



WEATHER-RESPONSIVE MANAGEMENT STRATEGIES

CASE STUDY

Source: Federal Highway Administration.

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Weather-Responsive Management Strategies for Hurricane Recovery in Louisiana, Pennsylvania, and New Jersey

Background

The Federal Highway Administration (FHWA) Weather-Responsive Management Strategies (WRMS) initiative promotes the use of road weather data from mobile and connected vehicle technologies to support traffic and maintenance management strategies during inclement weather. The goal is to improve safety and reliability, and reduce environmental impacts on the transportation system resulting from adverse weather.

The WRMS initiative helps mitigate the impacts of severe weather events through preparation activities that use existing data and tools and leverage State and local partnerships. By preparing for the impacts of severe weather events, State and local agencies are better positioned to support response and recovery efforts after an event.

This case study highlights the experiences and lessons learned from the Louisiana Department of Transportation and Development (Louisiana DOTD), Pennsylvania Department of Transportation (PennDOT), and New Jersey Department of Transportation (NJDOT) while managing major flooding events resulting from Hurricane Ida. This case study provides insight into the new and existing tools and resources used as well as the relationships leveraged to prepare for and respond to Hurricane Ida in the summer of 2021.

Hurricane Ida's Destructive Path

Hurricane Ida first made landfall as a Category 4 storm in Louisiana on August 29, 2021.¹ From southeast Louisiana, near Port Fourchon, the storm traveled through New Orleans and Baton Rouge, affecting roughly 70 percent of the State's population. As it moved into Mississippi, the hurricane was downgraded to a tropical storm.

¹World Vision. "2021 Hurricane Ida: Facts, FAQs, and How To Help." September 22, 2021. Accessed October 25, 2022. <https://www.worldvision.org/disaster-relief-news-stories/2021-hurricane-ida-facts>.

As shown in figure 1, Hurricane Ida continued its destructive path through parts of Alabama and Tennessee, before passing through Pennsylvania and New Jersey.² Extensive flooding occurred when the remnants of Hurricane Ida reached Pennsylvania, causing the closure of nearly 400 roads statewide.³ After the storm, PennDOT estimated that roughly 800 bridges across the State needed post-flood inspections.⁴ In New Jersey, the storm brought an unprecedented amount of rain within a short period and triggered a tornado, leaving an extensive cleanup effort and response for NJDOT.

Planning and Preparation: Tools, Strategies, and Tactics

Louisiana DOTD

In advance of Hurricane Ida making landfall, Louisiana began conducting standard hurricane preparations, including closing roads prone to flooding;⁵ reviewing and revising evacuation contraflow plans;

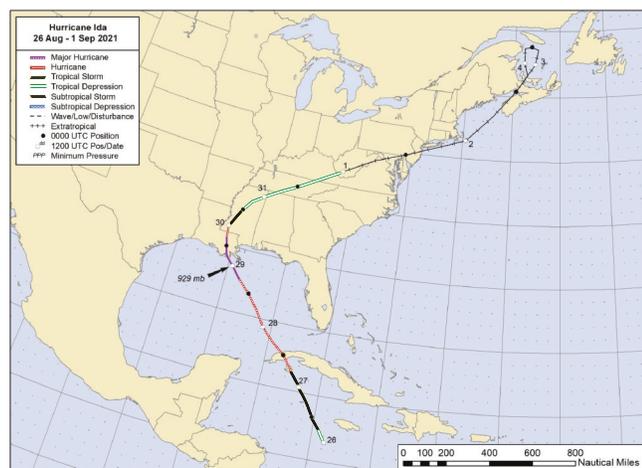


Figure 1. Hurricane Ida Path (Source: National Hurricane Center Tropical Cyclone Report https://www.nhc.noaa.gov/data/tcr/AL092021_Ida.pdf.)

bringing signal and sign repair personnel in from other parts of the State and from Texas; and signing contracts for response and recovery equipment and personnel. Because every weather event is different, Louisiana DOTD tweaked its preparations to fit the challenges brought on by the storm.

Contraflow Evacuation Planning

In advance of Hurricane Ida, Louisiana DOTD met with State and local personnel to discuss the contraflow plan. Everyone involved needed to have a clear understanding of the timeline and necessary locations of personnel and equipment to implement the contraflow plan. After the discussions, the group revised the plan to alleviate traffic issues that would be caused by the funneling of evacuees from I-10 and I-12 through Baton Rouge. Instead, an alternate route was created to divert traffic to U.S. Route 61. Louisiana DOTD noted that this route is now a permanent modification to the contraflow plan. After discussing the details with Louisiana stakeholders, Louisiana DOTD reviewed the contraflow plan with personnel from Mississippi DOT.

A hurricane must be forecasted as a Category 3 or higher to trigger the enactment of the contraflow plan and mandatory evacuation. With Hurricane Ida, during the timeframe in which Louisiana DOTD needed to implement the contraflow plan and evacuation, the storm was less than a Category 3. By the time the storm crossed the threshold to a Category 3, it was too late for the contraflow plan to be implemented.

²PBS News Hour. "Live Map: Track the Path of Hurricane Ida." August 28, 2021. Accessed October 25, 2022. <https://www.pbs.org/newshour/nation/live-map-track-the-path-of-hurricane-ida>.

³Flooding persists and roads remain closed in central Pennsylvania after remnants of Hurricane Ida. <https://www.pennlive.com>.

⁴AASHTO Journal. "State DOTs Continue Battling Aftereffects of Hurricane Ida." September 10, 2021. Accessed October 25, 2022. <https://aashtojournal.org/2021/09/10/state-dots-continue-battling-aftereffects-of-hurricane-ida>.

⁵Louisiana Department of Transportation & Development. "DOTD Closes Part of I-110 and Underpasses That May Flood in Capitol Region." August 29, 2021. Accessed October 25, 2022. <http://wwwapps.dotd.la.gov/administration/announcements/announcement.aspx?key=27875>.

Louisiana DOTD noted that given the speed and intensity of the hurricane, the contraflow plan would only have been in place for 6–12 hours, resulting in little impact. Instead, Louisiana DOTD used dynamic message signs and public service announcements to notify the public of alternate routes. The DOTD had to mitigate the impacts caused by a large construction zone on the evacuation route. One of the two travel lanes on the route was closed across a bridge in Morgan City, so Louisiana DOTD created detours to route traffic around the bridge.

Planning Challenges Related to the COVID-19 Pandemic

The COVID-19 pandemic played a large role in how Louisiana DOTD prepared for Hurricane Ida. Louisiana DOTD established contracts with bus companies to evacuate residents from the storm. However, due to a surge of COVID-19 cases across the State, Louisiana DOTD could no longer fill

the buses to capacity and had to request additional vehicles. Louisiana DOTD also executed contracts with van companies to help transport response personnel across the State. As with the buses, additional vans were needed to ensure that social distancing was maintained by personnel traveling to response sites. In total, 6,575 individuals were evacuated on 454 missions using 185 coach buses and 24 paratransit vans, costing more than \$15 million.

Social distancing also impacted plans for evacuee shelters and base camps. Before entering a shelter, evacuees had to be tested for COVID-19. While waiting to receive their test results, the evacuees were required to social distance reducing the capacity of each shelter. To account for the reduced capacity and increase in space requirements, Louisiana DOTD rented the Lamar-Dixon Expo Center in Gonzales, Louisiana. In addition to the expo center's size, its location was essential, as it was close enough to the three main districts affected by the storm.

Need for Additional Resources

With Hurricane Ida on track to hit the two most populated cities in the State, Louisiana DOTD requested aid from other parts of the State to assist in the large response effort. Signal and sign repair personnel arrived from the northern part of the State to help restore functionality to critical signs and signals. Additionally, through the Emergency Management Assistance Compact (EMAC) process,⁶ Louisiana DOTD worked with Texas DOT (TxDOT) to bring in TxDOT signal crews to backfill positions in Louisiana districts where there were not enough personnel to conduct routine maintenance.



Figure 2. Lamar-Dixon Expo Center setup for hurricane evacuees (Source: Louisiana Department of Transportation and Development.)

⁶ EMAC is a national disaster-relief compact signed into law in 1996 (Public Law 104-321). Its members include all 50 States, the District of Columbia, Puerto Rico, Guam, U.S. Virgin Islands, and the Northern Mariana Islands. EMAC offers assistance during governor-declared states of emergency or disasters through a system that allows States to send personnel, equipment, and commodities to assist with response and recovery efforts in other States. For additional information, see <https://www.emacweb.org>.

PennDOT

Statewide Coordination Meeting

Before major events like Hurricane Ida occur, PennDOT organizes a statewide coordination call with its districts, executive staff, Pennsylvania Emergency Management Agency, Pennsylvania State Police, Pennsylvania Turnpike Commission, and Accuweather, PennDOT's contracted weather service. Neighboring States are also invited, with representatives from New York and New Jersey often in attendance. These coordination calls are used to ensure that all parties are on the same page regarding roles and responsibilities, to discuss where within the State the main impacts will be, and to make neighboring States aware of Pennsylvania's response.

Flood Preparations

PennDOT prepared for the storm by clearing debris around drainage points and under bridges to prevent debris from contributing to flooding by blocking necessary drainage.⁷ Additionally, PennDOT staged barricades before the storm in flood-prone areas, so that if flooding started, these areas could be closed swiftly. PennDOT also worked to ensure that its traveler information was updated on the 511 Pennsylvania website (511PA.com), showing up-to-date closures, restrictions, and weather alerts.⁸ PennDOT monitored windspeeds; however, they were never high enough (i.e., sustained winds of 60 mph) to warrant the implementation of any commercial motor vehicle restrictions for this storm.

NJDOT

Leveraging Partnerships

NJDOT also took action to prepare for the storm, by leveraging existing relationships and assets. NJDOT regularly participates in open dialogue with neighboring States, its partner agencies, and the National Weather Service in the days and hours preceding a storm. NJDOT is a member of TRANSCOM, a coalition of 15 State and local agencies that includes transportation agencies, law enforcement agencies, transit agencies, and toll authorities in New York, Connecticut, and New Jersey. As a member of TRANSCOM, NJDOT is in constant communication with these agencies, keeping them informed on NJDOT's actions before an event and during recovery from the event.

Resiliency Strategies

Given the hard-hitting hurricanes that have impacted the area in recent years, resiliency efforts were already in place before Hurricane Ida. These efforts included increased generator capability for key field assets such as traffic signals, trimmed trees to reduce debris, established emergency "on-call" contractors, and pre-positioned equipment in high-risk flooding areas. Additionally, although it was an option and discussed at length, NJDOT decided not to enact its contraflow plan. Like Louisiana DOTD, there was insufficient time for NJDOT to initiate it.

⁷ Pennsylvania Department of Transportation. "Gov. Wolf and Members of Administration Provide Update on Response to Remnants of Ida." September 1, 2021. Accessed February 6, 2023. https://commons.wikimedia.org/wiki/File:Gov._Wolf_and_Members_of_Administration_Provide_Update_on_Response_to_Remnants_of_Ida_-_51417553226.jpg.

⁸ Pennsylvania Department of Transportation. "PennDOT Lowers Speed Limit on Sections of I-80 and I-81 to 55 MPH." September 1, 2021. Accessed February 6, 2023. https://www.einnews.com/pr_news/550323398/penn-dot-lowers-speed-limit-on-sections-of-interstates-80-and-81-to-55-mph.

Communication Programs

NJDOT activated its 511 NJConnect⁹ system six times during the storm, directly communicating with more than 2,100 motorists stuck on their road networks in more than 1,000 vehicles. NJDOT also has several “If and Where Directed” contracts in place that are used in emergencies such as Hurricane Ida. These contracts are in place for debris removal, slope stabilization, and road repair. After Hurricane Sandy, NJDOT added emergency response provisions to all infrastructure contracts to use in weather emergencies.

Response and Recovery

Louisiana DOTD

Debris Collection

In response to significant, recurring, post-hurricane debris cleanup, the Louisiana DOTD created a Debris Operations Dashboard.¹⁰ Starting with Hurricane Laura in 2020, the dashboard has been used to provide residents with information on 1) areas across the State that have been cleared, 2) the number of collection passes occurring in those areas, and 3) other big-picture information, such as how much debris has been removed across the State.

For Hurricane Ida, Louisiana DOTD added a new layer to the interactive map that enabled residents to submit locations with debris (i.e., crowdsourced data), removing the burden on agency staff to locate all the debris. Residents were able to enter the portal and input the debris location and type—either “Vegetation” or “Construction and Demolition (CND).” Historically, most debris is vegetation; however, Hurricane

Ida's 140 mph winds resulted in significant building damage, causing most of the post-storm debris collected to be CND debris. The severity of Hurricane Ida led to significant damage in the two coastal parishes of Terrebonne and Lafourche, with debris removal taking more than 6 months to complete. Across the State, debris collection officially ended in April 2022. The operation cleared 4,207,466 cubic yards of debris (equivalent to 2,607 acres, 1-ft deep) across 11,531 shoulder miles. At its peak, 237 Louisiana DOTD and contractor crews were the operation. The cleanup cost the State more than \$100 million dollars.

After-Action Reviews

Louisiana DOTD has a tiered approach to conducting After-Action Reviews (AAR). The first step is for DOTD District staff to meet with local agencies. Once this is complete, the Districts feed the information received up to the necessary groups within the DOTD. After the information is received, the DOTD departments meet to discuss the findings. Lastly, all the State-level organizations involved in the recovery efforts meet and reflect on the event, noting the key takeaways and lessons learned. The AAR also includes a tabletop exercise focused on how stakeholders should respond if another hurricane makes landfall during the current hurricane response. The AAR process is well documented so that Louisiana DOTD and other organizations involved can improve after each event.

⁹ 511NJ. Accessed October 25, 2022. <https://www.511nj.org>.

¹⁰ Louisiana Department of Transportation and Development. “Louisiana DOTD State Roadway Damage and Debris Operations.” Accessed October 25, 2022. <https://ladotd-state-highway-reporting-ds.hub.arcgis.com>.



Figure 3. I-676 flooding in Philadelphia (Source: Pennsylvania Department of Transportation.)

PennDOT

Flood Management

PennDOT's major challenge was the extensive flooding that occurred in District 6, which includes Philadelphia. The nearby Schuylkill River flooded, releasing 30 million gallons of water onto I-676. Although the interstate is equipped with a pumping station, the sheer volume of water rendered it unusable because it was underwater. PennDOT estimated that by using its available resources, it could pump all the water off the roadway in 21–27 days. Wanting to reopen the interstate as soon as possible, PennDOT contacted a private contractor to pump the water off the roadway.

The centrally located Area Command Center housed all PennDOT executive staff members and enabled them to make quick and timely decisions regarding the pumping



Figure 4. Pumping station along I-676 at 22nd Street in Philadelphia (Source: Pennsylvania Department of Transportation.)

contract. As a result, pumping operations began within hours of PennDOT's initial contact with the contractor. The increased pumping capacity resulted in the roadway being reopened within a day and a half. In addition, the contractor helped PennDOT with pressure washing and clearing debris from the roadway.

Recovery Documentation

After the event, PennDOT sent management teams to impacted districts to aid with disaster recovery documentation. The teams helped the districts complete the required documents to ensure that they would be reimbursed for all funds spent on disaster recovery.

NJDOT

Unexpected Severe Weather

Although NJDOT personnel conducted extensive preparation for the storm, they were not expecting the Enhanced Fujita Scale rating 3 tornado produced by Hurricane Ida that hit Mullica Hill. The tornado destroyed several trees and homes. In response, Region South Operations mobilized several strike teams, composed of both DOT staff and contracting partners, to assist in debris removal in Gloucester County. A total of 890 truckloads of debris was removed. Shortly after the tornado touched ground, heavy rain began. The forecast was 6 inches of rain over 12 hours. Instead, New Jersey received 11 inches of rain in 6 hours. As a result, 42 locations required emergency infrastructure repair, with several locations needing a complete rebuilding of existing infrastructure. These locations were spread across 10 counties and 13 State highways.



Figure 5. Somerset Patriots Stadium flooding (Source: New Jersey Department of Transportation.)



Figure 6. Example of roadway infrastructure damage caused by the storm in New Jersey (Source: New Jersey Department of Transportation.)

In addition to the emergency repairs, NJDOT had to tow abandoned vehicles that had been left on the roadway before roads could be reopened. NJDOT's quick response resulted in all interstates reopening within 12 hours of the storm, all major roads opening within 36 hours, and the entire system opening within 48 hours.

Conclusions

Louisiana DOTD, PennDOT, and NJDOT successfully implemented WRMS strategies when planning, preparing, and responding to Hurricane Ida. The agencies noted several lessons learned, including the following:

- Utilize a centrally located base camp when transporting DOT staff and residents to enable easier back-and-forth before and during severe events.
- Leverage public and private partnerships within and outside the DOT to increase available resources to enable more effective support for recovery efforts.
- Conduct Pathfinder activities, which is a collaborative strategy for proactive transportation system management, before and during an event. These activities include facilitating statewide coordination calls with all involved agencies in advance of an event to ensure everyone understands their respective roles and responsibilities.
- Assess existing contraflow plans during the off-season to assess their effectiveness based on experiences and lessons learned from the previous season's weather events.
- During the off-season, conduct response exercises for mobilizing emergency services to ensure staff and activities are "fine-tuned" for major disasters like Hurricane Ida.
- Work toward institutionalizing resiliency efforts within the agency to reduce the impact of major disasters like Hurricane Ida.

Available Resources

[Road Weather Management—FHWA Office of Operations \(dot.gov\)](#)

[Weather-Responsive Management Strategies \(WRMS\) for Flood Management \(dot.gov\)](#)

[Road Weather Spotlight Webinar Series—Severe Road Weather Impacts: Spotlight on Hurricane Ida](#)

Technical Contacts

David Johnson,
FHWA Office of Operations
David.Johnson@dot.gov

Chris Feintheil,
New Jersey DOT
Christopher.Feintheil@dot.nj.gov

Salvatore Cowan,
New Jersey DOT
Sal.Cowan@dot.nj.gov

David Miller,
Louisiana DOTD
David.Miller@LA.gov

Daniel Whetzel,
PennDOT
dwhetzel@pa.gov