SPR RESEARCH PROGRAM
SECOND-STAGE PROPOSAL SUMMARY

PROBLEM NUMBER AND TITLE

26-29: Explore the Effectiveness of Adaptive Traffic Control Work Zone Strategies

PROBLEM SUMMARY

Long-term stationary work zones that use the same traffic measures for months or even years present unique challenges. Driver exposure to static controls over extended periods can lead to reduced compliance due to habituation or desensitization. In addition, real-time changes in traffic and roadway conditions may necessitate prompt modification of existing traffic control. Research is needed to assess the influence of prolonged exposure on driver behavior, and to explore the effectiveness of real-time, adaptive traffic control strategies implemented to adjust to changing driver behaviors and work zone traffic conditions. There is a correlating need as part of the research to document the potentially complimentary and/or confounding instances when changes made to affect habitual driver behavior also influence other traffic control concerns (e.g., congestion) and first-time or infrequent driver behavior.

ODOT OBJECTIVES

The research aims to enhance safety and efficiency in Oregon's long-term construction and maintenance work zones by providing ODOT with adaptable, real-time traffic control solutions. The research will result in an implementation resource (e.g., "Adaptive Traffic Control Implementation Guide") for real-time design and management of temporary traffic control in long-term, stationary work zones, focusing on maintaining control effectiveness over extended periods and under dynamic conditions for drivers who are susceptible to desensitization due to regular exposure. In addition to the traffic control solutions targeted for regular drivers, the study will examine the results for drivers who experience the traffic control for the first time or infrequently. The final product would provide specific strategies, such as the periodic adjustment of signage and incorporating adaptive traffic control technologies that respond to real-time conditions, mitigating driver habituation and current traffic impacts, and enhancing motorist compliance for both regular and non-regular drivers.

BENEFITS

The proposed research directly addresses ODOT's research priority to enhance safety for transportation workers and the traveling public, and by doing so, also contributes to increased mobility throughout the state. Enhanced and adaptive control strategies will reduce the likelihood of accidents, promote safer driving behaviors, and create a safer environment for workers exposed to prolonged construction work zone hazards. The research outputs will also improve ODOT's overall safety culture by establishing data-driven recommendations that can be consistently applied across varied work zone conditions, ensuring safer travel conditions for all stakeholders involved.

SCHEDULE, BUDGET AND AGENCY SUPPORT

***Estimated Project Length*:** 30 months
***Estimated Project Budget*:** $226,000
***ODOT Support*:** Justin King, State Work Zone Engineer, Justin.S.King@odot.state.or.us
Vidal Francis, Region 2 Area Manager, Vidal.T.Francis@odot.state.or.us
Kevin Haas, State Traffic Standards Engineer, Kevin.J.Haas@odot.state.or.us

FOR MORE INFORMATION

For additional detail, please see the complete STAGE 2 RESEARCH PROBLEM STATEMENT online at:
https://www.oregon.gov/odot/Programs/ResearchDocuments/26-29

SPR RESEARCH PROGRAM
SECOND-STAGE PROBLEM STATEMENT
FY 2025

PROBLEM NUMBER AND TITLE

26-29: Explore the Effectiveness of Adaptive Traffic Control Work Zone Strategies

RESEARCH PROBLEM STATEMENT

ODOT relies on temporary traffic control measures to manage safety and vehicle flow through construction and maintenance work zones. While traffic controls may be effective in short-term deployments, long-term stationary work zones, which may use the same traffic control measures for months or even years, present unique challenges. Driver exposure to static controls over extended periods can lead to reduced compliance due to habituation or desensitization. In addition, the process to create traffic control designs has limited ability to adjust the design and/or plan to accommodate real-time changed conditions, such as higher truck traffic, higher amounts of traffic on a specific day/night, or other conditions. The work crew follows the plan without an efficient means and guidance to adjust the plan based on current conditions that expose workers and motorists to greater safety hazards and require more or different safety controls. There is a need to have additional or other traffic control ideas that can be deployed immediately based on conditions present in real-time and not wait until a near miss or safety-related incident occurs. In addition, guidance is needed to account for the potential conflicting influences of traffic control changes on those who regularly travel through the work zone and may be desensitized to it versus those drivers who experience the traffic control for the first time or infrequently. Research is needed to assess the impact of prolonged exposure on driver behavior and to explore the effectiveness and potential complimentary and/or confounding influences of real-time, adaptive traffic control strategies implemented to adjust to changing driver behaviors and work zone and traffic conditions. Potential factors additionally affected may be related to traffic congestion, vehicle speeds, time of day/night, mixture of vehicles based on size (e.g., cars vs. trucks), other traffic and roadway conditions, and first-time or infrequent driver behavior.

Previous ODOT and other research has highlighted the role of temporary traffic control measures—such as radar speed signs, portable changeable message signs (PCMSs), and flashing lights—in influencing driver behavior and speed in work zones. Studies by Garber and Srinivasan (1998), Pesti and McCoy (2001), and Sandberg et al. (2009) have explored the effectiveness of such measures, often indicating variability in their impact duration. However, these studies primarily evaluate short-term effects, leaving a critical gap regarding how these controls perform in long-term stationary work zones, where driver habituation may lessen their positive influence over time. Additionally, these studies do not offer clear, quantitative guidance on the relationship between effectiveness and exposure time that ODOT could apply in designing more enduring traffic control strategies, and how changes may lead to conflicting results.

Further research on adaptive and time-based traffic control strategies is essential for addressing this gap, particularly as ODOT seeks to develop dynamic, real-time approaches that can respond to prolonged deployment and evolving work zone conditions. For instance, research into adaptive feedback systems and dynamic speed monitoring, such as those examined in more recent studies (e.g., Cruzado and Donnell 2009; Finley et al. 2004), has shown promise for improving compliance and attentiveness over extended periods. By building on these findings, ODOT can establish data-driven guidelines and policies that ensure sustained effectiveness of traffic control in long-term roadway work zones for all types of drivers, aligning with ODOT's mission to deliver safe, reliable transportation infrastructure that effectively supports Oregon's unique and evolving needs.

RESEARCH OBJECTIVES

The research aims to enhance safety and efficiency in Oregon's long-term construction and maintenance

work zones by providing ODOT with adaptable, real-time traffic control solutions for standard traffic control plans (TCPs). The research will result in an implementation resource for real-time designing and managing temporary traffic control in long-term, stationary work zones, focusing on maintaining control effectiveness over extended periods. The final product will provide specific strategies, such as the periodic adjustment of signage and incorporating adaptive traffic control technologies that dynamically respond to real-time conditions, mitigating driver habituation and current traffic impacts, and enhancing motorist compliance. The research will also produce a guidance document (e.g., "Adaptive Traffic Control Implementation Guide") tailored for ODOT personnel, contractors, and traffic control teams to support immediate implementation. The guide will cover policy recommendations, procedures, and practical tools, such as adaptive response protocols and decision-making frameworks, that can be incorporated into ODOT standards. In addition, the guide would offer targeted training modules to equip field staff with the knowledge needed to apply these best practices effectively. If successfully implemented, these resources will change ODOT policies, reinforcing a data-driven and real-time approach to work zone traffic control. This approach promotes safe, responsive work zones across ODOT's network.

WORK TASKS, COST ESTIMATE AND DURATION

The proposed research will investigate the long-term and real-time effectiveness of standard temporary traffic control plans in long-term stationary work zones, focusing on mitigating reduced driver responsiveness over prolonged exposure while mitigating other negative impacts. The proposed research study will include the following essential tasks:

- A literature review and survey of state DOT practices related to work zone traffic control design, implementation, and management to establish current knowledge and best practices on time-based control effectiveness and implementation, as well as the potential negative impacts of modified traffic control (e.g., increased congestion, hazardous merging, etc.).
- Interviews with traffic control designers to identify common issues that traffic control measures may create and pinpoint opportunities for adaptive modifications in work zone designs. Consideration will be given to both drivers who regularly pass through the work zone and to first-time/infrequent drivers. Moreover, input on both potential positive and negative influences of modifications to standard TCPs will be solicited and documented.
- Identification and development of traffic control measures and/or processes that enable adaptive traffic control. This step will involve input from the Technical Advisory Committee to ensure the proposed measures are applicable and practically feasible. The focus will be on the influence of measures that minimize the negative impacts of habitual driver behavior, plus other corresponding issues (e.g. congestion) that may appear when a TCP is modified.
- Field testing of the selected traffic control measures and/or processes on actual roadway construction and/or maintenance projects to assess the traffic control measures over time.
- From the field-tested results, further develop and confirm adaptive strategies, such as periodic signage changes, re-location of temporary traffic control devices, or the addition of different or more devices, to counteract habituation effects and dynamic traffic conditions. The research will confirm how modifying the TCP to minimize desensitization for the regular driver will also affect other hazardous conditions (e.g. congestion) and how other non-regular drivers respond to the modification.
- Prepare a final research report that provides actionable guidance for ODOT's traffic control designs. Additionally, an implementation resource will be created that leverages the field data to enable real-time, data-informed adjustments to traffic control measures and enhance adaptability and sustained effectiveness in long-term work zones.

Key Deliverables:

- Interim report on current knowledge and practice related to the research topic.
- Implementation guide for adaptive traffic control strategies within ODOT.
- Final report presenting the research activities, results, analysis, conclusions, and recommendations for implementation and further research.

***Estimated Project Length*:** **30 months**
***Estimated Project Budget*:** **$226,000**

IMPLEMENTATION

It is expected that the research outputs will be used by the ODOT Transportation Safety Division and the Region Transportation Safety Coordinators in each Region as they plan and design traffic control for work zones. The results are expected to be incorporated into the activities of the Statewide Construction Office and implemented through communication and education of the Construction Project Managers statewide. Consideration of how to effectively integrate the results will be discussed with the TAC as part of the study. Lastly, it is also expected that the guidance will be beneficial to and used by ODOT Maintenance personnel as they plan and implement temporary traffic control during maintenance operations.

POTENTIAL BENEFITS

The proposed research directly addresses ODOT's research priority to enhance safety for roadway users, and by doing so, also contributes to increased mobility throughout the state. The research focuses on improving safety for transportation workers and the traveling public. The study aims to develop real-time, adaptive traffic management strategies that minimize risks associated with driver complacency and desensitization in long-term work zones by studying the long-term effectiveness of temporary traffic control measures. Enhanced and adaptive controls will reduce the likelihood of accidents, promote safer driving behaviors, and create a safer environment for workers exposed to prolonged construction zone hazards. The research outputs will also improve ODOT's overall safety culture by establishing data-driven recommendations that can be consistently applied across varied work zones, ensuring safer conditions for all stakeholders involved.

PEOPLE

Proposed Champion:

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REFERENCES

Cruzado, I., Donnell, E. T. (2009). " Evaluating Effectiveness of Dynamic Speed Display Signs in Transition Zones of Two-Lane, Rural Highways in Pennsylvania." Sage Journal, No. 2122, pp. 1–9.

Finley, M. D., Ullman, B. R., and Trout, N. D. (2004). "Traffic Control Devices and Practices to Improve the Safety of Mobile and Short Duration Maintenance Operations." Texas A&M Transportation Institute, FHWA/TX-05/0-4174-2.

Garber, N. and Srinivasan, S. (1998). "Effectiveness of Changeable Message Signs in Controlling Vehicle Speeds in Work Zones, Phase II." VA Transp. Research Council and FHWA, VTRC 98-R10, Dec. 1998.

Pesti, G. and McCoy, P. T. (2001). "Long-Term Effectiveness of Speed Monitoring Displays in Work Zones on Rural Interstate Highways." Transportation Research Record, No. 1754, pp. 21-30.

Sandberg, W., Shoenecker, T., Sebastian, K., and Soler, D. (2009). “Long-Term Effectiveness of Dynamic Speed Monitoring Displays (DSMD) for Speed Management at Speed Limit Transitions.” Washington, Dakota, and Ramsey Counties.

STAFF REVIEW PAGE

LITERATURE CHECK

TRID&RIP

☒ A review of TRID & RIP databases found no existing research that answers the research question

There were no recent TRID finding specifically for long-term adaptive work zones strategies.

ODOT DECISION LENSES

Climate: This research is not focused on climate and will not include analysis of climate.

Equity: While equity is not the primary focus of this research, the proposed study supports ODOT's equity goals by enhancing safety and accessibility across all Oregon communities. By examining the long-term effectiveness of temporary traffic control measures, the research aims to develop adaptive strategies that ensure consistent safety for all drivers, including those in underserved or rural areas who may encounter long-term construction work zones more frequently. Additionally, by improving temporary traffic control effectiveness, this research indirectly contributes to reducing accident risks and improving the reliability of travel times, which can disproportionately benefit those with limited transportation options or those relying on critical travel routes. This alignment with ODOT's equity goals fosters a safer and more reliable transportation experience that serves the needs of all Oregonians.

Safety: This research focuses on improving safety for transportation workers and the traveling public. The study aims to develop real-time, adaptive traffic management strategies using AI tools that minimize risks associated with driver complacency and desensitization in long-term work zones by studying the long-term effectiveness of temporary traffic control measures. Enhanced and adaptive controls will reduce the likelihood of accidents, promote safer driving behaviors, and create a safer environment for workers exposed to prolonged construction zone hazards. The research outputs will also improve ODOT's overall safety culture by establishing data-driven recommendations that can be consistently applied across varied work zones, ensuring safer conditions for all stakeholders involved. This research contributes to healthier, more livable communities by helping to reduce traffic incidents and promoting safer driving environments in long-term work zones. Ensuring the effectiveness of traffic control in areas where construction may disrupt normal traffic flow, especially in rural or underserved regions, enhances the overall livability and travel experience for residents and road users, creating a safer and more accessible transportation network. The proposed research will assess and recommend adaptive, real-time traffic control technologies tailored to long-term work zones. These best-available technologies, such as dynamic signage and automated real-time alerts, will ensure that ODOT implements the most effective measures to maintain driver attentiveness and responsiveness in complex or prolonged work environments. Utilizing these advanced technologies supports proactive safety management that evolves alongside current capabilities and work zone conditions. This study inherently requires collaboration between ODOT, traffic control personnel, and safety experts to develop a comprehensive implementation guide for adaptive traffic control strategies. By fostering communication among key stakeholders, this research aligns with ODOT's commitment to collaborative safety improvement, facilitating shared understanding and consistency in safety practices across construction sites. Investing in research to develop effective, long-term traffic control strategies is a strategic decision that will prevent accidents and enhance public safety on Oregon's transportation network. The outputs will provide actionable insights and practical tools that ODOT can incorporate into future construction projects, maximizing the impact of safety investments over the lifecycle of long-term infrastructure projects. ODOT is positioned to proactively address safety risks by strategically focusing on

adaptive traffic control measures, ultimately reducing statewide injury and accident rates in work zones.

TECHNOLOGY & DATA ASSESSMENT

☒ No Identified T&D output

☐ At the end of this project, the implementing unit(s) within ODOT will need to coordinate the adoption of new technology or data in order to realize the full potential of this research.

There are no anticipated T&D solutions for long-term traffic control.

CROSS-AGENCY IMPACTS

- List ODOT partners or impacted units.
  ODOT Construction Section, ODOT Maintenance and Operations Branch, and private contractors are the main audience.

- Identify any issues of concern raised by an ODOT partners. Note expected mitigation that addresses these concerns.

  Concern #1) A concern that identified treatment for the regular, habitual driver has a negative impact on the non-regular driver. This was addressed in the research to study the negative effects of established treatments to change the driver that is not paying attention to start paying attention AND to measure effects of the driver that is not familiar with the work zone and document their actions as well.
  Concern #2) The amount and circumstances of this situation may be too few for the proposed study timeframe. This concern is only realized if funded. The research team will work with the upcoming contracts for long-term work zone setups. If needed, the research contract will be extended to take advantage of planned outsourced “ideal” contracts that will have long-term work zones.