Design Speed and Beyond

Concepts, Principles, and Practices

Engineering for Speed Management: *A new challenge for designers*

2013-2014 MnDOT Context Sensitive Solutions events

Webinar

December 18, 2013

Welcome and Introduction

- Online participants are encouraged to add to the discussion by using the interactive chat.
- Submit comments and questions via chat at any time during the webinar by clicking on the gold box in the upper left corner of your screen. This will take you to the chat page.
- Sign in by creating a Chatroll account, or sign in using your Facebook or Twitter account.
- Next webinar: “So You Want to Build a Cross Section”, February 18, 2014, 2-4pm Central. For more information visit www.cts.umn.edu/contextsensitive/workshops/.

Today's Panel

Nathan Drews, MnDOT Traffic Safety
Derek Leuer, MnDOT Traffic Safety
Jack Broz, Avenue Design Partners
Jim Rosenow, MnDOT Flexible Design

Disclaimer

What you're about to see and hear is not entirely reflected in current Minnesota Department of Transportation design policy...yet.

Opening Thought

massDOT, Highway Division:

"Design speed is a choice."

Opening Discussion

What are we talking about?

Which speed do we mean?

- Speeding
- Design Speed
- Posted Speed
- Enforced Speed
- Operating Speed
- Running Speed
- 85th Percentile
- Target Operating Speed
- High Speed
- Low Speed
- Minnesota Statutory Speed
- Minnesota Statutory Speed with on-street Bicycling

Questions

- Is speeding a problem on any projects?
- Is speeding identified in the project's problem statement?
- Does Speed = Safety?

Question

- How can we manage traffic speeds during the off-peak periods?
  - Peak Period design results in roads that are overbuilt for the remainder of the day, week and year. Multi-modal needs for corridors require an off-peak management of speeds.

Mobility vs. Speed

- Speed: Measurement of how fast you are moving

- Mobility: Measuring if you are moving
  - Travel: Movement from point A to point B, (such as a trip to work)
  - Circulating: Movement around a community (stopping for gas, banking and groceries)
  - Access: Movement into a destination (You park, get off the bus or park your bicycle and walk into your destination)

Market Street: San Francisco, 1906

Speed this and speed that

Speed Engineering

What the Law Requires

Statutes 169.14

Driver's Duty

Prima Facie

- Special Provisions

Engineering and Traffic Investigation

Engineering and Traffic Investigation

Operating Speed

Roadway Design (Not Design Speed)

- Crash Experience

Authorization by the Commissioner

Speed Terms

Operating Speed –	The speed where 85% of traffic is driving at or below
Posted Speed –	The maximum lawful speed of the road (enforceable)
Design Speed –	The speed for selecting engineering elements and components
Target Speed –	The operating speed that is desired
Speeding –	A behavior that is difficult (or impossible) to control with engineering design

Speed Posting Law, Policy & Practice

Statutory speeds (MSA 169.14, Subd. 2):

1. Where no special hazard exists, the following speeds shall be lawful…
   a. 30 mph in an urban district
   b. 65 mph on non-Interstate freeways and expressways
   c. 55 mph in locations other than those specified in this section
   d. 70 mph on rural Interstate highways
   e. 65 mph on Interstate highways within 50,000-polulation cities
   f. 10 mph in alleys
   g. 25 mph on residential roadways if adopted by the jurisdiction
   h. 35 mph in a rural residential district if adopted by the jurisdiction

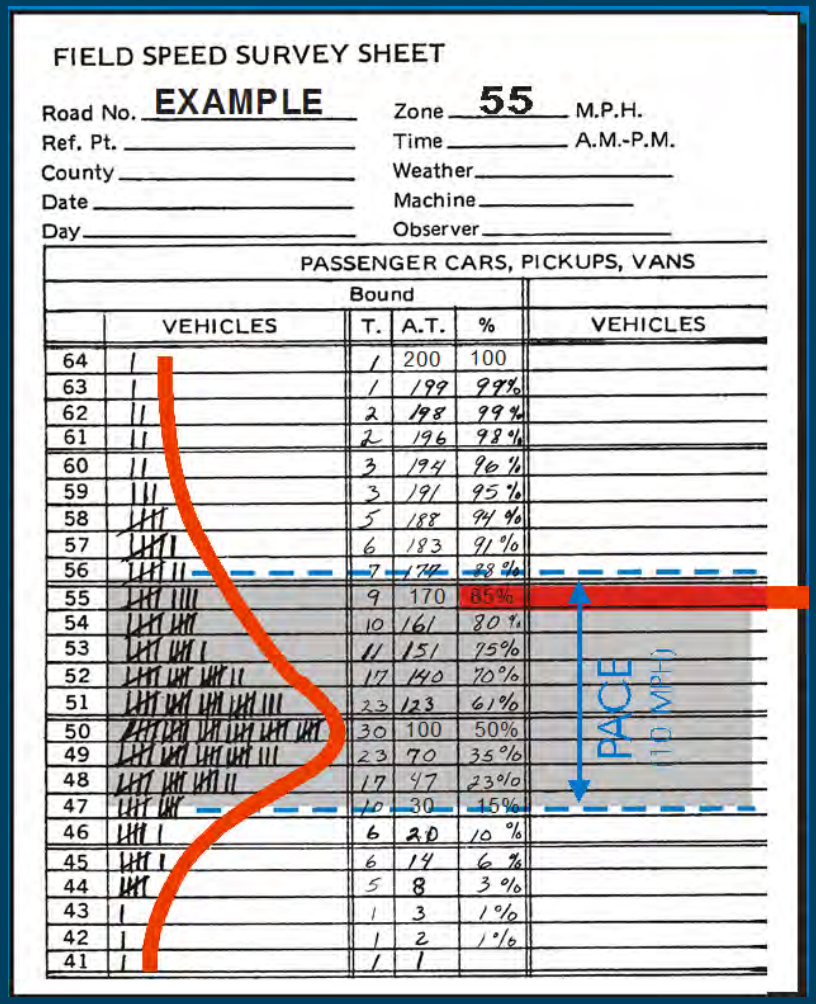
Speed Posting Law, Policy & Practice

MnDOT Traffic Engineering Manual, Sec. 13-6

"Alteration of the statutory speed limits to fit existing traffic and physical conditions of the highway constitutes the basic principle of speed zoning. The objective of correct speed zoning is to influence as many drivers as possible to operate at or near the same speed, thus reducing conflicts created by wide differentials in speed."

Operating Speed

85th Percentile and 10 MPH Pace Pack



FIELD SPEED SURVEY SHEET

Road No. EXAMPLE Zone 55 M.P.H.
Ref. Pt. _____ Time _____ A.M.-P.M.
County _____ Weather _____
Date _____ Machine _____
Day _____ Observer _____

PASSENGER CARS, PICKUPS, VANS

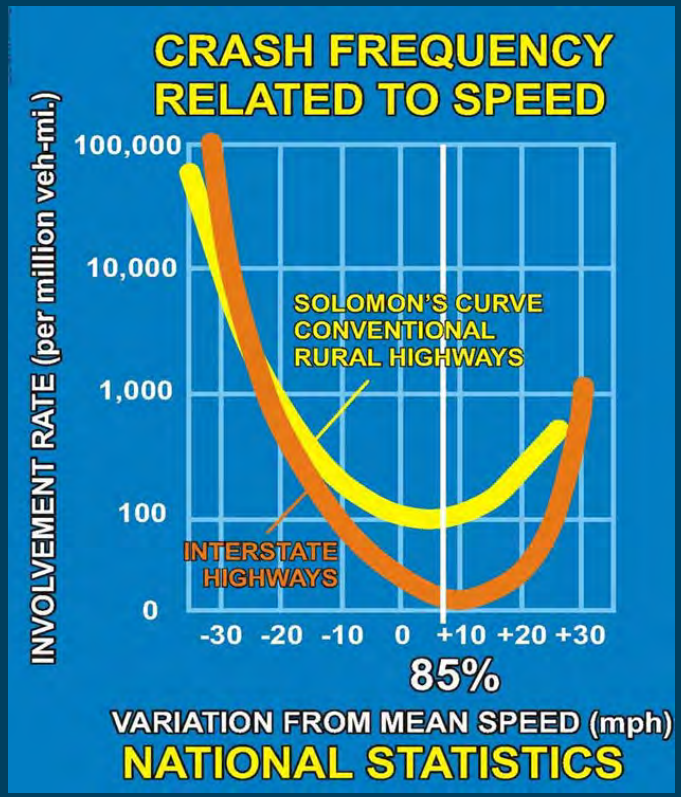
Bound

	VEHICLES	T.	A.T.	%	VEHICLES
64	I	1	200	100	
63	I	1	199	99%	
62	II	2	198	99%	
61	II	2	196	98%	
60	II	3	194	96%	
59	III	3	191	95%	
58	IIII	5	188	94%	
57	IIII I	6	183	91%	
56	IIII II	7	177	88%	
55	IIII IIII	9	170	85%	
54	IIII IIII	10	161	80%	
53	IIII IIII I	11	151	75%	
52	IIII IIII IIII II	17	140	70%	
51	IIII IIII IIII IIII III	23	123	61%	
50	IIII IIII IIII IIII IIII IIII	30	100	50%	
49	IIII IIII IIII IIII III	23	70	35%	
48	IIII IIII IIII II	17	47	23%	
47	IIII IIII	10	30	15%	
46	IIII I	6	20	10%	
45	IIII I	6	14	6%	
44	IIII	5	8	3%	
43	I	1	3	1%	
42	I	1	2	1%	
41	I	1	1		

PACE (10 MPH)

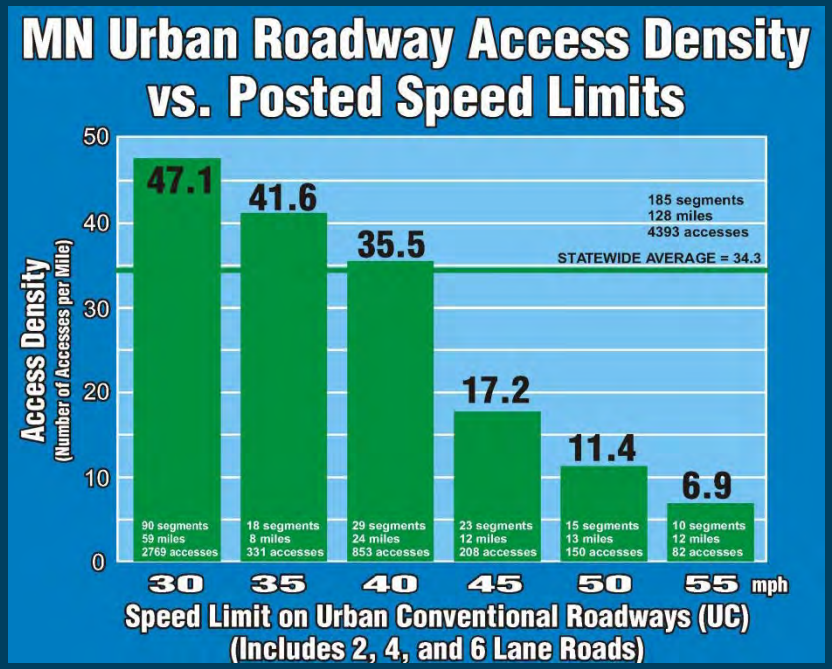
Operating Speed and Traffic Safety

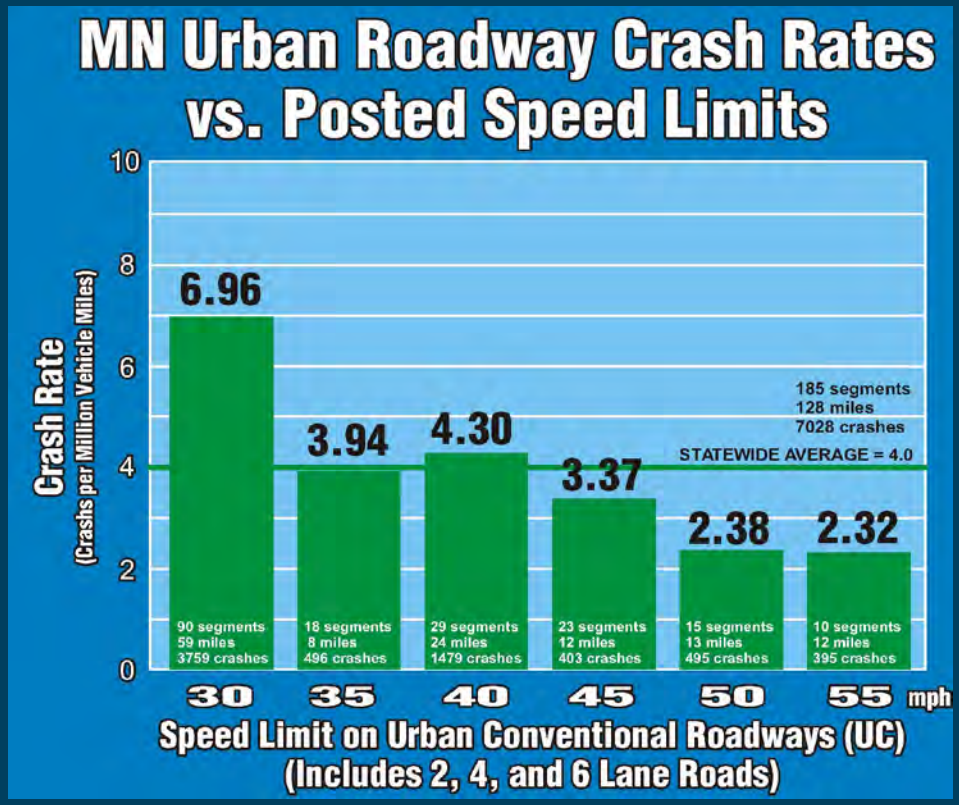
Speed vs. Safety



Operating Speed and Traffic Safety

Speed vs. Safety





Posted versus Operating Speed

Study Location	Before	After	Sign Change (MPH)	85% MPH Before	85% MPH After	Traffic Change (MPH)
MN 65	SPEED LIMIT 40	SPEED LIMIT 30	-10	34	34	0
MN 65	SPEED LIMIT 50	SPEED LIMIT 40	-10	44	45	+1
US 169 (Extra Enforcement)	SPEED LIMIT 40	SPEED LIMIT 30	-10	41	40	-1
Anoka CSAH 1	SPEED LIMIT 45	SPEED LIMIT 40	-5	48	50	+2
Anoka CSAH 24	SPEED LIMIT 30	SPEED LIMIT 45	+15	49	50	+1
Anoka CR 51	SPEED LIMIT 40	SPEED LIMIT 45	+5	45	46	+1

?

Study Location	Before	After	Sign Change (MPH)	85% MPH Before	85% MPH After	Traffic Change (MPH)
Hennepin CSAH 4	SPEED LIMIT 50	SPEED LIMIT 40	-10	52	51	-1
Nobles Ave	SPEED LIMIT 30	SPEED LIMIT 35	+5	37	40	+3
62nd Ave N	SPEED LIMIT 35	SPEED LIMIT 30	-5	37	37	0
Miss. St	SPEED LIMIT 30	SPEED LIMIT 35	+5	39	40	+1
Vicksburg Ln (Extra Enforcement)	SPEED LIMIT 50	SPEED LIMIT 45	-5	52	51	-1

“Grading Your Project”

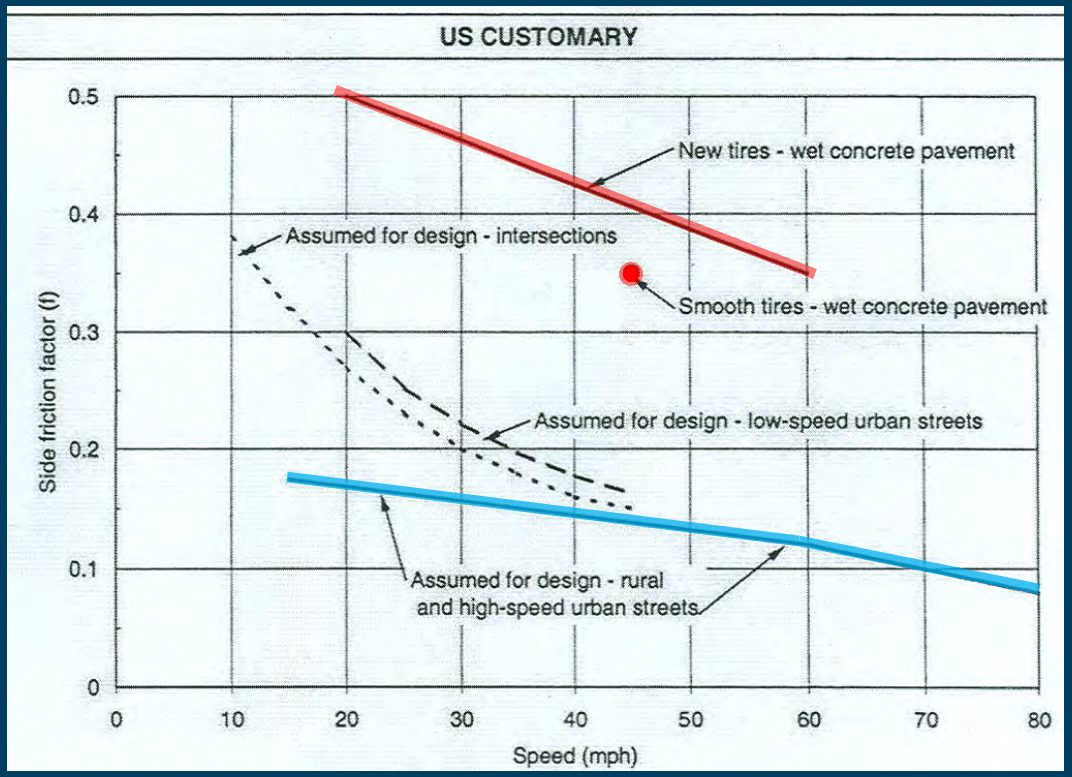
As a State, and as a Nation, the way we have generally designed roadway facilities to influence driver speed and behavior to act as we intend has not been entirely successful.

Roundtable


Guide for the Planning, Design, and Operation of Pedestrian Facilities
A Policy on Geometric Design of Highways and Streets
2011
ROAD DESIGN
ENGLISH MANUAL
PART I & Part II
HIGHWAY SAFETY MANUAL
1st Edition
HSM
AASHTO
HCM2010
HIGHWAY CAPACITY MANUAL
TRB

Design element attributes

Horizontal Curvature



Maximum side friction factor

- Provides ample margin of safety against skidding

Design element attributes

Stopping Sight Distance

Component	Percentile
Perception-reaction time	90th to 95th
Deceleration rate	90th
Eye height	90th
Taillight height	90th

Multiplicative total = 99.99%

Design element attributes

Stopping Sight Distance

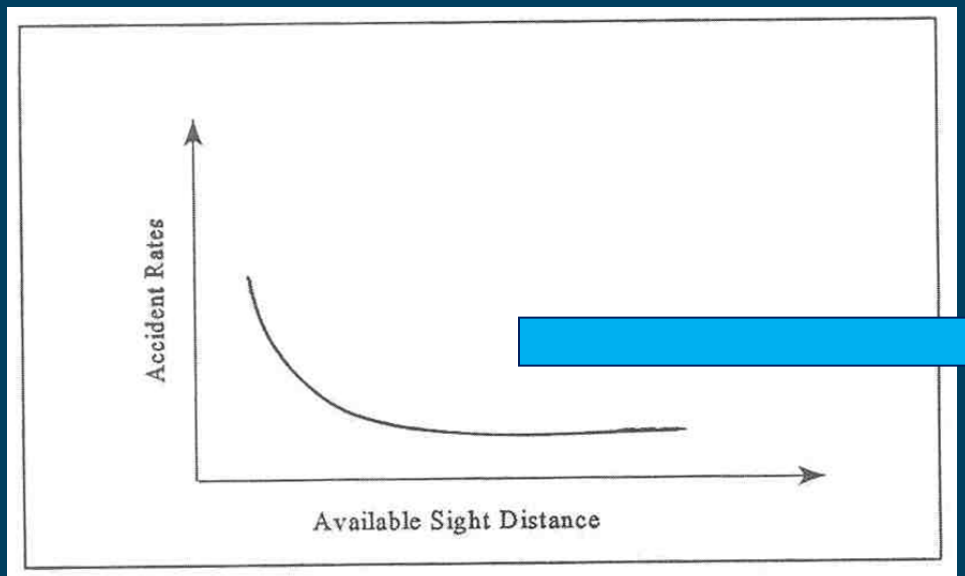


Figure 4. Conceptual Relationship Between Available Sight Distance and Safety at Crest Vertical Curves

Roundtable


Guide for the Planning, Design, and Operation of Pedestrian Facilities
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TRB

Let's get real

Relationship of design speed to reality

Research on Design Speed Issues

- Sought correlation between Design Speed, Operating Speed and Posted Speed
- Provides equations to assist in predicting operating speeds
- Makes recommendations for best practice for selecting Design Speed

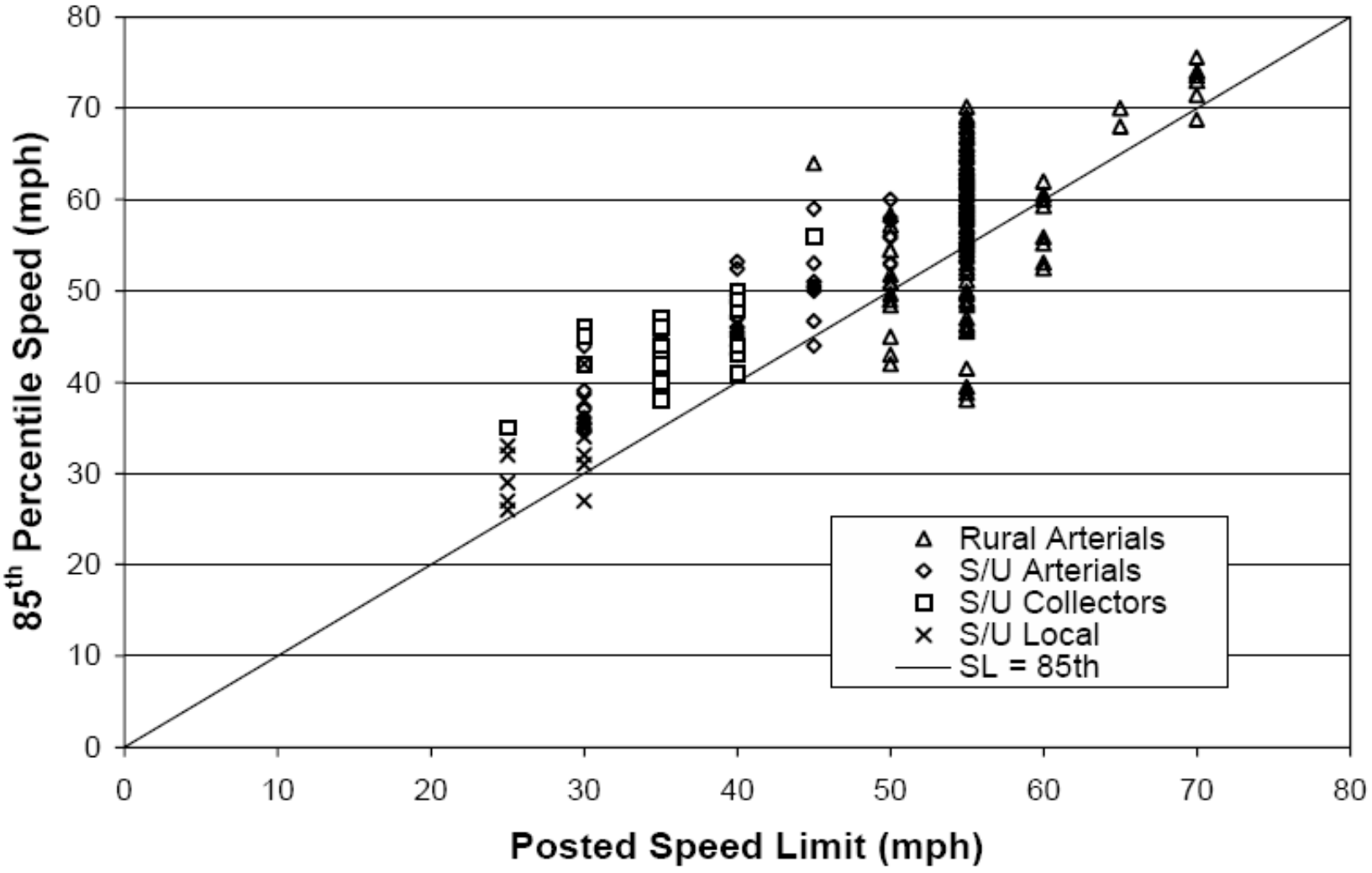


Figure 6. 85th percentile speed versus posted speed for NCHRP, Texas, and FHWA data.

Source: NCHRP Report 504

Suburban/ Urban Speeds

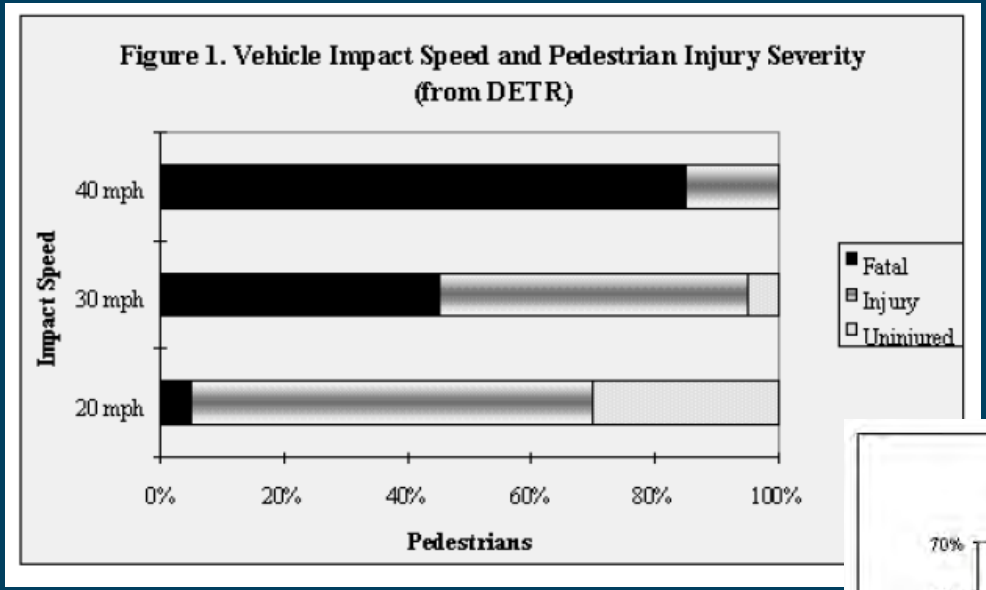
Table 24 Percentile speed that equals posted speed by area type and posted speed

How do you select Design Speed?

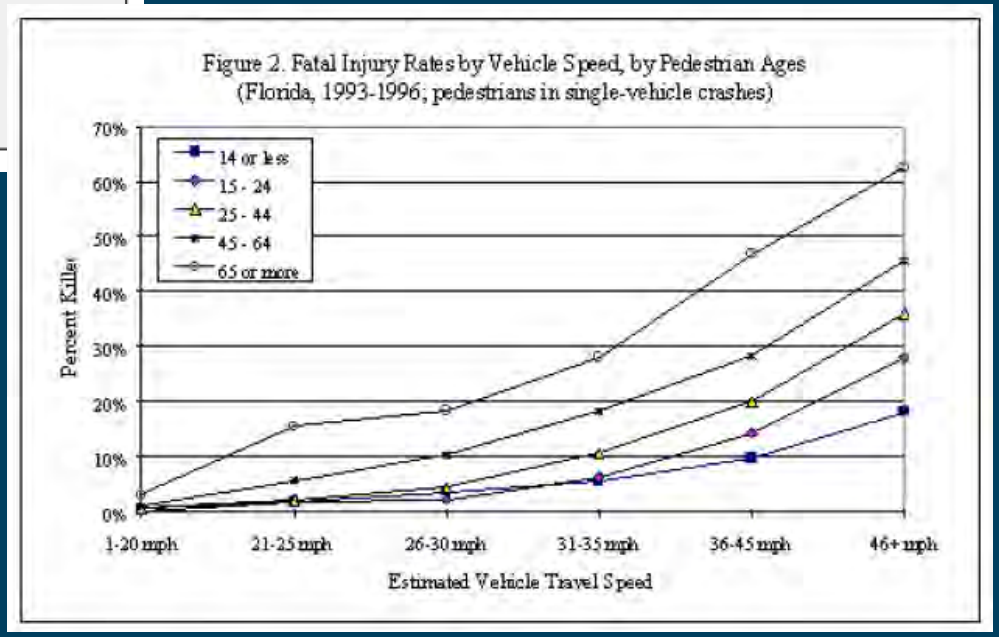
Area Type	Speed Limit (mph)	Percentile at or below Given Speed*.			Number of Sites
		Speed Limit	Speed Limit Plus 5 mph	Speed Limit Plus 10 mph	
Suburban/ Urban	25	42	77	94	7
	30	28	64	86	19
	35	22	62	90	23
	40	32	68	92	25
	45	37	70	90	15
	50	43	76	95	9
	55	48	80	95	6

Source: NCHRP Report 504

Vehicle Speeds and Pedestrians



UK: Department of Environment, Transport, and the Regions, (DETR)



Florida, 1993-1996; pedestrians in single-vehicle crashes

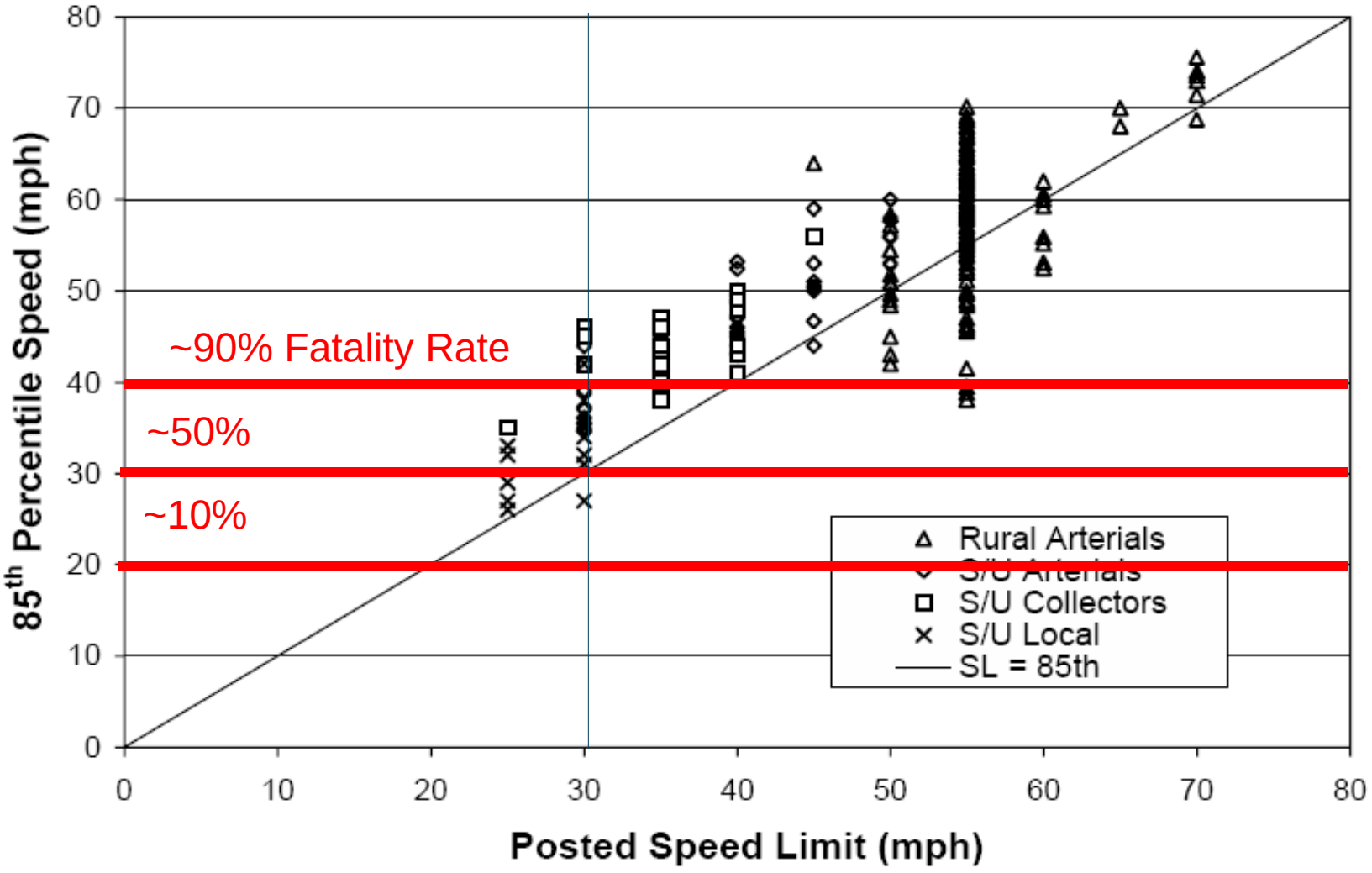


Figure 6. 85th percentile speed versus posted speed for NCHRP, Texas, and FHWA data.

Source: NCHRP Report 504

Ingersoll Avenue: After Restriping

Ingersoll Avenue: Speed and Travel Times (WB)

		Avg. Speed	Delay	Travel Time
AM	Before	25.4	36	213
	After	24.8	41	220
	Change	**-2%**	**14%**	**3%**
Noon	Before	22.9	56	238
	After	22.9	57	236
	Change	**0%**	**2%**	**-1%**
PM	Before	23.8	49	227
	After	21.9	69	247
	Change	**-8%**	**41%**	**9%**

Ingersoll Avenue: Crash History

Ingersoll Avenue - ML King to Polk Blvd		
Reported Crash History		
Time Period	May-August Crashes	Total Annual Crashes*
Total Crashes		
2005-2009 Average	21	49
2010	9	21*
No. Injuries		
2005-2009 Average	10	22
2010	4	9*

* Calculated number based on 2005-2009 percentages

Example: Excelsior Blvd.

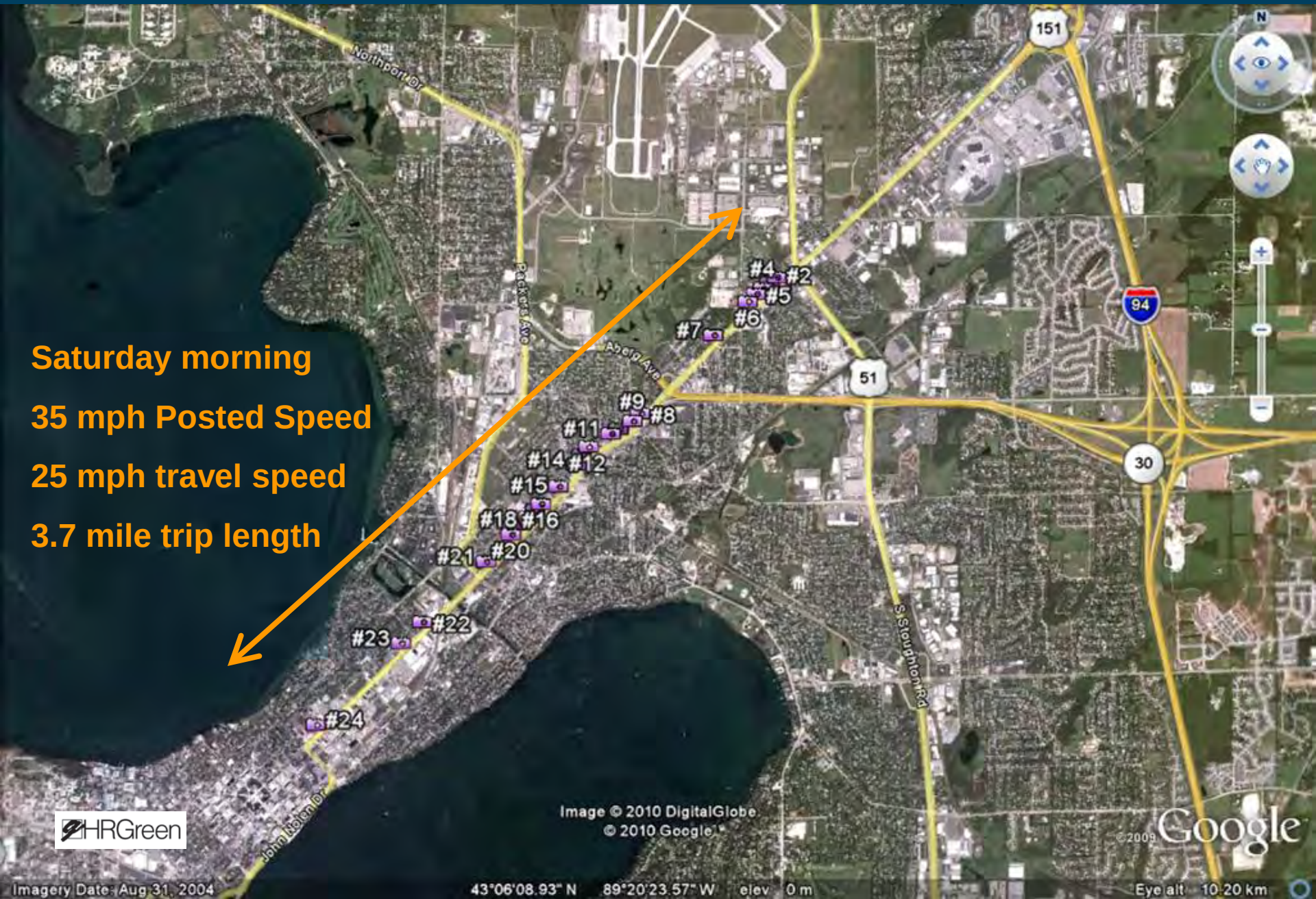
- 11 foot lanes – no shoulders
- 35 mph
- Turn lanes store 2 vehicles
- Tapers 10:1 on turn lanes; 5:1 for parking bays
- Crash reduction over 55%

Example: Excelsior Blvd.

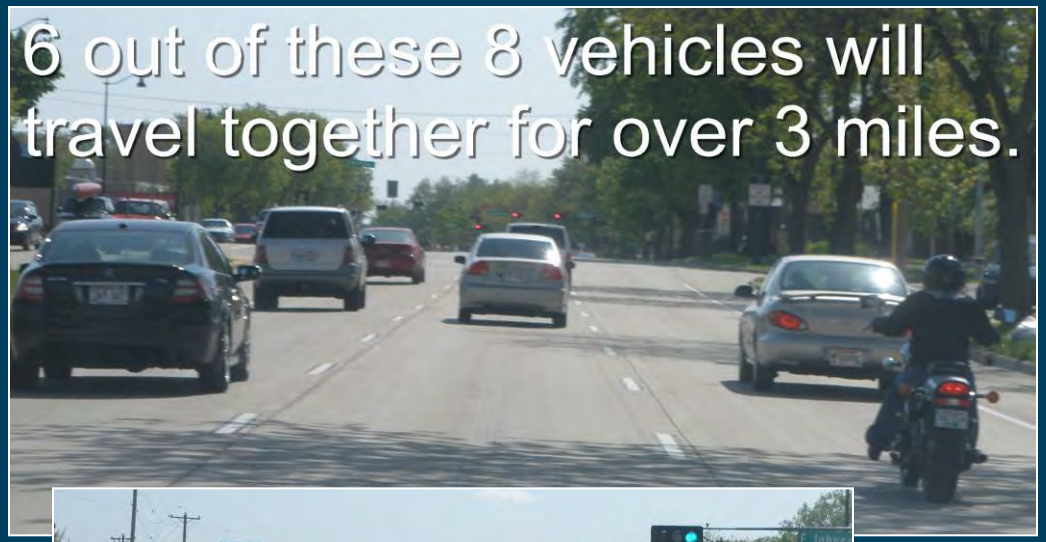
- CSD elements that needed to be strengthened:
  - "that the travel lanes are wider than necessary on Excelsior Blvd contributing to higher travel speeds than desirable or posted (posted at 35 mph) … while speeds were technically slowed in the study location and to the east (speeds and travel-way width increased to the west), the overall street is designed for a higher speed operation than is necessary".

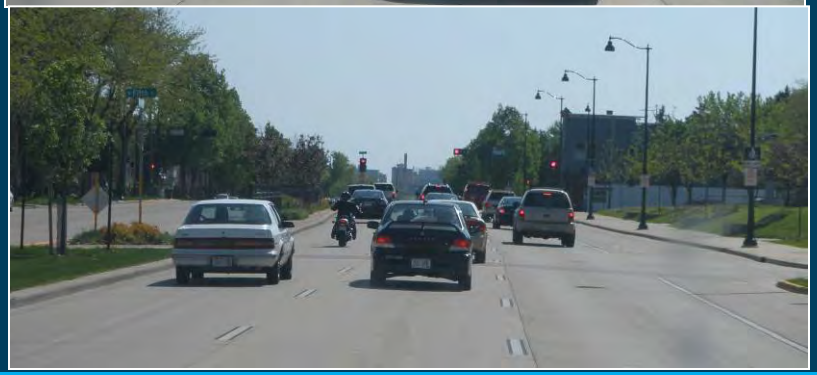
From ITE publication
Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities

Case Study: US 151, WI

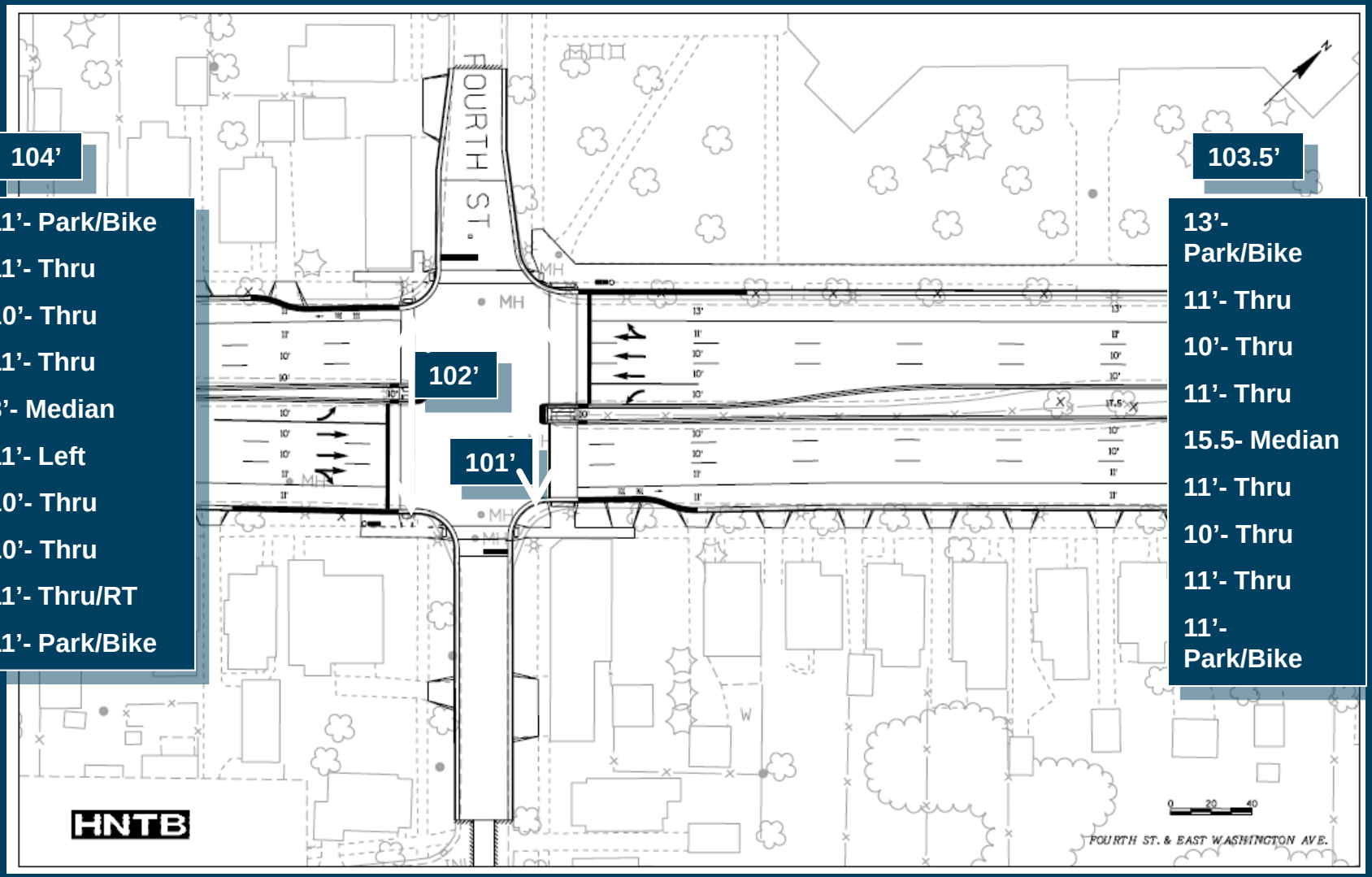


6 out of these 8 vehicles will travel together for over 3 miles.





Case Study: US 151, Madison WI

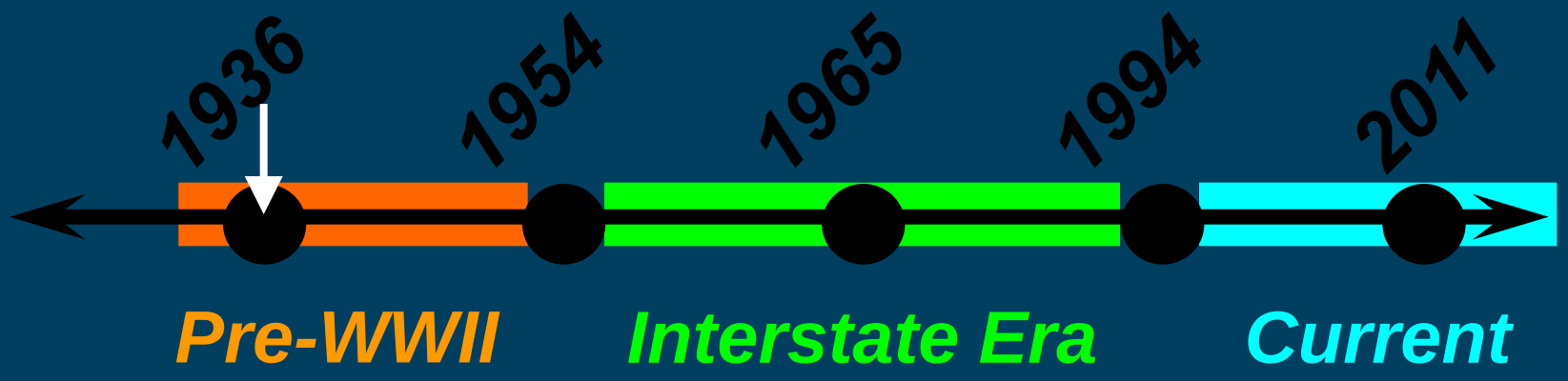


Case Study: US 151, WI

What does the Green Book (or the RDM) say?

…and how did we get to where we are now?

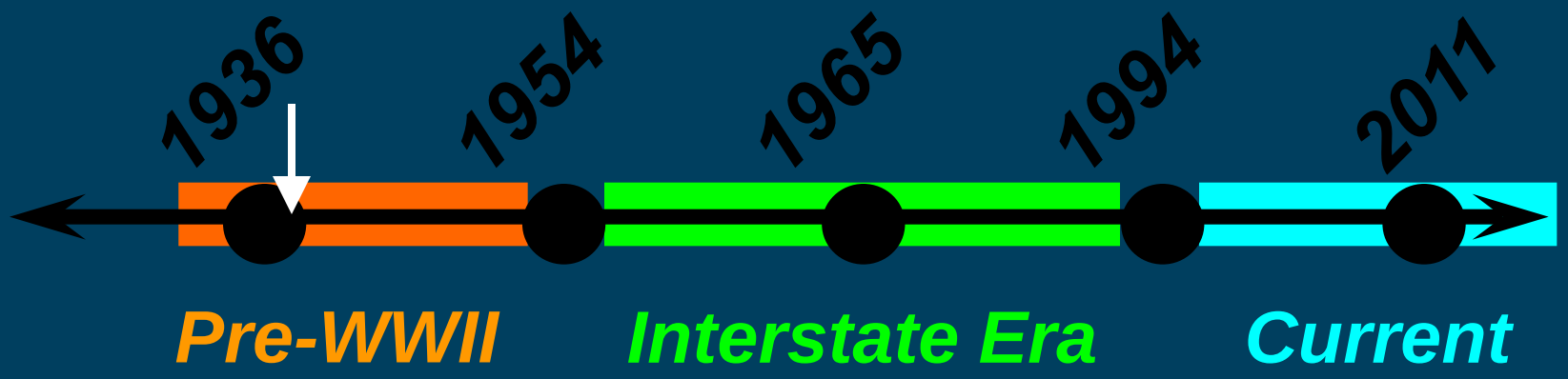
Evolution of Design Speed



Assumed Design Speed (Barnett 1936):

"The **maximum reasonably uniform** speed which would be adopted by the faster driving group of vehicle operators, once clear of urban areas"

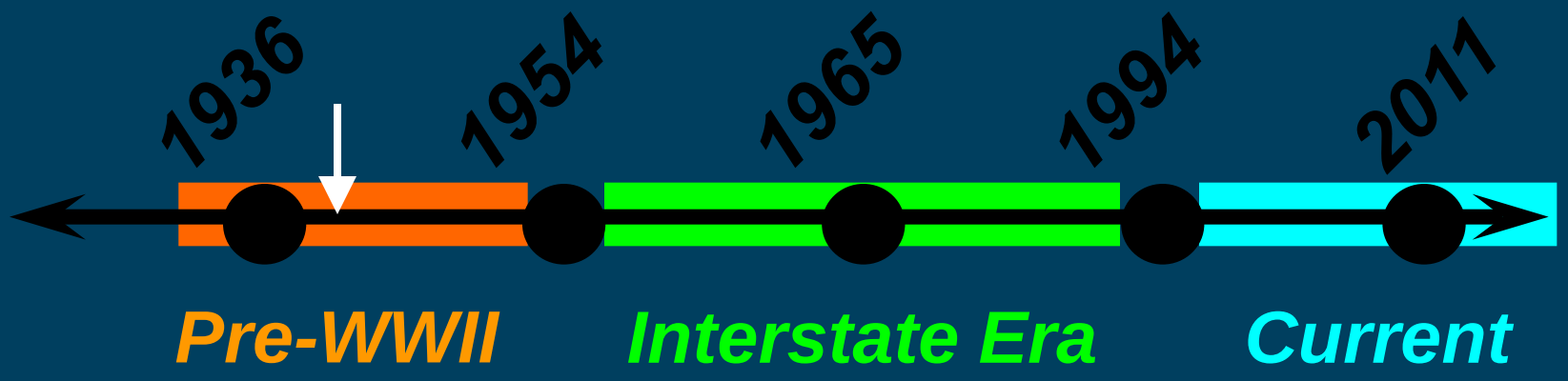
Evolution of Design Speed



Design Speed (AASHO 1938):

"The **maximum approximately uniform** speed which **probably** will be adopted by the faster group of drivers but not, necessarily, by the **small percentage of reckless ones**."

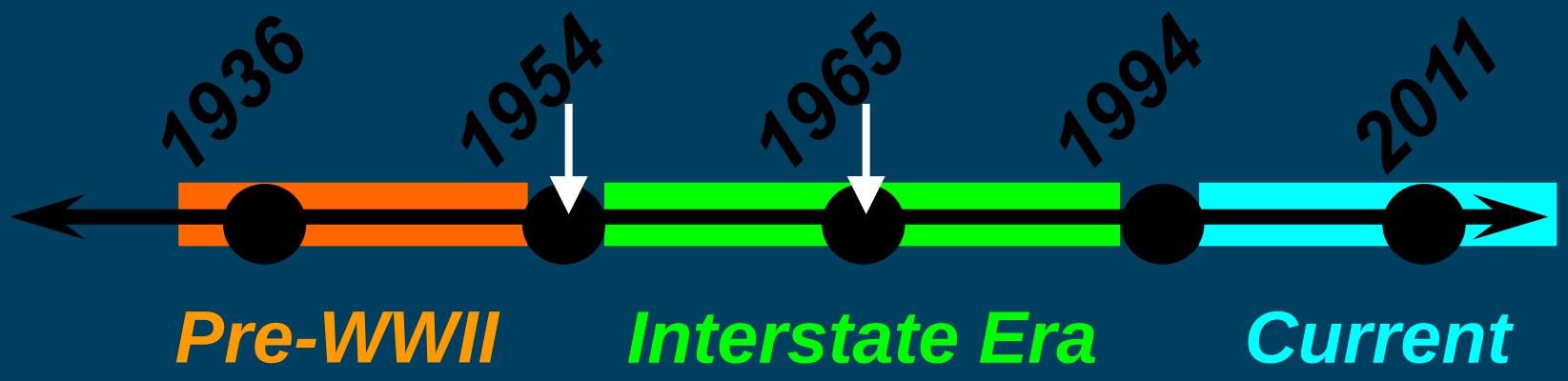
Evolution of Design Speed



Assumed Design Speed (AASHO 1940):

"The Assumed Design Speed selected for a highway is determined by consideration of the topography of the area traversed, economic justification based on traffic volume, cost of right-of-way and other factors, traffic characteristics, and other pertinent factors such as aesthetic considerations."

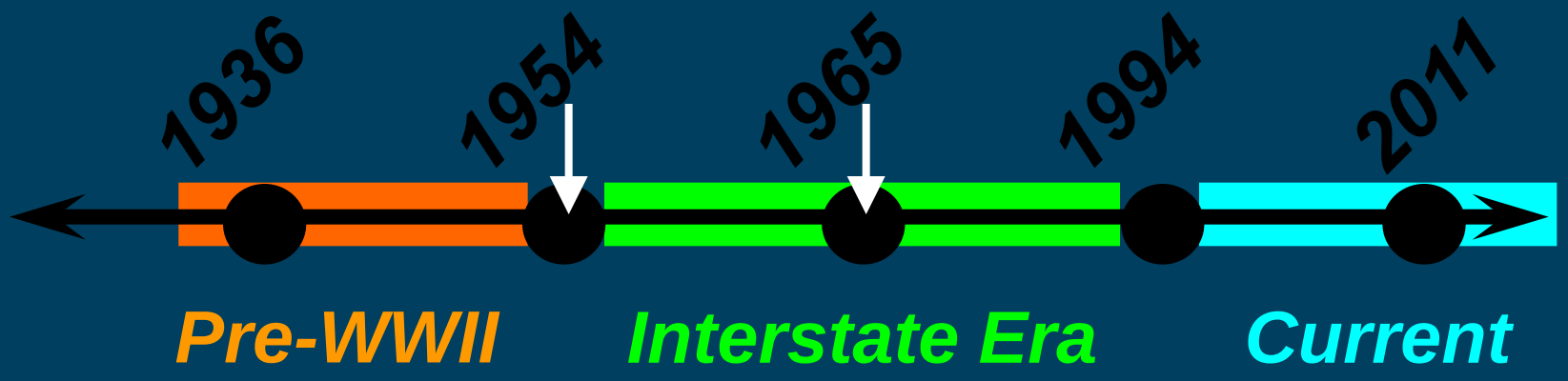
Evolution of Design Speed



AASHO (1954, 1965):

"The speed determined for design and correlation of the physical features of a highway that influence vehicle operation. It is the **maximum safe speed** that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern."

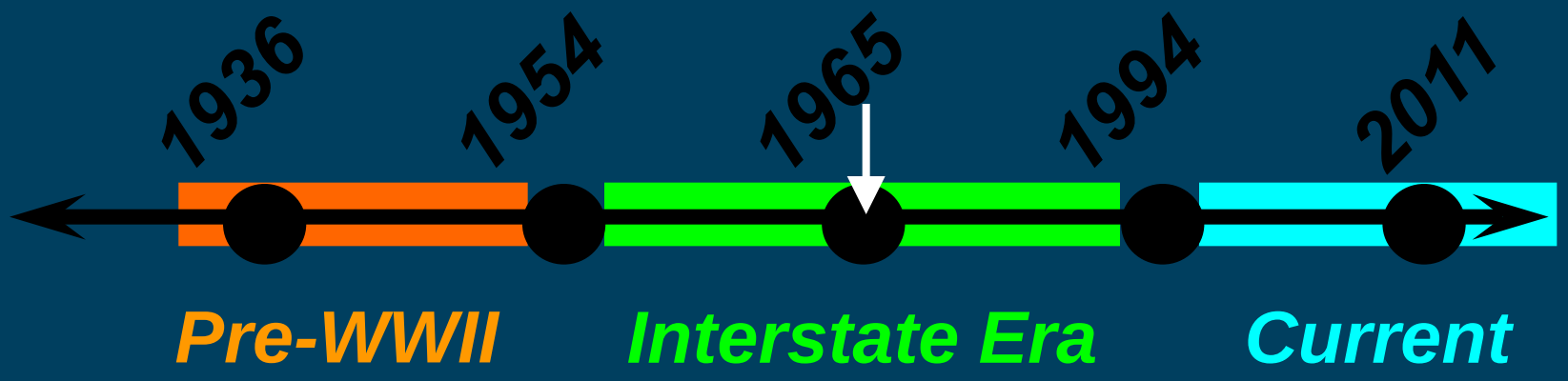
Evolution of Design Speed



AASHO (1954, 1965):

"The assumed speed should be **a logical one** with respect to the character of terrain and the type of highway. **Every effort** should be made to use **as high** a design speed **as practicable**…"

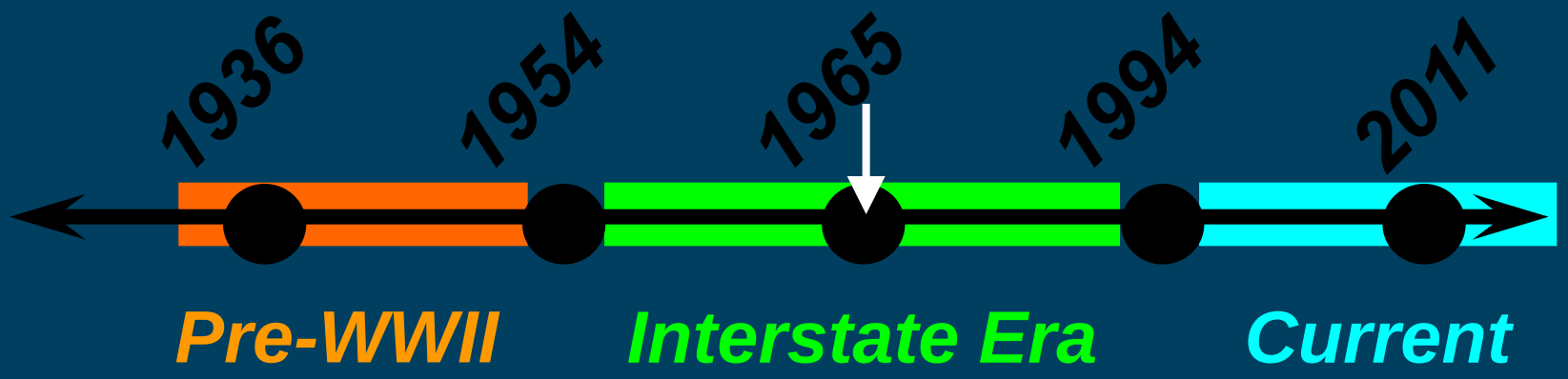
Evolution of Design Speed



AASHO (1965):

"The **increase in speeds on highways** during the last 15 years is a result of improvement in both the vehicles and the highways. The speed assumed for design **should fit the desires and travel habits of nearly all drivers**."

Evolution of Design Speed

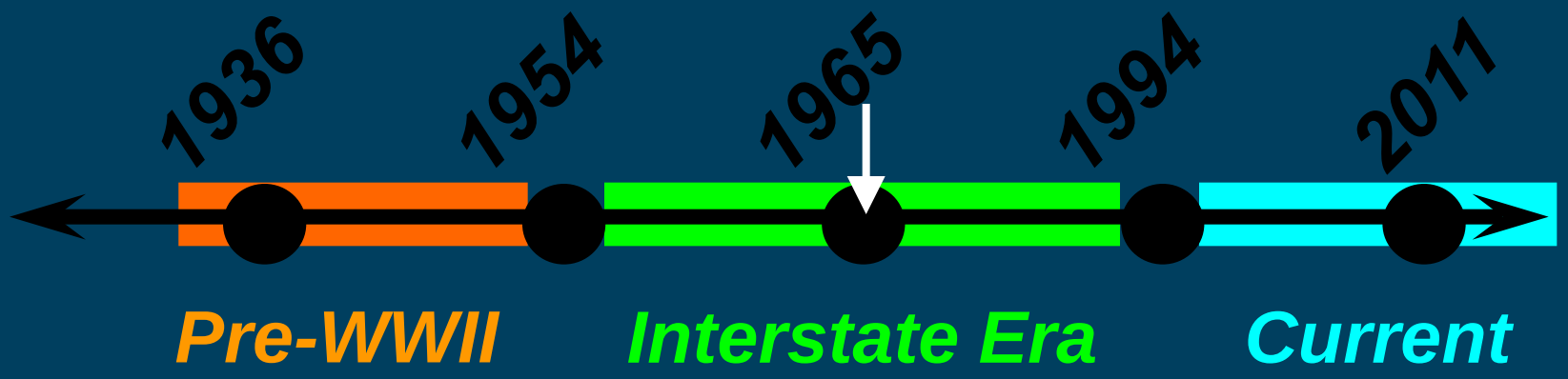


AASHO (1965):

"It can be expected that average speeds on main highways will continue to increase gradually."

"…**a top speed of 70 mph** currently would fit a very high percentile speed."

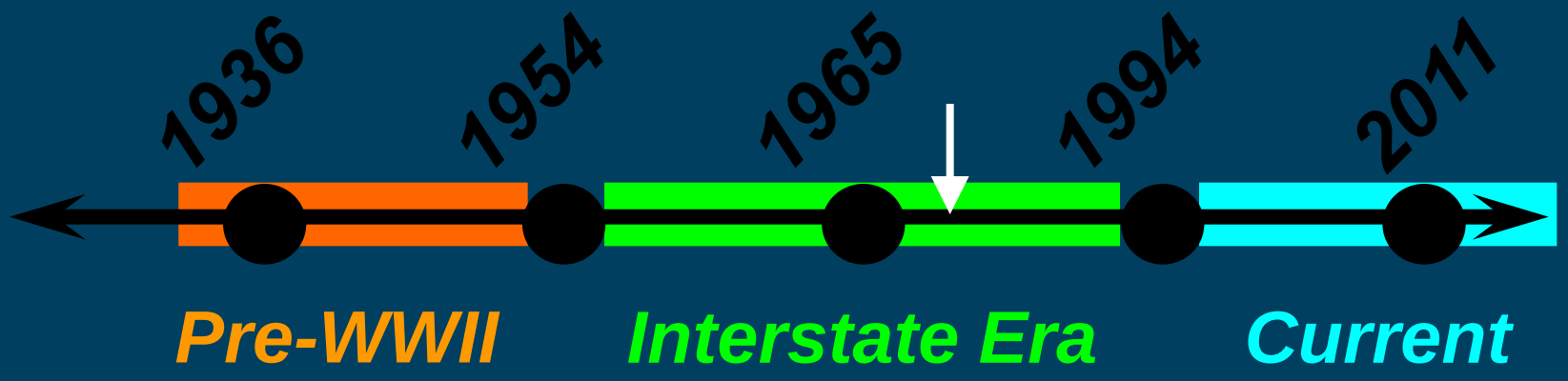
Evolution of Design Speed



AASHO (1965):

"Drivers do not adjust their speeds to the importance of the highway but to the physical limitations…"

Evolution of Design Speed

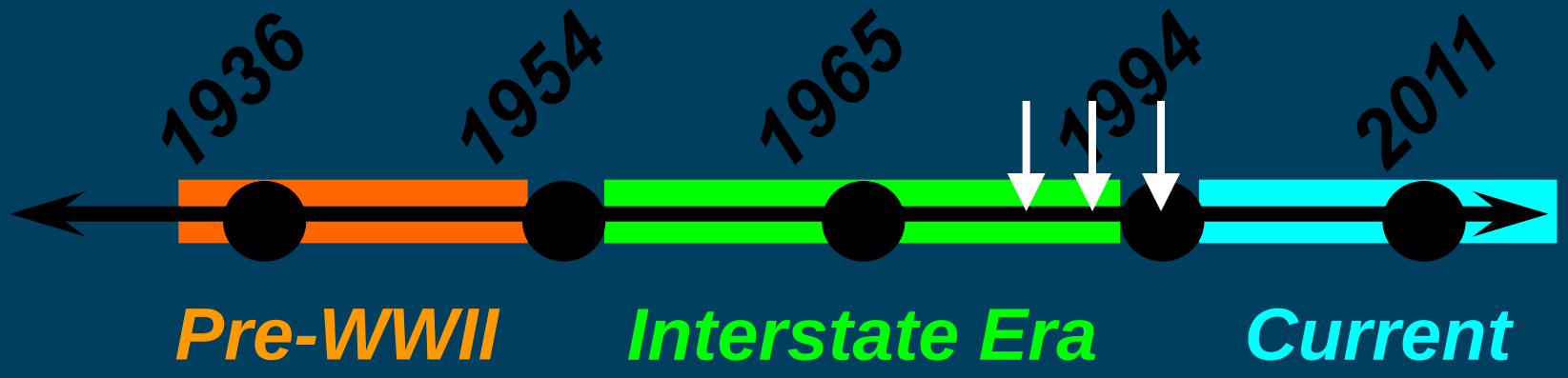


AASHO (1973):

"The maximum safe speed…" "Urban arterials should be designed **with all elements in balance**…"

"**Every effort** should be made to provide **above-minimum design values**, **but** in view of the numerous controls in urban areas…"

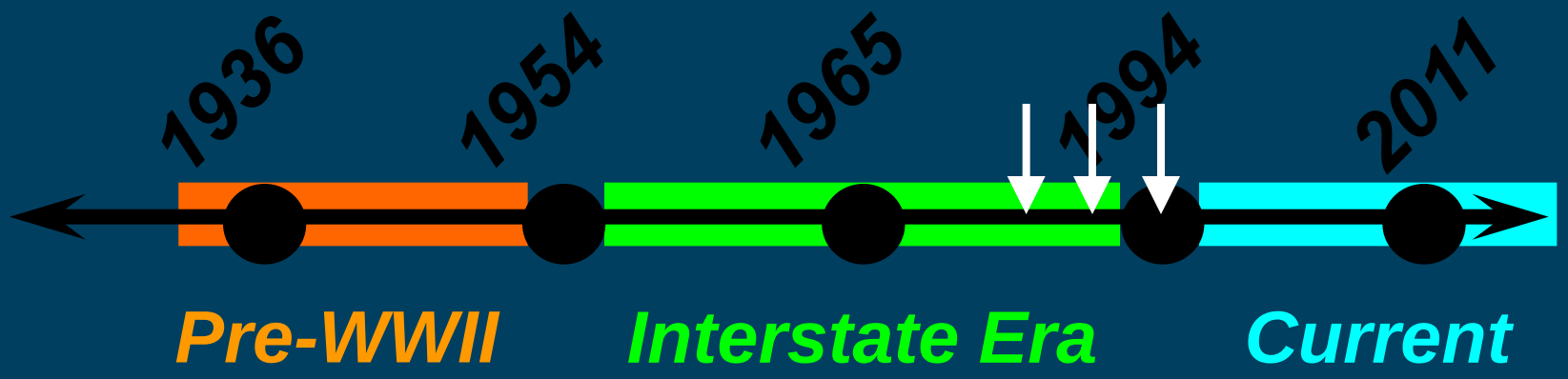
Evolution of Design Speed



AASHTO (1984, 1990, 1994):

"The maximum safe speed…" "The assumed design speed should be a logical one with respect to the topography, the adjacent land use, and the **functional classification** of highway."

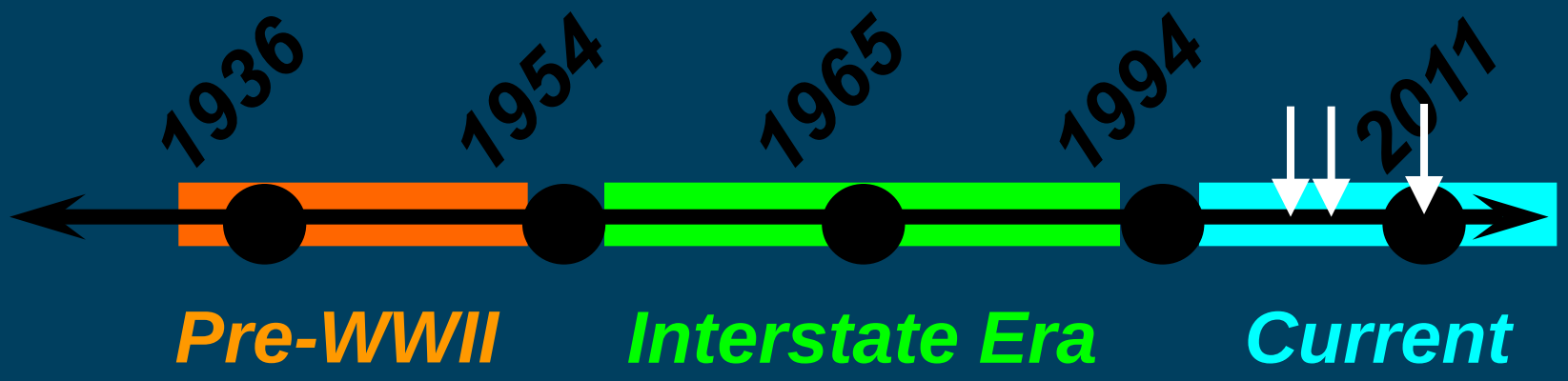
Evolution of Design Speed



AASHTO (1984, 1990, 1994):

Separate chapters for each functional classification with respective design speed guidance therein.

Evolution of Design Speed



AASHTO (2001–present) and MUTCD (2000–present):

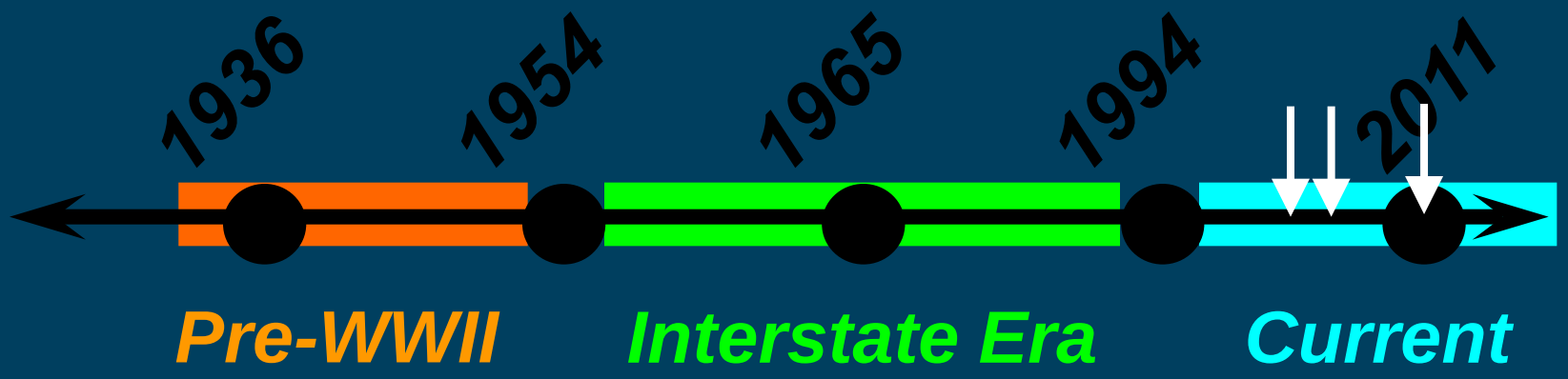
"Design Speed is a selected speed used to determine the various geometric design features of the roadway."

Evolution of Design Speed

Current design speed definition –

- Proposed in NCHRP Report 400 (1997)
- Term “safe” was removed to avoid the perception that speeds greater than the design speed were unsafe
- Recognized that operating speed can be – and commonly is – greater than the design speed

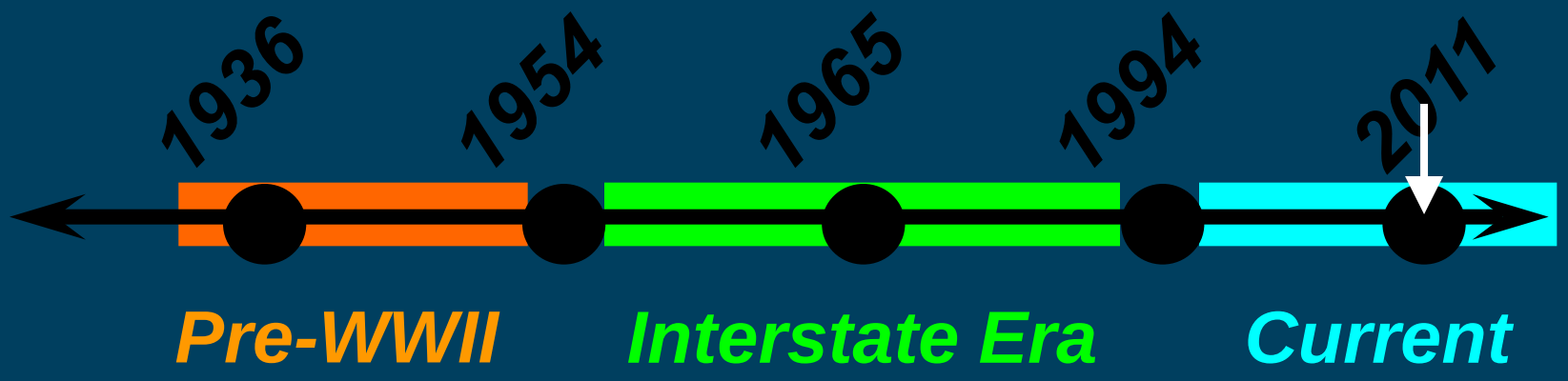
Evolution of Design Speed



AASHTO (present):

"The longer the trip, the greater is the driver's desire to use higher speeds."

Evolution of Design Speed



AASHTO (2004~~4~~11):

"The assumed design speed should be a logical one…"

"…every effort should be made ~~to provide as high a design speed as practical~~ to attain a desired degree of safety, mobility and efficiency…"

Pop Quiz!

In the AASHTO Green Book discussion on Design Speed selection, how many times is posted speed brought up as a factor to be considered?

Evolution – The Local Angle

Minnesota T.H. 73

Rural collector

Evolution – The Local Angle

Road Design Manual – October, 1970

"As high a design speed as practicable should be used…"

T.H. 73

Conditions	Design Speed (mph)	
	Desirable	Minimum
Full Control of Access:		
Urban Freeways	70	50
Rural Freeways	80	65
Partial Control of Access:		
Urban Expressways	60	40
Rural Expressways	70	60
Unlimited Access:		
Rural - Flat Terrain	70	65
Rural - Rolling Terrain	70	60
Rural - Rough Terrain	60	50
Urban	50	40

Table A 5-291.181

Evolution – The Local Angle

Road Design Manual – 1982 rewrite

Table 2-4.05A

DESIGN SPEED

New Construction and Multi-Lane Highways

CONDITIONS	DESIGN SPEED (MPH)	
	DESIRABLE	MINIMUM
FULL CONTROL OF ACCESS:		
URBAN FREEWAYS	70	50
RURAL FREEWAYS	70	65
PARTIAL CONTROL OF ACCESS:		
URBAN ARTERIALS	60	40
RURAL ARTERIALS	70	60
UNLIMITED ACCESS:		
RURAL – FLAT TERRAIN	70	65
RURAL – ROLLING TERRAIN	70	60
RURAL – RUGGED TERRAIN	60	50
URBAN	50	40

Evolution – The Local Angle

Road Design Manual – 1990's version

Table 2-5.07A
DESIGN SPEED

Conditions				DESIGN SPEED (km/h) desirable - minimum		
				ADT		
				< 1500	1500 - 2999	> 3000
2-Lane Highways	Rural	Principal Arterial	Flat	120 - 100		
			Rolling	120 - 100		
			Mountainous	100 - 80	100 - 90	
		Minor Arterial	Flat	120 - 100		
			Rolling	120 - 90		
			Mountainous	100 - 80		100 - 90
		Collector	Flat	120 - 80		
			Rolling	100 - 80		
			Mountainous	90 - 60		
	Urban	Low Speed Arterial or Collector		70 - 50		
		High Speed Arterial or Collector		110 - 80		
Freeway	Rural	Arterial		120 - 100		
	Urban	Arterial		120 - 80		
Multi-Lane High Speed	Rural	Arterial	Flat	120 - 100		
			Rolling	120 - 100		
			Mountainous	100- 90		
	Urban	Arterial		120 - 80		
Multi-Lane Low Speed	Urban	Arterial		70 - 50		
		Collector		70 - 50		

NOTE: Design Speeds normally should be higher than the minimum speeds shown.
Design Speeds must be equal to or exceed the posted speeds.

DESIGN SPEED (km/h)
desirable - minimum

NOTE: Design Speeds normally should be higher than the minimum speeds shown.
Design Speeds must be equal to or exceed the posted speeds.

Evolution – The Local Angle

Road Design Manual – Current, since 2004

Table 2-5.06A (Dual Unit)
DESIGN SPEED

Conditions				Design Speed, km/h (mph) ADT		
Type of Highway	Setting	Functional Class	Terrain	<1500	1500-3000	>3000
2-Lane Highway	Rural	Principal Arterial	Level	100-120 (60-75)		
			Rolling	90-110 (55-70)		
			Mountainous	60-100 (40-60)	80-100 (50-60)	
		Minor Arterial	Level	100-110 (60-70)		
			Rolling	80-110 (50-70)		
			Mountainous	60-100 (40-60)		80-100 (50-60)
		Collector	Level	80-100 (50-60)	100 (60)	
			Rolling	60-100 (40-60)	80-100 (50-60)	
			Mountainous	50-100 (30-60)	60-100 (40-60)	
	Urban High-Speed	Arterial	All	70-100 (45-60)		
		Collector				
	Urban Low- Speed	Arterial	All	50-60 (30-40)		
		Collector				
Freeway	Rural	Arterial	Level	110-120 (70-75)		
			Rolling	110 (70)		
			Mountainous	80-110 (50-70)		
	Urban	Arterial	All	80-110 (50-70)		
Multi-Lane Highway	Rural	Arterial	Level	100-120 (60-75)		
			Rolling	100-110 (60-70)		
			Mountainous	80-110 (50-70)		
	Urban High-Speed	Arterial	All	70-110 (45-70)		
	Urban Low-Speed	Arterial	All	50-60 (30-40)		
		Collector				

"The most appropriate design speed may be a lower value that recognizes the importance of attaining maximum design flexibility and a context sensitive roadway…"

"…it is typically desirable to choose a design speed that equals or exceeds the anticipated posted speed…"

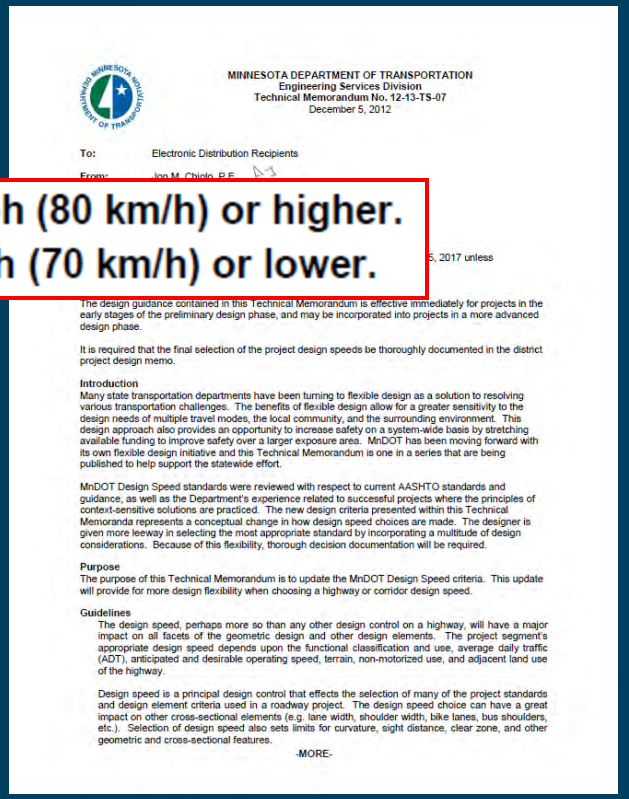
Evolution – The Local Angle

Technical Memorandum No. 12-13-TS-07

December 5, 2012

- **High-speed facilities will now be defined as 50 mph (80 km/h) or higher.**
- **Low-speed facilities will now be defined as 45 mph (70 km/h) or lower.**

- Revised to conform to AASHTO
- Relaxes design treatments (superelevation, cross section, bridge rail)
- Diminishes influence toward excessive speed



MINNESOTA DEPARTMENT OF TRANSPORTATION
Engineering Services Division
Technical Memorandum No. 12-13-TS-07
December 5, 2012

To: Electronic Distribution Recipients

From: Jon M. Chiglo, P.E.

5, 2017 unless

The design guidance contained in this Technical Memorandum is effective immediately for projects in the early stages of the preliminary design phase, and may be incorporated into projects in a more advanced design phase.

It is required that the final selection of the project design speeds be thoroughly documented in the district project design memo.

Introduction
Many state transportation departments have been turning to flexible design as a solution to resolving various transportation challenges. The benefits of flexible design allow for a greater sensitivity to the design needs of multiple travel modes, the local community, and the surrounding environment. This design approach also provides an opportunity to increase safety on a system-wide basis by stretching available funding to improve safety over a larger exposure area. MnDOT has been moving forward with its own flexible design initiative and this Technical Memorandum is one in a series that are being published to help support the statewide effort.

MnDOT Design Speed standards were reviewed with respect to current AASHTO standards and guidance, as well as the Department's experience related to successful projects where the principles of context-sensitive solutions are practiced. The new design criteria presented within this Technical Memoranda represents a conceptual change in how design speed choices are made. The designer is given more leeway in selecting the most appropriate standard by incorporating a multitude of design considerations. Because of this flexibility, thorough decision documentation will be required.

Purpose
The purpose of this Technical Memorandum is to update the MnDOT Design Speed criteria. This update will provide for more design flexibility when choosing a highway or corridor design speed.

Guidelines
The design speed, perhaps more so than any other design control on a highway, will have a major impact on all facets of the geometric design and other design elements. The project segment's appropriate design speed depends upon the functional classification and use, average daily traffic (ADT), anticipated and desirable operating speed, terrain, non-motorized use, and adjacent land use of the highway.

Design speed is a principal design control that effects the selection of many of the project standards and design element criteria used in a roadway project. The design speed choice can have a great impact on other cross-sectional elements (e.g. lane width, shoulder width, bike lanes, bus shoulders, etc.). Selection of design speed also sets limits for curvature, sight distance, clear zone, and other geometric and cross-sectional features.

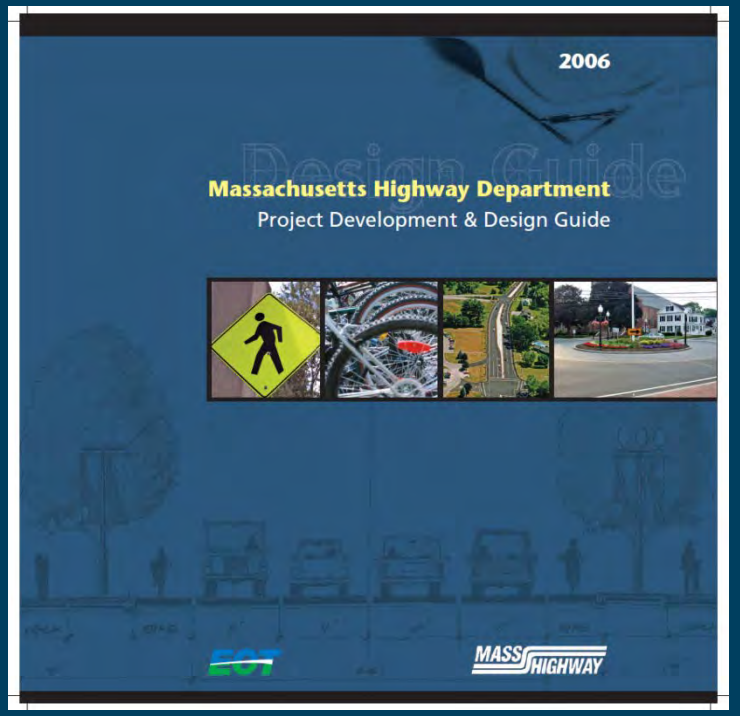
-MORE-

What's past is prologue...

Evolution – Going Forward

MASS HIGHWAY Project Development Guide

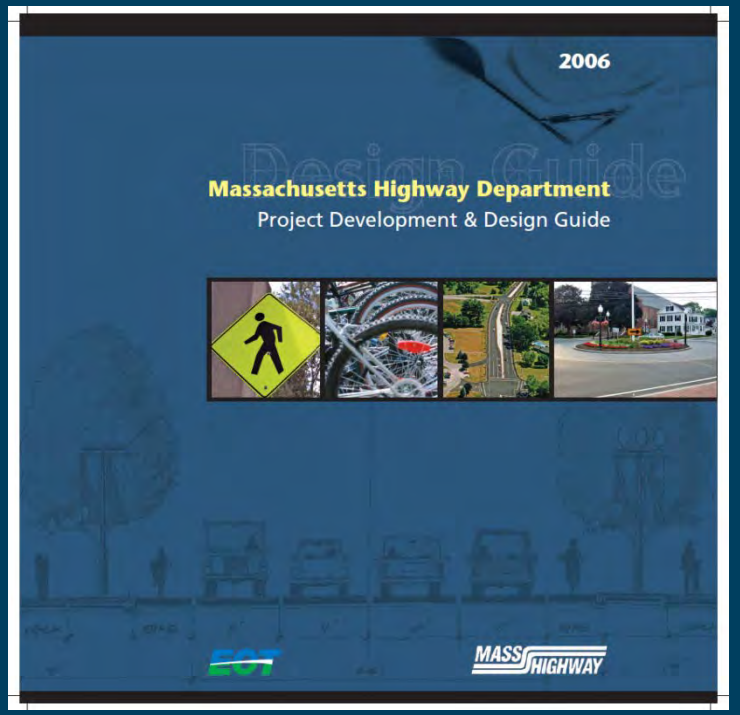
"Selection of a design speed influences the physical geometrics of the roadway. Similarly, the physical geometrics of the roadway are important determinants of the operating speeds that will result on the facility."



Evolution – Going Forward

MASS HIGHWAY Project Development Guide

"…the design speed should only be based on the speed limit if the speed limit is consistent with existing operating speeds or physical constraints of the built environment."



Pop Quiz – Answer

In the AASHTO Green Book discussion on Design Speed selection, how many times is posted speed brought up as a factor to be considered?

Once – as one of several factors to consider when designing arterial streets.

Nuts and Bolts

...or:

"How I Learned to Stop Over-designing and Start Right-sizing, and it Begins With Design Speed."

The Framework

Conditions				Design Speed, km/h (mph)		
				ADT		
Type of Highway	Setting	Functional Class	Terrain	<1500	1500-3000	>3000
2-Lane Highway	Rural	Principal Arterial	Level	100-120 **(60-75)**		
			Rolling	90-110 **(55-70)**		
			Mountainous	60-100 **(40-60)**	80-100 **(50-60)**	
		Minor Arterial	Level	100-110 **(60-70)**		
			Rolling	80-110 **(50-70)**		
			Mountainous	60-100 **(40-60)**		80-100 **(50-60)**
		Collector	Level	80-100 **(50-60)**	100 **(60)**	
			Rolling	60-100 **(40-60)**	80-100 **(50-60)**	
			Mountainous	50-100 **(30-60)**	60-100 **(40-60)**	
	Urban High-Speed	Arterial	All	70-100 **(45-60)**		
		Collector				
	Urban Low- Speed	Arterial	All	50-60 **(30-40)**		
		Collector				
Freeway	Rural	Arterial	Level	110-120 **(70-75)**		
			Rolling	110 **(70)**		
			Mountainous	80-110 **(50-70)**		
	Urban	Arterial	All	80-110 **(50-70)**		
Multi-Lane Highway	Rural	Arterial	Level	100-120 **(60-75)**		
			Rolling	100-110 **(60-70)**		
			Mountainous	80-110 **(50-70)**		
	Urban High-Speed	Arterial	All	70-110 **(45-70)**		
	Urban Low-Speed	Arterial	All	50-60 **(30-40)**		
		Collector				

Road Design Manual Table 2-5.06A

Leading Edge of Thinking

NCHRP Project 15-25: Alternatives to Design Speed for Selection of Roadway Design Criteria

Speed ⟶ Design

or

Design ⟶ Speed

Leading Edge of Thinking

NCHRP Project 15-25: Alternatives to Design Speed for Selection of Roadway Design Criteria

German "Design Class" Concept

Category group / connection-function		motorways	rural roads	non built-up main roads	built-up main roads	access roads
		AS	LS	VS	HS	ES
continental	0	AS 0		-	-	-
long distance	I	AS I	LS I		-	-
overregional	II	AS II	LS II	VS II		-
regional	III	-	LS III	VS III	HS III	
short distance	IV	-	LS IV	VS IV	HS IV	ES IV
local	V	-	LS V	-	-	ES V

RAA RAL RASt

Leading Edge of Thinking

NCHRP Project 15-25: Alternatives to Design Speed for Selection of Roadway Design Criteria

German "Design Class" Concept

Design Class	Traffic Mode on Road
EKL 1	
EKL 2	
EKL 3	
EKL 4	

Design Class	Cross Section Type
EKL 1	
EKL 2	
EKL 3	
EKL 4	

Leading Edge of Thinking

Project 15-25 has rolled into Project 15-47: Developing an Improved Highway Geometric Design Process

…but not before concluding:

- Design speed can be foregone in low and transitional speed circumstances (20-45 mph)
  - Would still need some design controls (minimum radius, K-value, intersection sight distance, etc.)
- Design speed still useful for high speed design
- Precise design speed values overrated as a control

Back to the Future

Design data in the Green Book and RDM are provided in 5 mph increments, but…

Old Road Design Manual (pre 1990's):

> "Design speeds usually fall between 30 and 70 mph at 10 mph increments. Occasionally, it is warranted to use 5 mph increments."

AASHTO Green/Blue Books (1984 and previous):

> "…it has been found desirable…to use increments of 10 mph. Smaller increments show little distinction in design elements between one design speed and the next…"

Rural Highways

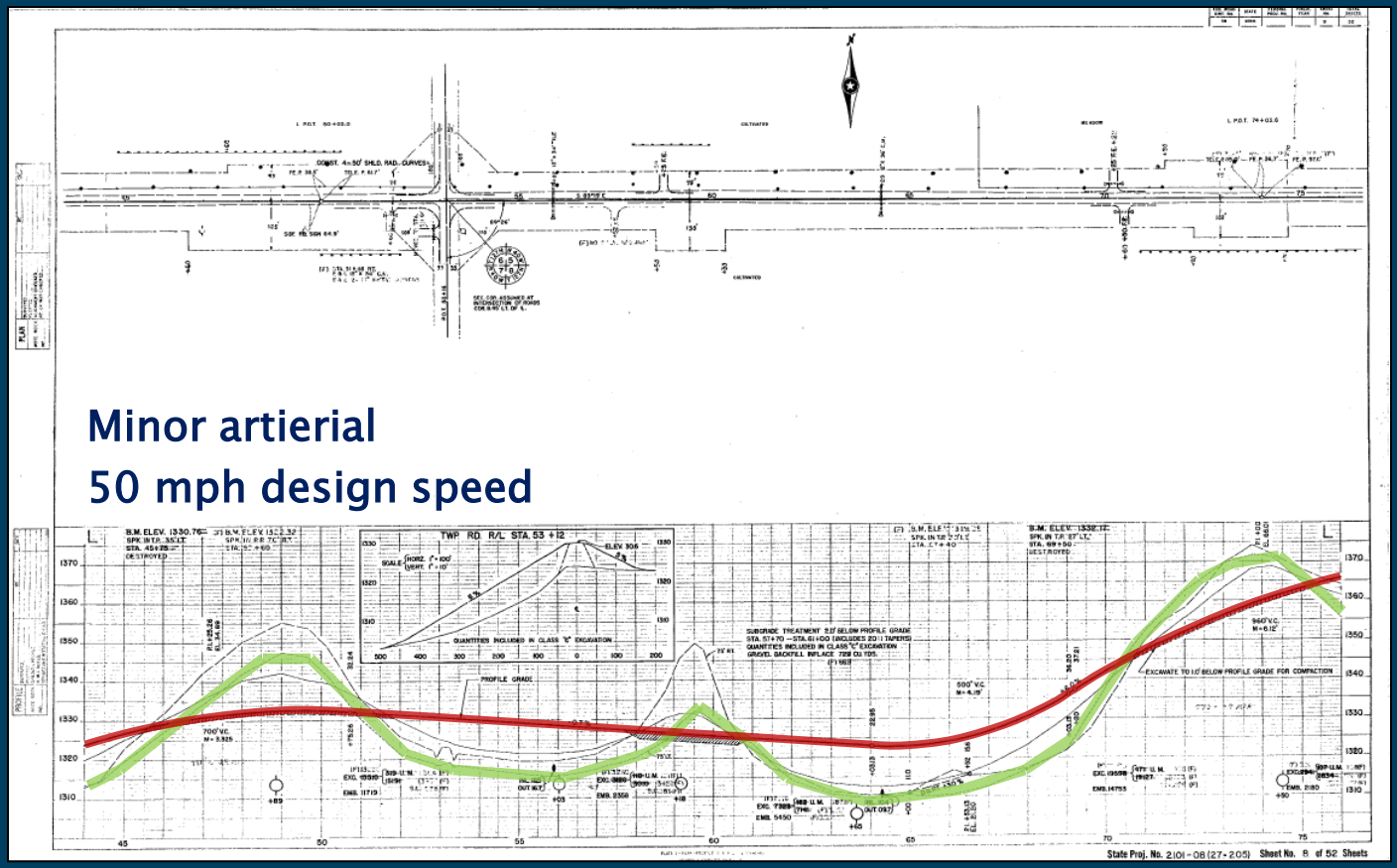
The Standard

30 to 75 mph

(…depending on functional class, terrain, setting and traffic volume.)

Rural Highways

Perspective



Minor artierial

50 mph design speed

Rural Highways

Perspective

Table 2-4.05A

DESIGN SPEED

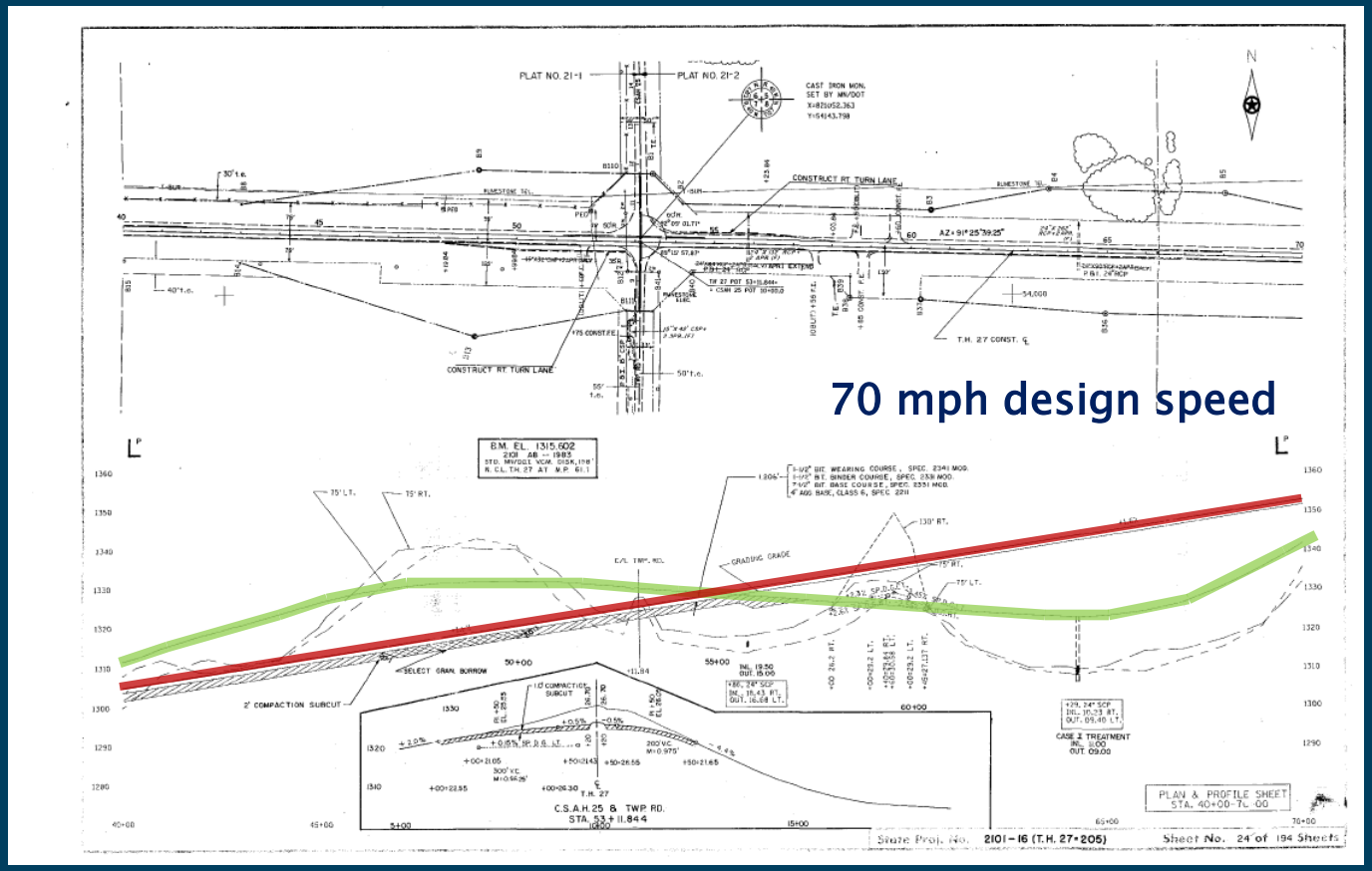
New Construction and Multi-Lane Highways

CONDITIONS	DESIGN SPEED (MPH)	
	DESIRABLE	MINIMUM
FULL CONTROL OF ACCESS:		
URBAN FREEWAYS	70	50
RURAL FREEWAYS	70	65
PARTIAL CONTROL OF ACCESS:		
URBAN ARTERIALS	60	40
RURAL ARTERIALS	70	60
UNLIMITED ACCESS:		
RURAL – FLAT TERRAIN	70	65
RURAL – ROLLING TERRAIN	70	60
RURAL – RUGGED TERRAIN	60	50
URBAN	50	40

Design criteria at the time

Rural Highways

Perspective



Rural Highways

Perspective

Rural Highways

Guiding Principles

- User expectation / transportation function
- Practicality
- Economy
- Sustainability
- Environmental stewardship

Rural Highways

Rules of Thumb

40 mph	50 mph	60 mph	70 mph

Collector

Arterial

Expressway

Freeway

Rural Highways

Merely rules of thumb, but they can be expected to apply routinely.

Subject to:

- Context
- Sub-class (e.g. minor vs principal arterial)
- Terrain
- Demand
- Driver expectation

Urban Freeways

The Standard

50 to 70 mph

Urban Freeways

Perspective

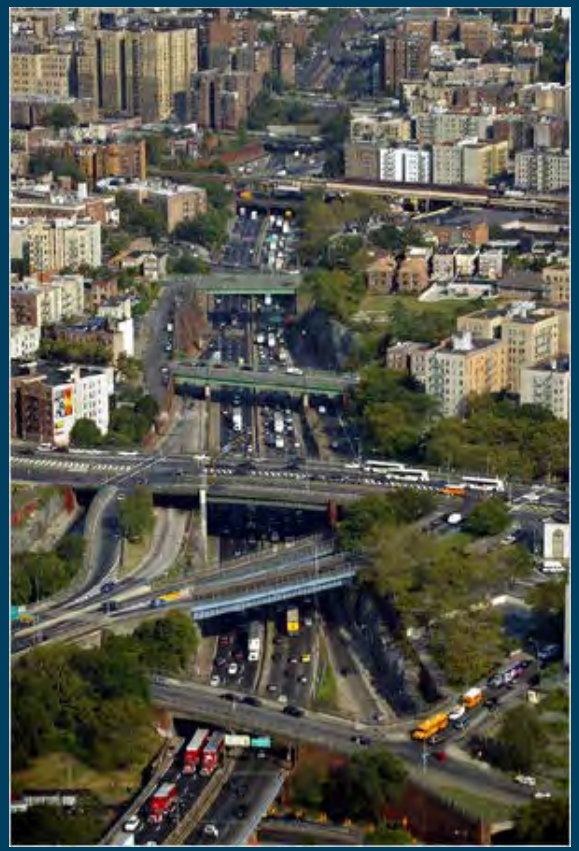
Robert Moses, 1964:

"You can draw any kind of picture you like…but when you operate in an overbuilt metropolis, you have to hack your way with a meat ax."

Urban Freeways

Perspective

Cross Bronx Expressway



Urban Freeways

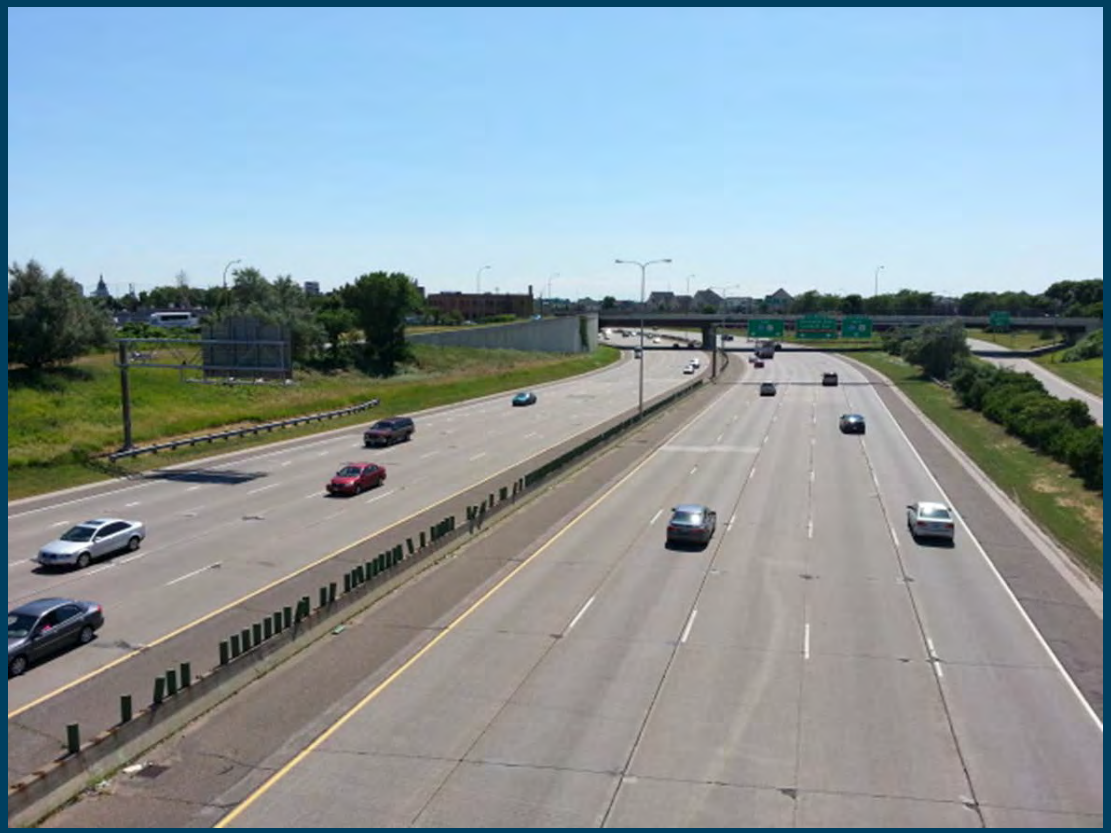
Perspective

From “Interregional Highways” (1943)

The design speed “shall be as high as practicable, consistent with the topography, proximity of urban improvements, and expected traffic volume.” With those limits, a design speed higher than 50 miles per hour “will usually be impracticable.”

Urban Freeways

Perspective



I-94 in North Minneapolis

60 & 70 mph DS's

Urban Freeways

Perspective

I-35E Parkway in St. Paul

50 mph DS

Urban Freeways

Guiding Principles

- Practicality
- Economy
- Feasibility
- Social and environmental impact

Freeways

Rules of Thumb

Urban	50 mph
Suburban	60 mph
Rural	70 mph

Urban Non-Freeways

The Standard

30 to 70 mph

Urban Non-Freeways

Perspective

- High-speed urban facilities are relatively rare

Urban Non-Freeways

Urban Non-Freeways

Perspective

- High-speed urban facilities are relatively rare
  - Where they do occur, a context-oriented approach is appropriate
- Low-speed streets are the great majority of cases

Low-speed Urban Streets

Guiding Principles

- Speed control / safety for all users
- Economy
- Feasibility
- Versatility
- Social and environmental impact

Low-speed Urban Streets

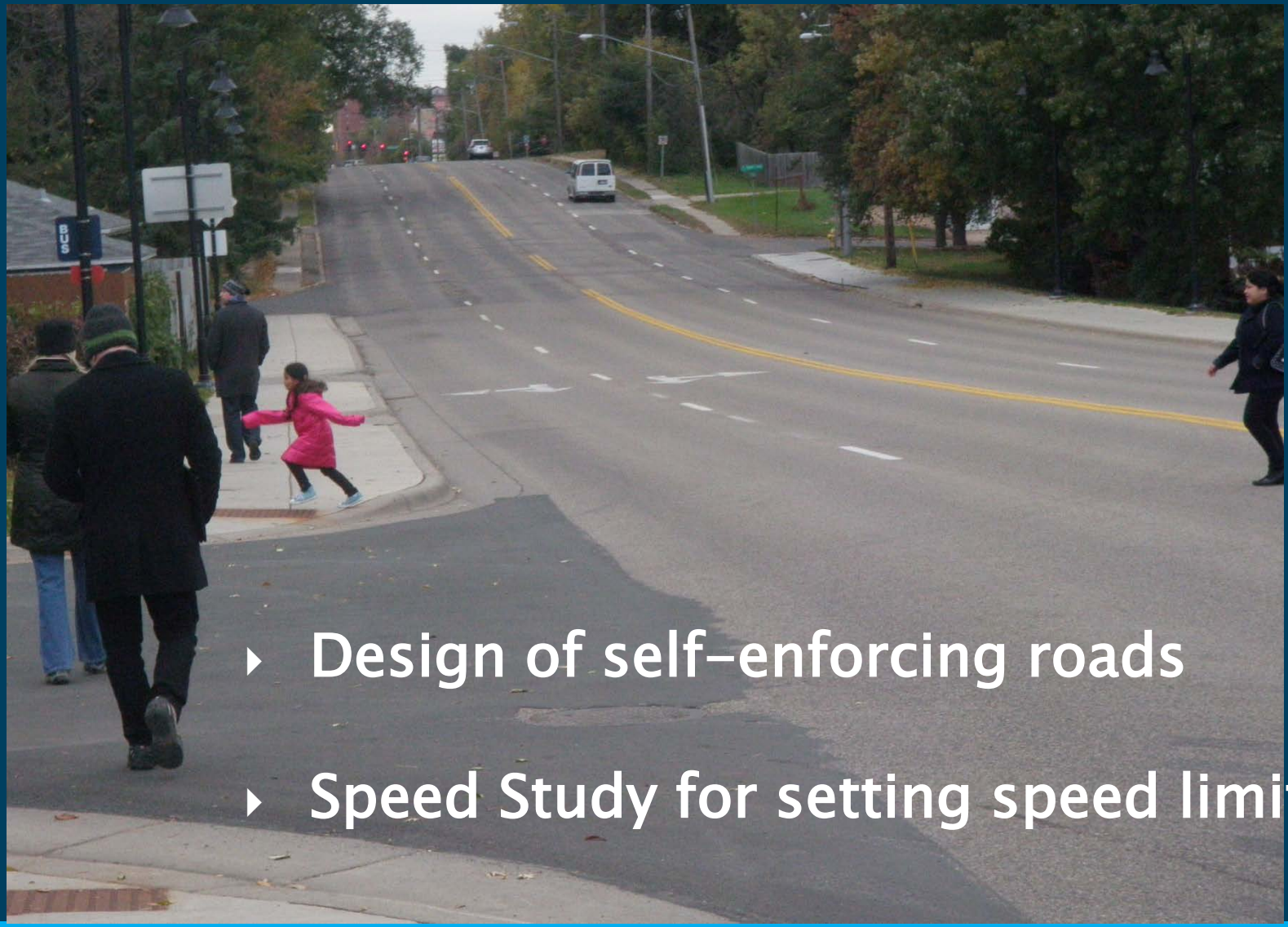
Rules of Thumb

Residential	20 mph
Collectors/Arterials	
Low-speed	30 mph
Transitional speed	40 mph

Closing Discussion

Engineering for speed management and safety

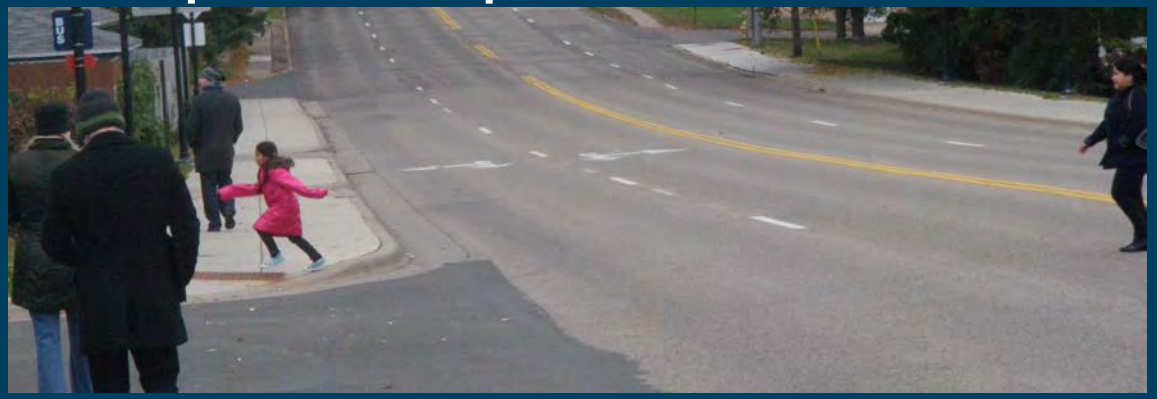
Engineering for Speed Management



- Design of self-enforcing roads
- Speed Study for setting speed limits

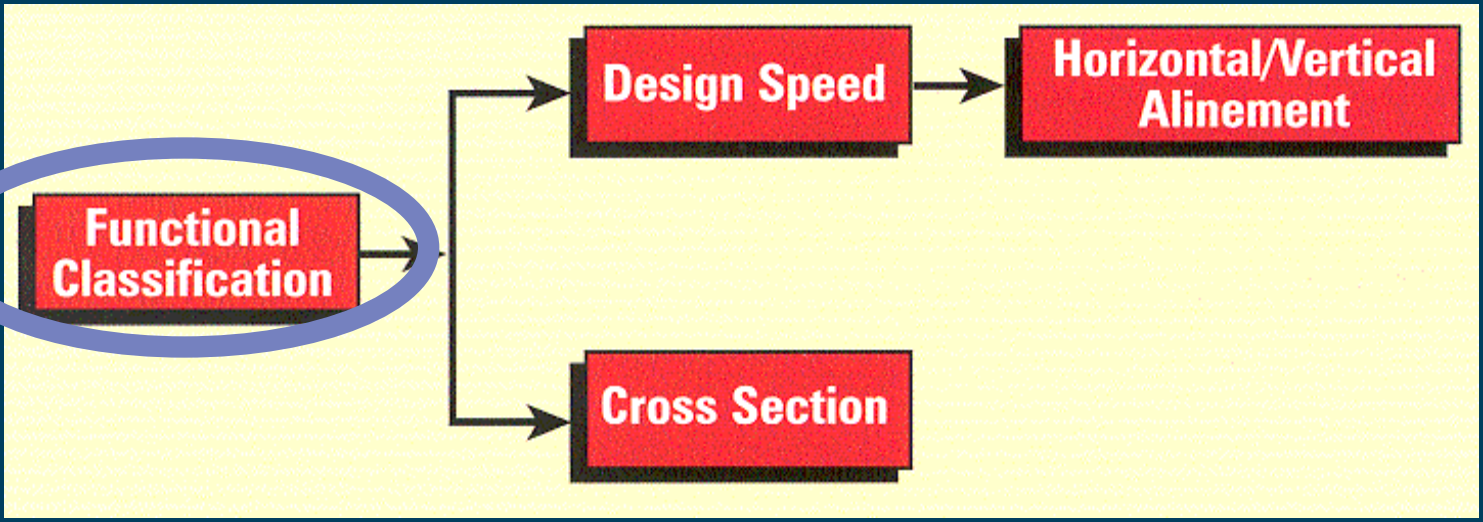
Question

- Can the Design Speed be lower than target operating speed or posted speed?



- Example:
  - Minor Arterial – CSAH
  - Context: City's "Main Street"
  - 85th Percentile: 42 mph
  - Posted: 35 mph
  - Reconstruction
  - Multimodal design
  - Target Operating Speed: 35 mph
  - Design Speed: ? (30-40 mph per state aid rule 8820.9936)

Conventional Approach



Classification required by Federal law

General Categories:

- Arterial
- Collector
- Local

Conventional Approach

\+ ? = D.S.

NCHRP Report 504, 2003

- Minimal relationship between Design Speed and Operating Speed

- Strong relationship to lower 85th percentile speeds
  - Increased access density
  - Increased pedestrian activity
  - Absence of pavement markings
  - Medians
  - On-street parking

Concept of Desired/Target Speed

Target Operating Speed

- "…desirable speed at which vehicles should operate on a thoroughfare in a specific context." (ITE)
- "…the desired operating speed along a roadway. An appropriate target speed should be determined early in the project development process." (FHWA)

Need for Flexibility:

- Community's Guiding Principles
  - Multimodal Design
  - Connectivity and Public Realm
  - Local Economy
  - Design for People
  - Community Character and Identity
  - Sustainable Solutions
  - Healthy and Active Lifestyles
  - Unique Location
- Environmental Stewardship
- Financial Sustainability

Question…

Where is the flexibility in selecting a design speed?

Self-Enforcing/Self-Explaining Roads

- Important Design Focus Areas
  - Rural Areas
    - Many types/functions of 2-lane rural roads
    - Make the effort to “get to know” the subject road
  - Transitions
    - Undeveloped to Developed
    - Developed to Urban Core
  - Curves
    - First curves after long tangents
    - Comparably more restrictive curves

Minnesota Trunk Highway 1

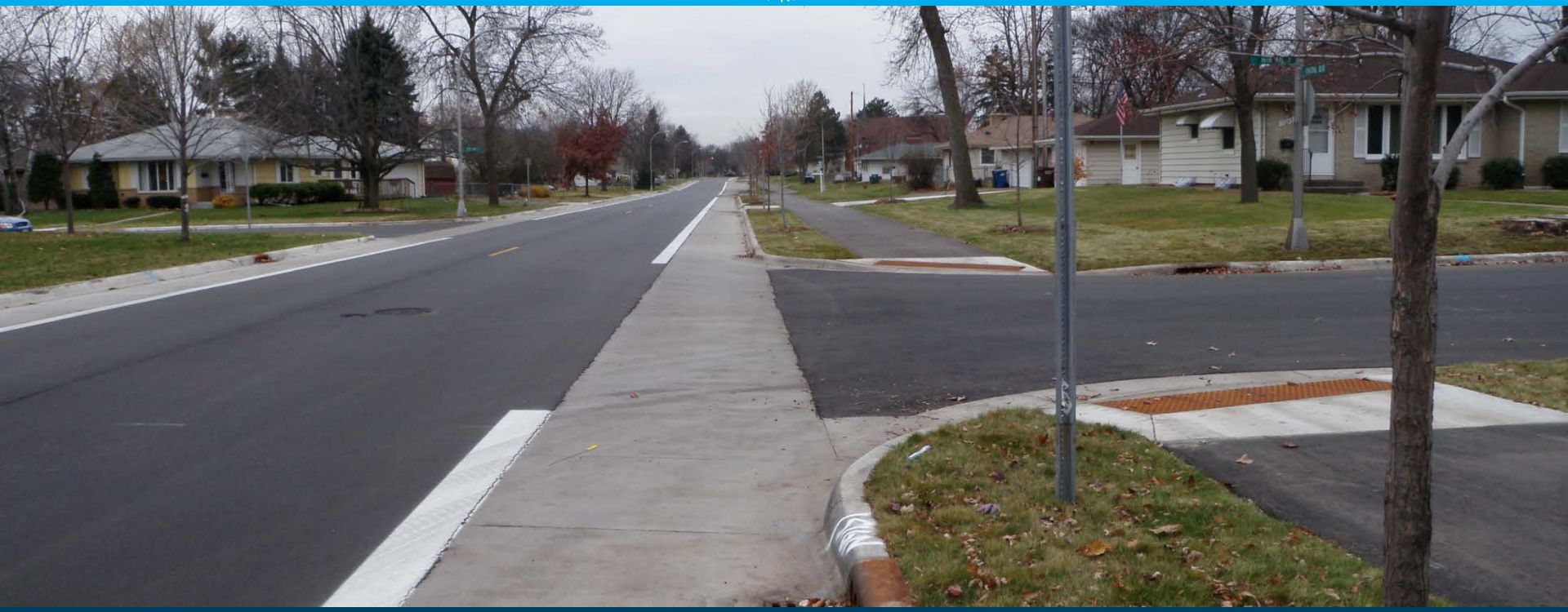
Design Speed of 40 mph was…

- 10 mph less than the existing (previous) posted speed
- 10 mph less than the low end of the “allowable” (standard) range

Minnesota Trunk Highway 1

The outcome was:

- 70% crash reduction
- Satisfaction of local and regulatory concerns
- Economical and context sensitive project



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Thank You

Next webinar:

"So You Want to Build a Cross Section"
February 18, 2014
2-4 p.m. Central

For more information visit:
www.cts.umn.edu/contextsensitive/workshops/