U.S. Department of Transportation
Federal Highway Administration

Data-Driven Work Zone Process Reviews Case Study: Kentucky Transportation Cabinet

December 2022

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16. Abstract Federal regulations in 23 CFR Part 630 Subpart J require States to conduct a work zone process review (WZPR) every 2 years to evaluate work zone processes and procedures, as well as identify systematic improvements to current and future projects. The Federal Highway Administration now encourages agencies to use a data-driven approach to make WZPRs more outcome- and performance-driven while bringing about a continuum mindset to WZPRs instead of isolated point-in-time reviews. This type of approach uses quantitative data and analyses, including exposure, safety, mobility, and inspection data, as well as qualitative information in WZPRs. This case study is one of a series of resources on data-driven WZPRs. It was developed in collaboration with the Kentucky Transportation Cabinet (KYTC) and focuses on two major program areas: safety and mobility. Anonymized data from crash reports, traffic sensors, probe vehicles, and work zone project tracking were used to conduct the analyses, derive metrics and trends, and identify key issues. The case study used data from 2019 through 2021. This case study demonstrates how KYTC successfully uses crash, traffic, and construction data to streamline its WZPRs and provide a repeatable quantitative basis for more systematic reviews that extend across multiple process review cycles.			
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List of Abbreviations and Acronyms

DOT	Department of Transportation
FHWA	Federal Highway Administration
KYTC	Kentucky Transportation Cabinet
TOC	Transportation Operations Center
TRIMARC	Traffic Response and Incident Management Assisting the River Cities
USDOT	U.S. Department of Transportation
VHT	Vehicle hours traveled
VMT	Vehicle miles traveled
WZ	Work zone
WZM	Work zone management
WZPR	Work zone process review

Introduction

Federal regulations in 23 CFR Part 630 Subpart J require State highway agencies to conduct a Work Zone Process Review (WZPR) every 2 years to evaluate work zone (WZ) processes and procedures, as well as identify systematic improvements to current and future projects.[1] WZPRs apply to all project development and implementation phases, including planning, preliminary engineering, impact assessment, design, implementation/construction, and performance monitoring and management. States are also required to use available data, observations, and information to manage WZ impacts of individual projects, as well as to continually pursue broader improvement of WZ processes and procedures through WZ data analysis (e.g., crash/safety data, mobility data, construction metrics, and operational metrics).[2]

An FHWA guidance document was published in April 2015 to help State highway agencies conduct effective WZPRs.[3] The guidance document includes a nine-step approach States can take when performing a WZPR, as shown in figure 1. This document also highlights the importance of using data and performance measures in WZPRs to make the process reviews more comprehensive, actionable, and effective.

Steps States Can Take to Conduct Effective Work Zone Process Reviews

1. Assemble a multidisciplinary team
2. Develop a review plan
3. Conduct review
4. Analyze and interpret results
5. Develop inferences, recommendations, and lessons learned
6. Prioritize recommendations and lessons learned
7. Develop an action plan to implement the prioritized recommendations
8. Present findings
9. Initiate the action plan

Figure 1. List. Nine-step approach for performing work zone process reviews.
Source: Federal Highway Administration.

However, many State departments of transportation (DOTs) have found it challenging to include data consistently and effectively in their WZPRs due to a lack of awareness and access to data, as well as limited resources for conducting streamlined data-driven process reviews. A renewed focus on performance-based work zone management (WZM), new industry paradigms, and the emerging data sources from connected, autonomous, and probe vehicles present State DOTs many new opportunities to leverage data in their WZPRs. A data-driven WZPR approach will enable agencies to make WZPRs more outcome-and performance-driven, while bringing about more of a continuum mindset to WZPRs, as opposed to isolated point-in-time reviews.

[1]Code of Federal Regulations. 2004. 23 CFR Part 630 Subpart J. https://www.ecfr.gov/current/title-23/part-630/subpart-J, last accessed March 13, 2023.
[2]Code of Federal Regulations. 2004. 23 CFR Part 630 Subpart J § 630.1008. https://www.ecfr.gov/current/title-23/chapter-I/subchapter-G/part-630/subpart-J/section-630.1008, last accessed March 13, 2023.
[3]FHWA. 2015. "Guidance for Conducting Effective Work Zone Process Reviews" (web page). https://ops.fhwa.dot.gov/publications/fhwahop15013/index.htm, last accessed March 13, 2023.

This Kentucky Transportation Cabinet (KYTC) case study was developed by FHWA to demonstrate a data-driven, systematic, and comprehensive approach to conducting WZPRs. It provides examples of how State DOTs can leverage existing data sources and performance assessment findings to incorporate data into steps two to five of the nine-step WZPR approach (figure 1). It does not represent FHWA guidance or an example WZPR report and is not intended to replace the WZPR report formats that State DOTs follow. As presented in figure 2, the data integration approach comprises identifying data needs for each program area, conducting data analyses, identifying trends for issues and best practices, collecting contextual information about trends identified, selecting action plans based on trends, developing metrics to assess action items, implementing continuous data collection, and analyzing the impacts of implemented action items on program outcomes.

KYTC conducted its previous WZPRs by focusing on select strategies implemented during the process review cycle. The discussions in those WZPRs were driven by qualitative observations, with limited focus on quantitative data assessments of outcomes. Although quantitative data were not included in prior WZPRs, KYTC has been routinely collecting WZ-related data as part of KYTC's internal performance management efforts. In addition, KYTC has access to probe and crowdsource traffic data from third-party data providers. This presents a significant opportunity for KYTC to use these data resources to make its WZPRs more data driven, with the goal of using quantifiable benchmarks for performance management.

Figure 2. Diagram. An integrated approach for data-driven Work Zone Process Reviews.
Source: Federal Highway Administration.

Performance Areas Selected for the Work Zone Process Review Case Study

The project team chose safety and mobility as the two main WZ performance areas for this WZPR case study. Anonymized data from crash reports, traffic sensors, probe vehicles, crowdsourcing, and WZ project tracking were used to conduct the analyses, derive metrics and trends, and identify key issues. KYTC provided the project team with WZ exposure, safety, and mobility data from 2019 to 2021 to use in the case study. The project team applied the WZ exposure data to filter and analyze safety and mobility data within the WZ timeframes and activity areas. Findings from the case study for each performance area are presented in the following sections. The discussion starts with an overview of the WZ exposure data that KYTC tracks, which provides a basis for assessing performance based on the volume of WZ activity.

Exposure Data

A comprehensive data-driven WZPR allows comparison of WZ performance across multiple years, as well as normalization of WZ performance by the volume of WZ activity (i.e., WZ exposure) in any given year. WZ exposure data include metrics such as the number of WZs, WZ vehicle miles traveled (VMT), mileage of construction/maintenance activity, project duration, lane closure hours, and traffic volume affected by WZs.

Exposure Data Used in Case Study

Sources: KYTC's Transportation Operations Center (TOC) and Traffic Response and Incident Management Assisting the River Cities (TRIMARC)

Metrics: Number of WZs, length of WZ activity

KYTC collects and archives current and historical construction WZ project information on its internal WZ database. KYTC follows a comprehensive process to collect WZ project data on all types of WZ activities, including road widening, bridge replacements, new road constructions, temporary maintenance, and total roadway reconstructions. On average, KYTC implemented 2,591 WZs per year from 2019 to 2021. During 2019 and 2021, 4 percent more WZs were implemented in Kentucky compared with the 3-year average (figure 3). KYTC implemented 7 percent fewer WZs in 2020. During qualitative discussions with the project team, the KYTC WZ team mentioned that the decrease in 2020 WZ activity was primarily due to the limited availability of maintenance crews during the COVID-19 pandemic.[4] The WZ activity change from 2019 to 2021 was consistent across all facility types, including interstates, U.S. routes, State routes, and other routes. Across the years from 2019 to 2021, close to 50 percent of the total WZ activity occurred on Interstates 24, 64, 65, 71, 75, 264, 265, and 275; U.S. routes 25, 27, 41, 60, and 68; and Kentucky routes 4 and 841. Interstate 75 experienced 9.5 percent of total WZ activity. During the qualitative discussions, the KYTC WZ team mentioned that the WZ activity findings align with the investments made by KYTC, as these are the most-traveled routes, which need regular maintenance and upgrades to meet the travel demand.[4]

[4]FHWA-KYTC WZ team conference calls February–October 2022.

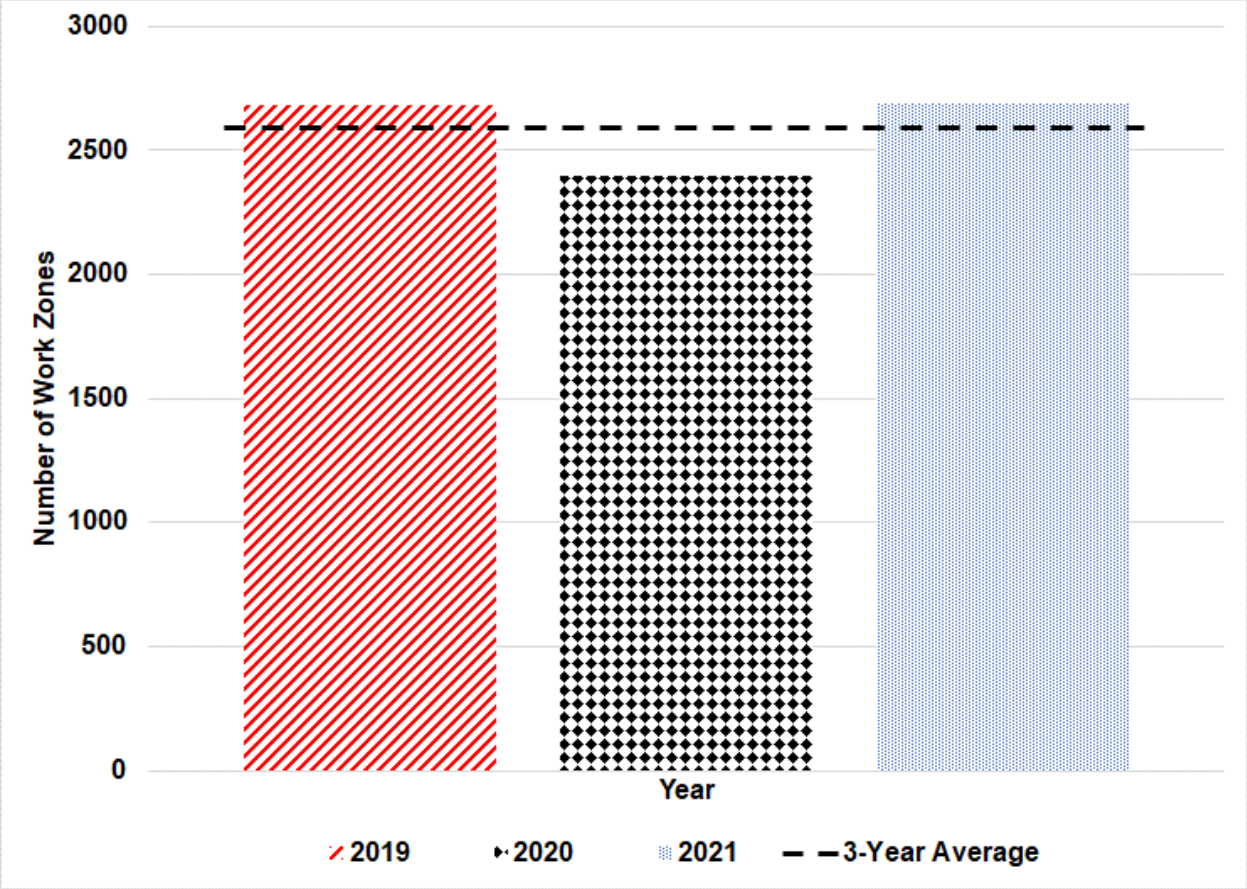

Figure 3. Chart. Total number of work zones.
Source: Kentucky Transportation Cabinet.

Length of Work Zones

The length of WZs provides context for the variation in the magnitude of the WZ activity performed each year. The project team analyzed the WZ length for the years 2019 to 2021. On average, KYTC performed WZ activity on 7,502 miles per year from 2019 to 2021. The total lengths of WZs implemented in 2019 and 2021 were 15 and 11 percent higher than the 3-year average, respectively. Lengths of WZs implemented were 26 percent lower in 2020 than the 3-year average. Although the total WZ length provides context about total WZ activity, it may not provide a relative comparison of WZ magnitude across the years, as the number of WZs implemented also varies. An average length per WZ provides a normalized metric for comparison across the years. After normalization, the average length of WZs in Kentucky was 2.8 miles from 2019 to 2021. The average lengths of WZs were 13 and 6 percent higher in 2019 and 2021, respectively, and 19 percent lower in 2020, when compared with the 3-year average from 2019 to 2021, as shown in figure 4.

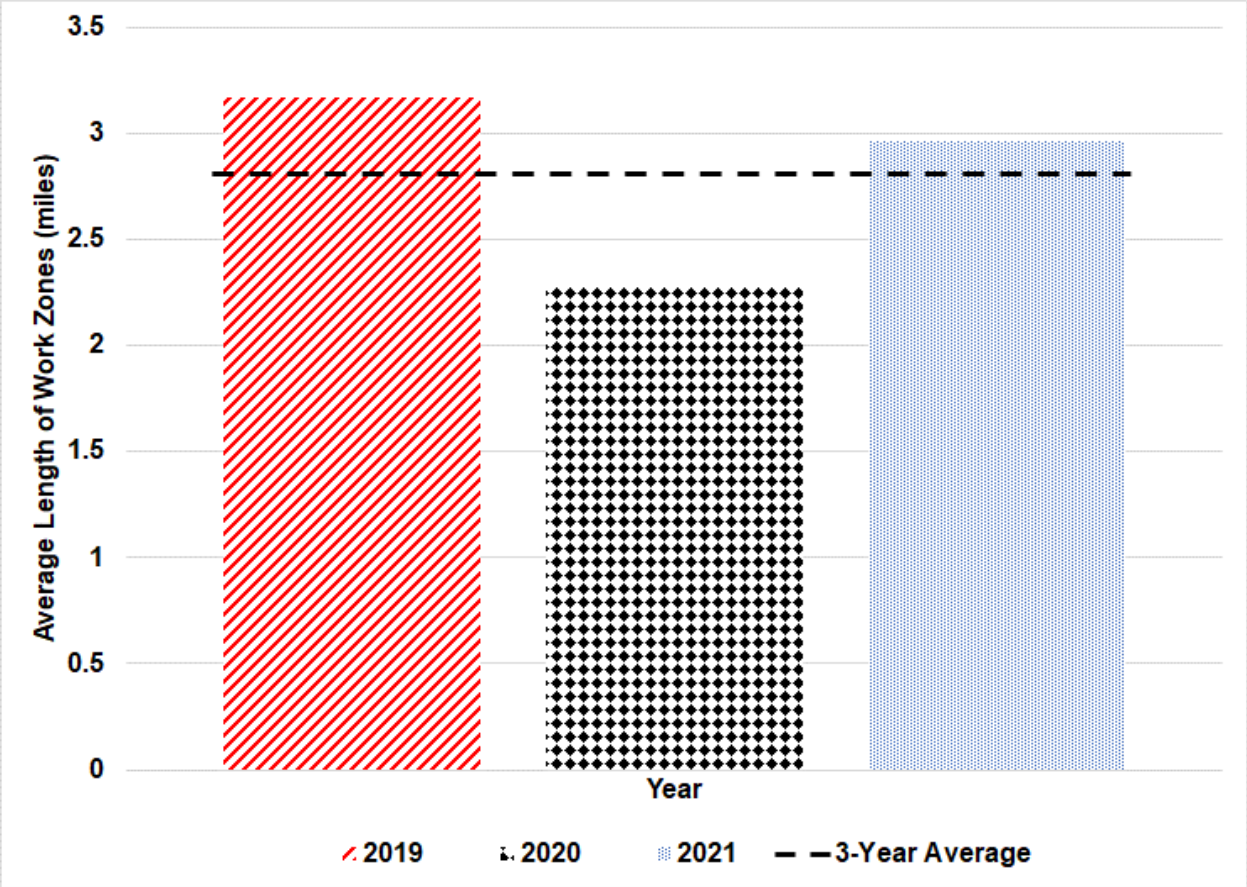

Figure 4. Chart. Average length of work zones.

Source: Kentucky Transportation Cabinet.

Key Findings and Observations for Data-Driven Work Zone Process Reviews

- KYTC tracks, digitizes, and publishes information about its WZ construction projects on its internal WZ database. This detailed tracking of WZ activity data allowed the project team to conduct comprehensive performance assessments of all WZs across the State.
- On average, KYTC implemented 2,591 WZs per year, with an average WZ length of 2.8 miles across the years 2019 to 2021.
- In 2020, KYTC decreased its WZ activity due to limited availability of maintenance crew. In 2019 and 2021, the WZ activity was 4 percent higher than the 3-year average from 2019 to 2021 of 2,591 WZs. The variations in the length of WZ activity also corresponded to the amount of WZ activity.
- From a WZPR standpoint, KYTC should consider collecting and analyzing additional traffic volume metrics such as VMT, vehicle hours traveled (VHT), and queue lengths. Having these data will enable KYTC to get a complete picture of WZ exposure; to compare, contrast, and normalize WZ performance trends; and to conduct more-comprehensive WZPRs.

Performance Area 1: Work Zone Safety

Work Zone Crashes

Safety Data Used in Case Study

Sources: Kentucky crash data from KYTC's TOC and TRIMARC

Metrics: Number of WZ crashes

The project team analyzed WZ-related crash data to assess the safety performance of WZs implemented in Kentucky from 2019 to 2021 (figure 5). The project team identified a crash as a WZ-related crash when it occurred within the WZ activity timeframes and was located within the WZ beginning and ending mileposts. Overall, KYTC experienced 401 crashes per year across these years. In 2019 and 2021, KYTC experienced 15 and 8 percent fewer crashes than the 3-year average. The number of WZ crashes in 2020 was 23 percent higher than the 3-year average.

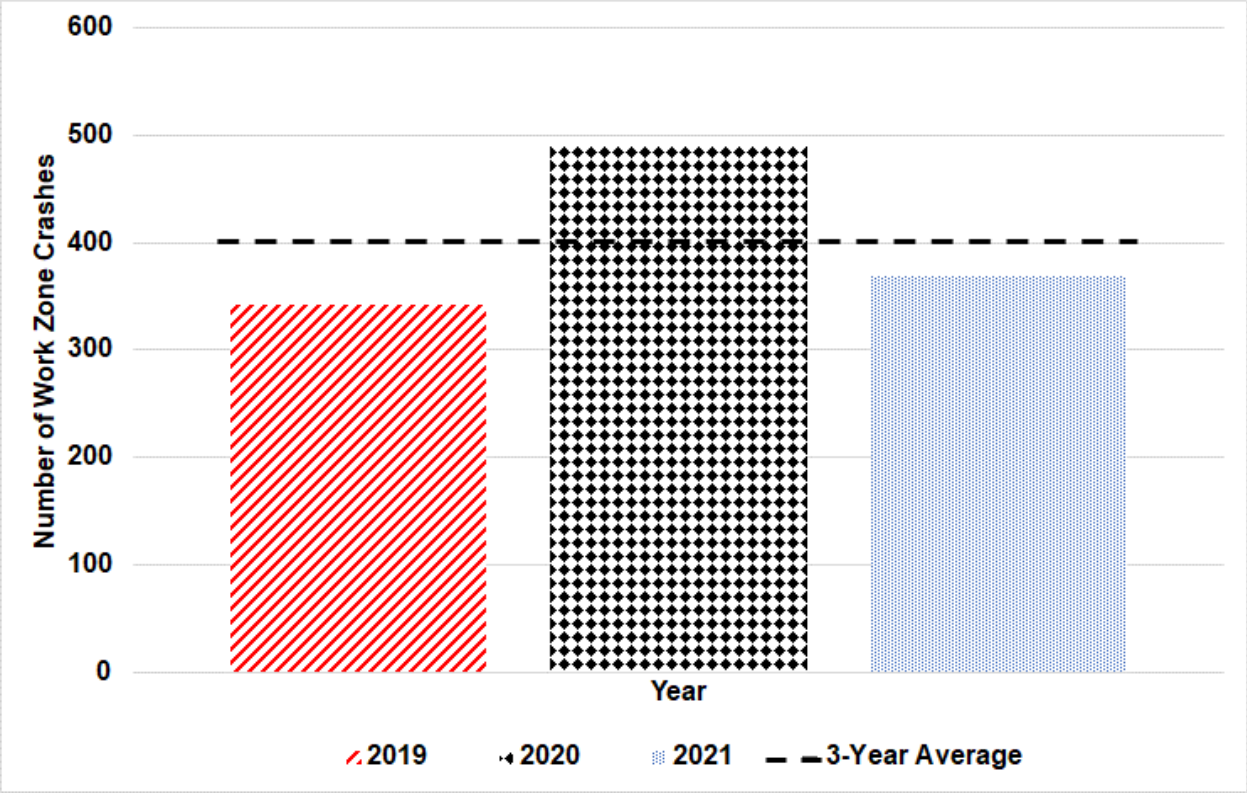

Figure 5. Chart. Number of work zone crashes.
Source: Kentucky Transportation Cabinet.

The project team also analyzed WZ crashes by the route. Findings indicate that WZs on interstate routes experienced 90 percent of the total WZ crashes.

Crashes per Work Zone

The project team analyzed WZ crashes per 100 WZs implemented. This normalization provides a comparable metric across the years by considering WZ activity. Findings indicated that Kentucky WZs experienced an average of 15 crashes per 100 WZs implemented across the years

2019 to 2021 (figure 6). During qualitative discussions with the project team, the KYTC WZ team mentioned that three factors might have contributed to the increased crashes in 2020: fewer patrolling hours in WZs, increased speeding behavior, and interchange improvements and widening projects implemented on interstates 64, 71, and 265 via the I-Move Kentucky initiative.[5]

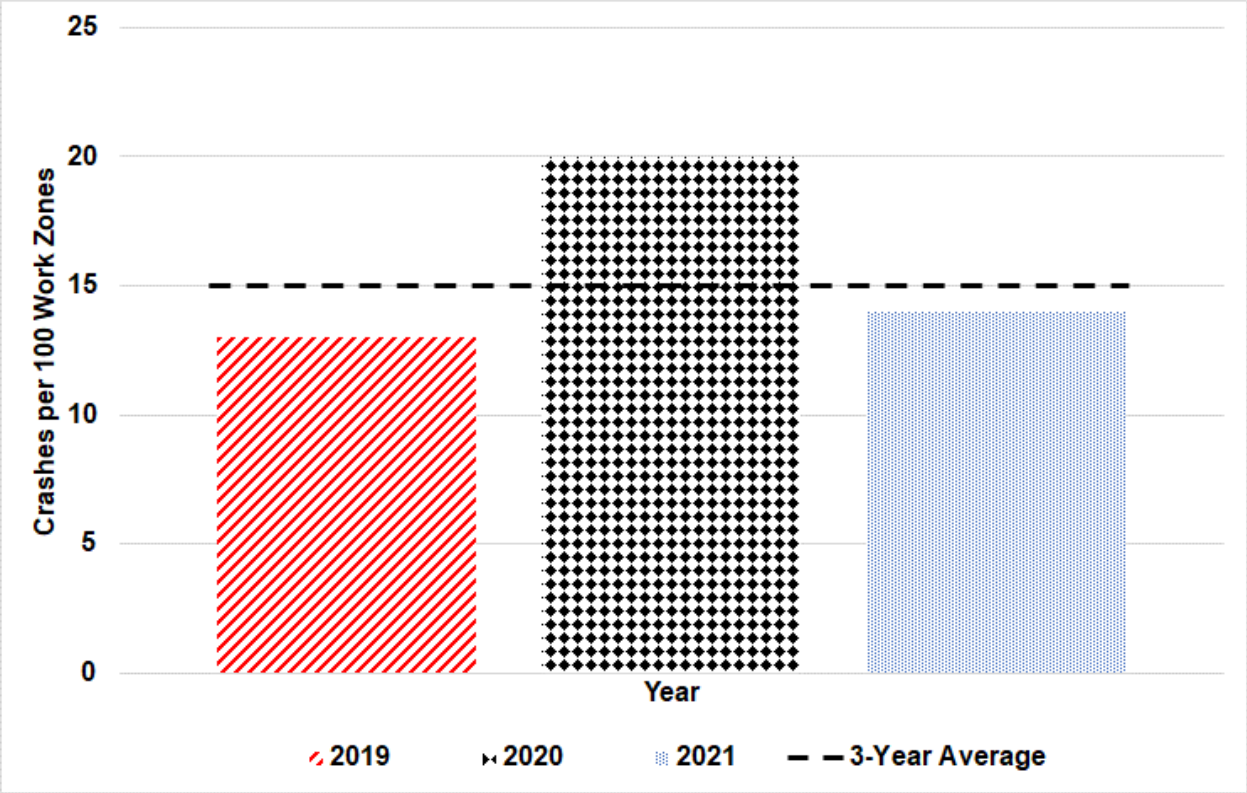

Figure 6. Chart. Number of work zone crashes per 100 work zones.
Source: Kentucky Transportation Cabinet.

[5]FHWA-KYTC WZ team conference calls February–October 2022.

Key Findings and Observations for Data-Driven Work Zone Process Reviews

- The project team analyzed WZ-related crash data to assess the safety performance of WZs implemented in Kentucky from 2019 to 2021.
- Compared with the 3-year average of 401 crashes per year, KYTC WZs experienced more crashes in 2020 and fewer crashes in 2019 and 2021. The project team performed a normalized comparison of crash rates across the years by using WZs. Findings indicated that KYTC WZs experienced an average of 15 crashes per 100 WZs for years 2019 to 2021. Normalized crash rate variations across the years were similar to total crash variations.
- During qualitative discussions with the project team, the KYTC WZ team mentioned that three factors might have contributed to the increased crashes in 2020: fewer patrolling hours in WZs, increased speeding behavior, and interchange improvements and widening projects implemented on interstates 64, 71, and 265 via the I-Move Kentucky initiative.
- The project team performed a route analysis to identify routes that experienced the most WZ crashes across the years 2019 to 2021. Findings indicate that WZs on interstate routes experienced 90 percent of the total WZ crashes.
- From a WZPR standpoint, KYTC's well-established processes to collect and publish WZ activity data allowed the project team to get a normalized metric across the years. Collecting additional WZ exposure metrics such as VMT, VHT, and volume and mapping them to the WZ activity data will enable the KYTC WZ team to analyze the safety performance data with a common frame of reference across years, accounting for varying travel demand.
- KYTC can get deeper insights on its WZ safety performance by analyzing granular crash data, including crash types (e.g., rear-end, sideswipe, and head-on) and violation types (e.g., unsafe speed, driving under influence, and improper turning). This additional analysis will help KYTC understand the major crash contributing factors and take mitigation strategies and minimize their impact on safety performance.

Performance Area 2: Work Zone Mobility

Kentucky WZ Mobility Policy: KYTC uses maximum queue length as a key measure to assess the mobility impact of WZs on travelers. KYTC's mobility policy defines significant traffic impact when queue length due to a WZ exceeds 3 miles more than the normal queue length without the WZ project.[6]

The mobility data presented in this case study are from WZ projects implemented in 2019, 2020, and 2021. The construction projects tracked by KYTC include road

Mobility Data Used in Case Study

Sources: TOC and TRIMARC WZs and crashes, data from third-party data provider

Analysis: Jam delays

Metrics: Delay per WZ jam and delay per WZ-crash-related jam

[6]Commonwealth of Kentucky. 2020. *Policy and Procedures for the Safety and Mobility of Traffic Through Work Zones*. https://transportation.ky.gov/Construction/Documents/workzonepolicy.pdf, last accessed March 13, 2023.

widening, bridge replacements, new road constructions, temporary maintenance, and total roadway reconstructions.

Based on the WZ project information available from KYTC, the project team conducted a comprehensive mobility analysis by using the crowd-sourced data from the third-party provider. Given that many State DOTs have access to probe and crowdsource data, the project team used these data to demonstrate the application of available resources for mobility-based WZ performance analysis. The project team conducted two types of delay analyses: WZ-related delay and WZ-crash-related delay. The WZ-related delay analysis combined WZ activity data with jam data to estimate the overall delay created by jams that occurred during the WZ timeframe and within WZ activity mileposts. Similarly, the WZ-crash-related delay analysis combined the WZ crash data with jam data to estimate the overall delay caused by jams that occurred during a WZ crash event and within the crash boundaries. The facility types selected for the mobility analysis were interstates, U.S. routes, and Kentucky routes.

Work-Zone-Related Delay

This metric presents the delay caused by all jams that occurred in WZs. Overall, KYTC WZs experienced an annual average of 45,315 jam events and 140,116 hours of jam delay across 2019 to 2021. KYTC experienced 18 and 13 percent more jams in 2019 and 2021, respectively, and 31 percent fewer jams in 2020 compared with the 3-year average. The total delays experienced by KYTC WZs were 4 and 10 percent higher in 2019 and 2021 and 14 percent lower in 2020. The project team concluded that this reduction in 2020 jams events and delays might be a result of reduced travel demand during the pandemic. One way to verify this qualitative observation is to normalize the jams by the WZ VMT. The project team could not perform this analysis, as the VMT data were not available. To account for the variability of WZ activity across the years, the project team normalized the WZ delays with WZ activity. The normalized metrics calculated include jams per WZ and delays per WZ. On average, 17 jams were experienced per WZ implemented by KYTC from 2019 to 2021, with 20, 13, and 19 jams per WZ experienced in 2019, 2020, and 2021, respectively. During these years, KYTC WZs experienced an average of 54 hours of delay per WZ (figure 7). WZs in 2019 and 2021 experienced 1 and 6 percent higher delays per WZ than the 3-year average, respectively. WZs in 2020 experienced 7 percent fewer delays than the 3-year average. Higher WZ activity on Interstates 24, 64, 65, and 71 in 2021 than in 2019 led to a higher per-WZ delay in 2021. The project team also assessed delay performance by route to identify the routes that experienced the most delay. Findings indicated that I–75, U.S. 60, and KY 536 experienced 16.7, 7.4, and 5.4 percent of total WZ delays, respectively, from 2019 to 2021.

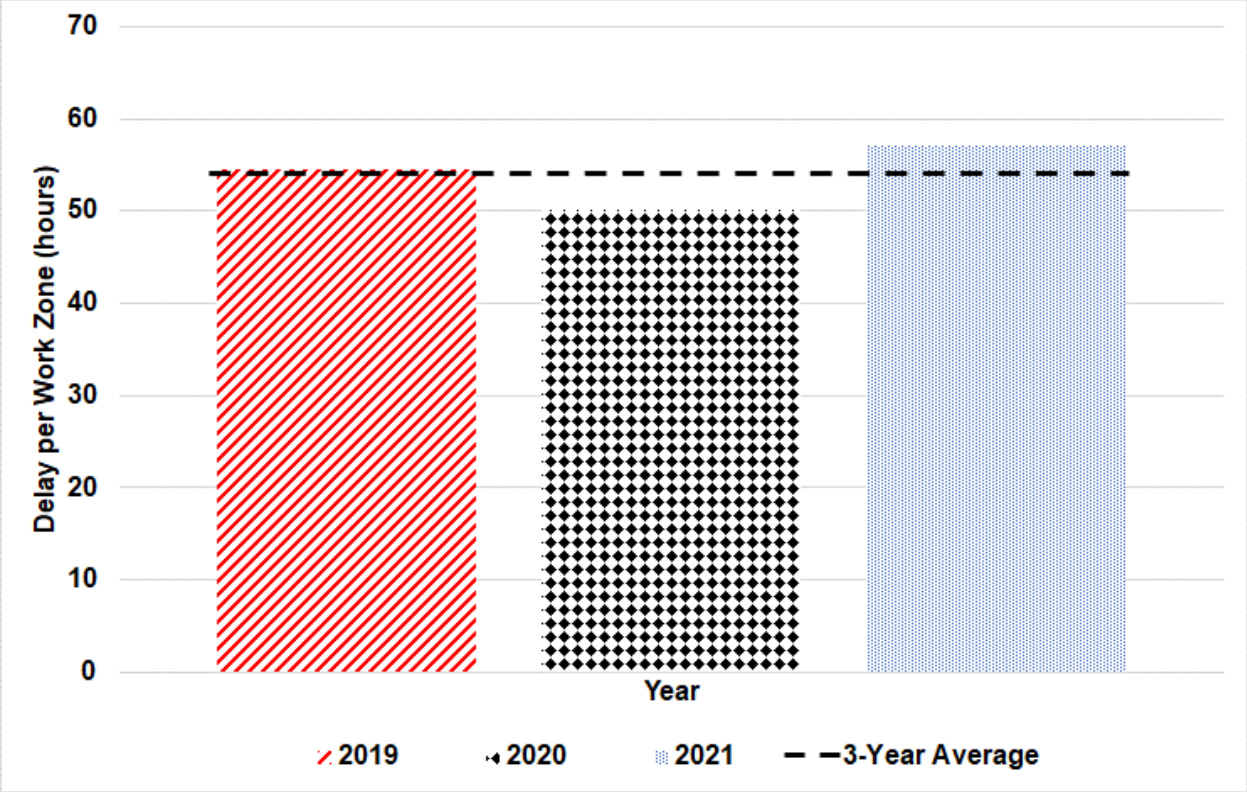

Figure 7. Chart. Delay per work zone.
Source: Kentucky Transportation Cabinet.

Work-Zone-Crash-Related Delay

This metric estimates the total delay experienced by travelers traversing KYTC WZs during a WZ-crash-related jam. Across all facility types, KYTC WZs experienced an annual average of 162 crash jam events and 2,203 hours of jam delay per year across the years 2019 to 2021 (figure 8). KYTC WZs experienced 101, 179, and 206 crash jams in 2019, 2020, and 2021, respectively. The total crash jam delays experienced by KYTC WZs were 4 and 11 percent lower in 2019 and 2021, respectively, and 14 percent higher in 2020 compared with the 3-year average from 2019 to 2021. The crash delay pattern across the years (i.e., lower in 2019 and 2021 and higher in 2020) corresponded with the WZ crash pattern. To account for the variability of WZ activity and associated crashes across the years, the project team normalized the WZ crash delays with crash activity. The normalized metrics include jams per 10 WZ crashes and delay per jam. On average, KYTC WZs experienced four jams per 10 WZ crashes across all facilities. KYTC WZs experienced an average of 13.6 hours of delay per jam across the years from 2019 to 2021. A key observation to note is that the delays experienced during a WZ crash event are 438 percent higher than the delays experienced during jams that occurred when there was no crash. KYTC WZ experienced 21, 14, and 9.5 hours of delay per jam in 2019, 2020, and 2021, respectively. Although there were more crash jams in 2021 than in other years, delays per jam were higher in 2019 and 2020. This was mainly due to the reduced 2021 WZ activity on I–75, which experienced 40 percent of the overall crash-jam-related delay across the years. Due to this reduced activity, there were fewer crash jams on I–75 WZs in 2021, leading to a considerable

delay-per-jam reduction. Also, a majority of the increase in 2021 crash jams occurred on Interstate 264, where the average delay per jam was 6 hours, which is 63 percent less than the 16.3 hours of average jam delay on I–75. During qualitative discussions with the project team, the KYTC WZ team concurred with the findings about the impact of I–75 on the overall crash delays. Also, the KYTC WZ team mentioned that the WZ activity on I–75 in 2022 will be more than in previous years, which could increase the overall 2022 crash delay.[7]

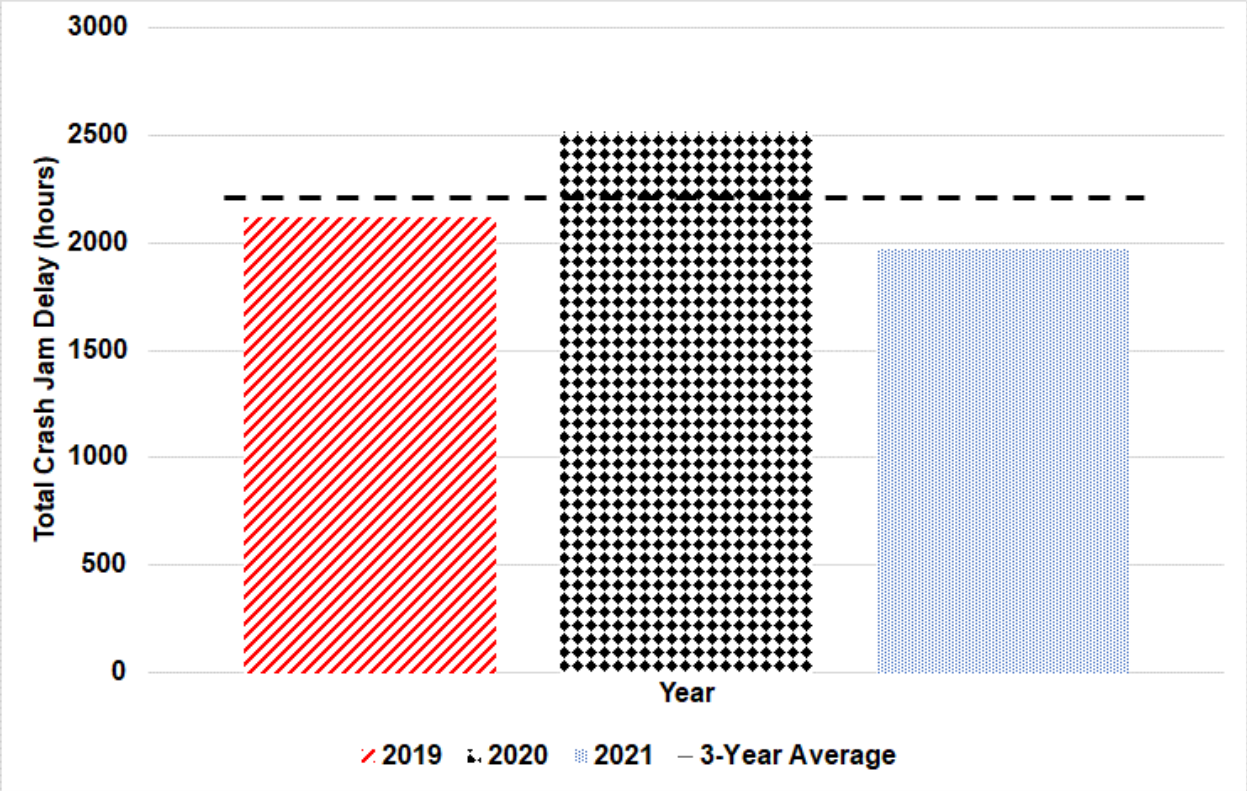

Figure 8. Chart. Total crash jam delay in work zones.
Source: Kentucky Transportation Cabinet.

[7]FHWA-KYTC WZ team conference calls February-October 2022.

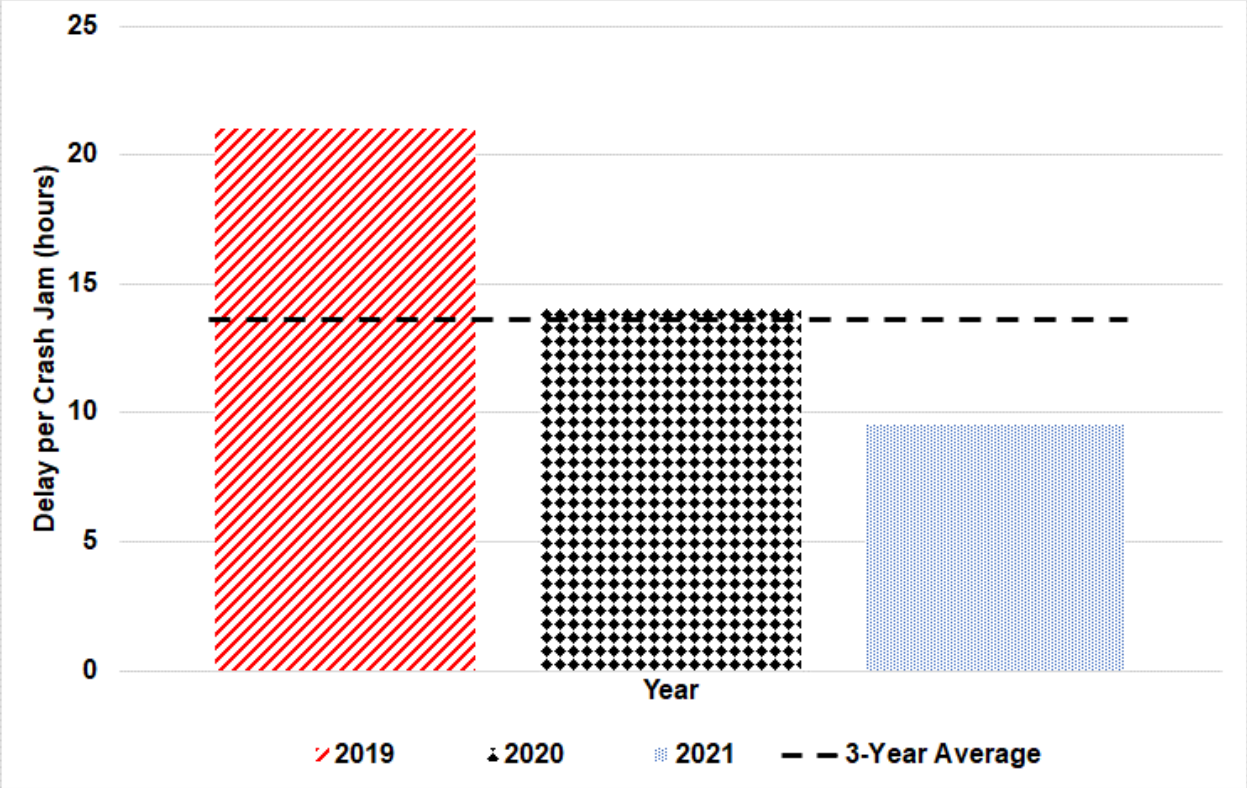

Figure 9. Chart. Delay per crash jam.
Source: Kentucky Transportation Cabinet.

Key Findings and Observations for Data-Driven Work Zone Process Reviews

- KYTC uses maximum queue length as a key measure to assess the mobility impact of WZs on travelers. KYTC's mobility policy defines significant traffic impact when queue length due to a WZ exceeds 3 miles more than the normal queue length without the WZ project. The project team could not analyze the queue lengths, as KYTC does not currently collect WZ queue length data.
- KYTC collects crowd-sourced data from the third-party provider for its internal mobility performance tracking. The project team combined the WZ activity data, crash data, and crowd-sourced data from the third-party provider to conduct two types of delay analyses: WZ-related delay and WZ-crash-related delay.
- Overall, KYTC WZs experienced an annual average of 45,315 jam events and 140,116 hours of jam delay across the years 2019 to 2021. KYTC experienced more jams and delays in 2019 and 2021 and fewer jams and delays in 2020 compared with the 3-year average from 2019 to 2021. The project team concluded that this reduction in 2020 jams events and delay might be a result of reduced travel demand during the COVID-19 pandemic. One way to verify this qualitative observation is to normalize the jams by the WZ VMT. The project team could not perform this analysis, as the VMT data were not available.
- To account for the variability of WZ activity across the years, the project team normalized the WZ delays with WZ activity. The normalized metrics calculated include jams per WZ and delay per WZ:
    - KYTC WZs experienced more jams per WZ in 2019 and 2021 and fewer jams per WZ in 2020 when compared with the 3-year average of 17 jams per WZ from 2019 to 2021.
    - KYTC WZs experienced an annual average of 54 hours of delay per WZ from 2019 to 2021. KYTC WZs experienced higher delays per WZ in 2019 and 2021 and lesser delays per WZ in 2020 when compared with the 3-year average of 54 hours of delay per WZ. Higher WZ activity on Interstates 24, 64, 65, and 71 in 2021 than in 2019 led to a higher per-WZ delay in 2021.
- Independent route analysis of WZ delays indicated that I–75, U.S. 60, and KY 536 experienced 16.7, 7.4, and 5.4 percent of total WZ delays, respectively, from 2019 to 2021.
- Across all facility types, KYTC WZs experienced an annual average of 162 crash jam events and 2,203 hours of jam delay per year across the years 2019 to 2021. The number of crash jams experienced by KYTC WZs increased across the years 2019 to 2021, whereas the total jam delays were less in 2019 and 2021 and more in 2020.
- The project team normalized the crash jams with WZ crash activity to determine jams per 10 WZ crashes and delay per crash jam. After normalizing, KYTC WZs experienced an average of 4 jams per every 10 WZ crashes experienced across all facilities. In 2019, 2020, and 2021, 3, 4, and 6 jams were experienced per 10 WZ crashes.

Key Findings and Observations for Data-Driven Work Zone Process Reviews (continued)

- KYTC WZs experienced an average of 13.6 hours of delay per jam across the years from 2019 to 2021. KYTC WZ experienced 21, 14, and 9.5 hours of delay per jam in the years 2019, 2020, and 2021:
  - Although there were more crash jams in 2021 than other years, delay per jam was higher in 2019 and 2020. This was mainly due to the reduced 2021 WZ activity on I–75, which experienced 40 percent of the overall crash-jam-related delay across the years. Due to this reduced activity, there were fewer crash jams on I–75 WZs in 2021, which led to a considerable reduction in delay per jam.
  - Also, a majority of increase in 2021 crash jams occurred on interstate 264, where the average delay per jam was 6 hours, which is 63 percent less than the 16.3 hours of average jam delay on I–75.
  - During qualitative discussions with the project team, the KYTC WZ team concurred with the findings about the impact of I–75 on the overall crash delays.
- From a WZPR standpoint, KYTC can benefit from tracking additional WZ exposure metrics such VMT, VHT, and traffic volumes. These metrics will enable KYTC to validate qualitative observations such as changes in traffic demand and calculate more-comparable metrics across the years with a common frame of reference.

Application of Case Study Results to Future Work Zone Process Reviews

Results of the quantitative analyses conducted for the two performance areas provide KYTC with a basis to make decisions on how to focus efforts for future WZPRs. KYTC's WZPR team will use the case study results, supplemented by qualitative data and additional quantitative data sources, to implement a data-driven approach for conducting program-level WZPRs, as well as other follow-up activities.

Follow-Up Work Zone Process Review Activities

KYTC will leverage the findings from this case study to conduct follow-up WZPR activities, including:

- Establishing normalized safety performance measures (i.e., crashes per WZ, crashes per WZ VMT) to compare WZ safety performance across the years.
- Identifying undesirable and desirable trends in each performance area, as well as projects, issues, and improvements contributing to the trends.

- Conducting WZ committee and district meetings to collect contextual information (e.g., root cause identification, correlating factors, and issue identification) behind the trends identified from the data in each performance area.
- Identifying common issues observed at both State and district levels.
- Selecting and prioritizing issues to address during the next WZPR cycle.
- Identifying action items to address the prioritized issues.
- Selecting metrics for assessing the impact of the implemented action items.
- Establishing processes for collecting data required to calculate the metrics selected.

These activities are not an extensive or exhaustive list, nor are required under any FHWA regulation. KYTC will tailor and conduct the activities to suit its WZPR goals and objectives.

Lessons Learned

Lessons learned from the KYTC case study include:

- **State DOTs have access to data resources for different performance areas through their intra-agency data collection efforts.** A comprehensive data inventory of all data resources can enable State DOTs to select their internal performance measures for various WZ strategies and performance assessments based on available data sources.
- **Combining quantitative data trends with qualitative contextual information can lead to better root cause identification.** Neither quantitative trends nor qualitative contextual information alone depicts a complete picture of WZ issues; synthesizing them enables more-robust and more-pointed identification of root causes and potential solutions to issues.
- **Developing quantifiable metrics can enable continuous performance tracking of WZ processes and procedures.** Developing and implementing metrics for different WZM outcome areas may enable States to quantify the impact of identified issues through qualitative data assessments. Depending on the level of impact, States can prioritize the most-pressing issues. Further, these metrics may also help States to assess the effectiveness of implemented action items in resolving issues.
- **Emerging probe and crowdsourced data sources can be leveraged to establish a continuously evolving WZ safety and mobility assessment.** Such data can be used to perform a variety of safety and mobility assessments within and outside the realms of WZ performance. After the initial process of geolocating WZ projects with the safety and mobility measures, these data can be used to gain program-level insights and compare performances over time. Further, these data can provide granular context into the route segments that primarily contribute to the WZ performances and thereby identify noteworthy practices and areas for improvement. When tracked across years, these data can also be used to establish thresholds for safety and mobility performance metrics.
- **KYTC's detailed data collection and publication of WZ projects (e.g., project timeframe, routes, and length) enabled the project team to select the project boundaries and assign analysis parameters accurately.** Mapping the unique route identifiers with third-party TMC segment IDs may allow KYTC to gather additional mobility metrics such as VMT and VHT. Additionally, tracking projects by their activity may allow KYTC to assess the impact of each type of WZ activity on the safety and mobility of travelers.
- **KYTC can gain deeper safety insights by tracking and analyzing the detailed crash performance variations, severities, types, and contributing factors.** In addition to the existing best practices for data collection, KYTC can benefit from:
    - Analyzing deidentified crash data to understand the contributing factors behind increasing or decreasing crash patterns.
    - Digitizing safety and mobility strategies implemented and locations of implementation. These qualitative data can help KYTC to correlate and identify

the quantitative impacts of the implemented strategies and make data-driven validations to their leadership on the strategy impacts.

Appendix A: Case Study Team and Follow-Up Activities

Work Zone Process Review Case Study Review Team

In its 2015 WZPR guidance document[Error! Bookmark not defined.], FHWA recommends that State DOTs include representatives from various WZM areas in their WZPR teams (figure 10). The KYTC WZPR team comprises members from KYTC's Division of Traffic Operations, Division of Safety, Division of Construction, Division of Design, Division of Maintenance, and FHWA Division Office, as well as project engineers from KYTC districts. Together, this multidisciplinary team enables comprehensive decisionmaking for WZPRs by covering all aspects of WSM.

Division/Office Representatives States Can Include on Work Zone Process Review Team

Planning
Occupational (Worker) Safety
Construction Administration
Roadway/Project Design
Materials
Traffic Operations/Management
Traffic Safety
Permitting
Maintenance
District Staff (Resident, Areas, and District Engineers)
Training/Workforce Development
Public Information Office
Design Consultants
FHWA Division Office

Figure 10. List. Division/Office Representatives States Can Include on Work Zone Process Review Team.
Source: Federal Highway Administration.

Follow-Up from the 2020 Work Zone Process Review

During its 2020 WZPR, KYTC identified action items to:

- **Action Item No. 1:** Revise the KYTC WZ policy to update outdated terminology and define clear expectations:
  - **Status:** KYTC is currently working on updating the terminology.
- **Action Item No. 2:** Conduct more project reviews:
  - **Status:** KYTC conducted reviews for three projects in 2022.
- **Action Item No. 3:** Identify available data sources and data collection methods needed to develop measures of interest to the agency:
  - **Status:** KYTC plans to use the safety and mobility metrics identified through this data-driven WZPR case study to conduct performance reviews in subsequent cycles and establish performance thresholds.
- **Action Item No. 4:** Develop dashboards for two pilot projects that send notifications to the project engineer on the review areas and action items:

  - **Status:** KYTC developed a dashboard that sends email notifications to project engineers on traffic slowdowns, congestion summaries, and WZ crashes. Engineers can sign up to receive notifications by county. This dashboard uses crowdsourced data to generate slowdown and congestion notifications. TOC and TRIMARC reports are used to generate crash notifications.
- **Action Item No. 5:** KYTC and Kentucky Transportation Center to collaborate, review the courses offered, and discuss which courses can help increase roadway safety training. Use the FHWA Work Zone Safety Grant (through American Traffic Safety Services Association) to provide roadway safety training courses in the next 2 years:
  - **Status:** KYTC attempted to add a training course for designers. However, KYTC could not move forward with implementing this course due to limited interest from the designers.
- **Action Item No. 6:** Develop special notes on how to use temporary portable rumble strips and recommend policy for projects requiring the special notes:
  - **Status:** Since 2020, KYTC implemented rumble strips on some WZ projects but applied more focus on implementing queue protection systems based on the safety benefits offered by the queue protection systems. KYTC is planning to conduct research on both rumble strips and queue protection systems and use the research findings to develop policies that help identify the projects that would benefit from these technologies.
- **Action Item No. 7:** Investigate innovative technologies in work zone safety to determine if KYTC can benefit from their use:
  - **Status:** KYTC WZPR committee regularly reviews and discusses technology innovations that can benefit KYTC WZs.

For more information on FHWA's Work Zone Management Program, please visit: https://ops.fhwa.dot.gov/wz and https://www.workzonesafety.org/swz

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