

## Technical Report Documentation Page

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<b>16. Abstract</b> Evaluations are critical in promoting innovative practices which may help to provide a safe and efficient transportation system. By conducting such evaluations, we develop quantifiable measures for those in policy development to appreciate and comprehend. Furthermore, it provides rationale to the public whom may be otherwise unaware of the benefits of such systems. By performing evaluations of such alternatives we provide the following benefits by answering some basic questions: <ol style="list-style-type: none"> <li>1. Document our successes – Has the system provided a realized benefit?</li> <li>2. Rationalize our investments versus the benefits – Do the financial benefits of the system outweigh the costs?</li> <li>3. Identify potential improvements – Can the system concept be enhanced by modifying future deployments?</li> </ol> <p>The following evaluations were conducted:</p> <p>E.1 CTC Earmark - Provided oversight, support and evaluation of the CTC FFY 02 ITS Earmark.</p> <p>E.3 Portable Signals Evaluation - Conducted an evaluation of portable signal units to identify best uses.</p> <p>E.4 ITS Maintenance Practices - Conducted an evaluation of ITS maintenance practices to identify National and Department best practices. Guidance was developed for Districts in order to maximize reliability and uptime of ITS devices</p> <p>E.6 Quick Clearance Best Practices - Conducted an evaluation of quick clearance practices to identify National and Department best practices</p> <p>E.7 Video Sharing Policy - Assisted BHSTE in updating their video sharing policy with consideration of the recommended BIS technical approach</p> <p>E.8 Freeway Service Patrol Evaluation - Conducted an evaluation of freeway service patrols (FSPs) to determine operating costs, benefits and best practices. The goal is to provide recommendations on how to implement a highly effective statewide FSP program from perspectives of both cost and performance.</p> <p>E.10 ITS Device Usage- Conducted an evaluation of existing practices and policies for dynamic messages signs (DMSs). GF will also review the status of pilot initiatives include proposed public-private partnerships.</p> <p>E.11 TMC Performance Measures - Conducted an evaluation of implemented and suggested traffic incident management performance metrics in use by traffic management centers to identify National and Department best practices.</p>			
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## 1. Introduction

### 1.1 Background and Purpose

PennDOT devotes resources to operational programs and initiatives to mitigate congestion and improve safety. By definition, *operations* represents technologies and institutional arrangements that allow transportation systems to operate more closely to their maximum design intent. In other words, this means identifying and applying beneficial and cost effective technologies while promoting communication regarding the planning, deployment, and operations of these technologies. To promote successful transportation operations, practitioners must:

- Evaluate technologies – Through Intelligent Transportation Systems (ITS) evaluations, our industry can document our successes, rationalize our investments in a fiscally-constrained environment, and identify potential improvements and lessons learned for future deployments.
- Coordinate inter-related activities – Many operational initiatives are inter-related. To promote successful operations, we must coordinate these initiatives to establish an operational foundation that supports goals such as better incident management and traveler information, as well as improved highway efficiency, safety, and security.
- Promote communications among specialized disciplines – Communications among specialized stakeholders within transportation systems operations assist in promoting best practices, properly deploying projects, and evaluating specialized initiatives.
- Expand the industry knowledge base – Ultimately, we must continue to educate our evolving industry regarding evaluations and initiatives so that lessons learned can be applied and operational solutions can be deployed in an appropriate manner that maximizes benefits while minimizing resources.

The Transportation Equity Act for the 21st Century (TEA-21) prescribed that the U.S. Secretary of Transportation issue guidelines and requirements for the evaluation of operational tests and deployment projects for ITS for projects under their jurisdiction. The goal of the mandate was to develop a basis for continuing support of decision makers addressing policy and investment issues by providing a clear understanding of ITS system effectiveness.

As we transitioned from TEA-21 to the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), the Federal Highway Administration (FHWA) undertook a number of new ITS/congestion mitigation operations projects, which may require evaluations. Regardless of the requirements, evaluations are critical in promoting innovative practices that may help to provide a safe and efficient transportation system. By conducting such evaluations, we develop quantifiable measures for those in policy development to appreciate and comprehend. Furthermore, it provides rationale to the public whom may be otherwise unaware of the benefits of such systems.

In the fiscally-constrained transportation industry, professionals must begin to consider alternatives to traditional road construction to improve mobility and reduce congestion. These principles are consistent with the Department's Smart Transportation practices.

By performing evaluations of such alternatives we provide the following benefits by answering some basic questions:

- **Document our successes** – Has the system provided a realized benefit?
- **Rationalize our investments versus the benefits** – Do the financial benefits of the system outweigh the costs?
- **Identify potential improvements** – Can the system concept be enhanced by modifying future deployments?

To mainstream operations, the industry must demonstrate the benefits of operational programs to our stakeholders to gain support and justify needed resources in a fiscally-constrained environment. As well as demonstrating the benefits, we must also identify opportunities to be more efficient in the manner we plan, deploy, operate, and maintain these initiatives. This can only be accomplished if we evaluate programs and initiatives, identify best practices and lessons learned, and communicate our findings among industry stakeholders.

## 1.2 Contacts

This project was coordinated by the Bureau of Planning and Research under the project, *ITS Evaluation and Activities (Contract No: 355I01 - 060908)*. The Bureau of Highway Safety and Traffic Engineering was the technical lead. The following are the contract contacts:

Last Name	First Name	Organization	Role	E-mail	Telephone
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## 2. Evaluations Overview

The following provides a summary of Evaluation Activities performed under Task 1 of *ITS Evaluation and Activities (Contract No: 355I01 - 060908)*.

### 2.1 Evaluation Approach

Evaluations are critical in promoting innovative practices which may help to provide a safe and efficient transportation system. By conducting such evaluations, we develop quantifiable measures for those in policy development to appreciate and comprehend. Furthermore, it provides rationale to the public whom may be otherwise unaware of the benefits of such systems.

In the fiscally-constrained transportation industry, professionals must begin to consider alternatives to traditional road construction in order to improve mobility and reduce congestion. By performing evaluations of such alternatives we provide the following benefits by answering some basic questions:

- **Document our successes** – Has the system provided a realized benefit?
- **Rationalize our investments versus the benefits** – Do the financial benefits of the system outweigh the costs?
- **Identify potential improvements** – Can the system concept be enhanced by modifying future deployments?

The outline of each evaluation follows this format which is consistent with *The Evaluation Plan for ITS Projects in Pennsylvania* and Federal Highway Administration's, *ITS Evaluation Guidelines – ITS Evaluation Resource Guide* as well as PennDOT's *Ideas Have Consequences* reporting procedure.

For each evaluation, the team worked with the Department in clearly defining the evaluation criteria, identifying potential performance measures to be tested, and discussing anticipated conclusions and deployment clarifications. Work plans considered the following elements.

Work Plan Component	Key Elements
<i>Project Definition</i>	<ul style="list-style-type: none"> <li>▪ Purpose of evaluation</li> <li>▪ Background</li> <li>▪ Performance measures and hypothesis to be tested</li> <li>▪ Anticipated conclusions</li> <li>▪ Deployment, design, operations, and maintenance issues to be clarified</li> <li>▪ Benefit/cost considerations to be tested               <ul style="list-style-type: none"> <li>○ Benefits to be evaluated</li> <li>○ Costs to be considered</li> <li>○ Value-engineering ideas to be tested</li> </ul> </li> </ul>
<i>Scope of Work</i>	<ul style="list-style-type: none"> <li>▪ Summary of evaluation activities</li> <li>▪ Evaluation team contacts</li> <li>▪ Estimated effort (time and cost)</li> <li>▪ Schedule</li> </ul>
<i>Research Activities</i>	<ul style="list-style-type: none"> <li>▪ Literature reviews</li> <li>▪ Interviews</li> <li>▪ Surveys</li> <li>▪ Data collection and analyses</li> </ul>
<i>Field-based Activities</i>	<ul style="list-style-type: none"> <li>▪ Location and schedule</li> <li>▪ Responsibilities and support</li> <li>▪ Data to be collected</li> <li>▪ Deployment, design, operations, and maintenance review</li> <li>▪ Key graphic resources for reporting and technology transfer               <ul style="list-style-type: none"> <li>○ Photos</li> <li>○ Video</li> </ul> </li> <li>▪ Special considerations               <ul style="list-style-type: none"> <li>○ Security</li> <li>○ Safety and MPT</li> <li>○ Privacy</li> </ul> </li> <li>▪ Data management and Quality Assurance/Quality Control procedures for testing</li> </ul>
<i>Analyses and Reporting</i>	<ul style="list-style-type: none"> <li>▪ Additional analyses</li> <li>▪ DRAFT evaluation report outline</li> <li>▪ DRAFT statewide implementation- strategy and recommendation report outline</li> </ul>

## 2.2 Summary of Evaluations

Evaluation Subtasks	Description	PennDOT Lead	Section	Appendix	Notes
E.1 CTTC Earmark	Provided oversight, support and evaluation of the CCTC FFY 02 ITS Earmark.	Pento	NA	NA	There was no formal report since this effort was terminated as a result of the CTTC Earmark being rescinded by FHWA.
E.2 RWIS Technologies	This evaluation activity was not carried forward at the direction of the Department. No effort was expended.				
E.3 Portable Signals Evaluation	Conducted an evaluation of portable signal units to identify best uses.	Laubach	5	E.3	
E.4 ITS Maintenance Practices	Conducted an evaluation of ITS maintenance practices to identify National and Department best practices. Guidance will developed for Districts in order to maximize reliability and uptime of ITS devices	Weaver	6	E.4	
E.5 Assessment of Public Input into Transportation Operations	This evaluation activity was not carried forward at the direction of the Department. No effort was expended.				
E.6 Quick Clearance Best Practices	Conducted an evaluation of quick clearance practices to identify National and Department best practices	Pack	7	E.6	
E.7 Video Sharing Policy	Assisted BHSTE in updating their video sharing policy with consideration of the recommended BIS technical approach	Pento	NA	NA	There was no formal report for this effort as the effort was a cursory review of existing policies only.
E.8 Freeway Service Patrol Evaluation	Conducted an evaluation of freeway service patrols (FSPs) to determine operating costs, benefits and best practices. The goal is to provide recommendations on how to implement a highly effective statewide FSP program from perspectives of both cost and performance.	Tomlinson	8	E.8	
E.9 Travel Time	This evaluation activity was not carried forward at the direction of the Department. No effort was expended.				
E.10 ITS Device Usage	Conducted an evaluation of existing practices and policies for dynamic messages signs (DMSs). GF will also review the status of pilot initiatives include proposed public-private partnerships.	Tomlinson	9	E.10	
E.11 TMC Performance Measures	Conducted an evaluation of implemented and suggested traffic incident management performance measures in use by traffic management centers to identify National and Department best practices.	Pack	10	E.11	

Sections 5 to 10 provide a summary of the evaluations performed under this contract. The appendices include copies of the applicable evaluation reports.

### 3. Support Overview

The following provides a summary of Support Activities performed under Task 2 of ITS Evaluation and Activities (Contract No: 355101 - 060908).

Communications is a fundamental element within transportation systems operations. Deploying technologies alone will not result in improved capacity management. There must be coordination and communication between initiatives, but also stakeholder communications within specialized operational initiatives. Stakeholders may include the Department as well as others that have a vested interest in better incident management and traveler information as well as improved highway efficiency, safety and security. Communications among specialized stakeholders within transportation systems operations assist in promoting best practices, properly deploying projects, and evaluating specialized initiatives.

The following provides a summary of Support Activities performed under Task II-A of Intelligent Transportation Systems Evaluation Activities (Contract No: 350A07/ Project Number: 040118).

Support Subtasks	Description	PennDOT Lead
S.1 Capital Complex Evacuation Plan	<p>Support included assisting the Capitol Complex Evacuation ESF #1 Work Group (CCEWG) in understanding their present evacuation plan, identifying gaps in these efforts, and charting a course for a plan of action to address tasks as entailed. Specifically, support included assisting PennDOT in evaluating responsibilities and logistics for activities associated with the planning and execution of the Capitol Complex Emergency Evacuation Plan (EEP) including:</p> <ul style="list-style-type: none"> <li>▪ Evaluating and identifying ESF #1 activities.</li> <li>▪ Establishing solutions for all phases of evacuation plan as they pertain to PennDOT’s designated response requirements.</li> <li>▪ Assisting in establishing a structure that will enable outreach among each stakeholder agency allowing the sharing of information and promoting unified approaches to compliance.</li> <li>▪ Assisting in the development of a protocol that facilitates continued evaluation of ESF #1 efforts.</li> </ul> <p>The deliverables from this subtask consisted of the following:</p> <ol style="list-style-type: none"> <li>1. Meeting agendas and minutes</li> <li>2. Progress reports.</li> </ol>	Jan
S.2 TSOP Master Schedule	<p>Support included maintaining and delivering bi-monthly (every other month) updates, tracking and analysis for PennDOT’s major ITS initiatives throughout the Commonwealth. The major ITS initiatives that were included, linked and tracked in the master schedule are as follows:</p> <ul style="list-style-type: none"> <li>▪ TSOP Projects (TSOP 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 13, 14, 15, 16)</li> <li>▪ ATMS Software Implementation Efforts for each District</li> <li>▪ Major ITS Infrastructure Deployments at the District Level (ITS field elements, Communications Systems, TMCs, etc.)</li> <li>▪ ITS Planning Efforts at the District Level (Concepts of Operations, ITS Master Plans, District Communications Master Plans, etc)</li> <li>▪ District Service Contracts</li> <li>▪ Other PennDOT initiatives that relate to or impact the efforts listed above.</li> </ul> <p>The deliverables from this subtask consisted of Bi-Monthly Tracking and Analysis schedules.</p>	Tomlinson



Support Subtasks	Description	PennDOT Lead
S.3 RCRS Coordinator	This support activity was not carried forward at the direction of the Department. No effort was expended.	
S.4 TSOP 4 Traveler Information	<p>Support included assisting the 511 Core Work Team in the development of TSOP 04: Traveler Information. Key activities included:</p> <ul style="list-style-type: none"> <li>▪ Attending “511 Core Work Team” meetings in person or by teleconference – 12 assumed</li> <li>▪ Preparing agendas in advance and minutes</li> <li>▪ Documenting project status and team decisions</li> <li>▪ Compiling and documenting 511 user needs</li> <li>▪ Gathering and analyzing RFPs from other relevant and successful programs</li> <li>▪ Assisting core team in identifying the 511 system functional requirements</li> <li>▪ Reviewing key governance guidelines relative to the RFP</li> <li>▪ Providing a weekly status reporting for BHSTE’s “TSOP A-team” committee</li> <li>▪ Managing correspondence.</li> </ul> <p>The deliverables from this task consisted of the following:</p> <ul style="list-style-type: none"> <li>▪ Meeting agendas and minutes</li> <li>▪ Weekly status reports</li> <li>▪ Technical documents related to the 511 procurement.</li> </ul>	Pento
S.5 ITS Earmark Committee	This support activity was not carried forward at the direction of the Department. No effort was expended.	
S.6 HOP Committee Support	<p>Support included assisting in the development of policies and guidelines relating to HOPs. Key activities included:</p> <ul style="list-style-type: none"> <li>▪ Reviewing the DRAFT “Turn Lane Warrant Guidelines” dated September 5, 2006</li> <li>▪ Reviewing comments received from Engineering Districts and assisting BHSTE staff in developing a response to comments</li> <li>▪ Assisting the Department in developing REVISED, DRAFT “Turn Lane Warrant Guidelines”</li> <li>▪ Conducting additional research, as directed by Department staff, regarding national best practices in turn lane warrant guidelines</li> <li>▪ Revising graphics for inclusion in the REVISED, DRAFT “Turn Lane Warrant Guidelines” as directed by Department staff</li> <li>▪ Assisting the Department in developing materials for upcoming Permit Managers Meetings.</li> </ul> <p>The deliverables from this task consisted of the following:</p> <ul style="list-style-type: none"> <li>▪ REVISED, DRAFT “Turn Lane Warrant Guidelines.”</li> </ul>	Patel

Support Subtasks	Description	PennDOT Lead
S.7 RCRS Coordinators Group	<p>Support included assisting the Department in coordinator their PennDOT's Road Closure Reporting System's (RCRS). Key activities included:</p> <ul style="list-style-type: none"> <li>▪ Assisting Bureau of Highway Safety and Traffic Engineering (BHSTE) and the Bureau of Planning and Research (BPR) with any activities needed to rollout the various phases of the RCRS and RCRS coordination with Traveler Information sources.</li> <li>▪ Assisting with the development of test scenarios.</li> <li>▪ Providing on-site technical assistance to the remaining Districts to ensure a thorough understanding of Phase I RCRS test scenarios and requirements.</li> <li>▪ Assisting with efforts needed to determine Phase IV and Phase V RCRS implementation requirements.</li> <li>▪ Assisting with the creation, organization, meeting coordination, and other associated activities of the RCRS Task Force.</li> <li>▪ Assisting with the development of the Electronic Commerce Security Assessment (ECSA).</li> <li>▪ Assisting with other RCRS activities as needed.</li> <li>▪ Assist PennDOT CO staff with establishing protocols for interagency RCRS use</li> <li>▪ Assisting District RCRS Administrators with implementation of Phase III Develop super administrator familiarization material</li> <li>▪ Assisting with PennDOT CO staff RCRS super administrator and administrator familiarization</li> <li>▪ Assisting District RCRS users group with identifying requirements for Phase IV RCRS implementation.</li> </ul> <p>The deliverables from this task consisted of the following:</p> <ol style="list-style-type: none"> <li>1. A brief summary of the information obtained at each technical assistance discussion</li> <li>2. Minutes of RCRS Task Force meetings.</li> </ol>	Tomlinson
S.8 ITS Curriculum Management	This support activity was not carried forward at the direction of the Department. No effort was expended.	
S.9. TMC Training	<p>Support focused on developing training materials for traffic management center (TMC) operators and personnel to execute their responsibilities within their area of responsibility. PennDOT's TMCs consist of ITS devices, supporting software, and protocols for supporting traffic incident and emergency management and improving mobility in Pennsylvania. Key activities included:</p> <ul style="list-style-type: none"> <li>▪ Inventorying existing materials and compare to needs for training material development</li> <li>▪ Reviewing PennDOT's Regional Traffic Management Center Resource Portal to determine the readiness of content for conversion into training materials</li> <li>▪ Determining additional resources needed by the curriculum development team to support the curricula</li> <li>▪ Developing an outline for training modules that cover the following topic areas: <ul style="list-style-type: none"> <li>○ Introduction</li> <li>○ TMC roles and responsibilities</li> <li>○ Tools and resources</li> <li>○ Emergency transportation operations</li> <li>○ Incidents and scenarios</li> </ul> </li> <li>▪ Developing training materials.</li> </ul> <p>The deliverables from this task consisted of the following:</p> <ol style="list-style-type: none"> <li>1. Curriculum outline</li> <li>2. Draft final curriculum</li> <li>3. Final training materials.</li> </ol>	Pack

#### 4. Technology Transfer Overview

Through technology transfer, evaluation experiences, “lessons learned” and findings are transferred throughout the transportation industry and to other stakeholders. By enlisting multiple trainers, technology transfer can be widespread through numerous events including: special sessions, committee presentations and presentation at professional organization events. The following summarizes technology transfer activities associated with each activity.

Subtasks	Report Generated for PennDOT Circulation	Policy Guidance Developed	Presentation or Technology Transfer	Other/Notes
<b>Evaluations</b>				
E.1 CTTC Earmark	NA	NA	NA	This effort was terminated as a result of the CTTC Earmark being rescinded
E.3 Portable Signals Evaluation	Yes - see appendices	Yes	Not required per BHSTE since policy was issued	
E.4 ITS Maintenance Practices	Yes - see appendices	Not required	Yes - presented at January 5, 2010 Technology Transfer Session	
E.6 Quick Clearance Best Practices	Yes - see appendices	Not required	Yes - presented at January 5, 2010 Technology Transfer Session	
E.7 Video Sharing Policy	NA	NA	NA	There was no formal report for this effort as the effort was a cursory review of existing policies only.
E.8 Freeway Service Patrol Evaluation	Yes - see appendices	Yes	Not required per BHSTE since policy was issued	
E.10 ITS Device Usage	Yes - see appendices	Yes	Not required per BHSTE since policy was issued	
E.11 TMC Performance Measures	Yes - see appendices	Not required	Yes - presented at January 5, 2010 Technology Transfer Session	
<b>Support</b>				
S.1 Capital Complex Evacuation Plan	NA	NA	NA	Not required per type of support
S.2 TSOP Master Schedule	NA	NA	NA	Not required per type of support
S.4 TSOP 4 Traveler Information	NA	NA	NA	Not required per type of support
S.6 HOP Committee Support	Yes - merged with existing materials	Yes	Not required per BHSTE since policy was issued	
S.7 RCRS Coordinators Group	NA	NA	NA	Not required per type of support
S.9. TMC Training	NA	NA	Yes - see note. Also, overview presented at January 5, 2010 Technology Transfer Session	Modules developed for BHSTE use

## 5. Assessment of Portable Signals Summary (Subtask E.3)

*Evaluation Summary as of June 30, 2008. Note final Department policies may vary.*

### 5.1 Background and Purpose

The Manual on Traffic Control Devices (MUTCD) defines portable signals as a temporary traffic control signal that is designed so that it can be easily transported and reused at different locations. These systems may be trailer-mounted or pedestal-mounted units.

The purpose of the *Assessment of Portable Signals* was to:

- Document current Department practices and procedures.
- Identify national practices.
- Identify practices and procedures in other states.
- Assess portable signals in field applications.
- Develop suggestions for approvals and permitting.
- Provide design guidance.
- Compare the use of portable signals versus other alternatives.



### 5.2 Key Issues

Three major issues associated with portable signal use in Pennsylvania are:

1. What processes should be employed to obtain approval to deploy portable signals within the Commonwealth while preserving PennDOT's ability to provide adequate oversight without negatively or unduly impacting usage of these devices at appropriate locations.
2. Are trailer-mounted portable signals and conventional pole-mounted temporary signals equal, and under what conditions should each be used?
3. Are PennDOT's pending equipment performance specifications for trailer-mounted and pedestal-mounted portable signal systems adequate and reflect current technology?

### 5.3 Key Facts

#### 5.3.1 National Requirements and Other Research

Per Federal and Pennsylvania requirements, portable signals shall meet FHWA requirements (in the MUTCD) for a conventional traffic signal. The Department is responsible for ensuring those requirements are met.

There has been limited research on portable signals, but other studies concluded that:

- There is a substantial savings in flagger labor costs that could be achieved by using portable signals.
- The potential for vehicle crashes within the work zone may be higher with portable traffic signals because of occasional driver noncompliance with these signals.

- The trade-off between this possible increase in vehicular crashes and the reduction in flagger crashes could not be estimated.

### 5.3.2 Department Practices and Proposed Legislation

Presently, the purpose of the Department's permit includes:

- Identification of legal permittee (responsible owner).
- Verification of appropriate traffic control devices (signs and markings per State and Federal requirements) for safe and efficient operation.
- Verification that operation parameters (green, yellow and red times) meet State and Federal requirements for safe and efficient operation.
- Provide an official document to prevent improper use of the device.
- Provide an engineering document to be used in litigation.

While the permitting process is perceived by some as cumbersome, it is consistent with current State statutes. Ultimately, the current process promotes the safe and efficient movement of work zone traffic while limiting the liability of the Department and the owner of the system. Since vendors do not technically own or deploy the system, they may be less concerned with the liability associated with improper deployments.

Proposed House Bill 2419 and Senate Bill 1428 promotes compliance with the MUTCD; however, the language does not require a permit under any circumstances, which may limit the Department's ability to provide proper oversight and to ensure safe and efficient movement of traffic.

### 5.3.3 Practices of Other States

PennDOT's procedures and practices as they compare to the other 21 states that responded are as follows:

- About half the states surveyed use portable traffic control signals. Of these, more than seventy-five percent use primarily trailer-mounted versus pedestal-mounted.
- Most states have limited or occasional deployments (approximate average of 3 to 6 per year). Some states have more than 10 deployments per year and one state uses portable signals approximately 50 times per year.
- In comparison to the states surveyed, usage of portable signals in Pennsylvania appears to equal or exceed other states.
- About 15 percent of the states have a permitting/documentation process.
- Site specific drawings and inspections are required in approximately 50 percent of the surveyed states.
- Most states are in the process of generating standard guidelines for the use of portable traffic signals since the desire to utilize these devices is increasing.

### 5.3.4 Contractor and Vendor Viewpoints

In many cases, contractors are charged with the completion of work zone construction activities. In a survey of contractors:

- Most (88 percent) agree that portable signals may increase safety.
- All feel that each work site has to be assessed independently.
- 44 percent feel portable signals are cost effective.
- The companies that have used these devices stated that they worked well.

An extensive review was conducted to collect information regarding vendors of portable signals. There are several vendors that manufacture portable signals, including Horizon Signal Technologies (based in Pennsylvania). Most vendors were passionate that they offer a product that they believe will improve flagger safety and reduce manpower costs. In summary, most vendors believe that:

- Portable signals can improve flagger safety.
- Portable signals can save manpower costs.
- Limited permitting/documentation is required.

### 5.3.5 Field Assessments

Field assessments conducted at two locations, involving non-complex applications, illustrated that portable signals can work effectively. In both assessments:

- A site visit was conducted prior to installation.
- An application was submitted (approximately 2 to 3 hours to prepare for each site).
- A site specific drawing was developed (approximately 2 to 3 hours to prepare for each site).
- A traffic signal permit was obtained.
- Training was provided to the crew one day prior to deployment.

While the portable signals worked effectively, the assessment team noted opportunities for future enhancements. During the assessments, no problems were observed with driver compliance.

## 5.4 Findings and Observations

The Department has a bridge enhancement initiative which include the upgrade of more than 1,000 bridges in the next few years. Many of these bridges are short spans on two-lane roads where portable signals may be a suitable work zone alternative.

To support this demand and other applications, PennDOT needs a well-documented, efficient process to deploy these devices in order to promote safe and efficient travel while meeting Federal requirements.

Portable signals provide another acceptable alternative (to flaggers and temporary signals) for controlling work zone traffic; however, they do have their appropriate uses and require oversight similar to flagger auditing and temporary signal permitting. All approaches have their benefits as well as their perceived negative impacts.

PennDOT has a well-established policy for the application, permitting and deployment of portable signals. The existing level of requirements for short-term, non-complex applications and more complex and long-term applications appear to be appropriate to meet Federal requirements, as well as to promote safe and efficient operations. However, the required process could be



streamlined in order to provide clarity and efficiency. Key suggestions to streamline the application and permitting process include:

- Continue to allow emergency deployments at the Department’s discretion.
- Combine the application of use and notice of commencement into one form for short-term, non-complex operations.
  - Allow “blanket approval” of multiple locations provided they are “non-complex.”
  - Require acknowledgment of operator responsibility to be compliant with PennDOT Publication 213 (Work Zone Traffic Control) and the Manual on Uniform Traffic Control Devices (MUTCD).
  - Require acknowledgment of operator responsibility to provide vendor training to staff deploying portable signals.
- Continue to require a site specific application, drawing, permit and inspection for short-term operations with complex conditions and for long-term operations.
- For long-term operations, encourage the design community to identify portable signals as a design alternative to be considered where appropriate on Department construction projects and on Highway Occupancy Permits (HOPs).
  - If portable signals are identified and designed as an acceptable design alternative, continue to accept the work zone traffic control plan as the site specific drawing and require only the combined the application and notice of commencement as noted above.

The assessment team reviewed PennDOT’s pending performance specifications for trailer-mounted and pedestal-mounted portable traffic control signal systems and has found that no major revisions are needed. However, the assessment team suggests that PennDOT revisit this specification yearly to update the document.

Other suggestions include:

## 5.5 Deployment

- Modify the traffic signal permit and application to emphasize that the liability is on the user of the system.
- Investigate other methods to waive Department liability, especially if oversight is diminished.
- Revisit deployment policy on an annual basis due to evolving technologies.
- Identify in work zone traffic control plans (for larger projects), locations where portable signals may be considered as an alternate to flaggers or pole-mounted temporary signals.
- Consider a “three strikes’ policy prohibiting the use of portable signals by users who do not follow requirements.
  - Prohibit “blanket” usage for one year.
  - Require site specific application for all uses.
  - Require documentation of vendor re-training.

## 5.6 Training and Education

- Request FHWA and/or TRB to conduct a national review and to develop Federal policy on portable traffic signal usage.
- Develop a work zone traffic control checklist to assist Department staff in identifying the appropriate locations to use portable signals, temporary signals and flaggers. Train designers

to identify portable signals as an acceptable design alternative to flaggers or pole-mounted temporary signals at the appropriate locations.

- Conduct a portable signal workshop at a future Transportation Engineering and Safety Conference. Highlight deployment policy as well as design considerations.
- Continue to have dialogue between the Department, contractors and vendors to discuss portable signal strengths, weaknesses and future opportunities for enhancements.
- Implement a public awareness program to educate motorists on this new technology they may encounter in a work zone versus a flagger.

## 5.7 Summary

Portable signals represent an emerging alternative to flaggers and pole-mounted temporary signals. Each alternative has its appropriate use. Training and education to designers is critical such that portable signals are identified as acceptable alternative where appropriate. Streamlining the permitting process, while ensuring safe and efficient traffic control, will provide an opportunity for contractors and other work zone users to utilize portable signals where appropriate.

While existing research has shown that portable signals improve flagger safety, the safety impact on motorized traffic has not been adequately evaluated. This issued needs further evaluation at the national level as many states are struggling with this issue.

Ultimately, the owner/operator (contractor or other work zone user) of the portable signal bears the liability to ensure they are deployed properly. The Department's responsibility is to provide oversight to ensure safe and efficient use. While the vendor community offers a "MUTCD compliant" product, the product is not MUTCD compliant if it is deployed improperly.

## 5.8 Rationalize Our Investments

As part of evaluation activities, costs were considered versus system benefits in order to assess the benefit-cost ratio of various ATRWS configurations. The goal is to determine if benefits outweigh costs in order to rationalize our investments.

The costs of the systems researched range from \$50,000 to nearly \$500,000. The systems deployed by PennDOT cost approximately \$210,000 while the system deployed by the Pennsylvania Turnpike cost approximately \$130,000.

The benefits of ATRWS include the value of the crash reduction as well as delay costs.

The systems currently deployed experience a benefit-to-cost ratio of 1.55 to 6.11 with an average of 3.64. Depending on the complexity and cost of systems deployed in other states, the average benefit-to-cost if applied to the Pennsylvania sites would range between 0.95 and 15.8.



## 5.9 Identify Potential Improvements

Part of the evaluation process is to identify potential improvements. Research, surveys and field activities provided insight into some basic guidance with regard to ATRWS design and operations.

The following is a summary of basic design considerations:

- Consider conventional countermeasures first to maximize available resources.
- Develop a consistent, preferred configuration in order to provide a uniform message to motorists.
- Utilize deployment procedures to assess site needs.
- Employ simplified triggering and non-invasive detection, where possible.
- Protect critical features, where possible.
- Utilize interchangeable components.

## 6. Assessment of ITS Maintenance Practices (Subtask E.4)

*Evaluation Summary as of November, 2008. Note final Department policies may vary.*

### 6.1 Background and Purpose

The purpose of this task was to conduct an evaluation of ITS maintenance practices in order to identify national and Department best practices. Best practices, presented in this report, were used to provide guidance such that the Department can maximize reliability and uptime of ITS devices.

Key activities included:

1. Researching National Best Practices
2. Researching current District practices
3. Establishing best practices for ITS maintenance.

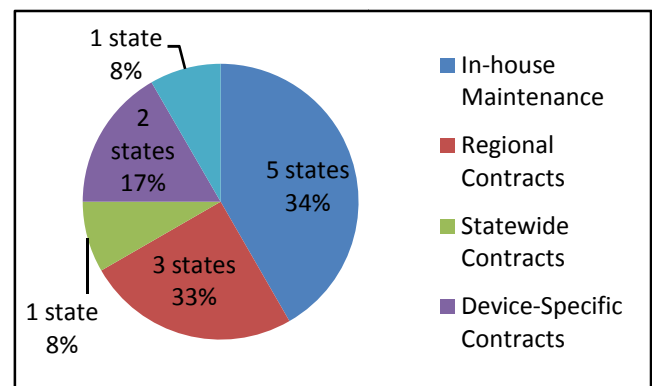
### 6.2 Literature Review Summary

As part of the research, a literature review was conducted. Documents related to ITS maintenance were reviewed and summarized. Each literature review summarizes guidance on different areas of ITS maintenance including:

- Programming
- Preventive maintenance
- Response maintenance
- Costs
- Contracting
- Funding and budgeting.

### 6.3 Survey of Other States

In order to research ITS maintenance practices across the country, a web-based survey was developed. The survey questions aimed to gauge perspectives on reliability and uptime requirements, regional versus statewide contracting, device specific contracting, and preventative and response maintenance requirements. The survey was sent to other state traffic and ITS contacts throughout the country. In total, 12 states responded to the survey (a 24% response rate), though not all states answered every question.



The states used a variety of methods to maintain their ITS devices. Most states used in-house staff to maintain devices (Wyoming, Mississippi, North Dakota, Washington, and Utah) or had

regional contracts (New York, West Virginia, and Illinois), like PennDOT. Two states, Delaware and New Hampshire, have device-specific contracts, while Georgia has a statewide contract. While Missouri did not respond to the survey, it is in a multi-state contract with Kansas to maintain ITS devices around the Kansas City metro area.

From the survey, there are three main benefits for using regional or district contracts for ITS maintenance:

1. First, local ITS managers are the most knowledgeable on the needs and care of their local systems. The regions are easier to manage than the entire state, and the managers know the details of ITS deployments throughout their region.
2. Second, travel costs are reduced by breaking the state down into smaller regions.
3. Third, local contractors are typically more familiar with local equipment. The local contractors are also familiar with details and the highway network within their region.

#### 6.4 Summary of District Surveys

In the course of this research, all 11 Districts were contacted in order to obtain their input to several survey questions which were developed.

- **Reasons for Long-term Downtime** - Districts reported relatively few devices being down in excess of 48 hours and many of these were due to delays receiving parts, correcting communications issues, or in some cases due to specific issues with an “off-brand” in that District.
- **Contract Structure** - Each District was polled on the issue of how a contract would be structured. While there was a difference of opinion with regards to the best way to configure a good maintenance contract, most Districts felt that a District-wide or a regional contract would be best. All Districts were of the opinion that a statewide contract would not be a good way to proceed.
- **Prequalifications** - The Districts were mixed on the issue of prequalification. Some felt that there were few enough contractors performing this work that they were all qualified, while others felt that prequalifications should be used to restrict bidders.
- **Liquidated Damages** - On the issue of liquidated damages, there were varied responses. Many Districts have no liquidated damages in place and do not feel that any are needed, while other Districts have them in place or intend to write them into the next contract.

#### 6.5 Summary of Contractor Surveys

Several ITS maintenance providers were contacted to gain their perspectives regarding best practices. As directed by the Department, it was agreed that the consultant team would not disclose specific information regarding maintenance providers.

- **Company Organization** - The service structure of the companies varied greatly. In some cases, staff lives in the Districts they serve while others are within 100 miles of the devices they service. All of the firms indicated that they make use of subconsultants when there is work outside of their area of expertise. Typically, such firms include actual construction firms, device suppliers, or specialized communications personnel. All respondents noted that, in order to provide for the necessary service, the Department has cell phone numbers through which staff can be contacted at any time.

- **Spare Parts** - All respondents commented that the supply of spare parts on hand for this maintenance is one of the primary delays in getting devices up and running. In some cases it is due to the fact that no spare parts are available, in other cases, there is lost time in getting to the storage facility or difficulty finding the part in the inventory.
- **Incentives and Liquidated Damages** - The issue of incentives and damages was also discussed with each respondent. It was mentioned by one firm that, as things exist right now, the Department is paying these fees themselves because, when a contractor submits his cost proposal, they assume that a certain number of fees will be levied against them and build it into the fee. It was suggested instead that the Department implement a system of uptime calculation for reward and penalties. The contact recommended setting incentives based on uptime. For example, if it was determined that a 90 percent uptime was normal, over 92 percent uptime gets a bonus, between 92-88 percent is no change, and below 88 percent gets a penalty.

## 6.6 Overview of Contract Mechanisms

Existing and proposed contract mechanisms were discussed with the Department to gauge their perspectives.

- In general, purchase orders were viewed as a current practice for small efforts, but most agreed that they may not be the most desirable contract mechanism in the future.
- Low-bid contracts through ECMS is the most common practice used to date; however, there are some concerns with “getting the right contractor” or “getting what you pay for.” These are valid concerns; however, most agreed that these issues can be offset by requiring qualifications, having a clear scope of work, and utilizing the appropriate combination of liquidated damages and financial incentives.
- A Request for Proposal (RFP) would allow the Department to select the most responsive and prepared contractor; however, most contractors are not familiar with the RFP process. More importantly, it would likely increase the selection process and result in more claims from non-selected contractors.
- A modified version of the Design-Build-Best-Value (DBBV) may warrant future consideration as it offers a mechanism to eliminate non-qualified respondents (in an impartial way), but also can include a low-bid or cost element. However, the Department is still fine-tuning the process; therefore, it may be best to revisit this option in the future.

## 6.7 Geographic Coverage

As part of the evaluation, geographic coverage was evaluated. Currently, the Department has a combination of District contracts with some statewide contracts for RWIS support and for other BIS activities. Most Districts stated that District-wide and Regional (more than District) maintenance contracts were their preferred method. Having District or Regional coverage allows Traffic Management Centers (TMCs) to take more ownership and have more direct oversight of maintenance activities. Several Districts cited the RWIS program as an example where statewide contracting has not worked effectively. It was noted by some in BIS that statewide maintenance contracting is the most appropriate mechanism because it is common to centralize maintenance in the IT industry in order to maintain consistency and to monitor service.

The Department’s ITS plans continue to evolve and develop. ITS management will extend beyond District boundaries, and in many cases, is regional in nature. At the highest level, there is a need

for statewide ITS management. To achieve these goals, it may be appropriate to utilize District-wide, regional, and statewide contracts as follows:

<p>When to use a regional contract</p> <ul style="list-style-type: none"> <li>▪ When there is one “lead” District and one nearby “developing” District</li> <li>▪ When both Districts have common (manufacturer) devices</li> <li>▪ When both Districts fall within common regional boundaries</li> <li>▪ Where it is preferred to have a regional contract</li> </ul> <p>When to use a District contract</p> <ul style="list-style-type: none"> <li>▪ When there is no apparent “lead” District</li> <li>▪ When most devices are not compatible</li> <li>▪ If the Districts do fall within regional boundaries</li> <li>▪ Where it is preferred to have a District contract</li> <li>▪ For specialty systems where response times are critical and most deployments reside in one District</li> </ul> <p>When to use a statewide contract</p> <ul style="list-style-type: none"> <li>▪ To provide maintenance to specialty systems that are not widely deployed</li> <li>▪ For specialty systems where response times are less critical.</li> <li>▪ To support “off-brands” of Dynamic Message Signs</li> </ul>
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### 6.8 Contract Element Summary

National practices, experiences from other states, and Department perspectives were all considered in identifying key elements to include in future ITS maintenance contracts.

Contract Element	Description
<b>Contract Length</b>	Based on experiences within the Department as well as other states, a base contract should be two years in length with an option for a one-year renewal.
<b>Qualifications</b>	<p>The Department should consider utilizing the established prequalification codes (P-codes) to ensure qualified respondents. While requiring P-codes may limit respondents and/or increase bid results, the proper use of P-codes will assist in delivering qualified contractors to perform ITS maintenance.</p> <p>An alternate would be to utilize P-code descriptions in developing qualification requirements, but not to formally require P-codes. This would allow respondents without P-codes to respond. It would also allow the Department to remove unrelated elements of P-codes developed for construction-only activities.</p>
<b>Liquidated Damages and Performance Metrics</b>	<p>For Districts with liquidated damages, values ranged from \$150 to \$1,500 dollars per day; however, some contractors noted that they include an estimated number of damages into their bid, essentially putting the cost back on to the Department. The study group suggests liquidated damage assessment be written into the contract and be at least \$500 per occurrence, with \$1200 for a second offense on the same claim, and potential for breach of contract beyond that.</p> <p>For future contracts, the Department may wish to also include an uptime incentive to encourage contractor responsiveness. For example, if it was determined that a 95 percent uptime was normal, over 95 percent uptime gets a financial incentive, between 95-85 percent is no change, and below 85 percent gets a penalty.</p>
<b>Preventative Maintenance</b>	<p>Preventative maintenance schedules in the Department and in other states vary from 2 to 4 times a year. In some cases, preventative maintenance can be scheduled more frequently based on the age of the equipment or historic issues. In all cases, preventative maintenance should be logged, and it may be desirable to require a monthly report for all devices.</p> <p>Based on the research conducted, it is suggested that preventive maintenance be scheduled at least twice a year.</p>

Contract Element	Description
<b>Response Maintenance</b>	<p>Response maintenance can be divided into the following elements:</p> <ol style="list-style-type: none"> <li>1. Receive notification – This is the point in time that the Department notifies the contractor that there is an issue that requires attention.</li> <li>2. Arrive at site and diagnose the problem. Upon notification, this is the time it takes for the contractor to diagnose the issue. Typical response times for step 2 range from 24 to 48 hours. An appropriate length of time may be 48 hours unless otherwise approved by the Department.</li> <li>3. Perform repairs – Upon notification, this is the time it takes for the contractor to perform repairs. Typical repair times range from 2 days upon notification up to 4 days upon notification. An appropriate length may be 4 days upon notification to allow for diagnostics. The Department should include a note, “<i>unless otherwise approved by the Department,</i>” and “<i>the Engineer may authorize additional time for procurement of materials</i>” to allow flexibility if the needed activity is beyond the control of the contractor.</li> <li>4. Log activity – This includes formally logging the activity into the maintenance log.</li> </ol>
<b>Emergency Repairs</b>	<p>The study team suggests emergency response to the site within 4 hours of notification. An appropriate length for repair may be 24 hours upon notification to allow for diagnostics. The Department should include a note, “<i>unless otherwise approved by the Department,</i>” and “<i>the Engineer may authorize additional time for procurement of materials</i>” to allow flexibility if the needed activity is beyond the control of the contractor.</p>
<b>Other Elements to Consider</b>	<p><u>Device Listing</u> - Most contracts reviewed include a listing of device types. However, the level of detail included varies. As part of the general provisions, the following information should be provided to the potential bidders:</p> <ul style="list-style-type: none"> <li>▪ Types of devices (DMS, CCTV, HAR, etc.)</li> <li>▪ Make and model of devices</li> <li>▪ Location of the devices</li> <li>▪ Expected additional deployments.</li> </ul> <p><u>Spare Parts</u> - By description for response maintenance, the contractor would likely need to have an inventory of spare parts in order to respond within time parameters; however, it may be appropriate to provide a basic listing of spare parts that should be maintained.</p> <p><u>Emergency Deployments</u> - Several Districts noted that many of the ITS maintenance providers are also the common deployers of ITS technologies. Due to the common use of ITS technologies for “all hazards,” it is not uncommon for there to be an unexpected, but urgent need for deployment (e.g. DMS needed in District 5-0 on I-78). When developing ITS maintenance contracts, consideration should be given to including a provision to allow for limited ITS deployments to include DMS, CCTV, and HAR, among others.</p>

## 6.9 ITS Maintenance and Asset Management

Asset management is the cost-effective operation, maintenance, and preservation of transportation systems, including intelligent transportation systems. As the Department’s ITS maintenance program continues to evolve, asset management will be a critical element to promote system-improved maintenance and reliability. When considering ITS asset management, it is critical for the Department to keep a detailed inventory database which includes:

- Tracking number
- ITS device make and model
- Photos and as-built drawings if available
- Location
- Key components and system communication
- Maintenance logs.

## 7. Quick Clearance Best Practices Summary (Subtask E.6)

*Evaluation Summary as of April 2009. Note final Department policies may vary.*

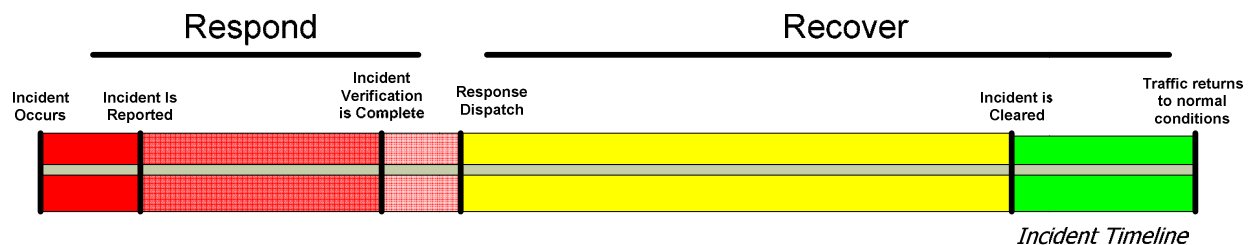
### 7.1 Background and Purpose

Ensuring that the traveling public experiences the least amount of delay due to non-recurring congestion while providing first responders with the greatest amount of safety possible is the essence of quick clearance. As the National Incident Management System (NIMS) describes, the first objective of any emergency is responder safety.

With regard to quick clearance policies and research, many engineering research groups such as the American Association of State Highway Officials (AASHTO) and the National Highway Cooperative Research Program (NCHRP) have conducted efforts in hopes of identifying practices that will reduce the amount of delay experienced by vehicles waiting in the queue after a crash has occurred.

### 7.2 How is Situational Awareness Improved?

Focusing on non-recurring congestion, traffic crashes and the time that it takes to verify, respond to, and recover from them is one of the most critical areas for maintaining situational awareness. Consider the incident timeline shown below:



On the graphic above, situational awareness is gained at the time incident verification is complete. So an initial improvement in situational awareness is obtained by reducing the time between “Incident is Reported” and “Incident Verification is Complete”.

For the type of incidents like the one described above, maintaining situational awareness is the knowledge gained from the progress of physically dispatched response personnel. The status of the recovery process is passed onto motorists and potential travelers through diversion and incident messages posted on dynamic message signs, through telephone access, and through internet access. **Effective quick clearance policies and procedures improve situational awareness by reducing the time to recover from an incident affecting the roadway.**

### 7.3 Review of Best Practices and Suggested Actions

A comprehensive review of literature that included such information sources as the I-95 Corridor Coalition Website, the Federal Highway Administration Website, and many State Department of Transportation Websites along with Pennsylvania stakeholder interviews and interviews of five states that had strong incident management and quick clearance efforts resulted in the following suggested action items.



Suggested Executive Actions	Suggested Sub-tasks
Evaluate the Need for Changes in Legislation	<ul style="list-style-type: none"> <li>• Driver Removal Law Examination</li> <li>• Consider the Need to Strengthen Hold-Harmless Language in Existing Laws</li> </ul>
Consider the Establishment of an Incident Management Program	<ul style="list-style-type: none"> <li>• Consider Implementing an Incident Management Policy</li> <li>• Consider establishing incident management memorandums of understanding with PSP</li> <li>• Consider developing an incident management Strategic Plan</li> <li>• Consider continuing and expanding the freeway service patrol program</li> <li>• Evaluate the benefit of implementing an incident management module into the Road Condition Reporting System</li> <li>• Consider implementing incident management performance metrics</li> <li>• Consider providing oversight and guidelines for work zone incident management plans</li> <li>• Facilitate the completion of FHWA's TIM Self Assessment on an annual basis</li> </ul>
Evaluate the Expansion Capabilities for Training and Outreach Efforts	<ul style="list-style-type: none"> <li>• Develop and disseminate a PennDOT Incident Management Brochure</li> <li>• Dedicate a portion of the PennDOT website to become a focal point for Pennsylvania Quick Clearance information and outreach efforts</li> <li>• Coordinate and hold 11 Saturday Incident Management Symposiums</li> <li>• Require District Incident/Emergency Management Coordinators to attend two county EMA coordination meetings per year</li> <li>• Provide quick clearance training opportunities by nationally recognized experts</li> <li>• Establish a relationship with the Pennsylvania Chiefs of Police Association</li> </ul>
Consider Facilitating the Improvement of the Towing and Recovery Qualification Process	<ul style="list-style-type: none"> <li>• Facilitate coordination efforts between the PSP and the Pennsylvania Towing Industry</li> <li>• 29% Shared with Traffic Engineering</li> <li>• 65% Shared with Maintenance Forces</li> </ul>
Consider developing regional partnerships to seek incident management funding	<ul style="list-style-type: none"> <li>• Investigate relationships and grant opportunities from the Department of Homeland Security</li> </ul>



## 8. Freeway Service Patrol Evaluation Summary (Subtask E.8)

*Evaluation Summary as of January 2009. Note final Department policies may vary.*

### 8.1 Background and Purpose

The purpose of this task was to conduct an evaluation of freeway service patrols (FSPs) to determine operating costs, benefits and best practices. The goal is to provide recommendations on how to implement a highly effective statewide FSP program from perspectives of both cost and performance.

Key activities included:

1. Research national best practices
2. Summarize current District practices
3. Identify suggested actions

FSP programs generally consist of trained personnel who use specially equipped vehicles to systematically patrol highways searching for and responding to traffic incidents. FSP have been documented to reduce traffic congestion, improve travel time reliability, and improve safety on limited access roadways

While there is no doubt that FSPs provide a beneficial service to the general motoring public, available data indicates that additional benefits are also realized with respect to reductions in incident durations and subsequent reductions in fuel consumption, emissions, and secondary incidents. Benefit/costs have been calculated for many of these initiatives on a nationwide basis, with ratios ranging from 2:1 to 36:1. On a localized level, PennDOT Engineering District 8-0 has experienced an approximate benefit/costs of 12:1.

### 8.2 Program Goals

While there is a demonstrated benefit, no specific guidelines or goals have been established for the implementation of FSPs throughout the Commonwealth of Pennsylvania. Therefore, the following program goals are recommended based on a review of the state of the practice in the United States.

### 8.3 Program Coverage Areas

In order for a selected roadway segment to be considered for the implementation of a FSP, the following guidelines should be considered:

- 1) Roadway must be a limited access roadway.
- 2) The segment must have an Incident Factor (IF) greater than or equal to 5.0. The (IF) shall be calculated by multiplying the average annual daily traffic (AADT) of the segment (both directions) by the annualized crashes per mile for the segment (average year for three years of crash data should be used). The calculated number should then be divided by 100,000 to obtain the resulting IF. Please note that the segment crash data must be converted to a crashes per mile value by pro rating based on segment length.

$$\text{Incident Factor (IF)} = \frac{\text{AADT} \times \text{crashes per mile}}{100,000}$$

- 3) Those segments that are on logical feeder routes or connections linking roadways meeting the criteria above.
- 4) Those segments deemed to be part of the critical infrastructure necessary to maintain traffic flow where incidents would cause excessive delay and safety concerns, or as identified by the planning partners as a congested corridor as part of their Congestion Management Plan (CMP).
- 5) Those segments with shoulder areas less than 6 feet in width may be given priority due to the capacity constraints experienced by the inability to move vehicles from the travel lane.

Note that the threshold for IFs was determined by conducting a statistical analysis of the Pennsylvania interstate system. IFs were determined for all interstates and the average was used to establish a program baseline along with some basic qualitative analysis.

#### 8.4 Program Services

All FSPs should provide the following recommend minimum services:

- Move disabled vehicles - Be able to tow or push a stalled or abandoned automobile or light truck out of the highway travel lane
- Provide fuel – Provide up to 2 gallons of fuel to a disabled vehicle
- Provide water – Provide water for overheating and to person(s) being assisted
- Change flat tire
- Minor mechanical assistance – Provide jump starts, tire inflation and other minor technical assistance
- Assist stranded motorists – Provide access to cell phone and direct them to a safer area
- Remove obstacles and obstructions from roadways – Remove small debris and other non-hazardous items
- Arrange for towing – Call commercial towing providers and provide towing services to a point of safety
- Share information with other agencies – Provide information including emergency service request
- Assist other agencies – Provide traffic control support to other first responders
- Provide traffic control

These are consistent with FHWA guidelines and are also consistent with existing service being provided in Engineering Districts 5-0, 6-0, 8-0 and 11-0.

Minimum hours of operation should include the morning and evening rush hour periods, and the fleet should be comprised of vehicles capable of moving disabled vehicles from the travelway.

Provide operators that are trained to safely provide limited emergency temporary traffic control at incident scenes and are trained in ICS, specifically IS-100 and IS-200 level courses.

### 8.5 Program Evaluation

Any PennDOT District that implements an FSP program must conduct a benefit/cost analysis on an annual basis at a minimum. The analysis should be based on:

- Reduction in incident duration
- Reduction in fuel consumption
- Reduction in motorist lost wages spent in congestion
- Motorists savings per incident
- Annual cost of FSP program.

The benefit/cost analysis must be submitted to the Bureau of Highway Safety and Engineering for review and approval.

### 8.6 Program Consistency and Funding

It is very important that motorists (customers) encounter a consistent experience as they travel throughout the State of Pennsylvania, similar to the baseline ITS device deployment and statewide 511 traveler information service initiatives. FSPs should be no different in this goal, and therefore the following course of action is suggested:

*Short-term* – Maintain the present course of action with local operation utilizing state/federal funding through the MPO or county funds. Develop and provide FSP implementation guidelines to the Districts to establish consistency.

*Long-term* – Establish statewide FSP program funded by Central Office. This would allow BHSTE to ensure statewide consistency with control of the funding source, but District operation should still be maintained because of the necessary coordination with the TMCs. Initial funding level should be set at approximately \$5 million/year.

Public/private partnerships should be encouraged, such as the one between the Pennsylvania Turnpike Commission and State Farm Insurance. However, this arrangement should be limited to the donation of funds in exchange for advertising on PennDOT vehicles. All PennDOT FSP vehicles shall be operated by PennDOT employees or their contractors.

### 8.7 Program Budgeting

As indicated above, a statewide FSP program should be initially budgeted at \$5 million/year. In absence of a statewide program, budgets for individual District programs/expansions should assume an annual budget of \$1,200/per mile/per year.

## 9. Dynamic Message Sign Usage Policy Summary (Subtask E.10)

*Evaluation Summary as of February 2009. Note final Department policies may vary.*

### 9.1 Background and Purpose

The purpose of this task was to conduct an evaluation of existing practices and policies for dynamic message signs (DMSs). Also, the task included a review of the status of pilot initiatives including proposed public-private partnerships.

### 9.2 National Policies

There are no written DMS operations policies at the national level. However, policies, standards, and guidance are embodied in the MUTCD and in FHWA Policy Memorandums. In summary, Federal policies dictate that:

1. DMSs shall display pertinent traffic operational and guidance information only and not advertising.
2. The use of DMSs for the display of general public information or other nonessential messages is discouraged.

Concerns expressed by FHWA include: general safety concerns regarding driver distraction, concern with possible decline in motorist credibility, and interaction with PennDOT business practices and procedures.

### 9.3 Pennsylvania Policies

Pennsylvania DMS Operating Guidelines state that states, *“Advertising – messages advertising any products, service, campaign, political party, etc. are prohibited.* Additionally, current laws are very prohibitive with regard to privatization within PennDOT right-of-way.

### 9.4 Other Initiatives and Studies

<b>California</b>	<p>Caltrans asked then Transportation Secretary Mary Peters to waive federal laws that ban commercial advertising on highway rights-of-way to allow partnerships with private businesses as a way of leveraging increasingly scarce transportation funding. In response to this proposal, Scenic America has prepared a position paper and letter to the US Department of Transportation that opposes advertising on changeable message signs based on the following:</p> <ul style="list-style-type: none"> <li>▪ Commercial advertising on the right-of-way violates the Highway Beautification Act.</li> <li>▪ Commercial advertising on the right-of-way violates the Federal Highway Statute.</li> <li>▪ Commercial advertising on the right-of-way is a willful violation of the Manual on Uniform Traffic Control Devices.</li> <li>▪ Commercial advertising on the right-of-way is a clear threat to highway safety.</li> <li>▪ Commercial advertising on the right-of-way undermines the integrity of the State's Outdoor Advertising Code.</li> </ul> <p>To our knowledge, there has been no response from FHWA regarding California's request as of this writing.</p>
<b>Pennsylvania Turnpike</b>	<p>Although it does not involve the use of changeable message signs for advertising as discussed above, in 2007 the Pennsylvania Turnpike Commission made a similar request of FHWA to allow co-branding of E-ZPass signs at toll plazas. FHWA denied the Turnpike's request.</p>

<b>ITE</b>	ITE found no statistical relationship between crashes and digital billboards, but also stated that because of the lack of crash causation data, no conclusions can be drawn regarding the ultimate safety of digital billboards.
<b>Maryland</b>	Maryland State Highway Administration conducted a comprehensive review of the two studies include in ITE’s effort and concluded that “it is our opinion that acceptance of these reports as valid is inappropriate and unsupported by scientific data, and that ordinance or code changes based on their findings is ill advised.”
<b>FHWA</b>	FHWA has initiated a two-phase study to determine the potential safety risks of digital billboards to address potential safety concerns more thoroughly.

## 10. Traffic Management Center Performance Measures Summary (Subtask E.11)

### 10.1 Background and Purpose

According to the 2009 Urban Mobility Report, Traffic Incident Management (TIM) efforts reduced delay by over 143 million hours in 2007 for a savings of over \$3 billion in America's top 439 urban areas. The authors estimate that if traffic incident management efforts were in place on all roads the delay reduction would approach \$200 million.<sup>1</sup>

The authors of the Urban Mobility Report can make that statement because they collected raw data and equated it to measureable statements that many American's can relate to, using terms such as delay costs per year and wasted fuel. Most American's are also aware of the need to improve safety on the Nation's surface transportation system, even though they may offer differing solution sets. In any case, the magnitude of the problem must be known so that limited resources can be applied in the most efficient way possible.

### 10.2 Research and Findings

This effort included the review of more than 80 publications from a variety of sources including FHWA, academia, individual states, private industry, and national coalitions. From the research over 200 performance measures were identified and cataloged as described below:

- **Program Measures** – Will justify the current direction of the program or identify the need to shift the direction of the program
  - Customer Driven Measures – Are high level and very visible to executive management and the public with the goal being to:
    - Show the value of money spent
    - Promote positive public perceptions
    - Manage public access portals to information
    - Manage public expectation
    - Demonstrate environmental stewardship
  - Efficiency Driven Measures – Focus on the overall scale of the program relative to the demands that face the program, with the goals being to:
    - Demonstrate fiscal responsibility
    - Monitor interoperability with the overall transportation network, including all available modes
    - Identify legacy systems that do not meet national standards or Federal expectations
    - Develop and maintain program totals into quarterly, biannual, and/or annual reports
- **Operation Measures** – Will ensure that the program is being executed as designed using:
  - Recurring Congestion Measures – Encompass the overall state and regional mobility goals found in the Pennsylvania Mobility Plan and the Transportation Advisory Committees Report on Congestion Mitigation and Smart Transportation.

<sup>1</sup> 2009 Urban Mobility Report, Texas Transportation Institute, Page 15, Exhibit 11

- Non-Recurring Congestion Measures – Include the direct functionality of TMCs as well as response to and clearance of incidents.

A performance measure matrix is included in the Appendix that assigns a classification to each performance measure that was examined.

In addition to the classification system, most of the guidance related to the selection of performance measures comes from *TMC Performance Monitoring, Evaluation and Reporting, A Technical Handbook*, released by FHWA in 2005 which is included in the Appendix. The Handbook includes 152 pages that offer suggestions on how to establish an effective performance measurement program and how to implement that program. At the core of the Handbook, three categories are suggested for identifying measures for a program:

- **Inputs** - address the supply of resources available to implement a program
- **Outputs** –quantitatively address the delivery of transportation programs, projects and services
- **Outcomes** –address the degree to which the transportation system meets policy goals and objectives

Any measure that is selected needs to be outcome-based and should generally be related to addressing stakeholder and customer concerns that center on mobility, safety, and fiscal responsibility.

One result of the evaluation and identified in the research effort in many sources is that the National Traffic Incident Management Coalition is one of the leading national organizations for traffic operations and should be sought as a development partner and subject matter expert. The coalition has representation from FHWA and many other public agencies facing congestion and traffic safety issues of all types.

### 10.3 Suggested Performance Measures

As a result of this effort, the following performance measures were identified. Operations performance measures are those most likely to be implemented by TMCs.

#### Program Performance Measures

- Delay Reduction
- Travel Time Reliability
- Planning Time Index
- Customer Satisfaction
- Wasted Fuel Consumption Reduction
- Reduced Emissions
- Dollars Saved Due to Traffic Incident Management Efforts

### **Operations Performance Measures**

- Incident Duration
- Secondary Crashes
- Benefit-Cost Ratio of Service Patrols
- Travel Time Index
- Average Speed
- TMC Performance

Section 6 of Appendix E.11 contains detailed information about each suggested measure including needed inputs, expected outputs and outcomes, and calculation methods.



# Assessment of Portable Signals

(Subtask E.3)

June 30, 2008



**Gannett Fleming**



Pennsylvania Department of Transportation,  
Bureau of Planning and Research  
Project Number 060908



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## Executive Summary

### Background and Purpose

The Manual on Traffic Control Devices (MUTCD) defines portable signals as a temporary traffic control signal that is designed so that it can be easily transported and reused at different locations. These systems may be trailer-mounted or pedestal-mounted units.

The purpose of the *Assessment of Portable Signals* was to:

- Document current Department practices and procedures.
- Identify national practices.
- Identify practices and procedures in other states.
- Assess portable signals in field applications.
- Develop suggestions for approvals and permitting.
- Provide design guidance.
- Compare the use of portable signals versus other alternatives.



### Key Issues

Three major issues associated with portable signal use in Pennsylvania are:

1. What processes should be employed to obtain approval to deploy portable signals within the Commonwealth while preserving PennDOT's ability to provide adequate oversight without negatively or unduly impacting usage of these devices at appropriate locations.
2. Are trailer-mounted portable signals and conventional pole-mounted temporary signals equal, and under what conditions should each be used?
3. Are PennDOT's pending equipment performance specifications for trailer-mounted and pedestal-mounted portable signal systems adequate and reflect current technology?

### Key Facts

#### National Requirements and Other Research

Per Federal and Pennsylvania requirements portable signals shall meet FHWA requirements (in the MUTCD) for a conventional traffic signal. The Department is responsible for ensuring those requirements are met.

There has been limited research on portable signals, but other studies concluded that:

- There is a substantial savings in flagger labor costs that could be achieved by using portable signals.
- The potential for vehicle crashes within the work zone may be higher with portable traffic signals because of occasional driver noncompliance with these signals.
- The trade-off between this possible increase in vehicular crashes and the reduction in flagger crashes could not be estimated.

### Department Practices and Proposed Legislation

Presently, the purpose of the Department's permit includes:

- Identification of legal permittee (responsible owner).
- Verification of appropriate traffic control devices (signs and markings per State and Federal requirements) for safe and efficient operation.
- Verification that operation parameters (green, yellow and red times) meet State and Federal requirements for safe and efficient operation.
- Provide an official document to prevent improper use of the device.
- Provide an engineering document to be used in litigation.

While the permitting process is perceived by some as cumbersome, it is consistent with current State statutes. Ultimately, the current process promotes the safe and efficient movement of work zone traffic while limiting the liability of the Department and the owner of the system. Since vendors do not technically own or deploy the system, they may be less concerned with the liability associated with improper deployments.

Proposed House Bill 2419 and Senate Bill 1428 promotes compliance with the MUTCD; however, the language does not require a permit under any circumstances, which may limit the Department's ability to provide proper oversight and to ensure safe and efficient movement of traffic.

### Practices of Other States

PennDOT's procedures and practices as they compare to the other 21 states that responded are as follows:

- About half the states surveyed use portable traffic control signals. Of these, more than seventy-five percent use primarily trailer-mounted versus pedestal-mounted.
- Most states have limited or occasional deployments (approximate average of 3 to 6 per year). Some states have more than 10 deployments per year and one state uses portable signals approximately 50 times per year.
- In comparison to the states surveyed, usage of portable signals in Pennsylvania appears to equal or exceed other states.
- About 15 percent of the states have a permitting/documentation process.
- Site specific drawings and inspections are required in approximately 50 percent of the surveyed states.
- Most states are in the process of generating standard guidelines for the use of portable traffic signals since the desire to utilize these devices is increasing.

### Contractor and Vendor Viewpoints

In many cases, contractors are charged with the completion of work zone construction activities. In a survey of contractors:

- Most (88 percent) agree that portable signals may increase safety.
- All feel that each work site has to be assessed independently.



- 44 percent feel portable signals are cost effective.
- The companies that have used these devices stated that they worked well.

An extensive review was conducted to collect information regarding vendors of portable signals. There are several vendors that manufacture portable signals, including Horizon Signal Technologies (based in Pennsylvania). Most vendors were passionate that they offer a product that they believe will improve flagger safety and reduce manpower costs. In summary, most vendors believe that:

- Portable signals can improve flagger safety.
- Portable signals can save manpower costs.
- Limited permitting/documentation is required.

### Field Assessments

Field assessments conducted at two locations, involving non-complex applications, illustrated that portable signals can work effectively. In both assessments:

- A site visit was conducted prior to installation.
- An application was submitted (approximately 2 to 3 hours to prepare for each site).
- A site specific drawing was developed (approximately 2 to 3 hours to prepare for each site).
- A traffic signal permit was obtained.
- Training was provided to the crew one day prior to deployment.

While the portable signals worked effectively, the assessment team noted opportunities for future enhancements. During the assessments, no problems were observed with driver compliance.

### **Findings and Observations**

The Department has a bridge enhancement initiative which include the upgrade of more than 1,000 bridges in the next few years. Many of these bridges are short spans on two-lane roads where portable signals may be a suitable work zone alternative.

To support this demand and other applications, PennDOT needs a well-documented, efficient process to deploy these devices in order to promote safe and efficient travel while meeting Federal requirements.

Portable signals provide another acceptable alternative (to flaggers and temporary signals) for controlling work zone traffic; however, they do have their appropriate uses and require oversight similar to flagger auditing and temporary signal permitting. All approaches have their benefits as well as their perceived negative impacts.

PennDOT has a well-established policy for the application, permitting and deployment of portable signals. The existing level of requirements for short-term, non-complex applications and more complex and long-term applications appear to be appropriate to meet Federal requirements, as well as to promote safe and efficient operations. However, the required process could be

streamlined in order to provide clarity and efficiency. Key suggestions to streamline the application and permitting process include:

- Continue to allow emergency deployments at the Department’s discretion.
- Combine the application of use and notice of commencement into one form for short-term, non-complex operations.
  - Allow “blanket approval” of multiple locations provided they are “non-complex.”
  - Require acknowledgment of operator responsibility to be compliant with PennDOT Publication 213 (Work Zone Traffic Control) and the Manual on Uniform Traffic Control Devices (MUTCD).
  - Require acknowledgment of operator responsibility to provide vendor training to staff deploying portable signals.
- Continue to require a site specific application, drawing, permit and inspection for short-term operations with complex conditions and for long-term operations.
- For long-term operations, encourage the design community to identify portable signals as an design alternative to be considered where appropriate on Department construction projects and on Highway Occupancy Permits (HOPs).
  - If portable signals are identified and designed as an acceptable design alternative, continue to accept the work zone traffic control plan as the site specific drawing and require only the combined the application and notice of commencement as noted above.

The assessment team reviewed PennDOT’s pending performance specifications for trailer-mounted and pedestal-mounted portable traffic control signal systems and has found that no major revisions are needed. However, the assessment team suggests that PennDOT revisit this specification yearly to update the document.

Other suggestions include:

### Deployment

- Modify the traffic signal permit and application to emphasize that the liability is on the user of the system.
- Investigate other methods to waive Department liability, especially if oversight is diminished.
- Revisit deployment policy on an annual basis due to evolving technologies.
- Identify in work zone traffic control plans (for larger projects), locations where portable signals may be considered as an alternate to flaggers or pole-mounted temporary signals.
- Consider a “three strikes’ policy prohibiting the use of portable signals by users who do not follow requirements.
  - Prohibit “blanket” usage for one year.
  - Require site specific application for all uses.
  - Require documentation of vendor re-training.

### Training and Education

- Request FHWA and/or TRB to conduct a national review and to develop Federal policy on portable traffic signal usage.



- Develop a work zone traffic control checklist to assist Department staff in identifying the appropriate locations to use portable signals, temporary signals and flaggers. Train designers to identify portable signals as an acceptable design alternative to flaggers or pole-mounted temporary signals at the appropriate locations.
- Conduct a portable signal workshop at a future Transportation Engineering and Safety Conference. Highlight deployment policy as well as design considerations.
- Continue to have dialogue between the Department, contractors and vendors to discuss portable signal strengths, weaknesses and future opportunities for enhancements.
- Implement a public awareness program to educate motorists on this new technology they may encounter in a work zone versus a flagger.

### Summary

Portable signals represent an emerging alternative to flaggers and pole-mounted temporary signals. Each alternative has its appropriate use. Training and education to designers is critical such that portable signals are identified as acceptable alternative where appropriate. Streamlining the permitting process, while ensuring safe and efficient traffic control, will provide an opportunity for contractors and other work zone users to utilize portable signals where appropriate.

While existing research has shown that portable signals improve flagger safety, the safety impact on motorized traffic has not been adequately evaluated. This issued needs further evaluation at the national level as many states are struggling with this issue.

Ultimately, the owner/operator (contractor or other work zone user) of the portable signal bears the liability to ensure they are deployed properly. The Department's responsibility is to provide oversight to ensure safe and efficient use. While the vendor community offers a "MUTCD compliant" product, the product is not MUTCD compliant if it is deployed improperly.

## Introduction

### 1.1 Background and Purpose

The Manual on Uniform Traffic Control Devices defines portable signals as a temporary traffic control signal that is designed so that it can be easily transported and reused at different locations. These systems may be trailer or pedestal-mounted units.



Portable signals are viewed as an acceptable work zone alternative to:

1. Flaggers – These individuals control traffic in a one-lane, two-way work zone with either a “STOP/SLOW” paddle or a hand held flag.



2. Temporary signals, per the MUTCD, are defined as a traffic control signal that is installed for a limited time period.



3. AFAD – An Automated Flagger Assistance Device (AFAD) is an automated device that replaces a human flagger to safely stop and control traffic through the work zone. However, the system is still manually controlled from the roadside.





The purpose of the *Assessment of Portable Signals* was to:

- Document current Department practices and procedures.
- Identify national practices.
- Identify practices and procedures in other states.
- Assess portable signals in field applications.
- Develop suggestions for approvals and permitting.
- Provide design guidance.
- Compare the use of portable signals versus other alternatives.



Current PennDOT policy is to generally require the issuance of a portable traffic signal permit in order to verify compliance with Federal and State traffic control requirements. The concern from some of the contracting/vendor community is the length of time required to obtain a permit for short-term operation of portable signals. PennDOT has developed standard drawings to assist contractors/ vendors in developing permits. Other issues of note include:

### Policy and Deployment

- Streamlining permitting while meeting Federal and State requirements.
- Maintaining consistency between Districts.
- Defining the role of design and construction in the process.

### Design and Operation

- Defining the process of choosing portable signals versus other alternatives (flaggers, pole-mounted temporary signals, etc).
- Defining the required engineering details on permit and traffic control plan.
- Refining the equipment performance specifications.

### Other

- Ensuring system safety and safe application
- Addressing the perception that the Department is anti-technology

## 1.2 History and Future

Portable signals have been in existence for over two decades; however, recent technological enhancements have made them a more practical work zone alternative. These advancements include light emitting diode (LED) indications, wireless communications, and generator/back-up power systems.

The usage and deployment of portable signal systems across the United States include varying levels of usage, different system configurations and developing/evolving permitting, and documentation processes.

Portable signal systems have been used in many locations for emergency traffic control due to natural disasters such as flooding, rockslides, etc. They also may be an acceptable work zone alternative in many short-term and long-term applications.

The Department has an aggressive bridge enhancement initiative including over 1,000 bridges in the next few years. Many of these bridges are short spans on two-lane roads where portable signals may be a suitable work zone alternative.

To support this demand and other applications, PennDOT needs a well-documented, efficient process to deploy these devices in order to promote safe and efficient travel while meeting Federal requirements.

### 1.3 Definitions and Acronyms

#### 1.3.1 Definitions

**Portable Traffic Signal** - as defined in the MUTCD is a temporary traffic control signal that is designed so that it can be easily transported and reused at different locations.

**Temporary Traffic Signal** - as defined in the MUTCD is a traffic control signal that is installed for a limited time period.

**AFADS** - are an automated flagger assistance device (AFAD) that is an automated device that replaces a human flagger to safely stop and control traffic through the work zone.

**Yellow Change Interval** - Signal interval following the green display for each phase which indicates a change in right-of-way assignment is occurring.

**Red Clearance Interval** - Interval following the yellow portion of each phase. In the case of portable signals, the red clearance is the time required to safely travel through the work zone.

**Long-Term Stationary Operation** - Work that occupies a location for more than 24 hours.

**Short-Term Stationary Operation** - Work that occupies a location up to 24 hours.

**Trailer-Mounted Units (Portable Signal)** - This system utilizes a trailer capable of accommodating a vertical upright and a horizontal mast to accommodate mounting two signal heads.

**Pedestal-Mounted Units (Portable Signal)** - This system utilizes a cart with a vertical upright that allows for the mounting of one signal head.

**Traffic Signal Permit** - Allows a town or city to install and operate a traffic control signal. Promote safe and efficient movement of traffic while limiting Department liability.

**Portable Signal Application** - The application will be filled out by a town or city applying for a traffic signal permit. Must be submitted and approved upon granting permit.

**Site Specific Drawing** – This drawing will indicate all proposed work zone traffic control, portable traffic control signal locations and operation (phasing, timing, etc.) taking into account work operations, roadway geometry, nearby intersection and driveway and other pertinent factors.

**Vendors** – Companies which supply parts or services to another company, also called supplier.

**Contractors** - A person or business which provides goods or services to another entity under terms specified in a contract.

**Performance Specification** – States how an element must perform as opposed to describing equipment, products or systems by name.

**Manual Operation** – Signal operations controlled by a person on site.

**Blanket Permit** – A generic permit covering multiple locations.

**Non-complex Operation** – An operation not involving long-term conditions, high volumes or significant length.

**Emergency Operation** – An emergency as designated by the Secretary of Transportation or their designee. They may include any natural or man-made disaster.

**Publication 111M** – *Signing and Marking Standard* which contains the traffic standards that provide detailed guidance for sign legends, expressway and freeway signs, sign spacing and location criteria and sign posts. The publication also includes detailed drawings of pavement marking lines and symbols, and the placement of delineation devices at on-ramps, off-ramps and lane drops.

**Publication 148M** – *Traffic Signal Standard Drawings, TC-8800 Series* which contains detailed guidance for the construction of traffic signals, controller assemblies, traffic signal supports, electrical distribution, signal heads and detectors.

**Publication 149M** – *Traffic Signal Design Handbook* which contains information for use in the design and operation of a traffic signal installation.

**Publication 212** – *Official Traffic-Control Devices* which contains this chapter, and an appendix containing additional guidance related to elements of appropriate engineering and traffic studies and the provisions of this chapter.

**Publication 213** – *Work Zone Traffic Control Guidelines* which provides additional guidance and suggested temporary traffic-control plans for maintaining traffic through highway construction, maintenance and utility work zones to supplement various situations not included in the MUTCD.

**Publication 236** – *Pennsylvania Handbook of Approved Signs* which contains the design and application details of official traffic signs.

### 1.3.2 Acronyms

**ADT** – Average Daily Traffic

**BHSTE** – Bureau of Highway Safety and Traffic Engineering

**BOMO** – Bureau of Maintenance of Operations

**BPR** – Bureau of Planning and Research

**FHWA** – Federal Highway Administration

**MPH** – Miles per Hour

**MUTCD** – Manual on Uniform Traffic Control Devices (2003 Edition)

**PennDOT** – Pennsylvania Department of Transportation

**TRB** – Transportation Research Board

**VPD** – Vehicles per Day

**VPH** – Vehicles per Hour



## 1.4 Contacts

This task was performed under Project Number 060908 managed by the Bureau of Planning and Research. The following are the task and contract contacts:

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The assessment was an independent effort led by the consultant team. PennDOT provided input regarding portable signals as did FHWA, other states, contractors and vendors.

## 1.5 Acknowledgements

The consultant team would like to thank all the states and vendors who provided information and active participation and insight during various stages of this study. Special thanks are extended to Horizon Signal Technologies, Inc. for providing the pedestal-mounted portable traffic signal systems that were deployed in the pilot applications.

## 2. Research and Benchmarking

A major component of the assessment included research of existing practices and knowledge with regard to the use of portable traffic signals in work zones. The research component included a review of national requirements, a review of existing Department practices, a survey of state DOT's, a survey of contractors and a vendor/product review of the subject matter.

### 2.1 National Requirements

FHWA was contacted regarding their perspectives on the use of portable signals as it relates to the Manual on Uniform Traffic Control Devices (MUTCD), as well as possible future rulemaking. The following guidance was received.

The following are the specific requirements as set forth in the Manual on Uniform Traffic Control Devices, 2003 Edition.

#### **Section 6F.80 Temporary Traffic Control Signal**

*Standard:*

*Temporary traffic control signals (see Section 4D.20) used to control road user movements through TTC zones and in other TTC situations shall meet the applicable provisions of Part 4.*

*Support:*

*Temporary traffic control signals are typically used in TTC zones such as temporary haul road crossings; temporary one-way operations along a one-lane, two-way highway; temporary one-way operations on bridges, reversible lanes, and intersections.*

*Standard:*

*One-lane, two-way vehicular traffic flow (see Chapter 4G) requires an all-red interval of sufficient duration for road users to clear the portion of the TTC zone controlled by the traffic control signals. Safeguards shall be incorporated to avoid the possibility of conflicting signal indications at each end of the TTC zone.*

*Guidance:*

*Where pedestrian traffic is detoured to a temporary traffic control signal, engineering judgment should be used to determine if pedestrian signals or accessible pedestrian signals (see Section 4E.06) are needed for crossing along an alternate route.*

*When temporary traffic control signals are used, conflict monitors typical of traditional traffic control signal operations should be used.*

*Option:*

**Temporary traffic control signals may be portable or temporarily mounted on fixed supports.**

*Standard:*

*The supports for temporary traffic control signals shall not encroach into the minimum required width of a "pedestrian access route" of 1200 mm (48 in) or an "alternate circulation path" of 900 mm (36 in).*

**Guidance:**

*Temporary traffic control signals should only be used in situations where temporary traffic control signals are preferable to other means of traffic control, such as changing the work staging or work zone size to eliminate one-way vehicular traffic movements, using flaggers to control one-way or crossing movements, using STOP or YIELD signs, and using warning devices alone.*

**Support:**

*Factors related to the design and application of temporary traffic control signals include the following:*

- A. Safety and road user needs;
- B. Work staging and operations;
- C. The feasibility of using other TTC strategies (for example, flaggers, providing space for two lanes, or detouring road users, including bicyclists and pedestrians);
- D. Sight distance restrictions;
- E. Human factors considerations (for example, lack of driver familiarity with temporary traffic control signals);
- F. Road-user volumes including roadway and intersection capacity;
- G. Affected side streets and driveways;
- H. Vehicle speeds;
- I. The placement of other TTC devices;
- J. Parking;
- K. Turning restrictions;
- L. Pedestrians;
- M. The nature of adjacent land uses (such as residential or commercial);
- N. Legal authority;
- O. Signal phasing and timing requirements;
- P. Full-time or part-time operation;
- Q. Actuated, fixed-time, or manual operation;
- R. Power failures or other emergencies;
- S. Inspection and maintenance needs;
- T. Need for detailed placement, timing, and operation records; and
- U. Operation by contractors or by others.

*Although temporary traffic control signals can be mounted on trailers or lightweight portable supports, fixed supports offer superior resistance to displacement or damage by severe weather, vehicle impact, and vandalism.*

**Guidance:**

*Other TTC devices should be used to supplement temporary traffic control signals, including warning and regulatory signs, pavement markings, and channelizing devices.*

*The design and placement of temporary traffic control signals should include interconnection to other traffic control signals along the subject roadway.*

*Temporary traffic control signals not in use should be covered or removed.*

---

#### **Section 4D.20 Temporary Traffic Control Signals**

**Standard:**

*A temporary traffic control signal shall be defined as a traffic control signal that is installed for a limited time period. A portable traffic control signal shall be defined as a temporary traffic control signal that is designed so that it can be easily transported and reused at different locations.*

*Support:*

A temporary traffic control signal is generally installed using methods that minimize the costs of installation, relocation, and/or removal. Typical temporary traffic control signals are for specific purposes, such as for one-lane, two-way facilities in temporary traffic control zones (see Chapter 4G), for a haul-road intersection, or for access to a site that will have a permanent access point developed at another location in the near future.

*Standard:*

Advance signing shall be used when employing a temporary traffic control signal.

**A temporary traffic control signal shall:**

- A. Meet the physical display and operational requirements of a conventional traffic control signal.
- B. Be removed when no longer needed.
- C. Be placed in the flashing mode when not being used if it will be operated in the steady mode within 5 working days; otherwise, it shall be removed.
- D. Be placed in the flashing mode during periods when it is not desirable to operate the signal, or the signal heads shall be covered, turned, or taken down to indicate that the signal is not in operation.

*Guidance:*

A temporary traffic control signal should be used only if engineering judgment indicates that installing the signal will improve the overall safety and/or operation of the location. The use of temporary traffic control signals by a work crew on a regular basis in their work area should be subject to the approval of the jurisdiction having authority over the roadway.

A temporary traffic control signal should not operate longer than 30 days unless associated with a longer-term temporary traffic control zone project.

For use of temporary traffic control signals in temporary traffic control zones, reference should be made to Section 6F.80.

Note that there is not a requirement that the temporary traffic signal system be designed and set up by a Professional Engineer. However, engineering judgment should be used to determine the proper phasing and timing for all traffic control signal systems.

In summary, temporary or portable signals must meet FHWA requirements for a conventional traffic signal. This includes proper engineering analysis and judgment in:

1. Identifying required signs and markings
2. Meeting requirements for a traffic signal installation
3. Determining phasing and timing

**2.2 Other National Research**

A literature review was conducted as part of the assessment including the review of a study completed by Texas Transportation Institute/Transportation Research Board entitled *An Evaluation of Portable Traffic Signals at Work Zones* (Transportation Research Record 1148). The abstract below summarizes the research:

*“Portable traffic signal systems are now being marketed by several manufacturers. These systems have the potential for replacing flaggers in many work zones that require alternating one-way traffic control. However, because these systems are relatively new, information is needed about*

*their effect on traffic operations and safety at work-zone locations. The Texas Transportation Institute recently conducted studies of a fixed-time portable signal system at three work-zone lane closures on two-lane, two-way highways. At each site, data were collected on traffic volumes, driver noncompliance with the signals, and vehicle stopped delay. The studies showed that a substantial savings in flagger labor costs could be achieved by using a portable fixed-time signal system with only a minimal increase in motorist delay costs. Conservative estimates of the savings at the study sites ranged from \$9 to \$14 per hour. The studies also suggested that the potential for vehicle accidents within the work zone may be higher with portable traffic signals because of occasional driver noncompliance with these signals. The trade-off between this possible increase in vehicular accidents and the reduction in flagger accidents could not be estimated from this research.*

See **Appendix A** for a complete copy of this report.

### **2.3 Existing PennDOT Guidance**

Presently, the Department generally requires a signal application and permit (including drawing) for the use of portable signals. The purpose of the permit includes:

1. Identification of legal permittee (responsible owner).
2. Verification of appropriate traffic control devices (signs and markings per State and Federal requirements) for safe and efficient operation.
3. Verification that operation parameters (green, yellow and red times) meet State and Federal requirements for safe and efficient operation.
4. Provide an official document to prevent improper use of the device.
5. Provide an engineering document to be used in litigation.

PennDOT has developed a standard application, permit, notice of commencement form, specifications, and guidance drawings for portable signals. These requirements are consistent with FHWA (MUTCD Section 6F.80) requirements for traffic signalization.

PennDOT will waive the need for a site specific drawing if the location meets certain thresholds for visibility and volume. Presently, PennDOT does not specifically prohibit portable signals in any particular application provided they can meet state and Federal requirements.

A Department summary of the current application and permit requirements are as follows:

### Existing Portable Signal Requirements and Time Frames

Type of Application	Department Acceptance	Site Visit Required by User	Application Required	Site-Specific Drawing	Permit Required	Notice of Commencement Required	Approximate Time from District Receiving Request
Long-Term Stationary Operation	X	X	X	X	X	X	15 Days
Short-Term Stationary Operation (Standard)	X	X	X	X	X	X	15 Days
Short-Term Stationary Operation (Alternative 1: Manual Operation)	X	X	X			X	72 Hours
Short-Term Stationary Operation (Alternative 2: Non-Compliant Operation)	X	X	X		X	X	15 Days
Short-Term Stationary Operation (Alternative 3: Blanket Permit)	X	X	X		X	X	72 Hours

Date: 6/29/2008

### Existing Practices/Procedures Long-Term Stationary Operation

NOTE: All part of the design process in the development of the PS&E package or highway occupancy permit (HOP) plans.

\* Approximately 15 days is currently required upon submission to PennDOT for approval or suggested temporary traffic control modifications.

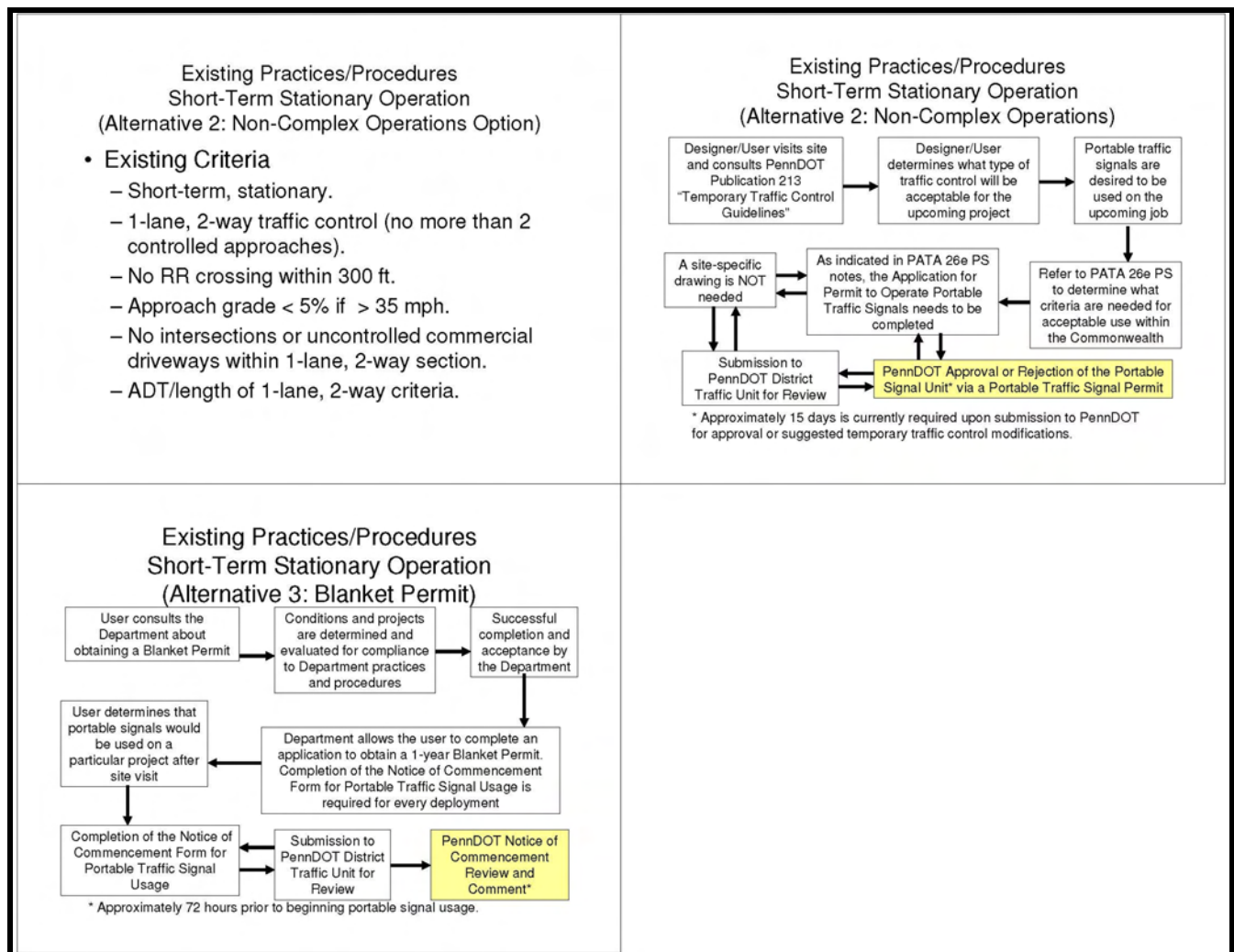
### Existing Practices/Procedures Short-Term Stationary Operation (Standard)

\* Approximately 15 days is currently required upon submission to PennDOT for approval or suggested temporary traffic control modifications.

### Existing Practices/Procedures Short-Term Stationary Operation (Alternative 1: Manual Operation)

\* Approximately 72 hours prior to beginning portable signal usage.





## 2.4 Current State Requirements and Proposed Legislation

There are several state requirements relevant to portable signals including:

- Publication 212 (Regulation)
  - Statue 212.2 (Adoption of Federal standards)
  - Statue 212.3 (Pennsylvania’s Supplement to the MUTCD)
  - Statue 212.4 (Application)
  - Statue 212.5 (Installation and maintenance responsibilities)
  - Statue 212.8 (Use, test, approval and sale of traffic-control devices)
  - Statue 212.12 (Department Publications)
  - Statue 212.401 (General)
  - Statue 212.403 (Temporary traffic-control plans)
  - statue 212.413 (Portable traffic-control signals)
- These regulations are also related to PennDOT Policy located in Publications 111M, 212, 213, 236M, 148M, and 149M.



These requirements require that:

- Legal ownership and maintenance authority be established.
- Traffic signals will be operated in accordance with Federal and State requirements.
- The Department is responsible for ensuring compliance with Federal and State requirements.

Currently, there is pending legislation regarding portable signals including House Bill 2419 and Senate Bill 1428.

The pertinent information in **House Bill 2419** and **Senate Bill 1428** is illustrated below:

*The use of trailer-mounted portable traffic signals shall be considered as an equal alternate to temporary pole-mounted traffic signals for Department projects. All traffic signal systems shall conform to the guidelines set forth in the FHWA MUTCD. Permits shall not be required for use of trailer-mounted portable signal systems. Any contractor seeking to install trailer-mounted portable traffic signal systems shall provide notice to the department within forty-eight (48) hours of signal activation.*

*The use of pedestal-mounted portable traffic signals shall be considered as an equal alternate to all flagger and flagger related traffic control applications. The signal devices shall be authorized for all daily traffic control applications and for continuous operation over multiple days. Pedestal-mounted portable traffic signal shall be authorized for use in the fixed-time, traffic-actuated or manual hand-control modes. The signals shall conform to the guidelines set forth in the FHWA MUTCD. Permits shall not be required for use of pedestal-mounted portable signal systems. Any contractor seeking to install pedestal-mounted portable traffic signal systems shall provide notice to the department within forty-eight (48) hours of signal activation.*

While the legislation promotes compliance with the MUTCD, the language does not require a permit which may limit the Department's ability to provide proper oversight and to ensure safe and efficient movement of traffic. See **Appendix B** for a complete copy of both of these bills.

A meeting was held in January of 2008 with a staff member from Representative Markosek's office, Horizon Signal Technologies, BHSTE, BOMO and Gannett Fleming. The following items were discussed:

- Introductions
- Outline Department commitments for this evaluation study
- Delivered a current progress report
- Discussed upcoming pilot projects
- Discussed future goals and target dates
- A commitment was made to have this study completed in early July 2008

## 2.5 Practices within PennDOT

A survey/interview was distributed to PennDOT staff to gauge their interest and concerns with the use of portable signals. Specifically, the following questions were asked:

- Are portable traffic control signals used in your District?
- Please indicate approved vendors for portable traffic control signals in your District.
- Please indicate all situations where portable traffic control signals may be used in your District.
- How often are portable traffic control signals deployed throughout your District?
- What do you require for permitting?
- When is a site specific drawing required?
- Is an inspection performed?
- Any safety concerns?

The following is a summary of responses

District	Comments
District 1-0 Sue Roach	<ul style="list-style-type: none"> <li>▪ Use them for bridge work</li> <li>▪ District owns one set of trailer-mounted units</li> <li>▪ Permit is issued using a generic drawing</li> <li>▪ Traffic Unit is not present for all turn-ons, but visits during operation</li> </ul>
District 2-0 James Roman, P.E.	<ul style="list-style-type: none"> <li>▪ They are currently used in their district, approx. 6 deployments/year</li> <li>▪ The vendor they deal with is Horizon Signal Technologies</li> <li>▪ They follow Publication 213 for Permitting and Site Specific drawing requirements</li> <li>▪ They perform inspection prior to turn-on</li> <li>▪ District 2-0 has been happy with their use when conditions are applicable</li> </ul>
District 3-0 Laura Lapinski/ Mara Skoczynski	<ul style="list-style-type: none"> <li>▪ Use on emergency, maintenance and construction projects</li> <li>▪ Require permit for use including a site specific drawing</li> <li>▪ Installations are inspected by the Traffic Unit or construction inspectors</li> <li>▪ Cannot interconnect into signal systems</li> <li>▪ District 3-0 prefers dual overhead signals and video detection</li> </ul>
District 4-0 Tom Pichiarella, P.E.	<ul style="list-style-type: none"> <li>▪ Own three sets</li> <li>▪ Good for emergency use</li> <li>▪ Require site specific drawing</li> <li>▪ Concern over programming and sunlight</li> </ul>
District 5-0 Tom Walter	<ul style="list-style-type: none"> <li>▪ Own two sets</li> <li>▪ Require permit for use including a site specific drawing and timings</li> <li>▪ Inspect all deployments</li> </ul>
District 6-0 Ashwin Patel, P.E.	<ul style="list-style-type: none"> <li>▪ Limited usage due to high volume on their roadways.</li> <li>▪ Only one deployment so far</li> <li>▪ They follow Publication 213 for Permitting and Site Specific drawing requirements</li> <li>▪ They perform as inspection at turn-on</li> <li>▪ They have visibility concerns where there is curvature of roadway</li> </ul>
District 8-0 Frank Cavataio	<ul style="list-style-type: none"> <li>▪ Require permit for use including a site specific drawings</li> <li>▪ Inspect all deployments</li> <li>▪ Present at turn-on</li> </ul>

District	Comments
District 9-0 Michael Pastore	<ul style="list-style-type: none"> <li>▪ Require permitting per Publication 213 including a site specific drawing</li> <li>▪ Used 2-3 times per season</li> <li>▪ Inspect before turn-on</li> <li>▪ Visibility of devices and conformance with requirements are concerns</li> <li>▪ Experience with portable signals is that they can only rest in red</li> <li>▪ Experience with portable signals is that multi-phase operations with overlaps are problematic</li> </ul>
District 10-0 Dan Tyger	<ul style="list-style-type: none"> <li>▪ Has deployed portable signals 10 to 15 per year over the last three years</li> <li>▪ Has special provision</li> <li>▪ Require permit for use including a site specific drawing</li> <li>▪ Inspect all deployments</li> <li>▪ Present at turn-on</li> <li>▪ The most active district with regard to usage</li> <li>▪ Drawings and applications are currently being submitted for upcoming projects</li> <li>▪ Used primarily on bridge maintenance projects</li> <li>▪ Video detection and emergency preemption is required on all units</li> </ul>
District 11-0 Ed Miller, P.E., P.T.O.E.	<ul style="list-style-type: none"> <li>▪ Typically used on long-term projects</li> <li>▪ Require permit for use including a site specific drawing and timings</li> <li>▪ Present at turn-on</li> </ul>
District 12-0 Nancy Kolenc, P.E.	<ul style="list-style-type: none"> <li>▪ Typically used on bridge projects, slide repairs and utility work</li> <li>▪ Permit per Appendix A of Publication 213</li> <li>▪ Require site specific details within reason</li> <li>▪ Present at turn-on</li> <li>▪ Have had some issues due to power failure</li> <li>▪ Have also had some vandalism issues</li> </ul>

In general, the following summarizes the data collected from the PennDOT District Offices:

- Most of the District Offices have deployed the trailer-mounted units some time in the last couple of years.
- Most require some type of permitting/documentation process, including a site specific drawing.
- Some sort of inspection/oversight is required during the portable signal system set-up, operation, etc.
- Issues experienced with these systems include: power failures, vandalism, errors with the applications/paperwork, multi-phase operation with overlaps have been problematic, visibility, programming.

Additional information is included in **Appendix C**.

## 2.6 Practices in Other States

A major component of the assessment included research of existing practices and knowledge with regard to the use of portable traffic signals in work zones. The research component included a survey of state DOT's as well as follow-up interviews.

Questions were similar to those asked of PennDOT officials. Interviews were conducted by the consultant team to gather other state unique perspectives and to contact vendor identified references.

Interview questions were as follows:

The Pennsylvania Department of Transportation (PennDOT) is currently acquiring information from other state DOTs regarding policies/procedures for portable traffic control signals. Gannett Fleming has been directed by PennDOT to develop this survey, and to distribute it to your state.

Are portable traffic control signals used in your state?

Please indicate approved vendors for portable traffic control signals in your state.

Please indicate all situations where portable traffic control signals may be used in your state.  
Trailer or Pedestal and what type of work activity

How often are portable traffic control signals deployed throughout your state?

Does your state have a permitting/documentation process for each use?

When is a site specific drawing required?

Is an inspection performed?

Do you have a pre-approval process for vendors/devices?

Enter the estimated number of portable traffic control signal deployments per year by type (trailer or pedestal).

Does your state currently have approved standard specifications for portable traffic control signals?

Does your state currently have approved portable traffic control signal standard drawings or criteria?

Could you please share any issues/concerns your agency has regarding portable traffic control signals?

Survey and/or interview responses were received from twenty-one state agencies including: Nebraska, Alabama, Missouri, Delaware, New Hampshire, Minnesota, Illinois, Rhode Island, Arizona, Iowa, Virginia, Mississippi, West Virginia, Ohio, Oregon, South Carolina, Colorado, Maine, Pennsylvania, Texas and New Jersey.

State	Vendor Ref (Y/N)?	Std Spec (Y/N)?	Permit/ Approval Req'd (Y/N)?	Site Specific Drawing (Y/N)?	Inspection Req'd (Y/N)?	Estimated Usage	Notes
AL	Y	N	N	N	N	Emergency uses	
AZ	-	-	-	-	-	-	Not used
CO	-	-	-	-	-	-	Not used
DE	-	-	-	-	-	-	Not allowed
IA	-	-	-	-	-	-	Not used
IL	Y	Y	N	N	Y	15/Year	Mostly trailer mtd.
ME	Y	N	N	N	N	Rarely used	Not used
MN	Y	Y	N	N	N	10 to 50/Year	Follow MUTCD
MO	Y	N	N	N	N	None given	
MS	N	N	N	N	Y	Occasional	
NE	Y	N	N	N	N	Occasional usage	Utilize actuation only
NH	N	Y	N	N	N	Less than 5/Year	
NJ	N	N	N	Y	Y		
OH	N	N	N	N	N	None given	Used in their state
OR	N	Y	Y	Y	Y	10 to 15/Year	Two-phase/low volume
PA	N	Y	Y	Y	Y	15 to 30/Year	Used trailer mtd. only
RI	-	-	-	-	-	-	Not used
SC	N	Y	N	N	N	2 to 3/Year	Used trailer mtd. only
TX	N	N	N	N	Y	Very seldom	
VA	-	-	-	-	-	-	Not used
WV	N	N	N	N	N	Occasional	

In summary:

- About half the states surveyed use portable traffic control signals. Of these, more than seventy-five percent use primarily trailer-mounted versus pedestal-mounted.
- Most states have limited or occasional deployments (approximate average of 3 to 6 per year).
- **In comparison to the states surveyed, usage of portable signals in Pennsylvania appears equal to or exceeds other states.**
- Very few of the states surveyed had good criteria/standards to share with the study team.
- **About 15 percent of the states have a permitting/documentation process.**
- **Site specific drawings and inspections are required in approximately 50 percent of the surveyed states but most comment that an individual assessment of each site will govern what is required.**
- **Most states are in the process of generating standard guidelines for the use of portable traffic signals since the desire to utilize these devices is increasing.**

Additional information is included in **Appendix D**.

## 2.7 Contractor Perspectives

A survey was also sent electronically to contractors that may have experience with deployments or might consider portable signals on future projects. Questions included:

Has your company used a portable traffic signal system on a PENNDOT project before?

Do you feel that a portable traffic signal system would increase safety versus a flagging operation for the traveling public?

Based on your company's experience with flagger personnel injuries or fatalities due to vehicle accidents, do you feel that additional safety measures need to be required?

Would you support a department requirement to use a portable traffic signal system were applicable versus a flagging operation to increase personnel safety?

Based on your company's experience, do portable traffic signal systems have any cost benefit versus a flagging operation?

Based on your company's experience, how do you feel about the performance portable traffic signal systems versus a flagging operation?

Based on your company's experience, do you feel that portable traffic signal systems are reliable in regards to daily operation?

Survey responses were received from ten contractors including:

- Balfour Beatty, Inc.
- Allan A. Myers, Inc.
- J.D. Eckman, Inc.
- Slusser Brothers, Inc
- The Walsh Group
- Golden Triangle Construction Company
- Eastern Industries, Inc.
- Brayman Construction Corporation
- HRI, Inc.
- New Enterprise Stone and Lime.

Company	Have You Deployed These Devices (Y/N)?	Increase Safety (Y/N)?	Support Department Requirement On Usage (Y/N)?	Cost Effective (Y/N)?	Reliable (Y/N)?
Allan A. Myers	N	Y	Y	N	N
Balfour Beatty, Inc.	N	N	Y	N	Y
Brayman	Y	Y	Y	Y	Y
Eastern Industries	Y	Y	Y	Y	Y
Golden Triangle	Y	Y	Y	Y	Y
HRI	Y	Y	Y	Y	Y
J.D. Eckman	N	Y	Y	N	N
New Enterprise	Y	Y	Y	N	Y
Slusser Brothers	Y	Y	Y	N	Y
The Walsh Group	N	Y	Y	N	N

The feedback received from these surveyed companies included the following:

- Most of these contractors have used portable signal technology on previous projects.
- Most (88 percent) agree that they may increase safety, especially if the flagger is not wearing the proper safety attire or following the proper flagging procedures.
- Most of the companies would use these devices if it became a requirement; however, they all feel that each work site should be assessed independently and cost/payment issues would need to be evaluated.
- 44 percent feel portable signals are cost-effective.
- The companies that have used these devices stated that they worked well with regard to performance.

Detailed responses and associated materials are included in **Appendix E**.

## 2.8 Product Reviews

Portable traffic signal systems were introduced to provide a system that provides automatic traffic operation where workers would manually control traffic with flags and hand held radio communications. These devices claim to increase the safety of the construction zone by removing workers from a potentially dangerous work zone.

These portable signal systems are being used in many states to eliminate flaggers in work zones and other suitable applications. Most of these devices have similar capabilities (pre-emption, back plates, video and microwave detection, indication lights, solar power back-up, LED signal heads, etc.).

An extensive review was conducted to collect information regarding portable signals. Information was obtained from several vendors including:

Vendor	PennDOT Approved Vendor (Y/N)?	Trailer/Pedestal-Mounted Units (Y/N)?	Overhead Mounting Capabilities (Y/N)?	LED Signal Heads (Y/N)?	Detection Capabilities (Y/N)/	Solar Power Backup (Y/N)?
<b>Horizon Signal Technologies</b> <a href="http://www.horizonsignal.com">http://www.horizonsignal.com</a>	Y	Y/Y	Y	Y	Y	Y
<b>OMJC Signal, Inc.</b> <a href="http://www.omjcsignal.com">http://www.omjcsignal.com</a>	Y	Y/N	Y	Y	Y	Y
<b>North America Traffic (formerly RC Flagman, Inc.)</b> <a href="http://www.northamericatraffic.com">http://www.northamericatraffic.com</a>	N (Pending Approval)	Y/N	Y	Y	Y	Y
<b>ADDCO</b> <a href="http://www.addco.com">http://www.addco.com</a>	Y	Y/N	Y	Y	Y	Y
<b>Tower Sign and Signal</b> <a href="http://www.towersignandsignal.com">http://www.towersignandsignal.com</a>	N	Y/N	Y	Y	Y	Y
<b>Georgetown Electric, Ltd.</b>	Y	N/Y	N	Y	Y	N
<b>International Traffic System, Inc.</b>	Y	Y/N	Y	Y	Y	Y

All these vendors manufacture very similar type products with the latest technology (battery, solar power, micro processor, detection capabilities, LED, etc.). The assessment team conducted a field



visit to Horizon Signal Technologies to get a demonstration of their products. This visit provided technical details of their systems as well as the ease of programming the controller units. This trip allowed the assessment team and Horizon Signal Technologies to work out the logistics for the field assessment portion of this study.

In summary, most vendors believe that:

- Portable signals can improve flagger safety.
- Portable signals can save manpower costs.
- Limited permitting/documentation is required.

Additional materials relating to vendor products are included in **Appendix F**.

### 3. Field Evaluations of Pilot Pedestal-Mounted Portable Signal Deployments

Field evaluations of pedestal-mounted signals were conducted at two locations to assess:

- Set-up and deployment
- Turn-on and system fine-tuning
- Operational performance

It should be noted that prior to installation:

- A site visit was conducted prior to installation.
- An application was submitted (approximately 2 to 3 hours each to prepare).
- A site specific drawing was developed (approximately 2 to 3 hours each to prepare).
- A traffic signal permit was obtained.
- Training was provided to the crew on set-up, operation, take down, etc. the day before work commenced.

In addition to above outlined steps performed prior to installation, the following tasks were performed at each evaluated site:

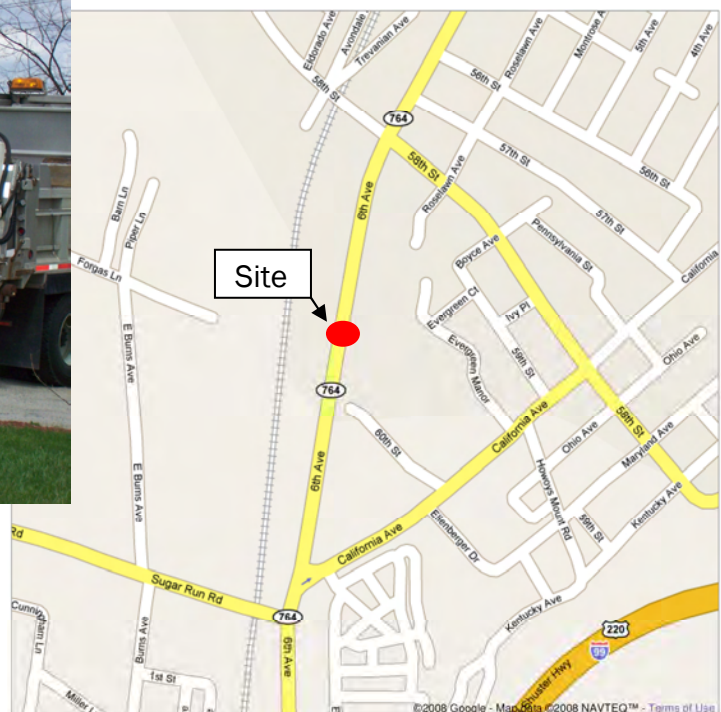
- Maintenance staff deployed and programmed the portable signals.
- Installed Automatic Traffic Recorders to collect volume and speed information, determine throughput for all evaluation modes.
- Videotaped the entire evaluation process (flagging as well as all modes of portable signal operation).
- Each mode (flagging, pre-timed, actuated, and manual portable signal operation) was evaluated for several hours during this field assessment.
- Observed and timed the set-up and takedown process of these devices.
- Obtained digital photos.
- Observed/measured vehicle queues.

### 3.1 Locations

#### 3.1.1 Site 1 – S.R. 0764, Blair County (District 9-0)

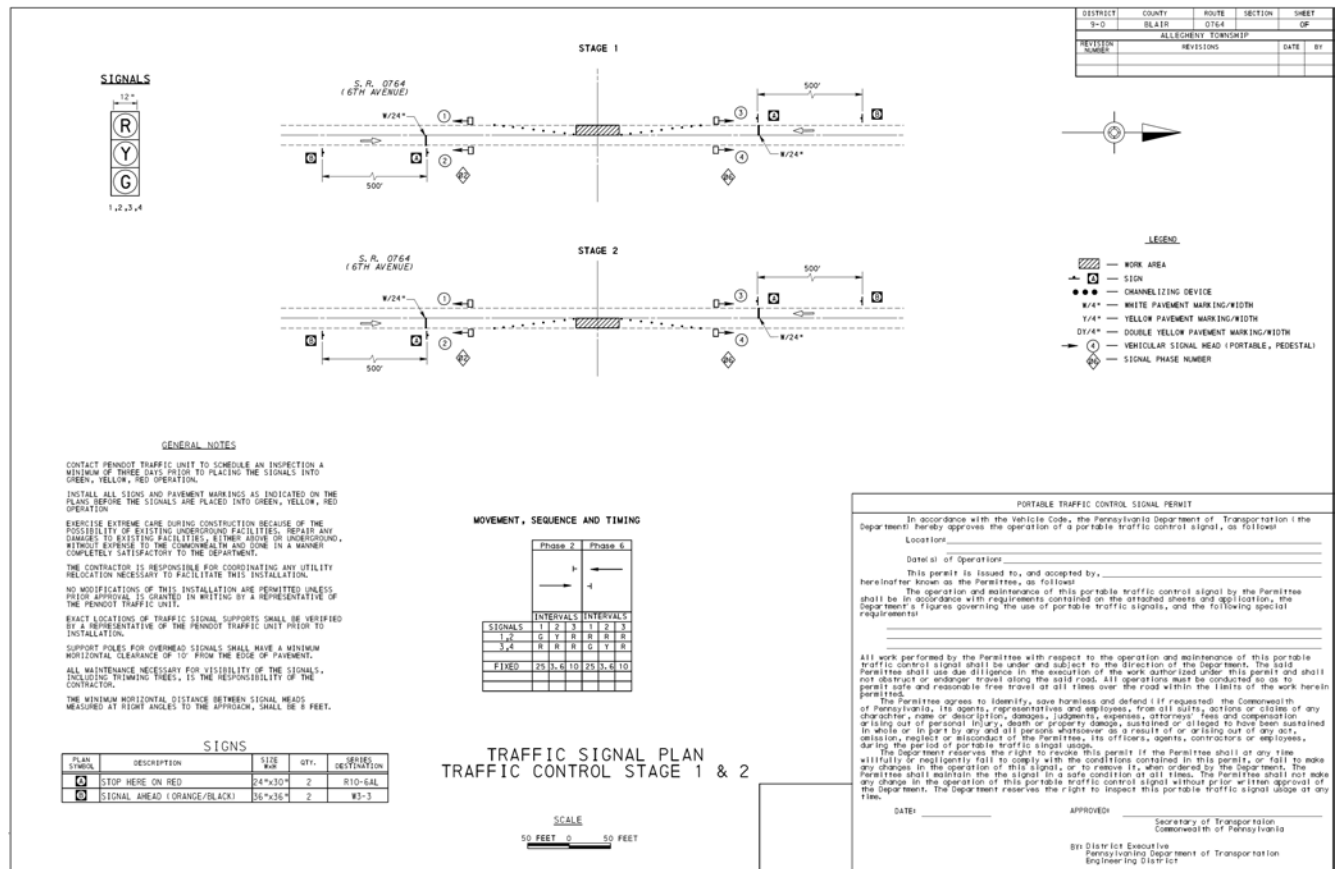
The first evaluated test site was located on S.R. 0764, Blair County in District 9-0 from April 12-14, 2008. This urban two-lane facility, with twelve foot lanes and shoulder widths of four feet or less was selected by PennDOT due to scheduled repair work on the bridge parapet. The sight distance was acceptable for this site with medium to heavy traffic volumes.

**Appendix G** contains preliminary application and information for PennDOT’s Portable Signals. **Appendix H** contains the applications and site specific drawing for each of the test sites.



The following are some statistics about this roadway segment and the use of portable signals:

Work zone length:	400 feet
Average Daily Traffic:	7200 VPD
Work activity:	Bridge repair
Total number of crew members:	8 workers
Speed limit:	35 MPH
Maximum speed through work zone:	25 MPH
Hourly volume:	510 vehicles (Bi-directional)
Signal timing:	
Maximum green time:	60 seconds
Yellow/Red clearance:	4/21 seconds
Violations of signal indications:	0
Number of trapped vehicles observed:	0
Maximum queue length:	11 vehicles (Signal was in pre-timed mode)
Average queue length:	7 vehicles
Average time for set-up:	35 to 50 minutes
Average time for take-down:	10 to 15 minutes



**General Observations:**

- It was essential to investigate signing and signal layout prior to performing work with these devices.
- Training of staff before deployment was beneficial.
- It is critical to check the visibility of all signing and signal displays.
- Avoid close proximity to adjacent intersections; signing and comprehension issues may result.
- Avoid work zones with driveways/intersections.
- Traffic should never be stopped in work zone until first switching to all-red with remote control in work zone.
- Always place signals on flashing yellow during setup.
- Prior to deployment, utilize a capacity analysis program to establish a base green time; clearance interval may be calculated using Publication 149 and Publication 213. The following formula can be used to verify timings in the field:
  - All-Red Clearance interval =  $W + L / 1.47 \times V$ 
    - W= Length of One-Lane, Two-Way Traffic section between Stop Here on Red Signs
    - L = 20 (Length of vehicle)
    - V = Speed of vehicle in Work zone in MPH
- Flagging operation versus the signal operations was very similar especially when the signal was set to actuated/manual mode.
- Signal indication compliance was adhered to during all test periods.
- The foreman and crew liked the portable signal device.
- Queuing did not impact adjacent signalized intersections.

See **Appendix I** for volume and speed data collected during these field assessments.



### 3.1.2 Site 2 – S.R. 0029, Luzerne County (District 4-0)

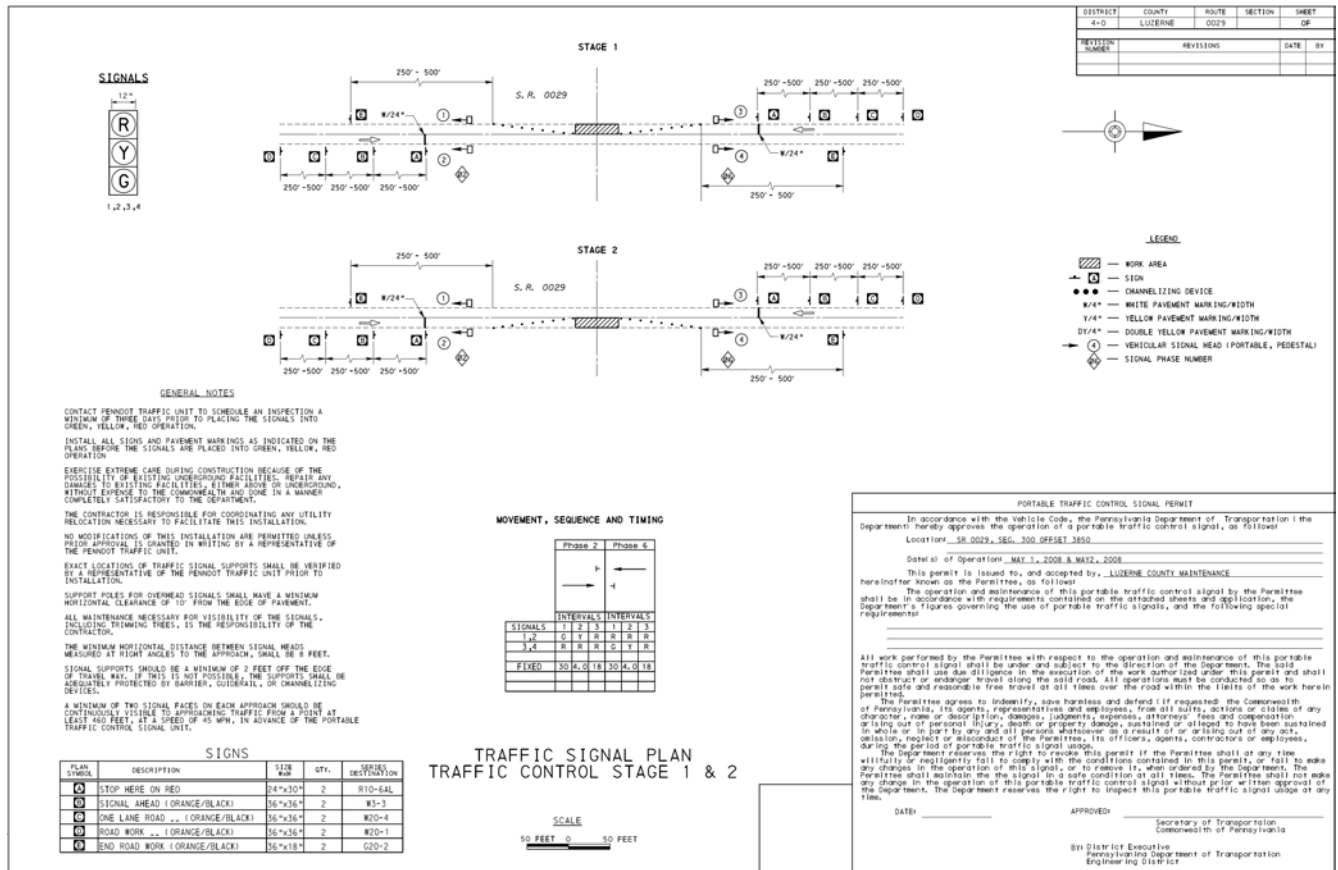
The second evaluated test site was located on S.R. 0029, Luzerne County in District 4-0 on May 12, 2008. This rural two-lane facility, with twelve foot lanes and shoulder widths of three feet or less was selected by PennDOT due to scheduled repair work on the bridge deck. The sight distance was acceptable for this site with low to medium traffic volumes.





The following are some statistics about this roadway segment and the use of portable signals:

Work zone length:	390 feet
Average Daily Traffic:	2800 VPD
Work activity:	Bridge repair
Total number of crew members:	5 workers
Speed limit:	35 MPH
Maximum speed through work zone:	23 MPH
Hourly volume:	206 vehicles (bi-directional)
Signal timing:	
Maximum green time:	40 seconds
Yellow/Red clearance:	4/20 seconds
Violations of signal indications:	0
Number of trapped vehicles observed:	0
Maximum queue length:	6 vehicles (Signal was in Pre-timed mode)
Average queue length:	3 vehicles
Average time for set-up:	30 to 45 minutes
Average time for take-down:	15 to 20 minutes



## General Observations

- Training of staff before deployment was beneficial.
- After switching to portable signal operation, two flaggers were able to assist with bridge repair work, beneficial for a small crew.
- Avoid work zones with driveways/intersections.
- Check visibility of all signing and signal displays.
- Always place signals on flashing yellow during setup.
- Prior to deployment, utilize a capacity analysis program to establish a base green time; clearance interval may be calculated using Publication 149 and Publication 213. The following formula can be used to verify timings in the field:
  - All-Red Clearance interval =  $W + L / 1.47 \times V$ 
    - W= Length of One-Lane, Two-Way Traffic section between Stop Here on Red Signs
    - L = 20 (Length of vehicle)
    - V = Speed of vehicle in Work zone in MPH
- Flagging operation and the portable signal operations were very similar especially when the signal was set to actuated mode.
- Signal indication compliance was adhered to during all test periods.
- The foreman and crew liked the portable signal device.

## 3.2 Summary of Field Observations

Some issues that came out of these test sites are as follows:

### Work Zone Characteristics

- *Visibility of Traffic Control Devices* - For any traffic control device to be effective, the device must be visible and able to convey its message with sufficient time for motorist perception and safe reaction. This same approach applies to portable traffic signals and the MUTCD should be adhered to for height, location and number of signal head requirements. Most of the vendor information specified equipment that was compliant with this Federal document. The trailer-mounted system provides overhead placement of the signal heads and may be more visible to approaching traffic as well as provide consistency with driver expectations versus the pedestal-mounted a system which locates the signal heads on each side of the roadway.
- *Intersecting Streets and Driveways within Work Zone* - Streets and driveways intersecting a work zone create difficulties for portable signal operation as well as for flaggers. These types of situations should be avoided but, if they cannot, assign a crew member the responsibility of alerting workers to any approaching hazard, especially a vehicle.
- *Speed Considerations* - During these field tests, speeds were reduced through the work zone by as much as 25 miles per hour from the posted speed limit. These values should be utilized in computing all-red times to allow for proper work site clearance and avoid any potential head-on collisions. It is imperative that the active one-way work zone is clear of all traffic prior to the opposing direction given the right-of-way.

### Traffic Signal Operation in a Work Zone

When portable signals replace human flaggers, the signal uses a green signal indication to replace the “SLOW” sign paddle of a human flagger. These signals are controlled by specific design logic and allow for multiple options which will be discussed below.

#### Modes of Operation

- *Pre-timed* – In this mode, the portable signals rely on a background cycle length that is composed of the time required for the green, yellow and all-red clearance times on each side of the work zone. This is the most inefficient mode since the timings are not adjusting to changing traffic volume demand.
- *Actuated* – This mode works very similar to the pre-timed operation, but on each side of the work zone the green could be extended longer than the minimum time if multiple vehicles were waiting on the approach through the use of a detection device. We found this mode to be the most efficient automated operation.
- *Manual* – Rather than using automatic cycling mode (i.e., pre-timed or actuated), the signal green time can be manually operated by a work zone crew member. The remote and crew member can also put the signals into an all-red phase (basically stop all approaching traffic) if need be to move equipment or if a potentially hazardous condition exists, etc. This individual can also watch over the work zone and alert fellow workers of any unsafe/hazardous conditions. This mode was very efficient because time was adjusted based on demand by the crew member in the work zone controlling the remote.
- *System Communication* – Communications is necessary between the two controllers that control the ends of the work zone. The wireless technology for our field assessments worked efficiently and allowed for a wireless remote in the work zone to control traffic in the manual mode and to interrupt the normal cycle and put the signal into an all-red phase if needed.

#### Driver Comprehension and Compliance

- One-lane, two-way work zones are often monitored by flaggers. Introducing these portable signals, as part of this field assessment, created the appearance and driver expectation similar to a standard permanent traffic signal.
- No problems were observed with driver compliance.
- It appeared to the study team that most drivers experienced no confusion and were in acceptance of the new traffic control device.

#### Flagger Reaction

- The flaggers were very positive about the use of portable signals; particularly because it removed them from a hazardous position. They also stated that flagging becomes tiring and stressful at times.

#### 4. Findings and Observations

Portable signals provide another acceptable alternative for controlling work zone traffic. Based on the research and evaluations, the following is a summary of considerations of portable signals versus flaggers, temporary signals or AFADs.

System	Portable Signals	Flaggers	Pole-Mounted Temporary Signals	AFADs
Pros	<ul style="list-style-type: none"> <li>Quick deployment</li> <li>Flexibility</li> <li>Less manpower</li> </ul>	<ul style="list-style-type: none"> <li>Responsiveness to unexpected conditions</li> </ul>	<ul style="list-style-type: none"> <li>Visibility</li> <li>Ability to coordinate with other signals</li> <li>Less susceptible to vandalism</li> <li>Less manpower</li> </ul>	<ul style="list-style-type: none"> <li>Work zone awareness</li> <li>Reduced manpower</li> <li>Safer flagger operation through the use of automation</li> </ul>
Cons	<ul style="list-style-type: none"> <li>Visibility, especially pedestal-mounted</li> <li>Mast arm length – ability to place indications overhead</li> <li>Trailer placement in roadway clear zone</li> <li>Ability to accommodate other intersections</li> </ul>	<ul style="list-style-type: none"> <li>Manpower</li> <li>Safety of flaggers</li> </ul>	<ul style="list-style-type: none"> <li>Material availability</li> <li>Ability to adjust configuration</li> </ul>	<ul style="list-style-type: none"> <li>Driver understanding</li> <li>Still requires manpower</li> </ul>
Appropriate Uses	<ul style="list-style-type: none"> <li>Short term stationary work zones</li> <li>Long-term work zones</li> <li>One-lane, two-way traffic control</li> <li>No intersection or commercial driveways within one-way, tow-lane section</li> <li>No RR grade crossing within 300 feet</li> <li>Speed limit of section not to exceed 55 mph</li> <li>Length between stop here on red signs not to exceed 1000 feet</li> </ul>	<ul style="list-style-type: none"> <li>Unique settings</li> <li>Very short-term operations</li> </ul>	<ul style="list-style-type: none"> <li>Intersections</li> <li>Long-term work zones</li> </ul>	<ul style="list-style-type: none"> <li>Portable signal not recommended and crew is limited in size</li> </ul>

All approaches have their benefits as well as their perceived negative impacts. In reality, it is up to the designer, contractor and Department to identify the safest, most efficient and cost-effective strategy for that location.

#### 4.1 Assessment Summary

The developments of reduced power signal technologies (such as light emitting diodes and wireless communications) have made the concept of portable traffic signals realistic. There are several manufacturers that can supply the product with adequate inventory.

Many states are facing similar issues as Pennsylvania. In reality, most states have not had widespread deployments but utilize portable signals on a case-by-case scenario. Applications are becoming very popular for emergency traffic control from natural disasters such as hurricanes,

flooding, tornadoes, etc. Most of these nationwide applications have been trailer-mounted units for emergency long term operations.

In Pennsylvania, several PennDOT Districts have deployed the trailer-mounted units. Performance, reliability, etc. have been adequate but there have been limited instances of power failures occurred, vandalism, operational malfunctions, etc.

Field assessments illustrated that portable signals have an appropriate application, but also that additional deployment, design and operational guidance may be warranted. However, all of these things can be streamlined into the approval process.

Specific design elements of note include:

- Roadways with ADTs greater than 10,000 vehicles per day should be evaluated on a case-by-case scenario.
- Devices were easy to set-up and takedown. The balancing outriggers provided on the pedestal units were helpful for installation of slight/moderate shoulder drop-offs.
- The actuated and manual signal mode was more efficient than the pre-timed mode of signal cycle operation.
- Indicator lights on back of signal heads to denote when the signal displays a red indication is a very good safety measure (standard on Horizon Signal Technologies systems).
- Battery system powered all four devices with no issues.
- Wireless communication operated with no issues.
- Devices had very simple programming of micro-processor controller and the installation/adjustment of microwave detector was very simple.
- No safety concerns/issues were observed during any period of the field assessment efforts.

## 4.2 Costs and Financial Benefits

### 4.2.1 System Costs

A phone call was made to Horizon Signal Technologies regarding the cost of both their trailer-mounted portable signal and pedestal-mounted portable signal systems. The costs for a trailer-mounted and pedestal-mounted system (which would include enough units, signal heads, remotes, controllers, batteries, etc. to control a two-lane, one-way work zone) are approximately \$60,000 and \$35,000, respectively. Detection devices for both of these systems will range from \$1,000/each for microwave (this technology was utilized for the field assessments) and up to \$10,000/each for video detection.

In past correspondence with Horizon Signal Technologies, they stated that they manufactured approximately 500 pedestal- and 2,000 trailer-mounted units or systems over the history of their company. These numbers seem to substantiate the findings of the state survey presented in section 2.5.

#### 4.2.2 Financial Benefits

To replace all flaggers in Pennsylvania with portable signals would have a significant economic impact to the Department, contractors, utility companies, etc. On any given day, the Department has between 300 and 400 flagging operations statewide. It would cost the Department between \$9,000,000 and \$12,000,000 to equip each daily operation, assuming a cost of \$30,000/unit.

However, these work crew members can be displaced elsewhere in the work site to assist the crew in performing these activities. Material cost to buy the units versus a flagger salary would have to be evaluated based on increased productivity in the work zone. Some states, contractors and district offices did state that the overall safety of the work zone would be increased by removing a worker from potential hazardous position of flagging. They also stated that these portable signal devices would not experience the fatigue issues, stress, require breaks, etc.

In practice, the financial benefits are subject to the parties bearing the costs. Some contractors noted that they would use portable signals to enhance work zone and save costs in some locations, but that portable signals may not be the most cost effective strategy in other locations.

#### 4.3 Deployment and Design Guidance

Per Federal and Pennsylvania requirements, portable traffic signals must meet the physical display and operational requirements of conventional traffic signals as specified in the Manual on Traffic Control Devices (MUTCD).

These procedures:

1. Identify the legal permittee (responsible owner)
2. Provide verification of the appropriate traffic control devices (signs and markings per State and Federal requirements)
3. Provide verification that operation parameters (green, yellow and red times) meet State and Federal requirements

The existing level of requirements for short-term, non-complex applications and more complex and long-term applications appear to be appropriate to meet Federal requirements as well as promote safe and efficient operations. However, the required process could be streamlined in order to provide clarity and efficiency. Key suggestions to streamline the application and permitting process include:

- Continue to allow emergency deployments at the Department's discretion.
- Combine the application of use and notice of commencement into one form for short-term, non-complex operations.
  - Allow "blanket approval" of multiple locations provided they are "non-complex."
  - Require acknowledgment of operator responsibility to be compliant with Publication 213 (Work Zone Traffic Control) and the Manual on Uniform Traffic Control Devices.
  - Require acknowledgment of operator responsibility to provide vendor training to staff deploying portable signals.



- Continue to require a site specific application, drawing, permit and inspection for short-term operations with complex conditions and for long-term operations.
- For long-term operations, encourage the design community to identify portable signals as an design alternative to be considered where appropriate on Department construction projects and on Highway Occupancy Permits (HOPs).
  - If portable signals are identified and designed as an acceptable design alternative, continue to accept the work zone traffic control plan as the site specific drawing and require only the combined the application and notice of commencement as noted above.

In summary, the following processes are suggested for consideration:

Classification		Threshold Criteria	Application Requirement	Other Considerations
<b>Emergency Usage</b>		<ul style="list-style-type: none"> <li>▪ Per the discretion of the Department and upon the approval of the Secretary of Transportation or his designee.</li> </ul>		
<b>Short-term, Non-Complex Usage</b>		<ul style="list-style-type: none"> <li>▪ Short-term, stationary operations as defined by Publication 213</li> <li>▪ Low-volume operations – 10,000 ADT or less</li> <li>▪ Limited length – less than 1,000 feet</li> <li>▪ No intersecting side streets</li> </ul>	<ul style="list-style-type: none"> <li>▪ Combined Application and Notice of Commencement for Portable Traffic Control Signal Usage required 72 hours prior</li> <li>▪ Discretionary inspection</li> <li>▪ Blanket approvals for multiple locations</li> </ul>	<ul style="list-style-type: none"> <li>▪ Pedestal permitted</li> <li>▪ Manual, pre-timed, or actuated operation permitted.</li> </ul>
<b>Short-term, Complex Usage</b>	<b>High Volume</b>	<ul style="list-style-type: none"> <li>▪ Greater than 10,000 ADT</li> </ul>	<ul style="list-style-type: none"> <li>▪ Application for Permit to Operate Portable Traffic Control Signals</li> <li>▪ Permit approval – submit at least 15 days prior to start of work</li> <li>▪ Notice of Commencement Form for Portable Traffic Control Signal Usage required 72 hours prior</li> <li>▪ Mandatory inspection</li> </ul>	<ul style="list-style-type: none"> <li>▪ Require capacity analyses and clearance interval timing calculations</li> <li>▪ Require actuation</li> <li>▪ Encourage overhead signals</li> <li>▪ Require battery backup</li> </ul>
	<b>Long Work Zone</b>	<ul style="list-style-type: none"> <li>▪ Locations with work zones greater than 1000 feet in length</li> </ul>	<ul style="list-style-type: none"> <li>▪ Application for Permit to Operate Portable Traffic Control Signals</li> <li>▪ Permit approval – submit at least 15 days prior to start of work</li> <li>▪ Notice of Commencement Form for Portable Traffic Control Signal Usage required 72 hours prior</li> <li>▪ Mandatory inspection</li> </ul>	<ul style="list-style-type: none"> <li>▪ Require capacity analyses and clearance interval timing calculations</li> <li>▪ May require pre-emption</li> <li>▪ Require actuation</li> <li>▪ Encourage overhead signals</li> <li>▪ Require battery backup</li> <li>▪ Require manual operation for work zones exceeding 2000 feet</li> </ul>
<b>Long-Term Usage</b>		<ul style="list-style-type: none"> <li>▪ Long-term operations as defined by Publication 213</li> </ul>	<ul style="list-style-type: none"> <li>▪ Application for Permit to Operate Portable Traffic Control Signals</li> <li>▪ Permit approval – submit at least 15 days prior to start of work                             <ul style="list-style-type: none"> <li>○ Work zone traffic control plan can be used in lieu of a site specific drawing</li> </ul> </li> <li>▪ Notice of Commencement Form for Portable Traffic Control Signal Usage required 72 hours prior</li> <li>▪ Mandatory inspection</li> </ul>	<ul style="list-style-type: none"> <li>▪ Require capacity analyses and clearance interval timing calculations</li> <li>▪ May require pre-emption</li> <li>▪ Require actuation</li> <li>▪ Encourage overhead signals</li> <li>▪ Require battery backup</li> </ul>
<b>Non-allowed Use</b>		Based on research, the following locations may not be appropriate for portable signal applications: <ul style="list-style-type: none"> <li>▪ Multi-lane approaches/work zones</li> <li>▪ Work zones with restricted sight distance</li> <li>▪ Work zones with active rail crossings within 300 feet</li> <li>▪ Work zones with severe grades greater than 5%</li> <li>▪ Work zones with intersections of uncontrolled commercial driveways</li> </ul>		

It is paramount that the Department monitors the safe and efficient use of portable signals, but at the same time efficiently processes applications. By having (existing) standard drawings for non-complex applications, the approval process can be streamlined while providing more detailed review of complex applications.

The assessment team reviewed PennDOT’s pending performance specifications for trailer-mounted and pedestal-mounted portable traffic control signal systems and has found that no major revisions are needed. However, the assessment team suggests that PennDOT revisit this specification yearly to update and streamline the document.

Other suggested actions include:

**Deployment**

- Modify the traffic signal permit and application to emphasize that the liability is on the user of the system.
- Investigate other methods to waive Department liability, especially if oversight is diminished.
- Revisit deployment policy on an annual basis due to evolving technologies.
- Identify in work zone traffic control plans (for larger projects), locations where portable signals may be considered as an alternate to flaggers or pole-mounted temporary signals.
- Consider a “three strikes’ policy prohibiting the use of portable signals by users who do not follow requirements:
  - Prohibit “blanket” usage for one year.
  - Require site specific application for all uses.
  - Require documentation of vendor re-training.

**Design Suggestions**

- Encourage vendors to enhance their products by:
  - Encouraging dual overhead signals
  - Requiring pre-emption in some applications (see above)
  - Requiring actuation in some applications (see above)
  - Requiring battery backup in some applications

**Design Considerations (Trailer- versus Pedestal-mounted)**

- Trailer-mounted portable signal systems are encouraged for the following:
  - Provide overhead signal head placement
  - Both signal heads are placed on same side as the approach lane
  - Vandalism issue are reduced by removing hitches and wheels
  - Stable base with trailer system
  - Larger roadside obstruction
  - Higher wind loading capabilities
- Pedestal-mounted portable signal systems are acceptable as follows:
  - Flexibility in transporting units
  - Easy set-up and takedown for daily operations
  - Both signal heads however are placed on opposite sides of the approach lane
  - Installation on narrow shoulder roadways
  - Smaller roadside obstruction

### Training and Education

- Request FHWA and/or TRB to conduct a national review and to develop Federal policy on portable traffic signal usage.
- Develop a work zone traffic control checklist to assist Department staff in identifying the appropriate locations to use portable signals, temporary signals and flaggers. Train designers to identify portable signals as an acceptable design alternative to flaggers or pole-mounted temporary signals at the appropriate locations.
- Conduct a portable signal workshop at a future Transportation Engineering and Safety Conference. Highlight deployment policy as well as design considerations.
- Continue to have dialogue between the Department, contractors and vendors to discuss portable signal strengths, weaknesses and future opportunities for enhancements.
- Implement a public awareness program to educate motorists on this new technology they may encounter in a work zone versus a flagger.



## Appendix A Evaluation Report on Portable Signals (TRB)

drivers approaching the work zone. Additional motorist delay per hour generated by the portable traffic signals above that incurred (or that would have been incurred) under flagger control is shown in the last column of Table 2. The values for both sites are nearly identical, and amount to less than 0.5 vehicle-hr of additional stopped delay per hour. The large increase in average delay at Site 1 affected only a small number of motorists, whereas the large number of drivers at Site 3 were affected by only a small increase in delay.

The low cost of additional motorist delay at the two study sites was more than offset by the savings in flagger labor costs. As Table 3 shows, fixed-time portable traffic signals provided significant cost savings over the use of flaggers. Computed savings at Sites 1 and 3 amounted to \$9 and \$14 per hour, respectively.

TABLE 3 SUMMARY OF PORTABLE SIGNAL COSTS AND BENEFITS

Site	Cost of Additional Motorist Delay (\$/hr) <sup>a</sup>	Savings in Labor Costs (\$/hr) <sup>b</sup>	Savings Achieved by Portable Signals (\$/hr)
1	3.12	12.00	8.88
3	4.16	18.00	13.84

<sup>a</sup>Based on recent estimates of value of travel time = \$10.40/vehicle-hr (2).

<sup>b</sup>Based on typical wages and benefits of approximately \$6/hr for Maintenance Technician I working for the Texas State Department of Highways and Public Transportation.

The portable signals examined in this study were reported to cost approximately \$8,000 per pair. Using the previous conservative estimates of flagger labor cost savings, the signals would pay for themselves after 1,600 hr of service. Although these comparisons do not include any signal maintenance costs, the system still appears to have been a cost-effective alternative to flagger control at the sites studied.

### Driver Noncompliance with Traffic Signals

One of the major concerns surrounding the use of portable signals in work zones is with whether drivers will obey them. Failure of a driver to obey the signal could lead to a serious head-on collision with an oncoming vehicle within the work zone.

In the following results of the noncompliance data collected at each site, column 1 gives the total number of motorists observed approaching and passing through the work zone, and column 2 gives the number of those vehicles that entered the work zone while facing a red indication. Columns 1 and 2 were then used to generate column 3, the rate of observed non-compliance per 1,000 vehicles.

Site	Vehicles Approaching Work Zone		
	Total No.	No. Running Red	No. Running Red/1,000
1	43	0	0
2	400	2	5
3	500	2	4

Although the rates indicate that noncompliance was not a major problem, the results show that a few vehicles were observed to enter the work zones on the red. These vehicles were stopped by research or work personnel, or both, before they had traveled very far into the site, so no accidents or major conflicts occurred. However, the potential for mishap was obviously present in these instances.

Although not shown, two different types of violations occurred at Sites 2 and 3. The first involved vehicles that initially came to a stop, but then entered the work zone while the light was still red. It appeared that the drivers of the vehicles saw the signals, but then chose to proceed through the work zone on the red even though they could not see completely through the work zone. (As stated previously, at none of the sites was there visibility from one end of the work zone to the other.) This type of noncompliance indicates that some drivers may question the validity of portable signals. It may be possible to improve signal validity by putting out a temporary stop line 50 to 60 ft in advance of the signal, as shown in Figure 1. The stop line identifies where drivers should stop and reinforces the need to stop. Also, a supplemental temporary Stop Here on Red sign (R10-6) (1) may be erected next to the bar to further enforce the need for stopping and add validity to the presence of the signals.

The other type of violation occurring at Sites 2 and 3 involved vehicles that ran the red light and entered the work zone without stopping, which suggests that they never saw the signals. Unfortunately, it may be quite difficult to reduce or eliminate these types of incidents. It was suggested that the manufacturer of the portable signals increase the wattage of the lamp heads in order to make them more visible in daylight. Other attention-getting devices may be available to increase the conspicuity and attention-getting capability of the signals. However, identification and experimentation with these types of devices was beyond the scope of this study.

### SUMMARY

The results have been presented of field studies examining the use of fixed-time portable traffic signals instead of flaggers at work zones requiring alternating one-way traffic control. On the basis of these limited studies, fixed-time signals appear to be a suitable alternative to the use of flaggers for alternating one-way traffic through a work zone. Significant savings in flagger labor costs can be realized with what appears to be a minimum of additional delay costs to motorists. However, the trade-offs between the potentials for reduced flagger accidents and increased vehicle accidents in work zones cannot be accurately estimated at this time. Some supplemental signs and devices have been suggested to reduce the occurrence of motorist noncompliance with the signals, but the devices have not been tested under field conditions.

As the use of portable signals increases and drivers become more accustomed to their presence in work zones, it would be expected that motorist compliance with them would improve. The limited studies documented here can only serve as a starting point to determining the effects of portable signals at work-zone lane closures. Continued research and experience with portable signals will be needed before the full benefits and costs associated with their use are known.



in either direction. At none of the sites was there visibility from one end of the lane closure to the other. The speed limit at each site was posted at 55 mph, with actual travel speeds very close to this value.

The traffic control plan for the sites was similar to that used for flagger-controlled minor work-zone operations (1), except that an orange-and-black symbolic Signal Ahead sign (W3-3) replaced the Flagger Ahead sign in advance of the closure, as shown in Figure 1.

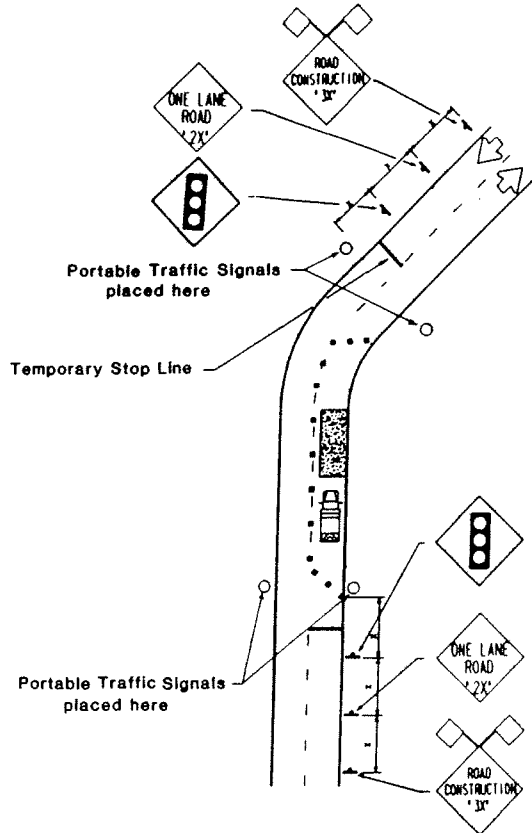


FIGURE 1 Traffic control plan.

### Data Collection and Analysis

A variety of data was collected during the setup and operation of the portable signals, including traffic volume, driver compliance with the signals, and vehicle stopped delay. Delay and compliance data were collected for about 4 hr each day during the time that work was actually being performed in the closed lane.

Stopped-delay data were also collected for flagger control on the first day of the lane closure at Site 3. These data were not available from Sites 1 and 2, which were only one-day operations. However, data collection personnel at Site 1 (average daily traffic of 600) noted that all vehicles approaching the work zone during the time of the portable-signal study were isolated arrivals. It was assumed that flaggers would have allowed these vehicles to pass through the work zone without stopping, because they were the only vehicles present at that particular time. Consequently, averaged stopped delay per vehicle would have been negligible had flaggers been the method of traffic control. Unfortunately, a similar estimation was not

possible at Site 2, because of the greater traffic volumes and longer work zone. Nevertheless, it was possible to compare vehicle stopped delay for flagger-controlled and signal-controlled operation at Sites 1 and 3.

## STUDY RESULTS

### Motorist Delay

One of the advantages to using flaggers is that they are responsive to random vehicle arrivals and gaps in the traffic stream, and can assign traffic movements through the work zone so as to minimize vehicle stops and delays. Fixed-time signals do not react to isolated random vehicle arrivals. Rather, motorist delay under signal control is a function of the timing parameters (cycle length, green phase time, etc.). Consequently, motorist delay should increase at a work zone when fixed-time portable signals are used in place of flaggers. At Site 1, which had low traffic demand, this was found to be the case. Table 2 shows that average stopped delay per vehicle was higher at Site 1 when traffic signals were used.

However, flaggers were not found to have as distinct an advantage over fixed-time signals when traffic demands were greater. As Table 2 shows, average stopped delay at Site 3 was nearly identical for both flagger and signal control. This site was a longer work zone than Site 1 and had dramatically higher traffic demand. Flaggers at Site 3 could not allow vehicles to pass through the work zone as they arrived (as could have been done at Site 1), but instead had to methodically assign traffic movement to one direction and then to the other. In effect, flaggers duplicated the operation of the fixed-time signals. Consequently, average stopped delay per vehicle was very similar for the two types of traffic control. These results indicate that at higher traffic volumes, fixed-time signals at a work-zone lane closure can provide a level of service to drivers comparable with that provided by flaggers. However, when volumes are low, signals may provide a poorer level of service than that attainable with flagger control.

TABLE 2 COMPARISON OF STOPPED DELAY: FLAGGER CONTROL VERSUS FIXED-TIME SIGNAL CONTROL

Site	Hourly Volume	Average Stopped Delay (sec/vehicle)			Added Stopped Delay (vehicle hr/hr)
		Flagger	Signal	Increase	
1	50 <sup>a</sup>	0 <sup>b</sup>	24	24	0.3
3	750 <sup>c</sup>	36	38	2	0.4

NOTE: Site 2 was not used in the comparison of stopped delays because such data were not available (and could not be reasonably estimated) for flagger control.

<sup>a</sup> Approach volume-to-capacity ratio ( $v/c$ ) = 0.13.

<sup>b</sup> Estimated from observed traffic arrivals. No vehicles would have been forced to stop at this location had flaggers been used.

<sup>c</sup>  $v/c$  = 0.9.

Although the quality of service provided to drivers is an important factor to be considered, it is probably more important to examine the impacts of signal control from an economic standpoint. Portable signal systems are designed to be simple and easy to operate, so they require little additional setup time over that necessary to close the travel lane to traffic. Consequently, the primary operating cost associated with using portable signals is the amount of additional delay that it causes

# An Evaluation of Portable Traffic Signals at Work Zones

GERALD L. ULLMAN AND STEVEN Z. LEVINE

Portable traffic signal systems are now being marketed by several manufacturers. These systems have the potential for replacing flaggers in many work zones that require alternating one-way traffic control. However, because these systems are relatively new, information is needed about their effect on traffic operations and safety at work-zone locations. The Texas Transportation Institute recently conducted studies of a fixed-time portable signal system at three work-zone lane closures on two-lane, two-way highways. At each site, data were collected on traffic volumes, driver noncompliance with the signals, and vehicle stopped delay. The studies showed that a substantial savings in flagger labor costs could be achieved by using a portable fixed-time signal system with only a minimal increase in motorist delay costs. Conservative estimates of the savings at the study sites ranged from \$9 to \$14 per hour. The studies also suggested that the potential for vehicle accidents within the work zone may be higher with portable traffic signals because of occasional driver noncompliance with these signals. The trade-off between this possible increase in vehicular accidents and the reduction in flagger accidents could not be estimated from this research.

As a general rule, work-zone lane closures on two-lane, two-way highways require some method of coordinating opposing traffic movements in the remaining open lane (1). Most often this coordination is provided by flaggers stationed at each end of the lane closure. Unfortunately, flagging is a costly method of traffic control, requiring two or more persons continuously for the duration of the closure. In addition, flaggers must work close to moving traffic, which leaves very little room for error by either flagger or driver. Because flagging is such a labor-intensive and hazardous activity, it would be desirable to use other methods of traffic control whenever possible.

Traffic signal systems similar to those installed at intersections have been used in work zones in limited cases as an alternative to the use of flaggers. However, the cost of a traditional traffic signal installation ranges from \$25,000 for a fixed-time system to \$50,000 for a traffic-activated system. Consequently, traffic signals have only been feasible for long-term stationary work operations. As an example, the Texas State Department of Highways and Public Transportation has generally limited the use of traffic signals to lane closures on restricted-width bridges where construction will take 3 months or longer to complete.

Recently, however, several manufacturers have developed and are now marketing portable traffic signal systems. These

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systems are free-standing, self-contained, and easily transportable. They are generally simple to set up and program, and are designed to be adaptable to a variety of situations.

Portable traffic signal systems have the potential for replacing flaggers in many work-zone operations requiring control of alternating one-way traffic. However, because these systems are relatively new, experience with them in actual work-zone application has been limited. Information about the effect of portable signal systems on work-zone safety and traffic operations is needed. The Texas Transportation Institute, as part of a study to improve flagger safety sponsored by the Texas State Department of Highways and Public Transportation, recently completed limited field studies of a portable fixed-time traffic signal system at several work-zone lane closures on two-lane, two-way highways. This paper presents the results of these studies.

## STUDY PROCEDURE

### Site Description

Portable fixed-time traffic signals were tested at three work-zone locations on two-lane, two-way rural highways (without paved shoulders) in Texas. Maintenance work on the roadway surface at each location required that one travel lane be closed. In each case, portable signals were used instead of flaggers to alternate opposing traffic through the one-lane section. The sites chosen for study represented a range of traffic volumes and work-zone lengths, as shown in Table 1. Also shown in Table 1 are the signal timing settings used at each site. Repairs at study Sites 1 and 2 were 1-day work activities, whereas repairs at Site 3 involved two 1-day lane closures. At Site 3, flaggers were used for traffic control on the first day, and signal control was used on the second.

Sites 1 and 2 had sight distances in excess of 1,000 ft to the work zone on both approaches, whereas severe horizontal and vertical geometry at Site 3 limited sight distance to about 500 ft

TABLE 1 SUMMARY OF TRAFFIC VOLUMES, WORK-ZONE LENGTHS, AND SIGNAL TIMING SETTINGS

Site	Traffic Volumes, 1985		Signal Timing Settings (sec)		
	AADT	Work-Zone Length (ft)	Cycle Length	Green Phase	All-Red Clearance
1	600	600	78	10	26
2	2,400	2,600	246	30	90
3	10,000	1,100	140	30	37

NOTE: AADT = annual average daily traffic.

## ACKNOWLEDGMENT

This research was conducted by the Texas Transportation Institute and sponsored by the Texas State Department of Highways and Public Transportation in cooperation with FHWA.

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*The contents of this paper reflect the views of the authors, who are responsible for the facts and accuracy of the data presented. The contents of this paper do not necessarily reflect the official views and policies of FHWA. This paper does not constitute a standard, specification, or regulation.*

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## Appendix B House Bill 2419 & Senate Bill 1428 (Portable Signals)

THE GENERAL ASSEMBLY OF PENNSYLVANIA

HOUSE BILL

No. 2419 Session of  
2008

INTRODUCED BY MARKOSEK AND GEIST, APRIL 2, 2008

REFERRED TO COMMITTEE ON TRANSPORTATION, APRIL 2, 2008

AN ACT

1 Amending the act of June 1, 1945 (P.L.1242, No.428), entitled  
2 "An act relating to roads, streets, highways and bridges;  
3 amending, revising, consolidating and changing the laws  
4 administered by the Secretary of Highways and by the  
5 Department of Highways relating thereto," providing for  
6 erection of traffic-control devices while working; and making  
7 editorial changes.

8 The General Assembly of the Commonwealth of Pennsylvania  
9 hereby enacts as follows:

10 Section 1. Section 102 of the act of June 1, 1945 (P.L.1242,  
11 No.428), known as the State Highway Law, is amended to read:

12 Section 102. Definitions.--When used in this act, the  
13 following words and phrases shall have the following meanings:

14 (1) "State highway" shall mean and include all roads and  
15 highways taken over by the Commonwealth as State highways under  
16 the provisions of any act of Assembly. Unless clearly so  
17 intended, the term shall not include any street in any city,  
18 borough or incorporated town, even though the same may have been  
19 taken over as a State highway.

20 (2) "Rural State highway system" shall mean and include all



1 roads and highways taken over by the Commonwealth as State  
2 highways under the provisions of the act, approved the twenty-  
3 second day of June, one thousand nine hundred thirty-one  
4 (Pamphlet Laws, five hundred ninety-four), act number two  
5 hundred three, entitled "An act establishing certain township  
6 roads as State highways; authorizing their construction,  
7 maintenance, and improvement under certain conditions and  
8 restrictions; limiting the obligation of the Commonwealth in the  
9 construction of certain structures located on such highways;  
10 conferring certain powers upon the Department of Highways and  
11 local authorities, persons, associations and corporations for  
12 sharing the cost of the maintenance and construction of such  
13 highways; and making an appropriation to carry out the  
14 provisions of said act," and its supplements and amendments, and  
15 all other roads and highways specifically designated as rural  
16 State highways.

17 (3) "Department" shall mean the Department of [Highways]  
18 Transportation of the Commonwealth.

19 (4) "Secretary" shall mean the Secretary of [Highways]  
20 Transportation of the Commonwealth.

21 Section 2. The act is amended by adding a section to read:

22 Section 407.1. Erection of Traffic-Control Devices While  
23 Working.--(a) Any person performing any work on or near the  
24 roadway which may create hazards shall erect traffic-control  
25 devices in accordance with the rules and regulations of the  
26 department for the maintenance and protection of traffic. The  
27 regulations of the department shall address the control of road  
28 users through a work zone and shall be an essential part of  
29 highway construction, utility work, maintenance operations and  
30 incident management. All official traffic-control devices

1 erected for maintenance and protection of traffic shall be  
2 removed as soon as practical if they are no longer needed. If  
3 work is suspended for short periods of time, official traffic-  
4 control devices erected for the maintenance and protection of  
5 traffic shall be removed or covered when they are no longer  
6 appropriate.

7 (b) To the extent practicable, the length of the work zone  
8 shall be appropriate to the work in progress so that motorists  
9 do not increase speed after passing through a long stretch with  
10 no sign of work activity.

11 (c) To the extent practical, lane restrictions in all work  
12 zones shall be minimized to prevent traffic congestion and  
13 unsafe traffic conditions.

14 (d) If the department determines that a contractor or any  
15 subcontractor has failed to comply with specifications  
16 prescribed by the department for the control of traffic within a  
17 work zone on a highway within this Commonwealth, a sum of not  
18 less than one thousand dollars (\$1,000) per day shall be  
19 assessed as liquidated damages from money due or to become due  
20 to the contractor.

21 (e) (1) The use of trailer-mounted portable traffic signals  
22 shall be considered as an equal alternate to temporary pole-  
23 mounted traffic signals for all department projects. All traffic  
24 signal systems shall conform to the guidelines set forth in the  
25 Federal Highway Administration Manual on Uniform Traffic Control  
26 Devices. Permits shall not be required for use of trailer-  
27 mounted portable traffic signal systems. Any contractor seeking  
28 to install a trailer-mounted portable traffic signal system  
29 shall provide notice to the department within forty-eight (48)  
30 hours of signal activation.

1       (2) The use of pedestal-mounted portable traffic signals  
2 shall be considered an upgrade to all flagger and flagger-  
3 related traffic control applications. The signal devices shall  
4 be authorized for all daily traffic control applications and for  
5 continuous operation over multiple days. Pedestal-mounted  
6 portable traffic signals shall be authorized for use in the  
7 fixed-time, traffic-actuated or manual hand-control modes. The  
8 signals shall conform to the guidelines set forth in the Federal  
9 Highway Administration Manual on Uniform Traffic Control  
10 Devices. Permits shall not be required for use of pedestal-  
11 mounted portable traffic signals systems. Any contractor seeking  
12 to install a pedestal-mounted portable traffic signal system  
13 shall provide notice to the department within forty-eight (48)  
14 hours of signal activation.

15       Section 3. This act shall take effect in 60 days.

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THE GENERAL ASSEMBLY OF PENNSYLVANIA

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**SENATE BILL**

**No. 1428** Session of  
2008

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INTRODUCED BY MADIGAN, STOUT, PILEGGI, WOZNIAK, RAFFERTY, FUMO,  
MUSTO, RHOADES, WAUGH, STACK AND WASHINGTON, JUNE 2, 2008

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REFERRED TO TRANSPORTATION, JUNE 2, 2008

---

AN ACT

1 Amending the act of June 1, 1945 (P.L.1242, No.428), entitled  
2 "An act relating to roads, streets, highways and bridges;  
3 amending, revising, consolidating and changing the laws  
4 administered by the Secretary of Highways and by the  
5 Department of Highways relating thereto," providing for  
6 erection of traffic-control devices while working; and making  
7 editorial changes.

8 The General Assembly of the Commonwealth of Pennsylvania  
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10 Section 1. Section 102 of the act of June 1, 1945 (P.L.1242,  
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16 the provisions of any act of Assembly. Unless clearly so  
17 intended, the term shall not include any street in any city,  
18 borough or incorporated town, even though the same may have been  
19 taken over as a State highway.

20 (2) "Rural State highway system" shall mean and include all

1 roads and highways taken over by the Commonwealth as State  
2 highways under the provisions of the act, approved the twenty-  
3 second day of June, one thousand nine hundred thirty-one  
4 (Pamphlet Laws, five hundred ninety-four), act number two  
5 hundred three, entitled "An act establishing certain township  
6 roads as State highways; authorizing their construction,  
7 maintenance, and improvement under certain conditions and  
8 restrictions; limiting the obligation of the Commonwealth in the  
9 construction of certain structures located on such highways;  
10 conferring certain powers upon the Department of Highways and  
11 local authorities, persons, associations and corporations for  
12 sharing the cost of the maintenance and construction of such  
13 highways; and making an appropriation to carry out the  
14 provisions of said act," and its supplements and amendments, and  
15 all other roads and highways specifically designated as rural  
16 State highways.

17 (3) "Department" shall mean the Department of [Highways]  
18 Transportation of the Commonwealth.

19 (4) "Secretary" shall mean the Secretary of [Highways]  
20 Transportation of the Commonwealth.

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23 Working.--(a) Any person performing any work on or near the  
24 roadway which may create hazards shall erect traffic-control  
25 devices in accordance with the rules and regulations of the  
26 department for the maintenance and protection of traffic. The  
27 regulations of the department shall address the control of road  
28 users through a work zone and shall be an essential part of  
29 highway construction, utility work, maintenance operations and  
30 incident management. All official traffic-control devices

1 erected for maintenance and protection of traffic shall be  
2 removed as soon as practical if they are no longer needed. If  
3 work is suspended for short periods of time, official traffic-  
4 control devices erected for the maintenance and protection of  
5 traffic shall be removed or covered when they are no longer  
6 appropriate.

7 (b) To the extent practicable, the length of the work zone  
8 shall be appropriate to the work in progress so that motorists  
9 do not increase speed after passing through a long stretch with  
10 no sign of work activity.

11 (c) To the extent practical, lane restrictions in all work  
12 zones shall be minimized to prevent traffic congestion and  
13 unsafe traffic conditions.

14 (d) If the department determines that a contractor or any  
15 subcontractor has failed to comply with specifications  
16 prescribed by the department for the control of traffic within a  
17 work zone on a highway within this Commonwealth, a sum of not  
18 less than one thousand dollars (\$1,000) per day shall be  
19 assessed as liquidated damages from money due or to become due  
20 to the contractor.

21 (e) (1) The use of trailer-mounted portable traffic signals  
22 shall be considered as an equal alternate to temporary pole-  
23 mounted traffic signals for all department projects. All traffic  
24 signal systems shall conform to the guidelines set forth in the  
25 Federal Highway Administration Manual on Uniform Traffic Control  
26 Devices. Permits shall not be required for use of trailer-  
27 mounted portable traffic signal systems. Any contractor seeking  
28 to install a trailer-mounted portable traffic signal system  
29 shall provide notice to the department within forty-eight (48)  
30 hours of signal activation.

1       (2) The use of pedestal-mounted portable traffic signals  
2 shall be considered an upgrade to all flagger and flagger-  
3 related traffic control applications. The signal devices shall  
4 be authorized for all daily traffic control applications and for  
5 continuous operation over multiple days. Pedestal-mounted  
6 portable traffic signals shall be authorized for use in the  
7 fixed-time, traffic-actuated or manual hand-control modes. The  
8 signals shall conform to the guidelines set forth in the Federal  
9 Highway Administration Manual on Uniform Traffic Control  
10 Devices. Permits shall not be required for use of pedestal-  
11 mounted portable traffic signals systems. Any contractor seeking  
12 to install a pedestal-mounted portable traffic signal system  
13 shall provide notice to the department within forty-eight (48)  
14 hours of signal activation.

15       Section 3. This act shall take effect in 60 days.





## Appendix C PennDOT Surveys and Feedback

1. PENNDOT District 11 Traffic Signals Unit
2. Yes
3. Both, typically used for long term construction projects.
4. Contractor is required to do a temporary traffic signal permit drawing showing the layout and timings.
5. Since we only use these for long term projects, we prefer to see a site specific drawing.
6. Yes, someone from the signals unit is present during the turn on.
7. No.
8. We've generally had good results with these types of devices when installed properly.

***Ed***

Edward M. Miller, P.E., PTOE  
Senior Civil Engineer Supervisor-Traffic  
PENNDOT 11-0  
45 Thoms Run Road  
Bridgeville, PA 15017  
(412) 429-4970  
(412) 429-4978 (fax)

-----Original Message-----

**From:** Chabak, Eugene M. [mailto:[echabak@GFNET.com](mailto:echabak@GFNET.com)]

**Sent:** Friday, April 25, 2008 1:42 PM

**To:** [jaroman@state.pa.us](mailto:jaroman@state.pa.us); [mskoczynsk@state.pa.us](mailto:mskoczynsk@state.pa.us); [ASHPATEL@state.pa.us](mailto:ASHPATEL@state.pa.us); [edmille@state.pa.us](mailto:edmille@state.pa.us); [NKOLENC@state.pa.us](mailto:NKOLENC@state.pa.us)

**Subject:** Portable Signal Survey

Good afternoon,

As part of the Portable Signal Survey effort that Gannett Fleming is working on with PennDOT Central Office, can each of you please take a few moments and provide brief answers to the following questions which will help us pull together the final evaluation report:

1. What Department do you represent?
2. Are Portable Signal Systems allowed for use in your district?
3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc.
4. What is the permitting/documentation process for each use?
5. When is a site specific drawing required?
6. Do you or someone in your district perform an inspection?
7. Has your district experienced any safety concerns/issues with the use of these devices versus flagging operation?
8. Other comment you would like to provide.

What Department do you represent? **District 10-0**

2. Are Portable Signal Systems allowed for use in your district? **Yes**
3. If yes, trailer or pedestal? **Trailer** What types of project are they being deployed at construction, utility work, maintenance, etc. **Construction/Maintenance type projects**
4. What is the permitting/documentation process for each use? **Permit and project drawings**
5. When is a site specific drawing required? **Always**
6. Do you or someone in your district perform an inspection? **Inspect at turn-on**
7. Has your district experienced any safety concerns/issues with the use of these devices versus flagging operation? **No**
8. Other comment you would like to provide. **10 to 15 deployments this year**

What Department do you represent? **District 9-0**

2. Are Portable Signal Systems allowed for use in your district? **Yes**
3. If yes, trailer or pedestal? **Trailer** What types of project are they being deployed at construction, utility work, maintenance, etc. **Construction/Maintenance type projects**
4. What is the permitting/documentation process for each use? **Permit and project drawings**
5. When is a site specific drawing required? **Always**
6. Do you or someone in your district perform an inspection? **Inspect during operation**
7. Has your district experienced any safety concerns/issues with the use of these devices versus flagging operation? **No**
8. Other comment you would like to provide.

What Department do you represent? **District 8-0**

2. Are Portable Signal Systems allowed for use in your district? **Yes**
3. If yes, trailer or pedestal? **Trailer** What types of project are they being deployed at construction, utility work, maintenance, etc. **Constuction/Maintenance type projects**
4. What is the permitting/documentation process for each use? **Permit and project drawings**
5. When is a site specific drawing required? **Always**
6. Do you or someone in your district perform an inspection? **Present for all turn-ons**
7. Has your district experienced any safety concerns/issues with the use of these devices versus flagging operation?
8. Other comment you would like to provide. **May own a couple units in the future**

Please see District 6-0 Responses in red below.

-----Original Message-----

**From:** Patel, Ashwin

**Sent:** Wednesday, June 25, 2008 9:23 AM

**To:** Farley, Daniel P

**Cc:** Anastasiadis, Emmanuel; Miele, Matthew; Belmonte, Louis

**Subject:** RE: Portable Signal Evaluation

See below in red

**Ashwin Patel, P.E.**

Signals and Safety Manager

7000 Geerdes Blvd

King Of Prussia, PA 19406

Ph No 610-205-6567

Fax No 610-205-6598

email: [ashpatel@state.pa.us](mailto:ashpatel@state.pa.us)

-----Original Message-----

**From:** Farley, Daniel P

**Sent:** Wednesday, June 25, 2008 8:44 AM

**To:** Patel, Ashwin

**Cc:** Laubach, William

**Subject:** Portable Signal Evaluation

Good morning Ashwin,

Below are questions being conducted for a portable signal evaluation being conducted by Gannett Fleming. Unfortunately they need this information as soon as possible, so try your best to answer the questions.

- Are portable traffic control signals used in your district? **Yes, but we have not had any request recently.**
- Please indicated approved vendors for portable traffic control signals in your district? **No central office does that.**
- Please indicated all situations where portable traffic control signals may be used in your district? **No one has blanket permit and our county maintenance office does not have any units. We have not used them on any bridge project. Mostly used by utility companies but due to complexity (i.e. AADT, Driveways/intersections) in our districts it is not widely deployed.**
- How often are portable traffic control signals deployed throughout your district? **Not often, we are only aware of one location so far.**
- What do you require for permitting? **As indicated in 213 and 212.**
- When is a site specific drawing required? **If not in accordance with 213.**
- Is an inspection performed? **Yes during the initial turn on.**
- Any safety concerns? **Visibility due to curves and driveways requires field view for each instance.**



What Department do you represent? **District 5-0**

2. Are Portable Signal Systems allowed for use in your district? **Yes**
3. If yes, trailer or pedestal? **Trailer** What types of project are they being deployed at construction, utility work, maintenance, etc. **Maintenance type projects**
4. What is the permitting/documentation process for each use? **Permit and project drawings**
5. When is a site specific drawing required? **Always**
6. Do you or someone in your district perform an inspection? **All deployments are inspected**
7. Has your district experienced any safety concerns/issues with the use of these devices versus flagging operation?
8. Other comment you would like to provide. **Need good timing information**

What Department do you represent? **District 4-0**

2. Are Portable Signal Systems allowed for use in your district? **Yes**
3. If yes, trailer or pedestal? **Trailer** What types of project are they being deployed at construction, utility work, maintenance, etc. **Maintenance type projects**
4. What is the permitting/documentation process for each use? **Permit and Generic CADD drawings**
5. When is a site specific drawing required? **Always**
6. Do you or someone in your district perform an inspection? **Site visit during operation**
7. Has your district experienced any safety concerns/issues with the use of these devices versus flagging operation?
8. Other comment you would like to provide. **Visibility and programming issues**

What Department do you represent? Department of Transportation, traffic signals unit, District 3-0

2. Are Portable Signal Systems allowed for use in your district? Yes
3. If yes, trailer or pedestal? Trailer What types of project are they being deployed at construction, utility work, maintenance, etc. We have used these on Emergency projects, Maintenance, and Construction projects where setting temporary poles was not feasible.
4. What is the permitting/documentation process for each use? Permit application, authorized Permit sheet, Letter and drawings
5. When is a site specific drawing required? Always
6. Do you or someone in your district perform an inspection? Anyone in the traffic signals section or the DTE will perform the signal inspections. On occasions we have allowed construction inspectors to review the work.
7. Has your district experienced any safety concerns/issues with the use of these devices versus flagging operation? We use the portable signals sparingly, the only concern we have is that we need to hard wire interconnect between signals. All other interconnects were problematic in our district.
8. Other comment you would like to provide. District 3-0 requires two overhead signals over the travel lane and video detection.

- Are portable traffic control signals used in your district? **Yes**
- Please indicated approved vendors for portable traffic control signals in your district?  
**Horizon Signal Technologies**
- Please indicated all situations where portable traffic control signals may be used in your district? **All requests reevaluated on a case by case basis and an engineering judgment is made if the use is acceptable.**
- How often are portable traffic control signals deployed throughout your district?  
**Approximately 6 units/year (More frequently being used (1 every 6 weeks approximately))**
- What do you require for permitting? **Requirements of PennDOT Publication 213**
- When is a site specific drawing required? **Requirements of PennDOT Publication 213**
- Is an inspection performed? **Yes all inspections are performed prior to turn on for safety and operational concerns**
- Any safety concerns? **None, District 2-0 has been happy with their use when the conditions are acceptable.**

What Department do you represent? **District 1-0**

2. Are Portable Signal Systems allowed for use in your district? **Yes**
3. If yes, trailer or pedestal? **Trailer** What types of project are they being deployed at construction, utility work, maintenance, etc. **Construction projects**
4. What is the permitting/documentation process for each use? **Permit and Generic CADD drawings**
5. When is a site specific drawing required? **Depends on complexity**
6. Do you or someone in your district perform an inspection? **Site visit during operation**
7. Has your district experienced any safety concerns/issues with the use of these devices versus flagging operation?
8. Other comment you would like to provide. **Not properly completed paperwork**

What Department do you represent? I represent District 12-0 out of Uniontown.

2. Are Portable Signal Systems allowed for use in your district? Yes, but we have not used any pedestal signals yet.
3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc. Bridge replacement projects, slide repairs, and utility work. Bridges and slides are Department Construction projects. The utility work has been highway occupancy permits. We have had a request from a contractor on a Department project to use them for pipe replacements and also a request for Department Maintenance forces to use one to signalize a bridge that had been weight restricted and narrowed to one lane. Neither of these were completed due to topography or lack of operational equipment.
4. What is the permitting/documentation process for each use? We use Appendix A of Pub 213. Once we approve a drawing a memo is sent to the applicant. They are asked to contact us when they are ready to activate the signal. We attend the signal turn-on, check timings, and make adjustments if necessary. The permit is issued after turn-on with a checklist, if applicable.
5. When is a site specific drawing required? Up to this point, yes. We do not usually come across an application where all the criteria from the application are met.
6. Do you or someone in your district perform an inspection? We do at the initial turn-on but after that the contractor is responsible to check the unit and assure every thing is operational and the batteries are sufficiently charged.
7. Has your district experienced any safety concerns/issues with the use of these devices versus flagging operation? Yes. Signals have stopped working due to non-charging of batteries. There have been other problems but we are seldom told of problems that occur with the units until we asked at a later date. Then the construction personnel do not really know the specifics of what was wrong. We have also had other problems with vandalism in the past.
8. Other comment you would like to provide. See attached memo I received from one of our construction ACES. I had emailed them to get any input on the use of the portables. He referred to them as “temporaries” but they are “portables”.

## Appendix D Surveys and Interviews with Other States



Henry Wickes  
Traffic Operations Division  
TxDOT

Let's Discuss the Future of Transportation at the 3rd  
Annual Texas Transportation Forum, April 20-22, 2008.  
For more information, visit  
[www.TexasTransportationForum.com](http://www.TexasTransportationForum.com).

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please reply immediately to the sender pointing out the  
error, and delete the message. This message may also  
contain personal opinions of the author and should not be  
considered as an official TxDOT policy or opinion.

>>> "Chabak, Eugene M." <echabak@GFNET.com> 4/25/2008 12:57  
PM >>>  
Good afternoon,

As part of the Portable Signal Survey effort that  
Gannett Fleming is working on with the Pennsylvania  
Department of Transportation Bureau of Highway Safety and  
Traffic Engineering, can each of you please take a few  
moments and provide brief answers to the following  
questions which will help us pull together the final  
evaluation report:

1. What Department of your agency do you  
represent? Traffic Operations Division
2. Are Portable Signal Systems allowed for  
use in your  
state? Yes, for one-lane two-way control for construction,  
and maintenance
3. If yes, trailer or pedestal? What  
types of project

are they being deployed at construction, utility work, maintenance, etc. Trailer

4. What is the permitting/documentation process for each use? In construction plans, a standard plan sheet and plan note requiring their use. When maintenance forces use them they install as directed by their supervisor, an engineer.

5. When is a site specific drawing required? Has not been required to my knowledge.

6. Do you or someone in your agency perform an inspection? All projects have a Construction inspector, he would inspect or have a signal technician inspect the installation.

7. Do you have a pre-approval process for vendors/devices? Yes

8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation? None that I have been made aware of.

9. Other comment you would like to provide. We have some concerns with these systems. Most of them do not use a NEMA, Type 170, or 2070 controller. These systems need to have some sort of interconnect. We have seen some that were not interconnected but made use of a clock, we do not accept systems that do not have an interconnect. Many use radio interconnect and can be set up at excessive distances. We have seen some units that passing semi trucks interrupt the radio causing loss of communications. Since they are trailer mounted they are susceptible to vandalism and theft.

If you have further questions regarding this please call ((512) 506-5125) or email.

1. What Department of your agency do you represent?  
**Manager, Traffic Signal and Safety Engineering**  
**(Responsible for traffic aspects of project design and construction)**
2. Are Portable Signal Systems allowed for use in your state?  
**Yes.**
3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc.  
**Both are used, primarily for alternating (one-way) traffic stages during bridge construction.**
4. What is the permitting/documentation process for each use?  
**Included in plans and specs. on project basis.**
5. When is a site specific drawing required?  
**Always.**
6. Do you or someone in your agency perform an inspection?  
**Typically at initial energization.**
7. Do you have a pre-approval process for vendors/devices?  
**Yes. New products screening.**
8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation?

**+ Eliminates the 24/7 man-power and worker exposure.**

**- Driveways within excessively large project lengths create conflicts that are difficult to resolve.**

**- Can severely queue traffic and create motorist diversions.**

9. Other comment you would like to provide.  
**Very limited use of these due to NJ's high volume roadway characteristics.**

What Department of your agency do you represent? DelDOT, Traffic Section.

2. Are Portable Signal Systems allowed for use in your state? They are allowed, but not currently used, nor have they been used in the recent past. Many years ago, I believe DelDOT had at least one portable signal system set up. We have one project in design that we are considering a temporary signal installation, but no portable signal projects/contracts in the works that I know of.
3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc. n/a
4. What is the permitting/documentation process for each use? For the temporary signal, we had the project designer submit a signal warrant and LOS analysis for review and approval. If that goes ahead, a signal plan would be developed similar to a permanent signal plan. The plan and a resolution would be signed by the Chief Traffic Engineer. I would assume we would follow a similar process for a portable signal.
5. When is a site specific drawing required? Always, I assume.
6. Do you or someone in your agency perform an inspection? Yes, we have signal construction inspectors who would inspect temporary/portable devices.
7. Do you have a pre-approval process for vendors/devices? We have on-call contractors for permanent/temporary signals we would use. For a portable signal, we would advertise a material contract, and buy devices off of that contract. There would be no pre-approval process - they just have to meet the applicable specs.
8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation? n/a
9. Other comment you would like to provide. The closest thing we have is that we recently advertised a material contract for portable CCTV cameras.

- What Department of your agency do you represent? [Traffic Engineering- HQ office](#)
2. Are Portable Signal Systems allowed for use in your state? [Yes](#)
  3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc. [Trailer; construction, emergency construction](#)
  4. What is the permitting/documentation process for each use? [During emergency bridge repair, the portable signals were rented by SCDOT; no permits were required; for a private job, an encroachment permit would be required;](#)
  5. When is a site specific drawing required? [If sketch is always required, however field adjustments are typically made.](#)
  6. Do you or someone in your agency perform an inspection? [So far, the District Traffic Engineer and District Signal Superintendent has supervised/inspected the set up.](#)
  7. Do you have a pre-approval process for vendors/devices? [We have a specification; see attached.](#)
  8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation? [No](#)
  9. Other comment you would like to provide.

[Please contact myself or Dan Campbell 803-737-1646 for more information.](#)

[V. Carol Jones, PE](#)

[Traffic Signal & Systems Engineer](#)

[SCDOT - Traffic Engineering](#)

[P.O. Box 191](#)

[Columbia, SC 29202](#)

[803-737-1050](#)

[803-351-3769 cell](#)

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## Survey Results -- Overview

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### Portable Traffic Control Signal Survey

**Respondents:** 23 displayed, 23 total

**Status:** Open

**Launched Date:** 12/28/2007

**Closed Date:** N/A

**Display:**

[Manage Filters](#) 0 filters

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**1.** Please enter the following contact information for the individual(s) in charge of portable signals

	Response R	Total	F
<a href="#">view</a> Name		24	
<a href="#">view</a> Organization		24	
<a href="#">view</a> Phone number		24	
<a href="#">view</a> E-mail		24	
<b>Total Respondents</b>			
(skipped this question)			

**2.** Are portable traffic control signals used in your state?

	Response Respons	Total	Percent
Yes		13	130%
No		1	10%
<b>Total Respondents</b>			<b>10</b>
(skipped this question)			13



**3.** If No, please briefly explain why they are not used.

No responses were entered for this question.

**Total Respondents** **0**  
(skipped this question) 23

**4.** Please indicate approved vendors for portable traffic control signals in your state.

	<b>Trailer Mounted</b>	<b>Pedestal Mounted</b>	<b>None Approved</b>	<b>Respos Total</b>
ADDCO	100% (5)	0% (0)	0% (0)	<b>5</b>
Enterprise Flasher Company	0% (0)	0% (0)	100% (5)	<b>5</b>
Georgetown Electric	20% (1)	20% (1)	60% (3)	<b>5</b>
Horizon Signal Technologies	100% (5)	20% (1)	0% (0)	<b>5</b>
International Traffic Systems	0% (0)	20% (1)	80% (4)	<b>5</b>
K & K Systems	0% (0)	0% (0)	100% (5)	<b>5</b>
OMJC Signal	60% (3)	0% (0)	40% (2)	<b>5</b>
R.C. Flagman	40% (2)	20% (1)	40% (2)	<b>5</b>
Ver-Mac	0% (0)	0% (0)	100% (5)	<b>5</b>
			<b>Total Respondents</b>	<b>3</b>
			(skipped this question)	20

**5.** Please list other approved vendors not included in Question 4.

View responses to this question [view](#)

**Total Respondents** **8**  
(skipped this question) 15

**6.** Please indicate all situations where portable traffic control signals may be used in your state.

	<b>Construction</b>	<b>Maintenance</b>	<b>Utilities</b>	<b>Other</b>	<b>None</b>	<b>Respos Total</b>
Trailer Mounted	81% (13)	62% (10)	38% (6)	19% (3)	0% (0)	<b>16</b>
Pedestal Mounted	45% (5)	45% (5)	27% (3)	9% (1)	9% (1)	<b>11</b>
						<b>Total Respondents</b>
						(skipped this question) 13

**7.** How often are portable traffic control signals deployed throughout your state?



		<b>Response Total</b>	<b>Response Percent</b>
Rarely		<b>4</b>	<b>44%</b>
Occasionally		<b>8</b>	<b>89%</b>
Routinely		<b>1</b>	<b>11%</b>
		<b>Total Respondents</b>	<b>9</b>
		(skipped this question)	14

**8.** Enter the estimated number of portable traffic control signal deployments per year.

View responses to this question [view](#)

<b>Total Respondents</b>	<b>11</b>
(skipped this question)	12

**9.** Does your state currently have approved standard specifications for portable traffic control signals?

		<b>Response Total</b>	<b>Response Percent</b>
Yes		<b>8</b>	<b>100%</b>
No		<b>4</b>	<b>50%</b>
		<b>Total Respondents</b>	<b>8</b>
		(skipped this question)	15

**10.** Does your state currently have approved portable traffic control signal standard drawings or criteria?

		<b>Response Total</b>	<b>Response Percent</b>
Yes		<b>5</b>	<b>62%</b>
No		<b>7</b>	<b>88%</b>
		<b>Total Respondents</b>	<b>8</b>
		(skipped this question)	15

**11.** Could you please share any issues/concerns your agency has regarding portable traffic control signals.

View responses to this question [view](#)

<b>Total Respondents</b>	<b>7</b>
(skipped this question)	16

**12. #**

		<b>Response Total</b>	<b>Response Percent</b>
Yes		<b>11</b>	<b>122%</b>
No		<b>2</b>	<b>22%</b>
		<b>Total Respondents</b>	<b>9</b>
		(skipped this question)	14

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## Ohio

1. What Department of your agency do you represent?  
Ken Linger  
Ohio Department of Transportation  
Work zone  
Central office
2. Are Portable Signal Systems allowed for use in your state?
  - a. Yes
3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc.
  - a. Trailer and portables allowed. Mainly trailers, but desire for pedestals is becoming more common.
  - b. Nothing that prohibits usage, but developing guidelines.
  - c. Do not see a future use for short-term (daily) operations.
  - d. Concerned over spacing.
  - e. More prevalent now that LEDs and solar is more prevalent.
  - f. Past usage was in culvert replacements and spacing was around 200 feet.
  - g. Mainly long term, but some districts take liberties in permitting usage.
4. What is the permitting/documentation process for each use?
  - a. An issue on the horizon, is how to permit short-term usage, In the past, just has to meet Ohio MUTCD which was vague.
  - b. Have a standard drawing for specific projects, but limited standard drawing coverage for daily short-term applications.
  - c. In the past, this caused issues due to spacing guidelines.
5. When is a site specific drawing required?
  - a. No.
6. Do you or someone in your agency perform an inspection?
  - a. No.
7. Do you have a pre-approval process for vendors/devices?
  - a. Yes.
8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation?
  - a. Exceeding desired spacing.
  - b. Developing standard guidelines.
  - c. Developing guidelines that prohibit automated modes in AFADS.
  - d. Manual controlled automated flagging is different than portable signals because there is still manual oversight.

Summary - Ohio is facing similar issues and have similar views if there is manual oversight of automated systems versus full automation. The challenge is how to assess and permit short-term applications when the Department has limited resources and the private side wants to use.

## Nebraska

1. What Department of your agency do you represent?  
Bob Simard  
Nebraska Department of Roads  
Central Office  
Traffic signal engineer  
1500 Nebraska Hwy. 2  
Lincoln, NE 68509  
Phone: (402) 479-4594  
Email: [bsimard@dor.state.ne.us](mailto:bsimard@dor.state.ne.us)
2. Are Portable Signal Systems allowed for use in your state?
  - a. Use trailer mounted for short-term, single lane closures
  - b. Use Horizon and ADDCO
  - c. Own a couple units.
  - d. Extendable arms/ 12" heads
3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc.
  - a. Use trailer only portable signals. Do not use pedestal portable units, but does not see a real issues.
  - b. More short-term by own maintenance forces. Longer term applications are typically, true temporary signals.
4. What is the permitting/documentation process for each use?
  - a. Own staff allowed to use for general purposes with analyses of signal timings by Central Office staff
  - b. Do not use contractor algorithms.
  - c. Field verify and adjust.
5. When is a site specific drawing required?
  - a. Have standard drawing for typical applications.
  - b. May require a special drawing for unique applications.
  - c. Have used them up to 1500 feet, but not the preference.
6. Do you or someone in your agency perform an inspection?
  - a. No Central Office inspection for Department usage, but inspection of others.
  - b. Would assess all long-term applications.
7. Do you have a pre-approval process for vendors/devices?
  - a. Horizon and ADDCO are preapproved.
8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation?
  - a. Prefer signals because they do not fall asleep, but flaggers can control efficiency of operations better.
  - b. Mainly automated operation. Do not use with manual control.
  - c. Had near head-on Platt River bridge

Summary – More of a short-term application using standard drawings and central office timing evaluation. Most applications are trailer only. Long term applications are typically true temporary signals. Portables could be used. Mostly two-lane roads.

1. What Department of your agency do you represent? Traffic Division within Missouri DOT

2. Are Portable Signal Systems allowed for use in your state? Yes

3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc. The trailer mounted portable signal systems (PSS) are allowed to be used on work zone operations and can be use both day and night operations. We are in the process to allow the smaller units for work zone operations, in lieu, of flaggers, AFADS.

4. What is the permitting/documentation process for each use? Construction and Utility - The contractor must provide literature at the pre-construction meeting that their units meet the specifications. If the units do not meet, then the contractor will need to find a different unit that can meet the specifications. Maintenance - MoDOT has a statewide bid for the trailer mounted signals.

5. When is a site specific drawing required? Normally, the designers will provide temporary traffic control plans that show the use within the project.

6. Do you or someone in your agency perform an inspection? The MoDOT construction inspector normally checks the units before and after installation.

7. Do you have a pre-approval process for vendors/devices? No. For internal use, MoDOT has a statewide bid.

8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation? To my knowledge, I have not heard of any issues or concerns.



## Illinois

1. What Department of your agency do you represent?  
Aaron Weatherholt, P.E.  
Illinois Dept. of Transportation  
Central office  
Traffic operations – traffic signals and some work zone issues  
2300 Dirksen Parkway  
Springfield, IL 62764  
Phone: (217) 782-2076  
Email: [Aaron.Weatherholt@illinois.gov](mailto:Aaron.Weatherholt@illinois.gov)
2. Are Portable Signal Systems allowed for use in your state?
  - a. Yes
3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc.
  - a. Both units are allowed.
  - b. Bridge reconstruction is the primary use. – Mostly trailers
  - c. Not too much short-term usage.
  - d. Have standards.
4. What is the permitting/documentation process for each use?
  - a. Standard-wide special provision upon statewide approval. Device standards not engineering standards.
  - b. Pedestals can be used if they meet signal standards.
  - c. Contractor is required to analyze timings for each application.
  - d. No apparent issues with the contractor algorithms.
5. When is a site specific drawing required?
  - a. Plans may be required. Near right and far left.
  - b. Do not use for short-term.
  - c. Would allow pedestal types if it meets their policies. Number of heads, controllers, conflict monitors.
6. Do you or someone in your agency perform an inspection?
  - a. Yes.
  - b. Each district has staff that review the installation.
  - c. Drawing may not be required, but inspection is.
7. Do you have a pre-approval process for vendors/devices?
  - a. No.
8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation?
  - a. As long as it is appropriate based on inspection and approval.
9. Other
  - a. Fair amount of trailer usage, but limited pedestal usage.

Summary - Short-term usage is limited; however for both short and long term, processes still must be followed. Mostly two-lane roads.

## Alabama

1. What Department of your agency do you represent?  
Lamar Boyd  
Alabama Department of Transportation  
Traffic signals  
Test new equipment  
Part of Central Office  
521 Traffic Operations Drive  
Montgomery, AL 36110  
Phone: (334) 242-6404  
Email: [boydl@dot.state.al.us](mailto:boydl@dot.state.al.us)
2. Are Portable Signal Systems allowed for use in your state?
  - a. Not a lot of usage. Used for emergencies only.
  - b. Some lanes closure such as on a bridge.
3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc
  - a. Trailer mounted – SQ3 model
  - b. Tim Taylor (State Traffic Engineer) would need to answer permitted usage. Number is 334-242-6275.
4. What is the permitting/documentation process for each use?
5. When is a site specific drawing required?
6. Do you or someone in your agency perform an inspection?
  - a. Local traffic engineer would provide input on timings.
7. Do you have a pre-approval process for vendors/devices?
  - a. Yes – On the DOT website
8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation?

Summary – Mainly used for emergency applications. Mostly two-lane roads.

May 1, 2006

APPROVED: MED. IV, 2006  
Division Administrator  
By: David B Law

TRAILER MOUNTED FEDERAL HIGHWAY ADMINISTRATION  
PORTABLE TRAFFIC SIGNAL SYSTEM

**1. General:**

This specification shall state the minimum requirements of all trailer mounted portable traffic signal systems utilized and placed into operation on all roadways in the state of South Carolina.

The portable traffic signal system is a temporary traffic control device for controlling the flow of traffic in single lane two-way traffic locations and at intersections. The system shall have no less than 2 individual units linked together through either radio controlled, hard wired, or microwave communications to comprise the system. The portable traffic signal system shall comply with the requirements of the MUTCD and shall be installed and utilized as designated by these Supplemental Specifications, the Standard Specifications, the Plans, and the Engineer.

**2. Requirements:**

**A. Signal Heads:** Each trailer mounted portable traffic signal shall contain 2 signal heads. Each signal head shall contain standard ITE approved signal indications with a minimum diameter of 12 inches. Each signal indication, including the arrow indications, shall be independently illuminated and shall emit a single color; red, yellow, or green. Illuminate each signal indication with light emitting diodes (LED's). The typical arrangement of the signal indications shall comply with the MUTCD.

**B. Signal Head Placement:** The bottom of a signal head and any related attachments located over a travel lane shall have a minimum distance of 15 feet above the pavement. The top of the signal head shall not exceed a distance of 25.5 feet above the pavement.

The bottom of the signal head of the lower signal shall have a minimum distance of 8 feet above the grade elevation of the travel lane.

**C. Controller:** The controller shall be an electronic unit housed in a weatherproof, rust resistant box, with a keyed lock and a light for night operation. The unit shall have a jack that will allow direct communications between the on-board controller and an IBM compatible personal computer. This unit shall also have an LCD display screen that will allow the operator to review the status of the system.

All radio communications between multiple trailer mounted units shall comply with all FCC regulations.

The controller shall provide default modes for the system to operate in when necessary. The default modes shall be "Red Flash" and "Yellow Flash". Failure of the controller, such as a power loss and total shut down of the system, shall require removal of the signal system from the roadway. When the system enters into a default mode or total shut down, the system shall have the capability to provide notification to the personnel responsible for the system status by contacting the pager(s) of the responsible personnel.

**D. Operational Requirements:** The portable signal system shall have the capability to operate in either a fixed timed mode, a vehicle actuation mode, or a remote control mode. In the fixed timed mode the system will operate in accordance with preset times programmed into the controller by the operator. In the vehicle actuation mode the system will operate in accordance with information inputs received from vehicle detectors. In the remote control mode the system will operate in accordance with information inputs received from a manual radio remote control unit.

When operating in the actuation mode, the system shall have the capability for pre-timed operation, traffic actuated operation, a variable green time interval dependent upon vehicle actuations, and programmable yellow clearance and red clearance intervals.

**E. Power Source:** The signal shall operate at an optimal voltage of 12 VDC. The system shall obtain the electrical power necessary for operation from the battery system, a 12 VDC power source supplied by solar power, or an adaptable 110 VAC or 120 VAC power source. Utilizing a portable generator for a power source is prohibited.

Equip each signal that is capable of utilizing a 110 or 120 volt AC power source with ground fault interrupting circuit breakers. Accomplish all AC power adaptations with UL approved equipment and methods.

**F. Trailer and Accessories:** Each trailer shall be properly equipped in compliance with South Carolina Law governing motor vehicles. The minimum requirement for lights and reflectors shall include turn signals, dual tail lights, and brake lights. The trailer shall be equipped with Safety chains meeting SAE J-697 standards. Both the trailer and the signal supports shall be painted Federal Standard No. 595, Orange No. 12246.

Each trailer shall be equipped to minimize overturning from wind and various terrain conditions when in the operating position. Equip each trailer with 4 crank type leveling jacks.

**3. Method of Measurement:** The Department will pay for each trailer mounted portable traffic signal unit at the contract unit price bid.

**4. Basis of Payment:** Payment shall be full compensation for providing, installing, removing, and relocating as necessary, operating, and maintaining the trailer mounted portable traffic signal system. Payment shall include furnishing all labor, hardware, equipment, tools, incidentals, and any miscellaneous items necessary for installing, operating, and maintaining the system.

flash is not less than half nor more than two-thirds of the total flash cycle.

17. The controller has circuitry which will detect low voltage and prevent the occurrence of an unsafe signal indication. This "brown out" circuit will hold the signal safe until adequate voltage is resumed. If a microprocessor is utilized, appropriate circuitry is included that will reset the processor when needed while holding the signal in a safe all red condition. When the processor is removed from the circuitry, the signal will default to a safe condition or flashing all red.

18. If the portable traffic signal utilizes radio transmission equipment:

a. Furnish non-licensed transmitters that are an accepted FCC-type and do not exceed 1 watt output per FCC Part 90.17. Comply with all specific limitations noted in FCC Part 90.17.

b. Furnish portable traffic signals that will display flashing all red in case of radio interference or failure.

c. If an FCC license is required, the Contractor will keep a copy of the license on file and provide a copy to the Engineer.

inaccessible to unauthorized access and protected by a sturdy lockable metal enclosure.

6. Signal supports consist of sturdy brackets attached to a trailer. Design the erected assembly to solidly support the roadside signals at the specified heights and be designed for 80 mph (128 km/h) wind loads. Signal head configurations for each approach are one signal post mounted at 8 feet (2.4 m) minimum height to the bottom of the housing of the vehicle signal face on the right side of the road plus another signal cantilever mounted over the right-hand traffic lane at a minimum height to the bottom of the housing of the vehicle signal face of 15 feet (4.6 m); or two signal heads, each post mounted at 8 feet (2.4 m) minimum height to the bottom of the vehicle signal face on both sides of the road. The lateral spacing between signals is not less than 8 feet (2.4 m).
7. The trailer and supports are orange.
8. The signal heads are yellow.
9. The controller portion of the portable traffic signal meets 633.07.
10. The portable traffic signal is capable of operating in manual, fixed time and traffic actuated modes.
11. The controllers for the portable traffic signal system electronically communicate to each other by cable, radio or other method approved by the Engineer.
12. It is not be possible even under manual control (1) to program the yellow clearance interval for less than 3 seconds or (2) for the green interval to be displayed for less than 5 seconds.
13. All timing intervals are capable of being set in increments of one second or less.
14. The controller provides a variable all red clearance interval from 0 to 600 seconds.
15. The portable traffic signal provides a method for insuring that the pairs of signal heads cannot display conflicting indications. This includes at least a system which will identify, as a conflict, the display of a green in one direction while (1) displaying green in the conflicting direction, (2) displaying a yellow in the conflicting direction or (3) displaying the all-red clearance interval for a conflicting approach. Further, a controller will be determined to be in conflict if a displayed green is less than 5 seconds or a displayed yellow is less than 3 seconds. Upon determination that a conflict exists, all signal heads must display flashing red as described in criteria 16.
16. The controller provides a red flash cycle that is flashed continuously at a rate of not less than 50 nor more than 60 times per minute. The illuminated period of each

**STATE OF OHIO  
DEPARTMENT OF TRANSPORTATION**

**SUPPLEMENTAL SPECIFICATION 961  
PORTABLE TRAFFIC SIGNALS**

**OCTOBER 30, 2003**

<b>961.01</b>	<b>Description</b>
<b>961.02</b>	<b>Prequalification</b>
<b>961.03</b>	<b>Requirements</b>

**961.01 Description.** This Supplemental Specification sets forth the requirements for portable traffic signals. A portable traffic signal is a self-contained traffic signal mounted on a trailer.

**961.02 Prequalification.** Furnish portable traffic signals that are prequalified in accordance with Supplement 1050.

**961.03 Requirements.** Furnish portable traffic signals that conform to the following criteria:

1. The portable traffic signal conforms to all Ohio Manual of Uniform Traffic Control Devices requirements for traffic control signals including Section 4D.20 which in part states, "A temporary traffic control signal shall meet the physical and operational requirements of a conventional traffic control signal."
2. Each signal head has three 12 inch ( 300 mm ) vehicular indications (red, yellow, green) and their candlepower distributions are not less than specified for standard 12 inch ( 300 mm ) signals in the Institute of Transportation Engineers' Standard for Adjustable Face Traffic Signal Heads.
3. The portable traffic signals may be powered by engine driven generator, solar or stored battery charge system. Design the portable traffic signals to provide electrical energy which will maintain the above described candlepower distribution for at least 24 hours at full output.
4. The dimming of a portable traffic signal, in a yellow flashing operation at night, is permitted in accordance with the Ohio Manual of Uniform Traffic Control Devices. The unit may include a photocell and circuitry which will permit the yellow lens light output to be reduced by up to 50 percent during night hours. The amount of dimming and the choice of not dimming is operator selectable.
5. The signal unit generator battery and electronic controls are completely



# 616.13 Crossovers, Temporary Connections and Detours

## From Engineering Policy Guide



The plans provide for the construction of crossovers or temporary connections for handling traffic where other means of traffic control are not available. The plans show complete details for constructing necessary crossovers or connections, including alignment, typical sections and grading and surfacing quantities.

### Figures

Crossovers on Divided Highways

One-Lane Two-Way Operation

Temporary connections used at the terminus of divided lane facilities temporary median crossovers

bypasses, crossovers or connections: anticipated posted speed of the approach roadway, anticipated posted speed of the temporary facility, approach roadway width and the type of construction which requires the temporary facility. This important element of design is addressed by the core team.

Drainage structures under temporary facilities are designed for a two-year flood frequency where the facility will carry fewer than 400 vpd. Drainage structures for facilities with traffic volumes of 400 vpd or more are designed for a five-year flood frequency. Temporary bridges are designed for a ten-year flood frequency, and are to be coordinated with Bridge.

The plans provide for the obliteration of all temporary facilities that do not become a part of the completed project, including the removal of drainage structures and facility surfaces. For payment, the components (aggregate, drainage, grading, etc.) of each bypass, crossover and temporary connection are calculated and the quantities added into the plans. Since the cost for removing and obliterating temporary facilities is significant, consideration is given to utilizing or enhancing existing facilities in lieu of constructing temporary facilities. Refer to appropriate figures in 903 Highway Signing.



**Temporary bridge**

Any proposed detour route must be evaluated to determine the condition of the pavement, capacity of the roadway and geometrics. Sometimes existing city streets and county roads can be improved for use as detours. If other agencies' facilities are used, an agreement with the agency having jurisdiction over the roadway will be required. Outer roadways may be constructed early in the project phasing or enhanced to serve as detours. Refer to detour signing details.





County Road

## Contents

- 1 616.13.1 Temporary Two-Lane, Two-Way Operations
- 2 616.13.2 Temporary One-Lane, Two-Way Operations
- 3 616.13.3 Temporary Connections
- 4 616.13.4 Temporary Median Crossovers for Construction Equipment

### 616.13.1 Temporary Two-Lane, Two-Way Operations

A temporary two-lane, two-way operation (head-to-head traffic) on one side of a normally divided highway is generally limited to rural locations. When head-to-head traffic is being considered, Design is contacted for concurrence. This type of traffic management may be used only after all of the following criteria are addressed and documented:

- The benefit/cost of the two-lane, two-way operation compares favorably to the benefit/cost of other potential traffic control options (e.g., alternate routes, temporary lanes, construction staging, use of shoulders, etc.). The analysis is to include both construction and road user costs associated with each option.
- A capacity analysis of the two-lane, two-way operation confirms this type of traffic management can reasonably accommodate the traffic volumes without detrimental delay to travelers.
- The median shoulder width must be adequate for emergency stopping.

When a two-lane, two-way operation is used, the TCP must include provisions for separating opposing traffic throughout the length of the operation with temporary concrete traffic barrier or channelizing devices as shown on Standard Plans 616.10 ([http://www.modot.mo.gov/business/standards\\_and\\_specs/documents/61610.pdf](http://www.modot.mo.gov/business/standards_and_specs/documents/61610.pdf)) and 617.20 ([http://www.modot.mo.gov/business/standards\\_and\\_specs/documents/61720.pdf](http://www.modot.mo.gov/business/standards_and_specs/documents/61720.pdf)), respectively, except when the two-lane, two-way operation is located on an urban travelway and the posted speed limit prior to construction is less than 45 mph. The speed limit for head-to-head traffic is based on Standard Plan 616.10. At these locations, all obstructions or fixed objects shall have protection provided for both directions of travel. This may require providing temporary installations of impact attenuators or crash cushions for guardrail, bridge ends, barrier walls, etc. on what would normally be the downstream side of the obstruction.

Crossovers constructed to facilitate two-lane, two-way operation are designed for speeds not less than 10 mph below the posted speed limit prior to construction, unless unusual site conditions exist. Crossovers are located where horizontal and vertical alignments provide sufficient sight distance.

For payment, the components (aggregate, asphalt, drainage, grading, etc.) of each crossover are calculated and the quantities added into the plans.

### 616.13.2 Temporary One-Lane, Two-Way Operations

Temporary one-lane, two-way operations are to be considered on a case-by-case basis. One-lane, two-way operations are avoided when hourly volumes exceed 600 vehicles per hour. When hourly volumes exceed 600 vehicles or conditions in

the following subsections cannot be met, the core team is to consider alternative construction methods, such as night work, shoulder improvements for maintaining two-way traffic, time restrictions for lane closures, construction during off-peak hours, detours, diversions, etc. Permitted one-lane, two-way operations include using flaggers, flaggers with pilot vehicles, automated flagger assistance devices (AFADs) ([http://mutcd.fhwa.dot.gov/res-interim\\_approvals.htm](http://mutcd.fhwa.dot.gov/res-interim_approvals.htm)) with operator or work zone traffic signals.

AFADs are portable traffic control systems that assist a flagger operation for a short-term lane closures on two-lane highways. In a typical flagging operation, the AFADs can be used to replace one or both flaggers. A flagger shall operate one or both AFADs by a radio control unit. If the flagger controls both AFADs on either side of the work zone, the flagger may be located away from the roadway. The primary benefit of the AFADs is the safety enhancement to the flaggers. MoDOT specifies the use of the Type B (Red/Yellow Lens) AFAD.

**616.13.2.1 Flagger Control.** Flagger control is used to control traffic when two-lane, two-way operations will be restored during non-working hours. Generally, flagger segments are not longer than 2 miles (3.2 km). The maximum length is specified on the TCP so the contractor can properly stage the work. For moving operations, such as resurfacing, a third set of signs as described in Signing for One-Lane, Two-Way Resurfacing Operations is also provided. Pilot vehicles may be specified to supplement flaggers when the length of the one-lane, two-way operation exceeds one-half mile. In addition to the normal flagger sign series, a vehicle mounted GO20-4 “Pilot Car Follow Me” sign and GO20-4a “Please Wait for Pilot Car” sign shall be used in pilot vehicle operations. The “Please Wait for Pilot Car” sign shall be placed at all roads within the length of the one-lane, two-way operation not controlled by a flagger. AFADs, while not specified, may be used by the contractor. No direct payment is made for flagger control, AFADs or pilot vehicles, with the exception of signs and other traffic control devices shown in the Figure 616.2.6.



**616.13.2.2 Traffic Signal Control.** Traffic signals are used for bridgework and other construction work on two-lane roadways when two-lane, two-way operation will not be restored during non-working hours. Work zone traffic signals (WZTS) as specified in Sec 616 ([http://www.modot.mo.gov/business/standards\\_and\\_specs/Sec0616.pdf](http://www.modot.mo.gov/business/standards_and_specs/Sec0616.pdf)) are used when the work area requires only two-phase signal operation. Specification of WZTS allows the contractor to use either temporary or portable traffic signals. Figure 616.2.6 shows typical layouts for signal control.

For locations requiring three- or more phase signal operation, temporary traffic signals as specified in Sec 616 are used and designed to meet the traffic control needs at the location. Wood pole span wire signals are used for temporary signals. It is not necessary to itemize components, but the traffic control plans are to include proposed pole and signal controller locations, type of signal heads, signing and signal phasing.

Lighting is provided for any one-lane, two-way traffic operation when WZTS are specified in the contract. A 150-watt luminaire mounted at 30 ft. is required on each approach for temporary traffic signals. At each portable traffic signal location, approved overhead lighting providing an average maintained intensity of 0.6 footcandles (6.5 lux) is required.

The item(s) specified, per each, for WZTS and temporary traffic signals consist of one unit at both ends of each one-lane,

two-way operation.

### 616.13.3 Temporary Connections

Temporary connections are provided on the plans as required to connect improvements to existing surfaces, and to connect lanes at the termini of divided lane facilities. Temporary connections will usually be used by traffic longer than such items as bypasses and are therefore designed to a higher standard.

**616.13.3.1 Surfacing.** Temporary connections are usually surfaced with the same surface type as that used on the improvement being planned. An exception is that, where concrete pavement is used, reinforcement and base may be omitted. Temporary connections constructed with concrete pavement are jointed along the edges of main traffic lanes in such manner that the ultimate removal of the connection will be simplified and can be accomplished without disturbing the through pavement.

**616.13.3.2 Alignment.** Temporary connections are usually constructed using a minimum radius of 1920 ft. Specific conditions may merit the use of flatter or sharper curves. Temporary connections used at the terminus of divided lane facilities are constructed using reversed curves with a minimum radius of 1920 ft. Temporary connections may be designed with or without superelevation.

**616.13.3.3 Location.** Temporary connections are located in such manner that will provide good sight distance for traffic approaching the connection and in such manner that drainage structures required for the connections are held to a minimum. The required sight distance for traffic approaching temporary connections is twice the stopping sight distance based on design speed. These sight distance requirements are the same as those tabulated in 233.2, At-Grade Intersections with Stop and Yield Control.

### 616.13.4 Temporary Median Crossovers for Construction Equipment

Temporary median crossovers on divided highways are considered when construction equipment will be crossing the median. A typical example is an equipment entrance from a borrow area. Temporary median crossovers may also be considered when existing crossovers or interchanges within the vicinity of the work zone do not exist.

If temporary median crossovers are provided for construction equipment, the locations and layouts are shown on the TCP. Guidance for temporary median crossovers is available.

Retrieved from "[http://epg.modot.org/index.php?title=616.13\\_Crossovers%2C\\_Temporary\\_Connections\\_and\\_Detours](http://epg.modot.org/index.php?title=616.13_Crossovers%2C_Temporary_Connections_and_Detours)"

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## SECTION 1063

### TEMPORARY TRAFFIC CONTROL DEVICES

**1063.1 Scope.** This specification covers material to be used for temporary traffic control devices.

**1063.2 General Requirements.** All temporary traffic control devices shall be manufactured as shown on the plans and as specified, in accordance with MUTCD requirements and shall be NCHRP 350 compliant. Nominal dimensions will be permitted for dimensional lumber where applicable. All temporary traffic control devices shall exhibit good workmanship and shall be free of objectionable marks or defects that affect appearance or serviceability. The brand name or model number shall be permanently identified on each traffic control device.

**1063.3 Channelizers and Tubular Markers.** All channelizers and tubular markers shall be manufactured from a non-metallic material, pigmented and molded of a Highway Orange color throughout and stabilized against fading by ultraviolet or other light rays by the incorporation of adequate inhibitors. Drum-like channelizers shall be closed-top. Retroreflective marking, as shown on the plans, shall be in accordance with [Sec 1042](#) and ASTM D 4956, Supplemental Requirements, Section S2. Retroreflective marking on cones will not be required.

#### 1063.4 Signs.

##### 1063.4.1 Rigid Signs.

**1063.4.1.1 Sign Substrate.** All signs shall be fabricated of substrate designed to provide satisfactory structural rigidity.

**1063.4.1.2 Sign Sheeting.** All signs shall have a retroreflectorized background. Retroreflective sheeting shall be in accordance with [Sec 1042](#), Type 3 or fluorescent orange, as shown on the plans. Sheeting shall be applied to the sign substrate in accordance with the manufacturer's recommendations and the surface shall be free of air bubbles, wrinkles or other blemishes as determined by the engineer.

##### 1063.4.2 Roll-up Signs.

**1063.4.2.1 Sign Substrate.** Sign and overlay blanks shall consist of fluorescent orange microprismatic retroreflective sheeting sealed to a heavy-duty coated fabric or vinyl material. The sheeting shall have a minimum coefficient of retroreflection, expressed as candelas per footcandle per square foot (candelas/lux/m<sup>2</sup>), as shown below, when measured in accordance with ASTM E 810. The color specifications shall be in accordance with ASTM D 4956. Material shall be submitted by the manufacturer to NTPEP for a minimum exposure time of one year. Results shall be published by NTPEP and available for MoDOT review. For all NTPEP test decks, weathered material shall be within the color specification limits.

<b>Minimum Coefficient of Retroreflection for Fluorescent Orange Sheeting</b>		
<b>Observation Angle, Degrees</b>	<b>Entrance Angle, Degrees</b>	<b>Candelas/footcandle/ft<sup>2</sup> (Candelas/lux/m<sup>2</sup>)</b>
0.2	-4	200
0.2	+30	100
0.5	-4	80
0.5	+30	30

**1063.4.2.2 Overlays.** Overlays, when used, shall be mechanically fastened to the face of the sign in a manner that will ensure the overlay remains securely attached. Fasteners shall not detract from the appearance of the sign when the overlay is not in use. Velcro fasteners will not be permitted.

**1063.4.2.3 Bracing.** Each sign shall have a horizontal and vertical cross brace and at least one anti-kiting device located near the center of the sign. Cross braces of sufficient cross-section shall be fastened to each other at the midpoints and the ends securely held to the back of the sign by mechanical means. The design shall ensure that the sign remains taut and retains the sign's intended shape when exposed to normal field conditions.

**1063.4.3 Legend and Borders.** Legends and borders of all signs shall be vinyl or silk-screened. Vinyl shall be cut by die or a computer-driven cutter. Stencil ink used shall be in accordance with the sheeting manufacturer's recommendations. Free-hand legend and borders will not be permitted.

**1063.4.4 Sign Layout and Design.** Sign layout and design shall be as shown on the plans or as directed by the engineer.

**10635 Strobe Lights.** Strobe lights shall be 12/24 VDC battery or solar-powered with amber fresnel, high-profile lenses. Strobe lights shall have a flash rate of 60 to 80 flashes per minute. Each strobe light shall provide no less than 500,000 candlepower ( $5.382 \times 10^6$  lux) of illumination. Each light shall be fully visible through an arc of approximately 120 degrees when viewed facing the sign.

**1063.6 Flashing Arrow Panels.** All lamps shall have a nominal 5-inch (125 mm), 360-degree tunnel visor. A lamp on the back side of the flashing arrow panel shall be continuously energized during operation of the flashing arrow panel. Lamps shall be visible at an angle of 15 degrees to the left and right of center and 4 degrees above and below center during "on" time. The flashing arrow panel shall contain a device to align the arrow panel to oncoming traffic. Arrow panels shall be capable of displaying the flashing arrow, flashing double arrow and four corner flashing caution modes. Solar-powered flashing arrow panels shall be capable of operating in the flashing arrow mode for 20 consecutive days and shall be provided with a device to indicate the remaining charge in batteries.

**1063.6.1 Trailer-Mounted Flashing Arrow Panels.** Trailer-mounted flashing arrow panels shall be MUTCD, Type C. Trailer-mounted flashing arrow panels shall be 4 feet (1.2 m) high and 8 feet (2.4 m) wide and shall have a minimum of 15 lamps. Trailer-mounted flashing arrow panels shall be solar powered.

**1063.6.2 Truck-Mounted Flashing Arrow Panels.** Truck-mounted flashing arrow panels shall be MUTCD, Type B. Truck-mounted flashing arrow panels shall be 30 inches (0.75 m) high and 60 inches (1.5 m) wide and shall have a minimum of 13 lamps.

**1063.7 Changeable Message Sign.** Each Changeable Message Sign (CMS) shall consist of a message board, solar power supply, computer interface and mounting and transporting equipment.

**1063.7.1 Message Board.** Each sign shall consist of three lines containing eight individually changeable characters per line. Each character shall be yellow in display on a black background. The CMS shall be legible up to a distance of 650 feet (200 m) for both day and night operation.

**1063.7.2 Computer Interface.** The CMS shall have a digital cellular transceiver capable of receiving a message in the location deployed from a remote location and forwarding the message to the CMS controller to change the displayed message.

**1063.7.2.1** The CMS shall have the necessary hardware to allow the message to be changed from the CMS location without connection. A minimum 5-foot (1.5 m) connecting cable shall be provided to connect the CMS sign controller to a notebook computer. For on-sight operation, the CMS shall have a removable waterproof keyboard with display panel.

**1063.7.2.2** The supplier shall provide the Commission the required software and licenses necessary to change the message from a remote location. This software shall be compatible with Windows 98, NT, XP, or 2000 operating systems and shall be able to issue -compatible modem commands. The supplier shall provide technical assistance with the installation and operation of software.

**1063.7.3 Solar Power Supply.** The power supply shall use a battery bank with sufficient capacity to operate a full display of characters for 30 consecutive days with no sun. All terminals and connections shall be clearly labeled.

**1063.7.4 Support.** A factory trained service representative shall be available at the delivery location to provide technical assistance, including the installation and operation of software. No additional payment will be made for travel expenses.

**1063.8 Portable Traffic Signals.** Each portable traffic signal (PTS) system shall consist of two trailer-mounted PTS units, a controller assembly and communication link. Each PTS unit shall consist of signal heads and indications, a solar power supply, vehicle detection and mounting and transporting equipment. All components shall be capable of operating in a temperature range of -20 to 120 F (-30 to 50 C).

**1063.8.1 Controller Assembly.** The controller assembly shall be a minimum two-phase, solid-state traffic signal controller with a conflict monitor capable of operating the signals in accordance with MUTCD requirements and NEMA Standard TS1. The controller shall operate as a fully-actuated unit and shall have the capability of being manually operated to display simultaneous red on both phases. The controller shall be capable of red rest during non-actuated periods. Upon detection of a conflict, the system shall change to a solid red clearance interval followed by flashing red.

**1063.8.2 Communication Link.** A continuous communications link between the PTS units shall be provided. If a break in communications between the PTS units occurs, the system shall change to a solid red clearance interval followed by flashing red. Upon restoration of communications, the system shall change to a solid red clearance interval followed by normal operations.

**1063.8.3 Signal Heads and Indications.** Each unit shall consist of two polycarbonate signal heads, including backplates and visors. One signal head shall be mounted on the mast arm assembly and the other on the vertical upright. The signal head mounted on the mast arm shall

provide a minimum lateral clearance of 9.5 feet (2.9 m) from the center of the outer signal head to the edge of the trailer and a minimum vertical clearance of 16 feet (4.88 m) from the bottom of the backplate to the roadway surface. The signal head mounted on the vertical upright shall provide a minimum clearance of 8 feet (2.4 m) from the bottom of the backplate to the roadway surface. All signal indications shall be 12 inches (300 mm) in diameter. Traffic signal heads and indications shall be in accordance with the vehicle traffic control signal head requirements of ITE and NEMA Standard TS1 and TS2.

**1063.8.4 Solar Power Supply.** The power supply shall use a battery bank with sufficient capacity to operate the PTS for 20 consecutive days with no sun. All terminals and connections shall be clearly labeled.

**1063.8.5 Vehicle Detection.** Detection shall be provided by one of the non-intrusive vehicular detection methods specified in [Sec 902](#) or temporary loop detectors with the capability of providing coverage for a 6-foot x 30-foot (1.8 m x 9 m) area. Temporary loops shall be preformed at the factory. The temporary loops shall have self-adhesive rubberized asphalt backing, which shall bond to the pavement.

**1063.8.6 Support.** A factory trained service representative shall be available at the delivery location to provide technical assistance and training, including the installation and operation of software. No additional payment will be made for travel expenses.

**1063.9 Radar Speed Advisory System.** Each radar speed advisory system shall consist of a radar unit, speed display, speed limit display, solar power supply and mounting and transporting equipment.

**1063.9.1 Radar Unit.** The radar unit shall include necessary cables for connection to the digital display and power supply, shall be capable of instantaneously displaying and locking readings and shall meet the following minimum requirements:

Radar Unit Requirements	
Speed range	15 to 99 mph
Accuracy	+1 mph
Internal test	32 mph check

**1063.9.2 Speed Display.** The speed display shall be a minimum of 12 inches (300 mm) high and shall be capable of displaying the radar unit output from 0 to 99 mph.

**1063.9.3 Speed Limit Display.** The speed limit display shall indicate the work zone speed limit by means of a 36 x 48-inch (900 x 1200 mm) speed limit sign. The speed limit sign may be comprised of a rigid or roll-up sign or a rigid sign with a variable speed display. The variable speed display shall be a minimum of 12 inches (300 mm) high and shall be capable of displaying two digits.

**1063.9.4 Solar Power Supply.** The power supply shall be capable of operating the radar unit, speed display and speed limit display, if applicable, for a minimum of eight hours per day.

**1063.10 Truck Mounted Attenuators.** Each Truck Mounted Attenuator (TMA) shall be in accordance with Test Level 3 criteria as set forth in NCHRP 350. Each TMA shall have a standard trailer lighting system, including brake lights, taillights, turn signal lights and Federal Motor Carrier Safety Administration identification bar lights. In the operating position, the rear facing of the TMA shall be marked with alternating 8-inch (200 mm) yellow and 8-inch (200 mm) black retroreflective sheeting. The marking shall form an inverted "V" at the center and slope downward at an angle of 45 degrees toward each side of the unit. The TMA shall be

marked with this same pattern and shall have the same standard trailer lighting system noted above when the unit is in the transport position.

**1063.11 Certification.** The contractor shall furnish a manufacturer's certification for all material governed by this specification. The certification shall indicate full compliance with each applicable specification.





## SECTION 616

### TEMPORARY TRAFFIC CONTROL

**616.1 Description.** This work shall consist of furnishing, installing, operating, maintaining, cleaning, relocating and removing temporary traffic control devices and equipment, and the removal and relocation or covering and uncovering of existing signs and other traffic control devices in accordance with the contract documents or as directed by the engineer. For purposes of this specification, the work zone will be defined as the area between the first and last temporary traffic control device as shown on the plans for the work being performed.

**616.2 Material.** All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Temporary Traffic Control Devices	1063

#### 616.3 Safety Requirements.

**616.3.1** All workers within highway right of way who are exposed to traffic or construction equipment shall wear high-visibility safety apparel meeting Class 2 or Class 3 requirements of ANSI/ISEA 107-2004 publication entitled, "American National Standard for High-Visibility Safety Apparel and Headwear".

**616.3.2** All traffic control devices shall be in accordance with the MUTCD and any applicable safety and design codes.

**616.3.3** The contractor shall furnish a manufacturer's certification of crashworthiness, per NCHRP 350 Evaluation Criteria, for FHWA Category 1 traffic control devices and appurtenances. The contractor shall furnish the FHWA acceptance letter for FHWA Category 2 and Category 3 traffic control devices and appurtenances. The FHWA acceptance letter shall indicate that the device and appurtenance complies with the crash test requirements of NCHRP 350, Test Level 3 (TL-3). Regardless whether the device meets NCHRP 350 criteria, the engineer reserves the right of final approval. Installation of a device prior to the engineer's approval will be at the contractor's risk.

**616.3.4** The contractor shall:

- (a) Designate a trained person at the project level who has the primary responsibility, with sufficient authority, for implementing the traffic management plan and other safety and mobility aspects of the project. The name of that person, proof they successfully completed MoDOT's Advanced Work Zone course, ATSSA's Traffic Control Supervisor course or an approved equivalent training course, and a 24-hour contact number for that person shall be provided to the engineer at the pre-construction meeting. Re-certification will be required as dictated by the organization providing the training.
- (b) Ensure all contractor personnel are trained in traffic control to a level commensurate with their responsibilities.

- (c) Advise the engineer, as required, at least two working days before any work requiring a lane closure begins and 14 calendar days prior to the imposition of height, width and weight restrictions.
- (d) Perform quality control of work zones to promote consistency and ensure compliance with contract documents, policies and guidelines.

#### **616.4 Construction Requirements.**

**616.4.1** Performance and operational aspects of the devices shall be in accordance with the latest editions of the MUTCD and the Missouri *Quality Standards for Temporary Traffic Control Devices*.

**616.4.1.1** All traffic control devices shall be removed as soon as practical when the devices are no longer needed. When work is suspended for short periods of time, traffic control devices that are no longer appropriate shall be turned away from traffic, removed or covered. All temporary traffic control devices shall be removed after the completion of construction and shall remain the property of the contractor unless specified otherwise. All permanent traffic control devices that are in conflict with temporary traffic control devices shall be covered or removed as shown on the plans or as directed by the engineer. Upon completion of the work, all permanent traffic control devices to remain in place shall be restored to original condition.

**616.4.1.2** All sign covers shall meet the requirements of the MoDOT *Quality Standards for Temporary Traffic Control Devices*.

**616.4.1.3** All permanent traffic control devices relocated on a temporary basis shall be moved in the timeframe designated by the engineer, and shall remain visible to the traveling public during all stages of construction. The contractor shall place temporarily relocated permanent traffic control devices in the final location when construction is complete. Damaged devices shall be replaced by the contractor at the contractor's expense.

**616.4.2** The contract will indicate the minimum requirements for traffic control. With the engineer's approval, the contractor may add to the traffic control plan any temporary traffic control devices or services the contractor considers necessary to adequately protect the public and the work. Device quantities may be adjusted accordingly.

**616.4.2.1** Signs and sign quantities for blasting areas will not be included in the contract traffic control plan. The contractor will be responsible for furnishing, installing, maintaining and removing blasting zone signs in accordance with the MUTCD, at the contractor's expense. Placement of blasting zone signs will be subject to approval from the engineer.

**616.4.2.2** All changes to the traffic control plan resulting from contractor staging revisions, including proposed total road closures for the contractor's convenience, shall be submitted in writing to the engineer for review and acceptance prior to implementation. Device quantities may be adjusted accordingly.

**616.4.2.3** If the engineer determines the need for additional traffic control devices not included in the traffic control plan, the contractor will be notified in writing to provide the additional devices. Reimbursement for authorized changes to the traffic control plan will be made in accordance with [Sec 104.3](#), unless covered by contract unit prices.

**616.4.2.4** The contractor shall monitor traffic flow through the project and verify that all traffic control devices are in place and functioning properly during both daytime and nighttime conditions, as applicable. If the contractor determines that a deficiency in any traffic control device exists, the contractor shall take corrective action. No additional payment will be made for the corrective action.

**616.4.2.5** As soon as possible after observing a traffic control deficiency, the engineer will report the deficiency to the contractor, either verbally or in writing. After receiving notification, if the contractor does not make corrections within the timelines specified below, order records or suspension of the work may occur. Regardless of the severity of the deficiency, corrections shall be made as soon as possible to maintain a quality work zone.

**616.4.2.5.1** The severity of a deficiency will be categorized as follows:

- (a) Category 1 – Presents an immediate danger to the traveling public or workers and needs to be addressed immediately.
- (b) Category 2 – The situation doesn't pose an immediate threat to either the public or the workers, but can impact the proper functioning of the work zone.
- (c) Category 3 – The situation doesn't impact the functioning of the work zone but is more of a maintenance or aesthetic issue.

**616.4.2.5.2** When the engineer determines that the contractor has not made a good faith effort in correcting a deficiency, an order record will be issued if any of the following timelines are not met:

- (a) A Category 1 deficiency is not corrected within the following timelines after the contractor is notified of the deficiency. If work is in progress, the deficiency shall be corrected within one hour. If no work is in progress, the deficiency shall be corrected within 8 hours.
- (b) A Category 2 deficiency is not corrected within 24 hours after the contractor is notified of the deficiency.
- (c) A Category 3 deficiency is not corrected within 96 hours after the contractor is notified.

**616.4.2.5.3** When the engineer determines the contractor has not made a good faith effort in complying with an order record issued in accordance with Sec 616.4.2.5.2, the following action will be taken and the engineer may find the contractor in violation of the contract in accordance with Sec 105.

- (a) When corrections are not made within one hour of receipt of an order record citing Category 1 deficiencies, another order record will be issued.

(b) When corrections are not made within 24 hours of receipt of an order record citing Category 2 deficiencies, another order record will be issued.

(c) When corrections are not made within 48 hours of receipt of an order record citing Category 3 deficiencies, subsequent order records will be issued every 48 hours until all of the deficiencies are corrected to the satisfaction of the engineer.

**616.4.2.5.4** For reoccurring deficiencies of similar nature within the contractor's control, the engineer may issue order records in accordance with [Sec 616.4.2.5.3](#), bypassing [Sec 616.4.2.5.2](#) requirements.

**616.4.2.6** The contractor shall provide written notice to the engineer of any pedestrian or vehicular accident when physical evidence or other information suggests an accident has occurred in the work zone. The contractor shall obtain and provide to the engineer copies of law enforcement accident reports for any accidents in the work zone.

**616.4.3** Each flagger, automated flagger assistance devices (AFAD) operator and pilot vehicle operator shall maintain a valid flagger certification card that certifies the individual has been trained in the principles of flagging in accordance with the MUTCD. Certifications will not be required in emergency situations that arise due to actions beyond the contractor's control when flagging is necessary to maintain safe traffic control on a temporary basis. All flagging, AFAD, and pilot vehicle operations shall be in accordance with the MUTCD. Flaggers and pilot vehicles shall be provided as shown on the plans or as approved or directed by the engineer. When not specified in the plans, the contractor may use a Type B (Red/Yellow Lens) AFAD or pilot vehicle to supplement the flagging operation upon approval from the engineer. When two-way traffic is maintained over a single lane, each flagger, AFAD operator, if used in tandem, and pilot vehicle operator involved in the traffic flagging operation shall be equipped with a portable, two-way, communication system approved by the engineer.

**616.4.4** When specified in the plans, law enforcement personnel and vehicles shall be provided within the work zone as directed by the engineer. Law enforcement personnel shall have jurisdiction to enforce all traffic laws in the area to be patrolled.

**616.4.5** Crossovers for hauling material will be permitted only at locations indicated in the traffic control plan or as authorized by the engineer. Modifications to specified locations shall be in accordance with applicable portions of [Sec 104](#). Crossovers shall be signed in accordance with the traffic control plan. When the project has been completed, temporary crossovers shall be removed and the area restored to original condition. Existing crossovers shall be restored to original condition, including surface material.

## **616.5 Lighting Requirements.**

**616.5.1** All construction-related vehicles and equipment, except for haul trucks within paving operations, shall be equipped with a USDOT-approved warning light. Lights shall be amber in output, mounted such that the lights are visible to traffic from 360 degrees and activated while in the work zone.

**616.5.2** Work zone lighting shall be provided between dusk and dawn as specified in [Secs 616.5.2.1](#) and [616.5.2.2](#). Lighting systems shall be positioned such that the lighting systems do not cause glare or hot spots, i.e. concentrated areas of high lighting intensity when compared to the average, for motorists, spillover to adjacent properties or become safety concerns. When work zone lighting is required, a lighting plan shall be submitted to the engineer for review 14 days prior to the start of operations. The lighting plan shall show the

areas to be illuminated, the type and layout of the lighting systems and calculations of average maintained footcandles (lux).

**616.5.2.1** Work area lighting shall be provided in areas where construction equipment and labor are active. Lighting shall provide a minimum maintained intensity of 5 footcandles (54 lux).

**616.5.2.2** Overhead lighting shall be provided for flaggers and other specified locations shown on the plans. Lighting in these areas shall provide a minimum maintained intensity of 0.6 footcandles (6.5 lux).

**616.6 Flashing Arrow Panel.** The contractor shall deploy, operate and maintain flashing arrow panels as specified on the plans for the duration of the project, in accordance with the manufacturer's recommendations, at the contractor's expense. A minimum vertical clearance of 7 feet (2.1 m) shall be maintained from the edge of pavement to the bottom of the flashing arrow panel.

**616.6.1** When not in use, trailer-mounted flashing arrow panels shall be stored in accordance with [Sec 107.5](#).

**616.6.2** Control programs shall be as follows:

(a) Caution: Flash the two highest and two lowest lamps on panel simultaneously.

(b) Left or Right Arrow: Flash five lamps in the arrowhead and five lamps in the horizontal shank simultaneously.

(c) Double Arrow: Flash five lamps in both the left and right arrowheads and three lamps in the horizontal shank simultaneously.

**616.7 Changeable Message Signs.** The contractor shall place the changeable message sign (CMS) at the location shown on the plans or as directed by the engineer. The CMS shall not be located in the median.

**616.7.1** The contractor shall deploy, operate and maintain the CMS as specified in the traffic control plan and in accordance with the manufacturer's recommendations for the duration of the project at the contractor's expense. The contractor shall program the CMS as directed by the engineer.

**616.7.2** When the CMS is not in use, the message board shall be turned away from traffic. When not required for longer than a 24-hour period, the CMS shall be stored in accordance with [Sec 107.5](#).

**616.8 Work Zone Traffic Signals.** Work Zone Traffic Signals (WZTS) provide one-lane, two-way temporary traffic control through the use of a temporary traffic signal or a portable traffic signal programmed for two-phase operation. WZTS shall be in accordance with the provisions of this section. Unless otherwise shown on the plans, the contractor may choose either method to fulfill the WZTS requirement.

**616.8.1** The contractor shall notify the engineer at least 48 hours prior to the work zone traffic signal installation. After installation, the contractor shall receive approval from the engineer prior to activating the WZTS system. The contractor shall provide a service technician to be available for day, night and weekend trouble calls as required under test period requirements in [Sec 902](#). The contractor shall furnish the telephone number or other contact information where the technician can be reached.

**616.8.1.1** The contractor shall operate and maintain the WZTS, at the contractor's expense, as specified in the traffic control plan until two-way traffic is restored.

**616.8.1.2** When the WZTS is not in use, the signal heads shall be covered to the satisfaction of the engineer.

**616.8.1.3** Adequate traffic control, including flaggers, shall be provided at the contractor's expense during the startup and shutdown of the WZTS installation. If the WZTS installation becomes inoperable due to alterations, malfunctions or periods of shutdown for required maintenance when one-way traffic control is required, the contractor shall provide adequate traffic control, including flaggers, at the contractor's expense.

**616.8.1.4** All signal timing and programming shall be provided by the contractor and furnished to the engineer for approval prior to use. The contractor shall ensure proper signal timing is provided for the duration of the project. The contractor shall provide the locations of the vehicle detection zones.

**616.8.1.5** The WZTS and lighting system shall be removed after two-way traffic has resumed or as directed by the engineer. All equipment shall remain the property of the contractor.

**616.8.1.6** Measurement of WZTS system, including lighting and traffic signals at both ends of a one-lane, two-way section, will be made per each.

**616.8.2 Temporary Traffic Signals.** Temporary traffic signals and lighting shall be in accordance with [Sec 902.3](#).

**616.8.3 Portable Traffic Signals.** The contractor shall place the portable traffic signal (PTS) units a minimum of 6 feet (2 m) beyond the edge of shoulder at the location shown on the plans or as directed by the engineer. Each PTS unit shall be level to the satisfaction of the engineer. Each PTS shall be delineated with a minimum of five non-metallic drum-like channelizers. The PTS shall not be located in the median.

**616.8.3.1** When not required for a longer than a 24-hour period, the PTS shall be stored in accordance with [Sec 107.5](#).

**616.8.3.2** The contractor shall deploy, operate and maintain the PTS in accordance with the manufacturer's recommendations. The contractor shall provide two copies of the operating manual to the engineer.

**616.8.3.3** Overhead lighting with an average maintained intensity of 0.6 footcandles (6.5 lux) shall be provided and maintained at each PTS location as authorized by the engineer.

#### **616.9 Method of Measurement.**

**616.9.1** Measurement for relocation of post-mounted signs will be made to the nearest square foot (m<sup>2</sup>) of sign area.

**616.9.2** Measurement for law enforcement services will be made to the nearest hour as approved by the engineer. Plans will include an estimated number of hours of law enforcement services.

**616.10 Basis of Payment.** Temporary traffic control devices specified in the traffic control plan or authorized by the engineer will be paid for at the contract unit price for each of the pay items included in the contract.

**616.10.1** The following deducts in payment will be made when an order record is issued in accordance with [Sec 616.4.2.5.3](#) or [616.4.2.4](#) and thereafter for each hour until the deficiencies are corrected to the satisfaction of the engineer:

<b>Order Record For</b>	<b>Deduct for Non-Compliance</b>
Category 1 Deficiencies	\$5000
Category 2 Deficiencies	\$2500
Category 3 Deficiencies	\$1000

**616.10.2** No direct payment will be made for the following:

(a) Incidental items necessary to complete the work, unless specifically provided as a pay item in the contract.

(b) Installing, operating, maintaining, cleaning, repairing, removing or replacing traffic control devices.

(c) Covering and uncovering existing signs and other traffic control devices.

(d) Relocating temporary traffic control devices, including permanent traffic control devices temporarily relocated, unless specifically included as a pay item in the contract.

(e) Worker apparel.

(f) Flaggers, AFADs, pilot vehicles, and appurtenances at flagging stations.

(g) Furnishing, installing, operating, maintaining and removing construction-related vehicle and equipment lighting.

(h) Construction and removal of temporary equipment crossovers, including restoring pre-existing crossovers.

1. West Virginia Division of Highways
2. Yes
3. Trailer; construction, utility work, maintenance, etc.
4. Permitting through the District office for maintenance, utility work typically; design within construction.
5. See #4
6. The District has oversight within their area relating to the project.
7. Yes, I oversee approval and contract language.
8. None as of yet. We have allowed PSS for at least 10 years.

Thanks  
Bruce Kenney

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**From:** Chabak, Eugene M. [mailto:echabak@GFNET.com]

**Sent:** Friday, April 25, 2008 1:57 PM

**To:** robert-coop@dot.ca.gov; mark.luszcz@state.de.us; lap.hoang@dot.state.fl.us; bruce.ibarguen@maine.gov; thicks@sha.md.us; bottmj@michigan.gov; susan.zarling@dot.state.mn.us; brian.chandler@modot.mo.gov; duwillaims@mt.gov; chris.barretts@dot.state.nj.us; jklacy@dot.state.nc.us; ed.l.fischer@odot.state.or.us; hwickes@dot.state.tx.us; david.rush@vdot.virginia.gov; Kenney, Bruce; jonesvc@sccd.org

**Subject:** Pennsylvania Department of Transportation Portable Signal Survey

Good afternoon,

As part of the Portable Signal Survey effort that Gannett Fleming is working on with the Pennsylvania Department of Transportation Bureau of Highway Safety and Traffic Engineering, can each of you please take a few moments and provide brief answers to the following questions which will help us pull together the final evaluation report:

1. What Department of your agency do you represent?
2. Are Portable Signal Systems allowed for use in your state?
3. If yes, trailer or pedestal? What types of project are they being deployed at construction, utility work, maintenance, etc.
4. What is the permitting/documentation process for each use?
5. When is a site specific drawing required?
6. Do you or someone in your agency perform an inspection?
7. Do you have a pre-approval process for vendors/devices?
8. Has agency experienced any safety concerns/issues with the use of these devices versus flagging operation?
9. Other comment you would like to provide.



## Appendix E Contractor Feedback

**Confidential Available Upon Request**

## Appendix F Vendor Information

**Confidential Available Upon Request**

## Appendix G PennDOT Preliminary Specifications

Commonwealth of Pennsylvania  
Department of Transportation

**Specification for Pedestal-Mounted Portable Traffic Control Signal Systems**

September 28, 2007

**1. Description**

This specification outlines the minimum requirements for pedestal-mounted portable traffic control signal systems used on public streets and highways within the Commonwealth of Pennsylvania.

**2. General Requirements**

**2.1 Publication 213.** Pedestal-mounted portable traffic control signal systems may be used for stationary, short-term operations in compliance with Department Publication 213. Pedestal-mounted portable traffic signal systems are not permitted for long-term operations. In addition to work areas, such systems may also be authorized for special events and applications that comply with the basic requirements outlined in Department Publication 213. Manufacturers shall advise users of their systems of these Department requirements and procedures.

**2.2 MUTCD.** Portable traffic control signal systems shall comply with Part 4 of the national Manual on Uniform Traffic Control Devices (MUTCD), including the physical display and operational requirements of a conventional traffic control signal.

**3. System Configuration**

Each pedestal-mounted portable traffic control signal system shall consist of a minimum of four units with a pedestal-mounted signal head on each unit.

**4. Pedestal Units**

**4.1 Structural Adequacy.** Each unit shall be structurally adequate to support all pedestal-mounted equipment. The units shall have adequate structural integrity to enable lifting and placing it as required.

**4.2 Stability.** The units shall be designed in a manner to provide acceptable stability and a suitable means for ballasting.

**4.3 Assembly Mechanisms.** Each unit shall be equipped with solid rubber tires and retractable handles to facilitate deployment, relocation, and removal. Signal heads shall be mounted on a retractable vertical upright that is equipped with a manual hand crank.

All assembly mechanisms shall be designed for simplicity and quick operation so that set up and take down time can be kept to a minimum, and so that they can be operated by one person.

- 4.4 Labels.** The manufacturer, serial number, and emergency phone number shall be permanently marked on each unit using a decal, metal plate, or other means suitable to the Department.

**5. Signal Displays**

- 5.1 Vertical Clearance.** The bottom of the housing of a signal face that is not mounted over the roadway shall be at least 8 feet, but not more than 15 feet, above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.
- 5.2 Size and Orientation.** Each signal head shall be vertically-mounted and shall consist of indications that are 12 inches in diameter.
- 5.3 Signal Head Design.** Signal head housings shall be yellow, complying with Section 1104.06 of Department Publication 408. Signal heads shall have visors that are a minimum depth of 9.5 inches. All signal heads shall be equipped with backplates that extend at least 5 inches beyond each side of the signal face. All backplates and the inside of visors shall have a non-reflective black finish.
- 5.4 Approved Material Types.** All signal heads shall have light emitting diode (LED) modules. All LED modules and the signal housings that make up each signal head shall have a Sale or Provisional Certificate of Approval issued by the Department.
- 5.5 Supplemental Signal Indicator Lamps.** Provide these lamps on the backside of each unit so that there is a visual status of the signal indications.

**6. Environmental Requirements**

The pedestal-mounted portable traffic control signal system shall operate acceptably over an ambient temperature range of minus 30° F to plus 165° F, and a relative humidity range of 0% to 95%.

**7. Power Supply**

The pedestal-mounted portable traffic control signal system shall be battery-powered. The power supply shall be of sufficient capacity to power each unit for 7 days at 72° F without charging. Each unit shall be equipped with batteries and a battery charger capable of being used with a 110-volt power source. There shall be a visual display of the battery charge status. The batteries and battery charger shall be in a lockable, weatherproof compartment. All locks for each unit in a system shall be keyed alike. The system shall also be capable of running via existing commercial power.

**8. Communication**

- 8.1 Hardwire or Radio.** All pedestal-mounted portable traffic control signal systems used for short-term operations may be interconnected via hardwire or wireless radio link to ensure fail-safe operation and proper functioning. The interconnected units shall function as a master/slave system. Radio communications shall conform to applicable FCC requirements.
- 8.2 Quartz Timing.** In addition to the communication options listed in Section 8.1, portable traffic control signal systems used for short-term operations may also use quartz timing when operated in the fixed-time mode. With quartz timing, multiple synchronized clocks in each unit are continually compared to each other to ensure accuracy.

**9. Modes of Operation**

- 9.1 Required Modes.** Each system shall be capable of operating via manually-controlled, fixed-time, traffic-actuated, and flashing modes.
- 9.2 Manually-Controlled Operation.** Manual control shall be wireless remote. The manual control mode shall not allow the operator to interrupt any preprogrammed all-red clearance time in a manner that would create a conflict.
- 9.3 Fixed-Time Operation.** The system shall be capable of accommodating a minimum of five timing patterns per 24-hour period.
- 9.4 Traffic-Actuated Operation.** Use detection systems that have a Department Sale of Provisional Certificate of Approval, or that are otherwise acceptable to the Department.
- 9.5 Flashing Operation.** The system shall be capable of both flashing red and flashing yellow operations.
- 9.6 Preemption.** The system shall be capable of accommodating an optical or sound-based preemption system to provide a green indication for a properly-equipped, approaching emergency vehicle. Preemption equipment shall have a Sale or Provisional Certificate of Approval issued by the Department.

**10. Timing Parameters**

- 10.1 Programmable Timing Patterns.** The system shall allow users to program red, yellow, and green times in at least 1-second increments. Green times shall be programmable from 3 seconds to 250 seconds; yellow times from 1 second to 10 seconds; and red times from 1 second to 250 seconds. Operation in the traffic-actuated mode will require the ability to program maximum and minimum green times, and green time extensions.

**10.2 Minimum Number of Phases.** As a minimum, the system shall be capable of six-phase traffic signal operations.

**10.3 Manual Programming.** The system shall allow users the ability to program pre-selected timing patterns.

**10.4 Timing Algorithms.** If the system has software to automatically determine timing patterns based on certain input data, the manufacturer must submit a complete description of the logic behind the timing algorithm for the review and approval of the Department.

## **11. Conflict Monitoring**

The system shall be capable of preventing or detecting the display of conflicting signal indications in accordance with the conflict monitoring provisions of the NEMA Standards. For short-term operations, if a conflicting display is detected, the system shall cause the transfer of the signals to steady red or flashing red.

## **12. Training and Documentation**

The manufacturer shall provide training and documentation to users of the pedestal-mounted portable traffic control signal system. Documentation shall include manuals that describe system operation, service procedures, and parts. The manuals may be supplied in an electronic format. A copy of the documentation, along with a training outline and training materials, shall be submitted to the Department when seeking approval of the system in accordance with Section 13.

## **13. Approval Procedure**

**13.1 Certificate of Approval.** The complete pedestal-mounted portable traffic control signal system must have a Certificate of Approval issued by the Department prior to sale or use within the Commonwealth of Pennsylvania.

**13.2 Application.** Manufacturers that wish to have their product reviewed for possible approval should request an application from the Chief, Intelligent Transportation Systems and Congestion Management Division, Bureau of Highway Safety and Traffic Engineering, Pennsylvania Department of Transportation, P.O. Box 2047, Harrisburg, Pennsylvania, 17105-2047.

**13.3 Product Demonstration.** As a part of the approval process, manufacturers will be required to demonstrate their pedestal-mounted portable traffic control signal system to Department representatives.

**13.4 30-Day Operational Test.** As a condition for approval, manufactures will be required to have their pedestal-mounted portable traffic control signal system subjected to a 30-day operational test. The testing will be conducted by the Department, or may be

conducted by an independent testing laboratory if approved by the Department. In order to be approved, the system shall perform acceptably for 30 consecutive days in accordance with this specification.

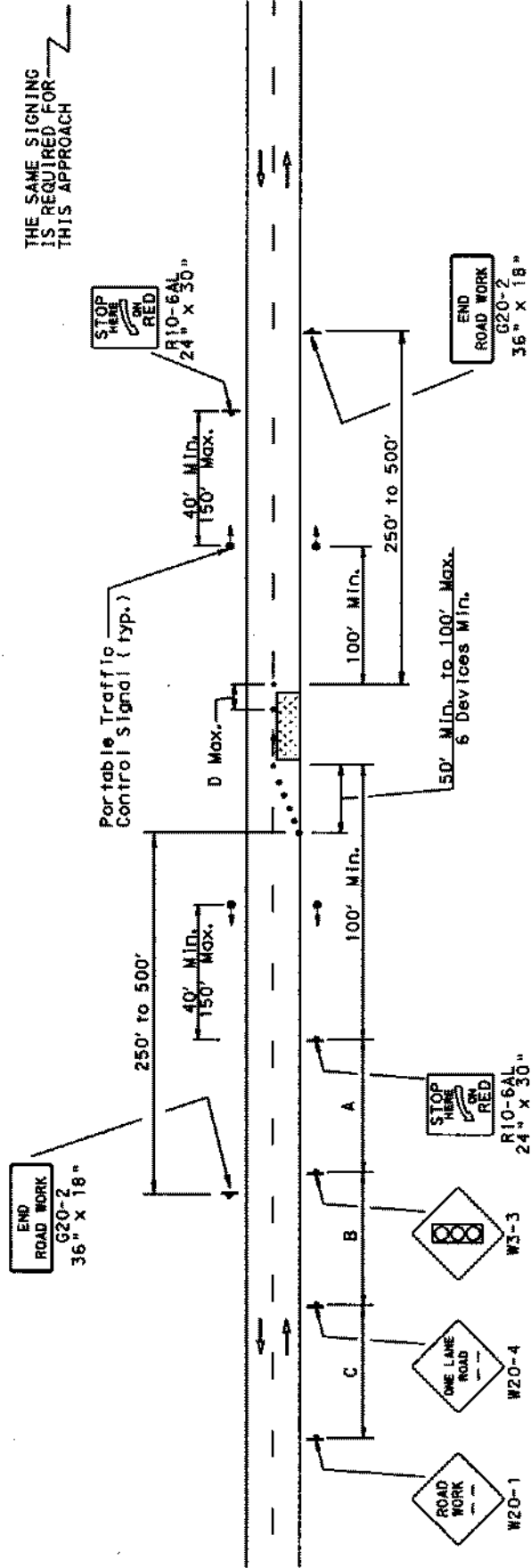
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Steven L. Koser, P.E., Chief  
ITS and Congestion Management Division  
Bureau of Highway Safety and Traffic Engineering

S:\BHSTE\ITS-Congestion Management\Product Specifications\PTCS Spec – Pedestal-Mounted



PUBLICATION 213  
SHORT-TERM STATIONARY OPERATION  
TWO-LANE, TWO-WAY ROADWAY - PORTABLE TRAFFIC CONTROL SIGNALS



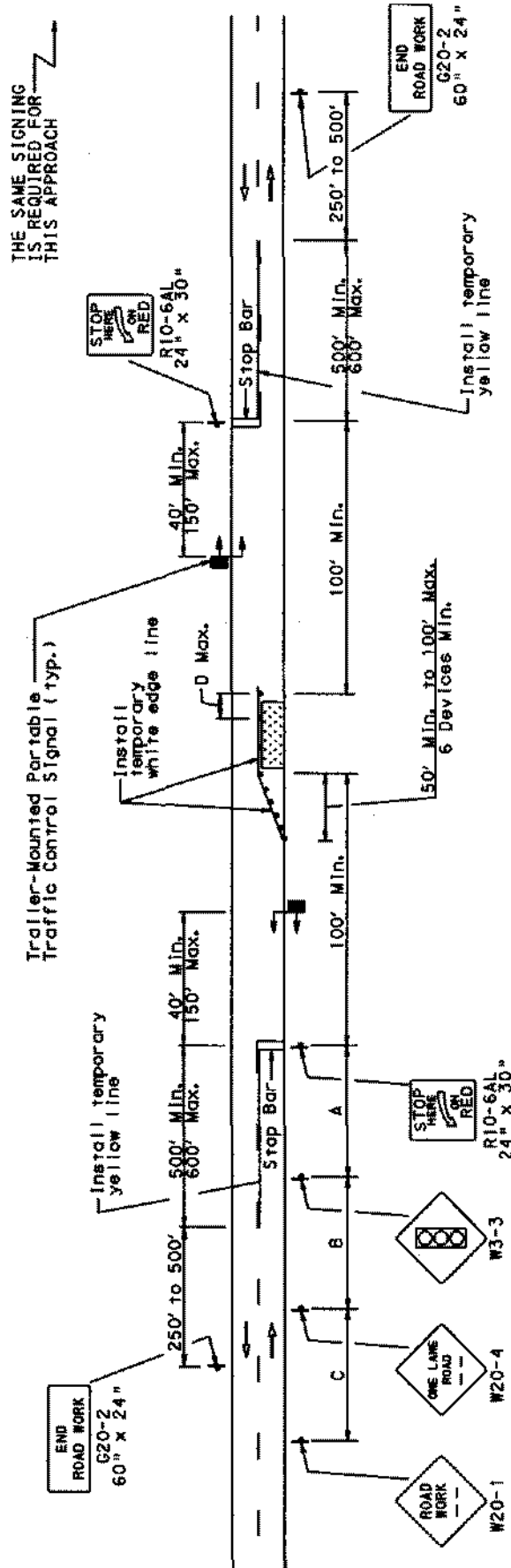
CONDITION 1: All Highways (except freeways and expressways)  
 A = 500 ft.  
 B = 500 ft., W20-4 sign distance plaque to read 1000 ft.  
 C = 500 ft., W20-1 sign distance plaque to read 1500 ft.  
 D = 2 times the normal speed limit

CONDITION 2: For Urban Streets  
 A, B and C = 200 ft. and sign distance plaque to read "AHEAD"  
 D = 2 times the normal speed limit

NOTES

1. The use of portable traffic control signals in Pennsylvania for short-term operations shall comply with the provisions of this figure.
2. Refer to Appendix A of this publication for additional notes and permit information pertaining to portable traffic control signals.
3. The design and application of the portable traffic control signals shall comply with the most current version of Publications 212, 213, and 145M.

PUBLICATION 213  
LONG-TERM STATIONARY OPERATION  
TWO-LANE, TWO-WAY ROADWAY - PORTABLE TRAFFIC CONTROL SIGNALS



THE SAME SIGNING IS REQUIRED FOR THIS APPROACH

CONDITION 1: All Highways (except freeways and expressways)

- A = 500 ft.
- B = 500 ft., W20-4 sign distance plaque to read 1000 ft.
- C = 500 ft., W20-1 sign distance plaque to read 1500 ft.
- D = 2 times the normal speed limit

CONDITION 2: For Urban Streets

- A, B and C = 200 ft. and sign distance plaque to read "AHEAD"
- D = 2 times the normal speed limit

NOTES

1. The use of portable traffic control signals in Pennsylvania for long-term operations shall comply with the provisions of this figure.
2. Refer to Appendix A of this publication for additional notes and permit information pertaining to portable traffic control signals.
3. The design and application of the portable traffic control signals shall comply with the most current version of Publications 212, 213, and 143M.
4. Remove conflicting pavement markings.
5. Stop bars shall be installed with portable traffic control signals for long-term operations. Existing conflicting pavement markings and raised pavement markers between stop bars shall be removed. After portable traffic control signals are removed, the stop bars shall be removed and the permanent pavement markings restored.



### PORTABLE TRAFFIC CONTROL SIGNAL PERMIT

In accordance with the Vehicle Code, the Pennsylvania Department of Transportation (PennDOT) hereby approves the operation of a portable traffic control signal as follows:

Location:

Date(s) of Operation:

This permit is issued to, and accepted by, \_\_\_\_\_, hereinafter known as the Permittee, as follows:

The operation and maintenance of this portable traffic control signal by the Permittee shall be in accordance with requirements contained on the attached sheets and application, PennDOT's figures governing the use of portable traffic control signals as contained in PennDOT Publication 213, and the following special requirements:

All work performed by the Permittee with respect to the operation and maintenance of this portable traffic control signal shall be under and subject to the direction of PennDOT. The said Permittee shall use due diligence in the execution of the work authorized under this permit and shall not obstruct or endanger travel along the said road. All operations must be conducted so as to permit safe and reasonable free travel at all times over the road within the limits of the work herein permitted.

The Permittee agrees to indemnify, save harmless and defend (if requested) the Commonwealth of Pennsylvania, its agents, representatives and employees, from all suits, actions or claims of any character, name or description, damages, judgments, expenses, attorneys' fees and compensation arising out of personal injury, death or property damage, sustained or alleged to have been sustained in whole or in part by any and all persons whatsoever as a result of or arising out of any act, omission, neglect or misconduct of the Permittee, its officers, agents, contractors or employees, during the period of portable traffic control signal usage.

PennDOT reserves the right to revoke this permit or to suspend the operation of the portable traffic control signal if the Permittee shall at any time willfully or negligently fail to comply with the conditions contained in this permit or PennDOT Publication 213, or fail to make any changes in the operation of this signal, or to remove it, when so ordered by PennDOT. The Permittee shall maintain the signal in a safe condition at all times. The Permittee shall not make any change in the operation of the portable traffic control signal as defined in the permit drawings without prior written approval of PennDOT. PennDOT reserves the right to inspect this portable traffic control signal usage at any time.

Date: \_\_\_\_\_

Approved: \_\_\_\_\_  
Secretary of Transportation  
Commonwealth of Pennsylvania

By: \_\_\_\_\_  
District Executive  
Pennsylvania Department of Transportation  
Engineering District \_\_\_\_\_



COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION

**NOTICE OF COMMENCEMENT FORM  
FOR PORTABLE TRAFFIC CONTROL SIGNAL USAGE**

*Notice is hereby given that portable traffic control signal usage will occur as follows:*

User Name: \_\_\_\_\_ Phone No.: \_\_\_\_\_

User Company: \_\_\_\_\_

Address: \_\_\_\_\_  
\_\_\_\_\_

DATE OF PORTABLE SIGNAL USAGE: Begin \_\_\_\_\_ End \_\_\_\_\_

**WORK LOCATION**

County: \_\_\_\_\_ Municipality: \_\_\_\_\_

On State Route (SR): \_\_\_\_\_ Direction: \_\_\_\_\_

From: Segment: \_\_\_\_\_ Offset: \_\_\_\_\_

To: Segment: \_\_\_\_\_ Offset: \_\_\_\_\_

On Local Road: \_\_\_\_\_ Direction: \_\_\_\_\_

From: \_\_\_\_\_

To: \_\_\_\_\_

Description of Proposed Work:

Portable Traffic  
Signal Manufacturer: \_\_\_\_\_

Model: \_\_\_\_\_  
PennDOT  
Approval No.: \_\_\_\_\_

<b>Check all that apply</b>	<b>Criteria</b>
	a. The operation will be a “stationary, short-term operation” as defined in PennDOT Publications 212 and 213.
	b. The portable traffic control signals will be used to control one-lane, two-way traffic, and no more than two approaches to the work zone will be controlled by portable traffic control signals.
	c. There will be no at-grade railroad crossing within the one-lane, two-way traffic section (between STOP HERE ON RED signs) and within 300 feet of a portable traffic control signal.
	d. No roadway approach to the portable traffic control signal will be on a downgrade of 5% or more, if the normal speed limit is greater than 35 miles per hour.
	e. There will be no intersections or uncontrolled commercial driveways within the one-lane, two-way traffic section.

If the portable traffic control signal will be operated solely in a manually-controlled mode of operation and Criteria a through e in the above table are satisfied (checked), the user must submit this completed Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

For repeated users of portable traffic control signals, PennDOT’s appropriate Engineering District Office, at its discretion, may issue a blanket portable traffic control signal permit covering multiple locations and dates of operation for up to a one-year period. These actions will only be considered by PennDOT’s appropriate Engineering District Office if that user has properly used portable traffic control signals in a safe and efficient manner within that District on numerous past occasions without problems and in compliance with PennDOT requirements, and with the understanding that all portable traffic control signal usage under the blanket permit will satisfy Criteria a through e in the above table. In the case of a blanket permit, the user must submit this completed Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

**Notice of Commencement Form  
for Portable Traffic Control Signal Usage (Continued)**

The user certifies that Criteria a through e in the above table are satisfied, and the portable traffic control signal:

- \_\_\_\_\_ Will be operated solely in a manually-controlled mode of operation, and/or
- \_\_\_\_\_ Will be operated in accordance with Blanket Permit No. \_\_\_\_\_

---

The user certifies that the information provided on this form is true and correct.

The user certifies that the portable traffic control signals will be operated and maintained in compliance with PennDOT Publications 212 and 213, and the provisions of any portable traffic control signal permit as issued by PennDOT.

The user agrees that it will indemnify, save harmless and defend (if requested) the Commonwealth of Pennsylvania, its agents, representatives and employees, from all suits, actions or claims of any character, name or description, damages, judgments, expenses, attorneys' fees and compensation arising out of personal injury, death or property damage, sustained or alleged to have been sustained in whole or in part by any and all persons whatsoever as a result of or arising out of any act, omission, neglect or misconduct of the user, its officers, agents, contractors or employees, during the period of portable traffic control signal usage.

BY: \_\_\_\_\_  
Signature of User

\_\_\_\_\_  
Date



COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION

**APPLICATION FOR PERMIT TO OPERATE  
PORTABLE TRAFFIC CONTROL SIGNALS**

Applicant: \_\_\_\_\_ Phone No.: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

**WORK LOCATION**

County: \_\_\_\_\_ Municipality: \_\_\_\_\_

On State Route (SR): \_\_\_\_\_ Direction: \_\_\_\_\_

From: Segment: \_\_\_\_\_ Offset: \_\_\_\_\_

To: Segment: \_\_\_\_\_ Offset: \_\_\_\_\_

On Local Road: \_\_\_\_\_ Direction: \_\_\_\_\_

From: \_\_\_\_\_

To: \_\_\_\_\_

Normal Speed Limit: \_\_\_\_\_ mph ADT: \_\_\_\_\_ veh/day

Maximum Length of One-Lane, Two-Way Traffic Section \_\_\_\_\_ feet  
(Between *STOP HERE ON RED* Signs)

Date of Portable Signal Usage: Begin \_\_\_\_\_ End \_\_\_\_\_

Description of Proposed Work:

**Application for Permit to Operate  
Portable Traffic Control Signals (Continued)**

Proposed Method of Controlling Traffic Emerging from Driveways within One-Lane, Two-Way Traffic Section:

Portable Traffic Signal Manufacturer: \_\_\_\_\_ Model: \_\_\_\_\_  
 PennDOT Approval No.: \_\_\_\_\_

Mode of Operation: Manual \_\_\_\_\_ Fixed Time \_\_\_\_\_ Actuated \_\_\_\_\_

Interconnection: Hard Wire \_\_\_\_\_ Radio \_\_\_\_\_ None (Quartz Timers) \_\_\_\_\_

Other (Please describe) \_\_\_\_\_

Name of Emergency Contact Person: \_\_\_\_\_ Phone No.: \_\_\_\_\_  
 (Must be available 24 hrs./day, 7 days/week during period of portable signal usage.)

<b>Check all that apply</b>	<b>Criteria</b>
	a. The operation will be a “stationary, short-term operation” as defined in PennDOT Publications 212 and 213.
	b. The portable traffic control signals will be used to control one-lane, two-way traffic, and no more than two approaches to the work zone will be controlled by portable traffic control signals.
	c. There will be no at-grade railroad crossing within the one-lane, two-way traffic section (between STOP HERE ON RED signs) and within 300 feet of a portable traffic control signal.
	d. No roadway approach to the portable traffic control signal will be on a downgrade of 5% or more, if the normal speed limit is greater than 35 miles per hour.



Check all that apply	Criteria (Continued)										
	e. There will be no intersections or uncontrolled commercial driveways within the one-lane, two-way traffic section.										
	f. The roadway ADT (average daily traffic) and length of one-way, two-way traffic section (between STOP HERE ON RED signs) meet one of the following conditions:										
	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: center; border-bottom: 1px solid black;">Maximum ADT (VEH./DAY) *</th> <th style="text-align: center; border-bottom: 1px solid black;">Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">4,000 (6,500*)</td> <td style="text-align: center;">1,000</td> </tr> <tr> <td style="text-align: center;">5,000 (7,500*)</td> <td style="text-align: center;">750</td> </tr> <tr> <td style="text-align: center;">6,000 (9,000*)</td> <td style="text-align: center;">500</td> </tr> <tr> <td style="text-align: center;">7,000 (11,000*)</td> <td style="text-align: center;">300</td> </tr> </tbody> </table>	Maximum ADT (VEH./DAY) *	Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)	4,000 (6,500*)	1,000	5,000 (7,500*)	750	6,000 (9,000*)	500	7,000 (11,000*)	300
Maximum ADT (VEH./DAY) *	Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)										
4,000 (6,500*)	1,000										
5,000 (7,500*)	750										
6,000 (9,000*)	500										
7,000 (11,000*)	300										
	* NOTE: These higher maximum ADT values are only applicable if portable traffic control signal usage will be limited to non-peak hours (i.e., other than 7:00 to 9:00 AM and 4:00 to 6:00 PM).										

To be considered for approval, submit this completed application to PennDOT’s appropriate Engineering District Office as early as possible. It must be received by PennDOT at least 15 working days prior to the desired beginning date of portable traffic control signal usage to enable PennDOT to respond before that desired starting date of usage.

Except as provided below, this completed application must be accompanied by a site-specific plan indicating the proposed work zone traffic control, portable traffic control signal locations, and operation (phasing, timing, etc.) taking into account work operations, roadway geometry, nearby intersections and driveways, and other pertinent factors. The plan should be prepared in accordance with the guidelines contained in PennDOT Publication 149M, and the available sight distance to each signal shall be indicated.

If **all** of the criteria (Criteria a through f) in the above table are satisfied (checked), a site-specific may not be required.

**Application for Permit to Operate  
Portable Traffic Control Signals (Continued)**

If the portable traffic control signal will be operated solely in a manually-controlled mode of operation and Criteria a through e in the above table are satisfied (checked), a completed application, a portable traffic control signal permit, and a site-specific plan will not be required. However, the user must submit a Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

For repeated users of portable traffic control signals, PennDOT's appropriate Engineering District Office, at its discretion, may waive the need for a site-specific plan and/or may issue a blanket portable traffic control signal permit covering multiple locations and dates of operation for up to a one-year period. These actions will only be considered by PennDOT's appropriate Engineering District Office if that user has properly used portable traffic control signals in a safe and efficient manner within that District on numerous past occasions without problems and in compliance with PennDOT requirements, and with the understanding that all portable traffic control signal usage under the blanket permit will satisfy Criteria a through e in the above table. In the case of a blanket permit, the user must submit a Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

---

The applicant certifies that the information provided on this application and accompanying documents is true and correct.

The applicant certifies that, if approved, the portable traffic control signals will be operated and maintained in compliance with PennDOT Publications 212 and 213, and the provisions of the portable traffic control signal permit as issued by PennDOT.

The applicant agrees that it will indemnify, save harmless and defend (if requested) the Commonwealth of Pennsylvania, its agents, representatives and employees, from all suits, actions or claims of any character, name or description, damages, judgments, expenses, attorneys' fees and compensation arising out of personal injury, death or property damage, sustained or alleged to have been sustained in whole or in part by any and all persons whatsoever as a result of or arising out of any act, omission, neglect or misconduct of the applicant, its officers, agents, contractors or employees, during the period of portable traffic control signal usage.

BY: \_\_\_\_\_  
Signature of Applicant Date

Sworn before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_

Notary: \_\_\_\_\_

# Existing Portable Signal Requirements and Time Frames

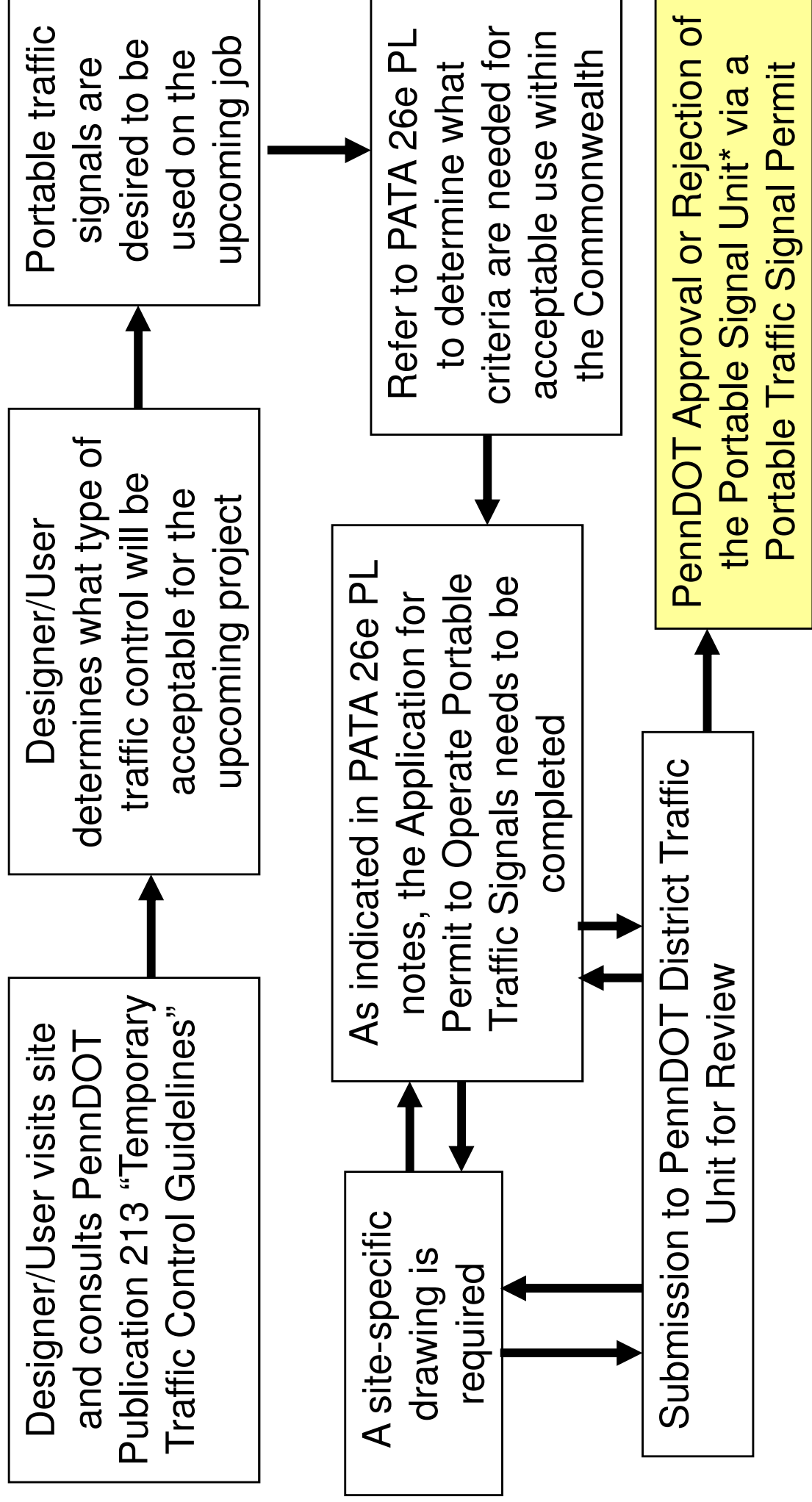
<i>Type of Application</i>	<i>Department Acceptance</i>	<i>Site Visit Required by User</i>	<i>Permit Required</i>	<i>Application Required</i>	<i>Notice of Commencement Required</i>	<i>Approximate Time from District Receiving Request</i>
Long-Term Stationary Operation	X	X	X	X		15 Days
Short-Term Station Operation (Standard)	X	X	X	X		15 Days
Short-Term Station Operation (Alternative 1: Manual Operation)	X	X			X	72 Hours
Short-Term Station Operation (Alternative 2: Non-Complex Operation)	X	X	X	X	X	15 Days
Short-Term Station Operation (Alternative 3: Blanket Permit)	X	X	X	X	X	72 Hours
Short-Term Station Operation (Alternative 4: Emergency)	X	X				<i>Time frame may vary</i>

Date: 6/25/2008

# Existing Practices/Procedures

## Long-Term Stationary Operation

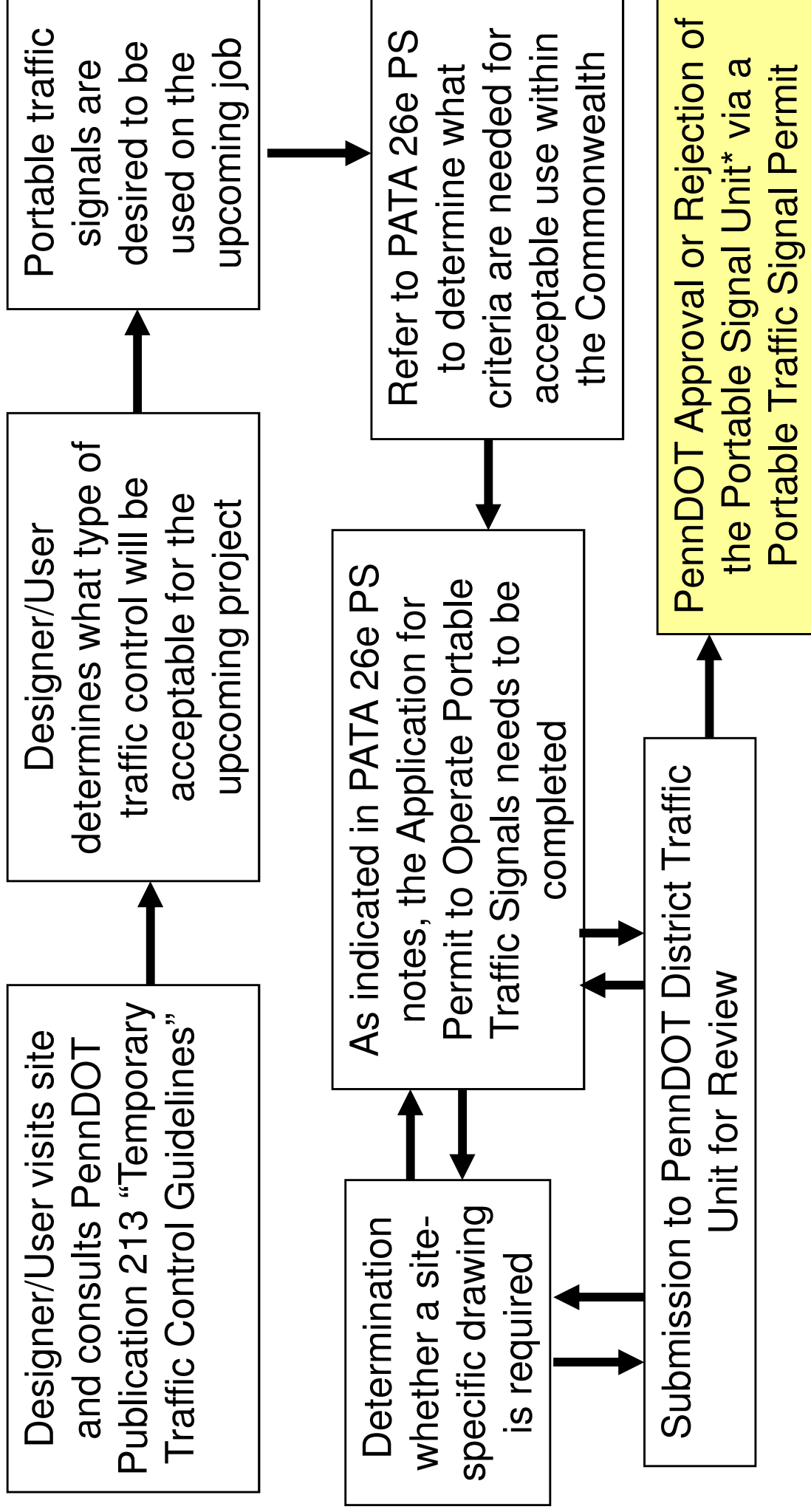
NOTE: All part of the design process in the development of the PS&E package or highway occupancy permit (HOP) plans.



\* Approximately 15 days is currently required upon submission to PennDOT for approval or suggested temporary traffic control modifications.

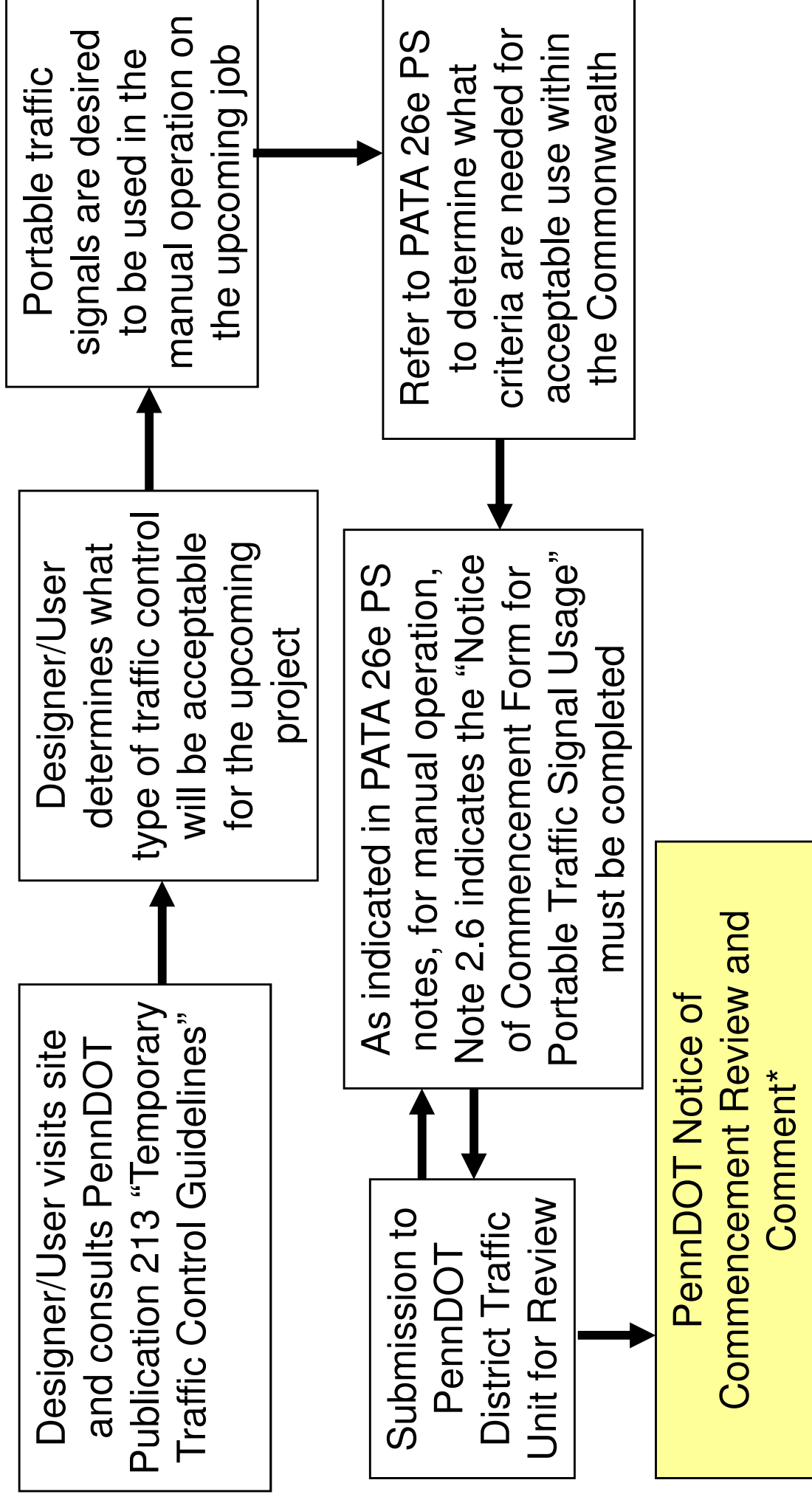
# Existing Practices/Procedures Short-Term Stationary Operation (Standard)

**NOTE:** All part of the design process into the development of the traffic control plan.



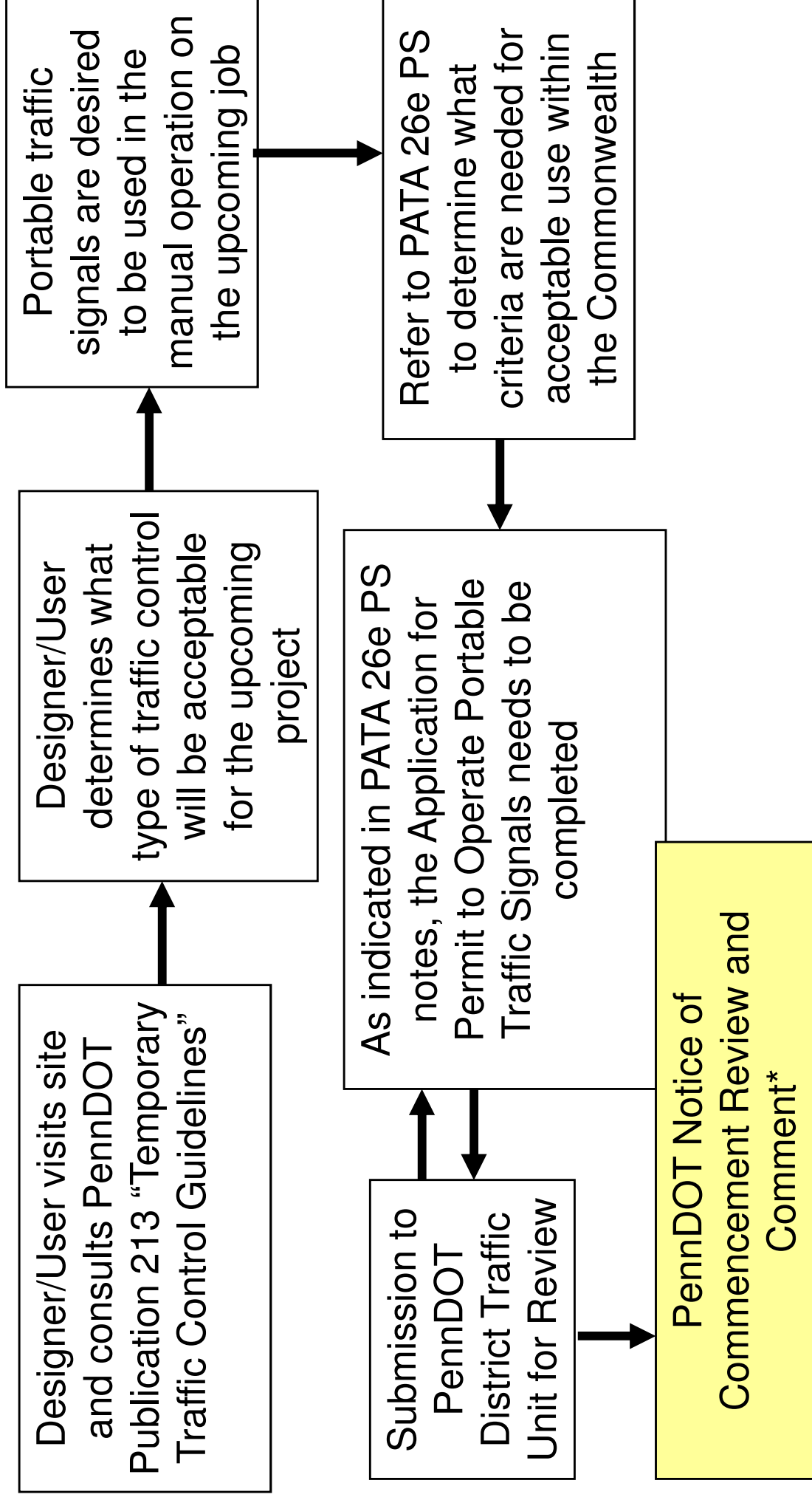
\* Approximately 15 days is currently required upon submission to PennDOT for approval or suggested temporary traffic control modifications.

# Existing Practices/Procedures Short-Term Stationary Operation (Alternative 1: Manual Operation)



\* Approximately 72 hours prior to beginning portable signal usage.

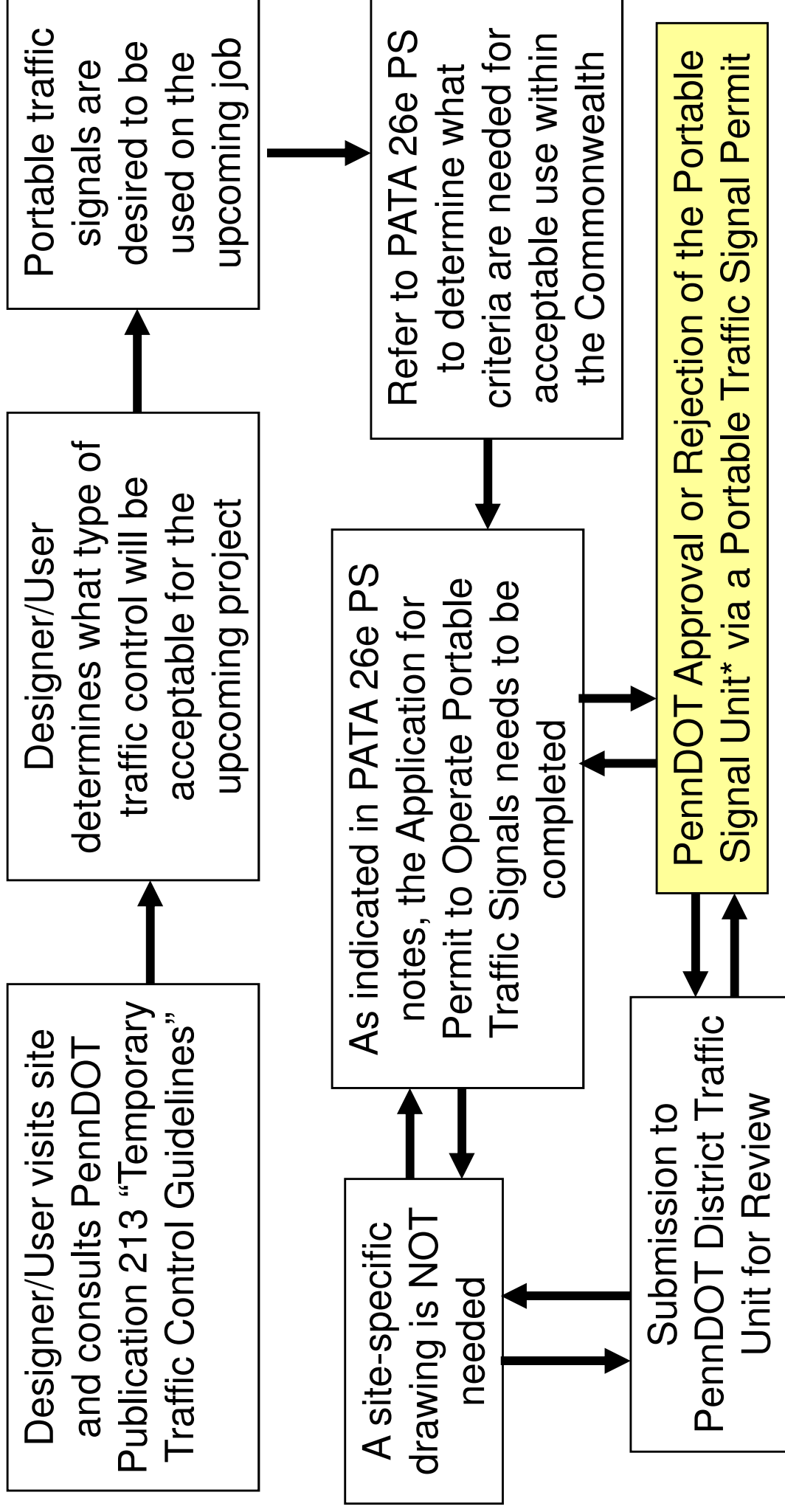
# Existing Practices/Procedures Short-Term Stationary Operation (Alternative 1: Manual Operation)



\* Approximately 72 hours prior to beginning portable signal usage.

# Existing Practices/Procedures Short-Term Stationary Operation

## (Alternative 2: Non-Complex Operations)



\* Approximately 15 days is currently required upon submission to PennDOT for approval or suggested temporary traffic control modifications.



## Existing Practices/Procedures

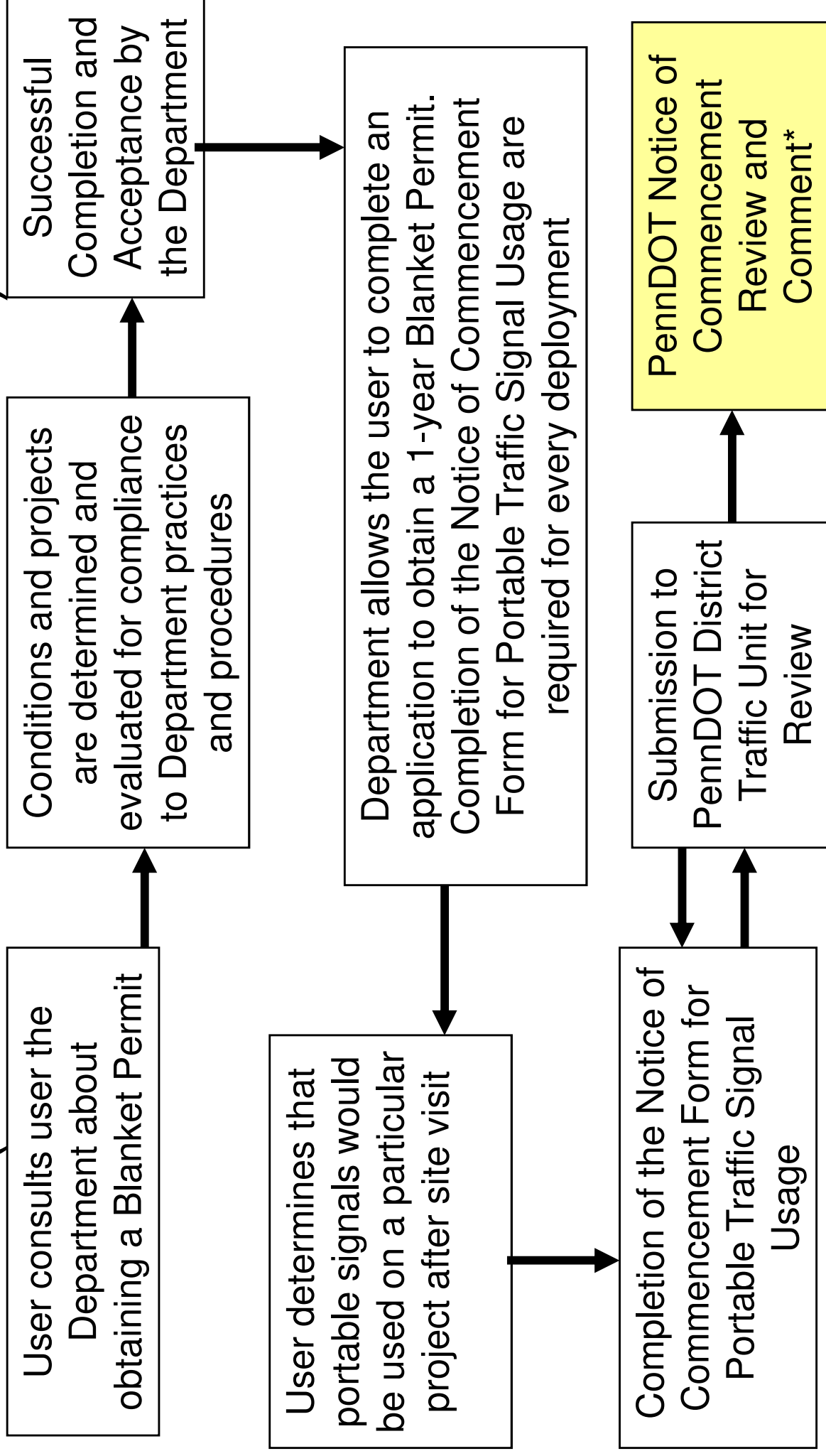
### Short-Term Stationary Operations

(Alternative 2: Non-Complex Operations Option)

- Existing Criteria
  - Short-term, stationary.
  - 1-lane, 2-way traffic control (no more than 2 controlled approaches).
  - No RR crossing within 300 ft.
  - Approach grade < 5% if > 35 mph.
  - No intersections or uncontrolled commercial driveways within 1-lane, 2-way section.
  - ADT/length of 1-lane, 2-way criteria.

# Existing Practices/Procedures Short-Term Stationary Operation

## (Alternative 3: Blanket Permit)



\* Approximately 72 hours prior to beginning portable signal usage.

**SECTION 1: GENERAL NOTES FOR PORTABLE TRAFFIC CONTROL SIGNALS**

- 1.1 Portable traffic control signals may be used for stationary, short-term or stationary, long-term operations. For the purposes of portable traffic control signals, short-term operations shall be defined as daylight work areas with work in active progress, emergency nighttime work areas with work in active progress, or work areas of relatively short duration where work begins during daylight and continues in active progress during hours of darkness. Work in active progress means that workers, other than flaggers, are present and are actively engaged in performing the necessary work. In addition to work areas, portable traffic control signals may also be authorized for special events and applications that comply with the basic requirements of the applicable figure.
- 1.2 Unless indicated otherwise, all terms used on PATA 26e PL and PATA 26e PS shall be as defined in PennDOT Publications 212 and 213.
- 1.3 A minimum of two signal faces on each approach should be continuously visible to approaching traffic from a point at least the following distance in advance of the portable traffic control signal unit:

<b>Normal Speed Limit (MPH)</b>	<b>Minimum Visibility Distance (FT.)</b>
25	215
30	270
35	325
40	390
45	460
50	540
55	625

- 1.4 Signal supports should be a minimum of 2 feet off the edge of travel way. If this is not possible, the supports shall be adequately protected by barrier, guiderail, or channelizing devices.
- 1.5 The bottom of the housing of a signal face suspended over the roadway shall be a minimum of 15 feet, but not more than 19 feet, above the pavement. The bottom of the housing of a signal face that is not mounted over the roadway shall be at least 8 feet, but not more than 15 feet, above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.
- 1.6 Additional signs and devices shall be installed as required in PennDOT Publications 212 and 213, and as required based on actual site conditions.
- 1.7 Signal modules and lamps must be replaced in accordance with the manufacturer’s recommendations, and a record of this must be maintained by the user.

## Appendix A – Portable Traffic Control Signals

- 1.8 When not in operation, signal heads shall be removed from the view of traffic or hooded with an opaque material that covers and hides the signal indications from the view of traffic. All inappropriate signs shall also be removed, covered, folded, or turned so that they are not readable by oncoming traffic when the portable traffic control signal is not in operation.
- 1.9 PennDOT reserves the right to inspect each portable traffic control signal usage. PennDOT also reserves the right to revoke a portable traffic control signal permit or to suspend the operation of the portable traffic control signal if the user shall at any time willfully or negligently fail to comply with the conditions contained in the permit or Publication 213, or fail to make any changes in the operation of the signal, or to remove it, when so ordered by PennDOT. The user shall not make any change in the operation of the portable traffic control signal as defined in the permit drawings without prior written approval of PennDOT.

**SECTION 2: SHORT-TERM STATIONARY OPERATION OF PORTABLE TRAFFIC CONTROL SIGNALS**

- 2.1 The use of portable traffic control signals in Pennsylvania for short-term operations shall comply with the provisions of PATA 26e PS.
- 2.2 Except as provided in Note 2.6 pertaining to manual control, advance written approval, in the form of a PennDOT portable traffic control signal permit, must be obtained from PennDOT prior to using portable traffic control signals for short-term operations on any public highway. The user must maintain a copy of the PennDOT portable traffic control signal permit and any submitted Notice of Commencement Form on-site during the period of portable traffic control signal usage.
- 2.3 To be considered for approval, a completed application for a permit to operate portable traffic control signals must be submitted to PennDOT’s appropriate Engineering District Office, except as provided in Note 2.6 pertaining to manual control. Submit the completed application as early as possible. It must be received by PennDOT at least 15 working days prior to the desired beginning date of portable traffic control signal usage to enable PennDOT to respond before that desired starting date of usage.
- 2.4 Except as indicated in Notes 2.5, 2.6, and 2.7, the completed application must be accompanied by a site-specific plan indicating the proposed work zone traffic control, portable traffic control signal locations, and operation (phasing, timing, etc.) taking into account work operations, roadway geometry, nearby intersections and driveways, and other pertinent factors. The plan should be prepared in accordance with the guidelines contained in PennDOT Publication 149M, and the available sight distance to each signal shall be indicated.
- 2.5 If **all** of the following conditions are satisfied, a site-specific plan may not be required in conjunction with the submission of a completed application for a permit to operate portable traffic control signals:
  - a. The operation will be a stationary, short-term operation as defined in PennDOT Publications 212 and 213.
  - b. The portable traffic control signals will be used to control one-lane, two-way traffic, and no more than two approaches to the work zone will be controlled by the portable traffic control signals.
  - c. There will be no at-grade railroad crossing within the one-lane, two-way traffic section (between STOP HERE ON RED signs) and within 300 feet of a portable traffic control signal.
  - d. No roadway approach to a portable traffic control signal will be on a downgrade of 5% or more, if the normal speed limit is greater than 35 miles per hour.

## Appendix A – Portable Traffic Control Signals

- e. There will be no intersections or uncontrolled commercial driveways within the one-lane, two-way traffic section. The proposed method of traffic control for non-commercial driveways shall be acceptable to PennDOT.
- f. The roadway ADT (average daily traffic) and length of one-way, two-way traffic section (between STOP HERE ON RED signs) meet one of the following conditions:

Maximum ADT (VEH./DAY) *	Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)
4,000 (6,500*)	1,000
5,000 (7,500*)	750
6,000 (9,000*)	500
7,000 (11,000*)	300

\* NOTE: These higher maximum ADT values are only applicable if portable traffic control signal usage will be limited to non-peak hours (i.e., other than 7:00 to 9:00 AM and 4:00 to 6:00 PM).

- 2.6 If the portable traffic control signal will be operated solely in a manually-controlled mode of operation in compliance with Notes 2.5a through 2.5e, a portable traffic control signal permit and a site-specific plan will not be required. However, the user must submit a Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.
  - a. For manual control, a single operator may be used if the operator has an unobstructed view of both traffic traveling through the one-lane, two-way section and traffic on the approach to each portable traffic control signal unit. Otherwise, a separate operator is required at each portable traffic control signal unit and communications must be maintained between the operators.
  - b. When manual control is used, supplemental signal indicator lamps are required to show the operator the status of the signal indications if the controller does not provide a visual display of the signal indications.
- 2.7 For repeated users of portable traffic control signals, PennDOT's appropriate Engineering District Office, at its discretion, may waive the need for a site-specific plan and/or may issue a blanket portable traffic control signal permit covering multiple locations and dates of operation for up to a one-year period. These actions will only be considered by PennDOT's appropriate Engineering District Office if that user has properly used portable traffic control signals in a safe and efficient manner within that District on numerous past occasions without problems and in compliance with PennDOT

## Appendix A – Portable Traffic Control Signals

requirements, and with the understanding that all portable traffic control signal usage under the blanket permit will satisfy Notes 2.5a through 2.5e. In the case of a blanket permit, the user must submit a Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

- 2.8 Signal heads on the left side of the roadway may not be necessary for portable traffic control signal units that have two signal heads and at least one is on a mast arm over the roadway, provided that signal visibility is adequate.
- 2.9 The length of yellow change intervals is normally in the range from about 3 seconds to 6 seconds. Use a 5-second yellow change interval, or an appropriate alternate value from PennDOT Publication 149M based on actual site conditions.
- 2.10 An all-red clearance interval must be used. The length of the all-red clearance interval is based on the length of the one-lane, two-way traffic section controlled by the portable traffic control signals and the speed of traffic through that section. Monitor traffic operations during the period of portable traffic control signal usage and adjust the length of the all-red clearance interval to account for site conditions and to provide for safe and efficient traffic operations. Unless otherwise indicated by PennDOT, the minimum length of all-red clearance intervals shall be as follows for fixed time and actuated operation:

Length of One-Lane, Two-Way Traffic Section between STOP HERE ON RED SIGNS (FT.)	Required Minimum Length of All-Red Clearance Interval (SEC.)		
	15 MPH	20 MPH	25 MPH
1,000	45	34	27
950	43	32	26
900	41	31	25
850	39	29	23
800	36	27	22
750	34	26	20
700	32	24	19
650	30	22	18
600	27	20	16
550	25	19	15
500	23	17	14
450	20	15	12
400	18	14	11
350	16	12	10
300	14	10	8

## Appendix A – Portable Traffic Control Signals

- 2.9 For fixed time and actuated operation, the minimum green interval provided for each approach shall be 10 seconds, unless otherwise indicated by PennDOT. The length of green intervals should be such as to provide for safe and efficient traffic operations. Use green intervals as indicated on the permit drawing. If there is no permit drawing, monitor traffic operations as traffic volumes change throughout the period of portable traffic control signal usage and adjust green intervals to provide for safe and efficient traffic operations.



**SECTION 3: LONG-TERM STATIONARY OPERATION OF PORTABLE TRAFFIC CONTROL SIGNALS**

- 3.1 The use of portable traffic control signals in Pennsylvania for long-term operations shall comply with the provisions of PATA 26e PL.
- 3.2 Advance written approval must be obtained from PennDOT prior to using portable traffic control signals for long-term operations on any public highway. A PennDOT portable traffic control signal permit will be required for long-term operations, and a copy must be maintained on-site during the period of portable traffic control signal usage.
- 3.3 To be considered for approval, a completed application for a permit to operate portable traffic control signals must be submitted to PennDOT's appropriate Engineering District Office. Submit the completed application as early as possible. It must be received by PennDOT at least 15 working days prior to the desired beginning date of portable traffic control signal usage to enable PennDOT to respond before that desired starting date of usage.
- 3.4 The completed application must be accompanied by a site-specific plan indicating the proposed work zone traffic control, portable traffic control signal locations, and operation (phasing, timing, etc.) taking into account work operations, roadway geometry, nearby intersections and driveways, and other pertinent factors. The plan should be prepared in accordance with the guidelines contained in PennDOT Publication 149M, and the available sight distance to each signal shall be indicated.
- 3.5 Portable traffic control signals used for long-term operations shall be trailer-mounted units having at least one signal head on a mast arm over the roadway. Pedestal-mounted portable traffic control signal units are not permitted for long-term operations.
- 3.6 For long-term operations, all signal lenses shall be 12 inches in diameter.
- 3.7 All portable traffic control signal units used for long-term operations must be interconnected via hard wire or radio to ensure fail-safe operation and proper functioning.
- 3.8 Steps must be taken to ensure continued proper placement and to forestall possible vandalism of the portable traffic control signal units. Tires and the "hitch" must be removed from the trailer, and battery enclosures, crank mechanisms for horizontal arms, and other mechanisms to adjust placement or operation must be locked to eliminate any tampering by unauthorized personnel.
- 3.9 The local police department must be provided with the name and telephone number of an emergency contact person who is available 24 hours per day, 7 days a week during the period of portable traffic control signal usage.

## Appendix A – Portable Traffic Control Signals

- 3.10 Pedestrian accommodation considerations, winter maintenance activities that could cause damage or dislodgement, and other important considerations may result in the denial to use portable traffic control signals for specific long-term operations.

Commonwealth of Pennsylvania  
Department of Transportation

**Specification for Trailer-Mounted Portable Traffic Control Signal Systems**

September 28, 2007

**1. Description**

This specification outlines the minimum requirements for trailer-mounted portable traffic control signal systems used on public streets and highways within the Commonwealth of Pennsylvania.

**2. General Requirements**

**2.1 Publication 213.** Trailer-mounted portable traffic control signal systems may be used for stationary, short-term operations or stationary, long-term operations in compliance with Department Publication 213. In addition to work areas, such systems may also be authorized for special events and applications that comply with the basic requirements outlined in Department Publication 213. Manufacturers shall advise users of their systems of these Department requirements and procedures.

**2.2 MUTCD.** Portable traffic control signal systems shall comply with Part 4 of the national Manual on Uniform Traffic Control Devices (MUTCD), including the physical display and operational requirements of a conventional traffic control signal.

**3. Trailer**

**3.1 General.** Each trailer shall be capable of accommodating a vertical upright and a horizontal mast arm.

**3.2 Structural Adequacy.** Each trailer shall be of welded steel construction, and shall be structurally adequate to support all trailer-mounted equipment. The trailer shall have adequate structural integrity to enable lifting and placing it as required.

**3.3 Stabilizers.** The trailer shall be equipped with at least four leveling jacks, pads, or feet, one at each corner of the trailer, for maintaining the trailer in a level, stabilized position. These stabilizers must be cable of locking in position.

**3.4 Licensing.** The trailer shall be equipped with all required lighting and other features to enable it to be legally transported on the public highway system. The trailer and all its components shall be of sufficient strength and rating to operate safely upon the public highway system at legal speeds without bending, cracking, bottoming, premature wear, or other damage.

- 3.5 Lifting and Assembly Mechanisms.** All lifting and other assembly mechanisms shall be designed for simplicity and quick operation so that set up and take down time can be kept to a minimum, and so that they can be operated by one person. The lifting mechanism shall be equipped with a locking device to secure the assembly in a raised position. The horizontal, lowered position shall be for transport. The raised, vertical position, facing rearwards from the trailer, shall be for operation.
- 3.6 Vandal-Resistant Features.** The trailer and its components shall be designed in such a manner as to help ensure continued proper placement and to forestall vandalism. The trailer design shall provide adequate vandal-proof housings for all equipment. The trailer tires and hitch must be capable of being removed, and battery enclosures, crank mechanisms for horizontal arms, and other mechanisms to adjust placement or operation must be lockable to eliminate tampering by unauthorized personnel. All lockable items must be keyed alike. The trailer drawbar shall be equipped with a swing-away, screw-type jack.
- 3.7 Reflective Markings.** Reflective tape or reflectors shall be placed at each corner on the front, rear, and sides of the trailer.
- 3.8 Labels.** The manufacturer, serial number, and emergency phone number shall be permanently marked on each trailer using a decal, metal plate, or other means suitable to the Department.

#### **4. Signal Displays**

- 4.1 Number and Location.** Each trailer shall have a minimum of two signal heads. At least one signal head shall be mounted overhead on the mast arm. The horizontal mast arm shall be capable of extending a minimum distance of 9 feet from the edge of the trailer. The minimum horizontal distance between signal faces shall be 8 feet measured between centers of signal faces along a line perpendicular to the centerline of the approach.
- 4.2 Vertical Clearance.** The bottom of the housing of a signal face suspended over the roadway shall be a minimum of 15 feet, but not more than 19 feet, above the pavement. The bottom of the housing of a signal face that is not mounted over the roadway shall be at least 8 feet, but not more than 15 feet, above the sidewalk or, if there is no sidewalk, above the pavement grade at the center of the roadway.
- 4.3 Size and Orientation.** Each signal head shall be vertically-mounted and shall consist of indications that are 12 inches in diameter. The signal heads shall be mounted so that they have the ability to rotate 180° horizontally. The mountings must also be reversible to allow for a trailer to be placed on both sides of the road.
- 4.4 Signal Head Design.** Signal head housings shall be yellow, complying with Section 1104.06 of Department Publication 408. Signal heads shall have visors that are a

minimum depth of 9.5 inches. All signal heads shall be equipped with backplates that extend at least 5 inches beyond each side of the signal face. All backplates and the inside of visors shall have a non-reflective black finish.

**4.5 Approved Material Types.** All signal heads shall have light emitting diode (LED) modules. All LED modules and the signal housings that make up each signal head shall have a Sale or Provisional Certificate of Approval issued by the Department.

**4.6 Supplemental Signal Indicator Lamps.** Provide these lamps on the backside of each unit so that there is a visual status of the signal indications.

## **5. Environmental Requirements**

The trailer-mounted portable traffic control signal system shall operate acceptably over an ambient temperature range of minus 30° F to plus 165° F, and a relative humidity range of 0% to 95%.

## **6. Power Supply**

The trailer-mounted portable traffic control signal system shall be battery-powered, or battery-powered with solar assist. The power supply shall be of sufficient capacity to power the system for 21 days at 72° F without charging. The system shall have a visual display of the battery charge status. There shall be an onboard battery charger capable of being used with a 110-volt power source. The system shall also be capable of running via existing commercial power.

## **7. Communication**

**7.1 Long-Term Operations.** All trailer-mounted portable traffic control signal systems used for long-term operations must be interconnected via hardwire or wireless radio link to ensure fail-safe operation and proper functioning. The interconnected trailers shall function as a master/slave system. Radio communications shall conform to applicable FCC requirements.

**7.2 Short-Term Operations.** In addition to the communication options listed in Section 7.1, portable traffic control signal systems used for short-term operations may also use quartz timing when operated in the fixed-time mode. With quartz timing, multiple synchronized clocks in each unit or trailer are continually compared to each other to ensure accuracy.

## **8. Modes of Operation**

**8.1 Required Modes.** Each system shall be capable of operating via manually-controlled, fixed-time, traffic-actuated, and flashing modes.

- 8.2 Manually-Controlled Operation.** Manual control shall be wireless remote. The manual control mode shall not allow the operator to interrupt any preprogrammed all-red clearance time in a manner that would create a conflict.
- 8.3 Fixed-Time Operation.** The system shall be capable of accommodating a minimum of five timing patterns per 24-hour period.
- 8.4 Traffic-Actuated Operation.** Use detection systems that have a Department Sale of Provisional Certificate of Approval, or that are otherwise acceptable to the Department.
- 8.5 Flashing Operation.** The system shall be capable of both flashing red and flashing yellow operations.
- 8.6 Preemption.** The system shall be capable of accommodating an optical or sound-based preemption system to provide a green indication for a properly-equipped, approaching emergency vehicle. Preemption equipment shall have a Sale or Provisional Certificate of Approval issued by the Department.

## **9. Timing Parameters**

- 9.1 Programmable Timing Patterns.** The system shall allow users to program red, yellow, and green times in at least 1-second increments. Green times shall be programmable from 3 seconds to 250 seconds; yellow times from 1 second to 10 seconds; and red times from 1 second to 250 seconds. Operation in the traffic-actuated mode will require the ability to program maximum and minimum green times, and green time extensions.
- 9.2 Minimum Number of Phases.** As a minimum, the system shall be capable of six-phase traffic signal operations.
- 9.3 Manual Programming.** The system shall allow users the ability to program pre-selected timing patterns.
- 9.4 Timing Algorithms.** If the system has software to automatically determine timing patterns based on certain input data, the manufacturer must submit a complete description of the logic behind the timing algorithm for the review and approval of the Department.

## **10. Conflict Monitoring**

The system shall be capable of preventing or detecting the display of conflicting signal indications in accordance with the conflict monitoring provisions of the NEMA Standards. For short-term operations, if a conflicting display is detected, the system shall cause the transfer of the signals to steady red or flashing red. For long-term operations, if a conflicting display is detected, the system shall cause the transfer of the signals to flashing red.

## **11. Training and Documentation**

The manufacturer shall provide training and documentation to users of the trailer-mounted portable traffic control signal system. Documentation shall include manuals that describe system operation, service procedures, and parts. The manuals may be supplied in an electronic format. A copy of the documentation, along with a training outline and training materials, shall be submitted to the Department when seeking approval of the system in accordance with Section 12.

## **12. Approval Procedure**

**12.1 Certificate of Approval.** The complete trailer-mounted portable traffic control signal system must have a Certificate of Approval issued by the Department prior to sale or use within the Commonwealth of Pennsylvania.

**12.2 Application.** Manufacturers that wish to have their product reviewed for possible approval should request an application from the Chief, Intelligent Transportation Systems and Congestion Management Division, Bureau of Highway Safety and Traffic Engineering, Pennsylvania Department of Transportation, P.O. Box 2047, Harrisburg, Pennsylvania, 17105-2047.

**12.3 Product Demonstration.** As a part of the approval process, manufacturers will be required to demonstrate their trailer-mounted portable traffic control signal system to Department representatives.

**12.4 30-Day Operational Test.** As a condition for approval, manufactures will be required to have their trailer-mounted portable traffic control signal system subjected to a 30-day operational test. The testing will be conducted by the Department, or may be conducted by an independent testing laboratory if approved by the Department. In order to be approved, the system shall perform acceptably for 30 consecutive days in accordance with this specification.

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Steven L. Koser, P.E., Chief  
ITS and Congestion Management Division  
Bureau of Highway Safety and Traffic Engineering





## Appendix H Site Assessment Applications/Drawings



**COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION**

**APPLICATION FOR PERMIT TO OPERATE  
PORTABLE TRAFFIC CONTROL SIGNALS**

Applicant: Luzerne County Maintenance Phone No.: (570) 239-5446

Address: 23 Old Berwick Rd.  
Drums, PA 18222-2802

**WORK LOCATION**

County: Luzerne Municipality: \_\_\_\_\_

On State Route (SR): 0029 Direction: NB/SB

From: Segment: 300 Offset: 3850

To: Segment: \_\_\_\_\_ Offset: \_\_\_\_\_

On Local Road: NA Direction: NA

From: NA

To: NA

Normal Speed Limit: 35 & 50 mph ADT: 2816 veh/day

Maximum Length of One-Lane, Two-Way Traffic Section Approx. 390 feet  
(Between *STOP HERE ON RED* Signs)

Date of Portable Signal Usage: Begin 5/1/2008 End 5/2/2008

**Description of Proposed Work:**

Bridge repair work.

**Application for Permit to Operate  
Portable Traffic Control Signals (Continued)**

Proposed Method of Controlling Traffic Emerging from Driveways within One-Lane, Two-Way Traffic Section:

Portable Traffic Signal Manufacturer: Horizon Signal Technologies      SQ2 Portable Traffic Control System  
 Model: \_\_\_\_\_  
 PennDOT Approval No.: HOR-005P

Mode of Operation: Manual  Fixed Time  Actuated

Interconnection: Hard Wire \_\_\_\_\_ Radio  None (Quartz Timers) \_\_\_\_\_

Other (Please describe) \_\_\_\_\_

Name of Emergency Contact Person: \_\_\_\_\_ Phone No.: \_\_\_\_\_  
 (Must be available 24 hrs./day, 7 days/week during period of portable signal usage.)

Check all that apply	Criteria
x	a. The operation will be a “stationary, short-term operation” as defined in PennDOT Publications 212 and 213.
x	b. The portable traffic control signals will be used to control one-lane, two-way traffic, and no more than two approaches to the work zone will be controlled by portable traffic control signals.
x	c. There will be no at-grade railroad crossing within the one-lane, two-way traffic section (between STOP HERE ON RED signs) and within 300 feet of a portable traffic control signal.
x	d. No roadway approach to the portable traffic control signal will be on a downgrade of 5% or more, if the normal speed limit is greater than 35 miles per hour.

Check all that apply	Criteria (Continued)										
x	e. There will be no intersections or uncontrolled commercial driveways within the one-lane, two-way traffic section.										
x	f. The roadway ADT (average daily traffic) and length of one-way, two-way traffic section (between STOP HERE ON RED signs) meet one of the following conditions: <table border="1"> <thead> <tr> <th>Maximum ADT (VEH./DAY) *</th> <th>Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)</th> </tr> </thead> <tbody> <tr> <td>4,000 (6,500*)</td> <td>1,000</td> </tr> <tr> <td>5,000 (7,500*)</td> <td>750</td> </tr> <tr> <td>6,000 (9,000*)</td> <td>500</td> </tr> <tr> <td>7,000 (11,000*)</td> <td>300</td> </tr> </tbody> </table> <p>* NOTE: These higher maximum ADT values are only applicable if portable traffic control signal usage will be limited to non-peak hours (i.e., other than 7:00 to 9:00 AM and 4:00 to 6:00 PM).</p>	Maximum ADT (VEH./DAY) *	Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)	4,000 (6,500*)	1,000	5,000 (7,500*)	750	6,000 (9,000*)	500	7,000 (11,000*)	300
Maximum ADT (VEH./DAY) *	Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)										
4,000 (6,500*)	1,000										
5,000 (7,500*)	750										
6,000 (9,000*)	500										
7,000 (11,000*)	300										

To be considered for approval, submit this completed application to PennDOT’s appropriate Engineering District Office as early as possible. It must be received by PennDOT at least 15 working days prior to the desired beginning date of portable traffic control signal usage to enable PennDOT to respond before that desired starting date of usage.

Except as provided below, this completed application must be accompanied by a site-specific plan indicating the proposed work zone traffic control, portable traffic control signal locations, and operation (phasing, timing, etc.) taking into account work operations, roadway geometry, nearby intersections and driveways, and other pertinent factors. The plan should be prepared in accordance with the guidelines contained in PennDOT Publication 149M, and the available sight distance to each signal shall be indicated.

If **all** of the criteria (Criteria a through f) in the above table are satisfied (checked), a site-specific may not be required.

If the portable traffic control signal will be operated solely in a manually-controlled mode of operation and Criteria a through e in the above table are satisfied (checked), a completed application, a portable traffic control signal permit, and a site-specific plan will not be required. However, the user must submit a Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

For repeated users of portable traffic control signals, PennDOT's appropriate Engineering District Office, at its discretion, may waive the need for a site-specific plan and/or may issue a blanket portable traffic control signal permit covering multiple locations and dates of operation for up to a one-year period. These actions will only be considered by PennDOT's appropriate Engineering District Office if that user has properly used portable traffic control signals in a safe and efficient manner within that District on numerous past occasions without problems and in compliance with PennDOT requirements, and with the understanding that all portable traffic control signal usage under the blanket permit will satisfy Criteria a through e in the above table. In the case of a blanket permit, the user must submit a Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

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The applicant certifies that the information provided on this application and accompanying documents is true and correct.

The applicant certifies that, if approved, the portable traffic control signals will be operated and maintained in compliance with PennDOT Publications 212 and 213, and the provisions of the portable traffic control signal permit as issued by PennDOT.

The applicant agrees that it will indemnify, save harmless and defend (if requested) the Commonwealth of Pennsylvania, its agents, representatives and employees, from all suits, actions or claims of any character, name or description, damages, judgments, expenses, attorneys' fees and compensation arising out of personal injury, death or property damage, sustained or alleged to have been sustained in whole or in part by any and all persons whatsoever as a result of or arising out of any act, omission, neglect or misconduct of the applicant, its officers, agents, contractors or employees, during the period of portable traffic control signal usage.

BY: \_\_\_\_\_  
Signature of Applicant Date

Sworn before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_\_

Notary: \_\_\_\_\_



COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION

Permit No. \_\_\_\_\_  
Sheet 1 of \_\_\_\_\_

### PORTABLE TRAFFIC CONTROL SIGNAL PERMIT

In accordance with the Vehicle Code, the Pennsylvania Department of Transportation (PennDOT) hereby approves the operation of a portable traffic control signal as follows:

Location:

Date(s) of Operation:

This permit is issued to, and accepted by, \_\_\_\_\_, hereinafter known as the Permittee, as follows:

The operation and maintenance of this portable traffic control signal by the Permittee shall be in accordance with requirements contained on the attached sheets and application, PennDOT's figures governing the use of portable traffic control signals as contained in PennDOT Publication 213, and the following special requirements:

All work performed by the Permittee with respect to the operation and maintenance of this portable traffic control signal shall be under and subject to the direction of PennDOT. The said Permittee shall use due diligence in the execution of the work authorized under this permit and shall not obstruct or endanger travel along the said road. All operations must be conducted so as to permit safe and reasonable free travel at all times over the road within the limits of the work herein permitted.

The Permittee agrees to indemnify, save harmless and defend (if requested) the Commonwealth of Pennsylvania, its agents, representatives and employees, from all suits, actions or claims of any character, name or description, damages, judgments, expenses, attorneys' fees and compensation arising out of personal injury, death or property damage, sustained or alleged to have been sustained in whole or in part by any and all persons whatsoever as a result of or arising out of any act, omission, neglect or misconduct of the Permittee, its officers, agents, contractors or employees, during the period of portable traffic control signal usage.

PennDOT reserves the right to revoke this permit or to suspend the operation of the portable traffic control signal if the Permittee shall at any time willfully or negligently fail to comply with the conditions contained in this permit or PennDOT Publication 213, or fail to make any changes in the operation of this signal, or to remove it, when so ordered by PennDOT. The Permittee shall maintain the signal in a safe condition at all times. The Permittee shall not make any change in the operation of the portable traffic control signal as defined in the permit drawings without prior written approval of PennDOT. PennDOT reserves the right to inspect this portable traffic control signal usage at any time.

Date: \_\_\_\_\_

Approved: \_\_\_\_\_  
Secretary of Transportation  
Commonwealth of Pennsylvania

By: \_\_\_\_\_  
District Executive  
Pennsylvania Department of Transportation  
Engineering District \_\_\_\_\_



COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION

**NOTICE OF COMMENCEMENT FORM  
FOR PORTABLE TRAFFIC CONTROL SIGNAL USAGE**

*Notice is hereby given that portable traffic control signal usage will occur as follows:*

User Name: \_\_\_\_\_ Phone No.: (570) 239-5446

User Company: luzerne County Maintenance

Address: 23 Old Berwick Rd.

Drums, PA 18222-2802

DATE OF PORTABLE SIGNAL USAGE: Begin 5/1/2008 End 5/2/2008

**WORK LOCATION**

County: Luzerne Municipality: \_\_\_\_\_

On State Route (SR): 0029 Direction: NB/SB

From: Segment: 300 Offset: 3850

To: Segment: \_\_\_\_\_ Offset: \_\_\_\_\_

On Local Road: NA Direction: NA

From: \_\_\_\_\_ NA

To: \_\_\_\_\_ NA

**Description of Proposed Work:**

Bridge repair work.

Portable Traffic  
Signal Manufacturer: Horizon Signal  
Technologies

SQ2 Portable Traffic  
Control System  
Model: \_\_\_\_\_  
PennDOT  
Approval No.: HOR-005P

<b>Check all that apply</b>	<b>Criteria</b>
x	a. The operation will be a “stationary, short-term operation” as defined in PennDOT Publications 212 and 213.
x	b. The portable traffic control signals will be used to control one-lane, two-way traffic, and no more than two approaches to the work zone will be controlled by portable traffic control signals.
x	c. There will be no at-grade railroad crossing within the one-lane, two-way traffic section (between STOP HERE ON RED signs) and within 300 feet of a portable traffic control signal.
x	d. No roadway approach to the portable traffic control signal will be on a downgrade of 5% or more, if the normal speed limit is greater than 35 miles per hour.
x	e. There will be no intersections or uncontrolled commercial driveways within the one-lane, two-way traffic section.

If the portable traffic control signal will be operated solely in a manually-controlled mode of operation and Criteria a through e in the above table are satisfied (checked), the user must submit this completed Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

For repeated users of portable traffic control signals, PennDOT’s appropriate Engineering District Office, at its discretion, may issue a blanket portable traffic control signal permit covering multiple locations and dates of operation for up to a one-year period. These actions will only be considered by PennDOT’s appropriate Engineering District Office if that user has properly used portable traffic control signals in a safe and efficient manner within that District on numerous past occasions without problems and in compliance with PennDOT requirements, and with the understanding that all portable traffic control signal usage under the blanket permit will satisfy Criteria a through e in the above table. In the case of a blanket permit, the user must submit this completed Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.



**Notice of Commencement Form  
for Portable Traffic Control Signal Usage (Continued)**

The user certifies that Criteria a through e in the above table are satisfied, and the portable traffic control signal:

- \_\_\_\_\_ Will be operated solely in a manually-controlled mode of operation, and/or
  - \_\_\_\_\_ Will be operated in accordance with Blanket Permit No. \_\_\_\_\_
- 

The user certifies that the information provided on this form is true and correct.

The user certifies that the portable traffic control signals will be operated and maintained in compliance with PennDOT Publications 212 and 213, and the provisions of any portable traffic control signal permit as issued by PennDOT.

The user agrees that it will indemnify, save harmless and defend (if requested) the Commonwealth of Pennsylvania, its agents, representatives and employees, from all suits, actions or claims of any character, name or description, damages, judgments, expenses, attorneys' fees and compensation arising out of personal injury, death or property damage, sustained or alleged to have been sustained in whole or in part by any and all persons whatsoever as a result of or arising out of any act, omission, neglect or misconduct of the user, its officers, agents, contractors or employees, during the period of portable traffic control signal usage.

BY: \_\_\_\_\_  
Signature of User

\_\_\_\_\_  
Date



Insert 1st page of 11x17 inserts for Appendix E3





COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION

**APPLICATION FOR PERMIT TO OPERATE  
PORTABLE TRAFFIC CONTROL SIGNALS**

Applicant: Blair County Maintenance Phone No.: (814)969-7271

Address: 1598 North Juniata Street  
Hollidaysburg, PA 16648

**WORK LOCATION**

County: Blair Municipality: \_\_\_\_\_

On State Route (SR): 0764 Direction: NB / SB

From: Segment: 0050 Offset: \_\_\_\_\_

To: Segment: 0060 Offset: \_\_\_\_\_

On Local Road: NA Direction: NA

From: NA

To: NAS

Normal Speed Limit: 35 mph ADT: 11281 veh/day

Maximum Length of One-Lane, Two-Way Traffic Section Approx. 400 feet  
(Between STOP HERE ON RED Signs)

Date of Portable Signal Usage: Begin 04/17/2008 End 04/18/2008

Description of Proposed Work:  
- Bridge Repair work.

**Application for Permit to Operate  
Portable Traffic Control Signals (Continued)**

Proposed Method of Controlling Traffic Emerging from Driveways within One-Lane, Two-Way Traffic Section:

Portable Traffic Signal Manufacturer: Horizon Signal Technologies Model: SQ@ Portable Traffic Control System  
 PennDOT Approval No.: HOR-005P

Mode of Operation: Manual  Fixed Time  Actuated

Interconnection: Hard Wire \_\_\_\_\_ Radio  None (Quartz Timers) \_\_\_\_\_

Other (Please describe) \_\_\_\_\_

Name of Emergency

Contact Person: \_\_\_\_\_ Phone No.: \_\_\_\_\_  
 (Must be available 24 hrs./day, 7 days/week during period of portable signal usage.)

Check all that apply	Criteria
x	a. The operation will be a “stationary, short-term operation” as defined in PennDOT Publications 212 and 213.
x	b. The portable traffic control signals will be used to control one-lane, two-way traffic, and no more than two approaches to the work zone will be controlled by portable traffic control signals.
x	c. There will be no at-grade railroad crossing within the one-lane, two-way traffic section (between STOP HERE ON RED signs) and within 300 feet of a portable traffic control signal.
x	d. No roadway approach to the portable traffic control signal will be on a downgrade of 5% or more, if the normal speed limit is greater than 35 miles per hour.

Check all that apply	Criteria (Continued)										
x	e. There will be no intersections or uncontrolled commercial driveways within the one-lane, two-way traffic section.										
	f. The roadway ADT (average daily traffic) and length of one-way, two-way traffic section (between STOP HERE ON RED signs) meet one of the following conditions: <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="text-align: center;">Maximum ADT (VEH./DAY) *</th> <th style="text-align: center;">Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">4,000 (6,500*)</td> <td style="text-align: center;">1,000</td> </tr> <tr> <td style="text-align: center;">5,000 (7,500*)</td> <td style="text-align: center;">750</td> </tr> <tr> <td style="text-align: center;">6,000 (9,000*)</td> <td style="text-align: center;">500</td> </tr> <tr> <td style="text-align: center;">7,000 (11,000*)</td> <td style="text-align: center;">300</td> </tr> </tbody> </table> <p>* NOTE: These higher maximum ADT values are only applicable if portable traffic control signal usage will be limited to non-peak hours (i.e., other than 7:00 to 9:00 AM and 4:00 to 6:00 PM).</p>	Maximum ADT (VEH./DAY) *	Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)	4,000 (6,500*)	1,000	5,000 (7,500*)	750	6,000 (9,000*)	500	7,000 (11,000*)	300
Maximum ADT (VEH./DAY) *	Maximum Accompanying Length of One-Lane, Two-Way Traffic Section (FT.)										
4,000 (6,500*)	1,000										
5,000 (7,500*)	750										
6,000 (9,000*)	500										
7,000 (11,000*)	300										

To be considered for approval, submit this completed application to PennDOT’s appropriate Engineering District Office as early as possible. It must be received by PennDOT at least 15 working days prior to the desired beginning date of portable traffic control signal usage to enable PennDOT to respond before that desired starting date of usage.

Except as provided below, this completed application must be accompanied by a site-specific plan indicating the proposed work zone traffic control, portable traffic control signal locations, and operation (phasing, timing, etc.) taking into account work operations, roadway geometry, nearby intersections and driveways, and other pertinent factors. The plan should be prepared in accordance with the guidelines contained in PennDOT Publication 149M, and the available sight distance to each signal shall be indicated.

If **all** of the criteria (Criteria a through f) in the above table are satisfied (checked), a site-specific may not be required.

If the portable traffic control signal will be operated solely in a manually-controlled mode of operation and Criteria a through e in the above table are satisfied (checked), a completed application, a portable traffic control signal permit, and a site-specific plan will not be required. However, the user must submit a Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

For repeated users of portable traffic control signals, PennDOT's appropriate Engineering District Office, at its discretion, may waive the need for a site-specific plan and/or may issue a blanket portable traffic control signal permit covering multiple locations and dates of operation for up to a one-year period. These actions will only be considered by PennDOT's appropriate Engineering District Office if that user has properly used portable traffic control signals in a safe and efficient manner within that District on numerous past occasions without problems and in compliance with PennDOT requirements, and with the understanding that all portable traffic control signal usage under the blanket permit will satisfy Criteria a through e in the above table. In the case of a blanket permit, the user must submit a Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

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The applicant certifies that the information provided on this application and accompanying documents is true and correct.

The applicant certifies that, if approved, the portable traffic control signals will be operated and maintained in compliance with PennDOT Publications 212 and 213, and the provisions of the portable traffic control signal permit as issued by PennDOT.

The applicant agrees that it will indemnify, save harmless and defend (if requested) the Commonwealth of Pennsylvania, its agents, representatives and employees, from all suits, actions or claims of any character, name or description, damages, judgments, expenses, attorneys' fees and compensation arising out of personal injury, death or property damage, sustained or alleged to have been sustained in whole or in part by any and all persons whatsoever as a result of or arising out of any act, omission, neglect or misconduct of the applicant, its officers, agents, contractors or employees, during the period of portable traffic control signal usage.

BY: \_\_\_\_\_  
Signature of Applicant Date

Sworn before me this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_

Notary: \_\_\_\_\_





COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION

Permit No. \_\_\_\_\_  
Sheet 1 of \_\_\_\_\_

### PORTABLE TRAFFIC CONTROL SIGNAL PERMIT

In accordance with the Vehicle Code, the Pennsylvania Department of Transportation (PennDOT) hereby approves the operation of a portable traffic control signal as follows:

Location:

Date(s) of Operation:

This permit is issued to, and accepted by, \_\_\_\_\_, hereinafter known as the Permittee, as follows:

The operation and maintenance of this portable traffic control signal by the Permittee shall be in accordance with requirements contained on the attached sheets and application, PennDOT's figures governing the use of portable traffic control signals as contained in PennDOT Publication 213, and the following special requirements:

All work performed by the Permittee with respect to the operation and maintenance of this portable traffic control signal shall be under and subject to the direction of PennDOT. The said Permittee shall use due diligence in the execution of the work authorized under this permit and shall not obstruct or endanger travel along the said road. All operations must be conducted so as to permit safe and reasonable free travel at all times over the road within the limits of the work herein permitted.

The Permittee agrees to indemnify, save harmless and defend (if requested) the Commonwealth of Pennsylvania, its agents, representatives and employees, from all suits, actions or claims of any character, name or description, damages, judgments, expenses, attorneys' fees and compensation arising out of personal injury, death or property damage, sustained or alleged to have been sustained in whole or in part by any and all persons whatsoever as a result of or arising out of any act, omission, neglect or misconduct of the Permittee, its officers, agents, contractors or employees, during the period of portable traffic control signal usage.

PennDOT reserves the right to revoke this permit or to suspend the operation of the portable traffic control signal if the Permittee shall at any time willfully or negligently fail to comply with the conditions contained in this permit or PennDOT Publication 213, or fail to make any changes in the operation of this signal, or to remove it, when so ordered by PennDOT. The Permittee shall maintain the signal in a safe condition at all times. The Permittee shall not make any change in the operation of the portable traffic control signal as defined in the permit drawings without prior written approval of PennDOT. PennDOT reserves the right to inspect this portable traffic control signal usage at any time.

Date: \_\_\_\_\_

Approved: \_\_\_\_\_  
Secretary of Transportation  
Commonwealth of Pennsylvania

By: \_\_\_\_\_  
District Executive  
Pennsylvania Department of Transportation  
Engineering District \_\_\_\_\_



COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF TRANSPORTATION

**NOTICE OF COMMENCEMENT FORM  
FOR PORTABLE TRAFFIC CONTROL SIGNAL USAGE**

*Notice is hereby given that portable traffic control signal usage will occur as follows:*

User Name: \_\_\_\_\_ Phone No.: (814)696-7271

User Company: Blair County Maintenance

Address: 1598 North Juniata Street

Hollidaysburg, PA 16648

DATE OF PORTABLE SIGNAL USAGE: Begin 04/14/2008 End 04/18/2008

**WORK LOCATION**

County: Blair Municipality: \_\_\_\_\_

On State Route (SR): 0764 Direction: NB / SB

From: Segment: 0050 Offset: \_\_\_\_\_

To: Segment: 0060 Offset: \_\_\_\_\_

On Local Road: NA Direction: NA

From: NA

To: NA

**Description of Proposed Work:**

Portable Traffic Signal Manufacturer: Horizon Signal Technologies

Model: SQ2 Portable Traffic Control System  
PennDOT  
Approval No.: HOR-005p

<b>Check all that apply</b>	<b>Criteria</b>
x	a. The operation will be a “stationary, short-term operation” as defined in PennDOT Publications 212 and 213.
x	b. The portable traffic control signals will be used to control one-lane, two-way traffic, and no more than two approaches to the work zone will be controlled by portable traffic control signals.
x	c. There will be no at-grade railroad crossing within the one-lane, two-way traffic section (between STOP HERE ON RED signs) and within 300 feet of a portable traffic control signal.
x	d. No roadway approach to the portable traffic control signal will be on a downgrade of 5% or more, if the normal speed limit is greater than 35 miles per hour.
x	e. There will be no intersections or uncontrolled commercial driveways within the one-lane, two-way traffic section.

If the portable traffic control signal will be operated solely in a manually-controlled mode of operation and Criteria a through e in the above table are satisfied (checked), the user must submit this completed Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

For repeated users of portable traffic control signals, PennDOT’s appropriate Engineering District Office, at its discretion, may issue a blanket portable traffic control signal permit covering multiple locations and dates of operation for up to a one-year period. These actions will only be considered by PennDOT’s appropriate Engineering District Office if that user has properly used portable traffic control signals in a safe and efficient manner within that District on numerous past occasions without problems and in compliance with PennDOT requirements, and with the understanding that all portable traffic control signal usage under the blanket permit will satisfy Criteria a through e in the above table. In the case of a blanket permit, the user must submit this completed Notice of Commencement Form to the appropriate PennDOT Engineering District Office so that it is received at least 72 hours before the desired beginning time of the portable traffic control signal usage at each specific site, except for emergency work as defined in PennDOT Publication 212.

**Notice of Commencement Form  
for Portable Traffic Control Signal Usage (Continued)**

The user certifies that Criteria a through e in the above table are satisfied, and the portable traffic control signal:

- \_\_\_\_\_ Will be operated solely in a manually-controlled mode of operation, and/or
- \_\_\_\_\_ Will be operated in accordance with Blanket Permit No. \_\_\_\_\_

---

The user certifies that the information provided on this form is true and correct.

The user certifies that the portable traffic control signals will be operated and maintained in compliance with PennDOT Publications 212 and 213, and the provisions of any portable traffic control signal permit as issued by PennDOT.

The user agrees that it will indemnify, save harmless and defend (if requested) the Commonwealth of Pennsylvania, its agents, representatives and employees, from all suits, actions or claims of any character, name or description, damages, judgments, expenses, attorneys' fees and compensation arising out of personal injury, death or property damage, sustained or alleged to have been sustained in whole or in part by any and all persons whatsoever as a result of or arising out of any act, omission, neglect or misconduct of the user, its officers, agents, contractors or employees, during the period of portable traffic control signal usage.

BY: \_\_\_\_\_  
Signature of User

\_\_\_\_\_  
Date

Insert second page from 11x17 inserts for Appendix E3



## Appendix I Site Assessments– Volume and Speed Data

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6830  
 Street: SR 764  
 State: PA  
 City: Duncansville  
 County:

Begin: Apr/14/2008 02:00:00 PM  
 Lane: SB  
 Oper: REB  
 Posted: 30  
 AADT Factor: 1

End: Apr/15/2008 02:00:00 PM  
 Hours: 24.00  
 Period: 15  
 Raw Count: 6712  
 AADT Count: 6,712

Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry
Mon, Apr/14/2008				
[14:00-14:15]	145	19 MPH	76 F	Dry
[14:15-14:30]	157	19 MPH	76 F	Dry
[14:30-14:45]	172	19 MPH	76 F	Dry
[14:45-15:00]	126	21 MPH	76 F	Dry
[15:00-15:15]	97	29 MPH	76 F	Dry
[15:15-15:30]	103	34 MPH	74 F	Dry
[15:30-15:45]	109	34 MPH	76 F	Dry
[15:45-16:00]	107	35 MPH	74 F	Dry
[16:00-16:15]	125	35 MPH	72 F	Dry
[16:15-16:30]	140	34 MPH	70 F	Dry
[16:30-16:45]	113	36 MPH	70 F	Dry
[16:45-17:00]	101	32 MPH	72 F	Dry
[17:00-17:15]	124	35 MPH	70 F	Dry
[17:15-17:30]	117	35 MPH	70 F	Dry
[17:30-17:45]	92	37 MPH	68 F	Dry
[17:45-18:00]	76	36 MPH	68 F	Dry
[18:00-18:15]	96	36 MPH	66 F	Dry
[18:15-18:30]	73	35 MPH	64 F	Dry
[18:30-18:45]	58	37 MPH	62 F	Dry
[18:45-19:00]	48	37 MPH	60 F	Dry
[19:00-19:15]	52	36 MPH	58 F	Dry
[19:15-19:30]	43	34 MPH	58 F	Dry
[19:30-19:45]	53	37 MPH	56 F	Dry
[19:45-20:00]	34	35 MPH	54 F	Dry
[20:00-20:15]	40	39 MPH	54 F	Dry
[20:15-20:30]	45	32 MPH	52 F	Dry
[20:30-20:45]	25	34 MPH	52 F	Dry
[20:45-21:00]	37	34 MPH	52 F	Dry
[21:00-21:15]	35	32 MPH	52 F	Dry
[21:15-21:30]	38	36 MPH	50 F	Dry
[21:30-21:45]	47	33 MPH	50 F	Dry
[21:45-22:00]	60	35 MPH	50 F	Dry
[22:00-22:15]	24	29 MPH	48 F	Dry
[22:15-22:30]	29	34 MPH	48 F	Dry
[22:30-22:45]	23	40 MPH	46 F	Dry
[22:45-23:00]	17	29 MPH	46 F	Dry



**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6830 Street: SR 764 State: PA City: Duncansville County:		Begin: Apr/14/2008 02:00:00 PM Lane: SB Oper: REB Posted: 30 AADT Factor: 1		End: Apr/15/2008 02:00:00 PM Hours: 24.00 Period: 15 Raw Count: 6712 AADT Count: 6,712	
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry	

Mon, Apr/14/2008

[23:00-23:15]	16	45 MPH	44 F	Dry
[23:15-23:30]	25	30 MPH	44 F	Dry
[23:30-23:45]	14	30 MPH	44 F	Dry
[23:45-00:00]	13	29 MPH	42 F	Dry

Mon, Apr/14/2008

2849 34 MPH 60 F

Tue, Apr/15/2008

[00:00-00:15]	19	43 MPH	42 F	Dry
[00:15-00:30]	11	25 MPH	42 F	Dry
[00:30-00:45]	9	24 MPH	42 F	Dry
[00:45-01:00]	12	34 MPH	42 F	Dry
[01:00-01:15]	4	31 MPH	42 F	Dry
[01:15-01:30]	4	31 MPH	42 F	Dry
[01:30-01:45]	6	32 MPH	41 F	Dry
[01:45-02:00]	4	23 MPH	41 F	Dry
[02:00-02:15]	8	36 MPH	39 F	Dry
[02:15-02:30]	3	35 MPH	39 F	Dry
[02:30-02:45]	8	35 MPH	39 F	Dry
[02:45-03:00]	5	31 MPH	39 F	Dry
[03:00-03:15]	13	33 MPH	39 F	Dry
[03:15-03:30]	8	40 MPH	39 F	Dry
[03:30-03:45]	7	29 MPH	39 F	Dry
[03:45-04:00]	13	34 MPH	39 F	Dry
[04:00-04:15]	15	37 MPH	37 F	Dry
[04:15-04:30]	22	36 MPH	37 F	Dry
[04:30-04:45]	21	36 MPH	37 F	Dry
[04:45-05:00]	17	34 MPH	37 F	Dry
[05:00-05:15]	18	32 MPH	37 F	Dry
[05:15-05:30]	34	32 MPH	37 F	Dry
[05:30-05:45]	38	39 MPH	37 F	Dry
[05:45-06:00]	56	30 MPH	37 F	Dry
[06:00-06:15]	49	32 MPH	35 F	Dry
[06:15-06:30]	63	39 MPH	35 F	Dry
[06:30-06:45]	64	32 MPH	35 F	Dry
[06:45-07:00]	72	38 MPH	35 F	Dry
[07:00-07:15]	47	36 MPH	37 F	Dry
[07:15-07:30]	77	36 MPH	39 F	Dry

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6830 Street: SR 764 State: PA City: Duncansville County:		Begin: Apr/14/2008 02:00:00 PM Lane: SB Oper: REB Posted: 30 AADT Factor: 1		End: Apr/15/2008 02:00:00 PM Hours: 24.00 Period: 15 Raw Count: 6712 AADT Count: 6,712													
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry													
Tue, Apr/15/2008																	
[07:30-07:45]	88	36 MPH	41 F	Dry													
[07:45-08:00]	119	34 MPH	42 F	Dry													
[08:00-08:15]	84	32 MPH	44 F	Dry													
[08:15-08:30]	111	21 MPH	48 F	Dry													
[08:30-08:45]	151	19 MPH	50 F	Dry													
[08:45-09:00]	148	20 MPH	52 F	Dry													
[09:00-09:15]	134	20 MPH	52 F	Dry													
[09:15-09:30]	126	19 MPH	50 F	Dry													
[09:30-09:45]	112	17 MPH	50 F	Dry													
[09:45-10:00]	116	18 MPH	54 F	Dry													
[10:00-10:15]	125	18 MPH	60 F	Dry													
[10:15-10:30]	117	18 MPH	66 F	Dry													
[10:30-10:45]	90	17 MPH	76 F	Dry													
[10:45-11:00]	135	17 MPH	76 F	Dry													
[11:00-11:15]	122	18 MPH	76 F	Dry													
[11:15-11:30]	148	16 MPH	78 F	Dry													
[11:30-11:45]	146	18 MPH	80 F	Dry													
[11:45-12:00]	149	17 MPH	82 F	Dry													
[12:00-12:15]	136	18 MPH	83 F	Dry													
[12:15-12:30]	101	19 MPH	85 F	Dry													
[12:30-12:45]	66	27 MPH	87 F	Dry													
[12:45-13:00]	82	26 MPH	89 F	Dry													
[13:00-13:15]	100	20 MPH	91 F	Dry													
[13:15-13:30]	157	17 MPH	89 F	Dry													
[13:30-13:45]	136	17 MPH	89 F	Dry													
[13:45-14:00]	137	18 MPH	91 F	Dry													
Tue, Apr/15/2008																	
		3863	31 MPH	52 F													
<table border="1"> <tr> <td>Apr/14/2008 02:00:00 PM</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Apr/15/2008 02:00:00 PM</td> <td>6712</td> <td>32 MPH</td> <td>56 F</td> <td colspan="2"></td> </tr> </table>						Apr/14/2008 02:00:00 PM						Apr/15/2008 02:00:00 PM	6712	32 MPH	56 F		
Apr/14/2008 02:00:00 PM																	
Apr/15/2008 02:00:00 PM	6712	32 MPH	56 F														

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6690 Street: SR 29 State: Pa City: County: Luzerne		Begin: May/01/2008 11:00:00 AM Lane: NB Oper: ARK Posted: 00 AADT Factor: 1		End: May/02/2008 04:00:00 PM Hours: 29.00 Period: 15 Raw Count: 4655 AADT Count: 3,852	
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry	

Thu, May/01/2008

[11:00-11:15]	40	19 MPH	83 F	Dry	
[11:15-11:30]	44	19 MPH	85 F	Dry	
[11:30-11:45]	47	26 MPH	87 F	Dry	
[11:45-12:00]	42	23 MPH	91 F	Dry	
[12:00-12:15]	56	21 MPH	89 F	Dry	
[12:15-12:30]	44	23 MPH	93 F	Dry	
[12:30-12:45]	56	21 MPH	91 F	Dry	
[12:45-13:00]	50	21 MPH	91 F	Dry	
[13:00-13:15]	44	22 MPH	93 F	Dry	
[13:15-13:30]	22	21 MPH	87 F	Dry	
[13:30-13:45]	1	0 MPH	82 F	Dry	
[13:45-14:00]	18	0 MPH	78 F	Dry	
[14:00-14:15]	0	0 MPH	76 F	Dry	
[14:15-14:30]	129	27 MPH	76 F	Dry	
[14:30-14:45]	337	43 MPH	76 F	Dry	
[14:45-15:00]	180	46 MPH	76 F	Dry	
[15:00-15:15]	80	41 MPH	76 F	Dry	
[15:15-15:30]	214	39 MPH	76 F	Dry	
[15:30-15:45]	147	32 MPH	76 F	Dry	
[15:45-16:00]	260	46 MPH	78 F	Dry	
[16:00-16:15]	0	0 MPH	78 F	Dry	
[16:15-16:30]	0	0 MPH	78 F	Dry	
[16:30-16:45]	0	0 MPH	76 F	Dry	
[16:45-17:00]	0	0 MPH	76 F	Dry	
[17:00-17:15]	0	0 MPH	76 F	Dry	
[17:15-17:30]	0	0 MPH	76 F	Dry	
[17:30-17:45]	0	0 MPH	74 F	Dry	
[17:45-18:00]	0	0 MPH	72 F	Dry	
[18:00-18:15]	0	0 MPH	70 F	Dry	
[18:15-18:30]	0	0 MPH	70 F	Dry	
[18:30-18:45]	0	0 MPH	68 F	Dry	
[18:45-19:00]	0	0 MPH	68 F	Dry	
[19:00-19:15]	0	0 MPH	66 F	Dry	
[19:15-19:30]	0	0 MPH	66 F	Dry	
[19:30-19:45]	0	0 MPH	64 F	Dry	
[19:45-20:00]	0	0 MPH	64 F	Dry	

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6690 Street: SR 29 State: Pa City: County: Luzerne		Begin: May/01/2008 11:00:00 AM Lane: NB Oper: ARK Posted: 00 AADT Factor: 1		End: May/02/2008 04:00:00 PM Hours: 29.00 Period: 15 Raw Count: 4655 AADT Count: 3,852	
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry	

Thu, May/01/2008

[20:00-20:15]	0	0 MPH	62 F	Dry
[20:15-20:30]	0	0 MPH	62 F	Dry
[20:30-20:45]	0	0 MPH	62 F	Dry
[20:45-21:00]	0	0 MPH	60 F	Dry
[21:00-21:15]	0	0 MPH	60 F	Dry
[21:15-21:30]	0	0 MPH	58 F	Dry
[21:30-21:45]	0	0 MPH	58 F	Dry
[21:45-22:00]	0	0 MPH	58 F	Dry
[22:00-22:15]	0	0 MPH	56 F	Dry
[22:15-22:30]	0	0 MPH	56 F	Dry
[22:30-22:45]	0	0 MPH	56 F	Dry
[22:45-23:00]	0	0 MPH	56 F	Dry
[23:00-23:15]	0	0 MPH	56 F	Dry
[23:15-23:30]	0	0 MPH	54 F	Dry
[23:30-23:45]	0	0 MPH	54 F	Dry
[23:45-00:00]	0	0 MPH	54 F	Dry

Thu, May/01/2008

1811 0 MPH 72 F

Fri, May/02/2008

[00:00-00:15]	0	0 MPH	54 F	Dry
[00:15-00:30]	0	0 MPH	54 F	Dry
[00:30-00:45]	0	0 MPH	54 F	Dry
[00:45-01:00]	0	0 MPH	52 F	Dry
[01:00-01:15]	0	0 MPH	52 F	Dry
[01:15-01:30]	0	0 MPH	52 F	Dry
[01:30-01:45]	0	0 MPH	52 F	Dry
[01:45-02:00]	0	0 MPH	52 F	Dry
[02:00-02:15]	0	0 MPH	52 F	Dry
[02:15-02:30]	0	0 MPH	52 F	Dry
[02:30-02:45]	0	0 MPH	52 F	Dry
[02:45-03:00]	0	0 MPH	52 F	Dry
[03:00-03:15]	0	0 MPH	52 F	Dry
[03:15-03:30]	0	0 MPH	52 F	Dry
[03:30-03:45]	0	0 MPH	50 F	Dry
[03:45-04:00]	0	0 MPH	50 F	Dry
[04:00-04:15]	0	0 MPH	50 F	Dry
[04:15-04:30]	0	0 MPH	50 F	Dry

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6690 Street: SR 29 State: Pa City: County: Luzerne	Begin: May/01/2008 11:00:00 AM Lane: NB Oper: ARK Posted: 00 AADT Factor: 1	End: May/02/2008 04:00:00 PM Hours: 29.00 Period: 15 Raw Count: 4655 AADT Count: 3,852		
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry

Fri, May/02/2008

[04:30-04:45]	0	0 MPH	50 F	Dry
[04:45-05:00]	0	0 MPH	50 F	Dry
[05:00-05:15]	0	0 MPH	50 F	Dry
[05:15-05:30]	0	0 MPH	48 F	Dry
[05:30-05:45]	0	0 MPH	48 F	Dry
[05:45-06:00]	0	0 MPH	48 F	Dry
[06:00-06:15]	0	0 MPH	48 F	Dry
[06:15-06:30]	0	0 MPH	48 F	Dry
[06:30-06:45]	0	0 MPH	48 F	Dry
[06:45-07:00]	0	0 MPH	48 F	Dry
[07:00-07:15]	0	0 MPH	48 F	Dry
[07:15-07:30]	0	0 MPH	48 F	Dry
[07:30-07:45]	0	0 MPH	48 F	Dry
[07:45-08:00]	0	0 MPH	48 F	Dry
[08:00-08:15]	0	0 MPH	48 F	Dry
[08:15-08:30]	211	49 MPH	48 F	Dry
[08:30-08:45]	282	57 MPH	50 F	Dry
[08:45-09:00]	435	58 MPH	52 F	Dry
[09:00-09:15]	184	52 MPH	52 F	Dry
[09:15-09:30]	334	60 MPH	54 F	Dry
[09:30-09:45]	304	59 MPH	56 F	Dry
[09:45-10:00]	361	60 MPH	58 F	Dry
[10:00-10:15]	211	56 MPH	60 F	Dry
[10:15-10:30]	323	58 MPH	62 F	Dry
[10:30-10:45]	197	56 MPH	64 F	Dry
[10:45-11:00]	2	0 MPH	66 F	Dry
[11:00-11:15]	0	0 MPH	66 F	Dry
[11:15-11:30]	0	0 MPH	68 F	Dry
[11:30-11:45]	0	0 MPH	68 F	Dry
[11:45-12:00]	0	0 MPH	68 F	Dry
[12:00-12:15]	0	0 MPH	70 F	Dry
[12:15-12:30]	0	0 MPH	70 F	Dry
[12:30-12:45]	0	0 MPH	70 F	Dry
[12:45-13:00]	0	0 MPH	70 F	Dry
[13:00-13:15]	0	0 MPH	70 F	Dry
[13:15-13:30]	0	0 MPH	70 F	Dry

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6690 Street: SR 29 State: Pa City: County: Luzerne		Begin: May/01/2008 11:00:00 AM Lane: NB Oper: ARK Posted: 00 AADT Factor: 1		End: May/02/2008 04:00:00 PM Hours: 29.00 Period: 15 Raw Count: 4655 AADT Count: 3,852	
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry	
Fri, May/02/2008					
[13:30-13:45]	0	0 MPH	70 F	Dry	
[13:45-14:00]	0	0 MPH	72 F	Dry	
[14:00-14:15]	0	0 MPH	72 F	Dry	
[14:15-14:30]	0	0 MPH	72 F	Dry	
[14:30-14:45]	0	0 MPH	72 F	Dry	
[14:45-15:00]	0	0 MPH	72 F	Dry	
[15:00-15:15]	0	0 MPH	72 F	Dry	
[15:15-15:30]	0	0 MPH	72 F	Dry	
[15:30-15:45]	0	0 MPH	72 F	Dry	
[15:45-16:00]	0	0 MPH	72 F	Dry	
Fri, May/02/2008		2844	0 MPH	58 F	
May/01/2008 11:00:00 AM		4655	0 MPH	64 F	
May/02/2008 04:00:00 PM					

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6546 Street: SR 29 State: Pa City: County: Luzerne		Begin: May/01/2008 11:00:00 AM Lane: SB Oper: ARK Posted: 00 AADT Factor: 1		End: May/02/2008 04:00:00 PM Hours: 29.00 Period: 15 Raw Count: 5938 AADT Count: 4,914	
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry	

Thu, May/01/2008

[11:00-11:15]	45	20 MPH	78 F	Dry	
[11:15-11:30]	44	19 MPH	82 F	Dry	
[11:30-11:45]	47	21 MPH	83 F	Dry	
[11:45-12:00]	43	22 MPH	87 F	Dry	
[12:00-12:15]	53	19 MPH	85 F	Dry	
[12:15-12:30]	48	21 MPH	89 F	Dry	
[12:30-12:45]	55	19 MPH	89 F	Dry	
[12:45-13:00]	52	19 MPH	89 F	Dry	
[13:00-13:15]	42	20 MPH	91 F	Dry	
[13:15-13:30]	29	21 MPH	87 F	Dry	
[13:30-13:45]	0	0 MPH	83 F	Dry	
[13:45-14:00]	34	31 MPH	78 F	Dry	
[14:00-14:15]	0	0 MPH	76 F	Dry	
[14:15-14:30]	129	37 MPH	76 F	Dry	
[14:30-14:45]	346	47 MPH	76 F	Dry	
[14:45-15:00]	225	50 MPH	76 F	Dry	
[15:00-15:15]	210	48 MPH	76 F	Dry	
[15:15-15:30]	334	50 MPH	76 F	Dry	
[15:30-15:45]	187	49 MPH	78 F	Dry	
[15:45-16:00]	290	50 MPH	78 F	Dry	
[16:00-16:15]	0	0 MPH	78 F	Dry	
[16:15-16:30]	0	0 MPH	78 F	Dry	
[16:30-16:45]	0	0 MPH	76 F	Dry	
[16:45-17:00]	0	0 MPH	76 F	Dry	
[17:00-17:15]	0	0 MPH	76 F	Dry	
[17:15-17:30]	0	0 MPH	76 F	Dry	
[17:30-17:45]	0	0 MPH	74 F	Dry	
[17:45-18:00]	0	0 MPH	72 F	Dry	
[18:00-18:15]	0	0 MPH	70 F	Dry	
[18:15-18:30]	0	0 MPH	70 F	Dry	
[18:30-18:45]	0	0 MPH	68 F	Dry	
[18:45-19:00]	0	0 MPH	68 F	Dry	
[19:00-19:15]	0	0 MPH	66 F	Dry	
[19:15-19:30]	0	0 MPH	66 F	Dry	
[19:30-19:45]	0	0 MPH	64 F	Dry	
[19:45-20:00]	0	0 MPH	64 F	Dry	

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6546 Street: SR 29 State: Pa City: County: Luzerne		Begin: May/01/2008 11:00:00 AM Lane: SB Oper: ARK Posted: 00 AADT Factor: 1		End: May/02/2008 04:00:00 PM Hours: 29.00 Period: 15 Raw Count: 5938 AADT Count: 4,914	
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry	

Thu, May/01/2008

[20:00-20:15]	0	0 MPH	62 F	Dry
[20:15-20:30]	0	0 MPH	62 F	Dry
[20:30-20:45]	0	0 MPH	62 F	Dry
[20:45-21:00]	0	0 MPH	60 F	Dry
[21:00-21:15]	0	0 MPH	60 F	Dry
[21:15-21:30]	0	0 MPH	58 F	Dry
[21:30-21:45]	0	0 MPH	58 F	Dry
[21:45-22:00]	0	0 MPH	58 F	Dry
[22:00-22:15]	0	0 MPH	58 F	Dry
[22:15-22:30]	0	0 MPH	56 F	Dry
[22:30-22:45]	0	0 MPH	56 F	Dry
[22:45-23:00]	0	0 MPH	56 F	Dry
[23:00-23:15]	0	0 MPH	56 F	Dry
[23:15-23:30]	0	0 MPH	54 F	Dry
[23:30-23:45]	0	0 MPH	54 F	Dry
[23:45-00:00]	0	0 MPH	54 F	Dry

Thu, May/01/2008

2213 0 MPH 71 F

Fri, May/02/2008

[00:00-00:15]	0	0 MPH	54 F	Dry
[00:15-00:30]	0	0 MPH	54 F	Dry
[00:30-00:45]	0	0 MPH	54 F	Dry
[00:45-01:00]	0	0 MPH	54 F	Dry
[01:00-01:15]	0	0 MPH	52 F	Dry
[01:15-01:30]	0	0 MPH	52 F	Dry
[01:30-01:45]	0	0 MPH	52 F	Dry
[01:45-02:00]	0	0 MPH	52 F	Dry
[02:00-02:15]	0	0 MPH	52 F	Dry
[02:15-02:30]	0	0 MPH	52 F	Dry
[02:30-02:45]	0	0 MPH	52 F	Dry
[02:45-03:00]	0	0 MPH	52 F	Dry
[03:00-03:15]	0	0 MPH	52 F	Dry
[03:15-03:30]	0	0 MPH	52 F	Dry
[03:30-03:45]	0	0 MPH	50 F	Dry
[03:45-04:00]	0	0 MPH	50 F	Dry
[04:00-04:15]	0	0 MPH	50 F	Dry
[04:15-04:30]	0	0 MPH	50 F	Dry



**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6546 Street: SR 29 State: Pa City: County: Luzerne	Begin: May/01/2008 11:00:00 AM Lane: SB Oper: ARK Posted: 00 AADT Factor: 1	End: May/02/2008 04:00:00 PM Hours: 29.00 Period: 15 Raw Count: 5938 AADT Count: 4,914		
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry

Fri, May/02/2008

[04:30-04:45]	0	0 MPH	50 F	Dry
[04:45-05:00]	0	0 MPH	50 F	Dry
[05:00-05:15]	0	0 MPH	50 F	Dry
[05:15-05:30]	0	0 MPH	50 F	Dry
[05:30-05:45]	0	0 MPH	50 F	Dry
[05:45-06:00]	0	0 MPH	48 F	Dry
[06:00-06:15]	0	0 MPH	48 F	Dry
[06:15-06:30]	0	0 MPH	48 F	Dry
[06:30-06:45]	0	0 MPH	48 F	Dry
[06:45-07:00]	0	0 MPH	48 F	Dry
[07:00-07:15]	0	0 MPH	48 F	Dry
[07:15-07:30]	0	0 MPH	48 F	Dry
[07:30-07:45]	0	0 MPH	48 F	Dry
[07:45-08:00]	0	0 MPH	48 F	Dry
[08:00-08:15]	0	0 MPH	48 F	Dry
[08:15-08:30]	262	53 MPH	50 F	Dry
[08:30-08:45]	378	45 MPH	52 F	Dry
[08:45-09:00]	353	46 MPH	52 F	Dry
[09:00-09:15]	214	45 MPH	54 F	Dry
[09:15-09:30]	521	48 MPH	56 F	Dry
[09:30-09:45]	485	46 MPH	58 F	Dry
[09:45-10:00]	506	48 MPH	60 F	Dry
[10:00-10:15]	368	45 MPH	62 F	Dry
[10:15-10:30]	411	46 MPH	64 F	Dry
[10:30-10:45]	222	50 MPH	66 F	Dry
[10:45-11:00]	5	0 MPH	66 F	Dry
[11:00-11:15]	0	0 MPH	68 F	Dry
[11:15-11:30]	0	0 MPH	68 F	Dry
[11:30-11:45]	0	0 MPH	68 F	Dry
[11:45-12:00]	0	0 MPH	70 F	Dry
[12:00-12:15]	0	0 MPH	70 F	Dry
[12:15-12:30]	0	0 MPH	70 F	Dry
[12:30-12:45]	0	0 MPH	70 F	Dry
[12:45-13:00]	0	0 MPH	70 F	Dry
[13:00-13:15]	0	0 MPH	70 F	Dry
[13:15-13:30]	0	0 MPH	72 F	Dry

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6546 Street: SR 29 State: Pa City: County: Luzerne		Begin: May/01/2008 11:00:00 AM Lane: SB Oper: ARK Posted: 00 AADT Factor: 1		End: May/02/2008 04:00:00 PM Hours: 29.00 Period: 15 Raw Count: 5938 AADT Count: 4,914	
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry	
Fri, May/02/2008					
[13:30-13:45]	0	0 MPH	72 F	Dry	
[13:45-14:00]	0	0 MPH	72 F	Dry	
[14:00-14:15]	0	0 MPH	72 F	Dry	
[14:15-14:30]	0	0 MPH	72 F	Dry	
[14:30-14:45]	0	0 MPH	72 F	Dry	
[14:45-15:00]	0	0 MPH	72 F	Dry	
[15:00-15:15]	0	0 MPH	72 F	Dry	
[15:15-15:30]	0	0 MPH	72 F	Dry	
[15:30-15:45]	0	0 MPH	72 F	Dry	
[15:45-16:00]	0	0 MPH	72 F	Dry	
Fri, May/02/2008		3725	0 MPH	58 F	
May/01/2008 11:00:00 AM					
May/02/2008 04:00:00 PM		5938	0 MPH	64 F	

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6843 Street: SR 764 State: PA City: Duncansville County:		Begin: Apr/14/2008 02:00:00 PM Lane: NB Oper: REB Posted: 30 AADT Factor: 1		End: Apr/15/2008 02:00:00 PM Hours: 24.00 Period: 15 Raw Count: 7088 AADT Count: 7,088	
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry	

Mon, Apr/14/2008

[14:00-14:15]	147	20 MPH	78 F	Dry	
[14:15-14:30]	158	19 MPH	76 F	Dry	
[14:30-14:45]	171	18 MPH	78 F	Dry	
[14:45-15:00]	141	19 MPH	76 F	Dry	
[15:00-15:15]	106	28 MPH	78 F	Dry	
[15:15-15:30]	119	33 MPH	76 F	Dry	
[15:30-15:45]	120	32 MPH	76 F	Dry	
[15:45-16:00]	110	34 MPH	76 F	Dry	
[16:00-16:15]	135	33 MPH	76 F	Dry	
[16:15-16:30]	153	30 MPH	72 F	Dry	
[16:30-16:45]	117	31 MPH	72 F	Dry	
[16:45-17:00]	119	32 MPH	72 F	Dry	
[17:00-17:15]	126	32 MPH	70 F	Dry	
[17:15-17:30]	123	32 MPH	70 F	Dry	
[17:30-17:45]	98	37 MPH	68 F	Dry	
[17:45-18:00]	86	34 MPH	66 F	Dry	
[18:00-18:15]	103	33 MPH	64 F	Dry	
[18:15-18:30]	78	34 MPH	64 F	Dry	
[18:30-18:45]	65	34 MPH	62 F	Dry	
[18:45-19:00]	55	35 MPH	60 F	Dry	
[19:00-19:15]	53	33 MPH	58 F	Dry	
[19:15-19:30]	45	33 MPH	56 F	Dry	
[19:30-19:45]	54	35 MPH	54 F	Dry	
[19:45-20:00]	41	35 MPH	54 F	Dry	
[20:00-20:15]	49	35 MPH	52 F	Dry	
[20:15-20:30]	47	34 MPH	52 F	Dry	
[20:30-20:45]	40	31 MPH	52 F	Dry	
[20:45-21:00]	44	35 MPH	50 F	Dry	
[21:00-21:15]	43	37 MPH	50 F	Dry	
[21:15-21:30]	40	35 MPH	50 F	Dry	
[21:30-21:45]	53	36 MPH	48 F	Dry	
[21:45-22:00]	77	33 MPH	48 F	Dry	
[22:00-22:15]	33	37 MPH	48 F	Dry	
[22:15-22:30]	32	33 MPH	46 F	Dry	
[22:30-22:45]	24	35 MPH	44 F	Dry	
[22:45-23:00]	23	34 MPH	44 F	Dry	

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6843 Street: SR 764 State: PA City: Duncansville County:		Begin: Apr/14/2008 02:00:00 PM Lane: NB Oper: REB Posted: 30 AADT Factor: 1		End: Apr/15/2008 02:00:00 PM Hours: 24.00 Period: 15 Raw Count: 7088 AADT Count: 7,088	
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry	

Mon, Apr/14/2008

[23:00-23:15]	15	33 MPH	44 F	Dry
[23:15-23:30]	25	35 MPH	42 F	Dry
[23:30-23:45]	16	33 MPH	42 F	Dry
[23:45-00:00]	16	35 MPH	42 F	Dry

Mon, Apr/14/2008

3100 33 MPH 60 F

Tue, Apr/15/2008

[00:00-00:15]	26	40 MPH	42 F	Dry
[00:15-00:30]	13	36 MPH	42 F	Dry
[00:30-00:45]	10	33 MPH	42 F	Dry
[00:45-01:00]	13	33 MPH	42 F	Dry
[01:00-01:15]	4	31 MPH	41 F	Dry
[01:15-01:30]	5	33 MPH	41 F	Dry
[01:30-01:45]	5	47 MPH	39 F	Dry
[01:45-02:00]	4	49 MPH	39 F	Dry
[02:00-02:15]	8	39 MPH	39 F	Dry
[02:15-02:30]	4	33 MPH	39 F	Dry
[02:30-02:45]	8	35 MPH	39 F	Dry
[02:45-03:00]	6	42 MPH	39 F	Dry
[03:00-03:15]	15	40 MPH	39 F	Dry
[03:15-03:30]	9	40 MPH	37 F	Dry
[03:30-03:45]	10	36 MPH	37 F	Dry
[03:45-04:00]	14	29 MPH	37 F	Dry
[04:00-04:15]	15	32 MPH	37 F	Dry
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[05:00-05:15]	17	37 MPH	35 F	Dry
[05:15-05:30]	36	32 MPH	35 F	Dry
[05:30-05:45]	44	36 MPH	35 F	Dry
[05:45-06:00]	61	34 MPH	35 F	Dry
[06:00-06:15]	51	33 MPH	35 F	Dry
[06:15-06:30]	59	34 MPH	35 F	Dry
[06:30-06:45]	67	34 MPH	35 F	Dry
[06:45-07:00]	72	34 MPH	35 F	Dry
[07:00-07:15]	51	35 MPH	35 F	Dry
[07:15-07:30]	78	35 MPH	37 F	Dry

**Date/Time/Volume/Average Speed/Temperature Report**

HI-Star ID: 6843 Street: SR 764 State: PA City: Duncansville County:		Begin: Apr/14/2008 02:00:00 PM Lane: NB Oper: REB Posted: 30 AADT Factor: 1		End: Apr/15/2008 02:00:00 PM Hours: 24.00 Period: 15 Raw Count: 7088 AADT Count: 7,088													
Date And Time Range	Period Volume	Average Speed	Roadway Temperature	Roadway Surface Wet/Dry													
Tue, Apr/15/2008																	
[07:30-07:45]	88	35 MPH	39 F	Dry													
[07:45-08:00]	126	33 MPH	42 F	Dry													
[08:00-08:15]	84	31 MPH	44 F	Dry													
[08:15-08:30]	119	19 MPH	48 F	Dry													
[08:30-08:45]	161	19 MPH	50 F	Dry													
[08:45-09:00]	144	20 MPH	48 F	Dry													
[09:00-09:15]	138	20 MPH	52 F	Dry													
[09:15-09:30]	125	19 MPH	58 F	Dry													
[09:30-09:45]	116	17 MPH	60 F	Dry													
[09:45-10:00]	116	17 MPH	62 F	Dry													
[10:00-10:15]	132	19 MPH	66 F	Dry													
[10:15-10:30]	108	17 MPH	72 F	Dry													
[10:30-10:45]	98	17 MPH	76 F	Dry													
[10:45-11:00]	132	17 MPH	76 F	Dry													
[11:00-11:15]	129	18 MPH	78 F	Dry													
[11:15-11:30]	151	17 MPH	80 F	Dry													
[11:30-11:45]	150	17 MPH	82 F	Dry													
[11:45-12:00]	140	17 MPH	82 F	Dry													
[12:00-12:15]	148	18 MPH	83 F	Dry													
[12:15-12:30]	107	19 MPH	87 F	Dry													
[12:30-12:45]	76	25 MPH	91 F	Dry													
[12:45-13:00]	87	23 MPH	93 F	Dry													
[13:00-13:15]	107	18 MPH	95 F	Dry													
[13:15-13:30]	164	17 MPH	93 F	Dry													
[13:30-13:45]	133	17 MPH	93 F	Dry													
[13:45-14:00]	138	17 MPH	93 F	Dry													
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November 17, 2009

Bob Pento  
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Re: Pennsylvania Department of Transportation,  
Bureau of Planning and Research  
Project Number 060908  
*Assessment of ITS Maintenance Practices*  
(Subtask E.4)

Dear Mr. Pento:

We are pleased to submit six (6) bound copies of the *Assessment of ITS Maintenance Practices*. Also included are six (6) electronic copies. Please distribute to the appropriate personnel.

The final report addresses all comments provided through Matt Weaver. If you have any questions regarding the submission materials, please do not hesitate to contact me. Thank you for the opportunity to work on this assignment.

Very truly yours,  
**GANNETT FLEMING, INC.**

A handwritten signature in black ink, appearing to read "RJT", written over a light grey rectangular background.

Robert J. Taylor, P.E.  
Project Manager  
Transportation Operations Group

C:  
file

RJT/rjt



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## Executive Summary

### Background and Purpose

The purpose of this task was to conduct an evaluation of ITS maintenance practices in order to identify national and Department best practices. Best practices, presented in this report, were used to provide guidance such that the Department can maximize reliability and uptime of ITS devices.

Key activities included:

1. Researching National Best Practices
2. Researching current District practices
3. Establishing best practices for ITS maintenance.

### Literature Review Summary

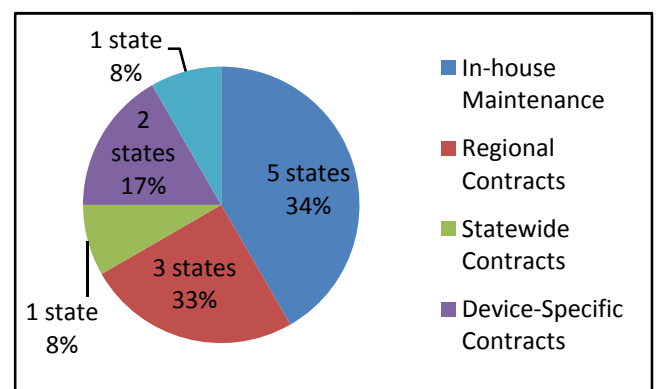
As part of the research, a literature review was conducted. Documents related to ITS maintenance were reviewed and summarized. The literature review may be found in **Appendix A**. Each literature review summarizes guidance on different areas of ITS maintenance including:

- Programming
- Preventive maintenance
- Response maintenance
- Costs
- Contracting
- Funding and budgeting.

### Survey of Other States

In order to research ITS maintenance practices across the country, a web-based survey was developed. The survey questions aimed to gauge perspectives on reliability and uptime requirements, regional versus statewide contracting, device specific contracting, and preventative and response maintenance requirements. The survey was sent to other state traffic and ITS contacts throughout the country. In total, 12 states responded to the survey (a 24% response rate), though not all states answered every question. **Appendix B** shows the survey questions and responses.

The states used a variety of methods to maintain their ITS devices. Most states used in-house staff to maintain devices (Wyoming, Mississippi, North Dakota, Washington, and Utah) or had regional contracts (New York, West Virginia, and Illinois), like PennDOT. Two states, Delaware and New Hampshire, have device-specific contracts, while Georgia has a statewide contract. While Missouri



did not respond to the survey, it is in a multi-state contract with Kansas to maintain ITS devices around the Kansas City metro area.

From the survey, there are three main benefits for using regional or district contracts for ITS maintenance:

1. First, local ITS managers are the most knowledgeable on the needs and care of their local systems. The regions are easier to manage than the entire state, and the managers know the details of ITS deployments throughout their region.
2. Second, travel costs are reduced by breaking the state down into smaller regions.
3. Third, local contractors are typically more familiar with local equipment. The local contractors are also familiar with details and the highway network within their region.

### Summary of District Surveys

In the course of this research, all 11 Districts were contacted in order to obtain their input to several survey questions which were developed. The questions and responses can be found in **Appendix D**. Below is a brief summary:

- **Reasons for Long-term Downtime** - Districts reported relatively few devices being down in excess of 48 hours and many of these were due to delays receiving parts, correcting communications issues, or in some cases due to specific issues with an “off-brand” in that District.
- **Contract Structure** - Each District was polled on the issue of how a contract would be structured. While there was a difference of opinion with regards to the best way to configure a good maintenance contract, most Districts felt that a District-wide or a regional contract would be best. All Districts were of the opinion that a statewide contract would not be a good way to proceed.
- **Prequalifications** -The Districts were mixed on the issue of prequalification. Some felt that there were few enough contractors performing this work that they were all qualified, while others felt that prequalifications should be used to restrict bidders.
- **Liquidated Damages** - On the issue of liquidated damages, there were varied responses. Many Districts have no liquidated damages in place and do not feel that any are needed, while other Districts have them in place or intend to write them into the next contract.

### Summary of Contractor Surveys

Several ITS maintenance providers were contacted to gain their perspectives regarding best practices. As directed by the Department, it was agreed that the consultant team would not disclose specific information regarding maintenance providers. Sanitized survey responses from the contractors are located in **Appendix C**.

- **Company Organization** - The service structure of the companies varied greatly. In some cases, staff lives in the Districts they serve while others are within 100 miles of the devices they service. All of the firms indicated that they make use of subconsultants when there is work outside of their area of expertise. Typically, such firms include actual construction firms,

device suppliers, or specialized communications personnel. All respondents noted that, in order to provide for the necessary service, the Department has cell phone numbers through which staff can be contacted at any time.

- **Spare Parts** - All respondents commented that the supply of spare parts on hand for this maintenance is one of the primary delays in getting devices up and running. In some cases it is due to the fact that no spare parts are available, in other cases, there is lost time in getting to the storage facility or difficulty finding the part in the inventory.
- **Incentives and Liquidated Damages** - The issue of incentives and damages was also discussed with each respondent. It was mentioned by one firm that, as things exist right now, the Department is paying these fees themselves because, when a contractor submits his cost proposal, they assume that a certain number of fees will be levied against them and build it into the fee. It was suggested instead that the Department implement a system of uptime calculation for reward and penalties. He recommends setting incentives based on uptime. For example, if it was determined that a 90 percent uptime was normal, over 92 percent uptime gets a bonus, between 92-88 percent is no change, and below 88 percent gets a penalty.

### Overview of Contract Mechanisms

Existing and proposed contract mechanisms were discussed with the Department to gauge their perspectives.

- In general, purchase orders were viewed as a current practice for small efforts, but most agreed that they may not be the most desirable contract mechanism in the future.
- Low-bid contracts through ECMS is the most common practice used to date; however, there are some concerns with “getting the right contractor” or “getting what you pay for.” These are valid concerns; however, most agreed that these issues can be offset by requiring qualifications, having a clear scope of work, and utilizing the appropriate combination of liquidated damages and financial incentives.
- A Request for Proposal (RFP) would allow the Department to select the most responsive and prepared contractor; however, most contractors are not familiar with the RFP process. More importantly, it would likely increase the selection process and result in more claims from non-selected contractors.
- A modified version of the Design-Build-Best-Value (DBBV) may warrant future consideration as it offers a mechanism to eliminate non-qualified respondents (in an impartial way), but also can include a low-bid or cost element. However, the Department is still fine-tuning the process; therefore, it may be best to revisit this option in the future.

### Geographic Coverage

As part of the evaluation, geographic coverage was evaluated. Currently, the Department has a combination of District contracts with some statewide contracts for RWIS support and for other BIS activities. Most Districts stated that District-wide and Regional (more than District) maintenance contracts were their preferred method. Having District or Regional coverage allows Traffic Management Centers (TMCs) to take more ownership and have more direct oversight of maintenance activities. Several Districts cited the RWIS program as an example where statewide contracting has not worked effectively. It was noted by some in BIS that statewide maintenance

contracting is the most appropriate mechanism because it is common to centralize maintenance in the IT industry in order to maintain consistency and to monitor service.

The Department’s ITS plans continue to evolve and develop. ITS management will extend beyond District boundaries, and in many cases, is regional in nature. At the highest level, there is a need for statewide ITS management. To achieve these goals, it may be appropriate to utilize District-wide, regional, and statewide contracts as follows:

<p><b>When to use a regional contract</b></p> <ul style="list-style-type: none"> <li>▪ When there is one “lead” District and one nearby “developing” District</li> <li>▪ When both Districts have common (manufacturer) devices</li> <li>▪ When both Districts fall within common regional boundaries</li> <li>▪ Where it is preferred to have a regional contract</li> </ul> <p><b>When to use a District contract</b></p> <ul style="list-style-type: none"> <li>▪ When there is no apparent “lead” District</li> <li>▪ When most devices are not compatible</li> <li>▪ If the Districts do fall within regional boundaries</li> <li>▪ Where it is preferred to have a District contract</li> <li>▪ For specialty systems where response times are critical and most deployments reside in one District</li> </ul> <p><b>When to use a statewide contract</b></p> <ul style="list-style-type: none"> <li>▪ To provide maintenance to specialty systems that are not widely deployed</li> <li>▪ For specialty systems where response times are less critical.</li> <li>▪ To support “off-brands” of Dynamic Message Signs</li> </ul>
---

**Contract Element Summary**

National practices, experiences from other states, and Department perspectives were all considered in identifying key elements to include in future ITS maintenance contracts.

Contract Element	Description
<b>Contract Length</b>	Based on experiences within the Department as well as other states, a base contract should be two years in length with an option for a one-year renewal.
<b>Qualifications</b>	<p>The Department should consider utilizing the established prequalification codes (P-codes) to ensure qualified respondents. While requiring P-codes may limit respondents and/or increase bid results, the proper use of P-codes will assist in delivering qualified contractors to perform ITS maintenance.</p> <p>An alternate would be to utilize P-code descriptions in developing qualification requirements, but not to formally require P-codes. This would allow respondents without P-codes to respond. It would also allow the Department to remove unrelated elements of P-codes developed for construction-only activities.</p>

Contract Element	Description
<p><b>Liquidated Damages and Performance Metrics</b></p>	<p>For Districts with liquidated damages, values ranged from \$150 to \$1,500 dollars per day; however, some contractors noted that they include an estimated number of damages into their bid, essentially putting the cost back on to the Department. The study group suggests liquidated damage assessment be written into the contract and be at least \$500 per occurrence, with \$1200 for a second offense on the same claim, and potential for breach of contract beyond that.</p> <p>For future contracts, the Department may wish to also include an uptime incentive to encourage contractor responsiveness. For example, if it was determined that a 95 percent uptime was normal, over 95 percent uptime gets a financial incentive, between 95-85 percent is no change, and below 85 percent gets a penalty.</p>
<p><b>Preventative Maintenance</b></p>	<p>Preventative maintenance schedules in the Department and in other states vary from 2 to 4 times a year. In some cases, preventative maintenance can be scheduled more frequently based on the age of the equipment or historic issues. In all cases, preventative maintenance should be logged, and it may be desirable to require a monthly report for all devices.</p> <p>Based on the research conducted, it is suggested that preventive maintenance be scheduled at least twice a year.</p>
<p><b>Response Maintenance</b></p>	<p>Response maintenance can be divided into the following elements:</p> <ol style="list-style-type: none"> <li>1. Receive notification – This is the point in time that the Department notifies the contractor that there is an issue that requires attention.</li> <li>2. Arrive at site and diagnose the problem. Upon notification, this is the time it takes for the contractor to diagnose the issue. Typical response times for step 2 range from 24 to 48 hours. An appropriate length of time may be 48 hours unless otherwise approved by the Department.</li> <li>3. Perform repairs – Upon notification, this is the time it takes for the contractor to perform repairs. Typical repair times range from 2 days upon notification up to 4 days upon notification. An appropriate length may be 4 days upon notification to allow for diagnostics. The Department should include a note, <i>“unless otherwise approved by the Department,”</i> and <i>“the Engineer may authorize additional time for procurement of materials”</i> to allow flexibility if the needed activity is beyond the control of the contractor.</li> <li>4. Log activity – This includes formally logging the activity into the maintenance log.</li> </ol>
<p><b>Emergency Repairs</b></p>	<p>The study team suggests emergency response to the site within 4 hours of notification. An appropriate length for repair may be 24 hours upon notification to allow for diagnostics. The Department should include a note, <i>“unless otherwise approved by the Department,”</i> and <i>“the Engineer may authorize additional time for procurement of materials”</i> to allow flexibility if the needed activity is beyond the control of the contractor.</p>

Contract Element	Description
<p><b>Other Elements to Consider</b></p>	<p><u>Device Listing</u> - Most contracts reviewed include a listing of device types. However, the level of detail included varies. As part of the general provisions, the following information should be provided to the potential bidders:</p> <ul style="list-style-type: none"> <li>▪ Types of devices (DMS, CCTV, HAR, etc.)</li> <li>▪ Make and model of devices</li> <li>▪ Location of the devices</li> <li>▪ Expected additional deployments.</li> </ul> <p><u>Spare Parts</u> - By description for response maintenance, the contractor would likely need to have an inventory of spare parts in order to respond within time parameters; however, it may be appropriate to provide a basic listing of spare parts that should be maintained.</p> <p><u>Emergency Deployments</u> - Several Districts noted that many of the ITS maintenance providers are also the common deployers of ITS technologies. Due to the common use of ITS technologies for “all hazards,” it is not uncommon for there to be an unexpected, but urgent need for deployment (e.g. DMS needed in District 5-0 on I-78). When developing ITS maintenance contracts, consideration should be given to including a provision to allow for limited ITS deployments to include DMS, CCTV, and HAR, among others.</p>

### ITS Maintenance and Asset Management

Asset management is the cost-effective operation, maintenance, and preservation of transportation systems, including intelligent transportation systems.

As the Department’s ITS maintenance program continues to evolve, asset management will be a critical element to promote system-improved maintenance and reliability. When considering ITS asset management, it is critical for the Department to keep a detailed inventory database which includes:

- Tracking number
- ITS device make and model
- Photos and as-built drawings if available
- Location
- Key components and system communication
- Maintenance logs.



## 1. Introduction

### 1.1 Background and Purpose

The purpose of this task was to conduct an evaluation of ITS maintenance practices in order to identify national and Department best practices. Best practices, presented in this report, were used to provide guidance such that the Department can maximize reliability and uptime of ITS devices.

Key activities included:

1. Researching National Best Practices
2. Researching current District practices
3. Establishing best practices for ITS maintenance.

### 1.2 Contacts

This task was performed as part of the Bureau of Planning and Research, Project Number 060908. The following are the task and contract contacts:

Last Name	First Name	Organization	Role	E-mail	Telephone
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Taylor	Bob	Gannett Fleming/ GeoDecisions	Consultant Lead	<a href="mailto:rtaylor@gfnet.com">rtaylor@gfnet.com</a>	717.763.7212

### 1.3 Acronyms

ATROWS	Automatic Truck Rollover Warning System
BHSTE	Bureau of Highway Safety and Traffic Engineering
BIS	Bureau of Information Systems
BPR	Bureau of Planning and Research
CCTV	Closed-Circuit Television
DMS	Dynamic Message Sign
FHWA	Federal Highway Administration
GIS	Geographic Information System
GPS	Global Positioning System
HAR	Highway Advisory Radio
ITS	Intelligent Transportation System
O&M	Operations and Maintenance
MMP	Maintenance Management Plan
PDA	Pre-Determined Amount
PennDOT	Pennsylvania Department of Transportation
RTMC	Regional Transportation Management Center
RTMS	Remote Traffic Microwave Sensor
RWIS	Road Weather Information System
STMC	Statewide Transportation Management Center
TMC	Transportation Management Center
TMS	Transportation Management System
USDOT	United States Department of Transportation



## 2. Overview of National Research

In order to gain an understanding of response and preventive maintenance for ITS devices, a literature review was performed, and a survey was developed and sent to state traffic and ITS contacts throughout the country. This section summarizes the findings from the literature review and survey.

### 2.1 Literature Review Summary

As part of the research, a literature review was conducted. Documents related to ITS maintenance were reviewed and summarized. The literature review may be found in **Appendix A**. Each literature review summarizes guidance on different areas of ITS maintenance including:

- Programming
- Preventive maintenance
- Response and emergency maintenance
- Costs
- Contracting
- Funding and budgeting.

This section includes the most important points of guidance for each area of ITS maintenance.

#### 2.1.1 Guidance on Maintenance Programming

Most of the documents reviewed include guidance for programming maintenance operations. The following points are some of the most important advice from the literature review:

- Agencies should support the National Transportation Communications for ITS Protocol (NTCIP), which is an initiative to standardize communications and ensure interoperability and interchangeability among traffic control and ITS devices.
- One of the most important aspects of maintenance is the upkeep of records. Up-to-date maintenance records can help provide efficient service, detect and correct recurring problems, develop maintenance schedules and strategies, and protect the agency in case of a lawsuit. The following are types of records that should be kept for the management of maintenance activities:
  - Master Record – master log of all service calls that includes the date, type of maintenance performed, and signatures of personnel performing the work.
  - Preventive Maintenance Record – a log for each preventive maintenance service that includes the date, tasks performed, and signatures of personnel performing the work.
  - Preventive Maintenance Problem Record – a record of problems or potential problems identified, corrective action taken, and information about a follow-up inspection.
  - Response Repair Log-on Record – a log recording the location, date, time, caller, receiver and complaint received, maintenance personnel, time dispatched, trouble found, and time cleared.

- Response Maintenance Repair Record – a log for each call of the problem, prevailing conditions, work performed, parts replaced/repaired, time and condition on departure, and signatures of personnel performing the work.
- Maintenance personnel and operators should be trained before any ITS technologies are implemented. That way, personnel will be familiar with equipment and proficient during maintenance. Also, agencies should have in-house, ongoing training programs because of personnel turnover.
- It should be noted that System Engineering requirements detailed in 23 CFR 940.11 require consideration of “procedures and resources necessary for operations and management of the system.” Key elements to consider in operations and management consist of:
  - Preventive maintenance
  - Response (and emergency) maintenance
  - Configuration management/design modifications
  - A maintenance inventory and management system
  - A database and management system
  - Equipment maintenance contracts
  - Training requirements
  - Cost estimates
  - An implementation schedule.
- It is critical for the agency to keep a detailed inventory database. This includes as-built documents, field inventory documents, stock room inventory lists, and maintenance logs; and all ITS components should be tracked and reviewed.
- Bar coding, geographic information systems (GIS), global positioning systems (GPS), field computers, and other emerging technologies help improve ITS maintenance inventory management.
- Agencies should be aware of and address several issues and policies regarding maintenance operations:
  - Allowing supervisors a credit limit and access to funds during a time of crisis
  - Limiting access to certain equipment by staff above a certain level
  - Not allowing connection to the control system network by outside applications
  - Keeping antivirus software up-to-date
  - Developing a policy for sharing data.
- Maintenance personnel should be involved during all levels of design so that roadside devices can be accessed safely, are protected, are easily visible, are properly labeled, and have available power sockets.
- Some agencies have asset management systems in place to keep track of the condition of highways and bridges. If one is already implemented, it can also be used for monitoring TMS assets. If there is no asset management system in place, there are a number of suppliers that offer these types of systems.
- Agencies should ensure the maintenance and operations system is reliable using the following recommendations:
  - Incorporate system diagnostic capabilities to detect early malfunctions and ensure data integrity.
  - Conduct regular M&O briefings with key agency personnel.
  - Monitor, measure, evaluate, and report system performance and benefits.
  - Establish performance requirements and criteria to manage and operate ITS.

- Agencies should establish and maintain a public education and information program for ITS. This means the agency should provide regular updates on traffic conditions, incidents, and planned events to the public and to the media. The agency should also report system performance and benefits to elected officials and to the general public.
- Installation of ITS devices and systems should be planned and coordinated by installation staff and M&O staff to expedite successful installations, clearly define acceptance testing, and minimize disruption to the motoring public. All issues associated with installing ITS field devices should be thoroughly discussed and evaluated prior to any installation. Major traffic management systems could be phase-installed to minimize disruption to the traveling public.
- The continuous monitoring of problems during installation should be quickly rolled back into the design process so that problems do not perpetuate.
- System and field documentation should be revised and completed as soon as possible following the installation of any ITS contract.
- Agencies should look for opportunities to share information and resources with other regional ITS programs and related public organizations and private transportation-related organizations. Metropolitan regions or states should be encouraged to share a wide area telecommunication backbone infrastructure, such as an ITS “informational superhighway” inclusive of multiple agencies. Also, M&O user groups involved with resource sharing and joint operations should be established to review or debrief operations on a regular basis.
- All interfaces should be designed and developed with an “open” architecture concept, which utilizes nonproprietary protocols.

### 2.1.2 Guidance on Preventive Maintenance

Most of the documents reviewed include guidance for preventive maintenance operations. Many of the reference materials reviewed offer checklists to go through while performing preventive maintenance for certain devices. One guide (“Traffic Control System Operations: Installation, Management, and Maintenance”) also had a sample preventive maintenance contract as an appendix. The following points are some of the most important advice from the literature review:

- ITS deployments should include remote diagnostic capabilities, if possible. By using computers to monitor and store operational data, preventive maintenance procedures will be facilitated.
- Preventive maintenance schedules should be submitted at least two weeks in advance for approval by the agency so that the work can be combined with construction work zones.
- “Traffic Control System Operations: Installation, Management, and Maintenance,” has a chapter dedicated to describing ITS technologies and recommendations for preventive maintenance. Each section on a specific technology includes:
  - Commentary on technology deployed in the field for the past 20 years
  - Operational strategies to maintain the devices
  - Photos of field installations and equipment
  - “Low maintenance” design details
  - Subsystem block diagrams
  - Replacement units, part numbers, and names of manufacturers

- Generic procedures and recommended time intervals for preventive maintenance of these devices
  - Generic and model-specific guides for troubleshooting problems: symptoms, probable causes, and recommended remedial actions
  - Information on system test equipment, including its uses, manufacturers, and approximate costs
  - Lists of system spare components and their costs, along with recommended amounts of each that should be available for immediate replacement to maintain system operations.
- When preventive maintenance is contracted out, the contractor should have access to the software in the control center so he/she is able to log the next day's activities. This notifies the operators, and if traffic is disrupted, more notice should be given.
  - A preventive maintenance report should be completed each time maintenance is performed. This report should include the location, date, inspector's name, a list of all tasks performed, and troubles found.

### *2.1.3 Guidance on Response (and Emergency) Maintenance*

The documents reviewed include guidance for response maintenance operations. The following points are some of the most important advice from the literature review:

- "Guidelines for Transportation Management Systems Maintenance Concept and Plans," provides legal wording to ensure a balance between the timeliness and costs of responding to a device failure.
- Response (and emergency) maintenance has five basic steps:
  - Receive notification – It is important that the person who receives notification determine the location and an accurate description of the problem. The person should then log the date and time of the initial report, location, initial description of the problem, date and time of initial response, crew assigned to initial response, description of solution, and serial numbers of devices/components replaced. However, it would be extremely beneficial for the ITS equipment to have the ability to monitor its own operation. If the device has an operational problem, personnel need not be dispatched to the field until the problem is understood.
  - Secure the site – When the response crew arrives they need to make sure the area is safe for the workers and the general public and then begin making repairs.
  - Diagnose the problem – In most cases, the fastest way to fix problems is by replacing faulty items.
  - Perform interim repairs – The guide advises agencies to replace the faulty device with a spare, and correct the faultiness in the shop. In doing so, the repairs will be more accurately logged than repairs in the field.

- Log the activity – The logging system should be computerized so that the database is widely accessible. Software bought from a vendor is likely to be more professional, cost less, and have a better graphical user interface than a system prepared within the agency. It is advised that whoever uses the computer system is involved with the design of the system. Also, the system should be flexible so that it can be easily changed in case priorities or budgets change.
- The maximum time to arrive at a problem intersection and identify the problem is one hour.
- Maintenance vehicles should not park on the shoulder, because they could cause crashes or increase delay. Instead, maintenance turnouts, parking spaces, or secondary roadway access should be built into the system.
- Agencies should consider how contractors will charge for timely response to a failure. Most of the time agencies want rapid action for response maintenance. This kind of response would require contractors to have staff available 24 hours per day, seven days a week. This kind of on-call service could increase costs significantly, and may outweigh the benefit of having such timely response.
- Software diagnostic programs facilitate maintenance through detection and isolation of malfunctions and errors. Databases are used to organize these diagnostics along with the date, time, location, and maintenance activity performed.
- Agencies performing maintenance should develop and establish a standard procedure for problem notification of failed equipment. Establishing a procedure will minimize potential tort liability claims. The basic elements of a problem notification procedure are as follows:
  - Notification of a possible problem – only one agency should be responsible for screening failed device calls.
  - Determination of problem severity
  - Decision to take action – a chain of command should be established to avoid confusion in making a decision.
- To solve recurring problems, the agency can modify the current design of the equipment. In addition, a comprehensive review can identify design modifications that might be needed, and the “Traffic Signal Installation and Maintenance Manual” includes a comprehensive review checklist and possible modifications for various problems.
- “Traffic Signal Installation and Maintenance Manual” has flowcharts and forms to determine if current response maintenance capabilities are acceptable and at what level can response maintenance be provided. Unacceptable response maintenance capabilities could be caused by lack of trained personnel, inadequate service equipment, and inadequate backup inventory.

2.1.4 Guidance on Maintenance Costs

One resource reviewed, “Guidelines for Funding Operations and Maintenance of Intelligent Transportation Systems/Advanced Traffic Management Systems,” is particularly helpful for advice on maintenance costs. The document quantifies the costs to operate and maintain a variety of ITS technologies. The authors compiled tables of ITS/ATMS elements that included the element’s basic unit of measure, estimated unit operations cost, estimated unit maintenance cost, combined unit O&M cost, any assumptions made to derive the cost figures, and the sources used to determine the cost. The O&M costs are categorized by ITS function. Another document, “Traffic Control System Operations: Installation, Management, and Maintenance,” gives a thorough list of miscellaneous equipment to purchase for preventive and response maintenance. Finally, the 2006 AASHTO Salary survey is a useful resource to estimate the costs for personnel performing maintenance in the field. The table below gives average salaries for different levels of maintenance personnel.

Title	Average Salary
M1(1) Highway Maintenance Worker Entry – under close supervision, performs routine equipment operations and physical labor activities	\$26,965
M1(2) Highway Maintenance Worker Intermediate – under moderate supervision, operates multiple gasoline and diesel powered construction equipment	\$29,140
M1(3) Highway Maintenance Worker Senior – under limited supervision, functions as a crew leader for staff specializing in highway maintenance services and assists in the coordination of planning work schedules and maintenance operations in the field	\$34,420
M1(4) Highway Maintenance Supervisor – top level supervisor that supervises multiple locations	\$45,259
M2(1) Equipment Mechanic Intermediate – under moderate supervision, performs skilled mechanical work in the maintenance and repair of motorized and non-motorized equipment	\$34,402
M2(2) Equipment Mechanic Senior – under limited supervision, functions as lead worker.	\$36,640
M2(3) Equipment Mechanic Supervisor – supervises staff engaged in repair of heavy equipment, mechanical equipment, and related equipment modification work	\$45,688



### 2.1.5 Guidance on Contracting

Most of the documents reviewed include guidance for contracting ITS device maintenance. The following points are some of the most important advice from the literature review:

- Agencies should form partnerships with the private sector. These public-private partnerships are different than hiring a contractor to perform work. Public-private partnerships are long-lasting which is important for operations and maintenance.
- “Guidelines for Transportation Management Systems Maintenance Concept and Plans” offers the pros and cons of keeping aspects of maintenance in-house versus contracting those tasks to outside companies.
- During multi-year procurements, states should be aware of the rapid changes in technology compared to the slow-moving changes in state procurement rules. For example, after an initial hardware acquisition, the next year of bids could be won by another vendor with incompatible hardware.
- The following questions should be considered when contracting maintenance responsibilities to outside companies:
  - What level of staffing is required in each area?
  - Does the agency wish to purchase and operate the required equipment?
  - What skill level is available from in-house staff, and what level can the agency afford to employ?
  - If outsourced, does the agency have the right people to manage a contractor?
- The procurement method for software may be different from the procurement method for the rest of the system. The agencies should consider what software modifications are necessary and who has intellectual rights to customized software.
- Caution should be taken when entering an extended maintenance agreement with contractors or vendors. One company front-end loaded all the maintenance costs. By the time maintenance was supposed to occur, the company went out of business, and the agency had almost no funds remaining. Instead, the contractor could have been paid a fixed monthly amount proportional to the percent of equipment working properly.
- Warranties cover the replacement of failed hardware devices. While warranties may be useful and desirable, they are hard to administer.

### 2.1.6 Guidance on Maintenance Funding and Budgeting

Most of the documents reviewed include guidance for funding and budgeting the maintenance of ITS devices. The following points are some of the most important advice from the literature review:

- It is possible to use Federal funding sources, such as Congestion Mitigation and Air Quality (CMAQ), National Highway System (NHS), and Surface Transportation Program (STP), to pay for traffic management O&M. Interstate Maintenance (IM) funds can also be used for O&M with some restrictions.
- There are two advantages to contracting maintenance. The first advantage is that the agency can use contracting dollars, which are abundant within the agency's budget. The second is that the agency can perform maintenance even if there are hiring freezes within the organization.
- Include spare parts in construction or maintenance contracts so that there are no part shortages in the future.
- ITS O&M should be identified as its own budget category. By doing so, it shows O&M is an ongoing expense and makes it easier to track costs.
- If additional O&M funding is not expected, new projects should be put on hold if they cannot be properly maintained or operated.
- "Traffic Control System Operations: Installation, Management, and Maintenance" offers a cost-comparison worksheet to find the break-even point for an agency to support a full-time in-house maintenance program.
- Using a fixed percentage of the capital costs for maintenance budgeting is not very reliable. Cost estimates need to be made on a case-by-case basis.
- "Guidelines for Transportation Management Systems Maintenance Concept and Plans" has a table of staffing levels for TMSs in Boston, Toronto, Long Island, Detroit, Milwaukee, Atlanta, Phoenix, and Houston. The table includes number of maintenance staff, organization responsible for maintenance, any special maintenance elements, centerline miles that the TMS is responsible for, and types of ITS equipment used in the field. The guide also has a thorough table of example life expectancies for ITS and TMS components.
- There is a point where preventive maintenance costs per year are equal to the annualized replacement costs. Agencies should calculate this break-even point to decide whether it would be worthwhile to purchase new equipment or perform preventive maintenance on old equipment. The break-even point may be found using data, such as the original purchase price, replacement cost, preventive maintenance and repair cost history, mean time between failures, and mean time to repair.
- It is important for the organizations to have detailed job requests and to let the contractors know exactly what they want for the project. A few times, agencies advertised for projects only to have contractors bid much higher prices than allowed for in the budget. After meeting with



some of the potential contractors, the agencies found that their request for proposals was too vague. The agencies refined their request for proposals and received much lower bids.

- The following steps are used to estimate a budget for a maintenance program:
  - Estimate the staffing requirements by system
  - Estimate the management needs – one or two persons for a typical TMS
  - Calculate the ITS device’s annual inventory replacement costs
  - Estimate maintenance for vehicles and maintenance garages, including salvage and replacement values.
- Any funding strategy should incorporate planned system and component replacements.

It is apparent that many important lessons can be learned from a review of previous ITS maintenance literature. First, when agencies decide to have an ITS maintenance program, they should know that Federal funding is available. Agencies should calculate the break-even point to decide if the agency could support in-house maintenance or if they need contractors to perform the maintenance. The literature review covers the costs to operate and maintain devices, maintenance personnel salaries, and equipment costs for activities that the agencies could use to calculate the break-even point. If the agency is contracting the maintenance, they must have detailed job requests. Also, the agency must take care of selecting the contractor, because contractors may go out of business or may not deliver on the contract. Agencies should communicate often when deploying and maintaining ITS devices, so that there is an open flow of knowledge and experiences.

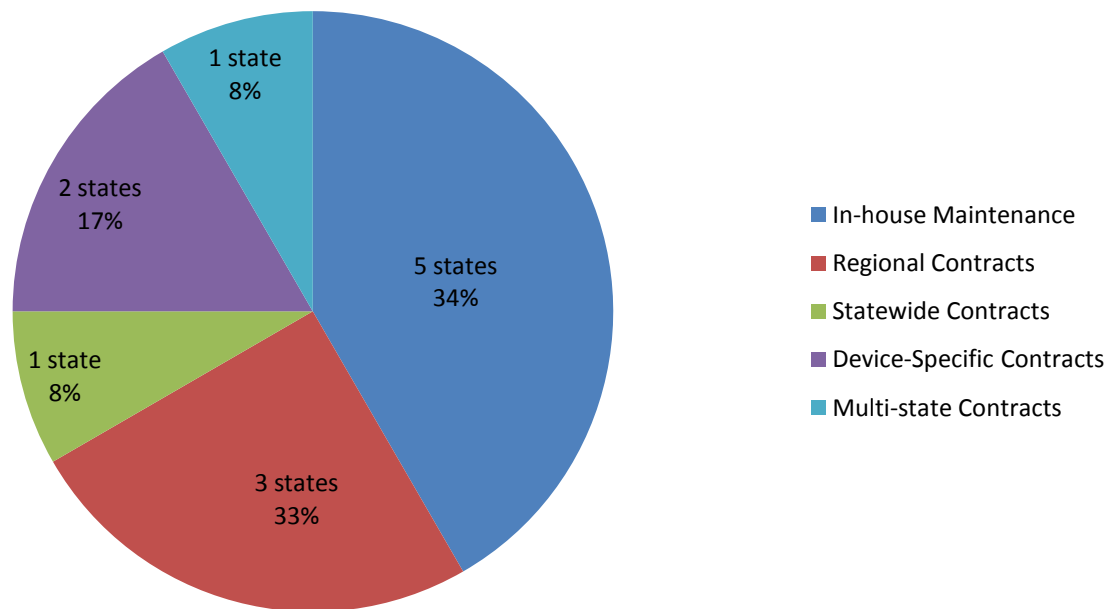
When actual maintenance is performed, the agency must keep records up-to-date and have a detailed parts inventory. Some of the guides reviewed offer helpful checklists to streamline preventive maintenance, and preventive maintenance should be scheduled so that the impact on traffic is minimized. If response maintenance must be performed, agencies should consider the overtime costs related to having personnel on call 24/7.

Agencies that consider the guidance offered in the literature review will lay the foundation for a successful ITS maintenance program.

## 2.2 Survey of Other States

In order to research ITS maintenance practices across the country, a web-based survey was developed. The survey questions aimed to gauge perspectives on reliability and uptime requirements, regional versus statewide contracting, device-specific contracting, and preventative and response maintenance requirements. The survey was sent to 49 state traffic and ITS contacts throughout the country. In total, 12 states responded to the survey (a 24% response rate), though not all states answered every question. **Appendix B** shows the survey questions and responses. This section serves as a summary of the survey responses.

The states used a variety of methods to maintain their ITS devices. Most states used in-house staff to maintain devices (Wyoming, Mississippi, North Dakota, Washington, and Utah) or had regional contracts (New York, West Virginia, and Illinois), like PennDOT. Two states, Delaware and New Hampshire, have device-specific contracts, while Georgia has a statewide contract. While Missouri did not respond to the survey, it is in a multi-state contract with Kansas to maintain ITS devices around the Kansas City metro area. The chart below summarizes the findings.

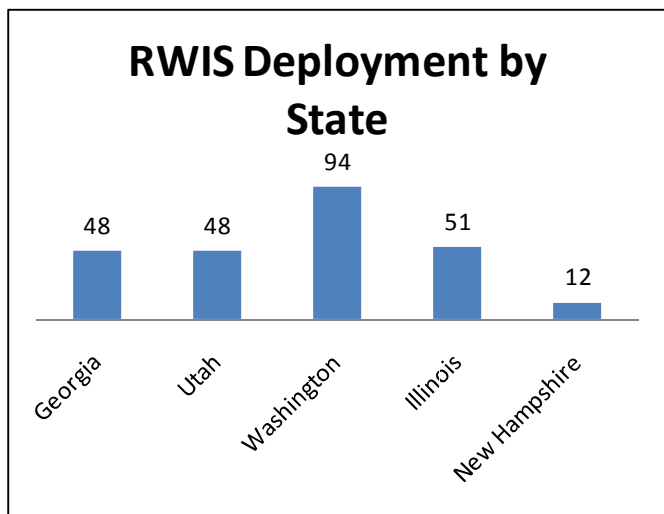
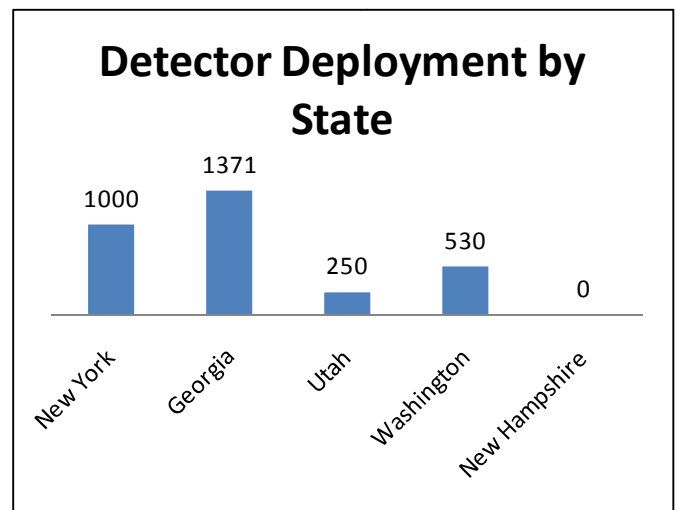
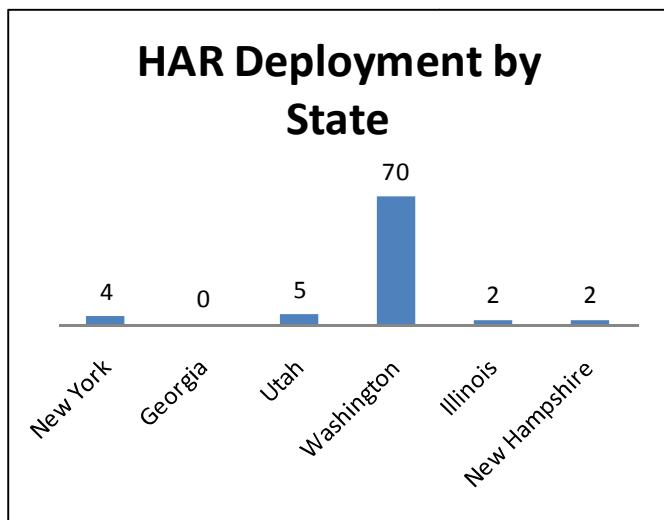
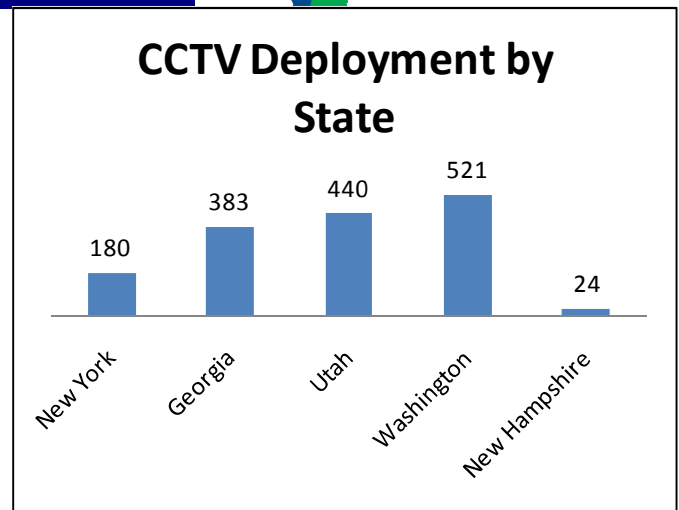
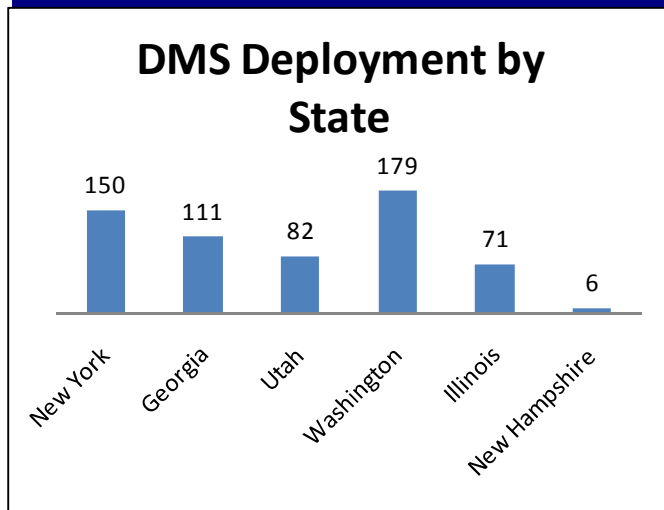


Each state voiced advantages and disadvantages for their particular type of maintenance approach. A general summary of the advantages and disadvantages for each method, as expressed by the respondents, can be found in the table below.

Maintenance Practice	Advantages	Disadvantages
In-house	<ul style="list-style-type: none"> <li>Stocked parts warehouse means better</li> </ul>	<ul style="list-style-type: none"> <li>Sudden peaks in workload may result in</li> </ul>

Maintenance Practice	Advantages	Disadvantages
(Wyoming, Mississippi, North Dakota, Washington, Utah)	<ul style="list-style-type: none"> <li>response times</li> <li>▪ Less costly than contract maintenance</li> <li>▪ Crews maintain technical knowledge</li> <li>▪ Interaction with engineering staff keeps engineers more knowledgeable about ITS hardware</li> <li>▪ Maintenance crews can assist with device deployment as necessary</li> <li>▪ No need to worry about getting bad contractors using the low bid process</li> <li>▪ Well trained and adaptable staff to deal with ever changing needs</li> </ul>	<ul style="list-style-type: none"> <li>understaffing for the work needed</li> <li>▪ Excessive drive times to sites results in excessive costs</li> <li>▪ ITS device maintenance may take a back seat to higher priority work</li> <li>▪ State crews are paid less; highly skilled employees may leave for better opportunities</li> <li>▪ Staff retention and hiring restrictions</li> </ul>
<b>Regional Contracts</b> (New York, West Virginia, Illinois)	<ul style="list-style-type: none"> <li>▪ Local ITS managers are the most knowledgeable on the needs and care of their local systems</li> <li>▪ Reduced travel costs</li> <li>▪ Local contractors are typically more familiar with local equipment</li> </ul>	<ul style="list-style-type: none"> <li>▪ Minimal opportunity for cost savings due to consolidated contracts</li> <li>▪ Increased oversight and coordination required to know “what contract is going where”</li> <li>▪ Lost opportunities for exchanging knowledge on previous experiences</li> <li>▪ Mississippi is trying to develop regional maintenance contracts, but it is difficult to find one vendor that will cover maintenance on all the ITS devices in the area.</li> </ul>
<b>Statewide Contracts</b> (Georgia)	<ul style="list-style-type: none"> <li>▪ ITS maintenance support for all districts</li> </ul>	<ul style="list-style-type: none"> <li>▪ A cancelled contract could mean no means for major maintenance repairs until a new contract is signed</li> </ul>
<b>Device-specific Contracts</b> (Delaware, New Hampshire)	<ul style="list-style-type: none"> <li>▪ An assortment of equipment is maintained by specialized companies and staff</li> </ul>	<ul style="list-style-type: none"> <li>▪ Many devices and contracts to track</li> <li>▪ Vendors are involved with specific ITS applications so it is difficult to find an entity to be responsible for and maintain the integrity of the overall program</li> </ul>
<b>Multi-state Contracts</b> (Kansas)	N/A	N/A

To understand how involved their maintenance practices are, the states were asked how many ITS devices are deployed within the state. The states were asked how many Dynamic Message Signs (DMS), Highway Advisory Radio (HAR), Closed Circuit Television (CCTV), Detection, and Road Weather Information Systems (RWIS) were deployed throughout the state. The following charts summarize the deployments for each state that answered.



In addition to the deployments summarized above, Georgia has six truck rollover warning systems and 148 motorist call boxes that are covered under ITS maintenance contracts. Utah maintains 800 computerized traffic signals within ITS (includes fiber optic communication system, modems, and controllers). Finally, Washington has 137 ramp metering systems that are covered under ITS maintenance contracts.

New York's regional contracts are typically two to four year contracts with extension years added as optional to the state. West Virginia's regional contracts are usually one year in length with an agreed renewal for up to three years. Georgia's statewide contracts usually last for three years. Delaware's device-specific contracts are normally one to three years in length. Illinois has regional contracts that are renewed annually. New Hampshire has device-specific contracts that are usually two years in length.

With regard to specialty maintenance contracts for communications systems, Utah has an open ended fiber-optic contractor for small jobs and emergency repairs. The contractor is not used for routine maintenance, because the in-house crew performs ITS maintenance. New Hampshire has a statewide radio maintenance contract. Kansas has a statewide contract with LightCore to replace cards in POPS (points of presence). Kansas also has a service agreement for radio towers.

In terms of specialty maintenance contracts for control centers, most of the states surveyed do not have specialty contracts. Six do not have specialty contracts, or have control center maintenance through general contracts. Georgia and New Hampshire were the only states that have specialty maintenance contracts for control centers.

Seven of the respondents (Wyoming, New York, West Virginia, Utah, Washington, and Illinois) have preventive maintenance strategies. New York and New Hampshire expressed that their preventive maintenance strategies were not well developed. Two of the states (Mississippi and Georgia) responded that they do not practice preventive maintenance.

Six of the respondents (Wyoming, New York, Mississippi, West Virginia, Illinois, and Kansas) have emergency response provisions for their ITS devices. Three of the states (Georgia, Washington, and New Hampshire) do not have emergency response provisions.

Two of the states (New York and West Virginia) have provisions set up that requires a certain percentage of devices be operable at all times. Seven of the respondents (Wyoming, Mississippi, Georgia, Utah, Washington, Illinois, and New Hampshire) do not have provisions requiring a percentage of devices be operable at all times.

The most useful responses to the survey are summarized in the following tables.

State	New York	Mississippi	West Virginia	Georgia
Maintenance Practice	Regional	In-house	Regional	Statewide
DMS Deployments	150	N/A	N/A	111
HAR Deployments	4	N/A	N/A	0
CCTV Deployments	180	N/A	N/A	383
Detection Deployments	1000	N/A	N/A	1371
RWIS Deployments	N/A	N/A	N/A	48
Other Deployments	N/A	N/A	N/A	6 truck rollover warning systems 148 motorist call boxes
Typical Contract Length	2-4 years with optional extensions	2 years	1 year with an agreed renewal up to 3 years	3 years
Specialty Contracts for Communications?	No	No	No	No
Specialty Contracts for Control Centers?	Tied with overall contract	Tied with overall contract	Tied with overall contract	Yes
Preventive Maintenance Deployed?	Yes	No	Yes	No
Emergency Response Provisions?	Yes	Yes	Yes	No
Percentage of Devices Required Operable?	Yes	No	Yes	No

State	Utah	Washington	Illinois	New Hampshire
Maintenance Practice	In-house	In-house	Regional	Device-Specific
DMS Deployments	82	179	71	6
HAR Deployments	5	70	2	2
CCTV Deployments	440	521	N/A	24
Detection Deployments	250	530	N/A	0
RWIS Deployments	48	94	51	12
Other Deployments	800 computerized traffic signals	137 ramp metering systems	N/A	N/A
Typical Contract Length	N/A	N/A	1 year	2 years
Specialty Contracts for Communications?	Yes	No	No	Yes
Specialty Contracts for Control Centers?	No	No	No	Yes
Preventive Maintenance Deployed?	Yes	Yes	Yes	Yes
Emergency Response Provisions?	N/A	No	Yes	No
Percentage of Devices Required Operable?	No	No	No	No

The survey also allowed the respondents to express any recommendations they have through their experiences. The recommendations include:

- Be prepared to pay a lot to have sufficient coverage to keep systems up and running at a high rate.
- In order to maintain large deployments with specialty people and skills, as well as having access to spare parts and needed equipment, companies must have a large amount of money to put upfront for maintenance contracts.
- For the most part, Washington's work with contractors is tied to the warranty period connected to new device purchase and deployment. The period is usually two years where the contractor is responsible for proper operations of the device. After the warranty period, Washington takes over the maintenance.

### 2.3 Summary of National Best Practices

It benefits larger states with many ITS deployments to maintain ITS devices regionally. Performing statewide maintenance, whether it is in-house or with statewide maintenance contracts, increases the costs related to travel time and expenses.

From the survey, there are three main benefits for using regional contracts for ITS maintenance:

1. First, local ITS managers are the most knowledgeable on the needs and care of their local systems. The regions are easier to manage than the entire state, and the managers know the details of ITS deployments throughout their region.
2. Second, travel costs are reduced by breaking the state down into smaller regions.
3. Third, local contractors are typically more familiar with local equipment. The local contractors are also familiar with details and the highway network within their region.

Performing regional maintenance is not without its faults. In some states, it is difficult to find one vendor that will cover maintenance on all the ITS devices in the region. In this instance, device-specific contracts would have to be used, either to supplement the regional contracts or to perform all of the ITS maintenance. It would be better to use device-specific contracts to supplement the regional contracts so that the overall regional contractor can be the entity responsible for the integrity of the entire system.

Another problem with performing regional maintenance is that it requires increased communication and coordination between the ITS managers in each region. The managers need to know details about other regional contracts, and they must share knowledge on previous experiences. This is further complicated if device-specific contracts are used for maintenance.

From the survey, New York and Washington have the best practices for ITS maintenance. Both perform maintenance at the regional level. Washington performs its maintenance in-house, while New York performs the maintenance through contracts. Washington has more ITS devices deployed than New York, but they both have extensive ITS systems. They both perform preventive maintenance, though New York's preventive maintenance strategy is a "5 out of 10." New York has on-call, emergency response provisions in the maintenance contracts and does require a certain percentage of devices to be operable at all times. This percentage varies throughout the state. Finally, New York's maintenance contracts run from two to four years with optional extensions.

A successful maintenance program may maintain devices by region. With staff retention problems and hiring restrictions, it may be better to contract out the maintenance work within the region. In-house personnel could perform general device maintenance, but contractors should perform detailed preventive maintenance and be on-call for emergency response. If needed, device-specific contracts could be used but should be kept to a minimum. Too many contracts could hinder open communications between ITS managers for each region. Finally, the program should strive to keep a certain percentage of devices operable at all times.



### 3. Overview of Existing Practices

#### 3.1 Summary of District Surveys

In the course of this research all 11 Districts were contacted in order to obtain their input to several survey questions that were developed. The questions and responses can be found in **Appendix C**. Please note that District 3-0 did not provide any feedback due to their limited ITS deployments. Below is a summary of the information that was obtained.

The first and second questions are in regards to what types as well as the numbers of devices that exist in each district. It was determined that there are vast differences between the Districts. Some districts have very robust systems with cameras, DMS, and a centralized control center, while other Districts have just a few DMS.

**Reasons for Long-term Downtime** - Districts reported relatively few devices being down in excess of 48 hours, and many of these were due to delays receiving parts, correcting communications issues, or in some cases, due to specific issues with an “off-brand” in that District. Some districts reported issues related to replacement parts and supplier non-responsiveness. When asked about what a reasonable contractor response time was, the time frame varied from several hours to a week.

**In-house versus Contracted Support** - Many of the Districts are pleased with having all of the ITS maintenance outsourced to contractors, but a few would like to have most of the work done in-house. The comment from these Districts was that Department personnel would be more responsive than contractors, but contractors should still be retained for weekends and holidays. The amount of work that is currently being done by District personnel is varied; some places do none, while others do most of the preliminary troubleshooting before calling the contractors. Some Districts felt they needed to learn more about ITS maintenance, while others would rather let the contractors continue to do the work.

**Contract Structure** - Each District was polled on the issue of how a contract should be structured. While there was a difference of opinion with regard to the best way to configure a good maintenance contract, most Districts felt that a District-wide or a regional contract would be best. All Districts were of the opinion that a statewide contract would not be a good way to proceed.

**Prequalifications** -The Districts were mixed on the issue of prequalification. Some felt that there were few enough contractors performing this work that they were all qualified, while others felt that prequalifications should be used to restrict bidders. Some additional concerns were that, if the requirements were too stringent, highly capable contractors would be restricted from bidding.

**Spare Parts** - The issue of spare parts seems to be one that many Districts agreed on. There are many differences between the Districts on the way this issue is handled, but all seem to agree that a supply of spare parts would be good to have access to. In some cases, the maintenance contractor is responsible for maintaining a predetermined list of parts. In other cases, the Department maintains this supply, or there is no supply of spare parts.

**Liquidated Damages** - On the issue of liquidated damages, there were varied responses. Many Districts have no liquidated damages in place and do not feel that any are needed, while other Districts have them in place or intend to write them into the next contract. Values ranged from \$150 to \$1500 per day.

In final discussions, several additional items were mentioned. It was noted that a budget for a spare parts supply and staff training would be very helpful. The issue of a mechanism for quick parts replacement was mentioned and included stories of long delays due to Department red tape. It was also mentioned that the addition of ITS device specifications to the PennDOT 408 would be very helpful to the Districts. Another concern that was raised was the issue of parts supply. The idea of getting an agreement with suppliers to provide parts was suggested. The cost of maintenance on many different brands of devices can become high. A limited list of device suppliers would be advantageous to the Districts to help reduce costs.

### 3.2 Overview of Existing Contracts

Several contracts from different Districts were reviewed. Below is a summary of the items which could be very useful or potentially an issue with these contracts. A summary of each contract is provided in **Appendix D**.

The following aspects of contracts reviewed were determined to be useful:

- In one contract, the contractor is required to give 4 days notice of traffic interruption.
- Most contracts had a three-tier classification for services. Preventative maintenance is used to provide regular service to devices. On-call services are used to repair, and emergency response is for correction of emergency situations.
- Preventative maintenance schedules vary from 2 to 4 times a year on a specified schedule.
- Respond time for on-call services ranged from 24 hours to 30 days of call from the Department.
- Emergency response services ranged from 4 to 48 hours.
- One of the contracts maintained a provision for a multiple failure event noting that the Department will determine failure priority.
- Some contracts have provisions on how quickly the work must begin. Examples include commence repairs within 5 days after receiving written notification or 24 hours after verbal notification for emergency conditions. Repairs are to be completed in 2 days.
- Some contracts contain provisions for the Department to terminate the contract as result of non-responsiveness or failure to satisfy time requirements. If not satisfied by response or results, the Department may call out other forces at the cost of the contractor.
- In some contracts, each device is clearly listed and includes supplier address. Information on device communications specifics is also included in the contract.
- Several contracts include a list of surplus devices that are available for use by the contractor. In addition to the maintenance work, the contractor is responsible for managing the spare parts supply. Provisions in the contract allow the contractor to buy parts, pending approval, in order to make repairs and get devices operational.
- Several of the contracts include a complete list of what should be done as part of the preventative maintenance. The contract calls out preventative maintenance but includes

“unless manufacturer recommends more”. One contract also calls for an initial survey and report but does not include guidance on what should be examined

- One contract includes provisions for temporary replacement if the device cannot be repaired within 24 hours.
- There are provisions for an emergency response coordinator to be on call at all times.
- Includes language to allow for the addition of other devices to the contract as they come online.
- One provision in “responsive maintenance” allows time to get parts from the Department. If responsive maintenance is necessary because of poor preventative maintenance, no pay.

The following aspects of contracts reviewed which could have adverse issues:

- Contracts have a provision for traffic modifications but no provision in place for emergency interruptions.
- Device lists should include manufacturer information and contact information if possible.
- Some contracts include reference to equipment that isn’t on the maintenance list. This can cause confusion for contractors.
- The list of available reserve devices could be clearer as to what is available.
- Some of the lists of preventative maintenance do not include anything on the communications devices or allow for additional items to be added to the list.
- One contract references a Preventative Maintenance Checklist that is not included.
- Direction on snow removal includes no information on frequency or response time.
- Provisions for utility coordination are included but nothing to get utilities to respond in a timely manner. There is also no protection for the contractor if the utility companies do not respond.
- A conflict exists for a provision in place that requires 4 day notice of traffic impact, which does not match with the required response time.
- Too much repetition of information in the contract made it difficult to follow and left the possibility for conflict.
- Calls for work twice a year but does not designate the schedule.
- One contract has only one timeline, with no provisions for regular, on-call and emergency response like the other contracts have.

### 3.3 Summary of Contractor Surveys

Several ITS maintenance providers were contacted to gain their perspectives regarding best practices. Sanitized survey responses from the contractors are located in **Appendix C**. As directed by the Department, it was agreed that the consultant team would not disclose specific information regarding maintenance providers.

A summary of the responses is included below. All of the contractors surveyed provide ITS maintenance services to PennDOT covering a total of nine different Districts. Additionally, three of the respondents have done this work outside of the state of Pennsylvania as well.

**Company Organization** - The service structure of the companies varied greatly. In some cases, staff lives in the Districts they serve, while others are within 100 miles of the devices they service. In one case, there are very few persons who actually do the work on the device, but they make use of computer technology such as VPN (Virtual Private Network) and web monitoring to complete diagnostic tasks from remote locations. It was mentioned that the additional use of this technology would help to reduce maintenance costs for the Department.

All of the firms indicated that they make use of subconsultants when there is work outside of their area of expertise. Typically, such firms include actual construction firms, device suppliers, or specialized communications personnel. All respondents noted that, in order to provide for the necessary service, the Department has cell phone numbers through which staff can be contacted at any time.

**District Consistency** - Each respondent was asked about the similarities or differences in the way the Districts operate, and responses were mixed. Some of the contractors felt that the agreements were similar between Districts, while others felt things were handled very differently between jurisdictions. It was also noted that work in other states is typically very different. It was mentioned that, in one case, there was a staff person who went from one management organization to another, which caused things to be similar.

**Spare Parts** - All respondents commented that the supply of spare parts on hand for this maintenance is one of the primary delays in getting devices up and running. In some cases, it is due to the fact that no spare parts are available. In other cases, there is lost time in getting to the storage facility or difficulty finding the part in the inventory. It was universally agreed that this issue could use some improvement, and most recommended having the contractor maintain the parts supply with Department oversight.

**Incentives and Liquidated Damages** - The issue of incentives and damages was also discussed with each respondent. It was mentioned by one firm that the Department should reconsider the issue of liquidated damages. As things exist right now, they are paying these fees themselves because, when a contractor submits his cost proposal, they assume that a certain number of fees will be levied against them and build it into the fee. It was suggested instead that the Department implement a system of uptime calculation for reward and penalties. He recommends setting incentives based on uptime. For example, if it was determined that a 90 percent uptime was normal, over 92 percent uptime gets a bonus, between 92-88 percent is no change, and below 88

percent gets a penalty. This incentive would be based on historic uptime data to establish a reasonable uptime target for contractors to demonstrate a net improvement. In their opinion, this would restrict firms who aren't able to provide adequate service from bidding on the contracts, while rewarding the firms that did good work. A separate firm commented that a geographic prequalification should be implemented to restrict firms from bidding on contracts that are outside of the geographic region they support.

**Contract Barriers** - Each firm was asked if there were times where the contract conditions restricted the firm from getting a device up and running. Several firms responded that the bureaucracy within the Department has negatively impacted their ability to have devices up and running in a timely manner. This system also ends up costing more as it ties up resources unnecessarily. An additional reason that services may have fallen short due to the contract is a monetary limit being assigned to particular tasks. If there is a cost limit, some of the services may come in higher than what is allowed.

Additional comments received from one contractor included a concern that some maintenance contracts do not appear fair when there are only a few bid items and the rest is PDA. There have been a few contracts where the contractor has bid one dollar for the initial setup. A second issue is the Prequalification and Qualification process. A firm is of the opinion that the qualifications are not fair and balanced. Even though they are fully factory-certified, they do not do construction and have never installed a sign, and therefore they are not qualified to bid on maintenance contracts. It is noted that construction and maintenance are two very different processes, and the qualifications should represent that difference. Another comment was that the Department will not be able to provide these services without the help of contractors. The cost of special equipment and personnel will be too high for the Department. However, contractors are going to need to have better educated people. One suggestion was that failure tracking systems and full time help desk access can reduce downtime, especially if they have been approved for offsite diagnostics (via VPN or other access). One final comment was that NTCIP is an important step in maintenance. The Department needs to be more open to new technology and they need to learn to trust the standards. Even if the item isn't proprietary, the Department makes it that way.

## 4. Findings and Suggested Actions

### 4.1 Overview of Contract Mechanisms

Existing and proposed contract mechanisms were discussed with the Department to gauge their perspectives.

Contract Mechanisms	Pros	Cons	Suggested Approach
<b>Purchase Order</b>	<ul style="list-style-type: none"> <li>Used in some forms now</li> <li>OK for small efforts and for Districts with very limited deployments</li> </ul>	<ul style="list-style-type: none"> <li>Limits responsiveness due to processing requirements/ timeframe</li> <li>May not be the most desirable mechanism in the future</li> </ul>	<ul style="list-style-type: none"> <li>May be appropriate for small projects</li> </ul>
<b>Low-bid</b>	<ul style="list-style-type: none"> <li>The most common method used presently</li> <li>Easiest for contractors to respond to</li> <li>Easiest to evaluate for selection</li> <li>Low-bid may be a viable mechanism in the future provided qualifications, scope of coverage, maintenance requirements (preventative, response, other) are detailed, and damages/incentives are detailed</li> </ul>	<ul style="list-style-type: none"> <li>Concerns by some that low-bid may not always yield the most reliable and responsive contractor</li> </ul>	<ul style="list-style-type: none"> <li>Preferred contract mechanism for near-term projects</li> </ul>
<b>RFP</b>	<ul style="list-style-type: none"> <li>Provides a mechanism to select the most desirable contractor</li> </ul>	<ul style="list-style-type: none"> <li>Not a format that contractors are used to</li> <li>Selection subject to protest</li> <li>Longer advertisement and selection period</li> <li>Although, the “best” contractor can be selected, the concerns over the selection process may not make this a viable option in the future</li> </ul>	<ul style="list-style-type: none"> <li>Not a suggested contract mechanism due to complexities</li> </ul>
<b>Design-Build-Best-Value (DBBV) Model</b>	<ul style="list-style-type: none"> <li>If DBBV can be adjusted for ITS maintenance contracts, it may offer a compromise between low-bid and RFP-based contracts</li> </ul>	<ul style="list-style-type: none"> <li>The Department is still evaluating their “innovative bidding models” and DBBV contracting is still being adjusted</li> <li>Final guidance will be included in Publication 448 and subject to approval</li> </ul>	<ul style="list-style-type: none"> <li>DBBV may be appropriate for future projects</li> </ul>

In general, purchase orders were viewed as a current practice for small efforts, but most agreed that they may not be the most desirable contract mechanism in the future.

Low-bid contracts through ECMS are the most common practice used to date; however, there are some concerns with “getting the right contractor” or “getting what you pay for.” These are valid concerns; however, most agreed that these issues can be offset by requiring qualifications, having

a clear scope of work, and utilizing the appropriate combination of liquidated damages and financial incentives.

A Request for Proposal (RFP) would allow the Department to select the most responsive and prepared contractor; however, most contractors are not familiar with the RFP process. More importantly, it would likely increase the selection process time and result in more claims from non-selected contractors.

A modified version of the Design-Build-Best-Value (DBBV) may warrant future consideration as it offers a mechanism to eliminate non-qualified respondents (in an impartial way), but also can include a low-bid or cost element. However, the Department is still fine-tuning the process; therefore, it may be best to revisit this option in the future.



## 4.2 Suggested Model ITS Maintenance Contract

### 4.2.1 Geographic Coverage

As part of the evaluation, geographic coverage was evaluated.

Currently, the Department has a combination of District contracts with some statewide contracts for RWIS support and for other BIS activities. Most Districts stated that District-wide and Regional (more than District) maintenance contracts were their preferred method. Having District or Regional coverage allows Traffic Management Centers (TMCs) to take more ownership and have more direct oversight of maintenance activities. Several Districts cited the RWIS program as an example where statewide contracting has not worked effectively.

It was noted by some in BIS that statewide maintenance contracting is the most appropriate mechanism because it is common to centralize maintenance in the IT industry in order to maintain consistency and to monitor service.

Maintenance Contract Model	Pros	Cons
<p style="text-align: center;"><b>Statewide</b></p>	<ul style="list-style-type: none"> <li>▪ Less administration required</li> <li>▪ Statewide architecture will eventually result in less brands used (this will take a long time to achieve)</li> <li>▪ Best chance for “volume discount” services</li> <li>▪ All Districts receive maintenance service</li> <li>▪ Better coordination of information</li> <li>▪ More streamlined maintenance practices</li> <li>▪ One person can oversee maintenance practices and make decisions if needed</li> <li>▪ More resources available for rural areas to obtain Federal funding</li> </ul>	<ul style="list-style-type: none"> <li>▪ No contractor is large enough to support the entire state</li> <li>▪ Could be difficult for a single firm to be familiar with every system in the state</li> <li>▪ Due to geographic restrictions, response times may be large</li> <li>▪ Familiarity with large number of device brands will be required</li> <li>▪ Lack of familiarity with local trends and issues</li> <li>▪ Statewide would need to use applications such as VPN to do long distance maintenance work. Information provided indicated that the Department has been resistant to utilize such technologies.</li> <li>▪ Poor history in similar contract configuration</li> <li>▪ Becomes very large when considering all of the “one of a kind” devices statewide</li> <li>▪ Chance for rural areas to be “de-prioritized”</li> <li>▪ More difficult coordination with TMCs</li> <li>▪ More difficult to have unanimous decisions on issues</li> </ul>
<p style="text-align: center;"><b>Regional</b></p>	<ul style="list-style-type: none"> <li>▪ Regional ITS managers are the most knowledgeable on the needs and care of their local systems</li> <li>▪ Less administration required than a District-wide contract</li> <li>▪ Chance for “volume discount” services</li> <li>▪ Aligns with proposed TMC configurations</li> <li>▪ More competition due to contractor size (statewide model rules out smaller firms)</li> </ul>	<ul style="list-style-type: none"> <li>▪ More administration required than statewide</li> <li>▪ Potential for longer response time than District contracts</li> </ul>



Maintenance Contract Model	Pros	Cons
<p><b>District-wide</b></p>	<ul style="list-style-type: none"> <li>▪ Regional ITS managers are the most knowledgeable on the needs and care of their local systems</li> <li>▪ Shortest response time</li> <li>▪ Contractor can be very familiar with the system</li> <li>▪ Tailored to exact needs of the District</li> <li>▪ Includes specific “one of a kind devices”</li> <li>▪ Most competition due to contractor size (statewide model rules out smaller firms)</li> </ul>	<ul style="list-style-type: none"> <li>▪ More administration required than other models</li> <li>▪ Little chance for volume discount services</li> </ul>

The Department’s ITS plans continue to evolve and develop. ITS management will extend beyond District boundaries and, in many cases, is regional in nature. At the highest level, there is a need for statewide ITS management. To achieve these goals, it may be appropriate to utilize District-wide, regional, and statewide contracts as follows:

<p>When to use a regional contract</p> <ul style="list-style-type: none"> <li>▪ When there is one “lead” District and one nearby “developing” District</li> <li>▪ When both Districts have common (manufacturer) devices</li> <li>▪ When both Districts fall within common regional boundaries</li> <li>▪ Where it is preferred to have a regional contract</li> </ul> <p>When to use a District contract</p> <ul style="list-style-type: none"> <li>▪ When there is no apparent “lead” District</li> <li>▪ When most devices are not compatible</li> <li>▪ If the Districts do fall within regional boundaries</li> <li>▪ Where it is preferred to have a District contract</li> <li>▪ For specialty systems where response times are critical and most deployments reside in one District</li> </ul> <p>When to use a statewide contract</p> <ul style="list-style-type: none"> <li>▪ To provide maintenance to specialty systems that are not widely deployed</li> <li>▪ For specialty systems where response times are less critical.</li> <li>▪ To support “off-brands” of Dynamic Message Signs</li> </ul>
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### 4.3 Contract Element Summary

National practices, experiences from other states, and Department perspectives were all considered in identifying key elements to include in future ITS maintenance contracts.

While all existing ITS maintenance contracts were considered, current contracts in Districts 6-0, 8-0, and 10-0 were chosen as base models in contract structure and wording.

#### 4.3.1 Contract Length

Based on experiences within the Department as well as other states, a base contract should be two years in length with an option for a one-year renewal.

#### 4.3.2 Qualifications

The Department should consider utilizing the established prequalification codes (P-codes) to ensure qualified respondents. While requiring P-codes may limit respondents and/or increase bid results, the proper use of P-codes will assist in delivering qualified contractors to perform ITS maintenance. It should not be a requirement that the prime contractor has all P-codes, but the contractor’s team should satisfy all necessary qualifications to perform the maintenance service request. In the future, the Department should consider establishing a P-code for basic ITS maintenance.

Existing P-codes are as follows:

- P1 CCTV, RWIS, Automated Anti Deicing Systems
- P2 Highway Advisory Radio Systems (HAR)
- P3 Dynamic Message Signs (DMS)
- P4 Integrated Communication Systems
- P5 Level 1 System Integrators (Hardware)
- P6 Level 2 System Integrators (Software)
- P7 Level 3 System Integrators (Hard/Software)
- P8 Highway/Sign Lighting Electrical
- Q Maintenance and Protection of Traffic

An alternative would be to utilize P-code descriptions in developing qualification requirements, but not to formally require P-codes. This would allow respondents without P-codes to respond. It would also allow the Department to remove unrelated elements of P-codes developed for construction-only activities.

#### 4.3.3 Responsiveness

Some contracts contain provisions for the Department to terminate the contract as a result of non-responsiveness or failure to satisfy time requirements.

#### Model Language

- *The time period allowed for the completion of repair work will commence upon the issuance of a work directive (written and/or verbal) by an authorized individual (Administrative or*

*Technical Contact). Each failure or damage will be considered as a separate incident. Repairs will be considered complete when the malfunctioning equipment or damaged device(s) are restored to a completely operational and functional condition.*

- *Inform the District's TMC/Incident Management Unit (Technical Activities Contact), from the site, prior to start of any work on the reported problem and at the completion of any work.*
- *THIS CONTRACT CAN BE TERMINATED AT ANY TIME IF THE CONTRACTOR IS NOT RESPONSIVE TO THE DEPARTMENT'S NEEDS OR DOES NOT MEET THE RESPONSE TIMES NOTED IN THIS DOCUMENT.*

#### 4.3.4 Liquidated Damages and Performance Metrics

For Districts with liquidated damages, values ranged from \$150 to \$1,500 dollars per day; however, some contractors noted that they include an estimated number of damages into their bid, essentially putting the cost back on to the Department.

The study group suggests liquidated damage assessment be written into the contract and be at least \$500 per occurrence, with \$1200 for a second offense on the same claim, and potential for breach of contract beyond that.

#### Model Language

- *PennDOT reserves the right to assess liquidated damages in the amount of five hundred dollars (\$500.00) per occurrence for any of the following circumstances:*
  - *Failure to properly perform any of the requirements.*
  - *Failure to comply with any permit requirements.*
  - *Damage to PennDOT property and equipment through negligence.*
  - *Failure to immediately notify the designated PennDOT representative in the event of a system failure.*
  - *Failure of Contractor to provide all necessary routine maintenance.*
- *On the second and all subsequent occurrences where the Contractor has failed to follow the reporting procedures as outlined above, a one thousand two hundred dollar (\$1200.00) liquidated damage assessment will be made for each occurrence.*
- *Additional charges may be assessed as indicated in the specifications for respective items. Multiple assessments of liquidated damages may result in termination of the contract for contractor noncompliance.*
- *In the event of an emergency call-out, failure of the Contractor or his representative to respond within 4 hours of notification by PennDOT may result in termination of the contract in accordance with paragraph X, Non-Compliance, of these specifications.*
- *The Contractor or his representative must arrange with the appropriate utility provider to respond to an emergency call within 24 hours after proper notification of the problem.*

For future contracts, the Department may wish to also include an uptime incentive to encourage contractor responsiveness. For example, if it was determined that a 95 percent uptime was normal, over 95 percent uptime gets a financial incentive, between 95-85 percent is no change, and below 85 percent gets a penalty.

#### 4.3.5 Start of Work

In one contract, the contractor is required to give 4 days notice of traffic interruption. The study team suggests a minimum of 3 days notice for start of work.

Model Language:

- *Notify the Assistant District Engineer for Construction three days prior to the actual start of work.*
- *Keep constant liaison with the Assistant District Engineer for Construction as to any changes to the date of starting work.*

#### 4.3.6 Preventive Maintenance

Preventative maintenance schedules in the Department and in other states vary from 2 to 4 times a year. In some cases, preventative maintenance can be scheduled more frequently based on the age of the equipment or historic issues. In all cases, preventative maintenance should be logged, and it may be desirable to require a monthly report for all devices.

Based on the research conducted, it is suggested that preventive maintenance be scheduled at least twice a year.

Model Language:

- *DESCRIPTION - This work is the performing of preventive maintenance of all the ITS equipment. Perform this work in April and October of each year. Preventative maintenance must be completed by the xxth day of the inspection month.*
- *MATERIAL AND CONSTRUCTION - Perform preventive maintenance in accordance with the manufacturer's recommendations or as follows, as directed. Perform all tasks indicated on the attached PM Checklists for the various preventative maintenance items. Check for proper clearance of tree branches or brush around power and communication lines associated with any ITS devices and report required tree trimming and/or brush clearing work.*
- *Field Equipment Cabinets - Inspect all field equipment cabinets, including camera control cabinets and junction and pull boxes, for damage, corrosion, water damage, and leaks. Check gaskets, ground rod clamps, heaters, and all connections. Check anchor bolts for rust and tightness. Repair as necessary. Clean filters. Replace filters (annually), lubricate hinges, locks, latches and clean accumulated dust. Inspect all connections, cabling, and physical appearance of the equipment within the cabinets. Perform local diagnostics on all applicable equipment. Tighten loose connections. Service air conditioner, fans, and heater controls. Test ground rods for 25 ohms or less resistance utilizing fall of potential test. Test power and communications line surge suppressors and replace as necessary. Report all deficiencies on the PM checklist and report any critical deficiencies directly to the Engineer (Technical Activities Contact) immediately.*
- *Camera Poles and Structures - Inspect camera poles/trailers for wear, rust, cracks, and missing, damaged, or bent sections. Check bolts for rust and tightness. Report all deficiencies on the PM checklist and report any critical deficiencies directly to the Engineer (Technical Activities Contact) immediately.*
- *Cameras, Pan/Tilt Drives and Housings - Inspect for general condition, wear, rust, cracks, loose connections, frayed cables, lowering device, and missing, damaged, or bent parts.*

Check attachment hardware. Clean, repaint, and repair as necessary. Thoroughly clean solar panels that power the battery packs. Test communications system. Test power and communications line surge suppressors and replace as necessary. Report all deficiencies on the PM checklist and report any critical deficiencies directly to the Engineer (Technical Activities Contact), immediately.

- *Dynamic Message Sign Structure – Inspect for general condition, wear, rust, cracks, loose connections, frayed cables, and missing, damaged, or bent parts. Check attachment hardware. Clean, repaint, and repair as necessary. Check anchor bolts for rust and tightness. Report all deficiencies on PM checklist and report any critical deficiencies directly to Engineer (Technical Activities Contact) immediately.*
- *Portable DMS, Semi-Permanent DMS, and Permanent DMS - Test operation of sign, all lamps and LED clusters, and perform diagnostic tests. Check batteries and add distilled water (record group voltage, split voltage, specific gravity). Thoroughly clean solar panels that power the battery packs. Clean surface of signs. Clean filters during every Preventive Maintenance inspection. Replace filters (annually). Test ground rods for 25 ohms or less resistance utilizing fall of potential test. Replace power and communication surge suppressors. Test communication system. Lubricate all hinges, jack stands, mast, and trailer hitches. Test power and communications line surge suppressors and replace as necessary. Report all deficiencies on PM checklist and report any critical deficiencies directly to Engineer (Technical Activities Contact) immediately.*
- *Highway Advisory Radios – Inspect for general condition, wear, rust, cracks, loose connections, frayed cables, damage caused by (lightning, leaning, car impacts, vandalism), and missing, damaged, or bent parts. Check batteries. Clean, repaint, and repair as necessary. Thoroughly clean solar panels that power the battery packs. Verify the broadcast signal strength of the HAR transmitter via the dials located on the front panel. Verify that the HAR transmitter is clearly transmitting a signal by utilizing a car radio and turning the dial to the appropriate channel. Test communication system. Test power and communications line surge suppressors and replace as necessary. Test all static sign flashing warning devices associated with the HAR systems, check batteries, clean controller cabinet and solar panels. Report all deficiencies on PM checklist and report any critical deficiencies directly to Engineer (Technical Activities Contact) immediately.*
- *Portable Solar Powered Speed Display Trailers - Test operation of sign, all lamps and LED clusters, and perform diagnostic tests. Check batteries and add distilled water (record group voltage, split voltage, specific gravity). Thoroughly clean solar panels that power the battery packs. Clean surface of signs. Clean filters. Lubricate all hinges, jack stands, mast and trailer hitches. Report all deficiencies on the PM checklist and report any critical deficiencies directly to Engineer (Technical Activities Contact) immediately.*
- *DISTRICT ITS EQUIPMENT- The Department will provide a list of the current locations for all ITS equipment operated out of the District XX Office. The Contractor will notify the Technical Activities Contact and the Construction Unit one (1) week in advance of performing preventative maintenance on the District ITS equipment. The notification will include emailing a detailed schedule of the date, time, place/route, and type of equipment for performing the preventative maintenance.*
- *COUNTY ITS EQUIPMENT- For portable DMS and Speed Display Trailers located at the County Maintenance Offices, notify each County Equipment Manager and the Construction Unit one (1) week in advance of performing Preventive Maintenance on county portable DMS message*



boards. Contact information for each County Equipment Manager will be provided at the Preconstruction Meeting. The Contractor will be responsible for coordinating and scheduling with each County regarding Preventative Maintenance. The County Equipment Manager will identify the locations of all portable DMS. The notification will include a detailed schedule of the date, time, and place/route, for performing the preventative maintenance.

- Immediately report any deficiencies discovered during the preventive maintenance to the Engineer (Technical Activities Contact).
- Submit a typed copy of the monthly status report showing all preventive maintenance completed during the previous month. Include in the report, a detailed description of the preventive maintenance performed, copies of payroll records, and work reports. Also, include the PM Checklists with test results in the report for all the tests conducted during preventive maintenance.
- Submit to XX for approval, within two (2) weeks of receiving notice to proceed, a schedule of periodic maintenance activities.
- For failure to complete the preventative maintenance by the 28th day of the inspection month, the Department will charge liquidated damages in the amount of Five Hundred Dollars (\$500.00) for each day that the work is not completed.
- For failure to submit a completed monthly status report by the 15th of the month, one (1) hard, typed copy of the status report and the PM Checklists showing all preventive maintenance completed during the previous month, the Department will charge liquidated damages of Five Hundred Dollars (\$500.00) for each day that the status report deadline is missed.
- MEASUREMENT AND PAYMENT - Each.

#### 4.3.7 Response Maintenance

Response maintenance can be divided into the following elements:

1. Receive notification – This is the point in time that the Department notifies the contractor that there is an issue that requires attention.
2. Arrive at site and diagnose the problem- Upon notification, this is the time it takes for the contractor to diagnose the issue. Typical response times for step 2 range from 24 to 48 hours. An appropriate length of time may be 48 hours unless otherwise approved by the Department.
3. Perform repairs – Upon notification, this is the time it takes for the contractor to perform repairs. Typical repair times range from 2 days upon notification up to 4 days upon notification. An appropriate length may be 4 days upon notification to allow for diagnostics. The Department should include a note, “*unless otherwise approved by the Department,*” and “*the Engineer may authorize additional time for procurement of materials*” to allow flexibility if the needed activity is beyond the control of the contractor.
4. Log activity – This includes formally logging the activity into the maintenance log.

Model Language:

- **DESCRIPTION** - *This work is the performing of non-emergency diagnostics, repair of failed component(s) of ITS equipment and operating systems, and the restoration to normal operation.*
- **MATERIAL AND CONSTRUCTION** –
- **SERVICES** - *Upon receipt of authorization to commence work, complete all work within four (4) calendar days unless otherwise approved by the Department. Continue to completion without*

interruption, except for traffic restriction. The Engineer may authorize additional time for procurement of materials. Respond to the site within 48 hours of notification for non-emergency diagnostics and repairs unless otherwise approved by the Department. For notification received after 3:00 PM Thursday, respond before 9:30 AM the following Monday.

- Repairs are to be constructed in a similar or better method to those being replaced.
- Submit by the 15th of the month, a monthly status report showing all response maintenance completed during the previous month. Include in the report, a detailed description of the response maintenance performed, copies of payroll records, and work reports. Also, include test results in the report for all the tests conducted during response maintenance.
- The time required to procure any spare parts will not count towards the response time.
- For failure to complete work within four (4) calendar days, the Department will charge liquidated damages in the amount of Five Hundred Dollars (\$500) for each day the work is not complete. Said liquidated damages do not include damages suffered by the Department as a result of any tort claims brought against the Department. The Department hereby reserves the right to seek recovery from the Contractor for any damages which the Department suffers as a result of any tort claims brought against the Department.
- MEASUREMENT AND PAYMENT - Dollar.
- The proposal will include an item and a predetermined amount (PDA) of money for this item. The contract item will have a unit of measure of DOLLAR, a unit price of \$1.00, and a quantity equal to the predetermined amount.
- Due to the contingent or unpredictable nature of the work being performed and/or the incentive or bonus status of the payment being made, the provisions of Section 110.02(d) are not applicable to this item.
- Measured and paid for, under this item as follows:
  - (a) Negotiated Price
  - (b) Force Account Basis
- Travel time to and from the site will be reimbursable under the mobilization item only.
- Repairs necessitated by the failure to properly perform preventive maintenance or untimely response to requests by the Engineer (Administrative or Technical Contact) will not be paid.
- After the Response Maintenance has been completed, perform a Preventive Maintenance inspection at no additional cost to the Department.
- All Maintenance and Protection of Traffic associated with Response Maintenance is payable under this item of work.
- To ensure the operational integrity of the ITS equipment, the Department retains the option to employ Department or other forces (including contractors, contract engineers, manufacturers, vendors, etc.) to accomplish work not completed by the Contractor, using the criteria presented in the section titled "RESPONSIVENESS". The cost of the work performed by others will be deducted from payments due to the Contractor.
- This Contract can be terminated at any time if the Contractor is not responsive to the Department's needs or does not meet the response and submittal times noted in ITEM 9000-XXXX.

#### 4.3.8 Emergency Repairs

Emergency response services ranged from 4 to 48 hours. The study team suggests emergency response to the site within 4 hours of notification. An appropriate length for repair may be 24 hours upon notification to allow for diagnostics. The Department should include a note, "unless

otherwise approved by the Department,” and “the Engineer may authorize additional time for procurement of materials” to allow flexibility if the needed activity is beyond the control of the contractor.

#### Model Language

- *DESCRIPTION - This work is the restoration of any malfunction or damage caused by severe and unusual forces of nature, vehicular accidents and collisions, vandalism, theft, fire, erosion, exposure to chemicals or pollutants, or any other damage not included elsewhere in these Special Provisions. The causes of such damages are generally considered to be those of an unpredictable nature.*
- *MATERIAL AND CONSTRUCTION - Emergency repairs generally will involve physical damage to part of the ITS equipment necessitating the removal and replacement of structures and/or equipment.*
- *Provide two contact persons who are available 24 hours a day for incidents/emergencies that are able to respond within four (4) hours of notification. Provide names and telephone numbers to the inspector in charge for distribution to the State Police, local police, emergency personnel, and the PennDOT Traffic Management Center.*
- *Respond to the site within four (4) hours after emergency notification is received.*
- *In the event normal operation cannot be restored immediately, supply a substitute device or structure until repairs to the existing device can be made. Repair the existing device and return it to the field as quickly as practical, or as directed by the Engineer (Technical Activities Contact).*
- *For damage caused by vehicular collision, notify the Engineer (Technical Activities Contact) immediately; photograph all damaged structures and equipment. Submit these photographs to the Engineer (Technical Activities Contact).*
- *Submit by the 15th of the month, a monthly status report showing all emergency maintenance completed during the previous month to the Engineer (Administrative Contact). Include in the report, a detailed description of the emergency maintenance performed, copies of payroll records, and work reports. Also, include test results in the report for all the tests conducted during emergency maintenance.*
- *Repairs are to be constructed in a similar or better method to those being placed.*
- *MEASUREMENT AND PAYMENT - Dollar.*
- *The proposal will include an item and a predetermined amount (PDA) of money for this item. The contract item will have a unit of measure of DOLLAR, a unit price of \$1.00, and a quantity equal to the predetermined amount.*
- *Due to the contingent or unpredictable nature of the work being performed and/or the incentive or bonus status of the payment being made, the provisions of Section 110.02(d) are not applicable to this item.*
- *Measured and paid for, under this item as follows:*
  - *(a) Negotiated Price*
  - *(b) Force Account Basis*
- *Travel time to and from the site will be reimbursable under the mobilization item only. To ensure the operational integrity of the ITS equipment, the Department retains the option to employ Department or other forces (including contractors, contract engineers, manufacturers, vendors, etc.) to accomplish work not completed by the Contractor, using the criteria*



*presented in the section titled "RESPONSIVENESS". The cost of the work performed by others will be deducted from payments due to the Contractor.*

- *This Contract can be terminated at any time if the Contractor is not responsive to the Department's needs or does not meet the response and submittal times noted in ITEM 9000-xxxx.*
- *Repairs necessitated by the failure to properly perform preventive maintenance or untimely response to requests by the Engineer (Administrative or Technical Contacts) will not be paid.*
- *After the Emergency Repairs have been completed, perform a general preventive maintenance at no additional costs. All Maintenance and Protection of Traffic associated with Emergency Repairs is payable under this item of work.*

#### 4.3.9 Other Elements to Consider

##### Device Listing

Most contracts reviewed include a listing of device types. However, the level of detail included varies. As part of the general provisions, the following information should be provided to the potential bidders:

- Types of devices (DMS, CCTV, HAR, etc.)
- Make and model of devices
- Location of the devices
- Expected additional deployments

##### Spare Parts

By description for response maintenance, the contractor would likely need to have an inventory of spare parts in order to respond within time parameters; however, it may be appropriate to provide a basic listing of spare parts that should be maintained.

The inventory should be sufficient to allow for efficient response maintenance but should be limited to an amount that will not result in an "outdated" inventory of equipment. An appropriate inventory may be 10-20 percent of the key components by ITS device type and make. These components may include:

- Controller fans, sensors, and power supplies by device/brand
- Modems for all devices
- Spare fiber and patch cords
- Pixel boards for DMS
- HAR antennas and transmitter modules
- CCTV units by brand
- Encoders/decoders for CCTV

### Emergency Deployments

Several Districts noted that many of the ITS maintenance providers are also the common deployers of ITS technologies. Due to the common use of ITS technologies for “all hazards,” it is not uncommon for there to be an unexpected but urgent need for deployment (e.g. DMS needed in District 5-0 on I-78).

When developing ITS maintenance contracts, consideration should be given to including a provision to allow for limited ITS deployments to include DMS, CCTV, and HAR among others.

#### **4.4 ITS Maintenance and Asset Management**

Asset management is the cost-effective operation, maintenance, and preservation of transportation systems, including intelligent transportation systems. Key elements in asset management include:

- Keeping an inventory of assets
- Maintaining available information on the condition of assets
- Determining the value of their assets
- Using effectively the data they collect
- Analyzing properly the cost of maintaining an asset over the cycle of its life
- Analyzing costs and benefits of a project and determining the best course of action

As the Department’s ITS maintenance program continues to evolve, asset management will be a critical element to promote system-improved maintenance and reliability. When considering ITS asset management, it is critical for the Department to keep a detailed inventory database which includes:

- Tracking number
- ITS device make and model
- Photos and as-built drawings if available
- Location
- Key components and system communication
- Maintenance logs

Additionally, the ability to provide remote diagnostics would help reduce maintenance costs for the Department. When practical, these capabilities should be integrated into deployment and maintenance contracts.



## Appendix A Detailed Literature Review Summary

<b>Document Name</b>	<b>Guidelines for Funding Operations and Maintenance of Intelligent Transportation Systems/Advanced Traffic Management Systems</b>
<b>Published By</b>	Transportation Research Board
<b>Date</b>	May 1997
<b>Electronic Source</b>	<a href="http://citeseer.ist.psu.edu/284635.html">http://citeseer.ist.psu.edu/284635.html</a>
<b>Abstract</b>	One of the most important areas of ITS has not been researched thoroughly, even if it is the backbone to solid intelligent transportation implementation. Operation and maintenance (O&M) of ITS technologies are not considered enough when planning for these systems. Due to this neglect, there is very little documentation regarding the costs of ITS and procuring the required funding. The paper attempts to quantify the costs to operate and maintain a variety of ITS technologies. The authors also address funding options for these technologies.
<b>Guidance on Maintenance Programming</b>	<ul style="list-style-type: none"> <li>▪ Designs are mostly considered by initial implementation costs, but agencies should also include O&amp;M costs into the decision.</li> <li>▪ Agencies should support the National Transportation Communications for ITS Protocol (NTCIP), which is an initiative to standardize communications and ensure interoperability and interchangeability among traffic control and ITS devices.</li> </ul>
<b>Guidance on Preventive Maintenance</b>	None
<b>Guidance on Response Maintenance</b>	None
<b>Guidance on Maintenance Costs</b>	<ul style="list-style-type: none"> <li>▪ The authors came up with operations and maintenance costs using the following sources:                             <ul style="list-style-type: none"> <li>□ Texas Department of Transportation (TxDOT) personnel from different metropolitan districts</li> <li>□ “Operation and Maintenance of Electronic Traffic Control Systems,” by ITE</li> <li>□ “Cost Estimates and Assumptions for the Core Infrastructure,” by FHWA</li> <li>□ Texas municipalities and transit agencies</li> <li>□ Technical journals</li> <li>□ Equipment suppliers</li> </ul> </li> <li>▪ The O&amp;M costs are categorized by ITS function/Advanced Traffic Management Systems (ATMS):                             <ul style="list-style-type: none"> <li>□ Traffic Management Center (TMC)</li> <li>□ Field Communications/Processing</li> <li>□ Surveillance</li> <li>□ Traffic Control</li> <li>□ Traveler Information</li> <li>□ Incident Emergency Response</li> </ul> </li> <li>▪ The authors compiled tables of ITS/ATMS elements that included the element’s basic unit of measure, estimated unit operations cost, estimated unit maintenance cost, combined unit O&amp;M cost, any assumptions made to derive the cost figures, and the sources used to determine the cost.</li> </ul>
<b>Guidance on Contracting</b>	<ul style="list-style-type: none"> <li>▪ Agencies should form partnerships with the private sector. These public-private partnerships are different than hiring a contractor to perform work. Public-private partnerships are long-lasting which is important for operations and maintenance.</li> </ul>
<b>Guidance on Maintenance Funding and Budgeting</b>	<ul style="list-style-type: none"> <li>▪ The authors surveyed 21 state transportation agencies and several had methods to fund operations and maintenance. Some of the methods are:                             <ul style="list-style-type: none"> <li>□ Utilizing federal funding sources, such as Congestion Mitigation and Air Quality (CMAQ), National Highway System (NHS), and Surface Transportation Program (STP), to pay for traffic management O&amp;M.</li> <li>□ Using contract maintenance instead of using in-house support for maintenance. There are two advantages to contracting maintenance. The first advantage is that the agency can use contracting dollars, which are abundant within the agency’s budget. The second is that the agency can perform maintenance even if there are hiring freezes within the organization.</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>□ Including spare parts in construction or maintenance contracts so that there are no complications in the future.</li> <li>□ Identifying ITS O&amp;M as its own budget category. By doing so, it shows O&amp;M is an ongoing expense and makes it easier to track costs. Unfortunately, using different ITS categories is cumbersome.</li> <li>▪ Agencies should track their O&amp;M costs over the long term to validate the tables presented in this paper. Tracking O&amp;M costs also goes hand-in-hand with identifying ITS O&amp;M as its own budget category.</li> <li>▪ Agencies should also detail the source and level of funding for operations and maintenance so that all O&amp;M activities get an appropriate share of funding. There are three ways this can be done:             <ul style="list-style-type: none"> <li>□ Provide managers with objective criteria by documenting the benefits of ITS O&amp;M.</li> <li>□ Acknowledge increased funding requirements for maintenance and operation of all transportation system expansions.</li> <li>□ Take advantage of federal funding that is available.</li> </ul> </li> <li>▪ If additional O&amp;M funding is not expected, new projects should be put on hold if they cannot be properly maintained or operated.</li> </ul>
<p><b>Benefit and Cost Considerations</b></p>	<ul style="list-style-type: none"> <li>▪ Many O&amp;M benefits arise when public agencies form partnerships with each other:             <ul style="list-style-type: none"> <li>□ Improved interjurisdictional coordination and integration</li> <li>□ Enhanced opportunities to share communications costs with other agencies</li> <li>□ Reduced personnel training requirements</li> <li>□ Reduced replacement parts costs</li> <li>□ Smaller equipment inventories</li> </ul> </li> <li>▪ A wide variety of proprietary equipment available increases O&amp;M costs. Noninterchangeable equipment, personnel training, and increased inventories add to costs.</li> </ul>
<p><b>Summary</b></p>	<p>The tables developed in this paper are a huge asset for projecting costs of ITS technologies. The authors breakdown O&amp;M costs for a variety of equipment ranging from support vehicles to call boxes. Even though most of the cost figures for the tables were derived from TxDOT metropolitan districts, other agencies throughout the country could find these costs useful. In addition to providing agencies with the cost breakdowns, the paper touches upon important funding and budgeting issues. The paper addresses many problems with financing for O&amp;M and offers advice to deal with these problems.</p>
<p><b>Other Notes and Observations</b></p>	<p>None</p>

<b>Document Name</b>	<b>Traffic Control System Operations: Installation, Management, and Maintenance</b>
<b>Published By</b>	Institute of Transportation Engineers
<b>Date</b>	2000
<b>Electronic Source</b>	Available for purchase at <a href="http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=TB-009A">http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=TB-009A</a>
<b>Abstract</b>	This guide helps engineers, administrators, and maintenance and operations personnel understand the impact of the management, installation, and operations of traffic control systems. The guide also describes how to install, manage, and operate ITS technologies cost-effectively and efficiently.
<b>Guidance on Maintenance Programming</b>	<ul style="list-style-type: none"> <li>▪ The personnel required to maintain an ITS system can be categorized into two groups: field hardware personnel and traffic management center personnel. <ul style="list-style-type: none"> <li>□ Field Hardware – technician, electronics technician, and electronics supervising technician</li> <li>□ Traffic Management Center – control center technician, communications specialist, software programmer, system operator, shift supervisor/manager, and operations center director</li> </ul> </li> <li>▪ The guide gives a table of entry-level qualifications, training, and experience needed for each position.</li> <li>▪ The required equipment for maintenance can be grouped into three categories: maintenance vehicles, test equipment and tools, and replacement parts and supplies. The guide includes a list of recommended equipment for each category.</li> <li>▪ The guide advises agencies on the location, layout, size, organization, outfitting, staffing, and budget of repair shops.</li> <li>▪ One of the most important aspects of maintenance is the upkeep of records. Up-to-date maintenance records can help: <ul style="list-style-type: none"> <li>□ Provide efficient service</li> <li>□ Detect and correct recurring problems</li> <li>□ Develop maintenance schedules and strategies</li> <li>□ Protect the agency in case of a lawsuit</li> </ul> </li> <li>▪ Maintenance personnel and operators should be trained before any ITS technologies are implemented. Personnel will be familiar with equipment and proficient during maintenance.</li> <li>▪ It is critical for the agency to keep a detailed inventory database. This includes the following documentation: <ul style="list-style-type: none"> <li>□ As-built documentation</li> <li>□ Field inventory documentation</li> <li>□ Stock room inventory lists</li> <li>□ Maintenance logs</li> <li>□ Tracking of all ITS components</li> </ul> </li> <li>▪ The following technologies help improve ITS maintenance inventory management: <ul style="list-style-type: none"> <li>□ Bar coding</li> <li>□ Geographic information systems (GIS)</li> <li>□ Global positioning systems (GPS)</li> <li>□ Field computers – pen-based computers allow the user to take notes, schedule appointments, and send email. Laptops are more capable, but are larger and more cumbersome. Handhelds are smaller versions of laptops.</li> <li>□ Emerging technologies such as radio frequency identification (RFID), video logging, voice recognition, optical character recognition, radio frequency data communications, and electronic data interface.</li> </ul> </li> <li>▪ There are many different types of schedules that can be used for ITS implementation: <ul style="list-style-type: none"> <li>□ Milestone chart – very simple but only shows completion dates</li> <li>□ Bar chart – one of the most widely used schedules and shows scheduled start and finish dates. It does not show the interrelationships among tasks, nor the priority of tasks.</li> <li>□ Critical path method (CPM) – graphically shows which task must be started first, which must be completed before another is started, and which can proceed simultaneously. Unfortunately, this method requires a significant amount of time to build and update.</li> </ul> </li> </ul>
	<ul style="list-style-type: none"> <li>▪ In the appendix, the document provides a sample preventive maintenance contract for variable message signs and traveler’s advisory radio advance signs.</li> <li>▪ ITS systems should be inspected every two to three years for conformance with the approved</li> </ul>

<p><b>Guidance on Preventive Maintenance</b></p>	<p>plan, conformance with state of the art practices, and compatibility with transportation demands and physical conditions. The guide provides a checklist to run through during the inspection.</p> <ul style="list-style-type: none"> <li>▪ ITS deployments should include remote diagnostic capabilities, if possible. By using computers to monitor and store operational data, preventive maintenance procedures will be facilitated.</li> <li>▪ Redundant and fault-tolerant equipment decreases the chances of an ITS device failing.</li> <li>▪ Preventive maintenance schedules should be submitted at least two weeks in advance for approval by the agency so that the work can be combined with construction work zones.</li> <li>▪ The guide offers general preventive maintenance checklists for key elements common to all field devices. The checklists include the minimum interval of maintenance and an average of the total time spent on the tasks.</li> <li>▪ The guide has a chapter dedicated to describing ITS technologies and recommendations for preventive maintenance. The recommendations come from manufacturers of the devices and members of the public and private sector who have experience implementing these devices. Each section on a specific technology includes:             <ul style="list-style-type: none"> <li>□ “Commentary on technology deployed in the field for the past 20 years</li> <li>□ Operational strategies to maintain the devices</li> <li>□ Photos of field installations and equipment</li> <li>□ “Low maintenance” design details</li> <li>□ Subsystem block diagrams</li> <li>□ Replacement units, part numbers, and names of manufacturers</li> <li>□ Generic procedures and recommended time intervals for preventive maintenance of these devices</li> <li>□ Generic and manufacturer- or model-specific guides for troubleshooting problems: symptoms, probable causes, and recommended remedial actions</li> <li>□ Information on system test equipment, including its uses, manufacturers, and approximate costs</li> <li>□ Lists of system spare components and their costs, along with recommended amounts of each that should be available for immediate replacement to maintain system operations”</li> </ul> </li> </ul>
<p><b>Guidance on Response Maintenance</b></p>	<ul style="list-style-type: none"> <li>▪ Response maintenance has five basic steps:             <ul style="list-style-type: none"> <li>□ Receive notification – It is important that the person who receives notification to determine the location and an accurate description of the problem. The person should then log the date and time of the initial report, location, initial description of the problem, date and time of initial response, crew assigned to initial response, description of solution, and serial numbers of devices/components replaced. However, it would be extremely beneficial for the ITS equipment to have the ability to monitor its own operation. If the device has an operational problem, personnel need not be dispatched to the field until the problem is understood.</li> <li>□ Secure the site – When the response crew arrives they need to make sure the area is safe for the workers and the general public and then begin making repairs.</li> <li>□ Diagnose the problem – In most cases, the fastest way to fix problems is by replacing faulty items.</li> <li>□ Perform interim repairs – The guide advises agencies to replace the faulty device with a spare, and correct the faultiness in the shop. In doing so, the repairs will be more accurately logged than repairs in the field.</li> <li>□ Log the activity – The logging system should be computerized so that the database is widely accessible. Software bought from a vendor is likely to be more professional, cost less, and have a better graphical user interface than a system prepared within the agency. It is advised that whoever uses the computer system is involved with the design of the system. Also, the system should be flexible so that it can be easily changed in case priorities or budgets change.</li> </ul> </li> <li>▪ The maximum time to arrive at a problem intersection and identify the problem is one hour.</li> <li>▪ Maintenance vehicles should not park on the shoulder, because they could cause accidents or increase delay. Instead, maintenance turnouts, parking spaces, or secondary roadway access should be built into the system.</li> <li>▪ Agencies should recognize the need for design modifications to correct recurring problems like lamp burnouts, signal head visor damage, and DMS pixel jamming.</li> </ul>
<p><b>Guidance on</b></p>	<ul style="list-style-type: none"> <li>▪ A complete bar coding system can cost between \$1,000 and \$15,000</li> </ul>



<p><b>Maintenance Costs</b></p>	<ul style="list-style-type: none"> <li>▪ Complex GIS software can cost between \$50,000 and \$100,000. Simple-purpose software costs about \$500. GIS hardware costs between \$2,500 and \$50,000 depending on complexity of the system.</li> <li>▪ GPS receivers that are accurate to within 328 feet can cost \$750. Receivers that are accurate to within 0.2 inches can cost \$30,000.</li> <li>▪ Pen-based computers can cost between \$2,000 and \$4,000, laptops between \$1,000 and \$3,000, and handhelds between \$300 and \$3,000.</li> <li>▪ There are two ways to reduce agency startup costs for preventive maintenance:                         <ul style="list-style-type: none"> <li>▫ Use a modified just-in-time delivery system for nonessential replacement parts. A just-in-time system would require an inventory of only essential equipment. If nonessential equipment fails, a replacement would be ordered for next-day delivery.</li> <li>▫ Obtain spare parts quarterly instead of yearly</li> </ul> </li> <li>▪ The manual gives a thorough list of miscellaneous equipment to purchase for preventive and response maintenance.</li> </ul>
<p><b>Guidance on Contracting</b></p>	<p>None</p>
<p><b>Guidance on Maintenance Funding and Budgeting</b></p>	<ul style="list-style-type: none"> <li>▪ To obtain a reasonable budget approximation, agencies can use an average of 42 hours of preventive maintenance time per intersection per year.</li> <li>▪ In order to budget future labor requirements, agencies should use local historical personnel and maintenance records.</li> <li>▪ If no historical data is available, the maintenance time per intersection should be split up as follows:                         <ul style="list-style-type: none"> <li>▫ Preventive maintenance – 70%</li> <li>▫ Response maintenance – 25%</li> <li>▫ Design modification maintenance – 5%</li> </ul> </li> <li>▪ The guide states that the most comprehensive source of maintenance staff salaries is “Progress Report on Maintenance and Operations Personnel,” published by the Transportation Research Board, Circular Number 493 (March 1999).</li> <li>▪ The guide offers a cost-comparison worksheet to find the break-even point for an agency to support a full-time in-house maintenance program.</li> </ul>
<p><b>Benefit and Cost Considerations</b></p>	<p>None</p>
<p><b>Summary</b></p>	<p>This manual provides valuable guidance for maintenance programming and planning. Possibly the most beneficial part of the guide is the last chapter, which describes ITS technologies and provides recommendations for maintenance. The recommendations were provided by people who have real-world experience with implementing the ITS technologies.</p>
<p><b>Other Notes and Observations</b></p>	<ul style="list-style-type: none"> <li>▪ The guide has an appendix of ITS standards in tabular format that includes the organization, standard number, description, web address, and contact and order information.</li> <li>▪ Another appendix is an itemized list of equipment requirements and estimated prices for replacement, in 1999 dollars.</li> <li>▪ The manual includes a copy of the “Federal Aid Policy Guide.”</li> </ul>



<b>Document Name</b>	<b>Guidelines for Transportation Management Systems Maintenance Concept and Plans</b>
<b>Published By</b>	Federal Highway Administration
<b>Date</b>	December 2002
<b>Electronic Source</b>	<a href="http://ops.fhwa.dot.gov/docs/TMSMaintCptandPlans/index.htm">http://ops.fhwa.dot.gov/docs/TMSMaintCptandPlans/index.htm</a>
<b>Abstract</b>	<p>This document is a technical reference manual associated with the maintenance of a Transportation Management System (TMS). The manual offers guidance to agencies on defining a system's maintenance concept, determining the elements to use in the concept, and incorporating the maintenance concept into all phases of the system. The guide identifies three different types of maintenance:</p> <ul style="list-style-type: none"> <li>□ Preventive maintenance – scheduled tasks to keep the systems operating</li> <li>□ Responsive maintenance – maintenance initiated by a fault or trouble report</li> <li>□ Emergency maintenance – maintenance requiring immediate action due to a serious fault or trouble report</li> </ul>
<b>Guidance on Maintenance Programming</b>	<ul style="list-style-type: none"> <li>▪ With systems that include a large number of devices, it is reasonable to have a policy stating what percentage of devices must be operable at any point in time.</li> <li>▪ The guide lists several issues and policies that an agency may want to address, including:             <ul style="list-style-type: none"> <li>□ Allowing supervisors a credit limit and access of funds during a time of crisis</li> <li>□ Limiting access to certain equipment by staff above a certain level</li> <li>□ Not allowing connection to the control system network by outside applications</li> <li>□ Keeping antivirus software up-to-date</li> <li>□ Developing a policy for sharing data</li> </ul> </li> <li>▪ While quality control programs may be used with maintenance programs, large systems, like ISO 9000, are not suitable for maintenance.</li> <li>▪ The guide reviews the steps in the systems engineering process and their implications in TMS maintenance. Systems engineering is a “requirements driven development process.”</li> <li>▪ A proper maintenance plan requires the following:             <ul style="list-style-type: none"> <li>□ Configuration management and traceability – Configuration management is a process for establishing and maintaining performance consistency.</li> <li>□ Qualifications of staffing – personnel that are working with electronic components should have a minimum of a two year associate degree and two years of relevant work experience. Agencies have reported instances where qualified personnel are proposed by a winning contractor, but less capable staff was actually used on the job.</li> <li>□ Planning a maintenance program – An important issue with the planning of a maintenance program is a consistent budget stream.</li> <li>□ Risk management – Agencies should assess the chances of an expensive piece of equipment being inoperable due to severe weather.</li> <li>□ Cost estimating</li> <li>□ Measures of performance</li> <li>□ Design life considerations</li> <li>□ Partnerships</li> <li>□ Procedures</li> </ul> </li> <li>▪ Agencies should have in-house, ongoing training programs because of personnel turnover.</li> <li>▪ Agencies should incorporate disk mirroring or other redundancy features with regularly scheduled backups. This will prevent data loss if a hard drive fails.</li> <li>▪ When designing a maintenance concept, the following issues should be addressed:             <ul style="list-style-type: none"> <li>□ Location of the property – strategic location of the property can help maintenance practices at a later time. Often, the maintenance and operations centers share a location so that resources can be shared.</li> <li>□ Institutional responsibilities – adjacent agencies may provide revenue or support in exchange for maintenance coverage.</li> <li>□ Staffing levels and reporting requirements</li> <li>□ Whether or not to use contractors</li> </ul> </li> <li>▪ Maintenance personnel should be involved during all levels of design so that roadside devices can be accessed safely, are protected, are easily visible, are properly labeled, and have available</li> </ul>

	<p>power sockets.</p> <ul style="list-style-type: none"> <li>▪ Sometimes, maintenance programs must be “sold” to other departments in the agency. This is to ensure that the goals of the maintenance program are in the minds of others within the organization.</li> <li>▪ A maintenance program must be developed along with the operations program. At a minimum, the maintenance program must consider:             <ul style="list-style-type: none"> <li>▫ Policy concerning the missions and objectives.</li> <li>▫ Goals in terms of what percentage of devices need to be working at a given time.</li> <li>▫ The procedure and processes to keep the investment operating.</li> <li>▫ Safety procedures for personnel with particular importance of on-site staff.</li> <li>▫ Costs and staffing levels necessary to keep the plant at a high operational level.</li> </ul> </li> <li>▪ Agencies should investigate partnerships with other organizations. For example, the City of Charleston, South Carolina, maintains the signals in nearby jurisdictions in return for an annual fee.</li> <li>▪ A maintenance program should include maintenance plans of action for the following devices:             <ul style="list-style-type: none"> <li>▫ TMC hardware</li> <li>▫ TMC software</li> <li>▫ Video walls</li> <li>▫ Communications plant</li> <li>▫ Surveillance devices</li> <li>▫ Signal controllers</li> <li>▫ Video Systems</li> <li>▫ Web pages</li> <li>▫ Dynamic Message Signs</li> <li>▫ Highway advisory radio</li> <li>▫ Environmental sensor stations</li> <li>▫ Public information dissemination</li> </ul> </li> <li>▪ Every maintenance program should have a Maintenance Management System (MMS). At a minimum, these systems include an inventory of all major devices and subsystems in the TMS. A few critical issues to consider when setting up a MMS are:             <ul style="list-style-type: none"> <li>▫ Determine the level of detail to maintain the inventory</li> <li>▫ Maintain a structured inventory</li> <li>▫ Barcode or tag system</li> <li>▫ Automated event logging in conjunction with the barcode or tag system</li> </ul> </li> <li>▪ The basics of managing a maintenance plan include:             <ul style="list-style-type: none"> <li>▫ Performance monitoring – regularly check the plan metrics and budget against projections</li> <li>▫ Oversight support – support the plan over time and its relationship to training and staffing issues</li> <li>▫ Ongoing multi-year planning – plan for changes in the future</li> <li>▫ Operational needs – make sure the maintenance concept is consistent with the operational concept</li> <li>▫ Safety considerations – make sure the maintenance is being performed according to safety regulations</li> <li>▫ Documentation – create and maintain reports on TMS status and maintenance practices</li> <li>▫ Configuration management – document and approve the maintenance that modifies system configuration</li> </ul> </li> <li>▪ The guide includes the requirements of the user service “Maintenance and Construction Operations” that an ITS device should provide, as provided in the National ITS Architecture.</li> <li>▪ The manual offers several methods to have the most properly trained personnel available:             <ul style="list-style-type: none"> <li>▫ Prequalification of contractors</li> <li>▫ Training by vendors</li> <li>▫ Training by contractors</li> <li>▫ Training library including a videotape library of training</li> <li>▫ Staff retention</li> <li>▫ Staffing qualifications</li> <li>▫ Estimating staffing workloads</li> </ul> </li> </ul>
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	<ul style="list-style-type: none"> <li>▪ During multi-year procurements, states should be aware of the rapid changes in technology compared to the slow-moving changes in state procurement rules. For example, after an initial hardware acquisition, the next year of bids could be won by another vendor with incompatible hardware.</li> <li>Some agencies have asset management systems in place to keep track of the condition of highways and bridges. If one is already implemented, it can also be used for monitoring TMS assets. If there is no asset management system in place, there are a number of suppliers that offer these types of systems. The suppliers cited in the guide include Hansen, Exor, Cartegraph, and Azteca.</li> </ul>
<p><b>Guidance on Preventive Maintenance</b></p>	<ul style="list-style-type: none"> <li>▪ When preventive maintenance is contracted out, the contractor should have access to the software in the control center so he/she is able to log the next day's activities. This notifies the operators, and if traffic is disrupted, more notice should be given.</li> <li>▪ Preventive maintenance crews should have direct voice communication with operators in the control center. This ensures efficient operations and safe practices.</li> </ul>
<p><b>Guidance on Response Maintenance</b></p>	<ul style="list-style-type: none"> <li>▪ Agencies should consider how contractors will charge for timely response to a failure. Most of the time, agencies want rapid action for response maintenance. This kind of response would require contractors to have staff available 24 hours per day, seven days a week. This kind of on-call service could increase costs significantly and may outweigh the benefit of having such timely response.</li> <li>▪ The manual provides legal wording to ensure a balance between the timeliness and costs of responding to a device failure.</li> </ul>
<p><b>Guidance on Maintenance Costs</b></p>	<p>None</p>
<p><b>Guidance on Contracting</b></p>	<ul style="list-style-type: none"> <li>▪ The guide offers the pros and cons of keeping some aspects of maintenance in-house versus contracting those tasks to outside companies.</li> <li>▪ The following questions should be considered when contracting maintenance responsibilities to outside companies:             <ul style="list-style-type: none"> <li>□ “What level of staffing is required in each area?</li> <li>□ Does the agency wish to purchase and operate the required equipment?</li> <li>□ What skill level is available from in-house staff, and what level can the agency afford to employ?</li> <li>□ If outsourced, does the agency have the right people to manage a contractor?”</li> </ul> </li> <li>▪ Caution should be taken when entering an extended maintenance agreement with contractors or vendors. The manual gives an example where one company front-end loaded all the maintenance costs. By the time maintenance was supposed to occur, the company went out of business and the agency had almost no funds remaining. Instead, the contractor could have been paid a fixed monthly amount proportional to the percent of equipment working properly.</li> <li>▪ Additionally, an agency should be prepared in case an equipment vendor goes out of business and cannot provide the agency with spare parts.</li> <li>▪ Warranties cover the replacement of failed hardware devices. While warranties may be useful and desirable, they are hard to administer:             <ul style="list-style-type: none"> <li>□ Warranties cover the cost of failed hardware but do not cover the labor to replace the hardware. Agencies could require the contractor to provide repair labor, but this makes it difficult for contractors to compete.</li> <li>□ Retaining a percentage of the contractor's funds until the end of the warranty period forces the contractor to minimize the length of the warranty period.</li> <li>□ Eliminating the retainage minimizes the incentive for the contractor to provide warranty and labor service.</li> <li>□ Agencies should procure warranties directly from the manufacturer. If the agency allows the contractor to obtain the warranty, the warranty costs will most likely be marked up.</li> </ul> </li> <li>▪ The benefits of contracting out maintenance includes:             <ul style="list-style-type: none"> <li>□ The ability to start and stop the work on specific dates</li> <li>□ Access to specialized skills, equipment, or space</li> <li>□ Situations where the agency's dedicated maintenance staff are not needed on a day-to-day basis</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>□ Situations where the agency’s resources are not available for hiring or training maintenance staff.</li> <li>▪ There is a searchable database (<a href="http://www.thebluebook.com">http://www.thebluebook.com</a>) that can provide lists of potential bidders in a certain region, like Eastern Pennsylvania.</li> </ul>
<p><b>Guidance on Maintenance Funding and Budgeting</b></p>	<ul style="list-style-type: none"> <li>▪ Using performance measures to set maintenance levels or as the basis for budgeting is advantageous, but it can also miss the big picture. If the goal is to keep 95% of the CCTV operational at all times, the bigger picture is why the CCTV are needed in the first place.</li> <li>▪ Using a fixed percentage of the capital costs for maintenance budgeting is not very reliable. Cost estimates need to be made on a case-by-case basis.</li> <li>▪ The guide has a table of staffing levels for TMSs in Boston, Toronto, Long Island, Detroit, Milwaukee, Atlanta, Phoenix, and Houston. The table includes number of maintenance staff, organization responsible for maintenance, any special maintenance elements, centerline miles that the TMS is responsible for, and types of ITS equipment used in the field.</li> <li>▪ The manual has spreadsheets to estimate the amount of labor required for preventive and responsive maintenance for each device.</li> <li>▪ The manual has a thorough table of example life expectancies for ITS and TMS components.</li> <li>▪ There is a point where preventive maintenance costs per year are equal to the annualized replacement costs. Agencies should calculate this break-even point to decide whether it would be worthwhile to purchase new equipment or perform preventive maintenance on old equipment. The organizations should use a computerized maintenance management system to estimate the break-even point using the following data:             <ul style="list-style-type: none"> <li>□ Original purchase price</li> <li>□ Replacement cost</li> <li>□ Preventive maintenance and repair cost history</li> <li>□ Mean time between failures</li> <li>□ Mean time to repair</li> </ul> </li> <li>▪ Some states insist that federal funds are not available for maintenance. Federal funds are, in fact, available, and it is up to the developer of the maintenance program to research these funding opportunities.</li> <li>▪ The following steps are used to estimate a budget for a maintenance program:             <ul style="list-style-type: none"> <li>□ Estimate the staffing requirements by system</li> <li>□ Estimate the management needs – one or two persons for a typical TMS</li> <li>□ Calculate the ITS device’s annual inventory replacement costs</li> <li>□ Estimate maintenance for vehicles and maintenance garages, including salvage and replacement values</li> </ul> </li> <li>▪ The document provides a few examples where agencies advertised for projects only to have contractors bid much higher prices than allowed for in the budget. After meeting with some of the potential contractors, the agencies found that their request for proposals were too vague. The agencies refined their request for proposals and received much lower bids. It is important for the organizations to have detailed job requests and to let the contractors know exactly what they want for the project.</li> </ul>
<p><b>Benefit and Cost Considerations</b></p>	<p>None</p>
<p><b>Summary</b></p>	<p>This guide outlines efficient maintenance practices for Transportation Management Systems. The document is very thorough in that it offers advice for planning a maintenance system, from budgeting and funding concerns to programming maintenance personnel and computer systems. The guide details agencies’ experiences with maintenance planning and contracting companies outside the organization.</p>
<p><b>Other Notes and Observations</b></p>	<ul style="list-style-type: none"> <li>▪ Agencies should develop “mean time between failures” data for the following reasons:             <ul style="list-style-type: none"> <li>□ To assist in determining how many spare parts to keep on hand.</li> <li>□ To determine the ordering policy for obtaining equipment.</li> <li>□ To assist with estimating the number and frequency of responsive maintenance calls.</li> <li>□ To help determine if an ITS device is reliable.</li> </ul> </li> <li>▪ Agencies should use performance measures to track organization issues, management issues, and the reliability of the ITS devices. Some metrics dealing with the reliability of the overall</li> </ul>

	<p>system include:</p> <ul style="list-style-type: none"><li>□ Downtime of the entire system</li><li>□ Time required to handle responsive maintenance</li><li>□ Time required to handle emergency maintenance</li><li>□ Negative calls from the public</li><li>□ Adverse press</li><li>▪ Some performance measures relating to specific ITS devices include:<ul style="list-style-type: none"><li>□ Time to detect failure</li><li>□ Mean time to respond</li><li>□ Mean time to repair</li><li>□ Failure rate</li></ul></li><li>▪ The guide has appendices consisting of the following:<ul style="list-style-type: none"><li>□ Example trouble reports</li><li>□ Maintenance procedures for ITS devices – the appendix includes checklists of tasks to go through for common ITS devices and how often these tasks should be performed.</li><li>□ A generic maintenance contract</li><li>□ A sample extended warranty</li></ul></li></ul>
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<b>Document Name</b>	<b>NCHRP Synthesis 245 – Traffic Signal Control Systems Maintenance Management Practices</b>
<b>Published By</b>	Transportation Research Board
<b>Date</b>	1997
<b>Electronic Source</b>	Available for purchase at <a href="http://www.trb.org/news/blurb_detail.asp?id=3312">http://www.trb.org/news/blurb_detail.asp?id=3312</a>
<b>Abstract</b>	<p>This guide provides some background on traffic signal control systems and software and goes on to detail the results of a survey the authors conducted with transportation agencies. The survey was mailed to 152 state, city, county, and Canadian province agencies to determine the current state of traffic signal system maintenance management. At least one city or county was chosen from each state, and the state representatives were the traffic engineers for the state departments of transportation. In total, the authors received 89 responses (a response rate of 59%).</p>
<b>Guidance on Maintenance Programming</b>	<ul style="list-style-type: none"> <li>▪ The following are types of records that should be kept for the management of maintenance activities: <ul style="list-style-type: none"> <li>□ Master Record – master log of all service calls that includes the date, type of maintenance performed, and signatures of personnel performing the work.</li> <li>□ Preventive Maintenance Record – a log for each preventive maintenance service that includes the date, tasks performed, and signatures of personnel performing the work.</li> <li>□ Preventive Maintenance Problem Record – a record of problems or potential problems identified, corrective action taken, and information about a follow-up inspection.</li> <li>□ Response Repair Log-on Record – a log recording the location, date, time, caller, receiver and complaint received, maintenance personnel, time dispatched, trouble found, and time cleared.</li> <li>□ Response Maintenance Repair Record – a log for each call of the problem, prevailing conditions, work performed, parts replaced/repaired, time and condition on departure, and signatures of personnel performing the work.</li> </ul> </li> <li>▪ Maintenance management systems are usually composed of a central processing unit, field units, like hand-helds or laptops, bar code readers, and communications capability.</li> <li>▪ The guide has an in-depth table of the attributes of an effective traffic control device maintenance management system. For example, the table lists the attributes of good “Field Crew Applications:” <ul style="list-style-type: none"> <li>□ Schedule maintenance work</li> <li>□ Locate all devices with specific attributes</li> <li>□ Automate stock reorder on materials, etc.</li> </ul> </li> <li>▪ The guide shows a few charts as examples of state maintenance organization hierarchies.</li> <li>▪ The manual has a table of the different types of traffic signal maintenance personnel. Each entry has the job title, that person’s responsibilities, the average hours per shift, the average percentage of work time devoted to maintenance work, and any training requirements for the position.</li> <li>▪ Using survey data, the authors calculate that 38 intersections can be maintained by a single mechanic. The ITE “Traffic Signal Installation and Maintenance Manual” says that 31 intersections can be maintained per mechanic.</li> <li>▪ Agencies in the I-95 Corridor Coalition (42 transportation agencies located from Virginia to Maine at the time of the survey) indicated that computer training was one of the top five training needs of 38 technologies surveyed. The remaining items on the list were communications systems, incident management, VMS, and CCTV.</li> <li>▪ The report has an example table of the different types and amounts of maintenance equipment that an agency should have at its repair facilities.</li> <li>▪ Repair shops should be located in locations such that travel time to all system components can be provided.</li> <li>▪ The following is a list of components to consider when an agency plans for their repair shop: <ul style="list-style-type: none"> <li>□ Work station/bench for each signal mechanic</li> <li>□ Work station/office for the supervisor</li> <li>□ Work station/electronic test bench for signal technician</li> <li>□ Work station/office for the signal engineer</li> <li>□ Communication equipment area</li> <li>□ Environmental test area</li> </ul> </li> </ul>



	<ul style="list-style-type: none"> <li>□ Record filing area and/or computer area</li> <li>□ Test fixture areas</li> <li>□ General work area</li> <li>□ Equipment inventory area</li> <li>□ Small spare parts area</li> <li>□ Large spare parts area</li> <li>□ Maintenance and protection of traffic items</li> <li>□ Locker room area</li> <li>□ Prequalifications test area</li> <li>□ Prequalifications storage area</li> <li>□ Employee room</li> <li>□ Environmental test area</li> <li>□ Cabinet assembly area</li> <li>□ Vehicle work area</li> <li>▪ Long Island, New York has the INFORM system to track maintenance equipment inventories. The software provides a list of equipment and a description, location, condition, purchase date, dates put in/out of service, quantity on-hand, and manufacturer.</li> </ul>
<p><b>Guidance on Preventive Maintenance</b></p>	<ul style="list-style-type: none"> <li>▪ From the survey, the top five preventive maintenance activities for signals are:             <ul style="list-style-type: none"> <li>□ Relamp (44% of respondents)</li> <li>□ Inspect and/or replace controllers and cabinets (33% of respondents)</li> <li>□ Test conflict monitors (27% of respondents)</li> <li>□ Clean signal heads and lenses (23% of respondents)</li> <li>□ Generally inspect all equipment (15% of respondents)</li> </ul> </li> <li>▪ Of the 66 agencies that practice preventive maintenance, 50% perform this maintenance annually, and 15% perform the maintenance twice a year.</li> <li>▪ The report has a preventive maintenance checklist as an appendix, which lists preventive tasks and how often these tasks should be performed.</li> </ul>
<p><b>Guidance on Response Maintenance</b></p>	<ul style="list-style-type: none"> <li>▪ Variable message signs (VMS) can be bulb matrix, flip disk, LED, fiber optic, or hybrid.             <ul style="list-style-type: none"> <li>□ Bulb matrix VMS have high maintenance requirements, because individual bulbs must be replaced when they fail.</li> <li>□ Fiber optic VMS have several maintenance problems. The mechanical shutters are difficult to maintain, the lamps need to be replaced when they fail, and the replacement parts are available only from European manufacturers.</li> </ul> </li> <li>▪ Software and equipment are available to diagnose equipment problems and determine what the problem is.             <ul style="list-style-type: none"> <li>□ Software diagnostic programs facilitate maintenance through detection and isolation of malfunctions and errors. Databases are used to organize these diagnostics along with the date, time, location, and maintenance activity performed.</li> <li>□ Equipment like malfunction management units (MMU), loop detector monitors, and automatic conflict monitor testers can monitor problems with intersection devices. An MMU monitors problems with controllers, loop detector monitors monitor faults with system loop detectors, and conflict monitor testers identify fault checks on traffic signal conflict monitors.</li> </ul> </li> <li>▪ From the survey, the top five response maintenance activities for signals are:             <ul style="list-style-type: none"> <li>□ Trouble/emergency calls (23% of respondents)</li> <li>□ Repair failures (18% of respondents)</li> <li>□ Burnouts (10% of respondents)</li> <li>□ Knockdowns (8% of respondents)</li> <li>□ Other (8% of respondents)</li> </ul> </li> </ul>
<p><b>Guidance on Maintenance Costs</b></p>	<p>None</p>
<p><b>Guidance on Contracting</b></p>	<ul style="list-style-type: none"> <li>▪ The survey results showed that only one city agency performs all maintenance by contracting to external companies.</li> <li>▪ For computer and communication system components, it may be more efficient to contract out the maintenance.             <ul style="list-style-type: none"> <li>□ It reduces the need for a highly skilled in-house technician.</li> </ul> </li> </ul>

<b>Guidance on Maintenance Funding and Budgeting</b>	<ul style="list-style-type: none"> <li>□ It eliminates the need for the agency to have expensive spare parts in its inventory.</li> <li>▪ From the survey results, local taxes provide the major source of maintenance funding for city and county agencies. State taxes are the major source of funding for state agencies.</li> </ul>
<b>Benefit and Cost Considerations</b>	<p>None</p>
<b>Summary</b>	<p>This document presented data attained from a survey of 152 transportation agencies. Unfortunately, the report does not offer straightforward guidelines. It presents the survey data and allows the reader to infer most of the respondents' answers. While the author does thoroughly analyze the respondents' answers, the author does not elaborate on any of the survey data. It would be nice if he pointed out positives and negatives of any trends and offered solutions on how to correct any negatives.</p>
<b>Other Notes and Observations</b>	<ul style="list-style-type: none"> <li>▪ The report identifies five consequences of traffic signal system failures:             <ul style="list-style-type: none"> <li>□ Increased motor costs</li> <li>□ Increased maintenance</li> <li>□ Increased accidents and liability</li> <li>□ Poor air quality</li> <li>□ Poor public image</li> </ul> </li> <li>▪ The survey data shows that for every 100,000 population, city agencies have 2.6 maintenance employees.</li> <li>▪ The survey results show that 90% of the agencies have a preventive maintenance program, 100% have a response maintenance program, and 77% perform design modifications.</li> <li>▪ The report has a table of statistics showing the average response times, minimum and maximum response times, and number of responses for either the day or night during the week or weekend.</li> <li>▪ Of the survey respondents, 45% rate their satisfaction with the current level of maintenance as fair or poor. In another recent ITE/FHWA survey, 44% of agencies rated their ability to maintain their systems as fair to poor, and 22% said more funding is needed to operate and maintain existing systems at a satisfactory level. The ITE/FHWA survey also revealed that a lack of funds was cited as one of the top seven problems public agencies faced for maintenance.</li> <li>▪ 12% of the agencies surveyed indicated that they did not have a maintenance management system to track maintenance activities. 37% have a preventive maintenance management system, and 14% have an emergency response management system.</li> <li>▪ 26% of the agencies surveyed indicated that they keep manual or paper logs of spare parts and materials. 24% use computer databases, 16% do not have a method for monitoring their parts inventory, and 14% have a centralized inventory control system where equipment are housed in a central location and are requested at this location on an as-needed basis.</li> <li>▪ Of the agencies surveyed, there was an average of eight lawsuits per agency. Removing the two highest numbers of lawsuits (150 and 200) brought the average down to two lawsuits per agency. 45% of the respondents said that they did not have any lawsuits.</li> </ul>



<b>Document Name</b>	<b>Management and Operations of Intelligent Transportation Systems</b>
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<b>Date</b>	September 1999
<b>Electronic Source</b>	Available for purchase at <a href="http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=RP-030A">http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=RP-030A</a>
<b>Abstract</b>	<p>The ITE conducted three conferences on the maintenance and operations (M&amp;O) of ITS. ITS owners, designers, implementers, operators, and maintainers from different organizations around the country attended these conferences and came up with a list of recommended practices for ITS operations and maintenance. These recommended practices were evaluated at twelve test sites around the country, and each agency completed a survey for each recommendation.</p> <p>This review is in a different format than the others to mirror the layout of the actual document. Most of the guide's recommendations are in the realm of maintenance planning and programming. For the most part, the guidance points are taken straight from the guide.</p>
<b>Guidance on System Management</b>	<ul style="list-style-type: none"> <li>▪ Organizations should maintain relationships among all participating agencies and disciplines in the coordination of operations and maintenance activities.                         <ul style="list-style-type: none"> <li>▫ Establish interjurisdictional committees or teams to coordinate activities and develop management strategies and operational plans.</li> <li>▫ Encourage partnerships, including public-public and public-private partnerships, when appropriate for ITS activities.</li> </ul> </li> <li>▪ Agencies should ensure the maintenance and operations system is reliable using the following recommendations:                         <ul style="list-style-type: none"> <li>▫ Incorporate system diagnostic capabilities to detect early malfunctions and ensure data integrity.</li> <li>▫ Conduct regular M&amp;O briefings with key agency personnel.</li> <li>▫ Monitor, measure, evaluate, and report system performance and benefits.</li> <li>▫ Establish performance requirements and criteria to manage and operate ITS.</li> </ul> </li> <li>▪ Agencies should establish and maintain a public education and information program for ITS. Agencies should:                         <ul style="list-style-type: none"> <li>▫ Provide regular updates on traffic conditions, incidents, and planned events to the public and to the media.</li> <li>▫ Report system performance and benefits to elected officials and to the general public.</li> </ul> </li> <li>▪ Transportation organizations should develop and maintain an agency-specific ITS Strategic System Plan.</li> <li>▪ Agencies should provide high-level management support of ITS M&amp;O. Management support for M&amp;O is critical to the success of ITS.                         <ul style="list-style-type: none"> <li>▫ Management should provide the necessary M&amp;O resources and place the ITS functions within the organization where they can perform most effectively.</li> </ul> </li> </ul>
<b>Guidance on Maintenance Planning</b>	<ul style="list-style-type: none"> <li>▪ Agencies should develop an ITS Regional Strategic Plan to identify the "big picture" vision for the future development of ITS in a region and state.                         <ul style="list-style-type: none"> <li>▫ Integrate the concepts of management systems and area-wide operational strategies into the ITS Regional Strategic Plan with the appropriate long-range statewide and metropolitan transportation plan.</li> <li>▫ Include the vital stakeholders appropriate to address the operation of systems and transportation management issues in a region when developing the ITS Regional Strategic Plan.</li> <li>▫ The ITS Regional Strategic Plan should include a regional architecture that depicts the various systems, interfaces, and data to be exchanged between various systems and agencies. This regional architecture should be consistent with the National ITS Architecture and applicable ITS standards.</li> <li>▫ Interagency support should be developed between the appropriate agencies and partners to obtain the necessary commitments for implementing the ITS Regional Strategic Plan.</li> </ul> </li> <li>▪ Transportation agencies should develop an ITS Strategic System Plan based on an identified operation strategy for an agency or group of stakeholders.                         <ul style="list-style-type: none"> <li>▫ The initial conceptual planning for a system should identify the proper personnel, equipment,</li> </ul> </li> </ul>

	<p>staff, and budget resources necessary for M&amp;O.</p> <ul style="list-style-type: none"> <li>□ The ITS Strategic System Plan should identify an approach to share information with other systems in the region through consideration for networking centers and ITS subsystems in a region.</li> <li>□ Develop a migration strategy or plan to bring previously installed systems into compliance with national standards as soon as practical based on life cycle considerations, cost alternatives, legislative requirements, and effectiveness considerations.</li> <li>□ Establish an ongoing process to update the Implementation and Operations Plan.</li> </ul>
<p><b>Guidance on Maintenance Funding</b></p>	<ul style="list-style-type: none"> <li>▪ Innovative funding sources should be explored within statutory constraints.</li> <li>▪ System expansion costs should be developed and included in the Strategic System Plan.</li> <li>▪ Any funding strategy should incorporate planned system and component replacements.</li> <li>▪ Management should consider the training requirements for all personnel when preparing plans and budgets.</li> </ul>
<p><b>Guidance on Maintenance Plan Design</b></p>	<ul style="list-style-type: none"> <li>▪ Agencies should prepare a System Design Plan to guide the development and deployment of each component of the system identified in the ITS Strategic System Plan.             <ul style="list-style-type: none"> <li>□ Before proceeding with a detailed design, a public relations or outreach plan should be prepared to support the development, implementation, and ongoing operation of each system.</li> <li>□ A detailed review and assessment of the M&amp;O strategy identified in the ITS Strategic System Plan should be added in the initial stages of preliminary design of a system or project.</li> <li>□ The System Design Plan should include an analysis of the functions, components, and other required implementation issues identified in the ITS Strategic System Plan.</li> <li>□ The level of system complexity and functionality should be supported by certain operations requirements.</li> <li>□ A technology assessment should be completed on the near-term projects identified for the phased implementation of the system.</li> <li>□ The System Design Plan and detailed project designs should be based on a detailed life cycle cost analysis.</li> <li>□ The System Design Plan should identify the products, quantities, and costs associated with the system and how they affect or are affected by other projects identified in the appropriate Metropolitan or Statewide Transportation Improvement Program.</li> <li>□ The System Design Plan should include a deployment strategy addressing the incremental development of various components and identified geographic coverage.</li> </ul> </li> </ul>
<p><b>Guidance on Computer Systems for Maintenance Plans</b></p>	<ul style="list-style-type: none"> <li>▪ The design and installation of computer systems should use generally accepted software systems practices including user requirements, standards, integration and implementation, quality assurance issues, documentation, system configuration, and security and acceptance testing to support M&amp;O of the system.             <ul style="list-style-type: none"> <li>□ In order to enhance the maintainability and expandability of the system, a consistent method of software coding should be required and adopted for software enhancements and for generation of new programs.</li> <li>□ A consistent method for documenting software, operations, and maintenance should be established.</li> <li>□ Systems should have user interfaces that are easy to understand, operate, and learn.</li> <li>□ The responsible agency should submit and perform a comprehensive system acceptance test plan appropriate for the configured system.</li> <li>□ Both in-house and outside levels of access to the advanced traffic management system should be designed to include a high level of security.</li> <li>□ The agency staff that will perform system maintenance should be aware of and participate in the software development process.</li> <li>□ ITS operating agencies should be aware of and work with ITS and information system groups from other agencies as applicable to agency needs.</li> </ul> </li> <li>▪ Operating agencies should undertake a long-term program for maintaining computer systems, including software and hardware support.             <ul style="list-style-type: none"> <li>□ Agencies should provide for adequate hardware and software support.</li> <li>□ As operating TMCs are modified over time, the manager should perform system configuration and change management coincident with every system change.</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>□ Agencies should have a Disaster Recovery Plan for their computer systems.</li> <li>□ Agencies should protect their investment in system software by assuring access to the source code if the original vendor no longer supports the system.</li> </ul>
<p><b>Guidance on Procurement</b></p>	<ul style="list-style-type: none"> <li>▪ In the procurement process, agencies should consider including provisions for clearly assigning responsibilities, training, use of standards, spares, transfer of property rights, use of testing and diagnostic tools, and other deliverables that will facilitate proper M&amp;O.</li> <li>▪ If done through contract, the procurement specifications for M&amp;O services should identify clear performance measures associated with effective traffic management as well as measures related to system maintenance, downtime, and staffing.</li> <li>▪ The procurement method for software may be different from the procurement method for the rest of the system. The agencies should consider what software modifications are necessary and who has intellectual rights to customized software.</li> </ul>
<p><b>Guidance on Installation of ITS Devices</b></p>	<ul style="list-style-type: none"> <li>▪ Installation of ITS devices and systems should be planned and coordinated by installation staff and M&amp;O staff to expedite successful installations, clearly define acceptance testing, and minimize disruption to the motoring public. All issues associated with installing ITS field devices should be thoroughly discussed and evaluated prior to any installation.             <ul style="list-style-type: none"> <li>□ Include M&amp;O personnel in preconstruction meetings.</li> <li>□ Require inspection teams to have specialized training for ITS installation and consider including M&amp;O personnel on inspection teams.</li> <li>□ The contractor and contracting agency should thoroughly discuss the procedures and requirements for acceptance testing.</li> <li>□ The continuous monitoring of problems during installation should be quickly rolled back into the design process so that problems do not perpetuate.</li> <li>□ Consider the phased installation of major traffic management systems to minimize disruption to the traveling public.</li> <li>□ On projects requiring software installation, extensive coordination between agency M&amp;O staff and the software provider is needed.</li> <li>□ System and field documentation should be revised and completed as soon as possible following the installation of any ITS contract.</li> </ul> </li> </ul>
<p><b>Guidance on Resource Sharing</b></p>	<ul style="list-style-type: none"> <li>▪ To ensure proper M&amp;O, close coordination with all involved agencies and disciplines should start in the early planning stages and continue throughout every phase of the project.             <ul style="list-style-type: none"> <li>□ Individual operational needs should be identified before operational commonalities are assessed.</li> <li>□ Mission statements, goals, objectives, and the benefits of joint operations should be identified and adopted by participating agencies.</li> </ul> </li> <li>▪ Agencies should look for opportunities to share information and resources with other regional ITS programs and related public organizations and private transportation-related organizations.             <ul style="list-style-type: none"> <li>□ Metropolitan regions or states should be encouraged to share a wide area telecommunication backbone infrastructure, such as an ITS “informational superhighway” inclusive of multiple agencies.</li> <li>□ A shared communication system should be considered to allow for coordinated traffic signal systems and other devices among multiple jurisdictions.</li> <li>□ M&amp;O user groups involved with resource sharing and joint operations should be established to review or debrief operations on a regular basis.</li> <li>□ Agencies should identify short-term resource-sharing opportunities.</li> </ul> </li> <li>▪ Agencies should look for opportunities for joint operations.             <ul style="list-style-type: none"> <li>□ The ability should be provided for transportation agencies or disciplines to access CCTVs, share images, and control cameras.</li> <li>□ For agencies involved with traffic management, the ability should be provided to allow operation of fixed or portable dynamic message signs by other agency staff.</li> </ul> </li> <li>▪ The integration of systems should be based on the need to share information among agencies in order to manage the regional transportation network and improve the operational efficiency of any one system or a particular agency.             <ul style="list-style-type: none"> <li>□ The need to advance or automate the interfaces between shared systems should be based on the ability of agencies to improve the efficiency of system operations, the provision of services, or the capability for multiagency control systems.</li> </ul> </li> </ul>

	<ul style="list-style-type: none"> <li>□ All interfaces should be designed and developed with an “open” architecture concept, which utilizes nonproprietary protocols.</li> </ul>
<p><b>Guidance on Staffing and Training for Maintenance Plans</b></p>	<ul style="list-style-type: none"> <li>▪ Agencies should provide for sufficient, qualified, and experienced staff for both operating and managing the system. Staff classifications, qualifications, and responsibilities should be developed to support the M&amp;O of the system.                             <ul style="list-style-type: none"> <li>□ An agency should provide backup capabilities in order to allow operations to continue during staffing shortages (e.g., holidays, vacations, or sick leave) or when peaks in workloads warrant additional staffing.</li> <li>□ When establishing staffing requirements, outsourcing should be considered.</li> </ul> </li> <li>▪ Agencies should develop and maintain an ongoing training program to provide a well-trained and cross-trained staff for planning, designing, constructing, operating, and managing the system.                             <ul style="list-style-type: none"> <li>□ For each classification, the training program should identify responsibilities, skill levels needed, certifications required, and training needs.</li> <li>□ Elements of the training program should include cross training, establishing a breadth of experience, mechanisms like debriefings, funding estimates, and other considerations.</li> <li>□ Establish outreach and educational opportunities.</li> <li>□ Train maintenance personnel on equipment installed before any conditional system acceptance is given in a construction project.</li> <li>□ The primary text during a training session should be the operations manual for that component.</li> </ul> </li> <li>▪ Agencies should include M&amp;O personnel in all phases of the project including planning, designing, constructing, implementation, inspection, and acceptance.</li> </ul>
<p><b>Benefit and Cost Considerations</b></p>	<p>None</p>
<p><b>Summary</b></p>	<p>This text is an extremely useful resource for transportation agencies looking to implement ITS maintenance practices into the organization. The guide is only 39 pages long but provides recommendations for almost every aspect of ITS maintenance. Each recommendation is clearly outlined and has a few bullet points detailing the suggestion.</p>
<p><b>Other Notes and Observations</b></p>	<p>None</p>

<b>Document Name</b>	<b>Traffic Signal Installation and Maintenance Manual</b>
<b>Published By</b>	Institute of Transportation Engineers
<b>Date</b>	1989
<b>Electronic Source</b>	The text is not available online and is out of print.
<b>Abstract</b>	This guide offers transportation organizations advice on maintenance practices for traffic signals. It breaks down the processes for preventive and response maintenance and offers sample forms and checklists to aid these efforts. The guide also covers agency risk and how to avoid tort liability lawsuits.
<b>Guidance on Maintenance Programming</b>	<ul style="list-style-type: none"> <li>▪ Any personnel performing maintenance on signals should be trained in accordance with the “Manual on Uniform Traffic Control Devices.”</li> <li>▪ There are five categories of maintenance personnel for signals:                             <ul style="list-style-type: none"> <li>□ Traffic Signal Mechanic – responsible for diagnostic maintenance.</li> <li>□ Supervising Traffic Signal Mechanic – responsible for diagnostic maintenance and scheduling and recording work performed by other mechanics.</li> <li>□ Traffic Signal Technician – responsible for maintaining solid state equipment in the field and identifying failures at intersections.</li> <li>□ Traffic Signal Engineer – responsible for the diagnostics and repair of all solid state controllers to the chip level.</li> <li>□ Traffic Engineer – responsible for signal design, design modifications, signal timing plans, and administration of signal installation and maintenance.</li> </ul> </li> <li>▪ The guide has an appendix of detailed descriptions of the responsibilities, knowledge, and skills for each type of personnel.</li> <li>▪ There are three primary categories of equipment needed to perform maintenance functions – maintenance vehicles, test equipment and tools, and replacement parts and supplies. The guide has an appendix of recommended equipment for each category.</li> <li>▪ The guide provides a discussion of tort liability issues and negligence. There are five guidelines to avoid a failure to meet accepted responsibilities:                             <ul style="list-style-type: none"> <li>□ Construction zone controls/Traffic control plans</li> <li>□ Installation inspection practices</li> <li>□ Periodic inspections and reviews</li> <li>□ Maintenance practices</li> <li>□ Maintenance records</li> </ul> </li> </ul>
<b>Guidance on Preventive Maintenance</b>	<ul style="list-style-type: none"> <li>▪ Like other publications, this manual provides a preventive maintenance checklist for traffic signals that includes how often the maintenance tasks should be performed. The guide includes a write-up of each task explaining what should be performed to complete the task.</li> <li>▪ A preventive maintenance report should be completed each time maintenance is performed at an intersection. This report should include the location, date, inspector’s name, a list of all tasks performed, and troubles found. One copy of the report should be kept at the intersection, and another copy should be stored in a central file.</li> <li>▪ The manual has an appendix of estimated time requirements for each of the recommended items in the preventive maintenance checklist.</li> <li>▪ The guide has a flowchart and forms to determine if current preventive maintenance capabilities are acceptable.</li> </ul>
<b>Guidance on Response Maintenance</b>	<ul style="list-style-type: none"> <li>▪ Agencies performing maintenance should develop and establish a standard procedure for problem notification of failed equipment. Establishing a procedure will minimize potential tort liability claims. The basic elements of a problem notification procedure are as follows:                             <ul style="list-style-type: none"> <li>□ Notification of a possible problem – only one agency should be responsible for screening failed device calls.</li> <li>□ Determination of problem severity</li> <li>□ Decision to take action – a chain of command should be established to avoid confusion in making a decision.</li> </ul> </li> <li>▪ The time to arrive at a reported problem location and identify the problem should not exceed one hour.</li> </ul>

	<ul style="list-style-type: none"> <li>▪ The guide identifies two types of repair - final repair and emergency repair. Final repair entails complete repair of failed devices within a 24-hour period. Emergency repair temporarily restores safe operation of the location within a 24-hour period. Final repair after the initial emergency repair should be completed within 30 days. The guide has a table of various device failures and the recommended type of repair.</li> <li>▪ The guide lists different scenarios and the emergency repair options that are available to the maintenance crew. For example, if a local controller fails, maintenance crews can set the controller for flash operation, install stop signs, or set the controller for manual operation by police.</li> <li>▪ To solve recurring problems, the agency can modify the current design of the equipment. In addition, a comprehensive review can identify design modifications that might be needed, and the guide includes a comprehensive review checklist and possible modifications for various problems.</li> <li>▪ The guide has flowcharts and forms to determine if current response maintenance capabilities are acceptable and at what level can response maintenance be provided. Unacceptable response maintenance capabilities could be caused by:             <ul style="list-style-type: none"> <li>□ Inadequate manpower</li> <li>□ Lack of trained personnel</li> <li>□ Inadequate service equipment</li> <li>□ Inadequate backup inventory</li> <li>□ Inadequate documentation and/or recordkeeping</li> <li>□ Delay in communications</li> <li>□ Inadequate contractor services</li> </ul> </li> </ul>
<b>Guidance on Maintenance Costs</b>	None
<b>Guidance on Contracting</b>	<ul style="list-style-type: none"> <li>▪ An appendix at the end of the guide includes a sample contract for traffic signal maintenance.</li> </ul>
<b>Guidance on Maintenance Funding and Budgeting</b>	<ul style="list-style-type: none"> <li>▪ While low bid procurement may reduce initial costs, this type of contracting method can result in high maintenance costs during the life of the equipment.</li> </ul>
<b>Benefit and Cost Considerations</b>	<ul style="list-style-type: none"> <li>▪ Expensive test equipment and time consuming procedures may not provide a good benefit-cost ratio. The preventive maintenance checklist in the guide is designed to allow the technician to use visual and auditory senses, experience, common sense, and basic equipment to evaluate the conditions.</li> <li>▪ The guide includes a chart of different contractor services available for preventive and response maintenance.</li> </ul>
<b>Summary</b>	<p>The guide is helpful in the fact that it contains a variety of figures, sample forms, and lists for maintenance practices at traffic signals. The chapter on tort liability issues is not covered in other pieces of maintenance literature, but could be helpful to agencies. Not all of the practices suggested in the text should be followed since the publication is almost 20 years old.</p>
<b>Other Notes and Observations</b>	None





**Appendix B Detailed Survey Summary**

Wyoming	
Which describes your state's approach to ITS maintenance?	We use internal forces to maintain our ITS devices
What are the advantages of your state's method for ITS maintenance?	In a rural state, like Wyoming, it is very difficult to contract for ITS device maintenance at a reasonable cost.
What are the disadvantages of your state's method for ITS maintenance?	We are understaffed for the number of devices we are required to maintain. Questions 4, 5, 6 and 7 do not apply to us as we don't contract for ITS device maintenance.
How many device deployments are included under your ITS maintenance contracts?	[No Answer Entered]
If there are other deployments included in the maintenance contracts, what are they?	[No Answer Entered]
What is the total value of your maintenance contracts?	[No Answer Entered]
What is the typical length of a maintenance contract?	[No Answer Entered]
Do you have specialty maintenance contracts for communications systems?	NA
Do you have specialty maintenance contracts for control centers?	NA
Do you have preventative maintenance strategies deployed?	Yes. We conduct preventative maintenance on the ITS devices.
Do you have emergency response provisions in the maintenance contracts?	We have an internal service level agreement between all parties involved in maintaining ITS devices (IT, ITS, and Telecom).
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	NA
Do you require that a certain percentage of devices be operable at all times?	No



New York	
Which describes your state's approach to ITS maintenance?	Regional contracts
What are the advantages of your state's method for ITS maintenance?	Capital Program money is generally used to fund ITS Maintenance contracts. NYSDOT distributes the bulk of its Capital Funds to each Regional office and decisions are made at the Regional level as to the best use of the funds. As a result, it is easiest for the contracts to be Regionally focused, as far as funding is concerned. From a management perspective, NY state's ITS system is at very different levels of "maturity", with some areas of the state only beginning to deploy ITS , while others have been at it for 20 years. The systems have very different needs on the maintenance side. Also, the local (Regional) ITS managers are the most knowledgeable on the needs and care of their local systems. This makes local, specific contracts more advantageous.
What are the disadvantages of your state's method for ITS maintenance?	Disadvantages noted in the past include: A) Minimal opportunity for cost savings due to consolidated contracts B) Increased oversight and coordination required to know "what contract is going on where" C) Lost opportunities for utilizing "knowledge gained" in one area and transferring it to another (i.e. Different consultants working on similar problems in different parts of the state).
How many device deployments are included under your ITS maintenance contracts?	Dynamic Message Signs (DMS) = 12-150 Highway Advisory Radio (HAR) = 0-4 Closed Circuit Television (CCTV) = 10-180 Detection = 20-1000 Road Weather Information Systems (RWIS) = Varies
If there are other deployments included in the maintenance contracts, what are they?	The contracts vary greatly in requirements, systems covered, and cost. They range from covering the basic repairs, on an "on-call" basis, to requirements to keeping the system working at an acceptable level (state of good repair) with minimum uptime requirements, etc.
What is the total value of your maintenance contracts?	
What is the typical length of a maintenance contract?	Varies - Typically 2 - 4 years with extension years added as optional to the state.
Do you have specialty maintenance contracts for communications systems?	Not in particular.
Do you have specialty maintenance contracts for control centers?	The maintenance of the systems within the operations centers are typically tied to an overall "operations" contract for each center. Otherwise, the field maintenance contractor bears responsibility for maintaining systems in the center.
Do you have preventative maintenance strategies deployed?	Regionally controlled - though not necessarily well developed. In general, I would rank our PM strategy as a "5 out of 10"
Do you have emergency response provisions in the maintenance contracts?	Yes. Typically it includes an on-call, emergency response element
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	Be prepared to pay a lot to have sufficient coverage to keep systems up and running at a high rate. In order to maintain large deployments, with specialty people and skills as well as having access to spare parts, needed equipment (lift trucks, etc.), covering the costs associated with MPT, and keeping the right skill sets on the payroll, companies have to put a large sum of money upfront for these contracts.
Do you require that a certain percentage of devices be operable at all times?	Some of the contracts are setup so that maintaining minimum percentage of uptime is required to receive payment. These vary throughout the state.

Mississippi	
Which describes your state's approach to ITS maintenance?	In-house maintenance
What are the advantages of your state's method for ITS maintenance?	We can control response times better, and because we keep a stocked parts warehouse, we very seldom have to wait on a part that may be on back order.
What are the disadvantages of your state's method for ITS maintenance?	Lost repair time due to drive times to the sites. Currently, all of the ITS repairs are dispatched out of the Statewide TMC in the central part of the state. It may take 3 hours (one way) to reach sites in Southaven or the Gulf Coast.
How many device deployments are included under your ITS maintenance contracts?	[No Answer Entered]
If there are other deployments included in the maintenance contracts, what are they?	MDOT does have a Support Services Engineering contract for the Metro Jackson Nokia/Siemens OTN Fiber Ring. There is an over-lapping small support services contract for signal controllers. This contract augments in-house MDOT signal crews.
What is the total value of your maintenance contracts?	\$200,000
What is the typical length of a maintenance contract?	2 years
Do you have specialty maintenance contracts for communications systems?	MDOT's Metro Fiber Ring contract is not a specialty maintenance contract; it is a support services contract. MDOT's Maintenance contracts are usually broad in scope & very general.
Do you have specialty maintenance contracts for control centers?	MDOT does contract on TMC Operations to URS Corp & GS&P. However, this service is covered under MDOT's Statewide ITS Integration Contract, not a specialty maintenance contract.
Do you have preventative maintenance strategies deployed?	No
Do you have emergency response provisions in the maintenance contracts?	MDOT does require an expedited emergency response time. An emergency service call is usually defined as an enterprise system failure.
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	MDOT is currently trying to track ITS Maintenance calls & plans to eventually develop regional maintenance contracts. However, it is very difficult to find one vendor that will cover maintenance on all of the ITS devices in the area.
Do you require that a certain percentage of devices be operable at all times?	No

West Virginia	
Which describes your state's approach to ITS maintenance?	Regional contracts
What are the advantages of your state's method for ITS maintenance?	At this point, we are just initiating an ITS solution within the State. However, I'm looking at specific statewide maintenance contracts for specific applications.
What are the disadvantages of your state's method for ITS maintenance?	N/A
How many device deployments are included under your ITS maintenance contracts?	[No Answer Entered]
If there are other deployments included in the maintenance contracts, what are they?	We are scheduling deployments for all of the above, as well as two transportation fusion centers. So at this time, we shall wait until these contracts are well underway before we engage into maintenance contracts.
What is the total value of your maintenance contracts?	\$0
What is the typical length of a maintenance contract?	They will be typically one year in length, with an agreed renewal for up to 3 years.
Do you have specialty maintenance contracts for communications systems?	Not as of yet.
Do you have specialty maintenance contracts for control centers?	They will go through our integration manager.
Do you have preventative maintenance strategies deployed?	Yes
Do you have emergency response provisions in the maintenance contracts?	Yes
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	We are going through this process currently.
Do you require that a certain percentage of devices be operable at all times?	Yes

North Dakota	
Which describes your state's approach to ITS maintenance?	No contracts at this time; rely on dept. technicians
What are the advantages of your state's method for ITS maintenance?	Less costly than contract maintenance.
What are the disadvantages of your state's method for ITS maintenance?	Maintenance can have a lower priority, as technicians also maintain state radio system, PC's, & network.
How many device deployments are included under your ITS maintenance contracts?	Dynamic Message Signs (DMS) = 0 Highway Advisory Radio (HAR) = 0 Closed Circuit Television (CCTV) = 0 Detection = 0 Road Weather Information Systems (RWIS) = 0 Others = 0
If there are other deployments included in the maintenance contracts, what are they?	[No Answer Entered]
What is the total value of your maintenance contracts?	\$0
What is the typical length of a maintenance contract?	NA
Do you have specialty maintenance contracts for communications systems?	[No Answer Entered]
Do you have specialty maintenance contracts for control centers?	[No Answer Entered]
Do you have preventative maintenance strategies deployed?	[No Answer Entered]
Do you have emergency response provisions in the maintenance contracts?	[No Answer Entered]
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	[No Answer Entered]
Do you require that a certain percentage of devices be operable at all times?	[No Answer Entered]

Georgia	
Which describes your state's approach to ITS maintenance?	Statewide contracts
What are the advantages of your state's method for ITS maintenance?	Our state is divided into 7 Districts with one General Office that supports each District. The statewide contract allows ITS maintenance support for all Districts.
What are the disadvantages of your state's method for ITS maintenance?	We had two separate contracts for this effort. One contract for managing the effort and another contract for the actual field work. We were not pleased with the performance of the contractor for installations, so we canceled that contract. Now, we do not have a method for getting major maintenance repairs (mainly conduit and fiber). The state was also supplying all the materials. Our internal purchasing material contract had issues, and we went a year with no materials. No materials, no maintenance.
How many device deployments are included under your ITS maintenance contracts?	Dynamic Message Signs (DMS) = 111 Highway Advisory Radio (HAR) = 0 Closed Circuit Television (CCTV) = 383 Detection = 1371 Road Weather Information Systems (RWIS) = 48 Others = 154
If there are other deployments included in the maintenance contracts, what are they?	Truck Rollover Warning System - 6 Motorist Call-Box - 148
What is the total value of your maintenance contracts?	\$5,000,000
What is the typical length of a maintenance contract?	3 years
Do you have specialty maintenance contracts for communications systems?	No
Do you have specialty maintenance contracts for control centers?	Yes
Do you have preventative maintenance strategies deployed?	No
Do you have emergency response provisions in the maintenance contracts?	No
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	None in current contract.
Do you require that a certain percentage of devices be operable at all times?	No

Utah	
Which describes your state's approach to ITS maintenance?	Mostly in-house DOT crews . We are working on putting out a portion of routine maintenance to private contract.
What are the advantages of your state's method for ITS maintenance?	In-house crews maintain technical knowledge (especially troubleshooting skills) within DOT. They provide good input on new equipment. Maintenance crews can assist with deployment of new equipment as necessary. Good interaction of in-house maintenance crews with engineering staff - helps make engineering staff more knowledgeable about practical ITS hardware. Responsive to after hour needs. Generally less expensive than contracting. Don't have to worry about getting bad contractors on low bid process. We select applicants to work on our crews. We direct training and certification.
What are the disadvantages of your state's method for ITS maintenance?	Hard to keep up with sudden peaks in workload. State crews are paid less than contractors, so highly skilled employees may leave to work for contractors and consultants. In-house crews require us to maintain and pay for vehicles, shop space, tools, spare parts, etc.
How many device deployments are included under your ITS maintenance contracts?	Dynamic Message Signs (DMS) = 82 Highway Advisory Radio (HAR) = 5 Closed Circuit Television (CCTV) = 440 Detection = 250 Road Weather Information Systems (RWIS) = 48 Others = 800
If there are other deployments included in the maintenance contracts, what are they?	We maintain 800 computerized traffic signals within ITS , includes fiber-optic communication system, modems, controllers.
What is the total value of your maintenance contracts?	\$0
What is the typical length of a maintenance contract?	NA
Do you have specialty maintenance contracts for communications systems?	We have an open ended fiber-optic contractor. We use them for small jobs and emergency repairs , but not for routine maintenance. We have an in-house crew of 3.
Do you have specialty maintenance contracts for control centers?	No
Do you have preventative maintenance strategies deployed?	Yes - We try to visit each device twice per year for PM. This is hard to do with current staff. We are looking to contract PM (clean, change filters, etc) and keep skilled troubleshooting in-house.
Do you have emergency response provisions in the maintenance contracts?	NA
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	[No Answer Entered]
Do you require that a certain percentage of devices be operable at all times?	No

Washington	
Which describes your state's approach to ITS maintenance?	Most ITS maintenance is done at the regional level with state forces.
What are the advantages of your state's method for ITS maintenance?	We have well trained and adaptable staff to deal with ever changing needs.
What are the disadvantages of your state's method for ITS maintenance?	Retention and FTE hiring restrictions.
How many device deployments are included under your ITS maintenance contracts?	Dynamic Message Signs (DMS) = 179 Highway Advisory Radio (HAR) = 70 Closed Circuit Television (CCTV) = 521 Detection = 530* Road Weather Information Systems (RWIS) = 94 Others = 137**
If there are other deployments included in the maintenance contracts, what are they?	We have very few contracts for maintenance. *The 530 for Detection represents data stations and not detectors. One data stations can have up to 16 detectors. **The 137 for Other represents ramp metering systems.
What is the total value of your maintenance contracts?	[No Answer Entered]
What is the typical length of a maintenance contract?	N/A
Do you have specialty maintenance contracts for communications systems?	No
Do you have specialty maintenance contracts for control centers?	No
Do you have preventative maintenance strategies deployed?	Yes, for some systems and devices. An example, RWIS stations are calibrated annually.
Do you have emergency response provisions in the maintenance contracts?	No
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	For the most part, our work with contractors is tied to the warranty period connected to new device purchase and deployment. Typically, the period is two years where the contractor is responsible for proper operations of the device. After the warranty period, we take over the maintenance.
Do you require that a certain percentage of devices be operable at all times?	No



Delaware	
Which describes your state's approach to ITS maintenance?	Device-specific contracts
What are the advantages of your state's method for ITS maintenance?	This allows us to have specialized companies and staff maintaining the assortment of equipment.
What are the disadvantages of your state's method for ITS maintenance?	There is a lot to track and keep a handle on.
How many device deployments are included under your ITS maintenance contracts?	[No Answer Entered]
If there are other deployments included in the maintenance contracts, what are they?	[No Answer Entered]
What is the total value of your maintenance contracts?	[No Answer Entered]
What is the typical length of a maintenance contract?	1 to 3 years
Do you have specialty maintenance contracts for communications systems?	[No Answer Entered]
Do you have specialty maintenance contracts for control centers?	[No Answer Entered]
Do you have preventative maintenance strategies deployed?	[No Answer Entered]
Do you have emergency response provisions in the maintenance contracts?	[No Answer Entered]
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	[No Answer Entered]
Do you require that a certain percentage of devices be operable at all times?	[No Answer Entered]



Illinois	
Which describes your state's approach to ITS maintenance?	Regional contracts
What are the advantages of your state's method for ITS maintenance?	Cheaper prices through reduced travel costs. Local contractors are typically more familiar with local equipment.
What are the disadvantages of your state's method for ITS maintenance?	[No Answer Entered]
How many device deployments are included under your ITS maintenance contracts?	Dynamic Message Signs (DMS) = 71 Highway Advisory Radio (HAR) = 2 Closed Circuit Television (CCTV) = ? Detection = ? Road Weather Information Systems (RWIS) = 51
If there are other deployments included in the maintenance contracts, what are they?	[No Answer Entered]
What is the total value of your maintenance contracts?	\$2,000,000
What is the typical length of a maintenance contract?	Annual
Do you have specialty maintenance contracts for communications systems?	No
Do you have specialty maintenance contracts for control centers?	No
Do you have preventative maintenance strategies deployed?	Yes
Do you have emergency response provisions in the maintenance contracts?	Yes
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	No
Do you require that a certain percentage of devices be operable at all times?	No

New Hampshire	
Which describes your state's approach to ITS maintenance?	Device-specific contracts
What are the advantages of your state's method for ITS maintenance?	Our ITS deployment is in the infant stages. Most currently deployed devices were somewhat randomly deployed. We have since completed a statewide ITS architecture and built a TMC, with dedicated ITS staff that will hopefully tie everything together. That being said, our current practice was pretty much the only option available.
What are the disadvantages of your state's method for ITS maintenance?	With so many different vendors involved in every ITS application (communications, devices, ATMS, etc.), it is difficult to find one entity to take responsibility to maintain the integrity of the overall ITS program.
How many device deployments are included under your ITS maintenance contracts?	Dynamic Message Signs (DMS) = 6 Highway Advisory Radio (HAR) = 2 Closed Circuit Television (CCTV) = 24 Detection = 0 Road Weather Information Systems (RWIS) = 12
If there are other deployments included in the maintenance contracts, what are they?	[No Answer Entered]
What is the total value of your maintenance contracts?	[No Answer Entered]
What is the typical length of a maintenance contract?	generally 2 years
Do you have specialty maintenance contracts for communications systems?	Yes, statewide radio maintenance
Do you have specialty maintenance contracts for control centers?	Yes, ATMS currently under development
Do you have preventative maintenance strategies deployed?	Not nearly adequate
Do you have emergency response provisions in the maintenance contracts?	Not that I am aware of.
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	[No Answer Entered]
Do you require that a certain percentage of devices be operable at all times?	No

Kansas	
Which describes your state's approach to ITS maintenance?	KDOT is part of a Bi-State Freeway Management System for the Kansas City metro area, with MoDOT, and it is called KC Scout. KC Scout has a maintenance contract for ITS Field Devices, with Capital Electric. MoDOT administers the contract.
What are the advantages of your state's method for ITS maintenance?	N/A
What are the disadvantages of your state's method for ITS maintenance?	N/A
How many device deployments are included under your ITS maintenance contracts?	N/A
If there are other deployments included in the maintenance contracts, what are they?	N/A
What is the total value of your maintenance contracts?	N/A
What is the typical length of a maintenance contract?	N/A
Do you have specialty maintenance contracts for communications systems?	In regard to fiber optic and radio towers, KDOT has a contract with LightCore to replace cards in POPS. This is statewide, along our shared resource installation. KDOT has a service agreement for radio towers, with no specialties.
Do you have specialty maintenance contracts for control centers?	N/A
Do you have preventative maintenance strategies deployed?	N/A
Do you have emergency response provisions in the maintenance contracts?	Yes, we have emergency response provisions in the maintenance contracts.
Do you have any recommendations regarding contracting? Specifically, how does your state agency word contracts to improve preventative maintenance, reduce response times, and ensure that the systems remain operational?	Recommend that you speak directly with KC Scout staff, as I believe that wording is quite good.
Do you require that a certain percentage of devices be operable at all times?	N/A

## Appendix C Contractor Survey Responses

### Contractor A

A conversation with Contractor A was conducted in order to get some input on how ITS maintenance is contracted and provided. Scott Nale from Gannett Fleming had a conversation with xxx and xxx for the following questions.

- 1) *Does your company have experience providing maintenance to the Department for ITS devices?*  
Yes
- 2) *How many districts have you provided these services to?*  
They provide maintenance for District x. Maintain equipment for District x (under warranty) and do some services for District x as favor when they are up there in the area.
- 3) *Do these districts handle things in a similar manner or are the requirements varied and unique?*  
District x is a hands on District, they like to fix things themselves. Districts x and x are content to just let a contractor go fix the problem.
- 4) *What staff do you keep available to provide these services? How close do they live/work to the areas they support?*  
They have quite a few technicians on board who can do some of this work, but ITS is a growth industry for this company. They have 3 people on staff who work on ITS devices. He did point out that many devices can be remotely monitored and accessed (eg. Vpn or webbased), and this has reduced the needs for people to go out to the site to fix problems.
- 5) *How have replacement and surplus parts been maintained in your experiences?*  
The company maintains a supply of spare parts to support devices as needed. There is a big difference on the between the rural districts and Districts x, x and x. The urban districts have spare parts and ITS specific contracts while the rural ones have to build their ITS piecemeal as part of other construction projects.
- 6) *Do you support all the work or are subconsultants used to provide some of these services? What directs your use of subs? Experience, location, ect.*  
They do all of the work unless there is actual construction work. Things like trenching and sign erection are items that get subbed out.
- 7) *Do you have experience performing similar services outside of the state of Pennsylvania?*  
Occasionally, they have done some work in xxx.
- 8) *How similar/dissimilar are the contract conditions between states?*  
They say that their work is usually more fringe related, as in support of devices, not as part of a structured maintenance agreement.
- 9) *How do you provide for emergency response? Do you have someone on call all the time? Just weekends? What are your expectations of response from your people?*  
They have technicians in all the districts, additionally the three people who manage ITS are always on call. The people in the Districts they work in have the work, cell, and home numbers.
- 10) *These questions are in the interested of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

Some of the contracts are set up in a difficult and crooked manner. When there are only a few bid items and the rest is PDA. There have been a few contracts where the contractor has bid 1 dollar for the initial set up.

A second issue is the Prequalification and Qualification process. They are of the opinion that the qualifications are not fair and balanced. Even though they are fully factory certified because they do not do construction and have never installed a sign they are not qualified to bid on maintenance contracts. It is noted that construction and maintenance are two very different processes and the qualifications should represent that.

11) *How could preventative and response be better incentivized?*

Can't think of any incentives or any reason that this would be necessary.

12) *Do you have run into situations where the existing contract prohibits your ability to take corrective action?*

Yes, due to contract monies. District x doesn't have the money to do all the preventative maintenance and they end up having to make decisions about what equipment to replace.

**Contractor B**

A conversation with Contractor B was conducted in order to get some input on how ITS maintenance is contracted and provided. Scott Nale from Gannett Fleming had a conversation with xxx for the following questions.

1) *Does your company have experience providing maintenance to the Department for ITS devices?*

Yes

2) *How many districts have you provided these services to?*

They provide service to District x and have serviced District x in the past.

3) *Do these districts handle things in a similar manner or are the requirements varied and unique?*

District x follows what District x does but they are slightly different

4) *What staff do you keep available to provide these services? How close do they live/work to the areas they support?*

They have in house maintenance staff which live fairly close to the area.

5) *How have replacement and surplus parts been maintained in your experiences?*

The district maintains the parts and they pull from the stores and then purchase a replacement. If the part is not maintained the contractor will purchase.

6) *Do you support all the work or are subconsultants used to provide some of these services? What directs your use of subs? Experience, location, ect.*

They use a system integrator sub. The sub is used on an as needed basis.

7) *Do you have experience performing similar services outside of the state of Pennsylvania?*

Yes, they have a contract with the xxx.

8) *How similar/dissimilar are the contract conditions between states?*

They contracts are very similar because of the head of xxx is a former xxx employee who worked on ITS maintenance. Essentially it's the same guy doing the same thing.

9) *How do you provide for emergency response? Do you have someone on call all the time? Just weekends? What are your expectations of response from your people?*

They maintain a 24 hour call service. This service gets in touch with the person who is on call. They typically shoot for a 4 hour response time however it is understood that if the call comes in on Christmas day or something like that the response time will be lower.

10) *These questions are in the interested of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

The department will not be able to provide these services without the help on contractors. The cost of special equipment and personnel will be too high for the department. However, contractors are going to need to have better educated people.

11) *How could preventative and response be better incentivized?*

One of the problems is that any contractor can bid on them. Personnel is lacking in some locations. They have seen some contractors stretching too far, ex. Pittsburg contractor bidding on Philly jobs. A prequel based on geographic location may be the way to get fast response for maintenance.

12) *Do you have run into situations where the existing contract prohibits your ability to take corrective action?*

No, they have not had this issue.

### **Contractor C**

A conversation with Contractor C was conducted in order to get some input on how ITS maintenance is contracted and provided. Scott Nale from Gannett Fleming had a conversation with xxx for the first several questions and xxx for the remainder of the questions.

1) *Does your company have experience providing maintenance to the Department for ITS devices?*

Yes, they have a total of 68 signs (including 5 portable) throughout Pennsylvania.

2) *How many districts have you provided these services to?*

They have devices in Districts x, x, x, x, x, x (pending)

3) *Do these districts handle things in a similar manner or are the requirements varied and unique?*

All the districts are pretty much the same. The thing that varies quite a bit is access to the devices. Some locations have catwalks while others require lane shutdowns. It was noted that most of the cost incurred is in accessing the device (i.e. lane closures ect)

4) *What staff do you keep available to provide these services? How close do they live/work to the areas they support?*

xxx maintains satellite offices throughout the country. In addition to that they have authorized service centers to work on the products. They keep these places within 100 miles of devices to reduce travel time costs.

5) *How have replacement and surplus parts been maintained in your experiences?*

This varies based on the customer; however the best and fastest way to manage this is to have the maintenance provider control it. There will need to be some inventory controls in place from the department standpoint but this approach reduces unnecessary trips and delays in getting repairs completed.

6) *Do you support all the work or are subconsultants used to provide some of these services? What directs your use of subs? Experience, location, ect.*

When the contract is just for sign maintenance they provide all the services. If it is a bigger contract they will do the sign work and sub out. He noted that in many cases smaller, device



specific, contracts provide a better quality produce. This is because those people who know the system can bid on the devices they are good with. xxx has experience as both Prime and Sub Contractor.

- 7) *Do you have experience performing similar services outside of the state of Pennsylvania?*  
Yes, they have held similar contracts all across the country. Some contracts are just parts supply and others are all the way up to a full time monitor and maintenance contract. They noted that the full maintenance contracts have greatly increased uptime.
- 8) *How similar/dissimilar are the contract conditions between states?*  
They are not at all similar. The only time that different states have the same contract requirements is in areas near state boundaries. The language and requirements can be similar near state boundaries because of consultants working in both jurisdictions. The only other time that requirements can match is when the supplier provides contract language on maintenance. Attached is a copy of a technical spec that xxx is putting together to give to anyone who asks.
- 9) *How do you provide for emergency response? Do you have someone on call all the time? Just weekends? What are your expectations of response from your people?*  
This depends on the terms of the contract. It is stressed that Emergency Response needs to be very clearly defined, otherwise the contract can get very expensive. They have their company set up for quality response services. All calls are routed to a project manager by area code, meaning the same person tracks the entire process. This person then follows the entire repair process to ensure a quality completion.
- 10) *These questions are in the interested of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*  
The spec which is attached is based on experience and should be reviewed as it is based on past experiences.  
Failure tracking systems and full time help desk access can reduce down time especially if they have the ability to offsite diagnostics (via VPN or other access).  
Suitable qualifications and pre-qualifications should be considered in order provide a better quality product to the department.
- 11) *How could preventative and response be better incentivized?*  
Liquidated damages are just priced into the contract so the department is paying their own damages. Contractors make an assumption as to how much LD they will have to pay and build it into the unit costs. Incentives would be a better way to go but in his opinion xxx would be the first ones doing that. He recommends setting incentives based on up time. Recommended over 92% uptime gets a bonus, between 92-88 is no change, and below 88 % gets a penalty. You would have to look at historic numbers and see what the uptime has been historically, that way you would know what would be a net improvement. He also noted that this would most likely scare away the people who are not really good at this work.
- 12) *Do you have run into situations where the existing contract prohibits your ability to take corrective action?*  
Yes, they have found that sometimes the Department rules can restrict their ability to get things fixed. When you have to get a certain person to make a decision that person can stop the entire process. Also delays in the Department getting parts and approving costs can really slow the process as well.

**Contractor D**

A conversation with Contractor D was conducted in order to get some input on how ITS maintenance is contracted and provided. Scott Nale from Gannett Fleming had a conversation with xxx.

- 1) *Does your company have experience providing maintenance to the Department for ITS devices?*  
Yes
- 2) *How many districts have you provided these services to?*  
District x, x, x, and x
- 3) *Do these districts handle things in a similar manner or are the requirements varied and unique?*  
No, all have different requirements. The current condition is almost like working in 4 different countries. He would welcome any standardization because it would improve conditions for his company. For example District x bids ITS by itself while District x lumps it into signal and lighting.
- 4) *What staff do you keep available to provide these services? How close do they live/work to the areas they support?*  
Technicians, electricians, laborers, engineers and manufacturers. The staff lives in each district because they do the signal work in these districts as well.
- 5) *How have replacement and surplus parts been maintained in your experiences?*  
Very poor. Contracts recommend that the Department maintains parts supplies but the districts are non-responsive. Many times this lack of parts is the reason for many delays in getting devices back up.
- 6) *Do you support all the work or are subconsultants used to provide some of these services? What directs your use of subs? Experience, location, ect.*  
Sometimes they have subs on their contracts. These subs are usually represented by manufactures or highly experienced ITS engineers.
- 7) *Do you have experience performing similar services outside of the state of Pennsylvania?*  
No
- 8) *How similar/dissimilar are the contract conditions between states?*  
N/A
- 9) *How do you provide for emergency response? Do you have someone on call all the time? Just weekends? What are your expectations of response from your people?*  
Everyone has xxx phone number, he and few others are on call 24hrs a day. Below that there is an emergency call list with other employees on it that is circulated to the Department, Police and Emergency services people.
- 10) *These questions are in the interested of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*  
NTCIP is an important step in maintenance. The Department needs to be more open to new technology. They need to learn to trust the standards. Even if the item isn't proprietary the Department makes it be.
- 11) *How could preventative and response be better incentivized?*  
Force account work provides a generous markup. The contracts are more desirable when they have less bid items in them.



12) Do you have run into situations where the existing contract prohibits your ability to take corrective action?

No, but sometimes it holds up when one guy needs to make a decision. There is too much red tape and this ends up costing the Department in uptime and excess costs.

Sometimes it can be more expensive to find the same manufacture parts instead of getting compliant NTCIP parts. All of the devices work but some districts require that you use more expensive or hard to get parts from specific manufactures. One person can cost the department a lot of money.

## Appendix D District Survey Interview Minutes

On Tuesday February 13<sup>th</sup>, a teleconference was held to discuss the experiences and practices of ITS maintenance in **District 1-0**. The following were in attendance (via telephone):

Tom McClelland	-	PennDOT, District 1-0
Brenda Murphy	-	PennDOT, Central Office
Bob Taylor	-	Gannett Fleming, Inc.
Scott Nale	-	Gannett Fleming, Inc.

Bob Taylor began the meeting by providing a project overview. After this initial explanation, Tom McClelland responded to the following questions:

1) *What types of ITS devices exist in your district?*

In District 1-0 there are dynamic message signs (DMS), semi-permanent message boards, highway advisory radio (HAR), bridge anti-icing systems, and road weather information systems (RWIS). It was noted that Tom had no actual interaction with the RWIS systems.

In general, ITS devices are an emergency management (weather) tool and have limited use to address congestion.

2) *Number of devices in each District (CCTV, DMS, HAR, other).*

There are 4 HAR, 10 DMS (1 is semi-permanent), 4 bridge anti-icing systems, and 17 RWIS stations.

3) *Number of devices inoperable for more than 48 hours and perspectives why as well as what can be done.*

All of the ITS devices have, at some point, been down for more than 48 hours. Tom noted that if there were some in-house expertise this down time could be reduced.

The majority of DMS are Daktronics boards, but two are a Display Solutions boards. While they have been able to receive responsive service to Daktronics board, responsiveness for the Display Solutions board has been limited.

Currently, two DMS in Mercer County have been having issues, but the District, with assistance from District 11-0, plans to troubleshoot the modems.

4) *How do you feel a good ITS maintenance contract would be structured? (i.e., from district/regional/statewide)*

Tom noted that he had thought about this issue in particular, and he saw advantages to all three approaches. A cost reduction would be realized from a Statewide and Regional contract, but a District Specific setup would provide better response and accuracy.

5) *What is an acceptable downtime for an ITS device? Does this vary by type? How would you group devices?*

Tom indicated that 24 hours would be applicable for all devices. He noted that if they had someone in-house, 24-hour response would be a good response time, but with a contractor, he felt that a week would be more reasonable.

- 6) *What sort of spare parts supply is maintained for ITS devices? Who maintains this supply? Where is it maintained?*

There are no spare parts supply maintained in District 1-0. Tom noted that a supply room where some amount of spare parts are kept would help immensely. Part of the reason for coordination with District 11-0 is due to the fact that spare parts are available. Tom noted that if there was one thing that would help most it would be a spare parts supply.

- 7) *Thoughts on outsourcing Preventative, Response, and Emergency ITS work.*

Tom indicated that the outsourcing as it is done now is fine, but it might be better to have someone in-house to do the work.

- 8) *What is a reasonable response time to a call out from the Department? Both communications with the Department and arrival on site. Does this vary for emergency and response tasks?*

24 hours would be a good response time. It was noted that these devices are primarily used in response to weather events and not on a regular basis.

- 9) *What sort of liquidated damages are currently in place for ITS maintenance contracts in your district?*

The HAR contract currently has damages built into the contract at \$250 dollars a day for non-responsiveness. It was also noted that they have never had to use it. Bruce and Merrilees is the contractor, and they have always been responsive.

- 10) *Does the current configuration of liquidated damages provide for a quality response in your district? In what ways could things be better arranged?*

Tom indicated that they have never had to use the penalty and has no input on this issue. He noted that there had been a previous contract with a contractor from Philadelphia (Signal Services), and due to the distance, they were slow to respond and subcontracted some of the on site work.

- 11) *Historically, how has ITS maintenance been provided within your District? What are your thoughts on how it has worked?*

All of their experience on this issue has been listed above. The District also requires 2-year operational support as part of construction projects. One issue that did come up here is that, in some cases, there have been service overlaps.

- 12) *Do you provide any in-house maintenance services? What sort and why?*

Yes, they do provide some services but are limited by their knowledge base and spare parts. Currently, they use the manual for troubleshooting purposes along with a few other things they have learned.

- 13) *Have you ever been denied services due to contract language?*

No, the contractor gets paid hourly, so there is no problem getting them to come out and work.

14) *These questions are in the interest of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

Tom is meeting with Jason Previte from District 11 to troubleshoot a DMS which is currently not functional. Brenda noted that there had been some problems with that specific supplier responding (Display Solutions).

In-house expertise and a supply of spare parts would be the biggest help to increasing uptime.

On Wednesday February 20<sup>th</sup>, a coordination meeting was held at PennDOT Central Office to discuss the experiences and practices of ITS maintenance in **District 2-0 and 9-0**. The following were in attendance (via telephone):

- Kevin Snyder - PennDOT Engineering District 9-0
- Mike Pastore - PennDOT Engineering District 9-0
- Jeff Walker - PennDOT Engineering District 2-0
- Dennis Prestash - PennDOT Engineering District 2-0
- Matt Weaver - PennDOT Central Office
- Brenda Murphy - PennDOT Central Office
- Bob Taylor - Gannett Fleming, Inc.
- Scott Nale (via telephone) - Gannett Fleming, Inc.

Matt Schiemer began the meeting by providing a project overview. After this initial explanation, Thomas Walter responded to the following questions:

- 1) *What types of ITS devices exist in your district?*
- 2) *Number of devices in each District (CCTV, DMS, HAR, other).*

District	CCTV		Permanent DMS		Semi-permanent DMS		Permanent HAR		Portable HAR	
	Current Inventory	Not Operational	Current Inventory	Not Operational	Current Inventory	Not Operational	Current Inventory	Not Operational	Current Inventory	Not Operational
2-0	9	0	12	0	3	0	12	0	7	0
9-0	31	1	23	0	0	0	1	0	1	0

- 3) *Number of devices inoperable for more than 48 hours and perspectives why as well as what can be done.*  
Everything is working now.
- 4) *How do you feel a good ITS maintenance contract would be structured? (i.e., from district/regional/statewide)*  
It is their opinion that a regional contract would be best in order to provide a high quality product and minimize cost.
- 5) *What is an acceptable downtime for an ITS device? Does this vary by type? How would you group devices?*  
Not discussed due to time/format of meeting.
- 6) *What sort of spare parts supply is maintained for ITS devices? Who maintains this supply? Where is it maintained?*  
They do not currently maintain a spare parts supply, although they noted that this would be a good thing to do.
- 7) *Thoughts on outsourcing Preventative, Response, and Emergency ITS work.*  
Do not appear to be concerned as long it is the right contractor. Also, there needs to be good communication with the manufacturer.

- 8) *What is a reasonable response time to a call out from the Department? Both communications with the Department and arrival on site. Does this vary for emergency and response tasks?*  
Not discussed due to time/format of meeting.
- 9) *What sort of liquidated damages are currently in place for ITS maintenance contracts in your district?*  
Not discussed due to time/format of meeting.
- 10) *Does the current configuration of liquidated damages provide for a quality response in your district? In what ways could things be better arranged?*  
Not discussed due to time/format of meeting.
- 11) *Historically, how has ITS maintenance been provided within your District? What are your thoughts on how it has worked?*  
Not discussed due to time/format of meeting.
- 12) *Do you feel that contractors should have to prequalify? Do you have any experience in this area?*  
They were concerned about the fact that the prequalifications may be satisfied, but the persons who met the criteria aren't the person doing the work.
- 13) *Do you provide any in-house maintenance services? What sort and why?*  
They have some expertise but most is by talking to the manufacturer and troubleshooting on the phone.
- 14) *Have you ever been denied services due to contract language?*  
Not discussed due to time/format of meeting.
- 15) *These questions are in the interest of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*  
Not discussed due to time/format of meeting.

**District 3-0** was contacted regarding ITS maintenance practices, but no interview was conducted due to the limited number of ITS deployments in the District.

On Wednesday February 14<sup>th</sup>, a teleconference was held to discuss the experiences and practices of ITS maintenance in **District 4-0**. The following were in attendance (via telephone):

- Jeff Fuhr - PennDOT, District 4-0
- Bob Taylor - Gannett Fleming, Inc.
- Scott Nale - Gannett Fleming, Inc.

Bob Taylor began the meeting by providing a project overview. After this initial explanation, Jeff Fuhr responded to the following questions:

- 1) *What types of ITS devices exist in your district?*  
 CCTV, DMS, Semi-permanent DMS, HAR, RWIS through BOMO

DMS Brands are as follows:

- PSC – Portable
- AMSIG - Portable
- AMSIG - Overhead
- Dambach - Overhead

- 2) *Number of devices in each District (CCTV, DMS, HAR, other).*

Device	Inventory	Number with Operational Issues
CCTV	8	1
DMS	9	2
Semi-permanent DMS	46	
HAR	9 (22 beacons)	
RWIS	8	Varies due to connection issues

- 3) *Number of devices inoperable for more than 48 hours and perspectives why as well as what can be done.*

- 1 CCTV - T1 not installed
- 2 DMS
  - 1 structural issue
  - 1 CPU issue

- 4) *How do you feel a good ITS maintenance contract would be structured? (i.e., from district/regional/statewide)*

Currently, the District utilizes a signing and lighting maintenance contract for ITS maintenance. A separate contract would be preferred.

Regional or statewide contracts would be good as long as response was the same and there could be direct communication with the contractor.

Specialty emergency contracts would be good for quick response needs.



5) *What is an acceptable downtime for an ITS device? Does this vary by type? How would you group devices?*

24 hours. DMS should be less due to there importance.

6) *What sort of spare parts supply is maintained for ITS devices? Who maintains this supply? Where is it maintained?*

- Battery shed for portables – boil and replace
- 50 pixel boards for portables
- Modems

All parts are maintained by signing and lightning contractor on Department property.

7) *Thoughts on outsourcing Preventative, Response, and Emergency ITS work.*

The District’s contractor (Kuharchick/PSI) provides all aspects of ITS maintenance and has been responsive to the District’s needs. The contractor provides preventive maintenance services four times a year. Jeff noted that his only concern about a larger contract structure is how fast a contractor can respond to a service call.

8) *What is a reasonable response time to a call out from the Department? Both communications with the Department and arrival on site. Does this vary for emergency and response tasks?*

24 hours from time of notification. Time expectation is the same for emergency or response maintenance due to the amount of redundancy in their system, i.e., there are other signs to carry the message while something is down.

9) *What sort of liquidated damages are currently in place for ITS maintenance contracts in your district?*

None. Jeff didn’t develop the contract, but they should probably add something in future contracts.

10) *Does the current configuration of liquidated damages provide for a quality response in your district? In what ways could things be better arranged?*

NA

11) *Historically, how has ITS maintenance been provided within your District? What are your thoughts on how it has worked?*

Through signing and lighting contracts with usually good service.

- Current contract is Kuharchick /PSI.
- Previous contract was Northwest Electric

Maintenance is provided to TMC, too.

12) *Do you provide any in-house maintenance services? What sort and why?*

Limited to include:

- Resetting boards.
- Changing pixel boards
- Preparing inspection reports

13) *Have you ever been denied services due to contract language?*

No.

14) *These questions are in the interest of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

It would be nice to have additional funds for deployments. In the context of ITS maintenance, it would be nice to allow for limited ITS deployments within maintenance contracts in response to special needs.

Also, it would be nice to have regional ITS maintenance contracts to support the development of RTMCs and the STMC.

The District inquired about how RWIS may be included. The District saw a benefit in enhancing RWIS to provide awareness in the TMC environment. GF noted that BHSTE and BOMO coordinated on a RWIS plan that address some of those issues, but they were unaware of the status.

On Tuesday February 26th, a teleconference was held to discuss the experiences and practices of ITS maintenance in **District 5-0**. The following were in attendance (via telephone):

- Thomas Walter - PennDOT Engineering District 5-0
- Matt Weaver - PennDOT BHSTE
- Mike Pack - PennDOT BHSTE
- Matt Schiemer - Gannett Fleming, Inc.
- Scott Nale - Gannett Fleming, Inc.

Matt Schiemer began the meeting by providing a project overview. After this initial explanation, Thomas Walter responded to the following questions:

1) *What types of ITS devices exist in your district?*  
See below.

2) *Number of devices in each District (CCTV, DMS, HAR, other).*

Device	Inventory	Number with Operational Issues
CCTV	8	
DMS	4	1
Semi-permanent DMS	24	3
HAR	5	
Portable HAR	4	

3) *Number of devices inoperable for more than 48 hours and perspectives why as well as what can be done.*  
1 DMS is down because of a bad data distributor board. A few DMS boards are being repaired.

4) *How do you feel a good ITS maintenance contract would be structured? (i.e., from district/regional/statewide)*

The current contract for preventive, standard, and emergency maintenance seems to work well. They have a PDA provision for large or common items and for preventative maintenance. For emergency maintenance, they use force account work, which has worked well with several different contractors over the years. Tom thinks a statewide-type contractor might be tough since the contractors are more regional and would not be able to make the necessary response times. As far as he knows, nobody is big enough to handle a statewide contract, and only two people in the state – Don Weiner is one who lives in 6-0; the other is Mike Matsko in the State College area in District 2-0 – have significant technical knowledge of PennDOT’s systems.

5) *What is an acceptable downtime for an ITS device? Does this vary by type? How would you group devices?*

This depends on the device and availability of parts. They have one sign brand in particular, AMSIG signs, that fail often, and the company does not support well.

- 6) *What sort of spare parts supply is maintained for ITS devices? Who maintains this supply? Where is it maintained?*  
Character LED boards. They have some encoders/decoders they have some for CCTVs. They have spare cameras. Also, they have some spare CPUs for the portable DMS. Parts are maintained by Department but they have the contractor purchase them.
- 7) *Thoughts on outsourcing Preventative, Response, and Emergency ITS work.*  
They are happy with the outside contractor approach. "It's the best" according to Tom for both preventative maintenance on a regular schedule or as-needed; it works fine.
- 8) *What is a reasonable response time to a call out from the Department? Both communications with the Department and arrival on site. Does this vary for emergency and response tasks?*  
The response time is spelled out in the contract. Emergency is 24 hours during normal weekday, and response maintenance non-emergency is longer time period.
- 9) *What sort of liquidated damages are currently in place for ITS maintenance contracts in your district?*  
No liquidated damages are in place, and this has not been a problem. Adding LD's would raise the costs since the bidders would have to bid that risk.
- 10) *Does the current configuration of liquidated damages provide for a quality response in your district? In what ways could things be better arranged?*  
They have been very pleased with the response they have received and do not see a need for liquidated damages.
- 11) *Historically, how has ITS maintenance been provided within your District? What are your thoughts on how it has worked?*  
This is the third different maintenance contractor that they have used and have been pleased with all three of them.
- 12) *Do you feel that contractors should have to prequalify? Do you have any experience in this area?*  
There are only a few companies that do this type of work, and they are qualified. It is possible to lose contractors who are qualified but don't necessarily have the P codes. They've lost some in the past, unnecessarily, and think the Department may have suffered because of this.
- 13) *Do you provide any in-house maintenance services? What sort and why?*  
They will go out and change a camera or encoder or reset a device before calling out the contractor.
- 14) *Have you ever been denied services due to contract language?*  
No.
- 15) *These questions are in the interest of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

He did not feel that a statewide contract would be the best approach; he has concerns about response time, equipment familiarity, and device knowledge. He pointed out that their contract is set up just like District 6, and it works very well. He is concerned that changing something could mess up the system they have in place.

*16)What are your thoughts on making use of your maintenance contract as an on-call construction contract?*

They did it for the relocation of their TMC, and it worked well. He likes the idea.

On Tuesday March 4th, a teleconference was held to discuss the experiences and practices of ITS maintenance in **District 6-0**. The following were in attendance (via telephone):

- Ed Burns - PennDOT Engineering District 6-0
- Frank DiJoseph - PennDOT Engineering District 6-0
- Matt Weaver - PennDOT BHSTE
- Bob Taylor - Gannett Fleming, Inc.
- Wayne Spaulding - Gannett Fleming, Inc.

Bob Taylor began the meeting by providing a project overview. After this initial explanation, Ed Burns responded to the following questions:

1) *What types of ITS devices exist in your district?*  
See below.

2) *Number of devices in each District (CCTV, DMS, HAR, other).*

Device	Inventory	Number with Operational Issues
CCTV	134	5
DMS	45	4
Semi-permanent DMS	25	5
HAR	0	0
Portable HAR	0	0

The District is in the process of adding numerous devices and expects to add a 100 or so in the near future.

3) *Number of devices inoperable for more than 48 hours and perspectives why as well as what can be done.*

Most operational issues are sporadic in nature due to intermittent communication failures, especially to wireless locations. T-1 sites are less of a problem. The District has very few operational issues lasting more than 48 hours.

Most long term operational issues are due to incidents such as a device being struck or another uncommon event. One CCTV that was struck during a crash has not been operational for several months.

4) *How do you feel a good ITS maintenance contract would be structured? (i.e., from district/regional/statewide)*

Regional is not preferred by District 6-0. There may be issues regarding who manages the contract, especially if there are personality conflicts. Additionally, response time may be diminished if the geographic area is too large.

A design build best value method may offer some benefits in that unresponsive contractors may be eliminated, but the time it takes to execute a contract may increase.

It would be nice to have multiple maintenance contracts in order to have some competition in ITS maintenance services.

In some cases, it would be nice to have access to outside expertise on specialty issues.

- 5) *What is an acceptable downtime for an ITS device? Does this vary by type? How would you group devices?*

The District uses a Response Maintenance Form. For future contracts, the expectation will be that the maintenance provider will respond to a request within 5 days and fix a request in 7 days.

- 6) *What sort of spare parts supply is maintained for ITS devices? Who maintains this supply? Where is it maintained?*

The District keeps a good deal of spare parts. It may be beneficial to specify generic spare parts such that the District does not create an inventory of out-of-date spare parts equipment.

It would be beneficial for the District to have full time access to a bucket truck.

- 7) *Thoughts on outsourcing Preventative, Response, and Emergency ITS work.*

Preventative maintenance is done biannually. There has been no direct correlation in the age of equipment and the amount of preventative maintenance required.

- 8) *What is a reasonable response time to a call out from the Department? Both communications with the Department and arrival on site. Does this vary for emergency and response tasks?*

See question 5.

- 9) *What sort of liquidated damages are currently in place for ITS maintenance contracts in your district?*

None at this time.

- 10) *Does the current configuration of liquidated damages provide for a quality response in your district? In what ways could things be better arranged?*

Not applicable.

Not sure. Uptime performance incentives would not work for the District since 99.9% of their devices are operational.

- 11) *Historically, how has ITS maintenance been provided within your District? What are your thoughts on how it has worked?*

Previous contracts have been managed by construction, which is not always fully aware of the issues at hand. It would be preferable for the ITS group to own and manage their own ITS maintenance contract.

- 12) *Do you feel that contractors should have to prequalify? Do you have any experience in this area?*

The District has included qualification requirements in their contracts. It is difficult to find responsive integrators since the number of qualified companies is limited.

13) *Do you provide any in-house maintenance services? What sort and why?*

The District does do some in-house maintenance. If staffing and resources were not an issue, it would be nice to have a team of two men to conduct in-house maintenance.

14) *Have you ever been denied services due to contract language?*

Not discussed.

15) *These questions are in the interest of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

Need to spell out preventative and response maintenance requirements.

16) *What are your thoughts on making use of your maintenance contract as an on-call construction contract?*

It might be a benefit to allow for some limited emergency deployments.



On Tuesday February 19<sup>th</sup>, a teleconference was held to discuss the experiences and practices of ITS maintenance in **District 8-0**. The following were in attendance (via telephone):

- Scott Nazar - PennDOT Engineering District 8-0
- Matt Weaver - PennDOT BHSTE
- Mike Pack - PennDOT BHSTE
- Bob Taylor - Gannett Fleming, Inc.
- Scott Nale - Gannett Fleming, Inc.

Bob Taylor began the meeting by providing a project overview. After this initial explanation, Scott Nazar responded to the following questions:

1) *What types of ITS devices exist in your district?*

- CCTV
- DMS
- HAR
- VMS (semi-portable and portable)
- Mobil Command Van

2) *Number of devices in each District (CCTV, DMS, HAR, other).*

Device	Inventory	Number with Operational Issues
CCTV	2	
DMS	12	1
Semi-permanent DMS	17	
HAR	3	
RWIS		
Mobil Command Center	1	

District 8-0 has a major deployment project ongoing in the Harrisburg area as well as I-81 that include several DMS and CCTVs.

3) *Number of devices inoperable for more than 48 hours and perspectives why as well as what can be done.*

There are currently no devices inoperable, although they have had their occasional issues. There is some in-house troubleshooting done to help reduce delay and cost of service calls.

All but one of the DMS boards is Daktronics; the other one is an FDS board. It was noted that, most of the time if there is a failure, it is due to a communication issue, which the District attempts to troubleshoot in-house first.

4) *How do you feel a good ITS maintenance contract would be structured? (i.e., from district/regional/statewide)*

Any help would be welcome. Noted that a statewide contract would not be as useful as Department personnel being trained in ITS support.

5) *What is an acceptable downtime for an ITS device? Does this vary by type? How would you group devices?*

72 hours for all devices. It was noted that the DMS boards are more critical due to being the most visible.

6) *What sort of spare parts supply is maintained for ITS devices? Who maintains this supply? Where is it maintained?*

They have old equipment that has been taken out of service. These devices are utilized for spare parts. The ongoing deployment project will provide a greater inventory of parts.

7) *Thoughts on outsourcing Preventative, Response, and Emergency ITS work.*

The Department has experienced some issues with responsiveness to on-call support.

The new contract will include a specific list of preventative maintenance work for each device to be covered. Preventive maintenance will be reduced from quarterly to two times per year.

8) *What is a reasonable response time to a call out from the Department? Both communications with the Department and arrival on site. Does this vary for emergency and response tasks?*

72 hours.

The District's new contract will have a PDA for response maintenance and will include 2 hours of travel time.

9) *What sort of liquidated damages are currently in place for ITS maintenance contracts in your district?*

Currently, there are liquidated damages in place for preventative maintenance but not for response activities.

10) *Does the current configuration of liquidated damages provide for a quality response in your district? In what ways could things be better arranged?*

They have found the contractor doesn't put response work on a high priority. A new contract is being prepared and will include liquidated damages of \$1500/day for being non-responsive.

11) *Historically, how has ITS maintenance been provided within your District? What are your thoughts on how it has worked?*

Currently, these services are provided by a signal contractor. They have been found to be more interested in signal work than ITS work. That is the reason for adding the response work liquidated damages.

12) *Do you feel that contractors should have to prequalify? Do you have any experience in this area?*

Yes, there are advantages to having the contractor prequalify. Care needs to be taken as it would easily be possible to set the bar so high that no one will bid on the contract.

13) *Do you provide any in-house maintenance services? What sort and why?*

Yes, they try to troubleshoot the problem first before they put in a service call.

Preventative maintenance for the Mobil Command Van is being handled in-house.

14) *Have you ever been denied services due to contract language?*

No, their contracts have provisions to cover the addition of future devices.

15) *These questions are in the interest of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

Rutgers has put together an ITS document that includes sample preventative maintenance task lists.

Technical expertise at the Department would be very helpful.

ITS devices should be added to the 408, and the addition of standards would be very helpful.

See combined interview for Districts 2-0 and 9-0 for **District 9-0** ITS maintenance perspectives.

On Tuesday February 19<sup>th</sup>, a teleconference was held to discuss the experiences and practices of ITS maintenance in **District 10-0**. The following were in attendance (via telephone):

- David Tomaswick - PennDOT Engineering District 10-0
- Paul Koza - PennDOT Engineering District 10-0
- Matt Weaver - PennDOT BHSTE
- Brenda Murphy - PennDOT BHSTE
- Bob Taylor - Gannett Fleming, Inc.
- Scott Nale - Gannett Fleming, Inc.

Bob Taylor began the meeting by providing a project overview. After this initial explanation, David Tomaswick and Paul Koza responded to the following questions:

- 1) *What types of ITS devices exist in your district?*
  - DMS – 29 (26 were recently deployed on I-80 and 3 were deployed on I-79)
  - HAR -13
  - CAS – 1
  - RWIS – 6 (not discussed)

2) *Number of devices in each District (CCTV, DMS, HAR, other).*

Device	Inventory	Number with Operational Issues
CCTV		
DMS	29	2
Semi-permanent DMS		
HAR	13	
RWIS	6	?

3) *Number of devices inoperable for more than 48 hours and perspectives why as well as what can be done.*

The 26 DMS on I-80 are still in the one-year operational testing period. Two of the three DMS on I-79 are not functional. The two that are not functional are Display Solution signs. The one that is functional is a Daktronics sign. DMS manufacturer support is needed for reliable operations.

4) *How do you feel a good ITS maintenance contract would be structured? (i.e., from district/regional/statewide)*

A good contract promotes responsiveness. Historic experience on previous ITS maintenance contracts has been favorable since the contractor (Wellington Power) was responsive. The new contract is just being initiated, and the success of the contract is to be determined. Bruce and Merrilees will be new contractor.

Regional contracts may be OK if the same level of responsiveness can be ensured.

5) *What is an acceptable downtime for an ITS device? Does this vary by type? How would you group devices?*

24 hours for all devices.

- 6) *What sort of spare parts supply is maintained for ITS devices? Who maintains this supply? Where is it maintained?*

The District will maintain an inventory of parts. The list will be provided. Presently, the deployer of the I-80 system is responsible for the inventory of parts. Parts include: Modem, Uninterrupted power supply, Field controller, HAR Antenna, 30 degree LED units, 70 degree LED units, Transmitter module, Digital Audio recorder/announcer, Synchro module, and Solar unit.

- 7) *Thoughts on outsourcing Preventative, Response, and Emergency ITS work.*

No opinion one way or the other. Internal staff may be more responsive, but doesn't feel it's realistic to expect PennDOT to staff ITS maintenance.

- 8) *What is a reasonable response time to a call out from the Department? Both communications with the Department and arrival on site. Does this vary for emergency and response tasks?*

Two hours to acknowledge a request and 24 hours to respond.

- 9) *What sort of liquidated damages are currently in place for ITS maintenance contracts in your district?*

Liquidated damages are \$1000 per occurrence. Second and subsequent occurrences are \$1200. The liquidated damages are not applied on a daily basis. It is a one time charge per event.

- 10) *Does the current configuration of liquidated damages provide for a quality response in your district? In what ways could things be better arranged?*

The District has never had to use it.

- 11) *Historically, how has ITS maintenance been provided within your District? What are your thoughts on how it has worked?*

Previous ITS maintenance contracts were through a purchase order agreement. Purchase order requests can be cumbersome to initiate. Start of work could take up to two months.

New contract was ECMS low bid. The pros and cons will play out. ITS Prequalification codes were not used.

- 12) *Do you provide any in-house maintenance services? What sort and why?*

No.

- 13) *Have you ever been denied services due to contract language?*

No.

- 14) *These questions are in the interest of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

- Need DMS support from manufacturer even with local ITS maintenance contracts.

- Contracts need to consider qualifications. Not all signal contractors can do ITS work. What is the role of ITS prequalification codes in ITS maintenance contracting?
- Need standard descriptions of devices to maintain in order to have contractors responding have a clear understanding.
- Make sure we have overlaps when planning contracts.

On Friday February 22nd, a teleconference was held to discuss the experiences and practices of ITS maintenance in **District 11-0**. The following were in attendance (via telephone):

- Matt Weaver - PennDOT BHSTE
- Brenda Murphy - PennDOT BHSTE
- Jason Previte - PennDOT Engineering District 11-0
- Todd Kravitz - PennDOT Engineering District 11-0
- Bob Taylor - Gannett Fleming, Inc.
- Scott Nale - Gannett Fleming, Inc.

Bob Taylor began the meeting by providing a project overview. After this initial explanation, Jason Previte and Todd Kravitz responded to the following questions:

1) *What types of ITS devices exist in your district?*

- CCTV
- DMS
- HAR
- Microwave
- HOV

2) *Number of devices in each District (CCTV, DMS, HAR, other).*

Device	Inventory	Number with Operational Issues
CCTV	92	1
DMS	16	
Semi-permanent DMS		
HAR	7	
Microwave	89	
HOV		

3) *Number of devices inoperable for more than 48 hours and perspectives why as well as what can be done.*

Some DMS and CCTV due to parts availability.

One CCTV is currently down due to communications and ability to get support.

In the past, the District had a problem with one DMS supplier (Display Solutions). Display Solutions was bought by National Signs, and responsiveness has improved. The District has not had the same problems with newer boards.

4) *How do you feel a good ITS maintenance contract would be structured? (i.e., from district/regional/statewide)*

- a. It should be a construction contract – more flexibility and ability to write specifications.
- b. Purchase Orders are too general.
- c. A regional contract may work when there is a big District and a smaller developing District with similar devices, but it depends on the number of devices.



- d. Contracts by device may work if you get a good contractor, but may not work if you get the wrong guy. – Not really preferred because it would be more contracts to admin.
- e. For any contract, continuity of staff is important.
- f. DBBV needs to be pursued cautiously- we don't want designers. It would be nice to evaluate contractors though.
- g. A Pcode qualification for ITS maintenance would be nice. -Regardless of contract, require qualifications.

5) *What is an acceptable downtime for an ITS device? Does this vary by type? How would you group devices?*

1 day to troubleshoot .

5 days to fix from notification.

Downtime varies by device and conditions. A one day response time is fine when the device isn't critical, but if there is a snow event, you need that device back up as fast as possible.

Some of the longest downtimes they have experienced have been because of communication issues, which are beyond their control (T1 connections, etc.).

6) *What sort of spare parts supply is maintained for ITS devices? Who maintains this supply? Where is it maintained?*

h. 10% of DMS pixel panels

i. 20% of CPUs and fans, sensors, and power supplies

j. 10% of microwave systems

k. 6 spare Vicon Cameras and 2 Pelco - 82 Vicon and 10 Pelco.

l. Spare fiber

m. A lot of spare HOV equipment since turnaround time is 6 weeks

n. 2 spare motors for HOV gates

District houses the parts, but contractor sends out for repair.

7) *Thoughts on outsourcing Preventative, Response, and Emergency ITS work.*

The Department should do as much as possible, but a contract allows for holiday and weekend support. Internal staffing can be difficult during non-working hours.

It would be nice to do routine maintenance in-house, but to have contractor for emergency support.

In general, internal knowledge is expanding. The model TMC organization would have a TMC technician.

As the systems get larger, the Department will be restricted on how much they are capable to support, and it will become necessary to work with contractors.

8) *What is a reasonable response time to a call out from the Department? Both communications with the Department and arrival on site. Does this vary for emergency and response tasks?*

Response time varies depending on situation and issue. Sometimes, spare parts are the controlling issues. It may not always be reasonable to have all parts for all systems.

9) *What sort of liquidated damages are currently in place for ITS maintenance contracts in your district?*

None.

10) *Does the current configuration of liquidated damages provide for a quality response in your district? In what ways could things be better arranged?*

Things have gone relatively smooth without; there have been in-house problems, which have caused response delays. It was noted that the importance of these contracts has been conveyed, and the problems have been resolved.

11) *Historically, how has ITS maintenance been provided within your District? What are your thoughts on how it has worked?*

Always with contract support.

12) *Do you feel that contractors should have to prequalify? Do you have any experience in this area?*

Yes. See above. It is important the contractor show they have previous experience supporting these devices.

13) *Do you provide any in-house maintenance services? What sort and why?*

- o. Modems
- p. Fiber
- q. Multiplexers
- r. Some field devices
- s. TMC Systems (computers, servers, phone)

The future of an ITS maintenance may include a IT/TMC specialist.

14) *Have you ever been denied services due to contract language?*

No.

15) *These questions are in the interest of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

ITS maintenance works best if you limit the number of brands of device types (within requirements). More brands means more knowledge required, and more spare parts are required. It would be nice to have an approved and limited list of brands.

No CCTVs are NTCIP. Some DMS are, but that does not mean maintenance is the same.

On Tuesday February 19<sup>th</sup>, a teleconference was held to discuss the experiences and practices of ITS maintenance in **District 12-0**. The following were in attendance (via telephone):

- Robb Dean - PennDOT Engineering District 12-0
- Brenda Murphy - PennDOT BHSTE
- Matt Weaver - PennDOT BHSTE
- Bob Taylor - Gannett Fleming, Inc.
- Scott Nale - Gannett Fleming, Inc.

Bob Taylor began the meeting by providing a project overview. After this initial explanation, Robb Dean responded to the following questions:

1) *What types of ITS devices exist in your district?*

- DMS - 2
- HAR - 4
- RWIS - 7
- ATRWS - 1
- Truck Preemption - 1
- Deicing - 1
- ATRs

2) *Number of devices in each District (CCTV, DMS, HAR, other).*

Device	Inventory	Number with Operational Issues
CCTV		
DMS	2	
Semi-permanent DMS		
HAR	4	
RWIS	7	

3) *Number of devices inoperable for more than 48 hours and perspectives why as well as what can be done.*

Everything is working now. The ATRWS, which was installed in 2001, had issues due to a lack of response from the installer/manufacturer. One DMS was down for 3 years because there was no funding or contract for repairs. One HAR was down for 3 years because there was no funding or contract for repairs. Due to a lack of communication, there was a time where the Department could not say if the Truck Preemption system was working.

4) *How do you feel a good ITS maintenance contract would be structured? (i.e., from district/regional/statewide)*

Unique systems (such as ATRWS) should be maintained at the District level. Common systems such as DMS could be maintained at a Regional level since DMS are controlled by 11-0. Regional contracts would have to be structured so that adequate response was provided. Regional contracts may force out smaller contractors.

- 5) *What is an acceptable downtime for an ITS device? Does this vary by type? How would you group devices?*

It depends on device and location. Generally, 48 hours (M-F) from time of notification to response.

Areas that have multiple devices and HAR with Static signs may be considered less important than wig wag HAR signs.

- 6) *What sort of spare parts supply is maintained for ITS devices? Who maintains this supply? Where is it maintained?*

None

- 7) *Thoughts on outsourcing Preventative, Response, and Emergency ITS work.*

2 contracts now:

- DMS
- HAR

Matt Matsko of Transys Services in Bellefonte is the contractor for both.

- 8) *What is a reasonable response time to a call out from the Department? Both communications with the Department and arrival on site. Does this vary for emergency and response tasks?*

48 hours is OK. 24 hours in the contract.

- 9) *What sort of liquidated damages are currently in place for ITS maintenance contracts in your district?*

\$250/day.

- 10) *Does the current configuration of liquidated damages provide for a quality response in your district? In what ways could things be better arranged?*

Not really an issue since most elements are new, and there are limited number of deployments.

- 11) *Historically, how has ITS maintenance been provided within your District? What are your thoughts on how it has worked?*

There wasn't anything until 2006. The current contracts were for one year, but each has been extended four years for a contract end date of 2011. One is for DMS, and one is for HAR. The decision to keep the contracts separate was to get the best bids.

- 12) *Do you feel that contractors should have to prequalify? Do you have any experience in this area?*

Contractor prequalification should be required but was not included in the District 12-0 contracts.

- 13) *Do you provide any in-house maintenance services? What sort and why?*

No.

14) *Have you ever been denied services due to contract language?*

No. Gaps have occurred when there were not any contracts.

15) *These questions are in the interest of making recommendations to the Central Office on the best way to structure ITS maintenance contracts. What additional comments do you have to add to the research?*

None.

Appendix E Existing Contracts Reviewed

Contract 76969

District 4

from 8/1/06 to 7/1/07

Notice to Contractors

Page 1 of 1


Notice to Contractors

[Sales Store Order Forms](#)

Project: ~~76969~~      Let Date: 07/13/2006 11:00 AM  
Moved to 07/27/2006 11:00 AM

Project: ~~76969~~      Let Date: 07/27/2006 11:00 AM

District/County: 04/Lackawanna \$R: 0 Section: Group ID: 4-06-LT2	Posted: 06/14/2006 Addenda Count: 1 State Type of MISCELLANEOUS Work: Cost Range: \$1,000,000.00 - \$4,999,999.99 Structure %: 0 MBE/WBE %: 0/0
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Anticipated NTP: 09/04/2006      Pre-Bid Meeting: None  
 Required 07/01/2007  
 Completion:  
 Project Type: Standard      Bid Files: 

Description: For the maintenance of Highway Lighting in LACKAWANNA, LUZERNE, PIKE, SUSQUEHANNA, WAYNE, AND WYOMING COUNTIES in the COMMONWEALTH OF PENNSYLVANIA. For the cleaning, testing and repair of mercury vapor high pressure sodium and traffic signal lamps for sign lighting and miscellaneous highway lighting and signing systems including replacement repairs and parts replacement. Also emergency traffic signal installation and maintenance as indicated in the approved bid package.

[Back](#)

[http://www.dotdom2.state.pa.us/ecms/ECMS\\_eBidding.nsf/frmNoticeToContractors?OPE...](http://www.dotdom2.state.pa.us/ecms/ECMS_eBidding.nsf/frmNoticeToContractors?OPE...) 2/28/2008

**Description:** For the maintenance of Highway Lighting in LACKAWANNA, LUZERNE, PIKE, SUSQUEHANNA, WAYNE, AND WYOMING COUNTIES in the COMMONWEALTH OF PENNSYLVANIA. For the cleaning, testing and repair of mercury vapor high pressure sodium and traffic signal lamps for sign lighting and miscellaneous highway lighting and signing systems including replacement repairs and parts replacement. Also emergency traffic signal installation and maintenance as indicated in the approved bid package.

**Pros:** Required to give 4 days notice of traffic interruption. Respond within 30 days of call from the Department. Commence repairs in 5 days after receiving written notification or 24 hours after verbal notification for emergency conditions.

**Cons:** No provision in place for emergency traffic interruptions. This is more for high mast lighting than actual ITS components.

**Contract 73352**      **District 5**  
Bid Package

**from 7/18/05 to 1/18/08**  
Page 1 of 1

<b>Bid Package</b>						
Project:	73352	<input type="button" value="Go"/>	Project Team			
Project Status	Dist. County	SR	Section	Group ID	Org Code	Municipality
Construction	05 Lehigh	78	ITS		0500	UPPER MACUNGIE
Short Description : ITS Maintenance						

Version: 1  
 Addenda Count: 0  
 Bid Package Status: [Bids Opened](#)

Description: The description and location of the project is as follows: for the maintenance and/or repair of the existing Intelligent Transportation Systems (ITS) on State Route 78, State Route 22 and State Route [MORE](#)

Project Cost Range: \$500,000.00 - \$999,999.99  
 Federal Project Status: Non - Federal (100% State)  
 MBE/WBE: 0% / 0%

- [+ Plans](#)
- [+ Project Items and Quantities](#)
- [+ Special Provisions](#)
- [+ Attachments](#)
- [+ Proposal Report - Original](#)
- [+ Proposal Report - Current](#)
- [+ Proposal Attachments](#)

Project Type: Standard  
 State Type of Work: MISCELLANEOUS  
 Prequalification Required: Yes

Pre-Bid Meeting: None

Actual Let: 05/19/2005 11:00 AM  
 Anticipated NTP: 07/18/2005  
 Required Completion: 01/18/2008

Additional Information:

Addenda	<input type="button" value="Go"/>	Bid Package Clarification	<input type="button" value="Add"/>
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Created by  
 Charles H. Richards/PennDOT  
 on 03/22/2005 at 09:41 AM

Last Modified by  
 Ecm: System/PennDOT  
 on 04/26/2005 at 12:25 PM

[http://www.dotdom2.state.pa.us/ecms/ECMS\\_eBidding.nsf/fmBidPackage?OpenForm&...](http://www.dotdom2.state.pa.us/ecms/ECMS_eBidding.nsf/fmBidPackage?OpenForm&...) 2/28/2008

**Description:** The description and location of the project is as follows: for the maintenance and/or repair of the existing Intelligent Transportation Systems (ITS) on State Route 78, State Route 22 and State Route 33 in Lehigh and Northampton Counties, State Route 80 in Monroe County and State Route 81 in Schuylkill County at locations specified herein.

**Pros:** Each device is clearly listed and includes supplier address. Information on device communications specifics is also included. Contract includes a list of surplus devices that are available for use by the contractor. Includes warranty of at least 6 months with transfer of remaining warranty to the Department. Includes complete list of what should be checked as



preventative maintenance. Calls for temporary replacement if can not be replaced within 24 hours. Includes 3 different tiers of response - regular, emergency, and on-call time frames.

**Cons:** Each device should also include phone number. Some devices on the list do not include supplier contact information. There are references made to devices, such as CCTV, that are never specified or included in the items list. The items list could be more clear as to the devices included. List of available reserve equipment could be more clear as to what is available. The complete list of preventative maintenance does not include anything on the communications devices or leave room for additional items to be added to the list. References a Preventative Maintenance Checklist, but it isn't included. Direction on snow removal includes no information on frequency or response time. Provisions for utility coordination are included but nothing to get utilities to respond in a timely manner; also no protection for the contractor if the utility companies do not respond.

**Contract 72837**      **District 6**  
Bid Package

**from 2/9/07 to 12/05/08**  
Page 1 of 1

<b>Bid Package</b>						
Project:	72837	<input type="button" value="Go"/>	Project Team			
Project Status	Dist County	SR	Section	Group ID	Org Code	Municipality
<b>Construction</b>	06 Montgomery	76	MAI		0600	UPPER MERION
Short Description: TCC & ITS FIELD INVENTORY - SYSTEMS MAINTENANCE						

Version: 1  
 Addenda Count: 0  
 Bid Package Status: [Bids Opened](#)

**Description:** GENERAL DESCRIPTION

For the construction or improvement of a certain section of STATE HIGHWAY in BUCKS, CHESTER, DELAWARE, MONTGOMERY, AND PHILADELPHIA COUNTIES, CITY OF PHILADELPHIA and VARIOUS TO [MORE](#)

Project Cost Range: \$500,000.00 - \$999,999.99  
 Federal Project Status: PENNDOT Oversight NHS  
 DBE: 0%

- [+ Plans](#)
- [+ Project Items and Quantities](#)
- [+ Special Provisions](#)
- [+ Attachments](#)
- [+ Proposal Report - Original](#)
- [+ Proposal Report - Current](#)
- [+ Proposal Attachments](#)

Project Type: Standard  
 State Type of Work: MISCELLANEOUS  
 Prequalification Required: Yes

Pre-Bid Meeting: None

Actual Let: 11/09/2006 11:00 AM  
 Anticipated NTP: 02/09/2007  
 Required Completion: 12/05/2008

Additional Information: All Addenda will be electronically posted

Addenda	<input type="button" value="Go"/>	Bid Package Clarification	<input type="button" value="Add"/>
<input type="button" value="Back"/>			

Created by  
 Anton K. Kuhner P.E./PennDOT BP-000118  
 on 06/06/2005 at 03:28 PM

Last Modified by  
 Ecms System/PennDOT  
 on 10/13/2006 at 01:46 PM

**Description:** GENERAL DESCRIPTION For the construction or improvement of a certain section of STATE HIGHWAY in BUCKS, CHESTER, DELAWARE, MONTGOMERY, AND PHILADELPHIA COUNTIES, CITY OF PHILADELPHIA and VARIOUS TOWNSHIPS, Commonwealth of Pennsylvania, STATE ROUTE 0076, SECTION MAI. This project being situated as follows: • I-95 just north of PA 420 to just south of Stoney Hill Road • Entire length of I-476 from I-95 to the Turnpike • Entire length of I-676 from I-95 to I-76 • I-76 from US 202 to Waverly Road overpass, I-76 EB near Montgomery Drive, and I-76 WB near Vare Avenue • US 422 from PA Turnpike overpass to approx ¼ mile west of PA 29 • US 202 from just north of Town Center Road to ½ mile south of Boot Road • Business Route 1 at I-95 Interchange • PA 413 at I-95 Interchange • PA 63 (Woodhaven Road) from just west of Knights Road to Millbrook Road • US 13 (Bristol Pike) at PA 63 (Woodhaven Road) interchange For the preventive maintenance, responsive maintenance, and emergency repairs of 101 closed circuit (CCTV) cameras, 12 incident cameras, 47 variable

message signs (VMS) permanent and portable, incident detection system consisting of 10 NB and 10 SB microwave detectors on I-95, 2 WB and 2 EB microwave detectors on I-676, 15 Ramp Meters VIDS on S.R. 202, all fiber communications, Uninterrupted Power Source (UPS), all software and all related equipment cabinets and load centers the Traffic Control Center (TCC) in which houses and operates work stations for CCTV, VMS Communication Systems and enclosures, dial-up and T-1 telephone lines leased from the local telephone company. It is proposed, after execution of the contract, to begin work on the date specified in the Notice to Proceed or as otherwise provided in the specifications, and, after that specified date, to prosecute all of said work so as to complete it 730 days later

**Pros:** Provisions for an Emergency Response coordinator on call at all times. In addition to the work, contractor is responsible for managing the spare parts. Two tiers of operations depending on complexity for temp signals; one in 24 hours, and one in 30 days (as long as functional in 24 hours). There was more detail in the equipment to be managed list. Calls for preventative maintenance twice a year. Included well defined list of preventative maintenance. Includes language to allow for the addition of other devices to the contract as they come online. Calls out preventative maintenance but includes “unless manufacture recommends more”. On call with 24 hour response, has a provision for multiple failure event; Department will determine priority. Includes tips for troubleshooting. Liquidated Damages, nonemergency is \$150 a day, plus tort costs. Department can call out other contractor if nonresponsive at primary contractor’s cost. Emergency signal work is \$400/ hour that no work is performed, after the first 2 hours plus tort costs.

**Cons:** Provision in place that requires 4 day notice of traffic impact which does not match with the required response time, a conflict exists here. Equipment to manage list did not include any contact information. Too much repetition of information in the contract, made it difficult to follow and left the possibility for conflict. Calls for work twice a year but does not designate the schedule. No provision for immediate press notification of traffic impacts.

**Contract 76867**      **District 8**  
 Bid Package

**from 8/28/06 to 6/30/08**  
 Page 1 of 1

Bid Package						
Project:	76867	<input type="button" value="Go"/>	Project Team			
Project Status	Dist	County	SR	Section	Group ID	Org Code Municipality
Construction	08	Dauphin	0	ITS		0800 BERRYSBURG
Short Description: ITS Maint Contract						
Version: 1						
Addenda Count: 1						
Bid Package Status: <a href="#">Bids Opened</a>						
Description: For the maintenance and/or repair of the existing and planned Intelligent Transportation System (ITS) equipment in DAUPHIN, PERRY, LEBANON, CUMBERLAND, LANCASTER, YORK, ADAMS, AND FRANKLIN COUNTIES, V <a href="#">MORE</a>						
Project Cost Range: \$500,000.00 - \$999,999.99			<a href="#">Plans</a> <a href="#">Project Items and Quantities</a> <a href="#">Special Provisions</a> <a href="#">Attachments</a> <a href="#">Proposal Report - Original</a> <a href="#">Proposal Report - Current</a> <a href="#">Plan Sets</a> <a href="#">Addenda</a>			
Federal Project Status: Non - Federal (100% State)						
MBE/WBE: 0% / 0%						
Project Type: Standard						
State Type of Work: MISCELLANEOUS						
Prequalification Required: Yes						
Pre-Bid Meeting: None						
Actual Let: 07/19/2006 11:00 AM						
Anticipated NTP: 08/28/2006						
Required Completion: 06/30/2008						
Additional Information:						
Addenda	<input type="button" value="Go"/>	Bid Package Clarification	<input type="button" value="Add"/>			
<input type="button" value="Back"/>						
Created by Jeff Costanzo/PennDOT on 04/29/2006 at 11:18 AM			Last Modified by Exms System/PennDOT on 05/19/2006 at 01:35 PM			

[http://www.dotdom2.state.pa.us/ecms/ECMS\\_eBidding.nsf/fmBidPackage?OpenForm&...](http://www.dotdom2.state.pa.us/ecms/ECMS_eBidding.nsf/fmBidPackage?OpenForm&...) 2/28/2008

**Description:** For the maintenance and/or repair of the existing and planned Intelligent Transportation System (ITS) equipment in DAUPHIN, PERRY, LEBANON, CUMBERLAND, LANCASTER, YORK, ADAMS, AND FRANKLIN COUNTIES, VARIOUS TOWNSHIPS, in the Commonwealth of Pennsylvania.

**Pros:** Provisions in the contract to allow the contractor to buy parts, pending approval, in order to make repairs and get things up and running. Repairs are to be completed in 2 days. The Department can terminate the contract as a result of non-responsiveness or failure to satisfy time requirements. Calls for an initial survey and report but does not include guidance on what should be examined. Includes specific timelines for preventative maintenance every 3 months. Includes

a good list of the things to accomplish during the maintenance. Includes 3 tiers of response - preventative, responsive, and emergency repairs. Responsive maintenance is to be on site in 24 hours (includes a provision to avoid weekend work). Provision in “responsive maintenance” allows time provisions to get parts from the Department. If responsive maintenance is necessary because of poor preventative maintenance, no payment. Same for non-responsiveness. If not satisfied by response or results, Department may call out other forces at the cost of the contractor. Emergency response is within 4 hours of contact.

**Cons:** A list of supported items is not included in the contract. This should be a part of the document.

Contract 72263

District 11

from 9/6/05 to 9/30/08

Bid Package Page 1 of 1

**Bid Package**

Project:	72263	CU					Project Team
Project Status:	Dist	County	SR	Section	Group ID	Org Code	Municipality
Construction	11	Allegheny	0	ITS	Maintenance	1100	PITTSBURGH
Short Description: ITS Maintenance 2005							

Version: 1  
Addenda Count: 1  
Bid Package Status: [Bids Opened](#)

**Description:** The description and location of the project is as follows: Routine maintenance and on-call repair of closed circuit television cameras, various intelligent transportation system (ITS) related cabinet. [MORE](#)

Project Cost Range: \$500,000.00 - \$999,999.99 Federal Project Status: Non - Federal (100% State) MBE/WBE: 0% / 0%	<ul style="list-style-type: none"> <li><a href="#">Plans</a></li> <li><a href="#">Project Items and Quantities</a></li> <li><a href="#">Special Provisions</a></li> <li><a href="#">Attachments</a></li> <li><a href="#">Proposal Report - Original</a></li> <li><a href="#">Proposal Report - Current</a></li> <li><a href="#">Proposal Attachments</a></li> <li><a href="#">Addenda</a></li> </ul>
---	--

Project Type: Standard  
 State Type of Work: MISCELLANEOUS  
 Prequalification Required: Yes

Pre-Bid Meeting: None

Actual Let: 07/07/2005 11:00 AM  
 Anticipated NTP: 09/06/2005  
 Required Completion: 09/30/2005

**Additional Information:** This is an ECMS project. Addenda to this proposal for this project will be electronically posted. Place for delivery of diskettes bid before 11:00 A.M. Prevailing Local Time on the scheduled let date:

PENNDOT BID ROOM 6TH FLOOR  
 COMMONWEALTH KEYSTONE BUILDING  
 400 NORTH STREET  
 HARRISBURG, PA 17120

Addenda:  Bid Package Certification:

Viewed by: William E. Hines/FarmDOT on 05/29/2008 at 10:31 AM  
 List Modified by: Eric S. Yonker/FarmDOT on 05/29/2008 at 02:51 PM

http://www.dtdom2.state.pa.us/ecms/ECMS\_eBidding.nsf/frmBidPackage?OpenForm&... 2/28/2008

**Description:** For the maintenance and/or repair of the existing and planned Intelligent Transportation System (ITS) equipment in Allegheny, in the Commonwealth of Pennsylvania.

**Pros:** On-call services require an on-site presence in 24 hours for both TMC and field repairs.

**Cons:** Individual specifications make the contract large and difficult to negotiate. On-call services have only one timeline; no provisions for regular, on call, and emergency response like the other contracts have.



**Appendix F ITS Maintenance Briefing – February 2008**

**1. CURRENT MAINTENANCE AGREEMENTS:**

Dist.	ECMS	Contractor	Current Amount	Award Date	Expiration
1-0		BRUCE & MERRILEES ELECTRIC CO	\$27,085.00	07/25/2007	06/30/2008
2-0		TRANSYS SERVICES CO LLC	\$62,770.00	09/13/2007	06/30/2009
3-0		TRANSYS SERVICES CO LLC	\$21,484.00	04/11/2007	06/30/2008
4-0	80729	Kuharchik Construction, Inc.	\$400,100.00	10/01/2007	12/31/2008
5-0	79954	Bruce - Merrilees Electric Company	\$608,723.00	05/25/2007	01/03/2010
6-0	72837	Carr & Duff Inc.	\$1,258,634.00	12/06/2006	12/05/2008
8-0	76867	Kuharchik Construction, Inc.	\$565,750.00	07/21/2006	06/30/2008
9-0		FIBEROPTIC DISPLAY SYSTEMS INC	\$15,600.00	05/21/2007	06/30/2008
9-0		SIGNAL SERVICE INC	\$97,054.00	04/18/2005	06/30/2009
9-0		TRANSYS SERVICES CO LLC	\$166,000.00	07/12/2007	06/30/2012
10-0	82206	Bruce - Merrilees Electric Company	\$984,211.03	12/20/2007	01/14/2011
11-0	72263	Bronder Technical Services, Inc	\$1,122,754.56	07/18/2005	09/30/2008
12-0		TRANSYS SERVICES CO LLC	\$476,484.68	03/16/2006	03/15/2011

**2. PLANNED MAINTENANCE AGREEMENTS:**

Dist.	ECMS	Est. Cost	Est. Let Date
4-0	81042	\$450,000.00	09/25/2008
8-0	81330	\$1,125,000.00	06/05/2008
11-0	83138	\$800,000.00	06/19/2008

**3. ITS MAINTENANCE RESEARCH PROJECT:**

- a. Consultant-Gannett Fleming, Inc.
- b. Agreement-355I01
- c. Current Budget-\$15,940.01
- d. General Scope of Work
  - i. Researching National Best Practices
  - ii. Researching current District practices
  - iii. Evaluating current District practices against National Best Practices
  - iv. Establishing standardized practices statewide
- e. Products to be Delivered
  - i. List of ITS devices currently inoperable for more than 48 hours



- ii. Summary report of existing and best practices
  - iii. Guide contract for District use
  - f. Anticipated Completion-04/30/2008
4. ITS DEVICES UPTIME REPORTING PROCESS
- a. Policy Established-January 16, 2008
  - b. Recommendation from PennDOT AAR of Valentine's Day 2007 Winter Storm
  - c. Districts report total "down" hours on a weekly basis
    - i. Permanent DMSs
    - ii. Semi-Permanent DMSs
    - iii. HARs
    - iv. CCTV Cameras
  - d. Official reporting began with February 5-11, 2008 reporting period (unofficial reporting by some Districts since November 2007)
  - e. Target-90% Uptime

**Appendix G ITS Maintenance Checklists**



Semi Annual Maintenance Checklist

Technician \_\_\_\_\_  
 ID # \_\_\_\_\_  
 ITS # \_\_\_\_\_

CCTV System  
 Location \_\_\_\_\_  
 Date \_\_\_\_\_

G = Good  
 N/G = Not good or in need of repair

### General

Task	Condition		Comments
Check clearance of tree branches or brush around power and communication lines, report required tree trimming and/or brush clearing work	G	N/G	
Test communications system	G	N/G	
Check bolts for rust and tightness	G	N/G	
Clean, repaint, and repair as necessary	G	N/G	
Check battery group voltage	G	N/G	
Clean and fill batteries	G	N/G	
Test battery charging system	G	N/G	
Thoroughly clean solar panels that power the battery packs	G	N/G	

### CCTV Assembly

Task	Condition		Comments
Perform preventative maintenance in accordance with the manufactures recommendations and as follows:	G	N/G	
Inspect camera poles/trailers for wear, rust, cracks, and missing, damaged, or bent sections	G	N/G	
Inspect camera housings for wear, rust, cracks, loose connections, and frayed cables.	G	N/G	
Check for missing, damaged or bent parts	G	N/G	
Check attachment hardware	G	N/G	
Clean cameras	G	N/G	
Check camera alignment	G	N/G	
Check for wear on the connection wires and mechanical hardware	G	N/G	
Check mast arms for deterioration, damage or visual failure	G	N/G	
Check for cracks or rust in the hardware	G	N/G	
Replace defective camera equipment	G	N/G	
Check hoods, wing nuts and hinges	G	N/G	
Replace substandard hardware	G	N/G	
Check locking rings, install proper locking devices as required	G	N/G	
Repaint camera housings (if painted every 6 months)	G	N/G	
Check lowering system operations	G	N/G	

### Junction Boxes and Handholes

Task	Condition		Comments
Check integrity of all splices	G	N/G	
Check the ground rod, clamp connection, and bonding of conduits	G	N/G	
Check the insulation	G	N/G	
Check for abnormal amount of water	G	N/G	
Check lid for abnormal condition and fit	G	N/G	



Semi Annual Maintenance Checklist

CCTV System

Technician \_\_\_\_\_  
 ID # \_\_\_\_\_  
 ITS # \_\_\_\_\_

Location \_\_\_\_\_  
 Date \_\_\_\_\_

G = Good  
 N/G = Not good or in need of repair

**Poles**

Task	Condition		Comments
Check alignment of mast arms	G	N/G	
Inspect poles, transformer bases, and arms for damage caused by impact with vehicles	G	N/G	
Inspect for rust; spot paint as required	G	N/G	
Inspect joints for rust and cracks at arm/upright location and at base plate	G	N/G	
Inspect horizontal and vertical angles of arms	G	N/G	
Inspect anchor bolts for rust and tightness	G	N/G	
Repaint exterior ( every 2 to 5 years)	G	N/G	

**Control Cabinet**

Task	Condition		Comments
Lubricate hinges, locks, and latches	G	N/G	
Clean or replace filters	G	N/G	
Vacuum Cabinet	G	N/G	
Remove accumulated dust	G	N/G	
Check weatherproof seals	G	N/G	
Check anchor bolts for rust or tightness	G	N/G	
Check for water accumulation and check duct sealant	G	N/G	
Check ground rod clamp and wire	G	N/G	
Check wiring schematics and records	G	N/G	
Check operation of fan and heater	G	N/G	
Check radio interference filter and lightning arrestor	G	N/G	
Check circuit breaker and fuses	G	N/G	
Check ground fault receptacle	G	N/G	
Measure voltages at service inputs in cabinet	G	N/G	
Check and record electrical current being drawn	G	N/G	
Repaint exterior (every 2-5 years)	G	N/G	
Remove any snow or brush from doorway opening or area surrounding cabinet	G	N/G	
Test ground rods for 25 ohms or less resistance utilizing fall of potential test	G	N/G	
Service air conditioner, fans, and heater controls	G	N/G	
Test power and communications line surge suppressors and replace as necessary	G	N/G	
Inspect all connections, cabling, and physical appearance of the equipment within the cabinets	G	N/G	
Perform local diagnostics on all applicable equipment	G	N/G	
Tighten any loose wire connections	G	N/G	



Semi Annual Maintenance Checklist

DMS System

Technician \_\_\_\_\_  
 ID # \_\_\_\_\_  
 ITS # \_\_\_\_\_

Location \_\_\_\_\_  
 Date \_\_\_\_\_

G = Good  
 N/G = Not good or in need of repair

**General**

Task	Condition		Comments
Clean, repaint, and repair as necessary	G	N/G	
Check clearance of tree branches or brush around power and communication lines, report required tree trimming and/or brush clearing work	G	N/G	
Check attachment hardware and replace as needed	G	N/G	
Check anchor bolts for rust and tightness	G	N/G	
Check circuit breakers to confirm proper operations	G	N/G	
Check battery group voltage	G	N/G	
Clean and fill batteries	G	N/G	
Test battery charging system	G	N/G	
Thoroughly clean solar panels that power the battery packs	G	N/G	

**DMS Assembly**

Task	Condition		Comments
Perform preventative maintenance in accordance with the manufactures recommendations and as follows:	G	N/G	
Inspect for general condition, wear, rust, cracks, loose connections, frayed cables, damage caused by (lightning, leaning, car impacts, vandalism)	G	N/G	
Note and replace any missing, damaged, or bent parts	G	N/G	
Clean display boards	G	N/G	
Check locking rings, install proper locking devices as required	G	N/G	
Check for cracks or rust in the hardware	G	N/G	
Check hoods, wing nuts and hinges	G	N/G	
Run test message	G	N/G	
Check trailer for cracks, rust and wear	G	N/G	
Check anchoring system	G	N/G	
Check antenna for proper communications	G	N/G	
Check catwalks and handrails for failure and deterioration	G	N/G	
Lube latches, locks and hinges	G	N/G	
Check for wear on the connection wires and mechanical hardware	G	N/G	
Check sign board alignment	G	N/G	
Check surge suppression systems to confirm proper operations	G	N/G	
Check gaskets for water filtration and deterioration	G	N/G	

**Junction Boxes and Handholes**

Task	Condition		Comments
Check integrity of all splices	G	N/G	
Check the ground rod, clamp connection, and bonding of conduits	G	N/G	
Check the insulation	G	N/G	
Check for abnormal amount of water	G	N/G	
Check lid for abnormal condition and fit	G	N/G	



Semi Annual Maintenance Checklist

DMS System

Technician \_\_\_\_\_  
 ID # \_\_\_\_\_  
 ITS # \_\_\_\_\_

Location \_\_\_\_\_  
 Date \_\_\_\_\_

G = Good  
 N/G = Not good or in need of repair

**Poles**

Task	Condition		Comments
Check alignment of mast arms	G	N/G	
Inspect poles, transformer bases, and arms for damage caused by impact with vehicles	G	N/G	
Inspect for rust; spot paint as required	G	N/G	
Inspect joints for rust and cracks at arm/upright location and at base plate	G	N/G	
Inspect horizontal and vertical angles of arms	G	N/G	
Inspect anchor bolts for rust and tightness	G	N/G	
Repaint exterior ( every 2 to 5 years)	G	N/G	
Check mast arms for deterioration, damage or visual failure	G	N/G	

**Control Cabinet**

Task	Condition		Comments
Lubricate hinges, locks, and latches	G	N/G	
Clean or replace filters	G	N/G	
Vacuum Cabinet	G	N/G	
Remove accumulated dust	G	N/G	
Check weatherproof seals	G	N/G	
Check anchor bolts for rust or tightness	G	N/G	
Check for water accumulation and check duct sealant	G	N/G	
Check ground rod clamp and wire	G	N/G	
Check wiring schematics and records	G	N/G	
Check operation of fan and heater	G	N/G	
Check radio interference filter and lightning arrestor	G	N/G	
Check circuit breaker and fuses	G	N/G	
Check ground fault receptacle	G	N/G	
Measure voltages at service inputs in cabinet	G	N/G	
Check and record electrical current being drawn	G	N/G	
Repaint exterior (every 2-5 years)	G	N/G	
Remove any snow or brush from doorway opening or area surrounding cabinet	G	N/G	
Test ground rods for 25 ohms or less resistance utilizing fall of potential test	G	N/G	
Service air conditioner, fans, and heater controls	G	N/G	
Test power and communications line surge suppressors and replace as necessary	G	N/G	
Inspect all connections, cabling, and physical appearance of the equipment within the cabinets	G	N/G	
Perform local diagnostics on all applicable equipment	G	N/G	
Tighten any loose wire connections	G	N/G	



Semi Annual Maintenance Checklist

HAR System

Technician \_\_\_\_\_  
 ID # \_\_\_\_\_  
 ITS # \_\_\_\_\_

Location \_\_\_\_\_  
 Date \_\_\_\_\_

G = Good  
 N/G = Not good or in need of repair

**General**

Task	Condition		Comments
	G	N/G	
Clean, repaint, and repair as necessary	G	N/G	
Check clearance of tree branches or brush around power and communication lines, report required tree trimming and/or brush clearing work	G	N/G	
Check attachment hardware	G	N/G	
Check anchor bolts for rust and tightness	G	N/G	
Check circuit breakers to confirm proper operations	G	N/G	
Test battery charging system	G	N/G	
Check battery group voltage	G	N/G	
Clean and fill batteries	G	N/G	
Thoroughly clean solar panels that power the battery packs	G	N/G	

**HARS Assembly**

Task	Condition		Comments
	G	N/G	
Perform preventative maintenance in accordance with the manufactures recommendations and as follows:	G	N/G	
Inspect for general condition, wear, rust, cracks, loose connections, frayed cables, damage caused by (lightning, leaning, car impacts, vandalism)	G	N/G	
Note and replace any missing, damaged, or bent parts	G	N/G	
Clean, repaint, and repair as necessary	G	N/G	
Verify the broadcast signal strength of the HAR transmitter via the dials located on the front panel	G	N/G	
Verify that the HAR transmitter is clearly transmitting a signal by utilizing a car radio and turning the dial to the appropriate channel	G	N/G	
Test communication system	G	N/G	
Test all static sign flashing warning devices associated with the HAR systems, check batteries, clean controller cabinet and solar panels	G	N/G	

**Junction Boxes and Handholes**

Task	Condition		Comments
	G	N/G	
Check integrity of all splices	G	N/G	
Check the ground rod, clamp connection, and bonding of conduits	G	N/G	
Check the insulation	G	N/G	
Check for abnormal amount of water	G	N/G	
Check lid for abnormal condition and fit	G	N/G	



Semi Annual Maintenance Checklist

HAR System

Technician \_\_\_\_\_  
 ID # \_\_\_\_\_  
 ITS # \_\_\_\_\_

Location \_\_\_\_\_  
 Date \_\_\_\_\_

G = Good  
 N/G = Not good or in need of repair

**Poles**

Task	Condition		Comments
Check alignment of mast arms	G	N/G	
Inspect poles, transformer bases, and arms for damage caused by impact with vehicles	G	N/G	
Inspect for rust; spot paint as required	G	N/G	
Inspect joints for rust and cracks at arm/upright location and at base plate	G	N/G	
Inspect horizontal and vertical angles of arms	G	N/G	
Inspect anchor bolts for rust and tightness	G	N/G	
Repaint exterior ( every 2 to 5 years)	G	N/G	
Check mast arms for deterioration, damage or visual failure	G	N/G	

**Control Cabinet**

Task	Condition		Comments
Lubricate hinges, locks, and latches	G	N/G	
Clean or replace filters	G	N/G	
Vacuum Cabinet	G	N/G	
Remove accumulated dust	G	N/G	
Check weatherproof seals	G	N/G	
Check anchor bolts for rust or tightness	G	N/G	
Check for water accumulation and check duct sealant	G	N/G	
Check ground rod clamp and wire	G	N/G	
Check wiring schematics and records	G	N/G	
Check operation of fan and heater	G	N/G	
Check radio interference filter and lightning arrestor	G	N/G	
Check circuit breaker and fuses	G	N/G	
Check ground fault receptacle	G	N/G	
Measure voltages at service inputs in cabinet	G	N/G	
Check and record electrical current being drawn	G	N/G	
Repaint exterior (every 2-5 years)	G	N/G	
Remove any snow or brush from doorway opening or area surrounding cabinet	G	N/G	
Test ground rods for 25 ohms or less resistance utilizing fall of potential test	G	N/G	
Service air conditioner, fans, and heater controls	G	N/G	
Test power and communications line surge suppressors and replace as necessary	G	N/G	
Inspect all connections, cabling, and physical appearance of the equipment within the cabinets	G	N/G	
Perform local diagnostics on all applicable equipment	G	N/G	
Tighten any loose wire connections	G	N/G	





# Quick Clearance Best Practices

(Subtask E.6)

April 6, 2009



***Gannett Fleming***



Pennsylvania Department of Transportation,  
Bureau of Planning and Research  
Project Number 060908

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## 1. Executive Summary

A comprehensive review of literature that included such information sources as the I-95 Corridor Coalition Website, the Federal Highway Administration Website, and many State Department of Transportation Websites along with Pennsylvania stakeholder interviews and interviews of five states that had strong incident management and quick clearance efforts resulted in the following suggested action items.

Suggested Executive Actions	Suggested Sub-tasks
Evaluate the Need for Changes in Legislation	<ul style="list-style-type: none"> <li>• Driver Removal Law Examination</li> <li>• Consider the Need to Strengthen Hold-Harmless Language in Existing Laws</li> </ul>
Consider the Establishment of an Incident Management Program	<ul style="list-style-type: none"> <li>• Consider Implementing an Incident Management Policy</li> <li>• Consider establishing incident management memorandums of understanding with PSP</li> <li>• Consider developing an incident management Strategic Plan</li> <li>• Consider continuing and expanding the freeway service patrol program</li> <li>• Evaluate the benefit of implementing an incident management module into the Road Condition Reporting System</li> <li>• Consider implementing incident management performance metrics</li> <li>• Consider providing oversight and guidelines for work zone incident management plans</li> <li>• Facilitate the completion of FHWA’s TIM Self Assessment on an annual basis</li> </ul>
Evaluate the Expansion Capabilities for Training and Outreach Efforts	<ul style="list-style-type: none"> <li>• Develop and disseminate a PennDOT Incident Management Brochure</li> <li>• Dedicate a portion of the PennDOT website to become a focal point for Pennsylvania Quick Clearance information and outreach efforts</li> <li>• Coordinate and hold 11 Saturday Incident Management Symposiums</li> <li>• Require District Incident/Emergency Management Coordinators to attend two county EMA coordination meetings per year</li> <li>• Provide quick clearance training opportunities by nationally recognized experts</li> <li>• Establish a relationship with the Pennsylvania Chiefs of Police Association</li> </ul>
Consider Facilitating the Improvement of the Towing and Recovery Qualification Process	<ul style="list-style-type: none"> <li>• Facilitate coordination efforts between the PSP and the Pennsylvania Towing Industry</li> <li>• 29% Shared with Traffic Engineering</li> <li>• 65% Shared with Maintenance Forces</li> </ul>
Consider developing regional partnerships to seek incident management funding	<ul style="list-style-type: none"> <li>• Investigate relationships and grant opportunities from the Department of Homeland Security</li> </ul>

## 2. Introduction

Ensuring that the traveling public experiences the least amount of delay due to non-recurring congestion while providing first responders with the greatest amount of safety possible is the essence of quick clearance. As the National Incident Management System (NIMS) describes, the first objective of any emergency is responder safety.

### 2.1 Background and Purpose

With regard to quick clearance policies and research, many engineering research groups such as the American Association of State Highway Officials (AASHTO) and the National Highway Cooperative Research Program (NCHRP) have conducted efforts in hopes of identifying practices that will reduce the amount of delay experienced by vehicles waiting in the queue after a crash has occurred.

#### Evaluation Questions

- What are other States doing?
- What laws are there?
- What does Federal guidance suggest?
- What is Pennsylvania doing?
- What are the best practices?
- What resources are there?
- What is the law enforcement community doing?
- What should PA consider doing?

Likewise, the law enforcement community has gone to great lengths to emphasize officer safety and best practices for responding to situations on the roadway network. For its part, the Federal Highway Administration (FHWA) has dedicated a portion of its website to traffic incident management (TIM), <http://www.ops.fhwa.dot.gov/incidentmgmt/>. Additionally, in the 2003 edition of the Manual on Uniform Traffic Control Devices (MUTCD), Chapter 6I is devoted to proper signing for emergency scenes and some guidance on the use of emergency vehicle lighting.

Finally, some individual states such as Florida, Kentucky, and Washington have been dedicated to establishing quick clearance policies and laws along with the I-95 Corridor Coalition. The I-95 Corridor Coalition, an alliance of transportation organizations along the eastern US Coast and Canada, has provided support for many quick clearance efforts including training, awareness, resource compilation, and other activities.

The sum of all of these efforts will hopefully result in saved lives and a reduction in lost time.

## 2.2 Contacts

This task was performed as part of the PennDOT Bureau of Planning and Research, Project Number 060908. The following are the task and contract contacts:

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## 2.3 Disclaimer

The contents do not necessarily reflect the official views or policies of the Pennsylvania Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

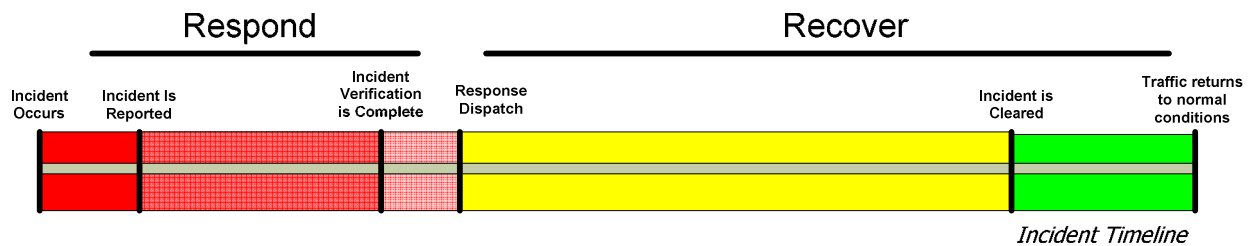
## 3. The Need to Quickly Clear Incidents

The idea of having an approach to quickly clearing incidents falls within the larger context of incident response and recovery, specifically in gaining and maintaining situational awareness. While transportation agencies implement devices, systems, and procedures to address non-recurring congestion, proper quick clearance policies and practices can reduce the amount of spending needed on these devices and systems.

Non-recurring congestion creates the largest challenge for the job of getting and maintaining situational awareness. Since adverse weather rarely causes more than regional effects on road surface conditions, strategically placed ITS devices combined with correct field personnel positioning can provide continuous knowledge of the condition of road segments in a relatively large area. Likewise, recurring congestion that typically affects the urban areas of the Commonwealth is chronicled and can be predicted based on historical experiences and identified trends for the future. In these cases, ITS devices and proper personnel policies are also effective. However, non-recurring congestion is the exact opposite of adverse road surface conditions and non-recurring congestion. In that case, a concentrated effort is required for systems and personnel at a specific location on the road network. Also, the slightest ambiguity in policy can strain the situation in undesired ways.

### 3.1 How is Situational Awareness Improved?

Focusing on non-recurring congestion, traffic crashes and the time that it takes to verify, respond to, and recover from them is one of the most critical areas for maintaining situational awareness. Consider the incident timeline shown below:



On the graphic above, situational awareness is gained at the time incident verification is complete. So an initial improvement in situational awareness is obtained by reducing the time between “Incident is Reported” and “Incident Verification is Complete”.

For the type of incidents like the one described above, maintaining situational awareness is the knowledge gained from the progress of physically dispatched response personnel. The status of the recovery process is passed onto motorists and potential travelers through diversion and incident messages posted on dynamic message signs, through telephone access, and through internet access. **Effective quick clearance policies and procedures improve situational awareness by reducing the time to recover from an incident affecting the roadway.**

#### 4. Literature Review

As stated in the Introduction, there are two main focus areas with regard to quickly clearing traffic incidents: increase the safety of responders and reduce the amount of time that citizens spend waiting in traffic queues. To develop the definition of efforts in both of these focus areas six documents and two online resources were examined to establish what the current environment is for quick clearance practices; each is shown in the table below with a small excerpt from the text to examine how quick clearance is defined.

Document Reviewed	Summary of Definition of Quick Clearance
NCHRP 318: Safe and Quick Clearance of Traffic Incidents, Published 2003	<ul style="list-style-type: none"> <li>The practice of rapidly and safely removing temporary obstructions from the roadway.</li> </ul>
National Traffic Incident Management Coalition Strategic Plan 2009-2013, Published 2008	<ul style="list-style-type: none"> <li><i>Strategy 10. Multidisciplinary TIM Procedures.</i> Traffic Incident Management partners at the state, regional and local levels should develop and adopt multidisciplinary procedures for coordination of Traffic Incident Management operations, based on national recommended practices and procedures.</li> <li><i>Strategy 11. Response and Clearance Time Goals.</i> Traffic Incident Management partners at the state, regional and local levels should commit to achievement of goals for traffic incident response and clearance times.</li> <li><i>Strategy 12. 24/7 Availability.</i> Traffic Incident Management responders and resources should be available 24/7.</li> </ul>

Document Reviewed	Summary of Definition of Quick Clearance
I-95 Corridor Coalition Coordinated Incident Management Toolkit for Quick Clearance, Published 2007	<ul style="list-style-type: none"> <li>▪ Active quick clearance legislation efforts that focus on responder safety and reduction of liability.</li> <li>▪ Implementation of Open Roads Policies.</li> <li>▪ Focus on interagency training and policies.</li> <li>▪ Field best practices for safety and standardization.</li> </ul>
FHWA Incident Management Performance Measures, Published 2002	<ul style="list-style-type: none"> <li>▪ The number of service patrol assists;</li> <li>▪ The average elapsed time from incident occurrence to detection;</li> <li>▪ The average elapsed time from the point at which the incident response team is called out until its arrival on-scene; and</li> <li>▪ The average elapsed time to normal traffic flow restoration.</li> </ul>
US Fire Administration Traffic Incident Management Systems, Published 2008	<ul style="list-style-type: none"> <li>▪ Concentrate all responders into a unified approach</li> <li>▪ Ensure proper safety for responders</li> <li>▪ Use ITS Devices to increase safety</li> <li>▪ Use responder indication lights correctly</li> </ul>
Washington State DOT and Patrol Joint Operations Policy, Published 2008	<ul style="list-style-type: none"> <li>▪ Increased responder safety</li> <li>▪ Shorter incident duration and improved traffic control</li> <li>▪ Reductions in secondary collisions and societal costs of congestion</li> </ul>
FHWA Operations Website	<ul style="list-style-type: none"> <li>▪ Timely and prudent clearance of incidents involving commercial vehicles.</li> <li>▪ Considerations as the potential for hazards associated with the load and the availability of appropriate towing and recovery equipment and personnel.</li> </ul>
A National Review of Best Practice Traffic Incident Management Quick Clearance Laws, December 2008	<ul style="list-style-type: none"> <li>▪ Quick clearance is the practice of rapidly and safely removing temporary obstructions – including disabled or wrecked vehicles, debris, and spilled cargo – from the roadway to increase safety of incident responders by minimizing their exposure to adjacent passing traffic, reduce the probability of secondary incidents, and relieve overall congestion levels and delay.</li> </ul>

#### 4.1 The Bottom Line of the Literature Review

Through all of the resources that were reviewed, below is the summary of what quick clearance involves as it applies to PennDOT’s Bureau of Highway Safety and Traffic Engineering (BHSTE).

PennDOT BHSTE Area of Concern	Summary of Applicable Quick Clearance Focal Area
Risk Management and Tort Liability	Coordination and review of laws as well as coordination with LTAP efforts
Crash Statistics	Metrics that track the effects of implemented policies and procedures on reducing lane blockages
Incident Management	Focus on safety of responders and increasing the efficiency of recovery efforts
Operations	Reducing the amount of time that incidents block travel lanes
Emergency Management	Increasing the efficiency of response and recovery efforts
Work Zone Safety	Development of standards and training materials that promote responder safety and fast removal of lane blockages
Traffic Signals	No specific items identified

#### 5. Quick Clearance Legislation

According to the 2003 NCHRP 318, 21 states had legislation that contained provisions for authority removal law or authority tow law, while four states had both. At the time, 38 states had legislation that included provisions that require drivers to stop when an incident occurs or for drivers to remove their vehicles when a traffic incident occurs, while ten states have laws for both.

There are four categories of Quick Clearance legislation

- Driver stop law
- Driver removal law
- Authority removal law
- Authority tow law

For marketing purposes, these laws are commonly grouped and referred to as “Move It” Laws

##### 5.1 Driver Stop Laws

NCHRP 318 states that these types of laws are the oldest type of quick clearance laws. The basic components of a Driver Stop Law include clauses that:

- ✓ Pertain to drivers involved in a crash
- ✓ Drivers must stop their vehicles in a way that affects traffic the least amount possible.



Most stop laws are created around the Uniform Vehicle Code, published by the National Committee on Uniform Traffic Laws and Ordinances.

**Stop Law Model Text  
Uniform Vehicle Code, Section 10-103**

The driver of any vehicle involved in an accident resulting only in damage to a vehicle or other property which is driven or attended by any person shall immediately stop such vehicle at the scene of such accident or as close as possible, but shall forthwith return to and in every event shall remain at the scene of such accident until he has fulfilled the requirements of [Section] 10-104. *Every such stop shall be made without obstructing traffic more than is necessary* (emphasis added). Any person failing to stop or comply with said requirements under such circumstances shall be guilty of a misdemeanor and, upon conviction, shall be punished as provided in [Section] 17-101.

Pennsylvania has a stop law and it can be found in Title 75 of the Pennsylvania Code.

**Pennsylvania Stop Law  
Vehicle Code (Title 75), Chapter 37, Section 3743**

The driver of any vehicle involved in an accident resulting only in damage to a vehicle or other property which is driven or attended by any person shall immediately stop the vehicle at the scene of the accident or as close thereto as possible but shall forthwith return to and in every event shall remain at the scene of the accident until he has fulfilled the requirements of section 3744 (relating to duty to give information and render aid). Every stop shall be made without obstructing traffic more than is necessary.

As can be seen above, Pennsylvania's Stop Law is closely aligned with the Model Text published in the Uniform Vehicle Code for incidents that do not cause injuries or fatalities. The Pennsylvania Code further defines its Stop Law as shown below.

**Pennsylvania Stop Law  
Vehicle Code (Title 75), Chapter 37, Section 3742**

The driver of any vehicle involved in an accident resulting in injury or death of any person shall immediately stop the vehicle at the scene of the accident or as close thereto as possible but shall then forthwith return to and in every event shall remain at the scene of the accident until he has fulfilled the requirements of section 3744 (relating to duty to give information and render aid). Every stop shall be made without obstructing traffic more than is necessary.

Although defined separately, the statutes referring to both non-injury and injury incidents are very similar.

## 5.2 Driver Removal Laws

Driver removal laws are typically designed to address vehicle disablements, property damage only crashes, and injury crashes where serious personal injuries are not apparent. According to the NCHRP 318, a strong driver removal law will address the following:

- ✓ Incident type
- ✓ Incident severity
- ✓ Type of roadway facility where the incident occurs
- ✓ Lateral location of the incident
- ✓ Specification of who may move a disabled or wrecked vehicle
- ✓ Specification of where to move a vehicle blocking traffic
- ✓ Specification of immobilized vehicle handling
- ✓ Specification of a hold harmless clause.

Pennsylvania does not have a Driver Removal Law. Many of the documents reviewed as part of this task including the National Traffic Incident Management Coalition and US Fire Marshal's documents site the lack of a hold harmless clause as a key weakness to many of the driver removal laws in place.

### 5.3 Authority Removal Laws

These type of laws usually identify agencies that are authorized to remove driver attended disabled vehicles or spilled cargo (non-HAZMAT) that impede traffic flow. These laws are also where the authorization for service patrols to move vehicles is typically partially drawn from. A key component of an authority removal law for DOTs to be aware of is that the responsibility of the agency to remove vehicles from traffic lanes as soon as possible is established.

According to the NCRP 318, the elements of a strong authority removal law are equivalent to the elements of a driver removal law. Pennsylvania has an authority removal law, shown below.

#### Pennsylvania Authority Removal Law Vehicle Code (Title 75), Chapter 37, Section 3743.1

Immediately following an accident, a police officer may remove or direct removal of spilled cargo from any roadway to the nearest point off the roadway where the spilled cargo will not interfere with or obstruct traffic.

(b) Storage of cargo.—When, in the opinion of a police officer, it is necessary to protect the contents, load or spilled cargo of a wrecked vehicle from the elements, spoilage or theft, the police officer may remove or direct the removal of the contents or load or spilled cargo and have the same stored, at the expense of the owner, at the nearest practical place of storage.

(c) Liability for damage or loss.—In carrying out the provisions of this section, no liability shall attach to the police officer or, absent a showing of gross negligence, to any person acting under the direction of the police officer for damage to or loss of any portion of the contents or load or spilled cargo.

#### Pennsylvania Authority Removal Law Vehicle Code (Title 75), Chapter 37, Section 3745.1

(c) Police officers.—A police officer may immediately remove or direct removal of a wrecked vehicle if the owner or operator cannot remove the wrecked vehicle or refuses or fails to have the vehicle removed as required under this section. In carrying out the provisions of this subsection, no liability shall attach to the police officer or, absent a showing of gross negligence, to any person acting under the direction of the police officer for damage to any vehicle or damage to or loss of any portion of the contents of the vehicle.

(d) No liability.—The driver or any other person who has removed a vehicle from the roadway as provided in this section before the arrival of a law enforcement officer shall not be considered liable or at fault regarding the cause of the accident solely by reason of moving the vehicle pursuant to this section.

### 5.4 Authority Tow Laws

According to NCHRP 318, an authority tow law accomplishes the same goal as an authority removal law with regard to the maintenance of open roads. However, an authority tow law emphasizes the removal of driver-attended disabled or wrecked vehicles from the highway right-of-way to a legal parking area or other area of safe refuge. Select states, including Pennsylvania, have expanded the law to include the removal of spilled cargo from a highway right-of-way. In certain cases, incident responders may apply an authority tow law when drivers or cargo owners cannot provide for the timely removal of an incapacitated vehicle or spilled cargo located on, and perhaps previously moved to, the shoulder. Pennsylvania's Tow Authority Law is also described by the statutes cited above.

## 5.5 The Bottom Line of Quick Clearance Legislation

Pennsylvania has three of the four types of legislation described by many of the reference materials used for this task. The notable missing statute is a Driver Removal Law. The criteria for a strong Driver Removal Law is described as similar to Driver Stop Laws, which Pennsylvania has. Still the passage of a Driver Removal Law may be a good opportunity to strengthen hold harmless clauses, as was described as a weakness in most quick clearance legislation by the NCHRP 318 and other reference documents used as part of this task.

## 6. National Best Practices

While no two Incident Management programs are alike, reviewing and incorporating lessons learned from other States is valuable. As stated previously, quick clearance policies and procedures fall within a more broad incident management program. As will be shown in this section, successful incident management programs have some typical commonalities and those common themes also apply to their quick clearance efforts:

- ✓ Good inter-agency communications protocols
- ✓ Cross training of personnel
- ✓ Support at all levels of State government
- ✓ A commitment to achieving identified goals
- ✓ Agility in modifying procedures to reflect current operational challenges.

### 6.1 Washington State

Each July, the Secretary of the Department of Transportation and the Chief of the Washington State Highway Patrol sign a revised “A Joint Operations Policy Statement”. Over ten years ago and in response to increasing congestion the Governor of Washington directed the Department of Transportation and the Highway Patrol to work together. Since that time, the two agencies update their joint operations policy on an annual basis.

#### 6.1.1 Washington State Joint Operations Policy

This document addresses a total of fifteen joint operational topics, and 27 percent of the document is directly focused on incident management. The incident management is divided into these subject areas:

- ✓ Responder safety
- ✓ Safe, Quick Clearance
- ✓ Incident Response Team (IRT) Program
- ✓ Contracted Service Patrols and Motorist Assistance Vans (MAVs)
- ✓ Instant Tow Dispatch (freeway service patrol)
- ✓ Blok-Buster Major Incident Tow Program
- ✓ Using Technology and Education to Expedite Investigations.

For this task, bullets one and two will be examined.

#### **Responder Safety**

- ✓ Objective – Everyone goes home safe.

- ✓ Policy - WSP and WSDOT will work with the WATIMCo to identify multi-discipline best practices to enhance the safety of all emergency responders.

### Washington State DOT and Highway Patrol Joint approach to Responder Safety

Emergency responders must be able to safely respond to and return from traffic incidents and other emergencies in order to fulfill their missions. If responders become involved in a traffic collision during an emergency response, not only are they unable to render aid to the emergency they were called to, but they have also exposed themselves and other motorists to unnecessary risk and place an unnecessary burden on other emergency responders.

Once on-scene, being struck (by a vehicle) is a leading cause of death and injury for emergency responders working alongside the highway. This makes responder safety the highest priority. Keeping responders safe requires implementing well designed traffic control procedures:

- Getting enough resources to the scene;
- Using proper apparel to maximize visibility;
- Utilizing proper tools;
- Strategically placing safety equipment;
- Improving cooperation and coordination between responding agencies.

### **Safe, Quick Clearance**

- ✓ Objective - To clear all traffic incidents from roads as safely and as quickly as possible.
- ✓ Policy - The WSP and WSDOT will collaborate to safely clear highway incidents within our mutual goal of 90 minutes.

#### **Washington State DOT and Highway Patrol Joint approach to Safe, Quick Incident Clearance**

Safe, quick clearance of traffic incidents increases responder safety by reducing their exposure time to traffic. Similarly, shorter incident duration and improved traffic control enhance motorist safety by reducing the length of lane blockages and road closures which reduces exposure and helps reduce secondary collisions. Quick clearance also reduces the societal costs of congestion such as lost time and extra fuel costs incurred when motorists and truck drivers are caught in traffic congestion.

The benefits of safe, quick clearance of incidents, although well documented, are not widely understood by all incident responders. In fact, many responders don't have a good understanding or appreciation of the roles that other responders perform at incidents. In addition, some responders mistakenly assume that safety and quick clearance policies must be in conflict, and that is clearly not the case. For these reasons, WSP, WSDOT, and Fire agencies have been partnering to present multi-disciplinary training sessions to provide responders with a better understanding of our Traffic Incident Management Program and the roles that various responders perform. These training sessions are a valuable tool to help improve on-scene communication, cooperation, and coordination.

## 6.2 Florida

Florida's incident management efforts are branded as part of the SMART SunGuide Program and can be seen at [smartsunguide.com](http://smartsunguide.com). This program has focus areas in all aspect areas of quick clearance discussed in this document. In addition to a strong freeway service patrol program, some of the strongest parts of the program are shown below.

- ✓ Established Relationships
- ✓ Spill Cleanup policy
- ✓ Transparency in Operations.

### Established Relationships

The Florida Open Roads Policy can be downloaded from the traffic incident management portion of [www.smartsunguide.com](http://www.smartsunguide.com) website. The policy begins by clearly stating that the Department of Transportation and the Florida Highway Patrol are jointly committed to expediting the removal of vehicles, cargo, and debris from the roadway. The policy also opens by stating that those types of blockages will be removed "...to restore, in an URGENT MANNER the safe and orderly flow of traffic..." Public safety is the stated highest priority of the two agencies and they are both responsible for the free movement of people, vehicles, and commerce. In addition to those goals the document also says that it is every agency's responsibility to do what is reasonable to reduce the risk to responders, secondary crashes, and delays associated with incidents, crashes, roadway maintenance, construction, and enforcement activities. Florida Highway Patrol Responsibilities are:

### Florida Highway Patrol Quick Clearance Responsibilities

- Responding personnel will make clearing the travel portion of the roadway a priority
- Investigations will be conducted as expediently as possible, considering the severity of the incident
- Non-critical portions of investigations will be delayed until non-peak periods
- Only lanes absolutely critical to the investigation will be closed and for the minimum length needed for safety
- Coordination with the DOT will be done to setup traffic control, establish alternate routes, expedite traffic movement
- For minor incidents, vehicles will be moved to areas unseen by traffic that might slow down to look at the scene
- Request tow-truck assistance when needed
- Ensure that tow-truck operators have met competency levels and that equipment is in good working order to accomplish removal.

The responsibilities of the DOT are:

### Florida Department of Transportation Quick Clearance Responsibilities

- When requested, the DOT will respond and deploy resources to major incidents at all times.
- Each DOT District develops and implements response procedures to meet the goal of providing initial traffic control within 30 minutes of notification during normal business hours and within 60 minutes outside of business hours
- Coordinate with the Highway Patrol to upgrade traffic controls, determine detour routes, and discuss clearance strategies
- When requested provide traffic control for a safe work zone for responders and motorists
- Deploy heavy equipment and manpower when there is a delay in clearing the travel lane or if the dispatched towing company is not equipped to deal with the situation
- If spilled (non-hazardous) cargo is involved with the incident, the DOT will make every effort to relocate the debris from the roadway in the shortest time possible
- Document all hours and equipment used for traffic control, roadway clearance, and debris clean up.
- Provide any traffic control for remaining or damaged cargo on the shoulder until removal occurs at a later time

### Spill Clean Up

The agreement dates back to 2004 but is still current on the TIM website. The guidelines involve the clarification of permissible responder actions when the release of vehicle fluids happens. The guidelines were jointly reviewed and approved by the DOT, the Florida Department of Environmental Protection, and the highway patrol. The policy is designed to aid the goal of achieving an open road within 90 minutes or arrival of the first responder. The guidelines include the following quick actions:

- ✓ Identify spill as a vehicle fluid
- ✓ Stop leaking material at the source
- ✓ Contain and limit spill from spreading
- ✓ Apply available solvents
- ✓ Sweep material off travel lanes
- ✓ Second application if necessary
- ✓ Gradually restore traffic flow
- ✓ ID RP and mark location of material
- ✓ Make proper notification.

### Transparency In Operations

All information pertaining to incident management efforts and coordination is posted on the public website and the information is used to help with branding the program. The open format creates an environment of knowledge.



### 6.3 Tennessee

The Tennessee Department of Transportation established the Office of Incident Management. The most recent definition of quick clearance activities was defined in the 2003 *Strategic Plan for Highway Incident Management in Tennessee*. The document was a joint publication of the Department of Safety, Department of Transportation, Department of Commerce and Insurance, and the Emergency Management Agency as well as other public and private organizations concerned with incident management activities.

The strategic plan is 98 pages long and contains many joint goals, but it also establishes clear performance metrics:

- ✓ Economic costs of travel delays
- ✓ Safety of responders and motorists
  - Secondary crashes
  - Unintended pedestrians
  - Responder safety
- ✓ Air pollution and wasted fuel.

The plan also points out the success of the HELP program. Tennessee's version of service patrols, although the role of the HELP personnel is closer to first responders than the roles that they play in Pennsylvania.

Overall, the five-year strategic plan included over 150 specific tasks and 10 overall goals. While not all 150 specific tasks are captured here, the 10 overall goals are shown below and all have implications to quick clearance efforts.

#### Goals of the Tennessee Incident Management Strategic Plan

- Reduce the number and severity of highway incidents
- Better inform and educate motorists to reduce congestion and improve safety
- Expand and enhance resources for systematic management of highway incidents
- Expand and enhance training for highway incident responders
- Support highway incident management teams in metropolitan and urban areas
- Sponsor highway incident management teams in rural areas
- Accelerate deployment of new technologies to improve incident management
- Reduce traffic congestion caused by highway work zones
- Establish working groups to focus on specific issues and recommend actions
- Promote ongoing interagency planning and coordination

## 6.4 Maryland

The Coordinated Highways Action Response Team (CHART) is a well documented program administered by the Maryland Department of Transportation through their Office of CHART and ITS Development. Through the years the success of the program has been partially measured by the widespread and consistent coordination among stakeholders along the critical corridors throughout Northern Virginia, Eastern Maryland, and Washington, DC.

Some of the recent focus in the area of quick clearance by CHART has been raising awareness of the Move It Law. In the Reading Room portion of their website, they have dedicated a space to explaining why it is important to move out of a lane if possible, when it is necessary to call the police, and when a police report is necessary. The website also provides a downloadable form, in bi-lingual format, that can be used for outreach.

Below are the main focus points of the incident management portion of the CHART website, all with the common theme of quickly removing lane blockages.

### Maryland's CHART Program Goals

- Emergency Traffic Patrols (ETP) used to provide emergency motorist assistance and to relocate disabled vehicles out of travel lanes.
- Emergency Response Units (ERU) used to set up overall traffic control at accident locations.
- Freeway Incident Traffic Management (FITM) Trailers, pre-stocked with traffic control tools such as detour signs, cones, and trailblazers used to quickly set up pre-planned detour routes when incidents require full roadway closure.
- A "Clear the Road" policy which provides for the rapid removal of vehicles from the travel lanes rather than waiting for a private tow service or time consuming off-loading of disabled trucks which are blocking traffic.
- An Information Exchange Network (IEN) Clearinghouse, provided by an I-95 Corridor Coalition workstation at the SOC, shares incident and traveler information to member agencies along the Corridor.

## 6.5 Ohio

The Quick Clear portion of the Ohio DOT's website states the mission of the Quick Clear Program: "Committed to maintaining the safe and effective flow of traffic during emergencies as to prevent further damage, injury, or undue delay of the motoring public." The website also dedicates an area to the focus of scene management for emergency responders:

### Ohio DOT Emergency Responder Checklist

#### PRE-ARRIVAL

1. Have dispatch verify incident severity in detail, and anticipate equipment needed. If conditions warrant, begin notification process for necessary agencies. Provide guidance to driver in accordance with local policy.
2. Start notification process for towing and recovery teams for departure preparations.
3. Plan for possible detour routes.

#### ARRIVAL

1. Protect scene and assess situation (self & others).
  - a. Assessment should factor risks of incident vs. risks of traffic delays.
  - b. Consider temporary channelization vs. shutdown.
2. Establish ICS (Incident Command System)/UCS (Unified Command System) as needed and start notifications for assistance. Establish formal or informal Command Post with contact number.
  - a. Towing and recovery.
  - b. Hazardous material/fuel response/EPA/Chemtrec.
  - c. Initial media notifications/EAS/evacuation.
  - d. ODOT (state or local).
  - e. Establish Command Post communications link with all agencies at scene and detour routes.
  - f. Contact utilities if needed.
3. Utilize ODOT (state or local) to establish detour if warranted.
4. Reposition emergency response vehicles to open partial traffic flow.
5. Plan for road opening as soon as possible.
6. Plan for secondary crashes as detour is established: position traffic warning devices (utilize DOT resources).
7. Remove traffic trapped between incident and detour (check on welfare of trapped motorists).
8. Utilize both law enforcement & DOT resources.
9. Monitor and respond to developments to insure delays are minimized.
10. Communicate anticipated road opening to media and detour units.
11. Communicate change of scene control to responding agencies.  
When appropriate ensure efficient and timely collection of evidence.

#### POST INCIDENT

1. Media information on reasons for delay so public is informed.
2. Debrief with agencies involved to better prepare for next incident.

The Ohio DOT has also published a 20 page *Ohio Quick Clear Professional Responders Guide for Safe and Effective Highway Incident Management*. The most recent edition was released in October 2007 and outlines the Departments goals of efficient incident management, including their freeway service patrols:

- ✓ Safety for incident responders by limiting their time at a scene.
- ✓ Reduce the risk of secondary crashes.
- ✓ Reduce the duration of traffic incidents, without compromising effective investigation by law enforcement agencies.
- ✓ Manage traffic around incidents to reduce congestion delay, and minimize the amount of traffic flowing past the incident scene.
- ✓ Minimize delay costs.

The document also addresses the needs for documentation, coordination, and specifically coordination in the area of towing. The Towing and Recovery Association of America has released guidance on how to report vehicle types to ensure that the proper recovery vehicle is dispatched.

### TRAA VEHICLE IDENTIFICATION GUIDE®

**CLASS 1 • LIGHT-DUTY** • (4,000 lbs. or less GVW - 4 tires)\*

**CLASS 2 • LIGHT-DUTY** • (4,001 - 10,000 lbs. GVW - 4 tires)\*

**CLASS 3 • MEDIUM-DUTY** • (10,001 - 14,000 lbs. GVW - 6 tires or more)\*

**CLASS 4 • MEDIUM-DUTY** • (14,001 - 16,000 lbs. GVW - 6 tires or more)\*

**CLASS 5 • MEDIUM-DUTY** • (16,001 - 19,500 lbs. GVW - 6 tires or more)\*

**CLASS 6 • MEDIUM-DUTY** • (19,501 - 26,000 lbs. GVW - 6 tires or more)\*

**CLASS 7 • HEAVY-DUTY** • (26,001 - 33,000 lbs. GVW - 6 tires or more)\*

**CLASS 8 • HEAVY-DUTY** • (33,001 lbs. and over GVW - 10 tires or more)\*

**Information Needed To Correctly Dispatch Towing and Recovery Units:**

- Year, Make and Model of Vehicle to be Towed or Recovered
- DOT Classification (Class 1 – 8 based on GVW)
- Location of Vehicle
- Type of Tow (imposed, accident, recovery material cost, etc.)
- Additional Vehicle Information
  - 2 wheel drive, 4 wheel drive, all wheel drive
  - damage to vehicle, tire condition
  - vehicle loaded or empty
  - cargo contents
  - does the vehicle have a trailer
  - are the keys with the vehicle

\*Note: Any vehicle may carry hazardous materials. Advise if present.

\*Note: The Gross Vehicle Weight Rating (GVWR) of the vehicle to be towed or recovered can be found on the identification label on the vehicle's driver's side door frame. The number of people listed on the label can then be compared with the DOT Classification Vehicle Type Chart for the correct DOT class.

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Law enforcement communications with towing and recovery operators describing an incident and the vehicles involved can insure quick and efficient clearing of these scenes and less disruption to traffic flow. In an effort to standardize communications, the towing industry is adopting the federal vehicle class standards as outlined herein.

#### VIN CODES

The year of the vehicle is critical information for towing operators in order for them to reference correct towing procedures. The diagrams on the front are examples of classifications. The following information about vehicle identification numbers affixed to the chassis will help determine the vehicle's year. As noted, the vehicle's year, identified by a letter or number in the VIN sequence, is the eighth character from the right.

**1P8ZA1279SZ215470**

**EXAMPLE 1995 VIN NUMBER:** \_\_\_\_\_↑

1980.....A	1987.....H	1994.....R	2001.....1	2008.....8
1981.....B	1988.....J	1995.....S	2002.....2	2009.....9
1982.....C	1989.....K	1996.....T	2003.....3	2010.....A
1983.....D	1990.....L	1997.....V	2004.....4	2011.....B
1984.....E	1991.....M	1998.....W	2005.....5	2012.....C
1985.....F	1992.....N	1999.....X	2006.....6	
1986.....G	1993.....P	2000.....Y	2007.....7	

#### TOW TRUCK/CAR CARRIER CLASSIFICATION

**LIGHT-DUTY**

TOW TRUCK CAR CARRIER

**MEDIUM-DUTY**

TOW TRUCK CAR CARRIER

**HEAVY-DUTY**

**LOW BOY TRAILER**

Information provided by Towing and Recovery Association of America Inc. • 1-800-728-6136 • 703-484-7713 • Sponsored by Tow Times® Magazine.

## 6.6 National Survey and PennDOT Environment

In 2008 PennDOT conducted a national incident management survey to determine what the characteristics of established incident management programs were. Overall 36 states responded to the survey with the results shown below. For the survey, differentiation between incident management and separate quick clearance activities were not made due to two reasons: within most agencies examined, Quick Clearance is a niche responsibility; and among states and literature reviewed, incident management activities encompass and embody quick clearance practices.

National Incident Management Survey	Answer (36 total responses)	Pennsylvania Response
Is there a distinction between incident management and emergency management in your organization?	<ul style="list-style-type: none"> <li>67% Yes</li> </ul>	<ul style="list-style-type: none"> <li>Yes</li> </ul>
Does your agency have dedicated personnel for incident management?	<ul style="list-style-type: none"> <li>81% Yes</li> </ul>	<ul style="list-style-type: none"> <li>Yes</li> </ul>
Where does coordination of incident management policy occur within your organization?	<ul style="list-style-type: none"> <li>85% State</li> <li>24% Regional</li> <li>6% Local</li> </ul>	<ul style="list-style-type: none"> <li>Regional</li> </ul>
Where does the function of incident management for non-construction related incident planning/response reside within your agency?	<ul style="list-style-type: none"> <li>56% Operations Division</li> <li>29% Shared with Traffic Engineering</li> <li>65% Shared with Maintenance Forces</li> </ul>	<ul style="list-style-type: none"> <li>Shared with Maintenance Forces</li> </ul>
What other state agencies share the responsibility of providing incident information pertaining to state roadways?	<ul style="list-style-type: none"> <li>100% State Police</li> <li>48% EMA</li> <li>39% 911 Call Centers</li> <li>4% Turnpikes</li> </ul>	<ul style="list-style-type: none"> <li>State Police</li> <li>EMA</li> <li>911 Call Centers</li> <li>Turnpikes</li> </ul>
What certifications/qualifications do incident managers in your agency have?	<ul style="list-style-type: none"> <li>100% Experience</li> <li>33% Professional Engineer</li> <li>36% NIMS Certs.</li> </ul>	<ul style="list-style-type: none"> <li>Experience</li> </ul>
Does your agency have (or is working toward) accreditation from the Emergency Management Accreditation Program?	<ul style="list-style-type: none"> <li>30% Yes</li> </ul>	<ul style="list-style-type: none"> <li>No</li> </ul>
Are incident management\emergency response functions collocated with other response agencies?	<ul style="list-style-type: none"> <li>76% Yes</li> </ul>	<ul style="list-style-type: none"> <li>No</li> </ul>
What levels of personnel are trained for incident management/emergency response?	<ul style="list-style-type: none"> <li>96% Field Responders</li> <li>69% Local Support</li> <li>69% Regional Support</li> <li>88% State Support</li> </ul>	<ul style="list-style-type: none"> <li>Field Responders</li> <li>Local Support</li> <li>Regional Support</li> <li>State Support</li> </ul>

A summary of the complete survey is included as Appendix 1.

## 6.7 Bottom Line of National Best Practices

The five agencies chronicled in this section all have unique aspects of their programs that make them the best in class, but they also have some things in common as well:

- ✓ Support at all levels of the agency
- ✓ Segregated departments of the agency
- ✓ Dedicated personnel at all levels of the agency
- ✓ Support from other State emergency response agencies
- ✓ Strong public outreach programs
- ✓ Transparency of processes and availability of materials
- ✓ Well defined performance metrics.

## 7. Pennsylvania Quick Clearance Stakeholder Interviews

Ultimately, the ability to move Pennsylvania forward with regards to quick clearance may rest with the ability of stakeholders to find common ground on the issues at hand. A number of stakeholder interviews were conducted to further ascertain the current state of the practice within the Commonwealth.

### 7.1 Pennsylvania Towing Association

A phone interview was held with the President of the Pennsylvania Towing Association on February 9, 2009. This Association is a member of the larger Towing and Recovery Association of America, Inc. Below is a list of the attendees and a summary of the conversation follows.

Cathy Tennis	Pennsylvania Towing Association, President
Jim Hunt	Federal Highway Administration - Harrisburg
Mike Pack	PennDOT Bureau of Highway Safety and Traffic Engineering
Bruce Kuhn	PennDOT Bureau of Highway Safety and Traffic Engineering
Eric Rensel	Gannett Fleming, Inc.

On the national association’s webpage the mission statement is comprised of the following points:

- ✓ To foster and promote the interest and welfare of all towing and recovery operators in North America and to towing professionalism and quality customer service throughout the world.
- ✓ To foster and encourage fair competition in all business dealings and to promote and encourage good fellowship among members.
- ✓ To promote and encourage the enactment of wise and uniform legislation that fosters professionalism, quality service, healthy competition, and fair compensation.
- ✓ To support the grassroots legislative process and be ready to provide hands-on advice and expertise when called upon to serve the legitimate interests of the towing and recovery industry; and to oppose unwise state and local legislation deemed to have potential negative impact on the towing and recovery industry as a whole.
- ✓ To seek to eliminate unfair and destructive industry practices.
- ✓ To foster cooperation and unity among associations in our industry so that we may have a representative body that speaks with a single voice and wields the collective power of the



group to protect and serve the interests of the towing and recovery industry and to promote fair dealings and quality customer service.

The Pennsylvania Towing Association has approximately 230 members, which Ms. Tennis estimates represents 50 percent of the towing and recovery companies in the Commonwealth that are not associated with automobile dealerships and nearly all of the companies that deal with incident management and response. Below is a summary of the discussion.

1. Does PennDOT or the State Police operate any program to register and/or qualify members other than general vehicle registration and inspection?
  - a. No. This is a problem within Pennsylvania because some companies do not maintain equipment or keep equipment current with new standards and advancements.
2. In general how is the relationship between members and the PennDOT?
  - a. Good. PennDOT field personnel provide support for members when they are on-scene including safety protection when completing operations.
3. In general how is the relationship between members and the State Police?
  - a. Bad. PSP field personnel do not typically respect the operations of the towing company and do not demonstrate a concern for towing operator safety.
    - i. All towing companies are required to have a contract with PSP and are required to respond when contacted.
    - ii. Although a revolving call-out procedure is advertised, most towing companies report favoritism shown by local personnel and these policies are not upheld.
    - iii. The lack of a statewide incident management policy makes it difficult to meet the demands of providing services.
    - iv. No quick clearance point of contact makes it difficult to resolve issues.
4. Are current laws and policies in Pennsylvania conducive to allow members to operate a business and make a profit?
  - a. No. When a towing company responds to the scene, removes, and stores a vehicle the towing company must release personal items in the vehicle even if the fee for the tow is not paid. Ms. Tennis reported that typically what happens is that the vehicle is abandoned and the fee is never reimbursed.
5. How are fees assessed when providing services?
  - a. By weight. For light duty towing operations, fees are typically assessed on per mile traveled basis. These are typically measured from the towing company location, to the scene, and the return trip. These fees typically range from \$3-4/mile.
    - i. For medium and heavy duty vehicles, fees are typically assessed based on the per pound weight of the vehicle.
6. Would a program that provided bonuses for quickly clearing incidents improve the operations?
  - a. No. In an environment that already places towing personnel safety in jeopardy at times, this practice may magnify the situation.
    - i. Florida has one of the only successful bonus programs known.
7. How can the towing industry help reduce incident clearance times?
  - a. State of the art Equipment. Ms. Tennis cited an example of equipment that uses air

to remove heavy vehicles versus one that uses hydraulics to accomplish the same tasks. She estimates that hydraulic equipment can reduce clearance times by as much as 4 hours.

8. What additional policies hinder operations?
  - a. Weight restrictions and policies regarding the movement of over-weight vehicles greatly hinder operations. Currently, a towing company may move an overweight vehicle one time and then it must remain stationary until the payload is altered.
9. What kind of policies for towing and incident management would make sense given the geographical and demographical situation of Pennsylvania?
  - a. A unified policy that allows for local adjustments based on the population of the area may make sense.
10. What legislative issues are on the Association's radar screen?
  - a. The Association played an important role in lobbying for the passage of the current Move Over Law.
  - b. The Association is not aware of any current pending legislation that will affect their industry.
  - c. The Association desires to be a part of the effort to increase safety of all incident responders.

## 7.2 Federal Highway Administration

A conference call was held on February 11, 2009 with the Federal Highway Administration to gain a national perspective on the issues surrounding quick clearance. Below is a list of the attendees and a summary of the conversation follows.

David Helman	Federal Highway Administration Traffic Incident Management Program Manager
Kim Vasconez	Federal Highway Administration Emergency Transportation Operations Program Coordinator
Mike Herron	Federal Highway Administration - Harrisburg
Jim Hunt	Federal Highway Administration - Harrisburg
Lieutenant Hopkins	PSP Patrol Safety
Doug Tomlinson	PennDOT Bureau of Highway Safety and Traffic Engineering
Mike Pack	PennDOT Bureau of Highway Safety and Traffic Engineering
Bruce Kuhn	PennDOT Bureau of Highway Safety and Traffic Engineering
Larry Lentz	PennDOT Bureau of Highway Safety and Traffic Engineering
Eric Rensel	Gannett Fleming, Inc.

### Legislative Discussions

- ✓ The FHWA has just released the *A National Review of Best Practice Traffic Incident Management Quick Clearance Laws, December 2008* as of January 2009 and the report was an effort by FHWA to compile the state of the practice with regards to quick clearance laws.
  - The document was summarized as part of this effort.
- ✓ The FHWA is aware of the issue that many state authority removal laws and hold-harmless clauses indemnify the on-scene agency representative but not the agency itself. They



offered the following examples of states that do have clauses that indemnify agencies:

- Rhode Island Code: 24-8-42
  - Oklahoma Code: 47-11-1002B.2
  - Texas Code: 545.3051E
- ✓ The FHWA stated that the National Towing Industry is attempting to change their image among emergency responders and that they support many efforts to improve safety, streamline clearance time, and other functions that they can assist with in incident response.

### **Publication Discussions**

- ✓ The FHWA recognizes that many of the published guidelines and best practices in the area of traffic incident management are not in conformance with NIMS and is working with stakeholders to address integration.
- ✓ The FHWA believes that the TIM Self Assessment is an appropriate tool for PennDOT Engineering Districts to assess their situation for clearing incidents.
- ✓ The FHWA acknowledged that its website needs to be updated with the definition of quick clearance.
- ✓ The FHWA is in the process of finalizing as many as ten documents that will deal with specific issues of traffic incident management in the near future.

### **Incident Management Program Discussions**

- ✓ FHWA believes that for quick clearance policies to be effective, they need to be contained within an incident management program at departments of transportation.
- ✓ One of the current issues with traffic incident management integration with traffic management centers is data sharing protocols. Many agencies are deploying computer aided dispatch programs at traffic management centers so that information can be shared and viewed among multiple agencies in a seamless fashion.
- ✓ Outreach to volunteers outside of DOT normal business hours is typically required for successful incident management programs.
- ✓ The FHWA believes that it is appropriate for work zone incident management to be a part of an incident management program.
- ✓ Performance metrics are one of the most important parts of an incident management program and the FHWA said that one of the upcoming publications will have updated approaches to metrics.

### **Funding Discussions**

- ✓ The FHWA stated that most state incident management programs are funded by budget line items both in DOTs and in State Police organizations.
- ✓ The FHWA as noted that there has been a decline in incident management funding over the last couple of years. There are some provisions for incident management in the currently proposed economic stimulus Bill, however there is limited optimism that money for incident management will be available once the Bill is passed.
- ✓ The FHWA believes that Homeland Security Grants are a potentially rich source of funding for incident management program and that local coalitions of agencies should work together to complete applications.

### Coordination Discussions

- ✓ The FHWA is planning to conduct incident management training in the top 40 urban areas in the country towards the end of fiscal year 2009. Pittsburgh and Philadelphia will be included in the training.
- ✓ The peer-to-peer program is well funded and the FHWA will help get subject matter experts to come to Pennsylvania if desired.

### 7.3 Pennsylvania State Police

A face-to-face meeting was held between PennDOT and the PSP on February 10, 2009 to have a general discussion about the PSPs view on quick clearance and any ongoing efforts. Below is a list of the attendees and a summary of the conversation follows.

Major Cole	Federal Highway Administration Traffic Incident Management Program Manager
Lieutenant Hopkins	Federal Highway Administration Emergency Transportation Operations Program Coordinator
Captain Patrick	Federal Highway Administration - Harrisburg
Sergeant Leydig	PSP Patrol Safety
Jim Hunt	Federal Highway Administration - Harrisburg
Doug Tomlinson	PennDOT Bureau of Highway Safety and Traffic Engineering
Mike Pack	PennDOT Bureau of Highway Safety and Traffic Engineering
Bruce Kuhn	PennDOT Bureau of Highway Safety and Traffic Engineering
Eric Rensel	Gannett Fleming, Inc.

- ✓ The PSP declined to comment on the Towing Industry due to ongoing litigation.
- ✓ The PSP estimates that there are two non-reportable crashes for every reportable crash.
- ✓ Every PSP Trooper receives incident management education at the Pennsylvania State Police Academy
- ✓ Getting the travel lanes reopened is a priority to the PSP, however these actions cannot supersede the need to conduct a thorough investigation of what transpired.
- ✓ By working with the PEMA and specifically the Pennsylvania State Fire Commissioner, outreach to many of the 2,400 fire departments across the Commonwealth may be possible.
- ✓ The PSP believes that the following items contribute to prolonged incident clearance times
  - **Over response** – a tendency for local emergency responders to send too much equipment to the scene.
  - **Scarcity of HAZMAT response teams** – There are only 32 HAZMAT response teams across the Commonwealth resulting in longer response times when needed.
  - **Fees assessed by HAZMAT cleanup** – Pennsylvania Law does not define what allowable fees are for cleanup, therefore contractors may increase the amount of time spent on scene to increase the fee assessed.
  - **Agency liability** – Pennsylvania Law does protect the officer on scene from litigation, however the agency may still be found liable for damages.
  - **PennDOT availability** – Because there is no PennDOT incident management policy, it is difficult to instruct troopers on what to expect from PennDOT.
  - **No delineated on-scene command** - Although the theory of the National Incident

Management System is known to many, often in real situations it is not fully implemented since roles and responsibilities are not pre-defined.

## 8. Action Item Details

The action items shown below are a culmination of the literature review and the identified best practices from other states. The primary source to continually monitor for best practice updates is the I-95 Corridor Coalition. Throughout this research task, all leads continually traced back to documents found on the coalition's website or in reference to a coalition event. The Incident Management Portion of the FHWA Website is also a good resource; however it is not kept as current as the I-95 Corridor Coalition's Website.

### 8.1 Evaluate the Need for Changes in Legislation

Although the view points were differing, all stakeholders that were interviewed as well as several of the reference documents that were reviewed cited weak legislation as a contributor to longer incident clearance times.

#### 8.1.1 Driver Removal Law Examination

There are four types of laws that make up quick clearance legislation and the group of the laws is typically referred to as "Open Roads" or "Move It" Laws/Policies. Pennsylvania does not have one of the four, a driver removal law. This type of law addresses the removal of vehicle disablements, property damage only crashes, and injury crashes where serious personal injuries are not apparent. NCHRP 318 and FHWA Traffic Incident Management Quick Clearance Laws: A National Review of Best Practices suggest that a strong driver removal law will address the following:

- ✓ Incident type
- ✓ Incident severity
- ✓ Type of roadway facility where the incident occurs
- ✓ Lateral location of the incident
- ✓ Specification of who may move a disabled or wrecked vehicle
- ✓ Specification of where to move a vehicle blocking traffic
- ✓ Specification of immobilized vehicle handling
- ✓ Specification of a hold harmless clause.

#### Examples of Drive Removal Laws

##### **Florida Statute 316.071**, entitled "Disabled vehicles obstructing traffic"

Whenever a vehicle is disabled on any street or highway within the state or for any reason obstructs the regular flow of traffic, the driver shall move the vehicle so as to not obstruct the regular flow of traffic or, if he or she cannot move the vehicle alone, solicit help and move the vehicle so as not to obstruct the regular flow of traffic. Any person failing to comply with the provisions of this section shall be cited for a nonmoving violation, punishable as provided in chapter 318.

##### **Florida, 316.027 & 316.061 (Sample Language – Driver Move Law)**

Every stop must be made without obstructing traffic more than is necessary, and, if a damaged vehicle is obstructing traffic, the driver of the vehicle must make every reasonable effort to move

the vehicle or have it moved so as not to obstruct the regular flow of traffic.

### **Tennessee, 54-16-113 (Sample Language - Authority Removal Law)**

The department of [public] safety, DOT, or local law enforcement may immediately remove or cause to be removed any [disabled or] wrecked vehicle, spilled cargo, or other personal property obstructing traffic because of its position in relation to the highway. Vehicles, cargo, or personal property may be removed to any place within the immediate vicinity. No removal shall occur after a crash resulting in apparent serious personal injury or death until a law enforcement officer collects adequate crash information. When the property obstructing traffic is a motor carrier, the agency causing its removal shall make a reasonable effort to allow the owner to arrange for its removal. The department of safety, DOT, or local law enforcement agency may require the owner or carrier of the vehicle, spilled cargo, or personal property removed to pay for any costs incurred in removal.

#### *8.1.2 Consider the Need to Strengthen Hold-Harmless Language in Existing Laws*

The NCHRP 318 indicated that the main reason quick clearance laws are not followed is because agencies or individuals fear being liable for actions taken. The Pennsylvania Towing Association and the PSP also expressed concern regarding existing hold-harmless clauses. Pennsylvania does not have a hold harmless clause in its Driver Stop Law. According to NCHRP 318 there are three types of hold-harmless clauses:

- ✓ One that apply to motorists that adhere to driver stop or removal laws
- ✓ One that applies to incident responders who are fulfilling the requirements of authority removal or tow laws,
- ✓ One that provides immunity to incident responders from any potential liability incurred by the failure to execute the requirements of any quick clearance legislation.

One of the most important things to consider when strengthening hold-harmless clauses in quick clearance legislation is that responders and the agencies that they represent are indemnified from liability.

## **8.2 Consider the Establishment of an Incident Management Program**

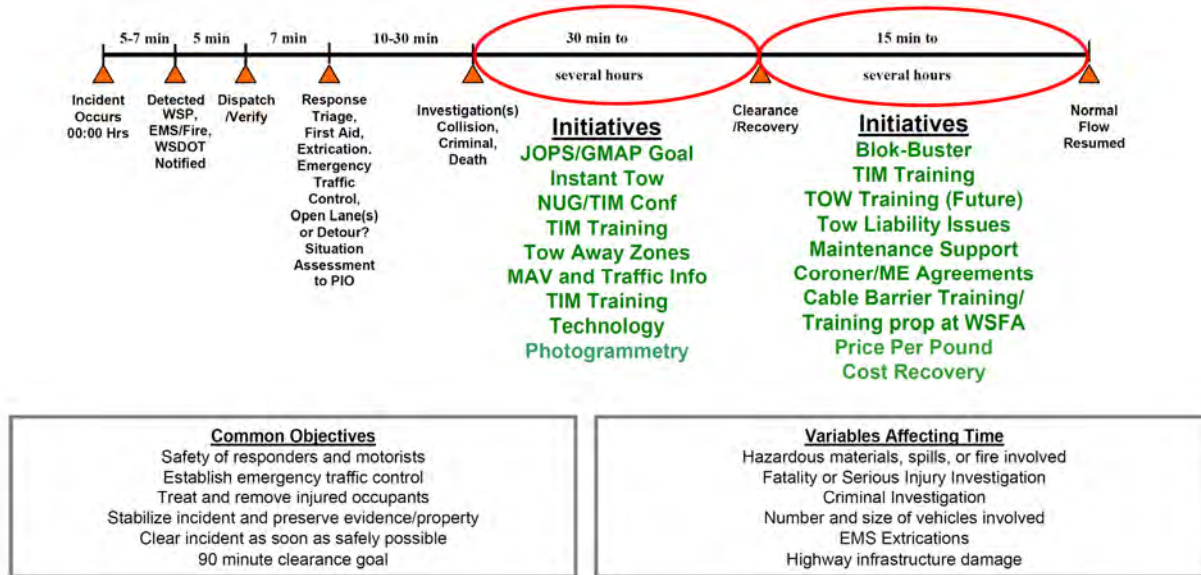
PennDOT does not have Central Office level personnel who are solely responsible for incident management and since quick clearance typically falls within a more broad incident management program at the five states identified in the best practices section, dedicated incident management personnel could be responsible for the items shown below in addition to creating a consistent statewide contact for coordination with other stakeholders.

### *8.2.1 Consider Implementing an Incident Management Policy*

Almost all of the materials reviewed as part of this task set target times for incident clearance. A typical target time is 90 minutes after arrival of emergency responders. Consider the major incident timeline taken from a presentation by Mr. Rick Phillips at the 2008 Traffic Incident Management Conference in Washington State:



### Major Incident Response Timeline Communication \* Coordination \* Cooperation



Revised 8-24-07

Adding the upper limits of the times shown above the timeline yields an incident clearance time of 94 minutes. The initiatives shown are focus areas for the Washington DOT, State Police and other emergency response organizations. To support the timeline above the objective and policy below are used.

### Washington State DOT Incident Management Objective and Policy

**Objective**

During major incidents, WSDOT’s primary Incident Response role is to coordinate with and support WSP and other emergency responders as needed, by providing traffic control to improve safety of on-scene responders and motorists approaching the incident, and periodic incident and traffic updates to the appropriate TMC for dissemination through established traveler information systems.

**Policy**

The WSDOT will deploy scheduled roving incident response patrols in coordination with WSP in congested areas and maintain 24/7 call out availability.



### 8.2.2 Consider Establishing Incident Management Memorandums of Understanding with PSP

As in the last section, the WSDOT and WSP have executed a Joint Operations Policy to define roles, responsibilities and outline specific personnel within each organization for accomplishing the goals. The Policy is reviewed each year and revisions are incorporated as needed. Such an agreement must have a commitment for implementation from the highest level of State government. In Washington, the State Police Commissioner and the Secretary of Transportation sign the document and specific personnel are named to carry out the tasks. Areas to be covered by the MOU should include:

- ✓ Responder Safety
- ✓ Information Sharing
- ✓ Incident Verification
- ✓ Mobilizing Forces
- ✓ Disseminating Information to the Public
- ✓ Quick Clearance
  - Incident classification system
  - Clearance time goals
  - Training and outreach
  - Queue and backlog monitoring

### 8.2.3 Consider Developing an Incident Management Strategic Plan

Tennessee, Ohio, and the National Traffic Incident Management Coalition have all recently created or updated incident management strategic plans that are interlaced with quick clearance theories. The subject areas from the Tennessee Strategic Incident Management Plan are:

- ✓ Reduce the number and severity of highway incidents
- ✓ Better inform and educate motorists to reduce congestion and improve safety
- ✓ Expand and enhance resources for systematic management of highway incidents
- ✓ Expand and enhance training for highway incident responders
- ✓ Support highway incident management teams in metropolitan and urban areas
- ✓ Sponsor highway incident management teams in rural areas
- ✓ Accelerate deployment of new technologies to improve incident management
- ✓ Reduce traffic congestion caused by highway work zones
- ✓ Establish working groups to focus on specific issues and recommend actions
- ✓ Promote ongoing interagency planning and coordination

A similar plan for PennDOT would help define actions to establish and meet an incident clearance time goal.

### 8.2.4 Consider Continuing and expanding the Freeway Service Patrol Program

All five of the States cited in this research as well as many of the ones identified by the Federal Highway Administration have expansive freeway service patrol programs. In addition, the NCHRP 318 document and several of the other reference documents used to complete this task highlight the benefits and strong positive public feedback for these programs.

### 8.2.5 *Evaluate the Benefit of Implementing an Incident Management Module into the Road Condition Reporting System*

PennDOT's Road Condition Reporting System (RCRS) has become a partial incident management tool since the implementation of the incident communications protocol module in February 2007 and is shared by the Pennsylvania Emergency Management Agency, State Police, PennDOT, and Pennsylvania Turnpike. To further enhance the incident management capabilities of the system, implement a module that includes the following:

- ✓ **The incident location** – Currently the RCRS is designed to report the length of the closure (from the beginning of the diversion point to the end of the diversion point). Providing the incident location will allow the system to more closely reflect information as reported by other incident management agencies.
- ✓ **Provide the capability to capture “reported” incidents** – Similar to the computer aided dispatch system, the RCRS needs the capability of capturing reported incidents that are not yet verified. This enhancement will reduce the decision time by operators on whether or not to capture an event and may increase accuracy of reporting by allowing operators to initially capture data and then update data as better information becomes available.
- ✓ **Enhanced map speed** – Currently maps may take up to 30 seconds to generate, and in an environment where incident verification and initial message dissemination goals are in the 5 minute range, slow maps will hamper operations.
- ✓ **Incorporate Emergency Detour Routes** – For effective backlog management, operators must have information available to them as quickly as possible. By incorporating information currently shown in the Emergency Detour Routing System (EDRS) PennDOT can provide the information at the point where it is needed (in the RCRS) and discontinue development of the EDRS.
- ✓ **Implement performance metrics that parallel national tracking criteria** – Provide the capability in the system to measure the categories shown below.

### 8.2.6 *Consider Implementing Incident Management Performance Metrics*

In 2002 the Federal Highway Administration, in conjunction with the Texas Transportation Institute published “Incident Management Performance Measures”. The publication recommended two tiers of performance measures as shown below.

Tier 1 Performance Metrics	Tier 2 Performance Metrics
<p><b>Incident Notification Time</b> – This represents the time it takes for all the appropriate response agencies to become aware of an incident. It would be computed by taking the time differential between when the first detection/report of an incident to any agency (whether it be fire, police, 911-dispatch, or TMC) to when the other response agencies also receive notification of the incident. This performance measure would need to be computed separately for each of the official response agencies.</p> <p><b>First-Responder Response Time</b> – This represents what many transportation agencies and emergency service responders are calling “response time”. This performance measure would be the time differential between the first report of an incident to any agency to when the first official responder from any agency arrived on the scene.</p> <p><b>Incident Assessment Time</b> – This time represents the duration it takes the first responder to determine what needs to be done to clear the incident and when capacity of the roadway is first partially restored. This performance measure would be defined as the time differential between when the first responder arrived on the scene and when the first action is taken to fully or partially restore capacity (for example, opening one previous blocked lane of traffic).</p> <p><b>Total Blockage Duration</b> – This time represents the total amount of time that freeway capacity is reduced. This performance measure would be defined as the time differential between when the first responder arrived on the scene to when the freeway capacity was fully restored (i.e., all lanes opened).</p> <p><b>Total Incident Duration</b> – This time represents the total amount of time that the incident had an effect on traffic operations. This performance measure would be defined as the time differential between when the event was first reported to any official response agency until when the last official response vehicle left the scene.</p>	<p><b>Agency Detection</b> - The frequency (or percentage of total incidents) at which each official response agency was the “first detector.”</p> <p><b>First on Scene</b> - The frequency (or percentage of total incidents) at which each official response agency was the “first responder.”</p> <p><b>Capacity Established</b> - The frequency (or percentage of total incidents) where capacity was partially restored.</p> <p><b>Last to Leave</b> - The frequency (or percentage of total incidents) at which each official response agency was the last to leave the scene.</p> <p><b>Device Activation Time</b> - The time lag between when an incident was reported to a TMC and when devices were activated on the roadway.</p> <p><b>Motorist Delay</b> - The average delay to motorists through an incident site.</p> <p><b>Queue Length</b> - The average queue length associated with different incident types.</p> <p><b>Diversion Time</b> - The average amount of diversion generated by the traffic control devices used in managing an incident.</p>



**8.2.7 Consider Providing Oversight and Guidelines for Work Zone Incident Management Plans**

Currently, there are special provisions that are developed by each PennDOT Engineering District for incident management in work zones. Currently, there is no central oversight or monitoring of current best practices in a coordinated way. The FHWA dedicates a segment of their website, under Operations, to work zone incident management best practices and guidance.

**8.2.8 Facilitate the Completion of FHWA’s Traffic Incident Management Self Assessment on an Annual Basis**

The FHWA facilitates the completion of the Traffic Incident Management Self Assessment in five major urban areas on an annual basis and that assessment can also be applied at the District level. This incident management program should use the assessment as an annual metric for measuring improvements in performance and perception of coordination for responding to incidents.

**8.3 Evaluate the Expansion Capabilities for Training and Outreach Efforts**

Almost all of the literature review documents and documents from other states outline extensive public and stakeholder outreach activities, and one thing is clear; providing quick and safe clearance of vehicles blocking roadways is a multi-agency effort. So for Pennsylvania to become a best-in-class state for incident clearance, political, institutional, and geographic challenges will need to be overcome.

Group to Outreach	Biggest Outreach Challenge
Local Fire Departments (Fire Police)	<ul style="list-style-type: none"> <li>• Most are volunteers and not available for coordination during PennDOT normal business hours</li> </ul>
County Emergency Management Agencies	<ul style="list-style-type: none"> <li>• Many have a very small staff for accomplishing all tasks county wide</li> </ul>
Local Police	<ul style="list-style-type: none"> <li>• Limited personnel and training budgets</li> </ul>
Pennsylvania State Police	<ul style="list-style-type: none"> <li>• Getting headquarters coordination efforts reflected at the local level</li> <li>• Strained local relationships</li> </ul>
Pennsylvania Emergency Management Agency	<ul style="list-style-type: none"> <li>• Getting buy-in from many different groups within the agency with varying opinions</li> </ul>
Pennsylvania Department of Environmental Protection	<ul style="list-style-type: none"> <li>• Streamlining policies and procedures that must be followed in HAZMAT and other potentially hazardous situations</li> </ul>
Towing Industry	<ul style="list-style-type: none"> <li>• Varying size and technological capabilities of recovery companies</li> </ul>
Adjacent State Emergency Services	<ul style="list-style-type: none"> <li>• Funding for travel and schedule coordination</li> </ul>
Motoring Public	<ul style="list-style-type: none"> <li>• Pass through traffic</li> </ul>

As can be seen from the table above, there are many challenges facing the success of the PennDOT incident management program. The strategies outlined below may help.

#### 8.3.1 *Develop and disseminate a PennDOT incident management brochure*

Once the incident management program is established and goals are clearly defined, a brochure for educating many different outlets about incident management and PennDOT capabilities will be needed.

#### 8.3.2 *Dedicate a portion of the PennDOT website to become a focal point for Pennsylvania Quick Clearance information and outreach efforts*

Many DOT websites have a portion dedicated to incident management/quick clearance efforts. This helps promote unity in efforts and inclusion for many different stakeholder groups.

#### 8.3.3 *Coordinate and hold 11 Saturday Quick Clearance Symposiums (One per District)*

One of the identified challenges above is that many of the on-the-ground response personnel are volunteers. This means that many hold regular jobs during normal PennDOT business hours. To truly achieve coordination, educational forums and coordination meetings need to take place when these individuals are available. In many cases this will be nights and Saturdays. PennDOT will need to make provisions in their budget to account for overtime accrued by personnel performing this effort. Also, these symposiums need to be highly coordinated with State Police and County EMA personnel.

#### 8.3.4 *Require District Incident/Emergency Management Coordinators to attend two county EMA coordination meetings per year*

Almost all counties hold regular meetings for emergency response coordination. For PennDOT to stay current on local and regional incident management issues, participation in these meetings will be necessary.

#### 8.3.5 *Provide quick clearance training opportunities by nationally recognized experts*


The I-95 Corridor Coalition has an existing relationship with national experts and other states that were contacted, including Washington State who has offered to come to Pennsylvania and perform outreach. The FHWA peer-to-peer program may be a source to facilitate this coordination. In addition, the course that was developed by LTAP may be updated and offered regionally once PennDOT and PSP personnel have received sufficient training to conduct the course.

#### 8.3.6 *Establish a relationship with the Pennsylvania Chiefs of Police Association*

In Pennsylvania, State Police patrol a percentage of the Commonwealth's road network, so outreach to local police and emergency responders is a very important task. On the association's website, they list a membership of over 1,200 command level law enforcement officers across the Commonwealth.

## 8.4 Consider Facilitating the Improvement of the Towing and Recovery Company Qualification Process

Modifications to improve the reimbursement process for towing agencies and improve the requirements for personnel and equipment to provide service will ensure that the most qualified companies are being used to complete operations. Texas has the most recent legislation addressing these two issues, and below is a summary of the Texas Tow Act, House Bill 2094 of the 80<sup>th</sup> Texas Legislature.




**Texas Tow Act**  
**HB 2094, 80<sup>th</sup> Texas Legislature**

As proposed by the Texas Towing & Storage Association (TTSA), the 80<sup>th</sup> Texas Legislature passed HB 2094 by Representative Fred Hill, Representative Jim Jackson & Senator John Carona. Supporters of the Legislation included: TTSA, Greater Dallas Emergency Wrecker Association, Texas Motor Transportation Association, Texas Auto Title & Registration, South West Tow Operations, Goodie Towing & Recovery, Safetow, AAA Texas and Arens Services (Texas House Research Organization, SB 1118).

With the passage of HB 2094, Texas now has the most meaningful and innovative towing and storage laws in the United States. Below are the key provisions of the Act:

- Transfers regulation of the towing and vehicle storage industry from the Texas Department of Transportation to the Texas Department of Licensing and Regulation (TDLR), the state's umbrella occupational regulatory agency.
- Creates the Towing and Storage Advisory Board to advise the department on matters relating to the towing and storage of vehicle.
- Requires criminal background checks and drug testing for towing operators and vehicle storage facility employees.
- Provides for three classifications of towing, establishes requirements for each class and requires permit.
  - Incident Management Towing Operations Permit - Establishes equipment and liability insurance requirements for incident management towing permits. Provides that permitted incident management tow trucks may be used for all types of towing.
  - Private Property Towing Operations Permit - Establishes equipment and liability insurance requirements for private property towing permits. Provides that permitted private property tow trucks may be used for private property towing and consent towing but not incident management towing.
  - Consent Towing Operations Permit - Establishes equipment and liability insurance requirements for consent towing permits. Provides that permitted consent tow trucks may be used only for consent towing.
- Provides for three classifications of towing operators and requires license:
  - Incident Management Towing Operator - Establishes requirements for an incident management towing operator license. Provides that licensed incident management towing operator may conduct all types of towing.
  - Private Property Towing Operator - Establishes requirements for a private property towing operator license. Provides that licensed private property towing operator may conduct private property towing and consent towing but not incident management towing.
  - Consent Towing Operator - Establishes for a consent towing operator license. Provides that licensed consent towing operators may only conduct consent towing.
- **Key Dates**
  - September 1, 2007 - HB 2094 Effective Date
  - September 1, 2008 - Towing Operators License Required  
 Incident Management Towing Operators & Private Property Towing Operators must be certified by Towing & Recovery Association of America or another certification approved by TDLR.
  - September 1, 2008 - Vehicle Storage Facility Employees License Required
  - After August 31, 2009 - Completion of Professional Development Course Required  
 At first license renewal, Incident Management Towing Operators must have completed professional development course relating to towing that is licensed or certified by the National Safety Council or another course approved by TDLR.



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### 8.4.1 Facilitate Coordination Efforts between the PSP and the Towing Industry

From stakeholder interviews, the relationship between PennDOT and the towing industry in Pennsylvania appears to be strong while the relationship between the PSP and the towing industry is weak. PennDOT should consider taking a leadership role in mediating the differences between these groups and creating an environment that is conducive to unity in response and creates efficiency in incident response.

## 8.5 Consider Developing Regional Partnerships to Seek Incident Management Funding

The Federal Highway Administration stated that the greatest source for incident management funding is through the Department of Homeland Securities Grant Program. The Federal Highway

Administration also stated that regions that demonstrate cooperation and coordination typically fair better in grant awards. PennDOT should consider investigating partnerships and grant opportunities to position itself for successful awards.

### 9. Traceability

The action items that were identified in this report have ties to many other reports that have been developed by PennDOT in recent years. Below are each of the action items from this report cross referenced to recent efforts by PennDOT.

Suggested Executive Actions	Suggested Sub-tasks	Is the Action Item Traceable?		
		ITS Strategic Plan (2008)	Transportation Operations Plan (2005)	Regional Operations Plans
Evaluate the Need for Changes in Legislation	<ul style="list-style-type: none"> <li>• Driver Removal Law Examination</li> <li>• Consider the Need to Strengthen Hold-Harmless Language in Existing Laws</li> </ul>	<ul style="list-style-type: none"> <li>• No</li> </ul>	<ul style="list-style-type: none"> <li>• Yes (TSOP 4 and 5)</li> </ul>	<ul style="list-style-type: none"> <li>• No</li> </ul>
Consider the Establishment of an Incident Management Program	<ul style="list-style-type: none"> <li>• Consider Implementing an Incident Management Policy</li> <li>• Consider establishing incident management memorandums of understanding with PSP</li> <li>• Consider developing an incident management Strategic Plan</li> <li>• Evaluate the benefit of implementing an incident management module into the Road Condition Reporting System</li> <li>• Consider implementing incident management performance metrics</li> <li>• Consider providing oversight and guidelines for work zone incident management plans</li> <li>• Facilitate the completion of FHWA’s TIM Self Assessment on an annual basis</li> </ul>	<ul style="list-style-type: none"> <li>• Yes (Goal 2 and Goal 3)</li> </ul>	<ul style="list-style-type: none"> <li>• Yes (TSOP 4 and 5)</li> </ul>	<ul style="list-style-type: none"> <li>• Yes (Southwestern, District 2,</li> </ul>

Suggested Executive Actions	Suggested Sub-tasks	Is the Action Item Traceable?		
		ITS Strategic Plan (2008)	Transportation Operations Plan (2005)	Regional Operations Plans
Evaluate the Expansion Capabilities for Training and Outreach Efforts	<ul style="list-style-type: none"> <li>Develop and disseminate a PennDOT Incident Management Brochure</li> <li>Dedicate a portion of the PennDOT website to become a focal point for Pennsylvania Quick Clearance information and outreach efforts</li> <li>Coordinate and hold 11 Saturday Incident Management Symposiums</li> <li>Require District Incident/Emergency Management Coordinators to attend two county EMA coordination meetings per year</li> <li>Provide quick clearance training opportunities by nationally recognized experts</li> <li>Establish a relationship with the Pennsylvania Chiefs of Police Association</li> </ul>	<ul style="list-style-type: none"> <li>Yes (Goal 4)</li> </ul>	<ul style="list-style-type: none"> <li>Yes (TSOP 5 and TSOP 14)</li> </ul>	<ul style="list-style-type: none"> <li>Yes (Southwestern, District 2,</li> </ul>
Consider Facilitating the Improvement of the Towing and Recovery Qualification Process	<ul style="list-style-type: none"> <li>Facilitate coordination efforts between the PSP and the Pennsylvania Towing Industry</li> <li>29% Shared with Traffic Engineering</li> <li>65% Shared with Maintenance Forces</li> </ul>	<ul style="list-style-type: none"> <li>No</li> </ul>	<ul style="list-style-type: none"> <li>No</li> </ul>	<ul style="list-style-type: none"> <li>No</li> </ul>
Consider developing regional partnerships to seek incident management funding	<ul style="list-style-type: none"> <li>Investigate relationships and grant opportunities from the Department of Homeland Security</li> </ul>	<ul style="list-style-type: none"> <li>No</li> </ul>	<ul style="list-style-type: none"> <li>Yes (TSOP 5)</li> </ul>	<ul style="list-style-type: none"> <li>Yes (Southwestern, District 2,</li> </ul>





January 23, 2009





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## Executive Summary

The purpose of this task was to conduct an evaluation of freeway service patrols (FSPs) to determine operating costs, benefits and best practices. The goal is to provide recommendations on how to implement a highly effective statewide FSP program from perspectives of both cost and performance.

Key activities included:

1. Research national best practices
2. Summarize current District practices
3. Identify suggested actions

FSP programs generally consist of trained personnel who use specially equipped vehicles to systematically patrol highways searching for and responding to traffic incidents. FSP have been documented to reduce traffic congestion, improve travel time reliability, and improve safety on limited access roadways

While there is no doubt that FSPs provide a beneficial service to the general motoring public, available data indicates that additional benefits are also realized with respect to reductions in incident durations and subsequent reductions in fuel consumption, emissions, and secondary incidents. Benefit/costs have been calculated for many of these initiatives on a nationwide basis, with ratios ranging from 2:1 to 36:1. On a localized level, PennDOT Engineering District 8-0 has experienced an approximate benefit/costs of 12:1.

## Program Goals

While there is a demonstrated benefit, no specific guidelines or goals have been established for the implementation of FSPs throughout the Commonwealth of Pennsylvania. Therefore, the following program goals are recommended based on a review of the state of the practice in the United States.

### *Program Coverage Areas*

In order for a selected roadway segment to be considered for the implementation of a FSP, the following guidelines should be considered:

- 1) Roadway must be a limited access roadway.
- 2) The segment must have an Incident Factor (IF) greater than or equal to 5.0. The (IF) shall be calculated by multiplying the average annual daily traffic (AADT) of the segment (both directions) by the annualized crashes per mile for the segment (average year for three years of crash data should be used). The calculated number should then be divided by 100,000 to obtain the resulting IF. Please note that the segment crash data must be converted to a crashes per mile value by pro rating based on segment length.

$$\text{Incident Factor (IF)} = \frac{\text{AADT} \times \text{crashes per mile}}{100,000}$$

- 3) Those segments that are on logical feeder routes or connections linking roadways meeting the criteria above.
- 4) Those segments deemed to be part of the critical infrastructure necessary to maintain traffic flow where incidents would cause excessive delay and safety concerns, or as identified by the planning partners as a congested corridor as part of their Congestion Management Plan (CMP).
- 5) Those segments with shoulder areas less than 6 feet in width may be given priority due to the capacity constraints experienced by the inability to move vehicles from the travel lane.

Note that the threshold for IFs was determined by conducting a statistical analysis of the Pennsylvania interstate system. IFs were determined for all interstates and the average was used to establish a program baseline along with some basic qualitative analysis.

### *Program Services*

All FSPs should provide the following recommend minimum services:

- Move disabled vehicles - Be able to tow or push a stalled or abandoned automobile or light truck out of the highway travel lane
- Provide fuel – Provide up to 2 gallons of fuel to a disabled vehicle
- Provide water – Provide water for overheating and to person(s) being assisted
- Change flat tire
- Minor mechanical assistance – Provide jump starts, tire inflation and other minor technical assistance
- Assist stranded motorists – Provide access to cell phone and direct them to a safer area
- Remove obstacles and obstructions from roadways – Remove small debris and other non-hazardous items
- Arrange for towing – Call commercial towing providers and provide towing services to a point of safety
- Share information with other agencies – Provide information including emergency service request
- Assist other agencies – Provide traffic control support to other first responders
- Provide traffic control

These are consistent with FHWA guidelines and are also consistent with existing service being provided in Engineering Districts 5-0, 6-0, 8-0 and 11-0.

Minimum hours of operation should include the morning and evening rush hour periods, and the fleet should be comprised of vehicles capable of moving disabled vehicles from the travelway.

Provide operators that are trained to safely provide limited emergency temporary traffic control at incident scenes and are trained in ICS, specifically IS-100 and IS-200 level courses.

### *Program Evaluation*

Any PennDOT District that implements an FSP program must conduct a benefit/cost analysis on an annual basis at a minimum. The analysis should be based on:

- Reduction in incident duration
- Reduction in fuel consumption
- Reduction in motorist lost wages spent in congestion
- Motorists savings per incident
- Annual cost of FSP program.

The benefit/cost analysis must be submitted to the Bureau of Highway Safety and Engineering for review and approval.

### *Program Consistency and Funding*

It is very important that motorists (customers) encounter a consistent experience as they travel throughout the State of Pennsylvania, similar to the baseline ITS device deployment and statewide 511 traveler information service initiatives. FSPs should be no different in this goal, and therefore the following course of action is suggested:

*Short-term* – Maintain the present course of action with local operation utilizing state/federal funding through the MPO or county funds. Develop and provide FSP implementation guidelines to the Districts to establish consistency.

*Long-term* – Establish statewide FSP program funded by Central Office. This would allow BHSTE to ensure statewide consistency with control of the funding source, but District operation should still be maintained because of the necessary coordination with the TMCs. Initial funding level should be set at approximately \$5 million/year.

Public/private partnerships should be encouraged, such as the one between the Pennsylvania Turnpike Commission and State Farm Insurance. However, this arrangement should be limited to the donation of funds in exchange for advertising on PennDOT vehicles. All PennDOT FSP vehicles shall be operated by PennDOT employees or their contractors.

### *Program Budgeting*

As indicated above, a statewide FSP program should be initially budgeted at \$5 million/year. In absence of a statewide program, budgets for individual District programs/expansions should assume an annual budget of \$1,200/per mile/per year.

## 1. Introduction

### 1.1 Background and Purpose

The purpose of this task was to conduct an evaluation of freeway service patrols (FSPs) to determine operating costs, benefits and best practices. The goal is to provide recommendations on how to implement a highly effective statewide FSP program from perspectives of both cost and performance.

Key activities included:

1. Research national best practices
2. Summarize current District practices
3. Identify suggested actions.

FSP programs generally consist of trained personnel who use specially equipped vehicles to systematically patrol highways searching for and responding to traffic incidents. FSP have been documented to reduce traffic congestion, improve travel time reliability, and improve safety on limited access roadways

### 1.2 Contacts

This task was performed under as part of Bureau of Planning and Research, Project Number 060908. The following are the task and contract contacts:

Last Name	First Name	Organization	Role	E-mail	Telephone
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Nale	Scott	Gannett Fleming/ GeoDecisions	Consultant Staff	snale@gfnet.com	304.296.6492
Taylor	Bob	Gannett Fleming/ GeoDecisions	Consultant Staff	rtaylor@gfnet.com	717.763.7212

### 1.3 Disclaimer

The contents do not necessarily reflect the official views or policies of the Pennsylvania Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

## 1.4 Acronyms

ADT	Average Daily Traffic
ATRWS	Automatic Truck Rollover Warning System
BHSTE	Bureau of Highway Safety and Traffic Engineering
BIS	Bureau of Information Systems
BPR	Bureau of Planning and Research
CCTV	Closed-Circuit Television
DMS	Dynamic Message Sign
FHWA	Federal Highway Administration
FSP	Freeway Service Patrol
GIS	Geographic Information System
GPS	Global Positioning System
HAR	Highway Advisory Radio
ITS	Intelligent Transportation System
O&M	Operations and Maintenance
MMP	Maintenance Management Plan
PDA	Pre-Determined Amount
PennDOT	Pennsylvania Department of Transportation
RTMC	Regional Transportation Management Center
RTMS	Remote Traffic Microwave Sensor
RWIS	Road Weather Information System
STMC	Statewide Transportation Management Center
TMC	Transportation Management Center
USDOT	United States Department of Transportation

## 2. Overview of National Research

In order to gain an understanding, a literature review was performed and a survey was developed and sent to state traffic and ITS contacts throughout the country. This section summarizes the findings from the literature review and survey.

### 2.1 Literature Review Summary

As part of the research, a literature review was conducted. Documents related to FSPs were reviewed and summarized. The literature review may be found in **Appendix A**.

The following documents were reviewed.

Reference	Description	Appendix
<p><b>Incident Management Assistance Patrols: Assessment of Investment Benefits and Costs</b></p> <p>North Carolina Department of Transportation January 2005</p>	<p><b>Key Points</b></p> <ul style="list-style-type: none"> <li>▪ The IMAP program covers 384 centerline miles</li> <li>▪ Literature review conducted as part of study found benefit/costs of 2.1 to 36.2, capacity increase of 20%, and incident reduction of 19% to 77%</li> <li>▪ The performance measure utilized was delay savings per single incident</li> <li>▪ Annual operating costs averaged \$10,200 per route mile</li> <li>▪ Operating cost per vehicle/per hour averaged \$18.90</li> <li>▪ Funding mechanisms and/or business models were not identified</li> <li>▪ NCDOT developed a decision-support tool to evaluate potential sites based on incident/crash indices, spatial analysis, incident type distribution, average hourly freeway traffic volumes, and incident delay estimations</li> </ul>	<p>A.1</p>
<p><b>Evaluation of the Freeway Service Patrol (FSP) in Los Angeles</b></p> <p>California Path Program Institute of Transportation Studies University of California, Berkley September 1998</p>	<p><b>Key Points</b></p> <ul style="list-style-type: none"> <li>▪ The FSP covers over 404 centerline miles of freeway</li> <li>▪ Evaluation segment involved 7.8 mile section of I-10</li> <li>▪ Calculated benefit/costs ranged from 3.8 to 5.6</li> <li>▪ Perceived benefits include reduction in demands on police highway patrol and improved safety</li> <li>▪ The performance measure utilized was delay savings per single incident</li> <li>▪ Delay values were calculated using probe vehicle and loop detector data</li> <li>▪ Operating cost per vehicle/per hour averaged \$40.63</li> <li>▪ The average annual budget for FSP is approximately \$24 million</li> <li>▪ The FSP is funded by ½ cent sales tax approved in 1990</li> </ul>	<p>A.2</p>
<p><b>A Return on Investment Study of the Hampton Roads Safety Service Patrol Program</b></p> <p>Virginia Department of Transportation June 2007</p>	<p><b>Key Points</b></p> <ul style="list-style-type: none"> <li>▪ Eight routes are patrolled 24/7, two are dispatch only</li> <li>▪ Benefit/cost is roughly 5.0</li> <li>▪ The performance measure utilized was delay savings per single incident</li> <li>▪ Operating costs are \$900,000 per year in fleet costs and \$2,986,589 per year in labor costs</li> <li>▪ Service includes 16 pick-up trucks, one manager, six foreman, and 51 patrollers</li> <li>▪ Funding mechanisms and/or business models were not identified</li> <li>▪ Service is contracted to URS</li> <li>▪ Service has been reduced since study</li> </ul>	<p>A.3</p>

Reference	Description	Appendix
<p><b>MDOT Freeway Courtesy Patrol in Southeast Michigan: 2007 Evaluation Report</b></p> <p>Southeast Michigan Council of Governments May 2008</p>	<p><b>Key Points</b></p> <ul style="list-style-type: none"> <li>▪ Coverage are includes all or sections of Interstates 75, 94, 96, 275, 375, and 696 and Michigan Routes 5, 8, 10, 14, and 39 in the Detroit area</li> <li>▪ Routes are patrolled 24/7</li> <li>▪ 75% is patrol, 25% is dispatch only</li> <li>▪ Benefit/cost is 15.9</li> <li>▪ The performance measure utilized was delay savings</li> <li>▪ Operating cost is \$2,133,000/year</li> <li>▪ \$1,706,400 CMAQ funds, \$426,000 Michigan Transportation Fund</li> <li>▪ Service contract is open for bid and configured as performance based lump sum with predefined minimums</li> </ul>	<p>A.4</p>
<p><b>Evaluating a Roadside Assistance Program: The Penn-Lincoln Parkway Service Patrol</b></p> <p>Transportation Research Board January 2007</p>	<p><b>Key Points</b></p> <ul style="list-style-type: none"> <li>▪ The coverage area includes 20 miles of the Penn-Lincoln Parkway</li> <li>▪ Area is patrolled by three specially equipped tow trucks</li> <li>▪ Benefit/cost is 30.0</li> <li>▪ The performance measure utilized was delay savings per single incident</li> <li>▪ Operating cost is \$220,000 per year</li> <li>▪ Funding mechanisms and/or business models were not identified</li> </ul>	<p>A.5</p>
<p><b>Survey of Efforts to Evaluate Freeway Service Patrols</b></p> <p>Transportation Research Board 1994</p>	<p><b>Key Points</b></p> <ul style="list-style-type: none"> <li>▪ Thirty-two FSP programs were reviewed</li> <li>▪ Benefits included improvements in public perception, safety, delay reductions, air quality, and energy consumption reductions</li> <li>▪ Benefit/costs ranged from 2.0 to 36.0</li> <li>▪ Operating costs were not discussed</li> <li>▪ Over 50% of the programs use tow trucks</li> <li>▪ Funding for some programs included radio station sponsorship, tolls, private funding, and a charitable organization</li> </ul>	<p>A.6</p>
<p><b>Federal Highway Administration Service Patrol Handbook</b></p> <p>Federal Highway Administration July 2008</p>	<p><b>Key Points</b></p> <ul style="list-style-type: none"> <li>▪ Document contains information relative to the development and implementation of a FSP</li> <li>▪ Identified benefits include reduced incident duration, motorist assistance, traveler information, quicker debris removal among a host of others</li> <li>▪ Operating costs range from \$35 to \$98 per service hour</li> <li>▪ Funding mechanisms identifies include legislative appropriations, operations and maintenance funds, traffic and safety funds, general revenue funds, highway trust funds, toll revenues, CMAQ funds, and public/private partnerships</li> </ul>	<p>A.7</p>
<p><b>Road Ranger Benefit Cost</b></p> <p>Florida Department of Transportation November 2005</p>	<p><b>Key Points</b></p> <ul style="list-style-type: none"> <li>▪ The coverage area includes 918 centerline miles</li> <li>▪ Six of seven District provide the service, of which five are 24/7</li> <li>▪ The Florida Turnpike operates during rush hours</li> <li>▪ Benefits include delay and fuel savings</li> <li>▪ Average benefit/cost exceeded 25.0</li> <li>▪ Annual operating cost was \$1,133,085</li> <li>▪ Funding mechanisms/business models were not discussed</li> </ul>	<p>A.8</p>

## 2.2 Survey of Other States

In order to research FSPs practices across the country, a web-based survey was developed. A total of 18 responses were obtained, representing a 36 percent return rate (three responses were received from Texas). The following is a list of states responding that provided contact information:

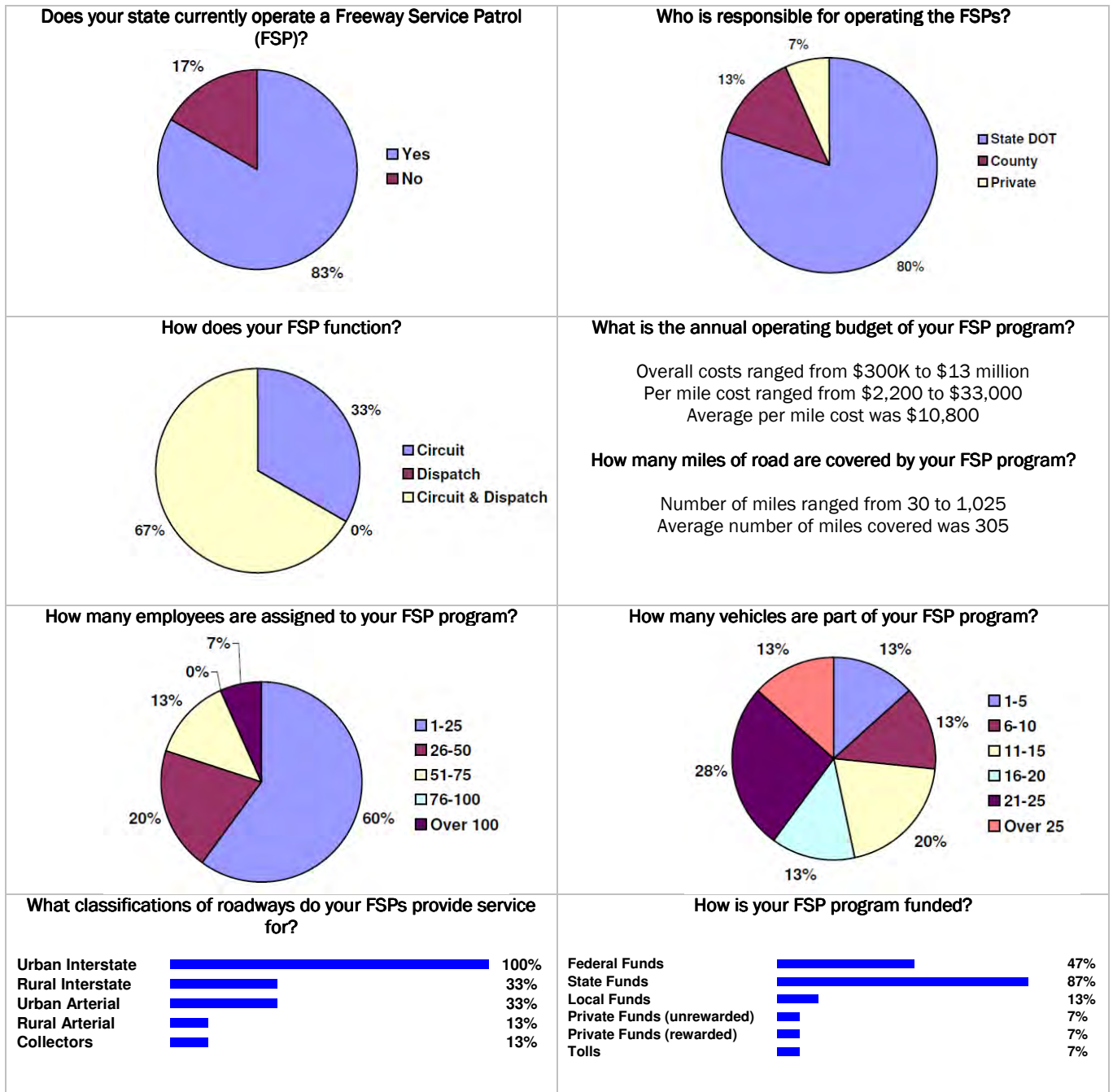
- |          |              |
|----------|--------------|
| Colorado | New Jersey   |
| Delaware | Oregon       |
| Idaho    | South Dakota |
| Kentucky | Texas        |

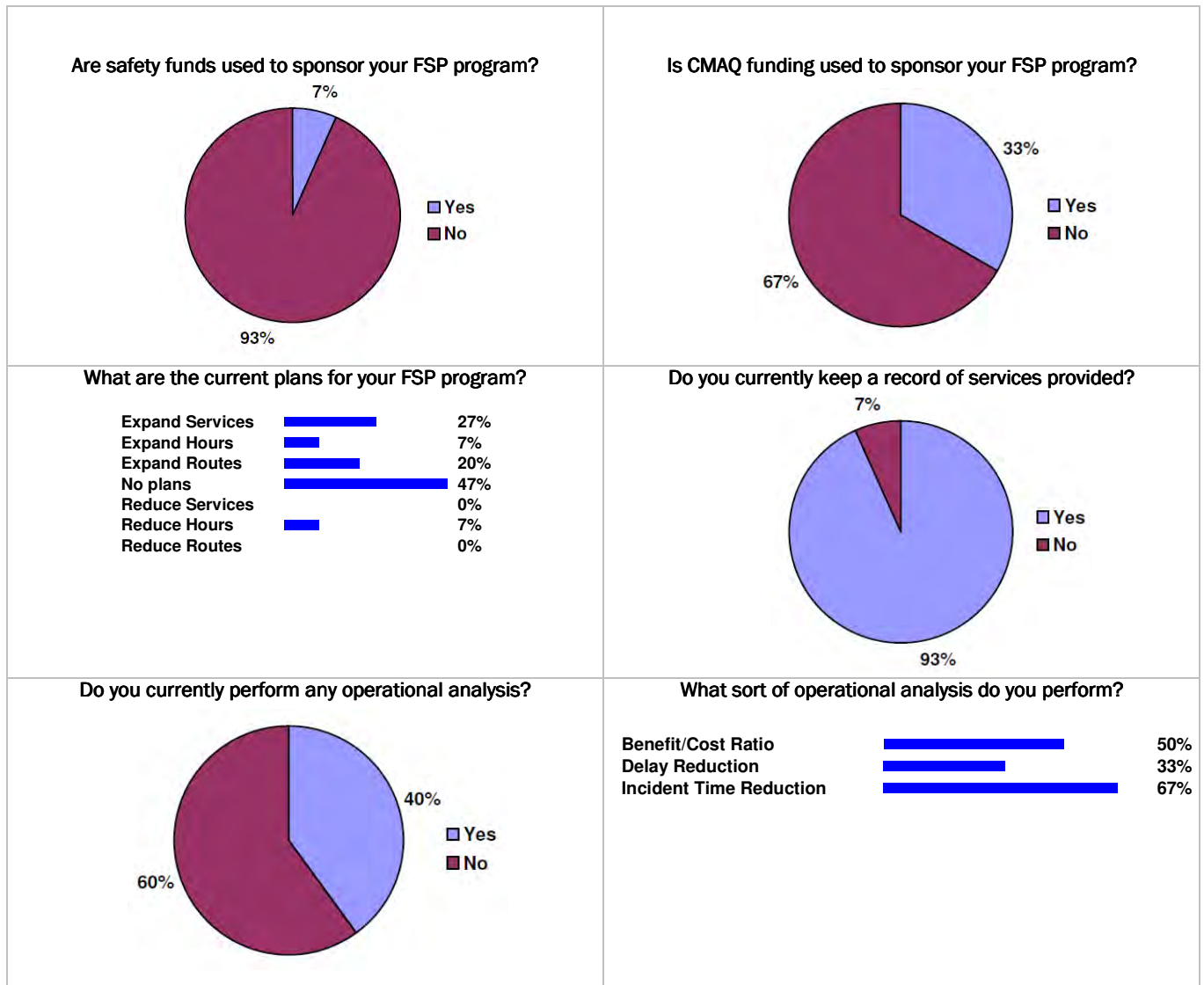


Louisiana  
Michigan  
Minnesota

Washington  
Wisconsin

A total of 25 questions were asked relative to the operational characteristics of freeway service patrols. The following is a summary of some of the more basic characteristics. A complete summary of the survey data is provided in **Appendix B**.





### 2.2.1 Services Provided and Hours of Service

The service provided generally included the following for all programs:

- Move disabled vehicles
- Provide fuel
- Provide water
- Change flat tire
- Mechanical assistance
- Assist stranded motorists
- Remove obstacles from roadway
- Arrange for towing
- Share information with other agencies
- Assist other agencies.

Additional services identified included:

- Provide temporary traffic control
- Provide first aid
- Provide antifreeze
- Transport motorists
- Provide fire suppression.

All respondents provided peak hour coverage, and three provided 24/7 coverage. However, 24/7 coverage appeared to be provided on a dispatch-only basis.

### 2.2.2 Warrants

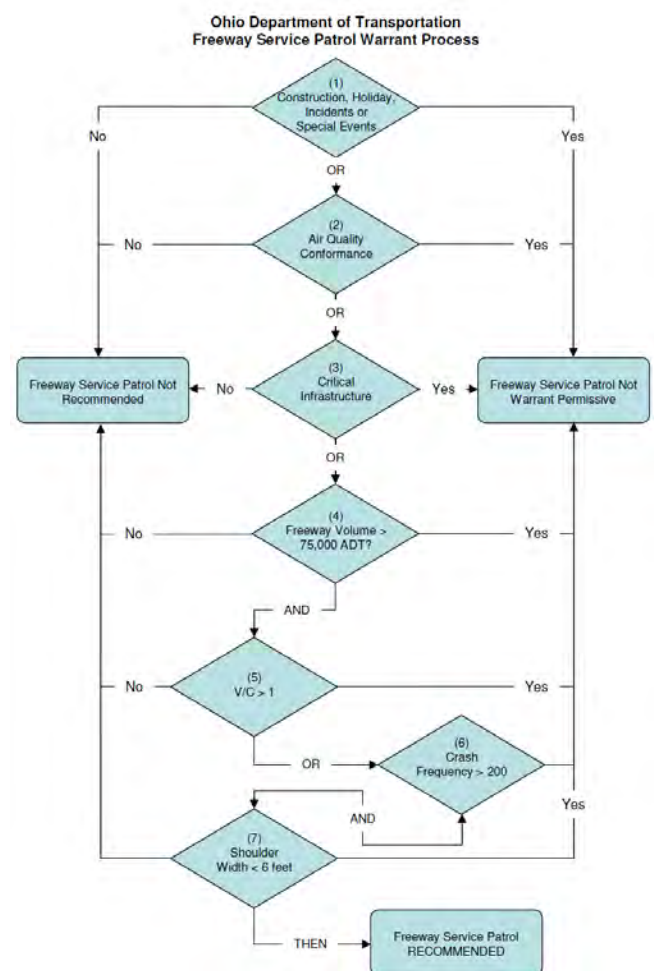
Only one respondent indicated that any type of warrants were utilized in identifying candidate locations for the implementation of FSPs (Ohio Department of Transportation). The warrants identified are as follows:

- 1) Impacted by construction, holidays, or special events
- 2) Identified as part of air quality conformity/transportation systems management plan
- 3) Part of critical infrastructure
- 4) Minimum freeway volume of 75,000 ADT
- 5) Volume-to-capacity ration greater than 1.0
- 6) In excess of 200 crashes for a three-year period for a two-mile segment
- 7) Shoulder width less than six feet.

If one of the warrants is met, the decision to implement is at the discretion of the district deputy director. If warrants 4, 5, or 6 are met, FSPs are recommended. The warrants were developed based on an evaluation of statewide traffic volumes and crashes for freeway facilities, and they do provide a qualitative starting point to identify candidate locations.

### 2.2.3 Benefit/Cost

Benefit/cost ratios ranged from 2:1 to 30:1. One respondent indicated that benefit/cost ratios have been calculated for construction and non-construction areas. The benefit/cost for construction areas ranged from 15:1 to 30:1, and for non-construction areas from 7:1 to 12:1.



#### 2.2.4 *Public/Private Partnerships*

Only four respondents have used public/private partnerships for FSPs, of which three had favorable experiences. Texas involves several private entities including the Houston Automobile Dealers Association and Verizon Wireless. In these cases, the private entities donate goods as their contribution to the program.

### 2.3 **Summary of National Best Practices**

The following provides a brief summary of pertinent points obtained from the literature search and nationwide survey.

#### 2.3.1 *Area of Coverage*

Coverage areas generally ranged from a low of 20 miles to over 1,000 miles, with an average of approximately 300 miles. Larger coverage areas were generally associated with the use of a combination of dispatch and circuit vehicles rather than circuit patrols only.

#### 2.3.2 *Benefits and Performance Measures*

Benefit/costs ranged anywhere from 2:1 to 36:1. In calculating benefit/costs, the most common unit of measure was reduction in incident duration.

#### 2.3.3 *Operating Costs*

Overall program operated costs varied greatly from \$300K to \$24 million per year. Per mile costs ranged from roughly \$1,200 to \$59,000 per year. Again, the wide variations can be explained by the relative use of dispatch vehicles as compared to circuit vehicles. The average per mile cost appeared to be approximately \$11,000.

#### 2.3.4 *Funding Mechanisms and Business Models*

Funding mechanisms generally consisted of the following:

- Sales tax
- CMAQ funds
- State transportation funds
- Federal transportation funds
- Tolls
- Sponsorships.

The majority of programs are funded using a combination of federal/state transportation funds.

### 2.3.5 *Other*

The Ohio Department of Transportation has developed warrants for the implementation of FSPs based on several criteria including traffic volume, crashes, capacity, and geometry.

**3. Overview of Existing Practices**

**3.1 Summary of District Practices**

Each of the PennDOT Districts employing FSPs (as well as the Pennsylvania Turnpike Commission) were surveyed to identify operating mechanisms and costs associated with the programs. Districts 5-0, 6-0, 8-0, and 11-0 currently utilize FSPs in some fashion. The following table provides a summary of the more important aspects of each program.

Program Aspect	District 5-0	District 6-0	District 8-0	District 11-0	PTC
<b>Circuit or Dispatch</b>	Both	Both	Both	Both	Circuit
<b># of Employees</b>	3	14	7	9	N/A
<b># of Vehicles</b>	3	9	3	7	28-29
<b># of Miles</b>	28	106	45	60	Entire System
<b>Hours of Service</b>	AM/PM Peaks	16 hours (4) AM/PM Peaks (5)	AM/PM Peaks	AM/PM Peaks Special Events	24/7
<b>Roadway Classifications</b>	Urban Interstate Urban Arterial	Urban Interstate Urban Expressway	Urban Interstate Urban Arterial	Urban Interstate Rural Interstate Urban Arterial	Urban Interstate Rural Interstate
<b>Funding</b>	80% Federal 20% State	80% Federal 20% State	100% State (county budget)	100% State	Private and tolls
<b>Record Keeping</b>	Yes	Yes	Yes	Yes	Yes
<b>B/C Analysis</b>	No	No	Yes	No	No

N/A – Not Available

Districts 8-0 and 11-0 use a minimum threshold value of 25,000 ADT in one direction and 90,000 ADT in two directions, respectively, to identify candidate locations, while also looking at crash/incident data from a qualitative standpoint.

The Pennsylvania Turnpike Commission currently operates a system-wide FSP which is partially funded by a sponsorship by State Farm Insurance. The program consists of 24-25 maintenance vehicles and 4 safety vehicles that patrol the entire Turnpike system. The maintenance vehicles provide dispatch service on a continuous 24/7 basis and the safety vehicles patrol from 7:30 AM to 3:30 PM Monday through Friday. The FSP does not provide mechanical assistance, but provides safety assistance (traffic control, towing arrangements, etc.) and coordinates response needs with the operations center. They do have contracted maintenance providers who can be contacted as needed. The State Farm sponsorship consists of three years with two, two-year options. The full seven-year program is valued at \$3.3 million, which allows for State Farm logos to be placed on the Commission operated vehicles.

In general, customer feedback has been exceptional for all FSP programs.

The following table provides a comparison of operating costs from SFY 03 to SFY 07.

District	SFY 03-07 5-Year Ave	SFY 03-07 Δ High-Low	Current SFY 08 Contract Amount	Δ SFY 08 Contract Amt - SFY 03-07 5-Year Ave
5-0	\$ 141,935.48	\$ 272,367.46	\$ 272,766.00	\$ 130,830.52
6-0	\$1,102,178.87	\$1,871,024.03	\$ 1,396,444.50	\$ 294,265.63
8-0	\$ 277,871.70	\$ 153,949.11	\$ 380,043.58	\$ 102,171.88
11-0	\$ 295,268.09	\$ 196,049.30	\$ 730,010.40	\$ 434,742.31

This table shows the cost difference between the year of most expended and the year of least expended by District over the last five years. In addition, this table shows the cost difference between the current contract amount and the 5-year average by District. It should be noted that District 6-0 has a patrol contract that was scheduled for renewal by October 2008. Based on this renewal, the contract amount would increase to approximately \$2.5 million, and the difference between this amount and the 5-year average will increase to approximately \$1.4 million.

The reasons for the increases over time are as follows by District:

District 5-0: The patrol contract has been in place for about 2.5 years. The 5-year average includes 2.5 years of no expenditures.

District 6-0: Expanded coverage with a new contract during SFY 06 and executed a new contract for its existing coverage area in SFY 07. Both of these contracts reflect a significant increase in operational costs per hour because of increased fuel prices.

District 8-0: Expanded from 2 patrol trucks to 3 patrol trucks during SFY 06.

District 11-0: Reflects an increase in operational costs per hour because of increased fuel prices and addition of PennDOT patrol personnel to Parkway North/HOV facilities.

### 3.2 Calculated Benefits

District 8-0 is the only District that conducts a benefit/cost analyses for their program, with a recent calculated value of 12:1.



**4. Findings and Suggested Actions**

**4.1 Program Coverage Areas**

Upon reviewing available literature on the subject and responses to the statewide and District surveys, it becomes evident that two of the most important factors related to maintaining traffic flow on limited access facilities are traffic volumes and crashes. In order to identify potential warrant criteria, the existing PennDOT FSP programs were reviewed relative to coverage area, traffic volumes, crashes, and number of lanes. The purpose of this exercise was to determine the characteristics of those areas deemed to be appropriate for FSPs at the present time. An Incident Factor (ADT volume\*crashes per mile) was calculated for each location in order to identify potential threshold criteria that can be used to evaluate candidate sites. The following table outlines the range of Incident Factors for each of the existing FSP programs. The detailed summary is included in **Appendix D**.

PennDOT District	Routes	Incident Factor
District 5-0	US 22	2.15
	I-78	5.95
District 6-0	I-95	31.39
	I-76	42.78
	I-476	21.74
	US 422	7.58
	US 202	10.51
District 8-0	I-81	7.61
	I-83	29.23
	I-283	10.31
	SR 581	6.62
	SR 15	7.84
District 11-0	I-279	20.76
	I-579	4.32
	I-379	15.62

Note that the threshold for Ifs for future FSP segments was determined by conducting a statistical analysis of the Pennsylvania interstate system. IFs were determined for all interstates and the average was used to establish a program baseline along with some basic qualitative analysis.

Based on a review of this information, it was deemed that a minimum Incident Factor of 5.0 should be established to validate the selection of existing locations and evaluate of potential locations. To test the application of this factor, calculations were conducted for several candidate sites as detailed in the following table.

PennDOT District	Candidate Route	Incident Factor
District 4-0	I-81	5.67
District 8-0	I-83 York	6.20
	SR 283 Lancaster	4.73
	SR 30 Lancaster	10.85
District 11-0	I-79	5.34

A review of the above data suggests that a minimum Incident Factor of 5.0 is reasonable and appropriate for the evaluation of candidate locations.



A IF threshold of 5 as well as 4 was applied to the existing Pennsylvania interstate system to determine the ramifications.

**IF5 summary based on 3-year crash records**

Miles that have FSP but do not warrant it	85.98
Miles that have FSP and do warrant it	214.23
Miles that don't have FSP and do not warrant it	2234.42
Miles that don't have FSP but do warrant it	21.65
<b>Percent of miles that have FSP but do not warrant it</b>	
	29%
<b>Percent of miles that have FSP and do warrant it</b>	
	71%
<b>Percent of miles that don't have FSP and do not warrant it</b>	
	99%
<b>Percent of miles that don't have FSP but do warrant it</b>	
	1%

**IF4 summary based on 3-year crash records**

Miles that have FSP but do not warrant it	56.66
Miles that have FSP and do warrant it	243.55
Miles that don't have FSP and do not warrant it	2209.28
Miles that don't have FSP but do warrant it	46.79
<b>Percent of miles that have FSP but do not warrant it</b>	
	19%
<b>Percent of miles that have FSP and do warrant it</b>	
	81%
<b>Percent of miles that don't have FSP and do not warrant it</b>	
	98%
<b>Percent of miles that don't have FSP but do warrant it</b>	
	2%

Based on this information and a review of the state of the practice, the following guidelines are suggested for the evaluation of candidate locations for FSPs:

- 1) Roadway must be a limited access roadway.
- 2) The segment must have an Incident Factor (IF) greater than or equal to 5.0. The (IF) shall be calculated by multiplying the average annual daily traffic (AADT) of the segment (both directions) by the annualized crashes per mile for the segment (average year for three years of crash data should be used). The calculated number should then be divided by 100,000 to obtain the resulting IF. Please note that the segment crash data must be converted to a crashes per mile value by pro rating based on segment length.

$$\text{Incident Factor (IF)} = \frac{\text{AADT} \times \text{crashes per mile}}{100,000}$$

- 3) Those segments that are on logical feeder routes or connections linking roadways meeting the criteria above.
- 4) Those segments deemed to be part of the critical infrastructure necessary to maintain traffic flow where incidents would cause excessive delay and safety concerns, or as

identified by the planning partners as a congested corridor as part of their Congestion Management Plan (CMP).

- 5) Those segments with shoulder areas less than 6 feet in width may be given priority due to the capacity constraints experienced by the inability to move vehicles from the travel lane.

Note that the threshold for IFs was determined by conducting a statistical analysis of the Pennsylvania interstate system. IFs were determined for all interstates and the average.

## 4.2 Program Services

All FSPs should provide the following recommended minimum services:

- Move disabled vehicles - Be able to tow or push a stalled or abandoned automobile or light truck out of the highway travel lane
- Provide fuel – Provide up to 2 gallons of fuel to a disabled vehicle
- Provide water – Provide water for overheating and to person(s) being assisted
- Change flat tire
- Minor mechanical assistance – Provide jump starts, tire inflation and other minor technical assistance
- Assist stranded motorists – Provide access to cell phone and direct them to a safer area
- Remove obstacles and obstructions from roadways – Remove small debris and other non-hazardous items
- Arrange for towing – Call commercial towing providers and provide towing services to a point of safety
- Share information with other agencies – Provide information including emergency service request
- Assist other agencies – Provide traffic control support to other first responders
- Provide traffic control

These are consistent with FHWA guidelines and are also consistent with existing service being provided in Engineering Districts 5-0, 6-0, 8-0 and 11-0.

Minimum hours of operation should include the morning and evening rush hour periods, and the fleet should be comprised of vehicles capable of moving disabled vehicles from the travelway.

Provide operators that are trained to safely provide limited emergency temporary traffic control at incident scenes and are trained in ICS, specifically IS-100 and IS-200 level courses.

## 4.3 Program Evaluation

It is suggested that all Districts that employ FSPs should conduct a benefit/cost analysis on an annual basis at a minimum. The analysis should be based on:

- Reduction in incident duration
- Reduction in fuel consumption

- Reduction in motorist lost wages spent in congestion
- Motorists savings per incident
- Annual cost of FSP program.

An example analysis (District 8-0) is provided in **Appendix C**.

#### 4.4 Program Budgeting

For program estimating purposes, operating costs should be calculated on a per mile basis. Based on a review of national and District operating costs, it suggested that a value of \$12,000 per mile per year be utilized.

#### 4.5 Program Consistency and Funding

It is very important that motorists (customers) encounter a consistent experience as they travel throughout the State of Pennsylvania. Several initiatives are currently underway to provide this consistency including baseline ITS device deployment and a statewide 511 traveler information service. FSPs should be no different in this goal. This can be accomplished in two ways:

- Establish a statewide FSP program (centrally funded)
- Provide implementation guidelines to the PennDOT Districts.

The minimum cost to establish a statewide FSP program would involve maintaining the current levels of funding for the existing programs in Districts 5-0, 6-0, 8-0, and 11-0. This amount for 2008 is \$2.5 million. Considering the success of the program, and many Districts' desire to expand the programs, it is not unreasonable to expect that this amount could double in the coming years to approximately \$5 million. This would be the best option to obtain statewide consistency, however it would still be desirable for the Districts to implement the program due to the close coordination required with Traffic Management Center (TMC) staffing.

If implementation is maintained at the District level, consistency may be sacrificed. However, implementation guidelines should be developed that identify program goals and minimum requirements, including:

- Services to be provided
- Reporting requirements
- Hours of operation
- Types of vehicles
- Operator requirements
- Equipment
- Communication requirements
- Contracting guidelines
- Vehicle markings (including advertising).

By maintaining FSP implementation at the District level, there may be more flexibility in obtaining funding since it will be programmed at the MPO level or utilize District maintenance funds. The

downside to this approach is the potential competition with other projects at the local level when priorities change. However, this can also be said at the statewide level.

As such, it is recommended that in the long-term that FSP funding come from Central Office (with District operations) in order to provide statewide consistency similar to ITS deployments and 511. In the mean time, implementation guidelines should be developed that provide minimum operational requirements for the Districts while continuing to utilize state/federal highway funds at the local level.

Additionally, the Federal Highway Administration (FHWA) strongly urges state DOTs to investigate the use of public/private partnerships as a way to defray the cost of FSPs. They caution to carefully choose sponsors with a strong commitment to highway safety and customer service so that the transportation agency can maintain the highest level of integrity.

## Appendix A Literature Review Summary

### Appendix A.1 Literature Review Summary – Incident Management Assistance.pdf

<b>Document Name</b>	<b>Incident Management Assistance Patrols: Assessment of Investment Benefits and Costs</b>
<b>Prepared By</b>	Asad J. Khattak
<b>Date</b>	January 2005
<b>Electronic Source</b>	<a href="http://www.ncdot.org/doh/preconstruct/traffic/tepl/Topics/I-04/I-04_report.pdf">http://www.ncdot.org/doh/preconstruct/traffic/tepl/Topics/I-04/I-04_report.pdf</a>
<b>Abstract</b>	<p>Incident Management Assistance Patrols (IMAP's), classified as part of Intelligent Transportation Systems, help enable smooth traffic flow by aiding stranded motorists and assisting in incident clearance. Many major urban areas currently have patrols and most medium-sized urban areas are following suit. The success of IMAP's has resulted in frequent requests for service expansion. The decision of where to put the next patrol is becoming more difficult because an assessment of greatest need typically indicates that the high-priority areas already have the service and possible effects of the service are often indistinguishable on lower-priority facilities. In this report, we develop a new approach that helps determine the most beneficial locations in North Carolina for patrol deployment using expanded placement criteria. Analysis of three incident/crash indices was combined with spatial analysis, incident type distributions, average hourly freeway traffic volumes, and incident delay estimations to identify, evaluate, and compare IMAP expansion candidate facilities. Results of the research have been incorporated into a decision-support tool that allows easy planning and operational assessment of candidate sites by comparing performance values between sites, modeling the effect of IMAP's, and estimating their key potential benefits and costs. By using the tool, decision-makers can quickly assess the needs of different facilities to make an informed, cost effective decision as to where to implement the next service patrol.</p>
<b>Coverage Area</b>	<ul style="list-style-type: none"> <li>▪ The model which was developed covers statewide traffic data, roadway information, per lane AADT, and 3 years of crash data</li> <li>▪ The state of North Carolina currently operates FSP in 6 Districts</li> <li>▪ The FSP program covers 384 centerline miles</li> </ul>
<b>Program</b>	<ul style="list-style-type: none"> <li>▪ Operational parameters are not discussed in this document</li> </ul>
<b>Benefits</b>	<ul style="list-style-type: none"> <li>▪ Benefits are based on delay savings for single incident types</li> <li>▪ Delay savings were estimated and then multiplied by the total number of estimated incidents</li> <li>▪ Delay was converted into monetary values</li> <li>▪ User inputs incident parameters into the model (severity, percent reduction, time of incident)</li> <li>▪ Model develops delay estimates, and delay benefit with FSP operation</li> <li>▪ User may input time value of money to produce cost savings</li> <li>▪ Results in an adjustable result based on the user data inputs</li> </ul>

	<b><u>Exhibit 20. Annual IMAP Implementation Cost/ Route Mile by NCDOT Division</u></b>			
	<b>Division</b>	<b>Length of Route (Centerline Miles)</b>	<b>Total Annual Cost</b>	<b>Total Annual Cost per Route Mile</b>
<b>Operating Costs</b>	5	43	\$436,900	\$10,200
	7	81	\$436,700	\$5,400
	9	75	\$610,600	\$8,100
	10	108	\$1,762,700	\$16,300
	12	57	\$379,000	\$6,600
	14	20	\$285,700	\$14,300
	<b>Average Cost</b>			<b>\$10,200</b>
	Note: Cost data as provided by NCDOT. <ul style="list-style-type: none"> <li>It cost \$16.70 per hour to operate a patrol vehicle in NC</li> <li>Using overhead factor of 1.4 this results in an average of \$18.90</li> <li>Due to outlier data (specifically D-14) it is suggested that the median value of \$19.00 per hour be used.</li> </ul>			
<b>Funding Mechanisms</b>	<ul style="list-style-type: none"> <li>Funding mechanisms were not discussed in this document</li> </ul>			
<b>Best Practices</b>	<ul style="list-style-type: none"> <li>Develops criteria for service expansion</li> <li>Develops a model base on roadways, crash data, and volumes</li> <li>Model used to recommend addition of routes near Raleigh and Ashville</li> <li>Recommends expansion of model to include additional parameters</li> <li>Recommends a database of FSP stops be maintained consistent with other states operations</li> <li>Encourages working outside the standard District Boundaries</li> </ul>			
<b>Other Considerations</b>	<ul style="list-style-type: none"> <li>Literature review determined BCR's of 2.1 to 36.2 among different agencies</li> <li>Literature review determined capacity increase of 20% without roadway expansion through use of FSP</li> <li>Literature review found incident reduction of 19% to 77%</li> </ul>			
<b>FSP Status</b>	<ul style="list-style-type: none"> <li>Active and considering expansion</li> </ul>			

Appendix A.2 Literature Review Summary – PRR-98-31.pdf

<b>Document Name</b>	Evaluation of the Freeway Service Patrol (FSP) in Los Angeles
<b>Published By</b>	CALIFORNIA PATH PROGRAM INSTITUTE OF TRANSPORTATION STUDIES UNIVERSITY OF CALIFORNIA, BERKELEY
<b>Date</b>	September 1998
<b>Electronic Source</b>	PRR-98-31.pdf
<b>Abstract</b>	The objectives of the study described in this report were to evaluate the effectiveness of the freeway service patrols on a 7.8 mile section of I-10 freeway (Beat 8) in Los Angeles. An evaluation methodology was developed to estimate incident delays based on field data from loop detectors and probe vehicles, and derive estimates of savings in performance measures in the absence of data for before FSP conditions. Field data were collected to develop a comprehensive database which completely describes the traffic conditions along Beat 8 for 32 weekdays, for a total of six hours each day. This 192-hour database includes detailed descriptions for 1,560 incidents, tach vehicle travel time traces for 3,619 runs (at 5.7 minute headways), and data from 240 loop detectors. Additional data include the electronic CHP/CAD logs and FSP logs for the entire study period.

	<p>The estimated benefit/cost ratios based on delay and fuel savings for a range of typical reductions in incident durations, indicate that FSP produces significant benefits at the test site. For reduction in duration due to FSP in the order of 15 minutes, the B/C ratio is greater than 5: 1. Additional benefits include reductions in air pollutant emissions, secondary accidents, CHP time used on nonenforcement activities, as well as increased safety to assisted motorists, and more efficient operation of the freeway system.</p>																																			
<b>Coverage Area</b>	<ul style="list-style-type: none"> <li>40 beats are patrolled by the service</li> <li>Covers 404 centerline miles of freeway in Los Angeles County</li> </ul>																																			
<b>Program</b>	<ul style="list-style-type: none"> <li>Operational since 1978</li> <li>Combination of Caltrans, CHP and local MPO involvement</li> <li>Patrolling tow trucks provide tire change, radiator, refill, one gallon of gas, and vehicle removal</li> <li>Average response time is 10.8 minutes</li> <li>Average beat length is 9.8 centerline miles</li> <li>Average of 3.6 trucks per beat</li> <li>The majority of FSP assists involved mechanical problems (24%), followed by flat tires (20%), and out of gas (12%).</li> <li>About 85% of the assisted incidents were located by the FSP driver, and 13% were identified by the CHP dispatcher</li> </ul>																																			
<b>Benefits</b>	<ul style="list-style-type: none"> <li>Delay calculation was based on 198 assisted incidents (out of 304)</li> <li>These incidents were based on having observed start and end times</li> <li>Value of delay savings were then converted into monetary values for inclusion in benefit cost calculations</li> <li>The reduction of congestion delay produces are reduction of excess fuel consumption and air pollutant emissions.</li> <li>Motorists assed by FSP receive time savings and direct cost benefits</li> <li>CHP receives benefit in reduction of time spent assisting motorists</li> <li>Potential benefit for research and operations data being provided by FSP vehicles</li> <li>Safety is improved by the reduction of incidents times</li> </ul> <p><b>TABLE 5.1 FSP PROGRAM BENEFITS</b></p> <table border="1"> <thead> <tr> <th rowspan="2">MOE Savings</th> <th colspan="3">Reduction in Incident Duration (min)</th> </tr> <tr> <th>10</th> <th>12.5</th> <th>15</th> </tr> </thead> <tbody> <tr> <td>Delay (veh-hr)</td> <td>462.83</td> <td>553.66</td> <td>681.34</td> </tr> <tr> <td>Fuel Consumption (gal)</td> <td>384.02</td> <td>465.08</td> <td>579.14</td> </tr> <tr> <td><b>Emissions (Kg)</b></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  H C</td> <td>50.28</td> <td>60.15</td> <td>74.02</td> </tr> <tr> <td>  c o</td> <td>394.95</td> <td>472.46</td> <td>581.41</td> </tr> <tr> <td>  Nox</td> <td>102.4</td> <td>122.49</td> <td>150.74</td> </tr> <tr> <td><b>B/C RATIO</b></td> <td><b>3.8</b></td> <td><b>4.6</b></td> <td><b>5.6</b></td> </tr> </tbody> </table>	MOE Savings	Reduction in Incident Duration (min)			10	12.5	15	Delay (veh-hr)	462.83	553.66	681.34	Fuel Consumption (gal)	384.02	465.08	579.14	<b>Emissions (Kg)</b>				H C	50.28	60.15	74.02	c o	394.95	472.46	581.41	Nox	102.4	122.49	150.74	<b>B/C RATIO</b>	<b>3.8</b>	<b>4.6</b>	<b>5.6</b>
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<b>Operating Costs</b>	<ul style="list-style-type: none"> <li>Annual budget of approximately \$24 million dollars</li> <li>Average cost per hour per beat is \$146.25 (\$40.63 per truck/hour)</li> <li>Full cost analysis provided in Appendix D</li> </ul>																																			
<b>Funding Mechanisms</b>	<ul style="list-style-type: none"> <li>Funded from a ½ cent sales tax approved in 1990 to fund Transportation Improvements</li> </ul>																																			
<b>Best Practices</b>	<ul style="list-style-type: none"> <li>Delay values were calculated by probe vehicles, loop detectors, and derived estimates of savings</li> <li>Benefit Cost ratio was determined to be 5 to 1</li> </ul>																																			
<b>Other Considerations</b>	<ul style="list-style-type: none"> <li>None</li> </ul>																																			
<b>FSP Status</b>	<ul style="list-style-type: none"> <li>Active</li> </ul>																																			



- Expansion is recommended

Appendix A.3 Literature Review Summary – Hampton Roads FFSP Cost Effectiveness Study

<b>Document Name</b>	<b>A Return on Investment Study of the Hampton Roads Safety Service Patrol Program</b>																																												
<b>Published By</b>	Virginia Department of Transportation																																												
<b>Date</b>	June 2007																																												
<b>Electronic Source</b>	Hampton Roads FFSP Cost Effectiveness Study																																												
<b>Abstract</b>	<p>Safety Service Patrol (SSP) programs are widely used to help mitigate the effects of nonrecurring congestion on our nation’s highways and have become an increasingly vital element of incident management programs. SSPs are typically deployed in areas that have high traffic volumes (e.g., urban freeways). They are charged with clearing obstructions such as debris and disabled vehicles from roadways and assisting state police with traffic control at crash scenes. In recent years and in conjunction with performance measurement activities, some state departments of transportation have initiated benefit evaluations of their SSP programs.</p> <p>In support of the Virginia Department of Transportation’s return on investment initiatives, staff from VDOT’s Operations Planning Division requested that a benefit-cost study be conducted with regard to the Hampton Roads SSP. To perform the study, an analysis of route geometrics, traffic characteristics, and incident data was conducted in the Hampton Roads area for the period from July 1, 2005, through June 30, 2006. These data were then used as inputs into an SSP evaluation model to obtain the benefits of the program.</p> <p>The research found that the total annual benefits of the Hampton Roads SSP (in terms of delay and fuel consumption) were approximately \$11.1 million. The costs associated with patrolling the routes in the region were approximately \$2.4 million; thus the savings generated by this program are nearly 5 times the expenditures it takes to run it. To understand better the program’s return on investment, the study recommends that the Hampton Roads SSP conduct an annual review of its benefits versus costs. In addition, because the Hampton Roads region experiences heavy tourist/vacation traffic during the summer months (especially during the weekends), similar reviews should also be conducted on a seasonal basis to assess the fluctuations in costs and benefits that occur during different times of the year. Performing such evaluations will require additional labor costs, but these costs can be minimized by integrating the Virginia State Police computer-aided-dispatch and SSP databases and managing them in such a way that would enable the capturing of relevant and pertinent benefit evaluation data.</p>																																												
<b>Coverage Area</b>	<ul style="list-style-type: none"> <li>At the time the study was conducted the following table was accurate, however adjustments have been made since this time.</li> </ul> <p style="text-align: center;"><b>Table 1. Hampton Roads SSP Patrolled Routes</b></p> <table border="1"> <thead> <tr> <th>Route Name</th> <th>Roadway(s)</th> <th>Begin</th> <th>End</th> </tr> </thead> <tbody> <tr> <td>Reversible Roadway (RR)</td> <td>I-64 and I-564 (reversible lanes)</td> <td>Indian River Rd.</td> <td>Naval Base Gate 3 on I-564</td> </tr> <tr> <td>Naval Base (NB)</td> <td>I-64 and I-564</td> <td>Indian River Rd.</td> <td>Naval Base Gate 3 on I-564</td> </tr> <tr> <td>2 Inner (2I)</td> <td>I-264</td> <td>Lynnhaven Pkwy. via inside lanes</td> <td>Campostella Rd.</td> </tr> <tr> <td>2 Outer (2O)</td> <td>I-264</td> <td>Lynnhaven Pkwy. via outside lanes</td> <td>Military Hwy.</td> </tr> <tr> <td>Hampton Roads Bridge Tunnel (HRBT)</td> <td>I-64</td> <td>4<sup>th</sup> View St.</td> <td>Armistead Ave.</td> </tr> <tr> <td>Coliseum A (ColA)</td> <td>I-64 and I-664</td> <td>J. Clyde Morris Blvd.</td> <td>Mallory St. on I-64 and Terminal Ave. on I-664</td> </tr> <tr> <td>Coliseum B (ColB)</td> <td>I-64 and I-664</td> <td>J. Clyde Morris Blvd.</td> <td>Mallory St. on I-64 and Terminal Ave. on I-664</td> </tr> <tr> <td>Highrise (HI)</td> <td>I-64</td> <td>Route 17</td> <td>Indian River Rd.</td> </tr> <tr> <td>Downtown Tunnel (DT)</td> <td>I-264 and I-464</td> <td>Military Hwy. via Berkeley Br.</td> <td>I-464 /I-64 Interchange</td> </tr> <tr> <td>Monitor-Merrimack Memorial Bridge Tunnel (MMMBT)</td> <td>I-664</td> <td>Aberdeen Rd. through MMMBT</td> <td>Dock Landing Rd.</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>8 routes are patrolled 24 hours a day, 7 days a week</li> <li>2 of the routes are dispatch only</li> </ul>	Route Name	Roadway(s)	Begin	End	Reversible Roadway (RR)	I-64 and I-564 (reversible lanes)	Indian River Rd.	Naval Base Gate 3 on I-564	Naval Base (NB)	I-64 and I-564	Indian River Rd.	Naval Base Gate 3 on I-564	2 Inner (2I)	I-264	Lynnhaven Pkwy. via inside lanes	Campostella Rd.	2 Outer (2O)	I-264	Lynnhaven Pkwy. via outside lanes	Military Hwy.	Hampton Roads Bridge Tunnel (HRBT)	I-64	4 <sup>th</sup> View St.	Armistead Ave.	Coliseum A (ColA)	I-64 and I-664	J. Clyde Morris Blvd.	Mallory St. on I-64 and Terminal Ave. on I-664	Coliseum B (ColB)	I-64 and I-664	J. Clyde Morris Blvd.	Mallory St. on I-64 and Terminal Ave. on I-664	Highrise (HI)	I-64	Route 17	Indian River Rd.	Downtown Tunnel (DT)	I-264 and I-464	Military Hwy. via Berkeley Br.	I-464 /I-64 Interchange	Monitor-Merrimack Memorial Bridge Tunnel (MMMBT)	I-664	Aberdeen Rd. through MMMBT	Dock Landing Rd.
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<p><b>Program</b></p>	<ul style="list-style-type: none"> <li>Program provides basic mechanical, towing , emergency services, directions, communications, and roadway services</li> <li>The program operation is contracted to URS</li> <li>URS maintains staffing consists of 1 Manager, 6 forepersons, and 51 patrollers</li> <li>URS maintains 16 pick up trucks for this service</li> </ul>																																																																																								
<p><b>Benefits</b></p>	<ul style="list-style-type: none"> <li>Total benefit was found to be \$11.1 million</li> <li>For the DT route there was an average reduction of 24.6 min per incident</li> <li>There was a model constructed to develop estimates of benefits for all the routes</li> </ul> <p style="text-align: center;"><b>Table 10. Estimates of Annual Delay Savings, Fuel Consumption Savings, and Emissions Savings</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">Route</th> <th rowspan="2">Annual Delay Savings (veh-hr)</th> <th rowspan="2">Annual Fuel Consumption Savings (gal)</th> <th colspan="3">Annual Emissions Savings (kg)</th> </tr> <tr> <th>ROG</th> <th>CO</th> <th>NOx</th> </tr> </thead> <tbody> <tr> <td>Naval Base/Reversible Roadway (NB/RR)</td> <td>138,843</td> <td>209,434</td> <td>5,521</td> <td>246</td> <td>3,690</td> </tr> <tr> <td>Hampton Roads Bridge Tunnel (HRBT)</td> <td>59,620</td> <td>89,932</td> <td>2,372</td> <td>105</td> <td>1,585</td> </tr> <tr> <td>Coliseum A/Coliseum B (CoIA/B)</td> <td>20,149</td> <td>30,393</td> <td>802</td> <td>35</td> <td>536</td> </tr> <tr> <td>Highrise (HI)</td> <td>21,683</td> <td>32,707</td> <td>863</td> <td>38</td> <td>576</td> </tr> <tr> <td>Downtown Tunnel (DT)</td> <td>21,434</td> <td>32,331</td> <td>852</td> <td>38</td> <td>569</td> </tr> <tr> <td>Monitor-Merrimack Memorial Bridge Tunnel (MMMBT)</td> <td>10,669</td> <td>16,094</td> <td>424</td> <td>18</td> <td>284</td> </tr> <tr> <td>2 Outer/2 Inner (2O/2I)</td> <td>183,458</td> <td>276,733</td> <td>7,297</td> <td>325</td> <td>4,875</td> </tr> <tr> <td><b>Total</b></td> <td><b>455,856</b></td> <td><b>687,624</b></td> <td><b>18,131</b></td> <td><b>805</b></td> <td><b>12,115</b></td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>ROG = reactive organic gases; CO = carbon monoxide; NOx = nitrogen oxides.</li> </ul>	Route	Annual Delay Savings (veh-hr)	Annual Fuel Consumption Savings (gal)	Annual Emissions Savings (kg)			ROG	CO	NOx	Naval Base/Reversible Roadway (NB/RR)	138,843	209,434	5,521	246	3,690	Hampton Roads Bridge Tunnel (HRBT)	59,620	89,932	2,372	105	1,585	Coliseum A/Coliseum B (CoIA/B)	20,149	30,393	802	35	536	Highrise (HI)	21,683	32,707	863	38	576	Downtown Tunnel (DT)	21,434	32,331	852	38	569	Monitor-Merrimack Memorial Bridge Tunnel (MMMBT)	10,669	16,094	424	18	284	2 Outer/2 Inner (2O/2I)	183,458	276,733	7,297	325	4,875	<b>Total</b>	<b>455,856</b>	<b>687,624</b>	<b>18,131</b>	<b>805</b>	<b>12,115</b>																															
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<p><b>Operating Costs</b></p>	<ul style="list-style-type: none"> <li>The following data was relevant at the time of study but has since been modified</li> <li>Service contract is to URS</li> <li>VDOT pays URS approximately \$900,000 per year in fleet costs at a rate of \$0.22 per mile</li> <li>VDOT pays URS \$2,986,589 per year in labor costs</li> </ul>																																																																																								
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<p><b>Best Practices</b></p>	<ul style="list-style-type: none"> <li>Individual BCR's were constructed for the routes</li> </ul> <p style="text-align: center;"><b>Table 12. Average Route Incidents/Day, V/C Ratios, and Benefit/Cost Ratios</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Route</th> <th>Average Incidents/Day</th> <th>V/C Ratio</th> <th>B/C Ratio</th> </tr> </thead> <tbody> <tr> <td><b>Naval Base/Reversible Roadway (NB/RR) (wk)</b></td> <td><b>27</b></td> <td><b>0.58</b></td> <td><b>8.04</b></td> </tr> <tr> <td>NB/RR (Sa)</td> <td>22</td> <td>0.42</td> <td>2.93</td> </tr> <tr> <td>NB/RR (Su)</td> <td>20</td> <td>0.40</td> <td>2.09</td> </tr> <tr> <td><b>Hampton Roads Bridge Tunnel (HRBT) (wk)</b></td> <td><b>4</b></td> <td><b>0.66</b></td> <td><b>8.02</b></td> </tr> <tr> <td>HRBT (Sa)</td> <td>5</td> <td>0.58</td> <td>9.94</td> </tr> <tr> <td>HRBT (Su)</td> <td>4</td> <td>0.56</td> <td>4.18</td> </tr> <tr> <td><b>Coliseum A/Coliseum B (CoIA/B) (wk)</b></td> <td><b>9</b></td> <td><b>0.50</b></td> <td><b>1.08</b></td> </tr> <tr> <td>CoIA/B (Sa)</td> <td>7</td> <td>0.46</td> <td>1.03</td> </tr> <tr> <td>CoIA/B (Su)</td> <td>6</td> <td>0.43</td> <td>0.44</td> </tr> <tr> <td><b>Highrise (HI) (wk)</b></td> <td><b>11</b></td> <td><b>0.56</b></td> <td><b>2.72</b></td> </tr> <tr> <td>HI (Sa)</td> <td>9</td> <td>0.41</td> <td>0.70</td> </tr> <tr> <td>HI (Su)</td> <td>7</td> <td>0.36</td> <td>0.11</td> </tr> <tr> <td><b>Downtown Tunnel (DT) (wk)</b></td> <td><b>12</b></td> <td><b>0.47</b></td> <td><b>2.90</b></td> </tr> <tr> <td>DT (Sa)</td> <td>11</td> <td>0.31</td> <td>0.00</td> </tr> <tr> <td>DT (Su)</td> <td>9</td> <td>0.26</td> <td>0.00</td> </tr> <tr> <td><b>Monitor-Merrimack Memorial Bridge Tunnel (MMMBT) (wk)</b></td> <td><b>4</b></td> <td><b>0.54</b></td> <td><b>2.00</b></td> </tr> <tr> <td>MMMBT (Sa)</td> <td>3</td> <td>0.32</td> <td>0.26</td> </tr> <tr> <td>MMMBT (Su)</td> <td>2</td> <td>0.28</td> <td>0.10</td> </tr> <tr> <td><b>2 Outer/2 Inner (2O/2I) (wk)</b></td> <td><b>33</b></td> <td><b>0.70</b></td> <td><b>12.21</b></td> </tr> <tr> <td>2O/2I (Sa)</td> <td>28</td> <td>0.35</td> <td>0.00</td> </tr> <tr> <td>2O/2I (Su)</td> <td>25</td> <td>0.31</td> <td>0.00</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>V/C = volume/capacity ratio; B/C = benefit/cost ratio; wk = weekday; Sa = Saturday; Su = Sunday.</li> <li>Note: V/C values represent an average of the highest 3-hr V/C ratios per segment per direction.</li> </ul>	Route	Average Incidents/Day	V/C Ratio	B/C Ratio	<b>Naval Base/Reversible Roadway (NB/RR) (wk)</b>	<b>27</b>	<b>0.58</b>	<b>8.04</b>	NB/RR (Sa)	22	0.42	2.93	NB/RR (Su)	20	0.40	2.09	<b>Hampton Roads Bridge Tunnel (HRBT) (wk)</b>	<b>4</b>	<b>0.66</b>	<b>8.02</b>	HRBT (Sa)	5	0.58	9.94	HRBT (Su)	4	0.56	4.18	<b>Coliseum A/Coliseum B (CoIA/B) (wk)</b>	<b>9</b>	<b>0.50</b>	<b>1.08</b>	CoIA/B (Sa)	7	0.46	1.03	CoIA/B (Su)	6	0.43	0.44	<b>Highrise (HI) (wk)</b>	<b>11</b>	<b>0.56</b>	<b>2.72</b>	HI (Sa)	9	0.41	0.70	HI (Su)	7	0.36	0.11	<b>Downtown Tunnel (DT) (wk)</b>	<b>12</b>	<b>0.47</b>	<b>2.90</b>	DT (Sa)	11	0.31	0.00	DT (Su)	9	0.26	0.00	<b>Monitor-Merrimack Memorial Bridge Tunnel (MMMBT) (wk)</b>	<b>4</b>	<b>0.54</b>	<b>2.00</b>	MMMBT (Sa)	3	0.32	0.26	MMMBT (Su)	2	0.28	0.10	<b>2 Outer/2 Inner (2O/2I) (wk)</b>	<b>33</b>	<b>0.70</b>	<b>12.21</b>	2O/2I (Sa)	28	0.35	0.00	2O/2I (Su)	25	0.31	0.00
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<p><b>Other Considerations</b></p>	<ul style="list-style-type: none"> <li>Analysis did not account for the reduction of secondary incidents as a part of the benefit calculations</li> <li>Recommends annual reviews of operations are continued to measure the effectiveness of the FSP</li> <li>Recommends better data for entry and clear times and sites</li> </ul>																																																																																								
<p><b>FSP Status</b></p>	<ul style="list-style-type: none"> <li>Active but reduced since the study</li> </ul>																																																																																								

Appendix A.4 Literature Review Summary – FreewayCourtesyPatrol\_2007.pdf

<b>Document Name</b>	<b>MDOT Freeway Courtesy Patrol in Southeast Michigan: 2007 Evaluation Report</b>
<b>Published By</b>	SEMCOG
<b>Date</b>	May 2008
<b>Electronic Source</b>	FreewayCourtesyPatrol_2007.pdf
<b>Abstract</b>	<p>This report summarizes operational changes and provides statistics on Freeway Courtesy Patrol (FCP) activities for the 2007 operation year. The FCP is part of a comprehensive incident management initiative to improve operations of the freeway system by reducing delay caused by non-recurring congestion. The Michigan Department of Transportation (MDOT) manages the FCP program that provides vital services to Metro Detroit motorists 24 hours a day, seven days a week.</p> <p>Preparation of this document was financed in part through grants from the U.S. Department of Transportation Federal Transit Administration and Federal Highway Administration through the Michigan Department of Transportation and local membership dues.</p>
<b>Coverage Area</b>	<ul style="list-style-type: none"> <li>▪ Patrols all or sections of Interstates 75, 94, 96, 275, 375, 696</li> <li>▪ Patrols all or sections of Michigan routes 5, 8, 10 14, 39</li> </ul>
<b>Program</b>	<ul style="list-style-type: none"> <li>▪ Recorded 51,554 stops in 2007</li> <li>▪ 68% were to assist motorists</li> <li>▪ 1,945 stops were to remove debris from the roadway</li> <li>▪ Between 20 and 24 service vans were in operation for the program</li> <li>▪ 75% of the FSP is run in circuit fashion and 25% is dispatch</li> <li>▪ Service provided: tire change, provide gas and fluids, mechanical assistance, five miles of towing, secure and assist crash scenes and remove debris from travel way</li> <li>▪ Service contract is open for bid and configured as a performance based lump sum with predefined minimums</li> </ul>
<b>Benefits</b>	<ul style="list-style-type: none"> <li>▪ Estimates a reduction in delay of 11.7 million hours</li> <li>▪ The delay reductions result in a pollution reduction of: 2,126 kg of VOC, 1014 kg of NOx, and 15,645 kg of CO</li> <li>▪ Calculation of BCR is based only on delay savings</li> </ul>
<b>Operating Costs</b>	<ul style="list-style-type: none"> <li>▪ Actual operating cost was \$2.3 million</li> </ul>
<b>Funding Mechanisms</b>	<ul style="list-style-type: none"> <li>▪ \$2,133,000 was programmed for the FSP</li> <li>▪ \$1,706,400 of the funding from Congestion Mitigation Air Quality</li> <li>▪ \$426,600 of the funding was from Michigan Transportation Fund</li> </ul>
<b>Best Practices</b>	<ul style="list-style-type: none"> <li>▪ A report of operations for the FSP is developed each year</li> </ul>
<b>Other Considerations</b>	<ul style="list-style-type: none"> <li>▪ BCR determined to be 15.9:1</li> </ul>
<b>FSP Status</b>	<ul style="list-style-type: none"> <li>▪ Active</li> </ul>

Appendix A.5 Literature Review Summary – PTI Freeway Service Patrol Evaluation.pdf

<b>Document Name</b>	<b>Evaluating a Roadside Assistance Program: The Penn-Lincoln Parkway Service Patrol</b>
<b>Published By</b>	TRB
<b>Date</b>	January 2007
<b>Electronic Source</b>	PTI Freeway Service Patrol Evaluation.pdf
<b>Abstract</b>	<p>The results of a preliminary evaluation of the Penn-Lincoln Parkway Service Patrol are summarized. The Pennsylvania Department of Transportation contracts with a local towing company to operate the Service Patrol on the Penn-Lincoln Parkway (PA Route 60, U. S. Route 22, and Interstates 279 and 376) in the Pittsburgh metropolitan area. The Service Patrol, consisting of specially equipped tow trucks driven by specially trained drivers, provides assistance to disabled vehicles along the parkway, thus reducing traffic delays and congestion. Service patrol hours of operation are during the morning and afternoon peak travel hours. The length of highway included in the evaluation is</p>

	approximately 32 km (20 mi). The evaluation compared data from the period January-April 1997 with incident data collected by the Pennsylvania State Police during the corresponding period in 1996. The data were analyzed to determine the effect of the Service Patrol on incident response times, incident clearance times, and incident-related congestion factors (i.e., vehicle-hours of delay, fuel consumption, and vehicle emissions). This evaluation yielded the following results: (a) the Service Patrol reduced incident response times by approximately 8.7 min; (b) the Service Patrol cleared incidents approximately 8.3 min faster than before implementation; (c) the Service Patrol reduced hours of delay by approximately 547,000 h per year; (d) total monetary savings resulting from implementation of the Service Patrol are approximately \$6.5 million per year; and (e) the public response to the Service Patrol is overwhelmingly favorable.
<b>Coverage Area</b>	<ul style="list-style-type: none"> <li>This network covers approximately 20 miles of the Penn-Lincoln Parkway</li> </ul>
<b>Program</b>	<ul style="list-style-type: none"> <li>Began in 1996</li> <li>Consists of 3 specially equipped tow trucks</li> </ul>
<b>Benefits</b>	<ul style="list-style-type: none"> <li>Response time to incident was 8.7 minutes</li> <li>Incidents were removed 8.3 minutes faster than without FSP</li> <li>FSP produced a delay reduction of 547,000 hours over one year</li> <li>Produced a total savings of \$6.5 million/year</li> </ul>
<b>Operating Costs</b>	<ul style="list-style-type: none"> <li>\$220,000 per year</li> </ul>
<b>Funding Mechanisms</b>	<ul style="list-style-type: none"> <li>Not discussed</li> </ul>
<b>Best Practices</b>	<ul style="list-style-type: none"> <li>BCR of approximately 30 to 1 is reported</li> </ul>
<b>Other Considerations</b>	<ul style="list-style-type: none"> <li>None</li> </ul>
<b>FSP Status</b>	<ul style="list-style-type: none"> <li>Active</li> </ul>

Appendix A.6 Literature Review Summary – High-Occupancy-Vehicle Systems and Freeway Operations.pdf

<b>Document Name</b>	Survey of Efforts to Evaluate Freeway Service Patrols
<b>Published By</b>	TRB
<b>Date</b>	1994
<b>Electronic Source</b>	High-Occupancy-Vehicle Systems and Freeway Operations.pdf
<b>Abstract</b>	<p>Some program administrators believe that there is no need to evaluate their service patrol programs unless funding is threatened. However, all programs should be evaluated to some extent to ensure that resources are used optimally. Before conducting an evaluation, program administrators should ask specific policy questions and clearly link the study to these questions. Therefore, it is recommended that larger programs perform comprehensive evaluations in which appropriate measures of effectiveness directly correspond with policy questions. Appropriate measures of effectiveness include the following: public perception, safety benefits, operating statistics, congestion delay, air quality and energy consumption benefits, and benefit-cost ratios. Approximately 32 service patrol programs in the United States and Canada were surveyed and the nature of the programs and the means by which their administrators are evaluating them were analyzed. All programs are very popular with motorists. Most programs keep some form of operating statistics, and several have conducted comprehensive evaluations, with benefit-cost ratios ranging from 2:1 to 36:1. Several upcoming studies also are discussed. If studies to date are any indication, service patrols are cost-effective programs to reduce incident-related congestion. If additional evaluations in large areas produce positive results, it is recommended that FHWA initiate programs and provide guidelines and training for large metropolitan areas with extreme congestion. Finally, it is recommended that states or regions coordinate similar programs and include them as part of a larger incident management program.</p>
<b>Coverage Area</b>	<ul style="list-style-type: none"> <li>32 separate FSP were reviewed as part of this study</li> </ul>

<b>Program</b>	<ul style="list-style-type: none"> <li>Over 50% of the programs examined use tow trucks as part of the service</li> </ul>										
<b>Benefits</b>	<ul style="list-style-type: none"> <li>Appropriate MOE's include public perception, safety benefits, operating statistics, congestion delay, air quality, energy consumption and BCR</li> <li>Additional MOE's include reduced peak congestion, improved air and reduced fuel consumption, and reduced secondary accidents</li> </ul>										
<b>Operating Costs</b>	<ul style="list-style-type: none"> <li>Not included</li> </ul>										
<b>Funding Mechanisms</b>	<ul style="list-style-type: none"> <li>Three of the FSP's reviewed are provided by private funding</li> <li>Samaritan, a private charitable entity, sponsors one patrol in the Boston area</li> <li>2 patrols in the Seattle area are sponsored by radio stations in return for advertising on the trucks</li> <li>Toll road and bridge patrols that were studied are provide in part by the tolls charged on these facilities</li> </ul> <table border="1"> <tr> <td>FUNDING SOURCE(S)</td> <td>State FSP, MTC SAFE, ISTE A, Federal Construction Funds</td> <td>State FSP, Local Sales Tax</td> <td>State FSP, Local Match</td> <td>State FSP, Local Match</td> <td>State FSP, Local Match</td> <td>State FSP, ISTE A, Local Match</td> <td>Maintenance Budget and Tolls</td> <td>Maintenance Budget and Federal Monies</td> <td>Gasoline Taxes and DMV Fees</td> </tr> </table>	FUNDING SOURCE(S)	State FSP, MTC SAFE, ISTE A, Federal Construction Funds	State FSP, Local Sales Tax	State FSP, Local Match	State FSP, Local Match	State FSP, Local Match	State FSP, ISTE A, Local Match	Maintenance Budget and Tolls	Maintenance Budget and Federal Monies	Gasoline Taxes and DMV Fees
FUNDING SOURCE(S)	State FSP, MTC SAFE, ISTE A, Federal Construction Funds	State FSP, Local Sales Tax	State FSP, Local Match	State FSP, Local Match	State FSP, Local Match	State FSP, ISTE A, Local Match	Maintenance Budget and Tolls	Maintenance Budget and Federal Monies	Gasoline Taxes and DMV Fees		
<b>Best Practices</b>	<ul style="list-style-type: none"> <li>Of the FSP studied BCR's ranged from 2 to 36</li> <li>Many agencies consider the FSP the "best public relations activity they have"</li> </ul>										
<b>Other Considerations</b>	<ul style="list-style-type: none"> <li>Recommends the FHWA facilitate FSP programs</li> <li>Each FSP reports production on different schedules</li> <li>BCR's are not comparable between FSP programs as different factors are included in costs and different Benefits are included in each</li> </ul>										
<b>FSP Status</b>	<ul style="list-style-type: none"> <li>Varied</li> </ul>										

Appendix A.7 Literature Review Summary – fssp\_handbook Final.pdf

<b>Document Name</b>	<b>Federal Highway Administration Service Patrol Handbook</b>
<b>Published By</b>	FHWA
<b>Date</b>	July 2008
<b>Electronic Source</b>	fssp_handbook Final.pdf
<b>Abstract</b>	This Handbook provides an overview of the Full-Function Service Patrol (FFSP) and describes desired program characteristics from the viewpoint of an agency that is responsible for funding, managing, and operating the services. Presented guidelines and rules of thumb illustrate operational characteristics, sponsorship, level of service, number of vehicles needed, vehicle types and equipment, patrol frequency, operator and manager training, and services provided. The primary audience for the Handbook comprises State department of transportation (DOT) decision-makers, managers, operators, and practitioners who are responsible for, or are considering, implementing an FFSP program as part of a strategy to reduce congestion.
<b>Coverage Area</b>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>
<b>Program</b>	<ul style="list-style-type: none"> <li>This document was developed as a guidebook for implementation and operation of FSP</li> <li>Typical services include:                             <ul style="list-style-type: none"> <li>Move disabled vehicles,</li> <li>Provide fuel</li> <li>Provide water</li> <li>Change flat tires</li> <li>Mechanical assistance</li> <li>Assist stranded motorists</li> <li>Remove obstacles and objects from roadway</li> <li>Arrange for towing</li> <li>Share information</li> <li>Assist other agencies</li> </ul> </li> <li>Document provides information on justifying this service</li> </ul>

<b>Benefits</b>	<ul style="list-style-type: none"> <li>▪ Reduced incident duration</li> <li>▪ Quicker debris removal</li> <li>▪ Assistance to stranded motorist and crash victims</li> <li>▪ Traffic control and management</li> <li>▪ Ability to receive high quality roadway information from roving patrols</li> <li>▪ Secondary benefits also noted:                         <ul style="list-style-type: none"> <li>▪ Improved traffic flow</li> <li>▪ Reduced travel time, fuel usage, and emissions</li> <li>▪ Improved travel time reliability</li> <li>▪ Improved motorist and TIM safety</li> </ul> </li> <li>▪ Frees up fire and police staff for intended purpose</li> <li>▪ Reduced number of lane closures</li> <li>▪ Reduced secondary crashes</li> <li>▪ Reduced false dispatches</li> </ul>
<b>Operating Costs</b>	<ul style="list-style-type: none"> <li>▪ Will be a function of program size and operational policies</li> <li>▪ Range from \$35 to \$98 per service hour depending on the area and type of vehicle used</li> <li>▪ Factors involved                         <ul style="list-style-type: none"> <li>▪ Operator wages and qualifications</li> <li>▪ Operator benefits</li> <li>▪ Operating training and certifications</li> <li>▪ Vehicle procurement</li> <li>▪ Vehicle maintenance</li> <li>▪ Fuel</li> <li>▪ Equipment procurement</li> <li>▪ Equipment maintenance and replenishment</li> <li>▪ Administrative cost</li> </ul> </li> </ul>
<b>Funding Mechanisms</b>	<ul style="list-style-type: none"> <li>▪ Traditional funding sources include:                         <ul style="list-style-type: none"> <li>▪ State legislative appropriations</li> <li>▪ State operations and maintenance funds</li> <li>▪ State traffic and safety funds</li> <li>▪ State general revenue funds</li> <li>▪ State highway trust funds</li> <li>▪ Public safety funds</li> <li>▪ Toll revenues</li> <li>▪ MPO funds</li> <li>▪ Federal surface transportation funds</li> <li>▪ CMAQ funds</li> <li>▪ National Highway System funds</li> </ul> </li> <li>▪ The option of Public Private Partnerships can be examined if legally allowed within the jurisdiction</li> </ul>
<b>Best Practices</b>	<ul style="list-style-type: none"> <li>▪ Recommends utilization of this document to build</li> </ul>
<b>Other Considerations</b>	<ul style="list-style-type: none"> <li>▪ This document contains significant information for the development and implementation of an FSP</li> </ul>
<b>FSP Status</b>	<ul style="list-style-type: none"> <li>▪ N/A – Focused on growing the number of FSP's</li> </ul>

Appendix A.8 Literature Review Summary – Fdot cost benefit.pdf

<b>Document Name</b>	<b>Road Ranger Benefit Cost</b>
<b>Published By</b>	Florida Department of Transportation
<b>Date</b>	November 2005
<b>Electronic Source</b>	Fdot cost benefit.pdf
<b>Abstract</b>	The objective of this study is to examine and evaluate the benefits of the Road Ranger service patrol against their operating costs in Florida. The five Districts and Turnpike were chosen due to the availability of Road Ranger program data and activity logs for analysis. The estimated benefit/cost

	ratios based on delay and fuel savings indicate and the Road Ranger program produces significant benefits in all five Districts and the Turnpike. The range of benefits and cost ratio of the Road Ranger program in different districts is from 2.3:1 to 41.5:1. the benefit-cost ratio of entire Road Ranger program is estimated to be in excess of 25:1.										
<b>Coverage Area</b>	<ul style="list-style-type: none"> <li>▪ 918 centerline miles</li> <li>▪ 6 of 7 Districts provide this service (not District 3)</li> <li>▪ Districts 1, 4, 5,6, and 7 are 24 hours a day and 7 days a week</li> <li>▪ District 2 operates 5:30 am to 7:30 pm each day</li> <li>▪ Florida Turnpike operates 6 am to 10 am and 4 pm to 8 pm 365 days a year</li> </ul>										
<b>Program</b>	<ul style="list-style-type: none"> <li>▪ Number of assists over 4 years shown below (Figure 1 of document)</li> </ul> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th>Year</th> <th>No. of Assists</th> </tr> </thead> <tbody> <tr> <td>2003</td> <td>316,883</td> </tr> <tr> <td>2002</td> <td>279,525</td> </tr> <tr> <td>2001</td> <td>198,372</td> </tr> <tr> <td>2000</td> <td>112,000</td> </tr> </tbody> </table>	Year	No. of Assists	2003	316,883	2002	279,525	2001	198,372	2000	112,000
Year	No. of Assists										
2003	316,883										
2002	279,525										
2001	198,372										
2000	112,000										
<b>Benefits</b>	<ul style="list-style-type: none"> <li>▪ Delay and fuel savings benefits were calculated by the FSPE model described in the document</li> <li>▪ Travel time estimated to be \$22.71 and fuel was \$1.96</li> <li>▪ Study also estimates savings of NOX, CO, and ROG</li> <li>▪ No dollar value assigned to pollution reduction and are not included in the BCR calculations</li> </ul>										
<b>Operating Costs</b>	<ul style="list-style-type: none"> <li>▪ \$1,133,085 (state wide)</li> <li>▪ Cost by corridor shown</li> </ul>										
<b>Funding Mechanisms</b>	<ul style="list-style-type: none"> <li>▪ Funding sources were not discussed</li> </ul>										



<b>Best Practices</b>	<b>District 2</b>	<b>Veh-hrs</b>	<b>Delay Savings (\$)</b>	<b>Fuel (gallons)</b>	<b>Fuel Savings (\$)</b>	<b>Total (\$)</b>	<b>Cost (\$)</b>	<b>B-C Ratio</b>
	I-10	2,916	66,212	3,599	7,054	74,831	13,665	6
	I-295	683	15,518	1,031	2,020	17,538	27,330	1
	I-95	2,628	59,677	3,963	7,768	67,444	27,330	3
	Turner Butler Road	1,163	26,402	1,753	3,436	29,838	13,665	2
	<b>Total</b>	<b>7,389</b>	<b>167,809</b>	<b>10,346</b>	<b>20,278</b>	<b>189,651</b>	<b>81,990</b>	
	<b>District 4</b>	<b>Veh-hrs</b>	<b>Delay Savings (\$)</b>	<b>Fuel (gallons)</b>	<b>Fuel Savings (\$)</b>	<b>Total (\$)</b>	<b>Cost (\$)</b>	<b>B-C Ratio</b>
	I-75	16,522	375,215	24,922	48,847	424,062	90,036	5
	I-595	18,260	414,685	27,544	53,986	468,671	90,036	5
	I-95	239,809	5,446,062	361,734	708,999	6,155,061	150,060	41
	<b>Total</b>	<b>274,591</b>	<b>6,235,962</b>	<b>414,200</b>	<b>811,832</b>	<b>7,047,794</b>	<b>330,132</b>	<b>21</b>
	<b>District 5</b>	<b>Veh-hrs</b>	<b>Delay Savings (\$)</b>	<b>Fuel (gallons)</b>	<b>Fuel Savings (\$)</b>	<b>Total (\$)</b>	<b>Cost (\$)</b>	<b>B-C Ratio</b>
	I-4	29,947	680,105	45,173	88,540	768,645	60,375	13
	<b>District 6</b>	<b>Veh-hrs</b>	<b>Delay Savings (\$)</b>	<b>Fuel (gallons)</b>	<b>Fuel Savings (\$)</b>	<b>Total (\$)</b>	<b>Cost (\$)</b>	<b>B-C Ratio</b>
	I-75	115	2,610	173	340	2,950	25,550	0
	I-95	224,574	5,100,073	338,754	663,958	5,764,032	77,390	75
	I-395	8,970	203,704	13,530	26,519	230,223	17,155	13
	I-195	2,503	56,845	3,776	7,400	64,246	17,155	4
	SR 836	296,902	6,742,648	447,856	877,799	7,620,447	52,025	147
	SR 112	6,751	153,319	10,184	19,960	173,279	35,950	5
	SR 878	20,216	459,096	30,494	59,768	518,864	23,325	22
	SR 826	87,594	1,989,267	132,130	258,975	2,248,242	127,750	18
	SR 874	57,378	1,303,045	86,550	169,638	1,472,683	35,960	41
	<b>Total</b>	<b>705,003</b>	<b>16,010,608</b>	<b>1,063,448</b>	<b>2,084,357</b>	<b>18,094,965</b>	<b>435,584</b>	<b>42</b>
	<b>District 7</b>	<b>Veh-hrs</b>	<b>Delay Savings (\$)</b>	<b>Fuel (gallons)</b>	<b>Fuel Savings (\$)</b>	<b>Total (\$)</b>	<b>Cost (\$)</b>	<b>B-C Ratio</b>
	I-275	80,051	1,817,958	120,751	236,672	2,054,630	117,400	18
	<b>Turnpike</b>	<b>Veh-hrs</b>	<b>Delay Savings (\$)</b>	<b>Fuel (gallons)</b>	<b>Fuel Savings (\$)</b>	<b>Total (\$)</b>	<b>Cost (\$)</b>	<b>B-C Ratio</b>
Northern Zone	13,299	302,028	20,058	39,313	341,341	53,802	6	
Southern Zone	28,589	649,245	43,088	84,453	733,698	53,802	14	
Overall Turnpike	41,888	951,273	63,146	123,766	1,075,039	107,604	10	
<b>FLORIDA</b>	<b>Veh-hrs</b>	<b>Delay Savings (\$)</b>	<b>Fuel (gallons)</b>	<b>Fuel Savings (\$)</b>	<b>Total (\$)</b>	<b>Cost (\$)</b>	<b>B-C Ratio</b>	
	1,138,869	25,863,715	1,717,064	3,365,445	29,230,724	1,133,085	26	
<b>Other Considerations</b>	<ul style="list-style-type: none"> <li>Comprehensive literature review conducted as part of this document. Found BCR's for several different FSP programs.</li> </ul>							
	<b>Table 2.2 Results of Service Patrol Benefit-Cost Studies</b>							
	<b>Patrol Location</b>	<b>Patrol Name</b>	<b>Year Performed</b>	<b>Results</b>				
	Charlotte, NC	Incident Management Assistance Patrol	1993	3:1 to 7:1				
	Chicago, IL	Emergency Traffic Patrol	1990	17:1				
	Dallas, TX	Courtesy Patrol	1995	3.3:1 to 36.2:1				
	Denver, CO	Mile High Courtesy Patrol	1996	20:1 to 23:1				
	Detroit, MI	Freeway Courtesy Patrol	1995	14:1				
	Fresno, CA	Freeway Service Patrol	1995	12.5:1				
	Houston, TX	Motorist Assistance Program	1994	6.6:1 to 23.3:1				
Los Angeles, CA	Metro Freeway Service Patrol	1993	11:1					
Minneapolis, MN	Highway Helper	1995	5:1					
New York, NY	Highway Emergency Local Patrol	1995	23.5:1					
Norfolk, VA	Safety Service Patrol	1995	2:1 to 2.5:1					
Oakland, CA	Freeway Service Patrol	1991	3.5:1					
Orange Co., CA	Freeway Service Patrol	1995	3:1					
Riverside Co., CA	Freeway Service Patrol	1995	3:1					
Sacramento, CA	Freeway Service Patrol	1995	5.5:1					
<b>FSP Status</b>	<ul style="list-style-type: none"> <li>Active</li> </ul>							

- Recommended that the program continue



## Appendix B Summary of State Surveys

**1.** Does your state currently operate a Freeway Service Patrols (FSPs)?



**2.** Who is responsible for operating the FSPs?



**3.** How does your FSP function?

		Respos Total
Circuit (vehicles are on predetermined path stopping when incident found or notified)		12
Dispatch (vehicles sent when notified)		7
Other, please specify <a href="#">view</a>		7

**Total Respondents**  
(skipped this question)

4. What is the annual operating budget of your FSP program?

View responses to this quest

**Total Respondents**

(skipped this question)

5. How many employees are assigned to your FSP program?

View responses to this quest

**Total Respondents**

(skipped this question)

6. How many vehicles are part of your FSP program?

View responses to this quest

**Total Respondents**

(skipped this question)

7. How many miles of roads are covered by your FSP program?

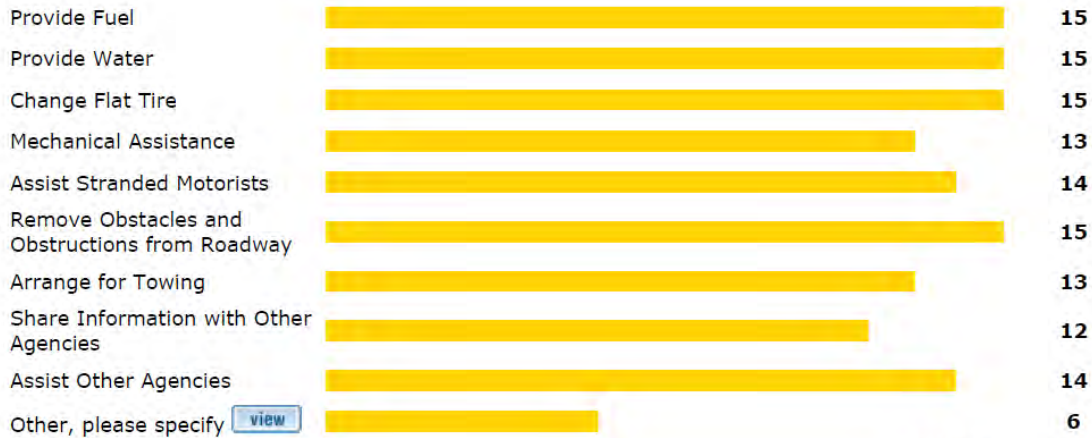
View responses to this quest

**Total Respondents**

(skipped this question)

8. What services are provided by your FSPs?

		Respos Total
Move Disabled Vehicles		14



**Total Respondents**  
(skipped this question)

**9.** What best describes your FSP hours of service?



**Total Respondents**  
(skipped this question)

**10.** If you answered other to the previous question, please describe.

View responses to this quest

**Total Respondents**  
(skipped this question)

**11.** Do you have any traffic volume warrants/ criteria for implementation of FSPs?

View responses to this quest

**Total Respondents**  
(skipped this question)

**12.** Do you have any crash warrants/ criteria for the implementation of FSPs?

View responses to this quest

**Total Respondents**

(skipped this question)

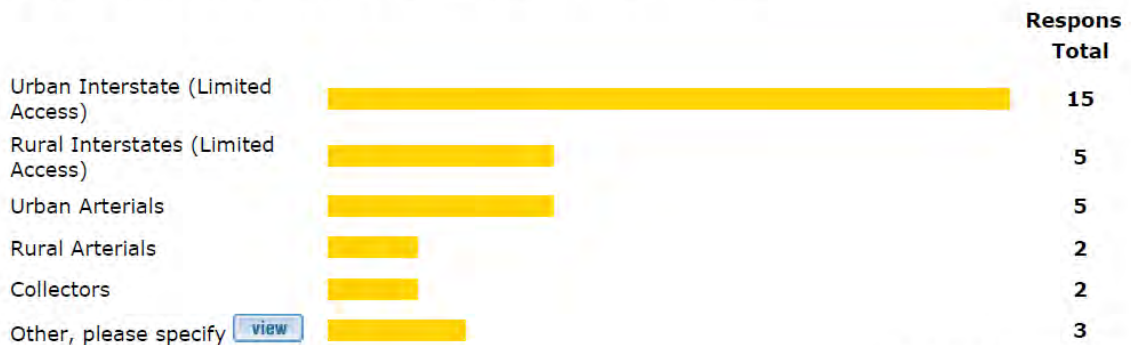
**13.** Do you have any other warrants or criteria for implementation of FSPs?

View responses to this quest

**Total Respondents**

(skipped this question)

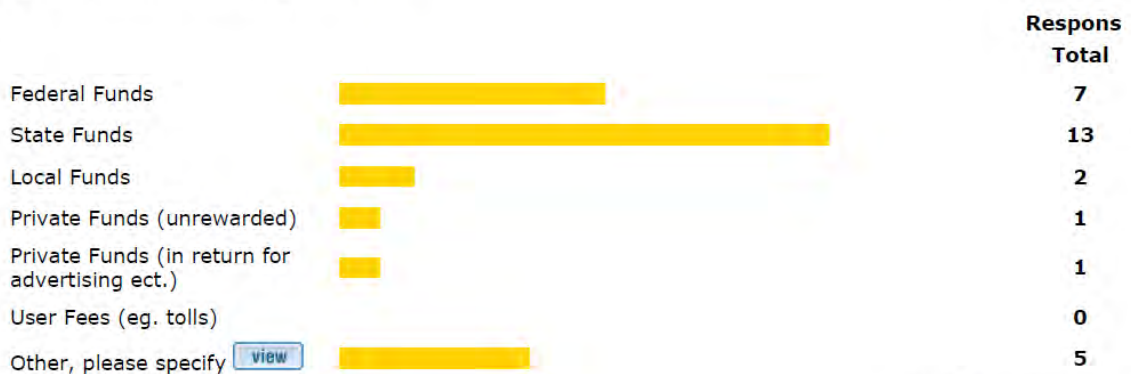
**14.** What classifications of roadways do your FSPs provide service for?



**Total Respondents**

(skipped this question)

**15.** How is your FSP program funded?



**Total Respondents**

**16.** Are safety funds used to sponsor your FSP program?



**17.** Is CMAQ funding used to sponsor your FSP program?



**18.** What are the current plans for your FSP program?



**19.** Do you currently keep a record of services provided?



**Total Respondents**  
(skipped this question)

**20.** Do you currently perform any operational analysis?

		<b>Respos Total</b>
Yes		<b>6</b>
No		<b>9</b>
		<b>Total Respondents</b> (skipped this question)

**21.** If you answered yes above, what sort of operational analysis do you perform?

		<b>Respos Total</b>
Benefit Cost Ratio		<b>3</b>
Delay Reduction		<b>2</b>
Emission Reduction		<b>0</b>
Incident Time Reduction		<b>4</b>
Traffic Modeling		<b>0</b>
Reduction of Secondary Incidents		<b>0</b>
Other, please specify <a href="#">view</a>		<b>1</b>
		<b>Total Respondents</b> (skipped this question)

**22.** If you determine a FSP program benefit-to-cost ratio, what is it?

View responses to this quest  
**Total Respondents**  
(skipped this question)

**23.** Has your jurisdiction tried any sort of public/private funding partnership?

		<b>Respos Total</b>
Yes, currently involved in partnership		<b>2</b>
Yes, in the past with a good		<b>1</b>





**24.** If you answered "yes" above, please describe the general business model and organization of your partnership.

View responses to this question

**Total Respondents**  
(skipped this question)

**25.** If you have a public/private partnership for providing FSPs, has it been favorable?



**26.** What is your name? (Optional)

View responses to this question

**Total Respondents**  
(skipped this question)

**27.** What is your email address? (Optional)

View responses to this question

**Total Respondents**  
(skipped this question)

**28.** What is your phone number? (Optional)

- 2.** Who is responsible for operating the FSPs?
  1. In Harris Co. Public/Private, Multi-Agency partnership - TxDOT, METRO, Sheriff's Office, Houston Auto Dealers Assoc. Verizon Wireless
  2. ITS Contractors in Urban areas
  
- 3.** How does your FSP function?
  1. 24/7 Emergency Call out
  2. Drivers are assigned routes to patrol and can also be dispatched as needed.
  3. primarily patrol but also dispatches as incidents become known
  4. Principally the MAP and STO vehicles run a circuit but are able to be dispatched to assist in other areas as needed
  5. combination of circuit and dipatch (dipatch monitors our ITS cameras for incidents
  6. Circuit 80% and Dispatch 20%
  7. Planned special events
  
- 4.** What is the annual operating budget of your FSP program?
  1. \$1.5 Million
  2. Approx \$9 million
  3. 13 Milllion
  4. It is absorbed by our districts in their operating costs. Total is a little more than \$2M for staff, equipment, vehicles, etc.
  5. Will send in a follow up email
  6. \$3.5 million
  7. 1,200,00.00
  8. \$1,176,000
  9. +/- \$3,250,000
  10. FY '08 = \$1.3 million
  11. \$1,550,216
  12. \$2.5 Million in the Detroit Area (about 300 miles)
  13. \$813,921.00
  14. Approx. \$4 million
  15. \$295,000.00, estimated



- 5.** How many employees are assigned to your FSP program?
1. 20 drivers, 2 supervisors, one manager
  2. About 60 including full and part time
  3. 19 supervisors and 83 drivers
  4. 29
  5. Our program is purely volunteer based so we have a pool of employees that are used to support our MAP and STO programs.
  6. 1 FTE to administer contracts
  7. 19 Employees
  8. 7
  9. 58
  10. 14 County employees
  11. 22
  12. One 24/7/365 dispatcher. two MDOT employees and 27 FCP employees
  13. 9 full time Responders, 10 full time Dispatchers
  14. 28
  15. 2 full time, 3 part time

- 6.** How many vehicles are part of your FSP program?
1. 13 - 3/4 ton pickups (10 plus 2 spares plus a supervisor truck)
  2. 55
  3. 65 patrol vehicles and 4 tow trucks and 4 Rapid Response Trucks
  4. 17
  5. 3 (2 as MAP in New Castle County, 1 in the Resort area during summer season); As part of STO as many as 2 dozen additional fleet vehicles may be used.
  6. 15
  7. 19 Tow Trucks
  8. 7
  9. 21
  10. 7
  11. 21
  12. 24 total vehicles in use and 6 additional backup.
  13. 11; 9 full time, 2 reserve
  14. 22
  15. 3

**7.** How many miles of roads are covered by your FSP program?

1. 220
2. 500, some areas have more than one unit assigned to cover the same area
3. 395
4. 430
5. Will send in a follow up email
6. 150
7. 160.00 Road Miles
8. 120
9. 335
10. 195 centerline miles
11. Regular Patrol - Approximately 180
12. 300
13. 2,965
14. 1025 (primary) 450 additional (available to respond to emergencies)
15. 30 miles of freeway on circuit patrols and the entire southwest portion of Idaho on call.

**8.** What services are provided by your FSPs?

1. provide temp traffic control at crashes and major incidents, provide First Aid/first responder
2. Assist Washington State Patrol (WSP) w/Traffic Control at collisions, Diesel pump off capabilities, Our IR personnel are dispatched by WSP
3. antifreeze and water for radiators
4. May provide very light mechanical assistance; Traffic control at incidents
5. Transport motorists, Jumpstart veh. Fire suppression, directions and information
6. First aid. Traffic control at incidents.

**10.** If you answered other to the previous question, please describe.

1. Mon-Fri we are fully staffed from 3:30 a.m. to 9:00 p.m. Sat. and Sun we are staffed 10 am to 6 pm with one driver only.  
Roving coverage from 5AM to 8:30 PM in major urban areas, Roving morning and afternoon coverage in some areas. Some rural areas have no roving coverage.
2. See coverage map here: [http://www.wsdot.wa.gov/Operations/IncidentResponse/irt\\_map.htm](http://www.wsdot.wa.gov/Operations/IncidentResponse/irt_map.htm)
3. We provide antifreeze and water for overheats. Mechanical help is limited to basic automotive repairs that can be done roadside.
4. Covering the peak hours causes us to have 2 shifts. Theoretically one driver/truck could cover both if split shifts were allowed but they are not in Ohio.  
We run a Motorist Assistance Patrol (MAP) program of 2 vehicles along 95, 495, 295 and parts of SR 1 (in New Castle County). This is typically operated during the morning and evening peak periods during the week and during the day on weekends. In summer we operate a 3rd MAP vehicle along SR 1 in the Resort/Beach area. This is supplemented by a Summer Traffic Operations (STO) program which deploys staff along a number of highly traveled resort routes (SR 1, US13, US113, 404, 24, 26 54 etc.) during the weekend travel periods roughly between mid-May and the end of September.
5. FSP operates 7 days per week, 16 hours per day during the daytime.
6. N/A
7. A mix of peak period and some routes in areas with higher volumes having the full daytime coverage
8. 5:00am - 9:30pm Mon-Fri
9. 11:00am - 7:30pm Sat-Sun
10. 6 a.m. - 10 p.m. 7 days a week
11. Mon. - Fri. 6:00 AM - 10:00 PM
12. n/a
13. 0600-2200 in most areas

**11.** Do you have any traffic volume warrants/ criteria for implementation of FSPs?

1. no
2. generally based upon traffic volume and congestion, but no magic formula.
3. Historical data is used to determine routes and hours.
4. yes
5. No. We have identified the monitored routes to be critical segments of transportation system during these periods.
6. No
7. No.
8. No
9. No
10. no
11. No - The Units patrol the urban areas where volumes are highest.
12. no
13. No.

**12.** Do you have any crash warrants/ criteria for the implementation of FSPs?

1. no
2. For us, the driver would be collision related congestion, not the number of collisions.
3. Not at this time.
4. yes
5. No.
6. No
7. No.
8. No
9. No
10. no
11. No
12. no
13. Dispatched by Idaho State Police for circuit patrols. Dispatched by District management for other incidents. The main objective is to keep traffic moving.

**13.** Do you have any other warrants or criteria for implementation of FSPs?

1. We need to have Freeway Management system elements deployed (detection, cameras, etc.)  
Incident response and clearance times by type of incident are continually monitored closely. With serious collisions, our goal is to clear them within 90 minutes or less. Minor incidents are the most common and provide the greatest opportunity to prevent collisions and congestion, so we track response and clearance times closely to monitor our performance.
2. Incident response and clearance times by type of incident are continually monitored closely. With serious collisions, our goal is to clear them within 90 minutes or less. Minor incidents are the most common and provide the greatest opportunity to prevent collisions and congestion, so we track response and clearance times closely to monitor our performance.
3. None
4. No.
5. Has to be within the boundary of a Metropolitan Planning Organization (MPO). The MPO has to provide half of the funding for their respective area.
6. No.
7. No
8. No
9. We only operate on controlled access interstate facilities in Tarrant County.  
Unit operators are Harris County Sheriff's deputies and they have criteria within their Department for patrol units.
10. Unit operators are Harris County Sheriff's deputies and they have criteria within their Department for patrol units.
11. no
12. Service deployed to try to cover as much of the limited access roadways as possible throughout the state.
13. FSP may be used for major events, haz-mat situations, fires, etc.

**14.** What classifications of roadways do your FSPs provide service for?

1. Highly travel seasonal routes
2. Parkways
3. Can be dispatched to any state route.

**15.** How is your FSP program funded?

1. None - No Program
2. we dont have one
3. No program
4. At one time we recieved some financial support from a vendor under a lease agreement at the old I9 Rest Area.
5. North Texas Tollway Authority

**21.** If you answered yes above, what sort of operational analysis do you perform?

1. Ongoing operational/activity analysis



**22.** If you determine a FSP program benefit-to-cost ratio, what is it?

1. 15.8
2. Each quarterly Gray Notebook Performance Report has an Incident Response Section : <http://www.wsdot.wa.gov/NR/rdonlyres/BE788045-A653-4716-ACB2-5D78B4>
3. Benefit to cost ratio of 19 to 1
4. n/a
5. N/A
6. From previous studies: In construction areas 15-30 to 1. In non-construction areas 7-12 to 1. Varies by lanes and shoulders available and volumes.
7. 15:1

**23.** Has your jurisdiction tried any sort of public/private funding partnership?

1. Have contracted for roving private tows in past, funding ran out. Partial sponsorship of local radio assistance van, funding expires in January 09.
2. Under consideration.
3. We have considered but not yet attempted.
4. Currently discussing options
5. We are investigating public/private funding partnership currently.
6. Considering

**24.** If you answered "yes" above, please describe the general business model and organization of your public/private partnership.

1. We contracted for roving tow trucks and a motorist assistance van in the past. No longer have funds for these. We do have instant towing program in partnership with WSP and tow industry where we pay \$25 for dry runs. We also have our Blok-Buster Tow Incentive program for heavy truck collisions that pays a \$2,500 incentive for meeting quick clearance goals.
2. see above
3. At one time we recieved some financial support from a gas station at the I95 Service Plaza that was required to operate a limited service patrol as part of their lease. In place of that they funded a portion of our program until their lease expired (at which time the station was closed as part of a pedning Service Plaza reconstruction).
4. N/A
5. Agreement form.  
Private partnership donates goods as their contribution to the program:  
Houston Automobile Dealers Assoc. - Vehicles  
Verizon Wireless - Phones and air-time  
Public Agencies contribute actual dollars as well as in-kind services.
6. Off topic: Please go to these links for further data on FCP:  
[www.michigan.gov/its](http://www.michigan.gov/its)  
[http://www.michigan.gov/mdot/0,1607,7-151-9615\\_44489\\_44992\\_48592---Y,00.html](http://www.michigan.gov/mdot/0,1607,7-151-9615_44489_44992_48592---Y,00.html)

## Appendix C Sample Benefit/Cost Analysis

### Capital Beltway Service Patrol (CBSP) Cost/Benefit Analysis

January 1, 2008 thru July 1, 2008

#### Background Information

Service Patrol Vehicles (SPV) responded to 142 crashes during this six month period and the average duration of each crash was 54 minutes. The average duration of incidents when CBSP is not on duty is 84 minutes.  $84 - 54 = 30$  minutes or 35.7% reduction of incident duration. The CBSP responds to approx 650 crashes a year.

\*  $(30 \text{ minutes}) \times (650 \text{ crashes}) = 19,500 \text{ minutes reduction in incident duration.}$

\*  $(19,500 \text{ minutes}) / (60 \text{ min per hour}) = 325 \text{ hours saved.}$

\* Beltway has AADT of 40,000  $\rightarrow (40,000 \text{ veh}) \times (K=.10) = 4,000 \text{ Vehicles per Hour}$

\*  $(4,000 \text{ veh/hour}) \times (325 \text{ hours}) = 1,300,000 \text{ impacted vehicles per year.}$

If the impact to drivers is an average of 15 minutes of delay then that is  $(1,300,000 \text{ vehicles}) \times (15 \text{ minutes}) = 19,500,000 \text{ minutes}$  or  $325,000 \text{ hours of delay per year.}$

Assuming that trucks make up 20% of traffic volume then the cost to truckers via engine idling and slow motion due to these delays can be calculated as:

$(325,000 \text{ hours of delay per year}) \times (20\% \text{ trucks}) = 65,000 \text{ hours of engine idle per year.}$

$(554,000 \text{ hours of delay per year}) \times (80\% \text{ autos}) = 260,000 \text{ hours of engine idle per year.}$

#### Calculated financial losses in fuel

Trucks consume approximately 1.2 gallons of fuel per hour while idling.

$(65,000 \text{ hours}) \times (1.2 \text{ gal/hour}) = 78,000 \text{ gallons of diesel fuel wasted.}$

$(78,000 \text{ gal}) \times (\$4.50 \text{ per gal}) = \$351,000 \text{ wasted on fuel in traffic delays.}$

Automobiles consume approximately 0.375 gallons of fuel per hour while idling.

$(260,000 \text{ hours}) \times (0.375 \text{ gal/hour}) = 97,500 \text{ gallons of fuel wasted.}$

$(97,500 \text{ gal}) \times (\$3.60 \text{ per gal}) = \$351,100 \text{ wasted on fuel in traffic delays.}$

#### Calculated financial losses in wages

$(325,000 \text{ hours of delay/year}) \times (\$12/\text{hour avg wage}) = \$3,900,000 \text{ per year wasted in wages.}$

#### Calculated costs related to 'free' CBSP services

The average cost to drivers for a service call of a tow truck is \$75 per event.

In a one year period, SPV operators provide the following services at no cost to the motorist:

Provide fuel 178 times per year

Tire repair 204 times per year

Minor repair 174 times per year

$(556 \text{ service stops per year}) \times (\$75 \text{ per event}) = \$41,700 \text{ driver savings per year.}$

#### Cost Benefit Summary for the Capital Beltway Service Patrol

\$351,000 saved in truck fuel

\$351,100 saved in automobile fuel

\$3,900,000 saved in wages

\$41,700 saved in service calls = **\$4,643,800 savings to drivers and business per year**

**\$4,643,800 (benefit per year)/\$381,000 (cost of CBSP per year)**

**B/C ratio= 12.2**

## Appendix D Incident Factor Calculations

### Existing FSP Routes

Route	Extents	District	Average 2-Way ADT	Distance (mi)	2007 Crashes	Crashes/Mile	ADT*(Crashes/mile) /100,000
I-279	I-79 to I-79	11	86364	17.1	411	24.03508772	20.75766316
I-579	-	11	70190	1.3	8	6.153846154	4.319384615
I-379	I-279 to Turnpike	11	78076	14.9	298	20	15.6152
I-95	Delaware Line to Woodhaven Road	6	137421	34.5	788	22.84057971	31.38775304
I-76	Schuylkill Expressway	6	113173	23.2	877	37.80172414	42.78134526
I-476	I-95 to I-276 (Blue Route)	6	127671	20.5	349	17.02439024	21.73520927
US-422	US-202 to PA-29	6	64968	10.8	126	11.66666667	7.5796
US-202	US-30 to Henderson Road	6	87063	13.0	157	12.07692308	10.51453154
I-78	Route 100 to Route 309/Route 145	5	61804	10.7	103	9.626168224	5.949357009
US-22	I-78 to Route 33	5	64149	17.6	59	3.352272727	2.150449432
I-81	Mountain Road (Exit 72) to Route 114	8	86723	15.5	136	8.774193548	7.609243871
I-83	I-81 to Route 114	8	82166	11.3	402	35.57522124	29.23073628
I-283	-	8	61414	2.8	47	16.78571429	10.30877857
Route 581	I-81 to I-83	8	54197	7.2	88	12.22222222	6.624077778
US-15	Slate Hill Road to Route 581	8	51102	1.5	23	15.33333333	7.83564

### Potential FSP Routes

Route	Extents	District	Average 2-Way ADT	Distance (mi)	2007 Crashes	Crashes/Mile	ADT*(Crashes/mile) /100000
I-79	Turnpike to Route 50/Washington Pike	11	56697	23.8	224	9.411764706	5.336188235
I-83	Route 238 to Route 182	8	54832	10.0	113	11.3	6.196016
Route 283	Route 722 to US 30	8	52236	3.2	29	9.0625	4.7338875
US 30	Centerville Road to Route 896	8	66628	12.4	202	16.29032258	10.85391613
I-81	Route 29/Cross Valley Expressway to Route 6/US 11/Scranton Expressway	4	67880	26.7	223	8.352059925	5.669378277





# Dynamic Message Sign Usage Policy

(Subtask E.10)

February 27, 2009



***Gannett Fleming***



Pennsylvania Department of Transportation,  
Bureau of Planning and Research  
Project Number 060908

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### Executive Summary

The purpose of this task was to conduct an evaluation of existing practices and policies for dynamic messages signs (DMSs). Also, the task included a review of the status of pilot initiatives including proposed public-private partnerships.

### National Policies

There are no written DMS operations policies at the national level. However, policies, standards, and guidance are embodied in the MUTCD and in FHWA Policy Memorandums. In summary, Federal policies dictate that:

1. DMSs shall display pertinent traffic operational and guidance information only and not advertising.
2. The use of DMSs for the display of general public information or other nonessential messages is discouraged.

Concerns expressed by FHWA include: general safety concerns regarding driver distraction, concern with possible decline in motorist credibility, and interaction with PennDOT business practices and procedures.

### Pennsylvania Polices

Pennsylvania DMS Operating Guidelines state that states, *“Advertising – messages advertising any products, service, campaign, political party, etc. are prohibited.* Additionally, current laws are very prohibitive with regard to privatization within PennDOT right-of-way.

### Other Initiatives and Studies

#### Other Initiatives

<b>California</b>	<p>Caltrans asked then Transportation Secretary Mary Peters to waive federal laws that ban commercial advertising on highway rights-of-way to allow partnerships with private businesses as a way of leveraging increasingly scarce transportation funding. In response to this proposal, Scenic America has prepared a position paper and letter to the US Department of Transportation that opposes advertising on changeable message signs based on the following:</p> <ul style="list-style-type: none"> <li>▪ Commercial advertising on the right-of-way violates the Highway Beautification Act.</li> <li>▪ Commercial advertising on the right-of-way violates the Federal Highway Statute.</li> <li>▪ Commercial advertising on the right-of-way is a willful violation of the Manual on Uniform Traffic Control Devices.</li> <li>▪ Commercial advertising on the right-of-way is a clear threat to highway safety.</li> <li>▪ Commercial advertising on the right-of-way undermines the integrity of the State’s Outdoor Advertising Code.</li> </ul> <p>To our knowledge, there has been no response from FHWA regarding California’s request as of this writing.</p>
<b>Pennsylvania Turnpike</b>	<p>Although it does not involve the use of changeable message signs for advertising as discussed above, in 2007 the Pennsylvania Turnpike Commission made a similar request of FHWA to allow co-branding of E-ZPass signs at toll plazas. FHWA denied the Turnpike’s request.</p>

Other Studies

<p><b>ITE</b></p>	<p>ITE found no statistical relationship between crashes and digital billboards, but also stated that because of the lack of crash causation data, no conclusions can be drawn regarding the ultimate safety of digital billboards.</p>
<p><b>Maryland</b></p>	<p>Maryland State Highway Administration conducted a comprehensive review of the two studies include in ITE’s effort and concluded that “it is our opinion that acceptance of these reports as valid is inappropriate and unsupported by scientific data, and that ordinance or code changes based on their findings is ill advised”</p>
<p><b>FHWA</b></p>	<p>FHWA has initiated a two-phase study to determine the potential safety risks of digital billboards to address potential safety concerns more thoroughly</p>

**Review of “SEP-15 Application – Advanced Changeable Message Sign System”**

A review was conducted of SEP-15 Application relative to the assumptions or statements contained therein. The following summarizes the concerns identified as part of this review.

- The application states that Clear Channel Digital (CCD) will be responsible for the installation, operation, and maintenance of the changeable message signs. This would relinquish control of the signs from the Districts to CCD. This is contrary to the ITS Strategic Plan identified for the Commonwealth that includes the control of these devices from State operated Traffic Management Centers (including District, Regional, and Statewide), and is likely not in the best interest of the travelling public to have the signs controlled by a private entity.
- The application states “a portion of each sign will be set aside for PennDOT’s exclusive use”. This implies that there could be advertising and PennDOT messages displayed simultaneously, which would significantly lessen the drivers recognition of critical traveler information.
- The application states that research studies “conclude that the display of information on changeable or static signs is not sufficiently distracting to contribute to highway vehicle accidents”. While the studies cited do identify that position, the ITE study discussed earlier indicates that no conclusion can be drawn regarding the ultimate safety of digital billboards.
- The application further states “there is no logical reason why the findings of the two studies should apply differently to on right-of-way signs than off right-of-way signs”. This is an opinion and there is absolutely no data to support this conclusion.
- Another cited study indicates “reductions in speed will be kept to a minimum, and possibly avoided, if clear, unambiguous text is uses on changeable message signs messages”. How will CCD guarantee that advertising messages will be clear and unambiguous? Also, the study specifically refers to “text” and does not discuss graphics. Will advertising be limited to text only?
- The application states that “PennDOT must dedicate significant staff resources, time, and money to assure the success of the Project”. Where will this infusion of staffing, time, and money come from when the States transportation resources are already stretched to their limits?

In summary, there are many questions to be answered relative to operation and control of the proposed system, resource commitments, and safety implications.

**1. Introduction**

**1.1 Background and Purpose**

The purpose of this task was to conduct an evaluation of existing practices and policies for dynamic messages signs (DMSs). Also, the task included a review of the status of pilot initiatives including proposed public-private partnerships.

Key activities included:

1. Research of existing policy and governance
2. Research of other initiatives and best practices
3. Review of the DRAFT “SEP-15 Application – Advanced Changeable Message Sign System” letter prepared by others on behalf of PennDOT for submittal to FHWA

**1.2 Contacts**

This task was performed under as part of Bureau of Planning and Research, Project Number 060908. The following are the task and contract contacts:

Last Name	First Name	Organization	Role	E-mail	Telephone
Tomlinson	Doug	BHSTE	Technical Manager	dtomlinson@state.pa.us	717.787.3657
Karavage	Lisa	BPR	Contract Manager	lkaravage@state.pa.us	717.705.2202
Metil	Mark	Gannett Fleming/ GeoDecisions	Consultant Staff	mmetil@gfnet.com	717.763.7212
Taylor	Bob	Gannett Fleming/ GeoDecisions	Consultant Staff	rtaylor@gfnet.com	717.763.7212

**1.3 Disclaimer**

The contents do not necessarily reflect the official views or policies of the Pennsylvania Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

## 1.4 Acronyms

AMBER	America's Missing: Broadcast Emergency Response
ATMS	Automated Traffic Management System
BHSTE	Bureau of Highway Safety and Traffic Engineering
BIS	Bureau of Information Systems
BPR	Bureau of Planning and Research
CCTV	Closed-Circuit Television
CMS	Changeable Message Sign
DMS	Dynamic Message Sign
DOT's	Departments of Transportation
FHWA	Federal Highway Administration
ITS	Intelligent Transportation Systems
MUTCD	Manual on Uniform Traffic Control Devices
OCC	Office of Chief Counsel
PennDOT	Pennsylvania Department of Transportation
RTMC	Regional Transportation Management Center
STMC	Statewide Transportation Management Center
USDOT	United States Department of Transportation

## 2. Policy and Governance

### 2.1 National Policies

There are no written DMS operations policies at the national level. However, policies, standards, and guidance are embodied in the MUTCD and in FHWA Policy Memorandums. In summary, Federal policies dictate that:

3. DMSs shall display pertinent traffic operational and guidance information only and not advertising.
4. The use of DMSs for the display of general public information or other nonessential messages is discouraged.
5. The display of safety messages associated with a safety campaign is allowable under the current MUTCD, as long as it conforms to sign design, location, and spacing requirements and does not block other regulatory, guide and/or warning signs.
6. AMBER Alert or child abduction messages can be displayed on DMSs if:
  - a. It is part of a well- established local AMBER Plan Program, and
  - b. Public agencies have developed a formal policy that governs the operation and messages that are displayed on DMSs.
7. Emergency or security alert messages can be displayed on DMSs if public agencies have developed policies and procedures that govern the messages.

Description of Policy	Key Points
<p>Manual on Uniform Traffic Control Devices</p> <p><a href="http://mutcd.fhwa.dot.gov/">http://mutcd.fhwa.dot.gov/</a></p>	<ul style="list-style-type: none"> <li>▪ Section 2A.07 of the Manual on Uniform Traffic Control Devices (MUTCD) requires that DMSs shall conform to the principles established in the MUTCD related to the use of signs within the right-of-way of all classes of public highways, and to the extent practical, the design and applications prescribed in Sections 6.F.02 and 6F.52.</li> <li>▪ Section 2E.21 of the MUTCD specifies that, <b><i>“Changeable message signs shall display pertinent traffic operational and guidance information only, not advertising.”</i></b></li> </ul>
<p>Memorandum on the Use of Changeable Message Signs</p> <p>January 19, 2001</p> <p><a href="http://www.fhwa.dot.gov/legisregs/directives/policy/pame.htm">http://www.fhwa.dot.gov/legisregs/directives/policy/pame.htm</a></p> <p>Appendix A</p>	<ul style="list-style-type: none"> <li>▪ Supports the use of DMSs as a traffic control device to safely and efficiently manage traffic by informing motorists of roadway conditions and required actions to perform.</li> <li>▪ <i>“Appropriate use of a CMS and other types of real-time displays should be limited to managing travel, controlling and diverting traffic, identifying current and anticipated roadway conditions, or regulating access to specific lanes or the entire roadway.”</i></li> <li>▪ <b><i>“The use of a CMS for the display of general public information or other nonessential messages is discouraged. Only essential messages should be displayed on a CMS as per MUTCD.”</i></b></li> <li>▪ <i>“The content of a CMS message should be based on requiring the motorist to take an action. However, operational, road condition, and driver safety focused messages are acceptable to be displayed on a CMS. If driver safety focused messages are to be displayed on a CMS, they should be kept current and relate to a specific safety campaign. The period of time that a specific message is displayed for a safety campaign should be limited to a few weeks. Motorists tend to ignore messages that are displayed for long periods of time.”</i></li> <li>▪ <i>“The improper operation and display of outdated or inaccurate information on a CMS has the potential to adversely affect traffic flow. Inaccurate, incomprehensible, or inappropriate information displayed on a CMS can also cause motorists to question the credibility and ignore all CMS messages. The CMS message should be continuously updated to display the action required by motorists, or to present essential information related to either the current or expected future roadway conditions.”</i></li> </ul>

Description of Policy	Key Points
<p>Memorandum on Safety Message Signs Interpretation ("Click it or Ticket" Signs)</p> <p>March 6, 2002</p> <p><a href="http://mutcd.fhwa.dot.gov/res-memorandum_clickit.htm">http://mutcd.fhwa.dot.gov/res-memorandum_clickit.htm</a></p> <p>Appendix B</p>	<ul style="list-style-type: none"> <li>▪ "The display of safety messages associated with a safety campaign is allowable under the current MUTCD, as long as it conforms to sign design, location, and spacing requirements and does not block other regulatory, guide and/or warning signs. We have determined that the "Click it or Ticket" signs meet the design requirements and are in conformance with the Manual based on the following analysis."</li> <li>▪ "The Federal Highway Administration (FHWA) supports the use of a Changeable Message Sign (CMS) as a traffic control device to safely and efficiently inform motorists of roadway conditions and required actions to perform. The FHWA issued a policy memorandum on CMS January 19, 2001. That policy gives general guidance and allows driver safety messages to be displayed on a CMS including those associated with a safety campaign. The "Click it or Ticket" sign design for a safety campaign conforms to the information in this memorandum."</li> </ul>
<p>Memorandum on AMBER Alert Use of Changeable Message Sign (CMS)</p> <p>August 16, 2002</p> <p><a href="http://www.fhwa.dot.gov/legregs/directives/policy/ambermemo.htm">http://www.fhwa.dot.gov/legregs/directives/policy/ambermemo.htm</a></p> <p>Appendix C</p>	<ul style="list-style-type: none"> <li>▪ "If public agencies decide to display AMBER Alert or child abduction messages on a CMS, FHWA has determined that this application is acceptable only if (A) it is part of a well-established local AMBER Plan Program, and (B) public agencies have developed a formal policy that governs the operation and messages that are displayed on CMS."</li> <li>▪ "(A) A local AMBER Plan Program would include written criteria for issuing and calling off an AMBER Alert, procedures on issues to coordinate with local agencies and other interests, and conforms to the recommendations of the national program (www.missingkids.org).</li> </ul>
<p>Memorandum on Use of Changeable Message Sign (CMS) for Emergency Security Messages</p> <p>March 21, 2003</p> <p><a href="http://www.fhwa.dot.gov/legregs/directives/policy/securememo.htm">http://www.fhwa.dot.gov/legregs/directives/policy/securememo.htm</a></p> <p>Appendix D</p>	<ul style="list-style-type: none"> <li>▪ <b>"We continue to discourage the display of general public information or other nonessential messages on CMS."</b></li> <li>▪ "If public agencies decide to display emergency or security alert messages on a CMS, FHWA has determined that this application is acceptable if public agencies have developed policies and procedures that govern the messages that are displayed on CMS and their operation."</li> </ul>
<p>Memorandum on Dynamic Message Sign (DMS) Recommended Practice and Guidance</p> <p>July 16, 2004</p> <p><a href="http://ops.fhwa.dot.gov/travelinfo/resources/cms_rept/travtime.htm">http://ops.fhwa.dot.gov/travelinfo/resources/cms_rept/travtime.htm</a></p> <p>Appendix E</p>	<ul style="list-style-type: none"> <li>▪ Memorandum offering recommended practices and guidance for the appropriate and effective use of DMSs.</li> <li>▪ It is important that these assets and investments be used more effectively to provide motorists with meaningful and useful information. Providing travel time information is an excellent method of notifying motorists about current conditions in a manner that can be easily interpreted and understood</li> </ul>
<p>FHWA Work Zone Safety and Mobility Final Rule</p> <p>October 12, 2007</p> <p><a href="http://ops.fhwa.dot.gov/wz/rule_guide/sec3.htm#footnote1">http://ops.fhwa.dot.gov/wz/rule_guide/sec3.htm#footnote1</a></p> <p>Appendix F</p>	<ul style="list-style-type: none"> <li>▪ "Policy guidance and agency processes and procedures help institutionalize, streamline, and standardize work zone safety and mobility practices. Policy guidance and agency processes and procedures may either be incorporated in the agency's policy, or be considered as an extension of the policy. Agency-level guidance processes and procedures for addressing work zone issues could streamline decision-making, make project delivery more efficient and effective, and ultimately result in better work zones."</li> </ul>
<p>Real-Time System Management Information Program Notice of proposed rulemaking (NPRM); request for comments.</p> <p>January 14, 2009</p> <p>Appendix G</p>	<ul style="list-style-type: none"> <li>▪ "The FHWA proposes to require that each State establish a real-time information program that would provide traffic and travel conditions reporting and support other efforts related to congestion relief. States and other public agencies instead would be encouraged to consider any salient technology, technology-dependent application, and business approach options that yield information products consistent with the requirements set forth in this proposed rule."</li> <li>▪ "Those real-time information programs that deliver traffic and travel conditions for Metropolitan Areas exceeding a population of 1 million inhabitants also would provide travel times for highway segments."</li> </ul>



## 2.2 National Guidelines for DMS

Reference	Description
<p>Changeable Message Sign Operation and Messaging Handbook</p> <p>Publication No. FHWA-OP-03-070 August 2004</p> <p>Appendix H</p>	<p>The Changeable Message Sign Operation and Messaging Handbook is written for personnel in state, regional, and local transportation agencies that have responsibility for the operation of and/or message design for large permanent changeable message signs (CMSs) or portable CMSs. The Handbook is designed to help both new and experienced users of CMSs at various levels of the agency including a) entry level personnel, b) personnel very experienced with traffic operations, and c) managers. It provides very specific information for entry-level personnel, reminders for experienced personnel, and higher-level information for managers regardless whether or not they work in one of the traffic management centers in the state.</p> <p>Restates many of the FHWA policies listed above. Also states:</p> <p><b><i>“Commercial advertisements on CMSs are prohibited by Federal regulations (see Section 2E.21 in MUTCD). The illegality is also emphasized in two memoranda—one written in 1995 by Jerry L. Malone, Chief Counsel, FHWA (19) and the other written in 2001 by Christine M. Johnson, Program Manager, Operations and Director, ITS Joint Program Office, FHWA.</i></b></p> <p><i>Oftentimes, special events will have a significant impact on motorists—those attending the special event and those using the same primary freeway to pass by the special event location. Messages for special events can be well designed without including the private company or person sponsoring or performing at the event. For example, if Garth Brooks was performing at the Meadowlands, rather than displaying GARTH BROOKS CONCERT, the facility at which the concert will be performed MEADOWLANDS can be used.”</i></p>
<p>Impacts of Using Dynamic Features to Display Messages on Changeable Message Signs</p> <p>Publication No. FHWA-HOP-05-069 August 2005</p> <p>Appendix I</p>	<p>The objective of the research effort documented in this report was to conduct human factors driving simulator studies to determine the effects on motorists of the following three types of changeable message sign (CMS) dynamic display features: 1) flashing an entire one-phase message; 2) flashing one line of a one-phase message; and 3) alternating text on one line of a three-line CMS while keeping the other two lines of text constant on the second phase of the message thus displaying redundant information. Guidelines emanating from this research and recommendations for changes/additions to the existing sections of the Manual on Uniform Traffic Control Devices are documented.</p> <p><b>The study concluded that some dynamic features can reduce driver comprehension.</b></p>
<p>Freeway Management and Operations Handbook</p> <p>Publication No. FHWA-OP-04-003 September 2003</p> <p>Appendix H\J</p>	<p>This document is the third such handbook for freeway management and operations. It is intended to be an introductory manual – a resource document that provides an overview of the various institutional and technical issues associated with the planning, design, implementation, operation, and management of a freeway network. The goal is to provide the user with a better understanding the wide variety of potential strategies, tools, and technologies that may be used to support management and operation of the freeway network.</p>

## 2.3 Additional FHWA Perspectives

FHWA was contacted to gain current perspectives on public-private dynamic message sign usage partnerships.

Jim Hunt of the FHWA - Pennsylvania Division office noted that although California had indicated they might request approval to enter into a similar arrangement as a Special Experimental Project, to date no official request has apparently been made. He also noted that while FHWA HQ may consider such a request, staff has serious reservations related to violations of the MUTCD and Highway Beautification Act (HBA). Specific concerns include:

- General safety concerns regarding driver distraction
- Concern with possible decline in motorist credibility

- Given that DMS operation is so closely tied to internal PennDOT business practices and standard operating procedures related to traveler information, emergency management, traffic management, how will commercial procedures interact with PennDOT procedures and practices.

## 2.4 Pennsylvania Policies

### 2.4.1 Pennsylvania DMS Operating Guidelines

In June 2008, the Bureau of Highway Safety and Traffic Engineering (BHSTE) released DMS operating guidelines which are included as Appendix K. The guidelines provide guidance on when to use a DMS, when not to use a DMS, message priorities, message display, examples of standard messages and acceptable abbreviations.

The guidelines have gone through the “clearance transmittal process,” with reviews by all Districts, BHSTE, FHWA and the Office of Chief Counsel (OCC).

Section 2.11 details when not to use a DMS and specifically states, ***“Advertising – messages advertising any products, service, campaign, political party, etc. are prohibited.”***

### 2.4.2 Privatization within PennDOT Right-of-Way

Current laws are very prohibitive with regard to privatization within PennDOT right-of-way. This issue has been explored with respect to rest area operations and is currently being explored with respect to signage for truck stop parking.

The few exceptions to this have included service or directional-based privatization which includes vending machine operations and tourist-oriented directional signage at interchanges.

### 3. Other Initiatives and Studies

#### 3.1 California

In 2008, Caltrans asked then Transportation Secretary Mary Peters to waive federal laws that ban commercial advertising on highway rights-of-way to allow partnerships with private businesses as a way of leveraging increasingly scarce transportation funding. One of the specific elements being considered by Caltrans is advertising on state-owned changeable message signs that are utilized for traveler information dissemination.

In response to this proposal, Scenic America has prepared a position paper and letter to the US Department of Transportation that opposes advertising on changeable message signs based on the following:

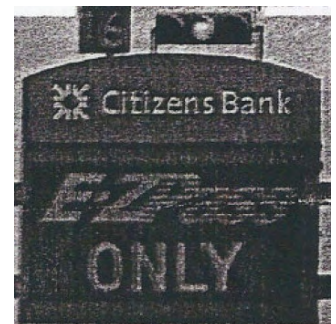
- Commercial advertising on the right-of-way violates the Highway Beautification Act.
- Commercial advertising on the right-of-way violates the Federal Highway Statute.
- Commercial advertising on the right-of-way is a willful violation of the Manual on Uniform Traffic Control Devices.
- Commercial advertising on the right-of-way is a clear threat to highway safety.
- Commercial advertising on the right-of-way undermines the integrity of the State's Outdoor Advertising Code.

It should be noted that the position paper or letter offer no research studies to back the claim that advertising is a clear threat to highway safety. To our knowledge, there has been no response from FHWA regarding California's request as of this writing.

#### 3.2 Pennsylvania Turnpike Commission

Although it does not involve the use of changeable message signs for advertising as discussed above, in 2007 the Pennsylvania Turnpike Commission made a similar request of FHWA to allow co-branding of E-ZPass signs at toll plazas. FHWA denied the Turnpike's request, citing the following:

- The proposal is in violation of FHWA's August 10, 2005 policy on the Optional Use of Acknowledgement Signs on Highway Rights-of-Way.
- The placement of acknowledgement signs in a manner which creates conflict with regulatory, warning and guide signs is not allowed.
- If Citizens Bank is not providing highway-related services for the maintenance of the roadway or its adjacent right of way, then co-branding is considered commercial advertising. Use of highway right-of-way for advertising purposes is not allowed.



### 3.3 Institute of Transportation Engineers (ITE)

In the April 2008 edition of the ITE Journal, an article titled *The Debate over Digital Billboards: Can New Technology Inform Drivers without Distracting Them?*, discusses the safety aspects of digital billboards in general. Two of the most recent studies commissioned by the Foundation of Outdoor Advertising Research and Education in 2007 found no statistical relationship between crashes and digital billboards, but also stated that because of the lack of crash causation data, no conclusions can be drawn regarding the ultimate safety of digital billboards.

In response, the Maryland State Highway Administration conducted a comprehensive review of the two studies and concluded that “it is our opinion that acceptance of these reports as valid is inappropriate and unsupported by scientific data, and that ordinance or code changes based on their findings is ill advised”

### 3.4 Federal Highway Administration (FHWA)

FHWA has initiated a two-phase study to determine the potential safety risks of digital billboards to address potential safety concerns more thoroughly. With respect to off-premise changeable message advertising signs (those located outside of the right-of-way), they have acknowledged that they have no scientific basis on which to prohibit the signs. However, it appears that they will continue to prohibit the use of changeable message signs within the right-of-way for advertising.

#### 4. Review of “SEP-15 Application – Advanced Changeable Message Sign System”

A review was conducted of SEP-15 Application relative to the assumptions or statements contained therein. The following summarizes the concerns identified as part of this review.

- The application states that Clear Channel Digital (CCD) will be responsible for the installation, operation, and maintenance of the changeable message signs. This would relinquish control of the signs from the Districts to CCD. This is contrary to the ITS Strategic Plan identified for the Commonwealth that includes the control of these devices from State operated Traffic Management Centers (including District, Regional, and Statewide), and is likely not in the best interest of the travelling public to have the signs controlled by a private entity.
- The application states “a portion of each sign will be set aside for PennDOT’s exclusive use”. This implies that there could be advertising and PennDOT messages displayed simultaneously, which would significantly lessen the drivers recognition of critical traveler information.
- The application states that research studies “conclude that the display of information on changeable or static signs is not sufficiently distracting to contribute to highway vehicle accidents”. While the studies cited do identify that position, the ITE study discussed earlier indicates that no conclusion can be drawn regarding the ultimate safety of digital billboards.

The application further states “there is no logical reason why the findings of the two studies should apply differently to on right-of-way signs than off right-of-way signs”. This is an opinion and there is absolutely no data to support this conclusion.

- Another cited study indicates “reductions in speed will be kept to a minimum, and possibly avoided, if clear, unambiguous text is uses on changeable message signs messages”. How will CCD guarantee that advertising messages will be clear and unambiguous? Also, the study specifically refers to “text” and does not discuss graphics. Will advertising be limited to text only?
- The application states that “PennDOT must dedicate significant staff resources, time, and money to assure the success of the Project”. Where will this infusion of staffing, time, and money come from when the States transportation resources are already stretched to their limits?

In summary, there are many questions to be answered relative to operation and control of the proposed system, resource commitments, and safety implications.



**Traffic Management  
Center Performance  
Measures for Traffic  
Incident Management  
Best Practices**  
(Subtask E.11)



***Gannett Fleming***



Pennsylvania Department of Transportation,  
Bureau of Planning and Research  
Project Number 060908

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## Appendices

- Appendix A: FHWA Reference Documents
- Appendix B: State Reference Documents
- Appendix C: Academia Reference Documents
- Appendix D: National Traffic Incident Management Coalition Reference Documents
- Appendix E: National Cooperative Highway Research Program Reference Documents
- Appendix F: American Association of State Highway Transportation Officials Reference Documents
- Appendix G: I-95 Corridor Coalition Reference Documents
- Appendix H: National Transportation Operations Coalition Reference Documents
- Appendix J: Text Reference Documents
- Appendix K: Performance Measures Matrix
- Appendix L: US Fire Administration Reference Documents



Gannett Fleming is continuing a considerable effort to raise awareness of sustainability in our day-to-day activities and our projects. Our goal is to work sustainability into our projects in a more consistent and meaningful way than we have in the past.

**As such, we are providing appendices only in electronic format in order to reduce paper waste while at the same time being able to provide additional resources and references.**



## 1. Executive Summary

According to the 2009 Urban Mobility Report, Traffic Incident Management (TIM) efforts reduced delay by over 143 million hours in 2007 for a savings of over \$3 billion in America's top 439 urban areas. The authors estimate that if traffic incident management efforts were in place on all roads the delay reduction would approach \$200 million.<sup>1</sup>

The authors of the Urban Mobility Report can make that statement because they collected raw data and equated it to measurable statements that many American's can relate to, using terms such as delay costs per year and wasted fuel. Most American's are also aware of the need to improve safety on the Nation's surface transportation system, even though they may offer differing solution sets. In any case, the magnitude of the problem must be known so that limited resources can be applied in the most efficient way possible.

This effort included the review of more than 80 publications from a variety of sources including FHWA, academia, individual states, private industry, and national coalitions. From the research over 200 performance measures were identified and cataloged as described below:

- ✓ **Program Measures** – Will justify the current direction of the program or identify the need to shift the direction of the program
  - Customer Driven Measures – Are high level and very visible to executive management and the public with the goal being to:
    - Show the value of money spent
    - Promote positive public perceptions
    - Manage public access portals to information
    - Manage public expectation
    - Demonstrate environmental stewardship
  - Efficiency Driven Measures – Focus on the overall scale of the program relative to the demands that face the program, with the goals being to:
    - Demonstrate fiscal responsibility
    - Monitor interoperability with the overall transportation network, including all available modes
    - Identify legacy systems that do not meet national standards or Federal expectations
    - Develop and maintain program totals into quarterly, biannual, and/or annual reports
- ✓ **Operation Measures** – Will ensure that the program is being executed as designed using:
  - Recurring Congestion Measures – Encompass the overall state and regional mobility goals found in the Pennsylvania Mobility Plan and the Transportation Advisory Committees Report on Congestion Mitigation and Smart Transportation.
  - Non-Recurring Congestion Measures – Include the direct functionality of TMCs as well as response to and clearance of incidents.

A performance measure matrix is included in the Appendix that assigns a classification to each performance measure that was examined.

<sup>1</sup> 2009 Urban Mobility Report, Texas Transportation Institute, Page 15, Exhibit 11



In addition to the classification system, most of the guidance related to the selection of performance measures comes from *TMC Performance Monitoring, Evaluation and Reporting, A Technical Handbook*, released by FHWA in 2005 which is included in the Appendix. The Handbook includes 152 pages that offer suggestions on how to establish an effective performance measurement program and how to implement that program. At the core of the Handbook, three categories are suggested for identifying measures for a program:

- ✓ **Inputs** - address the supply of resources available to implement a program
- ✓ **Outputs** -quantitatively address the delivery of transportation programs, projects and services
- ✓ **Outcomes** -address the degree to which the transportation system meets policy goals and objectives

Any measure that is selected needs to be outcome-based and should generally be related to addressing stakeholder and customer concerns that center on mobility, safety, and fiscal responsibility.

Yet another classification system was identified by *NCHRP Synthesis 311, Performance Measures of Operational Effectiveness for Highway Segments and Systems*. The review and findings from that work suggests measures can be generalized into five categories:

- ✓ Environmental factors
- ✓ Intensity
- ✓ Extent
- ✓ Duration
- ✓ Variation

One result of the evaluation and identified in the research effort in many sources is that the National Traffic Incident Management Coalition is one of the leading national organizations for traffic operations and should be sought as a development partner and subject matter expert. The coalition has representation from FHWA and many other public agencies facing congestion and traffic safety issues of all types.

As a result of this effort, the following performance measures were identified. Operations performance measures are those most likely to be implemented by Traffic Management Centers (TMCs).

### **Program Performance Measures**

- ✓ Delay Reduction
- ✓ Travel Time Reliability
- ✓ Planning Time Index
- ✓ Customer Satisfaction
- ✓ Wasted Fuel Consumption Reduction
- ✓ Reduced Emissions
- ✓ Dollars Saved Due to Traffic Incident Management Efforts

### **Operations Performance Measures**

- ✓ Incident Duration
- ✓ Secondary Crashes
- ✓ Benefit-Cost Ratio of Service Patrols
- ✓ Travel Time Index
- ✓ Average Speed
- ✓ TMC Performance

Section 6 of this report contains detailed information about each suggested measure including needed inputs, expected outputs and outcomes, and calculation methods.

## 2. Introduction

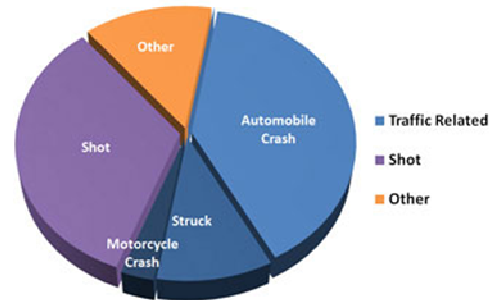
Like many other agencies, PennDOT must show the value of investment for every task implemented. Developing effective strategies to address non-recurring congestion caused by traffic incidents is a key component to operating existing highway infrastructure more effectively as described by theories relating to smart transportation. According to the Federal Highway Administration (FHWA) 25 percent of the congestion on our nation’s highways is caused by traffic incidents<sup>2</sup> and according to the National Law Enforcement Memorial Fund Research Bulletin for July 2009<sup>3</sup>, “If current trends continue, 2009 will be the 12th year in a row in which more officers are killed in traffic-related incidents than die from any other cause. Traffic-related incidents include automobile, motorcycle and bicycle crashes, plus officers struck while outside their vehicles.”

Each of the two facts highlighted by the graphs shown at the right are enough motivation to focus efforts on traffic operations and specifically, traffic incident management (TIM). Unfortunately, the need to be environmental stewards and to wisely spend shrinking amounts of available funds makes it difficult to organize and measure TIM activities.

The traffic management center (TMC) is a logical focal point for these efforts since most TMCs combine software, hardware, procedures, policies, and people to provide situational awareness, data fusion, information dissemination, and agency coordination. This text will explore opportunities to leverage the flow of data through a TMC to assist program coordinators with:

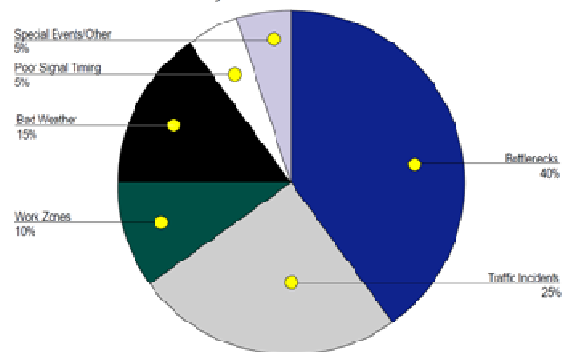
- ✓ Need and program justification
- ✓ Customer satisfaction
- ✓ Safety of field personnel
- ✓ Promoting efficient mobility
- ✓ Saving money and reducing lost time

**Causes of law enforcement officer deaths: Mid-Year 2009**



Source: National Law Enforcement Memorial Fund Research Bulletin, July 2009

**Figure ES.2 The Sources of Congestion**  
*National Summary*



Source: <http://www.ops.fhwa.dot.gov/aboutus/opstory.htm>.

Source: <http://www.ops.fhwa.dot.gov/aboutus/opstory.htm>.

<sup>2</sup> Traffic Congestion and Reliability: Linking Solutions to Problems, July 2004

<sup>3</sup> National Law Enforcement Officers Memorial Fund Research Bulletin, July 2009

## 2.1 Contacts

Last Name	First Name	Organization	Role	E-mail	Telephone
Tomlinson	Doug	BHSTE	Technical Manager	<a href="mailto:dtomlinson@state.pa.us">dtomlinson@state.pa.us</a>	717.787.3657
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Rensel	Eric	Gannett Fleming/ GeoDecisions	Consultant Staff	<a href="mailto:erensel@gfnet.com">erensel@gfnet.com</a>	717.763.7212
Taylor	Bob	Gannett Fleming/ GeoDecisions	Consultant Staff	<a href="mailto:rtaylor@gfnet.com">rtaylor@gfnet.com</a>	717.763.7212

## 2.2 Disclaimer

The contents of this report do not necessarily reflect the official views or policies of the Pennsylvania Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

## 3. TIM Performance Measurement and Situational Awareness

For the purposes of this report and Transportation Engineering in general, it is important to make the connection between different focus areas. The term of situational awareness has gained much attention in recent years; however the task of defining the term with quantifiable measurements is more difficult than initial perception may indicate.

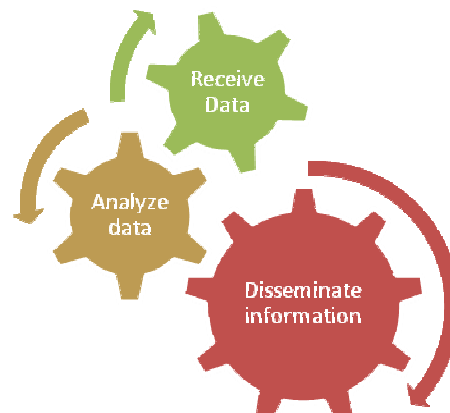
### 3.1 Traffic Management Centers

TMCs are the central location for traffic operations. A TMC represents the one place where policies, procedures, systems, and personnel combine to improve safety and reduce lost time. To better understand this, it is important to provide a frame of reference and to define what the functions of a TMC are.

#### 3.1.1 Work Flow

It is well documented that TMCs focus as a hub for information and coordination efforts within the context of traffic operations. Although specific roles and responsibilities of TMCs vary by jurisdiction and agency, the basic workflow as shown in the graph below is the general TMC workflow.

*Basic TMC Workflow shown to represent that each aspect relies heavily on the other and that the entire process is cyclical and never ending.*

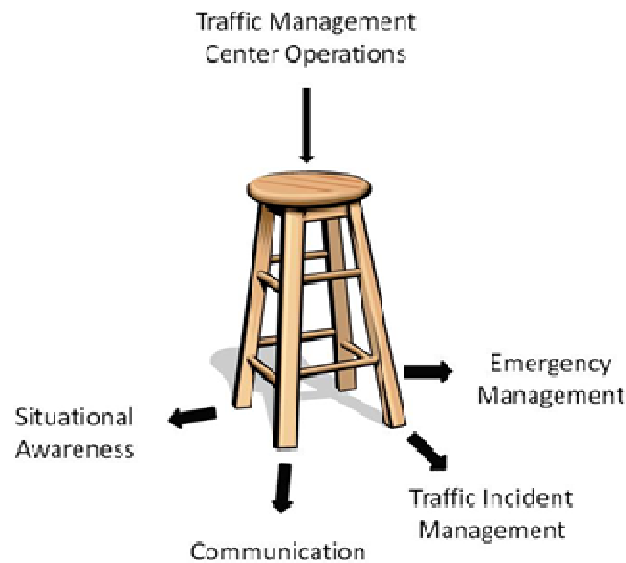


### 3.1.2 Functions

Most TMCs deal with day-to-day of tasks of:

- ✓ Maintaining systems
- ✓ Refining protocols
- ✓ Addressing staffing needs
- ✓ Compiling information for archiving purposes

At a higher level, however, TMCs generally work to fulfill the programmatic operations identified in the graphic below.



As the graphic indicates, if any one of the areas is not addressed adequately, the TMC and the agency that it supports risks negative perceptions, lost-time, reduced mobility, and less safe conditions.

General goals of TMCs for each of the four areas noted above are shown as follows:

Situational Awareness	Communication	Traffic Incident Management	Emergency Management
<ul style="list-style-type: none"> <li>▪ Maintain surveillance on ITS devices and systems</li> <li>▪ Be aware of planned events</li> <li>▪ Know the status of devices and systems</li> <li>▪ Understand who the network stakeholders are</li> <li>▪ Know how to contact all stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>▪ Maintain effective internal communication first</li> <li>▪ Understand what information sources provide validated information</li> <li>▪ Understand how to validate unverified information sources</li> <li>▪ Understand the lines of communication for each stakeholder agency</li> </ul>	<ul style="list-style-type: none"> <li>▪ Understand the agencies' roles both internally and externally</li> <li>▪ Understand how the National Incident Management System applies</li> <li>▪ Understand Chapter 6 of the MUTCD</li> <li>▪ Monitor events that may expand</li> </ul>	<ul style="list-style-type: none"> <li>▪ Identify expanding events to proper personnel</li> <li>▪ Supplement Area and/or Incident Commanders</li> <li>▪ Continue TIM responsibilities</li> </ul>

## 3.2 Traffic Incident Management

TIM philosophies are built around a few central themes:

- ✓ Every responder must go home safely
- ✓ Travelers must experience the least amount of delay possible
- ✓ Resources must be available, but must be used in the most efficient manner possible

The American Association of State Highway Transportation Officials (AASHTO) has one of the most organized TIM committees known as the National Traffic Incident Management Coalition (NTIMC). The NTIMC has been one of the chief proponents of effective TIM and has developed and released the National Unified Goal (NUG) for TIM.

Of course, the Federal Highway Administration (FHWA) is the chief governmental proponent of TIM and addressed the issue through both the Manual on Uniform Traffic Control Devices (MUTCD) and the Administration's webpage. Unlike certain aspects of highway engineering, the policies and approaches in this field are continuously evolving and being updated.

### 3.2.1 The National Unified Goal for Traffic Incident Management

According to the NTIMC website,

*"The National Unified Goal (NUG) for Traffic Incident Management (TIM) is a unified national policy developed by major national organizations representing traffic incident responders, under the leadership of the National Traffic Incident Management Coalition (NTIMC). The NUG will encourage state and local transportation and public safety agencies to adopt unified, multi-disciplinary policies, procedures and practices."*



The NUG is comprised of the three elements shown below and has eighteen cross-cutting strategies for traffic incident management.

- ✓ Responder safety
- ✓ Safe, quick incident clearance
- ✓ Prompt, reliable interoperable communications

From a performance measure standpoint, the table on the next page shows each of the strategies and how they might be applied to a State TIM program and TMC environment. The table is divided into four areas: the type of task, the inputs that are required, the outputs that are created and the outcomes that may result from the measurement. The reasoning behind the selection of these categories is described in sections 3.4 and 3.5.

# TMC Performance Measures for TIM Best Practices

(Subtask E.11)



NUG Strategy	Input	Output	Potential Outcome	
			TIM Program	TMC
TIM partners at the national, state, regional and local levels should work together to promote, develop and sustain effective TIM Programs.	<ul style="list-style-type: none"> <li>Written agreements</li> <li>Program definition</li> </ul>	<ul style="list-style-type: none"> <li>Training requirements</li> <li>Meetings</li> </ul>	<ul style="list-style-type: none"> <li>Customer satisfaction increased</li> <li>Negative public perception decreased</li> <li>Executive acceptance</li> </ul>	<ul style="list-style-type: none"> <li>More efficient use of existing resources</li> <li>Right sizing of TMCs for personnel and infrastructure</li> </ul>
TIM responders should receive multi-disciplinary NIMS and TIM training.	<ul style="list-style-type: none"> <li>Number of personnel to be trained</li> <li>Frequency of training</li> </ul>	<ul style="list-style-type: none"> <li>Percentage of personnel trained</li> <li>Increased efficiency in incident verification</li> <li>Increased fiscal responsibility for dispatched services</li> </ul>	<ul style="list-style-type: none"> <li>Increased Federal funding opportunities</li> <li>Reduction in manpower needs</li> <li>Reduction in disagreements between agencies</li> </ul>	<ul style="list-style-type: none"> <li>Personnel and infrastructure needs can be right-sized</li> </ul>
TIM partners should work together to establish and implement performance goals at the state, regional and local levels for increasing the effectiveness of TIM, including methods for measuring and monitoring progress.	<ul style="list-style-type: none"> <li>High level tasks</li> <li>Data-driven tasks</li> <li>Efficiency tasks</li> </ul>	<ul style="list-style-type: none"> <li>Measures of performance at all levels of program</li> </ul>	<ul style="list-style-type: none"> <li>Increased or decreased funding</li> <li>Funding focus identification</li> <li>System, protocol, and procedure needs</li> </ul>	<ul style="list-style-type: none"> <li>System enhancements</li> <li>Procedure streamlining</li> <li>Increased staffing</li> </ul>
TIM partners at the national, state, regional and local levels should work together for rapid and coordinated implementation of beneficial new technologies for TIM.	<ul style="list-style-type: none"> <li>Concept of Operations</li> <li>Architectures</li> <li>Stakeholder needs</li> </ul>	<ul style="list-style-type: none"> <li>Number of incidents responded to</li> <li>Efficiency of response</li> <li>Reduced incident response timeline</li> </ul>	<ul style="list-style-type: none"> <li>Right-sized TMCs</li> <li>Increased efficiencies for interagency communication and coordination</li> <li>Increased funding</li> </ul>	<ul style="list-style-type: none"> <li>Addition or subtraction of personnel</li> <li>Improved real-time communication and coordination</li> </ul>
TIM partners at the national, state, regional and local levels should join together to raise awareness regarding proposed policies and legislation that affect achievement of the NUG objectives of Responder Safety; Safe, Quick Clearance; and Prompt, Reliable Traffic Incident Communications.	<ul style="list-style-type: none"> <li>Responder safety statistics</li> <li>Incident duration statistics</li> <li>Communication protocol architectures (human and system)</li> </ul>	<ul style="list-style-type: none"> <li>Number of responders injured responding to traffic incidents</li> <li>Time to identify, verify, dispatch, clear, and return traveling conditions to normal</li> <li>Protocols for real-time communications</li> </ul>	<ul style="list-style-type: none"> <li>Increased customer satisfaction</li> <li>Changes in responder safety protocols</li> <li>Memorandums of understanding</li> </ul>	<ul style="list-style-type: none"> <li>Reduced demand for ITS deployment</li> <li>Right-sized TMCs</li> <li>Upgrades to central monitoring systems</li> </ul>



# TMC Performance Measures for TIM Best Practices

(Subtask E.11)



NUG Strategy	Input	Output	Potential Outcome	
			TIM Program	TMC
Broad partnerships should be developed to promote public awareness and education regarding the public's role in safe, efficient resolution of incidents on the roadways.	<ul style="list-style-type: none"> <li>Benchmark of customer satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>Percentage of customer satisfaction</li> <li>Increase in customer knowledge based on marketing principles</li> </ul>	<ul style="list-style-type: none"> <li>Improved public perception of the DOT</li> <li>Reduced customer complaints</li> <li>Responder safety campaigns</li> <li>Quick clearance campaigns</li> </ul>	<ul style="list-style-type: none"> <li>Additional congestion monitoring devices</li> <li>Additional resources added</li> </ul>
Recommended practices for TIM Responder Safety and for traffic control at incident scenes should be developed, and widely published, distributed and adopted.	<ul style="list-style-type: none"> <li>Existing status of TIM responder practices</li> <li>National best practices</li> </ul>	<ul style="list-style-type: none"> <li>Responder manuals</li> <li>Standard drawings for incident scenes</li> <li>Reduced infrastructure costs</li> <li>Reduced responder fatalities, injuries, and asset damage</li> </ul>	<ul style="list-style-type: none"> <li>TIP infrastructure costs are reduced</li> <li>Benefits paid due to fatalities and injuries are reduced</li> </ul>	<ul style="list-style-type: none"> <li>The amount of resources dispatched to a scene is reduced</li> <li>The amount or type of ITS devices needed are reduced</li> </ul>
Drivers should be required to Move Over/Slow Down when approaching traffic incident response vehicles and traffic incident responders on the roadway.	<ul style="list-style-type: none"> <li>Laws</li> <li>Standards for delineation</li> </ul>	<ul style="list-style-type: none"> <li>Reduced shoulder collisions</li> <li>Reduced rate of vehicle to responder collisions</li> </ul>	<ul style="list-style-type: none"> <li>Improved safety of freeway service patrol and police responders</li> </ul>	<ul style="list-style-type: none"> <li>More predictable outcomes for responder activity</li> </ul>
Driver training and awareness programs should teach drivers how to react to emergencies on the roadway in order to prevent secondary incidents, including traffic incident responder injuries and deaths.	<ul style="list-style-type: none"> <li>Revised driver training curriculum</li> <li>Secondary incident rates</li> </ul>	<ul style="list-style-type: none"> <li>Reduction in incident durations</li> <li>Reduction in queues and back logs</li> </ul>	<ul style="list-style-type: none"> <li>Increased driver awareness reducing program costs</li> </ul>	<ul style="list-style-type: none"> <li>No direct benefits, but many indirect benefits</li> </ul>
TIM partners at the state, regional and local levels should develop and adopt multidisciplinary procedures for coordination of TIM operations, based on national recommended practices and procedures.	<ul style="list-style-type: none"> <li>Stakeholder agreements</li> <li>National bench marks</li> </ul>	<ul style="list-style-type: none"> <li>More efficient coordination</li> <li>Meetings</li> </ul>	<ul style="list-style-type: none"> <li>Cost sharing among agencies</li> <li>Better overall use of State resources</li> </ul>	<ul style="list-style-type: none"> <li>Effective TIM partnerships leading to stronger relationships and reduced demand for agency resources</li> </ul>
TIM partners at the state, regional and local levels should commit to achievement of goals for traffic incident response and clearance times (as a component of broader goals for more effective TIM, see Strategy 3).	<ul style="list-style-type: none"> <li>Incident timeline milestones and duration goals</li> <li>Stakeholder agreements</li> </ul>	<ul style="list-style-type: none"> <li>Actual incident milestone durations</li> <li>Task durations</li> </ul>	<ul style="list-style-type: none"> <li>Measured success and direct evidence of resources in use positive outcomes</li> </ul>	<ul style="list-style-type: none"> <li>A more scalable approach to maintaining operations</li> </ul>



# TMC Performance Measures for TIM Best Practices

(Subtask E.11)



NUG Strategy	Input	Output	Potential Outcome	
			TIM Program	TMC
Traffic incident responders and resources should be available 24/7.	<ul style="list-style-type: none"> <li>Hours of operations</li> <li>Resource types</li> </ul>	<ul style="list-style-type: none"> <li>Money spent on resource availability</li> <li>Resource area of responsibility and coverage</li> </ul>	<ul style="list-style-type: none"> <li>Increased customer satisfaction and reduced costs of mobility</li> <li>Determination of staffing and resource levels as they tie directly to customer service</li> </ul>	<ul style="list-style-type: none"> <li>Greater customer satisfaction</li> <li>Reduced verification, dispatch, and scene arrival times</li> </ul>
Traffic incident responders should develop and implement standardized multidisciplinary traffic incident communications practices and procedures.	<ul style="list-style-type: none"> <li>Communication types</li> <li>Reliability</li> <li>Policies and procedures</li> </ul>	<ul style="list-style-type: none"> <li>Training opportunities</li> <li>Enhanced protocols</li> <li>Communication inventories</li> </ul>	<ul style="list-style-type: none"> <li>Systems and protocols that reduce the amount of lost time</li> <li>Maintaining current and efficient communication devices</li> </ul>	<ul style="list-style-type: none"> <li>Reduced dispatch of wrong resources</li> <li>Improved understanding of stakeholder needs</li> </ul>
All traffic incident responders should receive prompt, reliable notification of incidents to which they are expected to respond.	<ul style="list-style-type: none"> <li>Notification time latency</li> <li>Notification accuracy</li> <li>Stakeholder identification</li> </ul>	<ul style="list-style-type: none"> <li>Percentage of time notification is beyond the notification goal</li> <li>Percentage of time notifications (inbound and outbound) are accurate</li> <li>Stakeholder satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>Systems and/or protocols to speed up notifications and enhance the accuracy of notifications</li> <li>Stakeholder relationships can be improved</li> <li>Resources can be used more efficiently</li> </ul>	<ul style="list-style-type: none"> <li>Verified information that can be acted on quickly without question</li> <li>Improved situational awareness</li> <li>More efficient allocation of resources</li> </ul>
State, regional and local TIM stakeholders should work together to develop interoperable voice and data networks.	<ul style="list-style-type: none"> <li>Voice and data architectures from each stakeholder agency</li> </ul>	<ul style="list-style-type: none"> <li>Multiagency voice and data architecture</li> </ul>	<ul style="list-style-type: none"> <li>Appropriate technologies can be instituted to maintain or enhance communications</li> <li>Less lost time when new technologies are implemented</li> </ul>	<ul style="list-style-type: none"> <li>Reductions in lost time due to communication difficulties</li> <li>Less demand on operators to accomplish communication, possibly leading to less operators</li> </ul>
National TIM stakeholders (working through the NTIMC) should work together to reduce the barriers to integrated broadband emergency communications systems development and integration (both wired and wireless).	<ul style="list-style-type: none"> <li>Communication barriers</li> <li>Communication costs</li> <li>National comparisons</li> <li>Relationship with the NTIMC</li> </ul>	<ul style="list-style-type: none"> <li>Communication plan</li> <li>Percentage of communications below national standards</li> <li>Gaps in communication</li> </ul>	<ul style="list-style-type: none"> <li>Communication benchmarks</li> <li>Identification of overarching communication needs</li> <li>Implementation of communications to reduce lost time</li> </ul>	<ul style="list-style-type: none"> <li>Known immediate communication needs</li> <li>Known communication barriers</li> <li>Reduction in lost time to communicate</li> </ul>

# TMC Performance Measures for TIM Best Practices

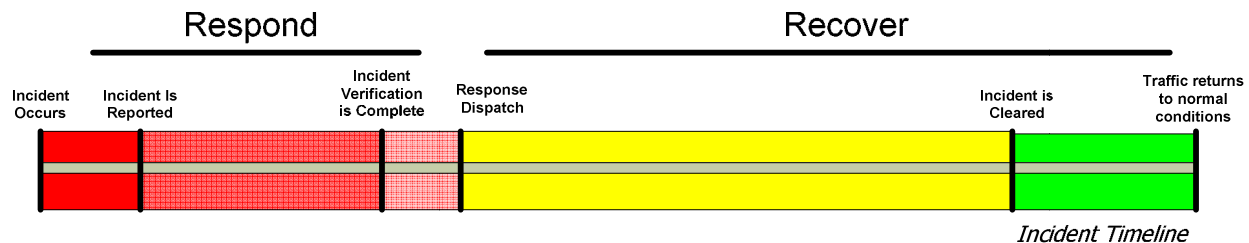
(Subtask E.11)



NUG Strategy	Input	Output	Potential Outcome	
			TIM Program	TMC
<p>TIM partners should encourage development of more prompt and reliable traveler information systems that will enable drivers to make travel decisions to reduce the impacts of emergency incidents on traffic flow.</p>	<ul style="list-style-type: none"> <li>Customer satisfaction</li> <li>Traveler information portals</li> <li>Traveler information statistics</li> </ul>	<ul style="list-style-type: none"> <li>Customer satisfaction with traveler information system and the aspects that support it</li> </ul>	<ul style="list-style-type: none"> <li>Implementation of additional traveler information services and cancellations of ones that are not effective</li> <li>Refined protocols</li> </ul>	<ul style="list-style-type: none"> <li>More efficient management of both recurring and non-recurring congestion</li> <li>Reduced time spent dealing with queues and backlogs</li> </ul>
<p>TIM partners should actively partner with news media and information service providers to provide prompt, reliable incident information to the public.</p>	<ul style="list-style-type: none"> <li>Stakeholder group identification</li> <li>Customer satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>Public-Private partnerships</li> </ul>	<ul style="list-style-type: none"> <li>Favorable reporting by media partners</li> <li>Greater recognition of DOT Traffic Operations in promoting mobility</li> <li>Reduced recurring congestion levels</li> </ul>	<ul style="list-style-type: none"> <li>More effective management of recurring and non-recurring congestions</li> </ul>

### 3.3 Situational Awareness

Focusing on non-recurring congestion, traffic crashes and the time that it takes to verify, respond to, and recover from them is one of the most critical areas for maintaining situational awareness. Consider the incident timeline shown below:



On the graphic above, situational awareness is gained at the time incident verification is complete. An initial improvement in situational awareness is obtained by reducing the time between “Incident is Reported” and “Incident Verification is Complete”.

For incidents like the one described above, maintaining situational awareness is the knowledge gained from the progress of physically dispatched response personnel. The status of the recovery process is passed onto motorists and potential travelers through diversion and incident messages posted on dynamic message signs, through telephone access, and through internet access. **Effective TIM programs and TMC operations improve situational awareness by reducing the time to respond to and recover from an incident affecting the roadway.**

### 3.4 Selecting Performance Measures

Most of the guidance related to the selection of performance measures comes from *TMC Performance Monitoring, Evaluation and Reporting, A Technical Handbook*, released by FHWA in 2005 and is included in the Appendix of this report. The Handbook includes 152 pages that offer suggestions on how to establish an effective performance measurement program and how to implement that program. At the core of the Handbook, three categories are suggested for identifying measures for a program:

- ✓ **Inputs** - address the supply of resources available to implement a program
- ✓ **Outputs** –quantitatively address the delivery of transportation programs, projects and services
- ✓ **Outcomes** –address the degree to which the transportation system meets policy goals and objectives

An example of these three categories applied might be in the evaluation of call volumes fielded by TMCs as shown on the following page.

### **Example of Input, Output, Outcome based Performance Measures**

Assume that one goal of a Statewide Traffic Management Program is to perform all TMC functions with two operators per shift between the hours of 10pm and 6am for each of 3 TMCs. What is the outcome performance measure of compiling call volumes?

#### **Inputs**

- 6 operators are provided equating to 2880 minutes of gross capacity per 8 hour shift
- The average call duration is 6 minutes (inbound or outbound) including the time to capture it in a call log
- It takes an average of 5 minutes to activate an ITS device with no centralized software to manage devices
- It takes 5 minutes to capture road conditions in an automated system
- It takes 2 minutes to read and interpret emails received in the TMC email account
- It takes an average of 5 minutes to verify a lane or road closure

#### **Outputs**

- Each operator gets a half hour lunch and two 15 minute breaks equating to 360 minutes
- An average of 300 calls are received, equating to a demand of 1800 minutes
- There are an average of 80 ITS device activations equating to a demand of 400 minutes
- There are an average of 100 conditions to capture in the automated system, equating to a demand of 500 minutes
- There are an average 60 emails received, equating to 120 minutes
- There are an average of 15 incidents, equating to a demand of 75 minutes
- There is a total demand of 3255 minutes resulting in a deficit of 375 minutes
- A stakeholder and customer survey reveals that customer satisfaction is only at 80 percent

#### **Outcomes**

- The results of the measure indicates that the DOTs goal of 95 percent customer satisfaction is not being met, action items include:
  - A further analysis that shows that one of the three TMCs is twice as busy as another, so compliment is adjusted
  - A further analysis that shows that the averages are not indicative of activity levels at peak times
  - The decision to work with human resources to add compliment
  - Software package or communication enhancements are considered for implementation to reduce the time to deploy messages on ITS devices
  - A call management software that automatically records calls and creates a communication log will be purchased if call volumes exceed 50 percent of TMC activities
  - A further analysis reveals that non-urgent maintenance calls are accounting for 30 percent of the call volume so a hotline or answering service is implemented to field those calls

### 3.5 Performance Measure Classification System

Section 4 provides a laundry list of well over 200 examples of performance measures. Tracking that volume of measures may not be valuable or even feasible. What is important is to match the performance measure to an individual program vision, mission, goals, and values.

One of the most valuable distinctions to make initially may be to decide if any given performance measure is programmatic or operational. Although operational measures can be used to justify program direction, the main difference between the two in this context is that program measures define the framework of the program and guide its strategic direction whereas operational measures ensure that the program is being executed. The Performance Measure Classification System is suggested to help PennDOT appropriately divide the task of measuring performance.

Performance Measure Classification System			
Program Measures		Operation Measures	
Customer Driven	Efficiency Driven	Recurring Congestion	Non-Recurring Congestion

Below are the definitions of the system shown in the table above.

- ✓ **Program Measures** – Will justify the current direction of the program or identify the need to shift the direction of the program
  - Customer Driven Measures – Are high level and very visible to executive management and the public with the goal being to:
    - Show the value of money spent
    - Promote positive public perceptions
    - Manage public access portals to information
    - Manage public expectation
    - Demonstrate environmental stewardship
  - Efficiency Driven Measures – Focus on the overall scale of the program relative to the demands that face the program, with the goal being to:
    - Demonstrate fiscal responsibility
    - Monitor interoperability with the overall transportation network, including all available modes
    - Identify legacy systems that do not meet national standards or Federal expectations
    - Develop and maintain program totals into quarterly, biannual, and annual reports
- ✓ **Operation Measures** – Will ensure that the program is being executed as designed
  - Recurring Congestion Measures – Encompass the overall state and regional mobility goals found in the Pennsylvania Mobility Plan and the Transportation Advisory Committees Report on Congestion Mitigation and Smart Transportation.
  - Non-Recurring Congestion Measures – Include the direct functionality of TMCs as well as response to and clearance of incident.

While this classification system helps segregate measures into the appropriate buckets, there will be some measures that are cross cutting, such as safety and user costs. The more broad categories such as those touch every aspect of any performance measure and will be seen throughout as benefits versus costs are weighed and as break-even analysis is completed.

Each performance measure identified through this effort was classified and is included in the Appendix.

- How much does this cost?
- How many travelers are waiting?
- How long will this take?



Photo courtesy of the Pennsylvania Department of Transportation, District 8-0 Incident Response Team

#### 4. National TIM Performance Measure Guidance

Document Reviewed	Identified TIM Performance Measures		Appendix
<p><i>Freeway Service Patrol Handbook</i></p> <p>FHWA, 2008</p>	<ul style="list-style-type: none"> <li>▪ Number of incidents</li> <li>▪ Detection time</li> <li>▪ Response time</li> <li>▪ Clearance time</li> </ul>	<ul style="list-style-type: none"> <li>▪ Number of calls</li> <li>▪ Incident type</li> <li>▪ Congestion levels</li> <li>▪ Customer satisfaction</li> <li>▪ Benefit Cost Ratio</li> </ul>	A
<p><i>Traffic Incident Management Handbook</i></p> <p>FHWA, 2000</p>	<ul style="list-style-type: none"> <li>▪ Incident Duration</li> <li>▪ Detection time</li> <li>▪ Verification time</li> <li>▪ Lost time by motorists</li> <li>▪ Time required to reach the incident site</li> <li>▪ IM Program costs</li> <li>▪ Incident debriefings</li> <li>▪ Number of service patrol assists</li> <li>▪ Average time from when incident is clear until traffic flow is normal</li> <li>▪ Survival rates of crash victims</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fuel consumption</li> <li>▪ Air quality</li> <li>▪ Negative public perception</li> <li>▪ Secondary crashes</li> <li>▪ Clearance time</li> <li>▪ Delay caused</li> <li>▪ Costs recovered from at-fault drivers</li> <li>▪ Average elapsed time from the point when the incident response team is called out until it arrives on scene</li> <li>▪ Improved safety of responders</li> </ul>	A
<p><i>Incident Management Performance Measures</i></p> <p>FHWA, 2002</p>	<ul style="list-style-type: none"> <li>▪ Notification time</li> <li>▪ First responder response time</li> <li>▪ Incident assessment time</li> <li>▪ Total blockage duration</li> <li>▪ Total incident duration</li> <li>▪ Time lag between incidents reported to a TMC and devices activated</li> <li>▪ Frequency that each agency was last to leave</li> <li>▪ Frequency that each agency was first detector</li> </ul>	<ul style="list-style-type: none"> <li>▪ Frequency that each agency was first responder</li> <li>▪ Average time when capacity was partially restored</li> <li>▪ Average delay to motorists through an incident site</li> <li>▪ Average queue length for different types of incidents</li> <li>▪ Average amount of diversion generated by traffic control devices used to manage the incident</li> </ul>	A



Document Reviewed	Identified TIM Performance Measures		Appendix
<p><i>Transportation Management Center Business Planning and Plans Handbook</i></p> <p>FHWA, 2005</p>	<ul style="list-style-type: none"> <li>▪ Response times</li> <li>▪ After action grading of situational information</li> <li>▪ Transit times</li> <li>▪ Satisfaction with network stats information</li> <li>▪ Satisfaction with quality of traffic information</li> <li>▪ Average speed by route</li> <li>▪ Accident rate</li> <li>▪ Clearance times</li> </ul>	<ul style="list-style-type: none"> <li>▪ Grading value of surveillance and monitoring</li> <li>▪ Grading response by responding agency</li> <li>▪ Incidence notification problems</li> <li>▪ Satisfaction with status/performance data</li> <li>▪ Average speed by time of day</li> <li>▪ System uptime</li> <li>▪ Average time to resume service if system failure occurs</li> </ul>	<p>A</p>
<p><i>Requirements for Transportation Management Center (TMC) Human Factors Guidelines</i></p> <p>FHWA, 2009</p>	<ul style="list-style-type: none"> <li>▪ Response failure</li> <li>▪ Incident detection latency</li> <li>▪ Response latency</li> <li>▪ Incident response adequacy</li> </ul>		<p>A</p>



Document Reviewed	Identified TIM Performance Measures		Appendix
<p><i>Transportation Management System Performance Monitoring, Evaluation, and Reporting</i></p> <p>FHWA, 2005</p>	<ul style="list-style-type: none"> <li>▪ Hours of incident related delay</li> <li>▪ Peak and off-peak travel times</li> <li>▪ Lane miles monitored by ITS</li> <li>▪ Transit on-time performance</li> <li>▪ Number of incidents by severity</li> <li>▪ Number of responded incidents versus total number of incidents</li> <li>▪ Number of person-hours answering calls</li> <li>▪ Number of incident related calls</li> <li>▪ Number of incidents detected/verified through calls versus the number of incidents detected and verified</li> <li>▪ Number of CCTV cameras</li> <li>▪ Miles of CCTV roadway coverage</li> <li>▪ Percent of time CCTV works properly</li> <li>▪ Number of incidents detected by using CCTV</li> <li>▪ Clearance time by incident type/severity</li> <li>▪ On-scene time</li> <li>▪ Percent of time VMS working properly</li> <li>▪ Time required to program a new VMS message</li> <li>▪ Effectiveness of VMS message</li> </ul>	<ul style="list-style-type: none"> <li>▪ Percent of signal systems coordinated</li> <li>▪ Frequency of work-zone accidents</li> <li>▪ Number of signals with pre-emption</li> <li>▪ Number of travel information website hits</li> <li>▪ Person-hours working for TIM system</li> <li>▪ Response time to incidents</li> <li>▪ Sensor percent time working properly</li> <li>▪ Sensor downtime</li> <li>▪ Percent time incident detection software is working properly</li> <li>▪ Software incident detection rate</li> <li>▪ Software false alarm rate</li> <li>▪ The mean time for software to detect incidents</li> <li>▪ Total number of EMS/Safety Patrol vehicles</li> <li>▪ Safety vehicle mileage per year</li> <li>▪ Average duration of lanes and/or shoulders closed by severity</li> <li>▪ Response time by incident type/severity</li> <li>▪ Person-hours spent on incident verification</li> <li>▪ Verification time</li> <li>▪ Number of secondary crashes per primary crash</li> <li>▪ More in Chapter 4, page 43</li> </ul>	<p>A</p>
<p><i>Travel Time Reliability</i></p> <p>FHWA</p>	<ul style="list-style-type: none"> <li>▪ 90<sup>th</sup> Percentile or 95<sup>th</sup> Percentile travel times</li> <li>▪ Buffer index</li> <li>▪ Planning time index</li> <li>▪ Standard deviations and coefficient of variation are the primary tools used to compute the above measures</li> </ul>		<p>A</p>

Document Reviewed	Identified TIM Performance Measures		Appendix
<p><i>Establishing Inter-Agency Regional Incident Management in Brisbane Australia</i></p> <p>10<sup>th</sup> World Congress Abstract [Professor Phil Charles], 2003</p>	<ul style="list-style-type: none"> <li>▪ Time to respond to incidents</li> <li>▪ Time for clearance of incidents</li> <li>▪ Level of safety at the scene</li> <li>▪ Effectiveness of diversions</li> </ul>		C
<p><i>I-95 Corridor Coalition Steering Committee Meeting</i></p> <p>I-95 Corridor Coalition, 2007</p>	<ul style="list-style-type: none"> <li>▪ Number of rear-end crashes</li> <li>▪ Number of shoulder crashes</li> <li>▪ Number of crashes due to debris</li> <li>▪ Crash duration</li> </ul>		G
<p><i>NCDOT TMT Mobility Workstream Implementation Plan</i></p> <p>NCDOT, 2008</p>	<ul style="list-style-type: none"> <li>▪ Travel time index</li> <li>▪ Buffer index</li> </ul>		B
<p><i>Benefits of Traffic Incident Management</i></p> <p>NTIMC</p>	<ul style="list-style-type: none"> <li>▪ Roadway clearance time</li> <li>▪ Incident clearance time</li> <li>▪ Non-recurring delay</li> <li>▪ Travel Time Reliability (Buffer Time)</li> </ul>		D
<p><i>Example Strategies for Building Stronger State Traffic Incident Management Programs</i></p> <p>NTIMC</p>	<ul style="list-style-type: none"> <li>▪ Average clearance time</li> <li>▪ Maximum clearance time</li> </ul>		D
<p><i>Traffic Congestion and Reliability</i></p> <p>FHWA, 2005</p>	<ul style="list-style-type: none"> <li>▪ Traffic Incident Delay</li> <li>▪ Work Zone Delay</li> <li>▪ Weather Delay</li> <li>▪ Ramp Delay</li> <li>▪ Delay per Person</li> <li>▪ Delay per vehicle</li> </ul>	<ul style="list-style-type: none"> <li>▪ Percent of VMT at average speed thresholds</li> <li>▪ Planning time</li> <li>▪ Planning time index</li> <li>▪ Buffer index</li> <li>▪ Other general congestion measures shown on page 2-21</li> </ul>	A
<p><i>Identifying Methods and Metrics for Evaluating Interagency Coordination in Traffic Incident Management</i></p> <p>University of Minnesota [Robert G. Feyen], 2009</p>	<ul style="list-style-type: none"> <li>▪ Response time</li> <li>▪ Clearance time</li> <li>▪ Number of fatalities</li> <li>▪ Number of injuries</li> <li>▪ Number of responders dispatched</li> <li>▪ Response arrival time</li> </ul>		C

Document Reviewed	Identified TIM Performance Measures		Appendix
<p><i>Sharing Information Between Public Safety and Transportation Agencies for Traffic Incident Management</i></p> <p>NCHRP Report 520, 2004</p>	<ul style="list-style-type: none"> <li>▪ “The consensus opinion among these officials was that information sharing provides strong benefits in supporting coordination and cooperation in planning for and managing traffic incidents. However, these opinions were based generally on anecdotes and experience rather than hard evidence. No location visited during this study could formally quantify the benefits of information sharing. Moreover, most locations had no data to measure how other TIM practices affected detection, notification, response, clearance time, responder safety, or other metrics of performance.” – Page 13 of the reference</li> </ul>		E
<p><i>State DOT Performance Management Systems: Select Examples</i></p> <p>AASHTO, 2007</p>	<ul style="list-style-type: none"> <li>▪ Reduction in incident congestion delay (vehicle hours saved)</li> <li>▪ Time for all lanes to be cleared</li> <li>▪ Travel time at posted speeds</li> </ul>	<ul style="list-style-type: none"> <li>▪ Average peak travel time</li> <li>▪ 95% reliable travel time</li> <li>▪ Ratio of peak travel time to maximum throughput travel time</li> <li>▪ Duration of peak congestion period</li> </ul>	F
<p><i>Measuring and Communicating the Effects of Traffic Incident Management Improvements</i></p> <p>NCHRP, 2004</p>	<ul style="list-style-type: none"> <li>▪ Translate the effect of TIM into equivalent lane-miles of new capacity (percentage of increased vehicle input multiplied by the number of highway lane miles treated)</li> <li>▪ Number of lanes blocked</li> <li>▪ Nature of blockage</li> </ul>	<ul style="list-style-type: none"> <li>▪ Start time of the event</li> <li>▪ Time verified</li> <li>▪ Time response initiated</li> <li>▪ Time of first responder arrival</li> <li>▪ Time roadway is reopened</li> <li>▪ Time last responder leaves</li> <li>▪ Time to return to normal operations</li> <li>▪ Figure 3.1 on page 26 has a chart that shows a general taxonomy</li> </ul>	E
<p><i>Transportation Management Center Concept of Operation Implementation Guide</i></p> <p>FHWA, 1999</p>	<ul style="list-style-type: none"> <li>▪ Number of freeway incidents per day</li> <li>▪ Number of metered ramps</li> <li>▪ Number of signalized intersections</li> <li>▪ Number of transit vehicles and routes</li> <li>▪ Number of centerline freeway miles managed</li> <li>▪ System down time</li> <li>▪ Number of functions provided</li> <li>▪ Extent and type of repair to systems</li> </ul>	<ul style="list-style-type: none"> <li>▪ Overall response time</li> <li>▪ Time to detect</li> <li>▪ Time to verify</li> <li>▪ Time to implement response</li> <li>▪ Time to develop a response plan</li> <li>▪ Time to deploy response actions</li> <li>▪ Time to dispatch response personnel</li> <li>▪ Time for responders to reach the scene</li> </ul>	A

Document Reviewed	Identified TIM Performance Measures		Appendix
<p><i>Guide to Benchmarking Operations Performance Measures Customer Satisfaction – Pilot Test Results</i></p> <p>NCHRP 20-7</p>	<ul style="list-style-type: none"> <li>▪ Frequency of access to traveler information services</li> <li>▪ Number of times accessed</li> <li>▪ Effect of the information or service on the traveler</li> <li>▪ Feedback on improvements</li> </ul>	<ul style="list-style-type: none"> <li>▪ Satisfaction rating for the service and various aspects of the service</li> <li>▪ Importance of providing the service</li> <li>▪ Rank of clearing incidents versus other priorities</li> <li>▪ Socio-demographic characteristics</li> </ul>	E
<p><i>National Transportation Operations Coalition (NTOC) Performance Measurement Initiative</i></p> <p>NTOC, 2005</p>	<ul style="list-style-type: none"> <li>▪ Customer satisfaction</li> <li>▪ Extent of spatial congestion</li> <li>▪ Extent of temporal congestion</li> <li>▪ Incident duration</li> </ul>	<ul style="list-style-type: none"> <li>▪ Non-recurring delay</li> <li>▪ Speed</li> <li>▪ Person throughput</li> <li>▪ Vehicle throughput</li> <li>▪ Link travel time</li> <li>▪ Reliability travel time</li> <li>▪ Trip travel time</li> </ul>	H
<p><i>Implementation Guidelines Performance Measure: Incident Duration</i></p> <p>FHWA</p>	<ul style="list-style-type: none"> <li>▪ Start time and end time of event</li> <li>▪ Incident location and roadway type</li> <li>▪ Type of incident</li> <li>▪ Time of notification</li> <li>▪ Notification source</li> <li>▪ Detection source</li> <li>▪ Confirmation source</li> <li>▪ Operator ID</li> <li>▪ Activation of ITS</li> <li>▪ Hours of delay</li> </ul>	<ul style="list-style-type: none"> <li>▪ Responder information (who, when, and from where)</li> <li>▪ Lane closure status and other measures of severity</li> <li>▪ Time and type of dispatch</li> <li>▪ Arrival time of any emergency responders</li> <li>▪ Departure time of any emergency responders</li> </ul>	A

Document Reviewed	Identified TIM Performance Measures		Appendix
<p><i>Measuring the Effectiveness and Performance of Multi-Agency TIM Programs</i></p> <p>Texas Transportation Institute [Kevin Balke]</p>	<ul style="list-style-type: none"> <li>▪ Total number of incidents</li> <li>▪ Number of incidents by type</li> <li>▪ Number of vehicles by incident type</li> <li>▪ Number of incidents by severity level</li> <li>▪ Number of incidents by number of lanes blocked</li> <li>▪ Number of incidents by milepost</li> <li>▪ Number of incidents by blockage duration</li> <li>▪ Average estimated detection time</li> <li>▪ Average clearance time</li> <li>▪ Average total duration by incident type</li> <li>▪ Estimated reduction in delay</li> <li>▪ Estimated reduction in fuel consumption</li> <li>▪ Estimated reduction in emissions (HC, CO, NO)</li> <li>▪ Number of assists per miles traveled by service patrol</li> <li>▪ Number of miles covered by ITS</li> <li>▪ Percentage of devices operational</li> <li>▪ Number of hours ITS operational</li> <li>▪ Number of DMS messages posted</li> </ul>	<ul style="list-style-type: none"> <li>▪ Number of incidents involving injuries and fatalities</li> <li>▪ Number of incidents by surface conditions</li> <li>▪ Number of incidents by day of the week</li> <li>▪ Number of incidents by period</li> <li>▪ Number of incidents by time of day</li> <li>▪ Number of incidents by blockage location</li> <li>▪ Number of incidents detected by detection source</li> <li>▪ Average estimated response time</li> <li>▪ Average total duration by severity level</li> <li>▪ Number of secondary crashes</li> <li>▪ Number of service patrol assists</li> <li>▪ Number of service patrol assists by nature of assist</li> <li>▪ Number of miles traveled by service patrol</li> <li>▪ Number of ITS devices deployed by type</li> <li>▪ Number of website hits</li> <li>▪ Number of calls/assists dispatched by operators</li> <li>▪ Number of false calls</li> </ul>	C
<p><i>Freeway Service Patrol Evaluation</i></p> <p>PennDOT, 2008</p>	<ul style="list-style-type: none"> <li>▪ Incident duration</li> <li>▪ Reduction in fuel consumption</li> <li>▪ Reduction in motorist lost wages spent in congestion</li> </ul>	<ul style="list-style-type: none"> <li>▪ Motorist savings per incident</li> <li>▪ Annual cost of freeway service patrol program</li> </ul>	I
<p><i>PennDOT Provided Information</i></p> <p>PennDOT, 2009</p>	<ul style="list-style-type: none"> <li>▪ PennDOT provided Table 6.1 from the Guide to Effective Freeway Performance Measurement for inclusion; it is available in the Appendix.</li> <li>▪ PennDOT OIST also provided information from a November 2008 internal performance measure review study.</li> </ul>		I

#### 4.1 The Bottom Line of the Literature Review

Overall, more than 70 publications were reviewed and over 200 performance measures were identified. Most measures were mentioned only once, however, indicating that as a whole there is much research to be done and very little definitive guidance available for practitioners.

- ✓ Documents published by the Federal Highway Administration suggested 166 different measures to consider
- ✓ The three academic resources reviewed suggested 41 different measures
- ✓ Three documents released by the American Association of State and Highway Transportation Officials, including the NTIMC, suggested 10 measures
- ✓ Two documents reviewed from the National Cooperative Highway Research Program suggested 13 measures
- ✓ The National Traffic Operations Coalition suggests 8 measures

Below is a list of performance measures that were identified by at least three separate sources.

Measure	Definition	Number of Sources
Incident Response Time	Elapsed time from when an agency verifies a report until the responder arrives at the scene of the event.	11
Incident Clearance Time	Elapsed time from when a responder arrives at the scene of an event until all travel lanes are restored to full capacity.	11
Incident Type	A description of the event that conforms to the Transportation Management Data Dictionary (TMDD) standards.	9
Incident Duration	Elapsed time from when the incident is detected until traffic is flowing at normal conditions for the given time of day.	9
Motorist delay	Typically measured in economic impact due to the difference between the anticipated trip duration and the actual trip duration.	8
Number of Incidents	A sum of the events that occurred within a given system.	6
Incident Detection Time	Elapsed time from when an incident occurs until a response agency learns of it.	6
System Uptime	The amount of time that ITS devices and support software are available for use for executing the designed task.	6
Customer Satisfaction	A qualitative measurement to determine if efforts by a program are meeting the requirements of the end user.	5
90 <sup>th</sup> or 95 <sup>th</sup> percentile travel time reliability	Estimates delay severity on specific routes during the heaviest traffic days. The worst one or two days each month mark the 95 <sup>th</sup> or 90 <sup>th</sup> percentile, respectively. Users familiar with the route (such as commuters) would know what to expect during those few days and plan their trips accordingly. This measure is reported in minutes.	5
Fuel consumption of delayed vehicles	Associates an economic impact of congestion on the end user by quantifying the amount of fuel that is used above the expected or average usage for a corridor or for a system.	4

Measure	Definition	Number of Sources
Secondary crashes	Crashes that are at least partially attributable to a previous crash. One example is when a rear-end crash occurs at the end of a queue from an earlier crash.	4
Travel times	The time required for a traveler to get from their origin to their destination. Typically defined by corridor.	4
Buffer Index	Represents the extra time (or time cushion) that travelers must add to their average travel time when planning trips to ensure on-time arrival.	4
Number of TMC Calls	The total number of inbound and outbound calls that TMC operators are involved with.	3
Number of incidents by number of lanes blocked	A subset of total number of incidents where the total number of lanes blocked is compared with the total number of lanes available for use.	3
First Responder Arrival Time	The first milestone measurement to help define the amount of time to clear an incident once responders are at the scene.	3
Time of Departure for last Responder	The second milestone measurement to help define the amount of time to clear an incident.	3
Verification Time	Elapsed time between when an incident is reported and when it is confirmed to exist.	3
Dispatch Time	Elapsed time between when an incident is verified and when responders are contacted	3
Number of Service Patrol Assists	The total amount of services provided to travelers by freeway service patrol vehicles	3
Time for traffic to return to normal after an incident is cleared	Elapsed time between when an incident is cleared (all lanes are available for travel) and when traffic is once again operating at normal levels of service for the time of day, day of the week, and day of the year	3
Air quality	A measure to determine the affects of traffic congestion on the environment.	3
Time lag of incidents reported to a TMC versus ITS device activation time	Elapsed time between when an incident is verified and when messages are available to travelers.	3
Average amount of diversion generated by ITS and traffic control devices to manage incidents	The amount of traffic that chooses an alternate route based on messages disseminated by ITS devices or other traffic control in advance of an incident scene.	3
Average speed by time of day	The expected speed of traffic on a given link of a highway.	3
Lane miles monitored by ITS devices	The amount of coverage that ITS devices provide surveillance for versus the total miles of the highway network.	3
Planning Time Index	The planning time index represents how much total time a traveler should allow, to ensure on-time arrival.	3



## 5. TIM Performance Measures Best Practices from Other States

Document Reviewed	Identified TIM Performance Measures	Appendix
<p><i>TMC Annual Report</i> Florida SMART SunGuide, 2006</p>	<ul style="list-style-type: none"> <li>▪ Divided by lanes blocked and lanes not blocked</li> <li>▪ Roadway clearance</li> <li>▪ Incident clearance</li> <li>▪ Percentage of TMC notification method</li> <li>▪ Average response time where there was CCTV coverage vs. no coverage</li> </ul>	<ul style="list-style-type: none"> <li>▪ Number of events</li> <li>▪ TMC detection time</li> <li>▪ TMC verification time</li> <li>▪ TMC response time</li> <li>▪ Road Ranger dispatch time</li> <li>▪ Road Ranger response time</li> <li>▪ TIM self-assessment scores</li> <li>▪ Customer services statistics</li> </ul> <p>B</p>
<p><i>The Gray Notebook</i> Washington State DOT May 2009</p>	<ul style="list-style-type: none"> <li>▪ Travel times</li> <li>▪ Vehicle occupancy rates</li> <li>▪ 511 calls</li> <li>▪ Website hits</li> <li>▪ Incident duration</li> <li>▪ Average clearance time of fatal incidents</li> <li>▪ Number of incidents cleared</li> <li>▪ Response time</li> </ul>	<ul style="list-style-type: none"> <li>▪ Over 90-minute clearance time average</li> <li>▪ Traffic volumes</li> <li>▪ Staff levels</li> <li>▪ Frequency of commercial motor vehicle involvement in incidents that take longer than 90 minutes to clear</li> </ul> <p>B</p>
<p><i>Annual Report</i> Georgia Department of Transportation 2007</p>	<ul style="list-style-type: none"> <li>▪ HERO                             <ul style="list-style-type: none"> <li>○ Vehicle Hours saved</li> <li>○ Mobility cost reduction</li> <li>○ Gas savings</li> <li>○ Diesel fuel savings</li> <li>○ Fuel cost savings</li> <li>○ Emissions reduced</li> <li>○ Emission cost reduction</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ Average travel speeds</li> <li>▪ Incident response time</li> <li>▪ Incident clearance time</li> <li>▪ Lane miles monitored by ITS</li> <li>▪ Travel time index</li> <li>▪ Many others that do not directly pertain to the subject of this report</li> </ul> <p>B</p>
<p><i>Tracker Measures of Departmental Performance</i> Missouri Department of Transportation April 2009</p>	<ul style="list-style-type: none"> <li>▪ Travel time index</li> <li>▪ Average travel speed</li> <li>▪ Incident clearance time</li> <li>▪ Average time to clear traffic backup from an incident</li> </ul>	<ul style="list-style-type: none"> <li>▪ Number of service patrol assists</li> <li>▪ Customer satisfaction with service patrol assist program</li> <li>▪ Fuel consumption</li> <li>▪ Many others that do not directly pertain to the subject of this report</li> </ul> <p>B</p>
<p><i>2009 Annual Attainment Report on Transportation System Performance</i> Maryland Department of Transportation</p>	<ul style="list-style-type: none"> <li>▪ User cost savings</li> <li>▪ Number of incidents responded to</li> </ul>	<ul style="list-style-type: none"> <li>▪ Service patrol assists</li> <li>▪ Number of ITS devices</li> <li>▪ Secondary crashes</li> </ul> <p>B</p>



Document Reviewed	Identified TIM Performance Measures		Appendix
<i>Performance Measures for Rural Transportation Systems Guidebook</i> California Transportation Commission, 2006	<ul style="list-style-type: none"> <li>▪ Origin-Destination times along major corridors</li> <li>▪ Average speeds</li> <li>▪ Delays</li> </ul>	<ul style="list-style-type: none"> <li>▪ Travel time</li> <li>▪ Vehicle operating cost</li> <li>▪ Emissions</li> </ul>	B
Virginia Department of Transportation Dashboard	<ul style="list-style-type: none"> <li>▪ Incident duration</li> <li>▪ Number of incidents</li> <li>▪ Travel speed</li> <li>▪ Travel times</li> </ul>	<ul style="list-style-type: none"> <li>▪ Incident severity</li> <li>▪ Incident type</li> <li>▪ Congestion level of service on freeways</li> <li>▪ Hours of delay</li> </ul>	Website
<i>Virginia Performs</i> Virginia Department of Transportation	<ul style="list-style-type: none"> <li>▪ Traffic crash related deaths</li> <li>▪ Hours of delay per traveler</li> </ul>		Website
<i>Strategic Plan 2009-2013</i> Texas Department of Transportation	<ul style="list-style-type: none"> <li>▪ Travel time index</li> <li>▪ Travel reliability</li> </ul>		B
<i>Congestion Mitigation and Smart Transportation</i> Pennsylvania Transportation Advisory Committee, 2009	<ul style="list-style-type: none"> <li>▪ Delay</li> <li>▪ Customer satisfaction</li> <li>▪ Travel time</li> <li>▪ Travel speed</li> <li>▪ Cost per user</li> <li>▪ Incident duration</li> <li>▪ Travel time reliability</li> </ul>	<ul style="list-style-type: none"> <li>▪ Incident response time</li> <li>▪ Desired operating speed</li> <li>▪ These were all identified along with others, as moderate or high importance to the Committee stakeholders</li> </ul>	B

### 5.1 The Bottom Line of the State Program Review

Eight states were reviewed to determine the level of performance measure implementation as it pertains to congestion of all types. Overall, the results were much narrower than the literature review yielded. Most states, it appears, tend to focus on just a few measures to guide their program.

The most common measures in use are incident clearance times and one of the following ways of measuring the time it takes travelers to get from their origin to their destination:

- ✓ Travel time
- ✓ Travel time index
- ✓ Travel time reliability

Other common measures implemented by the states in the table above included incident statistics such as:

- ✓ Number of assists by freeway service patrols
- ✓ Number of incidents
- ✓ Quantified delay
- ✓ Response time

## 6. Findings

This document divided measures into two broad categories of either measuring programs or measuring operations. There are many factors that will play into the selection and implementation of performance measures for PennDOT and the most important question to be answered by the selection is:

### How will this measure guide our program?

This question is central because even though two distinctive categories are apparent, every measure will shape the execution level or strategic future of the program.

To fully understand the answer to the question above and other associated questions, it is very important to use the three categories identified by FHWA as a process:

- ✓ **Inputs** - address the supply of resources available to implement a program
- ✓ **Outputs** - quantitatively address the delivery of transportation programs, projects and services
- ✓ **Outcomes** - address the degree to which the transportation system meets policy goals and objectives

Ultimately TMC performance measures must be integrated with TIM performance measures to satisfy mobility goals, promote safety of responders and motorists, and reduce costs levied against society and PennDOT. Furthermore, selected program measures should complement the selected operational measures as well as identify areas for expansion.

Yet another classification system was identified by *NCHRP Synthesis 311, Performance Measures of Operational Effectiveness for Highway Segments and Systems*. The review and findings from that work suggests measures can be generalized into five categories:

- ✓ Environmental factors
- ✓ Intensity
- ✓ Extent
- ✓ Duration
- ✓ Variation

## 6.1 Steps Needed for Effective Performance Measurement

Throughout the research phase of this effort, there were several notable differences between PennDOT and other agencies measuring performance. These are summarized in the table shown below as suggested action items for moving a performance measure program forward in Pennsylvania.

Suggested Actions	Explanation
Consider the Establishment of an Incident Management Program	<ul style="list-style-type: none"> <li>Most states refer to the task of measuring performance as a program that is a component of an overall incident management program</li> </ul>
Consider the creation of an Incident Management Strategic Plan	<ul style="list-style-type: none"> <li>To measure performances that will guide a program, the program needs to have a vision and established goals to measure against. While the Pennsylvania Mobility Plan and the Pennsylvania Strategic Agenda do have mobility interwoven, these high-level goals and objectives may not provide a specific enough direction at the individual program level</li> </ul>
Evaluate a threshold for and adopt an incident clearance goal	<ul style="list-style-type: none"> <li>While in the end this may be part of the Incident Management Strategic Plan it is worth calling out separately here because of the demonstrated importance among States and National Guidance alike</li> </ul>
Consider integrating the National Unified Goal for Traffic Incident Management into PennDOT business	<ul style="list-style-type: none"> <li>The NUG serves as a high-level strategic plan that can be used to show progress on the national TIM and Traffic Operations agenda</li> </ul>
Consider completing the TIM Self Assessments at all levels	<ul style="list-style-type: none"> <li>The FHWA TIM Self Assessment is scalable and should be applied at different levels of PennDOT as well as in conjunction with PSP and other responders as appropriate</li> </ul>
Develop a TIM performance measure Road map	<ul style="list-style-type: none"> <li>A road map is a tool that can help agencies implement programs over time as resources and capabilities become available</li> </ul>
Provide annual benchmarks of selected performance measures	<ul style="list-style-type: none"> <li>According to the FHWA <i>Transportation Management System Performance Measures</i>, agencies should benchmark themselves against other similar agencies as a part of determining the effectiveness of efforts.</li> </ul>

Particularly noteworthy is the lack of a statewide traffic incident management strategic plan. Most documents reviewed as part of this effort indicate that a successful performance measurement program will support the high-level goals of the traffic incident management program. Since PennDOT does not have such a plan it was not possible to correlate measures to goals. This effort did provide traceability to existing PennDOT documents where possible, which are presented in Section 9.

## 6.2 Suggested Performance Measures

To provide a comprehensive performance measurement program, PennDOT will need to phase in outcome-based measures as policies, systems, and capabilities come online. Operations performance measures are those most likely to be implemented by TMCs.

### Program Performance Measures

- ✓ Delay Reduction
- ✓ Travel Time Reliability
- ✓ Planning Time Index
- ✓ Customer Satisfaction
- ✓ Wasted Fuel Consumption Reduction
- ✓ Reduced Emissions
- ✓ Dollars Saved Due to Traffic Incident Management Efforts

### Operations Performance Measures

- ✓ Incident Duration
- ✓ Secondary Crashes
- ✓ Benefit-Cost Ratio of Service Patrols
- ✓ Travel Time Index
- ✓ Average Speed
- ✓ TMC Performance

During the research portion of this effort, many ITS device performance measures were also identified as a contributing factor to increasing mobility. While many, if not all, of these performance measures have merit, they were omitted from this report since the focus of this effort was not on ITS device system performance. They are shown as part of the Performance Measures Matrix included in the Appendix.

### 6.2.1 Suggested TIM Performance Measures for TMCs

As described throughout this report, all selected performance measures should support the goals and objectives of the overall incident management program. Since PennDOT does not have defined goals and objectives for its program, measures at both levels identified in section 6.2 are explained in this section.

#### Delay Reduction

Input	Output
<ul style="list-style-type: none"> <li>▪ Vehicle Miles Traveled</li> <li>▪ Number of incidents</li> <li>▪ Incident durations</li> <li>▪ Hourly traffic volumes</li> </ul>	<ul style="list-style-type: none"> <li>▪ Amount of delay due to incidents</li> </ul>

The Urban Mobility Plan that is periodically released by the Texas Transportation Institute (TTI) is highly regarded as a barometer for how the nation’s transportation network is performing. This document reports the amount of delay experienced by travelers in a variety of ways, but it is clear that TTI believes user delay is one of the most important system performance measures.

#### Calculation

The 2009 Urban Mobility Plan sets forth a process for establishing user delay levels. In addition to the vehicles that are directly delayed by being in the queue due to the incident, other users are also delayed in other parts of the transportation system due to diversion. The diverting vehicles themselves are also subject to delay. The Mobility Plan discusses a two-step process to determining true user delay that is based on models and reduction ratios; however, a basic calculation can be used as shown below:

- ✓ Determine the normal trip time through specified section of roadway.
- ✓ Determine the trip time when incidents occur.
- ✓ Determine the volume of traffic on the section of roadway when the incident occurs.
- ✓ Multiply the number of vehicles by the difference of the normal trip time and the incident trip time.

### Travel Time Reliability

Input	Output
<ul style="list-style-type: none"> <li>▪ Specified roadway section lengths</li> <li>▪ Travel times for the specified roadway sections</li> </ul>	<ul style="list-style-type: none"> <li>▪ A distribution of travel times during peak times for both when an incident occurs and does not occur.</li> </ul>

This measure is sometimes referred to as *Buffer Time* and describes the amount of time that must be added to a trip to ensure that travelers arrive at their destination at or before the intended time 95 percent of the time.

#### Calculation

Taken from the *National Transportation Operations Coalition (NTOC), Performance Measurement Initiative*, July 2005:

- ✓ Make multiple observations of travel time for a given section of roadway at a given time of day and day of week.
- ✓ Arrange the observed travel times in ascending order.
- ✓ Calculate the average trip time by summing the distribution and dividing by the number of observations.
- ✓ Truncate the list to disregard the longest 5 percent of trips
- ✓ The buffer time is the difference between the average trip time and the 95<sup>th</sup> percentile trip time.

### Planning Time Index

Input	Output
<ul style="list-style-type: none"> <li>▪ Travel time per section</li> </ul>	<ul style="list-style-type: none"> <li>▪ Percentages of customers who are satisfied with the surface transportation network</li> </ul>

Although the relationship between the terms Buffer Index and Planning Index can be confusing, FHWA uses the Planning Index as part of its monthly Congestion Dashboard report. The difference between a buffer index and a planning index is that the buffer index shows how much additional time is necessary to make the trip and the planning index shows how much total travel time is necessary.

This measure looks at the 95<sup>th</sup> percentile of travel times which means that drivers will complete their trip at or within the planned time 19 out of 20 work days per month.

This measure is critical with regards to posting travel times on DMS and other traveler information sources.

#### Calculation

Taken from *Travel Time Reliability*, (FHWA-HOP-06-070):

- ✓ The 95<sup>th</sup> percentile of the travel time index.

### Customer Satisfaction

Input	Output
<ul style="list-style-type: none"> <li>▪ Distributed customer surveys</li> <li>▪ Completed customer surveys</li> </ul>	<ul style="list-style-type: none"> <li>▪ Percentages of customers who are satisfied with the surface transportation network</li> </ul>

This measure was identified in almost all publications and resources that were reviewed as part of this effort. Since how travelers feel about the quality of their trips is a public relations gauge, this measure is suggested for PennDOT traveler information and incident management services.

A stakeholder survey is also suggested due to the widespread nature of incident response across the Commonwealth to gauge perception and satisfaction.

### Calculation

According to the NTOC Performance Initiative, selected questions should be evaluated with the following responses gathered:

- ✓ Very satisfied, somewhat satisfied, neutral, somewhat dissatisfied, very dissatisfied, Don't know/not applicable
- ✓ Arrange the distribution by category and report on the 95<sup>th</sup> percentile

### Wasted Fuel Consumption Reduction

Input	Output
<ul style="list-style-type: none"> <li>▪ Vehicle miles traveled</li> <li>▪ Travel delay</li> <li>▪ Average speeds</li> <li>▪ Average fuel economy of vehicles</li> </ul>	<ul style="list-style-type: none"> <li>▪ Amount of fuel consumed</li> </ul>

This measure is also taken from the 2009 Urban Mobility Report and is aimed at identifying the benefits of congestion management to America's reliance on petroleum based natural resources, foreign and domestic.

### Calculation

Taken from Appendix A of the 2009 Urban Mobility Report:

$$\text{Annual Fuel Wasted} = \frac{\text{Travel Delay (vehicle hours)}}{\text{(Eq. A - 4)}} \times \frac{\text{Average Peak Period System "Congested Speed" (Eq. A - 2)}}{\text{(Eq. A - 2)}} \div \frac{\text{Average Fuel Economy (Eq. A - 7)}}{\text{(Eq. A - 7)}} \times \text{250 Working Days per year}$$

Although this measure does not point directly to non-recurring congestion, it does reference both travel delay (defined previously) and congested speed. Both of these components are affected by incident management and TMC actions through traveler information services.

### Reduced Emissions

Input	Output
<ul style="list-style-type: none"> <li>▪ Average congested speed</li> <li>▪ Fuel consumption</li> <li>▪ Traffic volumes</li> </ul>	<ul style="list-style-type: none"> <li>▪ Amount of carbon monoxide emissions</li> <li>▪ Amount of nitrogen oxides emissions</li> <li>▪ Amount of volatile oxygen compounds emissions</li> </ul>

This measure was not widely discussed in the documentation that was reviewed as part of this effort. That may be partially attributable to the fact that most documents, although current, did not have the advantage of being released after the details regarding Federal stimulus funding were made available. As part of the Federal Government’s efforts to revitalize America’s economy, an effort was made to consider energy usage and overall environmental impacts. For roadways and congestion, this emphasis is addressed in measuring the amount of emissions from vehicles traveling on the roadway.

#### Calculation

Taken from PennDOT’s Congested Corridor Improvement Program Methodology, the 2009 Urban Mobility Plan, and the Trafficware Traffic Signal Software User Manual:

- ✓ Calculate the average fuel economy =  $8.8 + 0.25 \times (\text{Average peak period congested speed})$
- ✓ Multiply the sum by the volume of vehicles on the roadway section
- ✓ Calculate the average fuel economy during incidents =  $8.8 + 0.25 \times (\text{average incident speed})$
- ✓ Multiply the sum by the volume of vehicles on the road section during the incident
- ✓ Multiply the products above by:
  - Carbon monoxide (CO) = 69.9 gram/gal
  - Nitrogen Oxides Emissions (NOx) = 13.6 gram/gal
  - Volatile Oxygen Compounds Emissions (VOC) = 16.2 gram/gal

### Dollars Saved due to Traffic Incident Management Efforts

Input	Output
<ul style="list-style-type: none"> <li>▪ Delay differentials</li> <li>▪ Costs of delay</li> <li>▪ Percentages of trucks</li> </ul>	<ul style="list-style-type: none"> <li>▪ Measured efforts regarding combined incident management and traveler information efforts</li> </ul>

Also taken from the 2009 Urban Mobility Report, this measure is a wrap-up measure that is used to convey the magnitude of all efforts combined. This measure, applied to the traffic incident management program, will allow PennDOT to demonstrate a justification of expenditures as annual results are compared.

#### Calculation

- ✓ Use the PennDOT Congested Corridor Improvement Program methodology:
  - Apply the most recent value of time and idling costs as described
  - Multiply by the delay (as described previously)



### Incident Duration

Input	Output
<ul style="list-style-type: none"> <li>▪ Occurrence time</li> <li>▪ Clearance time</li> <li>▪ <i>Notification time</i></li> <li>▪ <i>Verification time</i></li> <li>▪ <i>Dispatch time</i></li> <li>▪ <i>Scene arrival time</i></li> <li>▪ <i>Time when traffic returns to normal for the time period</i></li> </ul>	<ul style="list-style-type: none"> <li>▪ Completed incident timeline</li> </ul>

This measure may be the most frequently cited of any measure examined during this effort. Many organizations use this as a cardinal measure. However the DOTs that are typically identified as best-in-class take it a step farther. The items shown in italics in the table above are not required to implement this measure but including them has benefits that allow the program to focus on specific segments of incident clearance.

#### Calculation

- ✓ Clearance time - Occurrence time

### Secondary Crashes

Input	Output
<ul style="list-style-type: none"> <li>▪ Traffic queue length</li> <li>▪ Crash locations</li> </ul>	<ul style="list-style-type: none"> <li>▪ Completed incident timeline</li> </ul>

Like incident duration, this measure was widely cited as important and several references indicated that 1 in 5 secondary crashes are fatal. This demonstrates a direct correlation to the economic and safety impacts of crashes to the public. However, there were no clear methodologies presented in the reviewed documents regarding a procedure for calculating or identifying these crashes.

#### Calculation

This measure is not calculation driven, but rather relationship driven. It will take coordination and training of responders and TMC operators to collect this information. Once collected, trends and corrective actions can be identified.

- Estimates are that 20 percent of crashes are secondary
- According to national reports, 1 in 5 secondary crashes are fatal



Photo courtesy of the Pennsylvania Department of Transportation, District 8-0 Incident Response Team

### Benefit-Cost Ratio of Freeway Service Patrols

Input	Output
<ul style="list-style-type: none"> <li>▪ Number of FSP vehicles</li> <li>▪ Number of assists</li> <li>▪ Incident durations when FSP responded</li> <li>▪ Incident durations when FSP did not respond</li> <li>▪ Annual cost of the FSP program</li> <li>▪ Cost of lost time</li> <li>▪ Cost of wasted fuel</li> </ul>	<ul style="list-style-type: none"> <li>▪ Calculated benefit of providing service</li> </ul>

This measure can be applied at both the micro and macro levels since the benefit can be calculated for a single FSP vehicle, a metro area, or the state. These calculations should be compared to evaluate overall performance and areas for improvements as well as areas for lessons learned.

#### Calculation

- ✓ As described in PennDOT’s Freeway Service Patrol Evaluation included in the Appendix.



Photo Courtesy of the Pennsylvania Department of Transportation, District 8-0 Incident Response Team

### Travel Time Index

Input	Output
<ul style="list-style-type: none"> <li>▪ Off peak travel times for specified sections of roadway</li> <li>▪ Identification of peak times</li> <li>▪ Peak travel times for specified vehicles</li> </ul>	<ul style="list-style-type: none"> <li>▪ Travel time estimates for use with traveler information systems</li> </ul>

This measure is typically combined with planning and buffer times to express travel time reliability. Of the three, travel time index is the easier to express in simple terms. TMCs can use systems or observations to record this information.

#### Calculation

There are two ways to compute the travel time index. The first way, shown below, is simply to divide the peak travel time by the free-flow travel time. The second way is to consider delay time in the numerator with the reduction factor discussed in the Delay Reduction discussion earlier in this section. This second method is typically reserved for TMCs that have advanced software to monitor congestion levels.

$$\text{Travel Time Index} = \frac{\text{Peak Travel Time}}{\text{Free - Flow Travel Time}}$$

### Average Speed

Input	Output
<ul style="list-style-type: none"> <li>Segment length</li> <li>Volume by lane</li> <li>Segment speed limit</li> </ul>	<ul style="list-style-type: none"> <li>Comparison of speeds to the posted speed limit</li> </ul>

This measure is used in many calculations and is also easy to convey in simple terms when compared to the posted speed limit. Consider using weighted averages when volumes are collected by lane.

#### Calculation

Taken from *Transportation Management Systems Performance Measures*, FHWA 2005 and in consideration of weighted averages:

Equation 4-3

$$V^i = \frac{\sum_{m=1}^n F^i_{Dm} V^i_{Dm}}{\sum_{m=1}^n F^i_{Dm}}$$

Where,

$V^i$  = Weighted average speed at the  $i$ th TMS site for the specified period

$V^i_{Dm}$  = Average speed at the  $m$ th detector of the  $i$ th TMS site for the specified period

$F^i_{Dm}$  = Total volume at the  $m$ th detector of the  $i$ th TMS site for the specified period

$n$  = Number of detectors at the  $i$ th TMS site (Martin 2003)

### TMC Performance

Input	Output
<ul style="list-style-type: none"> <li>Time required to program a new DMS/HAR message</li> <li>Number of person-hours spent answering calls</li> <li>Number of incident related calls</li> <li>Number of lane miles monitored by CCTV</li> <li>Number of DMS/HAR messages posted</li> <li>Number of operators</li> </ul>	<ul style="list-style-type: none"> <li>Documentation of TMC capabilities</li> </ul>

Many documents reviewed cited the inputs above as ways to monitor TMC effectiveness along with frequent after-action reviews and table-top exercises.

## 7. Suggested Measures Classification

Below is a summary of where each suggested measure falls within each classification type.

Suggested Performance Measures	FHWA 2005	NCHRP 2003	This Report	
Delay Reduction	Outcome	Intensity	P	C,E
Travel Time Reliability	Outcome	Variation	P,O	C,R
Planning Time	Output	Intensity	P,O	C,R
Customer Satisfaction	Outcome	Variation	P	C
Wasted Fuel Consumption Reduction	Outcome	Environmental	P,O	C,E,R,NR
Reduced Emissions	Outcome	Environmental	P,O	C,E,R,NR
Dollars saved due to TIM Efforts	Outcome	Variation	P	E
Incident Duration	Outcome	Duration	P	E
Secondary Crashes	Outcome	Variation	P	C,NR
Benefit Cost Ratios of Freeway Service Patrols	Output	Variation	O	NR
Travel Time Index	Outcome	Intensity	O	R
Average Speed	Output	Intensity	P,O	C,R
TMC Performance	Output	Variation	P,O	C,NR

P = Program  
 O = Operation  
 C = Customer  
 E = Efficiency  
 R = Recurring congestion  
 NR = Non-recurring congestion

## 8. Traceability

The performance measures that were identified in this report have ties to many other reports that have been developed by PennDOT in recent years. Below are each of the performance measures from this report cross-referenced to recent efforts by PennDOT.

Suggested Performance Measures	Is the Action Item Traceable?		
	ITS Strategic Plan (2008)	Transportation Operations Plan (2005)	Regional Operations Plans
Delay Reduction	▪ Yes (Goal 3)	▪ Yes (Goal 1)	▪ Yes (All)
Travel Time Reliability	▪ Yes (Goal 1)	▪ Yes (Goal 1)	▪ Yes (All)
Planning Time	▪ Yes (Goal 1)	▪ Yes (Goal 1)	▪ Yes (All)
Customer Satisfaction	▪ Yes (Goal 1 and 2)	▪ Yes (Goal 1)	▪ Yes (All)
Wasted Fuel Consumption Reduction	▪ Yes (Vision)	▪ Yes (Goal 1)	▪ Yes (All)
Reduced Emissions	▪ Yes (Vision)	▪ Yes (Goal 1)	▪ Yes (All)
Dollars saved due to TIM Efforts	▪ Yes (Mission)	▪ Yes (Goal 1)	▪ Yes (All)
Incident Duration	▪ Yes (Goal 3)	▪ Yes (Goal 1 and 2)	▪ Yes (All)
Secondary Crashes	▪ Yes (Mission)	▪ Yes (Goal 1 and 3)	▪ Yes (All)
Benefit Cost Ratios of Freeway Service Patrols	▪ Yes (Goal 3)	▪ Yes (Goal 1 and 2)	▪ Yes (All)
Travel Time Index	▪ Yes (Goal 1)	▪ Yes (Goal 1)	▪ Yes (All)
Average Speed	▪ Yes (Goal 1)	▪ Yes (Goal 1)	▪ Yes (All)
TMC Performance	▪ Yes (Goal 2 and 3)	▪ Yes (Goal 1)	▪ Yes (All)

Specific Regional Operations Plan references were not provided since all stated needs regarding TIM and traveler information services.