Ramp Reversal Projects

Guide to Successful Project Implementation

Photo Courtesy of NCTCOG

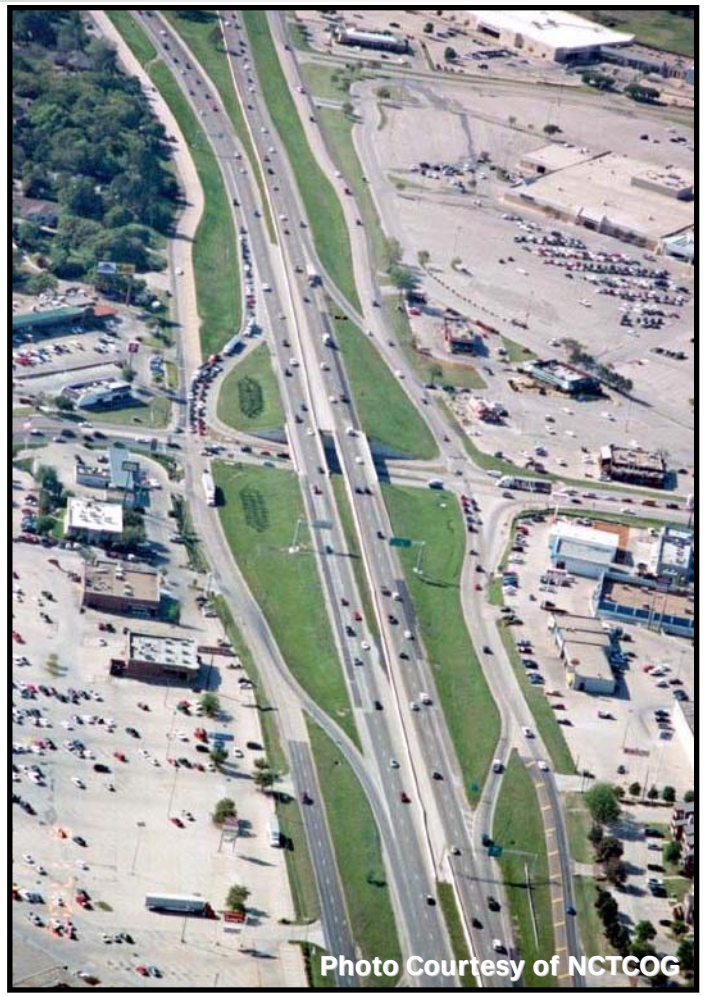
Texas Transportation Institute

Texas Department of Transportation

UTA

Presentation Outline

1) Background
2) Key topics
3) State-of-the-practice
4) District surveys
5) Case studies
6) Project evaluation
7) Guidelines



MODULE 1

BACKGROUND

Research Project 0-5105

- RMC 4 – Traffic Operations
- Project title
  - *Development of Guidelines for Ramp Reversal Projects*
- Funding
  - $135,262
- Joint Texas Transportation Institute (TTI) and University of Texas at Arlington (UTA) project

TxDOT Project Team

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- Project Advisors
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Photo Courtesy of TxDOT


Photo Courtesy of TexITE

The Research Team

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- Other members:
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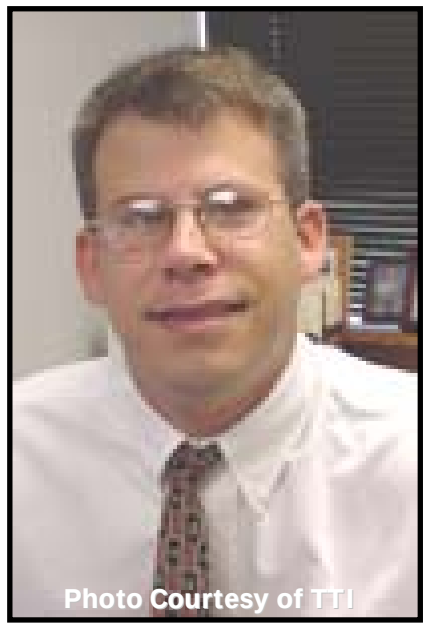
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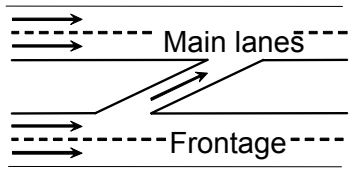
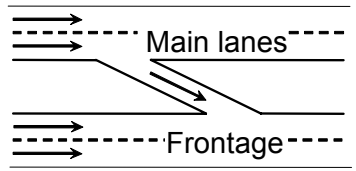
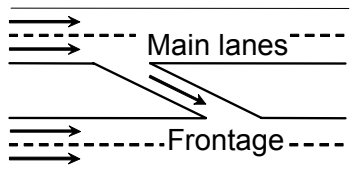
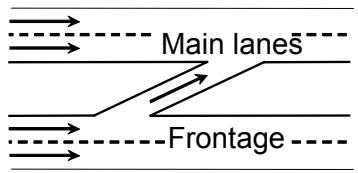
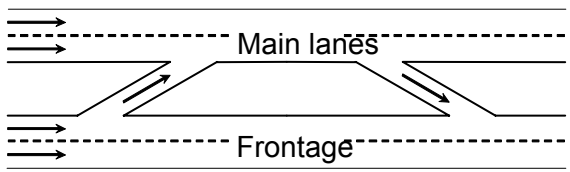
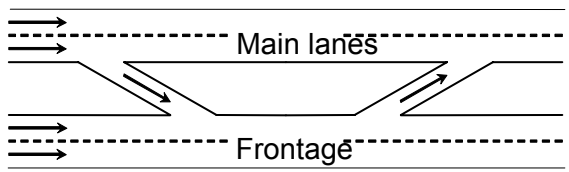
MODULE 2

KEY TOPICS

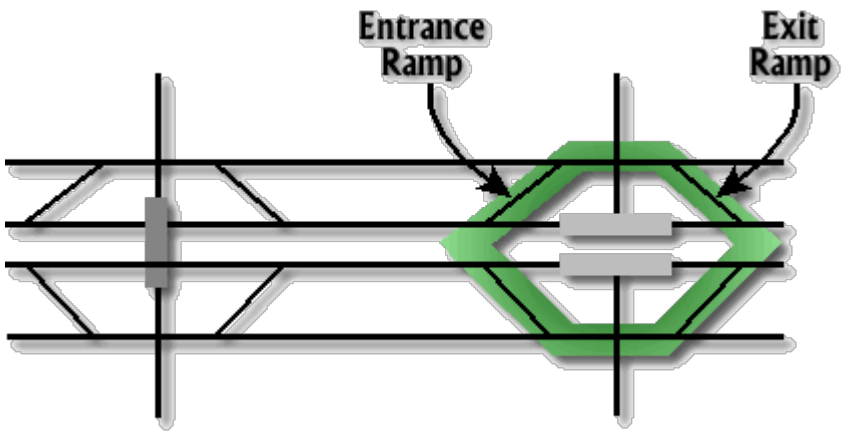
#1: When to Consider Reversals

- When & where should the use of ramp reversals be considered?

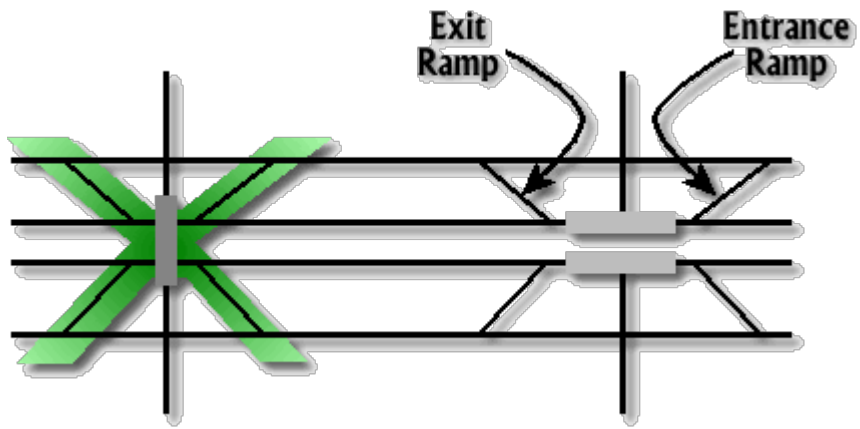
SINGLE ON > OFF		
SINGLE OFF > ON		
PAIR		

#2: Diamond vs. X-ramp Pattern

- When & where should an X-ramp pattern be used as opposed to diamond ramp design?



Diamond



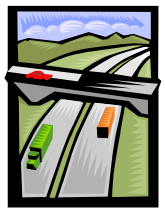
X-ramp

Pros and Cons of Converting from Diamond to X-Ramps

PROS	CONS
+ Increased development along frontage road	– ***Costly*** means of improving signal operation
+ ***Reduced through demand*** on frontage road approach to intersection	– Construction activities will ***disrupt business*** along frontage road
+ ***Move the weaving area*** between an entrance ramp and exit ramp from the main lanes to the frontage road, where speeds and volumes are lower	– Invites ***sling-shot maneuvers*** allowing motorists to bypass cross-street signals; this poses safety and capacity problems on frontage road
+ ***Increased storage area*** for cross-street intersection queuing	– Addresses the queue storage problem but ***queuing delay will not be remedied***
+ Better opportunity to use frontage road as alternate route as part of ***incident management*** if auxiliary lanes are provided	– Likely increase in ***short trips*** on the freeway
	– Construction of auxiliary lanes may require ***major reconstruction*** at cross-streets

#3: Project Evaluation

- How should ramp reversal projects be evaluated?



Operational impacts

Safety impacts

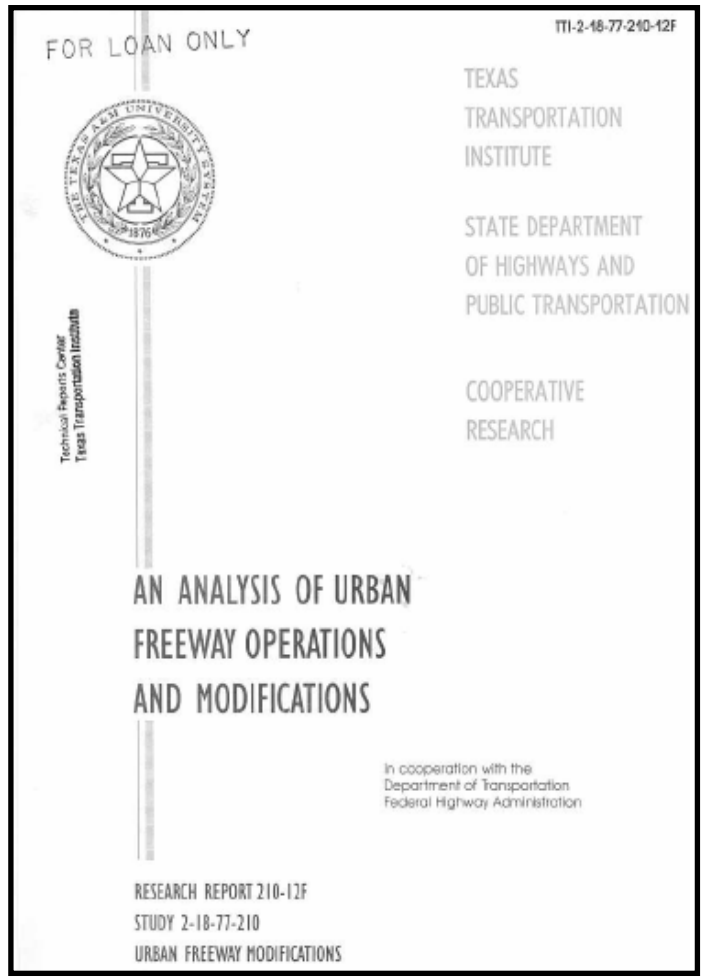
Basic economic impacts

MODULE 3

STATE-OF-THE-PRACTICE

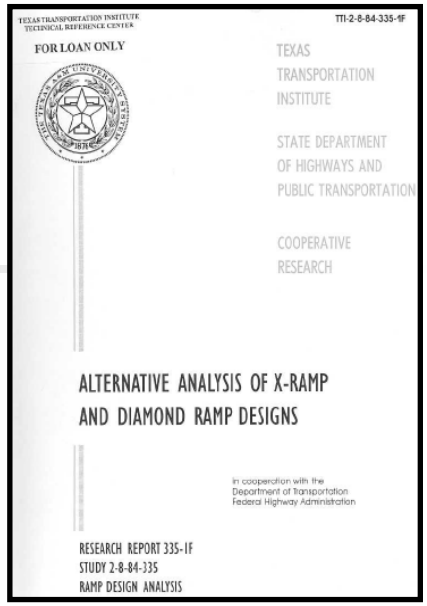
Ramp Reversal Studies

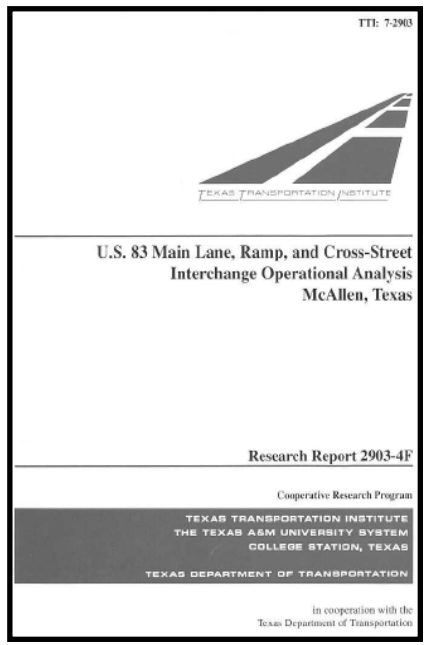
- Not much literature
- Report 210-12F
- Texas issue
  - Frontage Roads
- 1980s case study
  - IH 610 in Houston
  - B/C ratio of 3.8 to 1



X-ramp Studies

- Tipton & Pinnel – 1967
- Borchardt – 1986
  - TTI Report 335-1F
- Klaver – 1995
  - TTI Report 2903-4F
- Kockelman – 2000
  - CTR 1873-1





Braided Ramp Studies

- Bonilla & Urbanik (376-2F) – 1986
- Grade-separation when:
  - Weaving or access problems not solved by ramp elimination or relocation
- Warrants
- Guidelines

Freeway Weaving

- *Highway Capacity Manual*

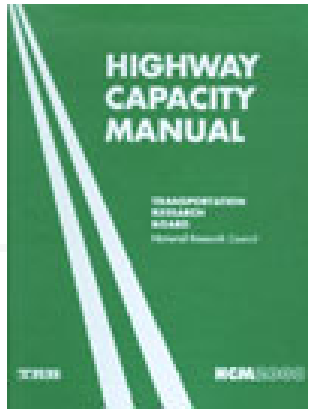
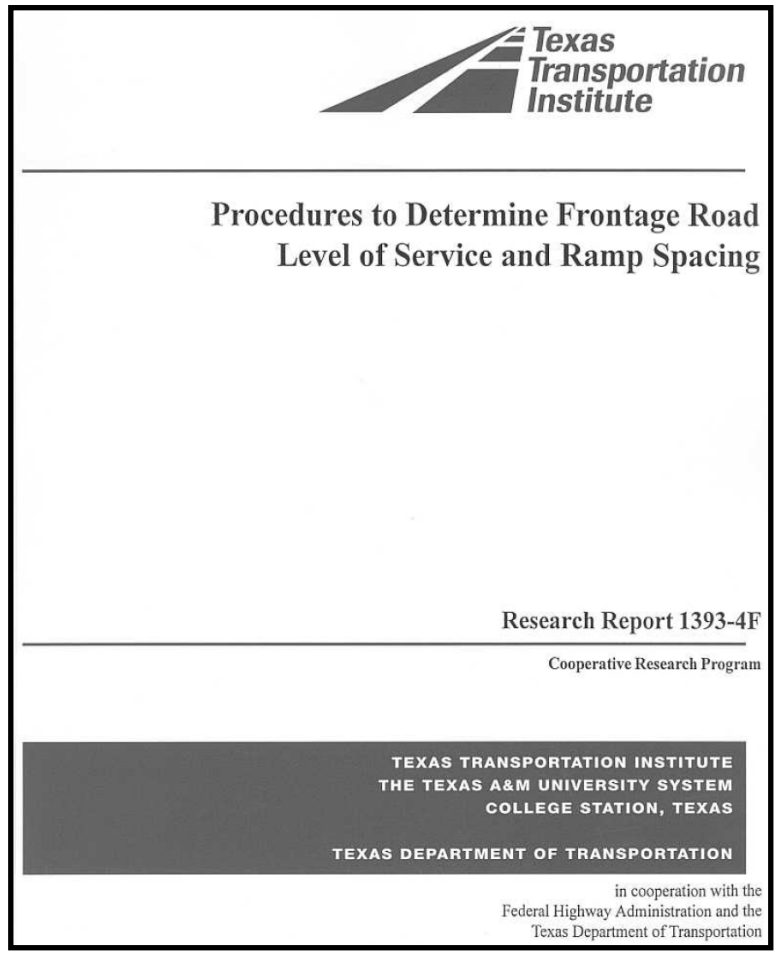


EXHIBIT 24-2. LOS CRITERIA FOR WEAVING SEGMENTS		
	Density	
LOS	Freeway Weaving Segment	Multilane and Collector-Distributor Weaving Segments
A	≤ 10.0	≤ 12.0
B	> 10.0 – 20.0	> 12.0 – 24.0
C	> 20.0 – 28.0	> 24.0 – 32.0
D	> 28.0 – 35.0	> 32.0 – 36.0
E	> 35.0 – 43.0	> 36.0 – 40.0
F	> 43.0	> 40.0

Frontage Road Weaving

- Fitzpatrick – 1996
  - Procedures for analyzing frontage road weaving
  - Spacing requirements for ramp junctions
  - LOS analysis
- Adopted in TxDOT Roadway Design Manual


Texas Transportation Institute

Procedures to Determine Frontage Road Level of Service and Ramp Spacing

Research Report 1393-4F

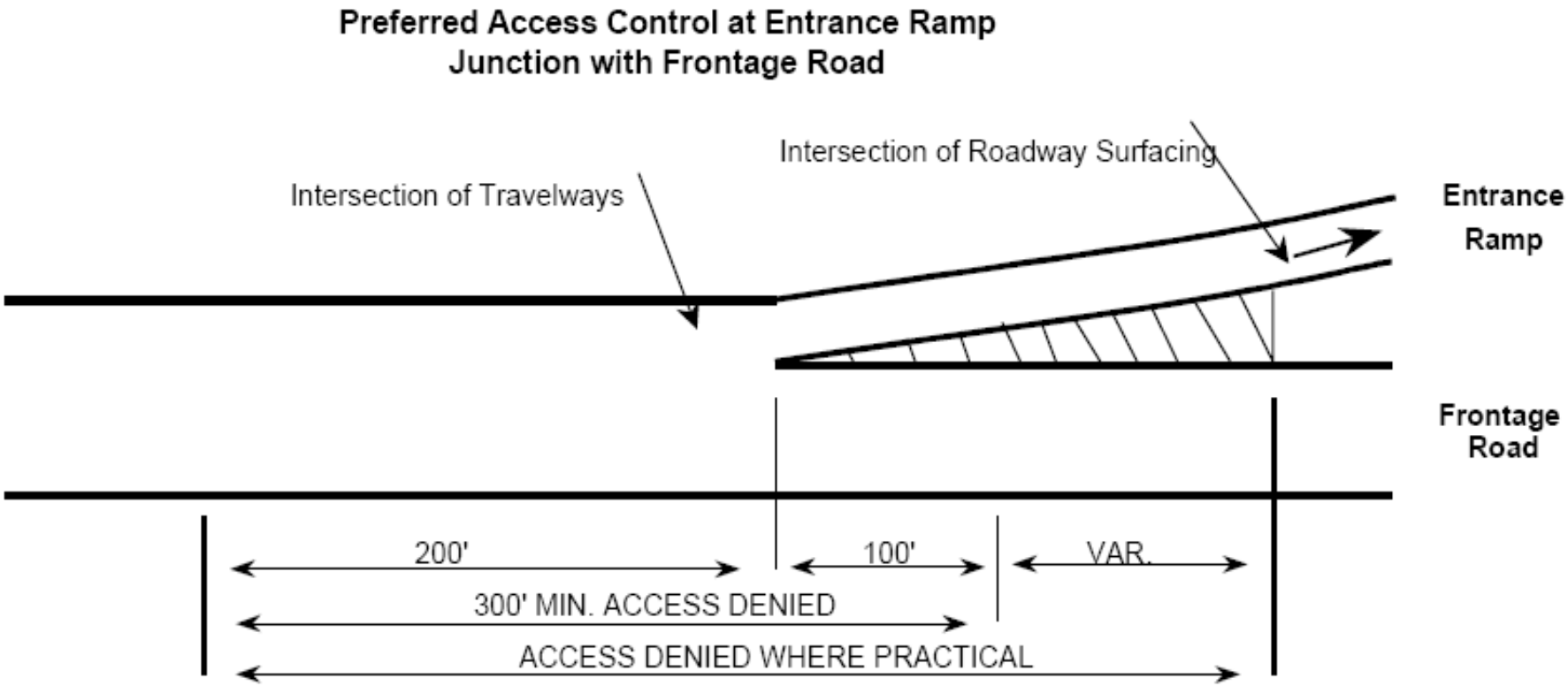
Cooperative Research Program

TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM
COLLEGE STATION, TEXAS

TEXAS DEPARTMENT OF TRANSPORTATION

in cooperation with the
Federal Highway Administration and the
Texas Department of Transportation

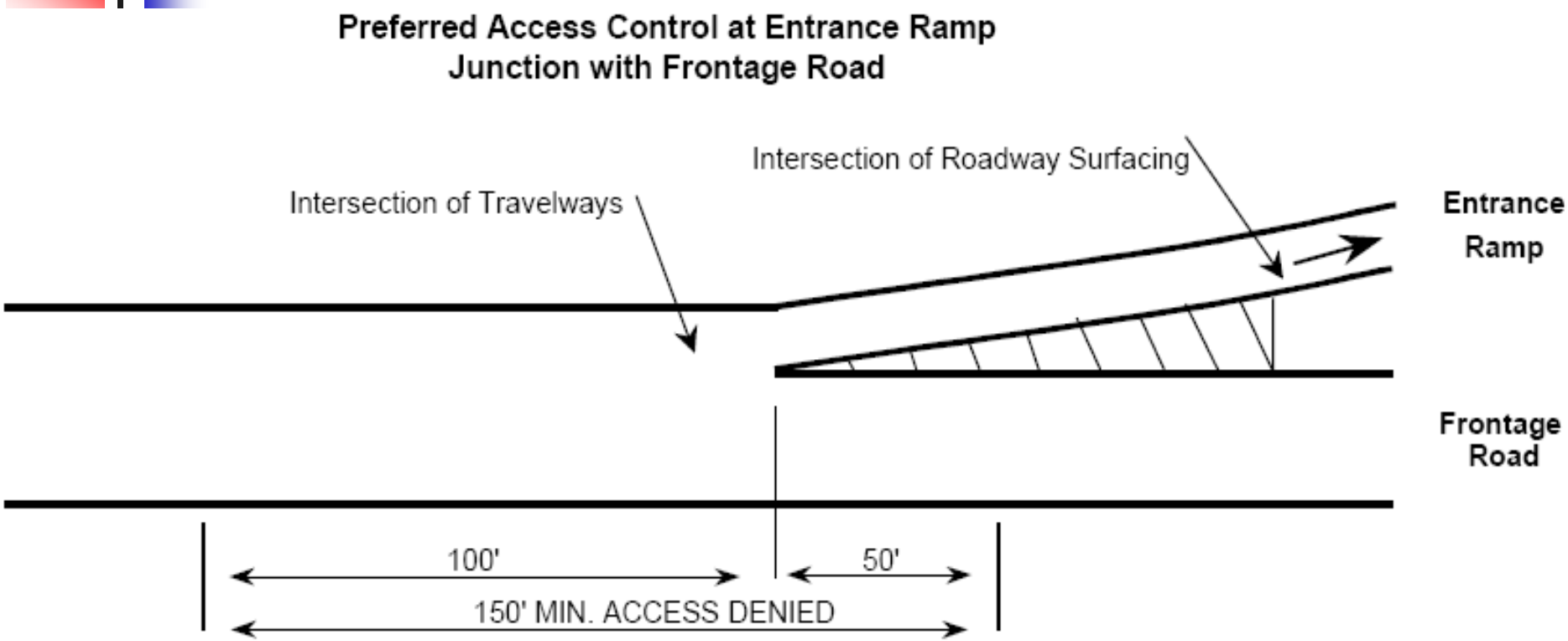
TTI Project 7-2927 - Desirable



Recommended "Desirable" Modifications to the Current Guidelines of the TxDOT *Operations and Procedures Manual*

(Figure 7, Texas Transportation Institute Report No. 2927-2)

TTI Project 7-2927 - Minimum



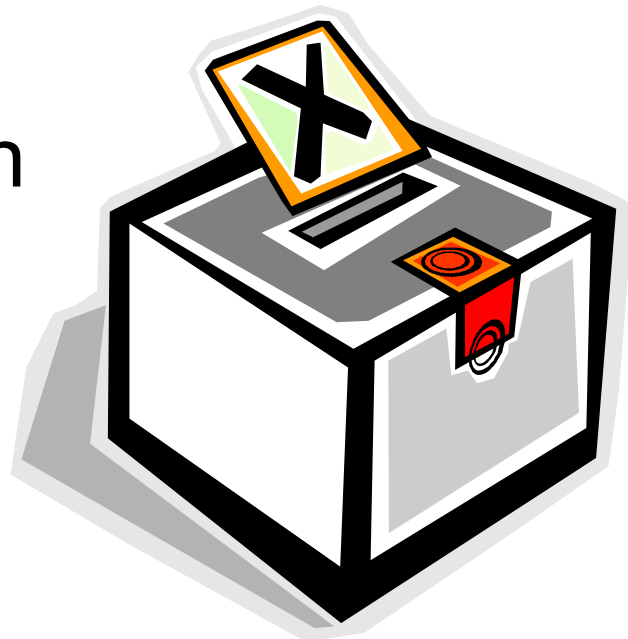
Absolute Minimum Guidelines for the TxDOT *Operations and Procedures Manual*
(Figure 8, Texas Transportation Institute Report No. 2927-2)

MODULE 4

DISTRICT SURVEYS

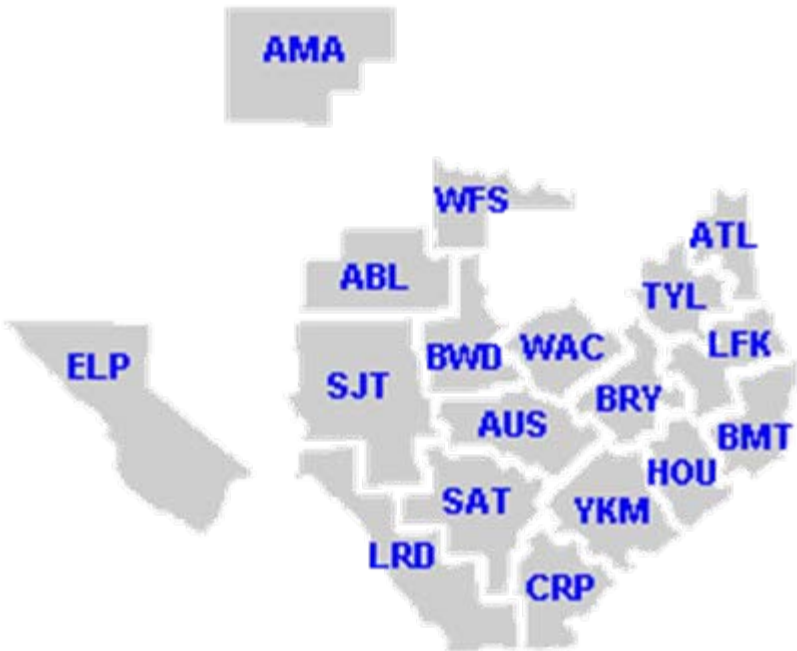
Survey Questions

- Project type
- Date of implementation
- Roadway type
- Project cost
- Project rationale
- Evaluation studies

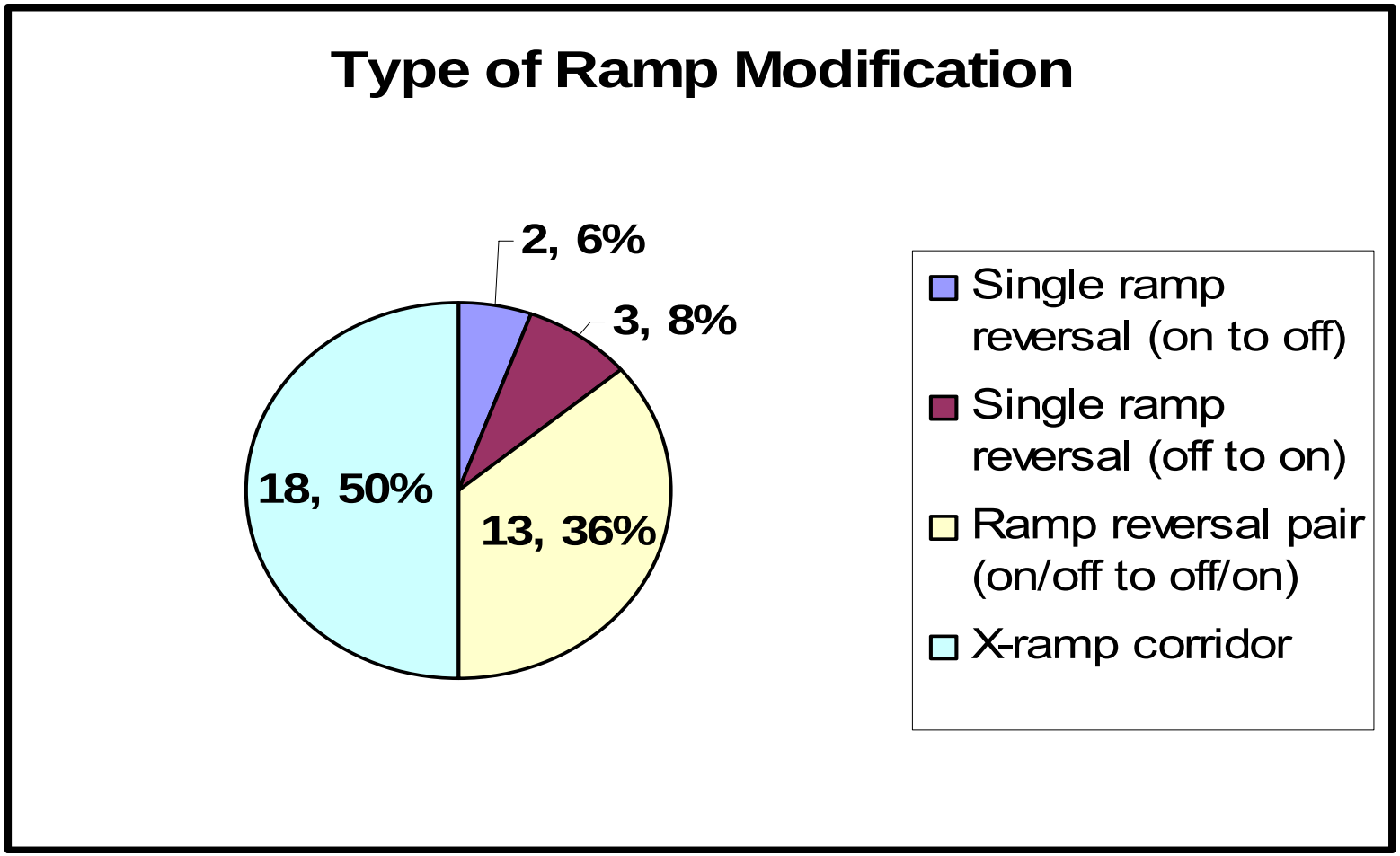


Survey Responses

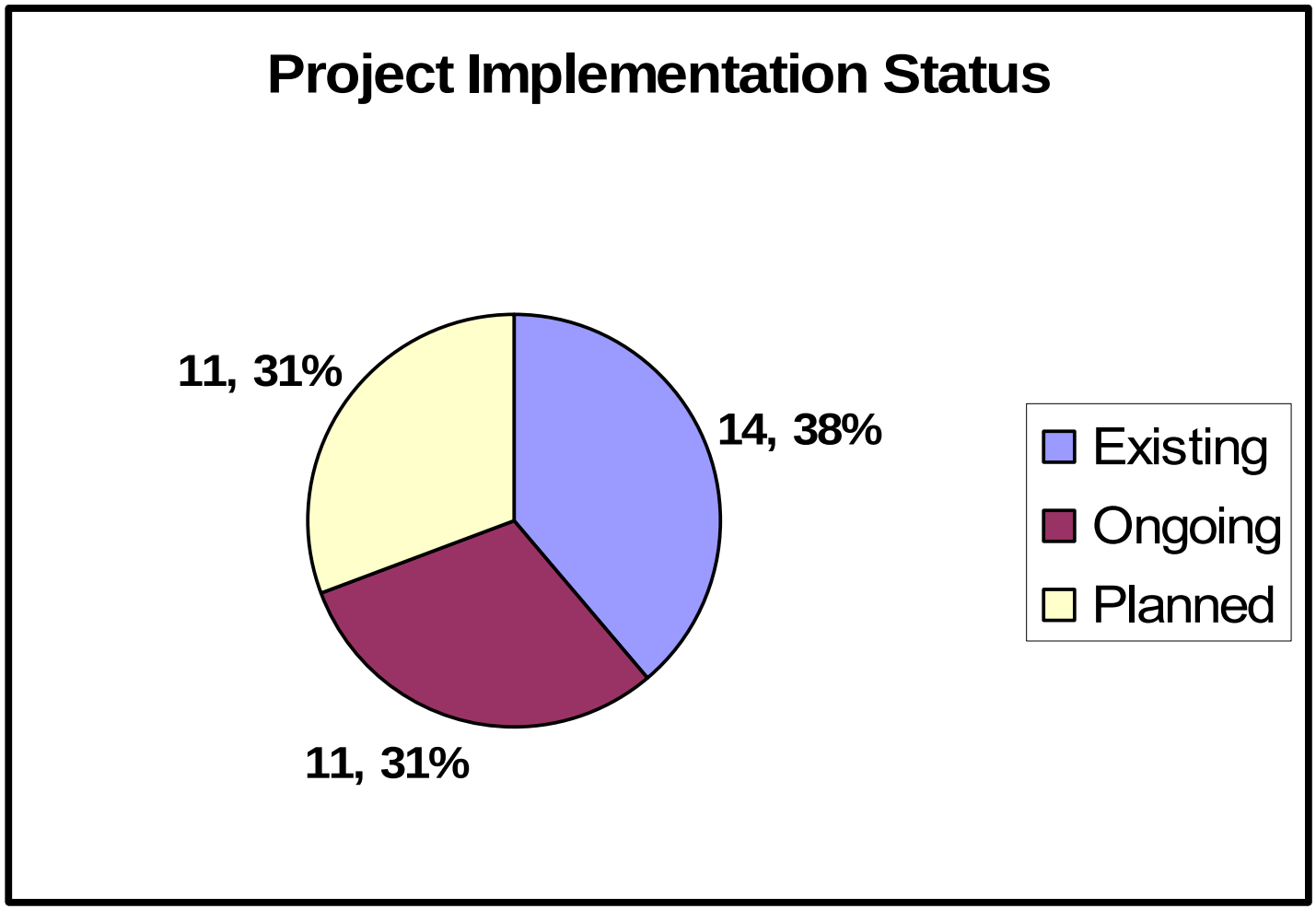
- 18 of 25 Districts responded



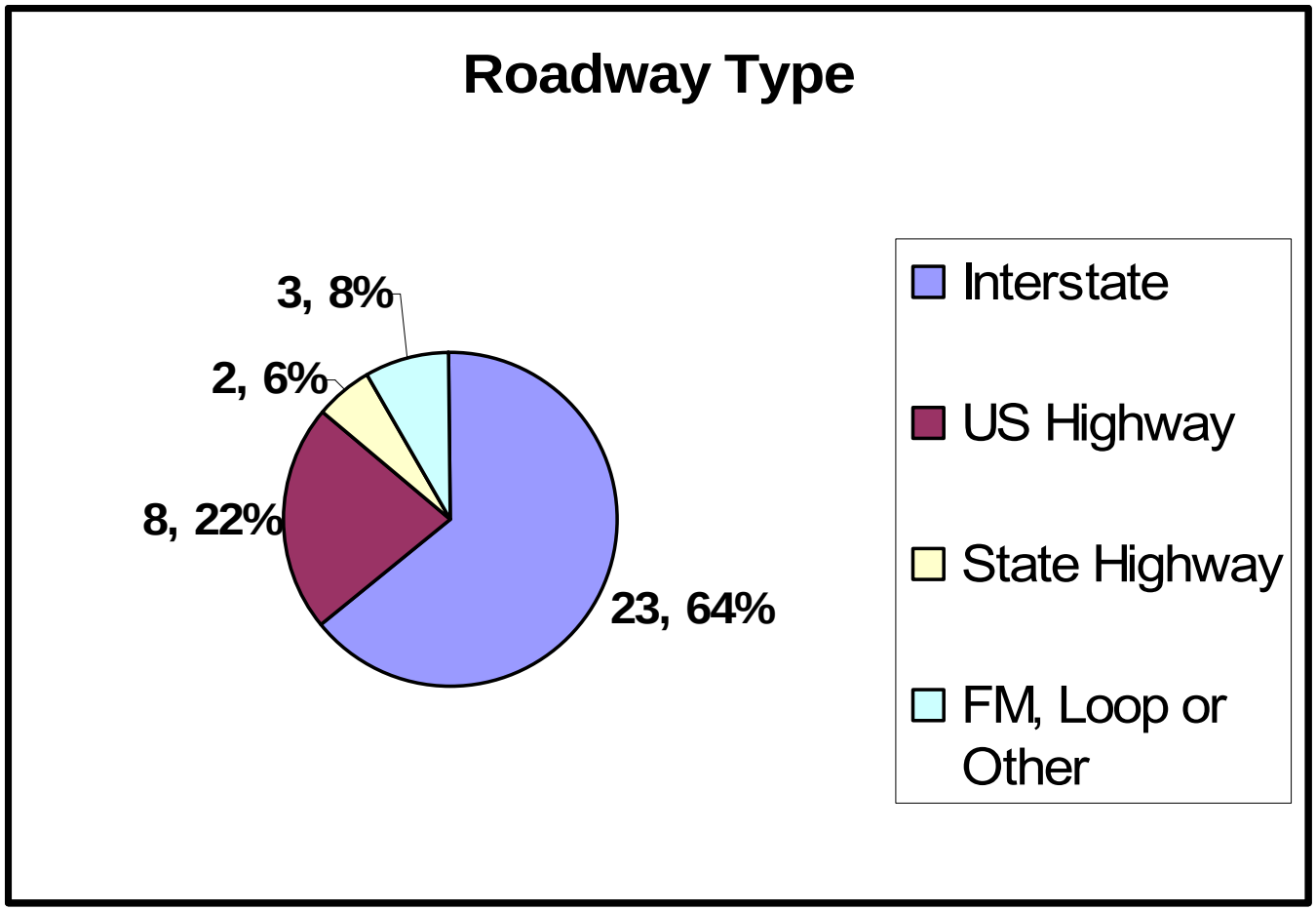
Project Type



Date of Implementation

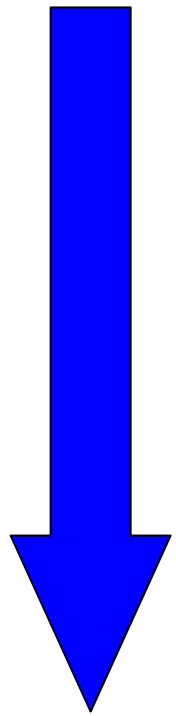


Roadway Type



Project Rationale

- Safety issues 68%
- High traffic volumes 60%
- Inadequate ramp spacing 43%
- Main lane weaving 43%
- Political/developer request 41%
- Land access 30%
- Frontage road weaving 11%



Project Rationale - Others

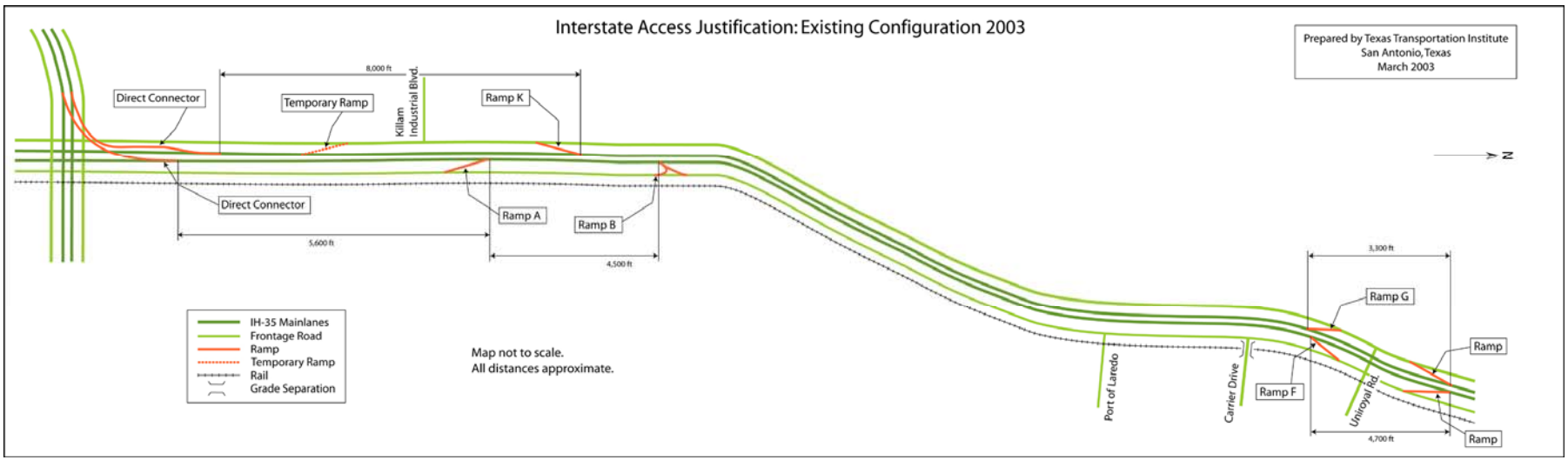
- Two-way to one-way frontage road conversion (6)
- Exit ramp queue spillback (5)
- Better utilize frontage road capacity (2)
- Eliminate two consecutive entrance ramps
- Construction of an additional overpass
- Alleviate frontage road congestion at the arterial street

MODULE 5

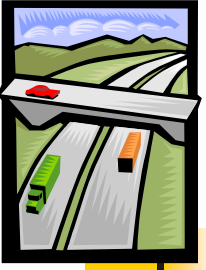
CASE STUDIES

Identify and Select Study Sites

- Candidate sites
  - Survey, internet searches & previous evaluations
- 12 ramp reversal case studies
- 3 X-ramp corridor case studies

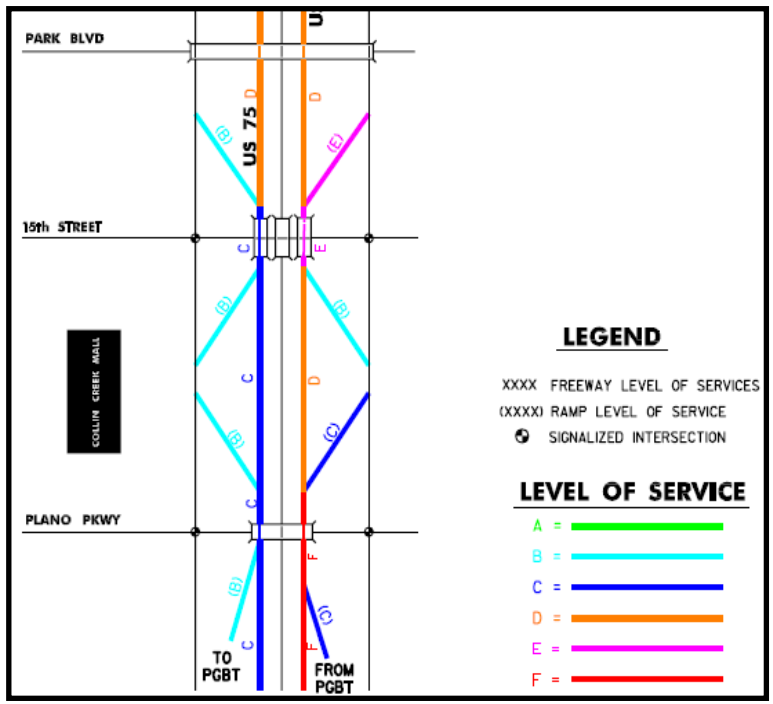


Graphic Courtesy of Texas Transportation Institute



Operational Evaluation

- Impacts
  - System delay
- Volume fluctuations
  - Freeway main lanes
  - Frontage road
  - Downstream intersection
- Queuing
- Ramp spacing



Graphic Courtesy of Jacobs Civil (Dallas)

Safety Evaluation

- Crash rate before vs. after
  - Main lane
  - Frontage road
  - Total
- Anecdotal

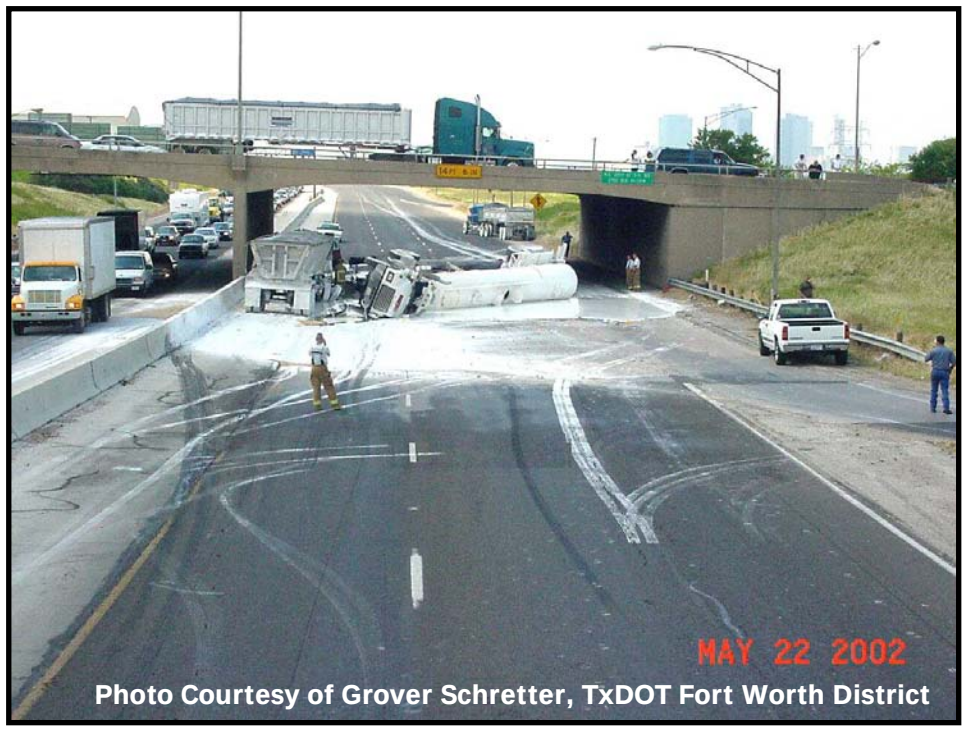


Photo Courtesy of Grover Schretter, TxDOT Fort Worth District

Basic Economic Evaluation

- Sales tax receipts
  - Corridor vs. citywide
- Property values
  - Corridor
- Business development

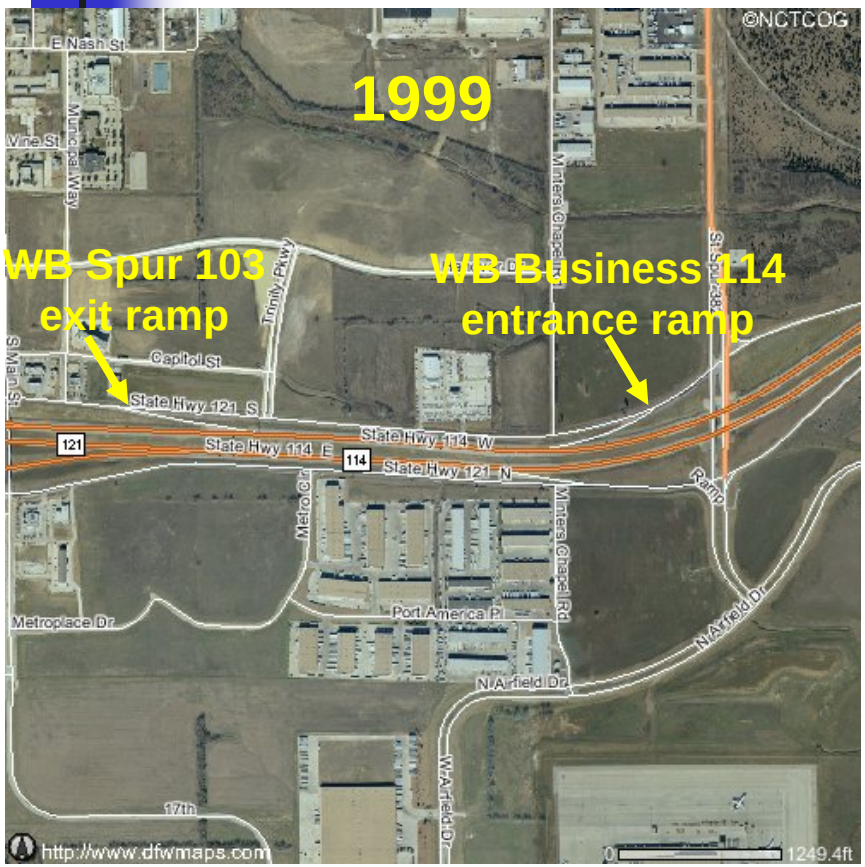
Photo Courtesy of Cedar Hill Economic Development Corporation

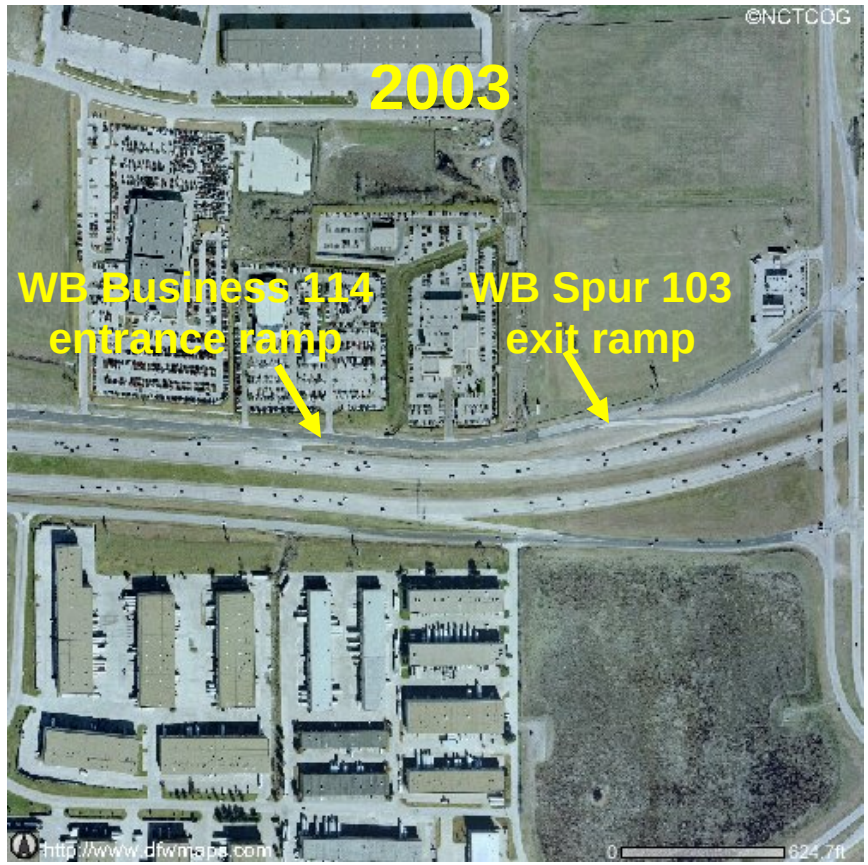
1 WB SH 114 in Grapevine

Photo Courtesy of Flickr.com (public)

- Reversed Bus. 114 entrance with Spur 103 (Main St.) exit
- Construction cost = $2,025,193
- Driving force = improved access
- Property owners paid for engineering design

1 Aerial Photos





1 Evaluation Results

Evaluation	Outcome
	+
	+
	« »

<u>Lesson learned</u>: exit ramp warning sign placement is critical.

2 WB IH 20 in Arlington

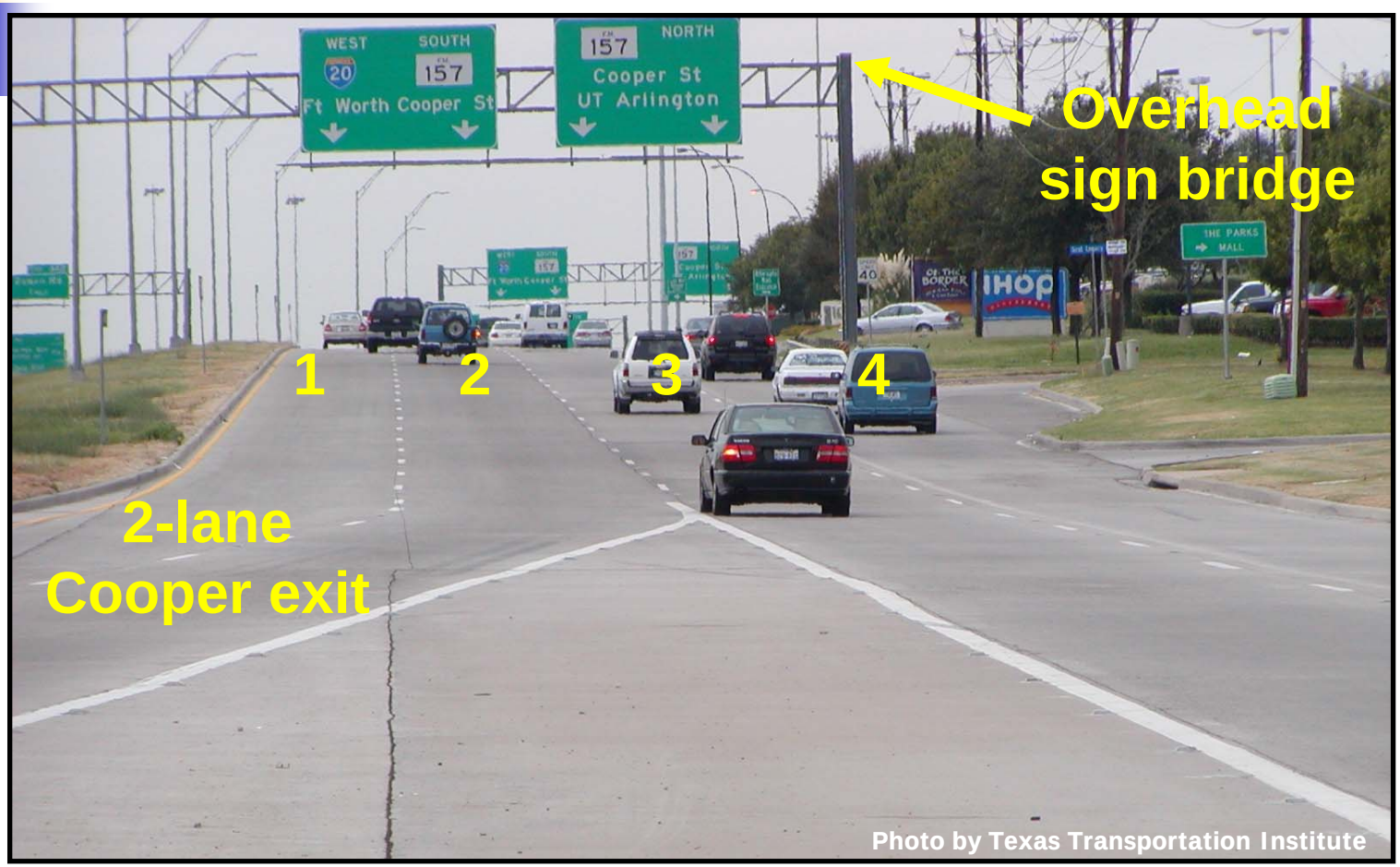
- Reversed the Matlock entrance with the FM 157 (Cooper St.) exit
- Construction cost = $7,049,023
- Driving force = improved access to Parks Mall
- Joint funding

Parks Mall of Arlington

Photo Courtesy of Arlington Chamber of Commerce

2 Roadway Layout

2 Improved Frontage Road



2 Evaluation Results

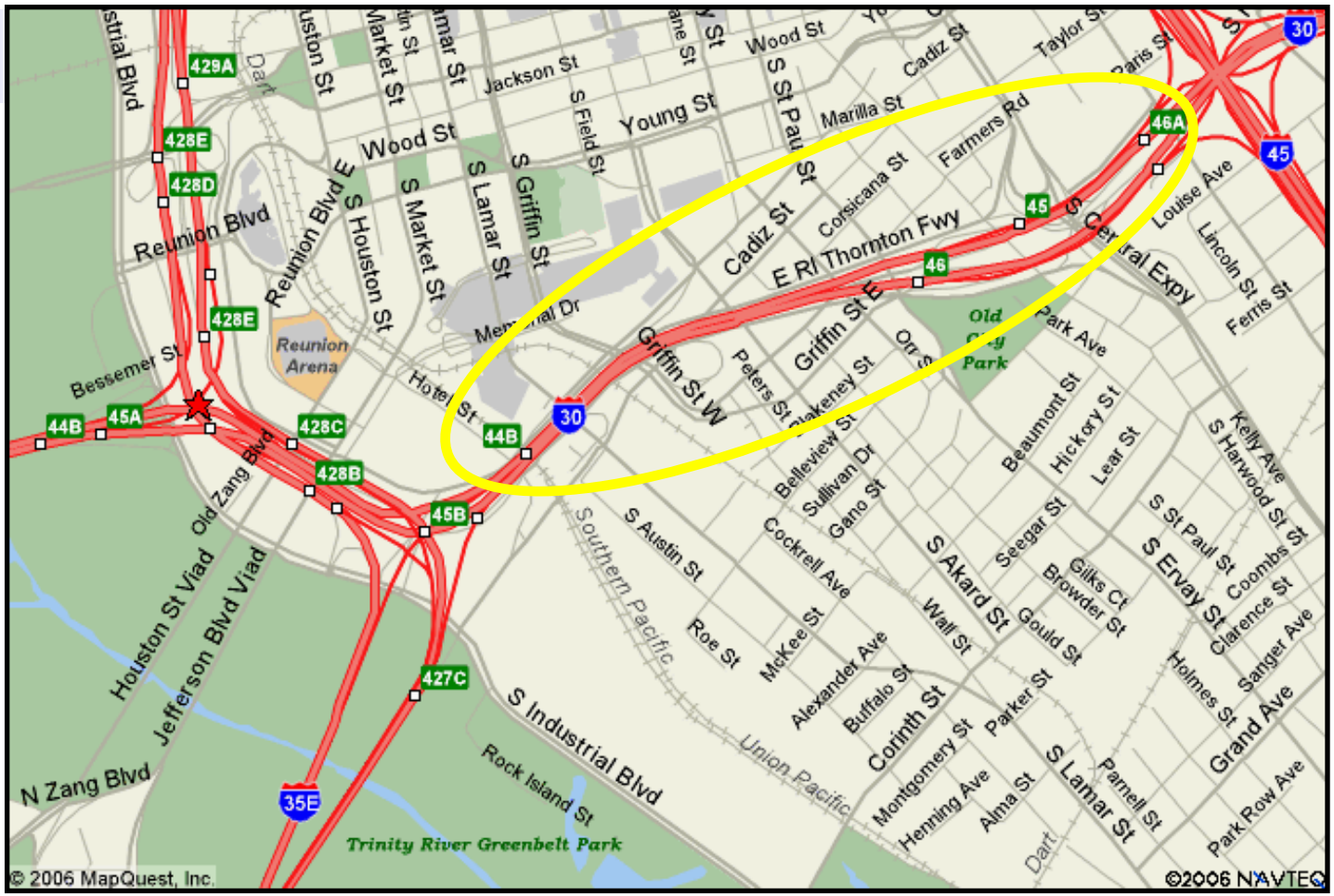
Evaluation	Outcome
	+
	+
	+

<u>Lesson learned</u>: speed enforcement needed on frontage road.

3 EB IH 30 in Dallas

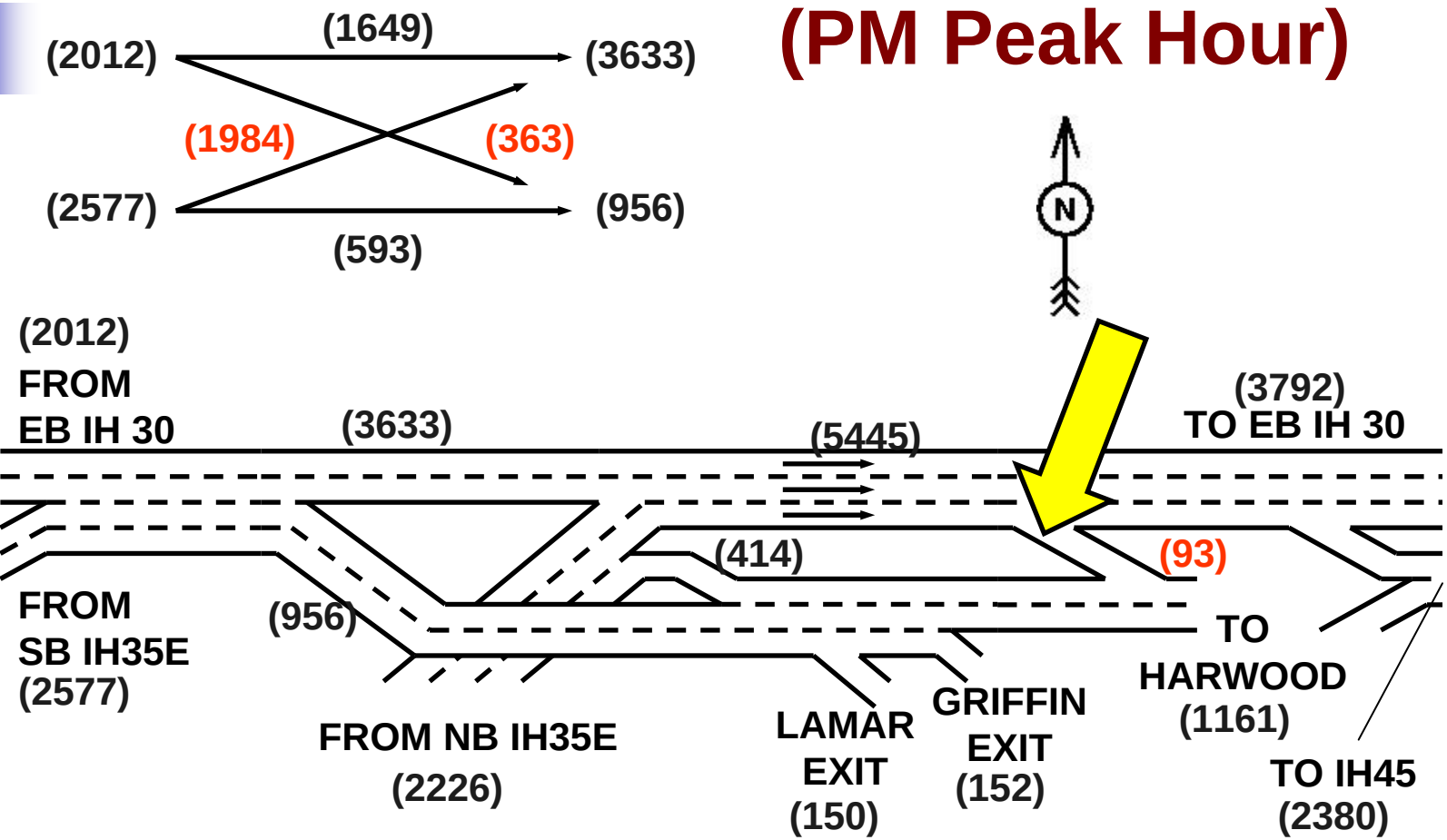
- Significant slowdown on IH35E
- Short weaving section
- Horizontal curve – truck rollovers
- Construction cost = $600,000

3 Roadway Layout



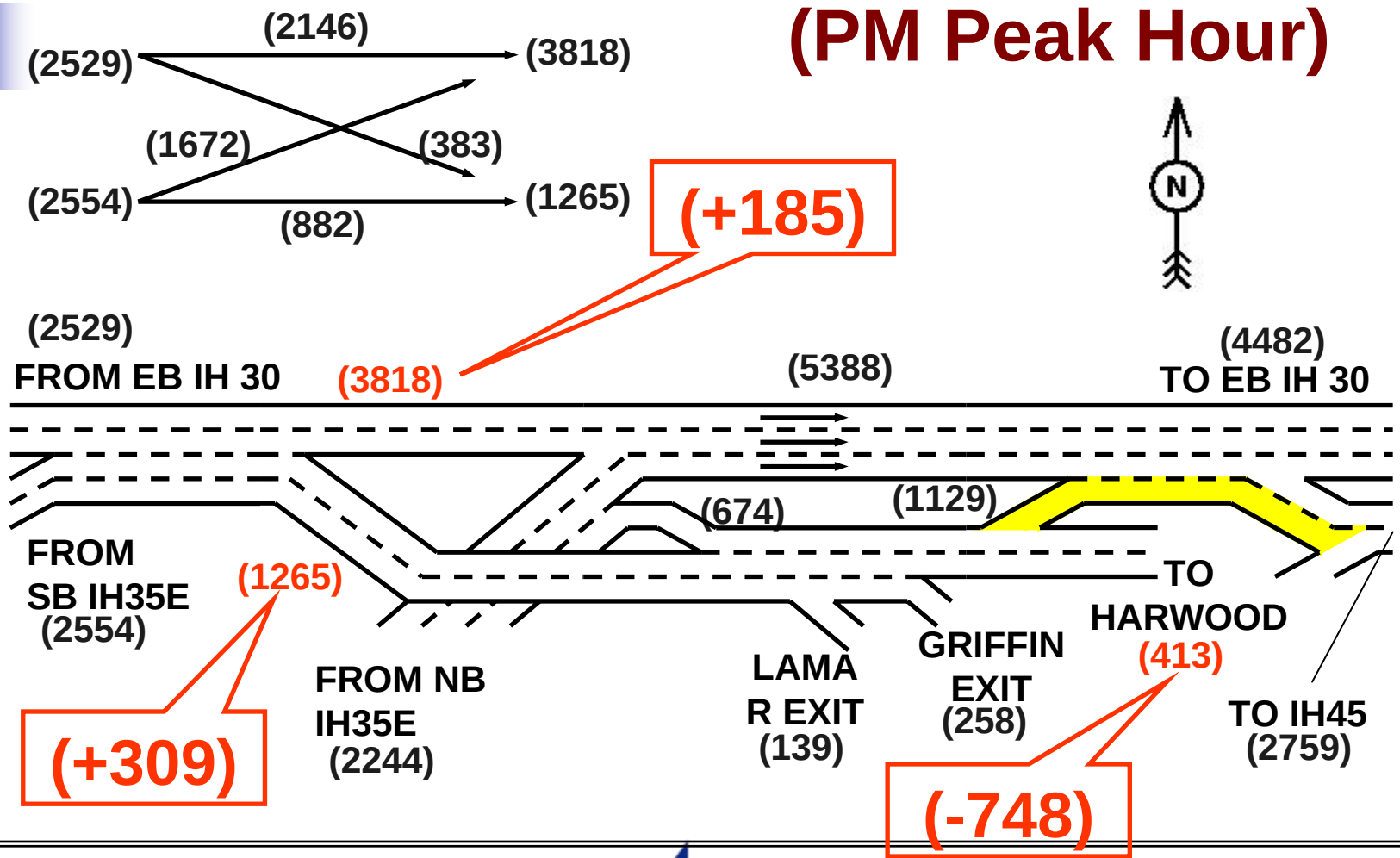
3 Before Volumes

(PM Peak Hour)



3 After Volumes

(PM Peak Hour)



3 Evaluation Results

- Delay reduction of $700,000/yr.
- 31% decrease in injury crash rate
- Truck rollovers have ceased
- B/C ratio = 9:1

3 Evaluation Results

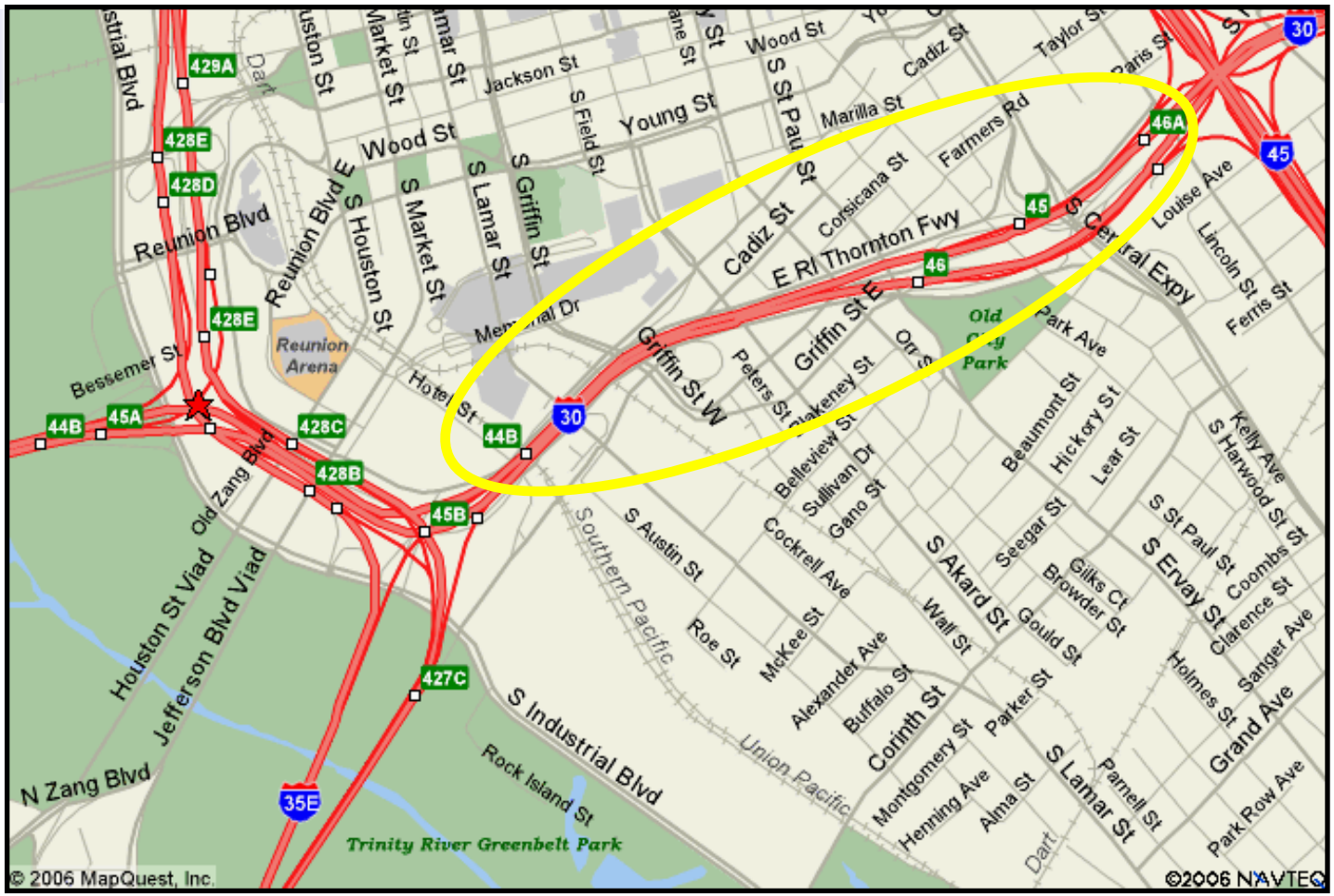
Evaluation	Outcome
	+
	+
	Ø

<u>Lesson learned</u>: even reversal of single ramp can produce significant benefits.

4 WB IH 30 in Dallas

- Emergency exit ramp built across the existing Harwood entrance ramp
- Closed with a traffic gate during non-incident conditions
- Construction cost = $600,000
- Driving force = incident management
- Property owners paid for engineering design

4 Roadway Layout



4 Evaluation Results

Evaluation	Outcome
	+
	+
	Ø

<u>Lesson learned</u>: operational flexibility provides benefits.

5 SB US 67 in Cedar Hill

- Reversed the SB Pleasant Run entrance with the FM 1382 exit
- Construction cost = $1,041,783
- Driving force = improved safety
- Joint funding

5 Roadway Layout

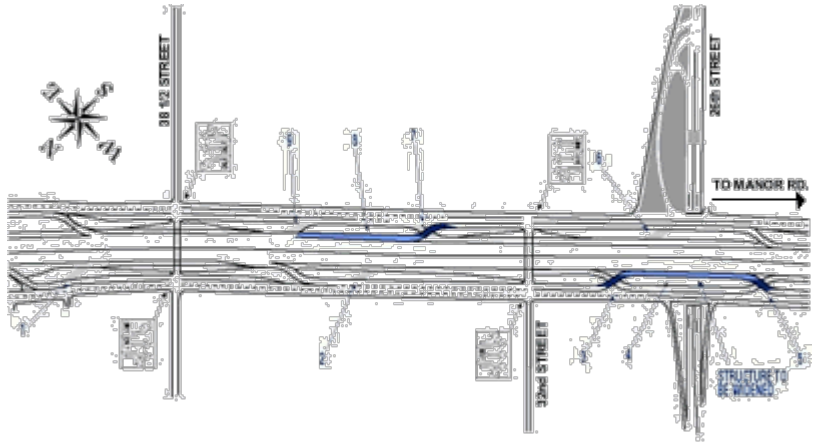
5 Evaluation Results

Evaluation	Outcome
	+
	+
	+

<u>Lesson learned</u>: ramp reversals can produce significant economic impacts.

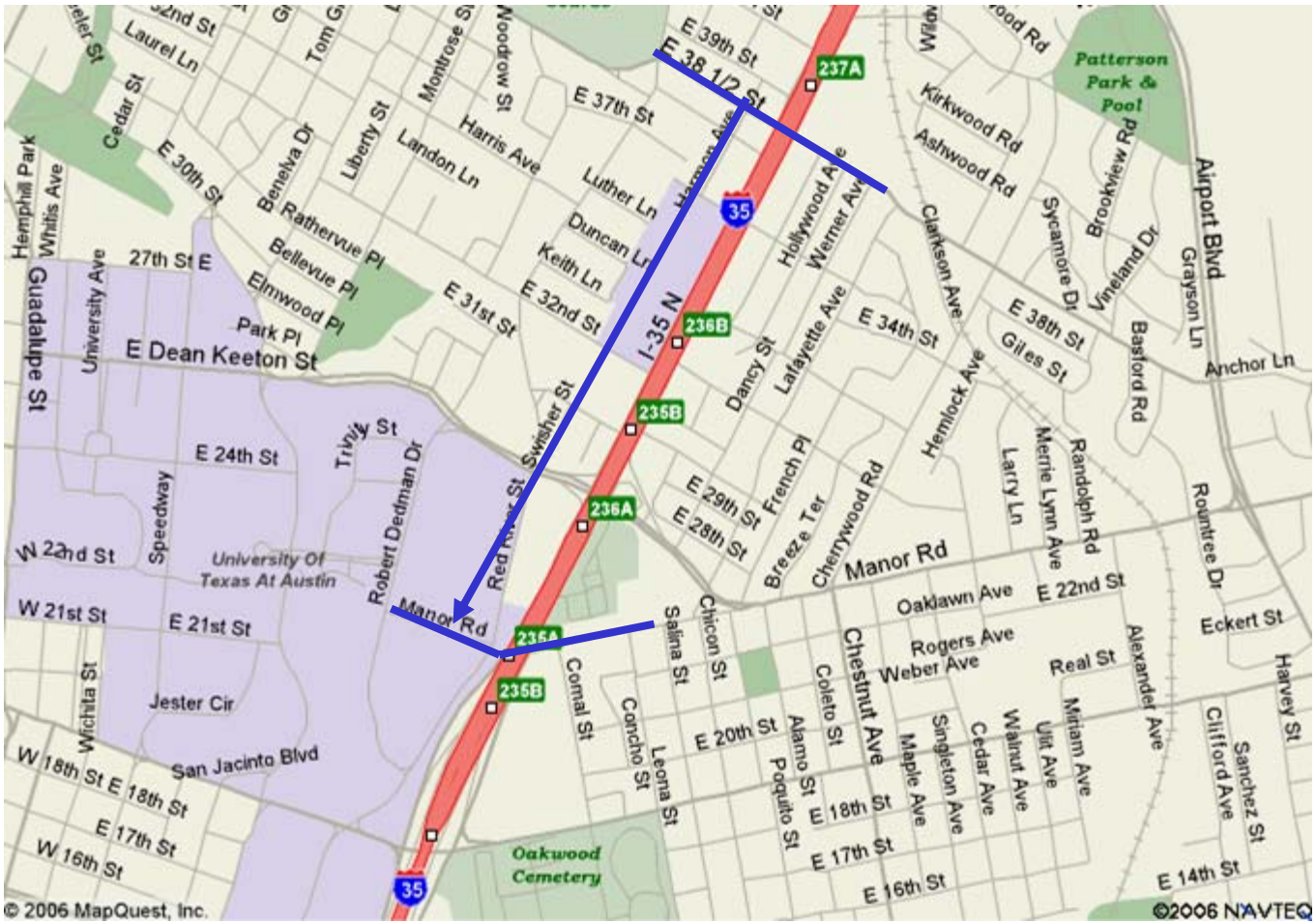
6 SB IH35 in Austin

- Bottleneck project on lower level of IH 35 – southbound
  - Eliminate 2 entrances
  - Reverse two ramps
  - Add auxiliary lane
- Construction cost = $2,376,137
- Driving force = improved safety



Graphic Courtesy of TTI

6 Roadway Layout



6 IH 35 Lower Level

Photo Courtesy of texasfreeway.com

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6 Main Lane Speed Study

Direction	Peak	Section	Speed Before (mph)	Speed After (mph)	Significant Difference?
Southbound	AM	51st – Airport	23.6	32.8	No
		Airport – 38 ½	53.3	52.9	No
		38 ½ – 32nd	55.0	56.3	No
		32nd – 26th	56.2	55.8	No
		26th – Manor	55.8	57.9	No
		Manor – MLK	56.8	58.4	No
	PM	51st – Airport	12.6	19.4	No
		Airport – 38 ½	7.5	11.8	Yes
		38 ½ – 32nd	7.3	10.8	Yes
		32nd – 26th	5.9	12.0	Yes
		26th – Manor	7.8	10.6	No
		Manor – MLK	8.0	11.6	Yes

6 Frontage Road Speed Study

Direction	Peak	Section	Speed Before (mph)	Speed After (mph)	Significant Difference?
Southbound	AM	51st – Hancock	26.9	41.3	Yes
		Hancock – 38 ½	8.1	10.9	No
		38 ½ – 32nd	17.1	20.5	Yes
		32nd – Manor	27.8	20.6	Yes*
		Manor – MLK	21.3	23.9	No
		MLK – 15th	19.5	36.5	Yes
	PM	51st – Hancock	38.4	38.9	No
		Hancock – 38 ½	5.3	8.3	Yes
		38 ½ – 32nd	18.9	15.9	No
		32nd – Manor	29.9	23.9	Yes*
		Manor – MLK	11.2	18.9	No
		MLK – 15th	25.5	28.4	No

6 Safety Evaluation

Direction	Condition	Total Crashes	Non-Injury	Minor Injury*	Major Injury or Fatality
Southbound	Before (4/30/00 – 5/1/01)	96	24	69	3
	After (10/2/01 – 9/30/02)	62 (-35%)	27 (+13%)	34 (-51%)	1 (-67%)

* Includes accidents classified as “possible injury”

6 Evaluation Results

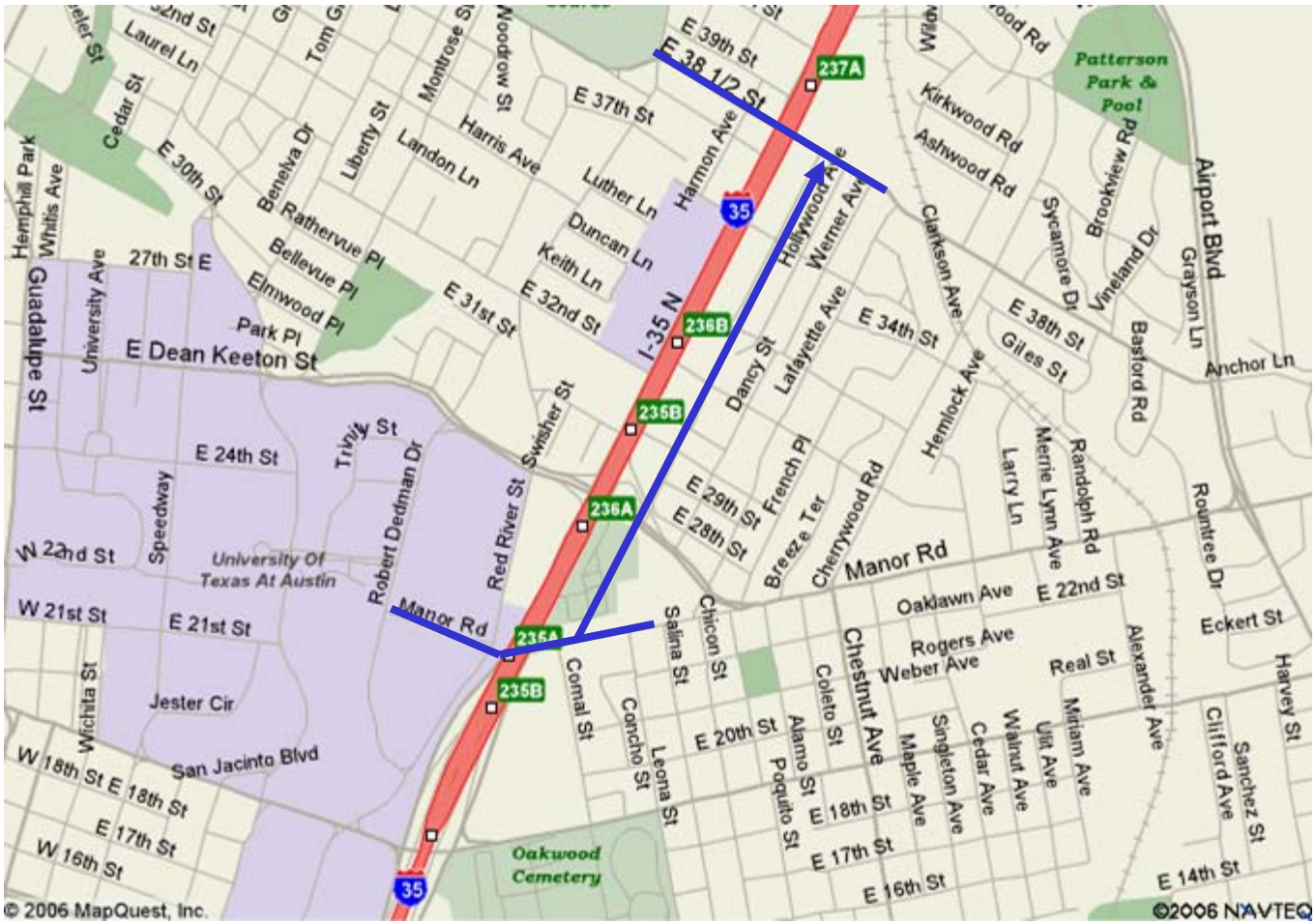
Evaluation	Outcome
	+
	+
	Ø

<u>Lesson learned</u>: proper implementation produces safety benefits.

7 NB IH 35 in Austin

- Bottleneck project on lower level of IH 35 – northbound
  - Eliminate 2 entrances
  - Reverse single ramp
  - Add acceleration lane
- Construction cost = $2,376,137
- Driving force = improved safety

7 Roadway Layout



7 Main lane Speed Study

Direction	Peak	Section	Speed Before	Speed After	Significant Difference?
Northbound	AM	11th – MLK	53.3	56.1	No
		MLK – 26th	57.0	58.0	No
		26th – 38 ½	60.1	61.4	No
		38 ½ - Airport	59.1	60.4	No
		Airport – 51st	54.7	50.4	No
	PM	11th – MLK	23.8	24.2	No
		MLK – 26th	32.8	36.4	No
		26th – 38 ½	36.9	33.5	No
		38 ½ - Airport	37.1	48.3	No
		Airport – 51st	34.3	38.0	No

7 Frontage Road Speed Study

Direction	Peak	Section	Speed Before	Speed After	Significant Difference?
Northbound	AM	MLK – Manor	26.0	10.5	Yes*
		Manor – 32nd	19.6	15.7	No
		32nd - 38 ½	32.1	35.8	No
		38 ½ – Hancock	16.6	21.1	No
	PM	MLK – Manor	26.2	12.1	Yes*
		Manor – 32nd	19.2	27.5	No
		32nd – 38 ½	30.5	27.0	No
		38 ½ - Hancock	13.3	12.6	No
		MLK – 15th	25.5	28.4	No

- Significant delay impacts are noticed in the after data collection due to the installation of a traffic signal at the Manor interchange along IH 35; these delays are not necessarily related just to the geometric reconfiguration of the lower level.

7 Safety Evaluation

Direction	Condition	Total Crashes	Non-Injury	Minor Injury*	Major Injury or Fatality
NB	Before (4/30/00 – 5/1/01)	64	13	50	1
	After (10/2/01 – 9/30/02)	37 (-42%)	9 (-31%)	28 (-44%)	0 (-100%)

* Includes accidents classified as “possible injury”

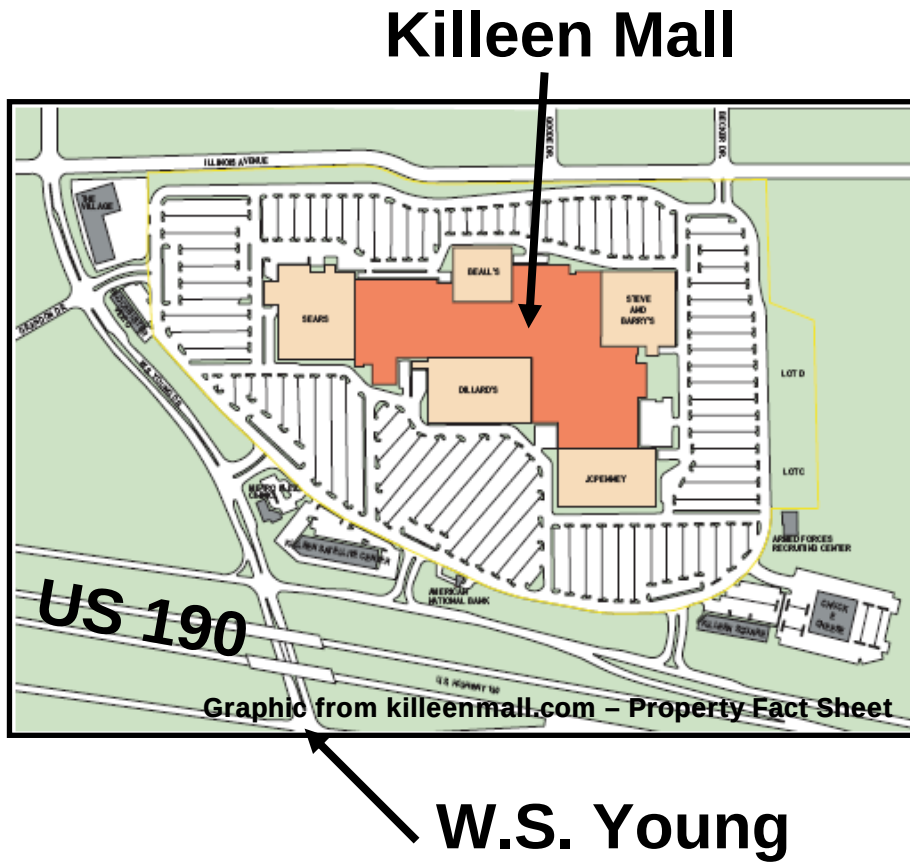
7 Evaluation Results

Evaluation	Outcome
	« »
	+
	Ø

<u>Lesson learned</u>: speed and throughput should be considered together in evaluating performance.

8 WB US 190 in Killeen

- Reversed the FM 2410 entrance with the W.S. Young exit ramp
- Construction cost = $1,169,149
- Driving force = commercial development & accommodate increased traffic volumes
- City of Killeen contributed $250,000



Graphic from killeenmall.com – Property Fact Sheet

8 Aerial Photograph

8 Evaluation Results

Evaluation	Outcome
	+
	+
	+

<u>Lesson learned</u>: side of freeway with reversals operates better.

9 SB IH 35E in Denton

- Reversed the southbound State School entrance with the Loop 288 exit ramp
- Construction cost = $1,242,529
- Driving force = improve access to the gateway roadway to a large master planned development
- City of Denton paid for engineering design services

9 Aerial Photograph

9 Evaluation Results

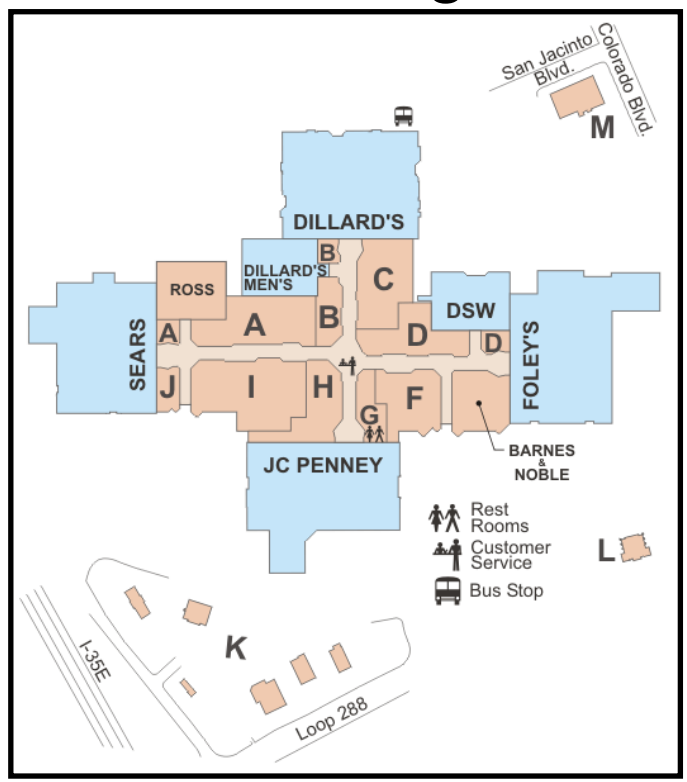
Evaluation	Outcome
	+
	+
	+

<u>Lesson learned</u>: Close coordination can lead to a project that is positive for all stakeholders.

10 NB IH 35E in Denton

- Reversed the State School entrance with the Loop 288 exit ramp
- Construction cost = $1,427,790
- Driving force = commercial development & relieve congestion at Loop 288 intersection
- City of Denton paid for engineering design services

Golden Triangle Mall



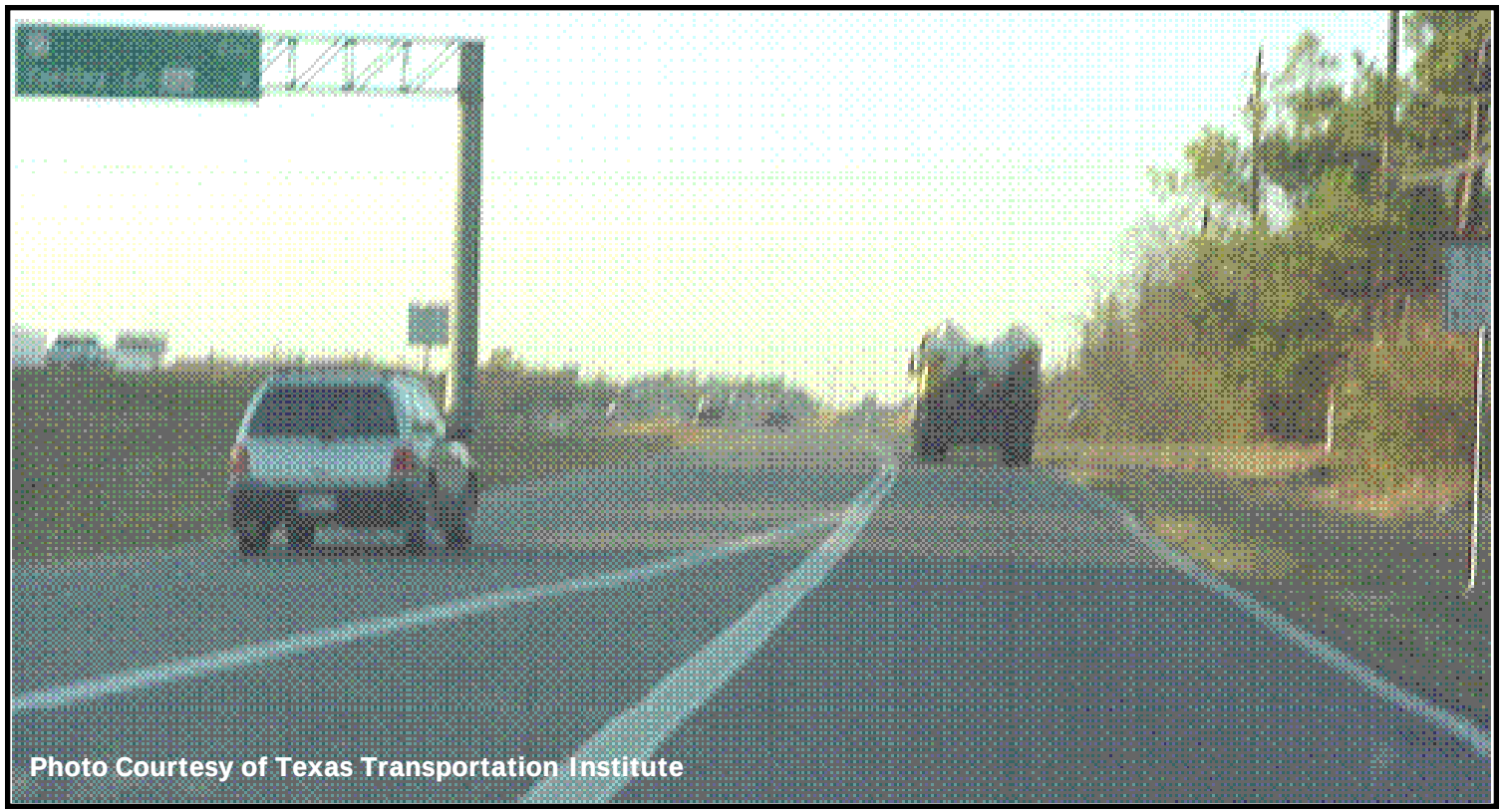
Graphic from simon.com – Leasing Fact Sheet

10 Aerial Photograph

10 Evaluation Results

Evaluation	Outcome
	+
	+
	+

10 Lesson Learned



<u>Lesson learned</u>: consideration of frontage road capacity is important – particularly if the cross section is only 2 lanes.

11 NB IH 35E in Lewisville

- Reversed the northbound Fox Avenue entrance with the FM 1171 exit ramp
- Added auxiliary lane on frontage road
- Construction cost = $1,012,826
- Driving force = improve safety – eliminate frequent queue spillback problem

11 Aerial Photograph

11 Evaluation Results

Evaluation	Outcome
	+
	+
	+

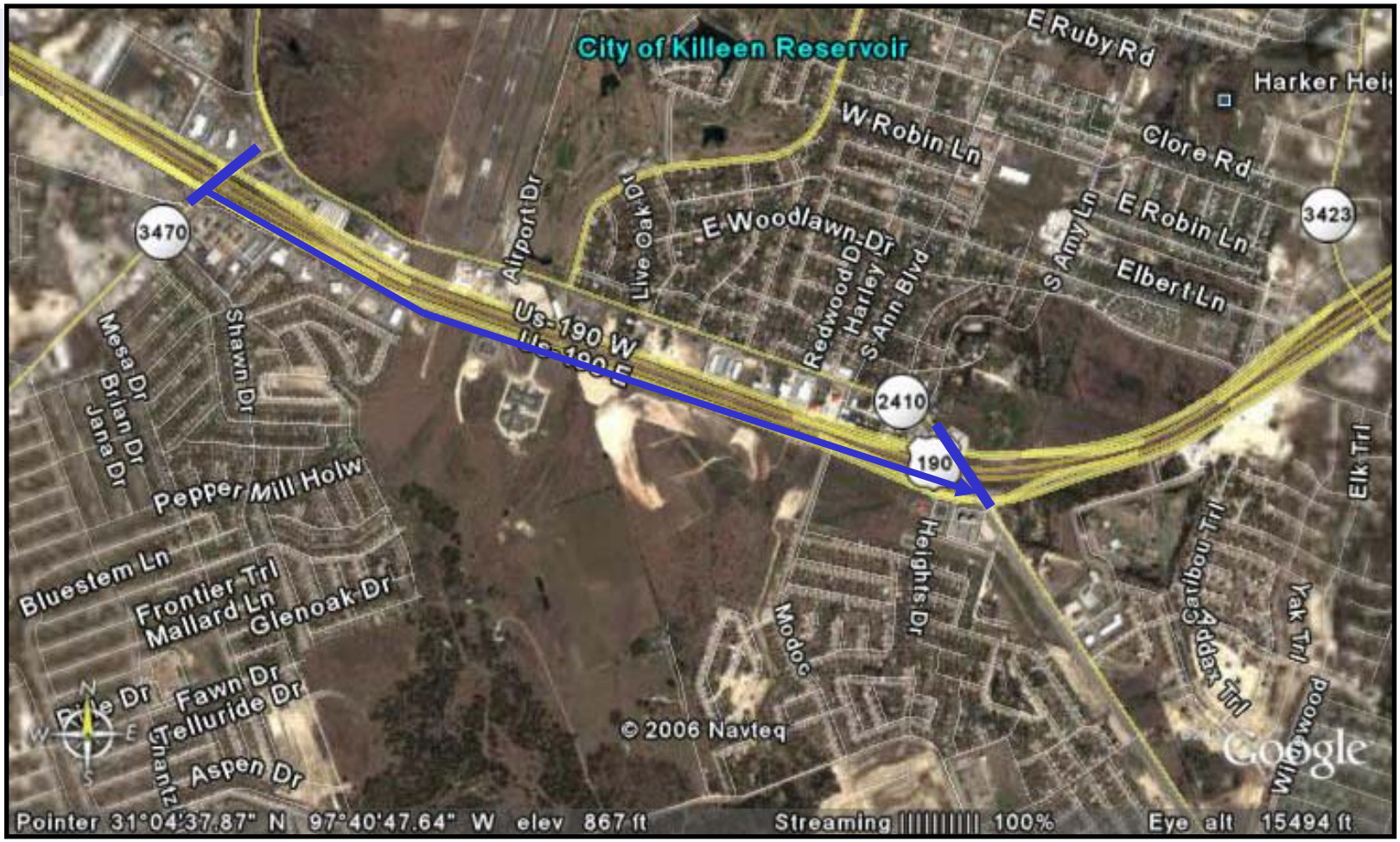
<u>Lesson learned</u>: safety and response time of emergency vehicles & access to emergency medical facilities are important to consider.

12 EB US 190 in Harker Heights

- Reversed the FM 3470 entrance with the FM 2410 exit ramp
- Construction cost = $986,747
- Driving force = improve access to a new Wal-Mart Supercenter
- Joint funding effort

Photo from Flickr.com (public)

12 Aerial Photograph



12 Evaluation Results

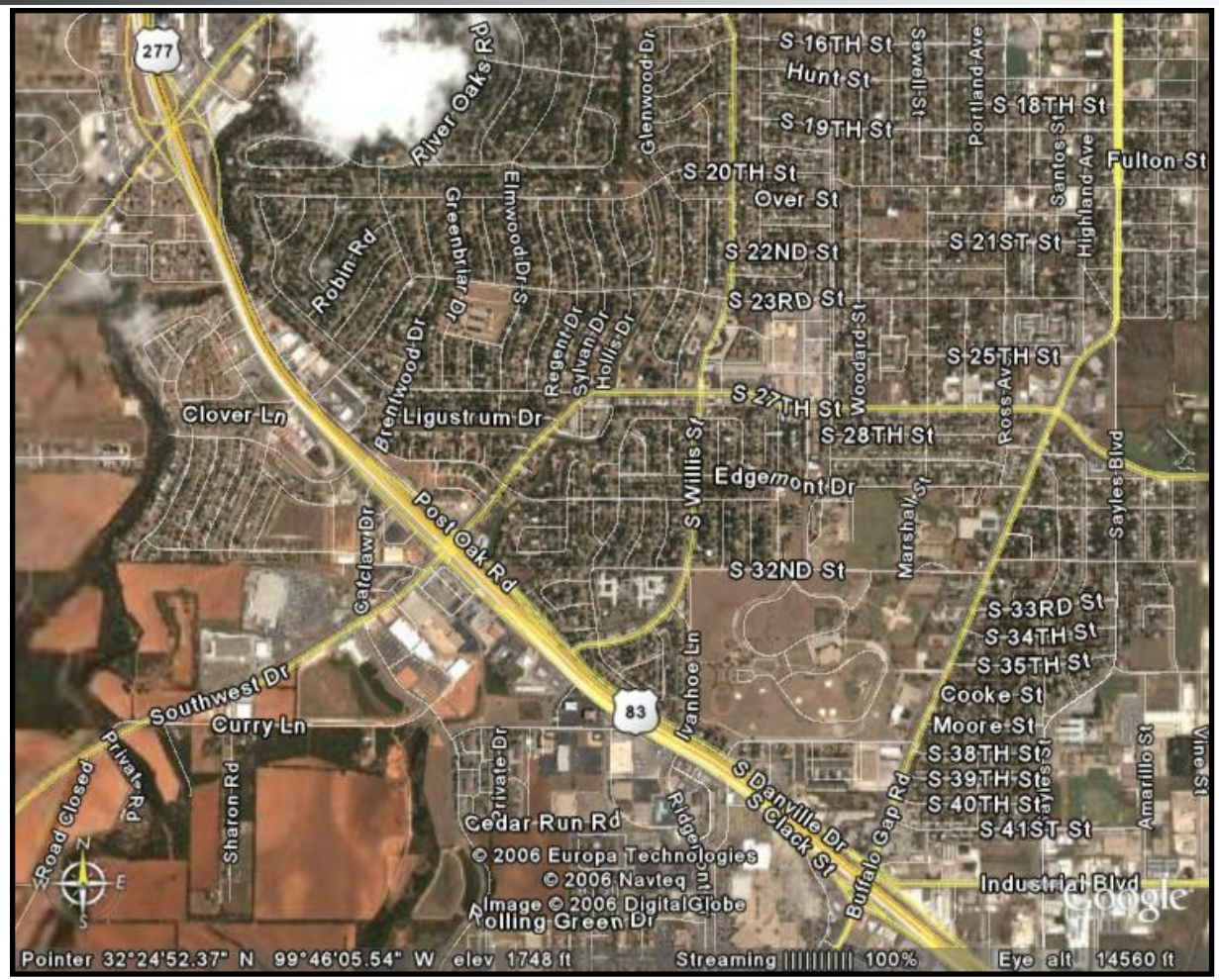
Evaluation	Outcome
	+
	+
	+

<u>Lesson learned</u>: Agreements to share funding can help accelerate project implementation.

13 US 83 in Abilene

- X-ramp corridor project
- Main lanes widened from 4 to 6 lanes
- Frontage road capacity unchanged – 2 lanes
- Construction cost = $20,000,000
- Driving force = improve traffic flow and access to businesses

13 Aerial Photograph



13 Negative Publicity

- Local newspaper headlines:
  - Freeway mess
  - Freeway ramps confuse drivers
  - Engineers work to fix signal timing
  - Tough exits
- Anecdotally
  - Main lane volumes & congestion decreased
  - Frontage road volumes & congestion increased

13 Evaluation Results

Evaluation	Outcome
	« »
	Ø
	+

<u>Lesson learned</u>: X-ramp corridor projects cause substantial shifts In volumes on the frontage road and this needs to be planned for.

14 US 83 in Pharr

- X-ramp corridor project
- Main lanes widened from 4 to 6 lanes
- Conway Avenue to Sugar Road
- Construction cost = $36,600,000
- Driving force = rapid growth and projected decrease in traffic operations

14 Aerial Photograph

14 Operational Benefits

Corridor Component	Net Present Cost Due to Delay, $Millions[1]		Net Benefits $Millions
	Existing Geometrics	Proposed Improvements	
Freeway main lanes	38.8	1.3	37.5
Cross-street interchanges	142.3	25.9	116.4
Frontage roads	0.2	4.1	-3.9
TOTAL	$181.3	$31.3	$150.0

[1] The net present cost of delay during the peak hours (AM + PM) over 20 years, assuming a discount rate of 4%, 250 working days per year, and a value of time of 10.78 per veh.-hr.

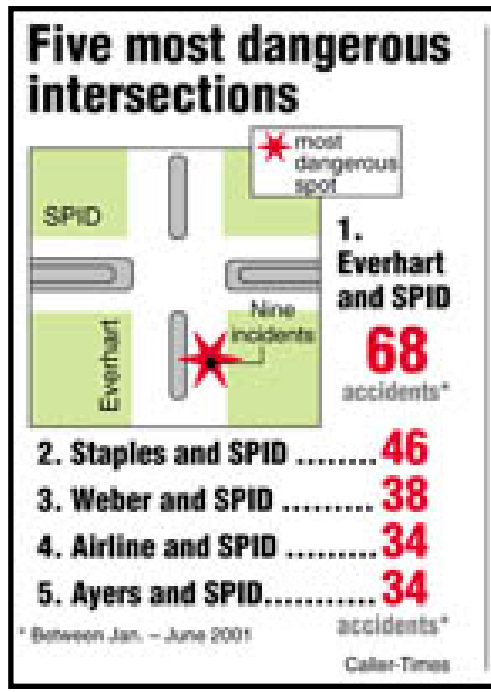
14 Evaluation Results

Evaluation	Outcome
	+
	Ø
	Ø

<u>Lesson learned</u>: X-ramp corridor projects can produce significant operational benefits compared to diamond or hybrid configurations.

15 SH 258 in Corpus Christi

- SH 258 is South Padre Island Dr.
- X-ramp corridor project
- Main lanes will be widened from 4 to 6 lanes in phases
- Project limits: SH 286 Crosstown Expressway to Airline Drive
- Driving force = safety issues and to improve traffic operations

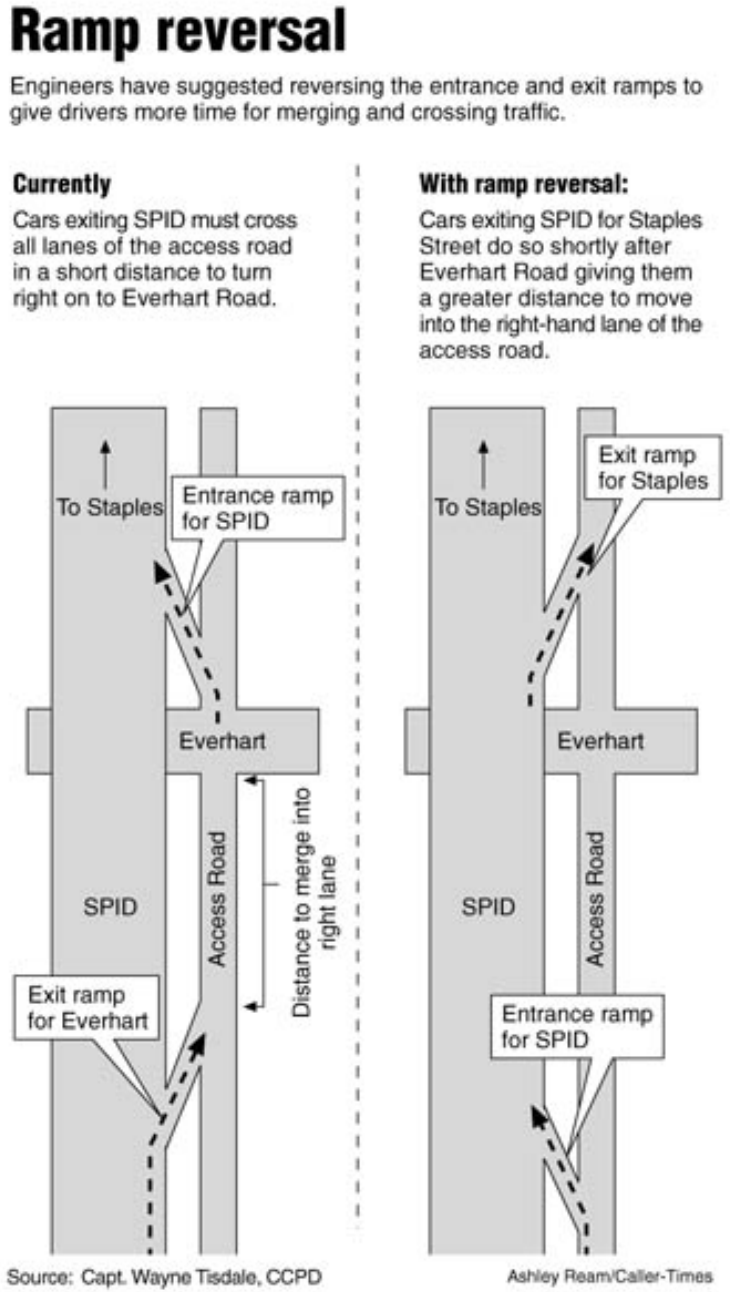


Graphic from Corpus Christi Caller-Times

15 Aerial Photograph

15 Promotion

- Effective promotion:
  - Newsletters
  - Press releases
  - Presentations
  - Outreach to local businesses
  - Local media coverage



Graphic from Corpus Christi Caller-Times

15 Evaluation Results

Evaluation	Outcome
	+
	+
	Ø

<u>Lesson learned</u>: Thorough evaluation & well-planned public education can lead to project implementation even in complex corridors.

MODULE 6

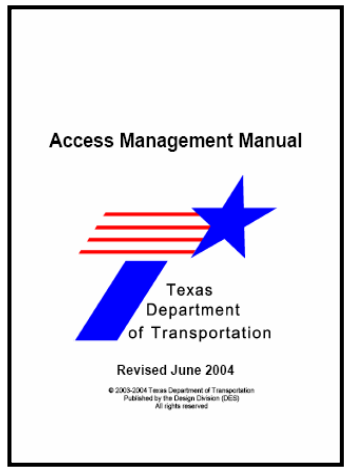
PROJECT EVALUATION

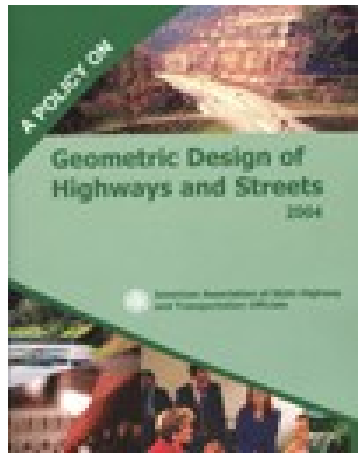
Project Evaluation Process

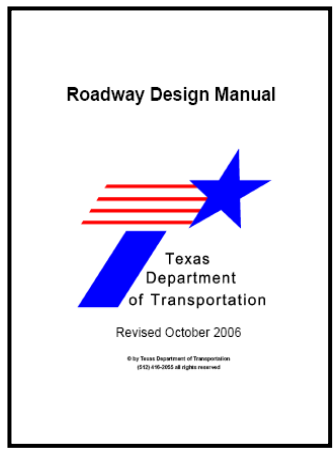
- Evaluation criteria
- Data collection activities
- Traffic analysis tools for project evaluation
- Evaluation framework
- Decision flowchart
  - Cost-effectiveness procedure for ramp reversals
  - Warrants for grade separated ramps

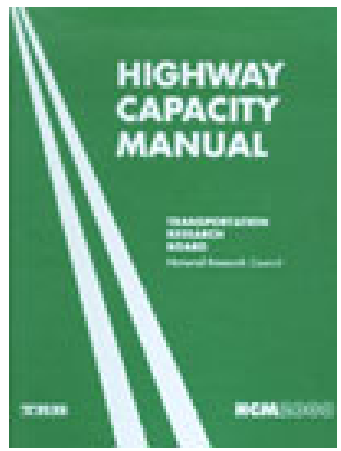
Evaluation Criteria

- Traffic volumes
- Ramp spacing
- Weaving
- Capacity/LOS
- Interchange type
- Cross-street operation
- Auxiliary lanes
- Access
- Queuing



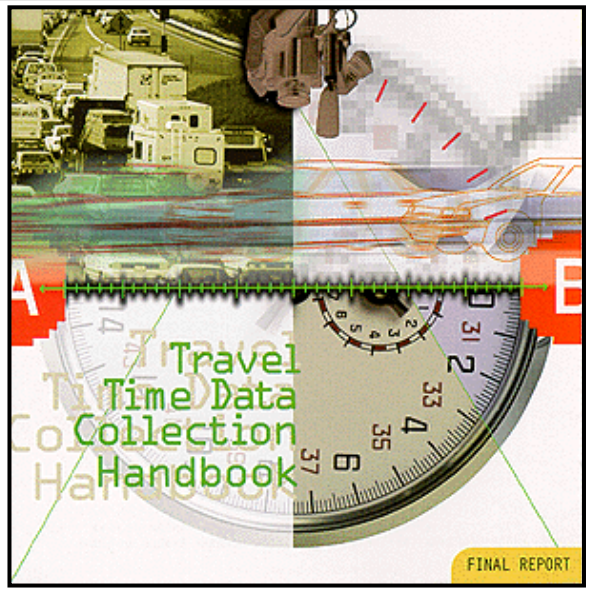






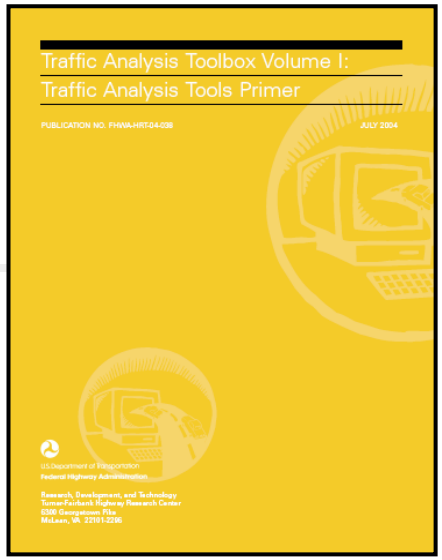
Data Collection Activities

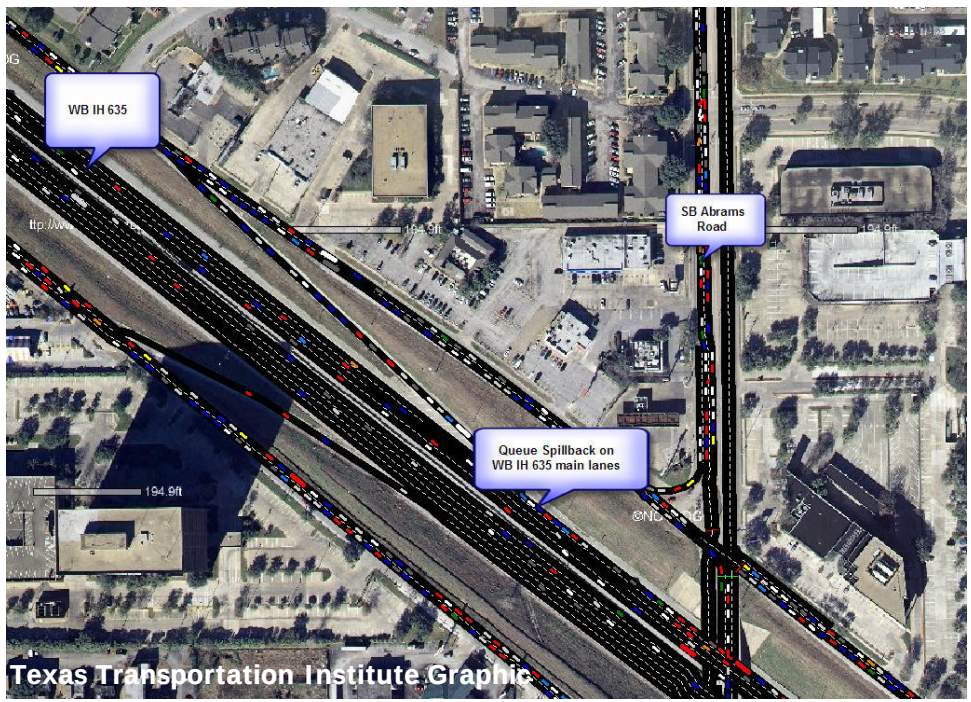
- Traffic volumes
- Travel times
- Queue lengths
- Physical inventory



Traffic Analysis Tools

- Model selection
  - FHWA Toolbox
- Microscopic models
  - CORSIM
  - VISSIM

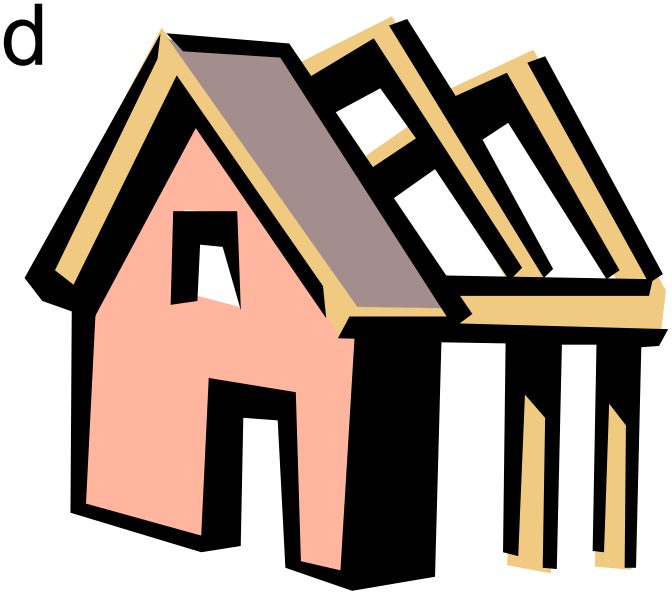




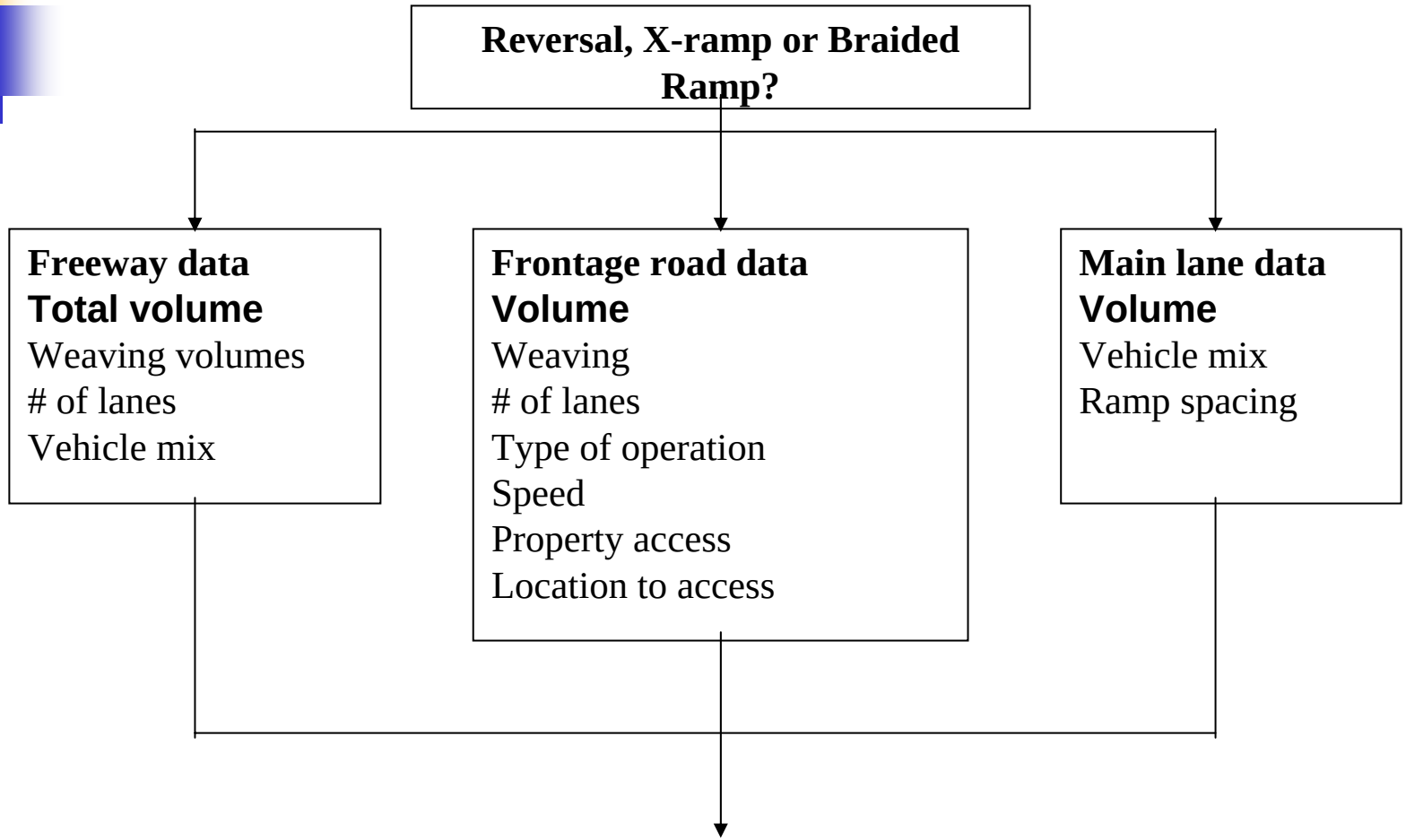
Texas Transportation Institute Graphic

Project Evaluation Framework

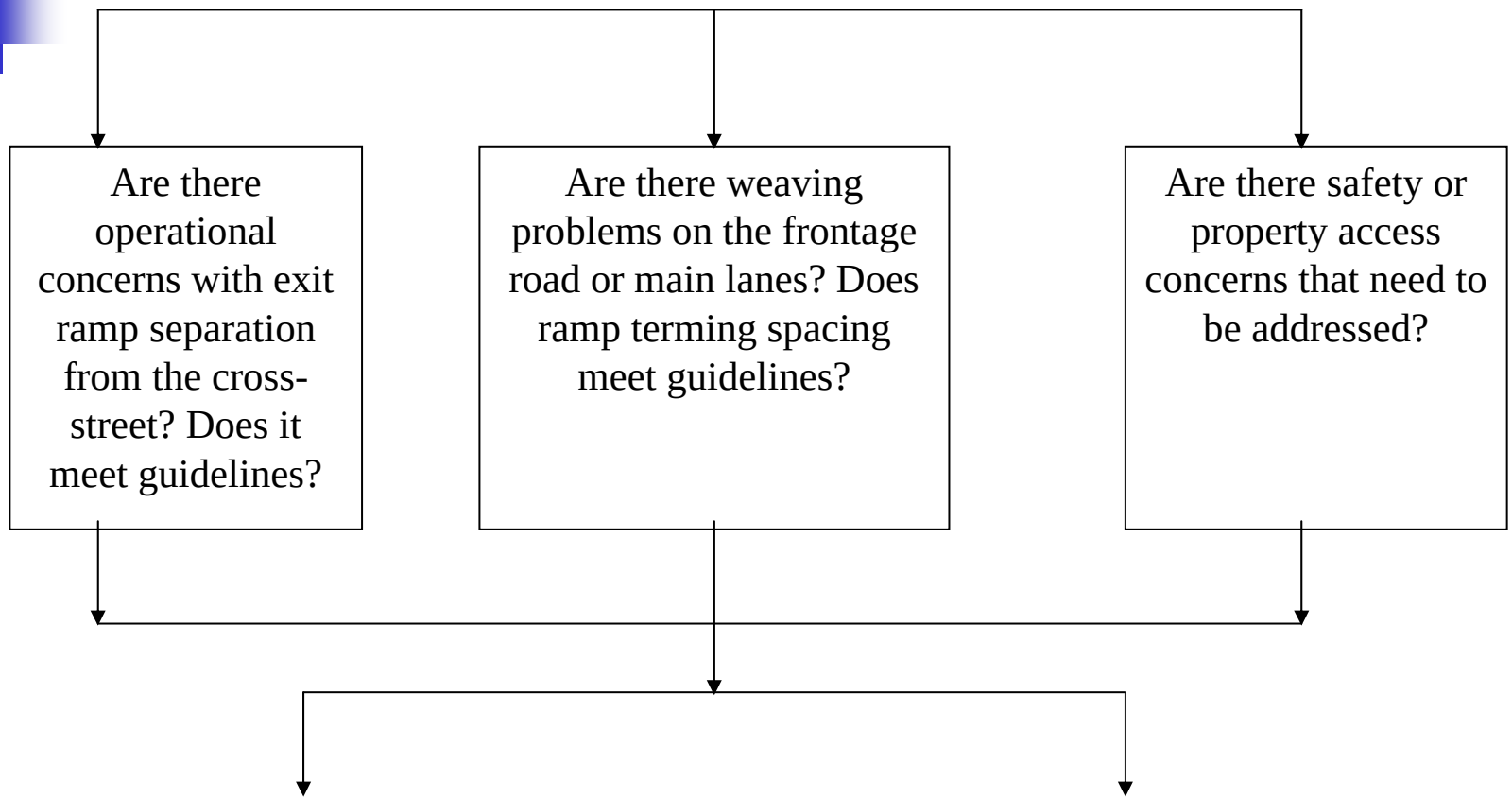
- Define purpose and need
- Collect data
- Select analysis tool(s)
- Perform analysis
- Assess viability



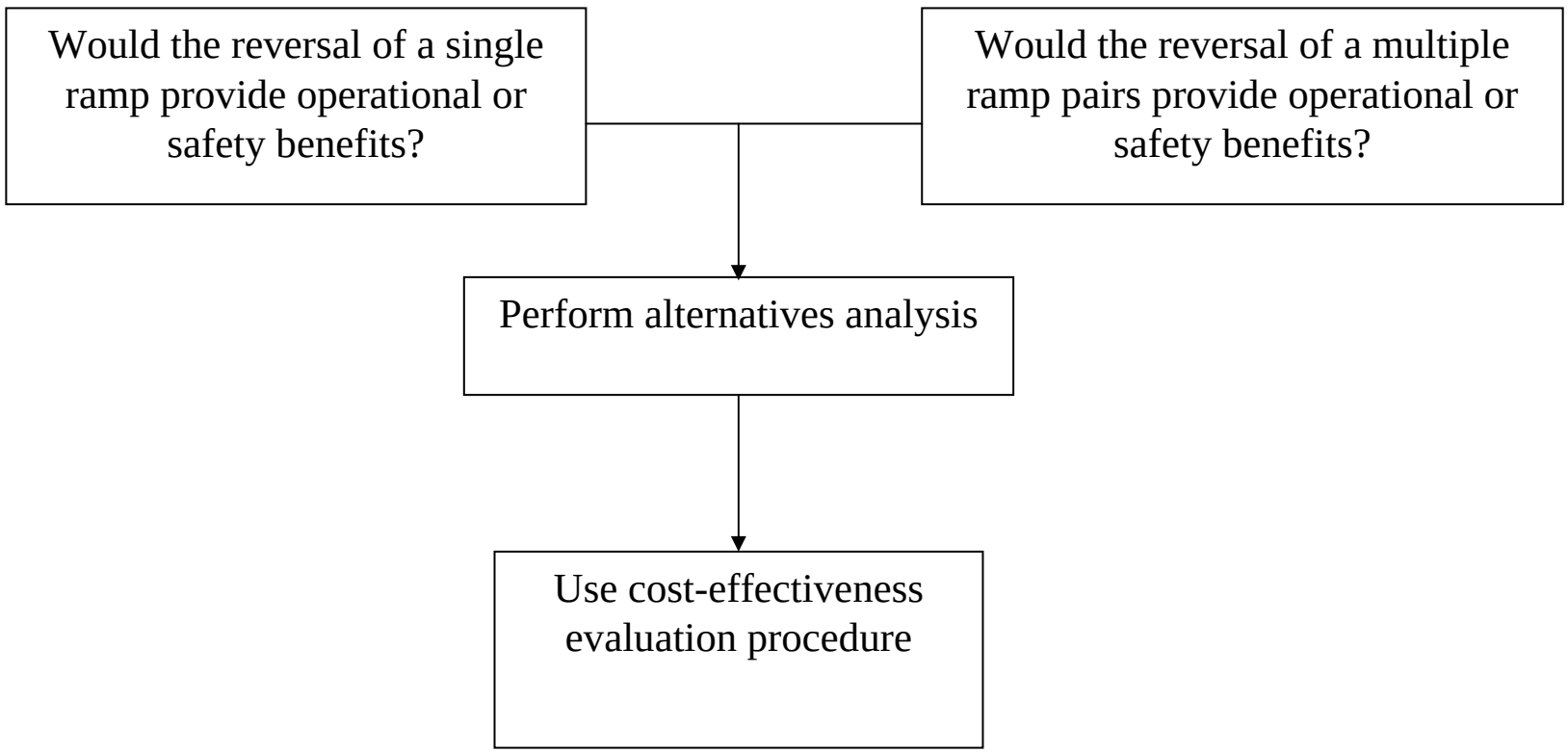
Decision Flowchart – Part I



Decision Flowchart – Part II

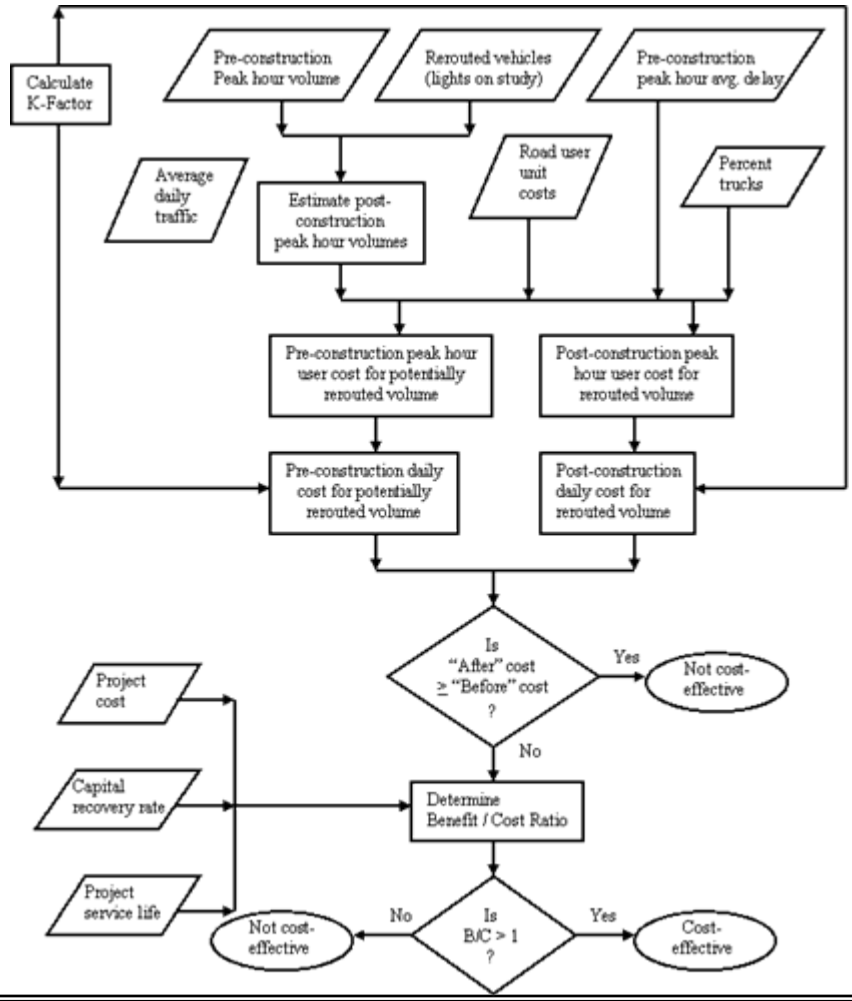


Decision Flowchart – Part III



Evaluation Procedures

- Ramp reversal
  - TTI research project 210-12F
  - Cost-effectiveness
  - Flowchart



Evaluation Procedures

- Grade-separated (i.e., braided) ramps
  - TTI research project 376
  - Warrants based on volume and crash rate thresholds
  - 1,600 vph

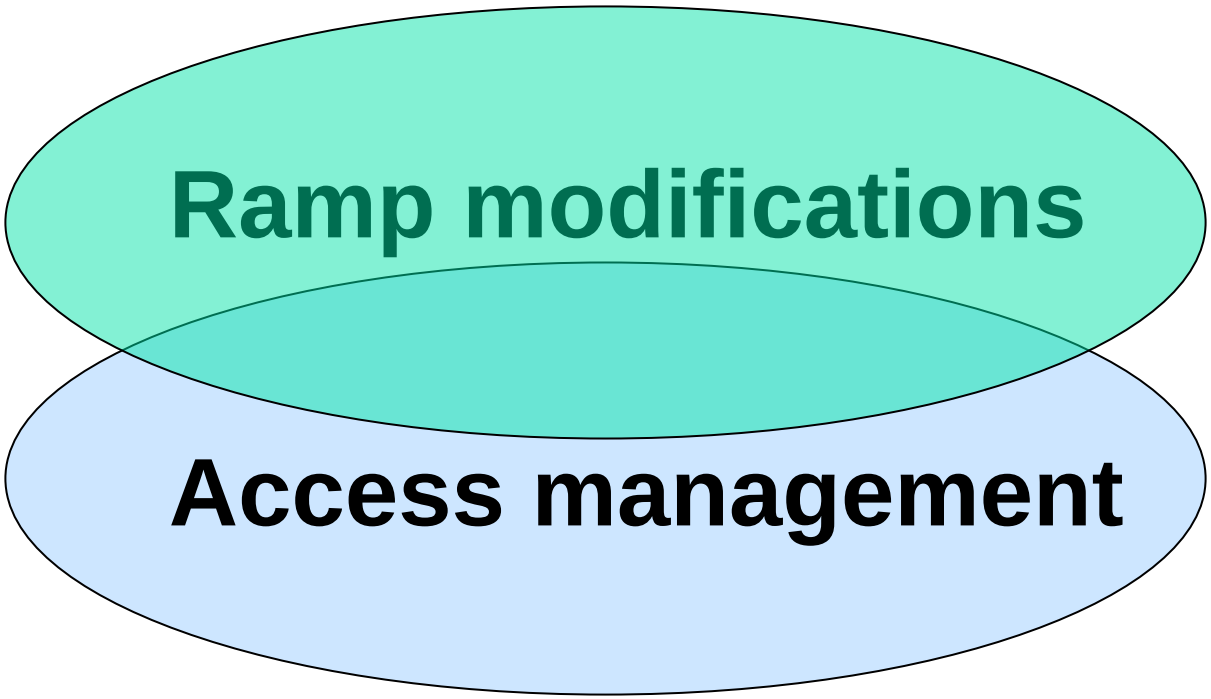
MODULE 7

GUIDELINES FOR SUCCESSFUL IMPLEMENTATION OF RAMP REVERSAL AND X-RAMP PROJECTS

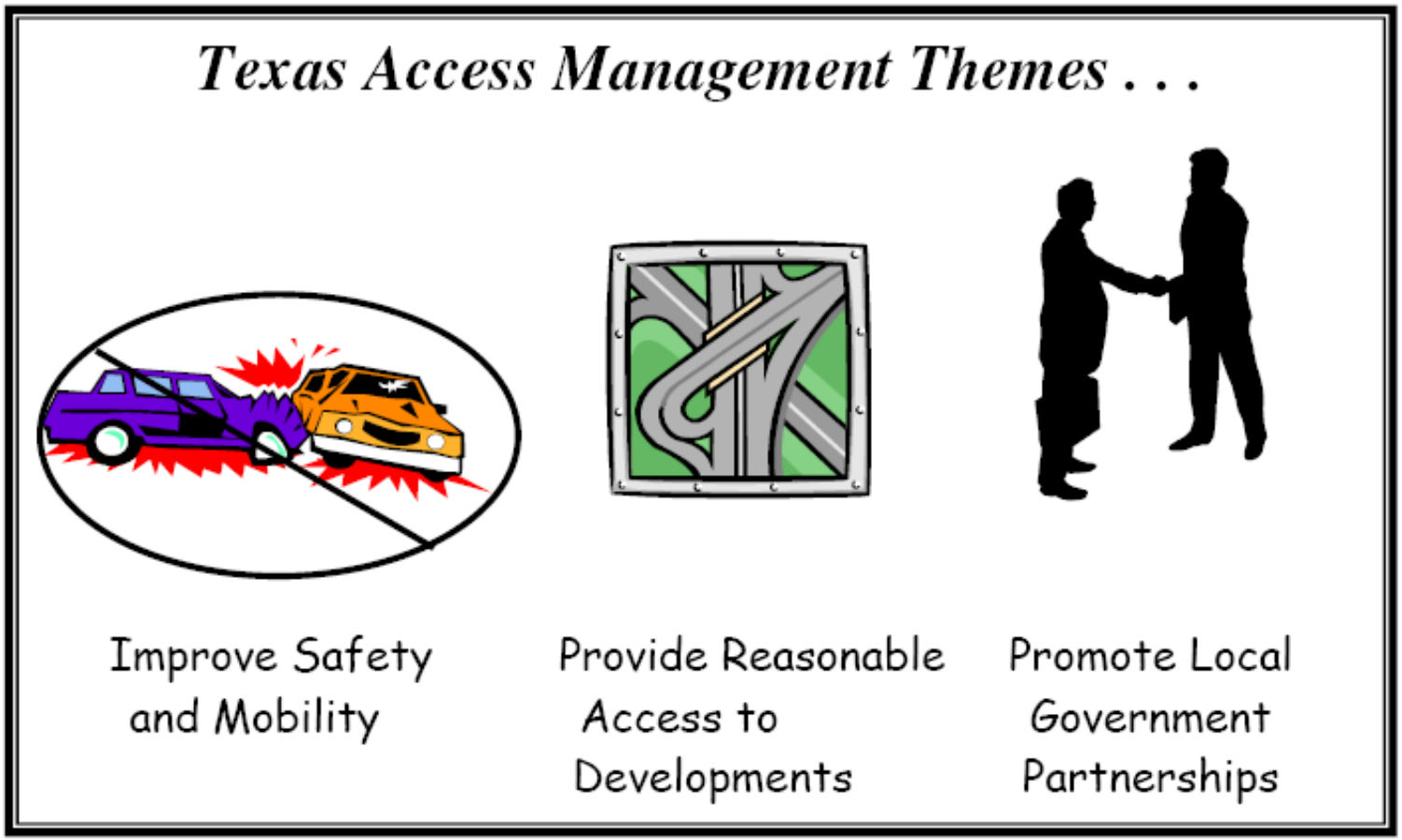
Guidelines Development

- Guidelines should be:
  - Clear
  - Concise
  - Practical

Guidelines Synergy



Access Management Themes



Graphic from Report No. 0-4141-P3, Texas Transportation Institute

Guidelines Framework

- 5 categories (based on 5*E*s of SR2S)
  - *E*ducational 
  - *E*ncouragement 
  - *E*ngineering 

  - *E*nforcement 

  - *E*valuation 

Guideline 1: Educational

- Use the local media, department resources and other innovative techniques to promote projects:
  - prior to construction
  - during construction
  - after completion
  - following evaluation

Prior to Construction

During Construction

ARLINGTON Texas
the online home of the City of Arlington TX

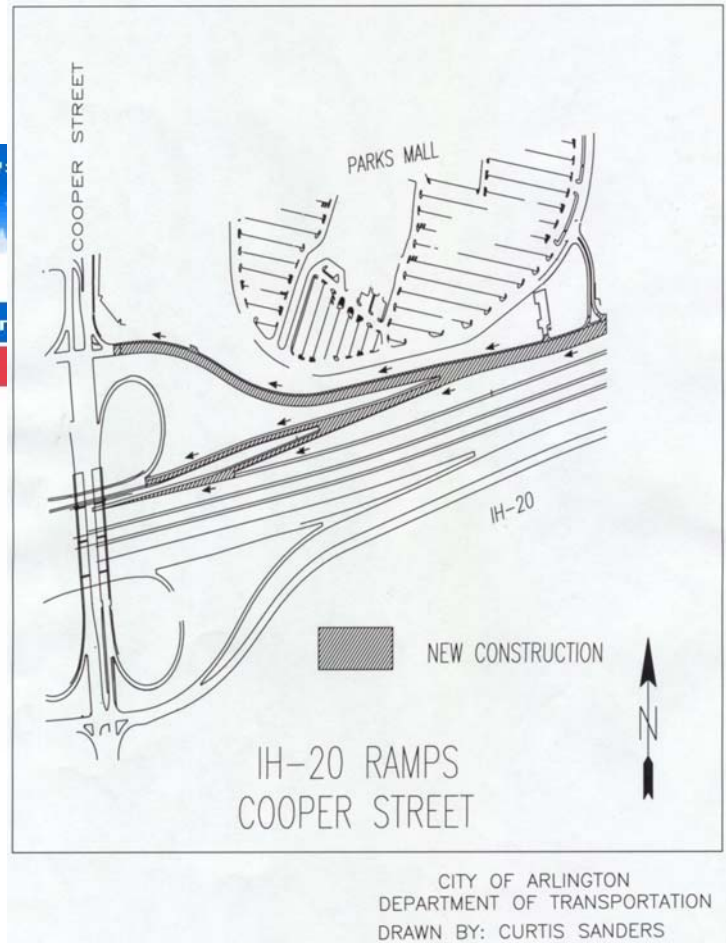
Information | City Government | Departments A-G | Departments H-Z | Economic Development | Cor

Home > Press Releases > Weekly News > Archives > October 2001 > Article 02

PRESS RELEASES
news archives

City Celebrates Progress of $7 Million Ramp Reversal Project at Interstate 20 Officials Say Cooperative Project is Six Months Ahead of Schedule

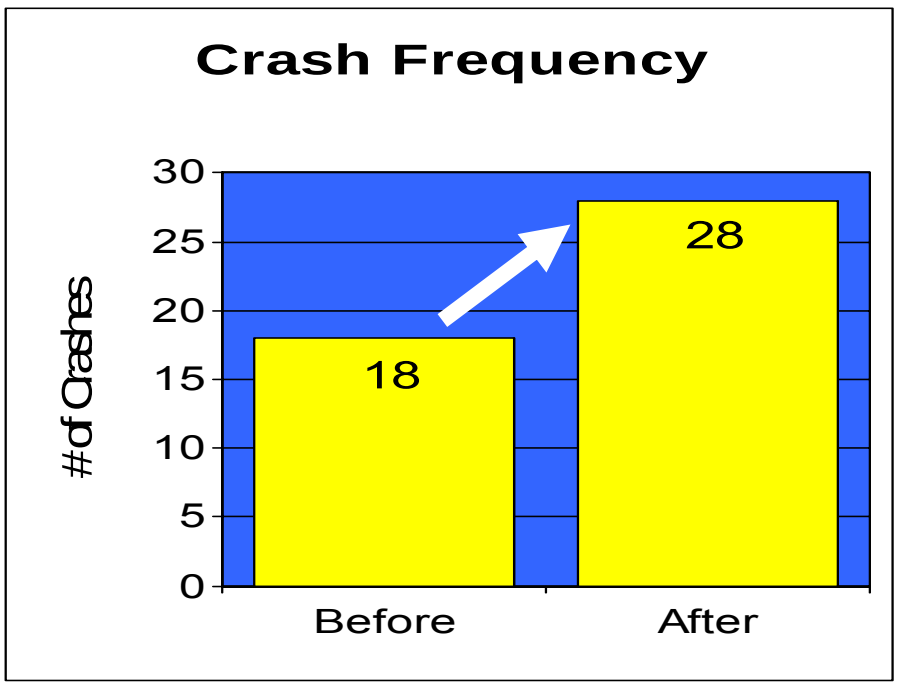
by Cheryel Carpenter
October 12, 2001



Following Evaluation

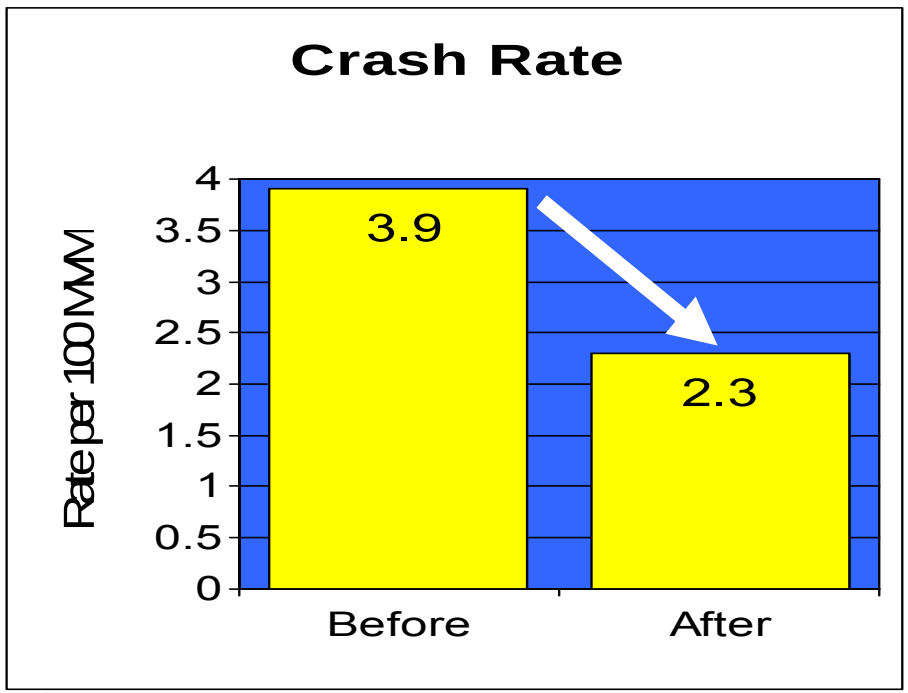
Fort Worth Star-Telegram

Accidents up on improved IH 20 frontage road



TTI Analysis

Crash rate actually significantly reduced



Guideline 2: Educational

- Develop fact sheets, brochures, newsletters or other media to educate the public and stakeholders of the proposed project.

Online Fact Sheet

Expressway

Search: Go

Tools | Links | What's New | Help

SH 6 (Earl Rudder Freeway) Ramp / Frontage Road Improvements - From Greens Prairie Road to FM 159

Brazos County

The Bryan District is currently developing a project to improve traffic flow within the SH 6 corridor. The improvements will include adjustment or addition of access ramps, conversion of the frontage roads to one-way operation and construction of additional turn-around interchanges. Public meetings were held to assist in determining the preferred improvements.

No new right-of-way acquisition is required for this project.

Construction is anticipated to begin in 2006.

Additional information about this project can be obtained by contacting:

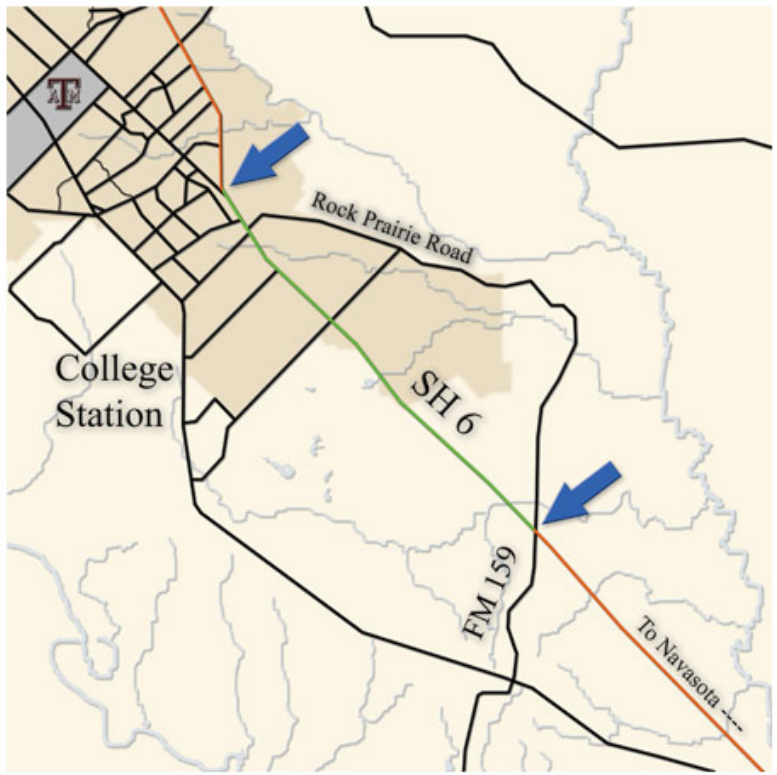
Mr. Karl Nelson, P.E.
Bryan Area Engineer

Phone: 979-778-6233
Fax: 979-778-1375
E-mail: knelson@dot.state.tx.us

Bryan Area Office
2102 Tabor Road - In Bryan

Back to Brazos County project list

Return to Bryan District county list



Graphic from TxDOT website – www.dot.state.tx.us

Newsletter

Good job of highlighting project goals

Texas Department of Transportation
Corpus Christi District

SH 358

South Padre Island Drive

Safety Improvement and Congestion Management Project

Project Description

The Texas Department of Transportation (TxDOT) is proposing improvements to four miles of State Highway (SH) 358, also known as South Padre Island Drive (SPID), extending from Kostoryz Road potentially to Nile Drive. Several approaches are being considered, such as reversing some ramps, moving some exit ramps back, reworking other ramps, and adding auxiliary lanes. The proposed project would improve safety, increase mobility, and address congestion along SPID, which carries more traffic than any other roadway in the Corpus Christi area. TxDOT recognizes that SPID is a main transportation connector to one of the area's primary economic centers and wants input from businesses, the public and local officials early in the project planning.

Background & Project History

The current "diamond" ramp design along SPID was the standard when the corridor was constructed decades ago. A different approach ("x ramp" design) has become the modern standard in urban Texas. As the SPID and south side area has become more urbanized and developed, the roadway has become more congested. Over the years, operational improvements have been made to the frontage roads, retaining walls, and signalization, but safety problems and congestion have increased. The Crosstown Interchange and Extension projects will help divert some traffic southward on SH 286, but in seven to ten years it is predicted that the current level of congestion will return.

TxDOT asked Texas Transportation Institute (TTI) to analyze accidents along the corridor, basic improvement approaches, and their benefits. In 2004, TTI reported their results to the Metropolitan Planning Organization (MPO) and the Corpus Christi City Council. They noted that 8 of the top 11 accident sites in the city were along this corridor. The major accident sites were between the exit ramps and the intersections except in the Staples to Airline area, where a significant number of accidents were occurring near both ramps. TTI estimated the annual economic cost of these accidents at $28.4 million. TTI recommended that the TxDOT make ramp changes. TxDOT engaged Turner Collie and Braden (TCB) and Olivarri & Associates to develop a project plan.

Project Goals

Improve Operations | Improve Safety | Address Congestion

Texas Transportation Institute

Texas Department of Transportation

UTA

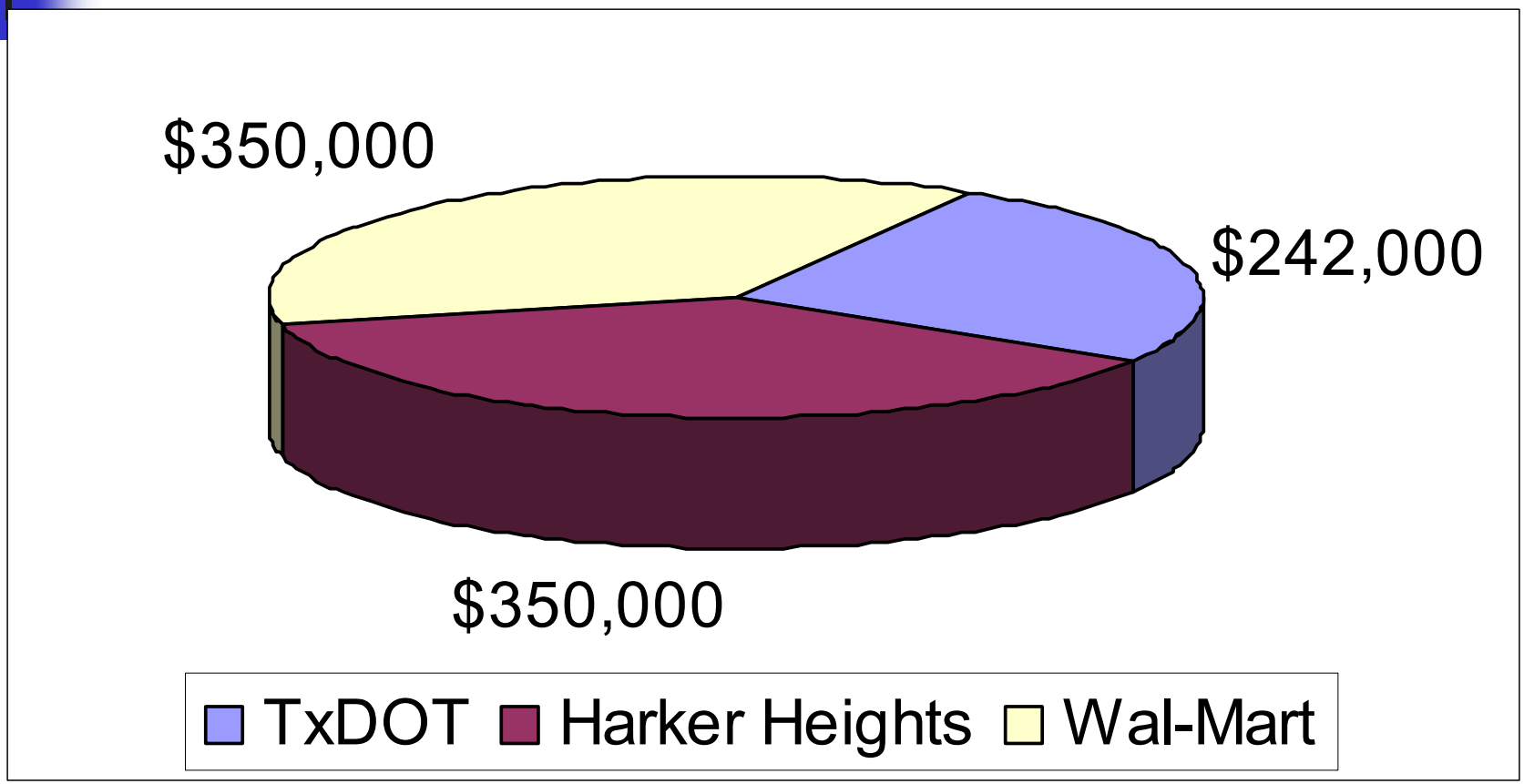
Guideline 3 - Educational

- Develop educational and promotional messages consistent with the three access management themes.
  - Improve safety and mobility
  - Provide reasonable access to developments
  - Promote local government partnerships

Guideline 4 - Encouragement

- Encourage funding contributions from local government entities and private developers to offset project implementation costs.

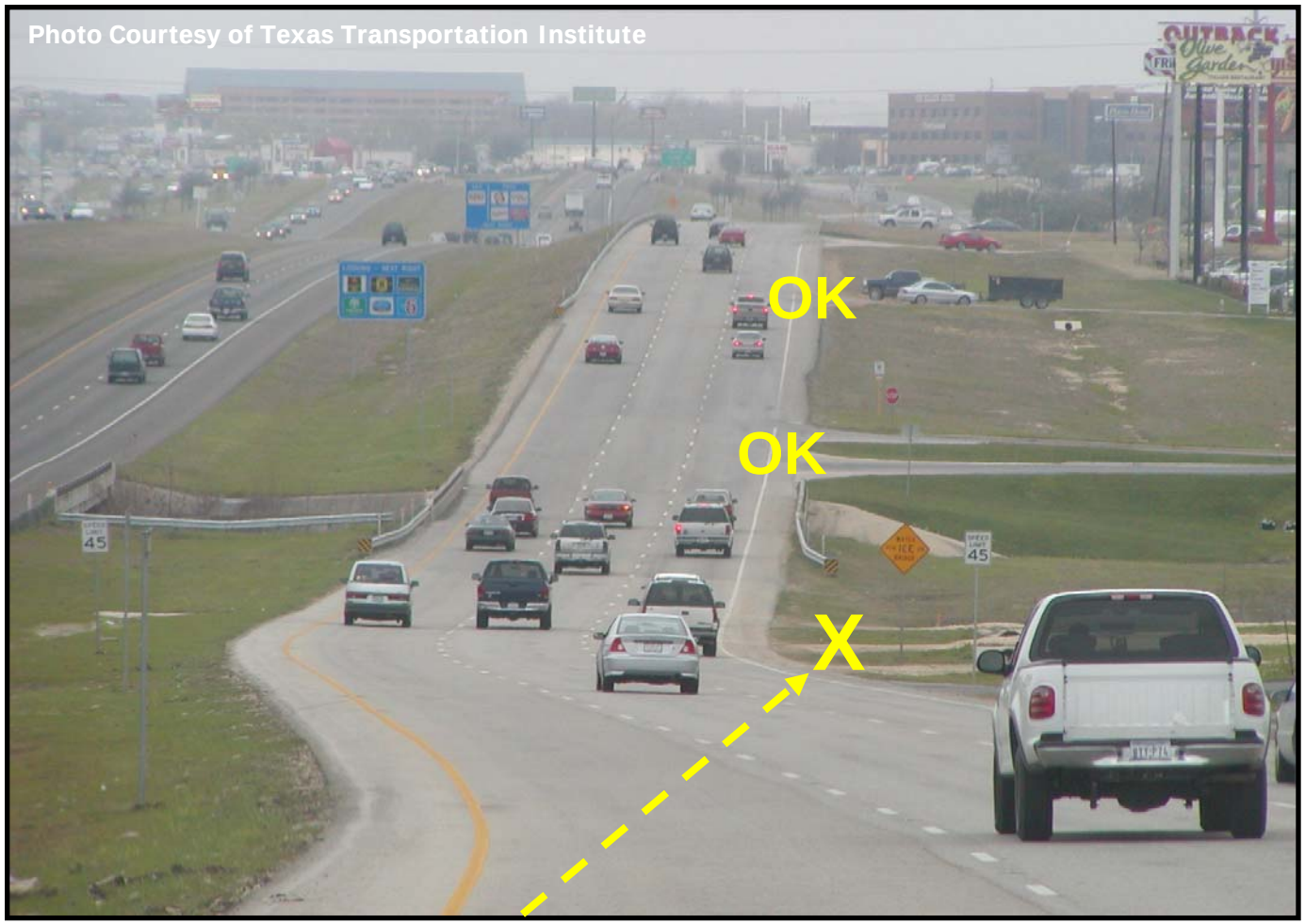
US 190 in Harker Heights



Guideline 5 - Encouragement

- Encourage local government entities and business owners to consider access revisions of frontage road driveways as part of the ramp modification project.

Driveway Closure/Consolidation

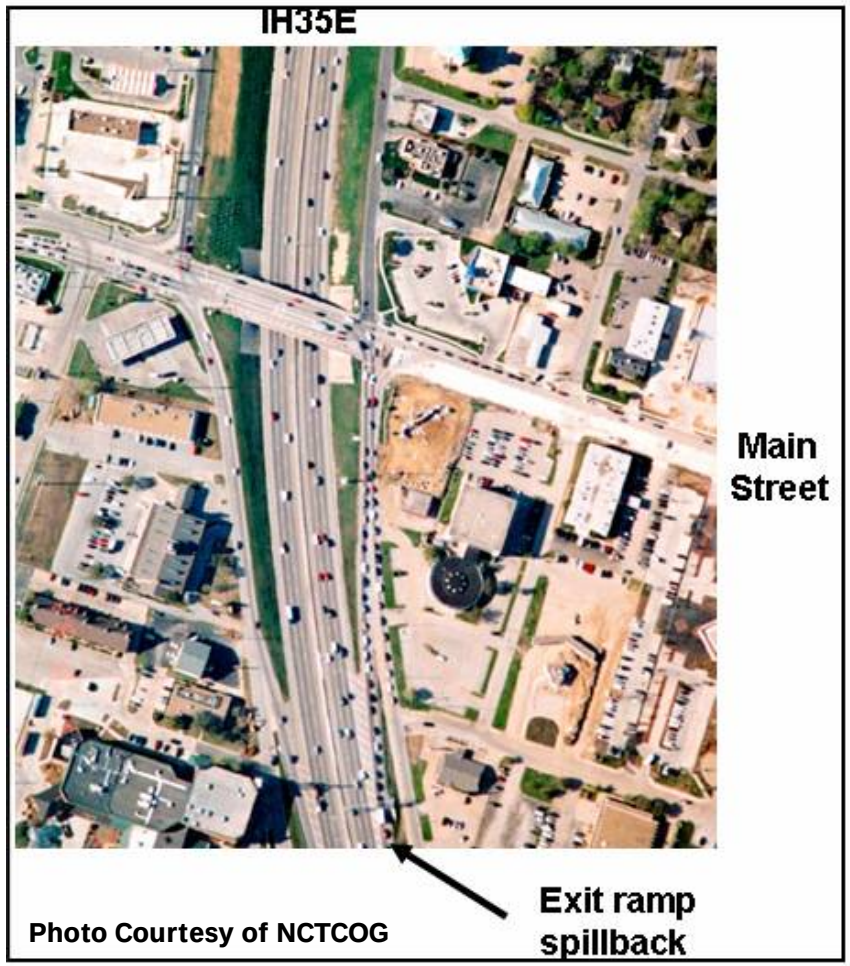


Guideline 6 - Engineering

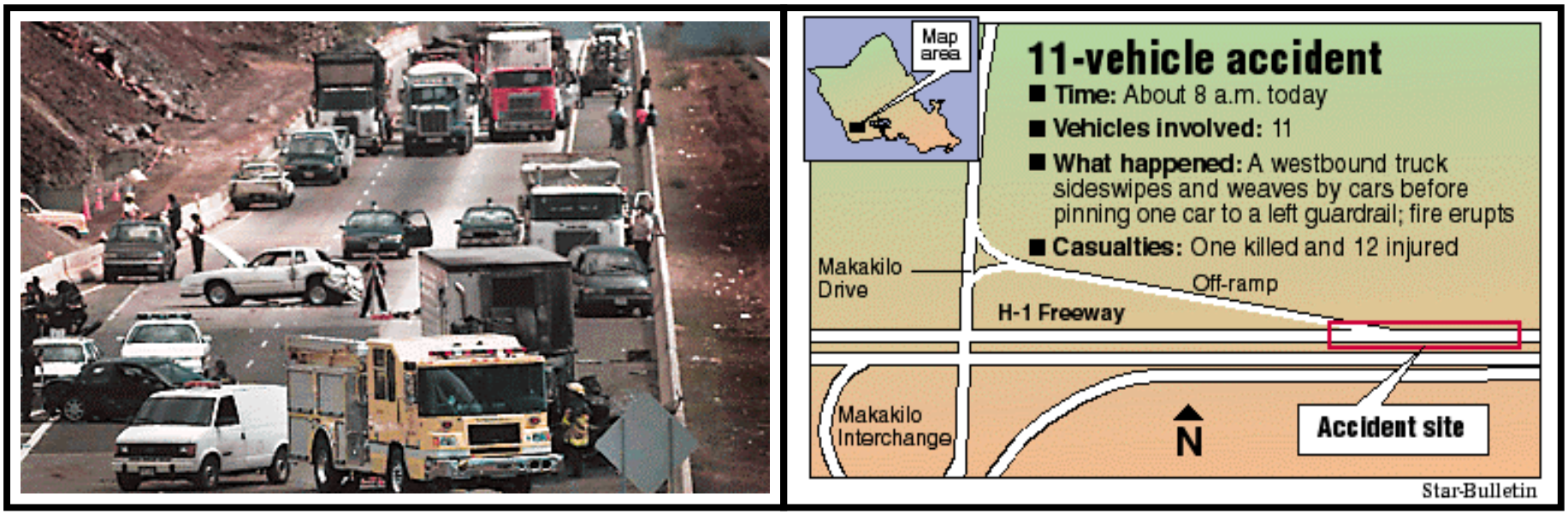
- Provide adequate storage to prevent vehicles from stacking onto the main lanes.

Exit Ramp Spillback

- Queue spillback from exit ramps is a common occurrence in urban areas, particularly at locations where inadequate storage is available.



Avoid Unsafe Situation



Graphic from Honolulu Star-Bulletin Article

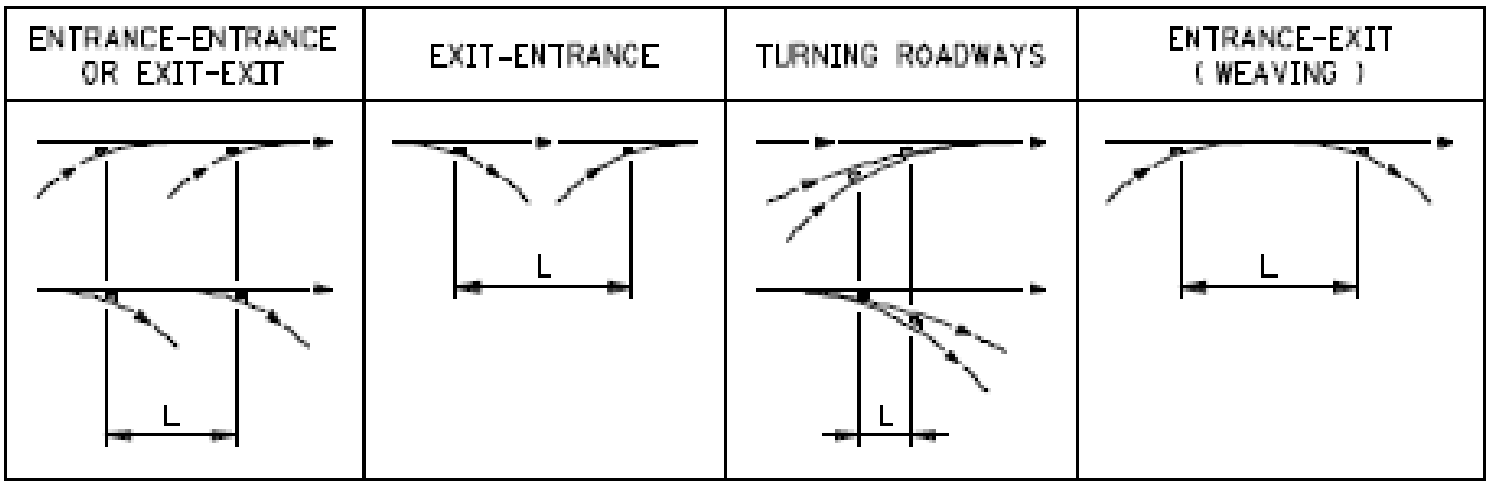
Roadway Design Manual

Table 3-16: Desirable Space Between Exit Ramps and Driveways, Side Streets, or Cross Streets

Total Volume (Frtg Rd + Ramp) (vph)	Driveway or Side Street Volume (vph)	Spacing (ft [m])		
		Number of Weaving Lanes		
		2	3	4
<2500	<250	460 [140]	460 [140]	560 [170]
-	>250	520 [160]	460 [140]	560 [170]
-	>750	790 [240]	460 [140]	560 [170]
-	>1000	1000 [300]	460 [140]	560 [170]
>2500	<250	920 [280]	460 [140]	560 [170]
-	>250	950 [290]	460 [140]	560 [170]
-	>750	1000 [300]	600 [180]	690 [210]
-	>1000	1000 [300]	1000 [300]	1000 [300]

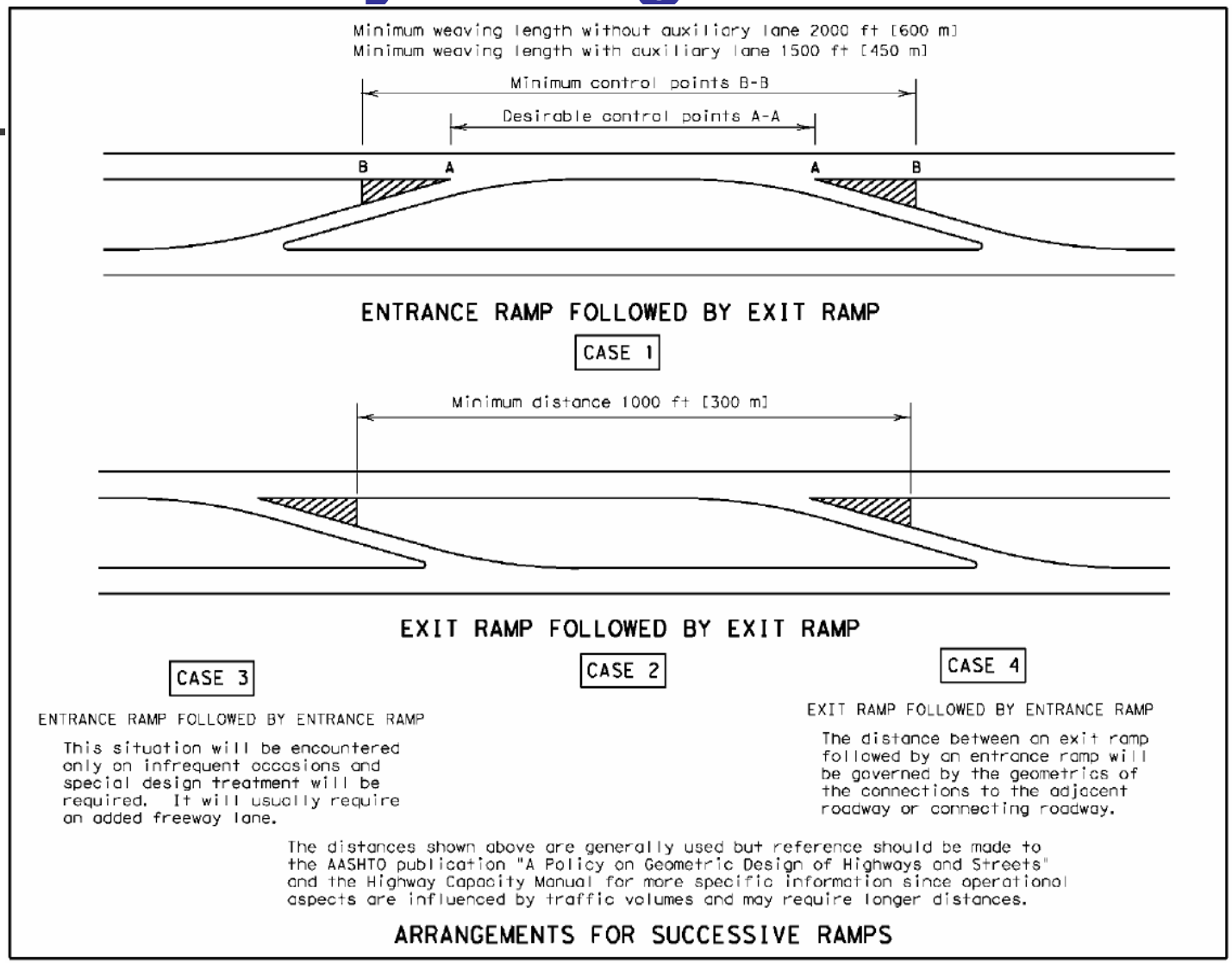
Guideline 7 - Engineering

- Provide adequate distance between successive ramps to facilitate safety and mobility.



Graphic from AASHTO Green Book

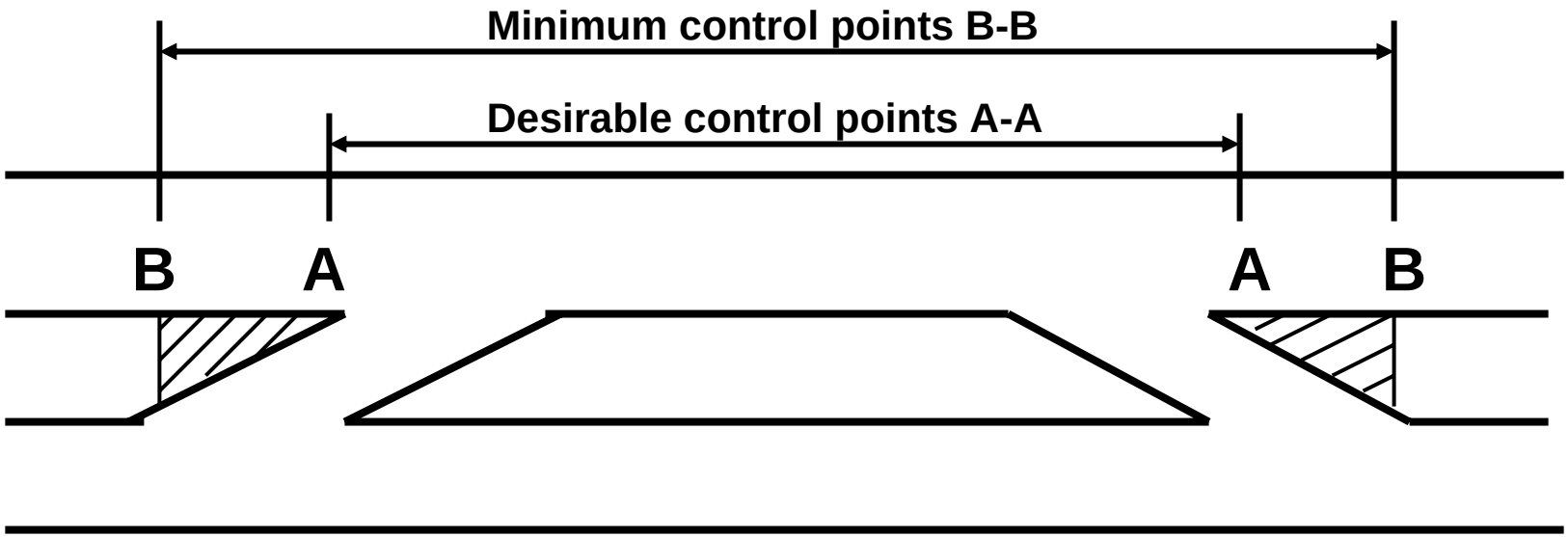
Roadway Design Manual



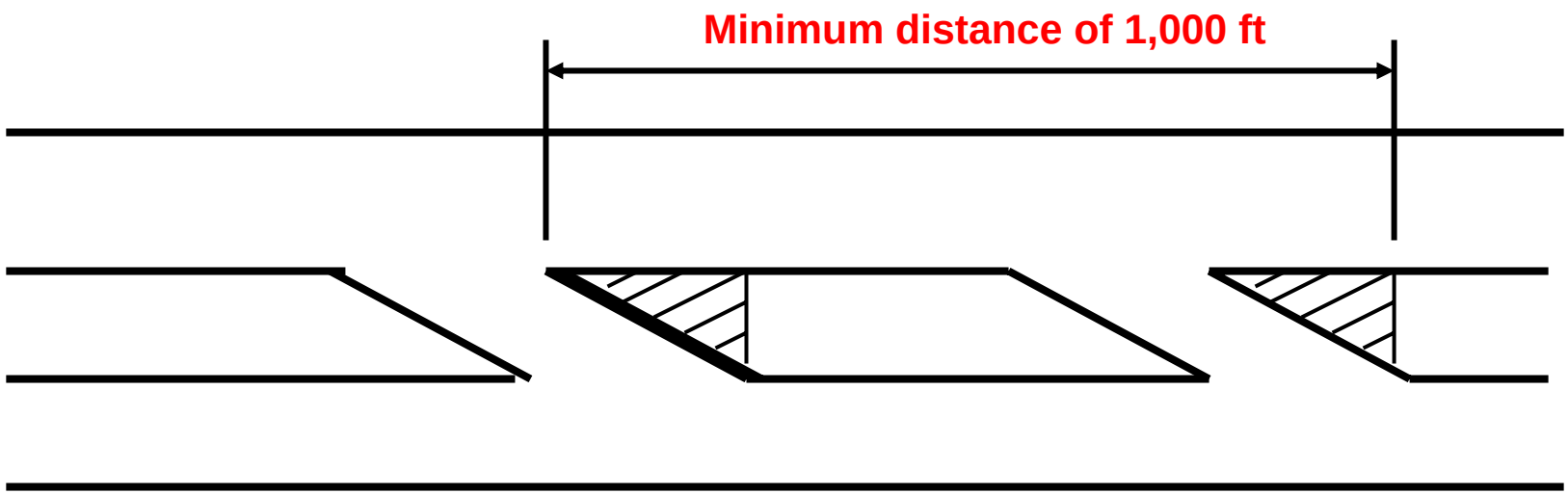
Graphic from TxDOT Roadway Design Manual, October 2005 (Figure 3-37)

Case 1: EN-EX

- Minimum weaving length without auxiliary lane 2,000 ft
- Minimum weaving length with auxiliary lane 1,500 ft

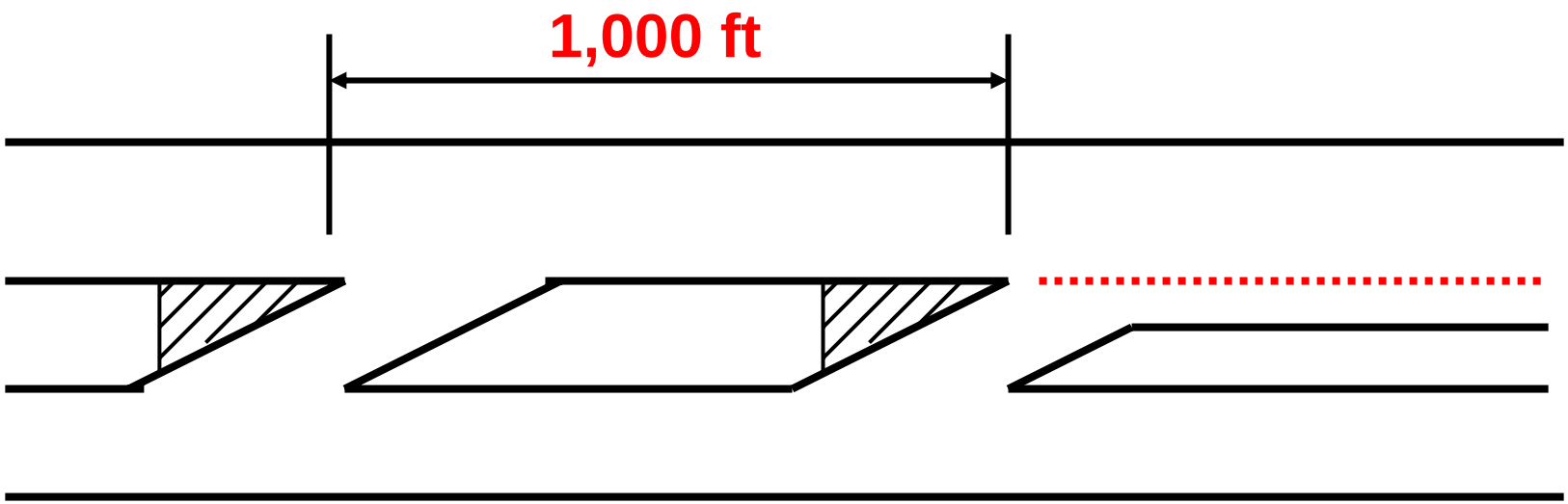


Case 2: EX-EX



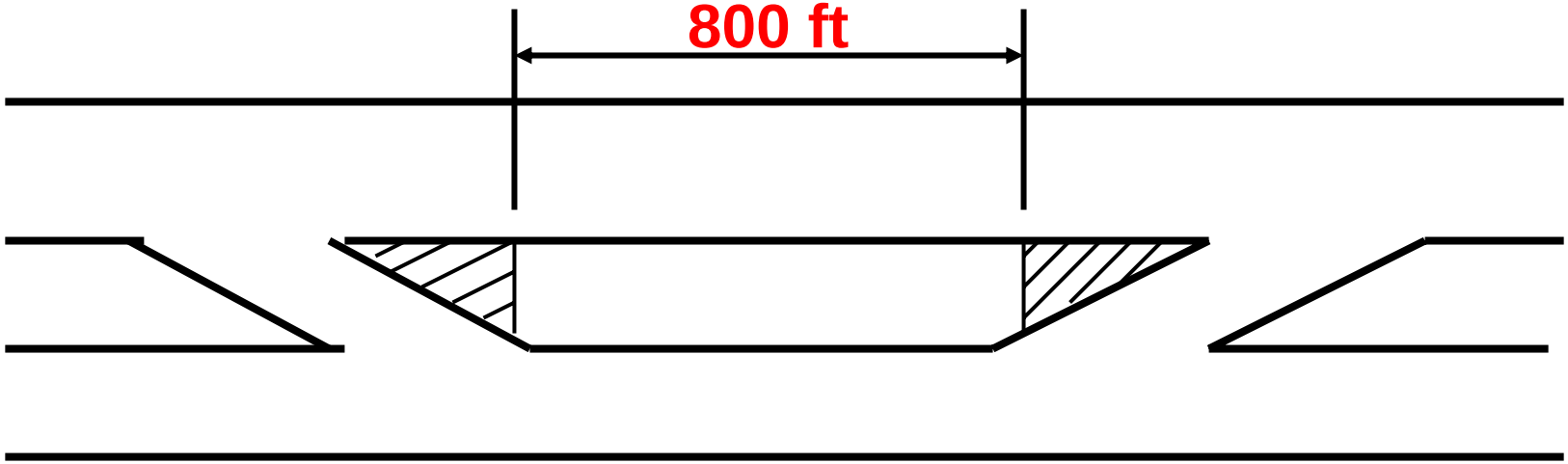
Case 3: EN-EN

This situation will be encountered only on infrequent occasions and special design treatment will be required. It will usually require an added freeway lane.



Case 4: EX-EN

The distance between an exit ramp followed by an entrance ramp will be governed by the geometrics of the connections to the adjacent roadway or connecting roadway.

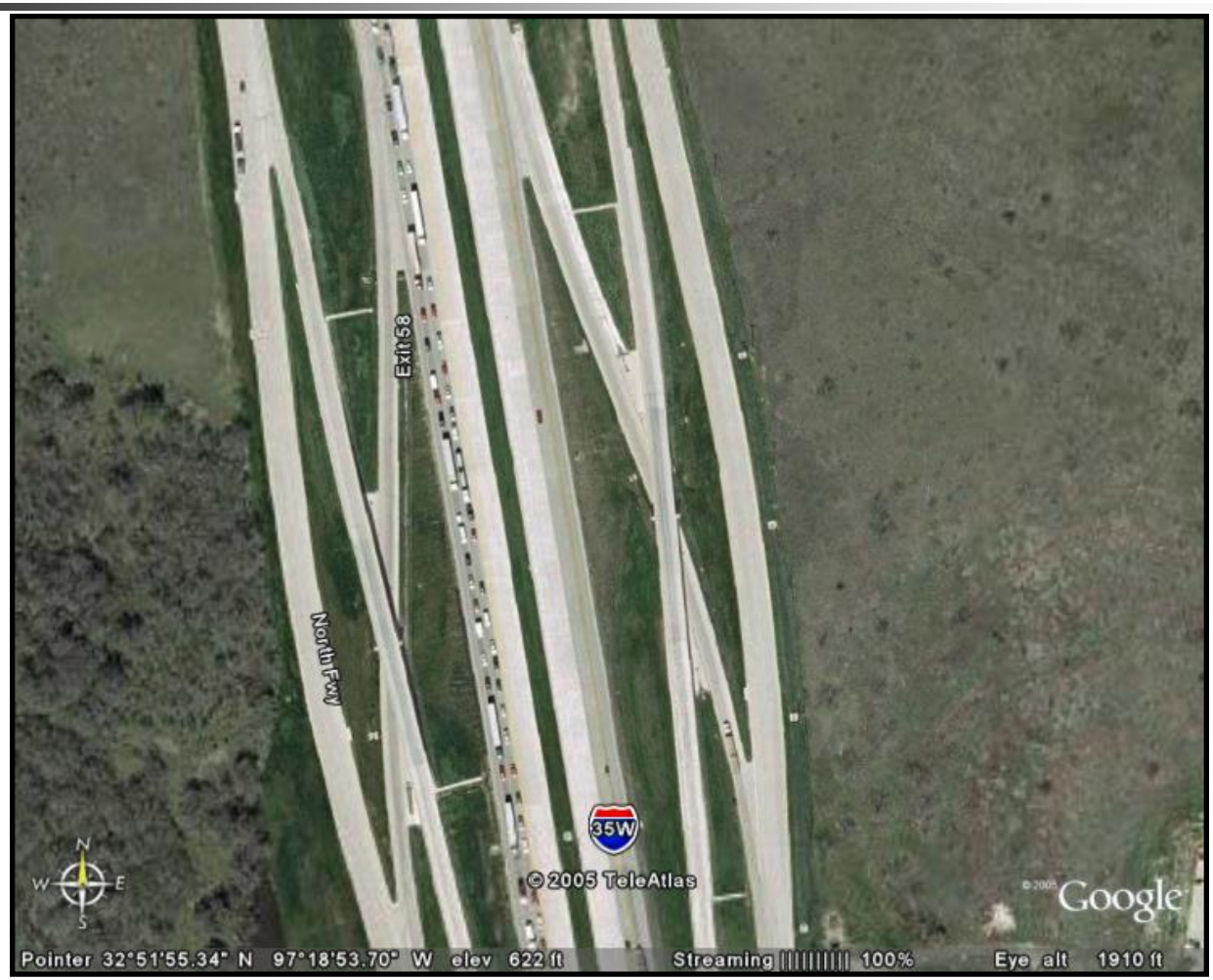


Guideline 8 - Engineering

- Consider the use of braided ramps when economic, geometric and traffic flow conditions are favorable.

Grade-separated ramps should be considered when the volume of the entrance and exit ramp pair exceeds **1,600 vphpl**.

Aerial View of Braided Ramps



Guideline 9 - Engineering

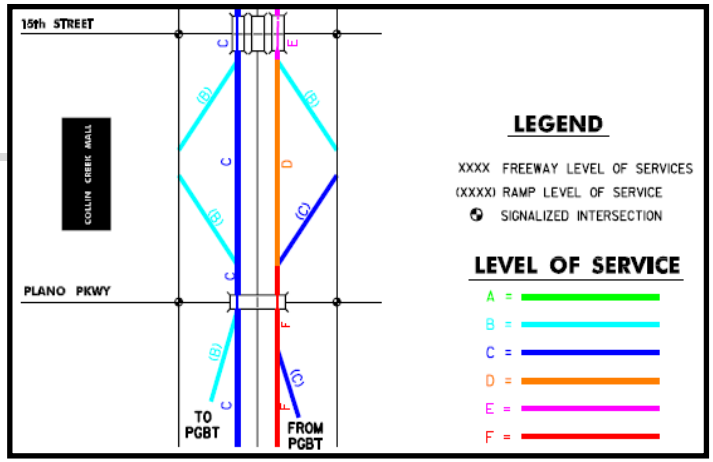
- Provide auxiliary lanes to mitigate merging impacts and provide operational continuity at strategic locations.

Guideline 10 - Engineering

- Provide adequate capacity on the frontage road to service anticipated traffic demands.

Photo Courtesy of Texas Transportation Institute

Frontage Road Operational Evaluation



Graphic from Jacobs Civil, Inc - Dallas

- Level-of-service procedures
- Not required in Interstate Access Justification report, but should be
- Avoid problems and public backlash
- Particularly important if the frontage road is **two lanes**

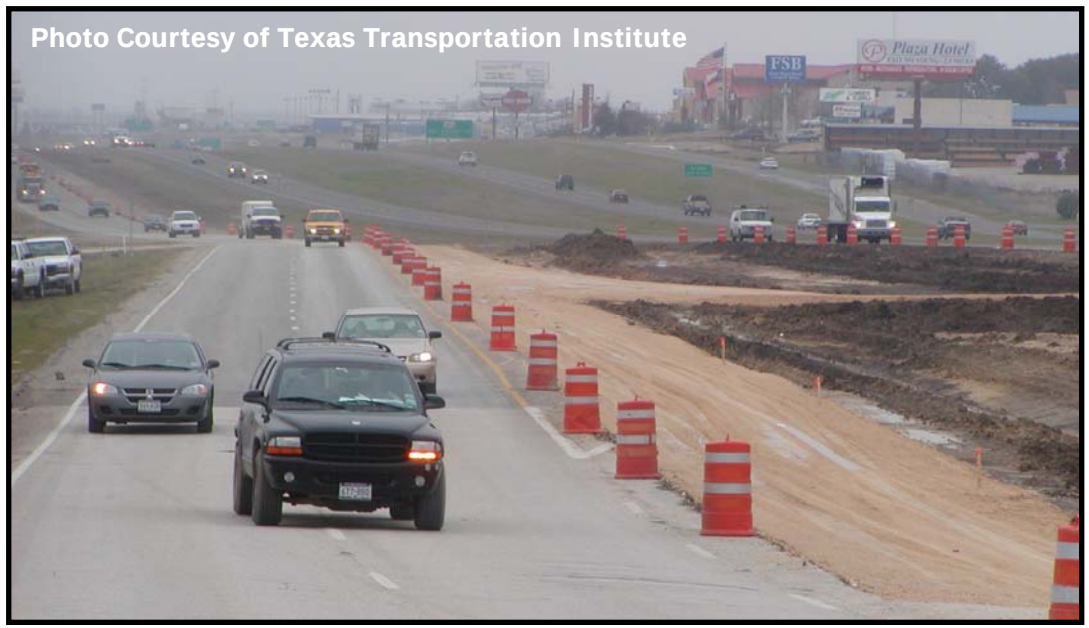
Guideline 11 - Engineering

- Adjust signalized intersection operations to account for traffic pattern changes caused by the ramp modifications.

Photo Courtesy of Texas Transportation Institute

Guideline 12 - Engineering

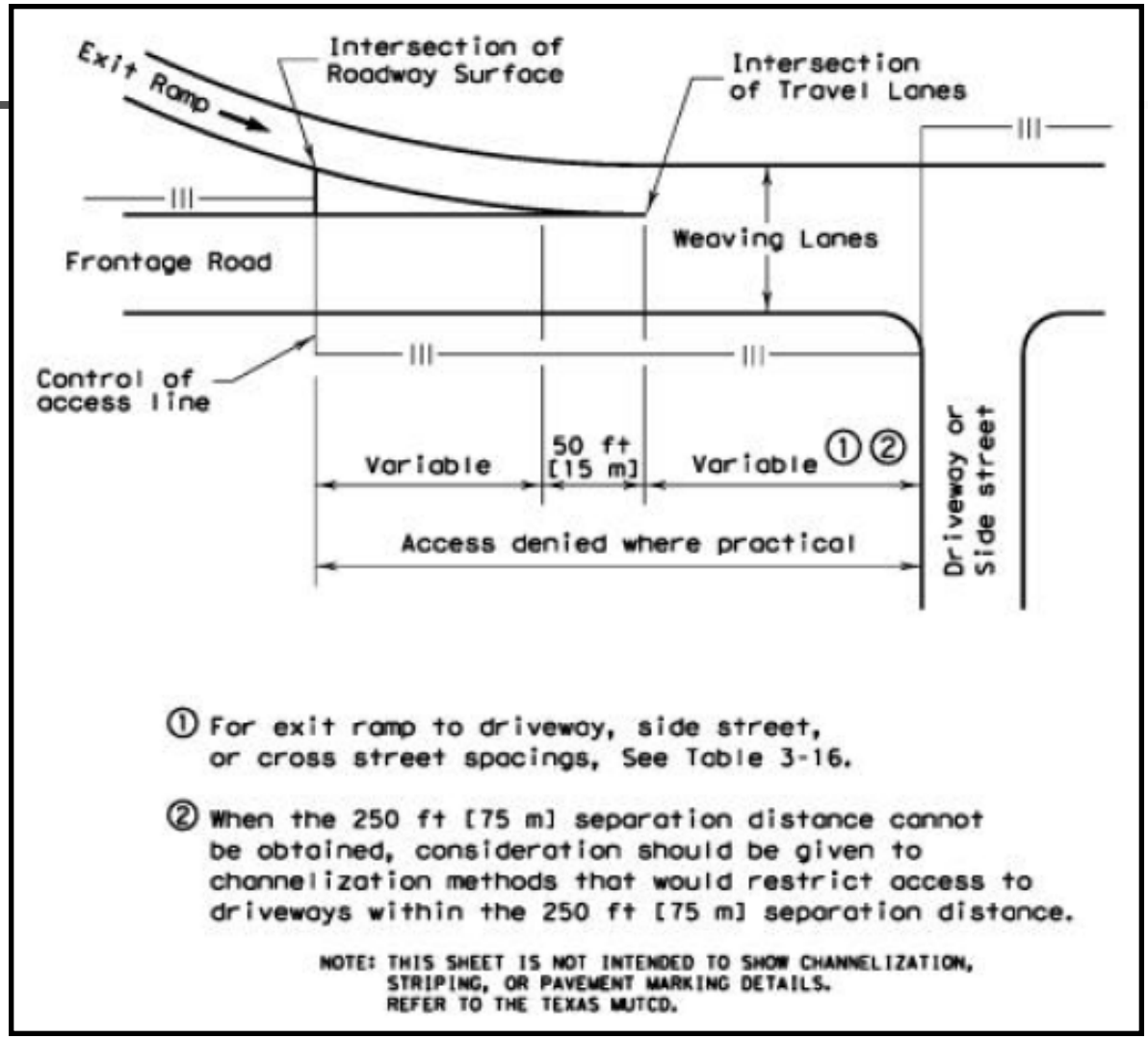
- Develop construction staging and traffic control plans to minimize the negative impacts of the ramp modification project.



Guideline 13 - Engineering

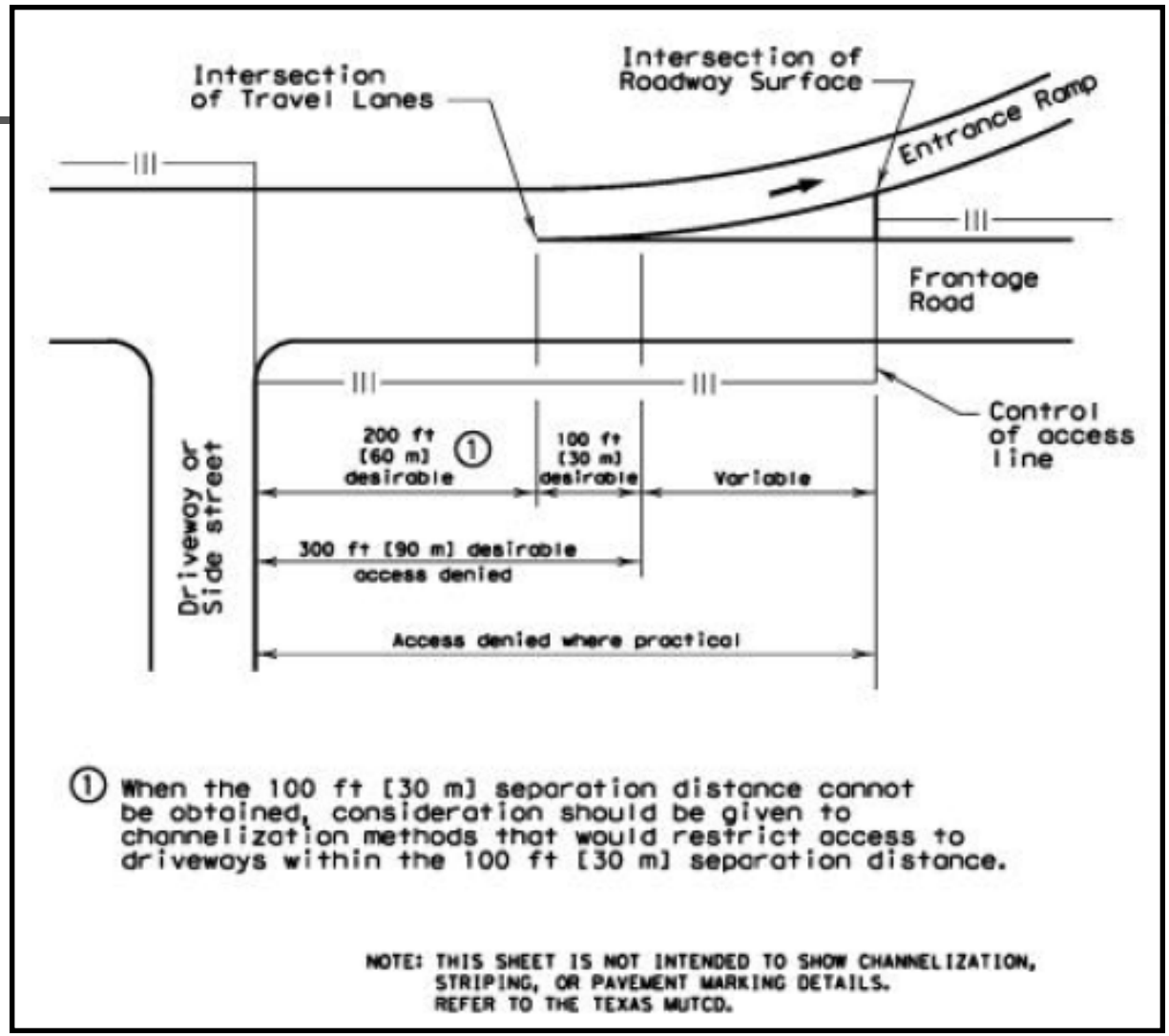
- Consider changes to frontage road driveway access to promote safe and efficient operations with the revised ramp locations.

Access Control @ Exit Ramps



Graphic from TxDOT Roadway Design Manual, October 2005 (Figure 3-13)

Access Control @ Entrances



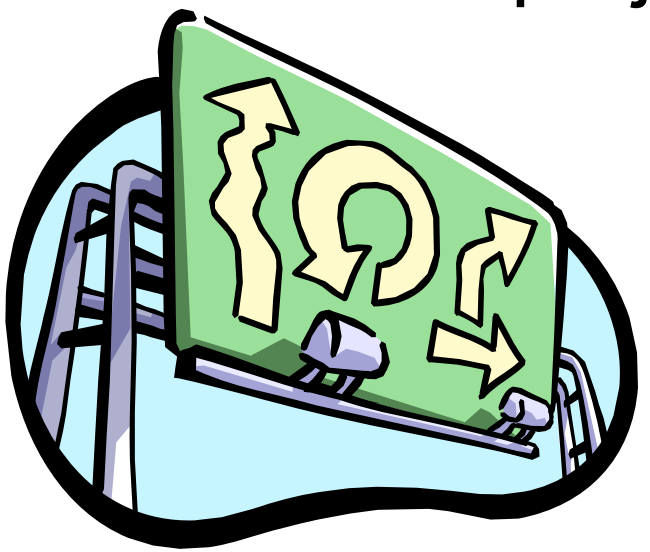
Graphic from TxDOT Roadway Design Manual, October 2005 (Figure 3-14)

Guideline 14 - Engineering

- Account for the impacts of revised ramp configuration on access to hospitals and other emergency medical facilities.

Guideline 15 - Engineering

- Make necessary revisions to guide and wayfinding signing so that motorists can react properly to the ramp modification project.



Guideline 16 - Engineering

- Ramp reversals should be considered when frontage roads are being converted from two-way to one-way operation.

Photo Courtesy of Texas Department of Transportation

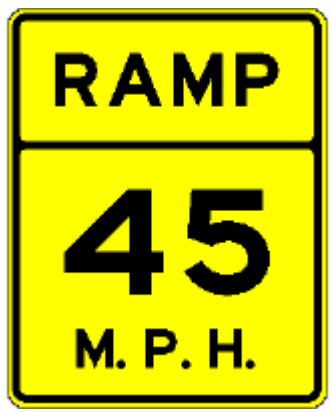
Guideline 17 - Enforcement

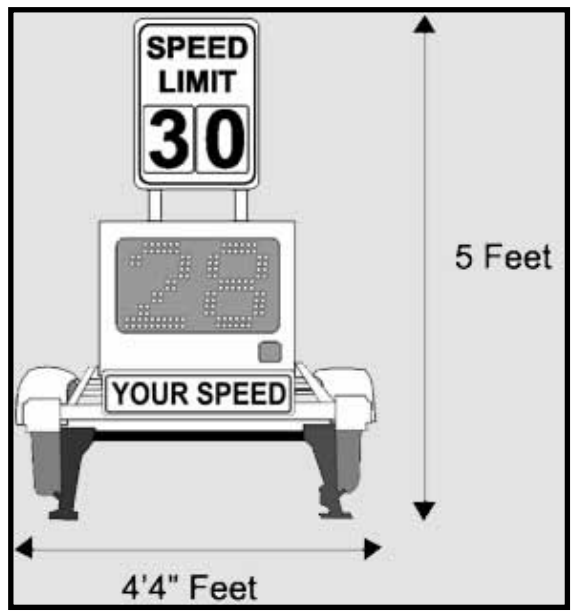
- Coordinate with law enforcement officials for speed enforcement on frontage roads following ramp modifications.

Photo Courtesy Flickr.com (public)

Guideline 18 - Enforcement

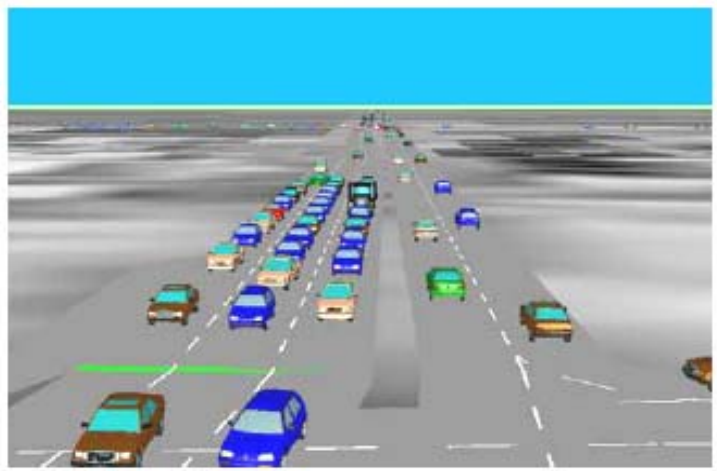
- Utilize speed trailers or other speed mitigation techniques to supplement enforcement efforts.





Guideline 19 - Evaluation

- Utilize traffic simulation models to evaluate and justify complex projects.

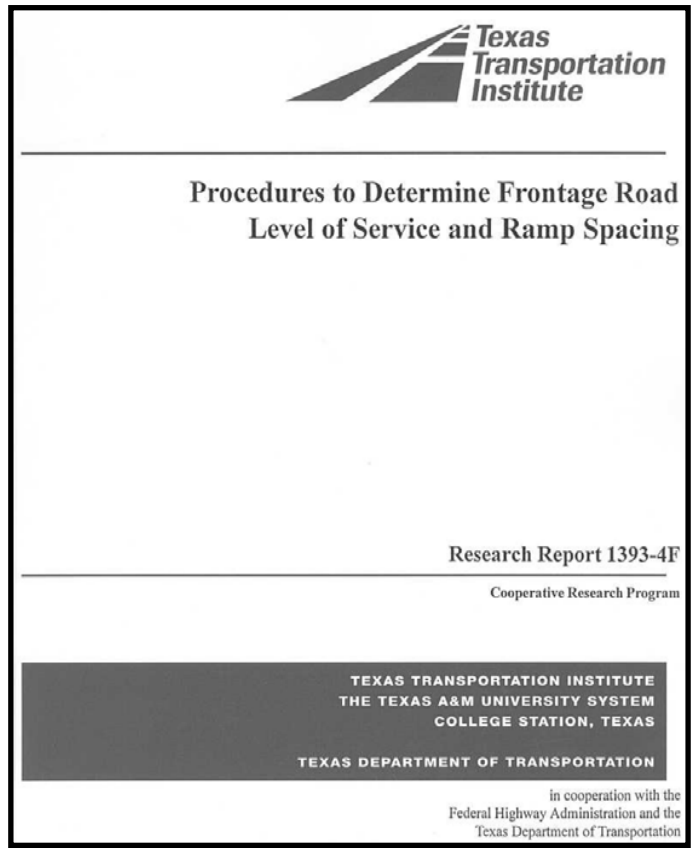


Guideline 20 - Evaluation

- For interstate projects, follow the requirements contained in Section 4 *Additional Access to the Interstate System* of the Roadway Design Manual.

Guideline 21 - Evaluation

- If evaluation studies are performed prior to project implementation, consider the operational impacts (capacity and level-of-service) on both the freeway main lanes and frontage road facilities.


Texas Transportation Institute

Procedures to Determine Frontage Road Level of Service and Ramp Spacing

Research Report 1393-4F

Cooperative Research Program

TEXAS TRANSPORTATION INSTITUTE
THE TEXAS A&M UNIVERSITY SYSTEM
COLLEGE STATION, TEXAS

TEXAS DEPARTMENT OF TRANSPORTATION

in cooperation with the
Federal Highway Administration and the
Texas Department of Transportation

WRAP-UP

How to implement a successful ramp reversal, braided ramp or X-ramp corridor project

When to Consider Reversed and X-ramp Implementation

6 scenarios:

- Locations where a significant level of existing or planned development is located along the frontage road.
- New construction of a freeway corridor in an urban or suburban setting.
- An existing freeway corridor is undergoing complete reconstruction.
- A lack of adequate spacing between the exit ramp and cross street exists that routinely causes exiting queues to back up onto the freeway main lanes.
- During conversion of frontage roads from two-way to one-way operations.
- When an evaluation study shows that ramp modifications will significant improve the overall operational performance and produce a benefit-cost ratio greater than 1.0.

Parting Message

- Overall, case studies show that the operational, safety and basic economic impacts of ramp modification projects are primarily positive in nature. Further implementation of this type of project is strongly recommended using the guidance developed in the 5105 research.

Questions?

0-5105 Project Summary Report is Online at:

ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/5105.pdf