U.S. Department of Transportation

Intelligent Transportation Systems *for* Traffic Incident Management

DEPLOYMENT BENEFITS AND LESSONS LEARNED

Americans lose 3.7 billion hours and 2.3 billion gallons of fuel every year sitting in traffic.[1] In 2004, trucks idling in traffic are estimated to have cost the trucking industry some 243 million hours, the equivalent of 17,000 work years, with a cost of $8 billion.[2] To combat the country's growing transportation congestion problem, the U.S. Department of Transportation launched the *National Strategy to Reduce Congestion on America's Transportation Network*. One element of this initiative is to reduce incident-related congestion by promoting operational and technological improvements that increase incident response capabilities.[3] ■

Traffic Incident Management

Traffic Incident Management (TIM) is a systematic, planned, and coordinated effort to detect, respond to, and remove traffic incidents and restore traffic capacity as safely and quickly as possible. TIM involves the application of institutional, mechanical, and technical resources, including Intelligent Transportation Systems (ITS), and offers a number of measurable benefits:

- Traffic incident management reduces fuel consumption by about 1.2 percent annually,[4] saving 2,600-7,700 gallons per incident.[5]
- Traffic incident management reduces incident duration by up to 65 percent[6] and reduces secondary crashes by 30–50 percent.[7]
- Service patrols' benefit-cost ratios range from 2:1 to 36:1.[8]

ITS technologies for traffic incident detection, verification, response, and communication are recognized as valuable tools by transportation professionals and are being used throughout the country:

- 32 percent of freeway miles are monitored by video to detect incidents, and 45 percent are served by service patrols.[9]
- Traffic incident management on arterial streets is growing: 5 percent of arterial streets have video monitoring for detection, and 10 percent have service patrols.[10] ■

BENEFITS

San Antonio Reduces Response Times by 20 Percent

As populations surge across the south and southwest, roads get busier and delays get longer. That's why the Texas Department of Transportation, the City of San Antonio (police/fire/emergency medical services/traffic), and VIA, the region's transit provider, teamed up to develop and implement the TransGuide "smart highway" system.

TransGuide is an Intelligent Transportation System that uses dynamic message signs, loop

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BENEFITS

Quicker Response, Fewer Secondary Incidents

Secondary crashes due to congestion caused by a previous crash are estimated to represent 20 percent of all crashes.[11]

The benefits of reduced incident duration through incident management programs are clear and well documented.

- Studies prove that the likelihood of a secondary crash increases by 2.8 percent for each minute the primary accident continues to be a hazard.[12]
- Maryland's Coordinated Highways Action Response Team (CHART) incident management program resulted in an estimated 377 fewer secondary crashes in 2002.[13]
- Indiana's Hoosier Helper service patrol contributed to an estimated reduction in secondary crashes of 259 in 1995.[14] ■

COSTS

FDOT Budget Supports a Variety of Traffic Incident Management Programs

All States and metropolitan areas are constrained by budget limitations, and the Florida Department of Transportation (FDOT) is no exception. But with a $36 million capital investment (annualized at about $8.3 million), FDOT has funded several programs designed to maintain traffic flow and hasten incident response through its District IV SunGuide Transportation Management Center.[15]

Some highlights of these efforts include:

- The Road Ranger service patrol utilizes 11 vehicles covering 84 centerline miles on I-95, I-595, and I-75 at an annual cost of about $2.5 million, including services and vehicle leases.[16]
- The Severe Incident Response Vehicle program is a pilot program providing an incident command station and support to FDOT and Road Rangers during such major incidents as tractor trailer roll-overs, hazardous material incidents, and fatalities.[17] The approximately $310,000 annual operating cost includes contracted services and one leased vehicle.[18]
- Traffic incident management services cost approximately $400,000 for 2005 and are geared toward maintaining interagency relationships and promoting dialogue.[19]
- The purchase of 45 closed circuit TV (CCTV) cameras and 106 detectors including installation, associated structures, and deployment have cost $2.8 million to date.[20] The next deployment phase, scheduled for 2006, will include approximately 55 CCTV cameras, 224 detectors, and 55 miles of in-ground fiber optic communications at an estimated cost of $15.5 million.[21]
- The estimated annual staffing cost for Southeast Florida's 511 Traveler Information System is $175,000.[22]
- The $11 million capital cost for dynamic message signs (DMS) includes approximately 50 miles of in-ground fiber optic communications, 31 signs, structures, foundation, controllers, cabinets, and installation. $18,600 has been budgeted annually for electricity, and annual maintenance costs will be about $750,000 for spare parts, labor, and preventative maintenance. DMS maintenance is contracted out.[23] ■

BENEFITS

Service Patrols Promote Fuel Conservation and Public Safety

Service patrols are known to help decrease incident-related delay, which means faster travel and fewer vehicle-hours annually. But less congestion also means less fuel wasted as vehicles idle while waiting for traffic to clear. The following examples show how fuel consumption was reduced at regional and local levels by decreasing incident-related congestion through service patrols.

Maryland's CHART Program

A 2000 study of Maryland's Coordinated Highways Action Response Team (CHART) program showed how incident reduction benefits Marylanders:

- Estimated fuel savings: 4.1 million gallons annually.[24]
- Estimated economic value of fuel savings: $6.1 million.[25]

Florida's Road Ranger Program

The Florida Road Ranger service patrol provides the residents of Florida with a significant reduction in wasted fuel due to congestion:

- Estimated fuel savings: 1.7 million gallons statewide monthly.[26]
- Estimated economic value of fuel savings: $3.4 million statewide monthly.[27]

According to the Florida Department of Transportation, this program not only cuts down on harmful emissions, it has an overall benefit-cost ratio of nearly 26:1.[28]

Thoughts from the Public

Service patrols are highly visible and have a powerful impact on frightened motorists. The box to the right contains excerpts from letters of appreciation that travelers have written to the Tennessee Department of Transportation in praise of their program in Chattanooga.[29] ■

"I truly felt my life was in danger as cars and trucks whizzed by…I felt my life was saved today due to this service…"

"He right off was thinking safety for everyone… me and my family, the traffic, and himself…"

"This is the best service the state provides. I was back on the road within 30 minutes…"

— Travelers in Chattanooga, TN

BENEFITS

ITS Benefits All Responders

Fire, rescue, and emergency medical services (EMS) have different priorities than transportation agencies when clearing an incident. Their first concern is the safety of the victims and motorists; getting traffic flowing again is secondary.

Including these first responders in the planning and development of a traffic incident management program, and maintaining consistent communication, will help ensure effective management of the traffic incident scene and cultivate multiagency ties, with the traveling public reaping the benefits of increased efficiency — and safety.

This kind of information sharing occurred during the 1996 Olympic Games in Atlanta. The Atlanta Fire Department, as part of its joint response efforts with the Georgia Department of Transportation, the State patrol, and the city police, realized the benefit of closed circuit TV cameras.[30]

" Being able to view the scene of a freeway incident using the surveillance cameras helped us to better decide the type and number of units to send to the incident."

— *Tony Davidson, Chief of Communications, Atlanta Fire Department*

It's important to keep all players in mind when deploying ITS. Better information to fire, rescue, and EMS means that they can arrive at the scene with the right equipment and resolve the incident more quickly. ■

Service Patrols Prove Cost Effective[31]

Location	Operating Costs (Millions Per Year)	Hours of Operation	Fleet Size	Benefit-Cost Ratio
Los Angeles, CA[32]	$20.5	6:00 a.m. to 7:00 p.m. Mon – Fri. 10:00 a.m. to 6:30 p.m. Sat – Sun	150 trucks	8:1
Detroit, MI[33]	$2.5	6:00 a.m. to 11:00 p.m. plus special events	32 drivers 34 vehicles	15:1
Ft. Lauderdale, FL[34]	$2.5	24 hours/day, 7 days/week	11 vehicles	21:1
Tennessee statewide[35]	$5.6	variable hours, 7 days/week	85 operators 69 trucks	not available
Denver, CO[36]	$1.5	6:30 a.m. to 9:00 a.m. 3:30 p.m. to 6:30 p.m. Mon – Fri	2 trucks	23:1

BENEFITS

How Can You Save $8 Million Per Year?

Houston TranStar did it by co-locating 75 personnel from the Texas Department of Transportation, Harris County, Houston Metro, and the City of Houston. Then they added a variety of traffic management tools, including a freeway management system, a freeway and arterial street incident management program, Intelligent Transportation System programs, a service patrol, and several other programs to the mix.

This combination of traffic professionals and a variety of traffic management tools, all with the goal of improving traffic flow, has saved an estimated 572,095 vehicle-hours annually. For Houston, a metropolis covering more than 600 square miles and home to the Port of Houston, through which more than 200 million tons of cargo pass every year,[37] that translates into an estimated economic value of $8.4 million saved annually.[38] Other summary data show additional benefits:

- In 1996, high-occupancy vehicle lane restrictions were lifted seven times due to incidents on the mainline that blocked all lanes. The Texas Transportation Institute estimated that, due to that action, 12,910 vehicles were able to avoid delay and save 13.5 to 27 minutes. Vehicle delay savings were estimated at between $42,500 and $85,100 for those seven incidents.[39]
- The service patrol, in place since 1989, has a benefit-cost ratio exceeding 23:1.[40] ■

DEPLOYMENT

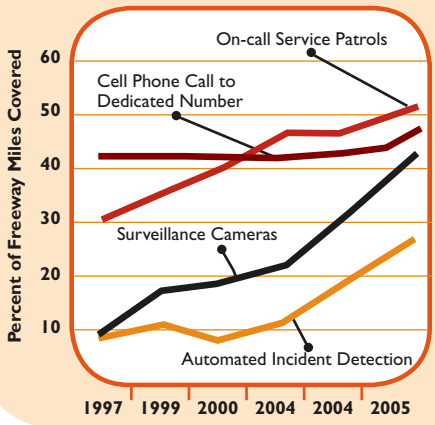
Trends in Detection and Verification

Since 1997, more than 40 percent of freeway miles utilized dedicated call numbers for travelers to report incidents via cell phones.[41] In fact, detection times can occur in as little as 1 minute in most metropolitan areas due to the proliferation of cellular phones. But, as the graph below shows, the number of cell phone calls to a dedicated number has remained flat; the fastest growing incident detection and verification method from 1997 to 2005 has been closed circuit TV (CCTV), which was deployed on 43 percent of freeways in 2005, a 35 percent increase since 1997.[42]

But no single method will detect everything, and transportation management professionals rely on several methods to detect and verify incidents, including CCTV cameras, cellular telephone calls, automated incident detection, and service patrols, among others.

- CCTV, deployed in some 73 metropolitan areas as of 2004,[43] is one of the most cost-effective and efficient methods for incident verification.[44]
- The number of freeway miles covered by service patrols, which have a benefit-cost ratio of up to 36:1,[45] has grown by 21 percent since 1997.[46] This incident detection method was utilized in 74 metropolitan areas in 2004 and now covers 41 percent of freeway miles and 10 percent of arterial miles.
- Freeway coverage by automated incident detection, currently used in 31 metropolitan areas, has increased by 19 percent since 1997 and was in use on some 16 percent of freeways in the United States in 2005.[47] ■

Propagation of Incident Detection and Verification Methods[48]



LESSONS LEARNED

Managing Traffic Incidents — Lessons from Experience

The following are lessons learned on how to plan, design, operate, and maintain traffic incident management programs.

Traffic Incident Management Program Development

- ***Develop a combined strategy and implementation plan for coordinated arterial signal control during incidents.***[49] In Minnesota, the During Incidents Vehicles Exit to Reduce Time system provides demand-responsive signal timing along the arterials to accommodate additional demand, and monitors the freeway and arterial system with detection and video surveillance.
- ***Cultivate relationships among transportation, law enforcement, fire, and rescue agencies when developing a coordinated, multiagency, traffic incident management program.***[50] At the TransGuide Operations Center in San Antonio, the staff and representatives from the Texas Department of Transportation, the San Antonio Police Department, VIA (the regional transit provider), the San Antonio Public Works Department, the Alamo Dome, the Bexar County Sheriff's Department, emergency services, and towing service providers formed the Corridor Management Team. The members meet regularly but informally to discuss traffic operations.
- ***Consider co-locating multiple agencies in a transportation management center (TMC) to foster personal relationships among key staff.***[51] The Houston TranStar TMC houses 75 co-located personnel from the Texas Department of Transportation, Harris County, Houston Metro, and the City of Houston (see related article on page 3). The streamlined management structure at TranStar maximizes public benefit by coordinating emergency response, increasing mobility, managing congestion, and enhancing safety.

Incident Detection, Verification, and Response

- ***Provide a combination of detection methods to detect incidents effectively and rapidly.***[52] While cellular phone calls continue to be the most widely used means of early detection, no single method will catch everything. Transportation management professionals rely on several methods to detect and verify incidents, including closed circuit TV cameras, cellular telephone calls, vehicle probes, call boxes, automated incident detection, and service patrols. Using a mix of detection methods enables more accurate and timely response.
- ***Establish common incident location identifiers.***[53] An agreement was developed between the Washington State Department of Transportation and the Washington State Police on a method of describing locations among the parties involved. As a result, both agencies were better able to pinpoint incident locations and decrease response times.
- ***Provide training to dispatchers to elicit useful information about the incident from motorists.***[54] Motorists calling in on cell phones often provide incorrect or inadequate information to dispatchers. It is important to train dispatchers to ask the right kinds of questions to obtain the most accurate information possible. The more accurate the information, the better traffic managers and emergency services are able to respond efficiently and effectively to an incident.
- ***Provide joint training among incident response agencies to improve response times and site management.***[55] In San Antonio, at the TransGuide Center, staff participate in three variations of training activities: mock incidents, tabletop exercises, and classroom workshops.

Incident Clearance and Evaluation

- ***Consider a service patrol to reduce incident clearance times.***[56] In the State of Washington, Incident Response Team personnel clear about 80 percent of incidents in less than 10 minutes each.
- ***Provide consistent, high-quality information about incidents to influence traveler behavior.***[57] TransGuide's survey of motorist reaction to the information in San Antonio demonstrated a high level of acceptance of the system (80 percent followed its instructions, and 71 percent believed they saved time).[58]
- ***Conduct post-incident debriefings.***[59] In Chattanooga, Tennessee, the Incident Commander coordinates debriefing sessions after major incidents and a lessons learned memorandum is produced and distributed to all participating agencies.

For these and other lessons, visit: www.itslessons.its.dot.gov. ■

THERE'S MORE ONLINE!

ITS Applications Overview: www.itsoverview.its.dot.gov

FHWA Office of Operations Traffic Incident Management Program: www.ops.fhwa.dot.gov/incidentmgmt/index.htm

National Traffic Incident Management Coalition: www.timcoalition.org

TIM Community of Practice: www.timexchange.org

The online version of this document contains a full list of sources: www.its.dot.gov/jpodocs/repts_te/14288.htm

San Antonio continued from page 1

detectors, video surveillance cameras, and a communication network to respond rapidly to accidents and emergencies.

The system provided a number of dramatic incident response improvements in a very short time as demonstrated in a comparison of sample crash statistics from the 3 years prior to deployment with sample statistics collected during the first year post deployment.

- Incident response times were reduced by 20 percent.[60]
- Average delay savings reached up to 700 vehicle-hours per incident.[61]
- Fuel consumption decreased by up to 2,600 gallons per incident.[62]
- All these numbers translate into annual savings of $1.65 million in 1995 dollars.[63]

Survey results also indicate improvements in driver confidence due to the improved quality of traveler information available. Surveys taken after implementation indicated that driver response to posted instructions improved from 33 percent just after implementation to 80 percent at the time of the report.[64] ■

Source Information

Page 1. Introduction

1. U.S. Department of Transportation, *National Strategy to Reduce Congestion on America's Transportation Network,* Washington, DC: May 2006. Report: **isddc.dot.gov/OLPFiles/OST/012988.pdf**
2. National Traffic Incident Management Coalition Website, **timcoalition.org/?siteid=41&pageid=591**
3. U.S. Department of Transportation, *National Strategy to Reduce Congestion on America's Transportation Network,* Washington, DC: May 2006. Report: **isddc.dot.gov/OLPFiles/OST/012988.pdf**

Page 1. Traffic Incident Management

4. The summary fact **"Traffic incident management reduces fuel consumption by about 1.2 percent annually"** is based on one article from the ITS Benefits Database:

Document Referenced	Simulated v. Measured Data	Location	Date of Study	Percent Decrease in Annual Fuel Consumption
Federal Highway Administration, *Metropolitan Model Deployment Initiative – Seattle Final Evaluation Report,* Washington, DC: May 2000. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/06D560796A6416DC852569610051E2E2** Report: **www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/12883.pdf**	Simulated	San Antonio, TX	2000	1.2%

5. The summary fact **"Traffic incident management saves 2,600-7,700 gallons per major incident"** is based on two articles from the ITS Benefits Database:

Document Referenced	Simulated v. Measured Data	Location	Date of Study	Decrease in Fuel Consumption per Incident
Henk, Russel H., et al., "Before-and-After Analysis of the San Antonio TransGuide System," paper presented at the 76th Annual Meeting of the Transportation Research Board, Washington, DC, January 1997. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/6653718EFFE52A5C852569610051E27F**	Simulated	San Antonio, TX	1996	2,600 gallons
Jacobson, L., et al., *Incident Management Using Total Stations,* Seattle, WA: August 1992. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/0D0D8496BCC0EF69852569E700716FB3**	Simulated	Washington statewide	1992	7,770 gallons

6. The summary fact **"Traffic incident management reduces incident durations by up to 65 percent"** is based on five articles from the ITS Benefits Database:

Document Referenced	Simulated v. Measured Data	Location	Date of Study	Percent Decrease in Incident Duration
Perrin, J., et al., *Advanced Transportation System Elemental Cost Benefit Assessment*, Washington, DC: March 2004. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/66602453BDBB0064852570C80070FFE6**	Measured	Salt Lake City, UT	2004	12%-36%
Bertini, R., et al., *Evaluation of Region 2 Incident Response Program Using Archived Data*, Portland State University Report No. PSU-CE-TRG-01-01, Portland, OR: June 2001. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/62838FB271765BD385257217005A5872**	Measured	Oregon, I-5 and Hwy 18	2001	15% and 30%
University of Maryland, College Park and Maryland State Highway Administration, *Performance Evaluation of CHART – Coordinated Highways Action Response Team – Year 2000*, College Park, MD: November 2003. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/9FBABB7833F303C3852571B8004D4EF5**	Measured	Maryland statewide	2003	28%

Document Referenced	Simulated v. Measured Data	Location	Date of Study	Percent Decrease in Incident Duration
Petrov. A., et al. "Evaluation of the Benefits of a Real-Time Incident Response System," paper presented at the 9th World Congress on Intelligent Transport Systems, Chicago, IL, October 14-17, 2002. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/151060B2B05095D385256C6F006FF9D6**	Measured	Maryland statewide	1999	55%
Petrov. A., et al. "Evaluation of the Benefits of a Real-Time Incident Response System," paper presented at the 9th World Congress on Intelligent Transport Systems, Chicago, IL, October 14-17, 2002. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/151060B2B05095D385256C6F006FF9D6**	Measured	Maryland statewide	2000	57%
Institute of Transportation Engineers, *1996 ITS Tour Report: Eastern North America & 1996 ITS World Congress: Volume 1*, Washington, DC: 1997, p. 4-5. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/26F64E34457928EC852569610051E2D7**	Measured	Toronto, ON	1997	65%

7. The summary fact **"Traffic incident management reduces secondary crashes by 30-50 percent"** is based on two articles from the ITS Benefits Database:

Document Referenced	Simulated v. Measured Data	Location	Date Conducted	Percent Decrease in Secondary Crashes
Henk, Russel H., et al., "Before-and-After Analysis of the San Antonio TransGuide System," paper presented at the 76th Annual Meeting of the Transportation Research Board, Washington, DC, January 1997. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/6653718EFFE52A5C852569610051E27F**	Simulated	San Antonio, TX	1996	30%
Highway Industry Development Organization, Ministry of Construction, *Intelligent Transportation Systems Handbook* in Japan, Tokyo, Japan: October 1997. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/30D32D9BB1685CF3852569610051E26F**	Measured	Odawara, Japan	1997	50%

8. The summary fact **"Motorist assistance patrols' benefit-cost ratio ranges from 2:1 to 36:1"** is based on four articles from the ITS Benefits Database:

Document Referenced	Simulated v. Measured Data	Location	Date of Study	Benefit-Cost Ratio
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Norfolk, VA	1995	2.1 to 2.5:1
Minnesota Department of Transportation, *Highway Helper Summary Report – Twin Cities Metro Area*, St. Paul, MN: July 1994. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/B285A1F883C7C2BE852569610051E263**	Benefits: Simulated Costs: Measured	Minneapolis, MN	1994	2.3:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Orange County, CA	1995	3:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Riverside County, CA	1995	3:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Charlotte, NC	1993	3:1 to 7:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Dallas, TX	1995	3.3:1 to 36.2:1

Document Referenced	Simulated v. Measured Data	Location	Date of Study	Benefit-Cost Ratio
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Oakland, CA	1991	3.5:1
Latoski, S., et al., "Cost-Effectiveness Evaluation of Hoosier Helper Freeway Service Patrol," *Journal of Transportation Engineering*, Volume 125, Number 5, September/October 1999. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/B32DDDE9827B2177852569610051E25C**	Benefits: Simulated Costs: Measured	Indianapolis, IN	1995	4.7:1 for daytime operations
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Minneapolis, MN	1995	5:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Sacramento, CA	1995	5.5:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Houston, TX	1994	6.6:1 to 23.3:1
Cuciti, P. and B. Janson, "Incident Management via Courtesy Patrol: Evaluation of a Pilot Project in Colorado," paper presented at the 74th Annual Meeting of the Transportation Research Board, Washington, DC, January 1995. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/BE1E4488FF0F3E5B852569610051E29F**	Benefits: Simulated Costs: Measured	Denver, CO	1995	10.5:1 to 16.9:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Los Angeles, CA	1993	11:1

Document Referenced	Simulated v. Measured Data	Location	Date of Study	Benefit-Cost Ratio
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Fresno, CA	1995	12.5:1
Latoski, S., et al., "Cost-Effectiveness Evaluation of Hoosier Helper Freeway Service Patrol," *Journal of Transportation Engineering*, Volume 125, Number 5, September/October 1999. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/B32DDDE9827B2177852569610051E25C**	Benefits: Simulated Costs: Measured	Indianapolis, IN	1996	13.3:1 for 24-hour operations
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Detroit, MI	1995	14:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Chicago, IL	1990	17:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	Denver, CO	1996	20:1 to 23:1
Fenno D., and M. Ogden, "Freeway Service Patrols: A State of the Practice," paper presented at the 77th Annual Meeting of the Transportation Research Board, Washington, DC, January 1998. ITS Benefits Database Entry: **www.itsbenefits.its.dot.gov/its/benecost.nsf/0/2B94636876E370D9852569610051E2DE**	Unknown	New York City and Westchester County, NY	1995	23.5:1

9. Federal Highway Administration, "Incident Management," ITS Deployment Statistics Database Entry: **www.itsdeployment.its.dot.gov/Trendsgraph.asp?comp=IM**
10. Federal Highway Administration, "Incident Management," ITS Deployment Statistics Database Entry: **www.itsdeployment.its.dot.gov/Trendsgraph.asp?comp=IM**

Page 2: Quicker Response, Fewer Secondary Incidents

11. Federal Highway Administration Office of Operations Webpage, "Traffic Incident Management," **www.ops.fhwa.dot.gov/aboutus/one_pagers/tim.htm**
12. Karlaftis, M.G., S.P. Latoski, N.J. Richards, and K.C. Sinha, "ITS Impacts on Safety and Traffic Management: An Investigation of Secondary Crashes," *ITS Journal,* Vol. 7, No. 1, 1999, pp. 39-52.
    Article: **www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/14296.htm**
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