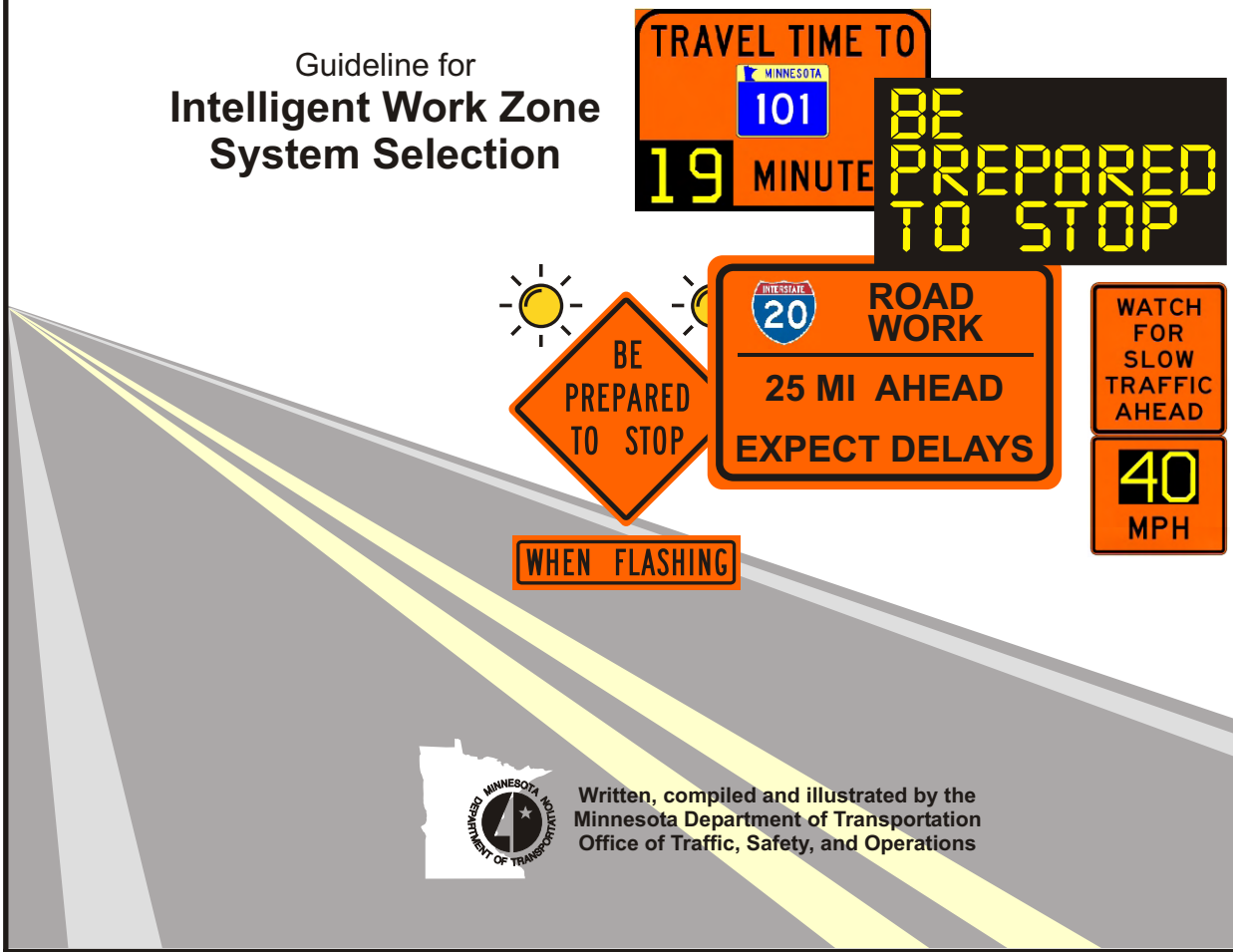
Minnesota IWZ Toolbox

Guideline for
Intelligent Work Zone System Selection



Written, compiled and illustrated by the
Minnesota Department of Transportation
Office of Traffic, Safety, and Operations

MINNESOTA INTELLIGENT WORK ZONE TOOLBOX
2008 EDITION

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Introduction:

The IWZ Toolbox has been prepared as a guideline for selecting an appropriate Intelligent Work Zone (IWZ) System for existing work zone traffic issues and to mitigate anticipated issues on scheduled projects. The IWZ System descriptions contained in this toolbox are intended as brainstorming material and should lead to practical solutions to a project's unique problems. The examples are purposely left void of many dimensions, except where particular distances are highly recommended, and engineering judgement is required to customize the system to a project.

IWZ Systems may be sorted into 3 category types based upon detectable stimuli: **"Traffic", "Vehicle", and "Environmental"**. The 3 categories are shown below with their typically associated systems:

Traffic Responsive Systems collect and respond to **average** traffic characteristics such as speed an volume of a group of vehicles and the systems react to **trends** of increasing/decreasing values. The combination of these basic systems form the basis for **Route Management Systems** (or Traveler Information Systems) by analyzing and reporting information in various ways. These applications may include:

- Travel Time Information (Trip Time or Estimated Delay)
- Speed Advisory Information
- Congestion Advisory
- Stopped Traffic Advisory
- Dynamic Merge (Late or Early)
- Traffic Responsive Temporary Signals
- Temporary Ramp Metering

Vehicle Responsive Systems collect and respond to **individual** vehicle characteristics such as speed, dimensions, and location. When adverse conditions are detected by these systems, motorist need **immediate warnings** for quick response. These applications may include:

- Excessive Speed Warning (including Dynamic Speed Display Signs)
- Over Dimension Warning
- Work Space / Haul Road Intrusion Warning
- Construction Vehicle Warnings

Environmentally Responsive Systems collect and respond to changing non-traffic conditions of weather, roadway or working characteristics such as visibility conditions or roadway surface conditions and hazards. These applications may include:

- Hazardous Condition Warnings (Flooding, Ice, Fog, Smoke, Dust, etc.)

The real-time data collected for any of these systems may be combined, averaged, analyzed for trends, and utilized for several informational uses. For example, data collected for 'Stopped Traffic Warnings' may be to control a 'Dynamic Merge' system or to calculate "Travel Time' through a corridor.

Temporary Traffic Control Devices may be equipped with advanced communication and/or remote control capabilities which that do not react "intelligently" to detectable field data, but the devices provide safer working conditions or improve incident response. Although these devices may not be "Intelligent", they have been included in the IWZ Toolbox as additional safety tools for consideration when an IWZ System is being deployed. These applications may include:

- Changeable Work Zone Signage (WZ Speed Limit Signs)
- Traffic Surveillance Cameras (removed from Toolbox)

Typical System Components:

Each IWZ System in the Toolbox is a collection of standard system components which have been combined to produce a useful real-time system. The individual component functions include the collection of data, verifying the accuracy of the data, transmitting the data, storing and managing the data, analyzing the data, and/or providing the data to the motorist.

Detection Components: The detectors may include:

- Radar
- Pneumatic Road Tubes
- Light Beams
- Acoustical
- Ultrasonic
- Magnetic
- Piezo-Electric
- Video
- RFID
- Probe Injection Technologies, etc.

System Monitoring Components: typical redundancies should be built into most systems (based upon risk assessment for the system failure) and the various types of quality control testing or system monitoring may be utilized.

System Communication Components: the typical forms of transmitting data, some of these may include:

- Cell Phones
- Internet - Wireless Access Points
- Radio
- Hard wired
- Optical, etc.

System Analysis Components: analysis algorithms are designed or modified for each application of an IWZ System to fit the conditions of the project. Algorithms can be designed with apparent limitations and strengths, and field testing is necessary to ensure the quality of the data analysis.

Data Management Components: the storage of data and analysis of the data for various trends, events, etc. may utilize many different database systems.

Dynamic Informational Components: dynamic components provide information to the motorists and may include:

- 511 Systems (internet & phone/cell phone),
- Changeable message signs (CMS) in dynamic mode,
- Static signs with dynamic features,
- Remotely activated traffic control devices,
- Audible or visual alarms,
- Real-time highway advisory radio (HAR),
- Public media announcements,
- CB Radio, etc.

Supplementing Existing System Components:

Mn/DOT, through it's Regional Transportation Management Center (RTMC) and out-state TOCC's, has the capability to provide a variety of IWZ Systems for Mn/DOT construction and maintenance projects. However, Mn/DOT's detection devices, communications networks or traveler information systems may not be adequate for a proposed IWZ System. Discrepancies may be due to construction interrupting permanent installations, or that the existing system components do not extend to the project area.

IWZ System components provided by a contractor would supplement the services of the RTMC or TOCC's, when various devices/services are not currently available and may include any of the component types listed above.

DEFINITIONS FOR USE IN THIS DOCUMENT

- **Changeable Message Sign (CMS):** a sign that is capable of displaying more than one message, changeable manually, by remote control, or by automatic control. The device is considered "portable" when trailer mounted. The device may be operated in one of two modes:
  - **Standard Mode:** message is programmed to remain displayed until changed by the operator or via a timer.
  - **Dynamic Mode:** the message is programmed to respond to traffic operating characteristics or roadway conditions.
- **Static Sign: a** message for the motorist is printed on a standard sign, either regulatory, warning or guide signs.
- **Advisory Speed:** a recommended speed for vehicles based on the current roadway conditions or operating characteristics. Advisory Speeds are not enforceable.
- **Speed Limit:** the speed applicable to a section of highway as established by law.
- **Travel Time:** the estimated amount of drive time from the motorist's current location to an identified location, generally limited to approx 10 miles maximum distance.
- **Travel Delay:** the estimated amount of extra time the motorist will incur due to traffic conditions in a work zone located downstream. Generally useful for spot locations at a great distance away from the motorist's current location, which provides alternate route possibilities.
- **Devices (components):** the individual parts or subsystems that makeup a working IWZ System. Examples include: cameras, various detectors, signs, data monitoring or recording equipment, communication systems, TTC devices, and remotely activated alarms, etc.
- **IWZ System:** An automated system of devices that provides motorists and/or workers **real-time** information for improved safety and mobility through a work zone. The devices are integrated to monitor traffic operating characteristics or roadway conditions and react with a predetermined response.
- **Warrants:** conditions which should be satisfied before considering an IWZ system for deployment as part of a project's temporary traffic control plan.
- **Benefits:** anticipated affects mobility and safety when the system is properly designed and deployed. Mobility and safety measures may be within the work zone or surrounding network, and may include the public, the workers, or the constructability of the project.
- **Options:** various options may be available for portions of the IWZ Systems. The options should be considered when they achieve satisfactory results with lower levels of 'system complication' and cost.

SYMBOLS USED IN IWZ TOOLBOX ILLUSTRATIONS

- **Changeable Message Sign (CMS):** Roadside location symbol shown on left with an example of two alternating messages shown on right.

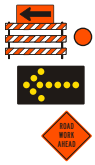
- **Static Guide Sign:** Roadside location symbol shown on left with example message shown on right.

- **Static Guide Sign with CMS Characters:** Roadside location symbol shown on left with example message shown on right.

- **Dynamic Flashing Warning Sign:** Roadside location symbol shown on left with example message shown on right.

- **Non-Intrusive Detection Device:** The symbol denotes any type of detection device(s) and the actual location and number of devices will vary from the toolbox illustration.

- **Advance Warning Sign:** Roadside location symbol shown on left with example message shown on right.



- **Temporary Traffic Control (TTC) Device:** The symbols denote standard TTC devices as defined by the MN MUTCD and the Field Manual of TTC Layouts. To highlight the IWZ systems, only a minimal amount of TTC devices have been shown on the toolbox illustrations. Key devices shown may include standard warning signs, Type III barricades, channelizing devices and flashing arrow panels.

GENERAL IWZ TOOLBOX NOTES

- Advance warning signs and other standard temporary traffic control devices have not been shown on this figure. Refer to the MN MUTCD including the 2007 Field Manual or the TTC Layout Templates for typical layout examples.
- All IWZ Guide Signs and CMS should be reviewed by the Mn/DOT Office of Traffic, Safety, & Operations for design and message approval.
- Approved CMS messages should be listed in the Special Provisions, and approx CMS locations should shown on the TTC plans. All CMS displays should be blank when messages are not warranted.
- Refer to the Toolbox Definitions Section for graphic symbols and terms.
- Toolbox Illustrations are NOT Drawn to Scale.

IWZ SYSTEMS LISTED IN THIS PUBLICATION

- **Travel Time Information - Trip Time or Estimated Delay**
- **Speed Advisory Information**
- **Congestion Advisory**
- **Stopped Traffic Advisory**
- **Dynamic Merge - Late or Early**
- **Traffic Responsive Temporary Signals**
- **Temporary Ramp Metering**
- **Excessive Speed Warning - incl. Dynamic Speed Display Signs**
- **Over Dimension Warning**
- **Work Space / Haul Road Intrusion Warning**
- **Construction Vehicle Warnings - Merging, Crossing & Exiting**
- **Hazardous Condition Warnings - Road Surface or Visibility**
- **Changeable Work Zone Signage - incl. WZ Speed Limits**
-

Note: The IWZ Toolbox Sheets contained within this document are preliminary illustrations and may not accurately represent all the IWZ Systems as typically deployed.

The systems may be combined, modified, enhanced or simplified as necessary for a particular project. Please use these toolbox sheets to brainstorm IWZ possibilities, and consider what conditions may be needed to make the application viable. When a system is deployed, we hope to quantify these conditions further, with refined warrants on the system's toolbox sheet. We also wish to quantify benefits derived from the deployments where ever possible in addition to the intuitive benefits that may be reaped from the IWZ systems.

WARRANTS

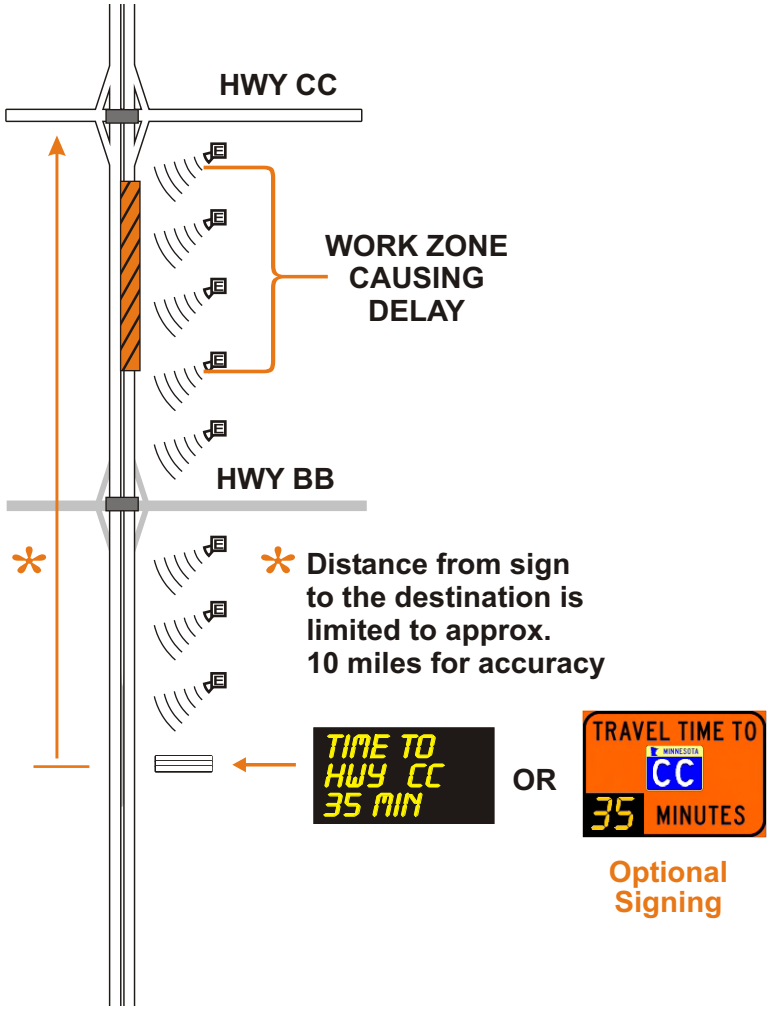
- The work zone may cause 15 minutes or more of additional travel time.
- The work zone causing the delay is within 10 miles of the CMS location.

BENEFITS

- The system should inform the drivers what the estimated travel time is between their current location and a specific destination beyond them (up to 10 miles maximum).
- The system will give drivers information which will allow them to decide whether to change routes, provide them opportunity to notify others of their estimated arrival time, and generally provide drivers sufficient information to calm tempers.

Layouts are NOT drawn to scale.

ESTIMATED TRIP TIME



Consideration should be given to posting an alternate route and travel time for additional driver information.

OPTIONS

- The CMS may be replaced with static warning signs equipped with two (2) CMS characters in dynamic mode. The characters would display the real-time travel time in the work zone downstream.
- Consideration should be given to posting an alternate route and travel time for additional driver information.
- The CMS may be supplemented with other informational devices such as Highway Advisory Radio (HAR).

NOTES

- Advance warning signs and other standard temporary traffic control devices have not been shown on this figure. Refer to the MN MUTCD including the 2007 Field Manual or the TTC Layout Templates for typical layout examples.
- All IWZ Guide Signs and CMS should be reviewed by the Mn/DOT Office of Traffic, Safety, & Operations for design and message approval.
- Approved CMS messages should be listed in the Special Provisions, and approx CMS locations should shown on the TTC plans. All CMS displays should be blank when messages are not warranted.
- Refer to the Toolbox Definitions Section for graphic symbols and terms.

WARRANTS

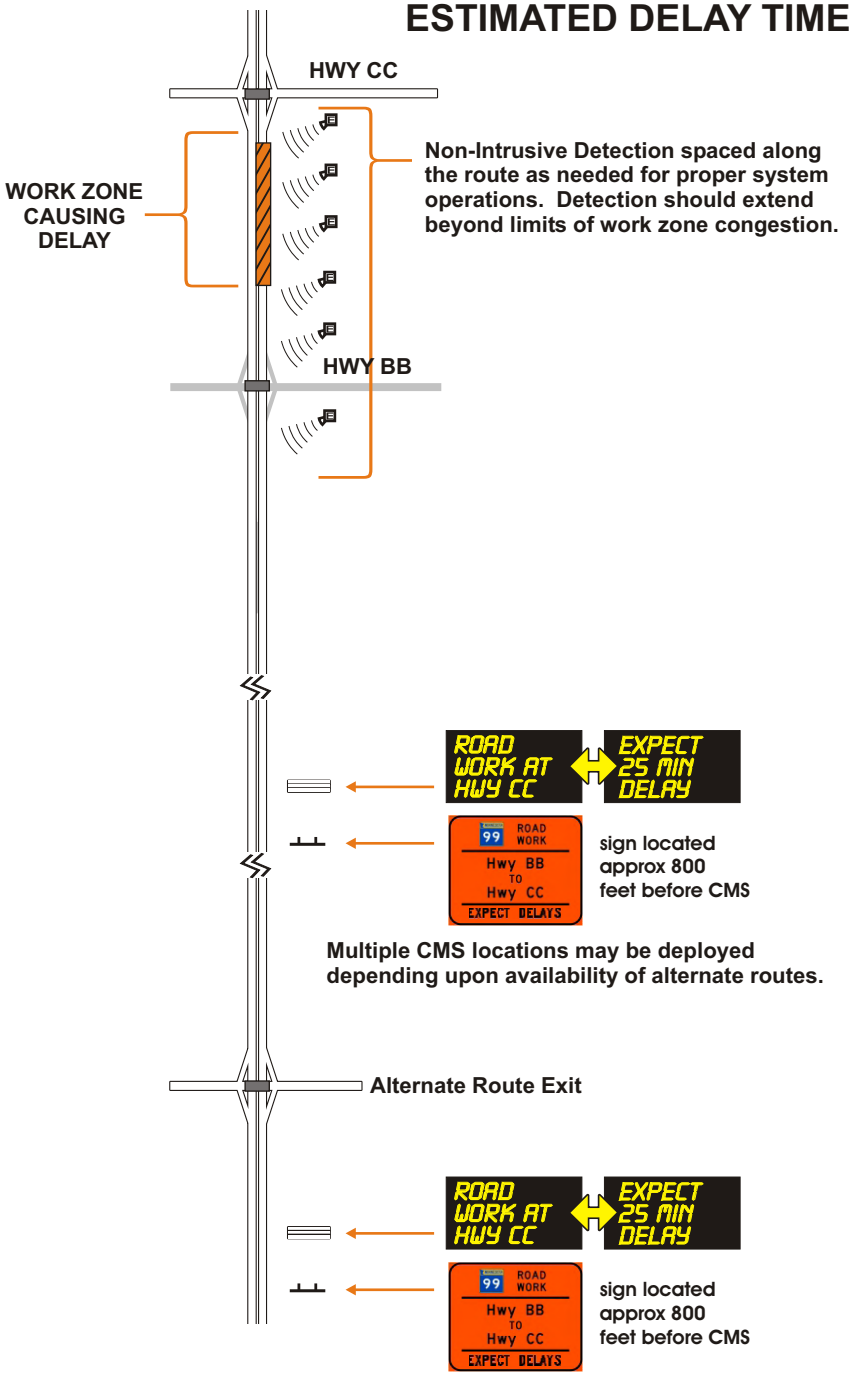
- The work zone may cause 15 minutes or more of additional travel time.
- The work zone causing the delay is located more than 10 miles beyond the CMS location (preferably 25 to 50 miles or more, such that multiple alternate routes are available).

BENEFITS

- System should inform the drivers what the estimated delay time is at an approximate location along the roadway downstream. The delay is calculated based upon queue speeds vs. normal travel speeds.
- The system will give drivers information which will allow them to decide whether to change routes, provide them opportunity to notify others of their estimated arrival time, and generally provides drivers sufficient information to calm tempers when they arrive at the cause of the delay.

Layouts are NOT drawn to scale.

ESTIMATED DELAY TIME



OPTIONS

- The CMS may be replaced with static warning signs equipped with two (2) CMS characters in dynamic mode. The characters would display the real-time travel delay in the work zone downstream.
- Consideration should be given to posting an alternate route and travel time for additional driver information.
- The system may be converted to a Travel Time system within 10 miles of the destination location (such as Hwy CC in this example).
- The CMS may be supplemented with other informational devices such as Highway Advisory Radio (HAR).

NOTES

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- All IWZ Guide Signs and CMS should be reviewed by the Mn/DOT Office of Traffic, Safety, & Operations for design and message approval.
- Approved CMS messages should be listed in the Special Provisions, and approx CMS locations should shown on the TTC plans. All CMS displays should be blank when messages are not warranted.
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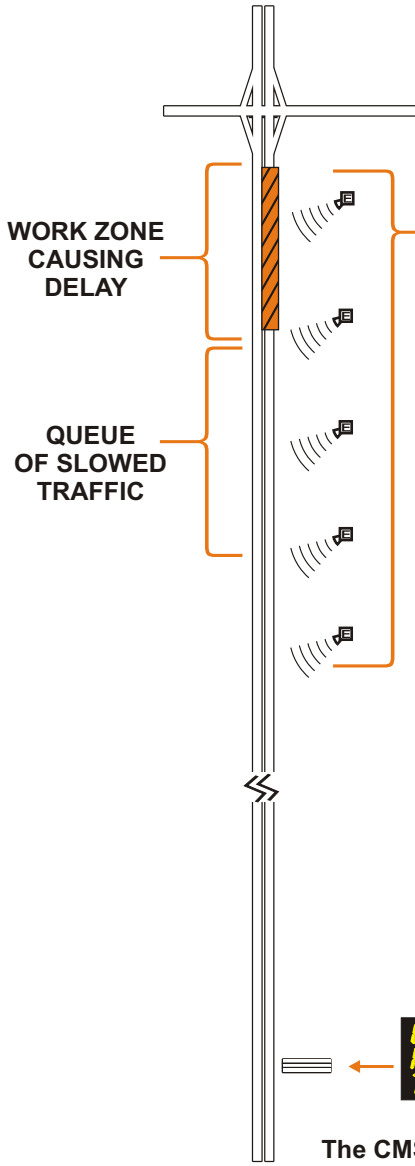
WARRANTS

- The work zone will cause additional travel time.
- The work zone queue is estimated to slow traffic at least 20 mph below the posted speed limit.

BENEFITS

- The system should advise drivers of an appropriate vehicle speed to allow them to travel through the work zone with minimal braking.
- The system will smooth the transition between faster and slower moving traffic.
- The system should provide an increase in capacity of the roadway through the work zone area.

Layouts are NOT drawn to scale.



Non-Intrusive Detection spaced along the route as needed for proper system operations. Detection should extend beyond limits of work zone congestion.

The CMS should be located 2 - 3 miles before the slow traffic queue. The displayed speed is the average speed detected entering the work zone location. Based on this information, the motorist may adjust speed to anticipate the slower traffic.

OPTIONS

- The CMS may be replaced with static warning signs equipped with two (2) CMS characters in dynamic mode. The characters would display the real-time average speed in the work zone downstream.

OPTIONAL DESIGN: combination of static sign and digital number display

NOTES

- Advance warning signs and other standard temporary traffic control devices have not been shown on this figure. Refer to the MN MUTCD including the 2007 Field Manual or the TTC Layout Templates for typical layout examples.
- All IWZ Guide Signs and CMS should be reviewed by the Mn/DOT Office of Traffic, Safety, & Operations for design and message approval.
- Approved CMS messages should be listed in the Special Provisions, and approx CMS locations should shown on the TTC plans. All CMS displays should be blank when messages are not warranted.
- Refer to the Toolbox Definitions Section for graphic symbols and terms.

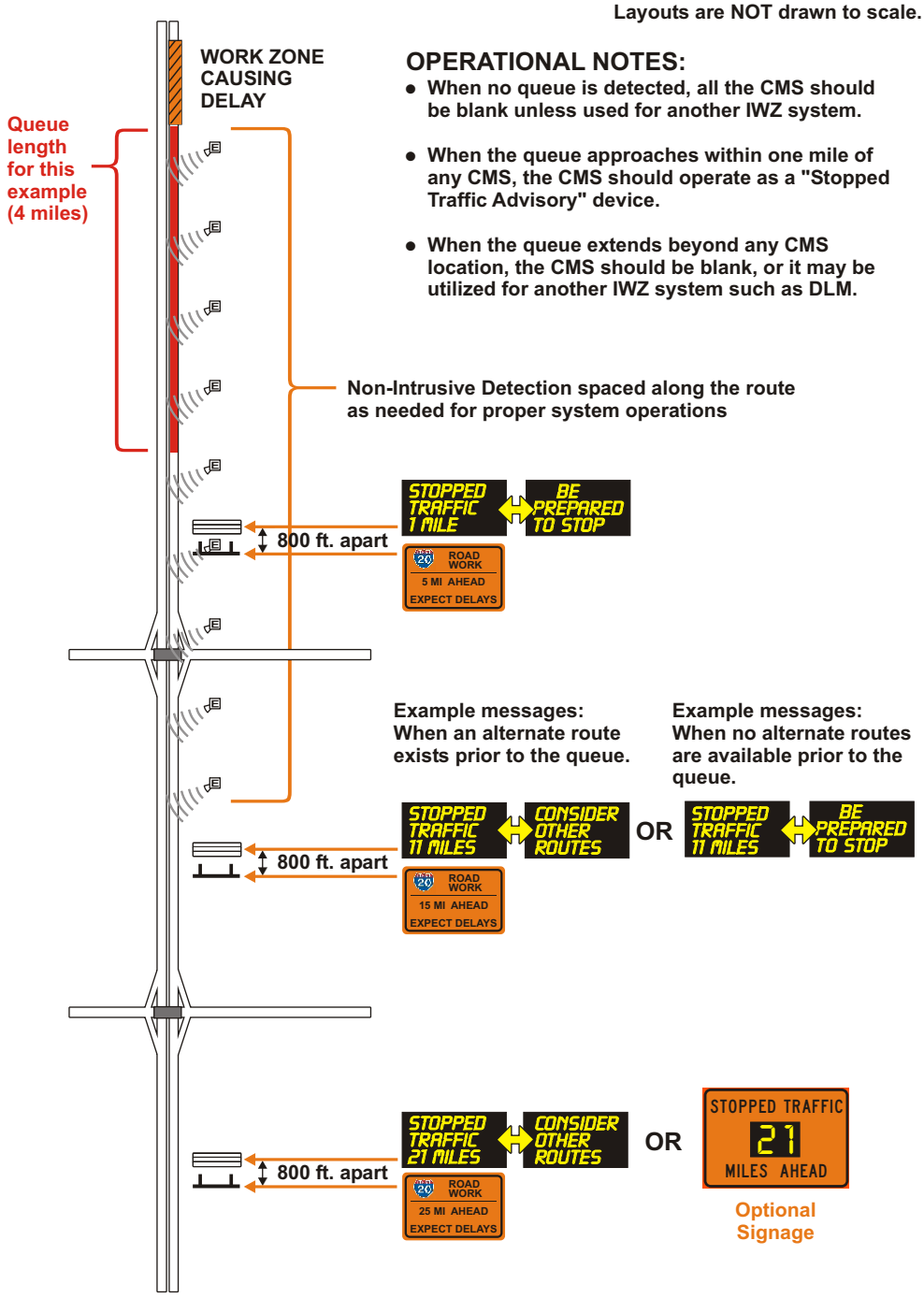
WARRANTS

- Queue lengths are estimated to vary greatly, day-by-day and hour-by-hour such that a suitable location for the TTC advance warning signage can not be predicted. Note: signs placed more than a mile ahead of confirmation are typically forgotten by the motorist.
- Queue lengths may encroach upstream beyond a motorist's reasonable expectations for stopped traffic and there is probability that the geometrics (terrain) may cause poor visibility of end of traffic queues, causing short reaction times and panic stopping.
- The queue is estimated to stop downstream of the last CMS in the system.

BENEFITS

- The system should alert drivers of an upcoming traffic slow-down or stopped traffic, providing time to determine possible route alternates, and to be prepared to stop safely.
- Traffic may divert to alternate routes.

Layouts are NOT drawn to scale.



OPERATIONAL NOTES:

- **When no queue is detected, all the CMS should be blank unless used for another IWZ system.**
- **When the queue approaches within one mile of any CMS, the CMS should operate as a "Stopped Traffic Advisory" device.**
- **When the queue extends beyond any CMS location, the CMS should be blank, or it may be utilized for another IWZ system such as DLM.**

OPTIONS

- When queues are estimated to never extend to the CMS location, the CMS may be replaced with a static warning sign equipped with two dynamic CMS characters for mileage. When no queues are detected, the mileage display would correspond with the accompanying guide sign for "Road Work XX Mi Ahead".

- When traffic queue lengths are reasonably predictable, warning motorists of stopped / slowed traffic may be accomplished with the use of typical TTC warning signs placed prior to the anticipated beginning of queue.
- The system may be combined with "Dynamic Merge", "Stopped Traffic Warning" and "Travel Time and/or Delay" systems.

NOTES

- Advance warning signs and other standard temporary traffic control devices have not been shown on this figure. Refer to the MN MUTCD including the 2007 Field Manual or the TTC Layout Templates for typical layout examples.
- All IWZ Guide Signs and CMS should be reviewed by the Mn/DOT Office of Traffic, Safety, & Operations for design and message approval.
- Approved CMS messages should be listed in the Special Provisions, and approx CMS locations should shown on the TTC plans. All CMS displays should be blank when messages are not warranted.
- Refer to the Toolbox Definitions Section for graphic symbols and terms.

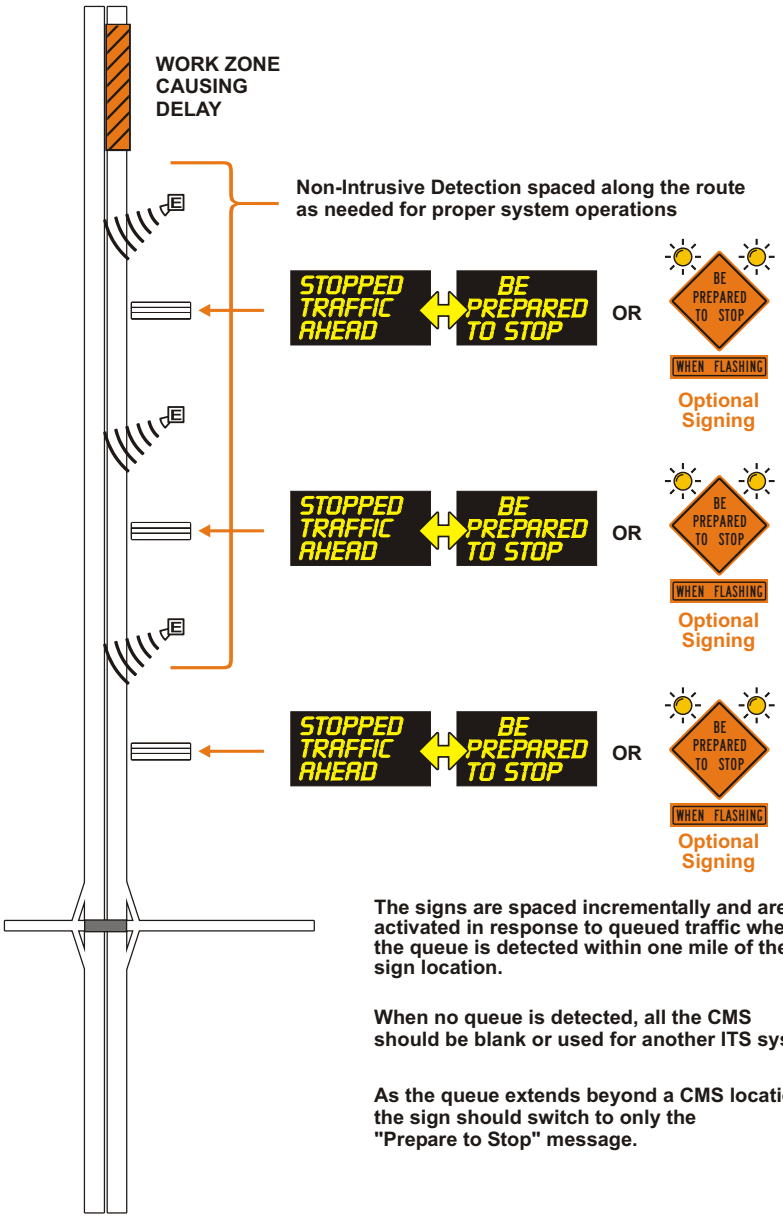
WARRANTS

- Queue lengths are estimated to vary greatly, day-by-day and hour-by-hour such that a suitable location for the TTC advance warning signage can not be predicted. Note: signs placed more than a mile ahead of confirmation are typically forgotten by the motorist.
- Queue lengths may encroach upstream beyond a motorist's reasonable expectations for stopped traffic and there is probability that the geometrics (terrain) may cause poor visibility of end of traffic queues, causing short reaction times and panic stopping.
- Queues initiated on crossroads are estimated to cause traffic conflicts and/or delays on the mainline road, such as backups beyond the length of ramps, through or around turns in intersections, or other hazardous congestion situations.

BENEFITS

- The system should alert drivers of an upcoming traffic slow-down or stopped traffic, providing time to determine possible route alternates, and to be prepared to stop safely.
- It is anticipated that the system will reduce rear-end crashes.
- Traffic may divert to alternate routes.

Layouts are NOT drawn to scale.



The signs are spaced incrementally and are activated in response to queued traffic when the queue is detected within one mile of the sign location.

When no queue is detected, all the CMS should be blank or used for another ITS system.

As the queue extends beyond a CMS location, the sign should switch to only the "Prepare to Stop" message.

OPTIONS

- The CMS may be replaced with an appropriate warning sign equipped with dynamically automated flashing lights as shown below.
- The static signs are spaced incrementally and the individual flashers are activated in response to queued traffic when the queue is detected within one mile of the sign location.

OPTIONAL SIGN DESIGN

- When traffic queue lengths are reasonably predictable, warning motorists of stopped / slowed traffic may be accomplished with the use of typical TTC warning signs placed prior to the anticipated beginning of queue.
- The system may be combined with "Dynamic Merge" and "Stopped Traffic Advisory" systems

NOTES

- Advance warning signs and other standard temporary traffic control devices have not been shown on this figure. Refer to the MN MUTCD including the 2007 Field Manual or the TTC Layout Templates for typical layout examples.
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- Approved CMS messages should be listed in the Special Provisions, and approx CMS locations should shown on the TTC plans. All CMS displays should be blank when messages are not warranted.
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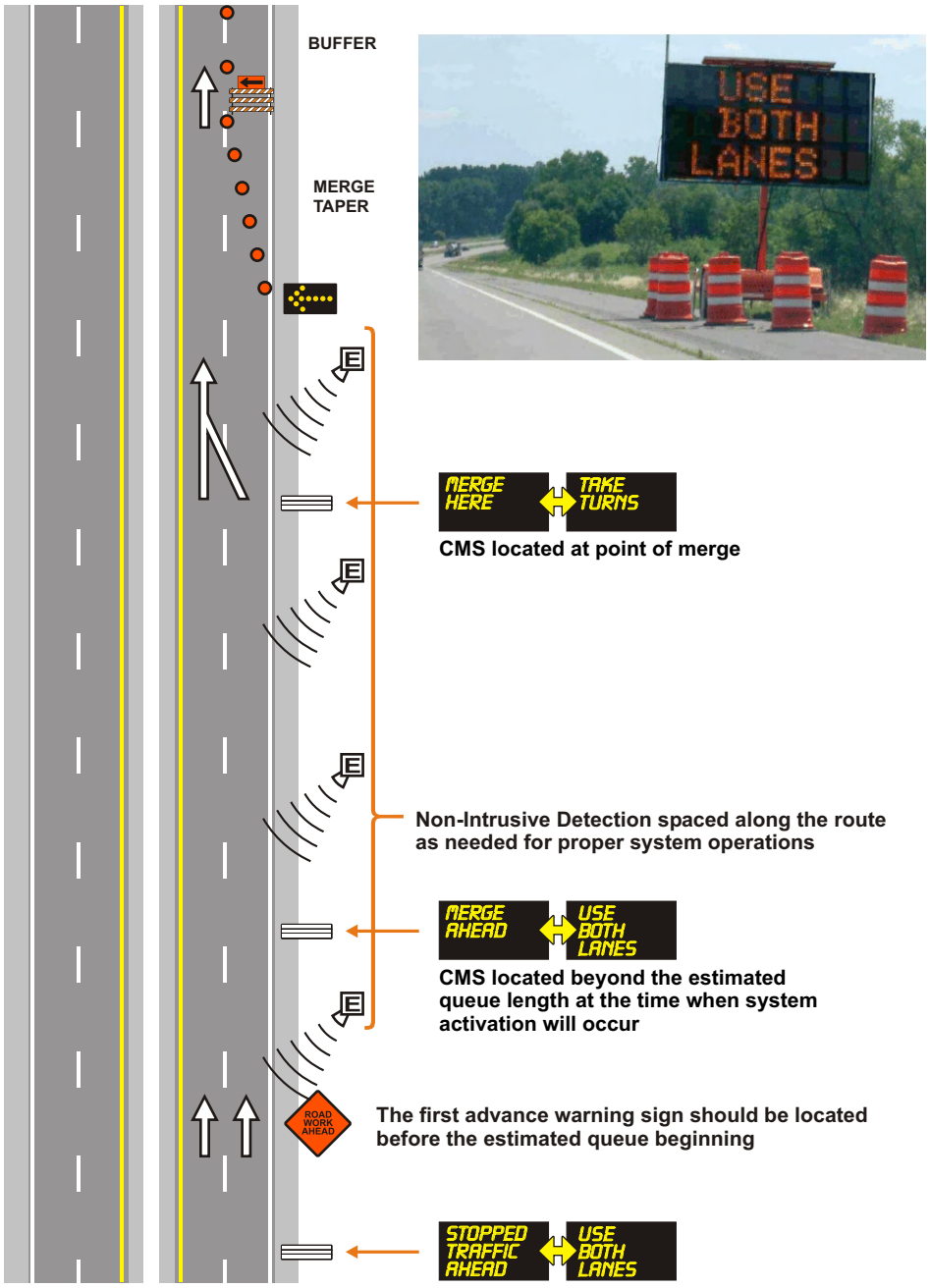
WARRANTS

- Two lanes of must merge into one direction will be closed to traffic and traffic must merge.
- Although queues may develop at low volumes for many reasons, typically, the volume must exceed 1500 vehicles/hour to sustain a queue that was caused by merging lanes.
- Estimated queue lengths may encroach beyond an upstream intersection or interchange operations.
- The speeds and lane occupancy volumes are anticipated to vary unpredictably causing the motorist to have trouble identifying the best lane usage practice, such as using both lanes versus moving into the continuous thru-lane.

BENEFITS

- The system should alert drivers of an upcoming traffic slow-down or stopped traffic, and inform them to use both lanes until the designated merge point.
- It is anticipated that the system will reduce the length of the upstream queue by 40%, which may reduce conflicts at nearby intersections.
- By utilizing both traffic lanes, the differential speed between lanes is greatly reduced since both lanes travel at approx the same speed.
- Motorists are given positive directions on lane usage and merging which clears misunderstandings between drivers and reduces road rage.

Layouts are NOT drawn to scale.



OPTIONS

- The dynamic system may be combined with Congestion Warning and Travel Time and/or Delay Systems.
- When the speeds and lane occupancy volumes are anticipated to increase very predictably and hold at that a high level, the motorist should have little trouble identifying when the traffic is congesting and begin to follow the posted merging procedure, such as using both lanes. Only clear directions on proper actions are needed by the motorist. Two options:
  - The directions may be supplied on static guide signs posted beyond the anticipated queue length and repeated within the queue area. An example series of **Static Signs** is shown below:

  - When the congestion time is highly predictable, the directions may be posted on CMS as shown in the illustration, and activated by timers, rather that traffic conditions.
- When traffic queue lengths are reasonably low and predictable, instructing motorists of proper lane usage may be accomplished with the use of typical TTC warning signs placed prior to the anticipated beginning of queue.

NOTES

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WARRANTS

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BENEFITS

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SHEET UNDER DEVELOPMENT

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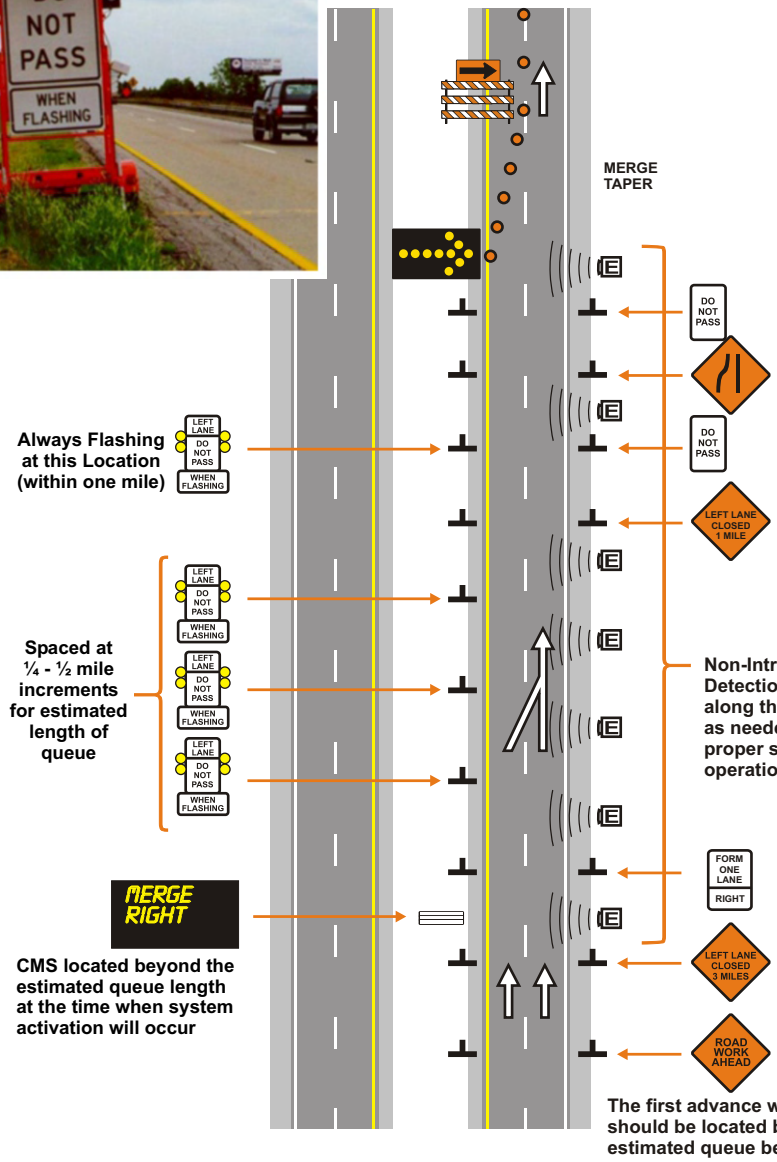

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WARRANTS

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BENEFITS

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Layouts are NOT drawn to scale.

OPTIONS

SHEET UNDER DEVELOPMENT

NOTES

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WARRANTS

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BENEFITS

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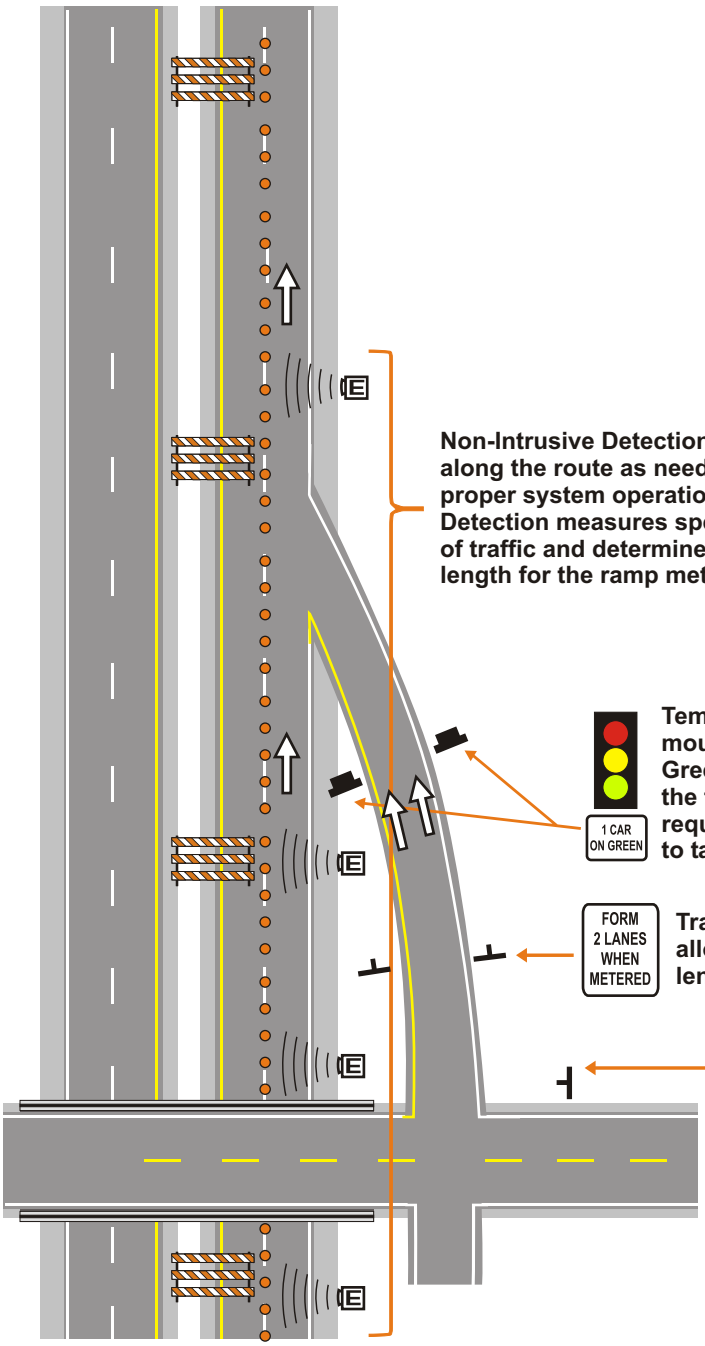
SHEET UNDER DEVELOPMENT

Layouts are NOT drawn to scale.



OPTIONS

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WARRANTS

- Traffic must reduce speed to safety negotiate a hazardous condition such as a temporary unusually tight curve, or a rough road surface.
- Buffer spaces and/or clear-zones should be analyzed for possible intrusions by vehicles unable to sufficiently slow down in time.

BENEFITS

- System should alert a driver that they have inadvertently entered a portion of the work zone at a speed substantially above the advisory speed limit.
- The system provides sufficient time to slow down for the hazardous condition.

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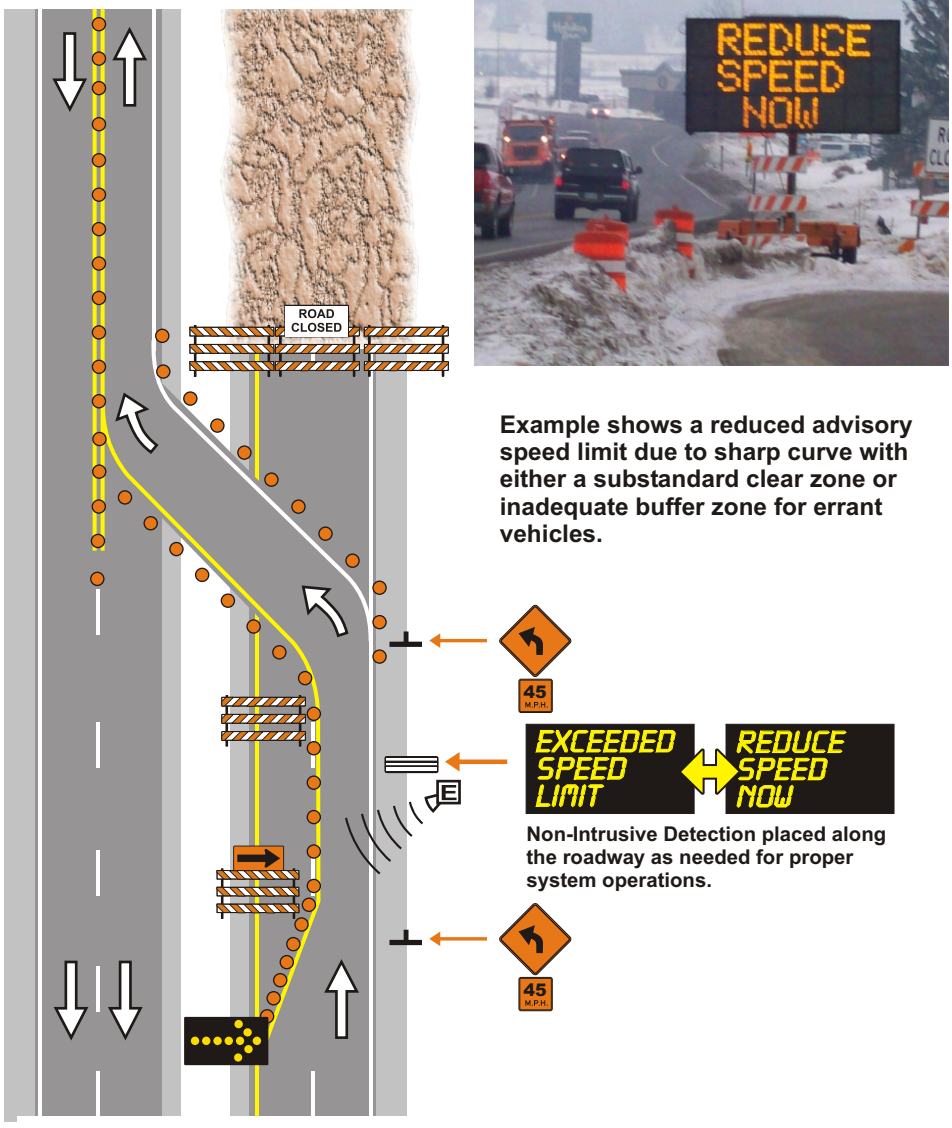

Example shows a reduced advisory speed limit due to sharp curve with either a substandard clear zone or inadequate buffer zone for errant vehicles.

Non-Intrusive Detection placed along the roadway as needed for proper system operations.

OPTIONS

NOTES

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WARRANTS

- Workers will be located adjacent to the open traffic lane, or
- Hazardous roadway conditions require extra driving precautions.

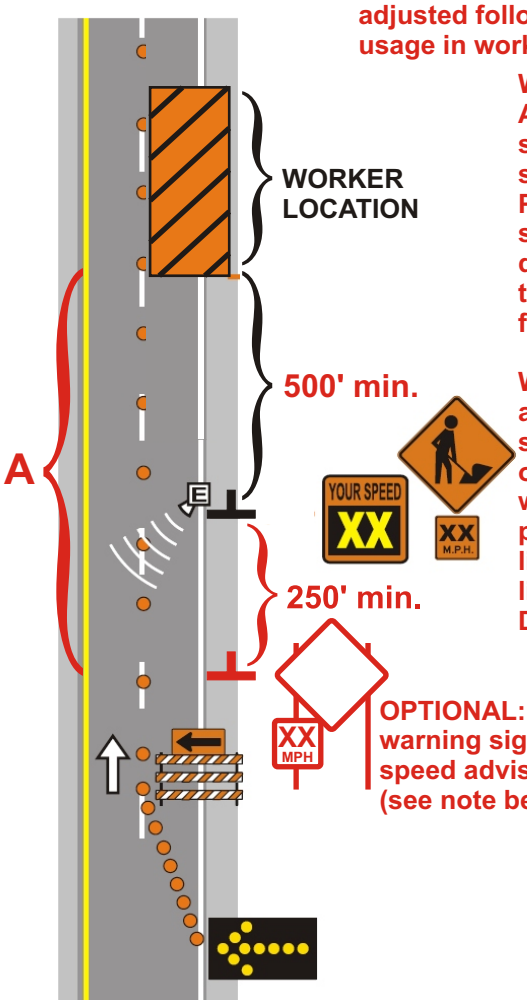
BENEFITS

- The system should alert a driver of their current speed and what the advisory speed is posted for the situation.
- The system will alert drivers of their speed and provide sufficient time to slow before passing workers or entering a hazardous roadway condition.

NOTE: The changes to this layout (in RED) are recommendations that are currently being studied for optimum sign usage and location. This preliminary layout should be followed until a final report made.

Layouts are NOT drawn to scale.

The work crew (or poor road condition) should be visible to the driver from the point of viewing the Advisory Speed Plaque and DSD sign display. Preliminary studies show 500' is the optimum distance for speed reduction, therefore, it's advised to maintain that distance as much as practical. As workers move within the work zone, the DSD location should be re-positioned such that it remains within 500 feet (min) and 2500 feet (max) of the worker location. The distances may be adjusted following further studies of the DSD sign usage in work zones.



When the DSD sign is utilizing an Advisory Speed Limit, a warning sign shall be displayed adjacent to the DSD sign location. The Advisory Speed Plaque may be attached to the warning sign, or mounted on the DSD sign device. The "YOUR SPEED" sign on the DSD device shall be black on flourescent orange.

When utilizing the DSD sign with either a regulatory speed limit or work zone speed limit, the "YOUR SPEED" sign on the DSD device shall be black on white. The DSD sign shall be either placed adjacent to the posted speed limit sign, or the appropriate speed limit sign shall be mounted to the DSD device.

OPTIONAL: warning sign with speed advisory (see note below)

When used, the optional advance warning sign with speed advisory should be placed a minimum distance 'A' ahead of the workers and a minimum 250 feet ahead of the DSD device location.
The distance 'A' is the Advance Warning Sign Spacing based upon the Posted Speed Limit and is found in the Field Manual (Part 6K of the MnMUTCD).

MINIMUM SPECIFICATIONS on DSD SIGN EQUIPMENT:

Display size of the DSD sign is dependent on the size of the speed plaque used.

Plaque size	DSD display MIN.
18" X 18"	10" character
24" X 24"	10"
30" X 30"	14" character
36" X 36"	14"

The static sign (YOUR SPEED) should be black letters on a **fluorescent orange** background when used with a work zone advisory speed plaque. The font should be a minimum of 4" high when used with a 10" display character, and 6" when used with a 14" or greater character display sign.

OPERATIONAL GUIDELINES:

The DSD sign should remain blank when no traffic is detected. When traffic speed is detected over the advisory speed plaque, the sign should blink at 50-60 cycles/minute. For speeds detected over a set max speed (generally 10 mph over the posted limit on low speed roadways and 20 mph over on high speed roadways) the display should go blank.

NOTES

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- Refer to the Toolbox Definitions Section for graphic symbols and terms.

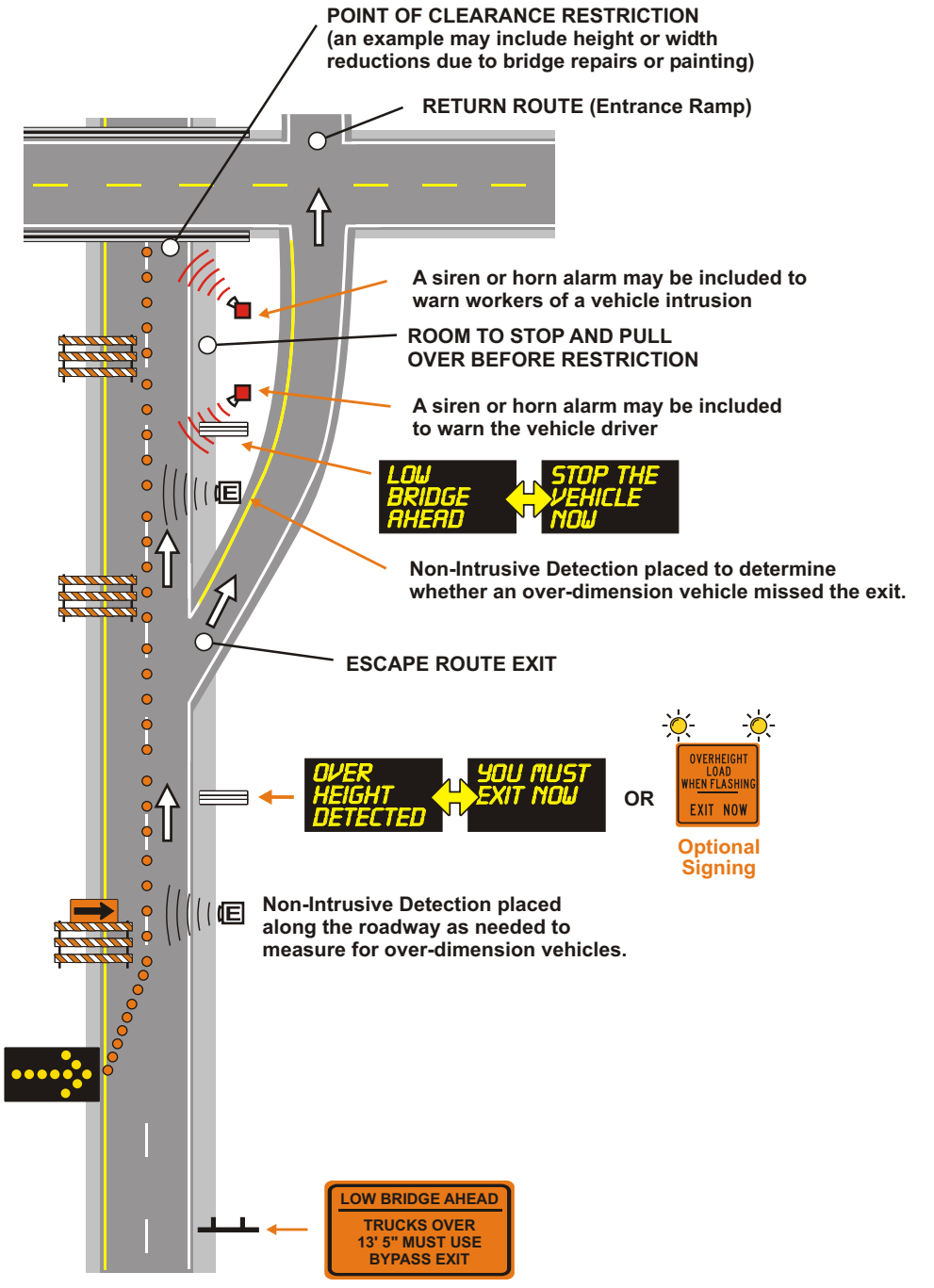
WARRANTS

- Construction causes temporary minimal clearance (or less than minimum) for large vehicles using the roadway, or
- A minimal clearance condition exists within a work zone and construction vehicles must be warned of the condition.

BENEFITS

- The system should alert a driver that their vehicle is over-dimension and they are required to use an escape route.
- The system should alert drivers of their route mistake and provide sufficient time to conduct the escape maneuver.
- The second portion of the system warns a driver to stop if he failed to use the designated escape route.

Layouts are NOT drawn to scale.



OPTIONS

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WARRANTS

WORK SPACE INTRUSION:

- Vehicles inadvertently fail to follow standard flagging operations.

HAUL ROAD INTRUSION:

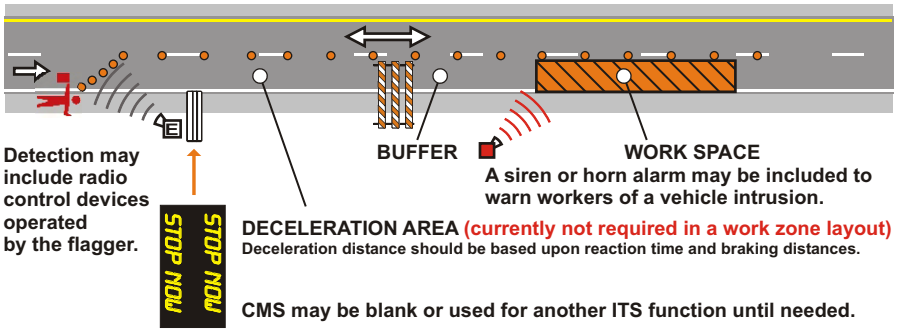
- Vehicles inadvertently follow a truck off the roadway.
  Reasons for following may vary:
  - High roadway volume causing tailgating
  - Truck exit is difficult to identify

BENEFITS

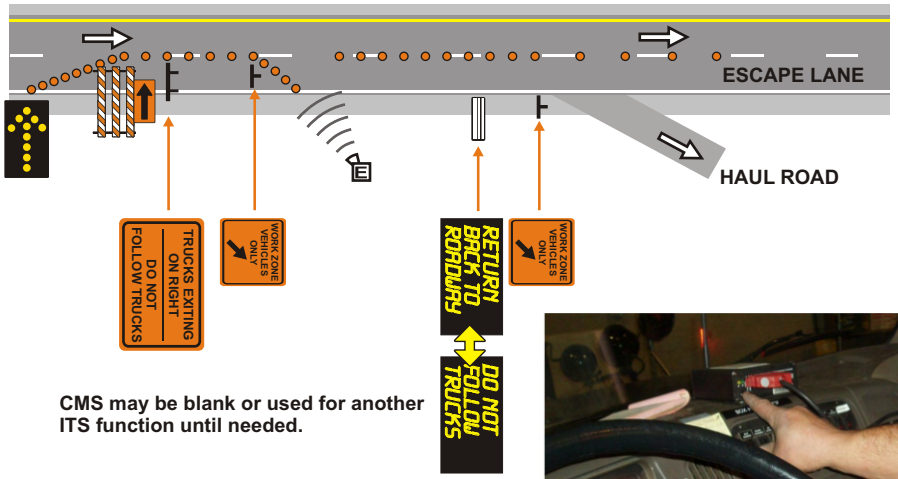
- The systems should alert a driver that they have inadvertently followed a construction truck into the construction zone or intruded into a work space.
- A work space intrusion system should alert a workers that a vehicle has intruded into the work zone.
- The systems should provide sufficient time for the driver to react appropriately, such as utilize an escape route back to the roadway traffic.

Layouts are NOT drawn to scale.

WORK SPACE INTRUSION



HAUL ROAD INTRUSION



Display/alarms activated by truck driver

OPTIONS

NOTES

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- Approved CMS messages should be listed in the Special Provisions, and approx CMS locations should shown on the TTC plans. All CMS displays should be blank when messages are not warranted.
- Refer to the Toolbox Definitions Section for graphic symbols and terms.

WARRANTS

- The trucks must utilize the mainline roadway to accelerate.
- A truck merge lane can not be provided on the project.
- The haul road entrance is visibly obscured to drivers.
- The ADT on the roadway is above the level where truck drivers can easily find a gap in traffic and accelerate within the traffic lane without causing traffic to suddenly adjust speed or change lanes.

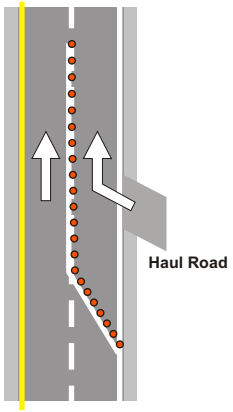
BENEFITS

- The system should alert drivers of a slowly accelerating truck entering the faster moving traffic lane.
- The system should provide sufficient time for drivers to react appropriately, such as slowing down or changing lanes.
-

Layouts are NOT drawn to scale.

Scenario A.

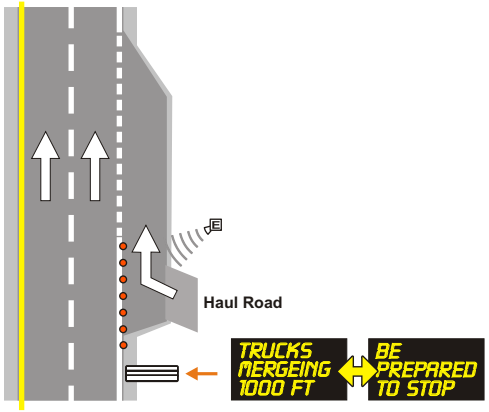
Dedicated Lane



Typically, IWZ Systems are not needed for construction traffic is this scenario.

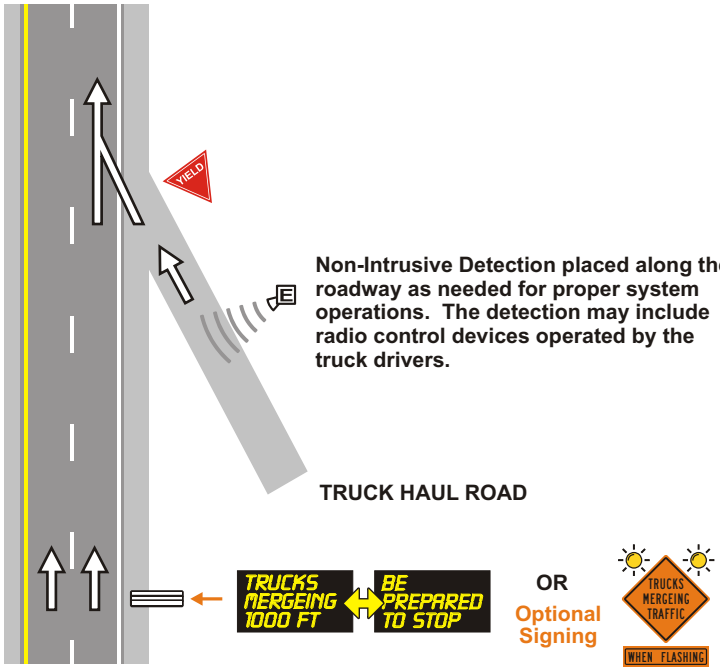
Scenario B.

Acceleration Lane



Although this scenario may operate efficiently without an IWZ system installed, higher traffic / truck volumes or a short accelleration lane would warrant the IWZ system.

Scenario C. No Acceleration Lane



Non-Intrusive Detection placed along the roadway as needed for proper system operations. The detection may include radio control devices operated by the truck drivers.

TRUCK HAUL ROAD

OPTIONS

- A variation of this system may be used to detect work vehicles in the vicinity which may create a traffic hazard. The example shown below warned the motorists when snow plows were clearing the roadway in a restricted section. The signs were activated by radio communications from the plow trucks.

NOTES

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- Approved CMS messages should be listed in the Special Provisions, and approx CMS locations should shown on the TTC plans. All CMS displays should be blank when messages are not warranted.
- Refer to the Toolbox Definitions Section for graphic symbols and terms.

WARRANTS

- The ADT on the roadway is above the level where truck drivers can easily recognize a gap in traffic and safety cross without causing conflicts with traffic.
-

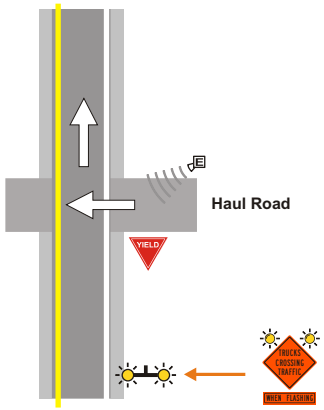
BENEFITS

- The system should alert drivers of a slowly accelerating truck crossing the traffic lane.
- The system should provide drivers sufficient time to react appropriately, such as slowing down.
-

Layouts are NOT drawn to scale.

Scenerio D.

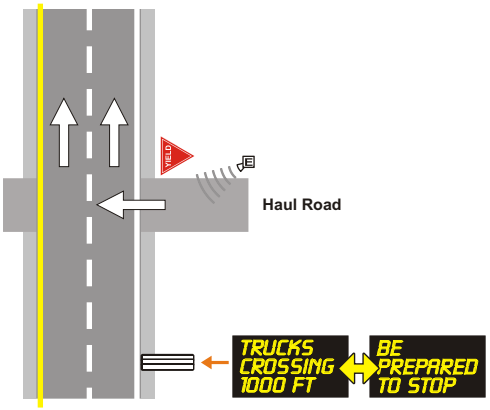
Cross Single Lane



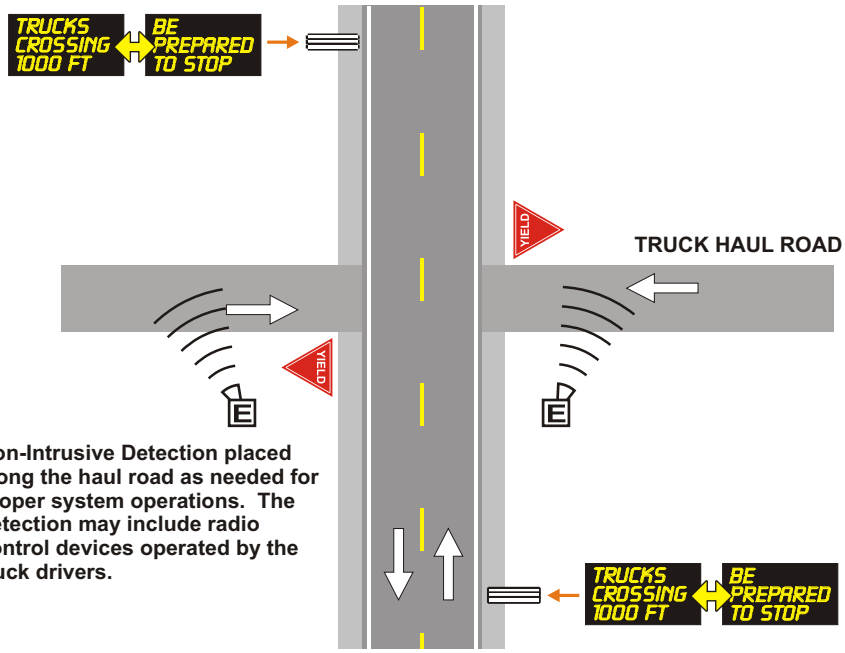
The crossing could be deployed with either the trucks yielding or the traffic yielding, depending upon the volume of each.

Scenerio E.

Cross Double Lane



Scenerio F. Cross 2-Lane 2-Way



Non-Intrusive Detection placed along the haul road as needed for proper system operations. The detection may include radio control devices operated by the truck drivers.

OPTIONS

- When higher ADT conditions exist such that trucks are not able to find a gap in traffic, then additional traffic control systems, such as flaggers, stop signs or temporary signals, should be utilized to slow or stop traffic.
- The CMS may be replaced with an appropriate warning sign equipped with dynamically automated flashing lights as shown below and on scenario D.

NOTES

- Advance warning signs and other standard temporary traffic control devices have not been shown on this figure. Refer to the MN MUTCD including the 2007 Field Manual or the TTC Layout Templates for typical layout examples.
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- Refer to the Toolbox Definitions Section for graphic symbols and terms.

WARRANTS

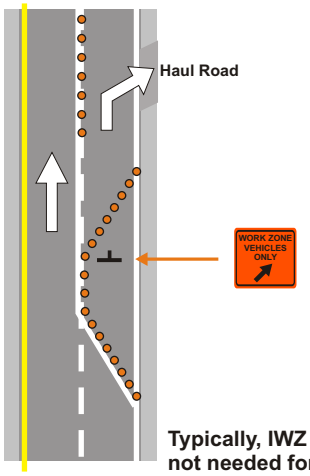
- The trucks must utilize the mainline roadway to de-accelerate, and
- The roadway volume is above the level where the traffic must suddenly adjust speed or change lanes.

BENEFITS

- The system should alert drivers of a decelerating truck exiting the faster moving traffic lane.
- The system should provide drivers sufficient time to react appropriately, such as slow down or change lanes if possible.

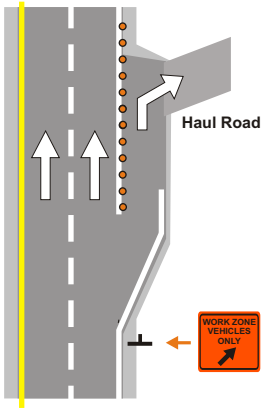
Layouts are NOT drawn to scale.

Scenerio G.
Dedicated Lane



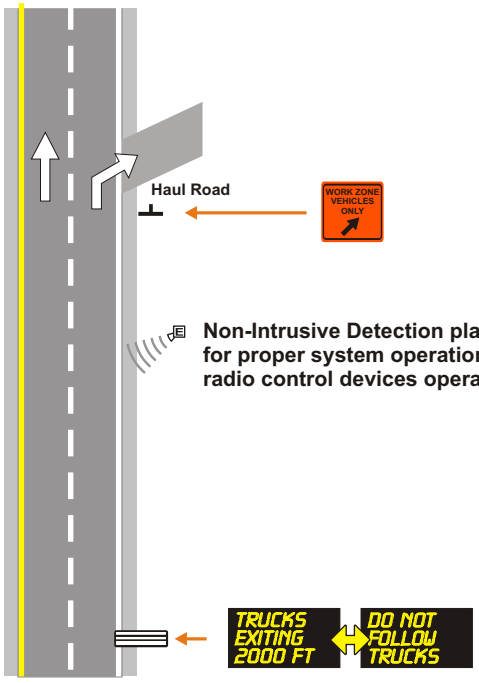
Typically, IWZ Systems are not needed for construction traffic is this scenario.

Scenerio H.
De-acceleration Lane



Typically, IWZ Systems are not needed for construction traffic is this scenario.

Scenerio I. No De-acceleration Lane



Non-Intrusive Detection placed along the roadway as needed for proper system operations. The detection may include radio control devices operated by the truck drivers.

OPTIONS

NOTES

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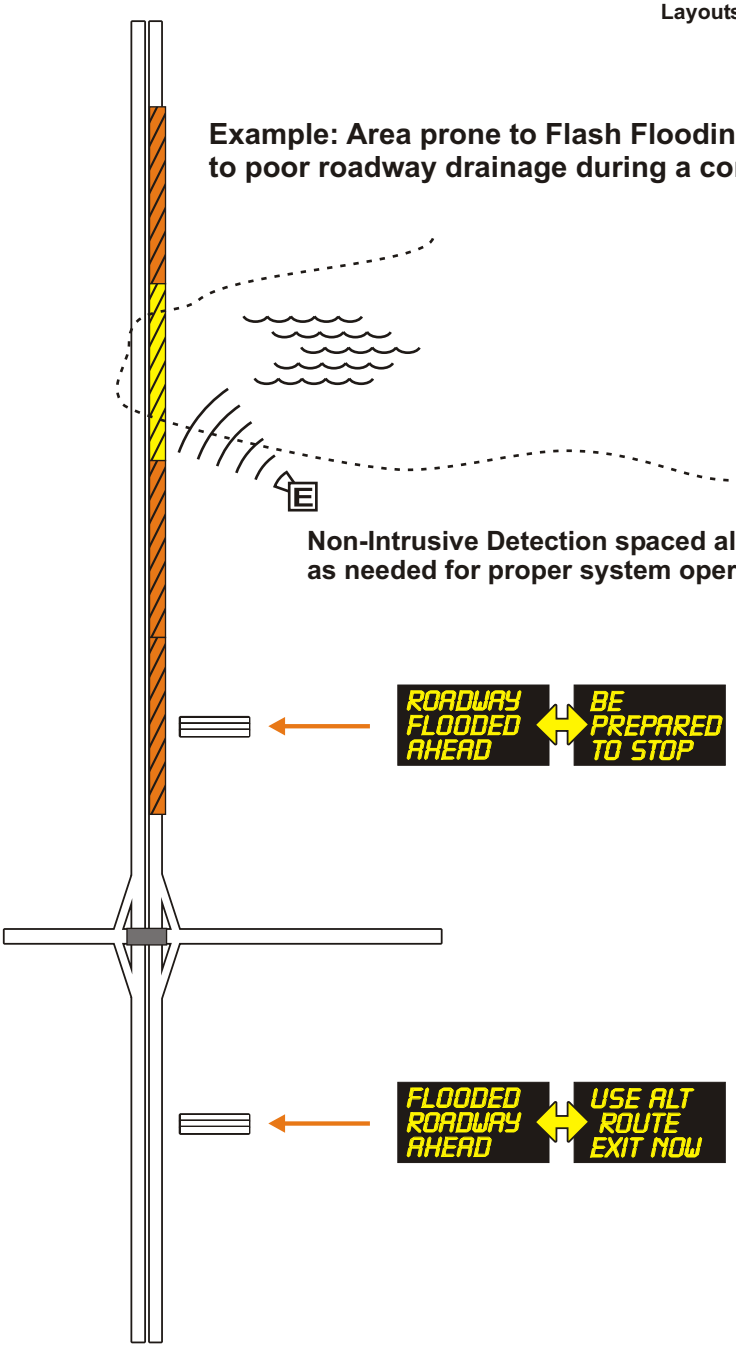
WARRANTS

- The system should be considered for deployment as part of a project's temporary traffic control plan when a temporary situation may cause a hazardous driving condition such as:
  - Flash flooding
  - Visibility (fog, smoke)
  - Slippery or rough conditions
  - Hazards on roadway (falling rock, debris)

BENEFITS

- The system should alert traffic of a hazardous condition on the roadway ahead and advise traffic of an appropriate action for the situation which may range from stopping, slowing, or diverting traffic.
- The system should notify construction staff of the situation such that corrective actions may begin.

Layouts are NOT drawn to scale.



OPTIONS

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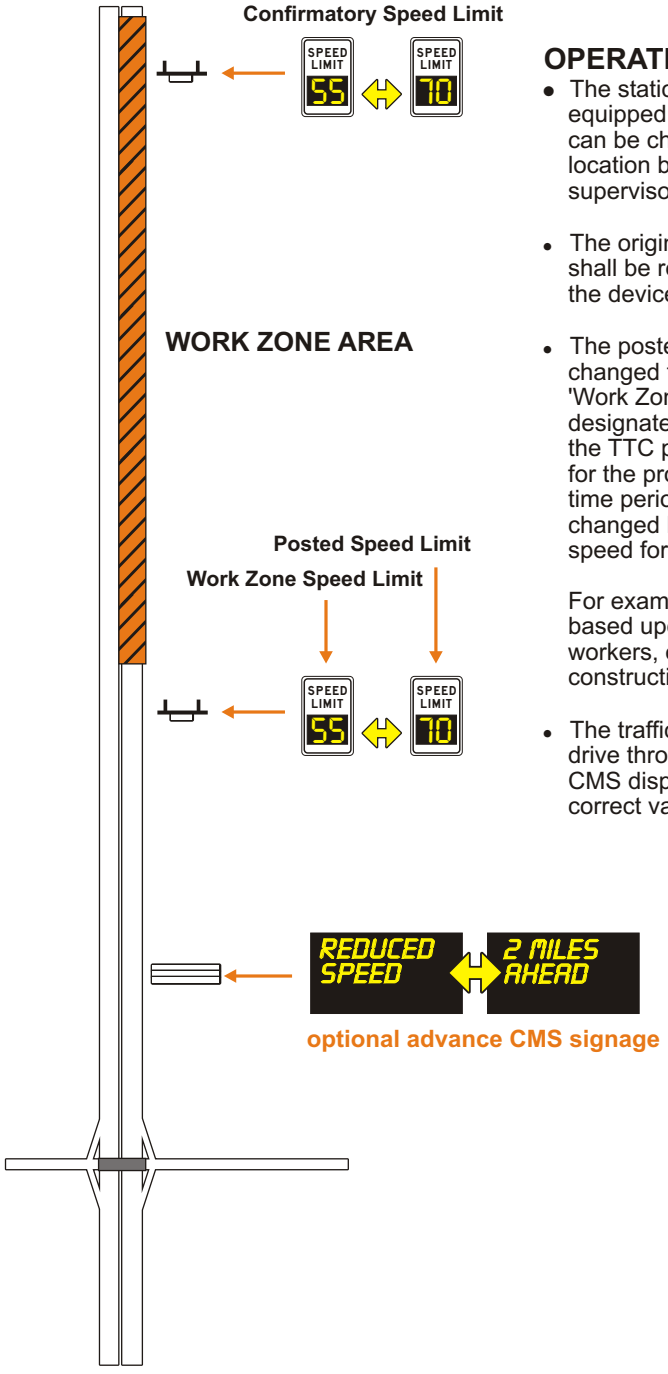
WARRANTS

- Refer to the "Guideline for Establishing Work Zone Speed Limits" for the procedure to change speed limits.
-

BENEFITS

- The traffic control supervisor will be able to change the work zone speed limit easily without manually covering signs.
-
-

Layouts are NOT drawn to scale.



optional advance CMS signage

OPERATIONAL NOTES:

- The static speed limit signs are equipped with 2 CMS characters that can be changed from a remote location by the traffic control supervisor for the project.
- The original posted speed limit signs shall be removed or covered while the device is activated.
- The posted speed limit value is changed to an approved enforceable 'Work Zone Speed Limit' during the designated time periods specified in the TTC plans or special provisions for the project. After the specified time period, the value of the sign is changed back to the normal posted speed for the roadway.

  For example, the time period may be based upon the presence of workers, or high volume of construction traffic.
- The traffic control supervisor shall drive through the work zone after the CMS display change to verify the correct value is displayed.

OPTIONS

- The CMS characters may be replaced with static regulatory speed limits printed with the appropriate speed values. The traffic control supervisor would be responsible to exchange the signs to enable the work zone speed limit to be enforceable and must return the normal posted speed limit following the approved time period. There are variations of covering the existing signs as approved alternatives to removing the signs.

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- Refer to the Toolbox Definitions Section for graphic symbols and terms.

WARRANTS

-

BENEFITS

-

SHEET UNDER DEVELOPMENT

Layouts are NOT drawn to scale.

Various real-time informational methods may be deployed as required for the intended audience including:

- Real-time Highway Advisory Radio may broadcast real-time:
  - travel times on various routes between landmarks,
  - project staging information such as pending traffic changes,
  - alternate route information with congestion information, and/or
  - alternate route information with incident information.
- 511mn.org should be updated continually to have real-time travel information through the work zone. This information is available to the motorist via cell phone (and internet).
- Real-time information available online for the project's work zone and vicinity which could include information on current incidents, congestion, traffic control changes, travel delays/times or other traffic data that may be requested.
- Email notices with the current information could be generated based upon parameters pre-selected by subscribers, such as per-determined time-of-day, major incidents, major congestion, etc.

OPTIONS

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