THE CONSEQUENCES OF INCIDENT CONGESTION IN FLORIDA: AN EXPLORATORY ASSESSMENT

FINAL REPORT

Prepared for the
Florida Department of Transportation
Office of Policy Planning

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Center for Urban Transportation Research
University of South Florida

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Executive Summary

This report is the result of a Florida Department of Transportation (FDOT) research task targeted to address the role of incidents in contributing to predominately non recurring congestion in Florida. It is one of the tasks in the Trends and Conditions research program initiated in 2002 by the FDOT Office of Policy Planning. The work scope spelled out the following principal goal:

> *This trends and conditions task will research the current congestion situation in Florida on the Florida intrastate system. The current extent of congestion and trends will be quantified, the nature of the congestion (incident versus recurring) will be explored and the implications of addressing the congestion will be discussed. Particular attention will be directed at incident congestion with the intention of identifying policy issues and strategies that might be directed at addressing incident congestion.*

An underlying premise in this initiative is that the congestion levels on Florida's roadways are increasing and hence various strategies, such as incident mitigation, are ever more important in helping to minimize traveler delay. Incident management has two very important goals. The first and most important is to protect or secure the welfare of the public by quickly responding with appropriate medical and other aid to involved parties and securing the site so that other travelers or nearby parties are not impacted as a result of the incident. The second goal is to restore normal functioning of the roadway quickly such that the traveling public will not be negatively impacted by the incident any longer than necessary. This initiative explores the second factor, thus, addresses only part of the overall set of considerations that go into incident management program decisions.

This report provides an overview and initial discussion of incident management and congestion and reviews incident and non-incident congestion and their relationship to roadway volume and incident frequency. The focus then shifts to explore a sketch planning strategy for evaluating incident congestion. This was carried out by utilizing a sketch planning model developed for FHWA and integrating that spreadsheet model with data from the Florida Decision Support System (DSS) databases. This strategy is applied using preliminary Florida data and some observations and conclusions are presented.

The focus of this effort was to explore development of an overall strategy. Subsequent decisions regarding method refinement, data updating, and application within Florida will be required by the Florida Department of Transportation should there be an interest in utilizing such an assessment strategy to support FDOT incident management resource prioritization. The proposed strategy provides a sound foundation for potential use by FDOT should there be an interest in using congestion relief as a criterion in prioritizing incident management priorities.

The preliminary results suggest that much of the congestion mitigation benefit of incident management would be concentrated on a relatively modest share of the system. It is also clear that additional data on Florida specific incident distribution, duration, and roadway conditions will be required to refine the data base of the assessment tool. The identified methodology could be incorporated within a broader database/decision management system by incorporating the spreadsheet analysis capabilities within the larger decision support program.

There are a number of promising areas for additional analysis. Florida may be well served by continuing to explore overall incident management priorities through refinements of the assessment tool while simultaneously carrying out more intensive corridor level programs for incident management and congestion management at a local level.

Chapter 1

Over the past few decades, the increasing prevalence of congestion has received growing attention from transportation planners, the mainstream media, and the public at large. It is common for transportation issues, congestion, and growth management to be discussion items everywhere from dinner tables to legislative chambers. In the fall 2002 elections, in spite of a slow economy, 25 jurisdictions across the country had transportation funding referendum questions on the ballot. As one Seattle columnist reported, “Congestion has traffic backed up onto the November ballot.” The media have acknowledged this growing interest with congestion articles being featured in many publications. City congestion rankings, census travel time data, and various other comparative analyses of congestion are aggressively reported.

The social and economic impacts of congestion are being explored and the linkages between economic development, quality of life, and travel congestion are being examined in everything from urban area attractiveness rankings to chamber of commerce literature to academic research. The Texas Transportation Institute’s (TTI) *The 2003 Urban Mobility Report* (1) calculated direct time and fuel costs of congestion for 75 major urban areas as nearly $70 billion annually. Approximately half of the urban congestion measured by TTI is attributed to incident congestion with the other half associated with recurring congestion as a result of capacity shortages. A recent report by the American Highway Users Alliance, *Saving Time, Saving Money: The Economics of Unclogging America’s Worst Bottlenecks*, indicated that total nationwide economic benefits from eliminating bottlenecks range as high as $336 billion (2).

The U.S. Department of Transportation has acknowledged both the congestion problem and the role of incidents in contributing to congestion delay by, among other things, publishing the report *Sketch Methods for Estimating Incident-Related Impacts,* Cambridge Systematics, 1998 (3). Florida is developing its own mobility performance measures and specifically addresses the issue of congestion and has acknowledged the role of incident management in numerous initiatives including investment in traffic management and intelligent transportation systems such as *iFlorida*, research initiatives, and programs for incident management on priority facilities. Activities include the establishment of a Statewide Incident Management Program by the FDOT Traffic Operations Office. The establishment of this program resulted in the adoption of an "Open Roads Policy" which resolves that state incident response agencies will coordinate and communicate better to achieve the goal of clearing all incidents from the roadway within 90 minutes of the arrival of the first responding officer.

Additionally, Freeway/Incident Management Teams have been established in the majority of Florida's urban areas to address policy, and technical issues to improve safety and clearance of incidents on Florida's intrastate system. The ITS Office has also developed a 10-year Cost Feasible Plan, based on ITS Implementation Plans developed for Florida's Intrastate Highway

System, which funds and supports the implementation of Freeway and Incident Management Systems along these important corridors to save lives, time and money.

This report is the result of a Florida Department of Transportation (FDOT) research task targeted to address the role of incidents in contributing to predominately non-recurring congestion in Florida. It is one of the tasks in the Trends and Conditions research program initiated in 2002 by the FDOT Office of Policy Planning. The work scope spelled out the following principal goal:

> *This trends and conditions task will research the current congestion situation in Florida on the Florida intrastate system. The current extent of congestion and trends will be quantified, the nature of the congestion (incident versus recurring) will be explored and the implications of addressing the congestion will be discussed. Particular attention will be directed at incident congestion with the intention of identifying policy issues and strategies that might be directed at addressing incident congestion.*

Mid-course guidance in light of evolving FDOT priorities heightened the interest in the role of incident management and coordination with other FDOT intelligent transportation system initiatives and incident management research such as the projects *Best Practices for Traffic Incident Management in Florida*, and *Incident Management Team and Resource Development*, also being carried out by CUTR for FDOT.

Data availability resulted in the analytical component of this effort focusing on higher speed segments of the FIHS. Specifically, the *Sketch Methods for Estimating Incident-Related Impacts* was applied to roadway segments in the Decision Support System (DSS), an FDOT information management program used to support resource programming and policy decision-making, that have roadway speeds in excess of 50 miles per hour. This also served to shift the emphasis to higher class facilities with a larger share of non-urban roads.

Incident management has two very important goals. The first and most important is to protect or secure the welfare of the public by quickly responding with appropriate medical and other aids to involved parties and securing the site so that other travelers or nearby parties are not impacted as a result of the incident. The second goal is to restore normal functioning of the roadway quickly such that the traveling public will not be negatively impacted by the incident any longer than necessary. This second goal is the one that received the most attention in the context of this research effort. While these goals are very complementary, this initiative explores the implications of incidents on Florida congestion at the aggregate level and offers some observations on the significance of the issue, the prospects for change and the strategies that might be appropriate in Florida.

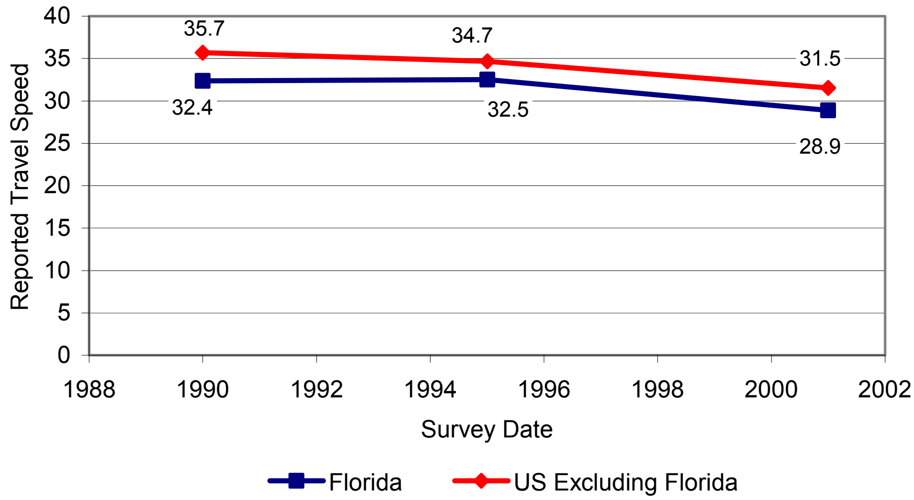
This report is organized into five chapters. The first chapter provides an overview and initial discussion of incident management and congestion and reviews incident and non-incident congestion and their relationship to roadway volume and incident frequency. The second chapter, titled *Methodology for Incident Congestion Impact Assessment,* discusses the evolving understanding of congestion, specifically existing methods for incident based congestion measurement. The third chapter, *Application of Sketch Planning for Incident Congestion Assessment*, discusses the sketch planning strategy for assessment applied in this effort. The fourth chapter, *Opportunities for Incident Congestion Reduction in Florida,* describes the screening of Florida data to identify the allocation of incident congestion across Florida facilities. The final chapter, *The Role of Incident Management in Congestion Reduction*, addresses in summary fashion each of the following areas: state of knowledge regarding non-urban incident management strategies, summary of congestion impacts of incident management program scenarios, observations on incident management as a congestion mitigation strategy, and policy implications of incident management.

The Case for Growing Congestion

An underlying premise in this initiative is that the congestion levels on Florida's roadways are increasing and hence various strategies, such as incident mitigation, are ever more important in helping to minimize traveler delay. The next few pages present information that portrays congestion levels and trends.

Figure 1.1 portrays recent data on the trends in travel speed for travelers on Florida's roadways. The declines in speed are an indication of congested roadways impacting the attained speed of travelers. This data set, from the National Household Traveler Survey (NHTS) carried out for the U.S. Department of Transportation, represents a sample of traveler-reported travel speeds. This decline in speed is contrary to prior historical trends. Travel trends showed both a shift of the share of travel on to higher speed roadways and freeways and growth in travel on previously less congested, and hence faster, suburban roads. In addition, there has been a shift in the share of travel by auto, the fastest travel mode. These trends had been enabling travel speeds to increase for travelers in spite of growing volumes. The newest data suggest the opportunities for shifting to other less congested or faster roads are less available as the overall network has gotten more congested.

Figure 1.1 National Household Travel Survey Data, Travel Speed Changes for All Trips



Source: CUTR analysis of NHTS data.

Table 1.1 shows the Census journey-to-work change in commute times. While full data are not yet available to determine how much of the travel time increase is a result of longer distances versus slower travel speeds, preliminary evidence including that on trip speed presented above and anecdotal data on commute distances associated with sprawl, suggests a combination of both factors contributing to this unprecedented increase in average commute times.

Table 1.1 Census Journey to Work Travel Time

Mean Commute to Work Time (minutes)	1990	2000	Change (minutes)
Arizona	21.6	24.9	+3.3
California	24.6	27.7	+3.1
Florida	21.8	26.2	+4.4
Georgia	22.7	27.7	+5.0
Illinois	25.1	28.0	+2.9
New York	28.6	31.7	+3.1
North Carolina	19.8	24.0	+4.2
South Carolina	20.5	24.3	+3.8
Texas	22.2	25.4	+3.2
Wisconsin	18.3	20.8	+2.5
U.S. Total	22.4	25.5	+3.1

Source: U.S. Census 1990 and 2000

The 2003 Urban Mobility Report from the Texas Transportation Institute focuses on trends and issues that are related to congestion in urban areas. The trend information for this study covers from 1982 through 2001. This data set is unique in that it includes estimates of recurring and incident congestion.

Eight of the subset of 75 United States urban areas studied by TTI are within Florida. These areas include Miami-Hialeah, Tampa-St. Petersburg-Clearwater, Fort Lauderdale-Hollywood-Pompano Beach, Orlando, West Palm Beach-Boca Raton-Delray Beach, Jacksonville, Pensacola, and Fort Myers-Cape Coral. These urban areas are classified according to population. Very large urban areas have populations over 3 million. Large urban areas have populations over 1 million, but less than 3 million. Medium sized urban areas have populations over 500,000 and less than 1 million, while small urban areas have populations less than 500,000. For this study, Miami-Hialeah, Tampa-St. Petersburg-Clearwater, Fort Lauderdale-Hollywood-Pompano Beach, Orlando, and West Palm Beach-Boca Raton-Delray Beach are large urban areas; Jacksonville is medium; and Pensacola and Fort Myers-Cape Coral are small. Table 1.2 contains the population for each of these urban areas for 2001. This table also contains the annual person hours of delay in these urban areas for 2001. This delay is broken down into the recurring delay and the nonrecurring delay associated with incidents.

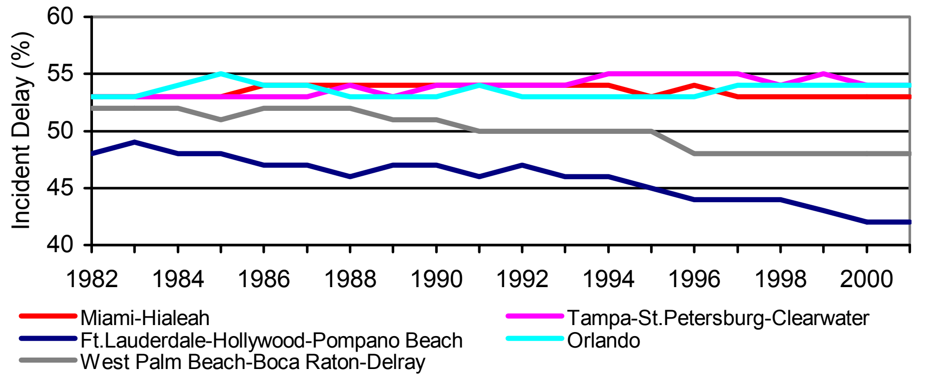
Table 1.2 Population and Annual Person Hours of Delay in 2001

Urban Area	Population (000)	Annual Person Hours of Delay (000), 2000		
		Recurring	Incident	Total
Miami-Hialeah	2,265	35,324	39,945	75,269
Tampa-St. Petersburg-Clearwater	2,000	18,043	22,053	40,097
Ft. Lauderdale-Hollywood-Pompano Beach	1,625	26,849	19,443	46,292
Orlando	1,220	18,592	21,285	40,417
West Palm Beach-Boca Raton-Delray	1,075	10,828	9,996	20,824
Jacksonville	890	6,306	7,402	13,709
Pensacola	305	1,430	1,612	3,042
Fort Myers-Cape Coral	300	1,048	1,135	2,183

Source: *The 2003 Urban Mobility Report* from the Texas Transportation Institute

Figure 1.2 shows the percentage of nonrecurring delay in the large and very large urban areas in Florida. In all the areas, except for Fort Lauderdale-Hollywood-Pompano Beach, and to a lesser extent, west Palm Beach, the percentage of nonrecurring delay has remained relatively constant over the study period. The average delay associated with incidents is about 52% of the total delay in these areas. This is also true for the medium and small urban areas. This result and the nature of the trend line could be a result of the methods used in this study to determine whether the delay was recurring or incident related.

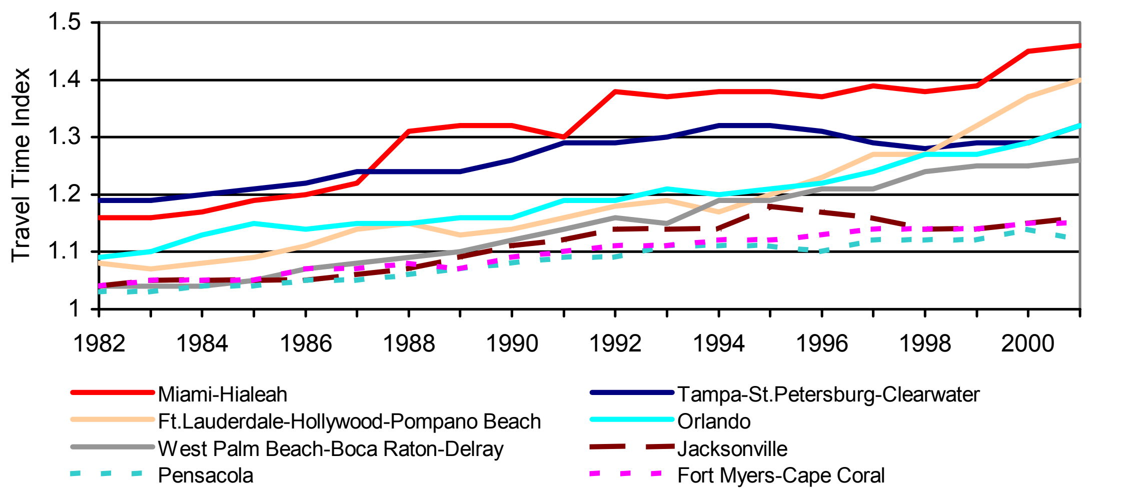
Figure 1.2 Percent of Delay Related to Incidents in Large and Very Large Urban Areas of Florida



Source: *The 2003 Urban Mobility Report* from the Texas Transportation Institute

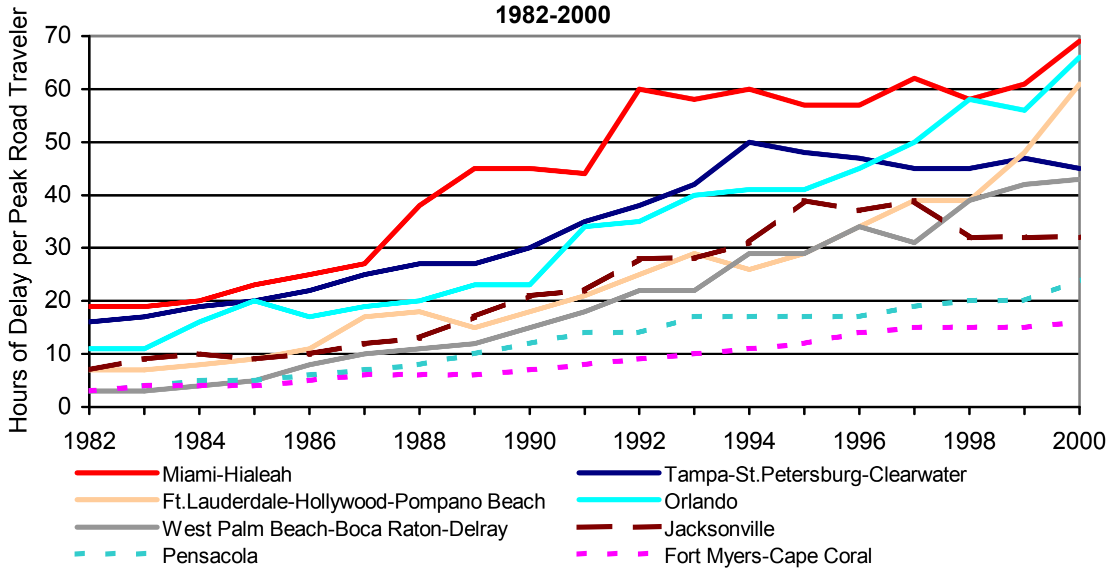
According to the study, the total amount of congestion in all sizes of urban areas is generally increasing. The amount of congestion is generally worse in larger urban areas where density tends to be far higher and the ability to add capacity is limited by right-of-way constraints. Figure 1.3 and Figure 1.4 show the trends for travel time index and hours of annual delay per peak road traveler in the eight urban areas in Florida. "Travel Time Index" is the ratio of the average peak period travel time to the free-flow travel time. The average increase in travel time index from 1982 to 2001 was 0.194 (1.08 to 1.274). The average increase in hours of delay per traveler from 1982 to 2000 was 36 (9 to 45). Figure 1.5 shows the roadway congestion index for the Florida urban areas.

Figure 1.3 Peak Period Travel Time in Eight Florida Urban Areas, 1982-2001



Source: *The 2003 Urban Mobility Report* from the Texas Transportation Institute

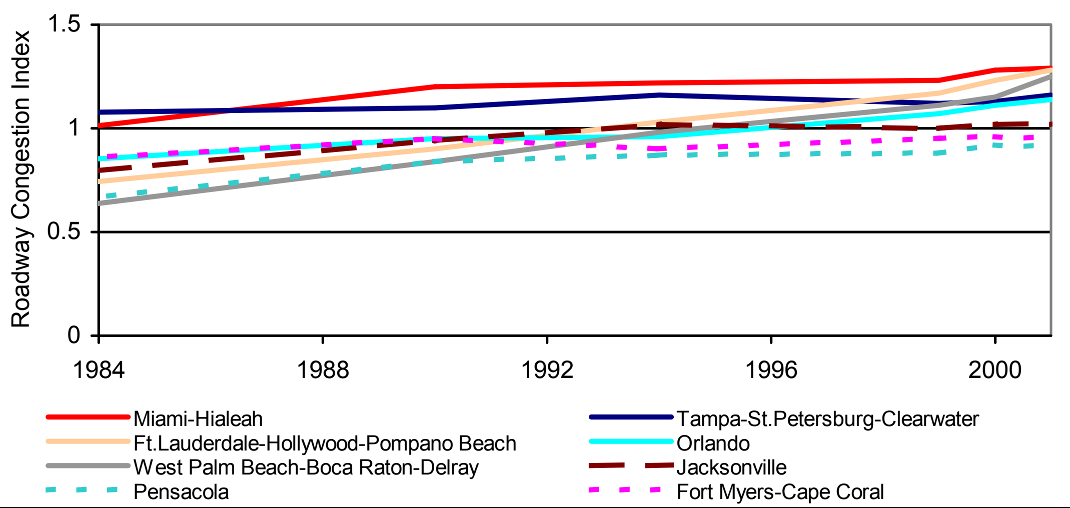
Figure 1.4 Annual Delay per Peak Road Traveler in Eight Florida Urban Areas, 1982-2000



Source: *The 2002 Urban Mobility Report* from the Texas Transportation Institute.

Note: Peak Road Traveler data not available in *The 2003 Urban Mobility Report* data tables.

Figure 1.5 Roadway Congestion Index, 1982-2001



Source: *The 2003 Urban Mobility Report* from the Texas Transportation Institute

Another aggregate perspective on system performance can be gleaned by reviewing the overall trends in roadway use as measured by VMT and roadway supply as measured in lane miles. Tables 1.3 and 1.4 portray the changes in the conditions as measured by VMT per lane mile. This is an indicator of the intensiveness of use of the roadway system on average. A more intensively used system will be more fragile as it relates to the impacts of incidents. Thus, higher volumes per lane mile not only indicate more recurring congestion but also more incident related congestion. Table 1.3 indicates significant changes over the ten-year period covered by the data. All the major facility categories had substantial increases.

Table 1.3 Florida Annual Vehicle Miles per Lane Mile - Rural

(millions)	Interstate	Other Principal Arterial	Minor Arterial	Major Collector	Minor Collector	Local	Total
1992	2,100,248	1,078,025	876,486	347,367	172,731	36,604	254,270
1993	2,282,086	1,108,925	870,006	348,195	175,606	36,499	258,111
1994	2,398,889	1,152,531	735,791	262,702	143,882	36,503	235,149
1995	2,450,038	1,164,775	738,962	264,811	145,972	36,503	238,693
1996	2,493,073	1,188,145	760,052	264,780	141,707	36,597	244,283
1997	2,584,281	1,206,831	765,791	311,216	141,175	36,504	250,798
1998	2,700,629	1,248,115	777,404	317,634	143,776	36,501	255,935
1999	2,795,482	1,304,549	808,554	336,365	154,664	36,500	265,981
2000	2,887,485	1,318,808	825,854	343,153	154,956	36,732	271,786
2001	2,971,197	1,352,002	842,765	399,065	170,586	58,647	373,027
Change from 1992	+41.47%	+25.41%	-3.85%	+14.88%	-1.24%	+60.22%	+46.71%

Source: Federal Highway Administration, Highway Statistics Series, Table VM-2.

Table 1.4 indicates a similar trend for urban roadways. Interestingly, the total increase in percentage terms for rural roadways outpaced that for urban roadways. However, urban roadways still have average volumes over twice as high as rural roadways. The reader should also recognize that some lane mileage is reclassified over time as urban boundaries expand.

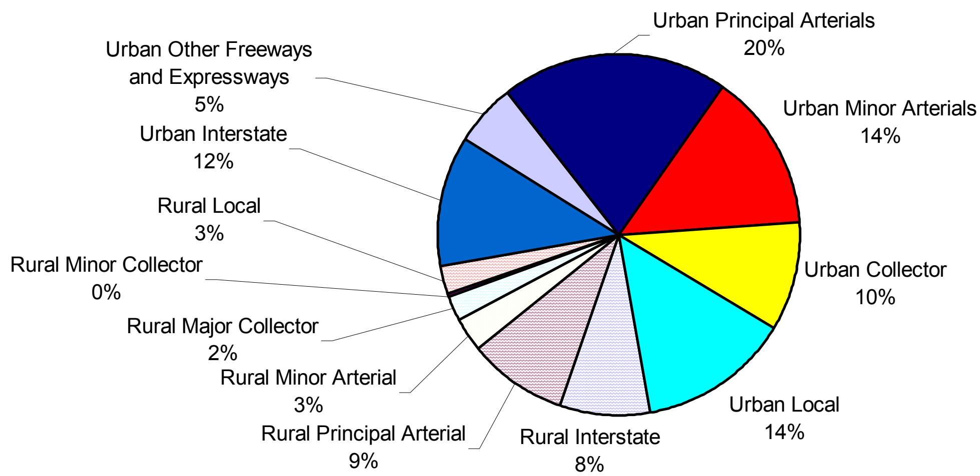
Table 1.4 Florida Annual Vehicle Miles per Lane Mile – Urban and Total

(millions)	Urban							Total Urban and Rural
	Interstate	Other Freeways and Expressways	Other Principal Arterial	Minor Arterial	Collector	Local	Total	
1992	4,940,704	3,519,031	2,460,339	1,908,488	864,031	270,122	754,488	481,482
1993	5,393,322	3,142,041	2,601,145	1,919,687	827,765	269,239	786,197	496,720
1994	5,224,865	3,375,494	2,506,708	1,670,902	694,728	270,357	828,305	500,170
1995	5,428,571	3,486,562	2,543,863	1,765,625	864,982	270,223	874,473	521,969
1996	5,555,436	3,469,542	1,633,795	1,761,272	866,920	271,010	882,048	527,303
1997	5,701,425	3,681,745	2,574,926	1,742,512	911,109	270,581	904,415	541,246
1998	5,625,596	3,802,707	2,611,472	1,762,566	96,938	271,022	921,179	550,419
1999	5,814,628	3,935,300	2,640,690	1,829,778	961,686	271,387	944,216	564,968
2000	6,142,906	3,971,121	2,690,165	2,066,071	1,102,807	289,256	1,007,706	600,502
2001	6,159,513	4,198,428	2,718,658	2,146,857	1,165,496	190,753	774,928	610,555
Change from 1992	+24.67%	+19.31%	+10.50%	+12.49%	+34.89%	-29.38%	+2.71%	+26.81%

Source: Federal Highway Administration, Highway Statistics Series, Table VM-2.

Figure 1.6 shows the shares of overall travel volume by roadway type. This data set indicates that 25 percent of total vehicle volume is on roads classified as rural. Twenty-five percent of all traffic is also on Interstates and other freeways and expressways.

Figure 1.6 Traffic Volume Shares by Functional Classification

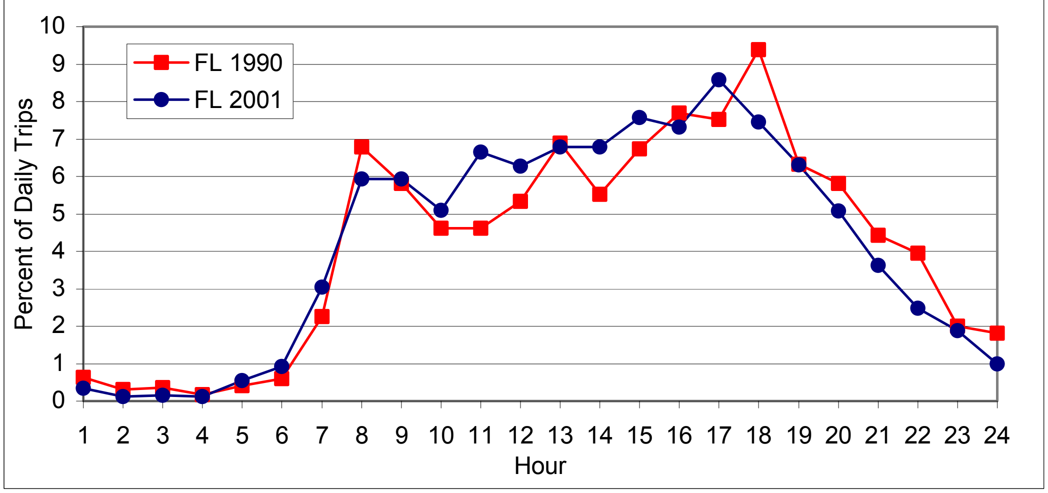


Source: Federal Highway Administration, Highway Statistics Series

Collectively, these data reinforce the commonly held presumption that our roadways are getting more crowded and travelers are experiencing more delays. It is apparent that the crowding is no longer isolated to a few radial urban roadway facilities, as the growth in volumes has occurred across all roadway classifications in both urban and rural areas with perhaps the exception of urban local streets. As indicated in Figure 1.7, this growth in demand has contributed to a flattening of the temporal travel pattern as more travelers shift travel to off-peak time periods. Figure 1.7, developed from National Household Travel Survey data and Nationwide Personal Travel Survey data, indicates a filling in of the midday peak and a flattening of the morning and evening peaks. This suggests that capacity constraints precluded the shares of travel from rising in those peak periods and, as a result, more of the growth in overall travel has to be accommodated in the midday travel periods. Thus, higher volumes mean more sensitivity to delays when subject to an incident. These higher volumes are occurring on more of the system in Florida and during more hours of the day.

The extent of volume on the roadway system is relevant in the context of our knowledge of how the roadway segments respond to various volume levels. Fundamental principles of traffic flow dictate that at certain levels of roadway traffic the performance of the system deteriorates, with both speed and volume declining beyond optimal points of capacity that vary with roadway type. We know that the relationship between volume and capacity is not a linear relationship and that when congested conditions are reached, minor additional volume results in ever more significant declines in speed with the driver perceiving congested conditions. Not surprisingly, as these conditions are approached, the system is also more sensitive to incident delays.

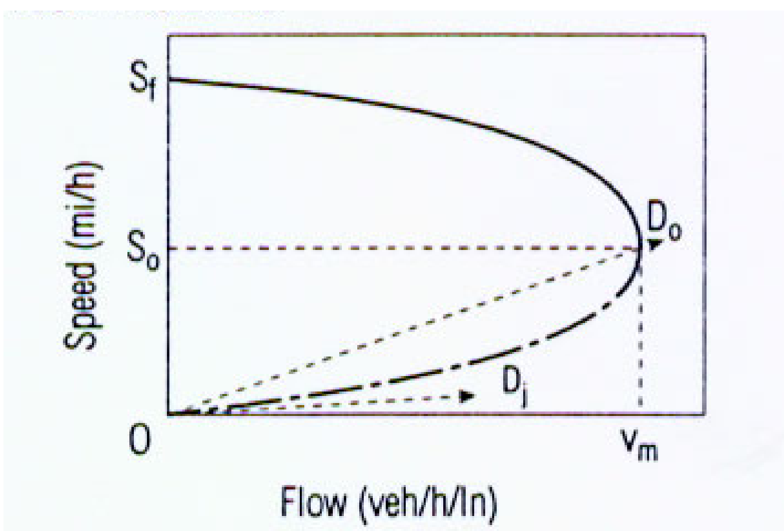
Figure 1.7 Trip Departure Time



Source: National Household Travel Survey

Figure 1.8 shows the classic relationship that governs traffic speed volume relationships. In this figure, S refers to speed, D to traffic density, and V to traffic volume. The tangent point on the right most part of the curve defines the situation where there is optimal volume and traffic density.

Figure 1.8 Generalized Relationship Between Speed, Density and Flow Rate on Uninterrupted Facilities



Source: Highway Capacity Manual, 2000

This figure suggests that as our overall roadway system becomes more congested, it is ever more sensitive to declining speeds and increasing congestion as more segments of the roadway for more hours of the day are subject to volume conditions characteristics of the areas to the right on Figure 1.8. In light of this situation, and given the evidence of far higher volumes occurring on our roadway system, prudence dictates exploring all promising strategies for minimizing traveler delays. Thus, this effort will focus on exploring the magnitude of the possible benefits from strategies to minimize incident delays in major intercity roadway facilities in Florida.

Subsequent chapters document our exploration into each of these issues in greater detail and provide recommended strategies for ongoing estimation of the significance of incident management in the context of a more fragile roadway system.

Chapter 2

Methodology for Incident Congestion Impact Assessment

This chapter documents the methodology that was selected in order to develop an assessment of the impact of incidents on congestion. Congestion is only one of many reasons why incident management is an important aspect of roadway management and certainly a minor factor relative to the safety consideration in developing incident management strategies. Thus, the goal of congestion mitigation is only one factor that will influence the design, implementation, and operation of incident management activities.

Roadway incidents can affect the safety of other travelers, persons near the incident and responders as well as the mobility of the traveling public using the affected roadways. The incident itself, spillage, fires and debris from an incident can be a threat to nearby persons. This might include businesses or residents in the vicinity, other travelers on the roadway or emergency personnel responding to the incident. In 1999, over half of the police officers killed in the line of duty died in traffic crashes. Nearly 10,000 police cars, 2,000 fire trucks, and 3,000 other service vehicles were struck while going to or at traffic incidents. Crashes that result from other incidents make up 14-18% of all crashes. These secondary crashes are estimated to cause 18% of deaths on freeways (4). For a richer understanding of the full range of issues and factors associated with incident management, the reader is encouraged to review the *Proceedings of the National Conference on Traffic Incident Management,* held on March 11-13, 2002. The American Association of State Highway and Transportation Officials (AASHTO), the Federal Highway Administration (FHWA), the Intelligent Transportation Society of America (ITSA), and the Transportation Research Board (TRB) sponsored the conference. The proceedings, available at http://www.ops.fhwa.dot.gov/Travel/IncidentMgmt/timconf/TIMconf.doc, document the state of research and thinking with regard to incident management.

Incidents and incident management also adversely affect traveler mobility and productivity. Well over half of non-recurring traffic delay in urban areas, and a growing share in rural areas, is a result of traffic incidents (ibid). Integrated traffic incident management (TIM) is emerging as a proven solution to address these safety and mobility concerns. Traffic incident management is a planned and coordinated process to detect, respond to, and remove traffic incidents and restore traffic capacity as safely and quickly as possible. It involves the coordinated interactions of multiple public agencies and private sector partners.

Over the past ten years, organizations have sponsored initiatives to determine the state of the practice, develop guidance in creating traffic incident management programs, document successful practices, assess needs, and provide training and education. Some examples of these efforts, as documented in the proceedings, include:

- *The National Incident Management Coalition, established in the early 1990s, to support, heighten awareness of, and provide education on incident management.*
- *Traffic Incident Management Handbook, published by FHWA in 1991 and updated in November 2000, to assist transportation and public safety agencies in improving their programs and operations.*
- *Managing Traffic Incidents and Roadway Emergencies, a National Highway Institute course taught continuously since 1998, designed for mid- and upper-level managers for all agencies involved in incident management. Focuses on practices to obtain good inter-agency and inter-disciplinary understanding and cooperation.*
- *Incident Management Successful Practices: A Cross-Cutting Study, published by FHWA in April 2000, to document successful partnerships, benefits of TIM programs, and lessons learned from TIM programs around the United States.*
- *An Assessment of Select Metropolitan Washington Public Safety and Transportation Agencies User Needs, a February 2001 report from the International Association of Chiefs of Police and the University of Virginia for the Capital Wireless Integration Network (CapWIN) Project. The report evaluates the current status of information sharing and major issues, concerns, and elements of CapWIN participants' needs.*
- *Regional Traffic Incident Management Programs: An Implementation Guide, a May 2001 FHWA publication describing a program formation process to provide institutional cohesion to help assure the continuity and success of traffic incident management programs.*
- *Traffic Incident Management Expert Focus Groups, an initiative of the National Incident Management Coalition, documented in a September 2001 report, to examine current practices, common challenges, the future of traffic incident management, measuring success, and determining the federal role.*

Thus, a substantial body of knowledge exists within the professional community regarding the policy issues, state of the practice and strategic directions regarding incident management implementation. Accordingly, this effort was directed at assisting in evaluating the impacts and benefits of implementation of such initiatives. Specifically, it proposes a strategy for preliminary assessment of the congestion impacts of incident management implementation using statewide data and a simple analysis tool.

Conceptual Logic for Assessment of Incident Management Impacts on Incident Congestion in Florida

The overall logic of the process for accessing the potential impacts of incident management on incident congestion in Florida is outlined below in Figure 2.1. This logic drives the methodology and data assembly that is reported in subsequent chapters of this report.

Figure 2.1 Conceptual Logic for Assessment of Incident Management Impacts on Incident Congestion in Florida

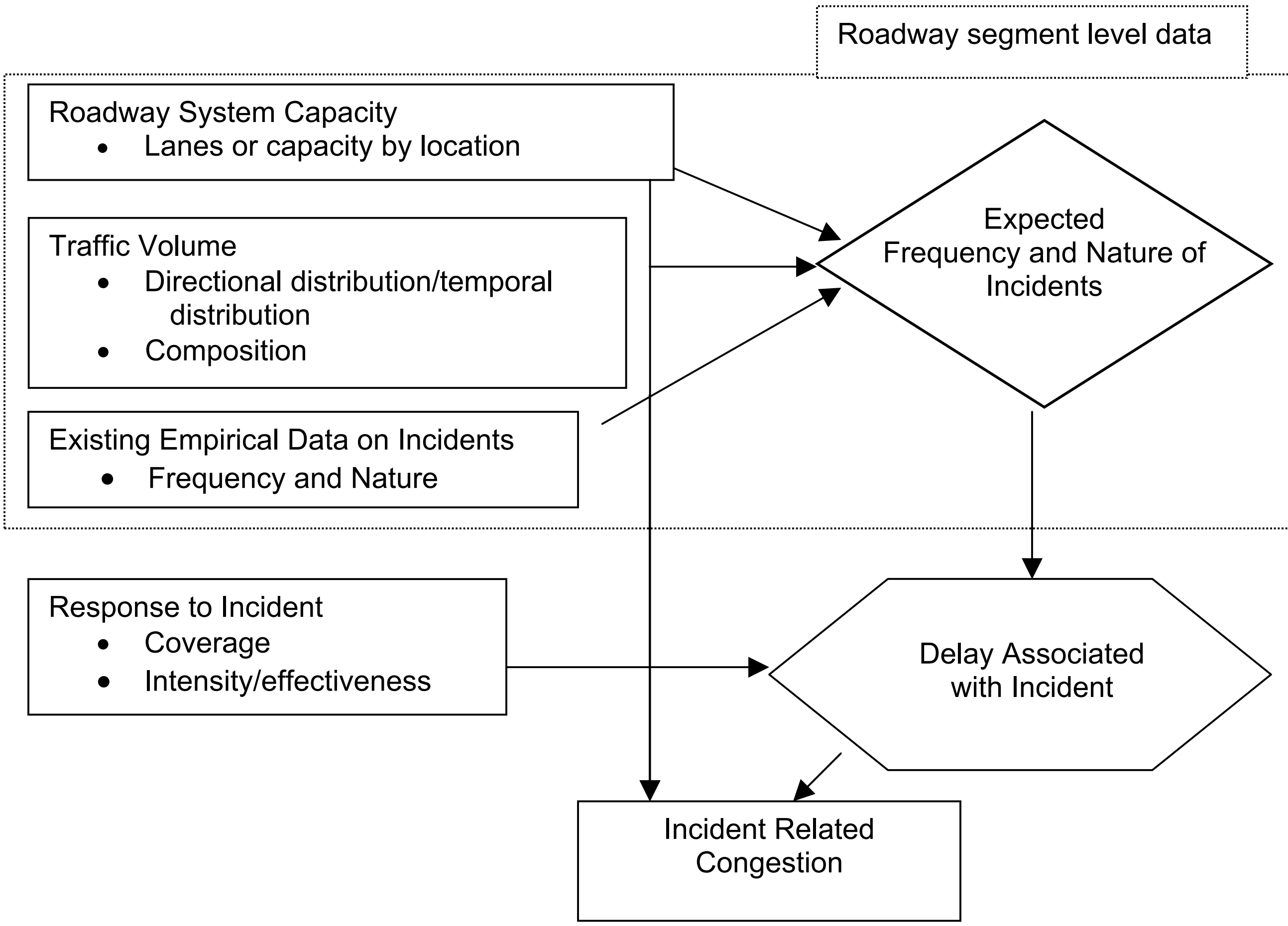


Figure 2.1 displays the conceptual logic for understanding and analyzing the congestion impacts of incidents on roadways. The analysis is applied at the roadway segment level. A roadway segment is a length of roadway with similar capacity characteristics defined by intervening roadways and other characteristics that result in moderate length segments for which data is available. The segments are part of the Florida Intrastate Highway System (FIHS). In total, the system comprises over 3,939 miles of roadway divided into over 2,600 segments and provides primary intercity connectivity and capacity to support movement around Florida. This system is the major mover of roadway travel, but is supplemented with local roads that provide direct access to property. This analysis was restricted to the FIHS though the methodology could be applied to databases covering other roadway system elements. The FIHS is the focus as that is the system for which data is available and that is the system that has substantial volume and is likely to provide stronger opportunities for congestion benefits associated with incident management. The FIHS segments are classified as urban, rural or transitional.

The Florida Decision Support System is the primary source for roadway segment data used in this analysis. The data was most recently updated in 2002. It contains volume forecast data through 2025.

Roadway System Capacity: Associated with each segment is a capacity. This information enabled an estimation of the level of service under differing volumes. Capacity was presumed to be constant over the time period of reference, i.e. no variation for time of day, or season.

Roadway System Volume: Associated with each segment is a volume. This will reflect average annual daily volume. Also associated with each segment is a temporal distribution that is used to show differential sensitivity to incident congestion at different times of the day as a result of the temporal distribution of the traffic volumes. Thus, roadways with the same total traffic volume, but meaningfully different temporal distributions might have different sensitivity to incident congestion. Vehicle composition is not a consideration in this analysis. However, since it is known that different vehicle types influence traffic capacity, one could extend the research to explore model recalibration or adjustment for situations with atypical roadway vehicle compositions.

Existing Empirical Data on Incidents: Each segment can have data representing actual or estimated incident frequency. This includes two components, accidents (now often referred to as crashes) and other incidents. Available actual incident data include accident data from FDOT sources. Non-accident incident data for Florida are maintained at the local level by FDOT districts and were not gathered for this exercise.

Expected Frequency and Nature of Incidents: A simple model of incident frequency and nature is required to simulate incident data for any given segment based on volume characteristics of the roadway and average empirical data from similar segments. The actual frequency of incidents is a function of a host of factors such as weather, roadway segment design and condition, traffic volume, and other factors. For purposes of this analysis, incident frequency is defined in terms of roadway volume per unit of capacity. Other factors are too dynamic for inclusion of the development of an average incident frequency measure. The nature of incidents is relevant in that it may determine the extent of delay associated with the incident. For purposes of impact assessment, a distribution of incident durations is required. Incident length is one of the policy variables that can be adjusted as part of a policy analysis of incident management strategies. Incident management programs would be expected to be able to clear the incident in a faster period of time, thus producing a lower average incident duration.

Given this basic framework, two specific incident management estimation strategies were reviewed: that developed by Cambridge Systematics for the FHWA (3) and that discussed in

Monitoring Urban Roadways in 2000: Using Archived Operations Data for Reliability and Mobility Measurement and developed by the Texas Transportation Institute as part of their exploration of travel reliability (8). Ultimately, incident management assessment will require the following features:

1. Able to be flexible to accommodate user specified inputs
2. Able to be applied to existing or forecast conditions for traffic and infrastructure
3. Able to be used for evaluating various incident management strategies/expectations
4. Able to accommodate evolving knowledge on incident delay relationship
5. Able to be easily manipulated with readily available spreadsheet software
6. Able to interface with FDOT Decision Support System or GIS

Incident Management Programs

Key factors in estimating the mobility effects of incident management operational treatments include:

1) The area covered by the treatment – how much of the system has the treatment?
2) Density of the treatment within the covered area (particularly as it applies to incident management programs) - how often is the area viewed or patrolled?
3) The delay reduction effect – how much effect does the treatment have?

All of these factors have to be expressed in terms of reductions in incident duration in order to understand the implications. Underlying these elements is an information base that involves knowledge of how incident duration is affected by incident management activities. Specifically, how each of the following actions influences the duration of an incident:

> Incident Identification – Sometimes referred to as monitoring, this is the mechanism by which response teams are made aware of incidents. This may involve motorists calling on their cell phones, closed circuit cameras, roving patrol vehicles or other mechanisms. Shortening the time to detect a disabled vehicle can greatly reduce the total delay due to an incident.
>
> Evaluation -- An experienced team of transportation and emergency response staff provide ways for the incident to be quickly and appropriately addressed. Cameras and on-scene personnel are key elements in this evaluation phase.
>
> Action -- Service patrols (i.e., highway helpers, motorist assistance programs) and tow trucks are two well-known response mechanisms that not only reduce the time of the blockage but also remove the incident from the area and begin to return the traffic flow to normal. Even in states where a motorist can legally move a wrecked vehicle from the travel lanes, many drivers wait for enforcement personnel, which dramatically increase the delay.

Establishing the Relationship Between Incidents and Delay

Initiatives to understand incident delay rely on empirical data and theoretical knowledge of traffic flow to attempt to develop an understanding of how incidents affect travel and how one can attribute the incremental increase in travel time to the presence of the incident. Two basic strategies are used: empirical data and simulation. These efforts have been aided in recent years by the growing attention to roadway system monitoring and increasingly sophisticated analytical simulation methods.

For example, the Mobility Monitoring Program funded by FHWA has allowed the Texas Transportation Institute and Cambridge Systematics to identify and help create several data archives for the freeways that are monitored in 21 cities. The data can be used to study the effects of a variety of treatments, as well as examine congestion and reliability levels and trends over several years when those data are available. These efforts are supported by national sources and analysis products including:

- ITS Deployment Tracking Survey (IDTS)
- ITS Deployment Analysis System (IDAS)
- Highway Performance Monitoring System (HPMS)
- Highway Economic Requirements System (HERS)

The relationship between delay and incidents is covered in greater detail in Chapter Three where the specific relationships assumed in the selected methodology that was applied to Florida are documented.

Incident Management Impacts on Delay

The second area of analysis was the determination of the impacts on incident duration that can be expected from a given type and level of intensiveness of an incident management strategy. Incident detection, incident response, and incident clearance are all relevant elements of incident management. Incident management is typically composed of these three separate functions; each suggests aspects of incident management program elements. Everything from training and communications to intensiveness of personnel deployment to the degree of available equipment for addressing various field conditions, can impact the duration of incident. The unique nature of each incident and each incident management tactic results in a complex set of interactions that ultimately produce the duration time for incidents. The paragraph below, extracted from the TTI analysis, exemplifies the complexity of the relationships.

> *The delay reduction percentages, however, are not as easily translated from the HERS model to the Urban Mobility Study methodology. HERS estimates the effect of service patrols as a 25% reduction in incident duration which, when modeled at the section*

level with HPMS data resulted in a 65% reduction in incident delay. The detection algorithms and camera systems each contributed an additional four to five percent reduction in incident duration. When all three treatments are combined, this would suggest a 35% reduction in incident duration and an 80 to 85 percent reduction in incident delay. This is too high to use for an areawide average, judging from the Buffer Time Index values in the 2001 and 2002 MMP reports and the incident management programs in the study cities. The net reduction in delay would seem to be less than the 65% value estimated in the model. The study will continue to compare the two analytical techniques (MMP and HERS). For methodology purposes, the UMS database was examined with a 15% reduction in duration and a 35% reduction in delay if all three components are present (see Table 2.1).

Table 2.1 Incident Delay Reduction Benefits of Incident Management Programs (HPMS and Deployment Tracking)

System Coverage (HPMS mileage versus DT mileage)	Patrol Cycle (miles each vehicle covers)	Congestion Level				
		Uncongested	Moderate	Heavy	Severe	Extreme
No patrols		0	0	0	0	0
Less than ¼ of system covered	More than 10 miles Less than 10 miles	0 0	14 21	17 24	20 27	23 30
Between ¼ and ½ of system covered	More than 10 miles Less than 10 miles	0 0	15 22	18 25	21 28	24 31
Between ½ and ¾ of system covered	More than 10 miles Less than 10 miles	0 0	17 24	20 27	23 30	26 33
More than ¾ of system covered	More than 10 miles Less than 10 miles	0 0	18 25	21 28	24 31	28 35

Source: HERS Operations Preprocessor and TTI Analysis

Chapter Three documents these relationships in greater detail as developed and documented in the *Sketch Methods for Estimating Incident-Related Impacts: Final Report*. The remaining pages of this chapter provide a brief annotated bibliography of selected key publications in the area of incident management.

Annotated References

Texas Transportation Institute, *The 2003 Urban Mobility Report*. (September 2003). http://mobility.tamu.edu

The 2003 Urban Mobility Report examines trends and issues related to congestion from 1982 through 2001. It discusses possible improvements in mobility and the significance and estimated cost of congestion. The report focuses on what reasonable expectations of congestion are, current congestion levels, and projects for managing and increasing system efficiency.

Incidents reduce the reliability of roadway systems. The report briefly discusses the effects of incidents, including crashes and breakdowns. According to the report, these incidents account for 52 to 58 percent of the delay experienced by motorist in urban areas. To reduce this type of congestion, incident management programs - that monitor, evaluate and act - can be implemented. *The Urban Mobility Report* lists some of the benefits of these programs as having benefit/cost ratios between 3:1 and 10:1, reducing secondary crashes and improving the public's perception of the agencies managing the roadways.

Federal Highway Administration – Office of Operations. "Traffic Incident Management Website." http://www.ops.fhwa.dot.gov/Travel/IncidentMgmt/IncidentMgmt.htm

This website provides an overview of FHWA's incident management programs and standards. Links to information on incident management, reports, documents and conferences are also available on this site. The Traffic Incident Management documents on the site include the Traffic Incident Management Handbook, Regional Traffic Incident Management Programs: Implementation Guide, and Incident Management Successful Practices.

Federal Highway Administration. "Traffic Incident Management Handbook." (November 2000). http://www.itsdocs.fhwa.dot.gov/jpodocs/rept_mis/@9201!.pdf

The Traffic Incident Management Handbook, prepared by PB Farradyne, is an updated version of the 1991 Freeway Incident Management Handbook. The purpose of this document is to assist the groups responsible for incident management programs to improve the operation of their programs.

The three main sections of this handbook include an introduction to incident management, the organizing, planning and designing of incident management programs, and operational and technical approaches to improving the incident management process. Each of these sections provided detailed information pertaining to the topic.

Federal Highway Administration. "Regional Traffic Incident Management Programs: Implementation Guide." (May 2001). http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_TE/@5901!.PDF

The Regional Traffic Incident Management Programs guide directs agencies in establishing incident management programs. The guide examines successful models, covers lessons learned by earlier programs, and provides a framework for developing new programs.

The guide states the goals of traffic incident management are to reduce the time for detection and verification, reduce response time, manage the scene safely, reduce clearance time, and provide correct, timely information to the public. According to this report, 57 percent of congestion in the United States is due to crashes and incidents. Incident management can reduce the impacts of non-recurrent congestion by providing efficient clearance of incidents and keeping motorists informed of the current condition of the system, thereby improving safety for individuals involved in the incident, responders and other travelers.

Federal Highway Administration. " Incident Management Successful Practices: A Cross-Cutting Study." (April 2000). http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE//8V001!.PDF

The Incident Management Successful Practices document describes successful incident management programs across the United States and lessons learned. These lessons focus on detection and verification, response, site management, interagency coordination, training, and leadership. The document also provides a brief overview of incident management, involved parties, and the impacts of incident congestion.

Cambridge Systematics, Inc. "Incident Management: Challenges, Strategies, and Solutions for Advancing Safety and Roadway Efficiency." (February 1997).

The Incident Management: Challenges, Strategies, and Solutions for Advancing Safety and Roadway Efficiency report focuses on the establishment of incident management programs. The report examines incident congestion and incident management, challenges of management, and strategies for overcoming the challenges.

An appendix of this report contains the benefit/cost analysis for the incident management program in Chicago, Illinois. A model developed by FHWA is used to determine the cost savings of the project resulting from reduced delay. The impacts of the program were determined to be a delay savings of 9.5 million vehicle-hours over a one-year period.

Varaiya, Pravin. "Creating Transportation System Intelligence." TR News 218. (January-February 2002).

In this article, Pravin Varaiya discusses his experience with California's Performance Measurement System (PeMS). This system collects data from loop detectors on California's freeways. This data can be used for planning and operations purposes. PeMS can be used to identify problem areas, such as bottlenecks and areas where ramp metering could be utilized to reduce congestion.

Another result of this study is that maximum throughput occurs at a free flow speed of 60 mph. This is different from the Highway Capacity Manual, which states that the maximum flow occurs between 35 and 50 mph. Varaiya suggests that congestion delay should be measured as the time spent traveling below 60 mph.

Cambridge Systematics, Inc. "Sketch Methods for Estimating Incident-Related Impacts: Final Report." (December 1998). http://plan2op.fhwa.dot.gov/pdfs/Pdf2/userguide.pdf

This report focuses on a sketch planning method that has been developed to estimate the impacts of nonrecurring (incident) congestion and the effects of incident management approaches. Instead of using delay-reduction factors for modeling, this study uses the existing conditions of corridors. According to the report, this approach is stochastic in nature, can incorporate the traffic characteristics of queues, produces delay equations and deals with the interaction between recurring and nonrecurring congestion. This approach estimates the proportion of delay caused by recurring and nonrecurring congestion.

The study produced a set of equations that can compute the vehicle-hours of travel for uncongested conditions, incident conditions and bottlenecks. The equations consider the direction of travel and time period and can be evaluated using available data that includes the number of lanes, free flow speed, average annual daily traffic divided by capacity (AADT/C) ratio, incident and crash rates, incident duration, shoulder conditions, and the location of recurring bottlenecks.

Booz-Allen & Hamilton - Vincent Pearce. "What Have We Learned About Intelligent Transportation Systems? - Chapter 2: What Have We Learned About Freeway, Incident and Emergency Management and Electronic Toll Collection?" (December 2000). http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/@9y01!.pdf

This report briefly discusses various approaches used in incident management, including service patrols, common communication frequencies, automated incident detection algorithms, cellular communication, call boxes, CCTV, cellular geolocation and regional incident management programs. According to this chapter, in order for a program to be successful it must be regional in nature. This is required so that agencies are coordinated in response and mitigation of incidents regardless of the location. Intelligent Transportation Systems (ITS) infrastructure can improve incident management.

In the future, incident management programs will be more formalized, regional and have more interagency coordination, according to Pearce. In order for this to materialize, effective long-term relationships must be developed. Also new technologies will change current methods for detection and may make them obsolete.

U.S. Department of Transportation – Intelligent Transportation Systems. "Safer Travel, Improved Economic Productivity – Incident Management Systems." http://www.itsdocs.fhwa.dot.gov/jpodocs/brochure/5@s01!.pdf

This pamphlet discusses how incident management systems can improve transportation systems. Through technology and interagency cooperation, the costs of congestion can be reduced. These costs include delays in emergency response and of emergency responders, adverse effects on citizens' quality of life, weakened regional economy, and lost tourism revenue. Some technologies that are commonly used in incident management systems include embedded sensors in roads, closed circuit television cameras, and variable message signs. By using these technologies, control centers can effectively reduce congestion by reducing the time required to clear incidents.

This pamphlet is a basic overview of how implementing an incident management system can stimulate the economy of a region. Incident management systems can save taxpayers dollars, reduce commute times, boost economic development, reduce operating costs of responding agencies, reduce fuel usage and emissions, and make communities more mobile and prosperous.

Volpe National Transportation Systems Center, "Intelligent Transportation Systems Impact Assessment Framework: Final Report." (September 1995). http://plan2op.fhwa.dot.gov/pdfs/Pdf1/Edl05325.pdf

This report provides a framework for assessing the impacts and benefits of different Advanced Traffic Management Systems (ATMS). The four key ATMS traffic management strategies this report focused on are ramp metering, signal coordination, integrated traffic management systems, and high occupancy vehicle (HOV) lanes.

The design of the framework combines the strengths of planning and simulation models. The transportation models are linked with software that allows for data transfer between components. This allows for feedback, which can lead to better estimates of speed and volume as compared with traditional models. The integration of regional planning models with freeway and arterial simulation models allows for estimation of emissions, fuel consumption and safety. Also since the framework estimates traffic characteristics over small discrete time intervals, dynamic interaction between intervals can be accomplished. This report also discusses how the four step transportation modeling process and the various models are incorporated into the framework.

Taylor, William and Sorawit Narupiti. "Incident Management, FAST-TRAC Phase IIB Deliverables, #20. The Model Analysis Report on the Benefits of SCATS in Alleviating the Impacts of Incidents." (1996). http://www.itsdocs.fhwa.dot.gov//JPODOCS/REPTS_TE/7C601!.PDF

In this report, Taylor and Narupiti studied how effective several incident control strategies are. According to this report, traffic incidents are random, unexplained events that affect traffic operations. The purpose of incident management is to effectively restore operations and limit congestion. The true impacts of incident management, especially using ITS, have not been thoroughly evaluated in the past. The selected Intelligent Transportation Systems studied included traffic metering (Advanced traffic Management system - ATMS), traffic diversion (Advanced Traveler Information System - ATIS), and traffic diversion with signal timing modification (ATIS/ATMS).

The results of this study include the following. Traffic metering reduces the total travel time or delay, but does not impact the duration of incident congestion. Traffic diversion is more effective than traffic metering. For this strategy, as demand increases the reduction of the delay or congestion time also increases. For traffic diversion with signal timing modification, three different settings were considered. The three diversion plans resulted in the overall congestion period remaining constant. However, optimal distribution at nearby intersections reduced conflicts with other traffic.

Ozbay, Kaan and Pushkin Kachroo. *Incident Management in Intelligent Transportation Systems.* (1999).

In this book, Ozbay and Kachroo discuss how integrated traffic incident management systems can reduce congestion through interagency communication and coordination between responders. The intelligent transportation systems described in this book use models from "real-world" research. These systems are capable of mapping, handling network queries, dispatching responders and forming response plans, estimating incident duration and delay, diverting traffic during incidents and support interagency communication.

Wunderlinch, Karl; Hardy, Matthew; Larkin, James and Vaishali Shah. "On-Time Reliability Impacts of Advanced Traveler Information Services (ATIS): Washington, DC Case Study." (January 2001).

http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/@@g01!.pdf

This report discusses HOWLATE (Heuristic On-line Web-Linked Arrival Time Estimator). HOWLATE is a process that can be used to estimate the roadway travel times for commuters and compare users of Advanced Traveler Information Services (ATIS) with non-users. This method considers "yoked pair" of commuters that have similar trips with regards to time of day, target arrival time, and destination.

The findings of a case study in Washington DC suggest that users of ATIS have significant benefits by improving on-time reliability, reduced early and late schedule delay and predictable travel.

HOWLATE can add to existing field study, traffic simulation and survey research by quantifying time management, trip predictability, and travel reliability. Actual field studies of ATIS are required so that the effects of human decision-making can be measured. Updating of HOWLATE is planned, so that en route and pre-trip ATIS can be evaluated.

Fu, Liping and Laurence R. Rilett. "Real-Time Estimation of Incident Delay in Dynamic and Stochastic Networks." Transportation Research Record - 1603.

This article discusses a new model for predicting the delay that vehicles will experience as a result of incidents. This model can be used within traffic models or intelligent transportation systems (ITS). The model considers stochastic attributes of incident duration, unlike traditional deterministic incident delay models. The dynamic and stochastic incident delay model uses random variables based upon a probability density function (PDF) to predict the time delay experienced by vehicles. The PDF is based upon historical traffic data.

Some conclusions that the authors draw from this study include that the model may over or underestimate the delay depending on when a vehicle reaches the location, high variation of results may occur when the expected delay is small, and the model can be updated by modifying the PDF.

Proceedings of the National Conference on Traffic Incident Management, March 11-13, 2002. The American Association of State Highway and Transportation Officials (AASHTO), Federal Highway Administration (FHWA), Intelligent Transportation Society of America (ITSA), and Transportation Research Board (TRB). http://www.ops.fhwa.dot.gov/Travel/IncidentMgmt/timconf/TIMconf.doc

Comprehensive proceedings on national conference providing a review of the full range of issues associated with incident management practices.

Chapter 3

Application of Sketch Planning for Incident Congestion Assessment

After exploring various strategies for estimating the impact of incidents on roadway congestion in Florida, including the prospect of developing a simplified spreadsheet analysis capability, it was determined that the most useful strategy would be to adopt the spreadsheet analysis capability embodied in the *Sketch Methods for Estimating Incident-Related Impacts* (16). This approach offers several advantages. It utilizes comprehensively researched relationships between incident frequency and duration and roadway volume based on simulation analysis and validated with empirical application in select urban areas. It is readily available in the public domain and is well documented, transparent, and able to be modified by the user as appropriate. Finally, it is a strategy consistent with the exploratory nature of this research initiative.

This chapter documents the relationships embodied in the tool, summarizes the key assumptions and inputs to the sketch-planning tool, and describes the integration of the spreadsheet with the available Florida Decision Support System data.

Incident Delay

Incident delay is a function of a number of characteristics of the roadway's physical condition, volume, and the frequency and nature of incidents. The following section contains edited extracts of descriptive materials that outline how the model is structured. The model is developed by running a series of simulations using the program QSIM (Quantitative Simulation) and then by developing a relationship between delay, roadway volume, incident frequency and durations based on the simulation results. These relationships, modeled as curves that relate incident delay measured as travel hours due to incidents on the y-axis to roadway volume for varying conditions on the x-axis, provide the basis for generalizing the findings to a broader set of roadway segments.

The QSIM output from the study was used to fit a series of equations for both daily and peak-period values for H_u, H_i, and H_r. (where H stands for hours of travel time and the subscripts *u* refers to uncongested, *i* refers to incident and *r* refers to recurring congestion).

The basic variables used in the analysis are:

X = This is expressed as a ratio of Average Annual Daily Traffic (weekends and weekdays)
divided by the capacity. This is expressed as the ratio, AADT/C and is scaled between (0 to 18);

Sff = free flow speed;
IncRate = incident rate factor; = (target incident rate)/(default incident rate);
DurFac = duration facto; = (target mean incident duration)/38.0;
SFac = shoulder factor; = 1.0 for usable shoulders both sides; = 0.5 for usable shoulders one side only; and, = 0 for no usable shoulders;
AccRate = accident rate factor; = (target accident rate)/(default accident rate).
AADT/C = average annual daily traffic divided by hourly capacity.

The peak period is defined as weekdays from 6:00 a.m. to 10:00 a.m. and 3:00 p.m. to 7:00 p.m. for both directions of travel. The daily equations include both weekdays and weekends.

Operationally, various roadway types perform differently when subject to an incident. Most obviously, wider roads and roads with shoulders are more likely to have available roadway space for vehicles to pass an incident blocking part or all of a lane. Thus, each roadway type was evaluated separately with roadways being classified into freeway and signalized arterial types with lane number options for each type. The estimation strategy developed separate equations for both freeways and signalized arterials of various lane widths. There is a higher degree of confidence in the freeway equations and more variability in arterial segments. Part of this variability is due to the prospect that access opportunities for arterials can affect the opportunity to clear an incident and also affect the prospect of detouring around an incident. Thus, the user is cautioned that application of the methodology to lower classifications of facilities is more variable and produces estimates with lower degrees of confidence.

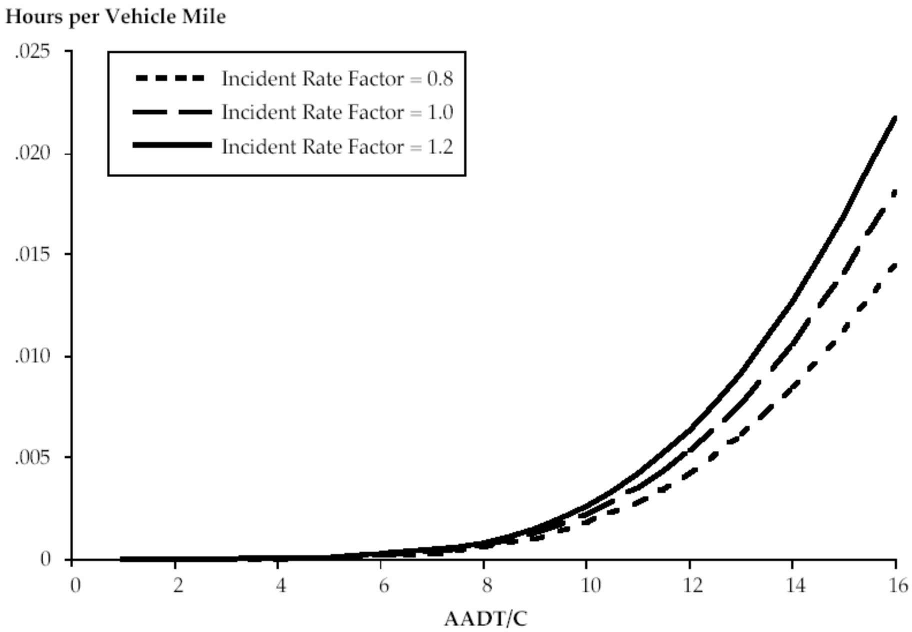
Figures 3.1 through 3.3 are selected curves developed in the analysis

In Figure 3.1 the three lines represent changes in the incident rate factor. Incident rates are default values that are expressed in terms of incidents per million vehicle miles of travel (MVMT) and range between 9.611 and 10.398 as a function of AADT/C rates. Accidents are a second component of total incident levels and range from 1.066 to 1.853 for default values. The incident rate factor is a scaled adjustment factor for the user to adjust the rate up or down to reflect changes in incident frequency as a result of local conditions or preventative strategies.

The model user can input local actual rates or use the default values. The three lines show the sensitivity to changes in the frequencies of plus and minus 20 percent. The y axis uses hours of incident travel time per vehicle mile. Thus, on a busy road an increase in incident frequency of 20% would result in an average increase of travel time of 0.001 hours per vehicle mile or approximately 3.6 seconds of additional travel time per vehicle mile, or a vehicle speed decline from 60 to approximately 56 miles per hour.

Figure 3.1 Incident Delay: Two-Lane Freeway

Incident Rate Factor



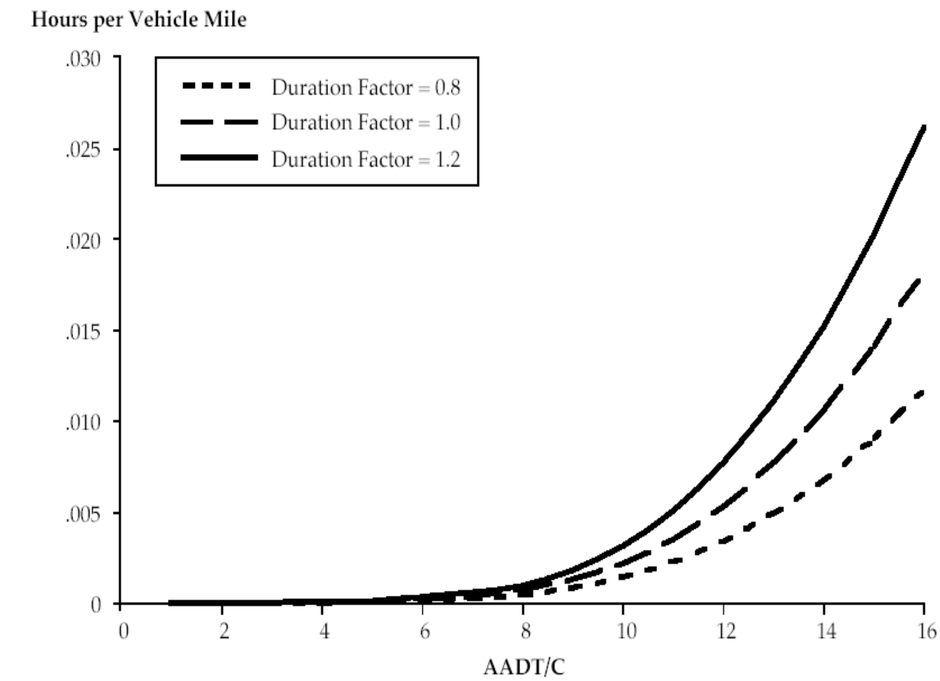
Source: *Sketch Methods for Estimating Incident-Related Impacts*

Figure 3.2 shows the sensitivity of incident delay to changes in the mean duration of the incident. The database used for model construction had a mean incident time of 38 minutes with a normal distribution. Actual incidence duration can vary dramatically depending on the context, with long incidents being relatively rare events.

This curve also shows that the sensitivity to incident duration is highly sensitive to traffic levels on the roadway. The vertical scale on this graph is slightly larger than in the prior graph and the differences between the lines increase, indicating a greater sensitivity to changes in incident duration. The sensitivity range varied the mean time of incident plus and minus 20 percent from the 38 minutes.

Figure 3.3 presents sensitivity to shoulder width. This is expressed in terms of a shoulder factor that was used in model development. The shoulder provides storage for a disabled or emergency vehicle and hence, can make a significant difference in the delay associated with an incident. As Figure 3.3 reveals, the presence of adequate shoulders is a more critical factor than either incident duration or frequency, at least within the variations presented in the prior graphics

Figure 3.2 Incident Delay: Two-Lane Freeway
Duration Factor



Source: *Sketch Methods for Estimating Incident-Related Impacts*

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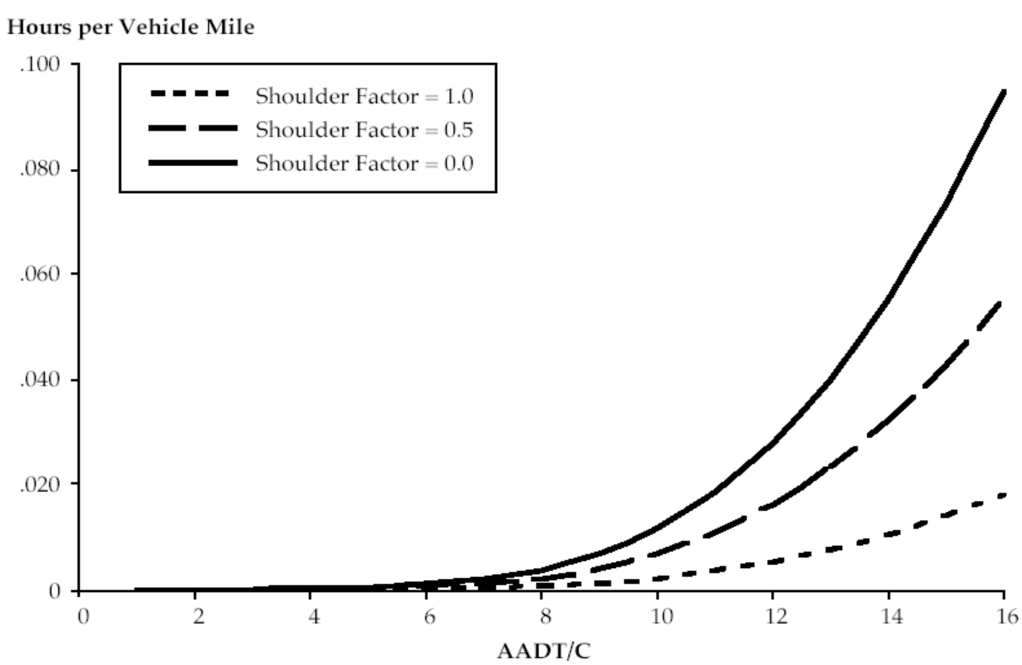
Figure 3.3 Incident Delay: Two-Lane Freeway
Shoulder Width Factor



Source: *Sketch Methods for Estimating Incident-Related Impacts*

The remainder of this chapter is an excerpt with a few minor edits from the users manual for the *Sketch Methods for Estimating Incident-Related Impacts*. Chapter Four addresses the application of the model to Florida data.

Chapter 3 Supplement from: *Sketch Methods for Estimating Incident-Related Impacts*

3.0 Application Guidelines for Sketch Planning Incident Analysis

■ 3.1 Freeways

Introduction

The sketch planning procedure for estimating incident impacts is meant to be applied for an extended section of freeway that can be anywhere from two to 20+ miles in length. The following input data and calculations are required.

Step 1: Decide If Directional Analysis is Needed

If traffic conditions vary substantially by direction, then each direction should be analyzed separately. This determination can be made based on directional volumes or the nature of bottlenecks (e.g., lane imbalance). For example, a lane-drop may exist in one direction and not the other, or an interchange may function as bottleneck in only one direction. Essentially, if capacity and volumes are close to being the same in both directions, then the corridor can be analyzed using combined directions; otherwise directional analysis should be undertaken.

Step 2: Identify Recurring Bottlenecks

The recurring bottlenecks in the corridor must be identified by the user. Based on the analysis undertaken with the QSIM model, recurring bottlenecks can occur whenever AADT/C values exceed 8.0. These can be on-ramps, freeway-to-freeway merges, lane drops, or work zones. Because the procedure is highly sensitive to the specification of recurring bottlenecks in the corridor, care should be taken to identify “true” bottlenecks from areas where traffic breaks down due to downstream conditions. For example, the queue from a “true” bottleneck may spread upstream and cause traffic flow in another onramp area to breakdown. It is possible to have several successive segments with AADT/C ratios greater than 8.0, yet only designate one of them as the “true” or “controlling” recurring bottleneck. Under no circumstances should two successive links be coded as recurring bottlenecks; only one will control traffic flow.

Step 3: Define Links

The corridor should be broken into links for separate analysis. Because AADT/C is the basis for delay prediction, links should be defined when either AADT or capacity changes significantly. Logical breakpoints include on-ramps, lane-drops, freeway-to-freeway merges, and work zones.

Step 4: Set Input Parameters

1. **Analysis Period:** Select peak period or daily analysis periods.
2. **Free Flow Speed (FFS):** For freeways, free flow speed is the common definition in practice: the speed of a vehicle under very light traffic conditions. Following guidance from *NCHRP 387*[1], the following equations should be used:

FFS = (0.88 * Speed Limit) + 14, for posted speed limits > 50 mph (1)
FFS = (0.79 * Speed Limit) + 12, for posted speed limits <= 50 mph (2)

3. **Annual Average Daily Traffic (AADT):** The AADT of a section or link is the same as defined in the *Traffic Monitoring Guide*. If a travel demand forecasting (TDF) model is used and if the model predicts

weekday traffic, then adjustments must be made to TDF link volumes to correspond with the AADT definition. If peak hour forecasts are made, they first must be converted to Annual Average Weekday Traffic (AWDT) by factoring: AAWT = PHV (3) F_{PHV} where PHV is the forecasted peak-hour volume and F_{PHV} is the percent of daily traffic moving in the peak hour. If peak-hour forecasts are adjusted internally to correspond with design hour volumes (e.g., 30th highest annual hour of traffic), then F_{PHV} should be set to the local K-factor. If peak-hour forecasts represent the average "typical" peak hour, then F_{PHV} should be based on the average peak hour percentage of traffic as determined from local continuous count stations. If local values are unavailable, the following default percentages may be used:

[1] *Planning Techniques to Estimate Speeds and Service Volumes for Planning Applications*, NCHRP Report 387, Transportation Research Board, 1997.

[2] *Development of Diurnal Traffic Distribution and Daily, Peak, and Off-peak Vehicle Speed Estimation Procedures for Air Quality Planning*, developed by COMSIS Corp. and SAIC for FHWA Office of Environment and Planning Work Order B-94-06, April 1996.

Highway Type	**AADT/C Range**	**Default Peak-Hour Percent (One Direction)**
	<= 7.5	0.0485
	7.5 < AADT/C <= 8.5	0.0469
Freeway	8.5 < AADT/C <= 9.5	0.0459
	9.5 < AADT/C <= 10.5	0.0438
	10.5 < AADT/C <= 11.5	0.0414
	11.5 < AADT/C <= 12.5	0.0390
	> 12.5 (see Equation 4)	
	<= 7.5	0.0483
	7.5 < AADT/C <= 8.5	0.0466
Nonfreeway	8.5 < AADT/C <= 9.5	0.0455
	9.5 < AADT/C <= 10.5	0.0436
	10.5 < AADT/C <= 11.5	0.0414
	11.5 < AADT/C <= 12.5	0.0392
	> 12.5 (see Equation 4)	

Peak hr pct = (0.0392* (24 - AADT/C)) + ((1/48) * (AADT/C - 12)) (4) 12

For TDF models, if volumes are based on one-way links, then these links must be combined to represent two-way flow, i.e., the one-way AAWTs should be added.

Once two-way AAWT is obtained, it must be converted to AADT by dividing by the ratio of AAWT/AADT: AADT = AAWT (5) F_{AWDT} where: F_{AWDT} is the area-wide ratio of AAWT/AADT. The default value for F_{AWDT} is 1.0757. If directional analysis is chosen, AADT should still be computed on the basis of both directions combined (to be consistent with how the equations were developed). Thus, if one direction of a freeway has an AADT value of 50,000 vehicles per day (vpd) and the other has an AADT of 60,000, the AADTs to use in the equations are 100,000 and 120,000, respectively.

4. **Capacity:** The capacity for all **through/general purpose lanes only** should be calculated. Do not consider extended acceleration lanes and lanes added to improve the functioning of interchange areas. If the area is a workzone, then capacity needs to account for the nature of the work zone. For all facilities, capacity is based on the *Highway Capacity Manual (HCM)* capacity for the peak hour. Freeway capacity for the speed/delay models is the same as defined by the *HCM*: the maximum sustainable flow rate past a point on the highway (i.e., flow rate at Level of Service E). All attempts should be made to follow Chapter 3 of the *HCM* in computing this value. If it is not available, then the following calculations, based on Equation 11-1 from *NCHRP 387* can be made.

Capacity (vph) = IdealCap * N * FHV * PHF (6) where:

IdealCap = 2,400 pcphpl if free flow speed >= 70 mph; 2,300 otherwise
N = number of through lanes
F_{HV} = heavy vehicle adjustment factor
= 1.0/(1.0 + 0.5 HV) for level terrain
= 1.0/(1.0 + 2.0 HV) for rolling terrain
= 1.0/(1.0 + 5.0 HV) for mountainous terrain (rare in urban areas)
HV = daily proportion of trucks and busses in traffic stream
PHF = ratio of peak 15-min flow rate to average hourly rate

The PHF factor should be chosen with care because the default value recommended by *NCHRP 387* (0.90) can have a significant influence on capacity. Examination of freeway surveillance data from Orlando (I-4) and Denver (I-25) show that for these urban interstates the PHF is approximately 0.95. Further, if local evidence exists that the ideal capacities given above can be sustained for hour-long periods, then the PHF should be set to 1.0. HV should be computed as a composite average for the corridor to avoid having capacity vary from section to section. In the predictive equations, capacity is the sum of the one-way capacities. Thus, assuming the result of Equation 6 is 2,100 vph and there are three lanes in each direction, capacity in the AADT/C term of the equations is (6 x 2,100 = 12,600). If directional analysis is chosen capacity should still be computed on the basis of both directions combined. Continuing the example, if the freeway segment has three lanes is one direction and two in the other, then capacities in the AADT/C term are 6,300 and 4,200, respectively.

5. **AADT/C:** For base/current year conditions, if AADT/C exceeds 13.0, then both AADT and capacity should be checked for accuracy. (AADT/C rarely exceeds 14.0 for existing facilities.) Under no conditions, including forecasted future volumes, should AADT/C exceed 18.0.

6. **Incident Rate Factor:** If the incident rate of the facility is known, it should be used in the equations. It is computed as: IncRateFac = (Facility Incident Rate)/(Default Incident Rate) (7) Here, the incident rate includes all forms of incidents, even minor ones. The types considered in the default model are: 1) abandoned vehicles, 2) accidents (crashes), 3) debris on roadway, 4) vehicle breakdowns (mechanical trouble, stalled vehicles, flat tires), and 5) "other" (vehicles parked without having a breakdown). If information on **all** of these types are not available, then the analyst should either use the default incident rate or can factor their data using the distribution of incident types information provided in Chapter 3. Note that the selection of the Incident Rate, Accident Rate, and Duration Factors (see below) are based on comparison to the default values. (If these are not known for the facility being analyzed, they should be set to 1.0.) Because individual links on the facility will usually have different AADT/C ratios, the Incident Rate Factor should be developed for each individual link (Table 3.1 offers guidance.)

Table 3.1 Default Accident and Incident Rates by AADT/C

AADT/C	Accident Rate per MVMT)	Total Incident Rate (per MVMT)
1	1.066	9.611
2	1.069	9.614
3	1.075	9.620
4	1.086	9.631
5	1.105	9.650
6	1.132	9.677
7	1.172	9.717
8	1.220	9.765
9	1.275	9.820
10	1.345	9.890
11	1.414	9.959
12	1.518	10.063
13	1.583	10.128
14	1.657	10.202
15	1.709	10.254
16	1.760	10.305
17	1.810	10.355
18	1.853	10.398

7. **Accident Rate Factor:** Accidents are a subset of total incidents. As with the incident rate factor, if the accident rate of the facility is known, it should be used in the equations. It is computed as: AccRateFac = (Facility Accident Rate/Default Accident Rate) - 1.0 (8) The Accident Rate Factor is developed differently than the other factors. It essentially measures the deviation of the facility-specific rate from the default accident rate that is imbedded in the overall incident rate. In other words, it is used to adjust the calculated incident delay to account for accident rates that are higher or lower than the default. Therefore, the results of the equation for accidents only should be added to the results of the equation for incidents (see Step 6 below).

Since accident rate varies by traffic volume it should be computed for each link based on its AADT/C level and the values in Table 3.1. *To avoid double counting, either the total incident rate* ***or*** *the accident rate should be adjusted for accidents, but not both.* For example, if the accident rate of a facility is known but not the incident rate, the default incident rate should be used and the accident rate factor adjusted as shown in Equation 8. If both are known, it is recommended that the incident rate factor only be adjusted.

8. **Duration Factor:** For incident duration, the overall weighted average duration of all incidents for the default case is 38.0 minutes. The duration factor is then: DurFac = (target mean incident duration)/38.0 (9)

9. **Shoulder Factor:** The ability of shoulders to shelter disabled vehicles has a strong influence on incident-related delay. Therefore, shoulder widths must be wide enough to store disabled vehicles without them encroaching on the adjacent travel lanes. However, it is possible that narrow shoulders can cause a stopped vehicle to encroach into the adjacent travel lane without causing that lane to be completely blocked. Therefore, values for the Shoulder Factor are computed as a function of shoulder width for right and left shoulders individually:

Shoulder Width Shoulder Factor (Left and Right)

<= 3 ft	0.0
4-5 ft 0	.5
6+ ft	1.0

The shoulder factor for use in the equations is then: ShldFac = {SF(left) + SF(right)}/2 (10)

10. **Link Length:** The length of the link in miles (to the nearest tenth) should be noted. Link length is used in VMT calculations.

11. **Percent of Annual VMT in the peak period:** This data item is used only if the peak period is used as the time period of analysis. The peak period is defined as weekdays between the hours 6:00 to 10: A.M. and 3:00 to 7:00 P.M. If locally defined values are unavailable, the defaults in Table 3.2 may be used. In developing weekday peak period VMT, it is necessary to account for both weekdays and weekends. A simple approximation would be: PPVMT = (PPVOL/AWDT) * (5/7) * (AWDT/AADT) (11) where:

PPVMT = percent of annual VMT in the weekday peak period
PPVOL = average peak period volumes
AWDT = annual average weekday traffic (5/7) = ratio of weekdays to total days in the year

As before, an average approximation of AWDT/AADT is 1.0757.

Table 3.2 VMT Proportions for Freeways (Both Directions Combined)

AADT/C	Percent of Traffic in Peak Hour	Percent of Traffic in Peak Period
1	0.0787	0.3844
2	0.0786	0.3844
3	0.0788	0.3847
4	0.0789	0.3852
5	0.0789	0.3845
6	0.0784	0.3842
7	0.0787	0.3844
8	0.0768	0.3830
9	0.0745	0.3814
10	0.0718	0.3777
11	0.0619	0.3720
12	0.0620	0.3644
13	0.0602	0.3497
14	0.0579	0.3339
15	0.0557	0.3188
16	0.0533	0.3045
17	0.0509	0.2925
18	0.0489	0.2823

Step 5: Calculate VMT and Hours per Vehicle-Mile for Uncongested (H_u) and Incident (H_i) Conditions

For each link, H_u and H_i are estimated using the appropriate equations. VMT is calculated as the AADT times the link length in miles if the daily time period is used for the analysis. If the peak period is used, then VMT is AADT times link length times the proportion of VMT during the peak period (use Table 3.2 if local values are unavailable).

Step 6: Calculate the Change in Hi Due to Deviation From the Default Accident Rate (Ha)

If the accident rate of the facility is known, then H_i should be adjusted to account for the actual accident rate of the facility by adding H_a to H_i. Note that in Equation 8 if the actual rate is lower than the default rate, H_a is negative.

Step 7: Calculate Hours per Vehicle (Hr) and Number of Vehicle (Vr) for Each Recurring Bottleneck

For each recurring bottleneck, H_r is calculated using the appropriate equation. V_r is set equal to the AADT of the link if the analysis period is daily. For the peak period, AADT is multiplied by the proportion of VMT during the peak period to derive V_r.

Step 8: Calculate Baseline Vehicle-Hours of Travel (VHT) for Entire Corridor (Extended Segment of Highway)

For the facility being analyzed, the total VHT for the corridor should be computed as: Total VHT =
$\Sigma_l ((H_{u(l)} + H_{i(l)}) * VMT_l) + \Sigma_b H_{r(b)} * V_{r(b)}$ (11)
where: *l* refers to individual links and *b* refers to recurring bottlenecks. If desired, the user can also track the proportion of VHT due to incidents (VHT_i), recurring bottlenecks (VHT_r), and uncongested travel (VHT_u) by breaking out the terms in Equation 11. For any given link:
VHTu = Hu * VMT (12)
VHTi = Hi * VMT (13)
VHTr = Hr * Vr (14)
The analyst is cautioned that VHT_i and VHT_r are measures of systemwide delay due to queuing while VHT_u is the total vehicle-hours of travel for vehicles traversing the segment, and, therefore, is not true delay. The delay incurred by vehicles for unqueued can be found by computing VHT under ideal or "desired" speeds for the segment (e.g., VHT at the free flow speed, VHT_{ffs}) and subtracting it from VHT_u.
Then, Total vehicle-hours of delay = $VHT_i + VHT_r + (VHT_u - VHT_{ffs})$ (15)
Nearly all of the delay imbedded in VHT_u is volume-related: the updated BPR curve predicts noticeable delay when V/C ratios exceed 0.75. Only a small amount of the delay is due to the capacity-reducing effect of incidents. The reason for incident's small influence on unqueued delay is that high volumes occur every day and incidents happen infrequently. The delay portion of VHT_u (the last term in equation 15) can either be kept separate from queued delay or can be counted as recurring delay, ignoring the small (less than one percent) contribution from incidents.

Chapter 4

Incident Congestion Assessment for Florida

This chapter describes the application of the sketch planning assessment tool for incident congestion in Florida. As noted before, this consists of extracting Florida roadway segment data from the FDOT Decision Support System (DSS) and using it as input data in a modified version of the USDOT developed and distributed sketch planning tool documented in *Sketch Methods for Estimating Incident-Related Impacts,* and available in spreadsheet format from the FHWA web site: http://plan2op.fhwa.dot.gov/toolbox/toolbox.htm.

The first step was to download and familiarize oneself with the spreadsheet tool. Documentation and instructions are available and have been reviewed in prior sections. The next step was to modify the spreadsheet in a number of ways to enable it to be of use for application to Florida data. The spreadsheet was originally envisioned for application to corridors with up to 20 segments. An initial step was to expand it to enable application for use with up to 3500 roadway segments. This number accommodates the full set of data included in the DSS database.

It was determined that the modifications would be made to enable easy subsequent application with Florida data. Thus, additional spreadsheet pages were added. As currently structured, the revised spreadsheet is designed to enable the user to import DSS data directly into the spreadsheet by copying the DSS database into the Sketch Analysis Tool. Necessary data for model application is extracted from the DSS data and the user then specifies a few additional inputs, which are incorporated into the subsequent analysis. The forecast output is subsequently expressed in an output page of the spreadsheet. The next several pages review the spreadsheet in greater detail.

Model Application

Table 4.1 is a description of the data fields in the DSS database that we used to provide the base data on Florida roadway segments. This database included far more data than necessary for use of the sketch planning tool. It was determined that the tool would be structured to enable direct importation of the full data set and extraction of the required data as this will be easier to use should FDOT choose to apply the tool with updated DSS data.

The first critical application issue involves the application of the model that was developed from freeway simulation to a broader set of roadways as included in the DSS database. As noted in the model documentation, curves have been fitted for freeway segments and for signalized arterials. The Sketch model spreadsheet was designed to be applied to freeway segments.

Table 4.1 FDOT DSS Data Fields

DSS FIELDS	Description / Derivation
District	FDOT district No.
RdwyID	Roadway ID No.
BegPt	Dynamic segmentation relative beginning mile mark
EndPt	Dynamic segmentation relative ending mile mark
NoLanes	No. of Lanes
US Route	US route designation, if applicable ("Intrastate Route")
St Road No	Section descriptor, if applicable
Access (ie. PC/FC)	Access Control
FIHS MPRF	FIHS ID Number
MAXSPEED	Maximum speed
SectAdt	Section AADT
Area Type	URB, RUR, or TRANS
TypeRoad	Type of Road Median - divided or other
HwyLoc	Current Hwy Location code
UrbSize	Urban Size Code
Elanes	No. of Lanes
Med Adt	Median AADT
Flanes	No. of Lanes
WPI	Work Program Item Number
MSV	Maximum Service Volume
LOS	Level of Service
Speed	Peak Period Speed
Dspd	Daily Average Speed
VCRatio	Volume/Capacity Ratio
AccSum	Number of Accidents for FIHS segment
FatSum	Number of Fatal Accidents for FIHS segment
InjSum	Number of Injury Accidents for FIHS segment
ParSum	Number of Property Damage Accidents for FIHS segment
DamSum	Dollar Amt. of Damage Caused by Accidents for FIHS segment
Actual	The number of accidents per 1 million vehicle miles
Critical	The critical crash rate
Ratio	Actual/Critical
Cost	Costs for Urban and Rural Fatalities, Injury, and Property Damage Accidents
Pcond	Pavement Condition
ImfDist	Distance from center of segment to nearest intermodal facility
FrtDist	Distance from center of segment to nearest freight facility
EDF	An Economic Development Score related to segment length (score is county-wide)
Zcond	Pavement Condition District
ZRatD	Safety (Crash Costs) District
ZimDD	Intermodal Connectivity District
ZFrtDD	Freight District
ZeDD	Economic Development District
Zcon	Pavement Condition Statewide
Zrat	Safety (Crash Costs) Statewide
ZimD	Intermodal Connectivity Statewide
ZfrtD	Freight Statewide
Zed	Economic Development Statewide
Truck	Truck AADT = AADT * TRUCK (%)
Score1	User input scores
Score2	User input scores
FIHS_ID	FIHS ID Number
Base year through Year 25	Models of AADT beginning with year 2000

For purposes of experimental application, the database was sorted by speed and all roadway segments with speed limits below 50 miles per hour were eliminated. This included some non-freeway segments. The reader is cautioned that this may introduce significant error into the estimates but it was felt that it would, nonetheless, provide reasonable order of magnitude estimates of total incident delay and reasonable estimates of changes in incident delay when subject to various sensitivity tests.

A second major assumption dealt with directional travel. The spreadsheet is designed to develop estimates for directional travel. Thus, the DSS database was factored to provide volume information appropriate for directional travel. This implicitly assumes that daily travel is equally split by direction for all segments. While this is almost always true, for some segments odd number of lanes and other conditions could result in different directional information being more precise than assuming average conditions. A number of segments showed an odd number of lanes indicating that acceleration lanes, merge lanes, and perhaps other conditions were not completely symmetric by direction. The model was designed to use the number of through lanes. Thus, for situations with an odd number of lanes the halved number of lanes was rounded down.

The model only has unique equations for freeways with up to 4 lanes per direction. In cases where there were five lanes per direction the segments were treated as if they were four lanes wide for purposes of modeling. The sensitivity to incidents decreases for wider facilities so this assumption may slightly overstate the consequences of incidents for five lane facilities. The limited number of these contexts will not be significant in the overall estimation.

Figure 4.1 is an image of the cover page of the excel workbook. This cover page provides the reader with some basic information about the model. The model consists of seven pages: the cover introduction page, five worksheets that directly relate to operation of the model and an appended page that serves as a notepad for test results. The descriptive information can be read from Figure 4.1.

Figure 4.2 and 4.3 are from the second page of the spreadsheet. This page is the page where the DSS data are inserted. After the segments with speeds below 50 miles per hour were sorted out and deleted, there were approximately 2000 roadway segments in the Florida analysis.

Figure 4.1 Model Cover Page

Page 1

Incident Congestion Assessment Screening

Version 2003.1 August 2003

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Introduction

This spreadsheet and its associated worksheets were compiled by research team members at the Center for Urban Transportation Research. It serves as a tool to explore the congestion consiquence of incident congestion on Florida's Intrastate Highway System. The project objective was to inditify the consequence of incidents on congestion and to explore strategies for prioritizing actions. This exploratory research both makes an initial review of that issue and provides a framework for more refined analysis as additional data or scenarios are developed. As such, this tool can be used to look at current or future conditions.

The ultimate value of screening to identify the congestion consequences of incidents is to a provide information that will support overall evaluations of incident management investments and programs.

Contents

This spreadsheet contains 6 different worksheets.

1. Introduction - This page provides a brief introduction.
2. DSS Data - This page lets the model user inport roadwy segment dta from the file format used in the Florida Decision Support System. This dta is the data based used in this explorator analysis.
3. Inputs - This Spreadsheet extracts the data required to drive the application of the Sketch Methods for Estimateing Incident Related Impacts, a screening tool developed by FHWA and Cambridge Systematics. It also allows the user to change select input variables to test various scenarios.
4. Default Accident and Incident Rates - This provides a number of tables that enable the user to set the classification criteria ranges for the variables used in classification.
5. Calculations - This worksheet calcualtes the travel time impacts of incidnets on a roadway segment basis.
6. Outputs - This is the main output worksheet.
7. Output Summary - This sheet serves as a note pad to save results from various tests.

Figure 4.2 shows only part of the column headings row. Figure 4.3 shows column headings from the far right upper section of the page. This is where two additional columns were added to the data to append information needed for the analysis. The DSS database does not include information on shoulder width, one of the model variables. Therefore, it was necessary to fabricate default data for model application. As shown in Figure 4.3, simplifying assumptions were made regarding the availability of shoulders as a function of roadway maximum speed.

Figure 4.2 DSS Roadway Segment Data Entry

Page 2

Roadway Segment Data

ID	FDOT DISTRICT	Roadway ID	BEGPT	ENDPT	Numer of Lanes	US ROUTE	State Road Number	ACCESS	FIHS MPRF	MAX SPEED
16	1	01075000	0.000	8.528	4	I-75	SR-93	FC	404	70
17	1	01075000	8.528	11.795	4	I-75	SR-93	FC	404	70
18	1	01075000	11.795	15.086	4	I-75	SR-93	FC	404	70
19	1	01075000	15.086	15.133	4	I-75	SR-93	FC	404	70
20	1	01075000	15.133	17.599	4	I-75	SR-93	FC	404	70
21	1	01075000	17.599	17.912	4	I-75	SR-93	FC	404	70
22	1	01075000	17.912	21.089	4	I-75	SR-93	FC	404	70
23	1	01075000	21.089	21.104	4	I-75	SR-93	FC	404	70
24	1	01075000	21.104	22.008	4	I-75	SR-93	FC	404	70
74	1	03175000	0.000	29.112	4	I-75	SR-93	FC	404	70
75	1	03175000	29.112	49.090	4	I-75	SR-93	FC	404	70
76	1	03175000	49.090	50.319	4	I-75	SR-93	FC	404	70
77	1	03175000	50.319	53.693	4	I-75	SR-93	FC	404	70

Figure 4.3 DSS Data Supplement

Derived Data

Left Shoulder Width	Right Shoulder Width
5.00	10.00
5.00	10.00
5.00	10.00
5.00	10.00

Shoulder Assumptions	Right	Left
Speed equal or greater than 55	10	5
Speed less than 55	4	3

Figure 4.4 is very close in format to the first page of the FHWA developed spreadsheet. Several minor modifications have been made to increase the usefulness and to facilitate the importation of data. For the Florida application the peak period analysis was not carried out. Subsequent work could enhance the analysis by looking at peak period data. However, it would ideally require segment level data on peak period volumes.

Figure 4.4 Data Extraction Sheet

Sketch Planning Incident Analysis											
Data Input Sheet							Analysis Year		2000	The analysis year sp	
Scenario:	FDOT Baseline		**Date:**	8/1/2003			Hourly Capacity Factor		0.09	Percent of Maximum ser	
			Duration (min)	45.00					0.09		
Links	**Name**	**Average Annual Daily Traffic** (by direction)	**% Peak Period**	**Speed Limit (MPH)**	**Free Flow Speed (MPH) (0 if default)**	**Incident Rate per MVMT (0 if default)**	**Accident Rate per MVMT (0 if default)**	**# Lanes (one-way)**	**Hourly Capacity (one-way)**	**Link Length (mi)**	**RT Shoulder (width in feet)**
1	SR-93	15,750		70	0	0	0	2	2156	8.53	10.00
2	SR-93	14,250		70	0	0	7.076	2	2156	3.27	10.00
3	SR-93	17,750		70	0	0	0.755	2	2156	3.29	10.00
4	SR-93	17,750		70	0	0	2.036	2	2156	0.05	10.00
5	SR-93	21,500		70	0	0	1.034	2	2156	2.47	10.00
6	SR-93	21,500		70	0	0	0.949	2	2156	0.31	10.00
7	SR-93	18,750		70	0	0	0.842	2	2156	3.18	10.00
8	SR-93	16,500		70	0	0	0.996	2	2156	0.02	10.00
9	SR-93	16,500		70	0	0	0.646	2	2156	0.90	10.00
10	SR-93	6,200		70	0	0	0.993	2	1440	29.11	10.00
11	SR-93	6,300		70	0	0	0.785	2	1440	19.98	10.00
12	SR-93	6,300		70	0	0	1.996	2	2156	1.23	10.00
13	SR-93	14,250		70	0	0	0.636	2	2156	3.37	10.00
14	SR-93	14,250		70	0	0	0.669	2	2196	1.63	10.00
15	SR-93	14,250		70	0	0	1.289	2	1440	0.84	10.00
16	SR-93	23,931		70	0	0	1.113	2	1440	0.02	10.00
17	SR-93	23,931		70	0	0	1.16	2	2156	4.25	10.00
18	SR-93	32,250		70	0	0	0.563	2	2156	3.07	10.00
19	SR-93	17,000		70	0	0	1.011	2	1440	7.06	10.00
20	SR-93	14,750		70	0	0	1.669	2	1440	4.39	10.00
21	SR-93A	21,250		70	0	0	0.78	3	2178	4.42	10.00
22	SR-93A	21,250		70	0	0	1.66	3	3249	0.51	10.00
23	SR-93A	21,250		70	0	0	1.49	3	2178	1.52	10.00
24	SR-93A	26,000		70	0	0	0.832	3	3249	5.83	10.00
25	SR-93A	26,000		70	0	0	0.105	3	4527	0.02	10.00
26	SR-93A	28,750		70	0	0	1.013	3	4527	4.17	10.00
27	SR-93A	30,750		70	0	0	2.072	3	4527	0.23	10.00
28	SR-93A	30,750		70	0	0	0.685	4	6035	2.26	10.00
29	SR-93A	30,750		70	0	0	0.699	4	6035	0.39	10.00
30	SR-93A	30,750		70	0	0	0.774	4	7547	0.17	10.00
31	SR-93A	30,750		70	0	0	1.239	4	7547	0.19	10.00
32	SR-93A	30,750		70	0	0	1.278	4	6035	0.37	10.00
33	SR-93A	26,500		70	0	0	1.476	4	6035	0.33	10.00
34	SR-93A	26,500		70	0	0	1.007	3	4527	0.53	10.00
35	SR-93A	26,500		70	0	0	1.208	4	6035	0.72	10.00
36	SR-93A	26,500		70	0	0	0.974	3	4527	0.29	10.00
37	SR-93A	29,250		70	0	0	1.599	3	4527	0.31	10.00
38	SR-93A	29,250		70	0	0	1.379	3	4527	0.48	10.00
39	SR-93A	29,250		70	0	0	2.996	3	4527	0.06	10.00
40	SR-93A	49,000		70	0	0	1.321	3	4527	0.20	10.00
41	SR-93A	49,000		70	0	0	0.727	3	4527	0.13	10.00
42	SR-93A	49,000		70	0	0	1.164	3	4527	2.49	10.00
43	SR-93A	43,000		70	0	0	1.675	3	4527	0.35	10.00
44	SR-93A	43,000		70	0	0	1.593	3	4527	0.66	10.00
45	SR-93A	43,000		70	0	0	1.051	3	4527	0.43	10.00
46	SR-93A	35,500		70	0	0	1.306	3	4527	3.55	10.00
47	SR-93A	35,500		70	0	0	0.195	2	3015	0.11	10.00
48	SR-93A	35,500		70	0	0	3.135	2	3015	0.28	10.00
49	SR-93A	35,500		70	0	0	2.643	2	3015	0.13	10.00
50	SR-93A	29,000		70	0	0	2.525	2	3015	0.30	10.00
51	SR-93A	29,000		70	0	0	1.691	3	4527	0.50	10.00

Additional modifications applied to the spreadsheet page shown in Figure 4.4 include adjusting the volumes to directional volumes and developing a spreadsheet variable to enable the user to select the peak hourly factor and the reference year for roadway volume data. These pull down menus are shown in the upper center of Figure 4.4. The DSS data has volume information from year 2000 to year 2025. The user is also asked to determine if the roadway segment has bottleneck congestion. For purposes of this analysis roadway segments that have level of service F, a designation provided in the DSS database, were assumed to have bottleneck conditions.

As shown in Figure 4.5, the spreadsheet has default accident rates as well as default incident rates. The DSS database has actual accident information for the Florida roadway segments. These actual data were used in the analysis, and, in general, were somewhat higher than the default rates shown in Figure 4.5. The DSS database does not have incident data; therefore, the default data incident rates were used. Notice that the incident rates are several times as large as the accident rates, thus, critical to the analysis. Not surprisingly, accident rates tend to increase significantly for busier roads. Incident rates also increase, though not at nearly the same pace, as the roadway volume climbs.

Figure 4.5 Default Accident and Incident Rates

Default Accident and Incident Rates		
AADT/C	**Accident Rate** (Per MVMT)	**Total Incident Rate** (per MVMT)
1	1.066	9.611
2	1.069	9.614
3	1.075	9.620
4	1.086	9.631
5	1.105	9.650
6	1.132	9.677
7	1.172	9.717
8	1.220	9.765
9	1.275	9.820
10	1.345	9.890
11	1.414	9.959
12	1.518	10.063
13	1.583	10.128
14	1.657	10.202
15	1.709	10.254
16	1.760	10.305
17	1.810	10.355
18	1.853	10.398

Figure 4.6, Incident Delay Calculations, is a screen capture from the spreadsheet page where the actual incident delay calculations are carried out. As shown, the links are currently shown in speed ranked order. The sums calculated on this page subsequently feed the results page.

Figure 4.7, Incident Delay Calculation Outputs, summarizes the results and presents the findings. This page includes roadway segment data as well as a summary of the full set of links that were included in the analysis. This page has been slightly modified to both accommodate the expanded roster of links as well as to add summary measures of VMT and speed. The speed calculation provides something of a reasonableness check on the results, irrational speeds indicating the prospect of erroneous entry data.

Figure 4.6 Incident Delay Calculations

Calculations

Links	FFS	ShldFac	X	IncRate	AccRate	DurFac	Daily H_u no queuing	Pk Per H_u no queuing	Daily H_r queuing	Pk Per H_r queuing	Daily H_i Two Lane Freeway	Pk Per H_i Two Lane Freeway	Daily H_i Three Lane Freeway	Pk Per H_i Three Lane Freeway	Daily H_i Four Lane Freeway	Pk Per H_i Four Lane Freeway
1	75.6	1	3.65	1.000	1.000	1.184	0.013228	0.013228	0.000000	0.000000	0.000069	0.000099	0.000018	0.000031	0.000007	0.000001
2	75.6	1	3.31	1.000	6.582	1.184	0.013228	0.013228	0.000000	0.000000	0.000055	0.000077	0.000012	0.000023	0.000004	0.000001
3	75.6	1	4.12	1.000	0.695	1.184	0.013228	0.013228	0.000000	0.000000	0.000093	0.000137	0.000028	0.000048	0.000012	0.000002
4	75.6	1	4.12	1.000	1.875	1.184	0.013228	0.013228	0.000000	0.000000	0.000093	0.000137	0.000028	0.000048	0.000012	0.000002
5	75.6	1	4.99	1.000	0.952	1.184	0.013228	0.013228	0.000000	0.000000	0.000160	0.000248	0.000062	0.000105	0.000030	0.000006
6	75.6	1	4.99	1.000	0.874	1.184	0.013228	0.013228	0.000000	0.000000	0.000160	0.000248	0.000062	0.000105	0.000030	0.000006
7	75.6	1	4.35	1.000	0.775	1.184	0.013228	0.013228	0.000000	0.000000	0.000108	0.000161	0.000035	0.000060	0.000015	0.000003
8	75.6	1	3.83	1.000	0.927	1.184	0.013228	0.013228	0.000000	0.000000	0.000077	0.000112	0.000021	0.000037	0.000008	0.000001
9	75.6	1	3.83	1.000	0.601	1.184	0.013228	0.013228	0.000000	0.000000	0.000077	0.000112	0.000021	0.000037	0.000008	0.000001
10	75.6	1	2.15	1.000	0.929	1.184	0.013228	0.013228	0.000000	0.000000	0.000025	0.000033	0.000003	0.000007	0.000001	0.000000
11	75.6	1	2.19	1.000	0.734	1.184	0.013228	0.013228	0.000000	0.000000	0.000025	0.000034	0.000003	0.000007	0.000001	0.000000
12	75.6	1	1.46	1.000	1.872	1.184	0.013228	0.013228	0.000000	0.000000	0.000014	0.000019	0.000001	0.000003	0.000000	0.000000
13	75.6	1	3.31	1.000	0.592	1.184	0.013228	0.013228	0.000000	0.000000	0.000055	0.000077	0.000012	0.000023	0.000004	0.000001
14	75.6	1	3.24	1.000	0.622	1.184	0.013228	0.013228	0.000000	0.000000	0.000053	0.000074	0.000011	0.000021	0.000004	0.000001
15	75.6	1	4.95	1.000	1.187	1.184	0.013228	0.013228	0.000000	0.000000	0.000157	0.000242	0.000060	0.000101	0.000029	0.000006
16	75.6	1	8.31	1.000	0.912	1.184	0.013275	0.013396	0.000000	0.000000	0.001194	0.002217	0.000736	0.001497	0.000676	0.001398
17	75.6	1	5.55	1.000	1.050	1.184	0.013229	0.013228	0.000000	0.000000	0.000227	0.000364	0.000100	0.000169	0.000055	0.000011
18	75.6	1	7.48	1.000	0.480	1.184	0.013263	0.013236	0.000000	0.000000	0.000722	0.001312	0.000414	0.000819	0.000340	0.000073
19	75.6	1	5.90	1.000	0.915	1.184	0.013231	0.013228	0.000000	0.000000	0.000281	0.000461	0.000132	0.000227	0.000077	0.000016
20	75.6	1	5.12	1.000	1.510	1.184	0.013228	0.013228	0.000000	0.000000	0.000174	0.000272	0.000070	0.000117	0.000035	0.000007
21	75.6	1	4.88	1.000	0.718	1.184	0.013228	0.013228	0.000000	0.000000	0.000150	0.000231	0.000057	0.000095	0.000027	0.000005
22	75.6	1	3.27	1.000	1.544	1.184	0.013228	0.013228	0.000000	0.000000	0.000053	0.000076	0.000012	0.000022	0.000004	0.000001

Figure 4.7 Incident Delay Calculation Outputs

FDOT Baseline

Date:

8/1/2003

Summary

	Vehicle Hours of Travel	Percent of VHT	Percent of Delay		VMT	Speed
Daily						
Delay due to Incidents (including Accidents)	77,929.34	3.59%	19.72%			
Delay due to Recurring Bottlenecks	317,173.62	14.62%	80.28%			
Uncongested Vehicle Hours of Travel	1,774,792.92	81.79%				
Total	2,169,895.88	100.00%	100.00%		122,344,536	56.38268
Peak Period						
Delay due to Incidents (including Accidents)	0.00	#DIV/0!	#DIV/0!			
Delay due to Recurring Bottlenecks	0.00	#DIV/0!	#DIV/0!			
Uncongested Vehicle Hours of Travel	0.00	#DIV/0!	#N/A			
Total	0.00	#DIV/0!	#DIV/0!			

Link by Link

Daily

Links	Name	Daily VMT	Daily V_r	Daily VHT_u	Daily VHT_i	Daily VHT_r	Total Daily VHT	Peak Period VMT	Peak V_r	Peak Period VHT_u	Peak Period VHT_i	Peak Period VHT_r
1	SR-93	134,316	15,750	1,777	9	0	1,786	0	0	0	0	0
2	SR-93	46,555	14,250	616	18	0	634	0	0	0	0	0
3	SR-93	58,415	17,750	773	4	0	776	0	0	0	0	0
4	SR-93	834	17,750	11	0	0	11	0	0	0	0	0
5	SR-93	53,019	21,500	701	8	0	709	0	0	0	0	0
6	SR-93	6,730	21,500	89	1	0	90	0	0	0	0	0
7	SR-93	59,569	18,750	788	5	0	793	0	0	0	0	0
8	SR-93	248	16,500	3	0	0	3	0	0	0	0	0
9	SR-93	14,916	16,500	197	1	0	198	0	0	0	0	0
10	SR-93	180,494	6,200	2,387	4	0	2,392	0	0	0	0	0
11	SR-93	125,861	6,300	1,665	2	0	1,667	0	0	0	0	0
12	SR-93	7,743	6,300	102	0	0	103	0	0	0	0	0

Results

Figure 4.8 exemplifies the presentation of the results of several sensitivity tests on this preliminary assessment of incident congestion on the Florida roadway system.

A base case was run initially using year 2003 volume data and the standard incident duration of 38 minutes. The hourly capacity factor of .09 was used in the calculation of the value of "c". The results indicate that the delay due to incidents is 4.08 percent of total travel time and approximately 14 percent of total vehicle delay.

The second scenario altered the mean incident duration time from 38 to 45 minutes. This resulted in an increase in incident delay time such that the incident delay increased to 5.64 percent of total travel time and to nearly 18.5 percent of total delay. This produced less than a one mile per hour decline in the average travel speed. The model appeared to be behaving reasonably given the input database.

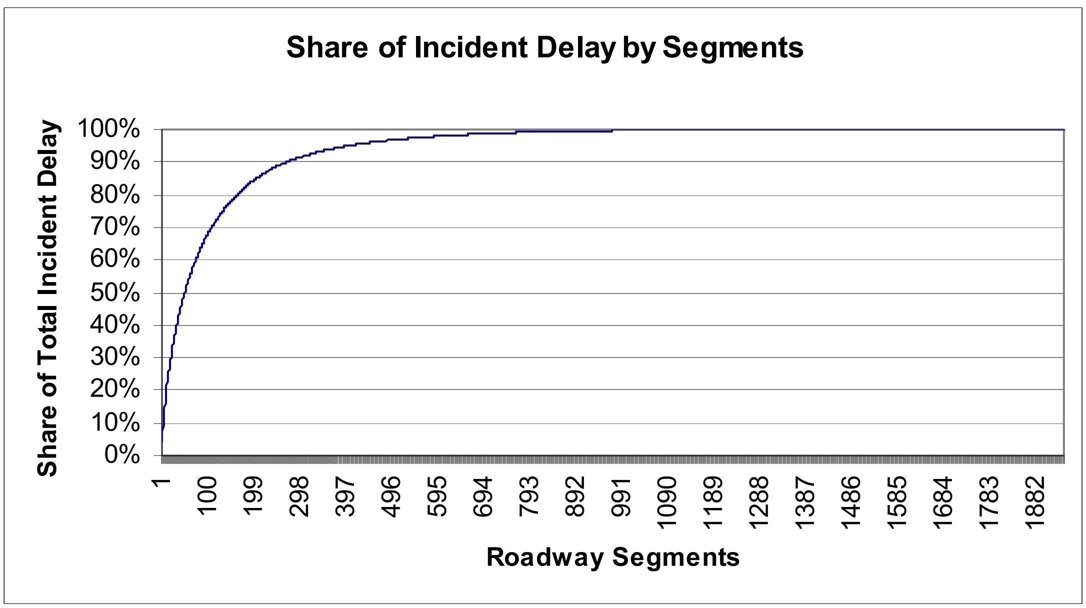
Figure 4.8 Output Summary

Output Summary								
			Vehicle Hours of Travel	**Percent of VHT**	**Percent of Delay**		**VMT**	**Speed**
Test One	**Daily**							
Yr 2003	**Delay due to Incidents (including Accidents)**		113,751.58	4.08%	13.96%			
Incident Duration = 38 minutes	**Delay due to Recurring Bottlenecks**		701,365.23	25.18%	86.04%			
Hourly Capacity Factor = .09	**Uncongested Vehicle Hours of Travel**		1,969,955.91	70.73%				
	Total		2,785,072.72	100.00%	100.00%		135,577,957	48.68022156
Test One-D	**Daily**							
Yr 2003	**Delay due to Incidents (including Accidents)**		159,520.05	5.64%	18.53%			
Incident Duration = 45 minutes	**Delay due to Recurring Bottlenecks**		701,365.23	24.78%	81.47%			
Hourly Capacity Factor = .09	**Uncongested Vehicle Hours of Travel**		1,969,955.91	69.59%				
	Total		2,830,841.19	100.00%	100.00%		135,577,957	47.89316956
Yr 2006	**Daily**							
Incident Duration = 38 minutes	**Delay due to Incidents (including Accidents)**		199,290.40	5.05%	11.32%			
	Delay due to Recurring Bottlenecks		1,561,250.85	39.54%	88.68%			
	Uncongested Vehicle Hours of Travel		2,187,802.76	55.41%				
	Total		3,948,344.01	100.00%	100.00%		150192983.2	38.03948766
Yr 2006	**Daily**							
Incident Duration = 45 minutes	**Delay due to Incidents (including Accidents)**		279,475.80	6.94%	15.18%			
	Delay due to Recurring Bottlenecks		1,561,250.85	38.75%	84.82%			
	Uncongested Vehicle Hours of Travel		2,187,802.76	54.31%				
	Total		4,028,529.41	100.00%	100.00%		150,192,983	37.28233502

The second test series altered the reference year for volume data. Year 2006 data were used. This test resulted in a meaningful change in the incident delay and a significant change in system performance with recurring delay increasing dramatically and a large drop in speed.

Figure 4.9 presents a graphic presentation of the concentration of incident delay by ranking the roadway segments based on the magnitude of delay, then calculating a cumulative distribution of incident delay in order to determine the extent of delay concentration. This graphic is developed as an example of the diagnostic strategies that one might use to identify priorities for incident delay treatments. The top ten percent of segments in terms of incident delay, approximately 200, comprise about 80 percent of the total cumulative incident delay. Thus, one would be inclined to focus incident management strategies on this subset of segments or clusters of these segments. Chapter Five will discuss additional strategies for enhanced diagnostic testing.

Figure 4.9 Incident Delay Distribution



The results from these tests are not intended to be used to draw site specific findings but rather to verify the functioning of the model. Thus, only broad conclusions can be drawn from the tests and decision making should only be based on refined applications with the most current input data. General conclusions include:

- The model is easy to use and produces results that appear logical and in scale with professional judgments.

- The model has not been validated for Florida data in terms of the fundamental behaviors of the system – i.e. the extent to which incidents impact roadway flows and the consequent incident delay – however, this fundamental relationship is not likely to be significantly affected by local conditions. Differences in driver behavior, climate, vehicle composition mix and other factors may result in some subtle difference that could be more fully explored if detailed Florida incident impact data could be tested against forecast impacts.
- Refined Florida data both with respect to data on roadway segments and specifically on incident frequency and duration would be very important to increase confidence in the reasonableness of the outputs of the model. This data refinement was beyond the scope of this effort.

Chapter Five provides additional comments that might be of value in determining the feasibility of subsequent applications of the assessment tool.

Chapter 5

Policy Implications and Research and Planning Recommendations for Incident Congestion Assessment

Incident management and incident congestion are increasingly receiving attention by both transportation professionals and lay policy makers. Part of the growing awareness of incident congestion is the fact that it has received attention because of the inclusion in the Texas Transportation Institute Mobility Reports that are aggressively reported by the media. In these reports, incident congestion is often the cause of approximately half of the total congestion reported for the urban areas analyzed. Additionally, as overall congestion levels have increased due to rapid demand growth and moderate capacity additions, transportation professionals are aggressively looking for strategies to improve the operation of existing roadways. As noted in the introductory chapter, incident management offers safety benefits as well, hence is an attractive and promising area for investigation.

Over the past ten years the knowledge base on incident management has been growing rapidly due to a host of factors including growth in incident management programs, enhanced analytical capabilities for simulation analysis, and dramatic growth in Intelligent Transportation System applications that can provide the data bases that are helpful in analysis of incident occurrences and responses to mitigation strategies. Nonetheless, the nature of incidents and accidents and the ability to influence the delays through various actions remain a relatively new area for research investigation. The variability of contexts, coupled with the “rare event” nature of incidents, complicates the process of developing a precise strategy for assessing the nature of incident delay. The complexity is compounded by the numerous factors that go into various strategies for minimizing incident delay.

The remainder of this chapter offers a number of observations -- about strategies for subsequent application of the sketch planning model in Florida and the role of incident management in the overall program of addressing mobility challenges.

Sketch Planning Model Strategies

The model utilized in this initiative proved to be an effective initial strategy but substantial additional development and application experience could significantly enhance the usefulness and confidence in the findings. The priority area would be to update and enrich the DSS database. Several areas of enhancement would include the following:

- The model is designed to take directional data - particularly if one wants to use the peak period incident delay analysis capability. FDOT personnel could enrich the data base or derive alternative databases with directional data for use in future applications.
- The model is designed for use on freeway segments - so the database could be sorted to focus on the application to only freeway segments with the existing spreadsheet database.
- The FHWA initiative did carryout some simulation work with signalized arterials and developed coefficients for curves that reported incident delay for various AADT/C levels on arterials. These coefficients could be input into the spreadsheet model to set it up for application on arterial roadway segments. The variability of contexts for arterials is much greater, making it more difficult to establish the consequence of incidents. Driveways and cross streets provide opportunities to clear incidents and accident damaged vehicles and most arterials are part of higher density networks, thus, delayed vehicles have many more opportunities to minimize the impact of incidents via detours depending on the context. A more detailed review of arterial incident frequency and consequence based on real world observation data may be helpful in evaluating the merits of additional investigation of incident management assessment for arterial facilities in Florida.
- Incident data beyond accidents is not part of the DSS database. FDOT does not collect incident data at the state level based on the understanding communicated to the research team. Various districts collect incident data. This initiative did not attempt to compile empirical incident data for Florida roadway segments. Future work exploring incident management and incident congestion consequences should assess the availability, quality, and definitions of Florida incident data. This would include actual incident frequency and incident duration distribution information. To meaningfully evaluate initiatives to improve incident management would require some descriptive information about the current incident response program activities and success. This would be required to subsequently determine how these traits would change under different incident management strategies.
- More research is required to measure or capture empirical data regarding the frequency and duration of incidents on the Florida intrastate system. General assumptions based on national averages are used in the model, which may not reflect actual conditions in Florida. Florida Highway Patrol (FHP) is a source of data for incidents. They enter all incidents that they respond to into their Computer Aided Design (CAD) system and provide information to the public through their Web site. This data has not been incorporated into this analysis.
- The DSS database did not specifically identify bottleneck segments and a surrogate strategy was used that assumed that Level of Service “F” sections had bottlenecks. Given the specific definitions of bottlenecks itemized in the model documentation, more

detailed review should be carried out by persons familiar with each poor performing segment prior to designation as a bottleneck segment.

- The DSS database does not include information about shoulder conditions of the segments. While assumptions were made for this preliminary analysis, more detailed segment level data regarding shoulder conditions would increase the confidence that could be placed in the results.
- The FDOT Roadway Characteristics Inventory (RCI) database could be integrated with into the DSS data base to provide additional information on direction flow, peak period factors and shoulder widths. This would enable more refined analysis.
- A number of alternative testing strategies could be used to screen for segments or locations where incident mitigation strategies might be promising. Among those strategies are the following:
    - The database of segments could be sorted by geography and sets of segments that were within a logical service area could be tested as a group. This would be a type of scenario testing where different geographic locations would be tested and the relative responsiveness used as a tool in helping with resource allocation and programming decisions.
    - The segment level incident delay measure could be converted into a geocoded measure and input back into the DSS database or another GIS database. A graphical presentation could be used to identify promising geographic areas for incident management treatment.
    - A more sophisticated variant of this would be to use some geographic clustering analysis algorithms to determine locations that offered promise for incident management treatments. This would seek out clusters of adjacent or nearby accessible segments that would be logical geographic foci for resource commitments.
- The model appears to be very sensitive to changes in roadway volume. Thus, it is illogical to test current roadway conditions with future volume for more than a few years into the future, especially for links that are congested today. Additional review and testing of sensitivities as volume changes would lead to a richer understanding of how the model behaves.
- A policy analyst is tempted to want to reach conclusions regarding the cost effectiveness of incident reduction strategies as a method of increasing roadway capacity in comparison to roadway capacity expansion. Unfortunately, one is at risk in attempting to answer that question in the absence of additional refinements in both the assessment tool inputs and a richer knowledge regarding how various incident management strategies actually affect roadway throughput capacity and what they cost. These kinds of policy questions are legitimate, and, over time additional data will be available to enable informed policy analysis.

Incident Mitigation Strategies

This initiative did not explicitly test any particular incident management strategies due principally to the difficulty in determining linkages between the particular strategy and the resultant response in terms of incident frequency and duration, and subsequently in terms of incident delay. If the model is robust, the incident delay for a given change in incident frequency and duration should be captured in the existing model. What is clearly missing is the relationship(s) between tactics and response in terms of duration and frequency of incidents.

Some recent work carried out by TTI has developed the relationships between delay and incident management strategies. Table 5.1 shows the current state of knowledge regarding this relationship with respect to the tactic of roving assistance vehicles. As the table indicates, the consequence is a function of the roadway conditions and the level of intensiveness of the mitigation strategy. Additional information regarding strategy impacts is likely to evolve as additional local communities implement incident management strategies and as more sophisticated traffic monitoring programs are in place where the impacts can be more quantitatively determined. Florida will be well served by both watching evolving information nationwide and developing a data base on Florida location responses to incident management strategies.

Table 5.1 Incident Delay Reduction (Percent) Benefits of Incident Management Programs (HPMS and Deployment Tracking)

System Coverage (HPMS mileage versus DT mileage)	Patrol Cycle (miles each vehicle covers)	Congestion Level				
		Uncongested	Moderate	Heavy	Severe	Extreme
No patrols		0	0	0	0	0
Less than ¼ of system covered	More than 10 miles Less than 10 miles	0 0	14 21	17 24	20 27	23 30
Between ¼ and ½ of system covered	More than 10 miles Less than 10 miles	0 0	15 22	18 25	21 28	24 31
Between ½ and ¾ of system covered	More than 10 miles Less than 10 miles	0 0	17 24	20 27	23 30	26 33
More than ¾ of system covered	More than 10 miles Less than 10 miles	0 0	18 25	21 28	24 31	28 35

Source: HERS Operations Preprocessor and TTI Analysis

Conclusions

The assessment of incident management in Florida shed light on the state of the practice nationally and provided an exploratory assessment of the consequences of incidents on delay in Florida. In addition, the modified tool is available should FDOT choose to continue to explore this issue and enhance the databases. Overall incident induced delay in Florida appears to be far more modest than the numbers typically estimated for urban areas. However, this would be expected when lower volume rural and transitional roadway segments are included.

There are a number of promising areas for additional analysis. Florida may be well served by continuing to explore overall incident managements priorities while simultaneously carrying out more intensive corridor level programs for incident management and congestion management at a local level. Much of the attention to incident management already underway in Florida will provide a richer data base on which subsequent work could refine the application presented in this report. All of the information reviewed and developed for this report confirms the importance of incident management as a strategy for reducing congestion delay. Many of the activities underway to enhance incident management efforts will provide congestion reduction benefits as well as safety benefits. Some activities such as strategies to reduce on site delays are applicable throughout the state and, hence, do not require segment prioritization. Other strategies such as technology or monitoring activities, are location specific and a prioritization strategy may benefit from a greater understanding of the congestion reduction benefits.

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