NCDOT CCTV Camera and DMS Preliminary Siting Guidance

Revised April 13, 2021

The purpose of this document is to provide planning-level guidance on locating Closed Circuit Television (CCTV) Cameras and Dynamic Message Signs (DMS) on roads owned and maintained by the North Carolina Department of Transportation (NCDOT).

The siting guidance provided is primarily focused on providing visual and traveler information coverage to support Traffic Operations activities. During the design process, locations should be field verified for constructability, visibility, and safety of maintenance operations. On their own, challenges in accessing electricity are not adequate justification for not fulfilling a need of the NCDOT's Traffic Operations program.

Interchange Classification

Interchanges are classified as major, intermediate, and minor in a manner consistent with Chapter 2E of the 2009 Manual on Uniform Traffic Devices (MUTCD), dated May 2012. Descriptions of these classifications are provided in the following paragraphs.

Major Interchanges

Major interchanges are subdivided into two categories: (a) interchanges with other expressways or freeways, or (b) interchanges with high-volume multi-lane highways, principal urban arterials, or major rural routes where the volume of interchanging traffic is heavy or includes many road users unfamiliar with the area.

Single-Point Urban Interchanges, Diverging Diamond Interchanges, and Partial Cloverleaf Interchanges with 5 or more ramps are higher-capacity interchanges that would likely qualify as a major interchange in the "b" category. Other design elements that may help identify service interchanges that qualify as "major" include free-flow movements where a motorist is not required to pass through a yield-, stop-, or signal-controlled intersection.

Intermediate Interchanges

Intermediate interchanges are those with urban and rural routes not in the category of major or minor interchanges.

Minor Interchanges

Minor interchanges include those where traffic is local and very light, such as interchanges with land service access roads. Where the sum of exit volumes is estimated to be lower than 100 vehicles per day in the design year, the interchange is classified as minor.

A rural diamond interchange where the ramps at the non-freeway are controlled by stop signs is a good example of a minor interchange.

Urban and Rural Classification

The Transportation Planning Branch of the NCDOT has generated urban boundaries. These boundaries were originally generated by the Census in 2000 and have been adjusted (smoothed) by the Transportation Planning Branch. Roads within the smooth boundary are considered urban and roads outside the smooth boundary are considered rural. These urban boundaries typically include less-dense developed areas such as suburban areas and medium-sized cities. The *NCDOT Smoothed Urban Boundaries* map is publicly available through the Go! NC online mapping portal.

For the purposes of this document, these boundaries can be used as general guidance when discussing urban and rural areas. Coverage areas in question or disputed shall be discussed with Traffic Systems Operations Section or the applicable Intelligent Transportation Systems (ITS) Engineer before a final determination is made.

Location of Dynamic Message Signs

The following sections are consistent with Chapter 2A and 2L of the 2009 MUTCD, dated May 2012.

Guidance

DMS are typically used on higher speed, multi-lane facilities with relatively high traffic volumes. The following factors should be considered when installing a DMS:

- DMSs should be located sufficiently upstream of known bottlenecks and high crash locations to enable road users to select an alternate route or take other appropriate action in response to a recurring condition.
- DMSs should be located sufficiently upstream of major diversion decision points, such as interchanges, to provide adequate distance over which road users can change lanes to reach one destination or the other.
- DMSs should not be located within an interchange except for toll plazas or managed lanes.
- DMSs should not be positioned at locations where the information load on drivers is already high because of guide signs and other types of information.
- DMSs should not be located in areas where drivers frequently perform lane-changing maneuvers in response to static guide sign information, or because of merging or weaving conditions.
- DMS should be located where maintenance operations can be safely carried out with minimal disruption to traffic.

DMS locations should also support Transportation Management Center (TMC) / Statewide Transportation Operations Center (STOC) operations. On incident affected routes, TMC / STOC operators utilize all DMS that are within the affected area and within 20 miles from the incident or end of queue. On adjacent routes, operators utilize DMS that are on adjacent routes to the affected area and within 10 miles of the adjacent routes' intersection with the affected route. To support this rule, DMS density on full-control access facilities (e.g. interstates and other freeways) should be equal to or greater than 1 DMS every 20 miles.

Major Interchanges

To provide time for comprehension and route change decisions, along with avoiding areas where drivers would be expected to perform lane-changing maneuvers, permanent DMS should be placed ¼ - 1 ½ miles upstream of the earliest advance guide sign where spacing and visibility permit and in a location conducive to safe maintenance operations

For major interchanges, per the 2009 MUTCD, dated May 2012, Advance Guide signs should be placed at ½ mile and at 1 mile in advance of the exit with a third Advance Guide sign placed at 2 miles in advance of the exit. It follows, that a DMS would then be installed 2 ¼ – 3 ½ miles in advance of the exit in that situation.

In urban areas with a higher density of interchanges and static signs, using a single DMS to cover multiple major interchanges is acceptable and may be the most practical solution. Alternatively, coverage of interchanges with interstates, expressways or freeways can be prioritized.

In suburban and rural areas, consideration should be given to intermediate and minor interchanges that serve known alternate/detour routes. Including them in the coverage area of a DMS primarily intended for a major interchange may be beneficial and should be evaluated.

Intermediate and Minor Interchanges

Urban Areas

In urban areas, DMSs specifically covering Intermediate or Minor interchanges would likely be special cases. Special cases may include:

- Locations that attract many unfamiliar road users such as sports arenas, concert venues, amusement parks, airports, etc.
- Fully-instrumented Integrated Corridor Management (ICM) routes
- Coverage of multiple Intermediate and/or Minor interchanges that provide access to alternate routes (e.g. SB U.S. 1 north of Wake Forest, WB US 74 in Union County)
- Supporting evacuation activities

Because interchange spacing is typically more dense in urban areas, it is anticipated that DMS spacing on designated interstate and future interstate routes will typically be ≤10 miles for a given direction in urban and suburban areas.

Rural Areas

DMSs in rural areas without major interchanges provide support during traffic incidents, particularly with queue warning. As aforementioned, to support incident management activities, no rural designated interstate or future interstate routes should have DMS spaced >20 miles for a given direction.

In rural areas, DMS specifically covering Intermediate or Minor interchanges would likely be special cases. Special cases may include:

- Locations that attract many unfamiliar road users such as sports arenas, concert venues, amusement parks, airports, etc.
- Fully instrumented ICM routes
- Coverage of multiple Intermediate and/or Minor interchanges that provide access to alternate routes
- Supporting Hurricane Evacuation activities
- Filling of large DMS coverage gaps (e.g. > 20 miles for a given direction)

Additional Cases

There are instances where a DMS is desired on a route that is not necessarily a high-speed multi-lane facility. These DMS may be associated with high wind locations, tunnels, ferry terminals, locations with regular snow or ice, or hurricane evacuation routes.

Designers should continue to follow the general guidance provided at the beginning of this section. Additional factors should be considered when installing a DMS in special cases:

- Excessive distances can reduce the effectiveness of messaging. However, DMS should be located at adequate distance to allow for motorists to take appropriate action (e.g. pull over) and/or select an alternate route.
- DMS locations should consider the locations of supporting devices (e.g. static signs with flashers and gates) and how they interact.
- DMS should be located upstream of any anticipated back of queue associated with the site.

CCTV Camera Coverage

CCTV Cameras are primarily used to monitor traffic conditions, provide situational awareness, and provide a broad range of support in incident management activities. CCTVs enable TMC staff to perform a number of valuable monitoring, detection, verification, and response activities.

Consistent with the FHWA's *Model Systems Engineering Documents for CCTV Systems v1.0 (May 2018)*, in order to effectively management the surface transportation system, a CCTV system should be able to see the current conditions in order to detect problems, verify problems, and ensure proper mitigation of the problems through various transportation management operations. Additionally, the CCTV system should provide operators the ability to verify proper operation of dynamic field devices, such as DMS, lane control signs, variable speed limit signs, and ramp signals.

Powering CCTV cameras through mains electricity is preferred due to reliability and maintenance issues associated with solar power systems. However, a CCTV camera location should not be immediately discarded simply because solar power is the more practicable solution.

Major Interchanges

All major interchanges should have complete CCTV camera coverage. At many major interchanges, this will most likely require two (2) or more cameras to provide visibility of all ramps and mainlines. Consideration of coverage should include visibility of flyovers and underneath overpasses.

Other considerations, such as impacts to maintenance resources, access to mains electricity, and safety of maintenance operations may impede achieving complete coverage of a major interchange and its ramps.

Urban Interstates

Interstates in Urban areas typically serve high volumes of traffic. They serve a combination of seasonal, regional, and local traffic. Therefore, camera coverage is important in these areas. The goal is to have 100% CCTV coverage of all designated interstate or future interstate routes in urban areas.

Rural Interstates

Rural interstates do not necessarily require full CCTV camera coverage. At a minimum, all conflict points (e.g. interchanges, lane-adds, and lane drops) and DMS should be visible by a CCTV camera.

Other areas where a CCTV camera is desirable include:

- Known high crash locations
- Areas that flood during significant rain events
- Primary evacuation routes
- Evacuation routes with hard-shoulder running
- IMAP Patrol Areas
- Other areas with potentially hazardous conditions (high winds, icy roads prior to steep inclines/decline, tunnels, etc)

Other Expressways and Freeways

Other controlled access facilities do not necessarily require full CCTV camera coverage. At a minimum, all conflict points (e.g. interchanges, lane-adds, and lane drops) and DMS should be visible by a CCTV camera.

Other areas where a CCTV camera is desirable include:

- Known high crash locations
- Areas that flood during significant rain events
- Primary evacuation routes
- Evacuation routes with hard-shoulder running
- IMAP Patrol Areas
- Routes serving regular commuter traffic
- Other areas with potentially hazardous conditions (high winds, icy roads prior to steep inclines/decline, tunnels, etc)

DMS

Consistent with FHWA guidance, every DMS should be visible by a CCTV camera. A typical use of a CCTV camera is to verify message displays on DMS. Coverage of DMS allows the system user (e.g. TMC Operator) to display camera feeds of DMS on video monitors and verify DMS operation, status, and message display.

Furthermore, the current software in use at NCDOT TMCs does not have the capability to provide certain confirmation that the intended message is being displayed on the sign.

Additional Cases

There are instances where a CCTV is desired on a route that is not necessarily a high-speed multi-lane facility. These CCTV camera locations may be associated with high wind locations, tunnels, ferry terminals, locations with regular snow or ice, or hurricane evacuation routes.

Designers should continue to follow the general guidance provided at the beginning of this section. Additional factors should be considered when installing a CCTV camera in special cases:

- CCTV cameras should be located to provide visibility of dynamic field devices, such as DMS, static signs with flashers, gates, ramp signals, lane control signals, and variable speed limit signs.
- CCTV cameras should be located to provide visibility of the back of the anticipated queues at these locations.