U.S. Department of Transportation
Federal Highway Administration

Speed Limit Setting Handbook

NOTICE

NON-BINDING CONTENTS

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16. Abstract This handbook provides practitioners with information on how to conduct an engineering study to set a speed limit for a speed zone based on the provisions in the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD). The discussion includes preparing for the study, the factors to consider, the data-collection process, evaluating the results, and implementing the results after completing the engineering study. This handbook also includes seven case studies to show examples of jurisdictions' processes for setting speed limits aligned to the steps in this Handbook and speed limit setting policy examples.			
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SI* (Modern Metric) Conversion

FACTORS APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in.	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
$in.^2$	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1,000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/$in.^2$	poundforce per square inch	6.89	kilopascals	kPa

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

SI* (Modern Metric) Conversion (continued)

APPROXIMATE CONVERSIONS TO SI UNITS				
SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
mm	millimeters	0.039	inches	in.
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	square millimeters	0.0016	square inches	$in.^2$
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
ILLUMINATION				
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-lamberts	fl
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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LIST OF ACRONYMS

AASHTO	American Association of State Highway Transportation Officials
DOT	department of transportation
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
ITE	Institute of Transportation Engineers
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
MP	milepost
MPO	metropolitan planning organization
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Transportation Safety Administration
SSA	Safe System Approach
TPO	transportation planning organization
USDOT	United States Department of Transportation
UVC	Uniform Vehicle Code
VSL	variable speed limit

Executive Summary

Setting and achieving safe speeds for all users of the transportation system is an important objective for jurisdictions across the Nation. Promoting safer speeds is a focus of the United States Department of Transportation's (USDOT) comprehensive approach to eliminating fatalities and serious injuries on our Nation's roadways. The Department has adopted the Safe System Approach (SSA), which focuses on five key objectives: safer people, safer roads, safer vehicles, safer speeds, and post-crash care. Achieving safer speeds requires promoting safe speeds in a variety of environments using thoughtful, equitable, context-appropriate roadway design, targeted education, outreach campaigns, and enforcement.

As part of the safer speed objectives, the USDOT, including the Federal Highway Administration (FHWA), is prioritizing safety and traveling at safe speeds over focusing exclusively on the throughput of motor vehicles. Studies show that higher speeds result in higher energy involvement at the time of the crash, which can lead to more severe injuries and fatalities. This risk is especially concerning for non-motorized road users, such as pedestrians, bicyclists, other cyclists, and persons on personal conveyances, who cannot rely on vehicle bodies or technologies to protect them. It is also important to acknowledge the variation in walking speeds, attention spans, and risk tolerance among certain non-motorized road users, such as older adults, school children, people with physical or invisible disabilities, parents with younger children, etc. Setting appropriate speed limits is an FHWA Proven Safety Countermeasure and is fundamental to the SSA and to making roadways safer for all road users.

The goal of this handbook is to provide practitioners with information on how to conduct an engineering study to set an appropriate non-statutory speed limit for a speed zone. A speed zone is defined by the *Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) as* "a section of highway with a speed limit that is established by law or regulation, but which might be different from a legislatively-specified statutory speed limit."[1] As specified in the MUTCD, among the factors that should be considered when conducting an engineering study for establishing or reevaluating speed limits within speed zones are the following:

- **Roadway environment** (such as roadside development, number and frequency of driveways and access points, and land use), functional classification, public transit volume and location or frequency of stops, parking practices, and pedestrian and bicycle facilities and activity
- **Roadway characteristics** (such as lane widths, shoulder condition, grade, alignment, median type, and sight distance)
- **Geographic context** (such as urban district, rural town center, non-urbanized rural area, or suburban area) and multimodal trip generation
- **Reported crash experience** for at least a 12-month period

1 FHWA. 2023. *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), 11th ed., §1C.02.03. Washington, DC: FHWA.

- **Speed distribution of free-flowing vehicles,** including the pace, median (50th-percentile), and 85th-percentile speeds
- **Review of past speed studies** to identify any trends in operating speeds

In this handbook, these elements will be referred to as the six **factors** that should be part of an engineering study for setting speed limits. Each factor can have one or more **data items** that should be recorded or collected. For many of these data items, there are specific data-collection and analysis processes practitioners should apply to quantify or evaluate the factor. Furthermore, a variety of tools are available to support the results of the engineering study, including existing expert systems for setting speed limits, such as USLIMITS2[2] and the *National Cooperative Highway Research Program (NCHRP) Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide*.[3]

An engineering study should include measurement of vehicle operating speeds and the consideration of other factors to arrive at a comprehensive understanding of the safety, operational performance, use and context of the roadway. It should be noted that an engineering study is not just limited to the speed distribution on urban and suburban arterials and rural main streets, and the 85th-percentile speed should not be used as the sole consideration in setting speed limits. This handbook describes the factors and data recommended to be used in an engineering study, including sample size considerations and how to use the results to set an appropriate non-statutory speed limit for all road users. The handbook also describes how tools and expert systems can be used and provides noteworthy practices to assist jurisdictions in effectively setting appropriate speed limits. Setting safe and appropriate speed limits is an important element in achieving a transportation system that is safe for all users.

"Safe and appropriate speed limits" are safe for all road users and appropriate based on road function, design, safety, and land use.[4]

2 FHWA. n.d. "USLIMITS2: A Tool to Aid Practitioners in Determining Appropriate Speed Limit Recommendations" (website). Accessed October 10, 2023, https://safety.fhwa.dot.gov/uslimits/.

3 Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, and Tim Gates. 2021. *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide. Transportation Research Board,* Washington, DC: The National Academies Press. https://doi.org/10.17226/26216, accessed October 10, 2023

4 FHWA. n.d. "Noteworthy Speed Management Practices" (website). https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa20047/sec9.cfm, accessed February 6, 2024.

Chapter 1. Establishing the Need and Basis for an Engineering Study

A speed limit, as defined by the MUTCD, is "the maximum (or minimum) speed applicable to a section of highway as established by law or regulation."[5]

As described later in this chapter, some speed limits are *statutory*, established by legislative action, while others are not. Statutory speed limits apply as the default speed limit for a particular class of highways, such as rural freeways or residential streets, and are not necessarily posted. *Non-statutory* speed limits override a statutory speed limit by setting the maximum allowed speed for a specific section of street or highway; this speed might be higher or lower than the default speed limit and is always posted. Non-statutory speed limits are also established for road sections for which no statutory speed has been defined.

Non-statutory speed limits are established on the basis of an engineering study by agencies that have the authority to set speed limits.[6] This study can consider "a range of factors such as land-use context, pedestrian and bicycle activity, crash history, intersection spacing, driveway density, roadway geometry, roadside conditions, roadway functional classification, traffic volume, and observed speeds."[7] A key objective of the engineering study is to establish an appropriate speed limit that *ensures safety for all road users*.

Managing and achieving safe speeds requires a multifaceted approach that leverages appropriate speed limit setting, road design and other infrastructure interventions, education, and enforcement. Over the years, FHWA has developed a variety of speed management resources for transportation agencies. These resources are available on the FHWA Office of Safety's Speed Management website. FHWA will continue to add more resources as speed management practices continue to grow and evolve.

As one of these resources, this handbook provides support to transportation agency personnel tasked with conducting an engineering study to set and implement non-statutory speed limits that are appropriate and safe for all road users.[8]

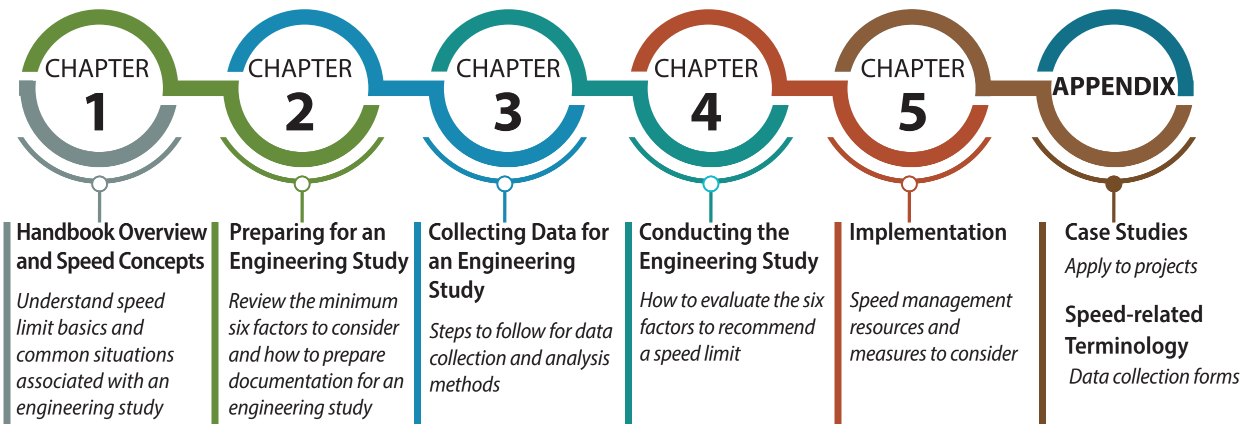
Setting and achieving safe speeds for all road users is fundamental to the SSA and to reducing fatalities on the Nation's streets and highways.

The purpose of this handbook is to help transportation agencies set non-statutory speed limits that are appropriate and safe for all road users.

5 FHWA. 2023. MUTCD, 11th ed., §1C.02.03. Washington, DC: FHWA.
6 FHWA, 2023. MUTCD, 11th ed., §2B.21. Washington, DC: FHWA.
7 FHWA. 2023. MUTCD, 11th ed., §2B.21.03. Washington, DC: FHWA.
8 FHWA. 2023. MUTCD, 11th ed., §2B.21. Washington, DC: FHWA.

1.1 Organization of Handbook

This handbook provides information on the process, data needs, analysis methods and tools, and evaluation considerations used in an engineering study. It also provides information about implementing a non-statutory speed limit, including treatments and practices for achieving speed limit compliance. Figure 1 provides an overview of how a practitioner can use the handbook, noting key concepts for the chapters and outcomes.



Source: FHWA.

Figure 1. Key chapter concepts and outcomes.

The chapters in this handbook present a recommended sequence of steps for conducting and implementing an engineering study, incorporating provisions provided in the MUTCD. Practitioners should be aware that Federal, State, and local laws and policies may supplement or supersede this handbook's guidance and should familiarize themselves with that information prior to beginning an engineering study.

Table 1 provides more information on the handbook's contents and can help direct practitioners to the appropriate chapter.

Table 1. Information on each chapter's purpose and what a user can learn.

1	**Establishing the Need and Basis for an Engineering Study** ▪ Introduces MUTCD provisions on setting non-statutory speed limits ▪ Provides an overview of the handbook ▪ Contrasts statutory speed limits, non-statutory speed limits, advisory speeds, and special situations where speeds may be posted ▪ Lists common situations that may result in the need for an engineering study ▪ Defines an engineering study and who performs the engineering study
2	**Preparing for the Study** ▪ Discusses preparations for documenting the study ▪ Provides guidance on defining a study area ▪ Introduces the six factors considered at a minimum in the engineering study and describes why each is important
3	**Collecting Data for the Study** ▪ Provides examples of commonly used data elements collected to support each study factor ▪ Suggests potential data sources for these data elements ▪ Describes, where necessary, suggested data collection and analysis methods
4	**Conducting the Study to Set a Non-Statutory Speed Limit** ▪ Describes a recommended approach to evaluating the six factors as a whole to arrive at a recommended speed limit ▪ Discusses how the Safe System Approach can enter into speed limit decision making ▪ Identifies potential applications for speed-limit-setting expert systems ▪ Describes situations when additional measures may be needed to achieve desired speed outcomes ▪ Discusses documenting the study findings and recommendations
5	**Implementing the Study Results** ▪ Introduces potential speed management measures to reduce speeds to desired levels ▪ Discusses potential geometric and access management measures to better match roadway conditions to current operating speeds ▪ Lists additional speed management resources
A	**Appendix A – Case Studies and Practices** ▪ Presents case studies and practices that illustrate various aspects of the engineering study
B	**Appendix B – Speed-related Terminology** ▪ Defines speed-related terminology used within this resource as well as other complementary speed limit terms
C	**Appendix C – Blank Data Collection Forms** ▪ Presents blank forms an agency can print or adapt to support the data collection process.

1.2 Speed Limit Basics

As introduced at the beginning of this chapter, speed limits can be statutory or non-statutory. Both are regulatory, meaning that (depending on State law) motorists who exceed the speed limit are always driving unlawfully or are presumed to be driving unlawfully. In contrast, advisory speeds are recommended speeds for all vehicles operating on a section of road and are not regulatory. Regulatory speed can also be developed for special circumstances, such as specific vehicle types, temporary conditions such as work zones, and school zones, and these special speed limits are discussed in this section as well.

1.2.1 STATUTORY SPEED LIMITS

State legislatures are empowered to set statutory speed limits, and in some States, statutory speed limits may also be set by other jurisdictions. These speed limits may apply differently to various road classifications (e.g., interstates, freeways, and expressways; two-lane undivided highways; rural highways; urban streets), land use (urban or rural), and special situations such as school zones. Statutory speed limits are enforceable by law, can vary by jurisdiction, and generally apply even in the absence of speed limit signs.

Statutory speed limits are based on the concept that uniform categories of roadways can operate safely at certain maximum speeds under ideal conditions. State motor vehicle laws can specify speed limits on specific categories of streets and highways.

Examples of statutory speed limits that may be established within State or local jurisdictions could include the following:

- Residential areas: 20 miles per hour (mph)
- Business districts: 25 mph
- Unpaved roads: 30 mph
- Two-lane undivided highways: 55 mph
- Rural interstate highways: 65 mph

While an engineering study is not typically required for setting statutory speed limits, the principles and concepts presented in this handbook can be informative.

1.2.2 NON-STATUTORY SPEED LIMITS

Road authorities may also have the power (enabled by statutes or ordinances) to establish non-statutory speed limits to reflect the safe maximum reasonable speed of a particular section of a road. Non-statutory speed limits may be lower or higher than the statutory speed limits and can be subject to limits set by statute. For example, a citywide statutory (default) speed limit may be "30 mph unless otherwise posted," with specific neighborhood streets having a non-statutory speed limit lower than the 30-mph citywide statutory limit. Similarly, certain arterial roadways may have a posted, non-statutory speed limit of 45 mph and an urban arterial could have a posted speed limit of 25 mph.

As another example, the statutory speed limit for rural freeways might be 65 mph, but statutes might also allow a State transportation agency to establish non-statutory speed zones up to 75 mph on rural freeways on the basis of an engineering study.

1.2.3 ADVISORY SPEEDS

An advisory speed is "a recommended speed for all vehicles operating on a section of highway and based on highway design, operating characteristics, and conditions."[9] Agencies use advisory speeds on short sections of road where the physical conditions of the road restrict safe operating speed to something lower than the speed limit (e.g., horizontal curves, intersections, or steep grades). Advisory speeds are typically used because the feature that dictates the lower speed is isolated, and it is not feasible or desirable to adjust the speed limit for a short section of road. Advisory speeds are not regulatory, but can be a factor in determining liability after a crash if an investigation showed the motorist was driving faster than the advisory speed.

Advisory speeds are typically provided as plaques accompanying a warning sign for a condition restricting the operating speed (e.g., a horizontal curve), although they can be incorporated into signs, such as Advisory Exit and Ramp Speed signs. The MUTCD outlines provisions for selecting advisory speeds in the sections pertaining to the corresponding warning signs.[10]

1.2.4 SPEED LIMITS FOR SPECIAL CONDITIONS

Appendix B briefly describes the following examples of special conditions that involve posting regulatory or advisory speeds, along with resources for more information:

- Minimum speed limits
- Nighttime speed limits
- School zones
- Seasonal or holiday speed limits
- Transition zones
- Truck speed limits
- Variable speed limits
- Work zone speeds

9 FHWA. 2023. MUTCD. 11th ed., §1C.02.03. Washington, DC: FHWA.

10 FHWA. 2023. MUTCD. 11th ed., §2C.59. Washington, DC: FHWA.

1.3 Situations That Call for an Engineering Study

The MUTCD requires that non-statutory speed limits be established on the basis of an engineering study in accordance with traffic engineering practices.[11] It also states that "setting appropriate speed limits is especially important to ensure safety for all road users in varying types of contexts, particularly on roadways where adjacent land use suggests that trips could be served by varied modes. These situations include urban and suburban non-freeway arterials or rural arterials that serve as main streets in smaller communities, consistent with the context classifications of urban core, urban, suburban, and rural towns found in the American Association of State Highway Transportation Officials' (AASHTO) *A Policy on Geometric Design of Highways and Streets.*"[12]

Listed below are example situations that may prompt practitioners to conduct an engineering study to establish or modify a non-statutory speed limit:

- Changes to road context and adjacent land use
- New roadway design and construction
- Corridor study and improvements
- Changes in road-user patterns or volumes
- Changes to road geometry (e.g., horizontal or vertical curvature, grade, sight distance, lane or shoulder width, number of lanes)
- Safety concerns identified from crash history or analysis, systemic safety study, hazard elimination study, or road safety audit findings
- Construction or modification of multimodal facilities (e.g., sidewalks, trails, bicycle lanes, bus or transit stops)
- Construction, modification, or elimination of driveways or intersections
- Changes in traffic signal operation or coordination
- Addition, modification, or elimination of onstreet parking
- Citizen or public official request based on perceived safety or public sentiment

To elaborate on the last bullet, perceived safety refers to how local residents and users of the roadway feel about the safety performance of the roadway, even if it may not be supported by crash data (or conflict data discussed below). A common example of perceived safety is related to the use of the roadway by non-motorized road users (e.g., pedestrians, bicyclists, other cyclists, and persons on personal conveyances). A road that is perceived to be unsafe due to elevated vehicle speed may discourage non-motorized road users from using the facility. As a result, while there may be few or no reported crashes or conflicts, speeding could still be a safety consideration for non-motorized users.

IMPORTANT

Before conducting an engineering study, be familiar with established laws, regulations, and ordinances within the State and local jurisdiction pertaining to setting speed limits and required studies or methodologies.

11 FHWA. 2023. MUTCD. 11th ed., §2B.21.03. Washington, DC: FHWA.

12 AASHTO. 2018. *A Policy on Geometric Design of Highways and Streets* (Green Book), 7th ed. Washington, DC: AASHTO.

Public sentiment is an important consideration in the engineering study, and may come from public stakeholders, including residents, transportation agency staff, and elected officials. These individuals have knowledge of how the roadway functions, how they would like it to function, and what speeds they may deem appropriate given roadway context and users. Practitioners are encouraged to involve a local perspective that can speak to what the community wants from the roadway in the process of conducting the study and forming a recommendation for a safe and appropriate speed limit based on the data findings of the engineering study.

It is important to be aware of the reason(s) the engineering study is being performed and to document them once the study begins because these reasons can influence data-collection needs and the importance assigned to different study factors when developing a recommended speed limit.

1.4 Who Performs an Engineering Study

The MUTCD defines an engineering study as "the analysis and evaluation of available pertinent information including but not limited to, the safety and operational efficiency of all road users, and the application of appropriate principles, provisions, and practices…for the purpose of deciding upon the design…use, installation, or operation of a traffic control device."[13]

The definition goes on to state that "an engineering study shall be performed by a professional engineer… with appropriate traffic engineering expertise, or by an individual working under the supervision of such an engineer, through the application of procedures and criteria established by the engineer."[14]

Some States and local jurisdictions have established laws and ordinances that allow practitioners other than professional engineers to perform engineering studies. This authorization is often necessary due to limited budgetary and staffing resources. Although other practitioners may be conducting and documenting engineering studies in jurisdictions where these laws and ordinances have been established, it is important that the engineering study process be based on traffic engineering practices such as those described in this handbook.

13 FHWA. 2023. MUTCD. 11th ed., §1C.02.03. Washington, DC: FHWA.

14 The MUTCD (§1C.02.03) defines a professional engineer as "an individual who has fulfilled education and experience requirements and passed examinations that, under State licensure laws, permit the individual to offer engineering services within areas of expertise directly to the public."

Chapter 2. Preparing for the Study

This chapter discusses the steps practitioners can use to prepare for conducting an engineering study to establish a non-statutory speed limit. These steps include starting the documentation process, defining a study area, and reviewing the six factors that should be considered (at a minimum) during the study. These steps are in addition to the normal preparation steps taken for any traffic engineering study, such as those described in section 4.0 of chapter 1 in the Institute of Transportation Engineers (ITE) *Manual of Transportation Engineering Studies*.[15]

2.1 Starting the Documentation Process

The MUTCD states, "An engineering study shall be documented in writing."[16] Some agencies have specific forms or report formats that should be followed. In other situations, it may be left to the judgment of the practitioner supervising the study as to the most appropriate documentation format. Regardless, it is a best practice to establish a study file at the beginning of the process and to document key decisions and information as they are developed.

Documenting the reason for the study is a key first step in the process. Setting a speed limit on a new road, or after significant reconstruction on an old road, can involve different considerations than a local community wanting to reconsider speed as part of a safe system. Understanding the study catalyst and the "why" behind the study is important for identifying appropriate data needs, involving appropriate partners, evaluating each of the six factors, and beginning the study with the approach goals and priorities in mind. It is advisable to document the reasoning behind the study in the introduction to the study and reference it as the study progresses.

2.2 Defining the Study Area

When establishing the study area, consider going beyond the initial limits of the road segment being assessed to include nearby features, such as a horizontal and vertical curves, adjacent intersections, nearby access points, surrounding land uses, or other treatments that may impact speeds. Including these adjacent features will help practitioners determine the homogeneity of the segment and whether the study area limits should extend any farther. It is beneficial to evaluate the study area for logical termini that may not be a map boundary. Once the overall study area is defined, it can then be divided into smaller, similar sections for analysis. Photographs of features in the study area are helpful supporting documentation for the engineering study.

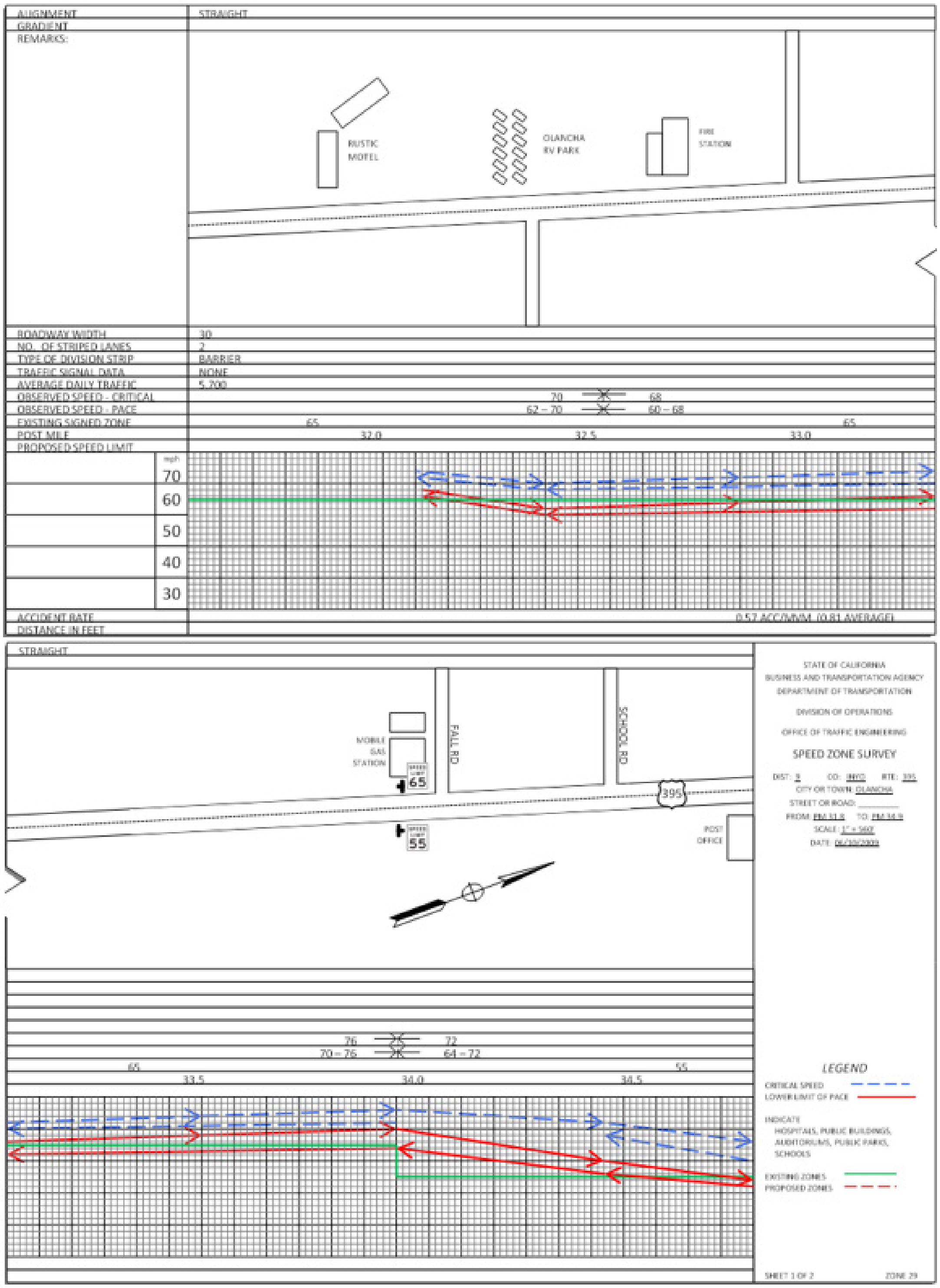
15 ITE. 2010. *Manual of Transportation Engineering Studies*, 2nd ed. Washington, DC: ITE.

16 FHWA. 2023. MUTCD. 11th ed., §1C.02.03. Washington, DC: FHWA.

The practitioner can prepare a scaled area map, sketch, or aerial view to show the study area and the field conditions. A strip map is an example of an appropriate format. A strip map is a set of map pages that follow the roadway, and each page of the map shows a defined geographic area on either side of the roadway. Collecting roadway data using specialized units or applications capable of geotagging data with spatial coordinates may help improve the map's accuracy.

A strip map typically includes a scaled sketch of the roadway, intersections, and specific or generalized land uses adjacent to the roadway. Inventory information, such as speed limits, number of lanes, sidewalks, bicycle lane presence, and traffic volumes, may also be shown below the sketch in a table-like format. The width of each cell corresponds to the point where a particular feature starts, ends, or changes characteristics. Operating-speed data collected within the study area might be shown in the form of a graph or as an additional inventory data row. Figure 2 shows an example of a strip map, and table 2 provides an example of the types of information contained in a strip map.

Section 2.3 outlines the six factors for an engineering study, which may be mapped. Chapter 3 identifies other data elements that can be considered in an engineering study and that may be included in the mapping process.



Source: California Department of Transportation (Caltrans). *2020 California Manual for Setting Speed Limits*. Sacramento, CA. https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/2020-california-manual-for-setting-speed-limits-a11y.pdf accessed May 8, 2023.

Figure 2. Example of a strip map of a study area showing existing conditions.

Table 2. Example information to show on strip map.

INFORMATION ITEM	NOTES
Name and identification number of the road to be zoned	• Show all names and identification numbers. • Indicate sections to be zoned with a wide center line on the strip map.

Cross section	• Show relevant details, which may include items such as:
	  • Width of the road, lanes, and pavement markings
	  • Number of lanes
	  • Parking restrictions
	  • Sidewalks
	  • Bicycle lanes
	  • Shared use paths

Crossroads, cross streets, and driveway access points	• Show all names and identification numbers.
Limits of the assessed road segment	• Indicate reference marker, milepoint, and other identifying information.
Adjoining road sections	• Note speed limit information for adjoining road sections.
Limits of any incorporated city or town	• Show reference marker, milepoint, control, and section numbers.
Names and approximate limits of the developed area of unincorporated towns	• Indicate by "beginning of developed area" and "end of developed area," not "city limits."
Urban areas	• Indicate any urban areas clearly under the heading "development." • According to definitions in 23 United States Code 101(a), areas of population greater than 5,000 generally qualify as "urban" for transportation purposes. Urban areas include FHWA-defined small urban areas (population of 5,000 – 49,999) and urbanized areas (population of 50,000+).
Schools and school crossings	• Show schools abutting the highway and those in the vicinity of the highway. • Show location of schools. Show all school crosswalks.
Traffic control devices	• Show location of existing devices to aid in proper spacing and placement of speed limit signs.
Important traffic generators	• Show all large employers, shopping centers/malls, event centers, medical facilities, and any other establishments that attract large volumes of motorized and non-motorized traffic.
Ball-bank indicator readings	• Show readings for each direction of travel for all curves.
Railroad crossings	• Indicate the number of tracks and type of grade crossing protection (crossbucks, cantilevers, crossbucks with signals, gates). • Show the name of the railroad at each crossing.
Bridges	• Indicate whether the road on the bridge is narrower than the road on either side of it.
Transit features	• Transit-only lanes • Transit stops • Transit priority at intersections

Note: This is not intended to be an exhaustive list but may prompt the practitioner to engage in thinking through the elements and features of the unique roadway and surrounding area.

Source: Adapted from Texas Department of Transportation. 2015. *Procedures for Establishing Speed Zones*. Austin: TxDOT. http://onlinemanuals.txdot.gov/txdotmanuals/szn/index.htm, accessed May 31, 2023.

2.3 Factors Considered in the Engineering Study

The MUTCD recommends six factors that should be considered by the engineering study.[17] Additional relevant factors may also be included depending on the specific needs of the study approach and study area. The six factors include the following:[18]

- **Roadway environment** (such as roadside development, number and frequency of driveways and access points, and land use), functional classification, public transit volume and location or frequency of stops, parking practices, and pedestrian and bicycle facilities and activity;
- **Roadway characteristics** (such as lane widths, shoulder condition, grade, alignment, median type, and sight distance);
- **Geographic context** (such as urban district, rural town center, non-urbanized rural area, or suburban area) and multimodal trip generation;
- **Reported crash experience** for at least a 12-month period;
- **Speed distribution of free-flowing vehicles,** including the pace, median (50th-percentile), and 85th-percentile speeds;
- **Review of past speed studies** to identify any trends in operating speeds.

The extent to which each factor is considered will depend on the specific study area; for example, most roadway environment considerations are not applicable to limited-access highways. However, these factors, as well as others that may inform the engineering study, such as community and stakeholder inputs, should be considered to the extent they are applicable. The remainder of this section describes each of these six factors in more detail, including how the factors can inform the process for setting safe, appropriate speeds, and examples of potential data to collect for each factor.

2.3.1 ROADWAY ENVIRONMENT

Roadway environment is characterized by the activity occurring immediately adjacent to the road, including, but not limited to, the following:

- **Number and frequency of driveways and access points.** As access density increases, the number of potential conflicts that motorists need to keep track of increases and the crash rate increases. Some States have developed access management tables based on sight distance principles that identify the minimum access point spacing for a given posted speed. Practitioners can use these tables as a cross-reference to determine an appropriate speed given the existing access density.[19] For freeways and other controlled-access highways, interchange spacing can be used instead.

17 FHWA. 2023. MUTCD. 11th ed., §2B.21.07. Washington, DC: FHWA.

18 FHWA. 2023. MUTCD. 11th ed., §2B.21.07. Washington, DC: FHWA.

19 Williams, Kristine M., Vergil G. Stover, Karen K. Dixon, and Philip Demonsthenes. 2014. *Access Management Manual*, 2nd ed. Washington, DC: National Academies Press.

- **Functional classification** (e.g., freeway, arterial, collector, local). A road's functional classification outlines the nature of its role and purpose in a road network or multimodal transportation system. FHWA's *Highway Functional Classification Concepts, Criteria, and Procedures* notes that, in general, there is a relationship between posted speed limits and functional classifications.[20] Arterials may have fewer at-grade intersections and driveways; therefore, higher speed limits may be appropriate, although safe traffic operations for non-motorized road users through separation of users is still a consideration. In contrast, the speed limit on urban roads is typically low to promote safe traffic operations in an environment that is meant to accommodate non-motorized road users (i.e., pedestrians, bicyclists, other cyclists, and persons on personal conveyances) and to provide access via driveways, intersecting roadways, crosswalks, and transfer points for buses and other modes.
- **Public transit service**. Elements of public transit service include the number and location of transit stops, the location of bus stops relative to the travel lane (whether buses or other transit vehicles stop in the travel lane or pull out of the roadway to stop), and the frequency of service. As the frequency of transit service increases, the number of potential conflicts between stopping transit vehicles and other vehicles also increases. In addition, the presence of transit services is an indicator that there will be a high number of pedestrians present.
- **Pedestrian and bicycle facilities and activity.** This element considers the type of existing or planned pedestrian and bicycle facilities provided (if any). Members of a community may believe that developed areas with a lack of pedestrian and bicyclist activity reflect a lack of demand. In reality, it may be a reflection that conditions are unsafe for walking and biking.
- **Traffic volumes (e.g., average annual daily traffic** (AADT), peak-hour volumes, heavy vehicle percentage). Practitioners need traffic volumes to determine crash rates. In developed areas (where the human-built environment has surpassed most of the natural environment), traffic volumes are also useful for assessing non-motorized road user exposure and risk.[21]
- **Onstreet parking and other curbside activity.** The presence of onstreet parking, loading zones, drop-off zones, and other curbside activity are another indicator of general activity levels within the study area and the potential for conflicts with other road users. The allowed parking duration gives an indication of how frequently spaces may turn over and thus the potential for conflicts.

20 FHWA. 2013. *Highway Functional Classification Concepts, Criteria, and Procedures*. FHWA-PL-13-026. https://dot.sd.gov/media/documents/HwyFunctionalClassification.pdf, accessed May 30, 2023.

21 Raghavan Srinivasan, Martin Parker, David Harkey, Dwayne Tharpe, and Roy Sumner. 2006. E*xpert System for Recommending Speed Limits in Speed Zones Final Report*. Transportation Research Board, Washington, DC: The National Academies Press. https://safety.fhwa.dot.gov/uslimits/documents/finalreport.pdf, accessed April 23, 2024.

Figure 3. Example of roadway environment factor. The facilities and intersection type indicate there may be a high likelihood of people walking and bicycling.

2.3.2 ROADWAY CHARACTERISTICS

Roadway characteristics include physical attributes and road design elements. Examples of roadway characteristics include, but are not limited to, the following:

- **Cross-sectional elements and widths.** The number of lanes provided for each travel mode, lane widths, and the presence and width of shoulders can influence motorists' speed choice. The roadway cross section can also affect how readily road users can cross the road at uncontrolled intersections and driveways. Cross sections also include sidewalks and bike lanes.
- **Median type and width.** The type of median, if present, influences the frequency and severity of crashes. In developed areas, non-traversable medians with refuge islands can make it easier for non-motorized road users to cross the roadway. A median with a barrier also reduces the risk of crossover head-on crashes.
- **Horizontal and vertical geometry.** Horizontal curves in the roadway may constrain the maximum safe speed that motorists can drive. Vertical curves may constrain sight distance, thus also influencing the maximum safe speed. The available sight distance to pedestrian crossings is also an important consideration that influences safe operating speed.
- **Grade and topography.** Long, steep grades can result in vehicles picking up too much speed on downgrades and large speed differentials between automobiles and heavy vehicles on upgrades. Mountainous terrain can constrain speeds due to frequent curves, sharp curves, or both, as well as potentially constrained sight distances.

- **Roadside design features.** Features may include curbs, trees, embankments, guardrails, barriers, retaining walls, and other features.
- **Sight distance constraints.** Horizontal and vertical geometry, terrain, vegetation and other roadside elements, or a combination of these, can all constrain sight distance. Depending on the situation, either stopping sight distance or decision sight distance could constrain safe operating speeds.
- **Intersection traffic control and railroad crossings.** The presence of traffic control devices that may require traffic on the roadway to stop or yield can influence the choice of speed limit.
- **Pedestrian, bicycle, and transit facilities.** The presence of crosswalks and possible accompanying safety countermeasures, such as rectangular rapid-flashing beacons or median islands, may be an indication of higher levels of pedestrian activity, pedestrian difficulty crossing the street, or both. Similarly, presence of bicycle lanes and bus stops may be an indication of bicycle and transit activity.
- **Lighting.** Street lighting, or the lack of it, influences the visibility of pedestrians and bicyclists at night.
- **Pavement and shoulder quality.** Poor pavement quality can increase the risk of a motorist losing control of the vehicle, while the composition and condition of the shoulder affects a motorist's ability to recover if they run off the road. Pavement quality is an important consideration for bicyclist safety as well.

Figure 4. Example of roadway characteristics factor. The cross-sectional elements of this road include sidewalks, parking, and bicycle lane.

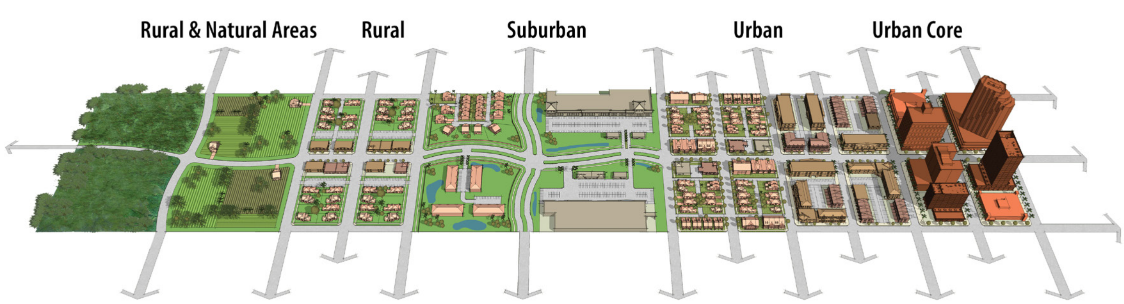
2.3.3 GEOGRAPHIC CONTEXT

Geographic context is the broader environment and development characteristics of the study area, including areas not immediately adjacent to the roadway. These characteristics are used to identify the expected intensity of trip-making and the types of road users generated by the land uses within and around the study area. In particular, practitioners may consider specific land uses that could generate trips along and across the roadway by non-motorized road users. Geographic context is an important consideration because wide roads are often difficult for non-motorized road users to cross and carry an increased risk of severe injury or death if a crash occurs.

Examples of geographic context include:

- Context classification (e.g., rural, rural town, suburban, urban, and urban core)
- Nearby non-motorized traffic generators (e.g., schools, grocery stores and markets, medical offices and facilities, event venues)
- Surrounding road network (connectivity for various users)
- Natural and environmental features (e.g., parks, greenways, bodies of water, mountains)
- Population characteristics and attributes (e.g., low-income areas, zero-car households, school children, aging population)

Context classifications help practitioners determine how factors relating to geographic context affect speeds and inform speed limit decision making. A commonly used classification system is that described in the American Association of State Highway Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets,* commonly known as the Green Book.[22] This resource identifies five context classifications: rural, rural town, suburban, urban, and urban core. *NCHRP Report 1022: Context Classification Application: A Guide* informed the latest version of the Green Book; its framework for the five classifications provides a mechanism for better targeting design solutions (e.g., for speed management) to specific contexts while providing needed flexibility to address planning and design needs.[23] Figure 5 provides an illustration of the type of density and development expected in each of the five contexts, while table 3 provides a description of each context area.



Source: Adapted from Nikiforos Stamatiadis, Adam Kirk, Laura Wright, Hermanus Steyn, Mary Raulerson, Jennifer Musselman. 2022. *NCHRP Research Report 1022: Context Classification Application: A Guide*. Transportation Research Board, Washington, DC, Figure 1, p. 2. Copyright, National Academy of Sciences. Reproduced with permission of the Transportation Research Board. Figure source: FDOT.

Figure 5. Illustration of context classifications.

22 AASHTO. 2018. *A Policy on Geometric Design of Highways and Streets* (Green Book), 7th ed. Washington, DC: AASHTO.

23 Stamatiadis, Nikiforos, Adam Kirk, and Laura Wright. 2022. *NCHRP Report 1022: Context Classification Application: A Guide*. Transportation Research Board, Washington, DC: National Academies Press. https://doi.org/10.17226/26819, accessed February 20, 2024.

Table 3. Characteristics of context classifications.

CONTEXT	DENSITY	LAND USE	SETBACK
Rural	Lowest (few houses or other structures)	Agricultural, natural resource preservation, and outdoor recreation uses with some isolated residential and commercial	Usually large setbacks
Rural town	Low to medium (single-family houses and other single-purpose structures)	Primarily commercial uses along a main street (some adjacent single-family residential)	Onstreet parking and sidewalks with predominately small setbacks
Suburban	Low to medium (single- and multifamily structures and multistory commercial)	Mixed residential neighborhood and commercial clusters (includes town centers, commercial corridors, big box commercial and light industrial)	Varied setbacks with some sidewalks and mostly off-street parking
Urban	High (multistory, low-rise structures with designated off-street parking)	Mixed residential and commercial uses, with some institutional and industrial and prominent destinations	Onstreet parking and sidewalks with mixed setbacks
Urban core	Highest (multistory and high-rise structures)	Mixed commercial, residential, and institutional uses within and among predominately high-rise structures	Small setbacks with sidewalks and pedestrian plazas

Source: Nikiforos Stamatiadis, Adam Kirk, Don Hartman, Jeff Jasper, Samantha Wright, Michael King, and Rick Chellman. 2018. *An Expanded Functional Classification System for Highways and Streets*. Transportation Research Board, Washington, DC: The National Academies Press. https://doi.org/10.17226/24775, accessed February 20, 2024.

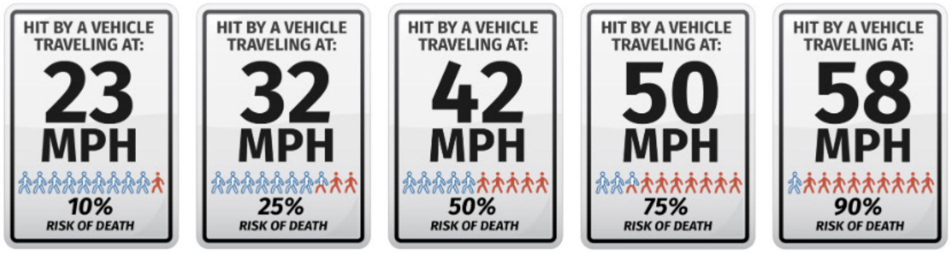
A growing number of agencies are using context classifications in conjunction with functional classifications to help establish ranges of appropriate roadway speeds—*target speeds*—for vehicles in relation to various user groups. Keep in mind that, while a speed limit focuses on vehicle speeds, the effects of vehicle speed significantly impact the safety and comfort of all road users and ought to be considered in relation to each user group.

For example, a suburban context may have infrastructure designed for higher speeds to serve drivers taking longer trips and moving between or within communities; however, the range of users within a suburban context may require slower speeds to decrease potential crash impact speeds, particularly for people walking and bicycling. A rural context is expected to have higher speeds due to generally lower traffic volumes and free-flow conditions. Speeds in an urban core context are typically lower due to the higher volume of user activity and potential conflicts between user types that occur in an urban core network.

Vehicle speeds affect the safety of all roadway users. Non-motorized road users, such as pedestrians and bicyclists, have no metal frames or airbags to protect them during a crash. Without adequate infrastructure protection, non-motorized road users are much more likely to be injured or killed in relatively low-speed crashes than vehicle occupants, as illustrated in figure 6. High vehicle speeds can also discourage non-motorized road users from using or crossing a roadway, creating barriers to individual mobility and increased reliance on modes with higher user costs.

Target Speed

The target speed is the highest desired operating speed given land-use contexts, multimodal activity, and vehicular mobility.



Data sources: NHTSA. 2021. *Traffic Safety Facts: Early Estimates of Motor Vehicle Traffic Fatalities and Fatality Rate by Sub-Categories in 2020*, DOT HS 813 118; Tefft, B.C. 2011. *Impact Speed and a Pedestrian's Risk of Severe Injury or Death*. Washington, D.C.: AAA Foundation for Traffic Safety; NHTSA. 2018. National Traffic Speeds Survey III: 2015, DOT HS 812 485. Figure source: FHWA.

Figure 6. Risk of death when hit by a vehicle at differing speeds.

Understanding the expected speed ranges in various contexts and functional classifications can create a starting point for assessing the engineering study outcomes and account for the surrounding community, user needs, and road function. In addition, as discussed further in chapter 4, identifying a target speed for a road can help agencies identify appropriate design and operational features to support a motorist speed choice consistent with the target speed.

NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide presents a table of suggested target speeds by context and functional classification.[24] Similar guidance is also found in *NCHRP Research Report 855: An Expanded Functional Classification System for Highways and Streets.*

Table 4 presents the target speed ranges identified in *NCHRP Research Report 966*. The table serves as an example of how agencies can identify target speed ranges based on roadway functional and context classifications. Roadway context and type align to functional classification and context classification for the purposes of this handbook.

Table 4. Sample target speed ranges by roadway context and type.

ROADWAY TYPE	ROADWAY CONTEXT				
	RURAL	RURAL TOWN	SUBURBAN	URBAN	URBAN CORE
Limited-access Freeway	High 50 mph and above	High 50 mph and above	High 50 mph and above	High 50 mph and above	High 50 mph and above
Principal Arterial	High 50 mph and above	Low to Medium 45 mph and below	Medium to High 30 mph and above	Low to Medium 45 mph and below	Low 25 mph and below
Minor Arterial	High 50 mph and above	Low to Medium 45 mph and below	Medium 30 to 45 mph	Low to Medium 45 mph and below	Low 25 mph and below

24 Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, and Tim Gates. 2021. *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide*. Transportation Research Board, Washington, DC: National Academies Press. https://doi.org/10.17226/26216, accessed February 20, 2024.

Table 4. Sample target speed ranges by roadway context and type. (continued)

ROADWAY TYPE	ROADWAY CONTEXT				
	RURAL	RURAL TOWN	SUBURBAN	URBAN	URBAN CORE
Collector	Medium 30 to 45 mph	Low 25 mph and below	Medium 30 to 45 mph	Low 25 mph and below	Low 25 mph and below
Local	Medium 30 to 45 mph	Low 25 mph and below	Low 25 mph and below	Low 25 mph and below	Low 25 mph and below

Source: Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, and Tim Gates. 2021. *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide. Transportation Research Board, Washington, DC: National Academies Press.* https://doi.org/10.17226/26216, accessed October 10, 2023.

2.3.4 CRASH EXPERIENCE

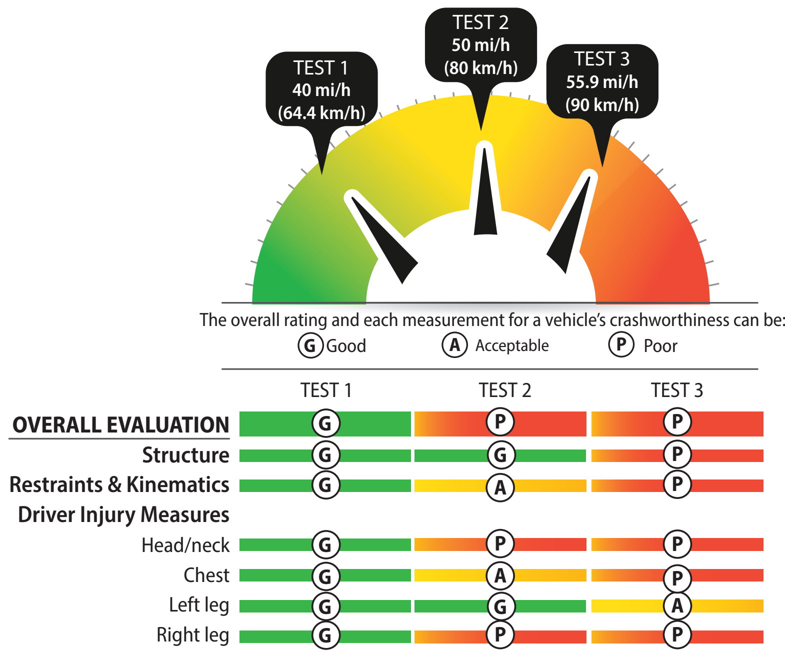
When conducting an engineering study, at a minimum, reported crash experience for a 12-month period[25] should be considered. There may be situations where a detailed crash analysis may be needed to evaluate crash types and patterns associated with speed and to identify potential safety countermeasures that could be implemented. Using fewer than 3 years of data may make it more difficult to distinguish patterns, while data that are more than 5 years old may be less valid due to changes in the corridor's characteristics. As such, using 3 to 5 years of crash data may be advisable.

Practitioners should consider any major roadway changes that may have occurred when deciding how many years of crash data to include. Where available, the data should be comprehensive enough to communicate crash patterns and to enable the practitioner to be confident that they understand the safety impact of adjusting the speed limit.

Crash data are useful in understanding the impact of the current speeds. A speed-setting practice known as "injury minimization" looks at managing speeds, and therefore crash forces, to levels that would not create serious injuries or fatalities in the event of a crash. Figure 6 illustrates the increased risk to pedestrians with higher vehicle speeds, and a similar risk extends to drivers and passengers in multi-vehicle collisions as well. This risk is further demonstrated in figure 7, which documents the results of a recent study using a test car and dummy in crashes at speeds of 40, 50, and 55.9 mph.[26]

25 FHWA. 2023. MUTCD. 11th ed., §2B.21.07.

26 Woon Kim, Tara Kelley-Baker, Raul Arbelaez, Sean O'Malle, and Jack Jensen. 2021. *Impact of Speeds on Drivers and Vehicles — Results from Crash Tests*. Washington, D.C.: AAA Foundation for Traffic Safety. https://aaafoundation.org/impact-of-speeds-on-drivers-and-vehicles-results-from-crash-tests/, accessed February 20, 2024.



Source: Adapted from Woon Kim, Tara Kelley-Baker, Raul Arbelaez, Sean O'Malle, and Jack Jensen. 2021. *Impact of Speeds on Drivers and Vehicles — Results from Crash Tests. Washington, D.C.: AAA Foundation for Traffic Safety.* https://aaafoundation.org/impact-of-speeds-on-drivers-and-vehicles-results-from-crash-tests/, accessed February 20, 2024.

Figure 7. Vehicle crashworthiness and occupant protection ratings based on Insurance Institute for Highway Safety protocols.

"At the 40-mph impact speed, there was minimal intrusion into the driver's space. But at the 50 mph impact speed, there was noticeable deformation of the driver side door opening, dashboard and foot area. At 56 mph, the vehicle interior was significantly compromised, with the dummy's sensors registering severe neck injuries and a likelihood of fractures to the long bones in the lower leg…

…***At both 50 and 56 mph, the steering wheel's upward movement caused the dummy's head to go through the deployed airbag. This caused the face to smash into the steering wheel. Measurements taken from the dummy showed a high risk of facial fractures and severe brain injury***."

Source: Insurance Institute for Highway Safety. "New crash tests show modest speed increases can have deadly consequences." January 28, 2021. https://www.iihs.org/news/detail/new-crash-tests-show-modest-speed-increases-can-have-deadly-consequences, accessed February 20, 2024. See also: Woon Kim, Tara Kelley-Baker, Raul Arbelaez, Sean O'Malle, and Jack Jensen. 2021. *Impact of Speeds on Drivers and Vehicles — Results from Crash Tests*. Washington, D.C.: AAA Foundation for Traffic Safety. https://aaafoundation.org/impact-of-speeds-on-drivers-and-vehicles-results-from-crash-tests/, accessed February 20, 2024.

Reviewing crash reports to identify trends in crash types and severity and comparing those data to conflicts and users most likely to be present in that context can help inform decision making for speed limits that support safety for all road users.

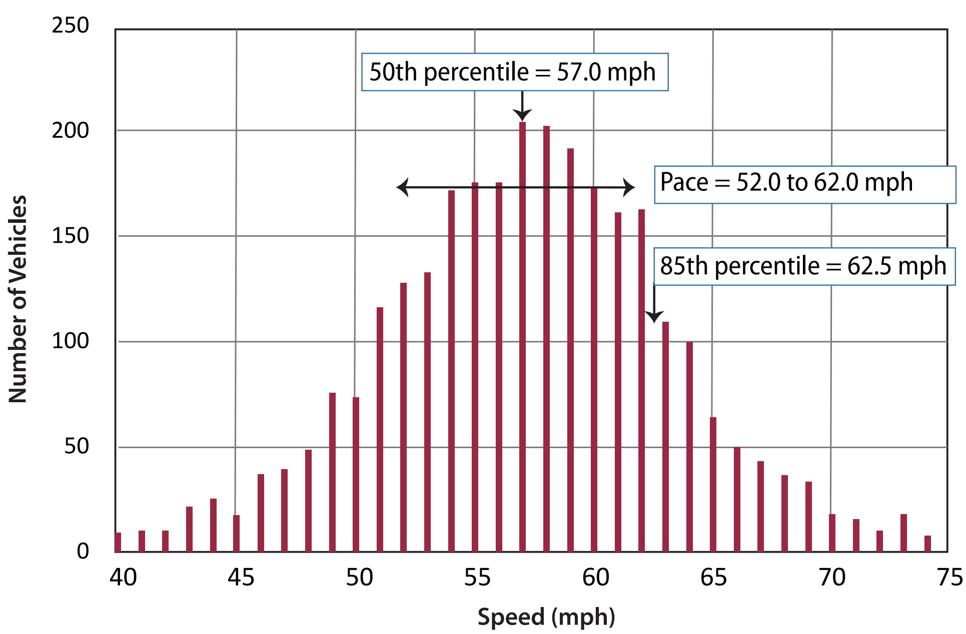
2.3.5 SPEED DISTRIBUTION OF FREE-FLOWING VEHICLES

Conducting a speed study within the study area provides important information about how motorists are currently driving on the roadway. Chapter 4 further describes how information from the speed study can be combined with information from the other five factors when developing a recommendation for a safe and appropriate speed limit.

Chapter 3 provides information on collecting data for the study. The data collected by a speed study consist of observations of the speeds of *free-flowing vehicles*—that is, the speeds selected by drivers who *are not* impeded by a vehicle in front of them. By focusing only on free-flowing vehicles, the 50th- and 85th-percentile speeds will be higher than the speed of the traffic stream as a whole because the traffic stream includes vehicles that *are* impeded by vehicles in front of them. However, it is important to understand the speed distribution of free-flowing vehicles since crash severity is likely greater at higher speeds.

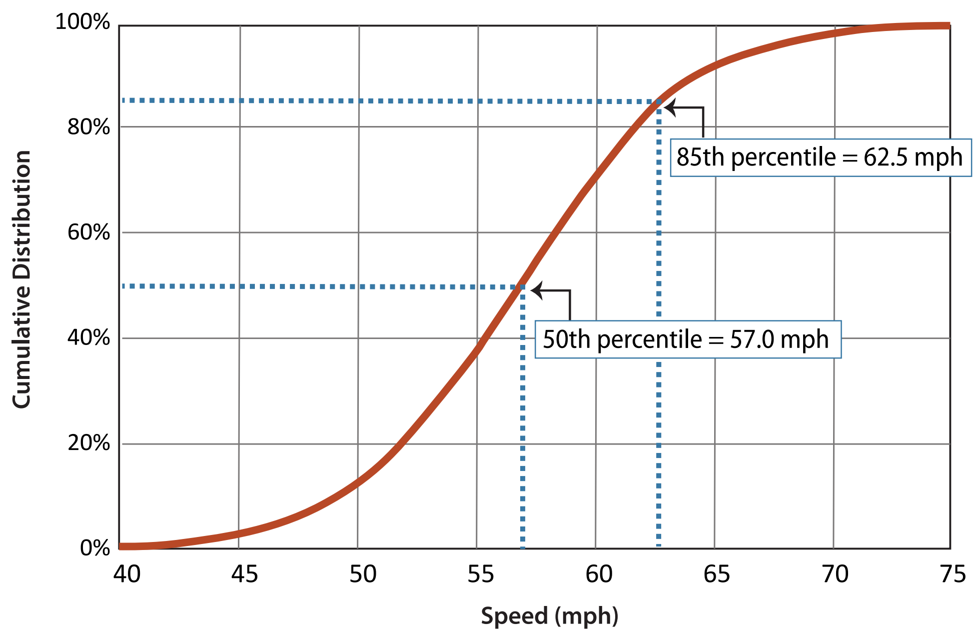
Speed observations can be plotted as speed distribution curves, such as those shown in figure 8 and figure 9. The term *speed distribution* reflects the arrangement of speed values showing their observed frequency of occurrence. These figures also illustrate the following important statistical metrics that describe important characteristics of the speed distribution:

- **50th-percentile (median) speed** is the speed at or below which 50 percent of vehicles travel (i.e., the observed speed that 50 percent of vehicles do not exceed).
- **85th-percentile speed** is the speed at or below which 85 percent of vehicles travel (i.e., the observed speed that 85 percent of vehicles do not exceed).
- **Pace** is the 10-mph range in which the greatest percentage of free-flow speed measurements fall into.



Source: Adapted from Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, and Tim Gates. 2021. *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide*. Transportation Research Board, Washington, DC, Figure 6, p. 16. Copyright, National Academy of Sciences. Reproduced with permission of the Transportation Research Board.

Figure 8. Histogram example of a speed distribution curve.



Source: Adapted from Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, and Tim Gates. 2021. *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide*. Transportation Research Board, Washington, DC, Figure 6, p. 16. Copyright, National Academy of Sciences. Reproduced with permission of the Transportation Research Board.

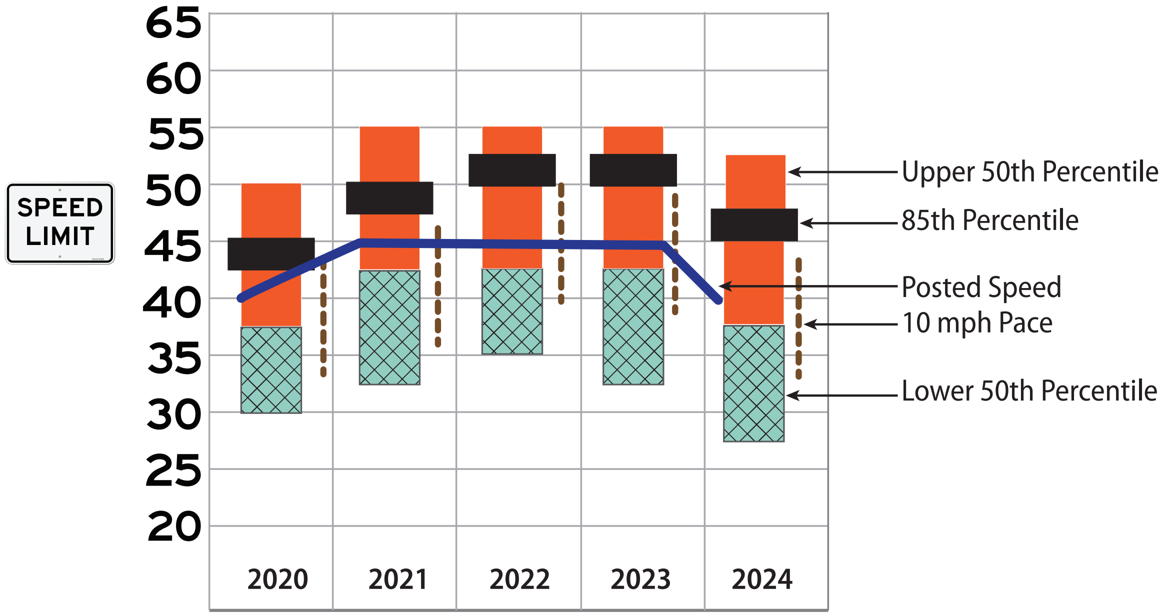
Figure 9. Cumulative distribution example of a speed distribution curve.

2.3.6 OPERATING SPEED TRENDS

The final of the six factors that should be considered in an engineering study involves a review of past speed studies. This review helps the practitioner determine whether traffic speeds have generally increased, decreased, or held steady over time. This information can be combined with knowledge of how development patterns, traffic volumes, etc. have changed over the same timeframe to determine potential correlations.

Ideally, operating speed trends will be evaluated over multiple years, similar to crash data. A study of operating speeds is most useful when the same speed-related metrics are used consistently across each historical study, and when a similar data-collection technique and tool(s) is used in each case. (See chapter 3 for additional details.)

Figure 10 provides one example to visualize key speed metrics studied at the same location over 5 consecutive years. At this hypothetical location, the jurisdiction increased the posted speed in years 2021 through 2023 and decreased it in 2024.



Source: FHWA.

Figure 10. Example study of operating speed trends.

2.3.7 OTHER FACTORS

In addition to the six factors above, agencies may consider additional factors to include in their engineering study. Every location and roadway is unique, with even adjacent regions having vastly different characteristics. Therefore, it is important for practitioners to use engineering judgment to verify that all relevant factors are considered. Some examples of additional factors that an agency may consider include weather, seasonality, and conflicts or surrogate safety measures.

Weather can be an important factor for consideration in an engineering study, as lighting conditions, temperature, visibility, and precipitation all influence the safety of a roadway or the speeds that are safe given certain weather conditions. Vehicle and bicycle tires lose traction when the pavement is wet or covered in snow and ice, driver reaction times are impacted by a lack of visibility due to rain or fog, and dark conditions with poor or inadequate roadway lighting may impact the ability for drivers to react to other roadway users or hazards. Given the geographic location of the engineering study and prevailing weather conditions, these are important considerations.

Another potential factor is the seasonality of travel patterns. Many places in the United States are subject to seasonal variations in traffic volumes due to tourist travel or other circumstances (e.g., commercial operations only active for parts of the year). The resulting changes in volume levels (for any road user type) and potential unfamiliarity of drivers within the local area may need to be considered in an engineering study.

Finally, an additional factor that could be considered involves conflict data or other surrogate safety measures. Conflict data may be recorded by trained observers or may be automated through video-based conflict analysis methods using machine learning and video image processing technology. Other surrogate safety measures may include rapid-breaking events obtained from connected vehicle trajectory data or observations of errant behavior along the corridor under study. The use of surrogate safety data may be particularly helpful for new locations, where multi-year crash data are not yet available. Surrogate safety measures can also be valuable for an assessment of non-motorized safety, as crashes involving pedestrians and bicyclists are often underreported.

In general, agencies are encouraged to consider additional factors, based on local context and the specific characteristics of the project, for inclusion in the engineering study.

2.4 Example Data Collection Template

A sample data-collection template that a practitioner can use to document findings relevant to each of the six factors included in the engineering study is found in appendix C. This template can be adapted and modified as needed to serve the specific needs of the local agency.

Chapter 3. Collecting Data for the Study

The previous chapter provided examples of data elements that can be considered as part of each factor assessed by an engineering study to establish a non-statutory speed limit. This chapter provides additional detail on collecting data for each factor, including identifying potential sources of these data as well as potential data-collection and analysis methods.

Each study area is unique, and not every data element described in this section will be applicable to a given study area. Practitioners will need to use their judgment and familiarity with the study area to determine which data elements are relevant to a given engineering study. In addition, each study area could have multiple segments that require different analysis based on speed-setting factors.

Although many data elements can be gathered from agency databases, design and planning documents, online imagery, and similar electronic sources, field visits by the practitioner supervising the engineering study are highly recommended to verify the accuracy of the information. Field visits at different times and under varying operating conditions will also confirm whether there were any recent changes in site conditions that may not yet be reflected in online sources, or if different data elements need to be identified.

Some data elements lend themselves to mapping on the study area map, described in section 2.1; these elements are noted in the tables in this chapter. The engineering study project file should document any data not included in the map. If an expert system is being considered during the study, it will also be necessary to collect any additional data used by that system. Expert systems are tools that are nationally available to supplement practitioner decision making when recommending safe and appropriate speed limits and are described in greater detail in chapter 4. Typical data elements used by expert systems are also noted in the tables in this chapter.

3.1 Roadway Environment

Practitioners can collect data on the roadway environment from online databases, mapping, and during field visits. Table 5 lists some commonly collected roadway environment data elements along with potential sources.

Table 5. Examples of roadway environment data elements and potential sources.

DATA ELEMENT	POTENTIAL SOURCE(S)
Roadside development	• Field visit (allows recent and in-process development to be identified, as opposed to online imagery)†
Intersection, driveway and median opening locations,* or interchange spacing*	• Field visit or online imagery†
Functional classification*	• Transportation plan or element
Transit facilities and service characteristics	• Field visit or online tools to determine bus lane and bus stop locations and whether pullouts are provided† • Peak period bus frequency from transit agency website
Pedestrian* and bicycle facilities (e.g., sidewalk, bidirectional buffered bicycle lane, side path)	• Field visit or online imagery to determine presence, type, and buffer of facilities from roadway† • Project as-built plans
Activity levels Non-motorized road users (e.g., ped,* bicycle,* horse) Farm vehicles, golf carts, scooters, etc. Wildlife crossings	• Field visit • User counts • Wearable fitness tracking data vendors • Crash data specific to wildlife- or livestock-involved crashes (see section 3.4 for crash data sources)
Traffic volume (AADT),* truck percentage*	• Current or recent count data from agency databases† • Connected vehicle data vendors
Onstreet parking and other curbside activity*	• Field visit or online tools to determine where onstreet parking, loading, and dropping off is allowed; how it is provided (parallel vs. angle); times of day allowed; and allowed durations†

*Data elements used by common speed-limit-setting expert systems.
†Data elements suitable for mapping.

Source: FHWA.

3.2 Roadway Characteristics

During design, roadway characteristics, or geometric design features, are typically established based on a design speed selected during project development. During an engineering study, practitioners should assess and consider the existing roadway characteristics as part of the overall process for determining a safe and appropriate speed limit. This activity may help ensure the proposed speed limit will not have adverse safety effects due to the road's design.

Similar to roadway environment data, practitioners can collect roadway characteristic data during a field visit and through a review of roadway plans. It is important for practitioners to consider features that have a relationship with speed, such as clear zones, roadway curvature, and stopping sight distances. Table 6 lists some commonly collected roadway characteristic data elements along with their potential sources.

Table 6. Examples of roadway characteristic data elements and potential sources.

DATA ELEMENT	POTENTIAL SOURCE(S)
Cross-sectional element features and widths • Number of travel lanes by mode*† • Turn-lane provision at intersections† • Lane width* • Shoulder width*† • Buffer presence and width† • Sidewalks, bike lanes, and other multimodal facilities	As-builts, online imagery, field visit
Median type and width*†	As-builts, online imagery, field visit
Horizontal and vertical geometry, design speed*	As-builts, field visit
Grade	As-builts, field visit
Topography	Field visit, online imagery
Roadside design feature presence† • Curbs • Guardrails, barriers • Trees, embankments, retaining walls	Field visit, as-builts§
Sight distance constraints	Field visit
Street lighting†	Field visit
Intersection traffic control (e.g., traffic signals, roundabouts, stop or yield control for the study roadway), and railroad crossings†	Online imagery, field visit
Marked crosswalk locations and safety countermeasures†	Field visit, online imagery
Pavement quality	Pavement condition database, field visit
Shoulder type and condition	Field visit
Other elements • Traffic-calming features† • Known drainage issues	As-builts, field visit, maintenance staff knowledge

*Data elements used by common speed-limit-setting expert systems.
†Data elements suitable for mapping.
§In rural areas, the clear zone width or the roadside hazard index could be used to describe the potential hazard of the roadside environment. See Charles V. Zegeer, Donald W. Reinfurt, Joseph Hummer, Lynne Herf, and William Hunter. 1988. "Safety Effects of Cross-Section Design for Two-Lane Roads." *Transportation Research Record 1195, pp. 20–32.* https://onlinepubs.trb.org/Onlinepubs/trr/1988/1195/1195-003.pdf, accessed February 6, 2024.
Source: FHWA.

3.3 Geographic Context

Collecting geographic context data will generally require a mix of data-collection techniques. High-level context information may have already been developed in the form of formal context classifications or can be readily determined from the practitioner's knowledge of the study area. *NCHRP Research Report 1022: Context Classification Application: A Guide* provides guidance on identifying geographic context, including characteristics and transportation expectations for each context that can help practitioners review the area.[27] Practitioners can inventory more detailed information through a field visit or from online sources.

27 Nikiforos Stamatiadis, Adam Kirk, Don Hartman, Jeff Jasper, Samantha Wright, Michael King, and Rick Chellman. 2018. *NCHRP Research Report 1022: An Expanded Functional Classification System for Highways and Streets*. Transportation Research Board, Washington, DC: The National Academies Press. https://doi.org/10.17226/24775, accessed October 10, 2023.

Demographic context may take more effort to develop, but Census data can be a useful tool for understanding the population nearby.[28] For example, a practitioner can search for age information from the American Community Survey on the Census site to determine the percentage of the population in an area that was 60 years old and older.[29] Other Federal data sources include the Climate and Economic Justice Screening Tool,[30] a mapping tool that summarizes information on the local area and population, and the USDOT Equitable Transportation Community Explorer tool, which provides data on transportation disadvantaged populations in a defined study area.[31]

Table 7 lists commonly collected information about geographic and demographic context, along with potential data sources.

Table 7. Examples of geographic and demographic data elements and potential sources.

DATA ELEMENT	POTENTIAL SOURCE(S)
Development† • Context classification,* urban/rural,* land use type*	• Agency designations • Practitioner judgment, based on applicable AASHTO, State, or local guidance • NCHRP Research Report 1022: Context Classification Application: A Guide
Multimodal trip generators† • Schools • Grocery stores, markets • Medical offices, clinics, hospitals, rehabilitation facilities • Senior centers, community centers, libraries, churches • Parks, playgrounds, recreation centers, trailheads • Restaurants, shopping • Multi-family housing, mixed-use development • Hotels	Field visit, online tools
Demographics • Elderly population • Youth population • Population with disabilities • Poverty rate • Zero-car households	• US Census American Community Survey • Climate and Economic Justice Screening Tool • Equitable Transportation Community Explorer
Community Feedback • Public perception of roadway and appropriate speeds • Community needs related to use of the street	• Public outreach in the form of public meetings or surveys • Social media discussion by community group • Direct outreach to residents and business owners along the corridor

†Data elements that lend themselves to mapping.
*Data elements used by common speed-limit-setting expert systems.
Source: FHWA.

28 See the U.S. Census Bureau website at https://data.census.gov/ for detailed demographic data and tables.

29 U.S. Census Bureau. 2024. "American Community Survey (ACS)." https://www.census.gov/programs-surveys/acs, accessed February 20, 2024.

30 Executive Office of the President, Council on Environmental Quality. n.d. "Climate and Social Justice Screening Tool." https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5, accessed February 20, 2024.

31 USDOT. n.d. "Equitable Transportation Community Explorer." (website). https://experience.arcgis.com/experience/0920984aa80a4362b8778d779b090723/page/Transportation-Insecurity-Analysis-Tool/, accessed February 20, 2024.

3.4 Crash Experience

Table 8 lists commonly collected safety performance data. The length of the road under study is part of the calculation to determine the overall crash rate for the study area. It is also an input into expert systems for recommending speed limits.

Crash experience and risk factors are an important aspect of applying the SSA principles, which emphasize injury minimization and recognize higher speeds exponentially increase the energy of a crash. Road user survivability is a key consideration when using injury minimization principles. Speed limits may be set according to the crash types that are likely to occur, the impact forces that result, and the human body's tolerance to withstand these forces. Because persons walking and bicycling are particularly at risk in higher speed crashes (see figure 6), applying injury minimization principles in areas with pedestrian and bicycle activity may result in speed limit recommendations that are lower than the current operating speeds of free-flowing vehicles.

Information as to whether a roadway is one- or two-way also enters into crash rate calculations. Table 9 provides more detail about potential sources of crash data as well as other kinds of safety performance data that can supplement the analysis.

Table 8. Examples of safety performance data and potential sources.

DATA ELEMENT	POTENTIAL SOURCE(S)
Number and severity of crashes*	• Federal, State, or local agency databases • Corridor or local safety plans
Crash patterns: types (e.g., angle, pedestrian-involved), locations, severity	• State or local agency databases • Corridor or local safety plans
Study area roadway segment length*	• Agency data, online tools
One- or two-way street*	• Field visit, online tools

*Data elements used by common speed-limit-setting expert systems.
Source: FHWA.

Table 9. Potential sources of safety performance data.

SOURCE	DATA	EFFORT	ADVANTAGES	DISADVANTAGES
Crash reports	Information on actual crashes and some information or speculation on crash cause.	Varies depending on agency. Some areas have very good records, others may need more work.	Useful data on actual crashes in the corridor. Typically offer detailed breakdowns on the crashes for evaluation.	Few, but most come from errors in record keeping and databases. Crashes involving pedestrians and bicyclists are less likely to be reported.

Table 9. Potential sources of safety performance data. (continued)

SOURCE	DATA	EFFORT	ADVANTAGES	DISADVANTAGES
Citations	Speeding and moving violations.	Varies depending on agency. Some areas have very good records, others may need more work.	Can give additional information on significance of speeding and different traffic patterns.	Speeding violations do not represent the actual quantity of speeders. Enforcement activity and the speed at which drivers are operating when officers choose to pull them over will vary.
Vision Zero plans	Historical crash analysis already performed. A High Injury Network is identified. Other data analysis may be available.	Low effort to acquire if a plan is in place.	Easy access to data trends in the general study area and may include other helpful information.	Unless the study corridor is on the High Injury Network, the Vision Zero plan is unlikely to be detailed enough for thorough analysis.
MPO/TPO transportation performance measures	Crash trends in a given area.	Low effort to acquire from organization.	Easy access to data trends in the general study area.	Corridor-level data not usually present.
Field review	Looking for evidence of aggressive driving, turn conflicts, near misses, emergency stops, driver behavior, speeding or speed differentials in traffic; pedestrians darting across the road; cyclists running red lights; etc.	Simple to acquire. Depends on length of corridor and drive time to get to location.	The study team has direct observation of traffic behavior on the corridor, including things such as near-misses that will not show up on crash reports.	No or limited ability to understand performance of the corridor outside the time the team is present without using video. Field visits may be for minimal times, e.g., one day.
Other studies (e.g., road safety audits, public engagement)	Wide-ranging safety analysis performed during prior evaluations and studies.	Mixed effort depending on availability of previous studies.	Varies by study type.	Varies by study type.

MPO = metropolitan planning organization; TPO = transportation planning organization.
Source: FHWA.

As mentioned in section 2.3.4, the MUTCD recommends that reported crash experience for at least a 12-month period be considered when conducting an engineering study.[32] While that is the recommended minimum, engineering studies can consider a longer period of time. Given typical year-to-year variability in crashes—particularly crashes involving people walking or bicycling—using 3 to 5 years of crash data may be advisable. This amount of data may be difficult to obtain in some areas, but most agencies can provide access to practitioners.

32 FHWA. 2023. MUTCD. 11th ed., §2B.21.07. Washington, DC: FHWA.

3.5 Speed Distribution of Free-Flowing Vehicles

This section describes potential approaches to conducting a speed study for the study area. Referring back to section 2.3.5, this section will discuss data-collection methods related to determining *speed distribution,* a term that reflects the arrangement of speed values showing their observed frequency of occurrence (e.g., 50th percentile or median, 85th percentile, pace).

Depending on the equipment used for data collection, either the speeds of individually selected vehicles or the speeds of all vehicles may be measured. In either case, the objective is to identify the speed of *free-flowing vehicles;* that is, vehicles whose drivers' choice of speed is unaffected by the vehicle ahead of them. In field studies, free-flowing vehicles may be defined as vehicles that are more than 5 seconds behind the vehicles ahead of them. Some researchers have also considered the gap between the leading and following vehicles and have defined free-flowing vehicles as having a 5-second headway (i.e., the distance between the front of the lead vehicle and the front of the following vehicle) and a 3-second tailway (i.e., the distance between the rear of the lead vehicle and the rear of the following vehicle).[33] Operating speeds are observed by vehicles operating during free flow conditions.[34]

The speeds of free-flowing vehicles are still affected by other roadway characteristics, such as roadway curvature, roadside design features, and number of access points and their activity. Indeed, the objective of designing "self-enforcing roads" is to create roadway characteristics that encourage drivers to select operating speeds consistent with the speed limit. Finally, as discussed later in this section, the definition of free-flowing vehicles excludes vehicles that are accelerating or decelerating due to traffic control devices (e.g., a signalized intersection or a roundabout) or due to entering or leaving the roadway.

3.5.1 APPROACHES TO COLLECTING OPERATING-SPEED DATA

3.5.1.1 Measuring Spot Speeds versus Segment Speeds

The data collection to determine operating speeds of free-flow vehicles should reflect individual vehicle speeds at a selected point or points along the roadway within the study area; these speeds are defined as spot speeds. Spot speeds can be measured by observing individual vehicles using equipment such as LiDAR or radar guns. Practitioners can use the distribution of spot speeds to estimate various measures of operating speed, including the 50th- and 85th-percentile speed and the 10-mph pace. The average of the collected speeds is known as time-mean speed.[35]

Some automated methods, such as license-plate or toll-tag readers, measure the time it takes vehicles to travel a known distance; practitioners can then convert this travel time into a segment speed, the average speed at which the vehicle traveled over that distance.[36]

33 Kay Fitzpatrick, Shaw-Pin Miaou, Marcus Brewer, Paul Carlson, and Mark Wooldridge. 2003. "Exploration of the Relationships Between Operating Speed and Roadway Features." Paper presented to the 82nd Annual Meeting of the Transportation Research Board. Washington, DC: The National Academies Press. https://www.researchgate.net/publication/228924817_Exploration_of_the_Relationships_Between_Operating_Speed_and_Roadway_Features, accessed June 1, 2023.

34 FHWA. 2009. *Speed Concepts: Informational Gui*de. FHWA-SA-10-001. Washington, DC: FHWA.

35 ITE. 2010. *Manual of Transportation Engineering Studies*, 2nd ed. Washington, DC: ITE.

36 Transportation Research Board. 2022. *Highway Capacity Manual: A Guide for Multimodal Mobility Analysis*, 7th ed. Washington, DC: The National Academies Press.

When using segment-based methods to estimate a vehicle's spot speed, a key assumption is that the vehicle's speed over the segment is constant and, therefore, its average speed is equal to its speed when it entered the segment. The longer the segment, the weaker this assumption, and the more likely that the actual spot speed at the entry to the segment will be different from the segment speed.[37]

3.5.1.2 Measuring Individual Vehicle Speeds versus All Vehicle Speeds

A key challenge when manually measuring individual vehicle speeds (e.g., using a LiDAR gun) is to ensure that vehicles are randomly selected; this is particularly true under higher volume conditions when it is not possible to measure all vehicles. Observers may tend to measure vehicles that stand out in some way (e.g., particularly fast, particularly slow, only in a particular lane), resulting in biased observations. Recording every *n*th vehicle (e.g., third, fifth, tenth) can control for this bias, but it is important for practitioners to make sure that external effects (e.g., traffic signals on an urban street) do not establish a regular pattern of traffic flow.[38] The ultimate objective of a sampling approach is to obtain a random sample of free-flowing vehicles. If the sample is not random, the statistical basis for the desired end results (e.g., being 95 percent confident that the true 85th-percentile speed is within 2 mph of the estimated speed) will not be in place.

In contrast, when observing all vehicles, the challenge to practitioners is ensuring that the analysis only includes the speeds of vehicles that meet the definition of "free flowing." Practitioners typically address this issue by including a time stamp with each speed observation and potentially measuring each travel lane separately on multilane roadways. When a time stamp is not available, it is possible to measure speeds at low-volume times of the week when free-flow conditions are expected.

Methods based on observations collected from probe vehicles (or other big data sources) are available to all public agencies through the National Performance Management Research Data Set (NPMRDS) for characterizing speeds along roadway segments.[39] Many agencies have also acquired additional big data sources for speed and travel time data. However, whether or not the available data are appropriate for estimating roadway operating speeds can depend on several factors, including:

- Road segments can be much longer than the study area. For example, NPMRDS, which uses data from three different data providers, uses segments that are typically 0.5–1-mile long in urban and suburban areas and 5–10-miles long in rural areas.[40] The assumption that vehicle speeds are constant over these lengths is unlikely. In particular, on urban streets, speed estimates may include traffic signal delay and other delays experienced while traveling along the segment rather than representing a free-flow speed at a point within the segment.

37 Roger P. Roess, Elena S. Prassas, William R. McShane. 2004. *Traffic Engineering*, 3rd ed. Hoboken, NJ: Prentice Hall.

38 ITE. 2010. *Manual of Transportation Engineering Studies*, 2nd ed. Washington, DC: ITE.

39 FHWA. 2020. *The National Performance Management Research Data Set (NPMRDS) and Application for Work Zone Performance Measurement*. https://ops.fhwa.dot.gov/publications/fhwahop20028/index.htm, accessed February 2024.

40 FHWA. 2020. *The National Performance Management Research Data Set (MPMRDS) and Application for Work Zone Performance Measurement*. FHWA-HOP-20-028. Washington, DC: FHWA.

- Some data sources only provide average (mean) speeds rather than a speed distribution. Mean speeds are more likely to be influenced by outlying observations of very-high-speed vehicles than are 50th- or 85th-percentile speeds.
- The probe vehicles used by the data provider(s) may not be representative of the vehicle fleet overall, particular if the data are heavily weighted toward freight or commercial fleet data.
- Because it is not possible to know whether a given probe vehicle was free flowing, practitioners can estimate the mean speed of free-flowing volumes using data from lowvolume times of the week. However, the number of probe vehicle observations used to develop the speed estimates during low-volume times of the week may be too low for the desired level of statistical validity.

Emerging data sources, including more high-resolution probe data or connected vehicle data, may be able to overcome some or all of these limitations. In general, practitioners and data analysts should be aware of the characteristics and limitations of the data they are using and assess the viability of using these data against the statistical principles (e.g., sample size) and measures in the speed distribution discussed in this document.

The speeds of vehicles involved in passing or turning maneuvers should not be included in the speed study's speed distribution because they are likely moving at atypical speeds. For the same reasons, those who collect data should not use turning lanes, acceleration and deceleration lanes, or other special lanes when collecting speed data. Due to their different physical and operational characteristics, speed data for trucks and buses should be recorded separately. If there is a question of whether separate speed limits are warranted for large trucks or other vehicle classifications, a separate count and analysis of these vehicles may be needed.

3.5.2 DATA COLLECTION

3.5.2.1 Methods

A variety of methods are available to measure speeds. These methods can generally be grouped based on the installation location of the collection equipment:

- Manually operated, handheld devices that are portable and can be used in most places (e.g., radar gun, LiDAR gun);
- In-road devices that are installed into or on top of the roadway surface (e.g., pneumatic road tubes, loop detectors);
- Out-of-road devices that are installed overhead or to the side of the roadway surface (e.g., radar recorders, toll-tag readers);
- Probe vehicles that operate within the traffic stream.

Ideally, data collection uses techniques that capture typical traffic behavior without affecting it. For example, vehicles equipped with radar detectors may detect the scatter from a radar beam measuring the speed of a vehicle ahead, causing those drivers to slow down before their speed can be measured.

Table 10 lists the advantages and disadvantages of common manual methods for measuring speeds, while table 11 does the same for common automated methods.

Table 10. Advantages and disadvantages of manual speed-collection methods.

METHOD	DATA COLLECTED	LABOR	EQUIPMENT COST*	ADVANTAGES	DISADVANTAGES
Pneumatic road tube	Spot speed,** traffic volumes, vehicle class, traffic flow gaps***	Low	Medium	Little labor required to collect and tabulate data. Can collect large data sample over long periods of time. Other traffic-related data may be collected at the same time.	Visible to traveling public, which may change driver behavior. Use discouraged when snowplows may be present. Equipment-intensive. Maintenance and calibration required.
Laser gun (LiDAR)	Spot speed	Medium	High	Equipment is easily portable. User controls vehicles sampled. A more focused laser beam limits the number of readings for non-target vehicles as compared to radar.	Cosine error limits horizontal/vertical deployment scopes and sights may not be user-friendly. Laser beams are more sensitive to environmental variances than radar. Maintenance and calibration are required. Can be detected by drivers; provides relatively small dataset.
Radar gun	Spot speed	Medium	Medium	Equipment is easily portable. User controls vehicles sampled. Accurate data-collection method. Widespread equipment availability has lowered its cost.	Cosine error limits horizontal and vertical deployment. Closely spaced and larger vehicles may create readings for non-targeted vehicles. Maintenance and calibration are required. Can be detected by drivers with radar detectors. Provides relatively small dataset.
Stopwatch	Segment speed	High	Low	Little equipment to purchase and maintain. Easy-to-perform data-collection process.	Labor intensive. Typically has low accuracy. Provides small dataset.
Floating car	Segment speed	Medium	Low	Data collectors not directly exposed to traffic. Safe operating speed determined by engineering judgment. Useful on low-volume roadways or as another data point.	Requires two data collectors (driver and observer). Selected operating speed may not be representative of general public. Another method may be required to estimate the 85th- percentile speed. Provides small dataset.

* Costs reflect the initial purchasing costs of the equipment and do not include future maintenance and calibration costs.
** Measures a very short segment speed that is assumed to be equal to a spot speed.
*** The amount of additional data collected varies for each device. Consult the device's user manual for a better understanding of its capabilities.

Source: Adapted from Wisconsin Department of Transportation. 2021. "13-5-1 Statutory Authority and the Approval Process," Table 3. Comparison of Data Collection Methods. In *Traffic Engineering, Operations & Safety Manual*. Madison, WI: WSDOT. https://wisconsindot.gov/dtsdManuals/traffic-ops/manuals-and-standards/teops/13-05.pdf , accessed May 31, 2023.

Table 11. Advantages and disadvantages of automatic speed-collection methods.

METHOD	DATA COLLECTED	LABOR	EQUIPMENT COST*	ADVANTAGES	DISADVANTAGES
Radar recorders	Spot speed, traffic volumes, vehicle class, traffic flow gaps**	Low	Medium	Little labor required to collect and tabulate data. Can collect large dataset over long periods of time. Other traffic-related data may be collected at the same time. Can be used when snowplows may be present without risk of damage. Less visible to traveling public than road tubes.	Some devices may not accurately collect data for multilane roadways or determine directionality of observed vehicles. Equipment-intensive method. Maintenance and calibration required.
Video camera	Spot speed, traffic volumes, vehicle class, traffic flow gaps**	Varies	Low	Image-processing tools may be available to collect and tabulate data, can collect large dataset over long periods of time. Other traffic-related data may be collected at the same time.	Overhead mounting required for best results. Manual data reduction may be less accurate.
Inductive loops	Spot speed,*** traffic volumes, vehicle class, traffic flow gaps**	Medium	†	Equipment already installed for other purposes. Can collect large dataset over long periods of time. Other traffic-related data may be collected at the same time.	Data collection site may not correspond to study area. Greater amount of data cleaning required. Greater level of maintenance required.
Toll tag readers, license plate readers	Segment speed, potentially others**	Low	†	Equipment already installed for other purposes. Can collect large dataset over long periods of time.	Long segments may not reflect study area conditions. Potential privacy concerns. Not all vehicles have toll tags.
Probe vehicle (big data)	Segment speed	Varies	Subscription costs may be high††	Dashboards provide key measures. Can collect larger dataset over long periods of time. Data available for most roadways.	Labor required to generate non-standard measures. May not be possible to generate all desired measures. Speed values may not reflect free-flow conditions or study area conditions. Observations are averaged from multiple probe vehicles.

* Costs reflect the initial purchasing costs of the equipment and does not include future maintenance and calibration costs.
** The amount of additional data collected varies for each device. Consult the device's user manual for a better understanding of its capabilities.
*** Measures a very short segment speed that is assumed to be equal to a spot speed.
† Typically uses equipment already installed for other purposes (e.g., traffic management centers, ramp metering).
†† USDOT has purchased the National Performance Monitoring Resource Data Set (NPMRDS) for the entire National Highway System (NHS) and has made it freely available for public agency use.
Source: Radar recorder information adapted from Wisconsin Department of Transportation. 2021. "13-5-1 Statutory Authority and the Approval Process," Table 3. Comparison of Data Collection Methods. In *Traffic Engineering, Operations & Safety Manual*. Madison, WI. https://wisconsindot.gov/dtsdManuals/traffic-ops/manuals-and-standards/teops/13-05.pdf, accessed May 31, 2023.

When resources permit, automated data collection is preferable, as it allows data to be collected for extended periods of time. Collecting data for one or more 24-hour periods will account for variation in traffic patterns; allow the practitioner to determine different speed limits for different times of the day, such as a time-limited school zone speed limit, a variable speed limit, or a nighttime speed limit; and provide greater confidence in the operating speed estimates.

3.5.2.2 Locations and Times

Data collection sites should be located to show all the important changes in prevailing speeds. At each site, the data collector should pick a location that will not unduly influence the behavior of drivers. In addition, any vehicle used in the data-collection effort should not resemble a law enforcement or other official vehicle (e.g., have lights on top), so as not to affect driver behavior. Practitioners should try to ensure that only operating speeds of free-flow vehicles are collected and, to the extent possible, that data-collection units are located at a sufficient distance from interchanges, intersections, and other access points such that accelerating or decelerating vehicles do not influence the speed profile. The MUTCD recommends that "speed studies for signalized intersection approaches should be taken outside the influence area of the traffic control signal, which is generally considered to be approximately 1/2 mile, to avoid obtaining skewed results for the speed distribution. If the signal spacing is less than 1 mile, the speed study should be at approximately the middle of the segment."[41]

Table 12 shows recommendations for data-collection sites used by three States—Massachusetts, Ohio, and Texas—for both urban and rural areas. While these States provide some guidance in the form of set distances between data-collection sites, it is important to remember that it is not the distance between sites that is critical; rather, it is the changes in the road, traffic, and environment that may lead to different speed profiles and operating speeds. Accordingly, practitioners may need to increase or decrease the distances between data-collection sites from those shown in the table.

41 FHWA. 2023. MUTCD.11th ed., §2B.21.12. Washington, DC: FHWA.

Table 12. Speed-data-collection site guidance for three example States.

STATE	CONTEXT	DATA-COLLECTION SITE LOCATION GUIDANCE
Massachusetts	Urban	• Speed check stations should generally be located at intervals not to exceed 0.25 miles, depending upon the locality and the uniformity of physical and traffic conditions. • Reduced spacing may be necessary to obtain an accurate picture of the speed pattern.
	Rural	• Speed check stations may be located at intervals greater than 0.25 miles, provided they properly reflect the general speed pattern. • Speed test runs can help locate appropriate station locations. • There should be at least one observation for each direction of travel in each zone of a different numerical limit.
Ohio	Any	• Speed checks may be taken with any device that will indicate vehicle speed with an accuracy of ±10 percent. • Speed checks should be taken at the one-third point (total of four checks) for zones 0.25–1.00 mile in length, and at intervals of 0.5–0.75 miles for zones longer than 1 mile in length.
Texas	Urban	• Sites should generally be located at intervals of 0.25 miles, or less if necessary, to ensure an accurate picture of the speed patterns. • Sites should be located midway between signals or 0.2 miles from any signal, whichever is less, to ensure an accurate representation of speed patterns. • Sites should be located midway between interchanges on freeway and expressway mainlines. • Sites should consider locality; the uniformity of physical and traffic conditions may be determined by trial runs through the area if volumes are too low or if a recheck of speeds is all that is needed. • Speeds should be checked midway between interchanges on the main lanes of expressways and freeways.
	Rural	• Sites may be at intervals greater than 0.25 mile, as long as the general speed pattern is followed and may only be necessary at each end and the middle point if the characteristics of the roadway are consistent throughout the entire section. • Sites may be determined by test runs through the area if the characteristics of the roadway are consistent throughout the entire section and a speed check in that section indicates that 125 vehicles cannot be checked within 2 hours if radar is used, or after 4 hours if a traffic counter that classifies vehicles by type is used.

Sources: Commonwealth of Massachusetts. 2021. "5d. Speed Data Collection." In *Procedures for Speed Zoning on State Highways and Municipal Roads*. https://www.mass.gov/doc/procedures-for-speed-zoning-on-state-and-municipal-roadways/download, accessed June 1, 2023. Ohio Department of Transportation. 2023. "1203-3 Speed Zone Studies." In Traffic Engineering Manual. https://www.transportation.ohio.gov/working/engAineering/roadway/manuals-standards/tem/12#1203SPEEDZONES, accessed June 1, 2023. Texas Department of Transportation. 2021. "Section 2: Determining the 85th-Percentile Speed." In *Procedures for Establishing Speed Zones*. http://onlinemanuals.txdot.gov/txdotmanuals/szn/determining_the_85th_percentile_speed.htm#BABCCCGC, accessed June 1, 2023.

When using automatic data-collection equipment, speed data should be collected at sites for one or more 24-hour periods on typical days.[42] When using manual data-collection techniques, the practitioner supervising the engineering study will need to determine an appropriate day-of-week and time-of-day to conduct the study. In addition, as discussed in the next subsection, the practitioner will need to identify the necessary sample size to produce statistically valid estimates of operating speeds among free-flowing vehicles.

3.5.2.3 Sample Size

When using manual data-collection techniques, it is important for practitioners to pay careful attention to determining the minimum sample size needed to produce statistically valid speed estimates. (In addition, as mentioned previously, a random sample of vehicle speeds is also needed to produce statistically valid speed estimates.) The ITE *Manual of Transportation Engineering Studies* provides discussion, equations, and tables to support practitioners in determining the necessary sample size.[43]

On very-low-volume roads, it may take some time to obtain a suitable sample size. Table 13 lists the sample sizes and sample periods used by Massachusetts, Ohio, and Texas. Most States use 100 or more vehicles in each direction for each station as a minimum sample size. Using automated data-collection equipment to collect speed data generally avoids sample-size issues and provides a more robust dataset that may have applications beyond the engineering study.

Table 13. Sample sizes and data-collection periods used by three States.

STATE	SAMPLE SIZE	EXCEPTIONS
Massachusetts	100 or more vehicles in each direction should be checked at each station.	On highways carrying low traffic volumes, the checks at any one station may be discontinued after 2 hours even if a minimum of 100 vehicles have not been timed.
Ohio	Record speeds of 100 vehicles for each direction of travel.	Observation need not exceed 1 hour even if less than 100 vehicles are recorded traveling in each direction.
Texas	A minimum of 125 cars in each direction, at each station.	Discontinue after 2 hours if radar is used, or after four hours if a traffic counter that classifies vehicles by type is used—even if 125 cars have not been timed.

Sources: Commonwealth of Massachusetts. 2021. "5d. Speed Data Collection." In *Procedures for Speed Zoning on State Highways and Municipal Roads*. https://www.mass.gov/doc/procedures-for-speed-zoning-on-state-and-municipal-roadways/download, accessed June 1, 2023. Ohio Department of Transportation. 2023. "1203-3 Speed Zone Studies." In Traffic Engineering Manual. https://www.transportation.ohio.gov/working/engineering/roadway/manuals-standards/tem/12#1203SPEEDZONES, accessed June 1, 2023. Texas Department of Transportation. 2021. "Section 2: Determining the 85th-Percentile Speed." In *Procedures for Establishing Speed Zones*. http://onlinemanuals.txdot.gov/txdotmanuals/szn/determining_the_85th_percentile_speed.htm#BABCCCGC, accessed June 1, 2023.

3.5.3 QUANTIFYING OPERATING SPEEDS

With the collected data, the practitioner or data analyst can derive the operating speeds (using free-flowing vehicles) and then develop operating speed metrics for the analysis. Both steps are discussed in the following sections.

42 ITE. 2010. *Manual of Transportation Engineering Studies*, 2nd ed. Washington, DC: ITE.

43 Ibid.

3.5.3.1 Identifying Free-Flowing Vehicles

The process for identifying free-flowing vehicles depends on the method of data collection selected for the study. The discussion below distinguishes between manual observations (e.g., from a handheld speed measurement device) and automated observations that can be collected either with or without time stamps, depending on the equipment available.

Manual Observations

If speed data are collected manually, all of the recorded observations should represent free-flowing vehicles, and this step can be skipped.

Automated Observations with Time Stamps

If speed data are collected automatically and each observation has an associated time stamp at a sufficient resolution (i.e., with sub-second accuracy), the practitioner should filter the data to identify those vehicles that meet the definition of free flowing. For example, if the definition of a free-flowing vehicle is a vehicle at least 5 seconds behind the preceding vehicle in its lane, all observations in a given lane with a time stamp less than 5 seconds after the preceding observation would be filtered out.

Automated Observations without Time Stamps

If speed data are collected automatically but do not include individual time stamps (just general time-of-day bins), the practitioner will need to identify low-volume periods where most vehicles can be assumed to be free-flowing. The Highway Capacity Manual (HCM) identifies the following volume ranges as being representative of free-flow conditions:[44]

- **Freeways and uninterrupted-flow multilane highways:** Volumes less than 1,000 passenger cars per hour per lane (1 truck = 2 passenger cars on level terrain) (Note: The HCM considers a roadway to have an uninterrupted flow if traffic signals (or other intersection traffic control devices that require roadway traffic to stop or slow) are spaced ≥ 2 miles apart.)
- **Uninterrupted flow two-lane highways:** Volumes less than 100 vehicles per hour per lane
- **Interrupted-flow streets**: Volumes less than 250 vehicles per hour per lane

The practitioner can use speed observations during 15-minute periods where traffic volumes meet these criteria (e.g., freeway volumes less than 250 passenger cars per lane during the 15-minute period) to develop the speed distribution. The same caveats presented earlier in this section for time-stamped data (i.e., checking the dataset for possible errors or issues) apply here.

44 Transportation Research Board. 2022. "Chapter 12: Basic Freeway and Multilane Highway Segments," p. 12–27, "Chapter 15: Two-Lane Highways," Equation 15–7, and "Chapter 18: Urban Street Segments," Exhibit 18-12. In *Highway Capacity Manual: A Guide for Multimodal Mobility Analysis*, 7th ed. Washington, DC: National Academies Press.

3.5.3.2 Developing Operating Speed Metrics from the Speed Distribution

Once free-flowing vehicles have been identified, the practitioner can import speed observations for these vehicles into a spreadsheet or statistical analysis software. Either type of software will be able to output the 85th- and 50th-percentile speed (and any other desired percentile), along with the mean speed. The pace can be determined from a histogram of the speed distribution similar to that shown in figure 8. It can also be determined by first counting the number of observations in each 1-mph speed bin and then summing the counts over each combination of 10 consecutive bins (e.g., 26–35 mph, 27–36 mph, 28–37 mph). The 10 consecutive bins with the highest total count represent the pace.

3.5.4 DATA INVENTORY AND OTHER CONSIDERATIONS WHEN STUDYING OPERATING SPEEDS

The *Manual of Transportation Engineering Studies* addresses other important considerations when planning a speed study, including:[45]

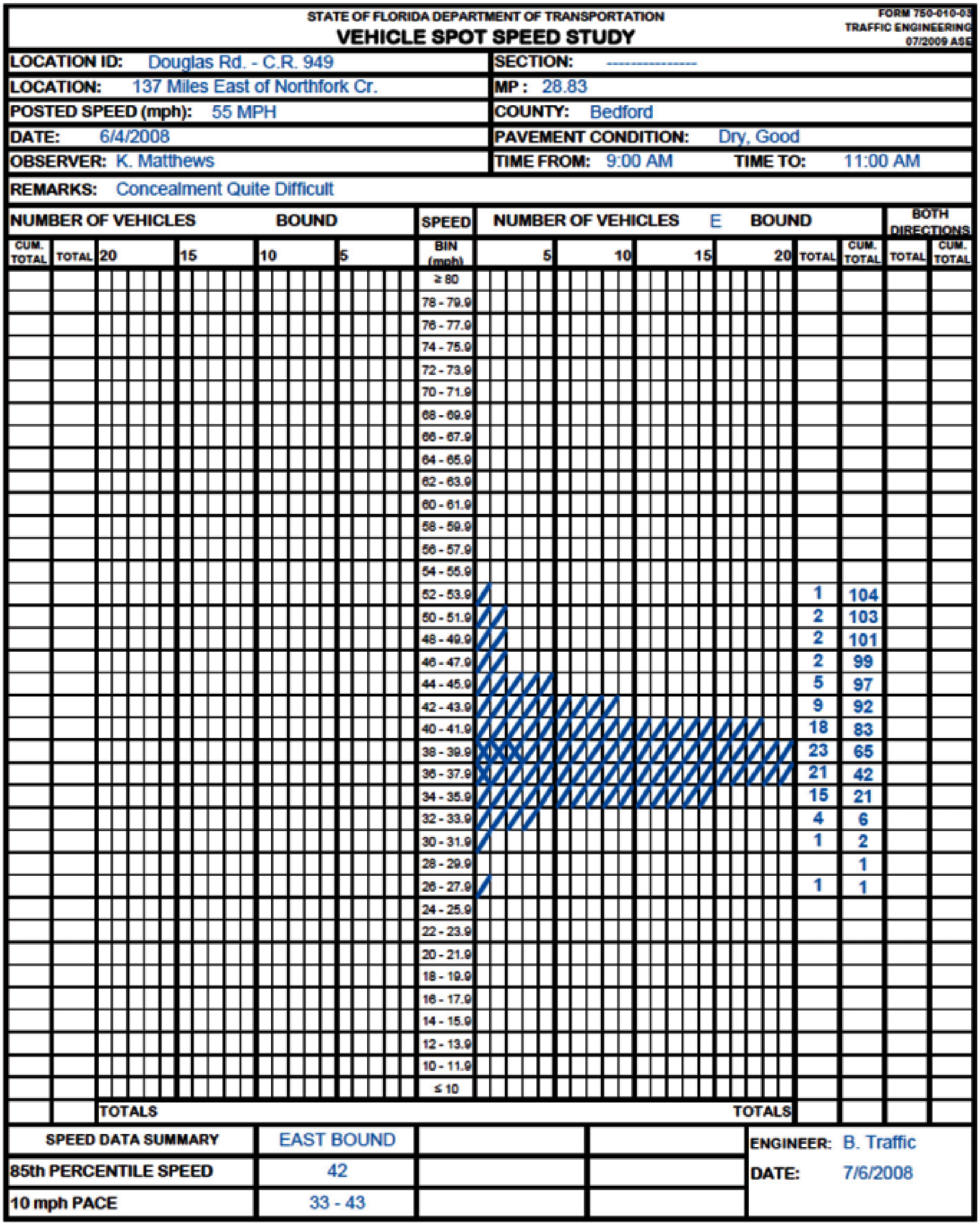
- Study preparation and coordination
- Safe deployment and recovery of equipment and personnel
- Positioning equipment to minimize measurement error (e.g., minimizing the angle of incidence for radar and LiDAR devices)
- Calibrating equipment
- Documentation

The manual also provides technical details of various common data-collection methods.

3.5.5 SAMPLE DATA COLLECTION FORM

Figure 11 presents an example data-collection form for collecting vehicle speeds at a spot location from the Florida Department of Transportation (FDOT). The form is set up to record speeds for vehicles traveling in two directions on the same road (e.g., eastbound and westbound). The form is divided into speed bins of 2 mph with the analyst recording a "slash" (/) every time a free-flowing vehicle is observed in the particular bin. As the vehicle count in a bin exceeds 20 observations, the analyst can record additional vehicles via a "backslash" (\) symbol under the first vehicle column (forming an "X"). That way, up to 40 vehicles can be recorded in each bin for each direction.

45 ITE. 2010. *Manual of Transportation Engineering Studies*, 2nd ed. Washington, DC: ITE.



STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
VEHICLE SPOT SPEED STUDY

FORM 750-010-03
TRAFFIC ENGINEERING
07/2009 ASE

LOCATION ID: Douglas Rd. - C.R. 949	SECTION: ---------------
LOCATION: 137 Miles East of Northfork Cr.	MP : 28.83
POSTED SPEED (mph): 55 MPH	COUNTY: Bedford
DATE: 6/4/2008	PAVEMENT CONDITION: Dry, Good
OBSERVER: K. Matthews	TIME FROM: 9:00 AM TIME TO: 11:00 AM
REMARKS: Concealment Quite Difficult	

NUMBER OF VEHICLES BOUND CUM. TOTAL	TOTAL	SPEED BIN (mph)	NUMBER OF VEHICLES E BOUND TOTAL	CUM. TOTAL	BOTH DIRECTIONS TOTAL	BOTH DIRECTIONS CUM. TOTAL
		≥ 80				
		78 - 79.9				
		76 - 77.9				
		74 - 75.9				
		72 - 73.9				
		70 - 71.9				
		68 - 69.9				
		66 - 67.9				
		64 - 65.9				
		62 - 63.9				
		60 - 61.9				
		58 - 59.9				
		56 - 57.9				
		54 - 55.9				
		52 - 53.9	1	104		
		50 - 51.9	2	103		
		48 - 49.9	2	101		
		46 - 47.9	2	99		
		44 - 45.9	5	97		
		42 - 43.9	9	92		
		40 - 41.9	18	83		
		38 - 39.9	23	65		
		36 - 37.9	21	42		
		34 - 35.9	15	21		
		32 - 33.9	4	6		
		30 - 31.9	1	2		
		28 - 29.9		1		
		26 - 27.9	1	1		
		24 - 25.9				
		22 - 23.9				
		20 - 21.9				
		18 - 19.9				
		16 - 17.9				
		14 - 15.9				
		12 - 13.9				
		10 - 11.9				
		≤ 10				
TOTALS			TOTALS			

SPEED DATA SUMMARY	EAST BOUND			ENGINEER: B. Traffic
85th PERCENTILE SPEED	42			DATE: 7/6/2008
10 mph PACE	33 - 43			

Source: FHWA. 2012. *Methods and Practices for Setting Speed Limits: An Informational Report*. FHWA-SA-12-004. Washington, DC: FHWA.

Figure 11. Vehicle spot speed study example from Florida Department of Transportation.

3.6 Operating Speed Trends

Reviewing past speed studies can help practitioners identify operating speed trends that may inform decisions about setting safe and appropriate speed limits. These studies will typically include information about 50th- and 85th-percentile speeds during previous years.

Similar to the earlier discussion, practitioners should assess operating speed trends in accordance with best practices for studying the speed distribution of free-flowing vehicles, described in section 3.5. It is important to strive for consistency in data-collection approaches and techniques for different data-collection periods, as different methods may produce slightly different results and have specific advantages and disadvantages, as previously discussed.

Trends in operating speed are generally considered over multiple years to explore how speeds have changed in response to changes in roadway environment, characteristics, or geographic context (e.g., rural areas becoming more suburban over time). It is advisable for trends in operating speeds to be evaluated at similar times of year. These evaluations should consider any external circumstances that may have impacted driver behavior (e.g., changes in local laws or enforcement).

Table 14 lists quality and consistency considerations for common methods of measuring speeds specific to their use in evaluating multi-year trends.

Table 14. Considerations of speed collection methods for evaluating operating speed trends.

METHOD	CONSIDERATIONS*
Radar recorders	• Generally reliable source for long-term data collection and often set up to store historical data • Subject to equipment malfunction
Video camera	• Camera positions subject to shifting, which may impact consistency when collecting speed data • System may not be set up to record data • Subject to equipment malfunction
Inductive loops	• Can be reliable source for multi-year data if equipment stays in place for multiple years • Subject to equipment malfunction • Data may not be automatically set up to record but could be configured to do so
Toll tag readers, license plate readers	• If in place for multiple years, generally provide the ability to access historical data, including raw observations • Many systems may not be set up to record historical speeds but could be configured to gather (and store) speeds at set intervals
Probe vehicle (big data)	• Most data providers have multi-year data available that can be leveraged for this • Data generally aggregated, rather than raw observations, which limits ability to calculate some metrics • Underlying data sources may change over time, which may impact results

* Considerations are specific to use of the methods for evaluating speed trends. Method-specific advantages and disadvantages described in section 3.5 still apply.
Source: FHWA.

3.7 Other Factors

Per the MUTCD, the six factors introduced in chapter 2 should be among the factors considered when conducting an engineering study for setting speed limits.[46] However, agencies may consider additional factors depending on agency practices, local context, or site-specific considerations. Table 15 lists examples of other factors and potential data-collection sources.

Table 15. Examples of other factors and potential sources.

DATA ELEMENT	POTENTIAL SOURCE(S)
Weather	• Weather data from airport weather stations or other online sources • Discussion with local agency staff, residents, or business owners • Presence of advisory signs or changeable message signs alerting drivers of (frequent) severe weather conditions
Seasonality	• Full-year traffic volume data from local sensors • Full-year speed and travel time data from probe-based data sources • Discussion with local agency staff, residents, or business owners.
Conflicts or surrogate safety measures	• Custom conflict studies following procedures in the ITE Manual of Transportation Engineering Studies or other sources • FHWA's A Safe System-Based Framework and Analytical Methodology for Assessing Intersections • Video-based conflict studies, including specific studies evaluating pedestrian and bicyclist conflicts with motor vehicles • Connected vehicle data or other trajectory data generating surrogate safety data (e.g., hard braking, rapid accelerations)

Note: See ITE. 2010. *Manual of Transportation Engineering Studies*, 2nd ed. Washington, DC: ITE. See also FHWA. 2021. *A Safe System-Based Framework and Analytical Methodology for Assessing Intersections*. FHWA-SA-21-008. Washington, DC: FHWA.

Source: FHWA.

46 FHWA. 2023. MUTCD. 11th ed., §2B.21.07. Washington, DC: FHWA.

Chapter 4. Evaluating Study Results to Set a Non-Statutory Speed Limit

Once the necessary data have been collected, the next steps in the engineering study are to evaluate the data and use the evaluation results and engineering judgment to arrive at a recommendation for a safe and appropriate speed limit. This process involves:

- Evaluating the six factors identified in the MUTCD (plus other factors as applicable) to identify a safe and appropriate operating speed for the study area's conditions;
- Incorporating an expert system, partner agency outreach, or both, on the initial speed limit recommendation (optional);
- Assessing the need for speed management and additional countermeasures to achieve desired speed and safety outcomes.

This chapter describes each of the above steps in the evaluation process.

4.1 Evaluating the Six Engineering Study Factors

Operating-speed data collected in the field indicate how fast motorists are driving. Their choice of speeds may or may not be appropriate for the road's conditions. The objective of the engineering study is to identify a speed limit that balances the need to provide a safe environment for all road users with a posted speed limit that motorists perceive as reasonable and will comply with. If there is a significant gap between the desired speed for safety and the operating speed, practitioners should consider applying speed-management techniques and engineering countermeasures to reduce operating speeds. Speed management concepts and resources are discussed in chapter 5.

In some cases, speed limit selection may be constrained by State or local policy (e.g., where State law specifies that the speed limit on a particular facility type should be within 5 mph of the 85th-percentile speed). However, a practitioner may still retain discretion within such a policy—for example, by setting the speed limit either 5 mph above or below the 85th-percentile speed—and the results of the engineering study should enter into the practitioner's recommendation.

It should also be noted that transportation professionals often make decisions based on engineering judgment using their education and on-the-job training regarding roadway operations and safety principles. This decision making represents a holistic approach to applying the six factors that the MUTCD recommends when conducting an engineering study. In developing a recommended speed limit, the practitioner weighs the roadway's design, crash history, and specific characteristics (e.g., context classification, non-motorized road user activity, driveway and intersection spacing) to determine whether current operating speeds are safe for all road users and appropriate based on the road's function, design, safety, and adjacent land use.

The MUTCD specifically recommends that "on urban and suburban arterials, and on rural arterials that serve as main streets through developed areas of communities, the 85th-percentile speed should not be used to set speed limits without consideration of" the six factors described in more detail in chapter 3.[47]

The MUTCD further recommends that "on a freeway, expressway, or rural highway (outside urbanized locations or conditions), the speed limit that is posted within a speed zone should be within 5 mph of the 85th-percentile speed of free-flowing motor-vehicle traffic," provided that all six factors have been considered and determined to be non-mitigating and that speed management techniques described in the MUTCD have been considered to the extent practical.[48,49]

4.1.1 ROADWAY ENVIRONMENT

When evaluating the roadway environment, it is advisable for practitioners to consider the likelihood of user conflicts and the types of conflict that may occur along the roadway. Different aspects of the roadway environment influence how users interact with the road. All features on the road and directly adjacent to it should be considered during an engineering study.

For instance, in a corridor with frequent driveways and median openings, mixed-use development, transit service, and pedestrian presence, a lower speed limit may be necessary to improve safety for all road users. Alternatively, or in addition, measures such as access management, separating non-motorized road users from traffic (e.g., protected bicycle lanes), adding median refuge islands and other pedestrian safety countermeasures, and converting onstreet parking to bus lanes or a narrower cross section could be considered to improve road user safety.

Evaluating the roadway environment factor generally takes the form of an inventory of the functional classification, public transit services and stops, pedestrian and bicycle facilities and activities, traffic volume, onstreet parking and curbside activity, and the number and frequency of driveways. Some States have developed specific requirements and guidance for how to consider these data elements in an engineering study. For example, the Michigan Vehicle Code (section 257.627 parts 2 (g)-(j)) recommends speed limits based on the number of vehicular access points.[50]

Exposure levels or vehicle, pedestrian, and bicyclist volumes, are important aspects of the roadway environment. In particular, streets with high volumes of pedestrians and bicyclists suggest a context in which lower target speeds (and speed limits) may be appropriate. Resources like the NACTO City Limits guide provide specific speed limit recommendations based on activity level (as well as conflict density) for urban and urban core contexts.[51] The presence of transit routes and stops further suggests walking and bicycling activity.

47 FHWA. 2023. MUTCD. 11th ed., §2B.21.09. Washington, DC: FHWA.

48 FHWA. 2023. MUTCD. 11th ed., §2B.21.10. Washington, DC: FHWA.

49 FHWA. 2023. MUTCD. 11th ed., §2B.21.08. Washington, DC: FHWA.

50 Michigan Motor Vehicle Code. 1949. https://legislature.mi.gov/Laws/MCL?objectName=mcl-257-627, accessed April 25, 2024.

51 NACTO. 2020. *City Limits – Designing Safe Speed Limits on Urban Streets.* https://nacto.org/wp-content/uploads/2020/07/NACTO_CityLimits_Spreads.pdf, accessed April 25, 2024.

Further, it is important to consider surrounding land uses and the potential desire for pedestrian and bicyclist activity, even if a count of current volumes may not reflect a high numbers of these users. A street that does not feel safe due to vehicle speeds exceeding what is appropriate for the context (i.e., target speed) is unlikely to show the true latent demand that the agency may see once the speed limit is set to the appropriate level.

4.1.2 ROADWAY CHARACTERISTICS

The AASHTO Green Book[52] and State and local design manuals commonly identify design criteria for roadways. The existing design features should be assessed and recorded in the engineering study. When evaluating the proposed speed limit, existing design features are an important consideration.

For example, suppose the minimum stopping sight distance along the studied roadway meets the criteria for a road with a design speed of 55 mph, which typically means that the speed limit is set at 10 mph below that design speed to provide a safety margin (not considering other factors for this example). Changing the speed limit from 45 mph to 55 mph would increase the amount of stopping sight distance necessary for a motorist to stop for a conflict, possibly affecting the safety of the roadway (that change may also not be viable given the design speed). Similarly, changing the speed limit from 45 mph to 35 mph may result in a mismatch between the posted speed and the speed drivers would travel on the roadway.

It is advisable for practitioners to carefully consider any proposed speed limit that would be inconsistent with the roadway's design, particularly key roadway design elements such as horizontal curvature and superelevation, stopping sight distance, intersection sight distance, and maximum grade. In addition, motorist yielding rates to pedestrians go down as motor vehicle speeds go up,[53] and the available stopping sight distance to pedestrian crossings is an important consideration in determining a safe operating speed.

Specific to intersection sight distance, the decision to increase the speed limit on a major roadway can have impacts on sight distance for vehicles on a stop-controlled minor roadway approach. With higher speeds, the availability of gaps to (safely) merge into major street traffic or cross the major roadway may be reduced, which is important to consider. This challenge is exacerbated by bicyclists that approach the intersection from the minor approach, given their lower speeds (and therefore larger gap needs).

4.1.3 GEOGRAPHIC CONTEXT

The geographic and demographic context factors look beyond the edges of the road to obtain a broader picture of the street or highway's surroundings and how they might influence the selection of a speed limit. Practitioners should understand how the surrounding transportation network interconnects and influences the specific road segment being studied.

52 AASHTO. 2018. *A Policy on Geometric Design of Highways and Streets* (Green Book), 7th ed. Washington, DC: AASHTO.

53 Tomas Bertalis and Daniel M. Dulaski. 2014. "Driver Approach Speed and Its Impact on Driver Yielding to Pedestrian Behavior at Unsignalized Crosswalks." *Transportation Research Record* 2464(1), 46–51. https://doi.org/10.3141/2464-06

Chapter 2 introduced the five specific context classifications in the AASHTO Green Book: rural, rural town, suburban, urban, and urban core.[54] It further introduced a potential target speed table for these context classes as well as the functional classification of the roadway (table 4). The specific combination of context and functional class is a key consideration in selecting an appropriate speed limit that is safe for all users.

Practitioners may also consider specific land uses that could generate trips along and across the road by non-motorized road users. Context helps practitioners understand the types of users and the intensity of use that can be expected on a facility. The roadway context also helps practitioners identify roadway design elements that both improve the safety and comfort of non-motorized road users and encourage motorists to drive at the desired speed. For example, a higher number of pedestrians, bicyclists, and transit users can be expected in the context of an urban core. Therefore, lower speed limits combined with shorter signal spacing, shorter crossing distances, and other design elements such as bicycle facilities, onstreet parking, wide sidewalks, and similar strategies for improving the safety and comfort of the anticipated non-motorized users are appropriate.

The demographic makeup of the communities adjacent to the roadway are another important element for consideration. High proportions of elderly individuals, children, or persons with disabilities can indicate a potential for more non-motorized activity, as well as more severe consequences should a crash occur. Additional factors such as percentage of households living in poverty and percentage of zero-car households may also indicate the presence of significant non-motorized activity. Vehicular noise and emissions increase at higher speeds, so practitioners should also consider the potentially negative effects higher speed limits may have on nearby communities as well.

4.1.4 CRASH EXPERIENCE

Safety is a primary consideration for any change to a roadway. Safer speeds are one of the key elements of the SSA due to the effect speed has on the overall safety of a roadway. Higher speeds increase both the likelihood of a crash occurring and its severity. Higher speeds are also associated with an increased risk of severe injury or death for non-motorized road users, as discussed in section 2.3 and in FHWA's *Primer on Safe System Approach for Pedestrians and Bicyclists*.[55] Understanding the safety issues that currently exist gives the practitioner important information for selecting a speed limit and determining whether specific speed-management features are needed.

54 AASHTO. 2018. *A Policy on Geometric Design of Highways and Streets* (Green Book), 7th ed. Washington, DC: AASHTO.

55 FHWA. 2021. *Primer on Safe System Approach for Pedestrians and Bicyclists*. FHWA-SA-21-065. Washington, DC: FHWA.

A desired outcome of the SSA is to mitigate crash energy by applying vehicle- and infrastructure-based countermeasures so that no user is exposed to impact forces capable of causing death or serious injury. Infrastructure-based safe system principles such as safer roads and safer speeds combined with design features and countermeasures can inform target speed evaluations as practitioners gather and analyze information about roadway users and context, including land use, facilities for people walking and bicycling, crash types, and history under different geometric conditions. A 20-mph speed limit for urban roads that have a mix of motorized and non-motorized road users along with the application of additional speed-management countermeasures to achieve the set 20-mph speed limit is an example of the outcome of applying the SSA principles.

Evaluating safety performance involves analyzing patterns in the crash data: Where have crashes occurred? What types of crashes have occurred? How severe were the crashes? This analysis may identify the need for safety treatments beyond or instead of a change in the speed limit. For example, a pattern of run-off-the-road crashes at a curve on a rural road could be mitigated by reducing the posted speed limit. A reduction in this crash type could also be achieved (or supplemented) by safety countermeasures such as curve widening, enhanced signing or pavement marking, rumble strips, clear zone improvements, or high friction surface treatment.

A location with a high occurrence and severity of crashes involving users walking or bicycling may be indicative of operating speeds for vehicle traffic being too high for the context. Treatments geared at separating users (e.g., protected intersections, side paths, median refuge islands), as well as a reduced speed limit supplemented by traffic calming treatments are ways to reduce that crash occurrence and improve safety for all users.

An overrepresentation of certain crash types, crash severity, or both may be indicative of speeds being too high for the roadway. Excessive rear-end crashes, although potentially due to many different factors, can be indicative of operating speeds that are too high, especially when other data, such as those reflecting limited available sight lines, support this conclusion. Higher overall crash rates can also be indicative of operating speeds that are too high. A pattern of severe crashes can justify lowering the speed limit to a level that is unlikely to result in a severe crash should a crash occur.

The AASHTO *Highway Safety Manual* (HSM) offers methodologies using safety performance functions and Empirical Bayes adjustments for determining crash estimates in a systemic process. Comparing the actual crash experience to the crash prediction models' estimations can help identify locations where the crash frequency and severity are overrepresented. These locations can then be cross referenced to locations where speed limits or operating speeds are more than the desired target speeds. It may be beneficial to target specific segments with major speed problems or where fatal and injury crashes can be most reduced first through systemic improvements.

4.1.5 SPEED DISTRIBUTION OF FREE-FLOWING VEHICLES

State and local statutes and policies may specify the methods and applicable measures for assessing operating speed. In the absence of such statutes or policies, an engineering study can be informed by the 50th- and 85th-percentile speeds. Other measures, such as the 10-mph pace, can also help inform the study.

Historically, many agencies have used the 85th-percentile speed of free-flowing vehicles as a primary consideration in setting speed limits. However, the MUTCD stresses the importance of all the factors that should be considered when conducting an engineering study to set a speed limit.[56] Depending on the roadway context and conditions, setting speed limits based on the 85th-percentile may not represent an appropriate speed considering all road users and may perpetuate high-speed travel for the majority of drivers.

Expert system tools for setting speed limits, such as USLIMITS2 and *NCHRP Research Report 966 (N17-76 SLS Tool),* include recommendations for using speed distribution data in setting speed limits.[57] These tools are discussed further under Speed Limit Setting Expert Systems referenced in section 4.2.1.2.

4.1.6 OPERATING SPEED TRENDS

An evaluation of operating speed trends over time can provide important insights into driver behavior and their responsiveness to changing contexts and speeds. If available, a practitioner is strongly encouraged to evaluate historical speed data to gain an understanding of speed conditions drivers have previously experienced on the roadway.

For example, a look at multi-year speed data, if available, may indicate that speeds have not changed on a roadway, even if the context has changed over time as development transitioned a roadway from a rural to a more suburban or urban character. This changing context may suggest that a lower speed limit, combined with speed management strategies, may be appropriate.

As another example, speed data may indicate that speeds did not meaningfully change even after a different speed limit was introduced several years previously. This result would suggest that despite the change in the speed limit, drivers are maintaining their historical behavior in the absence of other changes to the roadway (e.g., speed management strategies).

56 FHWA. 2023. MUTCD. 11th ed., §2B.21.07. Washington, DC: FHWA.

57 Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, and Tim Gates. 2021. *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide*. Transportation Research Board, Washington, DC: The National Academies Press. https://doi.org/10.17226/26216, accessed October 10, 2023.

4.2 Engineering Study Speed Limit Recommendation

After evaluating all relevant factors, including the six factors the MUTCD states should be considered and other factors at the discretion of the agency, the practitioner supervising the engineering study then develops a recommended speed limit to conclude the engineering study process. Some States or local agencies may have prescriptive processes in place that specify how to use the different study results. In other cases, the process may rely more heavily on engineering judgment. After developing an initial speed limit recommendation based on the relevant factors, the practitioner can also consider using an expert system as another data point on the recommendation or may start with the expert system and then compare against application of target speed policy. States may also require outreach to partner agency staff (e.g., law enforcement) and various decision-making bodies before a speed limit recommendation can be finalized. Finally, the data and decision-making process used to develop the speed limit recommendation should be documented in the project file. This section describes how each of these steps combine to develop a recommended speed limit.

4.2.1 DECISION SUPPORT CONSIDERATIONS

Once initial speed limit recommendations have been developed for the study area, the practitioner optionally can consider additional sources of information to help support or refine the recommendation. Three such sources include target speed policy, expert systems, and outreach to law enforcement and affected jurisdictions. Practitioners may choose to start with the expert system but are encouraged to evaluate the results against one of the methods in the previous section.

4.2.1.1 Target Speed Policy

Target speed policies usually consider some or all of the six factors as part of the development of target speeds for typical roadway conditions in a given context. When a jurisdiction has a target speed policy, it has already set a target speed for a roadway or for its combination of functional and context classifications (see table 3 in chapter 2).

When a jurisdiction's policy provides a range of target speeds for a given context, a target speed toward the lower end of the range could be considered when one or more of the following conditions exist:

- Geometric treatments are present that physically or visually narrow the roadway
- Lack of pedestrian or bicycle facilities
- Non-motorized user activity at higher levels than typical for the context
- Intersection or driveway spacing that is more frequent than typical for the context
- Potential need for motorists to stop or slow unexpectedly (e.g., limited sight lines to and from driveways)
- Presence of a high number of fixed objects on the roadside in rural areas

Conversely, a target speed could be considered from the higher end of the range in the absence of the above conditions when the roadway's geometry includes a wide roadway with room to maneuver and (on higher order roadways, like freeways) when safety features such as non-traversable medians and access control exist. These facilities often do not have pedestrian or bicyclist activity or may have pedestrian and bicyclist facilities that are fully separated from motorized traffic (e.g., a shared-use path separated by landscaping or another physical barrier).

Examples of operating speeds compared to the target speed and the six factors as follows:

- If operating speeds are less than 5 mph from the target speed, the speed limit can be set at the target speed, provided that none of the factors suggest a different speed is needed based on context or safety performance.
- If operating speeds are 5 mph or more higher than the target speed, operating speeds may be too high for the given context and roadway characteristics and may need to be lowered. In this case, practitioners should further consider the need to modify the roadway to achieve a safe speed through speed management techniques in addition to considering setting the speed limit at the target speed.
- If operating speeds are 5 mph or more lower than the target speed, the speed limit should be set based on the operating speeds (at a value lower than the target speed). Speed limits are set in 5-mph increments and need to be rounded accordingly.[58]

When evaluating target speeds, it is important to remember that roadway context can change over time. Most commonly, the target speed may need to lower over time as contexts shift from rural or suburban to a more urban context as development occurs and land use changes. In other cases, it may be that the roadway's target speed is too low given a changing context due to roadway design changes, access management, and separation of users walking and bicycling.

It is important to keep in mind that the recommended speed limit should be one that a majority of motorists will comply with. To achieve this goal, practitioners may need to identify a package of additional countermeasures and speed management strategies to support the recommended speed limit. This package may then be included in the agency's project prioritization and programming process for funding and implementation.

4.2.1.2 Expert Systems

Expert systems are tools that can supplement the decision-making that occurs when recommending non-statutory speed limits. This section provides an overview of the two expert-system tools that existed as of early 2024.

58 FHWA. 2023. MUTCD. 11th ed., §2B.21.13. Washington, DC: FHWA.

These systems have been developed by expert panels and consider a variety of data pertinent to the decision as to whether to adjust the posted speed on a road, including aspects of the six factors the MUTCD recommends be considered in an engineering study. Each system applies a set of decision rules developed by its expert panel that result in a recommended speed limit. For example, the expert panel that developed one of these tools, USLIMITS2, consisted of "experienced traffic engineers and other subject matter experts."[59] Practitioners can consider an expert system's output as part of the overall data collected during the engineering study when developing a recommended speed limit.

The recommended speed from an expert system should always be evaluated against the overall study objective and the local roadway context to check that the recommended speed would result in safe conditions for all users. Although expert systems consider a diverse set of factors, they do not include all the factors that may be considered in an engineering study; some of the factors not considered by expert systems may be particularly relevant to a particular study area. The following sections summarize the input data used by each expert system.

4.2.1.2.1 USLIMITS2

USLIMITS2 is a web-based expert system developed under NCHRP Project 3-67 for recommending the maximum speed limit for a given stretch of roadway.[60,61] Input data required by the system vary by road type but generally include the following:[62]

- Roadway environment
    - Annual average daily traffic
    - Rural or undeveloped areas:
        - Number of interchanges (freeways)
    - Developed areas:
        - Number of driveways
        - Presence or absence of onstreet parking
        - Extent of pedestrian and bicycle activity (high/not high)
- Roadway characteristics
    - Rural or undeveloped areas:
        - Presence or absence of adverse alignment
        - Terrain type (freeways)
        - Roadside hazard rating (non-freeways)
        - Median type (non-freeways)
    - Developed areas:
        - Number of through lanes
        - Number of traffic signals

59 FHWA. 2023. "USLIMITS2: A Tool to Aid Practitioners in Determining Appropriate Speed Limit Recommendations." (website). https://safety.fhwa.dot.gov/uslimits/, accessed October 15, 2023.

60 FHWA. 2023. "USLIMITS2: A Tool to Aid Practitioners in Determining Appropriate Speed Limit Recommendations." (website). https://safety.fhwa.dot.gov/uslimits/, accessed October 15, 2023.

61 As of 2023, NCHRP Project 03-139, the objective of which is developing the next generation of USLIMITS2, was in progress.

62 R. Srinivasan, M. Parker, D. Harkey, D. Tharpe, and R. Sumner. 2006. "Appendix L. User's Guide." In NCHRP Project 3-67 *Final Report: Expert System for Recommending Speed Limits in Speed Zones*. Transportation Research Board, Washington, D.C.: National Cooperative Highway Research Program.

- Geographic and demographic context
    - Road type (limited-access freeway, road section in undeveloped area, residential subdivision or neighborhood street, residential collector or arterial street, commercial street, street serving large complexes)
- Safety performance
    - Number and severity of crashes
    - Segment length
    - One- or two-way street (developed areas)
- Operating speed
    - 50th- and 85th-percentile speeds

4.2.1.2.2 Speed Limit Setting (SLS) Tool

The SLS tool is a spreadsheet-based tool that applies research-based decision rules to recommend a speed limit to apply to a roadway section. The SLS tool was developed under NCHRP Project 17-76 and introduces four speed-limit-setting groups (SLSG) that are defined as a function of context and facility type (i.e., functional class): (1) Limited-Access, (2) Undeveloped, (3) Developed, and (4) Full-Access. For each SLSG, the report and tool provide recommendations for the use of 50th- vs. 85th-percentile speed, as well as to the type of rounding that should be applied. Input data required by the tool vary by roadway context type but generally include the following:[63]

- Roadway environment
    - Roadway type (interstate, freeway, expressway, principal arterial, minor arterial, collector, local)
    - Number of lanes (total of both directions)
    - Annual average daily traffic
    - Limited access highways:
        - Directional design-hour truck volume
        - Number of interchanges
    - Roadways in undeveloped areas:
        - Number of access points (total of both directions)
    - Roadways in developed areas:
        - Number of access points (total of both directions)
        - Onstreet parking activity (high or not high)
        - Parallel parking permitted (yes or no) (except full-access roadways)
        - Presence of angle parking (no, yes < 40 percent of segment, yes ≥ 40 percent of segment)
        - Pedestrian activity (high, some, negligible)
        - Bicyclist activity (high or not high)

63 Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, and Tim Gates. 2021. *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide*. Transportation Research Board, Washington, DC: The National Academies Press.

- Roadway characteristics
  - Presence of adverse alignment
  - Limited access highways:
    - Design speed
    - Grade
    - Inside shoulder width
    - Outside shoulder width
  - Roadways in undeveloped areas:
    - Lane width
    - Median type (undivided or divided)
    - Shoulder width
  - Roadways in developed areas:
    - Median type (undivided, two-way left-turn lane, divided)
    - Number of traffic signals
    - Sidewalk buffer presence (yes or no)
    - Sidewalk width (none, narrow, adequate, wide)
- Geographic and demographic context
  - Roadway context (rural, rural town, suburban, urban, urban core)
- Safety performance
  - Number and severity of crashes
  - Segment length
- Operating speed of free-flowing vehicles
  - 50th- and 85th-percentile speeds

4.2.2 OUTREACH

Some States require outreach efforts to partner agencies prior to finalizing speed limit recommendations. This outreach is typically conducted first to identify any non-apparent conditions that the engineering study did not uncover and then to share the engineering study findings and recommendations with affected jurisdictions and the public. Importantly, the outreach is not intended to enable public and political opinions to override the results of the engineering study.[64]

4.2.3 PARTNER AGENCIES

In some States, State law requires that the State DOT consult with law enforcement agencies, such as the State highway patrol, and consider their input prior to finalizing and implementing a speed limit recommendation. Staff from other partner agencies, such as city or county traffic engineers, can also be consulted. These discussions can identify non-apparent conditions, help determine starting and ending points of specific speed zones, and identify the potential level of public opposition to changing a speed limit.[65]

64 California Department of Transportation. 2020. *California Manual for Setting Speed Limits*. Sacramento, CA: Caltrans. https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/2020-california-manual-for-setting-speed-limits-a11y.pdf, accessed February 22, 2024.

65 Ibid.

4.2.4 Decision-Making Bodies

In many cases, outreach to local jurisdictions, the State DOT, a State transportation commission, or a combination of these entities is required by State law before a speed limit recommendation can be finalized and implemented. For example, in Texas, speed zones on State highways within incorporated cities are normally implemented through a city ordinance, and the Texas DOT therefore works with cities to pass these ordinances. A process also exists in Texas to address instances in which the Texas DOT and a city cannot agree on an acceptable speed limit.[66] In California, State law requires that the State DOT give affected cities and counties an opportunity to hold a public hearing on proposed speed limit changes on State highways and to consider the results of the hearing before finalizing the speed limit.[67] State law in Oregon requires Oregon DOT (ODOT) approval for proposed speed zones on any road in the State; however, ODOT is authorized to delegate its speed-limit-setting authority to any incorporated city and to three designated counties when "ODOT determines the requesting agency 'will exercise the authority according to criteria adopted by the department.' "[68]

4.2.5 DOCUMENTATION

The basis for the recommended speed limit(s) should be documented in the project file. The documentation should describe how the six factors were applied in developing the recommendation, the proposed extent of the speed zone(s), and any recommendations for speed management measures to accompany the speed zone. Supporting data, including any results or input from an expert system, partner agencies, and public hearings should also be included in the project file.

4.3 Examples of Developing a Recommended Speed Limit

This section presents three example scenarios that show the hypothetical results of the evaluation of the six factors the MUTCD states should be included in an engineering study. Each example is evaluated against roadway context and target speed and includes a recommendation for speed limit setting and speed management. ***These examples are intended to illustrate how an agency may go about evaluating the factors only; this is not a prescriptive process for setting speed limits in general.***

4.3.1 SCENARIO A: RURAL ARTERIAL ROAD

The results of the six factors for Scenario A are presented in table 16. Figure 12 represents the results of the speed distribution factor along with the posted speed limit and estimated target speed for the roadway.

66 Texas Department of Transportation. 2015. *Procedures for Establishing Speed Zones*. Austin, TX: TxDOT. http://onlinemanuals.txdot.gov/txdotmanuals/szn/index.htm, accessed May 31, 2023.

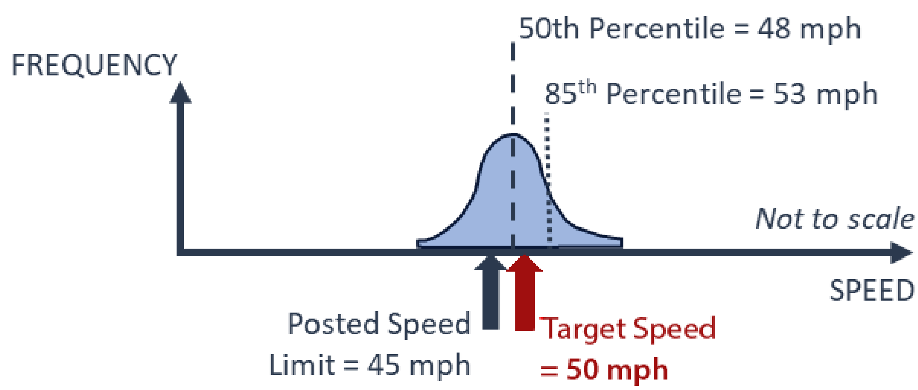
67 California Department of Transportation. 2020. *California Manual for Setting Speed Limits*. Sacramento, CA: Caltrans. https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/2020-california-manual-for-setting-speed-limits-a11y.pdf, accessed February 22, 2024.

68 Oregon Department of Transportation. "Delegated Authority for Speed Zones" (website). https://www.oregon.gov/odot/Engineering/Pages/Speed-Zone-Delegations.aspx, accessed February 20, 2024.

Table 16. Example Scenario A to illustrate engineering study results.

FACTOR	EXAMPLE SCENARIO A
Roadway environment	Principle arterial located in a rural area with low-density residential development. The AADT is 8,500. Users primarily include through traffic between a metropolitan area and outlying rural communities, moderate truck traffic, recreational bicyclists, and occasional pedestrians.
Roadway characteristics	Two-lane, two-way road with 12-foot travel lanes, 2-foot paved shoulders, 4-foot gravel shoulders, roadside ditches. There are no guardrails or rumble strips installed on this stretch of roadway. The 1.37-mile study segment has a total of 35 access points on both sides of the road. There are no traffic signals.
Geographic and demographic context	The roadway is located in a rural context and through a forested area with natural features, including a bridge crossing a body of water and several large, mature trees near the roadway.
Reported crash experience	There were a total of 25 reported crashes over the last 5 years. Of these crashes, eight involved non-serious injuries and four involved serious injuries; there were no fatal crashes. Approximately 70 percent of the crashes were run-off-the-road crashes.
Speed distribution of free-flowing vehicles	Posted speed limit of 45 mph, observed 85th-percentile speed of 53 mph and 50th-percentile speed of 48 mph. The State's statutory speed limit for rural roads is 55 mph.
Review of past speed studies	A speed study completed 5 years ago had similar speed distribution results and recommended a speed limit of 45 mph.

Source: FHWA.



Source: FHWA.

Figure 12. Illustration of speed distribution and target speed for Scenario A.

Scenario A Evaluation and Recommendation: Based on an evaluation of the six factors, the 85th-percentile speed is more than 5 mph over the posted speed limit, which is a trend that also persisted 5 years ago. This factor alone may suggest that raising the speed limit could be appropriate. The rural context for this arterial street suggests that a target speed may be 50 mph or above. The reported crash experience includes several serious injury crashes, and an injury minimization approach may suggest that a lower operating speed would enhance the safety of this roadway. That said, lowering the speed limit on this rural roadway may not match driver behavior or the target speed. The best course of action may be to keep the speed limit unchanged but consider safety treatments that can lower the 85th-percentile speed to be closer to the posted speed limit, supplemented with the application of Proven Safety Countermeasures, such as rumble strips or edge treatments. For comparison, both USLIMITS2 and the SLS Tool suggest a speed limit of 50 mph for this roadway segment.

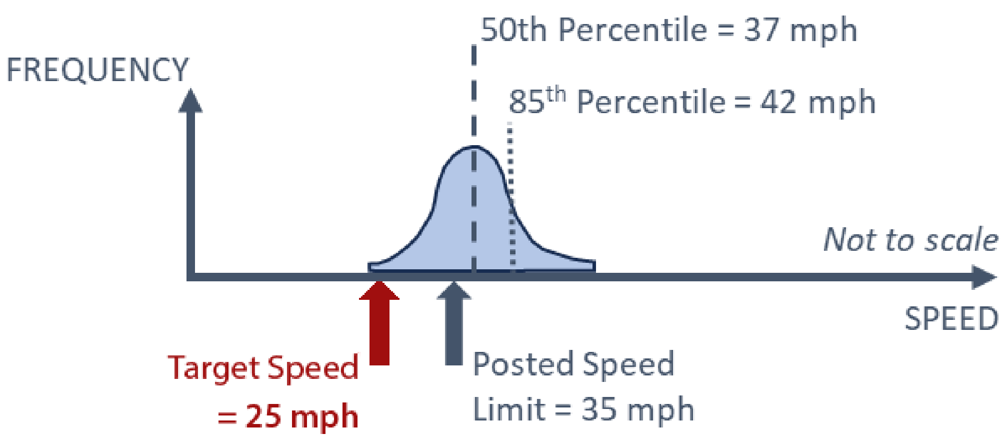
4.3.2 SCENARIO B: URBAN ARTERIAL STREET

The results of the six factors for Scenario B are presented in table 17. Figure 13 graphically represents the results of the speed distribution factor along with the posted speed limit and estimated target speed for the roadway.

Table 17. Example Scenario B to illustrate engineering study results.

FACTOR	EXAMPLE SCENARIO B
Roadway environment	Arterial street in urbanized area with residential and commercial activity, but not quite in a city center or urban core environment. The AADT is 11,600.
Roadway characteristics	Four-lane roadway with 12-foot travel lanes, with 5-foot sidewalks present on both sides of the roadway behind curb and gutter. Two transit lines use the corridor with several onstreet bus stops, and there is significant pedestrian and bicycle activity. The 0.44-mile study segment has a total of 23 access points on both sides of the street. There are two traffic signals. No onstreet parking is provided.
Geographic and demographic context	The roadway is located in an urban context. Users include motorists, pedestrians, bicyclists, and transit (buses).
Reported crash experience	There were a total of 56 reported crashes over the last 5 years. Of these crashes, 13 involved non-serious injuries, 8 involved serious injuries, 2 involved a pedestrian fatality, and 1 involved a bicyclist fatality. In addition to reported crash experience, a prior study identified frequent conflicts between motorists and non-motorists.
Speed distribution of free-flowing vehicles	Posted speed limit of 35 mph, observed 85th-percentile speed of 42 mph and 50th-percentile speed of 37 mph. The State's statutory speed limits for residential and business districts are both 25 mph, unless posted otherwise.
Review of past speed studies	A speed study completed 5 years ago had similar speed distribution results and recommended a speed limit of 35 mph.

Source: FHWA.



Source: FHWA.

Figure 13. Illustration of speed distribution and target speed for Scenario B.

Scenario B Evaluation and Recommendation: The evaluation of the six factors suggests that driver speeds are in excess of what is appropriate for the context and functional classification of the roadway. Free-flowing speeds are 7 mph above the posted speed limit for the 85th-percentile, a pattern that is consistent with a speed study from 5 years ago. The target speed for this arterial street in an urban context would be 25 mph or less. An injury minimization approach also suggests that lower speeds would be appropriate in this urban context, as there is a high expectation of pedestrians and bicyclists using the facility. The posted speed limit of 35 mph therefore may not be appropriate and may need to be lowered to match the context. Additional speed management strategies, as discussed in chapter 5, along with a speed limit change is likely needed to achieve speeds that are safe for all users. For comparison, USLIMITS2 suggests a 35mph speed limit, but notes that both the overall and injury and fatality crash rates are higher than for similar roadways and that pedestrian and bicyclist activity is high. It suggests implementing engineering measures to both address the crashes and reduce operating speeds in an area with high pedestrian and bicycle activity and suggests lowering the speed limit only "after all other treatments have either been tried or ruled out." An example of such a measure would be the reallocation of the existing right-of-way to accommodate separated bicycle lanes. The SLS Tool suggests a 30-mph speed limit, based on its maximum recommended speed limit for an arterial street in an urban context.

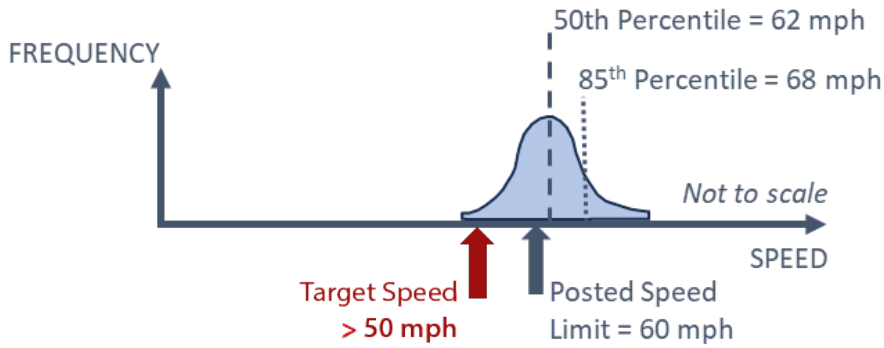
4.3.3 SCENARIO C: SUBURBAN FREEWAY

The results of the six factors for Scenario C are presented in table 18. Figure 14 graphically represents the results of the speed distribution factor along with the posted speed limit and estimated target speed for the roadway.

Table 18. Example Scenario C to illustrate engineering study results.

FACTOR	EXAMPLE SCENARIO C
Roadway environment	Access-controlled freeway in a suburban context. The AADT is 107,800.
Roadway characteristics	Four-lane freeway with 12-foot travel lanes, 6-foot shoulder on both sides of the road, which is median divided with barrier installation separating the two directions. There are no pedestrian or bicycle facilities on this road and no transit stops on the access-controlled facility. There are four interchanges within the 2.51-mile study segment, and the terrain is flat.
Geographic and demographic context	The road is located in a suburban context and serves as a commuter route bypassing the urban business district over 10 miles away. Users include primarily motorists, and there is some freight activity.
Reported crash experience	Over a 5-year period, the segment experienced a total of 322 reported crashes, of which 188 involved non-severe injuries and 3 involved serious injuries. There were no fatal crashes during this time. The corresponding crash rates are lower than those of similar freeways.
Speed distribution of free-flowing vehicles	Posted speed limit of 60 mph, observed 85th-percentile speed of 68 mph and 50th-percentile speed of 62 mph. The State's statutes permit the State DOT to post a freeway speed of up to 65 mph in urban areas, following an engineering study.
Review of past speed studies	A speed study completed 3 years ago showed an 85th-percentile speed of 64 mph and 50th-percentile speed of 58 mph. At the time, the posted speed limit was 55 mph, which was increased to 60 mph following the study.

Source: FHWA.



Source: FHWA.

Figure 14. Illustration of speed distribution and target speed for Scenario C.

Scenario C Evaluation and Recommendation: The evaluation of the six factors suggests the observed 85th and 50th-percentile speeds are 8 mph and 2 mph above the posted speed limit, respectively. Given the access-controlled nature of this suburban freeway, the target speed would likely be at 50 mph or above. A look at the crash experience factors does not suggest unusual safety performance that would suggest a lower speed from an injury minimization perspective. The review of past speed studies indicates that the speed limit was raised from 55 to 60 mph 3 years ago and that both 50th- and 85th-percentile speed have since increased slightly. Based on this assessment and context, it is recommended that no change in speed limit is needed.

For comparison, USLIMITS2 suggests a speed limit of 70 mph, based on the closest 5-mph increment to the 85th-percentile speed. It notes that the suggested speed is higher than the statutory speed. It further notes that 2.5 miles is typically too short for a 70-mph speed zone and suggests expanding the study area if it has similar characteristics. The SLS Tool suggests a speed limit of 60 mph based on the outside shoulder width, crash data, and speed data.

Chapter 5. Implementing the Study Results

After assessing the factors of the engineering study, practitioners may decide that the appropriate speed limit is lower than the current operating speeds and that changes to the roadway may be necessary to bring drivers to more appropriate speeds. In this case, speed management countermeasures should be considered for the study area. This chapter points the reader to existing processes and resources for speed management and presents an overview of geometric design and access management techniques as well as speed management countermeasures.

If the recommended speed limit or current operating speeds do not match with the target speed of a roadway, practitioners should consider these speed management techniques to align driver behavior with expectations. Such techniques are in line with the SSA and can support safer roadway user outcomes, assuming appropriate target speeds.

5.1 Speed Management Principles

The FHWA Office of Safety provides resources relating to the 24 Proven Safety Countermeasures as well as speed management strategies. There are many approaches to speed management, but most countermeasures and strategies fall into one of three basic principles for speed management: enclosure, engagement, or deflection.[69] Education and enforcement are additional factors that can modify driver behaviors and encourage them to travel at the posted speed limit.

5.1.1 ENCLOSURE

Creating a feeling of enclosure gives drivers the sense that the roadway is contained in an "outside room" rather than in an expanse of space. Drivers' sense of speed is enhanced when the environment they are driving through appears closer to them. This idea uses the physical environment to create a sense of confinement, which encourages drivers to slow down and drive more cautiously. Various design features, such as narrower lanes, trees along the street, landscaping, onstreet parking, and even signage can reinforce the perception of visual and physical restriction. This feedback system is an important element of speed management.

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69 These concepts are adapted from Florida Department of Transportation. 2023. *2023 FDOT Design Manual*. Topic No: 625-000-002. Tallahassee, FL: FDOT. https://www.fdot.gov/roadway/fdm/default.shtm, accessed October 15, 2023.

5.1.2 ENGAGEMENT

Visual and auditory inputs can connect the driver to the surrounding environment. Engagement encourages drivers to be aware of their speed and make conscious decisions about how fast they are traveling. As the cognitive load on a driver's decision making increases, they need more time for processing and become more likely to select a lower speed that enables them to process this sensory information. Uncertainty is one element of engagement; for example, the opening of a car door on a vehicle that is parallel parked alerts motorists to drive more cautiously. Onstreet parking and the proximity of other moving vehicles in a narrow lane are important elements of engagement, as are bicycle lanes and the presence of pedestrians on sidewalks and at crossings.

5.1.3 DEFLECTION

Deflection moves the driver horizontally or vertically within the path of travel. Horizontal deflection creates turns in the roadway, forcing drivers to slow down to negotiate the turn or shift safely; examples of horizontal deflection applications include chicanes, roundabouts, and curb extensions. Vertical deflection creates an undulation in the roadway and causes drivers to slow down to avoid discomfort or damage to their vehicle. Examples of vertical deflection applications include speed humps, speed cushions, and raised crosswalks.

Whereas enclosure and engagement rely in part on psychology, deflection relies primarily on physics. Both vertical and horizontal deflection can help reduce vehicle speeds and improve safety for all road users, but it is important to consider the context in which they are used. For example, vertical deflection measures may not be suitable for roadways frequented by emergency response vehicles or public transportation.

5.1.4 EDUCATION AND ENFORCEMENT

Education and enforcement are important factors in establishing initial driver compliance with established speeds as well as newly changed speed limits. Drivers actively select their speeds based on the prevailing conditions of the roadway environment and design. However, research has shown that over the course of their trips, drivers often are not consciously trading off perceived risk with perceived rewards prior to selecting a driving speed.[70, 71] As a result, many speeding episodes may occur unintentionally or incidentally. The presence of high-visibility enforcement and speed feedback signs can alert drivers to their speeds and reinforce the message to slow down.

If the public is not aware of, or does not understand, the potential consequences of speeding to themselves and others, they may not be willing to adjust their speeds or to comply with posted speed limits. Educating road users about target speeds is an important element in creating a traffic safety culture. Transportation agencies can partner with law enforcement and other safety stakeholders to communicate the benefits of speed management to ensure that drivers understand the safety benefits of reduced speeds, including how it promotes walkable and bikeable communities, health benefits, reduced stress, and reduced crashes for all. Partnering with law enforcement to communicate with the public about new speed limits or enforcement initiatives can help disseminate information and increase public understanding of the need for safe speeds.

70 Dumbaugh, E., Saha, D., and Merlin, L. A. 2020. "Toward safe systems: Traffic safety, cognition, and the built environment." Journal of Planning Education and Research 44(1). https://doi.org/10.1177/0739456X20931915.

71 Theeuwes, J., van der Horse, R., and Kuiken, M. 2012. *Designing safe road systems: A human factors perspective*. CRC Press.

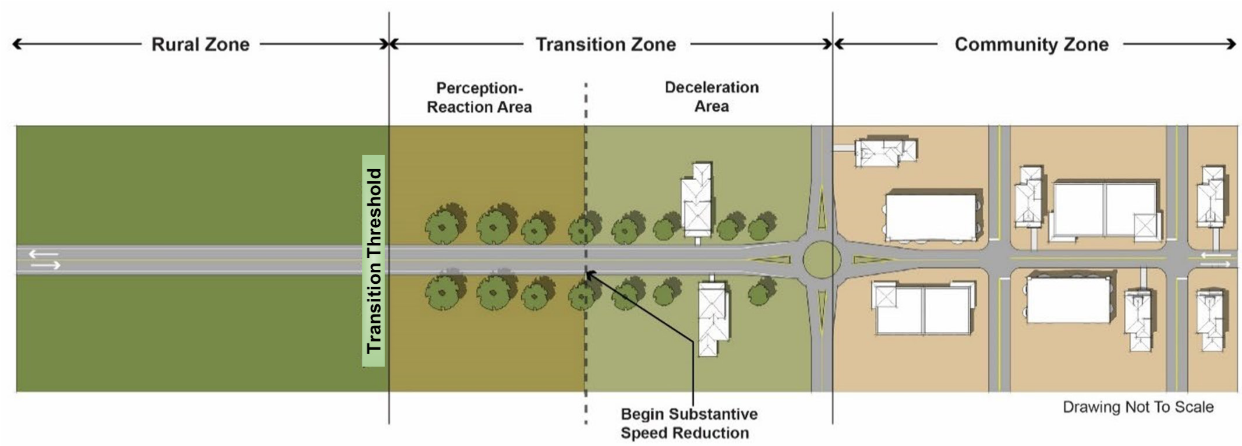
5.2 Transition Zones

Roadways often traverse more than one context. When this happens, the design features and target speed in one area may not be appropriate for an adjacent one. What may be a higher speed rural area may quickly transition into a small town or suburban context. It is important for practitioners to consider safe speeds for each context; for example, practitioners may choose to lower the speed from a rural area to a small town, which likely has much higher concentrations of non-motorized road users.

To achieve rapid speed changes, practitioners can use transition zones to communicate the change to the driver in a way that intuitively leads them to slow down to an appropriate speed. This concept is also referred to as *self-enforcing roadways*. Transition zone speed limits are generally considered when there is a speed reduction of more than 25 mph between adjacent zones. The following factors may be considered in determining the need for a transition zone speed limit:

- Roadway operating speeds in advance of speed reduction
- Existing operational and safety issues
- History of aggressive braking at the entrance to the reduced speed limit area
- Low speed-limit compliance in the lower speed-limit area

A transition may occur over the course of several steps, as illustrated by the perception-reaction and deceleration areas within the transition zone in figure 15.[72]



Source: Florida Design Manual.

Figure 15. Transition zone from rural to community or rural town zone.

72 Florida Department of Transportation. 2023. "202 Speed Management." *2023 Florida Design Manual*. Tallahassee, FL: FDOT. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/fdm/2023/2023fdm202speedmgmt.pdf, accessed June 1, 2023.

In the perception-reaction area, drivers are made aware of the changing contexts, and thus the upcoming change in speed. The practitioner's goal is to begin providing visual cues to the driver and to begin using enclosure, engagement, and deflection strategies. In many locations, gateway signs, regulatory signs, landscaping, and lane narrowing are used together to provide visual cues. Architectural features can also communicate the change to a more populated area. The speed limit may begin decreasing in the perception-reaction area.

After passing through the perception-reaction area, drivers enter the deceleration area. In this area, drivers begin slowing down to match the upcoming speed limit. The length of this area depends on the speed difference between the two primary (non-transition) speed zones and how quickly the driver can be expected to slow down. In this transition area, practitioners may implement more robust speed management features to encourage deceleration, such as roundabouts, lane narrowing or shifting, or other methods of deflection. Practitioners can use enclosure and engagement efforts as speed limits decrease further. It is important to remember that a combination of strategies is more effective for reducing speed than any single design feature.

5.3 Geometric and Access Management Techniques

When constructing a new roadway, the geometric design should consider the target speed and desired operating speeds of the roadway to be successful. Generally speaking, the roadway design features should match the speed vehicles are intended to travel. Important design criteria are a function of the agency-identified design speed for the roadway, including sight lines, superelevation, horizontal curvature, and clear zones are a function of the speed vehicles are traveling at. These elements can create a safety issue if they are not appropriate for the chosen target speed (e.g., minimal clear zones for a high-speed roadway). Likewise, these criteria can encourage drivers to go too fast for a road with a lower target speed (e.g., roads with superelevated curves, large clear zones in a residential area).

It is critical to consider target speed and desired operating speeds when choosing these design speed and resulting features during planning and design and when posting new speeds while maintaining the roadway. It may be necessary to redesign portions of a roadway to be safe at higher speeds or implement more speed management techniques and countermeasures to bring operating speeds in line with what is appropriate. The AASHTO Green Book and local governing design manuals provide guidance on appropriate geometric design using desired operating speed identified based on the recommendation of the engineering study.

Access management helps control conflict points and how drivers interact with the area surrounding the roadway. Restricting access removes conflict points, which can lead to fewer crashes, and helps reduce and separate the decisions drivers have to make, which is critical at higher speeds. By allowing more access, the system owner communicates to the driver more about the character of the roadway, and as access increases it would be assumed that speeds would decrease. The FHWA publication *Safety Evaluation of Access Management Policies and Techniques* can be helpful to the practitioner when making project decisions on a roadway.[73]

Both geometric design and access management decisions should be collaborative and involve all interested parties.

5.4 Evaluation

Reviewing speed limits for effectiveness is a continuous process. After speed limits have been set or changed, conducting follow-up spot speed observations may be beneficial to determine the speed zone's effectiveness and to evaluate any changes in speed patterns. It is helpful to compare data from speed observations prior to the speed limit change and six to 12 months after the speed limit has been posted. It may also be beneficial to review police crash reports after one year to analyze a full 12 months of data. While more years of crash data are needed for a true crash analysis, this data may be able to provide insight into whether speed-related crashes have changed in frequency and if the new speed zones have affected overall safety.[74] This process can also be repeated with additional years of crash data.

5.5 Speed-Management Resources

For additional speed management and Proven Safety Countermeasures resources that can support the speed-limit-setting process, practitioners can refer to the FHWA Office of Safety Speed Management website.[75,76]

73 FHWA. 2018. *Self-Enforcing Roadways: A Guidance Report*. FHWA-HRT-17-098. Washington, DC: FHWA. https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-HRT-17-098.pdf, accessed February 21, 2024.

74 Massachusetts Department of Transportation. *Procedures for Speed Zoning on State Highways and Municipal Roads*. Boston, MA: MassDOT. https://www.mass.gov/doc/procedures-for-speed-zoning-on-state-and-municipal-roadways/download accessed May 8, 2024.

75 FHWA. n.d. "FHWA Office of Safety." (website). https://highways.dot.gov/safety, accessed February 21, 2024.

76 FHWA. n.d. "Speed Management." (website). https://highways.dot.gov/safety/speed-management, accessed April 18, 2024.

Appendix A. Case Studies

This appendix provides case studies and noteworthy practices related to setting speed limits. The following examples cover a range of different corridor contexts and include some noteworthy State-specific programmatic or policy-related examples for setting speed limits. The purpose of these examples is to provide practitioners with real-life scenarios of how jurisdictions consider the six factors outlined in the MUTCD as well as other factors when conducting an engineering study to recommend a speed limit.

HESPERIDES ROAD SPEED LIMIT STUDY: LAKE WALES, FLORIDA

BACKGROUND

Florida DOT (FDOT) received a request to evaluate the speed limit on SR 60 (Hesperides Rd.) in Lake Wales, FL. The roadway carries approximately 26,000 vehicles per day, and while there are some segments of sidewalks on the western portion of the study area, there are no marked bicycle lanes or off-street facilities. Five bus stops are located across approximately 1.6 miles of the western portion of the study area. The stops are generally located mid-block with unmarked crosswalks. Each bus stop does have sidewalk access. While the study concluded in May 2020, spot speeds along the corridor were collected in February 2020 prior to traffic impacts caused by the COVID-19 pandemic. Posted speed limits at the time of the study are shown in table 19.

Table 19. Posted speed limits on SR 60 (Hesperides Rd.).

BEGIN MILEPOST	END MILEPOST	POSTED SPEED LIMIT (MPH)
0.000	0.213	40
0.213	2.400	45
2.400	3.069	55
3.069	5.000	65

Source: FDOT.

APPROACH

FDOT conducted a study on a 5-mile portion of Hesperides Rd. in Polk County, FL, between 4th Street and Dude Ranch Rd. The study followed methods detailed in the 2009 *Manual on Uniform Traffic Control Devices for Streets and Highways,*[77] the FDOT *Manual on Uniform Traffic Studies,*[78] and FDOT's *Speed Zoning for Highways, Roads and Streets in Florida.*[79]

77 FHWA. 2009. *Manual on Uniform Traffic Control Devices for Streets and Highways*. 10th ed. Washington, DC: FHWA.

78 FDOT. 2021. *Manual on Uniform Traffic Studies. Topic No. 750-020-007*. Tallahassee, FL: FDOT. https://www.fdot.gov/traffic/TrafficServices/Studies/MUTS/MUTS.shtm, accessed February 22, 2024.

79 FDOT. 2018. *Speed Zoning for Highways, Roads and Streets in Florida*. Topic No. 750-010-002, Rule 14-15.012, F.A.C. Tallahassee, FL: FDOT. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/traffic/speedzone/2019-01-28_speed-zoning-manual_august-2018.pdf?sfvrsn=ac20bad7_0, accessed February 22, 2024.

The study evaluated the roadway environment, roadway characteristics, geographic context, crash experience, and speed distributions. The operating speed trends over time (i.e., historical speed distributions) were not evaluated as part of the study.

Roadway Environment and Functional Classification

Hesperides Rd. is classified as an urban principal arterial west of Stokes Rd. (milepost (MP) 3.844) and as a rural principal arterial east of Stokes Rd. The study also noted development density tended to reduce slightly east of the intersection of Hunt Brothers Rd. and Buck Moore Rd. (MP 1.689). West of that point, land on both sides of the road featured residential or commercial buildings, while land east of that point tended to feature development on only one side of the road.

Roadway Characteristics

The roadway featured three distinct cross sections:

- MP 0.00 to 2.845 miles is a four-lane divided roadway with a raised grass median, curb and gutter, and a closed drainage system.
- MP 2.845 to 3.080 is a four-lane divided roadway with a raised grass median, paved shoulders, and an open drainage system.
- MP 3.080 to 5.000 is a four-lane divided roadway with a flush grass median, paved shoulders, and an open drainage system.

Additionally, there is a crest vertical curve near MP 0.500 and a pair of reverse curves between MP 0.202 and 0.391. None of the curves featured advisory speed signs, and the engineer conducting the study noted a comfortable feeling while driving the segment at the regulatory speed.

Geographic Context

FDOT has statewide standard context classifications for use in considering the geographic context of segments, and this roadway had four distinct classifications. Table 20 shows the allowable speed range of each classification per the FDOT *Design Manual.*

Table 20. Hesperides Road context classifications.

BEGIN MILEPOST	END MILEPOST	CONTEXT CLASSIFICATION	ALLOWABLE SPEED RANGE (MPH)
0.000	0.014	Suburban Commercial	35–55
0.014	0.615	Rural Town	25–45
0.615	2.228	Suburban Commercial	35–55
2.228	5.000	Rural	55–70

Source: FDOT.

Crash Experience

Crash data for the 5 calendar years preceding the study were reviewed. Over the study period, 11 of 105 crashes were related to speed, with 9 of those crashes occurring when drivers lost control of vehicles on wet roadways. The nine crashes were distributed among the corridor, suggesting there was no discernable pattern related to the roadway environment or roadway characteristics.

Four of the crashes involved fatalities and 38 crashes resulted in 62 injuries. None of the fatalities occurred among the 11 speed-related crashes.

Speed Distribution

Twenty-four-hour spot speed studies were conducted at four points along the corridor. Observers collected measurements for vehicles traveling at unrestricted free-flow speeds. Table 21 shows the pace, 50th-percentile, and 85th-percentile speeds at each location.

Table 21. Collected speeds and volumes on Hesperides Road.

MILEPOST	POSTED SPEED (MPH)	DIRECTION	10-MPH PACE SPEED (MPH)	MEDIAN (50TH-PERCENTILE) SPEED (MPH)	85TH-PERCENTILE SPEED (MPH)
0.545	45	EB	25-34	29	35
		WB	38-47	40	47
1.900	45	EB	43-52	46	53
		WB	39-48	46	56
2.699	55	EB	44-53	49	55
		WB	45-54	51	59
4.188	65	EB	43-52	48	67
		WB	51-60	55	69

Source: FDOT.

OUTCOME

Following the analysis of the roadway environment, roadway characteristics, geographic context, crash experience, and speed distributions, the study recommended subdividing the existing 45mph segment into a 45-mph segment from MP 0.213 to MP 1.689 and a 55-mph segment from MP 1.689 to MP 2.400. FDOT's 2019 *Speed Zoning for Highways, Roads, and Streets in Florida* does not authorize speed limits which are more than 8 mph below the 85th-percentile speed, and the westbound 85th-percentile speed at MP 1.900 was measured at 56 mph, 11 mph above the 45-mph posted speed limit.

Although this outcome was restricted by the FDOT speed zoning requirements, the engineer of record was able to evaluate and identify the most appropriate physical limits of the speed zone. The spot speed studies were conducted at individual points, not continuously along the length of the study extents. Examination of the factors beyond the speed study provided insight for a contextually appropriate demarcation between the 45- and 50-mph segments. Ultimately, the roadway environment informed the decision making for the speed zone limits, and the western limit of the 50-mph segment was recommended to be set beginning at MP 1.689, coinciding with the reduction in development density. Table 22 shows the final recommended speed zones.

Table 22. Recommended speed limits for Hesperides Road study corridor.

BEGIN MILEPOST	END MILEPOST	EXISTING POSTED SPEED LIMIT (MPH)	RECOMMENDED SPEED LIMIT (MPH)
0.000	0.213	40	40
0.213	1.689	45	45
1.689	2.400	45	50
2.400	3.069	55	55
3.069	5.000	65	65

Source: FDOT.

CITY WIDE SPEED LIMIT STUDY: CITY OF MINNEAPOLIS, MINNESOTA

BACKGROUND

From 2017 to 2021, approximately 150 people died or were severely injured each year due to traffic crashes in Minneapolis, MN.[80] Speed and speeding were key factors in these crashes, with speeding being one of the top five behaviors that lead to severe crashes in the city.

In May of 2019, the State passed a new law that gave cities the ability to set speed limits within their jurisdictions. Previously, most streets owned by Minneapolis had a statutory speed limit of 30 mph. Under the new law, Minneapolis decided to use a tiered approach to set speed limits based on street classifications, conclusions from various local and national studies, as well as the experiences of other cities that have changed their speed limits to promote safety.

Minneapolis worked with the City of Saint Paul to verify consistency between each city's efforts to complete a speed limit analysis focused on improving safety performance. Minneapolis also worked with various internal and external partners such as the city attorney's office, communications, police, Minnesota DOT, Hennepin County, the Minneapolis Park and Recreation Board, and Metro Transit.

80 City of Minneapolis Public Works Department. 2020. "City of Minneapolis Speed Limit Evaluation." https://lims.minneapolismn.gov/Download/RCAV2/12769/Minneapolis-Speed-Limits-Evaluation-Final-3-12-2020.pdf, accessed February 22, 2024.

APPROACH

Minneapolis established goals relating to setting speed limits that:

- Support the city's Vision Zero Action Plan
- Reflect the city's Complete Streets policy by improving access and comfort for people walking, bicycling, and taking transit
- Consider projected future street and land use
- Support moving people and goods
- Are reasonable, comfortable, and technically defensible

The city considered multiple components when determining their speed limits, including national practices and studies, speed limits in other cities, safety studies, a traffic speed study, and classification of different street types.

National Practices and Studies

The city referred to research performed by national organizations to inform their approach to setting urban speed limits. For example, the city considered the 2017 National Transportation Safety Board's report directly addressing traditional methods of establishing speed limits and the related challenges. It also sought to align is speed limits to the City's Complete Streets policy adopted in 2016, which focused on the safety of non-motorized road users.[81] Minneapolis spoke to other cities such as New York City, Portland, and Seattle about their experiences related to recent speed limit changes that involved successfully lowering speed limits to support safety for all users. They also assessed the speeds other States used as their statutory speed limit for urban areas. They discovered all of Minnesota's neighboring States used 25 mph speed limits.

New York City has a default speed limit for all streets throughout the city and identifies specific zones in which they may have either lower or higher speed limits than the default. Portland and Seattle are similar to Minneapolis in terms of context and street design; both cities have successfully used a tiered approach to setting speed limits.

Crash Experience

In 2017 and 2018, Minneapolis conducted two comprehensive crash studies that examined non-interstate crashes that took place between 2007 and 2016:

- A pedestrian crash study focusing on pedestrian crashes
- A Vision Zero crash study focusing on motor vehicle and bicycle crashes

The following are some key findings from these studies that informed speed limit decision making:

- Speed and speeding are key factors in severe and fatal crashes in Minneapolis.
- Speeding was one of the top five behaviors leading to severe crashes.
- Streets with higher speed limits have greater likelihood of crashes.
- An average of 11 people were killed and 84 people were severely injured in traffic crashes throughout the city each year.
- Pedestrians and bicyclists are overrepresented in severe and fatal crashes in Minneapolis.

81 City of Minneapolis Public Works Department. 2020. *City of Minneapolis Speed Limit Evaluation*. https://lims.minneapolismn.gov/Download/RCAV2/12769/Minneapolis-Speed-Limits-Evaluation-Final-3-12-2020.pdf, accessed February 22, 2024.

Traffic Speed Study

In 2018, Minneapolis conducted a comprehensive study of traffic speeds to collect information and evaluate future traffic calming measures. Over 11,000 radar readings were taken at 448 locations throughout the city to gather data. Some of the core findings and conclusions are summarized below:

Local residential streets:

- The median speed (50th-percentile speed) was 22 mph, 8 mph below the 30-mph speed limit.
- Only 5 percent of drivers were exceeding the speed limit.
- Based on pedestrian and Vision Zero crash studies, these are the city's safest streets. However, the city regularly receives inputs from citizens about traffic being too fast, suggesting that the city can set more appropriate speed limits to better support safety and community expectations.

Other city streets (generally collector and arterial):

- The median speed was 27 mph.
- The 85th percentile speed was close to 35 mph.
- Most drivers felt more comfortable traveling below the speed limit of 30 mph, suggesting the city should consider lower speed limits to support safety goals.
- The city concluded that the 85th percentile speed of 35 mph is too high to support the safety goals of the city and should not be used in reference to setting urban speed limits.

Geographic Context – Classification of Street Types

Minneapolis owns and manages a range of streets with different designs, uses, and contexts. The city considered five categories of streets as it was setting speed limits, with percentages shown in figure 16:

- Local residential streets
- Local industrial access streets
- Mixed-use, commercial, and downtown streets
- Residential access streets
- Parkways

Local residential and local industrial access streets are considered minor streets. Mixed-use, commercial, and downtown streets and residential access streets are considered major streets. Table 25 summarizes the typical details for each category, except for parkways.[82]

82 Nearly all parkways are owned by the Minneapolis Park and Recreation Board, and very few are owned by the City.

Source: FHWA.

Figure 16. Percentage of Minneapolis city streets per category.

Table 23. City of Minneapolis roadway context and characteristics.

GEOGRAPHIC CONTEXT	TRAFFIC CHARACTERISTICS	ROADWAY CHARACTERISTICS	MULTIMODAL CHARACTERISTICS
Local residential streets	Low volume	• Width of 32-feet or narrower • Two-way traffic • Onstreet parking	• Regular pedestrian and bicycle use • Sidewalks on both sides • No dedicated bicycle lanes • No transit service
Local industrial access streets	Low volume	• Width of 32-feet or narrower • Two-way traffic • Onstreet parking	• Low pedestrian and bicycle use • Some streets lack sidewalks • No dedicated bicycle lanes • No transit service
Mixed-use, commercial, and downtown streets	Medium to high volume	• Two to four lanes • Onstreet parking	• High pedestrian and bicycle use • Sidewalks on both sides • Bicycle lanes • Transit service
Residential access streets	Low to medium	• Width of 36–44 feet • Two-way traffic • Onstreet parking	• Regular pedestrian and bicycle use • Sidewalks on both sides • Some bicycle lanes • Transit service

Source: City of Minneapolis.

OUTCOMES

Considering the national practices and research, safety and traffic speed studies, and classification of different street types, Minneapolis decided to implement a tiered approach to setting speed limits on city streets, as follows:

- Speed limit of 20 mph on minor streets (predominantly local residential streets)
- Speed limit of 25 mph on major streets (generally collector and arterial streets)

The city may set a speed limit higher than 25 mph based on conditions on some city streets. Overall, this approach is supported by guidance from the National Association of City Transportation Officials, which recommends considering categories of streets when setting speed limits, as well as suggesting a 20-mph speed limit on minor urban streets and 25-mph speed limit for major urban streets.

One key component that contributed to the outcomes is the likelihood of fatalities or serious injuries resulting from higher speeds (e.g., serious injuries or fatalities are 40 percent more likely to occur when a person is hit at 30 mph than 20 mph).[83] These lower speed limits also support other city policies and plans, such as Vision Zero. The city plans to incorporate additional supplementary speed limit information and changes into various city policies, including the Minneapolis 2040 comprehensive plan, Minneapolis complete streets, transportation action plan, and street design guide.

Overall, the findings from the studies and this approach support the safety goals for Minneapolis and the State of Minnesota. Lower speed limits will help the city achieve traffic safety goals, reflect future street uses based on expected land-use changes, and improve access and comfort for all road users throughout the city.

CONTEXTUAL SPEED-LIMIT-SETTING: NEW CASTLE, COLORADO

BACKGROUND

US Route 6 is a two-lane rural highway that runs through the mountainous rural town of New Castle, CO. New Castle is located on the Western Slope of the Rocky Mountains, 173 miles west of Denver. The segment of US Route 6 that runs through New Castle from MP 104 to MP 110 extends through multiple contextual settings. Within a 3-mile section of this 7-mile segment, the context of US Route 6 transitions from rural highway (55 mph) to rural residential (45 mph) to rural town center (35 mph) to rural commercial (45 mph) and then back to rural highway (55 mph).

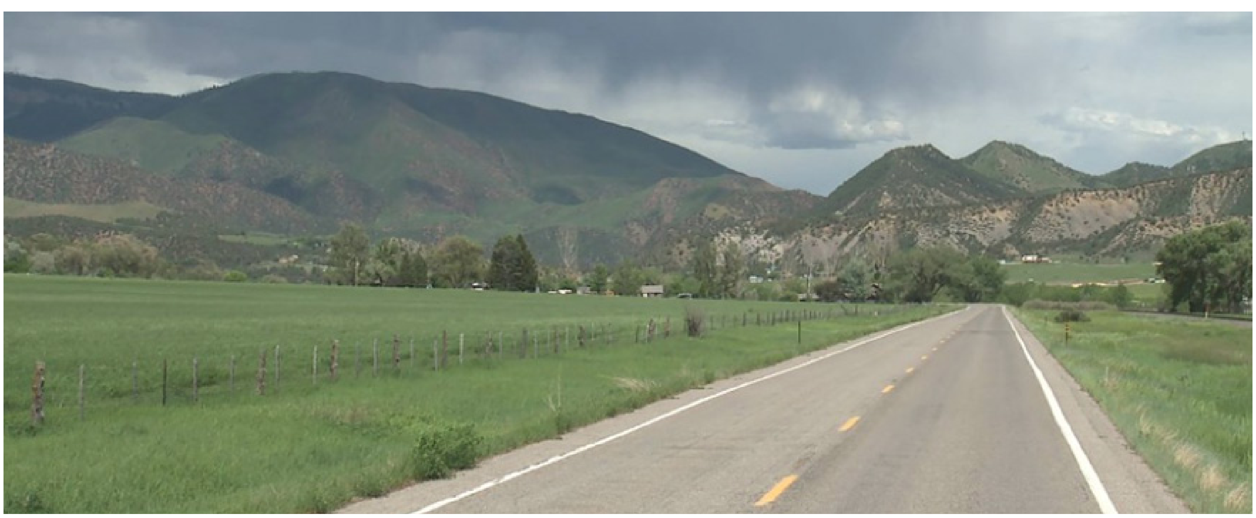
Colorado Department of Transportation (CDOT) has set speed limits based on the 85th percentile since the 1970s. The town of New Castle had previously requested to lower the speed limit on US Route 6, but due to the 85th percentile persisting at higher speeds, the speed limit was never lowered. In 2019, the town requested that CDOT conduct a speed study. This study resulted in a reduction of the rural town-wide speed limit from 35 to 30 mph due to the context of the roadway, high presence of access points, and high rates of pedestrian activity.

83 FHWA. 2021. "Appropriate Speed Limits for All Road Users." https://safety.fhwa.dot.gov/provencountermeasures/pdf/PSC_New_App%20Speed%20Limits_508.pdf, accessed April 14, 2024.

However, in 2022, a new charter school opened in the rural town center segment, causing operational and safety issues for non-motorized road users on US Route 6. CDOT investigated further by conducting a school study in 2023 to identify how the various contextual factors can support a safe and operational speed limit for all road users. A school study establishes school zones by conducting a speed study that considers the added elements of situations one would see in a school environment, such as children being dropped off, children riding bicycles, and children crossing the street. School studies may determine appropriate singing for school speed limit, the establishment of a school zone that has a lower speed limit at a certain time, or a combination of the two. This school study led to CDOT's transformative approach to their speed-limit-setting process and overall enhancements to their speed management program.

© 2024 Google® Maps, modifications to show mileposts by FHWA.

Figure 17. Milepost map displaying the varying contextual segments along US Route 6.



Source: CDOT.

Figure 18. Rural highway segment at MP 108.

APPROACH

The charter school opening in 2022 led to operational and safety concerns in the rural town segment, which contains school and municipal bus stops, onstreet parking, 10 designated pedestrian crossings, more than 80 residential and commercial access points, sidewalks, and bicycle lanes. The primary concern focused on the congestion that led to extensive queuing (up to 1/4 mile in both directions) near the school and extending into the 45-mph speed zones, increasing the likelihood of non-motorized road user crashes for those students commuting to school via walking or bicycling.

School Study

CDOT collaborated with its Region 3, which supports northwestern Colorado projects, and the surrounding school district in New Castle to begin the school study process. With the varying contexts and speed limits throughout the area, CDOT studied smaller concentrated areas of roadway segments to understand the needs and to consider multiple factors for determining the most appropriate speed limit recommendation. Breaking the study down into smaller segments allowed the study team to identify each context's individual purpose, design geometry, infrastructure needs, and operational and safety priorities. The factors considered in the school study included:

- Location of school crossings
- Presence of pedestrians and bicyclists
- School start and end times for pedestrian, bicyclist, and school crossings
- Sight distance
- Three years of crash data
- Operational data
- Adjacent land uses and traffic generators, such as nearby commercial development

Assessing the operational data with field observations within the smaller contextual segments allowed CDOT to understand the baseline operations for New Castle thoroughly.

CDOT used radar units, video cameras, and ball bank indicators to gather field data and collect the 50th and 85th percentile speeds at each individual segment. The team used this data to create field logs of sign locations, existing infrastructure, curve run data, point of tangency and curvature, and strip maps.

Table 24. New Castle 50th- and 85th-percentile speeds collected over speed studies.

YEAR	50TH-PERCENTILE SPEED (MPH)	85TH-PERCENTILE SPEED (MPH)
2019	33	36, 37
2023	28	29, 30

Source: CDOT.

Once these data were analyzed and reviewed by CDOT engineers, a draft report containing the speed recommendation for the school study was developed that included a project overview, reasoning for the methodologies used, and overall recommendations for Region 3. The results of the school study recommended a 25-mph speed limit on US Route 6 through the town center with a 20-mph school zone speed limit during specific morning and afternoon timeframes near the school. Although speed distribution and all other factors were considered, CDOT prioritized the contextual, safety, and geometric factors to develop their recommendations.

CDOT's Region 3 acted as a liaison between the CDOT main office and all stakeholders involved to discuss the recommendations before finalizing the report. Once Region 3 approved the draft, CDOT finalized and signed the report for implementation. The newly established speed limit and school zone were paired with new crosswalk pavement markings and designated pedestrian signage along the roadway to increase visual awareness.

OUTCOME

The results of the school study led CDOT to enhance their speed-limit-setting process and their overall speed management program. Although CDOT looked at contextual factors in the 2019 speed study, the 2023 school study allowed them to see the necessity of additional factors to consider when setting the speed limit by conducting multiple smaller speed studies based on context. As described in this study, there are many contexts throughout the study segment. Restructuring the speed limit study process to separate the roadway segment into smaller context areas allowed the team to better assess the associated factors such as geometry, environment, crash patterns, operations, and safety, which in turn allowed the study team to assess the appropriate speed limit for each segment based on its context. Assessing the roadway geometry should support those changes to get road users into natural compliance. CDOT prioritizes the factors to help to assess the factors further based on project and community needs.

To further enhance their speed limit setting process based on their unique needs, CDOT is currently developing their own tool using insights from various sources including USLIMITS2 (see FHWA's "USLIMITS2: A Tool to Aid Practitioners in Determining Appropriate Speed Limit Recommendations" at https://safety.fhwa.dot.gov/uslimits/.) and the NCHRP Research Report: 966 Speed Limit Setting Tool (Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, and Tim Gates. 2021. Posted Speed Limit Setting Procedure and Tool: User Guide. Transportation Research Board, Washington, DC: The National Academies Press. https://doi.org/10.17226/26216).

CDOT plans to conduct an after study in 2024. Based on input from law enforcement and town officials, the road users are obeying the reduced speed limits and pedestrians are generally feeling safer. Additionally, the reduced speed limits across New Castle have improved safety performance, particularly for children commuting to school.

RICHMOND HIGHWAY SPEED LIMIT STUDY: FAIRFAX COUNTY, VIRGINIA

BACKGROUND

Richmond Highway (or US Route 1) is an urban principal arterial that functions as a multimodal corridor serving commuters, through traffic, and freight traffic in Fairfax County, VA. The roadway carries about 47,000 vehicles per day and has significant pedestrian activity due to the dense concentration of transit bus stops and commercial developments along the corridor.

Richmond Highway was experiencing higher than average crash rates, and there had been several crashes resulting in pedestrian fatalities. Pedestrian safety had become a concern for local officials. In addition, two major projects are planned that will affect future conditions of Richmond Highway: a widening project that will be completed in 2028 and Fairfax County's bus rapid transit project, estimated to be complete in 2031. Based on the future plans for Richmond Highway, coupled with growing concern about the safety of pedestrians and vehicles alike, Fairfax County requested that the Virginia Department of Transportation (VDOT) examine the existing speed limit of 45 mph. VDOT, Fairfax County, and local elected officials agreed that there was a need to conduct an engineering study of this corridor to assess the current speed limit and determine if changes were necessary.[84]

APPROACH

VDOT conducted a study of Richmond Highway from the intersection of Meade Rd. and Belvoir Rd. to Interstate 495 (I-495). The study assessed the existing roadway environment, roadway characteristics, geographic context, crash experience and speed distribution. Operating speed trends were not evaluated as part of this study.

Roadway Environment

As noted, Richmond Highway is an urban principal arterial that functions as a multimodal corridor serving commuters, through traffic, and freight traffic. There is significant pedestrian activity in the middle and northern portions of the corridor due to the dense concentration of transit bus stops and commercial pedestrian generators. Within the 8-mile-long section, there are 35 bus stops in the southbound direction and 31 bus stops in the northbound direction (figure 20).

Sidewalk facilities are sporadically located and do not provide a continuous pedestrian access network through the length of the corridor. No bike lanes are present north of Jeff Todd Way. However, the southern portion of the corridor has bike lanes and pedestrian facilities present on both sides of the road.

84 Information in this case study is adapted from the technical report: VDOT, *Richmond Highway (U.S. Route 1) Speed Limit Study, Fairfax County, Virg*inia (March 10, 2023).

Roadway Characteristics

Richmond Highway has three distinct sections within the study (figure 19).

- The northern portion from I-495 to Buckman Rd. consists of three lanes in each direction and a raised concrete median. Traffic signals and driveways are frequent in this section.
- The middle portion from Jeff Todd Way to Buckman Rd. has two lanes in each direction with a variable median, ranging from no median to a two-way left turn only center lane. Similar to the northern section, driveways and intersections are frequent.
- The southern section from Meade Rd. to Jeff Todd Way consists of three lanes in each direction, a wide grass median, and a limited number of access points.

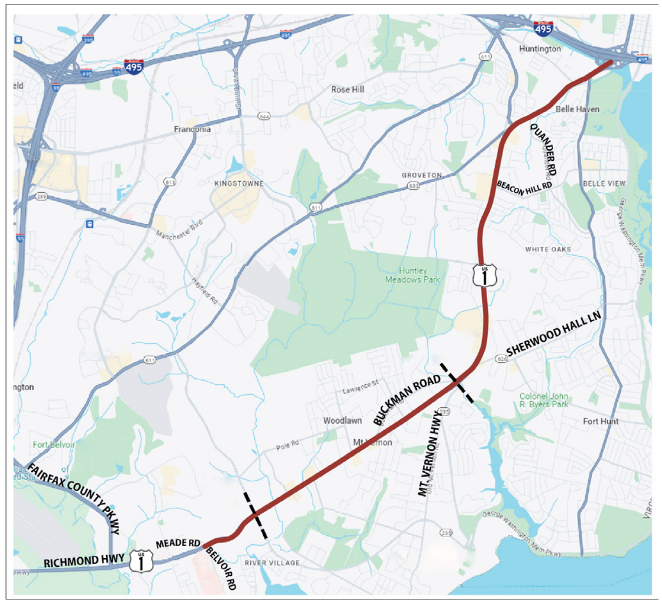


Figure 19. Map of Richmond Highway study corridor.

Geographic Context

Richmond Highway is in an urban area and has consistent commercial development on both sides of the roadway.

Crash Experience

VDOT evaluated the crash data for 2016-2020. Table 25 shows the crash severity data by year.

Table 25. Crash severity data for Richmond Highway study area, 2016–2020.

YEAR	FATAL INJURY	SEVERE INJURY	VISIBLE INJURY	NONVISIBLE INJURY	PROPERTY DAMAGE ONLY	TOTAL
2016	2	8	21	105	143	279
2017	2	14	72	38	141	267
2018	0	8	78	6	122	214
2019	2	9	71	8	139	229
2020	3	3	59	4	145	214
Total	9	42	301	161	690	1203

Source: VDOT.

Some key takeaways from the overall crash study were:

- The majority of the crashes were rear end or angle crashes.
- There were 50 pedestrian-related crashes and four bicyclist-related crashes.
- Seven of the nine fatal crashes involved pedestrians.
- Nearly 42 percent of the reported crashes involved an injury.
- There were 79 speeding-related crashes. Of those, three were fatal crashes.
- The middle and northern portions of the corridor had crash rates higher than the statewide average.

Speed Distribution

VDOT collected data using radar at seven locations throughout the corridor to provide a comprehensive set of data to evaluate existing speeds. These locations represented varying typical sections and AADT conditions. Data was collected on Tuesday, Wednesday, and Thursday for each site. Table 26 shows the collected speeds and volumes at each site.

Table 26. Collected speeds and volumes for Richmond Highway study corridor.

DATA COLLECTION LOCATION	50TH-PERCENTILE SPEED (MPH)	85TH-PERCENTILE SPEED (MPH)	AADT (VEHICLE/DAY)
Site 1	40.8	48.8	47,069
Site 2	38.5	46.8	52,319
Site 3	37.7	44.8	50,299
Site 4	39.5	46.8	35,910
Site 5	38.8	45.7	36,504
Site 6	42.4	49.1	34,028
Site 7	45.1	52.2	43,545

Source: VDOT.

In addition to the radar collected speeds, VDOT also assessed travel speeds collected from crowd-sourced data over a 24-hour period over multiple days at various locations within the study area. That data revealed that the average operating speeds on Richmond Highway are near 35 mph during much of the day.

VDOT also used the speed-limit-setting methodology developed under the *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide*.[85] The application of this methodology supports lowering the speed limit on Richmond Highway based on the 50-percentile speed. When considering the high crash rates along the corridor, the application supported speed limits between 35 and 40 mph.

85 Kay Fitzpatrick, Subasish Das, Michael P. Pratt, Karen Dixon, and Tim Gates. 2021. *NCHRP Report 966: Posted Speed Limit Setting Procedure and Tool: User Guide*. Transportation Research Board, Washington, DC: National Academies Press. https://doi.org/10.17226/26216, accessed October 10, 2023.

OUTCOME

Upon completion of the study, VDOT recommended that the current speed limit of 45 mph on Richmond Highway be lowered to 35 mph in the middle and northern sections, between Jeff Todd Way and I-495. The southern section, south of Jeff Todd Way, would remain at 45 mph. The main factors that informed this decision were:

- High rate of crashes
- High number of pedestrian crashes and speed-related crashes
- Large number of bus stops along the corridor
- Frequency of signal-controlled intersections
- Frequency of driveways

While the future bus rapid transit project was not a component of this study, the reduced speed limit of 35 mph aligns with the proposed design speed of that project.

STAKEHOLDER COLLABORATION AND COMMUNICATION

A stakeholder meeting was held with representatives from VDOT and Fairfax County's Department of Transportation, Transit Services, Fire and Rescue Department, and Police Department. The stakeholders concurred with the recommendation to reduce the speed limit.

Public involvement meetings were also held to inform the public on the proposed speed limit change. Public comments indicated an overall consensus in favor of the lower speed limit.

VDOT supports the Safe System Approach. Geometric conditions such as the high number of driveways and traffic signals, lack of turn lanes and raised median in certain areas, and frequent bus stops, as well as high pedestrian activity, create situations where drivers may need to react to several conflicts within a short period of time. By reducing overall driver speeds on Richmond Highway, drivers will be more readily able to identify conflicts and have more time to react. In addition, when a collision does happen, the chances for an injury or fatality to occur are greatly reduced compared to situations with higher speeds.

U.S. 89A SPEED LIMIT STUDY: KANAB, UTAH

BACKGROUND

The Utah Department of Transportation (UDOT) evaluated the speed limit of U.S. 89A in Kanab, UT, from milepost (MP) 0.398 to MP 2.960. The roadway is two lanes from MP 0.398 to 0.900, at which point a two-way-left-turn lane is present for the remaining length of the study segment. From MP 2.350 to MP 2.960, an additional travel lane is provided in each direction for a total of five lanes across the cross section. Posted speed limits at the time of the study are shown in table 27.

Table 27. Posted speed limits.

BEGIN MILEPOST	END MILEPOST	POSTED SPEED LIMIT (MPH)
0.398	1.800	55
1.800	2.470	45
2.470	2.840	35
2.840	2.960	30

Source: UDOT. Study #24-TS2238-04-SIG,SP,SM 0089 (MP 0.398-2.96)

APPROACH

UDOT's study complied with UDOT Policy 06C-25 which controls the establishment of speed limits on State highways. Under this policy, freeways and interstate system facilities (classified by UDOT as Access Category 1), as well as non-urban roads outside of "other development areas," establish speed limits using 85th percentile speeds. However, speed limits on all other State highways are established based on context. "Other development areas" are those areas which are not "urbanized but that include a permanent residential dwelling and at least two other land uses… providing commercial, industrial, or public services for the community…"[86] For this corridor, the roadway from MP 0.398 to MP 1.950 is a rural setting (subject to speed limit establishment based on 85th-percentile speeds), while MP 1.950 through MP 2.960 is an "other developed area" with residential and commercial land use.

UDOT's speed study guidelines outline the considerations for establishing a speed limit based on context, including roadway environment factors, such as pedestrian and bicycle activity and infrastructure, parking practices, and roadside development and culture. Additionally, the guidelines call for all speed studies to investigate roadway environment such as the condition of the road, speed distributions, and crash experience. Finally, the *geographic context* is reviewed for all roads in urban or other developed areas through the use of access categories which correspond to recommended speed limit ranges.

86 UDOT. 2023. "06C-25 Establishment of Speed Limits on State Highways." https://drive.google.com/file/d/17HgtIMB81G8P3DreWCNa3Mro_RFGrl9X/view, accessed February 26, 2024.

Although not explicitly called for in the UDOT speed study guidelines, the speed study of U.S. 89A included documentation of roadway characteristics. Operating speed trends were not evaluated as part of this study.

Roadway Environment

The study team conducted a field visit of the corridor and observed some pedestrian and bicyclist activity, all within the "other developed area" between MP 1.950 and 2.960. Heavy trucks were also present along the roadway. The team noted that while recreational traffic and farming equipment was not present during the visit, their presence was possible based on the surrounding land uses. The local middle school and high school are both within a quarter of a mile of the roadway, including a school crosswalk located at MP 2.600.

Roadway Characteristics

During the field visit, the study team noted the roadway and shoulder both appeared to be in good condition throughout the study corridor. As noted previously, the corridor transitions from a two-lane section (one lane in each direction) to a three-lane section with the addition of a two-way left-turn lane, and then to a five-lane section featuring two lanes in each direction as well as the two-way left-turn lane. The field notes indicate the corridor generally appears to meet the UDOT design standards.

A traffic signal exists at MP 2.960 with an additional signal proposed at MP 2.050. Per UDOT policy, the speed limit should not exceed 55 mph within 0.25 miles of a traffic signal.

Geographic Context

UDOT classifies all State highways into 1 of 10 access categories based on a combination of functional and context factors. The full length of the study corridor is classified as category 7, "community-rural importance." For the portion of the study within the "other developed area," the recommended range of posted speed limits for access category 7 is 30–40 mph.

Crash Experience

The study team reviewed approximately 5 years of crash data from January 1, 2019, through January 16, 2024. Over the study period, three of four crashes were related to speed, with no crashes being categorized as severe. One crash, also not severe, involved a non-motorist at MP 2.370.

Speed Distribution

The study team used a handheld radar device to collect speed data at nine locations along the corridor. Procedures followed those described in UDOT policy as well as the MUTCD 2009 edition. Figure 20 shows the 50th- and 85th-percentile speeds at each location.

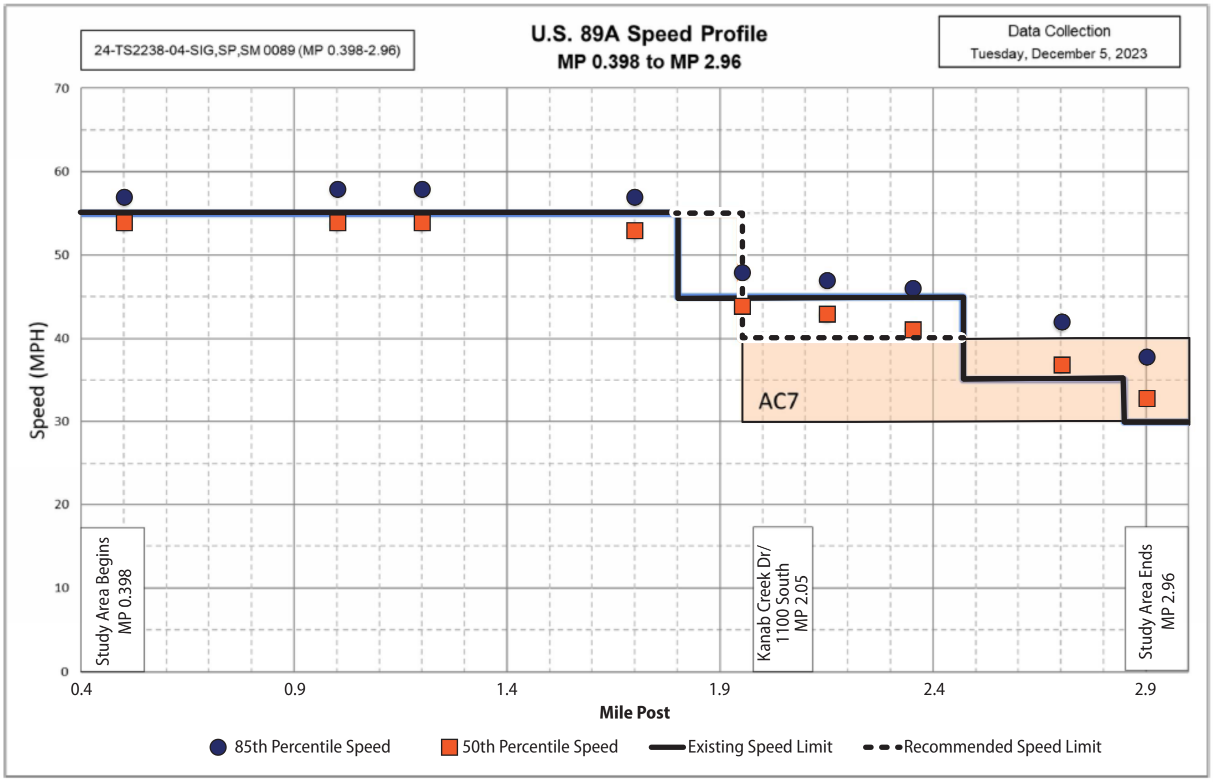


Figure 20. Speed profile for U.S. 89A.

OUTCOME

Following an analysis of the roadway environment, roadway characteristics, geographic context, crash experience, and speed distributions, the study recommended lowering the speed limit to 40 mph from 45 mph between MP 1.950 and MP 2.470. This recommendation was based on the corridor being within the "other developed area" with an access category of 7 and a recommended speed limit range of 30–40 mph. A field visit revealed limited pedestrian and bicycle activity with minimal history of pedestrian or bicycle crashes, suggesting a speed limit at the upper end of the range is appropriate. Sidewalks exist on the west side of the corridor in this section but the context suggests limited pedestrian generation with mostly farming and industrial land use on the east side.

The study also recommended raising the speed limit from 45 mph to 55 mph between MP 1.800 and MP 1.950 to better align with the "other developed area" segment. Figure 21 shows the existing as well as recommended speed limits throughout the corridor.

In addition to the speed limit recommendations, the speed study also provided recommendations on speed management strategies from MP 2.050 to MP 2.470 because the 85th-percentile speeds exceeded the recommended speed limit of 40 mph. Speed management strategies were also recommended from MP 2.470 to MP 2.960 due to the 85th-percentile speed exceeding the posted speed limit. Strategies along this section included a radar speed sign, road diet, roadside gateway feature, landscaping, conversion of intersections to roundabouts, landscaped median island, curb extensions, or side treatments (e.g., curb, gutter, sidewalk). The study indicated additional strategies, either in isolation or combination, could be considered if additional speed management is needed in the future.

SPEED ZONING POLICY: FLORIDA

BACKGROUND

FDOT developed the 2018 manual entitled *Speed Zoning for Highways, Roads, and Streets in Florida* to present guidelines and recommended procedures for determining speed limits on State, municipal, and county roads.87

POLICY HIGHLIGHTS

The FDOT speed limit setting process provides target speed ranges. The target speeds are defined for specific context classifications. The process also considers the pace speed of the corridor in addition to the 85th-percentile speed.

DATA COLLECTION

The manual discusses noteworthy practices for collecting data on both spot speeds and segment speeds. It details the types of technologies State practitioners can use for measurements, common reasons to select one type of technology over another, and known errors in each technology as well as methods for addressing these errors. In addition to technologies, the manual provides a list of location characteristics to avoid when collecting speeds due to distortion of the free-flow speed. These characteristics include the presence of:

- Stop signs and traffic signals as well as areas within proximity of interchanges or with congested traffic
- School crossings, railroad crossings, and rest areas
- Steep grades, horizontal curves, areas of poor sight distance, segments with dips in the roadway
- Narrow bridges, diverge and merge areas, or when construction is occurring on an adjacent roadway

The manual also provides recommendations regarding the time of day, day of week, or season of the year to conduct the study to capture the typical conditions.

DETERMINING THE SPEED LIMIT

FDOT recognizes the connection between speed and crashes. As such, the manual discusses means of calculating the expected crash modification factor of an adjusted speed limit. The manual also emphasizes that a reduction in the speed limit does not correspond to an equal reduction in mean travel speed, absent mitigation techniques.

87 FDOT. 2018. *Speed Zoning for Highways, Roads and Streets in Florida*. Topic No. 750-010-002, Rule 14-15.012, F.A.C. Tallahassee, FL: FDOT. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/traffic/speedzone/2019-01-28_speed-zoning-manual_august-2018.pdf?sfvrsn=ac20bad7_0, accessed February 22, 2024.

The manual generally directs the speed limit be set within three mph of the lesser of the 85th-percentile speed or the upper limit of the 10-mph pace. (See section 2.3.5 for a discussion of these concepts.) However, the manual allows lowering this speed limit further, to be between 4 and 8 mph below this limit based on supplemental investigation. The investigation should consider roadway environment, roadway characteristics, and crash history. The agency may also reduce the speed limit to align with the context classification target speed.

Context Classification Target Speed

FDOT defines context classifications for all State roads that are not limited access roads. The context of a roadway is determined through distinguishing characteristics as well as defining measures such as intersection density, block perimeters and lengths, land use, building height and setback, off-street and onstreet parking, allowed residential and commercial density, and population and employment density.[88]

FDOT's manual adopts FHWA's context-sensitive solution definition of target speed as the "highest speed at which vehicles should operate on a thoroughfare in a specific context, consistent with the level of multimodal activity generated by adjacent land uses, to provide both mobility for motor vehicles and a safe environment for pedestrians, bicyclists, and public transit users."[89]

Combining the context classifications with targe speeds, the manual recommends engineers consider the context classification when determining the speed limit. Table 28 presents the design speeds by context classification.

Table 28. Allowable design speed range by context classification.

CONTEXT CLASSIFICATION	ALLOWABLE RANGE (MPH)
C1 Natural	55–70
C2 Rural	55–70
C2T Rural Town	25–45
C3 Suburban	35–55
C4 Urban General	25–45
C5 Urban Center	25–35
C6 Urban Core	25–30

Source: FDOT. 2024. *2024 FDOT Design Manual.* See Table 201.5.1. Design Speed.

88 FDOT. 2020. *Context Classification Guide*. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/completestreets/files/fdot-context-classification.pdf, accessed February 23, 2024.

89 FHWA. 2017. "CSS Design Controls and Criteria." https://www.fhwa.dot.gov/planning/css/design/controls/factsheet3_ite.cfm, accessed February 13, 2024.

SPEED LIMIT SETTING POLICY: UTAH DOT

BACKGROUND

UDOT updated its policy on establishing speed limits on State highways (Policy 06C-25) in November 2023. The intent of the policy update was to "promote traveling at reasonable and consistent speeds to reduce the potential of severe and fatal crashes"[90] in line with UDOT's goal of zero fatalities. The policy was developed in accordance with the MUTCD and relevant State codes.

POLICY HIGHLIGHTS

The UDOT speed limit setting process uses roadway access to determine if using 85th-percentile speeds is necessary. For many access types, the appropriate speed is determined from within a given target speed range for the access type using the roadway environment, culture, and characteristics to determine where to set a speed limit within the range. UDOT speed limit setting procedures also include identification of speed management techniques when the recommended speed limit is more than 10 mph below the 85th-percentile speed. Speed management techniques may be identified where the recommended speed limit is 10 mph or less below the 85th-percentile speed.

DATA COLLECTION

In completing a speed study, UDOT requires six types of data:

- Spot speed data
- Five years of crash data
- Roadway access category designation
- Roadway environment
- Roadside development, culture, and friction
    - Pedestrian and bicycle activity and infrastructure, parking practices, other traffic
- Roadway characteristics and condition
    - Shoulder condition, grade, alignment, sight distance, horizontal and vertical curves[91]

While these data are like data collected under previous policies, UDOT's new policy encourages the engineer to approach field visits with additional considerations in mind, such as how land use impacts the roadway, whether the area is experiencing development and growth, and whether turning volumes are creating slowdowns or safety concerns.

90 UDOT. 2023. "06C-25 Establishment of Speed Limits on State Highways." (web page). https://drive.google.com/file/d/17HgtIMB81G8P3DreWCNa3Mro_RFGrl9X/view, accessed February 26, 2024.

91 UDOT. 2023. *UDOT Speed Study Guidelines*. Salt Lake City: UDOT. https://drive.google.com/file/d/1O3uAjPaQeec0O1Uy647iLuXi0ZtFR0J0/view?usp=sharing, accessed February 27. 2024.

POLICY

Figure 21 is a flowchart of the main policy provisions. For freeway and interstate facilities (defined as Access Category 1) as well as roadways in non-urban settings without other development, speed limits are established within 5 mph of the 85th-percentile speed. All other roads use roadway context to determine the posted speed limit within a recommended range, as defined by the road's access category.

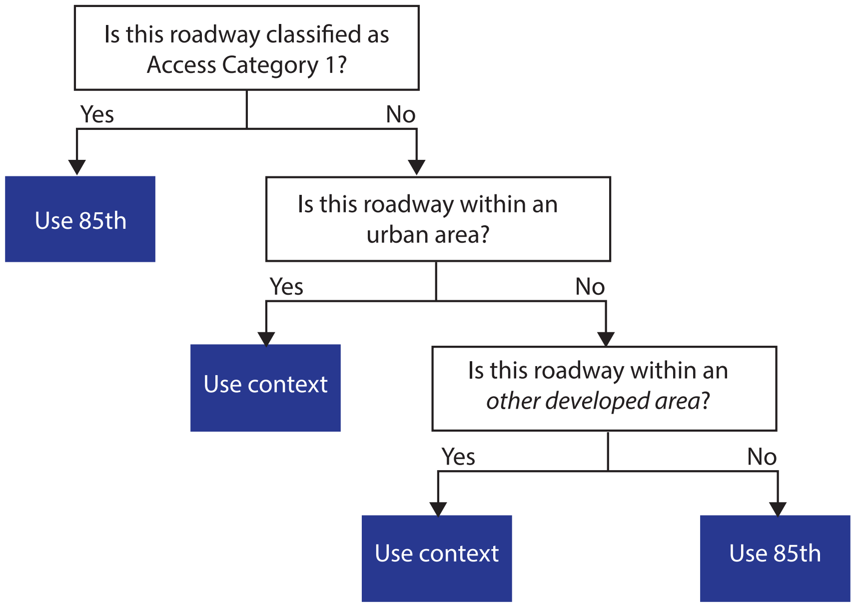


Figure 21. Utah Department of Transportation policy flowchart.

Access Categories

Utah Administrative Code 930-6-6(2) provides access categories as a means of grouping all sections of State highway. The 10 categories are based on functional classification, rural versus urban designation, roadway attributes and characteristics, among other considerations.[92]

Other Developed Areas

The UDOT policy defines "other developed areas" as non-urbanized areas that "include permanent residential dwellings and at least two other land uses in separate buildings that provide commercial, industrial, or public services for the community, surrounding area, or persons traveling through the area."[93] The UDOT speed study guidelines indicate that additional locations should generate a modest number of trips and that the two areas should be close to each other. Land uses such as churches, tourist attractions, and gas stations would meet the intent of the policy while farms and junk yards would not. The guidelines encourage the use of engineering judgment in designating an "other developed area."

92 UDOT. 2023. Administrative Code 930-6-6(2)(a)(iii). https://casetext.com/regulation/utah-administrative-code/transportation/title-r930-preconstruction/rule-r930-6-access-management/section-r930-6-6-access-control#:~:text=(iii)%20The%20number%2C%20spacing,the%20roadway%20for%20access%20management, accessed February 26, 2024.

93 UDOT. 2023. "06C-25 Establishment of Speed Limits on State Highways." https://drive.google.com/file/d/17HgtIMB81G8P3DreWCNa3Mro_RFGrl9X/view, accessed February 26, 2024.

SPEED LIMIT RANGES

Table 29 presents the recommended posted speed limit range for each access category. Note that access category 1 is not listed, as the posted speed limit for roadways in that access category are set according to the 85th-percentile speed.

Table 29. UDOT recommended posted speed limit ranges by access categories.

ACCESS CATEGORY	RECOMMENDED POSTED SPEED LIMIT RANGE (MPH)
2: System priority-rural importance	45–55
3: System priority-urban importance	35–50
4: Regional-rural importance	40–50
5: Regional priority-urban importance	35–45
6: Regional-urban importance	30–45
7: Community-rural importance	30–40
8: Community-urban importance	30–40
9: Other importance	15–30
10: Freeway one-way frontage road	35–55

Source: UDOT. 2023. "06C-25 Establishment of Speed Limits on State Highways." https://drive.google.com/file/d/17HgtIMB81G8P3DreWCNa3Mro_RFGrl9X/view, accessed February 26, 2024.

Context Considerations

For roadways in access categories 2–10 which are in urban or other developed areas, UDOT determines the recommended posted speed limit through consideration of:

- Reported crash experience
- Pedestrian and bicycle activity
- Onstreet parking utilization
- Observed speeds
- Roadway context, including roadside development, raised medians, side treatments, and lighting[94]

Table 30 shows the roadway conditions that can support decisions for setting the posted speed limit toward the lower or higher end of the recommended range for the access category.

Table 30. UDOT suggestions for speed limit setting based on current roadway conditions and access category.

SUGGESTS SETTING SPEED LIMIT AT LOWER END OF RANGE	SUGGESTS SETTING SPEED LIMIT AT HIGHER END OF RANGE
History of pedestrian, bicycle, or severe speed-related crashes; frequent pedestrian or bicycle activity; frequent parking activity; slower observed speeds; or curves or other conditions that provide limited sight distances	No history of pedestrian, bicycle, or severe speed-related crashes; limited pedestrian or bicycle activity; no or infrequently used onstreet parking; faster observed speeds; and adequate geometry

Source: UDOT. 2023. "06C-25 Establishment of Speed Limits on State Highways." https://drive.google.com/file/d/17HgtIMB81G8P3DreWCNa3Mro_RFGrl9X/view, accessed February 26, 2024.

94 UDOT. 2023. "06C-25 Establishment of Speed Limits on State Highways." https://drive.google.com/file/d/17HgtIMB81G8P3DreWCNa3Mro_RFGrl9X/view, accessed February 26, 2024.

SPEED MANAGEMENT TECHNIQUES

Under UDOT's policy for establishing speed limits, recommended speed limits can be lower than 85th-percentile speeds. Recognizing the concerns of posted speed limits deviating substantially from measured travel speeds, UDOT policy is to consider speed management techniques when the recommended speed limit is greater than 10 mph below the 85th-percentile speed. UDOT recognizes speed management is also appropriate when the 85th-percentile speed is 5–10 mph above the recommended speed limit and in some cases where the 85th-percentile speed is less than 5 mph above the recommended speed limit.[95]

These strategies, used in isolation or combination, modify the roadway environment with a goal of reducing driver's comfortable traveling speed. Example speed management techniques include landscaping, roundabouts, radar speed signs, and wider striping. Strategies range in cost as well as in the travel speeds, volumes, and number of lanes over which they provide impact.

Figure 22 shows an example of a speed management info sheet provided by UDOT.

Figure 22. Utah Department of Transportation curb extension info sheet.

95 UDOT. 2023. "Speed Management Info Sheets." https://drive.google.com/file/d/1n4NBMyx6nxL6ZnKPJxdUu5mNp7m1VCo5/view, accessed February 26, 2024.

Appendix B. Speed-Related Terminology

This appendix defines speed-related terminology used within this resource as well as other complementary speed limit terms that may be useful for the practitioner.

50th-percentile speed. The 50th-percentile speed is the speed at or below which 50 percent of vehicles travel. (i.e., the observed speed that 50 percent of vehicles do not exceed).

85th-percentile speed. The 85th-percentile speed is the speed at or below which 85 percent of vehicles travel (i.e., the observed speed that 85 percent of vehicles do not exceed).

Absolute speed limit. States may have laws relating to absolute speed limits. An absolute speed limit is a limit above which it is unlawful to drive regardless of roadway conditions, the amount of traffic, or other influencing factors.

Advisory speed. Advisory speeds are recommended speeds for all vehicles operating on a section of highway based on highway design, operating characteristics, and conditions.[96] Agencies use advisory speeds on short sections of roadway where the physical conditions of the roadway restrict safe operating speed to something lower than the speed limit (e.g., horizontal curves, intersections, or steep grades). Advisory speeds are typically used because the feature that dictates the lower speed is isolated, and it is not feasible or desirable to adjust the speed limit for a short section of road. Advisory speeds are posted with warning signs and are not required to be met.

Design speed. Design speed is the selected speed used to determine the various geometric design features of the roadway. It is the value used for engineering calculations that affects the geometric design of a roadway.

Minimum speed limits. Minimum speed limits are justified when studies show that slow-moving vehicles on any part of a highway consistently impede the normal and reasonable movement of traffic to such an extent that they contribute to unnecessary lane changing or passing maneuvers.

Nighttime speed limits. Speed limits are typically determined and posted on the basis of daylight speed values determined under good weather conditions. However, it may be beneficial to post different day and night speed limits where it can be shown to be necessary by an engineering study. Nighttime speed limits generally begin 30 minutes after sunset and end 30 minutes before sunrise, although this may vary by jurisdiction. Nighttime speed limits are generally established on roads where safety problems require a speed lower than what is prescribed by the daytime limit and the operating speed that is self-selected by drivers. Examples of roads that might require nighttime speed limits are non-illuminated roads with relatively high operating speeds and an overrepresentation of nighttime crashes and roads crossing the routes and movement patterns of large-sized, nocturnal wildlife.

96 FHWA. 2023. MUTCD, 11th ed, §1C.01.03. Washington, DC: FHWA.

Non-statutory speed limit. Non-statutory speed limits are established based upon an engineering study. Where statutory speed limits do not fit specific road design, traffic, road user, or land-use conditions, most road authorities have the power (enabled by statutes or ordinances) to establish non-statutory speed limits to reflect the safe maximum reasonable speed. Non-statutory speed limits may be higher or lower than statutory speed limits.

Operating speed. Operating speed is the speed at which vehicles are observed operating during free-flow conditions. Free-flow conditions occur when vehicles are unimpeded by other vehicles or by traffic control devices such as traffic signals.

***Prima facie* speed limit.** States may have laws relating to *prima faci*e speed limits. A *prima facie* speed limit is one above which drivers are presumed to be driving unlawfully but, if charged with a violation, they may contend that their speed was safe for conditions existing on the roadway at that time.

School zone speed limits. School zone speed limits are reduced speed limits for school zones during the hours when children are going to and from school. Reduced speed limits are appropriate near schools because of the vulnerability of children in high-speed crashes. Typically, the speed limit for school zones is established by State statute. Where they are not established by statute, practitioners should conduct an engineering study to determine whether a reduced speed limit is warranted. Examples of factors to consider may include the following:

- Children walking or bicycling along or crossing the roadway
- Location of children in relation to motorized traffic
- Number and size of gaps in traffic for school-age pedestrians to cross the street
- Existing traffic control
- Presence of crosswalks
- Presence of crossing guards
- Average pedestrian demand per appropriate gap
- Location of school property
- Presence of fencing around school property
- Presence of sidewalks
- Type and volume of vehicular traffic

Seasonal speed limits. A seasonal or holiday speed limit applies for a specified period or periods during a year, generally at locations with significantly different levels of roadside activity at different times. For example, a beach resort that is popular in summer, but only sparsely populated for the remainder of the year, may have a lower speed limit during the summertime. In these instances, traffic volume and level of activity of the surrounding area should be considered in setting a speed limit. Weather during certain times of the year may also impact speed limits in some locations, especially during the winter season when ice and snow may be present.

Self-enforcing roadway. Self-enforcing roadways are those that are planned and designed to encourage drivers to select operating speeds consistent with the speed limit.

Speed distribution. Speed distribution is the arrangement of speed values showing their observed frequency of occurrence. The speed distribution includes the mean, 50th-percentile, and 85th-percentile speeds that are important statistical terms for assessing speed limits.

Speed limit. Speed limit is the maximum lawful vehicle speed for a particular location. It is the legally enforceable speed drivers must follow. Speed limits can be posted through MUTCD-compliant signing (i.e., non-statutory speed limits), or can be statutory to apply to a general area (e.g., citywide speed limit).

Speed management. Speed management is the use of engineering, enforcement, education, or a combination of the three to encourage drivers to travel at the target speed.

Statutory speed limit. Statutory speed limits are maximum speed limits established by State legislatures. These speed limits apply to various road classifications (e.g., interstates, freeways, and expressways; two-lane undivided highways; rural highways; urban streets), land use (urban or rural), and special situations such as school zones. Statutory speed limits are enforceable by law, can vary by jurisdiction, and apply even in the absence of speed limit signs.

Target speed. Target speed is the highest operating speed at which vehicles should operate on a roadway in a specific context.

Transition zone speed limits. Transition zone speed limits are generally considered when there is a speed reduction of more than 25 mph between adjacent zones. They may be considered at other locations if an assessment has determined that a transition zone speed limit may improve safety or traffic operations. In situations where rural roads approach and continue through urban areas and villages, there may be a need for a commensurate reduction in the speed limit that reflects the change in the roadway, roadside context, and roadway users. In many instances these speed transitions can be sizable, and an intermediate or transition zone speed limit is needed to direct drivers to reduce speeds. The following factors may be considered in determining the need for a transition zone speed limit:

- Roadway operating speeds in advance of speed reduction
- Existing operational and safety issues
- History of aggressive braking at the entrance to the reduced speed limit area
- Low speed-limit compliance in the lower speed-limit area

Truck speed limits. Speed limits are typically determined and posted on the basis of all motorized traffic. It may be desirable for trucks and other heavy commercial vehicles to have different (i.e., lower) maximum speeds than passenger cars. The need for a lower speed limit for trucks is primarily demonstrated by an engineering study considering factors such as the magnitude and length of roadway grades and horizontal curvature.

Variable speed limits. Variable speed limits (VSLs), an FHWA Proven Safety Countermeasure, are speed limits that adapt to changing circumstances using changeable signs. VSLs use prevailing information on the roadway, such as traffic speed, volumes, weather, and road surface conditions, to determine appropriate speeds and display them to drivers.[97] VSLs may be implemented as a regulatory or an advisory system. Agencies can implement VSLs to mitigate crash risk arising from congestion, incidents, work zones, and inclement weather. The speed limit that is to be posted depends on the purpose for installing VSLs. In cases where congestion or post-incident management are the impetus for use, the recommended speed limit for the condition is generally a function of the average speed of traffic and reflects an attempt to minimize speed differentials in the traffic stream. Weather-related VSLs are often determined by an algorithm that uses data gathered from road weather monitoring stations.

Work zone speed limits. Work zone speed limits vary depending on the location of the work activities in relation to the travel way. Work zone speed limits are dependent upon the potential hazard present or the actual conditions within the work zone. Work zone speed limit signs are erected only for the limits of the section of roadway where speed reduction is necessary for the safe operation of traffic and the protection of construction personnel. The FHWA Work Zone Management Program website provides information on planning, designing, and implementing safer, more efficient, and less congested work zones.[98]

97 FHWA. 2021. "Proven Safety Countermeasures: Variable Speed Limits," FHWA-SA-21-054. https://safety.fhwa.dot.gov/provencountermeasures/variable-speed-limits.cfm, accessed May 30, 2023.

98 FHWA. n.d. "Work Zone Management Program." (web page). https://ops.fhwa.dot.gov/wz/, accessed December 19, 2024.

State of Florida Department of Transportation

Form 750-010-03
TRAFFIC ENGINEERING
March 2020

VEHICLE SPOT SPEED STUDY

General Information		Site Information	
Analyst/Observer:		Location:	
Agency or Company:		City:	County:
Date Performed:		Roadway ID:	
Time Period From:	To:	Milepost:	Posted Speed (mph):
Weather/Road Condition:		Remarks:	

Vehicles traveling	bound					Speed (mph)	Vehicles traveling	bound					Both Directions	
Cum Total	Total	20	15	10	5		5	10	15	20	Total	Cum Total	Total	Cum Total
						≥ 80								
						78 - 79.9								
						76 - 77.9								
						74 - 75.9								
						72 - 73.9								
						70 - 71.9								
						68 - 69.9								
						66 - 67.9								
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						30 - 31.9								
						28 - 29.9								
						26 - 27.9								
						24 - 25.9								
						22 - 23.9								
						20 - 21.9								
						18 - 19.9								
						16 - 17.9								
						14 - 15.9								
						12 - 13.9								
						10 - 11.9								
						≤ 10								
						TOTALS								

Travel Direction 1 →		Speed Data Summary		← Travel Direction 2	Both Directions
		85^{th} Percentile Vehicle		85^{th} Percentile Vehicle	
		85^{th} Percentile Speed		85^{th} Percentile Speed	
		50^{th} Percentile Vehicle		50^{th} Percentile Vehicle	
		50^{th} Percentile Speed		50^{th} Percentile Speed	
		10 mph pace		10 mph pace	

Source: FDOT.

Figure 23. Florida Department of Transportation vehicle spot speed study form.

VEHICLE SPOT SPEED STUDY

General Information		Location Information			
Analyst/Observer		Location			
Agency or Company		City		County	
Data Collection Date		Roadway ID		Posted Speed	
Time Period from		Mile post		Target Speed	
Weather/Road Condition		Study Purpose			
Roadway Environment					
Functional Classification					
AADT		Truck Volume			
Public Transit		Access Management			
Bicycle Activity		Pedestrian Activity			
Bicycle Facilities		Both Sides?		Width?	
Pedestrian Facilities		Both Sides?		Width?	
Curbside Activity (ex. Parking)					
Roadway Characteristics					
Segment Length		Number of Lanes			
Max Lane Width		Min Lane Width			
Pavement Type		Pavement Quality			
Inside Shoulder Width		Ousdie Shoulder Width			
Shoulder Type		Curbing			
Clear Zone		Barrier Protection			
Median Type		Width			
Horizontal Curves		Vertical Curves			
Vertical Grade		Sight Distance Restrictions?			
Number of Signals		Pedestrian Crossings			
Emergency Signals		Railraod Crossings			
Street Lighting					
Geographic Context					
Roadway Context		Recommended Range			
Crash Experience					
Years of Data		From		To	
Total Crashes (KABCO)		Bicycle/Pedestrian Crashes (KABCO)			
Total KABC Crashed		KABC Bicycle/Pedestrian Crashes			
Percent KABC		Percent KABC			
Notes					

VEHICLE SPOT SPEED STUDY					
Speed Distribution of Free Flowing Vehicles*					
Maximum Recorded Speed			Minimum Recorded Speed		
85th Percentile Speed			50th Percentile Speed		
10 mph Pace			Percent of vehicles in Pace		
Percent of vehicles at or under POSTED speed			Percent of vehicles at or under TARGET speed		
*see data collection page for collection notes					
Operating Speed Trends					
Speed Study 1 | Year	Month		Posted Speed		mph
Maximum Recorded Speed		mph	Minimum Recorded Speed		mph
85th Percentile Speed		mph	50th Percentile Speed		mph
10 mph Pace	to	mph	Percent of vehicles in Pace		
Speed Study 2 | Year	Month		Posted Speed		mph
Maximum Recorded Speed		mph	Minimum Recorded Speed		mph
85th Percentile Speed		mph	50th Percentile Speed		mph
10 mph Pace	to	mph	Percent of vehicles in Pace		
Speed Study 3 | Year	Month		Posted Speed		mph
Maximum Recorded Speed		mph	Minimum Recorded Speed		mph
85th Percentile Speed		mph	50th Percentile Speed		mph
10 mph Pace	to	mph	Percent of vehicles in Pace		
Speed Study 4 | Year	Month		Posted Speed		mph
Maximum Recorded Speed		mph	Minimum Recorded Speed		mph
85th Percentile Speed		mph	50th Percentile Speed		mph
10 mph Pace	to	mph	Percent of vehicles in Pace		
Speed Study 5 | Year	Month		Posted Speed		mph
Maximum Recorded Speed		mph	Minimum Recorded Speed		mph
85th Percentile Speed		mph	50th Percentile Speed		mph
10 mph Pace	to	mph	Percent of vehicles in Pace		

Source: FHWA.

Figure 24. Blank vehicle spot speed study form.

U.S. Department of Transportation

Federal Highway Administration

Office of Safety

1200 New Jersey Avenue, SE

Washington, DC 20590

https://highways.dot.gov/safety

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