December 12, 2024

Roadway Design Manual

Webinar 1: Overview & Chapters 1 - 15

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Learning Objectives

- Present key updates made to the Roadway Design Manual Chapters 1 – 15
- Outline manual restructure and changes
- Appendices content

Agenda

- Overall Manual Organization & Table of Contents
- Performance Based Practical Design (PBPD) (Chapter 2)
- Context Classification & Functional Classification (Chapter 3)
- Basic Design Criteria (Chapter 4)
- 4R Criteria (Chapters 5-8)
- 3R (Chapter 10)
- Intersections (Chapter 13)
- Alternative Intersection & Interchange Design (Chapter 14)
- Grade Separation & Interchanges (Chapter 15)
- Appendices (Minimums) (Appendix A & B)
- Questions?

Publication and Implementation Timeline

Texas Department of Transportation

Manual Notice 2024-1

From: *Jason Pike, P.E.*

Manual: *Roadway Design Manual*

Effective Date: *11/15/2024*

Purpose

The *Roadway Design Manual* has been revised, reorganized, and reformatted to update to the current national guidance, national standards, state-of-the-practice, recent transportation research, recent transportation policies, and new topics.

Instructions

This manual, and all revisions, applies to all transportation project development (all modes), whether developed by the department or by other entities. Due to projects that may be further along in development with current criteria, this manual, and all revisions, will be effective for all projects beginning with March 2026 Letting, and if final Schematic or 30% plans have not been approved by May 31, 2025. The Districts have the option to use these revisions prior to these dates.

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Manual Organization & Table of Contents

Manual Organization

- Follows 2018 AASHTO Green Book organization and design philosophy
- Interactive pdf
  - "eBinder" format
  - Table of Contents
  - Reference Links

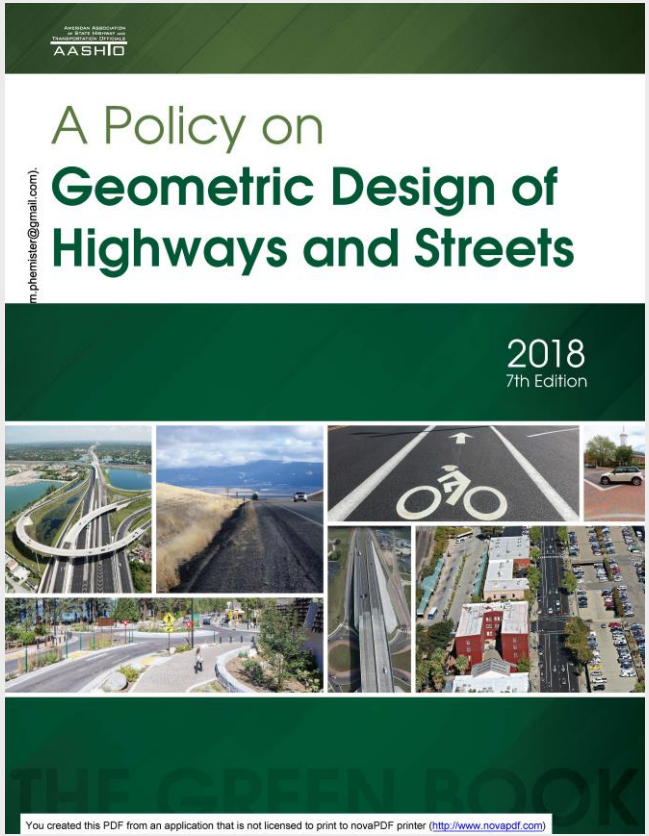

Table of Contents

- 24 Chapters of Content
- 2 Appendices
- Previous appendices are now separate chapters
- 4R: Chapters 5 – 8 by Functional Classification
  - Chapter 5: Local Roads
  - Chapter 6: Collectors
  - Chapter 7: Arterials
  - Chapter 8: Freeways

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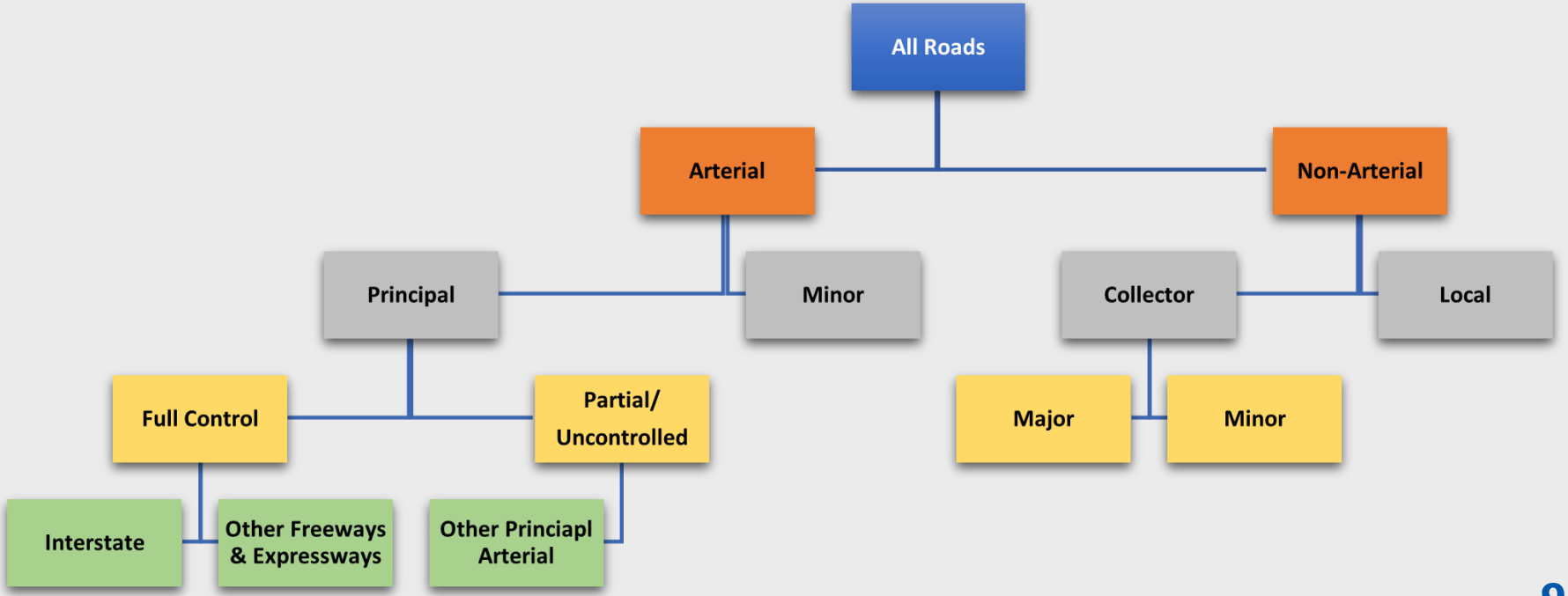
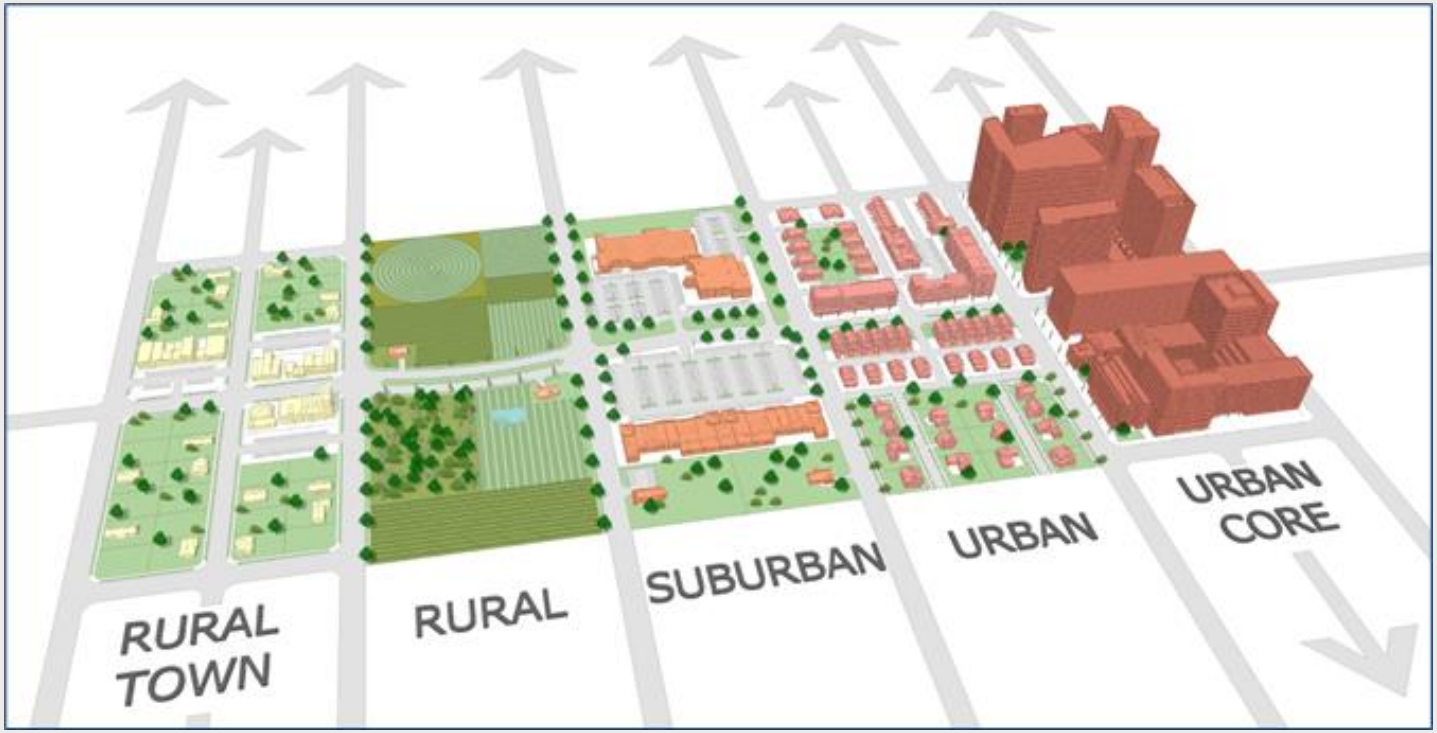
Functional Classification & Context Classification

Navigate to Chapter 3

Functional Classification



Context Classification



Rural

- Few houses or structures
- Widely dispersed residential, commercial, or industrial land uses
- Large building setbacks
- Undeveloped land, farms, large outdoor recreation areas, or low densities of other types of development
- Heavy freight use
- Intersection/driveway density ~ 1 to 10/mile

Source: Google Maps

Rural Town

- Low development densities with mixed land uses
- Average building setbacks less than 50 ft
- May include residential neighborhoods, schools, industrial facilities, and commercial main street business districts
- Some pedestrian and bicyclist activity, often with sidewalks and marked crosswalks in some locations; some on-street parking
- Light transit and moderate freight use
- Intersection/driveway density ~ greater than 30/mile

Source: Google Maps

Suburban

- Low-to medium density development
- Mixed land uses with:
  - Single-family residences
  - Some multi-family residential structures
  - Nonresidential development including
- Building setbacks are varied
- Mostly off-street parking
- Pedestrians and bicyclist activity; may or may not have sidewalks and marked crosswalks
- Little transit use and moderate freight activity
- Intersection/driveway density ~ 10 to 30/mile

Source: Gresham-Smith Partners

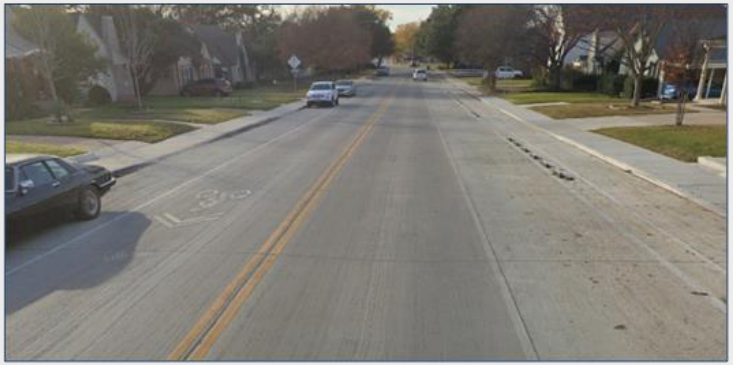
Urban

- High-density development
- Multi-story and low-to medium-rise structures for residential, commercial, parking and educational uses
- Light to heavy industrial land use
- Prominent destinations with specialized structures, (e.g., large theaters, sports facilities, or conference centers)
- Varied building setbacks
- Some on-street parking
- High levels of pedestrian and bicyclist activity, with nearly continuous sidewalks and marked crosswalks

Source: Gresham-Smith Partners

Urban Contd.

- Higher density of transit stops and routes
- Driveway densities greater than 30 driveways/mile on both sides of the road
- Minor commercial driveway densities of 10 driveways/mile or greater
- Major commercial driveways



Source: Google Maps

Urban Core

- High-density development
- Multi-story and high-rise structures for residential, commercial, and educational uses
- Small building setbacks
- On-street, time-restricted parking, or off-street in parking structures
- High pedestrian, bicycle, and transit use
- Driveway density ~ greater than 30/mile


Source: Gresham-Smith Partners

Figure 3-7: Example Roadway in Urban Core Context

Context Classification

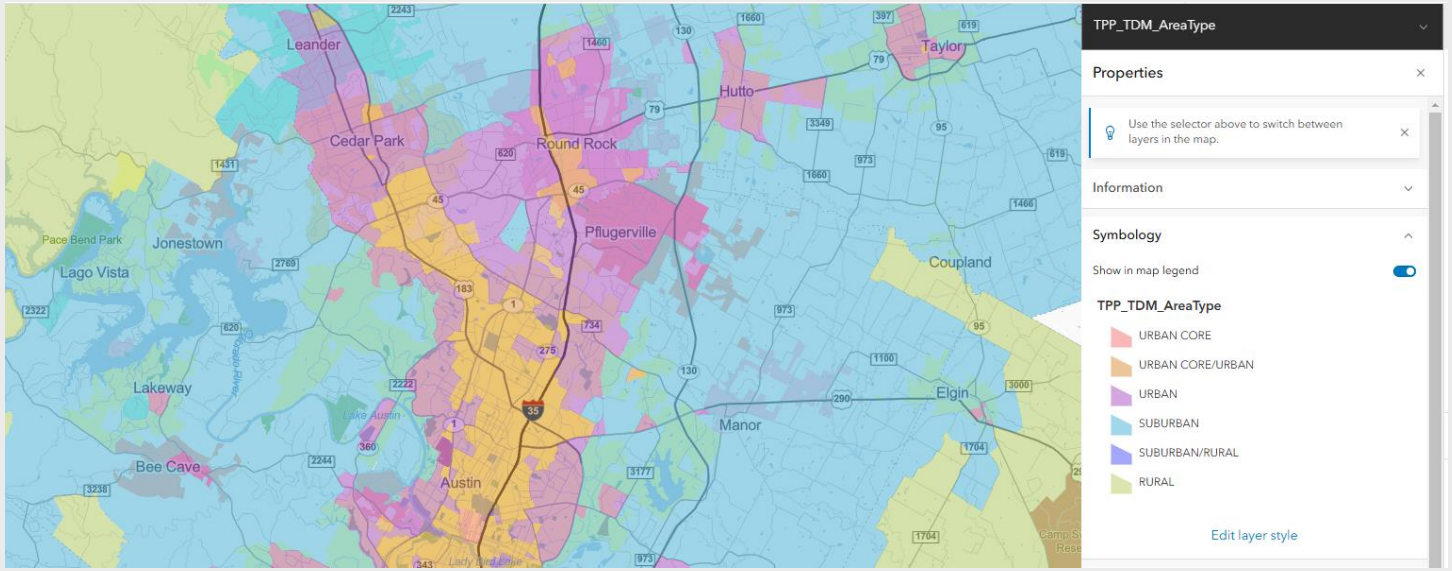
- Table 3-2 provides additional guidance on selecting the appropriate Context Classification
- Segments of the roadway may cover different Context Classifications
- Document design criteria in the DSR

Table 3-2: Context Classification Categories and the Primary Factors used to Determine the Context of Roadways.

Context Classification	Development Density	Land Use	Setbacks	Sidewalk and Parking	Transit and Freight	Intersection / Driveway Density
Rural	Lowest (few houses or other structures)	Agricultural, natural resource preservation, and outdoor recreation uses with some isolated residential and commercial	Usually large setbacks	No sidewalks or on-street parking	No transit; heavy freight	1-10/mile
Rural Town	Low to medium (single-family houses and other single purpose structures)	Primarily commercial uses along a main street with some adjacent single-family residential	Predominately small setbacks	Some on-street parking and some sidewalks	Little transit; moderate freight	>30/mile
Suburban	Low to medium (single- and multifamily structures and multistory commercial)	Mixed residential neighborhood and commercial clusters (includes town centers, commercial corridors, big box commercial and light industrial)	Predominately large setbacks	Some sidewalks and no street parking	Little transit; moderate freight	10-30/mile
Urban	High (multistory, low-rise structures with designated off-street parking)	Mixed residential and commercial uses, with some institutional, industrial, and prominent destinations	Mixed setbacks	On-street parking and sidewalks	High transit; moderate freight	>30/mile
Urban Core	Highest (multistory and high-rise structures)	Mixed commercial, residential, and institutional uses within and among predominately high-rise structures	Small setbacks	On-street parking and sidewalks and pedestrian plazas	High transit; low freight	>30/mile

TxDOT ArcGIS context tool

- TP&P Tool to assist designers with base, intermediate, and future year contexts base on the respective Travel Demand Model:



https://txdot.maps.arcgis.com/home/item.html?id=fcbdf3a8eafb4c5e961ce4d1d7310608

Road User Types


Vehicles


Bicycles


Pedestrians


Freight


Transit

Table 3-4: Context Classification Matrix and Typical User Priorities

Functional Class	Context Class				
	Rural	Rural Town	Suburban	Urban	Urban Core
Principal Arterial					
Minor Arterial					
Collector					
Local					

Low

Medium 

High 

Table 3-5: Speed, Mobility, and Access Considerations

Functional Class	Context				
	Rural	Rural Town	Suburban	Urban	Urban Core
Freeway	Speed: High Mobility: High Access: Low	N/A	Speed: High Mobility: High Access: Low	Speed: High Mobility: High Access: Low	Speed: High Mobility: High Access: Low
Arterial	Speed: High Mobility: High Access: Med	Speed: Low/Med Mobility: Med Access: High	Speed: Med Mobility: Med Access: Med	Speed: Low/Med Mobility: Med Access: Med/High	Speed: Low Mobility: Med Access: Med/High
Collector	Speed: High/Med Mobility: Med Access: Med	Speed: Low Mobility: Med Access: High	Speed: Med Mobility: Med Access: High	Speed: Low Mobility: Med Access: High	Speed: Low Mobility: Med Access: High
Local	Speed: Med Mobility: Med Access: Med	Speed: Low Mobility: Med Access: High	Speed: Low Mobility: Low Access: High	Speed: Low Mobility: Low Access: High	Speed: Low Mobility: Low Access: High

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Performance Based Practical Design (PBPD)

Navigate to Chapter 2

Performance Based Practical Design (PBPD) Overview

- Looks at system-wide performance
- Evaluates how performance is affected through selection of criteria
- Relies on quantitative analysis to guide decision-making.

Practical Design Principals

Performance Based Design Principals

Practical Design Principals

- Sound engineering judgement
- "Design Up" philosophy
- Get the project scope right
- Safer system focus

Practical Design's purpose is to "build good projects everywhere – rather than perfect projects somewhere."

- Missouri DOT 2005 Strategic Objective to Implement PD

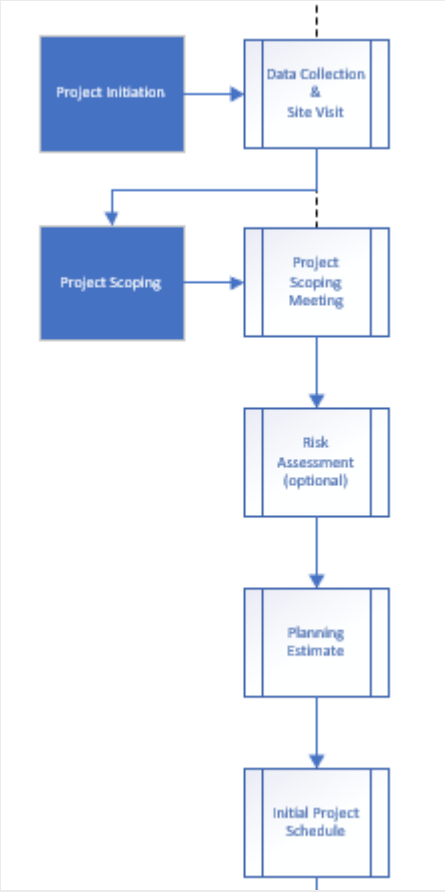
PD is not new – 3R was the first example of PD.

Practical Design

- Designers should not "design to the manual"; instead "design to the purpose and need" of a project
- Design exceptions and design waivers are strategically used and adequately supported
- All projects must be as safe, or safer, than the existing condition
- PD approach is NOT optional or elective
- Combine with Performance Based Design to develop the proper application

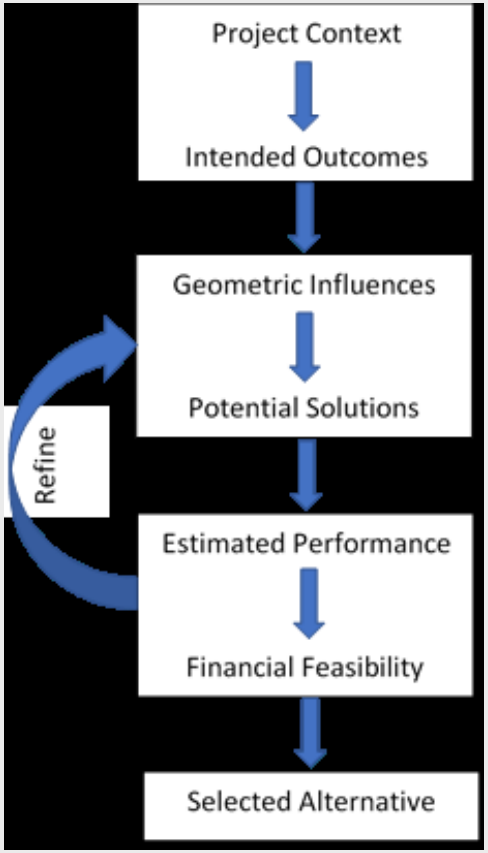
Performance Based Design Principals

- Intended outcomes
- Connection to project development process
- Performance categories
  - Quality of service
  - Safety
  - Reliability
  - Accessibility
  - Infrastructure integrity
  - Ease of use
  - Ease of maintenance
  - Visual quality
  - Fit to context and community



Performance Based Design Process

- NCHRP Report 785
- NCHRP Report 839
- Incorporate process through project development lifecycle
  - Project Initiation/Scoping
  - Project Planning
  - Preliminary Engineering
    - B/C ratio development

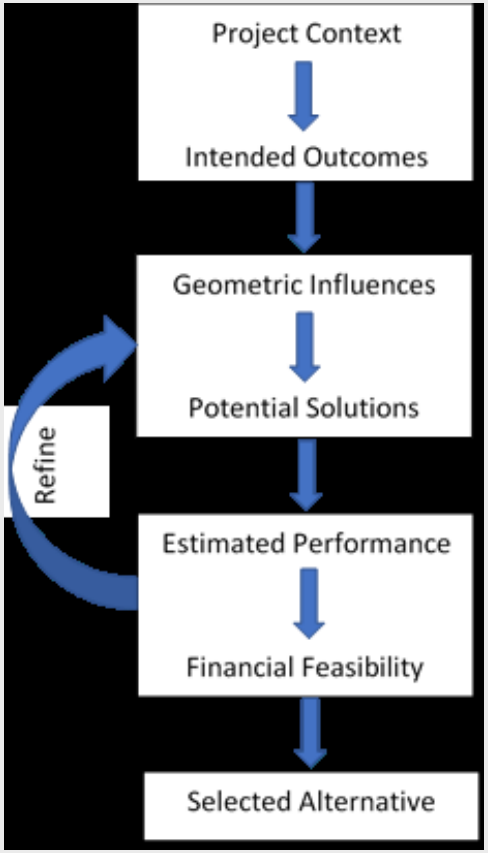


Performance Based Design Process

- Benefit Cost Ratio (for implementing improvements)

$$BC = \frac{Benefits}{Implementation\ Costs}$$

- B/C ≥ 2.0 (ideally)
- B/C between 2.0 and 1.0 require additional sensitivity analyses
- B/C < 1.0 should not be considered



PBPD is:

- Grounded in performance management
- Exercises engineering judgement to address a project's purpose and need
- Uses appropriate performance-analysis tools
- Considers both short- and long-term project and system goals

PBPD is NOT

- New version of Value Engineering (VE)
- Replacement for Context Sensitive Solutions (CSS)
- Opportunity to disregard long-term needs
- Compromise on safety or user needs to save money

Training on the application of PBPD is being developed.

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Basic Design Criteria

Navigate to Chapter 4

Speed

- Speed is one of the most important factors considered by travelers in selecting alternative routes or transportation modes. In addition to capabilities of the drivers and their vehicles, the speed of vehicles on a road depends upon five general conditions:
  - Physical characteristics of the roadway
  - The amount of roadside interference
  - Weather
  - Presence of other vehicles
  - Speed limitations established by law or by traffic control devices.

Target → Design → Operating → Posted

- Target Speed:
  - The operating speed that the designer intends for drivers to use
  - Target speed for rural contexts should be on the higher end
  - Target speed for urban contexts should be on the lower end
  - Target speeds shown in 4R criteria should guide the selection of the proposed Design speed
- Design Speed:
  - A selected speed used to determine the various geometric design features of the roadway
  - **Design speed should be as close to operating speed as possible**
  - A low design speed should not be selected where drivers are likely to travel at high speeds

Target → Design → Operating → Posted

- Operating Speed:
  - The speed at which drivers are observed operating their vehicles during free-flow conditions
  - 85th percentile
- Posted Speed:
  - The maximum speed limit posted on a section of highway

Superelevation Methods & Updates

- **Table 4-3** added to provide a summary of scenarios for the use of Method 2 and Method 5
- Intermediate speed designation
- Flexibility in choosing methodology

	Low-Speed (≤ 45 mph)	Intermediate-Speed (50 – 60 mph)	High-Speed (65 mph and greater)
Urban All Functional Classifications (Excluding Freeway Mainlanes, Ramps and Direct Connectors)	Method 2 Table 4-4	Method 5 4%, 6% or 8% emax Table 4-5, Table 4-6 or Table 4-7	Method 5 6% or 8% emax Table 4-6 or Table 4-7
Rural All Functional Classifications	Method 5 6% or 8% emax Table 4-6, or Table 4-7		
Urban or Rural Freeway Mainlanes, Ramps, and Direct Connectors	Method 5 6% or 8% emax Table 4-6 or Table 4-7		
Urban Frontage Roads	Method 2 Table 4-4	Method 5 4%, 6% or 8% emax Table 4-5, Table 4-6 or Table 4-7	Method 5 6% or 8% emax Table 4-6 or Table 4-7
Rural Frontage Roads	Method 5 6% or 8% emax Table 4-6 or Table 4-7		
Urban Ramps for Grade Separations on Non-Access Controlled Facilities	Method 2 Table 4 4	Method 5 4%, 6% or 8% emax Table 4-5, Table 4-6 or Table 4-7	Method 5 6% or 8% emax Table 4-6 or Table 4-7
Rural Ramps for Grade Separations on Non-Access Controlled Facilities	Method 5 6% or 8% emax Table 4 6 or Table 4 7		
Roundabouts and Alternative Intersections (Including Approaches)[2]	Method 2 Table 4-4	Method 5 4%, 6% or 8% emax Table 4-5, Table 4-6 or Table 4-7	N/A
Temporary Traffic Control[3]	Method 2 expanded Table 23-1		
Low-Volume Off-System Bridges (approach roadway)	Meet or improve conditions that are typical on the remainder of the roadway.		

Superelevation Methods & Updates

- Emax = 4% is a new table (Table 4-5)

Table 4-5: Minimum Radii and Superelevation Rates[1] for High-Speed Suburban and Urban Non-Freeway Facilties, e_{max} = 4%[1, 2] (Method 5)

e (%)	Design Speed									
	15 mph R(ft)	20 mph R(ft)	25 mph R(ft)	30 mph R(ft)	35 mph R(ft)	40 mph R(ft)	45 mph R(ft)	50 mph R(ft)	55 mph R(ft)	60 mph R(ft)
NC[3,5]	See Table 4-4 (Method 2)							7,220	8,650	10,300
RC[4,5]								4,940	5,950	7,080
2.2								4,280	5,180	6,190
2.4								3,690	4,500	5,410
2.6								3,130	3,870	4,700
2.8								2,660	3,310	4,060
3.0								2,290	2,860	3,530
3.2								1,980	2,490	3,090
3.4								1,720	2,170	2,700
3.6								1,480	1,880	2,350
3.8								1,260	1,600	2,010
4.0								926	1,190	1,500

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4R Criteria

Navigate to Chapters 5-8

Overview

The design criteria tables in the RDM will provide target or desirable values as a function of context and roadway functional classification. The minimum values will be provided in the respective Appendices:

- Appendix A – Design Exceptions
- Appendix B – Design Waivers

4R Criteria Tables

- Design Element and Target Values
  - For each Context Classification
- Star = Design Exception needed
- Flag = Design Waiver needed
- Reference column for additional discussion

	Design Element	Rural	Rural Town	Suburban	Urban	Urban Core	Reference
Roadway	★ Design Speed [1]	40 to 50 MPH	25 to 30 MPH	40 MPH	25 to 30 MPH	20 to 25 MPH	See 5.1.3
	★ Lane Width	12-ft	11 to 12-ft	12-ft	11-ft	11-ft	See 5.1.6
	★ Shoulder Width (Uncurbed)	8-ft	4-ft	10-ft	8-ft	2-ft	See 5.1.7
	Offset to Face of Curb	N/A	1-ft	2-ft	2-ft	2-ft	See 4.10.12
	Curb Parking Lane Width[2]	N/A	9-ft	N/A	9-ft	9-ft	See 4.10.16
	Bike Lane Width	See 18.4					
	Speed Change Lane Width	12-ft	11 to 12-ft	12-ft	11-ft	11-ft	See 4.10.2
	Median Width	See 4.10.15					
	★ Horizontal Curve Radius (Minimum)	See 4.7					
	★ Cross Slope on a Tangent	2%					See 4.10.4
	★ Cross Slope on a Tangent (Maximum)	3%					See 4.10.4
	★ Superelevation Rate	See Table 4-3 through Table 4-7					See 4.7.3
	Minimum Grade (PGL)	0.25% (lined ditch channels), 0.3% (curbed facilities), or 0.5% (unpaved ditches)					See 4.8.1

Table 5-1: Target Design Values for Local Roads

5.1 Local Roads

		Design Element	Rural	Rural Town	Suburban	Urban	Urban Core	Reference
Roadway	★	Design Speed [1]	40 to 50 MPH	25 to 30 MPH	40 MPH	25 to 30 MPH	20 to 25 MPH	See 5.1.3
	★	Lane Width	12-ft	11 to 12-ft	12-ft	11-ft	11-ft	See 5.1.6
	★	Shoulder Width (Uncurbed)	8-ft	4-ft	10-ft	8-ft	2-ft	See 5.1.7
	⚑	Offset to Face of Curb	N/A	1-ft	2-ft	2-ft	2-ft	See 4.10.12
	⚑	Curb Parking Lane Width[2]	N/A	9-ft	N/A	9-ft	9-ft	See 4.10.16
	⚑	Bike Lane Width			See 18.4			
	⚑	Speed Change Lane Width	12-ft	11 to 12-ft	12-ft	11-ft	11-ft	See 4.10.2
	⚑	Median Width			See 4.10.15			
	★	Horizontal Curve Radius (Minimum)			See 4.7			
	★	Cross Slope on a Tangent			2%			See 4.10.4
	★	Cross Slope on a Tangent (Maximum)			3%			See 4.10.4
	★	Superelevation Rate	See Table 4-3 through Table 4-7					See 4.7.3
		Minimum Grade (PGL)	0.25% (lined ditch channels), 0.3% (curbed facilities), or 0.5% (unpaved ditches)					See 4.8.1

Star = Design Exception needed, Flag = Design Waiver needed, Reference for additional discussion

6.1 Collectors

		Design Element	Rural	Rural Town	Suburban	Urban	Urban Core	Reference
Roadway	★	Design Speed[1]	50 to 70 MPH	35 to 40 MPH	45 to 55 MPH	35 to 40 MPH	25 to 30 MPH	See 6.1.3
	★	Travel Lane Width	12-ft	11 to 12-ft	12-ft	11-ft	11-ft	See 6.1.6
	★	Shoulder Width (Uncurbed)[2]	10-ft[2]	3 to 8-ft[2]	8-ft[2]	3 to 8-ft[2]	3 to 8-ft[2]	See 6.1.7
	⚑	Offset to Face of Curb	See 4.10.12	2-ft	See 4.10.12	2-ft	2-ft	See 4.10.12
	⚑	Curb Parking Lane Width[5]	N/A	10-ft	N/A	10-ft	10-ft	See 4.10.16
	⚑	Bike Lane Width	N/A	5-ft	N/A	5-ft	5-ft	See 18.4
	⚑	Speed Change Lane Width	12-ft	12-ft	12-ft	11-ft	11-ft	See 4.10.2
	⚑	Median Width			See 4.10.15			

		Design Element	Rural	Rural Town	Suburban	Urban	Urban Core	Reference
Roadside	★	Horizontal Curve Radius	See 4.7					
	★	Cross Slope on a Tangent	2%					See 4.10.4
	★	Cross Slope on a Tangent (Maximum)	3%					See 4.10.4
	★	Superelevation Rate	See Table 4-3 through Table 4-7					See 4.7.3
		Minimum Grade (PGL)	0.25%(lined ditch channels), 0.3% (curbed facilities), or 0.5%(unpaved ditches)					See 4.8.1
	★	Maximum Grade (Level)	4%	8%	6%	8%	9%	See 4.8.1
	★	Maximum Grade (Rolling)	5%	9%	7%	9%	11%	See 4.8.1
	★	Vertical Clearance at New Structures[3]			16.5-ft[3]			See 4.8.6

Table 6-1: Target Design Values for Collectors

Star = Design Exception needed, Flag = Design Waiver needed, Reference for additional discussion

7.1 Arterials

		Design Element	Rural	Rural Town	Suburban	Urban	Urban Core	Reference
Roadway	★	Design Speed[1]	70 MPH	40 to 45 MPH	50 to 60 MPH	40 to 45 MPH	30 to 35 MPH	See 7.1.3
	★	Travel Lane Width	12-ft	11 to 12-ft	12-ft	11-ft	11-ft	See 7.1.6
	★	Shoulder Width (Uncurbed)[2]	10-ft[2]	4 to 10-ft[2]	8 to 10-ft[2]	4 to 10-ft[2]	4 to 10-ft[2]	See 7.1.7
	⚑	Offset to Face of Curb			2-ft			See 4.10.12
	⚑	Curb Parking Lane Width[5]	N/A	10-ft	N/A	10-ft	10-ft	See 4.10.16
	⚑	On-Street Bike Lane Width	N/A	5-ft	5-ft	5-ft	5-ft	See 18.4.5
	⚑	Speed Change Lane Width	12-ft	12-ft	12-ft	11-ft	11-ft	See 4.10.2
	⚑	Median Width	See 4.10.15					
	★	Horizontal Curve Radius	See 4.7					
	★	Cross Slope on a Tangent	2%					See 4.10.4
	★	Cross Slope on a Tangent (Maximum)	3%					See 4.10.4
	★	Superelevation Rate	See Table 4-3 through Table 4-7					See 4.7.3

Star = Design Exception needed, Flag = Design Waiver needed, Reference for additional discussion

8.1 Freeways

- Ramps no longer in Freeways section. Now in **Chapter 15 – Grade Separations and Interchanges**
- Expanded guidance on collector-distributors and managed lanes

		Design Element	Rural	Suburban	Urban	Urban Core	Reference
Roadway	★	Design Speed[1]	75 MPH	70 MPH	65 MPH	60 MPH	See 8.1.3
	★	Lane Width	12-ft				See 8.1.6
	★	Inside Shoulder Width (4-Lane Divided)	8-ft				See 8.1.7
	★	Inside Shoulder Width (6-Lane or More Divided)	12-ft				See 8.1.7
	★	Outside Shoulder Width	12-ft				See 8.1.7
		Speed Change Lane					
		- Lane Width	12-ft				See 8.1.8
		- Shoulder Width	10-ft				See 8.1.8
		Median Width	Varies				See 4.10.15 and 8.1.9
	★	Horizontal Curve Radius (Minimum)	See 4.7				
	★	Cross Slope on a Tangent (Typical)	2%				See 4.10.4
	★	Cross Slope on a Tangent (Maximum)	3%				See 4.10.4
	★	Superelevation Rate (Maximum)	See Table 4-3, Table 4-6, and Table 4-7				See 4.7.3

Examples

- Urban Arterial

	Design Element	Rural			Urban	Urban Core	Reference
★	Design Speed[1]	70 MPH			40 to 45 MPH	30 to 35 MPH	See 7.1.3
★	Travel Lane Width	12-ft	11 to 12-ft	12-ft	11-ft	11-ft	See 7.1.6
★	Shoulder Width (Uncurbed)[2]	10-ft[2]	4 to 10-ft[2]			10-ft[2]	See 7.1.7

7.1.7.3 Rural Town, Urban and Urban Core
Rural town, urban, and urban core contexts will typically use curbs and maintain curb offsets instead of shoulders due to the lower operating speeds. See Chapter 4, Section 4.10.12 for curb offset requirements and additional information on curbs.

For uncurbed roadways, shoulder widths may vary from 4 to 10-ft. Uncurbed arterials on the Texas Highway Freight Network (THFN) should provide at least 8 ft outside shoulders for these contexts.

7.1.6.3 Suburban, Urban and Urban Core
Suburban, urban, and urban core arterials will commonly use 11-ft lanes on facilities with lower target speeds as a traffic calming measure (i.e., 45 mph or less). If the anticipated target speed is 50 mph or greater and/or truck volumes are significant (>10%), 12-ft lanes should be used.

Lane widths may be reduced to 10-ft if the conditions described in 7.1.6.2 are met.

7.1.3 Design Speed
The design speed for arterials can vary greatly between the five contexts. The design speed should reflect the anticipated target speed during non-peak hours. However, the design speed should not exceed the limits of prudent construction, right-of-way, and socioeconomic costs. Minimum design speeds for arterials are

7.1.3.4 Urban and Urban Core
Urban core arterials generally have des
speeds of 35 mph or less while urban a
typically have design speeds ranging fr
45 mph.

7.1.4 Design Traffic Volumes
Arterial roadways for all contexts shoul
designed to accommodate traffic proje

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3R

Navigate to Chapter 10

Freeways & Interstates

- **Section 10.1.2**
  - In 2022, FHWA allowed for 3R design criteria on freeways **including Interstates**
  - Geared towards more PBPD approach for 3R projects
  - Freeways follow the same 3R principles and analysis as other 3R projects
  - Design exception or wavier needed if 4R freeway criteria is not met
  - Benefit-cost evaluation serves as the basis for design exceptions or waivers

NCHRP Report 876

- *Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing , and Rehabilitation Projects (3R) (Published 2021)*
- Presents a rational approach for estimating the cost-effectiveness of including safety and operational improvements in a 3R project
- Intended to replace *TRB Report 214*
- PBPD approach provides the basis for determining design improvements that should be incorporated into 3R projects

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP RESEARCH REPORT 876

Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects

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Subscriber Categories
Design

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TRANSPORTATION RESEARCH BOARD
2021

NCHRP Project 15-50

- Companion to NCHRP 876 and web-based 244
- Developed cost-benefit analysis equations for the most common design improvements applied to 3R projects
- These guidelines are accompanied by two spreadsheet tools
  - Tool 1 for analyzing a single design alternative
  - Tool 2 for comparing several alternatives or combinations of alternatives

Roadway Tradeoff Guidance & Cross Section Optimization

Guidance based on TTI Report 0-7035-R1 and 0-7136-R1

These alternative cross sections include:

Providing a four-lane undivided a:	Converting a two-lane section into a:
• 4-ft median buffer; • two-way left turn lane (TWLTL)	• Super 2 • Super 2 with a two-way left turn lane (TWLTL)

Table 10-1: Guidelines for Selecting Rural Cross-Sections

AADT	Driveway Activity Index per Mile	Truck Percentage	Preferred Cross Section
< 3,000	Any	Any	Two-Lane Undivided/ Two Lanes with TWLTL
3,000 – 15,000	< 30	Any	Super 2
	> 30	< 15%	Super 2 with TWLTL
		15 – 25%	Super 2 with TWLTL
		> 25%	Four Lanes with TWLTL
15,000 – 20,000	< 30	< 15%	Four Lanes with 4-ft Median Buffer[b]
		15 – 25%	Four Lanes with 4-ft Median Buffer[b]
		> 25%	Four Lanes with TWLTL
	> 30	< 15%	Four Lanes with 4–ft Median Buffer[b]
		15 – 25%	Four Lanes with TWLTL
		> 25%	Four Lanes with TWLTL
> 20,000	Any	Any	Four Lanes with TWLTL/ Four-Lane Divided

Notes:

a. Driveway activity index is the number of residential driveways. The index is equal to three times the number of industrial driveways, or 12 times the number of commercial driveways (measured per mile).
b. 6-ft minimum shoulder width. Greater widths are desirable.

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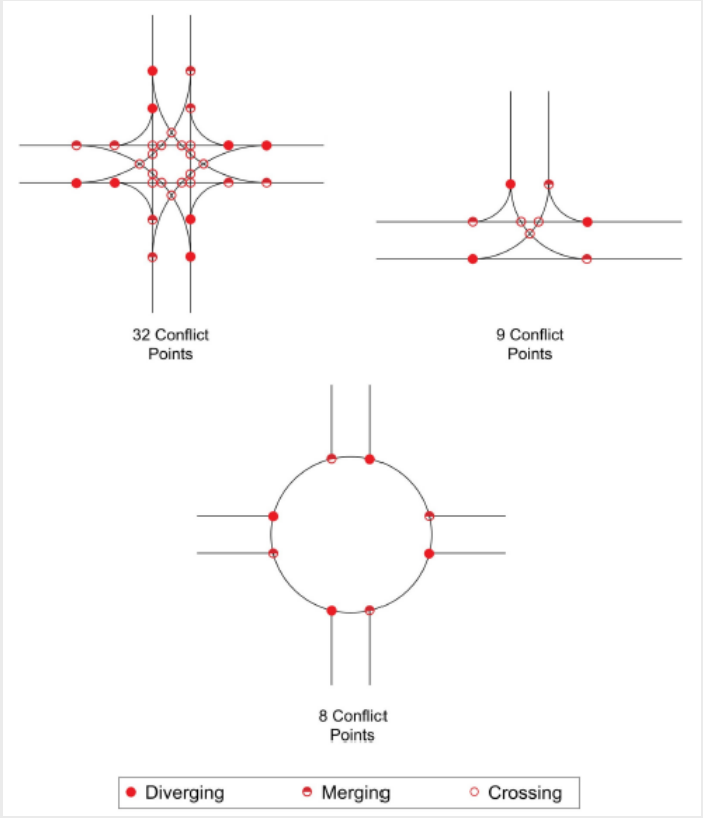
Intersections

Navigate to Chapter 13

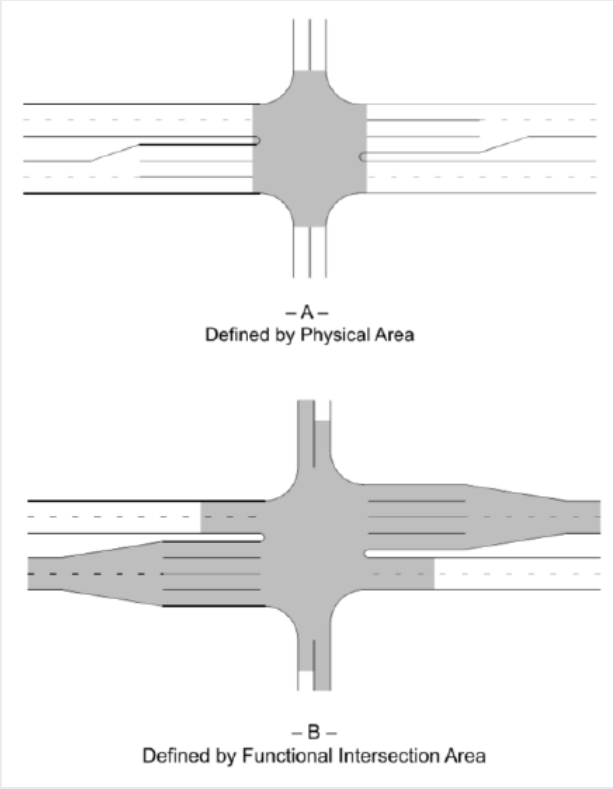
Significant Updates & New Information

- Design Considerations
  - Provide for all modes of travel
    - Automobile
    - Bicycle
    - Pedestrian
    - Truck
    - Transit
  - Conflict points
- Railroad Highway Grade Crossings



Significant Updates & New Information

- Design Considerations
  - Physical vs. Functional Area
  - Functional area components
    - Perception-reaction distance
    - Deceleration distance
    - Storage length
  - Driveways should not be situated within the functional area of an intersection

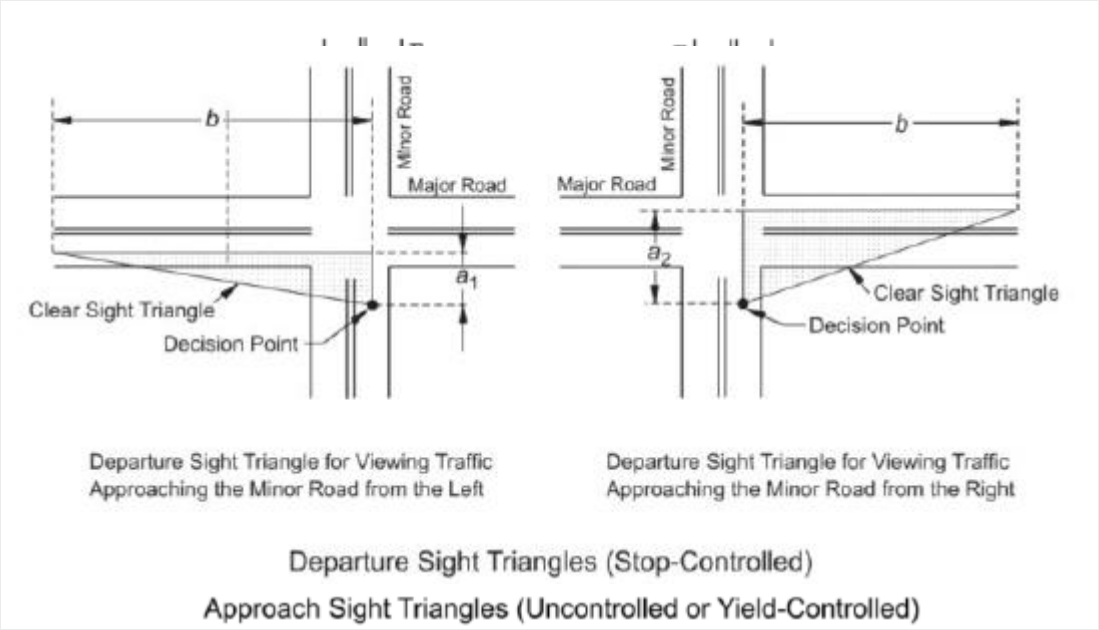


Significant Updates & New Information

- Design Considerations
  - Intersection User Groups

Significant Updates & New Information

- Intersection Sight Distance
  - Approach Sight Triangles
  - Departure Sight Triangles
  - Criteria for Intersection Control Cases A through G.



Significant Updates & New Information

- Intersection Sight Distance
  - Equation

$$b = 1.47 V_{major} t_g$$

  - Adjustment factors in **Table 13-1** for approach grade

U.S. Customary														
Approach Grade (%)	Design Speed (mph)													
	15	20	25	30	35	40	45	50	55	60	65	70	75	80
-6	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	1.2
-5	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2
-4	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
-3 to +3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
+4	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
+5	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
+6	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Notes:

1. Based on ratio of stopping sight distance on specified approach grade to stopping sight distance on level terrain.
2. This table is used in determining intersection sight distance criteria for Case C.

Significant Updates & New Information

- Intersection Sight Distance Example Calculation – Case B (Int. w/ stop control on the minor roadway):
  - Given Information:
    - Movement: **Left Turn From Stop**
    - Major Road Design Speed: 45 MPH
    - Design Vehicle: Combination Truck (CT)
    - Time Gap: 11.5 seconds
    - Additional Crossing lanes: 3
    - Minor Roadway Approach Grade: -5%

$$t_g = 11.5s \text{ (See Table } 13-2)$$

$$t_g \text{ for additional lanes} = 0.7s \times 3 = 2.1s$$

$$t_g \text{ for approach grade} = 0.2s \times 2 = 0.4s$$

$$t_g \text{ Total} = 11.5s + 2.1s + 0.4s = 14.0s$$

$$b = 1.47 V_{major} t_g$$

$$b = 1.47 \times 45 \times 14.0$$

$$b = 926.1 \sim \mathbf{930}\boldsymbol{ft}$$

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Grade Separation & Interchanges

Navigate to Chapter 15

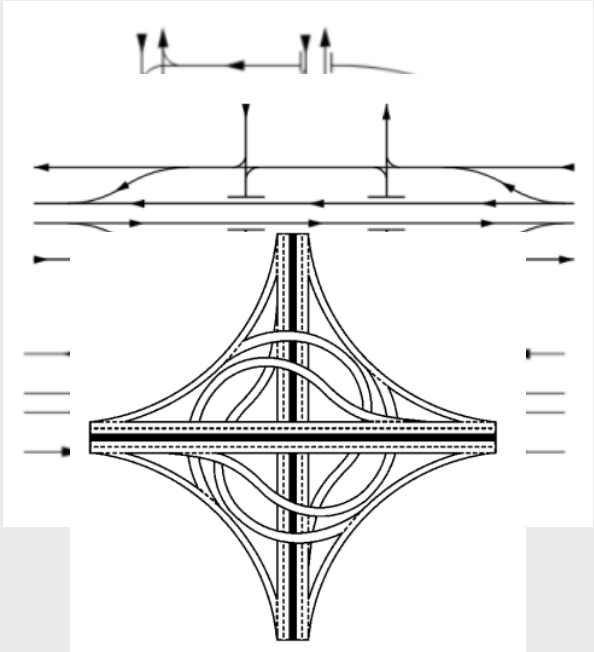
Warrants for Interchanges and Grade Separations

- Section 15.2 added to discuss the factors that should be considered when considering new interchanges and/or grade separations.
  - Design designation
  - Reduction of bottlenecks or spot congestion
  - Reduction of crash frequency and severity
  - Site topography
  - Traffic volume warrant

Not all warrants for grade separations are included for interchanges. See Section 15.2 for additional grade separations.

Additional Types of Interchanges

- Added discussion on additional interchange types including
  - Variation of a “stacked diamond”
  - “Split diamond” with one-way cross streets and frontage roads”
  - “Diamond interchange” with frontage roads and turnarounds
  - “Turbine interchange”

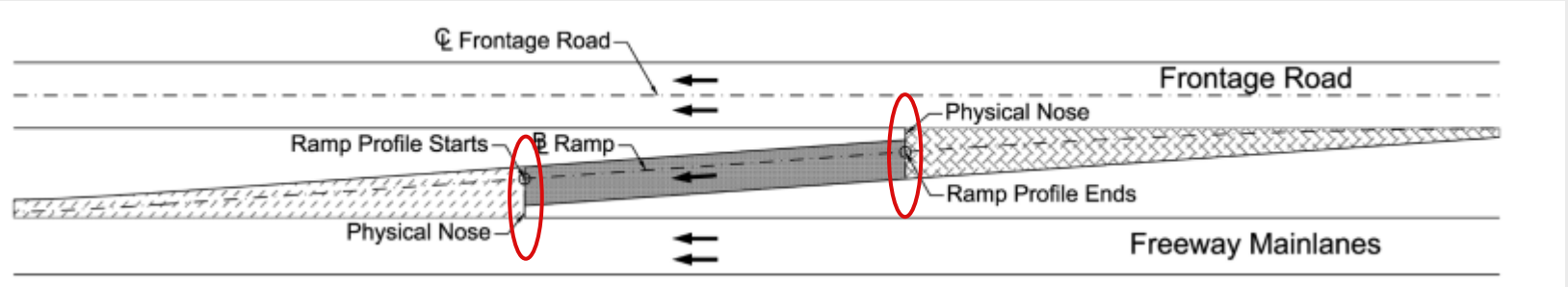


Safety of At-grade Intersections

- Added Section 15.5 that provides discussion from AASHTO on safety of at-grade intersections at:
  - Major intersections with high traffic volumes
  - Railroad crossings
- Outlines benefits of grade-separated intersections
  - Converting four-way stop to a grade separation ➡ 57% injury crash reduction
  - Converting four-way stop to a grade separation ➡ 28% injury crash reduction

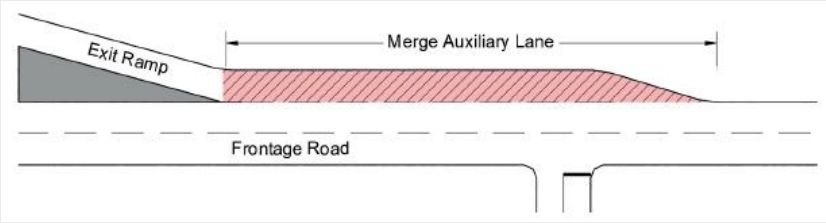
Selecting Ramp Design Speeds

- NCHRP Report 313
- Independent ramp design speed
  - Applies from end of one physical nose to beginning of the opposite physical nose
  - Should not be less than design speed of intersecting frontage road



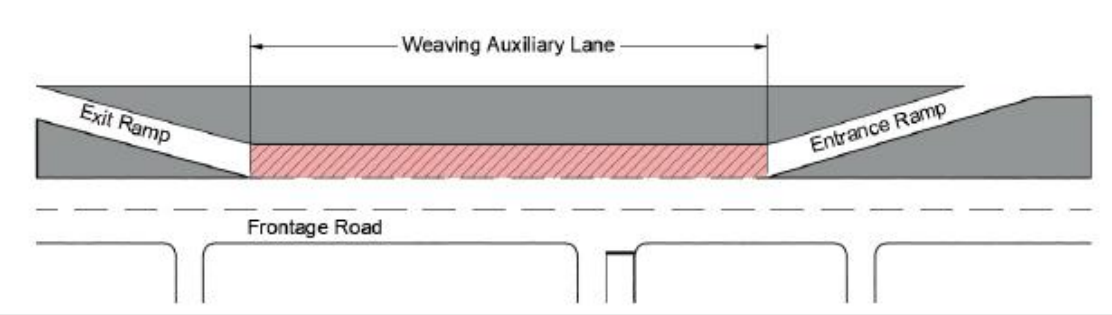
Guidelines for Designing Auxiliary Lanes (AL) on Frontage Roads

- Section 15.8.1 provides guidance from RTI Report 0-7047
- AL merge length = 550-ft (not including the taper)
  - If future volumes > 1,000 vph/lane or
  - Heavy vehicles > 10% of frontage traffic
  - Total AL length of 750-ft.



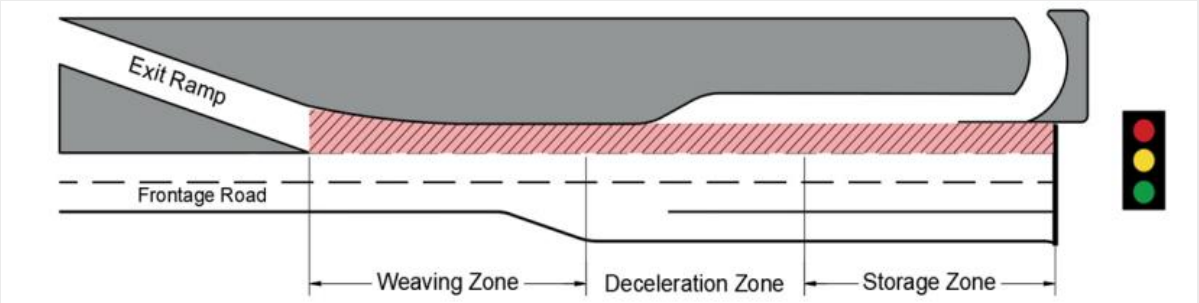
Guidelines for Designing Auxiliary Lanes (AL) on Frontage Roads

- X-Ramp spacing
  - Rural/less developed urban = 1000-ft min.
  - Urban with development = 1500-ft to 2000-ft



Weaving Zone Discussion

- Provides guidance on weaving, deceleration and storage zone lengths to downstream intersections and rural and urban comparison
- TTI Report 0-7047
- Components:
  - Weaving zone
  - Deceleration zone
  - Storage zone



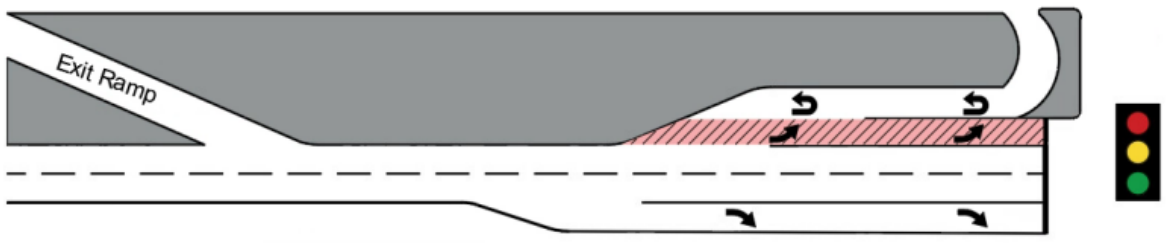
Weaving Zone Discussion

- New research from TTI suggests longer queue length in urban areas
  - Previously 420-ft
  - New 700-ft
- Total distances:
  - Urban = 1, 750-ft
  - Rural = 925-ft

Context	Assumed Frontage Road Speed (mph)	Weaving Zone Length, Exit Ramp to Right Lane Change(s) (ft)	Deceleration Zone (ft)	Queue Storage Zone (ft)	Total Ramp-to-Interchange Spacing (ft)
Urban	45	911.8 (two lane changes)	117.6	700	1,750
Rural	55	548.2 (one lane change)	194.4	180	925

Left-turn Deceleration Lane Length

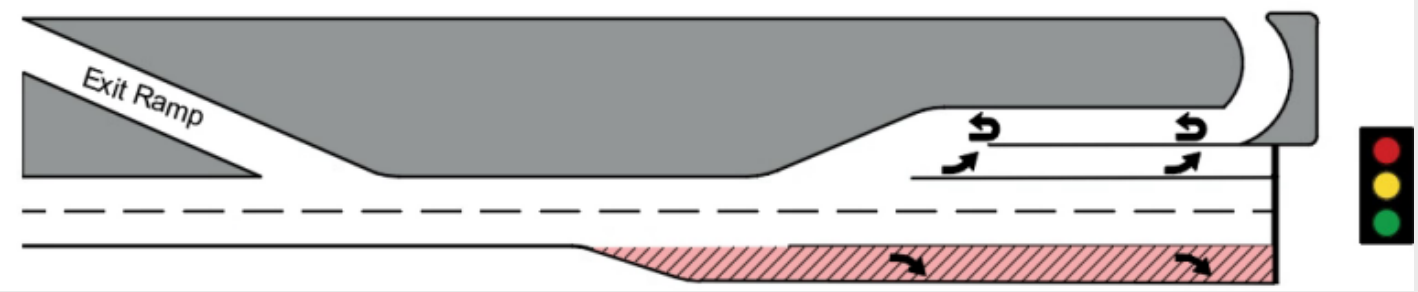
- Length of a frontage road AL (left-turn lane in this case) is the sum of:
  - Entering taper
  - Deceleration distance
  - Storage length



- Rural: develop length using procedures contained in the RDM (will be more than the previously discussed 180-ft queue length check value)
- Urban: check length developed using RDM against 700-ft TTI value. Use at least the 700-ft length

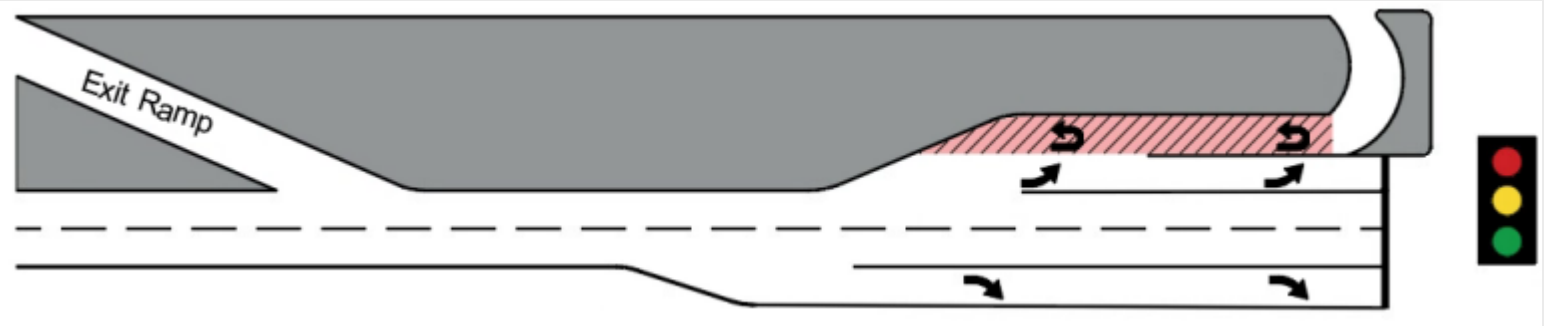
Right-turn Deceleration Lane Length

- Rural: 180-ft adequate
- Urban: Recommended minimum of 700-ft to avoid blocking issues



U-Turn/Turnaround Deceleration Guidance

- Rural and suburban: 525-ft recommended
- Recommend traffic analysis for high ADT (40,000 or greater) intersections and/or those with LOS E or F
- TTI Report 0-7047: recommended 700-ft minimum to avoid blocking issues in urban areas



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Alternative Intersection & Interchange Design

Navigate to Chapter 14

Roundabouts

- Design guidance for:
  - Multilane
  - Single lane
  - Compact
  - Mini
- Design process and context
- Design parameters & performance checks
- Special considerations
- Preliminary and Final Design guidance


Mini-Roundabout

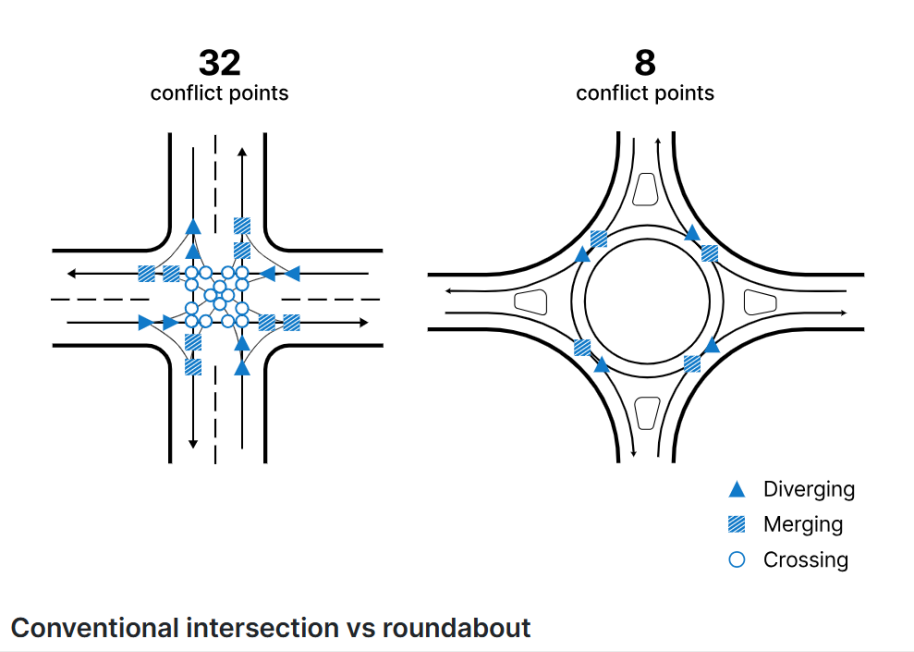

Compact Roundabout


Single-lane Roundabout


Multilane Roundabout

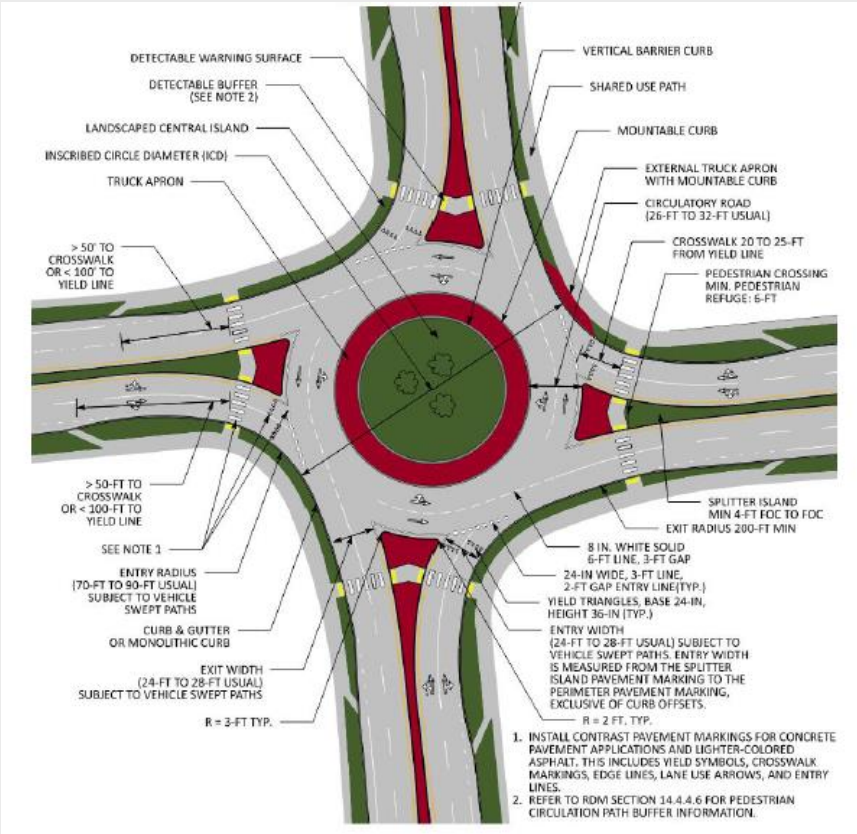
Roundabout Benefits

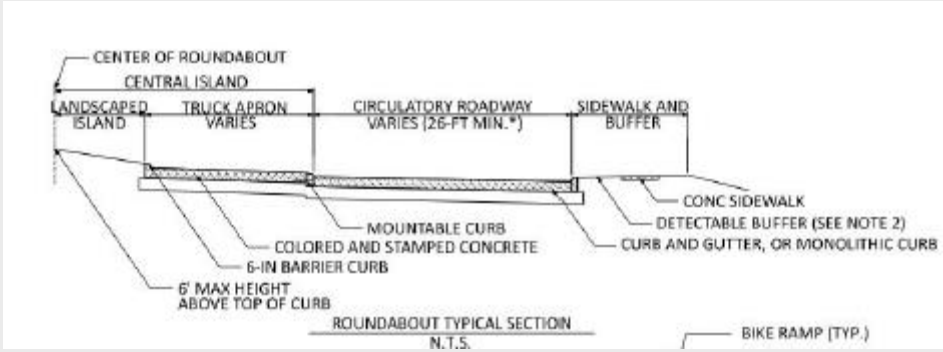
- Safety: Reduces fatalities by 90% by eliminating crossing conflict points and head-on crashes
- Slower vehicle speeds which improves ped. and cyclist outcomes
- Operational: Improves overall traffic flow by using a yield-on-entry system
- Aesthetic Landscaping and Hardscaping opportunities



Conventional intersection vs roundabout

Roundabouts





Updated Guidance for Other Alternative Intersections

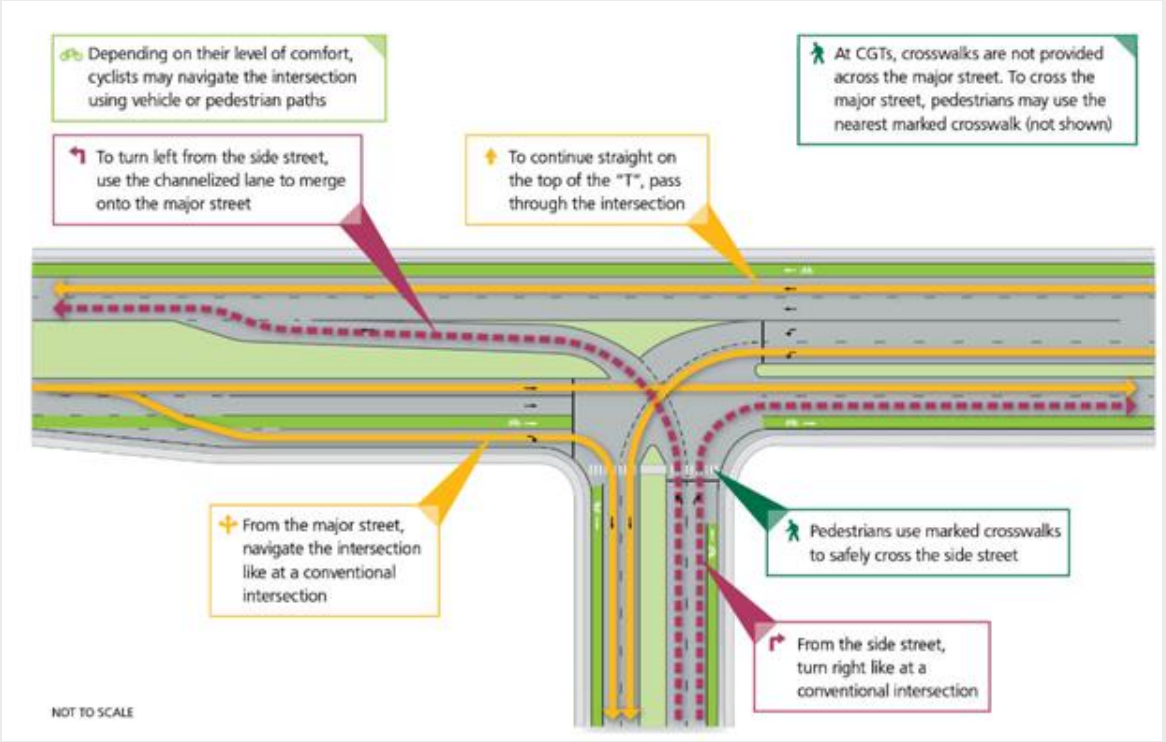
- Restricted Crossing U-Turn Int. (RCUT)
- Median U-Turn Int. (MUT)
- Diverging Diamond Interchange (DDI)
- Displaced Left-Turn Intersection (DLT)

New Guidance for Other Alternative Intersections

- Continuous Green T-Intersection (CGT)
- Quadrant Roadway Intersection
- Contraflow Left Interchange (CLI)
- Single-Point Urban Interchange (SPUI)

Continuous Green T

- Benefits:
  - Improved safety
  - Increased efficiency
  - Free-flow in one directions



Quadrant Roadway Intersections

- Benefits:
  - Reduced traffic signal phases
  - Reduced conflict points
  - Improved intersection operations

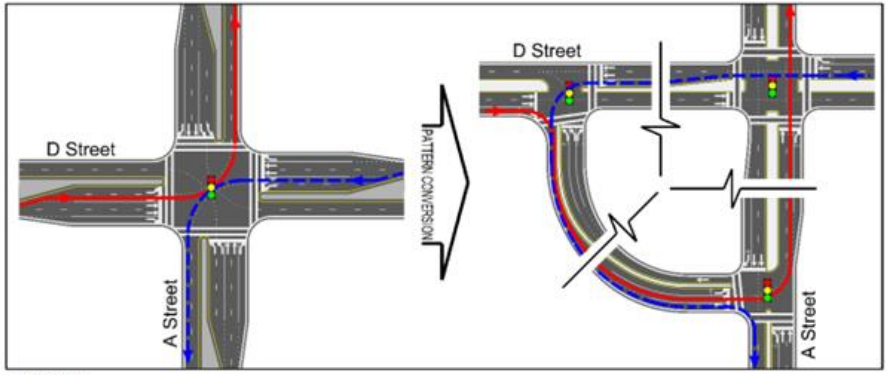


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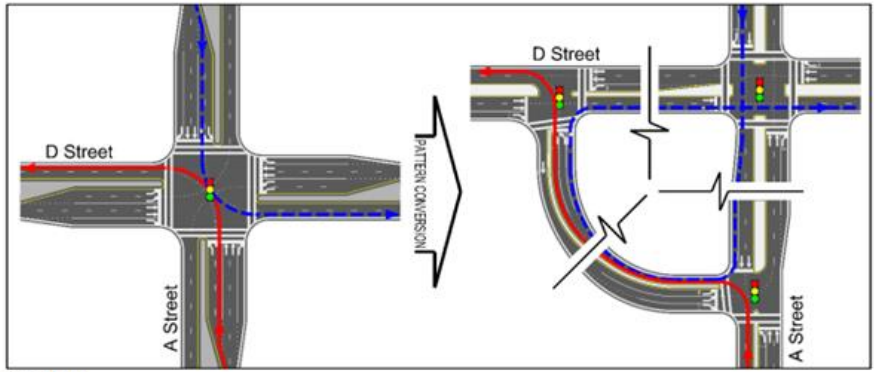
Figure 58. Graphic. Conventional versus QR left turn movements: D Street.



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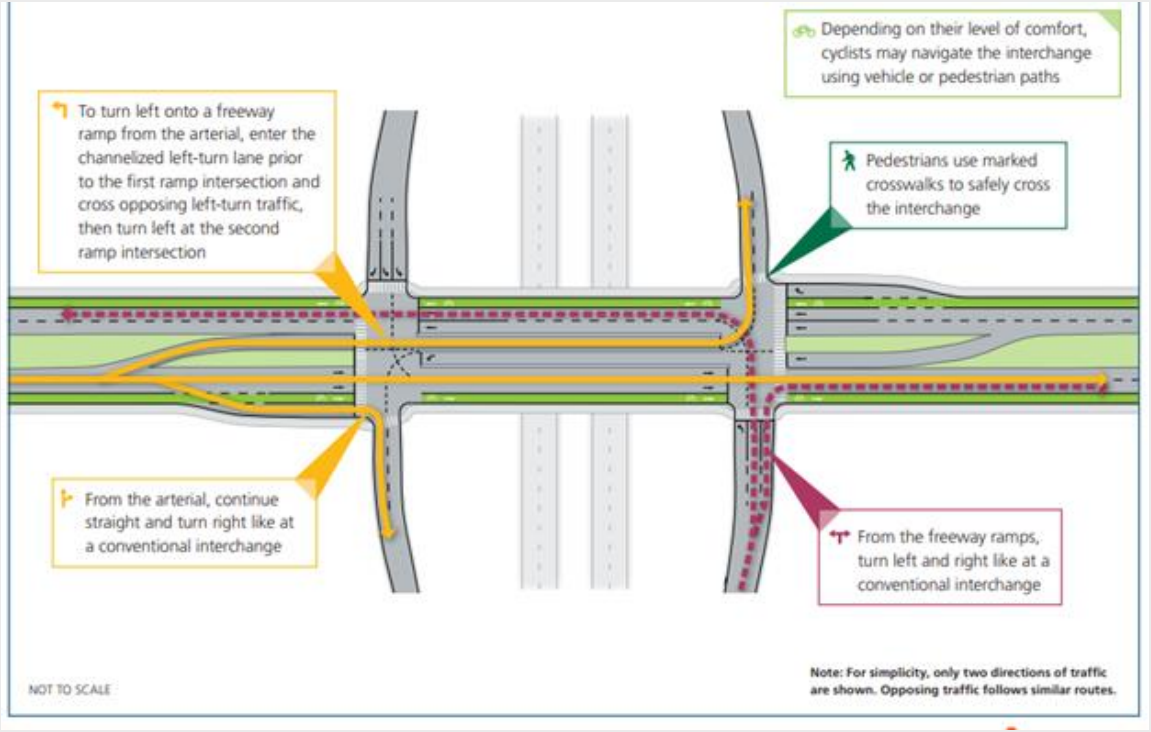
Contraflow Left Interchange

- Benefits:
  - Increases traffic flow through the intersection
  - Reduces the likelihood of congestion and backups



Single-Point Urban Interchange (SPUI)

- Benefits:
  - Increases traffic flow through the intersection
  - can be advantageous along a corridor of closely-spaced signalized intersections

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Appendices

Navigate to Appendix A & Appendix B

Appendix A – Design Exception Tables

- Section 1.2 – Design Exceptions and Design Waivers

Table 1-4: AASHTO's Controlling Criteria for New Location and Reconstruction Projects (4R)

Criteria	Minimum Criteria	Criteria Reference	Explanation
Design Speed	Appendix Table A-1	Section 4.2	Minimum design speed based on the functional classification.
Lane Width	Appendix Table A-2	Note 1	Minimum lane width based on functional classification, type of lane (Mainlane, etc.) and design speed.
Shoulder Width	Appendix Table A-3	Note 2	Minimum outside and inside shoulder widths based on functional classification, type of facility and design speed.

Table A-2: 4R Lane Width (Minimum)

Facility Type	Additional Factors	Lane Width	Reference
Freeways	Rural Suburban Urban Urban Core	12-ft	TxDOT Criteria
Arterials	Rural:[5,6,7,8] 2 lane: ADT < 400 ADT 400 - 2000 ADT > 2000	12-ft	TxDOT Criteria
	Rural:[5,6,7,8] 4 lane divided 6 lane divided 4 lane undivided	12-ft	
	Rural Town[1] Suburban[1] Urban[1] Urban Core[1]	11-ft	
Collector	Rural[5,6,7,8]: 2 lane: ADT < 400 (DS ≤ 55 MPH)[2] ADT < 400 (DS > 55 MPH)[2] ADT 400 - 1500 (DS ≤ 70 MPH)[2] ADT 400-1500 (DS > 70 MPH)[2] ADT 1500 - 2000 (DS ≤ 45 MPH)[2] ADT 1500 - 2000 (DS > 45 MPH)[2] ADT > 2000	 10-ft 11-ft 11-ft 12-ft 11-ft 12-ft 12-ft	TxDOT Criteria

Appendix B – Design Waiver Tables

- Section 1.2 – Design Exceptions and Design Waivers

Table 1-10: TxDOT Non-Controlling Criteria for 4R Projects

Criteria	Minimum Criteria	Criteria Reference	Explanation
Curb Parking Lane Width	Appendix Table B-1	Section 4.10.16	Minimum width required for vehicles to park on the edge of the roadway in urban and suburban areas based on the functional class of the roadway.
Speed Change Lane Width	Appendix Table B-2	Section 4.10.2	Minimum width of acceleration or deceleration lanes for left or right turns, exit or entrance lanes, or a climbing lane based on the highway class.
Length of Speed Change Lanes	Appendix Table B-3	Section 4.10.2	Minimum length of acceleration or deceleration lanes for left or right turns, exit or entrance lanes, or a climbing lane based on the highway class.

Table B-2: 4R Speed Change Lane Width (Minimum)

Facility Type	Additional Factors	Lane Width	Reference
Freeways	Rural Suburban Urban Core Urban	12-ft[1]	TxDOT Criteria
Arterials	Rural Rural Town Suburban Urban Core Urban	10-ft	TxDOT Criteria
Collectors	Rural Rural Town Suburban Urban Core Urban	10-ft	TxDOT Criteria

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Thank You and Questions?

Next RDM Webinar: Chapters 16 - 24

Wednesday, December 18, 1:00 – 2:30 PM