On a Collision Course:

Smart Growth and Traffic Safety

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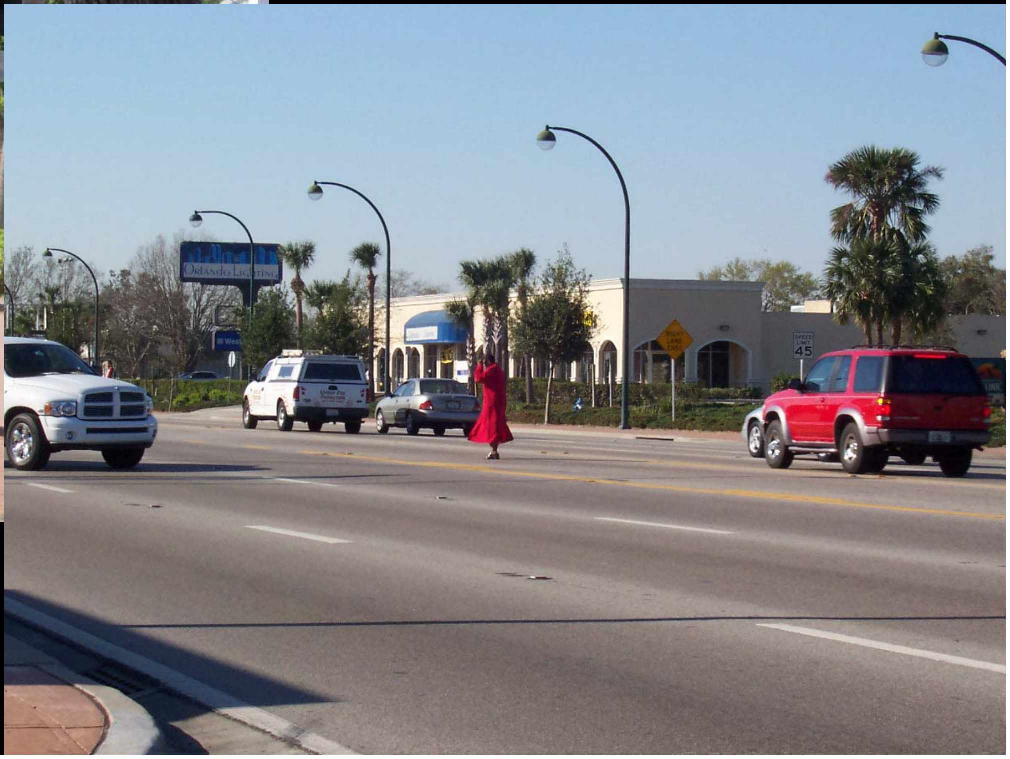
Evolution of Design

What we used to design…

what we currently design



The Urban Grid at the Turn of the 20^{th} Century

"[I]t has been the tendency of street planners, whether acting for the city or for landowners, to give quite inadequate attention to the need of the public for main thoroughfares laid out with sole regard for the problems of transportation."

- F.L. Olmstead, jr. (1916)

An Alternative: Central Park

Olmstead’s Plan for Central Park

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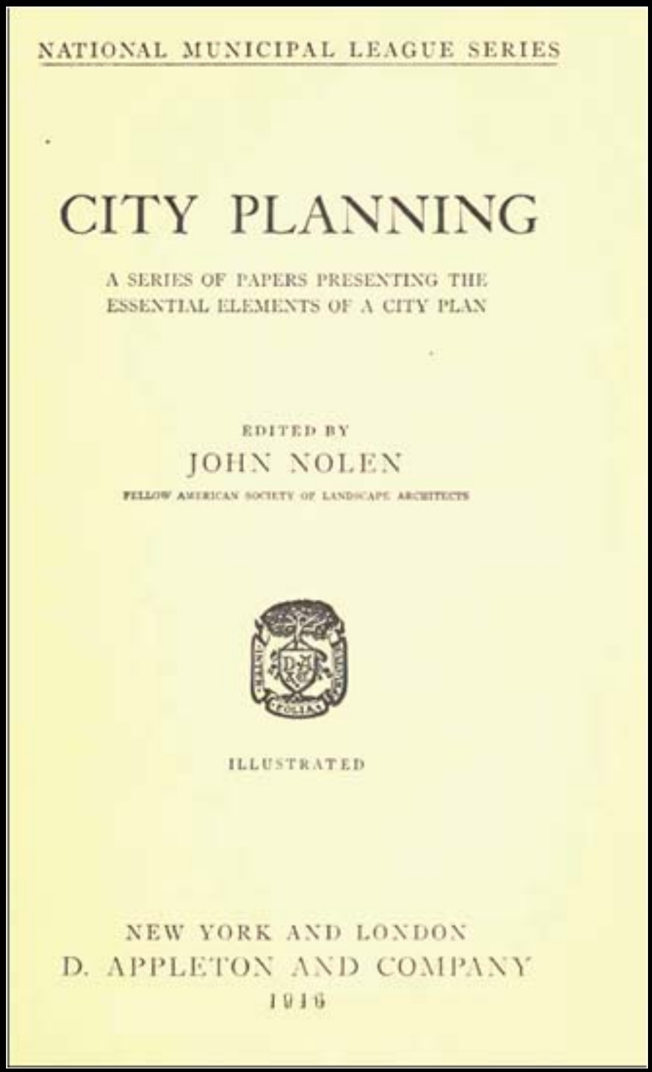
Central Park's Transverse Roads

The Design Idea: Functional Design


NATIONAL MUNICIPAL LEAGUE SERIES

CITY PLANNING

A SERIES OF PAPERS PRESENTING THE ESSENTIAL ELEMENTS OF A CITY PLAN

EDITED BY

JOHN NOLEN

FELLOW AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS

ILLUSTRATED

NEW YORK AND LONDON

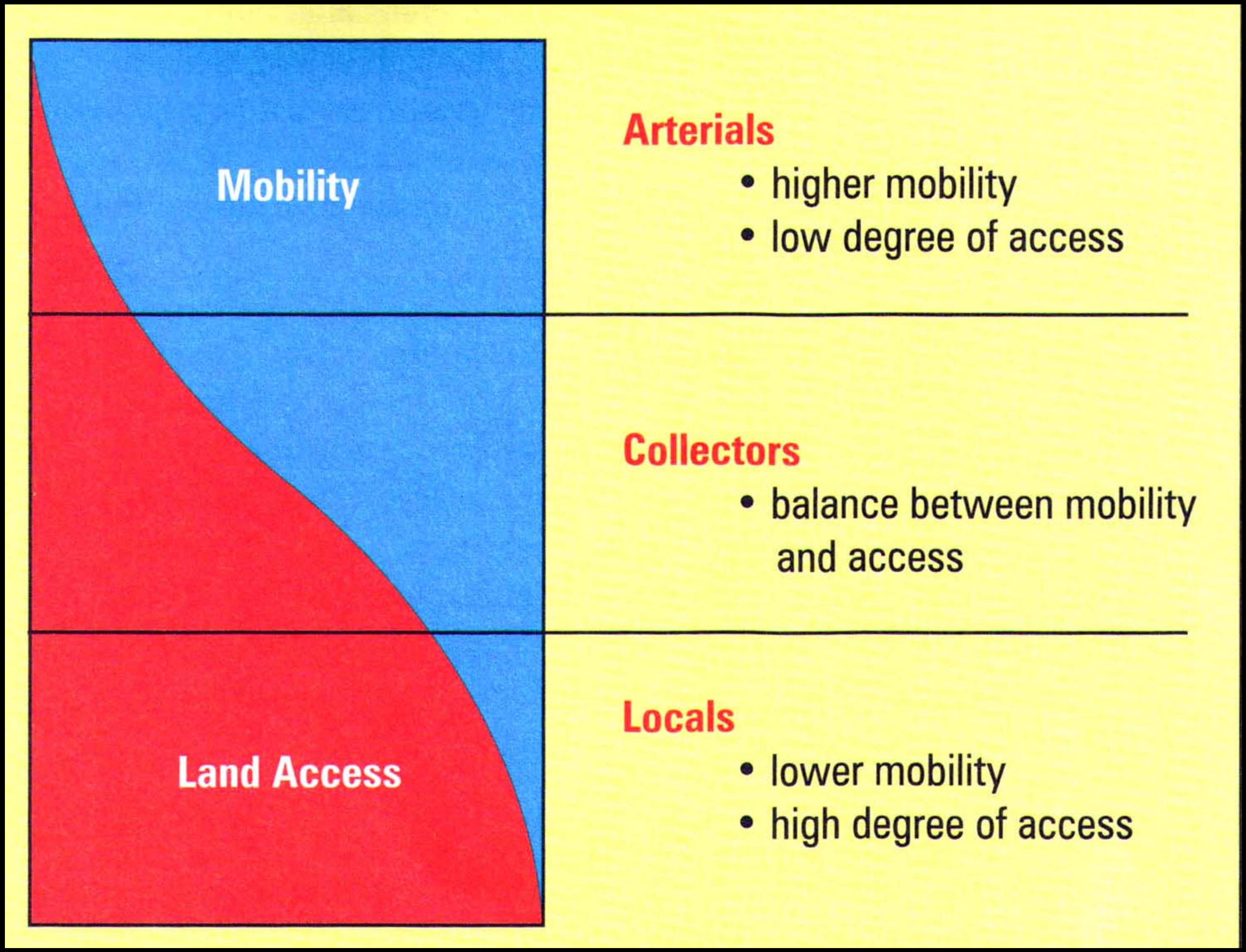
D. APPLETON AND COMPANY

1916

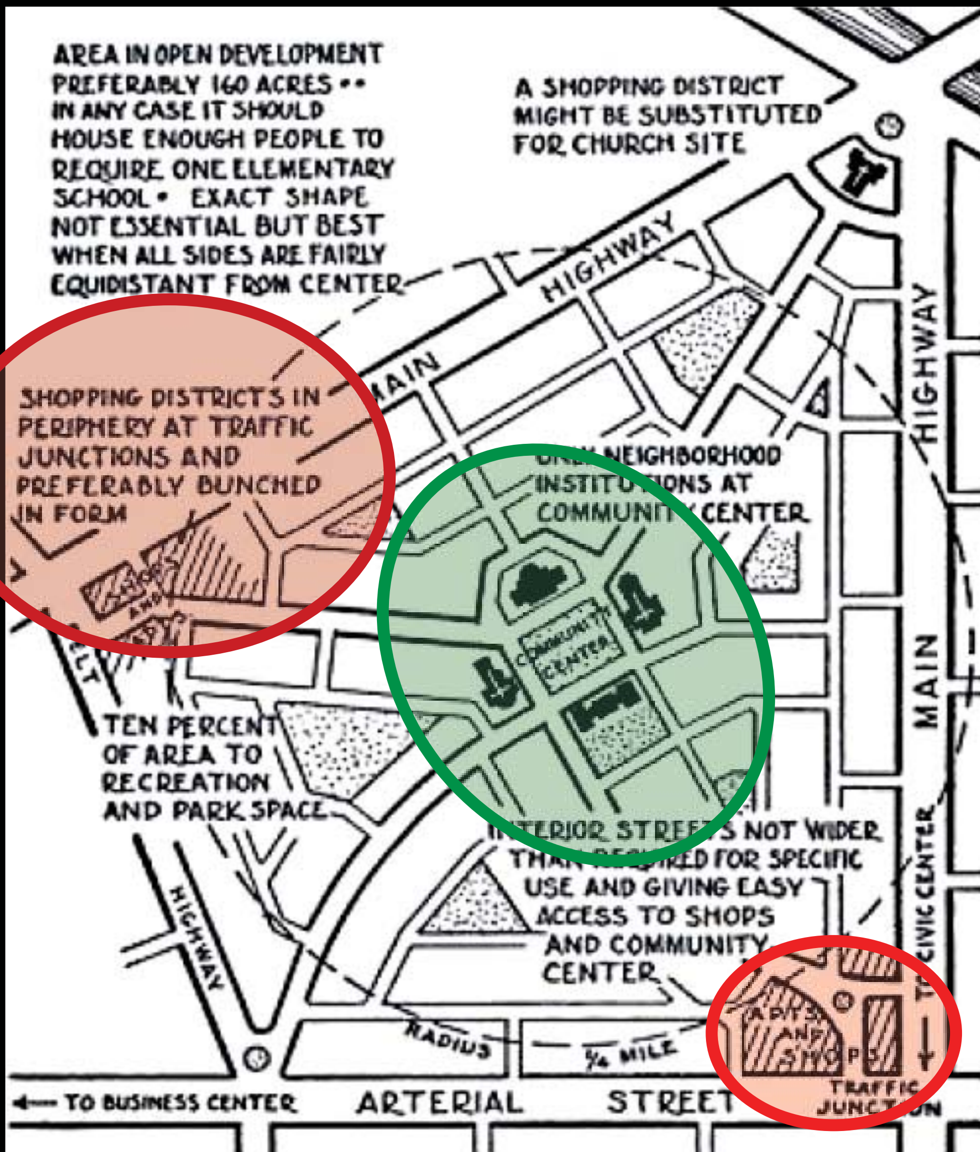
"[There needs to be] a pronounced **differentiation** between **main thoroughfares** intended for traffic carriers and secondary or intermediate **ones intended for local development**."

- City Planning, 1916

Functional Design



Designing Functional Communities



The most important reason for wide highways as boundaries arises from their relation to **street safety**…

With adequate express channels in the circumference of the unit, through traffic will have no excuse for invading its territory, and its own internal streets can fairly and deliberately be made inconvenient and forbidding for vehicles having no destination within the neighborhood confines.

- Clarence Perry, 1939

Perry’s Proposal for Retail Uses

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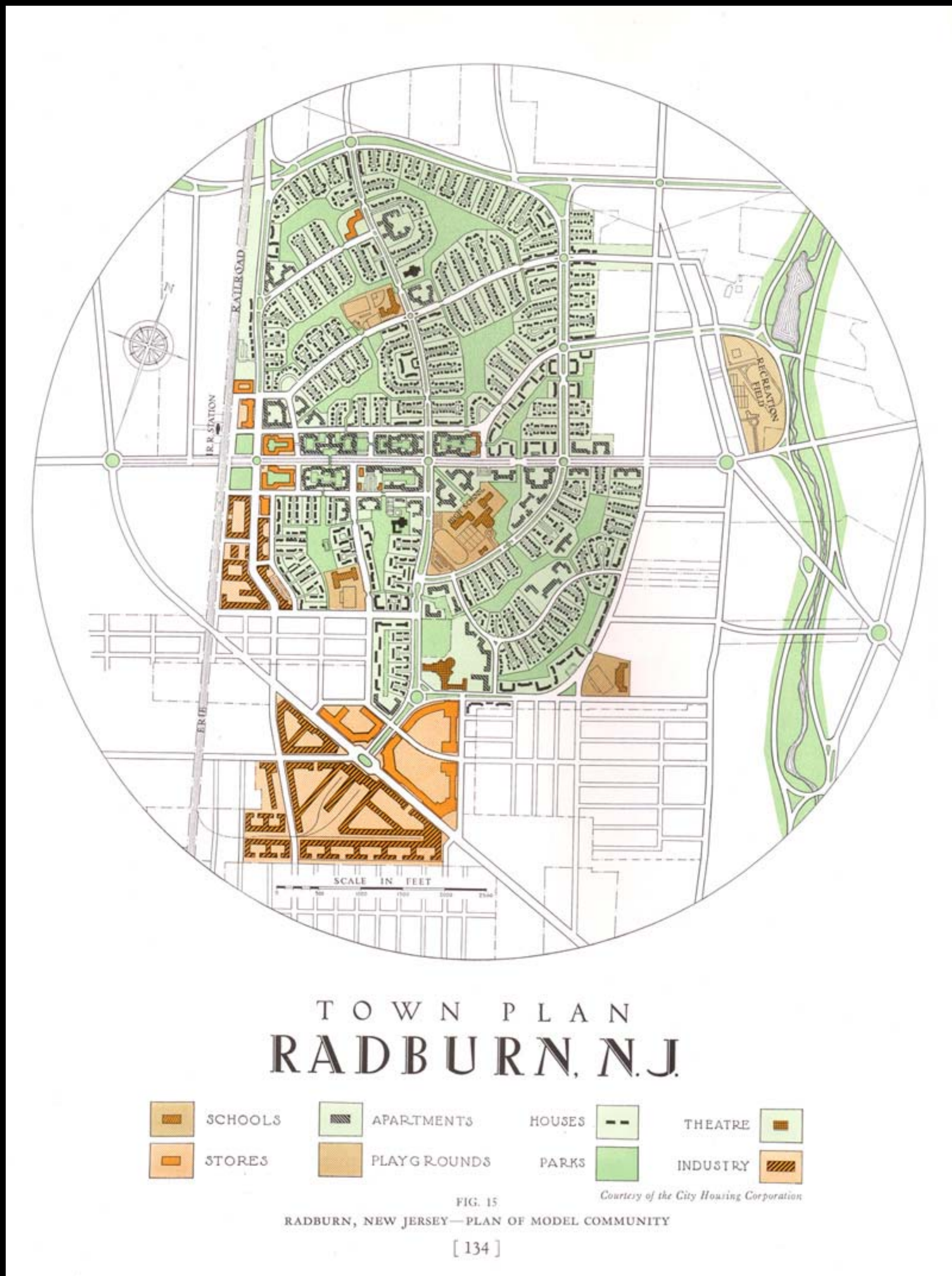
It is the one of the advantages of the [neighborhood] unit scheme that it makes good business locations definite and easily found... at the traffic junctions, on the main highways which bound the unit.

- Clarence Perry, 1939



Radburn

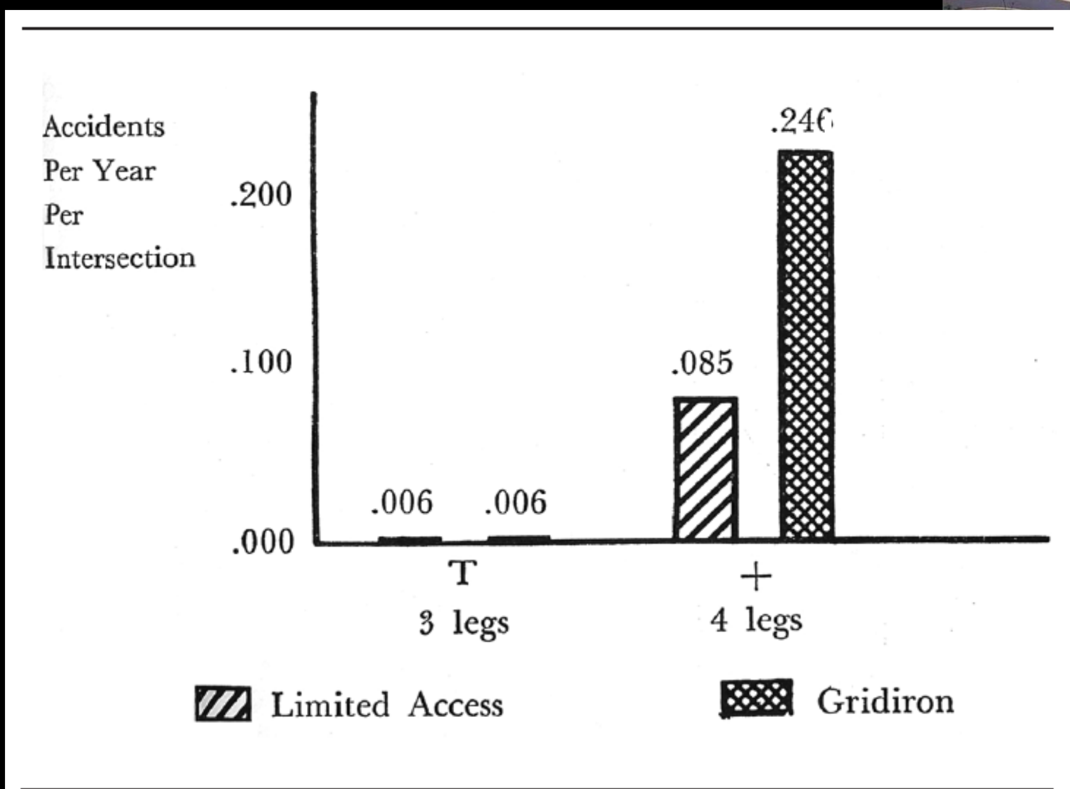
Key innovation: the residential cul-de-sac

The gridiron street pattern [is] as obsolete as a fortified town wall. Every year, there were more Americans **killed and injured in automobile accidents** than the total American war causalities in any year… **it was in answer to these conditions that the Radburn plan was formed**.

- Clarence Stein

“Our new subdivisions have built-in traffic safety.”

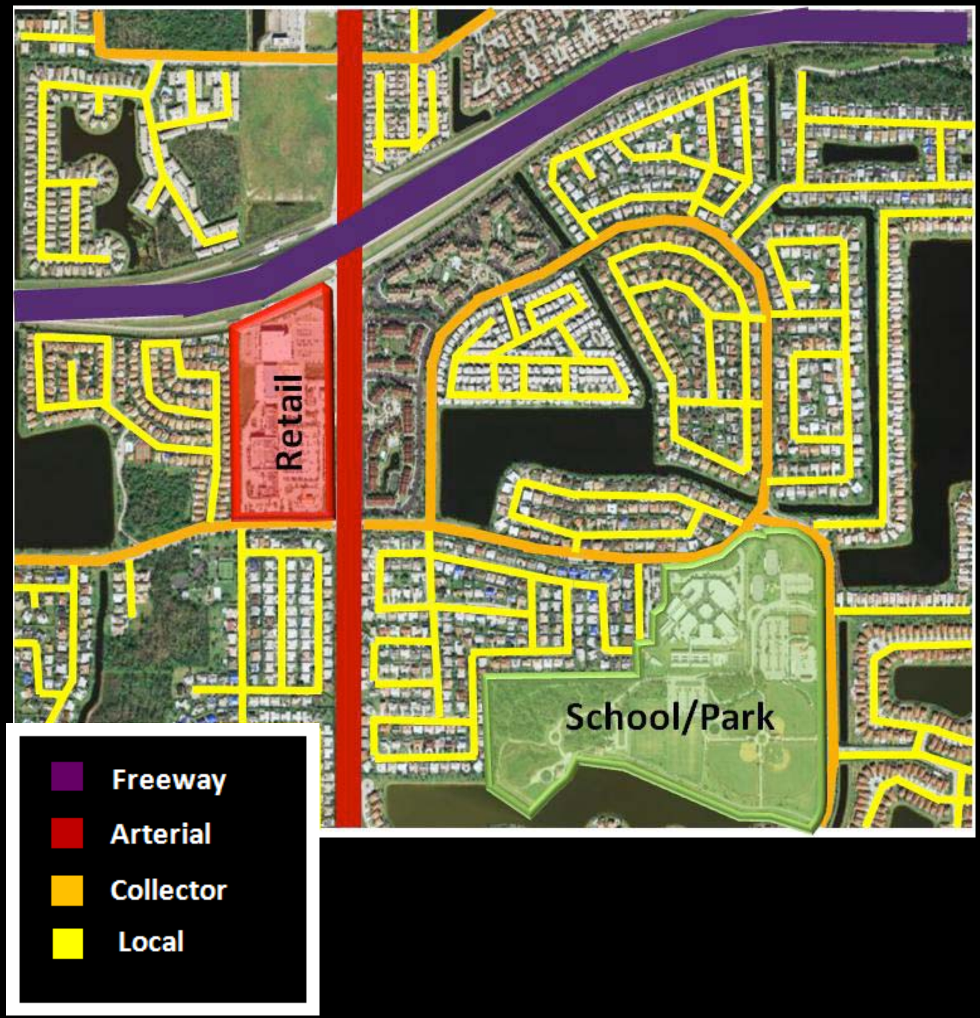
- Harold Marks, 1957



Problems:

- Did not account for VMT
- Did not consider the effects of shifting retail and traffic onto arterials.

Guiding Safety Ideas

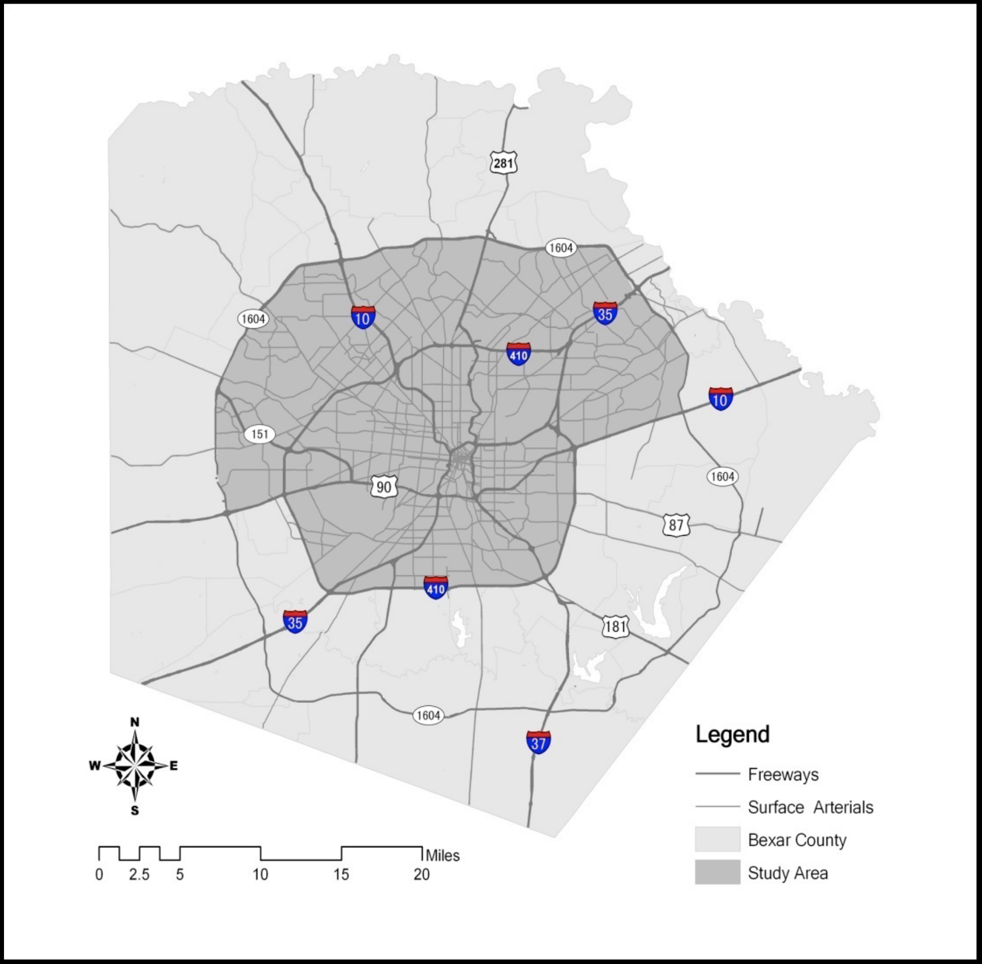


Guiding Design Ideas:

1. Design roadways for specific traffic functions.
2. Redesign street network to reduce cut-through traffic.
3. Relocate traffic-generating land uses (i.e., commercial and retail) onto arterial roadways.

Revisiting Traffic Safety and Urban Form

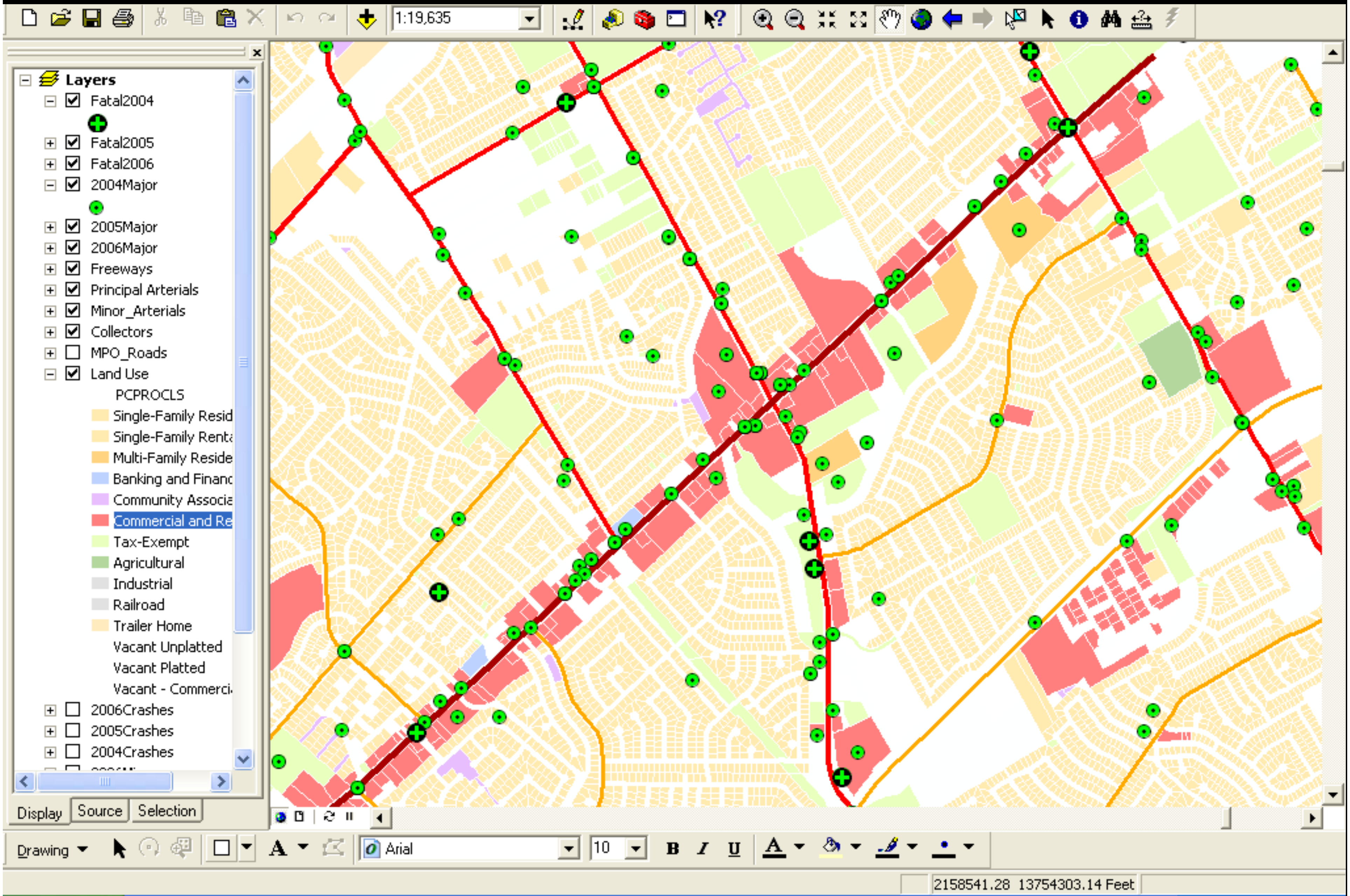
Examining Crash Incidence and Urban Form



San Antonio-Bexar County

Examining Crash Incidence and Urban Form

Examining Crash Incidence and Urban Form



Dependent Variables
Crashes (2003-2007)

Crash Type	Crashes	
Motorist	**263,809**	
Multiple Vehicle		*217,028*
Parked Car		*40,300*
Fixed Object		*3,077*
Motorist - Other		*3,404*
Pedestrian	**3,108**	
Cyclist	**1,022**	
Total	**267,939**	

Negative Binomial Regression Models

Examined the effects of:

- Population Density
- # 3-Leg Intersections
- # 4-Leg Intersections
- Arterial Lane Miles
- Freeway Lane Miles
- # Strip Commercial Uses
- # Big Box Stores
- # Neighborhood-Scaled Commercial Uses

While controlling for:

- Block Group Acreage
- VMT

Model Results

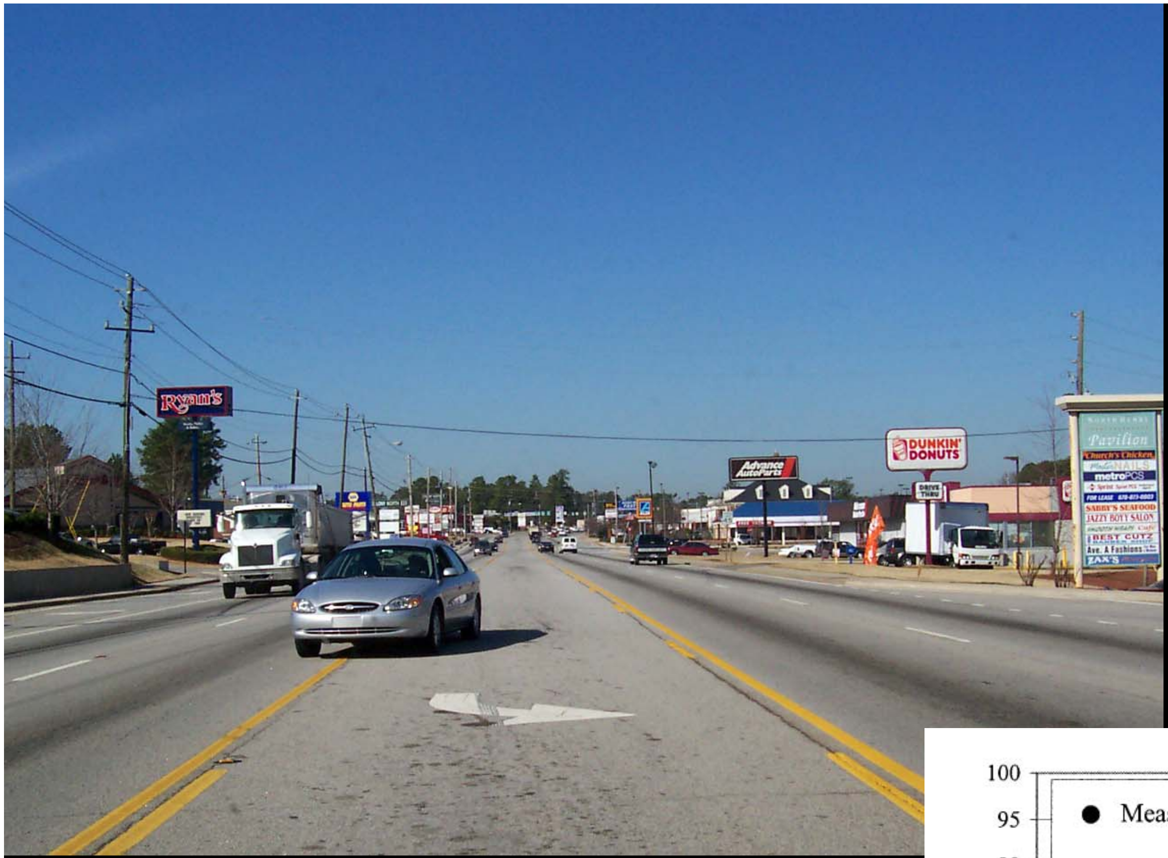
	Motorist	Multiple-Vehicle	Parked Car	Fixed Object	Pedestrian	Cyclist
Block group acreage	-0.00037***	-0.00040***	0.00007	-0.00011	-0.00026$^{\Psi}$	-0.00037*
VMT (millions)	0.00561***	0.00548***	0.00100**	0.00526***	0.00091*	0.00040
# of 3-Leg Intersections	0.00012	0.00005	0.00020	-0.00053	-0.00367*	0.00227
# of 4-or-more-leg intersections	0.00612*	0.00564*	0.00381	0.00884***	0.00911**	0.01309***
Net population density	0.00041	0.00057	0.00116$^{\Psi}$	-0.00026	0.00283**	0.00007
Freeway miles	-0.04192*	-0.05287**	-0.03738*	-0.00065	-0.01670	-0.01384
Arterial miles	0.09795***	0.11384***	0.06638**	0.02981	0.09297**	0.06611$^{\Psi}$
# of strip commercial uses	0.02205***	0.02355***	0.02057***	0.01398***	0.02962***	0.01718***
# of big box stores	0.07687***	0.08414***	0.11428***	-0.01063	0.08700***	0.03276
# of pedestrian-scaled retail uses	-0.03073***	-0.03518***	-0.01183$^{\Psi}$	-0.01007$^{\Psi}$	-0.01604$^{\Psi}$	-0.01216

$^{\Psi}$ p < .10 * p < .05 ** p < .01 *** p < .001

Safety and Urban Form

The Original Design Condition

The Current Design Reality



Wider lanes and longer sight distances lead to higher vehicle speeds…

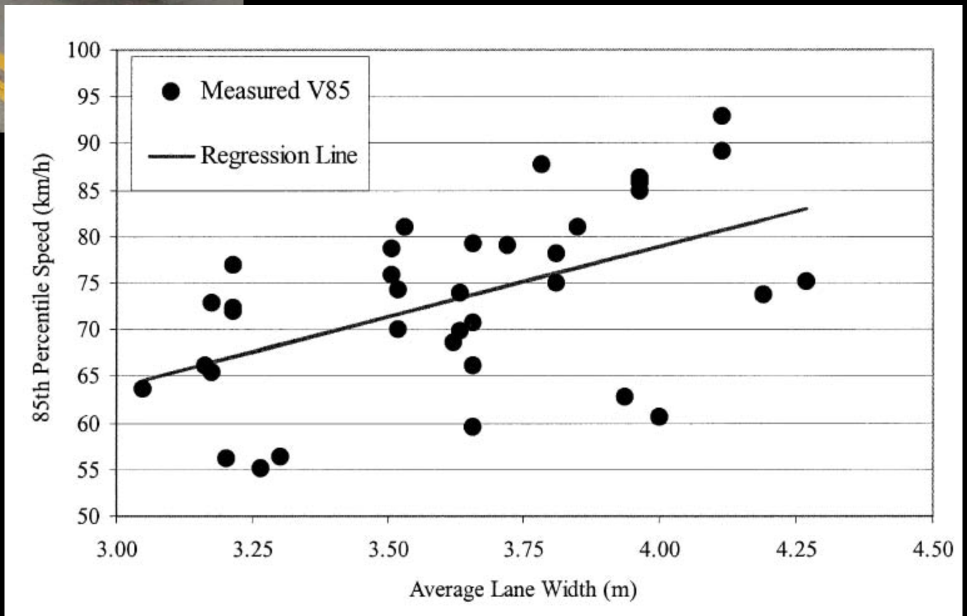
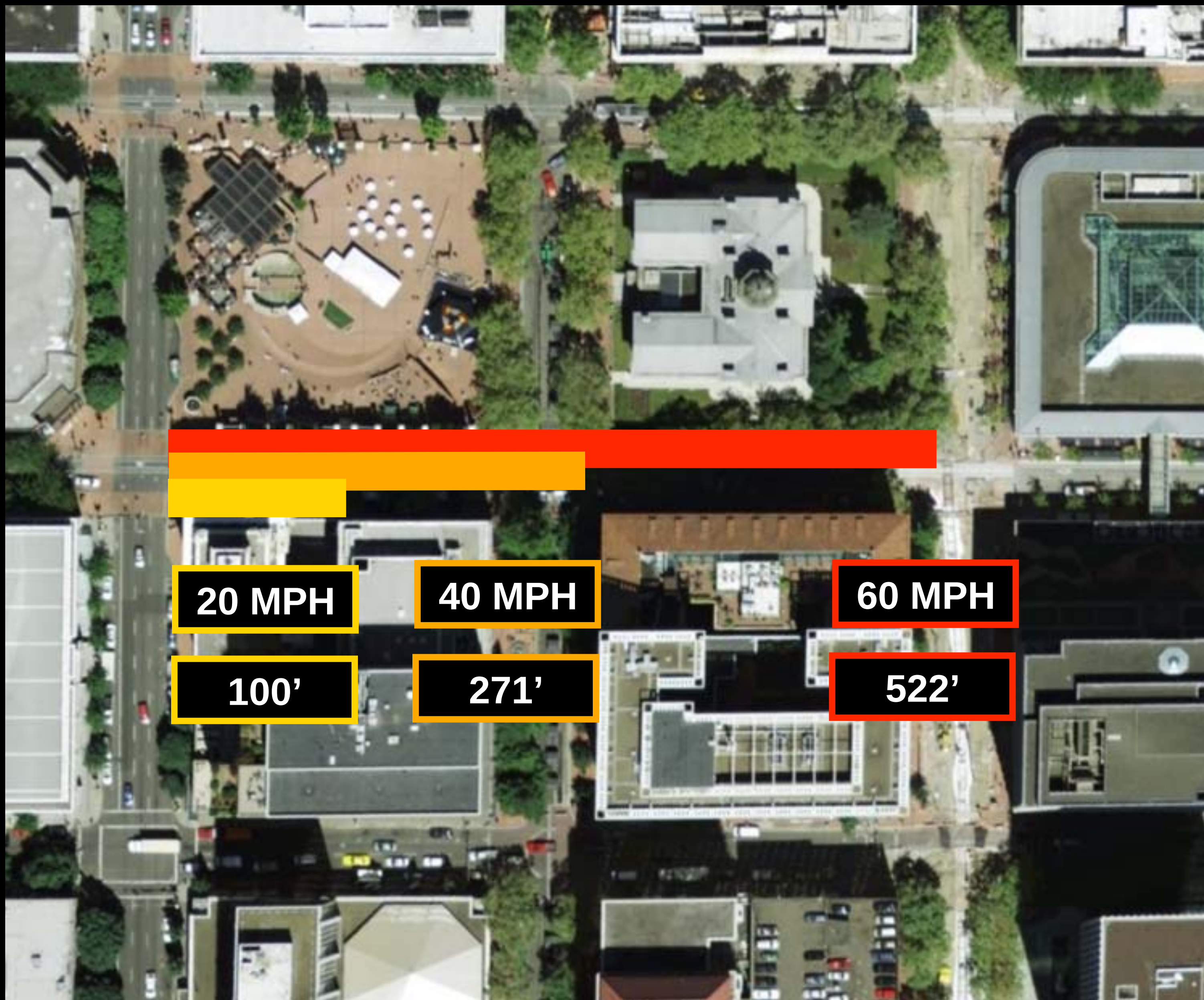


FIGURE 1 Average lane width versus 85th percentile speed.

Source: Fitzpatrick et. al. (2001)

…which leads to longer stopping sight distances…



…which make drivers unprepared to stop if a there is a conflict in the roadway

Regardless of whether the conflict is caused by a cyclist, a pedestrian…

…or another motorist

Arterials

Arterials are associated with increased crash risks for all users, regardless of mode. Each mile of arterial is associated with a:

- 10% *increase* in multiple-vehicle crashes.
- 9.2% *increase* in pedestrian crashes.
- 6.6% *increase* in bicyclist crashes.

Strip Commercial

Each additional arterial-oriented commercial use is associated with:

- 2.4% *<u>increase</u>* in multiple-vehicle crashes
- 3.0% *<u>increase</u>* in pedestrian crashes.
- 1.7% *<u>increase</u>* in vehicle-cyclist crashes.

Big Box Stores

Each big box store is associated with:

- 8.4% *increase* in multiple-vehicle crashes.
- 8.7% *increase* in pedestrian crashes.

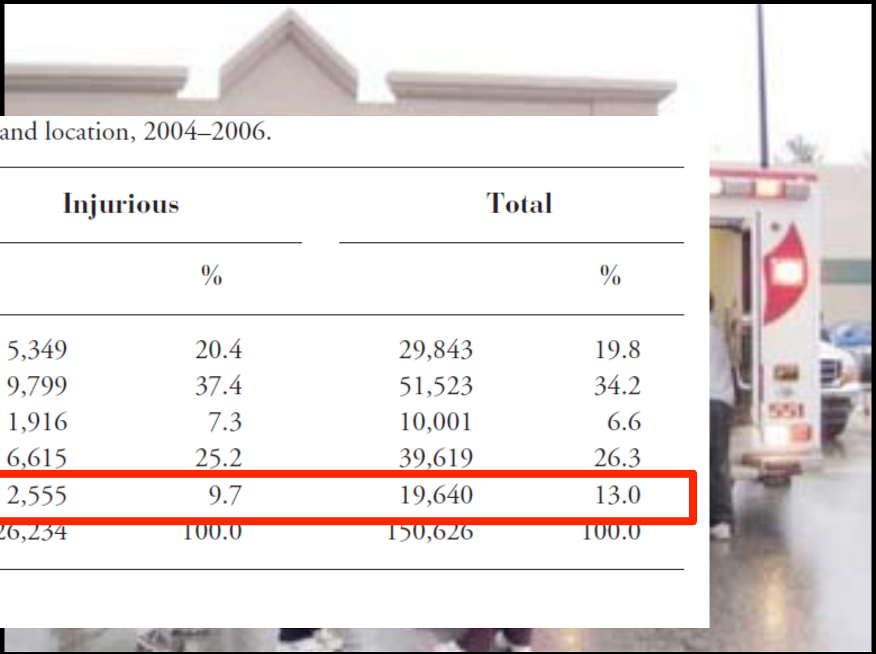
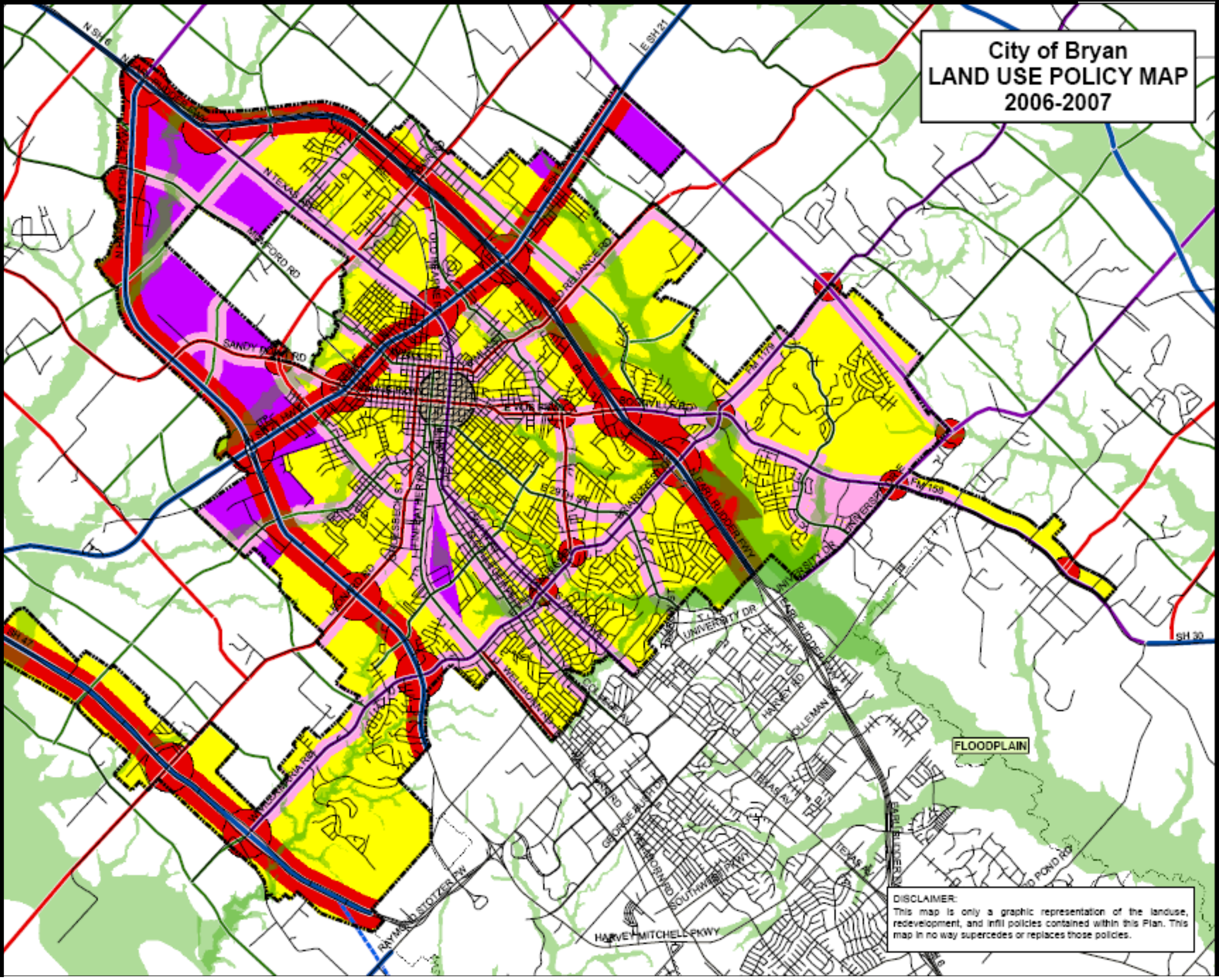


Table 2. Number and percentages of crashes in the City of San Antonio, by crash type and location, 2004–2006.

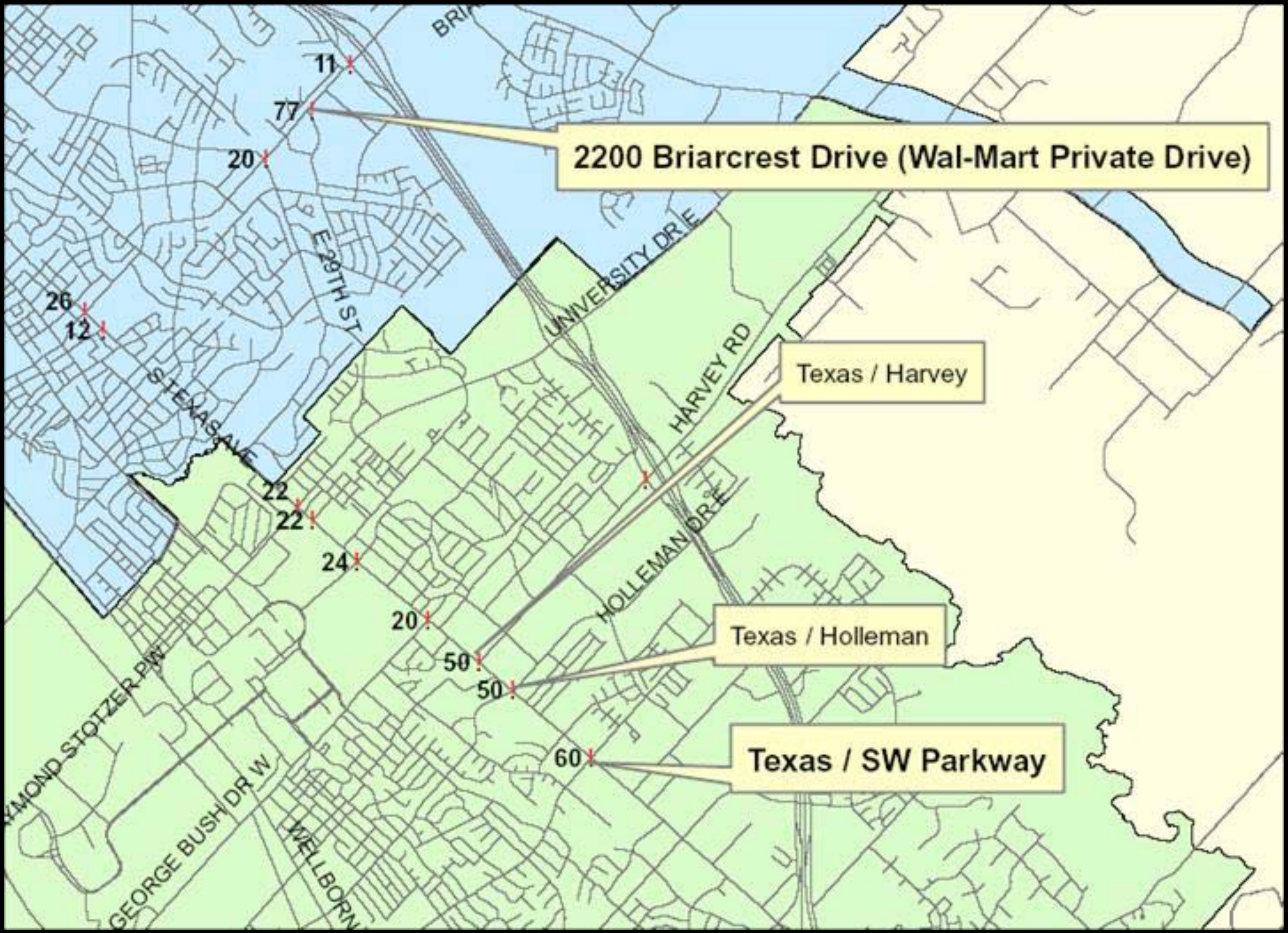
	Fatal		Injurious		Total	
		%		%		%
Freeway	104	24.0	5,349	20.4	29,843	19.8
Arterial	128	29.6	9,799	37.4	51,523	34.2
Collector	27	6.2	1,916	7.3	10,001	6.6
Local	103	23.8	6,615	25.2	39,619	26.3
Private/off-network	71	16.4	2,555	9.7	19,640	13.0
Total	433	100.0	26,234	100.0	150,626	100.0

Note: Percentages may not add to 100 due to rounding.

The Point: Land Use Decisions are Creating Traffic Safety Problems



Black Spot Analysis



Black Spot Analysis

Pedestrian-scaled Retail

Each pedestrian-scaled retail use is associated with:

- 3.4% *<u>decrease</u>* in multiple-vehicle crashes.
- 1.6% *<u>decrease</u>* in pedestrian crashes
- A negative but statistically-insignificant effect on bicyclist crashes

Visual enclosure leads to lower speeds…

- Roadside elements that create visual enclosure – such street trees and street-oriented buildings – are associated with lower vehicle speeds.
- The effect is independent of a roadway's geometry.

Dumbaugh, 2005; 2006; Ivan, Garrick, & Hanson, 2009; Naderi Kweon & Maghelal, 2008)

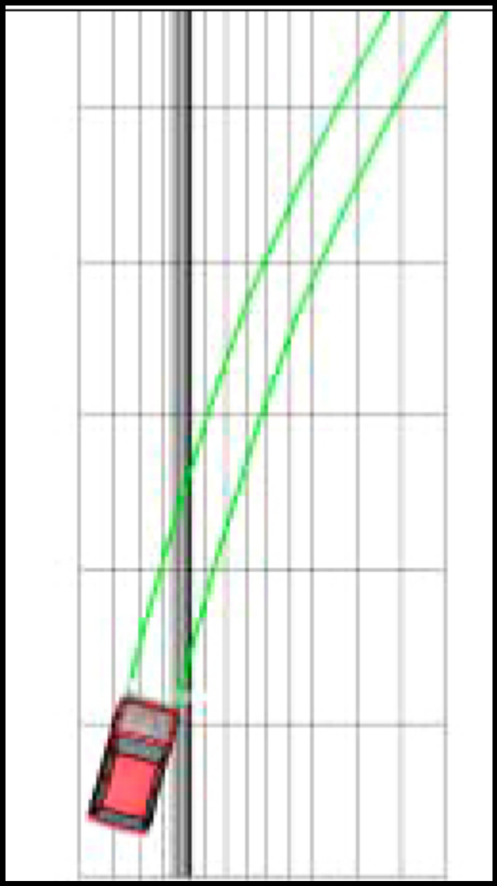
... and lower speeds equal reductions in crash frequency AND severity.

Table 8 Speed and yield behavior

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

Garder, 2001

Single Vehicle Fixed-Object Crashes



Presumed Roadside Encroachment Pattern

- **Engineering presumption is that run-off-roadway events are *random* and *unpreventable*.**
- **If so, then rates of run-off-roadway events should be relatively constant, and clear zones should enhance safety.**
- **Studies of two-lane, rural roads support this conclusion…**

The Evidence

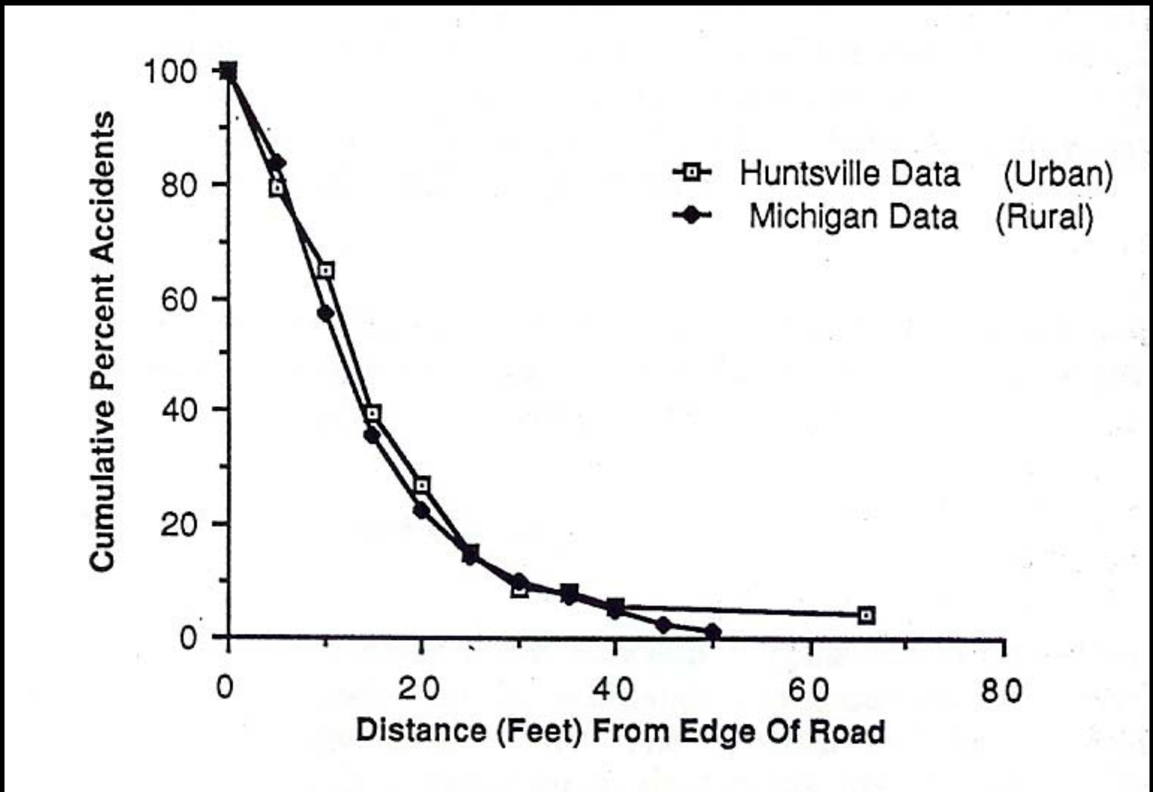


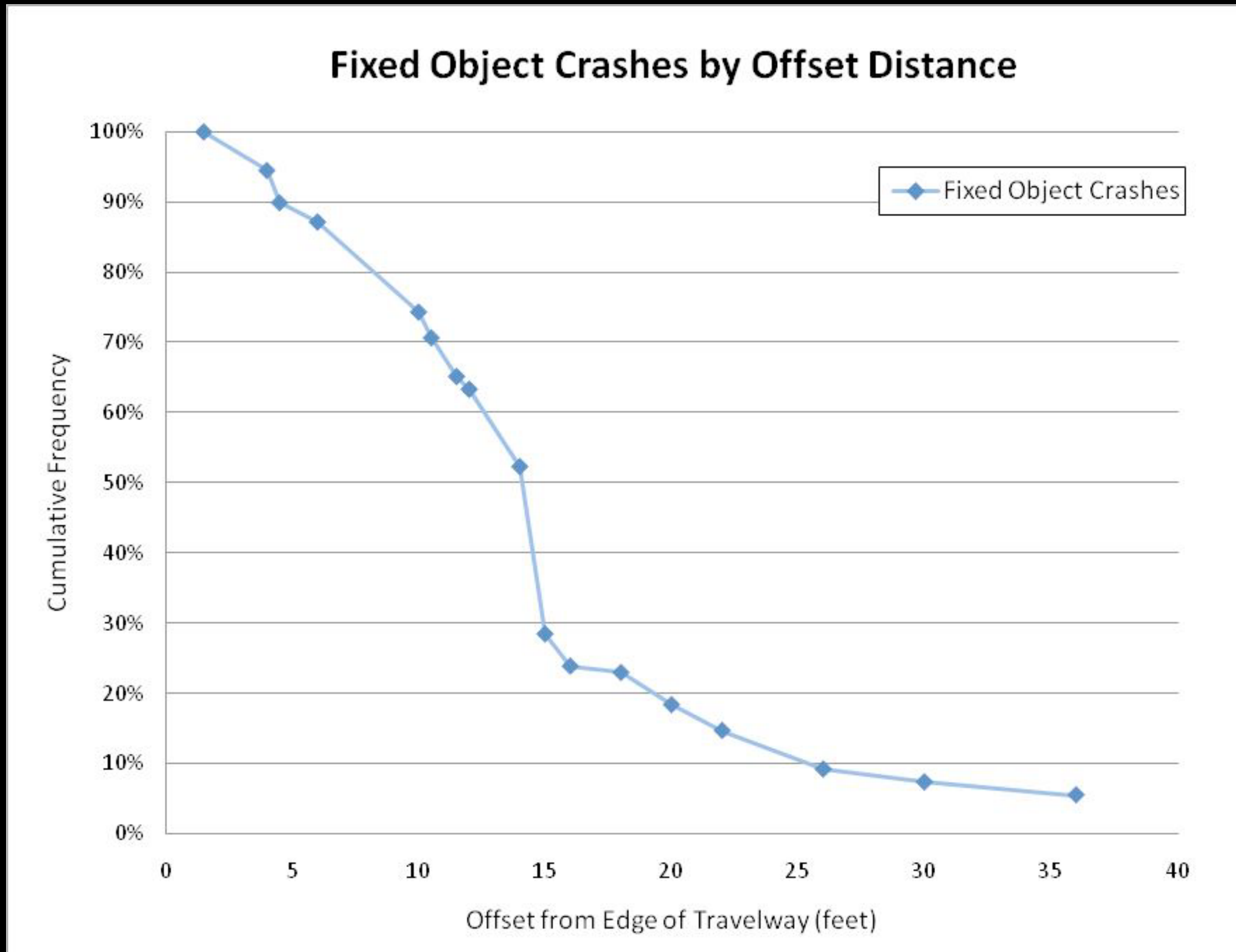
FIG. 8. Lateral Clearance to Trees

Source: Turner and Mansfield, 1990

The majority of urban tree-related crashes occur less than 20 ft from the travel-lane

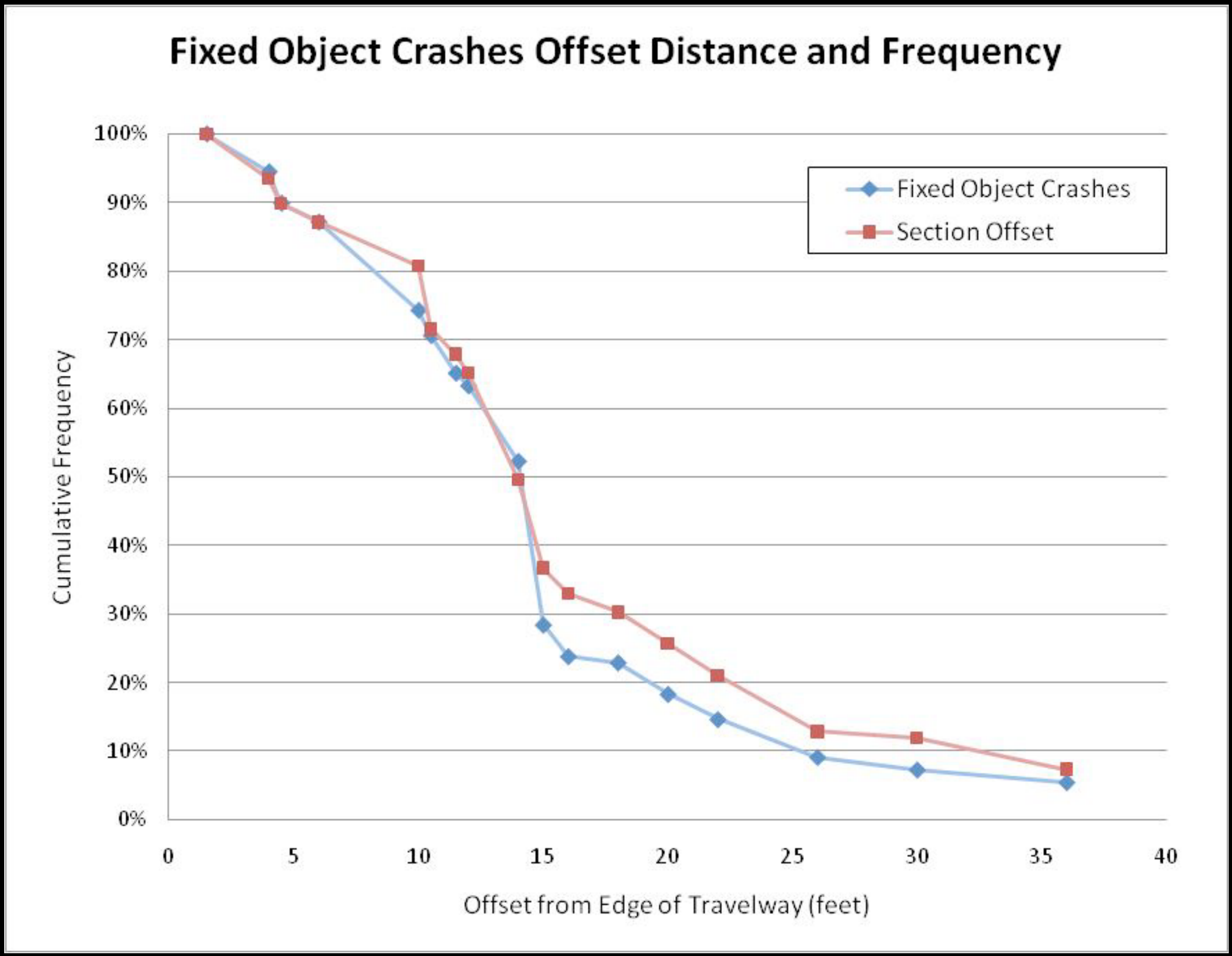
Study Conclusion:
20 ft clear zones in urban areas are desirable for safety.

Re-Examining Urban Roadside Crashes



Dumbaugh, 2005

Re-Examining Urban Roadside Crashes



Dumbaugh, 2005

Urban Roadside Crashes

Representative Urban Fixed-Object Crash

- **Field examination (Florida) of roadside crash locations:**
- **<u>83%</u> 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.

Livable Streets

- **<u>Further:</u>**
  - Not a single injurious fixed object-related crash occurred on the livable sections during the 5-year analysis period
  - Nor was there a single traffic fatality involving either a pedestrian ***<u>or</u>*** a motorist.
  - The reason: speed.

Livable Streets

- Per vehicle mile traveled, the livable streets reported:
  - 40% fewer midblock crashes than roadway averages.
  - 67% fewer roadside crashes than roadway averages.

San Antonio Results Confirm These Findings

- Arterials were positively associated with fixed-object crashes at 85% confidence level.
  - problem is not just speed alone, but speed and ACCESS.
- Each 4-leg intersection and strip commercial use associated with a 1% increase in fixed-object crashes.
  - These are where turns occur.
- Each pedestrian-scaled retail use associated with a 1% *decrease* in fixed-object crashes.

What about population density?

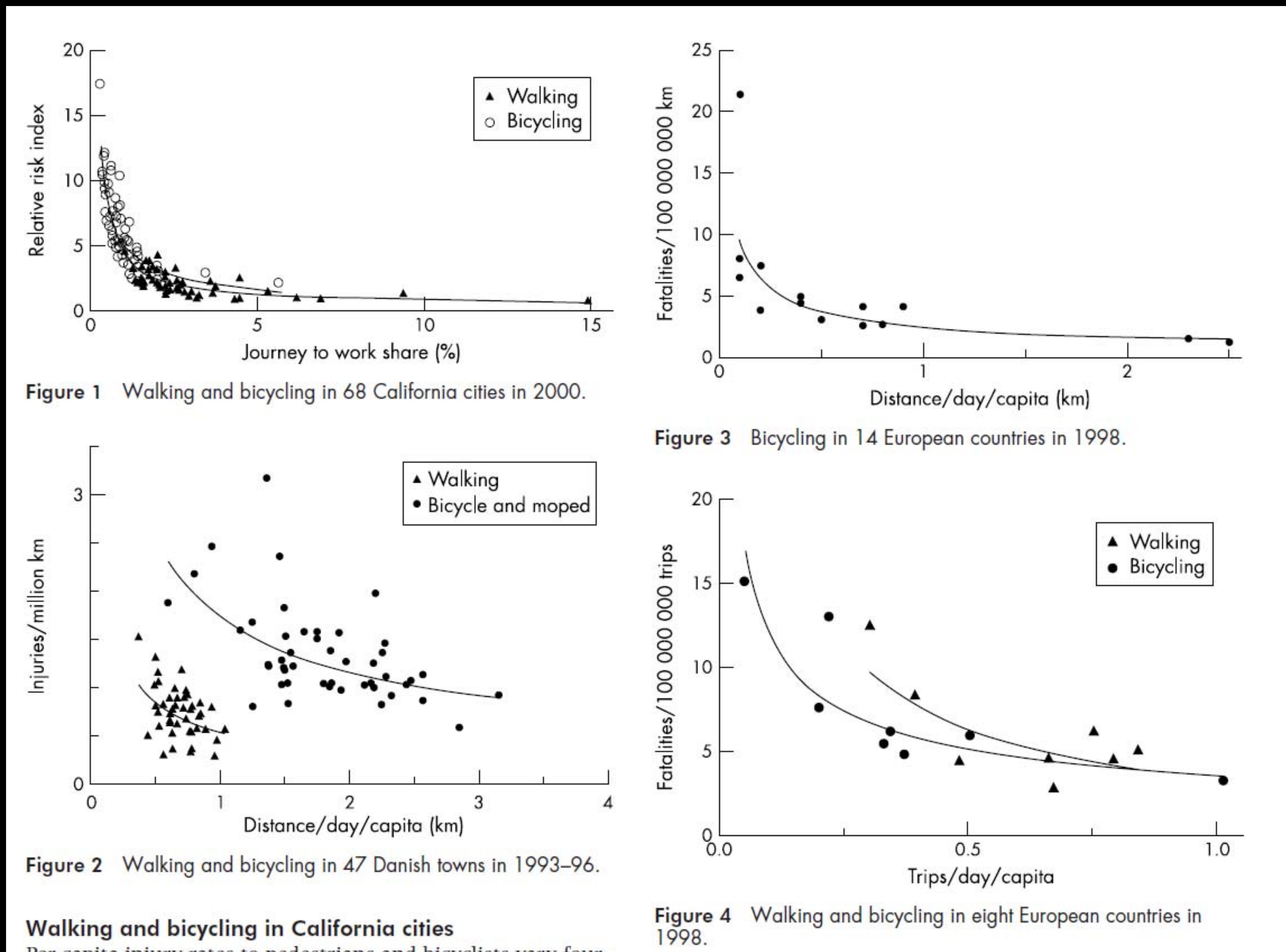
- Identified in crash forecasting models as a risk factor.
- Had no effect on motorist cyclist or fixed object crashes.
- Associated with a significant **increase** in pedestrian crashes.
  - Every 3 additional persons per acre associated with a 1% increase in ped crashes.

Density may be more important for its indirect effects…

Higher densities:

- reduce VMT, which reduces crash incidence.
- Encourages “urban” development configurations, which reduces crash incidence.

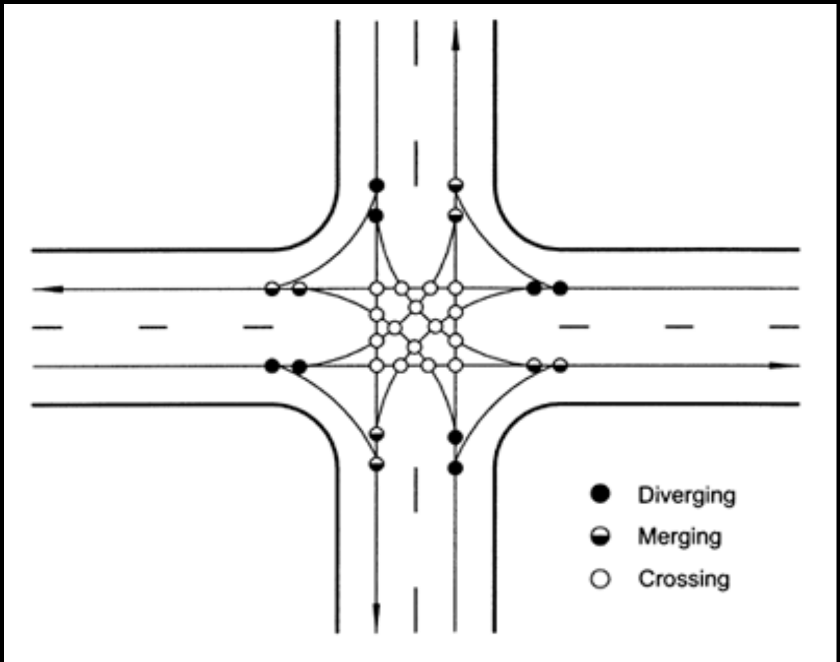
Density and critical masses



Source: Jacobsen, 2003

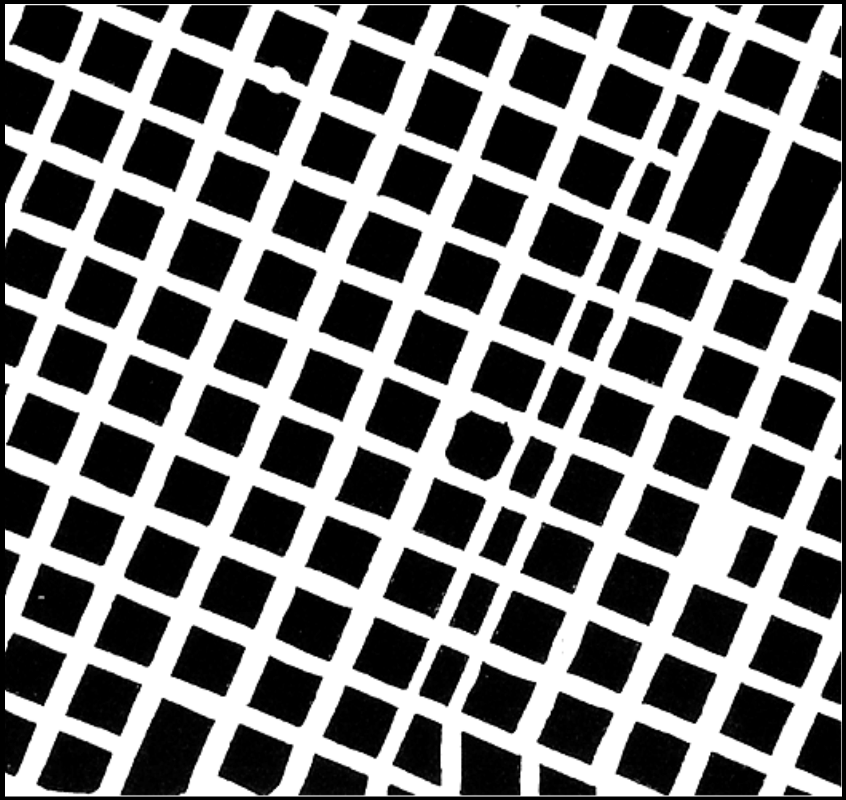
What about connectivity?

- Intersections reduce speeds - and thus fatal crashes – but…
- They also increase *traffic conflicts*.
  - 4-leg intersections are associated with **INCREASED** total and injurious crashes.
  - 3-Leg intersections have **NO EFFECT** on total or injurious crashes.

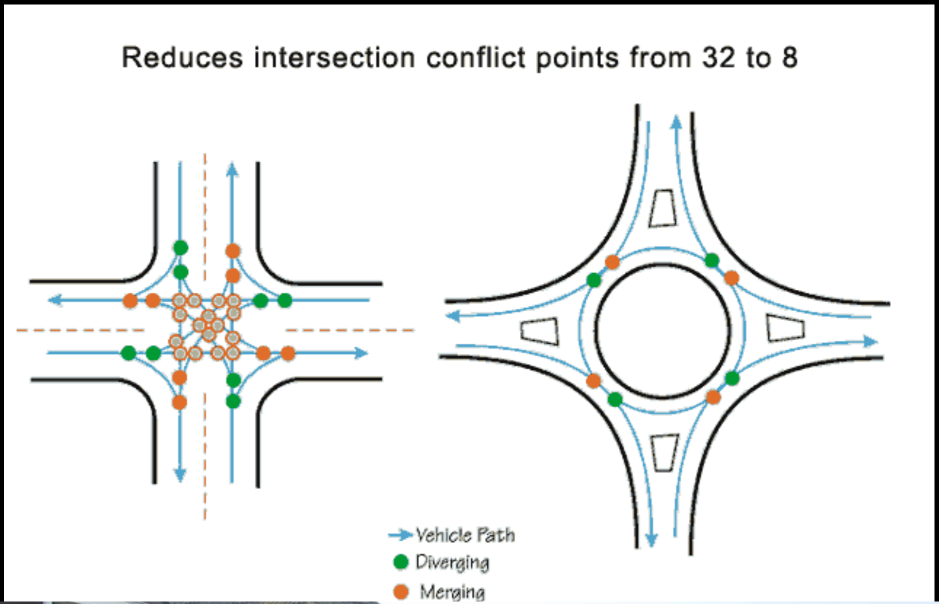


Reconsidering Street Networks

- The results do not suggest that a wholesale return to the grid is desirable.
- **Hybrid street networks**, using frequent T-intersections, are preferable to limited access or grid-iron configurations, ceteris paribus.



Intersection Alternatives

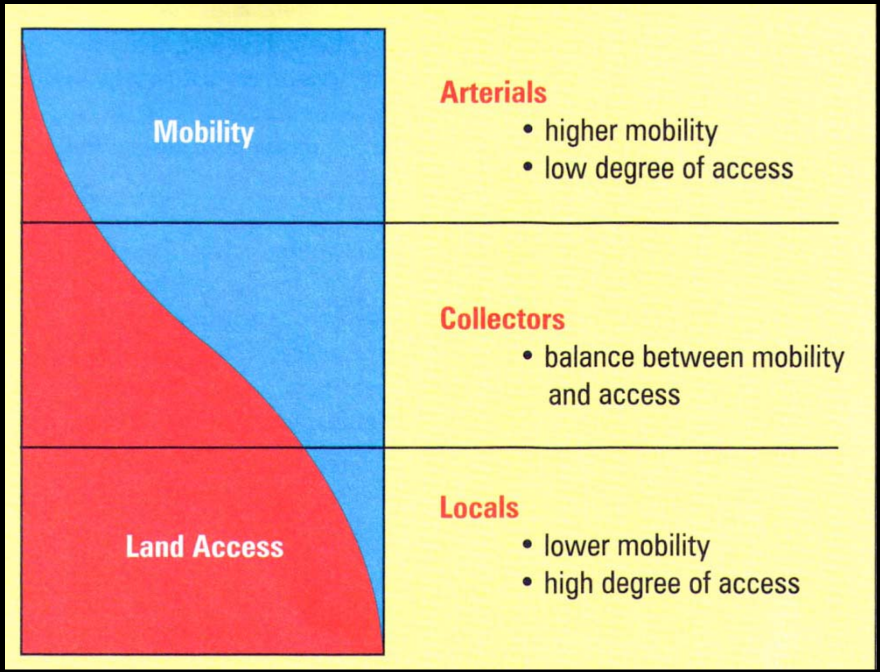


The Engineer Says:

"The majority of crashes are attributable to errors on the part of the driver."

- VMT (and random error) matters, but:
  - A single **strip commercial use** produces ***6 times*** more crashes than would occur from 1 million miles of vehicle travel.
  - A single **big box store** is associated with ***14 times*** as many crashes as a million miles of travel.
  - For an **arterial** carrying 40,000 VPD, the crash risk per mile of travel is ***438 times*** greater than would be expected from random error alone.

Systematic Design Error: A mismatch between the way a designer *intends* a designed environment to be used, and the way it is **actually used**.



- Arterials are designed and intended for higher-speed, mobility functions
- Roadside development forces them to serve access functions.
- This combining of functions creates the majority of urban traffic safety problems:
  - Rear-end, angle, pedestrian and roadside crashes

Rethinking Conventional Safety Practices

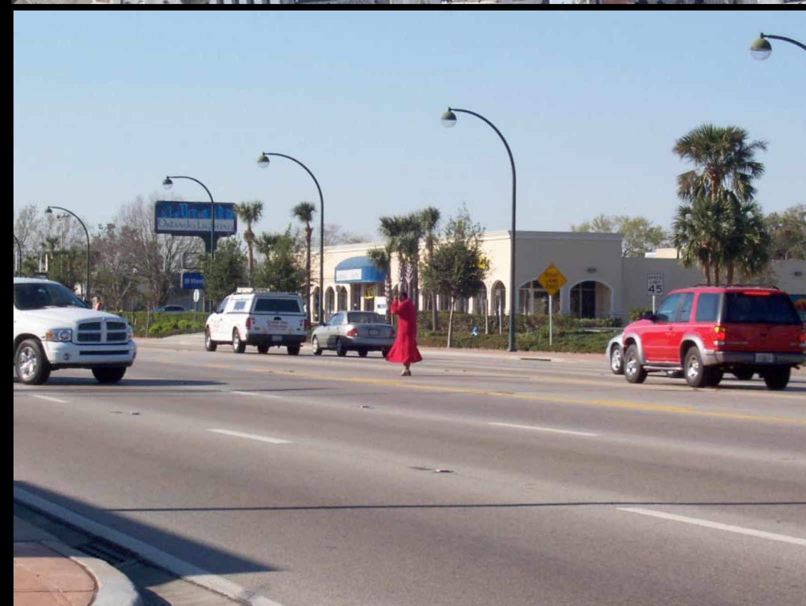
Freeways

Urban Surface Streets

Rethinking Conventional Safety Practices

Freeways

Urban Surface Streets



High Speed, Low Conflict:

Freeways and Access Management

High Conflict, Low Speed:

Traffic Calming, Woonerven and Shared Spaces

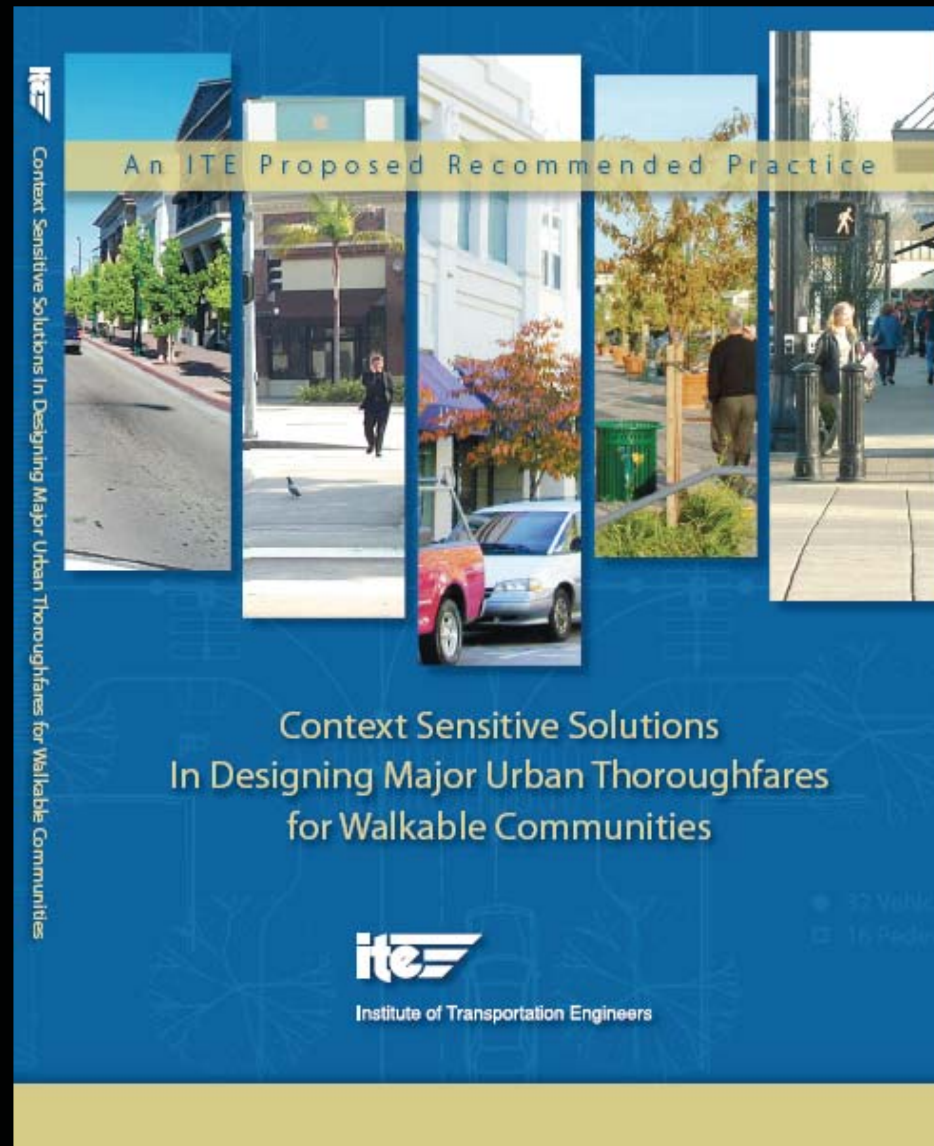
Intermediate Class Roadways

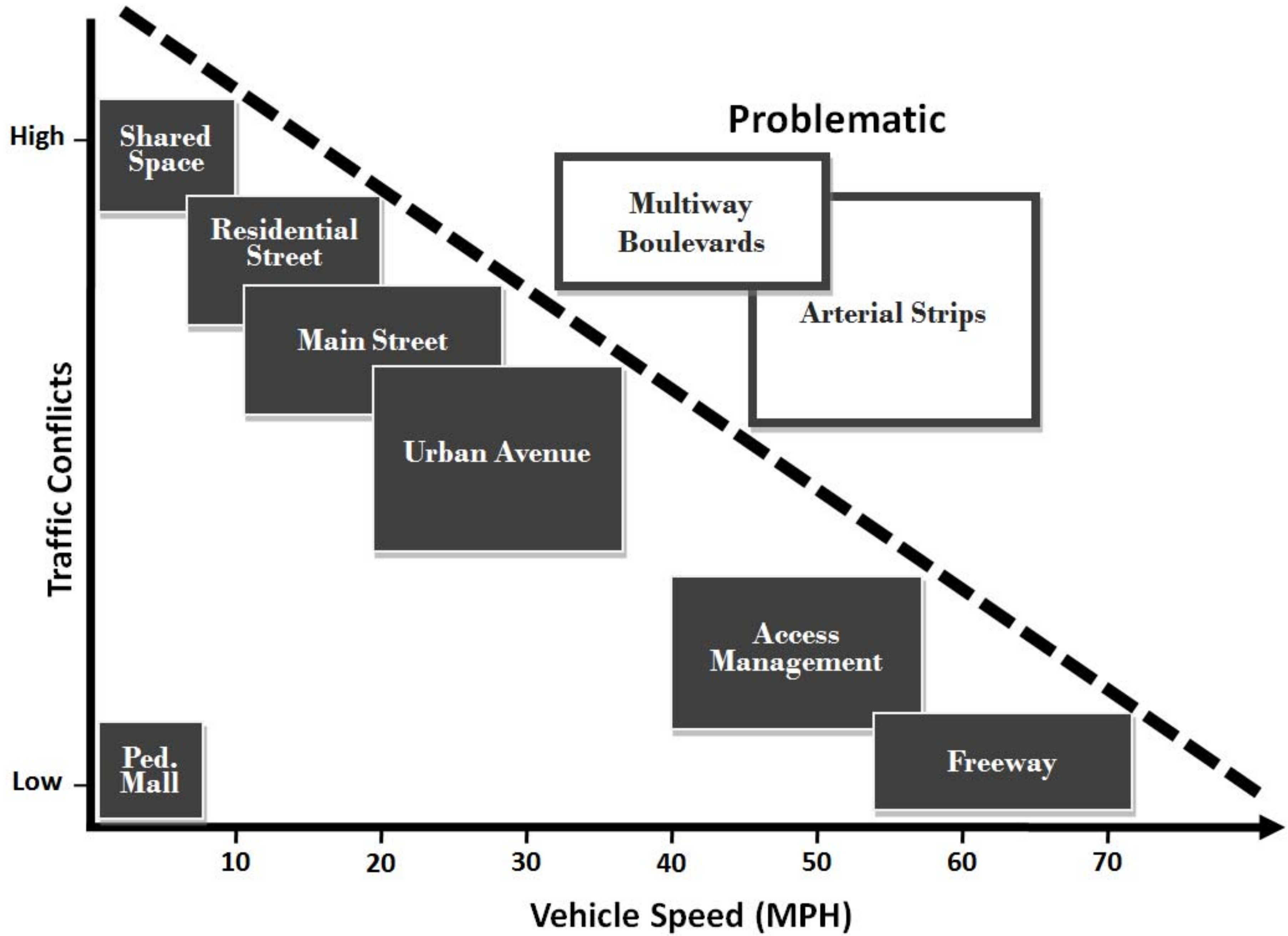
Urban Avenue

Commercial Main Streets

Commercial Street

Avenue




Problematic
High
Low
Traffic Conflicts
Shared Space
Residential Street
Main Street
Urban Avenue
Multiway Boulevards
Arterial Strips
Access Management
Freeway
Ped. Mall
10
20
30
40
50
60
70
Vehicle Speed (MPH)

Questions?
Copies of Articles?

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