Pennsylvania's Approach to Context Sensitive Solutions and Flexible Design

CONTEXT MATTERS

December 6, 2018

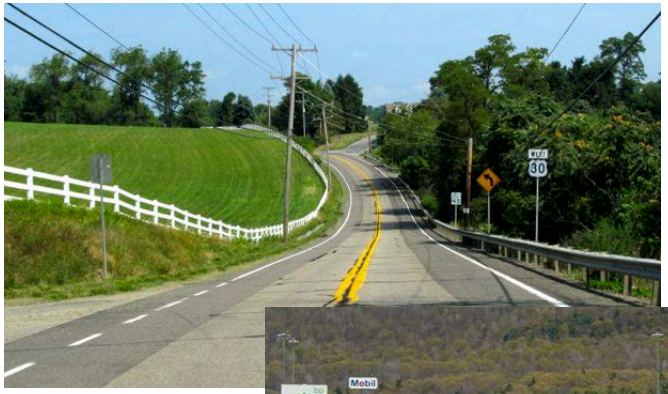
pennsylvania

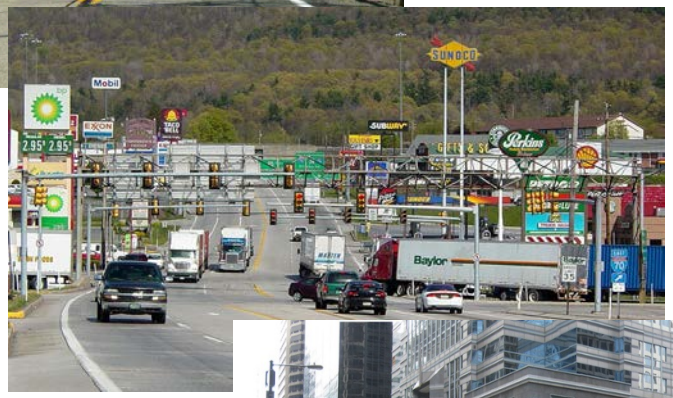
DESIGN MANUAL 2 REWRITE

UNDERSTANDING THE CONCEPT

pennsylvania

What Does an Arterial Look Like?





One Size Fits All

Photo courtesy of STUDIO | BRYAN HANES

pennsylvania

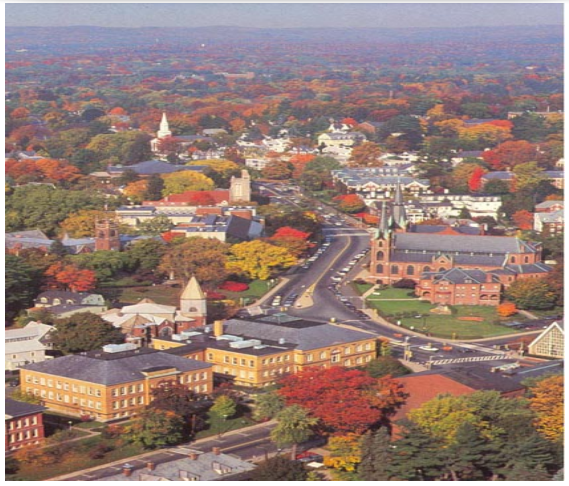
Understanding the Concept

- The Concept - Context Based Multimodal Approach
- Requires **understanding of the function of the roadway** within its **current and expected future context** and the **needs of the potential roadway users**.

PennDOT's Context Based Design Goal

Safety, Access, and Mobility

Livability and Context -preserving scenic, aesthetic, historic, and environmentally sensitive areas



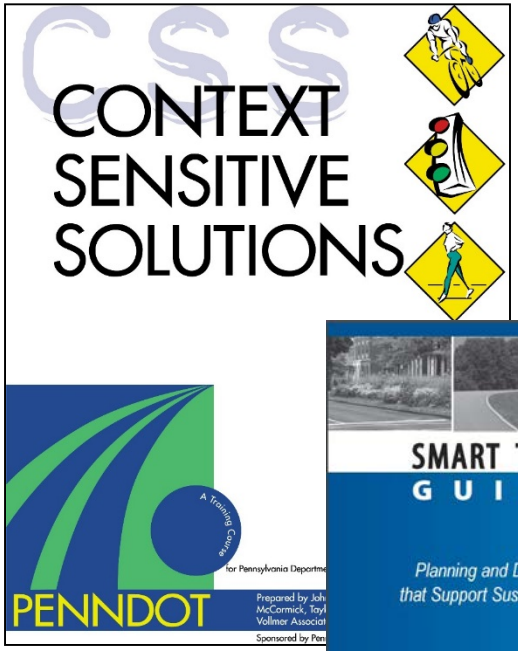
Enhance the Quality of Life for Pennsylvania Communities

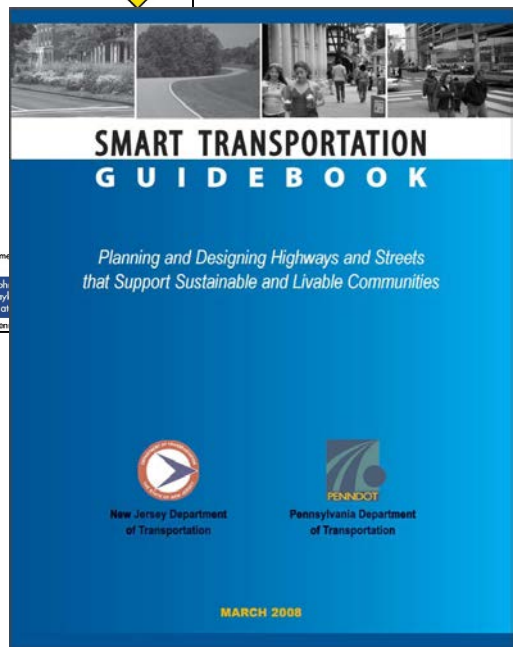
pennsylvania

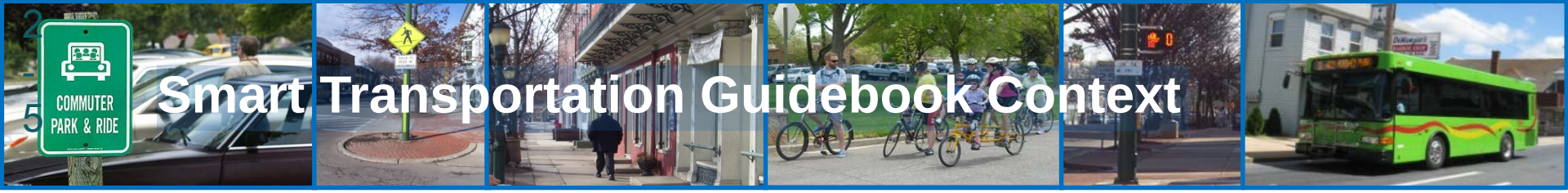
PennDOT's CSS History

- Discussed:
  - A collaborative project development process
  - Community Involvement
  - Flexibility in Design
  - Project Implementation & Network Maintenance and Operation
  - Safety and Risk Management

- Guide Book and Statewide Training in 2008



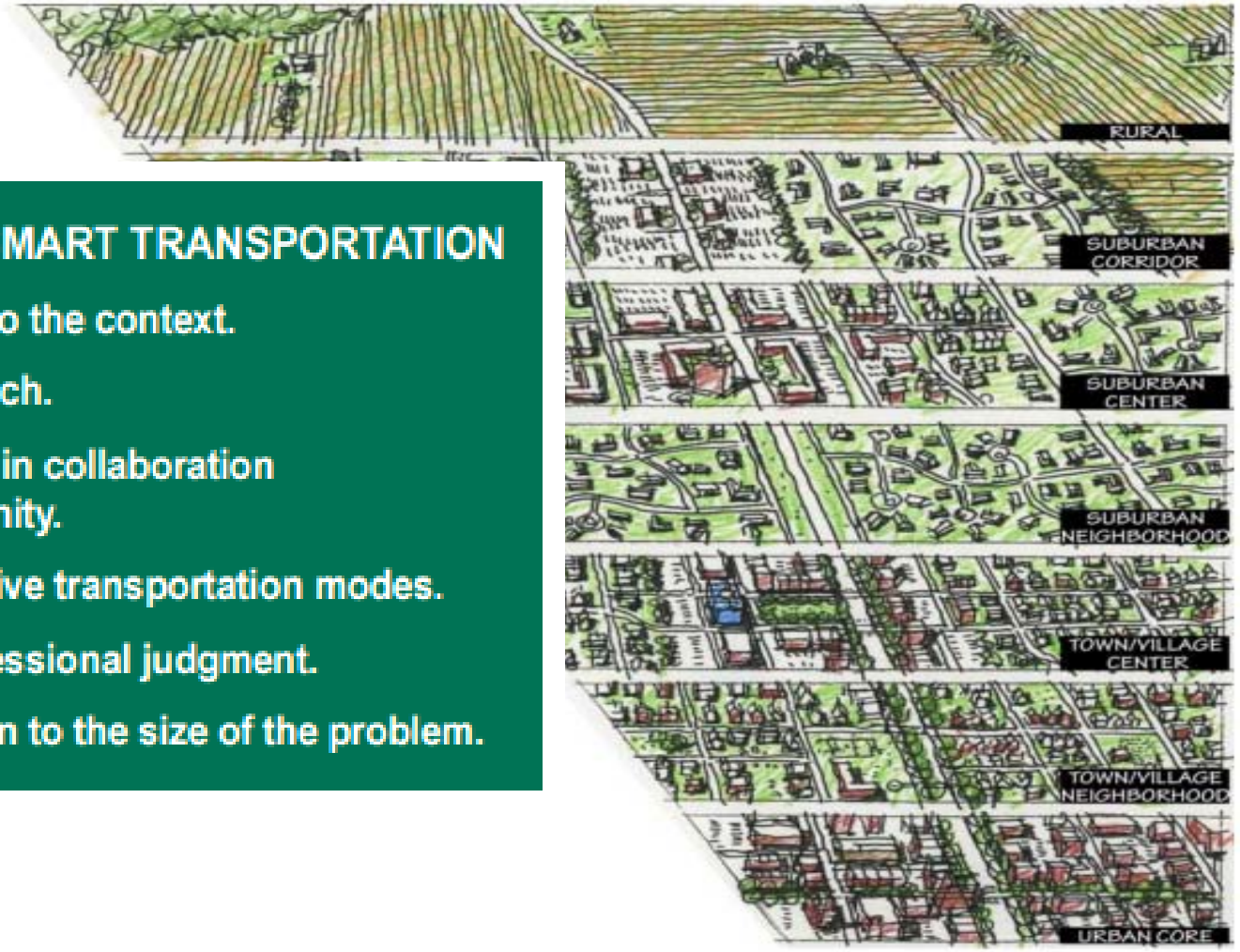




Smart Transportation Guidebook Context

PRINCIPLES OF SMART TRANSPORTATION

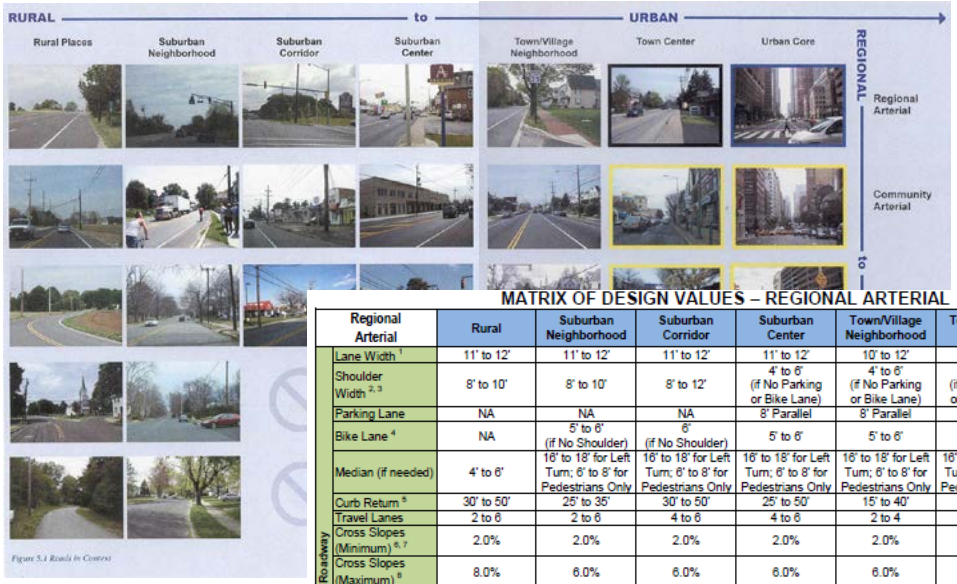
1. Tailor solutions to the context.
2. Tailor the approach.
3. Plan all projects in collaboration with the community.
4. Plan for alternative transportation modes.
5. Use sound professional judgment.
6. Scale the solution to the size of the problem.



pennsylvania

Selecting Context and Design Values

- Table for each classification
  - ✓ Regional Arterial
  - ✓ Community Arterial
  - ✓ Community Collector
  - ✓ Neighborhood Collector
  - ✓ Local Road/Street



MATRIX OF DESIGN VALUES – REGIONAL ARTERIAL

	Regional Arterial	Rural	Suburban Neighborhood	Suburban Corridor	Suburban Center	Town/Village Neighborhood	Town/Village Center	Urban Core
Roadway	Lane Width [1]	11' to 12'	11' to 12'	11' to 12'	11' to 12'	10' to 12'	10' to 12'	10' to 12'
	Shoulder Width [2, 3]	8' to 10'	8' to 10'	8' to 12'	4' to 6' (if No Parking or Bike Lane)	4' to 6' (if No Parking or Bike Lane)	4' to 6' (if No Parking or Bike Lane)	4' to 6' (if No Parking or Bike Lane)
	Parking Lane	NA	NA	NA	8' Parallel	8' Parallel	8' Parallel	8' Parallel
	Bike Lane [4]	NA	5' to 6' (if No Shoulder)	6' (if No Shoulder)	5' to 6'	5' to 6'	5' to 6'	5' to 6'
	Median (if needed)	4' to 6'	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only	16' to 18' for Left Turn; 6' to 8' for Pedestrians Only
	Curb Return [5]	30' to 50'	25' to 35'	30' to 50'	25' to 50'	15' to 40'	15' to 40'	15' to 40'
	Travel Lanes	2 to 6	2 to 6	4 to 6	4 to 6	2 to 4	2 to 4	2 to 6
	Cross Slopes (Minimum) [6, 7]	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
	Cross Slopes (Maximum) [8]	8.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
	Bridge Widths (Two-Lane Facilities) [9, 10, 16]	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side
	Bridge Widths (Four-Lane or More Facilities) [9, 10, 16]	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side	Lane Widths Plus Shoulders Each Side
	Vertical Grades (Minimum) [11]	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
	Vertical Clearance (Minimum)	16'-6", See Chapter 2	16'-6", See Chapter 2	16'-6", See Chapter 2	16'-6", See Chapter 2	16'-6", See Chapter 2	16'-6", See Chapter 2	16'-6", See Chapter 2
Roadside [12]	Clear Sidewalk Width	NA	5'	5' to 6'	5' to 6'	6' to 8'	6' to 10'	6' to 12'
	Buffer [13]	NA	6'+	6' to 10'	4' to 6'	4' to 6'	4' to 6'	4' to 6'
	Shy Distance	NA	NA	NA	0' to 2'	0' to 2'	2'	2'
	Total Sidewalk Width	NA	5'	5' to 6'	9' to 14'	10' to 16'	12' to 18'	12' to 20'
	Clear Zone Widths [14]	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12
	Right-of-Way Widths [15]	Varies	Varies	Varies	Varies	Varies	Varies	Varies
Speed	Desired Operating Speed (Design Speed)	45-55 mph	35-40 mph	35-55 mph	30-35 mph	30-35 mph	30-35 mph	30-35 mph
	Stopping and Passing Sight Distances (Minimum)	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1	2004 AASHTO Green Book, Exhibit 7-1
	Vertical Grades (Maximum)	2004 AASHTO Green Book, Exhibit 7-2	2004 AASHTO Green Book, Exhibit 7-10	2004 AASHTO Green Book, Exhibit 7-10	2004 AASHTO Green Book, Exhibit 7-10	2004 AASHTO Green Book, Exhibit 7-10	2004 AASHTO Green Book, Exhibit 7-10	2004 AASHTO Green Book, Exhibit 7-10

DESIGN MANUAL 2 REWRITE

STEPS TO IMPLEMENTATION

pennsylvania

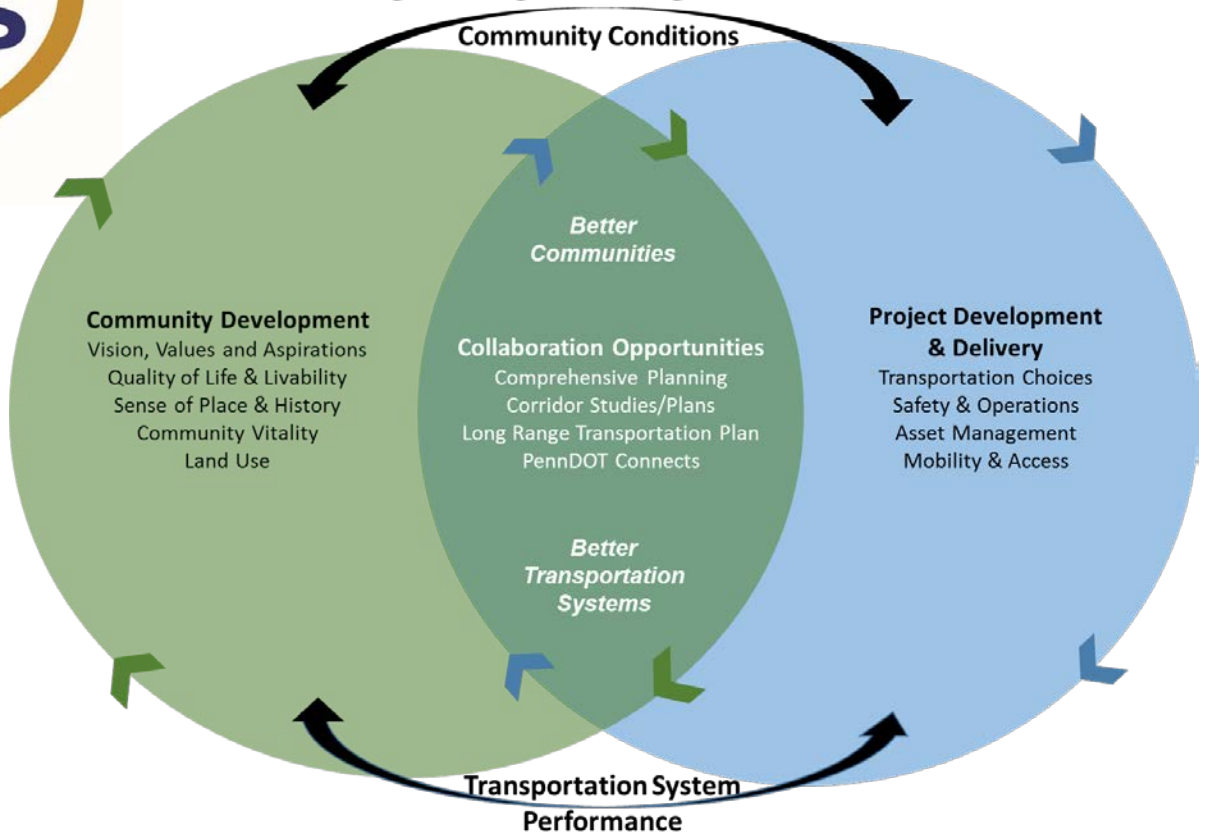
Know What is Needed for an Effective Transportation Network

- Enable safe, convenient and comfortable travel for all residents
- Improve network connectivity for all modes and address gaps
- Focus on providing access to key destinations
- Align project designs with the goals articulated in state, regional, and local plans

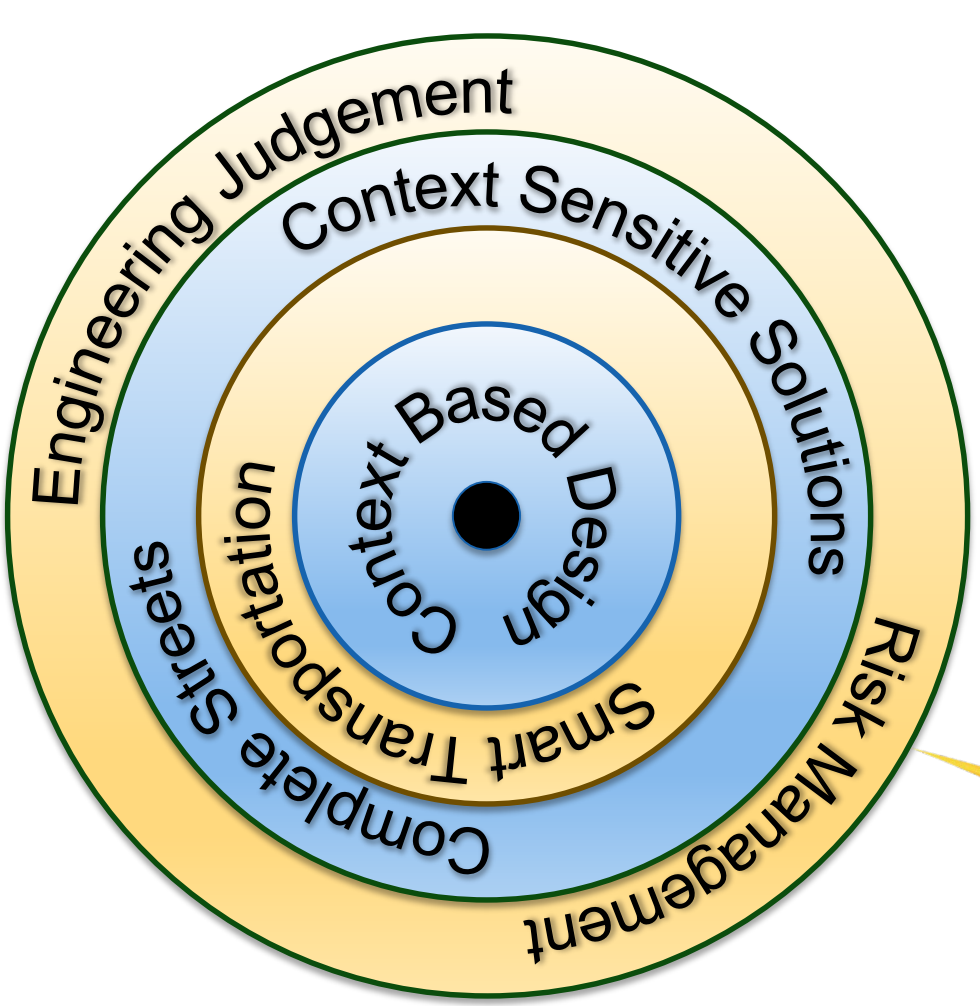
Involve Planning Partners

PennDOT Connects
Planning with our communities

Planning & Engineering Collaboration



Retool Geometric Design Manual



- Context classification considering all modes
- Project type classification
- Flexible design approach
- Performance-based approach

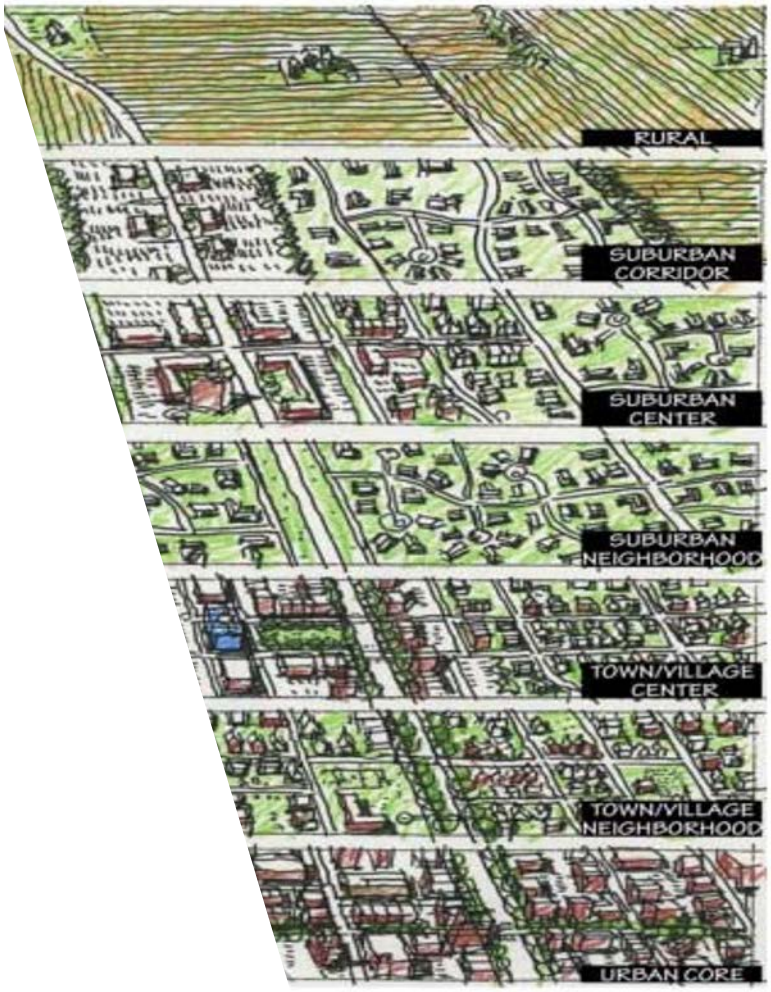
pennsylvania

Where do we start?

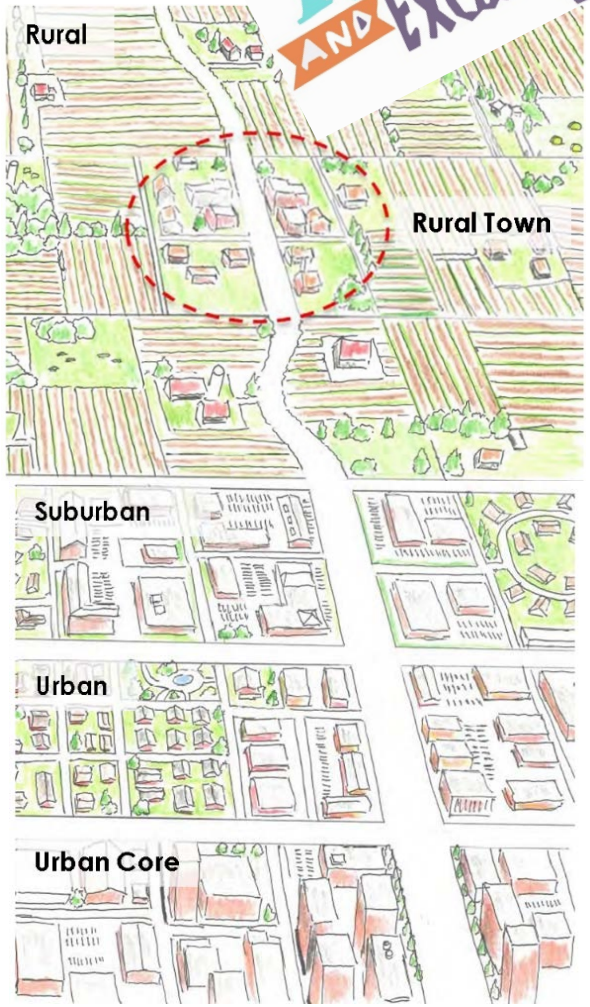
- Working with University of Kentucky
- Pennsylvania is a pilot state

Context Change

New and Exciting



From 7 to 5 Contexts



pennsylvania

Functional Classification

- ✓ Limited Access Freeway
- ✓ Regional Arterial
- ✓ Community Arterial
- ✓ Community Collector
- ✓ Neighborhood Collector
- ✓ Local Road/Street

- ✓ Limited Access Expressway
- ✓ Arterial
- ✓ Collector
- ✓ Local Road/Street

NCHRP 855

Roadway \ Context	Rural	Rural Town	Suburban	Urban	Urban Core
Principal Arterial	DRIVER BICYCLIST PEDESTRIAN				
Minor Arterial					
Collector					
Local					

Roadway \ Context	Rural	Rural Town	Suburban	Urban	Urban Core
Principal Arterial					
Minor Arterial					
Collector					
Local					

Legend
Low Medium High
Low Medium High
Low Medium High

pennsylvania

DESIGN MANUAL 2 REWRITE

UNDERSTANDING DESIGN FLEXIBILITY

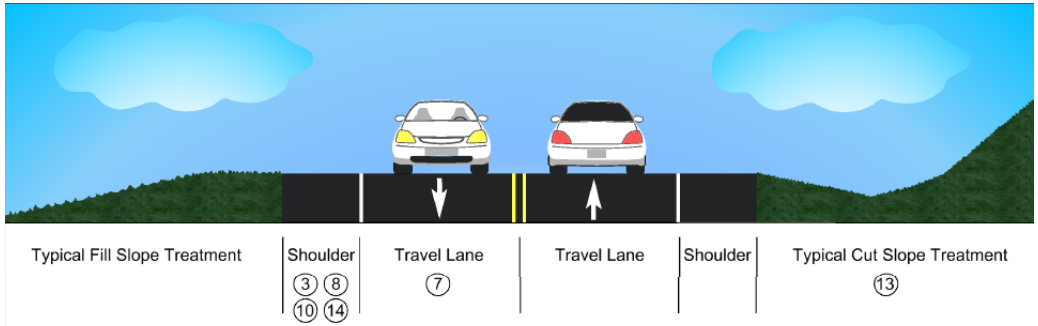
pennsylvania

Flexible Environment

- Flexibility creates an environment for designers to use engineering judgement rather then picking numbers.

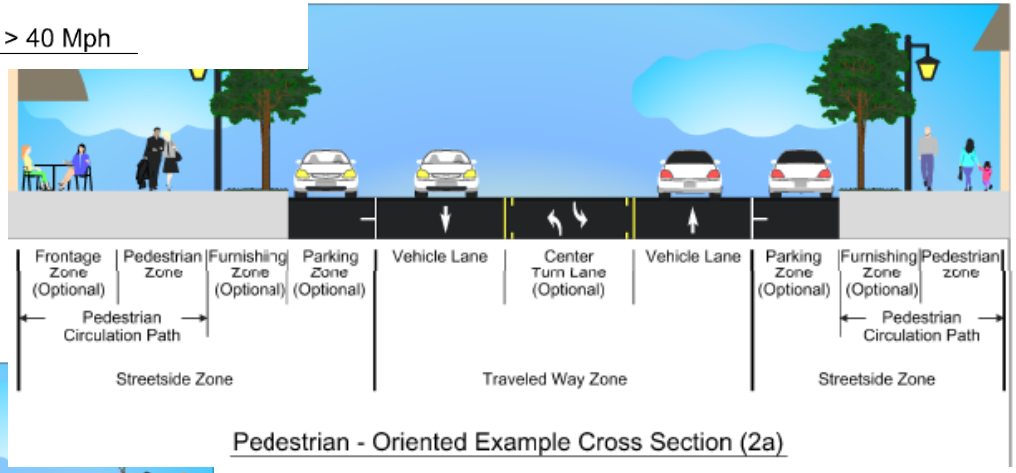
- Flexibility creates the need to Document the Decision Making Process
  - Documenting and communicating assumptions and decisions reduces misunderstandings and wasted work
    - Provide a clear understanding of the project
    - Understand who is responsible for the final decision

Typical Sections

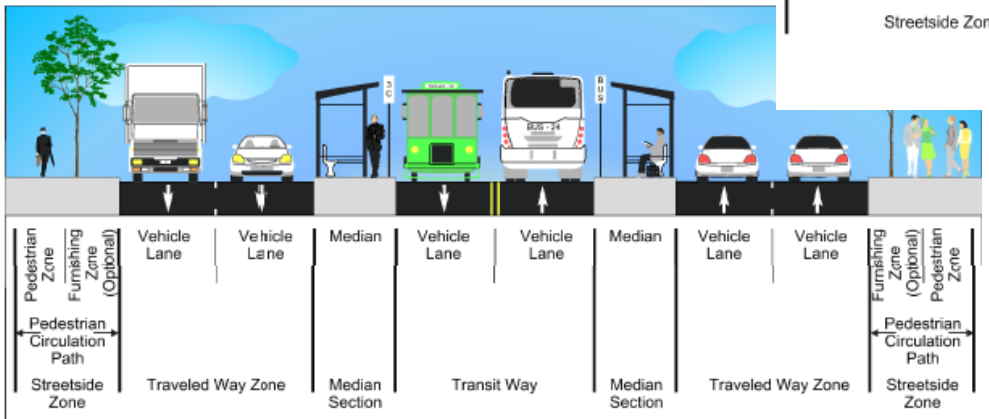


Arterial - Rural or Urban without Curbs, Speed > 40 Mph

- No dimensions
- Cross slope determined by drainage needs
- Mode accommodation as needed



Pedestrian - Oriented Example Cross Section (2a)



Transit - Oriented Cross Section Transit Boulevard (4a)

Vehicle Table

MATRIX OF DESIGN VALUES – COLLECTOR

	Collector	Rural	Rural Town	Suburban	Urban	Urban Core
Roadway	Lane Width [1]	Preferred: 12′ Minimum: 10′	Preferred: 11′ Minimum: 9′	Preferred: 12′ Minimum: 10′	Preferred: 11′ Minimum: 9′	Preferred: 11′ Minimum: 9′
	Shoulder Width [2, 3]	Preferred: 8′ Minimum: 4′	Preferred: 6′ or Curbed Minimum: 4′ (if No Parking or Bike Lane)	Preferred: 10′ Minimum: 4′ Minimum: 4′* *(if No Parking or Bike Lane)	Preferred: 6′ or Curbed Minimum: 4′* *(if No Parking or Bike Lane)	Preferred: 6′ or Curbed Minimum: 4′* *(if No Parking or Bike Lane)
	Parking Lane	NA	Parallel; Preferred: 8′ Parallel; Minimum: 7′	N/A to 8′ Parallel	Parallel; Preferred: 8′ Parallel; Minimum: 7′	Parallel; Preferred: 8′ Parallel; Minimum: 7′
	Bike Lane [4]	See DM-2, Exhibit 14.X	See DM-2, Exhibit 14.X	See DM-2, Exhibit 14.X	See DM-2, Exhibit 14.X	See DM-2, Exhibit 14.X
	Median (if needed) for Left Turn	NA	Preferred: 16′ Minimum: 12′	Preferred: 16′ Minimum: 12′	Preferred: 16′ Minimum: 12′	Preferred: 16′ Minimum: 12′
	Median (if needed) for Pedestrians Only	NA	Preferred: 8′ Minimum: 6′	Preferred: 8′ Minimum: 6′	Preferred: 8′ Minimum: 6′	Preferred: 8′ Minimum: 6′
	Median (if needed) for Landscaping	NA	Preferred: 10′ Minimum: 8′	Preferred: 10′ Minimum: 8′	Preferred: 10′ Minimum: 8′	Preferred: 10′ Minimum: 8′
	Curb Return [5]	Preferred: 40′ Minimum: 15′	Preferred: 25′ Minimum: 10′	Preferred: 40′ Minimum: 15′	Preferred: 25′ Minimum: 10′	Preferred: 30′ Minimum: 10′
	Travel Lanes	2	2 to 4	2 to 4	2 to 4	2 to 4
	Cross Slopes (minimum)[6, 7]	2.0%	2.0%	2.0%	2.0%	2.0%
	Cross Slopes (maximum) [8]	8.0%	6.0%	6.0%	6.0%	6.0%
	Vertical Grades (minimum)[9]	0.5%	0.5%	0.5%	0.5%	0.5%
	Vertical Clearance [11A] (minimum)	14′-6″ See DM-2, Chapter 3	14′-6″ See DM-2, Chapter 3	14′-6″ See DM-2, Chapter 3	14′-6″ See DM-2, Chapter 3	14′-6″ See DM-2, Chapter 3
Roadside	Clear Sidewalk Width[10]	NA	Preferred: 6′ Minimum: 5′	Preferred: 8′ Minimum:4′	Preferred: 8′ Minimum: 6′	Preferred: 10′ Minimum: 6′
	Buffer [11]	NA	Preferred: 5′ Minimum: 3′	Preferred: 10′ Minimum: 4′	Preferred: 5′ Minimum: 3′	Preferred: 6′ Minimum: 4′
	Shy Distance	NA	Preferred: 2′ Minimum: 0′	Preferred: 2′ Minimum: 0′	2′	2′
	Total Sidewalk Width	NA	Preferred: 13′ Minimum: 8′	Preferred: 15′ Minimum: 4′	Preferred: 15′ Minimum: 11′	Preferred: 18′ Minimum: 12′
	Clear Zone Widths [12]	See DM-2 Chapter 12	See DM-2 Chapter 12	See DM-2 Chapter 12	See DM-2 Chapter 12	See DM-2 Chapter 12
	Stopping Sight Distance (minimum)	2011 AASHTO Green Book, Table 3-3	2011 AASHTO Green Book, Table 6-3	2011 AASHTO Green Book, Table 6-3	2011 AASHTO Green Book, Table 6-3	2011 AASHTO Green Book, Table 6-3
	Passing Sight Distance (minimum)	DM-2, Exhibit 3-X	DM-2, Exhibit 3-X	DM-2, Exhibit 3-X	DM-2, Exhibit 3-X	DM-2, Exhibit 3-X
	Vertical Grades (maximum) [14]	2011 AASHTO Green Book, Table 6-2	2011 AASHTO Green Book, Table 6-8	2011 AASHTO Green Book, Table 6-8	2011 AASHTO Green Book, Table 6-8	2011 AASHTO Green Book, Table 6-8

See Table 3.XXXXX

If all the values are the same, do they need to be in the table?

Move to Pedestrian Chapter?

If all the values are the same, do they need to be in the table?

pennsylvania

DESIGN MANUAL 2 REWRITE

BALANCE MULTIMODAL SOLUTIONS

pennsylvania

Multimodal Considerations

- Overlays* for:
  - ✓ Bicycle
  - ✓ Pedestrian

  } Complete Rewrite

  - ✓ Transit
  - ✓ Freight
  - ✓ Plain People Community Considerations

  } New

Context / Roadway	Rural	Rural Town	Suburban	Urban	Urban Core
Principal Arterial	DRIVER BICYCLIST PEDESTRIAN				
Minor Arterial					
Collector					
Local					

* Overlays may not exactly replicate design parameter tables

- Each chapter contains:
  - Important Context Questions
  - Key Design Components

Design Manual 2 Rewrite

Chapter 14 – Bicycle Facilities

Where to Begin?

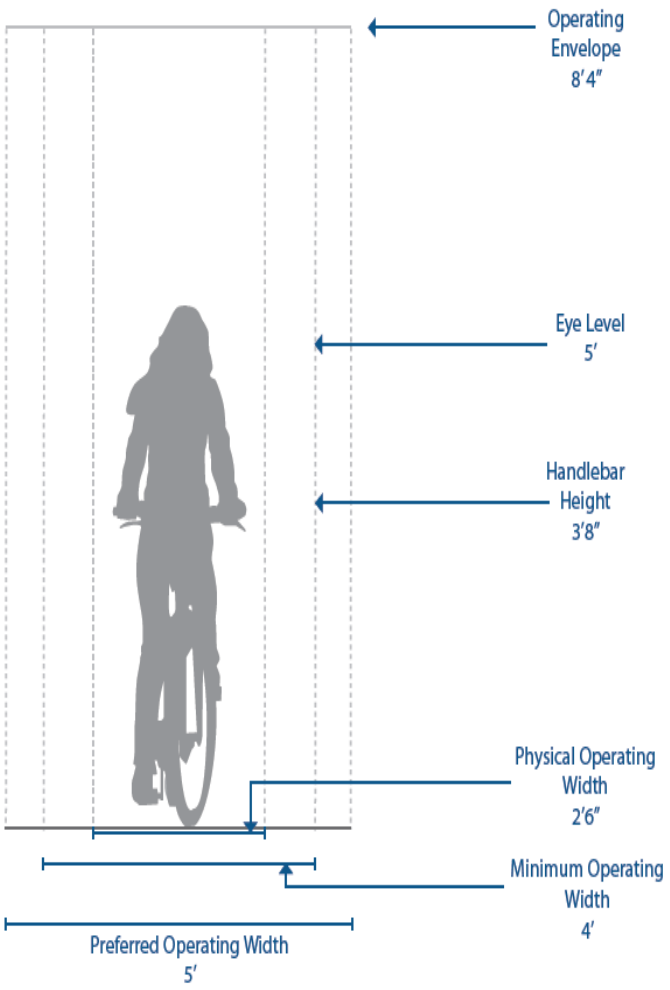
Important Context Questions

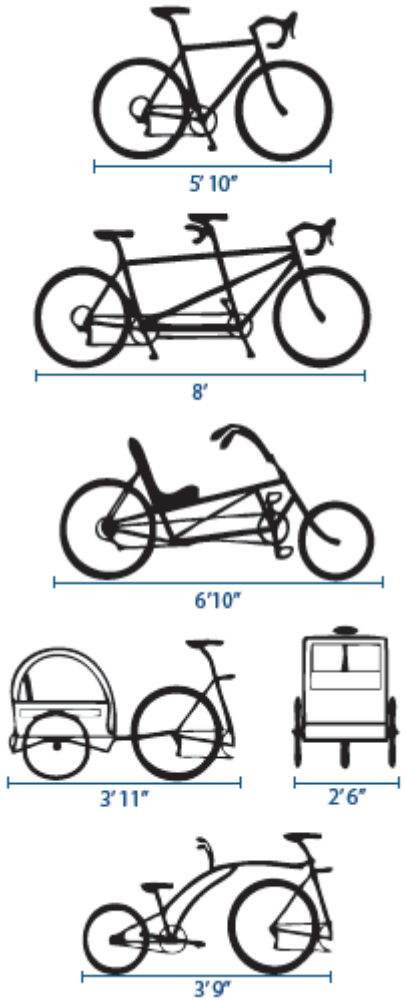
- *Is this bicycle facility in an urban or rural setting?*
- *Is this bicycle facility identified in a local, state or regional transportation plan (indicating importance to local bicyclists)?*
- *What types of bicyclists will likely use the facility (e.g., commuters, young or inexperienced cyclists, bicycle touring, recreational cyclists, disabled cyclists, others)?*
- *Will this facility be used by others (e.g., pedestrians, equestrians, skaters, dog walkers, etc…)?*

Key Design Components

- *Work to Minimize Conflict Points*
- *Be Cognizant of Barriers*
- *Work Toward Continuity*

Bicycle as a Design Vehicle





Bicycle Type	Feature	Typical Dimensions
Upright Adult Bicyclist	Physical width	2 ft 6 in
	Operating width (Minimum)	4 ft
	Operating width (Preferred)	5 ft
	Physical length	5 ft 10 in
	Physical height of handlebars	3 ft 8 in
	Operating height	8 ft 4 in
	Eye height	5 ft
	Vertical clearance to obstructions (tunnel height, lighting, etc)	10 ft
	Approximate center of gravity	2 ft 9 in - 3 ft 4 in
Recumbent Bicyclist	Physical length	8 ft
	Eye height	3 ft 10 in
Tandem Bicyclist	Physical length	8 ft
Bicyclist with child trailer	Physical length	10 ft
	Physical width	2 ft 6 in

Facility Classification

Shared Roadway

Visually Separated Bikeway

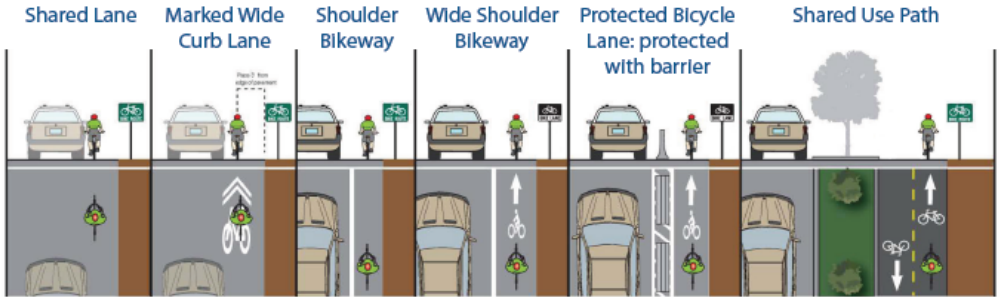
Physically Separated Bikeway

Shared-Use Path

Facilities for Various Roadway Environments

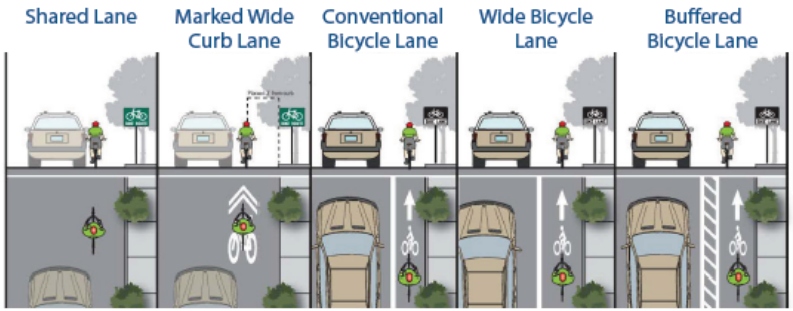
Least Protected → Most Protected

Arterial/Highway Bikeway Continuum (without curb and gutter)



Arterial/Highway Bikeway Continuum (with curb and gutter)

Collector Bikeway Continuum



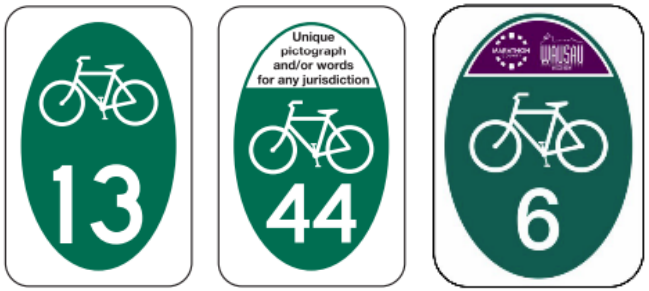
Bike Route Signing

General Bike Route Signing

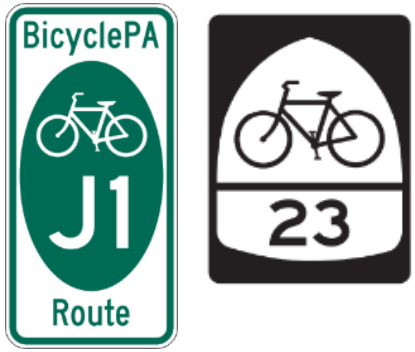
D1-1b

D1-3c

Numerically Labeled Bike Route Signing



M1-8



pennsylvania

Contextual Guidance

BICYCLE FACILITY CONTEXTUAL GUIDANCE

AVERAGE ANNUAL DAILY TRAFFIC (1,000 veh/day or 100 veh/peak hr)

FACILITY TYPE	STREET CLASS
BICYCLE BOULEVARD ●●○○ Comfortable and attractive bicycling environment without utilizing physical separation; typically employs techniques to prioritize bicycling.	LOCAL
BIKE ROUTE ●○○○ Marking that is applicable on roadways where speed differential between motorists and bicyclists is low and/or to fill short gaps in the bikeway network.	LOCAL
BIKE LANE ●●○○ Exclusive space for bicyclists through the use of pavement markings and signage (without buffers or barriers).	COLLECTOR ARTERIAL
BUFFERED BIKE LANE ●●●○ Traditional bike lane separated by painted buffer to vehicle travel lanes and/or parking lanes.	COLLECTOR ARTERIAL
PROTECTED BIKE LANE ●●●● Physically separated bikeway. Could be one or two way and protected by a variety of techniques	COLLECTOR ARTERIAL
PATHWAY ●●●● Completely separated from roadway, typically shared with pedestrians	COLLECTOR ARTERIAL

0 2 4 6 8 10 15+ 20+ 25+ 30+

15 20 25 30 35 40 45 50 55 60+

POSTED TRAVEL SPEED (mph)

LEGEND

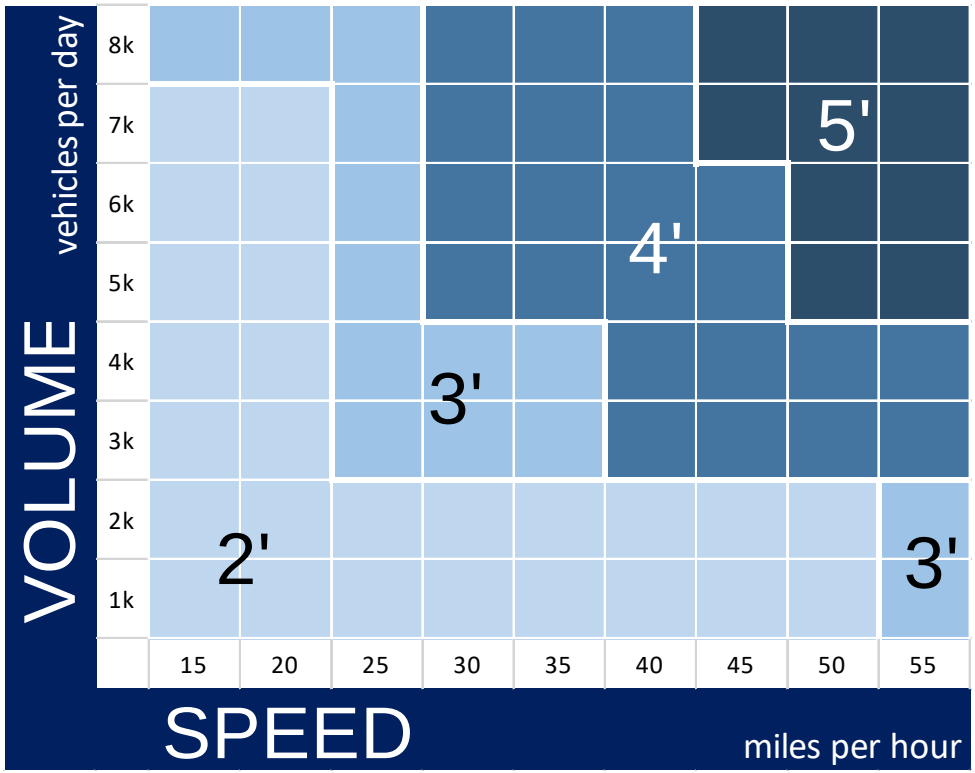
SEPARATION
- ●○○○ Minimal Separation
- ●●○○ Moderate Separation
- ●●●○ Good Separation
- ●●●● High Separation

	min	VOLUME	max
	min	SPEED	max
	Acceptable	Desired	Acceptable

Rural Town, Suburban, Urban, and Urban Core Bicycle Considerations

pennsylvania

Rural Shared Road Considerations



Shoulder Width Considerations for Rural, Rural Town, and Suburban Bicycle Accommodation

pennsylvania

Design Guidance

- ✓ Shared Roads
- ✓ Bicycle Boulevards
- ✓ Shoulder Bikeways / Bike Lanes
- ✓ Visually Separated (Conventional) Bike Lanes
- ✓ Physically Separated Bike Lanes
- ✓ Vertical Traffic Calming
- ✓ Horizontal Traffic Calming
- ✓ Traffic Diversion
- ✓ Minor Intersection Treatments
- ✓ Major Intersection Treatments
- ✓ Single Lane Roundabouts
- ✓ Railroad Grade Crossing
- ✓ Marked / Unsignalized Crossings
- ✓ Shared-Use Paths
- ✓ Bicycle Parking
- ✓ Local Neighborhood Access ways

Marked Shared Roadway

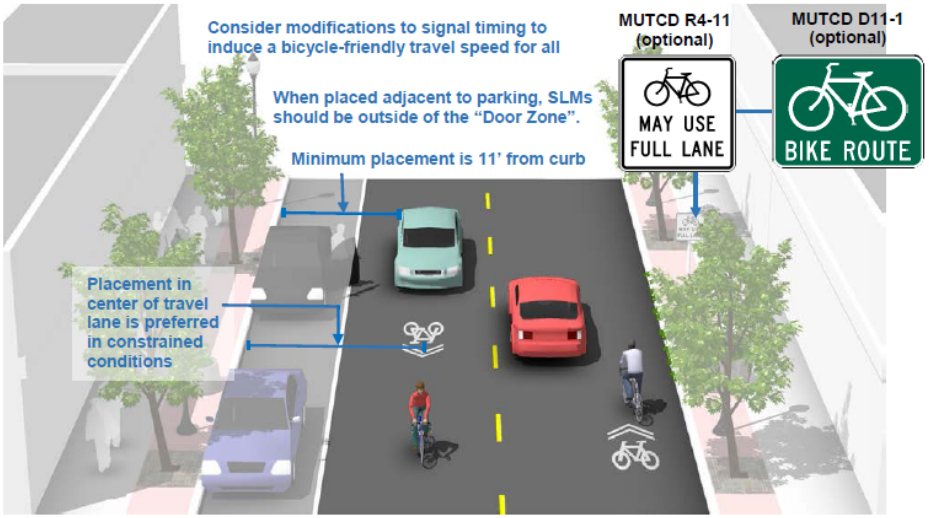
A marked shared roadway is a general-purpose travel lane marked with shared lane markings (SLM) used to encourage bicycle travel and proper positioning within the lane. In constrained conditions, the SLMs are placed in the middle of the lane. On a wide outside lane, the SLMs can be used to promote bicycle travel to the right of motor vehicles. In all conditions, SLMs should be placed outside of the door zone of parked cars.

If the roadway is a collector or arterial, this should not be a substitute for dedicated bicycle facilities if space is available.

Bike Lanes should be considered on roadways with outside travel lanes wider than 15 feet, or where other lane narrowing or removal strategies may provide adequate road space. SLMs shall not be used on shoulders, in designated bike lanes, or to designate bicycle detection at signalized intersections. (MUTCD 9C.07)

Guidance

- May be used on streets with a speed limit of 35 mph or under. Lower than 30 mph speed limit preferred.
- In constrained conditions, preferred placement is in the center of the travel lane to minimize wear and promote single file travel.
- Minimum placement of SLM marking centerline is 11 feet from edge of curb where on-street parking is present, 4 feet from edge of curb with no parking. If parking lane is wider than 7.5 feet, the SLM should be moved further out accordingly.



Design Manual 2 Rewrite

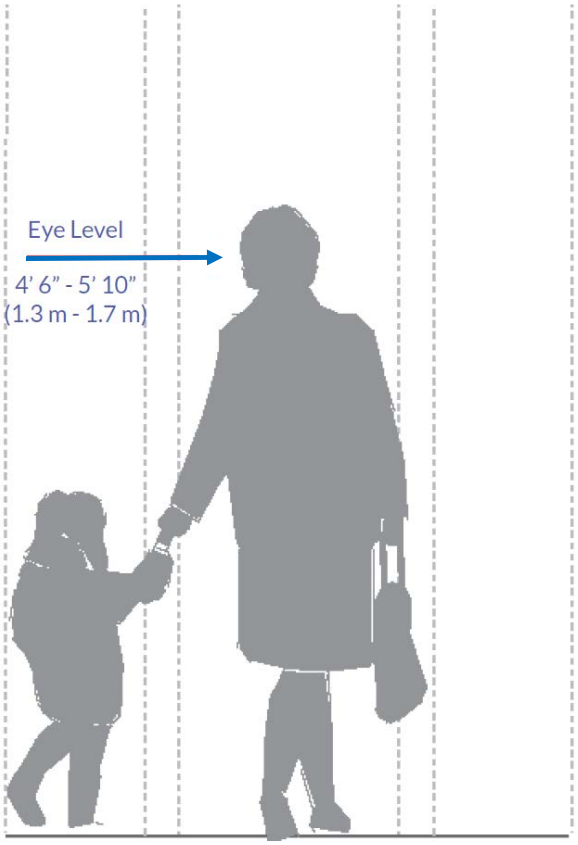
Chapter 13 – Pedestrian Facilities

pennsylvania

Key Design Components

- Manage Traffic Speeds
- Pay Attention to Crossings and Intersections
- Separate Pedestrians from the Roadway
- Ensure Walkway Continuity
- Remember Younger People, the Aging, and Persons with Disabilities
- Take Precautions for Backing Vehicles

Pedestrian as a Design Vehicle



Shoulders – 1' 10"

Walking - 2' 6"

Preferred Operating Space – 5'

Age	Characteristics
0 - 4	Learning to walk
	Requires constant adult supervision
	Developing peripheral vision and depth perception
5 - 8	Increasing independence, but still requires supervision
	Poor depth perception
9 - 13	Susceptible to "darting out" in roadways
	Insufficient judgment
	Sense of invulnerability
14 - 18	Improved awareness of traffic environment
	Insufficient judgment
19 - 40	Active, aware of traffic environment
41 - 65	Slowing of reflexes
65+	Difficulty crossing street
	Vision loss
	Difficulty hearing vehicles approaching from behind

Source: AASHTO. *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, Exhibit 2-1. 2004.

Selecting the Appropriate Facility

Shared Roadway

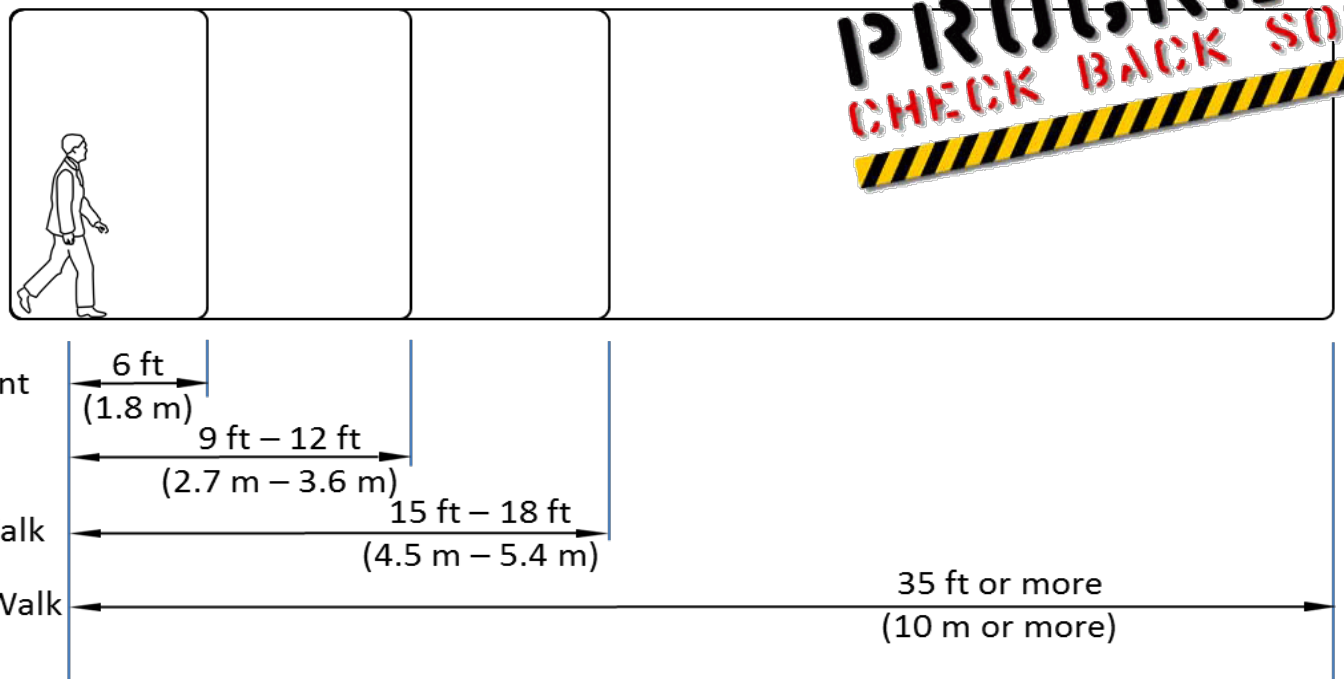
Pedestrian Lane/Path

Shared Use Path

Sidewalk

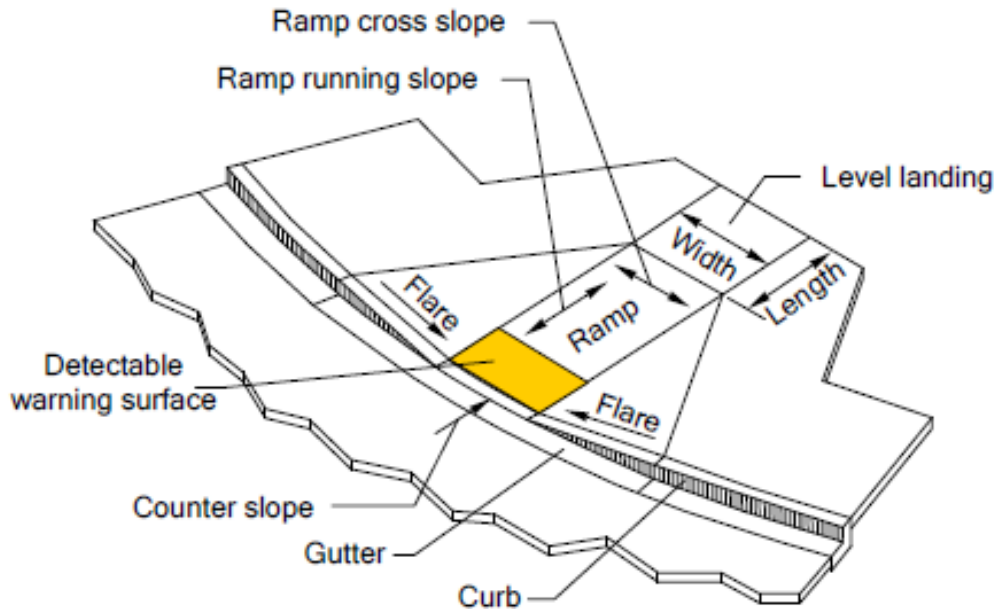
Pedestrian Attributes

- Pedestrian Travel Speed
- Flow Rate
- Spatial Characteristics



Pedestrian Facility Design

pennsylvania



pennsylvania

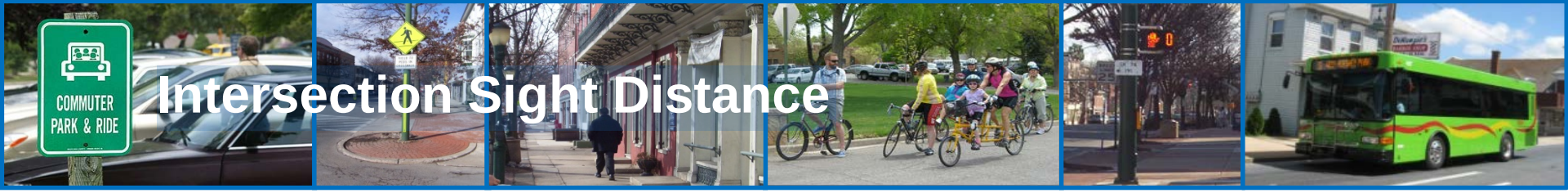
Design Manual 2 Rewrite

Chapter 17 – “Plain People” Community Considerations

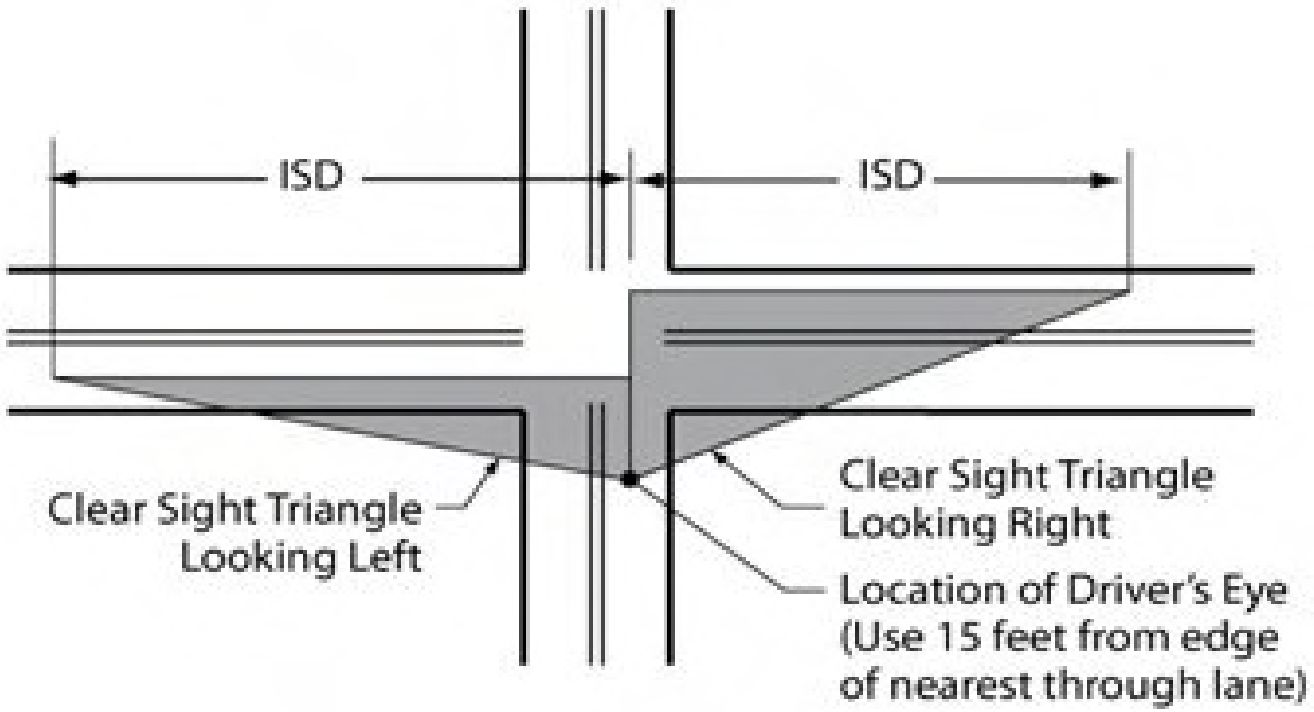
pennsylvania

Key Context Questions

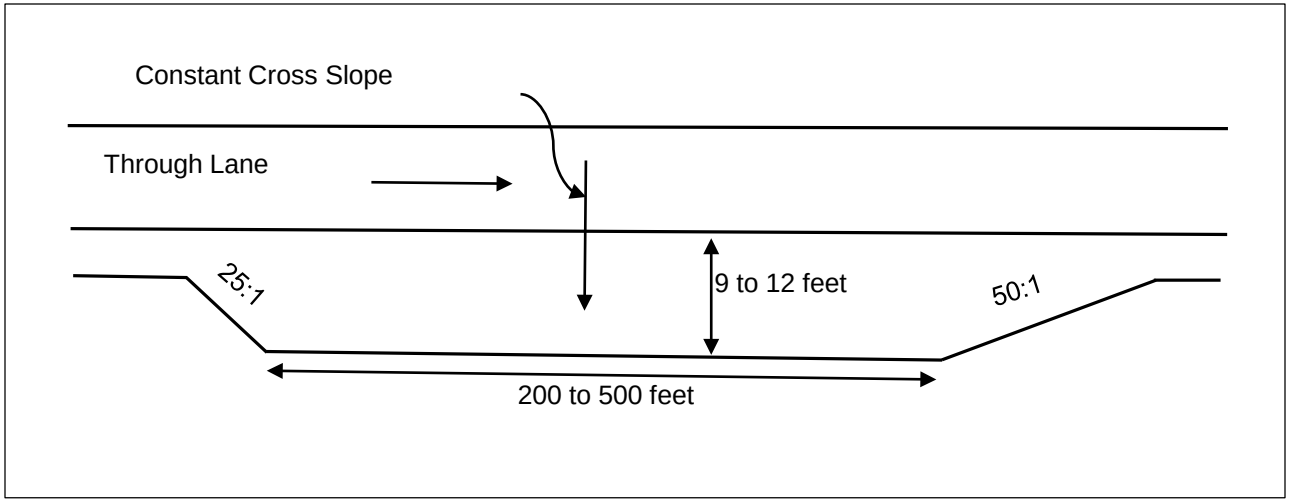
- *Are the Plain People Community considerations along an urban or rural corridor?*
- *What types of Plain People Community transportation modes will likely use the facility (e.g., pedestrians, scooter, roller skate/roller blade, horseback, horse & buggy, farm equipment)?*
- *Is the corridor along a primary walking path to the Plain People Community school?*
- *Are there destination points for the Plain People Community along the corridor (e.g. markets, work places, etc…)?*



Intersection Sight Distance



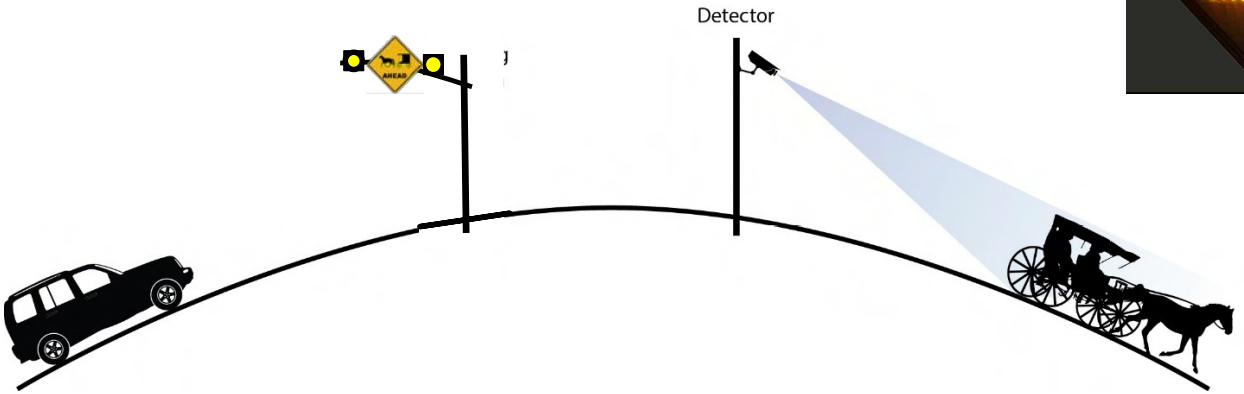
Horse-Drawn Vehicle Turnout



D16-102

D16-103

Horse-Drawn Vehicle Warning Detection System

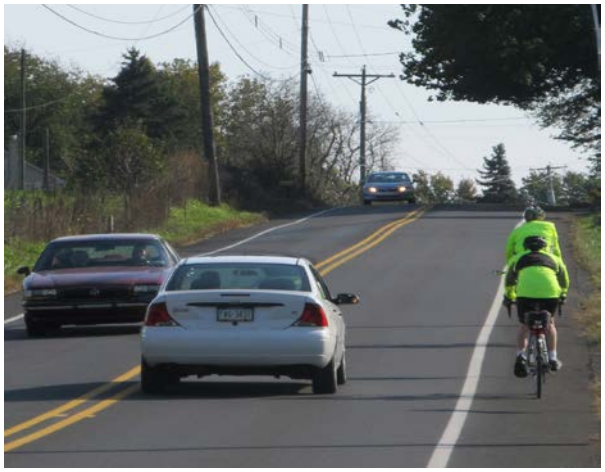


pennsylvania

DM 2 Outline

	Preface	Design Guidance
1	Context-Based Design	
2	Design Controls	
3	New Construction and Reconstruction Projects	Project Type Specifics
4	3R Projects	
5	Pavement Preservation Projects	
6	Bridge Projects	
7	Interchanges	Design Details
8	Intersections and Driveways	
9	Maintenance and Protection of Traffic	
10	Drainage	
11	Erosion and Sedimentation Control	
12	Guide Rail, Median Barrier, and Roadside Safety Devices	

13	Pedestrian Facilities	Modal Considerations
14	Bicycle Facilities	
15	Transit Facilities	
16	Freight Facilities	
17	Plain People Community Considerations	
18	Traffic Calming	Additional Topics
19	Road Diet	
21	Parking	
22	Lighting	
23	Wildlife Crossings	
24	Landscape Planting	
25	Emergency Escape Ramps	
26	Rest Areas and Welcome Centers	
27	Project Development Considerations	



pennsylvania

Contact Information

Brian E. Shunk, P.E.
Project Development Engineer

PennDOT - Bureau of Project Delivery
400 North Street – 7th Floor Harrisburg, PA 17120

Phone: 717.214.1276
bshunk@pa.gov