Development of a Statewide Freight System Resiliency Plan

Final Research Report

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Table of Contents

1. Introduction and Overview

All organizations, both public and private, are faced with unplanned emergencies, disruptions, and disasters. Recent disasters ranging from the 9/11 terrorist attacks to natural events—such as the Nisqually Earthquake of 2001, Hurricanes Katrina and Rita in 2005, Seattle's Hanukkah Eve Wind Storm of 2006, and Minneapolis' 35W bridge collapse of August 2007—have raised the need for companies and government agencies to be able to handle these events.

Most work, however, has focused on how an organization should successfully respond to these disasters during and in the immediate aftermath in order to save lives. On the other hand, very little research has been conducted on how organizations or regions should plan to recover economically from these disasters, and few states have any meaningful recovery plans outlined for their freight systems. While many organizations view the terms response and recovery as interchangeable, they are distinct and this report outlines the important differences between the immediate response to an incident, and the longer-term recovery from the event.

Emergency response plans, for example, focus on minimizing the immediate loss of life and damage, are generally "incident specific," and are usually considered the responsibility of the public sector. Longer-term recovery plans, on the other hand, focus on business resumption and stability, are industry or company specific, and are usually considered the responsibility of each individual company in the private sector. Collectively, however, this suggests that there is little awareness or visibility of the interdependence of the public sector infrastructure and the private sector business community. This is most evident in the general lack of defined plans and priorities for allocation and use of limited public sector transportation resources post-incident by private sector entities through recovery.

The lack of this will ultimately hamper state and regional economic recovery. In addition to the absence of recovery plans, there is a lack of any substantial planning for addressing disruptions in freight (rather than passenger) movement. The net result is a high risk situation that will likely result in high cost and consequences in the aftermath of predictable disruptions to freight movement systems that could otherwise be mitigated or possibly avoided with prior planning and public-private sector coordination.

This report presents the key insights and findings from a research project conducted with the Washington State Department of Transportation on the development of a statewide Freight System Resiliency (FSR) Plan.

Disasters, both natural and man-made, wreak havoc on all aspects of human endeavors and are the source of most disruptions. The immediate damage and loss of life that massive storms, earthquakes, and hurricanes cause are usually well documented and communicated to the public. However, much of the true cost of the damage to a town, state, or region from a disruption is hidden from these initial assessments and reports. The longer-term or delayed impact of storms can actually be larger than the direct immediate impact. For example, on December 14 and 15, 2006, Washington State was pummeled by rainfall and gale force winds in what came to be called the Hanukkah Eve Wind Storm of 2006. Over 1.8 million residences and businesses were left without power for up to 11 days causing 15 deaths. The National Oceanic and Atmospheric Administration noted that while four of these deaths occurred during the storm due to falling trees or drowning, most died days after the storm: eight due to carbon monoxide poisoning because of improper use of barbecue cookers and generators indoors, two electrocutions from downed power lines, and one in a house fire started by a candle used for light.

Indirect damages from disruptions may adversely affect the economy for years. There is often a large time lag between the disruption occurrence and the system returning to equilibrium. Almost 400 people were injured and one was killed in

the Nisqually earthquake in Washington State, on February 28, 2001. The larger economic impact trailed the actual event; in the 6-month period after the quake the Small Business Administration paid over $77 million in loans. Chang and Falit-Baiamonte (2002) report that 13 percent of all of the businesses in the affected area reported long-term revenue loss, and 80 percent of the businesses reported that they paid for their losses out of their own pockets (thus not reflected in the loans). From these two examples, one can see that the ability of a region to recover from a disaster can be just as important as the ability to immediately respond to a disaster.

Our research on disruptions and their effect on corporations have guided us to propose developing resilience and adopting business continuity planning (BCP) processes as critical capabilities. These allow a firm to mitigate the consequences of disruptions and in some cases actually reduce the probability of disasters through early warning systems. By adopting both resilience and BCP, companies can help make their organizations be prepared, at the same time also breeding a culture of awareness and readiness. While many companies have embraced these insights, the public sector has appeared to lag in the development of resilience and BCP. We believe this body of knowledge has fertile application in the freight transportation system and that many of the lessons can be applied to the freight system of an entire region, state, or country.

At the highest level, disruptions affect the overall economy by constraining the free and efficient flow of raw materials, work in process, and finished goods. Additionally, any telecom infrastructure breaches can have significant impact on the information and financial flows that are critical to a firm's supply chains.

It should come as no surprise that disruptions have significant impact on economic performance. Ninety-eight percent of all international cargo arrives by ship and subsequently is moved via surface freight transportation systems in the U.S. This is in addition to the freight that is produced here in the U.S. for domestic and international distribution. Therefore, disruptions ultimately affect

infrastructure, freight transportation systems ultimately constrain freight movements, and without freight movements the economy will similarly stop.

Disruptions that affect infrastructure have made headlines lately. In addition to several big failures that have had some large affect on freight movements and local economies—such as Hurricane Katrina's devastation of New Orleans' transportation and port infrastructure—some recent failures have exposed the vulnerable condition of the freight transportation infrastructure itself. These include the Bridge 9340 that carried I-35 over the Mississippi in Minneapolis collapsing (despite annual inspections since 1993 and being constructed as recently 1967) and the April 2007 tanker truck accident just outside San Francisco (that knocked out the elevated roadway connecting eastbound traffic from the Bay Bridge onto Interstates 580 and 980 and state Highway 24).

But the disruptions to the freight transportation system are not new—the Midwest Floods in 1993 disrupted freight movements on three rives in the Midwest, constraining barge, rail, and truck operations for months. The estimated economic damage was over $12 billion, see Feder (1993). With an ever tighter and leaner supply chain 15 years later in 2007, there is a greater likelihood that the impact of such a loss today would be significantly higher. These examples suggest that we need to expand the scope of resilience planning from within a company to include the supporting public and private transportation infrastructure. One could argue that the U.S. transportation infrastructure is under funded and insufficient for current operations—not even considering any disruptions or disasters.

There has been some work conducted to quantify the long-term economic impact of disruptions. One study on the financial impact of seaport closures found that the potential duration of the closure has a larger impact than the probability of a closure occurring. This means that the length of the disruption can cause more harm to a firm's operations than the occurrence of an event itself. Increasing the expected port closure from two to 20 days, for example, resulted in a 10 percent

decrease in a firm's operating margin, see Lewis, Erera, and White (2006). This makes sense if one considers that safety stock levels are set by most companies to cover short periods of time without resupply. An analysis of the 1994 Northridge earthquake—that destroyed portions of the I-5, I-10, and other highways near Los Angeles—found that road closures caused approximately 4,400 truck hours of delay each workday during reconstruction. The overall impact on the economy in terms of job loss and business closure was not calculated, but it's estimated that the average shipping costs increased by eight percent as a result of the road closures, see Wesemann et. al. (1996). Other studies have analyzed the financial impact of disruptions on other segments of a transportation network to include light rail (Silkunas, 2006), highway corridors (Wirtz, Schofer, and Schulz, 2005), and ports (Congressional Budget Office Report, 2006).

The 2004 National Response Plan (NRP) calls for each state to have a full complement of plans for response to domestic incidents that encompasses all disciplines and all hazards. As stated in the plan, "It provides the structure and mechanisms for the coordination of Federal support to State, local, and tribal incident managers" and "assists in … reducing the vulnerability to all natural and manmade hazards; and minimizing the damage and assisting in the recovery from any type of incident that occurs." The NRP is comprehensive in outlining many of the requirements of a response plan, but it does not actually constitute an actionable plan for each state. Specific to transportation, it defines Emergency Support Functions (ESF) and presents two that are relevant to freight movement and economic recovery—ESF #1 – Transportation, and ESF #14 – Long-Term Community Recovery and Mitigation. Despite the existence of the ESFs in the NRP, they only provide a general framework for response. It is incumbent upon the state to define the detailed response plans for their respective transportation systems and recovery.

Interestingly, while the NRP calls for ESFs focused on transportation and long-term community recovery, it does not call for plans to address freight movements or their impact on economic recovery. Therefore, the absence of such a plan for

freight system resilience (FSR) represents both a shortcoming of the current systems as well as an opportunity to improve the current system.

This shortcoming calls for each state to develop a state-specific FSR Plan that addresses the recovery of freight systems in order to preserve the economic viability of the state and region. A standard FSR would not be adequate because each state has different freight movements that have different impacts on their economy. Additionally and perhaps more importantly, each state has a different risk profile where the leading disaster might range from earthquake, to hurricane, to mudslide, to forest fire. But, as Sheffi and Rice (2005) point out, the specific cause of the disaster is less important than the effect it has on the state's transportation infrastructure network. Viewed from a "consequences" rather than a "causal" perspective then, the multitudes of potential disasters can be classified based on their impacts on the network and therefore more easily addressed and prioritized.

While the specifics of each state's plan will differ according to the state's freight network, risk profile, and other factors, the process by which the state develops the plan is standard. A detailed process for general planning is outlined in the NRP, and specific processes, roles, and responsibilities are defined in detail in the 2004 National Incident Management System (NIMS), commonly adopted as the standard for incident response planning. Any FSR Plan should be prepared in the context of and be consistent with the NIMS recommendations and processes. For example, NIMS Chapter IV—Resource Management—outlines the recommendations and processes for allocating and managing scarce resources, which is directly applicable to post-incident freight system resource allocation. Once the FSR Plan is developed and in place, it should be reviewed and updated at least annually or whenever a significant change in the underlying network or region occurs. An increasingly common and popular approach in industry entails creating a plan, such as an FSR Plan, and updating it after each relevant learning opportunity. This would then be described as the "Current Best Approach." In

the context of transportation systems, the FSR Plan should be updated after each incident, incorporating insights and learnings from an after-action-report (AAR).

Based on these and other examples of significant disruptions to the state's freight systems, coupled with the lack of actionable federal guidance, the Washington State Department of Transportation (WSDOT) decided to undertake an analysis of how they could improve their ability to economically recover from disasters by creating a Freight System Resiliency (FSR) Plan. Washington State already has a well developed capability to respond to all types of disasters. The FSR Plan is designed to complement the existing emergency response plans by anticipating and planning how WSDOT should monitor, manage, and control its transportation network assets and work with private sector partners to improve the resiliency of the entire network. Resiliency for this project is focused on the restoration or recovery of the state's economy as it is affected, enabled, or disabled by the performance of the freight system.

Resilience, for any system, is the measurement of how quickly and efficiently it can recover from a disruption. There are two primary methods to improve system resilience—increase robustness or improve flexibility. Robustness is the capability that the system is able to sustain an impact or force and still continue to function. For supply chains, this could mean having higher inventory levels that allow them to rely on safety stock for a sufficient period of time. For transportation infrastructure systems, an example of robustness is having alternate routes around a city or excess highway capacity. Flexibility, on the other hand, captures the ability for the system to adapt itself in order to recover rapidly. For supply chains, this could be having multiple suppliers that enable switching to an alternate if the original vendor fails. For transportation systems, an example of flexibility is the use of multi-directional High Occupancy Vehicle (HOV) lanes.

Working with the Massachusetts Institute of Technology's (MIT) Center for Transportation and Logistics (CTL), the team conducted a review of all existing state plans for disaster response and recovery. In parallel to the national review,

WSDOT and MIT conducted several dozen interviews with representatives from the public and private sectors in the state of Washington. The MIT team incorporated lessons learned from the development of Resiliency Planning for large corporations in the plan. The end result is a process by which any state (or other governing agency) can create a FSR Plan.

The remainder of this report is organized as follows. Section 2 outlines the shell of the process by which a Freight System Resiliency (FSR) Plan can be developed. Each step is discussed and examples from the WSDOT research are provided. Section 3 identifies common elements of freight resilience systems and plans and describes how they can be implemented. Following this, Section 4 highlights the key lessons learned from this project that are likely applicable to all organizations developing a FSR Plan. Finally, in Section 5 we discuss next steps and areas for future research. For this report we will use WSDOT when we are referring specifically to the Washington State Department of Transportation. When we are referring to any state's DOT that is happens to be creating a Freight System Resiliency plan, we will use "state DOT."

2. The FSR Planning Process

There are numerous ways that the steps required to create a resiliency plan can be categorized or grouped. For our purposes, we have grouped them into three general phases: identification, assessment, and implementation. Each phase consists of one or more specific tasks that may differ from state to state. The overall process, however, should be similar for all FSR Plans. This section will describe each of the three phases in turn.

2.1. Identification Phase

The objective of this first phase is to identify the economic objectives and key usage patterns that will inform the development of a state-specific FSR Plan. The users or customers of the transportation network are different from the stakeholders. The customers can be represented as distinct categories of 'consumers' of the state transportation assets (public and private). The stakeholders are those individuals and organizations that influence and are influenced by the decisions made concerning the transportation network and the FSR Plan. The results of this phase will set the course for the remaining planning efforts.

2.1.1. Step 1. Identify and Segment Customers of the Transportation System.

The transportation infrastructure within the region should be analyzed in the context of how it is used by different shippers. This can be accomplished through a comprehensive market and flow analysis of the existing transportation system. This stage should consider different uses for the network in terms of origins, destinations, direction, and flow of goods. The two to four major types or categories of users should be identified and characterized. These could be arch-

types similar to how retail stores will segment and characterize their different customers.

WSDOT has already completed this analysis and has categorized its freight users into three groups:

- **Global Gateways**: channeling international flow (containers, bulk goods, automobiles, grains, and crude oil) through the ports and across the state to national destinations.

- **Made in Washington**: receiving components and shipping goods made by the state's freight-dependent industries (manufacturing, agribusiness, construction, and timber/wood products) into the U.S. market.

- **Delivering Goods to You**: supporting retail distribution of goods (food, fuel and parcel deliveries, as well as garbage pick up) to consumers within the state.

This identification of major system users is similar to the concept of customer segmentation in the private sector. A firm identifies the critical sets or clusters of customers that can be served by similar practices in order to simplify operations and better allocate scarce resources. It helps the firm to determine how to best serve the different types of end users and to customize different offerings suited to serve distinct customer needs and interests.

In the same fashion, if a state examines how their infrastructure is used by various business sectors, different categories of users can be identified. In the case of Washington, the three user groups represent the three major types of flows through a network: flow-through traffic (which originates and destines in locations outside the network, but travels within the network), outflow traffic (that originates within the state's network but is destined for outside the network), and inflow traffic (that originates elsewhere but ends up within the network). A notable exception for this segmentation is the intra-flow traffic which would start

and end within the network. Larger states, such as California or Texas, might find such a classification helpful.

2.1.2. Step 2. Identify and quantify the objective of an FSR Plan for this region.

Once the key customer segments are identified, the next step is to understand the key objectives and requirements for each of the segments. Because the overall objective of an FSR Plan is to restore economic output, we need to understand specifically what this means for the different user groups.

The FSR Plan covers the time after the first responders have completed their triage until economic output has been restored. In some cases, there may be some overlap as there may be response operations ongoing at the same time that recovery activities may be starting or are in process. In part this relates to the lack of a distinct definition and meaning of 'restore economic output' and therefore this needs to be more clearly defined. Furthermore, key stakeholders and decision-makers at the state level should concur and subsequently incorporate this into the vast array of response plans and parties involved in the process.

The usage patterns identified in step one should be used within the definition suggested above. There are many potential ways that this objective can be measured and desired outcomes will differ by usage pattern. The different user groups will most likely have different metrics and objectives. The process to develop the goal will be the same, however, in that the system should be able to deliver some percentage of the prior level of service within a certain amount of time. The economic cost of any disruption should be conceptually measured as the time that the level of service is below the established benchmark.

Some potential metrics or goals include:

- Return total container flow through the key ports to 80% percent of the previous level within 3 days of the event – where the specific numbers would be established.

- Ensure key trucking corridor flows outbound from state to U.S. market are kept open to at least one lane of traffic at all times.

- Identify detours that are available that will not exceed out of route miles or time by more than 25 percent.

How these objectives are defined helps set the priorities for the state. For example, if truck access is considered critical, two metrics could be used:

1. Restore truck access across the entire state to X percent of the previous level within Y days.

2. Restore truck access within each region of the state to X percent of the previous level within Y days.

Metric 1 would focus efforts on those counties or regions which have the largest freight operations while metric 2 would spread this effort around to all of the counties. The net effect would most likely be that under metric 1 a higher percentage of the total users would be restored, but the time until the smaller regions were restored would be quite long. Under metric 2, all of the regions would advance at (roughly) the same pace, so the total amount of network restored within a certain time frame would be less than for metric 1, but the gap between small and large regions would be much smaller. The difference between the two metrics is a decision whether to focus on the state as a single entity (which would concentrate efforts at high impact junctures for maximum improvement) or apply efforts evenly across all of the regions. The challenge here is that this is a political discussion.

This is an “effectiveness versus fairness” argument that is best handled by the elected officials. Each state DOT, however, should assist in framing and guiding the debate.

Additionally, the priorities between the different segments should be clearly established. The state’s policy makers need to agree upon the priority of the

different usage patterns before significant disruptions. For example, should the initial efforts be to restore the flow-through traffic network or the inflow network? Should we provide similar efforts across the regions, or do we initially focus on high-economic impact regions?

The metrics should be focused on the transportation network capabilities—not directly on the economic output that is out of the state DOTs' control. The transportation network should not be the bottleneck that is preventing economic recovery. So, the metrics should fall into categories that the state DOT can actually affect: transportation infrastructure, operating controls of the systems, etc.

2.2. Assessment Phase

The Assessment Phase takes the customer segmentation and the overall objectives of the FSR and determines the current state of the network.

2.2.1. Step 3. Conduct a vulnerability assessment of the region's transportation network.

The team needs to identify those points in the transportation network that are the most vulnerable to disruption. The analysis should include an assignment of magnitude and probability of failure of each of these critical junctures. The focus is on the consequences of failure of the specific transportation component—not the cause of the disruption.

Essentially, any transportation network failure is simply the inability of the system to process the required flow. This can happen in two general ways: supply side or demand side. In supply side failure, key components are constricted or totally fail in one portion of the network, thus forcing traffic to be redirected to another segment that is not prepared for that volume level. Demand side failure occurs when the total flow for the system greatly exceeds the planned levels and the entire system is saturated. This is usually caused by external disruptions, such

as other West Coast ports being shut down, so that more container traffic is funneled through the Ports of Seattle and Tacoma.

In either case, a bottleneck will result at some point in the transportation system. Step 3 identifies which segment (public and private) is most vulnerable for becoming a bottleneck in the case of any disruption. This allows for a prioritization of the different segments. The network should also be classified according to the customer segmentation identified in Step 1. A network segment that is critical across all usage patterns should be clearly identified and granted a higher assessment level. The consequences of failure in these different segments should be characterized as well.

This assessment can be achieved through market research, the use of both public/private forums, and an analysis of the transportation network. Analysis of this type differs from traditional traffic flow modeling in that it needs to consider multiple modes, involves private sector firms that act independently, includes a wide variety of products with differing value profiles, and takes into account infrastructure dependencies and interdependencies.

In addition to determining the vulnerability of the infrastructure, the analysis should consider the vulnerability of the various customer segments. Chang and Falit-Baiamonte (2002) analyzed the business vulnerability to and impact from the 2001 Nisqually earthquake. They found that the "hidden" economic costs of disasters for businesses exceeded the published direct damage costs. The study also found that businesses were impacted differently with the key causal factors being speed of re-opening, survival of the market it served, and the change in the competitiveness of the market during the recovery from the disruption.

The assessment should identify and consider a broad variety of state-specific vulnerabilities including those noted below. In order to be complete, the team assigned with conducting the assessment should consider the impact on the freight system for a wide variety of potential causes. These should include: radiological, hazardous materials, winter storms, tornadoes, earthquakes, floods, structural

damage to bridges over navigable water, hurricanes, plane crashes, as well as terrorism.

A relatively simple way to conduct this analysis is through the standard Failure Mode and Effect Analysis (FMEA) framework. See George et al. (2005) for more details. While there are many variations, the primary FMEA methodology is as follows:

1. Brainstorm a list of potential ways that the freight system can fail. These are called *failure modes*. This should focus on specific infrastructure failures, not root causes. An example of a failure mode could be if the SR 520 floating bridge (the Evergreen Point Bridge) was out of commission for 3 months. The cause of the failure (wind damage, construction, etc.) is less important than the failure itself and the expected duration.

2. For each failure mode, identify the potential *failure effects*. Failure effects are simply the consequences of a specific failure. For the SR 520 bridge example, these could be the shifting of the 150,000+ daily crossings to the I-90 Lake Washington Bridge, diversion of port traffic south, increased traffic time for city commuters, etc.

3. For each failure mode assign three rankings:

    - Severity of Failure – from 1 to 10 where 10 is the most severe.
    - Likeliness of Failure – from 1 to 10 where 10 is the most likely.
    - Detectability of Failure – from 1 to 10 where 10 is least likely to detect with current monitoring systems in place.

4. Calculate a risk priority number (RPN) for each failure mode by multiplying the three rankings together. The failure modes will then range from 1,000 to 1—but the absolute numbers do not really matter.

5. Prioritize the failure modes by ranking them from highest to lowest RPN. The only exception is any failure mode that has a severity ranking of 10 should be addressed initially as well. Specific actions should be considered to lower each of the failure mode's RPN—this can include decreasing the likelihood of failure, improving the monitoring capability, adding redundancy, etc.

The way in which these rankings are collected can vary by state. It would be a valuable exercise to have these brainstorming sessions held with a variety of stakeholders and customers. The use of Delphi techniques (a multiple round consensus technique where the rankings are collected anonymously and the aggregated results are widely shared before collecting a new set of rankings) can help draw out less vocal constituents. The resulting RPN rankings can be compared for the different user groups to identify those infrastructure components that are critical to all segments.

The output from this step is a rough ranking of the key infrastructure sites that the state DOT should focus their immediate attention on. More detailed methods for conducting a FMEA are discussed in Section 3.

2.2.2. Step 4. Create public/private collaboration mechanisms.

This step involves understanding how the state DOT can best provide service to, obtain support from, and work with the private sector companies operating within the state for recovery from disasters. It is important that the state considers this a two-way relationship in that while companies will need support during a disaster, they can also provide support and guidance. As has been noted in several after action reports of the 2005 Hurricanes Rita and Katrina, the private sector has tremendous expertise in handling disasters that the public sector may learn from and tap into, see for example Business Executives for National Security (2007). As an initial step, the state DOT should review the business continuity plans of a handful of the larger firms operating in the state. This should include firms with

their own transportation infrastructure (railroads and pipelines), transportation power units (shippers, for-hire trucking firms), or other valuable assets.

The next part of this step is to determine how the state DOT should work with the thousands of companies that comprise the private sector. The most important element is a communication plan that is in place and operational well in advance of any disaster. A common statement heard in interviews with both public and private sector professionals is that the actions and relationships that are formed and used during disruptions will mirror the form of the relationship during daily practice. In other words, the worst time to meet the fire chief is during a fire.

At the heart of the communication plan is the notification process. Firms can be informed actively (where information is pushed to them) or passively (where information is made available for them to access on their own). Both are useful. As a general rule, routine information, such as scheduled maintenance of infrastructure or contact information, should be handled passively so that interested shippers can access this information when they need to without the need for the state DOT to use limited staff resources.

Information on currently evolving situations, on the other hand, should be actively handled with timely data pushed to the relevant users in multiple channels. The state DOT should consider building robust channels, such as radio and/or satellite, that will function during and post-disruption.

During the interviews, private sector companies provided some potential alert messages that they would find useful. For example, one vice president of transportation asked if the WSDOT could notify her for disruptions in the following different ways, depending on the situation:

- If capacity on I-5 is reduced by 25 percent for five or more hours then notify via voicemail.
- If capacity on I-5 is reduced by 50 percent for three or more hours, notify by voicemail.

- Any delay of 24 hours or more on any highway, notify by email.

This is similar to event management systems used by shippers for managing the movement of their raw materials, work in process, and finished goods across their supply chain. The format of these messages is standard and need to specify WHEN to notify WHO about WHAT and HOW. This structured flexibility simplifies how the state DOT delivers the information while allowing the user to customize how they receive it.

The use of a menu of items can help streamline the complexity of the system and still provide tiered notification based on severity and location. For example, options for notification method (the HOW) could include email, text, or voicemail. The recipient (the WHO) can be any number of different people within a company, ranging from local transportation managers to the Chief Operations Officer (COO) of a firm, depending on the severity. The selection of the segments in the infrastructure network to monitor (the WHAT) should come from the vulnerability assessment in Step 3. The threshold level (the WHEN) can be limited to a few obvious choices while the WHO can be self-updated in the form of a contact database.

Another insight gathered during interviews with companies is that information flow is critical even if the state DOT does not have full information. Letting companies know the minimum impact as well as when they can expect to be updated lets them start planning for contingencies. For example, rather than wait several hours for complete information, most firms would rather receive a message such as:

- There will be a minimum of 12 hours of closure on Highway I-5 Entrance Ramp 32. Next update will occur at 15:00.

By making the state DOT communication platform more proactive and customizable, it increases the level of acceptance by the private sector and it could reduce the demand on its standard Web site.

The private sector is generally very adept at adapting to changes in the environment. If a road is closed, they will look at their options, which might range from re-routing vehicles, sourcing from alternative suppliers or locations, shifting deliveries to off-hours, dipping into safety stock, substituting product, etc. The critical element that the private sector needs is information on the freight transportation network. As one Coast Guard official noted, "the private sector will always find a new port" if their primary is closed.

2.2.3. Step 5. Determine what regulatory and policy procedures need to be put into place.

Transportation networks are complex systems that cross multiple authorities. A commonly traveled route might have segments of roadway that are monitored, managed, and controlled by city, region, state, and federal agencies. In some cases, different radio frequencies and protocols are used. It is critical that in times of emergency, and during the recovery afterwards, that the authority to manage and control identified critical segments of the transportation network be coordinated, if not completely centralized. The U.S. Department of Transportation's Integrated Corridor Management (ICM) pioneer program is being developed to reduce these overlapping authority issues in both normal operations as well as in emergencies. See http://www.its.dot.gov/icms/ for more details and updates on this program.

An additional capability that a state DOT should possess in order to be resilient is the ability to over-ride or modify selected standard regulations during a time of crisis. These can be done to increase efficiency, extend the use of existing assets, or speed up reconstruction time. In the 1994 Northridge earthquake, for example, Caltrans bypassed traditional contracting procedures by fast-tracking design and re-construction contracts as well as including significant bonuses for early completion. The net result was that reconstruction of the affected highway segments began just 12 days after the earthquake and was completed, in many cases, months ahead of schedule, Wesemann et al. (1996).

Some potential areas for pre-arranging the ability to relax regulations that were mentioned during our interviews include the ability to:

- Change HOV lanes to be freight-only lanes for a period of time.
- Extend the hours of service for truck operations.
- Relax weight restrictions for selected vehicles for selected routes.

Having these options already thought out and read to execute prior to any disruption will speed up the recovery process.

2.2.4. Step 6. Agree on priority and trigger setting processes.

This step helps determine how and when the different plans and policies developed in the previous steps will be enacted. Priority generally refers to determining which users are granted access to the scarce capacity while the trigger setting refers to understanding what has to happen in order for a set of decisions to be enacted. Discussions for this step include determining the following:

- How will the state make priority decisions for use of infrastructure during the recovery period? For example, it might become necessary to dedicate certain highways for set times of the day to being freight only in order to ensure that gas stations are replenished and businesses can continue to operate. The state DOT needs to understand how (and even if) they can make this decision when capacity is scarce.
- When will the state DOT actually take over from the first responders to control critical infrastructure? This is non-trivial in that the boundary between emergency response and long-term recovery is neither clear nor consistent across a distressed region. Having a process established ahead of time to determine when control shifts from the EOC to a different entity will reduce friction during the actual event. It might make sense to stagger

this hand-off for specific segments of the transportation network as they become stable.

- Do incident commanders have the right information to be able to prioritize freight restoration efforts by their impact on the entire system and the state's economy?

- At what point can the state direct private trucking firms or railroads to start hauling certain freight? When can the state start offering incentives? Who will make these decisions and what are the legal ramifications?

- When can the state direct which ships get unloaded? While the Maritime Transportation Security Act (MTSA) of 2002, Part 104 specifies that the Coast Guard Captain of the Port should set the priorities for unloading at ports based on security risks, the prioritization of one type of freight over another is not specified.

Again, like the objective setting in step 2, this can be a charged political decision. However, if priorities and protocols are not established and recognized by all parties ahead of time, then these decisions will be made during a crisis with very limited local information.

2.3. Implementation Phase

The final phase takes the deliverables from the first six steps and tests whether the plan can be implemented. The idea is to first test this internally in a controlled setting to work out inconsistencies and procedures. Once comfortable with the overall plan, various scenarios can be tested in more detail with larger involvement from other players and stakeholders.

2.3.1. Step 7. Conduct a small-scale in-house simulation.

Using the prioritized list of network components from the failure mode and effect analysis in Step 3, the state DOT should conduct simulations on the most critical

failure modes. These simulations should try to analyze how the system can mitigate, recover from, and restore to the established metrics for each of these failures. The objective is to flesh out the impacts of each of these failures in isolation to understand the full impact. The simulation techniques and methods might differ from each failure. For example, simulating the SR 520 bridge failure would probably involve a traffic flow analysis that would estimate the added travel time for traffic entering and exiting the area.

The simulation should be run internally within the state DOT with the explicit objective being to identify gaps in the plan. This is essentially a dry run or pre-test of the plan before conducting a larger scale "acceptance" test with a wider audience.

2.3.2. Step 8. Test the plan with a large scale simulation.

The plan, once developed and pre-tested, should be run through a table top simulation with all of the stakeholders represented. This involves the decision makers responding to a disruption—not just a mathematical simulation. The ideal time to run an "economic recovery" simulation would be directly after an emergency response simulation.

For example, since 2004 Washington State has run a number of Regional Response simulations with the Center for Asymmetric Warfare where a terrorist event cripples or disables a critical component of the state's infrastructure, see Cook and Alexander (2004) for more details. Exercise participants in the past have included elements of the Washington Army and Air National Guard, United States Coast Guard, Fort Lewis, the Washington State Department of Transportation, the Washington State Emergency Management Operations Center, Tacoma Police Department, and the Port of Tacoma. While the focus of these simulation exercises are on the emergency response actions, it would be a logical next step to start having the longer term economic recovery issues at least being addressed at the same time.

2.4. Closure

The three phased approach described in this section can be adopted and customized for use by any state transportation department. While the three phases (identification, assessment, and implementation) should be used for the development of any Freight System Resiliency (FSR) Plan, the specific tasks within each phase may differ.

In a larger sense, the development of an FSR Plan should fit into a larger context concerning the creation and on-going management of the plan. For example, a common Six Sigma methodology used in corporations is DMAIC, which is an acronym for a 5-stage process: Define, Measure, Analyze, Improve, and Control. More detailed descriptions of this larger methodology can be found in George et al. (2005) or in several on-line sites such as http://www.isixsigma.com/dictionary/DMAIC-57.htm.

The next chapter goes into more detail into each of the three phases introduced in Section 2.

3. Application and Examples of FSR Plans

Whereas Section 2 introduces the Freight System Resilience Plan (FSR Plan) and explains what it is, this section offers some insight and examples to help and explain HOW to create the FSR Plan.

3.1. Identification Phase

3.1.1. HOW: Identify and Segment Customers of the Region's Transportation System.

There are a number of steps required in identifying and segmenting the customers. A first step is identifying the freight flows for the region.

The FHWA has profiles completed for each state which represent a starting point for understanding the freight movements. The profiles show freight movements to, from, and within the state. These are broken out for different time points in the past along with a forecast for several points in the future. Additionally the freight shipments are segmented by mode and a written description of the various materials and/or commodities shipped is included. This information is provided in text and in graphic fashion, in the form of freight flow maps. Altogether, this provides a useful data source that establishes a data-based quantification of the freight flows which will come as no surprise to state DOTs.

The segmentation should go beyond this foundation, to the extent of identifying the specific industries and leading shippers. It is important to not only quantify the freight flows and know the shippers, it will be important to establish a relationship with the shipping community and shippers in specific. Central players in the freight shipping community include the carriers, freight forwarders, and other agents that facilitate the movement of freight and use of the freight transportation system.

While the data collection did not entail deep interviews with shippers from all 50 states, the interviews conducted suggest that there is a strong need for a structured and meaningful understanding and characterization of the various segments of the freight shipping community using the respective freight transportation system. In its simplest form, this would entail a spreadsheet with a listing of each shipper, freight movement characteristics (products moved, frequency, volume, lanes traveled, equipment utilized, shipment size, etc.), listing of day-to-day operational contacts and their contact information, listing of emergency contacts and emergency contact information, senior executive name, and contact information. See Figure 1 below for one example.

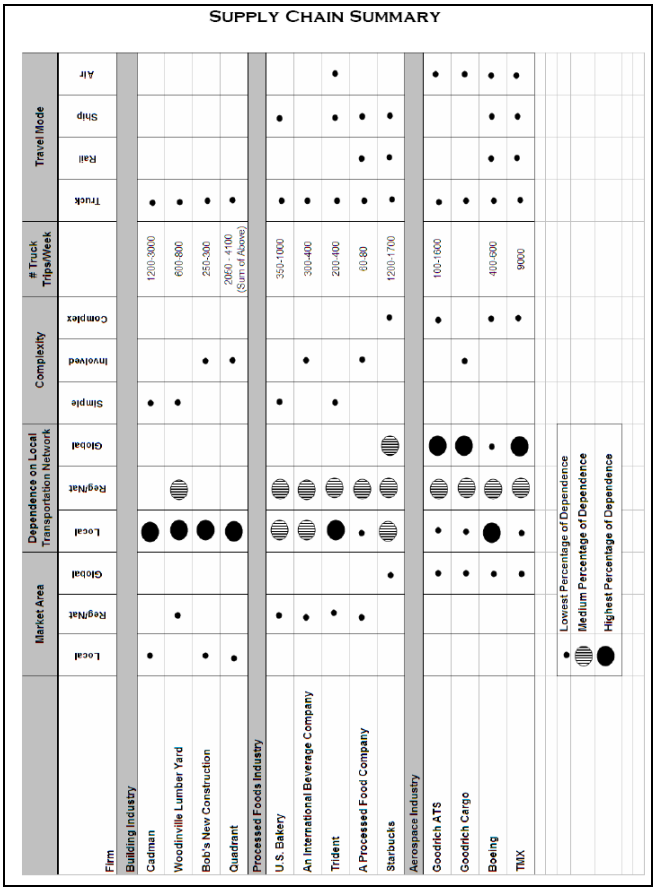


Figure 1 Supply chain summary. Source: Wilbur Smith Associates, et al 2006.

Ideally, the segmentation would also capture additional qualitative information, such as freight sensitivity to disruptions (e.g., is there a critical time element to

the shipment, such as exists for perishable foods? Is the material required for basic sustenance (such as foodstuffs, medical supplies), or does the material enable critical basic services (such as fuel supply)? Additional quantitative information would also be useful, such as data on available equipment, warehouse space (type, volume, location, constraints), key freight suppliers (and their contact information) and sensitivity to disruption. An example of a proxy of the latter can be observed in Figure 2 below.

Product Category	Point(s) of Origin	Mode	Target Inventory On-Hand
Empty Cans/Bottles	Kent, Olympia	Truck	2 Hours
Liquid Sweetener & Liquefied Gasses	Fife	Tanker Truck	24 Hours
Concentrates	Texas	Truck	3 days
Packaging Materials	California	Truck	7 Days

Figure 2 - Inbound Product Categories (sorted by volume).
Source: Wilbur Smith Associates, et al 2006

The same report provides industry-specific profiles that provide both qualitative and quantitative assessments of the freight system and the users of the system (including Building Industry, Processed Foods Industry, and the Aerospace Industry).

Some examples of deeper analysis to understand the intricacies of the freight in the specific environment can be found in the WSDOT Freight Efficiency & Competitiveness Phase I Final Report, June 2006. Figure 3 shows a qualitative analysis of the dependence of specific shipments on local transportation.

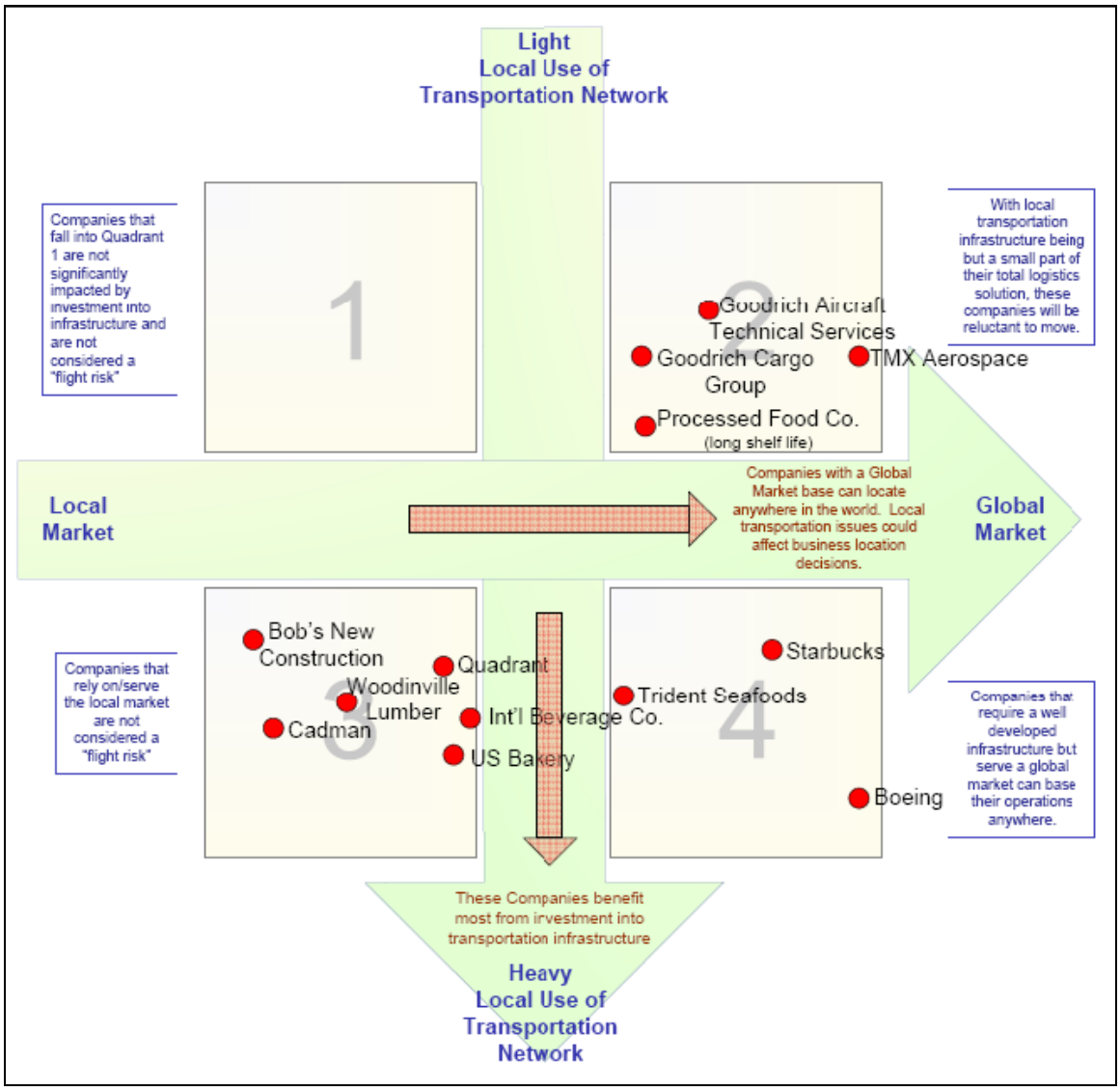


Figure 3 - Business Classification: Market Area vs. Dependence on Local Transportation System. Source: Wilbur Smith Associates, et al 2006, page 32, Exhibit 14.

Figure 4 from the same report shows the potential reduction in supply chain reliability by mode. These kinds of analyses begin to illustrate the nature of the relationship between the shippers and the transportation system.

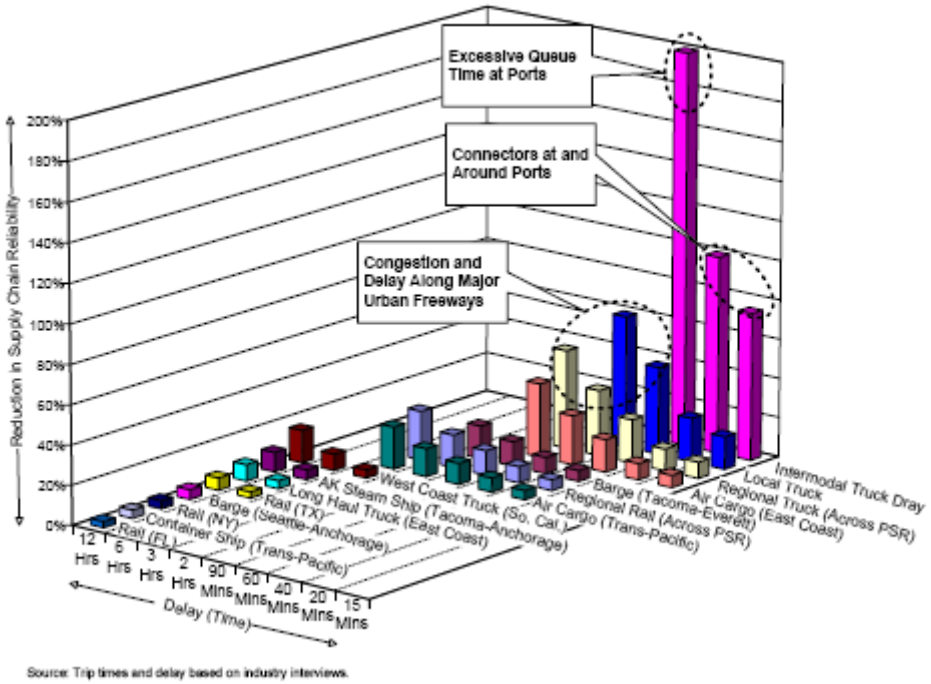


Figure 4 - Impact of Delay on Supply Chain Reliability (By Mode).
Source: Wilbur Smith Associates, et al 2006, page 4-5.

One interesting approach to understanding freight movements in a state was developed by the state of California. Figure 5 depicts the ultimate destination for freight flows into and through California.

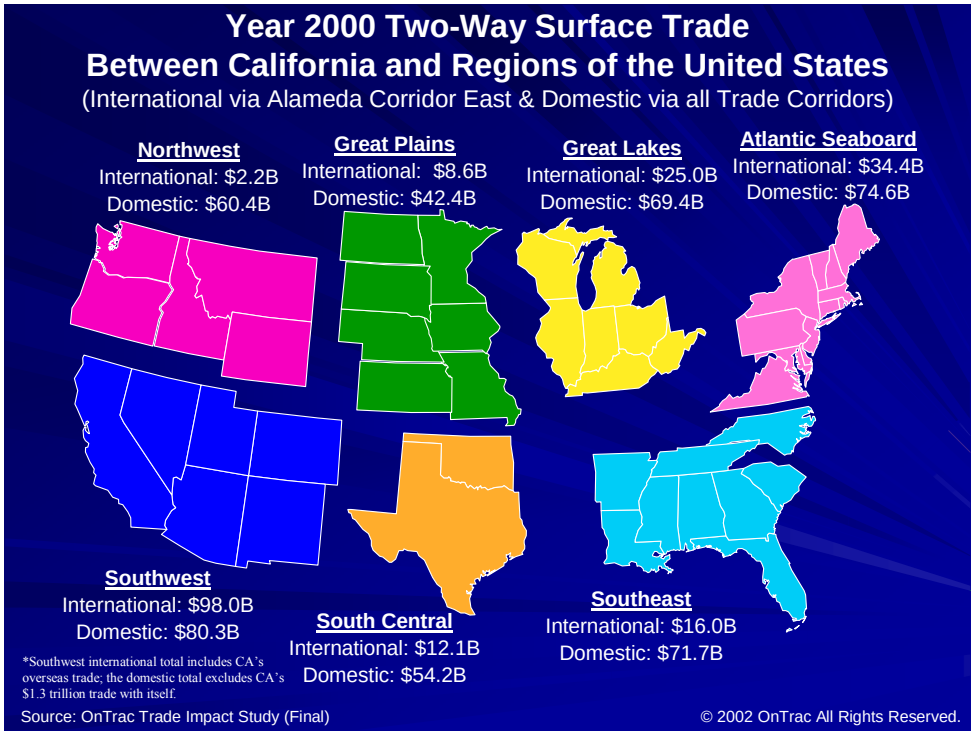


Figure 5 - Two-Way Surface Trade Flows between California and Regions of the U.S. Source: Hicks (2002).

On the surface, this merely shows general flows, but one can also consider this a representation of seven critical customer segments for the state of California. Inbounds destined for these different regions may have distinct characteristics and challenges that warrant consideration and treatment as a distinct segment.

Interestingly, the state of Florida includes a report on customer satisfaction in their Short Range Planning Report—sadly, their interpretation of 'customer' is limited to individual public transportation system users rather than freight users.

Perhaps the most specific characterization of the freight customer segments comes from the state of Washington. WSDOT has categorized its freight users into three groups:

- Global Gateways: channeling international flow (containers, bulk goods, automobiles, grains, and crude oil) through the ports and across the state to national destinations.

- Made in Washington: receiving components and shipping goods made by the state's freight-dependent industries (manufacturing, agribusiness, construction, and timber/wood products) into the U.S. market

- Delivering Goods to You: supporting retail distribution of goods (food, fuel, and parcel deliveries, as well as garbage pick up) to consumers within the state.

The state of California similarly considers "Global Gateways' as an important freight flow for the state, but there is no distinct grouping the way that the state of Washington has done it.

WSDOT went the necessary step further to extended the analysis to identify the specific industries associated with the various freight flows.

3.1.2. HOW: Identify and Quantify the Objective of the FSR Plan for the Region.

The objective of the FSR Plan will vary depending on several factors in the state. Some will be the state's dependence on certain freight movements to maintain basic sustenance—that is, the movements necessary for food, water, and shelter needs. Other factors should include the type of freight movements and their ability to sustain delay without damage to the materials and the customer's ability to continue operation without disrupting the business operations. Anecdotal evidence suggests this could be in the two to six days range, but a more detailed and scientific study is required to make such an assertion.

Also, depending on the segmentation of the customers, the state may elect to have different service levels for different customers, again depending on the importance of the freight movement. Perhaps the most important aspect of this task is holding the discussions with private industry and establishing mutual expectations for response and recovery, sharing day-to-day operations contacts as well as emergency operations contacts, sharing protocols for communications and the foundations of relationship development. While relationship development and

coordination are covered elsewhere, they are mentioned here because the customer needs should be one factor to consider when establishing the response and recovery objective.

The final selection of a single objective or set of objectives is an exceptionally politically charged question. It requires the establishment of priority to one set of users over another. While it might not be possible to achieve a firm decision ahead of time, going through the exercise with a realistic scenario can help raise awareness of what decisions will have to be made during an actual disruption.

Consider, for example, a scenario where the intersection at State Highway 99 and the Seattle Freeway is damaged so that truck traffic to the Port of Seattle was severally limited—especially for Terminals 3, 5, and 18. This also limited north-south traffic on State Highway 99, which is a major truck route for outbound manufactured goods. Your resources are such that you cannot recover the east west traffic or north south traffic lanes at the same time. Should your priorities be to bring each of them up to 50 percent before completing one or the other? Or should you concentrate all efforts on fixing the east-west port lanes to get the Global Gateway traffic flowing 100 percent first?

This scenario is simple, but it illustrates the basic trade off, do we recover "enough" across the system first before we focus on 100 percent recovery anywhere? Or do we bring selected sections up to 100 percent as soon as possible, ignoring other sections until much later. Several of these scenarios could be developed and then brainstormed through table top exercises. The idea is to identify if there are any obvious priority sections of the network that should be recovered ahead of other sections. One example of a qualitative characterization of the various priorities at the state level, California in this case, is presented in Figure 6 below.

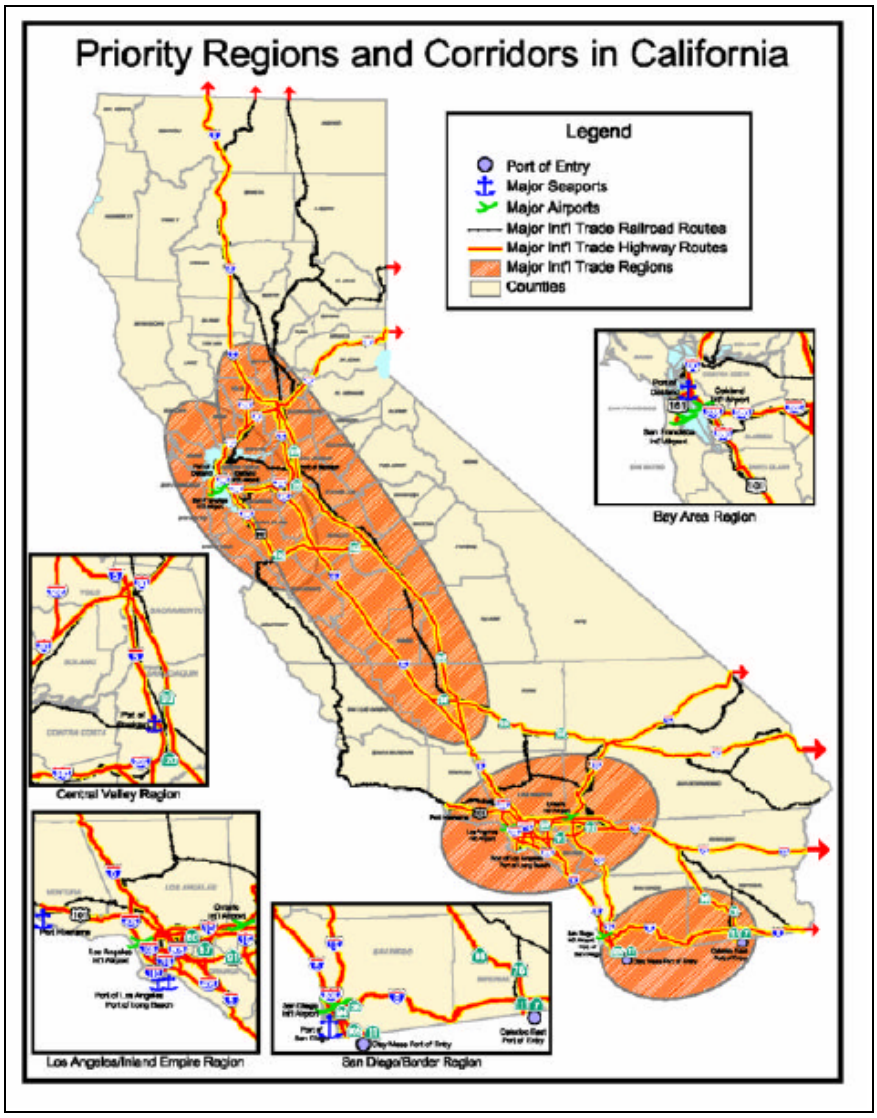


Figure 6 - Priority Regions and Corridors in California.
Source: California Business Transportation and Housing Agency (2005)

3.2. Assessment Phase

3.2.1. HOW: Conduct a Vulnerability Assessment of the Region's Transportation Network.

A number of examples of vulnerability assessment warrant mention and consideration as possible resources or templates for conducting a vulnerability assessment. These include:

A Guide to Highway Vulnerability Assessment for Critical Asset Identification and Protection, prepared by the Science Applications International Corporation (SAIC), provides one of the richest references for the planner preparing an FSR Plan. This reference was designed specifically for state DOTs to help them in their respective vulnerability assessments, identify countermeasures, and incorporate security operational planning as part of the process assessing critical assets. See Figure 7, below.

INFRASTRUCTURE	*FACILITIES*	*EQUIPMENT*	*PERSONNEL*
▪ Arterial Roads ▪ Interstate Roads ▪ Bridges ▪ Overpasses ▪ Barriers ▪ Roads Upon Dams ▪ Tunnels	▪ Chemical Storage Areas ▪ Fueling Stations ▪ Headquarters Buildings ▪ Maintenance Stations/Yards ▪ Material Testing Labs ▪ Ports of Entry ▪ District/Regional Complexes ▪ Rest Areas ▪ Storm Water Pump Stations ▪ Toll Booths ▪ Traffic Operations Centers ▪ Vehicle Inspection Stations ▪ Weigh Stations	▪ Hazardous Materials ▪ Roadway Monitoring ▪ Signal & Control Systems ▪ Variable Messaging System ▪ Vehicles ▪ Communications Systems	▪ Contractors ▪ Employees ▪ Vendors ▪ Visitors

Figure 7 - Listing of Critical Transportation Assets.
Source: Science Applications International Corporation (2002), page 11.

The reference includes a step-by-step process for conducting a vulnerability assessment, and includes various tools for scoring and assigning vulnerability factors to critical assets, and includes examples from several states (including Maryland and Utah) that the planner can use for reference.

CRITICAL ASSET FACTOR	VALUE	DESCRIPTION
Deter/Defend Factors		
A) Ability to Provide Protection	1	Does the asset lack a system of measures for protection? (i.e., Physical or response force)
B) Relative Vulnerability to Attack	2	Is the asset relatively vulnerable to an attack? (i.e., Due to location, prominence, or other factors)
Loss and Damage Consequences		
C) Casualty Risk	5	Is there a possibility of serious injury or loss of life resulting from an attack on the asset?
D) Environmental Impact	1	Will an attack on the asset have an ecological impact of altering the environment?
E) Replacement Cost	3	Will significant replacement cost (the current cost of replacing the asset with a new one of equal effectiveness) be incurred if the asset is attacked?
F) Replacement/Down Time	3	Will an attack on the asset cause significant replacement/down time?
Consequences to Public Services		
G) Emergency Response Function	5	Does the asset serve an emergency response function and will the action or activity of emergency response be affected?
H) Government Continuity	5	Is the asset necessary to maintain government continuity?
I) Military Importance	5	Is the asset important to military functions?
Consequences to the General Public		
J) Available Alternate	4	Is this the only asset that can perform its primary function? (i.e., There are no alternate facilities that will substitute adequately if this asset is damaged or destroyed)
K) Communication Dependency	1	Is communication dependent upon the asset?
L) Economic Impact	5	Will damage to the asset have an effect on the means of living, or the resources and wealth of a region or state?
M) Functional Importance	2	Is there an overall value of the asset performing or staying operational?
N) Symbolic Importance	1	Does the asset have symbolic importance?

Figure 8 - Critical Asset Factors and Values.
Source: Science Applications International Corporation (2002), page 12.

The reference also walks the planner through a 6-step process for conducting a comprehensive vulnerability assessment, Figure 9.

Figure 9 - SAIC Vulnerability Assessment Overview.
Source: Science Applications International Corporation (2002), page 5.

A qualitative framework is also provided for setting priorities for most critical assets as a function of criticality versus vulnerability (see below). As shown in Figure 10, Quadrant I is the most critical and vulnerable and therefore should be a primary focus area for countermeasures.

Figure 5 - Criticality and Vulnerability Matrix

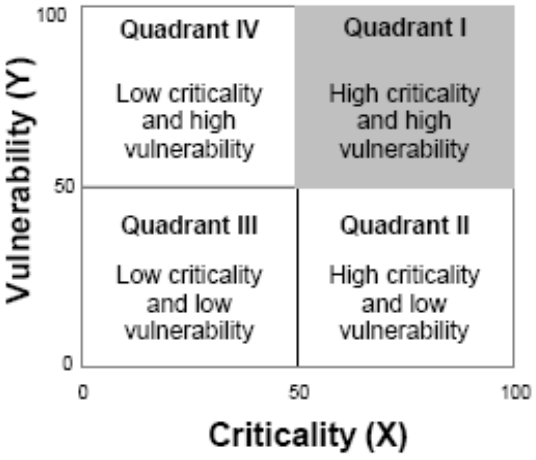


Figure 10 - Criticality and Vulnerability Matrix.
Source: Science Applications International Corporation (2002), page 22.

The Washington State 2001 Hazard Identification and Vulnerability Assessment (HIVA), prepared by the Washington State Military Department Emergency

Management Division, provides a comprehensive assessment of natural and technological hazards by specific hazard, including high-level historical data and narrative about the vulnerability. The report serves as the first step of the Washington State Integrated Emergency Management approach that emphasizes preparedness, education, contingency planning, and effective response for fast recovery. The report does not include a quantitative assessment, and the assessments would need to be refined to understand the vulnerability of the freight transportation system whereas the report addresses overall system vulnerability and is not transportation sector specific.

The King County Hazard Mitigation Plan, specifically Section 5, includes a detailed Hazard Identification and Vulnerability Assessment similar to the Washington State HIVA, but introduces an interesting qualitative framework for assessing vulnerability. It is described as follows:

> *"The first step toward a mitigation program is the identification of the hazards a community may face. Firsthand information can be obtained from interviews of businesses, local employees, first responders, and residents; or gathered from newspaper archives, FEMA documents, state and local government records, and the Internet. Largely, local hazards can be categorized as either natural or technological/manmade events. While the local climate changes rather slowly, our manmade environment can change rapidly, especially in terms of the local economic base. Some hazard events occur on an almost annual basis while others may not happen once within our lifetime. Additionally, not every hazardous event occurs with notable damage or loss of life. For this reason, hazards are assessed by comparing the experienced frequency of the event versus the potential impact that may result.*
>
> *Planning begins with events that are expected to occur often and have potentially high impacts on life and property followed by*

those with more moderate probabilities or moderate impacts. Jurisdictional strategies are dependant on the philosophy and experiences of local officials. Largely, the priorities addressed in HIVA years one through five are a reflection of this assessment and local philosophical priorities.

For the purpose of this document, the criteria for high, moderate, and low probability are: High Probability: once a year, Moderate Probability: once every two to ten years, and Low Probability: once every ten to fifty years.

Events occurring once every 50 to 1,000 years are treated as "low probability" for the purpose of this document. Criteria for evaluating impacts are somewhat more subjective. While some figures are available for dollar damages, productivity and economic losses are difficult to gauge. Injuries and fatalities are similarly difficult to assess. There is no known method for evaluating and quantifying the impacts of personal injury or loss of life, and whether the potential exists to affect one life or many. However, without establishing a value to human casualty, calculation of benefit-cost analysis for proposed mitigation projects could not be conducted.

Benefit-Cost analysis is required to prioritize mitigation projects. High ratios (benefits/costs)would receive a higher priority than lower ratios. We will use $2.3 million as the minimum benefit of one life saved by these projects. The figure was one used by some in the 9-11 World Trade Tower settlement discussions." Source: King County HIVA.

High Probability Low Impact	High Probability Moderate Impact	High Probability High Impact
Moderate Probability Low Impact	Moderate Probability Moderate Impact	Moderate Probability High Impact
Low Probability Low Impact	Low Probability Moderate Impact	Low Probability High Impact

Probability vs. Impact

Figure 11 –Probability versus impact chart. Source: King Country HIVA.

AppendixThe King County report continues with useful further explanations of their qualitative assessment process and specific assessments of the various vulnerabilities. A transportation-specific vulnerability matrix is included on pages 5-57 through 5-61. See Appendix for this excerpt.

The report, *Getting Ready: Company Primer on Preparedness and Response Planning for Terrorist and Bioterrorist Attacks*, prepared by the Business Executives for National Security (BENS) in January 2007, provides a company-focused report on preparedness for disruptions due to terrorist activities. The report overviews risks and includes a health preparedness check list from the Centers for Disease Control and Prevention (CDC), a physical security check list developed by BENS, and a list of private sector security measures associated with the Department of Homeland Security (DHS) Security Alert System.

In addition to considering these resources, one might consider conducting a "Hubs, Corridors and Connectors" analysis of transportation systems within the region. This analysis entails identifying the various elements of the transportation system and graphically noting the interconnections (or lack thereof) that can possibly identify potential vulnerabilities and illustrate the need for specific new pathways. Ultimately, this analysis can provide guidance to noting the interdependencies and needs of the transportation system. One example from the Florida State DOT is shown in Figure 12 and Figure 13 below.

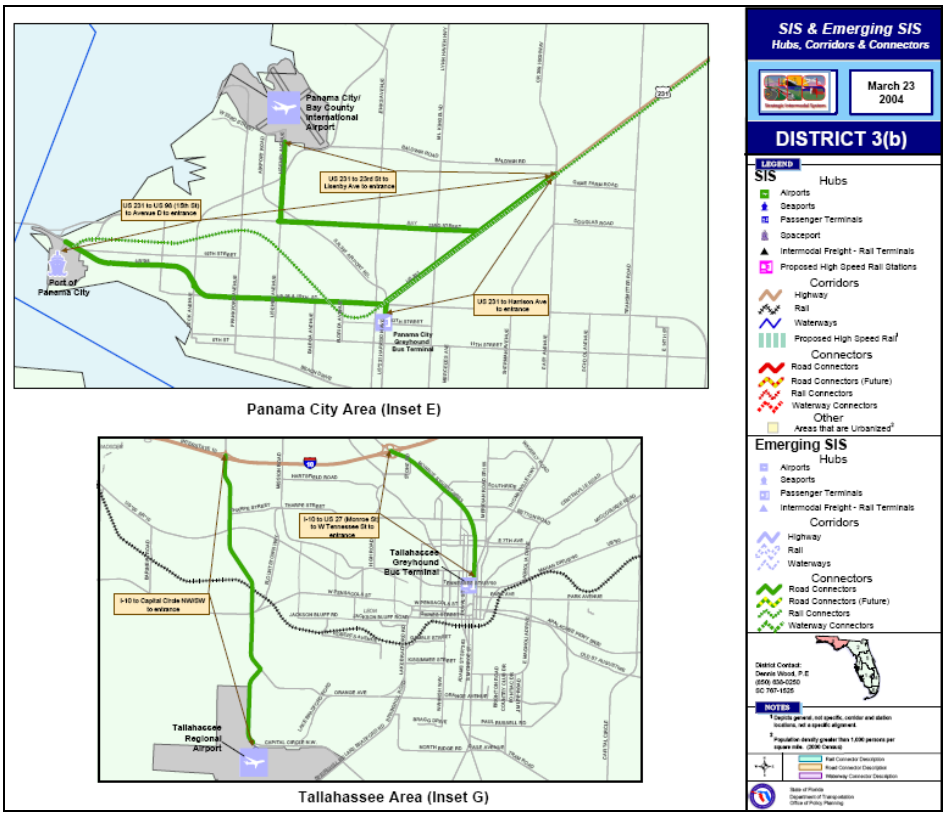


Figure 12. Example of Hubs Corridors and Connectors Graphic Analysis.
Source: Florida State DOT (2003), page 34.

District 3 SIS Hubs and Corridors

Facilities That Meet Adopted Criteria and Thresholds

	Freight rail corridors	**CSX Lines** From the Alabama State Line east to Jacksonville via Pensacola, Chattahoochee, Tallahassee, and Baldwin
	Interregional or interstate passenger rail corridors	**Amtrak Corridors** From the Alabama State Line east to Jacksonville via Pensacola, Chattahoochee, Tallahassee, and Baldwin (along CSX tracks)
	Waterways	Gulf Intracoastal Waterway and shipping lanes
	Highways	**Interstates** I-10, I-110 (entire lengths) **Other FIHS Facilities** U.S. 98 from Okaloosa/Walton County Line to Panama City urban limits U.S. 231 from Baldwin Road in Panama City to the Alabama State Line U.S. 319 from I-10 to the Georgia State Line SR 85 from SR 123 to I-10 SR 87 from U.S. 98 to I-10 SR 123 from SR 85 south to SR 85 north U.S. 331 from U.S. 98 to I-10 **Non-FIHS Routes** U.S. 29 from I-10 to the Alabama State Line U.S. 331 from I-10 to the Alabama State Line

Figure 13. Supporting Detail to the Hubs Corridors and Connectors Graphic Above.
Source: Florida State DOT (2003), page 35.

3.2.2. HOW: Create public/private collaboration mechanisms.

Public sector organizations—state DOTs—should consider adopting some of the practices used in the private sector for intercompany relationships. These include various types of collaboration and can include technology that enables the collaboration. Prior to selecting a specific technology or vendor, a state DOT should identify its objective as it relates to private industry. This could range from wanting to develop and maintain a deep and ongoing relationship with regular face-to-face meetings across multiple levels in the organization, to the more Spartan disruption-only emergency communications and coordination. Clearly doing the former will enable a more effective disruption response and recovery, but organizations should have a purpose for meeting when there is not a disruption. Developing a relationship with the top members of the key customer segments prior to an actual disruption is a worthwhile activity for the state DOTs to engage in.

There are a number of industry processes that can lend themselves to formal relationship management. Customer Relationship Management (CRM) Programs are software-based programs to capture the details and manage the engagement with customers. CRM Programs are based on principles that do not necessarily require software. They do require and enforce disciplined and regular follow up and data capture about the customers' needs and characteristics that should be archived on an ongoing basis and accessible by multiple authorized parties.

Other approaches may offer promise for developing these relationships with private industry. This could include creating a Transportation System User Group, or adopting progressive customer service management practices to engage the customer in your business operations (and vice versa).

3.2.3. HOW: Agree on Priority and Trigger Setting Processes.

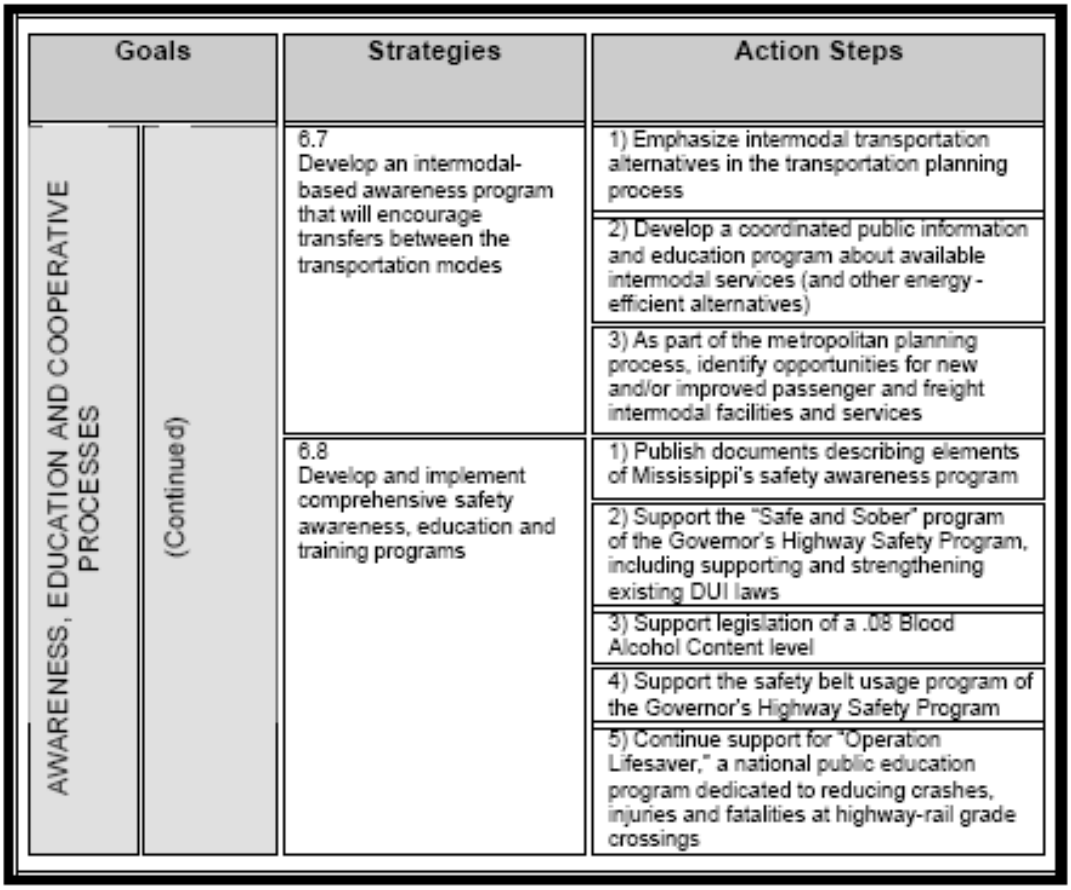
At the highest level, the Mississippi Unified Long-Range Transportation Infrastructure Plan (MULTIPLAN) created by the Mississippi State DOT may be

useful in terms of providing an outline for long-term planning and coordination across the state, among multiple parties, and serving multiple goals. Their plan is progressive in being among the few that has a strong orientation towards recovery planning that includes the role of the transportation system. The MULTIPLAN also outlines goals and action plans for partnerships as illustrated by Figure 14 and Figure 15 below.

The MULTIPLAN also includes a chapter on Best Practices that summarizes leading practices from other state DOT planning processes, which can be useful to the planner overall, but also for higher level priority-setting.

Goals		Strategies	Action Steps
AWARENESS, EDUCATION AND COOPERATIVE PROCESSES	CREATE EFFECTIVE TRANSPORTATION PARTNERSHIPS AND COOPERATIVE PROCESSES THAT ENHANCE AWARENESS OF THE NEEDS AND BENEFITS OF AN INTERMODAL SYSTEM	6.1 Address the transportation needs of local governments in state planning policies and procedures	1) Provide every urban place of more than 5,000 population with financial and administrative assistance for construction projects
			2) Consider local plans when selecting alternative alignments for transportation improvements
		6.2 Maximize benefits from technical and research advancements that may be applied to continued development of high quality transportation systems	1) Support and participate in cooperative programs with the State's institutions of higher learning to carry out research that will benefit transportation efficiency and intermodalism
			2) Utilize federal aid research funds and participate in federally sponsored research programs
			3) Continue to support the Technology Transfer program for local agencies
		6.3 Encourage more public-private partnerships in the expansion of rural transit services and the connectivity between rural and intercity transportation services	1) Promote a collaborative process among federal, state, local and other organizations (public and private) to foster improved service planning, communications and coordination through the Mississippi Public Transit Association
		6.4 Promote effective public-private rail transportation partnerships, including Class I short line ventures	1) Provide seed funding and-or other activities for local involvement and use of local resources
			2) Seek cooperation of carriers in joint funding of mutually beneficial projects
			3) Enhance the rail program through the use of programs such as economic development and establish other revenue enhancement measures
		6.5 Continue the partnership between the Mississippi Development Authority, the Department of Transportation and providers of transportation for marketing of transport services	1) Improve the cooperative processes between MDOT and transport providers to gather information on transportation capabilities, facilities, intermodal connections, rates and services that can be used to mount effective marketing campaigns
			2) Improve the cooperative processes with MDA and the transport providers to offer strong marketing and business development efforts on behalf of the service providers
		6.6 Continue the advisory group for transportation concerns at the state level	1) Support Advisory Committees, using existing groups to provide a conduit for transportation policy and programming between state and local government and the private sector

Figure 14. Goals and Action Steps Illustrating Transportation System Partnership Development. Source: Mississippi DOT, page 16



Goals		Strategies	Action Steps
AWARENESS, EDUCATION AND COOPERATIVE PROCESSES	(Continued)	6.7 Develop an intermodal-based awareness program that will encourage transfers between the transportation modes	1) Emphasize intermodal transportation alternatives in the transportation planning process
			2) Develop a coordinated public information and education program about available intermodal services (and other energy-efficient alternatives)
			3) As part of the metropolitan planning process, identify opportunities for new and/or improved passenger and freight intermodal facilities and services
		6.8 Develop and implement comprehensive safety awareness, education and training programs	1) Publish documents describing elements of Mississippi's safety awareness program
			2) Support the "Safe and Sober" program of the Governor's Highway Safety Program, including supporting and strengthening existing DUI laws
			3) Support legislation of a .08 Blood Alcohol Content level
			4) Support the safety belt usage program of the Governor's Highway Safety Program
			5) Continue support for "Operation Lifesaver," a national public education program dedicated to reducing crashes, injuries and fatalities at highway-rail grade crossings

Figure 15 - Continuation of previous Figure from MULTIPLAN.

The MULTIPLAN also includes a series of SWOT (strengths, weaknesses, opportunities, threats) analyses with one dedicated to Emergency Response, Emergency Management, and Multi-modal Coordination among others. While these specific plans and analyses do not provide detailed processes for priority and trigger-setting mechanisms, the plan illustrates key issues and some potential solutions for consideration.

4. Key Insights and Issues

This chapter includes insights from the field work as well as some recommendations derived from applying corporate resilience concepts to freight transportation systems and infrastructure. Additionally, a few issues are highlighted for reference, but these are not given expansive treatment. They are presented here only to recognize potential issues that should be considered when developing the FSR Plan.

For reference, the insights were drawn from literature and field work, intended to identify key issues and state-of-the-art FSR Planning performance. The field work included interviews with shippers, carriers, and pertinent government officials from Washington State. While the observations are anecdotal as they lack the statistical significance required to make assertions, they are enough to suggest potential themes that warrant further study and potential action, along with the following insights and observations.

4.1. Response Does Not Equal Recovery

The concepts of response and recovery in the context of emergencies, disruptions, and disasters are neither precise nor standard. For many organizations, the terms response, recovery, and resilience are interchangeable. We believe that there are important and distinct differences between the immediate response to an incident and the longer-term recovery from the event.

We have defined response as all actions taken before, during, or after an incident with the objectives of (1) saving lives, (2) minimizing damage, or (3) enhancing longer-term recovery. Recovery, on the other hand, are actions taken after an event to return vital economic systems to minimum standards (in the short term) and all economic systems to normal or improved levels (in the long term).

Emergency Response plans focus on minimizing the immediate loss of life and damage, are generally "incident type specific," and are usually considered the responsibility of the public sector. Long-Term Recovery plans focus on business resumption and stability, are industry or company specific, and are usually considered the responsibility of each individual company in the private sector. The FSR Plan is clearly a long-term recovery plan but is different in that it is owned by WSDOT.

The distinction between recovery and response is important. The skills, resources, objectives, time horizons, and stakeholders all differ dramatically between the response and recovery phases. They are not totally independent, however. Actions taken during the response phase of an incident can have significant impact on the recovery phase—both positive and negative.

While the response activities have received a significant amount of attention by government at all levels over the last several years (and rightfully so), very little attention has been paid to the recovery stage. In fact, a review of all 50 states emergency response plans has yet to reveal another state with recovery plans in line with what WSDOT is developing. This is surprising since one could argue that the long-term effect of poor economic recovery can dwarf the initial impact of the incident itself. If the economic livelihood of a region is not resumed, then it could potentially die.

Therefore, having a recovery plan is different than just modifying or adding on to the existing emergency response plans. While recovery does not have the same feel of urgency as the immediate response to a disaster, if ignored it has potential for causing greater and longer-term damage to a region.

4.2. Public/Private Relationships Are Integral

Falling in line with the first insight (response is not the same as recovery) is the idea that the public and private sectors need to own this phase jointly. Both

sectors have a role to fill within each of the two major phases. Much has been written about how private sector companies out-performed FEMA in getting supplies, food, and medicine to victims in Hurricane Katrina during the immediate response and shorter-term recovery stages. And of course, local governments have taken steps to reduce regulations or create economic incentives to speed up economic recovery of certain regions post-disaster.

The idea, however, is that each sector should serve different yet complementary roles during the recovery stage. There are three general forms of this relationship:

1) information flow from the state DOT to the private sector during the recovery,

2) resources and expertise from the private sector to assist the DOT, and

3) assistance or management of the public infrastructure to improve the private sector's recovery capabilities.

This can be a very complicated set of relationships. It requires a significant amount of understanding and trust to exist between the state DOT and the hundreds (thousands) of individual companies that are affected. Of course, these relationships cannot be initiated during or after the crisis occurs—they must exist prior to the event.

This means that the state DOT needs to build ties to the various private sector companies now—before a crisis occurs. There are many ways to achieve this goal; three potential actions for a state DOT to consider are shown below:

- Create a company forum that meets quarterly to discuss transportation related concerns. These meetings will help the state DOT better understand the specific needs of each company in terms of economic viability and recovery as well as determine the specific capabilities of each firm that the state might be able to tap during a crisis.

- Develop a credible, reliable, and easily accessible communication platform for transportation network information dissemination that can be used during normal operations by the companies. This is discussed in more detail below.

- Develop business continuity expertise within the state DOT and deliver this to companies in the state. The delivery can be in the form of workshops whereby state DOT officials act as a facilitator/mediator in a table top exercise that helps firms test out their continuity (and recovery) plans in a realistic setting. This reinforces the idea that the state DOT understands economic recovery and is the place to go for assistance during an actual crisis.

The key insights are that the public and private sector have different and complementary expertise's and the relationships need to be formed and strengthened well in advance of a crisis to have any value.

4.3. Communication Capabilities

In order be able to direct different agencies and private sector firms during disaster recovery, WSDOT needs to have a credible, reliable, and easily accessible communication platform. By credible, we mean that the information provided needs to be accurate and up-to-date. If the information is seen to be dated or slightly off from what they understand the actual situation is, it will become ineffective. By reliable, we mean that the communication platform needs to be robust enough to be available during a crisis and the recovery stage. Sufficient redundancy needs to be built to absorb exceptionally high volume levels and peaking during the crisis. Reliability can also be improved by having multiple paths or channels of communication— to provide targeted (pre-defined) updates, for example, to selected firms in order to keep them from coming to a Web site (for example) to find the same information. By easily accessible, we mean that the information needs to be able to be accessed in multiple ways

depending on the users' needs. This could include information on a Web site for pulling down, direct access to real-time traffic data, email notices pushed out to individuals based on a trigger event, cell phone or text message announcements, etc.

Having a communication platform in place and operating ahead of a crisis can also serve to strengthen the trust between state DOT and the private sector (and other public agencies as well). It also gets users in the habit of either going to the state DOT Web site (for example) for information or getting information pushed to them. This trains the users so that in a time of crisis they already have an idea of where to turn to for specific and timely information.

4.4. Mechanisms for Fast-Tracking Recovery

There are many regulations and rules that are in place during normal business operations for various safety, environmental, and health reasons. During a crisis or post-crisis during the recovery stage, it is helpful for the government to have the authority to temporarily suspend selected regulations in order to improve the economic recovery. For example: driver hours rules can be loosened for a period of time to ensure sufficient capacity, competitive bidding requirements can be relaxed for certain critical reconstruction projects that enable the economic recovery, or the use of restricted lanes can be used for alternative sources (trucks on HOV lanes).

The insight is that the ability of a government authority to make well thought out and reasoned trade-offs between economic recovery and other regulatory objectives can significantly improve the economic recovery.

4.5. Ability to Actively Manage Scarce Public Resources

The FSR Plan deals with how a state DOT can speed up the economic recovery of a region after any type of disruption to the state's transportation network

infrastructure. The failure of the transportation system could be caused by specific damage to the infrastructure itself or some other factor that forces the system to not be able to be fully used as originally designed.

A state DOT needs to have the competence and capability to determine the best way to allocate the scarce resource that is transportation capacity. Several insights have been gathered to understand how this is best handled:

- A prioritization scheme that determines which type of traffic has priority over another for a certain location or time period will improve the economic recovery. This requires that some method of prioritization can be developed, agreed to politically, communicated, implemented, and enforced.

- The use of economic incentives (congestion pricing, variable tolls) as well as government fiat (lane restrictions, road closures, curfews) all can play a role.

- Having pre-existing tolling capabilities in the limited access highway infrastructure provides potentially added flexibility in use of that segment of the system. Congestion or variable pricing (whereby different vehicles are charged different toll rates in order to reduce the overall traffic volume and ensure that the 'most important' traffic gets through) is much easier to implement if the physical infrastructure (booths, signage, etc.) is in place.

- As a first step, a state DOT at least has to have the ability and the authority to monitor the key infrastructure segments identified during a failure mode analysis during and just after a crisis. The Integrated Corridor Management (ICM) pioneer program is a promising advance in this direction as well.

4.6. Integration of Other Concerns

According to a FHWA working paper "Trade: From National Markets to Global Markets" (see Cambridge Systematics, 2005), capacity constraints, regulations affecting cross-border trade flows, and international trade policies are emerging as critical issues affecting freight movement. Each of these is currently affecting the amount of flexibility available that will enable or retard freight flows domestically and across borders. The FSR Plan should consider these constraints and limitations as they should be accounted for given that there are more complexities, less flexibilities, and greater uncertainty in freight movement processes.

The FSR Plan should also include a serious assessment of system infrastructure. Increasingly, there is widespread recognition that the public transportation systems are at risk and in need of significant investment. See for example, Conkey et al (2007), Ford and Hall (2007), Kotkin (2007), and Chang et al (2007).

Many state DOT plans include some infrastructure investment but some now are recognizing the need for significant new investments. The 2004 New York State Transportation Plan entitled "Trouble Ahead" states, "Current transportation infrastructure, after years of improvement, is starting to deteriorate again and conditions will worsen quickly without significant new investment." They further note that 37 percent of the bridges in the state are "structurally deficient or functionally obsolete." Further, the report goes on to assert that "restoring and maintaining our existing infrastructure is not enough. New infrastructure and system-wide improvements are needed in order to keep up with the increased demands" as they cite NY state's role in global trade flows.

A final issue is more of an opportunity for freight system resilience planning. Currently, most state DOTs include some focus on security in their transportation plans. This suggests that there are some freight security planning processes in place. The opportunity is that the planning process for developing an FSR Plan

should be coordinated, if not integrated, with the planning process for the freight system security, and if the freight security planning process exists, it may make the freight resilience planning process easier to initiate. The SAIC "Guide to Highway Vulnerability Assessment" includes a section describing Security Operational Planning as part of the Vulnerability Assessment, providing a method for integrating the FSR Plan and security planning.

4.7. Adapting Insights from Resilience Research

Recent research insights illustrate the importance of choosing flexibility over redundancy, when developing corporate systems to reduce the consequences of disruptions. Flexibility entails making investments in capabilities that permit repurposing of assets, materials, and personnel that then allow the organization to reconfigure systems to perform a broad variety of tasks and products, in some cases additional volume as well. Flexibility pays useful benefits to the business because it can be used in daily operations, and need not be limited in utility to disruptions. Redundancy, one alternative to flexibility, entails making investments in assets (inventory, surplus capacity) that provide benefit when used, but no return when not used. In practice, most organizations will use both redundancy and flexibility when crafting a response plan. The critical choice is determining how much of each is appropriate for the firm and it's desired 'disruption service level.'

Applying this concept to the FSR Plan may entail considering how much flexibility to incorporate in the actual freight system, versus how much excess capacity to include. This could possibly entail redesigning certain transportation assets to accommodate different types of transportation flows, specifically freight. (This may require getting conditional waivers in advance for short-term use of certain assets that may carry weight, size, or material restrictions.)

Another concept from recent research is the emergence of a flexibility culture that imbues the importance of flexibility in the employees, and incorporates flexibility

in product and process design decisions. When important decisions are made, the decision makers consider flexibility as an important and desirable factor. Similarly, a security culture is emerging in corporations whereby security is becoming socialized amongst the employees; an awareness of security and risk emerges and subsequently security too becomes an important decision factor.

For the FSR Plan, this may be eventually designed into the process by specifically defining flexibility measures as part of the decision criteria for infrastructure and operational decisions. Education for awareness of the need for system resilience, and then training for proper response helps build such a culture.

4.8. State Plans Lack Emphasis on Economic Recovery

State DOT transportation plans should supplement current project-oriented plans with long-term plans for economic recovery. While some state transportation plans note how the freight transportation system plays an important economic role in the state, most do not include plans to protect the freight transportation system in the event of a disruption. There are emergency response plans developed at the state level, but these focus primarily on response and not recovery, and they do not focus on freight transportation system. The net result is that freight transportation systems are inadequately prepared to respond to, and recover from, disruptions. This puts state economies at risk beyond what most state planners currently recognize.

Some of the state DOT plans recognize the linkage between the freight transportation system and the economy. The 2006 New York State Transportation 2030 Master Plan recognized the importance of freight transportation in facilitating commodity flow. They note that in 2002, intra-state commodity flow was valued at $124 billion, inter-state flow out of New York was valued at $195 billion, and inter-state flow into New York was valued at $248 billion.

The New York State Transportation 2030 Master Plan goes further and provides a qualitative assessment of future demands on the transportation system that will enable and facilitate the commodity flows, implicitly making the case for necessary investment in infrastructure. See Figure 16 below for reference.

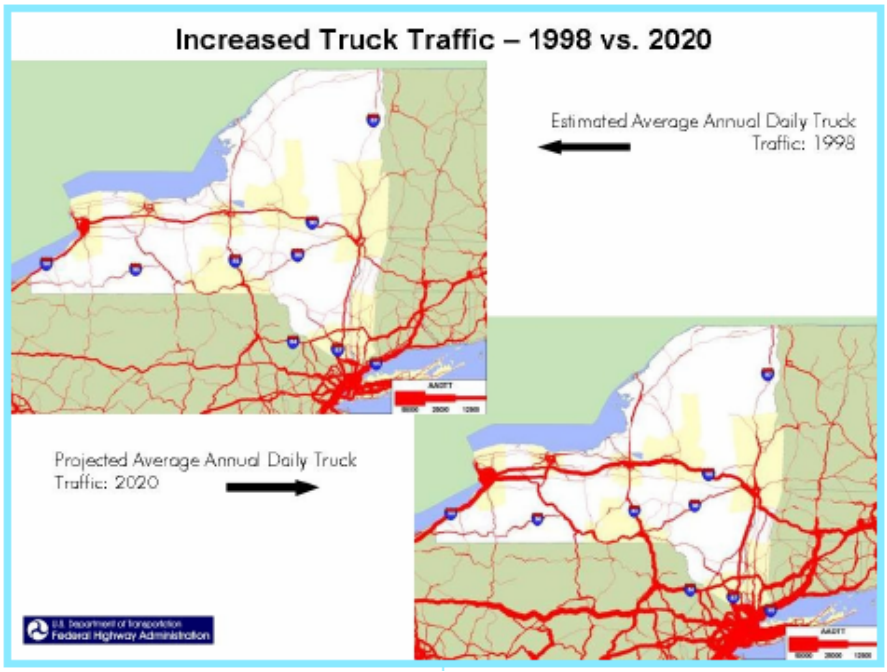


Figure 16. Average Truck Traffic Chart. Source: New York State (2006), page 26.

The state of Florida has gone further to establish Florida's Strategic Intermodal System (SIS), which was started in 2003 with the stated objective "to enhance Florida's economic competitiveness by focusing limited state resources on those transportation facilities that are critical to Florida's economy and quality of life," Florida State DOT (2007)." The SIS is a network across the state of Florida of high-priority transportation infrastructure—transportation facilities, airports, waterways, rail, highways, and bus terminals and operations. These systems are critical to Florida's economy as they carry the vast majority of Florida's passengers and freight. The plan ensures that this infrastructure gets funding and adequate necessary attention and support via an integrated series of assessments and oversight committees.

The SIS is a statewide network of high-priority transportation facilities, including the state's largest and most significant commercial service airports, spaceport, deepwater seaports, freight rail terminals, passenger rail and intercity bus terminals, rail corridors, waterways, and highways. These facilities are the workhorses of Florida's transportation system, carrying more than 99 percent of all commercial air passengers, virtually all waterborne freight tonnage, almost all rail freight, more than 68 percent of all truck traffic, and 54 percent of total traffic on the state highway system. Once fully developed, the SIS could be as significant to Florida's future as the construction of the interstate highway system.

The California Transportation Plan 2025 directly lists a key goal as being to "Support the Economy" and includes a series of policies to achieve that goal. Being the world's fifth largest economy by itself, California is well focused to recognize the importance of the transportation system on their economic livelihood. Other states should take notice.

4.9. Federal Guidelines Are Lacking

The life cycle of a disruption is not entirely well understood, although there is general awareness of four sets of activities for addressing and considering disruptions: prevention, preparedness, response, and recovery.

Among the various stages of the Disruption Life Cycle, recovery is the least well understood:

- What is required for fast recovery?
- What is required for recovery with minimal negative affects?
- How can/should organizations/governments plan for recovery?
- How important is the transportation and logistics systems for economic recovery?

- Can the economy recover without fully operable freight transportation systems?

- What is the desired level of recovery post-disruption? How can this be measured?

- How can governments plan in advance for the necessary freight system resilience in order to provide the desired recovery post-disruption?

The National Incident Management System (NIMS) provides a federal guideline for preparation for and response to incidents. It describes in detail the various issues, processes, operational requirements for planning, and response to incidents, which for all intents and purposes are better described as disruptions. These disruptions can arise from various sources, ranging from natural disasters, organized labor actions, and terrorist attacks, to industrial accidents. Yet they all share a few elements in common, most importantly that they threaten the collective economic viability of our locale, and more broadly our country and world (for grand scale disruptions).

NIMS emphasizes planning and response, but provides little recognition of the importance of economic recovery. Among the 130 pages of NIMS, recovery plans only surfaces on one page with two sentences: "Recovery plans describe actions beyond rapid damage assessment and those necessary to provide immediate life support for victims. Long-term recovery planning involves identifying strategic priorities for restoration, improvement, and growth," National Incident Management System (2004), page 43. There are other references to recovery, but these only suggest that there is a need to transition from response to long-term recovery without any meaningful discussion to explain why this is important, what this entails, or how to implement.

The 2004 National Response Plan (NRP) does not do much better. The purpose of the NRP is to "establish a comprehensive, national, all-hazards approach to domestic incident management across a spectrum of activities including

prevention, preparedness, response, and recovery," NRP (2004), page 2. Further, the NRP uses NIMS to achieve many of its objectives. Specific to recovery, the NRP is meant to serve as the basis for "long-term community recovery and mitigation activities." While the NRP states that one of the top priorities is to "facilitate recovery of individuals, families, businesses, governments, and the environment," it does not provide any guidelines for specific recovery planning or implementation aside from a rough outline in the annex under Emergency Support Function #14.

While it meets that objective on a strict interpretation by providing response planning guidelines, if we think more broadly it should be providing adequate guidelines for full economic recovery and not just response. Without discounting the impact of loss of life, one could argue that loss of economic viability—our local, national and potentially the global livelihood—deserves equal if not greater attention given that some disruption decisions could potentially have a greater long-term impact on human existence on a global basis. We do not propose to subordinate the preservation and protection of human life to economic security, but suggest that recognition of the economic impacts may alter disruption-period decisions.

Consider this example—amidst the Foot-and-Mouth Disease, the UK government decided to protect the population and the agriculture industry by slaughtering all the animals in the UK (cattle, sheep, etc.). This effectively protected a $2+ billion industry—but this also sacrificed the $5+ billion travel/tourism industry and had significant downstream effects on manufacturers that depended on the leather from the animals for their products, Sheffi (2005). Arguably, the UK government could have contained the potential dispersion of the Foot-and-Mouth Disease equally well by selectively slaughtering animals from affected abattoirs rather than all of the animals, and therefore mitigating the economic impact of the decision without significantly affecting the risk to human life.

The NRP does address recovery primarily through the Emergency Support Function (ESF) Annexes where ESF #1 addresses Transportation and ESF #14 addresses Long-term Community Recovery and Mitigation.

Finally, the U.S. Government is not alone in focusing largely on response and not recovery. The London Strategic Emergency Plan, for example, fails to mention recovery at all, see London Resilience Team (2007). The Emergency Response and Recovery report, UK Resilience (2005), does mention recovery but only to identify the role of the UK central government in emergencies. It also briefly mentions economic implications, but lacks any specific suggestions beyond indicating that the UK government would "apply risk assessment methodology and cost-benefit analysis within an appropriate economic model to inform decision-making." Economic recovery in the UK similarly needs greater attention in their formal planning processes.

5. Next Steps and Future Research

The objective of the Freight System Resiliency (FSR) Planning project was to help WSDOT to develop its own FSR Plan. While the plan for each state will be unique, the process used can be the same. This process can take substantial effort and a great deal of work is still underway for the development of Washington State's FSR Plan.

There are several areas that require additional research. First is the development of quantitative models that will help a state DOT to determine the specific impact of infrastructure being limited or removed. This modeling needs to be fine grained enough to allow for the inclusion of the different customer segments and their particular concerns, yet granular enough to be run with available data.

Second, there needs to be a better understanding of how innovative technologies and processes can be used when setting and implementing priorities for use of scarce infrastructure. Congestion pricing, automated signage, etc. can all be used to incorporate more flexibility into the existing network.

6. MIT Roundtable Report Summary

This section contains the meeting report for the Freight System Resilience and Economic Recovery roundtable held at MIT on November 28, 2007. Various government, shipper, and carrier representatives were in the audience. The meeting was held to continue to develop insights into how a state DOT can develop a Freight System Resilience Plan.

The roundtable was organized into four overall sessions: Research Briefing on Freight System Resilience, Managing Risk and Responding to Disruptions, Pubic/Private Partnerships in Disaster Response and Recovery, and Observations/Issues/Learnings.

The following is a summary report of each of the interactive sessions. For the purpose of this report, questions and comments are grouped into the Discussion and Exchange section of each session. Individuals are not identified by name or company with the exception of the research team members from MIT and WSDOT.

6.1. Session 1: Overview of Freight System Resilience

The session was divided into two parts: presentation and discussion.

6.1.1. Presentation Summary

Jim Rice, CTL, opened the session by explaining the two objectives for the day: 1) to provide feedback on the Freight System Resiliency Process and 2) to bring to light new ideas on Freight System Resiliency. Why the roundtable format? There is no single expert because it is a new area; expertise sits around the table not at the front of the room; and discussion is not just encouraged, it is required.

Chris Caplice, CTL, then provided an overview of the work with the Washington State Department of Transportation (WSDOT), a report of which had been provided as pre-work to roundtable participants.

WSDOT recognized potential problems in freight movement systems, understanding that freight systems are vulnerable to disruptions that affect transportation infrastructure. Meeting Professor Yossi Sheffi at a conference, Barbara Ivanov, WSDOT, initiated a discussion with him about how to apply the same concepts of resilience to freight systems driven by state DOTs. CTL found this an intriguing question.

In 2005 CTL had conducted a survey of shippers, carriers and government agencies on freight system congestion and capacity constraints. The survey indicated a gap in perceptions of the cause of the crisis. Shippers and carriers tend to focus on operational issues while government agencies concentrate on longer-term infrastructure issues. The survey also found that shippers and carriers tend to be more collaborative in both planning and execution with less commodity-like purchasing and management. This collaboration, however, did NOT appear to extend to government.

WSDOT's motivation for this research was the December 2006 windstorms, which produced wind gusts of 69 mph, a record rainfall (2.1″ Seattle), pushed the West Point Treatment Plant off-line, forced 70 percent of the Puget Sound Energy (PSE) customers to be without power, and closed 44 roads in unincorporated areas. Property damage amounted to $14.6 million for citizens and businesses and $28.5 million for governments. Eight people died from carbon monoxide poisoning and 293 people were hospitalized for carbon monoxide illnesses.

Caplice described other examples of natural disasters, including the McArthur Maze in Oakland, California and the I-35 Bridge Collapse over the Mississippi River in Minneapolis. Looking more broadly at dependence on infrastructure, Caplice and Rice described new infrastructure in Shanghai, where development of the Yangshan Port ($6.2 billion over three years) makes it the largest deep water

port in the world by capacity. The 31 km Donghai Bridge connects the city to the port, both of which are significantly dependent on the weather. In fact there have already been disruptions in freight movement because of wind and weather. Then there is the possibility of a dissident creating economic havoc by breaking the bridge in one or more places. "Of course, the Chinese government would respond quickly to discourage further activity of this kind," Rice quipped.

The U.S. economy is dependent on freight transportation. What happens if there is a disruption in material flows? The ability of the U.S. to conduct commerce is fully dependent on imports (with 90 percent of the economic value of global commerce via maritime containerized cargo). Also, the ability to move imported cargo from ports to eventual points of consumption requires the use of multiple other modes—mainly by truck or rail.

Caplice then turned once again to Washington State, where the water and land global gateways are essential to the nation's economy, with roughly 6 percent of all U.S. exports and 4.5 percent of all U.S. imports move through Washington's water and land gateways. Moreover, about 70 percent of containers entering Washington gateways are delivered to other U.S. markets, mostly via rail. Although Washington's economy is dependent in large part on the ability to move materials, there is little public recognition on that dependence.

With this background, Caplice laid out the methodology for the CTL/WSDOT project, which included interviews of several dozen shippers and carriers in the state, a literature review at the state and federal level relating to response, recovery, emergency management, transportation plans, freight movement plans, and development of a process for creating a Freight Systems Resiliency Plan, involving three key elements: 1) principles of building resilience; 2) recognition of the importance of relationships (government-business, business-government, and government-government across the state and from state to federal; and 3) response planning, business continuity planning, and recovery planning principles.

Caplice outlined the key research insights for the CTL/WSDOT project:

1. Response does not equal recovery. Response is defined as all actions taken before, during or after an incident with the objectives of: 1) saving lives; 2) minimizing damage; or 3) enhancing longer-term recovery. Recovery is the set of actions taken after an event to return vital economic systems to minimum standards (in the short term) and all economic systems to normal or improved levels (in the long term). Emergency Response plans focus on minimizing the immediate loss of life and damage, are generally "incident type specific," and are usually considered the responsibility of the public sector. Long-Term Recovery plans focus on business resumption and stability, are industry or company specific, and are usually considered the responsibility of each individual company in the private sector.

2. Public/Private Relationships are integral. Public and private sectors have roles to fill within each of two major phases. Each serves different yet complementary roles during the recovery stage. There are three general forms of relationships: 1) information flow from the state DOT to private sector during recovery; 2) resources and expertise from private sector to assist the state DOT; and 3) assistance or management of the public infrastructure to improve the private sector's recovery capabilities.

3. Managing scarce resources is a key capability. As the first step, the state DOT needs to have at least the ability and authority to monitor key infrastructure segments identified in Step 3 of the FSR process during and just after a crisis. Other high value activities include: a prioritization scheme that determines which type of traffic has priority over another for a certain location and/or time period; the ability to use of economic incentives (congestion pricing, variable tolls) as well as government fiat (lane restrictions, road closures, curfews); and the presence of pre-existing

tolling capabilities on limited access highway infrastructure to provide potentially added flexibility in terms of directional traffic control.

4. Fast tracking mechanisms allow flexibility. Ability of a government authority to make well considered and reasoned trade-offs between economic recovery and other regulatory objectives can significantly improve the economic recovery. Examples, loosening driver hours to ensure sufficient capacity, relaxing competitive bidding requirements for certain critical reconstruction projects, redirecting use of restricted lanes (trucks on HOV lanes).

5. Communication capabilities are critical. WSDOT (and other states) needs to have a credible, reliable, and easily accessible communication platform.

The National Response Framework (a recent renaming of the National Response Plan to better align the document with its intent and to encourage the continued development and refinement of detailed, robust all-hazards emergency operations plans) actually uses the word "recovery," but this means community recovery, not transportation. "The purpose of the National Response Framework is to establish a comprehensive, national, all-hazards approach to domestic incident response. In this document, incidents include actual or potential emergencies or all-hazards events that range from accidents and natural disasters to actual or potential terrorist attacks. They include modest events wholly contained within a single community to others that are catastrophic in nature and national in their scope of consequences. It describes how communities, states, the federal government, and private-sector and nongovernmental partners apply these principles for a coordinated, effective national response." <http://www.fema.gov/pdf/emergency/nrf/about_nrf.pdf>.

The National Response Framework is intended to provide a template for each state to develop its own plan. Caplice noted that only three states have plans dealing with freight or goods movement, and none of the states discussed recovery. Only Florida, Mississippi, California, and Connecticut have done some

work to embed in their response what to do about disruptions and how to think about freight. Caplice indicated that the MIT team could not find the word "freight" in any of the transportation plans. Other than Washington State, no state DOTs had recovery plans.

CTL incorporated lessons learned from the development of resiliency planning for large private sector corporations into the Freight Resiliency Plan for Washington State. The end result is a process by which any state (or governing agency) can create an FSR Plan.

Caplice then outlined the three phases in an 8-step process for developing an FSR Plan.

6.1.2. Discussion and Exchange Summary

In the discussion portion of the session, the various points that were debated are collected into common topics. The identity of speakers is masked for confidentiality, with the exception of CTL and WSDOT personnel.

Topic: Recovery vs. Response

There was confusion among roundtable participants about distinctions between response and recovery, where there is overlap, results produced, etc. Because of martial law in Katrina, for example, the ability to focus on recovery became secondary to life saving response activities.

CTL noted that emergency response can be defined as all the actions taken prior to, during, and just after an incident with the onus on saving lives, minimizing damage, and recuperation over the long term. Recovery involves the post-event actions taken to return vital economic systems to minimum standards of health in the short term and to full health over a longer period. The two phases are distinct and require different types of skills and resources, yet they are also interdependent because the nature of the response has a direct bearing on the success of the subsequent recovery operation. Response and recovery will clearly overlap and what someone does in response can enhance or inhibit recovery.

Participants agreed on importance of starting recovery as soon as possible, preparing for it even before a disaster. CTL gave the example of Intel operations in Portland, OR where the plant is located on a fault line. Intel employees were trained and certified by the state to inspect not only their own facilities, but other buildings post-earthquake. This provides the dual benefits of faster inspection to Intel and more inspection capacity for the state.

Topic: Scope of FSR – State or Regional?

There was considerable discussion concerning how large the scope of an FSR Plan should be. Some shippers and carriers mentioned that it should extend beyond individual states to larger regions. This might alleviate the problem of dealing with 50 different states. The carriers in attendance noted that they have to consider regions over individual states for several reasons:

1. Lines, routes, infrastructure, customers, and supply chains are not limited by state borders.

2. Disruptive events tend to be either multi-state, e.g, Katrina, or they cause ripple effects that cross state borders.

3. Larger, multi-state regions may have common issues, problems, infrastructure, weather, or culture that make planning easier to conduct.

4. Private sector companies simply do not have the time, energy, or resources to deal with 50 different entities for resiliency planning.

Companies simply want an easier forum for information exchange. For example, the FHWA convened a Manufacturing Housing Industry about shipping from Pennsylvania through all of the New England states. By treating the New England states as a single entity, it streamlined the whole process. Several attendees noted that this need for a "larger than one state" approach is a call for a stronger national transportation policy.

The president of a carrier specializing in hazardous materials cited the complete disregard for the bottleneck created by Boston's "Big Dig" for hazardous materials. Due to this construction, deliveries have 20 to 60 miles added to their trip to circumvent the city. However, each state and metropolitan area has their own set of regulations on HazMat, with new restrictions, lawsuits, and federal preemptions continually popping up. Having a standard set of rules applying to a larger region would be very beneficial.

Government attendees noted that, unfortunately, regions do not fit legislative, political, budgetary, command, and control frameworks for dealing with disruptions or disasters. Regions have no authority, no control over dollars, little or no influence at the state level, but could provide strong multi-state influence at the federal level. A regional approach might work if there were a national identification of key infrastructure (ports, bridges, routes) whose disruption would cause serious economic impact regionally and nationally, e.g. West Coast ports, bridges crossing the Mississippi River, critical gas pipelines, etc.

Topic: FSR Planning – How to Start?

One roundtable participant questioned the first step in the FSR Planning Process, which identifies key freight usage patterns by customer segment. He proposed, instead, to push the vulnerability assessment to the first step. He asserted that by doing this one can eliminate early in the process any events that don't need to be considered. For example identifying a bridge that is the only way in and out or a region would definitely need a contingency plan put in place.

CTL argued the importance of knowing first who is being served. WSDOT explained that the FSR Plan is an investment not only in preparing for a disaster, but also for better management of daily operations where they have to squeeze more capacity out of a very congested metropolitan system. WSDOT is hoping that the FSR platform will enable them to respond quicker and more effectively to daily disruptions. It isn't just redundancy, which is a solution for a particular problem; there might be a variety of other solutions.

WSDOT noted that there are thousands of bridges in Washington State and some don't matter even if they are the only way in and out. The issue is one of priority—which bridges to plan for first?

A Director of Transportation for a retailer agreed with segmenting users first. He asserted that the stakeholders are very different in the segmentation of users in Washington. Global Gateways, for example, will affect all of the large shippers at the roundtable as well as those in California. "Made in WA" is interesting but not as relevant to his company as it would be to, say, a local lumber company or someone trying to move things across state. "Segmentation is good, but [what's important is] how you crack it , line up different stakeholders, not to add complexity, but hopefully to simplify looking at taking the elephant a piece at a time," he indicated.

Another participant liked the CTL/WSDOT approach that identifies first the users for the infrastructure and then examines the bottlenecks. But first you have to identify who actually uses the system in order to prioritize. They also noted that this method provides a mechanism to get an organization to think differently. Instead of thinking about each bridge, they now have to think of corridors, connections, and the end users of the overall network.

A larger truckload carrier argued that in his criticality of products for demand, he asks the question, "Related to the bottleneck, what is the most important product?" In Katrina, water was the most important product to be delivered. Perhaps the focus should be on how to prioritize products in the bottleneck rather than users? We don't want to be moving lumber during Katrina in the response stage. Even in the recovery stage, there is a priority of products.

Topic: What is Restoration of Economic Output?

CTL asked how different organizations would measure the restoration of economic output. Global Gateways has a very different vision of what's important to them, to get product through the state and out, which is different from Made in WA. There are complications since we can really only measure

capabilities. So a disaster, whatever it is, means that some of your capacity is restricted. A bridge or port is out, so you have either too much flow for existing capacity or too little supply or infrastructure for the demand; one or the other. For instance, if the Port of Vancouver is out, that traffic is being diverted to Seattle/Tacoma. That's going to cause a problem because you have too much demand. Nothing necessarily is happening to your system, but more is coming through.

One participant observed that implicit in the discussion is looking at the economic value of restoration by segment because each uses infrastructure differently. If you get different constituencies working in parallel, it's a tougher coordination exercise for the state. For example, if the road infrastructure is wiped out in a part of the state, you could have the big retailers and the local railroad getting the rail up and have other local providers or producers trying to get certain bridges up. It would be a tricky coordination exercise.

Topic: Transfer from Response to Recovery

A number of attendees noted the change in how to interact with government agencies during the two key phases. During response, local law enforcement officials hold power and control. During response and recovery, relationships with local officials, power companies, and elected officials are critical. Participants agreed and provided multiple examples of importance of prior relationships (personal ties, playing golf, supporting charities, etc.).

In Washington State, local county sheriffs have the power during the response phase. WSDOT noted that it does not have the ability to know, much less maintain, relationships with all of county sheriffs. They noted the need to develop a standard decision path for the state. They suggested mapping a path for priority customers and their needs and assigning someone to take responsibility.

Local law enforcement and fire departments don't think beyond saving lives and extinguishing the fires. WSDOT noted that, "In a simulation, the plan always

stops after the terrorist is caught or the fire is extinguished." Little thought is given to what should be done in the recovery stage.

Topic: Public Sector/Private Sector Gap

There was considerable discussion over the gap between the two sectors. The private sector's view of the government sector is one big entity where everyone talks to each other and they all leave work at 5:00 p.m. There are no different levels. On the other side, the public sector's view of the private sector is monolithic and simplistic as well—each firm is highly efficient and everyone is profitable and only out to make a buck. There are misperceptions on both sides.

Several shippers commented that something needs to get to the politicians to make something happen. Congress is not hearing from the private sector about transportation needs. The Highway Trust Fund is in danger of going into deficit because Congress is not being pressured to do something. There is a huge disconnect between intelligent masters trying to operate within the system and operate the system, and those who fund and make policy—Congress and people like that.

A U.S. Chamber of Commerce survey of businesses on the impacts of congestion indicated that they are so lean they are too busy to talk to anyone. While most firms recognize congestion as a problem, they felt it is not as important as labor or healthcare. If Congress is not hearing from local constituents that transportation, congestion, redundancy, and capacity are problems, they won't put money into it. U.S. Chamber of Commerce is putting a big effort into thinking about this sort of thing, as an indication. Ten years ago they wouldn't have even thought about it. Public sector responds to what the politicians hear from the business community, so there's a huge yawning gap between people who do operations and people who actually speak to their Congressman through their business councils or other means.

Roundtable participants agreed on the need for creating a sense of urgency (to bring back to their own companies) and business case to get the message to

Congress. There has to be some activity wrapped around how to create a sense of urgency in the public and private sector so that they do the things to get their Congressmen and Senators to actually say that there's a problem. Infrastructure doesn't go up overnight and it's very expensive.

A great deal of money and effort went into figuring out recovery effort, but it took Katrina to make that happen. To avoid waiting for some disaster to happen, how do the private and public sectors coordinate?

Roundtable participants agreed on the importance of a steady effort, a collaboration between private and public sectors to bring forward good planning, and good ideas so that, at a minimum, there is a platform that can be sold to the media which might be able to influence the public in messaging that allows the Congressional players to say, "I understand that."

Topic: Creating Communication Systems

The attendees were asked how they forge relationships and establish trust ahead of time. Does the private sector even believe information from a state DOT? Do they have the private sectors' best interests at heart? How do you develop the rapport? What about communication to the state DOT from the private sector?

Katrina demonstrated that much of the best information originated from the private sector. Several shippers and carriers noted that their individual driver and other employees on site were able to provide accurate and timely information. There was discussion on where and how the state should harness this information.

CTL's interviews during the project indicated a need for an Event Management System. The public sector must understand that the private sector really needs information to make decisions, to be able to flex—will the bridge be out for six months, or will a route be cleared in an hour? CTL asserts that this is a technical but relatively solvable problem.

CTL asserts that the idea from the state DOT's perspective is to build in trust and rapport ahead of time by having a communication platform, which the private sector uses and trusts is a source for accurate, timely data on infrastructure.

Topic: Failure Mode Analysis

CTL noted that vulnerability assessment means that there are many, many different causes that can produce disruptions, but the critical component is the outcomes. A port could fail for many different reasons, but the critical issue is that one cannot get product out. The specific cause is less important than the final outcome.

An FHWA attendee noted that they can do some failure mode analysis with their Freight Analysis Framework (FAF). The FAF is a model of all freight loads in the U.S. on a national level. FHWA provides the FAF to every state.

The VP of a logistics planning company questioned whether there is an associated protocol in using that information to communicate the results of the model to the private sector. The FHWA responded that this model does not tell states where alternative routes should be. Instead, it indicates the likely routes the commodities will take, given the network that is available using shortest routes. WSDOT agrees that the model has very significant limitations and is not something they would use to actually re-route traffic, but the model has a lot of planning capacities.

A director of a large consumer products company recommended the tool be used to examine ports. He explained that ports are one of our biggest vulnerabilities, since they are essentially locations where we don't have alternatives. Shippers would like to know where freight is going to divert to and be able to anticipate in advance that flow and know what's going to happen relative to available capacities. Additionally, consider the locations where there is a single available primary route, such as I-5 in Seattle. We know that if I-5 is taken out, freight traffic will divert to secondary roads. Are these roads even capable of handling the capacities which will be generated by the fact that we are diverting?

A large shipper commented that it all comes down to a cost-benefit tradeoff for investing in excess capacity. His contention is that probably no individual state or port would be willing to invest in surplus capacity. The federal government should be stepping in to protect the nation's "Achilles heel" in the freight transportation network. WSDOT asserts that the failure mode analysis helps to identify the network's Achilles heel and assorted bottlenecks.

A large carrier argued for the need to look at resources within the area as you're going through failure modes. For Katrina, the driver could get there, but once he arrived, there wasn't enough fuel to get out. They're going to tell you to go on this route, but it becomes a well-travelled route and now there's no longer any fuel there. These are the kinds of things we have to take into consideration. We can't send a driver in under those conditions.

A rail carrier indicated that in Florida there are already contingency plans dictating that gas stations have power backup generators. If ports are closed, the railroad will bring fuel in by rail.

A large retailer noted that they go through various "what if" scenarios such as, what if we lose a food distribution center, a regional general merchandise distribution center, etc.? We have found that you need a certain level of redundant capacity in the network to cover a certain number of losses. During Katrina, we lost two distribution centers for a limited amount of time. We had to cover store needs from other distribution centers. That kind of redundancy has to be built in at the regional level—we could not build it on a state level. A manufacturer of specialty devices noted that they add redundant capacity both on the manufacturing and distribution sides. They felt that the distribution side was easier to recover on than the manufacturing side where they had to rely on their global facilities.

Topic: Decision Making During Response

There were some questions on how shippers and carriers manage operations during disruptions. Do the shippers dictate routes and plans, or do they allow their carriers to make these decisions?

A large carrier noted that they do it both ways, because they act as both internal and contracted carriers. Their rule of thumb is the owner of the asset on the ground makes the operational decisions.

A large manufacturer confirmed this approach. Carriers make the primary decision. During a disruption, the carrier will get the first-hand information. We can use this information to see if we need to totally change the mission or divert them to a different distribution center.

A large carrier commented that shippers should approach their carriers to have their help in determining where available capacity can be found. Then as the carrier, I'm going to decide what route is safe, where I can get fuel, and how I can keep our assets moving. Then we're going to talk to our customers. Most carriers will work with their individual customers to figure out their priorities. So to some degree, we're going to be the middle person and understand what the general capacities and capabilities of the system are, then specific needs of users. Somehow we'll work those priorities out. So a lot of it is being the input gatherer and then coordinate the decision process.

6.2. Session 2: Managing Risk and Responding to Disruptions

6.2.1. Presentation Summary

Craig Babcock, Business Continuity Manager, for the Product Supply Network within the Procter & Gamble Company (P&G) presented on their supply network, specifically business continuity planning and their experience during Hurricane Katrina. The Product Supply Network at P&G is externally rather than internally

focused. The message for this group, according to Babcock, "is that P&G has derived a great business benefit because the company is focused on the consumer. P&G is focused externally on what would make us most efficient and most desired externally, as opposed to an internal focus on how my silo is doing."

The experiences surrounding Hurricane Katrina were probably as much about P&G culture as it was about planning and execution. For example, the primary credo for P&G throughout the disaster was "Putting People First." This included employees, family members of employees, as well as customers and suppliers. P&G believes that with this credo built into the organization, good things will happen. People will rise to the challenge if they are allowed to be entrepreneurial and take business ownership.

New Orleans is home to both the Folger's and Millstone brand coffees. P&G produces more than 50 percent of its coffee in New Orleans with the Folgers brand accounting for 40 percent of all U.S. coffee consumed. The brand is important to P&G, so there was a compelling business need to restore operations when Hurricane Katrina arrived.

P&G typically has plans at every site that are renewed and tested annually for business continuity. The New Orleans plant has had pretty robust hurricane shut down plans for years, which it did execute. P&G started planning well in advance in terms of locating and building facilities in a "smart" way. For example, the main facility at Gentilly is built eight feet above sea level outside of the flood zone and was designed to withstand 30 mph winds.

Babcock noted that the leadership for the coffee brand had two daily conference calls for many weeks. The morning call focused on operational issues while the afternoon call dealt with engineering restoration. One of the key learnings from the event was that a company must have a system of early communications in place in advance of the disaster.

On August 25 Katrina entered the Gulf and made landfall as a category 4 hurricane on August 29. P&G had already started evacuation of personnel by August 27. The Folgers Plant was lucky and did not incur the brunt of the hurricane, suffering only indirect wind and water damage.

P&G did a number of things in order to facilitate keeping employees and families safe. One challenge was actually reaching employees. While the hurricane hit on August 29, P&G could not account for all of its employees until September 19! The local communications infrastructure was completely inoperable and could not be relied on. Another key learning was to not rely on external communications networks. P&G has now upgraded their own internal communication systems so that the company will be able to find people more quickly.

Continuing with the "Putting People First" credo, P&G established employee call-in lines, ensured continuity of pay and work, provided fast cash loans and created an employee relief fund. P&G partnered with the American Red Cross and America's Second Harvest, providing more than $10 million in cash and over 180 truckload shipments of product.

Some successful strategies that P&G conducted included pre-staging generators ahead of Katrina hitting landfall and establishing command centers in two separate locations. Each of the command centers had slightly different priorities. The center located at the Alexandria plant focused on operations while the Baton Rouge center became the restoration command center for engineering, contractors, and suppliers. P&G made extensive use of helicopters to move key personnel between the various sites until roads and bridges were passable.

P&G worked with trucking companies, suppliers, and local authorities to improve the access of trucks in and out of their facilities. The failure of the highway and bridge infrastructure increased transit time in and out of the damaged area by over 3 hours. In order to speed this up, P&G enlisted the local community police who escorted critical vehicles through FEMA and National Guard roadblocks. This was only possible with P&G's prior relationships. The additional transit time also

created a need for re-fueling. To address this, P&G brought in a fuel tank and set it up at a distribution center to re-fuel incoming trucks so they so could get back out.

In order to serve their own employees and their families, P&G had to create their own infrastructure and services. They created their own fire department at the Gentilly site, continuously trucked in water for the first three weeks from Baton Rouge, and eventually dug their own well. Because 60 percent of their employees had major or complete damage to their homes, they decided to provide housing. After investigating many options, to include using cruise ships, they decided to establish their own village with 130 trailers to house the over 500 P&G employees and construction workers. P&G provided around the clock meals (feeding both employees and law enforcement officials). They also set up medical services and other recreational activities.

They found that communication was one of the biggest problems early on. There was no cell phone connectivity. While some personnel had a satellite phone, it did not work particularly well. They eventually decided to mount their own satellite dish so they could get data in and use voice over internet protocol (VOIP) for phone service.

In order to get the plants up and running as soon as possible, P&G brought in people from other operations with coffee manufacturing experience, changed shift hours to more concentrated 7-day bursts, and contracted some outside coffee roasters for additional capacity. By September 17, 19 days after Katrina hit, the plant was running. They had 85 percent capacity by September 23 and hit 100 percent in mid-October.

P&G had several key learnings from this event. They have established a process to better tie together each market's business strategy with the required resources—to include suppliers, infrastructure, talent, etc. This process enables them to determine how much operating capacity to single source, when to use internal versus external capacity, where it makes sense to use multiple versus

single locations, etc. Essentially, sustainability and recovery concerns have been included in the supply chain design process.

Another critical lesson they learned is to maintain communication with their customers on exactly what's happening throughout the crisis. During Katrina, for example, P&G immediately informed all of their large customers of the impact on their operations as well as their plan for recovery. They then kept an on-going dialogue updating them on all progress made.

P&G also noted that one of the key success factors was to promote an environment where people across the hierarchy can become leaders. Management has to give the employees a framework and a target and then trust them to make the correct decisions. People can be very creative on how things get done, they noted.

6.2.2. Discussion and Exchange Summary

Common topics of discussion are grouped together.

Topic: Communications During the Incident

A representative from a carrier commented that for them, the best source of information were the first-hand observers. They were able to ask drivers directly if the roads are passable. They could not rely on the state of Louisiana's DOT. They made specific efforts to identify and talk to their drivers in the area. A secondary source was local law enforcement, if they had a good relationship. The local observation of circumstances was critical.

One reason for this is that truckers usually have the best communication. Between the Qualcomm system and radios, they are able to communicate better than anyone else can outside of law enforcement. Because their onboard systems are usually satellite connected, they are not reliant on cell phones or land lines.

A large manufacturer commented that they too relied on specific drivers to get first-hand details. All parties seemed to pass information back and forth. At one

point, they hired helicopters to provide traffic reporting. All new information was fed out to the supporting carriers as well.

WSDOT commented that they currently do not have the mechanisms to collect that type of data nor disseminate it. WSDOT questioned whether the carrier trusted only their own drivers or other carriers' drivers as well. They replied that it was not that they only trust their own drivers, but that is who they have the most direct contact with. "Our drivers might be on the radio talking to someone else while waiting in line and they would relay that information to us and we'd probably trust that. It's more the connection, the communication network."

A large broker was asked if they had the same kind of mechanism as the individual carrier. They replied that they did—but that it was very informal. "A lot of information was out there because key managers within our organization let people know what routes were open. Information came from the drivers. Every day we were in contact with hundreds of carriers, getting information back and then distributing it out to the rest of the organization to let them know."

An attendee noted that this is really valuable information, but that it seems as if it's used internally for each company. They asked if it makes sense for a central organization, say the state DOT, to collect and disseminate this information?

A large retailer commented that a number of states have set up their own EOCs (Emergency Operations Centers). These EOCs could communicate with each company's base. "Our past experience, however, has been that we were usually feeding them information, rather than getting information from them."

Interestingly, several attendees noted that the information from the drivers is widely distributed to any one who wants to listen. "They [the drivers] don't care—it's a brotherhood that's going to talk about what's happening on the road and it's going to spread like wildfire. They are willing to share beyond their constituents and the people affected. It's a guerilla system that operates so fast that we could spend a lot of time here trying to figure out how to design an

information technology solution that would never be nearly as effective as a guerilla system that operates automatically just by telephone [or CB radio]."

A large manufacturer turned the question around for WSDOT and asked how they would be able to listen or tap into this network that already seems to work very well? WSDOT noted that collecting and disseminating the information may be an appropriate goal for a state or other government entity, but it seems that it is not a high priority need for the private sector since they are already getting the needed information they need from their drivers. The manufacturer pressed the matter by noting that, "By the time you tell us, we'd have known it a long time. It's not a perfect system. There's somebody stuck and the person who is stuck is telling others and they're not stuck. So my question to WSDOT is whether you can come up with preemptive system, so I wouldn't have to send the first one down the pipeline. If the pipeline is going to be closed and I know in advance it's going to be closed, it would be nice to know that , so we wouldn't have the first one [driver] stuck."

One attendee noted that there are examples of such a system. States in the North East corridor from Massachusetts to Washington, DC have an information exchange network that's up and running. It was very heavily used after 9/11. Essentially, a core set of organizations in the New York/New Jersey area feed information on major incidents and the exchange network instantly disseminates the information on major incidents through pagers, fax, and the Web. Unfortunately it was designed in an era of dialup systems and it is now being rebuilt in a Web environment. It doesn't provide instantaneous information on road conditions, but it does provide the police and state DOT managers across that region information on what happens if a bridge closes, for example. It took ten years to get the system built, put the institutional pieces in place, and build relationships with the ultimate users, county sheriffs, state police, truckers, etc.

WSDOT commented that providing current road conditions is good, but that an even higher value of information would be advance notification of or the expected

duration of closure. A trucker on the ground would not know this—but the state DOT might. A large manufacturer concurred noting that pre-emptive information is great. This would keep a company from "sending that first truck down the pipeline." Additionally, knowing how long a road will be down is equally important because it influences what remedial action to take—drive an extra two days to go around or wait it out for a few hours. Those kinds of things can add a lot of value. But, the manufacturer continued, "I would prefer the state and federal transportation agencies look at creating alternatives to increase the [network] capacity rather than just improving communication."

Topic: Controlled Access

It was noted that initially there was no access across damaged infrastructure and then controlled access. There was a curfew, people were stopped, and they had to have a good reason to go through. Several companies noted that they had to step in to ensure that they had unencumbered access through these points. One firm noted that their brand on the trucks made it easier to pass through. They even created placards for for-hire carriers to place them on the trucks, so that it was obvious where the shipments were headed.

One carrier commented that they had to go through a local Parish Police chief for access and that there was substantial confusion between National Guard, federal, Army, regular folks, local police, etc. As WSDOT put it, the problem shifted from being "broken infrastructure to broken authority." Having transportation worker identification cards might have helped here. A railroad noted that while they were able to get authority for passage for their badged employees, getting access for contract workers was a big challenge. One manufacturer concurred. They solved this by bussing in all of the contractors collectively and per-arranging the movement with the local sheriff.

Topic: Applying Key Learnings from Katrina

P&G was asked if they were able to apply their learnings from Katrina to other incidents. They noted that, unfortunately, they had. For example, in a Mexico

plant a pipeline was wiped out for a week, which impacted a number of plants. The personnel at these sites knew about the Katrina experience and had actually looked ahead of time at what key disasters might befall them, and, in some cases, had done a decent job of planning for that.

6.3. Session 3: Industry Response to Humanitarian Disasters

Dr. Edgar Blanco, Executive Director for the MIT – Center for Latin America Logistics Innovation, presented results from a recent project conducted for several companies in the Quick Service Restaurant (QSR) industry.

6.3.1. Presentation Summary

The motivation for this study was a question asked by one of the sponsor companies, "What is the best way for an individual company to support recovery efforts from natural disasters?" The project focused on efforts taken by QSR firms in the aftermath of Hurricane Katrina.

Contributions from both non-governmental organizations (NGOs) and private sector firms totaled over $362 million in direct donations as well as much more as in-kind donations. These relationships took four different types: single company philanthropic partnerships, multicompany philanthropic partnerships, single-company integrative partnerships, and multicompany integrative partnerships.

The type of support provided differed by organization. The American Red Cross (ARC) provided both basic medical care and basic amenities while American Second Harvest (ASH) provided basic sustenance to displaced families. Private sector firms also participated. WalMart provided amenities and CVS Pharmacy provided both basic medical care and amenities, while Dunkin' Brands and McDonalds provided basic sustenance.

Dr. Blanco then went into detail on what several companies did during the crisis. We will discuss two: Dunkin' Brands and a large food distributor. Dunkin' Brands approached major relief organizations (e.g. ARC, Salvation Army, and ASH) to understand how they could support their operations. They then collaborated with Chef John Folse & Co. to deliver hot meals to relief victims. This relationship came from personal friendships between senior management in each firm. They also supported first and second responders by providing coffee and donuts and ran a clothes drive amongst their employees.

The most important task they undertook was deciding to contribute through NGOs (ARC/ASH/Salvation Army) rather then directly to victims on their own. There are many examples where firms tried to support victims directly but did not have sufficient coordination to perform successfully. Collaborating with NGO's and other organizations (like Chef John Folse & Co.) allowed each organization to play to their own strengths. It was also thought, in retrospect, that the clothes drive was less successful, since these tend to not collect the clothing or other material that is needed the most.

The large food distributor did similar things during the crisis. They too decided to deliver product to major relief organizations (e.g. ARC, Salvation Army and ASH) rather than directly to victims. They provided the American Red Cross with mobile kitchens and leveraged their own private fleet to move products to the impacted region.

From these case studies, the research team created a framework to help firms determine how to work with other companies during crises. The framework consists of two dimensions: consumer/beneficiary reach and logistics control. Reach is a measure of an organization's ability to provide support to the affected population and areas in terms of coverage, density, and commitment. Control is a measure of the level of supply chain expertise in the organization where low control means the function is outsourced, while a high level of control indicates an end–to-end supply chain.

Any organization can be classified to fit within one of the quadrants in this two-by-two matrix. The role that each entity should take is determined by where it falls within this framework. For example, a high control/low reach organization should sustain and support aid flow. These include most large food distributors. Low control/low reach organizations are usually good sources of raw material and services. Examples in the Katrina example include Chef John Folse & Co., as well as Dunkin' Brands. High control/high reach organizations are usually strong at being first in recovery; examples include, WalMart, CVS, McDonalds, and other QSRs. Finally, those in the low control/high reach quadrant play a large role collecting and funneling material to the most needy.

Dr. Blanco explained that NGO and relief organizations can be classified in the same matrix as well. American Second Harvest, for example, fits in the low control/low reach category, while the American Red Cross and the Salvation Army are examples of the high control/high reach category. Finally, most faith-based organizations and local charities fit in the low controlhigh reach category.

6.3.2. Discussion Summary

Topic: Relationships Between NGOs and Government Agencies

Attendees asked about the relationship between these organizations. Dr. Blanco explained that it depends on the level of the relationship. For example, at the national response level, predetermined protocols are set up to interact with state agencies and the ARC is part of that plan as third responders for mass care. ARC's role is sanctioned as is the role of the Salvation Army. ARC provides shelter, basic first aid, and some bulk distribution. Once an emergency is declared, ARC already has its mandates set.

The president of a carrier asked about the future role of FEMA in directing aid organizations. Dr. Blanco noted that there were several problems on response. Prior to Katrina, FEMA did not have full authorization for pre-positioning ahead of the disaster occuring. The private sector, of course, did not have this limitation and the key to success at WalMart, CVS, and even Dunkin' Brands, to some

degree, was their ability to position key material ahead of the crisis. FEMA is clarifying some of guidelines so they can act more quickly without necessarily getting numerous state approvals.

Dr. Blanco noted that the study did not focus much on government relationships. However, most of the organizations that were studied complained about a lack of information from state governments. Those that tried to approach state agencies found that the people might be willing to help, but they were unclear on how they could help and did not have the right information.

Topic: Lessons Learned

A representative from the USTRANSCOM asked whether there were lessons learned from the Katrina recovery that were applied to the recent California fires. Dr. Blanco noted that FEMA was able to move resources much faster into the affected areas for this new crisis due to lessons learned from Katrina.

A large retailer noted that while the scale of the two crises was very different there were several things learned from Katrina. They knew to immediately put together a focal point within the organization to help make the transition from response to recovery. That team was responsible for contacting local authorities and internal experts for assistance.

A medical devices manufacturer noted that they have three manufacturing facilities in Tijuana and that the border was closed for several hours. This delay impacted their operations for moving finished product to market. They were also concerned about the quality impact on their products being shipped through the area. They had to examine alternative routes for their product through California—but since their sterilization and distribution facility was in Ontario, CA (just north of the affected areas) it would be a very circuitous route. Fortunately the fires were contained within a few days so the situation resolved itself before drastic action had to be taken.

6.4. Session 4: Final Discussion

Topic: Relaxing Policies During Disaster

An executive from a railroad noted that they use construction contractors that are on standby with prearranged unit costs. This enables them to react very quickly to any local disaster. "We just press a button and they are there with their stuff." Can a state DOT do the same thing? WSDOT noted that they do not have that in place. They do relax some policies during crises, such as extending drivers' hours services requirements, or allowing oversize and overweight loads. He noted that, "The idea of relaxing standards when people (drivers) are already tired and stressed sounds terrible to me."

It was noted that CC Meyers won a contract to rebuild the recent on-ramp collapse near San Francisco and got millions of dollars in bonuses for it. The FHWA commented that a number of states have authority to do design-build, and they can let contracts very quickly under emergency situations. This is a state by state function rather than a national issue.

The president of a trucking firm commented that the suspension of hours of service regulation is usually because of circumstances on the ground. However, there should be a prearranged protocol for doing this. The FHWA commented that hours of service is a federally mandated carrier function, but that regional FMCSA (Federal Motor Carrier Safety Administrations) have the authority to waive hours of service. For size and weight, however, no state DOT or even the federal government has the authority to waive any of those requirements. These are all congressionally decided. What a state DOT can do, if there is an oversized or overweight load, for example, is to issue permits for any overweight loads. They have authority to do that. The burden is on the industry to tell permitting officials what they want to do.

Topic: Arrangements Made in Advance to Deal with Disruptions

Attendees were asked what kind of arrangements they made in advance to deal with potential disruptions. One Third Party Logistics Provider (3PL) noted that they created a network with some of their carriers across the country to have pre-agreed pop-up fleet capacity. If there is a disaster on the West Coast or storm in the East, they would call these carriers up and make sure of some minimal continuity of capacity. The key, he noted, is convincing people to spend the time for pre-planning, testing plans, etc., because it costs money, takes time, and is often viewed as a wasted expense. A carrier noted that they try to pre-position equipment, to get it into the area, whether that's a trailer pool, whether added utilization from casual workforce, all the things trying to put in place.

A carrier noted that they spent a lot of time establishing a protocol between the state police and the state DOT. These are very informal relationships, but it is a mechanism for passing information back and forth. They also belong to a Commercial Vehicle Safety Alliance which includes state DOT officials and state police. They attend those meetings along with other industry associations such as American Trucking Associations.

Topic: Prioritizing and Rationalizing Assets

An attendee noted the importance of system rationalization during recovery, specifically, that the public sector will decide who gets priority to use the system. A large manufacturer noted that he did not think that this was doable, but, "if you want to put our stuff first, I'm okay." A state DOT noted that, "You are either going to allocate by some explicit mechanism or by queueing. You decide." The manufacturer continued that the state DOTs should determine when to divert traffic and use available arterials instantaneously. Transportation folks expect the public sector to keep the infrastructure up and running and conduct recovery planning for the private sector. "Think about it like you're a plant manager. Your job is you {public sector] own this road system and you're supposed to be generating and operating availability with it, and your job is to, regardless of what happens, have it operating and available."

As to setting priorities, this is more difficult. "There is no way to determine a prioritization agreement across all the different industries. For example, suppose we had to decide whether to expedite the transportation of blood supply, deliver fuel to restoring electricity, or bring in machinery to keep a hospital running. With just those three choices we could sit in a room for three months and not come up with a decision. The government needs to do this. And, the best way is to make it with economics. Let the economics rule, because that's really the best prioritization method we've ever come up with." Rationing of assets, an attendee noted, is being done today through the use of high occupancy vehicle (HOV) lanes as well as the new High Occupancy Toll (HOT) lanes, where a single occupancy vehicle can pay their way onto less congested lanes.

A carrier noted that with the increase in private ownership of network infrastructure, there might be more of these types of creative rationing schemes coming into practice. Rationing will be made on an economic basis.

An attendee noted that Hurricane Katrina is a good case study of the government rationing access. "It's not written up much, but the power outages shut down the pumping stations for the petroleum lines that feed most of the East Coast and Midwest, and basically we were within a day or two of running out of fuel in much of the Midwest to the South Central part of the U.S. The Office of the Secretary rationed the allocation of generators and transportation services into the petrochemical industry in New Orleans in order to ensure you didn't bring the Central and East Coast to a halt. That was a pure economic and social security issue. They stepped in and said 'Thou shalt move these generators to the following.' That was a very considered economic action by the Secretary's Office."

An attendee noted that this action was taken during the response phase not during recovery. This is a good example of doing something in response mode that might make sense locally, but could have large scale ramifications later on for other regions.

7. Appendix

King County Hazard Mitigation Plan: HIVA (pages 5-57 through 5-61)

Transportation

Introduction

Transportation systems available in King County include air, rail, water and road. All of these systems and supporting transportation resources provide services on a national, regional and local basis and are critical to local, regional, national and international commerce. While highway traffic accidents are a daily occurrence, transportation accidents with impacts to local commerce or resulting in transportation diversions are fairly rare.

High Probability Low Impact	High Probability Moderate Impact	High Probability High Impact
Moderate Probability Low Impact	Moderate Probability Moderate Impact	Moderate Probability High Impact
Low Probability Low Impact	Low Probability Moderate Impact	Low Probability High Impact

Hazard Identification

King County is a transportation hub in the northwest. Major highways, air transportation, railroad operations and a deep water marine port all exist in King county.

Highways: Privately owned vehicles and local bus services traveling on area freeways, highways and roads provide the primary means of transportation for individuals in King County. The principal north-south arterials are Interstate 5 and Interstate 405. Interstate 90, which connects Seattle with Spokane and points eas is the most heavily traveled east-west corridor. US Highway 2 crosses the Cascac Mountains in northeast King County at Steven's Pass. The two Floating Bridges over Lake Washington link Seattle to the eastern portion of the county as well as eastern Washington, Idaho, Montana and other states.

Air Transportation: The largest airport in King County, for both passenger and carg traffic, is the Seattle-Tacoma International Airport, where domestic and internation service is provided by several major airlines. Sea-Tac is the largest airport in Washington and was ranked 18th in the United States for passenger carriage in 1998.[53]

[53] Washington State Department of Transportation Aviation Division Report on the Economic Impac of Seattle-Tacoma International Airport, http://www.wsdot.wa.gov/aviation/EconImpacts/NWR/SeaTac.pdf

Sea-Tac generates substantial economic impacts to the region, as shown by the total combined direct output of on-airport tenants and general aviation and air carrier visitors, which was approximately $11.6 billion. Additionally, these expenditures were responsible for approximately 94,952 jobs, generating $1.8 billion in wages. Sea-Tac also provides numerous secondary impacts to the King County area through visiting passengers and airport-dependant firms, accounting for 22,486 jobs and posting wages of $1 billion. The total employment impact of Sea-Tac stands at approximately 146,245 jobs earning $3.6 billion, while the sum total impact of economic activity was $16.9 billion.[54]

Rail Transportation: Rail Carriers in this area include Burlington Northern and the Union Pacific for freight traffic, and Amtrak for passenger travel. North-South railways travel along the coastline though much of King County. East-West rail traffic primarily uses Steven's Pass, traveling a 7-mile tunnel through the Cascade Mountains. Sounder commuter rail service is initially providing one-way service during peak hours between Tacoma and Seattle on weekdays, while service will eventually be expanded to operate along the entire 82-mile track between Everett and Lakewood.[55]

Marine Transportation: As with other modes of transportation, there are both passengers and cargo transported in King County. The Washington State Ferry System provides the primary means of marine passenger transport in our region with four ferry terminals located in the County jurisdiction. In 1995, 1256 different ships made 3,619 calls to Puget Sound ports either through the Straits of Juan de Fuca or the Straits of Georgia.[56]

Washington State Ferries is the largest ferry transit system in the United States and one of the busiest, carrying over 25 million riders in 2003, and is the largest transit system in Washington State, second only to King County Metro. Commuters make up about 50% of the annual ridership, as exemplified by the busiest commuter route, Bainbridge to Seattle, where 20,000 people are carried in an average day.[57] Additional water transport systems exist with the Port of Seattle and numerous private marine facilities located on Puget Sound, Lake Union and Lake Washington, which provide services and docking facilities for marine cargo and tanker traffic.

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[54] Washington State Department of Transportation Aviation Division Report on the Economic Impacts of Seattle-Tacoma International Airport, http://www.wsdot.wa.gov/aviation/EconImpacts/NWR/SeaTac.pdf

[55] Pierce County Department of Emergency Management, Hazard Identification and Vulnerability Assessment, Technological Hazards: Transportation Accidents, http://www.co.pierce.wa.us/pc/abtus/ourorg/dem/techaz.htm

[56] Washington State Office of Marine Safety, Vessel Entries and Transits for Washington Waters, 1995, p B2.

[57] Washington State Ferries: An Introduction to the Largest Ferry System in the Nation, http://www.wsdot.wa.gov/ferries/pdf/WSFLargest.pdf

Transportation Impacts

The Puget Sound region is vulnerable to all types of transportation emergencies. Growth in this region will continue to increase the risk of transportation accidents.

Highways: King County is likely to experience an increase of accidents along our highways as congestion increases. Many accidents involve rain, high speeds, and heavy traffic. These conditions are certainly not unique, as rain and fog are common, especially during the winter months, while heavy traffic and high speeds are common throughout the year. The bridges in King County play an important role in commerce and in the daily commute. Thanksgiving Day weekend in 1990, a span of the I-90 floating bridge over Lake Washington sank. While the span was replaced and a second bridge built, traffic patterns were disrupted for two years.

Air Transportation: The Puget Sound region is vulnerable to two types of major air transportation accidents. One is a crash involving a large passenger aircraft, while the other is an airplane crash causing casualties on the ground. Despite the large number of planes flying over heavily populated areas, the number of crashes killing or injuring non-passengers is quite small. In general, crashes are most likely to occur within five miles of an airport, typically along flight paths. The area within a five mile radius of airports in the Puget Sound region are heavily populated and therefore could result in a mass casualty event if a plane crashed in these areas, even if the plane itself was not a passenger aircraft. Weather is a significant factor in these air transportation accidents. Down bursts, thunderstorms, and ice are the primary weather-related events that increase risk.

Sea-Tac Airport is becoming as congested as some of the nation's major airports including Chicago's O'Hare and New York City's Kennedy airports. Currently, King County International Airport averages 400,000 flights per year while Sea-Tac is reaching its design capacity with 350,000 flights per year.[58] The proximity of King County International Airport's flight path also increases the risk. The flight paths for these two airports overlap, increasing the risk of mid-air collisions. With the completion of a third runway, congestion will be reduced, but the total volume of flights over Seattle will probably increase, offsetting some of the benefits of the reduced congestion.

Rail Transportation: An accident involving an Amtrak train traveling through Washington State could result in a mass casualty incident. However, the greatest risk associated with freight trains is a spill of hazardous materials.[59] Nevertheless, with the development of Sound Transit, King County's railway vulnerability will

[58] City of Seattle Emergency Management, Human Caused Disasters: Aircraft Accidents Resource Section, http://www.cityofseattle.net/emergency_mgt/hazards/aircraftAccidents.htm

[59] Transportation accidents involving hazardous materials releases and spills are discussed in a separate HIVA section.

increase, as new hazards may present themselves with the continued growth of this light rail service.

Marine Transportation: In addition to the Puget Sound itself, the region contains many smaller bodies of water. These areas are vulnerable to shipping and boating accidents, as well as those involving ferries. Ferry accidents could result in a mass casualty incident that may be difficult to address, though the United States Coast Guard has the primary responsibility for safety and rescue on the open waterways. Major emergencies associated with freight vessels though, are more likely to result from spills or collisions with passenger vessels.

History of Events

Highway Accidents: King County has averaged around 117 traffic fatalities during the past nine years.[60] Past history also shows the potential for major incidents, like a 42 car pileup that occurred in 1996, closing southbound Interstate 5 for four hours, and was responsible for 23 injuries and one death.

Marine Accidents: It is fortunate that the Puget Sound region has not experienced a major incident involving a Washington State Ferry, but with an examination of the history of near misses, one can see that potential for a fatal accident does exist. For example, two incidents in 1994 involved a ferry running aground off Orcas Island, as well as a ferry colliding with a pleasure craft while attempting to dock.[61] Additionally, in the case of freight vessels, a Canadian Study that examined past collisions, accidents, and groundings in the Straits of Juan de Fuca, found that 56% involved bulk carriers, 12% involved container vessels, 12% involved passenger vessels and 18% involved tankers. Tankers are currently the most heavily regulated, as the Exxon Valdez oil spill in Alaska caused Washington State to pass strict regulations on their usage.

Air Accidents: There has not been a major air accident in the Puget Sound region in recent history. However, accidents in other parts of the country allow us to examine the potential vulnerabilities we face in this area. In 1995 there were 175 deaths associated with large scheduled airline traffic and 732 deaths associated with general aviation flights. King County is at risk for these threats, as the region experiences extensive air traffic of both these types. SeaTac airport handles most of the scheduled airline traffic while King County International Airport/Boeing Field handles most of the general aviation traffic. A relatively minor commercial air traffic accident occurred when a Dash 8 commuter plane lost control after landing at SeaTac International Airport. It crashed into the terminal building causing some damage but no deaths or service disruptions.

[60] Washington Traffic Safety Commission, 1993-2001: Fatalities by County, http://www.wtsc.wa.gov/stats/Table3.pdf

[61] Taken from 1997 King County Hazard Identification and Vulnerability Assessment.

Rail Accidents: The Puget Sound region has not experienced a major rail accident in recent history, however recent examples point to the potential for this hazard to occur in King County. For example, a massive landslide in nearby Snohomish County pushed five freight cars into Puget Sound, knocking out 100 yards of track. Railroad-related fatalities, on the other hand, are generally the result of people walking on or near railroad tracks. A 1994 statistic gathered that almost 75% of railroad-related deaths were attributed to such a situation.[62]

Past Mitigation Efforts

The source and location of transportation accidents can vary widely but the response is typically the same. Response is focused on determining the presence or absence of hazardous materials and then assisting the injured. Local emergency managers should work with transportation planners to mitigate current risks associated with major transportation corridors. Additionally these agencies should work together when planning new infrastructure such as the Regional Transit Authority or a third runway at SeaTac Airport to minimize associated risks.

For any type of transportation accident, mitigation involves first and foremost, the following of safety guidelines as well as using caution in unusual conditions or situations. Inspections required on a regular basis on carriers, as well as infrastructure like highways, airports, railroad, or marine systems must be carried through as required by the regulations in place in order to prevent transportation incidents. In addition, as new technology comes into being or new information is gathered as to the cause of transportation accidents, regulations on safety and maintenance need to be updated.[63]

Additionally, local media outlets, as well as King County Department of Transportation take care to keep the public updated of transportation-related emergencies and resulting highway, airport, rail, or ferry delays and closures. The Regional Public Information Network (RPIN) also provides the public with a central source for breaking news by providing links to information being released by a variety of agencies and organizations in central Puget Sound, including those incidents involving transportation accidents.[64] Citizens can subscribe to RPIN to stay abreast of breaking transportation news and other regional alerts.

[62] Taken from 1997 King County Hazard Identification and Vulnerability Assessment.
[63] Pierce County Department of Emergency Management, Hazard Identification and Vulnerability Assessment, Technological Hazards: Transportation Accidents, http://www.co.pierce.wa.us/pc/abtus/ourorg/dem/techaz.htm
[64] Regional Public Information Network (RPIN), http://www.govlink.org/rpin/

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9. State by State Matrix of Transportation Plans

State	Transportation Plan	Transportation Plan Security Section	Transportation Plan Recovery Section	Transportation Plan Risk Management Vulnerability Assessment	Homeland Security Strategy Plan	Emergency Response Plan	Economic Recovery Plan	ESF 14
Alabama	http://www.dot.state.al.us/Bureau/Multi_Modal/AL_Rail_Plan.pdf http://www.dot.state.al.us/TransPlanning/stateplan.pdf	1	0	0		Yes	Yes	Yes
Alaska	http://www.dot.state.ak.us/stwdplng/areaplans/pub/pwsfinal7-01.pdf http://www.dot.state.ak.us/stwdplng/areaplans/pub/SWplanfinalnov02.pdf http://www.dot.state.ak.us/stwdplng/areaplans/nwplanlibrary/nw_cta_chapters.pdf http://www.dot.state.ak.us/stwdplng/areaplans/pub/YKDelta_Plan_final.pdf	0	0	2*		Yes		
Arizona	http://www.moveaz.org/Projects/AboutTheProject.html	1	0	0	Yes	Yes		
Arkansas	http://www.arkansashighways.com/planning/F%20&%20E/SWLRIP02.pdf http://www.cityhs.net/pdfs/mpo/lrtp%20draft%20sept%2015.pdf	2	0	0				
California	http://www.dot.ca.gov/hq/tpp/offices/osp/ctp.htm	3	1	1	Yes	Yes	Yes	
Colorado	http://www.dot.state.co.us/StateWidePlanning/PlansStudies/2030Plan.asp	1	0	0	Yes	Yes		Yes
Connecticut	http://www.cga.ct.gov/2000/pridata/Studies/DOT%20Final%20Introduction.htm http://www.ct.gov/dotinfo/cwp/browse.asp?a=2337&bc=0&c=19776&dotinfoNav=| http://www.ct.gov/dotinfo/site/default.asp	3	1	1		Yes		
Delaware								

State	Transportation Plan	Transportation Plan Security Section	Transportation Plan Recovery Section	Transportation Plan Risk Management Vulnerability Assessment	Homeland Security Strategy Plan	Emergency Response Plan	Economic Recovery Plan	ESF 14
Florida	http://www.dot.state.fl.us/planning/ftp/default.htm	2	1	1	Yes		Yes	
Georgia	http://www.dot.state.ga.us/dot/plan-prog/planning/swtp/index.shtml	3	0	0		Yes		Yes
Hawaii	http://www.hawaii.gov/dot/stp/hstp.htm	2	0	0				
Idaho	http://itd.idaho.gov/newsandinfo/publications.htm	2	0	0		Yes		
Illinois	http://www.dot.state.il.us/5yrstrat.html http://www.cityofdanville.org/COD/Maps/dats%20pdfs/Danville%202030%20LRTP%20Final.pdf http://www.co.sangamon.il.us/Downloads/LongRangePlan2030FinalReport.pdf	2	0	0				
Indiana	http://www.ai.org/dot/pubs/longrange/index.html	2	0	0	Yes			
Iowa	http://www.dot.state.ia.us/motion.htm	0	0	0	Yes			
Kansas	http://kdot1.ksdot.org/publications.asp	3	0	0		Yes		Yes
Kentucky	http://transportation.ky.gov/planning/stp/2006/FINAL.pdf	2	0	0	Yes			
Louisiana	http://www.dotd.louisiana.gov/study/	1	0	0	Yes	Yes	Yes	Yes
Maine	http://www.state.me.us/mdot/planning-documents/planning-docs-home.php http://www.maine.gov/mdot/pubs/pdf/text04-09.pdf	3	0	0	Yes			

State	Transportation Plan	Transportation Plan Security Section	Transportation Plan Recovery Section	Transportation Plan Risk Management Vulnerability Assessment	Homeland Security Strategy Plan	Emergency Response Plan	Economic Recovery Plan	ESF 14
Maryland	http://www.mdot.state.md.us/Planning/Plans%20Programs%20Reports/Index.html	2	0	1				
Massachusetts	http://berkshireplanning.org/3/5/ http://www.ctps.org/bostonmpo/resources/plan/planpp.htm http://www.frcog.org/services/transportation/trans_rtp.php	3	0	1	Yes	Yes		
Michigan	http://www.michigan.gov/mdot/1,1607,7-151-9621_14807_14809---,00.html	4	1	1				
Minnesota	http://www.oim.dot.state.mn.us/Final%202003%20STP%20PDF%27s/2003%20MN%20STP.pdf	2	0	0				
Mississippi	http://www.gomdot.com/research/pdf/SS163.pdf http://www.mdotmultiplan.com/content.aspx?key=mpo_plans	3	1	1		Yes	Yes	
Missouri	http://www.modot.mo.gov/plansandprojects/long-range_plan/longrangetransportationplan.htm	1	0	0	Yes	Yes		
Montana	http://mdt.mt.gov/pubinvolve/tranplan21.shtml http://mdt.mt.gov/publications/brochures.shtml	0	0	0		Yes		
Nebraska	http://www.dor.state.ne.us/lrtp/index.htm http://www.dor.state.ne.us/lrtp/docs/6-2006/FINAL%20Systems%20Needs-Revenues%20atr%20june%2015.pdf	1	0	0	Yes	Yes		Yes
Nevada	http://www.nevadadot.com/reports_pubs/NevPlan/	1	0	0				

State	Transportation Plan	Transportation Plan Security Section	Transportation Plan Recovery Section	Transportation Plan Risk Management Vulnerability Assessment	Homeland Security Strategy Plan	Emergency Response Plan	Economic Recovery Plan	ESF 14
New Hampshire	http://www.nh.gov/dot/bureaus/aeronautics/sasp/sasp-report.htm	0	0	0		Yes		
New Jersey	http://www.state.nj.us/transportation/works/njchoices/	0	0	0				
New Mexico	http://www.nmshtd.state.nm.us/upload/images/Long_Range_Planning_Section/GuidingPrinciples/FulfillingNMDOTs_GuidingPrinciples.pdf	1	0	0		Yes		
New York	http://www.dot.state.ny.us/tranplan/files/masterplan-010906.doc	3	1	1		Yes		
North Carolina	http://www.ncdot.org/doh/preconstruct/tpb/statewideplan/	1	0	0		Yes		
North Dakota	http://www.dot.nd.gov/manuals/planning/TransAction.pdf http://www.dot.nd.gov/docs/planning/DRAFTTransActionII10-24-06.pdf	2	0	0		Yes		
Ohio	http://www.dot.state.oh.us/planning/ACCESS%20OHIO/Final/Final_Doc.pdf	3	1	1	Yes	Yes		
Oklahoma	http://www.incog.org/transportation/destination2030/FinalPlan.htm http://www.acogok.org/Newsroom/Downloads/tip0507prelim.pdf	1	0	0		Yes		Yes
Oregon	http://www.oregon.gov/ODOT/TD/TP/ http://www.oregon.gov/ODOT/TD/TP/ortransplanupdate.shtml	4	0	1	Yes	Yes		
Pennsylvania	ftp://ftp.dot.state.pa.us/public/Bureaus/Cpdm/FinalLRTPGuide.pdf http://www.dot.state.pa.us/Internet/Bureaus/CPDM.nsf/CPMDHomepage?openframeset	1	0	0		Yes		
Rhode Island	http://www.planning.state.ri.us/sgp/pdf/611.pdf	1	1	0				
South Carolina	http://www.dot.state.sc.us/inside/transportation_planning.shtml	1	0	0				

State	Transportation Plan	Transportation Plan Security Section	Transportation Plan Recovery Section	Transportation Plan Risk Management Vulnerability Assessment	Homeland Security Strategy Plan	Emergency Response Plan	Economic Recovery Plan	ESF 14
South Dakota	http://www.sddot.com/pe/planning/project_plan.asp	1	0	0				
Tennessee	http://www.tdot.state.tn.us/plango/home.htm http://www.tdot.state.tn.us/plango/library.htm#FinalDocs http://www.tdot.state.tn.us/plango/pdfs/tup.pdf	2	1	0	Yes			
Texas								
Utah	http://www.udot.utah.gov/dl.php/tid=207/save/2030%20Appendix%20D%20CMPO.pdf	1	0	0				
Vermont	http://www.aot.state.vt.us/planning/Documents/LRTPfinal.pdf	2	0	0	Yes	Yes		
Virginia	http://www.vdot.virginia.gov/about/resources/VDOT_Strategic_Plan_January_2006.pdf http://www.co.stafford.va.us/Departments/Planning_&_Community_Development/Online_Plans_and_Reviews/asset_upload_file159_8230.pdf http://www.vdot.virginia.gov/projects/	1	0	0				
Washington	http://www.wsdot.wa.gov/planning/wtp/	1	0	1	Yes	Yes		
West Virginia	http://www.wvdot.com/domains/mariontrans/plan/	0	0	0		Yes*		
Wisconsin	http://www.dot.wisconsin.gov/library/publications/topic/plans.htm	0	0	0	Yes			
Wyoming	http://dot.state.wy.us/Default.jsp?sCode=hompk	1	0	0				

	Transportation Plan Security Section Legend
	Transportation Plan is only available at regional level
0	Security is not mentioned in Transportation Plan
1	Security is briefly mentioned but not as a separate section
2	Security is mentioned with safety as a separate section in Transportation Plan
3	Security is mentioned as a separated section in Transportation Plan
4	Security Technical Report
*	The report was written in 1997
	Transportation Plan Recovery Section Legend
0	Recovery is not mentioned in Transportation Plan
1	Recovery is briefly mentioned but not as a separate section
2	Recovery is mentioned as a separate section in Transportation Plan
3	Recovery Technical Report
*	Alternative
	Transportation Plan Risk Mgt Vulnerability Assessment Section Legend
0	Vulnerability assessment is not mentioned in Transportation Plan
1	Vulnerability assessment is briefly mentioned but not as a separate section
2	Vulnerability assessment is mentioned as a separate section in Transportation Plan
3	Vulnerability Assessment Technical Report