Derailed: A Case Study of the 2001 Baltimore Howard Street Tunnel Fire with Exercises

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Key Questions

- Which critical infrastructure sectors, stakeholders, and assets were affected by the incident?
- What were the cascading effects of the incident and how robust was information sharing?
- How could the information sharing environment be improved for the future?

Case Narrative

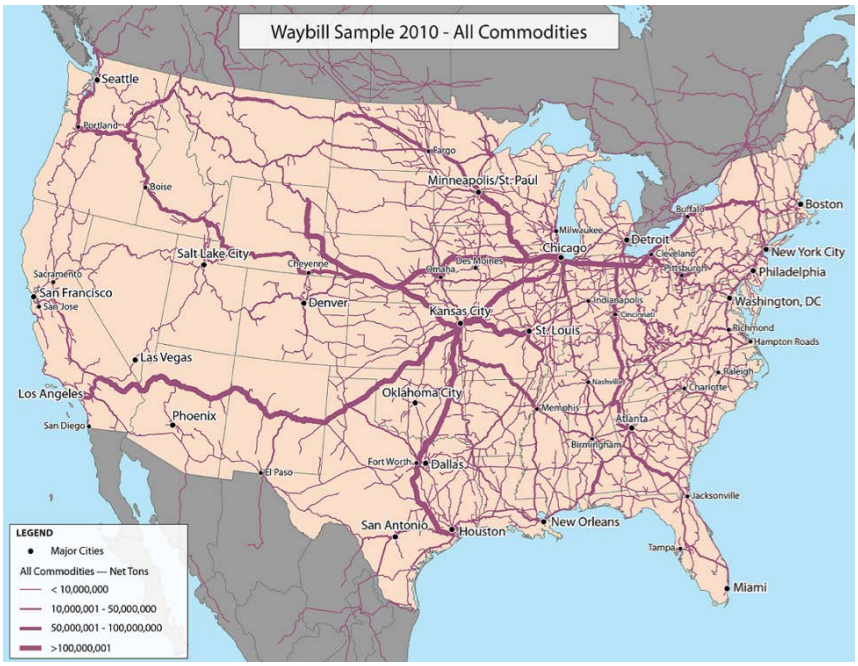
Introduction: Smoke Billows, Sirens Wail

On the evening of July 18, 2001, civil defense sirens wailed in Baltimore, Maryland to alert citizens to a fire that raged below the city. As the alarms sounded, thick, black smoke billowed from both ends of the 1.7-mile Howard Street Tunnel that traversed the city's downtown area. Intense heat, lack of visibility, and noxious fumes repelled firefighters who attempted to enter the tunnel, forcing them to use water cannons at each end to battle the 1,500-degree Fahrenheit blaze.[1] In addition to the fire, a forty-inch wide water main ruptured above the tunnel, allowing water to seep into the tunnel and flooding the streets and surrounding businesses. As the fire raged and the flooding continued, about 1200 customers in the area lost power, and Internet service in a corridor stretching from Washington to New York City slowed.[2] Vehicular traffic and public transportation ground to a halt as authorities closed all major highways into the city, cordoned off streets above the tunnel, and directed citizens to close their windows, remain inside, and stay away from the affected areas as chemical fumes and billowing smoke filled the air.[3] Late that evening the mayor of Baltimore announced "an apparent derailment" of a freight train in the Howard Street Tunnel and warned that "we still don't know what we're dealing with."[4]

Freight Rail: A Supply Chain Workhorse

The United States freight railroad system is the largest in the world. It consists of over 140,000 rail miles and serves almost every sector of the U.S. economy.[5] (See Figure 1) Freight rail cargo includes resources such as coal; retail items such as clothes; wholesale items such as bulk paper goods; and industrial items such as construction equipment and chemicals. The movement of these goods accounts for over $60 billion in revenue each year for the industry and employs over 221,000 people.[6] These rails are also important to

Map 1: Freight Rail in the United States by Tons

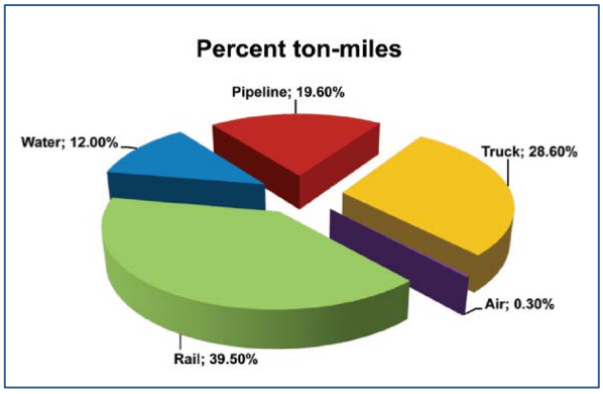


Source: Federal Railroad Administration, "National Rail Plan Progress Report," 2010, http://www.fra.dot.gov/Page/P0362.

national security; the Department of Defense has designated 30,000 miles of rail and associated structures as critical to mobilization and resupply of U.S. military forces.[7]

The freight rail system includes rails, rail yards, tunnels, bridges, and cyber infrastructure that are owned, operated, and maintained by private U.S. freight railroad companies. There are seven Class I railroads, 21 regional railroads, and 310 local railroads in the United States.[8] Class I railroads are those with operating revenue of $272 million.[9] This freight rail system accounts for nearly 40 percent of overall U.S. freight movement. (See Table 1) Freight rail also plays a significant role in intermodal traffic—the transport of freight using containers that can be transferred among multiple carriers such as planes, trains, trucks, or ships—because trains can haul large loads over long distances at relatively low cost.[10] Freight rail lines crisscross the country to connect ports, manufacturing hubs, and industrial and agricultural areas to population centers. This network of rails allows large cargos to be transported easily through city centers and to and from suburban and rural areas.

Table 1: Yearly U.S. Freight by Mode



Source: Federal Railroad Administration, "National Rail Plan Progress Report," 2010, http://www.fra.dot.gov/Page/P0362.

Under the 2013 Presidential Policy

Directive-21 on Critical Infrastructure Security and Resilience, which superseded the 2003 Homeland Security Presidential Directive-7 on Critical Infrastructure Identification, Prioritization, and Protection, the Transportation Systems Sector is designated as one of 16 critical infrastructure sectors.[11] Freight Rail is one of seven interconnected subsectors of the Transportation Systems Sector that includes aviation, highway infrastructure and motor carrier, maritime, mass transit and passenger rail, pipelines, and postal and shipping. The Department of Homeland Security (DHS) and the Department of Transportation (DOT) are the co sector-specific agencies (SSA). Together with other federal, state, local, territorial, tribal, and private industry partners, the SSAs work to "continuously improve the risk posture of transportation systems serving the nation."[12]

Table 2: Critical Infrastructure Sectors and Sector-Specific Agencies

Critical Infrastructure Sector	Sector Specific Agency
Chemical	Department of Homeland Security
Commercial Facilities	Department of Homeland Security
Communications	Department of Homeland Security
Critical Manufacturing	Department of Homeland Security
Dams	Department of Homeland Security
Defense Industrial Base	Department of Defense
Emergency Services	Department of Homeland Security
Energy	Department of Energy
Financial Services	Department of the Treasury
Food and Agriculture	U.S. Department of Agriculture and Department of Health and Human Services
Government Facilities	Department of Homeland Security and General Services Administration
Healthcare and Public Health	Department of Health and Human Services
Information Technology	Department of Homeland Security
Nuclear Reactors, Materials, and Waste	Department of Homeland Security and Department of Transportation
Transportation Systems	Department of Homeland Security and Department of Transportation
Water and Wastewater Systems	Environmental Protection Agency

Several factors make this mission particularly challenging in the freight rail context. The sheer size of the freight rail system, its co-location with population centers, and its criticality to the supply chain make freight rail not only an attractive target for terrorists but also particularly vulnerable to man-made and natural disasters. In addition, the cargo itself is often both essential for our economy and potentially dangerous. Federal law requires freight railroads to accept all shipments that are in accordance with Department of Transportation (DOT) regulations, including hazardous materials (HAZMAT). These materials have a broad range of applications in areas such as in manufacturing, farming, mining, and energy production. In some cases HAZMAT cargo includes flammable chemicals and radioactive materials.[13] In addition to DOT, the U.S. Environmental Protection Agency (EPA), Transportation Security Administration (TSA), and the U.S. Department of Homeland Security (DHS) all play a role in regulating safe transport of these materials by rail. The railroads themselves are responsible for ensuring that they comply with federal law regarding the disposition of HAZMAT and its safe and secure storage and transport.

Baltimore: A Critical Freight Rail Bottleneck.

The Howard Street Tunnel cuts through the heart of Baltimore and is a critical path for freight traveling to and from the Northeast United States. The brick tunnel was built in 1895, is owned by CSX Transportation, and is the only freight through-route in the Northeast corridor from the southern states through Washington, Baltimore, New York and to New England.[14] This makes the tunnel a bottleneck for all freight rail cargo moving up and down the Eastern seaboard. Over thirty trains a day traverse the tunnel at a maximum speed limit of 25 miles per hour due to the relatively steep grade and sharp curve in the track at the north end of the tunnel. The tunnel is reserved for freight traffic,

but south and north of the tunnel the freight rail tracks are co-located with other rail lines, including the Maryland Area Regional Commuter (MARC) Train, and Light Rail passenger railways. Unlike the privately owned CSX freight railroad, the Maryland Transit Administration (MTA)—a division of the Maryland Department of Transportation—operates the light rail, metro subway, MARC Train Service, regional buses, and a Paratransit (Mobility) system, making MTA one of the largest multi-modal transit systems in the United States.[15]

The tunnel lies directly under Howard Street, a busy urban thoroughfare that cuts a north-south path through the downtown Baltimore business district. The southern entrance to the tunnel lies directly adjacent to Camden Yard and the Baltimore Convention Center, and just a few blocks west from the Inner Harbor area that is home to the Baltimore Aquarium, Science Center, and other attractions, including a U.S. Coast Guard Cutter. The large University of Maryland (UMD) campus—along with the UMD Medical Center—lies a few blocks to the west of Howard Street, and numerous state government buildings, such as the Federal Building and Courthouse and the First Mariner Arena, are situated within a block of Howard Street above the tunnel. (See Map 2)

The Port of Baltimore makes the city a busy freight hub. Overseen by the Maryland Port Authority, it is the largest roll-on, roll-off freight port in the Nation and one of the busiest overall ports in the United States for container shipments. CSX Transportation provides on-dock direct rail service for container shipments, which move from ship to rail at a rate of 37 containers per hour. This intermodal shipping capability allows for delivery of most cargo destined for the East Coast and Midwest with in a day of arrival at port.[16]

Below Ground: Fire and Flood

At 3:08 p.m. on the afternoon of July 18, 2001, CSX train L41216 came to an abrupt halt in the Howard Street Tunnel about 1,850 feet from the north portal of the tunnel.[17] The sixty-car train was en route from Hamlet, North Carolina to Oak Island, New Jersey when Carl Cadden, the train's engineer and one of the two crew members on board, felt the train lurch and then stop. Lights on the control panel indicated that the train's emergency air brakes had automatically engaged.[18] Neither Cadden nor the train's conductor Edward Brown could see what had caused the brakes to deploy, but the growing smoke indicated that something was wrong. At 3:15 pm they tried to radio the dispatcher, but the radio was not working. Next, they used Cadden's personal cell phone to call a local Baltimore trainmaster for help. The trainmaster in turn relayed the information to the CSX dispatcher. Left with no other choice, Cadden and Brown uncoupled the three engines from the railcars and drove out of the tunnel.[19] They left behind sixty cars, 31 loaded and 29 empty. Eleven of the cars had derailed. Four of the derailed cars were tank cars carrying HAZMAT. Unbeknownst to Cadden and Brown, a tank car carrying tripropylene had been punctured and had ignited.[20]

Map 2: Baltimore City Center

Source: Maryland Transit Administration, http://mta.maryland.gov/sites/default/files/DowntownBaltimoreVisitorsMap.pdf

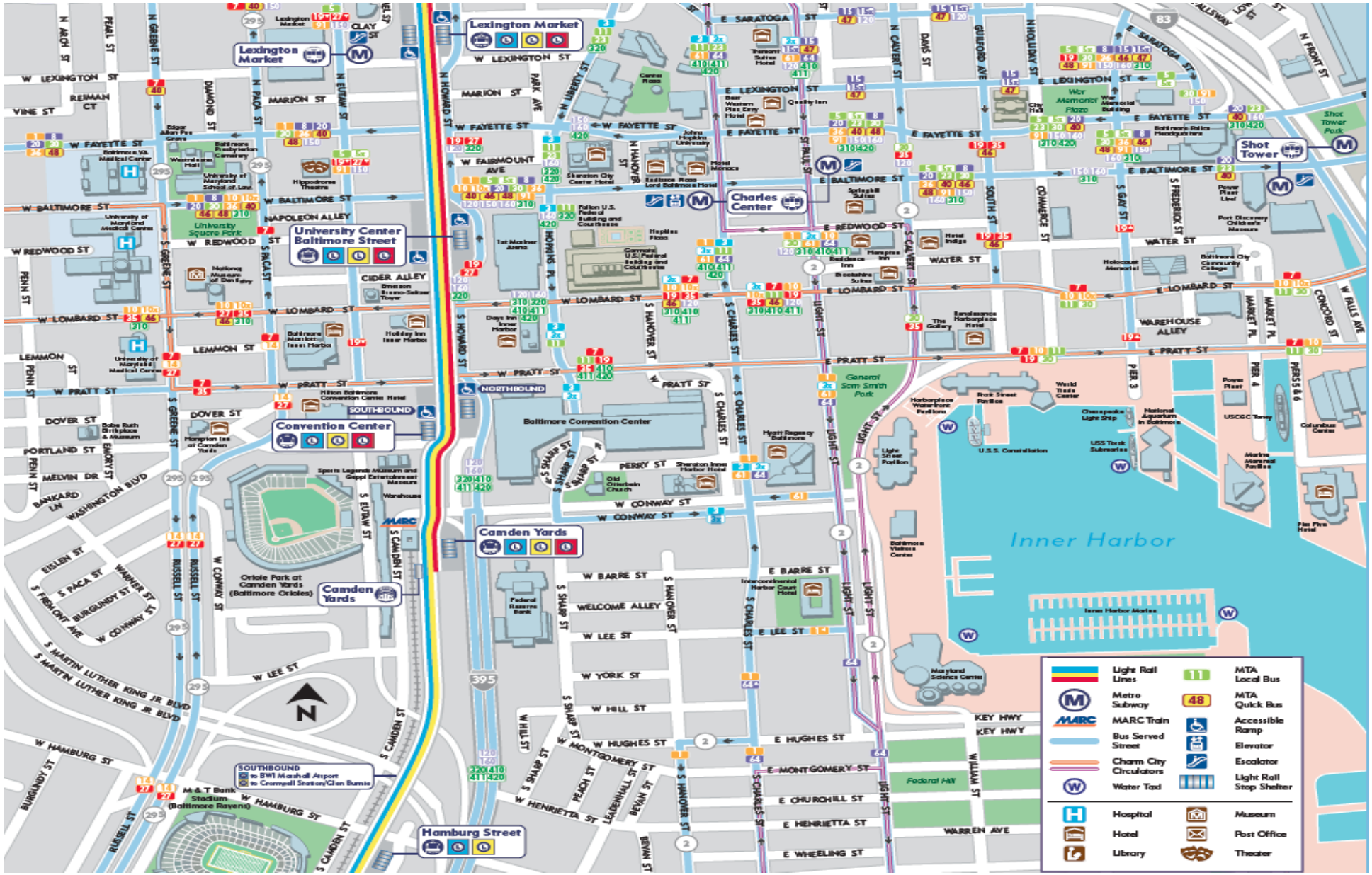
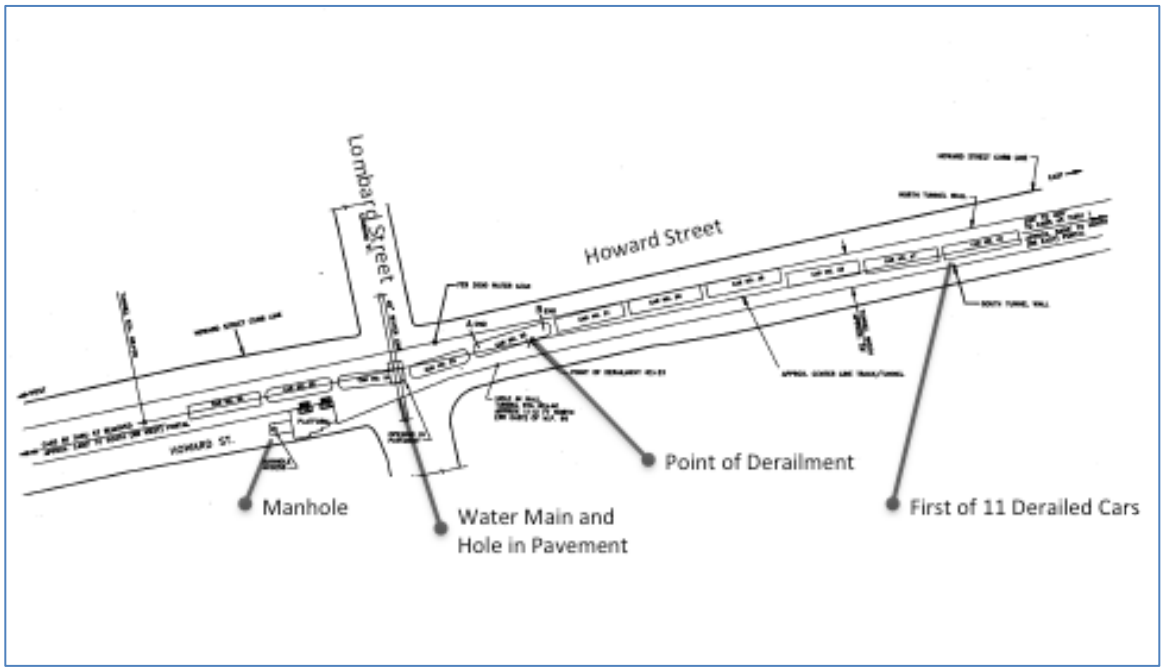


Figure 1: Annotated NTSB Train Derailment Sketch



Source: Base Schematic from National Transportation Safety Board. Railroad Accident Brief NTSB/RAB-04/08. Incident Number DCA-01-MR-0004. July 18, 2001. http://www.ntsb.gov/doclib/reports/2004/RAB0408.pdf.

That ignition soon grew into a raging fire under Howard and Lombard Streets as the fire spread to adjacent train cars, but responders did not know exactly where or how large the fire was. Adding to the confusion, at about 6:20 pm a 40-inch cast iron water main situated above the tunnel and below the pavement broke. Water gushed down Howard Street and poured down into the tunnel below. By the time Baltimore Department of Public Works officials shut down the water main line at 11:59 pm, the city of Baltimore had lost an estimated 14 million gallons of water. Businesses and streets were flooded and about 1,200 customers had lost electrical power.[21] Meanwhile, the fire severed fiber optic cables serving seven large telecommunications firms, causing service disruptions and delays along the entire East Coast. In some areas Internet traffic was 10 times slower than usual.[22]

The fire that began in the tripropylene car ignited paper and wood products in nearby cars, producing a conflagration topping 1,500 degrees Fahrenheit. In all, 28,600 gallons of tripropylene were released, and the fire penetrated adjacent cars carrying hydrochloric acid and ethyl hexyl phthalate, an environmentally hazardous substance. Smoke now began to billow from manhole covers above the tunnel. But no one could reach the fire.

Table 3: Chemicals in the Cargo

Hydrochloric acid	A metal cleaner. Not combustible, but highly corrosive. If inhaled, can cause a burning sensation, cough, labored breathing, shortness of breath and sore throat. On contact with skin or eyes, can cause severe burns.
Glacial acetic acid	A glass solvent. Flammable. If inhaled, can cause sore throat, cough, burning sensation, headache, dizziness, shortness of breath, or labored breathing. On contact with skin or eyes, can cause pain, redness and severe burns.
Fluorosilicic or hydrofluoric acid	Used to fluoridate water. Not combustible, but corrosive. If inhaled, can cause a burning sensation, cough, and shortness of breath. On contact with skin or eyes, can cause pain, redness, blisters and severe burns.
Propylene glycol	A de-icing fluid. Combustible. Can cause redness and pain in eyes.
Tripropylene	A lubricant similar to paint thinner.
Ethyl hexyl phthalate	Used to make flexible products like PVC piping. Combustible. If inhaled, can cause cough or sore throat.

Source: U.S. Fire Administration, CSX Tunnel Fire Baltimore, Maryland, USFA-TR-140/July 2001. http://www.usfa.fema.gov/downloads/pdf/publications/tr-140.pdf, p. 5.

Above Ground: The City Shuts Down

Above ground, the City of Baltimore Emergency Response Plan swung into action. Over the next six days City, State, and Federal officials fought to pinpoint the location of the fire, protect the public from any adverse effects, and bring the fire and its cascading effects under control. This required a broad cast of players who brought with them a variety of critical capabilities and resources.

In the minutes following the initial call from the train crew members, the CSX dispatcher issued a request for assistance to the CSX hazardous materials team, notified the Maryland Department of the Environment, and requested that CSX police notify the Baltimore City Fire Department (BFD).[23] Just after 4:00 pm firefighters arrived at the north and south tunnel entrances. Captain James Smith from Engine Company 13 and his team were the first to try to enter the north end of the tunnel, but they turned back after venturing only 100 feet out of concerns that there was a caustic substance in the tunnel.[24] The combination of location, intensity, lack of visibility, and caustic substances made this fire unique and difficult to battle. The special 6th Battalion HAZMAT team was called in.

Map 3: Street Closures Above the Howard Street Tunnel

Source: Satellite Photo Underlay, Google Earth.

Upon arrival on the scene, the Baltimore Fire Department took over incident command and immediately turned to issues of safety and security above ground. The Maryland Department of the Environment and U.S. Coast Guard determined that the presence of HAZMAT would not require an evacuation. The Incident Commander sent out a shelter

in place order via radio and television and asked the Baltimore Police and Maryland Department of Transportation to shut down major highways into the city and a stretch of the city streets above the tunnel. The city streets were quickly snarled in evening rush hour traffic as road closures restricted east-west traffic in the city and precluded access to interstate highways. By 5:00 p.m. the Coast Guard shut down the Inner Harbor waterway and began taking measures to prevent any environmental contaminants from entering the Harbor. At 5:45 p.m. civil defense sirens sounded. By 6:20 p.m. the streets around Howard and Lombard Streets flooded as the water main broke. Traffic was at a standstill. The fire still raged. (See Map 3)

Table 4: Incident Response and Agency Responsibilities

Jurisdiction	Modal Administration or Agency	Role in Incident Response	Area of Concern
Baltimore City	Fire Department	Incident command	Fire suppression
	Police Department	Traffic enforcement	Closing of streets crossing over the Howard Street Tunnel.
	Department of Public Works Traffic management	Infrastructure repairs	Repairs to water main and street surface at Howard and Lombard Streets. Traffic control in Baltimore City.
	Office of Emergency Management	Interagency coordination Public information	Media Information
Maryland Department of Transportation	Headquarters	Coordination of DOT response activities	Working with Baltimore Department of Public Works (DPW) to establish a plan on how to repair the infrastructure damage once the fire was extinguished (procure ment issues – having a contractor in place to do repairs, developing a plan on how repair work would be implemented once the "green light" would be received, plans for site survey, traffic diversion plan, etc.).
	State Highway Administration	Traffic management on interstate system	Through Coordinated Highways Action Response Team (CHART) system, posted notices on fixed and mobile VMS advising that major routes into the City were closed.
	Mass Transit Administration	Rail and bus transit operations in Baltimore City	Light rail and bus operations. Establishing bus bridge between north and south segments of light rail. MARC operations. METRO subway operations – tunnel inspection.
	Maryland Transportation Authority	Traffic management on I-95 approaches to Fort McHenry Tunnel; I-395	Responsible for ensuring I-395 route into Baltimore was closed off during initial incident response activities.
Maryland Department of the Environment	Emergency Response Division	Air quality Water quality Hazardous materials leaks/discharge	Obtaining information on possible environmental impact of train fire (hazardous materials). Monitoring air and water quality in area around the tunnel and the Inner Harbor. Working with Coast Guard to contain leakag into Inner Harbor. Checking rail cars pulled from tunnel for structural integrity. Coordinating removal and disposal of hazardous materials from the train.
Maryland Emergency Management Agency	N/A	Coordination of state government emergency esponse and incident management activities	Coordinating activities of state agencies. Media relations and rumor control.
U.S. Coast Guard	US DOT	Supported MDE	Implementing waterway safety measures, including closing of Inner Harbor. Supporting hazardous material detection and containment.
U.S. Environmental Protection Agency	N/A	Supported MDE	Assisting with monitoring of air and water quality.

Source: U.S. Department of Transportation, "Effects of Catastrophic Events on Transportation System Management and Operations, Baltimore, MD—Howard Street Tunnel Fire—July 18, 2001."

Serendipitously, fire officials had recently conducted a drill of a railroad tunnel accident response, albeit in an Amtrak passenger rail tunnel. After initially being repelled by the smoke, blaze, and fumes, firefighters and CSX Transportation specialists lowered a large diameter hose from the street above into the tunnel where they set up suppression operations attack lines. The next day firefighters were able to reach the burning cars by about 10:30 pm using Self-Contained Breathing Apparatuses. In all, 150 firefighters battled the blaze for the next five days.[25] On Monday, July 23, at 7:42 am the Incident Commander declared the scene under control.[26]

Chronology of Events from Maryland Department of Transportation

This Chronology has been edited slightly for length.[27]

July 18, 2001 – Day 1

3:04 PM	60-car CSX freight train L412-16 enters the Howard Street Tunnel in downtown Baltimore.
3:07 PM	Train unexpectedly comes to stop in tunnel.
3:15 PM	Engineers notify CSX dispatcher via cell phone that train is stopped in tunnel.
3:27 PM	Engineers decouple engines and exit from tunnel. Dispatcher notified via radio that train is on fire.
4:15 PM	Baltimore City Fire Department arrives as first responder and assumes incident command responsibilities.
4:11 PM	CSX notifies Maryland Department of the Environment (MDE) that the train cars are carrying hazardous materials.
4:15 PM	The Baltimore City Department of Health contacts the Maryland Emergency Management Agency (MEMA).
4:20 PM	MDE arrives on scene, contacts National Transportation Safety Board, Baltimore City Fire Department Battalion Chief 6, and Baltimore City Fire Department hazardous materials (HAZMAT) coordinator. Units begin assisting city personnel with analysis of train documentation and potential hazard products. MARC commuter rail, MTA's Central Light Rail Line, and rail freight movement are disrupted by fire. MTA initiates bus-bridge to bring MARC passengers from Dorsey Station south of Baltimore to the City. Chief of the City Fire Department requests that all major roads (I-395, I-83, US-40) into Baltimore City be closed.
4:30 PM	Baltimore City Police Department and Department of Public Works starts rerouting downtown traffic away from the scene using signs and barriers; Howard Street and all streets crossing over the Howard Street tunnel are closed. Interstate highways I-395 northbound and I-83 southbound are closed to traffic trying to get into the City.
4:35 PM	MDE advises Baltimore City Hazmat of potential hydrogen fluoride (HF) vapor hazard due to thermal degradation of fluorosilicic acid; identifies specialized treatment needed for HF exposures.
4:45 PM	Baltimore City Emergency Management contacts MDE reports that city officials are preparing to sound siren system to notify nearby residents to shelter in place. MDE concurs with shelter in place order.
4:50 PM	Initial air monitoring by MDE and Baltimore City HAZMAT commences at Mt. Royal. MDE directed to begin air monitoring around Camden Yards.
4:53 PM	MDE contacts U.S. Coast Guard and requests assistance.
5:00 PM	U.S. Coast Guard closes Inner Harbor to boat traffic. Orioles' office workers are told to leave B & O Warehouse.
5:45 PM	Civil Defense warning sirens sound.
6:15 PM	Water from the broken water main located under the Howard and Lombard Street intersections surfaces and floods the street. MTA closes Metro's State Center station due to smoke.
7:15 PM	MTA initiates bus-bridge connecting north and south segments of light rail. Exact location of fire is identified (near Howard and Lombard Street intersection). MDE determines that a catastrophic environmental event is unlikely; Baltimore City determines that an evacuation of the downtown area is not necessary.
8-9:00 PM	Roads and entrance/exit ramps on major thoroughfares into the City reopen sporadically.
11:00 PM	Baltimore City Fire Department Command Staff direct primary Command Post operations to be relocated to the vicinity of Camden Yards stadium complex. Water is cut off by BCDPW at the point of the water main break.
11:15 PM	MD DOT, MDE, MEMA, MD Department of General Services discuss possible closure of state offices near Mt. Royal on July 19. MDE shares results of environmental monitoring and indicates no hazardous materials threat to those facilities. MD DOT and MD GSA tentatively agree to enact liberal leave for state office complex due to road closures and mass transit disruptions. Coordination call between city and state agencies set for 4:00 AM July 19, 2001 so that final recommendation can be made to the Governor.

July 19, 2001 – Day 2

4:00 AM	MDE operations shift to Camden Yards command post.
5:00 AM	MDE confers with CSX and Baltimore City Fire Department incident command staff to discuss incident mitigation strategy. Fire appears to be located under the Howard and Lombard Street intersection and may be accessible from the surface. Inner Harbor reopened. State Personnel assigned to State Center office complex granted liberal leave.

6:30 AM Baltimore City Fire Department, U.S. Coast Guard Activities Baltimore, and MDE discuss marine safety zones on Patapsco River and agree to lift it.

9:30 AM MDE meets with USCG Activities Baltimore and requests assistance from Activities Baltimore staff in establishing a Hazardous Materials division with the USCG ICS to coordinate monitoring efforts of CSX, MDE, EPA, USCG and SBIMAP assets.

10:30 AM Fire personnel access the tunnel via manhole at the Howard and Lombard Street intersection and begin fighting the fire at that location. Small leaks reported in one tank car of hydrochloric acid (HCl). CSX, MDE, and Baltimore City fire personnel begin planning acid transfer operations along with CSX contractors.

1:00 PM MDE deploy to Lombard/Howard intersection to assist with product transfer operations and monitor air and liquids for presence of HCl.

7:00 PM MDE personnel escort first tank truck of transferred hydrochloric acid to Sasol facility in South Baltimore. Transfer and escort operations continue until approximately 3:00 AM July 20, 2001.

July 20, 2001 – Day 3

6:00 AM CSX personnel consult with MDE regarding construction of dike around leaking HCL car. Initial suggestion by contractor staff was to use soda ash bags as material to build a dike. This action changed after MDE staff expressed serious safety reservations about the reaction with soda ash should the tank car suddenly fail.

8:00 AM USCG Activities Baltimore develops written site safety plan; MDE adopts plan and is covered by it in order to ensure unity of operations and safety purposes.

1:30 PM MDE and two CSX personnel enter north end of tunnel via high-rail vehicle to assess tank cars. SBIMAP consultant is overcome by fatigue and exhausts air supply. Personnel begin to evacuate the tunnel and contact intervention team for assistance per existing safety plan. Transported to University of MD medical center for observation and released.

4:00 PM Multi-agency incident strategy meeting led by Baltimore City Office of Emergency Management.

July 21, 2001 – Day 4

State Center Metro station reopened. Camden Yards Central Light rail line station is reopened; however, bus bridge continues to operate between Patapsco and North Avenue stations due to presence of emergency equipment near Camden station.

4:00 AM MDE personnel are provided with status update on all cars. Tank cars at northern end of tunnel removed and assessed. All are reported intact. Remaining tank cars being removed from south end of tunnel.

5:45 AM Undamaged HCl tank removed from tunnel's south portal.

11:30 AM Damaged HCl tank car are removed from south end of tunnel.

11:45 AM MDE confers with CSX, USCG, EPA, Baltimore City Fire regarding need for continued MDE presence. Monitoring and long-term clean up efforts discussed.

1:30 PM MDE personnel depart scene as emergency operations have concluded. Work plan established for follow-on monitoring and assessment during clean-up operations.

7:05 PM First Orioles game played at Orioles' Park at Camden Yards since the day of the incident.

July 23, 2001 – Day 6

Broken valve is repaired near water main break and water flow stops. Howard Street is reopened to traffic, except in vicinity of water main break. Cross streets intersecting Howard Street reopen except streets between Baltimore Street and Pratt Street. MTA continues bus-bridge between north/south light rail branches. Liberal leave for state employees ends, and regular work hours resume.

7:10 AM Final rail car is removed from tunnel and remaining fires are extinguished.

4:45 PM CSX bridge maintenance engineers, Federal Railroad Administration officials, Baltimore City engineers, and Baltimore Mass Transit Administration officials enter the tunnel for the first time to inspect the damage.

July 24, 2001 – Day 7

MARC's Camden Line resumes service from Washington, DC to Camden Yards station for morning commute. CSX's test run through the Howard Street tunnel with two locomotives and 50 loaded cars at reduced speed is successful; CSX resumes freight service through the Howard Street tunnel at limited speeds.

July 29, 2001 – Day 12

Water main repairs are completed.

August 11, 2001 – Day 25

Manhole covers fly four feet into the air and traffic signals are disrupted in small area downtown due to the ignition of tripropylene by electrical sparks. Approximately 2,000 gallons of tripropylene are recovered from storm drain system and nearby conduit vaults.

September 4, 2001 – Day 49

Intersection of Howard Street and Lombard Street is reopened to traffic. Central Light Rail line is repaired.

September 8, 2001 – Day 53

Central Light Rail Line is reopened, bus bridge is discontinued.

September 10, 2001 – Day 55

Baltimore City completes repairs to road surfaces.

It took several more weeks for the city to return to normal. The city, state, and federal governments granted liberal leave and most businesses in the immediate vicinity above the tunnel closed for the week following the incident. Three weeks after the incident, an underground pool of 2,000 gallons of tripropylene ignited, causing manhole covers to fly into the air and disrupt traffic. A bus bridge that the city established during the fire remained in operation until the light rail could be reopened nearly two months after the incident. Roadways above the tunnel were not fully repaired until September 2001.[28]

There were many economic consequences for the city of Baltimore and beyond. The incident cost an estimated 12 million dollars, including response and clean up costs.[29] Many local businesses cited an 80 percent drop in revenues. The fire forced the cancelation of three Major League Baseball games—at a cost of 1.5 to 2 million dollars per game.[30] The tunnel fire also disrupted rail traffic along the East Coast, causing supply chain disruptions that reverberated throughout the system. CSX was forced to reroute trains, causing delays of up to three days.[31]

Local officials touted the highly coordinated response, citing a well-rehearsed emergency management plan that was implemented among state, local, and federal agencies. Questions surfaced, however, about public-private information sharing, particularly that among the City, State, and CSX Transportation prior to the accident, and among the Incident Command, Office of Emergency Management, the media, and the public during the early hours of the incident. Particular concerns included the hour-long delay between the derailment and the first alarm that alerted firefighters to the fire as well as a short delay in the appointment of a public information officer. Nevertheless, there were only five reported injuries, and these were minor. And despite the length and severity of the incident, no lives were lost and the Health Department reported no long-term health consequences from the fire or HAZMAT fumes. By September 10, 2001, the remaining road closure areas were repaired and the city fully returned to normal operations.

Recommended Reading

U.S. Fire Administration, *CSX Tunnel Fire Baltimore, Maryland, USFA-TR-140/July 2001*. http://www.usfa.fema.gov/downloads/pdf/publications/tr-140.pdf.

National Transportation Safety Board. *Railroad Accident Brief NTSB/RAB-04/08.* Incident Number DCA-01-MR-0004. July 18, 2001. http://www.ntsb.gov/doclib/reports/2004/RAB0408.pdf.

U.S. Department of Transportation. *Effects of Catastrophic Events on Transportation System Management and Operations.* Baltimore, MD—Howard Street Tunnel Fire—July 18, 2001. http://ntl.bts.gov/lib/jpodocs/repts_te/13780_files/13780.pdf.

Derailed: Critical Infrastructure Security and Resilience in Exercises

Introduction

The 2001 Howard Street Tunnel freight train derailment in Baltimore is a compelling case study that illustrates the central role that information sharing plays in critical infrastructure security and resilience. The multi-modal and multi-sector consequences in this case—particularly due to the cascading effects of fire, flood, traffic disruptions, and communications and power outages associated with this prolonged event—present a rich opportunity for learners to think critically about how information sharing strategies can be developed and implemented to mitigate risks and improve response.

The case exercises are designed to build core competencies in Risk Analysis and Information Sharing through exercises that prompt critical thinking about the full range of information sources and types. The exercises model techniques that develop critical thinking skills and are designed as repeatable, practical methods that learners can apply not only in the course but also in the workplace.[32] The goal of the exercises is to employ sound critical thinking about information sharing strategy and planning activities, not simply to model the known outcome. To this end, the exercises help the learner employ a robust and structured approach to these activities and explicitly identify the value added by using them. Many times the value of a technique lies in the conversation that it prompts about evidence, factors, assumptions, and gaps that would otherwise be overlooked. Learners should judge their performance, therefore, on *how* they have conducted their analyses rather than on the specific case outcome.

Exercise 1. Building a Robust Information Sharing Environment: Stakeholder Identification using Mind Mapping.

Mind Maps are visual representations or diagrams of a topic of interest. A mind map has two main elements. The first element is the information (people, places, things) that is relevant to the topic being mapped. The second element is the connections (lines, or other links) that illustrate how the information is connected. The spatial placement of the information and connections on the page can help the user to explicate and analyze the relationships among the items being mapped.

Mind mapping is a visual brainstorming technique that sparks not only divergent thinking about all the actors, factors, and forces being mapped, but also convergent thinking about what those interactions reveal about the environment or issue being mapped. It is a flexible technique can be useful before, during, and after an incident to understand the complex relationships surrounding a given issue. A mind map can be a powerful brainstorming technique because it uses a combination of words, symbols, and images to build a picture of a problem that can be easily shared and discussed.

Task: Using the information in the case as your starting point, create a mind map of the information sharing environment surrounding the Howard Street Tunnel incident.

Mind Map Technique Steps

Materials: Paper (large, if possible), and drawing implements (colors help). Alternatively, a White Board and colored markers will also suffice. The map can also be drawn digitally using specialized mind mapping software or another program such as PowerPoint.

Step 1: Identify the focal issue to be mapped. For this exercise, the case is a starting point from which to build a map of the actual information sharing environment surrounding the freight rail line in the Howard Tunnel. If the technique is being used in a planning process the focal question might be to build a map of the ideal information sharing environment. The most important aspect of step 1 is to identify clearly the issue to be mapped.

Step 2: Make a list of the information (people, places, things, concepts, issues) to be mapped. Start with as many as possible and then group them in a logical manner. For this case, for instance, groupings by critical infrastructure sector or subsector might be instructive.

Step 3: Using paper or a white board, array the general groups and more specific concepts on the page so that the most relevant or focal concepts are at the middle of the page. These concepts may be represented by images, symbols or words. The Mind Map presents an opportunity for creativity in this regard that can spark imaginative thinking. Use a pencil or erasable marker as you begin to sketch so that you may refine the placement of the concepts as necessary.

Step 4: Make links between the related concepts. Use lines, arrows, dotted lines, or other markings to illustrate the information flow. Add labels to clarify the nature of the relationships.

Step 5: As you build the binary links, look for any tertiary or crosslinks that are

noteworthy. Label these links and refine the positioning and labels as necessary.

Step 6: Consider any additional concepts to be added to the map. Are there any gaps? Are any stakeholders missing who should be there? Are there any links that should be added? Are there any links that in an ideal world should be there but are not?

Step 7: Add any additional notations to the Mind Map to highlight important connections or interrelationships.

Step 8: Reposition and refine the map adding color, images, or other clarifying items.

Analytic Value Added

Who are the central stakeholders that emerge from the Mind Map? What relationships are most important in this case? Are there any binary or tertiary relationships that emerge from the map that should be pursued? What is the nature of the relationships among the concepts on the map? What could be done to improve information sharing environment? Is anything missing (stakeholders or links) from the map that could improve the information sharing environment? If working with others, compare mind maps. How have others presented their maps and what can be learned from these different perspectives?

Exercise 2. Building a Robust Information Sharing Environment: Red Hat Information Sharing Matrices

Red Hat analysis is a technique that prompts the user to adopt the perspective of another person or group and to conduct an analysis from this new perspective. Shifting one's perspective in this manner is particularly salient when building information sharing relationships because it shifts the focus from one's own information needs to that of one's interlocutors. The goal of developing an information strategy using a Red Hat analysis is to improve the chances of finding common ground and unearthing new areas for collaboration. A matrix is a simple but powerful analytic tool that uses a grid to organize data for easy comparison and analysis of variables. Matrices are particularly helpful when there are more variables to be sorted and compared than the human mind can process and track unaided. The matrix allows for easy binary comparison of all the variables as well as an easy way to identify gaps. Combining Red Hat analysis and matrices can be a helpful way to develop a roadmap for information sharing with numerous stakeholders.

Task: Using case narrative, create information sharing matrices for the case.

Red Hat Information Sharing Matrices Technique Steps

Step 1: Clearly define the focal issue for the Red Hat Information Sharing Matrices. In this exercise, the focal issue is to identify ideal information sharing relationships between the stakeholders.

Step 2: Create *two* matrices with the desired stakeholders listed down the left side and across the top. (See Matrices #1 and #2 below) Label the first matrix *Information to Provide*. Label the second matrix *Information to Seek*. Use as many rows and columns as necessary to accommodate the number of stakeholders assigned or desired.

Step 3: Shade the pairwise comparisons so that the cells in the matrices that compare the same stakeholder are shaded.

Information Sharing Matrix 1: Information to Provide

	ISE Stakeholder 1	ISE Stakeholder 2	ISE Stakeholder 3	ISE Stakeholder…
ISE Stakeholder 1				
ISE Stakeholder 2				
ISE Stakeholder 3				
ISE Stakeholder…				

Information Sharing Matrix 2: Information to Seek

	ISE Stakeholder 1	ISE Stakeholder 2	ISE Stakeholder 3	ISE Stakeholder…
ISE Stakeholder 1				
ISE Stakeholder 2				
ISE Stakeholder 3				
ISE Stakeholder…				

Step 4: Begin the information sharing analysis by starting with the first stakeholder listed along the left of the Information to Provide matrix. Working across Stakeholder 1's row, ask: what information does this stakeholder possess that could be shared with Stakeholder 2. List that information in the corresponding cell on the Stakeholder 1 row. Do the same for the Stakeholder 3 and 4 cells on the Stakeholder 1 row. Next, move down the left hand column to Stakeholder 2. Ask the same question: what information does this stakeholder possess that should be shared with Stakeholder 1. The goal is to identify specific information that should be shared with each of the other Stakeholders.

Step 5: As you identify specific information for each Stakeholder to provide, make a note of any barriers to sharing in the cell. Barriers to information sharing take many forms and should be noted at this stage in the analysis. When encountering a barrier, ask whether the barrier is the Stakeholder's or is something in the environment that is external to the Stakeholder. Note this in the applicable cell.

Step 6: Once the Information to Provide matrix is complete, conduct the same process using the Information to Seek matrix.

Step 7: Again, note any information barriers in the corresponding cells.

Step 8: Track the relationships over time and note any changes to the binary relationships. Do these changes affect any other relationships?

Analytic Value Added

Which relationships are most or least developed? What are the key barriers to information sharing? Where do opportunities exist to improve the information sharing relationships? Is there a particular stakeholder that is best positioned to play a leadership role in sharing information? Is there a stakeholder that should be more integrated into the environment and what type of information might they contribute?

[1] David Michael Ettlin and Del Quentin Wilber, Train fire, toxic cargo shut city," The Baltimore Sun, July 19, 2001, http://www.baltimoresun.com/bal-te.md.train19jul19,0,1211824,full.story.

[2] Linda Rosencrance, "Baltimore Train Fire Disrupts Internet Service in Northeast," Computerworld, July 19, 2001, http://www.computerworld.com/s/article/62375/Baltimore_train_fire_disrupts_Internet_service_in_Northeast.

[3] David Michael Ettlin and Del Quentin Wilber, Train fire, toxic cargo shut city," The Baltimore Sun, July 19, 2001, http://www.baltimoresun.com/bal-te.md.train19jul19,0,1211824,full.story.

[4] David Michael Ettlin and Del Quentin Wilber, Train fire, toxic cargo shut city," The Baltimore Sun, July 19, 2001, http://www.baltimoresun.com/bal-te.md.train19jul19,0,1211824,full.story.

[5] "The Freight Rail Network," Federal Railroad Administration, http://www.fra.dot.gov/Page/P0362.

[6] "How Freight Moves," Federal Railroad Administration, http://www.fra.dot.gov/Page/P0362.

[7] "Transportation Systems Sector-Specific Plan," The Department of Homeland Security, 2010 http://www.dhs.gov/xlibrary/assets/nipp-ssp-transportation-systems-2010.pdf, p. 15.

[8] Class I refers to railroads with operating revenues of $433.2 million or more.

[9] This figure is for 2002, the year most recent to the derailment. See Overview of Freight Railroads, National Atlas, http://nationalatlas.gov/articles/transportation/a_freightrr.html.

[10] "How Freight Moves," Federal Railroad Administration, http://www.fra.dot.gov/Page/P0362.

[11] "Presidential Policy Directive/PPD-21 Critical Infrastructure Security and Resilience," *The White House*, Office of the Press Secretary, February 12, 2013, www.whitehouse.gov.

[12] "Transportation Systems Sector-Specific Plan," The Department of Homeland Security, 2010 http://www.dhs.gov/xlibrary/assets/nipp-ssp-transportation-systems-2010.pdf, p. 3.

[13] Ibid., p. 284.

[14] U.S. Department of Transportation, "Effects of Catastrophic Events on Transportation System Management and Operations," Baltimore, MD—Howard Street Tunnel Fire—July 18, 2001, http://ntl.bts.gov/lib/jpodocs/repts_te/13780_files/13780.pdf, p. 6.

[15] Overview of the Maryland Transit Administration, http://mta.maryland.gov/content/mta-offices.

[16] Maryland Department of Transportation Port Authority, "Cargo," http://www.mpa.maryland.gov/content/types-of-cargo.php.

[17] National Transportation Safety Board. Railroad Accident Brief NTSB/RAB-04/08. Incident Number DCA-01-MR-0004. July 18, 2001. http://www.ntsb.gov/doclib/reports/2004/RAB0408.pdf, p 2.

[18] Dan Fesperman, "Chronology: With a Rumble, Chaos," *Baltimore Sun*, July 21, 2001, www.baltimoresun.com.

[19] National Transportation Safety Board. Railroad Accident Brief NTSB/RAB-04/08. Incident Number DCA-01-MR-0004. July 18, 2001. http://www.ntsb.gov/doclib/reports/2004/RAB0408.pdf, p 3-4.

[20] National Transportation Safety Board. Railroad Accident Brief NTSB/RAB-04/08. Incident Number DCA-01-MR-0004. July 18, 2001. http://www.ntsb.gov/doclib/reports/2004/RAB0408.pdf, p 1.

[21] U.S. Fire Administration, *CSX Tunnel Fire Baltimore, Maryland, USFA-TR-140/July 2001*, http://www.usfa.fema.gov/downloads/pdf/publications/tr-140.pdf, p. 13; David Michael Ettlin and Del Quentin Wilber, "Train, Fire, Toxic Cargo Shut City, Baltimore Sun, July 19, 2001, http://www.baltimoresun.com/bal-te.md.train19jul19,0,5542714.story#ixzz2Zmopc3Jj.

[22] U.S. Fire Administration, *CSX Tunnel Fire Baltimore, Maryland, USFA-TR-140/July 2001*. http://www.usfa.fema.gov/downloads/pdf/publications/tr-140.pdf, p. 13; U.S. Department of Transportation, "Effects of Catastrophic Events on Transportation System Management and Operations," Baltimore, MD—Howard Street Tunnel Fire—July 18, 2001, http://ntl.bts.gov/lib/jpodocs/repts_te/13780_files/13780.pdf, p. 21.

[23] National Transportation Safety Board. Railroad Accident Brief NTSB/RAB-04/08. Incident Number DCA-01-MR-0004. July 18, 2001. http://www.ntsb.gov/doclib/reports/2004/RAB0408.pdf, p 3-4.

[24] Dan Fesperman, "Chronology: With a Rumble, Chaos," *The Baltimore Sun*, July 21, 2001, www.baltimoresun.com.

[25] U.S. Fire Administration, *CSX Tunnel Fire Baltimore, Maryland, USFA-TR-140/July 2001*. http://www.usfa.fema.gov/downloads/pdf/publications/tr-140.pdf, p. 1-2.

[26] National Transportation Safety Board. Railroad Accident Brief NTSB/RAB-04/08. Incident Number DCA-01-MR-0004. July 18, 2001. http://www.ntsb.gov/doclib/reports/2004/RAB0408.pdf, p. 6.

[27] U.S. Department of Transportation, "Effects of Catastrophic Events on Transportation System Management and Operations," Baltimore, MD—Howard Street Tunnel Fire—July 18, 2001, http://ntl.bts.gov/lib/jpodocs/repts_te/13780_files/13780.pdf.

[28] U.S. Department of Transportation, "Effects of Catastrophic Events on Transportation System Management and Operations," Baltimore, MD—Howard Street Tunnel Fire—July 18, 2001, http://ntl.bts.gov/lib/jpodocs/repts_te/13780_files/13780.pdf, Appendix Chronology.

[29] National Transportation Safety Board. Railroad Accident Brief NTSB/RAB-04/08. Incident Number DCA-01-MR-0004. July 18, 2001. http://www.ntsb.gov/doclib/reports/2004/RAB0408.pdf, p. 1.

[30] U.S. Department of Transportation, "Effects of Catastrophic Events on Transportation System Management and Operations," Baltimore, MD—Howard Street Tunnel Fire—July 18, 2001, http://ntl.bts.gov/lib/jpodocs/repts_te/13780_files/13780.pdf, p 21.

[31] Ibid., p. 16.

[32] For more cases that employ these and other techniques, please see Sarah Miller Beebe and Randolph H. Pherson, *Cases in Intelligence Analysis: Structured Analytic Techniques in Action*, Washington, DC: CQ Press, 2012.