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List of Abbreviations and Acronyms

DOT	Department of Transportation
FHWA	Federal Highway Administration
MoDOT	Missouri Department of Transportation
mph	miles per hour
vpd	vehicles per day

Abstract

Management of work zone speeds and ensuring driver compliance with work zone speed limits play an important role in reducing the number and severity of work zone crashes. The objective of this research study is to assess speeds driven by motorists in Missouri freeway work zones, including average speeds, 85th percentile speeds, maximum speeds, and levels of work zone speed limit compliance and noncompliance. The research methodology to meet this objective includes a literature review and field study to collect and measure work zone speed data. The field study included the measurement and analysis of speeds (with and without a work zone) for almost 5.5 million vehicles at five interstate work zones in Missouri. Probe data from HERE were also analyzed, and crashes corresponding to the dates and locations of the data collection were reviewed. Results from the literature review indicate that previous studies generally found various levels of speed limit compliance in work zones. The crash review identified four crashes across all sites during the data-collection period, with severities ranging from property-damage-only to a serious injury crash. One of the crashes, which resulted in a minor injury, was attributed to excessive speed. Overall, results from the analysis of field data and HERE data indicate prevalent speeding in Missouri work zones. While vehicle speeds were lower with the work zone compared to non-work zone conditions, speed variation with the work zone in place also increased. The presence of workers in the closed lane separated by channelizers on I-44 was associated with lower speeds and greater speed limit compliance. Possible strategies to reduce speeds and improve speed limit compliance in Missouri work zones could include law enforcement presence, speed feedback trailers, public outreach campaigns, and reviewing existing policies on setting work zone speed limits.

Executive Summary

Improving work zone safety is a major challenge faced by state departments of transportation (DOTs). Management of work zone speeds and ensuring driver compliance with work zone speed limits play an important role in reducing the number and severity of work zone crashes. Additional data on work zone speeds, especially speed limit compliance and higher levels of speeding, will help DOTs to focus their work zone speed enforcement efforts with the overall goal of reducing the number and severity of crashes in work zones.

The project objective is to assess speeds driven by motorists in Missouri freeway work zones, including average speeds, 85th percentile speeds, maximum speeds, and levels of work zone speed limit compliance and noncompliance. The research methodology to meet this objective includes a literature review and field study to collect and measure work zone speed data. Attainment of the project objective will help the Missouri Department of Transportation (MoDOT) make data-driven decisions on selecting the best Safe System strategies to improve speed limit compliance in work zones.

The field study included the measurement and analysis of speeds for almost 5.5 million vehicles at the following five interstate work zones in Missouri: I-70 (Kingdom City, Improve I-70 Project), I-70 (Rocheport, Bridge Replacement), I-70 (Warrenton, Improve I-70 Project), I-44 (Rolla/St. James, Pavement Repair), and I-55 (St. Louis, Bridge Rehabilitation). For the I-70 Warrenton and I-44 Rolla/St. James sites, non-work zone speed data were also collected. As shown in Table ES-1, the work zones encompass a wide range of characteristics with regard to factors such as work zone speed limit, non-work zone speed limit, type of work, lane closure configuration, lane width, presence of channelizers or barrier, and worker presence and location.

Table ES-1. Summary of site characteristics for work zone speed study.

Location	Work Zone (WZ) or Non-Work Zone (NWZ)	WZ Speed Limit / Non-WZ Speed Limit (mph)	Type of Work	Lane Closure	Lane Width (ft)	Channelizers (C) or Barrier (B)	Worker Presence / Location*
I-70 Kingdom City	WZ	55/70	Added travel lanes	None	10	B	PT / Median
I-70 Rocheport	WZ	60/70	Bridge replacement	None	12	None	N/ No workers near travel lanes
I-55 St. Louis	WZ	50/60	Bridge rehabilitation	4 to 2	11–11.5	B	PT / Opposing direction
I-55 St. Louis	WZ	50/60	Bridge rehabilitation	4 to 2	11–11.5	B	N/A
I-44 Rolla / St. James	WZ	50&60/60&70	Pavement repair	2 to 1	12	C	FT / Adjacent to travel lane
I-44 Rolla / St. James	NWZ	50&60/60&70	N/A	None	12	N/A	N/A
I-70 Warrenton	WZ	60/70	Added travel lanes	None	11–12	B	PT / Median, outside shoulder
I-70 Warrenton	NWZ	60/70	N/A	None	12	N/A	N/A

* FT = Workers Present (Full-time), N = Workers Not Present, PT = Workers Present (Part-time)

Data were collected continuously at different locations within the work zone (beginning, middle, end) using radar sensors, typically for two to four weeks per location. For I-70 in Kingdom City, the data collected included vehicle speeds in 5-mile per hour (mph) bins based on 2-minute intervals. For all other project sites, the collected datasets consisted of time stamp, individual speeds, and vehicle type (small, medium, or large). These data were analyzed to calculate various measures such as average speed, 85th percentile speed, maximum speed, standard deviation of speed, and speed limit compliance (including percentage of drivers exceeding the speed limit, percentage of drivers exceeding the speed limit plus 10 mph, and percentage of drivers exceeding the speed limit plus 20 mph). Speed standard deviation represents speed consistency; higher values indicate greater variability among vehicles and are associated with increased potential for crashes.

The following analyses of the field data were performed for each site:

- I-70 Kingdom City: work zone
- I-70 Rocheport: work zone
- I-70 Warrenton: work zone and non-work zone
- I-44 Rolla/St. James: work zone and non-work zone
- I-55 St. Louis: work zone (active work days – i.e., weekdays) and work zone (non-active work days – i.e., weekends and holidays)

Analyses were also conducted based on vehicle type and time of day. Vehicle types were grouped by size using FHWA vehicle classification, with small and medium vehicles corresponding to FHWA Classes 1-3 and large vehicles corresponding to FHWA Classes 4-12. Time periods were defined as daytime (5 AM to 9 PM) and nighttime (9 PM to 5 AM). The hours for daytime and nighttime were determined as an approximation based on 30 minutes before sunrise and 30 minutes after sunset.

To supplement the field data and further investigate speeds with and without the presence of a work zone, probe data from HERE were also analyzed for each project site. HERE data are based on segment travel times in 5-minute intervals, and HERE estimates a penetration rate of 15% for freeways.

Statistical tests were performed on both field and HERE data to determine if differences in average speeds, 85th percentile speeds, and standard deviation of speeds were statistically significant. In this report, all hypothesis tests were conducted at a 0.05 significance level.

Crash data for the work zone sites were also analyzed. The boundaries were established using the speed sensor deployment locations and corresponding HERE roadway segments for each study site, and each crash record within the defined spatial area was extracted for the period matching the speed monitoring duration. Each identified crash was reviewed for its type, severity, and primary contributing factor to determine whether the incident was related to work zone conditions, driver behavior, or external roadway factors. In addition, for crashes occurring during periods of active speed monitoring, the crash recovery time was measured.

The crash review identified four crashes across all sites during the data-collection period: two property-damage-only crashes, one minor-injury crash, and one serious-injury crash. The contributing circumstances for one of the crashes was identified as too fast for conditions. Contributing circumstances for the other crashes were improper load securement, improper lane change, and object in roadway. Across all monitored work zones, no significant changes in traffic speed or flow were observed around the time of the reported crashes, indicating that these incidents were isolated events and did not cause measurable impacts on overall work zone operations.

Results from the literature review indicate that previous studies generally found various levels of speed limit compliance in work zones. Countermeasures such as the use of law enforcement and speed display trailers have been shown to help reduce vehicle speeds in work zones.

The field study results are summarized in Table ES-2 and Table ES-3, followed by a discussion of site-specific and overall results.

Table ES-2. Overall summary of speed statistics by site and time period.

Site/Period	Posted Speed Limit (mph)	Average Speed (mph)	Standard Deviation of Speed (mph)	85th Percentile Speed (mph)	Maximum Speed (mph)	% Large Vehicles
I-70 Kingdom City	55	63.1	7.1	72.6	95-100	n/a
I-70 Rocheport	60	67.9	6.5	74	103	11.9
I-70 Warrenton (Non-Work Zone Period)	70	66.0	8.1	73	92	6.7
I-70 Warrenton (Work Zone Period)	60	63.0	8.8	70	92	9.0
I-44 Rolla Work Zone Period	50	50.7	10.9	61	85	6.4
I-44 St. James Work Zone Period	60	49.1	14.7	64	102	11.3
I-44 Rolla Non-Work Zone Period	60	66.3	7.2	73	101	7.7
I-44 St. James Non-Work Zone Period	70	69.8	6.8	76	105	10.4
I-55 St. Louis (Work Zone, Active Work Period)	50	59.1	7.4	65	99	6.6
I-55 St. Louis (Work Zone, Non-Active Work Period)	50	61.7	5.8	67	98	4.4

Table ES-3. Overall summary of work zone speed limit compliance statistics by site and time period.

Site / Period	Posted Speed Limit	Total Duration (hour)	Total Number of Vehicles	% Exceeding Speed Limit	% Exceeding Speed Limit +10	% Exceeding Speed Limit +20
I-70 Kingdom City	55	60.1	69,595	94.2	50.1	5.4
I-70 Rocheport	60	1069.7	827,132	89.9	33.7	1.5
I-70 Warrenton (Non-Work Zone Period)	70	456.3	217,083	27.7	0.5	0.0
I-70 Warrenton (Work Zone Period)	60	2343.9	1,038,904	73.0	13.8	0.2
I-44 Rolla Work Zone Period	50	142.2	105,551	58.6	17.0	1.5
I-44 St. James Work Zone Period	60	261.5	161,077	23.9	4.3	0.1
I-44 Rolla Non-Work Zone Period	60	713.1	616,215	84.5	25.7	0.7
I-44 St. James Non-Work Zone Period	70	450.6	356,757	50.6	2.7	0.0
I-55 St. Louis (Work Zone, Active Work Period)	50	926.7	1,164,389	91.6	44.8	3.2
I-55 St. Louis (Work Zone, Non-Active Work Period)	50	542.3	490,573	97.4	58.8	6.0

The results for each site from the field study and HERE data analysis are summarized as follows:

- I-70 Kingdom City:** There was prevalent speeding in both directions, with approximately 88-95% of drivers exceeding the work-zone speed limit of 55 mph. The average and 85th percentile speeds were lower in the eastbound direction, with an average speed of 62.1 mph and an 85th percentile speed of 72.4 mph, compared to 64.5 mph and 73.8 mph, respectively, in the westbound direction. Analysis of HERE data indicates that mean and the 85th percentile speeds were lower by approximately 8 mph and 6.45 mph, respectively, and speed variability was higher by 2.8 mph in 2025 with the work zone than in 2024 without the work zone.
- I-70 Rocheport:** There was pervasive speeding, with approximately 90% of drivers exceeding the work zone speed limit of 60 mph. The 85th percentile speeds ranged from 73–76 mph, which is at least 13–16 mph above the posted limit. Based on analysis of

HERE data, 2025 speeds (with the work zone) were similar to 2022 speeds (without the work zone), but there was significantly more speed variation by approximate 0.7 mph in 2025 with the work zone in place.

- **I-70 Warrenton:** Speeds exceeded the posted limits in both the non-work zone and work zone periods, with higher levels of speed limit compliance during the non-work zone period than the work zone period. During the work zone period, about 72-73% of vehicles exceeded the work zone speed limit of 60 mph. Average and 85th percentile speeds during the work zone period were lower than during the non-work zone period by 3 mph respectively, but speed variability was higher by 0.7 mph during the work zone period. In addition, analysis of HERE data indicated that average and 85th percentile 2025 speeds (with the work zone) were significantly lower by 2 mph than 2024 speeds (no work zone), but there was significantly more speed variation of 3.7 mph in 2025 with the work zone in place.
- **I-44 Rolla/St. James:** During the work zone period, mean speeds dropped to the 50–52 mph range at Rolla and 48–51 mph at St. James, with more pronounced midday slowdowns. Based on field data for both Rolla and St. James, mean and 85th percentile speeds were lower during the work zone period than during the non-work zone period. At Rolla, the mean speed decreased by 15.4 mph and the 85th percentile speed decreased by 12 mph, while at St. James the corresponding decreases were 20.7 mph and 12 mph. In contrast, speed variation was higher during the work zone period by 3.8 mph at Rolla and 7.9 mph at St. James. Analysis of HERE data for Rolla did not find statistically significant differences in speed and speed variability between the 50-mph work zone speed limit and the 60-mph speed limit with no work zone present.
- **I-55 St. Louis:** There was pervasive speeding, with over 90% of drivers exceeding the work zone speed limit of 50 mph during both the work zone (active work) and work zone (non-active work) periods. Average speeds and 85th percentile speeds were significantly lower by 2.6 mph and 2 mph in the active work period than in the non-active work period, and speed variation was significantly higher by 1.6 mph in the active work period. Based on analysis of HERE data, mean speeds and 85th percentile speeds were significantly lower near the work area (posted speed limit 50 mph) than on the adjacent upstream segment within the work zone (posted speed limit 55 mph) by approximately 6.5 mph and 5.9 mph. Speed variation was significantly higher near the work area by 0.7 mph.

Overall results from the analysis of field data and HERE data are summarized as follows:

- Across all sites, a large majority of drivers exceeded posted work zone limits, often by more than 10 mph. In some locations, over 90% of vehicles were speeding.
- The maximum speed recorded across all sites with a work zone present was 103 mph. All sites saw a maximum speed of at least 85 mph.
- Speeds were lower with the work zone in place than during non-work zone conditions. However, work zones introduced greater fluctuations in speeds, especially compared with normal freeway conditions.

- With the exception of I-44 Rolla (with workers in the closed lane separated by channelizers), less compliance was observed with stricter posted speed limits (e.g., 50–55 mph zones).
- Vehicles tended to slow through the middle of work zones, with upstream sections having the highest speeds and midpoints the lowest.
- Small/medium vehicles consistently drove faster than large trucks, usually by 2–4 mph. Speeding was also prevalent among large trucks, especially under work zone conditions.
- Compliance improved when workers were visible near the travel lanes. The I-44 work zone (with workers in the closed lane separated by channelizers) had the highest work zone speed limit compliance of all the work zones studied in this research.
- Other work zone characteristics (e.g., lane width, lane configuration, barrier versus channelizers) did not seem to influence drivers' speeds.
- With the exception of I-55 St. Louis (which experienced slower speeds during the morning peak), speeds were generally lower during nighttime than during daytime. This result could potentially be due to drivers being more cautious when traveling through work zones at nighttime.

Overall, the results indicate prevalent speeding in Missouri work zones. While vehicle speeds were lower with the work zone compared to non-work zone conditions, speed variation with the work zone in place also increased. The presence of workers in the closed lane separated by channelizers on I-44 was associated with lower speeds and greater speed limit compliance. Possible strategies to reduce speeds and improve speed limit compliance in Missouri work zones could include law enforcement presence, speed feedback trailers, public outreach campaigns, and reviewing existing policies on setting work zone speed limits.

1. Introduction

Improving work zone safety is a major challenge faced by state departments of transportation (DOTs). In 2023, there were 33 fatalities in Missouri work zones (Missouri Department of Transportation (MoDOT) 2025). Management of work zone speeds and ensuring driver compliance with work zone speed limits play an important role in reducing the number and severity of work zone crashes. A 2022 study of various work zone speed countermeasures on I-270 in St. Louis found that 93% of drivers exceeded the work zone speed limit, and 60% of drivers exceeded the work zone speed limit by at least 10 miles per hour (mph) (Brown et al. 2022). Additional data on work zone speeds in Missouri, especially speed limit compliance and higher levels of speeding, will help MoDOT to focus its work zone speed enforcement efforts with the overall goal of reducing the number and severity of crashes in Missouri work zones.

1.1 Project Objective

The project objective is to assess speeds driven by motorists in Missouri freeway work zones, including average speeds, 85th percentile speeds, maximum speeds, and levels of work zone speed limit compliance and noncompliance. The research methodology to meet this objective includes a literature review and field study to collect and measure work zone speed data. Attainment of the project objective will help MoDOT make data-driven decisions on selecting the best Safe System strategies to improve speed limit compliance in work zones.

1.2 Report Overview

This report is organized as follows:

- Chapter 1: Introduction
- Chapter 2: Literature Review
- Chapter 3: Study Methodology
- Chapter 4: I-70 Kingdom City
- Chapter 5: I-70 Rocheport
- Chapter 6: I-70 Warrenton
- Chapter 7: I-44 Rolla/St. James
- Chapter 8: I-55 St. Louis
- Chapter 9: Conclusions

2. Literature Review

This chapter provides an overview of the existing literature regarding speed limit compliance, setting work zone speed limits, and speed countermeasures.

2.1 Speed Limit Compliance and Setting Speed Limits

Prior research studies have generally found low levels of compliance with speed limits in work zones. For example, results from a field study of an 8-mile interstate work zone to add a lane in Tennessee found that more than 75% of drivers exceeded the posted speed limit of 55 mph without any speed feedback countermeasures in place (Neupane et al. 2025). The study utilized computer vision-based tracking to continuously track vehicle speeds. The Tennessee study also found higher levels of noncompliance with the speed limit for the inside lane, on weekends, during clear weather, and for vehicles following a passenger car. In addition, passenger cars had higher levels of noncompliance with the speed limit than trucks.

A previously completed Missouri study of work zone speed countermeasures included a field study of I-270 in St. Louis, driving simulator study, and driver survey (Brown et al. 2022). Results from the field study indicated an overall compliance rate of 7.2% across all scenarios with and without work zone speed countermeasures. Results from the simulator study showed the greatest speed reductions near the countermeasures. In the driver survey, respondents indicated that the presence of active work was the factor that most influenced their speed choice in work zones, followed by presence of law enforcement, visibility/weather, and work zone speed limit.

A field study in Wisconsin investigated speed limit compliance at 36 work zone sites with various permanent posted speed limits ranging from 25–70 mph (Schoon 2016). There was a speed reduction at 19 of the 36 sites (three of them were permanent reductions), while there was no speed reduction at 11 sites, and a permanent speed increase (suburban to rural) at five sites. Overall results showed compliance within 5 mph of the work zone speed limit for 27 of the 36 sites. Six of the nine sites that did not get compliance within 5 mph of the work zone speed limit had a speed limit reduction of 15 mph. Most projects with speed limit reductions from 70 mph to 55 mph did not have speeds under 60 mph, even with concrete barrier. Two projects with speed limit drops from 70 mph to 55 mph resulted in compliance within 5 mph of the work zone speed limit. Both of these sites included a lane closure, shoulder restrictions, workers present within 6 feet of traffic, and no concrete barrier wall.

An Oregon study investigated speed variation in work zones (Gambatese and Jin 2021). Researchers analyzed data from two sources: archived data collected using traffic sensors (see Figure 2-1) on five previous Oregon work zone projects and HERE data when there was no work zone present. Overall, results showed higher speed variation with a work zone than prior to the work zone or without the presence of a work zone. An example plot of 5-minute standard deviation distributions at different locations in the work zone is shown in Figure 2-2. Researchers also reviewed crash data, but a connection between speed variation and crashes

could not be established due to the limited availability of crash data with or without a work zone present.

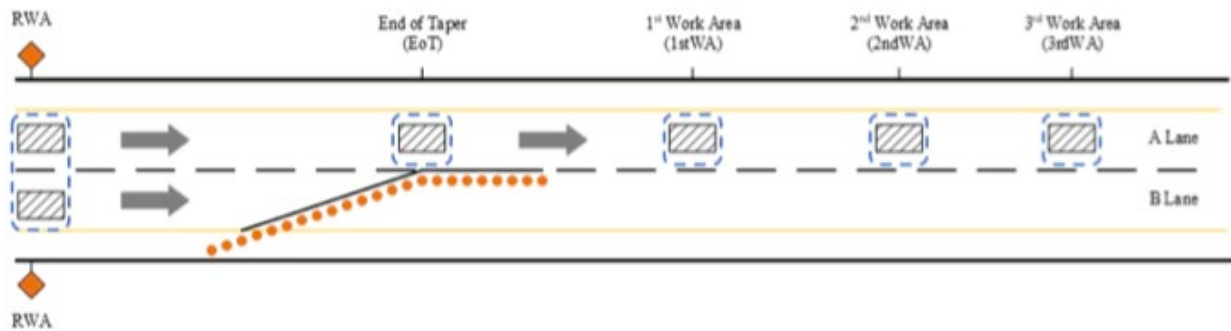


Figure 2-1. Layout of sensors for analysis by work zone location in Oregon study (Gambatese and Jin 2021).

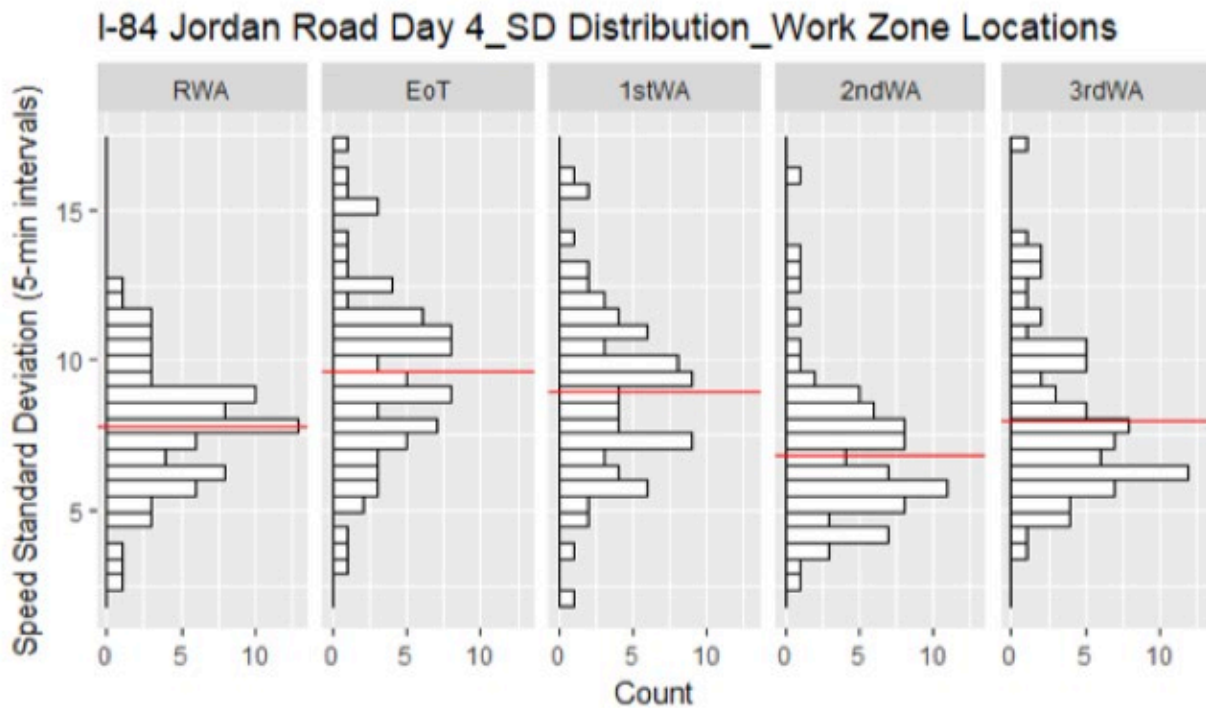


Figure 2-2. Example plot of 5-minute speed standard deviation distribution for Oregon (Gambatese and Jin 2021).

In a Texas study, field data were collected from 12 work zones during the daytime (Finley et al. 2008). Findings indicated that while drivers generally reduced their speeds, the magnitude of speed reduction varied based on the operating speed during non-work zone conditions. Results from a driver survey conducted as part of the study indicated that 43% of drivers said (as an open-ended answer) that they would slow down in a work zone if workers were present. Researchers in the Texas study suggested maximum speed limit reductions of 5 mph (shoulder activity and lane encroachment) and 10 mph (lane closures and temporary diversions). Researchers indicated that use of speed reductions should be limited for existing speed limits

less than 65 mph unless there are lane closures with workers in the closed lane without the use of temporary barrier.

In an Iowa study, speed data were collected from nine work zones (Sharma et al. 2017). Findings indicated reduced speeds with the use of work zone speed limits. The use of a 10-mph speed limit reduction on roadways with existing speed limits of 65 mph was associated with the greatest speed reductions.

A Pennsylvania study evaluated data from 4,008 work zones during a three-year period (Zhang et al. 2023). Researchers found the work zone presence was associated with crash potential, with speed being a factor associated with higher crash occurrences when the actual speed was at least 55 mph. Findings indicated that strict enforcement of speed limits when speeds are more than 55 mph could potentially help to reduce work zone crashes, especially with high traffic volumes (more than 20,000 vehicles per day) on long (more than 3,000 meters) daytime work zones.

A Federal Highway Administration (FHWA) pooled fund study included a literature review and DOT survey regarding practices for setting work zone speed limits (Savolainen et al. 2022). Findings indicated that site characteristics taken into account when setting work zone speed limits include permanent speed limit, facility type, presence of workers, duration of work, and type and location of work activity. In addition, the most commonly implemented work zone speed limit reduction on high-speed (50 mph or more) roadways is 10 mph.

2.2 Work Zone Speed Countermeasures

The previously completed Missouri study investigated the effectiveness of various work zone speed countermeasures, including speed feedback trailers (with and without red and blue lights), presence of active and passive law enforcement, and work vehicle with red and blue lights (Brown et al. 2022). Results showed that all countermeasures led to speed reductions in the work zone, with law enforcement presence generally leading to the highest level of speed reduction.

The Tennessee speed study investigated the effects of various speed feedback messaging on vehicle speeds (Neupane et al. 2025). Results indicated that the dynamic speed feedback system (“YOUR SPEED XX”) had the greatest influence on reducing speeds, with a 51% decrease in higher-order (more than 15 mph over the posted work zone speed limit) speed violations.

In the Oregon study, researchers investigated the effects of the following work zone speed countermeasures on speed variation: pace car, portable changeable message sign (PCMS) with custom messages such as “MAINTAIN CONSTANT SPEED / THRU WORKZONE,” combination of pace car and PCMS, and combination of PCMS and flashing amber/white lights on paving equipment (Gambatese and Jin 2021). Findings indicated that the PCMS reduced speed variation in the work zone (decrease in 5-minute standard deviation ranging from 0.8–2.5 mph). In addition, the combination of PCMS and pace car led to greater reductions in speed variation in the active work area than single treatments.

The FHWA pooled fund study by Savolainen et al. (2022) found that, based on DOT survey results, higher fines for speeding in work zones and lights on contractor or maintenance vehicles are the most often used strategies for work zone speed management. The study also included field assessments of speed feedback trailers and law enforcement presence in Michigan. Results showed that that the speed reduction using speed feedback trailers was greatest near the speed feedback trailer. The visible presence of law enforcement led to work zone speed reductions of 5–7 mph.

3. Study Methodology

This chapter provides an overview of the methodology for the field study, analysis of crash data, and analysis of HERE data.

3.1 Methodology for Field Study

The field study included the measurement and analysis of speeds for almost 5.5 million vehicles at the following five interstate work zones in Missouri: I-70 (Kingdom City, Improve I-70 Project), I-70 (Rocheport, Bridge Replacement), I-70 (Warrenton, Improve I-70 Project), I-44 (Rolla/St. James, Pavement Repair), and I-55 (St. Louis, Bridge Rehabilitation). For the I-70 Warrenton and I-44 Rolla/St. James sites, non-work zone speed data were also collected. As shown in Table 3-1, the work zones encompass a wide range of characteristics with regard to factors such as work zone speed limit, non-work zone speed limit, type of work, lane closure configuration, lane width, presence of channelizers or barrier, and worker presence and location.

Table 3-1. Summary of site characteristics for work zone speed study.

Location	Work Zone (WZ) or Non-Work Zone (NWZ)	WZ Speed Limit / Non-WZ Speed Limit (mph)	Type of Work	Lane Closure	Lane Width (ft)	Channelizers (C) or Barrier (B)	Worker Presence / Location*
I-70 Kingdom City	WZ	55/70	Added travel lanes	None	10	B	PT / Median
I-70 Rocheport	WZ	60/70	Bridge replacement	None	12	None	N/ No workers near travel lanes
I-55 St. Louis	WZ	50/60	Bridge rehabilitation	4 to 2	11–11.5	B	PT / Opposing direction
I-55 St. Louis	WZ	50/60	Bridge rehabilitation	4 to 2	11–11.5	B	N/A
I-44 Rolla / St. James	WZ	50&60/60&70	Pavement repair	2 to 1	12	C	FT / Adjacent to travel lane
I-44 Rolla / St. James	NWZ	50&60/60&70	N/A	None	12	N/A	N/A
I-70 Warrenton	WZ	60/70	Added travel lanes	None	11–12	B	PT / Median, outside shoulder
I-70 Warrenton	NWZ	60/70	N/A	None	12	N/A	N/A

* FT = Workers Present (Full-time), N = Workers Not Present, PT = Workers Present (Part-time)

Data were collected continuously at different locations within the work zone (beginning, middle, end) using radar sensors, typically for two to four weeks per location. Two different types of sensors were utilized. The iCone was used to collect data for I-70 Kingdom City, while the Houston Radar Armadillo Tracker was utilized to collect data for the other sites.

The iCone traffic sensor (manufactured by iCone Products LLC) uses Doppler radar technology to measure the speed of vehicles passing the sensor (iCone Products LLC n.d.). Data output from the iCone includes vehicle speeds in 5-mph bins based on 2-minute intervals. The iCone is designed for work zone monitoring and includes GPS and cellular communication for automatic location tracking and remote data transfer. The lightweight unit can be quickly attached to roadside signs or utility posts, allowing for easy setup and relocation with minimal disruption to

traffic. Each sensor was powered by an external rechargeable battery and configured to record speed data continuously during active work periods.

The second type of device used was the Houston Radar Armadillo Tracker, which also employs Doppler radar technology to measure vehicle speeds without requiring any equipment to be placed in the travel lanes (Houston Radar 2025). Data output for the Armadillo consists of time stamp, individual speeds, and vehicle type (small, medium, or large). The Armadillo units can record traffic data from multiple lanes and in both directions, providing detailed vehicle-by-vehicle information. Each unit is equipped with internal memory capable of storing over 300,000 vehicle records and is powered by a built-in rechargeable battery that supports more than two weeks of continuous operation. While the units do not have cellular communication capability, data can be downloaded using Bluetooth or through a direct USB connection. All traffic sensors were mounted on portable roadside supports and positioned on shoulders or medians to allow for safe installation and removal without disrupting traffic.

Furthermore, for the Armadillo sensor, vehicles were classified using the sensor-defined categories, which align with the FHWA classifications (FHWA 2016). Specifically, the small class refers to vehicles typically shorter than 14 feet (corresponding to FHWA Class 1); the medium class includes vehicles ranging from 14–20 feet in length (corresponding to FHWA Classes 2 and 3); and the large class includes vehicles longer than 20 feet (corresponding to FHWA Classes 4 through 12). In practice, the small and medium categories are often difficult to distinguish accurately during data collection. Therefore, they were combined into a single category for the purposes of this analysis.

The collected data were analyzed to calculate various measures such as average speed, 85th percentile speed, maximum speed, standard deviation of speed, and speed limit compliance (including percentage of drivers exceeding the speed limit, percentage of drivers exceeding the speed limit plus 10 mph, and percentage of drivers exceeding the speed limit plus 20 mph). Average speed represents the central tendency of vehicle operating speeds and provides a general indication of overall traffic behavior. The 85th percentile speed reflects the speed at or below which most drivers travel and is commonly used to characterize prevailing operating conditions and driver speed choice. Maximum speed captures extreme speeding behavior. Speed limit compliance was evaluated using the percentage of drivers exceeding the posted speed limit, as well as the percentages exceeding the speed limit by more than 10 mph and more than 20 mph, to distinguish moderate from excessive speeding behavior. The standard deviation of speed was used as an indicator of speed variability, with higher values reflecting greater dispersion in vehicle speeds and reduced speed consistency. For example, a standard deviation of 5 mph with an average speed of 50 mph indicates that approximately 68% of vehicle speeds fall between 45 and 55 mph, reflecting noticeable variation around the mean. Work zones aim to promote speed uniformity, gradual transitions, and minimal speed differentials; increased speed variability therefore reflects conditions associated with elevated crash potential and the need for improved speed management (FHWA 2023).

Analyses were also conducted based on vehicle type (small and medium versus large) and daytime versus nighttime. The hours for daytime (5 AM to 9 PM) and nighttime (9 PM to 5 AM) were determined as an approximation based on 30 minutes before sunrise and 30 minutes after sunset.

The following analyses of the field data were performed for each site:

- I-70 (Kingdom City): work zone
- I-70 (Rocheport): work zone
- I-70 (Warrenton): work zone and non-work zone
- I-44 (Rolla/St. James): work zone and non-work zone
- I-55 St. Louis: work zone (active work days – i.e., weekdays) and work zone (non-active work days – i.e., weekends and holidays)

3.2 Methodology for Analysis of HERE Data

To supplement the field data and further investigate speeds with and without the presence of a work zone, probe data from HERE were also analyzed for each project site. HERE data is based on segment travel times in five-minute intervals, and HERE estimates a penetration rate of 15% for freeways. HERE segments were selected to overlap with the sensor locations, and the dates corresponded to the dates of the data collection. In addition, historical HERE data (before the work zone was implemented) were also analyzed for most sites. For I-55, HERE data from an adjacent segment were analyzed because historical data were not available.

3.3 Methodology for Statistical Analyses

Statistical analyses were conducted to evaluate whether observed differences in speed characteristics (mean speed, 85th percentile speed, and standard deviation of speed) between study periods were statistically significant for both field data and HERE data. All hypothesis tests were performed using a significance level of 0.05.

A two-sample t-test was used to assess differences in mean vehicle speed between the study periods. This test evaluates whether average speeds from two independent samples differ beyond what would be expected due to random variability (Moore et al., 2017). Given the large sample sizes associated with speed data, the assumptions of independence and approximate normality of the sampling distribution of the mean were considered reasonable. A p-value less than 0.05 indicates that the difference in average speed between periods represents a meaningful change, where a p-value greater than 0.05 indicates that the observed difference is not statistically significant and may be attributed to random variability.

An F-test was used to compare speed variability between periods by examining the ratio of speed variances. The F value represents how much larger the variability is in one period relative to the other (Moore et al., 2017). For example, an F value of 1.20 indicates that speed variability is approximately 20 percent higher in one period, while larger F values indicate greater differences in variability. A p-value less than 0.05 associated with the F-test indicates

that the difference in variability is statistically significant. A statistically significant result means that the observed difference in variability reflects a real and meaningful change between periods.

In addition, a quantile test was applied to compare the 85th percentile speed between periods. This test focuses on changes in the upper portion of the speed distribution and is useful for assessing how higher-end operating speeds differ between conditions, which may not be fully reflected by average speed alone.

Together, these statistical tests provide a comprehensive assessment of changes in overall speed levels, speed variability, and higher-end speeding behavior associated with work zone conditions.

3.4 Methodology for Analysis of Crash Data

The crash review process began with spatial filtering to define the geographic limits of each work zone. The boundaries were established using the speed sensor deployment locations and corresponding HERE roadway segments for each study site. This approach ensured that only crashes occurring within or immediately adjacent to the monitored roadway segments were included in the analysis. Crash data were then retrieved from the MoDOT Crash Map platform, which compiles statewide law enforcement crash reports containing detailed attributes such as date and time, mile marker, GPS coordinates, crash type, injury severity, and contributing circumstances. Each crash record within the defined spatial area was extracted for the period matching the speed monitoring duration.

Each identified crash was reviewed for its type, severity, and primary contributing factor to determine whether the incident was related to work zone conditions, driver behavior, or external roadway factors. In addition, for crashes occurring during periods of active speed monitoring, the crash recovery time was measured. This metric represents the elapsed time between the reported crash event and the point at which average traffic speeds returned to their pre-crash levels, providing an indication of how quickly normal traffic conditions were restored following an incident.

4. I-70 Kingdom City

This chapter presents the methodology and results for the field study for I-70 in Kingdom City, Missouri.

4.1 I-70 Kingdom City: Site Overview

A single iCone traffic sensor was deployed to collect traffic speed data within the I-70 Kingdom City work zone. The work zone speed limit was 55 mph with a non-work zone speed limit of 70 mph. The sensor was non-intrusively mounted and operated sequentially at two locations (Table 4-1). As shown in Table 4-1 it was first installed at Location A on the eastbound shoulder at the mile marker 143.0 for approximately two weeks. Following this period, the same device was relocated to Location B in the median for another two weeks to capture westbound traffic speeds. At Location A, the unit was placed on the shoulder with GPS coordinates at 38.951974, -92.032267, while at Location B it was attached to a temporary camera post positioned in the median at 38.954020, -92.142150. The iCone sensor was powered by a battery station during both deployments. However, the battery unit at Location A was stolen during the data collection period, resulting in partial data loss. At Location B, the sensor experienced temporary misalignment due to strong winds affecting the stability of the non-permanent mounting post. Figure 4-1 illustrates the sensor locations within the work zone.

Table 4-1 Data collection period for I-70 Kingdom City.

City	Location	Start Time	End Time	Duration	Mile Marker
Kingdom City (eastbound)	A	March 11, 1:05 PM	March 11, 9:15 PM	8 hours	143.0
Kingdom City (westbound)	B	March 24, 1:23 PM	April 10, 11:53 AM	52 hours	137.2



Figure 4-1. Sensor setup at the I-70 Kingdom City work zone.

4.2 I-70 Kingdom City: Results from Field Study

Speed data were collected at two locations within the I-70 Kingdom City work zone using iCone Doppler radar sensors. At the Location A, the external battery was stolen during the monitoring period, resulting in a shortened dataset. As a result, valid data was obtained only on March 11, between 1:05 PM and 9:15 PM, covering 10,307 vehicles. Analysis of the collected data indicated an average speed of 62.13 mph, which exceeds the posted work zone speed limit (55 mph). The 85th percentile speed was 72.4 mph. In addition, 87.5% of vehicles (9,029 vehicles) were traveling above the posted speed limit, 37.8% (3,897 vehicles) exceeded the limit by more than 10 mph, and 3.3% (340 vehicles) exceeded the limit by more than 20 mph. These results indicate a high level of non-compliance with the temporary speed reduction within the monitored area. The speed distribution for Location A is shown in Figure 4-2.

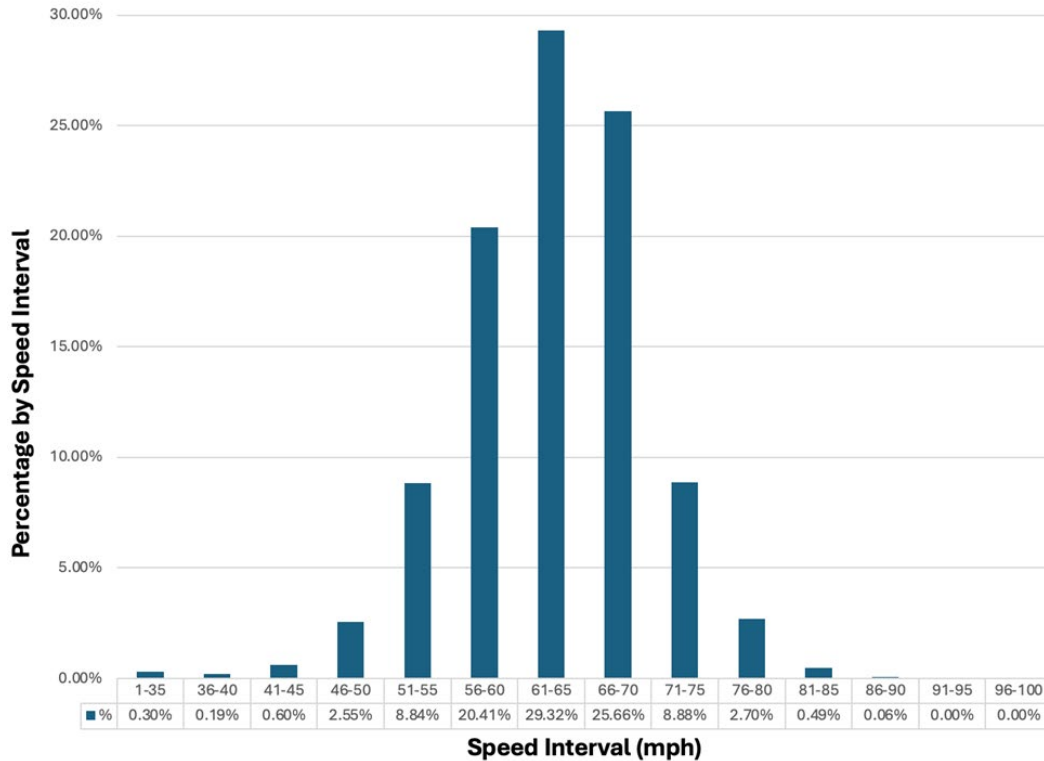


Figure 4-2 Speed distribution for Location A, I-70 Kingdom City.

At Location B, data were successfully collected on March 24, March 30, and April 2 through April 4, totaling approximately 52 hours of observation. During this period, a total of 59,288 vehicles were recorded, with an average speed of 64.54 mph and 85th percentile speed of 73.8 mph. The data show that 95.4% of drivers (56,572 vehicles) exceeded the work zone speed limit, 52.2% (30,960 vehicles) were traveling more than 10 mph above the limit, and 5.8% (3,438 vehicles) were traveling more than 20 mph over the limit. Similar to Location A, these findings reflect a consistent pattern of speed non-compliance. The speed distribution for Location B is shown in Figure 4-3.

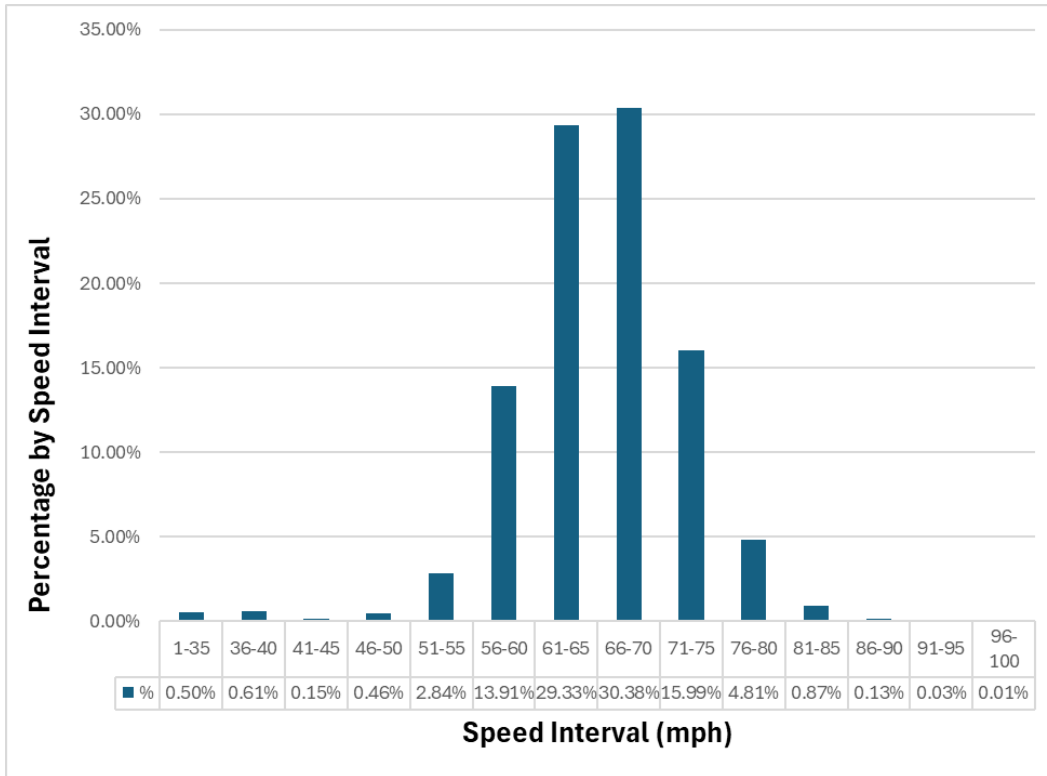
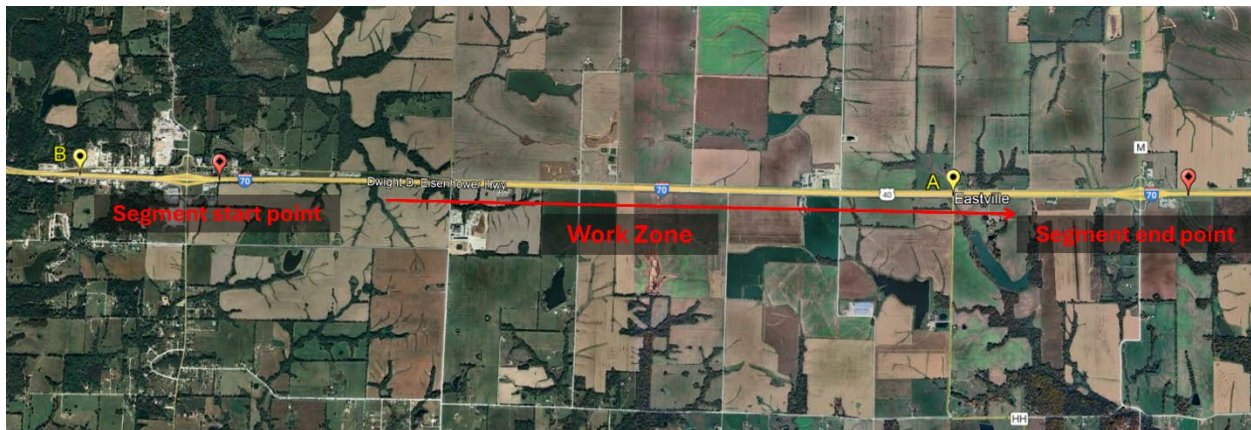


Figure 4-3 Speed distribution for Location B, I-70 Kingdom City.

4.3 I-70 Kingdom City: Results from Analysis of HERE Data

As shown in Figure 4-4, the limits of the HERE segment for I-70 Kingdom City encompassed both sensors. HERE data were extracted from March 11 to March 24, 2025 (same dates as sensors were in place) and from March 11 to March 24, 2024 (historical dates before the work zone installation).



(Imagery © 2025 Airbus, Landsat / Copernicus, Maxar Technologies, Map data © 2025 Google)

Figure 4-4. Aerial showing HERE segment and speed sensors for I-70 Kingdom City.

The results for speed distribution are shown in Figure 4-5, and the cumulative speed distributions are shown in Figure 4-6. The results indicate that the mean speed in 2025 was 8 mph lower than the mean speed in 2024, while the standard deviation increased from 2.05 mph to 4.85 mph, reflecting both reduced average speeds and greater variability in 2025.

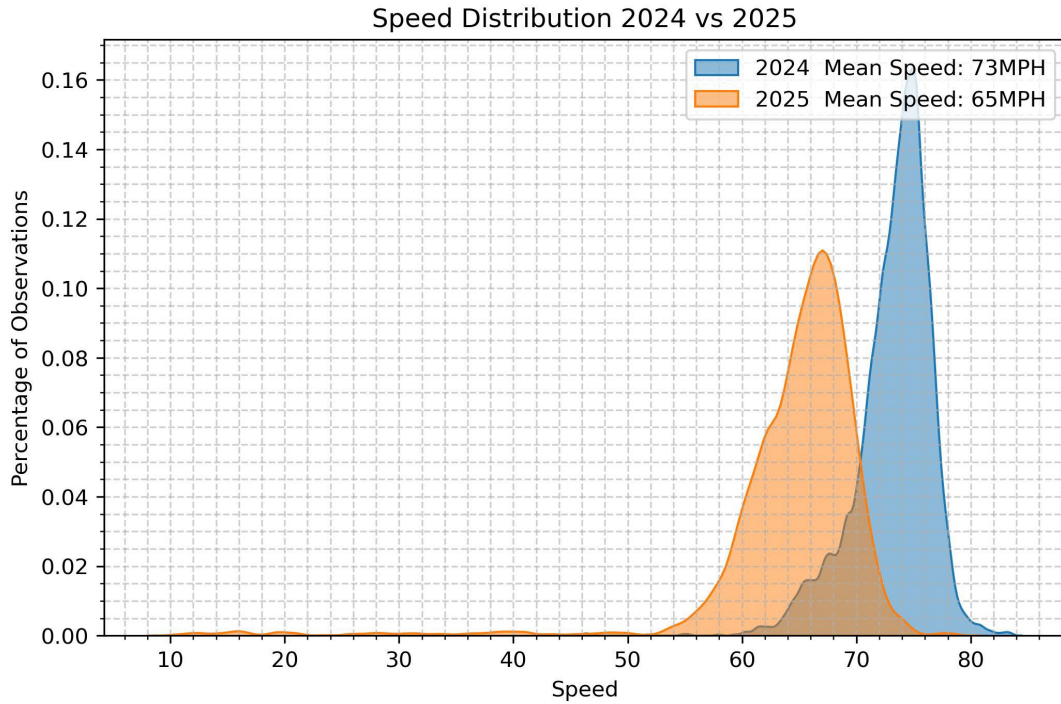


Figure 4-5. Speed distributions for 2024 and 2025 HERE data for I-70 Kingdom City.

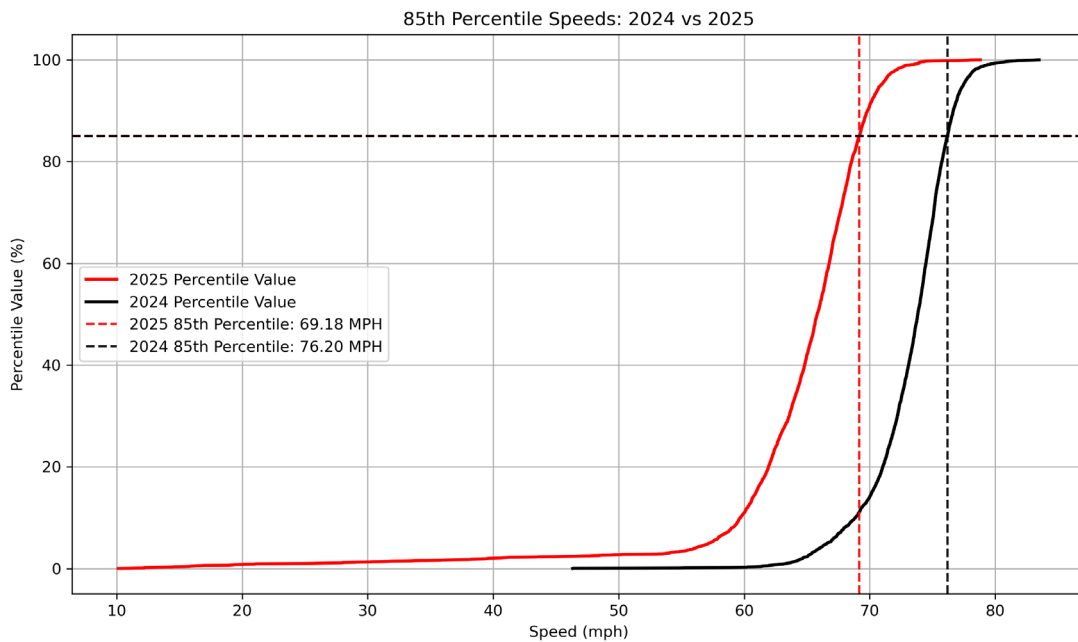


Figure 4-6. Cumulative speed distributions for 2024 and 2025 HERE data for I-70 Kingdom City.

Statistical analyses were conducted to evaluate the significance of the observed differences between the two periods. The two-sample t-test indicated a significant reduction in mean speed during 2025 ($t = -28.37$, $p < 0.001$) by 8 mph. The F-test further confirmed that the increase in speed variability was statistically significant ($F = 5.58$, $p < 0.001$) by 2.8 mph. In addition, the 85th percentile quantile test showed a significant decrease of 6.45 mph ($p < 0.001$), indicating that high-end speed levels were also lower in 2025. Overall, the results demonstrate statistically significant declines in both average and upper-tail speeds, accompanied by higher variability in 2025. The detailed results of the statistical tests are presented in Table 4-2.

Table 4-2. Statistical comparison of speed characteristics between work zone and non-work zone periods for HERE data for I-70 Kingdom City.

Test	What it Tests	Significance Level	Test Result	Difference	Key Finding
t-test	Difference in Average Speed	0.05	$t=-28.37$, $p<0.001$	-8 mph	Mean speed significantly lower by 8 mph during construction
F-test	Difference in Speed Variability	0.05	$F=5.58$, $p<0.001$	2.8 mph	Speed variability significantly higher by 2.8 mph during construction
Quantile test	Difference in the 85 th Percentile Speed	0.05	$\Delta=-$ 6.45mph, $p<0.001$	-6.45 mph	Significant, fast-driver speeds lower by 6.45 mph during construction

The speed limit compliance results for the HERE data are shown in Table 4-3. The results indicate a lack of compliance with the 55-mph speed limit in 2025, with nearly 90% of observations exceeding the speed limit by 5 mph.

Table 4-3. Summary of HERE speed limit compliance results for I-70 Kingdom City.

Exceeding Speed Limit By	2024 (Speed Limit = 70 mph)	2025 (Speed Limit = 55 mph)
5 mph	31.8 %	89.1 %
10 mph	0.7 %	57.9 %
15 mph	0.0 %	8.9 %
20 mph	0.0 %	0.3 %

4.4 I-70 Kingdom City: Results from Analysis of Crash Data

The crash data obtained from the MoDOT Crash Map platform was reviewed for the I-70 Kingdom City work zone. The dataset was refined to include only crashes that occurred within the speed monitoring limits and during the corresponding monitoring periods. The monitored area was defined as the roadway segment extending from the nearest upstream interchange to the nearest downstream interchange from the sensor locations. However, due to the limited duration of sensor deployment, no crashes were recorded within the monitored areas while the sensors were actively collecting data. As a result, no detailed crash data analysis was conducted for this site.

4.5 I-70 Kingdom City: Summary of Results

Overall speed statistics for I-70 Kingdom City are shown in Table 4-4, and overall speed limit compliance results are shown in Table 4-5. The I-70 Kingdom City results are summarized below.

- There was prevalent speeding, with approximately 88–95% of drivers exceeding the work-zone speed limit of 55 mph.
- The average speeds ranged from 62 to 65 mph, with standard deviations of 7.1–7.2 mph, indicating consistent and elevated travel speeds throughout the monitored periods.
- The 85th percentile speeds were 72.4 mph at Location A and 73.1 mph at Location B, or 17–18 mph above the posted work-zone speed limit.
- The data indicates a persistent pattern of speeding in both directions.

Table 4-4. Overall summary of speed statistics for I-70 Kingdom City.

Location	Posted Speed Limit (mph)	Average Speed (mph)	Standard Deviation of Speed (mph)	85th Percentile Speed (mph)
Location A (eastbound)	55	62.1	7.1	72.4
Location B (westbound)	55	64.5	7.2	73.1
All	55	63.1	7.1	72.6

Table 4-5. Overall summary of speed limit compliance results for I-70 Kingdom City.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
Location A (eastbound)	55	10307	1113	87.5	481	37.8	42	3.3
Location B (westbound)	55	59288	1088	95.4	595	52.2	66	5.8
All	55	68595	1091	94.2	580	50.1	63	5.4

5. I-70 Rocheport

This chapter presents the methodology and results for the speed study on I-70 in Rocheport, Missouri.

5.1 I-70 Rocheport: Study Overview

5.1.1 I-70 Rocheport: Site Overview

Data were collected at a work zone on I-70 eastbound in Rocheport from April 15 to May 6, 2025. This work zone involved a bridge replacement over the Missouri River with a work zone speed limit of 60 mph. Construction began in 2022, and the non-work zone speed limit on this section of I-70 is 70 mph. During the time period of the data collection, there were no lane closures in place. Lane widths were 12 feet, and there was a speed feedback trailer in place on eastbound I-70. Workers were not present near the travel lanes during the time period of the data collection, as there was no paving, and the data collection took place towards the end of the project.

5.1.2 I-70 Rocheport: Experimental Setup

A total of three Armadillo traffic sensors were deployed to collect vehicle speed data within the I-70 Rocheport work zone. As shown in Figure 5-1, the sensors—designated as Locations A, B, and C—were installed along the eastbound direction within the active work zone limits. Location A near the downstream end, Location C was positioned near the upstream end of the monitored segment, and Location B approximately at the midpoint between them. The distance between Locations A and B was approximately 1.12 miles, and between Locations B and C was 1.12 miles, providing continuous coverage throughout the corridor. Figure 5-2 illustrates the Armadillo sensor mounted at Location B.



(Imagery © 2025 Airbus, Landsat / Copernicus, Maxar Technologies, Map data © 2025 Google)

Figure 5-1. Sensor layout for I-70 Rocheport.



Figure 5-2. Sensor mounted at Location B for I-70 Rocheport.

The data collection period of each location are listed as follows:

- Location A (38.9612993, -92.5422806): Data were collected from 2:40 PM on April 15 to 12:49 PM on May 6, resulting in approximately 20 days, 22 hours, and 18 minutes of observations.
- Location B (38.9509064, -92.5585964): Data collection at Location B occurred in two segments due to a sensor battery issue, from 3:01 PM on April 15 to 5:16 PM on April 26, and then from 2:47 PM on April 28 to 3:09 PM on May 4 yielding a total of 17 days, 2 hours, and 37 minutes of observations.
- Location C (38.9405332, -92.5752607): Sensor installation occurred one week after the first two sensors, with data collected from 09:57 AM on April 22 to 12:43 PM on May 6, corresponding to approximately 14 days, 2 hours, and 46 minutes of observations.

Based on the sensor installation timeline, data analysis was conducted in two stages: first using the two initial sensors (Locations A and B) and subsequently incorporating all three sensors after Location C became operational. The specific data collection time of each sensor is provided in Table 5-1. The posted work zone speed limit of all the three locations is 60 mph.

Moreover, due to the orientation of the sensors installed, only incoming data from Location B and outgoing data from Location A and Location C were considered in this study.

Table 5-1. Data collection periods for I-70 Rocheport.

Location	Start Time	End Time	Duration	Mile Marker
A	April 15, 2:31 PM	May 6, 12:49 PM	20 days, 22 hours, 18 minutes	115.0
B (Period 1)	April 15, 3:01 PM	April 26, 5:16 PM	11 days, 2 hours, 15 minutes	113.8
B (Period 2)	April 28, 2:47 PM	May 4, 3:09 PM	6 days, 22 minutes	113.8
B (Total)	n/a	n/a	17 days, 2 hours, 37 minutes	113.8
C	April 22, 9:57 AM	May 6, 12:43 PM	14 days, 2 hours, 46 minutes	112.6

5.2 I-70 Rocheport: Results from Field Study

To ensure consistency across sensor locations, corresponding time periods were selected for analysis at each point. Given the relatively short distances between the sensors, vehicles typically take only one to two minutes to travel between them. Therefore, this negligible time lag was excluded from further analysis.

To minimize potential errors in vehicle counts and speed measurements resulting from differences in sensor installation times and occasional interruptions caused by battery issues, time alignment was performed based on the recorded start and end times of each sensor’s deployment. After alignment, the overall observation period spans from April 15 at 3:01 PM to May 4 at 3:09 PM, with specific time coverage varying by sensor. The aligned timeline of data collection is shown in Table 5-2.

Table 5-2. Aligned timeline of data collection phases for I-70 Rocheport.

Time Window	Start Time	End Time	Duration
Two-sensor window (A, B)	April 15, 3:01 PM	April 22, 9:57 AM	6 days, 18 hours, 56 minutes
Three-sensor window (A, B, C) (Period 1)	April 22, 9:57 AM	April 26, 5:16 PM	4 days, 7 hours, 19 minutes
Three-sensor window (A, B, C) (Period 2)	April 28, 2:27 PM	May 4, 3:09 PM	6 days, 42 minutes
Three-sensor window (A, B, C) (Total)	n/a	n/a	10 days, 8 hours, 1 minute

Note: The three-sensor window comprises two segments due to a temporary sensor interruption. Duration reported is the total across both segments.

5.2.1 I-70 Rocheport: Results for Two-Sensor Window

For the period from April 15 at 3:01 PM to April 22 at 9:57 AM, a total of 107,699 vehicles were recorded at Location A, while 132,617 vehicles were recorded at Location B, after timestamp alignment. The vehicle counts for each class at both locations are summarized in Table 5-3.

Table 5-3. Vehicle counts at Locations A and B in Two-Sensor Window for I-70 Rocheport.

Location	Small and Medium	Large	Total
A	92,162	15,537	107,699
B	120,051	12,566	132,617

The summary of speed statistics and speed limit compliance is depicted in Table 5-4 and Table 5-5. At Location A, the average speed was 67.8 mph, with a standard deviation of 7.2 mph, and the 85th percentile speed recorded at 75.0 mph. Approximately 88% of vehicles exceeded the speed limit of 60 mph, with 35.9% exceeding it by at least 10 mph and 1.4% exceeding it by at least 20 mph. The average speed at Location B was 65.9 mph, with a standard deviation of 7.5 mph, and the 85th percentile speed recorded at 73 mph. Approximately 82.1% of vehicles exceeded the speed limit, with 25.1% exceeding it by 10 mph and 1.2% exceeding it by 20 mph.

Table 5-4. Summary of speed statistics by location in Two-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	67.8	7.2	75.0	96
B	60	65.9	7.5	73.0	103

Note: All speeds are in mph.

Table 5-5. Summary of speed limit compliance by location in Two-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	107,699	594	88.0	243	35.9	9	1.4
B	60	132,617	679	82.1	208	25.1	10	1.2

Note: VPH = vehicles per hour.

To further examine temporal variations, the data were separated into daytime (5 AM to 9 PM) and nighttime periods (9 PM to 5 AM), as shown in Table 5-6 through Table 5-9. Both locations exhibited higher speeds and exceedance rates during daytime compared to nighttime. At Location A, the average speed increased from 65.0 mph at night to 68.2 mph during the day, while at Location B it rose from 61.7 mph to 66.4 mph. Similarly, the proportion of vehicles exceeding the posted speed limit was greater in daytime at both sites, indicating more aggressive driving behavior under daylight conditions. This result could potentially be due to drivers being more cautious when traveling through work zones during nighttime.

Table 5-6. Summary of daytime speed statistics in Two-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	68.2	7.1	75.0	96.0
B	60	66.4	7.1	73.0	98.0

Table 5-7. Summary of daytime speed limit compliance in Two-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	93,793	792	89.9	335	38.1	13	1.4
B	60	116,224	925	84.9	291	26.7	14	1.3

Table 5-8. Summary of nighttime speed statistics in Two-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	65.0	7.0	72.0	94.0
B	60	61.7	9.1	70.0	103.0

Table 5-9. Summary of nighttime speed limit compliance in Two-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	13,906	196	74.7	56	21.3	2	1.0
B	60	16,393	190	62.3	42	13.7	2	0.8

Figure 5-3 and Figure 5-4 display the speed distribution and cumulative speed distribution in Two-Sensor Window, respectively. Both sites exhibited mean and 85th percentile speeds above the 60 mph limit, with Location B showing slightly higher values than Location A.

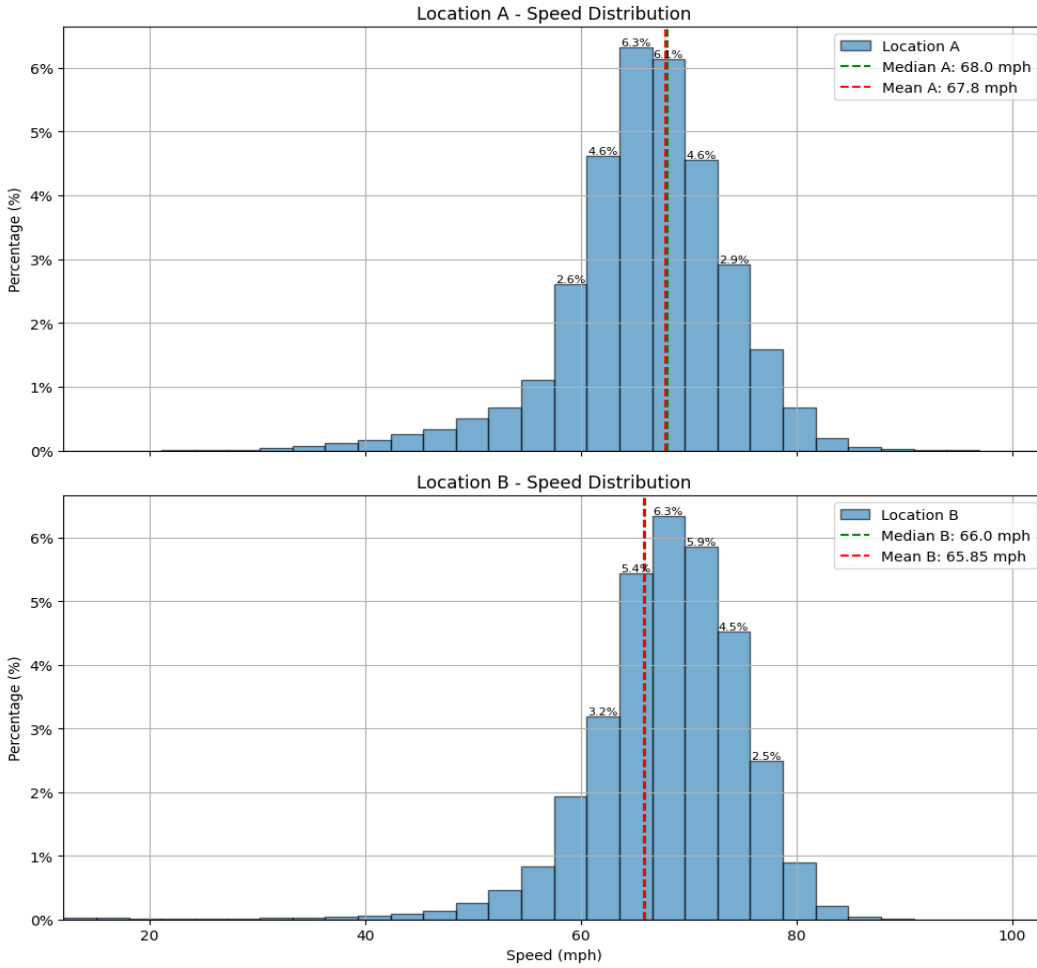


Figure 5-3. Speed distribution within the Two-Sensor Window for I-70 Rocheport.

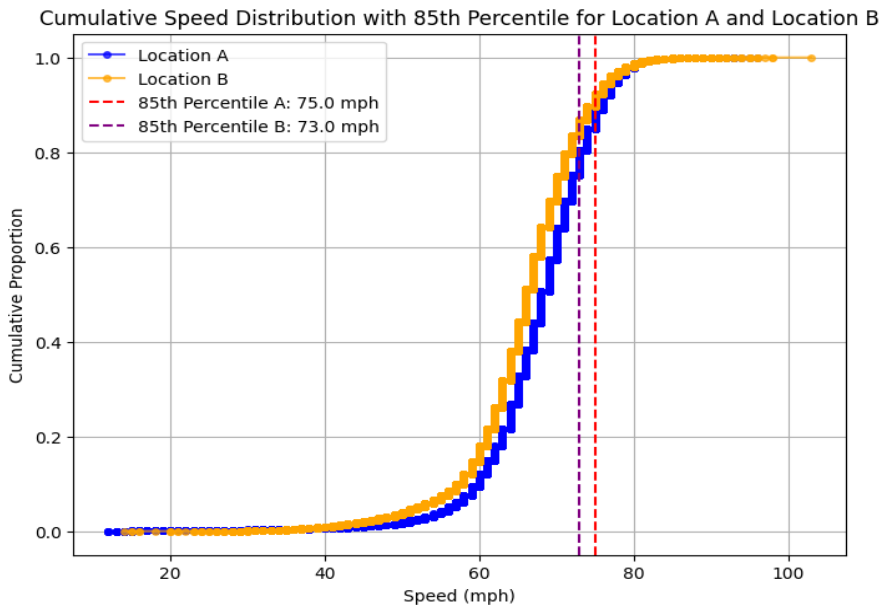


Figure 5-4. Cumulative speed distribution within the Two-Sensor Window for I-70 Rocheport.

Figure 5-5 presents the speed distribution by vehicle class within the two-sensor window. At both locations, the average speeds of small and medium vehicles are noticeably higher than those of large vehicles. Furthermore, vehicles at Location A, which is located near the downstream end of the work zone, exhibit lower average speeds compared to those at Location B, which lies near the midpoint.

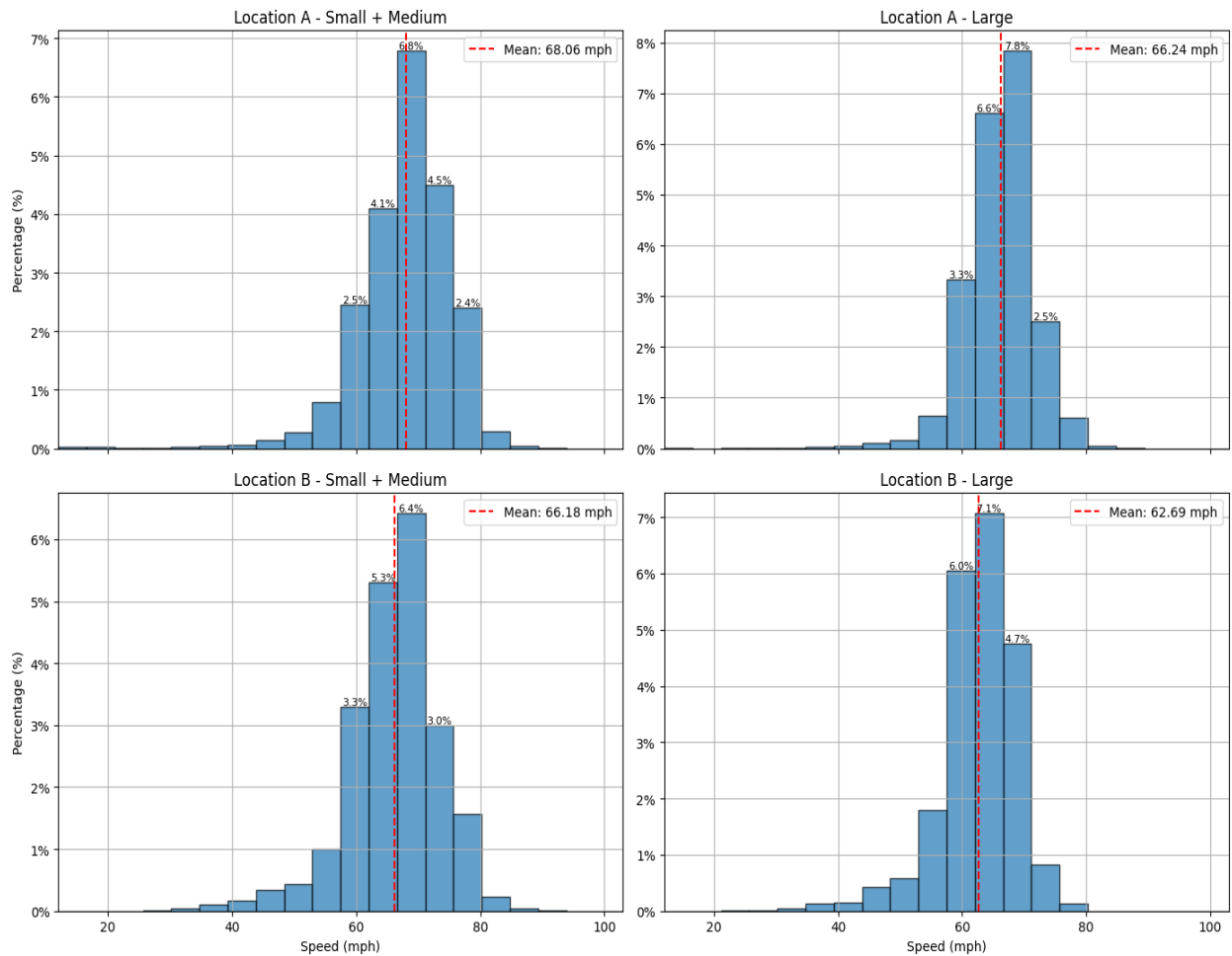


Figure 5-5. Speed distribution by vehicle class within the Two-Sensor Window for I-70 Rocheport.

To provide a clearer comparison of these differences, Table 5-10 summarizes the average speeds of each vehicle class and the corresponding differences between the two locations. Small and medium vehicles traveled 1.8 mph and 3.5 mph faster than large vehicles at Locations A and B, respectively, indicating a greater speed differential at the midpoint location.

Table 5-10. Average speeds and speed differences by location and vehicle class within the Two-Sensor Window for I-70 Rocheport.

Location	Average Speed of Small and Medium (mph)	Average Speed of Large (mph)	Difference in Average Speed (mph)
Rocheport A	68.1	66.2	1.8
Rocheport B	66.2	62.7	3.5

Figure 5-6 illustrates the average speed and average volume by hour within the two-sensor window. As shown in the figure, during the early morning hours (12 AM–5 AM), volumes were low and average speeds remained moderate. As volumes increased sharply between 6 AM–8 AM, average speeds at both locations increased correspondingly, peaking near 70 mph and exceeding the 60-mph speed limit. Throughout the daytime (9 AM–4 PM), volumes remained high while average speeds stabilized at relatively elevated levels. In the evening (5 PM–8 PM), traffic volumes stayed high, but speeds declined, especially at downstream Location A, reflecting greater congestion effects compared to midpoint Location B.

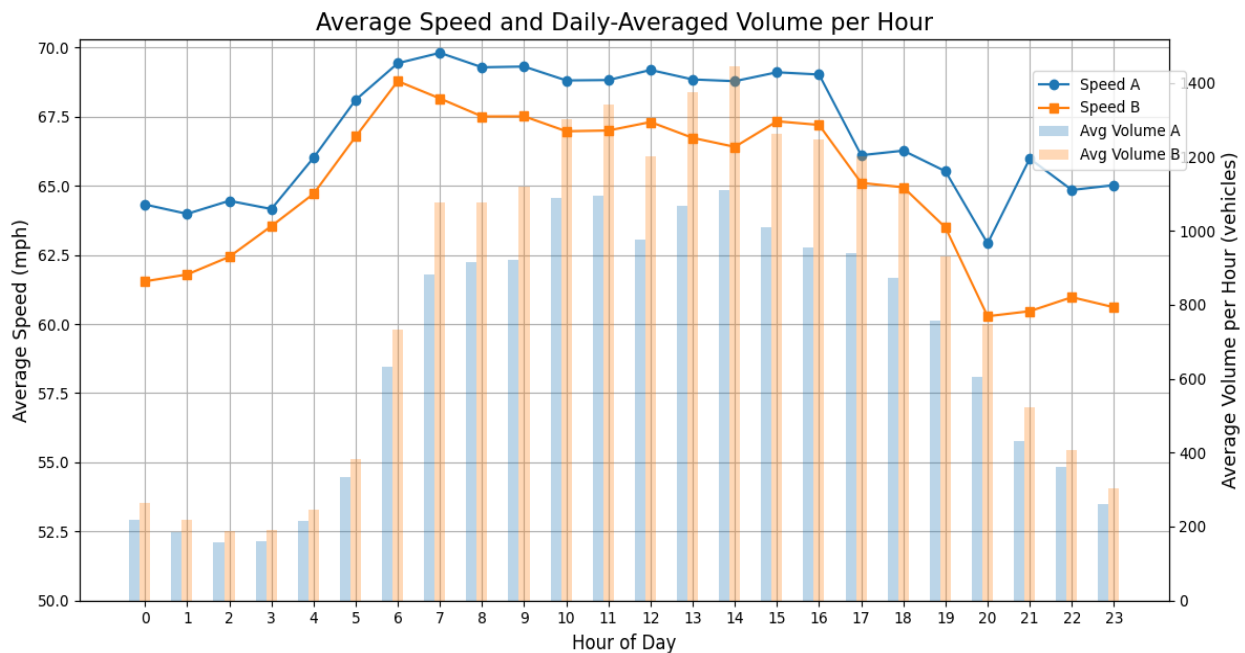


Figure 5-6. Average speed and volume by hour within the Two-Sensor Window for I-70 Rocheport.

5.2.2 I-70 Rocheport: Results for Three-Sensor Window

For the three-sensor window, time alignment produced two segments: April 22 at 9:57 AM to April 26 at 5:16 PM, and April 28 at 2:27 PM to May 4 at 3:09 PM. During these periods, a total of 176,261 vehicles were recorded at Location A, 215,432 vehicles at Location B, and 195,123 vehicles at Location C. The vehicle counts for each class at these locations are summarized in Table 5-11.

Table 5-11. Vehicle counts at Locations A, B, and C in Three-Sensor Window for I-70 Rocheport.

Location	Small and Medium	Large	Total
A	149,999	26,262	176,261
B	194,706	20,726	215,432
C	171,890	23,233	195,123

The speed statistics are shown in Table 5-12 and Table 5-13. At Location A, the average speed was 68.8 mph, with a standard deviation value of 5.5 mph, and the 85th percentile speed at 74 mph. Approximately 94.0% of vehicles exceeded the speed limit, with 37.5% exceeding the speed limit by at least 10 mph and 1.2% exceeding the speed limit by at least 20 mph. At Location B, the average speed was 66.6 mph, with a standard deviation value of 6.1 mph, and the 85th percentile speed at 73 mph. Approximately 87.4% of vehicles exceeded the speed limit, with 24.0% exceeding by 10 mph and 1.1% exceeding by 20 mph. At Location C, the average speed was 69.9 mph, with a standard deviation value of 5.7 mph, and the 85th percentile speed at 76 mph. Approximately 95.5% of vehicles exceeded the speed limit, with 45.6% exceeding by 10 mph and 2.4% exceeding by 20 mph.

Table 5-12. Summary of speed statistics by location within Three-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	68.8	5.5	74.0	97
B	60	66.6	6.1	73.0	102
C	60	69.9	5.7	76.0	103

Table 5-13. Summary of speed limit compliance by location within Three-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	176,261	676	94.0	270	37.5	9	1.2
B	60	215,432	769	87.4	212	24.0	9	1.1
C	60	195,123	759	95.5	362	45.6	19	2.4

To explore the temporal variations, the data were also separated into daytime and nighttime periods, as shown in Table 5-14 through Table 5-17. Daytime speeds and exceedance rates were generally higher than those observed at night across all three locations. Average speeds

increased slightly at each site during the day, with Location C showing the greatest difference, indicating a higher tendency for speeding under daylight conditions.

Table 5-14. Summary of daytime speed statistics at Rocheport within Three-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	68.9	5.5	75.0	97.0
B	60	66.7	6.1	73.0	102.0
C	60	70.0	5.7	76.0	103.0

Table 5-15. Summary of daytime speed limit compliance at Rocheport within Three-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	155,325	871	94.2	356	38.5	11	1.2
B	60	190,672	1,003	88.0	284	24.9	12	1.1
C	60	171,046	976	95.8	479	47.0	25	2.5

Table 5-16. Summary of nighttime speed statistics at Rocheport within Three-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	68.0	5.4	74.0	96.0
B	60	65.4	6.0	71.0	102.0
C	60	68.7	5.7	75.0	101.0

Table 5-17. Summary of nighttime speed limit compliance at Rocheport within Three-Sensor Window for I-70 Rocheport.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	20,936	251	92.3	81	29.9	3	1.1
B	60	24,760	264	82.5	56	17.4	3	0.9
C	60	24,077	291	93.6	111	35.7	6	2.1

Figure 5-7 and Figure 5-8 show the speed distribution and cumulative speed distribution in the Three-Sensor Window, respectively. Mean and 85th percentile speeds at all locations exceeded the posted 60-mph speed limit, with the highest values observed at upstream Location C and downstream Location A.

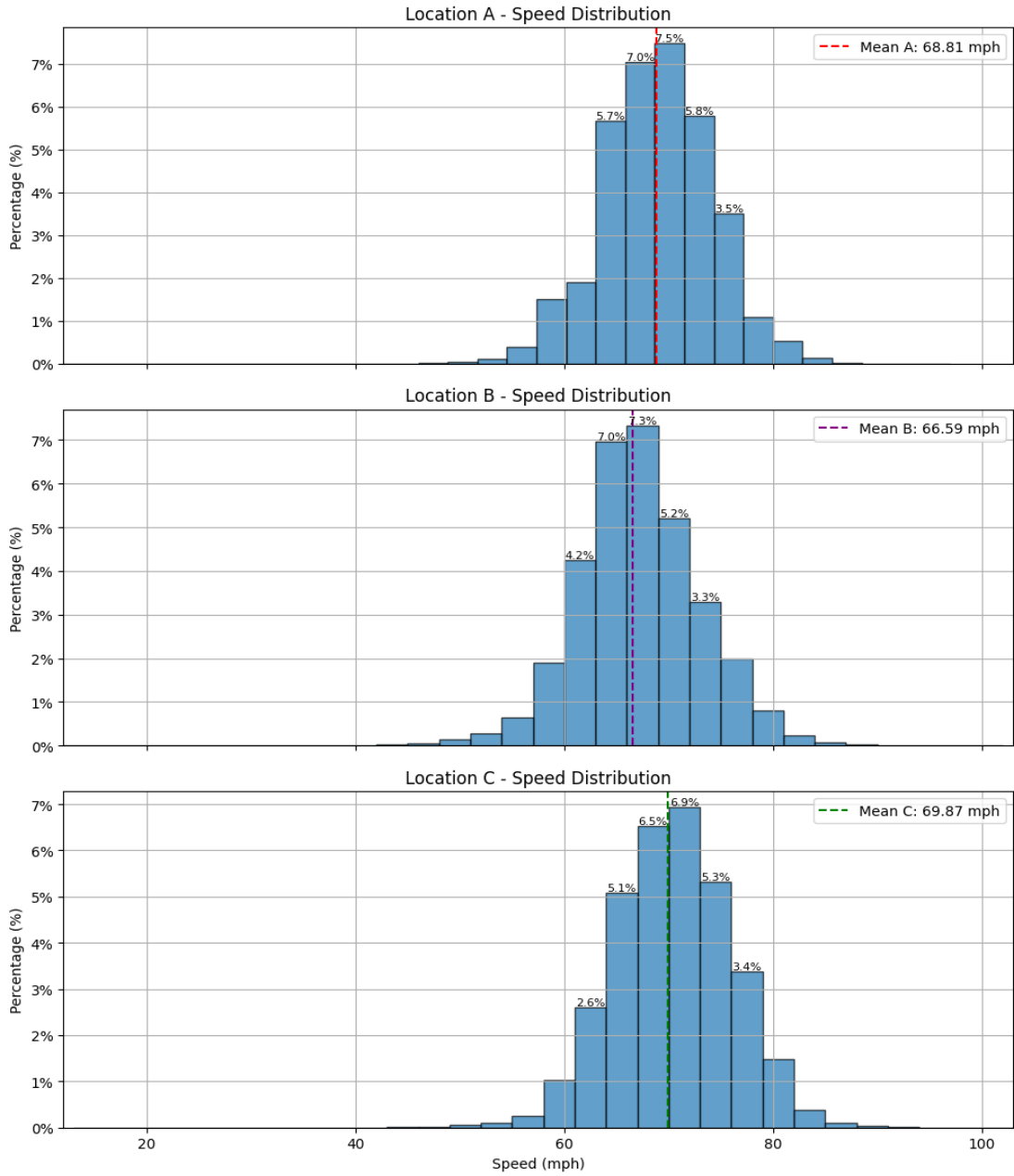


Figure 5-7. Speed distribution within the Three-Sensor Window for I-70 Rocheport.

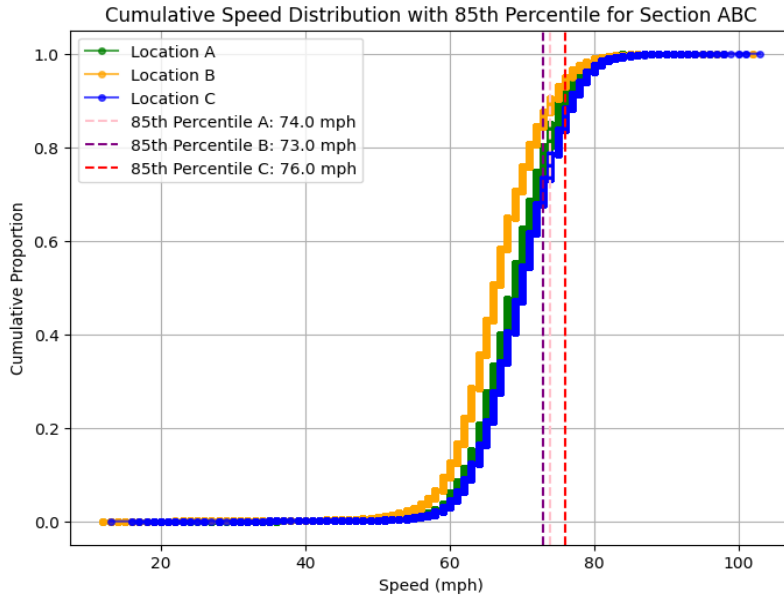


Figure 5-8. Cumulative speed distribution within the Three-Sensor Window for I-70 Rocheport.

Figure 5-9 indicates the speed distribution by class within the Three-Sensor Window. Across all three locations, large vehicles consistently exhibited lower mean speeds than small and medium vehicles, reflecting more conservative driving behavior within the work zone. For both classes, the lowest mean speeds were observed at Location B, while Locations A and C maintained relatively higher values. This pattern suggests that traffic flow at the midpoint of the work zone experienced greater speed reduction than at either upstream or downstream locations. As shown in Table 5-18, small and medium vehicles traveled 2.4–3.9 mph faster than large vehicles across all locations, with the greatest speed difference observed at Location C.

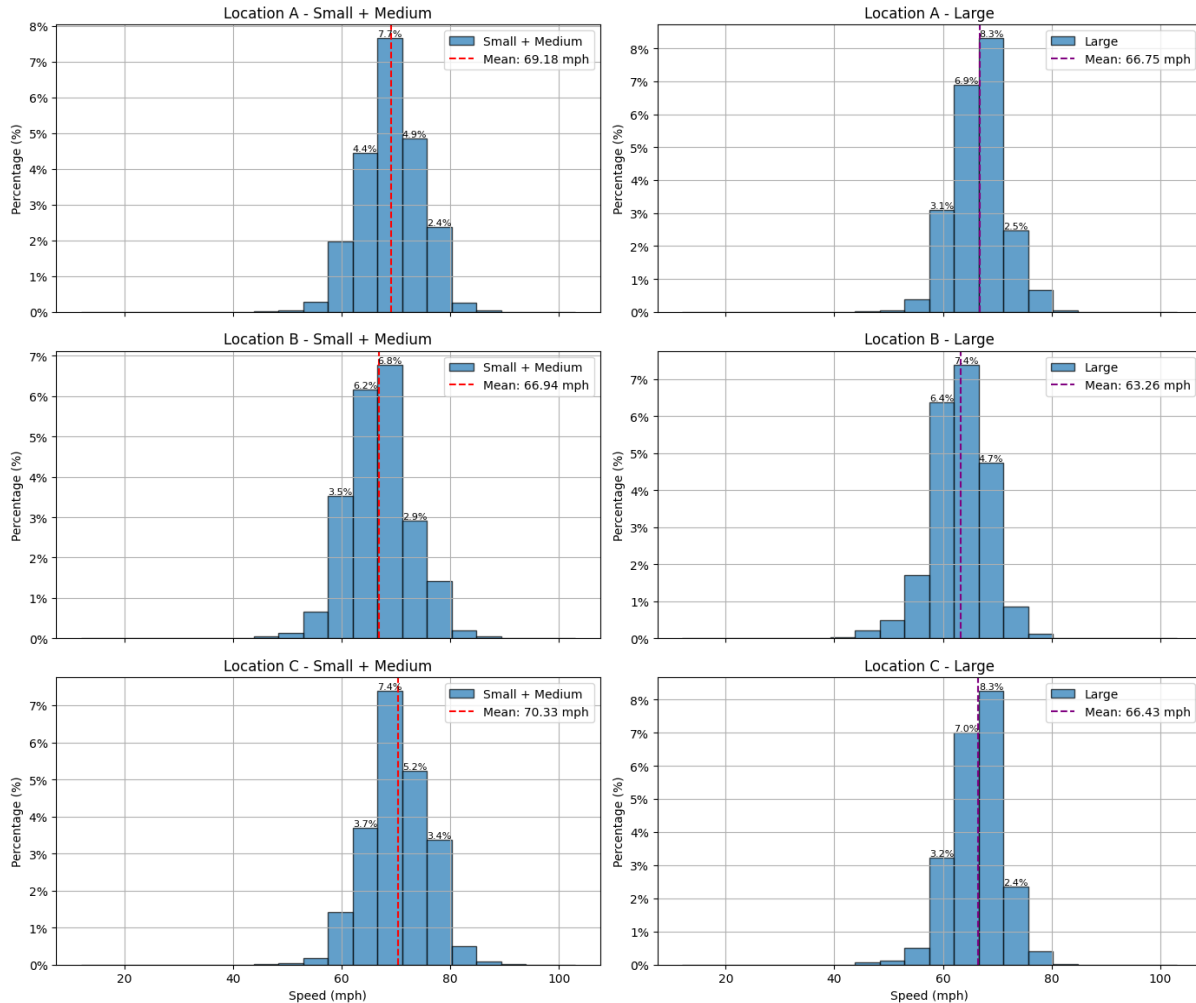


Figure 5-9. Speed distribution by class within the Three-Sensor Window.

Table 5-18. Average speeds and speed differences by location and vehicle class within the Three-Sensor Window for I-70 Rocheport.

Location	Average Speed of Small and Medium (mph)	Average Speed of Large (mph)	Difference in Average Speed (mph)
A	69.18	66.75	2.42
B	66.94	63.26	3.68
C	70.33	66.43	3.90

To explore speed patterns across the three sensor locations, hourly average speeds were analyzed using data from all three sensors. Figure 5-10 presents the average speed and average volume by hour of the day within the three-sensor window. As shown in the figure, Location C (upstream) consistently exhibited the highest speeds, while Location B (midpoint) maintained the lowest speeds, with Location A (downstream) falling in between. This pattern suggests that the midpoint of the work zone experienced the greatest speed reduction relative to the

upstream and downstream ends. In terms of traffic volume, all three locations followed similar temporal patterns, with flows increasing sharply from 6 AM, peaking between 10 AM–4 PM, and declining steadily in the evening. High volumes together with stable speeds during the daytime suggest that the work zone could handle heavy traffic without major speed reductions. However, the persistently lower speeds at Location B indicate localized flow constraints at the midpoint compared to the upstream and downstream ends.

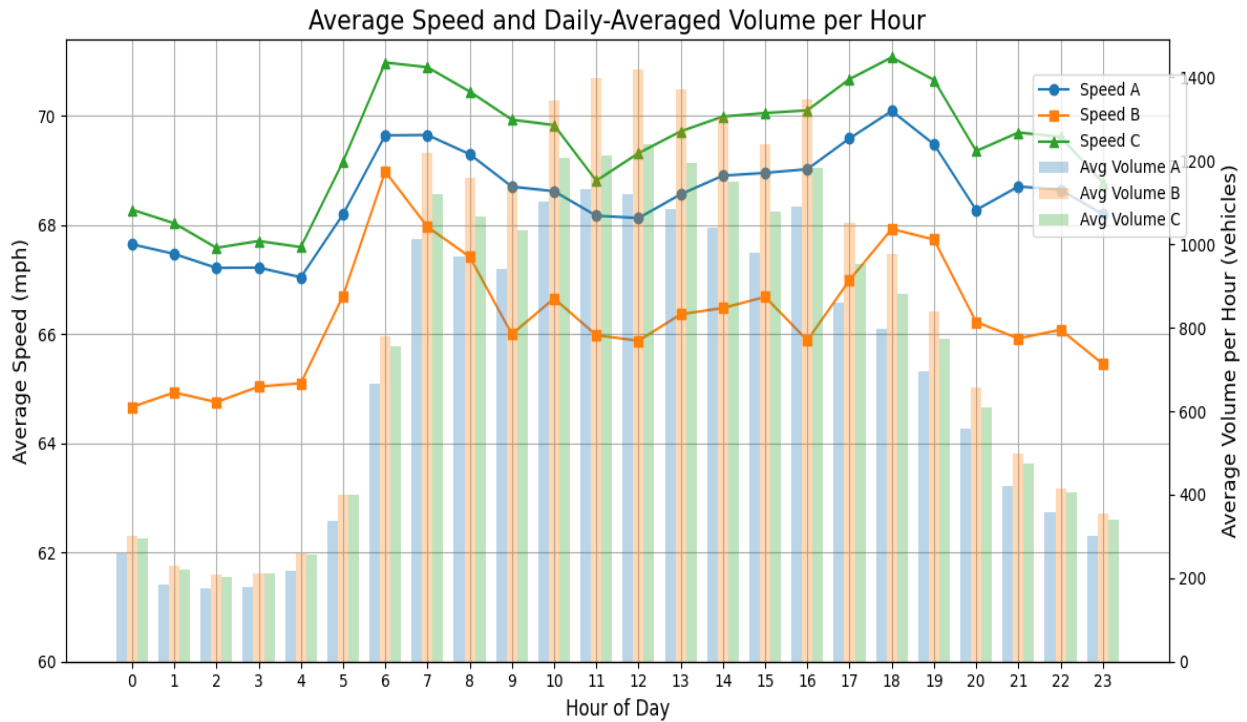


Figure 5-10. Average speed and volume by hour of the day within Three-Sensor Window.

5.3 I-70 Rocheport: Results from Analysis of HERE Data

As shown in Figure 5-11, the limits of the HERE segment for I-70 Rocheport encompassed all three sensors. HERE data were extracted from April 15 to May 6, 2025 (same dates as sensors were in place) and from April 15 to May 6, 2022 (historical dates before the work zone was in place).



(Imagery © 2025 Airbus, Landsat / Copernicus, Maxar Technologies, Map Data © 2025 Google)

Figure 5-11. Aerial showing HERE segment and speed sensors for I-70 Rocheport.

The results for speed distribution are shown in Figure 5-12, and the cumulative speed distributions are shown in Figure 5-13. The results indicate that the mean speed in 2025 was 0.2 mph lower than the mean speed in 2022, and the standard deviation in 2025 was 0.7 mph higher than the standard deviation in 2022.

Three statistical tests were performed to evaluate speed characteristics between the work zone period (2025) and the non-work zone period (2022) using HERE data, including a t-test for average speed, an F-test for speed variability, and a quantile test for the 85th percentile speed. The test results are summarized in Table 5-19. In summary, construction activities at the I-70 Rocheport site did not lead to a statistically significant change in either average or 85th percentile speeds, indicating that overall and fast-driver speeds remained largely stable between the construction and non-work zone periods. However, the analysis revealed a marked increase in speed variability during construction, suggesting that while typical speeds were maintained, driving behavior became less consistent under work zone conditions.

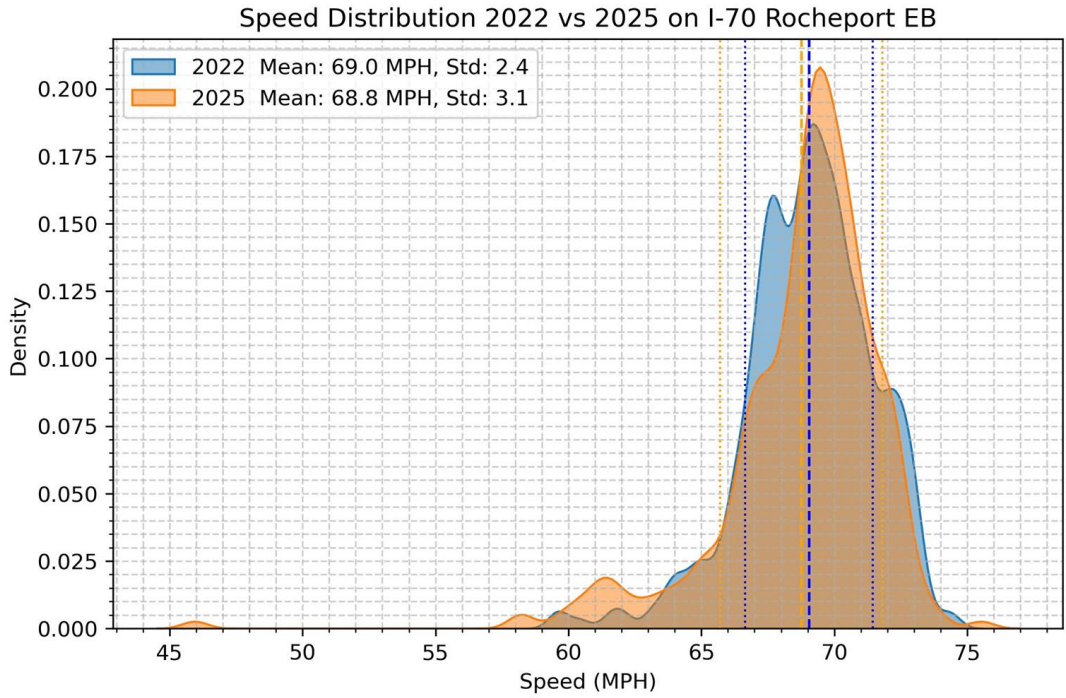


Figure 5-12. Speed distributions for 2022 and 2025 HERE data for I-70 Rocheport.

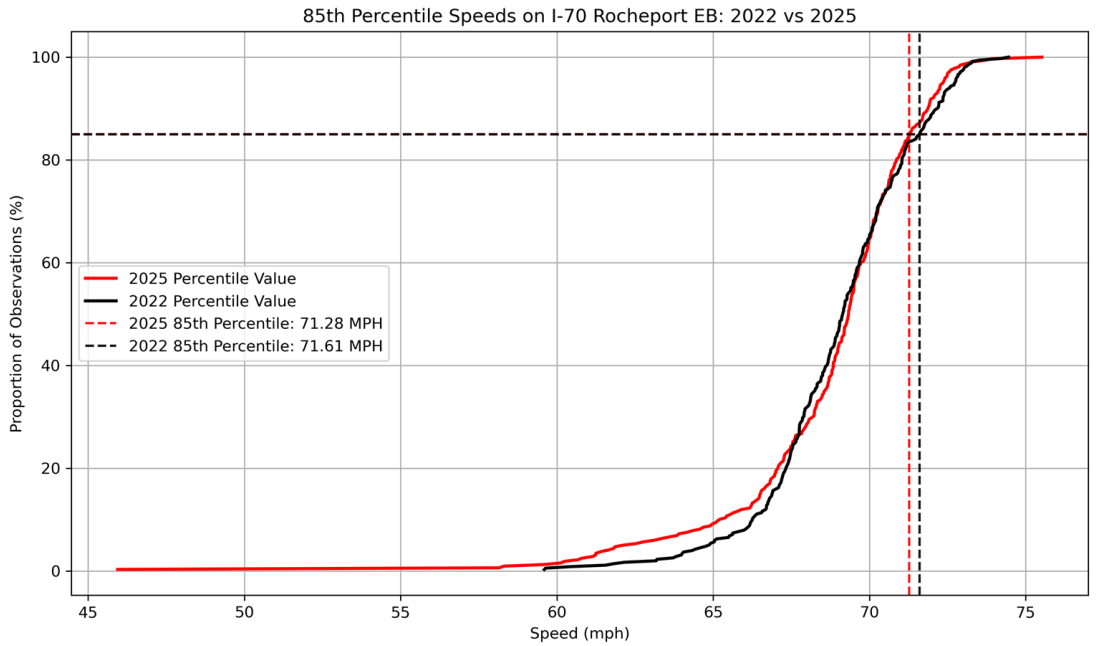


Figure 5-13. Cumulative speed distributions for 2022 and 2025 HERE data for I-70 Rocheport.

Table 5-19. Statistical comparison of speed characteristics between work zone and non-work zone periods for HERE data for I-70 Rocheport.

Test	What it Tests	Significance level	Test Result	Differences	Key Finding
t-test	Difference in Average Speed	0.05	t=-1.64, p=0.102	- 0.2 mph	Mean speed not significantly different during work zone period
F-test	Difference in Speed Variability	0.05	F=1.72, p=0.00	0.7 mph	Speed variability significantly higher by 0.7 mph during work zone period
Quantile test	Difference in the 85 th Percentile Speed	0.05	Δ =-0.24 mph, p=0.358	- 0.33 mph	Fast-driver speeds not significantly different during work zone period

The speed limit compliance results for the HERE data are shown in Table 5-20. The results indicate a lack of compliance with the 60-mph speed limit in 2025, with over 90% of observations exceeding the speed limit by 5 mph.

Table 5-20. Summary of HERE speed limit compliance results for I-70 Rocheport.

Exceeding Speed Limit By	2022 (Speed Limit = 70 mph)	2025 (Speed Limit = 60 mph)
5 mph	0.0 %	90.9 %
10 mph	0.0 %	35.5 %
15 mph	0.0 %	0.3 %
20 mph	0.0 %	0.0 %

5.4 I-70 Rocheport: Results from Analysis of Crash Data

A total of two crashes were reported within the vicinity of the I-70 Rocheport work zone during the monitoring period. The first crash occurred on April 20 at 5:35 AM near Mile Marker 112.9. This incident involved a single vehicle that ran off the roadway and struck a fixed object, resulting in a suspected minor injury. The contributing circumstance was identified as too fast for conditions. The second crash occurred on April 26 at 8:44 AM near Mile Marker 114.6, classified as a property damage only crash. The crash type was struck by a falling or shifting object, attributed to failed or improper load securement.

A review of the speed sensor data for both crash dates indicated no observable changes in average speed or traffic flow in the monitored area. The speed record remained consistent with

typical operating conditions before and after each crash, suggesting that the incidents did not cause measurable slowdowns or congestion within the work zone. These findings indicate that both crashes were isolated driver- or vehicle-related events rather than being influenced by the work zone traffic control or geometric layout.

5.5 I-70 Rocheport: Summary of Results

Overall speed statistics for I-70 Rocheport are shown in Table 5-21, and overall speed limit compliance results are shown in Table 5-22. The I-70 Rocheport results are summarized below.

- There was pervasive speeding, with approximately 90% of drivers exceeding the work zone speed limit of 60 mph.
- The 85th percentile speeds ranged from 73 to 76 mph, which is at least 13–16 mph above the posted limit.
- Speeds were highest at Location C (upstream) and lowest at Location B (midpoint).
- Nighttime speeds were generally lower than daytime speeds, possibly due to drivers being more cautious during nighttime.
- Small/medium vehicles were consistently faster than large vehicles.
- Based on analysis of HERE data, 2025 speeds were similar to 2022 speeds, but there was significantly more speed variation in 2025 with the work zone in place.

Table 5-21. Overall summary of speed statistics for I-70 Rocheport.

Period	Posted Speed Limit (mph)	Average Speed (mph)	Standard Deviation of Speed (mph)	85 th Percentile Speed (mph)	Maximum Speed (mph)	% Large Vehicles
Two-Sensor Window	60	66.7	7.4	74	96	11.7
Three-Sensor Window	60	68.3	6.0	75	103	12.0
All	60	67.9	6.5	74	103	11.9

Table 5-22. Overall summary of speed limit compliance results for I-70 Rocheport.

Time of Day	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
Day	60	727,060	2404	90.9	926	35.0	40	1.5
Night	60	100,072	611	82.8	180	24.4	9	1.2
All	60	827,132	1810	89.9	679	33.7	30	1.5

6. I-70 Warrenton

This chapter presents the methodology and results for the speed study on I-70 in Warrenton, Missouri.

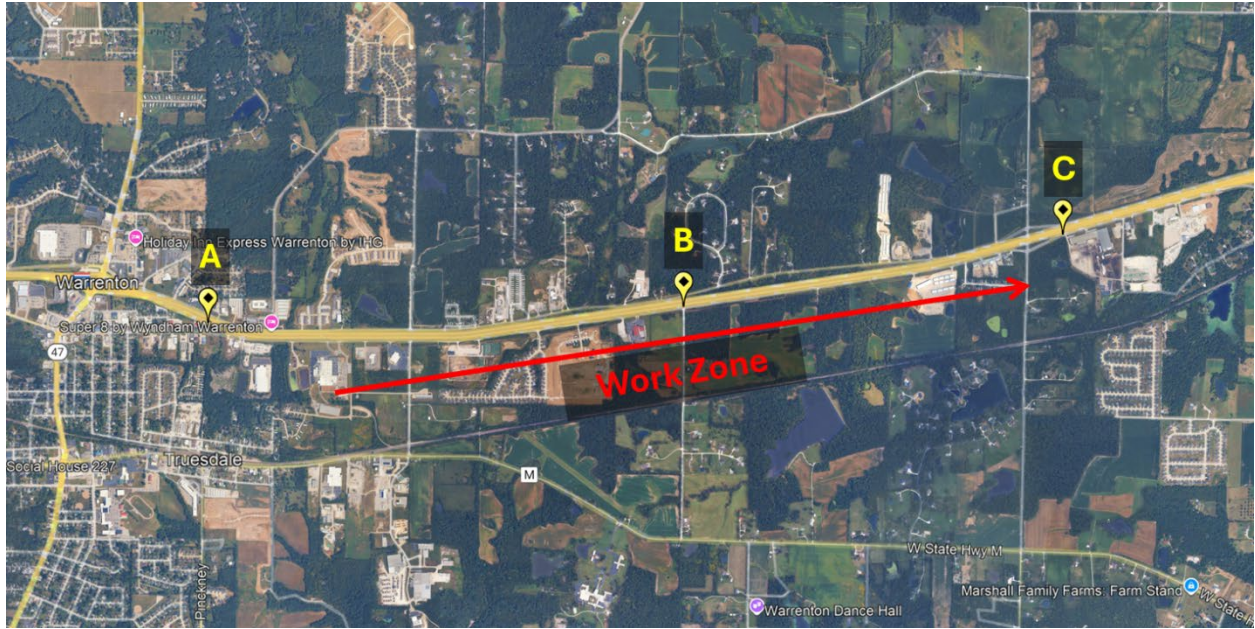
6.1 I-70 Warrenton: Study Overview

6.1.1 I-70 Warrenton: Site Overview

Data were collected at a work zone on I-70 eastbound in Warrenton from April 22 to May 31, 2025. This work zone involved the addition of a third lane in each direction as part of the Improve I-70 project. The work zone speed limit was 60 mph. Construction began on April 29, and the non-work zone speed limit on this section of I-70 is 70 mph. Some data were collected before the work zone was implemented. During the time period of the data collection, there were no lane closures in place. Lane widths were 11 feet to 12 feet. Workers were in the median and outside shoulder and separated from traffic by temporary concrete barrier. Detailed data on when workers were present in the work zone were not available.

6.1.2 I-70 Warrenton: Experimental Setup

This study investigates traffic speed within the I-70 Warrenton work zone, where sensors were positioned at the upstream, midpoint, and downstream of the zone along the eastbound travel direction. As shown in Figure 6-1, all three sensors were placed within the zone, where Location A is situated at the upstream end, Location B is near the midpoint, and Location C close to the downstream end. The distance between Location A and Location B is approximately 1.5 miles, while the distance from Location B to Location C is about 1.8 miles. Figure 6-2 shows the sensor mounted at Location B.



(Imagery © 2025 Airbus, Landsat / Copernicus, Maxar Technologies, Map data © 2025 Google)

Figure 6-1. Sensor layout for I-70 Warrenton.



Figure 6-2. Sensor mounted at Location B for I-70 Warrenton.

The data collection period of each location are listed as follows:

- **Location A** (38.8190444, -91.1314564): Data collection at Location A occurred from 4:18 PM on April 22 to 7:11 PM on May 31, resulting in a total of 39 days, 2 hours, and 53 minutes of observations.
- **Location B** (38.819937, -91.0981471): Data were collected from 3:33 PM on April 22 to 9:03 PM on May 31, corresponding to approximately 39 days, 5 hours, and 30 minutes of observations.
- **Location C** (38.823857, -91.0715704): Data were collected from 3:51 PM on April 22 to 4:52 AM on May 31, for a total of 37 days, 13 hours, and 53 minutes of observations.

Based on the work zone implementation timeline, the data analysis was divided into two periods: the non-work zone period and the work zone period. The non-work zone period spanned from April 22 to April 28 (before the work zone was implemented), while the work zone period covered April 29 to May 31. During the work zone period, the posted speed limit at all three sensor locations was 60 mph, whereas it was 70 mph during the non-work zone period. In addition, due to the orientation of each sensor, only incoming data from all three locations are considered in this study. The data collection periods are shown in Table 6-1.

Table 6-1. Data collection period for I-70 Warrenton.

Location	Start Time	End Time	Duration	Mile Marker
A	April 22, 4:18 PM	May 31, 7:11 PM	39 days, 2 hours, 53 minutes	194.0
B	April 22, 3:33 PM	May 31, 9:03 PM	39 days, 5 hours, 30 minutes	195.8
C	April 22, 3:51 PM	May 31, 4:52 AM	37 days, 13 hours, 53 minutes	197.4

6.2 I-70 Warrenton: Results from Field Study

To minimize potential errors in vehicle counts and speed measurements resulting from differences in sensor installation times and occasional interruptions caused by battery issues, time alignment was performed. The aligned timeline of data collection is shown in Table 6-2.

Table 6-2. Aligned timeline of data collection phase for I-70 Warrenton.

Period	Start Time	End Time	Duration
Non-work zone	April 22, 4:18 PM	April 28, 11:59 PM	6 days, 7 hours, 42 minutes
Work zone	April 29, 12:00 AM	May 31, 4:52 AM	32 days, 4 hours, 52 minutes

6.2.1 I-70 Warrenton: Results for Non-Work Zone Period

For the period from April 22 at 4:18 PM to April 28 at 11:59 PM, a total of 64,061 vehicles were recorded at Location A, while 80,542 vehicles were recorded at Location B, and 72,480 vehicles were recorded at Location C after timestamp alignment. The vehicle counts for each class at all three locations are summarized in Table 6-3.

Table 6-3. Vehicle counts at all locations during the non-work zone period for I-70 Warrenton.

Location	Small and Medium	Large	Total
A	57,550	6,511	64,061
B	73,996	6,546	80,542
C	65,902	6,578	72,480

The summary of speed statistics and compliance outcomes is provided in Table 6-4 and Table 6-5. At Location A, the average speed was 64.0 mph, with a standard deviation of 9.2 mph and an 85th percentile speed of 72.0 mph. In total, 20.1% of vehicles exceeded the posted speed limit of 70 mph, with 0.2% exceeding it by at least 10 mph and none exceeding it by 20 mph or more. At Location B, the average speed increased to 67.2 mph, with a standard deviation of 7.1 mph and an 85th percentile speed of 74 mph. Approximately 31.9% of vehicles exceeded the speed limit, among which 0.8% exceeded it by 10 mph, while no vehicles exceeded it by 20 mph. At Location C, the average speed was 66.6 mph, with a standard deviation of 7.7 mph and an 85th percentile speed of 73 mph. In this location, 29.9% of vehicles exceeded the speed limit, including 0.5% by at least 10 mph and none by at least 20 mph.

Table 6-4. Summary of speed statistics by location during non-work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	70	64.0	9.2	72.0	90
B	70	67.2	7.1	74.0	92
C	70	66.6	7.7	73.0	90

Table 6-5. Summary of speed limit compliance by location during non-work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	70	64,061	145	20.1	3	0.2	0	0.0
B	70	80,542	171	31.9	4	0.8	0	0.0
C	70	72,480	87	29.9	1	0.5	0	0.0

To further evaluate temporal variations in driving behavior, the data were classified into daytime and nighttime periods, as summarized in Table 6-6 through Table 6-9. Across all

locations, both mean speeds and exceedance rates were consistently higher during daytime compared to nighttime. At Location A, the average speed increased from 57.3 mph during nighttime to 65.4 mph during daytime, while at Location B it increased from 63.1 mph to 68.0 mph, and at Location C from 63.4 mph to 67.3 mph. Likewise, the proportion of vehicles exceeding the posted speed limit was higher during daytime at all three sites, which indicates more aggressive driving behavior under daylight conditions.

Table 6-6. Summary of daytime speed statistics during non-work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	70	65.4	7.3	72.0	89.0
B	70	68.0	6.1	74.0	92.0
C	70	67.3	7.5	73.0	90.0

Table 6-7. Summary of daytime speed limit compliance during non-work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	70	52,814	115	21.8	1	0.2	0	0.0
B	70	66,122	228	34.8	6	0.9	0	0.0
C	70	59,875	195	32.9	3	0.6	0	0.0

Table 6-8. Summary of nighttime speed statistics during non-work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	70	57.3	13.4	70.0	90.0
B	70	63.1	9.3	71.0	87.0
C	70	63.4	8.0	71.0	85.0

Table 6-9. Summary of nighttime speed compliance during non-work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	70	11,247	28	12.0	0	0.2	0	0.0
B	70	14,420	54	18.4	1	0.4	0	0.0
C	70	12,605	41	15.5	1	0.2	0	0.0

Figure 6-3 and Figure 6-4 show the speed distribution and cumulative speed distribution during the non-work zone period, respectively. The 85th percentile speed exceeded the posted 70 mph limit at all locations, whereas the mean speed remained below 70 mph at each site. Among the three locations, Location B exhibited the highest mean and 85th percentile speeds, followed by Location C and then Location A.

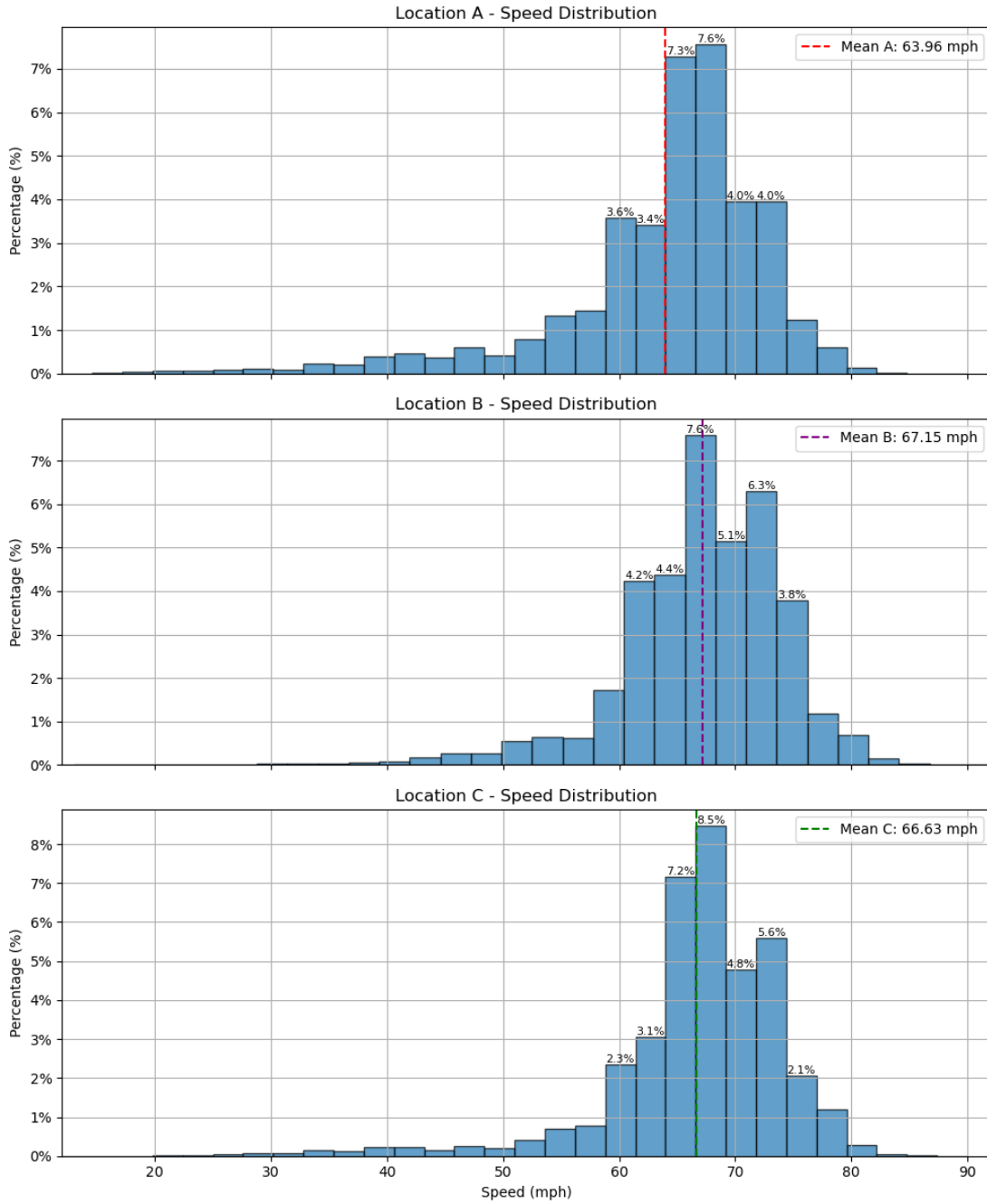


Figure 6-3. Speed distribution during non-work zone period for I-70 Warrenton.

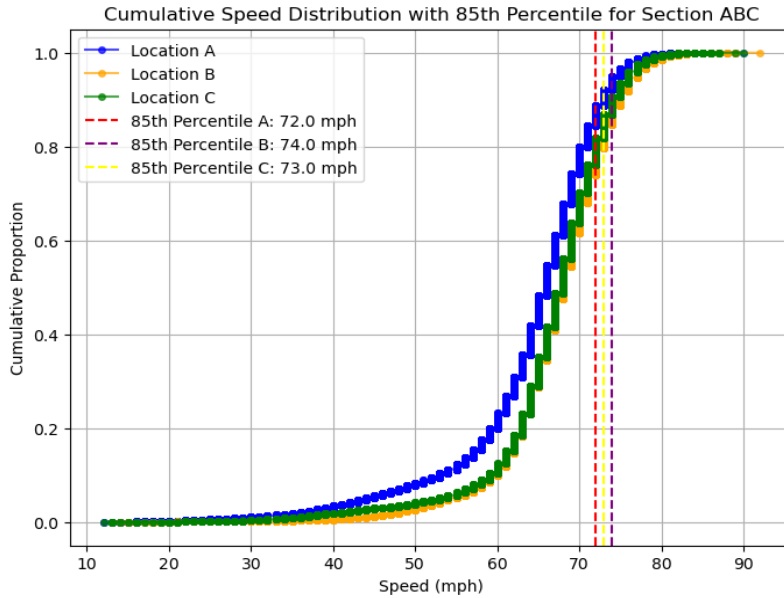


Figure 6-4. Cumulative speed distribution during non-work zone period for I-70 Warrenton.

Figure 6-5 illustrates the speed distribution by vehicle class during the non-work-zone period, with corresponding mean speed and speed differences summarized in Table 6-10. Across all locations, small and medium vehicles consistently exhibited higher mean speeds than large vehicles, suggesting comparatively more conservative driving behavior among larger vehicles. For small and medium vehicles, mean speeds were highest at Location B, followed by Location C, and lowest at Location A. In contrast, for large vehicles, the highest mean speed was observed at Location C, closely followed by Location B, while Location A consistently exhibited the lowest mean value across both vehicle classes. The speed gap between vehicle classes was largest at Location A and progressively narrowed at Locations B and C. These findings indicate that while vehicle size influenced operating speeds, the magnitude of this effect varied by location, with upstream and downstream segments showing more pronounced class-based differences than the midpoint.

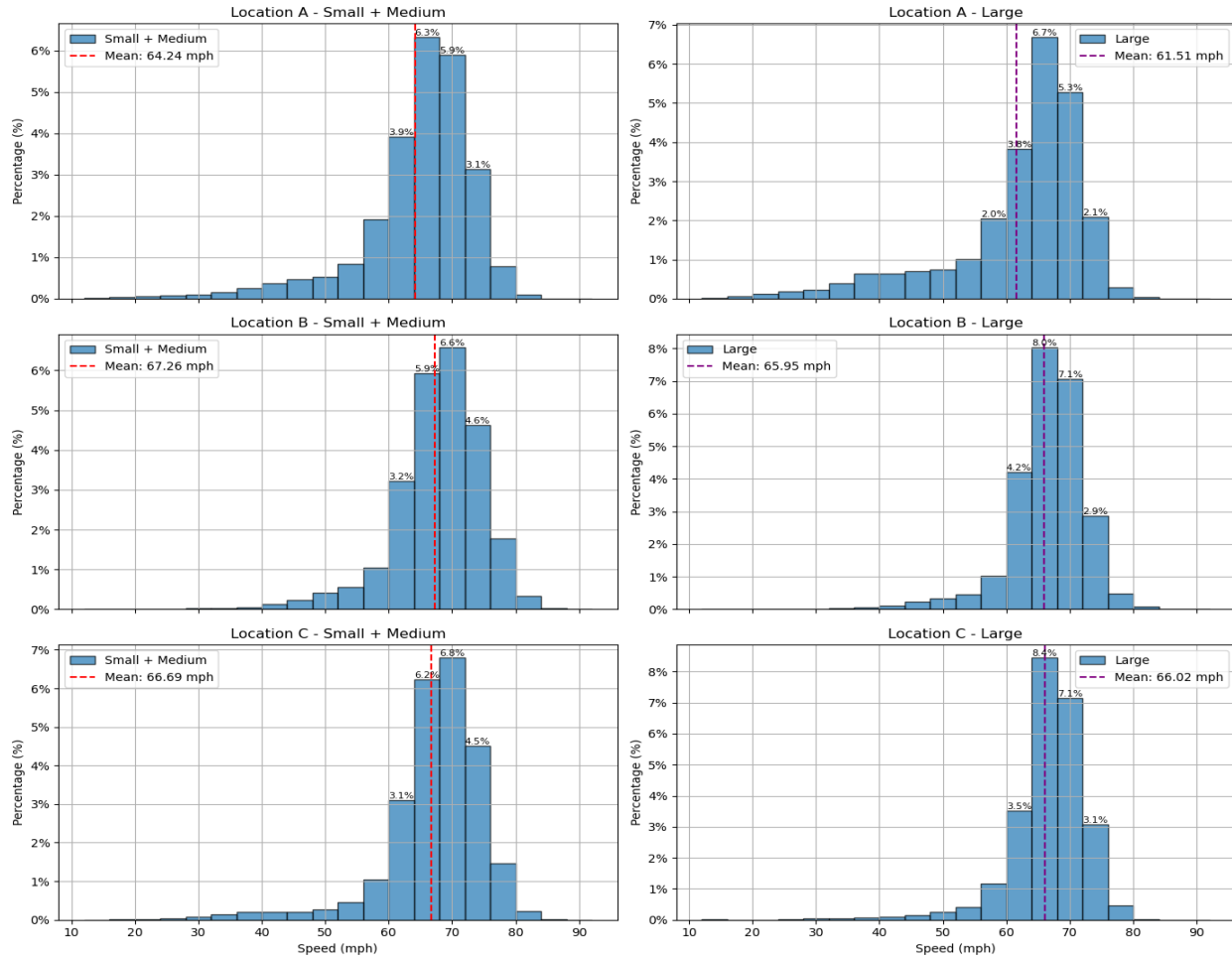


Figure 6-5. Speed distribution by class during non-work zone period for I-70 Warrenton.

Table 6-10. Average speeds and speed differences by location and vehicle class during non-work zone period for I-70 Warrenton.

Location	Average Speed of Small and Medium (mph)	Average Speed of Large (mph)	Difference in Average Speed (mph)
A	64.2	61.5	2.7
B	67.3	66.0	1.3
C	66.7	66.0	0.7

To analyze temporal variations in traffic flow and speed during the work zone period, hourly average volumes and speeds were evaluated across the three sensor locations. As illustrated in Figure 6-6, traffic volumes were lowest overnight, increased sharply after approximately 5 AM, peaked from late morning through the afternoon, and gradually declined during the evening hours. In terms of speed, vehicle speeds increased during the early morning hours, remained relatively stable around midday despite elevated traffic volumes, and decreased slightly toward the evening. Spatially, Location A generally recorded the lowest speeds throughout the day,

Location B exhibited the highest speeds, and Location C consistently fell between the other two, with values closer to those at Location B.

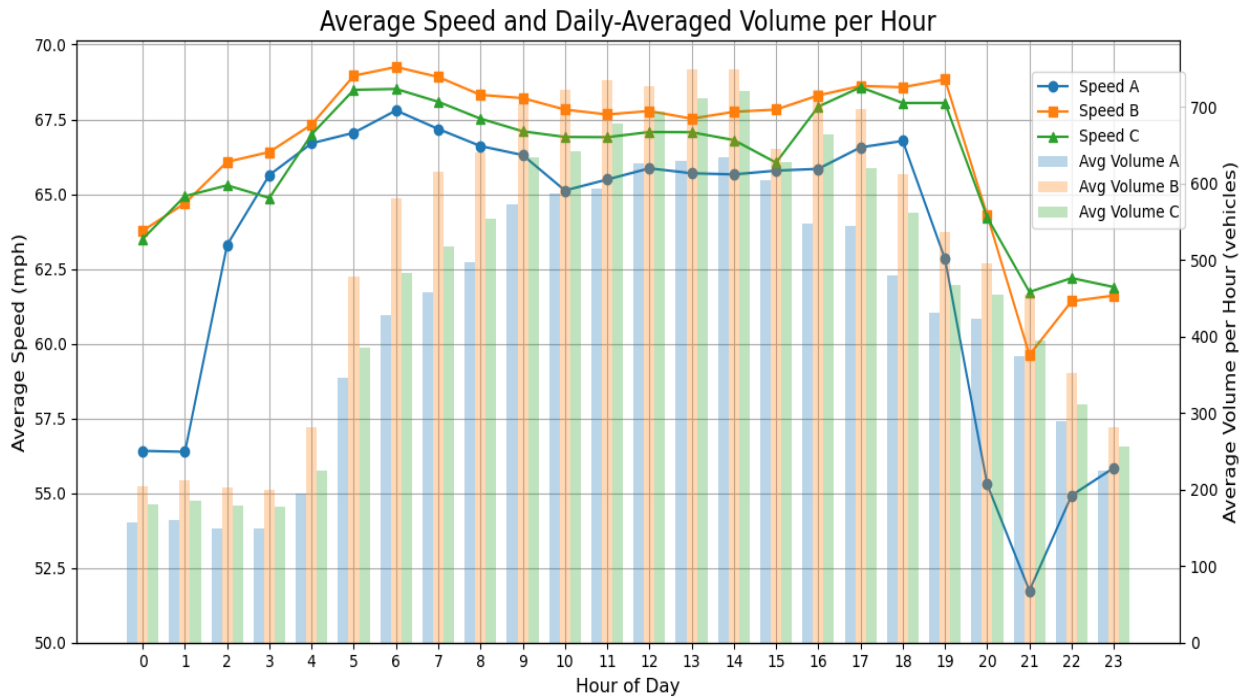


Figure 6-6. Average speed and volume by hour of the day during non-work zone period for I-70 Warrenton.

6.2.2 I-70 Warrenton: Results for Work Zone Period

For the period from April 29 at 12:00 AM to May 31 at 4:52 AM, a total of 379,594 vehicles were recorded at Location A, while 319,349 vehicles were recorded at Location B, and 339,961 vehicles were recorded at Location C after timestamp alignment. The vehicle counts for each class at all three locations are summarized in Table 6-11.

Table 6-11. Vehicle counts at all locations during the work zone period for I-70 Warrenton.

Location	Small and Medium	Large	Total
A	34,8068	31,526	37,9594
B	30,2009	17,340	31,9349
C	31,8762	21,199	33,9961

The summary of speed statistics and compliance is presented in Table 6-12 and Table 6-13. Average speeds were the highest at Location A, followed by Location B, and Location C. The standard deviation was highest at Location C. At Location A, the average speed was 63.4 mph with a standard deviation of 8.0 mph, and the 85th percentile speed was 70.0 mph. A total of 73.3% of vehicles exceeded the posted speed limit of 60 mph, with 12.9% exceeding it by at least 10 mph and 0.1% by at least 20 mph. At Location B, the average speed was 63.1 mph with

a standard deviation of 9.0 mph, and the 85th percentile speed was 70 mph. Approximately 73.3% of vehicles exceeded the speed limit, including 14.7% exceeding it by 10 mph and 0.3% by 20 mph. At Location C, the average speed was 62.4 mph with a standard deviation of 9.4 mph, and the 85th percentile speed was 70 mph. In this location, 72.0% of vehicles exceeded the speed limit, with 14.1% exceeding it by 10 mph and 0.2% by 20 mph.

Table 6-12. Summary of speed statistics by location during work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	63.4	8.0	70.0	90
B	60	63.1	9.0	70.0	92
C	60	62.4	9.4	70.0	91

Table 6-13. Summary of speed limit compliance by location during work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	37,9594	322	73.3	63	12.9	1	0.1
B	60	31,9349	320	73.3	64	14.7	1	0.3
C	60	33,9961	369	72.0	65	14.1	1	0.2

To further evaluate temporal variations in traffic performance, the data were classified into daytime and nighttime periods, as summarized in Table 6-14 through Table 6-17. Across all three locations, both mean speeds and exceedance rates were higher during daytime compared to nighttime. At Location A, the average speed increased from 61.7 mph at night to 63.7 mph during the day, while at Location B it increased from 59.9 mph to 63.9 mph, and at Location C from 60.2 mph to 63.0 mph. Likewise, the proportion of vehicles exceeding the posted speed limit was consistently higher during daytime at all sites, indicating a greater tendency toward aggressive driving behavior under daylight conditions.

Table 6-14. Summary of daytime speed statistics during work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	63.7	8.0	70.0	90.0
B	60	63.9	8.9	71.0	92.0
C	60	63.0	9.3	71.0	91.0

Table 6-15. Summary of daytime speed limit compliance during work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	318,397	472	75.5	87	14.0	1	0.1
B	60	255,296	404	78.4	86	16.7	2	0.3
C	60	278,309	397	74.7	82	15.5	1	0.2

Table 6-16. Summary of nighttime speed statistics during work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	61.7	7.5	68.0	88.0
B	60	59.9	8.4	68.0	91.0
C	60	60.2	9.7	68.0	90.0

Table 6-17. Summary of nighttime speed limit compliance during work zone period for I-70 Warrenton.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	61,197	155	62.1	19	7.5	0	0.1
B	60	64,053	144	53.1	18	6.6	0	0.1
C	60	61,652	155	59.7	20	7.8	0	0.1

Figure 6-7 and Figure 6-8 illustrate the speed distribution and cumulative speed distribution during the work zone period, respectively. Both locations recorded mean and 85th percentile speeds exceeding the posted 60 mph limit, with Location A showing the highest values, followed by Location B, while Location C exhibited the lowest.

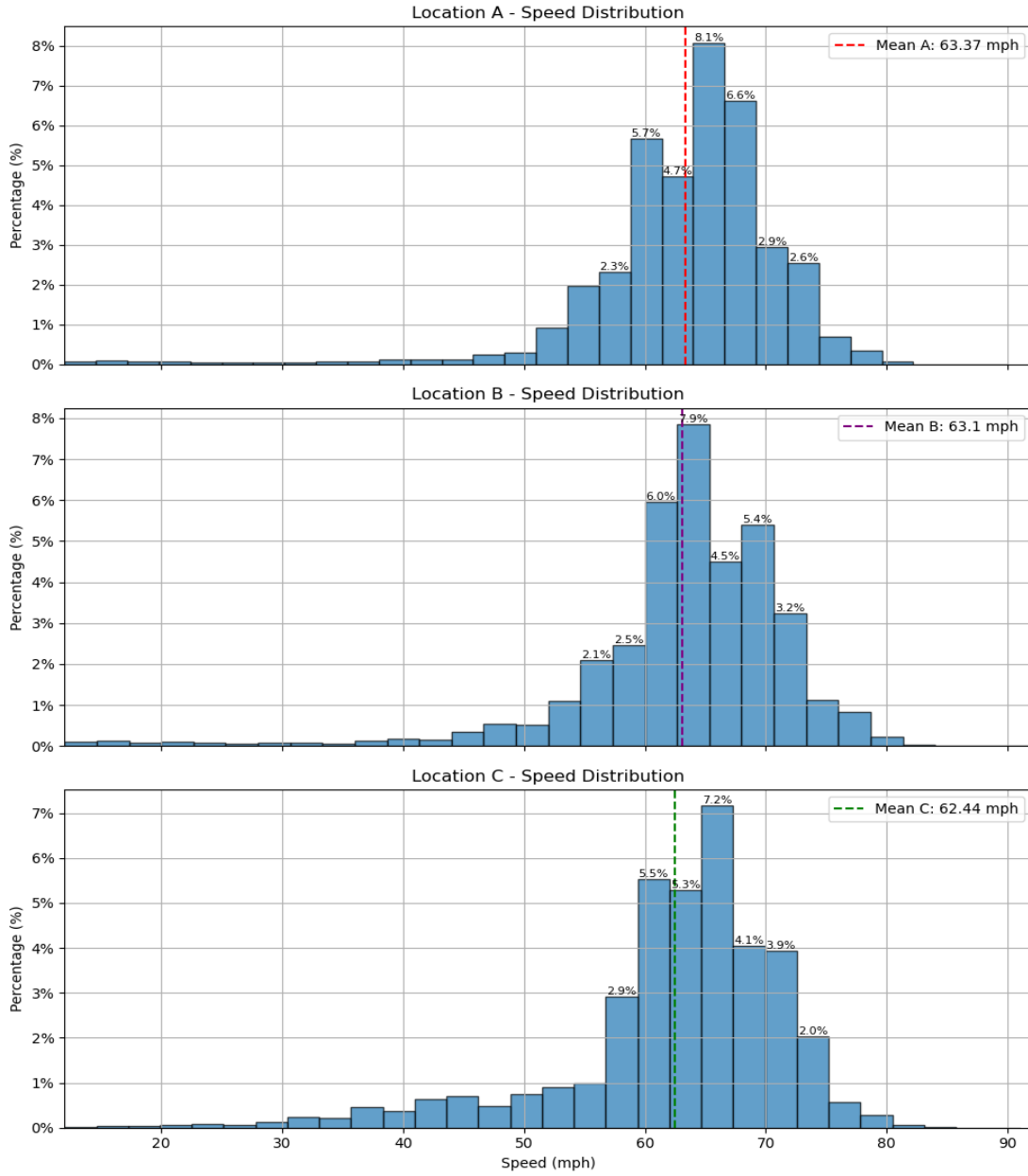


Figure 6-7. Speed distribution during work zone period for I-70 Warrenton.

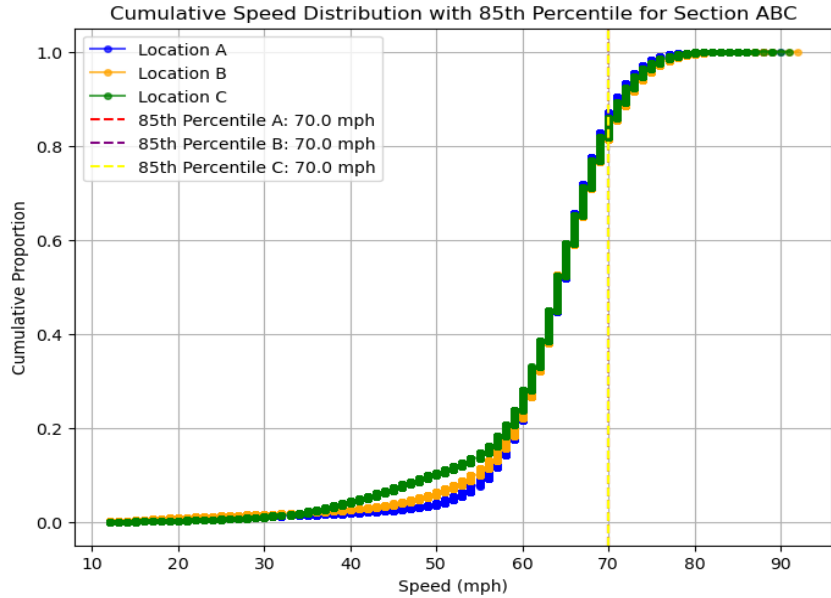


Figure 6-8. Cumulative speed distribution during work zone period for I-70 Warrenton.

Figure 6-9 shows the speed distribution of combined small and medium vehicles and large vehicles at the three locations during the work zone period, while Table 6-18 summarizes the corresponding mean speeds and the differences of each location by class. At Location A, small and medium vehicles traveled faster than large vehicles, whereas at Locations B and C, large vehicles recorded slightly higher mean speeds. The differences at B and C were marginal, all within ± 0.3 mph. Overall, the class-based speed gap varied by location, with the most noticeable difference observed at Location A.

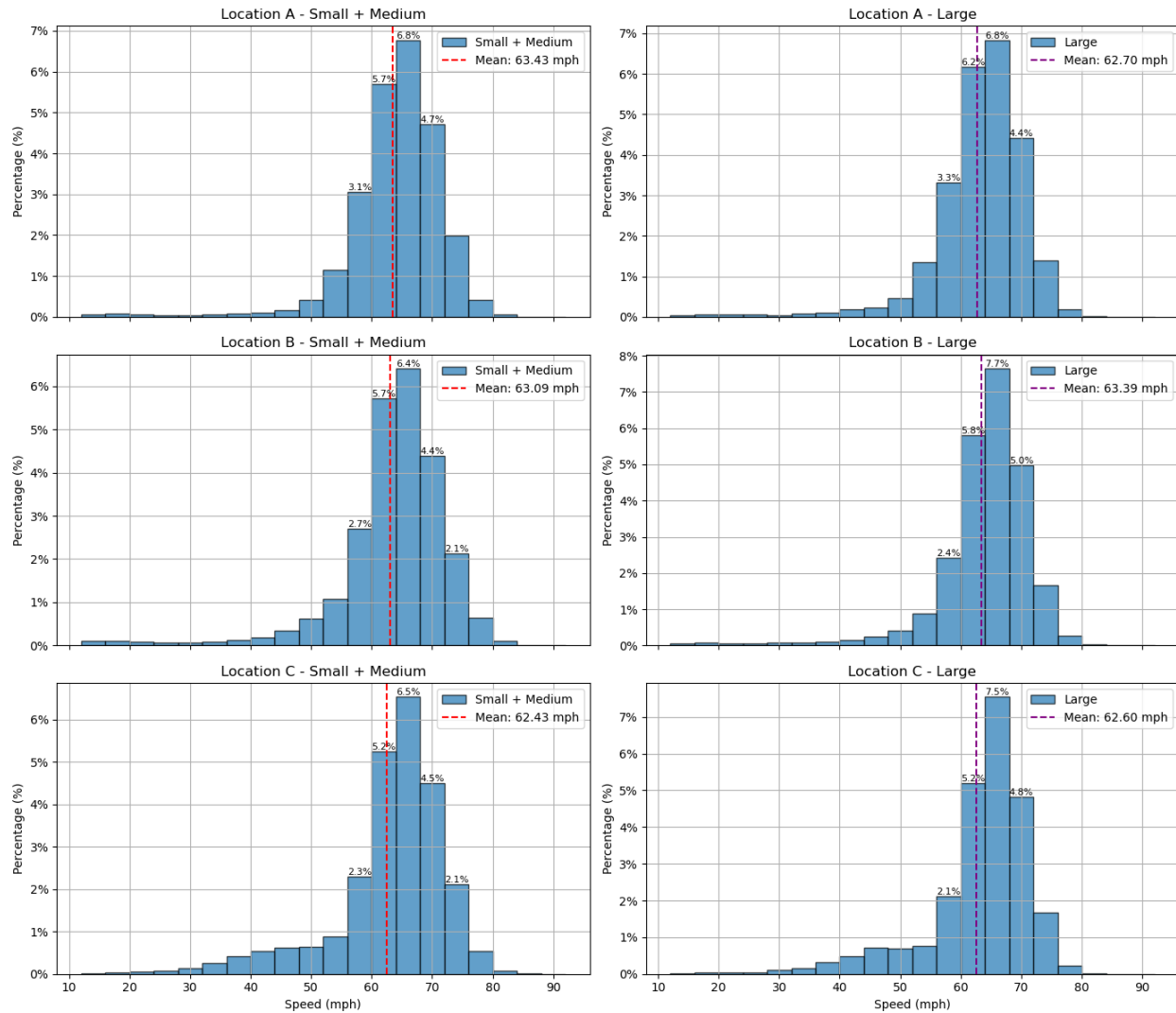


Figure 6-9. Speed distribution by class during work zone period for I-70 Warrenton.

Table 6-18. Average speeds and speed differences by location and vehicle class during work zone period for I-70 Warrenton.

Location	Average Speed of Small and Medium (mph)	Average Speed of Large (mph)	Difference in Average Speed (mph)
A	63.43	62.70	0.73
B	63.09	63.39	-0.30
C	62.43	62.20	0.23

To examine temporal variations in traffic flow during the work zone period, hourly average volumes and speeds were analyzed for all three sensor locations. As shown in Figure 6-10, traffic volumes remained low overnight, began increasing after approximately 5 AM, and reached peak levels from late morning through the afternoon, followed by a gradual decline toward the evening. Correspondingly, vehicle speeds were relatively high during nighttime

hours, experienced a moderate decrease as volumes increased during the daytime, and partially recovered during evening off-peak conditions. Across locations, speeds exhibited minor variations during construction, with Location C generally displaying slightly lower values, while Locations A and B showed comparable trends.

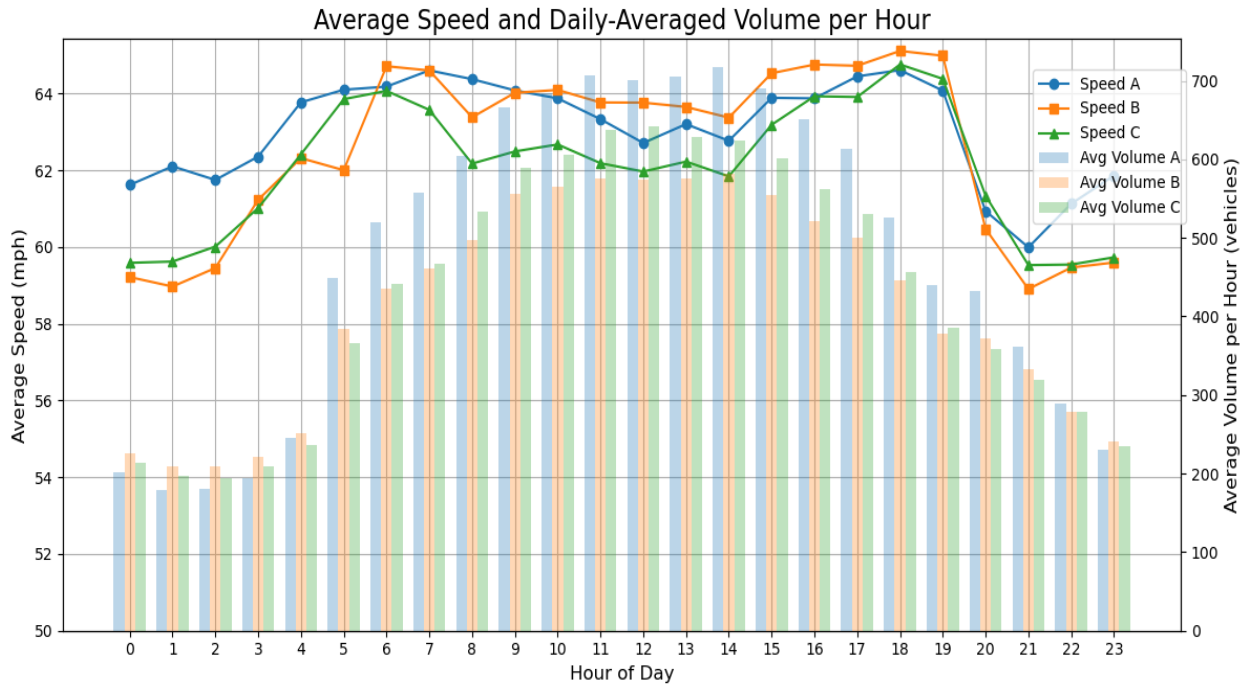


Figure 6-10. Average speed and volume by hour of the day during work zone period for I-70 Warrenton.

6.2.3 I-70 Warrenton: Comparison of Non-Work Zone and Work Zone Periods

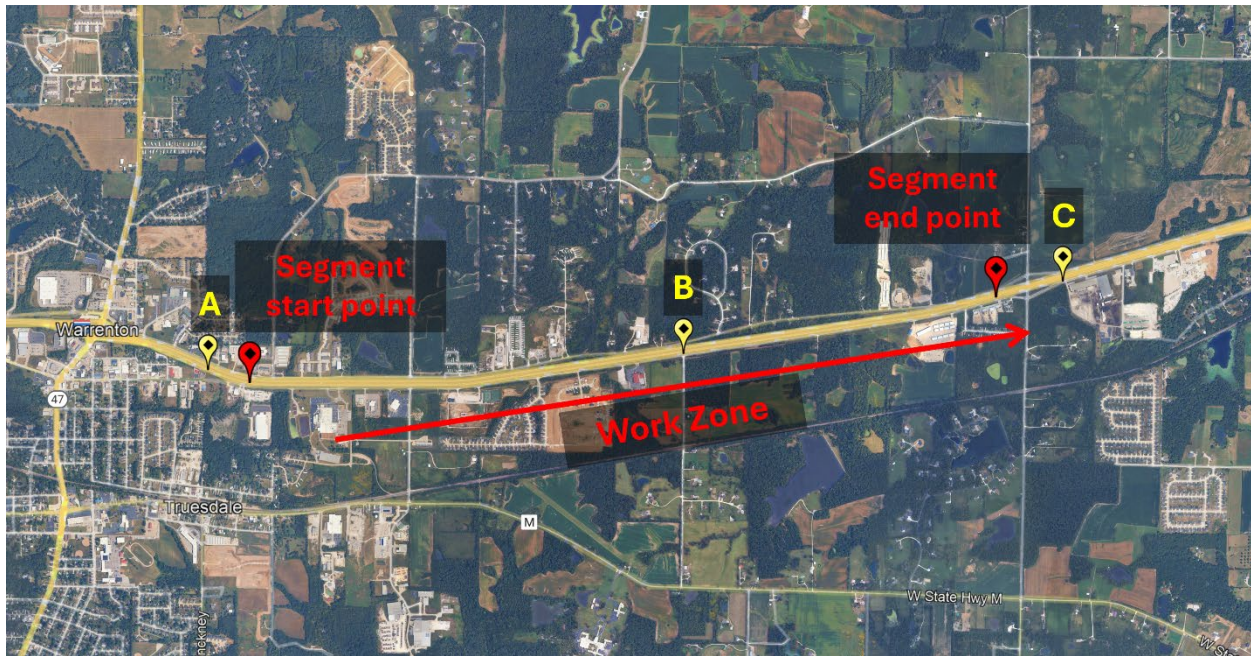
To quantitatively assess differences in traffic performance between the non-work zone period and the work zone period, three statistical tests were conducted to compare key speed characteristics across the two timeframes. Specifically, a t-test was used to examine differences in average speed, an F-test was employed to evaluate changes in speed variability, and a quantile test was applied to assess variations in the 85th percentile speed, representing fast-driver behavior. The results of these tests are summarized and interpreted in Table 6-19. In summary, the statistical testing results indicate that construction activities at the I-70 Warrenton sites had a statistically significant effect on speed performance. The t-test results showed that average speeds were significantly lower during the work zone period compared to non-work zone period. Similarly, the quantile test revealed a significant reduction in fast-driver (85th percentile) speeds under work zone conditions. In contrast, the F-test results demonstrated a significant increase in speed variability during the work zone period, suggesting greater fluctuations in driving behavior. Overall, these findings suggest that the implementation of the work zone led to lower overall and fast-driver speeds, accompanied by heightened variability in speed behavior relative to historical data.

Table 6-19. Statistical comparison of speed characteristics between non-work zone period and work zone period for I-70 Warrenton.

Test	What it Tests	Significance Level	Test Results	Difference	Key Finding
t-test	Difference in Average Speed	0.05	t=-157.7, p<0.001	-3 mph	Mean speed significantly lower by 3 mph during work zone period
F-test	Difference in Speed Variability	0.05	F=1.185, p<0.001	0.7 mph	Speed variability significantly higher by 0.7 mph during work zone period
Quantile test	Difference in the 85 th Percentile Speed	0.05	Δ =-3 mph, p<0.001	-3 mph	Fast-driver speeds significantly lower by 3 mph during work zone period

6.3 I-70 Warrenton: Results from Analysis of HERE Data

As shown in Figure 6-11, the limits of the HERE segment for I-70 Warrenton nearly encompassed all three sensors. HERE data were extracted for April 29 to May 31, 2025 (same dates as sensors and work zone were in place) and for April 29 to May 31, 2024 (historical dates before work zone was in place).



(Imagery © 2025 Airbus, Landsat / Copernicus, Maxar Technologies, Map Data © 2025 Google)

Figure 6-11. Aerial showing HERE segment and speed sensors for I-70 Warrenton.

The results for speed distribution are shown in Figure 6-12, and the cumulative speed distributions are shown in Figure 6-13. The results indicate that the mean speed in 2025 was 2 mph lower than the mean speed in 2024, and the standard deviation in 2025 was 3.7 mph higher than the standard deviation in 2024.

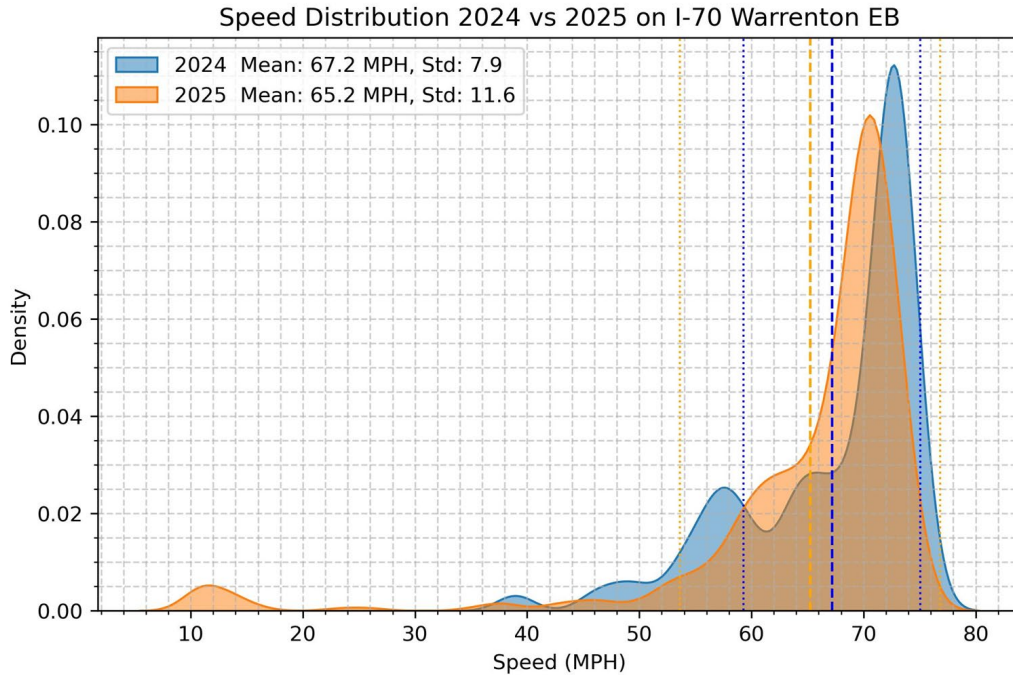


Figure 6-12. Speed distributions for 2024 and 2025 HERE data for I-70 Warrenton.

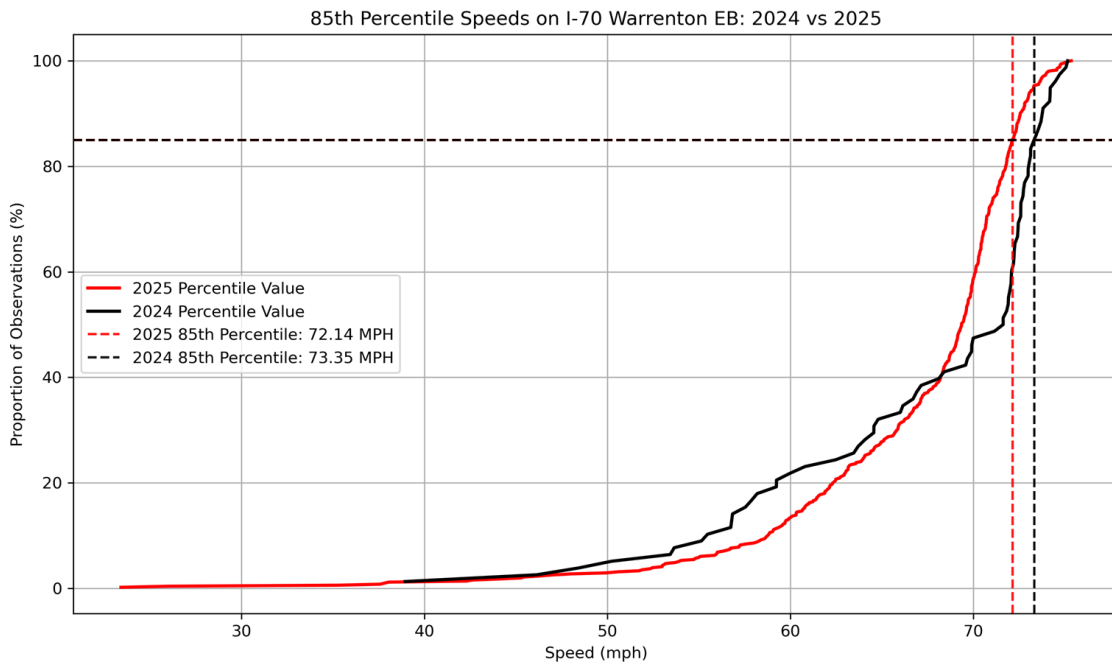


Figure 6-13. Cumulative speed distributions for 2024 and 2025 HERE data for I-70 Warrenton.

Three statistical tests were performed to evaluate speed characteristics between the work zone period (2025) and the historical data (2024) using HERE data, including a t-test for average speed, an F-test for speed variability, and a quantile test for the 85th percentile speed. The test results are summarized in Table 6-20. In summary, statistical testing revealed that construction activities at the I-70 Warrenton site led to a significant reduction in both average and 85th percentile speeds, indicating that overall and fast-driver speeds were lower during the construction period compared to non-active work conditions. However, despite the reduction in central tendency, the F-test results showed a significant increase in speed variability during construction, suggesting greater fluctuations in driving behavior under work zone conditions. These findings imply that drivers not only traveled more slowly but also exhibited less consistent speed patterns in response to work zone related impacts.

Table 6-20. Statistical comparison of speed characteristics between construction and historical data for HERE data for I-70 Warrenton.

Test	What it Tests	Significance Level	Test Results	Difference	Key Finding
t-test	Difference in Average Speed	0.05	t=-15.01, p<0.001	-2 mph	Mean speed significantly lower by 2 mph during construction
F-test	Difference in Speed Variability	0.05	F=28.49, p<0.001	3.7 mph	Speed variability significantly higher by 3.7 mph during construction
Quantile test	Difference in the 85 th Percentile Speed	0.05	Δ=-2.67 mph, p<0.001	-2.67 mph	Fast-driver speeds significantly lower by 2.67 mph during construction

The speed limit compliance results for the HERE data are shown in Table 6-21. The results indicate a lack of compliance with the 60-mph speed limit in 2025, with approximately 70% of observations exceeding the speed limit by 5 mph.

Table 6-21. Summary of HERE speed limit compliance results for I-70 Warrenton.

Exceeding Speed Limit By	2024 (Speed Limit = 70 mph)	2025 (Speed Limit = 60 mph)
5 mph	6.7 %	70.1 %
10 mph	0.0 %	40.2 %
15 mph	0.0 %	0.6 %
20 mph	0.0 %	0.0 %

6.4 I-70 Warrenton: Results from Analysis of Crash Data

A single crash was reported within the I-70 Warrenton work-zone limits during the monitoring period. The incident occurred on May 24 at 1:43 PM near Mile Marker 194.3. The crash was classified as property damage only and involved a motor vehicle in traffic. The primary contributing circumstance was listed as improper lane usage or lane change.

A review of the corresponding speed sensor data for the Warrenton site showed no noticeable fluctuations in average traffic speed around the time of the crash. Vehicle speeds remained stable throughout the monitoring period, indicating that the incident did not cause measurable disruptions to traffic flow within the work zone.

6.5 I-70 Warrenton: Summary of Results

Overall speed statistics for I-70 Warrenton are shown in Table 6-22, and overall speed limit compliance results are shown in Table 6-23 and Table 6-24. The I-70 Warrenton results are summarized below.

- Speeds exceeded the posted limits in both the non-work zone and work zone periods, with higher levels of speed limit compliance during the non-work zone period than the work zone period. Average speeds during the work zone period were significantly lower than during the non-work zone period, while speed variation was significantly higher during the work zone period.
 - **Non-work zone period:** Average speeds ranged from 64–67 mph, under the 70-mph limit. The share of vehicles exceeding the limit dropped to 20-32%, with less than 1% exceeding by more than 10 mph, and virtually none exceeding by more than 20 mph.
 - **Work zone period:** Average speeds at all three sites (62–63 mph) were above the 60 mph limit. About 72-73% of vehicles exceeded the limit, with 13-15% driving more than 10 mph over and a small share (up to 0.3%) more than 20 mph over.
- During the non-work zone period, speeds were lowest at Location A (upstream) and highest at Location B (midpoint).
- During the work zone period, speeds were highest at Location A (upstream) and lowest at Location C (downstream).
- During the non-work zone period, average speeds for small and medium vehicles were higher than speeds for large vehicles by 0.7–2 mph.
- During the work zone period, differences in average speeds by vehicle class varied by location, with average speeds for large vehicles slightly (less than 0.5 mph) higher than average speeds for small and medium vehicles at Locations B and C.
- Speeds were consistently lower during nighttime than during daytime, possibly due to drivers being more cautious when traveling through the work zone during nighttime.

- Based on analysis of HERE data, average and 85th percentile 2025 speeds (with the work zone) were lower than 2024 speeds (no work zone), but there was significantly more speed variation in 2025 with the work zone in place.

Table 6-22. Overall summary of speed statistics for I-70 Warrenton.

Period	Posted Speed Limit (mph)	Average Speed (mph)	Standard Deviation of Speed (mph)	85 th Percentile Speed (mph)	Maximum Speed (mph)	% Large Vehicles
Non-Work Zone Period	70	66.0	8.1	73	92	6.7
Work Zone Period	60	63.0	8.8	70	92	9.0

Table 6-23. Overall summary of speed limit compliance results for I-70 Warrenton (non-work zone period).

Time of Day	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
Day	70	178,811	536	30.4	10	0.6	0	0.0
Night	70	38,272	117	15.6	2	0.3	0	0.0
All	70	217,083	396	27.7	8	0.5	0	0.0

Table 6-24. Overall summary of speed limit compliance results for I-70 Warrenton (work zone period).

Time of Day	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
Day	60	852,002	1229	76.1	247	15.3	3	0.21
Night	60	186,902	418	58.2	52	7.3	1	0.1
All	60	1,038,904	961	73.0	182	13.8	3	0.2

7. I-44 Rolla/St. James

This chapter presents the methodology and results for the speed study on I-44 in Rolla and St. James, Missouri.

7.1 I-44 Rolla/St. James: Study Overview

A total of six Armadillo radar sensors were deployed along the eastbound direction of I-44 to monitor vehicle speeds within the Rolla/St. James work zone. As shown in Figure 7-2, three sensors (Locations A, B, and C) were installed near Rolla, and three (Locations D, E, and F) were positioned near St. James. The Rolla sensors captured speed behavior at the upstream end of the corridor, with Location A (37.972169, -91.757139) placed approximately 1.2 miles upstream of Locations B and C, which were installed side-by-side to record incoming and outgoing vehicle speeds. In St. James, the sensor layout extended downstream, where Location D (37.9880674, -91.6597602) served as the upstream monitoring point, located roughly 1 mile upstream of Location E (37.993162, -91.6379227) and 1.41 miles upstream of Location F (37.9961288, -91.6317506), the terminal point of the monitored segment. All sensors were mounted non-intrusively on roadside signposts and operated continuously throughout the monitoring periods.

7.1.1 I-44 Rolla/St. James: Site Overview

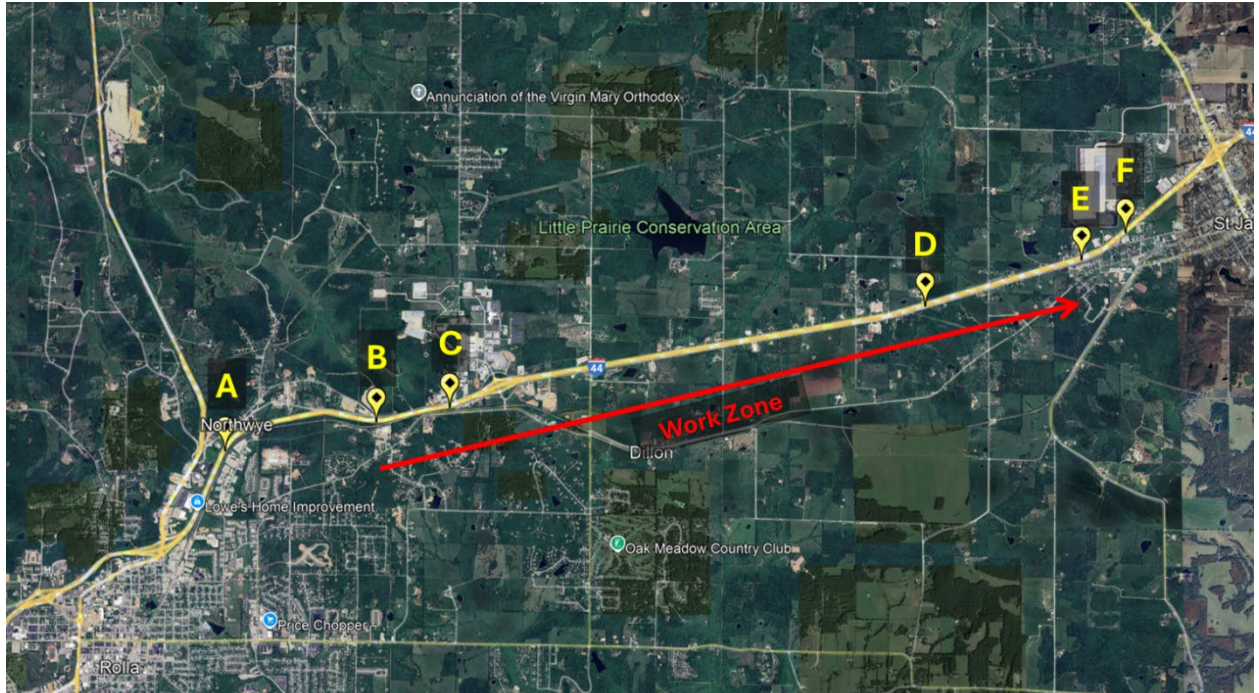
Data were collected at a work zone on I-44 eastbound at Rolla and St. James from May 9 to June 4. This work zone involved pavement repair at different sections along I-44. The work zone speed limit was 50 mph near Rolla and 60 mph east of Rolla. The non-work zone speed limit is 60 mph near Rolla and 70 mph east of Rolla. Work on the project between Rolla and St. James began in April of 2022; however, work on the eastbound side did not begin until February 2023. The location of the work zone changed during the time of the data collection. The work zone included a closure of one lane, with workers present near the travel lanes and separated by channelizers (see Figure 7-1). Active work took place continuously while the work zone was in place at a given location (including night work). Lane widths were 12 feet.



Figure 7-1. Workers and equipment in closed lane on I-44 near Rolla and St. James.

7.1.2 I-44 Rolla/St. James: Experimental Setup

This study examined vehicle speed patterns within the I-44 work zone near Rolla and St. James, Missouri, along the eastbound travel direction. As shown in Figure 7-2, radar sensors were installed at six sites distributed across two cities along the corridor. In Rolla, three sites were established: Location A, Location B, and Location C. In St. James, another three sites were set up: Location D, Location E, and Location F, to continuously monitor traffic conditions and driver behavior. Specifically, at Locations B and C, two radar sensors were installed in close proximity to collect incoming and outgoing traffic data. Initially, the downstream direction of vehicle flow was directed from Location A to Location F. Figure 7-3 shows the downstream view from Location C.



(Imagery © 2025 Airbus, Landsat / Copernicus, Maxar Technologies, Map data © 2025 Google)

Figure 7-2. Sensor Layout for I-44 Rolla/St. James.



Figure 7-3. Downstream view from Location C on I-44 eastbound.

The spatial layout of the sensors is shown below:

Rolla

- **Location A** (37.972169, -91.757139) is positioned approximately 1.2 miles upstream of Location B and C, capturing the initial eastbound flow.
- **Location B** (37.9753483, -91.7361408) is positioned close to Location C to record incoming data.
- **Location C** (37.975417, -91.736113) is placed adjacent to Location B to monitor outgoing traffic.

St. James

- **Location D** (37.9880674, -91.6597602) serves as the upstream monitoring point, located approximately 1 mile upstream of Location E and 1.41 miles upstream of Location F.
- **Location E** (37.993162, -91.6379227) is the intermediate point, located approximately 0.41 mile upstream of Location F.
- **Location F** (37.9961288, -91.6317506) is the downstream monitoring point, marking the terminal location within the observation corridor.

Based on the work zone installation period, the data collection was conducted in Rolla and St. James respectively. In Rolla, continuous speed data were collected from May 19 at 1:35 PM to June 4 at 1:32 PM at three eastbound I-44 locations (A, B, and C). In St. James, speed data were collected from May 9 at 12:03 PM to May 19 at 10:53 AM at three eastbound I-44 locations (D, E, and F). Table 7-1 summarizes the data collection periods, locations, and durations for both Rolla and St. James.

Table 7-1. Data collection period for I-44 Rolla and St. James.

City	Location	Start Time	End Time	Duration	Mile Marker
Rolla	A	May 19, 1:35 PM	June 4, 12:35 PM	15 days, 23 hours	187.8
Rolla	B	May 19, 1:40 PM	June 4, 1:32 PM	15 days, 23 hours, 52 minutes	189.0
Rolla	C	May 19, 1:40 PM	June 1, 7:02 PM	13 days, 5 hours, 22 minutes	189.4
St. James	D	May 9, 12:03 PM	May 19, 10:42 AM	9 days, 22 hours, 39 minutes	193.2
St. James	E	May 9, 12:16 PM	May 19, 10:47 AM	9 days, 22 hours, 31 minutes	194.4
St. James	F	May 9, 12:25 PM	May 19, 10:53 AM	9 days, 22 hours, 28 minutes	194.8

7.2 I-44 Rolla/St. James: Results from Field Study

Based on information obtained from MoDOT on work zone times and locations (see Table 7-2) and the aligned timeframes, the observations were divided into two distinct phases based on when the work zone was present: the work zone period and the non-work zone period. This classification enables direct comparisons of driver speed behavior under work-zone and normal-flow conditions. Table 7-3 and Table 7-4 present the detailed phases information and the corresponding speed limit settings for the six sensor locations.

Table 7-2. Summary of work zone times and locations for I-44 Rolla/St. James.

Start Date (Time)	End Date (Time)	Location	Sensors Included in Work Zone	Work Zone Speed Limit (mph)	Notes
May 11, 11:00 PM	May 15, 3:00 PM	Mile Marker 192.4 to Route 8/68 interchange	D, E, F	60	Active work in passing lane
May 19, 7:00 AM	May 21, 3:00 AM	Mile Marker 187.2– 189.0	A	50	Active work in driving lane
May 21, 3:00 AM	May 22, 9:30 AM	Mile Marker 189.0– 190.8	B, C	50	Active work in driving lane
May 27, 7:00 PM	May 28, 6:00 AM	Mile Marker 187.2– 189.4	A, B, C	50	Active work in driving lane
May 28, 7:00 PM	May 29, 6:00 AM	Mile Marker 187.2– 189.4	A, B, C	50	Active work in driving lane

Table 7-3. Work zone period timeline for I-44 at Rolla and St. James.

Location/Period	Start Time	End Time	Speed Limit	Duration
A (Construction Period)	May 19, 7:00 AM	May 21, 3:00 AM	50	1 day, 20 hours
A (Lane Closure 1)	May 27, 7:00 PM	May 28, 6:00 AM	50	11 hours
A (Lane Closure 2)	May 28, 7:00 PM	May 29, 6:00 AM	50	11 hours
A (Total)	n/a	n/a	50	2 days, 18 hours
B (Construction Period)	May 21, 3:00 AM	May 22, 9:30 AM	50	1 day, 6 hours, 30 minutes
B (Lane Closure 1)	May 27, 7:00 PM	May 28, 6:00 AM	50	11 hours
B (Lane Closure 2)	May 28, 7:00 PM	May 29, 6:00 AM	50	11 hours
B (Total)	n/a	n/a	50	2 days, 4 hours, 30 minutes
C (Construction Period)	May 21, 3:00 AM	May 22, 9:30 AM	50	1 day, 6 hours, 30 minutes
C (Lane Closure 1)	May 27, 7:00 PM	May 28, 6:00 AM	50	11 hours
C (Lane Closure 2)	May 28, 7:00 PM	May 29, 6:00 AM	50	11 hours
C (Total)	n/a	n/a	50	2 days, 4 hours, 30 minutes
D	May 11, 11:00 PM	May 15, 3:00 PM	70	3 days, 16 hours
E	May 11, 11:00 PM	May 15, 3:00 PM	70	3 days, 16 hours
F	May 11, 11:00 PM	May 15, 3:00 PM	70	3 days, 16 hours

Table 7-4. Non-work zone period timeline for Rolla and St. James.

Location	Start Time	End Time	Speed Limit	Duration
A (Period 1)	May 21, 3:00 AM	May 27, 7:00 PM	60	6 days, 16 hours
A (Period 2)	May 28, 6:00 AM	May 28, 7:00 PM	60	13 hours
A (Period 3)	May 29, 6:00 AM	June 1, 7:02 PM	60	3 days, 13 hours, 2 minutes
A (Total)	n/a	n/a	60	10 days, 18 hours, 2 minutes
B (Period 1)	May 22, 9:30 AM	May 27, 7:00 PM	60	5 days, 9 hours, 30 minutes
B (Period 2)	May 28, 6:00 AM	May 28, 7:00 PM	60	13 hours
B (Period 3)	May 29, 6:00 AM	June 1, 7:02 PM	60	3 days, 13 hours, 2 minutes
B (Total)	n/a	n/a	60	9 days, 11 hours, 32 minutes
C (Period 1)	May 22, 9:30 AM	May 27, 7:00 PM	60	5 days, 9 hours, 30 minutes
C (Period 2)	May 28, 6:00 AM	May 28, 7:00 PM	60	13 hours
C (Period 3)	May 29, 6:00 AM	June 1, 7:02 PM	60	3 days, 13 hours, 2 minutes
C (Total)	n/a	n/a	60	9 days, 11 hours, 32 minutes
D (Period 1)	May 9, 12:03 PM	May 11, 11:00 PM	60	2 days, 10 hours, 57 minutes
D (Period 2)	May 15, 3:00 PM	May 19, 10:42 AM	60	3 days, 19 hours, 42 minutes
D (Total)	n/a	n/a	60	6 days, 6 hours, 39 minutes
E (Period 1)	May 9, 12:16 PM	May 11, 11:00 PM	60	2 days, 10 hours, 44 minutes
E (Period 2)	May 15, 3:00 PM	May 19, 10:47 AM	60	3 days, 19 hours, 47 minutes
E (Total)	n/a	n/a	60	6 days, 6 hours, 31 minutes
F (Period 1)	May 9, 12:25 PM	May 11, 11:00 PM	60	2 days, 10 hours, 35 minutes
F (Period 2)	May 15, 3:00 PM	May 19, 10:53 AM	60	3 days, 19 hours, 53 minutes
F (Total)	n/a	n/a	60	6 days, 6 hours, 28 minutes

7.2.1 I-44 Rolla/St. James: Results for Work Zone Period

For the work zone period at the I-44 Rolla site, a total of 32,268 vehicles were recorded at Location A, while 36,171 vehicles were recorded at Location B, and 37,112 vehicles were recorded at Location C after timestamp alignment. It should be noted that the observation periods for Location A and Locations B/C were not identical. However, all three locations fall within their respective work zone periods. For the St. James site during the work zone period, a total of 54,737 vehicles were recorded at Location A, followed by 52,442 vehicles at Location B, and 53,898 vehicles at Location C after timestamp alignment. Unlike Rolla, the observation periods for all three locations in St. James were consistent during the work zone period. The vehicle counts for each class at all locations are summarized in Table 7-5.

Table 7-5. Vehicle counts at all locations during the work zone period for I-44 Rolla/St. James.

Location	Small and Medium	Large	Total
A	30,209	2,059	32,268
B	34,231	1,940	36,171
C	34,326	2,786	37,112
D	46,930	7,807	54,737
E	47,940	4,502	52,442
F	48,009	5,889	53,898

The speed statistics of I-44 Rolla and St. James during work zone periods are shown in Table 7-6 and Table 7-7. Along the Rolla segment (Location A, B, and C), average speeds were generally close to the 50-mph speed limit, with Location C exhibiting the highest mean speed and Location A the lowest. Speed variability remained moderate and relatively consistent across the three sites, while the 85th percentile speeds clustered around 60 mph. A notable portion of vehicles exceeded the posted limit, particularly at Locations B and C, although exceedances of 20 mph were relatively rare. In contrast, the St. James segment (Locations D, E, and F), operating under a 60-mph speed limit, showed lower average speeds relative to the posted limit, especially at the midpoint and the downstream sites (E and F). Location D experienced the highest speed variability, indicating less stable driving behavior in the upstream area. The proportion of vehicles exceeding the speed limit was noticeably lower at Locations E and F compared to Rolla, with only a small fraction exceeding the limit by 10 mph or more. Overall, Rolla locations demonstrated slightly higher operating speeds and a greater rate of speed-limit exceedance, whereas St. James exhibited more conservative driving behavior, particularly in midpoint and the downstream areas, with higher variability concentrated upstream.

Table 7-6. Summary of speed statistics by location during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	50	50.0	10.6	59.0	84
B	50	50.6	11.7	62.0	83
C	50	52.0	10.0	62.0	89
D	60	50.8	19.5	69.0	97
E	60	48.1	10.9	59.0	102
F	60	48.4	11.8	60.0	88

Table 7-7. Summary of speed limit compliance by location during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	50	32,268	305	56.6	64	11.8	4	0.8
B	50	36,171	411	60.2	132	19.3	10	1.5
C	50	37,112	412	58.8	135	19.3	12	2.0
D	60	54,737	295	47.4	68	10.9	3	0.4
E	60	52,442	68	11.5	6	1.1	0	0.0
F	60	53,898	74	12.1	4	0.7	0	0.0

To explore the temporal variations, the data were also separated into daytime and nighttime periods. Since the posted speed limit of these two cities are different, each city was analyzed respectively, as shown in Table 7-8 through Table 7-15. At both the Rolla and St. James sites, daytime speeds and exceedance rates were generally higher than those observed at night across all locations. Average speeds increased slightly at each site during the day, with Location A at Rolla and Location F at St. James showing the greatest differences, indicating a higher tendency for speeding under daylight conditions.

Table 7-8. Summary of daytime speed statistics at Rolla during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	50	48.9	11.1	59.0	82.0
B	50	49.8	12.8	62.0	83.0
C	50	53.0	9.9	62.0	89.0

Table 7-9. Summary of daytime speed limit compliance at Rolla during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	50	23,621	438	53.6	78	9.5	5	0.6
B	50	26,469	586	58.5	211	19.6	19	1.9
C	50	26,937	644	63.2	220	19.5	27	2.6

Table 7-10. Summary of nighttime speed statistics at Rolla during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	50	53.2	8.3	62.0	84.0
B	50	52.9	7.4	60.0	80.0
C	50	49.6	9.8	60.0	80.0

Table 7-11. Summary of nighttime speed limit compliance at Rolla during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
A	50	8,647	195	65.0	54	18.1	4	1.3
B	50	9,702	253	64.9	57	14.6	2	0.4
C	50	10,175	194	47.4	55	13.4	2	0.5

Table 7-12. Summary of daytime speed statistics at St. James during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
D	60	48.3	20.3	69.0	97.0
E	60	46.9	11.0	58.0	84.0
F	60	47.3	12.0	59.0	88.0

Table 7-13. Summary of daytime speed limit compliance at St. James during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
D	60	45,388	352	43.2	88	10.8	3	0.4
E	60	44,373	79	10.0	7	0.9	0	0.0
F	60	45,927	83	10.1	5	0.6	0	0.0

Table 7-14. Summary of nighttime speed statistics at St. James during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
D	60	63.2	6.3	69.0	92.0
E	60	54.8	7.2	62.0	102.0
F	60	54.7	8.4	63.0	81.0
Overall	60	57.9	8.3	66.0	102.0

Table 7-15. Summary of nighttime speed limit compliance at St. James during work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
D	60	9,349	220	68.1	37	11.4	1	0.3
E	60	8,069	55	19.5	6	2.0	0	0.0
F	60	7,971	66	23.9	3	1.0	0	0.0

Figure 7-4 and Figure 7-5 show the speed distribution and cumulative speed distribution during the work zone period, respectively. The 85th percentile speed exceeded the posted limits (50 mph at Rolla and 60 mph at St. James) at five of the six locations, indicating that most sites experienced high-end speed behavior beyond regulatory thresholds. In contrast, mean speeds remained relatively moderate, ranging from 50 to 52 mph at the Rolla sites and from 48 to 51 mph at the St. James sites. Among the six locations, Location C exhibited the highest mean speed, while Location D recorded the highest 85th percentile speed.

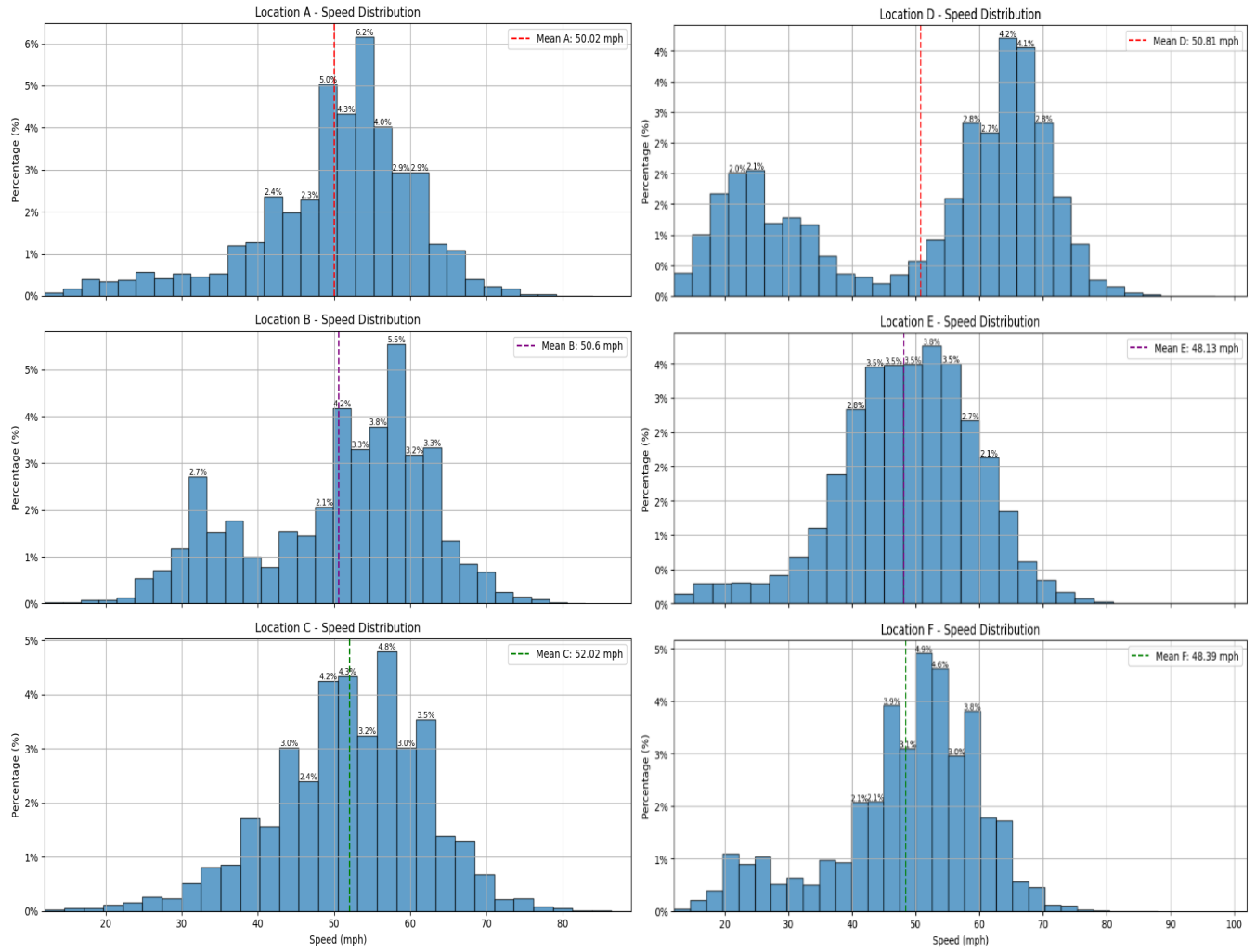


Figure 7-4. Speed distribution during work zone period for I-44 Rolla (left) and St. James (right).

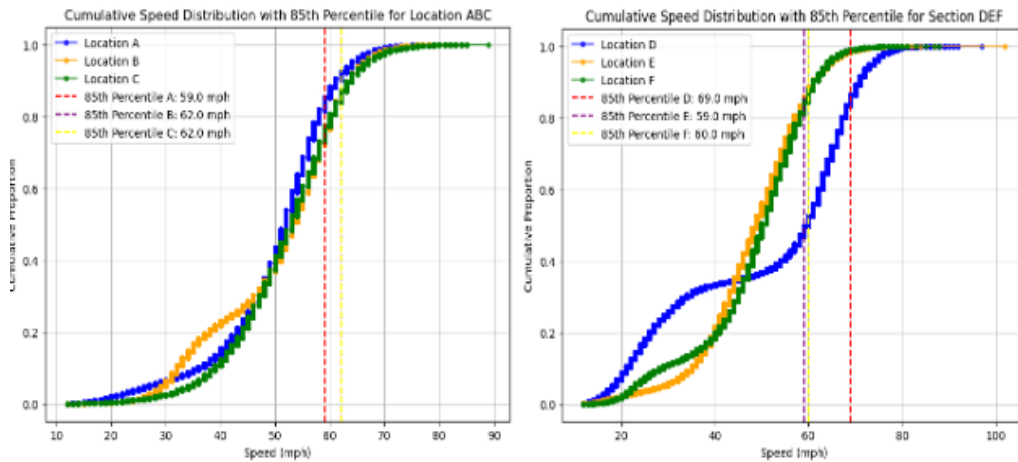


Figure 7-5. Cumulative speed distribution during work zone period for I-44 Rolla (left) and St. James (right).

Figure 7-6 and Figure 7-7 illustrate the class-based speed distribution during the work zone period at Rolla and St. James. The results are summarized in Table 7-16. At both sites, small and medium vehicles consistently exhibited higher mean speeds than large vehicles, except Location D, indicating more cautious driving behavior among larger vehicles. At Rolla, speeds for both classes peaked at Location C, while at St. James, mean speeds peaked at Location D.

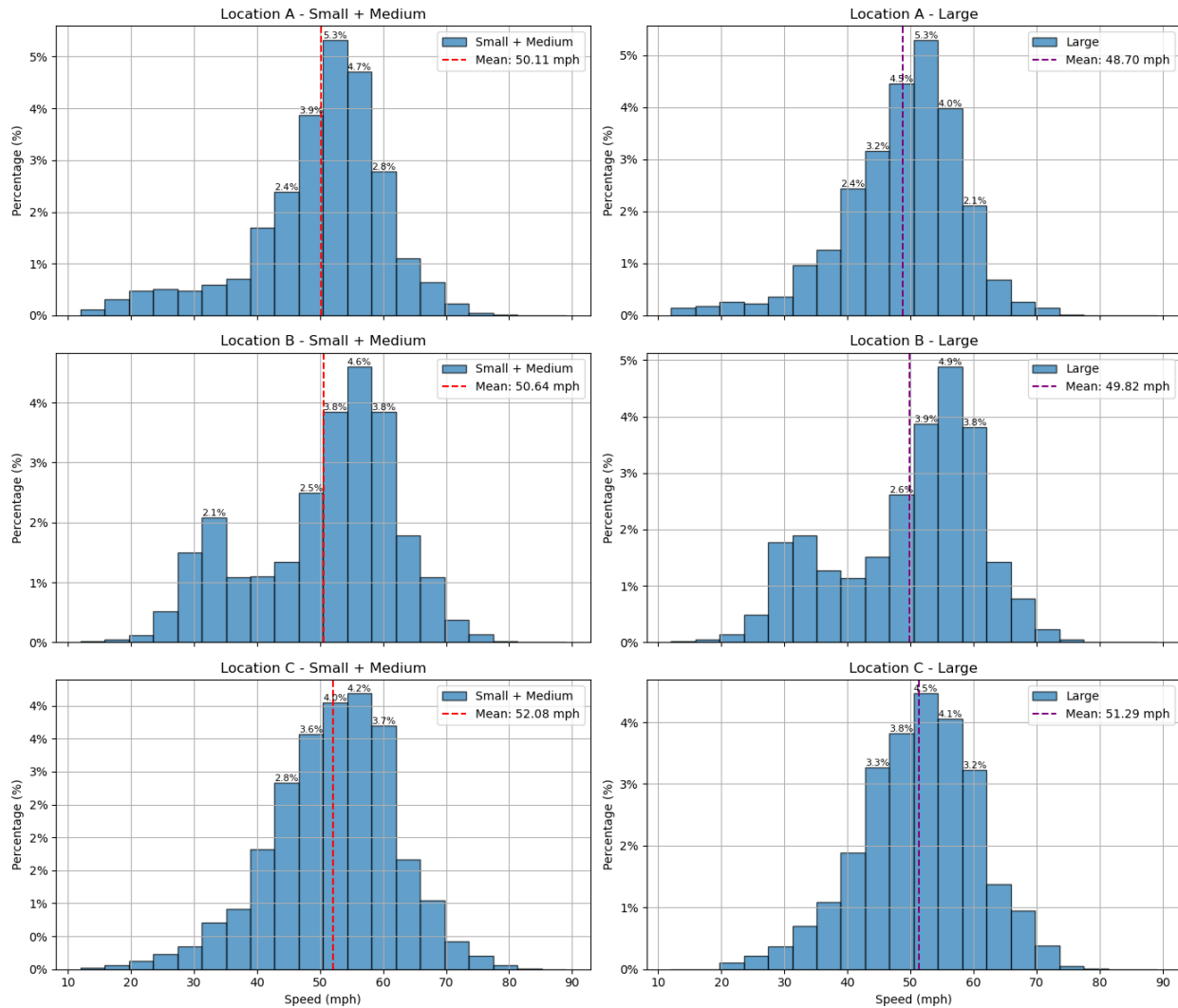


Figure 7-6. Speed distribution by class during work zone period for I-44 Rolla.

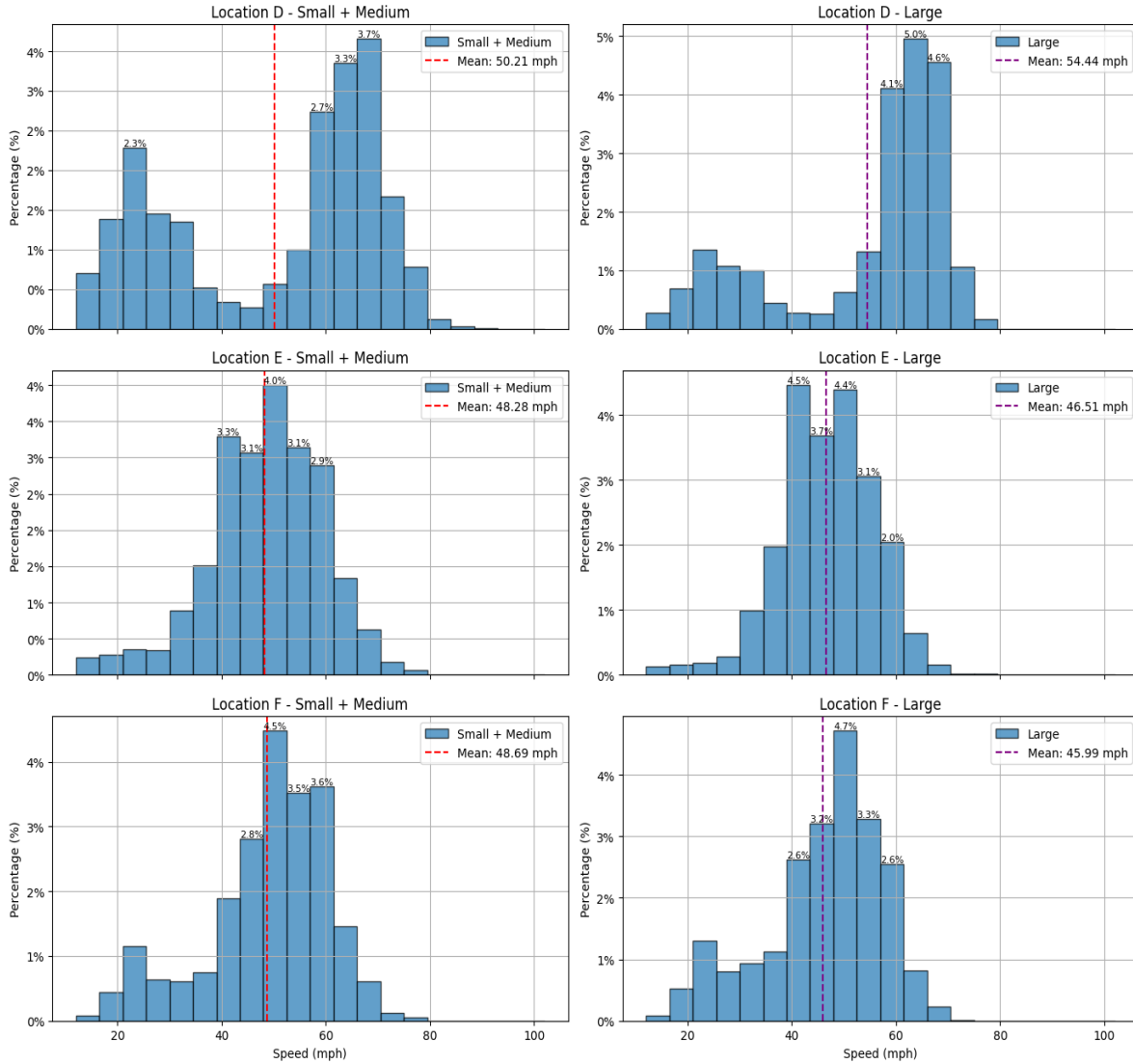


Figure 7-7. Speed distribution by class during work zone period for I-44 St. James.

Table 7-16. Average speeds and speed differences by location and vehicle class during work zone period for I-44 Rolla/St. James.

Location	Average Speed of Small and Medium (mph)	Average Speed of Large (mph)	Difference in Average Speed (mph)
A	50.1	48.7	1.4
B	50.6	49.8	0.8
C	52.1	51.3	0.8
D	50.2	54.4	-4.2
E	48.3	46.5	1.8
F	48.7	46.0	2.7

To analyze temporal variations in traffic flow and speed during the work zone period, hourly average volumes and speeds were evaluated across the three sensor locations at each site. As illustrated in Figure 7-8, both sites exhibited AM and PM peaks with reduced volumes overnight, with Rolla showing higher hourly volumes than St. James. In terms of speed, both sites experienced a midday slowdown followed by partial evening recovery. At Rolla, all three locations followed similar trends, although Location B displayed a sharper midday reduction. At St. James, Location D showed a more pronounced midday decline, while Locations E and F remained more stable with higher overall speeds. Spatially, Rolla locations exhibited consistent speed behavior with noticeable differences in volume, whereas St. James locations were more uniform, except for Location D, which demonstrated greater midday sensitivity.

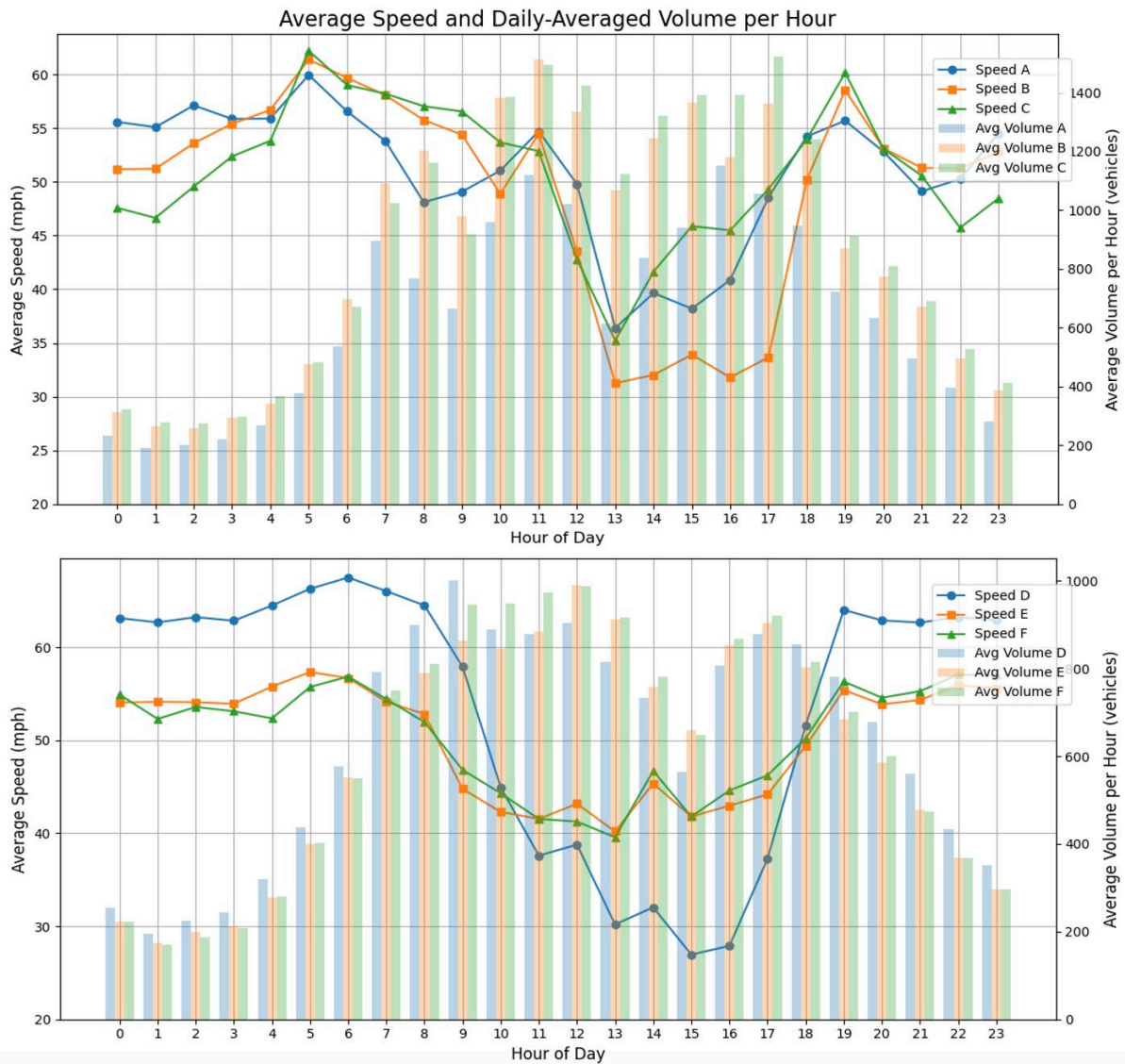


Figure 7-8. Average speed and volume by hour of the day during work zone period for I-44 Rolla (top) and St. James (bottom).

7.2.2 I-44 Rolla/St. James: Results for Non-Work Zone Period

For the non-work zone period at the I-44 Rolla site, a total of 194,424 vehicles were recorded at Location A, while 189,609 vehicles were recorded at Location B, and 232,182 vehicles were recorded at Location C after timestamp alignment. Similar to the work zone period, the observation periods for Location A and Locations B/C were not identical. However, all three locations fall within their respective non-work zone periods. For the St. James site during the non-work zone period, a total of 121,345 vehicles were recorded at Location A, followed by 118,516 vehicles at Location B, and 116,896 vehicles at Location C after timestamp alignment. In contrast to Rolla, the observation periods for all three locations in St. James were consistent during the non-work zone period. The vehicle counts for each class at all locations are summarized in Table 7-17.

Table 7-17. Vehicle counts at all locations during the non-work zone period for I-44 Rolla/St. James.

Location	Small and Medium	Large	Total
A	181,319	13,105	194,424
B	117,003	12,606	189,609
C	210,662	21,520	232,182
D	102,266	19,079	121,345
E	109,343	9,173	118,516
F	108,123	8,773	116,896

The speed statistics for the I-44 Rolla and St. James segments during the non-work zone period are summarized in Table 7-18 and Table 7-19. Overall speeds were higher at St. James. At the Rolla site, average speeds ranged around 66 mph with 85th percentile speeds between 72 and 74 mph. Speed limit exceedance was notably high, with 82.3-87.1% of vehicles surpassing the posted 60 mph limit. The average speed was highest at Location A (upstream) and lowest at Location B (middle). In contrast, the St. James sites recorded average speeds between 67.2–72.2 mph and 85th percentile speeds of 75–77 mph, yet only 37.7–66.8% of vehicles exceeded the higher 60 mph limit. For St. James, the average speed was highest at Location D (upstream) and lowest at Location E (midpoint).

Table 7-18. Summary of speed statistics by location during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	66.4	6.6	72.0	94
B	60	66.1	5.9	72.0	91
C	60	66.3	8.0	74.0	101
D	70	72.2	5.5	77.0	105
E	70	67.2	7.6	75.0	96
F	70	69.8	6.1	75.0	95

Table 7-19. Summary of speed limit compliance by location during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	60	194,424	649	87.1	178	23.9	3	0.4
B	60	189,609	693	84.4	187	22.8	2	0.3
C	60	232,182	827	82.3	299	29.7	12	1.2
D	70	121,345	537	66.8	38	4.7	1	0.1
E	70	118,516	296	37.7	11	1.4	0	0.0
F	70	116,896	362	46.8	15	2.0	0	0.0

To explore the temporal variations, the data were also separated into daytime and nighttime periods, as shown in Table 7-20 through Table 7-27. At both Rolla and St. James site, daytime speeds and exceedance rates were generally higher than those observed at night across all locations. Average speeds increased slightly at each site during the day, with Location C at Rolla and Location E at St. James showing the greatest differences, indicating a higher tendency for speeding under daylight conditions.

Table 7-20. Summary of daytime speed statistics at Rolla during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	66.5	6.7	72.0	93.0
B	60	66.5	5.7	72.0	91.0
C	60	66.7	7.7	74.0	101.0

Table 7-21. Summary of daytime speed limit compliance at Rolla during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
A	60	172,902	827	87.5	231	24.5	4	0.4
B	60	168,732	889	86.1	246	23.8	3	0.3
C	60	209,068	1074	84.0	394	30.8	16	1.3

Table 7-22. Summary of nighttime speed statistics at Rolla during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	60	65.8	5.6	71	94
B	60	63.6	6.7	70	88
C	60	62.8	9.6	72	92

Table 7-23. Summary of nighttime speed limit compliance at Rolla during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
A	60	21,522	255	84.2	57	18.8	1	0.5
B	60	20,877	241	70.6	48	14.1	1	0.2
C	60	23,114	253	67.5	74	19.8	2	0.7

Table 7-24. Summary of daytime speed statistics at St. James during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
D	70	72.4	5.6	77.0	105.0
E	70	67.6	7.5	75.0	96.0
F	70	70.0	6.2	76.0	95.0

Table 7-25. Summary of daytime speed limit compliance at St. James during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
D	70	104,118	711	68.3	52	5.0	1	0.1
E	70	102,578	406	39.6	16	1.5	0	0.0
F	70	101,189	490	48.5	21	2.1	0	0.0

Table 7-26. Summary of nighttime speed statistics at St. James during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
D	70	71.1	5.3	76.0	102.0
E	70	64.7	7.7	73.0	92.0
F	70	68.8	5.4	74.0	94.0

Table 7-27. Summary of nighttime speed limit compliance at St. James during non-work zone period for I-44 Rolla/St. James.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
D	70	17,157	202	57.3	11	3.0	0	0.1
E	70	15,938	82	25.0	3	0.9	0	0.0
F	70	15,707	116	35.8	5	1.5	0	0.0

Figure 7-9 and Figure 7-10 show the speed distribution and cumulative speed distribution during the work zone period, respectively. The 85th percentile speed exceeded the posted limits (60 mph at Rolla and 70 mph at St. James) at all six locations, indicating that all locations experienced high-end speed behavior beyond regulatory thresholds. In contrast, mean speeds remained relatively moderate, approximately 66 mph at the Rolla sites and from 67 to 72 mph at the St. James sites. Notably, average speeds at the St. James sites fluctuated around the posted 70 mph limit, whereas all Rolla locations consistently exceeded their 60 mph limit.

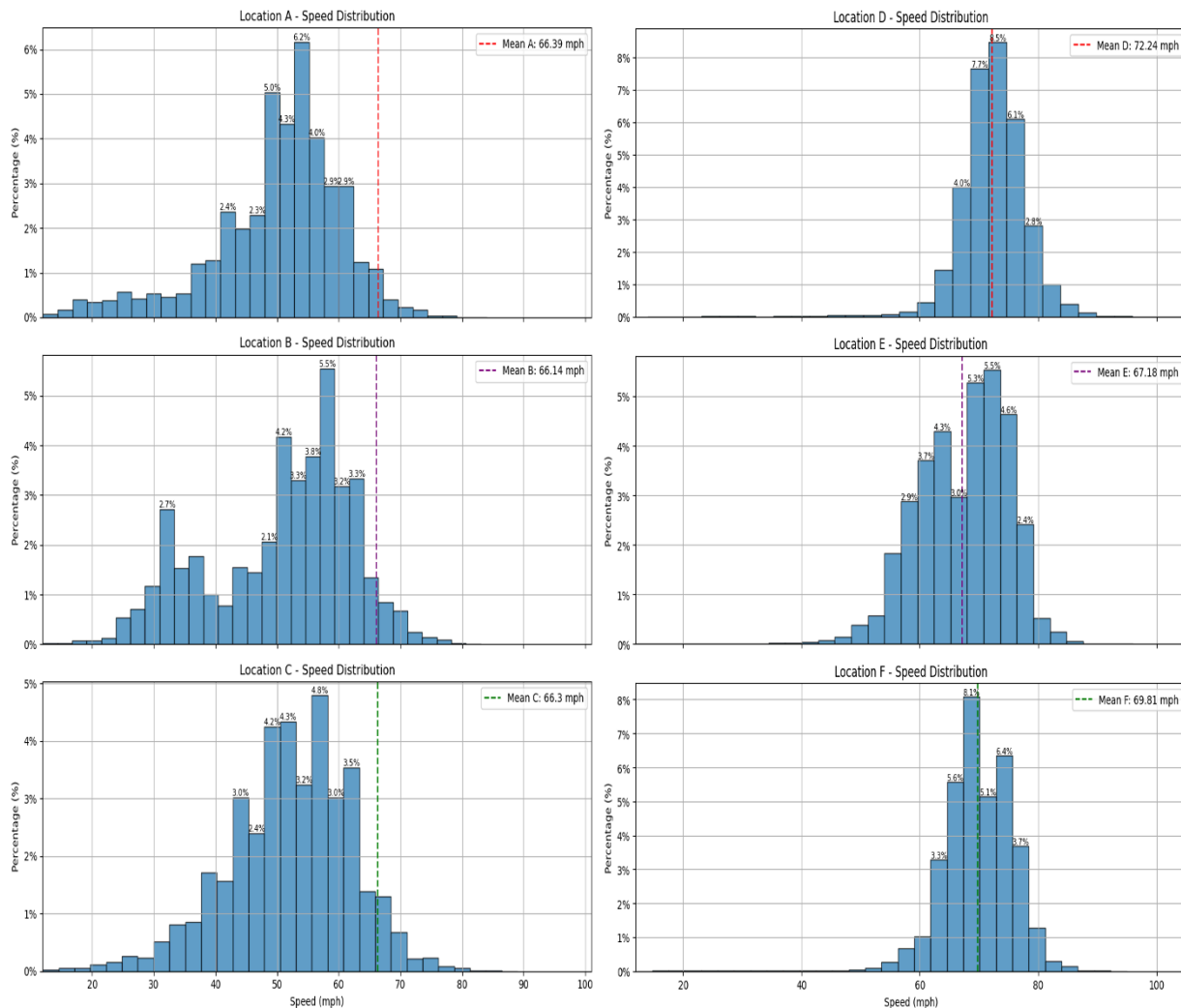


Figure 7-9. Speed distribution during non-work zone period for I-44 Rolla (left) and St. James (right).

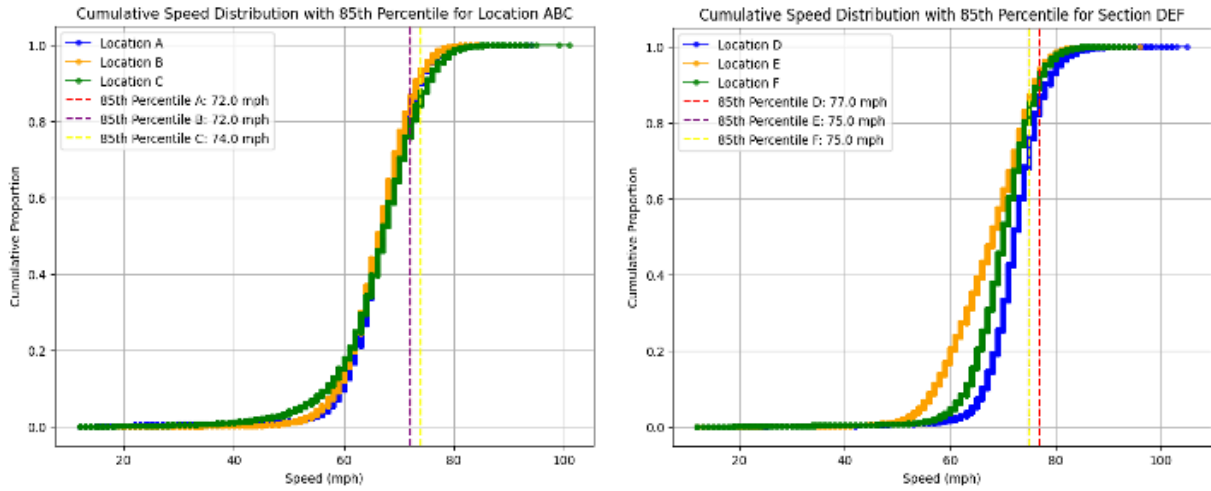


Figure 7-10. Cumulative speed distribution during non-work zone period for I-44 Rolla (left) and St. James (right).

Figure 7-11 and Figure 7-12 illustrate the class-based speed distribution during the non-work zone period at Rolla and St. James. The results are summarized in Table 7-28. At both sites, small and medium vehicles consistently exhibited higher mean speeds than large vehicles with differences of 2–6 mph, indicating more cautious driving behavior among larger vehicles. In addition, both sites demonstrated a general trend of higher speeds at upstream locations, followed by midpoint segments, and lowest speeds downstream.

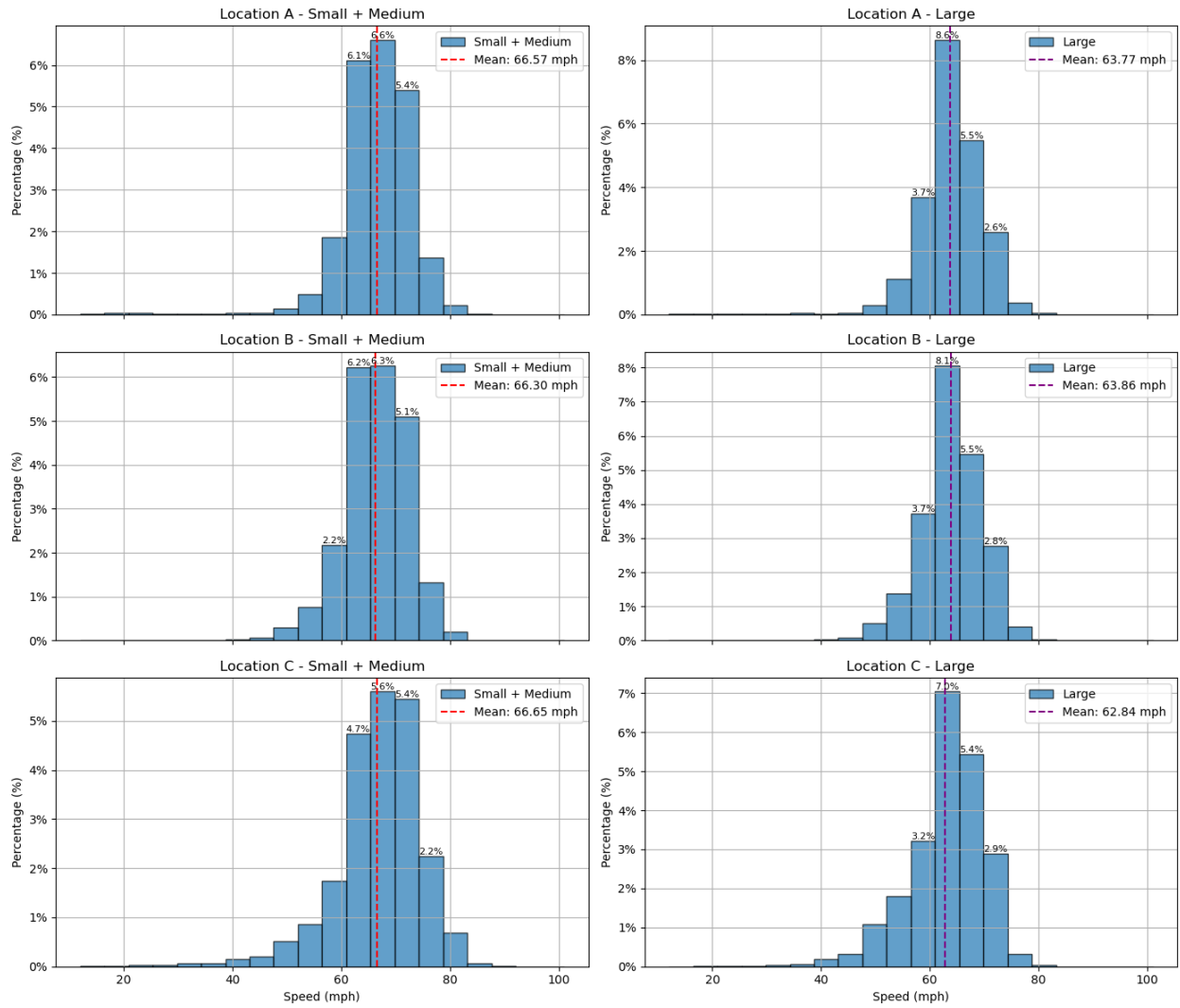


Figure 7-11. Speed distribution by class during non-work zone period for I-44 Rolla.

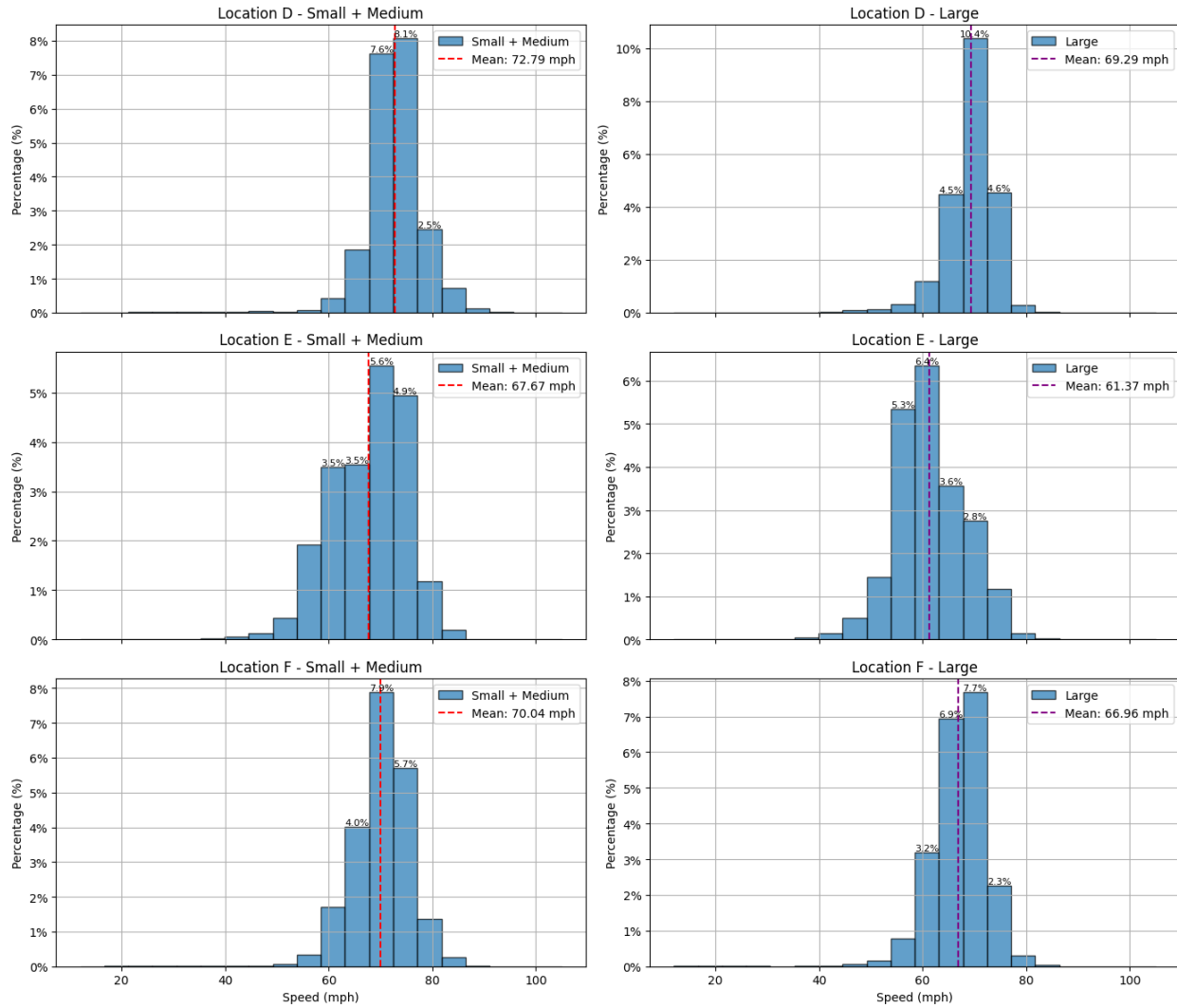


Figure 7-12. Speed distribution by class during non-work zone period for I-44 St. James.

Table 7-28. Average speeds and speed differences by location during non-work zone period for I-44 Rolla/St. James.

Location	Average Speed of Small and Medium (mph)	Average Speed of Large (mph)	Difference in Average Speed (mph)
A	66.6	63.8	2.8
B	66.3	63.9	2.4
C	66.7	62.8	3.9
D	72.8	69.3	3.5
E	67.7	61.4	6.3
F	70.0	67.0	3.0

To analyze temporal variations in traffic flow and speed during the non-work zone period, hourly average volumes and speeds were evaluated across the three sensor locations at each site. As shown in Figure 7-13, both sites exhibited a clear morning rise, a midday peak, and an evening decline in traffic volume, with Rolla consistently recording higher hourly volumes than St. James. In terms of speed, Rolla exhibited early-morning peaks around 67 mph that remained relatively high throughout the day with only a slight midday dip, while St. James maintained generally higher speeds up to approximately 72 mph with more stable daytime patterns. Spatially, Rolla locations displayed nearly identical speed and volume profiles, whereas St. James locations also followed similar patterns, with Location E showing slightly lower overall speeds.

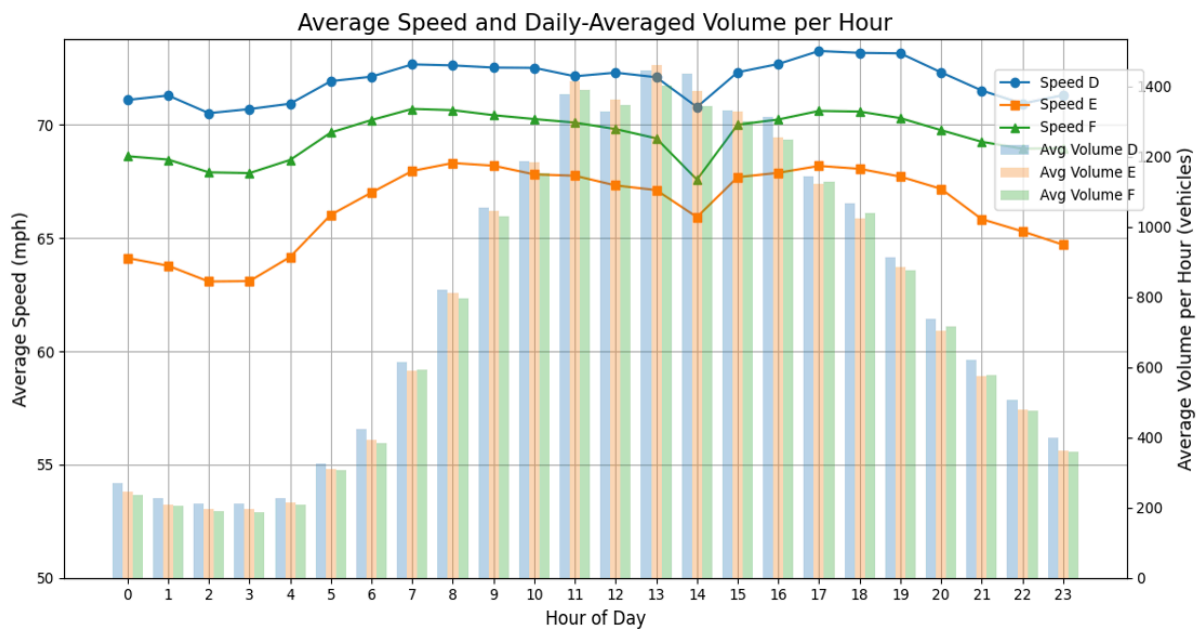
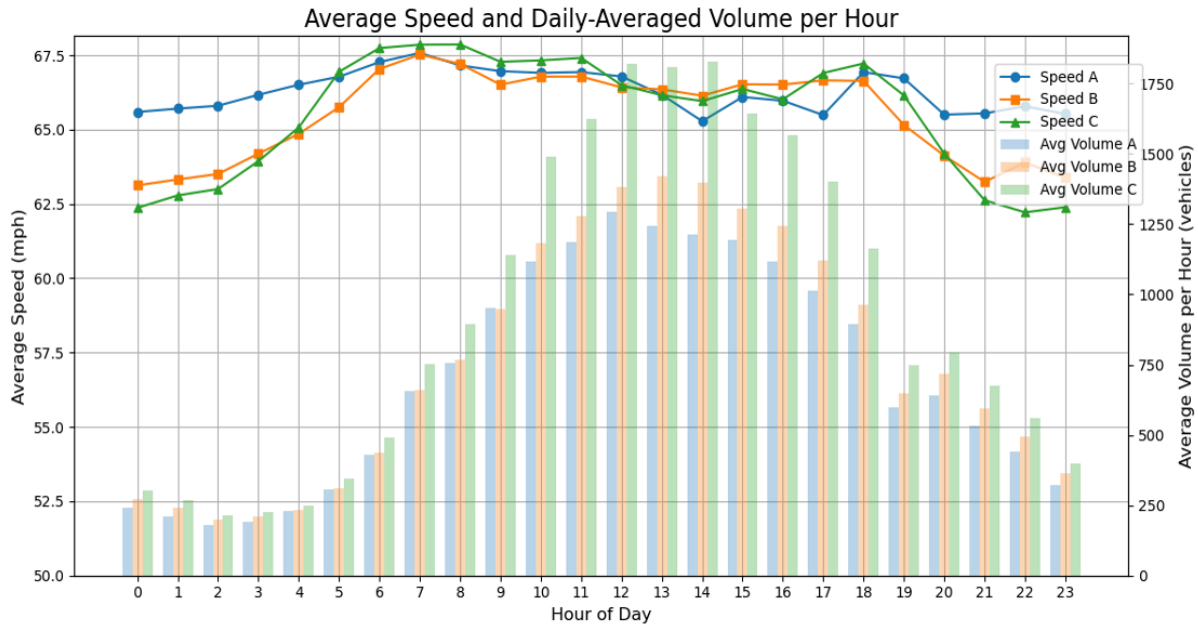


Figure 7-13. Average speed and volume by hour of the day during non-work zone period for I-44 Rolla (top) and St. James (bottom).

7.2.3 I-44 Rolla/St. James: Comparison of Work Zone and Non-Work Zone Periods

To evaluate potential differences in traffic performance between the work zone and non-work zone periods along the I-44 corridor, statistical tests were conducted separately for the Rolla and St. James locations. The results are shown in Table 7-29 and Table 7-30. At both sites, the t-test results revealed significantly lower average speeds during work zone period compared to the non-work zone period. Similarly, the quantile test indicated that fast-driver (85th percentile) speeds decreased substantially under work zone conditions. In addition, the F-test results showed a significant increase in speed variability at both locations, suggesting greater

fluctuations in driving behavior during the work zone period. Overall, these findings indicate that construction activities along I-44 led to consistent reductions in both overall and fast-driver speeds, accompanied by heightened variability in speed behavior at both the Rolla and St. James sites.

Table 7-29. Statistical comparison of speed characteristics between work zone period and non-work zone period for I-44 Rolla.

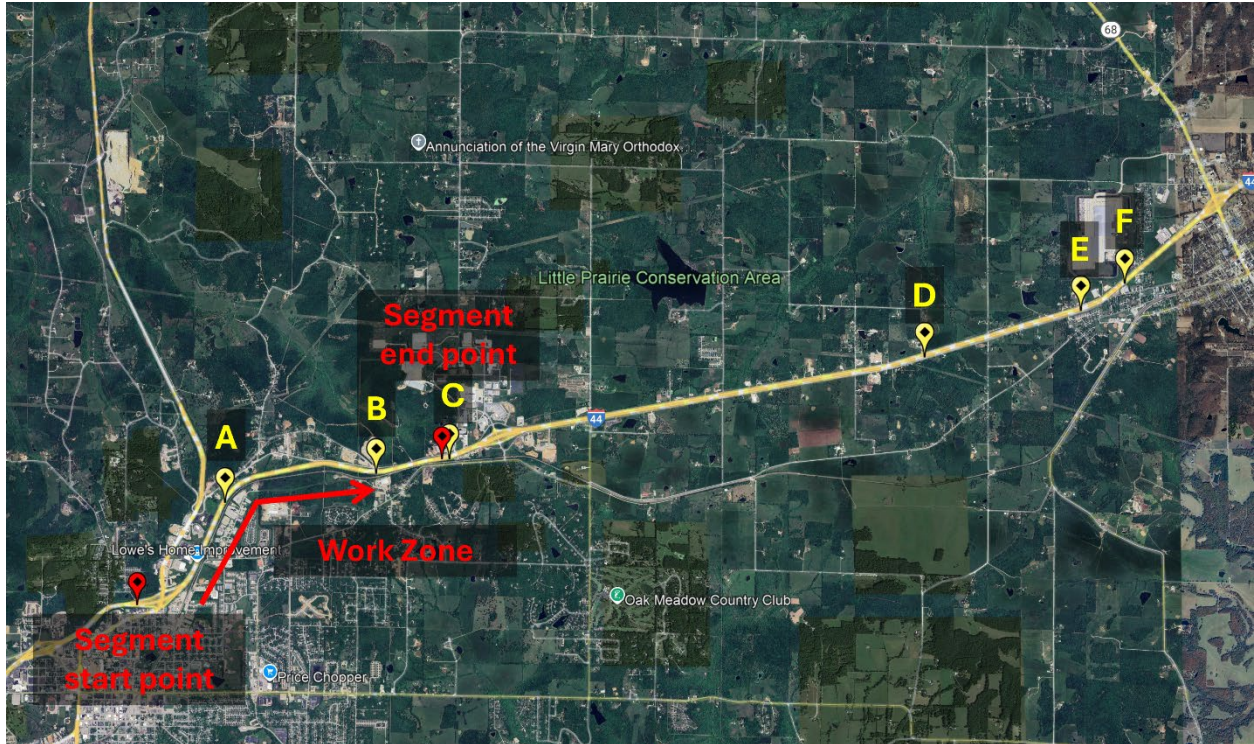
Test	What it Tests	Significance Level	Test Results	Difference	Key Finding
t-test	Difference in Average Speed	0.05	t=-445.4, p<0.001	-15.4 mph	Mean speed significantly lower by 15.2 mph during work zone period
F-test	Difference in Speed Variability	0.05	F=2.419, p<0.001	3.8 mph	Speed variability significantly higher by 3.8 mph during work zone period
Quantile test	Difference in the 85 th Percentile Speed	0.05	Δ =-12 mph, p<0.001	-12 mph	Fast-driver speeds significantly lower by 12 mph during work zone period

Table 7-30. Statistical comparison of speed characteristics between work zone period and non-work zone period for I-44 St. James.

Test	What it Tests	Significance Level	Test Result	Difference	Key Finding
t-test	Difference in Average Speed	0.05	t=-538.2, p<0.001	-20.7 mph	Mean speed significantly lower by 20.7 mph during work zone period
F-test	Difference in Speed Variability	0.05	F=4.696, p<0.001	7.9 mph	Speed variability significantly higher by 7.9 mph during work zone period
Quantile test	Difference in the 85 th Percentile Speed	0.05	Δ = -12 mph, p<0.001	-12 mph	Fast-driver speeds significantly lower by 12 mph during work zone period

7.3 I-44 Rolla/St. James: Results from Analysis of HERE Data

As shown in Figure 7-14, the limits of the HERE segment for I-44 Rolla/St. James nearly encompassed all three of the sensors near Rolla. Part of the HERE segment was located outside of the work zone. HERE data were extracted from 7 AM on May 19 to 3 AM on May 21, 2025 (same dates as work zone and sensors were in place) and from 7 AM on May 19 to 3 AM on May 21, 2022 (historical dates before the work zone was in place).



(Imagery © 2025 Airbus, Landsat / Copernicus, Maxar Technologies, Map data © 2025 Google)

Figure 7-14. Aerial showing HERE segment and speed sensors for I-44 Rolla/St. James.

The results for speed distribution are shown in Figure 7-15, and the cumulative speed distributions are shown in Figure 7-16. The results indicate that the mean speed in 2025 was 1.1 mph lower than the mean speed in 2022, and the standard deviation in 2025 was 1.1 mph higher than the standard deviation in 2022.

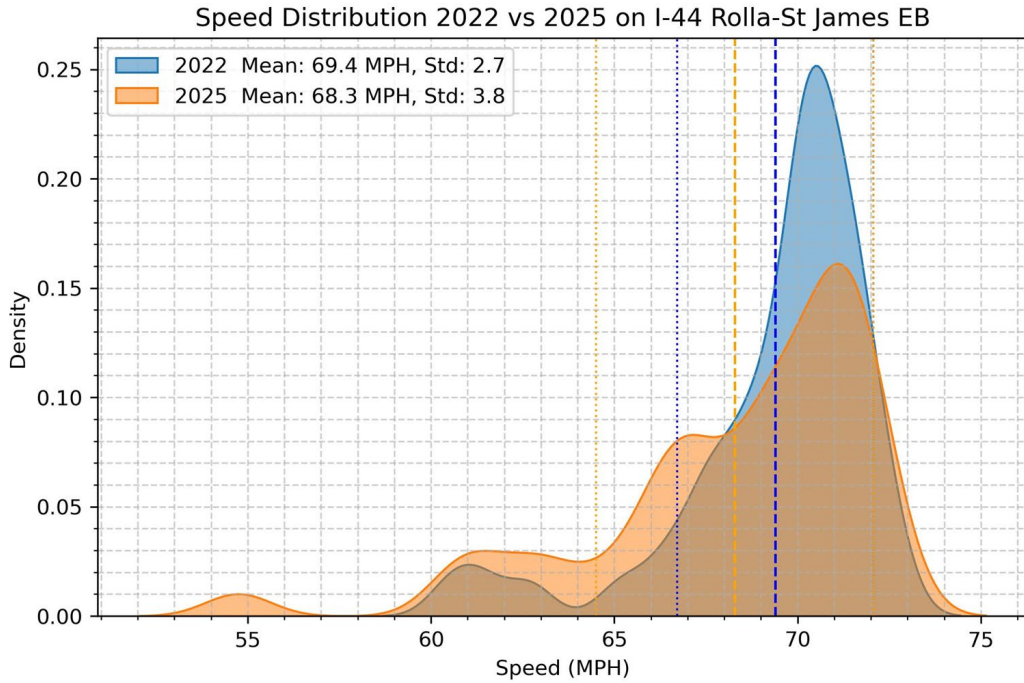


Figure 7-15. Speed distributions for 2022 and 2025 HERE data for I-44 Rolla/St. James.

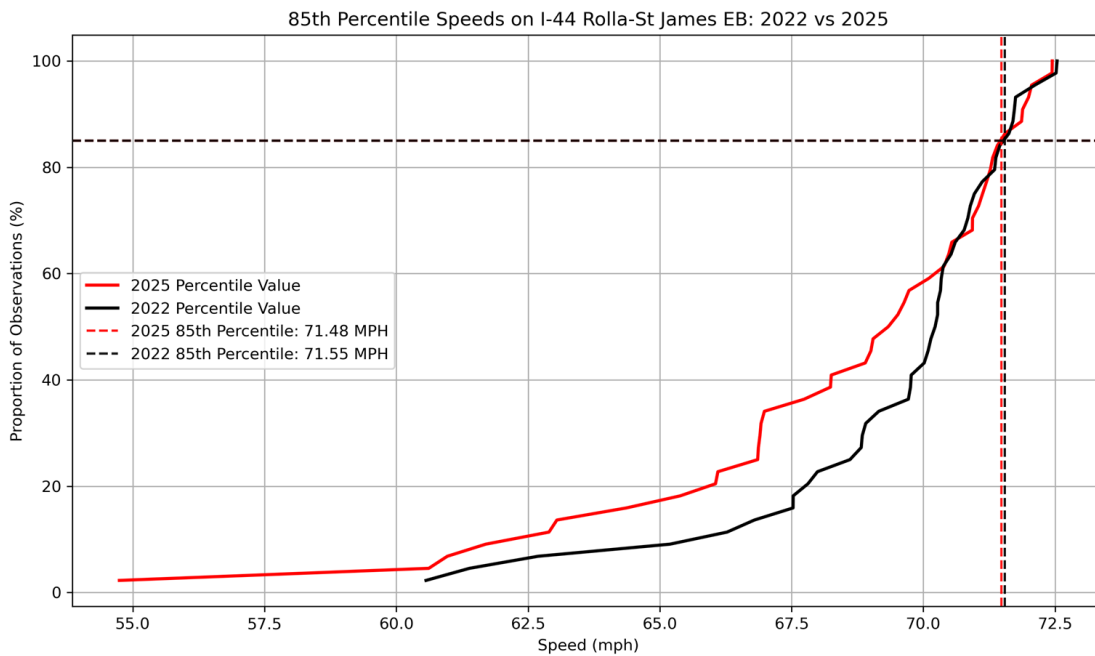


Figure 7-16. Cumulative speed distributions for 2022 and 2025 HERE data for I-44 Rolla/St. James.

Three statistical tests were performed to evaluate speed characteristics between the work zone period (2025) and the historical data (2022) using HERE data, including a t-test for average speed, an F-test for speed variability, and a quantile test for the 85th percentile speed. The test results are summarized in Table 7-31. In summary, the statistical testing results indicate that

construction activities at the I-44 Rolla/St. James sites did not have a statistically significant effect on speed performance. The t-test results showed no significant difference in average speeds between construction and historical data, while the quantile test similarly confirmed that fast-driver (85th percentile) speeds remained comparable across both conditions. Additionally, the F-test results demonstrated that speed variability did not differ significantly between the two periods. These findings suggest that the implementation of construction activities did not substantially alter overall, fast-driver, or variability-related speed behaviors at the studied locations comparing with historical data.

Table 7-31. Statistical comparison of speed characteristics between construction and historical data for HERE data for I-44 Rolla/St. James.

Test	What it Tests	Significance Level	Test Results	Difference	Key Finding
t-test	Difference in Average Speed	0.05	t=-1.286, p=0.202	- 1.1 mph	Mean speed not significantly different during construction
F-test	Difference in Speed Variability	0.05	F=1.482, p=0.196	1.1 mph	Speed variability not significantly different during construction
Quantile test	Difference in the 85 th Percentile Speed	0.05	Δ =-0.074 mph, p=0.9	- 0.07 mph	Fast-driver speeds not significantly different during construction

The speed limit compliance results for the HERE data are shown in Table 7-32. The results indicate a lack of compliance with the 50-mph speed limit in 2025, with almost 98% of observations exceeding the speed limit by 5 mph. Speed limit compliance with the 60-mph speed limit in 2022 was also low as 93% of observations were greater than the speed limit by at least 5 mph.

Table 7-32. Summary of HERE speed limit compliance results for I-44 Rolla/St. James.

Exceeding Speed Limit By	2022 (Speed Limit = 60 mph)	2025 (Speed Limit = 50 mph / 60 mph)
5 mph	93.2 %	97.7 %
10 mph	59.1 %	97.7 %
15 mph	0.0 %	84.1 %
20 mph	0.0 %	43.2 %

7.4 I-44 Rolla/St. James: Results from Analysis of Crash Data

No crashes were reported within the I-44 Rolla/St. James work-zone limits during the monitoring period.

7.5 I-44 Rolla/St. James: Summary of Results

Overall speed statistics for I-44 Rolla/St. James are shown in Table 7-33, and overall speed limit compliance results are shown in Table 7-34 through Table 7-37. The I-44 Rolla/St. James results are summarized below.

- Speeds were significantly lower in the non-work zone period compared to the work zone period, indicating that drivers reduced their speeds when the work zone was present. However, speed variation was higher in the work zone period.
- In the non-work zone period, mean speeds generally stayed above 65 mph at Rolla and from approximately 67–72 mph at St. James.
- During the work zone period, mean speeds dropped to 50–52 mph range at Rolla and 48–51 mph at St. James, with more pronounced midday slowdowns.
- Compliance was higher during the work zone period than the non-work zone period. For Rolla, 56% to 61% of drivers exceeded the work zone speed limit of 50 mph, while 82% to 87% of drivers exceeded the non-work zone speed limit of 60 mph. For St. James, 12% to 47% of drivers exceeded the work zone speed limit of 60 mph, and 38% to 67% of drivers exceeded the non-work zone speed limit of 70 mph.
- Speeds for Locations A, B, and C at Rolla show highly similar trends, with modest speed differences (less than 2 mph) and consistent 85th percentiles.
- Speeds for Locations D, E, and F align closely overall, but Location E (midpoint) consistently shows the lowest speeds and sharpest drop during construction, standing out as a localized bottleneck.
- Average speeds for small and medium vehicles were generally higher (1–3 mph) than average speeds for trucks at most locations.
- Speeds were consistently lower during nighttime than during daytime, possibly due to drivers being more cautious when traveling through the work zone during nighttime.
- During the work zone period, both Rolla and St. James experienced clear AM (7–9 AM) and PM (4–6 PM) peaks, with the lowest volumes overnight.
- For the non-work zone period, traffic patterns were smoother, still showing overnight lows and daytime increases, but the peaks were less pronounced.
- Analysis of HERE data for Rolla shows a lack of speed limit compliance with the 50-mph work zone speed limit and 60-mph speed limit with no work zone present. Differences in speed and speed variability were not statistically significant.

Table 7-33. Overall summary of speed statistics for I-44 Rolla/St. James.

Period	Posted Speed Limit (mph)	Average Speed (mph)	Standard Deviation of Speed (mph)	85 th Percentile Speed (mph)	Maximum Speed (mph)	% Large Vehicles
Work Zone Period (Rolla)	50	50.9	10.8	61	85	6.4
Work Zone Period (St. James)	60	49.1	14.7	64	102	11.3
Non-Work Zone Period (Rolla)	60	66.3	7.0	73	101	7.7
Non-Work Zone Period (St. James)	70	69.8	6.8	76	105	10.4

Table 7-34. Overall summary of speed limit compliance results for I-44 Rolla (work zone period).

Time of Day	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
Day	50	77,027	914	58.6	276	17.7	27	1.8
Night	50	28,524	428	58.7	111	15.2	5	0.7
All	50	105,551	699	58.6	203	17.0	18	1.5

Table 7-35. Overall summary of speed limit compliance results for I-44 St. James (work zone period).

Time of Day	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
Day	60	135,688	512	21.1	100	4.1	4	0.2
Night	60	25,389	328	38.8	44	5.2	1	0.1
All	60	161,077	448	23.9	80	4.3	3	0.1

Table 7-36. Overall summary of speed limit compliance results for I-44 Rolla (non-work zone period).

Time of Day	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
Day	60	550,702	2577	85.7	802	26.7	20	0.7
Night	60	65,513	657	74.0	157	17.7	4	0.4
All	60	616,215	2026	84.5	617	25.7	16	0.5

Table 7-37. Overall summary of speed limit compliance results for I-44 St. James (non-work zone period).

Time of Day	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
Day	70	307,955	1605	52.3	88	2.9	1	0.0
Night	70	48,802	389	39.8	18	1.8	1	0.0
All	70	356,757	1201	50.6	65	2.7	1	0.0

8. I-55 St. Louis

This chapter presents the methodology and results for the speed study on I-55 in St. Louis, Missouri.

8.1 I-55 St. Louis: Study Overview

8.1.1 I-55 St. Louis: Site Overview

Data were collected at a work zone on I-55 northbound in St. Louis from June 24 to July 22, 2025. This work zone involved bridge rehabilitation. The work zone speed limit was 50 mph, with a non-work zone speed limit of 60 mph. The speed limit drop was implemented in two steps (60 mph to 55 mph, 55 mph to 50 mph). The lane configuration included a two-lane drop (four lanes to two lanes) implemented in two steps (four lanes to three lanes, three lanes to two lanes). Two-way traffic was separated with temporary barrier (see Figure 8-1). Data were collected within the two-lane section with a posted work zone speed limit of 50 mph. Active work took place in the southbound lanes during daytime. Lane widths were 11 feet to 11.5 feet. The overall project on I-55 in St. Louis with lane reductions began in April of 2022. The lane configuration studied in this research was implemented in May 2025. The work zone was present during the entire time of data collection.

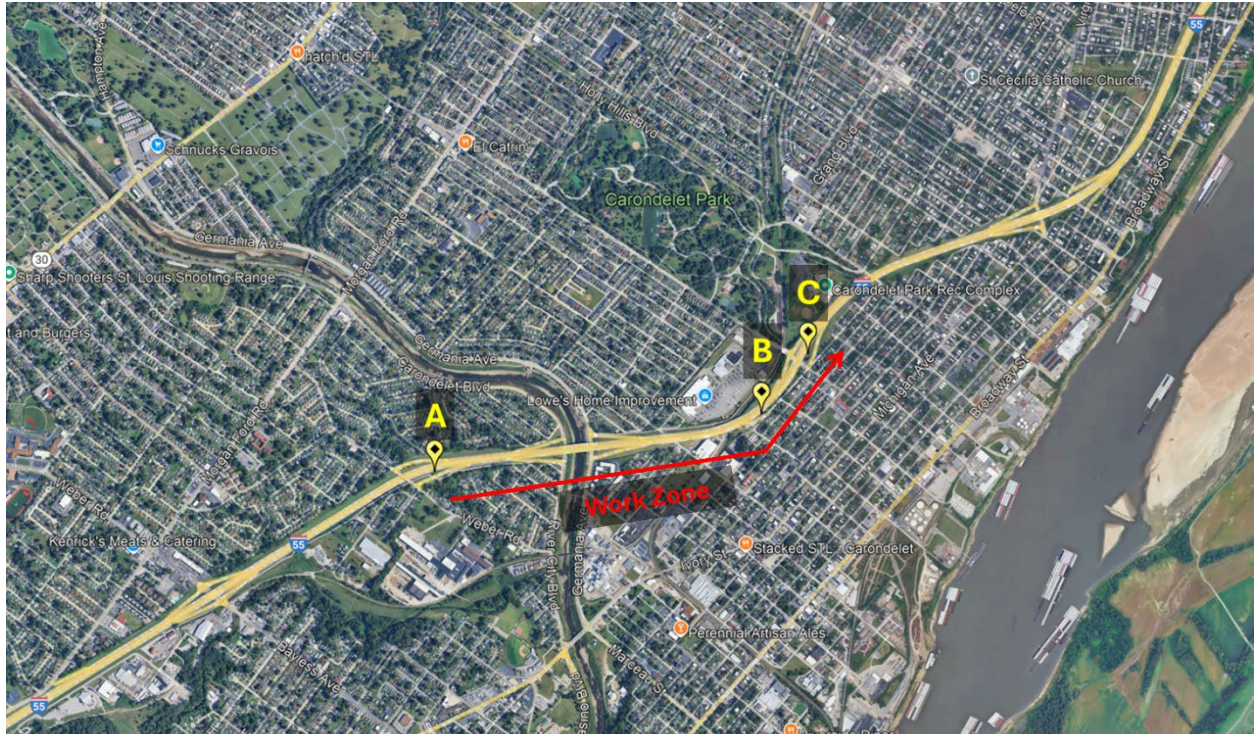


Figure 8-1. Two-way traffic separated by temporary barrier on I-55 in St. Louis.

8.1.2 I-55 St. Louis: Experimental Setup

This project analyzed vehicle speed patterns within the I-55 work zone at St. Louis, Missouri. As shown in Figure 8-2, three radar sensors were positioned at three locations along eastbound I-55 to monitor traffic conditions and drive behavior. All three sensors were deployed within the two-lane section of the work zone. Location A was installed at the upstream end, Location B

near the midpoint, and Location C toward the downstream end. Location A is located approximately 1.0 mile upstream of Location B and approximately 1.2 miles upstream of Location C. Figure 8-3 shows a view of oncoming traffic at Location B.



(Imagery © 2025 Airbus, Landsat / Copernicus, Maxar Technologies, Map data © 2025 Google)

Figure 8-2. Sensor layout for I-55 St. Louis.



Figure 8-3. View of oncoming traffic at Location B for I-55 in St. Louis.

The sensors were installed on June 24; however, due to limited storage capacity, data from June 24 to June 29 were partially overwritten before being saved. The data collection period of each location is listed as follows:

- **Location A** (38.8190444, -91.1314564): Data were collected from 11:11 AM on June 29 to 9:58 AM on July 10, and then from 6:10 PM on July 11 to 12:45 PM July 22, resulting 21 days, 17 hours, and 22 minutes of observation in total.
- **Location B** (38.819937, -91.0981471): Data were collected from 9:14 AM on June 27 to 4:38 PM on July 8, and from 14:18 on July 11 to 4:04 PM on July 22, corresponding to approximately 22 days, 9 hours, and 10 minutes of observation.
- **Location C** (38.823857, -91.0715704): Data were collected from 1:17 PM on June 27 to 1:46 PM on July 22, 2025, for a total of 25 days and 29 minutes of observations.

The work zone was in place during the entire time period of the data collection. According to the work zone implementation timeline, the dataset were segmented into two distinct periods: the active work period and the non-active work period. The active work period spanned June 30-July 3, July 7-11, July 14-18, and July 21-22, totaling 20 days. On those days the contractor worked on the site during the daytime, but the entire 24-hour period for each date was included in this time period. The non-active work period comprised the remaining dates (generally holidays and weekends), specifically June 29, July 4–6, July 8, July 12–13, and July 19–20, totaling 9 days. During both the active work and non-active work period, the posted speed limit at all three sensor locations was 50 mph. In addition, due to the orientation of each sensor, only incoming data from Location A and B, and outgoing data from Location C are considered in this study.

8.2 I-55 St. Louis: Results from Field Study

To minimize potential errors in vehicle counts and speed measurements resulting from differences in sensor installation times and occasional interruptions caused by battery issues, time alignment was performed. The aligned timeline of data analysis for each sensor is shown in Table 8-1.

Table 8-1. Aligned timeline of data analysis phase for I-55 St. Louis.

Period	Posted Speed Limit	Start Time	End Time	Duration
Active Work Period 1	50	June 30, 12:00 AM	July 3, 11:59 PM	4 days
Active Work Period 2	50	July 7, 12:00 AM	July 11, 11:59 PM	5 days
Active Work Period 3	50	July 14, 12:00 AM	July 18, 11:59 PM	5 days
Active Work Period 4	50	July 21, 12:00 AM	July 22, 12:45 PM	1 day, 12 hours, 45 minutes
Active Work Period Total	50	n/a	n/a	15 days, 12 hours, 45 minutes
Non-Active Work Period 1	50	June 29, 11:11 AM	June 29, 11:59 PM	12 hours 48 minutes
Non-Active Work Period 2	50	July 4, 12:00 AM	July 6, 11:59 PM	3 days
Non-Active Work Period 3	50	July 12, 12:00 AM	July 13, 11:59 PM	2 days
Non-Active Work Period 4	50	July 19, 12:00 AM	July 20, 11:59 PM	2 days
Non-Active Work Period Total	50	n/a	n/a	7 days, 12 hours, 48 minutes

8.2.1 I-55 St. Louis: Results for Active Work Period

For the active work period, a total of 406,555 vehicles were recorded at Location A, while 400,638 vehicles were recorded at Location B, and 357,196 vehicles were recorded at Location C after timestamp alignment. The vehicle counts for each class at all three locations are summarized in Table 8-2.

Table 8-2. Vehicle counts at all locations during the active work period for I-55 St. Louis.

Location	Small and Medium	Large	Total
A	381,807	24,748	406,555
B	376,278	24,360	400,638
C	329,846	27,350	357,196

The summary of speed statistics and compliance outcomes is provided in Table 8-3 and Table 8-4. Overall, the results indicate a low level of compliance with the work zone speed limit of 50 mph. Average and 85th percentile speeds were highest at Location A (upstream) and lowest at Location B (middle). At Location A, the average speed was 60.6 mph, with a standard deviation

of 7.9 mph and an 85th percentile speed of 67.0 mph. In total, 92.6% of vehicles exceeded the posted speed limit of 60 mph, with 58.3% exceeding it by at least 10 mph and 5.2% exceeding it by 20 mph or more. At Location B, the average speed decreased to 57.9 mph, with a standard deviation of 6.9 mph and an 85th percentile speed of 64 mph. Approximately 90.4% of vehicles exceeded the speed limit, among which 34.7% exceeded it by 10 mph, while 1.8% vehicles exceeded it by 20 mph. At Location C, the average speed was 58.7 mph, with a standard deviation of 7.2 mph and an 85th percentile speed of 65 mph. In this location, 91.7% of vehicles exceeded the speed limit, including 40.6% by at least 10 mph and 2.5% by at least 20 mph.

Table 8-3. Summary of speed statistics by location during active work period for I-55 St. Louis.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	50	60.6	7.9	67.0	99
B	50	57.9	6.9	64.0	95
C	50	58.7	7.2	65.0	95

Table 8-4. Summary of speed limit compliance by location during active work period for I-55 St. Louis.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	50	406,555	1,282	92.6	807	58.3	72	5.2
B	50	400,638	1,219	90.4	468	34.7	25	1.8
C	50	357,196	1,024	91.7	453	40.6	28	2.5

To further evaluate temporal variations in driving behavior, the data were classified into daytime and nighttime periods, as summarized in Table 8-5 through Table 8-6. The contractor only worked during daytime. Across all locations, both mean speeds and exceedance rates were consistently lower during daytime compared to nighttime. The result for lower daytime speeds may be due to traffic congestion during the morning peak. At Location A, the average speed increased from 60.5 mph during daytime to 61.6 mph during nighttime, while at Location B it increased from 57.8 mph to 59.3 mph, and at Location C from 58.5 mph to 60.3 mph. Likewise, the proportion of vehicles exceeding the posted speed limit was higher during nighttime at all three sites, which indicates more aggressive driving behavior under nighttime conditions.

Table 8-5. Summary of daytime speed statistics during active work period for I-55 St. Louis.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	50	60.5	8.1	67.0	99.0
B	50	57.8	6.9	64.0	92.0
C	50	58.5	7.2	64.0	92.0

Table 8-6. Summary of daytime speed limit compliance during active work period for I-55 St. Louis.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
A	50	364,447	1,703	92.2	1,081	58.5	90	4.9
B	50	362,362	1,627	90.3	611	33.9	26	1.5
C	50	319,188	1,347	91.5	584	39.7	29	2.0

Table 8-7. Summary of nighttime speed statistics during active work period for I-55 St. Louis.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	50	61.6	6.4	68.0	93.0
B	50	59.3	7.0	66.0	95.0
C	50	60.3	6.9	67.0	95.0

Table 8-8. Summary of nighttime speed compliance during active work period for I-55 St. Louis.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
A	50	42,108	420	96.3	248	56.9	33	7.6
B	50	38,276	364	91.2	169	42.3	21	5.4
C	50	38,008	345	93.5	179	48.5	24	6.6

Figure 8-4 and Figure 8-5 show the speed distribution and cumulative speed distribution during the active work period, respectively. The 85th percentile speed and mean speed exceeded the posted 50-mph limit at all locations. Among the three locations, Location A exhibited the highest mean and 85th percentile speeds, followed by Location C and then Location B.

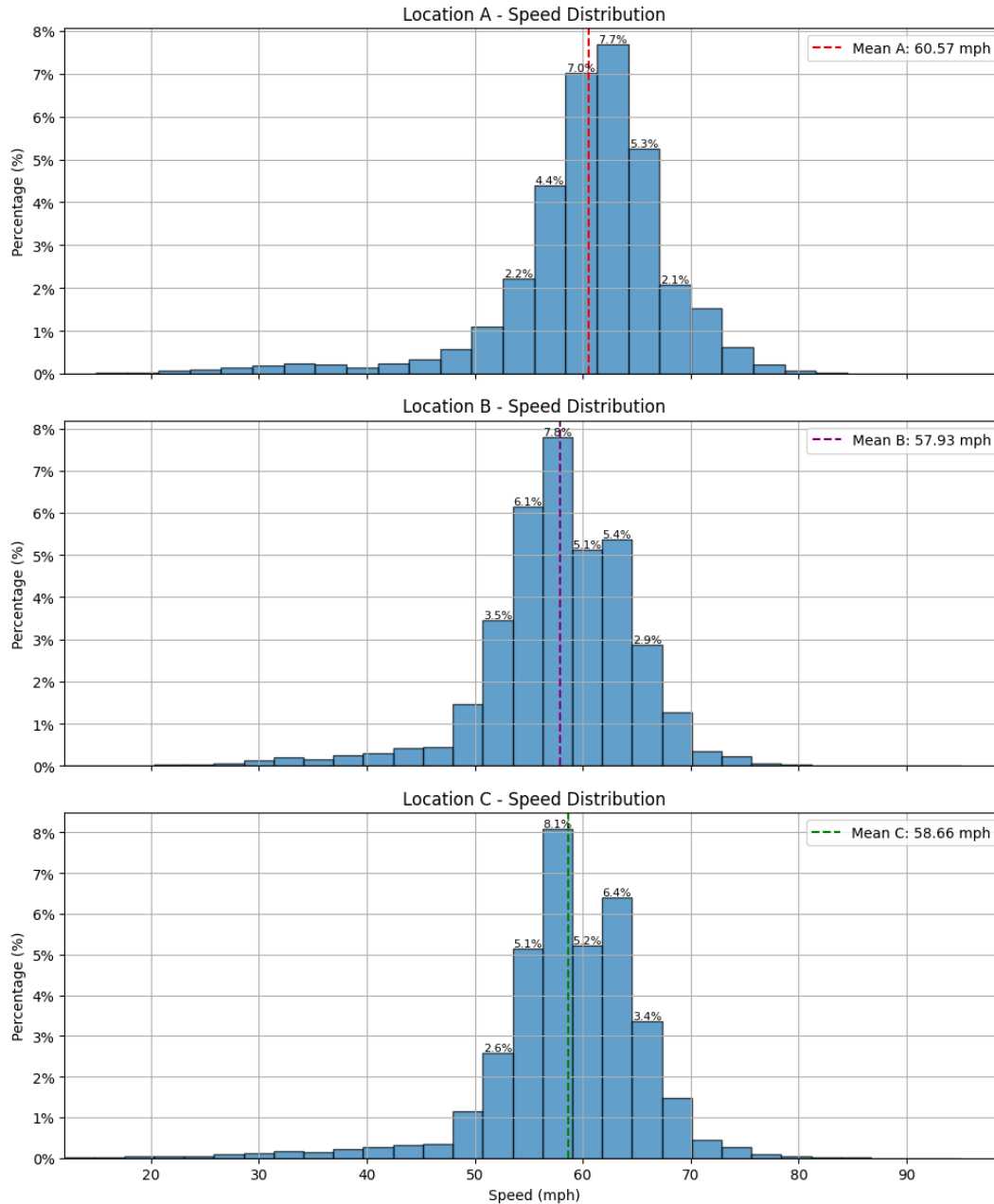


Figure 8-4. Speed distribution during active work period for I-55 St. Louis.

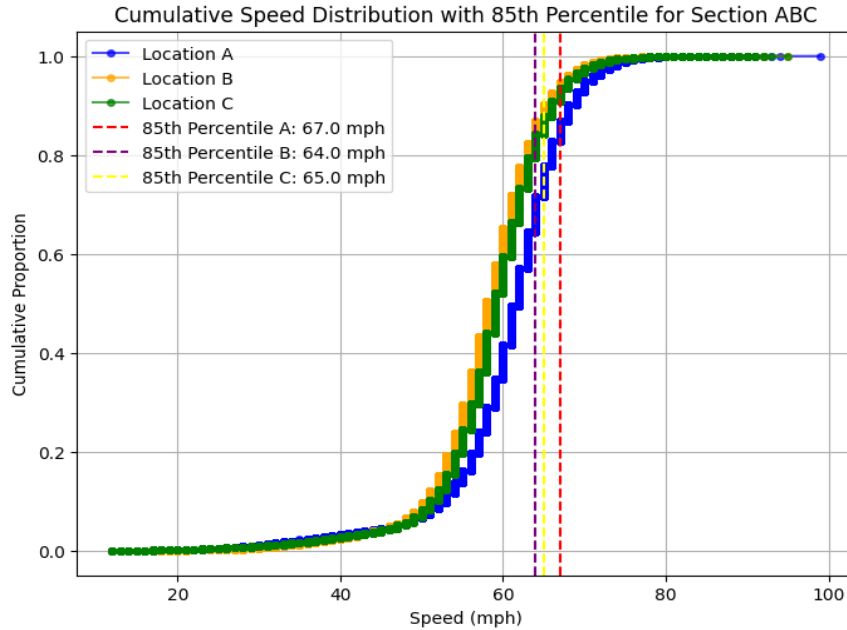


Figure 8-5. Cumulative speed distribution during active work period for I-55 St. Louis.

Figure 8-6 presents the speed distributions for small and medium and large vehicles across the three locations during the active work period for I-55 St. Louis, with corresponding mean speed and speed differences summarized in Table 8-9. A clear and consistent pattern is observed across all sites: small and medium vehicles travel at higher mean speeds than large vehicles, indicating relatively more cautious driving behavior among larger vehicles. In terms of spatial variation, both vehicle classes follow the same speed ranking, with Location A exhibiting the highest mean speeds, followed by Location C, and Location B showing the lowest. This consistent ordering across both classes reinforces the influence of location-specific roadway or traffic conditions on overall operating speeds. Although small and medium vehicles consistently outpaced large vehicles across all locations, the magnitude of this difference varied by site, ranging from 1.83 mph at Location A to 3.29 mph at Location C.

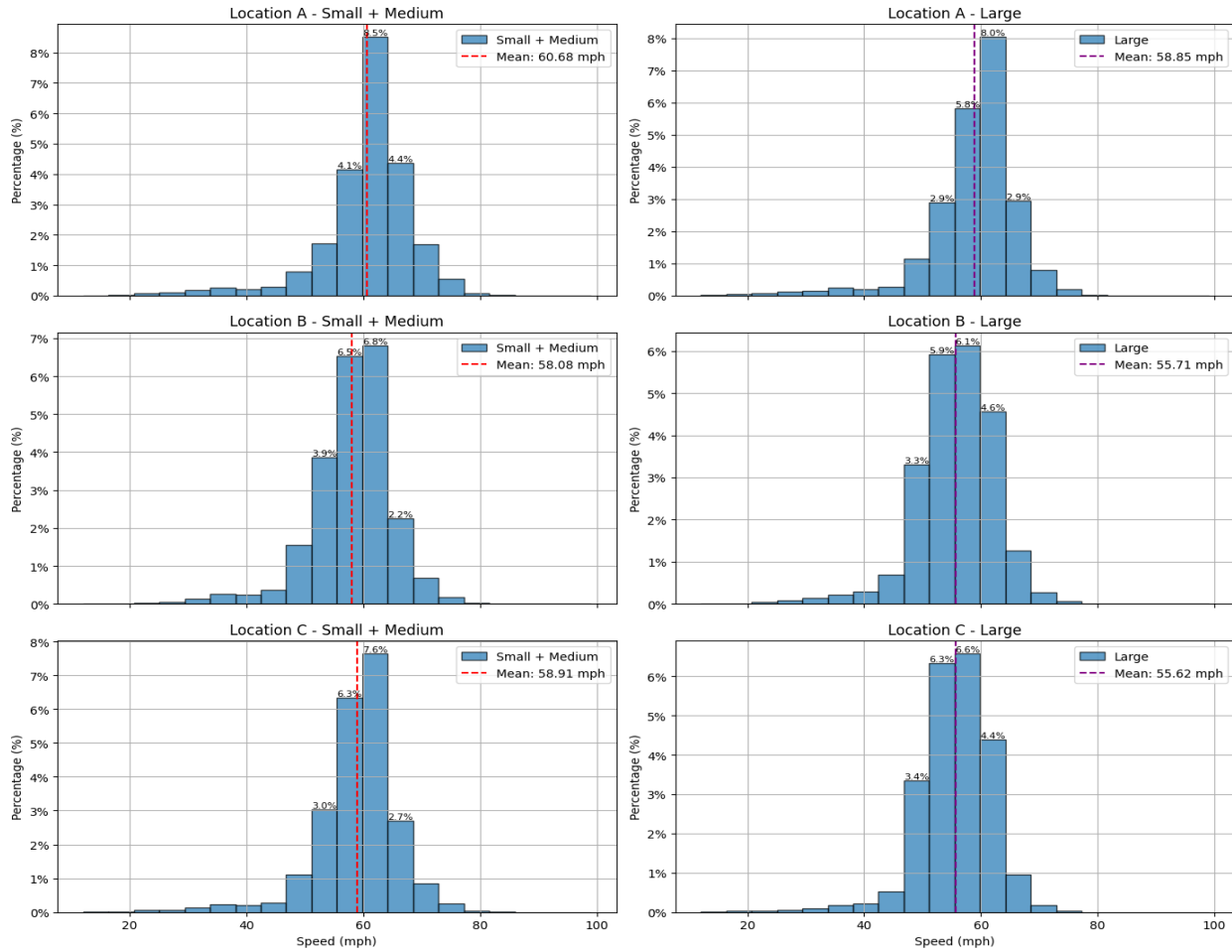


Figure 8-6. Speed distribution by class during active work period for I-55 St. Louis.

Table 8-9. Average speeds and speed differences by location and vehicle class during active work period for I-55 St. Louis.

Location	Average Speed of Small and Medium (mph)	Average Speed of Large (mph)	Difference in Average Speed (mph)
A	60.68	58.85	1.83
B	58.08	55.71	2.37
C	58.91	55.62	3.29

To analyze temporal variations in traffic flow and speed during the active work period, hourly average volumes and speeds were evaluated across the three sensor locations. As illustrated in Figure 8-7, traffic volumes were very low overnight, began to rise sharply after approximately 4:00 AM, peaked around 6:00 AM–8:00 AM, and then remained relatively steady at a moderate level throughout the day before gradually declining during the evening hours. In terms of speed, vehicle speeds dropped sharply during the morning peak period (around 7:00 AM) when volumes were highest, then gradually recovered and remained relatively stable throughout the

afternoon and evening. Spatially, Location A consistently exhibited the highest speeds, Location B recorded the lowest, and Location C fell in between.

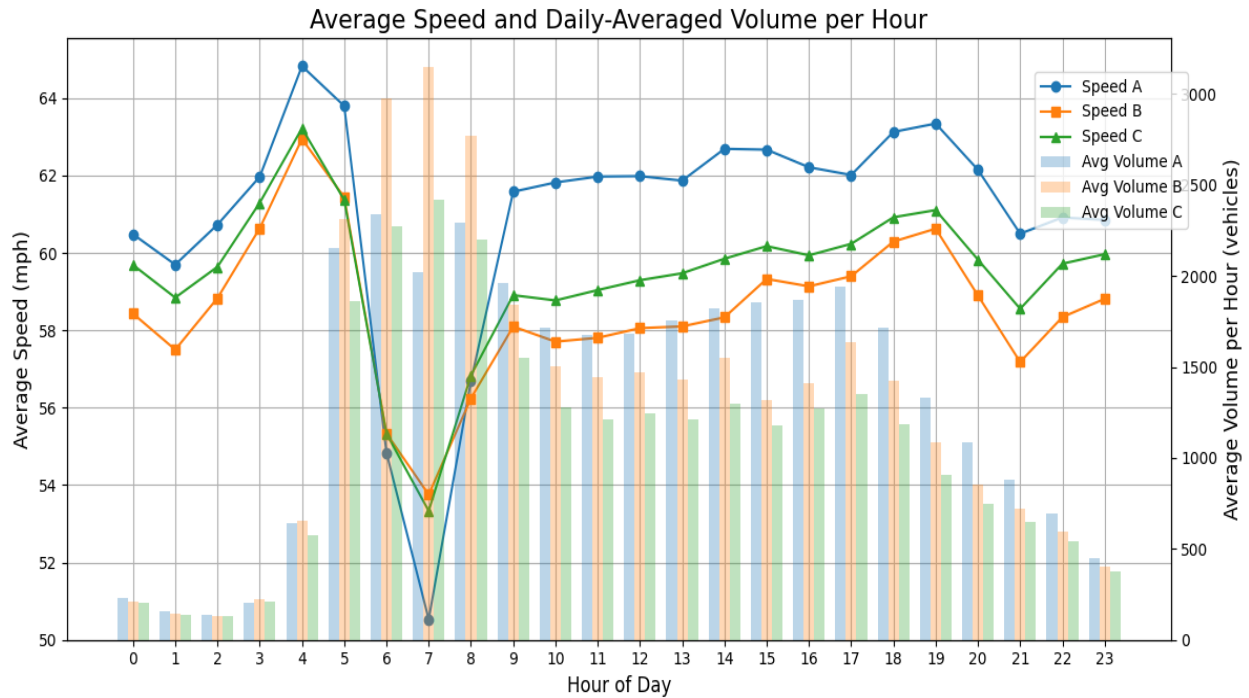


Figure 8-7. Average speed and volume by hour of the day during active work period for I-55 St. Louis.

8.2.2 I-55 St. Louis: Results for Non-Active Work Period

For the non-active work period, a total of 190,924 vehicles were recorded at Location A, while 160,205 vehicles were recorded at Location B, and 139,444 vehicles were recorded at Location C after timestamp alignment. The vehicle counts for each class at all three locations are summarized in Table 8-10.

Table 8-10. Vehicle counts at all locations during the non-active work period for I-55 St. Louis.

Location	Small and Medium	Large	Total
A	184,036	6,888	190,924
B	152,867	7,338	160,205
C	132,177	7,267	139,444

The summary of speed statistics and compliance is presented in Table 8-11 and Table 8-12. Overall, average speeds were higher than during the active work period. Average speeds were the highest at Location A, followed by Location C, and Location B. The standard deviation was highest at Location B. At Location A, the average speed was 63.4 mph with a standard deviation of 5.4 mph, and the 85th percentile speed was 69.0 mph. A total of 98.8% of vehicles exceeded the posted speed limit of 60 mph, with 71.9% exceeding it by at least 10 mph and 8.8% by at

least 20 mph. At Location B, the average speed was 60.3 mph with a standard deviation of 5.8 mph, and the 85th percentile speed was 66 mph. Approximately 96.0% of vehicles exceeded the speed limit, including 48.2% exceeding it by 10 mph and 3.7% by 20 mph. At Location C, the average speed was 61.0 mph with a standard deviation of 5.6 mph, and the 85th percentile speed was 67.0 mph. In this location, 97.1% of vehicles exceeded the speed limit, with 53.0% exceeding it by 10 mph and 4.8% by 20 mph.

Table 8-11. Summary of speed statistics by location during non-active work period for I-55 St. Louis.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	50	63.4	5.4	69.0	98
B	50	60.3	5.8	66.0	91
C	50	61.0	5.6	67.0	94

Table 8-12. Summary of speed limit compliance by location during non-active work period for I-55 St. Louis.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit +10	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit +20	% Exceeding Speed Limit +20
A	50	190,924	1,058	98.8	770	71.9	94	8.8
B	50	160,205	860	96.0	432	48.2	33	3.7
C	50	139,444	758	97.1	414	53.0	37	4.8

To further evaluate temporal variations in traffic performance, the data were classified into daytime and nighttime periods, as summarized in Table 8-13 through Table 8-16. Across all three locations, both mean speeds and exceedance rates were higher during daytime compared to nighttime. At Location A, the average speed increased from 61.7 mph at night to 63.6 mph during the day, while at Location B it increased from 58.9 mph to 60.5 mph, and at Location C from 60.0 mph to 61.2 mph. Likewise, the proportion of vehicles exceeding the posted speed limit was consistently higher during daytime at all sites, indicating a greater tendency toward aggressive driving behavior under daylight conditions.

Table 8-13. Summary of daytime speed statistics during non-active work period for I-55 St. Louis.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	50	63.6	5.3	69.0	95.0
B	50	60.5	5.7	66.0	91.0
C	50	61.2	5.4	67.0	94.0

Table 8-14. Summary of daytime speed limit compliance during non-active work period for I-55 St. Louis.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
A	50	165,415	1,345	99.1	1,006	74.1	123	9.0
B	50	137,648	1,093	96.6	564	49.9	42	3.7
C	50	118,917	954	97.7	531	54.4	45	4.6

Table 8-15. Summary of nighttime speed statistics during non-active work period for I-55 St. Louis.

Location	Posted Speed Limit	Average Speed	Standard Deviation	85 th Percentile Speed	Maximum Speed
A	50	61.7	5.9	68.0	98.0
B	50	58.9	6.5	65.0	89.0
C	50	60.0	6.5	66.0	92.0

Table 8-16. Summary of nighttime speed limit compliance during non-active work period for I-55 St. Louis.

Location	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
A	50	25,509	439	97.5	261	58.0	31	6.9
B	50	22,557	364	91.9	151	38.1	15	3.8
C	50	20,527	338	93.7	163	45.0	20	5.6

Figure 8-8 and Figure 8-9 illustrate the speed distribution and cumulative speed distribution during the work zone period, respectively. All locations recorded mean and 85th percentile speeds exceeding the posted 50-mph limit, with Location A showing the highest values, followed by Location C, while Location B exhibited the lowest.

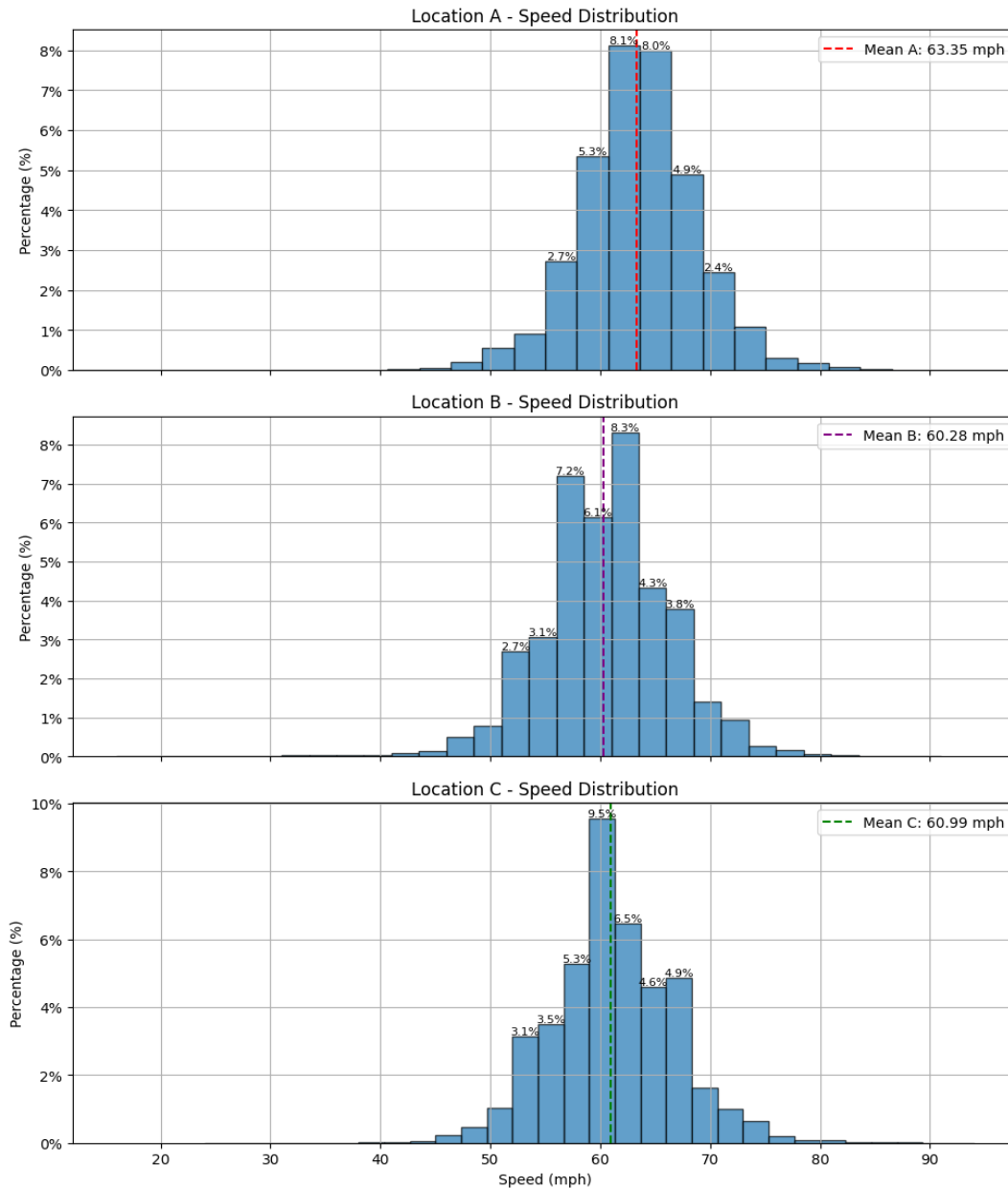


Figure 8-8. Speed distribution during non-active work period for I-55 St. Louis.

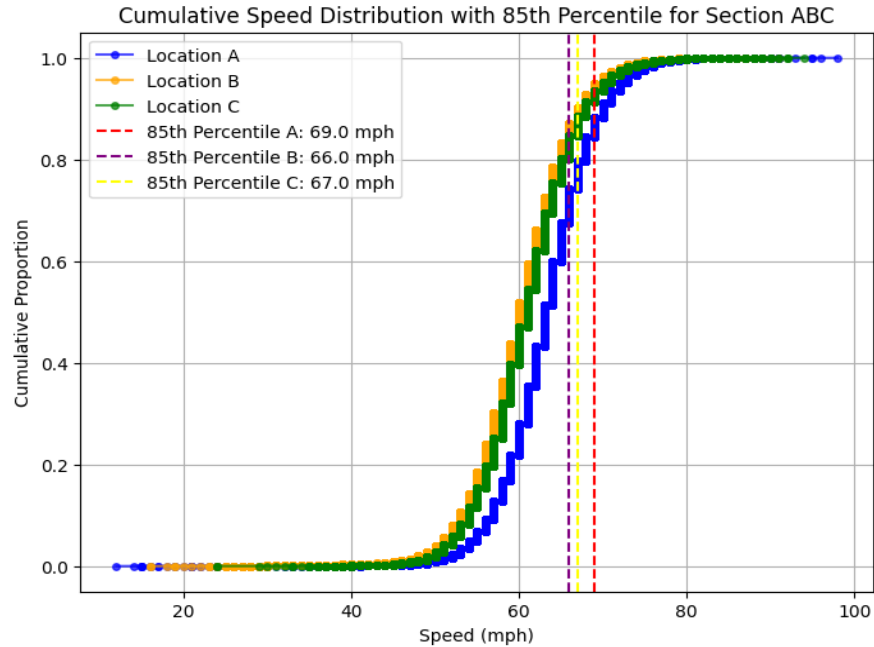


Figure 8-9. Cumulative speed distribution during non-active work period for I-55 St. Louis.

Figure 8-10 presents the speed distributions for small and medium and large vehicles across the three locations during the non-active work period for I-55 St. Louis, with corresponding mean speed and speed differences summarized in Table 8-17. A clear and consistent pattern is observed across all sites: small and medium vehicles travel at higher mean speeds than large vehicles, indicating relatively more cautious driving behavior among larger vehicles. In terms of spatial variation, both vehicle classes follow the same speed ranking, with Location A exhibiting the highest mean speeds, followed by Location C, and Location B showing the lowest. This consistent ordering across both classes reinforces the influence of location-specific roadway or traffic conditions on overall operating speeds. Although small and medium vehicles consistently outpaced large vehicles across all locations, the magnitude of this difference varied by site.

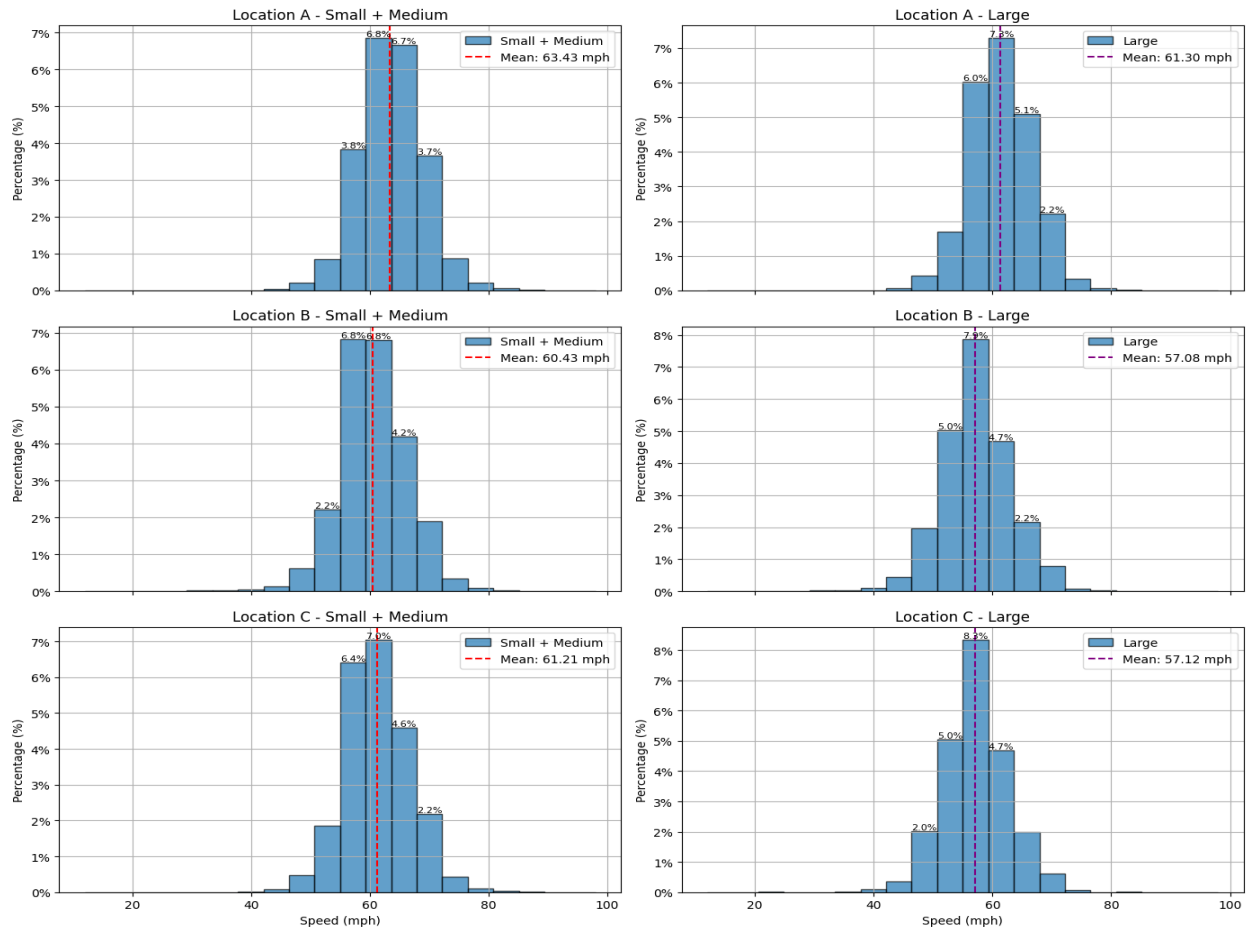


Figure 8-10. Speed distribution by class during non-active work period for I-55 St. Louis.

Table 8-17. Average speeds and speed differences by location and vehicle class during non-active work period for I-55 St. Louis.

Location	Average Speed of Small and Medium (mph)	Average Speed of Large (mph)	Difference in Average Speed (mph)
A	63.43	61.30	2.12
B	60.43	57.08	3.35
C	61.21	57.12	4.09

To analyze temporal variations in traffic flow and speed during the non-active work period, hourly average volumes and speeds were examined across the three sensor locations. As shown in Figure 8-11, traffic volumes remained very low overnight, began to rise steadily after approximately 5:00 AM, reached their highest levels around midday to early afternoon, and gradually declined into the evening. In terms of speed, vehicle speeds initially increased during the early morning hours, then dropped as traffic volumes built up, remained relatively steady throughout the afternoon, and experienced a slight decline again during the evening. Spatially, Location A consistently recorded the highest speeds throughout the day, Location B exhibited

the lowest, and Location C fell between the two, with speed levels generally closer to those at Location B.

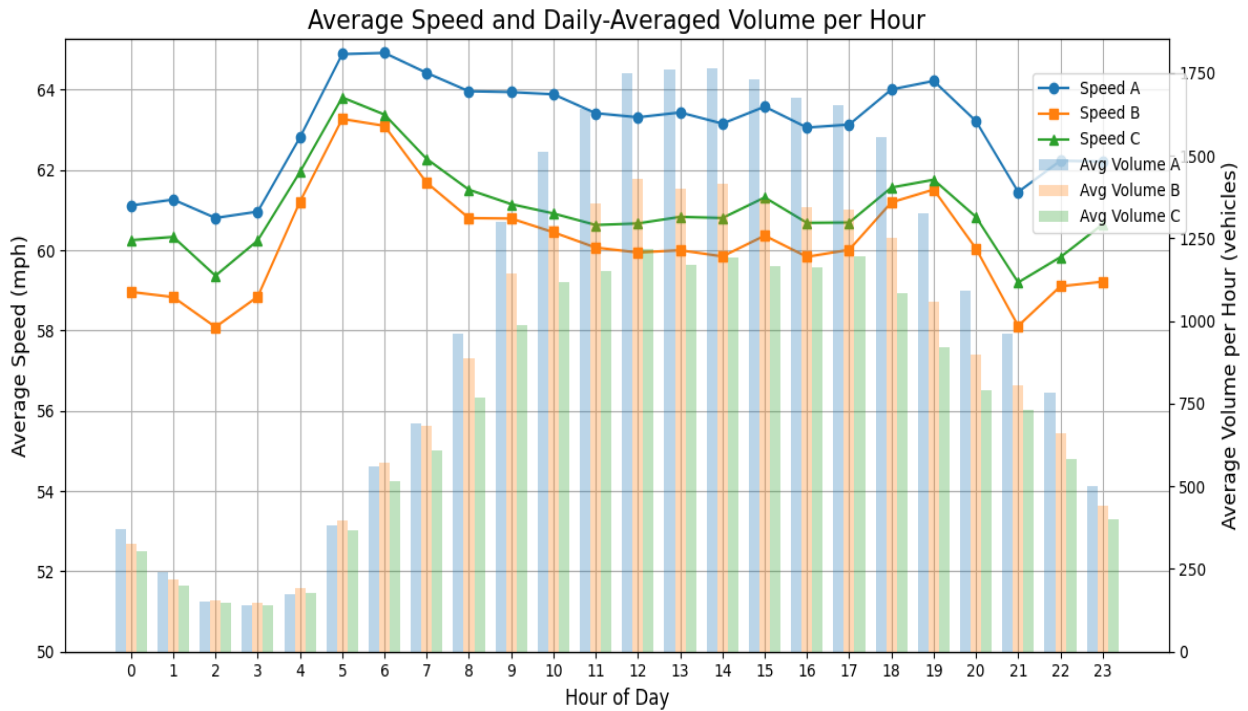


Figure 8-11. Average speed and volume by hour of the day during non-active work period for I-55 St. Louis.

8.2.3 I-55 St. Louis: Comparison of Active Work and Non-Active Work Periods

To evaluate speed performance changes associated with construction activities along I-55 in St. Louis, statistical tests were conducted to compare the active work period and non-active work periods. The t-test results indicated that average speeds were significantly lower during active work than during the non-active work period. Consistently, the quantile test showed a significant reduction in fast-driver (85th percentile) speeds under active work conditions. In addition, the F-test revealed a significant increase in speed variability during the construction period, suggesting greater fluctuations in driving behavior. Overall, these findings indicate that construction activities along I-55 in St. Louis contributed to reduced overall and high-end speeds, along with heightened speed variability relative to non-active work conditions. The detailed result is shown in Table 8-18.

Table 8-18. Statistical comparison of speed characteristics between active work period and non-active work period for I-55 St. Louis.

Test	What it Tests	Significance Level	Test Result	Difference	Key Finding
t-test	Difference in Average Speed	0.05	t=-242.3, p<0.001	-2.6 mph	Mean speed significantly lower by 2.6 mph during active work period
F-test	Difference in Speed Variability	0.05	F=1.656, p<0.001	1.6 mph	Speed variability significantly higher by 1.6 mph during active work period
Quantile test	Difference in the 85 th Percentile Speed	0.05	Δ = -2 mph, p<0.001	-2 mph	Fast-driver speeds significantly lower by 2 mph during active work period

8.3 I-55 St. Louis: Results from Analysis of HERE Data

Since there was no historical HERE data available for 2021 for I-55 St. Louis, data for 2025 were extracted for two HERE segments to allow for comparison of two segments with different speed limits. As shown in Figure 8-12, the western segment was located upstream of sensor A, while the eastern segment was located between sensors A and B (just east of the River des Peres Bridge). The adjacent (upstream) section was located in the work zone with a work zone speed limit of 55 mph, while the work zone speed limit for the downstream segment was 50 mph. HERE data from June 24 to July 22, 2025 were extracted for both segments.



(Imagery © 2025 Airbus, Landsat / Copernicus, Maxar Technologies, Vexcel Imaging US, Inc., Map Data © 2025 Google)

Figure 8-12. Aerial showing HERE segments and speed sensors for I-55 St. Louis.

The results for speed distribution are shown in Figure 8-13, and the cumulative speed distributions are shown in Figure 8-14. The results indicate that the mean speed on the upstream (adjacent) segment was 6.5 mph higher than the mean speed on the downstream segment (between sensors A and B), and the standard deviation on the upstream (adjacent) segment was 0.7 mph lower than the standard deviation on the downstream (between sensors A and B) segment.

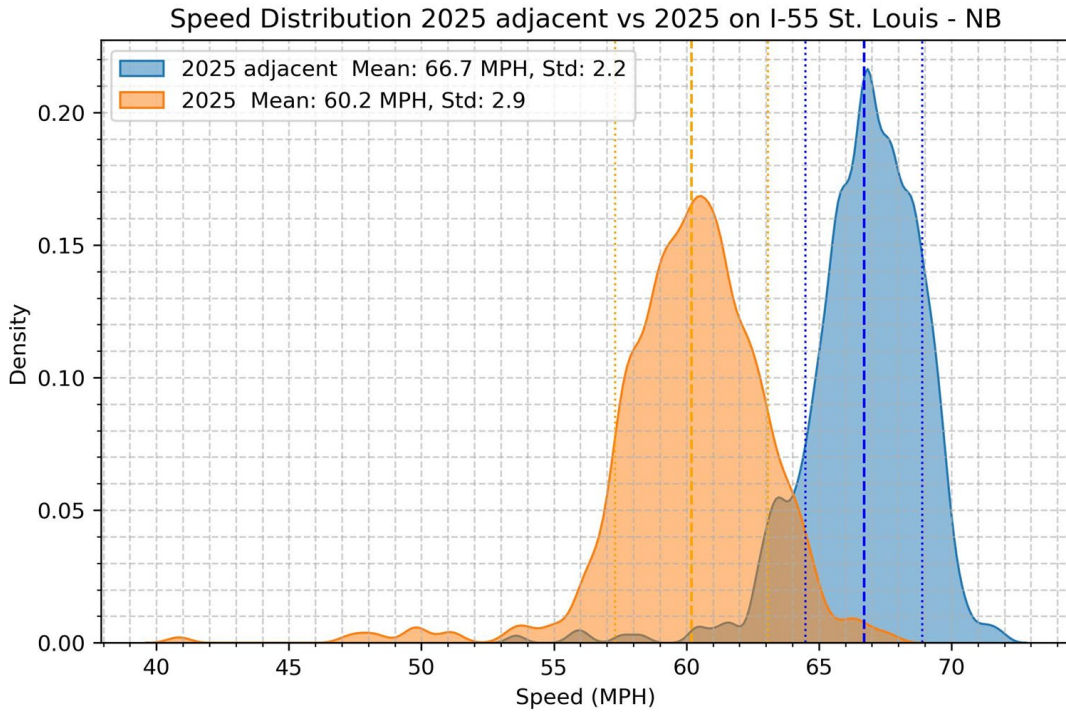


Figure 8-13. Speed distributions for HERE data for upstream (adjacent) and downstream (between sensors A and B) segments for I-55 St. Louis.

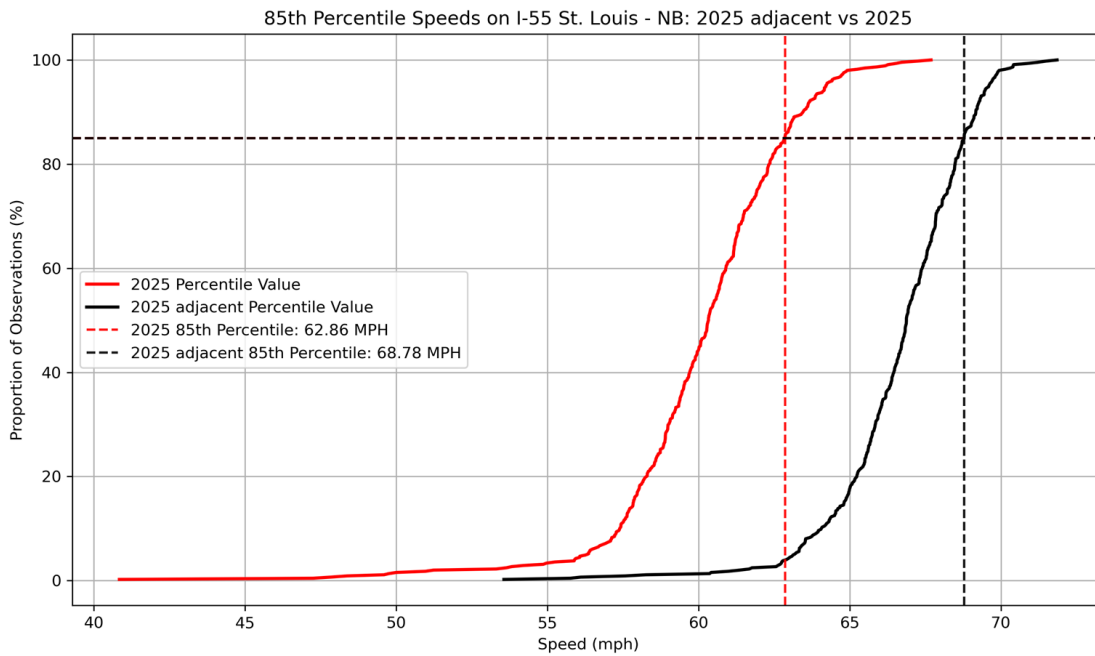


Figure 8-14. Speed distributions for HERE data for upstream (adjacent) and downstream (between sensors A and B) segments for I-55 St. Louis.

Three statistical tests were performed to evaluate speed characteristics between the upstream (adjacent) and the downstream (between sensor A and B) segments using HERE data, including

a t-test for average speed, an F-test for speed variability, and a quantile test for the 85th percentile speed. The test results are summarized in . In summary, statistical testing revealed that construction activities at the I-55 St. Louis site led to a significant reduction in both average and 85th percentile speeds at the downstream site, indicating that overall and fast-driver speeds were lower on downstream segment compared to the adjacent segment. However, despite the reduction in central tendency, the F-test results showed a significant increase in speed variability in the downstream segment, suggesting greater fluctuations in driving behavior under active work conditions. These findings imply that drivers not only traveled more slowly but also exhibited less consistent speed patterns in response to work zone related impacts.

Table 8-19. Statistical comparison of speed characteristics between upstream (adjacent) and downstream (between sensors A and B) segments for I-55 St. Louis.

Test	What it Tests	Significance Level	Test Result	Difference	Key Finding
t-test	Difference in Average Speed	0.05	t=-37.958, p<0.001	-6.5 mph	Mean speed significantly lower downstream by 6.5 mph during active work period
F-test	Difference in Speed Variability	0.05	F=1.708, p<0.001	0.7 mph	Speed variability significantly higher downstream by 0.7 mph during active work period
Quantile test	Difference in the 85 th Percentile Speed	0.05	Δ = -5.93 mph, p<0.001	-5.93 mph	Fast-driver speeds significantly lower downstream by 5.93 mph during active work period

The speed limit compliance results for the HERE data are shown in Table 8-20. The results indicate a low level of compliance with the work zone speed limits, with over 95% of observations on both segments at least 5 mph above the work zone speed limit.

Table 8-20. Summary of HERE speed limit compliance results for I-55 St. Louis.

Exceeding Speed Limit By	Upstream (Adjacent) Segment (Speed Limit = 55 mph)	Downstream (Between Sensors A and B) Segment (Speed Limit = 50 mph)
5 mph	98.9 %	96.7 %
10 mph	82.4 %	55.8 %
15 mph	2.0 %	2.0 %
20 mph	0.0 %	0.0 %

8.4 I-55 St. Louis: Results from Analysis of Crash Data

A single crash was reported within the St. Louis work zone during the monitoring period. The incident occurred on July 14 at 1:45 PM near Mile Marker 202.8 on I-70. The crash resulted in a suspected serious injury and was classified as an “other object” type crash. According to the report, the contributing circumstance was an object in the roadway, suggesting that the event was caused by debris or material present within the travel lane.

A review of the speed sensor data for the St. Louis work zone indicated no significant variation in average speeds or traffic flow at the time of the crash. Speed conditions before and after the incident were consistent with normal operating patterns, suggesting that the event did not generate notable congestion or delay within the monitored segment.

8.5 I-55 St. Louis: Summary of Results

Overall speed statistics for I-55 St. Louis are shown in Table 8-21, and overall speed limit compliance results are shown in Table 8-22 and Table 8-23. The I-55 St. Louis results are summarized below.

- There was pervasive speeding, with over 90% of drivers exceeding the work zone speed limit of 50 mph during both the active work and non-active work periods.
- Average speeds and 85th percentile speeds were significantly lower in the active work period than in the non-active work period, and speed variation was significantly higher in the active work period.
- The 85th percentile speeds ranged from 65–67 mph, which is 15–17 mph above the posted limit.
- Average and 85th percentile speeds were highest at Location A (upstream) and lowest at Location B (middle).
- During the active work period, across all locations, both average and 85th percentile speeds were consistently lower during daytime compared to nighttime, possibly due to congestion during the morning peak. During the non-active work period, average and 85th percentile speeds were lower during nighttime, possibly due to traffic congestion during the morning peak.
- Small/medium vehicles were consistently faster (2–3 mph) than large vehicles.
- Based on analysis of HERE data, mean speeds and 85th percentile speeds were significantly lower near the work area (posted speed limit 50 mph) than on the adjacent upstream segment within the work zone (posted speed limit 55 mph). Speed variation was significantly higher near the work area.

Table 8-21. Overall summary of speed statistics for I-55 St. Louis.

Period	Posted Speed Limit (mph)	Average Speed (mph)	Standard Deviation of Speed (mph)	85 th Percentile Speed (mph)	Maximum Speed (mph)	% Large Vehicles
Active Work Period	50	59.1	7.4	65	99	6.6
Non-Active Work Period	50	61.7	5.8	67	98	4.4

Table 8-22. Overall summary of speed limit compliance results for I-55 St. Louis (active work period).

Time of Day	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
Day	50	1,045,997	4392	91.3	2127	44.2	136	2.8
Night	50	118,392	1027	93.8	542	49.5	72	6.6
All	50	1,164,389	3274	91.6	1600	44.8	114	3.2

Table 8-23. Overall summary of speed limit compliance results for I-55 St. Louis (non-active work period).

Time of Day	Posted Speed Limit	Total Number of Vehicles	VPH Exceeding Speed Limit	% Exceeding Speed Limit	VPH Exceeding Speed Limit	% Exceeding Speed Limit +10	VPH Exceeding Speed Limit	% Exceeding Speed Limit +20
Day	50	421,980	3391	97.9	2101	60.7	209	6.0
Night	50	68,593	1100	94.5	554	47.6	64	5.5
All	50	490,573	2644	97.4	1597	58.8	162	6.0

9. Conclusions

This chapter summarizes the results of this research, with site-specific findings presented first followed by general findings.

9.1 Summary of Site-Specific Findings

Table 9-1 provides an overall summary of speed statistics by site and time period, while Table 9-2 summarizes the speed limit compliance by site and time period. Findings for each site are summarized in the following sections.

Table 9-1. Overall summary of speed statistics by site and time period.

Site/Period	Posted Speed Limit (mph)	Average Speed (mph)	Standard Deviation of Speed (mph)	85 th Percentile Speed (mph)	Maximum Speed (mph)	% Large Vehicles
I-70 Kingdom City	55	63.1	7.1	72.6	95-100	n/a
I-70 Rocheport	60	67.9	6.5	74	103	11.9
I-70 Warrenton (Non-Work Zone Period)	70	66.0	8.1	73	92	6.7
I-70 Warrenton (Work Zone Period)	60	63.0	8.8	70	92	9.0
I-44 Rolla Work Zone Period	50	50.7	10.9	61	85	6.4
I-44 St. James Work Zone Period	60	49.1	14.7	64	102	11.3
I-44 Rolla Non-Work Zone Period	60	66.3	7.2	73	101	7.7
I-44 St. James Non-Work Zone Period	70	69.8	6.8	76	105	10.4
I-55 St. Louis (Work Zone, Active Work Period)	50	59.1	7.4	65	99	6.6
I-55 St. Louis (Work Zone, Non-Active Work Period)	50	61.7	5.8	67	98	4.4

Table 9-2. Overall summary of work zone speed limit compliance statistics by site and time period.

Site / Period	Posted Speed Limit	Total Duration (hour)	Total Number of Vehicles	% Exceeding Speed Limit	% Exceeding Speed Limit +10	% Exceeding Speed Limit +20
I-70 Kingdom City	55	60.1	69,595	94.2	50.1	5.4
I-70 Rocheport	60	1069.7	827,132	89.9	33.7	1.5
I-70 Warrenton (Non-Work Zone Period)	70	456.3	217,083	27.7	0.5	0.0
I-70 Warrenton (Work Zone Period)	60	2343.9	1,038,904	73.0	13.8	0.2
I-44 (Rolla) Work Zone Period	50	142.2	105,551	58.6	17.0	1.5
I-44 (St. James) Work Zone Period	60	261.5	161,077	23.9	4.3	0.1
I-44 (Rolla) Non-Work Zone Period	60	713.1	616,215	84.5	25.7	0.7
I-44 (St. James) Non-Work Zone Period	70	450.6	356,757	50.6	2.7	0.0
I-55 St. Louis (Active Work Period)	50	926.7	1,164,389	91.6	44.8	3.2
I-55 St. Louis (Non-Construction Period)	50	542.3	490,573	97.4	58.8	6.0

9.1.1 Summary of Findings for I-70 Kingdom City

- There was prevalent speeding in both directions, with approximately 88–95% of drivers exceeding the work-zone speed limit of 55 mph.

- The average speeds ranged from 62–65 mph, with standard deviations of 7.1–7.2 mph, indicating consistent and elevated travel speeds throughout the monitored periods.
- The 85th percentile speeds were 72.4 mph at Location A and 73.1 mph at Location B, or 17–18 mph above the posted work-zone speed limit.
- The average and 85th percentile speeds were lower in the eastbound direction.
- Analysis of HERE data indicates that mean speeds were lower and speed variability was higher in 2025 with the work zone than in 2024 without the work zone.

9.1.2 Summary of Findings for I-70 Rocheport

- There was pervasive speeding, with approximately 90% of drivers exceeding the work zone speed limit of 60 mph.
- The 85th percentile speeds ranged from 73–76 mph, which is at least 13–16 mph above the posted limit.
- Speeds were highest at Location C (upstream) and lowest at Location B (midpoint).
- Nighttime speeds were generally lower than daytime speeds.
- Small/medium vehicles were consistently faster than large vehicles.
- Based on analysis of HERE data, 2025 speeds were similar to 2022 speeds, but there was significantly more speed variation in 2025 with the work zone in place.

9.1.3 Summary of Findings for I-70 Warrenton

- Speeds exceeded the posted limits in both the non-work zone and work zone periods, with higher levels of speed limit compliance during the non-work zone period than the work zone period. Average speeds during the work zone period were lower than during the non-work zone period.
 - **Non-work zone period:** Average speeds ranged from 64–67 mph, under the 70-mph limit. The share of vehicles exceeding the limit dropped to 20-32%.
 - **Work zone period:** Average speeds at all three sites (62–63 mph) were above the 60 mph limit. About 72–73% of vehicles exceeded the limit.
- During the non-work zone period, speeds were lowest at Location A (upstream) and highest at Location B (midpoint).
- During the work zone period, speeds were highest at Location A (upstream) and lowest at Location C (downstream).
- During the work zone period, differences in average speeds by vehicle class varied by location, with average speeds for large vehicles slightly (less than 0.5 mph) higher than average speeds for small and medium vehicles at Locations B and C.
- Speeds were consistently lower during nighttime than during daytime.
- Based on analysis of HERE data, average and 85th percentile 2025 speeds (with the work zone) were lower than 2024 speeds (no work zone), but there was significantly more speed variation in 2025 with the work zone in place.

9.1.4 Summary of Findings for I-44 Rolla/St. James

- In the non-work zone period, mean speeds generally stayed above 65 mph at Rolla (speed limit 60 mph) and from approximately 67–72 mph at St. James (speed limit 70 mph).
- During the work zone period, mean speeds dropped to the 50–52 mph range at Rolla (speed limit 50 mph) and 48–51 mph at St. James, with more pronounced midday slowdowns.
- Compliance was higher during the work zone period than the non-work zone period. During the work zone period, 59% of drivers exceeded the speed limit at Rolla, while 24% of drivers exceeded the speed limit at St. James.
- Speeds for Locations A, B, and C at Rolla show highly similar trends, with modest speed differences (less than 2 mph) and consistent 85th percentiles.
- Speeds for Locations D, E, and F at St. James align closely overall, but Location E (midpoint) consistently shows the lowest speeds and sharpest drop during construction.
- Average speeds for small and medium vehicles were generally higher (1–3 mph) than average speeds for trucks at most locations.
- Speeds were consistently lower during nighttime than during daytime.
- During the work zone period, both Rolla and St. James experienced clear AM (7–9 AM) and PM (4–6 PM) peaks, with the lowest volumes overnight.
- For the non-work zone period, traffic patterns were smoother, still showing overnight lows and daytime increases, but the peaks were less pronounced.
- Analysis of HERE data for Rolla shows a lack of speed limit compliance with the 50-mph work zone speed limit and 60-mph speed limit with no work zone present. Differences in speed and speed variability were not statistically significant.

9.1.5 Summary of Findings for I-55 St. Louis

- There was pervasive speeding, with over 90% of drivers exceeding the work zone speed limit of 50 mph during both the active work and non-active work periods.
- Average speeds and 85th percentile speeds were significantly lower in the active work period than in the non-active work period, and speed variation was significantly higher in the active work period.
- The 85th percentile speeds ranged from 65–67 mph, which is 15–17 mph above the posted limit.
- Average and 85th percentile speeds were highest at Location A (upstream) and lowest at Location B (middle).
- During the active work period, across all locations, both average and 85th percentile speeds were consistently lower during daytime compared to nighttime, possibly due to congestion during the morning peak. During the non-active work period, average and 85th percentile speeds were lower during nighttime.
- Small/medium vehicles were consistently faster (2–3 mph) than large vehicles.

- Based on analysis of HERE data, mean speeds and 85th percentile speeds were significantly lower near the work area (posted speed limit 50 mph) than on the adjacent upstream segment within the work zone (posted speed limit 55 mph). Speed variation was significantly higher near the work area.

9.2 Summary of Results of Crash Review

Due to the relatively short monitoring duration and the limited number of recorded crashes (four total events across all sites), the analysis was limited to a descriptive review rather than a formal statistical evaluation. The crash review identified four crashes across all sites during the time of the data collection: two property-damage-only crashes, one minor-injury crash, and one potential serious-injury crash. The contributing circumstance for the minor-injury crash was identified as traveling too fast for conditions. Contributing circumstances to the other crashes were improper load securement, improper lane change, and object in roadway. Across all monitored work zones, no significant changes in traffic speed or flow were observed around the time of the reported crashes, indicating that these incidents were isolated events and did not cause measurable impacts on overall work zone operations.

9.2 Summary of Overall Findings

The overall findings of this research study (based on speed data for almost 5.5 million vehicles) are summarized as follows:

- Across all sites, a large majority of drivers exceeded posted work zone limits, often by more than 10 mph. In some locations, over 90% of vehicles were speeding.
- The maximum speed recorded across all sites with a work zone present was 103 mph. All sites saw a maximum speed of at least 85 mph.
- Speeds were lower with the work zone in place than during non-work zone conditions. However, work zones introduced greater fluctuations in speeds, especially compared with normal freeway conditions.
- With the exception of the I-44 Rolla work zone (with workers in the closed lane separated by channelizers), less compliance was observed with stricter posted speed limits (e.g., 50–55 mph zones).
- Vehicles tended to slow through the middle of work zones, with upstream sections having the highest speeds and midpoints the lowest.
- Small/medium vehicles consistently drove faster than large trucks, usually by 2–4 mph. Speeding was also prevalent among large trucks, especially under work zone conditions.
- Compliance improved when workers were visible near the travel lanes. The I-44 work zone (with workers in the closed lane separated by channelizers) had the highest work zone speed limit compliance of all the work zones studied in this research.
- Other work zone characteristics (e.g., lane width, lane configuration, barrier versus channelizers) did not seem to influence drivers' speeds.
- With the exception of the I-55 St. Louis work zone (which experienced slower speeds during the morning peak), speeds were generally lower during nighttime than during

daytime. This result could possibly be due to drivers being more cautious when traveling through work zones during nighttime.

Overall, the results indicate prevalent speeding in Missouri work zones. While vehicle speeds were lower with the work zone compared to non-work zone conditions, speed variation with the work zone in place also increased. The presence of workers in the closed lane separated by channelizers on I-44 was associated with lower speeds and greater speed limit compliance. Possible strategies to reduce speeds and improve speed limit compliance in Missouri work zones could include law enforcement presence, speed feedback trailers, public outreach campaigns, and reviewing existing policies on setting work zone speed limits.

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