

A Work Zone Intrusion Initiative to Reduce Highway Construction Accidents
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ABSTRACT

A worker was killed on a NYSDOT construction project in 1999 when a vehicle intruded into the work space, in spite of the presence of adequate temporary traffic controls. In response, agency management launched an initiative to reduce the risk to workers from intrusion accidents in highway work zones. Seven specific countermeasures were selected for widespread implementation: transverse rumble strips, reduced spacing for channelizing devices, enhanced flagger station setups, reduced work zone speed limits, increased police enforcement, variable message signs, and drone radar. These countermeasures were specifically intended to enhance driver awareness of work zones through additional visual, audible and tactile stimuli and messages. A coordinated program was developed to ensure consistent application at appropriate work sites throughout the state. Reporting, quality assurance, and evaluation and follow-up steps were included to facilitate implementation and evaluation of program effectiveness. Results over the 1999 construction season confirmed widespread application of countermeasures at appropriate sites. Extensive outreach to agency staff, contractors and police agencies, combined with public awareness efforts, resulted in an enhanced focus on work zone safety throughout the 1999 season. While specific accident reductions cannot be associated with individual countermeasures or program elements, accident records show a substantial reduction in serious work zone traffic accidents in 1999, as well as a reduction in serious worker injuries. Based on these positive results, the agency is integrating the countermeasures into its standard specifications and operational procedures. Lessons learned from this initiative are listed for consideration by other agencies considering work zone safety improvement initiatives.

Key words:

work zone traffic control
work zone accidents
work zone safety
intrusion countermeasures

INTRODUCTION

A state transportation agency often moves slowly to modify design and procedures for temporary traffic control on highway construction projects. At the New York State Department of Transportation (NYSDOT) an extensive internal review precedes changes to specifications, design manuals and standardized drawings. This is necessary to ensure consistent, high quality temporary traffic control. However, it may thus take considerable time to develop innovative or improved approaches and incorporate them into practice. NYSDOT's work zone quality assurance program (1) has effected many improvements to work zone traffic control through its annual inspections, but this has been a gradual, long-term process of raising overall quality by identifying areas where improvement is needed.

In contrast, the initiative described in this paper discusses another way programmatic changes are effected at NYSDOT—by coordinated, rapid response and dedication of staff time, resources and attention to a specific problem. This happened when a tragic and dramatic accident suddenly directed both agency and public attention to work zone traffic control issues. The safety improvements implemented and the processes used to quickly and systematically address a major work zone safety issue may be of interest to other highway agencies facing similar situations.

This accident occurred at the start of the construction season in early April, 1999, on a rural two-lane highway in the western part of the state. A lane closure had been set up, at about seven o'clock in the morning, to protect an edge-drain operation involving a backhoe and dump truck. Advance warning signs and channelizing devices were in place, and two flaggers were controlling alternating one-way traffic through the open lane. A few minutes after work started, a tractor-trailer traveling at a high rate of speed approached the work zone, but failed to slow down in the advance warning area. The flagger indicating traffic to stop jumped down an embankment to avoid being struck as the truck went by. The truck continued into the closed lane and struck the backhoe, killing its operator. The impact pushed the backhoe into the dump truck, occupied by two other workers, then continued through the work space, just missing a NYSDOT inspector who was getting out of his car to begin work. The vehicle finally came to rest in some trees off the roadway. The truck driver, who was uninjured, complained to police that he had not seen any signs in advance of the operation.

This accident clearly showed that an intrusion into a work space presents a deadly threat to those working there. A life was lost, and one fatality could easily have been several more. Fortunately for the other workers present, they sustained no serious injuries. The accident generated a great deal of attention within NYSDOT, the construction industry, and in western New York, where the backhoe operator had lived and worked for many years. It reinforced the construction industry's perception of the dangers of working around traffic and aroused public concern about highway work zone safety. Especially troubling, and puzzling, to NYSDOT, was the way the accident occurred. Conditions at the site were optimum—fair weather, light traffic, and good sight distance. The work zone was set up following guidelines and requirements in both the federal New York State MUTCD, signs and channelizing devices were in good condition, and proper flagging procedure was followed.

There was no involvement of drugs or alcohol. One possible contributory factor may have been driver fatigue, because the truck driver had been on duty for several hours prior to the accident. However, this was not established with certainty. Yet, in spite of everything having been done “right,” the accident happened and a worker died.

This tragedy raised the question of whether additional safety features, above and beyond standard work zone procedures, might have prevented this accident. NYSDOT executive management charged its staff with developing specific measures to prevent vehicles from intruding into highway work spaces and to enhance the safety of all NYSDOT work zones. Coordination responsibilities were given to the Construction Division, which oversees the Department’s capital construction projects. The Work Zone Intrusion Initiative was to be implemented almost immediately for the 1999 construction season. Therefore, it could involve no extensive design or program changes and no major research effort. Requirements were that selected countermeasures must be existing technology, demonstrated effective, readily available, reasonable cost, and easy to implement. The initiative emphasized measures not already widely used on NYSDOT projects, but that could be used widely with potentially good results. Improving worker safety was the primary objective, with implementation to be at locations where workers were exposed to traffic, such as working alongside an active travel lane without protection by concrete barrier. The focus was on driver attention and behavior, with measures directed at “invading the compartment” of the vehicle to alert drivers and increase their attention when approaching and traversing a work zone.

Although a reaction to a particular incident, the initiative was also a response to previously recognized concerns with work zone accidents. A study by NYSDOT had shown that 22 percent of all serious worker injuries and 43 percent of fatal injuries on NYSDOT construction projects from 1993 through 1997 resulted from traffic accidents.(2) Further research investigated the occurrence and characteristics of intrusion accidents, in which a vehicle enters a defined work space or buffer space, or into the transition area inside channelizing devices, as defined in figure VI-1 of Part VI of the Federal MUTCD.(3) This study showed that in a six year period from 1993 through 1998, intrusions into the work space were a relatively small proportion of all accidents. However, serious injuries to workers and the traveling public did occur. Intrusion accidents accounted for four fatal accidents and 60 accidents requiring hospitalization. These represented about nine percent of all traffic accidents, about eight percent of the hospital injuries and seven percent of the fatalities. Workers were directly involved in just under half the intrusion accidents, either as pedestrian workers or as operators or passengers in vehicles and equipment.

WORK ZONE INTRUSION INITIATIVE

1. Countermeasure Selection Process

NYSDOT has in place an integrated safety and health management program, including traffic control, for its construction and maintenance operations. (4) Traffic control management procedures incorporate engineering(standardized specifications, design and details; traffic control plans for all

projects; a formal quality assurance procedure to evaluate the effectiveness of work zone traffic control) law enforcement, and public awareness. An initial evaluation was made of all three areas to identify intrusion countermeasures already in place or having potential for use. Measures identified were then categorized according to use, potential for use, cost, and whether NYSDOT had existing policy or guidelines in place for them. Using this as a starting point, further suggestions were solicited from various NYSDOT divisions—Construction, Design, Research and Transportation Maintenance—and from NYSDOT’s 11 Regional offices. As examples of the kind of input received, one Region submitted an enhancement to the standard flagging operation setup that used a flag tree on the shoulder and cones along the centerline in advance of the flagger to attract driver attention. Another Region had discovered that reducing the spacing between channelizing devices was an inexpensive way to improve visibility of work areas. These were incorporated into the initiative and their use was extended statewide. Additionally, other states’ “best practices” were reviewed through literature searches and personal contacts, and contributions from the construction industry and vendors of traffic control devices were requested.(5)

Following development of a preliminary proposal for the initiative, a Department-wide review was performed on a very tight schedule. Staff involved in developing the initiative met with Main Office and Regional managers to discuss concerns and develop a working consensus to ensure support for the program. Revisions were made as appropriate prior to issuing the Department directive.

2. Implementation Process

Start-up of the state-wide initiative for NYSDOT construction and maintenance operations was scheduled for late May, just before the Memorial Day holiday. The Work Zone Intrusion Countermeasures were issued by Engineering Directive (6) from NYSDOT executive management, and made effective as a one-year effort. Issuance of the directive was accompanied by various news releases, press conferences and other public awareness events. It called for implementing seven specific countermeasures on Department projects where applicable. Existing emphasis on safety features routinely in use, or available for use, would continue. These included credible signing, temporary concrete barrier, shadow vehicles with truck-mounted attenuators, high-quality work zone pavement markings, crash cushions, arrow panels, warning lights, and other features.

The directive contained provisions to manage the initiative and evaluate results:

- Mechanisms for adding countermeasure to contracts - Specific instructions were provided for incorporating the measures into contracts in various stages of design or construction, either by the normal bidding process or by order-on-contract.
- Payment issues - Provisions were made for reimbursing contractors for extra traffic control costs incurred on ongoing contracts.
- Implementation dates - Deadlines were established for installation of each countermeasure. The target date was mid-June for most countermeasures. All others were to be in use by July 1.

- Reporting and follow-up requirements - The directive required reports by the Regions on specified dates to enable tracking of the initiative's progress and to allow adjustments as necessary to improve effectiveness. The Regions were also requested to submit a summary report at the end of the construction season so an evaluation of the initiative's results could be made.
- Guidelines - Each countermeasure listed existing Departmental guidelines as references, provided criteria to determine what operations were candidates for each countermeasure, and added new guidance developed from research conducted in the first phase of the initiative.
- Evaluation - In addition to Regional follow-up reports, NYSDOT's annual work zone inspection program would specifically evaluate these countermeasures. Their use would be noted on individual projects and if not used where appropriate, an explanation would be required from the Region.

COUNTERMEASURES

Seven countermeasures were developed for the initiative. Some of the measures were applicable to a wide range of projects, where others could be used more selectively. Use of every countermeasure on every project was not mandated. The Regions were to choose an appropriate combination based on the criteria in the guidelines and using sound engineering judgment.

1. Transverse rumble strips
Specifications and criteria for temporary transverse rumble strips already existed, but their use had been very limited on NYSDOT projects. While they are generally not effective in reducing speed significantly, they provide audible and tactile warning that the driver is approaching a work zone.⁽⁷⁾ Rumble strips are relatively easy to install, and earlier experience indicated they are sufficiently durable to last through the construction season even under heavy traffic. The directive required temporary transverse rumble strips to be installed at approaches to long-duration projects, primarily on high speed, open-road locations. Several options were provided—saw cut, milled-in, or raised asphalt strips were acceptable where pavement would be overlaid or removed. Pavement marking tape strips were allowed where removal from the pavement was an important consideration. Rumble strips were not to be used near residences where noise might be objectionable or in situations where they would provide no additional warning. The standard pattern called for six transverse strips spaced 3m (10 ft.) apart, with a thickness or depth of 9mm (3/8 in.)
2. Channelizing device spacing reduction
Channelizing devices such as cones, drums and vertical panels physically separate the travel space and work area. While they cannot prevent an intrusion, they provide positive guidance and discourage intentional intrusion. Based on favorable experience at nighttime construction work zones and on urban projects in several Regions, it appeared that closely spaced devices combined with use of larger devices reduces deliberate intrusions and inadvertent intrusions as well. The initiative required maximum device spacing of 12m (40 ft.) at stationary work

sites where workers are exposed to traffic, in tapers located close to the work area, and optionally throughout the work zone. Drums or vertical panels were recommended for long-duration work zones and at locations where the risk of intrusion is high. In long lane or shoulder closures, at least two channelizing devices were to be placed transversely at maximum 225m (750 ft.) intervals to discourage traffic from driving through the closed lane.

3. Flagger station enhanced setups

Supplemental traffic control devices upstream of flagger locations can increase conspicuity and provide added warning. Upstream cones and flag trees were required as supplemental devices for flagger station setups on moderate and high-speed roadways with unencumbered approaches. However, the extra devices were not required to constantly moving, very short-term operations, or those in congested work zones where additional devices would result in clutter or confusion.

4. Work Zone Speed Limit Reductions

This countermeasure extended a procedure already established for reducing speed limits in work zones.(8) Under the initiative, reduced speed limits were to be considered for work sites with normal speed limits of 45 mph or higher meeting either of two criteria: workers present on or adjacent to travel lanes with no positive barrier, or alternating one-way traffic controlled by flaggers. Speed reduction was to be 10 to 20 mph depending upon highway conditions. Guidance in the directive emphasized that reduced speed limits should not be routinely imposed on all projects or throughout the length of an entire project unless warranted by restricted roadway conditions. They should be posted only in the vicinity of workers. Where possible, reduced speed limits were to be combined with visible police presence to maintain credibility, and signs were to be removed or covered when workers or the restricted roadway conditions were not present. New York State vehicle and traffic law permits such temporary application of reduced speed limits.

5. Police enforcement

NYSDOT has procedures for providing full-time police presence in work zones, both on a paid (dedicated) and unpaid (cooperative) basis. A survey conducted during the development stage of the initiative showed uneven use of police enforcement in different areas of the state, from extensive use to almost none. While full-time police presence in every work zone is not a reasonable expectation, an increased driver expectancy for encountering police presence is expected to reduce traffic speed, control erratic driver behavior and result in safer, smoother flow through the work zone. The directive called for a visible police presence on a regular basis on Department work sites, with highest priority given to night work, freeways and expressways when workers are exposed to high-speed traffic, other high-speed roadways with worker exposure, and locations where traffic conditions present a high risk. Police presence was to be provided through a combination of dedicated and cooperative enforcement. Regions were directed to establish a mechanism to increase and coordinate cooperative enforcement and to ensure dedicated enforcement procedures already in place

were being managed effectively. At the statewide level, an understanding was developed between NYSDOT management and the New York State Division of State Police to encourage troopers on patrol to routinely stop for a few minutes when they encounter a NYSDOT work zone and check the traffic conditions. This new “Stop/Check” program increased police visibility on projects, especially for short duration and isolated work zones.

6. Variable message signs

Variable message signs are permitted on NYSDOT projects to supplement standard highway signs where real-time information is needed. Most Regions already owned a number of VMS signs and more were available through contractors on a rental basis. Under the initiative, VMS's were to be used to provide added advance warning on high speed roadways where work activities required stopping, slowing, merging or other activities that calling for a specific reaction. Priority use was on high-speed expressways and rural arterials with worker exposure to traffic, and slowly moving and mobile operations. Guidelines issued in the directive restated criteria for appropriate messages (e.g. state the specific roadway condition ahead; provide instructions for the driver) and reinforced NYSDOT policy that signs should be turned off when not needed to convey specific information. Use of VMSs for presenting general information and generic safety messages is discouraged.

7. Drone radar

Commercially available drone radar units emit radio signals that activate radar detectors used by the traveling public. They are typically mounted on work vehicles, arrow panels or variable message signs. While the experience of other states indicated that speed reduction effects are small, activation of the radar detector can alert drivers and increase their attention.⁽⁹⁾ Although radar detectors are illegal in commercial vehicles in New York, it is believed that they are in common use. Passenger cars and other noncommercial vehicles also use radar detectors, although the level of use is unknown. NYSDOT had not used drone radar previously. Therefore, a small quantity of drone radar units was to be purchased in each Region to use in a pilot project, with additional units to be acquired if the initial experience was successful.

RESULTS

Progress reports submitted by the Regions at specified dates throughout the summer, and a summary report from each Region in December, provided an overview of the implementation and evaluation of results. Extent of countermeasure use was also observed in the annual work zone inspection.

Table 1 summarizes use of the individual countermeasures as reported in the Regions' summary reports. Based on these reports, there was widespread implementation of the countermeasures throughout the state. It is also apparent that the Regions were selective in applying the countermeasures. Some, such as channelizing device spacing reduction and enhanced flagger station setups, were used at most sites where channelizing devices and flaggers were used, while other

countermeasures were used only occasionally. Results for each countermeasure are discussed in more detail later in this section.

Table 2 summarizes the extent of countermeasure use observed in the statewide work zone inspection. That inspection noted two points for each countermeasure at each site inspected. First, the need for individual countermeasures, or any countermeasures, was noted. A number of factors could indicate that a particular countermeasure (or any countermeasures) was not needed. Examples include:

- No worker exposure—work took place off road, temporary barrier in place, etc.
- Residential area precluded use of rumble strips
- Speed limit already reduced
- No flagging used
- Channelizing devices not used to separate traffic and workers
- Low speed urban approach—no rumble strips needed
- Short term or moving work sites

Second, the use of each countermeasure was noted where it was judged to be appropriate for use. The rating was based on a simple three-point scale, with an “OK” indicating a countermeasure used correctly, “Occasional Problem” indicating the countermeasure was present but some adjustment was needed, and “Not Used” where the site was appropriate, but a required countermeasure was not used. Because the target date for implementation of drone radar was later in the season, use of that countermeasure was not noted during the inspection.

Statewide, at least one countermeasure was used at well over half of all construction sites, and over one-third of all maintenance sites. Equally important, the number of sites where one or more countermeasures should have been used, but none were present, was very low—five percent for construction and nine percent for maintenance. Table 2 shows that one or more countermeasures were used at 89 percent of the sites where they were considered appropriate for use and at 80 percent of the maintenance sites where they were considered appropriate. Based on both the statewide inspection results and the Region’s reports, it is clear that widespread implementation of the countermeasures was achieved.

The sections that follow describes the Regions’ experience with individual countermeasures and the perceived usefulness of the countermeasure in attaining the goals of the initiative:

1. Rumble strips. Extensive use was reported at construction sites by six Regions, and some use by four others. Only occasional use was reported or observed for maintenance projects. The consensus was that rumble strips are effective at appropriate locations, but improvements are needed for materials, strip patterns and use guidelines. There was a strong feeling that rumble strips are most appropriate for relatively high-speed, unencumbered work zone approaches in situations where they can be placed relatively near the work location or roadway restriction where traffic actually needs to slow down or observe added caution. While removable black

pavement marking tape was widely used, its effectiveness was mixed. Costs of tape strips were typically several hundred dollars per lane for each set of six strips and were thus viewed as very expensive. Although a few Regions tried alternate materials on a limited trial basis, removable tape remains the predominant material at this time.

2. Reduced channelizing device spacing. This countermeasure was used almost universally on both construction and maintenance projects, and every Region but one agreed this practice is worth continuing. Reduced spacing appears to be effective in reducing the risk of intrusions as well as providing improved guidance and possibly helping to slow or calm traffic. Although reduced spacing involves extra effort for set up and removal, it is inexpensive and easy to implement, and the extra effort was not a major concern. The only significant concern expressed for this countermeasure is that the close spacing makes it difficult for work vehicles to enter and exit the work space. However, this is easily addressed by providing a wider spacing at periodic intervals as needed. Based on favorable experience, this countermeasure has become a Department standard practice.
3. Enhanced flagger station setups. This countermeasure was also implemented on most construction and maintenance work where flagging was in use. Although there was a great deal of support for this countermeasure when used selectively, it was also the most controversial. The primary concern was that addition of flag trees and cones resulted in visual clutter— a “sea of orange”—that in some cases made flaggers harder to see. However, for open-road approaches to flagger stations it was generally agreed that the flag tree was helpful in providing extra visual warning and the added cones were helpful in guiding drivers to stop at the proper location.

Additional guidance was forwarded to the Regions in mid-summer to address some of the concerns. However, based on observations during the statewide inspection and comments in the Regional reports, there is still confusion about the best practices for flagger station setup. The conclusion reached from experience with this countermeasure is that enhanced flagger setups can provide benefits when used properly, but additional guidance and training are needed to ensure optimum setup and operation. More guidance is to be developed to continue appropriate use of this countermeasure.

4. Work zone speed limits. Seven Regions reported extensive use on construction projects and occasional use at maintenance sites, with less extensive use in four other Regions. Primary use was on expressways and freeways, especially those with 65 mph limits. Transportation Maintenance reduced speed limits mostly at bridge maintenance sites and other long-term setups. There is a clear consensus that reduced speed limits should be restricted to those sites where it is really needed. Restricted geometries through the work site and exposure of workers to high-speed traffic are the primary justifications. It is also generally accepted that speed limits should be restored to normal levels by covering or removing the temporary signs

when they are not needed. It was strongly felt that reduced speed limits are much more effective when used in conjunction with police enforcement.

5. Police enforcement. While there is generally strong consensus that police enforcement is effective in controlling speeds through work zones and provides an overall safety benefit, use of police at NYSDOT work sites varied widely. Three Regions reported extensive use of dedicated enforcement on construction projects, four others reported occasional use, and four reported no use. Cooperative enforcement varied widely, with three Regions reporting extensive use on construction sites. Use by the other Regions for construction work, and by all Regions for maintenance, varied from occasional to none. Management of police enforcement varies widely from Region to Region. Some provide substantial coordination at the Regional level, while others assign most of the responsibility to the project or residency level. There were indications from a few Regions that it is difficult to obtain cooperative enforcement either for construction or maintenance, while other Regions report excellent support. Suggestions were made that standard procedures and guidance are needed to ensure the most effective use of police resources at the project level. Department management will continue to work with New York State Police and other police agencies to promote good enforcement at work sites.
6. Variable message signs. Five Regions reported extensive use of VMSs on construction projects, with some use in the other six Regions. Occasional use at maintenance sites was reported by four Regions, with no use or no information reported by the other six for maintenance. VMSs are generally viewed as an effective device for improving work zone safety and traffic flow, but only when use is limited to essential real-time information. Concern was expressed by most Regions that VMSs are overused and used for non-essential messages. This diminishes effectiveness and leads to driver disregard. Some messages were not formatted correctly to convey critical information, and adequate procedures and guidance are not available to ensure proper message content and use.
7. Drone radar. Use of drone radar was minimal, reported by three Regions on construction sites and three maintenance sites. In addition, radar-activated VMSs were used in two Regions. The limited use of drone radar was primarily because the radar units had to be purchased, which took some time, and because of some resistance to the concept. Generally, there was a lack of understanding about the use and purpose of drone radar. While it is recognized that it has a small effect at best on traffic speed, it has value as a warning device to provide an audible or visual stimulus inside the vehicle. At the end of the construction season there was some positive feedback from one Region that tried to use this countermeasure extensively. Drone radar units had been placed on vehicles used in moving operations like mowing and sweeping, where the radar signal is not at the same location every day. Vehicle and equipment operators reported a perceived slowdown and smoother traffic flow, and the operators are requesting drone radar for all their routine moving operations in the next

construction season. Drone radar will continue to be used on a limited basis to gain more experience.

1999 TRAFFIC ACCIDENT EXPERIENCE

NYSDOT maintains a data base of accidents occurring on Department construction projects. Every year a report is prepared of the statewide accident experience for project-related construction and traffic accidents. Because this information is available, at the end of the construction season a comparison could be made between the 1999 season and prior years to see if there were discernible safety improvement resulting from the Work Zone Intrusion Initiative. Transportation Maintenance operations are tracked under a different system and detailed accident information is not available. Therefore, these results reflect construction projects only. Table 3 summarizes accident experience on Department construction projects from 1995 through 1999. A review of construction program size over the past five years, based on contract dollar volume awarded and dollar volume remaining, indicated that the program was larger in 1999 than in previous years by about 30 percent. In spite of the larger program, the table indicates that construction projects were safer in 1999 for both workers and the traveling public. Serious traffic accidents—those resulting in a fatal or hospital-level injury—were the lowest since 1995, and totaled 10 percent less than the average of the last four years.

Traffic accidents involving workers also showed a decline. Most important, no serious worker injuries were caused by intrusion accidents after July 1, 1999. This date is when substantial implementation of the intrusion countermeasures began to occur on construction projects. The period from 1993 through 1999 averaged about three serious worker injuries from intrusion accidents, with four serious injuries during the first half of 1999—before the countermeasures were in place. All traffic accidents, intrusion and non-intrusion, resulting in serious worker injuries also declined dramatically in the second half of 1999. Only one serious worker injury was reported in a traffic accident after July 1, compared to eight during the first half of the year, and an average of ten per year over the past six years.

Based on the substantial reduction in serious traffic accidents in 1999, in spite of a larger construction program, and the absence of serious worker injuries from intrusion accidents, it appears that at least a part of the overall improvement in safety experienced in 1999 is attributable to the work zone intrusion initiatives. Other safety initiatives were also active during the 1999 season. A statewide Work Zone Driver Awareness Initiative was conducted by the Public Relations Division; a “100 Safe Days of Summer” campaign was conducted within NYSDOT for its own employees; and contractor/worker safety outreach programs were developed and presented. It is expected that these all contributed to an enhanced awareness and positive attitude toward safety, for the public, for contractor employees and for NYSDOT employees.

LESSONS LEARNED

NYSDOT's 1999 Work Zone Intrusion Initiative demonstrated measurable success in improving traffic safety in highway work zones. Accident data for construction projects in 1999 reflect fewer serious traffic accidents than over the previous four years, as well as a reduction in serious traffic accidents involving workers. While these accident reductions cannot be attributed solely to the intrusion initiative, it was clearly the catalyst that provided greatly enhanced awareness of work zone safety issues throughout New York State in 1999. Analysis of data in future years will further investigate the effect of enhanced work zone set-ups on intrusion accident occurrence.

The initiative further demonstrated that an intensive, focused effort by a highway agency can be successful in enhancing work zone safety efforts within a very short period. Even though the NYSDOT already had a strong, effective program to manage work zone safety, and excellent temporary traffic control was already the norm on Department projects, this initiative resulted in the rapid and widespread implementation of additional safety measures throughout the state.

For other agencies considering such an initiative, there are a number of key elements that are essential to ensure a successful outcome:

- well-defined goals
- management commitment, starting at the top level and reinforced throughout the agency
- adequate resources to fund implementation
- assigned responsibilities for oversight and tracking
- specific schedule for implementation of mandated actions
- support and supervision by field staff
- opportunity for experimentation and modification to adjust to changing situations and “fine-tune” applications
- outreach and communication to distribute guidance, within the organization and the contracting community
- public relations efforts to increase public awareness
- quality assurance efforts to evaluate implementation
- accident reporting and data analysis procedure to evaluate success
- good awareness of work zone safety issues throughout the agency
- sharing and coordinating Regional best practices to improve statewide quality
- identification of follow-up needed to increase program effectiveness
- outreach to and buy-in by all stakeholders—agency, contractors, police agencies, etc.
- adequate technical specifications to ensure consistent implementation
- detailed program guidance
- opportunity for research and demonstration projects to explore additional countermeasures

Because of the positive results of the initiative, NYSDOT extended this effort through 2000. All the countermeasures will be continued while follow-up activities are completed. Some of the countermeasures will be incorporated into standard practice (enhanced flagger setups, reduced

channelizing device spacing, rumble strips). To do this, typical designs and details will be developed and issued. Additional guidance will be developed to make some countermeasures more effective (work zone speed limits, variable message signs, coordination of police enforcement). Guidelines will be developed and added to appropriate design and construction manuals. Further study will develop improved rumble strip materials and practices.

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Table 1 Countermeasure Use Reported by Regions in Summary Reports

Table 2 Observed Countermeasure Use - Statewide Work Zone Inspection

Table 3 Accident Summary, NYSDOT Construction Projects

TABLE 1 Countermeasure Reported by Regions in Summary Reports, Construction and Transportation Maintenance Division (TMD)

Region	1. Rumble Strips	2. Chan. Devices	3. Flag Sta.	4. Speed Limits	5. Police Enf.	6. VMS	7. Drone Radar
1 - Constr.	12	all	all	21	18 D	34	2
TMD	Occ	all	all	some	Occ D&C	?	Occ
2 - Constr.	8	all	all	12	2D 2C	5	-
TMD	1	all	all	2	Occ C	?	-
3 - Constr.	2	all	all	some ⁽¹⁾	1D	8	-
TMD	-	all	all	?	?	?	-
4 - Constr.	8	most	most	12	7D 6C	19	-
TMD	?	?	?	?	?	?	?
5 - Constr.	8	all	all	5	none	Occ	5
TMD	2	all	all	Br. Maint.	1D-multi	Occ	3
6 - Constr.	3	all	all	Xways	1D	8	Occ VMS
TMD	-	all	all	Xways	Occ C 1D-multi	Occ	-
7 - Constr.	6	all	all	12	2C	2	-
TMD	1	all	some	Br. Maint.	-	Occ-Br. Maint.	-
8 - Constr.	all app.	all	all	Occ	C-40%	10	Occ VMS
TMD	all app.	all	all	Occ	-	-	-
9 - Constr.	5	all	all	13	5C	4	4
TMD	-	all	all	all 65 mph	-	Occ	1
10-Constr.	1	all	all app.	some ⁽²⁾	Occ C+D	some	-
TMD	?	all	all	?	?	?	-
11-*Constr.	-	40	20	25	25	21	-

Occ: Occasional
 -: No use reported
 ?: No information provided
 all app: All sites where appropriate -- no specific information provided
 *: Number includes completed and planned implementation on ongoing projects
⁽¹⁾: Most 65 mph highways, some others
 Xways: Expressway projects
⁽²⁾: Where workers were exposed to traffic
 D: Dedicated enforcement
 C: Cooperative enforcement

D-multi: Dedicated MOU encompassing multiple work sites or projects

TABLE 2 Observed Countermeasure Use by Countermeasure - Statewide Work Zone Inspection Based on Implementation of Individual Countermeasures

Countermeasure	Construction - % Use		Maintenance - % Use	
	Sites Where Needed*	All Sites**	Sites Where Needed*	All Sites**
1 - Rumble strips	86	19	75	3
2 - Channelizing	92	46	86	36
3 - Flagger stations	79	15	68	17
4 - Speed limits	90	29	86	7
5 - Enforcement	90	15	80	5
6 - VMS	90	21	83	6
7 - Drone radar***	-	-	-	-
Total	89	21	80	11

* % of sites where used based on number of sites where individual countermeasures were considered appropriate for use.

** % of individual countermeasure applications based on all sites observed.

*** Observations were not compiled for drone radar.

TABLE 3 Accident Summary: NYSDOT Construction Projects

SERIOUS WORK ZONE TRAFFIC ACCIDENTS

	FATAL	HOSPITAL
1999	9 (5 after 7/1)	127 (74 after 7/1)
1998	8	170
1997	10	166
1996	9	142
1995	12	90

WORK ZONE ACCIDENTS RESULTING IN FATAL OR HOSPITAL INJURIES TO WORKERS

1993-1999 All Work Zone Accidents: Total = 69; Avg. = 9.9/yr.

1993-1999 Intrusion Work Zone Accidents: Total = 22; Avg. = 3.1/yr.

1999 All Work Zone: Total = 9; Before 7/1 = 8; After 7/1 = 1

1999 Intrusion Work Zone: Total = 4; Before 7/1 = 4; After 7/1 = 0