# Research Problem Statement

## Research Problem Title:

Temporary Traffic Control Advance Warning Sign Placement

## Statement of Problem

The 11th Edition of the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) presents two different methods for determining warning sign spacing, depending on the chapter in the Manual. Guidance in the MUTCD’s warning signs chapter, (Section 2C.04 – Placement of Warning Signs) recommends placing warning signs such that they provide adequate Perception-Response Time (PRT), which is the time needed for detection, recognition, decision, and reaction. The distances related to PRT, shown in Table 2C-3, are based on research and engineering calculations. Depending on the posted or 85th percentile speed and the warning sign condition, the table details how many feet in advance the sign should be placed. These distances can be adjusted for roadways features, other signing, and to improve visibility.

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MUTCD guidance for Temporary Traffic Control (TTC) warning signs (Section 6B.04 – Advance Warning Area) references a warning sign spacing table (Table 6B-1) based on classification, facility location, and speed and provides further written guidance. This written spacing guidance sometimes conflicts with the table values depending on speed. TTC warning signs are typically arranged in a series of three advance warning signs. Warning sign spacing is provided between the workspace and closest warning sign and between each warning sign in the series.

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Challenges can also arise due to the nature of TTC warning signs. In urban areas with close intersection or driveway spacing, or in mountainous rural areas, the warning sign spacing is dependent on site conditions rather than calculated distances (FHWA, 2023). Compound that with queue lengths, which may impact vehicle speeds and sight distance, and the placement of advance warning signs becomes more complex than the distances shown in Table 6B-1.

The basis for the recommendations in the MUTCD for TTC warning sign spacing and placement is unclear to practitioners. There is a need to determine if the simplified spacing guidance for TTC warning signs is appropriate to provide sufficient warning in TTC zones.

The objectives of this research are to 1) consider the differences in warning sign spacing guidance between MUTCD Part 2 (for sign spacing), and Part 6 (for signing in temporary traffic control zones) and 2) to better align the Part 6 guidance to the Part 2 guidance as appropriate, based on research findings. The research will involve evaluating methods for determining distances for road users to react to different temporary traffic control warning messages. The research will also consider whether methods should vary based on the type of TTC warning sign (e.g., whether the TTC message requires action or not).

## Summary of Existing Literature

#### State of Practice for Advance Warning Sign Spacing and Placement

As described in the Statement of the Problem, the MUTCD 11th Edition provides recommendations and guidance for the placement and spacing of TTC advance warning signs.

Several states (including Wisconsin, South Carolina, Idaho, Washington, California, Michigan, Delaware, and Virginia) modify or supplement MUTCD Tables 6B-1 or 6C-1 in various ways including adding more specific road categories, adding additional speed categories, removing road categories and only using speed limits, defining low and high speeds, etc.; More specific information can be found in Appendix A.

#### Relevant Research for Advance Warning Sign Spacing and Placement

Little research that focuses on TTC advance warning sign placement is publicly available and most of what is available took place outside of the United States. A simulator study by Hang et al. sought to understand how placement of Lane End signs and traffic volume impact driving behaviors in TTC zones. They found that the placement of the Lane End sign had a significant impact on perception of drivers approaching work zones. They recommend installing the Lane End signs 500 meters in advance of the merge point (Hang et al., 2018). This study looked at a specific type of advance warning sign with a focus on lane merges.

Another study by Li and Bai sought to determine optimal placement of portable changeable message signs (PCMS) in work zones to reduce speeds. The study included two field experiments in which PCMS were placed in three different locations and vehicle speeds were evaluated. The first experiment found that 575 ft in front of the first static TTC sign was the ideal location. The second experiment was conducted in an effort to confirm the findings of the first study by placing PCMS 750 ft, 575 ft, and 400 ft in advance of the first static TTC sign. A regression analysis found that the optimal PCMS placement was between 556ft and 575 ft in advance of the first TTC static sign (Li & Bai, 2012).

While few studies have evaluated ideal placement of TTC warning sign placement, studies such as those in Texas A&M Transportation Institute’s (TTI’s) Studies to Improve Temporary Guide Signs in Work Zones have acknowledged the importance of sign placement in work zones to provide adequate time for drivers to view and process the sign content (Theiss et al., 2021).

## Potential Research Approach

The general approach to addressing the research objective is to analyze the sources that have traditionally been used to determine sign placement and validate whether the practices are appropriate given past research and knowledge of human capabilities when navigating work zones. The research team would gather information on the current state of practice, how the current MUTCD recommendations were developed, and what other relevant research has been conducted. Utilizing the findings, the research team would develop a method for TTC advance warning sign placement based on research and best practices.

#### Task 1 – Kick-off Meeting and Project Management

Researchers will attend a kickoff meeting with the Task Order Contracting Officer’s Representative (TOCOR) and the TCD PFS members. The research team will work with the TOCOR to confirm that all parties have a shared understanding of the research scope. The research team will obtain input on existing research information available, potential practitioner contacts to provide feedback or who may be able to provide historical context for the current MUTCD guidance.

#### Task 2 – Literature Review and State of Practice

The research team will review and synthesize literature regarding research that has been performed on sign placement in work zones. Additionally, they will summarize current practices and MUTCD text along with any information that can be gathered on the sources that led to the current MUTCD language. As part of gathering information about current practices, the research team will obtain feedback from practitioners via e-mail and/or phone calls about their procedures, challenges they encounter, and any changes they feel should be implemented.

#### Task 3 – Development of TTC Advance Warning Sign Placement Method

The research team will compare and analyze the current practices and research from Task 2. Based on the findings, the research team will develop and submit to the TOCOR a method for determining TTC advance warning sign placement and spacing. The research team will also consider whether methods should vary based on the type of TTC warning sign and will discuss, as needed, with the expert panel (Task 4).

#### Task 4 – Expert Panel Workshop to Review TTC Advance Warning Sign Placement Method

The research team will assemble an expert panel with members of the TCD PFS who have TTC work experience. Other TTC practitioners and experts, such as members of the ATSSA sign committee and/or ATSSA TTC committee and the NCUTCD TTC Technical Committee (Chapters 6A and 6B Task Force and Typical Applications Task Force). will also be included. The method from Task 3 will be provided to the expert panel for review and then a virtual workshop will be conducted to obtain feedback on the sign placement method.

#### Task 5 – Final Report and Presentation

The research team will revise the TTC advance warning sign placement method per comments received at the expert panel workshop. The research team will then develop a final report that includes the state of practice and literature review, the revised TTC advance warning sign placement method, and a summary of the justification for the methodology.

## Chance of Successful Evaluation

Medium to High

An effective field study that incorporates the findings would be extremely difficult to implement given the numerous factors that are present in work zones as well as the difficulty determining whether any effects were from sign placement, or an external variable. However, an evaluation of the existing body of knowledge would be beneficial to document the basis of the distances used to place warning signs.

## References

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IDDOT. (2020). *Traffic Manual: Idaho Supplementary Guidance to the MUTCD*.

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Washington State Legislature. (n.d.). *WAC 468-95-300:* Retrieved September 23, 2024, from https://app.leg.wa.gov/wac/default.aspx?cite=468-95-300

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# Appendix A – State Variations to MUTCD Table 6B-1 or Table 6C-1

Several states have provided additional information regarding placement and spacing of TTC advance warning signs, to supplement the prior edition of the MUTCD (2009). For example, the Wisconsin Manual on Uniform Traffic Control Devices (WMUTCD) provided clarifications to differentiate high speed and low speed urban roads with high speeds being defined of 35-40 mph and low speeds being 25-30 mph (Wisconsin DOT, 2009). Wisconsin also provides approximate distances between the closest sign to the TTC zone and the signs in Table 6B-1.

South Carolina DOT (SCDOT) has also provided specific speeds to differentiate between low speed and high speed urban roads with low speed roads being 35 mph or less and high speed roads being 40-50 mph. SCDOT also revised the recommended distance between signs for low speed roads to 200 ft (SCDOT, 2011).

Idaho DOT also provides speeds for differentiation with urban low speed roads being 35 mph or lower and urban high speed roads being 40 mph or greater (IDDOT, 2020).

Washington State DOT supplements the MUTCD through Washington Administrative Code and amends Table 6C-1 of the 2009 MUTCD to provide more categories of roads with specific speed limits associated, as shown below (Washington State Legislature, n.d.).

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The 2014 Edition of the California MUTCD adds a mid-speed (25 mph to 40 mph) urban line to Table 6C-1 (Washington State Legislature, n.d.).

A screenshot of a computer

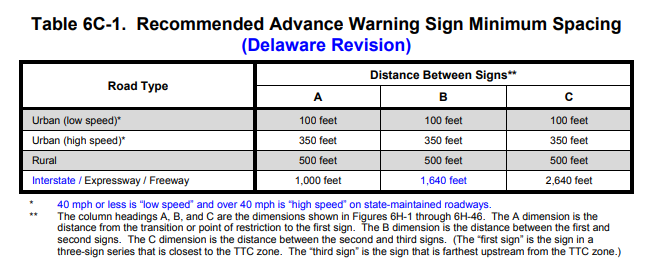
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Michigan DOT also modified Table 6C-1 of the 2009 MUTCD basing it solely on speed limits as shown below (MDOT, n.d.).

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Delaware DOT revised Table 6C-1 of the 2009 MUTCD to define low speed and high-speed roads as well as to include interstates in the bottom row as shown below (DE MUTCD, 2018).



Virginia DOT’s Work Area Protection Manual and Pocket Guide provides additional information including recommended spacing of advance warning signs (VDOT, n.d.).

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Although the aforementioned states provided amendments or additional information regarding Table 6B-1 or Table 6C-1 in the 2009 MUTCD, these tables were unchanged in the 11th Edition of the MUTCD.