery is divided into two phases—rapid response and resilient recovery in addition to the readiness phase. The distinction is appropriate because available information for decision-making and type work performed by phase support fundamentally different objectives and sometimes follow different rules and allowances. The U.S. Office of Management and Budget (OMB) administrative allowances and FHWA's Emergency Relief (ER) policies and cost-share requirements differ for work performed during emergency conditions in the rapid response phase and the resilient recovery phase of long-term roadway reconstruction work. Administrative flexibility permitted during rapid response is largely eliminated in the resilient recovery phase.

Distinctions between rapid response and resilient recovery can also be true for work funded through the Federal Emergency Management Agency's (FEMA's) Public Assistance Program. Available funding can vary by type of Federal emergency or disaster declaration as well whether disaster-specific relief is authorized that exceeds Federal participation in regulatory cost share requirements which sometimes occurs following concurrent regional disasters. When authorized, FEMA's Pubic Assistance Program funds debris removal of Federal-aid roads and supports repairs to certain toll roads, bridges and structures; airport and port facilities; and buildings and other non-infrastructure assets such as storage facilities (e.g., salt sheds) damaged by disaster that are not covered by insurance and meet other requirements. Federal funding is discussed under policy and funding in Chapters 4, 5, and 6.

NOAA states. "first 9 months of 2020 ties the annual record of 16 events that occurred in 2011 and 2017. 2020 is the sixth consecutive year (2015-2020) in which 10 or more billion-dollar weather and climate disaster events have impacted the United States. Over the last 41 years (1980-2020), the years with 10 or more separate billion-dollar disaster events include 1998, 2008, 2011-2012, and 2015-2020 (NCEI 2020)." If the disaster magnitudes reflected in Figure 1-5 for 2020 and Figure 1-6 showing trend data from 1980-2019 continue, the research findings will be timely in helping transportation professionals bolster administrative systems in order to reduce risks, costs, and corridor downtime and increase project quality and resilience following concurrent, regional emergencies.

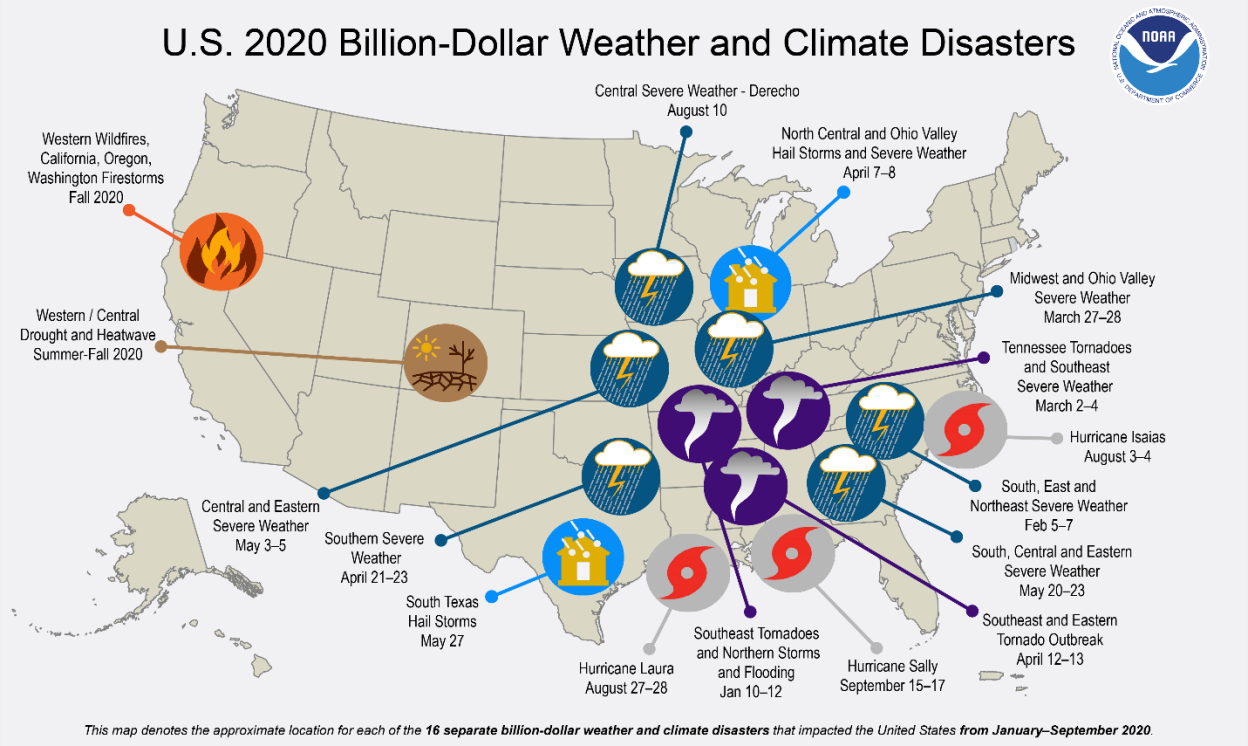


Figure 1-5: Billion-dollar disasters in the United States, January to September 2020 (NCEI 2020)

In 2020 (as of October 7), there have been 16 weather/climate disaster events with losses exceeding $1 billion each to affect the United States. These events included 1 drought event, 11 severe storm events, 3 tropical cyclone events, and 1 wildfire event. Overall, these events resulted in the deaths of 188 people and had significant economic effects on the areas impacted. The 1980–2019 annual average is 6.6 events (CPI-adjusted); the annual average for the most recent 5 years (2015–2019) is 13.8 events (CPI-adjusted).

NCHRP 08-107 applied research used several data collection methods. To keep the Report as user-friendly as possible for practitioners, research methods are described in Chapter 7 and detailed in respective appendices.

The literature review formed a picture of the current research in transportation administration, disaster resilience, and concurrent, regional emergencies. The results of the literature review are summarized in Chapter 7 and presented in full in Appendix A. Case studies were conducted, beginning with a Long Beach Pilot at Western Association of State Highway and Transportation Officials (WASHTO), involving regions in high-hazard areas, and included either reflections following functional exercises for concurrent, regional emergency scenarios or reflections following an actual event. Case studies were conducted in Washington State, the central U.S. earthquake region (New Madrid Seismic Zone), the greater Miami metropolitan area, Colorado, and the U.S. Virgin Islands. The case studies provided the fulcrum through which the critical issue areas were analyzed and informed many of the research questions and recommendations. See Chapter 2 for the critical issue areas and Appendix B for case study summaries.

Applied research included a Disaster Practitioner Cadre Survey (survey) of over 100 emergency management and disaster resilience professionals, most of whom have spent an average of 7 or more

years responding to disasters of all scales. They served principally as consultants for FEMA's Public Assistance or Hazard Mitigation Grant Program but have also supported a wide range of other Federal, state, territorial, and local agencies. The survey provided outstanding trend data as well as a snapshot of the strengths and weaknesses in rapid response and resilient recovery that were observed after hundreds of disasters over the last two decades. In addition, technical experts in emergency management were convened at an optional session of FEMA's Emergency Management Executive Academy (Cohort IV) with a focus on consequences and cascading impacts associated with multi-hazards, including human-caused events. Survey responses and recommendations are integrated throughout the report. Reports from the field capture interview feedback from transportation administrators who found themselves in key executive and management roles following concurrent, regional emergencies. Their experiences are summarized in Section 1.7, and their feedback is integrated into the Report and the Guidebook using the "reports from the field" icon:

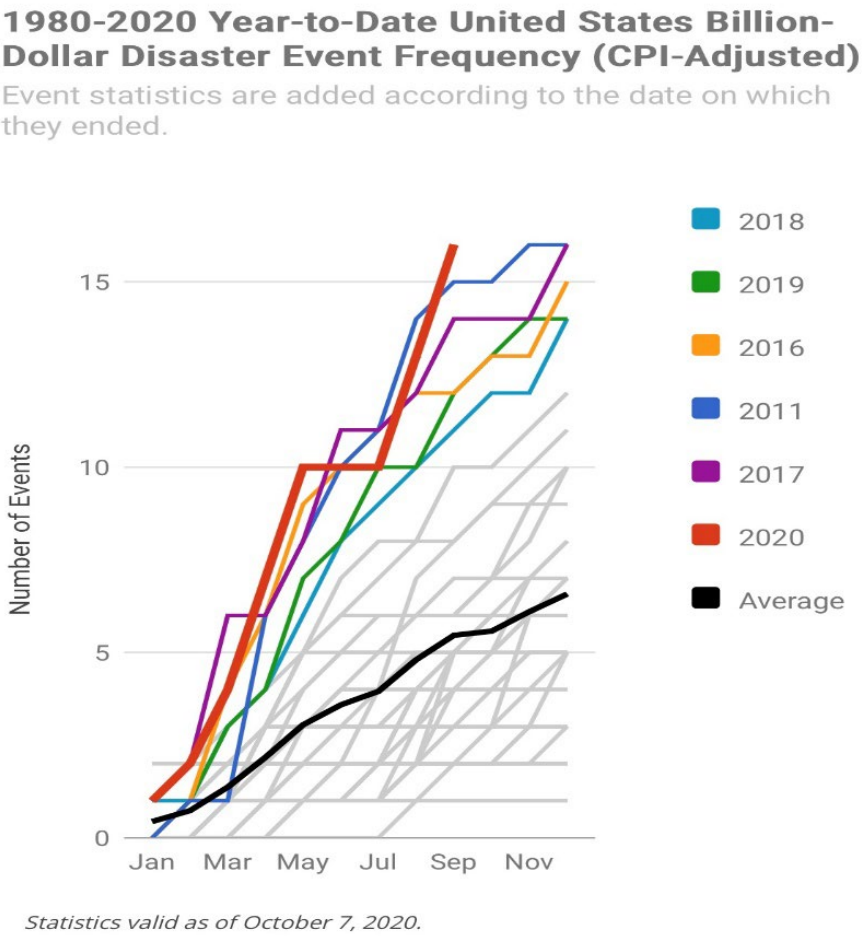
The research team conducted a multi-variate statistical analysis (MVSA) to test the veracity of anecdotal information related to the FEMA Office of Inspector General's (OIG's) audit findings concerning post-disaster administrative controls and practices, including procurement and contracting. The results establish correlations, but not causality. The results are summarized in Chapter 7 and presented in Appendix C. While MVSA results are useful, readers are cautioned that the results do not establish causality; therefore, additional research is warranted.

1.3 Context and Key Questions

The United States has experienced an increased rate of natural and human-caused disasters as shown in Figure 1-6. Large-scale and high-consequence emergencies and disasters involve cooperative decision-making that cross political jurisdictions. Often, the largest disasters result in cascading impacts and consequences and involve multiple transportation corridors. For example, an earthquake may undermine roadways and bridges/structures, and fires caused by the earthquake may result in unanticipated secondary road closures that stymie access to local hospitals.

" Effective and complete coordination will require frequent meetings with key stakeholders and accountable entities on a regular basis throughout the entire recovery process. While assigned accountabilities must be clear and unambiguous as to whom is the primary party, there needs to be a focus on overcommunicating amongst all parties that emphasizes that it is better for some overlapping of responsibilities than to have gaps. And, lastly and most importantly, the overall priority for establishing this mandate of coordination must come from the highest level of the state executive branch of government (Governor) either by him/herself chairing the meetings or delegating that responsibility to one of their staff.

– Tom Prendergast,
Former Chairman, NYMTA and
Former CEO, NY MTA Transit



*Over the last 41 years (1980-2020), the **years with 10 or more** separate billion-dollar disaster events include **1998, 2008, 2011-2012, and 2015-2020**. Grey lines denote 1980-2020 data except where otherwise noted in legend.*

Figure 1-6: Billion Dollar Disaster Declarations by Year, 1980 to 2020 (NCEI 2020)

In light of increasing frequency of hazards and severity of impacts, U.S. transportation organizations need to recognize that they are carrying significant embedded risks in their built infrastructure assets and systems. Similarly, administrative risks are sometimes reinforced within DOT governance and operational models that are typically designed to operate efficiently during blue skies as well as to support minor or moderate shock events. The inability of these systems to withstand significant scale and magnitude shocks not only undermines transportation assets but also has destabilizing effects on people and communities, the local and regional economy, and the environment.

Concurrent, Regional Emergencies and Disasters

Concurrent, regional emergencies and disasters need to be treated as a high-stakes threat. The consequences of failing to take timely action to prepare for concurrent, regional emergencies are clear—longer recovery times with adverse social, economic, and environmental impacts to communities, higher costs to the taxpayer, and lost opportunities to durably improve, adapt, and strengthen systems.

Framing questions for this applied research are whether today's transportation professionals are equipped, organized, and properly resourced to administer a $500

million or $10 billion rapid response and resilient recovery operation successfully? Do they have the necessary tools to contemplate and materially decrease post-disaster recovery time, risks, and costs? Do they have resources to evaluate opportunities to capture durable gains for the DOT, the community and travelling public, and the taxpayer? The research explores these and other key questions and provides recommendations to meaningfully improve outcomes shaped through effective processes and procedures, controls, and actions. It guides the user through important administrative steps to get ready for, respond to, and recover from concurrent, regional emergencies and disasters.

Increasing a transportation organizations maturity along the resilience continuum is absolutely integral to its public service mission and its fiscal health. FHWA's definition of resilience is generally aligned with the National Academies of Sciences' definition as expressed in *Disaster Resilience: A National Imperative* (NRC 2012), which defines resilience as "the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events."

FHWA's Definition of Resilience

The applied research uses the term "resilience" in keeping with FHWA published definitions which include:

(1) "The capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment." (FHWA 2013).

(2) "the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions" (FHWA 2014b).

Walker and Salt (2006) in *Resilience Thinking—Sustaining Ecosystems and People in a Changing World* suggest that when resilience is organized around a vision and a common set of framing values, it enables stakeholders to move beyond organizational interests. When moving from an insular organization approach a whole-of-community approach to support cross-region resilience, it is essential to open the aperture and see the interconnectedness and interdependencies of transportation systems with other systems as well as new perspectives and ways of working. Walker and Salt's core principles are useful in cultivating this holistic view of resilience. They recognize key resilience variables that include valuing diversity, ecological variability, and modularity; acknowledging slow variables, tight feedbacks, social capital, and innovation; and overlapping in governance and ecosystem services. The Transportation Research Board's (TRB's) Transportation Research Circular Number E-C226, *Transportation Systems Resilience: Preparation, Recovery, and Adaptation* (TRB 2017), aligns these values and the added potential transportation system outcomes shown in Table 1-1. This values and outcomes alignment is necessary to thoughtfully restore a region's transportation assets and consider with the Report's content on readiness and resilient recovery phases when preparing for concurrent, regional emergencies and disasters.

Table 1-1: Summary of Resilient System Values

Resiliency Value	Supporting Statement	Possible Outcomes in Transportation System under This Resiliency Value
Diversity	A resilient world would promote and sustain diversity in all forms (biological, landscape, social, and economic).	Meaningful engagement with stakeholders. Diversity in land uses within near proximity. Multimodal transportation planning. Diversified mobility choices for ridesharing. Equitable allocation of mobility investment.

Resiliency Value	Supporting Statement	Possible Outcomes in Transportation System under This Resiliency Value
Ecological variability	A resilient world would embrace and work with ecological variability (rather than attempting to control and reduce it).	Context-sensitive approaches, not one size fits all. Variety or reduction of policy and regulations based on desired outcomes and evidence based.
Modularity	A resilient world would consist of modular components.	Gridded networks for all transportation modes to allow for multiple options from origins to destinations.
Acknowledging slow variables	A resilient world would have a policy focus on "slow," controlling variables associated with thresholds.	Phasing out of surface parking over structured or hidden parking as redevelopment occurs. Land use changes or growth priorities within municipalities in the long term.
Tight feedbacks	A resilient world would possess tight feedbacks (but not too tight).	Piloting projects to test potential outcomes. Monitoring and evaluation programs feeding into new development and planning procedures (e.g., refining trip generation rates).
Social capital	A resilient world would promote trust, well-developed social networks, and leadership (adaptability).	Projects that do not just build infrastructure but contribute to communities strengthening their social bonds (e.g., Build a Better Block, Tactical Urbanism).
Innovation	A resilient world would place an emphasis on learning, experimentation, locally developed rules, and embracing change.	Local standards and national guidance are beginning to accommodate new evidenced-based resilience guidelines and designs. Guided by standards and specifications and the legal and regulatory climate, to use technical judgment in supporting resilient asset performance in transportation decisions rather than strict adherence minimum codes and standards.
Overlap in governance	A resilient world would have institutions that include "redundancy" in their governance structures and a mix of common and private property with overlapping access rights.	Stronger emphasis on participatory planning and community engagement. Regional partnerships and national associations as partners in governance of practitioners.
Ecosystem services	A resilient world would include all the unpriced ecosystem services in development proposals and assessments.	Lifecycle cost accounting or full-cost accounting that aims to include more externalities associated with infrastructure.

Source: TRB (2017)

1.4 Concurrent, Regional Emergencies: Challenges in Readiness, Rapid Response, and Resilient Recovery

A significant gap exists in the current body of knowledge and state of practice in surface transportation for the effective administration of concurrent, regional emergencies and disasters and the delivery and risk controls that must be built into procurement and contracting strategies and other administrative functions. Where emergency procedures align with real or perceived risks, the procedures typically accommodate isolated annualized (or probabilistic) risks such as a flood with a 2% annual chance of occurring in a given year. Typically, these procedures are also shaped around the assumption that an emergency will impact only a limited number of assets within a well-defined footprint.

Responding to Concurrent, Regional Emergencies and Disasters

Many DOTs and MPOs lack experience with concurrent, regional disasters and fail to have scalable emergency procedures along with the authorization triggers needed to pivot to the demands of an exigent $500 million to $1 billion+ infrastructure crisis. The applied research responds to this gap by focusing recommendations on the critical issue areas that were examined in this applied research and provides information, recommendations, and tools to promote success during resilience lifecycle phases of readiness, rapid response, and resilient recovery.

As illustrated in the American Association of State Highway Transportation Officials (AASHTO) report, *Understanding Transportation Resilience: A 2016-2018 Roadmap*, many facets come together in support of transportation resilience (AASHTO 2017). Figure 1-7 shows "honeycomb" cells, each representing a key resilience facet. Like safety, resilience affects every major business function within a transportation agency; therefore, each department that has a connection to these facets must play a role.

Figure 1-7: Transportation resilience honeycomb (AASHTO 2017; used with permission)

Applied research recommendations can shorten the time to the project award, lower total costs, and/or result in shorter downtime, thereby lessening disruptions and the cascading impacts that adversely affect people and communities, the regional economy, and the environment during response operations. Additionally, these recommendations can result in buying down risks through resilient reconstruction.

The research integrates best practices evidenced through alternative or innovative contracting that can actively be applied to concurrent, regional emergencies and disasters. The National Academies of Sciences, Engineering, and Medicine (2008) identifies key barriers in an NCHRP report survey that captured most of the important barriers to implementation of alternative contracting, which are enumerated in Section 1.9.

Gaps Identified by NCHRP 08-107 Research Team that Shaped Methods and Findings

- ✓ Poorly documented and executed emergency contracting policies that cannot readily accommodate the scale and complexities unique to concurrent, regional emergencies
- ✓ Lack of accelerated construction techniques for regional-scale events and complex assets
- ✓ Lack of DOT administrative plans and exercises coordinated with other state and Federal agencies, local partners, and the private sector that focus on restoring essential traffic and resilient reconstruction of multiple critical corridors and structures across a region
- ✓ Inadequate controls in procurement and contracting methods used in emergency conditions that result in unmitigated audit risks
- ✓ Inadequate or uncoordinated corridor prioritization
- ✓ Gap in knowledge and experience with alternative/innovative contracting procedures, although this is changing rapidly as these methods are being mainstreamed
- ✓ Lack of strategic consultation with administrators to shape clear, ambitious goals for procurement and contracting for concurrent, regional emergencies
- ✓ Lack of experience controlling risks and promoting risk transfer in exigent conditions as well as structuring emergency procurements to save time and costs and bolster quality outcomes
- ✓ Lack of administrator exposure to and experience with resilience and adaptation and leveraging co-benefits

The Report and this applied research's primary deliverable, the Guidebook, respond directly to the challenges outlined above with research findings, clear information, recommendations, and cautions to enhance opportunities for transportation professionals to rapidly respond to, resiliently recovery from, or get ready to successfully administer concurrent, regional emergencies.

1.5 How Research Findings Benefit Transportation Professionals

The applied research focuses on the following ways to support transportation professionals:

- ✓ Understand the mission-critical role of finance and administration leadership and personnel as key actors on the incident command team;
- ✓ Evaluate advantages and disadvantages of disaster-related procurement and contracting options and structure strategies to materially improve post-disaster outcomes;
- ✓ Leverage administrative controls to shape disaster response and recovery project planning and delivery;
- ✓ Access sample and customizable tools to support key decisions on emergency response and recovery project selection and delivery;

Transportation professionals using the applied research findings in the midst of an emergency or disaster are directed to Chapters 4, Rapid Response, and 5, Resilient Recovery for recommendations, cautions, and sample tools and templates as well as the "Grab and Go Appendix."

- ✓ Structure administrative systems to help maximize disaster funding and drive down audit risks to avoid de-obligation of funds or non-reimbursement of direct disaster-related expenses;
- ✓ Unlock the benefits of using administrative controls, including procurement and contracting, to shorten corridor downtime, realize cost savings, improve quality in project delivery, optimize compliance and drive down audit risks, and improve Return on Investments (RoIs) for resilience and social, environmental, and economic co-benefits.

The applied research's target audience includes executives, regional engineers, administrators, and other transportation professionals at DOTs and MPOs working to oversee all phases of resilience and disaster program preparedness and delivery. It also offers value to infrastructure owners supporting other STTLs and Federal agencies. While the research recommendations offer multimodal applicability, they are written primarily for the needs and requirements of surface transportation.

Utilizing findings and recommendations will yield more value for transportation professionals who leverage the time prior to a concurrent, regional emergency or disaster to collaborate with colleagues and partners within their respective region to systematically improve administrative readiness for concurrent, regional emergencies and disasters. However, the research findings and recommendations are also specifically designed and organized to aid the transportation professional in the midst of crisis who wants to readily access recommendations and tools to help mitigate imminent risks while stabilizing roadways and restoring essential traffic. Findings and recommendations are similarly designed to support those turning their attentions from rapid response to resilient recovery needing to use administrative controls to leverage the full suite of resilience and other co-benefits to positively impact people and communities, the regional economy, and the environment.

1.6 Organization of the Report

The Report introduces critical issue areas and then quickly steps into chapters organized by disaster phase—moving from readiness to rapid response to resilient recovery. Information about the methodology of this applied research is presented in Chapter 8 of the Report and in the appendices.

To further aid the user, the Report and the Guidebook include a "grab and go" compilation of tools in Appendix G that contains a number of useful resources as well as a wayfinding guide in Appendix F that points the user to other relevant resilience and other research and guides. An annotated bibliography is provided in Appendix A.

1.7 Reports from the Field: Experiences and Recommendations from Transportation Professionals

Several transportation professionals were interviewed about their experience during and insights after responding to concurrent, regional emergencies and to discuss administrative controls that helped them deliver portfolios of rapid response and resilient recovery projects involving hundreds of millions of dollars or more in Federal disaster funds. They are introduced below, and their feedback appears throughout both the Report and the Guidebook with the "reports from the field" icon: 

Perspectives from FHWA sustainable transportation and resilience resources were also solicited to help understand trends and discuss opportunities for Federal cooperation.

Jim Weinstein
AECOM Transportation lead, former Executive Director of New Jersey Transit (NJ Transit) during Hurricane Irene and Hurricane Sandy, and former Commission for New Jersey DOT

Leading NJ Transit through Hurricane Sandy: "It was tough emotionally. The first priority was to make sure our people are safe and stay safe and we were not putting them at risk—the rest of it is equipment, and however painful it may be or expensive it may be, it's replaceable—lives are not. We took an immense amount of pride; there were virtually no injuries at all during Sandy of either of our staff or our customers."

Susanne DesRoches
Deputy Director, Infrastructure + Energy
NYC Mayor's Office of Resiliency
NYC Mayor's Office of Sustainability
and former Engineer at the Port Authority during Hurricane Sandy

"Nobody at Port Authority had any idea about FEMA grants before Sandy; it was a bit of nightmare. It took a massive mobilization in order to understand the ins and outs of the grant programs in-and-of themselves —what was eligible? how did you qualify? how could you procure in a way that was satisfactory?—and all of that had to happen very quickly, and there was no previous knowledge."

Heather Paddock
CDOT Region 4 Director and former CDOT Flood Recovery Manager for 2013 flood

"First off, our maintenance crews really know how to respond to this catastrophic event. They were very strategic with their road closures and concerned about life safety first. What they did was spot on, that's what we do really well as an agency."

"Our contractors know how to build things, and our engineers know how to design things, they are very competent. Our ability to cut red tape allowed us to respond quickly."

Colette DeSonier
CDOT Director of Procurement & Business Services Flood Recovery Business Manager at CDOT for the 2013 Flood

"I would say, adopt similar procedures to the ones we did after the flood. We went through an exercise for establishing emergency procedures where we took a deep look at lessons learned and best practices—we developed standard operating procedures to not get caught off guard the next time."

Marci Gray
CDOT Engineering Contracts Manager

"On the highway side, the (region-based) NPS is the method by which we have very broad scope contracts that are available for use on smaller project needs. Those were used as a resource during the emergency (such as for design and professional services). We are now adding to our toolbox for highway construction work. Previously, we had only been doing Design-Bid-Build offerings to the public. Now we are recognizing the benefits of a specialized service contract that isn't tied to a geographic project, per say."

Thomas Prendergast
Executive Vice President, Transit at AECOM and former CEO of New York Metropolitan Transportation Authority (MTA) Subways and Chair, NY MTA

"As someone who has worked as a CEO of a large transit organization, who has had to navigate the difficult maze and detailed processes to obtain federal and state grant programs, the need to do so in an efficient manner for COVID-19 operations and capital needs cannot be overstated."

Users will gain additional insights from the transportation professionals featured in this section throughout the Report.

1.8 Overview of Administration, Procurement, and Contracting

Traditional and innovative project delivery, as well as cost and payment methods, need to be considered in the context they occur−blue skies, in response to modest or minor events, and for response and recovery following concurrent, regional emergencies and disasters.

Emergency conditions often require rapid-fire decision-making based on incomplete information concerning extents of damages and scopes of work and take place in highly complex and often politically charged situations. The applied research reflects an understanding of the regulatory climates facing DOTs concerning rapid emergency procurement methods following disasters and innovative contracting vehicles, such as indefinite delivery, indefinite quantity (IDIQ) contracts, and the allowable use of accelerated construction techniques as well as innovative delivery methods.

Innovative methods typically involve (1) shifting greater responsibility and risk to the contractor and (2) tightening alignment between design and construction services—both warrant consideration for large-scale, complex events characterized by dynamic conditions. Figure 1-8 presents a snapshot of traditional and innovative methods of procurement, project delivery, and cost and payment.

Figure 1-8: Procurement, project delivery, and payment methods

1.8.1 Basic Tools and Terminology

Every federally funded procurement must meet certain minimum documentation requirements and offer a good general framework for procurement planning. Two essential requirements for 2 CFR Part 200 are that the file should document the procurement method decision and the payment/contract type decision, defined below (see suggested documentation lists in Section 4.6). Although the project delivery method is not as tightly regulated by Federal regulations as the procurement method and contract type, good practice begins with identifying the optimum project delivery method and then proceeding to procurement method and contract type selection. This is particularly true as the state of practice, state laws, and Federal policies have permitted the use of a wider range of project delivery methods. The terms and their definitions listed in Table 1-2 are used in the Report and the Guidebook:

These definitions are consistent with 2 CFR Part 200 and 48 CFR Chapter 1 (Federal Acquisition Regulation [FAR]).

Table 1-2: Terminology Used in the Report and Guidebook

Term	Definition
Project Delivery Method	Formulation of complementary contract scopes to address the development phases of planning, design, financing, construction, operations, and maintenance, such as design-bid-build delivery method or design-build
Traditional Project Delivery Method	Traditional Project Delivery methods complete discrete tasks in iterative phases of the project delivery lifecycle. design-bid-build is the most common traditional delivery method used by DOTs
Alternative Project Delivery Method	Alternative Project Delivery methods leverage project delivery efficiencies to meet specific value objectives such as time or cost savings and often involve work being planned, designed, and delivered collaboratively by the entire project team and tasks being completed in parallel. Examples include design-build, Construction Manager/General Contractor, and Construction Manager-at-Risk
Procurement method	Manner of selecting the contractor for one of the contracts, such as sealed bidding, competitive negotiation, informal quotations, or noncompetitive negotiation (sole source); of particular importance in emergency contracting is the availability of changes or task orders under existing (standby or emergency) contract vehicles and interagency or mutual aid contracts; these existing contracts may offer accelerated delivery in the wide range of emergency contracts
Contract Type	Certain major structural terms of the resulting contract, including the method of compensation, such as unit price, lump sum, and time and materials with not-to-exceed cap

1.8.1.1 Project Delivery Methods

The term “project delivery method” is used narrowly in contracting practice and refers to the planned scope of an iterative series of contracts to accomplish project design and construction. In some methods, the contract scopes can begin with planning and can continue past construction to include maintenance and operations. Project delivery methods are generally referred to as traditional project delivery using design-bid-build (DBB) and alternative project delivery (the methods wherein the private sector plays a greater role than for DBB). In considering project delivery methods—even when emergency contracting simplifies the procurement process, such as when noncompetitive or limited competition procurement is warranted—there is enough time to follow the best practice of soliciting a proposal from the contractor, preparing an independent cost estimate (engineer’s estimate), and negotiating a fair and reasonable contract that must include federally required provisions.

This Report compares traditional and alterative project delivery methods and describes key characteristics of successful alternative project delivery methods and barriers to implementation. It goes on to briefly discuss the types of alternative project delivery methods best suited to responding to concurrent regional emergencies and disasters.

Key Barriers to Implementing Alternative Contracting (Alternative Project Delivery Method)

- ✓ Lack of prior expertise
- ✓ Lack of enabling legislation (for design build (DB) and public-private partnership (P3)
- ✓ Lack of resources, i.e., staff time
- ✓ Lack of supportive organization structure for alternative contracting methods (ACM)
- ✓ Lack of funding
- ✓ Adherence and familiarity with known and proven methods
- ✓ Employee union opposition
- ✓ Inexperience of contracting community
- ✓ Lack of demand considering the type of projects
- ✓ Lack of leadership for innovative actions
- ✓ Size of contracts
- ✓ Certification Regarding Use of Contract Funds for Lobbying

Source: NASEM 2008

Characteristics of Successful Alternative Contracting (Alternative Project Delivery Method)

- ✓ Articulating a department vision and objectives for project delivery performance
- ✓ Assigning additional staffing/consultants to meet project management needs
- ✓ Creating an alternative contracting methods (ACMs) unit or office within an organization to expedite the use of ACM and including junior staff in the effort
- ✓ Aligning project delivery methods and contractor selection with project needs
- ✓ Improving coordination with MPOs
- ✓ Ensuring early continuous contractor involvement from design to construction
- ✓ For holistic design, collaborating early with environmental regulators, construction managers, and designers to minimize environmental impacts and expedite permitting DOTs and environmental departments should prepare a “crosswalk” between technical detail/design and the information necessary for environmental approvals
- ✓ Establishing performance measures to monitor progress using data-driven analysis

Source: NASEM 2008

The two primary project delivery methods currently in use for emergency contracting purposes are design-bid-build (DBB) and design-build (DB). The time required for each procurement and performance step will depend largely on the work and circumstances, and the procurement steps can be accelerated through simplified- or limited-competition emergency contracting, but the number of steps cannot be reduced unless emergency work is performed without design to restore essential traffic (see Figure 1-9). Preferably, no fewer than three offers must be requested, an independent cost estimate (engineer’s estimate) must be prepared, the best offer (including best value) must be reviewed and accepted, and the key decisions must be documented to qualify for Federal reimbursement.

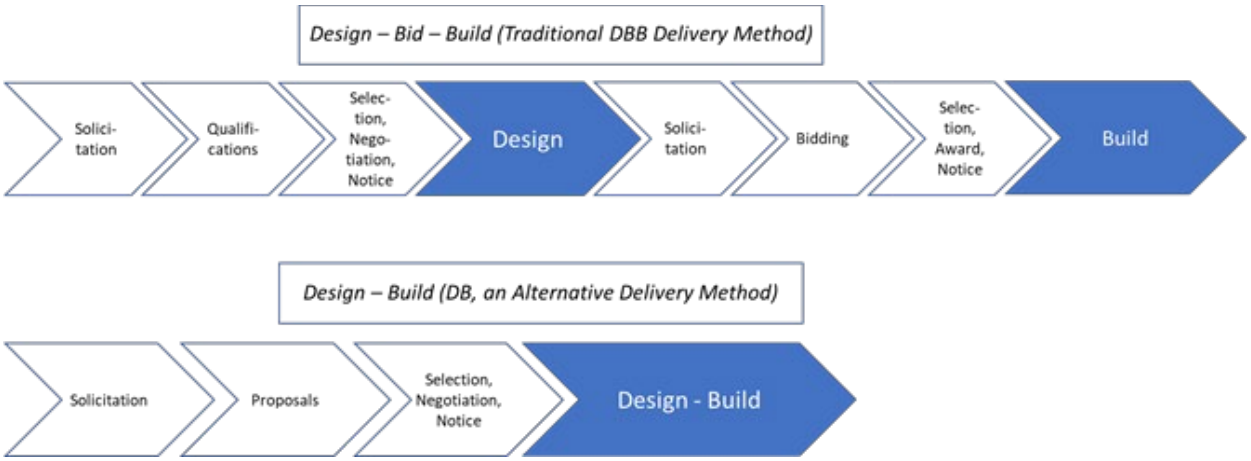


Figure 1-9: Design-Build: Often faster for response or recovery work delivery than DBB

It is commonly understood that planning and procurement using any alternative project method including a DB contract requires somewhat more time than the solicitation of either the designer or the constructor in the DBB method. However, Figure 1-9 shows the timesaving benefits of overlapping the initial construction mobilization and startup tasks with the completion of the planning/design tasks and shows why the DB method has been found to compress a project schedule to accelerate completion. In addition, DB has the advantage of using one procurement process instead of two.

One disadvantage of the DB method is that there is loss of complete control over the design by the DOT owner. Because time is generally more critical in emergency contracting and efficiency is paramount, this disadvantage override the benefits it can convey, making the DB delivery method a strong consideration. During rapid response, the goal is to stabilize surface transportation and restore essential traffic. In many cases, emergency contracts are advanced for construction with nominal design directed in the field by DOT or consultant engineers.

Independent cost estimates should be secured as quickly as possible as the scope of damages and work becomes defined, even for rapid response contracts. Sometimes cost estimates need to be developed in the first few days after the event and the construction force is mobilized to stabilize a roadway or structure. While exigent repairs are being performed, the long-term project delivery method to reconstruct or relocate the corridor or structure(s) can be planned. The omission of required steps in emergency contracting, such as an independent cost estimate (engineer's estimate), is a common basis for Federal agencies disallowing costs. This is especially true after the emergency period is over for work performed in support of resilient recovery.

The adage "sometimes you need to slow down to speed up" applies to the judicious selection and planning of project delivery method following concurrent regional emergencies and disasters. It is essential to take adequate time of outline risks associated with project delivery and to use the right project delivery methods along with procurement and contract type to help mitigate those risks along with robust terms and conditions. In addition to DBB and DB, there are project delivery methods that may be advantageous is such as the Construction Manager/General Contractor (CM/GC) method. The CM/GC method provides for awarding the major contract to a Construction Manager during the planning or

design process. The state transportation agency (STA) can manage the designer separately or provide in-house design services, while collaborating with the Construction Manager on planning the work. This suits many Rapid Response and Resilient Recovery requirements by providing for fluid collaboration and overlapping phases of various tasks. As the materials work approaches, if the STA and Construction Manager agree on overall cost reasonableness, the Construction Manager transitions to the role of Construction Manager and General Contractor, often competitively bidding the work to respective task or trade subcontractors. CM/GC contracts can provide a fallback to close the contract if the parties do not agree on cost reasonableness for the overall cost of the work.

The Construction-Manager-at-Risk (CM at Risk) delivery method, is also an alternative project delivery method that can be used to address emergencies. The primary contract scope resembles the CM/GC contract scope; however, as the designs and scopes of the construction contract(s) become clear, CM at Risk is structured to transfer more cost risk to the CM at Risk firm.

Construction-Manager-at-Risk

When the construction phase work is particularly critical or challenging, the Construction-Manager-at-Risk delivery method allows the owner agency to control the design as in DBB but to collaborate with the construction manager during the planning/design phase. When the specifications are sufficiently clear, the construction manager and owner negotiate a guaranteed maximum price (or alternatively, a simple lump sum), and the construction manager continues as the general contractor for completion of the work.

The remaining alternative delivery methods are principally the Public-Private Partnership (P3) methods, which involve transferring substantial responsibility and risk to a P3 contractor. The P3 contractor may also be called a concessionaire, particularly if the P3 contractor takes revenue (e.g., toll) responsibility and risk. P3 contracts almost always include both final design and construction phases and may also include financing (private equity and/or private debt), maintenance, and operation of the assets.

The contract term length in P3 delivery corresponds to the scope and may be as long as 50 years or longer if maintenance or operation are included. Because of the length of time required for negotiating contracts and the scarcity of need for private financing, maintenance, or operation, P3 delivery methods have less applicability for transportation professionals charged with addressing disasters. Further, there is not a clear body of policy that delineates eligibility for a P3 project using Federal disaster funds, including FHWA ER, when compared with DB or CM/GC where ownership and control of the roadway clearly remain with the DOT or transportation agency.

Transportation professionals can consider with their procurement officers which delivery methods will best accomplish the needed rapid response or resilient recovery of assets following concurrent, regional emergencies. In selecting a delivery method, the phases of contracting necessary to complete the work are largely determined. The next consideration involves identifying which methods to use to select contractors and entering into the contracts. These decisions (selecting a contractor and entering into a contract) are called procurement methods.

1.8.1.2 Procurement Methods

Because of the opportunity to improve the cost-effectiveness of results, as well as the unfortunate dangers of corruption and waste, the procurement methods are the most carefully regulated aspect of federally funded procurements. The guardrails required to manage procurements are in 2 CFR Part 200 and the related FHWA and FEMA policy guidance that must also comport with jurisdictional requirements. Regulation and policy require that funding recipients and subrecipients use specific methods that are appropriate to the size and object of the procurement. Several procedures are required for the respective procurement methods.

FHWA Form 1273 Required Contract Clauses

- ✓ Nondiscrimination
- ✓ Non-segregated facilities
- ✓ Davis-Bacon Act and related provisions
- ✓ Contract Work Hours and Safety Standards Act (40 U.S.C. §§ 3701 et seq.) provisions
- ✓ Subletting or assigning the contract
- ✓ Safety: Accident prevention
- ✓ False statements concerning highway projects
- ✓ Implementation of Clean Air Act (42 U.S.C. §§ 7401 et seq.) and Federal Water Pollution Control Act (33 U.S.C. §§ 1251-1387)
- ✓ Compliance with government-wide suspension and debarment requirements
- ✓ Certification Regarding Use of Contract Funds for Lobbying

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In general, the use of these procurement methods except the last two (micropurchase and noncompetitive negotiation) call for "full and open competition," although this term is also sometimes used to describe only the first two (Invitation for Bids [IFB] and Request for Proposals [RFP]). The second method, competitive negotiation, is the required method for architects and engineers. The Brooks Act (40 U.S.C. §§ 541 et seq.) adds an additional step: a Request for Qualifications or RFQ (confusingly, the same acronym as is used for Request for Quotations) precedes the RFP. A price proposal is initially requested only from the most qualified competitor, so direct price competition is discouraged and there is less likelihood of selecting a less qualified architect or engineer simply based on a lower price.

All of the allowable procurement methods can be used in emergency contracting, but non-competitive—or more preferably limited-competition—negotiation has a particular relevance in the rapid response phase. Transportation professionals should have a clear understanding of when emergency contracting using non-competitive negotiation can be applied. In particular, it is important to establish the demarcation line where the emergency response transitions to resilient recovery. At that time, the Federal grant requirements will prohibit the use of non-competitive or limited procurement and will require full and open competition. For example, when Puerto Rico used a contract entered into without competition for response and recovery from a hurricane, the auditors and FEMA reimbursed Puerto Rico for only the first 50 hours of work under the contract; the auditors and FEMA found that the remainder of the contract work was not under emergency circumstances and that a competitive contract should have been used. Similarly, after a flood in Dearborn, Michigan, a hospital used noncompetitive contracting in August 2014. The same contract was used for recovery work continuing after 6 months. The Federal funder (FEMA) determined that the danger to life and property, even mitigation of potential mold and bacteria,

warranted the noncompetitive contract, but that the threat was eliminated by October 2014, and subsequent work under the noncompetitive contract was disallowed.

1.8.1.3 Payment Method / Contract Types

Following concurrent, regional emergencies, DOTs want to secure and maintain disaster funds and serve as effective stewards of the public trust. The following presents federally allowable contract types and flags others that involve an unallowable contract type or component thereof. The optimum choice of contract type requires an initial assessment of risk transfer.

- ✓ **Cost reimbursement contracts** place most of the risk on the owner since the contractor is virtually guaranteed the firm's costs as well as overhead and profit.
- ✓ **Fixed-price (unit) contracts** transfer risk to the contractor, which may suit emergency situations in which the full quantities of the required work are unknown. In a fixed-price (unit-price) contract, the owner bears the risk that the quantities will be higher than expected. The contractor bears risk when (1) the cost rate exceeds the contract rate; and (2) when the owner's estimated contract quantities are much higher than final project quantities, and the contractor cannot realize anticipated benefits of economies of scale.
- ✓ **Fixed-price (lump-sum) contracts** compel the contractor to bear the risk of the rate and the quantity. However, if the owner is not confident that the scope and quantities are firm, the owner is exposed to contract modification risks that are urgently needed to resolve emergency conditions, thereby giving the owner little room to negotiate fair and reasonable pricing on modifications without the threat of voluntary contract termination by the contractor.

Three basic types of contracts outlined, below, are permitted for federally funded contracts; one is prohibited. It is also essential to following policy guidance issued by the Federal agency funding awards including FHWA's Emergency Relief Manual (Federal-Aid Highways) updated May 31, 2013 and FEMA's *Public Assistance Program and Policy Guide* the most recent of which is Version 4, Effective June 1, 2020.

Permitted and Prohibited Contract Methods for Federally Funded Awards

Permitted

- ✓ **Fixed-price contracts** in which a fixed or determinable amount of compensation is associated with a specific deliverable, or an amount or scope of work is a prevalent type.
  - A fixed payment for each unit of delivery (e.g., cubic yard of concrete installed, barrel of fuel supplied, or hour of work performed)
  - A lump sum for deliverable of the entire scope of work that is required
  - Milestone and lump sum payments for specific portions of the work
- ✓ **Time and materials contracts** in which a fixed price per hour of labor is paid (with rates differentiated as needed by categories of labor) and materials, equipment, or other expenses such as travel are paid on a cost reimbursement basis.
  - These contracts always require a not-to-exceed cap based on the scope of work that is established at time of contract and for any subsequent contract modification.
  - FEMA and FHWA permit this type of contract for professional services contracts. This contract is allowed for construction for rapid response activities that require urgent action, including the restoration of essential traffic, and the project scope of work cannot yet be readily defined.
  - Federal funders encourage the best practice of avoiding time and materials contracts where practicable in part because final costs are not established at the outset of the contract.
- ✓ **Cost reimbursement contracts** in which payment is for the actual cost to the contractor of the work performed or goods and equipment delivered. “Actual cost” is the sum of direct cost incurred entirely for the accomplishment of the contract and an allocation of indirect costs that the contractor incurs to accomplish multiple pursuits, including the contract. This type of contract includes:
  - Cost-plus-fixed-fee, where the actual, allowable costs are reimbursed plus an agreed fixed fee is paid for the contractor’s overhead and profit
  - Cost plus incentive fee, where the actual costs plus a fee determined based on the results of the work is paid
  - Pure cost, where only costs are reimbursed (typically used for non-profit contractors)

Prohibited for Tribal and Local Governments and Strongly Discouraged for States and Territories

- ✘ **Cost reimbursement contracts using cost-plus-percentage of costs** in which the actual, allowable costs are reimbursed plus an agreed-upon percentage for the contractor’s overhead and profit (e.g., 15% overhead/profit). Cost-plus-percentage of cost contracts are strictly prohibited for federally funded contracts for Tribal and local governments; as they might incentivize contractors to increase project costs for increased profitability and, thus, cause waste. They are also strenuously discouraged for use by States.

In addition to the contract types with fixed-price or cost-based compensation, the term "contract type" is used to describe indefinite delivery contracts. The most common is the task order contract or indefinite delivery-indefinite quantity (IDIQ) contract. There is great merit in entering into pre-positioned contracts in the readiness phase to have resources under contract and ready to be immediately activated for emergency response needs, or to have in place in order to quickly down-select from a pool of vendors via rapid task order competition. Because the contractor is taking risks in providing pricing before knowing the specific quantity of work and delivery circumstances, the contract terms generally will not be as cost-effective as when quantity and delivery are known and specified. Nevertheless, the flexibility and responsiveness of these contract types warrant limited use.

Key Procurement and Contracting Objectives Beyond Cost

- ✓ **Transfer of risks to contractors**. Extreme conditions, the volume of work, the extraordinary value of time, and supply chain uncertainties raise risks in contracting for regional emergencies that are qualitatively greater than in routine capital and maintenance contracts. If the risks (e.g., supply chain issues) are more easily managed by contractors than by the owner agencies, then to the extent the risks can be identified and defined, the risk should be clearly transferred to the contractor in a prominent place in the contract documents. If the risk is better managed by the owner agency (e.g., knowledge of the infrastructure condition and the required type of work), the risk should be retained by the owner agency. However, contracting agencies can go too far in shedding risk: if the contract attempts to transfer risk to the contractor over which the contractor has little or no control, the owner should expect a premium in the price and/or a decrease in the available pool of highly experienced contractors.
- ✓ **Schedule.** The extraordinary value of time in the response and recovery phases of emergency management is one of the critical risks and one of the most difficult to manage. Management of schedule is one of the highest priorities of the traveling public whose industry, lives, and recreation have been disrupted. When reasonable estimates of time may be less readily available than in routine contracting, incentive provisions that transfer some of the schedule risk to the contractor play a larger role than in typical liquidated damage provisions. The cost of delays to the public is generally higher and accelerates faster than for routine work. Therefore, special attention to time estimates and incentive provisions in contracting is warranted.
- ✓ **Quality**. Managing quality in emergency contracting is subject to as many uncertainties as is managing timely delivery. In addition, many of the quality standards, codes, and testing procedures relied on in more routine contracting are unavailable or impractical in emergency response work. Indeed, the imperatives of timely delivery under the pressures of emergency response often compete directly with the need to manage quality.

1.8.2 Federal Compliance

Emergency and exigent circumstances during the delivery of work in the rapid response phase sometimes weigh against onerous Federal compliance and documentation requirements. The need to get transportation systems stabilized and to restore essential traffic does not outpace the need for stewardship of the public trust when taxpayers are footing the bill. There is a common misperception that "anything goes" when procuring, contracting, and administering work during the emergency phase. While Federal fund agreements include some relief from administrative procedures where authorized at the STTL level, most requirements remain in force. The principal latitude that is allowed in emergency contracting is noncompetitive negotiation as a procurement method, but its allowability is highly limited. Negotiations with limited competition and significantly shortened turn-around times on solicitation and proposals/bids are more acceptable for emergency procurements. Most standard requirements otherwise remain in force when using FHWA ER funds, such as the labor provisions in the Davis-Bacon Act of 1931 (40 US Code

[U.S.C.] §§ 3141 et seq.), targets for disadvantaged business enterprise and other civil rights requirements, required contract and subcontract clauses, prohibitions against state or local preferences, and prohibitions against cost-plus-percentage-of-cost contract types. DOTs risk the loss of Federal funds if these requirements are not met, even if the procurement process is compliant.

Both FHWA and FEMA draw down requirements from 2 Code of Federal Regulations (CFR) Part 200, Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (informally known as the Common Grant Rule), and applicability differs for types of recipients (e.g., states, local and regional, tribal, educational). Under 2 CFR Part 200, compliance requirement differ for states and territories, which are required to strictly follow their own rules governing procurement and contracting, and requirements for tribal and local entities, which must follow more proscriptive guidance delineated within the regulations.

However, FHWA and FEMA have separate statutory requirements for their funds. Some policy requirements and contract clauses may differ if FEMA Public Assistance funds are involved (e.g., for debris removal). For example, FHWA's disadvantaged business enterprise requirements differ from FEMA's requirements. Further, the Federally-required contract clauses under 2 CFR Part 200 are always required for local recipients, and best practice requires their consideration in state contracts as well. These clauses contemplate the following:

- ✓ Changes to the contract
- ✓ Damages for breach of contract
- ✓ Need to terminate without cause
- ✓ Need to terminate for cause
- ✓ Rights to intellectual property
- ✓ Access to records

1.8.3 Delivery and Contracting Considerations

Contracting is very often a chokepoint in project delivery; local or regional units of government may not have the contracting capacity and/or the technical expertise in federally funded emergency contracting to best undertake the delivery. Based on the State/Territory requirements and the funding stream, DOTs might be able to provide contracting assistance or arrange for contracting partnerships, so the best available resources are brought to the contracting needs.

For example, in 3 days in 2013, Jamestown, Colorado, a town of 300, sustained flooding causing two creeks to create new channels through the town, undercutting town roads, causing the evacuation of 90% of the residents, claiming one life, and causing major structural damage. Under an intergovernmental agreement with the town, Boulder County, Colorado, contracted for more than $2.7 million in major services for which the town was the FHWA ER program recipient, while the town itself was able to directly execute a number of procurements under the Federal simplified contracting threshold.

Whether a state DOT is dealing largely with its own transportation assets or overseeing work by smaller units of government, mutual aid agreements should be evaluated, and governmental entities should move quickly as agreement and consensus build for which entities can most responsively and cost-effectively contract for the work. It is recommended to bring the district office of FHWA to the table and consider engaging the State/Territory office of emergency management.

As transportation professionals formulate plans for contracting for rapid response and for resilient recovery, the constant question should be “which is the best organization to contract for the work?”

The applied research sets out key objectives (summarized in the text box above) of procurement and contracting for concurrent, regional emergencies and presents guidance in Chapters 4 to 6 on the procurement and contracting in the three phases: rapid response, resilience recovery, and readiness.

Irrespective of the project delivery, procurement, or contracting method, it is important that a record of key decisions be maintained via memorandum to the project file that describes prevailing conditions and establishes both prudence and management controls throughout the administrative process. This is particularly true when exigence demands deviation from the use of normal procurement and contracting provisions, or emergency provisions codified prior to the emergency, in order to stabilize roadways to protect the public or restore essential traffic. Ideally, the DOT or transportation agency has secured concurrence for such actions from the Federal funder (e.g., from the state’s FHWA division office assigned to the disaster). When this is the case, it is also prudent to secure the Federal agency representative’s signature agreement and date to memorialize key decisions when they took place, which will help improve audit assurance for the future.

1.8.3.1 Contracting Resources: General Services Administration

Some of the resources that are available to DOTs and MPOs but that are often untapped can help control risks, manage costs, and accelerate time to contract awards. For example, the U.S. General Services Administration (GSA) Disaster Purchasing Program allows STTL governments to directly purchase disaster services, equipment, materials, and supplies from the nearly 30 GSA Schedules. The products and services that are purchased must be used for readiness, rapid response, or recovery involving Presidentially Declared Emergencies or Disasters or recovery from acts of terrorism. Though underutilized, GSA Schedules offer rapid contracting and price controls.

In fiscal year 2017 (FY17), GSA Schedules were used for approximately $130 million in disaster purchasing. Figure 1-10 shows the 10 GSA Schedules with the highest reported utilization for disaster purchasing sales in FY17. The Federal regulations on GSA Disaster Purchasing Program contracting can be found under FAR 8.405 (48 CFR Part 8.405). The benefit of using GSA resources for disaster purchasing is that contract rates and terms have already undergone Federal competition for the awards, and vendors rates and terms have been approved for use in Federal (or federally funded) purchasing. GSA recommends that owners solicit availability and interest from no fewer than three vendors for any purchase. FEMA has developed policy concerning the use of GSA Schedules for disaster purchasing; despite the fact that GSA vendors meet stringent Federal requirements according to GSA, FEMA still requires no fewer than three solicited offers and not less than two responses in order for the contract costs to be eligible for PA Program funding.

Figure 1-10: GSA disaster purchasing program summary for STTL governments

Chapters 4 to 6 of the Report further discuss administrative actions including procurement, contracting, and other risk controls to facilitate effective delivery of project portfolios following concurrent, regional emergencies while securing, managing, or complying with Federal disaster awards.

2 Critical Issue Areas

Chapter 2 summarizes the eight critical issue areas undertaken as part of the NCHRP 08-107 applied research. This chapter defines each critical issue area and poses a key question related to the issue that grew out of the NCHRP 08-107 gap analysis. This chapter also identifies the topics for each critical issue area that are addressed by disaster phase in Chapters 4, Rapid Response; Chapter 5, Resilient Recovery; and Chapter 6, Readiness.

The eight critical issue areas are:

- DOT Emergency Plan Coordination
- Scope and Scale
- Prioritization and Capacity
- Flexible Arrangements
- Innovative Delivery
- Audit and Other Risks
- Policy and Funding
- Other Relevant Considerations

2.1 No. 1: DOT Emergency Plan Coordination

DOT emergency plan coordination actively encourages STTL and Federal agencies to work together in advance of major disruptions to enhance rapid restoration of essential traffic, including structures. This critical issue area also includes cooperative planning for durable, region-wide resilience and adaptation among multiple transportation owners and operators after concurrent, regional emergencies. See Table 2-1.

Key Question: How can multiagency plans, agreements, and roles be clearly defined before a large-scale disaster to shorten downtime, rapidly restore essential traffic, and successfully advance resilient reconstruction?

Table 2-1: DOT Emergency Plans Considerations by Disaster Phase

Readiness	Rapid Response	Resilient Recovery
✓ Identify incident command structures needed to administer multibillion-dollar, enterprise-wide events ✓ Plan for administration, including procurement and contracting	✓ Activate emergency plans, and identify additional resources required to align administrative policies and procedures, and coordinate partnerships ✓ Activate relevant incident command structure	✓ Transition from rapid response to resilient recovery ✓ Consider region-wide resilience and long-term planning goals

2.2 No. 2: Scope and Scale Considerations

Scope and scale consider how the magnitude and severity of an emergency crossing jurisdictional boundaries affects administration. Scope and scale are also related to improving bounce-back time, controlling risks, and enhancing resilient transportation outcomes, as well as leveraging resilience and additional co-benefits through structured administrative controls. See Table 2-2.

Key Question: How can administrative measures manage complexities, risks, and costs that arise during management of a large-scale, multi-jurisdictional disaster?

Table 2-2: Scope and Scale Considerations by Disaster Phase

Readiness	Rapid Response	Resilient Recovery
✓ Develop triggers based on event magnitude and severity ✓ Understand hazards and vulnerability to buy-down risks pre-shock ✓ Evaluate regional logistics and supply chain constraints, and take action to reduce risks	✓ Establish administrative mechanisms to assess disaster damages ✓ Identify work in "manageable buckets"	✓ Integrate standards and specifications into procurement and contracting to increase asset resilience ✓ Leverage co-benefits for recovery

2.3 No. 3: Prioritization and Capacity

Prioritization and capacity are concerned with how administrative controls, including procurement and contracting methods, can address urgency and criticality in rapid response to effectively manage resources and shorten corridor or structure downtime, as well as reduce future risks through resilient reconstruction and adaptation. See Table 2-3.

Key Question: What gets fixed first, and how can transportation agencies effectively organize to meet extreme demands attendant to rapid response and resilient recovery operations for concurrent, regional emergencies?

Table 2-3: Prioritization and Capacity Considerations by Disaster Phase

Readiness	Rapid Response	Resilient Recovery
✓ Optimize procurement for multiple-corridor prioritization ✓ Identify potential gaps in effective project oversight	✓ Define and manage portfolio of all disaster-related rapid response projects ✓ Identify level of "fix": stabilize, temporary repair, or complete repair	✓ Identify the highest priority corridors within the region ✓ Develop procedures that facilitate differentiated levels of resilience rates of return (risk reduction)

2.4 No. 4: Flexible Arrangements

Flexible arrangements using flexible procurement and contracting methods to assure access to services and goods in concurrent, regional emergencies to attenuate problems involving dynamic market conditions, pricing, and resource scarcity, as well as organizational capacity of impacted organizations. See Table 2-4.

Key Question: How can flexible procurement and contracting methods yield access to scarce resources, gains in time and cost savings, and risk transfer?

Table 2-4: Flexible Arrangements Considerations by Disaster Phase

Readiness	Rapid Response	Resilient Recovery
✓ Conduct due diligence for pre-positioned emergency contracts ✓ Identify contracting and project delivery options, including regulatory constraints facing DOTs	✓ Implement emergency procurement procedures ✓ Optimize risk transfer and other risk reduction mechanisms	✓ Consult with partners in region to advance resilience and climate adaptation objectives ✓ Build adaptive capacity into project design and delivery

2.5 No. 5: Innovative Delivery

Innovative delivery uses tools that aid in accomplishing key rapid response and resilient recovery objectives. See Table 2-5.

Key Question: Which innovative contracting and delivery options promote time, quality, and cost objectives following concurrent, regional emergencies, and in which circumstances are they best applied?

Table 2-5: Innovative Delivery Considerations by Disaster Phase

Readiness	Rapid Response	Resilient Recovery
✓ Establish project delivery for standby contract capacity ✓ Define procurement methods and payment//contract types for standby contract capacity ✓ Prepare for response and recovery procurement and contracting	✓ Consider project delivery, procurement methods, and payment/contract type	✓ Optimize resilience and adaptation through administrative controls

2.6 No. 6: Audit and Other Risks

Audit and other risks include unique considerations associated with post-disaster administration and how to anticipate and minimize the risks. See Table 2-6.

Key Question: What administrative controls need to be in place to mitigate audit and other risks when utilizing Federal disaster funds?

Table 2-6: Audit and Other Risks Considerations by Disaster Phase

Readiness	Rapid Response	Resilient Recovery
✓ Establish or refine needed administrative business processes ✓ Develop monitoring plans for compliance requirements ✓ Identify procedures to minimize claims and financial exposure in dynamic post-shock conditions	✓ Monitor compliance and document control ✓ Confirm requirements for emergency contracting methods align with compliant field documentation ✓ Initiate DOT monitoring of local agency subrecipients	✓ Ensure normal administrative procedures and controls are restored ✓ Manage compliance for recovery

2.7 No. 7: Policy and Funding

Policy and funding provide a quick snapshot of where to find key regulatory and policy requirements for Federal disaster funding streams and introduce additional strategies to support cash management, post-disaster. See Table 2-7.

Key Question: What key regulations govern Federal disaster funding, and what strategies can support post-disaster cash management?

Table 2-7: Policy and Funding Considerations by Disaster Phase

Readiness	Rapid Response	Resilient Recovery
✓ Identify post-shock funding sources and requirements ✓ Innovative financing tools summary	✓ Know the rules of engagement on funding streams on day one ✓ Ensure personnel know how to support project delivery with funding in view	✓ Understand regulatory and policy considerations involving resilient reconstruction and co-benefits ✓ Maintain good relationships with Federal funders

2.8 No. 8: Other Relevant Considerations

Other relevant considerations discusses the influence of other relevant considerations such as community capital and resilience stresses including a region's social, economic, and climate conditions and how these considerations inform prioritization and administrative actions involving concurrent, regional emergencies. See Table 2-8.

Key Questions: How can relevant considerations such as social and economic indicators and climate adaptation shape decisions? What administrative strategies are vital to combat threats that do not physically scar roadways like cyber incidents and pandemics?

Table 2-8: Other Relevant Considerations by Disaster Phase

Readiness	Rapid Response	Resilient Recovery
✓ Social Dimensions of Readiness ✓ Cyber Incidents ✓ Pandemics and COVID-19 ✓ Resilience and Climate Adaptation	✓ Social Dimensions of Rapid Response ✓ Cyber Incidents ✓ Pandemics and COVID-19 ✓ Resilience and Climate Adaptation	✓ Social Dimensions of Resilient Recovery ✓ Cyber Incidents ✓ Pandemics and COVID-19 ✓ Resilience and Climate Adaptation

As DOTs identify strategies and tactics during all phases of resilience including readiness, rapid response, and resilient recovery, they must create space to understand, plan for, and respond to social dimensions that affect community life, in general, and the needs of vulnerable populations, specifically. What happens when good data on social dimensions drives decision-making, and how is that accomplished in relation to this applied research? This critical issue area focuses on how social dimensions crosscut the resilience lifecycle. It also shows how readiness work focused on the social dimensions of a disaster enhances a DOT's common operating picture. When social data collected during readiness helps shape post-disaster decisions, it leads to more robust outcomes during rapid response operations and durable community benefits when incorporated into resilient recovery.

3 Summary of Resilience Lifecycle Phases

Figure 3-1 highlights the three phases of the resilience lifecycle (in dark background) that are the focus of this applied research involving concurrent, regional emergencies and disasters—Readiness, Rapid Response, and Resilient Recovery. The shock event itself and the life-safety operations phase of the disaster resilience lifecycle are not included in the scope of this research, which is principally centered on life-safety and stabilizing conditions rather than on transportation corridor repairs and reconstruction.

Figure 3-1: Phases within the scope of applied research (highlighted with dark background)

Oftentimes, the emergency managers who manage the incident post-shock and the transportation professionals who are responsible for restoring essential traffic and reconstructing surface transportation assets following concurrent, regional emergencies manage discrete phases of disaster operations with little or no overlap. The emergency managers who are responsible for life-safety operations and the transportation professionals charged with restoring and rebuilding routes must work together to establish a common operating picture to facilitate the seamless transfer of the baton, which enables the incident command team responsible for all phases of the disaster resilience lifecycle to share information and event-specific decisions necessary to anticipate and avoid risks and capture opportunities for robust recovery.

The more severe the shock, the more difficult it is to share information and decisions because life-safety operations functions such as debris management operations typically occur in parallel with disaster damage assessments and emergency repairs. Further, finance and administration section functions, including documenting damages for eligibility with FHWA and other funders, typically begin while the life-safety operations phase is still active. In fact, finance and administration section personnel can play a pivotal role in providing some of the only continuity across all phases of the disaster resilience lifecycle.

The Report and Guidebook segregate the emergency management phase of recovery into two segments in order to align with 2 CFR Part 200, as well as FHWA ER and FEMA Public Assistance regulatory and policy requirements concerning eligibility, allowability, and state/local matching fund requirements.

This chapter presents information, actionable recommendations, and tools for DOT and MPO transportation professionals that grew out of the NCHRP 08-107 applied research. The following subsections describe the three phases of the disaster resilience lifecycle undertaken as part of NCHRP 08-107 research. Each phase is substantively presented with information, examples, sample tools, and resources in Chapter 4 to Chapter 6.

3.1 Readiness

Readiness, also described in emergency management circles as preparedness, refers to that which can be undertaken pre-shock to improve outcomes post-shock. For example, overtopping of roadways can be

minimized by procuring and contracting drainage system improvements (e.g., upsizing culverts) pre-shock. Shortening corridor downtime will be more readily accomplished if expedited emergency procurement and contract plans are developed and actions are taken to establish vehicles that allow for the potential use of innovative project delivery methods such as DB.

In discussing readiness, this applied research challenges transportation professionals to calculate the real costs of doing nothing—or not enough—prior to concurrent, regional emergencies. The Report walks through mission-critical, pre-event activities and provides ideas and tools to aid planning, multi-agency coordination and relationship building, and training and exercising that are structured to enhance administrative outcomes following concurrent, regional emergencies. It also demonstrates ways to incorporate information such as hazard and vulnerability assessments and long-term regional planning goals into administrative actions that are intentionally structured to meet ambitious resilient recovery objectives.

3.2 Rapid Response

Rapid response refers to the period when disaster damages are assessed, and construction and other work are performed to stabilize surface transportation assets and restore essential traffic. This phase occurs immediately following (and often begins in parallel with) the life-safety operations phase, which restores life-safety conditions to a steady state. Chapter 4, Rapid Response, walks through ways to drive down multiple risks, reduce service downtime, and save costs during emergency conditions. It should be noted that the applied research does not undertake an analysis of debris management at the request of the Panel. Instead, it directs the user to available resources issued by FEMA and the U.S. Environmental Protection Agency (EPA). Chapter 4 includes customizable tool and template excerpts useful to maximize the benefits of administrative controls such as procurement and contracting method selection. These tools are included in whole in Appendix G.

3.3 Resilient Recovery

Resilient recovery refers to the phase that, in concept, begins after rapid response phase when emergency work has effectively stabilized conditions and restored essential traffic (see Figure 3-2). However, planning for the resilient recovery phase begins in tandem with rapid recovery−immediately after the event−so projects can be structured to integrate well together. The resilient recovery phase, presented in Chapter 6, is also characterized by the restoration of regular, non-emergency administrative policies and procedures.

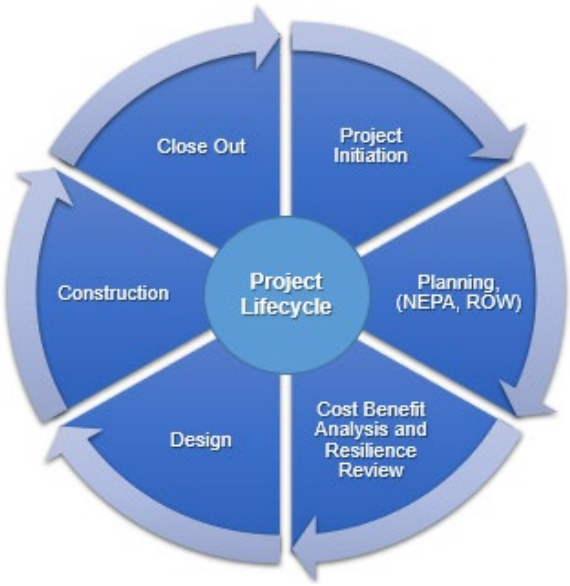


Figure 3-2: Typical resilient recovery project lifecycle

This phase focuses on administrative controls that are structured to maximize durable benefits

for DOTs and MPOs through planning, design, and reconstruction relative to increased levels of protection against future hazard impacts and also include climate adaptation. Resilient recovery is discussed in the context of a system, a corridor, or a single asset.

For example, innovative contracting played a role in shortening the time to complete the rebuilding of a severely hurricane-damaged twin-span bridge with high average daily traffic (ADT) in Puerto Rico, while simultaneously enhancing the bridge's resilience for seismic, tsunami, hurricane, and human-caused threats.

Th e resilient recovery phase walks through ways to use administrative controls to improve resilient asset performance. It also introduces opportunities to leverage co-benefits for environmental sustainability, community benefit, and stabilizing and catalyzing the regional economy following a concurrent, regional emergency or disaster.

3.4 Chapters by Disaster Phases

Readiness is presented in Chapter 4 followed by Rapid Response in Chapter 5 and Resilient Recovery in Chapter 6. Throughout Chapters 4, 5, and 6, the Report reviews important information to help shape and guide transportation professionals to structure and deliver durable and robust administrative systems for concurrent, regional emergencies and disasters. Phases are organized by critical issue area, and redundant content is kept to a minimum. Again, since the applied research is ultimately focused on physical infrastructure repair or reconstruction, the life-safety operations phase not included.

4 Readiness

Transportation professionals are busier than ever before—asked to do more with less. When stacked up against competing agency interests that are both urgent and concrete, planning for concurrent, regional emergencies and disasters often falls to the wayside. When emergency planning does occur, it often focuses on critically important lifesaving activities during the life-safety operations phase of the resilience lifecycle, such as evacuation planning and exercising responses to major car pile-ups and hazardous waste spills.

The readiness phase, however, uniquely affords transportation professionals the opportunity to understand threats and vulnerabilities, and take actions to buy down risks to critical corridors and structures, as well as the regional transportation system as whole. Administrative planning during blue skies enables a DOT to develop robust systems that help control how rapid response and resilient recovery operations unfold. Taken together, the DOT that uses planning time wisely has the opportunity to avoid or mitigate damage to its multibillion-dollar system pre-shock, and to truncate corridor downtime post-shock. Buying down risks for the transportation system also helps protect the broader community, because these actions constrain consequences of concurrent, regional emergencies that disproportionately adversely affect vulnerable populations, and often undermine both environmental health and the regional economy.

*"In order to be effective a Rapid Response strategy must be **timely and organized—able to hit the ground running.** In the case of NYMTA, the occurrence of Hurricane Irene the year prior to Superstorm Sandy significantly informed revisions to the Rapid Response strategy. This resulted in significant improvements to the execution of the Rapid Response efforts undertaken for the latter storm which in turn further mitigated impacts to all ."*

– Tom Prendergast,
Former Chairman, NYMTA and
Former CEO, NY MTA Transit

Chapter 6 considers this applied research's critical issue areas with pragmatic recommendations and examples of steps to avoid and mitigate damages, as well as to prepare for the worst. Many readiness activities that go undone pre-shock must be expedited during the rapid response or resilient recovery phases, and are discussed in Chapters 4 and 5. Where recommendations are made in prior chapters, the user will be directed back to those chapters to avoid unnecessary redundancy.

4.1 DOT Emergency Plan Coordination

- ✓ Identify incident command structures needed to administer multibillion-dollar enterprise-wide events; and
- ✓ Plan for administration, including procurement and contracting.

4.1.1 Identify Incident Command Structures Needed to Administer Multibillion-dollar Enterprise-wide Events

In the best circumstances, partners in the unified command treat the DOT emergency plan as a living document, and come together on a regular basis to train and exercise plan activation to identify coordination and responsibility gaps, and opportunities for continuous improvement through after-action reviews. Conversely, emergency plans can sometimes be treated as procedural documents completed to

"check the box," or are not updated in a way that keeps pace with organizational, procedural, and leadership changes. Almost universally, DOT emergency plans fail to identify roles and responsibilities; designate responsible parties; train; or conduct tabletop and functional exercises focused on rapid response and resilient recovery simulations. See discussions about ICS in Section 4.1.

As part of NCHRP 08-107, the research team facilitated functional exercises with transportation professionals and partner agencies such as FHWA and other Federal agencies in regions across the U.S. Where the region had not experienced a major shock in recent memory, functional exercises and after-action reflections were conducted for both rapid response and resilient recovery.

In all of these instances, transportation professionals and unified command partners frequently remarked that it was the first time in their professional careers that they participated in exercises contemplating the restoration of essential traffic and the efforts to procure, contract, and deliver billion-dollar recovery operations. In fact, many transportation representatives from DOTs represented emergency management functions due to the nature of the case study, and some emergency managers expressed feeling totally ill-equipped to meaningfully contribute to programmed exercise simulations that involved reviewing disaster impact maps, requesting FHWA funding, identifying project prioritization, drafting high-level scopes of work and corresponding cost estimates, and justifying funding requests to the leadership team represented by the exercise's incident commander, the F&A section chief, and FHWA.

These observations by DOT emergency managers do not undercut the essential, life-saving function of exercises focused on life-safety operations; rather, the take-away shows the real need to practice the transfer of the baton between phases of the resilience lifecycle—incident command to rapid response and resilience recovery. Response- and recovery-centric training and exercises force DOTs and partners to identify right-skilled, define clear roles and responsibilities (individually and within a larger unified command environment), and provide opportunities to practice and then reflect on ways to successfully stand up massive response and recovery operations.

Figure 4-1 through Figure 4-8 walk through representative snapshots of the research team's Greater Miami and the Beaches Case Study that considered rapid response as well as resilient recovery in the present day, as well as for 2060 projections that included an estimated increase of sea-level rise of 1.5 feet. The case study focused on inter-operable lifelines and community habitability. As part of the same event, the NCHRP 08-107 case study was followed by a wastewater case study in coordination with the Miami-Dade Sewer and Water Board, and was sponsored in part by the 100 Resilient Cities network and a water resilience network supported by the Rockefeller Foundation. Planning for these events was integrated, and included Florida DOT, many local governments, private industry, a global catastrophe bond reinsurance vendor.

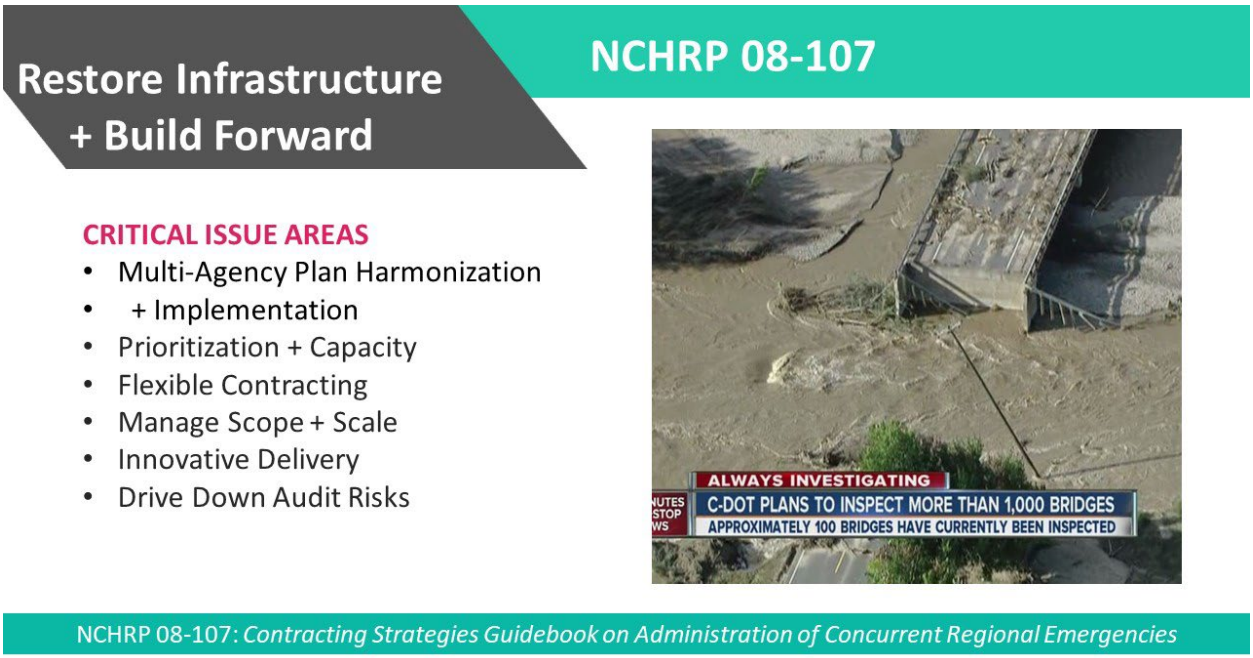


Figure 4-1: Case Study: Critical issue areas

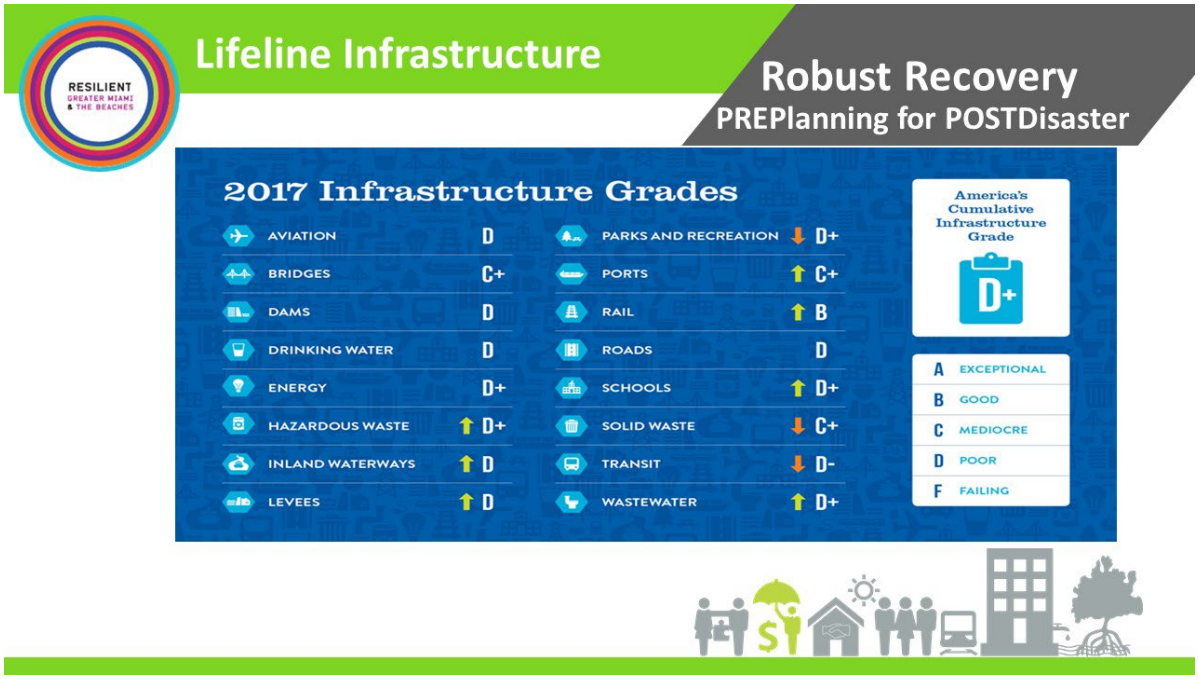


Figure 4-2: Case Study: National infrastructure scorecard

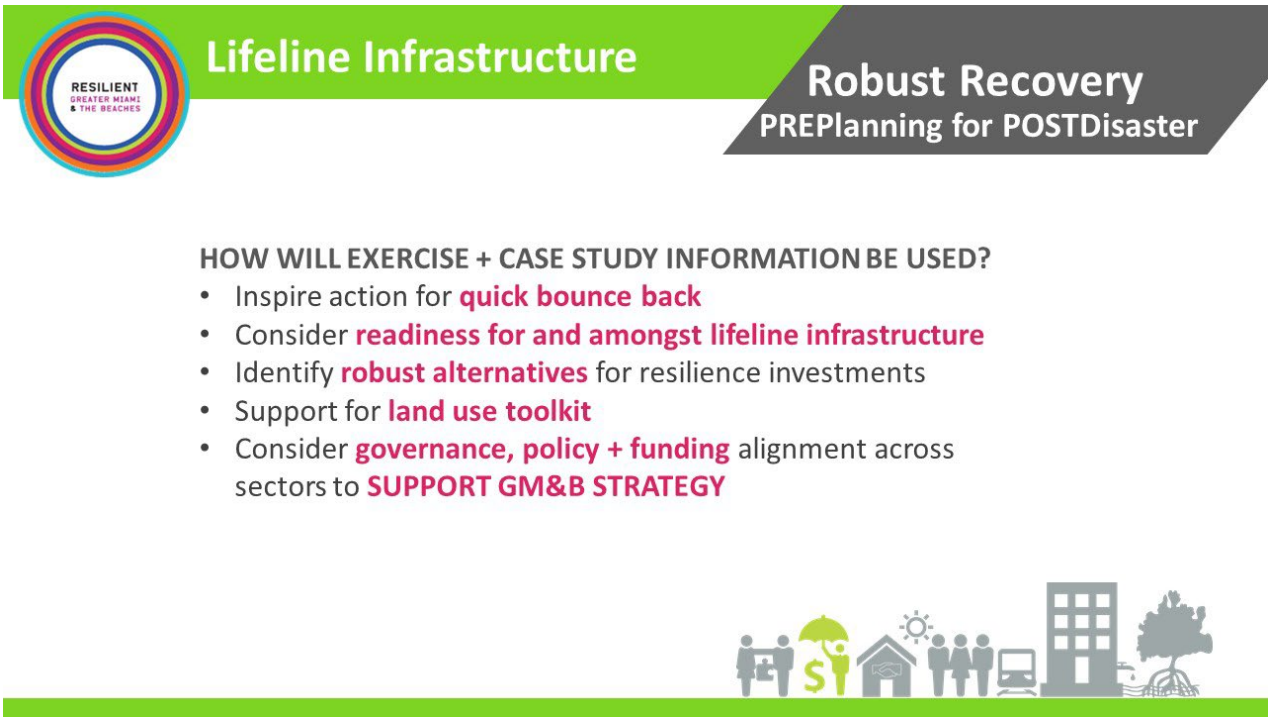


Figure 4-3: Case Study: How information will be used

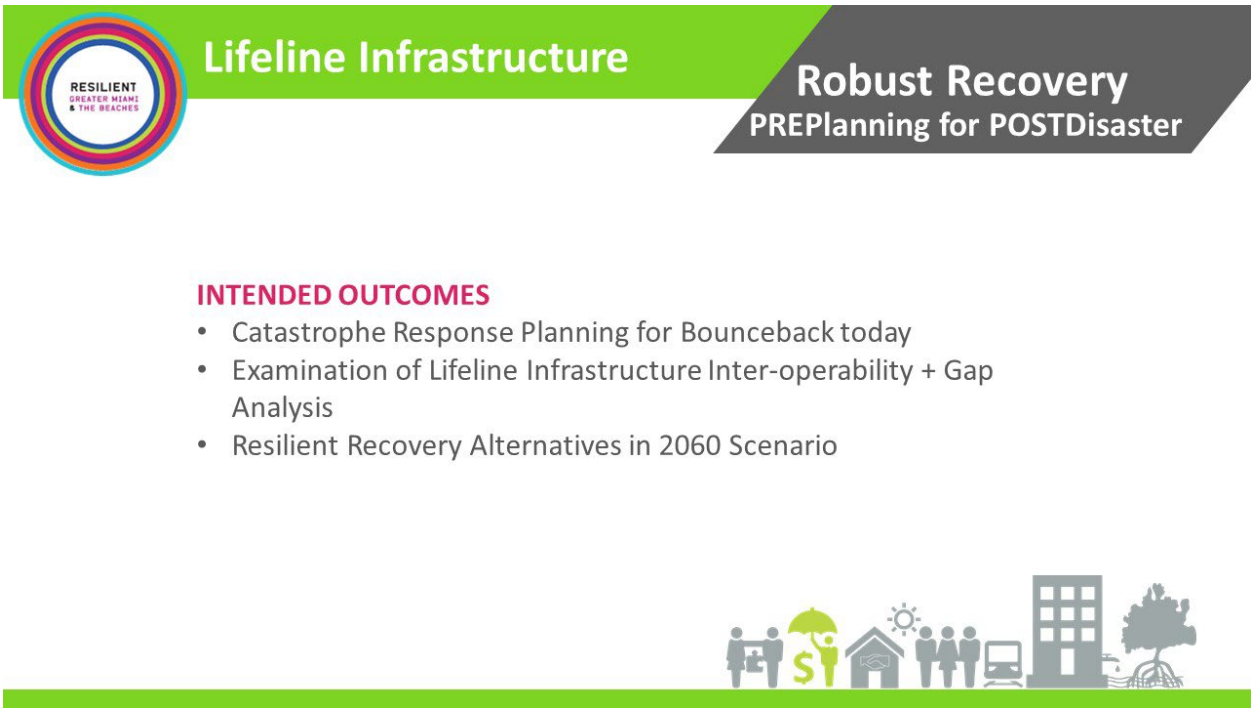


Figure 4-4: Case Study: Intended outcomes

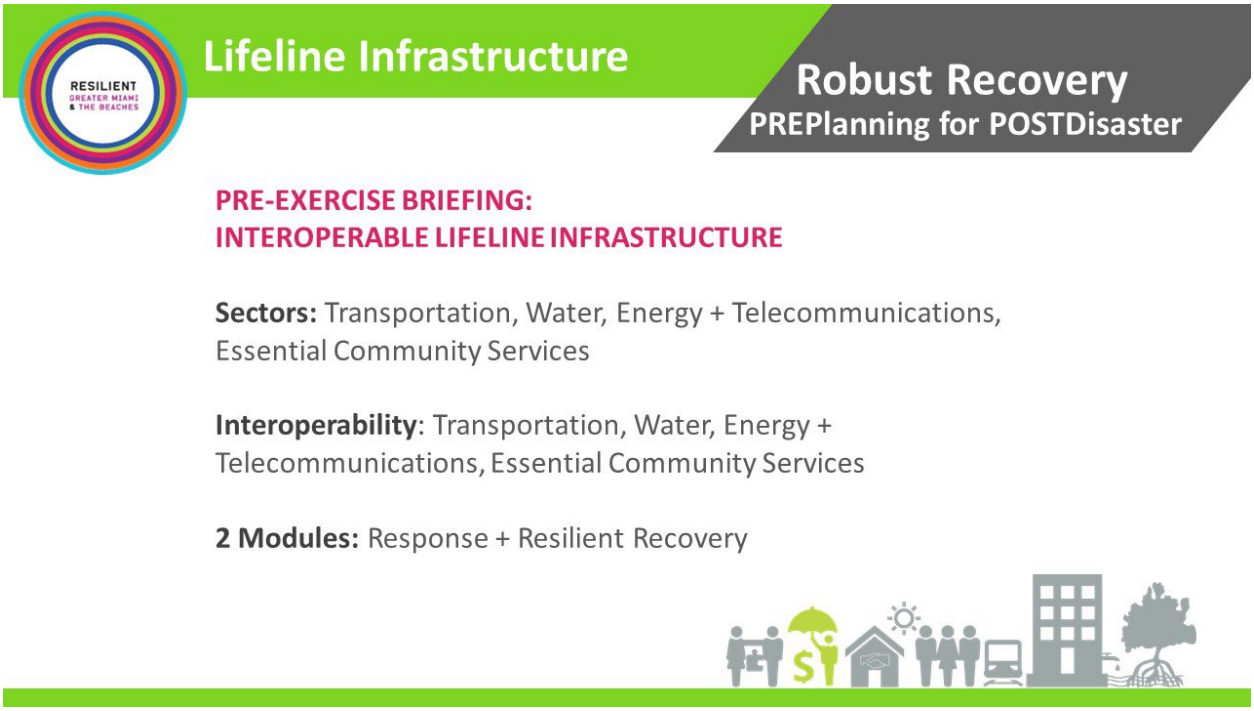


Figure 4-5: Case Study: Sectors

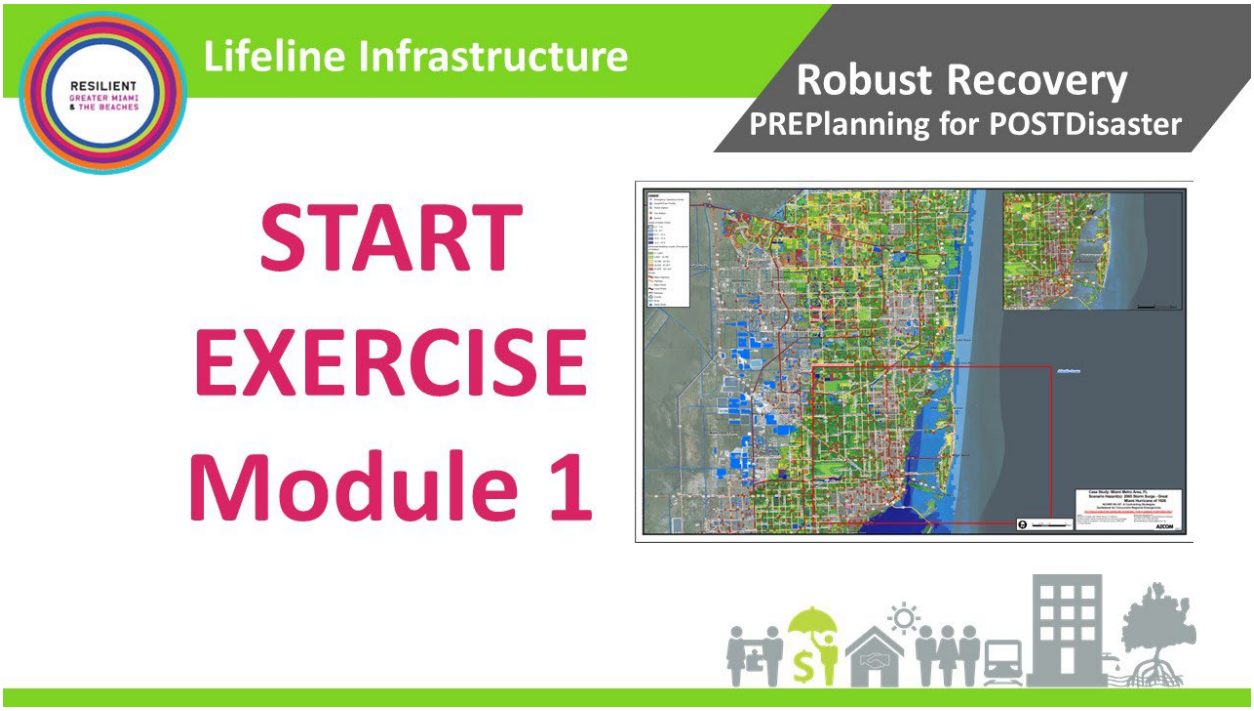


Figure 4-6: Case Study: Exercise 1 initiation

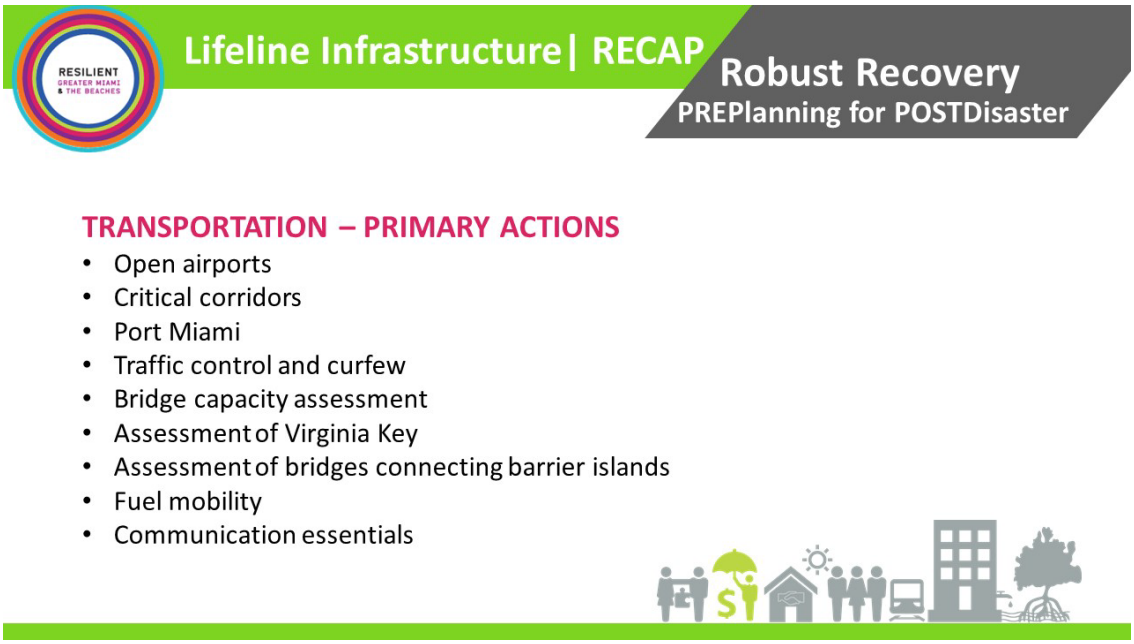


Figure 4-7: Case Study: Primary actions

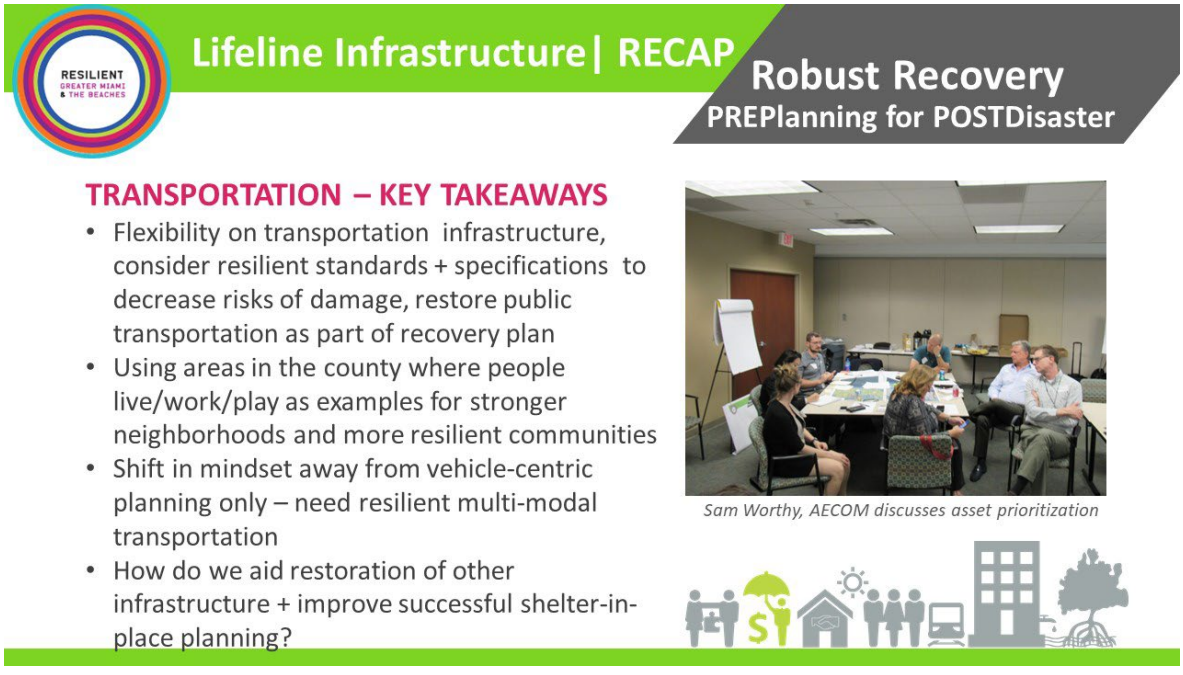


Figure 4-8: Case Study: Key takeaways

Overall, the case study performed its intended function. It confirmed strengths in the region's readiness for concurrent, regional emergencies and disasters and highlighted gaps that are now assigned to

working groups. While relationships within the region are strong, the biggest area for improvement in rapid response pointed to the need to develop better situational awareness about partner agencies' respective lifeline infrastructure assets. This included facility conditions and vulnerabilities to better understand cascading impacts following a major or multiple shocks such as failures probabilities and projected downtimes and the relationship to residents sheltering in place. For resilient recovery, the needs identified a multimodal focus, development and adoptions of resilient asset improvement standards in consideration of state regulatory constraints, and the continued need to focus on lifeline infrastructure resilience. Case study maps and full materials are available in Appendix D.

Successful post-disaster recovery is reliant on robust pre-shock planning, ultimately enhancing readiness and increasing resilience. This demands significant inter-departmental coordination and continuity across all DOT divisions—operationally, and in delivery of recovery efforts, as well as deepening partnerships that will be instrumental in the incident command. To maximize this coordination as part of the recovery process, plan development in advance of an emergency or disaster event should incorporate all aspects of regional planning efforts and goals, including prioritization of corridors and assets. This requires understanding of local threats and risks facing communities and asset conditions, including anticipating vulnerabilities to diverse hazards, better preparing the DOT for possible recovery needs in advance of an emergency or disaster occurrence. It will also drive planning and capital investments to systematically reduce risk currently embedded in the system. As importantly, developing relationships with local communities (beyond transportation needs and assets alone) will facilitate judicious decisions making by DOTs following concurrent, regional emergencies that stand the test of time.

Embedding pre-disaster resilient recovery planning into comprehensive plans allow DOTs to assess risk and prioritize future investments in advance of a natural disaster or impacts from a human-caused event. During the pre-disaster planning process, it is critical that DOTs and local agencies perform an exposure analysis to better determine when, where, and how recovery efforts should occur. Findings from this analysis should also prompt a funding conversation between agencies, which could include cooperative funding and incentives for resilience investments.

The following excerpt is taken from the *Greater Miami & the Beaches Resilient305 Strategy*, developed with the support of 100 Resilient Cities network, and enumerates many key priorities and critical tasks necessary to plan and deliver durable gains through the resilience cycle. The signing of the plan is shown in Figure 4-9.

> Over the last three years, while Miami-Dade County, the City of Miami and the City of Miami Beach were developing this unified Strategy as Greater Miami & the Beaches, each entity has been busy developing and implementing comprehensive strategies and action plans to build resilience within their jurisdictions. This includes integrating resilience into city and county-wide strategies, budgets, comprehensive plans, and emergency management plans; appointing resilience liaisons from key departments; developing and passing bonds to finance resilient infrastructure; passing policies and securing funds to accelerate the creation and preservation of affordable housing; improving and expanding mobility options; expanding economic opportunities and mitigating flood risks. The unified Strategy development process informed and

strengthened how we approached building resilience within our own jurisdictions. The Resilient305 Strategy will now become the overarching link of our planning efforts and the foundation for not only our individual strategies, actions, and investments, but also for the other municipalities, businesses, institutions and community organizations within Greater Miami & the Beaches.

We recognize that implementing each of the actions within the Resilient305 Strategy will require dedicated effort from a team that we call PIVOT or Progress, Innovation, and Vision for Our Tomorrow. The PIVOT team will look at resources, timeframes, and priorities to develop a work plan and oversee implementation and strategy progress." See signing of the Resilient305 Strategy in Figure 4-9.

(Resilient305. 2019)

Figure 4-9: Signing of the Greater Miami & the Beaches Resilient305 Strategy

4.1.2 Plan for Administration, including Procurement and Contracting

An overall conclusion from AASHTO's Resiliency Case Studies was that organizing repair and response contracts, as well as regional collaboration with who may aid in an emergency, be done during an emergency planning phase. Vermont, Louisiana, Colorado, North Carolina, Oklahoma, and Florida all echoed this as being key to efficient emergency response (AASHTO 2018).

Recommended practices for emergency preparedness include developing a plan; establishing evacuation routes; having mutual aid agreements in place; having a policy addressing service and facility closures; fare suspension; preplanning for special needs populations; backup communications; exercises and mobilization planning; fueling vehicles prior to emergencies; establishing command structure; accounting and record keeping policies; debriefing; and working with MPOs to develop partnerships within a region (Chandler and Sutherland 2013).

GAO Recommended Practices for Disaster Procurements

- ✓ Developing knowledge of contractor capabilities and pricing for commodities and services;
- ✓ Establishing scalable operations; formally assigning disaster responsibilities and participating in joint training, and
- ✓ Providing sufficient numbers of field staff (Cooper 2005; GAO 2006a; Woods 2006)

After Hurricane Katrina, the GAO found that the response could have benefitted from adequate planning and preparation to anticipate needed goods and services, improved communication about specific responsibilities across agencies and jurisdictions, and an additional number of deployed personnel to provide effective contractor oversight.

Post-mortem analysis on Hurricanes Katrina and Rita found that we need a national action plan with emphasis on when and how the Federal Government will take action in disasters. The plan cannot be dependent upon state or local governments or organizations. Additional issues identified and targeted for improvement included: information gaps between data and the need for decisive actions; lack of initiative (reactive versus proactive); ability for the Federal Government to respond when local and state governments are overwhelmed; lack of agility to address needs due to government procedures; agencies are unfamiliar with their roles and responsibilities under the National Response Plan; ineffective command and control within and between military and civilian agencies; lack of emergency housing; and overwhelmed supply chain (U.S. House of Representatives 2006).

As a result of disasters like Hurricane Katrina, FEMA developed the *National Disaster Recovery Framework*. This is a guide that enables effective recovery support to disaster-impacted states, Indian Tribal governments, Territorial, and local jurisdictions. It provides a flexible structure that enables disaster recovery managers to operate in a unified and collaborative manner. It also focuses on how best to restore, redevelop, and revitalize the health, social, economic, natural, and environmental fabric of the community and build a more resilient Nation (FEMA 2016).

4.2 Managing Scope and Scale

- ✓ Develop triggers based on event magnitude and severity;
- ✓ Understand hazards and vulnerability to buy-down risks pre-shock; and
- ✓ Evaluate regional logistics and supply chain constraints, and take action to reduce risks.

The FAST Act requires that the transportation planning process consider options to "improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation" (FHWA 2018a). DOTs can integrate resilient policies into the procurement and contracting processes to enhance project outcomes. Work with local agencies to develop policies that integrate climate change objectives and embed those policies into DOT or key partner-led procurements. As of November 2018, it is federally mandated that State DOTs must evaluate facilities that have been repeatedly damaged in emergency events. For example, In Florida, the Palm Beach MPO has advanced that mandate to also have an objective of increasing the percentage of facilities that can accommodate a 2-foot sea-level rise with a 90% performance target for the network in 2025 (FHWA 2018a).

Consider developing a database of resilient procurement tools and practices in advance of a request; this will allow procurement officers to work with transportation professionals across the agency to integrate appropriate language in procurement solicitation and contract scopes of work, as well as project ranking and scoring methods. In addition, consider the use of criticality based oversight measures and the use of the DOT Sustainable Highways Self-Evaluation Tool, INVEST (Infrastructure Voluntary Evaluation

Sustainability Tool) for each project to better enable contractors to evaluate and improve the resiliency of the project being proposed.

4.2.1 Develop Triggers Based on Event Magnitude and Severity

DOTs can review and implement readiness measures to anticipate hazards and projected impacts. A risk profile or "risk register" can be used (and shaped by state and transportation agency hazard assessments and hazard mitigation plans) to anticipate region-scale shocks based on potential magnitude and severity profiles (FHWA 2018a). Triggers or indicators can be established and monitored by the DOT for early warning signs (i.e., down-grading of particular asset condition) and aid in the development of contingency plans. Transportation agencies and their partners should make the most of blue skies and work together to buy down risk pre-shock (see Section 4.2.2, below) by leveraging resources, optimizing returns on investments, and capturing triple-bottom-line co-benefits in advance of concurrent, regional emergencies and disasters.

Risk registers are important tools; however, DOTs need to translate what is known about potential future threats and vulnerabilities into risk mitigations for administrative system and controls in addition to physical assets. To this end, planning, training, exercising, and then defining administrative controls that will be used according to shock severity, magnitude, and impact are mission-critical for restoring essential traffic and community habitability and quickly progressing through sustainable, resilient recovery. Maintaining "business as usual" systems and processes that are well understood, tested, and rigorous should remain firmly in place wherever current systems can quickly and reliability be used post-shock without creating insurmountable bottlenecks or undermining system integrity. Key activities also include defining extraordinary provisions, policies, procedures, and operational systems that will be triggered according to shock type and magnitude and system impacts.

Transportation professionals should exercise scenarios that stress-test day-to-day systems and clearly define new (or modified) ways of working only when systems fail, and no amount of staff augmentation will answer requirements. As a simple activity, shocks can be categorized by contemplating projected type (e.g., earthquake) and magnitude [e.g., Richter Magnitude Scale (M) M 6.2, M 7.2, M 8.2], and severity of system impacts in three shock scenarios or buckets such as low impact, moderate impact, and high impact. Use exercises and post-shock after-action reviews to evaluate how systems and business processes and administrative systems and controls perform. Evaluate the capacity of tried and true administrative systems and controls to stretch and define breaking points. As part of exercises and after-action analysis, consider answering questions such as:

- ✓ What threats cannot be overcome for systems to maintain administrative control (e.g., requires reliable internet, email, and vendor hosted websites), and how can that suite of tasks be accomplished until systems are available while maintaining integrity such as anti-fraud, waste and abuse (AFWA) controls (e.g., manual payments to vendors)?
- ✓ What can existing systems efficiently accommodate with current personnel, and what could they accommodate with (trained and ready) augmented resources?

- ✓ How many actions or transactions can occur using current systems successfully, and over what duration(s) of time? For example, when considering capability to manage increased postings to the general ledger:
  - Increase 100% of capacity without losing system reliability by authorizing personnel overtime;
  - Successfully go from 125,000 postings to the general ledger per (fiscal) quarter to 500,000 postings with 3 additional full-time equivalent, grade 11 system users; and
  - System cannot exceed 700,000 postings per quarter without $350,000 system module upgrade and $10,000 per month increase in licensing fees from proprietary financial system vendor.

At a baseline level, the following should be considered when defining what triggers involve modifications or new business processes, policies, or procedures:

- ✓ Designating the ICS structure to operationalize for rapid response and resilient recovery efforts.
- ✓ Clarifying roles and responsibilities for each partner agencies.
- ✓ Defining when and which resilience BCA methods and design standards for sustainable resilience will be used based on whole-system or specific asset shock impacts or resilient future state asset performance goals.
- ✓ Identifying shock and impact triggers impacts on emergency policies and procedures related to administrative controls, including:
  - Gubernatorial declarations on states of emergency;
  - State fiscal rules;
  - Emergency procurement rules;
  - Emergency contract pricing and terms and conditions;
  - Activation of pre-shock contract agreements such as IDIQs; and
  - Activation of supplier agreements (pricing, volumes).
- ✓ Defining current asset management and capital expenditure plans based on corridor or asset characterization, vulnerability, and STIP (and TIP, as applicable) status.

Readiness engenders continuous improvement. In the first iteration of stress-testing systems, rudimentary analysis of systems and trigger-based solutions can be outlined. As readiness cycles repeat over time, the transportation agency's business processes will mature, and ongoing training, exercising, and analysis will result in more granular and specific policies, procedures, and business processes and shock-specific triggers.

4.2.2 Understand Hazards and Vulnerability to Buy Down Risks Pre-Shock

There are many approaches to identifying hazards and assessing vulnerability to a transportation system. Vulnerability assessments are commonly used and increasingly accompanied by, according to FHWA's *Integrating Resilience into the Transportation Planning Process* (2018), DOT and MPOs that are utilizing scenario planning and workshops to better understand existing shocks and known exposures. The variety of tools help transportation professionals better identify vulnerabilities on both a local and regional scale, where all stakeholders contribute to reducing risk, or risk buy-down, for the long-term.

"Moving forward, our state needs to understand where our assets are most vulnerable. We need to understand from a risk profile where we are most vulnerable to natural and manmade threats, including flooding, tornadoes, and wildfires."

– Heather Paddock, Flood Recovery Manager at CDOT for the 2013 Flood

When asked about whether STTL agencies have clear understandings of hazards and vulnerabilities related to the assets and facilities they control, disaster practitioners were split in the survey, as shown in Figure 4-10.

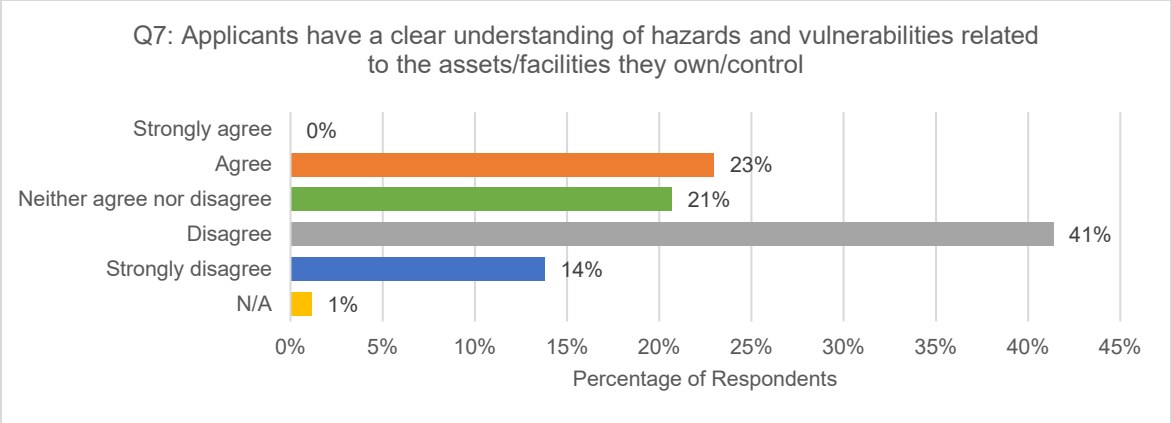


Figure 4-10: NCHRP 08-107 survey question 7 (graph, AECOM)

Understanding hazards and vulnerabilities increases readiness and provides information necessary to plan and implement mitigation actions that exceed minimum codes and standards while also shortening bounce-back time to transportation networks post-shock. Creating a robust set of buy-down measures also provides cumulative benefits to a region, addressing impacts from hazard events such as road closures needed during evacuation, improving continuity of services and improving community habitability during and post-hazard, and/or constraining negative environmental, economic, and social consequences.

4.2.3 Evaluate Regional Logistics and Supply Chain Constraints, and Take Action to Reduce Risks

Figure 4-11 shows the degree of difficulty that many disaster practitioners in AECOM's survey observed public-sector agencies facing relative to the supply-chain and procurement of long-lead items. These challenges are exacerbated for transportation professionals in remote and insular locations following

concurrent, regional emergencies, as observed following shock events impacting the U.S. Virgin Islands, Puerto Rico, Hawaii, Guam, and the Commonwealth of the Northern Mariana Islands.

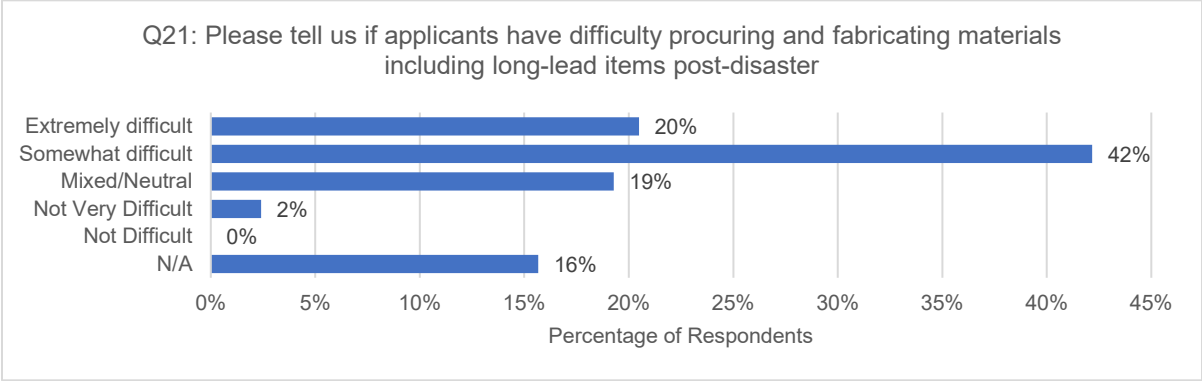


Figure 4-11: NCHRP Survey 08-107 Question 21 (graph, AECOM)

The COVID-19 emergency has elucidated the extraordinary supply chain pressures that can be produced by concurrent, regional emergencies on a global scale. In its *Stocktaking Report on Immediate Public Procurement and Infrastructure Responses to COVID-19*, the Organisation for Economic Cooperation and Development (OECD) demonstrates the magnitude of the problem and the partnerships required to navigate forward successfully. It states:

> Governments are experiencing extremely high demands for the same specific medicines, health and personal protective products due to the worldwide nature of the epidemic. Not only are countries rushing for the same products and services, but central governments have also become internal competitors with their regional and local authorities for the same vital supplies. In many jurisdictions, the procurement of health products falls within the remit of regions, municipalities and, sometimes, even individual hospitals. Yet, a coordinated approach to procure these products has never been more necessary to avoid chaotic competition between public buyers.
>
> At the same time, production in certain parts of the world has been seriously disrupted (or even fully stopped) due to the restrictive measures introduced by the governments in order to stop or at least slow the outbreak of the epidemic. Some countries imposed export prohibitions and restrictions on essential goods, such as masks and ventilators to mitigate critical shortages at the national level. The market has also started to react in a different way to demands from the public sector, compared to what is normally expected. In addition, many suppliers are demanding advance payment to secure supplies, and in some cases that is not even enough of a guarantee to secure the goods. Public buyers are experiencing price volatility of essential goods and services. The extremely high demand for certain products has also increased the risks of fraud and misconduct by suppliers and service providers.
>
> Aside from the procurement of essential goods and services, the constantly evolving COVID-19 situation creates many uncertainties for procurement professionals, as well

> as for the supply chain. Many suppliers are struggling to meet their contractual obligations because of restrictions, putting their financial viability and their supply chain at risk. Contracting authorities therefore need to act to support their at-risk suppliers so that they are better prepared to cope with the current crisis and can resume normal service delivery when the outbreak is over. Beyond procuring items directly needed for the fight against the virus, contracting authorities need to properly manage their ongoing contracts (and tender [bid] procedures, if any).

The (OECD) stocktaking report goes on to state:

- Public procurement is at the frontline of many countries' responses to the crisis, with the need to increase co-ordination and enhanced flexibility;
- Countries generally use their established frameworks for emergency contracting whilst at the same time providing additional guidance and support to their contracting authorities on how to use them correctly;
- Centralised and coordinated approaches on supranational, national and regional levels are being introduced to avoid sending competing messages to the market and to join forces against the COVID-19 pandemic (such as in Germany, Italy or by the European Commission);
- Public buyers are engaging with suppliers more often to find innovative and alternative solutions for their needs, and they are looking at alternative sourcing (such as in Canada, Italy, Korea, UK and USA); and

Emphasis was put on improved transparency and accountability related to emergency contracting in most of the countries (such as in Colombia, Latvia, Peru) (OECD 2020). The McKinsey Global Institute report, Risk, Resilience, and Rebalancing in Global Value Chains*,* indicates that 2019 brought 40 extreme weather disasters that exceeded $1 billion each in damages. The report classifies shocks by types and includes maximum credible event outliers. The analysis considers diverse threats such as natural and human-caused disasters, as well as crimes like theft, military conflicts, and financial crises according to magnitude of disruption, frequency, and ability to anticipate the threat. It shows the relationship between the high magnitude and increased costs from the millions of dollars for frequent events to tens of trillions for extreme outliers such as solar storms, super-volcanos, and extreme pandemics. The report also underscores that increased digitization has increased the exposure of supply chains to cyber threats. Targeted measures taken before an event occurs can mitigate the impact of a shock or speed time to recovery. As more physical assets are digitized, for example, companies will need to step up investment in cybersecurity tools and teams. The McKinsey Global Institute report incisively observes:

One of the most important steps is building more redundancy into supplier networks. Relying on a single source for critical components or raw materials can be a vulnerability. In fact, even if a company relies on multiple suppliers, they may be concentrated in the same place. Taking the time to identify, prequalify, and onboard backup vendors comes at a cost. But it can provide much-needed capacity if a crisis strikes. Auditing and diversifying the supply chain can have the added benefit of reducing carbon intensity, raising environmental and labor standards, and expanding opportunities for women- and

minority-owned businesses (Lund, Manyika, Woetzel, Barriball, Krishnan, Alicke, Birshan, George, Smit, Swan, and Hutzler. 2020).

This issue is further discussed in Section 4.3.1.

4.3 Prioritization and Capacity

- ✓ Optimize procurement for multiple-corridor prioritization;
- ✓ Identify potential gaps in effective project oversight.

Examples from the literature show that prioritization is mainly focused on the most vulnerable populations and infrastructure. The identified potential impacts are also used in parallel with maps of existing infrastructure (e.g., bridges, culverts, and other structures). Prioritization has also focused on the most used infrastructure and services where the greatest impact will occur from a disruption. Many of these analyses use GIS to identify geographic trends and geospatial relationships (FHWA 2018a).

FHWA Conclusions on Building Resilience

- ✓ Need for comprehensive assessments of key structures;
- ✓ Capital investment in resiliency and protection of critical assets;
- ✓ Incentives to encourage resiliency;
- ✓ The ability for local jurisdictions to influence emergency planning and preparedness guides;
- ✓ A plan for staffing to respond to an emergency;
- ✓ Increasing public awareness; defining agency responsibilities in case of an emergency; and
- ✓ Advance contracting and updating public emergency response policies.

(FHWA 2018a)

For special prioritization and planning, several states have also identified specific areas of focus, including maintenance facilities and communities at risk of being cut off in the event of an emergency caused by severe weather or other hazard. In one example, a state developed a model that used sea-level rise to identify urban centers that would potentially be lost (population retreat), and also identify new centers that might be developed as a means of guiding future infrastructure investment and development of housing stock. A review of state plans revealed some key areas to focus on during plan development. FHWA recommendations and requirements are included in the adjacent textbox (FHWA 2018a).

4.3.1 Optimize Procurement for Multiple-Corridor Prioritization

When more than one critical corridor is down, the urgency and adverse impacts on communities across a region, its economy, and often the state of its environment are extraordinary. That makes it especially difficult to reliably predict the scope, scale, and impacts of concurrent, regional emergencies and disasters, and it also means that these are, probabilistically, outlier events.

- ✓ Conduct rapid task order competitions to determine the most qualified contractor for the time and type of contract required.
- ✓ Consider if multiple projects can be awarded to one contractor that has demonstrated the firm's capacity to perform particularly well for work required (e.g., award one major contract or multiple projects that cannot exceed a project total of $125 million).

- ✓ Recognize that small vendors are least able to enter into pre-positioned contracts so encouraging relationships through professional networks, events, and contract requirements will facilitate participate of small and DBE/MWBE firms.
- ✓ Consider vertical and horizontal supply chains, and determine if procurement and contracting should require contractor proposals to present delivery and price agreements that include components and prioritization in the fabrication queue. For example, for a major temporary k-12 school program in the U.S. Virgin Islands following back-to-back Category 5 Hurricanes Irma and Maria installing 150 modular and sprung facilities plus extensive code-triggered civil works, the awarded contractor engage both the temporary facility fabricator and an electric component provider to be integrated with the team from the outset of the proposed work. This shorten time to delivery and provided greater supply chain assurance and control.

Multi-corridor prioritization can look to the USACE for examples of delivering high-priority projects across a broad region on a rapid time schedule. The GAO report, *Hurricane Katrina: Strategic Planning Needed to Guide Future Enhancements Beyond Interim Levee Repairs* (GAO 2006b), states that USACE rapidly procured and awarded 59 contracts with diverse scopes of work and some contractors working 24 hours a day. USACE project managers monitored progress and reported that 22.7 miles of new levees and 195 miles of scour repairs were completed, with 100% of pre-hurricane protection levels restored before the 2006 hurricane season. The 2006 project, however, was the precursor to USACE's nearly $15B Hurricane and Storm Damage Risk Reduction System which involved the procurement, award and monitoring of hundreds of construction contract awards−delivered in parallel and in succession. USACE's master scheduling was likened to conducting a symphony of construction and provides rich instruction in rapidly delivering billions of dollars in resilient design and construction work. USACE used an unprecedented number of prime contractors working in an integrated fashion across a broad impact area (USACE 2020).

4.3.2 Identify Potential Gaps in Effective Project Oversight

Incident command leadership and section chiefs need to establish mission, goals, and objectives; and progress projects and the POP through critical path tasks through response and recovery completion. Organization is paramount to effectively monitor both POP and project-specific performance so leadership time can be focused on resolving performance gaps, especially where trends are visible. Trend monitoring by project and the POP for exceptions (linked to urgency and importance) is critical because it highlights gaps and enables root cause/single point of failure analysis. Setting up a robust system to monitor trends as part of readiness planning is mission-critical. Monitoring the following for gaps is vital to recovery program success:

- Projects or program personnel−right-skilled, trained on response-/recovery-specific procedures, and ramp-ups to avoid bottlenecks and ramp-downs to maintain efficiency;
- Other projects and program resources
  - Better information/data
  - Technology

  - Financial (e.g., contractor non-performance due to slow payments);

- Project and program quality, schedule, and performance;
- Projects or program areas experiencing changing conditions;
- Projects or program decisions requiring course correction to succeed;
- Partnership agreements that are not in fulfillment and need attention;
- Contractor performance;
- Project and program monitoring, compliance, and document control.

Supervisors in the incident command also need to monitor staff performance and direct support and coaching where it is needed. The extraordinary pace, demands, and pressures to deliver urgently needed work are real and predictable, and each person can be expected to respond to the stress of the work differently. Consider engaging human resources to build a climate of success and support by design within the incident command.

Provisions to aid personnel in coping with stress should be planned; from encouraging access to employee assistance resources such as counseling; identifying and building in breaks and identifying places for exercise; and providing quiet/meditation space (sometimes called the “cry room”); providing the incident command team healthy meals, snacks, and beverages improves performance. For example, on one Sandy response project, incident command staff were temporarily authorized to use nearby state policy exercise facilities. On a flood recovery, all available staff took a quick 1-mile walk at 11 AM each workday, and no non-urgent meetings were scheduled during this time to maximum elective participation. Also, ensure adequate personnel are trained and equipped in first aid and defillibrator use, and train all to spot signs of cardiac events and strokes in one another and themselves, and map accessible routes to emergency and urgent care.

Ground rules for conduct should be developed for all incident command personnel and programmed into exercises. All ground rules should apply up and down the chain of command; these can be socialized and reinforced in readiness training and exercises. Tempers can be expected to flair, but a climate of accountability must be put in place, and bullying or demeaning cannot not be tolerated irrespective of the pressures everyone is under.

GIS-Enabled Dashboard with Drill-Down Capabilities

Use GIS-enabled dashboards with key project delivery, performance, financial, and compliance information, and consider using stop-light (red, yellow, green) flags or other “heatmap” presentation to clearly show hotspots. Dashboards should include drill-down capabilities by project, and preferably include back-end data access in accessible formats (e.g., data “dumps” into Excel). The dashboards are particularly useful when programmed with workflows for each incident command section and personnel as assigned. Using dashboards with workflows provides a number of benefits that address the oversight considerations and trend analysis requirements described above.

Programmed Workflows

Similar in importance to GIS-enabled dashboards that track major project delivery milestones are document control workflows and schedules that can be integrated into dashboards through enterprise

architecture integration. Workflows can help the POP through rapid response and resilience recovery with tight administrative controls. Many DOTS are improving functionality to support engineering, asset management, and maintenance and operations. In this case, only minor adjustments that can be planned in advance may be required to meet the specific and unique needs of response and recovery projects and the POP. Workflows can help ensure that workloads are managed, and that timely compliance documentation is maintained.

For example, a GIS-enabled dashboard shows a permanent repair project to replace bridge approach slabs. The dashboard records the construction bid response date as January 4th. The project is being delivered as DBB; therefore, all pre-construction activities through the "bid set" drawings should be complete. The POP dashboard workflows send an alert to the bridge project's document controller on January 20 to review the following project documentation: full procurement documentation and contract for engineering; full procurement documentation and contract for construction management; engineering files for schematics design at 25%, 50%, 90%, 100% and or "bid set;" permits; and NEPA clearance. If the files are missing, an automatic flag can be sent to the project manager or assignee to remind the team in the field to catch up on paperwork, or the document controller can reach out to meet requirements and also maintain communications between the F&A and operations sections. In this one example, effective workflows can support project and program success by providing a check and balance on how the project is progressing; flagging any outdated information on the dashboard; reducing audit risk on the projects, and spotting any compliance or documentation problems early−when communications with contractors can be quickly resolved by the project team or other personnel; avoiding bottlenecks; and promoting communication among different sections supporting the incident command.

4.4 Flexible Arrangements

- ✓ Conduct due diligence for pre-positioned emergency contracts; and
- ✓ Identify contracting and project delivery options, including regulatory constraints facing DOTs.

4.4.1 Conduct Due Diligence for Pre-Positioned Emergency Contracts

There is no better mechanism to flatten contractor mobilization time than with pre-positioned emergency contracts. They also offer the best way to realize cost savings and provide equitable risk or risk transfer to contractors. However, special care is required when contemplating the activation of pre-positioned contracts following concurrent, regional emergencies.

"From a contracting/design perspective, the most challenging was ensuring the procurement of the pre-qualified list met the Federal standards. We were clear about that from the get-go."

– Susanne DesRoches, former Engineer at the Port Authority during Hurricane Sandy

When investing significant time and preparation to enter into pre-positioned emergency contracts with vendors, DOTs should consider how to attenuate its risks. Be sure to conduct due diligence on contractor capabilities and capacity, and include provisions for contractor non-performance. It is much more difficult for contractors to deliver promised resources that are not within its control. For example, many STTL government agencies have pre-positioned debris removal and debris

management contracts in place along the U.S. Gulf Coast due to frequency of tropical impacts generating debris in the region. It is predictable that contractors will pursue unspecified work that exceeds its capacity to perform on all pre-positioned contracts in an outlier event. When preparing pre-positioned contracts, F&A personnel can consider the following representative steps as part of its due diligence analysis and contract development:

- ✓ Vet the capacity of each contractor by evaluating past performance.
- ✓ Evaluate the contractor's self-perform on construction, and establish minimum thresholds for self-performance.
  - Designate how many tiers of subcontractors are allowed on a project based on its scale or complexity.
  - Determine if a contractor employs its personnel or hires workers on temporary assignments.
  - Define the contract response periods, and numbers and types of (and sometimes named) qualified personnel that the contractor commits to mobilize when contracts are activated for events at different scales (e.g., debris volumes).
- ✓ Evaluate if contractors own or have long-term leases on equipment generally needed for project delivery for surface transportation/structures.

Example on Contract Performance Clauses

After Hurricane Harvey hit Texas in 2017, a relatively small pool of vendors responded, leaving little or no bench capacity for other work. When Hurricane Irma hit a few weeks later, a Miami-area local government tried to activate its pre-positioned debris removal contract, but the contractor refused to perform the work. It was not until Hurricane Irma made landfall that the operations section chief learned that F&A had not defined consequences for non-performance in the debris removal contract. In this case, the concurrent, regional disasters caused by the unprecedented 2017 hurricane season left an otherwise prepared and diligent local agency shopping for a debris removal vendor, putting it in the worst possible position for price and performance. The upside was that the local agency then had the opportunity to add non-performance penalties to its suite of emergency contracts.

Leverage GSA schedules that can be arranged for use after a Presidential disaster declaration or Public Health Emergency.

4.4.2 Identify contracting and project delivery options, including regulatory constraints facing DOTs

Based on regulatory and legal constraints, using lists of pre-qualified vendors is the better or more feasible route in preparing for post-shock contract awards. Pre-qualified lists of vendors vary widely among transportation agencies as well as STTL governments. Wherever possible, defining and rating specific qualifications will realize better gains than the loosest alternative, which is that the firm is qualified to conduct business in the state. Fortunately, DOTS usually have the most well-developed and stringent vetting of pre-qualified firms, and this applies particularly for professional services firms.

"With 250 engineers on staff, a lot of the initial repairs were in-house or with design engineers that we had already on contract. Once we started to get into real recovery projects, we had to go back out and do "Sandy call-in" which was a Sandy pre-procured list."

– Susanne DesRoches, former Engineer at the Port Authority during Hurricane Sandy

4.5 Innovative Delivery

- ✓ Establish project delivery for standby contract capacity;
- ✓ Define procurement methods and payment//contract types for standby contract capacity; and
- ✓ Prepare for response and recovery procurement and contracting.

"We are forward looking now, having on-call contractors for debris management work or different parts of recovery. It behooves us to get ahead of the next event. We're trying to arm ourselves a better than when we were surprised by the 2013 flood."

– Marci Gray, Engineering Contracts Manager at CDOT

Alternative contracting method effectiveness can be measured objectively with metrics on schedule, cost, quality, and safety. Some barriers identified in an NCHRP report survey on implementing alternative contracting methods are listed below. The first two barriers listed were seen to be the most important obstacles to successful implementation (NASEM 2008):

- Lack of prior expertise
- Lack of enabling legislation (for design build (DB) and public-private partnership (P3)
- Lack of resources, i.e., staff time
- Lack of supportive organization structure for alternative contracting methods (ACM)
- Lack of funding
- Adherence and familiarity with known and proven methods
- Employee union opposition
- Inexperience of contracting community
- Lack of demand considering the type of projects
- Lack of leadership for innovative actions
- Size of contracts

Alternatively, the NCHRP effort revealed that successful projects using alternate contracting have included several of the following features:

- ✓ Articulating a department vision and objectives for project delivery performance.
- ✓ Additional staffing/consultants to meet project management needs.
- ✓ Creation of an alternative contracting methods (ACM) unit or office within an organization is a measure that expedites the use of ACM and including junior staff in the effort.
- ✓ Aligning project delivery methods and contractor selection with project needs.
- ✓ Improving coordination with MPOs.
- ✓ Early continuous contractor involvement from design to construction.
- ✓ Holistic design should include early collaboration with environmental regulators, construction managers, and designers to minimize environmental impacts and expedite permitting. This

includes DOTs and environmental departments coordinating on a "crosswalk" between technical detail/design and the information necessary for environmental approvals.

- ✓ Establishing performance measures to monitor progress using data-driven analysis.

This section provides guidance for project delivery, procurement, and contracting during the readiness phase. The objective is to improve resilience to minimize impacts and to prepare for rapid response when disasters hit. In general, two readiness contracting modes are addressed: (1) in preparation for disasters and prior to their occurrence, entering contracts that can be used after a disaster hits, for response and for recovery (in effect, standby contracts); (2) preparing for additional contracts that will be entered after the disasters occur; i.e., preparing for response and recovery procurement and contracting. The first mode has been mentioned in the rapid response and resilient recovery phases as the exercise of IDIQ contracts or utilization of change capacity of pre-existing contracts, while the second mode has been a key topic addressed in the rapid response and resilient recovery discussions above.

4.5.1 Establish Project Delivery for Standby Contract Capacity

As discussed under managing the scope and scale and the flexibility issues, resiliency must be adaptable to the wide range of needs that may occur in response to disasters, and particularly when contemplating concurrent emergencies. Consequently, the resilient contracts put in place to be prepared when needed should offer multiple project delivery methods to the managers who will ultimately manage the disasters.

"The language has to be broad enough to encompass any kind of a situation that demands it, but specific enough to preclude it from being abused. You're always walking a fine line with that."

– Jim Weinstein, AECOM and former Executive Director, New Jersey Transit

The prevalence of DB delivery method in both rapid response and resilient recovery contracting shows that putting in place contracting capacity for DB work is warranted. At least one IDIQ contract for DB work should be considered.

Managers of disasters and procurement personnel should also consider contracting in advance for a CM at Risk capacity, so that incident command and procurement will have the ready option of using this method, which does not transfer as much risk to the contractor, but retains more design and planning responsibility with the DOT.

To provide options to the managers addressing disasters, a capacity to undertake traditional delivery, that is, to order design/planning work, and to order construction work, should also be provided.

4.5.2 Define Procurement Methods and Payment/Contract Types for Standby Contract Capacity

Consideration should be given both to issuing IDIQ contracts that would be designed to be usable in disaster response and recovery, as well as writing scope provisions that clearly allow for issuance of changes within the overall scope of the contract to initiate disaster response and recovery work. The latter procurement method (response and recovery changes within general scope) would be adaptable to a number of emergency needs if implanted in the DOT's other relevant IDIQ contracts.

The feasibility of standby IDIQ contracts specifically for emergency response and recovery will depend on the history of the agency and the market interest; there would be no minimum quantity that could be guaranteed, because the occurrence of a disaster is never guaranteed.

The procurement method for the IDIQ contract would be formal competition for unit-priced contracts, and competitive negotiation for DB contracts.

Any such rapid response and resilient recovery IDIQ contracts should contain terms that allow quick start (e.g., process for quick negotiation of scope, price, and schedule for task order issuance) when disasters hit.

In addition to these standby contracts, the DOT should enhance its prequalified contractors lists to ensure that the needs of managers addressing disasters will be met by those lists. This will enable the use of accelerated prequalified solicitations, as discussed under rapid response and resilient recovery, above.

As part of the implementation of its Action Strategies (CDOT, 2015), CDOT's Emergency Procedures Working Group convened a procurement and contracting subcommittee from across the agency to prepare for a future major shock. Figure 4-12 and Figure 4-13 show the subcommittee's actionable planning priorities. All of the priorities were successfully incorporated in the first figure, and have been substantially accomplished in the second figure.

Originally, CDOT planned on developing an emergency contract vehicle that could be utilized following disaster. Instead, CDOT's working group saw the opportunity to advance an agency-wide innovation to expedite contract actions on all procurements. CDOT undertook business process improvement and built in meaningful efficiencies in coordination with CDOT and the state controllers. This structured approach to administrative improvements yielded dividends for the entire agency and its contractors.

Review Progress & Decisions

1. Issue emergency procurements

- 1.1 Prof. Services NPS – ICP Services
- 1.2 Prof. Services NPS – Replenish capacity for emergency use as-needed
- 1.3 Prof. Services NPS – Expand structures inspection vendor pool
- 1.4 Construction IDIQ
- 1.5 Design-build IDIQ
- 1.6 Debris Removal IDIQ
- 1.7 Risk/Property Management NPS (potential action)
- 1.8 Consider robust pre-qualifications process
- 1.9 Secure FHWA approval for contracting pilots

2. Develop emergency contract templates

- 2.1 Templates will include Federal and State provisions
- 2.2 Templates will be plug-and-play ready for rapid execution

3. Develop best contracting strategy evaluation tool:

- 3.1 Force Account
- 3.2 Design-Bid-Build
- 3.3 Design-Build
- 3.4 Construction Manager-General Contractor (CMGC)

4. (Addressed in Next Slide)

5. Identify key ICP roles/authority for rapid contracting

- 5.1 Contracting Office
- 5.2 CDOT Controller's delegated representative
- 5.3 Establish thresholds for procurement/contracting/encumbrances

Figure 4-12: Review Progress & Decisions

Today's Focus

4. Pursue other event procurements – Evaluate need for additional procurement actions and develop pre-scripted agreements/anticipated scopes of work:

- 4.1 Colorado Army National Guard
- 4.2 Colorado State Patrol
- 4.3 Potential materials
- 4.4 Evaluate State Purchasing Agreements to leverage for emergency response
- 4.5 Evaluate resources available through US GSA schedules
- 4.6 Map workflow for securing materials secured via non-traditional supply chain

Figure 4-13: Today's Focus

4.5.3 Prepare for Response and Recovery Procurement and Contracting

In addition to providing standby contract capacity, readiness in procurement and contracting function can enable more cost-effective rapid response and resilient recovery. This includes establishing, in coordination with the incident command structure framework, a network of procurement contacts at related agencies. These include other state agencies, as well as regional and local entities that may have transportation assets interfacing with the state system, and who may also be subrecipients for Federal emergency aid from the DOT.

The procurement function can ensure that its pre-qualified contractor lists are enhanced to be responsive to the likely needs of managers addressing disasters. Geographic coverage of the capabilities used by managers addressing disasters can be accommodated in the prequalified contractors lists. In this way, the use of prequalification procurement methods mentioned above under rapid response and resilient recovery will be more successful.

Finally, the procurement function should be integrated into the readiness process and should prepare its rapid response and resilient recovery capabilities in policies, procedures, and staffing along with the other DOT disaster management functions.

In its analysis of *Emergency Reconstruction of Critical Transportation Infrastructure* in the State of Alabama, Hitchcock, Nunez, and Watson (2008) identified the innovative delivery methods best suited for emergency reconstruction, which include, “Bid Contracts with Incentives/Disincentives, Design-Build, A+B with Incentives/Disincentives, and Lane Rental. All of the methods are designed to reduce the time necessary to complete the project, and yet (1) preserve fair opportunity for participation by construction firms, subcontractors and material suppliers, (2) assure reasonable contract pricing for public projects, and (3) insure responsibilities for scope and quality inspection and testing are not diluted” (Hitchcock et al. 2008). Their research yielded to the following findings concerning contracting and contractor selection:

Contracting Methods and Pricing

- ✓ Incentive contracting attracts the best equipped and skilled contractors available.
- ✓ In order to determine incentive amounts for the contracts, it was necessary to establish target completion times of completion and a daily incentives/disincentives for each day under or over the target completion time. The current approach to estimating possible compressed construction schedule and a reasonable price for the contractor and tax payer needs to be reviewed.
- ✓ Phased construction arrangements or an acceptable form of design-build allows the earliest start to construction and the best chance for optimal completion time.

Contractor Selection Process:

- ✓ Construction projects with compressed schedules and contract premiums attract the region’s most capable builders.

- ✓ Prequalification of contractors was used and is a necessity for quick response and also a quality bidders list.

It is important to have a fresh list of potential contractors available so that competitive bidding (cost and ideas) are solicited whenever practical to do so (Hitchcock et al. 2008).

4.6 Audit and Other Risks

- ✓ Establish or refine administrative business processes;
- ✓ Develop monitoring plans for compliance requirements; and
- ✓ Identify procedures to minimize claims and financial exposure in dynamic post-shock conditions.

4.6.1 Establish or Refine Administrative Business Processes

In some states, the legislature will appropriate funding to share in local agencies required to match Federal disaster funding. Due to severity of the 2013 flood damages and the burden on local agencies, the state authorized a 50% cost share of the local agency match for Federal disaster grants from FHWA and FEMA. A best administrative practices was offered by CDOT on local agency match to FHWA ER funds for which CDOT is a recipient agency. As recipient, CDOT was responsible for making payments using FHWA ER to local agencies for eligible work performed on FHWA "on-system" roadways. CDOT entered into an inter-agency agreement with Colorado Division of Homeland Security and Emergency Management to direct state-funded match awards to local agencies, along with eligible FHWA ER funds being paid to the local agency by CDOT. This eliminated a second grant request process for local agencies; reduced local agency wait time on matching funds; decreased the administrative burden, and therefore costs, to local agencies and the taxpayer; and ensured that the cost share was properly managed through project close. While it took CDOT additional effort to perform this additional administrative function, it still save administrative time, provided a tangible benefit to local agencies, and improved relationships.

Increasingly, projects are funded through multiple sources. However, combining funding sources invites additional audit risk, and therefore, scrutiny. DOTs need to be alert to the need to segregate funds effectively; however, clear methods to easily track multiple sources of funds on a project should be developed so that the funds can be separately tracked on the same project within the DOTs risk-based financial management system. Identify method(s) to be used to track multiple funding sources on a single project and include it in DOT emergency procedures. Educate designers and construction contractors about how scope and costs must be segregated in engineering designs, typically through notes and line delineation on plans for this purpose. In addition, design and construction quantities and prices should be tracked by funding stream. DOT instructions should consider alerting contractors to this requirement in contract terms and conditions and should also consider encouraging compliance through training, direction, and sample invoice templates. An effective practice includes directing contractors to use a schedule of values per funding source, even on a single project and within a single invoice (CDOT

2015). This is particularly important when change orders arise, because it facilitates easy tracking to the responsible funding source.

4.6.2 Develop Monitoring Plans for Compliance Requirements

"The other part of this to consider is that the level of oversight of the expenditures of both state and Federal dollars is intense. It's just not retroactive oversight and audits, it's proactive."

– *Jim Weinstein, AECOM and former Executive Director, New Jersey Transit and former Commission for New Jersey DOT*

FHWA ER–funded projects differ very little from other FHWA-supported projects, except for the compressed timelines for work. FHWA 1273 requirements remain in place such as Davis-Bacon, Disadvantaged Business Enterprise goals, and Buy America requirements. There is some relief on the procurement of emergency repairs, and DOTs can follow procurement guidance on emergency contracting in consultation with guidance from 2 CFR Part 200 and FHWA's Emergency Relief Manual, dated May 2013. Despite the fact that compliance is largely the same for disaster and non-disaster projects, compliance is watched very closely by FHWA and FHWA's Office of Inspector General. Therefore, scrupulous attention must be paid to ensure all compliance requirements are followed and clearly documented. This includes maintaining a detailed decision log and/or using a request for information process for this purpose that records requests and responses such as owner-decisions and direction in the system of record.

Because some disaster projects are authorized to be completed with fewer procurement controls, and because disaster projects, by nature, involve dynamic conditions, disaster funds are more closely monitored by FHWA's Inspector General to support AFWA objectives. That means audits can and should be expected. Records should be kept with this expectation in view.

To the extent feasible, use systems plans and methods that are part of "business as usual" within the DOT. This will promote compliance because people will already be accustomed to using those systems; and in high stress conditions, those habits may default to use of standard systems and compliance.

If new systems for monitoring in compliance are developed, roll them out and begin to train with them in advance of concurrent, regional emergency. Consult with federal partners on compliance plans to solicit feedback in advance of needing to use them.

4.6.3 Identify Procedures to Minimize Claims and Financial Exposure in Dynamic Post-shock Conditions

Administrative controls are mission-critical when it comes to avoiding pre-claims and claims by contractors. The lifting up of certain administrative restrictions during periods of emergency, combined with more frequent verbal-only direction or quickly (or poorly crafted) written direction, occurs too often in the field based on the extraordinary demands to complete rapid response work as quickly as feasible. This invites undue risks to the DOT when not mitigated through administrative controls. Although there is no panacea when delivering high volumes of work in complex and dynamic conditions, the following suggestions can get transportation professionals thinking about risk reduction alternatives:

Leverage technologies such as tablets in the field, and use software programmed with workflows that have gates (to prohibit certain actions) or triggers (for additional review or signature approvals); these workflows can and should be staffed at all times (in the office or the field based on communications system responsiveness) by incident command administrators with appropriate understanding and authority to reduce risks, but keep work on the ground moving swiftly.

Assign engineers-in-training or other operations or F&A section staffers to shadow senior engineers or project managers in the field to record and document information and key decisions on tablets and/or scanning paper in the field. This allows the senior person to focus on safe, high-quality project delivery, but provides assurance that the documentation keeps pace with the work. This also "buys back" time that can be used to increase hours available to eat and sleep, rather than progress into a "second shift" of administrative paperwork, or risk paperwork getting deferred or never completed. It also provides an ancillary training opportunity for junior staff development.

Follow recommendations in Section 4.6, and ensure staff are trained and ready to immediately deploy proper compliance and document control policies, procedures, and business processes from (before!) day one.

4.7 Policy and Funding

- ✓ Identify post-shock funding sources and requirements; and
- ✓ Innovative Financing Tools Summary.

4.7.1 Identify Post-Shock Funding Sources and Requirements

The DOT and local agencies will be eligible for disaster funding following concurrent, regional emergencies, and it makes sense to understand program rules and develop structures to optimize funding and define compliance tasks as part of readiness.

FHWA

FHWA ER funding operated under the authority of 23 CFR Part 668, Subpart A. A DOT must submit an application to FHWA via a "letter of intent"; submit the Presidential disaster declaration or gubernatorial state emergency proclamation; and submit an application for FHWA ER funds. FHWA's division administrator then acknowledges the letter of intent in writing. The acknowledgement letter contains important information characterizing the event, estimating damages, and outlining certain procedures and requirements (FHWA 2013). Subrecipient local agencies apply for FHWA ER funds through the DOT.

An event must generate at least $700,000 (Federal share) in documented disaster damages for FHWA ER funding to be triggered. Emergencies and disasters resulting in less than $700,000 in documented damages are generally treated as heavy maintenance or routine work, and are ineligible for FHWA ER funding. In addition, a single site (segment, section) must not have less than $5000 in repair costs to be eligible. Due to the magnitude of damages involved with concurrent, regional emergencies and disasters, a request for Congressional appropriation to support emergency repairs and permanent repairs under

FHWA ER will almost certainly be required. FHWA does have a standard process in place for quick release funds to provide an initial infusion of funding to the DOT.

In its Emergency Relief Manual (2013), FHWA states,

> Roads and bridges on Federal-aid highways that are damaged as a direct result of a natural disaster or catastrophic failure from an external cause are eligible for ER funds. Federal-aid highways are public roads that are classified as arterial, urban collectors and major rural collectors. Highways that are classified as minor rural collectors or local roads are not eligible for ER funding even if other Federal-aid funds have been used on those roads. For example, "off system" bridges that were replaced with Federal-aid funds or non-highway projects that were constructed with enhancement funds are not eligible for ER funding. State roadway classification maps identify these routes and their designations.

It should also be noted that while DOTs are encouraged to access FHWA's online publication, "Guidance for the Functional Classification of Highways," which has descriptions of roadway functional classifications, it should conduct its own due diligence to verify its roadways are properly updated to reflect recent STIP work, and do the same for STIP and Transportation Improvement Plan (TIP) work for subrecipient local agencies.

Parameters for eligible work are defined by FHWA for its ER program (FHWA 2013) as,

> The ER program generally provides funding to repair and restore highway facilities to pre-disaster conditions. ER funds are not intended to replace other Federal-aid, State, or local funds for new construction, to correct non-disaster related deficiencies, or to otherwise improve highway facilities. By statute, ER funding is limited to the cost of repair or reconstruction of a comparable facility. A comparable facility is a facility that meets the current geometric and construction standards required for the types and volume of traffic that the facility will carry over its design life. While ER funds are primarily provided for repair activities following a disaster; design and construction of repairs should consider the long-term resilience of the facility.

The FHWA ER Manual (2013) goes on to state,

> Generally, all elements within the cross section of a highway that are damaged as a direct result of a disaster are eligible for repair under the ER program. This includes, but is not limited to, pavement, shoulders, slopes and embankments, guardrails, signs and traffic control devices, bridges, culverts, cribbing or other bank control features, bike and pedestrian path, fencing, and retaining walls. The repair of a pedestrian or bicycle trail inside the right-of-way of a Federal-aid highway is eligible for ER funding whether or not the roadway itself is damaged. The purpose of the ER program is to fund repairs to damaged roadways caused by a natural disaster or catastrophic failure from an external cause. ER funds are not intended to fund repairs of preexisting damage or non-disaster related damage, such as inherent deficient conditions.

The FHWA ER Manual (2013) should be referenced for eligible work concerning the treatment of engineering and ROW; indirect costs; detours and temporary substitute highway traffic service; traffic damage; overlays; raising grades including traditional flooding and basin flooding; slides; work on active construction projects; toll facilities; traffic control devices; landscaping; roadside appurtenances; timber and debris removal (including debris removal eligible for FEMA funding and debris removal by FHWA); transportation management strategies; projects and project features resulting from the NEPA process; outside of the highway ROW; administrative expenses; supplies and materials; equipment; and catastrophic failure from an external cause.

FEMA

FEMA applicants, including DOTs, must submit a request for public assistance for any categories of FEMA Public Assistance funds for which it may be eligible in counties where a Federal disaster has been declared. The process for applying for aid and submitting information on damaged eligible assets, and other key milestones, is time-bound. It makes sense for DOTs to coordinate with Public Assistance personnel at the state office of emergency management to develop an understanding of eligible work, and develop compliance and monitoring systems aligned to FEMA funding. As with any Federal agency, FEMA cannot provide duplication of benefits where funds for the same task are provided from any other federal organization, such as FHWA.

FEMA Public Assistance Emergency Protective Measures (Category and Category B work)

For DOTs, FEMA primarily funds debris removal following a Presidential disaster declaration designating support for Category A work under FEMA's Public Assistance Program. FEMA supports work under the Public Assistance Program under Category B Emergency Protective Measures for those measures where the DOT is eligible for FEMA Public Assistance Funding (e.g., installing security fencing or boarding up a disaster-damaged building until repairs are completed). FEMA will also consider supporting the proportion of incident command/EOC operations that are dedicated to eligible DOT emergency protective measures, including debris management, but scope and costs of this work must be clearly segregated from life-safety operations and rapid response operations performed with the support of FHWA ER funds.

FEMA Public Assistance Permanent Work (Category C-G)

FEMA supports a DOT's permanent buildings, parking lots, and other facilities such as maintenance sheds damaged by disaster for which permanent work is authorized by county specified within a Presidential disaster declaration.

There are limited additional circumstances where FEMA public assistance supports the restoration of post-disaster repair and recovery work for surface transportation networks where FHWA ER funding is prohibited. This issue is discussed further, below.

FEMA typically restores facilities to pre-disaster function and capacity. However, it has new rules concerning upgrades triggered by codes and standards. These rules support FEMA's Principles to:

- ✓ Increase Resiliency of Communities After a Disaster

- ✓ Protect Lives and Property, and
- ✓ Support the Efficient Use of Federal Dollars
- ✓ (FEMA. 2019b)

Section 406(e) of FEMA's Stafford Act now requires FEMA to fund repair, restoration, reconstruction, or replacement in conformity with "the latest published editions of relevant consensus-based codes, specifications, and standards that incorporate the latest hazard-resistant design and establish minimum acceptable criteria for the design, construction, and maintenance of residential structures and facilities that may be eligible for assistance under this Act for the purposes of protecting the health, safety, and general welfare of a facility's users against disasters." FEMA defines these requirements as follows:

> The purpose of the (FEMA) *Consensus-Based Codes, Specifications and Standards for Public Assistance, Recovery Interim Policy FP-104-009-11* (FEMA 2019b) is to define the framework and requirements for consistent and appropriate implementation of consensus-based design, construction and maintenance codes, specifications and standards (subsequently referred to as "consensus-based codes, specifications and standards" in this Policy) for Public Assistance (PA) to promote resiliency and achieve risk reduction under the authority of the Stafford Act Part 323… and 406(e) and 44 Code of Federal Regulations (CFR) Part 206, subpart M. These codes, specifications and standards only apply to repair and replacement of disaster damaged elements and facilities. Nothing in this Policy makes eligible the cost associated with ongoing operations and maintenance. This interim Policy supersedes *the Public Assistance Program and Policy Guide* (PAPPG) 1 subsection: FEMA Required Minimum Codes and Standards (FEMA 2019b).

When triggered in permanent work projects funded under the PA Program, FEMA will require DOTs and other eligible applicants to incorporate consensus-based codes, specifications, and standards in the planning, design, and delivery of eligible repair, replacement, or new construction projects. This includes relevant consensus-based codes, specifications, and standards to applicable infrastructure for all disasters declared after November 6, 2019. "Failure to include applicable codes, specifications and standards in eligible PA projects will result in denial or de-obligation of some or all of the projects funding" (FEMA 2019b).

For toll roads that remain in the control of the transportation agency, FHWA requires that all toll proceeds are reinvested in the asset on which tolls are collected. Where tolls are invested in additional assets outside of the roadway for which tolls are collected, FHWA ER eligibility is prohibited. However, those toll roads may be eligible under the FEMA public assistance program where stringent criteria are met. For example, disaster recovery funding for the MTA Bridges and Tunnels was supported through FEMA Public Assistance following Superstorm Sandy due to the use to support MTA Subways.

It is prudent for DOTs to garner concurrence from FHWA (or FEMA, where applicable) on toll roads that are operated as P3 ventures. Similar discussions should occur with FHWA concerning its ER program eligibility and FEMA as part of economic and revenue forecasting for potential toll roads and other revenue-generating ventures such as ferries being planned as P3 projects (e.g., those involving design, build, operate, and maintain agreements). In addition to engaging Federal partners, involve risk

management and legal counsel specifically to discuss force majeure clauses and all-hazards insurance requirements so those can dovetail to provide appropriate risk cover to the DOT.

FEMA Management Costs

In addition, FEMA awards management costs for F&A section activities related to establishing eligibility, grants management and compliance, and grants closeout on FEMA-related awards.

FEMA provides contributions for management costs that a Recipient or Subrecipient incurs in administering and managing PA awards. For Recipients, FEMA provides PA funding for management costs based on actual costs incurred up to 7 percent of the total award amount. For Subrecipients, FEMA provides PA funding for management costs based on actual costs incurred up to 5 percent of the Subrecipient's total award amount. Additional information is available in FEMA's interim policy, *FEMA Public Assistance Management Costs (Interim), Recovery Policy FP 104-11-2* (FEMA 2018b) and *FEMA Public Assistance Management Costs Standard Operating Procedures* (FEMA 2019a)"

FEMA Section 428 Alternate Procedures

Coming out of its pilot program status, FEMA has rolled out a new benefit to support resilience outcomes that are in the "best interest of the community." This policy allows for the flexible use of eligible funding for permanent repairs authorized under Public Assistance Alternative Procedures (Section 428) for FEMA's Public Assistance Program under sections 403(a)(3)(A), 406, 407 and 502(a)(5) of the Stafford Act. For example, for permanent work on eligible facilities, such as buildings and maintenance "sheds," FEMA and STTL governments can now agree on capped project values, but can use those funds in a flexible way, provided criteria are approved and met. FEMA's assessment process to evaluate disaster damages, scopes of work, and costs is based on actual direct disaster damages. However, STTL agencies can now request to use the FEMA Public Assistance funding for permanent work with greater flexibility to bounce forward when it is in the best interest of the community.

Another example includes a sewage treatment plant, which could change design and technologies used at the plant (e.g., add methane sequestration for energy conversion). Funding can be segmented or pooled across many projects. For example, in rebuilding schools post-Katrina, two FEMA grants (called project worksheets) captured $1.8 billion in funding, which funded new schools and historic rehabilitation of 89 schools in line with the School Facilities Master Plan for Orleans Parish. This eligibility was drawn from over 125 combined campuses.

DOTs may wish to employ stand-by contracts to support Federal grants management grant formulation, eligibility, and compliance support. Blue skies work under the contract can include developing compliance and document control policies and procedures; evaluating enterprise systems such as the system of record; business processes; pre-shock training; and just-in-time training; as well as exercises discussed in Section 4.1.

DHS Building Resilient Infrastructure and Communities

In September 2020, DHS rolled out its invitation to STTL governments to apply for a $.5 billion round of competitive resilience funding, and the program will be included in FEMA's suite of annual grant

awards to support pre-shock readiness and resilience. The BCA defined for BRIC is consistent with FEMA Hazard Mitigation Grant Program, and all mitigation projects must have a benefit-cost ratio of 1.0 or greater. According to the DHS *Notice of Funding Opportunity for FY2020* for BRIC, STTL governments may apply for funding for Capability and Capacity Building (C&CB) activities to "enhance the knowledge, skills, expertise, etc., of the current workforce to expand or improve the administration of mitigation assistance;" Mitigation Projects, which are "cost-effective projects designed to increase resilience and public safety; reduce injuries and loss of life; and reduce damage and destruction to property, critical services, facilities, and infrastructure." Management Costs for BRIC are also allowable. In addition, FEMA will provide direct technical assistance to communities to "build its capacity and capability to improve its resiliency to natural hazards and to ensure stakeholders are capable of building and sustaining successful mitigation programs, submitting high-quality applications, and implementing new and innovative projects that reduce risk from a wide range of natural hazards" (DHS 2020).

BRIC's guiding principles of the program are to:

(1) support state and local governments, tribes, and territories through capability- and capacity-building to enable them to identify mitigation actions and implement projects that reduce risks posed by natural hazards; (2) encourage and enable innovation while allowing flexibility, consistency, and effectiveness; (3) promote partnerships and enable high-impact investments to reduce risk from natural hazards with a focus on critical services and facilities, public infrastructure, public safety, public health, and communities; (4) provide a significant opportunity to reduce future losses and minimize impacts on the Disaster Relief Fund; and (5) support the adoption and enforcement of building codes, standards, and policies that will protect the health, safety, and general welfare of the public, take into account future conditions, and have long-lasting impacts on community risk reduction, including for critical services and facilities and for future disaster costs (DHS 2020).FEMA published a user guide for STTL governments to share promising practices and case studies in resiliency. The *FEMA Hazard Mitigation Action Portfolio* provides an interactive guide with over 100 case study vignettes. The dynamic format is accessible and provides information on the case study, its primary resiliency achievement, identifies primary hazards, and community lifelines. It best accessed in electronic format via the following URL:https://www.fema.gov/sites/default/files/2020-08/fema_mitigation-action-portfolio-support-document_08-01-2020_0.pdf (FEMA 2020e).

CDBG-DR. When appropriated by Congress, HUD awards Community Development Block Grant – Disaster Recovery (CDBG-DR) funding, which is widely known for housing recovery. However, CDBG-DR can be appropriated for strategic infrastructure investments to support HUD's anti-poverty mission following disaster. Unlike FHWA and FEMA funding, the work is not predicated on disaster damaged elements, so community benefit is the primary driver for investment decisions when aligned to certain stringent grant requirements, heavily informed by income and poverty rates by county. While DOTs are not typically the lead agencies on these CDBG-DR infrastructure awards following concurrent, regional disasters, DOTs can meaningfully contribute planning for the state's most pressing infrastructure needs.

Policy Alignment. While winning new funding is always a key target of opportunity, DOTs are increasingly expected to whether economic—as well as weather-related—storms. That creates opportunities for innovation, and transportation professionals are advised to work with STTL agency partners on doing more, together, with less; or simply amplifying the power of joint resilience investments. That can take a number of forms, such as:

- ✓ Collaborate or support other STTL organizations pursuing funding for resilience initiatives that support a larger agenda (e.g., allow transportation planners or other resilience and sustainability staff to provide proposal feedback, write a letter of support from the DOT).
- ✓ Meet with STTL partners that make funding and project awards and agree on key language or definitions, starting with the definitions of resilience and adaptation. For example, in the Miami Metro Area, over 120 local government entities agreed on using standard 2060 sea-level rise projections so goals and actions can be focused on the 1.5 feet of rising waters anticipated; this way, everyone moves together on major goals to attenuate risk, rather than arguing over the exact level of rising waters.
- ✓ Require benefit-cost analyses findings to be included in proposals to the DOT for projects/funding to promote quantification and/or validation of proposed resilience benefits.
- ✓ Add resilience and triple-bottom-line co-benefits goals as part of scoring criteria on grant funding and project awards.
- ✓ Working with STTL agencies to harmonize scope and timelines of awards that can be aligned to increase resilience and triple-bottom-line co-benefits to help applicants access funding to support full project costs.
- ✓ Allow STTL government-to-government match on resilience projects.

4.7.2 Innovative Financing Tools Summary

Innovative financing is quickly becoming an integral part of the state and local government agency toolkit in attenuating risks as a companion to resilience and mitigation investments in physical assets. One innovative finance tool rapidly gaining momentum is parametric insurance. This section provides introductory information about parametric insurance, as well as other innovative financing instruments, and points the user to resources.

In the survey of disaster practitioners, almost three-quarters of respondents reported that state and local governments are underinsured. The survey also cited inadequate insurance coverage by STTL agencies. See Figure 4-14, below.

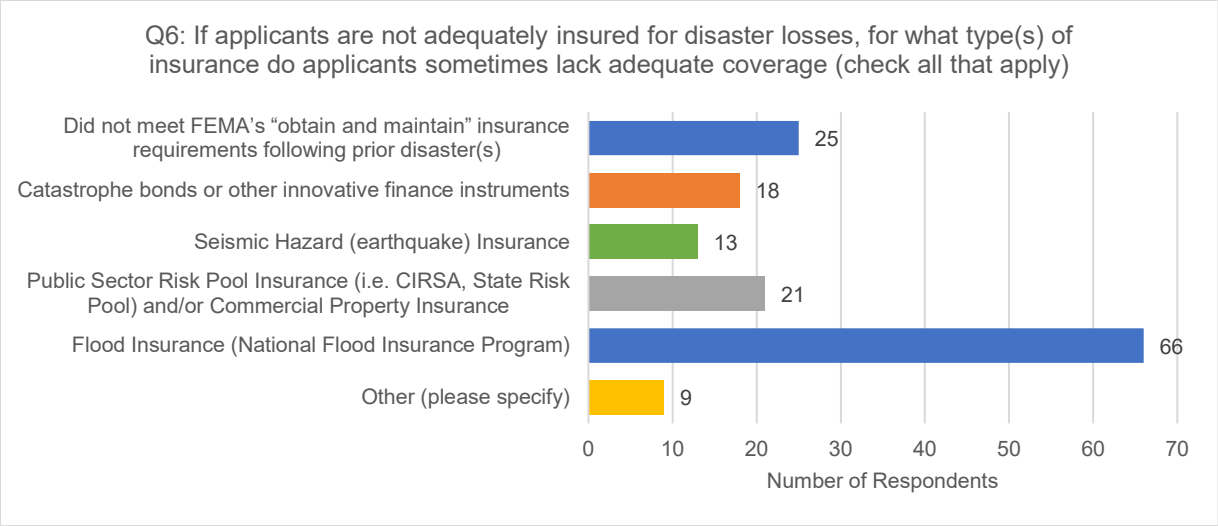


Figure 4-14: NCHRP 08-107 survey question 6 (graph, AECOM)

Figure 4-15 shows a mix of resources and risk transfer instruments that support a government's capability to service its debts and obligations. Innovative financing tools are now becoming included in the toolkit of instruments available to governments when tackling the complex demands facing communities around resilience and climate adaptation, among other hazards. Not surprisingly, vendors in the marketplace or otherwise involved in opportunities offered through innovative financing tools are out in front with information. Materials presented in this section come from three vendors that are associated with these tools, along with social sector organizations such as Pew and the Nature Conservancy.

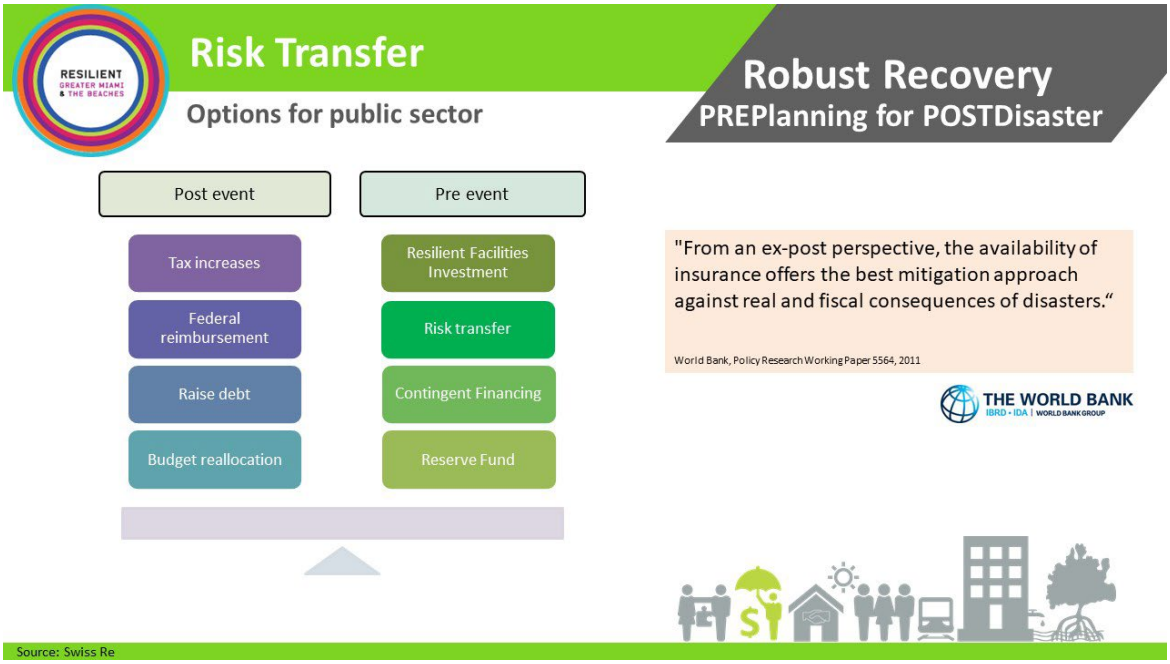


Figure 4-15: Public Sector Options on risk Transfer

As part of a full-day symposium, the Greater Miami and the Beaches network, Resilient 305 hosted a session on disaster funding and innovative financing, including parametric insurance. A team of practitioners presented materials shown in an excerpt reflected in Figure 4-16 through Figure 4-18. The City of Miami Beach is generally regarded as the first local government in the nation to use parametric insurance to help manage risks. It initially used the insurance for a narrowly defined set of risks and triggers involving potential tourism losses associated with the mosquito-borne illness, Zika. In the City's case, it was at risk of losing revenue even if there was not an outbreak of the illness, but a threat alone is adequate to cause widespread vacation cancellations. This test use of parametric insurance resulted in expanded consideration of parametric insurance for other triggers such as tropical threats. Resilient 305 symposium provided a forum to provide peer-to-peer exchange and understanding. A couple of the most compelling aspects of parametric insurance is that payouts occur based on pre-agreed triggers—irrespective of disaster damages—and are made within days or weeks.

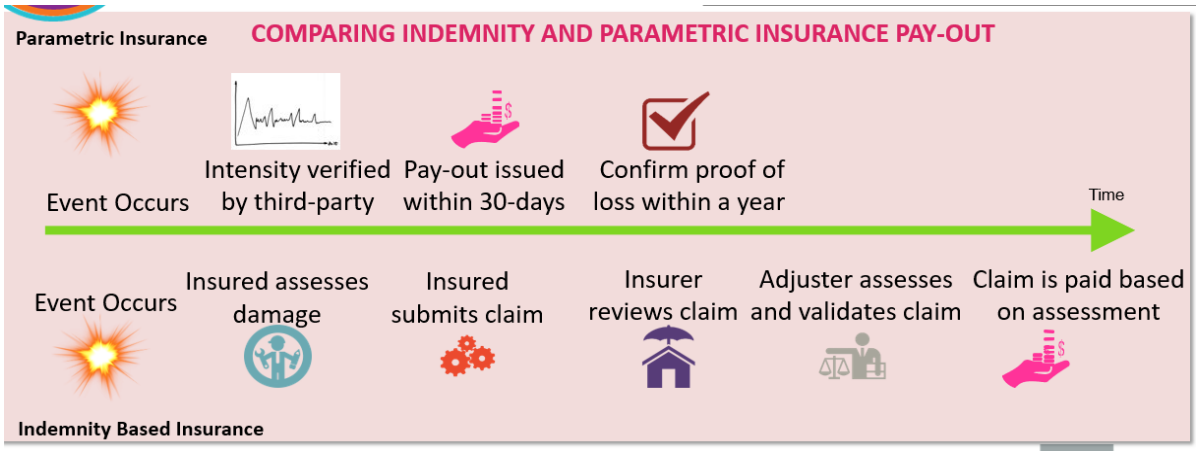


Figure 4-16: Comparison of traditional and parametric insurance policies payouts

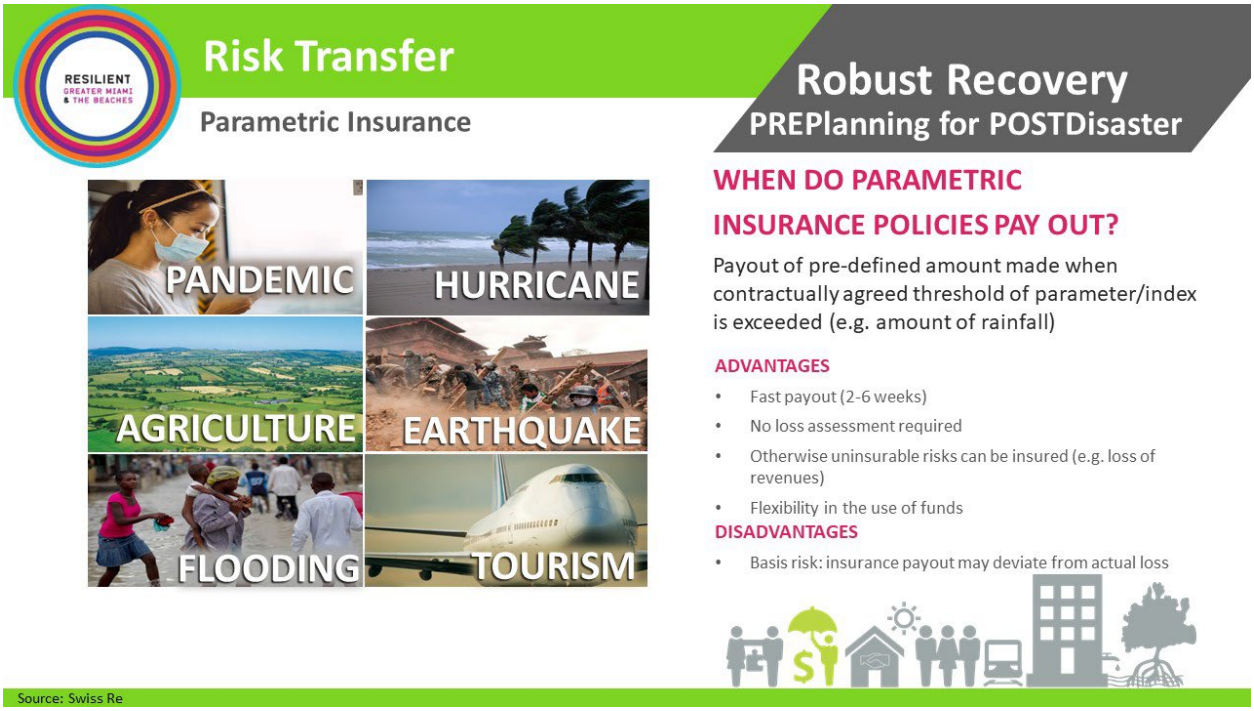


Figure 4-17: Outlines advantages and disadvantages of parametric insurance

Marsh and McLennan also published, Parametric Insurance: A Tool to Increase Climate Resilience. It states,

> Parametric covers are alternative risk solutions provided by insurance and reinsurance companies that enable organizations to finance or to transfer risk in a non-traditional way. The solutions revolve around a measurable index, and are based on predefined triggers or pay-out mechanisms—without necessarily needing physical damage to occur. As climate-related weather risks become increasingly complex and unpredictable, the requests for such innovative parametric insurance structures have been increasing.
>
> Parametric insurance (for a definition, see Exhibit 1), also known as index-based cover, is gaining traction, especially for weather-related events. Hazard modeling continues to improve, while weather stations and satellites capture more accurately weather-related parameters. Improved data and models enable parametric cover as an increasingly efficient, affordable, and viable option in the market (Markovic and Harry 2019).

Figure 4-18 summarizes the answer to the question: How does parametric insurance work? The full document, referenced above, can be found at the following link: https://www.mmc.com/insights/publications/2018/dec/parametric-insurance-tool-to-increase-climate-resilience.html.

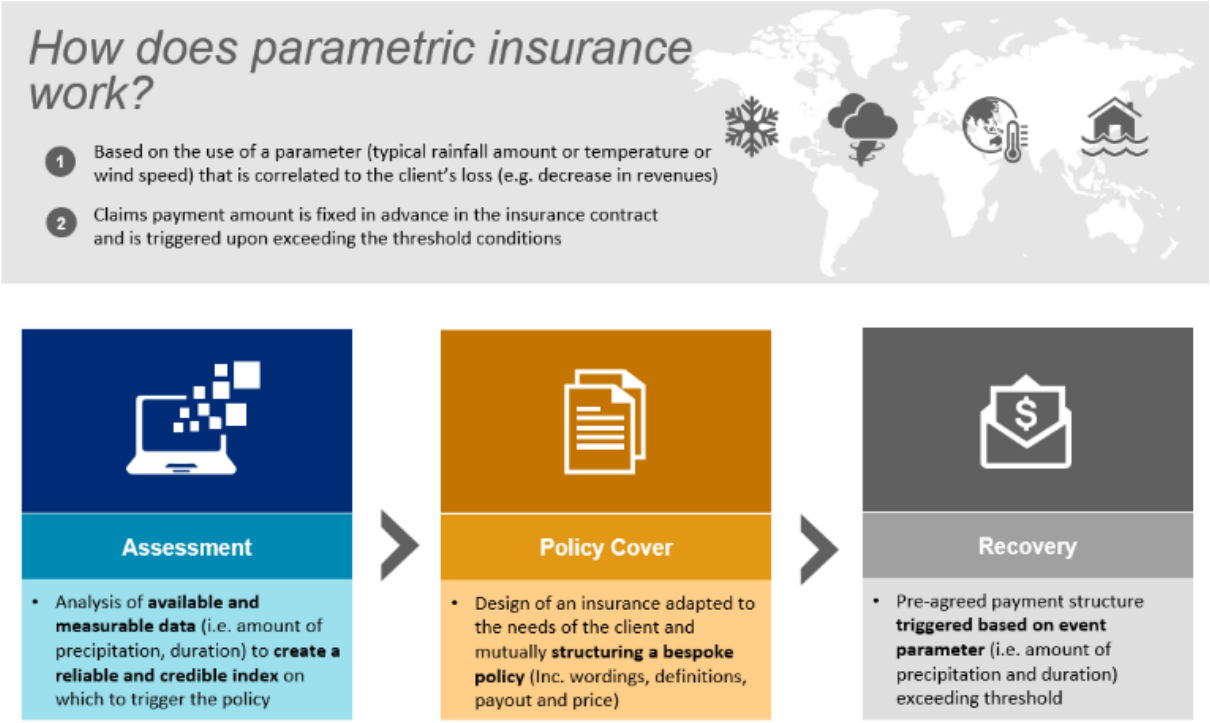


Figure 4-18: How does parametric insurance work?

While parametric insurance continues to garner close attention, many state and local governments are only now beginning to consider the full range of innovative financing tools. The Nature Conservancy published a resource on innovative finance options targeted for coastal communities and supported through the UN Development Programme for Environment and Climate Change Canada. Figure 4-19 provides a good overview of many of the most popular innovative finance mechanisms for disaster resilience and climate adaptation. See link for the full report: https://www.nature.org/content/dam/tnc/nature/en/documents/Innovative_Finance_Resilient_Coasts_and_Communities.pdf.

INNOVATION	PROBLEM ADDRESSED	KEY STAKEHOLDERS	POTENTIAL SCALABILITY
Nature-based insurance	Provides immediate funding for post-storm restoration of the protective functions of coral reefs.	Local governments, local private sector, insurance companies.	Based on Mexico pilot, scalable to at least 10 countries providing coverage protecting millions of people and billions of dollars in built assets; scalable to other forms of natural capital beyond coral reefs.
Regional Risk Pools for SIDS and vulnerable coastal states	Reduces the insurance premium costs for sovereign risk insurance against catastrophes.	SIDS governments, multilateral agencies, insurance industry.	Expand the number of countries: currently cover 18 out of 37 SIDS. Expand the model of "Contingency Plans" to facilitate disaster recovery and risk reduction in the case of exceptional risks. Develop more sector-specific products, esp. for fisheries and utilities.
Green / Blue Bonds	Provides up-front capital for investment in coastal resilience, contingent on some cash flow to repay private investors.	Large and small project developers, large and small financial institutions and insurance companies, backstopping governments and donors.	Green bond issuances have reached a USD 156b in 2017 but very little use of proceeds tied to coastal resilience. Blue bonds and resilience bonds are still nascent. Opportunity for growth by: having a clear use of proceeds agreed from development finance institutions for blended finance for coastal resilience; development of pay-for-performance impact bond stuctures linked to disaster insurance.
Resilience Bonds	Provides an investible debt instrument for resilience, offsetting municipal or national budget shortfalls.	Local governments (municipalities), private sector (infrastructure investors).	Scalability is significant but tied to local circumstances: these target infrastructure shortfalls in a given geography that lack public funding but provide resilience for the community against disasters (i.e. a seawall) and whose cost savings accrued (from less damage due to the building of the infrastructure) can be modelled before investment.
Debt Restructuring	Provides annual cash flow through a trust fund mechanism for investments in coastal resilience, and provides additional fiscal space for indebted countries.	National governments (mainly SIDS), public and/or private lenders, local stakeholders.	Scalable from a USD 22m innovation in the Seychelles to, potentially, approx. USD 2b in restructurable debt across perhaps a dozen SIDS, and then billions more for developing coastal states. Seychelles experience also shows the potential to link debt restructuring, sovereign bonds, and trust funds.

Figure 4-19: Summary of innovative Financing Mechanisms

RMS, known for its place in the catastrophe reinsurance market, presents the following vignettes or use cases to promote understanding on different innovative financing tools such as insurance-linked loans, resilience impact bonds, resilience bonds, and Resilience-Service Company (ReSCO) products.

Insure Resilience: Innovation in Financing Resilient Infrastructure

Insurance-linked Loan Package

- **Product:** Embedded insurance component within the concessional loan products offered by international financial institutions to finance new or upgraded infrastructure.
- **Mechanism:** A portion of the loan amount is allocated to a resilience fund to cover the future costs of insurance. If a resilience-based design option is chosen, future insurance savings arising from the associated risk reduction would be transferred to the financing part of the loan. This model is predicated upon the take-out of insurance, but where the savings in insurance offset or partially offset the additional cost of building resiliently. The resilience fund itself could be a trust fund or special purpose vehicle and its purpose could be extended to cover maintenance costs.
- **Use Case:** Large infrastructure projects in high-risk regions where there is a need to consider both the long-term financial and physical resilience of the assets.

Resilience Impact Bond

- **Product:** Pay-for-performance model which has been used successfully in social impact bonds and development impact bond models, adapted to achieve key resilience objectives.
- **Mechanism:** An impact investor supplies the project capital, carries out the project through an implementation agent, and receives an RoI determined by the success of the contract. Success is measured by pre-defined criteria and assessed by an "outcomes funder," who repays the initial capital outlay and provides the performance-linked return. The outcomes funder can ensure they are paying for results against a set of physical, operational, and financial resilience objectives. Such a project could be the reconstruction or retrofit of a portfolio of schools. Criteria can be measurable outcomes such as the number of days of service interruption, or based on action-based outputs such as the creation of a robust emergency preparedness plan.
- **Use Case:** Likely to work best at scale due to transaction costs and when an outcomes funder is motivated to be able to incentivize and monitor the positive impact of investments.

Resilience Bond

- **Product:** Concept developed by Re:Focus Partners as part of the RE.Bound Program and further adapted for a development setting. Based on the catastrophe bond, an instrument that transfers risk from a sponsor/risk holder to a set of investors, with savings made as resilience investments are completed.
- **Mechanism:** The bond principal, paid by investors, is placed into a special purpose vehicle, and in the absence of a pre-defined catastrophic event, investors receive coupon payments and the

return of the bond principal at maturity. If a triggering event occurs, the bond principal can be used to cover disaster losses and/or provide rapid funding for emergency response. The resilience bond aligns this structure with planned resilience projects and allows for a variable coupon that is reduced as resilience measures are implemented. The generated savings can be ring-fenced for future project financing. In the development context, stakeholders with an interest in reducing future disaster losses could form a sponsoring consortium, aligning private, public and development interests.

- **Use Case:** Large-scale resilience interventions where multiple stakeholders can benefit from the lower risk environment.

Resilience-Service Company (ReSCO) Products

- **Product:** Concept inspired by the energy service company (ESCO) where the company, a non-profit or commercial venture, designs and implements an energy saving project for a home or business, and then receives the benefit of the reduction in energy cost to repay the initial outlay. In the case of the ReSCO, the company would carry out a retrofit to a building and receive the savings in insurance premium resulting from the lowered risk.
- **Mechanism:** The resilience dividend is monetized through the insurance savings and the asset owner benefits by a reduction or removal of upfront costs, with the resilience dividend transferred to an entity that is willing to wait to recoup their investment.
- **Use Case:** ReSCO relies upon securing risk-linked reductions in premium in a predictable fashion, and is likely best suited to scalable projects such as home retrofits where a significant saving can be achieved with a low-cost intervention (Acton, 2019).

The Pew Charitable Trusts published the following examples of communities pursing risk reduction in its article, "Vulnerable Communities Are Using Innovative Financing to Prepare for Natural Disasters," which presents the following examples of communities pursuing innovative financing tools.

- **The District of Columbia Water and Sewer Authority issued the Nation's first environmental impact bond**, a partnership using money from a range of investors to finance green infrastructure to help reduce flood risk. Proceeds from the $25 million tax-exempt bond will be used to construct projects that mimic natural processes to slow stormwater surges from heavy rainfall. The cost of installing the infrastructure is paid by the utility, but the performance risk of managing stormwater runoff is shared by the authority and its investors.
- **Nonprofit group piloted insurance and long-term loans in coastal South.** MyStrongHome, a nonprofit focused on making communities stronger, is lending homeowners in coastal areas the upfront cost of meeting standards developed by the insurance industry for home risk-mitigation activities. These include enhanced roof deck attachments, sealed roof decks, high-wind-rated roof coverings, gable end-wall bracing, and opening protection systems. Homeowners have five years to repay the loan, using savings from reduced insurance premiums because of the decreased risk to their structures. Piloted in Alabama, South Carolina, and Louisiana, the program is expanding to other areas at risk of hurricanes. MyStrongHome is not alone; Zurich

Insurance Group also endorsed the concept of coupling savings on insurance premiums with long-term loans tied to the property.

- **Charlotte-Mecklenburg County, North Carolina, funds buyouts through stormwater fees.** Stormwater fees are being levied to fund the relocation of houses, apartment buildings, and businesses located in flood-prone areas in Charlotte-Mecklenburg County. The program includes "orphan buyouts" for homes or buildings next to properties that qualify for Federal buyouts. The goal is to encourage the last homeowners living in a high-risk area to move so roads can be removed and the site can be restored to its natural function as a flood plain. More than 400 flood-prone houses have been purchased, and more than 600 families no longer reside in high-risk areas (Lightbody, 2016).

While the still-nascent market for innovative financial tools has great potential when used as part of a diverse mix of risk attention strategies, it is important for transportation professionals to be alert to challenges that may not be in plain sight when entering into agreements for innovative financial instruments. For example, analysis and consultation need to occur with Federal disaster funders such as FHWA and FEMA. FEMA funding, for example, is last dollar funding (as is the case with number of Federal funding sources).

That means that if a government agency benefits financially through payouts of innovative financing instruments on work that would otherwise have been eligible for disaster funding such as FEMA Public Assistance funds, those proceeds can be expected to be treated just like private insurance. With private insurance, the value of the payout would be equal to reductions in eligible Federal dollars. Since vendors in the market are not conversant in Federal disaster law, regulations, and policies, it is critical that agreements are vetted with appropriate technical expertise to help an agency weight a full picture of costs and benefits. Also, because there is inadequate history on which to rely when assessing Federal treatment of these policies (and associated financial proceeds) relative to eligible disaster work and funding, the best path includes full transparency with Federal partners—in advance, with agreements/concurrence in writing to whatever extent the Federal partner will allow.

4.8 Other Relevant Considerations

- ✓ Social Dimensions of Readiness;
- ✓ Cyber Incidents;
- ✓ Pandemics and COVID-19; and
- ✓ Resilience and Climate Adaptation.

Although there are many diverse issues to consider in relation to concurrent, regional emergencies and disasters, the applied research focuses on three of the most pressing areas for DOTs, including the social dimensions of readiness, implications of pandemics—specifically COVID-19, and resilience and climate adaptation. Grounding concepts are presented, and users are directed to resources that will aid their understanding of the respective issues for DOTs. In keeping with the goals of this applied research, the issues are considered through the lens of administrative controls to access reliable guidance and

information on complex and complicated issues, and promote high-quality project delivery outcomes, agency risk attenuation, and/or opportunities for time and cost savings. Layered within each of these three relevant considerations is the opportunity to leverage co-benefits for people and communities, environmental sustainability, and economic stability and growth.

4.8.1 Social Dimensions of Readiness

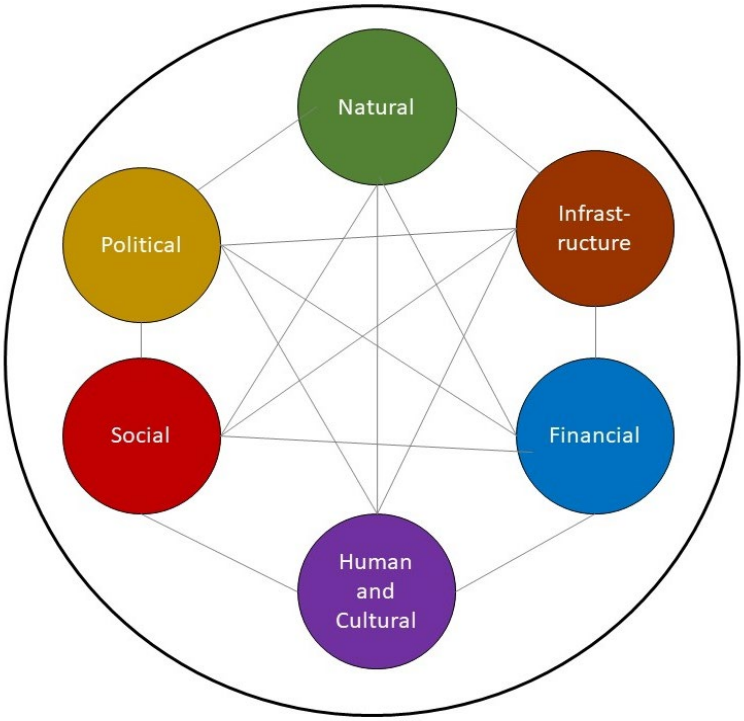
Social dimensions of readiness and resilience (as listed below) cut across a number of the critical issue areas presented in this applied research. Decisions involving the social dimensions of disaster are usually key areas of focus while incidents are being managed due to imminent risks to life and safety (e.g., evacuation, emergency road closures, getting roadways passable for emergency management service vehicles). After the immediate crisis has passed, there is wide inconsistency in addressing transportation-related community needs before and after disaster. Failing to include community data and social dimensions in decisions creates both immediate-term and long-term opportunity costs felt by the community long after the event has passed.

- ✓ **Natural (or environmental):** The natural resources base or environmental conditions within communities. This includes air, land, water, mineral resources, stability and health of ecosystems, natural land cover, and/or indicators of environmental quality.
- ✓ **Built (infrastructure):** The buildings and infrastructure systems within communities. This includes critical response support facilities, residential housing, schools, commercial and industrial buildings, and supporting infrastructure, such as power, transportation, bridges, roads, communication, water, and wastewater.
- ✓ **Financial (economic):** The totality of economic assets and livelihoods in a community. This includes income levels, personal wealth, income equality, overall employment rates, sector-specific employment, and business size and diversity.
- ✓ **Human and cultural:** Demographic characteristics, knowledge, skills, health, and physical abilities of community members including language competencies, cultural symbols, and belief systems. Some specific examples are educational levels, age distributions, health insurance, access to medical and mental health services, food security, special needs populations, and access to transportation and communication services.
- ✓ **Social:** The social networks and connectivity among groups and individuals within a community. This includes levels of trust and reciprocity, political engagement, length of residence, volunteerism, religious affiliation, and community organizations and services. Also included is the feeling of belonging to and a sense of place about the community.
- ✓ **Political (institutional or governance):** Access to resources and the ability/power to influence their distribution as well as the ability to engage external (to the community) entities in efforts to achieve community goals. This includes disaster insurance coverage (e.g., flood, crop), jurisdictional coordination or fragmentation, disaster experience in response and recovery, mitigation spending, and emergency management capacities.

As DOTs and MPOs identify strategies and tactics during all phases of resilience, including readiness, rapid response, and resilient recovery, they must create space to understand, plan for, and respond to social dimensions that affect community life, in general, and the needs of vulnerable populations, specifically.

What happens when good data on social dimensions drives decision-making, and how is that accomplished in relation to this applied research? This section focuses how social dimensions crosscut the resilience lifecycle. It also shows how readiness work focused on the social dimensions of a disaster enhances a DOT's common operating picture. When social data collected during the readiness phase help shape post-disaster decisions, it leads to more robust outcomes during rapid response operations and durable community benefits when incorporated into resilient recovery plans. The community must be a key component of readiness discussions and considerations.

Any given community has many forms of capital, also referred to as assets or resources. According to a 2019 National Academies Consensus Study Report on measures and metrics of community resilience (NASEM 2019), six types of capital are at work in communities—natural (environmental), built (infrastructure), financial (economic), human and cultural, social, and political (institutional or governance). These are described below and shown in Figure 4-20.



Source: (NASEM 2019)

Figure 4-20: The multidimensional nature and interconnectedness of community capitals (NASEM 2019)

In the context of social aspects of contracting, there are a number of advantages to planning. As outlined in the NIST)2016 *Community Resilience Planning Guide*, these advantages include the following suite of benefits: (a) to create situational awareness and to understand social vulnerability and resilience; (b) to

enhance relationship building and increase knowledge about the key actors in the community and region (who they are and their capacities); and (c) to be in a position to integrate with Incident Command System.

Just as community leaders and decision makers need to understand the strengths and vulnerabilities of their transportation system (and other forms of capital), they also need to understand the capacities and vulnerabilities regarding the social environment of their community. The increasing impacts of disasters, caused by more frequent extreme events coupled with the growth of adverse anthropogenic activities, has raised the importance of fostering more resilient communities.

Measuring resilience is a vital step in the process of building and strengthening a community's resilience, because it helps with identifying the priorities and monitoring the progress. Searching the literature through content analysis and applying three selection criteria resulted in a list of 149 variables. These criteria required the variables to be influential on disaster resilience of households; to be quantitatively measurable; and to be obtainable from publicly available data sources. Additionally, a selection of resilience and vulnerability assessment models suggested in the literature were reviewed to highlight the importance of resilience variables in addressing their planned objectives. The variables were classified into five categories titled demographic, socioeconomic, infrastructural, environmental, and institutional. Further analysis led to identification of the most prevalent variables and commonalities among the categories, aimed to provide a more integrated approach toward resilience planning. This research can serve as an initial yet relatively extensive inventory for selecting variables that are deemed to be influential on households' resilience to extreme events. Further, quantifying a community's resilience using resilience variables can help with identifying and prioritizing the resilience needs, monitoring the progress, and justifying the costs of resilience programs (Moradi et al. 2019). In the context of planning, doing so involves a series of steps to identify social vulnerabilities, as described in NIST's *Community Resilience Planning Guide* (CRPG) (NIST 2016). Among these are prioritizing human needs, and assessing hazards and mitigating risks to continually improve readiness efforts and to develop emergency plans.

For example, the 2020 COVID-19 pandemic brought to light the magnitude of vulnerabilities facing low-income workers. The US recorded over 30 million unemployment claims without counting those workers who have taken salary reductions and non-exempt workers who have lost scheduled work hours. Millions have lost access to health insurance. Disparities are reported by the University of California, Davis' (UC Davis's) Institute of Transportation Studies in the *Impacts of the COVID-19 Pandemic on Transportation Use: Updates from UC Davis Behavioral Study* (Circella and Dominguez-Faus 2020). The study identified income disparities related to telecommuting prior to the pandemic. It found that only 8% of study respondents telecommuted every day prior to the pandemic; that figure shifted to 20% for low-income study participants after the pandemic, and grew to 50% for the high-income participants. The study states:

> These numbers add up to the already unequal impacts on employment, as low income workers more often report that they have lost their jobs or have been furloughed without pay during the pandemic. The differences are even starker if we compare occupations.

> The adoption of telecommuting has increased by nearly four times for white collar workers but has remained unchanged for blue collar workers. Lower income workers are also more concerned about the economic impact of the pandemic than about its health impact, an additional indicator of the difficult challenges facing low income workers (Circella and Dominguez 2020).

Characterizing the population can be accomplished by reaching out to local and regional entities such as city or county planning departments that are resourced with expertise in accessing, providing, and interpreting social and economic data. Additional resources include local area institutes of higher learning (e.g., departments of business, economics, geography, planning, political science, public administration, and sociology in universities and community colleges); research centers; chambers of commerce; consulting firms; and other organizations with data and analysis capacities that likely have a vested interest in supporting readiness. Examples of questions to ask about your community during readiness are provided in the box below.

4.8.1.1 Community Readiness Planning

There are a number of steps in readiness planning. As highlighted in NIST's CRPG (NIST 2016), the first is to characterize the population within the area where planning is taking place. This step involves using data—including local knowledge—to systematically describe a community and those who live there. These data are needed so that planners can better understand where vulnerable populations are, such as those with low income, older adults, renters, individuals who do not speak or read English, and those with limited transportation options (NIST 2016). With respect to transportation planning, a key question to keep in mind here is whether there are concentrations of populations that are more vulnerable because of their physical locations? For example, those who do not have adequate access to transportation, or those who rely primarily on public transit.

Questions to Ask About Your Community During Readiness

1. Are there geographic concentrations of vulnerable populations in the community, such as low income households, older adults (ages 65+), individuals living with disabilities, and others? If so, where are these populations located? How might their locations further increase their vulnerabilities in the event of a disaster?
2. Are there substantial numbers of non-English speaking populations in the community? If so, are they geographically concentrated in specific areas of the community?
3. To what extent do residents have access to transportation (public or otherwise) in an emergency? Are there geographic concentrations of populations without the ability to evacuate in the event of a disaster? What is the proportion of transit-dependent people?
4. Are key businesses and industries located in hazard-prone areas in the community? What transportation routes are critical for response and recovery efforts?
5. Are health care facilities, including hospitals, urgent care facilities, dialysis treatment facilities, and residential care facilities located in hazard-prone areas in the community? What transportation routes are critical for response and recovery efforts?
6. How can information about the community's social dimensions, including social capital, be leveraged or used in the context of planning for transportation needs and mitigation efforts?

2016 NIST Special Publication 1190GB1:4

4.8.1.2 Social Indicators and Data

As described in NIST's approach to planning for community resilience (2016 NIST Special Publication 1190GB1:2), there are a number of indicators that should be included in characterizing the population. Among these are population demographics (e.g., age, health, education, income, employment status, language); economic indicators (e.g., industries present in the community, primary types of employment); more specific indicators of social vulnerabilities (e.g., mobility issues, renting, living or working in hazard-prone areas); and other measures associated with resilience (e.g., social capital). Examples of indicators are presented in Table 4-1 below. Later in the process, these data can be linked to geographic locations, and more importantly, to different aspects of the transportation infrastructure and other elements of the built environment, to present a more complete overview of the community. This process allows planners to more easily identify spatial trends and relationships between the social and built environments—and to see where vulnerabilities, as well as strengths, might be in the community.

Table 4-1: Examples of Social Indicators to Understand Communities during Readiness

Demographic Indicators
% household income under $35,000
% household income over $100,000
Median household income (dollar amount)
Number of owner-occupied housing units per some number (e.g., 1,000/10,000)
Ratio of Transfer Payments* to Earned Income
Households receiving Food Stamp/SNAP benefits (%)
Unemployment rate

Demographic Indicators
Poverty rate
% population without health insurance
% population (25 +) with high school diploma or equivalent
% population (25 +) with four year degree or higher
% population below 18 years
% population 65 years of age or above
% female
% population with disabilities
% population that is linguistically isolated (non-English-speaking)
% households with telephone service available
% households with at least one vehicle
Violent crime rate
Life expectancy
Number or percent of school-age children on free and reduced price lunch
Economic Indicators
Major and minor industries by type (list and %)
Major and minor businesses by type (list and %)
Occupations by type (list and %)
Owner-occupied housing units (%)
Employment/Unemployment rates (%)
Federal employment (%)
Employees not in farming, fishing, forestry, extractive industry, or tourism (%)
Gender income equality
Race/ethnicity income equality (negative Gini coefficient)
Ratio of large to small businesses
Large retail stores per 10,000 persons (#)
Licensing boards (#)
Labor unions (#)
Employment agencies (#)
Employment/career centers (#)
Professional associations (#)
Social Capital Indicators
Number of civic organizations and political organizations per some number (e.g., 1,000/10,000)
Number of registered non-profit organizations per some number (e.g., 1,000/10,000)
Number of non-profit organizations per some number (e.g., 1,000/10,000)
Number of religious adherents per some number (e.g., 1,000/10,000)
Number of religious organizations per some number (e.g., 1,000/10,000)

Demographic Indicators
Number of recreational centers (bowling centers, fitness centers), golf clubs, sports organizations
Number of arts and cultural centers per some number (e.g., 1,000/10,000)
Number of professional and business associations per some number (e.g., 1,000/10,000)
Number of registered voters per some number (e.g., 1,000/10,000)
Percentage of registered voter turnout in presidential elections
Net migration rate per some number (e.g., 1,000/10,000)
US Census response rates for the decennial (2000) population and housing survey
Number of owner-occupied housing units per some number (e.g., 1,000/10,000)
Property crime rate

In most cases, the basic data needed to characterize the population are available online, at no cost to users, through the U.S. Census Bureau (http://www.census.gov/). Additional sources of data that might be useful in the process include, but are not limited to the Bureau of Economic Analysis, Centers for Medicare and Medicaid Services, Department of Housing and Urban Development, Department of Justice, Health Resources and Services Administration, Institute of Health Metrics and Evaluation, and the Internal Revenue Service.

Example Sources for Social Indicator Data

- ✓ Bureau of Economic Analysis http://bea.gov/
- ✓ Centers for Medicare and Medicaid Services https://www.cms.gov/
- ✓ Department of Housing and Urban Development http://portal.hud.gov/hudportal/HUD
- ✓ Department of Justice https://www.justice.gov/
- ✓ Health Resources and Services Administration http://www.hrsa.gov/
- ✓ Institute of Health Metrics and Evaluation http://www.healthdata.org/
- ✓ Internal Revenue Service https://www.irs.gov/
- ✓ U.S. Census Bureau, American Community Survey https://www.census.gov/programs-surveys/acs/
- ✓ U.S. Religion Census http://www.rcms2010.org/

4.8.1.3 Vulnerability and Resilience

Additional terms that are applicable to understanding the importance of social dimensions in transportation planning are vulnerability and resilience. These are discrete but overlapping concepts. Vulnerability is the potential for loss, which includes physical, social, economic, and environmental factors (Moradi et al. 2019). Understanding a given community's vulnerabilities is key to planning for both the readiness and rapid response phases across the critical issue areas.

Knowing about ways in which communities exhibit resilience or—in this case, capacities—is essential to each of the three phases of planning for readiness, rapid response, and resilient recovery. There are four physical and social dimensions of resilience that must be considered in terms of planning (Cutter and Derakhshan 2018; Moradi et al. 2019):

- ✓ Ability of critical infrastructure to quickly recover from impacts;

- ✓ Ability of buildings and other structures to resist disasters;
- ✓ Social factors that improve or restrain recovery, such as an array of socioeconomic features or availability of recovery workforce; and
- ✓ Special needs related to minority status, mobility, and health status.

The latter two, especially, are the focus of social dimensions that need to be included in readiness planning.

The best opportunities to support social factors in concurrent, regional emergencies and disasters is to engage with community leadership and residents in a region prior to a shock event. Regardless of whether this occurs, there is never a wrong time in the resilience lifecycle to understand social dimensions and meaningfully engage in delivering solutions that bring the greatest value. This is particularly true because evidence consistently shows that vulnerable communities consistently experience disproportionate burdens following shocks, and the body of social research in disasters tells us that those impacts are amplified in concurrent, regional emergencies and disasters.

4.8.2 Cyber Incidents

Despite the decades of warnings on cyber-attacks and their impacts on most Americans through the loss of personally protected information on organizations ranging from Wall Street banks to Paypal to DHS have not resulted in the robustness and deft skill necessary to get ahead of private and state-sponsored attackers. On September 7, 2017, *The New York Times* reported:

> Equifax, one of the nation's big three credit bureaus, said … 143 million Americans were potentially affected by a cybersecurity incident. The hackers gained unauthorized access to certain personal information, including names, Social Security numbers, birth dates, addresses and, in some cases, driver's license numbers. Credit card numbers for some 209,000 consumers were also accessed (Bernard et al. 2017).

The article went on to quote Equifax CEO, Richard Smith, "This is clearly a disappointing event for our company, and one that strikes at the heart of who we are and what we do" (Bernard et al. 2017).

In fact, following a lack of effective response to its cyber-attack reported in September 2017, which exposed sensitive data of over one-third of the U.S. population, Equifax has the ignominious distinction of being the first firm to see its outlook downgraded by Moody's in 2019 (O'Flaherty 2019).

This has implications for DOTs and other transportation agencies whose access to capital markets includes state and municipal bonds and secondary markets such as catastrophe bonds, and where ratings could be affected similar risk assessments.

> *"We are treating this with more significance because it is the first time that cyber has been a named factor in an outlook change…This is the first time the fallout from a breach has moved the needle enough to contribute to the change."*
>
> *– Joe Mielenhausen, a spokesperson for Moody's*
>
> *Source: O'Flaherty 2019*

Both before and after the Equifax breach, Paypal reported cyber-attacks, including one to its TIO Networks holdings that compromised personally identifiable information of over 1.6 million customers, and intelligence reported in January 2020 by Forbes indicates that Paypal and other Fortune 200 firms are at risk of cyber threats involving "phishing kits" and "as-a-service" products that make phishing attacks accessible to the non-tech-savvy attacker.

These massive breaches speak to the fact that even when powered by best-in-class cyber-security professionals, avoidance of diverse, sophisticated cyber-attacks is increasingly difficult. Fortunately, few transportation agencies have reported major cyber incidents.

Nevertheless, *The Philadelphia Examiner* reported that the Southeastern Pennsylvania Transit Authority (SEPTA) experienced an attack on its servers that caused widespread impacts and stated:

> The severity of SEPTA's malware attack seems "pretty high" as it's been the cause of so much disruption, said Michael Levy, former chief of computer crimes at the U.S. Attorney's Office for the Eastern District of Pennsylvania. The attack caused SEPTA to shut down access to payroll and remote timekeeping, and there's no internet at SEPTA headquarters at 12th and Market Streets. SEPTA has found a way for most employees to regain email access through a 'cloud-based' system. The length of time that systems have stayed down suggests malware may have "infected a whole lot of things" or hasn't been seen before, Levy said. SEPTA does not know how much has been infected, the spokesmen said. Authorities investigating such cyberattacks often look for 'log files,' such as emails that came in and the IP addresses they came from, as potential leads, Levy said. Attackers often access computer systems with 'phishing' emails that dupe employees into handing over user credentials or clicking links that download malware. SEPTA does not know whether issues arose from a phishing attempt. It's 'continuing to look at' whether personal information has been compromised (August 2020a).

For riders on the platform, the cyber-attack reportedly interrupted their opportunities to gather reliable, real-time information on service.

The Philadelphia Inquirer reported, in a Govetech.com post from August 28, 2020, that the attack SEPTA suffered exposed personally identifiable information of approximately 9300 employees (Madej 2020b). The article states:

> 'Unauthorized individuals may have accessed' files containing employee names, Social Security numbers, addresses, benefits enrollment information, salary or hourly rate, as

> well as bank account and routing numbers, SEPTA General Manager Leslie Richards told employees in an email Thursday morning, which was shared with The Inquirer. and then states, 'SEPTA prioritizes the protection of the personal information of our employees,' Richards said in the message. 'While we are still in the process of confirming the full extent of the data that may have been impacted, SEPTA is providing you with resources as quickly as possible so that you may protect your personal information for actual or attempted use' (Madej 2020b).

In 2020, TxDOT experienced a ransomware attack similar to CDOT's 2018 event. According to local news outlet, Fox 7 Austin, TxDOT notified the public of the attack in a transparent manner and posted a statement on social media, as shown in Figure 4-21. Online tech journal, *Security Affairs*, posted a screenshot of a May 15, 2020 social media post by TxDOT providing greater information about the incident (Paganini 2020).

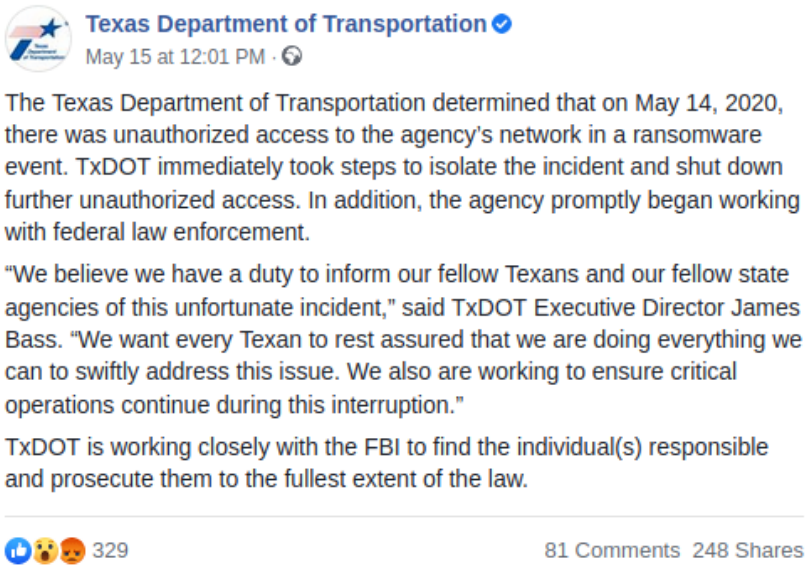


Figure 4-21: TxDOT social media post on cyber incident

The TxDOT ransomware incident occurred 1 week after Texas's court system was attacked in a similar event. In 2019, 23 local governments in Texas were similarly targeted by ransomware attacks. The TxDOT incident was described as having forced a system shutdown to avoid propagation of ransomware. Ransomware invades computer systems, and cyber attackers encrypt files and demand ransom to unlock the files. TxDOT reported the incident to local authorities and is supporting the FBI's investigation.

Following its 2018 Ransomware attack, CDOT has been highly forthcoming in providing advice to administrators responsible for protecting IT systems to its peers across the nation. In its CDOT Cyber Incident: After-Action Report Releasable to the Public (CDOT 2018), CDOT shares its partner organizations in its unified command; provides an incident overview; summary; timeline; root cause analysis; potential aids to attack/delays in recovery (see Section 4.8.2); and other key actions; recommendations; and conclusions.

CDOT credits its major strengths in managing the incident as interagency coordination and support, CDOT continuity of operations (COOP) planning and execution, incident support augmentation, and strategic communications. In assessing primary opportunities for improvement, CDOT outlines the following four key go-forward opportunities.

CDOT Go-Forward Opportunities

1. **Pre-incident planning and exercises:** The State Emergency Operations Plan and OIT Cyber Incident Response Plan were not integrated or operationalized. As a result, a systematic approach to an escalating cyber incident did not exist. Integrated and supporting operational plans would promote commonly understood roles, responsibilities, escalation triggers and expected responses to those triggers. These plans would also ensure supporting functions, such as internal/external communications, response team life support and vendor integration were addressed pre-incident. Once these plans are in place, a deliberate training and exercise program that includes both cyber response and business continuity is necessary to rehearse and test the plans.
2. **Commonly understood Incident Command System approach:** Though versed in cyber incident response, the OIT cyber response team was not versed in the Incident Command System approach. CDOT utilized ICS as part of their COOP and the UCG employed it once engaged. Having ICS trained personnel on the cyber incident response team would have facilitated a common approach to incident handling and may have reduced friction points between the response team and the CDOT COOP team. Anecdotally, it appears most state agencies do not have the level of ICS training necessary to successfully employ the system in an incident.
3. **Cyber Incident Response Capabilities Gap Analysis:** Pre-incident cyber gap analysis in two areas could have contributed to a more coordinated and efficient cyber incident response. a. Cyber Incident Response Plan (CIPR). Capabilities gap analysis in the CIRP could identify known gaps in OIT capabilities. These could then be mitigated through pre-event contracts or MOUs with other agencies (i.e.: National Guard). b. Continuity of Operations Plans (COOP). Though CDOT had a thorough COOP that was instrumental in continuing its mission, these plans did not account to the challenges related to a cyber incident. Plans considered loss of infrastructure and the requirement to move people to alternate worksites, however, these plans assumed that employees would take their computers with them and be able to establish connectivity with key online applications. All State Agencies could benefit from capabilities gap analysis in their COOP for a cyber incident response.
4. **Third Party Vendor Relationships:** There were a number of third party vendor allegations pertaining to vulnerabilities and weaknesses made at various levels of state government. This after action review addresses the principle vulnerabilities that contributed to the incident, including root cause analysis identifying a virtual server without standardized security controls. Several vendors leveraged these vulnerabilities as part of their effort to sell the State either products or services during incident response. While third party vendors provided critical technical capability, bending the incident into a high pressure sales campaign was distracting and unhelpful. Vendor insights were used during the after action review process and OIT is evaluating areas where enhanced vendor support might improve pre-incident security and post-incident response.

Source: CDOT 2018

While all of the above opportunities require coordinated administrative oversight and control, finance and administration staff should explore those technical expert resources that can be secured on a stand-by basis. A value-added approach would include ensuring adequate contract capacity to require and provide for the following: coordinated pre-event readiness, joint ICS training, and unified command exercises, as well as the contract capacity necessary for sufficient training to understand DOT technology for those services that would be mobilized only after a cyber incident.

In addition, any contracts for day-to-day cyber protection or event-triggered cyber incident management or support should pay special attention to force majeure contract terms and conditions. Rather than allowing for the normal mutual termination clauses, procurement and contract administrators should work with legal to develop terms and conditions that provide for maintaining blue skies levels of service and consider if ramp-up capacity during concurrent, regional emergencies, and disasters support DOT cyber risk mitigation objectives. CDOT also makes the following seven recommendations to transportation professionals with the opportunity to mitigate cyber threats:

CDOT Recommendations

- ✓ **SEOP Cyber Incident Annex: Improve.** Convene a cross-functional planning team to review and revise the SEOP Cyber Incident Annex with lessons learned from this incident and industry best practices and standards. This annex should address escalading cyber incidents, establish triggers for response actions, including establishing scalable command and control and assigning roles and responsibilities. Office of Primary Responsibility (OPR): DHSEM with OIT assistance
- ✓ **Cyber Incident Response Plan**: *Improve.* OIT has a cyber incident response plan and did use it for this incident, however the plan was not as operational as it could have been and was not rehearsed often enough to facilitate confident employment of the plan. Further refinement of this plan with lessons identified during this incident, the incorporation of known malware response playbooks and deliberate rehearsals of the plan can make significant improvements for the next incident. OPR: OIT with OEM support.
- ✓ **Integration of external assets:** *Improve.* Future cyber response will require external support from vendors, the National Guard and federal assets. Pre-incident planning and coordination will help ensure the right support is provided and integrated as rapidly as possible to facilitate a cohesive response effort that leverages the capabilities of each asset. OPR: OIT
- ✓ **COOP Planning:** *Sustain/Improve.* Share CDOT best practices and lessons learned with other state agencies. Incorporated specific considerations for a cyber incident in COOPs. Traditional COOP planning focuses on the loss of access to a physical location (e.g., offices). This incident highlighted the importance of digital resiliency and the need to plan for loss of data and/or connectivity. As program manager for the State Agency COOP Program, DHSEM should develop and promulgate digital COOP planning guidance to State Agencies. OPR: DHSEM with CDOT assistance.
- ✓ **Statewide Network Assessment and Hardening**: *Sustain.* As part of the response to and recovery from this incident, OIT completed an extensive analysis of the statewide network and implemented immediate solutions to harden the network. OIT should continue its current work to secure the network against future attacks. OPR: OIT
- ✓ **Backup Colorado:** *Sustain:* Backup Colorado was a key to successfully recovering from this incident and a significant factor in the decision not to pay the ransom. The backup solution provided two advantages. First, it was segmented from the network making it inaccessible to the adversary and, second, it has the ability to detect malware. The ability to detect malware protected the data and provided one of the first indicators of the attack. The State should continue to programmatically use the backup solution for backup and recovery. OPR: OIT
- ✓ **Network Segmentation:** *Sustain:* Segmentation of the network allowed OIT to isolate the malware within one department, allowed for isolation, and therefore, protection of the CDOT Intelligent Transit System and also protected the cloud based backup system. Though the effects on CDOT were significant, this segmentation directly contributed to containment of the malware and prevent the spread throughout the Colorado State Network (CSN).

In summary, CDOT (2018) concludes, “The State must remain vigilant…by continuing to harden its networks, improving and rehearsing its cyber incident response plans and sharing information about this

attack with stakeholders and partner agencies. Additionally, the State must allocate resources to both the necessary personnel and technology to effectively mitigate, respond to and recover from future cyber-attacks."

4.8.3 Pandemics and COVID-19

- ✓ Determine DOT policies and procedures for safe work environment
- ✓ Consider Application to project portfolio: Standby, active, and new contracts
- ✓ Plan to manage consequences for multiple, concurrent emergencies and disasters
- ✓ Determine which DOT policies—in letter or spirit—should naturally extend to contractors
- ✓ Determine if any unique policies or contract terms should be established for contractors
- ✓ Consider allowances and consequences due to COVID-19 mitigation
- ✓ Plan to manage consequences for multiple, concurrent emergencies and disasters

The new and special needs of a pandemic introduce myriad challenges for DOTs. This section explores a number of considerations for DOTs that are still developing their policies or procedures or are revising them for continuous improvement, particularly as conditions such as infection rates and treatment alternatives change. The UC Davis Institute of Transportation Studies published a report, *Impacts Of The COVID-19 Pandemic on Transportation Use: Updates from UC Davis Behavioral Study* (Circella and Dominguez-Faus 2020). The key takeaway, not surprisingly, is that, "mobility has changed during the COVID-19 pandemic. With social distancing and people working from home, travel has decreased significantly. However, as the economy has started to reopen, single-occupant car travel and bicycling have increased, while the use of public transit, ride-hailing, carpools, and shared e-scooters remains low." For example, the study reports that 37% of bus riders are using public transportation less often, while only 8% of riders have increased bus use. The study also showed people retreating to cars where they had access to them, forgoing transit and ride-hailing such as Uber and Lyft. Income level and whether work was white collar or blue collar were key determinants in survey participants' opportunities to telecommute during the pandemic, with 20% of low-income participants able to telecommute, in contrast to 50% of high-income participants being able to do so. The study also reports increased recreational walking, and points to other research that shows an uptick in cycling (Circella and Dominguez-Faus 2020). The Report outlines the following key actionable recommendations for DOTs to mitigate risks associated with COVID-19 for both personnel and the travelling public.

4.8.3.1 Determine DOT Policies and Procedures for Safe Work Environment

An essential part of pandemic risk mitigation is putting in procedures that support transmission reduction. Each of the following should be considered for the application of pandemic mitigation strategies to support the health and wellness of personnel and the traveling public.

- In the office
- In field facilities
- During field assessments

- On active construction sites, including provisions for construction trailers
- In relation to protecting personnel and contractors responsible for sanitization and disinfection
- Point-to-point travel/vehicles policies

Although this applied research is focused on administrative actions and controls related to contractors, it is important to start with a review of baseline plans and actions to mitigate the public health threat in relation to the pandemic. Where comprehensively planned and implemented and continually revisited, DOT executive leadership should designate executive(s) responsible for worker and contractor protection procedures for the pandemic to work in close consultation with civil rights, headquarters and regional engineering leadership, procurement and contracting, and/or human resources. To develop robust policies and procedures, transportation professionals should actively review the body of literature on COVID-19 in consultation with legal counsel to develop a grounded understanding of workplace risks, the evolving nature of reliable information and infection levels of this novel pandemic threat in the local population, and risk reduction measure planning and implementation.

Like many DOTs, TxDOT is leaning forward on its COVID-19–related communications to the public. On March 17, 2020, TxDOT describes key actions, "to help reduce the risk of COVID-19. On Friday and over the weekend, the department took several steps to protect the public and TxDOT employees. At the same time, TxDOT remains committed to delivering services to its customers all over the Lone Star State." The website lists the following overarching steps taken by TxDot to protect its personnel and the traveling public.

- ✓ Postponing or canceling its in-person public hearings and gatherings (revisited at intervals) (outside of Texas Transportation Commission meeting) making provisions to offer virtual participation strategies for public input.
- ✓ Ongoing commitment to improve its transportation system and ongoing work to maintain and operate the state's transportation system, to include ferry operations.
- ✓ Closing lobbies at Travel Information Centers, but keeping restrooms open during daytime hours, and keeping safety rest areas on highways in service.
- ✓ Travelers are also directed to call or access website information on travel conditions.
- ✓ Sharing safety messages on digital highway signs statewide such as, "Give Xtra Space, With Each Other, And On The Road" and "Hands Clean, 2 Beat Covid-19, Be on TX Team." to help reinforce the importance of preventing the spread of the virus.
- ✓ Requiring office-based employees to telework.

Source: TxDOT 2020

The ever-growing body of vetted information from reliable sources available to DOTs include consultation with state and local departments of health and the CDC, as well as consulting with industrial hygienists and other qualified personnel and contractors, means that transportation professionals are not expected to become epidemiologists overnight. It does mean that they need to develop a living body of DOT policies and procedures that keeps pace with contemporaneous information as more is learned about the virus and the disease. In use with its clear and concise checklist, Workplace Checklist of Prevention of Exposure to SARS-Cov-2 Virus in Non-Healthcare Industries, the National Institutes of

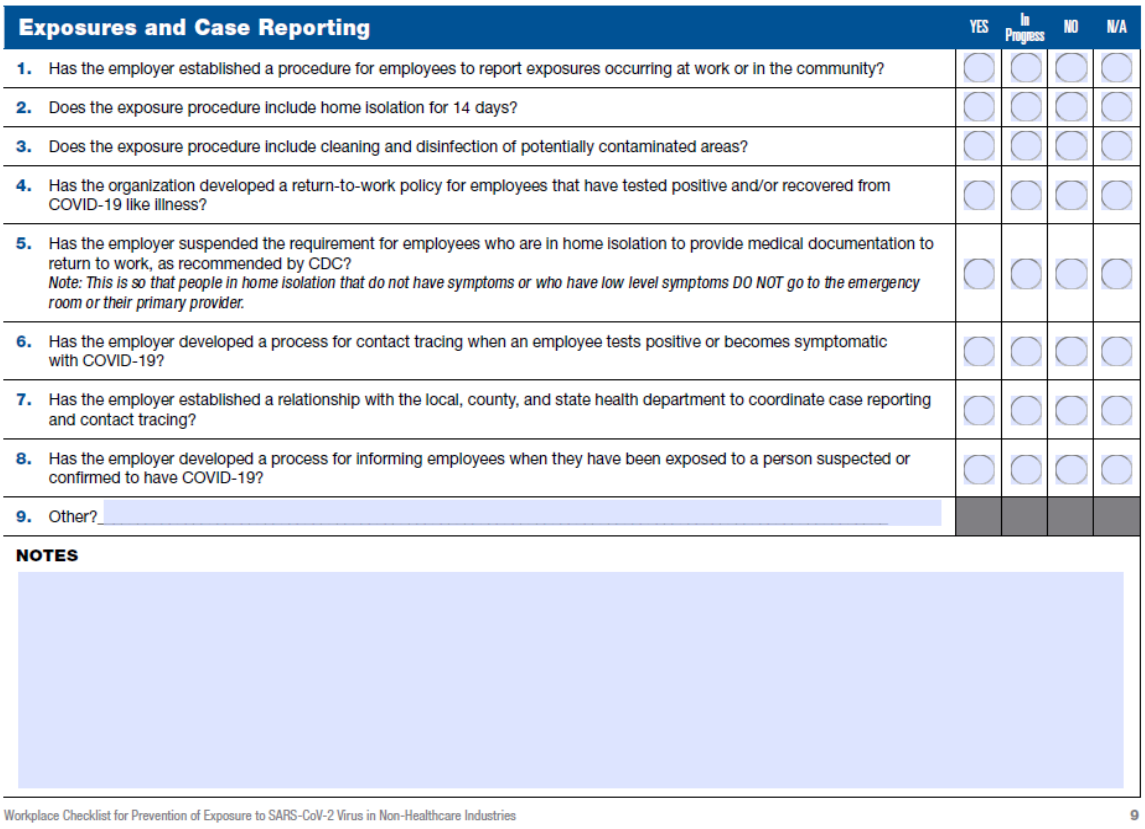
Health's (NIH's) National Institute of Environmental Health Sciences (NIEHS) Worker Training Program (WTP) recommends the following for collaborative teams or individuals.

Workplace Checklist of Prevention of Exposure to SARS-Cov-2 Virus (excerpt)

- ✓ Review each action item to develop or maintain:
  - COVID-19 Exposure Control Plan
  - Social Distancing
  - Engineering Controls
  - Work Practices
  - Enhanced Cleaning and Disinfection
  - Personal Protective Equipment (PPE) and Respiratory Protection
  - Sick Leave, Screening, and Employee Health
  - Exposure and Case Reporting
  - Measures to Protect Employee Mental Health and Physical Well-Being
- ✓ Develop an action plan that lists each (action) item, who is responsible, what needs to be done, and by when.
- ✓ Develop a communication plan to inform employees, customers, and the public of actions taken by the organization to protect workers and the public from exposure to the virus.

Source: NIEHS n.d.

The following Figure 4-22 presents an excerpt from a clear, succinct checklist developed by NEIHS.



Exposures and Case Reporting	YES	In Progress	NO	N/A
1. Has the employer established a procedure for employees to report exposures occurring at work or in the community?	○	○	○	○
2. Does the exposure procedure include home isolation for 14 days?	○	○	○	○
3. Does the exposure procedure include cleaning and disinfection of potentially contaminated areas?	○	○	○	○
4. Has the organization developed a return-to-work policy for employees that have tested positive and/or recovered from COVID-19 like illness?	○	○	○	○
5. Has the employer suspended the requirement for employees who are in home isolation to provide medical documentation to return to work, as recommended by CDC? *Note: This is so that people in home isolation that do not have symptoms or who have low level symptoms DO NOT go to the emergency room or their primary provider.*	○	○	○	○
6. Has the employer developed a process for contact tracing when an employee tests positive or becomes symptomatic with COVID-19?	○	○	○	○
7. Has the employer established a relationship with the local, county, and state health department to coordinate case reporting and contact tracing?	○	○	○	○
8. Has the employer developed a process for informing employees when they have been exposed to a person suspected or confirmed to have COVID-19?	○	○	○	○
9. Other?_____				

NOTES

Workplace Checklist for Prevention of Exposure to SARS-CoV-2 Virus in Non-Healthcare Industries 9

Figure 4-22: Workplace Checklist for Prevention of Exposure to SARS-CoV-2 Virus in Non-Healthcare Industries *(Source: NEIHS n.d.)*

For example, the mission of the CPWR's Center for Construction Research and Training, created by the North America's Building Trades Unions (NABTU) is to improve safety and health in the U.S. construction industry. According to its website, "CPWR serves as the National Construction Center for the National Institute for Occupational Safety and Health (NIOSH). In this capacity, CPWR responds to existing and emerging hazards facing construction workers, their employers, and other industry stakeholders by conducting research and developing training materials and other resources to help the industry identify hazards and solutions to reduce or eliminate the risks." At time of publication, the CPWR's COVID-19 Clearinghouse contained 100 guidance documents on workplace practices, over 50 training resources and safety in action bulletins, and 40 employer recommendations and requirements. Resources can be found at: http://covid.elcosh.org/search/category-5/Employer+Recommendations++Requirements

The University of California at Los Angeles (UCLA) Labor Occupational Safety and Health Program has resources on protecting workers from COVID-19. It includes guidance on protecting workers on the job, has links to OSHA standards, provides information on worker legal rights, and offers resources for specific occupations and industry, including construction resources offered in both English and Spanish. Resources can be found at: https://losh.ucla.edu/resources-2/resources-protecting-workers-from-covid-19-2/#top.

The University of Washington School of Public Health Environmental and Occupational Health Sciences Continuing Education Program does a good job of distilling complicated and sometimes difficult-to-find information on cleaning and disinfection in simple and accessible terms in its document, Safer Cleaning, Sanitizing and Disinfecting Strategies to Reduce and Prevent COVID-19 Transmission.

Its guidance highlights the importance of following OSHA's Hazard Communication Standard (29 CFR Part 1910.1200) to ensure workers are trained on the hazards of cleaning chemicals used in the workplace, which applies to disinfection for COVID-19. It can be accessed at the following link: https://osha.washington.edu/sites/default/files/documents/FactSheet_Cleaning_Final_UWDEOHS_0.pdf.

The World Health Organization platform for COVID-19 Training is extensive and can be found at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/training/online-training.

Useful CDC and other federally supported resources can be accessed through the following links:

CDC (Centers for Disease Control and Prevention). 2020. Cleaning and Disinfection for Community Facilities: Interim Recommendations for U.S. Community Facilities with Suspected/Confirmed Coronavirus Disease 2019 (COVID-19). Last Updated May 27, 2020. https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/cleaning-disinfection.html.

CDC. 2020. *COVID-19 Critical Infrastructure Sector Response Planning. Last Updated May 6, 2020*. https://www.cdc.gov/coronavirus/2019-ncov/community/critical-infrastructure-sectors.html.

CDC. 2020. *Employer Information for Heath Stress Prevention during the COVID-19 Pandemic*. Last Updated August 2, 2020. https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/heat-stress-employers.html.

CDC. 2020. Interim Guidance for Implementing Safety Practices for Critical Infrastructure Workers Who May Have Had Exposure to a Person with Suspected or Confirmed COVID-19. Last Updated April 20, 2020. https://www.cdc.gov/coronavirus/2019-ncov/community/critical-workers/implementing-safety-practices.html.

CDC. 2020. Testing Strategy for Coronavirus (COVID-19) in High-Density Critical Infrastructure Workplaces after a COVID-19 Case Is Identified. Last Updated June 13, 2020. https://www.cdc.gov/coronavirus/2019-ncov/community/worker-safety-support/hd-testing.html.

CDC.2020. *What Construction Workers Need to Know about COVID-19*. Last Updated May 19, 2020. https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/construction-workers.html.

National Institute of Health, National Institute of Environmental Health Sciences (NIEHS), Worker Training Program COVID-19 Essential and Returning Workers Training Tool: Protecting Workers from COVID-19 in the Workplace dated April 2020 and found at the following link: https://tools.niehs.nih.gov/wetp/public/hasl_get_blob.cfm?ID=11922.

National Institute of Health, National Institute of Environmental Health Sciences (NIEHS), Worker Training Program, Workplace Checklist for Prevention of Exposure to SARS-CoV-2 Virus in Non-Healthcare Industries (undated) available the following link: https://tools.niehs.nih.gov/wetp/public/hasl_get_blob.cfm?ID=12001.

National Institute of Health, National Institute of Environmental Health Sciences (NIEHS), Worker Training Program, WTP NEISH COVID-19 Response: Technology Tips for Virtual Meetings and Interactive Online Sessions (undated), available the following link: https://tools.niehs.nih.gov/wetp/public/hasl_get_blob.cfm?ID=11941.

National Institute of Health, National Institute of Environmental Health Sciences (NIEHS), Worker Training Program, Safety and Health Alert: Preventing SARS-CoV-2 Eye Exposure and Infection (undated), available the following link: https://tools.niehs.nih.gov/wetp/public/hasl_get_blob.cfm?ID=12041.

OSHA (Occupational Safety and Health Administration). n.d. “Construction Work.” COVID-19 – Control and Prevention. https://www.osha.gov/SLTC/covid-19/construction.html.

OSHA. n.d. “COVID-19: Additional Resources.” Safety and Health Topics. https://www.osha.gov/SLTC/covid-19/additional_resources.html.

OSHA. n.d. “COVID-19: Control and Prevention.” Safety and Health Topics. https://www.osha.gov/SLTC/covid-19/controlprevention.html.

Other worthwhile resources include:

World Health Organization, Getting your workplace ready for COVID-19, dated March 3, 2020.

AIHA healthier workplaces: A Healthier World Returning to Work: Construction Environment, Guidance Document, Version 3, dated July 8, 2020.

Construction Leadership Council Construction Sector – Site Operating Procedures Protecting Your Workforce During Coronavirus (Covid-19) Version 5, dated July 4, 2020.

The University of California at Los Angeles (UCLA), Labor Occupational Safety and Health Program Resources on Protecting Workers from COVID-19. Resources can be found at: https://losh.ucla.edu/resources-2/resources-protecting-workers-from-covid-19-2/#top.

4.8.3.2 Determine which DOT policies should naturally extend to contractors (e.g., professional services, construction)

As important as setting the agenda to protect its own personnel, a DOT must clarify those policies, in spirit and letter, to its contractors through the lenses of legal and regulatory requirements, worker protection, mission support, risk mitigation, and cost management.

NABTU and CPWR have undertaken the important work of outlining COVID-19 Standards for U.S. Construction Sites (dated April 27, 2020) that encourage construction industry employers to create comprehensive COVID-19 exposure control plans. NABTU and CPWR recommend employers

implement the plan on all construction job sites prior to the identification of any workers testing positive for the disease. It provides an excellent foundation to assess conditions for both DOT maintenance and other staff working on active constructions sites, as well as construction contractors hired by DOT. Overarching components of the COVID-19 exposure control plan include: control measure, symptom checking, social distancing, hygiene, and decontamination procedures, and training.

Summary Excerpts from COVID-19 Industry Standards for U.S. Construction Sites

To implement a COVID-19 exposure control plan, employers should:

- ✓ **Designate COVID-19 officer** at each and every job site.
- ✓ **Work Remotely**: Plan for office personnel work remotely from home.
- ✓ **Training:** Train workers with the most recent information on the hazard and control measures, including social distancing, handwashing facilities on site, and how high-touch surfaces are disinfected.
- ✓ **Screening:** Ask workers to self-identify symptoms of fever, coughing, shortness of breath, chills, muscle pain, headache, sore throat, and new loss of taste or smell each day, before the shift, mid-shift, and at home.
  - Screen all workers for fever at the beginning of shifts and when they become ill on the job.
  - Workers with COVID-19 and other workers who have had close contact with those workers should be put on sick leave. Local health departments should be notified. The area where the sick person worked should be immediately disinfected.
  - Ensure affected workers receive paid sick leave as required under the Families First Coronavirus Response Act (FFCRA). The U.S. Department of Labor's poster about paid sick leave under the FFCRA should be posted at the workplace. A copy can be found here: https://www.dol.gov/sites/dolgov/files/WHD/posters/FFCRA_Poster_WH1422_Non-Federal.pdf
- ✓ **Social distancing:** Implement social distancing procedures:
  - Create at least 6 feet of space between workers by staging/staggering crews.
  - Modify work schedules to stagger work, provide alternating workdays or extra shifts to reduce the total number of employees on a job site at any given time to ensure physical distancing. The recommendation for shifting individual employees should be at the sole discretion of the Local Business Manager or their Representative.
  - Identify choke points where workers are forced to stand together, such as hallways, hoists and elevators, ingress and egress points, break areas, and buses, and put in place policies to maintain social distancing.
  - In elevators and personnel hoists, ensure six feet distance between passengers in all directions and equip operator with appropriate respirator and other personal protective equipment.
  - Minimize interactions when picking up or delivering equipment or materials. Organize the placement of materials to minimize movement on the work site.
- ✓ **Decontamination:** Clean and disinfect high-touch surfaces on job sites and in offices—such as shared tools, machines, vehicles and other equipment, handrails, doorknobs, and portable toilets—frequently, per CDC guidelines: https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/cleaning-disinfection.html
- ✓ **Personal hygiene:** Provide soap and running water whenever possible on all job sites for frequent handwashing. If it is not possible to provide running water, disclose the reasons to your workers. Provide alcohol-based hand sanitizers with greater than 60% ethanol or 70% isopropanol as a backup only if providing running water is impossible.
- ✓ **Respiratory protection:** If workers need to be near each other to perform tasks or when working in close quarters, such as confined space work, they should wear a NIOSH-approved respirator implemented under a full respiratory protection program. NIOSH-approved respirators include filtering facepiece and elastomeric negative or positive pressure half or full facepiece respirators equipped with N95, N99, N100, R95, P95, P99, or P100 filters.

The full COVID-19 Standards for U.S. Construction Sites can be found at this link: https://www.cpwr.com/wp-content/uploads/publications/NABTU_CPWR_Standards_COVID-19.pdf

The CPWR and NABTU also recommend that special guidance be implemented for older workers and people with underlying health conditions at greater risk of becoming very sick from COVID-19. The CDC has issued guidance for at-risk populations at: https://www.cdc.gov/coronavirus/2019-ncov/specific-groups/high-risk-complications.html. In addition, NABTU and CPWR remind employers that people may be at greater likelihood to need mental health services or care related to substance use, and encourage employers to promote employee assistance programs and the National Suicide Prevention Lifeline at National Suicide Prevention Lifeline: 1-800-273-TALK (8255) https://suicidepreventionlifeline.org.

In context of the applied research scope, it is important to evaluate contract clauses related to contractor's project performance with questions in view such as, what are DOT notice and approval requirements for the temporary replacement of key personnel with a professional services firm under contract? It is very likely that such contract provisions are in place, but it makes sense to reacquaint personnel and DOT contractors with policies and procedures in anticipation of a possible uptick in requests related to all manner of contractor personnel health and wellness.

The construction industry has been actively asking questions on the COVID-19 outbreak to NABTU and CPWR, resulting in the following recommendations to communicate directly with construction workers (and others on job sites) to have clear safety precautions for COVID-19.

COVID-19 Safety Steps for Construction Workers

- ✓ Don't go to work if you are feeling sick.
- ✓ Don't go to work if you have a fever.
- ✓ Don't go to work if you have a cough or shortness of breath.
- ✓ Avoid contact with sick people.
- ✓ Don't shake hands when greeting others.
- ✓ Avoid large gatherings or meetings of 10 people or more.
- ✓ Stay at least 6 feet away from others on job sites and in gatherings, meetings, and training sessions.
- ✓ Cover your mouth and nose with tissues if you cough or sneeze or do so into your elbow.
- ✓ Avoid touching your eyes, nose, or mouth with unwashed hands.
- ✓ Clean your hands often by washing them with soap and water for at least 20 seconds. When hand washing isn't available, use an alcohol-based hand sanitizer with greater than 60% ethanol or 70% isopropanol. Soap and water should be used if hands are visibly dirty.
- ✓ Clean your hands frequently, including before and after going to the bathroom, before eating, and after coughing, sneezing, or blowing your nose.
- ✓ Bring food and water bottles from home to the job site and do not share.
- ✓ Drive to worksites or parking areas by yourself—no passengers or carpooling.
- ✓ Disinfect interiors and door handles of machines or construction vehicles, and the handles of equipment and tools that are shared following employer's COVID-19 exposure control plan.

Source: NABTU and CPWR 2020

The standards and instructions for construction workers and job sites are a great starting point to help mitigate pandemic transmission on construction sites, but they represent policy baseline activities that

must be augmented by administrative actions and controls to prevent both the spread of infection and reduce other risks for the DOT.

The following tool was developed to aid in decision support to justify requests for COVID-19–related clinical care, and requests for facility adaptation to temporary alternate care/hospital use. The concept can easily be adapted for a transportation organization making decisions (e.g., consideration of upgrades to MERV 13 filters and associated system performance assessments of HVAC systems in buildings housing essential staff or the traveling public to potentially reduce virus transmission).

DECISION SUPPORT TOOL: CLINICAL CARE PROVISION IN (STATE) AHFs
Provider-Specific Standards Concerning Alternative Hospital Sites (AHS)

A notification or request was submitted from the clinical care team or other party to (Program Manager) in relation to the delivery Alternative Hospital Facility (AHF) site(s) in (State). This tool supports justification and review to aid in decision support. Add additional sheets including relevant citations, if necessary.

I. What is being requested?

Describe:

Ii. Identify applicable sites(s)

Iii. What benefits will be produced if request is approved (use all that apply)?

Codes, standards, or licensing required that remain in force for AHFs

Describe:

Required to reduce transmission risks to non-COVID positive patients or staff

Describe:

Increases speed to delivery of care or other efficiencies for ahfs

Describe:

Improves standard of care for patients in ahfs

Describe:

Reduces fatigue/stress on AHF staff delivering care including support functions necessary to keep the AHFS operational

Describe:

Other

Describe:

IV. Decision Recommendation (to State)

_____Approve as Requested

_____Approve with Provisos/additional requirements (describe)

_____Do not Approve and why

_____Additional information required (describe) required to make decision

_____Budget/Specifications Required (attach cost estimate)

Program Manager Signature/Project Title:_____

Print Name:_____ Date: _____

(Tool for rapid decision making on COVID-19 AECOM. 2020)

4.8.3.3 Determine if any unique policies or contract terms should be established for contractors

As with its own facilities, the DOT should consider policies for contractors by type of contractor, scope of services or goods, and extent of contact with DOT personnel, facilities, and roadways, and structures/ bridges. The Scottish Government has defined a set of common relevant provisions of construction contracts (presented in the excerpt, below), and requires contracting authorities to look at provisions in active contracts or construction projects to consider the following, at a minimum:

- Suspension of work other than that necessary for ensuring site safety and security, the responsibility for which must remain with the contractor;
- Insurance coverage including but not limited to suspension of work;
- Safe resumption of work when covid-19 restrictions are suitably relaxed, and /or robust operating procedures are in place;
- Extension of time;
- Loss and expense;
- Liquidated and ascertained damages;
- Rules governing retentions or equivalent form of defects' liability assurance;

Force majeure.

The Scottish Government has also defined Corporate Governance Rules and Potential COVID-19 Mitigations and further states, "Contracting authorities should in a positive supportive manner consider what flexibility exists within their corporate governance to enable actions which would be substantive in meeting the guidance provided." The rules go on to state:

- The introduction of typed, facsimile or scanned manuscript signatures to expedite contract execution in lieu of "wet" signatures meantime;
- Securing continuance on site of those projects' categorised as essential;
- Where social distancing cannot be achieved, making arrangements for their orderly suspension and effective resumption;
- Payment of overheads and establishment costs on sites not at full capacity;
- Avoiding the application of liquidated and ascertained damages where at all possible
- Granting extensions of time where necessary;
- Initiating mid-monthly or weekly interim payments;
- Where a project bank account is not in place, ensuring that payments are disbursed by the main contractor fully and promptly to their subcontractors;
- Making direct payment to subcontractors;
- The prompt and proportional release of retentions taking cognisance of work done in order to aid contractors' cash flow and, where a project bank account is not in place, to require this to be effected and evidenced down the supply chain in public works contracts to which it is applied;
- Maintaining constant contact with contractors and monitoring progress on site (Government of Scotland, Construction Procurement Policy Unit 2020).

The following presents questions that DOTs consider when planning and implementing administrative policies and procurement and contracting actions that apply to its contractors.

- In the office
  - Are there limitations/restrictions on contractor co-location with DOT personnel (e.g., offices, designated work areas, office access for essential personnel only)?
  - What standards are being followed to reduce virus transmission?
  - Is a contractor responsible for providing PPE? What types of PPE are required?
    - Will facilities be available for support personnel to relax without wearing PPE?
    - Will facilities be available for support staff to put on and take off PPE?
  - What are standards of care and enforcement for use of PPE and/or care of DOT office facilities (e.g., are contractors responsible for disinfecting spaces after use; and to what disinfection standard)?
  - Have steps been taken to reduce transmission in areas designated for contractor use (e.g., increasing physical distancing of workspaces)?
    - Will the facility be zoned through the use of barriers and signage?
    - How will area boundaries be identified – color coding, tape on floors, arrows on walls?
  - Are contractors required to complete office entry health screenings and temperature checks?
  - Will the DOT provide the protocols, reimburse direct costs, require reporting, and what are consequences of non-compliance for items listed above?
- In field facilities, including construction trailers
  - If the field facility is a project trailer controlled by the contractor, will the DOT govern mitigation strategies for transmission reduction? What are consequences of non-compliance? Are DOT personnel allowed to go into trailers controlled by contractors?
  - Do special provisions need to be made to enhance sanitation for field facilities for transmission mitigation, especially if "porta potties" are typically used in non-pandemic conditions (e.g., mobilization of portable toilet trailers with flush toilets and running water)? What are standards for sanitization will be maintained?
  - See "in the office" questions as above.
- During field assessments and active construction sites
  - With safety being a key driver on how construction is performed on the job site and recognizing construction contractor control over means and methods, what is the DOTs role in encouraging virus transmission reduction? How can any requirements or recommendations be de-conflicted from safe actions?
  - What conditions are expected to be encountered that now present virus transmission risks and require mitigations such as limited access to sanitary facilities (e.g., lack of running water and soap for handwashing)?

- Point-to-point travel/vehicles policies
    - Can contractors carpool to/from job site?
    - Are rental vehicles preferred, and will they be restricted for use only to/from/within job site?
        - Are passengers (including DOT personnel) allowed in a contractor's rental vehicle?
        - Are costs are covered by the project (specify in bid or as allowable direct pass-through expense)?
    - Are contractors allowed in DOT vehicles?
    - What are standards for disinfection of vehicle?

Special considerations should also be given to contracts involving the service provision and protection of contractors responsible for sanitization and disinfection of facilities. The following questions are helpful in using administrative controls to protect workers and support risk mitigation.

- What standards for personal protection are being followed and enforced? Are notices being posted, translated, and being conveyed verbally? Are there required trainings or certifications or performance monitoring standards?
- To what extent are contractors providing support (operations, maintenance, custodial) trained on:
    - Disease signs, symptoms, complications, and risk factors?
    - Means to report symptoms (both their symptoms and those they have observed in people being sheltered)?
    - Appropriate use of PPE, including respirator fit testing and fit checks?
- Where will disinfection chemicals, equipment for disinfection, and PPE for those performing the disinfection services be stored?
- How will spent disinfection chemical, equipment, and materials be handled?
    - Where will waste disposal containers, bags, and spent equipment be stored? How will these items be disinfected? And where?
    - Is spill equipment available – including decontamination chemicals and PPE?
- How will this inventory be maintained? What party is responsible for costs for activities, above, and are those costs reimbursable or included in negotiated rates? (AECOM 2020a).

4.8.3.4 Consider specific procurement and contract requirements, allowances, and consequences relative to COVID-19 mitigation

- Responsibility
    - Does the DOT wish to designate responsibility for COVID-19 impacts with its contractors, recognizing a lack of legal precedence? or
    - Does the DOT take a more agnostic position that it will cover a series of specified direct costs to strategically avoid pre-claims, claims, or contractor non-performance?

- Time/Delays
    - If work is slowed due to more stringent standards of care or reduced number of workers allowed on a job site per shift (or more shifts are required), how will contract terms concerning time be addressed?
    - If a worker needs to be isolated due to testing positive for COVID-19, what are requirement for shutting down the site, for how long, and how will time in contract be treated?
    - If contractors' employees from one or multiple firms (and/or DOT personnel) are exposed to a COVID-19 positive worker on the job site and should/must quarantine for 2 weeks, will the DOT provide 2 or more weeks of time for on-time contract performance?
    - How shall contractors notice the agency on time/delays, and does the DOT need to revisit is standards for entitlement?
- Cost
    - If a worker needs to be isolated due to testing positive for COVID-19, what are requirements for paying costs for the contractor's isolation such as per diem hotel and meals and incidentals (and at what rates) if the contractor's employee claims potential exposure on the job site?
    - If contractors' employees from one or multiple firms (and/or DOT personnel) are exposed to a COVID-19 positive worker on the job site and should/must quarantine for 2 weeks, will the DOT support those as allowable projects costs (in the bid price or as direct pass-through expenses, and what costs exactly?)
    - What party is responsible for disinfection on a site if a contractor tests positive for COVID-19, and what standard of disinfection should be followed, and what costs are allowable? Are there monitoring or performance requirements for successful disinfection? Is there a legal basis for setting a standard for disinfection?
    - Will the contractor be able to negotiate amended rates if the DOT requests smaller teams or multiple shifts in order to reduce risk exposure?
- Other Mitigations and Remedies
    - Are contract impacts on existing awards substantial or non-substantial?
    - Will the DOT allow the contractor to be released from a contract (and under what termination terms and conditions)?
    - What steps can be taken to mitigate or contract non-compliance or non-progression if the goal is to avoid termination or "frustration" (whereby no contractual relief is available, but the contract cannot progress)?
    - Is there a current suite of waivers and amendments that can be included at mutual consent, or do they need to be developed to respond to unique pandemic conditions?
    - Can the DOT have the latitude to "step in" to the contract to progress a project?
    - How is the DOT qualifying pandemics relative to change in law or force majeure?
    - How can the DOT encourage regular communications with contractors such as standing briefings and conference calls to promote timely and constructive two-way exchange? Are

there new considerations that must be considered to preserve legal privilege and/or confidentiality?
  - How will the DOT navigate new considerations on a contract that was already in dispute? How will dispute risk profiles change?
  - Will the DOT continue to pay vendors at risk of closure such as DBE and MWBE enterprises that had service delivery ramp-down due to the pandemic? Is this permitted under regulatory and legal authority, and are resources available to do so?

- (Dentons 2020; Giles 2020; Government of Scotland, Construction Procurement Policy Unit 2020; Norton Rose Fulbright 2020a; Norton Rose Fulbright. 2020b).

Should DOTs Pay Small Contractors that Do Not Perform Due to COVID-19?

Contracting authorities should continue to pay any suppliers deemed "at risk" due to COVID-19 until at least the end of June 2020. Contracting authorities are not expected to undertake a detailed assessment of suppliers' financial viability, and the PPN 02/20 indicates that the "at risk" threshold is low. Authorities should apply this concept as broadly as possible to ensure service continuity. This is to ensure these suppliers are supported during this period, particularly where works have ceased due to the impact of COVID-19, which may result in the collapse of the supplier, or where it would enable business continuity in the long term to pay suppliers in the short term. Where applicable, contracting authorities can provide payment relief to suppliers in a number of ways, including payments against revised/extended milestones or timescales, interim payments, forward ordering and pre-payments. Contracting authorities should: a. Assess and document the level of risk associated with advance or pre-payments, and seek legal advice if necessary b. Ensure invoices identify which elements relate to services suppliers are continuing to supply and which elements relate to the impact of COVID-19 c. Not make payments to suppliers where there is no contractual volume commitment to supply, and suppliers who are underperforming or are subject to an existing improvement plan (Squire Patton Boggs. 2020).

- Concurrent, regional emergencies and disasters invariably result in adverse consequences. In the case of COVID-19, it makes sense to examine issues outside the contract, proper, such as the supply chain and contractor cost of money. The following U.K. industry piece considers the question, Are there any issues to consider outside of the contract?

  When assessing the potential impact of COVID-19 on a project, it may be necessary to consider the wider implications outside the immediate employer/contractor relationship. For example, where a project has received financing from third parties, the borrower may need to seek relief from its debt obligations under the financing agreement, should there be shortfall or delay in revenue from the project. Lenders and borrowers should also consider whether events on site could constitute an event of default under the financing arrangements (whether as a result of the contractor suspending or abandoning the works or for a failure to achieve a relevant milestone), or a breach of the financial covenants and obligations. The impact on the project could even constitute a material adverse change in the context of a representation or warranty.

  Additionally, parties to finance documents should consider the extent to which notification requirements are triggered by COVID-19 events, including those relating to

potential project delays, cost overruns, claims or material adverse consequences or effects.

- Consideration should also be given to how the COVID-19 may affects parties further down the chain. For example, a contractor may experience difficulties obtaining materials or components from its supply chain which are required in order to fulfil its obligations to the employer. Counterparties may also be facing liquidity issues and therefore payment terms should be checked and monitored. (Norton Rose Fulbright. 2020b)

4.8.3.5 Consider Application to project portfolio: Standby, active, and new contracts

- Consider current projects issued pre-pandemic
- During-pandemic projects where information and best practices have changed
- New, active-pandemic projects
- Post-pandemic projects to be prepared for future pandemics

4.8.3.6 Plan to Manage Consequences for Multiple, Concurrent Emergencies and Disasters

In addition to the challenges of addressing the pandemic's urgent threats to health and safety, DOTs must continue to be prepared for concurrent, regional emergencies and disasters from wildfires in the West to Pacific and Atlantic hurricanes, flooding, droughts, tornado storms, and seismic events, combined with stresses such as climate change and human-caused threats. When facilities are disrupted, carefully laid plans and practices to systematically reduce health and safety threats from the pandemic are upended.

Transportation professionals must also anticipate and formulate safe plans of actions for all parties. For example, the DOT can evaluate protocols for when normal EMS systems are overwhelmed by concurrent, regional emergencies, and help is required. Map routes to hospitals from DOT assets to determine the status of roadway conditions, and have contractors working in the field do the same. Establish alternate evacuation procedures that call on administrative arrangements such as standby-contracts to provide for the sick and injured, such as "medi-vac" helicopter airlifts, and/or request arrangements with the Governor's Office to support such services through the Army National Guard where capacity is available.

Human-caused events are historically some of the most disruptive. With safe physical distancing standards in place, along with other pandemic risk reduction efforts such as remote work from home and dependencies on employee-dependent and -supplied communications (e.g., internet, mobile phones and service), some personnel and facilities normally located in proximity to lifesaving response to human needs such as accident sites may be less available than normal.

Other examples may include special planning for personnel and contractors interacting with civil rights protests and any counter-protests that take place on state and local surface transportation assets, as Americans have literally "taken to the streets." Like all public agencies, protesting pedestrians (and sometimes cyclists and drivers) represent the very traveling public DOTs serve each and every day.

Separately, bad actors will look for opportunities in chaos and disruption to optimize access and exploit DOT vulnerabilities. Surface transportation systems can be attractive targets due to accessibility, wide utilization, and access to the public (e.g., traffic choke points), and sometimes iconic assets that symbolize America such as the Golden Gate Bridge, the Verrazano Bridge, and Route 66. The longer out-of-control conditions are allowed to remain and the greater the scale of the concurrent, regional emergencies, the greater the opportunity made available, inadvertently, to bad actors. Therefore, it is absolutely essential to use administrative oversight and controls as much as feasible during these events. Doing so will narrow the opportunity for threat exploitation and adverse consequences for life/safety and transportation asset security.

DOTs should examine vulnerabilities to terrorist and active shooter threats during the pandemic, and can consult with the state office of emergency management, state police, and/or regionally assigned DHS security advisors to facilitate or conduct rapid threat hazard assessments. These could survey key assets and locations with personnel, contractors, and the public. This need is particularly urgent for temporary spaces set up by the DOT to manage events that may lack access controls and security normally in place. Consider the need for additional security on a temporary basis, and installation of temporary protection measures such as bollards, gates, security fencing, and deployment of blockades such as Jersey Barriers.

For SEPTA employees working remotely from home, the challenges resulting from multiple, concurrent emergencies were amplified when SEPTA's cyber-attack shut down systems. *The Philadelphia Enquirer* reports, "The effect behind the scenes left employees scrambling to find colleagues' phone numbers and resorting to personal email accounts as many work remotely. Lack of access to SEPTA servers where files and projects are stored also has made their jobs harder." Employees cite that they were already overwhelmed as "they navigate challenges of the COVID-19 pandemic" (Madej 2020a).

SEPTA malware attack has stifled operations and exasperated frustrated employees: 'I think about quitting every day.'

Like terrorist attacks and active shooter incidents, opportunities for cyber-attacks are enhanced when IT and adjacent security measures are not in consistent use and being monitored appropriately. The challenges of the pandemic combined with the impacts of a cyber-attack are many. DOTs should ensure technical expertise and staff capacity are maintained, and ready resources are identified and alert to potential mobilizations. Be certain that cyber protection personnel have adequate technical skills and availability to backfill personnel who become ill during a pandemic. Consider evaluating stand-by contract capacity for the unique technical functions necessary to protect technology assets, DOT data, and information vulnerable to cyber-attacks.

Like physical terrorist threats, cyber-attacks prey on system vulnerabilities. These occur during blue skies, but the likelihood of attacks and consequences—like widespread access to mission-critical data and information—are expanded in times of crisis. Lessons can be drawn from CDOT's blue skies cyber incident which it described on its website as:

> Between February 21-23, 2018, a threat actor executed a ransomware attack on that ultimately affected roughly half of the department's (CDOT-wide) computers. Despite immediate action by the Colorado Department of Transportation (CDOT) and Governor's Office of Internet Technology (OIT), CDOT suffered a second attack on

> March 1, 2018. On March 3, CDOT, OIT, and the Colorado Division of Homeland Security and Emergency Management (DHSEM) formed a unified command group (UCG) to provide direction and control for incident responders. On March 8, the UCG completed phase one (Containment) objectives and shifted to phase two (Eradication) operations. On March 9, the UCG completed phase two (Eradication) objectives and shifted to phase these (Recovery) operations. Recovery operations continued for several weeks.

Not all news is bad—DOTs that are coping with the major consequences of the pandemic are often successfully maintaining construction schedules for funded projects, and even leverage the unprecedented opportunities presented by record-quiet roadways—particularly during mid-week, daytime travel hours. For example, local news outlet, *Community Impact Newspaper*, described a number of TxDOT projects speeding to completion due to lighter roadway travel. In April 2020, it reported:

> Despite the coronavirus outbreak, contractors are making progress on transportation projects around the Bay Area. The COVID-19 pandemic has not delayed road work, officials told *Community Impact Newspaper*…In fact, the outbreak may lead to some parts of the project being completed sooner, said Danny Perez, a Texas Department of Transportation public information officer. 'We agree that lighter traffic on our roadways potentially presents some opportunities to advance some of our work, and that is being assessed on a case-by-case basis,' Perez wrote in an email. 'That said, there are a few opportunities where our contractors have already been able to advance some of their work…Due to lighter traffic, some contractors are asking for extended road closure times to speed up their work,' Perez wrote. 'In such cases, the contractor is being allowed to work in some areas for longer stretches of time, specifically because peak travel periods are not as congested as they would be under 'normal' circumstances,' Perez wrote. Additionally, the widening of Hwy. 146, another TxDOT project, is unaffected by the coronavirus, according to online schedules of road closures (Magee 2020).

TxDOT Bay Area transportation projects are presented in Figure 4-23.

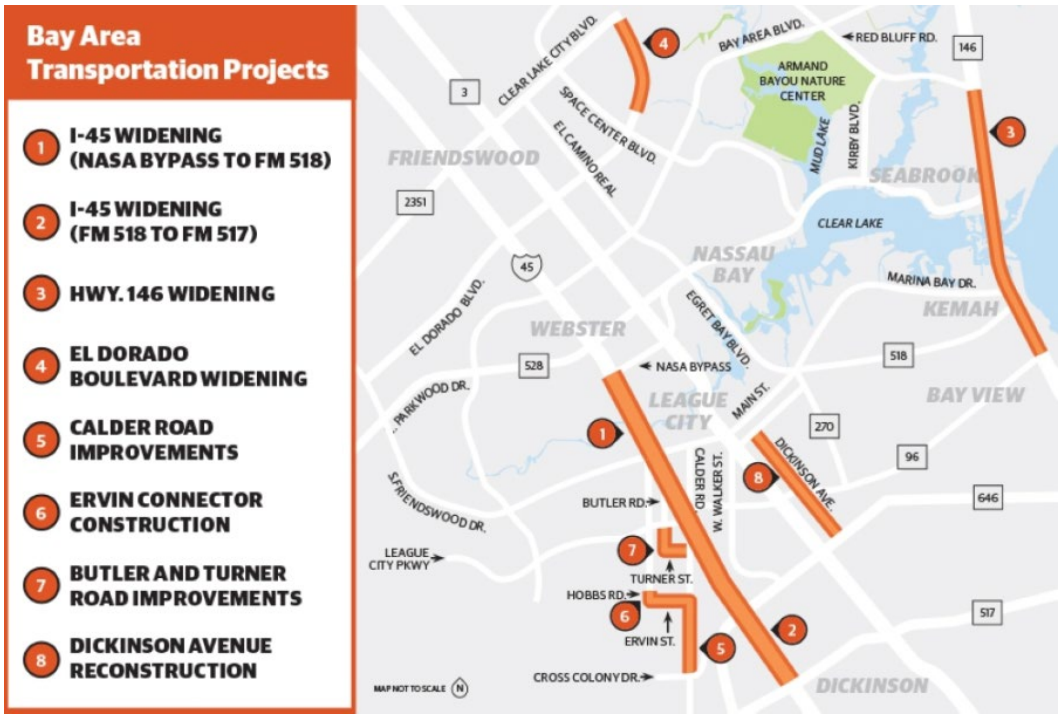


Figure 4-23: TxDOT Bay Area Transportation Projects

Opening the aperture to the nation's largest transportation network, the NY MTA, which serves an estimated 15.3 million people, faces a $7 billion to $8.5 billion deficit this year alone due to COVID-19 according to the *New York Post* citing an August 2020 report by consulting firm McKinsey. "Even with an infusion from the Federal CARES Act (Transit funding), this spells not so much a budget deficit as a budget bomb" (Gelinas 2020). The article goes on to state:

> Ironically, COVID-19 conditions make for 'renovation prime time.' Low ridership has enabled the MTA to accelerate $2 billion worth of work, including repairs on its underwater tunnel between Brooklyn and Manhattan and the installation of 11 elevators. Signal modernization could be next. If the MTA can obtain Federal funding, tied to reform, this could signal the best solution. Why not take advantage of historic low ridership to do more work, more quickly, without inconveniencing passengers? If Federal funding isn't forthcoming, the authority should at least prioritize repair and replacement, argues political scientist Philip Plotch (Gelinas 2020).

Opportunities are developing, too, to try to imagine future opportunities the unintended pandemic consequence of air quality improvements due to reduced greenhouse gas emissions, and robust discussions continue on connected and automated vehicles as well as rapid expansion of electric vehicle use.

The pandemic is catalyzing temporary and durable shifts that were almost unimaginable at the beginning of the new decade. Changes are unfolding related to ADT and commute times and costs, impacts to toll roadway use and revenue, decreases in transit and increases in bike and pedestrian transportation, shifts in the "gig" economy addressing "last mile" needs, potential population migration back into the suburbs

due to decreased costs, population density, and shuttering of local businesses. Protecting transportation agencies from these impacts may be nearly impossible, but shepherding the adaptation of the agencies is squarely in the "guardrails" of transportation professionals to innovate for the new normal.

There are no simple answers to address multiple, concurrent emergencies and disasters, but planning for personnel requirements in the incident command, training, and exercise events, and having contract capacity in place for the full range of possibilities will optimize administrative success. That necessitates planning for all hazards in concurrent situations because, although probabilities are small on outlier events, regional-scale events, and even smaller for multiple, concurrent events, the potential for adverse impacts are multiplied for people and communities, the environment, and economic health.

4.8.4 Resilience and Climate Adaptation

It is well established that DOTs and their assets are vulnerable to extreme weather events, such as hurricanes and flooding. As climate change is predicted to increase the frequency and intensity of these events, climate resilience and adaptation must be integrated into DOT and MPO planning, designing, constructing, and maintaining infrastructure. This is especially true for DOT assets, such as roadways, which have a long service life. The FHWA's Vulnerability Assessment Adaptation Framework manual can help transportation agencies assess the vulnerability of transportation infrastructure to extreme weather and climate effects (FHWA 2017b).

"We have to consider how much money does it cost to just replace the asset as it was, compared that to what was the impact to the public/community/traveler/user of roadway when this asset is out of service? There is a tradeoff, because we don't have unlimited funding."

– Heather Paddock, Flood Recovery Manager at CDOT for the 2013 Flood

Assessing multi-hazard threats and current and projected impacts of climate change are key components of readiness for DOTs and MPOs. To adapt to climate change is to implement forward-looking planning and design to have reliable infrastructure that can withstand ongoing and future climate threats. Regions can strengthen disaster and climate by incorporating climate change considerations during all major stages of project scoping and development, and then during recovery project execution (FHWA 2017b; Maxwell et al. 2018). FHWA is developing resources to assist transportation agencies with integrating resilience into the transportation planning process. For more information, visit the FHWA's Sustainability and Resilience website at: http://www.fhwa.dot.gov/environment/sustainability/resilience/

In its transportation planning resources shown in Figure 4-24, below, FHWA (2017a) outlines opportunities to incorporate resilience into transportation planning.

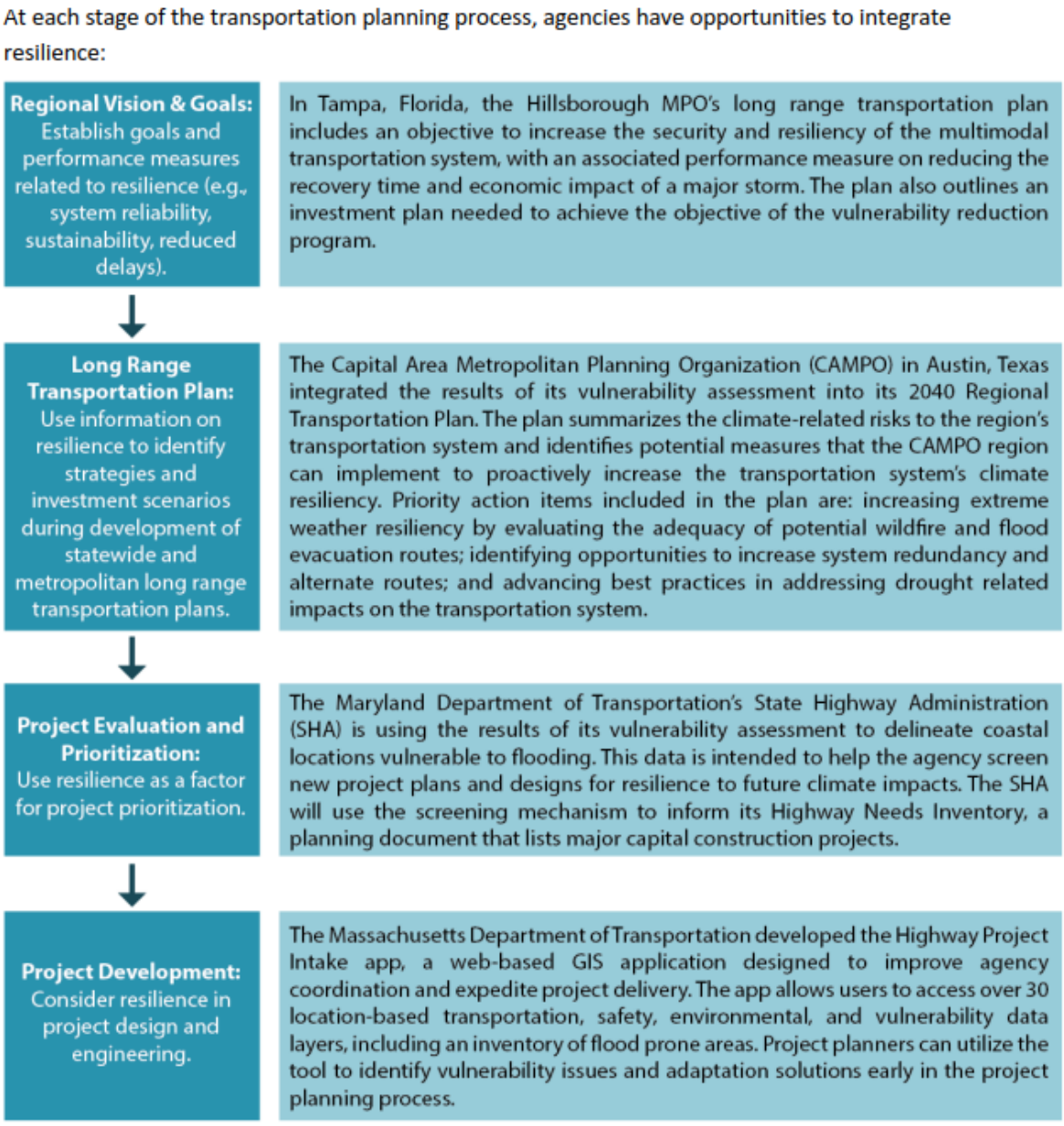


Figure 4-24: Planning stages at which agencies integrate resilience (FHWA 2017a)

For example, triggers can be established by a DOT to facilitate effective planning and implementation to reduce risk before or respond to concurrent, regional emergencies. Triggers can be built around a number of criteria to assess and then mitigate risks for a regional system as a whole, or to transportation corridor-specific characteristics. Once a DOT has established its risk assessment and mitigation priorities, transportation planners, economists, and engineers can work collaboratively with procurement and contracting peers. Together, they will be well-equipped to integrate the DOT's risk assessment and risk mitigation objectives and key decisions into DOT-wide or project-specific procurement, contracting, and project delivery actions.

Some of these initial risk assessment and mitigation decisions that could trigger defined administrative actions might include the following:

To Assess Risks

- ✓ Define hazard and vulnerability profile;
- ✓ Assess availability of redundant route (and its vulnerability profile);
- ✓ Assess probability of impacts and damages by hazard type and severity and suite of risk mitigation strategies and triggers, and when and how any triggers are applied in procurement, contracting, and project delivery monitoring;
- ✓ Identify potential consequences in disaster impact areas and define associated requirements (e.g., prioritize route if disaster impact is located near a high population of bus transit-dependent seniors or the corridor is adjacent to a regional medical center), and how those requirements translate into contract terms and conditions and project delivery monitoring;
- ✓ Identify barriers to risk mitigation and develop work-around strategies such as securing right-of-way in advance of projected population growth.

To Mitigate Risks

- ✓ Establish standards and specifications required for resilient reconstruction based on the severity of disaster damages and other key considerations, and when and how they are applied in procurement, contracting, and project delivery monitoring;
- ✓ Establish requirements or goals for sustainability or climate adaptation (e.g., relocate asset out of the floodplain if severely damages), and when and how they are applied in procurement, contracting, and project delivery monitoring;
- ✓ Define requirements and methodologies for conducting cost-benefit analysis and RoI calculations and what requirements are applied in procurement, contracting, and pre-construction work. Also, clearly segregate scope between parties responsible for developing the analysis results (e.g., economists) from parties using the analysis results (e.g., engineers) in pre-construction work;
- ✓ Define design requirement for consultant engineers to develop resilient design alternatives during schematic design (e.g., 15% design), and when design alternatives are required;
- ✓ Determine if and when adaptive capacity should be included in an asset's design approach to provide flexibility into future capital expenditure projects (e.g., when climate threat hazard data or population growth are uncertain during the useful life of the asset). Clarify requirements and responsible parties clearly, and define how assumptions will be identified and approved before using in the design approach.

By going through this process before an emergency or disaster, the agency can better respond and prioritize recovery efforts. This process is also depicted in the following Figure 4-25 (FHWA 2017b).

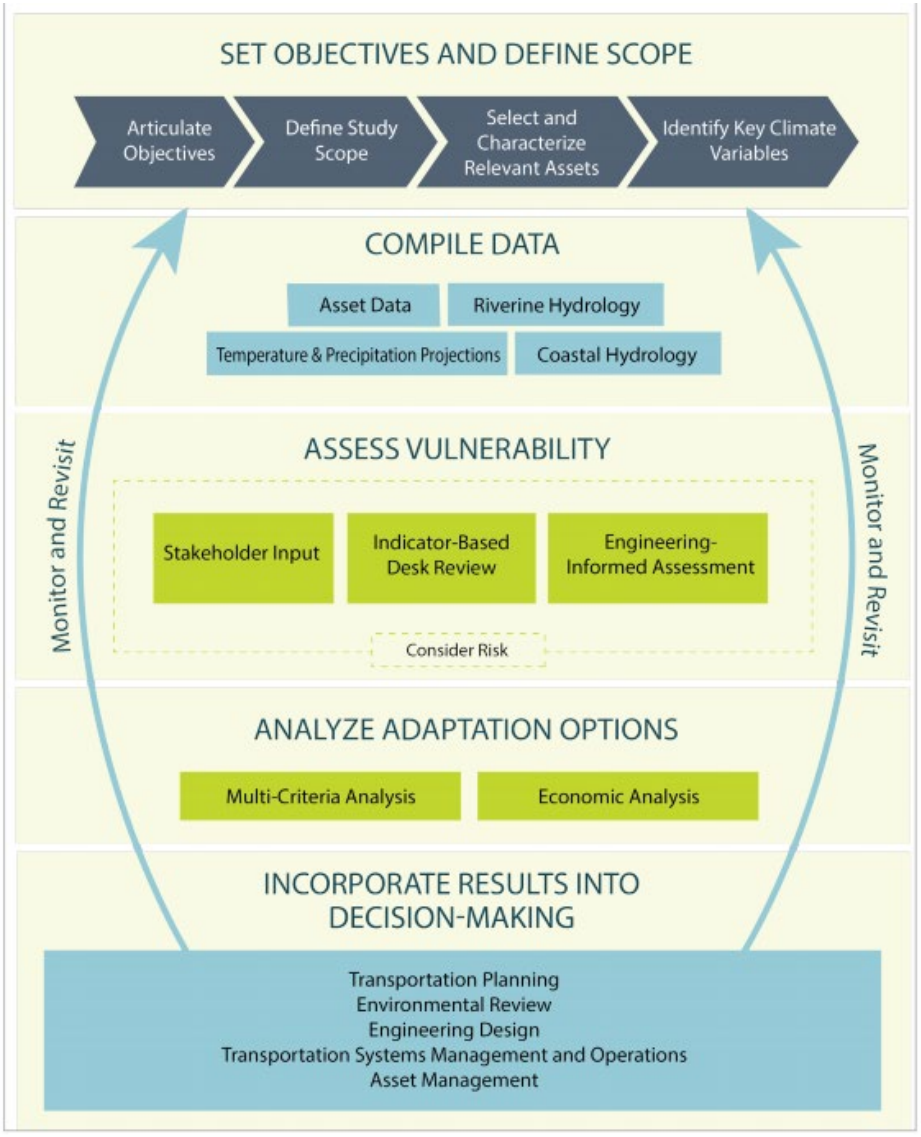


Figure 4-25: FHWA's vulnerability assessment adaptation framework

Characterizing the population can be accomplished by reaching out to local and regional entities such as city or county planning departments that are resourced with expertise in accessing, providing, and interpreting social and economic data. Additional resources include local area institutes of higher learning (e.g., departments of business, economics, geography, planning, political science, public administration, and sociology in universities and community colleges); research centers; chambers of commerce; consulting firms; and other organizations with data and analysis capacities that likely have a vested interest in supporting readiness. Examples of questions to ask about your community during readiness are captured in the callout box below, adapted from NIST (2016).

FHWA has been increasing the integration of climate change vulnerability and risk into all aspects of transportation decision-making. FHWA issued Order 5520: Transportation System Preparedness and Resilience to Climate Change and Extreme Weather Events, in 2014. The order establishes FHWA policy on preparedness and resilience to climate change and extreme weather events.

This means that climate change must be a part of planning, including administrative control planning in contracts and procurement. The Fixing America's Surface Transportation (FAST) Act (2015) expands the scope of the metropolitan planning process to "improve the resiliency and reliability of the transportation system." For the statewide transportation planning process, it expands the scope of consideration to include projects, strategies, and services that will improve the resiliency and reliability of the transportation system (Holsinger 2017).

The list below was published by FHWA and includes the process FHWA, DOTs, and LPAs should follow for integrating resilience into ER Program decisions. The following excerpts are relevant to readiness (FHWA 2018a):

> Prior to disasters, ensure that state and metropolitan transportation plans and state asset management plans include resilience and risk considerations as required by Federal regulations. This facilitates incorporating resilience considerations in decisions such as siting new transportation facilities, allocating funds to rehabilitate or protect assets, and including adaptive action in regular maintenance and rehabilitation of assets. See https://www.fhwa.dot.gov/environment/sustainability/resilience/ for technical assistance.
>
> Ensure that the state DOT has completed the evaluation of facilities repeatedly requiring repair, as required by 23 CFR Part 667. Information and strategies in these documents can inform resilience improvements pursued in project development inside and outside of the FHWA ER Program. See *Questions and Answers Regarding Implementation of 23 CFR Part 667: Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events* for guidance (FHWA 2018b).

Examples of Questions to Ask About Community Readiness

- ✓ Are there geographic concentrations of vulnerable populations in the community, such as low-income households, older adults (ages 65+), individuals living with disabilities, and others? If so, where are these populations located? How might their locations further increase their vulnerabilities in the event of a disaster?
- ✓ Are there substantial numbers of non-English speaking populations in the community? If so, are they geographically concentrated in specific areas of the community?
- ✓ To what extent do residents have access to transportation (public or otherwise) in an emergency? Are there geographic concentrations of populations without the ability to evacuate in the event of a disaster? What is the proportion of transit-dependent people?
- ✓ Are key businesses and industries located in hazard-prone areas in the community? What transportation routes are critical for response and recovery efforts?
- ✓ Are health care facilities, including hospitals, urgent care facilities, dialysis treatment facilities, and residential care facilities located in hazard-prone areas in the community? What transportation routes are critical for response and recovery efforts? How can information about the community's social dimensions, including social capital, be leveraged or used in the context of planning for transportation needs and mitigation efforts?

Credit: NIST 2016

The body of research and practice in resilience and climate adaptation is growing and dynamic as more transportation professionals innovate new ways to anticipate, respond, and adapt to emerging threats. AASHTO's Center for Environmental Excellence delivers on its billing as a One Stop Source for Environmental Information for Transportation Professionals. Developed in cooperation with FHWA to promote environmental stewardship and innovation to streamline the transportation delivery process, it offers transportation professionals technical assistance, training, information exchange, and opportunities to build partnerships and provides ready access to environmental tools. Uniquely, it recognizes the complexities involved with the legal and regulatory considerations that must be successfully navigated to make advances in sustainable resilience.

For example, the Center for Environmental Excellence includes a programmatic agreements library. Although library entries need to be considered through the lens of a DOT's regulatory and policy framework, as well as transportation and sustainable resilience goals, the library's 76 entries offer the potential to save many people hundreds of research and writing hours of these often long, procedurally heavy documents, and provide examples that have been tested. Such agreements cover NEPA Categorical Exclusions, the Endangered Species Act, and the (Section 106) National Historic Preservation Act, as well as transportation enhancements and land management.

The Center for Environmental Excellence maintains case law updates on the environment, and organizes a comprehensive review of case law summaries for policy makers and practitioners. The updates are organized into a "database (that) primarily includes recent court decisions involving challenges to environmental reviews and permits for highway and transit projects."

AASHTO's Resilient and Sustainable Transportation Systems Technical Assistance Program helps DOTs understand the effects of climate change and strategies and options for climate change mitigation and adaptation. The technical assistance program underpins AASHTO's 2017 *The Resilient and Sustainable Transportation Systems Steering Committee Action Plan (2017–2019)*, which keys into Policy Development as one of four core strategic goals. In addition to published resources available through the Center for Environmental Excellence, technical assistance requests can focus on administrative procedures and controls to optimize reliance and climate adaptation objectives, in addition to the bevy of requests for best engineering practices.

AASHTO's Center for Environmental Excellence website can be accessed at: https://environment.transportation.org/environmental_topics/infrastructure_resilience/recent_dev.aspx#.

With over $700 million in 2013 flood damages, CDOT had more rapid repair and resilient recovery work to perform than dollars available, despite critical funding from FHWA ER. CDOT deployed an RnR benefit-cost analysis methodology based on roadway segments and structures that FHWA and CDOT had agreed were "severely damaged" in DDIRs. In advance of this issue, FHWA and CDOT defined "severely damaged" in a co-signed policy memorandum to promote consistency, which was part of CDOT's larger structure of administrative controls for FHWA-supported emergency repairs and permanent repairs.

Although much of the discussion about sustainable resilience and climate adaptation are, appropriately, focused on how to optimize protection of transportation assets and supporting adjacent and cascading risk avoidance, there are merits to keeping all options on the table.

Increasingly, that should include consideration of designing assets not only to absorb impacts of stresses and shocks, but even to fail with as few adverse impacts as possible. For rural STTLs and communities that experience "sunny day" flooding, such as in Southeast Florida and along portions of the Florida and the Gulf Coast, this may well be a necessity. In CDOT's case following the 2013 flood, assets that were generally not severely damaged and were not escalated through the prioritization process driven by RnR benefit cost analysis outcomes were evaluated for restoring to pre-disaster condition. This occurred even where resilience solutions were technically feasible. CDOT considered ADT and freight utilization, route redundancy, and other special factors such as the route's role in handling restricted materials, and access for emergency vehicle and military asset access, as well as access to major or growing population centers when contemplating higher protection standards. Examples of roadways that were not built sometimes involved low-water crossings or other rural routes in Colorado's Eastern Plains that could be quickly and inexpensively repaired if damaged in a subsequent flood event. In some cases, roadways that might fail in the future (e.g., in a 50+ year rate-of-return event) were hardened using innovative materials to better absorb the shock of repeated (water) overtopping. That brings the reader back to the question of administrative controls to meet DOT objectives.

"You're evaluating the system as a whole. There are areas where mother nature will win and maybe it's not worth the infrastructure investment and have planned failures."

– Heather Paddock, Flood Recovery Manager at CDOT for the 2013 Flood

In addition to the above considerations on resilience and climate adaptation involving DOT personnel, contractors, Federal and STTL partner organizations, and the traveling public, transportation professionals need to revisit the policy implications of the new normal. For example, sweeping pandemic impacts show ADT and bus use down; and car use, walking, and bicycling up. Concurrent, regional emergencies and disasters present new opportunities to pivot to the new normal and the future normal to capture co-benefits for people and communities, environmental sustainability, and economic stability and growth.

These may take shape through fast-tracking regulatory and policy support of zero-emission and connected and automated vehicles, expansion of complete streets, leveraging other opportunities to promote safe lane access for higher volumes of pedestrians and cyclists, all within the context of concurrent, regional emergencies and chronic stresses such as poverty and climate change. At the same time, transportation administrators will be called on to help develop actionable strategies to address the financial health of their respective agencies. The confluence of the decade's stresses and shocks may result in seismic organizational shifts as the future state comes into view.

5 Rapid Response

Life-saving activities are the singular priority following any shock. However, following concurrent, regional emergencies and disasters, the baton must quickly pass from emergency managers leading life-safety operations to the transportation professionals charged with delivering an emerging portfolio of rapid response projects. Their charge is to assess and stabilize roadways and structures, restore essential traffic, and begin planning for resilient recovery.

The first order of business is to understand and continue to maintain a common operating picture (COP) on the shock(s) impacts and consequences, including any agency and key partner situation reports and actions to date. In the best circumstances, those responsible for leading rapid response and resilient recovery are already mobilized and co-located with emergency managers in the emergency operations center (EOC)−listening to, conferring with, and supporting peers who are executing life-safety operations while laying the groundwork for the imminent work ahead.

"Initially, we told everyone to go out and take a lot of photos to document the damage, but we lacked practices on how to data-collect. We have made a lot of progress in the GIS environment and turned around our process to create dashboards. We also centralize how we collected information."

– Heather Paddock, Flood Recovery Manager at CDOT for the 2013 Flood

The backbone of effective response and recovery operations includes a right-sized and right-skilled team working within an effective organizational structure that has ready access to truly useful data−by design. Taking adequate time to set up administrative structures, systems, and controls is an inflection point between structuring for success or choosing to accept controlled chaos.

In the NCHRP 08-107 survey, over 70% of disaster professionals indicated that state and local government entities (applicants) do not have a clear understanding of how to restore temporary assets (rapid response phase). See Figure 5-1.

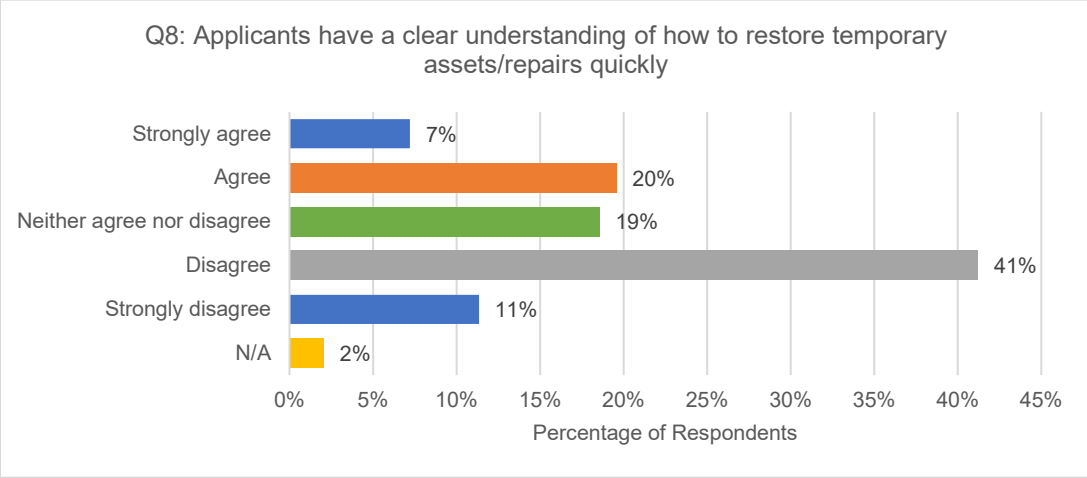


Figure 5-1: NCHRP 08-107 survey question 8 (graph, AECOM)

To promote meaningful buy-in, it is important to involve personnel mobilized in the rapid response organization to shaping the mission they are working collectively to accomplish, along with the goals that underpin mission-success. The rapid response mission should cascade from the transportation agency's mission. Goals should be concrete, measurable, and achievable. The rapid response mission is useful to break down silos, to keep all mobilized personnel working towards the same big picture outcome, and to provide clarity in dynamic and sometimes politicized post-disaster environments.

"Alignment of Rapid Response goals, objectives and efforts to achieve them is an absolute necessity which cannot be overstated. It is the single most variable factor affecting achievement of success."

– Tom Prendergast,
Former Chairman, NYMTA and
Former CEO, NY MTA Transit

CDOT established its rapid response mission and goals (described as Infrastructure Recovery Force) for the 2013 flood presented in the call-out box. CDOT developed a separate recovery mission when it shifted to its resilient recovery organizational structure (see Chapter 5).

CDOT 2013 Flood Mission Statement

"Conduct an aggressive response and recovery campaign to repair destroyed and damaged roads and bridges which will allow other CDOT resources to continue normal day-to-day operations and the delivery of newly established RAMP* program."

Disaster Operations Goals:

1. Efficient Project Delivery
2. Build Back Better – Risk and Resiliency
3. Maximize Eligible Funding
4. Mitigate Audit Risks
5. Data/Document Management
6. Effective Communication

RAMP: Responsible Acceleration of Maintenance and Partnerships (capital expenditure program)*

See full mission, values, and goals in Appendix G.4

Most DOTs use the incident command system's (ICS's) inter-operable organization structure to manage life-safety operations. However, the ICS's modular and scalable features, combined with its clear chain-of-command and a sound structure, make it ideal for rapid response and resilient recovery. The use of ICS encourages a COP and close coordination on all aspects of task performance and project delivery, which is valuable given the incomplete information, dynamic field conditions, and rapid-fire decision-making that characterize the rapid response phase, in particular. This work can be integrated into one centralized command environment, or can be mobilized using a hub-and-spoke model deployed across many regions or ICS sections.

When adjusting the modular and scalable ICS organization structure to move the baton from life-safety operations to rapid response and recovery operations, it is important for personnel to cross-train counterparts wherever feasible. Oftentimes, personnel leading and delivering life-safety operations immediately demobilize leaving avoidable gaps in the common operating picture and facilitating transitions of work such as debris removal and intelligent transportation systems/roadway signage contracts.

Make sure the organizational structure serves the mission by resourcing it with competent people, sufficient numbers of positions to avoid bottlenecks, and positions that scale up or down based on need. When responding to a concurrent, regional emergency, it is not unusual for 80 to 100+ personnel to be dedicated full-time in the rapid response ICS structure across all sections. This excludes maintenance personnel and construction contractors performing work in the field. These numbers are typically cut in half (or more) once the rapid response phase shifts to resilient recovery, and permanent repair projects are planned and under contract.

"When assigning resources to lead and manage the Rapid Recovery efforts focus needs to be placed on making sure that critical incident command personnel are available for the entire duration of those efforts and that those staff are not overworked and/or totally spent such that none are available when needed. This is especially the case for incidents/events where the recovery takes days and not just hours. Failure to do so will likely result in employees being placed in compromising positions, unsafe conditions and/or unable to make sound decisions."

– Tom Prendergast,
Former Chairman, NYMTA and
Former CEO, NY MTA Transit

Drawing on ICS organizational structures, DOT disaster plans, and working with partner agencies in a joint command environment to support the COP and to identify ways to solve problems is essential, and avoids duplicative or conflicting work. This is discussed under DOT Plan Coordination in Section 4.1, below. Section 4.2 through Section 4.8 address critical issue areas for effective administration of the rapid response phase, including scope and scale of the emergency or disaster, prioritization and capacity, flexible arrangements, innovative delivery, audits and other risks, funding and policy, and other relevant considerations such as social dimensions of rapid response, cyber incidents, pandemics and COVID-19, and resilience and climate adaptation.

5.1 DOT Emergency Plan Coordination

- ✓ Activate emergency plans, and identify additional resources required to align administrative policies and procedures, and coordinate partnerships; and
- ✓ Activate an incident command system (ICS) structure.

5.1.1 Activate Emergency Plans, and Identify Additional Resources Required to Align Administrative Policies and Procedures, and Coordinate Partnerships

Inviting key stakeholders into a DOT's Incident Command Structure as partners or has been cited repeatedly as instrumental in saving time, avoiding confusion, garnering clear agreements, and collecting signature concurrence on key decisions and actions. Organizations that are typically represented within a DOT's command structure include liaisons from Federal agencies such as FHWA; FEMA; impacted MPO(s); local agencies; and the state office of emergency management (OEM). Where deployed on transportation-related missions, other organizations include state highway patrol, the applicable local utilities, and sometimes at the governor's request, the Army or Air National Guard. For human-caused emergencies or accidents, Federal and state investigation agencies are typically included such as DHS, the Federal Bureau of Investigation (FBI), and Nuclear Regulatory Commission.

The DOT's incident commander typically liaises daily with key officials in the governor's office, the DOT's CEO, and Transportation Commission to provide situation reports and address questions.

Situation reports provide daily data on safety data such as weather reporting and key metrics related to the event response such as the status of disaster declations, the number of bridges cleared to handle live traffic loads, information on closed assets and durations of downtime, cubic yards of debris removed, and assets inspected for damage, and status of funding.

In addition, the DOT's private-sector professional services consultants support program management and funding and compliance and/or augment gaps in the incident command system organization structure, discussed below.

Following concurrent regional emergencies and disasters, Federal agencies are frequently tapped to provided leadership for roles defined within the Department of Homeland Security's (DHS's) National Response Framework (Fourth Edition, October 28, 2019). For example, following Presidentially-declared emergencies, the USACE may be tasked by FEMA to lead critical infrastructure-related operations. A USACE task, often called mission assignment, can be activated though either a FEMA-approved gubernatorial request or assigned directly from FEMA to USACE (Federal-to-Federal support). A DOT's emergency plan activation should benefit from coordination and agreements developed during the readiness phase. Where Federal and other government agencies are involved, emergency plans that contemplate Federal agency support should be structured to capitalize on the benefits of and comply with regulatory frameworks such as provided through the authority of FEMA's Stafford Act and expressed in the National Response Framework (2019).

Leveraging partnerships can put available capacity to work for the benefit of the transportation network and communities across impacted region(s). The following vignettes describe partnerships activated during the rapid response phase:

- Through a multi-agency partnership, USACE led a Dewatering Task Force following Superstorm Sandy (2012) that included MTA, New York City DOT, the Port Authority of New York and New Jersey, and Con Edison, and successfully undertook FEMA-mission assignments to:

  > "…remove 270 million gallons of saltwater from tunnels, underpasses, and other areas in the NY metro area within two weeks of Sandy making landfall. In total, the mission involved the removal of 470 million gallons of water from the metro area, enough to fill all 843 acres of Central Park with roughly two feet of water. Dewatering operations included MTA's Brooklyn Battery Tunnel (est. 86 million gallons), the World Trade Center / PATH Train (est. 20 million gallons), MTA's South Ferry Subway Station (est. 20 million gallons), 14th Street Tunnel-Canarsie (est. 3.5 million gallons), the Battery Park Exchange (est. 57 million gallons), the Montague Tunnel (est. 60 million gallons), and the Amtrak Substation Kearny (est. 40 million gallons)" (USACE 2012).

- In addition, "MTA completed dewatering operations at Queens Midtown Tunnel (est. 2 million gallons) and the 53rd Street Tunnel (est. 2 million gallons); the New York Department of Transportation completed dewatering at the Metropolitan Avenue Bridge" (USACE 2012).

- The U.S. Coast Guard conducted boat removal operations of approximately 850 vessels from bays in the U.S. Virgin Islands and Puerto Rico following Hurricanes Irma and Maria under its designated Emergency Support Function Number 10 (Allen 2018). Additionally, the U.S. Coast Guard reunited boat owners with their vessels, removed over 3600 hazardous chemical containers, and removed tens of thousands of gallons of oil water. They worked in close coordination with local officials, FEMA, and NOAA;s Office of Response and Restoration, which help lead the protection and restoration of impacted coral colonies (Gray 2018).
- Following Colorado's 2013 flood, a successful partnership was mobilized to leverage available capacity and reduce system downtime. The Governor of Colorado engaged the support of the CO Army National Guard to provide construction labor on US Highway 36, overseen by CDOT with support of a construction contractor. The contractor, experienced with CDOT roadways, provided training to Guard Members on the project, as well as furnishing construction management on the project. The work was performed under the aegis of an exercise by the CO Army National Guard and provided critically needed construction capacity for CDOT and the State, while concurrently restoring essential traffic on both the US 34 and US 36 corridors. Both corridors pass through the Rocky Mountains, and together provide the only direct routes to communities cut off by the flooding of multiple rivers. The effort was threatened by a Federal government shutdown that began only weeks after floods began, and the sitting governor authorized payment of Guard Members from the State's emergency relief fund.

DOT plan coordination takes many forms. Partnerships can add needed funding, technical expertise, and capacity, as shown above. However, new requirements, policies, and procedures introduce many questions within a transportation agency, as well. Largely focused on internal communications, the tool in Figure 5-2 was developed at the request of regional engineering and maintenance leadership at CDOT who needed to know how to get emergency- and disaster-related answers quickly and with reliable information. This tool was developed to flatten the chain of command and promote an inter-operability matrix accessible to the whole organization, which is discussed in detail in Section 5.1.2, below. This data should be managed within the system of record tied to project documentation. Key data can also be recorded in a GIS-enabled dashboard so that the project data can be compiled across the portfolio of projects and viewed from a number of lenses such as by project type, key complexity or resilience factor, and/or impact zone.

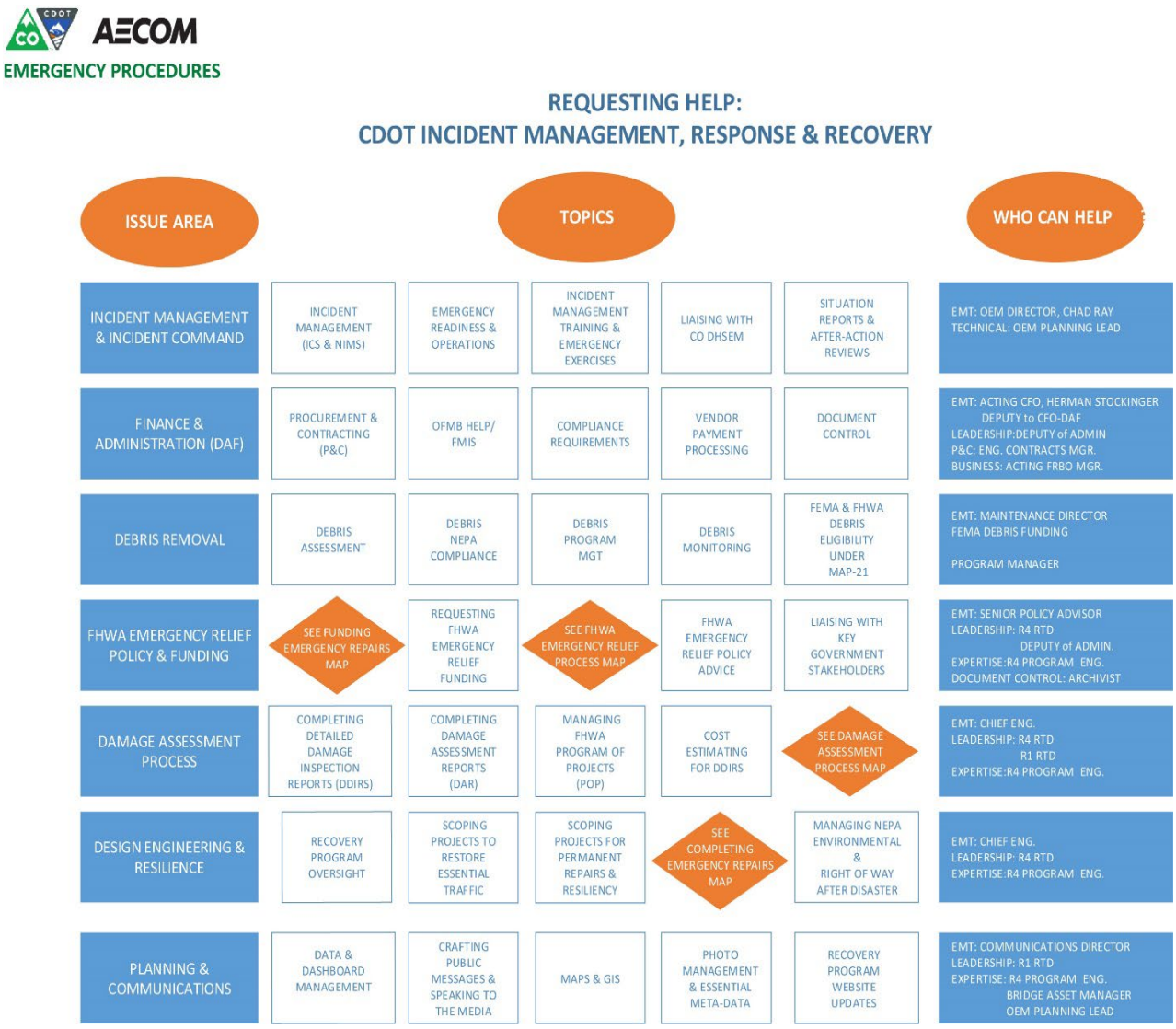


Figure 5-2: CDOT Requesting Help

5.1.2 Activate the Relevant Incident Command Structure

A relevant incident command structure for the whole transportation enterprise involved in rapid response is critical. Partner organizations and key internal resources such as the finance and administration section are essential personnel within the ICS to drive rapid response operations successfully.

It is important to step back and consider partnerships in the rapid response phase that are an important variable in success. Figure 5-3 shows the ICS structure typically used to manage an incident while an emergency or disaster unfolds, and mirrors the ICS structure included in FEMA's (March 2018) presentation of ICS Organizational Structure and Elements extracted from -E/L/G 0300 Intermediate Incident Command System for Expanding Incidents, ICS 300. The ICS structure provides a standardized, interoperable approach to the command, control, and coordination for mobilized personnel to provide on-scene life-safety operations.

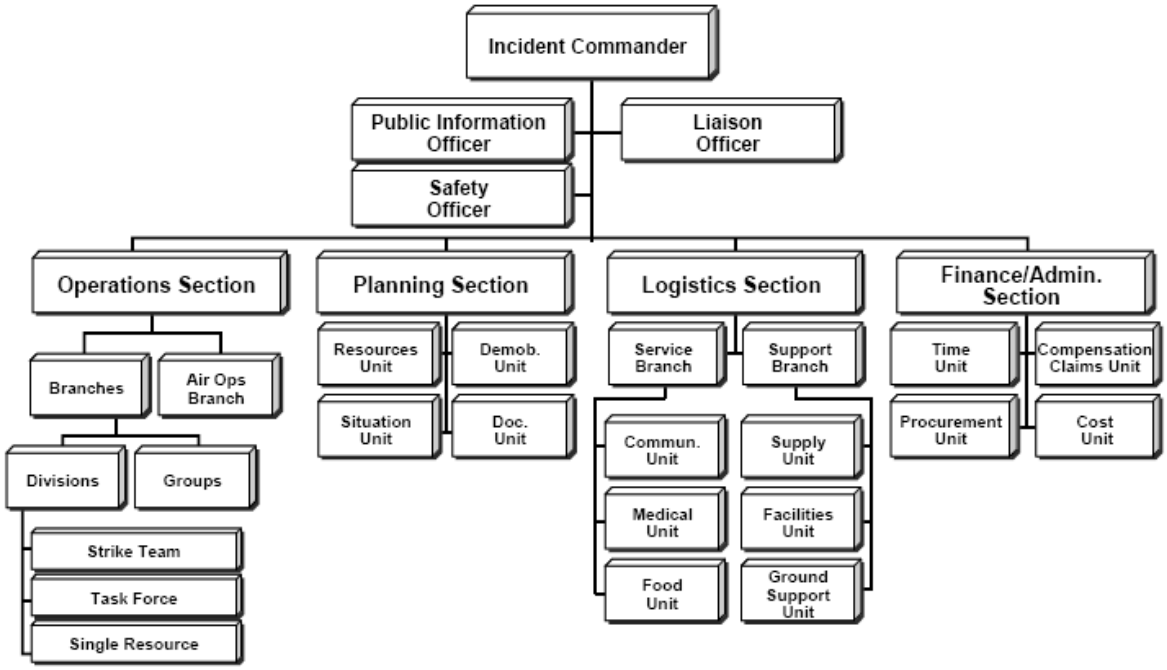


Figure 5-3: Typical ICS structure

The Report and the Guidebook describe sections and positions using ICS terminology throughout Chapter 4 through Chapter 6 for consistency. The ICS uses a modular and scalable organizational structure that has five primary components or sections. FEMA presents a cursory description of incident command sections as shown in Figure 5-4. However, in its "who does what" response describing ICS section functions, FEMA does not capture the magnitude of responsibilities or the complexity of the work required by ICS sections to collaboratively deliver potentially billions of dollars of transportation infrastructure in an integrated and cohesive portfolio of rapid response and resilience recovery projects.

"It's important for people to be trained on the whole implementation of ICS and the benefits of it. Over the course of a couple years of training, ICS becomes second nature and how we do business. In an emergency situation where lives are at stake, you need someone to give the orders. There is an efficiency in doing things the same way and following the same rules. The real challenge is for managers to keep their egos intact and understand the ICS process. You're going to stay in the loop, but you're not going to the be making the call."

– Jim Weinstein, AECOM and former Executive Director, New Jersey Transit and former Commission for New Jersey DOT

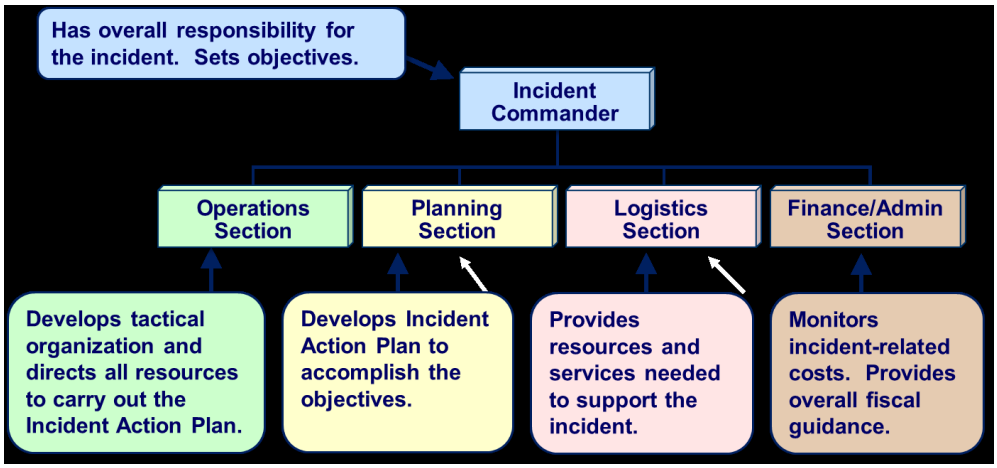


Figure 5-4: Who Does What? ICS Organizational Structure and Elements extracted from -E/L/G 0300 Intermediate Incident Command System for Expanding Incidents, ICS 300 (March 2018)

A summary of representative FEMA ICS chief roles and section chief responsibilities are derived from FEMA's ICS Organizational Structure and Elements extracted from -E/L/G 0300 Intermediate Incident Command System for Expanding Incidents, ICS 300 (2018a).

Incident Commander. The Incident Commander (IC) is responsible for:

- Having clear authority and knowing agency policy
- Ensuring incident safety
- Establishing an Incident Command Post
- Setting priorities, and determining incident objectives and strategies
- Establishing the ICS organization
- Coordinating Command and General Staff activities
- Ensuring after-action reports are completed
- Authorizing information release to the media
- Ordering demobilization as needed

Command Staff. The Command Staff is assigned to carry out staff functions needed to support the Incident Commander. These functions include interagency liaison, incident safety, and public information, and are assigned by the Incident Commander.

General Staff. The General Staff represents and is responsible for the functional aspects of the Incident Command structure (or sections). The General Staff typically consists of the Operations, Planning, Logistics, and Finance/Administration Sections. In some incidents, the General Staff may also include the Intelligence/Investigations Function, either operating under a staff section, or as a stand-alone section. General guidelines related to General Staff positions include the following:

- Only one person will be designated to lead each General Staff position
- General Staff positions may be filled by qualified persons
- Members of the General Staff report directly to the Incident Commander

- General Staff members may exchange information with any person within the organization. Direction takes place through the chain-of-command. This is an important concept in ICS

Operations Section Chief Responsibilities. The Operations Section Chief is responsible for managing all tactical operations at an incident. The Incident Action Plan (IAP), prepared for a defined planning period (e.g. daily), provides the necessary guidance. The need to expand the Operations Section is generally dictated by the number of tactical resources involved and is influenced by span of control considerations. Major responsibilities of the Operations Section Chief are to:

- Assure safety of tactical operations
- Manage tactical operations
- Supervise execution of operations
- Maintain close contact with IC, subordinate Operations personnel, and other agencies involved in the incident

Planning Section Chief Responsibilities. The Planning Section Chief is responsible for providing planning services for the incident. Under the direction of the Planning Section Chief, the Planning Section collects situation and resources status information, evaluates it, and processes the information for use in developing action plans. Major responsibilities of the Planning Section Chief are to:

- Collect and manage all incident-relevant operational data
- Supervise preparation of the IAP
- Provide input to the IC and Operations in preparing the IAP
- Incorporate Traffic, Medical, and Communications Plans and other supporting materials into the IAP
- Conduct and facilitate planning meetings
- Compile and display incident status information
- Establish specialized data collection systems as necessary (e.g., weather)
- Assemble information on alternative strategies
- Provide periodic predictions on incident potential
- Report significant changes in incident status

Logistics Section Chief Responsibilities. The Logistics Section Chief provides all incident support needs, with the exception of logistics support to air operations. The Logistics Section is responsible for providing:

- Provide all facilities, transportation, communications, supplies, equipment maintenance, and food and medical services for incident personnel, and all off-incident resources
- Identify anticipated and known incident service and support requirements
- Oversee demobilization of the Logistics Section and associated resources

Finance/Administration Section Chief Responsibilities. The Finance/Administration Section Chief is responsible for managing all financial aspects of an incident. Major responsibilities of the Finance/Administration Section Chief are to:

- Manage all financial aspects of an incident
- Provide financial and cost analysis information as requested
- Ensure claims functions are being addressed relative to the incident
- Gather pertinent information from briefings with responsible agencies
- Develop an operating plan for the Finance/Administration Section
- Meet with assisting and cooperating agency representatives as needed
- Maintain daily contact with agency(s) headquarters on finance matters
- Ensure that personnel time records are completed accurately and transmitted to home agencies
- Ensure that all obligation documents initiated at the incident are properly prepared and completed
- Brief agency administrative personnel on all incident-related financial issues needing attention or follow up

"The earlier that you can be prepared the better. I think that emergency management plays a really critical role, but other parts of the organization have to actually mobilize if disaster is large. That piece is often not set up in advance."

– Susanne DesRoches, former Engineer at the Port Authority during Hurricane Sandy

CDOT used the ICS structure for its 2013 flood rapid response and recovery operations, which it further refined based on flood lessons learned and best practices (Action Strategies 2015). CDOT received high marks from FHWA on the value of the ICS structure for its successful response and recovery. CDOT's ICS organizational structure was refined following its lessons learned and best practices to meet its specific post-disaster needs (distilled into Action Strategies disseminated in 2015) and its post-flood emergency procedures working group. CDOT ICS structures are included in CDOT's Emergency Plan and presented in Figure 5-5.

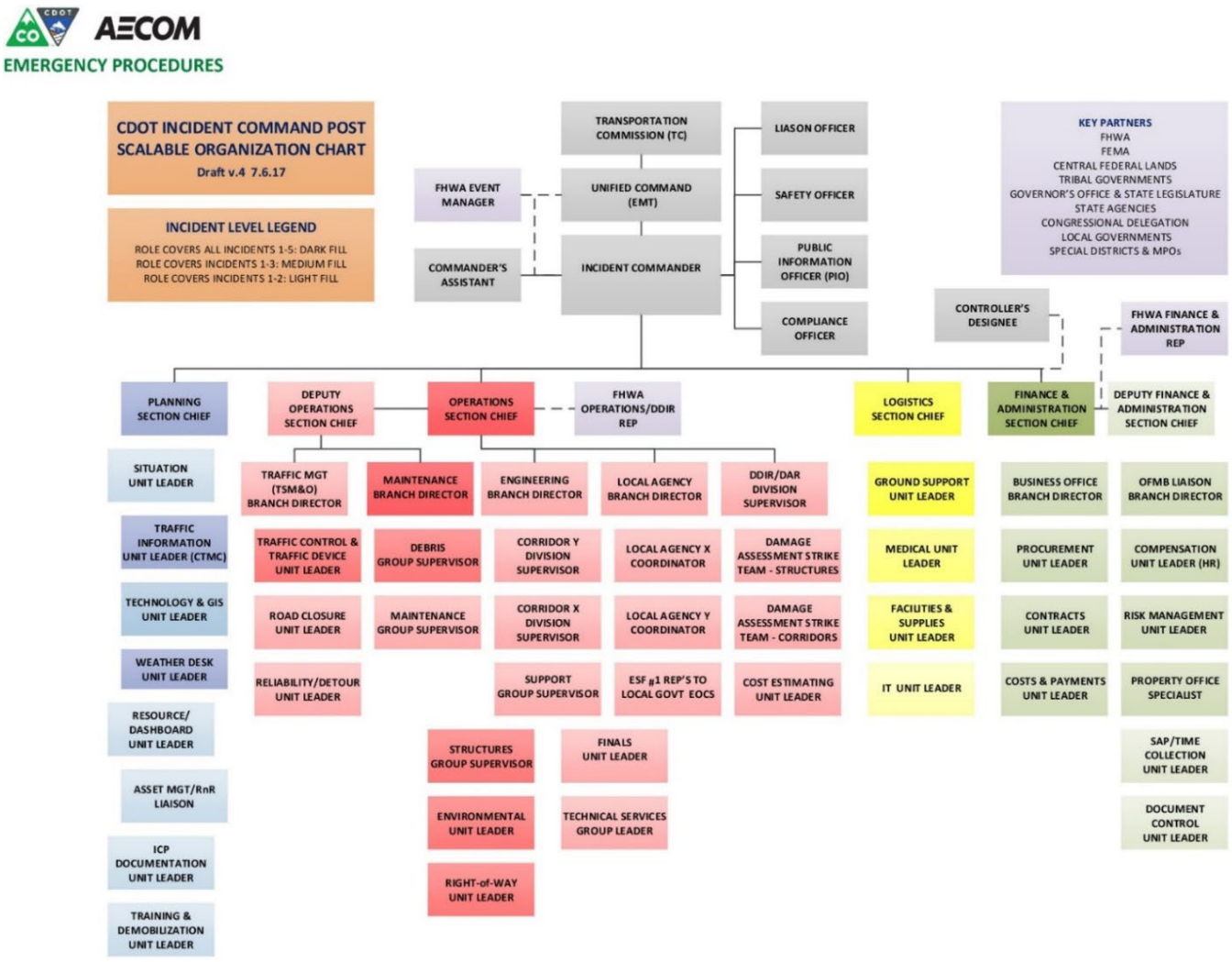


Figure 5-5: CDOT ICS organizational structure

When CDOT experienced a cyber-attack in 2018, it again activated ICS using a unified command environment. CDOT brought the following agencies into its unified command for the 2018 cyber incident:

- Colorado Department of Transportation
- Colorado Governor's Office of Information Technology (OIT)
- Colorado Division of Homeland Security and Emergency Management
- Colorado Army National Guard
- Colorado Bureau of Investigation
- Federal Bureau of Investigation
- Department of Homeland Security-Cyber
- Department of Homeland Security-Infrastructure Protection
- Department of Homeland Security-Hunt and Incident Response Team
- Federal Emergency Management Agency

- Federal Emergency Management Agency-MER
- Private cybersecurity contractors

CDOT credits ICS in the effectiveness of its rapid response and recovery operations in responding to the cyber incident response:

> This success may be attributed to a sound Continuity of Operations Plan that allowed CDOT to continue to operate and an OIT response that brought in the right people at the right time to contain and eradicate the threat. The creation of the UCG (unified command) provided a clear direction and control structure that unified and focused the efforts of the numerous government agencies and private contractors involved. Though the State effectively responded to and recovered from this incident without paying the ransom, the threat to the State and its networks remains (CDOT 2018).

Not all successful rapid response and recovery operations must use a co-located, unified command in order to be successful, but can draw from those elements that best support its success. For example, NY MTA Bridges and Tunnels followed the basic precepts of ICS following Superstorm Sandy, but teams remained organized within its normal operating structure. The Chief Engineer acted as incident commander, and department leads acted as section chiefs who met daily and later weekly, and as-needed. Often, those acting as section chiefs coordinate many times per day in addition to structured meetings. MTA Bridges and Tunnels engaged only a small handful of administrative and policy consultants in its Sandy response and recovery. The City of Calgary also used a hub-and-spoke organizational structure for its rapid response and resilient recovery operations following the 2013 flood, whereby a small response and recovery organization was built that liaised with all engaged departments across the City's Corporate enterprise. Calgary hired a consultant to advise and provide feedback on strengths and provide a gap analysis.

Urgent tasks related to transportation asset and corridor stabilization are often initiated during the life-safety operations phase by maintenance or contract forces and must be sustained for weeks and months rather than days due to the magnitude of a concurrent, regional emergency or disaster. While these activities vary by agency, but often include a number of essential functions. Activities typically include scaling-up traffic incident management systems (TIMS) and safety functions and coordinating with state patrol forces to keep the traveling public off unstable routes, and alert the public to travel-restricted roadways. Activities also include setting up detours, commencing debris management operations (to push debris to roadway shoulders, allow for utility restoration, begin roadway repairs, and/or make roads passable), stabilizing roadways to avoid further undermining, or enable emergency ingress and egress for shock-impact zones.

Often the personnel charged for life-safety operations in the ICS transition to others who will lead the multi-million or multi-billion dollar infrastructure reconstruction process in order to right-skill the ICS operation. Where there is a transition of personnel and responsibilities, it is essential that incoming Ops and Finance and Administration (F&A) section chiefs responsible for rapid response and resilient recovery be briefed in by section chiefs responsible for life-safety operations to get situational awareness about—and make go-forward decisions to transition from life-safety operations to rapid recovery

work—together. This includes sharing information about completed contracts (including mutual aid activities) activated in support of life-safety operations both to support the ICS environment as well as field work.

As part of any baton handoff, it is critical to tightly manage tasks and responsibility to migrate information and supporting documentation for completed and active work, contracts, and costs into the disaster's administrative system(s), data management systems, and dashboard reporting. Key tasks that support success include recording costs, contracts, and project numbers for past and current activities related to the event in the ICS system of record used for rapid response and resilient recovery. Make sure any general ledger adjusting entries or changes to project codes are completed as quickly as practicable. If coordination related to decision-making on past and current emergency contracts described above does not occur, then the transportation agency can create avoidable confusion, waste time and financial resources, inhibit capture of all eligible disaster funding, and invite audit risk exposure.

Battle Rhythm

It is important in any disaster response operations for the incident command staff to develop a battle rhythm that sets a predictable cadence for each day. Daily all-hands meetings, daily section chief's meetings, receipt of internal and external reports, and late-afternoon executive briefings involving the governor and staff, transportation agency director, and executive leaders such as the chief operating officer, chief financial officer, and controller, among others, are typically part of an effective response operation. Daily press briefings are also typical.

The all-hands meeting provides a time to share key messages and maintain a COP. Section chiefs often provide summary reports on work completed and urgent and important tasks. The all-hands is designed to allow anyone—regardless of position—to elevate time-sensitive information or concerns. As importantly, a daily all-hands meeting creates space to celebrate small successes that helps buoy spirits and maintain momentum. The in-person meeting format is often held standing up rather than around a table and is limited to 15 to 30 minutes. In a virtual meeting format, extra effort will need to be taken to promote free, two-way exchange. It is also valuable to include key partners in daily all-hands meetings to support the COP and stay current with recent decisions and changing conditions. Often, representatives include Federal partners such as FHWA and FEMA, USACE, the state office of emergency management, MPOs, state police patrol, and sometimes local agencies.

Staff Resources

After the first week, a rapid response team that has typically worked 16+ hour days begins to show signs of fatigue and can no longer function effectively—either physically or cognitively. Therefore, the incident commander needs to determine if the rapid response phase requires staffing to operate 24/7, or hours are greater than one person per role can safety maintain. Schedules that maintain one shift only and often structured at 12 to 14 hours per day, 6 days per week are common. If operations require 14- to 24-hour-per-day operations, a full or partial second shift (sometimes section chiefs and operations only) needs to be mobilized and cross-trained and requires scheduled shift-overlap (typically 1 to 2 hours) to harmonize operations. Determine and communicate direction on authority levels for each shift if more

than one is used (e.g., equal authority; decisions by joint concurrence; first shift empowered to make decisions, and second shift implements decisions).

Determine if the DOT has personnel to scale adequately for response operations. While rapid response periods vary widely for concurrent, regional disasters, 6 months is typical to sustain the operation at peak resource levels.

The DOT's executive leadership team, in consultation with the transportation commission or other governing board, and often with the governor, will decide if planned, pre-disaster capital expenditure work will continue as planned, modified, or ramped down to focus on the regional rapid response. The Port Authority of New York and New Jersey suspended planned capital expenditure work to respond to Superstorm Sandy. CDOT decided to move forward on all planned capital expenditure projects throughout the state unless the transportation asset was damaged by the 2013 flood. The DOT's decision to set aside or move forward with planned capital expenditure projects informs whether personnel are available to deploy from within the agency or if staff augmentation by consultants is required.

Monitor Labor Compliance

It is important to closely monitor labor law compliance for exempt and non-exempt personnel working in the incident command organization. Develop and communicate controls to ensure labor law compliance for non-exempt personnel. For example, "high-will, high-skill" non-exempt personnel will often offer to work extra hours in maintenance and traffic divisions to keep roads safe, and administrative assistants will solve countless challenges. It is easy to lose track of the labor laws that govern the time and rights of agency personnel so good controls are essential.

Compensation should be evaluated for non-exempt agency personnel. If provided, some form of additional compensation to non-exempt transportation professionals often working grueling hours is supported in concept; define triggers for if/when and the form of any additional compensation would take for personnel (e.g., straight overtime paid at 1.0 standard hourly after the first 3 weeks of deployment; additional benefits accrual, if any; compensatory time). The following outlines key considerations on compensation for ICS deployed personnel.

Key Tasks When Considering Elective Compensation Adjustments for ICS Personnel

- ✓ Memorialize decision;
- ✓ Secure required administrative agency/state authorizations, if approved;
- ✓ Communicate decision on compensation and why, regardless of decision;
- ✓ Assign human resources and/or civil rights personnel assigned to the EOC or Incident Command Post (typically in F&A) to track implementation through disaster close.
- ✓ Take administrative steps to engage human resources in order to define if personnel are being directed to report to the disaster or if participation is voluntary.
- ✓ Determine if temporary job duties must be defined and roles assigned. For parity, risk management, and morale, the DOT should determine rules and requirements governing mobilizations of personnel as soon as practicable. This may include special terms or refreshers on conduct safety, (fraternization), dress code, and ethics.

- ✓ Consider, too, if personnel can opt out of mobilizations for specific reasons.
  - Will the agency require personnel to sign affidavits if they decline deployments?
  - If mobilization is outlined as a job duty, can an employee decline for cause (e.g., caring for sick family members, childcare)?
  - Are there penalties for declining (e.g., lost points for promotion) if they do opt out?
  - How long can personnel be required to mobilize (minimum and maximum durations, terms for extension)?
  - Will deployed staff get designated rest and relaxation time after certain intervals (if so, when and how will it be compensated)?

In addition, personnel are often required to respond to an EOC or Incident Command Post location within or adjacent to the impact area. Consider and make decisions concerning the following questions:

- How any travel time and costs will be managed (e.g., direct bill lodging to agency with GSA per Diem for meals and incidentals or state travel policies)?
- If consultants will follow DOT or state travel policies, if they follow Federal Travel Regulations or state travel policies and ensure that scope and cost eligibility is clearly defined in consultant contracts supporting the DOTs incident command functions?
- If/when travel costs will be supported for professional services (engineering, construction management) and/or construction contracts, and clarify in solicitations for services?
- If contract pricing allows for travel under “other direct costs” or if any cost incurred must be included within fixed labor rates, unit pricing, or low-bid contract pricing?

Designate funding sources to correspond with decisions made above. Extraordinary expenses may need to be self-funded by the DOT. FHWA may allow the DOT to pay costs for these functions from the ER indirect cost allocation. If FEMA funds are eligible for emergency repairs to damaged transportation assets, FEMA policy generally supports extraordinary (overtime) costs for time, fringe, or compensatory time for non-executive personnel governed by adopted and enforced pre-disaster emergency procedures; define terms. FEMA may support costs for consultant staff augmentation, but this is determined by eligibility and type of services performed. Consult FHWA’s ER Manual and FEMA’s Public Assistance Program and Policy Guide (PAPPG) and discuss these considerations with Federal agency liaison personnel assigned to the DOT to support response and recovery for details.

Many DOTs that have not previously experienced a regional disaster do not have technical expertise on the team related to both post-disaster planning and disaster funding and compliance. Professional services firms support these functions, often through staff augmentation in the incident command structure or via a comprehensive disaster program management services contract. When properly procuring these services, consider the qualifications, experience, and availability of the specific personnel proposed, and not just the firm’s capabilities. Also, do request and check references.

5.2 Scope and Scale Considerations

- ✓ Establish administrative mechanisms to assess disaster damages; and
- ✓ Identify work in "manageable buckets."

It is reasonable to expect that a combined response and recovery project portfolio of $750 million in damages can take roughly 7 years to deliver, and $2 to $5 billion recovery can take between 15 to 20 years to deliver. Work in support of rapid response occurs at a sprint pace, and resilient recovery is the marathon.

5.2.1 Establish Administrative Mechanisms to Assess Disaster Damages

FHWA typically uses Detailed Damage Inspection Reports (DDIRs) to provide windshield-level assessments of surface transportation and structure damages. The DDIR provides the DOT with an opportunity to quickly document its Program of Projects (POP), which is critical to not only identify and organize projects needing stabilization and rapid repairs to restore essential traffic, but to get funding requests escalated through FHWA—and based on the level of funding involved—to Congress. Figure 5-6 shows a sample DDIR.

Sheet _____ of _____

U.S. Department of Transportation Federal Highway Administration	**DETAILED DAMAGE INSPECTION REPORT (Title 23, Federal-aid Highways)**	Report Number:
		Inspection Date: 11.4.2013
Location (Name of Road and Milepost)		FHWA Disaster Number: CO-13-1
Route 034A **at Mile Post** 64.10 **to** 87.66		Federal-aid Route Number: 034A
Description of Damage (ONLY ONE ITEM MAY BE CHECKED) ☐ Emergency Repair ☑ Permanent Repair ☐ Debris Removal		State: Colorado
Rockfill, embankment, ABC, HMA to rebuild roadside gravel pullouts and third lanes that were not reconstructed during ER phase. Remove all ER HMA, reprocess top 2 feet of embankment, replace 6" ABC, and replace 6" HMA. Repave all areas back to preflood widths. Pending FWD results, remove overtopped HMA and replace. Pending pavement analysis, 2" mill and overlay for all construction damaged surfaces (MP 65.1-83.2). All riprap slopes rebuilt during ER phase - place new 36" + riprap at base of armored slope and reset riprap on remainder of slope. Narrows wall - place flowfill under caisson caps that were not filled during ER. Place riprap at base of walls. Narrows - replace CIP retaining walls, anchor slab, and bridge rail in the areas of non "tieback" type walls. All other miscellaneous items such as guardrail, signage, striping, and drainage.		County: Larimer
Project Phase (ONLY ONE ITEM MAY BE CHECKED) ☑ Pre-Construction ☐ Construction		Work Order Number: Not Maintenance Forces

Cost Estimate

Description of Work to Date (Equipment, Labor, and Materials)	Unit	Unit Price	Quantity	Cost Completed	Cost Remaining
Major Earthwork Items	CY	$ 58.96	161600		$ 9,527,500.00
Aggregate Base Course	CY	$ 30.00	22000		$ 660,000.00
Surfacing - HMA	TN	$ 81.63	71200		$ 5,812,000.00
Surfacing - Concrete	SY		0		$ -
Structure Repairs	LS	$ -	1		$ -
Walls	SF	$ 32.32	35700		$ 1,153,750.00
Drainage	LF	$ 84.00	600		$ 50,400.00
Misc. Items	LS	$ 485,700.00	1		$ 485,700.00
General Construction Items	LS	$ 5,218,358.25	1		$ 5,218,358.25
Environmental Assessment	LS	$ 2,290,770.83	1		$ 2,290,770.83
Force Account - Miscellaneous	LS	$ 2,519,847.91	1		$ 2,519,847.91
Minor Contract Revisions	LS	$ 500,000.00	1		$ 500,000.00
			Construction Estimate Subtotal		$ 28,218,326.98
			Contingencies		$ 5,643,665.40
			ROW		$ 2,500,000.00
			Preliminary Engineering		$ 5,454,298.86
			Construction Engineering		$ 3,636,199.24
			11% Indirects		$ 4,999,773.95

Method ☐ Local Forces ☐ State Forces ☒ Contract	Estimated Project Total	$ 50,452,300.00
Environmental Assessment Recommendation ☐ Categorical Exclusion ☒ EA/EIS	Prepared By: Carin Groh	Date: 3.3.2014

Figure 5-6: Representative FHWA DDIR cover page

While getting the funding pipeline activated and flowing is efficient, DDIRs do not always comprehensively document damages to the disaster-impacted roadway segment or structure, or along a corridor, particularly for complex permanent repair projects involving resilience improvements or betterments. In fact, this is not their function. Therefore, it is recommended that the DOT rapidly establish or refine business processes to assess and document disaster damages that will stand the test of time.

"The biggest issue that remains today is this post-disaster funding program. This is a huge problem because if we couldn't prove it was damaged by Sandy and what the pre-Sandy state of repair it was in—there was a big battle."

– Susanne DesRoches, former Engineer at the Port Authority during Hurricane Sandy

For example, the DOT may deploy damage assessment teams to support the incident command using a strike team model to either assess the full portfolio of impacted sites or focus on those sites expected to be the most difficult, complex, or costly to reconstruct. Multiple strike teams can be assigned by region or zone, or can be assigned based on characteristics of damages (such as hotspots for threatened and endangered species or that focus on riverine damages and likely in need of significant consultation with river morphologists and watershed management groups). Alternatively, damage assessment strike teams may include a cross-section of specialties (e.g., engineering, right-of-way [ROW], environmental) to get 360-degree visibility on project complexities and potential resilience opportunities.

The damage assessment report model was used by the City of New Orleans using engineering consultants who walked every mile of roadway to document damages for over $500 million in FEMA Public Assistance funds for roadways following Hurricane Katrina. The City of Calgary utilized in-house engineering staff to capture immediate damages, and further instructed professional services contractors to record damages as part of existing conditions following the May 2013 flood. CDOT began utilizing strike teams with cross-sections of specialists for permanent repair projects following the September 2013 flood, and has since developed procedures for maintenance personnel to geo-locate and document damages on tablets as "first on scene," and record any stabilization or temporary repairs.

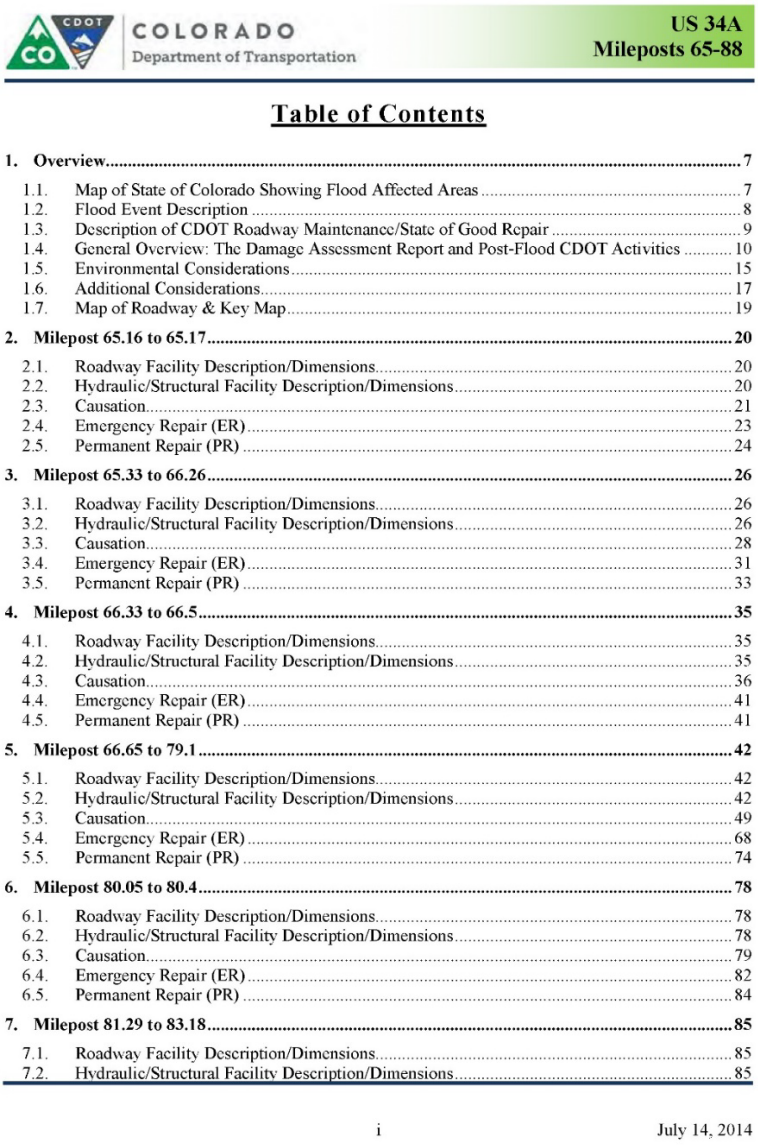
"Damage assessment reports should be established in structured form and also digitized consistent with the agency's Whole Life Asset Management system. That ensures consistency with pre-established nomenclature and provides an ability to track and record information for both the near and long terms through recovery and for historical purposes."

– Tom Prendergast, Former Chairman, NYMTA and Former CEO, NY MTA Transit

Damage assessment reports (DARs) should also be developed to describe key information about the project and damages. These should include information about the Federally declared assistance authorized (e.g., FHWA acknowledgement of the Governor's request for assistance and/or Presidential Emergency and Disaster Declarations). Provide a high level description of the DOT and its state of good repair, walk-through detailed evidence and descriptions of the cause (e.g., 18-foot hurricane storm surge) and impact (e.g., structural undermining of bridge piers) of damages and include specifics about the impact location, evidence of damages (e.g., photographs with metadata, drone footage, ESRI pre- and post-event GIS data), and record the anticipated repair type (temporary, permanently restore to pre-disaster conditions,

resiliently reconstruct or relocation asset), describe a scope of work, and estimated costs. In addition, DARs can be harmonized with asset management conditions and other data.

Figure 5-7 through Figure 5-12 present CDOT's DAR Table of Contents (page 1 of 3) and excerpts of a comprehensive DAR that provides a survey of damages and repairs on a critical corridor that had widespread damages. The project was essential to restore essential traffic, and therefore access, for a community cut off by the 2013 flood. The DAR excerpts provide a good example of documentation of damages and anticipated repairs on a small segment of US 34A that was not severely damaged; however, as shown in the DDIR, above, the overall project cost estimate was $50 million.



COLORADO
Department of Transportation

US 34A
Mileposts 65-88

Table of Contents

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Figure 5-7: CDOT DAR table of contents (page 1 of 3)
The Report user may note the DAR excerpt was dated almost a year after the event because CDOT maintained 2013 flood DARs as a living documents to record summary information about repair and resilient recovery project work on each subject corridor segments.

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US 34A
Mileposts 65-88

2. MILEPOST 65.16 TO 65.17

2.1. Roadway Facility Description/Dimensions

- This roadway segment consists of two 12 ft lanes with 4 ft shoulders.
- The roadway is functionally classified as a Principal Arterial with an average annual daily traffic (AADT) of 5,000 with 5.4 percent being trucks.
- The ROW at this site is varies from approximately 80 to 100 ft wide to the left and right of the centerline of roadway.
- No pedestrian or bike facilities are present at the site.
- Generally, the surrounding terrain is a mountainous corridor that slopes down from west to east.
- This highway provides east-west access from Estes Park to Loveland through northern Colorado.
- US 34 is generally surrounded by the Roosevelt National Forest.

2.2. Hydraulic/Structural Facility Description/Dimensions

- The Big Thompson River lies adjacent to the east side of US 34 at this location.
- Lake Estes lies approximately 1 mile upstream of the site.

Summary of Culverts:

Route	MP	No. of Pipes	Structure Type	Size (ft)	Length (ft)
0034A	65.15	1	CMP	4	64

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Figure 5-8: CDOT DAR roadway and structure descriptions

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2.3. Causation

2.3.1. Aerial views

Figure 8 - MP 65.16-65.17, Pre-disaster aerial photo

Figure 9 - MP 65.16-65.17, Post-disaster aerial photo

2.3.2. Severity of damages

FHWA has reviewed this site and has determined that the damage was ☐ severe ☒ not severe.

Watershed runoff in combination with flows released from Lake Estes Dam, equivalent to approximately 6,000 cfs, and flow surges due to debris dam breaches from adjoining tributaries produced flows in excess of the hydraulic capacity of the Big Thompson River. The floodwaters caused massive damage to the paralleling highway and the roads/bridges adjoining to the highway. The river channel experienced widening, degradation and aggradation throughout the canyon. This resulted in flood waters overtopping and washing out large segments of the highway, adjacent retaining walls and access roads/bridges.

Based on the memorandum *CDOT/CWCB Hydrology Investigation, Phase 1 – 2013 Flood Peak Flow Determinations* and observed flows at this site during the September 2013 flood event, the flood frequency of the Big Thompson River at this location during the flood is assumed to be the 100-year event with surges in excess of the 500-year storm event.

2.3.3. Detailed damage description

Below is a breakdown of the damage experienced within the highway ROW for this segment of US 34 as a result of the September 2013 flood event.

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Figure 5-9: CDOT DAR causation and severity

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Milepost		Description of Damage – *All Dimensions are "Approximate"*
Start	End	
65.16	65.17	Flows in the west roadside ditch overtopped the road and washed out portions of the riverside roadway embankment. 250 ft of asphalt curb was damaged and/or undermined, 100 ft of the eastbound paved shoulder was undermined by 2 ft and two areas of east embankment slope were washed out 3 ft deep x 30 ft long x 20 ft down the slope.

2.3.4. **Damage Photos**

Figure 10 - MP 65.17, Facing south, Damaged asphalt curb, paved shoulder and embankment slope.

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Figure 5-10: CDOT DAR damage description/photo

Figure 11 - MP 65.17, Facing east, Washed out embankment and undermined asphalt curb and pavement.

2.4. Emergency Repair (ER)

2.4.1. Descriptions of ER work performed

The table below lists ER work performed by milepost for this segment of US 34.

Milepost		ER Work
Start	End	
65.16	65.17	Removed asphalt curb, pavement and ABC. Rebuilt the embankment slope and replaced the damaged pavement section.

Figure 5-11: CDOT DAR segment emergency repair description

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2.4.2. **Photo of ER work after completion**

Figure 12 -MP 65.16, Completed pavement and embankment repair section.

2.5. Permanent Repair (PR)

2.5.1. Description of recommended PR work

- Pending analysis of roadway stability using a falling weight deflectometer (FWD), remove and replace asphalt that was overtopped by flood water but not damaged during this event.
- Remove material placed during the emergency repairs and replace using appropriate materials and construction methods consistent with standard specifications.
- Reestablish/place native grass seed and erosion control blanket on all roadway embankment slopes disturbed during emergency and permanent repairs.

The table below lists recommended PR work by milepost for this segment of US 34.

Milepost		PR Work
Start	End	
65.16	65.17	Remove and replace temporary pavement placed during ER. Revegetate and place erosion blanket on the embankment slope.

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Figure 5-12: CDOT DAR segment permanent repair description

Capturing irrefutable evidence of specific damages (e.g., dimensions, cause, effect, severity) is not only valuable to organize and plan high-quality project delivery, but plays an instrumental role in

substantiating by cause and impacts of damage to auditors—who are charged with revisiting eligibility, cost reasonableness, and prudence of key project decisions—long after work is complete.

DOTs are increasingly collecting DDIRS and more detailed damage assessment documentation on tablets in the field using software capabilities uploaded into GIS-enabled environments such as dashboard reporting, systems of record, and other workflows that provide efficiencies throughout the project delivery lifecycle and across a POP. Also, the accessibility of unmanned aircraft systems (often called drones) and more readily available GIS data are beginning to transform the damage assessment process. For example, North Carolina DOT conducted its Hurricane Florence (2018) damage assessment process primarily using drones.

The department closed access routes due to flooding, downed power lines, and other critical transportation needs. This $430,000 project allowed drone-collected data, images, and video to be shared with federal, state, and local emergency responders through a custom-designed online dashboard portal that also allowed that information to be shared with the public via traditional and social media. NCDOT flew more than 260 drone missions and captured more than 8,000 videos and photos of roads, bridges, and dams—which helped government agencies assess conditions quickly, deploy emergency responders efficiently, and divert traffic away from damaged areas. The drones also helped to provide quick assistance to first responders, and to identify critical and evolving issues more efficiently, particularly when it came to flooding, and helped the repair team optimize mobility in damaged areas (AASHTO's America's Transportation Awards. 2019).

See additional information in Section 5.2.2, below.

5.2.2 Identify work in "manageable buckets"

Stratifying like-type or zone-specific projects in manageable buckets ties closely with rapid damage assessment and is discussed, below. Most transportation disruptions are relatively limited in area, scope, and complexity. Concurrent, regional emergencies and disasters cause widespread damage and service disruptions that exceed the DOT's capabilities to restore essential traffic quickly. The following highlights examples to guide the transportation professional's approach to organizing project planning based on the scope and scale of the shock impact.

For the US Virgin Islands' response to Hurricanes Irma and Maria, some members of the research team were involved in supporting the high-level rapid damage assessment process of approximately 2,000 government-owned facilities (from sheds to government centers) located on approximately 500 plots of land across 3 islands. Desktop damage assessments were completed and were followed by field validation visits to 30% of the facilities. Damage impacts to facilities were characterized as (1) minor, (2) moderate (25%), (3) major (up to 50%, but not catastrophic), and (4) catastrophic, with 50% or greater damage. Before and after GIS data were used for desktop estimates, and rough order-of-magnitude cost estimates were developed based on estimated square-foot pricing for each damage category and building typology. Building measurements were estimated using available data (tax records and GIS data to dimension facilities). Desktop damage and cost estimates were developed in a matter of

days. Field validation of the planning-level damage estimates used to rapidly characterize and segregate assets into "buckets," described above, supported initial desktop findings in all but a handful of cases.

While this method would be inadequate to use for design development, it was a cost- and time-efficient exercise in stratifying projects into buckets according to severity of damage. In particular, it can be used to improve the common operating picture of staffing needed for the incident command, timelines for master scheduling of rapid repairs and anticipated scheduling for resilient recovery, and number and types of probable procurement, contracting, and project delivery methods. In addition, desktop rapid assessments can also be used to right-skill and plan level of effort for field-based DDIRs and damage assessment reports, as discussed in the Section 5.2.1. In circumstances where internet is out of service, desktop assessments can be assigned to non-impacted regions within the DOT, or to consultants.

Putting projects in like-type categories enables transportation professionals to quickly assess and respond to a project type's unique and specific needs. This example is clear for certain hazard impacts on bridges and structures. When bridge piers or abutments have been exposed to swiftly moving water and scour damage occurs, especially critical scour, it is essential to develop a stand-alone strategy to identify these projects immediately. This should include damage assessments that include rapid engagements for inspections by boat or underwater assessments and rapid repairs (as applicable), in order to evaluate and take actions to preserve structural integrity of assets with shock impacts resulting in critical scour.

The following excerpts are from CDOT's *Decision Support Toolkit* (CDOT 2018) and offer one practical example of questions a DOT can consider to rapidly characterize projects in the POP. When like-type projects are put into buckets, they can then be further sub-grouped for deliver by region, zone, or other key drivers.

Projects with Low-Moderate Disaster Damages and Straight-Forward Repairs

If the disaster project damages and repair scope seem clear, complete, and relatively straightforward (e.g., repair to pre-disaster design), it is worth considering completing the permanent repairs immediately with no temporary repairs. For example, if a redundant route is available, an impacted road or bridge could be closed for a week while construction for the entire project is competitively bid and rapidly contracted. This *One and Done* type project uses resources efficiently and gets the transportation asset up and running to its full capacity quickly. In doing so, it makes more time available to dedicate to larger, more complex multi-year projects.

Projects with Severe Damages and/or Corridor-Scale Impacts

The extent of a disaster's damages—the impacts on communities, the economy, and the environment—often drive the pace of disaster response with life/safety always of the first concern. When immediate safety is addressed, sometimes the first response is to (GO!) rapidly and fully repair the most severely damaged transportation infrastructure. However, repairing severely damaged infrastructure is often difficult, complex, and represents a major taxpayer investment. Sometimes it is better to slow down to make decisions that are aligned to work in the near and long terms where feasible.

Some factors to consider:

- What is the minimum scope to safely restore essential traffic? By using a simple fix to restore essential traffic, the engineer has more time to find the best long-term solution to plan, design, procure, contract, and deliver the project on time and on budget and preserved the potential for resiliencies, betterments and/or innovative contracting.
- Does this project need specialized support due to complex ROW, environmental, public engagement requirements? If dedicated support of specialty groups is needed to successfully plan, design and deliver the project, restoring essential traffic to "buy" planning time might be a good option.

- Would this project require special collaboration? Is this a Federal Lands Access Program (FLAP) project? Are Tribal lands involved? Is there a known historic or culture site within 500 feet of the impacted asset? Should CDOT consider asking the Governor's Office to consider CO Army National Guard support for this project? Allow planning time to coordinate with partners and stakeholders effectively.
- Are repair costs FHWA eligible to rebuild to CDOT Specifications? That depends. Typically, FHWA will support repairs to CDOT specifications only in those corridor segments or structures that are severely (catastrophically) damaged and where CDOT already has (or is about to) bring the adjacent segments up to CDOT Specifications. For example, if CDOT specifications call for a 10'-12' roadway shoulder, but CDOT has made recent nearby improvements on the corridor with an 8' shoulder allowed through a waiver, FHWA will likely only pay for up to an 8' shoulder.
- Does this transportation infrastructure have high potential to be rebuilt resiliently? Can it be designed to reduce impacts to the transportation assets in a future disaster? Would rebuilding stronger (higher, elsewhere) reduce negative impacts to critical assets surrounding CDOT's transportation infrastructure like hospitals, hydro-electric dams, fire stations or police barracks, sensitive waterways or habitat? CDOT worked with a consultant to develop a Risk and Resiliency (RnR) method of analysis to help guide the consideration of resilient reconstruction alternatives. FHWA has a number of conditions that must be met for resiliency improvements to be paid for with FHWA Emergency Relief funds so ensure it is clear if - and what exactly - FHWA will support and whether or not CDOT will fund any balance.
- Do conditions like remaining useful life, future growth and congestion, multi-modal access, and/or potential autonomous vehicle use affect how the project might be planned, designed or delivered? If so, vet these betterments in planning. Betterments funded by FHWA in disasters are limited, but if long-term planning is the best plan for Colorado either FHWA or CDOT may be willing to support additional investments to accommodate real needs.
- Does the project have good potential to use an innovative contracting method? Design-build and Construction Manager/General Contractor (CM/GC) are the two methods of innovating contracting CDOT uses as this time. Consider if either of these methods might provide savings in costs, time and/or risk on the project. See CDOT's *Project Delivery Selection Matrix* for a comprehensive analysis of innovative contracting options, as well as CDOT's *Design-Build Manual*.

(CDOT. 2018)

Sorting like project types into buckets promotes efficiency, administrative control, and project quality and consistency. It provides structure for the incident command team to break down large numbers of projects and identify risks and opportunities for each respective grouping of projects, accelerating the decisions on methods for procurement, contracting, and project delivery; incentives and disincentives; funding and compliance; and project controls. It also makes project delivery less complex for personnel to manage and easier for them to spot both positive trends for replication and negative trends for course correction. Adjacent concepts are discussed in Section 5.3, below.

5.3 Prioritization and Capacity

- ✓ Define and manage portfolio of all disaster-related rapid response projects;
- ✓ Identify level of "fix": stabilize, temporary repair, or complete repair.

5.3.1 Define and Manage Portfolio of all Disaster-Related Rapid Response Projects

Section chiefs in the incident command organization need to work together to establish a defined portfolio of rapid response projects, comprising emergency projects under the POP for FHWA's ER program. Together, section chiefs identify ways to progress through the management and delivery of the

project portfolio. Personnel responsible for delivering the project portfolio need to rely on leadership to clearly identify high-priority projects and resource-load accordingly. Manage personnel workloads to promote safe, high-quality work; and provide sufficient project oversight—for administration-related tasks and in the field. Business processes should be defined that clarify any new expectations and compliance requirements so that each project and the entire POP progress through the project delivery lifecycle, through completion and construction closeout.

In managing concurrent, regional emergencies and disasters, supply chains and prioritization and capacity are inextricable linked.

Prioritization and capacity are materially impacted by supply chain considerations during concurrent, regional emergencies. The COVID-19 pandemic has brought international attention to the challenges and consequences of supply chain construction, and offers lessons for all types of emergencies and disasters at scale. The professional services firm McKinsey Global Institute, issued a report, *Risk, Resilience, and Rebalancing in Global Value Chains* (2020) that found, “Today most large firms have only a murky view beyond their tier-one and perhaps some large tier-two suppliers. Working with operations and production teams to review each product’s bill of materials can reveal whether critical inputs are sourced from high-risk areas and lack ready substitutes. Companies can also work with their tier-one suppliers to create transparency.” (Lund, Manyika, Woetzel, Barriball, Krishnan, Alicke, Birshan, George, Smit, Swan, and Hutzler. 2020).

DOTs preparing to procure and award hundreds of millions or billions of dollars in work must conduct due diligence to confirm that contractors have access to necessary materials (including Buy America compliant components) and equipment to perform work and work together with supply chain disruptions that could compromise project delivery on critical corridors and structures. As importantly, DOT to investigate and work with contractors to address available project resources for technical experts, engineers, construction craft and labor and any associated demands resulting from concurrent, regional emergency such access to the project site and necessary transportation, lodging, meals, required technology and systems access, and other requirements.

5.3.2 Identify Level of “Fix”: Stabilize, Temporary Repair, or Complete Repair

Much like segregating like or related work in “manageable buckets” (see Section 5.2.2), it is important for DOTs to quickly assess how a project will be treated so

that it can begin its march to successful completion. As important as getting rapid repairs complete is the need to evaluate durable benefits that can be leveraged through repair and reconstruction work.

"Our biggest challenge in using force account after the 2013 flood was that we didn't cut it off after a certain period. If we decide to go force account in the future, we expect to use it for a pre-determined time or milestone. That will allow us to get in the field quickly for emergency repairs and move to a more controlled pricing method when we have a good understanding of what's needed in the field and build a good scope of work."

– Colette DeSonier, Flood Recovery Business Manager at CDOT for the 2013 Flood

For projects that are not severely damaged and for which permanent repairs to pre-disaster condition can be quickly expedited, it makes send to push those "low hanging fruit" projects out the door, and get them wrapped up and closed out quickly for construction and grant management. Wherever possible, consider using lump-sum or fixed/unit pricing for these projects to avoid mountains of paperwork that come with time and materials or cost based invoicing. If the contractor needs certain mobilization costs due to the post-shock conditions (e.g., equipment and labor need to be brought in from further afield than normal due to supply chain pressure or damages), those costs can be swiftly handled on a time-and-material or other cost basis, which would only add minimal administrative work to the job.

Due to the nature of concurrent regional emergencies, many critical corridors and structures will have severely damaged elements and may involve many miles of roadway. With DDIRs in hand and damage assessment reports under-way (see Section 5.1.2), this is the point in concurrent, regional emergency response where it pays dividends to "slow down" in order to speed up. Severely damages corridors and structures have the highest potential to leverage durable gains for social, environmental, and economic benefit in the long term. If the complexity of a project is too significant to contemplate how to repair it in the immediate term, sometimes the best strategy is simply to stabilize the roadway or structure and/or consider temporary detours, temporary bypasses (e.g., shoeflies), or using established redundant routes. This might be as simple as restoring essential traffic in one lane in each direction until more concrete plans have been formulated to maximize the benefits of the resilient recovery project.

The following shows two worksheets that are part of CDOT's Emergency Project Decision Toolkit in Figure 5-13 and Figure 5-14. The Toolkit was developed to rapidly walk transportation professionals through critical project considerations to aid in the selection of the best procurement, contracting, and project delivery methods to repair damages to a disaster-impacted roadway or structure. Worksheet 1 in Figure 5-13 captures key project information, and documents the transportation professional's decision about how the project will be set up and delivered.

Worksheet 2 in Figure 5-14 provides prompts to promote decision-making support to the transportation professional. It highlights key project factors to consider when setting up and delivering a project, including which specialty groups to consult early in the process.

EMERGENCY REPAIR PROJECT DECISION TOOL: WORKSHEET No. 1 **Emergency Repairs Subaccount #: _____**

EMERGENCY REPAIR PROJECT INFORMATION				
Project Name	Inc. watershed/community			
Project Location	Inc. MP/E&N/GPS			
Date				
Resident Engineer	Print Name:		Title:	Region:
Budget Estimate	DDIR Construction Only: $		DDIR Total Costs: $	
Project Est. Duration	Planning:	Design:	Construction:	
Scope of Work ***Attach DDIR & DAR*** *Attach additional detail*				
Unique Project Factors *Note all known now*	Potential Severe Damages No Alternate Routes Available	Highly Complex Project Bridges/Structures Impacted	ROW Issues Urgent Community Impacts	Critical Corridor NEPA Impacts
Funding	**ASSUME FEDERAL FUNDING:** ***Set Up Project To Meet All FHWA 1273 Requirements***			
Design	Yes – *External Consultant*	Yes –*Staff Only*	No – *Not needed*	
Construction Management	Yes – *External Consultant*	Yes – *Staff Only*		

KEY EMERGENCY REPAIR PROJECT DECISIONS				
Procurement Engineering	N/A	NPS *(Specify)*	New: *Secure 3 qualification-based proposals*	
Procurement Construction Mgt	N/A	NPS *(Specify)*	New: *Secure 3 qualification-based proposals*	
Procurement Construction	N/A Maintenance	Emergency IDIQ	Collect 3 bids by Email	New Advertisement
Construction Pricing ***Additional Conditions***				
Contract Delivery				
Right of Way (ROW)	Project Within Existing ROW		ROW Purchase or Easement Required	
NEPA Complexity	High – *complex*	Moderate – *needs environmental support*	Low – *no issues anticipated*	
Level of Work Note all that apply	One & Done – *Complete all work now* Restore Essential Traffic Now – *Asphalt*		Restore Essential Traffic Now – *Gravel only* Other	
Additional Permanent Repairs Required?	No: *One & Done* Yes: *Consider Resilience Analysis*	Yes: *Repair to Pre-Disaster Condition* Yes: *Consider Other Betterments*	Yes: *Repair to Standards & Specifications*	

Figure 5-13: CDOT Emergency Project Decision Tool Worksheet 1

EMERGENCY REPAIR PROJECT DECISION TOOL: WORKSHEET No. 2 **Emergency Repairs Subaccount #:____**

KEY PROJECT DECISION SUPPORT	
Summary	**This tool is designed to aid in rapid decision-making on emergency repair projects**
Community Impacts *See Situation Reports*	Community is functioning Community is negatively impacted Community access is cut off!
Criticality High ADT/Freight	High Moderate Low
Alternate route redundancy?	Yes – good through construction Yes – very short term only No - detour not feasible No - consider detour
Road closure(s)	Yes – road open through construction Yes – very short term only No - road closed through construction
Heavy Equipment Route	Yes – must be able to handle heavy equipment No – alternate routes available
Permanent repair project complexity	High Moderate Low
Severe damages	Yes – entire corridor destroyed (crown to ROW) Yes – some segments (crown to ROW) destroyed No
Permanent repairs can be completed quickly & efficiently	Yes – expedite whole project No – complete emergency repairs now then permanent repairs
Right of Way (ROW)	No – project in existing ROW Yes - Easement(s) Required Yes - ROW Purchase(s) Required
NEPA Status	Categorical Exclusion & 128 *Complete* 128 *in Process* 128 Required *Supported Needed*
Utilities/Railroad (RR)	Yes – Major Utilities Impacted No - No Major Utilities Impacted Yes – RR crossing damaged Yes – RR crossing affected No – No RRs crossing impacts
Bridges/Structures	Yes – bridges/structures impacted Yes – Abutments & Scour only No
STIP Status	*Yes – this location in the long-range transportation for STIP construction? No ** May not be eligible for FHWA ER funding*
Governor's Disaster Declaration Status	Yes – Governor declared disaster No – Declaration is pending No - Declaration Anticipated
Funding - Has FHWA acknowledged disaster	Yes – FHWA signed *DDIR No – *DDIR is in Draft No – *DDIR is NOT Anticipated **Detailed Disaster Damage Report (DDIR) describes project scope of damages with planning level cost estimate signed by FHWA*
Special Safety	Yes – Unique Safety Issues No – Follow Standard Standards & Specifications for Safety
Permanent Repair Resiliency Potential	Yes – Build back stronger No – Resiliency not feasible/cost effective Help Requested
Other Betterments *Specify*	Yes No – Not feasible or cost effective

Figure 5-14: CDOT Emergency Project Decision Tool Worksheet 2

The worksheets shown in Figure 5-13 and Figure 5-14, above, are supplemented by a more substantive Decision Support Toolkit that discusses procurement, contracting, and project delivery options in greater detail, with attention paid to disaster-impacted transportation infrastructure, and offers disaster-related

project tips. The Decision Support Toolkit (CDOT 2018) drew heavily from CDOT's Project Delivery Selection Matrix (CDOT n.d.). The Project Delivery Selection Matrix was truncated in recognition of constraints a DOT faces following concurrent, regional emergencies, and was also based on feedback collected during the development of Action Strategies (CDOT 2015) from the 2013 flood and through validation as part of CDOT's Emergency Procedures Working Group, whereby CDOT engineers from across the agency were involved in developing the document, which is provided in full in the "Grab and Go" Appendix (CDOT 2018).

CDOT's Emergency Procedures Working Group convened innovation workshops with a cross-section of region maintenance and engineers (and representing all regions), as well as workshops with regional finance and administration personnel. The document in Figure 5-15 presents a business process flow developed to help those responsible for project scope development and delivery to set up temporary repair projects administratively and usher them through project completion. It was built around CDOT's everyday business processes, which are well-understood throughout the agency, and identified those activities that differ from the nature of disaster impacts or FHWA ER funding. What could have been perceived as confusion was simply the unanswered questions of staff who wanted to make sure they helped protect CDOT do things the right way on disaster projects.

AECOM

EMERGENCY PROCEDURES

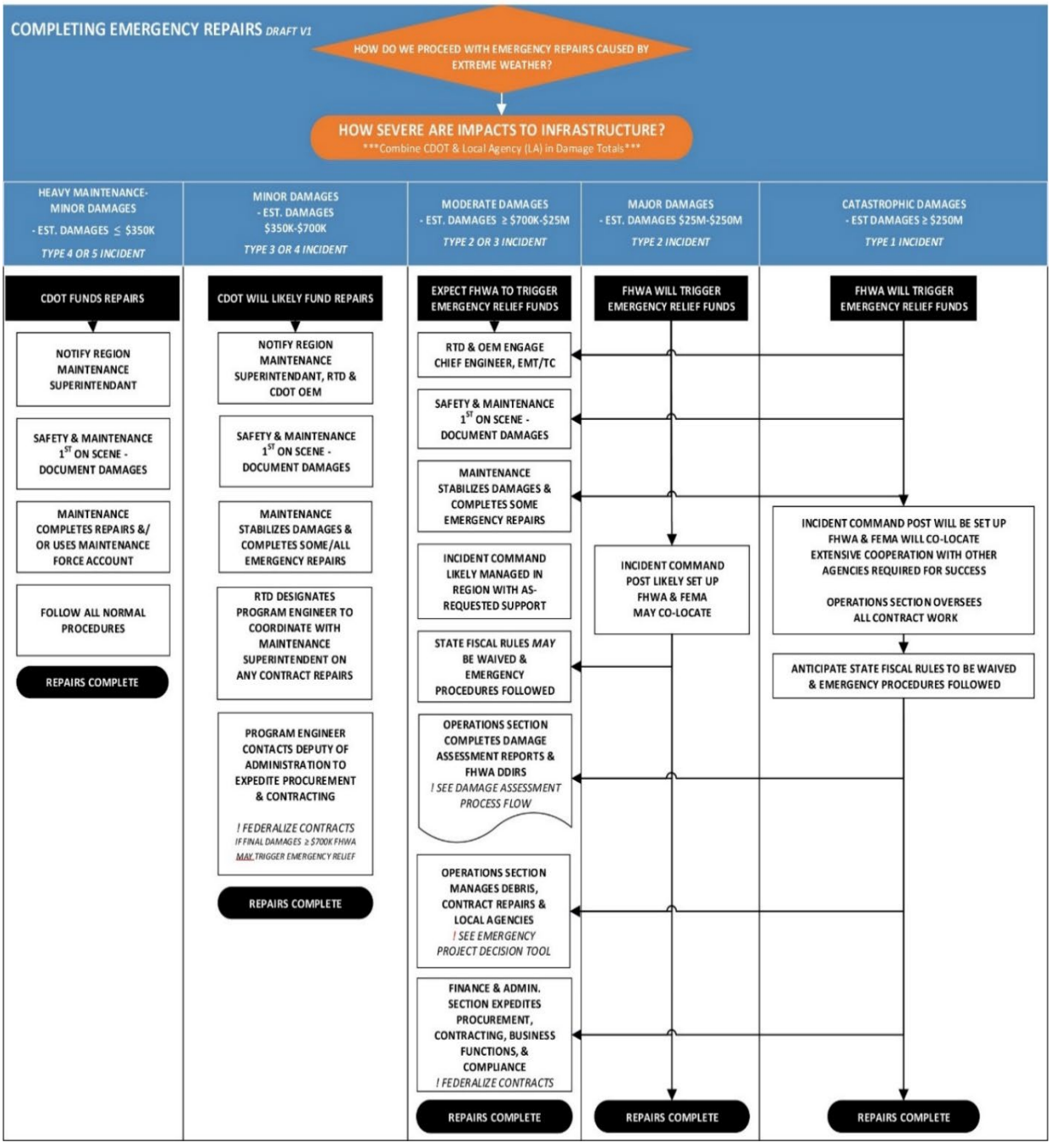

Figure 5-15: Completing Emergency Repairs: How do we proceed with emergency repairs CDOT caused by extreme weather?

5.4 Flexible Arrangements

- ✓ Implement emergency procurement procedures;
- ✓ Optimize risk transfer and other risk reduction mechanisms.

"A CDOT contracting officer was there (in the incident command center) from the onset issuing purchase orders"

– Colette DeSonier, Flood Recovery Business Manager at CDOT for the 2013 Flood

5.4.1 Implement Emergency Procurement Procedures

The length of time and the circumstances under which emergency contracting is permitted are determined on a case-by-case basis governed by the event and through guidance from the Federal funder, but imminent danger to human life or to improved property is a strong indicator that noncompetitive contracting may apply. Typically, a state executive or DOT CEO designates an agency emergency following a gubernatorial emergency order. The state or agency's emergency designation typically provides for delegation of authority to executive financial offices such comptrollers to trigger relief from using normal business operations, policies, and procedures due to extraordinary life/safety conditions such as certain State fiscal rules. Such relief is usually time-bound and rolls back specific requirements. In addition, agency emergency procedures are already pre-defined. Unfortunately, many times the emergency procedures do not contemplate the scale of concurrent, regional emergencies, and new business processes need to be defined while rapid response project scopes of work are being developed to restore essential traffic. The roll back of requirements usually provides the greatest flexibility in the areas of emergency procurement and contracting.

" Transportation agencies need to actively consider and pursue streamlined procurement processes to get the recovery work started and completed as soon as reasonably possible. During these type of incidents risk aversion behaviors should not unduly dominate the decision making process nor should there be a focus on detailed scoping and design being completed before undertaking them. If the agency uses its own Force Account resources and/or contractors that have a long established and successful history of performing work for the agency in the particular area that they have been contracted to perform in than less detail in needed. In essence, focus on and reward behaviors that deliver timely completion rather than exact completion"

– Tom Prendergast, Former Chairman, NYMTA and Former CEO, NY MTA Transit

While full and open competition is required for resilient recovery of transportation assets, DOTs and Federal funders often allow latitude to truncate solicitation timelines in order to reduce adverse impacts to the broader community when transportation assets have not been restored to full use. Transportation professionals should communicate closely with FHWA (and FEMA, as applicable) and develop agreement in principle on emergency procurement and contracting methods if they are not already clearly defined for the scale of the event(s) at hand. Moreover, competition is so important to cost-effective contracting that as much competition should be used as is feasible, given prevailing life/safety conditions. In addition, simplified methods requiring informal scope and price quotations should be used

even when noncompetitive negotiation is technically permissible.

To increase transparency concerning when emergency and exigent circumstances warrant non-competitive or limited-procurement actions, FEMA developed an outstanding resource that is highly transferable as a guide for rapid response procurements for DOTs, entitled Procurement Under Grants: Under Exigent or Emergency Circumstances: Fact Sheet (FEMA 2020a).The Fact Sheet provides a succinct summary defining emergency and exigent conditions that may warrant limited post-disaster procurement actions. As the Federal cognizant agency responsible for managing emergencies and disasters and awarding tens of billions of dollars each year to state and local governments, FEMA provides reliable guidance on substantiating the use of limited procurement actions, and DOTS should consider assembling documentation retained in the paper trail that satisfies the following FEMA recommendations (2020a):

FEMA Procurement Under Grants: Under Exigent or Emergency Circumstances

Fact Sheet: Suggested Elements for Noncompetitive Procurement Justification

- ✓ Identify which of the four circumstances listed in 2 CFR Part 200.320(f) justify a noncompetitive procurement:
  - The item is available only from a single source;
  - The public exigency or emergency for the requirement will not permit a delay resulting from competitive solicitation;
  - The Federal awarding agency or pass-through entity expressly authorizes noncompetitive proposals in response to a written request from the non-Federal entity; or
  - After solicitation of a number of sources, competition is determined inadequate.
- ✓ Provide a brief description of the product or service being procured, including the expected amount of the procurement.
- ✓ Explain why a noncompetitive procurement is necessary. If utilizing the exigency/emergency exception, the justification should explain the nature of the public exigency or emergency, including specific conditions and circumstances that clearly illustrate why procurement other than through noncompetitive proposals would cause unacceptable delay in addressing the public exigency or emergency. (Failure to plan for transition to competitive procurement cannot be the basis for continued use of noncompetitive procurement based on public exigency or emergency).
- ✓ State how long the noncompetitively procured contract will be used for the defined scope of work and the impact on that scope of work should the noncompetitively procured contract not be available for that amount of time (e.g., how long do you anticipate the exigency or emergency circumstances will continue; how long will it take to identify your requirements and award a contract that complies with all procurement requirements; or how long would it take another contractor to reach the same level of competence).
- ✓ Describe the specific steps taken to determine that full and open competition could not have been used, or was not used, for the scope of work (e.g., research conducted to determine that there were limited qualified resources available that could meet the contract provisions).
- ✓ Describe any known conflicts of interest and any efforts that were made to identify possible conflicts of interest before the noncompetitive procurement occurred. If no efforts were made, explain why. If a conflict of interest is unavoidable, such as due to exigent/emergency circumstances, explain how it was unavoidable and any steps taken to address the impact of that conflict of interest.
- ✓ Include any other information justifying the use of noncompetitive procurement in the specific instance.

5.4.2 Optimize Risk Transfer and Other Risk Reduction Mechanisms

Administrative controls can and should be structured to accomplish the rapid response mission and facilitate key project goal achievement. Methods of procurement and contracting; project delivery; project planning, design, and construction management; and compliance comprise the administrative and operational framework to move from concepts to delivery. Look for ways to include provisions that treat both the DOT and the contractor fairly when pricing is out of the firm's control. As importantly, build in judicious scope and price controls to guard against avoidable disputes and claims, as well as unscrupulous conduct despite dynamic post-shock conditions.

" The greater the amount of risk transfer and/or the greater the vagueness of what (risk) is being transferred will have a direct effect on the cost and time to complete the work. Not only might that result in fewer contractors bidding to perform the work, it will likely result in their stating it will take more time to complete. The need for balance in this area is key."

– Tom Prendergast,
Former Chairman, NYMTA and
Former CEO, NY MTA Transit

Procurement and contracting needs to exert administrative controls, and the process can and should explicitly state project goals and reinforce/measure project objectives, including time savings to reduce asset downtime; project cost savings; promote risk transfer to the contractor; and drive other objectives for temporary repairs such as real-time reporting on project delivery for the whole POP.

Scope of work and contract pricing:

- How clear is the scope of work?
  - For standby construction contracts:
    - Which contracts have standby or IDIQ awards and capacity to offer immediate contractor mobilization?
    - How much flexibility is available in the standby contract, and how should scope, costs, and performance be defined to meet rapid response objectives for a project?
    - Would a rapid task order competitively offer additional controls and opportunities to meet project objectives such as time savings or risk transfer?
  - For professional services (such as general engineering services contracts):
    - Consider how contract scope, capacity, and pricing may require special or additional effort for emergency repair projects, then
    - Consider compensation rates, skills mix, and levels of effort required by discipline to support the project.
- How will discoveries or changing conditions be addressed in scope and costs?
  - Consider what administrative controls will be used if a project site may change due to the shock (e.g., earthquake aftershocks), as a consequence of the shock (e.g., a slope failure worsens due to unstable conditions), or due to unrelated (but exacerbating) conditions (e.g., project site conditions in a burn scar area further degrades after a major rainfall event).

  - Consider that major shocks often unearth archaeological artifacts, and have administrative controls in place for rapid mobilization of the National Environmental Policy Act (NEPA) Section 106 archaeological resources for site identification and monitoring. Include direction to construction contractor and archaeology team to delineate the area of potential effect, and develop agreements that both preserve the potential or known culture resources, and allow for work to continue by shifting where or what type of work is performed on the job site where feasible, rather than shutting it down or moving to a new project segment. In an archaeologically rich area, consider developing a Programmatic Agreement under Section 106 of the National Historic Preservation Act.

- Can fixed (unit) or lump sum pricing be used, and can additional administrative controls overcome any legitimate contractor objections given dynamic conditions?
- Is immediate mobilization required due to emergency need to stabilize roadways, sweep debris to ROW to enable emergency vehicles passage, and/or commence utilities restoration?
  - Explore building in multiple steps for scope and cost refinement as more detailed information is learned about post-shock existing conditions (e.g., at prescribed time interval or performance milestone), and clarify in solicitation.
  - Define possible or anticipated changes to contract scope and pricing.
- How will changes to scope and price be handled if market pricing for certain goods surges post-shock? The DOT could:
  - Clarify business process in the contract to clearly and quickly resolve any price surges (or ramp-down of market costs on longer projects).
    - Define if contract pricing will be reviewed at pre-designated dates or milestone delivery points for construction.
    - Add an adjustment factor to the contract or on designated items within the contract (can also request the contractor designate items in the firm's price proposal) for the disaster. Include any ramp downs in factors by pre-designated date or milestone delivery point for construction on long contracts.
    - Define contingency allowances to be defined in the contract and determine if unused contingency can be captured by the contract as profit (or not).
    - Consider using economic price adjustments to be triggered for joint review by the incident command organization's F&A and operations sections (e.g., raw material pricing to the contractor exceeds normal market conditions by 27% against prior 1-year average price on any material; designate a watch list for pricing on specific items expected to be subject to extreme market price increases).
- Has contract scope and pricing been delineated by Federal disaster funding stream and cost share?
  - If one contract has more than one funding source, ensure the contract includes segregation of contract scope and costs and requires contractor invoicing according to the same. For

example, debris management is supported through FEMA Public Assistance Program Category A funding for 15 counties, but FHWA ER support debris management for 5 counties that do not have Presidential disaster declarations. Therefore, the contractor should be directed to invoice a schedule of values that segregated scope and costs by county—or, at a minimum, funding stream (for debris, counties often added one at a time, so the former is preferable despite the additional administrative effort).

- Consider any possible shift on date-driven cost shares. For example, the Federal cost share can change (FEMA) based on debris management performance or dates. The Federal cost share can also change (FHWA ER or FEMA) on long projects that begin at one Federal cost share percentage, and change to a different cost share later in the project.
- Clarify any implication and owner direction to the contractor on invoicing for Federal funding stream or cost share.

- Does the DOT want work completed by a specific timeline, or cut down delivery timeframe by a specific benchmark to reduce asset downtime?
  - Consider allowable contract incentives.
  - Consider allowable disincentives (penalties), but be sure that contract terms and conditions on the application of any penalties are clearly defined and applied in the context of dynamic post-shock conditions, or it may land the project in pre-claims and claims, wicking away time, money, and attention better invested in the restoration of essential traffic.

University Transportation Center for Alabama
Recommendations on Incentives and Disincentives

"To provide an impetus to complete the project ahead of the specified project completion date, a daily cash incentive is included in the contract to encourage the contractor to use innovative construction techniques and overtime to complete the project ahead of schedule.

Similarly, a disincentive clause is established to discourage contractors from construction delays beyond the stated completion date. When this process is used, standard approval timelines, procurement schedules and reporting protocols are typically streamlined." The research also cautions that liquidated damages must be clearly distinguished from contract incentive/disincentive provisions (Hitchcock, Nunez, Watson 2008).

- Does the contract provide for specific and measurable performance benchmarks to monitor accomplishment of objectives defined for the subject project during the procurement process?
  - Define business processes between F&A and operations to work together to monitor project performance on project objectives.
  - Establish final performance review procedures to evaluate if contract objectives are met during construction closeout.
  - Memorialize key project decisions and direction in writing through requests for information procedures (and include in workflows for system of record) or decision logs.

- Do contract scope and costs for contractors include submission of reporting data that can be integrated in GIS-enabled dashboard data and reporting? If so, the contract scope and costs need to aid the DOT to meet its planning section mission.
    - Consider if accomplishment of this task will be supported by DOT provision of tablets, software, tools, and just-in-time training, or if the contract is expected to mobilize for the contract immediately and meet these data requirements within a specific number of days.

Also, incident command leadership needs to "pan out" to consider how the above conditions and contract matters play out across the POP, address implications in how the incident command organization is structured, and define how rapid response administrative controls are managed throughout the project delivery and POP lifecycle.

In its *Coronavirus (COVID-19)-Guidance for Contractors*, Barrett, Charney, Friedman, and Kinzel (2020) provide guidance and recommendations specifically to constructors to help contractors hold the "fire line" on administrative risks or shift risk back to owners. The guidance was developed in response to supply chain constrictions and other challenges related to contractor performance during the 2020 pandemic. The following excerpts are being presented to DOTs because it is instructive to view administrative risks and controls through the perspective of its contractors when brokering robust agreements. It is important to determine if the transportation agency is prepared to manage its own risks if its contractor are organized in the manner presented below, and to make a clear-eye appraisal of the DOT's risk position. Shoring up gaps for response and recovery contracts will reduce risk exposure and result in better outcomes for owners and contractors. The *Coronavirus (COVID-19)-Guidance for Contractors* states:

> The potential impacts of the Coronavirus to the construction industry are wide reaching. Consequences on a project site can include quarantines or other governmental actions resulting in impacts to the project work force. Offsite impacts can cover a much broader scope of issues including labor shortages at factories of manufacturers or fabrication facilities, resulting in production delays, transportation embargoes causing project supply issues, or governmental actions which inhibit manufacturing and production causing supply chain shortages and inabilities to service existing demands. So, what can contractors facing such impacts do to avoid losses, mitigate the impacts, and prepare for what's to come?
>
> 1. **Find the Relevant Contract Terms.** Review each contract carefully for contract clauses that address rights in the event of unforeseen conditions, or excusable conditions or delays…If there is a "force majeure" clause, scrutinize it carefully to evaluate whether the current conditions fall within the terms of the clause. If there appears to be no such clause in a given contract, keep looking; many construction contracts contain a clause that affords relief in circumstances outside of the contractors control or arising from unforeseen conditions or circumstances. Such clauses entitle the contractor to additional time and compensation, and can exist in a wide range of forms. In certain contracts, for example federal government contracts, subtle but critical distinctions may be at play that must be carefully considered.

2. **Provide Clear and Compliant Notice.** Identify your contract's express notice provisions for claiming delays and additional costs, including the time limits for giving proper notice, who must be copied on the notice and the method of delivery. For each project, a written notice should be sent to the project's owner that complies with the contract requirements, explains the cause, and reserves rights for time and money. Some contracts include provisions by which the contractor may be exposed to forfeiting rights to adjustments if notice is not made timely. Do not rely on verbal communications, and take particular care to be sure that the notice is provided exactly as required by the contract. Some contracts will permit a simple email, others may require hand delivery in a specific way (certified mail, for example), with copies to certain individuals. The point is to create a written record establishing that the contractor complied with the contract, providing the owner with advanced warning of the likely impacts within the time as required by the contract, with updates as they develop.

   This may also enable the owner and the contractor to make appropriate, informed business decisions…Take appropriate steps to advise that, due to the dynamic and fluid nature of the situation, you are currently unable to provide a reasonable impact assessment. To the extent required by the contract, work to provide a reasonable prediction of overall impact as promptly as circumstances permit. Consider the possibility that economic impacts (shortages of labor, material, and/or equipment) and other such indirect impacts, including transit shutdowns, travel restrictions, or school/daycare closings, may affect the project as well. Of course, the tone of these notice letters should be professional, sympathetic, cooperative, and collaborative...

3. **Pay Special Attention to Suspension and Termination Clauses.** Many contracts give the owner the right to suspend a project. Those clauses typically provide rights for time extensions and additional compensation if the project is re-started. They often also give a contractor the right to terminate the agreement and to receive defined compensation if the suspension lasts for a stated duration…be on the lookout for actions by owners that could be fairly characterized as a suspension, even if they do not expressly call it one.

4. **Document Cost and Schedule Impacts.** Document and segregate into separate "buckets" any impact that the Coronavirus has on your construction project. Contractors will be well advised to recognize the two key components in delay and disruption recovery – 1) establishing the right to added time and a price adjustment, and 2) establishing the amount or extent of the delay and added cost. The second of these two points is often overlooked and is an area that is particularly prone to dispute. In generating your record, be specific; record impacts in daily reports, schedule updates and timesheets with an express notation, such as "due to Coronavirus impacts." The more clear, specific, and accurate, the better.

5. **Ensure that Contractually Required Support is Created.** In some case, contracts may require (construction management program) support or analysis to back up a claim for additional time. Contractors should review their (construction management program) schedule prior to performing a time impact analysis, to ensure that the

baseline reflects current logic and restraints, and that it will support the delay claim…

6. **For Contracts that Don't Address the Issue.** What about contracts that afford no relief for events like pandemics or epidemics or even for matters beyond the contractor's control? Under common law, circumstances that are sufficiently disruptive to performance may excuse the contractor's non-performance. A contractor may have rights that are not spelled out in the contract. However, when a contracting party has the benefit of knowledge or information regarding likelihood of a future occurrence, a concept known as foreseeability begins to operate. The contractor's argument that performance is excused may be undermined where that party arguably should have foreseen the problematic circumstances. We recommend consulting with counsel as assessing these issues tend to involve a fact-intensive inquiry.
7. **Consider Insurance.** Contractors should evaluate whether existing insurance policies potentially provide coverage for Coronavirus-related losses. It is important to review all insurance policies and request that the project owner provide copies of all applicable insurance policies including Builder's Risk, business interruption, and any other policies.
8. **Assess Both Prime and Subcontracts.** A careful analysis of prime and subcontracts should be conducted as well – one approach likely does not fit all, as agreements (particularly, negotiated agreements) often address relevant matters differently. Some subcontract agreements may have flow down of identical terms and conditions as exist in the prime contract, while other agreements have different terms and conditions that would operate in the same situation…
9. **Attempt to Identify Challenges Early.** Generally speaking, a contractor may have the responsibility to mitigate the consequences of a delay or disruption. Contractors will be well served by taking diligent action designed to reduce the impact and by maintaining a clear record of those efforts. Reach out to subcontractors and vendors to identify and assess potential issues impacting labor and the supply-chain. Discuss and develop contingency plans and protocols with subcontractors and vendors. If supply chain issues are likely, consider exploring alternative sourcing options and the pricing for such alternatives or consider substitution options. Most construction contracts afford a right to notify the project owner in the event a contractor desires to propose substitutions, but be prepared to demonstrate the comparison for the substituted products and/or materials. If shortages to project labor are expected, consider alternatives such as the retention of temporary labor companies. Having a strong sense of the actual market conditions and potential impacts may be critical for loss mitigation.
10. **Consider Unique Safety Issues Pertinent to the Pandemic.** Revisit office and job site safety protocols to address disease spreading and to implement healthy procedures. Many employers are already providing guidance to employees regarding hygiene, travel, etc. Such measures may become a factor with regard to the continued

performance or the shutting down of a project. As an example, although virtually all project sites contain temporary toilet facilities, some do not include handwashing stations that may help support worker health and control the spread of infection. Another consideration is the implementation of infection control measures, such as screening to test for fevers or other symptoms of illness. Exactly what measures should be adopted are unclear at this stage, and protocols and policies with regard to the treatment of infected and potentially infected persons will likely evolve; "Monday morning quarterbacking" is likely…it is suggested that contractors/employers seek guidance from professionals, as well as monitor and follow the standards and recommendations offered by organizations such as the Occupational Safety and Health Administration (OSHA), Centers for Disease Control (CDC), and the World Health Organization (WHO).

11. **Carefully Consider Language in Contracts that are About to be Executed.** Contracts that may be signed now that the pandemic is underway present unique challenges as one may argue that the conditions were not "unforeseen" at the time the contract was signed. Contractors should carefully consider the risks of delay and disruption, and add language that clearly provides for adjustments consistent with how those risks are being allocated. In the interest of mitigating the risk of ending up in court or arbitration, parties would be well advised to meet in advance and attempt to reach a consensus on what project-related occurrences and impacts are foreseeable in light of the Coronavirus, and then memorializing that understanding in the contract language (Barrett et al. 2020).

Associated considerations are also discussed in 4.6.2.

5.5 Innovative Delivery

✓ Consider project delivery, procurement methods, and payment/contract type.

This section provides guidance for innovative project delivery, including procurement and contracting, during the rapid response phase. The objective is to quickly stabilize surface transportation and restore essential traffic. In the research team's survey, disaster practitioners considered which accelerated construction techniques were most effective in shortening recovery time. CM/GC was ranked first at 41%, followed by DB at 41%. Construction manager at risk fell short, only garnering 13% of top billing. See Figure 5-16.

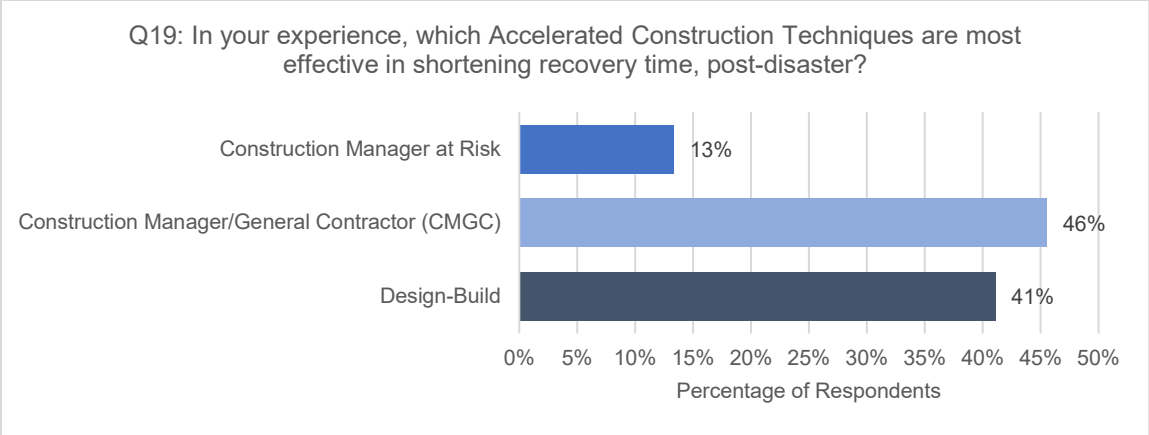

Figure 5-16: NCHRP 08-107 survey question 19 (graph, AECOM)

Innovative delivery makes judicious use of a collaborative team working closely throughout the pre-construction and construction process. Often, innovative delivery meets aggressive timelines on projects of all sizes and scales, but can be uniquely suited to the demands of large, complex projects. Time savings can be realized through DB, CM/GC, and CM at risk delivery methods. Further F&A professionals can introduce time saving as performance criteria for the contracts supported by incentives or disincentives. Where cooperative relationships are in place, it makes good sense to include Federal funders to participate in critical path meetings in advance of the procurement action, and in meetings set and benchmark major milestone progress.

5.5.1 Consider Project Delivery, Procurement Methods, and Payment/Contract Type

5.5.1.1 Project Delivery

Rapid response generally suggests consideration of an alternative delivery method to avoid delays and coordination issues between design and construction contractors. Critical success factors in successfully using innovative delivery methods include clear and robust business processes, clearly defined and measurable contract terms and conditions, and directing only staff well-experienced with innovative contracting to oversee the use of these methods in emergency and exigent conditions. Specifically:

- ✓ **Design-Build** project delivery has the potential to accelerate the transition through any necessary design work directly into construction; bundling a range of response needs into a single design-build contract can amplify this benefit by combining the procurement actions, as well as the contractor's options for rapid transition into construction and project completion. Other advantages of DB have been recorded in the literature. According to the *Accelerated Bridge Construction Manual* by Culmo published by FHWA, most agencies consistently report expedited project schedules by using the DB process. It also provides contractors some flexibility, since the design can be tailored to the contractor's expertise and available equipment. Additionally, contractors have the ability to make modifications to preliminary designs as a cost saving measure, as well as incorporate innovative construction processes. Lastly, owners have also reported being able to quickly obligate monies on "meaningful capacity projects" (FHWA 2011).

The NCHRP Synthesis Report 438, *Expedited Procurement Procedures for Emergency Construction Services* (NASEM 2012), found that most transportation agencies use expedited design-bid-build procurement processes to procure emergency design and construction services, because it is familiar to them and can mitigate certain risks. This familiarity among agencies often translates into confidence; therefore, time-sensitive decisions can be made with less fear of procurement law violations (TRB 2012).

Some drawbacks of the DB process include a reduction in owner control of the final design, with changes requested after bids often leading to additional costs. The project owner also needs to be able to clearly articulate the desired project outcomes. For example, complete design drawings at completions are typically not available using DB unless especially delineated by the owner in the project requirements. On the contractor side, the increase in risk may also be seen as a drawback; however, the DB process allows contractors to manage risks using innovative solutions.

Under FHWA, DB is governed under the authority of 23 CFR Part 112(b.)3 Design-Build Contracting. The regulations authorize the use of design-build where allowed by state and local law, and include provisions; limitation on final design; qualified project; design-build contract defined; and other requirements. The Federal Register published FHWA's Final Rule on Design-Build in February 2014, and revised regulations (effective March 2014) related to the use of alternative technical concepts (ATCs) in design-build project delivery of highway construction. The final rule eliminated the requirement to "submit a base proposal when a contracting agency allows design-build proposers to submit ATCs in their technical and price proposals," simplifying the process.

Both the Design-Build Institute of America and the American Society of Civil Engineers offer training on DB technical delivery and management skills needed to realize time and/or cost savings. The Design-Build Institute of America also offers contract resources such as standard consulting contract, preliminary agreement between owner and design-builder, and sample solicitation documents.

Georgia DOT DB Project: Northwest Corridor Express Lanes

The largest in Georgia DOT's history used DB to 29.7 miles of reversible tolled express lanes along I-75 and I-575 in metropolitan Atlanta and is the State's first design-build-finance project. It involved the design of six express lane interchanges on I-75, new access points on I-575 and 36 bridge structures. The project features,

> "over 1 million square feet of bridge deck supported by 195 intermediate bents and 772 prestressed concrete beams. The project included more than 100 retaining walls up to 45 feet in height with a combined length of 10.5 miles. There are approximately 1.4 million square feet of noise barriers, 640,000 square feet of mechanically stabilized earth (MSE) walls, and 261,000 square feet of soil nail cut walls."

Using accelerated bridge construction and other techniques, the project met key objectives of maintaining live traffic during construction through Atlanta, and reportedly shaved 10 years off project delivery and $110 million in cost savings. The project cost came in at 647 million and took 64 months to complete construction. (DBIA. 2019).

- ✓ **Design-Bid-Build** may have competing advantages where a major challenge is mastering the nature and design solution for a group of response needs that is so large that design-build resources would be limited; by contracting a high-capacity professional services firms to rapidly issue bid specifications, the range of responses may be more rapidly fulfilled.
- ✓ **Construction Manager / General Contractor (CM/GC),** wherein the ultimate contractor parallels the internal or contracted design processes, and then takes overall responsibility for delivering the project to the design specifications, may have some utility also if design is a particular concern over which the owner wishes to retain control. According to FHWA's 2016 Final Rule on CM/GC, the following is in force:
  - The CM/GC contracting method allows a contracting agency to use a single procurement to secure pre-construction and construction services. In the pre-construction services phase, a contracting agency procures the services of a construction contractor early in the design phase of a project in order to obtain the contractor's input on constructability issues that may be affected by the project design. If the contracting agency and the construction contractor reach agreement on price reasonableness, they enter into a contract for the construction of the project.
  - The CM/GC method has proven to be an effective method of project delivery through its limited deployment in the FHWA's Special Experimental Project Number 14 (SEP-14) Program. Using the contractor's unique construction expertise in the design phase can recommend for the contracting agency's consideration innovative methods and industry best practices to accelerate project delivery and offer reduced costs and reduced schedule risks (FHWA 2016a).
- ✓ **Construction Manager at Risk (CM at Risk)** wherein, like CM/GC, a construction contractor parallels the independent design process, but then negotiates a lump sum or not-to-exceed (NTE) price for overall delivery will have less applicability in the response phase of

catastrophic emergencies, because the uncertainties and delays involved in negotiating the NTE price are a severe disadvantage.

The remaining, more integrated delivery methods including financing, maintenance, and/or operation of some or all of the assets including design-build-finance (DBF), design-build-finance-maintain (DBFM), design-build-finance-operate-maintain (DBFOM) (e.g., P3) are, like CM at Risk, less likely to offer advantages during the response phases of a catastrophic emergency because the integration advantages are unlikely to warrant the procurement delays.

In one example by del Puerto et al. (2017), the Minnesota Department of Transportation (MnDOT) used emergency contracting procedures to reduce project schedule following the collapse of the I-35W highway bridge in 2007. The agency used a streamlined DB process with a best value award that included extensive confidential one-on-one meetings with each design-builder to discuss questions and allow for innovation via alternative technical concepts. A key factor in MnDOT's success with the relatively quick procurement process, and later, against the lawsuit brought, was their extensive experience with DB (best value award was allowed via legislation in 2001). Major incentives and disincentives were used to truncate construction time. MnDOT also strove to "build the largest project possible with the smallest environmental process" and minimized permitting due to exigent circumstances via the NEPA Categorical Exclusion. MnDOT successfully defended itself against an award protest because it published the details of the project's proposal evaluation plan, making it transparent, and strictly followed the plan throughout the procurement and award process (del Puerto et al. 2017).

In another example, the Florida DOT (FDOT) was responsible for reopening a 2.5-mile section of I-10 bridges over Escambia Bay destroyed by Hurricane Ivan in 2004. Officials selected DB because the urgency of the work demanded that a single point of responsibility for the simultaneous design and construction phases. FDOT chose to constrain design to favor available materials and resources and was able to re-open one side of the bridge within 3 weeks. One key lesson learned is that "speed can only be achieved if FDOT is willing to accept available materials for repair" (Gransberg 2013).

This applied research's survey of AECOM's disaster cadre found there is an adequate number of general A&E firms most of the time, and more likely than not adequate technical specialty A&E firms in the post-disaster marketplace, as shown in Figure 5-17. However, the survey found that specialty subcontract construction firms and craft workers are not available in sufficient supply in the post-disaster market, as shown in Figure 5-18.

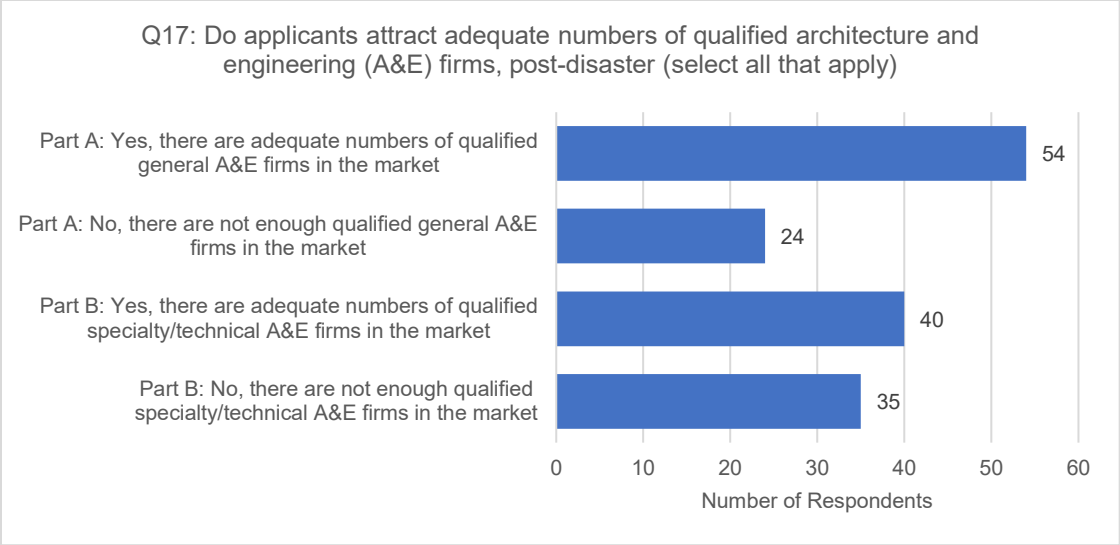

Figure 5-17: NCHRP 08-107 survey question 17 (graph, AECOM)

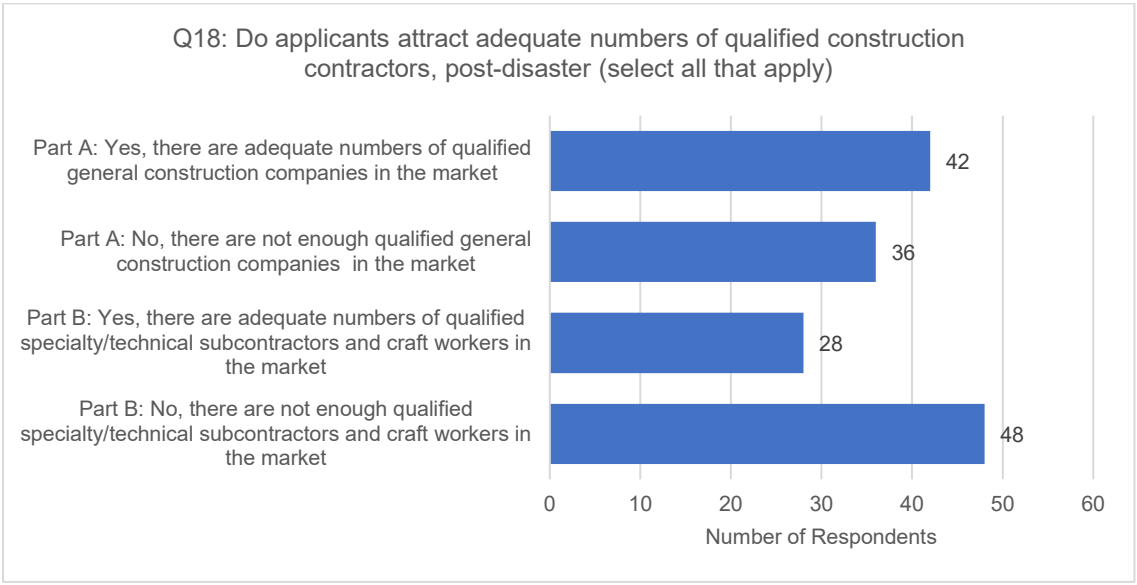

Figure 5-18: NCHRP 08-107 survey question 18 (graph, AECOM)

5.5.1.2 Procurement Methods

One initial consideration for obtaining a contractor in the response phase should be existing contracts and mutual aid agreements. Existing contracts held by one of the agencies directly involved in the response may have the capacity. The contracting recommendations for the Readiness Phase will have put in place contracts that can be activated in the response phase. In the case of IDIQ contracts, a task order may be issued. In the case of other current contracts, a change may be issued within the current general scope of the contract. Looking somewhat further afield, the agencies may have mutual aid agreements with counties, municipalities, or neighboring states that would permit a task order or change under one of the mutual aid partners' contracts.

If new contracting is to be considered, best procurement practice and Federal regulations require that as much competition should be sought as can be warranted. Assuming there is still some exigency in the response contracting, the normal procurement thresholds may be relaxed, but emergency managers should recognize that cost is still a consideration and that competition will assist them in obtaining the best price and terms for any given level of urgency and acceptable procurement time. Therefore, formal competition (sealed bids or request for proposals) are the preferred method of procurement. If the formal competition threshold is not met, or if the exigency of the catastrophic event response warrants, then informal competition (obtaining three quotes without the necessity of public advertisement) may suffice. Finally, if the exigency warrants, for example if there is risk of injury or loss of life from delay, then a sole source procurement may be used. Among the most common audit findings and bases for disallowing reimbursement claims is inadequate competition in procurement.

5.5.1.3 Payment/Contract Type

In general, more leniency is granted with regard to selection of the major contract terms, including the compensation structure. However, if an adequately precise scope can be developed without undue delay, the lump sum form of compensation is preferred. It transfers the most cost risk to the contractor and facilitates competitive pricing. If the scope cannot be adequately defined in the time available given the exigencies, then a time-and-materials contract with an NTE price limit may be used. Finally, if there is not enough time or information to negotiate reasonable cost rates, then a cost reimbursement contract may be used. The most common is the cost-plus-fixed-fee contract; it provides the contractor some reassurance that costs and a profit will be realized, reduces the contractor's incentive to increase costs in order to gain profit, and assures the agency that a controlled level of profit will be paid.

IDIQ contracts are feasible in the response phase, with the compensation structure to be set on a task-by-task basis, when lump sums or time-and-materials may be feasible.

Emergency managers should be aware that, unlike some state regulations, Federal requirements strictly prohibit a cost-plus-percentage-of-cost contract; whenever the structure results in the contractor's profit increasing as a result of the contractor's increased costs, the compensation structure should be closely examined for compliance. The time-and-materials contract (where the amount of contractor profit may increase with increased hours) is a safe harbor from this prohibition, in part because the contractor is taking the risk that the actual cost per hour will exceed its expectation in negotiations.

The primary benefit of IDIQ contracting is the flexibility allowed in quantity ordered and delivery schedule (Rueda-Benavides and Gransberg 2014). The NCHRP Synthesis Report 438 *Expedited Procurement Procedures for Emergency Construction Services* found that establishing this contracting type in advance is the surest contractual means to minimize the impact of an emergency (TRB 2012). IDIQ provides an effective means for maximizing the efficient use of funding (NASEM 2015). Other benefits include time savings, opportunities for smaller companies to bid, and competitive pricing by awarding multiple IDIQ contracts. DOTs can use IDIQ contract vehicles to keep firms available on-call for specific work to be done quickly. For example, the New York Department of Transportation used its IDIQ entitled, Emergency Bridge Repair/Replacement Job Order Contract in New York, in the aftermath of Hurricane Irene in 2011. FDOT's IDIQ contracts for hurricane debris removal only come into effect if

a hurricane hits the contractor's geographic area of responsibility (Rueda-Benavides and Gransberg 2014). More advantages of IDIQs are shown in Figure 5-19.

Single Work Order	- Owner only has to deal with one contractor	Level 1
Single Award	- Owner can keep lower inventory levels - Flexibility in quantity and delivery scheduling - Supplies and services are ordered when they are really needed - Agencies commit only for a minimum or no amount of work to be ordered - Owner can direct shipments directly to the users	
Multiple Award	- Allows contractor involvement in preconstruction activities - Fast use of year-end funding - Lower cost in future issuance of work orders - Useful contracting option during emergencies - Increase quality and timeliness of delivery	Level 2
	- Reduce potential for graft and corruption - Highly competitive - Lower bid prices - Larger participation of small-size and disadvantaged business - Preference over single award contracts expressed by the FAR	Level 3

Figure 5-19: Contracting Advantages by IDIQ Model (NASEM 2015)

IDIQs can take many forms: multiple-work-order contracts with multiple contractors, multiple-work-order contracts to a single contractor, and single work order to a single contractor (Rueda-Benavides and Gransberg 2014). Multiple award contracts have more apparent benefits, but also are more complex and require more administration. The main disadvantage of IDIQ, particularly compared to CM/GC, is the inability to determine a reliable guaranteed maximum price.

Multiple awards of IDIQ contracts serve as a useful tool during emergencies. Such contracts can be used to narrow down a set of contractors that are capable of providing the services needed during an emergency, and reduces the resources required to respond to any potential orders. Specifically, 48 CFR § 16.504 describes an indefinite-quantity contract as one that "provides for an indefinite quantity, within stated limits, of supplies or services during a fixed period."

To effectively use IDIQ contracts post-disaster, the following approaches should be used (Wilkinson, 2007):

- ✓ Acquisition planning;
- ✓ Commercial commodities and commoditized services;
- ✓ Open contracts;
- ✓ Simplified contracts; and
- ✓ Use of central purchasing bodies as gap fillers.

Some agencies like to award a large number of small IDIQ contracts, like the Missouri DOT, which awarded 86 IDIQ contracts since April 2010. Conversely, agencies like FDOT have found success in awarding large contracts on a less frequent basis. FDOT combined DB with IDIQ methods used to execute two $20 million contracts in 3 years (Rueda-Benavides and Gransberg 2014). IDIQ contracts are primarily used by Federal agencies, serving as a replicable model for state and local agencies seeking to adopt this method.

GSA Schedules

GSA Schedules are long-term government-wide contracts with commercial firms providing Federal, state, and local government buyers access to more than 11 million commercial supplies (products) and services at volume discount pricing. GSA Disaster Purchasing Programs allows state and local governments to buy supplies and services directly from all GSA Schedules to facilitate disaster preparation, response, or major disaster recovery.

The benefits of using GSA schedules include streamlined procedures to increase acquisition speed, access to small businesses to support socioeconomic goals, FAR compliance, pre-qualified contractors, pre-negotiated ceiling prices to achieve best value, and access to emerging technologies and innovative solution. Schedules offer key features, including Blanket Purchase Agreements (BPAs), Contractor Team Arrangements (CTAs), and the ability to easily connect with small businesses. Figure 5-20 shows the steps to use the GSA Disaster Purchasing Program's Schedule. Figure 5-21 shows a representative excerpt from the GSA e-Library's contractor listing for environmental services.

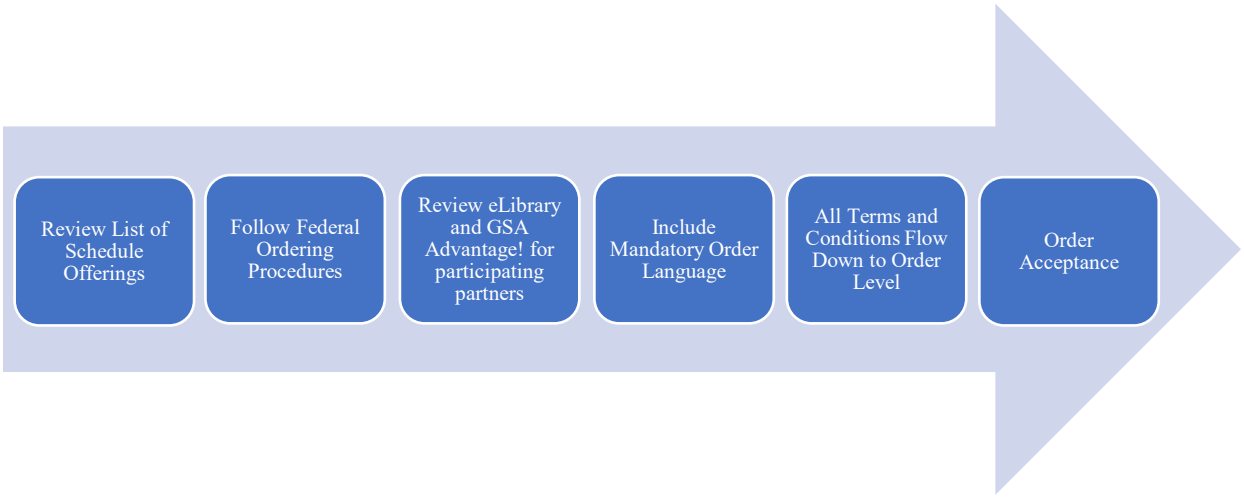

Figure 5-20: How to use GSA Disaster Purchasing Program's Schedule

GSA Disaster Purchasing Key Facts

- ✓ Identify needs for commercial products and services. For a full list of Schedule offerings, visit GSA eLibrary or list of Schedule contract offerings (see Figure 5-21 below for an example).
- ✓ GSA recommends eligible buying entities follow Federal Schedule ordering procedures (see Appendix I) to receive best value (General Services Administration Regulation [GSAR] 552.238-79 (h)).
- ✓ Review participating partners are identified by the logo DISAST PURCH in eLibrary and GSA Advantage!®.
- ✓ Order language must include the following:

  This order is placed under GSA Schedule number "insert number here" under the authority of the GSA Disaster Purchasing program. The products and services purchased will be used in preparation or response to disasters or recovery from major disaster declared by the President, or recovery from terrorism or nuclear, biological, chemical, or radiological attack.

- ✓ GSA terms and conditions must flow down to the order level, as outlined in GSAR Clause 552.238-79(a)(3) Additional terms and conditions may be added where they do not conflict with base level Schedule.
- ✓ Schedule contractors have the option of accepting or declining orders placed by STTL government buyers.

Contractor		Contract #	Phone	City, State	Socio-Economic	Contractor T&Cs /Pricelist	View Catalog
3D ENVIROLOGICS LLC	DISAST PURCH	GS-10F-023CA	4349894223	EARLYSVILLE ,VA	s/w/wo		
A E H S INCORPORATED	DISAST PURCH	GS-10F-0227R	(210)656-9300	SAN ANTONIO ,TX	s/v		
A.D. MARBLE & CO., INC.	DISAST PURCH	GS-00F-411GA	484-533-2550	KING OF PRUSSIA ,PA	s		
A.I.S., INC.	DISAST PURCH	GS-10F-0131T	508-990-9054	MARION ,MA	s		
AARCHER INC	DISAST PURCH	GS-10F-0451M	4108979100	ANNAPOLIS ,MD	s		
ABR INC	DISAST PURCH	47QRAA20D0010	(907)455-6777	FAIRBANKS ,AK	s		
ABR INC	DISAST PURCH	GS-10F-0175M	907-455-6777	FAIRBANKS ,AK	s		
ABT ASSOCIATES INC.	DISAST PURCH	GS-00F-252CA	301-347-5093	CAMBRIDGE ,MA	o		
ACADIAN CONSULTING GROUP	DISAST PURCH	47QRAA19D000Z	2257692603	BATON ROUGE ,LA	s		
ADANTA, INC.	DISAST PURCH	GS-10F-041CA	707-709-8894	NAPA ,CA	s/w/wo/ew/d/8a		
ADI NV INC	DISAST PURCH	GS-00F-048DA	(702)435-3731	HENDERSON ,NV	s/w/wo		
ADVANCED AIR ANALYSIS, INC.	DISAST PURCH	GS-00F-154GA	(410)653-7676	PIKESVILLE ,MD	s/d		
ADVANCED ENVIRONMENTAL MANAGEMENT GROUP, LLC	DISAST PURCH	GS-10F-0338X	734-354-9070	PLYMOUTH ,MI	s/d		
ADVANCED RESOURCE SOLUTIONS, INC	DISAST PURCH	GS-10F-0261S	530-676-1095	SHINGLE SPRINGS ,CA	s		
ADVANCED RESOURCES INTERNATIONAL INC	DISAST PURCH	GS-10F-077AA	7035288420	ARLINGTON ,VA	s		
ADVANCED TECHNOLOGIES AND LABORATORIES (ATL) INTERNATIONAL, INC	DISAST PURCH	GS-00F-067CA	3015156785	GAITHERSBURG ,MD	s/w/wo		

Figure 5-21: GSA eLibrary Contractor Listing Example for Environmental Services

All relevant GSA ordering regulations are currently housed in Appendix H: Federal Supply Schedule Regulations.

5.6 Audit and Other Risks

- ✓ Initiate and compliance program and document control;
- ✓ Confirm requirements for emergency contracting methods align with compliant field documentation; and
- ✓ Initiate DOT monitoring of local agency subrecipients.

A DOT's financial capacity to rapidly recovery from concurrent, regional emergencies and disasters often hinges on accessing and holding on to FHWA ER funding and other Federal resources such as

FEMA Public Assistance funds for (Category A) debris management. Therefore, the DOT should reverse-engineer the policies, procedures, and business process, and other administrative and project delivery controls that result in full funding that is considered eligible, cost reasonable, properly allocated to the DOT's general ledger by funders such as FHWA and FEMA, and resulting in no adverse findings in OIG audits, especially those that recommend de-obligation of funds. Despite the exhausting pace of rapid repairs to restore essential traffic, compliance and document control are another area where the DOT should consider "slowing down in order to speed up." The commonly held perception that "everything" changes when FHWA ER and FEMA Public Assistance funds are in play is often over-stated, or at a minimum is misunderstood. The good news is that many transportation professionals supporting rapid response are cautious about not putting funding at risk.

5.6.1 Monitor Compliance and Document Control

With the focused support of F&A personnel within the incident command, transportation professionals leading rapid response need to become versed in the three law, regulation, and policy considerations that govern DOT compliance on FHWA ER funding, from which monitoring and document control should cascade:

- ✓ State DOT law, regulation, policies, standards, and specifications;
- ✓ FHWA 1273 – Required Contract Provisions Federal-Aid Construction Contracts; and
- ✓ 2 CFR Part 200.

Bottom Line Up Front—if the DOT does not monitor compliance and document control following a concurrent, regional emergency, it could lose tens of millions of dollars or more in funding after it has already gone out the door. The incident commander and section chiefs need to message this fact—clearly and often from day one. A "get 'er done" and "we'll deal with paper later" leadership style is a threat to the financial health and credibility of the DOT, and that gets in the way of the DOT's mission to serve the traveling public.

"We had a lot to learn about compliance related to the Federal disaster funding streams, but we built robust systems and reviewed 100% of project documentation for compliance."

– Colette DeSonier, Flood Recovery Business Manager at CDOT for the 2013 Flood

The fact is that only a handful of administrative and project delivery controls are allowed to change or be modified to accommodate the enormous demands of restoring essential traffic when multiple critical corridors and structures are impacted by shock(s) across one or more regions. The pace of the work and the lack of pre-construction planning (and thus organization) is what sets this process apart from programs and capital expenditure programs. This comes with its own set of real challenges discussed throughout the Report. For example, due to lack of scope clarity, time- and cost-based contracts are often used, and these generate a tremendous amount of work to review in the F&A section, and for the operations section to deliver properly in the field (see Section 5.6.2).

F&A personnel in the incident command need to quickly get down to the business of structuring compliance and document control activities. The earlier F&A can get a new or modified structure and

clear instructions out in front of those leading and delivering work in the field, the fewer problems and less work the F&A team will have on the back end.

Document the concurrent, regional emergency and its macro impacts across the region (consider engaging NEPA environmental specialists to support this task within the planning section of the incident command). See the Grab and Go Appendix for an example of the CDOT Damage Assessment Report. The following provides a snapshot of those project-related activities that are most subject to potential changes in policies, procedures, and business processes due to an event, and recommendations on documenting compliance.

Project Areas Requiring Special Attention

- ✓ **Document shock impacts and resultant damages**. See DDIRs and the POP for FHWA, project worksheets for FEMA, and damage assessment reports (see details in Section 5.2).
- ✓ Substantiate your right to use emergency administrative procedures.
  - Develop the paper trail on the administrative authorities that triggered allowable use of emergency waivers to fiscal rules and tie these back to the management of the scope and scale of damages;
  - Document applicable emergency declarations at the agency, state, and Federal level;
  - Document authority to use emergency procurement methods.
    - Secure a signed and dated written opinion from legal counsel or authorization of the CFO, controller, or other executive with the authority to approve emergency procedures and govern their use.
  - Pull citations and applicable excerpts in law, regulations, and policies that provide for the implementation of emergency procedures if the process is not clearly defined and used regularly.
  - If no emergency procedures are written and adopted, then develop the procedures, and have them vetted and authorized in writing.
    - Consider developing an affidavit to be signed by key personnel in charge of procurement and contracting to be attached to the new emergency procedures. Reinforce the commitment of personnel to the highest standards of ethics in using emergency procedures established post-shock for F&A personnel supporting procurements.
- ✓ Carefully document procurements, contracting, and methods of project delivery. Include:
  - Evidence of solicitation/posting;
  - Solicitation – RFP or RFQ, or
  - Memo to file if standby or emergency procurements contracts are used outlining:
    - Rationale for vendor selection, including review, rating, and selection;
    - Evidence of task order competition including the firms invited to apply, the task order solicitation, all task order responses, details on selection.

- Memo to file if pre-qualified contractors (including professional services and construction) are used for selection;
  - Include list of prequalified contractors showing active status;
  - Be aware that FHWA requires pre-qualified vendor lists to remain open for firms that wish to submit qualifications and be considered for work.
- Proposals or bids received;
- Selection committee names, positions, and standard certifications (e.g., conflict of interest);
- Selection committee meeting notes and rating sheet(s)/scoring;
- Section and notification to contractor along with notice of intent to award, if applicable.
  - If notifications are verbal (e.g., in person, via satellite phone), include notes in memo to file.

✓ Contracting

- Memo to file if a selected vendor declines work and why (this can be two sentences);
- Details of contract price negotiations;
- Changes to contract terms and conditions (e.g., addition of time to completion incentives);
- Contract award with requirements (e.g., insurance, bond, pricing; triggers on pricing);
- Notice of intent to award, if issued;
- Notice or memorandum from director to contractor to mobilize or begin work.
- FHWA approval on contract modifications that involve additional FHWA ER funding for the project. Consider establishing a threshold with FHWA Division office. For example:
  - Develop written concurrence to define approval requirements on project modifications such as FHWA approval waived on projects of less than $1 million on changes of less than 10% of total DDIR approval project costs.

✓ Confirm alignment with documentation collected in the field (see next section, 5.6.2).

✓ **Davis-Bacon Act and Related Compliance.** Davis-Bacon Act compliance remains in full force.

- The fact that Davis-Bacon Act and related requirements are not waived needs to be messaged by the DOT to local agencies clearly from day one. Local agencies that do not typically receive federal awards get confused on this point because in many parts of the country, they are unaccustomed to following stringent Federal prevailing wage requirements.
- Davis-Bacon Act compliance is not required by FEMA. Because local agencies are often receiving significantly more disaster funding through FEMA than FHWA ER, local agency personnel sometimes generalize FEMA's requirements across all disaster funding.

✓ **Civil Rights.** Civil rights requirements must be met, but they can sometimes be adjusted in order to accommodate the demands to respond to essential traffic. For example:

- DBE/MWBE. The DOT's civil rights office can establish concurrence with the FHWA Division and its civil rights staff to quickly define participation requirements that meet goals for inclusion and rapid recovery.
- On-the-Job Training. Because of the pace of rapid response work and the frequent lack of pre-construction planning and drawings, the environment for on-the-job training is difficult for both safety and rapid project delivery. Discuss this with FHWA to determine if and when this requirement should be waived in the rapid repair phase.

✓ **Documentation and Document Control.** Use one clear system backed up in the cloud with appropriate access protections. Determine if contractors providing staff augmentation need access, and secure it.

- If consultants are supporting this function, know what the DOT is paying for—clarify the contract standards for access to DOT information; hand-off format, reporting, and tracking capabilities; and hand-off procedures when contract ends. Recognize that end-to-end project data will be needed for not fewer than 3 years after POP closeout, or longer if audits have been initiated.

✓ **Adjust compliance and document control.** to meet the specific needs to monitor local agencies (e.g., TIP/STIP, "ad and award," scope and change order and other requirements).

In addition to the procurement and contracting actions to restore essential traffic, the work requires an addition mix of procurements needed to set up, feed, house, and (as-needed) augment staff to support the incident command organization. Ensure that F&A staff support the procurement of these tasks, which are normally supported through the logistics section.

Best Practices to Promote Compliance and Document Control

✓ Develop compliance matrix for DOT aligned to document control plan.

✓ Develop compliance matrix for local agencies aligned to document control plan.

- One system can be by type (e.g., innovative contracting for emergency repair projects)

✓ Document anything different.

- Memorialize policy decision

Substantiate key decisions as soon as practicable in writing.

✓ Leverage technologies and automated workflows.

Build dashboard capabilities for the people who need them (roll up dashboard with drill-down capabilities)

Use exception reporting—use heat maps with defined metrics for on target, warning potential, and requiring action/course correction.

- ✓ **Provide judicious technology access, particularly with cyber threats.** There is such a thing as being too strict with permissions, so that it constrains project information sharing, stymieing success. Seek balance.
- ✓ **Monitor – trust but verify.** Things that get measured get done.
- ✓ Get cash out the door.

"We were not good at initially understanding all of the Federal disaster requirements and the volume of paperwork required. It became an exhaustive process. We temporarily fixed the road in 90 days, but we were looking at paperwork for 3 years."

– Heather Paddock, Flood Recovery Manager at CDOT for the 2013 Flood

  - Consider choosing procurement methods that shift risk to contractor and generate less documentation, such as invoicing.
  - Consider implementing cursory reviews and less-than-full release of funds to balance payments with compliance demands. For example, conduct a cursory review of invoicing, and release 85% of payments; then release the balance following final document review. Consider the combined impact of this temporary reduction along with holding liquidated damages; ensure payments are high enough to enable contractors to continue to support the response effort.

Ramp up personnel and system capacity and track resource requirements to avoid bottleneck and adequately keep pace with administrative demands.

5.6.2 Confirm Requirements for Emergency Contracting Methods Align with Compliant Field Documentation

"Documentation collected in the field needs to fully align with whatever is committed−regardless of (type of) procurement mechanism selected−is extremely important. Many, agencies fail to understand this and as a result find themselves in the position of being unable to clearly demonstrate to funding partners what was done and how it was done with the end result being that they (transportation agencies) are not reimbursed for some work."

– Tom Prendergast, Former Chairman, NYMTA and Former CEO, NY MTA Transit

It is important that the procurement, contracting and project delivery method align with documentation collected in the field. Often, initial project scopes of work are unclear, so it is difficult for the DOT and the construction contractor (or innovative delivery team) to establish fair and reasonable contract pricing. In this case, projects with unclear scope are often set up on a cost basis such as such as time and materials with NTE cap. In the right circumstances, a cost-based contract can equitably share risks between the owner and the contractor if the job is closely monitored at reasonable rates for labor and direct expenses. However, the benefits of using cost-based methods break down quickly if not properly structured. First, cost-based contracts need to be carefully tracked for labor via certified payrolls, and must also include detailed invoices describing every single expense. These must be supported by proper documentation costs such as detailed information on level of labor utilization to perform the scope of work, detailed materials descriptions, quantities, and costs tracking, equipment utilization and rates, materials, and supplies; everything must be backed up

with a clear, dated, and detailed invoice. That includes a receipt and authorization for a $20 pair of work gloves, or $30 in water and ice for the safety tailgate meeting at the start of a shift.

Second, not only does the volume of paperwork that must be reviewed and reconciled quickly mount up, the manner in which the job must be monitored in the field is dramatically different than for a fixed-price contract. Typically, DOT construction projects with significant capital costs use fixed contract price methods such as unit pricing or lump sum, and standard DOT workflows are built around these requirements. A project manager assigned to a cost-based job needs the following in order to succeed:

- ✓ Be fully versed in the contract scope and pricing as well as terms and conditions;
- ✓ Have a clearly defined and understood roadmap of business processes to monitor the cost-based contract;
- ✓ Be prepared to actively monitor cost performance at a highly granular level in addition to assuring project safety and quality through construction and grant closeout;
- ✓ Have adequate training in construction management ready to cover the entire span of a project (e.g., a 30-mile damaged corridor) and be able to confirm that all costs allowed under the contract were reasonable and properly incurred; this includes inspecting truck driver badges and license plates and making sure the DOT is not being charged fully burdened equipment rental rates when on standby, and that each construction worker was monitored well enough for the project team to confirm that the number of hours charged were correct (or at least reasonable for work performed).

Is it possible to monitor large jobs effectively for cost-based contracts? Yes, but going in unprepared invites significant and often avoidable audit risks. Regardless, F&A staff in the incident command will have a significantly higher volume of financial documentation to review, and that not only costs money, but can slow down time to payment for contractors the DOT is relying on to help them restore essential traffic.

Some alternatives to cost-based contracts include:

- Using a cost basis for a limited duration while the scope of work is validated, and define extremely clear procedures and dates when the project costs convert from time-based to unit costs or other method of fixed-price contract definitization;
- Developing a core list of unit-priced items typically used for corridor and structure construction; pricing can be bid at multiple quantity levels to reduce risk to contractors based on economies of scale;
- Allow for time-/cost-based mobilization/demobilization for extraordinary costs incurred due to the scale of the concurrent regional emergency or disaster (e.g., bringing in craft labor from outside the area, or specialty equipment that must be hauled 500 miles);
- Use unit pricing with terms and conditions that provide for economic price adjustments. For example, an economic price adjustment might be triggered when a material's raw costs to the

contractor is 30% higher than the prior year average for the region; thereby enabling equitable compensation to the contractor where market scarcity makes certain costs uncertain.

5.6.3 Initiate DOT Monitoring of Local Agency Subrecipients

Local agencies need support in delivering projects and monitoring compliance during concurrent, regional emergencies and disasters. Not only are their staff benches stretched to capacity and beyond, local agencies typically have more roadway miles subject to damage and repair that are eligible for FEMA public assistance. Further, because "on system" roads under the DOT are often built to more stringent standards and specifications, those roadways tend to better absorb shock impacts, resulting in fewer damaged structures and lane miles. Two funding sources mean that local agencies are managing two distinct sets of rules, and it is very difficult for them not to get rules conflated. In addition, even where the local agency has personnel who typically deliver DOT local agency projects and have a good understanding of FHWA's general requirements, those experienced staff often get moved into roles due to their experience with Federal funding. Oftentimes, experienced staff become responsible for the FEMA funded restoration of roadways, and are therefore pulled away from more familiar FHWA supported projects.

5.7 Policy and Funding

- ✓ Know the rules of engagement on funding streams on day one;
- ✓ Ensure personnel know how to support project delivery with funding in view.

5.7.1 Know the Rules of Engagement on Funding Streams on Day One

Understand the rules of engagement – disaster law, regulations, and policies, and how they differ from traditional funding programs supported by FHWA and state sources. For disaster response operations to successfully capture allowable FHWA ER funding, it is crucial to access technical expertise in governing law, regulation, and policy. While most Federal regulations are harmonized with 2 CFR Part 200, a number of agency authorizing regulations differ and sometimes conflict. Not only is it important to develop an integrated compliance matrix for each funding stream such as FHWA Emergency Relief and FEMA's Public Assistance Program, funding matrices must be integrated and deconflicted where more than one Federal or other non-discretionary funding source is used on the same project.

In order to begin rapid repairs in compliance with Federal funding requirements, it is essential that personnel in the incident command organization be versed in key requirements for each applicable funding stream. Primer-level "just-in-time" training on key policy requirements is recommended for all-hands personnel supporting field delivery (planning, operations, logistics [supply chain focused], and finance and administrations sections). Full day instruction on policy for incident command leaders and section chiefs is essential, despite the frenetic pace of work in the rapid response phase.

Consider including a policy expert as a key role to support the incident commander and liaise across all incident command sections, and ensure that policy discussions be at the nexus of the finance and administration and operations sections, in particular. Be sure to systematically record all policy decisions with the Federal funder in writing (and support with rationales and policy citations); secure signature

concurrence from the funder and the transportation agency wherever the funder is willing to do so, or default to robust record of correspondence transmittal logs when funder signature cannot be obtained.

5.7.2 Ensure Personnel Know How to Support Project Delivery with Funding in View

Using decision trees and process flows are extremely helpful in quickly clarifying (often new) business processes for concurrent, regional emergencies and disasters. The following process flow diagram in Figure 5-22 was developed to help transportation professionals quickly identify what funding stream is expected to support the project and whether day-to-day business processes will be used for project delivery or if special or additional requirements are triggered. The diagram was developed at the request of project managers and engineers, as well as maintenance managers.

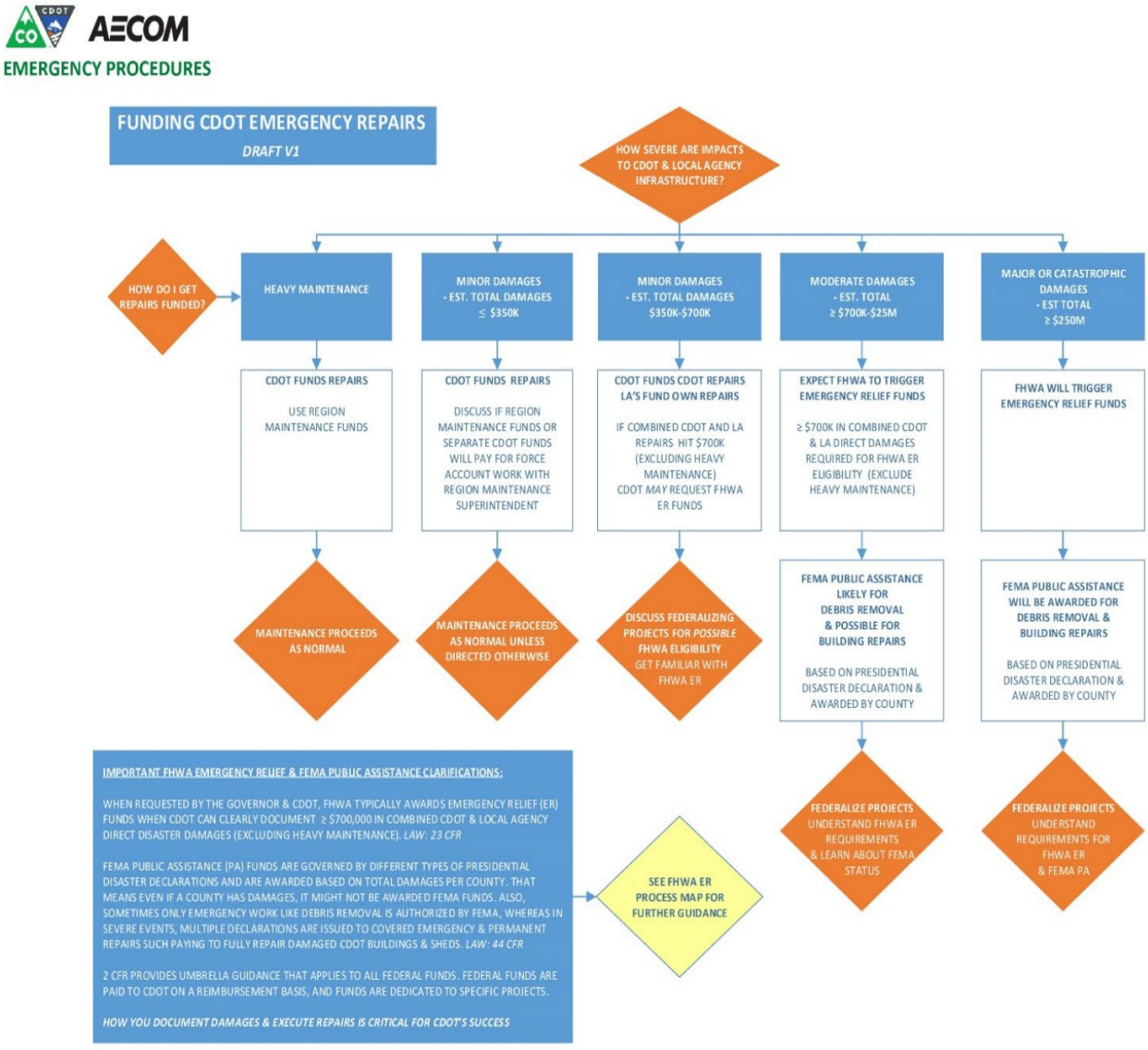

Figure 5-22: Funding CDOT Emergency Repairs

5.8 Other Relevant Considerations

- ✓ Social Dimensions of Rapid Response;
- ✓ Cyber Incidents;
- ✓ Pandemics and COVID-19; and
- ✓ Resilience and Climate Adaptation.

When concurrent, regional emergencies and disasters are beginning to unfold, it can be difficult to track the universe of near, mid-term, and long-term issues, challenges, and opportunities facing DOTs. The magnitude and urgency of the work combined, often keep transportation professionals in responsible charge "up at night." While one response can be to shorten one's horizon in order to put out fires generated by the immediate crisis (or crises), one can unknowingly put roadblocks in the path to resilient recovery; many of those can be avoided. While the urgency to protect life/safety and restore essential traffic is the first concern, transportation professionals can be better served by tapping ready resources to resolve work on imminent challenges while looking forward and planning the major, long-term projects ahead, such as resilient roadway reconstruction or bridge relocation.

Engaging those affected by short-term decisions (such as community members cut off from supply lines, receiving life-saving care such as kidney dialysis, or accessing economic centers) will result in better outcomes that support community survivors. Similarly, meaningfully engaging the community on projects with generational impacts will result in a better transportation asset that yields dividends through strengthening community health and quality of life, supporting sustainable resilience and climate adaptation, and promoting economic stability and growth.

5.8.1 Social Dimensions of Rapid Response

Baseline data from the readiness phase are essential for rapid response to events that are either minor or major in scale and scope. Based on the activities carried out during readiness, transportation decision-makers can work with emergency management personnel and planners during rapid response. In the rapid response phase, the planner (in consultation with key stakeholders) must consider what types of social dimensions in a community might be affected; for example, the following are essential to ensuring that all vulnerable populations are accounted for and can be prioritized when assessing damage and beginning rapid response efforts (adapted from National Institute for Standards and Technology [NIST] 2016).

- ✓ Access to key transportation facilities (airports, ports/harbors, railway stations) so goods can be transported, and supply chains restored;
- ✓ Ability of public sector employees (who run government, direct traffic, respond to emergencies, run transit systems, and teach or work in schools) to reach their posts;
- ✓ Access for workers to restore critical facilities and supporting infrastructure (power, communications, water, wastewater);

- ✓ Access to businesses (both small and large), banks, retail, manufacturing, and similar facilities so they can receive supplies and serve their customers;
- ✓ Ability of individuals and groups to evacuate to shelters or outside the community to determine who would be sheltering-in-place vs. who would be evacuating;
- ✓ Ingress of goods and supplies immediately after event to provide aid; and
- ✓ Ability for community members to get to work, school, medical facilities, sports and entertainment venues, and places to gather for religious or cultural events.

5.8.1.1 Hiring Community Planners

A number of options are available for identifying individuals who are likely to be well qualified to support readiness activities. One source is the American Planning Association (APA), which has a rigorous credentialing process through the American Institute of Certified Planners (AICP). AICP certification is the national qualifying standard for planners. AICP certification helps to ensure ethical practice and the ability to make sound decisions for communities in which they are working. The process requires that applicants meet the following eligibility requirements before applying for AICP Certification: (1) be a current member of the APA, (2) be engaged in professional planning, either currently or in the past, as defined by AICP, and (3) have completed, at the time of application submission, one of the combinations of education and corresponding years of professional planning experience presented in Table 5-1.

Table 5-1: Example Qualifications to Seek for an Urban/Community Planner

Level of Education	Required Number of Years of Professional Planning Experience
Graduate degree in planning from a program accredited by the PAB	2 years
Bachelor's degree in planning from a program accredited by the PAB	3 years
Graduate degree in planning from a program not accredited by the PAB	3 years
Any other post-graduate, graduate, or undergraduate degree	4 years
No college degree	8 years

PAB = Planning Accreditation Board

According to the APA website, by passing the AICP exam, individuals demonstrate comprehensive understanding of planning. This shows the versatility and breadth of knowledge of planning and ensures that the individual has the ability to take on—and successfully complete—a wide range of projects. Furthermore, continuous learning keeps those who are certified engaged, informed, and in command of contemporary planning practice. Using certified planners saves those who are hiring them both time and money. In addition to this formal certification, it is beneficial to involve planners who have experience working in resilience planning and/or in post-disaster contexts. Thus, another way to seek verification of someone's qualifications might be through recommendations from other trusted sources, such as the

NIST, or disaster-related research centers, such as the Natural Hazards Center, Disaster Research Center, or Hazards and Vulnerability Research Institute.

5.8.2 Cyber Incidents

The Southeastern Pennsylvania Transit Authority (SEPTA) experienced a cyber-attack during the pandemic in August 2020. *The Philadelphia Inquirer* highlights the challenges facing transportation system users caught in the crosshairs of concurrent, regional emergencies in an August 26, 2020 article, "The malware issue does seem to have involved Customized Community Transportation Connect, referred to as CCT, said Kellie Flanagan, a social worker who recently attempted to schedule a ride for a client to get to a doctor's appointment and was told its 'computer systems are down.' 'I was frustrated on behalf of the client, but I was also frustrated with the lack of information,' Flanagan said" (Madej 2020a).

The article goes on to describe the experience of a rider with mobility impairments who used SEPTA's CCT service. Colleen Marinelli and Richard Marinelli are riders.

> " 'I feel that it's discrimination because we feel that if an able-bodied person had this problem or a similar problem, SEPTA would have taken care of it faster,' said CCT rider Colleen Marinelli, 59. 'It's like saying that because you're disabled, where you have to go isn't important.' The malware attack forced SEPTA to pause CCT's routine scheduling abilities, but SEPTA shifted operations in the interim to make sure riders are still getting where they need to go, SEPTA spokesperson Andrew Busch said. CCT has been communicated as 'a priority to get restored,' Kelly said. "In no way are we trying to discriminate against riders with disabilities and others who use CCT," Busch said. 'We're in a situation where we have to make these temporary workarounds to keep the system moving.' Real-time data for riders — meaning the 'next-to-arrive' feature on its app and automated announcements at stations — were restored late Monday afternoon" (Madej 2020a).

Cyber incidents require specialized engagement of investigative and protective services in addition to right-skilled staff working in an integrated command environment.

On February 21–23, 2018, the CDOT suffered a ransomware attack affecting nearly half of its computers. Despite CDOT's immediate action, a second attack followed on March 1, 2018. In its 2018 After-Action Report, CDOT maps the root cause of the attack (see below).

Root Cause

A virtual server was created on February 18, 2018. The virtual server was directly connected into the Colorado Department of Transportation (CDOT) network, as if it was a local on premise system. The virtual server instance also had an internet address and did not have OIT's standardized security controls in place. The account utilized to establish the connection into the CDOT network was a domain administrator account - this is the highest level privileged account, and means that 1) the account cannot be disabled for too many failed login accounts, and 2) it provides the highest level of access to the agency domain controllers (gatekeepers for all access to everything in the department).

Later, OIT was informed by the vendor that when an external IP address is requested, the vendor automatically opens the Remote Desktop protocol to the internet. The Remote Desktop protocol is how this attack was initiated.

An attacker discovered this system available on the internet, broke into the Administrator account using approximately 40,000 password guesses until the account was compromised. From there, the attacker was able to access CDOT's environment as the domain administrator, installing and activating the ransomware attack.

The virtual server was built on 2/18. The brute force attack began the same day. The system was compromised on 2/20. The ransomware attack was launched on 2/21.

Source: CDOT 2018

In its After-Action Report, CDOT describes the conditions that may have aided the attack or delayed recovery, described below (CDOT 2018). CDOT's After-Action Report can be found in full in the Grab and Go Appendix.

Potential Aids to the Attack/Delays in Recovery

Turnover and lack of firewall personnel - OIT had, and continues to be effected by turnover in areas of subject matter expertise…Additionally, OIT is deploying tools with automated security response capabilities to handle the repeatable, lower-skill, mundane tasks, thereby creating more interesting and fulfilling work, as a way to retain our scarce human resources.

Separate internet access and outdated firewall - controls, protection, and visibility built into enterprise services, such as firewall services, were scheduled for implementation into the CDOT network as part of a planned building move in the upcoming weeks. As a result, the firewall had not yet been replaced and upgraded. The replacement effort would have resulted in a stricter policy and better visibility into and blocking of malicious traffic.

Outdated systems in use - A couple of outdated systems were discovered in the agency environment - the attackers utilized these outdated systems to establish staging environments and persistent backdoors into the environment. These systems are easy targets and easily penetrated, since security patches are no longer being released by the vendor. These systems have since been depreciated and replaced.

An isolated network and lack of familiarity with the agency network - Diagrams of the network were stored on systems which had been encrypted by the ransomware. As a result, incident response teams had to recreate the diagrams from memory and knowledge of the network…

Little visibility into the cloud - the virtual server instance was created only 2 days prior to the attacker gaining access. And while a penetration test was conducted in November, because this system's internet address was not on the state network it would have never been detected. Better partnership with cloud service providers and better tools to gain visibility into cloud services is needed to detect poorly configured systems that might put state data and networks at risk.

Source: CDOT 2018

In 2020, the Texas DOT (TxDOT), like SEPTA, experienced a cyber-attack. The attack on SEPTA had targeted employee personally identifiable information and other data; namely, information that is used for phishing. TxDOT's attack used ransomware much like the CDOT attack in 2018.

Further recommendations on administrative systems and controls to prepare for cyber incidents are discussed in readiness Section 4.8.2.

5.8.3 Pandemics and COVID-19

Because Chapter 4 focuses on the needs of transportation professionals who may be in the midst of a recent concurrent, regional emergency, redundant content is kept to a minimum. See Section 4.8.3 for an overview of baseline strategies and tactics a transportation agency should consider when establishing pandemic policies and procedures for the DOT and its contractors.

5.8.4 Resilience and Climate Adaptation

During rapid response, DOTs can incorporate climate change into discussions on asset failure and likelihood of reoccurrence. This can drive the response and eventual recovery efforts toward resilience. The list below was published by FHWA and includes the process FHWA, DOTs, and local public agencies (LPAs) should follow for integrating resilience into ER Program decisions. The following is relevant to rapid response (FHWA 2019):

Improving resilience when planning, designing, maintaining, and repairing transportation assets may yield cost savings in the long term, through reduced repair costs, improved safety, and reduced travel disruption…Emergency Relief (ER) Program funds that are provided following a disaster may be used on repairs that improve the long-term resilience of the Federal-aid highways, if 1) consistent with current standards, or 2) the State DOT demonstrates that the resilience feature is economically justified to prevent future recurring damage.

1. **Consistent with current standards.** Repaired facilities may be rebuilt to current geometric and construction standards. Simply rebuilding to current standards may result in a resilience improvement. For example, following current hydraulic standards may result in a larger culvert, which will allow larger stream flows to pass under the roadway without washing out the pavement. Rebuilding to current standards is not considered a betterment and does not require economic justification.

2. **Economically justified.** If rebuilding to current standards does not reduce risks to acceptable levels, facilities being repaired under the FHWA ER program may use ER funds for betterments (added protective features), if the State DOT can demonstrate that that the feature is economically justified to prevent future recurring damage. The economic justification must weigh the cost of the betterment against the risk of eligible recurring damage and the cost of future repair. Note that for the justification, only costs to the FHWA ER program are included. Other costs, such as traveler delay or reduced economic activity, are not included.

If the State DOT plans to fund a betterment that is not economically justified, the State DOT may use ER funding up to cost of repairing to current standards. The State DOT may then use its own funds or other apportioned Federal-aid funds to cover any incremental costs beyond ER eligible costs.

Resilience and climate adaptation, including applicable regulations, are discussed in Sections 4.8.4 and 6.8.4.

6 Resilient Recovery

Readiness planning creates space for resilient recovery that leverages triple-bottom-line benefits for people and communities, environmental sustainability, and economic stability and growth. To promote this "build back better" co-benefit approach, rebuilding of transportation assets and corridors should be prioritized in order to drive key investments that support regional recovery. State and national standards can also be used to incentivize and guide this approach by requiring resiliency upgrades and specifications as part of procurement and contracting.

Resilient recovery efforts are enhanced by long-term capacity on behalf of both DOT and local agencies, where coordination efforts work in parallel to support strategic investments at multiple project scales. The research team survey found that STTL agencies (applicants for Federal disaster funds) do not currently have a clear understanding of the level of effort involved to support resilient, long-term recovery reflected in Figure 6-1.

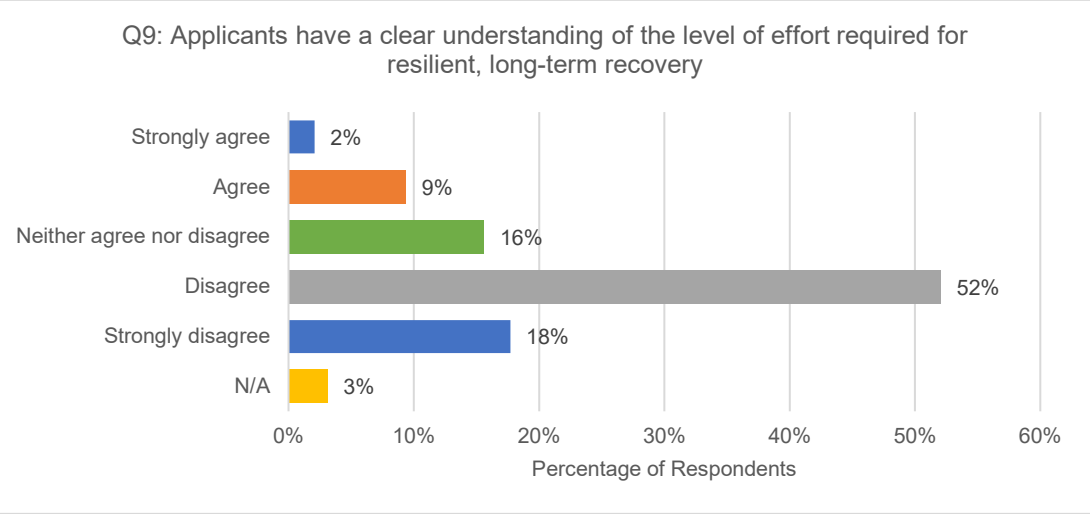

Figure 6-1: NCHRP 08-107 survey question 9 (graph, AECOM)

The National Institute of Building Sciences (NIBS) released a finding that every $1 invested in hazard mitigation measures by FEMA, HUD, and the Economic Development Agency produces a $6 RoI for the nation. It found that mitigations against riverine flooding produced a $7 ROI for every $1 invested (NIBS 2018).

6.1 DOT Emergency Plan Coordination

- ✓ Transition from rapid response to resilient recovery; and
- ✓ Consider region-wide resilience and long-term planning goals.

6.1.1 Transition from Rapid Response to Resilient Recovery

The transition from response to recovery technically occurs once hazards impacting critical operations have been mitigated and efforts are able to shift focus to the restoration, rebuilding, and reshaping of

assets. By communicating risk and tracking response efforts, DOTs are better prepared to prioritize recovery efforts by the criticality and damage of the respective asset. This involves having key personnel in the planning and operations sections of the incident command focus on resilient recovery operations from day one of rapid response operations. While not all rapid response projects can naturally advance resilience recovery objectives, any barriers that do persist from rapid recovery will be visible, and that means work-around alternatives can be planned from the early days of response operations.

Partnerships in the resilient recovery phase continue to amplify opportunities for transportation system and community benefit. The following partnership example comes from the 2013 flood in Colorado, and is between a local agency and a Federal partner. Due to the magnitude of flood damages, the significant number of projects requiring concurrent delivery, and the resultant rate of high cash expenditures, Boulder County identified an opportunity to increase its administrative capacity and commence critically important roadway reconstruction following its temporary repairs on Lefthand Canyon Drive. Lefthand Canyon transects Federal Lands. In 2015, Boulder County—in cooperation with FHWA and CDOT—entered into an agreement with Central Federal Lands to perform eligible repairs on behalf of Boulder County. The project tied together with Central Federal Land restoration of Left Hand Creek, the flow of which was remapped by the flood. According to Boulder County,

> "…(the) partnership provided an opportunity to improve the design and accelerate the construction schedule. The project includes not only the reconstruction of the damaged road sections, but also better shoulders to improve safety for everyone who uses the canyon, four new bridges where the road crosses the creek and restoration of Left Hand Creek in areas adjacent to the road, which will create a vast improvement of the ecological health of the creek."

In addition, the agreement authorized CDOT to make payments of FHWA ER funding for the project directly to Central Federal Lands, rather than Boulder Country, reducing administrative efforts and time to pay for work performed. This allowed Boulder County to focus on widespread damages across the County, including repairs to "off-system" roads, as well as non-transportation assets damaged by the floods.

6.1.2 Consider Regionwide Resilience and Long-term Planning Goals

Regional competitiveness comes into focus during the resilient recovery phase. Recovery partnerships are essential to broker formal agreements on (above-minimum) codes, standards, and specifications and other key characteristics to support resilience and climate adaptation, and to leverage triple-bottom-line-benefits. For example, contract scopes should clarify cross-regional dependencies or key project characteristics required to move forward following concurrent, regional emergencies or disasters. Establishing new or strengthening existing partnerships and regional planning networks between the DOT and MPOs and local agencies helps encourage the collaboration necessary to connect recovery needs both within and across planning areas. Planning for anticipated community-specific assets and needs can take many forms. The following present a small handful of opportunities that can be leveraged in region-wide and multi-region partnerships:

- Supporting partner agency applications for state or federal tax credits to support shared objectives for co-benefits;
- Co-developing recovery plans tied to capital budgets that help improve bond ratings;
- Rewarding communities that participate in resiliency education programs to increase local demand and buy-in for resilience and recovery planning;
- Moving up planned network improvements to assets that had some impacts with resilience and adaptation improvements:
    - To promote safety;
    - To capture ROI and enhance capacity to avoid or absorb shocks, reducing disruption;
    - To save costs to deliver project(s) in the future (escalation);
    - To make system improvements now to increase system reliability;
- Enhancing competitiveness for funding through partnerships, regional or multi-regional resilience and adaptation approaches to provide funding beyond disaster funding. Work together on HUD Action Plans for Community Development Block Grant – Disaster Recovery (CDBG-DR) funding that is appropriated by Congress, and use that as an opportunity to charter the region's resilience and adaptation goals; and
- Continuing the resilience adaptation planning work to develop or refine a regional or state resiliency framework and action plan that is not limited to the concurrent, regional emergency impact area.

Examples of sustainable resilience and recovery plans include the *Colorado Resiliency Framework* (State of Colorado 2018),The *US Virgin Islands Hurricane Recovery and Resilience Task Force Report* (2018), and the Greensburg, Kansas *Long-Term Community Recovery Plan* (2008). The following provides an overview of the post-catastrophe planning effort in Greensburg and excerpts from its plan. On May 4, 2007, an EF-5 tornado estimated to be 1.7 miles wide with 205 mph winds struck the City of Greensburg and Kiowa County, Kansas. Damage to Greensburg was significant, with more than 90% of the structures in the community severely damaged or destroyed.

Approximately 500 community members among Greensburg's population participated in an intensive 12-week process that meaningfully engaged citizens, civic groups, business owners, local, state, and federal officials, and the long-term recovery planning team. Planning included a "public square process" that facilitated asset-based conversations, citizen engagement, and partnership. The public square process discussed sustainable and resilient rebuilding for government, education, business, and health and community services. Four major community meetings were held to guide key decisions, attended by 400+ participants per meeting.

The community nominated community members attended a visions retreat. Excerpts of the vision included:

Greensburg + Kiowa County is…

A community where city and county government provide strong, visionary leadership and where citizens enjoy a well-maintained infrastructure, efficient government services, city-county cooperation, and healthy community growth guided by a comprehensive plan and plan process that meets high standards.

A progressive community that offers urban services within the unassuming feel of a rural, Midwest community. A community where progressive, integrated services provide outstanding medical, mental, spiritual, social, and civic health and where doctors, therapists, ministers, social agencies and service clubs collaborate in designing and delivering services that provide a high quality of life.

A community where partnerships among key institutions combine with citizen volunteers to provide a community center, parks, library, arts & culture, childcare, youth services and an effective communication system to keep citizens well-informed.

A community that opens its doors to new residents and visitors without affecting the values and lifestyles of its current residents.

A community that provides opportunities for its young people in the way of jobs, education and recreation as reasons to stay in Greensburg/Kiowa County and where residents are attracted to a school system that provides excellent elementary and secondary education, uses state-of-the-art technology, and provides adult learning opportunities.

A community where entrepreneurial spirit, customer service, and a sustainable economy permeate the business sector and where residents, travelers, and tourists enjoy a full line of locally owned businesses that provide jobs and services to an exceptional example of small-town America.

A community that recognizes the importance of the natural environment and balances the need for growth and economic development with the maintenance and improvement of the environment.

An up-to-date, affordable rural community where housing plans and strategies incorporate energy-efficient design and materials and serve as a regional and national model for integrating residents of all ages and needs with services of all kinds.

In addition, community interviews, with groups of approximately 25 participants, met weekly to continue planning activities for each of the four public square focus areas. In addition, a 2-day design charette benefited from significant community participation, and a community rebuilding fair brought together additional partners to undergird Greensburg's direction to rebuild as a model for sustainable resilience. Partners for the rebuilding fair included the U.S. Department of Energy via the National Renewable Energy Laboratory, the U.S. Environmental Protection Agency, FEMA, U.S. Small Business Administration, U.S. Department of Agriculture–Rural Development, Kansas Energy Office, Kansas Housing Resource Corporation, Kansas Small Business Development Center, American Institute for Architects–Kansas Chapter, building and trade associations, and several nonprofit organizations.

The Greensburg Long-Term Community Recovery Plan was presented in draft at a community meeting with 350 attendees and developed the following priorities:

- Rebuild City and County Buildings
- Rebuild Schools and Expand Educational
- Opportunities in Kiowa County Develop Affordable and Diverse Housing

- Opportunities Rebuild Medical and Emergency Service
- Facilities Create a Business Incubator
- Expand Lake Recreation Area / Relocate
    - County Fairgrounds
- Develop a Kiowa County Museum & Tourism Center
- Rebuild Downtown Greensburg including roadways and structures
    - Establish a Community Leadership Program

(Kansas, Office of the Governor and FEMA 2018).

Greensburg rebuilt largely in accordance with its *Long-Term Community Recovery Plan* (Kansas, Office of the Governor and FEMA 2007) and constructed the highest density of Leadership in Energy and Environmental Design (LEED) Platinum buildings in the world. A case study sums up the accomplishments fomented by Greensburg's planning effort and reported in the *100% Renewable Energy Atlas* which tracks sustainability and renewable energy savings, states.

- ✓ **Target:** 100% renewable energy
- ✓ **Status: Achieved**
- ✓ **RES:** Wind farm, small solar installations and biogas and biodiesel generator, LEED Buildings, geothermal heating, charging stations for electric vehicles.
- ✓ **Implementation:** Greensburg is a small rural town in Kansas, USA. It is a story of triumph from tragedy. In 2007, a tornado hit Greensburg and severely damaged or destroyed 90% of its structures. Shortly after this tragedy, the community, led by Mayor Bob Dixon decided to rebuild Greensburg as a sustainable community. A 'Long-Term Community Recovery Plan' was developed in 2007 and in 2008 Greensburg residents developed a 'Sustainable Comprehensive Plan' for the city's next 20 years that would focus on cost-effective energy efficiency and on operating with 100% renewable energy (RE).

  Today, Greensburg Wind Farm supplies 12.5 MW of RE to the town. The RE production is complemented by small solar installations, while biogas and biodiesel generators are used for emergency backup. The town uses only about 1/3 of the power generated and excess power is fed back to the grid and offered as RE credits for other customers. Greensburg's Plan mandated that all city-owned buildings had to achieve the U.S. Green Building Council's LEED Platinum rating. This has resulted in 42% energy savings, with 13 community buildings saving a combined total of USD$200,000 in energy costs per year. Also many private buildings are exceeding 40% in energy savings. For the transport sector, the city encourages alternative and efficient transportation options, more pedestrian activity and promoting charging stations for electric vehicles.

  The creation of the Greensburg Plan essentially involved a range of stakeholders through many community meetings. It included city leaders, business owners, non-profit organizations (e.g. Greensburg Green Town), residents as well as experts from the U.S. Department of Energy (DOE) and the National Renewable Energy Laboratory (NREL). To implement Greenburg's Plan, the DOE/NREL team helped identify key steps: bringing stakeholders together, choosing the right leaders, creating a common vision, having goals, finding funds and writing an energy plan. Energy data is tracked by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy [EERE]. (100% Renewable Energy Atlas 2019).

Planning for sustainable resilience and adaptation and delivering durable triple-bottom-line benefits only happens when partners work diligently together with community to establish a vision, goals, and objectives that are resourced, monitored, and continuously revisited for process and performance.

6.2 Scope and Scale Considerations

- ✓ Integrate standards and specifications into procurement and contracting to increase asset resilience; and
- ✓ Leverage co-benefits for recovery.

"Colorado is unique in our flooding because we don't have sea level rise or storm surge floods – we have high velocity roaring through a canyon type of flooding. Also, out in the eastern plains we have slow rising of water. I think the epiphany came to breaking-down agency walls to really figure out how do we work in parallel with the road and the river. How do we get these things to function? At the end of the day, mother nature will always win if we don't make strategic investments."

– Heather Paddock, Flood Recovery Manager at CDOT for the 2013 Flood

6.2.1 Integrate Standards and Specifications into Procurement and Contracting to Increase Asset Resilience

Procurement and contracting are successfully executed when the recovery effort and its intended outcomes are clearly outlined in scoping elements. This includes defining not only recovery goals and objectives, problems and needs, as well as known impacts, but current and consistent standards and specifications that can encourage more resilient assets. Concurrence with DOT geometric, hydraulic, or construction standards—or best practices—encourage resilience, such as specifications that require rebuilding larger culverts to increase stream flow and prevent future roadway washouts (FHWA 2018a).

Standards and specifications can be in the form of reference to internal guidance or best practice that may be used, or detailed requirements that should be followed (e.g., elevation standards) for any recovery efforts. Scoping materials should include federal regulations that need to be considered and met, specifically focused on protection of future assets and those that may require federal funding to remain eligible for reimbursement (at the state and federal level) or pass an audit. Maintenance and operation plans should also be included in any procurement or contract document where applicable, including how repeated repairs and known improvements may be addressed within Transportation Asset Management Plans (TAMPs).

6.2.2 Leverage Co-benefits for Recovery

To encourage bounce-back time, recovery efforts should incorporate how rebuilding the transportation network and assets benefits the economic, natural, and social environments for a more resilient region over the long-term. During Superstorm Sandy recovery efforts, stormwater infrastructure was rebuilt to moderate demand on drainage facilities, addressing roadway flooding while also reducing future flood risk to vulnerable communities and housing infrastructure. To realize these co-benefits, scoping elements should align with the recovery support functions as defined in the 2015 State of Colorado Recovery Plan and FEMA's National Disaster Recovery Framework. These functions include community planning and capacity-building, economic, health and social services, housing, infrastructure systems, and natural and cultural resources. This offers transportation professionals the ability to complement investment recommendations while leveraging resources at all scales.

6.3 Prioritization and Capacity

- ✓ Identify the highest priority corridors within the region; and
- ✓ Develop procedures that facilitate differentiated levels of resilience rates of return (risk reduction).

6.3.1 Identify the highest priority corridors within the region

It is important to identify the highest priority corridors within the region requiring resilience measures, and at the same time successfully navigate a project's critical success factors.

For example, following Superstorm Sandy, MTA Bridges and Tunnels needed to complete temporary and permanent repairs to the Hugh Carey Tunnel (formerly known as the Brooklyn Battery Tunnel) while remaining in service for commuter traffic for this key artery in and out of Manhattan following dewatering operations; and to be cleared for safe restoration of essential traffic. Inspections and temporary repairs were completed from the evening through early morning, and inbound and outbound tunnels were closed on an alternating basis, and instead conveyed two-way traffic when full tunnel closures were required. The repairs were successful in part because administrative controls, including project procurement and contracting processes, clearly defined terms and conditions for the continuous operation of the tunnel. Effective public communications and good use of ITS also supported project success. The following schedule was used for permanent tunnel repairs in 2018:

> STATEN ISLAND, N.Y. — One tube of the Hugh L. Carey Tunnel (formerly known as the Brooklyn-Battery Tunnel) will be closed every week night beginning Monday to repair damage caused by Hurricane Sandy, according to MTA Bridges and Tunnels. In addition, there will be weekend-long closures of one tube at least once a month. All of the closures are expected to last through 2018.
>
> - One tube will be closed every Monday through Friday from 9:30 p.m. to 5:30 a.m. One tube also will be closed for routine maintenance work every week from 11 p.m. Sunday to 5:30 a.m. Monday.
> - The monthly weekend-long closures will take place between 9:30 p.m. Friday and 5:30 a.m. Monday.
> - During all of these closures, the remaining tube will provide one lane of traffic in each direction.
>
> The work is part of a four-year, $282.5 million contract that was awarded to Tully Construction Co. in December to make permanent repairs to the tunnel, which was flooded with some 60 million gallons of water during Hurricane Sandy on Oct. 29, 2012. The Sandy restoration work will be coupled with some previously planned capital improvement projects in an effort to get the projects completed quickly and more efficiently. 'Not only will this project restore and improve the tunnel, it will increase the level of resiliency against future weather events,' said Jim Ferrara, MTA Bridges and Tunnels president.

> The resiliency measures in the project include installing submersible drainage pumps at tunnel pump rooms in Manhattan, Brooklyn and at Governors Island, and elevating various electrical control system components to reduce their vulnerability to flooding. The Brooklyn toll plaza also will be rehabilitated to improve traffic flow (Porpora 2015).

While MTA Bridges and Tunnels was supporting resilient recovery for Superstorm Sandy on the Hugh Carey Tunnel, it was making similar resilience gains on critical, impacted structures, including the Queens Midtown Tunnel, as well as its Far Rockaway facilities. For example:

> **MTA Announces Superstorm Sandy Recovery and Resiliency Progress 5 Years After Storm**
>
> MTA Bridges and Tunnels has installed four giant, two-foot thick, 44,600-pound flood blocking doors at entrances to the Queens Midtown Tunnel and Hugh Carey Tunnel. The doors are 29 feet long and 14 feet high. The remaining four doors will be put into place by the end of the year. The tunnels are also undergoing a complete reconstruction of tunnel electrical, lighting, communications and pumping systems, and replacement of the tunnel wall tiles, ceiling panels, catwalks, curbs and gutters. This work is in its final stages and completion is slated for next year. See Figure 6-2 for installation of one of the doors at the Hugh Carey Tunnel (MTA 2015).

Figure 6-2: Flood door installation, Hugh Carey Tunnel

6.3.2 Develop Procedures that Facilitate Differentiated Levels of Resilience Rates of Return (risk reduction)

Following the 2013 flood, CDOT entered into one of two eventual resiliency pilots with FHWA to consistently evaluate resilience alternatives. In the first pilot, CDOT and its contractor developed a Risk and Resiliency (RnR) tool to quantify benefit-to-cost ratios of resiliencies to severely damaged infrastructure slated for permanent repairs. The RnR tool considers a number of factors, and differentiates levels of risk reduction and financial returns on investment based on resilience opportunities presented by engineers at 30% design. The tool allows for professional engineering judgment and is sensitive to key

considerations like roadway criticality. The model can evaluate social, environmental stewardship (beyond NEPA), and economic factors such as stability and growth (CDOT 2015). CDOT and FHWA also developed a second pilot to establish resilience BCA methods for transportation assets that have not been impacted by disaster in order to define best values resilience investments to avoid and reduce disruption and damages. Resilience planning is further discussed in Chapter 6.

6.4 Flexible Arrangements

- ✓ Consult with partners in region to advance resilience and climate adaptation objectives; and
- ✓ Build adaptive capacity into project design and delivery.

6.4.1 Consult with Partners in Region to Advance Resilience and Climate Adaptation Objectives

Partnerships build the foundation for successful resilience investments across a region. This section provide one example of a robust process that grew out of a deepened partnership following concurrent, regional disaster. As a result of its collaboration following the 2013 flood and its follow-on work on a number of statewide resilience initiatives, including playing an instrumental role in the development of the award-winning *Colorado Resiliency Framework* (State of Colorado 2015), CDOT and the Colorado Water Conservation Board developed an innovative partnership. The agencies developed an agreement to peer-review one another's major capital expenditure projects during the planning stage to explore opportunities for resilience.

Baseline agreements included that the agencies would look for opportunities to move transportation assets out of the floodplain where feasible when planning new or major capital investments, and "make room for the water" when relocating assets is not feasible. Similarly, the agencies would explore opportunities to improve resilience above minimum standards and specifications and improve riparian habitat restoration when working in or adjacent to waterways. This collaborative partnership has resulted in award-winning project outcomes. It also inspired other partnerships in the State such as the US 34 Big Thompson Canyon Permanent Repair Project, which was awarded Engineering News-Record's 2018 Overall National Best of the Best Project. As an outgrowth of its commitment to holistic resilience in the State, CDOT's successful Tiger Grant application (2016) defined specific objectives to leverage co-benefits for people and communities, environmental sustainability, and economic stability and growth.

6.4.2 Build Adaptive Capacity into Project Design and Delivery

Building adaptative capacity into a project involves creating space for unknown and dynamic conditions to be addressed at a planned, future interval. In some circumstances, a project or program can be designed from the outset to be short term in nature relative to the useful life of a project. New York & Connecticut Sustainable Communities developed a guide, *Urban Waterfront Adaptive Strategies*, (2013) to evaluate potential strategies for adapting to coastal flooding and sea level rise. The guide's evaluation framework includes the following six step process:

1. Identify Study Area and Planning Context

2. Assess Hazards, Vulnerabilities, and Risk
3. Identify Potential Strategies
4. Evaluate Alternatives
5. Develop Adaptation Pathways
6. Implement Strategies

Strategies evaluated in the guide include stabilizing land against erosion and daily tide levels, reducing wave forces, blocking flooding of upland neighborhoods, and removing development from vulnerable areas. (New York & Connecticut Sustainable Communities 2013).

Miami-Dade County has developed a risk-based approach based on asset criticality and develop facility hardening plans and design guidelines for program design teams to minimize risk and increase adaptive capacity. In another example, due to sea-level rise causing "sunny day" flooding in the city of Miami Beach, the City elevated roadway crowns, built additional stormwater conveyance and storage, and installed pump stations in areas where nuisance flooding was creating a high-frequency hazard to the traveling public. From the outset, the City knew this was not a permanent solution; however, the City needed time to coordinate with partners in the region, explore concurrent threats such as tropical events and sea-level rise, and conduct capital planning. See pump station and road elevation in the City of Miami Beach's Sunset Harbor community in Figure 6-3.

City of Miami Beach, used with permission

Figure 6-3: City of Miami Beach Sunset Harbor pump station and road hardening (elevation)

In other instances, adaptive capacity can be incorporated into a project's planning, design, delivery, operations, and maintenance to build in control points in the useful life of a project to be revised when major changes occur, such as impacts of climate change stresses and other considerations like population growth in a region, or planned major developments in the region. Some examples of climate stress impacts that are being considered within adaptive capacity projects include droughts and fires, lost land to planned buffers in urban-wild land areas, and climate-driven population retreat.

6.5 Innovative Delivery

- ✓ Optimize resilience and adaptation through administrative controls.

6.5.1 Optimize resilience and adaptation through administrative controls

This section provides guidance for project delivery, procurement, and contracting during the resilience recovery phase. The objective is to recover infrastructure to its condition prior to the disaster and improve infrastructure resilience.

When using administrative controls, including project delivery methods to support resilience, climate adaptation, and other triple-bottom-line benefits, it is important to harmonize objectives for these unique objectives with standard business processes for project delivery. For example, under 23 CFR, FHWA requires value engineering analyses on all "on-system" projects and all bridge projects with total estimated costs of $50 million and $40 million, respectively. FHWA exempts DB projects from this requirements. Many DOTS have more stringent thresholds for value engineering analyses. Sometimes, the objectives of value engineering include both reducing the total cost of the project, and providing a better or equal quality project. While RoI in resilience investments should bear out in resilience benefit-cost analyses (BCAs), DOTs should go through a policy and procedure charette to clarify and prioritize objectives, and deconflict any business processes that would otherwise lead project planners and designers with unclear or conflicting direction.

6.5.1.1 Project Delivery

Project delivery in the resilient recovery phase of concurrent emergencies should take full advantage of pre-existing contracts with change capacity, as well as IDIQ contracts that may have been signed in readiness for emergency response and recovery.

With some reduction in urgency from the response phase, some additional attention to the optimal project delivery method may be feasible. If existing contracts do not have this optimality, DB may provide more timely execution than traditional methods. CM/GC will provide some of the same time-saving advantages with increased collaboration over the DB method on design and planning issues.

The remaining alternative project delivery methods are less likely to be employed during resilient recovery. They are generally the P3 group of delivery methods, with the private sector performing project financing or ongoing maintenance functions; and the negotiation time to resolve the issues for these roles is generally not warranted. However, in an unusual case where the recovery for assets may benefit from private financing (usually more costly than public financing where FHWA funds are involved) or more possibly may benefit from ongoing private maintenance, the P3 project delivery method is available. It may better align the design and construction quality decisions with the longer-range maintenance risks, and may efficiently transfer some risk management to the contractor.

CDOT recommends the following actions in its 2015 Action Strategies:

- ✓ Select consulting resources on standby;

- ✓ Where feasible, use a pool of engineering resources that are well-versed in DOT roads, standards and specifications, and procedures, and can easily integrate with DOT staff;
- ✓ Develop response and recovery project delivery protocols with distinct tiers, based on event magnitude and severity;
- ✓ Use tiers to trigger appropriate procedures and requirements, including procurement, contracting, and project requirements; and
- ✓ Establish alternate, approved protocols to justify change order pricing that address changing market conditions after disasters (e.g., escalating regional cost estimating data); as historical pricing is not an accurate benchmark immediately after a disaster (CDOT 2015).

6.5.1.2 Procurement Methods

Once the operations and finance and administration section chiefs have inventoried their needs and outlined the optimal project delivery methods, they will select the procurement method best aligned to each contract.

As in the rapid response phase, initial consideration should be given to IDIQ contracts and other contracts in effect that have task order or change capacity to deliver the needed work. Emergency procurement method leniency will no longer be available during the resilient recovery phase of work. The managers addressing disaster recovery and particularly the procurement personnel should be aware of when the emergency for procurement purposes ends and should be in communication with FHWA about FHWA's determinations in that regard. However, IDIQ and other relevant contracts entered into in the readiness phase will have been subject to full and open competition, so that if the managers determine they have appropriate capacity and scope for cost-effective delivery, they will meet the regulatory requirements for competition.

If one or more contracts are to be newly procured, using sealed bids (formal competition) is often the most expeditious procurement method. Accelerated mobilization can be achieved through use of pre-qualified contractor lists, shortened advertising periods, and accelerated tabulation and notice to proceed. In some states, the best value procurement method may be available for construction contracts, which resembles competitive negotiation. Selection is based on price and other factors, and the Best Value method is advantageous where the range of potential work required, or the difficulty of specifying quality, calls for selection based on factors in addition to price. As with other competitive negotiation methods, the factors and selection process should be clearly stated in the solicitation.

If design or other professional services contracts are to be procured based on the project delivery method plan, competitive negotiation (with initial selection based on qualifications in the case of architects or engineers) is the method most generally used. Simplified procurement methods may be used below the simplified procurement threshold.

6.5.1.3 Payment / Contract Types

Unit pricing will generally be the simplest and most flexible contract type to use during resilient recovery. If there are fixed scopes with little uncertainty in quantities, it may be possible to use a lump sum contract

price, which does shift material cost risk to the contractor; however, the nature of recovery operations often requires unit pricing to accommodate uncertain quantities.

There will be some consideration of time and materials contracts during this phase. They provide for the flexibility of unit price contracts without the complexity of formulating all-in prices per unit (per cubic yard, per linear foot or mile, per truckload, etc.). In a time-and-materials contract, the contractor is reimbursed for the firm's costs (or a recognized rate set to cover costs) for materials and other expenditures, and then per hour based on negotiated hourly rates. Because the contractor generally perceives each hour of labor as including a margin of profit, there is a potential incentive to maximize the hours of labor in order to maximize profit. Largely for this reason, it is often said that time-and-materials contracting should only be used when no other contract type is feasible.

For both unit price and particularly for time-and-materials contracts, project managers and procurement administrators should be aware of the record keeping requirements; when an invoice is presented, they will be expected to ascertain the quantities on which the invoices are based.

It is also possible to use a cost reimbursement contract type; usually a cost-plus-fixed-fee (CPFF), in which a fixed fee is negotiated to cover any profit. Unlike a time-and-materials contract, there is less incentive to increase costs in a CPFF contract type. CPFF is particularly common for professional services contracts where unit costs are inappropriate, and lump sums may not offer enough flexibility for disaster recovery work. It is also feasible for contractors, but seldom employed because their cost accounting systems and the complexity of cost structures make it difficult to resolve actual indirect costs.

6.6 Audit and Other Risks

- ✓ Ensure normal administrative procedures and controls are restored; and
- ✓ Manage compliance for recovery.

6.6.1 Ensure Normal Administrative Procedures and Controls are Restored

There are only emergency management procedures for timeline of solicitation and response; therefore, administrative procedures and controls should be restored as quickly as possible to adequately monitor and track process, programs, and projects. Utilizing procedures that have already been put into place will help avoid quality control discrepancies and protect quality assurance.

6.6.2 Manage Compliance for Recovery

In many aspects of management, FHWA ER–supported emergency repairs are undifferentiated at the project delivery level from other FHWA work performed under the State Transportation Improvement Program.

In almost all circumstances this is the case—procurement and contracting (with some accommodation to shorten solicitation response and award timelines), standards and specifications, civil rights, NEPA, performance testing, etcetera. The document control process should rely on the tried and true methods used with a few extra cautions: that lump sum or unit pricing is used, that any special contract terms and conditions are monitored (such as provisions resilient design standards not yet adopted in standards and specifications), and an especially well-documented file with detailed photographs of all major milestones.

"Overall, reviewing our compliance systems helped us develop a lot more comprehensive check and balance process."

– Colette DeSonier, Flood Recovery Business Manager at CDOT for the 2013 Flood

In addition, DOT engineers and project managers are accustomed to having wide authority in managing projects, including changes that affect project scope and costs during construction. Due to the structure of FHWA ER funding, decisions to change scope and encumber additional (non-de minimis) project costs are often prohibited without consultation and concurrence of FHWA. Therefore, for FHWA ER–supported projects, it is recommended that DOTs implement administrative gates, such as signature authorization, prior to providing direction and approval to designers and construction contractors on changes involving project scope and costs.

While the survey question in Figure 6-4 shows that disaster practitioners do not always see a clear link between procurement and contracting practices and closeout/audit risks, the research team's MVSA found a significant correlation between compliant procurement and contracting practices and closeout/audit risks. This former might be attributable to the fact that disaster practitioners are typically demobilized from disaster recovery prior to publication of Office of Inspector General audits reports, and may not maintain situational awareness on such findings.

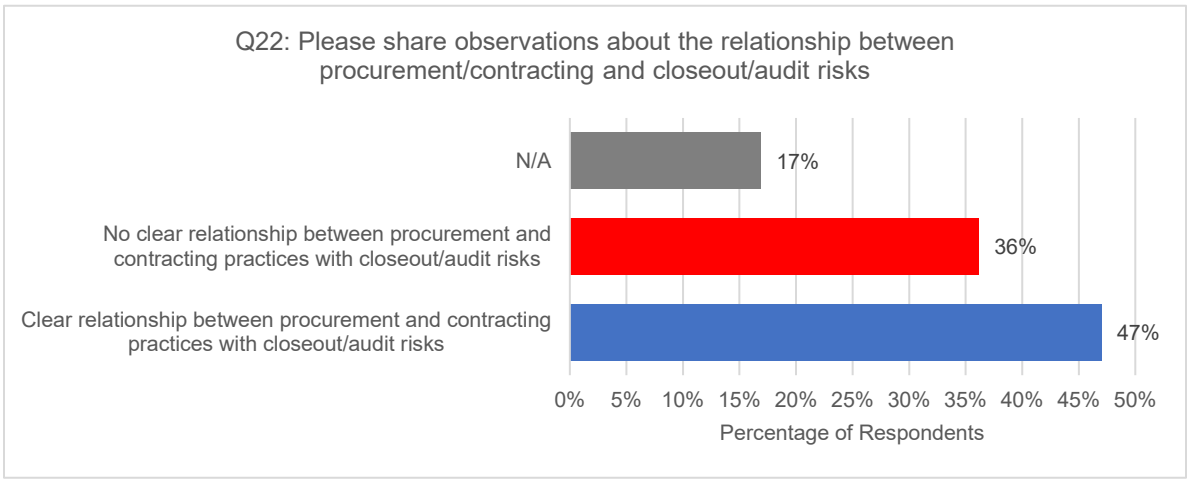

Figure 6-4: NCHRP 08-107 survey question 22 (graph, AECOM)

Survey respondents did identify the most common challenges observed for STTL government closeout and document control, post-disaster. Respondents rated the top three challenges as inadequate

documentation for change orders (contract modifications), lack of full procurement and contracting documentation, and (performance of) ineligible work; see Figure 6-5.

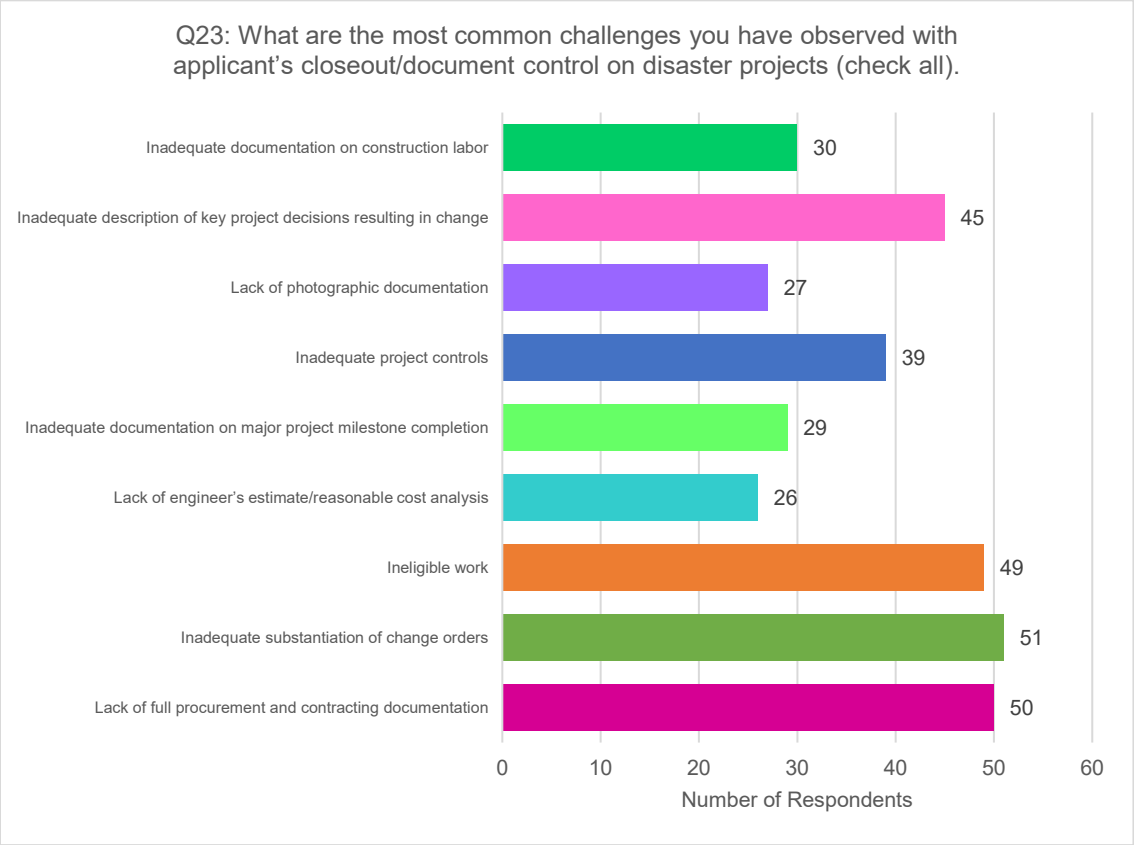

Figure 6-5: NCHRP 08-107 survey question 23 (graph, AECOM)

6.7 Policy and Funding

- ✓ Understand regulatory and policy considerations involving resilient reconstruction and co-benefits; and
- ✓ Maintain good relationships with Federal funders.

6.7.1 Understand Regulatory and Policy Considerations Involving Resilient Reconstruction and Co-benefits

Understand the rules of engagement – disaster law, regulations, and policies, and how they differ from traditional funding programs from FHWA and state sources. While there are constants in what is eligible, how policy is applied can be subject to interpretation and informed by the character of the damages and repair and resilience options. This is particularly true with FHWA ER funding. Sometimes, disaster-specific decisions are made that affect all projects or that are specific to only one project.

For resilient recovery, the chief concern is about funding tying back to the level of repair allowed by the Federal funder (or elective improvements supported by the DOT). If a damaged asset is not severely

impacted, the standard is typically to restore to pre-disaster condition. Repairs to non-severely damages assets may allow or require code triggered upgrades.

For severely damaged asset segments or components, resilience investments with FHWA ER funding is allowable, but concurrence with the FHWA Division on how this is defined and how the planning, design, and work proceed is essential. It is critical to memorialize policy agreements in memoranda that are acknowledged by FHWA (or other Federal funder); this will prevent policy decisions from being "reinterpreted" or rolled-back by successive Federal staff or auditors. DOT needs to be conversant in the off-the-shelf methods provided by the funder or work to establish concurrence on the method of evaluating infrastructure investments to produce a reliable ROI, and ensure that methods produce apples to apples comparisons to the extent practicable for the POP. Clarify agreement on eligibility and resilience improvements in the context of standards and specifications for reconstruction. The following walks through resilience-related regulations and then discusses funding guideposts for resilient reconstruction.

FHWA's *White Paper on Literature Review Findings* on integrating resilience in the transportation planning process cites the following laws, regulations, and policies that require or facilitate resilience considerations (FHWA. 2018a).

Required

- ✓ 23 CFR 450.206(a)
  - "(a) Each State shall carry out a continuing, cooperative, and comprehensive statewide transportation planning process that provides for consideration and implementation of projects, strategies, and services that will address the following factors: (9) improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation."
- ✓ 23 CFR 450.306(b)
  - "(b) The metropolitan transportation planning process shall be continuous, cooperative, and comprehensive, and provide for consideration and implementation of projects, strategies, and services that will address the following factors: (9) Improve the resiliency and reliability of the transportation system and reduce or mitigate stormwater impacts of surface transportation."
- ✓ 23 CFR 216 (c)
  - "(c) The long-range statewide transportation plan shall reference, summarize, or contain any applicable short-range planning studies; strategic planning and/or policy studies; transportation needs studies; management systems reports; emergency relief and disaster preparedness plans;" (applies to STIP)
- ✓ 23 CFR 450.324(f)(7)
  - "(f) The metropolitan transportation plan [MTP] shall, at a minimum, include: 7) Assessment of capital investment and other strategies to preserve the existing and projected future metropolitan transportation infrastructure, provide for multimodal capacity increases based

on regional priorities and needs, and reduce the vulnerability of the existing transportation infrastructure to natural disasters (Applies to MTP).

- ✓ 23 CFR 515.7 (c)(6) and 515.9 (h)
  - o "Asset Management Plan (c) A State DOT shall establish a process for developing a risk manageme3nt plan. This process shall, at a minimum, produce the following information: (6) Risk management analysis, including the results for NHS pavements and bridges, of the periodic evaluations under part 667 of this title of facilities repeated damaged by emergency event. and (h) A State DOT shall integrate its asset management plan into its transportation planning processes that lead to the STIP, to support its efforts to achieve the goals in paragraphs (f)(1) through (4) of this section" (Applies to TAMP).
- ✓ 23 CFR 667/FAST ACT
  - o State DOTs must evaluate facilities that have repeatedly been damaged in emergency events.(required by Fixing America's Surface Transportation Act [FAST Act])

Non-Binding

- ✓ MAP-21
  - o Goals for the national transportation system include increasing safety, security, and reliability.
- ✓ DHS
  - o National Infrastructure Protection Plan invests to produce significant reductions in national risk.

In addition, other agencies in the Federal family have made tremendous inroads in adopting policies that support sustainable and resilient construction of assets. FEMA established its intial BCA method to calculate ROIs decades ago. In many respects, FEMA's BCA for the FEMA Hazard Mitigation Grant Program and its newly launched program, Building Resilient Infrastructure and Communities (BRIC), are among the most forward-leaning methodologies for considering resilience, including triple-bottom-line benefits. The following FEMA regulations also support resilience and above-minimum-code improvements.

Supportive (FEMA 2020)

- ✓ 44 CFR Part 201
  - o STTL governments must develop or adopt approved hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance. The (FEMA) Stafford Act authorizes the following grant programs for those eligible applications with an approved and adopted hazard mitigation plan:
    - Hazard Mitigation Grant Program
    - Public Assistance Grant Program
    - Building Resilient Infrastructure and Communities (BRIC)

- Pre-Disaster Mitigation Grant Program
- Fire Management Assistance Grant Program (FEMA 2020f).

When developing or utilizing BCAs to define resilience standards to guide resilience investments in transportation infrastructure, it is essential to recognize that there exists wide variability defining when resilience improvements can be made or considered for a project. For example, FHWA generally only considers resilience investments for severely damaged corridor segments or structures/components, and concurrence must be reached between the FHWA Division Office and the DOT to establish the BCA method, alternatives (e.g., 25% schematic design alternatives), and final project scope and costs.

FHWA ER funds are designed with latitute for professional judgement. For example, cost-sharing on resilient reconstruction on disaster-damaged assets can be adjusted by mutual agreement based on a number of factors, as shown in the following example:

> A washed-out bridge originally built to a 50-year standard of protection is being evaluated for replacement at a 100 year and 500-year rate of return for flood protection. The preferred FHWA alternative based on the resilience ROI and a number of other factors offer a 100-year level of flood protection with an engineer's estimate of $13.5 million. The DOT wishes to select the alternative that offers a 500-year level of flood protection in line with newly adopted (post-shock) provisional standards and specifications with an engineer's estimate of $14.2 million. The FHWA division office and the DOT agree that FHWA ER funds can be used at the approved cost share of the $13.5 million alternative, and the DOT and locals agencies within the MPO will continue the $700,000 required to reconstruct the bridge to the more resilient design alternative.

FEMA's Public Assistance program supports permanent repairs on disaster-damaged facility element(s). This code and standrd upgrade applies to the element, and not all codes and standards for the asset. The entire asset can be replaced or upgraded to the code and standards of the STTL government's adopted codes and standards and consensus standards if an eligible building or infrastructure assets met its strict formula descibed as the "50% rule" in its *FEMA Public Assistance Program and Policy Guide* (PAPPG) (FEMA 2020d). See Section 4.7 for information on FEMA's 2020 BRIC competitive grants program.

It is clear that when developing the methodology to evaluate resilience benefits and costs, those must align with the Federal funder's requirements on what must be included, what must not be included, and what may be included to understand and gain written agreement on the rules of resilience calculations if a proscriptive methodology is not provided by the Federal funder. When preparing for many hundreds of millions of dollars in resilence investments, leverage opportunities to use a holsitic definition of resilience to consider co-benefits for people and communities, enviromental sustainability, and economic stability and growth where allowable. Explore key partnerships to support resilience investments that exceed levels of protection allowed under Federal grant awards.

6.7.2 Maintain Good Relationships with Federal Funders

Transportation professionals work hard to actively develop collaborative relationships with FHWA and FEMA officials. These relationships are instrumental for honest dialogue and to create a climate for

finding win-win solutions within Federal laws and policies. When you have a good rapport, you will elect to work more closely together. From visiting sites with complex conditions or those that are on "the bubble" between being eligible for resilient improvements or being restored to pre-disaster conditions, the best place to mete that out is in the field, and then in the conference room (or a video conference based on the concurrent, regional emergency). It is not about exerting influence, it is about listening to one another, getting a fair hearing, and respect the decisions that comes down in order to continue to work collaborative for the many years of work involving resilient recovery.

6.8 Other Relevent Considerations

- ✓ Social Dimensions of Resilient Recovery;
- ✓ Cyber Incidents;
- ✓ Pandemics and COVID-19; and
- ✓ Resilience and Climate Adaptation.

6.8.1 Social Dimensions of Resilient Recovery

For transportation, resilient recovery projects typically take at least 9 to 18 months to plan and design a severely damaged transportation corridor, and then 1 to 5 years to complete construction. While steps can be taken to shorten these durations, such as using innovative contracting methods (e.g., DB), there is ample time to access social consideration data and involve STTL governments and community stakeholders in meaningful ways.

For example, considering roadway/bridge reconstruction may include the possible relocation of a transportation asset. Imagine if critical corridors that cut through communities of color during urban renewal were structurally compromised and needed to be rebuilt or relocated? What would the process look like, and then how would a DOT ensure that the right planning process was supported with consultants to facilitate community planning sessions and the National Environmental Policy Act (NEPA) (including environmental justice) compliance? Now imagine a highway and bridges that run along and over a river – sometimes, a severe event will split the flow of the river, and the DOT needs to decide if they should restore the highway as well as the old path of the river, or build either along the river's new path or altogether out of the floodplain. What are the questions the DOT should be asking in addition to the environmental quality/sustainability questions? In either case, the DOT's decisions influence the way the community lives with that asset for the next 50 or 75 years. While it will be a collaborative process with STTL, we should encourage the DOT to explore the right answers with the community. What does that look like (what's the scope of work for the consultant – how many community meetings, what types of meetings? What constituent populations should be consulted?

This is where we want to encourage planning and incentives for triple-bottom-line benefits in addition to physical asset resilience. What we know about community health and wellness, the population projections, planning development, changes to local jobs and the economic outlook are all integral to transformative recovery. DOTs are not used to thinking about this, but they will if they understand (1) why it's important; (2) how to access useful information they can use; and (3) how to incorporate that

information into decision-making, including benefit cost analyses. It will also look different in different communities, as you know.

6.8.1.1 Community Engagement

Overall, attending to the social disaster readiness and response activities needs to be in place to ameliorate social impacts of events and to ensure resilient recovery. Community engagement for resilient recovery is crucial. Adapted from NIST Guide Brief (GB) 14: Those engaged should be key decision-makers, community leaders; and stakeholders across the public, non-profit, and private domains are more likely to support rapid response and resilient recovery that reflects the interests and needs of all stakeholders and improves plan implementation. Transportation planners should ask, “What groups are not represented on the planning team but may be affected by or benefit from possible projects?” They should also consider how to fill gaps in expertise and community perspectives that will inform and support resilience efforts.

It is vital to include those who can help navigate potential barriers to community support. A well-selected team is a strategic asset that enables planners to proactively address implementation hurdles and a wide range of community interests. Sensitivity to the diversity of needs within the community is foundational to effective planning for resilient recovery (2016 NIST Special Publication 1190GB14:2).

In a post-disaster setting, the lead planner would begin by meeting with a limited set of key actors in the affected community, such as local agency EOCs. Next, the lead planner would identify and liaise with key stakeholders—representatives from groups, organizations, and individuals in the community—to obtain local perspectives and insights. This includes collaborating with MPOs and planners and geographic information system (GIS) staff working with STTL agencies.

Next, the team planning lead would begin pre- and post-disaster data analysis, focusing on the importance of understanding the locations of vulnerable populations and critical transportation lines. Here, the planner must work with ICS to determine which transportation routes need to be restored to accommodate the needs of these populations.

Case Studies on Social Dimensions of Resilient Recovery:
Vietnamese American Community in New Orleans Post-Hurricane Katrina

Hurricane Katrina devastated communities and destroyed infrastructure when it made landfall in New Orleans in August 2005, leaving an estimated $125 billion worth of damage. Members of the Vietnamese American Community in New Orleans made a remarkable recovery, with many returning to rebuild less than a year after Katrina ravaged their community. Scholars studying disaster recovery post-Katrina suggest that the Vietnamese American community's unique culture, socioeconomic status, and strong social ties facilitated their resilient and rapid recovery. Culturally, their shared history of re-establishing community ties after fleeing South Vietnam, a shared cultural emphasis on insularity, collective perseverance and progress are among the factors identified as contributing to their resilient recovery in the aftermath of Katrina. Social factors such as level of education, employment in the skilled sector of the economy, homeownership, and marital status were found to be essential for recovery efforts (Vu et al., 2009). Community ties, such as involvement with religious organizations, also contributed to post-Katrina recovery. These findings suggest that strong network ties at the community level have important implications for post-disaster recovery.

Resilient Recovery after the 2009 Victoria, Australia Bushfires

In February 2009, the Black Saturday bushfires ravaged communities in Victoria, Australia, killing 173 Australians and injuring hundreds more (National Museum Australia). The Black Saturday bushfires destroyed an estimated 2000 homes and devastated communities, negatively impacting the physical health, mental health, and well-being of affected communities. Studies that examine the recovery of communities affected by Black Saturday find that individual and community ability to recover from a disaster are heavily influenced by network ties such as the presence of close family and friends, strong social networks, and community groups (Gibbs et al. 2016). In fact, the mere presence of community groups enhanced recovery for all members of the community regardless of individual involvement. This suggests that robust community networks are essential for resilient recovery and maintaining healthy communities.

Community-led Recovery after the 1995 Kobe, Japan Earthquake

In January 1995 a 6.9 magnitude earthquake struck near the city of Kobe, Japan, killing thousands and causing more than an estimated $200 billion in damage (Chung 1996). Case studies following this devastating disaster show the value of social capital and community networks for ward, or neighborhood, level disaster recovery. Case studies of wards after the 1995 Kobe earthquake in Japan show social capital and community networks in the form of pre-disaster, ward (neighborhood) level nonprofit and community-based organizations resulted in a quicker and more resilient population recovery. The presence of strong community ties combined with a communicative and collaborative approach to recover allowed urban planners, government officials and citizen-formed groups to work together on post-disaster urban development and planning led by interests of communities (Oliva and Lazzeretti 2017). This case demonstrates the value of utilizing local and regional resources, present prior to the onset of a disaster, in post-disaster recovery.

6.8.2 Cyber Incidents

Resilient recovery for cyber incidents typically occurs in parallel with incident management and rapid response, in sharp contrast with critical path tasks to restore physical assets, such as designing permanent repairs, reconstruction, or new transportation assets following concurrent, regional emergencies. See Readiness Section 4.8.2 for discussion of lessons learned and recommended actions for cyber protection.

6.8.3 Pandemics and COVID-19

Chapter 5 focuses on resilient recovery. Rather than drawing out distinctions on otherwise redundant content, the Report reader is directed to Section 4.8.3 for an overview of baseline strategies and tactics a

transportation agency should consider when establishing pandemic (specifically COVID-19) policies and procedures for a DOT and its contractors.

6.8.4 Resilience and Climate Adaptation

During recovery, state DOTs should develop and review economic justifications for any betterments and ensure they comply with all Federal requirements. Note that a betterment may not satisfy economic justification for use of FHWA ER funding, but may be a desirable resilience betterment based on additional factors (traveler delay, reduced economic activity, etc.), and be funded with state funding or other apportioned Federal-aid funds.

"I think that the whole region is more resilient because of the work that thousands of people put into these systems following Sandy. However, we haven't had any tests of it and I'm sure there were gaps that will need to be evaluated."

– Susanne DesRoches, former Engineer at the Port Authority during Hurricane Sandy

After the emergency event, state DOTs should update the evaluation of facilities repeatedly needing repair to the extent needed to add any roads, highways, or bridges that were affected by the event, and reflecting improvements to damaged facilities intended to increase resilience. State DOTs can share best practices with other state DOTs through FHWA's ongoing technical assistance and information sharing webinars, case studies, and trainings. See the ER Program's website at: https://www.fhwa.dot.gov/programadminerelief.cfm.

Observed and projected climate change should be considered while doing any resilient recovery work. Decisions made during recovery will affect how resilient the system is far into the future. Climate change projections are often presented on mid- and end-of-century timescales, which align with the long lifespan of DOT assets such as roadways and bridges. Considering these projections during planning, design, and execution of DOT projects is essential for resilience.

Guidelines can be developed for DOTs to build back assets (or build forward) to a standard that would be more resilient to extreme weather and climate change. These can incorporate future climate change projections and adaptation approaches for the region. Putting clear and measurable standards and specifications in design and construction and innovative delivery solicitations (including scopes of work) and contract requirements will advance more resilient recovery. Of course, there is work that must be advanced through pre-construction so that F&A administrators have clear information with appropriate authorizations (e.g., region director, chief engineer, and CFO signatures on provisions or adopted resilience standards and specifications) necessary to include in procurement and contract actions. Again, this underscores the necessity of incident command section chiefs to work together—by design—in support of collective resilient recovery goals.

"Pre-Sandy, we had started to do some work on how to incorporate climate change projections into the built environment … Post-Sandy we started an effort to solidify climate change design guidelines. FEMA will only build back to adopted codes and standard, so there was added urgency to get those published."

– Susanne DesRoches, former Engineer at the Port Authority during Hurricane Sandy

Two examples of a useful resource for this process are FHWA's Highways in the Coastal Environment: Assessing Extreme Events (FHWA 2014a) and Highways in the River Environment: Floodplains,

Extreme Events, Risk, and Resilience (FHWA 2016b). These publications provide technical guidance on how to incorporate extreme events and climate change into highway designs in coastal and riverine environments. Having these guidelines set and available to contractors at the onset of the rebuild and recovery phase will standardize work across an agency while building back in a more resilient way.

Key DOT and MPO partners are moving forward with ambitious strategies and resilience investments. The Greater Miami and Beaches 100 Resilient Cities Network (Resilient 305) Strategy was published, and local governments are moving forward with ambitious plans tied to funding. For example, on January 14, 2020, Miami-Dade County Mayor Carlos A. Gimenez delivered his final State of the County Address and highlighted the County's resilience planning. The following is from his speech:

"A strong economy gives us the resources we need to be flexible and resilient so that we can meet future challenges head-on," Gimenez said. "This year, the County is investing $466 million of its operating budget to promote resiliency efforts. This will help us overcome the challenges of sea level rise and other shocks, like the hurricanes that inevitably will hit our County. We also have close to $3.2 billion dedicated to our County's community resilience capital plan" (Giminez 2020).

The resource list, below, was published by FHWA and includes the process FHWA, DOTs, and LPAs should follow to integrate resilience into ER Program decisions. The following actions are relevant to resilient recovery (FHWA 2018a):

- ✓ Prior to disasters, ensure that State and metropolitan transportation plans and State asset management plans include resilience and risk considerations as required by Federal regulations. This facilitates incorporating resilience considerations in decisions such as siting new transportation facilities, allocating funds to rehabilitate or protect assets, and including adaptive action in regular maintenance and rehabilitation of assets. See https://www.fhwa.dot.gov/environment/sustainability/resilience/ for technical assistance.
- ✓ Ensure that the State DOT has completed the evaluation of facilities repeatedly requiring repair, as required by 23 CFR part 667. Information and strategies in these documents can inform resilience improvements pursued in project development inside and outside of the FHWA ER Program. See *Questions and Answers Regarding Implementation of 23 CFR Part 667: Periodic Evaluation of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events* for guidance.
- ✓ When developing Detailed Damage Inspection Reports (DDIR), discuss the cause of the asset failure and likelihood of recurrence. Discuss potential for resilience improvements from rebuilding to current standards or rebuilding with protective features that would save the FHWA ER Program money over time. Discuss eligibility of ER Program funds and other Federal-aid Program funds for resilience. The DDIR form on the ER Data Portal is being designed to include fields for capturing recurrent damage data and assisting with the consideration of measures to increase infrastructure resilience.

- ✓ Develop and review economic justifications for any betterments and ensure they comply with all Federal requirements. Note that a betterment may not satisfy economic justification for use of ER funding, but may be a desirable resilience betterment based on additional factors (traveler delay, reduced economic activity, etc.), and be funded with State funding or other apportioned Federal-aid funds.
- ✓ After the emergency event, ensure the State DOT updates the evaluation of facilities repeatedly needing repair to the extent needed to add any roads, highways, or bridges that were affected by the event, and reflecting improvements to damaged facilities intended to increase resilience.
- ✓ Share best practices with other State DOTs through FHWA's ongoing technical assistance and information sharing webinars, case studies, and trainings. See ER Program website at: https://www.fhwa.dot.gov/programadmin/erelief.cfm.

The FHWA has extensive research, technical assistance, and guidance on incorporating resilience into transportation decision-making available at: https://www.fhwa.dot.gov/environment/sustainability/resilience/.

The above reference includes navigation to the following, important resilience resources:

- Frequently Asked Questions: Emergency Relief Program and Resilience
- Transportation Engineering Approaches to Climate Resilience (TEACR)
- Hydraulic Engineering Circular (HEC) 25, Vol. 2: Highways in the Coastal Environment: Assessing Extreme Events
- Hydraulic Engineering Circular (HEC) 17: Highways in the River Environment - Floodplains, Extreme Events, Risk, and Resilience
- Resilience pilot projects

"At the onset of the country experiencing large scale magnitude events there was a reluctance, if not absolute refusal, for many Federal and other third party funders to consider anything beyond repair to previously established standards. However, as time (measured in years) has gone by, a more enlightened view has emerged that it is centered on the understanding that it is in the best interests of all parties for agencies to perform judicious repairs that are more consistent with current performance design standards for longer-term sustainability."

– Tom Prendergast,
Former Chairman, NYMTA and
Former CEO, NY MTA Transit

To progress from ideation on resilience to action, a DOT needs to structure a robust process for success. Examples of work that must be in place in order to unlock the power of administrative controls to make gains in resilience and adaptation might include use of benefit-cost analysis results, establishment of new design criteria for sustainable resilience, and climate adaptation for standards and specifications, and opportunities to identify triple-bottom-line co-benefits into projects. Representative tasks might include:

- ✓ Develop Benefit-cost Analysis
  - o Development of BCA methods (such as CDOT RnR);

- Formal adoption of BCA methods—provisional use (e.g., applies to severely damaged assets eligible where FHWA Division authorized resilient design alternatives analysis to DOT as a pilot project); based on specific triggers (e.g., BCAs only apply to new assets or major capital expenditure projects over $80 million); or emergency adoption of planned permanent resilience updates to DOT standards and specifications);
- Business process maps showing how BCA analysis will be delivered on pre-construction planning and compared to standard process for projects built to current standards and specifications;
- Designation of responsible parties and timelines for conducting the BCA analysis for an asset or portfolio of assets (defined in contract terms if supported by consultants);
- DOT dated sign-off on BCA to be used for design;
- Roadmap for designers on how BCA ties to standards and specifications for resilience and climate adaptation; and
- Direction to designers to use approved BCA asset design (include BCA in contract).

Once robust business processes, BCA methods and analyses, and resilient engineering and design standards and specifications and other requirements are in place, administrators need to give clear instructions to consultants along with terms and specifications that define accountability. The DOT will not be able to transfer all of its risks to contractors on new initiatives, particularly when initiated in challenging post-disaster conditions. Therefore, meaningful engagement with, and training for, DOT contractors in consultations with FHWA's division office is recommended.

Resilience and adaptation methods, analyses, and benchmarks such as provisional standards and specifications need to cascade into administrative controls such as procurement and contracting actions to enable effective project delivery. An example of information that should be contemplated for administrative controls includes the need to develop directions for designers on sustainable resilience and climate adaptation.

✓ Develop Directions to Designers on Sustainable Resilience and Climate Adaptation

- Define what above minimum standards and specifications should be used (are there design guides you want them to follow published by FHWA or AASHTO?) – DOTs need to tell designers what they want them to produce;
- Define standards for risk tolerance or asset performance standard (e.g., Category 4 hurricane, F5 tornado, estimated 250-year rate of return on flood risk plus 2 feet of freeboard elevation);
- Engage environmental specialists for NEPA compliance reviews (e.g., riprap plans, erosion controls, riparian habitat restoration plans) and best professional practices;
- Define the number and level of design/engineering detail required per alternative (e.g., develop three 25% schematic design alternatives with engineering cost estimates appropriate to the level of schematic design);
- Provide clear final written direction on design standards and specifications or specific alternative selected for final design;

- Clarify planning charettes to consider alternatives (which may take more meetings, field visits, design analysis, and coordination until final design scope is selected);
- Define compensation for any additional tasks such as design alternatives development and planning charettes; clarify the level of detail required for new milestones, and define not-to-exceed limits for contracts or task orders; and
- Direct the designer in writing on selection of specific design to progress to final design, and memorialize written acceptance to each iteration of design as it progresses through final.

As part of its broader effort to promote change management and business process improvement on sustainable resilience and climate adaptation, DOTs may wish to consider engaging local industry associations such as the American Council of Engineering Companies (ACEC), local contractors' associations, and watershed management districts or councils. Seek out technical assistance and tap into peer learning networks through AASHTO, the Transportation Research Board, the FHWA, and the VOLPE National Transportation Systems Center to help support success during times of change and innovation. See additional information on resilience and climate adaptation on Section 4.8.4.

7 Literature Review Summary and Other NCHRP 08-107 Applied Research

7.1 Initial Findings of the Literature Review

7.1.1 Review Approach

A review was performed to leverage prior experience and research on disaster-related administration, including procurement and contracting. Additionally, the literature review establishes a baseline for the current state of practice on emergency procurement and contracting procedures across state DOTs. The literature review consisted of conventional and emergency contracting procedures, as well as an analysis of the varied regulatory constraints on allowable procurement and contracting actions facing state DOTs. The research team used resources identified in the NCHRP 08-107 RFP, NCHRP Synthesis 404 (NASEM 2010), scientific journals, and post-disaster lessons learned from Federal, state, and local governments, including DOTs, as well as reports by Federal agencies that fund recoveries and other government reporting, auditing, and accountability bodies.

7.1.2 Review Findings

The following subsections provide a summary of review findings grouped by common themes and concepts found during the literature review. Full content of the literature review under these topics can be found in Appendix A.

7.1.2.1 Role of Procurement and Contracting

Procurement and contracting are tactical and strategic components of successful and strong local government plans for readiness and robust recovery. “Procurement has been distanced from policy and seen as a tool; however, the procurement role is more than a mere mechanism for acquiring products, because its outcomes and impacts are policy-related ends in themselves … Involving procurement before and after a disaster in meaningful ways can become a hallmark of government that is itself resilient, and will help its community recover more quickly” (Atkinson and Sapat 2012).

A central challenge of disaster procurement and contracting is the urgency: jurisdictions must rapidly mobilize people and materials in service of urgent and widespread recovery needs. Acting too quickly and without planning may pose more problems down the road through price gouging, slipshod legal review, and poor-quality services and materials. For this reason, preplanning is essential. Making provisions in advance is the fastest way to react to an emergency, and develop the capacity to move without the need to expedite procurement procedures (TRB 2012). Building a standing list of prequalified designers and contractors, pre-emergency, can reduce the time needed to identify qualified sources and reduce risk exposure (NASEM 2012, 2014). In addition, moving forward with purchase agreements ahead of time has also been found to expedite procurement processes (Hurst et al. 2017).

The legal context of procurement and contracting is also important to consider before, during, and after a disaster. State law permitting, local agencies have the power to take whatever actions are necessary to provide for safety, health, and welfare of residents during an emergency. One primary example is 2 CFR

Part 200.320 that allows a temporary suspension of the prescribed bidding requirements for construction contracts under emergency conditions. However, it is important to remember that during an emergency, agencies must still coordinate and comply with other Federal and state agencies to meet NEPA requirements (Gransberg 2013).

7.1.2.2 Barriers and Success Factors

Findings from an NCHRP report survey on alternative contracting methods reveal 11 barriers to implementation. The top two barriers are lack of relevant expertise and lack of enabling legislation for DBs and P3s. The survey also revealed factors that led to success, including articulating objectives for project delivery performance, additional staffing/consultants, and early continuous contractor involvement from design to construction (NASEM 2008).

7.1.2.3 Contracting (Project Delivery) Methods

This section of the Literature Review provides an overview of the contracting and procurement methods, as well as the pros and cons and case studies of use of the methods during disaster scenarios when available. The conventional method reviewed is DBB. Alternative contracting methods reviewed include DB, P3, IDIQ, construction manager/general contractor, and construction manager at risk. Conventional procurement methods include low bid, alternative bid, best value, and sole source. Alternative procurement methods include bid averaging, reverse auction bidding, and cost-plus-time bidding.

7.1.2.4 Payment Methods

This section of the Literature Review provides an overview of the payment methods found during the literature review, and includes pros and cons and case studies of use of the payment methods during disaster scenarios when available. Conventional methods include lump-sum bidding and fixed-price contracting. Alternative methods include incentive/disincentives, no excuse incentives, interim completion dates, contract force accounts, and lane rental.

7.1.2.5 Flexible Emergency Contracting Procedures

When concurrent regional emergencies or multiple routes are affected, transportation officials may need to rely on a subset of emergency contracting procedures. Challenges encountered during this process are well documented in the literature and include inadequate planning, poor definitions, and lack of communication of responsibilities (U.S. House of Representatives 2006). The challenges led to the consolidation of emergency procurement information by the OMB through the 2006 release of FAR Part 18, which provides a summary of emergency acquisition flexibilities (Jeffrey and Menches 2008). Besides strategies developed by DOTs to support emergency contracting, the Federal Government continues to provide resources that support transportation emergency response and recovery. The Emergency Acquisitions Guide (OMB 2011) is a source of consolidated information on flexibilities that are allowed during emergency contracting. Among other things, the guide discusses the acquisition flexibilities that are available under FAR Part 18.

Flexible procedures include interagency acquisitions, multiple award task and delivery orders, oral solicitations, letter contracts, exceptions for full and open competition, use of commercial item procedures, waiver of bid guarantees, and agency-designed innovative contracting.

7.1.2.6 Optimum Procurement Involving Multiple Corridors and Stakeholders

Emergency response and management often require coordination by multiple stakeholders. P3s are a useful way to do this according to the literature. Particularly, the area of preparedness provides opportunities for the private sector to identify and showcase innovative technologies, risk reduction strategies, and advanced emergency planning. It is recommended that private-sector members be included in agency emergency management committees. The use of no-bid contracts should be a last resort, and transportation agencies are encouraged to adopt provisions and regulations to allow private-sector integration into emergency management operations.

When responding to and recovering from a disaster that occurred across multiple corridors, coordination efforts need to be planned and centralized. Resources needed for response and recovery such as materials, contractors, available routes, and ROWs need to be prioritized to ensure efficient allocation of resources. Consequently, clear recovery priorities need to be articulated by the managing transportation agencies to support the resilience of the entire network. By identifying service restoration priorities, resources may then be allocated in order of priority. Agencies must understand the significance of different corridors within a network, and the impact of restoring a corridor's service on the overall network. Many authors in transportation resilience literature have explored network resilience in the context of service restoration and resource expenditure. Some highlights from these approaches are featured in the literature review in Appendix A.

7.1.2.7 Coordination of DOT Plans by Federal, State and Local Agencies in Advance of Major Disruption

Coordination of plans by transportation agencies at various levels of government prior to a major disruption is critical for ensuring that the appropriate response and recovery strategies are implemented to minimize losses and rapidly restore pre-emergency conditions. This section provides an overview of some efforts used by agencies at different levels of government to prioritize emergency preparedness, response, and recovery efforts. Some challenges to such interagency coordination are also discussed.

The literature points to the usefulness of predicting potential impacts and then prioritizing populations and infrastructure in planning efforts. Prioritization can be focused on the most vulnerable populations and infrastructure, or on the most used infrastructure and services where the greatest impact will occur from a disruption.

Common issues in multi-level planning identified in an FHWA study on preparedness and response (FHWA 2007) include the regional coordination on transportation and evacuation routes, coordination of emergency operation centers, understanding different command systems, interagency language barriers, and the prioritization of resources.

7.1.2.8 Supply Chain Issues in Emergency Procurement and Contracting (Risks and Strategies)

Disasters often cause one or more disruptions within the supply chains, including construction. Disruptions can present a major challenge in the aftermath of a disaster because they could threaten the availability of contractors and materials to support recovery efforts. Supply chains have an inherent amount of risk through the use of few corridors and ports for large volumes of freight, centralized inventories, centralized production, and clustering of suppliers with similar products. Strategies identified to reduce these risks include using multiple ports, off-peak freight movement, improved communications, flexible transportation, and domestic sourcing (McKinnon 2014).

7.1.2.9 Best Practices and Lessons Learned from Regional Emergencies

This section of the Literature Review provides best practices from a variety of sources and agencies, including FEMA and FHWA. Some of the best practices covered include improving information to travelers, better connectivity between modes, better planning for events and emergencies, establishing evacuation routes, having mutual aid agreements in place, and preplanning for special needs populations.

This section also reviews case studies of transportation agencies responding to and recovering from disasters, and pulls some lessons learned from those experiences. High-level lessons learned include the need for adequate planning and preparation to anticipate needed goods and services, improved communication about specific responsibilities across agencies and jurisdictions, and increased personnel to provide effective contractor oversight. Practices identified to better manage disaster-related procurement include developing knowledge of contractor capabilities and pricing for commodities and services, establishing scalable operations, formally assigning disaster responsibilities and participating in joint training, and providing a sufficient number of field staff.

7.2 Multi-Variate Statistical Analysis

How effectively do STTL governments comply with administrative compliance requirements, post-disaster? To address this question, the research team conducted a multi-variate statistical analysis (MVSA) as part of this applied research to identify statistically significant relationships between procurement and contracting methods and compliance with Federal rules involving project delivery.

The MVSA was conducted to investigate anecdotal observations about adverse audit findings, post-disaster. It examined correlations between procurement, contracting, and post-disaster project delivery conditions that resulted in DHS OIG findings that recommended reductions (de-obligations) of Federal disaster funds.

There is not a strong body of information available in the public domain presenting FHWA OIG audits; Federal compliance was reviewed and assessed using diverse methods, and data were presented in disparate ways, thereby making comparisons and establishing statistical correlations unreliable. Therefore, the MVSA models utilized sample data from Department of Homeland Security (DHS) OIG audit reports for FEMA PA grants published between January 2016 and February 2017 following Presidentially Declared Disasters.

FEMA rules for compliance were grouped into the following categories:

- ✓ Procurement process
- ✓ Contract provisions
- ✓ Cost reasonableness
- ✓ Scope of work
- ✓ Allocability
- ✓ Policies and procedures
- ✓ Management and control
- ✓ Project delivery

The MVSA found that procurement and contracting exceptions (or "violations") are strongly correlated with subsequent exceptions to eligibility and compliance, resulting in the recommended de-obligation of Federal disaster funding. If the procurement method or contract method was unallowable, it led to adverse DHS OIG findings. It is important to note that the models are descriptive and do not carry causal interpretation. That said, one possible hypothesis is that agencies that have trouble complying with procurement and contracting law, regulation, and policy in post-disaster conditions simply lack effective emergency policies and procedures or capabilities or other resources to comply with additional Federal compliance requirements. In other words, the failure to comply with allowable procurement and contracting methods and requirements in post-disaster conditions, and the failure to follow additional Federal compliance requirements during project delivery may both be symptoms of the same organizational challenges. The MVSA found that failure to comply with procurement methods and requirements is most strongly correlated with DHS OIG findings of noncompliance involving management control, a potential reflection of post-disaster administrative stress and disorganization and/or lack of information about applicable law, regulations, and policies required for FEMA PA Program disaster funding.

The MVSA established important correlations that may warrant future investigations. See Appendix C for more details on the MVSA methods and findings.

7.3 AECOM Disaster Practitioner Cadre Survey and Results

For the NCHRP 08-107 survey, the research team surveyed primarily AECOM employees deployed to administer disaster programs at all levels of government, and with particular experience representing FEMA in the field to help administer its PA Program. A limited number of transportation professionals with deep experience in concurrent, regional emergencies also participated. The survey solicited observations on response and recovery practices by all types of state and local governments, largely following Presidentially Declared Disasters. The survey included questions on post-shock procurement and contracting practices and other issues relevant to readiness, rapid response, and resilient recovery administrative practices. The survey included discussion of competitive awards, innovative contracting methods, and durable recovery benefits for the government agencies and the community at large.

Over 100 disaster practitioners responded to the NCHRP 08-107 survey, with an average duration of direct disaster experience of 7 or more years per respondent across diverse hazards. The results helped hone the research team's approach, and shed light on promising practices by state and local governments.

For example, respondents observed that applicants are much better prepared for subsequent events after recovering from a major or catastrophic disaster (49% agree).

Respondents believed the top three chronic stresses that threat response and recovery operations include are aging/undersize infrastructure (n=93), workforce capacity/skill level/training (n=70), and the need for improved social cohesion and support services, particularly with vulnerable populations (n=60).

The majority of respondents felt that having pre-disaster relationships in place between Federal/state/local agency professionals was extremely valuable (54%). They also felt that using flexible emergency procedures, including emergency procurement and/or having contracting in place pre-disaster, was extremely valuable (66%). The responses are shown in Figure 7-1 to Figure 7-4.

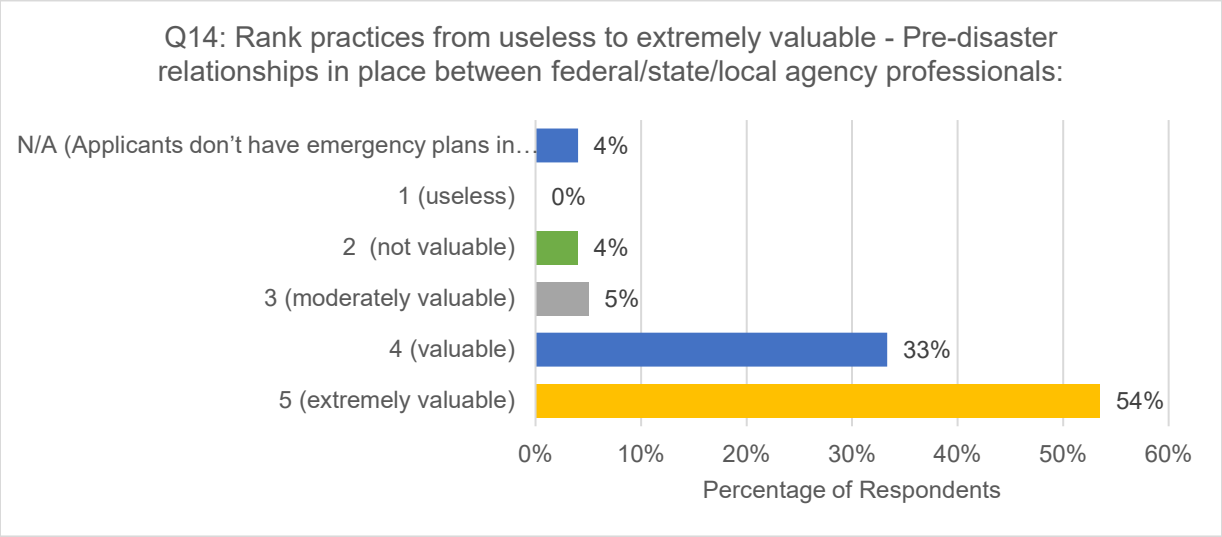

Figure 7-1: NCHRP 08-107 survey question 14 (graph, AECOM)

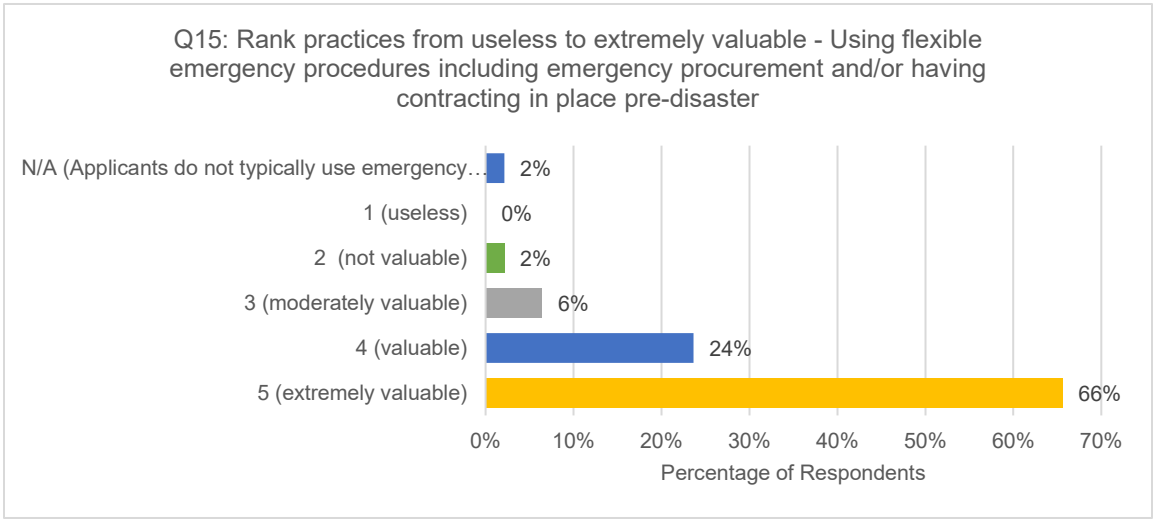

Figure 7-2: NCHRP 08-107 survey question 15 (graph, AECOM)

Respondents consider CM/GC and DB to be more effective than the CM at Risk.

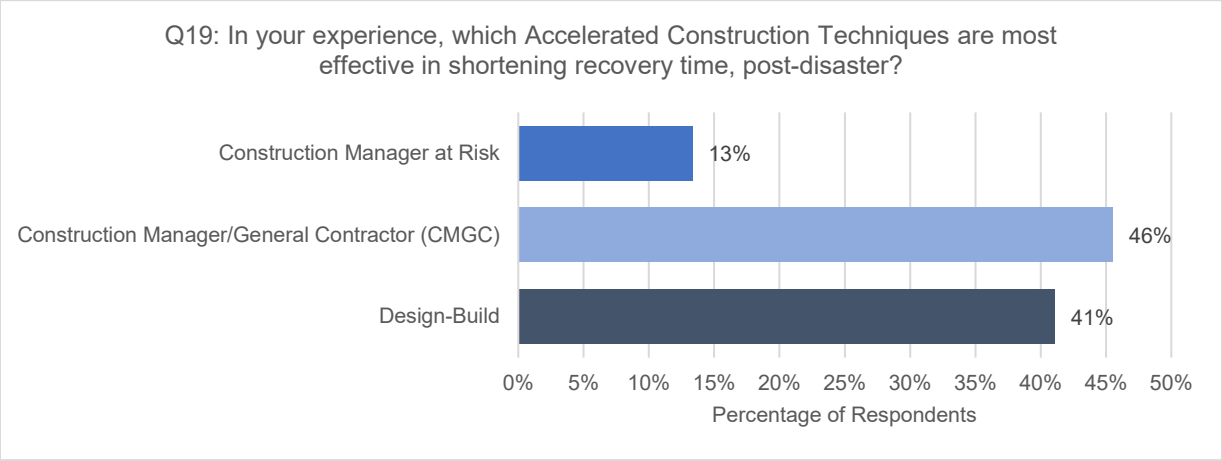

Figure 7-3: NCHRP 08-107 survey question 19 (graph, AECOM)

There was not a clear trend on the most common challenges respondents had observed with applicants' closeout/document control on disaster projects. The majority of respondents selected inadequate substantiation of change orders (n=51), lack of full procurement and contracting documentation (n=50), and ineligible work (n=49). See Figure 7-4.

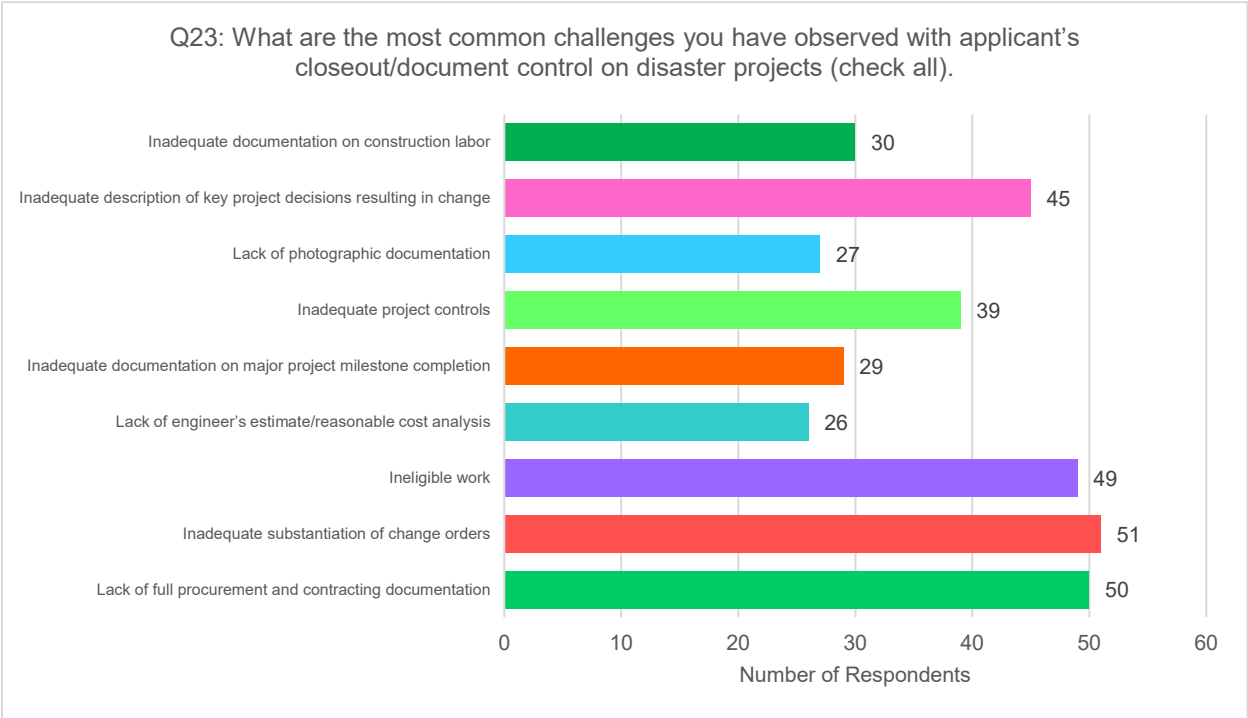

Figure 7-4: NCHRP 08-107 survey question 23 (graph, AECOM)

See Appendix D, AECOM Disaster Cadre Practitioner Survey, for full survey results.

7.4 FEMA Emergency Management Executive Academy (Cohort IV) Voluntary Session

The principal investigator of NCHRP-08-107 applied research facilitated a voluntary afternoon symposium at FEMA's Emergency Management Institute in Emmitsburg, Maryland, with participants in FEMA's Emergency Management Executive Academy, Cohort IV. Participants represented Federal agencies, state and local governments, and academia, and had career backgrounds in the U.S. military. In discussing the applied research concerning critical issue areas, great attention was paid to multiple and coordinated stakeholder engagement among local, state, and Federal agencies, as well as private industry.

In an unprecedented step, the U.S. military, outside of the USACE and national guards, was mobilized following catastrophic impacts of back-to-back Category 5 Hurricanes Irma and Maria in 2017. In doing so, many questions were answered that had been speculative previously. In this case, U.S. military support integrated into the joint field office environment (incident command) in support of the Federal/state disaster operations environment. The U.S. military provided discrete support on task-specific requests of incident command leadership, thus answering the question, in this first real test, of whether the military would "takeover" disaster operations. Symposium participants were quick to point out and dispel the myth that there is an unlimited supply of available resources, or "magic military locker" within the U.S. military to provide surge support in catastrophic emergency and disaster response. This discussion was substantiated by descriptions of force optimization in support of active multiple military missions worldwide, as well as strategic reductions over the last quarter century of military bases and force capacity across the United States. Of the 450,000 active duty military, forces were described as working at capacity in combat, combat support, and adjacent services.

Another center point of discussion included supply chain management and the consequent exposure for rapid recovery due to the nation's transition from maintaining inventories of materials, supplies, and equipment to an on-demand model for fulfillment goods, whereby fabrication is tied to orders placed rather than fabricated in the anticipation of future needs. Examples of the impacts of on-demand or just-in-time supply chain and distribution model on disaster response and recovery operations are many. This concern was borne out during rapid response in the US Virgin Islands following hurricanes Irma and Maria, where materials for roof repairs required items such as composite metal sheeting and lumber, which added 12 weeks to the supply chain before any repairs could be initiated on failing roofs. This was also seen in New York following Hurricane Sandy, when damages to a major asset's bridge decking was not available in the US steel market, but required long-lead custom steel fabrication from China, which is challenging not only in terms of time for fabrication and international shipping and customs, but also regulatory compliance requirements under Buy America.

Participant recommendations in response to supply chain challenges tie naturally to the CIA of prioritization and capacity, and symposium participants wisely recommended repairing the least damaged and most accessible projects to restore essential traffic on as many roads and structures as feasible. Participants recommended restoring the three highest-capacity structures involving long lead items in parallel with the "low hanging fruit" projects, and then moving through the entire asset portfolio or repair and replacement projects.

Finally, symposium participants paid great attention to encouraging transportation professionals to anticipate consequences following concurrent, regional emergencies and disasters outside of their responsibility, particularly for max-of-max or “black swan” events. Although low probability, these events create widespread impacts to populations; are the most difficult and complex to successfully respond to; and have the greatest adverse effects, such as the concurrent events following the Great East Japan Earthquake (also known as the 2011 Tōhoku earthquake) and tsunami and the consequent level 7 meltdowns at the Fukushima Daiichi Nuclear Power Plant.

To get out in front of these potentially catastrophic outliers, participants recommended that transportation practitioners acquaint themselves with structural ratings on USACE and locally owned dams and bridges to address additional consequences in their DOT’s emergency plans in the event those assets fail; this is particularly important where a major dam failure would cause catastrophic and widespread flooding in densely populated areas with zero or limited warning for evacuations. They also pointed to the complexity and importance of restoring interoperable lifeline infrastructure such as potable water and wastewater, electric utilities, fiber, and cellular communications that are necessary to keep a community habitable, even where the roads can be restored. Examples of vulnerable interoperable infrastructure include utilities that run across the Mississippi River and on causeways between Miami and the City of Miami Beach, as well as monumental fiber running across oceans, worldwide, that is slowly eroding from the impacts of salt water. In addition, they cite the importance of partnering with industry to understand threats and develop coordinated response plans such as chemical facilities that are not hardened in seismic zones beyond a 6.0 event or on EF3 tornado.

8 Conclusions and Suggested Research

U.S. transportation organizations typically operate with governance and operational models that are designed to operate efficiently during blue sky conditions, and minor or moderate shock events, but not to withstand events of significant scale and magnitude, or concurrent, regional emergencies, such as a $500 million or $10 billion rapid response and resilient recovery operation. A transportation organizations' inability to respond rapidly and effectively to large and/or concurrent emergency events results in risk not only to transportation assets, but also to people and communities, local and regional economies, and the environment. Outcomes include long recovery times with adverse social, economic, and environmental impacts to communities, higher costs to the taxpayer, and lost opportunities to durably improve, adapt, and strengthen systems.

Developed with the support of the NCHRP, this Report discusses findings and recommendations for transportation administrators and other professionals to help them move through actionable steps to reduce risks, time, and costs, and to improve project delivery outcomes when faced with the responsibility of stabilizing and rapidly restoring essential traffic and resiliently reconstructing hundreds of millions or billions of dollars in transportation infrastructure assets.

8.1 Summary of Key Recommendations

Significant gaps exist in the current body of knowledge and state of practice in surface transportation for the effective administration of concurrent, regional emergencies, and the delivery and risk controls built into procurement and contracting strategies, as well as other administrative functions. Although the challenges are clear, the solutions are varied and region-specific; however, they do follow some general approaches captured in the key |Report recommendations. The recommendations are intended to equip transportation agencies with the necessary tools to decrease post-disaster time, risks, and costs, and evaluate opportunities to capture durable gains for the DOT, the community and traveling public, and the taxpayer. Although the Report's recommendations offer multimodal applicability, they are written primarily for the needs and requirements of surface transportation.

Figure 8-1 shows the intersection of the three key focus areas of this applied research—administration, including procurement and contracting; surface transportation corridors; and concurrent, regional emergencies—as eight critical issue areas: DOT emergency plan coordination, managing scope and scale, prioritization and capacity, flexible arrangements, innovative delivery, audit and other risks, policy and funding, and other relevant considerations. The critical issue areas have been developed by the research team to recognize threats to transportation infrastructure; anticipate consequences resulting from concurrent, regional emergencies; and recommend concrete administrative actions to attenuate direct losses to surface transportation, and severe and long-term cascading impacts to people and communities, the environment, and the regional economy.

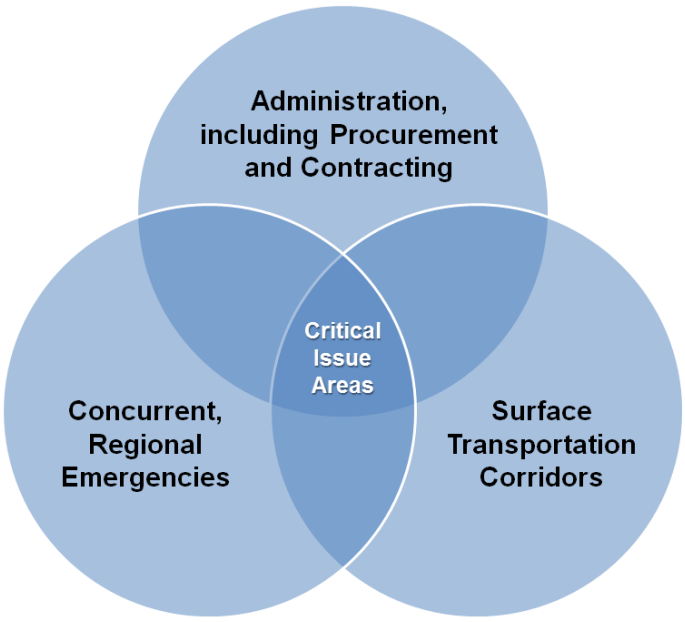

Figure 8-1: Subject matter focus of research

The research team established a foundation for how procurement and contracting policies, procedures, and practices accommodate the strains of major and catastrophic disaster conditions. The conditions often involve rapid-fire decision-making based on incomplete information concerning extents of damages and scopes of work, and take place in highly complex and often politically charged circumstances. The Report reflects an understanding of the regulatory climates facing DOTs concerning rapid emergency procurement methods following disasters, and innovative contracting vehicles such as IDIQs and the allowable and beneficial use of accelerated construction techniques. Resources available to DOTs that can help control risks, manage costs, and accelerate time to contract awards often go untapped.

8.1.1 Prepare for Response via Administration, Procurement, and Contracting Processes

Procurement and contracting are tactical and strategic components of successful and strong local government plans for readiness and robust recovery.

> Procurement has been distanced from policy and seen as a tool; however, the procurement role is more than a mere mechanism for acquiring products, because its outcomes and impacts are policy-related ends in themselves … Involving procurement before and after a disaster in meaningful ways can become a hallmark of government that is itself resilient, and will help its community recover more quickly (Atkinson and Sapat 2012).

Urgency is a central challenge of disaster procurement and contracting—jurisdictions must rapidly mobilize people and materials in service of urgent and widespread recovery needs. Acting too quickly and without planning may pose more problems down the road through price gouging, slipshod legal review, and poor-quality services and materials. For this reason, pre-planning is essential. Making provisions in advance is the fastest way to react to an emergency, as transportation agencies develop the flexible

capacity to take action without the need to expedite procurement procedures (NASEM 2012). Building a standing list of prequalified designers and contractors before an emergency can reduce the time to identify qualified sources and reduce risk exposure (NASEM 2012, 2014). Moving forward with purchase agreements ahead of time has also been found to expedite procurement processes (Hurst et al. 2017).

The legal context of procurement and contracting is also important to consider before, during, and after a disaster. State law permitting, local agencies have the power to take whatever actions are necessary to provide for safety, health, and welfare of residents during an emergency. One primary example is the U.S. Code, which allows a temporary suspension of the prescribed bidding requirements for construction contracts under emergency conditions. However, it is important to remember that during an emergency, agencies must still coordinate and comply with other Federal and state agencies to meet NEPA requirements (Gransberg 2013).

The following actions are recommended:

- ✓ Place select consulting resources on standby and allow the use of a local pool of engineering resources that are well-versed in local roads, specifications, and procedures. Such local resources will be able to easily integrate with DOT staff to develop response and recovery project delivery protocols, with distinct tiers based on event magnitude and severity use tiers that will trigger appropriate procedures and requirements.
- ✓ Use procurement, contracting, and project requirements to establish alternate, approved protocols to justify change order pricing to address changing market conditions after disasters (e.g., escalating regional cost estimating data). Historical pricing is not an accurate benchmark immediately after a disaster (CDOT 2015).

8.1.1.1 Administration

The research team hopes the Report and its primary deliverable, the Guidebook, provide useful information, recommendations, tools, and resources that help enable transportation professionals to build administrative policies and procedures that respond to tragedy by making communities and transportation systems safer, stronger, and more resilient; and to structure recovery investments to yield durable co-benefits for communities, for the regional economy, and for the environment.

Review existing processes and prepare for the future. To best prepare, the following actions are recommended:

- ✓ Collect and review disaster processes and procedures to ensure they align with known and emergent threats and combined impacts of concurrent, regional emergencies and disasters, such as extreme weather events, climate change, and pandemics.
- ✓ Develop a permanent budget and accounting code structure along with a consistent process for setting up repair projects (e.g., segregate emergency and permanent repair project costs).
- ✓ Consider where consistency across DOT systems would yield dividends in a disaster event (e.g., consistent project documentation methods across regions).

- ✓ Evaluate training materials and business processes in place to facilitate local agency success, including direction, support, and oversight.
- ✓ Incorporate tools presented in the applied research recommendations and appendices into DOT and local agency compliance and document control procedures.
- ✓ Develop training modules for local agencies so they are ready for presentation to subrecipient agency representatives in advance of and immediately following the next event.

8.1.1.2 Procurement

Emergency response and management often require coordination by multiple stakeholders. P3s are a useful way to accomplish this coordination according to the literature. Particularly, the area of preparedness provides opportunities for the private sector to identify and showcase innovative technologies, risk reduction strategies, and advanced emergency planning. Including private-sector members on agency emergency management committees is recommended. The use of non-competitive contracts should be a last resort. Adopting provisions and regulations to allow private-sector integration into emergency management may speed coordination and recovery times.

When responding to and recovering from a disaster that occurs across multiple corridors, coordination efforts need to be planned and centralized. Resources needed for response and recovery such as materials, contractors, available routes, and ROWs need to be prioritized to ensure efficient allocation of resources. Consequently, clear recovery priorities need to be articulated by the managing transportation agencies to support the resilience of the entire network. By identifying service restoration priorities, resources may then be allocated in order of priority.

Agencies must understand the significance of different corridors within a network and the impact of restoring a corridor's service on the overall network. Many authors in transportation resilience literature have explored network resilience in the context of service restoration and resource expenditure. Some highlights from these approaches are featured in the literature review.

The contracting recommendations for the readiness phase include putting contracts in place that can be activated in the response phase.

- ✓ GSA eligible buying entities follow Federal Schedule ordering procedures (see Appendix I) to receive the best value.
- ✓ Identify which method(s) will be used to track multiple funding sources on a single project, and including the method(s) in emergency procedures.
- ✓ Educate designers and construction contractors about how scope and costs must be segregated in designs, quantities and pricing, and invoicing on projects with multiple funding sources.

8.1.1.3 Contracting

To remain flexible in responding to large disaster events or concurrent, regional emergencies, transportation officials should consider whether conventional contracting, procurement, and payment

methods should be used, or whether alternative methods might better serve the needs of concurrent, regional emergencies and disasters.

- ✓ Conventional contracting methods are DBB, and conventional procurement methods are low bid, alternative bid, best value, and sole source. Conventional payment methods include lump-sum bidding and fixed-price contracting.
- ✓ Alternative contracting methods include DB, P3, IDIQ, CM/GC, and CM at Risk; alternative procurement methods include bid averaging, reverse auction bidding, and cost-plus-time bidding. Alternative methods include incentive/disincentives, no excuse incentives, interim completion dates, contract force accounts, and lane rental.

Innovative financing recommendations. Consider implementing risk financing, which can be used to mobilize funds very quickly for rebuild and maintenance after a shock. Consider parametric insurance, which allows the cost of recovery/reconstruction to be financed through regular premium payments. Consider catastrophe bonds, which are risk-linked securities that transfer a specified set of risks from an insurer or reinsurer to an investor.

Barriers and success factors for alternative contracting methods. Findings from an NCHRP report survey on alternative contracting methods (NASEM 2008) revealed 11 barriers to implementation. The top two barriers were lack of expertise and lack of enabling legislation for DB and P3s. The survey also revealed factors that led to success, including articulated objectives for project delivery performance, additional staffing/consultants, and early continuous contractor involvement from design to construction.

Emergency contracting. When concurrent, regional emergencies or multiple routes are affected, transportation officials may need to rely on a subset of emergency contracting procedures. FAR Part 18 provides a summary of emergency acquisition flexibilities (Jeffrey and Menches 2008), and the Federal Government continues to provide resources that support transportation emergency response and recovery. The *Emergency Acquisitions Guide* is a source of consolidated information on flexibilities allowed during emergency contracting (OMB 2011).

8.1.2 Prepare for Concurrent, Regional Emergencies, including Regional Coordination

Recommended practices for emergency preparedness include developing a plan; establishing evacuation routes; having mutual aid agreements in place; having a policy addressing service and facility closures; implementing fare suspension; preplanning for special needs populations, backup communications, exercises and mobilization planning; fueling vehicles prior to emergencies; establishing command structure; accounting and record keeping policies; debriefing; and working with MPOs to develop partnerships within a region (Chandler and Sutherland 2013).

A review of state plans revealed key areas to focus on plan development. Recommendations included the following (FHWA 2018a):

- ✓ Comprehensive assessments of key structures
- ✓ Capital investment in resiliency and protection of critical assets

- ✓ Incentives to encourage resiliency
- ✓ Ability for local jurisdictions to influence emergency planning and preparedness guides
- ✓ Plan for staffing to respond to an emergency
- ✓ Increasing public awareness
- ✓ Defining agency responsibilities in case of an emergency
- ✓ Advance contracting and updating public emergency response policies

Coordination of multiple stakeholders. Emergency response and management often require coordination by multiple stakeholders. P3s are a useful way to do this according to the literature. Particularly, the area of preparedness provides opportunities for the private sector to identify and showcase innovative technologies, risk reduction strategies, and advanced emergency planning. Including private-sector members in agency emergency management committees is recommended. The use of no-bid contracts should be a last resort, and transportation agencies are encouraged to adopt provisions and regulations to allow private-sector integration into emergency management operations.

Coordination of DOT Plans. Coordination of plans by transportation agencies at various levels of government prior to a major disruption is critical to ensuring that the appropriate response and recovery strategies are implemented to minimize losses and rapidly restore pre-emergency conditions.

The literature points to the usefulness of predicting potential impacts, and then prioritizing populations and infrastructure in planning efforts. Prioritization can be focused on the most vulnerable populations and infrastructure, or on the most-used infrastructure and services where the greatest impact will occur from a disruption.

Common issues in multi-level planning identified during an FHWA study on preparedness and response (FHWA 2007) include regional coordination on transportation and evacuation routes, coordination of emergency operation centers, understanding different command systems, interagency language barriers, and the prioritization of resources.

8.1.3 Surface Transportation Corridors

Disasters often cause one or more disruptions within the supply chains, including construction. Disruptions can present a major challenge in the aftermath of a disaster because this could threaten the availability of contractors and materials to support recovery efforts. Supply chains have an inherent amount of risk through the use of few corridors and ports for large volumes of freight, centralized inventories, centralized production, and clustering of suppliers with similar products. Strategies identified to reduce these risks include using multiple ports, off-peak freight movement, improved communications, flexible transportation, and domestic sourcing (McKinnon 2014).

Seek out best practices from a variety of sources and agencies, and consult with partners such as the state office of emergency management, as well as FEMA and FHWA. Some best practices include improving information to travelers, better connectivity between modes, better planning for events and emergencies, putting mutual aid agreements in place, and preplanning for vulnerable populations.

To expand capacity to effectively restore essential traffic, clarify specific responsibilities in coordination with partner agencies and jurisdictions, and plan how the DOT will ramp up personnel to provide effective contractor oversight, preferably using the ICS structure designed to support rapid response and resilient recovery at scale.

In addition, practices identified to better manage disaster-related procurement and contracting must be tied to optimum project delivery methods. Developing knowledge of contractor capabilities, monitoring blue skies pricing for materials and services, establishing scalable operations, formally assigning disaster responsibilities to personnel, and participating in joint training and exercises with public-sector partners, including the state emergency management, FEMA, FHWA, and local agency officials, as well industry partners in important test plans. Not only will joint coordination expose gaps that can be addressed in advance of when the DOT is called on to deliver critical work, it will create opportunities for relationship development with partners that facilitate post-event coordination.

In doing so, these activities will set the stage to effectively administer quickly, and as cost effectively as possible, while controlling quality on pre-construction and construction work. By planning for rapid response and resilient recovery for concurrent, regional emergencies and disasters that leverages triple-bottom-line co-benefits for people and community, environmental sustainability, and economic stability and growth, DOT transportation professionals prepare themselves to continue meeting their responsibilities as effective stewards of the public trust, while thoughtfully investing billions of dollars in transportation infrastructure that will positively impact generations of multimodal travelers.

Novel events are often the most challenging, and the pandemic has underscored this with its breathtaking scope, scale, and impacts on the nation's entire transportation network. Its new and changing demands have been left to transportation professionals and elected officials, and (at writing) there are more unknowns than knowns—as is always the case when the common operating picture is still coming into focus.

The clarion call for resilience and adaptation is underscored by pandemic conditions and impacts on DOTs, combined with the continued barrage of familiar threats such as wildfire, hurricanes, and floods. Administrators will need to harness the urgency, the stress, and the opportunities as a counterbalance to the tragic tolls of concurrent, regional emergencies and disasters to build a better way forward. To do this, transportation professionals will reimagine business processes, policies, and procedures for the near-, mid-, and long-terms to do the essential work of keeping people and communities, the environment, and economies stable, healthy, and prosperous across regions.

8.2 Suggested Research

The following contemplates opportunities for future research focused on sustainable resilience.

8.2.1 Understanding and Attenuating Adverse Impacts in Remote Locations Following Regional Emergencies and Disasters

The suggested applied research would consider the unique risks affecting people, and improved infrastructure in remote locations following regional emergencies and disasters. Given the often limited

opportunities for evacuation from hazards with notice, as well as from no-notice hazard events, people in remote locations are often required to shelter in place or in designated community shelters, irrespective of the levels of risk to which they are exposed. After a severe event, communities in remote locations typically experience long wait times for outside help to arrive and successfully delivery any urgently needed provisions. Similarly, these communities must not only endure potential losses of lifeline infrastructure following severe events, they must cope with system downtimes that are amplified by supply chain challenges, complexities, and durations, particularly if transportation infrastructure such as ports, airports, rail, and ferry terminals and/or surface transportation are out of service as a result of damage. Together, these and other circumstances dramatically increase the potential for adverse post-event consequences related to human needs, time, and costs for maximum credible events in remote locations.

The proposed applied research would leverage credible threat and vulnerability data on lifeline infrastructure, as well as social and economic data in remote locations to consider risk exposure facing multiple remote location communities. It would then use risk data to work in close consultation and collaboration with local community networks (e.g., formal and informal faith- and community-based groups) to identify and prioritize readiness and sustainable resilience tasks to be accomplished prior to a regional emergency or disasters (e.g., planning charettes). The applied research would result in readiness plans developed in cooperation with the community to measurably decrease risks specific to the needs, composition, and assets of a community/region in a remote location.

8.2.2 Maximum Credible Events: Calculating the Real Costs of Doing Nothing

The suggested research would develop and test robust cost-benefit-analysis methodologies to establish near-, mid-, and long-term impacts and costs to people and communities, the environment, and regional and national economies resulting from outlier, maximum credible events (also known as “black swan” events or catastrophes). Risk calculations in the U.S. typically rely on probabilistic risk data in relation to hazard frequency and severity for benefit-cost analyses to calculate the RoI. As a result, outlier event impact data are typically excluded from risk data that are used to establish transportation resilience standards and specifications above minimum code. Consequently, outlier threats are often excluded from how transportation assets are planned, designed, constructed, operated, and maintained, even when sustainable resilience is a primary goal.

When maximum credible events do occur, they have adverse—and sometimes severe and persistent adverse—impacts at regional, national, and international levels, including humanitarian crises and economic recessions. Sometimes, events at this scale also threaten security and the rule of law. Examples of these events are the Great Alaskan Earthquake of 1964, 2004 Indian Ocean Earthquake, 2011 Tohoku Earthquake and Tsunami (i.e., Fukushima), and Hurricane Maria in Puerto Rico and the U.S. Virgin Islands. Disaster event frequency and severity are rising, and event outcomes are expected to be further exacerbated by the effects of climate change.

The financial costs of the pandemic to transportation agencies through combined losses in revenue from the farebox, the gas pump, and state-dependent revenue streams are unprecedented, as are the wholesale shifts in travel patterns on America’s transportation system, writ-large.

It is necessary to understand and calculate the costs of outlier events resulting from direct impacts, as well as cascading impacts and consequences, to determine true risk exposure to the Nation and inform commensurate actions to attenuate those risks, as appropriate.

8.2.3 Transportation Planning, Design, and Project Delivery for Sustainable Resilience

The suggested applied research would build on the growing body of literature on effective methods to integrate resilience in transportation planning, design, and execution. It would use the FHWA sustainable highway initiative's description of sustainability, which states:

> Sustainability is often described using the "triple bottom line" concept, which includes giving consideration to three primary principles: Social, Environmental, and Economic. The goal of sustainability is the satisfaction of basic social and economic needs, both present and future, and the responsible use of natural resources, all while maintaining or improving the well-being of the environment on which life depends (FHWA n.d.).

The suggested research would evaluate the effective application of sustainable resilience concepts by transportation agencies, consistent with FHWA's Infrastructure Voluntary Evaluation Sustainability Tool (INVEST) self-evaluation tool, which includes a suite of voluntary sustainability best practices. It would assess the robustness of the long-term transportation planning level for critical transportation corridors, and success in cascading those goals to the project delivery level. The suggested research could focus on high-priority vulnerable surface transportation corridors and structures in high-hazard areas that have been delineated for FHWA-required transportation asset management plans (TAMPs). In addition, sustainable resilience should consider hazards, vulnerabilities, and sustainable resilience for interoperable life-line infrastructure and multi-modal system; the importance of this work is reflected in Figure 8-2, which shows a flight attendant's photo of a San Francisco Airport tower against the backdrop of one of hundreds of wildfires across the American West in 2020.

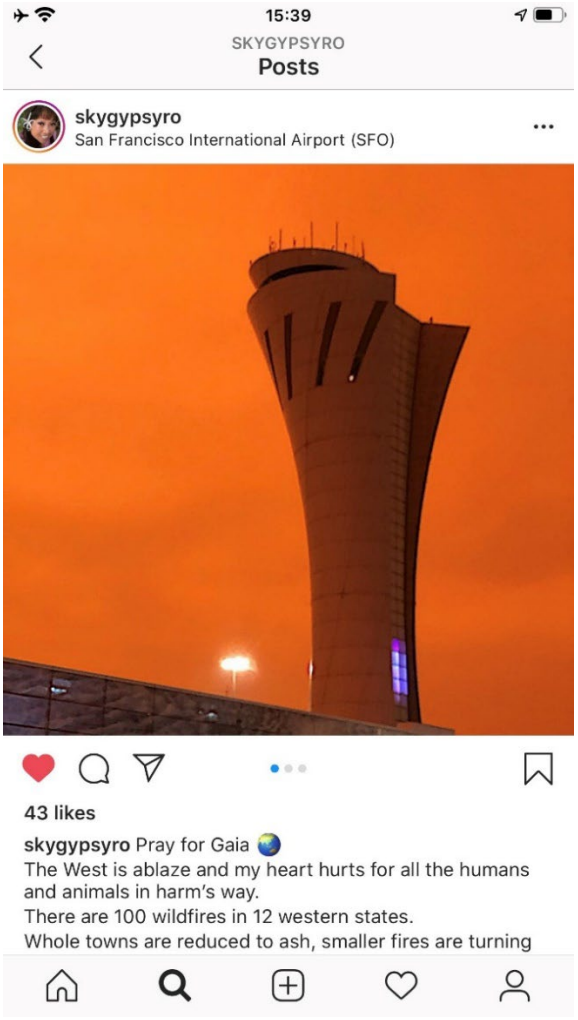

Figure 8-2: 2020 social media post of California Wildfire taken from San Francisco International Airport (Rowena Yapit, used with permission)

The goal of the applied research would be to evaluate the robustness of sustainable resilience planning that has been completed to date, and recommend opportunities to facilitate seamless integration at key transition points between goal development for long-term transportation planning level down to the project delivery lifecycle for priority corridors and structures. Stress testing could be used to evaluate robustness, and could take many forms. Desktop and functional exercises similar to those conducted for the NCHRP 08-107 case studies might provide one method of rapidly identifying strengths and gaps, but with a different set of key objectives and outcomes. The exercises would test linkages between long-term transportation planning goals and project-specific planning and design criteria (e.g., RoI analysis through benefit-cost analysis, sustainable resilience standards and specifications), and further test linkages to associated project excellence throughout the project lifecycle. After-action reviews could be used to provide independent feedback to participating transportation agencies aligned with INVEST. Optionally, exercises to test the robustness of sustainable resilience plans and linkages could be repeated over intervals (e.g., yearly, biannually) to benchmark improvement over time, particularly where after-action

reviews resulted in the formulation of task-based objectives in response to areas of improvement evidenced through stress-testing.

Information elucidated through stress testing at a number of transportation agencies (if the sample is statistically significant) could be evaluated to establish trend data on strengths and gaps in the field. Sustainable resilience program maturity could be tracked over time, and outcomes could be monitored to inform future iterations of sustainable resilience resources from FHWA.

8.2.4 Transportation Agency Rapid Response and Resilience Recovery During Prolonged Shock Events

Managing concurrent, regional emergencies and disasters that strike with a "one-two" punch such as Hurricanes Katrina and Rita and Hurricanes Irma and Maria, while difficult, requires a different set of strategies for progressing through rapid response and resilient recovery. In these multi-shock events, work can be structured to be delivered in a time-bound fashion once emergency conditions are stable and essential traffic is restored. Through master scheduling of one or more POPs, adequate resourcing, and judicious procurement and contract actions, work can progress on an iterative path(s) to defined project and program completion (and integrated into asset management plans).

Unlike one-two punch shocks, prolonged shocks behave more like chronic stresses such as climate change and consequences of failing infrastructure (often referred to as the infrastructure gap). Unfortunately, the long-term or recurrent state prolonged shocks create a long stasis of disruption. COVID-19 and its impacts on the health and well-being of transportation agency employees and the travelling public; on surface transportation use; on available financial resources; and on the ways it has transformed traditional ways of working shed light on this pernicious challenge. For example, COVID-19 demonstrates the liminal, emergency or exigent conditions that must be accommodated while DOTs and other transportation agencies concurrently battle natural disasters such as wildfires in California, Oregon, and Colorado (2020), hurricanes such as Category 4 Hurricane Laura (2020) on the Louisiana/Texas Gulf Coast, and other shocks.

Similar concerns about strategies to effectively address long duration shocks or many successive shocks over a prolonged duration were identified in the NCHRP 08-107 case study with the Central U.S. Earthquake Consortium (CUSEC). In that session, representatives from CUSEC, member state DOTs across the New Madrid region, and FHWA discussed the unique challenges of the New Madrid Seismic Zone's history of aftershocks that did (and could again) last for many months in a row. This would create a shock-cycle that makes stabilization of assets and restoration of essential traffic uniquely complicated. This circumstance also presents special challenges for effectively managing supply chains and progressing into resilient reconstruction.

NCHRP 08-107 applied research scope could be extended to focus more directly and deeply on potential long-duration shocks or shock-cycles through the lens of the applied research's phases, and key questions and potential lessons learned, best practices, and tools aligned in relation to the research's critical issue areas with a continued focus on administrative controls.

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