Eric Dumbaugh | CNU | April 3rd, 2008

Enabling Great Streets:

Improving Traffic Safety through an Integrated Approach to Roadway and Urban Design

Outline

- Why Does Safety Matter?
- Isn't Traffic Safety an Engineering Problem?
- Transect Street Elements and Urban Traffic Safety
  - Travelway
  - Roadside
  - Context

Considering Transportation Safety

- Worldwide, more than **1 million** people are killed in traffic crashes each year.
- Up to **50 million** more are injured.
- More than half are pedestrians.
- Traffic injuries and fatalities are projected to **increase by 65%** by 2020 – making traffic crashes the 6th leading cause of preventable deaths.
- Traffic crashes are **ALREADY** the 6th leading cause of preventable deaths in the United States.

- Source: World Health Organization, 2004

US Road Safety Improvements?

Fatalities 1999: 41,717

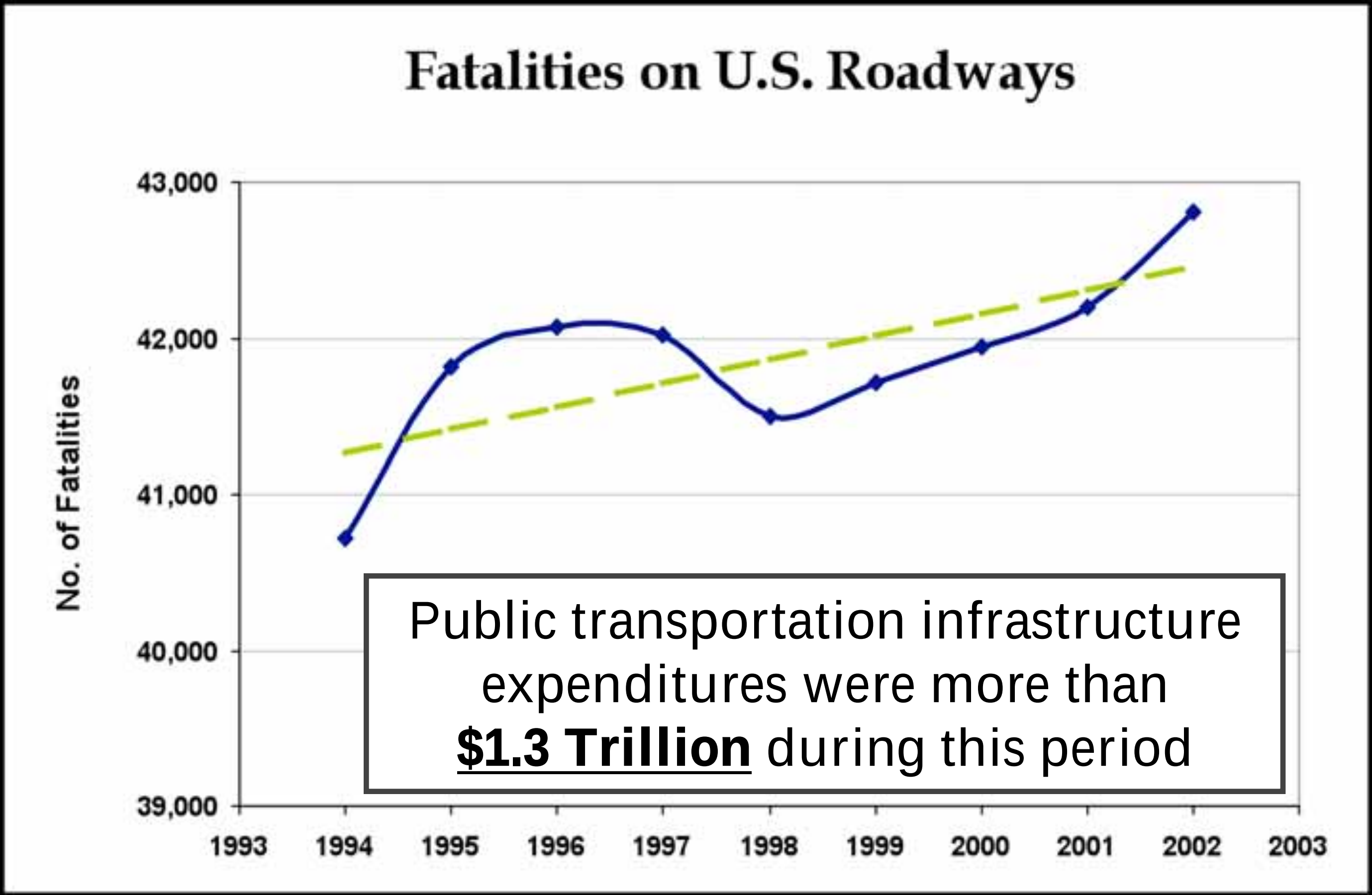
Fatalities 2005: 43,442

Do you see a trend?

Fatalities 2001: 41,821

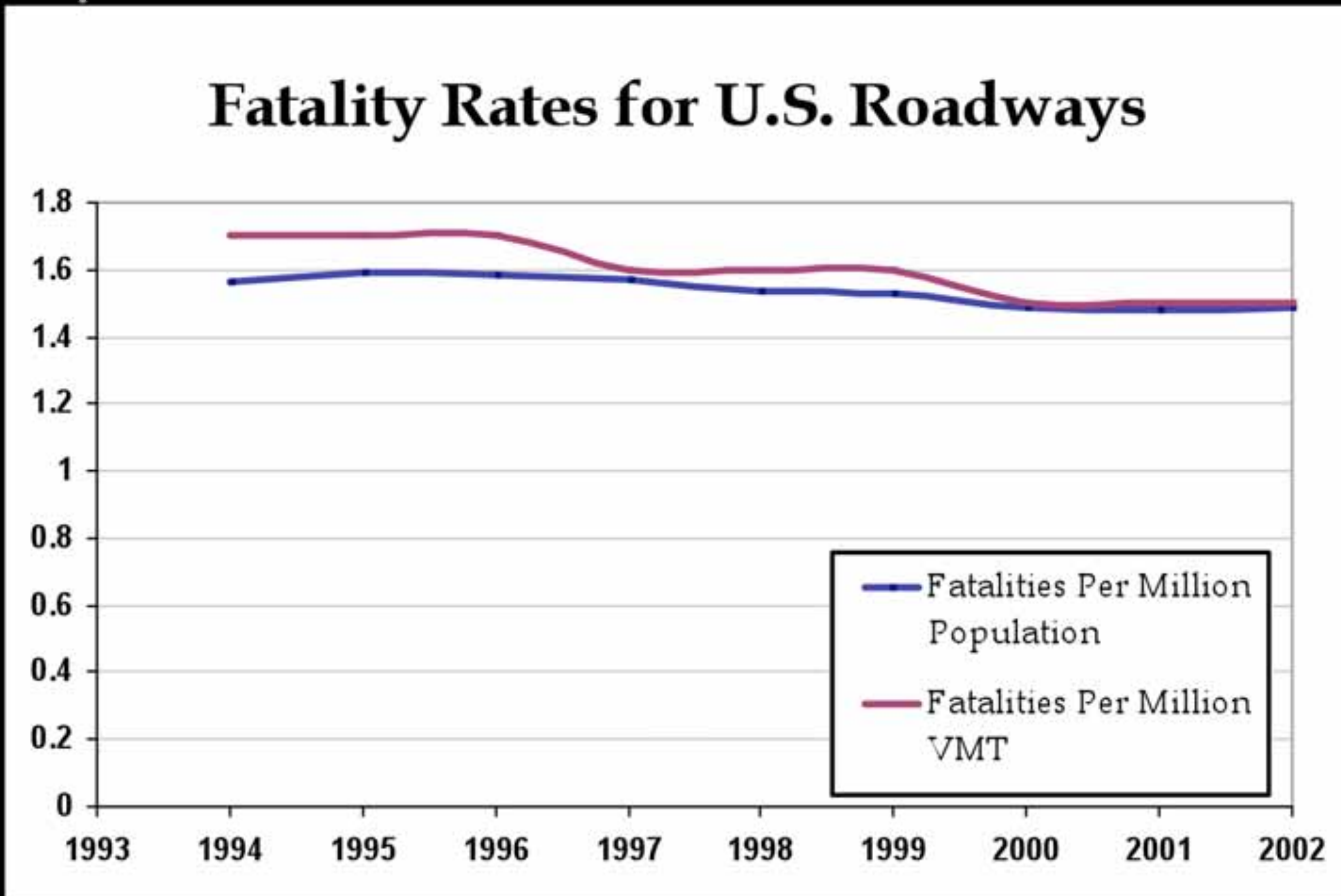
Fatalities 2003: 42,643

The Trend...



Source: FARS

Conventional Traffic Safety Measures



Fair enough, but…

Source: FARS

Design Improvements

- "**Changes in highway infrastructure… have not reduced traffic fatalities and injuries** and have even had the effect of increasing total fatalities and injuries… other factors, primarily changes in the **demographic age mix of the population**, increased seatbelt usage, and improvements in medical technology are responsible for the downward trend in total fatal accidents."

- Robert Noland, 2003

Projected growth in traffic fatalities associated with an aging population

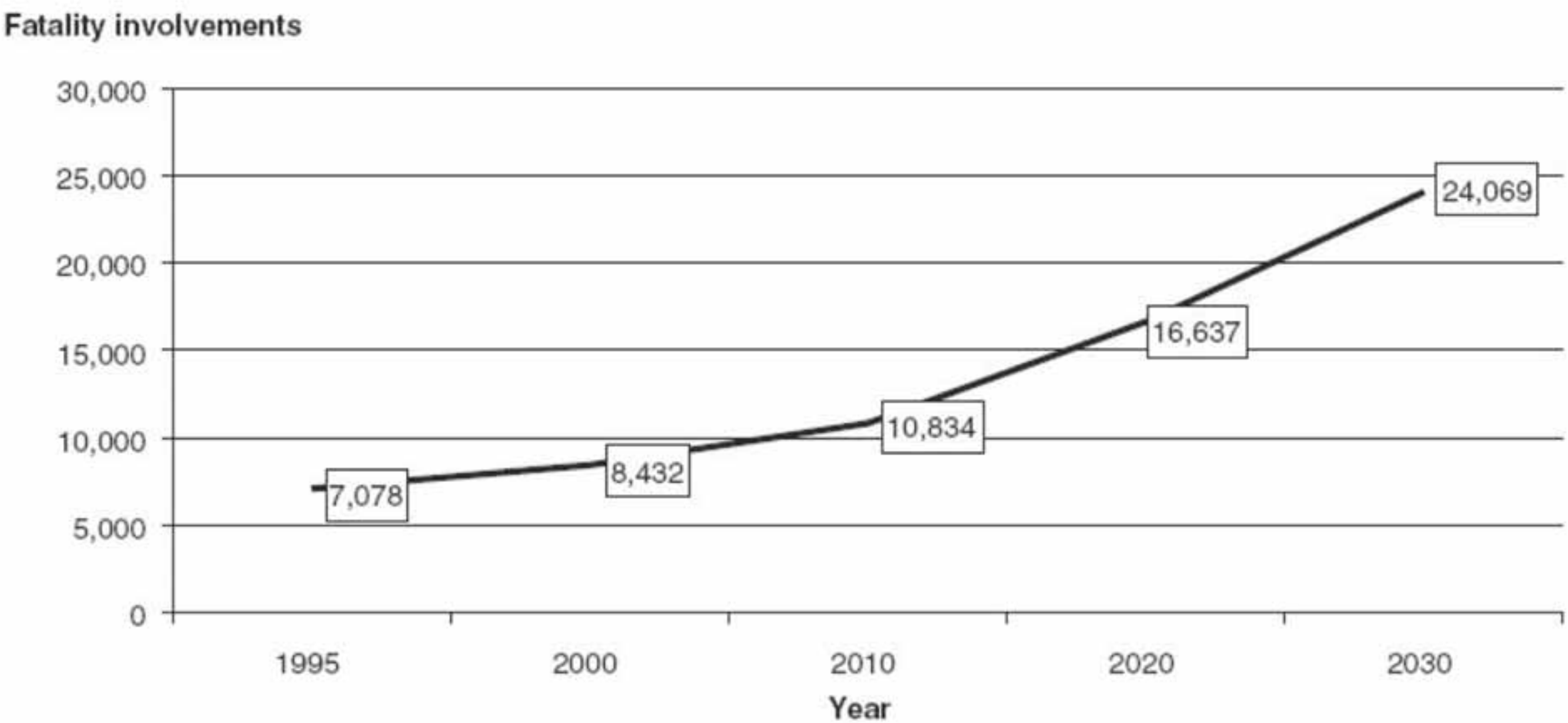


FIGURE 4 Projection of fatalities involving older drivers in the United States, 1995–2030 [adapted from Burkhardt et al. (6)].

Source: TRB, 2004

International Comparisons

- In **1965**, only Britain surpassed the US in terms of safety.
- Currently, we rank behind **all** other developed countries.

Road Traffic Fatalities (2000)

Country or Area	**Per 100,000 Inhabitants**
Australia	9.5
European Union*	11
Great Britain	5.9
Japan	8.2
Netherlands	6.8
Sweden	6.7
United States	**15.2**

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom

Source: World Health Organization

"But Americans Drive More..."

TABLE 1: Comparative Fatality Rates per Billion Vehicle-Kilometers Traveled

Country	Rate	Year
Australia	8.0	2003
Canada	8.9	2003
Finland	7.6	2003
Netherlands	7.7	2003
Norway	8.3	2002
Sweden	7.5	2002
Switzerland	8.8	2003
United Kingdom	7.2	2001
United States	9.1	2003

Opportunities for Improvement…

- Reduction in annual traffic fatalities if US safety performance had paralleled safety trends in peer countries:

  Canada: 13,718 fewer deaths – ***<u>32% reduction</u>***

  Britain: 16,695 fewer deaths – ***<u>39% reduction</u>***

  Australia: 20,426 fewer deaths – ***<u>48% reduction</u>***

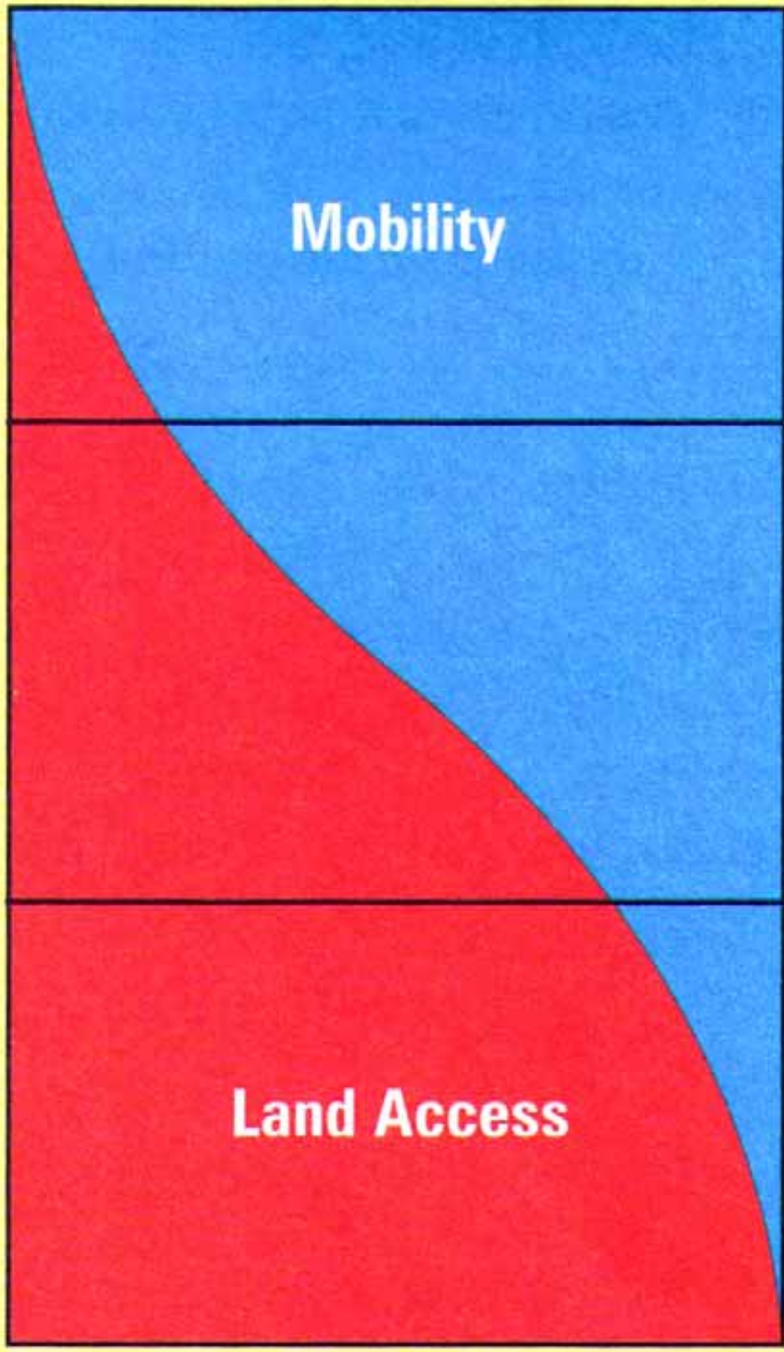
Isn't Traffic Safety an Engineering Problem?

Yes – and that's part of the problem.

Garden Cities of To-Morrow

Radburn

- The planning profession emerged in the late 19th century to address health and safety issues.
- The professional focus moved to defining networks, and then to the administration of development codes.
- Street design and traffic safety largely abandoned to the engineering profession – armed with Radburn-era street concepts.



Arterials

- higher mobility
- low degree of access

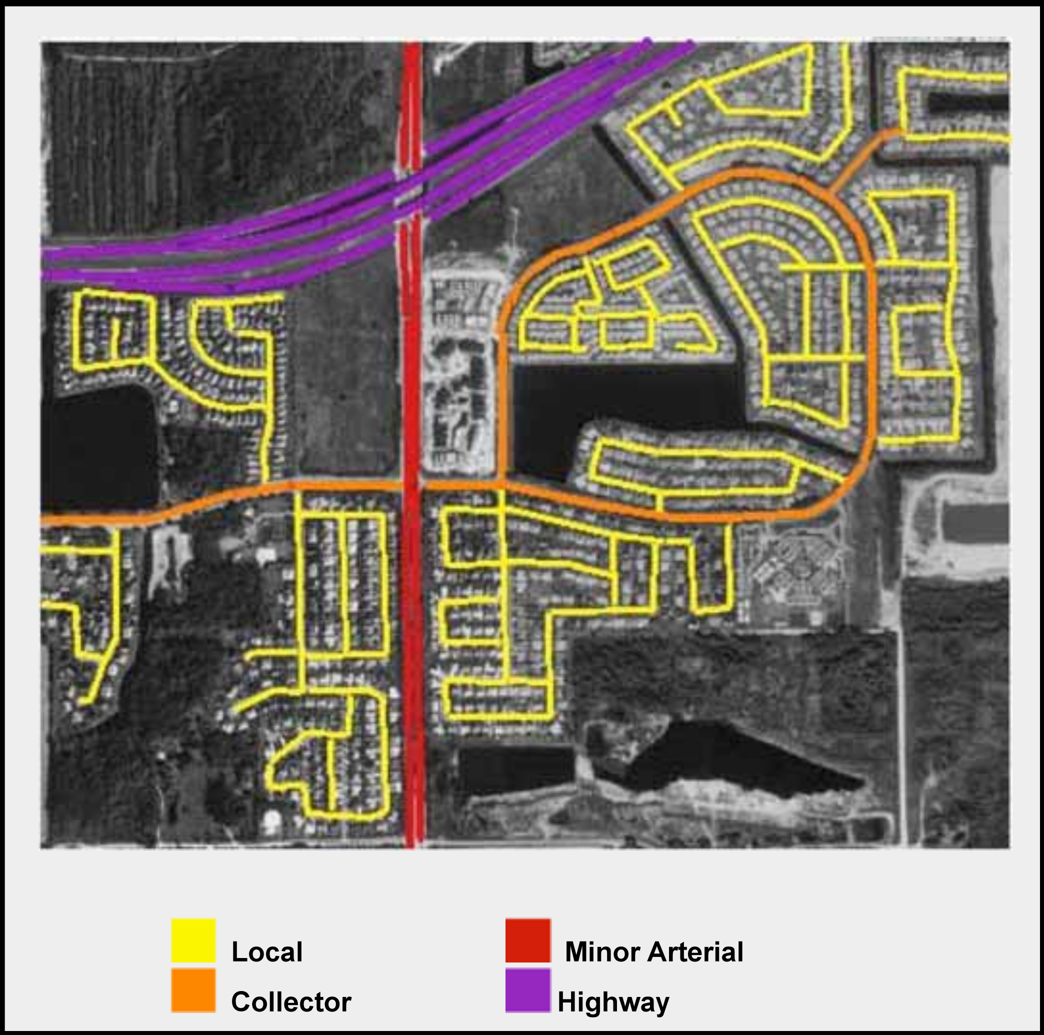
Collectors

- balance between mobility and access

Locals

- lower mobility
- high degree of access

The Garden Cities of To-Day



The conventional subdivision: Radburn without the internal pedestrian-way.

The focus of planners shifted from health and safety to the administration of land use codes.

Street design and traffic safety relegated to traffic engineers. – who are ill-trained to deal with safety in a substantive manner.

How did engineers deal with safety?

- Examined safety by roadway class.
  - Observed that Interstates reported fewer crashes than other roadway types.
- Safety performance attributed to the use of high design values.
  - “Forgiving to error”
- Resulted in the conclusion that the use of high design values for design speeds, offsets and clear zones enhances safety.

Highway Safety Hearings of 1966

What we must do is to operate the 90% or more of our surface streets just as we do our freeways… [converting] the surface highway and street network to freeway road and roadside conditions.”

Kenneth A. Stonex

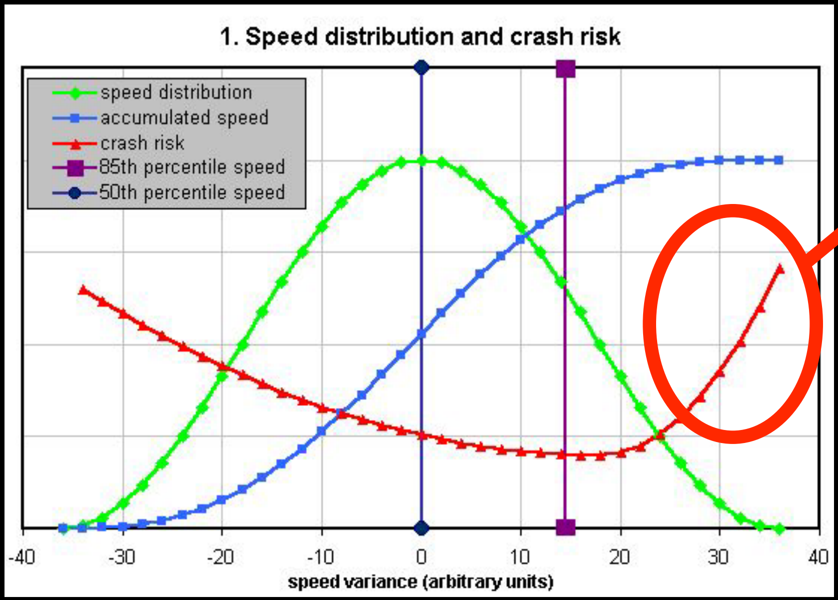
Design Speed and Safety

"Every effort should be made to use as high a design speed as practical to attain a desired degree of safety."

- AASHTO, 2001

The (Presumed) Benefit of High-Speed Design

- **Design Speed (85th Percentile Speed)**



Drivers at the high-end of speed distributions are more likely to crash

85th percentile speed seeks to address hazard by designing for the needs of this behavior

Source: FHWA, 1998

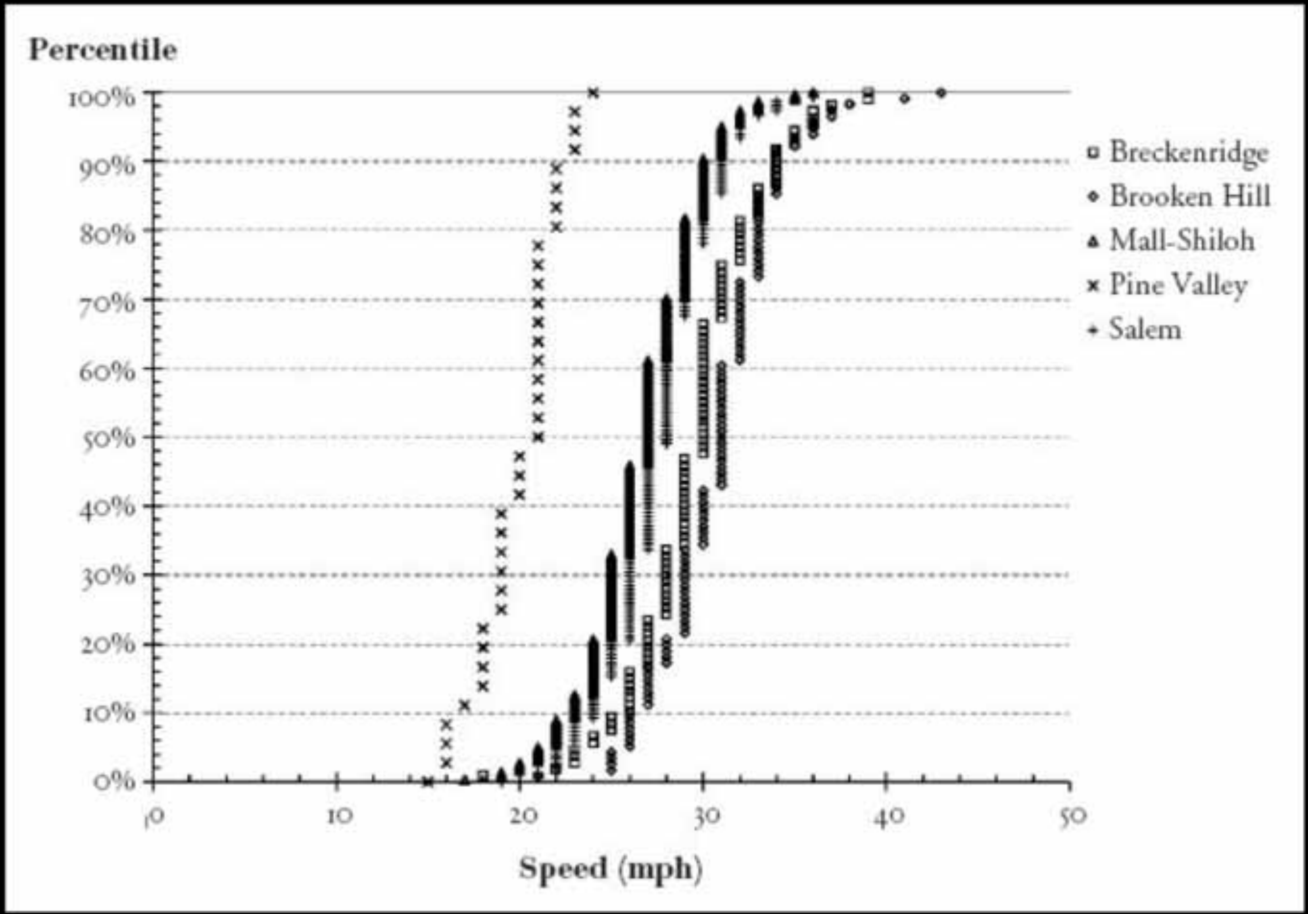
The Engineering Idea…

The Brooklyn Bridge has a design load of 80,000 tons…

…therefore it can safely accommodate 40,000 tons.

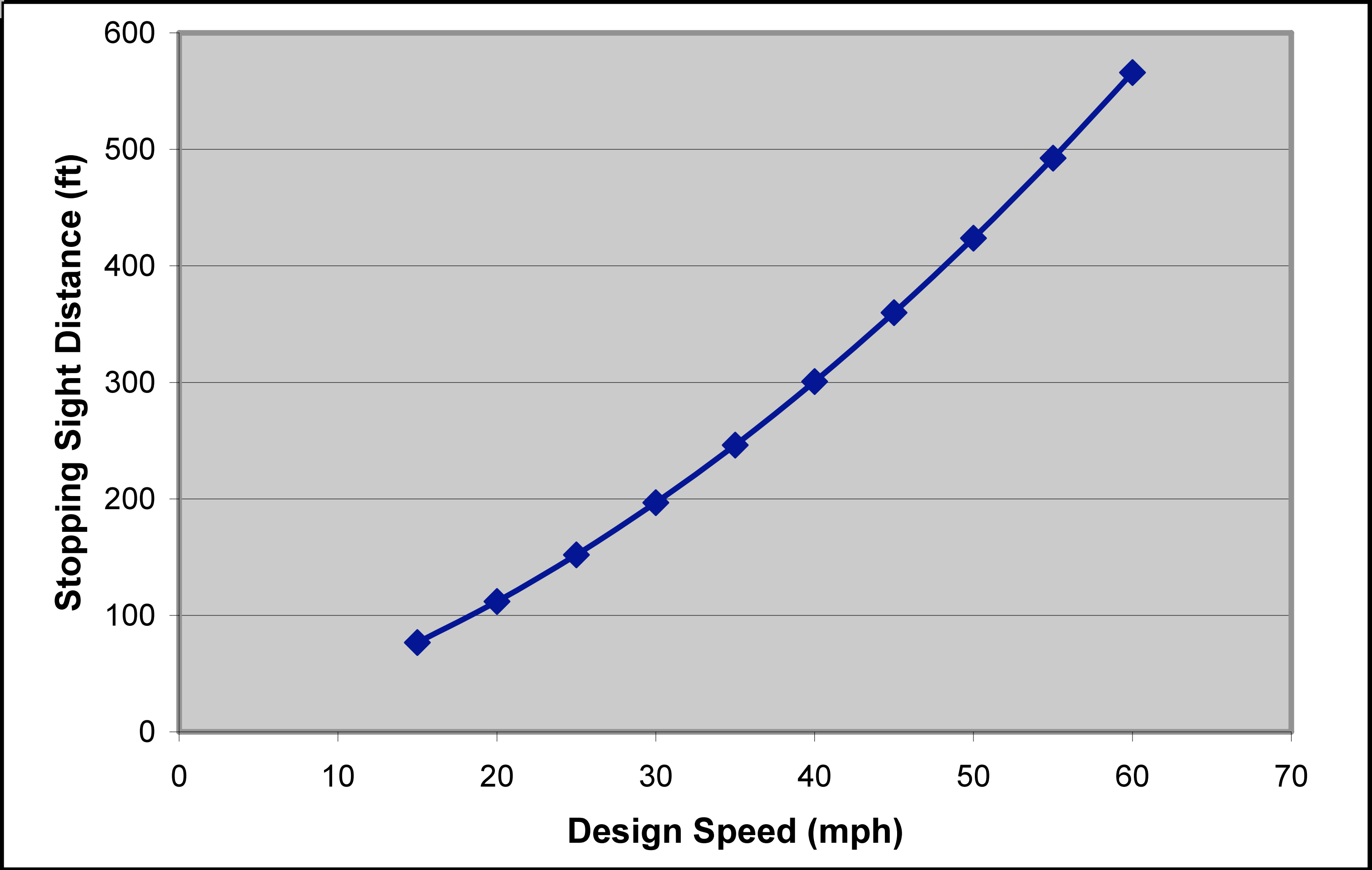
Likewise, if a street is designed for persons driving at 60 MPH, it is safe for persons driving 30 MPH.

...but people don't behave like structures



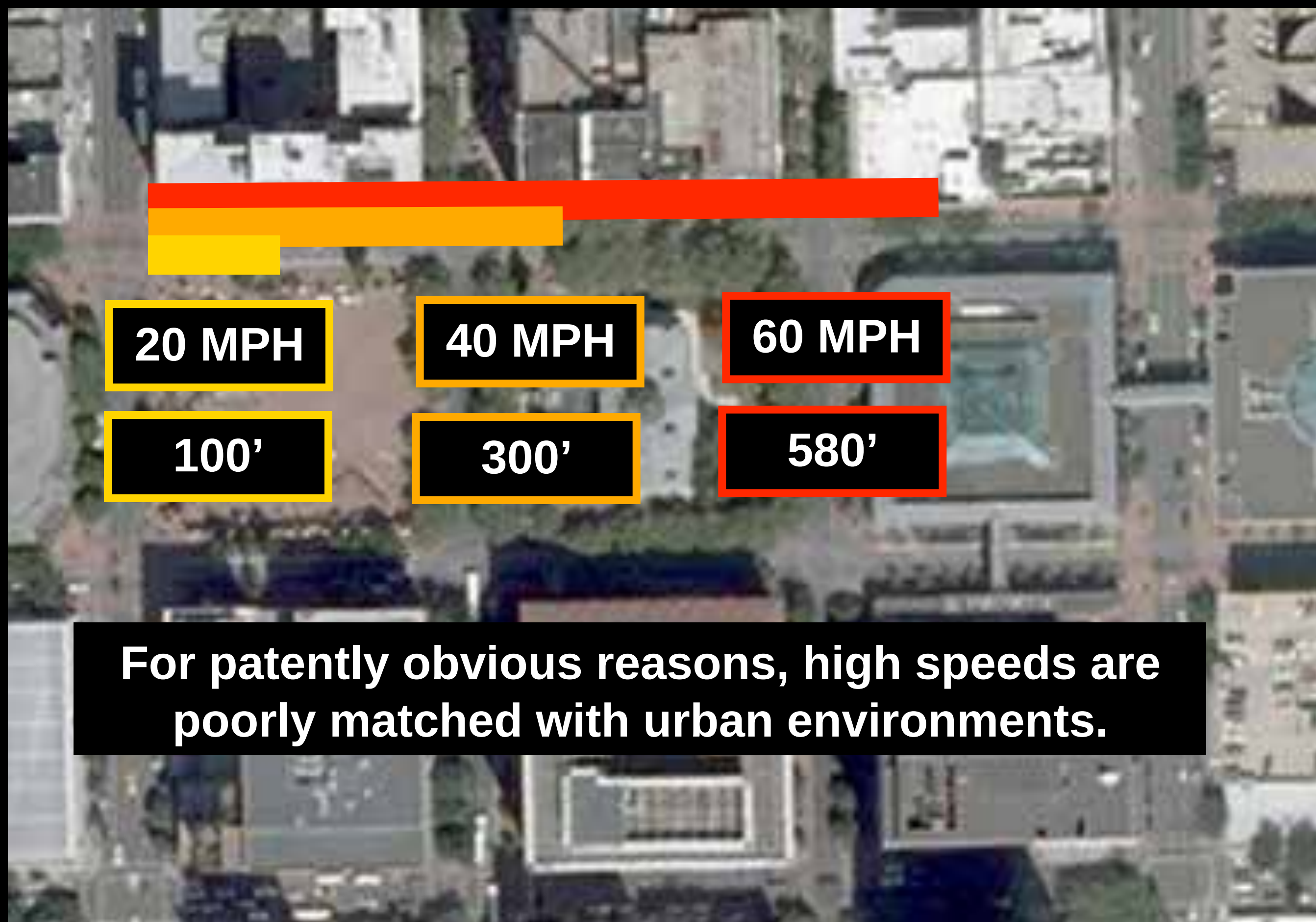
Increase a roadway's design speed and the operating speed curve shifts upwards.

Speed and Stopping Sight Distance



Speed and stopping sight distance (Source: AASHTO)

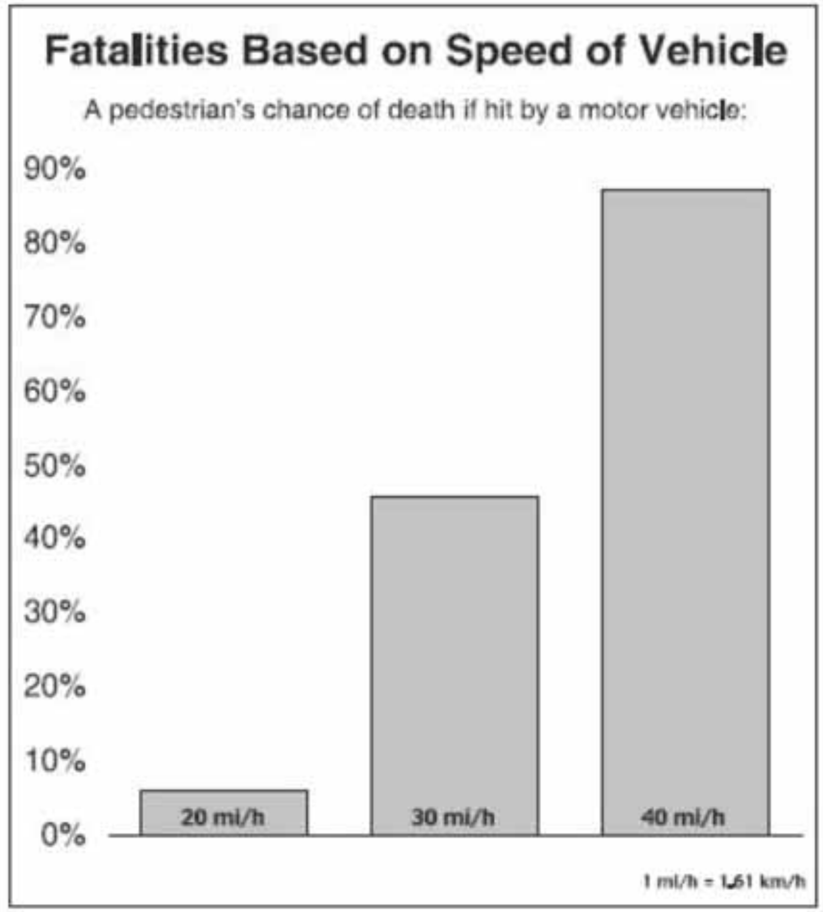
Distance traveled before vehicle can be brought to a complete stop at different speeds:



Portland, OR

Speed and Pedestrian Crash Severity

- Motorist speed and crash severity
  - Maximum confrontation speed lower for sensitive user groups, such as children.

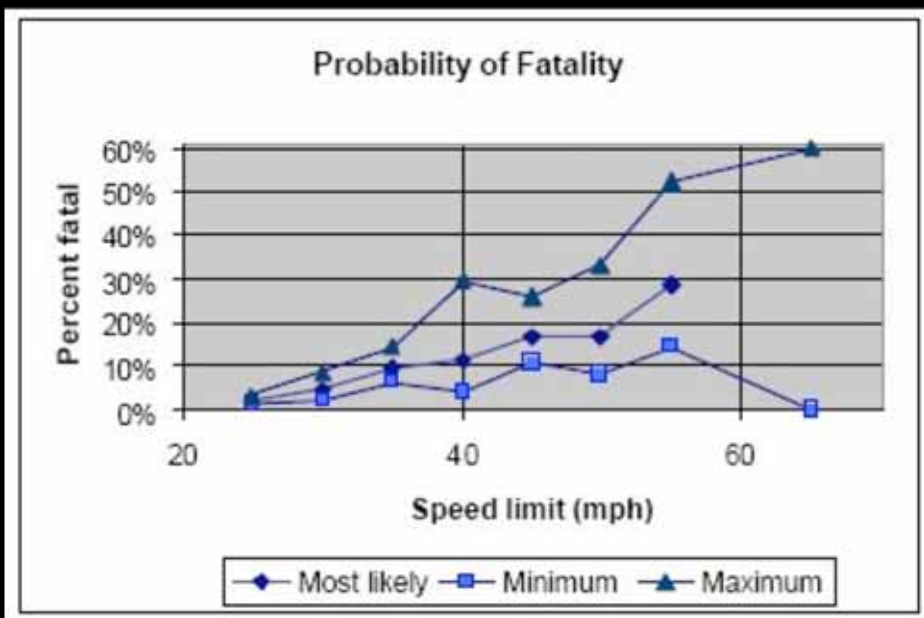


Source: U.K. Department of Transportation, *Killing Speed and Saving Lives*, London, 1987.

Anderson et. al., 1997; Ashton, 1982; Durkin and T. Pheby, 1992; UK Department of Transport, 1987; Vahl and Giskes, 1990.

Speed and Pedestrian Crash Frequency

- Yielding and pedestrian crash frequency



Garder, 2001; 2004

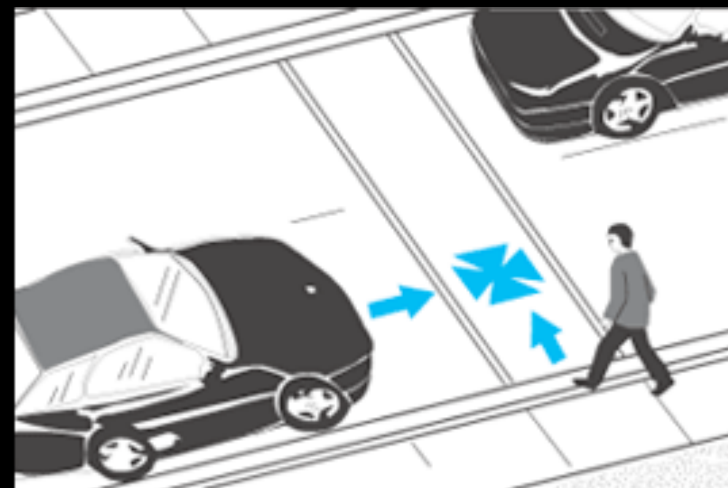
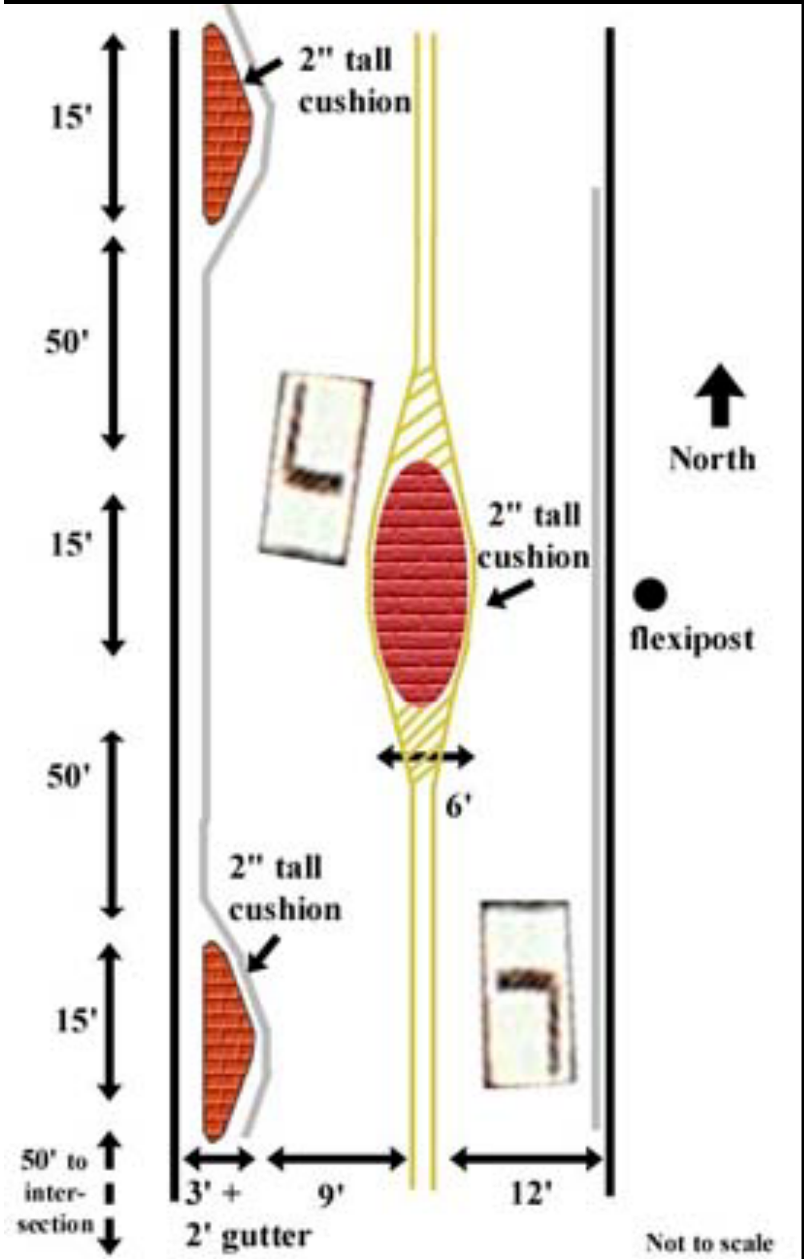


Table 8 Speed and yield behavior

Speed (mph)	% yielding
0-10	100%
11-15	28%
16-20	23%
21+	17%

Speed and Motorist Safety



- Traffic calming consistently reduces both vehicle speeds and crashes.
  - Effect varies by location and application type, but in general, traffic calming devices report average crash reductions of **at least 15%, and upwards to 87%**.
  - Pedestrian effects presumed rather than understood (especially roundabouts), but lower speeds logically benefit pedestrians.

Clarke and Domfield. 1994; Elvik, 1998; Ewing, 1999; Geddes, 1996; Hass-Klau et. al., 1999; Klik and Faghri, 1993; Mackie, Hodge, and Webster. 1993; Walter, 1995; Zein et. al., 1997; Huang and Cynecki, 2000; Sarkar, Nederveen, and Pols. 1997; Sarkar, Kaschade, and de Faria. 2003

What about our (safer) international peers?

United States

Every effort should be made to use as high a design speed as practical to attain a desired degree of safety.

- AASHTO, 2001

United Kingdom

Place considerations are important in determining the appropriate design speeds, speed limits, and road geometry.

- UK Manual for Streets, 2007

Considering the UK

An intermediate function road – safely addressing BOTH form and movement by reducing speeds.

Source: UK Manual for Streets

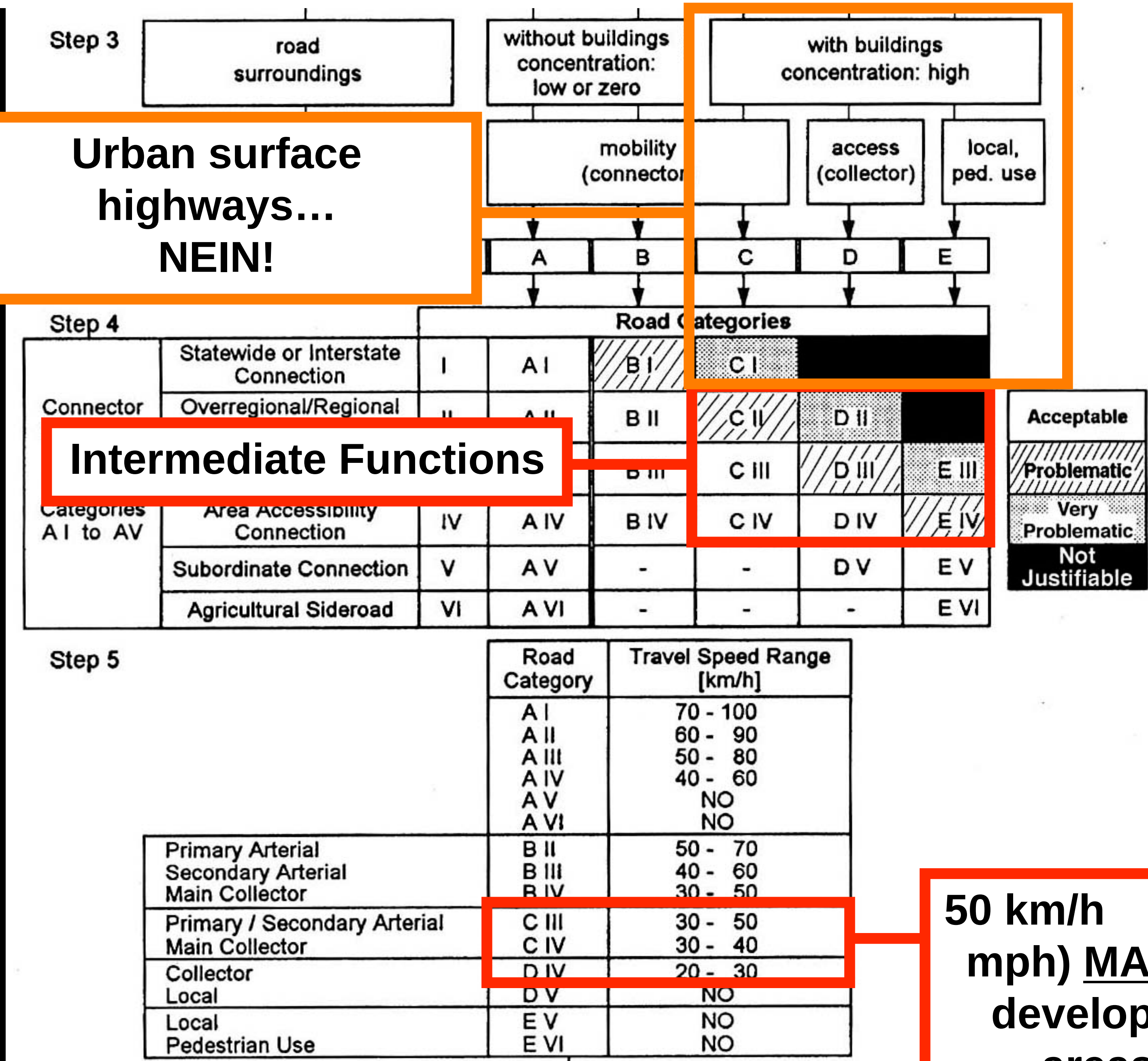
Curbing Speed in the UK

Sight Distance and Design Speed

Table 7.1 Derived SSDs for streets (figures rounded).

Speed	Kilometres per hour	16	20	24	25	30	32	40	45	48	50	60
	Miles per hour	10	12	15	16	19	20	25	28	30	31	37
SSD (metres)		9	12	15	16	20	22	31	36	40	43	56
SSD adjusted for bonnet length. See 7.6.4		11	14	17	18	23	25	33	39	43	45	59
		Additional features will be needed to achieve low speeds										

Source: UK Manual for Streets



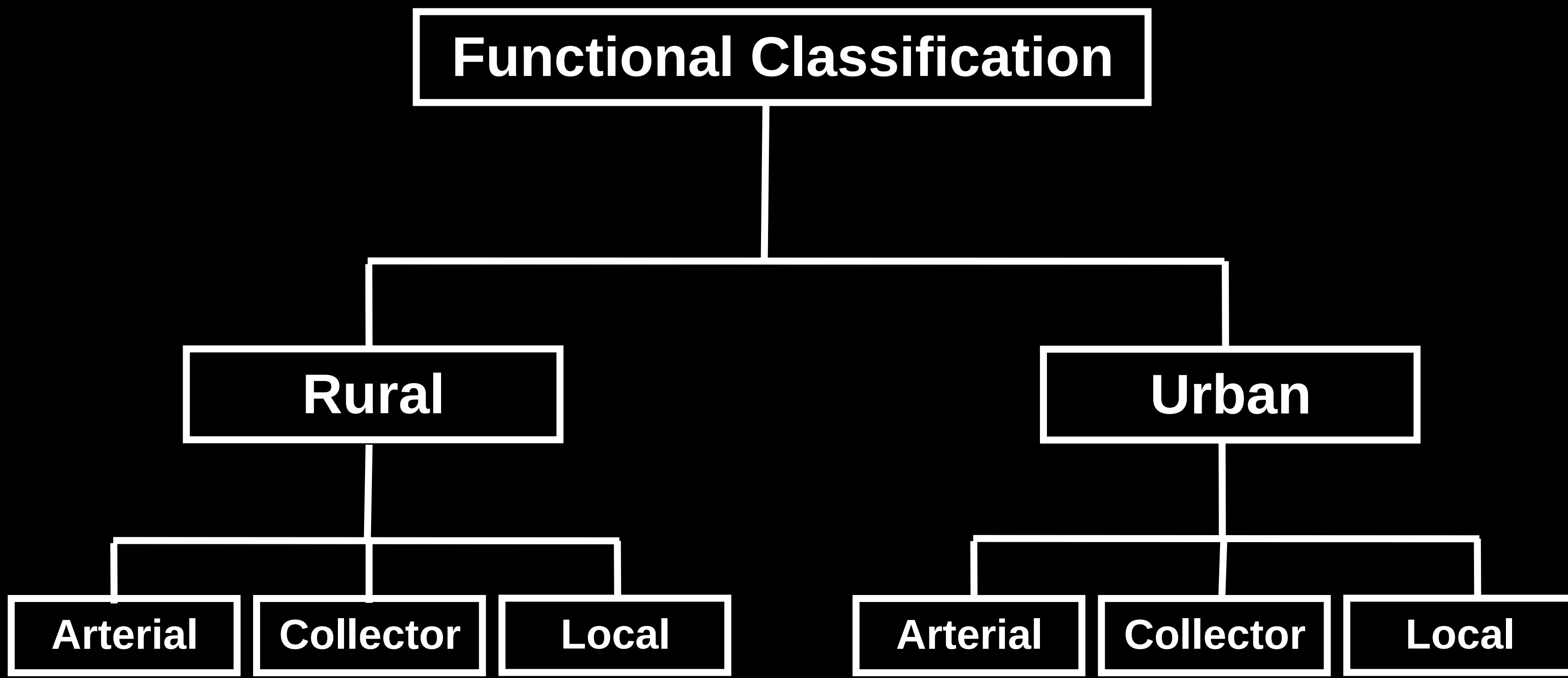
Urban surface highways… NEIN!

Intermediate Functions

50 km/h (30 mph) <u>MAX</u> in developed areas

The German Functional Classification System

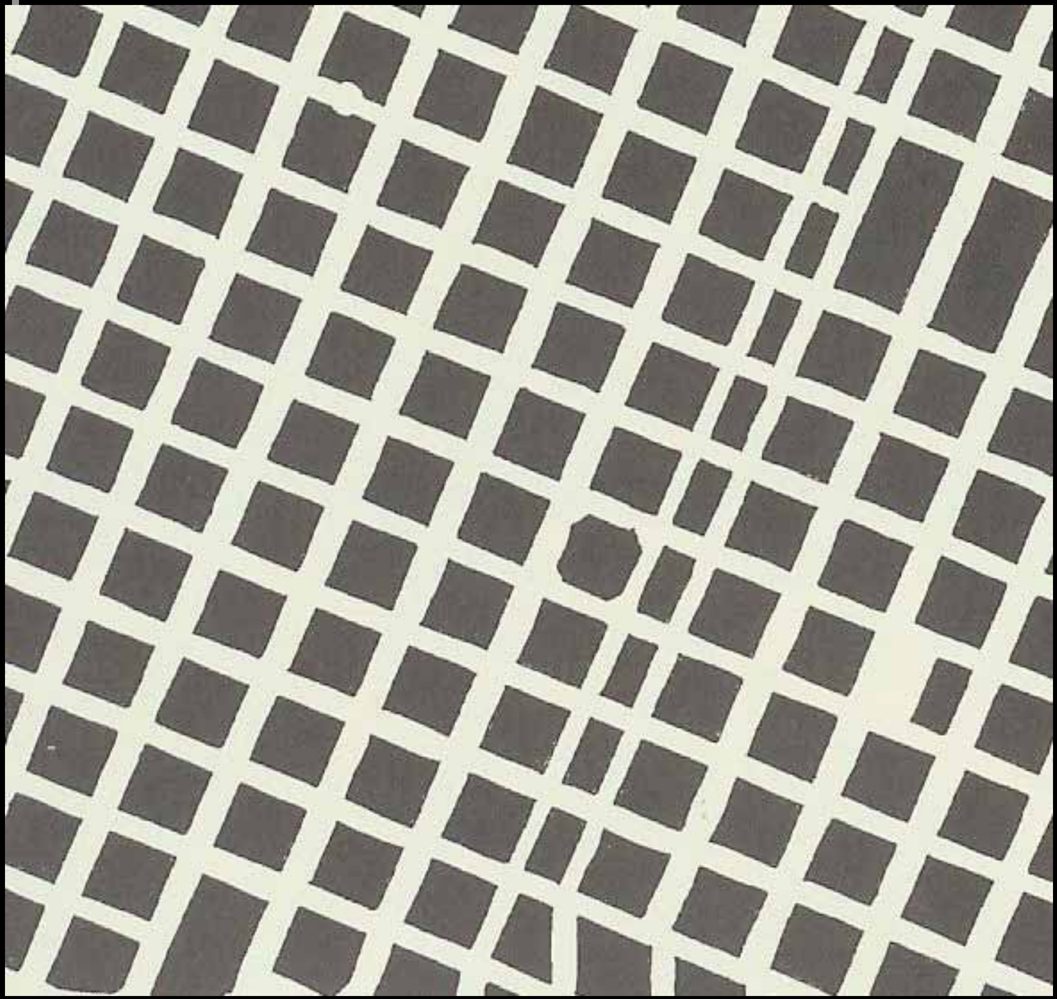
The United States



Considering Speed…

Classification	Example	Description	Design Speed
Arterial		Provides the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control.	**30-60 mph**
Collector		Provides a less highly developed level of service at a lower speed for shorter distances by collecting traffic from local roads and connecting them with arterials.	**30 mph or higher**
Local		Consists of all roads not defined as arterials or collectors; primarily provides access to land with little or no through-movement.	**20-30 mph**

Linking Function and Context



<u>Which are…</u>

- Arterials?
- Collectors?
- Locals?

Linking Function and Context

Which streets are urban arterials?

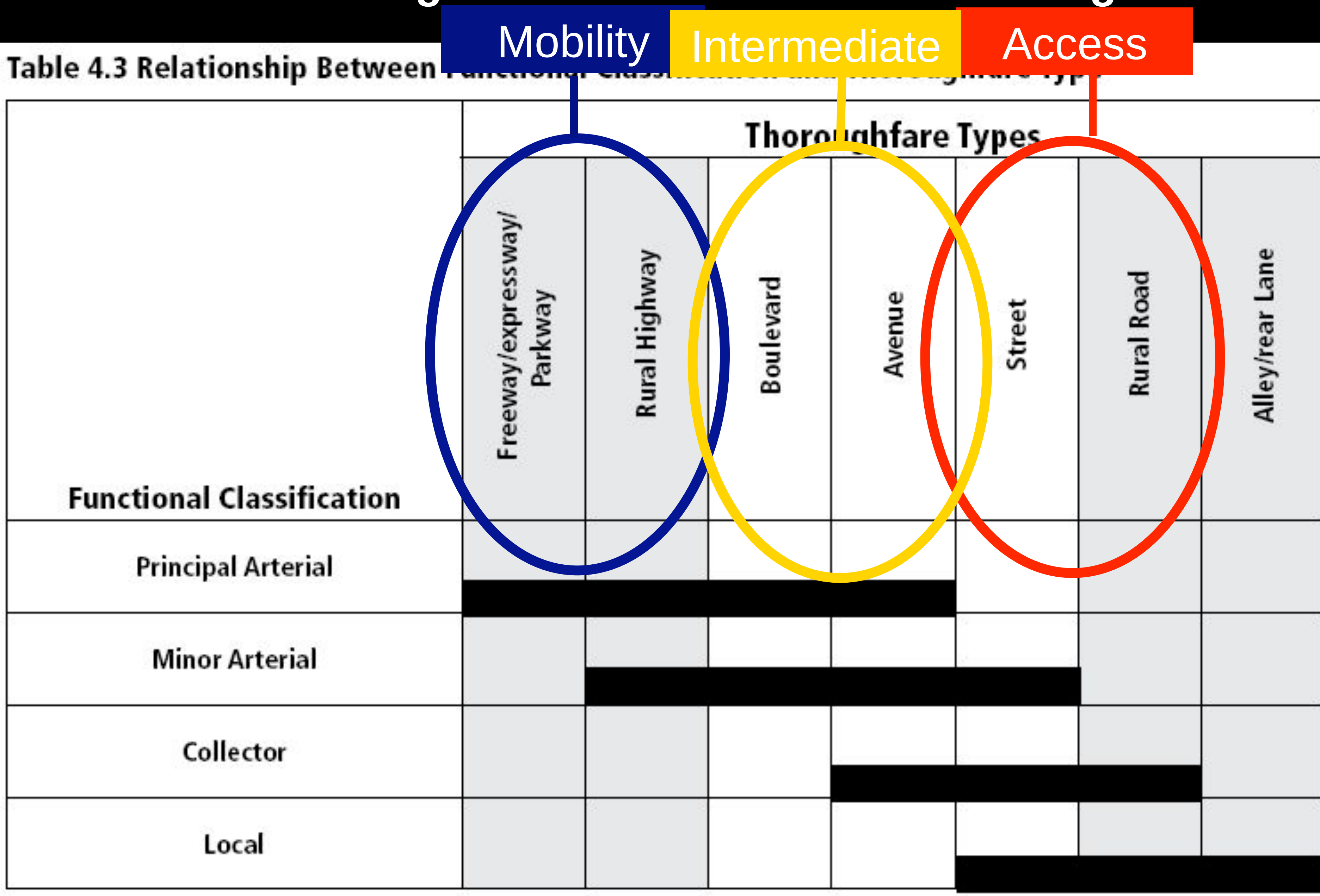
(a)

(b)

(c)

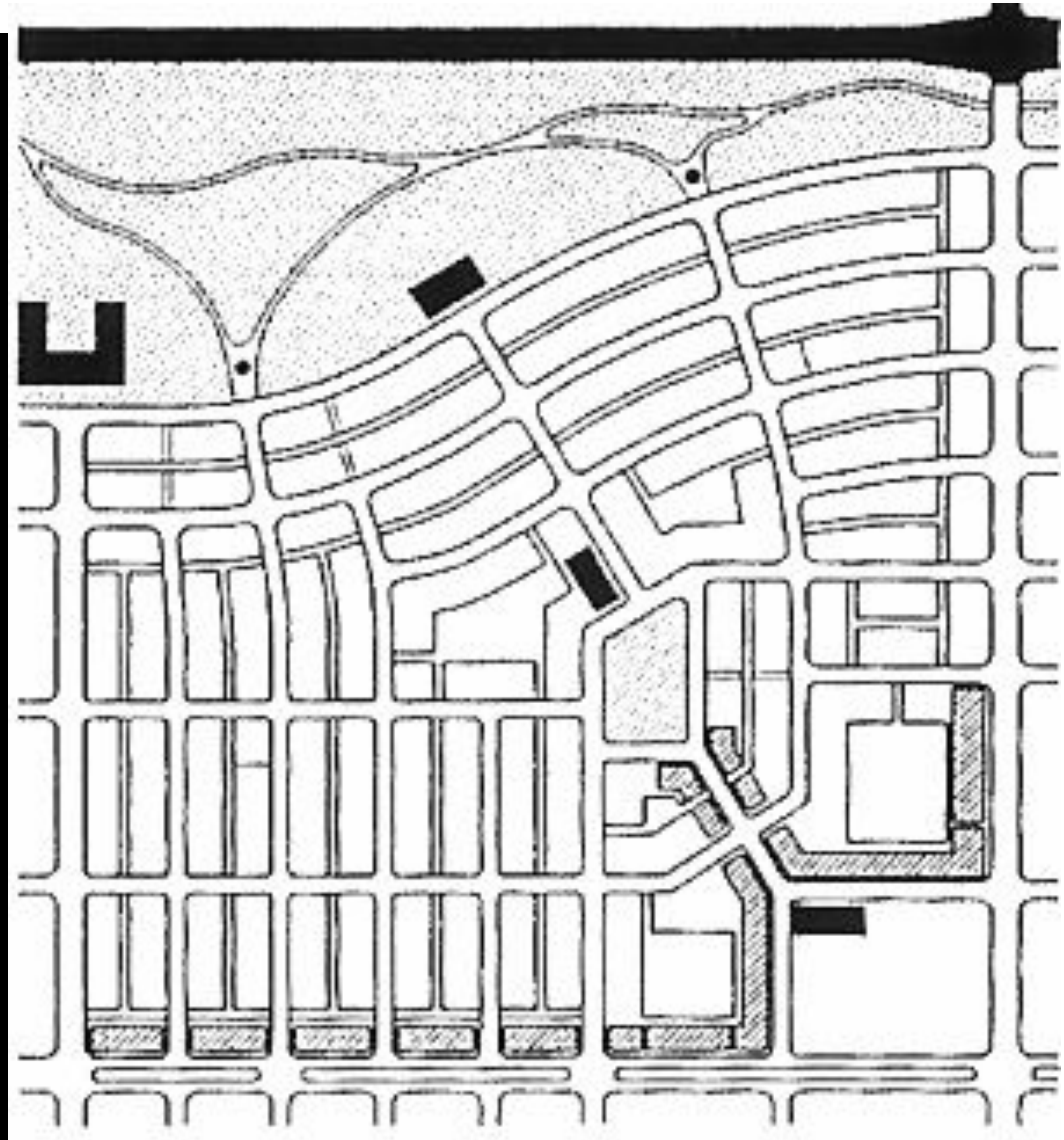
Urban designers have revisited street design

Table 4.3 Relationship Between



Rural

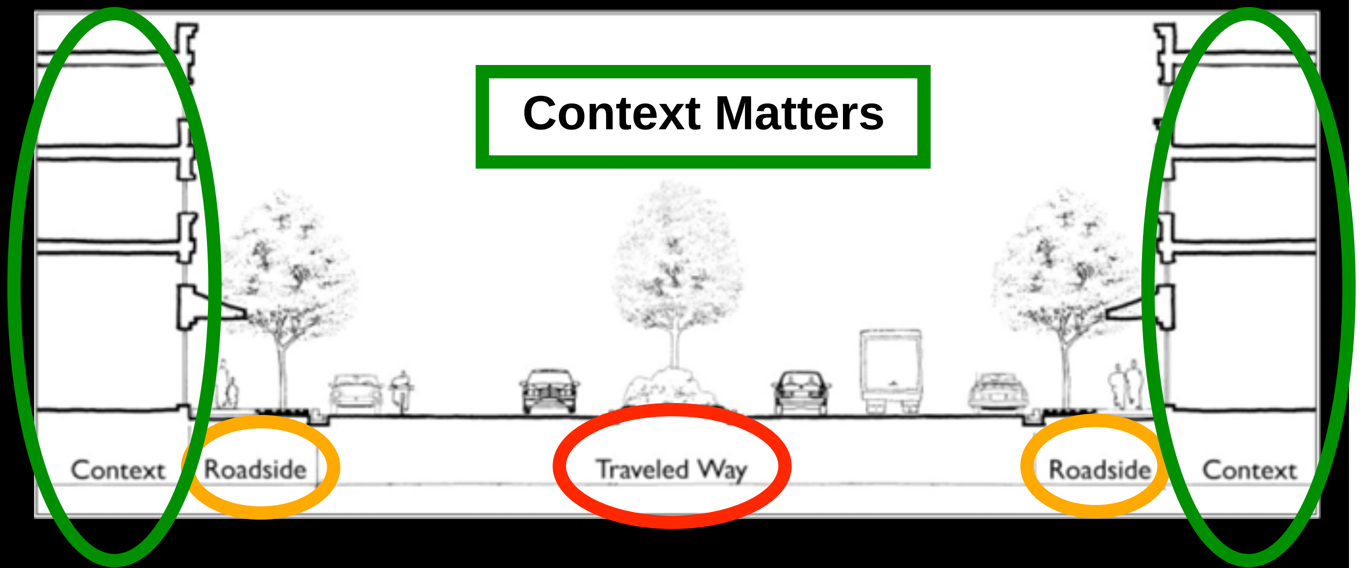
Urban



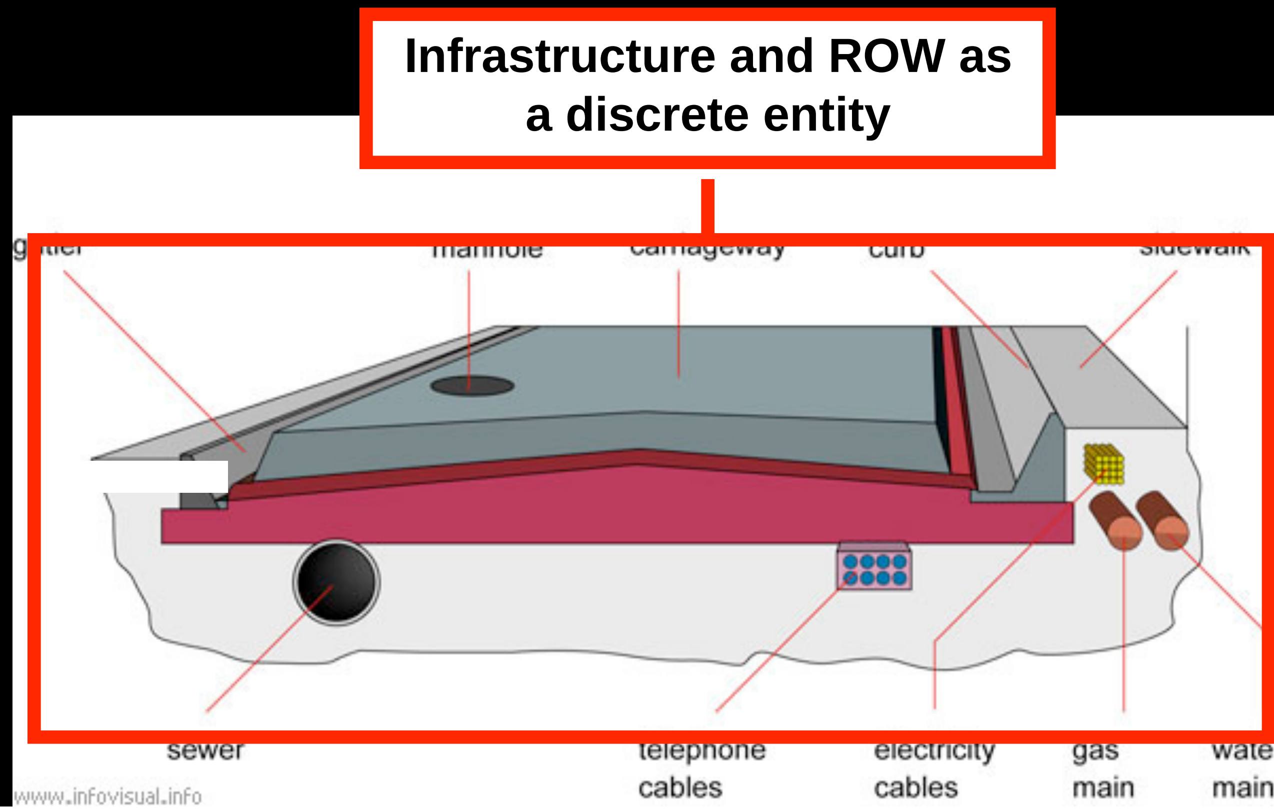
Linking Design to Function AND Context

	Suburban (C-3)				General Urban (C-4)				Urban Center/Core (C-5/6)			
	Residential		Commercial		Residential		Commercial		Residential		Commercial	
Context	Boulevard	Avenue	Boulevard	Avenue	Boulevard	Avenue	Boulevard	Avenue	Boulevard	Avenue	Boulevard	Avenue
Building Orientation (entrance orientation)	front, side	front, side	front, side	front, side	front	front	front	front	front	front	front	front
Maximum Setback [1]	20 ft.	20 ft.	5 ft.	5 ft.	15 ft.	15 ft.	0 ft.	0 ft.	10 ft.	10 ft.	0 ft.	0 ft.
Off-Street Parking Access/Location	rear, side	rear, side	rear, side	rear, side	rear, side	rear, side	rear, side	rear, side	rear	rear	rear	rear
Roadside												
Recommended Roadside Width [2]	14.5 ft.	12.5 ft.	16 ft.	15 ft.	16.5 ft.	12.5 ft.	19 ft.	16 ft.	21.5 ft.	19.5 ft.	21.5 ft.	19.5 ft.
Pedestrian Buffers (planting strip exclusive of travel way width) [2]	8 ft. planting strip	6-8 ft. planting strip	7 ft. tree well	6 ft. tree well	8 ft. planting strip	6-8 ft. planting strip	7 ft. tree well	6 ft. tree well	7 ft. tree well	6 ft. tree well	7 ft. tree well	6 ft. tree well
Street Lighting	For all arterial thoroughfares in all context zones, intersection safety lighting, basic street lighting and pedestrian-scaled lighting is recommended. See Chapter 8 (Roadside Design Guidelines) and Chapter 10 (Intersection Design Guidelines).											
Traveled Way												
Target Speed (mph)	35	25-30	35	35	35	25-30	35	25-30 [3]	35	25-30	30	25-30 [3]
Design Speed	Design speed should be a maximum of 5 mph over the operating speed. Design speed is used as a control for certain geometric design elements including sight distance and horizontal and vertical curvature.											
Number of Through Lanes [4]	4-6	2-4	4-6	2-4	4-6	2-4	4-6	2-4	4-6	2-4	4-6	2-4
Lane Width [5]	10-11 ft.	10-11 ft.	10-12 ft.	10-11 ft.	10-11 ft.	10-11 ft.	10-12 ft.	10-11 ft.	10-11 ft.	10-11 ft.	10-11 ft.	10-11 ft.
Parallel On-Street Parking Width [6]	7 ft.	7 ft.	8 ft.	8 ft.	7 ft.	7 ft.	8 ft.	8 ft.	7 ft.	7 ft.	8 ft.	8 ft.
Min. Combined Parking/Bike Lane Width	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.	13 ft.
Horizontal Radius (per AASHTO) [7]	762 ft.	510 ft.	762 ft.	762 ft.	762 ft.	510 ft.	762 ft.	510 ft.	762 ft.	510 ft.	510 ft.	510 ft.
Vertical Alignment	Use AASHTO minimums as a target, but consider combinations of horizontal and vertical per AASHTO Green Book.											
Medians (which will accommodate single left-turn lanes at intersections) [8]	14-16 ft.	Optional 14 ft.	14-16 ft.	Optional 14 ft.	14-16 ft.	Optional 14 ft.	14-16 ft.	Optional 14 ft.	14-16 ft.	Optional 14 ft.	14-16 ft.	Optional 14 ft.
Bike Lanes (min./preferred width)	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.	5 ft./6 ft.
Access Management [9]	Moderate	Low	High	Moderate	Moderate	Low	High	Low	Moderate	Low	High	Low
Typical Traffic Volume Range (vpd)	20,000-35,000	15,000-25,000	20,000-50,000	10,000-35,000	10,000-30,000	10,000-20,000	15,000-40,000	5,000-30,000	15,000-30,000	10,000-20,000	15,000-40,000	5,000-30,000

The Urban Design Perspective



The Engineering Perspective



Safety and the Transect

Considering the Safety Benefits of the design concepts embodies in the ITE/CNU Manual

Safety and Transect Street Design

1. Travelway
   - ROW and Lane Widths
   - Median Design and Width
   - On-Street Parking
2. Roadside
   - Sidewalks
   - Buffer Zones vs. Clear Zones
3. Context and Traffic Safety

Considering Safety Research – A Disclaimer

One size does not fit all…

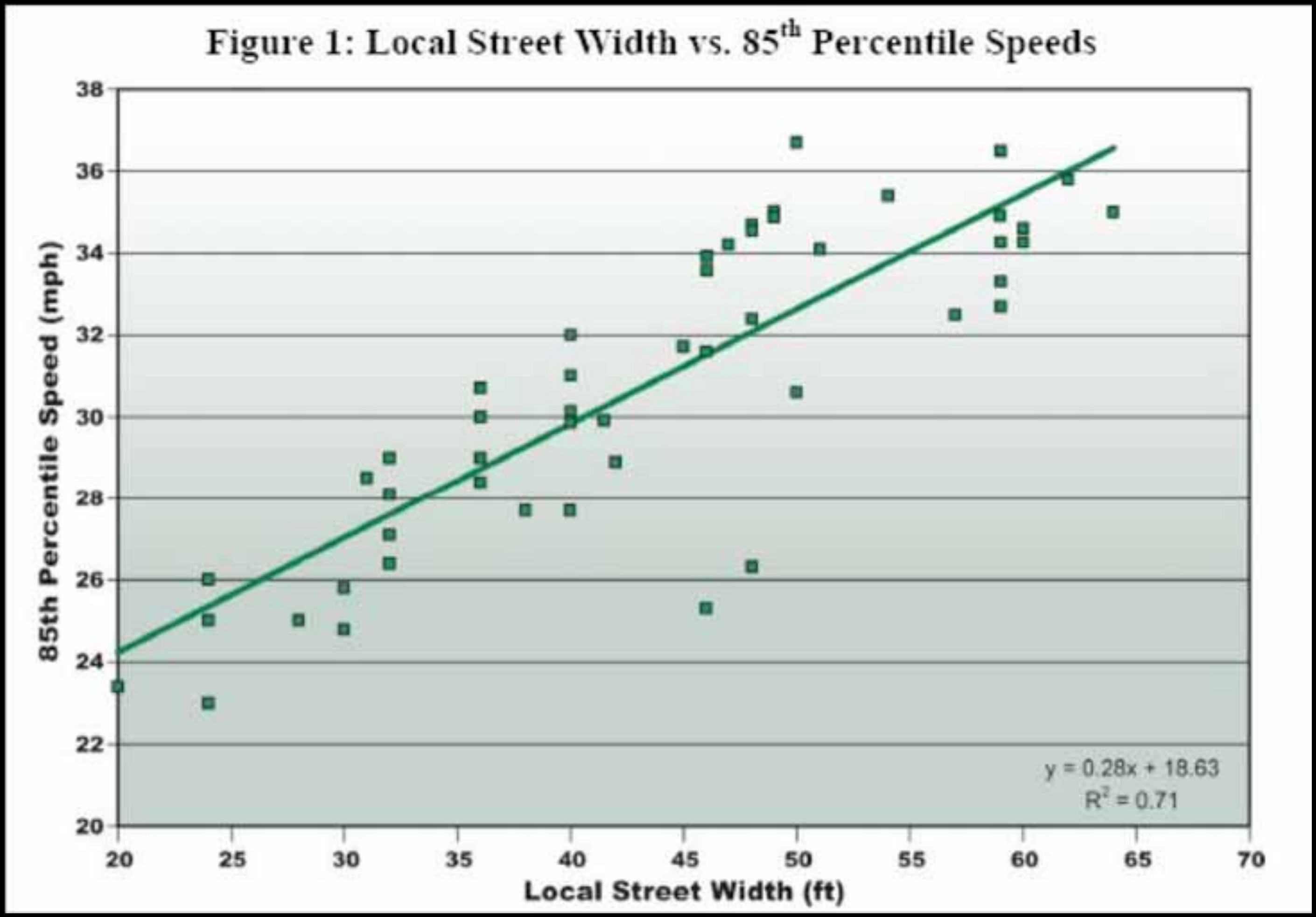
Considering Safety Research – A Disclaimer

… and few studies explicitly account for the safety effects of the built environment.

1. Safety and the Travelway

- Right-of-Way Widths
- Lane Widths
- Medians (and Access Management)
- Street Parking

Speed and ROW Width



Source: McCourt et. al, 2005

The Safety of the Travelway: ROW Widths

Studies consistently find that adding lanes ***increases*** crashes, while eliminating lanes though "road diet" projects decreases crashes.

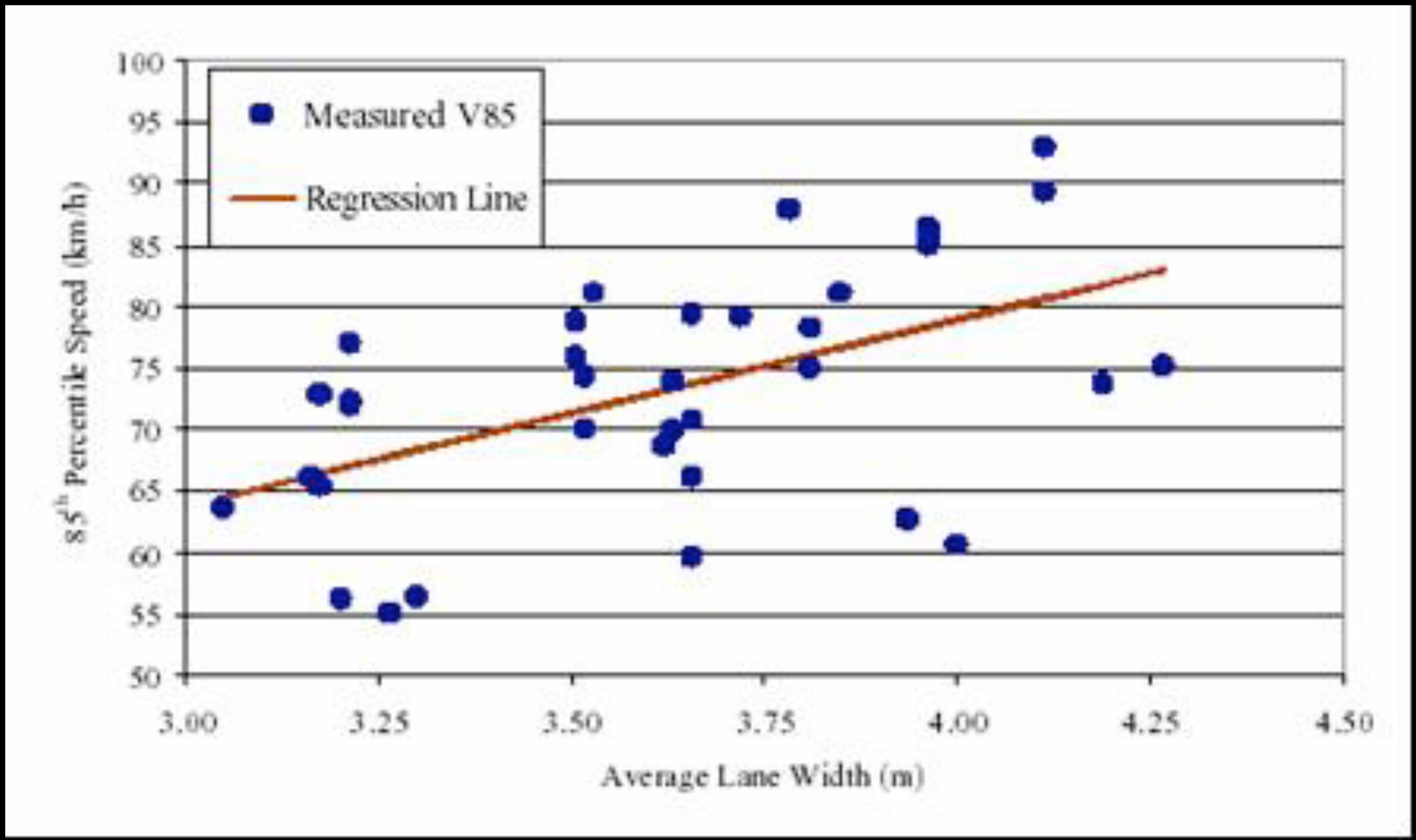
Collisions per 100 Vehicle Miles

Development Type	Residential	Commercial
Cross Section		
Two-Lane	110	270
Three-Lane	180	210
Undivided Four Lane	230	260

Source: Hummer and Lewis, 2000

Sources: Harwood, 1986; Harwood,1990; Huang, Stewart, and Zegeer, 2001; Hummer and Lewis, 2000; Knapp and Giese, 2001; Milton and Mannering, 1998; Noland and Oh, 2004; Sawalha and Sayed (2001); Vitalano and Held 1991.

Speed and Lane Widths...



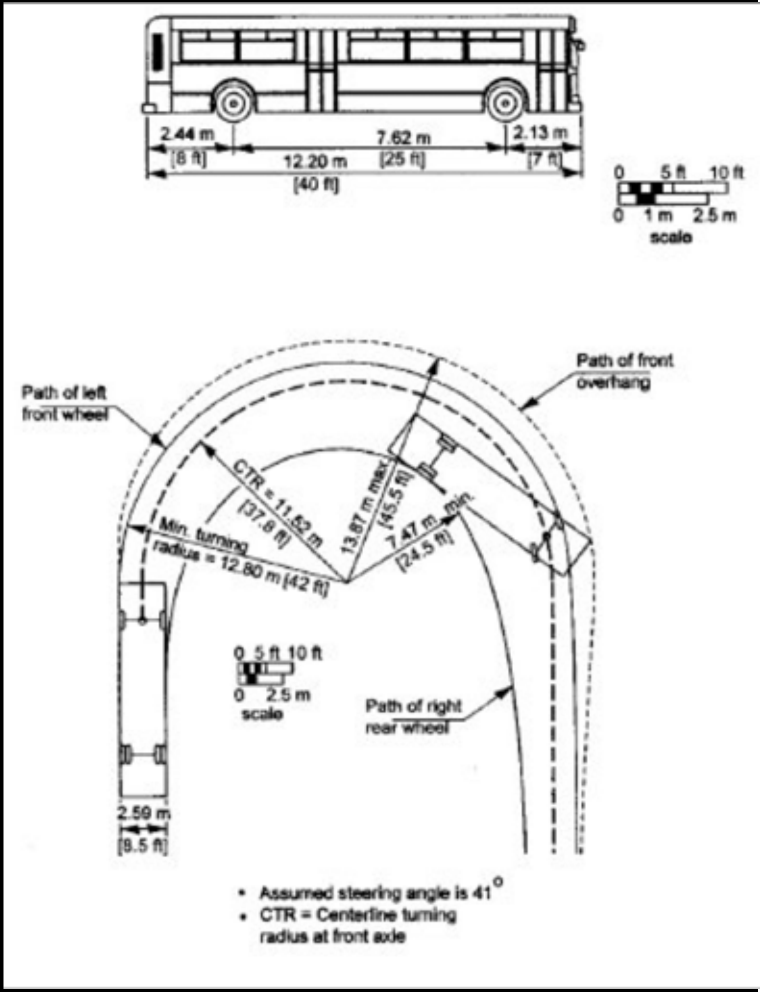
Source: Fitzpatrick et. al., 2001

The Safety of the Travelway: Lane Widths

- Studies on lane widths report ***mixed results***, with some studies finding wider lanes are safer, and other finding wider lanes are more dangerous.
- In general, lane widths appear to have a “U” shaped relationship with crash performance, with crashes decreasing until lane widths reach roughly 11.5 feet, and increasing thereafter.

Sources: Clark, 1985; Dumbaugh, 2005; Farouki and Nixon, 1976; Fitzpatrick et al., 2001; Gattis and Watts, 1999; Harwood, 1990; Hauer, 1999; Heimbach et al., 1983; Lee and Mannering, 1999; Noland and Oh, 2004; Zegeer, Deen and Mayes,1981.

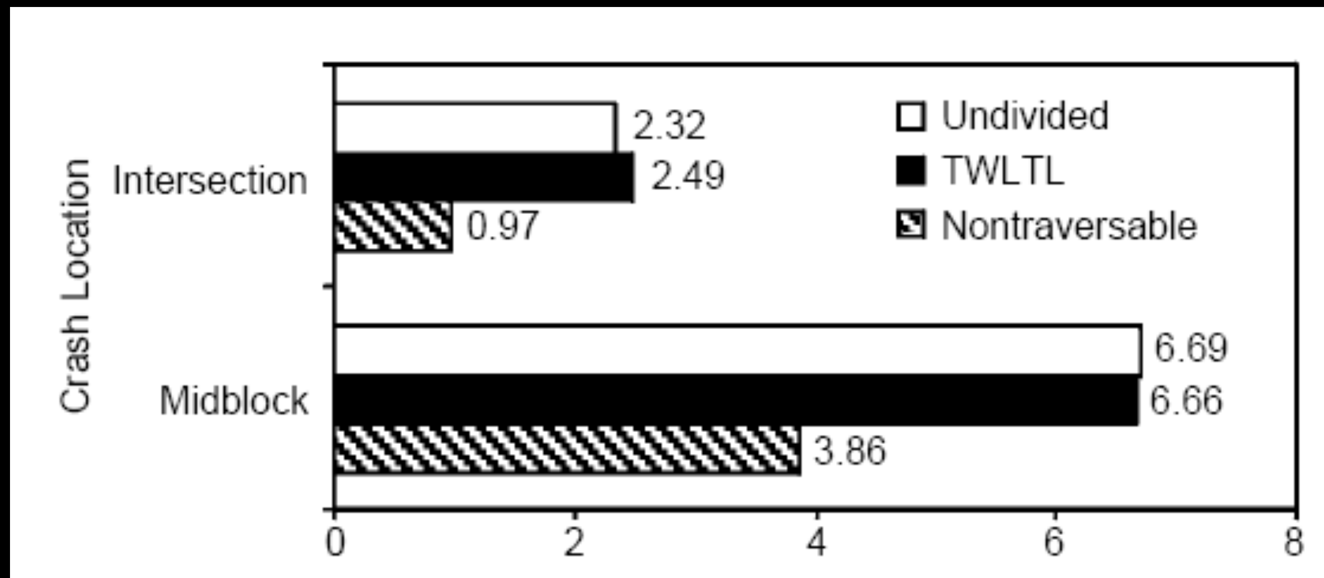
Link lane widths to use



The Safety of the Travelway: Medians

Medians and Pedestrian Safety

Source: Boman and Vecellio, 1994



The Safety of the Travelway: Medians

Motorist Safety

	Median Type		
Access Points per Mile	Undivided	Two-Way Left-Turn Lane	Non-Traversable Median
≤ 20	3.8	3.4	2.9
20-40	7.3	5.9	5.1
40-60	9.4	7.9	6.8
>60	10.6	9.2	8.2

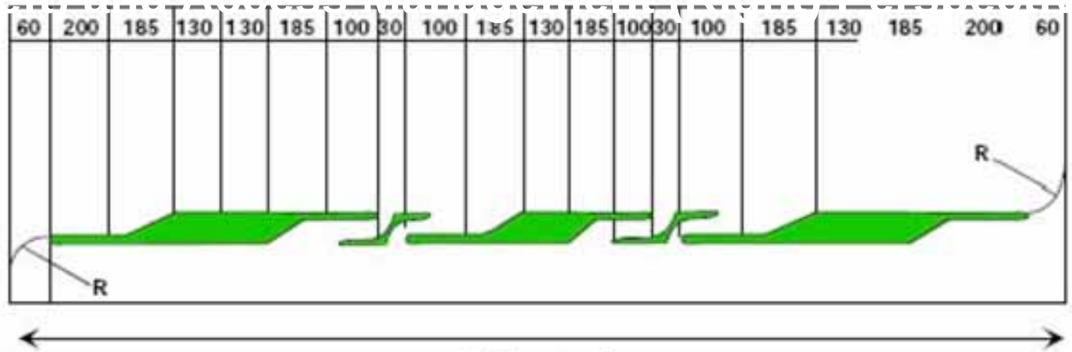
Source: Committee on Access Management, 2003

A Caution about Access Management…

WHY IS ½ MILE SPACING SO GOOD?

Space for:

- Safety
- Operations
- Flexibility
- Signal Progression
- Aesthetics



45 mph
2,610 ft

The Safety of the Travelway: Street Parking

The presence of on-street parking reduce vehicle speeds by 2-5 MPH

But…

Link parking	*Whether any accidents on link* *No*	*Yes*	*Sample size*	*Percentage of links with personal injury incidents*
No parking	32	3	35	8.6
Parking on one side	18	4	22	18.2
Parking on both sides	9	5	14	35.7

Source: UK Manual for Streets

The Safety of the Travelway: Street Parking

- Before you get too dispirited…
  - There is little detailed research on street parking.
  - The increase in crashes were associated largely with property-damage only crashes – **not** injuries or fatalities.
  - The UK Manual for Streets proceeds to encourage the use of on-street parking as a speed-control measure.

2. Safety and the Roadside

- Sidewalks
- Buffer Zones vs. Clear Zones

Roadside Design and Safety: Sidewalks

- **Sidewalks:**
  - 50% fewer crashes in residential and mixed-use areas with sidewalks.
  - 88% fewer walking along roadway crashes.
  - No observed benefit on pedestrian safety in commercial areas.
  - Safety research is limited, and little contextual information available.

Knoblauch et. al., 1988; McMahon et. al., 1999.

Roadside Design and Safety: Buffer Zone

- **Safety issues: buffer zones vs. clear zones**
- **Roadside safety is a real issue…**
  - Roughly **12,000** fatal crashes, and **190,000** injury crashes associated with fixed-objects each year (FARS; GES)
  - Current practice encourages the provision of clear runout zones – i.e., eliminate the "roadside hazards," like trees.

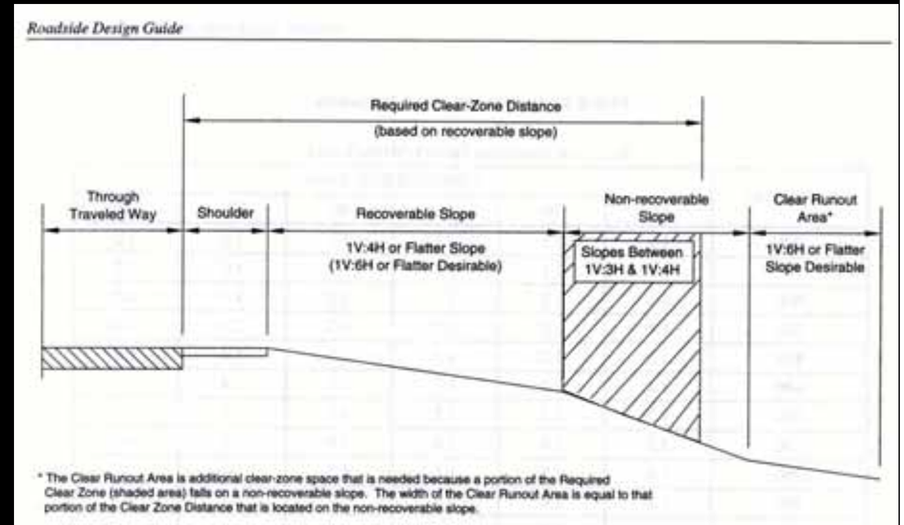


FIGURE 3.2 Example of a parallel foreslope design

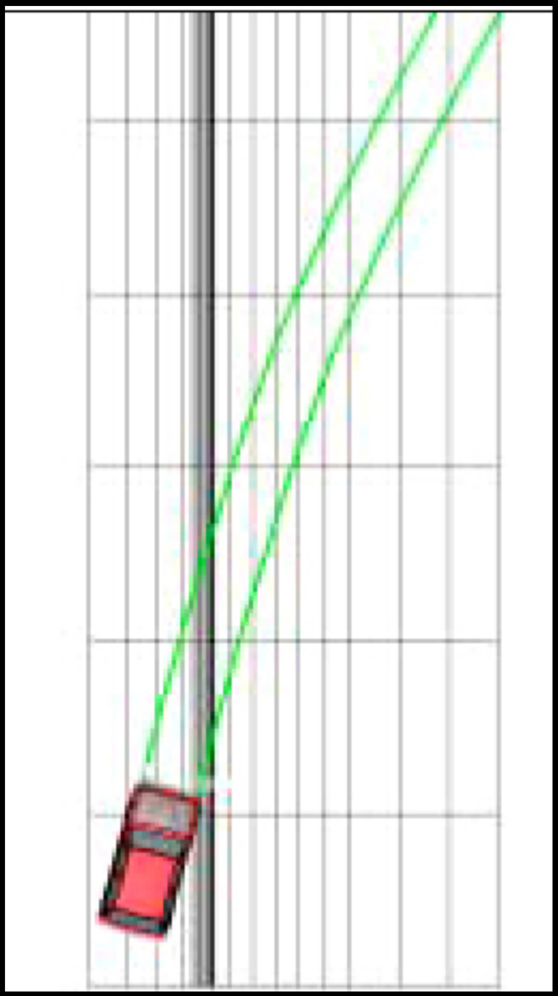
Roadside Design and Safety: Buffer Zone

- The presence of roadside objects generally ***reduces*** crashes on non-freeway urban roadways, while they increase crashes in rural environments.

Sources: Dumbaugh, 2005a; 2005b; 2006; Ossenbruggen, Pendharkar and Ivan, 2001; Lee and Mannering, 1999; Naderi, 2001.

The Engineering Theory

- Guidance and literature and crash tests all assume run-off-roadway crashes are random, midblock events.
- If so, than increasing fixed-object offsets should enhance safety.



Source: FDOT

Roadside Design and Safety: Buffer Zone

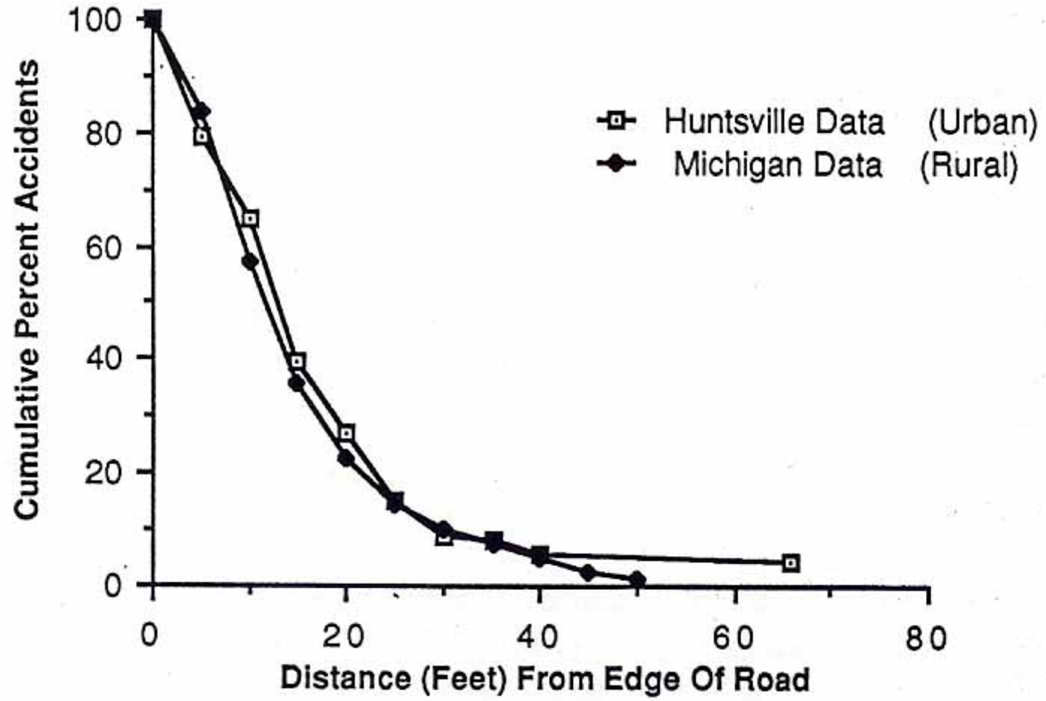


FIG. 8. Lateral Clearance to Trees

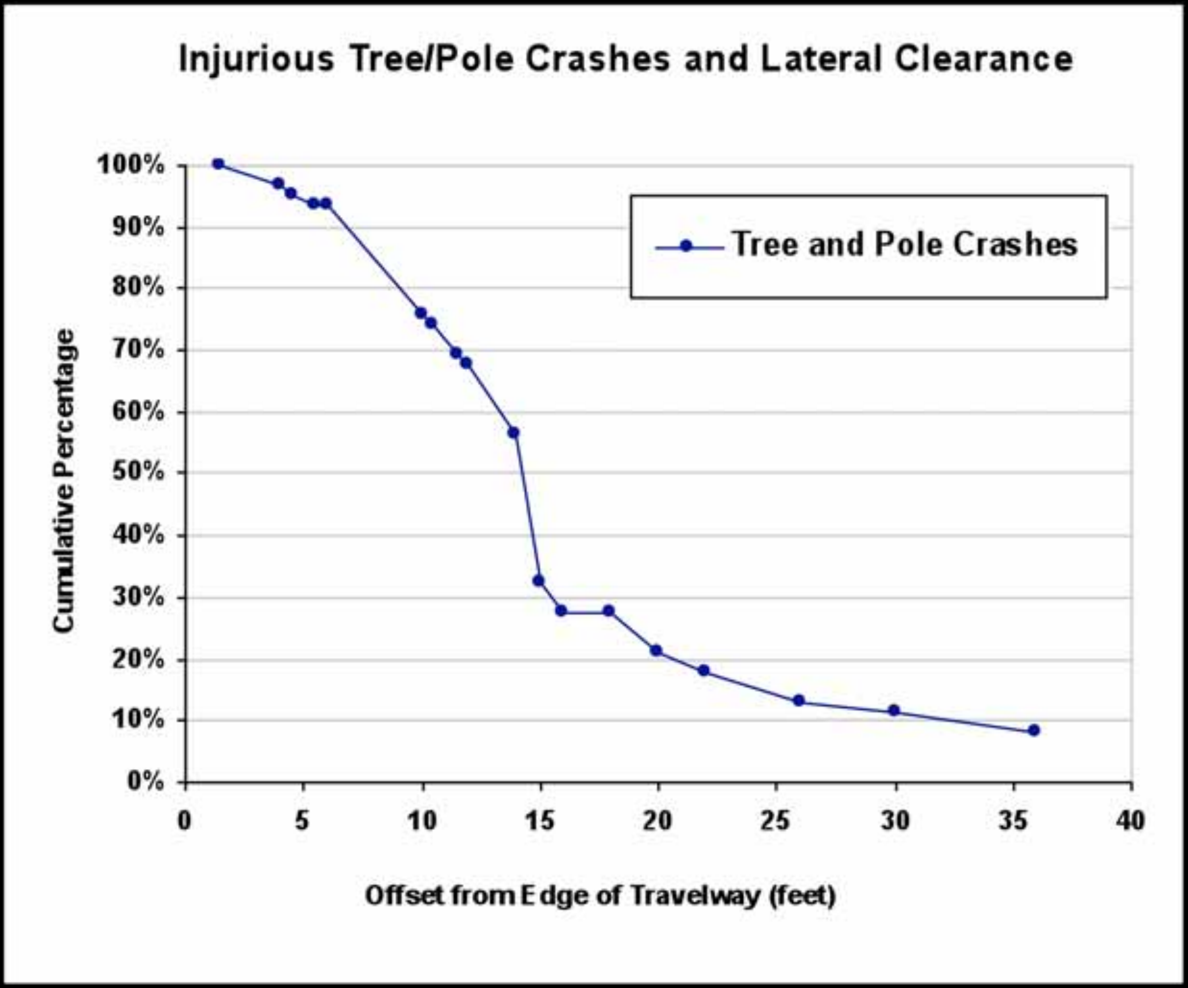
The Evidence:

The majority of urban tree-related crashes occur on roadways with offsets of 30 feet or less.

Study Conclusion:
30 ft clear zones in urban areas are desirable for safety.

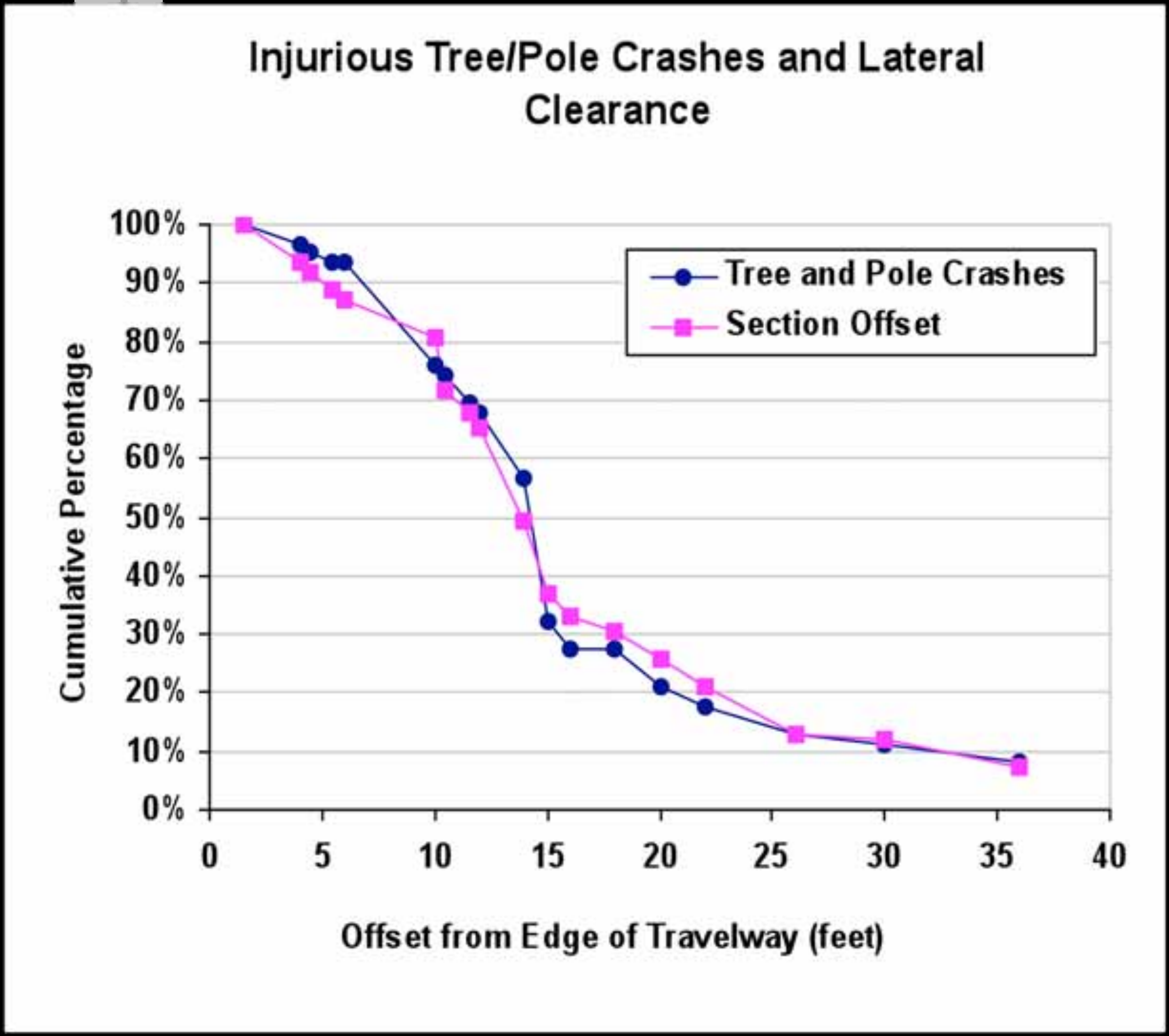
Source: Turner and Mansfield, 1990

Re-Examining Roadside Statistics…



Same crash distribution…

Crash Probability Roughly Constant



…which simply reflects the low percentage of total lane miles with wide clear offsets.

The relative probability of a roadside crash is relatively constant for roadways with all clear offset widths.

Livable Streets

Woodland Blvd - Stetson University

5-Year Crash Totals:

- 0 Fixed-Object Crashes
- 0 Fatalities
- 0 Pedestrian Crashes
- 4 Injurious Midblock Crashes

Urban Roadside Crashes

Representative Urban Fixed-Object Crash

- Why do roadside crashes occur? Field investigations…
- **83%** of tree and pole crashes occurred behind an intersection or driveway on higher-speed roadway sections.

Urban Roadside Crashes

Representative Urban Fixed-Object Crash

Systematic Pattern:

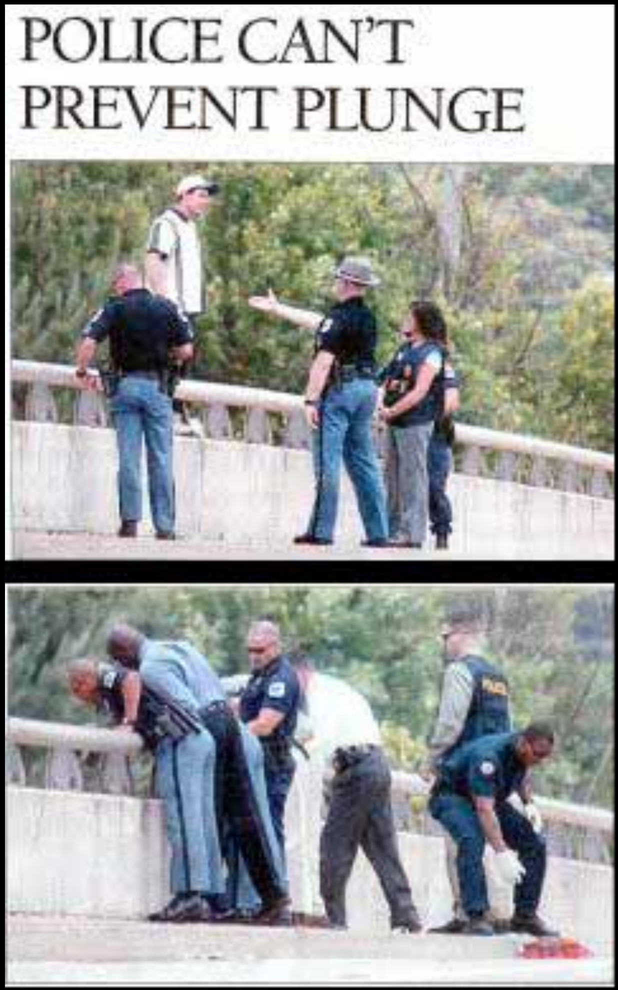
- Higher operating speeds along primary arterial
- Attempt to turn onto a driveway or side street at higher speeds.
- Higher-speed turn results in vehicle leaving the travelway behind the side street.

3. Context and Traffic Safety

- Rethinking Error, Risk, and Urban Design

Don’t blame the victim…

- **We engineers often blame the victim: “driver failure.”**
- **People (generally) <u>do not</u> intend to be injured or killed as part of their travel activity.**
  - Only 91 transportation-related suicides in 2001
    (Source: WISQARS)
  - This means that 42,105 people died that did not intend to die.



Source: AJC, May 28, 2004

Random vs. Systematic Error

- ***Random Error*** is error that naturally occurs as a result of human fallibility.
  - Humans will err, and a roadway should be “forgiving” when they do.
  - Assumes driver error is constant and fixed.
  - Strives for a single, “fail-safe” design solution.
  - Conventional traffic engineering practice is based on assumptions of **random error – for *95%* of all crashes**
- ***Systematic Error*** is an idea from the field of ergonomics – systematic error is a design problem that results from **mismatches in the interaction between people and their environments**.
  - Recognizes that designs may ***produce*** error.
  - Systematic error occurs when a roadway encourages inappropriate expectations regarding safe operating behavior.
  - Focuses on understanding and addressing unsafe driver behavior, rather than attempting to engineer “fail-safe” designs.

Question…

- Why would different geometric design features have different effects in different environments?
- Answer: CONTEXT MATTERS.

Drivers read the road

- **Drivers read the road – not signs.**

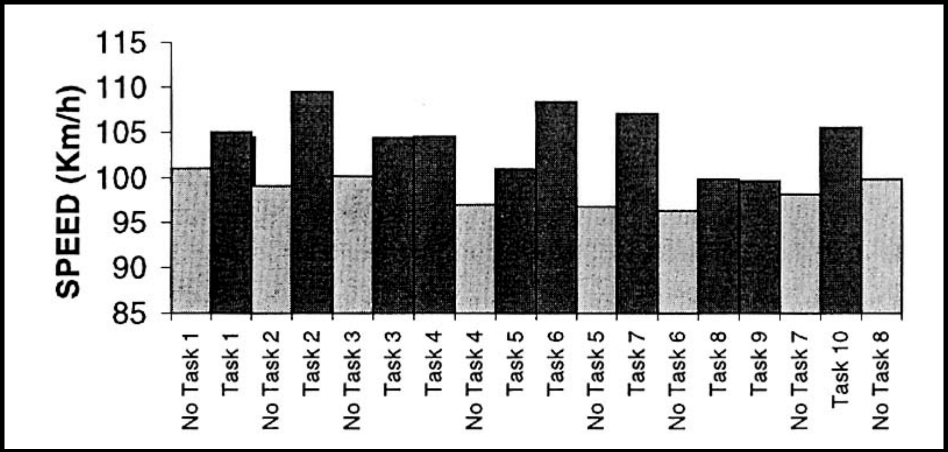
75% of drivers in urban areas ignore posted speed limits

Drivers fail to interpret roughly half of all road signs

Sources: Al-Madani and Al-Jahani, 2002; Chowdhury et. al., 1998; Fitzpatrick et. al., 2003; Fitzpatrick et. al., 1996; Kubilins, 2000; Tarris et al., 2000

Drivers read the road

- **Drivers are *naturally inclined* to read the road – not signs**



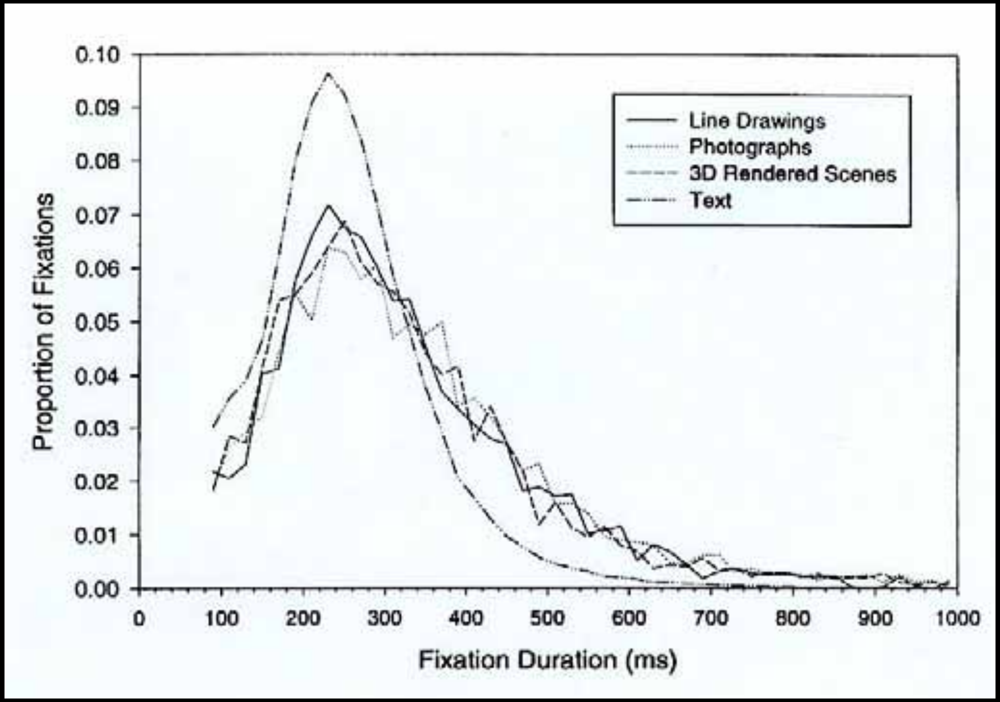
Source: Recarte and Nunes, 2002

Minor arterial designed to freeway standards

Drivers read the road

Visio-perceptive activity for viewing scenes and images is similar to that of reading.

Key difference: the locations where information is sought.



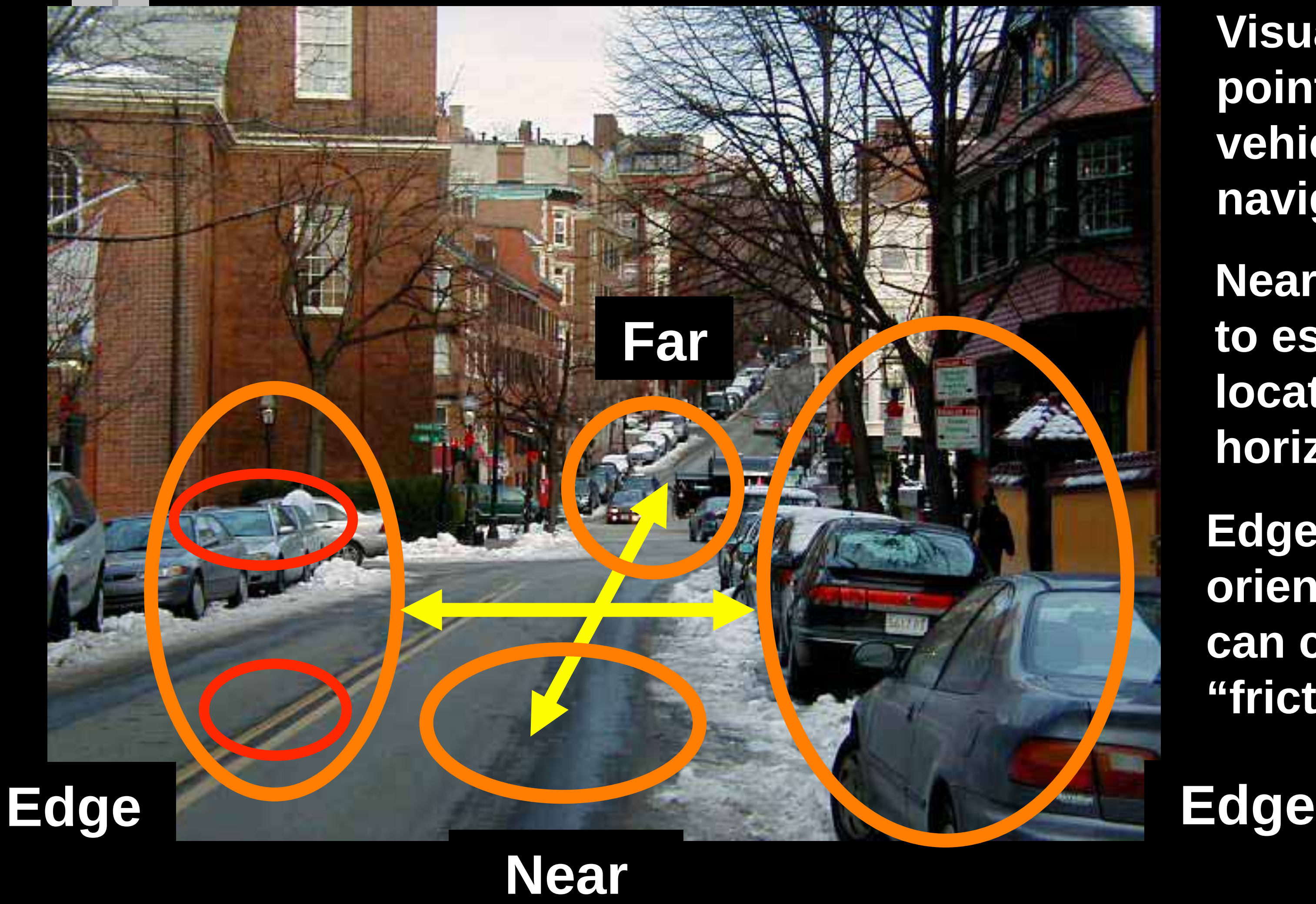
Source: Henderson and Hollingsworth, 1998

Drivers read the road

- Key question: What information to drivers use when they “read” the road?

- The next slide will show a road scene
  - Analyze the scene from a driving perspective

The road as text



Visual fixation points used in vehicle navigation.

Near and far used to establish location and horizon.

Edges used for orientation, and can create visual "friction."

The road as text

- **Road scene are broken down into "salient" visual regions**
- Salience based on:
  - **Information Needs**
  - **Luminance**
  - **Contrast**
  - **Texture**
  - **Color**
- **Drivers are more diligent in searching for potential hazards in in more complex, or "salient," environments.**

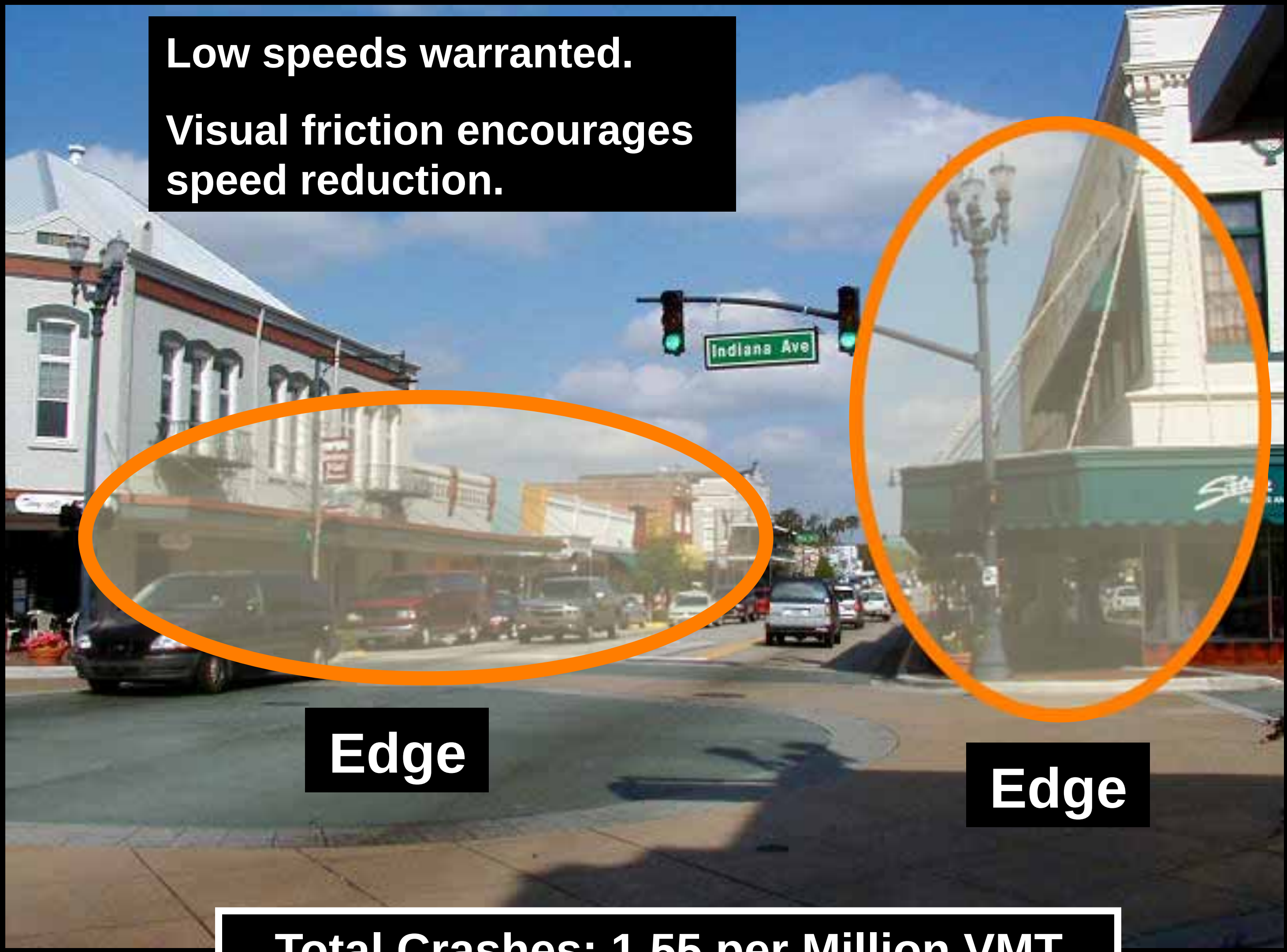
Sources: Groeger, 2000; Henderson and Hollingsworth, 1998

The road as text

- **Driving in monotonous environments results in a fewer eye movements and fixations, and results in driver inattentiveness (Roge et. al, 2002).**

Salient regions are less engaging along suburban and rural roadways

Salience and Safety



Total Crashes: 1.55 per Million VMT

Injury Crashes: 0.99 per Million VMT

Salience and Safety

Low speeds warranted for safety.

Design communicates speed.

Total Crashes: 2.87 per Million VMT

Injury Crashes: 2.11 per Million VMT

The Interstate Approach

Interstate Design

- **Random error addressed through "forgiving" design.**
- **Systematic error minimized *<u>by design</u>*:**
  - Limited access, with few opportunities for turning maneuvers.
  - Where turns permitted, they are accompanied by ramps that allow for gradual deceleration.
- The design is safe and appropriate in its given context – undeveloped areas.

Full Access-Management is also an effective safety approach...

- Similar design solution appropriate on urban arterials where access-management principles are fully applied.
- Similar characteristics:
  - Higher speeds
  - Few driveways and side streets.
  - Deceleration lanes.

"Access Management"

The Livable Street Approach

- "Unforgiving" by design:
  - But roadside hazards are **obvious** and **expected**, resulting in <u>behavioral compensations</u> from drivers.
  - **Risk Homeostasis Theory**
- Systematic error substantially reduced:
  - Turning movements safely accommodated because of lower operating speeds.
- Minimizes the consequences of random error:
  - Lower speeds result in less severe crashes when they occur.
  - Lower speeds equate to reduced stopping sight distance, and thus reduced crash frequency.

The Safety Problem: Applying Interstate Standards Without Regard to Context

65% of these crashes are attributable to mixing access and speed

A “Suburban” Arterial: Orange Blossom Trail

Crash Type	Count	Percent
Rear-End	188	46.4%
Head-On	6	1.5%
Angle	52	12.8%
Left-Turn	5	1.2%
Right-Turn	1	0.2%
Sideswipe	63	15.6%
Pedestrian/Bicyclist	24	5.9%
Roadside	23	5.7%
Other/System Missing	43	10.6%
Total	**405**	**100.0%**

Crash rates are higher because the environment conveys incorrect information on appropriate operating behavior.

The Safety Problem: Applying Interstate Standards Without Regard to Context

A "Suburban" Arterial: Orange Blossom Trail

	Crashes per 100 MVMT		
	Livable Streets (Avg)	OBT	Ratio OBT/Livable
Total Roadside	3.3	12.1	3.7
Injurious Roadside	0	5.3	NA
Total Midblock	23.1	102.2	4.4
Injurious Midblock	18.1	64.6	3.6

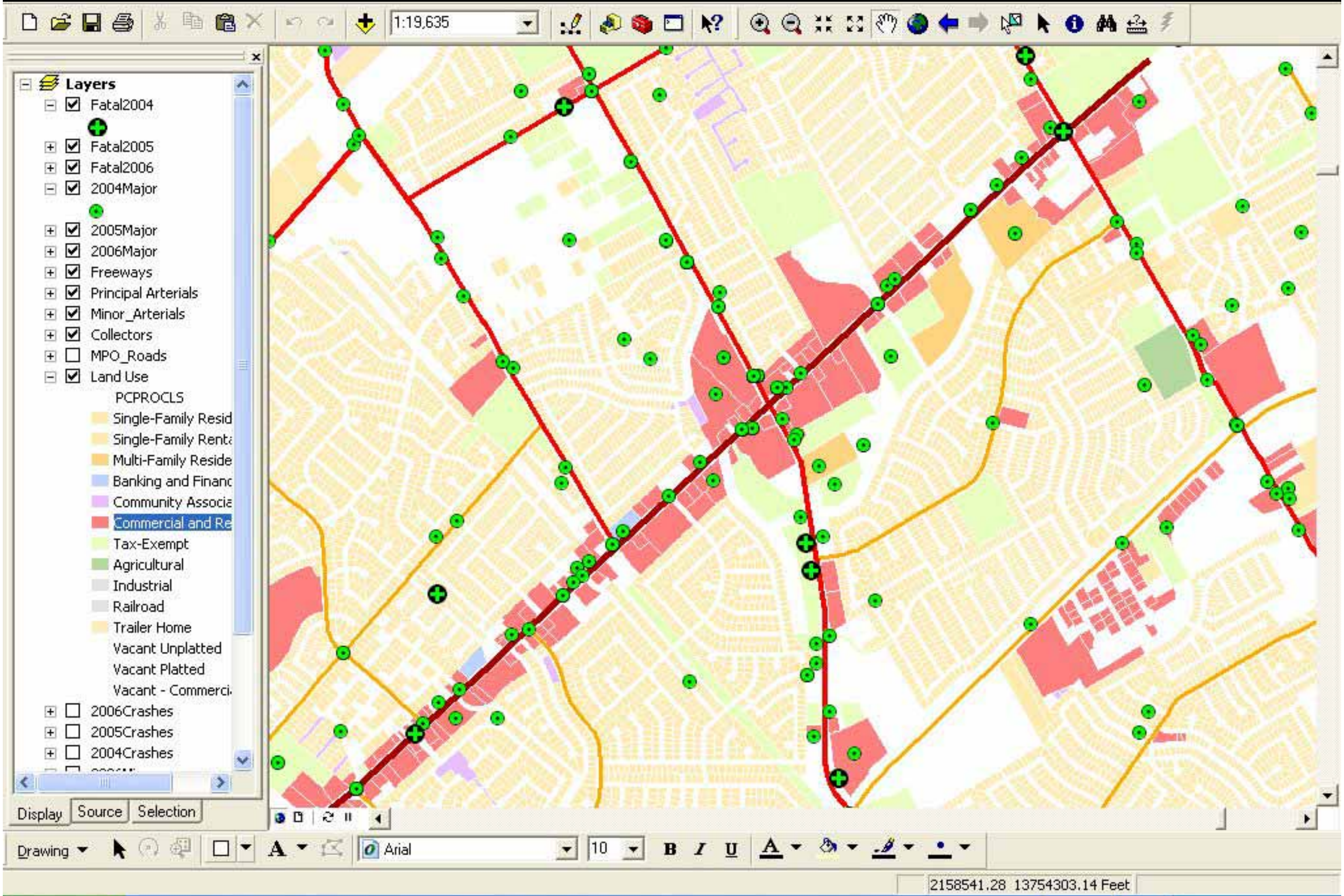
Livable Streets: Midblock Crashes

		Crashes Per 100 MVMT		
		Urban (All)	Livable Only	Difference (%)
SR 15	Total Midblock	31.9	28.6	-10.5%
	Injurious Midblock	22.7	22.2	-2.2%
SR 44	Total Midblock	37.1	18.3	-50.7%
	Injurious Midblock	27.7	18.3	-33.9%
SR 40	Total Midblock	42.0	15.7	-62.8%
	Injurious Midblock	25.7	7.8	-69.5%
Averages	**Total Midblock**	**38.3**	**23.1**	**-39.7%**
	Injurious Midblock	**25.1**	**18.1**	**-27.7%**

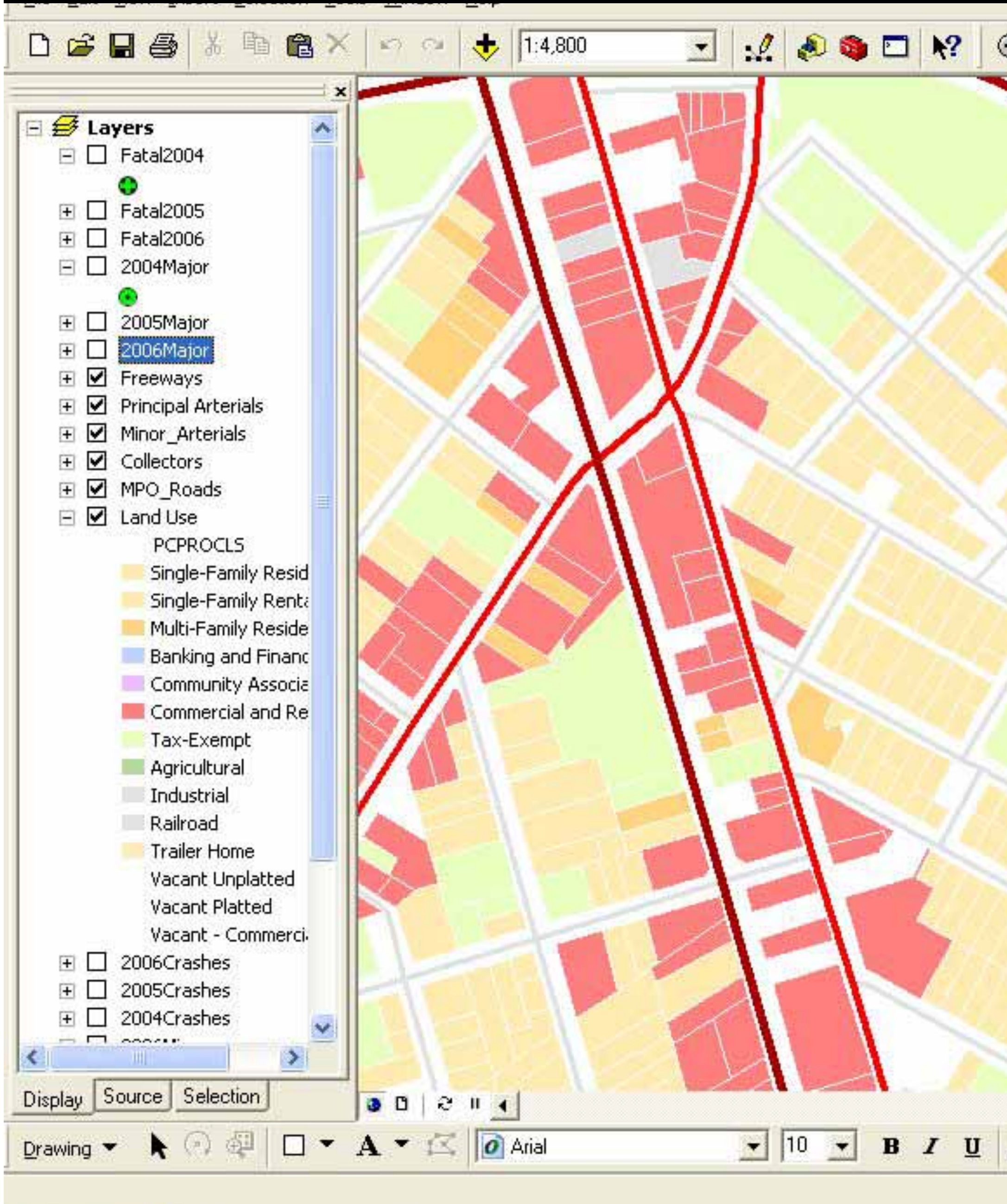
Source: Dumbaugh, 2006

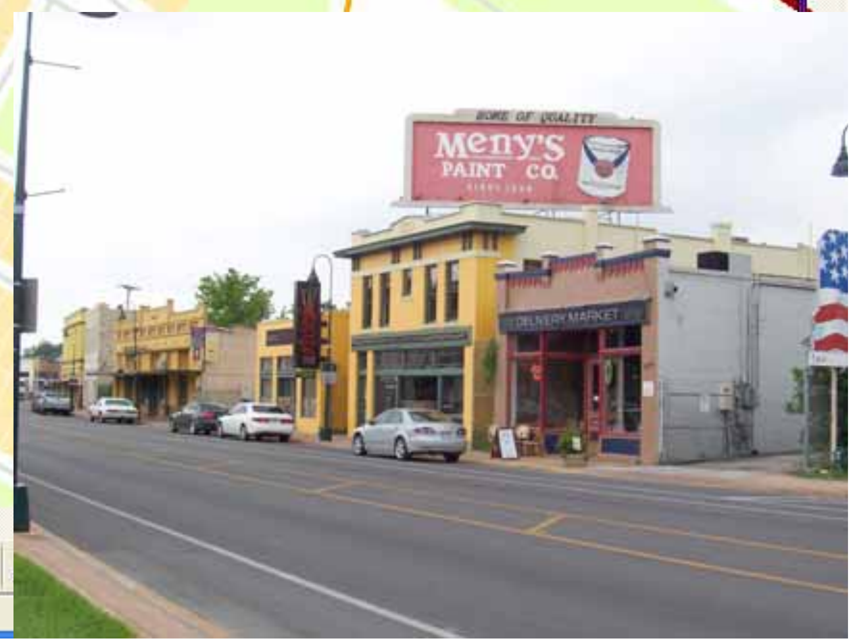
Conventional Suburban Form in San Antonio

Crash Distribution

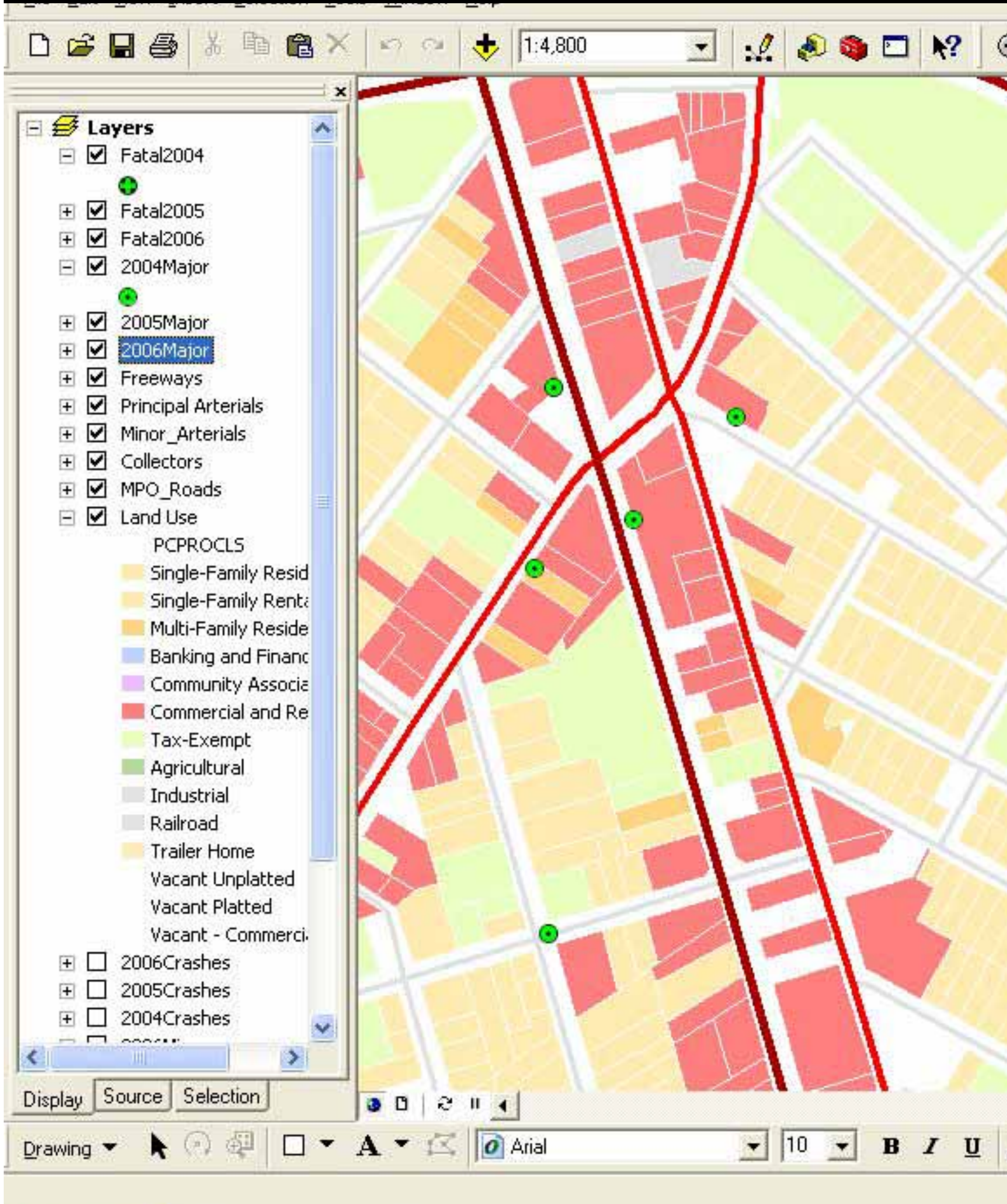


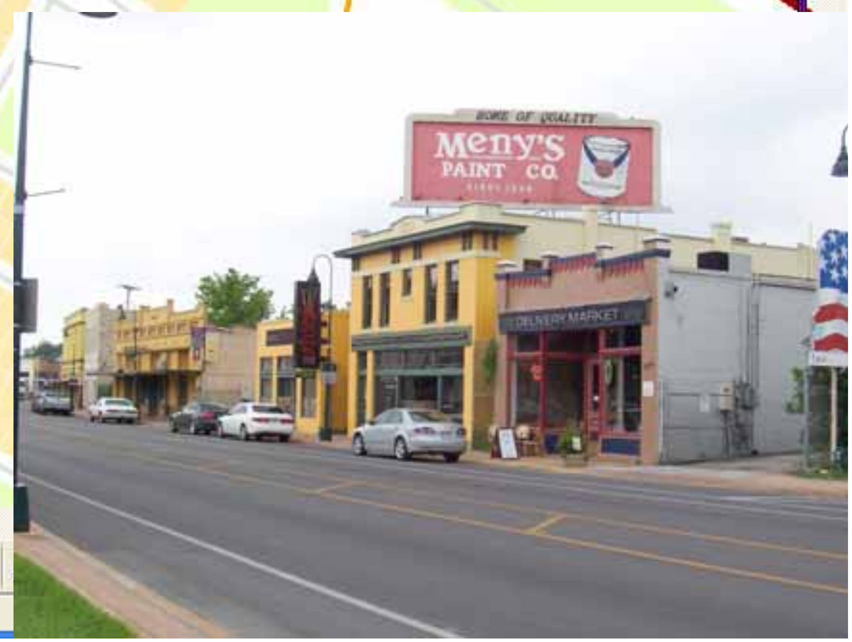
Traditional Urban Form in San Antonio





Traditional Urban Form in San Antonio





Shared Space

Conclusions

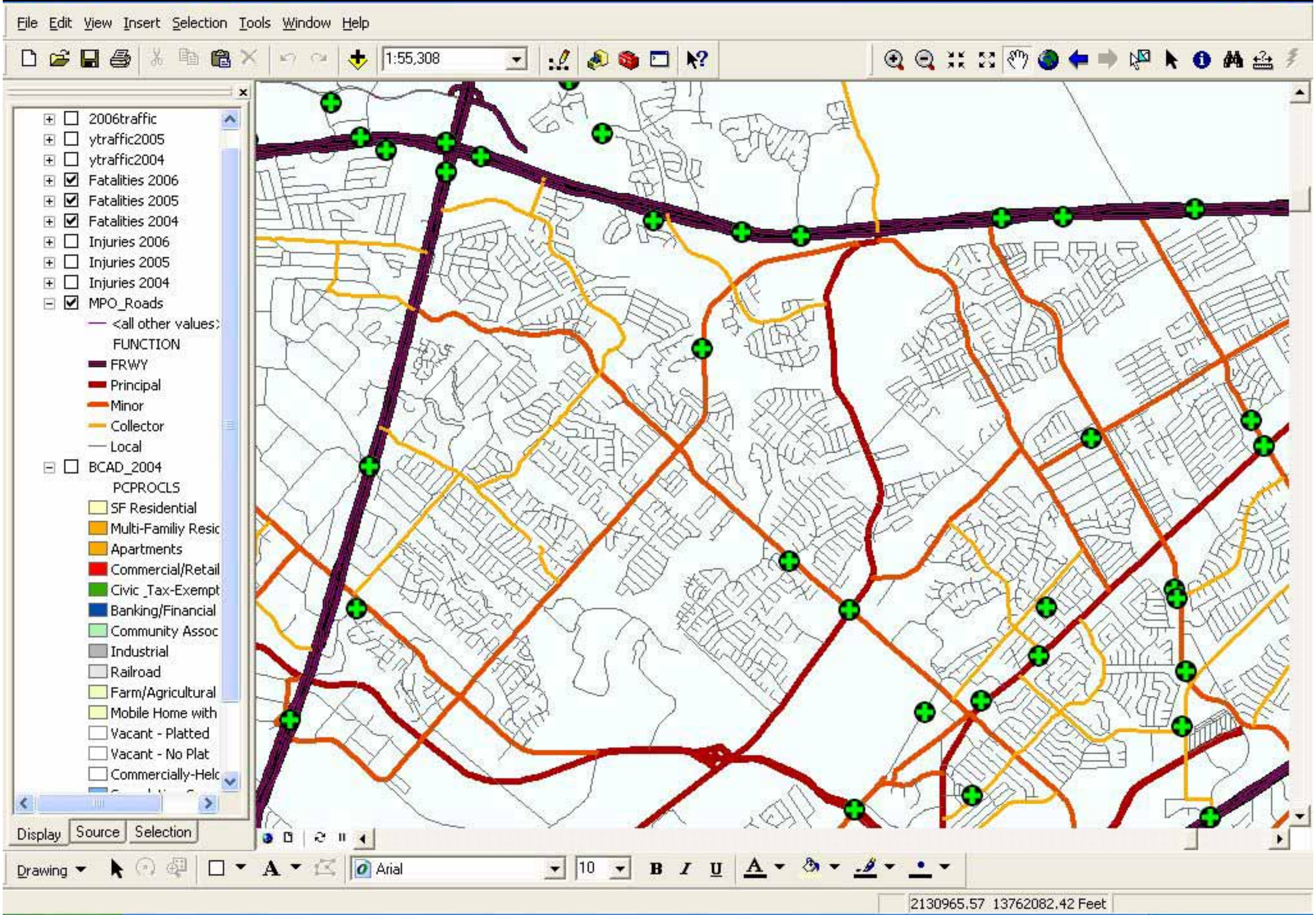
Conclusions

- Traffic safety should be a ***guiding principle***, not as a barrier to be overcome.
  - Too much of the safety debate is focused on "pedestrians vs. motorists."
  - Even the Transportation Research Board has acknowledged that the engineering profession has abdicated leadership on road safety. Who will champion this issue? Why not CNU?
  - Many safety issues are also urban design issues – on which CNU would have much to say.

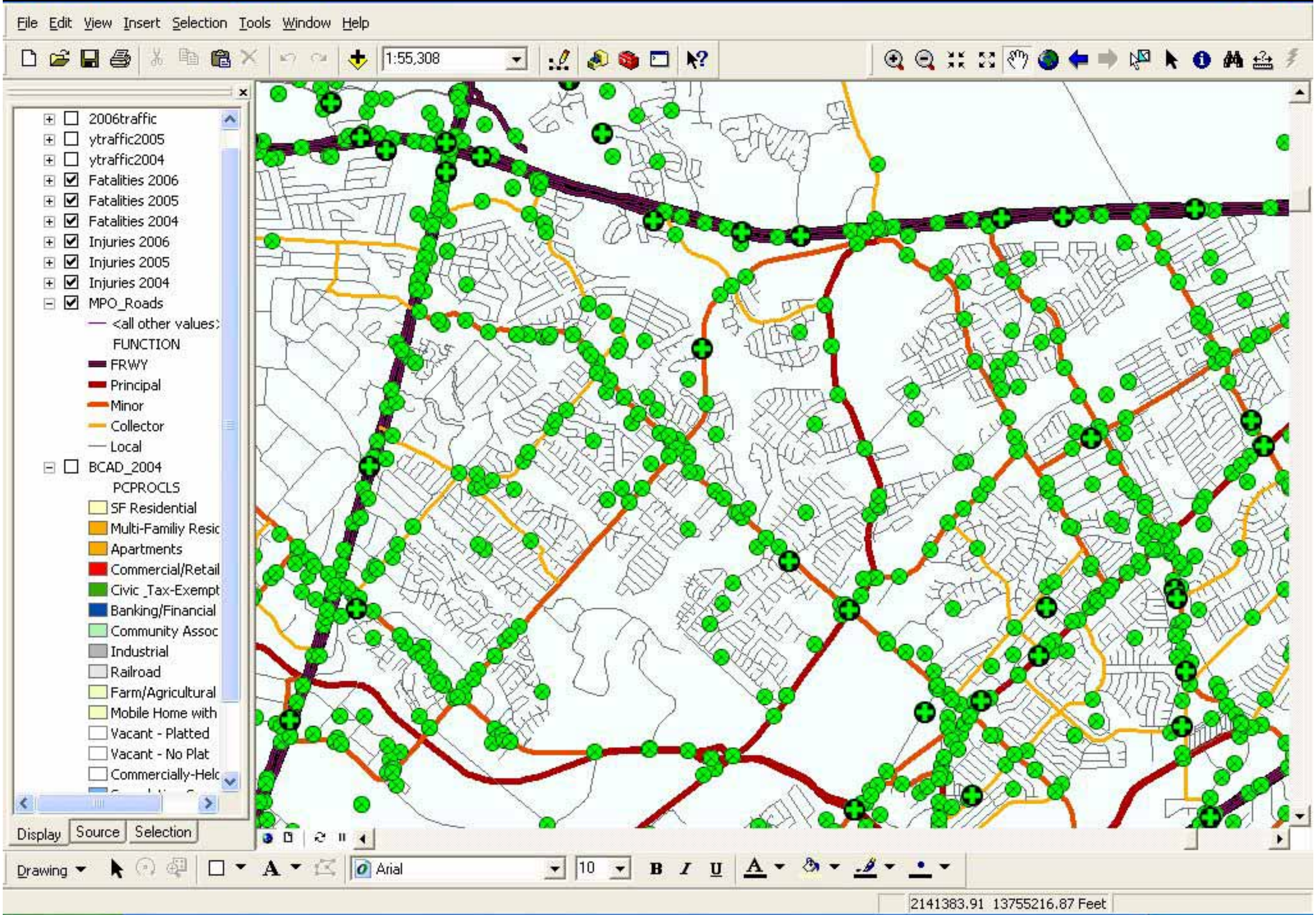
Conclusions

- Urban design plays an important and heretofore under-appreciated role in traffic safety.
  - A roadway's context **<u>determines</u>** the types of road users and road behaviors that will occur along a specific roadway.
  - Linking geometric design to context – with an understanding of their behavioral relationships – would appear to have a profound effect on reducing traffic-related deaths and injuries.
  - While the empirical evidence is growing, context-specific research is needed to fully make the case.

Conventional Subdivision Design – Deaths (San Antonio)



Conventional Subdivision Design – Injuries (San Antonio)



Positive Roadway Design

- **<u>Positive roadway design</u>** seeks to enhance safety through the physical design of roadways.
  - "Positive" has two specific connotations:
    1. **<u>Positivism</u>**: based on <u>empirical evidence</u> of actual driver <u>*behavior,*</u> as well as crash incidence and severity.
    2. Safety can best be achieved by *encouraging* desired operating behavior
       - Cognitive Psychology
       - Consider the road as "text" (semiotics)

Positive Design

- **Goal:** Design environments – including roadways and their surrounding development – to provide drivers to communicate safe behavior to all road users.

- A good design:
  - Reduces the consequences of random error (physics)
  - Minimizes the occurrence of **systematic error**

Positive Design

- Addressing systematic error requires a more solid understanding of how drivers and pedestrians react to the built environment.
  - **Risk Homeostasis Theory (Wilde)**
    - Drivers attempt to maintain static exposure to harm or injury

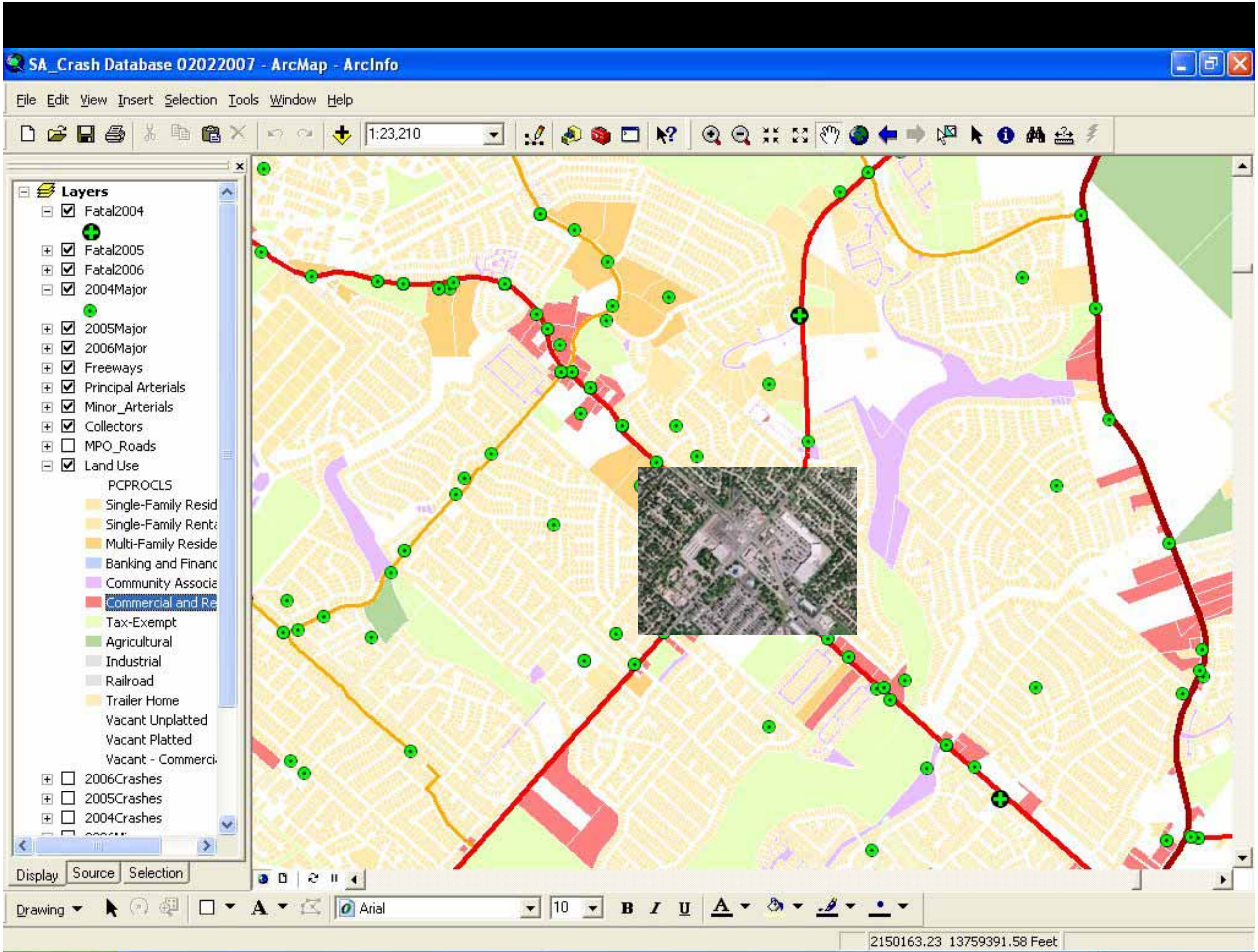
2. Design Self-Explaining Environments

High Saliency

2. Design Self-Explaining Environments

- **Drivers use four fixation points to guide vehicles:**
  - Long range preview (beyond 2 seconds)
  - Short-range preview for immediate hazards (within 2 seconds)
  - Short-range correction based on proximity to the road edges

Liu et. al., 1998


SA_Crash Database 02022007 - ArcMap - ArcInfo
File Edit View Insert Selection Tools Window Help
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Layers
Fatal2004
Fatal2005
Fatal2006
2004Major
2005Major
2006Major
Freeways
Principal Arterials
Minor_Arterials
Collectors
MPO_Roads
Land Use
PCPROCLS
Single-Family Resid
Single-Family Renta
Multi-Family Reside
Banking and Financ
Community Associa
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Tax-Exempt
Agricultural
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Railroad
Trailer Home
Vacant Unplatted
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Display
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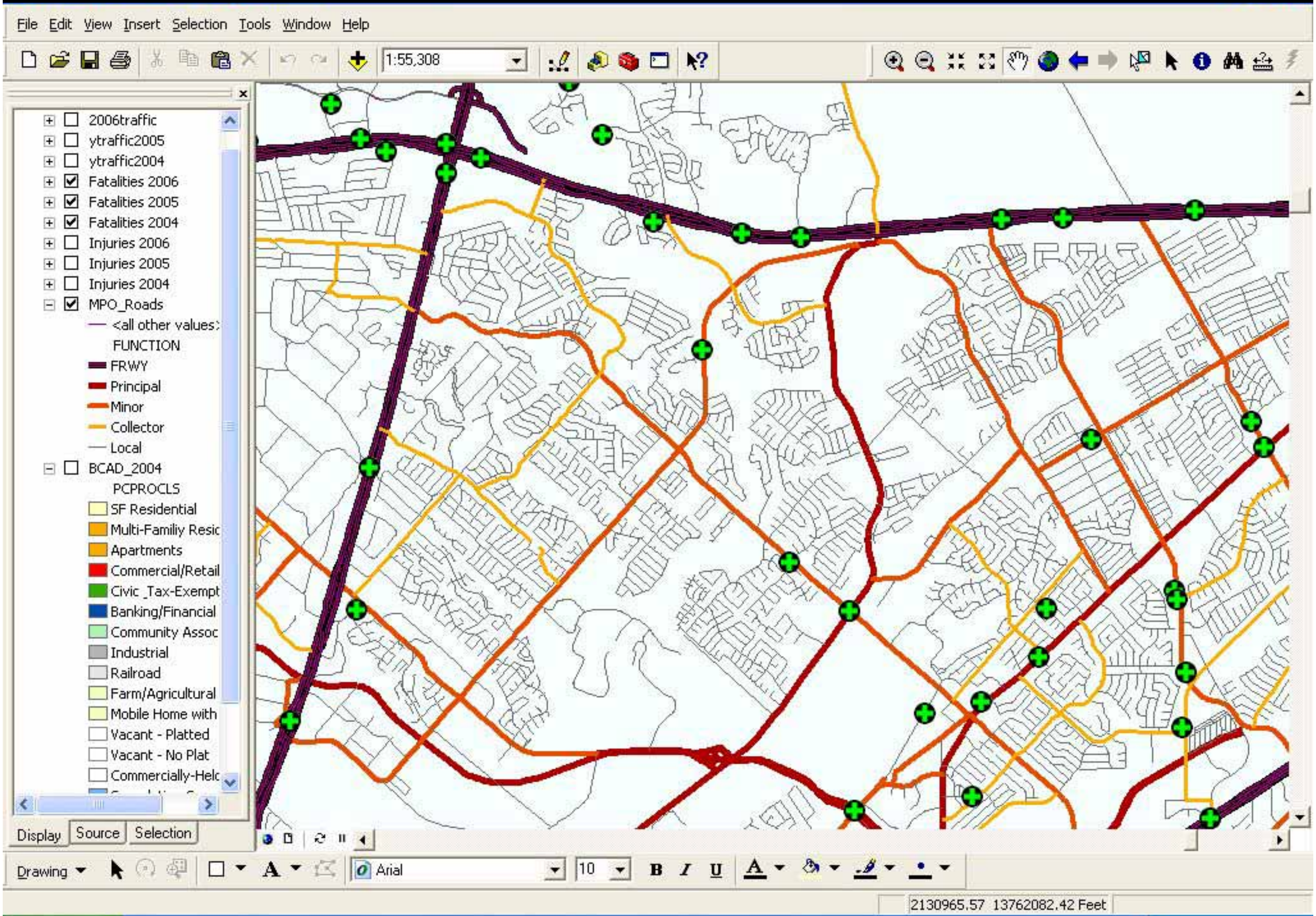
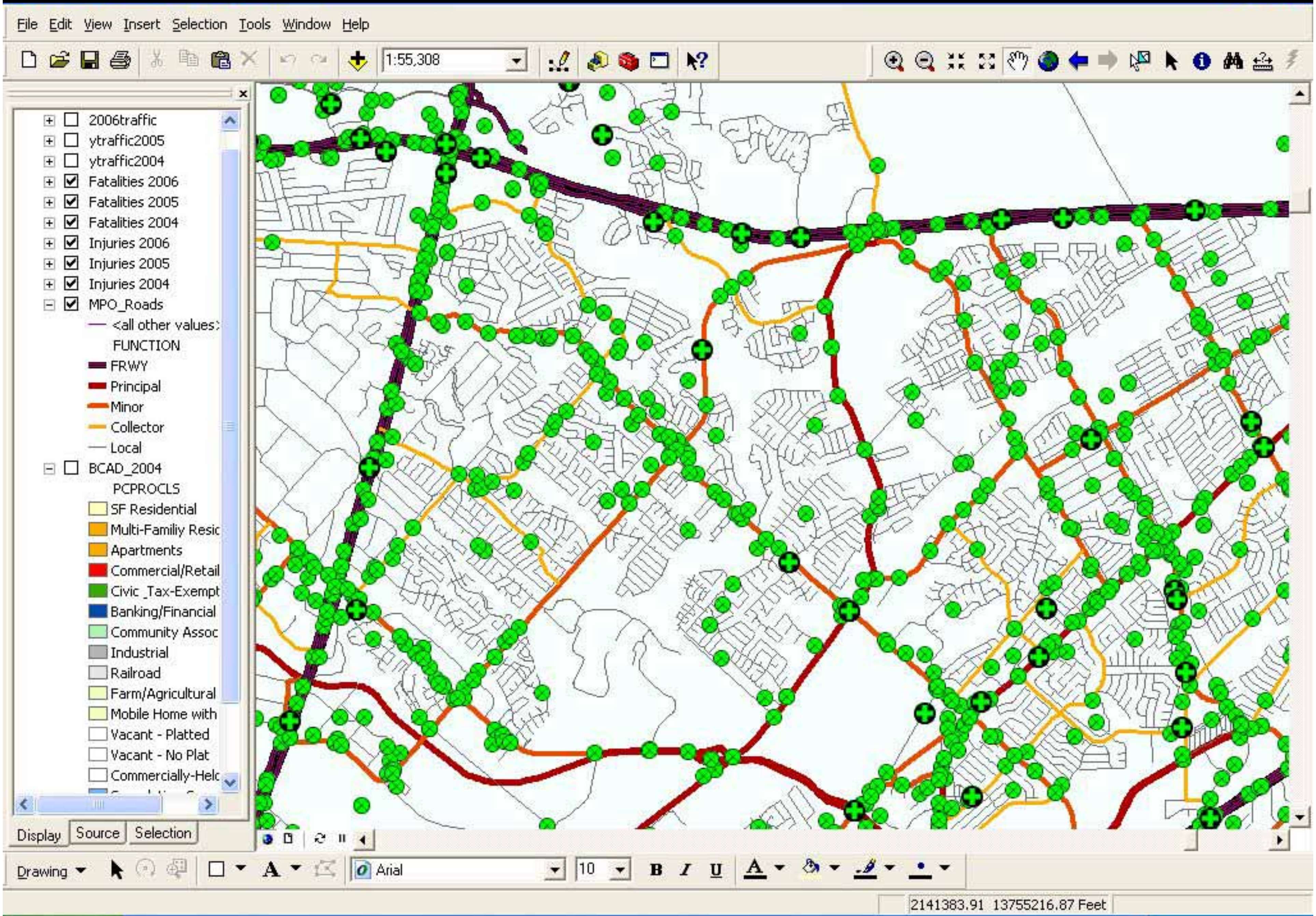
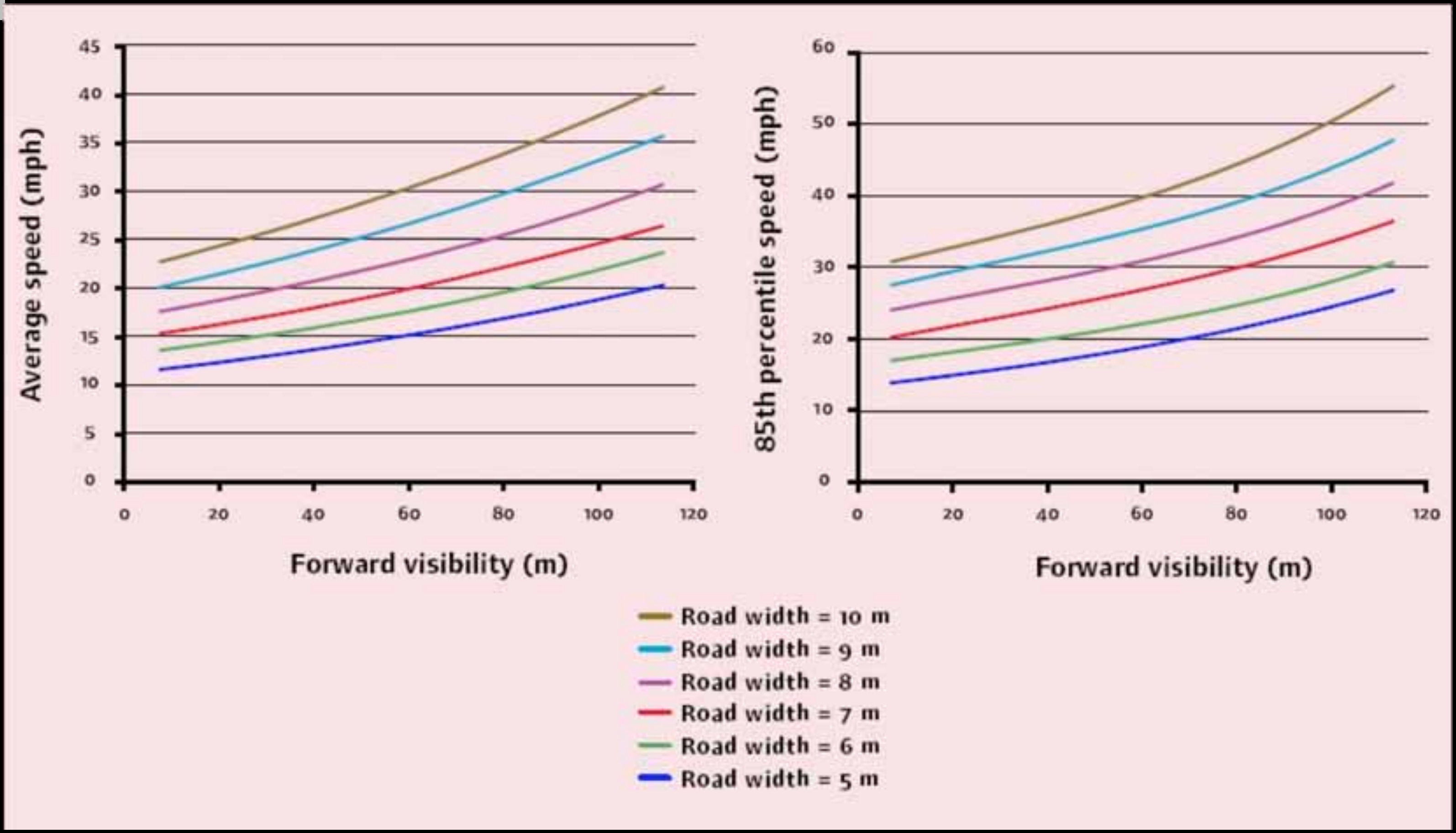
Conventional Subdivision Design – Deaths



Conventional Subdivision Design - Injuries



ROW, Sight Distance, and Speed



Source: York et. al., 2007