

**I-80 Design Criteria**  
 Pennsylvania Department of Transportation, District 5-0  
 Agreement No. E02656, Monroe County  
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	Functional Classification Map	Urban Interstate	Urban Interstate	ITMS Data Attached
Terrain	AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-32	4 or More 12'-0" Lanes	4-6 12'-0" lanes	
Shoulder Width	DM2 pg 1-32	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	12'-0" Right Shoulder 10'-0" Median Shoulder	12' used because truck traffic > 250 DDHV, shoulder widths provided in scope (attached)
Median Width	DM2 pg 1-32	2 Lane Directional: 10'-0" Min 3+ Lane Directional: 22'-0" Min Max = 6.0%	26'-0" Min Max = 6.0%	Two 12'-0" Shoulders and a 2'-0" Median Barrier, Truck Traffic > 250
Cross Slope / Superelevation	DM2 pg 1-32	Min = 2.0%	Min = 2.0%	
Bridge Width	DM2 pg 1-32	Lane Widths + Right Shoulder + 6'-0" Left Shoulder	Lane Widths + Right Shoulder + 6'-0" Left Shoulder	
Vertical Grades	2005 AASHTO Publication pg. 3	Max = 4%	Max. = 4%	
	DM2 pg 1-32	Min = 0.5%	Min = 0.5%	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14' Min	
Vertical Clearance	AASHTO Green Book pg 506 & DM2 Sect. 2.20 pg 2-47	16'-0" Min. + 6" for resurfacing	16'-6"	
Horizontal Curvature	AASHTO Green Book, Exhibit 3-15 pg 147	Min Radius = 1,330'	Min Radius = 1,330'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Zone Widths	DM2 Chapter 12	See Table 12.1	See Table 12.1	See attached table
Guide Rail and Median Barrier	DM2 Chapter 12	See Table 12.3	See Table 12.3	See attached table
Design Speed	DM2 Chapter 12	50 - 70 MPH	60 MPH	Posted at 50MPH
Vertical Sight Distance	AASHTO Green Book, Exhibit 3-72, pg 272	Stopping Sight Distance = 570'	Stopping Sight Distance = 570'	

**NOTES:**

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)*; 2005 AASHTO Publication, *A Policy on Design Standards - Interstate System*; and the AASHTO Greenbook, 2004 Edition

**Interchange 303 - PA611 Design Criteria**  
Pennsylvania Department of Transportation, District 5-0  
Agreement No. E02656, Monroe County  
SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	Functional Class Map	Urban Minor Arterial	Urban Minor Arterial	ITMS Data Attached
Roadway Typology	DM2 pg 1-7	Regional Suburban Corridor	Regional Suburban Corridor	
Terrain	DM2, pg 2-11 AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-12	11' - 12'	11'-12'	
Shoulder Width	DM2 pg 1-12	8'-12'	8'-12'	
Bike Lane	DM2 pg 1-12	6' (if no shoulder)	NA	Match existing section
Median Width (if needed)	DM2 pg 1-12	16' - 18' For Left Turn; 6' to 8' for Peds	16' - 18' For Left Turn; 6' to 8' for Peds	
Curb Return	DM2 pg 1-12	30' - 50'	NA	No curbs on existing roadway
Travel Lanes	DM2 pg 1-12	4 - 6	4	
Cross Slope / Superelevation	DM2 pg 1-12	Max = 6.0%	Max = 6.0%	
		Min = 2.0%	Min = 2.0%	
Bridge Width	DM2 pg 1-12	Lane Width + Shoulder each side	Lane Width + Shoulder each side	
Vertical Grades	AASHTO Greenbook, pg 472	Max. = 7%	Max. = 7%	
Vertical Clearance	DM2 pg 1-12	Min = 0.5%	Min = 0.5%	
Vertical Clearance	DM2 pg 2-50	16' 0" MIN + 6" for resurfacing	16'-6" Min	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0"	
Horizontal Curvature	AASHTO Green Book, pg 147	Min Radius = 643'	Min Radius = 643'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Compound Curve Length	AASHTO Green Book, pg 202	60' to 200' minimum	See exhibit 3-42, pg 202	
Clear Zone Widths	DM2 Chapter 12	See Table 12.1	See Table 12.1	See attached Table
Guide Rail and Median Barrier	DM2 Chapter 12	See Table 12.3	See Table 12.3	See attached Table
Desired Operating Speed	DM2 pg 1-12 & 2-11	35 - 55 MPH	45 MPH	Posted 45MPH
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	Stopping Sight Distance= 360'	Stopping Sight Distance = 360'	

**NOTES:**

1) The design criteria for this project are taken from PENNDOT Publication 13M, Design Manual Part 2 (Aug 2009 ED); 2005 AASHTO Publication, A Policy on Design Standards - Interstate System;



**Inerchange 304 - US-209 Design Criteria**  
 Pennsylvania Department of Transportation, District 5-0  
 Agreement No. E02656, Monroe County  
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification Roadway Typology	Functional Classification Map DM2, pg 2-17	Urban Other Principal Arterial Urban Non-Interstate	Urban Other Principal Arterial Urban Non-Interstate	ITMS Data Attached
Terrain	DM2, pg 2-11 AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-32	4 or More 12'-0" Lanes	4 12'-0" lanes	
Shoulder Width	DM2 pg 1-32	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	12'-0" Right Shoulder 10'-0" Median Shoulder	12' used because truck traffic > 250 DDHV
Median Width	DM2 pg 1-32	2 Lane Directional: 10'-0" Min	10'-0" Min	
Cross Slope / Superelevation	DM2 pg 1-32	Max = 6.0%	Max = 6.0%	
		Min = 2.0%	Min = 2.0%	
Bridge Width	DM2 pg 1-32	Lane Widths + Right Shoulder + 6'-0" Left Shoulder	Lane Widths + Right Shoulder + 6'-0" Left Shoulder	
Vertical Grades	2005 AASHTO Publication pg. 3 DM2 pg 1-32	Max = 4%	Max. = 4%	
		Min = 0.5%	Min = 0.5%	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14' Min	
Vertical Clearance	AASHTO Green Book pg 506 & DM2 Sect. 2.20 pg 2-47	16'-0" Min. + 6" for resurfacing	16'-6"	
Horizontal Curvature	AASHTO Green Book, Exhibit 3-15 pg 147	Min Radius = 1,330'	Min Radius = 1,330'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Zone Widths	DM2 Chapter 12	See Table 12.1	See Table 12.1	See attached table
Guide Rail and Median Barrier	DM2 Chapter 12	See Table 12.3	See Table 12.3	See attached table
Design Speed	DM2 Chapter 12	50 - 70 MPH	60 MPH	Posted at 55MPH
Vertical Sight Distance	AASHTO Green Book, Exhibit 3-72, pg 272	Stopping Sight Distance = 570'	Stopping Sight Distance = 570'	

**NOTES:**

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*

# Interchange 305 - SR2012, West Main Street Design Criteria

Pennsylvania Department of Transportation, District 5-0  
Agreement No. E02656, Monroe County  
SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	Functional Class Map	Urban - Other Principal Arterial	Urban - Other Principal Arterial	ITMS Data attached
Roadway Typology	DM2 pg 1-7 & 1-16	Community Arterial Suburban Corridor	Community Arterial Suburban Corridor	
Terrain	DM2 pg 2-11, AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-16	11' - 12'	11' - 12'	
Shoulder Width	DM2 pg 1-16	8' to 10'	8' - 10'	
Bike Lane	DM2 pg 1-16	5' - 6' (if no shoulder)	NA	Match existing section
Parking Lane	DM2 pg 1-16	NA	NA	Match existing section
Median Width (if needed)	DM2 pg 1-16	16' - 18' For Left Turn	Not Needed	
Curb Return	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds		
Travel Lanes	DM2 pg 1-16	25'-50'	25'-50'	
		2 - 4	2	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0%	Max = 6.0%	
		Min = 2.0%	Min = 2.0%	
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulder each side	Lane Widths plus Shoulder each side	
Vertical Grades	AASHTO Green Book, Exhibit 7-10 pg 472	Max. = 8%	Max. = 8%	
	DM2 pg 1-16	Min = 0.5%	Min = 0.5%	
Vertical Clearance	DM2 section 2.20 pg 2-50	16' 0" MIN + 6" for resurfacing	16' 6"	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0" Min	
Horizontal Curvature	AASHTO Green Book, pg 168	Min Radius = 485'	Min Radius = 485'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Sidewalk Width	DM2 pg 1-16	5' - 6'	5' - 6'	
Buffer	DM2 pg 1-16	5' - 10'	5' - 10'	
Shy Distance	DM2 pg 1-16	NA	NA	
Total Sidewalk Width	DM2 pg 1-16	5' - 6'	5' - 6'	
Clear Zone Widths	DM2 Chapter 12	Table 12.1	Table 12.1	See attached table
Desired Operating Speed	DM2 pg 1-7 & 1-16	35 - 55 MPH	40 MPH	Posted 40MPH
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	Stopping Sight Distance= 305'	Stopping Sight Distance = 305'	
		Passing Sight Distance= 1470'	Passing Sight Distance = 1470'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*



**Interchange 306 - SR2004, Dreher Ave Design Criteria**  
 Pennsylvania Department of Transportation, District 5-0  
 Agreement No. E02656, Monroe County  
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	Functional Class Map	Urban - Minor Arterial	Urban - Minor Arterial	ITMS Data attached
Roadway Typology	DM2 pg 1-7 & 1-16	Community Arterial Suburban Neighborhood	Community Arterial Suburban Neighborhood	
Terrain	DM2 pg 2-11, AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-16	10' - 12'	10' - 12'	
Shoulder Width	DM2 pg 1-16	4' to 8' (if no parking or bike lane)	4' - 8'	
Bike Lane	DM2 pg 1-16	5' - 6' (if no shoulder)	NA	Match existing section
Parking Lane	DM2 pg 1-16	7' to 8' Parallel	NA	Match existing section
Median Width (if needed)	DM2 pg 1-16	16' - 18' For Left Turn	Not Needed	
Curb Return	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds		
Travel Lanes	DM2 pg 1-16	25'-35'	25'-35'	
		2 - 4	2	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0%	Max = 6.0%	3% min Cross Slope recommended for DS < 40 MPH; 3% Cross Slope may be on Tangents if vertical grade < 1%
Bridge Width	DM2 pg 1-16	Min = 2.0%, 3.0% Desired	Min = 2.0%, 3.0% Desired	
Vertical Grades	AASHTO Green Book, Exhibit 7-10 pg 472	Lane Widths plus Shoulders each side	Lane Widths plus Shoulders each side	
	DM2 pg 1-16	Max. = 8%	Max. = 8%	
Vertical Clearance	DM2 section 2.20 pg 2-50	Min = 0.5%	Min = 0.5%	
Lateral Clearance to Structures	DM2 pg 4-3	16' 0" MIN + 6" for resurfacing	16' 6"	
Horizontal Curvature	AASHTO Green Book, pg 168	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0" Min	
Compound Curve Ratio	AASHTO Green Book, pg 201	Min Radius = 340'	Min Radius = 485'	
Clear Sidewalk Width	DM2 pg 1-16	1.5:1	1.5:1	
Buffer	DM2 pg 1-16	5'	5'	
Total Sidewalk Width	DM2 pg 1-16	6'+	6'+	
Clear Zone Widths	DM2 Chapter 12	5'	5'	
Desired Operating Speed	DM2 pg 1-7 & 1-16	Table 12.1	Table 12.1	See attached table
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	30-35 MPH	35 MPH	Posted 35MPH
		Stopping Sight Distance= 250'	Stopping Sight Distance = 250'	
		Passing Sight Distance= 1280'	Passing Sight Distance = 1280'	

**NOTES:**

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*

**Interchange 307 - PA611 Design Criteria**  
 Pennsylvania Department of Transportation, District 5-0  
 Agreement No. E02656, Monroe County  
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	Functional Class Map	Urban - Minor Arterial	Urban - Minor Arterial	iTMS Data attached
Roadway Typology	DM2 pg 1-7 & 1-16	Community Arterial Suburban Neighborhood	Community Arterial Suburban Neighborhood	
Terrain	DM2 pg 2-11, AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-16	11' - 12'	11' - 12'	
Shoulder Width	DM2 pg 1-16	8' to 10'	8' - 10'	
Bike Lane	DM2 pg 1-16	6' (if no shoulder)	NA	Match existing section
Parking Lane	DM2 pg 1-16	7' to 8' Parallel	NA	Match existing section
Median Width (if needed)	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds	12' - 18' For Left Turn; 6' to 8' for Peds	
Curb Return	DM2 pg 1-16	25'-50'	25'-50'	
Travel Lanes	DM2 pg 1-16	2 - 4	2	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0% Min = 2.0%	Max = 6.0% Min = 2.0%	
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulders each side	Lane Widths plus Shoulders each side	
Vertical Grades	AASHTO Greenbook pg 472	Max. = 8% Min = 0.5%	Max. = 8% Min = 0.5%	
Vertical Clearance	DM2 pg 1-16	16' 0" MIN + 6" for resurfacing	16' 6"	
Lateral Clearance to Structures	DM2 pg 2-50	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0" Min	
Horizontal Curvature	AASHTO Green Book, pg 168	Min Radius = 340'	Min Radius = 340'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Zone Widths	DM2 Chapter 12	Table 12.1	Table 12.1	See attached table
Guide Rail and Median Barrier	DM2 Chapter 12	Table 12.3	Table 12.3	See attached table
Desired Operating Speed	DM2 pg 1-16 & pg 2-11	35-50 MPH	35 MPH	Posted 35MPH
Sight Distance	DM2 pg 1-16 & AASHTO Greenbook pg 445	Stopping Sight Distance= 250'	Stopping Sight Distance = 250'	

**NOTES:**

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*



**Interchange 307 - SR191 Design Criteria**  
 Pennsylvania Department of Transportation, District 5-0  
 Agreement No. E02656, Monroe County  
 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	Functional Class Map	Urban Other Principal Arterial	Urban Other Principal Arterial	ITMS Data attached
Roadway Typology	DM2 pg 1-7 & 1-16	Community Arterial Suburban Corridor	Community Arterial Suburban Corridor	
Terrain	DM2 pg 2-11, AASHTO Greenbook pg 231	Rolling	Rolling	
Lane Widths	DM2 pg 1-16	11' - 12'	11' - 12'	
Shoulder Width	DM2 pg 1-16	8' to 10'	8' - 10'	
Bike Lane	DM2 pg 1-16	5'-6' (if no shoulder)	NA	Match existing section
Median Width (if needed)	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds	12' - 16' For Left Turn; 6' to 8' for Peds	
Curb Return	DM2 pg 1-16	25'-50'	25'-50'	
Travel Lanes	DM2 pg 1-16	2 - 4	2	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0% Min = 2.0%	Max = 6.0% Min = 2.0%	
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulders each side	Lane Widths plus Shoulders each side	
Vertical Grades	AASHTO Greenbook pg 472	Max. = 8%	Max. = 8%	
	DM2 pg 1-16	Min = 0.5%	Min = 0.5%	
Vertical Clearance	DM2 pg 2-50	16' 0" MIN + 6" for resurfacing	16'-6" Min	
Lateral Clearance to Structures	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protecting walls or piers	14'-0" Min	
Horizontal Curvature	AASHTO Green Book, pg 168	Min Radius = 340'	Min Radius = 340'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Zone Widths	DM2 Chapter 12	Table 12.1	Table 12.1	See attached table
Guide Rail and Median Barrier	DM2 Chapter 12	Table 12.3	Table 12.3	See attached table
Desired Operating Speed	DM2 pg 1-16 & pg 2-11	35-50 MPH	35 MPH	Posted 35MPH
Sight Distance	DM2 pg 1-16 & AASHTO Greenbook pg 445	Stopping Sight Distance= 250'	Stopping Sight Distance = 250'	

**NOTES:**

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)* and *The AASHTO Greenbook, 2004 Edition*

## I-80 Design Criteria

Pennsylvania Department of Transportation, District 5-0  
Agreement No. E02656, Monroe County  
SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	DM2 pg 1-7 & Functional Classification Map	Regional Arterial Suburban Corridor	Regional Arterial Suburban Corridor	
Terrain	PENNDOT	Rolling	Rolling	
Lane Widths	DM2 pg 1-12	11' - 12'	12'-0"	
Shoulder Width	DM2 pg 1-12	8' - 12'	10' RT; 4' LT	
Bike Lane	DM2 pg 1-12	6' (if No Shoulder)	NA	
Median Width (if needed)	DM2 pg 1-12	16' - 18' for LT Turn; 6' - 8' for Peds Only	10'	Min 4' - 6' OK in areas without at-grade intersections per AASHTO Green Book pg 456
Curb Return	DM2 pg 1-12	30' - 50'	NA	
Travel Lanes	DM2 pg 1-12	4-6	4	
Cross Slope / Superelevation	DM2 pg 1-12	Max = 6.0% Min = 2.0%	Max = 6.0% Min = 2.0%	
Bridge Width	DM2 pg 1-12	Pavement Width + Shoulder each side	Pavement Width + 10' RT Shld + 4' LT Shld	For bridges over 200' length shoulder may be reduced to 4' on each side (Note 16 DM-2 pg 1-13) & AASHTO Green Book pg 455
Vertical Grades	AASHTO Green Book, pg 472	Max = 7% - 5% Min = 0.5%	Max = 7% Min = 0.5%	
Vertical Clearance	DM2 pg 1-12	16'-6" (Min.)	16'-6" (Min.)	
Horizontal Clearance	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protecting walls or piers	14'-0"	
Horizontal Curvature	AASHTO Green Book, pg 168	Min Radius = 340' - 1060'	Min Radius = 833'	
Compound Curve Ratio	AASHTO Green Book, pg 201	1.5:1	1.5:1	
Clear Zone Widths	DM2 pg 1-12	See DM-2, Chapter 12	See DM-2, Chapter 12	
Guide Rail and Median Barrier	DM2 pg 1-12	See DM-2, Chapter 12	See DM-2, Chapter 12	
Desired Operating Speed	DM2 pg 1-12 & pg 2-11	35 - 55 MPH	50 MPH	
Sight Distance	DM2 pg 1-12 & AASHTO Green Book pg 445	Stopping Sight Distance=250' - 495'	Stopping Sight Distance = 425'	

### NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)*



**I-80 Design Criteria**  
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 SR 0080, Section 17M

Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	DM2 pg 1-7 & Functional Class Map PENNDOT, AASHTO pg 231	Community Arterial (Town/Village/Neighborhood) Rolling	Community Arterial (Town/Village/Neighborhood) Rolling	
Terrain				
Lane Widths	DM2 pg 1-16	10' - 12'	12'	
Shoulder Width	DM2 pg 1-16	4' to 6' (if no parking or bike lane)	6'	
Bike Lane	DM2 pg 1-16	5' - 6'	NA	Not provided to match adjoining section
Parking Lane	DM2 pg 1-16	7' to 8' Parallel	NA	Not provided to match adjoining section
Median Width (if needed)	DM2 pg 1-16	16' - 18' For Left Turn	NA	Not Needed
Curb Return	DM2 pg 1-16	12' - 18' For Left Turn; 6' to 8' for Peds		
Travel Lanes	DM2 pg 1-16	15' - 30'	15' - 30'	Should be as small as possible
		2 - 4	2 - 4	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0%	Max = 6.0%	3% min Cross Slope recommended for DS < 40 MPH;
		Min = 3.0%	Min = 3.0%	3% min Cross Slope recommended on Targets if Vert. Grade < 1%
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulder each side	Lane Widths plus Shoulder each side	Bridges over 200' in length, shoulder may be 4' each side; On curbed approaches: curb to curb width = bridge width
Vertical Grades	AASHTO Green Book, Exhibit 7-10 pg 472	Max. = 8%	Max. = 8%	0.75% Min Recommended Grade on Curbed Sections
Vertical Clearance	DM2 pg 1-16	Min = 0.5% - 0.75% (if curbed) 16' 0" MIN + 6" for resurfacing	Min = 0.5% - 0.75% 16' 6"	
Horizontal Clearance	DM2 pg 4-3	14' Lateral Clearance to front face of barrier protectings walls or piers Min Radius = 144' - 231'	14' 0"	
Horizontal Curvature	AASHTO Green Book, pg 147	1.5:1	Min Radius = 340'	
Compound Curve Ratio	AASHTO Green Book, pg 201	60' to 200' minimum	See exhibit 3-42, pg 202	(in the direction of sharper curvature)
Compound Curve Length	AASHTO Green Book, pg 202	6' - 8'	6'	(min length of compound curve)
Clear Sidewalk Width	DM2 pg 1-16	4' - 6'	4'	Need to check vs future pedestrian volumes
Buffer	DM2 pg 1-16	0' - 2'	0'	(grass area between shldr & sidewalk)
Shy Distance	DM2 pg 1-16	10' - 16'	10' 0"	
Total Sidewalk Width	DM2 pg 1-16	See DM-2, Chapter 12	See DM-2, Chapter 12	
Clear Zone Widths	DM2 pg 1-16	25 - 55 MPH	35 MPH	
Desired Operating Speed	DM2 pg 1-7 & 1-16	Stopping Sight Distance= 250'	Stopping Sight Distance = 250'	
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	Passing Sight Distance= 1280'	Passing Sight Distance = 1280'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)*

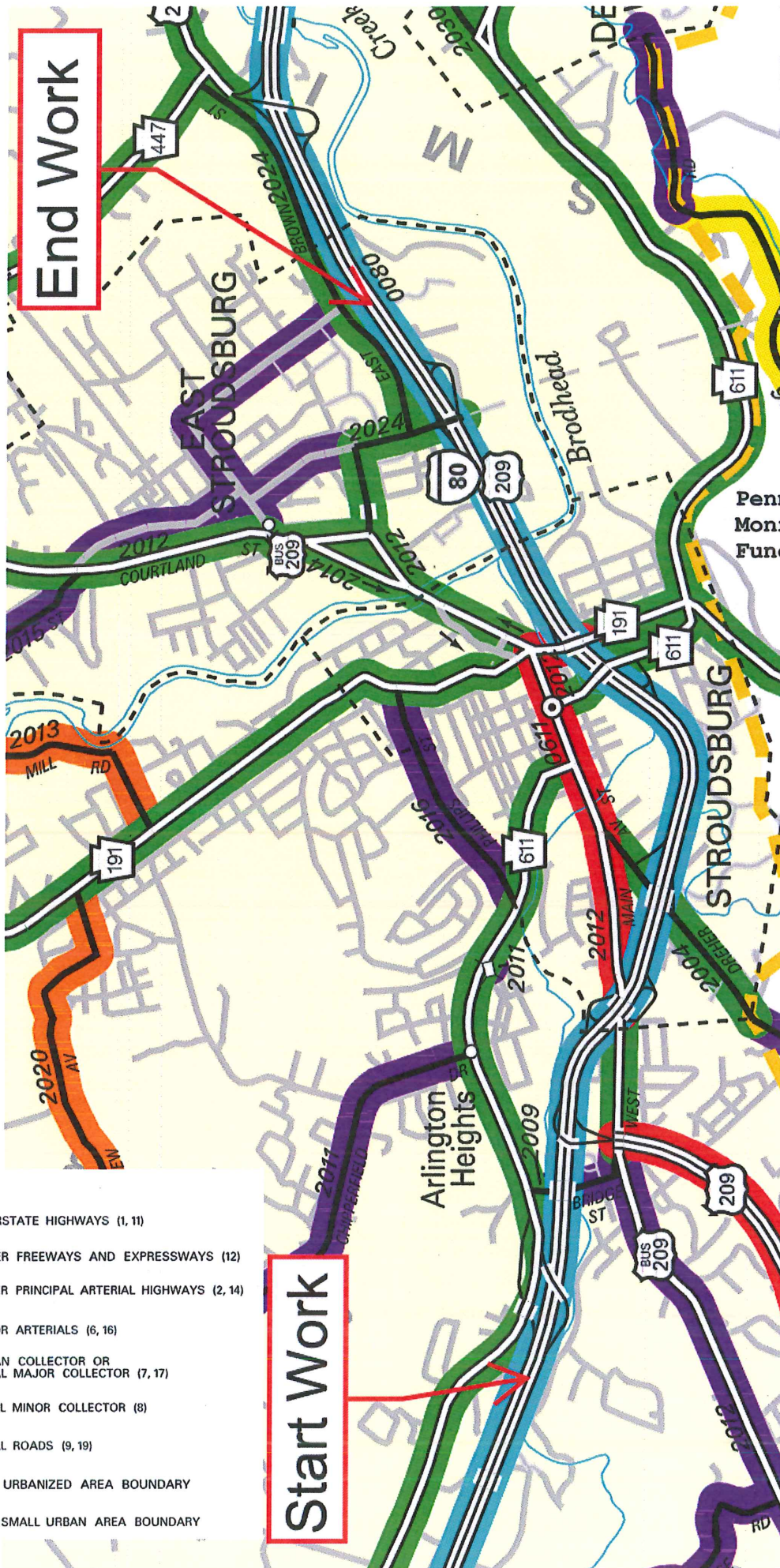
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Design Element	Criteria Source	Standard Criteria	Applied Criteria	Comments
Functional Classification	DM2 pg 1-7 & Functional Class Map PENNDOT, AASHTO pg 231	Community Arterial (Town/Village/Neighborhood) Rolling	Community Arterial (Town/Village/Neighborhood) Rolling	
Terrain				
Lane Widths	DM2 pg 1-16	10' - 12'	12'	
Shoulder Width	DM2 pg 1-16	4' to 6' (if no parking or bike lane)	6'	
Bike Lane	DM2 pg 1-16	5' - 6'	NA	Not provided to match adjoining section
Parking Lane	DM2 pg 1-16	7' to 8' Parallel	NA	Not provided to match adjoining section
Median Width (if needed)	DM2 pg 1-16	16' - 18' For Left Turn 12' - 18' For Left Turn; 6' to 8' for Peds	NA	Not Needed
Curb Return	DM2 pg 1-16	15' - 30'	15' - 30'	Should be as small as possible
Travel Lanes	DM2 pg 1-16	2 - 4	2 - 4	
Cross Slope / Superelevation	DM2 pg 1-16	Max = 6.0%  Min = 3.0%	Max = 6.0%  Min = 3.0%	3% min Cross Slope recommended for DS < 40 MPH; 3% min Cross Slope recommended on Targets if Vert. Grade < 1%
Bridge Width	DM2 pg 1-16	Lane Widths plus Shoulder each side	Lane Widths plus Shoulder each side	Bridges over 200' in length, shoulder may be 4' each side; On curbed approaches: curb to curb width = bridge width
Vertical Grades	AASHTO Green Book, Exhibit 7-10 pg 472	Max. = 8%  Min = 0.5% - 0.75% (if curbed) 16' 0" MIN + 6" for resurfacing	Max. = 8%  Min = 0.5% - 0.75% 16' 6"	0.75% Min Recommended Grade on Curbed Sections
Vertical Clearance	DM2 section 2.20 pg 2-47	14' Lateral Clearance to front face of barrier protectings walls or piers	14'-0"	
Horizontal Clearance	DM2 pg 4-3	Min Radius = 144' - 231'	Min Radius = 340'	
Horizontal Curvature	AASHTO Green Book, pg 147	1.5:1	1.5:1	(in the direction of sharper curvature)
Compound Curve Ratio	AASHTO Green Book, pg 201	60' to 200' minimum	See exhibit 3-42, pg 202	(min length of compound curve)
Compound Curve Length	AASHTO Green Book, pg 202	6' - 8'	6'	Need to check vs future pedestrian volumes
Clear Sidewalk Width	DM2 pg 1-16	4' - 6'	4'	(grass area between shldr & sidewalk)
Buffer	DM2 pg 1-16	0' - 2'	0'	
Shy Distance	DM2 pg 1-16	10' - 16'	10'-0"	
Total Sidewalk Width	DM2 pg 1-16	See DM-2, Chapter 12	See DM-2, Chapter 12	
Clear Zone Widths	DM2 pg 1-16	25 - 55 MPH	35 MPH	
Desired Operating Speed	DM2 pg 1-7 & 1-16	Stopping Sight Distance= 250'	Stopping Sight Distance = 250'	
Sight Distance (minimum)	AASHTO Green Book, Exhibit 7-1 pg 445	Passing Sight Distance= 1280'	Passing Sight Distance = 1280'	

NOTES:

1) The design criteria for this project are taken from PENNDOT Publication 13M, *Design Manual Part 2 (Aug 2009 ED)*





End Work

Start Work

# LEGEND

- INTERSTATE HIGHWAYS (1, 11)
- OTHER FREEWAYS AND EXPRESSWAYS (12)
- OTHER PRINCIPAL ARTERIAL HIGHWAYS (2, 14)
- MINOR ARTERIALS (6, 16)
- URBAN COLLECTOR OR RURAL MAJOR COLLECTOR (7, 17)
- RURAL MINOR COLLECTOR (8)
- LOCAL ROADS (9, 19)
- 2000 URBANIZED AREA BOUNDARY
- 2000 SMALL URBAN AREA BOUNDARY

PennDOT  
Monroe County  
Funct Class Map

**TABLE 1.2**  
**ROADWAY TYPOLOGIES**

ROADWAY CLASS	ROADWAY TYPE	DESIRED OPERATING SPEED	AVERAGE TRIP LENGTH	VOLUME	INTERSECTION SPACING	COMMENTS
Arterial	Regional	50-90 km/h (30-55 mph)	24-56 km (15-35 mi)	10,000-40,000 veh/day	200-400 m (660-1,320 ft)	Roadways in this category would be considered "Principal Arterial" in traditional functional classification.
Arterial	Community	40-90 km/h (25-55 mph)	11-40 km (7-25 mi)	5,000-25,000 veh/day	90-400 m (300-1,320 ft)	Often classified as "Minor Arterial" in traditional classification but may include road segments classified as "Principal Arterial".
Collector	Community	40-90 km/h (25-55 mph)	8-16 km (5-10 mi)	5,000-15,000 veh/day	90-200 m (300-660 ft)	Often similar in appearance to a community arterial. Typically classified as "Major Collector".
Collector	Neighborhood	40-60 km/h (25-35 mph)	< 11 km (< 7 mi)	< 6,000 veh/day	90-200 m (300-660 ft)	Similar in appearance to local roadways. Typically classified as "Minor Collector".
Local	Local	30-50 km/h (20-30 mph)	< 8 km (< 5 mi)	< 3,000 veh/day	60-200 m (200-660 ft)	

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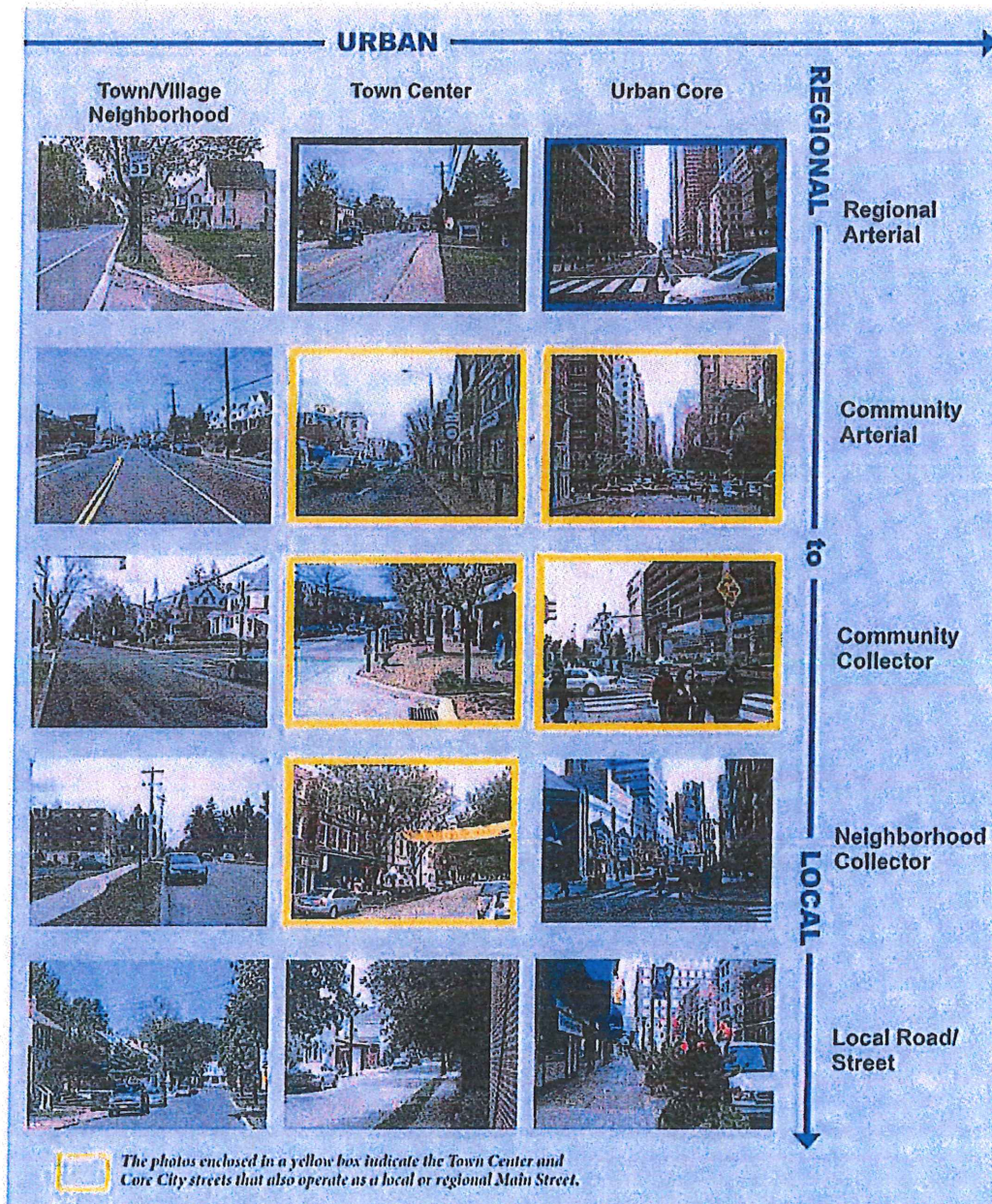


**FIGURE 1.2  
ILLUSTRATED ROADWAY TYPOLOGIES**





**FIGURE 1.2 (CONTINUED)**  
**ILLUSTRATED ROADWAY TYPOLOGIES**





**TABLE 1.4 (ENGLISH)  
MATRIX OF DESIGN VALUES – COMMUNITY ARTERIAL**

Community Arterial	Rural	Suburban Neighborhood	Suburban Corridor	Suburban Center	Town/Village Neighborhood	Town/Village Center	Urban Core
Lane Width <sup>1</sup>	11' to 12'	10' to 12'	11' to 12'	10' to 12'	10' to 12'	10' to 12'	10' to 12'
Shoulder Width <sup>2,3</sup>	8' to 10'	4' to 8' (if No Parking or Bike Lane)	8' to 10'	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 <sup>16</sup>	NA	7' to 8' Parallel	NA	8' Parallel	7' to 8' Parallel	7' to 8' Parallel	7' to 8' Parallel
Bike Lane <sup>4</sup>	NA	5' to 6' (if No Shoulder)	5' to 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 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians	16' to 18' for Left Turn 12' to 18' for Left Turn; 6' to 8' for Pedestrians
Curb Return <sup>5</sup>	25' to 50'	25' to 35'	25' to 50'	20' to 40'	15' to 30'	15' to 35'	15' to 40'
Travel Lanes	2 to 4	2 to 4	2 to 4	2 to 4	2 to 4	2 to 4	2 to 4
Cross Slopes (Minimum) <sup>6,7</sup>	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Cross Slopes (Maximum) <sup>8</sup>	8.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Bridge Widths (Two-Lane Facilities) <sup>9,10,17</sup>	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 Facilities) <sup>9,10,17</sup>	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) <sup>11</sup>	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Vertical Clearance (Minimum)	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2
Clear Sidewalk Width	NA	5'	5' to 6'	6'	6' to 8'	6' to 10'	8' to 14'
Buffer <sup>13</sup>	NA	6'+	5' 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'	10' to 14'	10' to 16'	12' to 18'	14' to 22'
Clear Zone Widths <sup>14</sup>	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 <sup>15</sup>	Varies	Varies	Varies	Varies	Varies	Varies	Varies
Desired Operating Speed (Design Speed)	35-55 mph	30-35 mph	35-50 mph	30 mph	25-30 mph	25-30 mph	25-30 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



**TABLE 1.3 (ENGLISH)**  
**MATRIX OF DESIGN VALUES – REGIONAL ARTERIAL**

Regional Arterial	Rural	Suburban Neighborhood	Suburban Corridor	Suburban Center	Town/Village Neighborhood	Town/Village Center	Urban Core
<b>Roadway</b>							
Lane Width <sup>1</sup>	11' to 12'	11' to 12'	11' to 12'	11' to 12'	10' to 12'	10' to 12'	10' to 12'
Shoulder Width <sup>2,3</sup>	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 <sup>4</sup>	NA	5' to 6' (if No Shoulder)	6'	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 <sup>5</sup>	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) <sup>6,7</sup>	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Cross Slopes (Maximum) <sup>8</sup>	8.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Bridge Widths (Two-Lane Facilities) <sup>9, 10, 16</sup>	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) <sup>9, 10, 16</sup>	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) <sup>11</sup>	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Vertical Clearance (Minimum)	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2
Clear Sidewalk Width	NA	5'	5' to 6'	5' to 6'	6' to 8'	6' to 10'	6' to 12'
Buffer <sup>13</sup>	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 <sup>14</sup>	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 <sup>15</sup>	Varies	Varies	Varies	Varies	Varies	Varies	Varies
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



**TABLE 1.3 (ENGLISH) (CONTINUED)**  
**MATRIX OF DESIGN VALUES - REGIONAL ARTERIAL**

1	12' preferred for regular transit routes, and heavy truck volumes > 5%, particularly for design speeds of 35 mph or greater. A 1' to 2' offset to the curb is desirable. 14' for an outside lane with no shoulder or bike lane, if optimal accommodation for bicyclists is desired.
2	Shoulders should only be installed in urban contexts as a retrofit of wide travel lanes to accommodate bicyclists. For rural divided arterials with three or more lanes in each direction, a 10' wide left shoulder within the median is desirable.
3	Paving for railroad grade crossings shall extend 2' beyond the extreme rails for the full graded width of the highway.
4	Design of bike lanes should be considered when identified as part of the Engineering & Environmental (E&E) Scoping process. For additional guidance, refer to Publication 10A, Design Manual, Part 1A, <i>Transportation Engineering Procedures</i> , Appendix J, Bicycle and Pedestrian Checklist.
5	Curb return radius should be as small as possible. Number of lanes, on street parking, bike lanes, and shoulders should be utilized to determine effective radius.
6	Cross slopes of 3.0% are recommended for design speeds less than 40 mph.
7	In curbed areas with longitudinal slopes of 1% or less, 3.0% cross slopes may be used on tangents.
8	For additional guidance, refer to Chapter 2, Sections 2.13.B, Rates of Superelevation and 2.13.C, Maximum Superelevation.
9	On curbed approaches, the minimum bridge width may equal the curb-to-curb width. Where pedestrian traffic is anticipated, provisions for a sidewalk, preferably on the outside of the parapet, should be considered and shall meet the Department's Standards and requirements (see Chapter 6). Where paved or curbed parking lanes exist or have been approved for construction on approaches, the clear roadway width of the proposed bridge in each case shall be determined by the Central Office, Bureau of Design upon receipt of the District Executive's recommendation.
10	For appropriate bridge widths, refer to the Minimum Width Criteria for Bridges.
11	Recommended minimum grade of 0.75% on curbed sections.
12	The Roadside design values should be considered and implemented as feasible and reasonable; however, Chapter 6, <i>Pedestrian Facilities</i> , should still be used for minimum design criteria. ADA accommodations must be addressed in accordance with ADA policy.
13	Buffer is assumed to be planted area (grass, shrubs and/or trees) for suburban neighborhood and corridor contexts; street furniture/car door zone for other land use contexts. Minimum of 6' for transit zones.
14	Center piers are not desirable. Increase bridge span where necessary to provide for required horizontal stopping sight distance. Provide clearance for guide rail in front of substructures if protection is required. For offset distances to substructure units, see Publication 15M, Design Manual, Part 4, <i>Structures</i> .
15	No minimum right-of-way width is suggested. The procurement of sufficient right-of-way width should be based on the preferable dimensions for all the elements of the composite highway cross section and should be adequate to accommodate the construction and proper maintenance of the highway throughout the project. Future widening should be considered and, where needed for safety, additional right-of-way may be required for adequate sight distance. For additional information on right-of-way widths, refer to the 2004 AASHTO Green Book.
16	For long bridges over 200' in length, the shoulder width may be 4' on each side.

Matrix of Design Values - Notes (Regional Arterial)



TABLE 1.4 (ENGLISH) (CONTINUED)  
MATRIX OF DESIGN VALUES – COMMUNITY ARTERIAL

1	12' preferred for regular transit routes, and heavy truck volumes > 5%, particularly for design speeds of 35 mph or greater. A 1' to 2' offset to the curb is desirable. 14' for an outside lane with no shoulder or bike lane, if optimal accommodation for bicyclists is desired.
2	Shoulders should be installed in urban contexts only as part of a retrofit of wide travel lanes to accommodate bicyclists.
3	Paving for railroad grade crossings shall extend 2' beyond the extreme rails for the full graded width of the highway.
4	Design of bike lanes should be considered when identified as part of the Engineering & Environmental (E&E) Scoping process. For additional guidance, refer to Publication 10A, Design Manual, Part 1A, <i>Transportation Engineering Procedures</i> , Appendix J, Bicycle and Pedestrian Checklist.
5	Curb Return radius should be as small as possible. Number of lanes, on street parking, bike lanes, and shoulders should be utilized to determine effective radius.
6	Cross slopes of 3.0% are recommended for design speeds less than 40 mph.
7	In curbed areas with longitudinal slopes of 1% or less, 3.0% cross slopes may be used on tangents.
8	For additional guidance, refer to Chapter 2, Sections 2.13.B, Rates of Superelevation and 2.13.C, Maximum Superelevation.
9	On curbed approaches, the minimum bridge width may equal the curb-to-curb width. Where pedestrian traffic is anticipated, provisions for a sidewalk, preferably on the outside of the parapet, should be considered and shall meet the Department's Standards and requirements (see Chapter 6). Where paved or curbed parking lanes exist or have been approved for construction on approaches, the clear roadway width of the proposed bridge in each case shall be determined by the Central Office, Bureau of Design upon receipt of the District Executive's recommendation.
10	For appropriate bridge widths, refer to the Minimum Width Criteria for Bridges.
11	Recommended minimum grade of 0.75% on curbed sections.
12	The Roadside design values should be considered and implemented as feasible and reasonable; however, Chapter 6, Pedestrian Facilities, should still be used for minimum design criteria. ADA accommodations must be addressed in accordance with ADA policy.
13	Buffer is assumed to be planted area (grass, shrubs and/or trees) for suburban neighborhood and corridor contexts; street furniture/car door zone for other land use contexts. Minimum of 6' for transit zones.
14	Center piers are not desirable. Increase bridge span where necessary to provide for required horizontal stopping sight distance. Provide clearance for guide rail in front of substructures if protection is required. For offset distances to substructure units, see Publication 15M, Design Manual, Part 4, Structures.
15	No minimum right-of-way width is suggested. The procurement of sufficient right-of-way width should be based on the preferable dimensions for all the elements of the composite highway cross section and should be adequate to accommodate the construction and proper maintenance of the highway throughout the project. Future widening should be considered and, where needed for safety, additional right-of-way may be required for adequate sight distance. For additional information on right-of-way widths, refer to the 2004 AASHTO Green Book.
16	7' parking lanes on this roadway type to be considered in appropriate conditions.
17	For long bridges over 200' in length, the shoulder width may be 4' on each side.



**TABLE 1.8 (ENGLISH)**  
**MATRIX OF DESIGN VALUES – LIMITED ACCESS FREEWAY**

Limited Access Freeway	Rural Interstate	Rural Non-Interstate	Urban Interstate	Urban Non-Interstate
Lane Widths <sup>1</sup>	4 or More 12'-0" Lanes	4 or More 12'-0" Lanes <sup>2</sup>	4 or More 12'-0" Lanes	4 or More 12'-0" Lanes <sup>2</sup>
Shoulder Widths <sup>3, 4, 5</sup>	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)	10'-0" Right Shoulder 8'-0" Graded, 4'-0" Paved Left Shoulder (Medians Only)
Median Widths	10'-0" to 50'-0" <sup>6, 7</sup> (Mountainous) 36'-0" to 100'-0" <sup>8</sup> (Level or Rolling)	10'-0" to 100'-0" <sup>6, 7, 8</sup>	10'-0" <sup>6</sup>	10'-0" <sup>6</sup>
Gross Slopes (Minimum)	2.0%	2.0%	2.0%	2.0%
Gross Slopes (Maximum)	8.0%	8.0%	6.0%	6.0%
Bridge Widths <sup>9, 10</sup>	Lane Widths Plus Right Shoulder Plus 6'-0" Left Shoulder	Lane Widths Plus Right Shoulder Plus 6'-0" Left Shoulder	Lane Widths Plus Right Shoulder Plus 6'-0" Left Shoulder	Lane Widths Plus Right Shoulder Plus 6'-0" Left Shoulder
Vertical Grades (Minimum)	0.5%	0.5%	0.5%	0.5%
Vertical Clearance (Minimum)	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2	16'-0", See Chapter 2
Clear Zone Widths <sup>11</sup>	See Chapter 12	See Chapter 12	See Chapter 12	See Chapter 12
Right-of-Way Widths <sup>12</sup>	Varies	Varies	Varies	Varies
Design Speed <sup>13</sup>	70 mph	70 mph	50-70 mph	50-70 mph
Stopping Sight Distances (Minimum)	2004 AASHTO Green Book, Exhibit 3-72	2004 AASHTO Green Book, Exhibit 3-72	2004 AASHTO Green Book, Exhibit 3-72	2004 AASHTO Green Book, Exhibit 3-72
Vertical Grades (Maximum) <sup>14, 15</sup>	2004 AASHTO Green Book, Exhibit 8-1	2004 AASHTO Green Book, Exhibit 8-1	2004 AASHTO Green Book, Exhibit 8-1	2004 AASHTO Green Book, Exhibit 8-1



**TABLE 1.8 (ENGLISH) (CONTINUED)**  
**MATRIX OF DESIGN VALUES - LIMITED ACCESS FREEWAY**

Matrix of Design Values - Notes (Limited Access Freeway)	
1	Number of lanes determined by lane capacity design for selected Level of Service.
2	Paving for railroad grade crossings shall extend 2' beyond the extreme rails for the full graded width of the highway.
3	Where truck traffic exceeds 250 DDHV, a paved width of 12' for the right shoulder should be considered.
4	On sections with six or more lanes, a paved width of 10' for the left shoulder should be provided. Where truck traffic exceeds 250 DDHV, a paved width of 12' for the left shoulder should be considered.
5	In mountainous terrain, a reduced paved shoulder width together with a minimal median width may be used to reduce the high costs associated with providing a full width roadway cross section. In these instances, a 8' minimum paved right shoulder and a 4' minimum paved left shoulder may be used on a traveled way consisting of four or six lanes. Where eight or more lanes are provided, a 8' minimum paved shoulder width should be used on both sides.
6	Use a minimum width of 10' for a two-lane directional facility which provides for two 4' shoulders and a 2' median barrier. For three or more lane directional facilities, the minimum width is 22' and preferably 26' where DDHV is greater than 250 Trucks.
7	All median widths 20' or less should be paved. When Type 1 shoulders are specified for the 4' median shoulders, Type 3 shoulders may be used for the remainder if the remaining width is 8' or greater.
8	The 100' dimension shown in the 2004 AASHTO Green Book, Exhibit 8-3B permits the designer to use independent profiles in rolling terrain to blend the freeway more appropriately with the environment while maintaining flat slopes for vehicle recovery.
9	Selection of single or dual structures shall be made based on an economic analysis. Such items as structure length and width, horizontal and vertical curvature and ramp geometry shall be considered.
10	Provide 12' left shoulder for bridges carrying three or more through lanes. Auxiliary lanes shall not be counted as through lanes.
11	Center piers are not desirable. Increase bridge span where necessary to provide for required horizontal stopping sight distance. Provide clearance for guide rail in front of substructures if protection is required. For offset distances to substructure units, see Publication 15M, Design Manual, Part 4, Structures.
12	No minimum right-of-way width is suggested. The procurement of sufficient right-of-way width should be based on the preferable dimensions for all the elements of the composite highway cross section and should be adequate to accommodate the construction and proper maintenance of the highway throughout the project. Future widening should be considered and, where needed for safety, additional right-of-way may be required for adequate sight distance. For additional information on right-of-way widths, refer to the 2004 AASHTO Green Book.
13	Where terrain is mountainous, a design speed from 50 to 60 mph may be used. In urban areas, the design speed shall be at least 50 mph.
14	For short grades less than 500' and for one-way downgrades, maximum grades may be up to 1% steeper.
15	Grades up to 1% steeper than the value shown in Exhibit 8-1 may be provided in urban areas with crucial right-of-way constraints or where needed in mountainous terrain.



c. **Running Speed.** The speed at which an individual vehicle travels over a highway section, defined as the length of the highway section divided by the running time required for the vehicle to travel through the section.

6. **Traffic Flow Relationships.** Traffic flow conditions on roadways can be characterized by the volume flow rate expressed in vehicles per hour, the average speed in kilometers per hour (miles per hour) and the traffic density in vehicles per kilometer (vehicles per mile). Generalized speed-volume-density relationships are shown in the 2004 AASHTO Green Book, Chapter 2, Exhibit 2-30.

D. **Safety.** The section "Safety" in the 2004 AASHTO Green Book, Chapter 2 discusses how a viable safety evaluation and improvement program is a vital part of the overall highway improvement program. Areas of primary importance include the identification of potential safety problems, the evaluation of the effectiveness of alternative solutions, and the programming of available funds for the most effective improvements.

E. **Environment.** The section "Environment" in the 2004 AASHTO Green Book, Chapter 2 discusses how a highway should be considered as an element of the total environment. Because highway location and design decisions have an effect on the development of adjacent areas, it is important that environmental variables be given full consideration. Also, care should be exercised to ensure that applicable local, state, and federal environmental requirements are met.

F. **Economic Analysis.** Highway economics is concerned with the cost of a proposed improvement and the benefits resulting from it. The AASHTO publication, "User Benefit Analysis for Highways", may be used to perform economic analysis of proposed highway improvements.

## 2.20 VERTICAL CLEARANCE REQUIREMENTS

Vertical clearance represents one of the key highway elements or features as the controlling criteria for developing geometric design for both highway and bridge projects.

As such, the clearances presented in this Section represent the minimum acceptable criteria and shall be used as the required vertical control for all new structures, superstructure replacements and reconstructed pavements on or over the highway based on the functional classification of the facility. Vertical clearance shall apply to the required clearance over the entire roadway width and the usable width of the shoulders and shall also include auxiliary lanes, when applicable, to structures passing over the highway facility. Where a bridge deck is to be replaced or a portion of the superstructure is to be replaced, achievement of the vertical clearance requirements should be considered. The minimum vertical clearance required shall preferably be maintained within the recovery area.

All structures having a vertical clearance below the minimum acceptable criteria should ultimately be considered for improvement of clearance. When the vertical clearance requirements cannot be achieved, justification to support a design exception submission request shall be provided.

A. **Strategic Highway Network (STRAHNET).** The Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) of the Department of Defense has developed and continues to refine the Strategic Highway Network (STRAHNET). The STRAHNET is a system of highways that provides defense access, continuity and emergency capabilities for movements of personnel and equipment in both peacetime and wartime. The STRAHNET includes all Interstate highways in Pennsylvania (including the Pennsylvania Turnpike) and has been incorporated into the National Highway System (NHS). Figure 2.10 shows the highway facilities that are designated as part of the STRAHNET, including major STRAHNET connectors to military facilities.

All highway facilities on the STRAHNET require the following vertical clearance:

THE VERTICAL CLEARANCE AT ALL UNDERPASSES SHALL BE AT LEAST 4.9 m (16 ft, 0 in) PLUS AN ALLOWANCE OF UP TO 0.15 m (6 in) TO ACCOMMODATE FUTURE RESURFACING.



crossings, appearance, or aesthetic dimension relations; and cost factors such as lengthy depressed sections of roadway.

The lateral clearances for major roadway underpasses are illustrated in the 2004 AASHTO Green Book, Chapter 10, Exhibit 10-6. For a two-lane roadway or an undivided multilane roadway, the minimum lateral clearance from the edge of the traveled way to the face of the protective barrier should be the normal shoulder width. On divided highways, the clearances on the left side of each roadway are usually governed by the median width. A minimum median width of 3.0 m (10 ft) may be used on a four-lane roadway to provide 1.2 m (4 ft) shoulders and rigid median barrier. For a roadway with six or more lanes, the minimum median width should be 6.6 m (22 ft) to provide 3.0 m (10 ft) shoulders and a rigid median barrier. Where structural design makes it necessary to reduce their horizontal clearance through an underpass, the change in lateral width should be accomplished through gradual adjustments in the cross section of the approach roadway rather than abruptly at the structure. Such transitions in width may have a longitudinal/lateral ratio of  $0.6 \times$  design speed to 1 for a design speed in kilometers per hour (design speed to 1 for a design speed in miles per hour). For lateral width "flare" transitions, refer to [Chapter 12, Table 12.7](#) (Flare Rates for Barrier Design).

For new or reconstruction projects, the minimum lateral clearance from the edge of the pavement to the face of the protective barrier in front of retaining walls and bridge substructures including piers, columns, and abutments shall be 4300 mm (14 ft) unless supporting documentation is provided. A design exception for lateral clearance will not be required if 4300 mm (14 ft) of lateral clearance is not provided; however, other geometric criteria such as required shoulder width and sight distance must still be met unless properly justified through the design exception process.

Sound barrier walls shall be located as far away as possible from the edge of traveled way while still providing the maximum benefit for insertion loss. Positive protection is required as per Publication 218M, *Standards for Bridge Design*, for sound barrier walls located within the clear zone. When a sound barrier wall protected by a concrete barrier is constructed along a highway or when a concrete barrier alone is constructed along a highway, the barrier shall be located no closer than the outer edge of shoulder and preferably should be located 0.6 m (2 ft) beyond the outer edge of shoulder.

Positive protection shall be provided when substructure units, retaining walls, or sound barrier walls must be placed within the clear zone width identified in [Chapter 12, Table 12.1](#).

For the vertical clearance requirements of all structures, refer to [Chapter 2, Section 2.20](#).

**D. Overpass Roadways.** The roadway dimensional design of an overpass or other bridge should be the same as that of the basic roadway in cross section dimensions unless the cost becomes prohibitive. The use of bridge railings, lateral clearances and median treatment should be as specified in Publication 15M, *Design Manual, Part 4, Structures*, and Publication 218M, *Standards for Bridge Design*.

**E. Longitudinal Distance to Attain Grade Separation.** The longitudinal distance needed for adequate design of a grade separation depends on the design speed, the roadway gradient and the amount of rise or fall needed to achieve the separation. To determine whether or not a grade separation is practical for given conditions, Exhibit 10-8 from Chapter 10 of the 2004 AASHTO Green Book should be used as a guide for preliminary design to determine horizontal distance in flat terrain. The figure also may serve as a general guide in other than flat terrain and adjustments can be made in the length of the terminal vertical curves.

**F. Grade Separations Without Ramps.** There are many situations where grade separations are constructed without the provision of ramps. In other situations, despite sufficient traffic demand, ramps may be omitted: (1) to avoid having interchanges so close to each other that signing and operation would be difficult, (2) to eliminate interference with large highway traffic volumes and (3) to increase safety and mobility by concentrating turning traffic where it is practical to provide adequate ramp systems.

For additional guidelines and criteria for the procedures, considerations and geometric design features for grade separation structures, refer to the section "Grade Separations without Ramps" in the 2004 AASHTO Green Book, Chapter 10.



METRIC						US Customary					
Design Speed (km/h)	Maximum e (%)	Maximum f	Total (e/100 + f)	Calculated Radius (m)	Rounded Radius (m)	Design Speed (mph)	Maximum e (%)	Maximum f	Total (e/100 + f)	Calculated Radius (ft)	Rounded Radius (ft)
15	4.0	0.40	0.44	4.0	4	10	4.0	0.38	0.42	15.9	16
20	4.0	0.35	0.39	8.1	8	15	4.0	0.32	0.36	41.7	42
30	4.0	0.28	0.32	22.1	22	20	4.0	0.27	0.31	86.0	86
40	4.0	0.23	0.27	46.7	47	25	4.0	0.23	0.27	154.3	154
50	4.0	0.19	0.23	85.6	86	30	4.0	0.20	0.24	250.0	250
60	4.0	0.17	0.21	135.0	135	35	4.0	0.18	0.22	371.2	371
70	4.0	0.15	0.19	203.1	203	40	4.0	0.16	0.20	533.3	533
80	4.0	0.14	0.18	280.0	280	45	4.0	0.15	0.19	710.5	711
90	4.0	0.13	0.17	375.2	375	50	4.0	0.14	0.18	925.9	926
100	4.0	0.12	0.16	492.1	492	55	4.0	0.13	0.17	1186.3	1190
						60	4.0	0.12	0.16	1500.0	1500
15	6.0	0.40	0.46	3.9	4	10	6.0	0.38	0.44	15.2	15
20	6.0	0.35	0.41	7.7	8	15	6.0	0.32	0.38	39.5	39
30	6.0	0.28	0.34	20.8	21	20	6.0	0.27	0.33	80.8	81
40	6.0	0.23	0.29	43.4	43	25	6.0	0.23	0.29	143.7	144
50	6.0	0.19	0.25	78.7	79	30	6.0	0.20	0.26	230.8	231
60	6.0	0.17	0.23	123.2	123	35	6.0	0.18	0.24	340.3	340
70	6.0	0.15	0.21	183.7	184	40	6.0	0.16	0.22	484.8	485
80	6.0	0.14	0.20	252.0	252	45	6.0	0.15	0.21	642.9	643
90	6.0	0.13	0.19	335.7	336	50	6.0	0.14	0.20	833.3	833
100	6.0	0.12	0.18	437.4	437	55	6.0	0.13	0.19	1061.4	1060
110	6.0	0.11	0.17	560.4	560	60	6.0	0.12	0.18	1333.3	1330
120	6.0	0.09	0.15	755.9	756	65	6.0	0.11	0.17	1656.9	1660
130	6.0	0.08	0.14	950.5	951	70	6.0	0.10	0.16	2041.7	2040
						75	6.0	0.09	0.15	2500.0	2500
						80	6.0	0.08	0.14	3047.6	3050
15	8.0	0.40	0.48	3.7	4	10	8.0	0.38	0.46	14.5	14
20	8.0	0.35	0.43	7.3	7	15	8.0	0.32	0.40	37.5	38
30	8.0	0.28	0.36	19.7	20	20	8.0	0.27	0.35	76.2	76
40	8.0	0.23	0.31	40.6	41	25	8.0	0.23	0.31	134.4	134
50	8.0	0.19	0.27	72.9	73	30	8.0	0.20	0.28	214.3	214
60	8.0	0.17	0.25	113.4	113	35	8.0	0.18	0.26	314.1	314
70	8.0	0.15	0.23	167.8	168	40	8.0	0.16	0.24	444.4	444
80	8.0	0.14	0.22	229.1	229	45	8.0	0.15	0.23	587.0	587
90	8.0	0.13	0.21	303.7	304	50	8.0	0.14	0.22	757.6	758
100	8.0	0.12	0.20	393.7	394	55	8.0	0.13	0.21	960.3	960
110	8.0	0.11	0.19	501.5	501	60	8.0	0.12	0.20	1200.0	1200
120	8.0	0.09	0.17	667.0	667	65	8.0	0.11	0.19	1482.5	1480
130	8.0	0.08	0.16	831.7	832	70	8.0	0.10	0.18	1814.8	1810
						75	8.0	0.09	0.17	2205.9	2210
						80	8.0	0.08	0.16	2666.7	2670
15	10.0	0.40	0.50	3.5	4	10	10.0	0.38	0.48	13.9	14
20	10.0	0.35	0.45	7.0	7	15	10.0	0.32	0.42	35.7	36
30	10.0	0.28	0.38	18.6	19	20	10.0	0.27	0.37	72.1	72
40	10.0	0.23	0.33	38.2	38	25	10.0	0.23	0.33	126.3	126
50	10.0	0.19	0.29	67.9	68	30	10.0	0.20	0.30	200.0	200
60	10.0	0.17	0.27	105.0	105	35	10.0	0.18	0.28	291.7	292
70	10.0	0.15	0.25	154.3	154	40	10.0	0.16	0.26	410.3	410
80	10.0	0.14	0.24	210.0	210	45	10.0	0.15	0.25	540.0	540
90	10.0	0.13	0.23	277.3	277	50	10.0	0.14	0.24	694.4	694
100	10.0	0.12	0.22	357.9	358	55	10.0	0.13	0.23	876.8	877
110	10.0	0.11	0.21	453.7	454	60	10.0	0.12	0.22	1090.9	1090
120	10.0	0.09	0.19	596.8	597	65	10.0	0.11	0.21	1341.3	1340
130	10.0	0.08	0.18	739.3	739	70	10.0	0.10	0.20	1633.3	1630
						75	10.0	0.09	0.19	1973.7	1970
						80	10.0	0.08	0.18	2370.4	2370
15	12.0	0.40	0.52	3.4	3	10	12.0	0.38	0.50	13.3	13
20	12.0	0.35	0.47	6.7	7	15	12.0	0.32	0.44	34.1	34
30	12.0	0.28	0.40	17.7	18	20	12.0	0.27	0.39	68.4	68
40	12.0	0.23	0.35	36.0	36	25	12.0	0.23	0.35	119.0	119
50	12.0	0.19	0.31	63.5	64	30	12.0	0.20	0.32	187.5	188
60	12.0	0.17	0.29	97.7	98	35	12.0	0.18	0.30	272.2	272
70	12.0	0.15	0.27	142.9	143	40	12.0	0.16	0.28	381.0	381
80	12.0	0.14	0.26	193.8	194	45	12.0	0.15	0.27	500.0	500
90	12.0	0.13	0.25	255.1	255	50	12.0	0.14	0.26	641.0	641
100	12.0	0.12	0.24	328.1	328	55	12.0	0.13	0.25	806.7	807
110	12.0	0.11	0.23	414.2	414	60	12.0	0.12	0.24	1000.0	1000
120	12.0	0.09	0.21	539.9	540	65	12.0	0.11	0.23	1224.6	1220
130	12.0	0.08	0.20	665.4	665	70	12.0	0.10	0.22	1484.8	1480
						75	12.0	0.09	0.21	1785.7	1790
						80	12.0	0.08	0.20	2133.3	2130

Note: In recognition of safety considerations, use of  $e_{max} = 4.0\%$  should be limited to urban conditions.

Exhibit 3-15. Minimum Radius Using Limiting Values of  $e$  and  $f$



**METRIC**

$e$ (%)	$V_d = 20$ km/h $R$ (m)	$V_d = 30$ km/h $R$ (m)	$V_d = 40$ km/h $R$ (m)	$V_d = 50$ km/h $R$ (m)	$V_d = 60$ km/h $R$ (m)	$V_d = 70$ km/h $R$ (m)	$V_d = 80$ km/h $R$ (m)	$V_d = 90$ km/h $R$ (m)	$V_d = 100$ km/h $R$ (m)	$V_d = 110$ km/h $R$ (m)	$V_d = 120$ km/h $R$ (m)	$V_d = 130$ km/h $R$ (m)
1.5	94	121	158	205	252	300	348	396	444	492	540	588
2.0	126	168	210	263	316	369	422	475	528	581	634	687
2.2	138	180	228	285	340	393	446	499	552	605	658	711
2.4	150	192	240	300	355	408	461	514	567	620	673	726
2.6	162	204	252	312	367	420	473	526	579	632	685	738
2.8	174	216	264	324	379	432	485	538	591	644	697	750
3.0	186	228	276	336	391	444	497	550	603	656	709	762
3.2	198	240	288	348	403	456	509	562	615	668	721	774
3.4	210	252	300	360	415	468	521	574	627	680	733	786
3.6	222	264	312	372	427	480	533	586	639	692	745	798
3.8	234	276	324	384	439	492	545	598	651	704	757	810
4.0	246	288	336	396	451	504	557	610	663	716	769	822
4.2	258	300	348	408	463	516	569	622	675	728	781	834
4.4	270	312	360	420	475	528	581	634	687	740	793	846
4.6	282	324	372	432	487	540	593	646	699	752	805	858
4.8	294	336	384	444	499	552	605	658	711	764	817	870
5.0	306	348	396	456	511	564	617	670	723	776	829	882
5.2	318	360	408	468	523	576	629	682	735	788	841	894
5.4	330	372	420	480	535	588	641	694	747	800	853	906
5.6	342	384	432	492	547	600	653	706	759	812	865	918
5.8	354	396	444	504	559	612	665	718	771	824	877	930
6.0	366	408	456	516	571	624	677	730	783	836	889	942

Exhibit 3-26. Minimum Radii for Design Superelevation Rates, Design Speeds, and  $e_{max} = 6\%$

**US CUSTOMARY**

$e$ (%)	$V_d = 15$ mph $R$ (ft)	$V_d = 20$ mph $R$ (ft)	$V_d = 25$ mph $R$ (ft)	$V_d = 30$ mph $R$ (ft)	$V_d = 35$ mph $R$ (ft)	$V_d = 40$ mph $R$ (ft)	$V_d = 45$ mph $R$ (ft)	$V_d = 50$ mph $R$ (ft)	$V_d = 55$ mph $R$ (ft)	$V_d = 60$ mph $R$ (ft)	$V_d = 65$ mph $R$ (ft)	$V_d = 70$ mph $R$ (ft)	$V_d = 75$ mph $R$ (ft)	$V_d = 80$ mph $R$ (ft)
1.5	100	133	166	200	233	266	300	333	366	400	433	466	500	533
2.0	133	178	222	267	311	356	400	444	489	533	578	622	667	711
2.2	145	190	234	279	323	368	412	457	501	546	591	635	680	724
2.4	157	202	246	291	335	380	424	469	513	558	603	647	692	736
2.6	169	214	258	303	347	392	436	481	525	570	615	659	704	748
2.8	181	226	270	315	359	404	448	493	537	582	627	671	716	760
3.0	193	238	282	327	371	416	460	505	549	594	639	683	728	772
3.2	205	250	294	339	383	428	472	517	561	606	651	695	740	784
3.4	217	262	306	351	395	440	484	529	573	618	663	707	752	796
3.6	229	274	318	363	407	452	496	541	585	630	675	719	764	808
3.8	241	286	330	375	419	464	508	553	597	642	687	731	776	820
4.0	253	298	342	387	431	476	520	565	609	654	699	743	788	832
4.2	265	310	354	399	443	488	532	577	621	666	711	755	800	844
4.4	277	322	366	411	455	500	544	589	633	678	723	767	812	856
4.6	289	334	378	423	467	512	556	601	645	690	735	779	824	868
4.8	301	346	390	435	479	524	568	613	657	702	747	791	836	880
5.0	313	358	402	447	491	536	580	625	669	714	759	803	848	892
5.2	325	370	414	459	503	548	592	637	681	726	771	815	860	904
5.4	337	382	426	471	515	560	604	649	693	738	783	827	872	916
5.6	349	394	438	483	527	572	616	661	705	750	795	839	884	928
5.8	361	406	450	495	539	584	628	673	717	762	807	851	896	940
6.0	373	418	462	507	551	596	640	685	729	774	819	863	908	952

Exhibit 3-26. Minimum Radii for Design Superelevation Rates, Design Speeds, and  $e_{max} = 6\%$



Compound curves at intersections for which the radius of one curve is more than twice the radius of the other should have either a spiral or a circular curve of intermediate radius inserted between the two. If, in such instances, the calculated length of spiral is less than 30 m [100 ft], it is suggested that a length of at least 30 m [100 ft] be used.

### Compound Circular Curves

Compound circular curves are advantageous in effecting desirable shapes of turning roadways for at-grade intersections and for interchange ramps. Where circular arcs of widely different radii are joined, however, the alignment appears abrupt or forced, and the travel paths of vehicles need considerable steering effort.

On compound curves for open highways, it is generally accepted that the ratio of the flatter radius to the sharper radius should not exceed 1.5:1. For compound curves at intersections where drivers accept more rapid changes in direction and speed, the radius of the flatter arc can be as much as 100 percent greater than the radius of the sharper arc, a ratio of 2:1. The ratio of 2:1 for the sharper curves used at intersections results in approximately the same difference (about 10 km/h [6 mph]) in average running speeds for the two curves. These curves are compounded as for a ratio of 1.5:1 on the flatter curves used on the open highway. General observations on ramps having differences in radii with a ratio of 2:1 indicate that both operation and appearance normally are satisfactory.

Where practical, a smaller difference in radii should be used. A desirable maximum ratio is 1.75:1. Where the ratio is greater than 2:1, a suitable length of spiral or a circular arc of intermediate radius should be inserted between the two curves. In the case of very sharp curves designed to accommodate minimum turning paths of vehicles, it is not practical to apply this ratio control. In this case, compound curves should be developed that fit closely to the path of the design vehicle to be accommodated, for which higher ratios may be necessary needed as shown in Chapter 9.

Curves that are compounded should not be too short or their effectiveness in enabling smooth transitions from tangent or flat-curve to sharp-curve operation may be lost. In a series of curves of decreasing radii, each curve should be long enough to enable the driver to decelerate at a reasonable rate, which at intersections is assumed to be not more than 5 km/h/s [3 mph/s], although 3 km/h/s [2 mph/s] is desirable. Minimum curve lengths that meet these criteria based on the running speeds shown in Exhibit 3-14, are indicated in Exhibit 3-42. They are based on a deceleration of 5 km/h/s [3 mph/s], and a desirable minimum deceleration of 3 km/h/s [2 mph/s]. The latter deceleration rate indicates very light braking, because deceleration in gear alone generally results in overall rates between 1.5 and 2.5 km/h/s [1 and 1.5 mph/s].



Metric				US Customary			
Design speed (km/h)	Stopping sight distance (m)	Rate of vertical curvature, $K^a$		Design speed (mph)	Stopping sight distance (ft)	Rate of vertical curvature, $K^a$	
		Calculated	Design			Calculated	Design
20	20	0.6	1	15	80	3.0	3
30	35	1.9	2	20	115	6.1	7
40	50	3.8	4	25	155	11.1	12
50	65	6.4	7	30	200	18.5	19
60	85	11.0	11	35	250	29.0	29
70	105	16.8	17	40	305	43.1	44
80	130	25.7	26	45	360	60.1	61
90	160	38.9	39	50	425	83.7	84
100	185	52.0	52	55	495	113.5	114
110	220	73.6	74	60	570	150.6	151
120	250	95.0	95	65	645	192.8	193
130	285	123.4	124	70	730	246.9	247
				75	820	311.6	312
				80	910	383.7	384

<sup>a</sup> Rate of vertical curvature,  $K$ , is the length of curve per percent algebraic difference in intersecting grades ( $A$ ).  $K = L/A$

Exhibit 3-72. Design Controls for Stopping Sight Distance and for Crest Vertical Curves

Metric			US Customary		
Design speed (km/h)	Passing sight distance (m)	Rate of vertical curvature, $K^a$ design	Design speed (mph)	Passing sight distance (ft)	Rate of vertical curvature, $K^a$ design
30	200	46	20	710	180
40	270	84	25	900	289
50	345	138	30	1090	424
60	410	195	35	1280	585
70	485	272	40	1470	772
80	540	338	45	1625	943
90	615	438	50	1835	1203
100	670	520	55	1985	1407
110	730	617	60	2135	1628
120	775	695	65	2285	1865
130	815	769	70	2480	2197
			75	2580	2377
			80	2680	2565

Note: <sup>a</sup>Rate of vertical curvature,  $K$ , is the length of curve per percent algebraic difference in intersecting grades ( $A$ ).  $K = L/A$

Exhibit 3-73. Design Controls for Crest Vertical Curves Based on Passing Sight Distance

Generally, it is impractical to design crest vertical curves to provide for passing sight distance because of high cost where crest cuts are involved and the difficulty of fitting the resulting long vertical curves to the terrain, particularly for high-speed roads. Passing sight



Type of terrain	Metric			US Customary		
	Design speed (km/h) for specified design volume (veh/day)			Design speed (mph) for specified design volume (veh/day)		
	0 to 400	400 to 2000	over 2000	0 to 400	400 to 2000	over 2000
Level	60	80	100	40	50	60
Rolling	50	60	80	30	40	50
Mountainous	30	50	60	20	30	40

Note: Where practical, design speeds higher than those shown should be considered.

Exhibit 6-1. Minimum Design Speeds for Rural Collectors

Metric				US Customary			
Design speed	Design stopping sight distance	Rate of vertical curvature, $K^a$		Design speed	Design stopping sight distance	Rate of vertical curvature, $K^a$	
(km/h)	(m)	Crest	Sag	(mph)	(ft)	Crest	Sag
20	20	1	3	15	80	3	10
30	35	2	6	20	115	7	17
40	50	4	9	25	155	12	26
50	65	7	13	30	200	19	37
60	85	11	18	35	250	29	49
70	105	17	23	40	305	44	64
80	130	26	30	45	360	61	79
90	160	39	38	50	425	84	96
100	185	52	45	55	495	114	115
				60	570	151	136

<sup>a</sup> Rate of vertical curvature,  $K$ , is the length of curve per percent algebraic difference in the intersecting grades (i.e.,  $K = L/A$ ). (See Chapter 3 for details.)

Exhibit 6-2. Design Controls for Stopping Sight Distance and for Crest and Sag Vertical Curves



	00	2135	1628
a. Rate of vertical curvature, $K_v$ , is the length of curve per percent algebraic difference in the intersecting grades (i.e., $K_v = L/A$ ). (See Chapter 3 for details.)			

	Metric												US Customary								
	Maximum grade (%) for specified design speed (km/h)												Maximum grade (%) for specified design speed (mph)								
Type of terrain	30	40	50	60	70	80	90	100					20	25	30	35	40	45	50	55	60
Level	7	7	7	7	7	7	6	6	5				7	7	7	7	7	7	6	6	5
Rolling	10	10	9	8	8	7	7	7	6				10	10	9	9	8	8	7	7	6
Mountainous	12	11	10	10	10	9	9	9	8				12	11	10	10	10	10	9	9	8

Note: Short lengths of road.

### Exhibit 6-4. Maximum Grades for Rural Collectors



## Sight Distance

Sight distance is directly related to and varies appreciably with design speed. Stopping sight distance, a key safety-related design element, should be provided through the length of the roadway. Passing and decision sight distances influence roadway operations and should be provided wherever practical. Providing decision sight distance at locations where complex decisions are made greatly enhances the chances that drivers will be able to safely accomplish maneuvers. Examples of locations where complex decisions are required include high-volume intersections, transitions in roadway width, and transitions in the number of lanes. Provision for adequate sight distance on rural arterials, which may combine both high speeds and high traffic volumes, can be complex. Exhibit 7-1 presents the recommended minimum values of stopping and passing sight distance. Refer to Chapter 3 for a comprehensive discussion of sight distance and for tabulated values for decision sight distance.

Metric			US Customary		
Design speed (km/h)	Minimum stopping sight distance (m)	Minimum passing sight distance (m)	Design speed (mph)	Minimum stopping sight distance (ft)	Minimum passing sight distance (ft)
50	65	345	30	200	1090
60	85	410	35	250	1280
70	105	485	40	305	1470
80	130	540	45	360	1625
90	160	615	50	425	1835
100	185	670	55	495	1985
110	220	730	60	570	2135
120	250	775	65	645	2285
130	285	815	70	730	2480
			75	820	2580
			80	910	2680

Exhibit 7-1. Minimum Sight Distances for Arterials

Ideally, intersections and railroad crossings should be grade separated or provided with adequate sight distance. Intersections should be placed in sag and/or tangent locations, where practical, to allow maximum visibility of the roadway and pavement markings.

## Alignment

A smooth flowing alignment is desirable on a rural arterial. Changes in alignment, both horizontal and vertical, should be so gradual that they will not surprise the driver. Roads with adequate alignment usually operate more efficiently and safely than roads with poor alignment, even where improved signing and pavement marking are provided; therefore, adequate alignment should be provided wherever practical.



guidance applicable to both rural and urban arterials is presented in the section on “Superelevated Cross Sections” in the earlier discussion of rural arterials in this chapter.

	Metric						US Customary							
	Maximum grade (%) for specified design speed (km/h)						Maximum grade (%) for specified design speed (mph)							
Type of terrain	50	60	70	80	90	100	30	35	40	45	50	55	60	
Level	8	7	6	6	5	5	8	7	7	6	6	5	5	
Rolling	9	8	7	7	6	6	9	8	8	7	7	6	6	
Mountainous	11	10	9	9	8	8	11	10	10	9	9	8	8	

Exhibit 7-10. Maximum Grades for Urban Arterials

### Cross Slope

Sufficient cross slope for adequate pavement drainage is important on urban arterials. The typical problems related to splashing and hydroplaning are compounded by heavy traffic volumes and curbed sections, especially for high speeds. Cross slopes should range from 1.5 to 3 percent; the lower portion of this range is appropriate where drainage flow is across a single lane and higher values are appropriate where flow is across several lanes. Even higher cross-slope rates may be used for parking lanes. The overall cross section should provide a smooth appearance without sharp breaks. Because urban arterials are often curbed, it is necessary to provide for longitudinal as well as cross-slope drainage. The use of higher cross-slope rates also reduces flow on the roadway and ponding of water due to pavement irregularities and rutting. The section on “Cross Slopes” in Chapter 4 provides additional guidance.

### Vertical Clearances

New or reconstructed structures should provide 4.9-m [16-ft] vertical clearance over the entire roadway width. Existing structures that provide clearance of 4.3 m [14 ft], if allowed by local statute, may be retained. In highly urbanized areas, a minimum clearance of 4.3 m [14 ft] may be provided if there is an alternate route with 4.9-m [16-ft] clearance. Structures should provide additional clearance for future resurfacing of the underpassing road.

### Lane Widths

Lane widths may vary from 3.0 to 3.6 m [10 to 12 ft]. Lane widths of 3.0 m [10 ft] may be used in highly restricted areas having little or no truck traffic. Lane widths of 3.3 m [11 ft] are used quite extensively for urban arterial street designs. The 3.6-m [12-ft] lane widths are most desirable and should be used, where practical, on higher speed, free-flowing, principal arterials.



interchange facilities and the need for frequent changes in speed make it desirable to use flat grades wherever practical. On sustained upgrades, the need for climbing lanes should be investigated, as discussed in Chapter 3.

Type of Terrain	Metric						US Customary							
	Design Speeds (km/h)						Design Speeds (mph)							
	80	90	100	110	120	130	50	55	60	65	70	75	80	
	Grades (%) <sup>a</sup>						Grades (%) <sup>a</sup>							
Level	4	4	3	3	3	3	4	4	3	3	3	3	3	
Rolling	5	5	4	4	4	4	5	5	4	4	4	4	4	
Mountainous	6	6	6	5	—	—	6	6	6	5	5	—	—	

<sup>a</sup> Grades 1% steeper than the value shown may be provided in mountainous terrain or in urban areas with crucial right-of-way controls.

Exhibit 8-1. Maximum Grades for Rural and Urban Freeways

## Structures

The design of bridges, culverts, walls, tunnels, and other structures should be in accordance with the principles of the current *Standard Specifications for Highway Bridges* (2) or with the *AASHTO LRFD Bridge Design Specifications* (3). Structures carrying freeway traffic should provide an MS 18 [HS 20–44] design loading.

The clear width on bridges carrying freeway traffic should be as wide as the approach roadway, as discussed in Chapter 10. On bridges longer than 60 m [200 ft], some economy in substructure costs may be gained by building a single structure rather than twin parallel structures. In such cases, the approach shoulder widths are provided and a median barrier is extended across the bridge.

Structures carrying ramps should provide a clear width equal to the ramp width and paved shoulders. Clear widths for structures carrying auxiliary lanes are discussed in Chapter 10.

The structure width and lateral clearance of highways and streets overpassing or underpassing the freeway are dependent on the functional classification of the highway or street as discussed in Chapters 5, 6, and 7.

## Vertical Clearance

The vertical clearance to structures passing over freeways should be at least 4.9 m [16 ft] over the entire roadway width, including auxiliary lanes and the usable width of shoulders (with an allowance for future resurfacing). In highly developed urban areas, where attainment of the 4.9-m [16-ft] clearance would be unreasonably costly, a minimum clearance of 4.3 m [14 ft] may be used if there is an alternate freeway facility with the minimum 4.9-m [16-ft] clearance.



**TABLE 12.1 (ENGLISH)**  
**CLEAR ZONE WIDTH**  
**(in feet from edge of through traveled way)**

DESIGN SPEED	DESIGN ADT	FORESLOPE			BACKSLOPE		
		1V:6H OR FLATTER	1V:5H TO 1V:4H	1V:3H	1V:3H	1V:5H TO 1V:4H	1V:6H OR FLATTER
40 mph or less	Under 750	7	7	**	7	7	7
	750 - 1500	10	12	**	10	10	10
	1500 - 6000	12	14	**	12	12	12
	Over 6000	14	16	**	14	14	14
45-50 mph	Under 750	10	12	**	8	8	10
	750 - 1500	14	16	**	10	12	14
	1500 - 6000	16	20	**	12	14	16
	Over 6000	20	24	**	14	18	20
55 mph	Under 750	12	14	**	8	10	10
	750 - 1500	16	20	**	10	14	16
	1500 - 6000	20	24	**	14	16	20
	Over 6000	22	26	**	16	20	22
60 mph	Under 750	16	20	**	10	12	14
	750 - 1500	20	26	**	12	16	20
	1500 - 6000	26	30	**	14	18	24
	Over 6000	30	30	**	20	24	26
65-70 mph	Under 750	18	20	**	10	14	14
	750 - 1500	24	28	**	12	18	20
	1500 - 6000	28	30	**	16	22	26
	Over 6000	30	30	**	22	26	28

\*\* Since recovery is less likely on the unshielded, traversable 1V:3H slopes, consider removal of fixed objects present beyond the toe of these slopes. Determination of the width of the recovery area provided, if any, at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety needs, and crash histories. Also, the distance between the edge of the through traveled lane and the beginning of the 1V:3H slope should influence the recovery area provided at the toe of slope.



To determine the need for guide rail, refer to Section 12.4, Barrier Placement, and the preceding sections of this Chapter. Additional selection guidelines and criteria for standard and nonstandard conditions are presented below in Sections 12.3.D and 12.3.E.

**TABLE 12.3 (METRIC)  
GUIDE RAIL AND MEDIAN BARRIER SYSTEMS**

TYPE DESIGNATION	DESCRIPTION	MOUNTING HEIGHT	MINIMUM UNOBSTRUCTED DISTANCE	POST SPACING
2 - W	WEAK POST W-BEAM GUIDE RAIL (NORMAL POST SPACING)	815 mm TO TOP OF BEAM	2.1 m	3810 mm
2 - WC	WEAK POST W-BEAM GUIDE RAIL (CLOSE POST SPACING)	815 mm TO TOP OF BEAM	1.5 m	1905 mm
2 - WCC	WEAK POST W-BEAM GUIDE RAIL (VERY CLOSE POST SPACING)	815 mm TO TOP OF BEAM	1.2 m	952.5 mm
2 - S	STRONG POST W-BEAM GUIDE RAIL (NORMAL POST SPACING)	706 mm TO TOP OF BEAM	0.9 m	1905 mm
2 - SC	STRONG POST W-BEAM GUIDE RAIL (CLOSE POST SPACING)	706 mm TO TOP OF BEAM	0.6 m	952.5 mm
2 - SCC	STRONG POST W-BEAM GUIDE RAIL (VERY CLOSE POST SPACING)	706 mm TO TOP OF BEAM	0.3 m	476.25 mm
2 - WM	WEAK POST W-BEAM MEDIAN BARRIER	815 mm TO TOP OF BARRIER	2.1 m	3810 mm
—	CONCRETE MEDIAN BARRIER SINGLE & DOUBLE FACE	810 mm TO TOP OF BARRIER	0.0 m	—
—	CONCRETE GLARE SCREEN	1270 mm TO TOP OF BARRIER (TYP)	0.0 m	—

**TABLE 12.3 (ENGLISH)  
GUIDE RAIL AND MEDIAN BARRIER SYSTEMS**

TYPE DESIGNATION	DESCRIPTION	MOUNTING HEIGHT	MINIMUM UNOBSTRUCTED DISTANCE	POST SPACING
2 - W	WEAK POST W-BEAM GUIDE RAIL (NORMAL POST SPACING)	32" TO TOP OF BEAM	7' - 0"	12' - 6"
2 - WC	WEAK POST W-BEAM GUIDE RAIL (CLOSE POST SPACING)	32" TO TOP OF BEAM	5' - 0"	6' - 3"
2 - WCC	WEAK POST W-BEAM GUIDE RAIL (VERY CLOSE POST SPACING)	32" TO TOP OF BEAM	4' - 0"	3' - 1 1/2"
2 - S	STRONG POST W-BEAM GUIDE RAIL (NORMAL POST SPACING)	27 3/4" TO TOP OF BEAM	3' - 0"	6' - 3"
2 - SC	STRONG POST W-BEAM GUIDE RAIL (CLOSE POST SPACING)	27 3/4" TO TOP OF BEAM	2' - 0"	3' - 1 1/2"
2 - SCC	STRONG POST W-BEAM GUIDE RAIL (VERY CLOSE POST SPACING)	27 3/4" TO TOP OF BEAM	1' - 0"	1' - 6 3/4"
2 - WM	WEAK POST W-BEAM MEDIAN BARRIER	32" TO TOP OF BARRIER	7' - 0"	12' - 6"
—	CONCRETE MEDIAN BARRIER SINGLE & DOUBLE FACE	32" TO TOP OF BARRIER	0' - 0"	—
—	CONCRETE GLARE SCREEN	50" TO TOP OF BARRIER (TYP)	0' - 0"	—



# CHAPTER 1

## GENERAL DESIGN

Job# 60284833  
Calc# 1  
Page 32  
Project: I-80 Reconstruction  
Originator: SLC 2/04/13  
Reviewer:

### 1.0 INTRODUCTION

The purpose of this Manual is to provide its users with the current, uniform procedures and guidelines for the application and design of safe, convenient, efficient and attractive highways that are compatible with their service characteristics and that optimally satisfy the needs of highway users while maintaining the integrity of the environment.

This Manual does not attempt to encompass the total scope of important, published information and literature relative to the formulation of highway design criteria, policies and procedures. Sources of additional publications and related material which may complement the concepts contained herein include the following:

- Publication 408, *Specifications*, and associated changes, Pennsylvania Department of Transportation (PENNDOT).
- *A Policy on Geometric Design of Highways and Streets*, 2004 AASHTO Publication.\*
- *Roadside Design Guide*, 2006 AASHTO Publication.\*\*
- *Highway Capacity Manual*, Transportation Research Board, 2000 or newer edition.\*\*\*
- *Manual on Uniform Traffic Control Devices*, Federal Highway Administration, 2003 or newer edition.\*\*\*\*
- *A Policy on Design Standards---Interstate System*, 2005 AASHTO Publication.

Initiative should be exercised to utilize the most appropriate design values within the given ranges based upon the project context and roadway typology wherever practicable and within reasonable economic limitations and sound engineering judgment. When design criteria presented in this Manual differs from criteria presented in other sources, this Manual shall take precedence. However, for Federal-aid projects on the National Highway System (NHS), this Manual only takes precedence when criteria in this Manual exceed the criteria in the 2004 AASHTO Green Book and the 2005 AASHTO publication, *A Policy on Design Standards---Interstate System* (for Interstate Federal-aid projects). The design criteria and text presented herein provide guidance to the designer by referencing a range of values for critical dimensions.

Since the concepts, practices and procedures described in this Manual are subject to future change, the contents shall be updated accordingly to reflect those changes in order to retain its usefulness. The Highway Quality Assurance Division, Bureau of Design shall be responsible for keeping the Manual current by incorporating revisions, additions or deletions when required.

Whenever a District Executive determines that modifications or additions are required to improve the current design criteria in this Manual, the following procedures shall be followed:

1. The recommended modifications or additions shall be transmitted to the Director, Bureau of Design with the following information:

\* Hereinafter referred to as the 2004 AASHTO Green Book.

\*\* Hereinafter referred to as the AASHTO Roadside Design Guide.

\*\*\* Hereinafter referred to as the *HCM*.

\*\*\*\* Hereinafter referred to as the *MUTCD*.



## RIGHT-OF-WAY

### Right-of-Way

The width of right-of-way shall be sufficient to accommodate the roadway cross section elements and requisite appurtenances necessary for an adequate facility in the design year and for known future improvements.

### Control of Access

Access to the interstate system shall be fully controlled. The interstate highway shall be grade separated at all railroad crossings and selected public crossroads. At-grade intersections shall not be allowed. To accomplish this, the intersecting roads are to be grade separated, terminated, rerouted, and/or intercepted by frontage roads. Access is to be achieved by interchanges at selected public roads.

Access control shall extend the full length of ramps and terminals on the crossroad. Such control shall either be acquired outright prior to construction or by the construction of frontage roads or by a combination of both.

Access control beyond the ramp terminals should be affected by purchasing access rights, providing frontage roads, controlling added corner right-of-way areas, or prohibiting driveways. Such control should extend beyond the ramp terminal at least 30 m (100 ft) in urban areas and 90 m (300 ft) in rural areas. However, in areas of high traffic volume, where exists the potential for development which would create operational or safety problems, longer lengths of access control should be provided.

## GEOMETRIC CONTROLS AND CRITERIA

### Design Speed

A minimum design speed of 110 km/h (70 mph) should be used for rural areas. Where terrain is mountainous, a design speed from 80 to 100 km/h (50 to 60 mph) may be used. In urban areas, the design speed shall be at least 80 km/h (50 mph).

### Sight Distance

The minimum stopping sight distance shall be the values established in the current edition of AASHTO's *A Policy on Geometric Design of Highways and Streets* for the appropriate design speed.

### Curvature and Superelevation

Curvature, superelevation, and allied features, such as transition curves, shall be correlated with the design speed in accordance with the current edition of AASHTO's *A Policy on Geometric Design of Highways and Streets*.

## Gradients

Maximum grades as a function of the design speed and the type of terrain are shown in the following table:

Type of Terrain	Metric						U.S. Customary							
	Design Speed (km/h)						Design Speed (mph)							
	80	90	100	110	120	130	50	55	60	65	70	75	80	
	Grades (%)*						Grades (%)*							
Level	4	4	3	3	3	3	4	4	3	3	3	3	3	
Rolling	5	5	4	4	4	4	5	5	4	4	4	4	4	
Mountainous	6	6	6	5	—	—	6	6	6	5	5	—	—	

\* Grades up to one percent steeper than the value shown may be provided in urban areas with crucial right-of-way constraints or where needed in mountainous terrain.

## CROSS SECTION ELEMENTS

### Number of Lanes

A minimum of four traffic lanes shall be provided on the interstate system. The number of lanes shall be sufficient to accommodate the DHV at an acceptable level of service for the applicable conditions. A capacity analysis using the design year traffic should be performed to determine the number of lanes required to achieve the acceptable level of service. Refer to AASHTO's *A Policy on Geometric Design of Highways and Streets* for guidance in the selection of level of service.

On ascending grades, which exceed the critical design length, a climbing lane analysis should be performed and climbing lanes added where appropriate. Likewise, on extended lengths of maximum or near maximum descending grades, emergency escape ramps should be added where an analysis indicates they are required.

### Width of Traffic Lanes

All traffic lanes shall be at least 3.6 m (12 ft) wide.

### Shoulders

The paved width of the right shoulder shall not be less than 3.0 m (10 ft). Where truck traffic exceeds 250 DDHV, a paved shoulder width of 3.6 m (12 ft) should be considered. On a four-lane section, the paved width of the left shoulder shall be at least 1.2 m (4 ft). On sections with six or more lanes, a 3.0 m (10 ft) paved width for the left shoulder should be provided. Where truck traffic exceeds 250 DDHV, a paved width of 3.6 m (12 ft) should be considered.

In mountainous terrain, a reduced paved shoulder width together with a minimal median width may be used to reduce the high costs associated with providing a full width roadway cross section. In these instances, a 2.4 m (8 ft) minimum paved right shoulder and a 1.2 m (4 ft) minimum paved left shoulder may be used on a traveled way consisting of four or six lanes. Where eight or more lanes are provided, a 2.4 m (8 ft) minimum paved shoulder width should be used on both sides.



## Pavement and Shoulder Cross Slope

On tangent sections, the pavement cross slope shall be a minimum of 1.5 percent and desirably two percent. In areas of intense rainfall, the cross slope may be increased to 2.5 percent. Paved shoulders should have a cross slope in the range of two to six percent but not less than the cross slope of the adjacent pavement.

## Sideslopes

Foreslopes within the clear zone should not be steeper than 1V:4H and desirably should be 1V:6H or flatter. Where steeper slopes are used within the clear zone, roadside barriers shall be installed where warranted by the criteria in the current edition of AASHTO's *Roadside Design Guide*.

## Medians

Medians in rural areas in level or rolling topography shall be at least 11 m (36 ft) wide. Medians in urban or mountainous areas shall be at least 3.0 m (10 ft) wide. AASHTO's *Roadside Design Guide* should be consulted to determine the details and warrants, based on consideration of average daily traffic, median width, and crash history, for barrier installation in the median. When economically feasible, consideration should be given to decking over the opening between parallel structures and extending a median barrier across the deck. Where continuous decking is not feasible, median barriers or guardrails should be installed to stop or redirect an errant vehicle safely.

## Horizontal Clearance to Obstructions

The width of the clear recovery area shall be commensurate with the design speed and roadside conditions, and be determined through application of the currently accepted procedures in the AASHTO *Roadside Design Guide*. To the extent practicable, the piers and abutments of overcrossing structures should be designed to provide a horizontal clearance equal to the clear recovery area.

In restricted areas, it may be necessary to construct barriers, walls, piers, abutments or other unyielding objects nearer to the traveled way than the width required for a clear recovery area. Fixed objects within the limits of the clear recovery area shall be made breakaway, made yielding, or be shielded by installation of crashworthy barriers or attenuators. The minimum horizontal clearance from the edge of the traveled way to the face of the barrier shall be consistent with the requirements for the paved shoulder width.

## Curbs

Vertical curbs shall not be used. Sloping curbs, when used, should be located at the outer edge of the paved shoulder. The height of sloping curb should be limited to 100 mm (4 in).

The use of curbs in conjunction with guardrail is discouraged. When the installation of curb is necessary in conjunction with a guardrail, the face of the curb should be located behind the face of the guardrail, or at least no closer to the traveled way than the face of the guardrail. AASHTO's *Roadside Design Guide* should be consulted for detailed information concerning installation of curb in conjunction with guardrail.

## INTERCHANGES

Interchanges shall be provided between all intersecting interstate routes, between other selected access-controlled highways, and at other selected public highways to facilitate the distribution of traffic. Each interchange shall provide for all traffic movements.

The ramp curvature, pavement widths, and related elements, which constitute an interchange, shall be adequate to accommodate the appropriate design vehicles.

Spacing of interchanges has a significant effect on the operation of interstate highways. In areas of concentrated development, proper spacing may be difficult to obtain because of demand for frequent access. As a rule, minimum spacing should be 1.5 km (1 mi) in urban areas and 5 km (3 mi) in rural areas, based on crossroad to crossroad spacing. In urban areas, spacing of less than 1.5 km (1 mi) may be developed by grade-separated ramps or by collector-distributor roads.

## BRIDGES AND OTHER STRUCTURES

### General

The following standards apply to interstate highway bridges, overpasses and underpasses. Standards for crossroad overpasses and underpasses are to be those of the crossroad.

### Vertical Clearance

On all rural sections, the clear height of structures shall be not less than 4.9 m (16 ft) over the entire roadway width, including the width of paved shoulder. In urban areas, the 4.9 m (16 ft) clearance shall apply at least to a single interstate routing. On other interstate urban routes, the clear height shall be not less than 4.3 m (14 ft). An allowance should be made for future resurfacing. The vertical clearance to sign trusses and pedestrian overpasses shall be 5.1 m (17 ft). On interstate urban routes with less than the 4.9 m (16 ft) clearance, the vertical clearance to sign trusses shall be 0.3 m (1 ft) greater than the minimum clearance of other structures. The vertical clearance from the deck to the cross bracing on through truss structures shall also be a minimum of 5.1 m (17 ft).

### Cross Section

The width of all bridges, including grade separation structures, measured between rails, parapets, or barriers shall equal the full paved width of the approach roadways. The approach roadway includes the width of paved shoulders. Long bridges, defined as bridges having an overall length in excess of 60 m (200 ft), may have a lesser width. Such bridges shall be analyzed individually. On long bridges, offsets to parapet, rail or barrier shall be at least 1.2 m (4 ft) measured from the edge of the nearest traffic lane on both the left and the right.

### Structural Capacity

All new bridges shall have at least an MS 18 (HS 20) structural capacity. A bridge can remain in place if the operating rating capacity can safely service the system for an additional 20-year service life.

### Existing Bridges to Remain in Place

Mainline bridges on the interstate system and bridges on routes to be incorporated into the system may remain in place if, as a minimum, they meet the following: a) the bridge cross section consists of 3.6 m (12 ft) lanes, 3.0 m (10 ft) shoulder on the right and 1.1 m (3.5 ft) shoulder on the left; b) for long bridges, the offset to the face of parapet or bridge rail on both the left and right is 1.1 m (3.5 ft) measured from the edge of the nearest traveled lane; c) bridge railing shall meet or be upgraded to current standards.



length. Even in this case, the alignment may be unpleasant in appearance when both curves are clearly visible for some distance ahead.

- To avoid the appearance of inconsistent distortion, the horizontal alignment should be coordinated carefully with the profile design. General controls for this coordination are discussed in the section of this chapter on "Combination of Horizontal and Vertical Alignment."

## VERTICAL ALIGNMENT

### Terrain

The topography of the land traversed has an influence on the alignment of roads and streets. Topography affects horizontal alignment, but has an even more pronounced effect on vertical alignment. To characterize variations in topography, engineers generally separate it into three classifications according to terrain.

In level terrain, highway sight distances, as governed by both horizontal and vertical restrictions, are generally long or can be made to be so without construction difficulty or major expense.

In rolling terrain, natural slopes consistently rise above and fall below the road or street grade, and occasional steep slopes offer some restriction to normal horizontal and vertical roadway alignment.

In mountainous terrain, longitudinal and transverse changes in the elevation of the ground with respect to the road or street are abrupt, and benching and side hill excavation are frequently needed to obtain acceptable horizontal and vertical alignment.

Terrain classifications pertain to the general character of a specific route corridor. Routes in valleys, passes, or mountainous areas that have all the characteristics of roads or streets traversing level or rolling terrain should be classified as level or rolling. In general, rolling terrain generates steeper grades than level terrain, causing trucks to reduce speeds below those of passenger cars; mountainous terrain has even greater effects, causing some trucks to operate at crawl speeds.

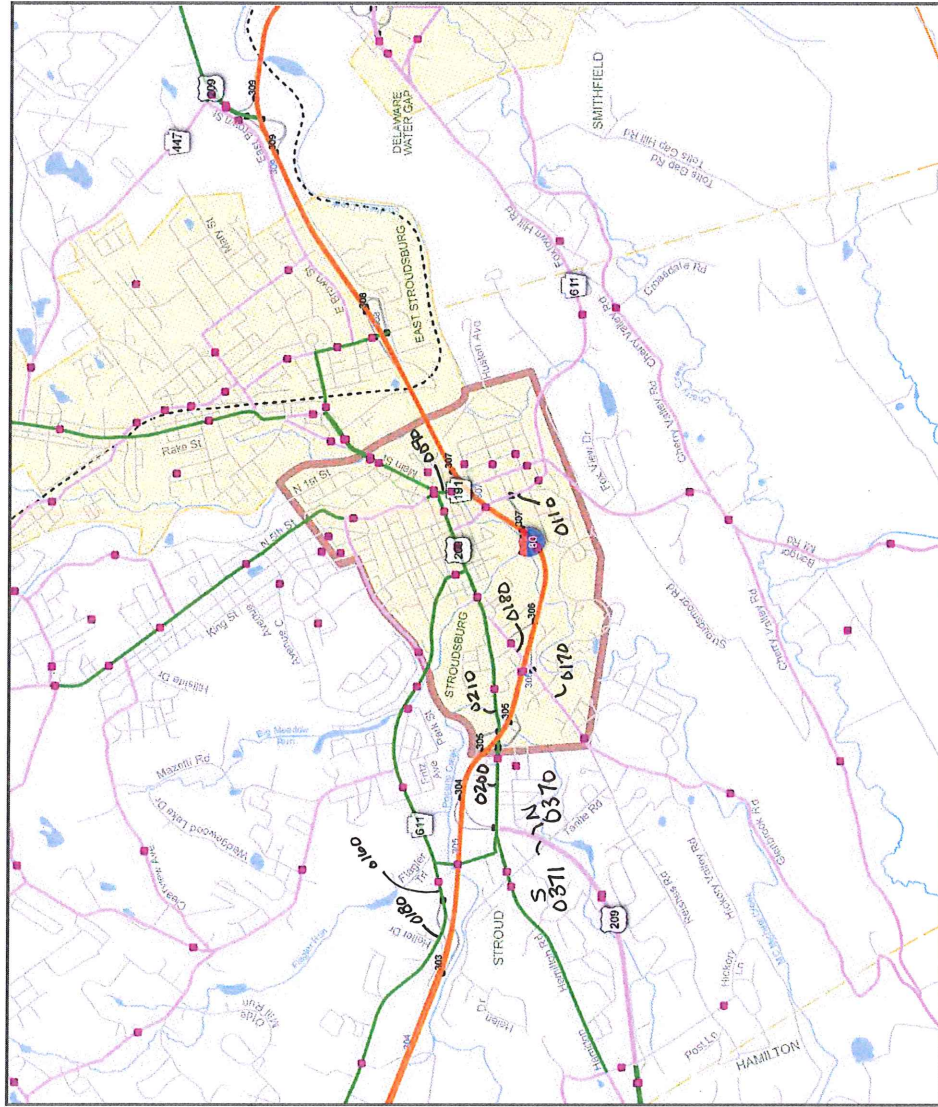
### Grades

Roads and streets should be designed to encourage uniform operation throughout. As discussed earlier in this chapter, design speeds are used as a means toward this end by correlation of various geometric features of the road or street. Design criteria have been determined for many highway features, but few conclusions have been reached on the appropriate relationship of roadway grades to design speed. Vehicle operating characteristics on grades are discussed and established relationships of grades and their lengths to design speed are developed below.

# I-80 Reconstruction

## Map Legend

- Traffic Sites
- AADT 20,000 - 50,000
- AADT 10,000 - 20,000
- AADT < 10,000
- Exits
- Interstates
- State Routes
- Local Roads
- Rail
- Selected Municipality
- Municipality Boundaries
- Water
- Cities / Boroughs
- District Boundary
- Route Shields
- Text Labels



0 0.66 mi 1.32 mi

2/4/2013 1:32 PM





<b>SITE NO: 3784</b>	
County	MONROE (45)
Route	0080
Segment	3064
Dir	E
Current Avg Daily Traffic	28146
Current Avg Daily Truck Volume	6192
K Factor	9
D Factor	65
T Factor	10
Truck Percent	22
Base Traffic Year	2010
Traffic Pattern Group	URBAN - INTERSTATE



Project: I-80 Reconstruction  
Calc# 1  
Page 39  
Originator: JWC 4/29/13  
Reviewer:

<b>SITE NO: 3779</b>		Job # 40284833 Calc# 1 Page 40 Project: I-80 Reconstruction Originator: <u>W</u> 2/18/13 Reviewer:
County	MONROE (45)	
Route	0080	
Segment	3011	
Dir	W	
Current Avg Daily Traffic	27195	
Current Avg Daily Truck Volume	5581	
K Factor	8	
D Factor	55	
T Factor	15	
Truck Percent	21	
Base Traffic Year	2011	
Traffic Pattern Group	URBAN - INTERSTATE	





Int. 303

**SITE NO: 10792**

County	MONROE (45)
Route	0611
Segment	0180
Dir	B
Current Avg Daily Traffic	15894
Current Avg Daily Truck Volume	664
K Factor	10
D Factor	55
T Factor	4
Truck Percent	4
Base Traffic Year	2009
Traffic Pattern Group	URBAN - MINOR ARTERIALS, COLLECTORS, LOCAL ROADS



Job # 40284833

Calc # 1

Page 41

Project: I-80 Reconstruction

Originator: JAL 2/19/13

Reviewer:

Int. 303

**SITE NO: 6947**

County	MONROE (45)
Route	0611
Segment	0160
Dir	B
Current Avg Daily Traffic	18648
Current Avg Daily Truck Volume	559
K Factor	11
D Factor	55
T Factor	2
Truck Percent	3
Base Traffic Year	2008
Traffic Pattern Group	URBAN - MINOR ARTERIALS, COLLECTORS, LOCAL ROADS



Job# 60284833

Calc# 1

Page 42

Project: I-80 Reconstruction

Originator: JAC 2/29/13

Reviewer:



Int. 304

**SITE NO: 3796**

County	MONROE (45)
Route	0209
Segment	0370
Dir	N
Current Avg Daily Traffic	8959
Current Avg Daily Truck Volume	718
K Factor	9
D Factor	70
T Factor	5
Truck Percent	8
Base Traffic Year	2011
Traffic Pattern Group	URBAN - OTHER PRINCIPAL ARTERIALS



Job # 60294833

Calc # 1

Page 43

Project: L&D Reconstruction

Originator: 304 2/14/13

Reviewer:

Int. 304

**SITE NO: 3796**

County	MONROE (45)
Route	0209
Segment	0371
Dir	S
Current Avg Daily Traffic	8960
Current Avg Daily Truck Volume	643
K Factor	9
D Factor	70
T Factor	5
Truck Percent	7
Base Traffic Year	2011
Traffic Pattern Group	URBAN - OTHER PRINCIPAL ARTERIALS





Int. 305

**SITE NO: 31422**

County	MONROE (45)
Route	2012
Segment	0200
Dir	B
Current Avg Daily Traffic	12947
Current Avg Daily Truck Volume	485
K Factor	9
D Factor	55
T Factor	3
Truck Percent	4
Base Traffic Year	2008
Traffic Pattern Group	URBAN - MINOR ARTERIALS, COLLECTORS, LOCAL ROADS



Posted 40 mph

Int. 305

**SITE NO: 6908**

County	MONROE (45)
Route	2012
Segment	0210
Dir	B
Current Avg Daily Traffic	11324
Current Avg Daily Truck Volume	793
K Factor	13
D Factor	55
T Factor	4
Truck Percent	7
Base Traffic Year	2008
Traffic Pattern Group	URBAN - OTHER PRINCIPAL ARTERIALS



Job# 60284833

Calc# 1

Page 46

Project: I-80 Reconstruction

Originator: JAL 2/28/13

Reviewer:



Int. 306

**SITE NO: 17163**

County	MONROE (45)
Route	2004
Segment	0180
Dir	B
Current Avg Daily Traffic	3773
Current Avg Daily Truck Volume	134
K Factor	11
D Factor	65
T Factor	7
Truck Percent	4
Base Traffic Year	2009
Traffic Pattern Group	URBAN - <u>MINOR ARTERIALS</u> , COLLECTORS, LOCAL ROADS



FCMap

posted speed = 35 mph

Project: I-80 Reconstruction Job# 40284833

Calc# 1

Originator: JAL 2/25/13

Reviewer: Page 47

Int. 306

**SITE NO: 6920**

County	MONROE (45)
Route	2004
Segment	0170
Dir	B
Current Avg Daily Traffic	3455
Current Avg Daily Truck Volume	100
K Factor	9
D Factor	60
T Factor	4
Truck Percent	3
Base Traffic Year	2011
Traffic Pattern Group	URBAN - MINOR ARTERIALS, COLLECTORS, LOCAL ROADS



Job # 00284333

Calc# 1

Page 48

Project: I-80 Reconstruction

Originator: JML 2/15/13

Reviewer:



Int 307 (WB 1-80)

**SITE NO: 25156**

County	MONROE (45)
Route	0191
Segment	0090
Dir	B
Current Avg Daily Traffic	12378
Current Avg Daily Truck Volume	495
K Factor	11
D Factor	55
T Factor	2
Truck Percent	4
Base Traffic Year	2009
Traffic Pattern Group	URBAN - OTHER PRINCIPAL ARTERIALS



Posted 35 mph

Int. 307 (EB I-80)

**SITE NO: 25189**

County	MONROE (45)
Route	0611
Segment	0110
Dir	B
Current Avg Daily Traffic	8871
Current Avg Daily Truck Volume	444
K Factor	10
D Factor	55
T Factor	3
Truck Percent	5
Base Traffic Year	2006
Traffic Pattern Group	URBAN - <u>MINOR</u> <u>ARTERIALS</u> , COLLECTORS, LOCAL ROADS



Posted 35 mph

Project: I-80 Reconstruction Job# 40284333

Originator: JMC ZLW/JS

Reviewer:

Calc# 1  
Page 50