Safety Impacts: Presentation Overview

- The #1 Theme
- How Access Management Improves Safety
  - Conflict Points
- The Science of Access Management
  - By Treatment
- Studies

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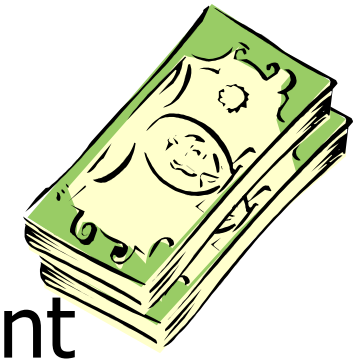
Themes for Texas Access Management

- Improve Safety

- Increase Mobility

- Protect Infrastructure Investment



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How Access Management Improves Safety

- Reduces Conflict Points at Intersections
  - Driveways are Intersections too!!
- Removes Speed Differentials
- Increases Driver Expectations

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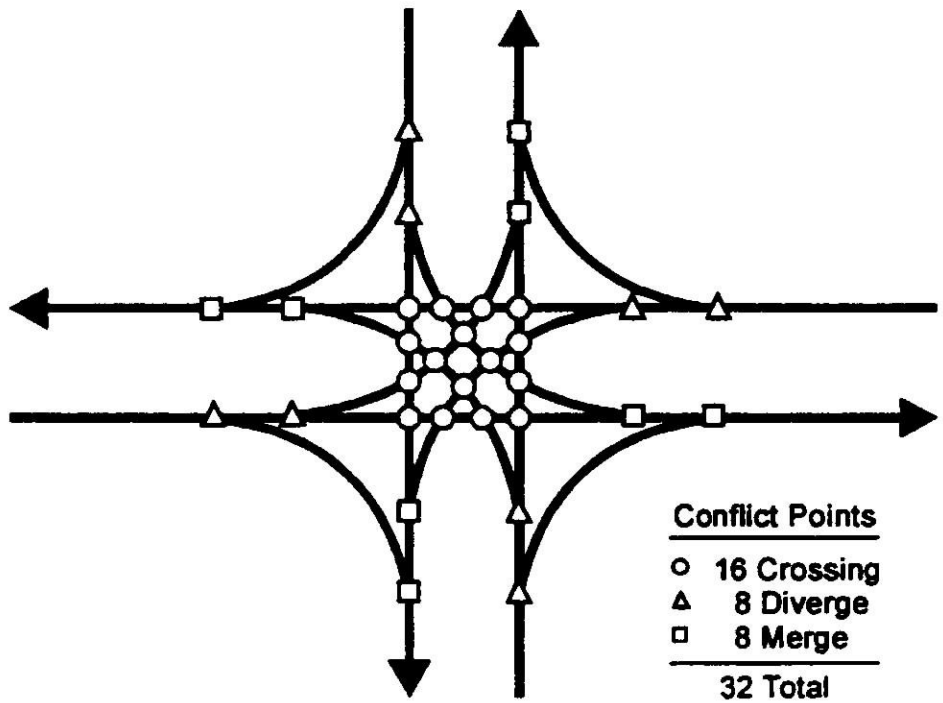
4-Leg Intersection Conflict Points



Vehicular Conflicts

Source - NHI Course 15255

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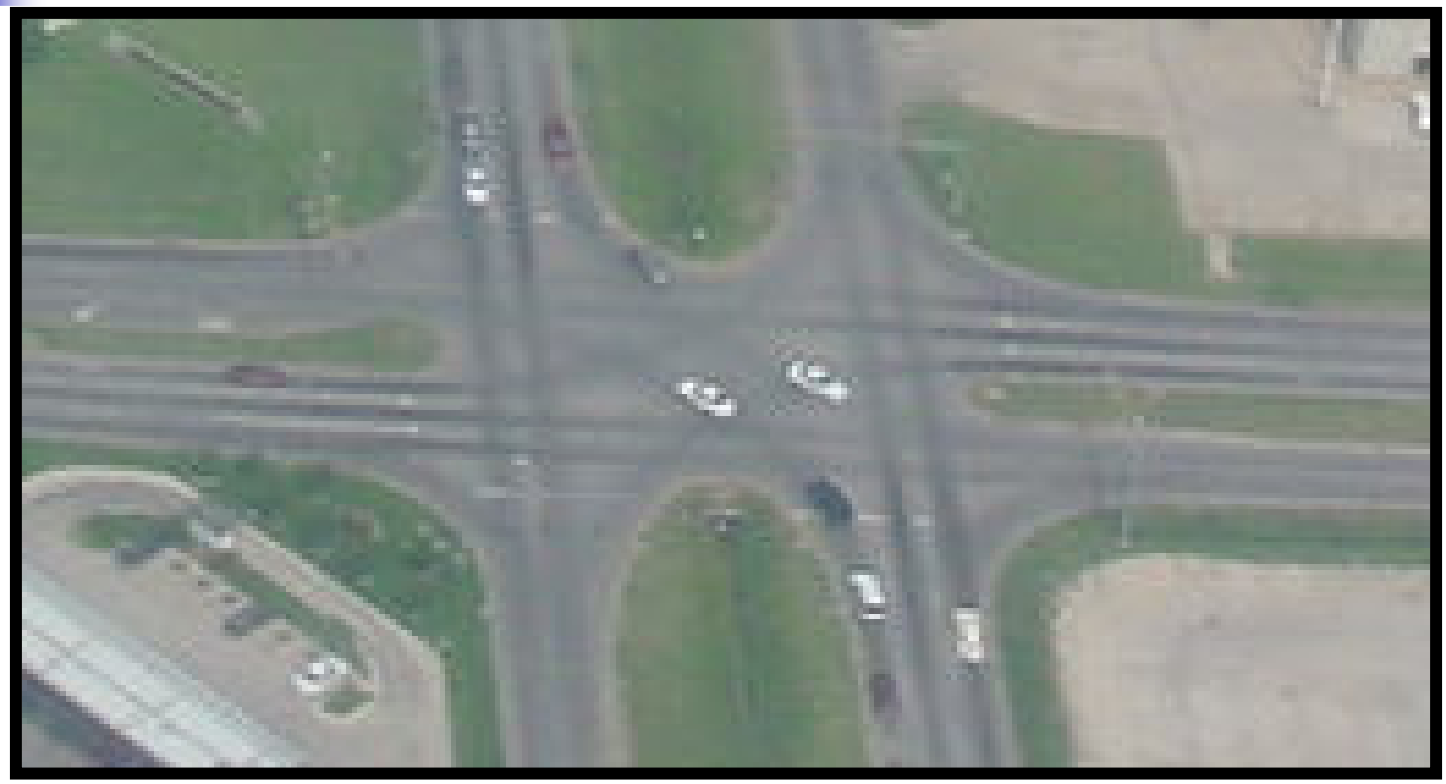
Conflict Points



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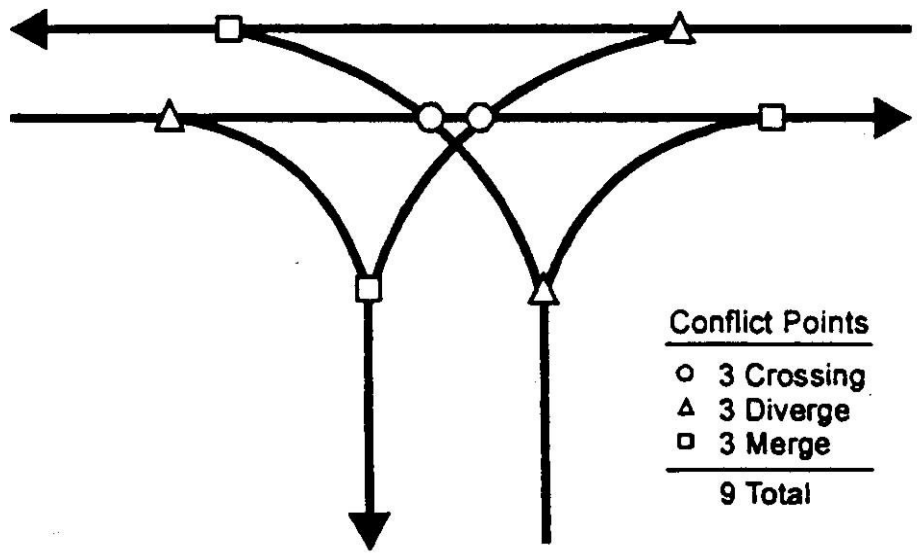
3-Leg Intersection Conflict Points



Vehicular Conflicts

Source - NHI Course 15255

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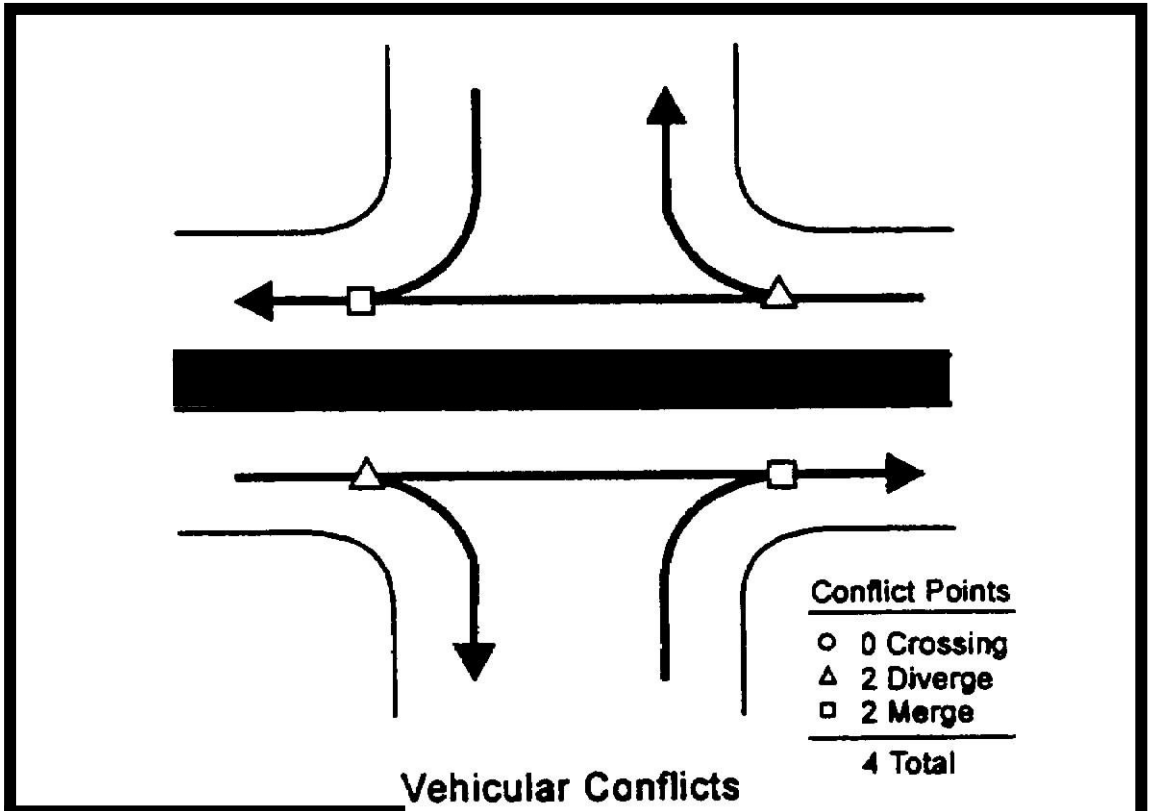
Conflict Points with Raised Median



Source - NHI Course 15255

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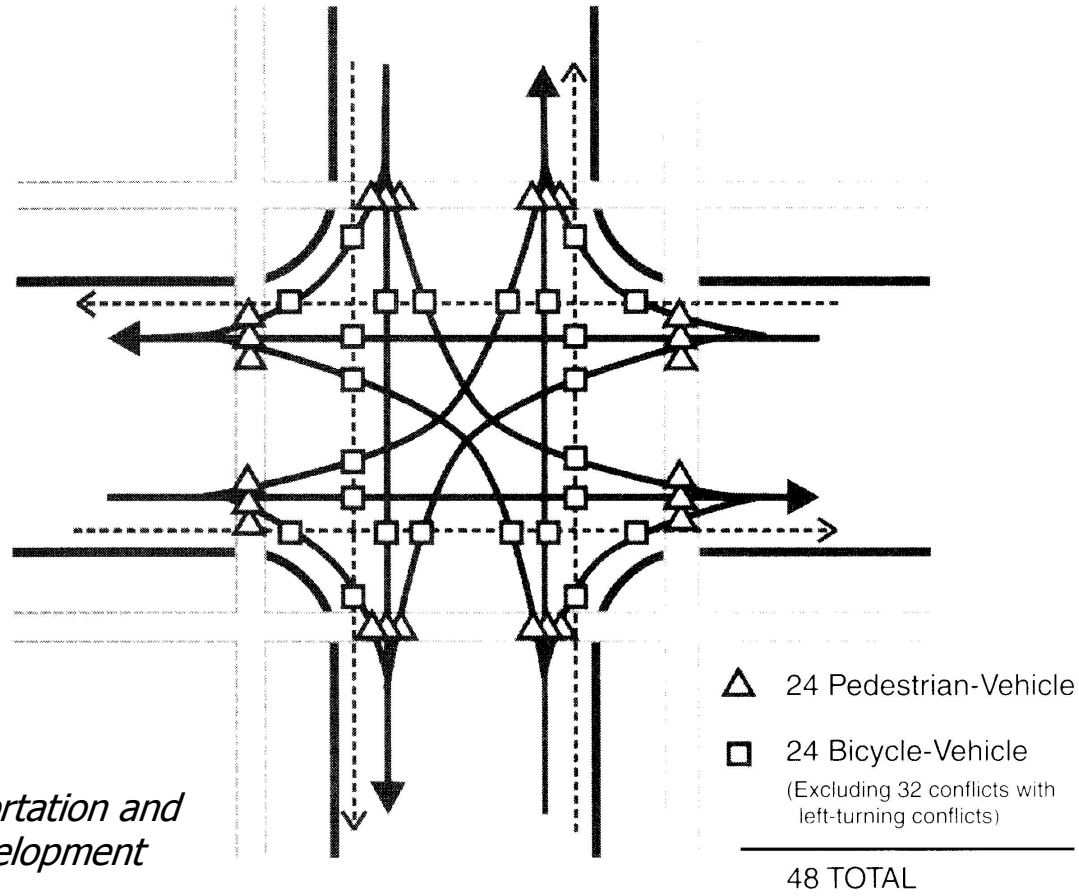
Conflict Points with Bicyclist / Pedestrians



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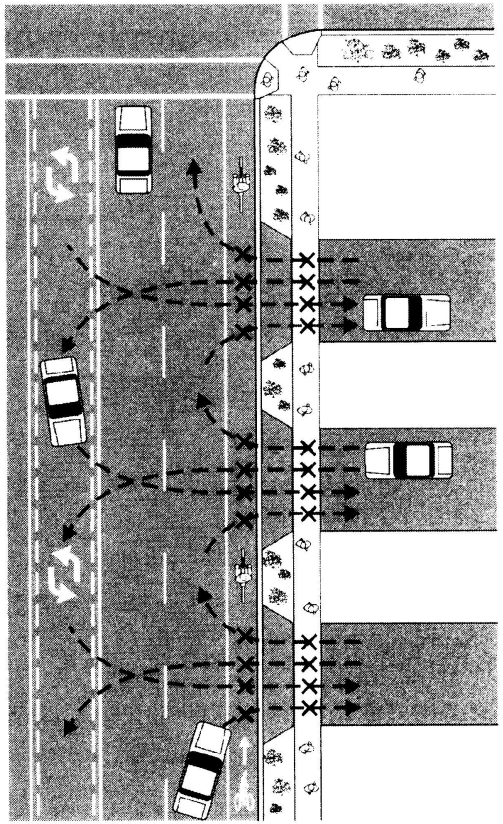
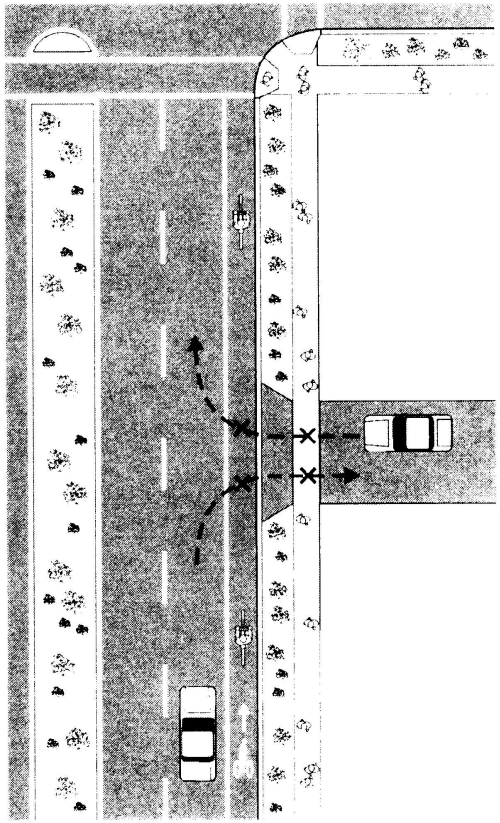
Conflict Points with Bicyclist / Pedestrians



Uncontrolled Accesses Create
8 Potential Conflict Points
at Every Driveway



A Raised Median and
Consolidating Driveways
Reduce Conflict Points

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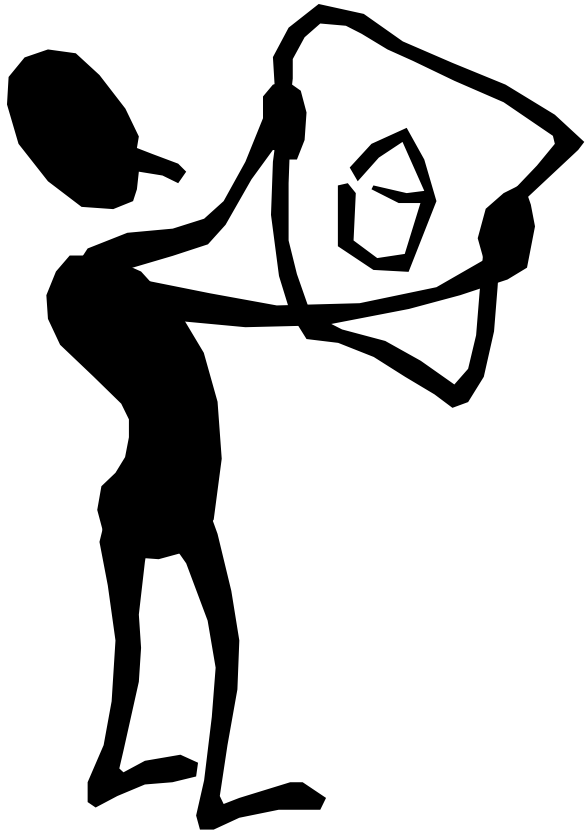
The Science of Access Management

Considerations by Treatment

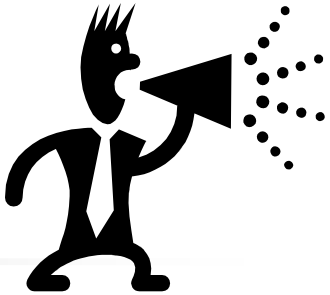
- Unsignalized Spacing
- Signalized Spacing
- Raised Medians
- Acceleration / Deceleration Lanes

Unsignalized Access Spacing

- Engineering considerations:
  - Functional intersection area
  - AASHTO guidance
  - Stopping sight distance
  - Intersection sight distance
  - Case-by-case
    - No cookbooks allowed!



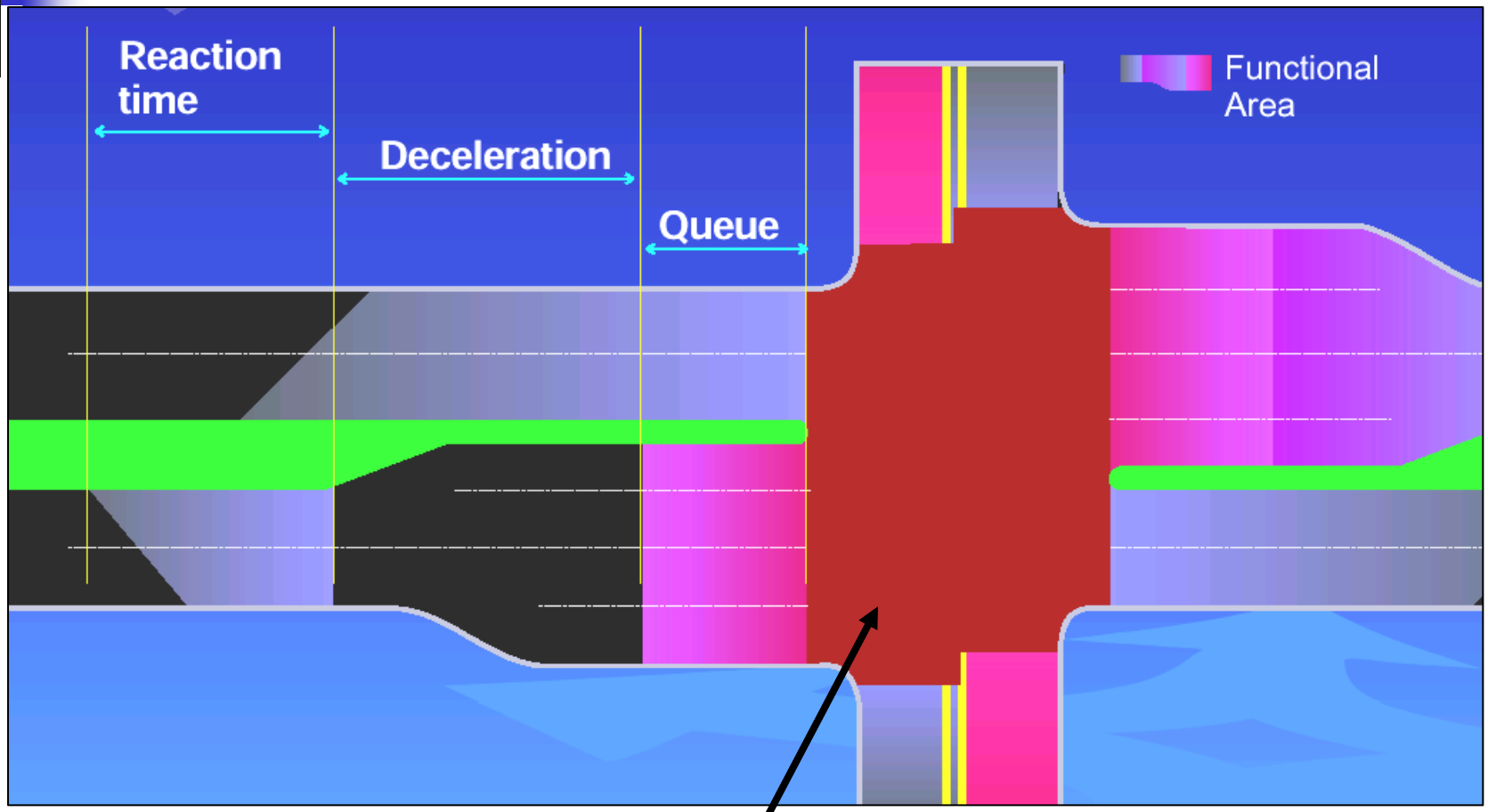
AASHTO says:



- "Ideally, driveways <u>should not be</u> located within the functional area of an intersection or in the influence area of an adjacent driveway. The functional area extends both upstream and downstream from the physical intersection area and includes the longitudinal limits of auxiliary lanes."

  (AASHTO, 2004, Green Book, page 729)

Functional Area of an Intersection (vs. Physical Area)



Physical Area (Red)

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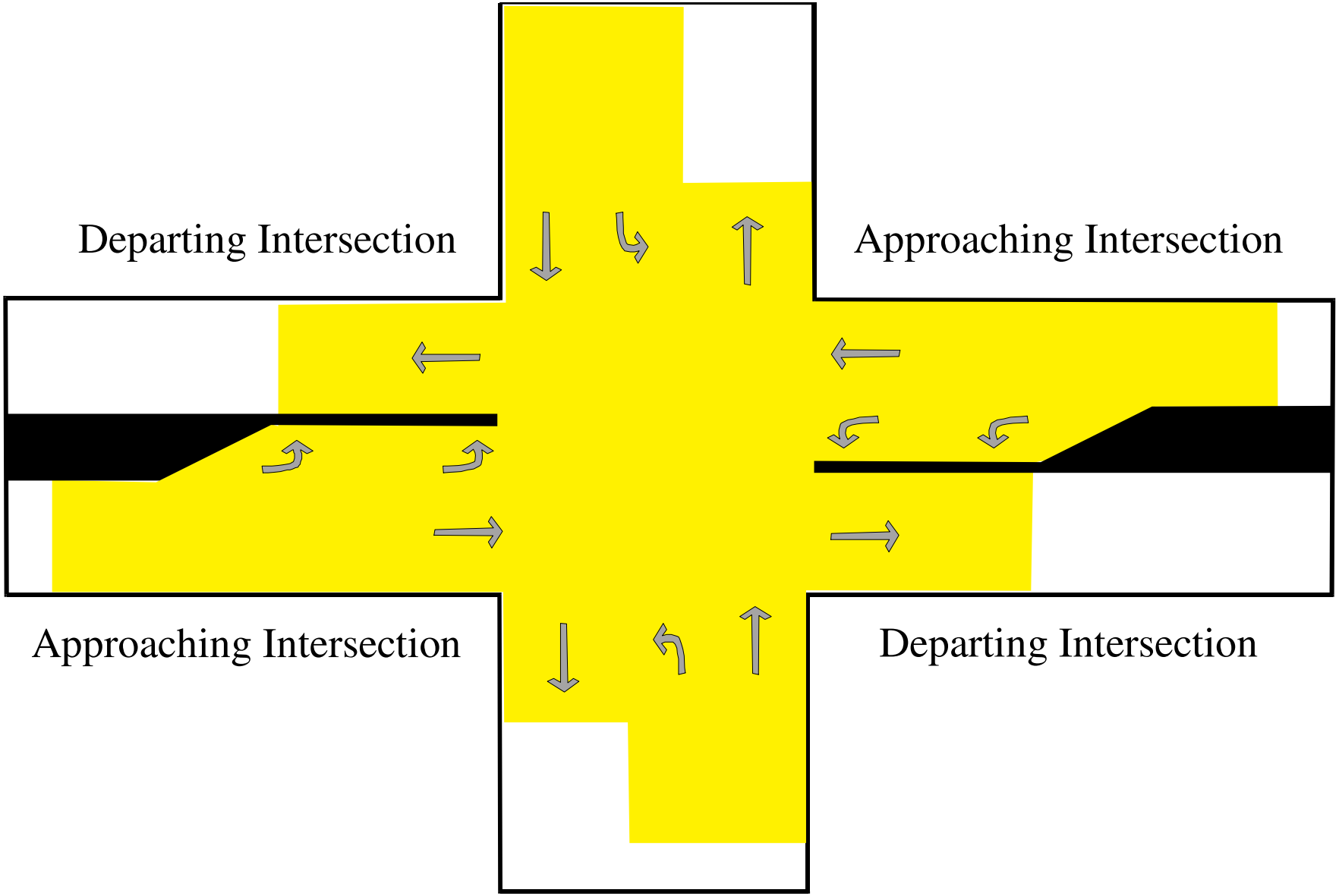
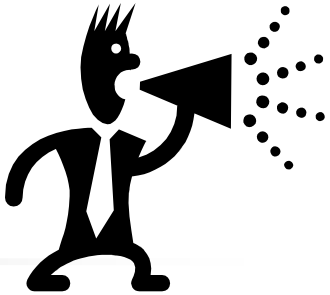
Functional Area of an Intersection



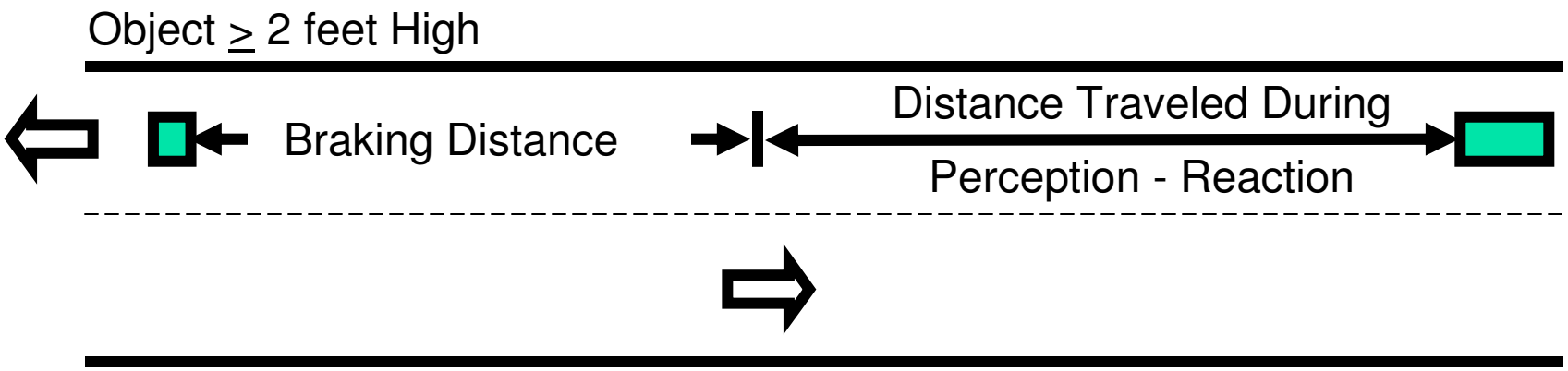
More from AASHTO:



- "The spacing of driveways should reflect the impact lengths and influence areas associated with motorists entering or leaving a driveway. The impact length represents the distance upstream when the brake lights of through vehicles are activated or there is a lane change due to a turning vehicle."

  (AASHTO, 2004, Green Book, page 729)

Stopping Sight Distance



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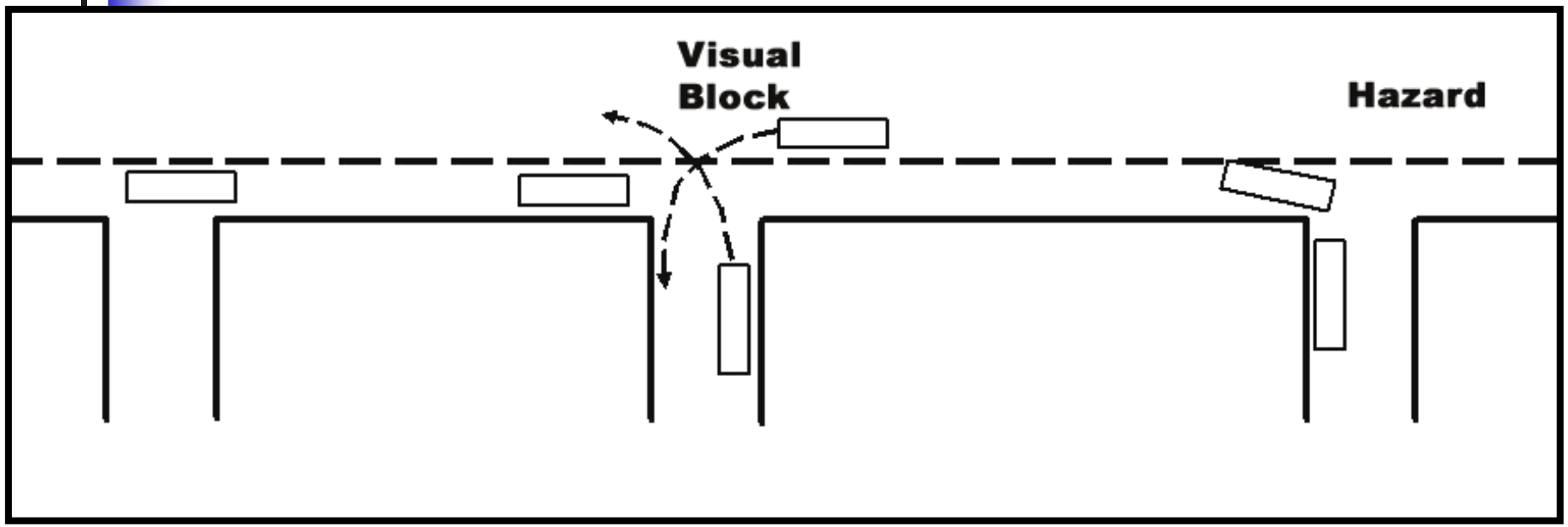
Application of Access Criteria

Edge of pavement versus centerline spacing

Application of Access Criteria



Stopping Sight Distance Example

(Discussion Paper #5C, Oregon DOT)

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Unsignalized Spacing Criteria (Texas)

Other State Highways Minimum Connection Spacing	
Posted Speed (mph)	Distance (ft)
≤ 30	200
35	250
40	305
45	360
≥50	425

Distances are for passenger cars on level grade. These distances may be adjusted for downgrades and/or significant truck traffic.

When these values are not attainable, refer to the deviation process

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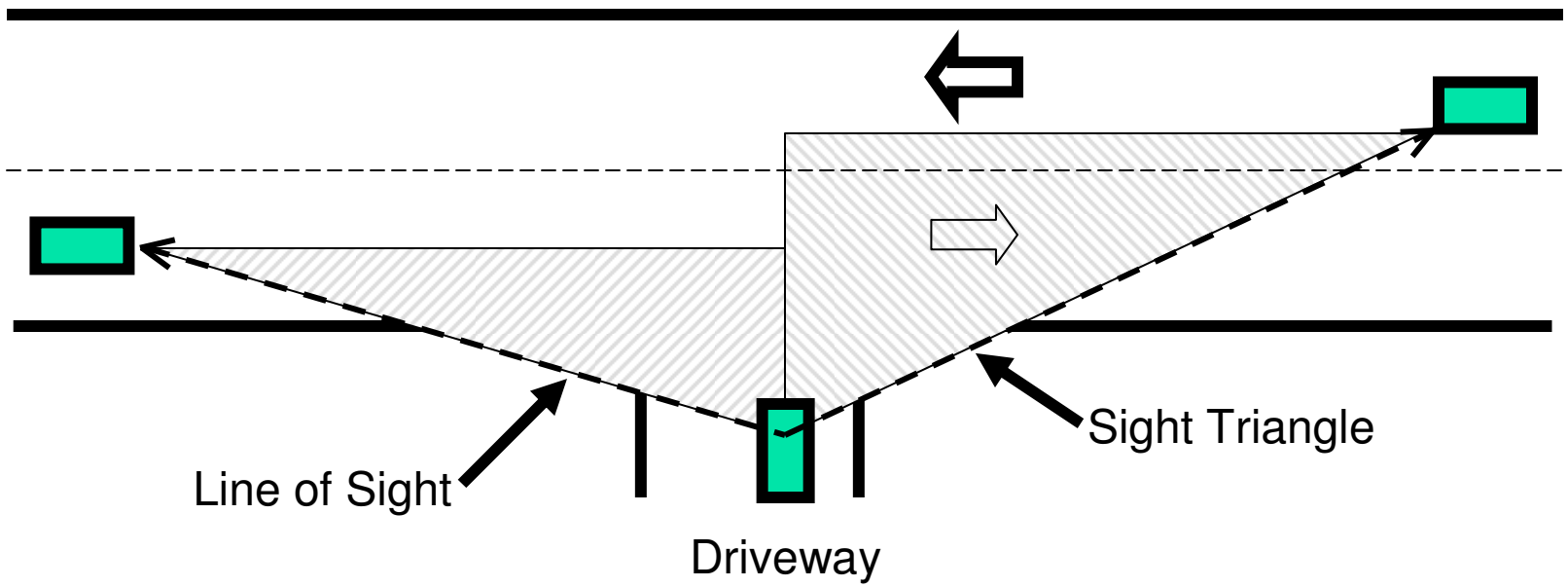
Corner Clearance

- Based on stopping sight distance (Texas)
- Where adequate space cannot be provided
  - May allow lesser spacing when shared access is allowed
  - Access may be allowed when no alternative exists, but at farthest location from intersection
  - Consideration given to right-in/right-out only operations

Intersection Sight Distance (enter / cross roadway)



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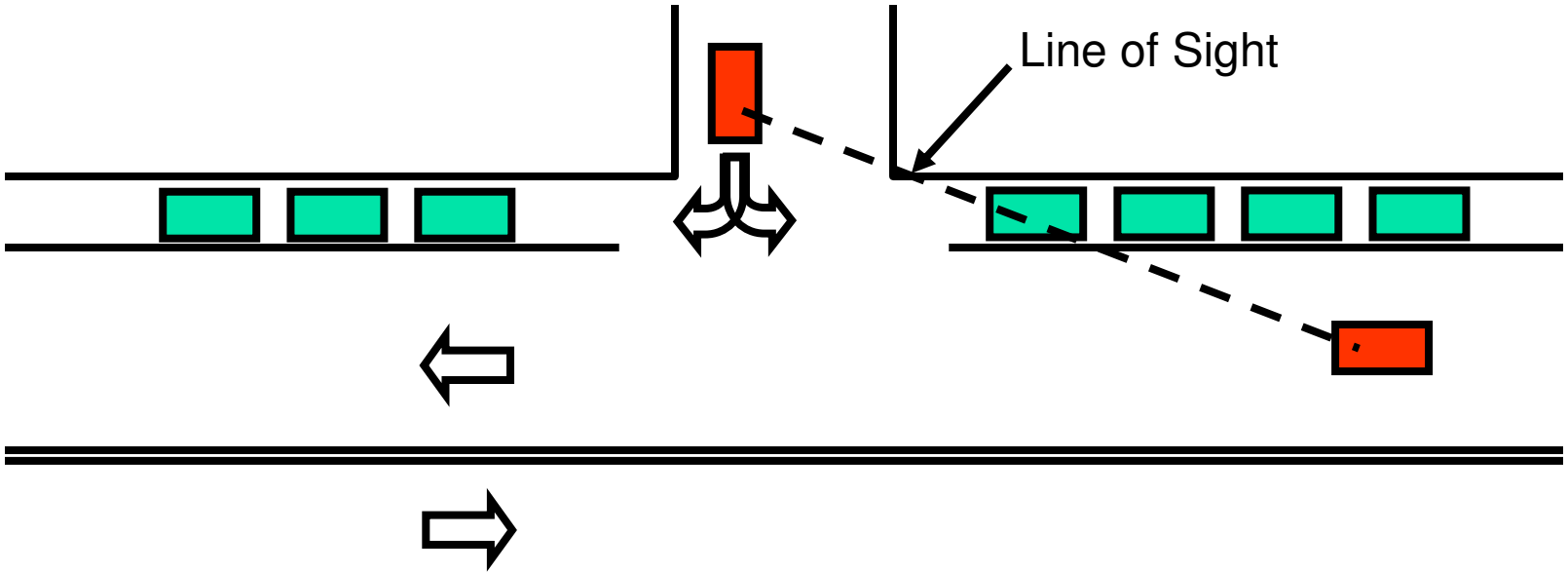
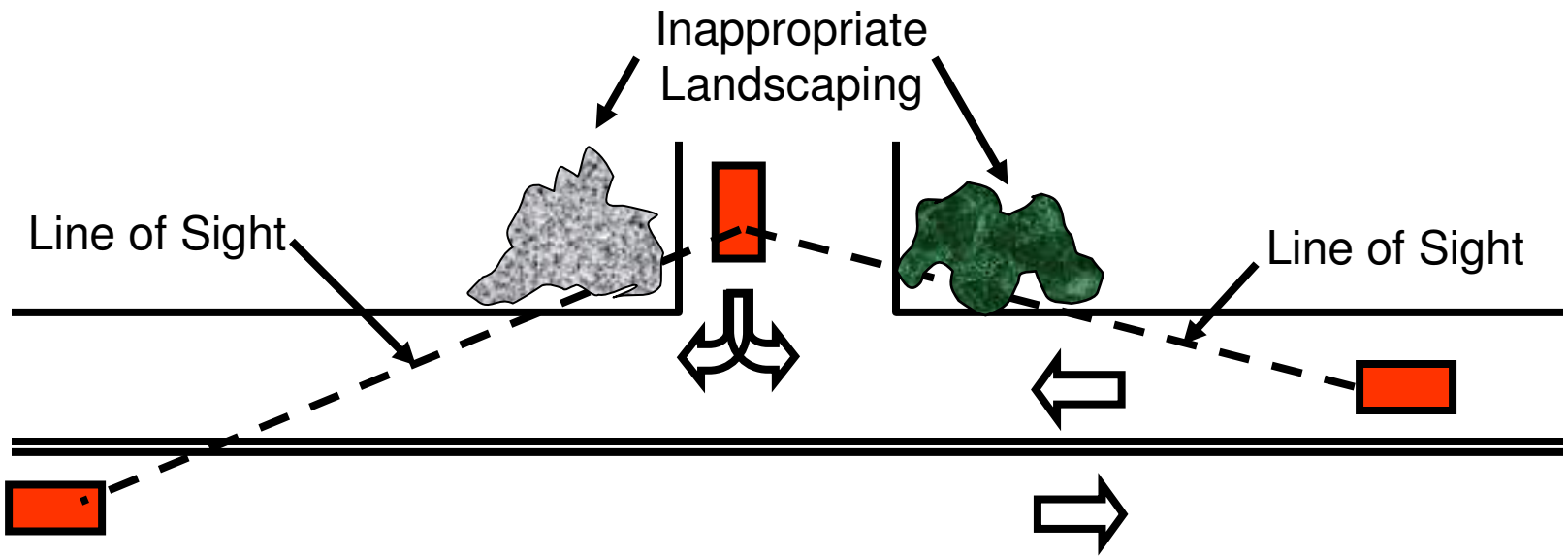
On-street Parking Obstruction



Landscaping Obstruction



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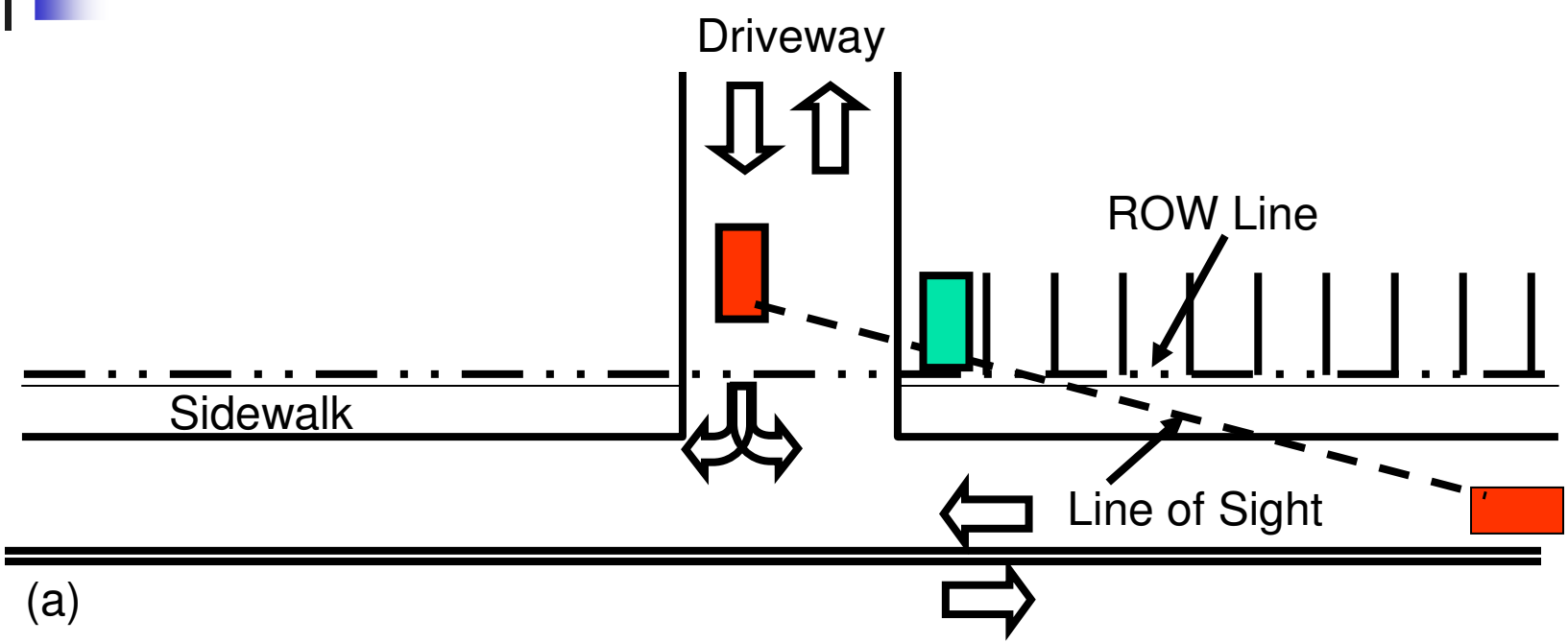
Close Proximity Parking (problem)



How do we fix this?

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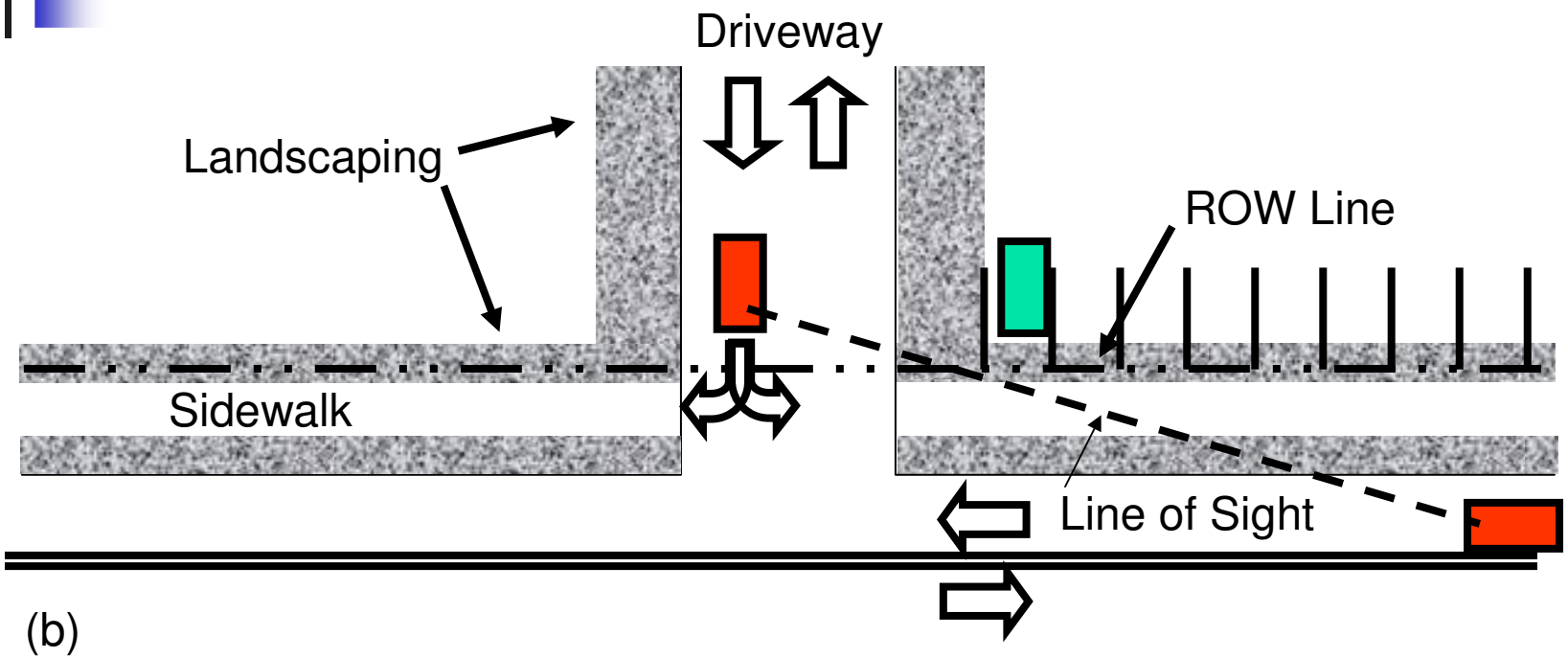
Close Proximity Parking (solution)



Coordination needed between local and state agencies => policies/procedures

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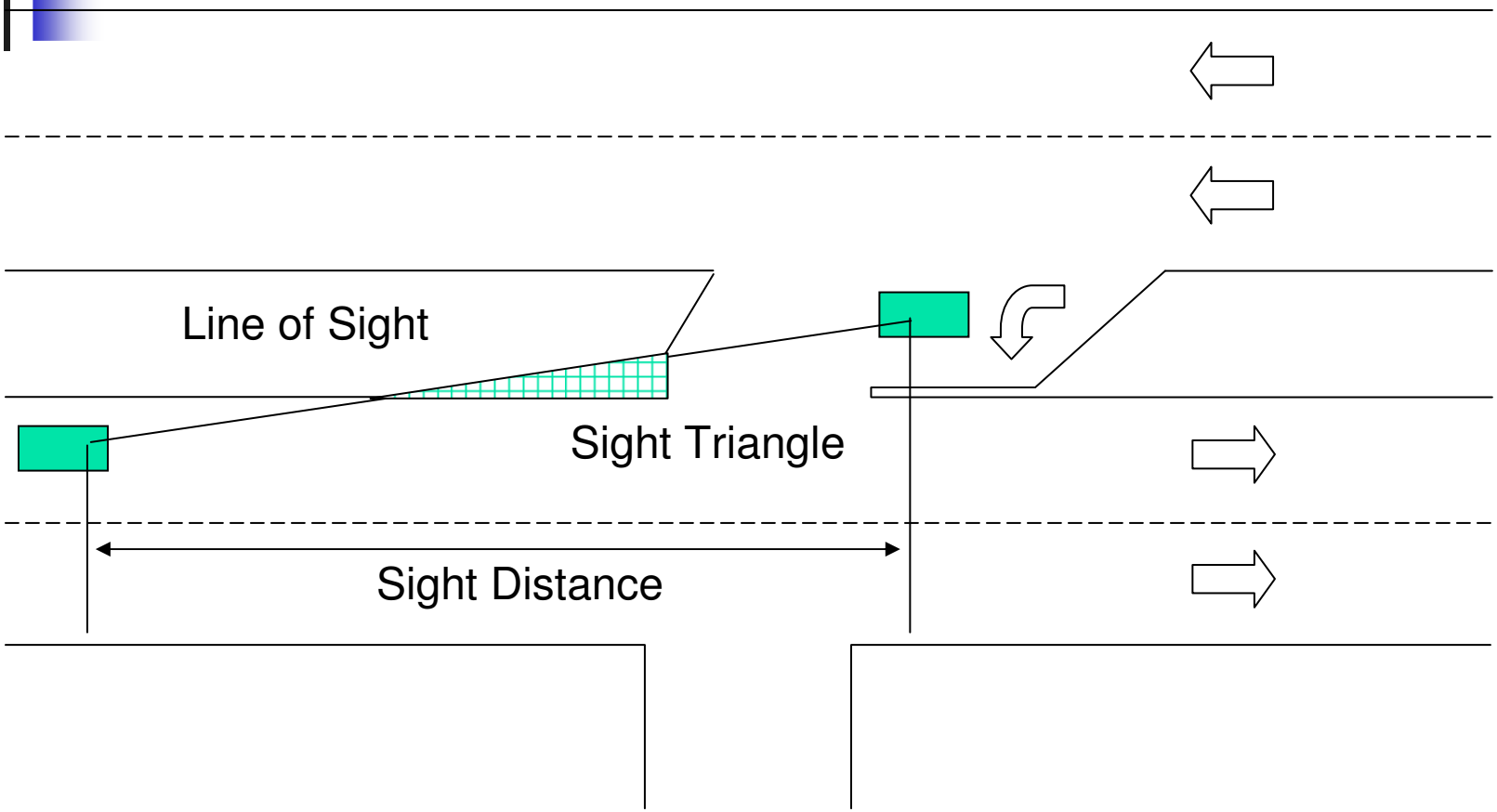
Intersection Sight Distance (left turn from roadway)



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Driveway Geometric Design Considerations

- Adequate lighting
- Driveway entry speed
  - Speed differential and crash potential
  - Function of driveway radius
- Design vehicle
- Throat width and length
- Driveway profile considering drainage

Signalized Access Considerations

Signalized Intersection Spacing

- Consider within the functional design
- Consider future signal locations when laying out streets
- Optimal and uniform signal spacing is essential if efficient progression and appropriate speeds for arterial streets are to be achieved

Signalization Variables

- Roadway Speed and Traffic Volumes
- Cycle Length and Offset
- Signal spacing
- Efficiency of progression
- Texas Manual on Uniform Traffic Control Devices

Raised Median Considerations

Why and When to Consider a Raised Median

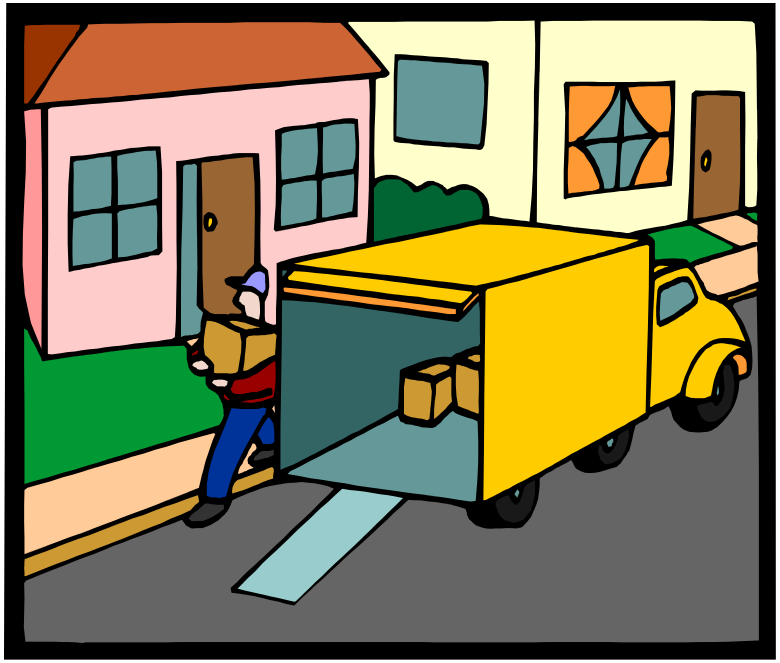
- Play critical role of operations and safety of roadway
- Roadways where aesthetic considerations are a high priority
- Multilane roadways with a high level of pedestrian activity

When to Consider a Raised Median

- High crash locations or where it is desirable to limit left turns to improve safety
  - Clear safety benefit
  - Studies shown later
- When ADTs exceed 20,000 vpd

Keep in Mind….

- Need adequate locations and width to handle U-turns
  - Can flare intersections or use loons
  - Jughandles/MI U-turn
- Alternate routes to handle delivery truck traffic



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Raised Median Openings

- Provide selected access
- Consider directional openings to limit access
- Considerations Included in TxDOT *Roadway Design Manual*

Photo courtesy City of Garland, TX

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Acceleration and Deceleration Lanes

Acceleration / Deceleration Lanes

- For left and right turns
- Include taper, storage lengths and accel/decel lengths
- Auxiliary lane thresholds in the TxDOT *Access Management Manual*
- TxDOT *Roadway Design Manual* should be used for designing accel/decel lane lengths

Safety Studies

Safety

- Reducing conflict points reduces crash potential
- Approximately 50% of all crashes are intersection-related
  - Driveways are intersections too!
- More than 3,500 people die in Texas crashes each year

Overview

- Studies: Crash Reductions of 30-70%
  - Depends on Conditions
  - Depends on Techniques
- Every new access point increases the opportunity for crashes

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Overview

- 50-55% Related to Intersections
  - 60% in Urban areas
  - 40% in Rural areas
- Remember, Driveways are Intersections Too!!

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Safety

2001	Texas	US	Best State
Fatalities	3,724	42,116	
Fatality Rate per 100M VMT	1.72	1.51	0.90
Fatality Rate per 100K Population	17.46	14.79	7.48

2000 Economic Cost of Motor Vehicle Traffic Crashes	
Texas	$ 19.761 Billion
US Total	$ 230.568 Billion

Texas Studies

Safety Impacts – Texas

- Texas Avenue – College Station

  Crashes reduced by 50-67%

  Severity of crashes decreased (evidenced by injuries)

TxDOT Research Project 0-4221

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Texas Safety Study (Objectives)

- Investigate the impacts of raised median installation and driveway density
  - 11 case studies
- Investigate crash data collection and reduction processes

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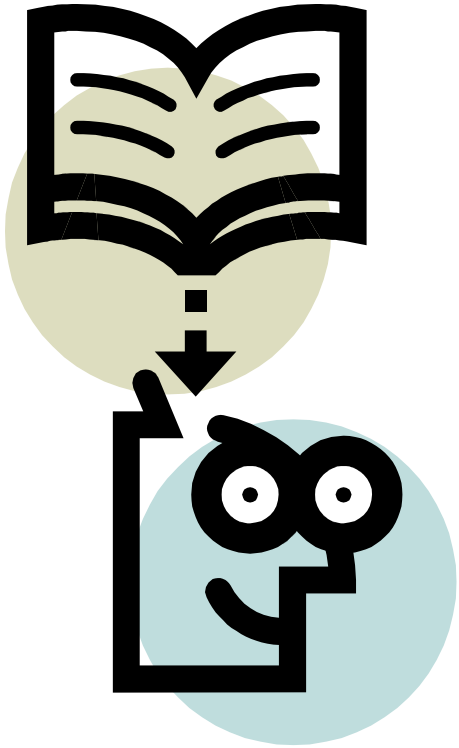
Methodology

- Determine crashes per million VMT
- Compare corridors before and after raised median presence
- Compare high, medium, and low access point density corridors and segments



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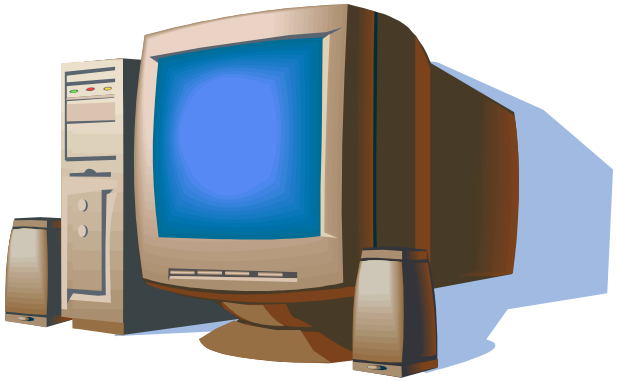
List of Case Study Corridors

- Texas Ave (Bus SH 6 – College Station)
- Loop 281 (Longview)
- Grant Ave (US 385 – Odessa)
- 42nd St (SH 191 – Odessa)
- Camp Bowie Blvd (US 377 – Fort Worth)
- University Dr (US 380 – McKinney)
- Preston Rd (SH 289 – Plano)
- Park Blvd (Plano)
- 31st St (FM 1741 – Temple)
- Broadway (US 69 – Tyler)
- 71st St (Tulsa, OK)

Studied Corridors With . . .

- Raised Medians
- No Raised Medians
- Before and After Raised Medians
- Low/High Access Point Densities



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Methodology

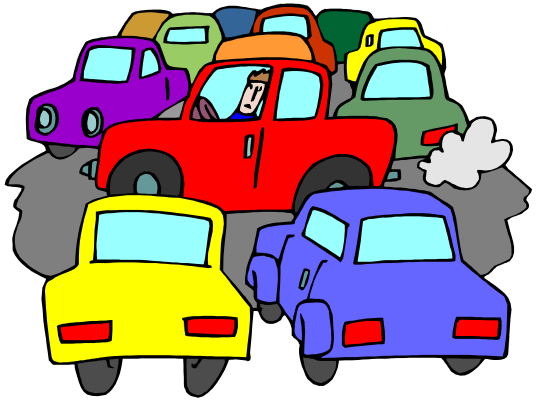
- Determine crashes per million VMT
- Compare corridors before and after raised median presence
- Compare high, medium, and low corridors and segments

Resources (Crash Data)

- Texas DPS
  - Crash reports (most detail)
- Oklahoma DOT
  - Crash listings (some detail)
- Cities (Plano and Wichita Falls)
  - Crash listings (least detail)
- Some reporting errors
- Typically not more than 10 years available

Resources (Traffic Volumes)

- Texas DOT
- City of Plano
- Indian Nation Council of Governments (Tulsa)
- Some interpolation for missing years



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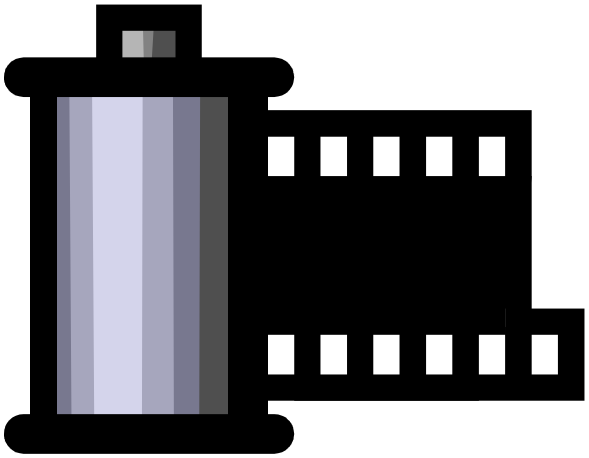
Resources (Aerial Photos)

- Cities
- Councils of Governments
- Other state agencies
- Varying resolution and quality



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Loop 281 – Injuries (Before and After Raised Median)

	'92	**'93**	**'94**	**'95**	***'96***	**'97**	**'98**	**'99**
None	112	125	186	155	*80*	114	119	85
Possible	28	54	51	50	*45*	45	64	52
Non-incapac	0	4	8	18	*15*	7	12	11
Incapac	1	1	0	3	*0*	0	0	1
Fatality	0	0	0	1	*0*	0	0	0

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Loop 281 – Crash Types

	'92	**'93**	**'94**	**'95**	***'96***	**'97**	**'98**	**'99**
Rear-End	16	31	27	20	***18***	21	23	17
Side-Impact	10	22	27	44	***18***	15	30	25
Side-Swipe	9	8	11	4	***3***	1	2	0
Single	0	0	0	2	***1***	1	2	0
Head-On	9	1	1	1	***2***	0	0	0

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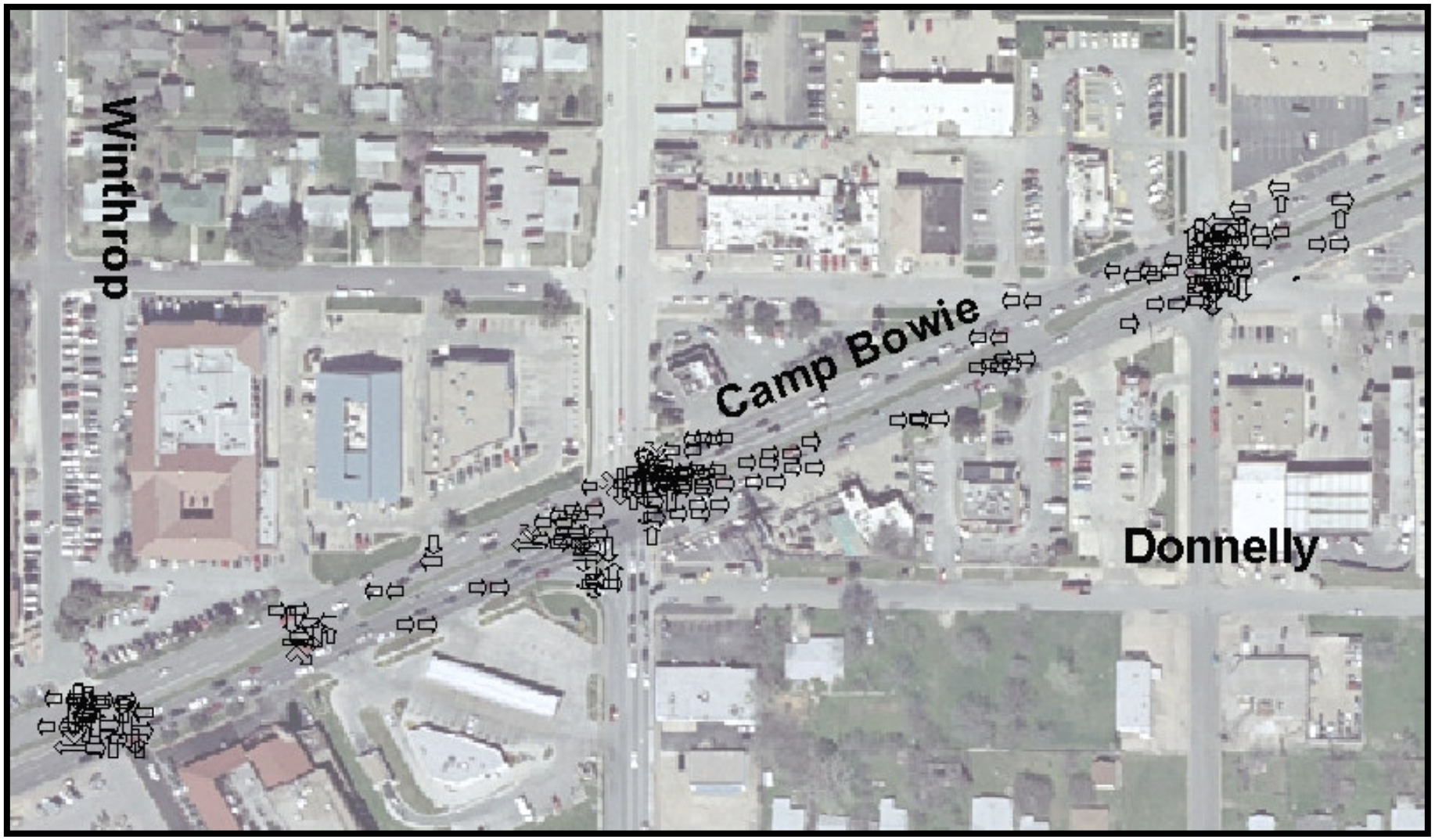
Loop 281 - Longview

US 377 – High Access Density



US 377 – Low Access Density

US 377 – Total Crashes

Year	Segment	Access Density (pts/mi)	Number of Crashes	Crashes / Million VMT
1993	East	110	28	9.59
	West	50	27	7.40
1994	East	110	27	9.25
	West	50	22	6.03
1995	East	110	29	9.46
	West	50	16	4.17
1996	East	110	24	7.83
	West	50	26	6.78

US 377 – Total Crashes

1997	East	110	24	8.52
	West	50	25	7.10
1998	East	110	17	6.40
	West	50	14	4.21
1999	East	110	22	8.19
	West	50	26	7.74
2000	East	110	29	10.85
	West	50	13	3.89

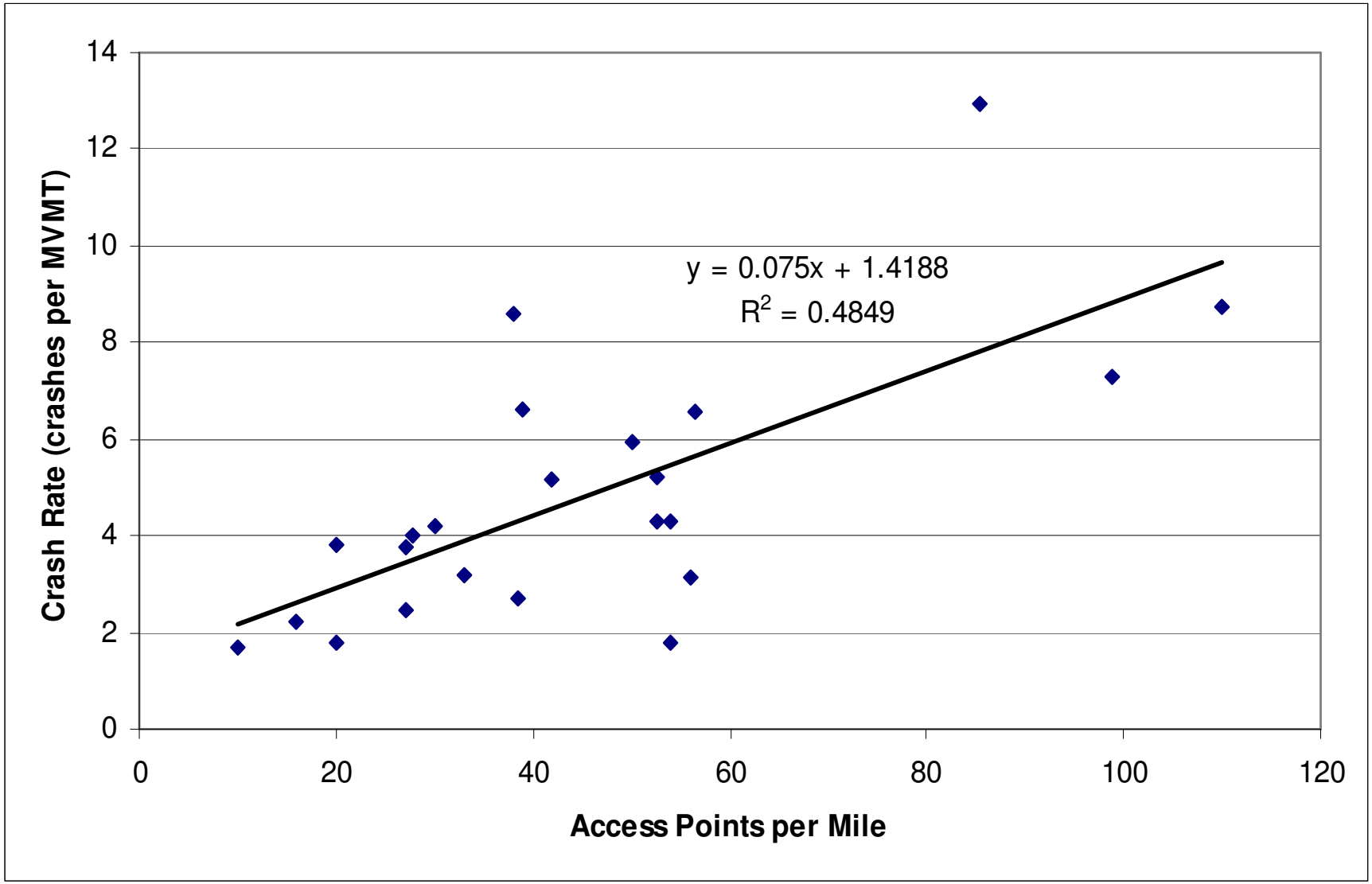
Corridor Summaries

SH 289	44-53K	30.0	Yes	4.21
Park Blvd (west)	28-37K	10.0	Yes	1.71
Park Blvd (central)	33-36K	38.9	Yes	6.59
Park Blvd (east)	34-35K	16.0	Yes	2.23
71st Street (west)	20-24K	27.0	Bef	3.76
71st Street (west)	28-33K	27.0	Aft	2.48
71st Street (west-central)	20-21K	20.0	Bef	*3.82*
71st Street (west-central)	22-37K	20.0	Aft	1.78
71st Street (east-central)	27-47K	33.0	Yes	3.20
71st Street (east)	25-51K	42.0	Yes	5.17

Corridor Summaries

US 380 (west)	14-29K	56.0	Yes	3.12
US 380 (east)	13-24K	98.8	Yes	7.29
US 377 (west)	18-21K	50.0	Yes	5.92
US 377 (east)	18-21K	110.0	Yes	8.76
FM 1741	26-31K	38.5	No	2.71
Loop 281	20-27K	52.5	Bef	5.21
Loop 281	20-17K	52.5	Aft	4.29
US 69 (north)	30-39K	38.1	No	8.60
US 69 (south)	27-40K	85.4	No	12.92
US 385	9-12K	50.0	Bef	*19.57*
US 385	9-12K	50.0	Aft	15.39
SH 191 (west)	29-36K	56.4	No	6.55
SH 191 (east)	16-24K	27.7	No	4.00

Access Density and Crash Rates



Raised Median Installations

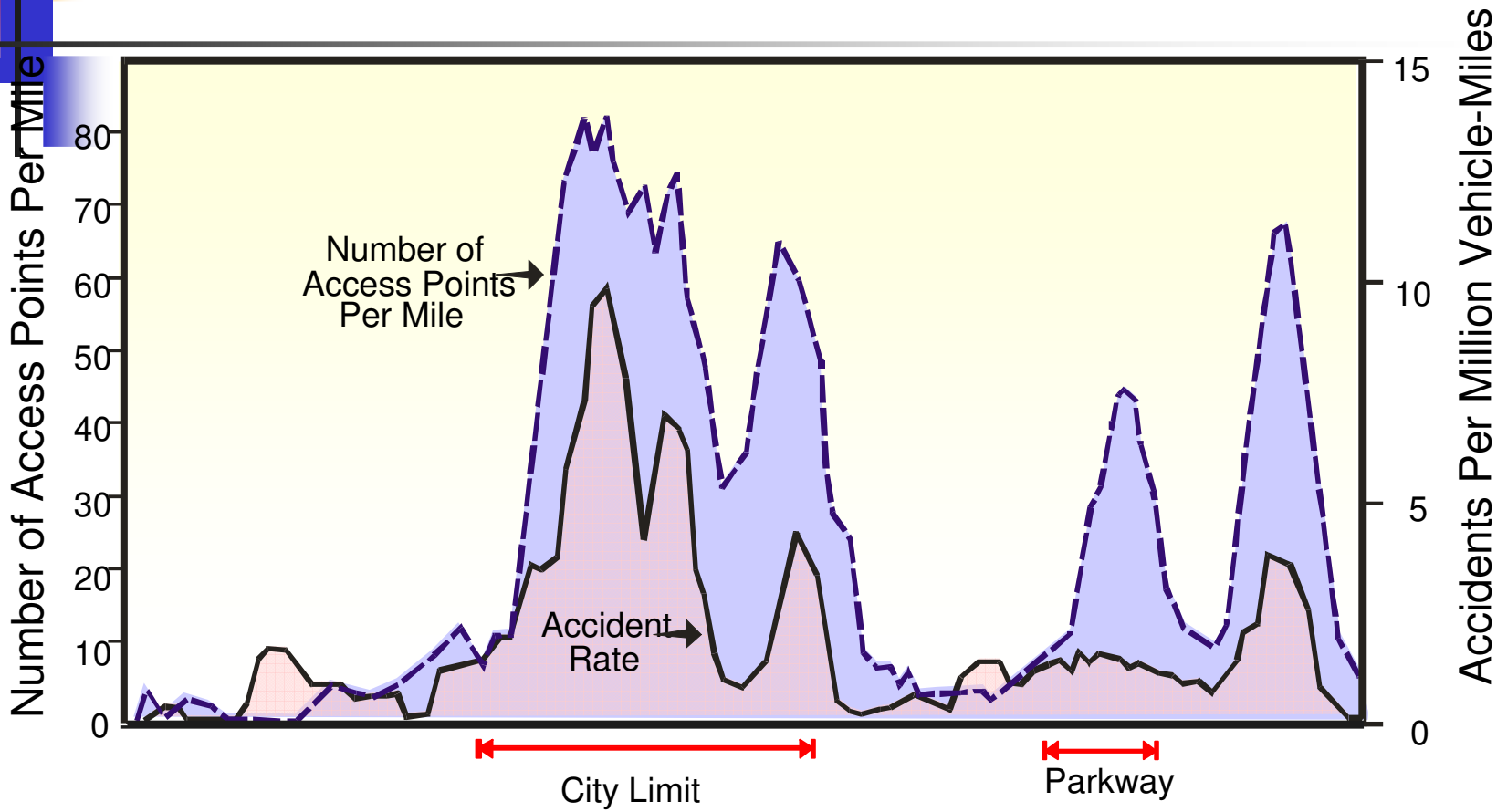
Corridor	ADT[1]	Before Median Type	Crash Rate				Access Dens
			Pre	Post	Abs. Diff	% Diff	
Bus SH 6	41,000	TWLTL	4.3	1.8	-2.5	**-58**	54
Loop 281	23,500	TWLTL	5.2	4.3	-0.9	**-17**	53
71st West	30,500	Undiv	3.8	2.5	-1.3	**-34**	27
71st WC	29,500	Undiv	3.8	1.8	-2.0	**-53**	20
US 385	10,600	Undiv	19.6	15.4	-4.2	**-21**	50
Others[2]	30,600	Varies	7.0	4.8	-2.2	**-31**	49

[1]ADT is the traffic volume in the "after" condition that has the raised median present.
[2]This is a comparison of the average crash rate for all the corridors "before" and "after" the raised median was installed. Note that the "before" condition was typically a TWLTL

Safety Conclusions

- Each corridor is unique
  - Varying conditions
- Lower access density correlates to lower crash rates
  - NCHRP 420
- Presence of raised median correlates to lower crash rates and less severe crashes

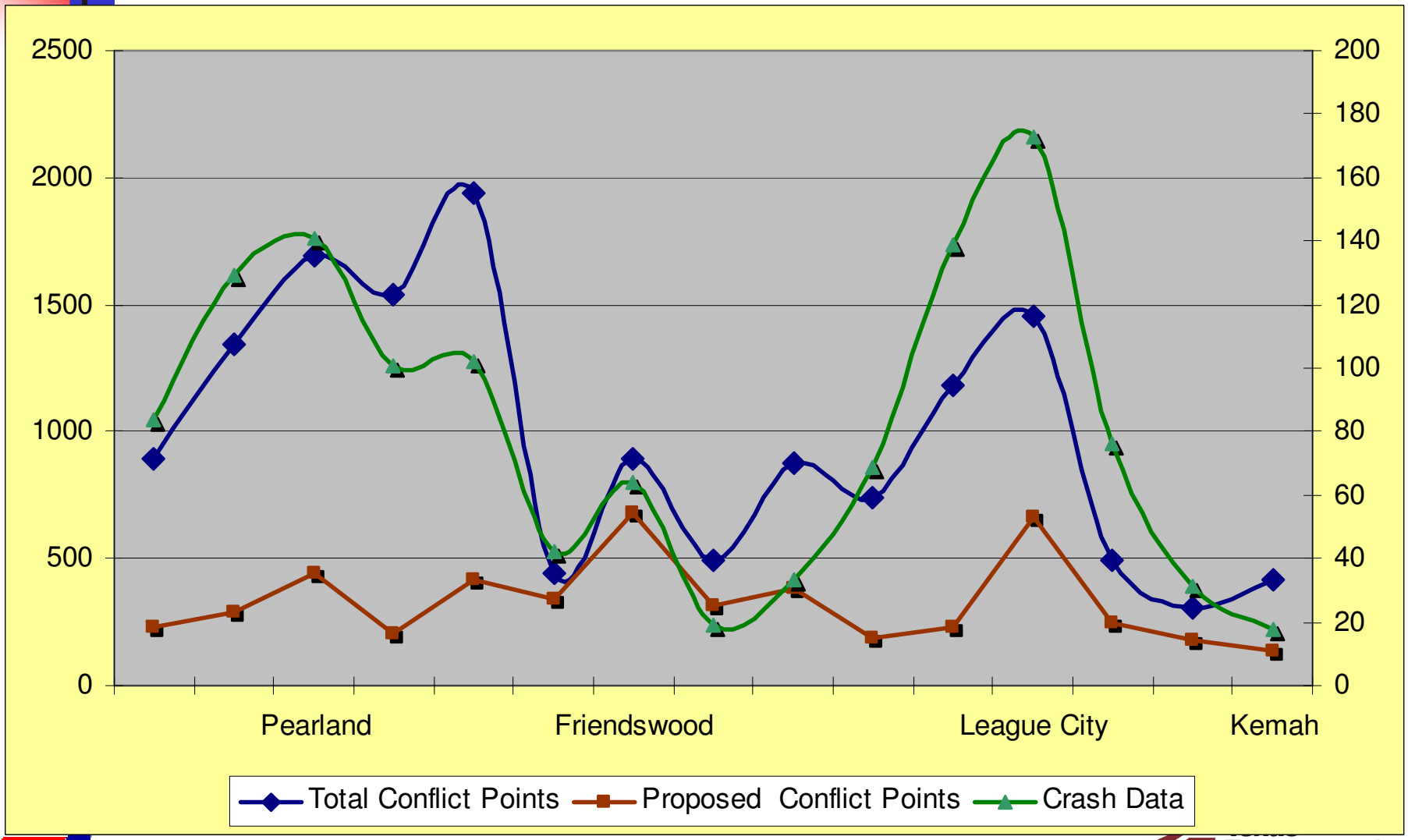
Oregon Case Study



Comparison of Access Connections Per Mile with Crashes per Mile on a Segment of US 101 in Oregon

Source: Lall, et al, 1996

FM 518 Corridor Study



Studies Outside of Texas

Case Study: Memorial Drive - Atlanta

- Memorial Drive Before Median Installation
  - 4.34-mile section
  - 6 lanes with TWLTL
  - densely commercial
  - ADT: 28,300-47,685
  - driveways per mile: 59.21
  - speed limit: 45 mph

Memorial Drive: One Year After Completion

- 37% reduction in total accidents
  - preventing about 300 accidents
- 48% drop in injury rate
  - preventing about 150 injuries
- Left-turn accidents between intersections virtually eliminated
- No fatalities (15 in previous 11.6 years)

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Reasons for Crash Reduction

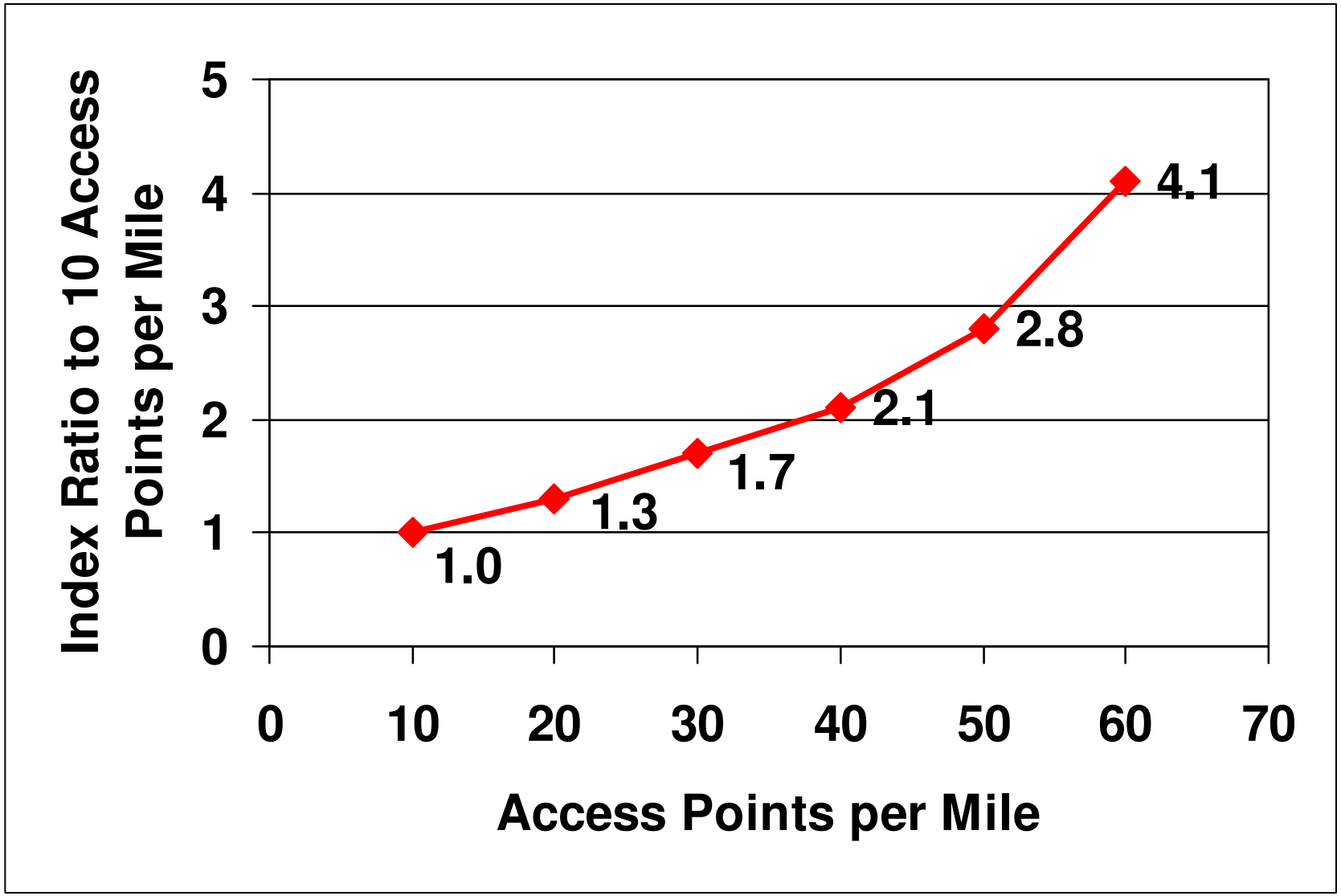
- Conflict points reduced in number
- Conflict areas reduced in size
- Pedestrians found refuge while crossing
- No mid-block left turns
- Left-turns eliminated at 7 public roads
- All 14 median crossovers were signalized

Memorial Drive: Eight Years Later

- Still no fatalities
- Accident reduction not as dramatic: 17% vs. 37%
- Injury reduction not as dramatic: 10% vs. 38%.
  - Police believe this is mainly due to increased driver carelessness

National Studies (NCHRP Report 420)

National Studies



Crash Rates

Representative Crash Rates (Crashes per Million VMT) by Type of Median – Urban and Suburban Areas			
	Median Type		
Total Access Points per Mile (1)	Undivided	Two-Way Left-Turn Lane	Non Traversable Median
<20	3.8	3.4	2.9
20.01-40	7.3	5.9	5.1
40.01-60	9.4	7.9	6.8
>60	10.6	9.2	8.3
Average Rate	9.0	6.9	5.6

(1) Includes both signalized and unsignalized access points.