

11 August 2008

*MONTANA DEPARTMENT OF
TRANSPORTATION*

ROAD DESIGN MANUAL

**Chapter Twelve
GEOMETRIC DESIGN TABLES**

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Chapter Twelve

GEOMETRIC DESIGN TABLES

12 GENERAL

This chapter presents summary tables of the Department's criteria for the geometric design of State projects. The designer should consider the following in the use of the tables:

1. Functional Classification. Figure 12-1 illustrates the designated functional classification of State highways in Montana. To determine the latest functional classification of a facility, the designer should contact the Rail, Transit and Planning Division. The selection of design values depends on the functional classification of the highway facility. Note that, in general, National Highway System facilities within the current Federal-aid system will be designed using the freeway table (Figure 12-2) and the rural/urban principal arterial tables (Figures 12-3 and 12-7). As discussed in Section 8.2, arterials and collectors are approximately equivalent to primary and secondary facilities within the former Federal-aid system.
2. Manual Section References. These tables are intended to provide a concise listing of design values for easy use. However, the designer should review the Manual section references for more information on the design elements.
3. Footnotes. The tables include many footnotes, which are identified by a number in parentheses (e.g., (6)). The information in the footnotes is critical to the proper use of the design tables.
4. Controlling Design Criteria. The tables provide an asterisk to indicate controlling design criteria. Section 8.8 discusses this in more detail and presents the process for approving design exceptions to controlling criteria.
5. Local Agency Criteria. The roads and streets agencies within Montana's counties and cities may have developed their own geometric design criteria for local facilities. If a facility is not on the State highway system, it may be acceptable to use the local agency criteria where there are conflicts with the MDT criteria. This decision will be made on a case-by-case basis.
6. Design Speed. The assumed design speed for a project should be a logical one with respect to topography, anticipated operating speed, the adjacent land use and the functional classification of the highway. In rural areas the topography and the functional classification of the routes are generally the controlling factors. In the determination of the type of terrain, utilize the following descriptions:

Level Terrain: The available stopping sight distances are generally long or can be made to be so without construction difficulty or major expense.

Rolling Terrain: The natural slopes consistently fall below and rise above the roadway and occasional steep slopes offer some restriction to horizontal and vertical alignment.

Mountainous Terrain: Longitudinal and transverse changes in elevation are abrupt and extensive grading is frequently need to obtain acceptable alignments

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MONTANA FUNCTIONAL CLASSIFICATION SYSTEM

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MONTANA FUNCTIONAL CLASSIFICATION SYSTEM
Figure 12-1

Figure 12-2

**GEOMETRIC DESIGN CRITERIA FOR FREEWAYS
(National Highway System — Interstate) U.S. Customary**

Design Element		Manual Section	Rural			Urban	
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years			20 Years	
	*Design Speed	Level	8.3	70 mph			50 mph
		Rolling		60 mph			
		Mountainous		50 mph			
Level of Service	8.4	B			B		
Roadway Elements	*Travel Lane Width	11.2	4 @ 12'			4 @ 12'	
	*Shoulder Width	Outside Shoulder	11.2	10' (1)			10' (1)
		Inside Shoulder		4' (2)			4' (2)
	Cross Slope	*Travel Lane	11.2	2%			2%
		Shoulder		2% (3)			2% (3)
	Median Width	Level	11.3	Minimum: 36'			Desirable: 36' Minimum: 16' (4)
Rolling		Minimum: 36'					
Mountainous		Minimum: 16' (4)					
Earth Cut Sections	Ditch	Inslope	11.4	6:1 (Width: 6')			6:1 (Width: 6')
		Width	11.4	10' Min.			10'
		Slope		20:1 towards back slope			20:1 towards back slope
	Back Slope; Cut Depth at Slope Stake (5)	0' - 5'	11.4	5:1			5:1
		5' - 10'		Level/Rolling: 4:1; Mountainous: 3:1			3:1
		10' - 15'		Level/Rolling: 3:1; Mountainous: 2:1			2:1
> 15'		Level/Rolling: 2:1; Mountainous: 1.5:1			1.5:1		
Earth Fill Slopes	Fill Height at Slope Stake (6)	0' - 10'	11.4	6:1			6:1
		10' - 20'		4:1			4:1
		20' - 30'		3:1			3:1
		> 30'		2:1			2:1
Alignment Elements	DESIGN SPEED	N/A	50 mph	60 mph	70 mph	50 mph	
	*Stopping Sight Distance	8.6	425'	570'	730'	425'	
	*Minimum Radius (e = 8.0%)	9.2	760'	1200'	1820'	760'	
	*Superelevation Rate (7)	9.3	e _{max} = 8.0%			e _{max} = 8.0%	
	*Vertical Curvature (K-value)	Crest	10.5	84	151	247	84
		Sag		96	136	181	96
	*Maximum Grade	Level	10.3	3%			5%
		Rolling		4%			
Mountainous		5% (8)					
*Minimum Vertical Clearance (9)	10.6	17.0'			17.0'		

* Controlling design criteria (see Section 8.8).

Figure 12-2

**GEOMETRIC DESIGN CRITERIA FOR FREEWAYS
(National Highway System — Interstate) Metric**

Design Element		Manual Section	Rural			Urban	
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years			20 Years	
	*Design Speed	Level	8.3	110 km/h			80 km/h
		Rolling		100 km/h			
		Mountainous		80 km/h			
Level of Service	8.4	B			B		
Roadway Elements	*Travel Lane Width	11.2	4 @ 3.6 m			4 @ 3.6 m	
	*Shoulder Width	Outside Shoulder	11.2	3.0 m (1)			3.0 m (1)
		Inside Shoulder		1.2 m (2)			1.2 m (2)
	Cross Slope	*Travel Lane	11.2	2%			2%
		Shoulder		2% (3)			2% (3)
	Median Width	Level	11.3	Minimum: 11 m			Desirable: 11 m Minimum: 5 m (4)
Rolling		Minimum: 11 m					
Mountainous		Desirable: 11 m Minimum: 5 m (4)					
Earth Cut Sections	Ditch	Inslope	11.4	6:1 (Width: 1.8 m)			6:1 (Width: 1.8 m)
		Width	11.4	3.0 m Min.			3.0 m
		Slope		20:1 towards back slope			20:1 towards back slope
	Back Slope; Cut Depth at Slope Stake (5)	0 m – 1.5 m	11.4	5:1			5:1
		1.5 m - 3.0 m		Level/Rolling: 4:1; Mountainous: 3:1			3:1
		3.0 m - 4.5 m		Level/Rolling: 3:1; Mountainous: 2:1			2:1
> 4.5 m	Level/Rolling: 2:1; Mountainous: 1.5:1			1.5:1			
Earth Fill Slopes	Fill Height at Slope Stake (6)	0 m - 3.0 m	11.4	6:1			6:1
		3.0 m - 6.0 m		4:1			4:1
		6.0 m - 9.0 m		3:1			3:1
		> 9.0 m		2:1			2:1
Alignment Elements	DESIGN SPEED	N/A	80 km/h	100 km/h	110 km/h	80 km/h	
	*Stopping Sight Distance	8.6	130 m	185 m	220 m	130 m	
	*Minimum Radius (e = 8.0%)	9.2	230 m	395 m	500 m	230 m	
	*Superelevation Rate (7)	9.3	e _{max} = 8.0%			e _{max} = 8.0%	
	*Vertical Curvature (K-value)	Crest	10.5	26	52	74	26
		Sag		30	45	55	30
	*Maximum Grade	Level	10.3	3%			5%
		Rolling		4%			
Mountainous		5% (8)					
*Minimum Vertical Clearance (9)	10.6	5.20 m			5.20 m		

* Controlling design criteria (see Section 8.8).

**GEOMETRIC DESIGN CRITERIA FOR FREEWAYS
(National Highway System — Interstate)**

Footnotes to Figure 12-2

- (1) Outside Shoulder Width. In mountainous terrain, these may be reduced to a 8' (2.4 m) minimum width where costs would be prohibitive to provide wider shoulders.
- (2) Inside Shoulder Width. The following will apply:
 - a. For 3 or more through lanes in one direction, inside shoulders will be 10' (3.0 m) wide.
 - b. Where continuous curbs are used in narrow medians on ramps, the inside shoulder should desirably be 2' (0.5 m) and a minimum of 1' (0.3 m).
 - c. Where vertical elements (other than abutments, piers or walls) in the median are more than 1' (0.3 m) high, the minimum offset from the edge of travel lane to the element is 4' (1.2 m).
- (3) Shoulder Cross Slope. Existing shoulder slopes on existing freeways may be 3.75%. If the proposed pavement work is resurfacing, the existing 3.75% slope may be retained. If the proposed pavement work is full-depth reconstruction or major rehabilitation, the shoulder slope should match the cross slope of the traveled way, typically 2%.
- (4) Minimum Median Width. The minimum median width of 10' (3.0 m) may be used in urban areas with high right-of-way costs and in rugged mountainous terrain. It may also be used on any long and unusually costly bridges. The minimum median width should be the width of the two inside shoulders and the width of the base of the barrier.
- (5) Cut Slopes (Rock). The back slope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the back slope typically will not exceed 0.25:1. For large cuts, benching of the back slope may be required.
- (6) Fill Slopes (Rock). In rock fills over 10' (3.0 m) high, the typical fill slope is 1.5:1. In rock fills ≤ 10' (3.0 m), the typical slope is 6:1.
- (7) Superelevation Rate. See Section 9.3 for superelevation rates based on design speed and curve radii.
- (8) Maximum Grade (Mountainous). Gradients of up to 7% may be provided with approval by the Preconstruction Engineer. FHWA approval may also be required.
- (9) Minimum Vertical Clearance. The clearances apply to a freeway passing under a bridge. The minimum clearance includes a 6" (150 mm) additional allowance for future overlays.

Figure 12-3

**GEOMETRIC DESIGN CRITERIA FOR RURAL PRINCIPAL ARTERIALS
(National Highway System — Non Interstate) U.S. Customary**

Design Element		Manual Section	Design Criteria			
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)			
	*Design Speed	Level	8.3	70 mph		
		Rolling		60 mph		
		Mountainous		50 mph		
Level of Service	8.4	Level/Rolling: B Mountainous: C				
Roadway Elements	*Travel Lane Width	11.2	12' (2)			
	*Shoulder Width	11.2	Varies (2)			
	Cross Slope	*Travel Lane	11.2	2%		
		Shoulder		2%		
Median Width	11.3	Varies (3)				
Earth Cut Sections	Ditch	Inslope	11.4	6:1 (Width: 10')		
		Width	11.4	10' Min.		
		Slope		20:1 towards back slope		
	Back Slope; Cut Depth at SlopeStake (4)	0' – 5'	11.4	5:1		
		5' – 10'		Level/Rolling: 4:1; Mountainous: 3:1		
		10' – 15'		Level/Rolling: 3:1; Mountainous: 2:1		
		15' – 20'		Level/Rolling: 2:1; Mountainous: 1.5:1		
> 20'	1.5:1					
Earth Fill Slopes	Fill Height at Slope Stake (5)	0' – 10'	11.4	6:1		
		10' – 20'		4:1		
		20' – 30'		3:1		
		> 30'		2:1		
Alignment Elements	DESIGN SPEED		N/A	50 mph	60 mph	70 mph
	*Stopping Sight Distance		8.6	425'	570'	730'
	Passing Sight Distance		8.6	1835'	2135'	2480'
	*Minimum Radius (e=8.0%)		9.2	760'	1200'	1810'
	*Superelevation Rate (6)		9.3	emax = 8.0%		
	*Vertical Curvature (K-value)	Crest	10.5	84	151	247
		Sag		96	136	181
	*Maximum Grade	Level	10.3	3%		
		Rolling		4%		
Mountainous		7%				
Mimimum Vertical Clearance (7)		10.6	17.0'			

* Controlling design criteria (see Section 8.8).

Figure 12-3

**GEOMETRIC DESIGN CRITERIA FOR RURAL PRINCIPAL ARTERIALS
(National Highway System — Non Interstate) Metric**

Design Element		Manual Section	Design Criteria			
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)			
	*Design Speed	Level	8.3	110 km/h		
		Rolling		100 km/h		
		Mountainous		80 km/h		
Level of Service	8.4	Level/Rolling: B Mountainous: C				
Roadway Elements	*Travel Lane Width	11.2	3.6 m (2)			
	*Shoulder Width	11.2	Varies (2)			
	Cross Slope	*Travel Lane	11.2	2%		
		Shoulder		2%		
Median Width	11.3	Varies (3)				
Earth Cut Sections	Ditch	Inslope	11.4	6:1 (Width: 3.0 m)		
		Width	11.4	3.0 m Min.		
		Slope		20:1 towards back slope		
	Back Slope; Cut Depth at SlopeStake (4)	0 - 1.5 m	11.4	5:1		
		1.5 m - 3.0 m		Level/Rolling: 4:1; Mountainous: 3:1		
		3.0 m - 4.5 m		Level/Rolling: 3:1; Mountainous: 2:1		
		4.5 m - 6.0 m		Level/Rolling: 2:1; Mountainous: 1.5:1		
> 6.0 m		1.5:1				
Earth Fill Slopes	Fill Height at Slope Stake (5)	0 - 3.0 m	11.4	6:1		
		3.0 m - 6.0 m		4:1		
		6.0 m - 9.0 m		3:1		
		> 9.0 m		2:1		
Alignment Elements	DESIGN SPEED		N/A	80 km/h	100 km/h	110 km/h
	*Stopping Sight Distance		8.6	130 m	185 m	220 m
	Passing Sight Distance		8.6	550 m	675m	750 m
	*Minimum Radius (e=8.0%)		9.2	230 m	395 m	500 m
	*Superelevation Rate (6)		9.3	emax = 8.0%		
	*Vertical Curvature (K-value)	Crest	10.5	26	52	74
		Sag		30	45	55
	*Maximum Grade	Level	10.3	3%		
		Rolling		4%		
Mountainous		7%				
Mimimum Vertical Clearance (7)		10.6	5.20 m			

* Controlling design criteria (see Section 8.8).

GEOMETRIC DESIGN CRITERIA FOR RURAL PRINCIPAL ARTERIALS (National Highway System — Non Interstate)

Footnotes to Figure 12-3

- (1) Design Forecast Year (Geometrics). For overlay and widening projects, the design year for geometrics is based on the design analysis period used for the pavement design, with 8 years as a minimum design forecast year.
- (2) Travel Lane/Shoulder Width. See the accompanying Route Segment Map to determine the applicable roadway width for the facility under design. Reconstruction projects will be designed in accordance with the criteria in Figure 12-3. **For pavement preservation projects**, the objective is to provide the maximum roadway width. This is accomplished by the following:
 - a. If the existing width exceeds the Route Segment width, the overlay should be accommodated by reducing the top width. If accommodating the overlay would result in a roadway width less than the Route Segment width, narrow the roadway width to a width equal to or greater than the Route Segment width, before steeping the inslopes.
 - b. If the overlay will result in a roadway width less than the Route Segment width, steepen the surfacing inslopes to no steeper than 4:1 to maximize the roadway width.
 - c. If the Route Segment width cannot be achieved with surfacing inslopes no steeper than 4:1, the roadway width may be reduced. In no case can the roadway width be reduced to less than 28' (8.4 m).

If widening (other than inslope dressing) is necessary to provide at least an 28' (8.4 m) roadway width with 4:1 surfacing inslopes, the project should be considered an "overlay and widening" project, and the roadway should be widened to the criteria in the accompanying Route Segment Map. This does not preclude some earthwork for safety purposes.

If 25% of an overlay and widening project or pavement preservation project requires intermittent reconstruction, then reconstruct the entire project to meet the criteria in Figure 12-3.
- (3) Median Width. For two-way, left-turn lanes in rural conditions, the minimum width is 14' (4.2 m). See Section 11.3 for additional information on median widths.
- (4) Cut Slopes (Rock). The back slope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the back slope typically will not exceed 0.25:1. For large cuts, benching of the back slope may be required.
- (5) Fill Slopes (Rock). In rock fills over 10' (3.0 m) high, the typical fill slope is 1.5:1. In rock fills \leq 10' (3.0 m), the typical slope is 6:1.
- (6) Superelevation Rate. See Section 9.3 for superelevation rates based on design speed and curve radii.
- (7) Minimum Vertical Clearance. The clearances apply to the arterial passing under a bridge. The minimum clearance includes a 6" (150 mm) additional allowance for future overlays.

**Route Segment Plan
(Freeways/Principal Arterials)
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**Route Segment Plan
(Freeways/Principal Arterials)
(To Be Inserted By The Department)**

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Figure 12-4

**GEOMETRIC DESIGN CRITERIA FOR RURAL MINOR ARTERIALS
(Non-NHS — Primary) U.S. Customary**

Design Element		Manual Section	Design Criteria			
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)			
	*Design Speed	Level	8.3	60 mph		
		Rolling		55 mph		
		Mountainous		45 mph		
*Level of Service	8.4	Level/Rolling: B	Mountainous: C			
Roadway Elements	*Travel Lane Width	11.2	12' (2)			
	*Shoulder Width	11.2	Varies (2)			
	Cross Slope	*Travel Lane	11.2	2%		
		Shoulder		2%		
Median Width	11.3	Varies (3)				
Earth Cut Sections	Ditch	Inslope	11.4	6:1 (Width: 10')		
		Width	11.4	10' Min.		
		Slope		20:1 towards back slope		
	Back Slope; Cut Depth at Slope Stake (4)	0' – 5'	11.4	5:1		
		5' – 10'		Level/Rolling: 4:1; Mountainous: 3:1		
		10' – 15'		Level/Rolling: 3:1; Mountainous: 2:1		
		15' – 20'		Level/Rolling: 2:1; Mountainous: 1.5:1		
> 20'		1.5:1				
Earth Fill Slopes	Fill Height at Slope Stake (5)	0' – 10'	11.4	6:1		
		10' – 20'		4:1		
		20' – 30'		3:1		
		> 30'		2:1		
Alignment Elements	DESIGN SPEED	N/A	45 mph	55 mph	60 mph	
	*Stopping Sight Distance	8.6	360'	495'	570'	
	Passing Sight Distance	8.6	1625'	1885'	2135'	
	*Minimum Radius (e=8.0%)	9.2	590'	960'	1200'	
	*Superelevation Rate (6)	9.3	e _{max} = 8.0%			
	*Vertical Curvature (K-value)	Crest	10.5	61	114	151
		Sag		79	115	136
	*Maximum Grade	Level	10.3	3%		
		Rolling		4%		
Mountainous		7%				
*Minimum Vertical Clearance (7)	10.6	17.0'				

* Controlling design criteria (see Section 8.8).

Figure 12-4

**GEOMETRIC DESIGN CRITERIA FOR RURAL MINOR ARTERIALS
(Non-NHS — Primary) Metric**

Design Element		Manual Section	Design Criteria			
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)			
	*Design Speed	Level	8.3	100 km/h		
		Rolling		90 km/h		
		Mountainous		70 km/h		
*Level of Service		8.4	Level/Rolling: B	Mountainous: C		
Roadway Elements	*Travel Lane Width	11.2	3.6 m (2)			
	*Shoulder Width	11.2	Varies (2)			
	Cross Slope	*Travel Lane	11.2	2%		
		Shoulder		2%		
Median Width		11.3	Varies (3)			
Earth Cut Sections	Ditch	Inslope	11.4	6:1 (Width: 3.0 m)		
		Width	11.4	3.0 M Min.		
		Slope		20:1 towards back slope		
	Back Slope; Cut Depth at Slope Stake (4)	0 - 1.5 m	11.4	5:1		
		1.5 m - 3.0 m		Level/Rolling: 4:1; Mountainous: 3:1		
		3.0 m - 4.5 m		Level/Rolling: 3:1; Mountainous: 2:1		
		4.5 m - 6.0 m		Level/Rolling: 2:1; Mountainous: 1.5:1		
> 6.0 m	1.5:1					
Earth Fill Slopes	Fill Height at Slope Stake (5)	0 - 3.0 m	11.4	6:1		
		3.0 m - 6.0 m		4:1		
		6.0 m - 9.0 m		3:1		
		> 9.0 m		2:1		
Alignment Elements	DESIGN SPEED		N/A	70 km/h	90 km/h	100 km/h
	*Stopping Sight Distance		8.6	105 m	160 m	185 m
	Passing Sight Distance		8.6	490 m	615 m	675 m
	*Minimum Radius (e=8.0%)		9.2	175 m	305 m	395 m
	*Superelevation Rate (6)		9.3	e _{max} = 8.0%		
	*Vertical Curvature (K-value)	Crest	10.5	17	39	52
		Sag		23	38	45
	*Maximum Grade	Level	10.3	3%		
Rolling		4%				
Mountainous		7%				
*Minimum Vertical Clearance (7)		10.6	5.20 m			

* Controlling design criteria (see Section 8.8).

GEOMETRIC DESIGN CRITERIA FOR RURAL MINOR ARTERIALS (Non-NHS — Primary)

Footnotes to Figure 12-4

- (1) Design Forecast Year (Geometrics). For overlay and widening projects, the design year for geometrics is based on the design analysis period used for the pavement design, with 8 years as a minimum design forecast year.
- (2) Travel Lane/Shoulder Width. See the accompanying Route Segment Map to determine the applicable roadway width for the facility under design. Reconstruction projects will be designed in accordance with the criteria in Figure 12-4. **For pavement preservation projects**, the objective is to provide the maximum roadway width. This is accomplished by the following:
 - a. If the existing width exceeds the Route Segment width, the overlay should be accommodated by reducing the top width. If accommodating the overlay would result in a roadway width less than the Route Segment width, narrow the roadway width to a width equal to or greater than the Route Segment width, before steepening the inslopes.
 - b. If the overlay will result in a roadway width less than the Route Segment width, steepen the surfacing inslopes to no steeper than 4:1 to maximize the roadway width.
 - c. If the Route Segment width cannot be achieved with surfacing inslopes no steeper than 4:1, the roadway width may be reduced. In no case can the roadway width be reduced to less than 28' (8.4 m).

If widening (other than inslope dressing) is necessary to provide at least an 28' (8.4 m) roadway width with 4:1 surfacing inslopes, the project should be considered an "overlay and widening" project, and the roadway should be widened to the criteria in the accompanying Route Segment Map. This does not preclude some earthwork for safety purposes.

If 25% of an overlay and widening project or pavement preservation project requires intermittent reconstruction, then reconstruct the entire project to meet the criteria in Figure 12-4.
- (3) Median Width. For two-way, left-turn lanes in rural conditions, the minimum width is 14' (4.2 m). See Section 11.3 for additional information on median widths.
- (4) Cut Slopes (Rock). The back slope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the back slope typically will not exceed 0.25:1. For large cuts, benching of the back slope may be required.
- (5) Fill Slopes (Rock). In rock fills over 10' (3.0 m) high, the typical fill slope is 1.5:1. In rock fills \leq 10' (3.0 m), the typical slope is 6:1.
- (6) Superelevation Rate. See Section 9.3 for superelevation rates based on design speed and curve radii.
- (7) Minimum Vertical Clearance. The clearances apply to the arterial passing under a bridge. The minimum clearance includes a 6" (150 mm) additional allowance for future overlays.

**Route Segment Plan
(Minor Arterials)
(To Be Inserted By The Department)**

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**Route Segment Plan
(Minor Arterials)
(To Be Inserted By The Department)**

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Figure 12-5

**GEOMETRIC DESIGN CRITERIA FOR RURAL COLLECTOR ROADS
(Secondary System) U.S. Customary**

Design Element		Manual Section	Design Criteria					
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)					
	*Design Speed	Level	8.3	60 mph				
		Rolling		50 mph				
		Mountainous		45 mph				
Level of Service	8.4	Desirable: B Minimum: C						
Roadway Elements	TRAFFIC	Current AADT	N/A	0-299	300-999	1000-1999	2000-3000	> 3000
		DHV		50-99	100-199	200-299	300-400	>400
	*Roadway Width (Travel Lanes & Shoulders) (2)	11.2	24'	28'	32'	36'	40'	
	Cross Slope	*Travel Lane	11.2	2%				
		Shoulder		2%				
Median Width	11.3	Varies (3)						
Earth Cut Section	Ditch (4)	Inslope	11.4	DHV, 200 — 6:1 (Width: 10') DHV < 200 — 4:1 (Width: 6')				
		Width	11.4	10' Min.				
		Slope		20:1 towards back slope				
	Back Slope; Cut Depth at Slope Stake (5)	0' – 5'	11.4	5:1				
		5' – 10'		Level/Rolling: 4:1; Mountainous: 3:1				
		10' – 15'		Level/Rolling: 3:1; Mountainous: 2:1				
		15' – 20'		Level/Rolling: 2:1; Mountainous: 1.5:1				
> 20'	1.5:1							
Earth Fill Slopes	Fill Height at Slope Stake (6)	0' – 10'	11.4	DHV, \geq 200 - 6:1 DHV < 200 — 4:1				
		10' – 20'		DHV, \geq 200 - 4:1 DHV < 200 — 3:1				
		20' – 30'		3:1				
		> 30'		2:1				
Alignment Elements	DESIGN SPEED		N/A	45 mph	50 mph	60 mph		
	*Stopping Sight Distance		8.6	360'	425'	570'		
	Passing Sight Distance		8.6	1625'	1835'	2135'		
	*Minimum Radius (e=8.0%)		9.2	590'	760'	1200'		
	*Superelevation Rate (7)		9.3	e _{max} = 8.0%				
	*Vertical Curvature (K-value)	Crest	10.5	61	84	151		
		Sag		79	96	136		
	*Maximum Grade	Level	10.3	5%				
		Rolling		7%				
Mountainous		10%						
*Minimum Vertical Clearance (8)		10.6	16.5'					

* Controlling design criteria (see Section 8.8).

Figure 12-5

**GEOMETRIC DESIGN CRITERIA FOR RURAL COLLECTOR ROADS
(Secondary System) Metric**

Design Element		Manual Section	Design Criteria					
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)					
	*Design Speed	8.3	100 km/h					
			80 km/h					
			70 km/h					
Level of Service	8.4	Desirable: B Minimum: C						
Roadway Elements	TRAFFIC	Current AADT	N/A	0-299	300-999	1000-1999	2000-3000	> 3000
		DHV		50-99	100-199	200-299	300-400	>400
	*Roadway Width (Travel Lanes & Shoulders) (2)	11.2	7.2 m	8.4 m	9.6 m	10.8 m	12.0 m	
	Cross Slope	11.2	*Travel Lane	2%				
			Shoulder	2%				
Median Width	11.3	Varies (3)						
Earth Cut Section	Ditch (4)	Inslope	11.4	DHV, 200 — 6:1 (Width: 3.0 m) DHV < 200 — 4:1 (Width: 2.0 m)				
		Width	11.4	3.0 m Min.				
		Slope		20:1 towards back slope				
	Back Slope; Cut Depth at Slope Stake (5)	0 - 1.5 m	11.4	5:1				
		1.5 m - 3.0 m		Level/Rolling: 4:1; Mountainous: 3:1				
		3.0 m - 4.5 m		Level/Rolling: 3:1; Mountainous: 2:1				
		4.5 m - 6.0 m		Level/Rolling: 2:1; Mountainous: 1.5:1				
> 6.0 m		1.5:1						
Earth Fill Slopes	Fill Height at Slope Stake (6)	0 - 3.0 m	11.4	DHV, \geq 200 — 6:1 DHV < 200 — 4:1				
		3.0 m - 6.0 m		DHV, \geq 200 — 4:1 DHV < 200 — 3:1				
		6.0 m - 9.0 m		3:1				
		> 9.0 m		2:1				
Alignment Elements	DESIGN SPEED		N/A	70 km/h	80 km/h	100 km/h		
	*Stopping Sight Distance		8.6	105 m	130 m	185 m		
	Passing Sight Distance		8.6	490 m	550 m	675 m		
	*Minimum Radius (e=8.0%)		9.2	175 m	230 m	395 m		
	*Superelevation Rate (7)		9.3	e _{max} = 8.0%				
	*Vertical Curvature (K-value)	Crest	10.5	17	26	52		
		Sag		23	30	45		
	*Maximum Grade	Level	10.3	5%				
		Rolling		7%				
Mountainous		10%						
*Minimum Vertical Clearance (8)		10.6	5.05 m					

* Controlling design criteria (see Section 8.8).

GEOMETRIC DESIGN CRITERIA FOR RURAL COLLECTOR ROADS (Non-NHS — Secondary)

Footnotes to Figure 12-5

- (1) Design Forecast Year (Geometrics). For overlay and widening projects, the design year for geometrics is based on the design analysis period used for the pavement design, with 8 years as a minimum design forecast year.
- (2) Travel Lane/Shoulder Width. Reconstruction projects will be designed in accordance with the criteria in Figure 12-5. **For pavement preservation projects**, the objective is to provide the maximum roadway width. This is accomplished by the following:
 - d. If the ADT \geq 300 or DHV \geq 100 and the top width exceeds 28' (8.4 m), the overlay should be accommodated by reducing the roadway to a width greater than or equal to 28' (8.4 m). If the ADT $<$ 300 or DHV $<$ 100 and the existing top width exceeds 24' (7.2 m), the overlay should be accommodated by reducing the roadway to a width greater than or equal to 24' (7.2 m).
 - e. If the overlay will result in a roadway width less than 24' (7.2 m) or 28' (8.4 m) as determined by the ADT or DHV described above, steepen the surfacing inslopes to no steeper than 4:1 to maximize the roadway width.

If widening (other than inslope dressing) is necessary to provide at least a 24' (7.2 m) or 28' (8.4 m) roadway width as determined by the ADT or DHV described above with 4:1 surfacing inslopes, the project should be considered an "overlay and widening" project. Consequently, the roadway should be widened in accordance with the criteria in Figure 12-5.

If the roadway width is less than 28' (8.4 m), add 2' (0.6 m) to each side of the roadway where a barrier is located.

If 25% of the overlay and widening project or pavement preservation project requires intermittent reconstruction, then the entire project should be reconstructed to meet the criteria in Figure 12-5.
- (3) Median Width. For two-way, left-turn lanes in rural conditions, the minimum width is 14' (4.2 m). See Section 11.3 for additional information on median widths.
- (4) Ditch. A V-ditch may be used with an approved design exception. For backslopes steeper than 4:1, place the toe of the backslope outside the clear zone.
- (5) Cut Slopes. The designer should attempt to locate back slopes steeper than 4:1 outside the clear zone. The back slope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the back slope typically will not exceed 0.25:1. For large cuts, benching of the back slope may be required.
- (6) Fill Slopes (Rock). In rock fills over 10' (3.0 m) high, the typical fill slope is 1.5:1. In rock fills \leq 10' (3.0 m), the typical slope is 6:1.
- (7) Superelevation Rate. See Section 9.3 for superelevation rates based on design speed and curve radii.
- (8) Minimum Vertical Clearance. The clearances apply to the collector passing under a bridge. The minimum clearance includes a 6" (150 mm) additional allowance for future overlays.

Figure 12-6

**GEOMETRIC DESIGN CRITERIA FOR RURAL LOCAL ROADS
(Off-System BR Projects) U.S. Customary**

Design Element		Manual Section	Design Criteria			
Design Controls	Current ADT	N/A	≤ 300 (1)			
	*Design Speed	Paved Surface	50 mph (2)			
		Gravel Surface	45 mph (2)			
Roadway Elements	*Minimum Roadway Width	11.2	24' (3)			
	Cross Slope	*Travel Lane	Paved: 2% Gravel: 3%			
		Shoulder	Paved: 2% Gravel: 3%			
Median Width	11.3	Varies (4)				
Earth Cut Sections	Inslope	11.4	4:1			
	Ditch (5)	11.4	V-Ditch (1.5' Depth)			
	Back Slope; Cut Depth at Slope Stake (6)	0' – 5'	11.4	4:1		
		5' – 10'		Level/Rolling: 3:1; Mountainous: 2:1		
		10' – 15'		Level/Rolling: 2:1; Mountainous: 1.5:1		
> 15'		1.5:1				
Earth Fill Slopes	Fill Height at Slope Stake (7)	0' – 10'	4:1			
		10' – 20'	3:1			
		> 20'	1.5:1			
Alignment Elements	DESIGN SPEED		N/A	30 mph	45 mph	50 mph
	*Stopping Sight Distance		8.6	200'	360'	425'
	Passing Sight Distance		8.6	1090'	1625'	1835'
	*Minimum Radius (e=8.0%)		9.2	220'	590'	760'
	*Superelevation Rate (8)		9.3	e _{max} = 8.0%		
	*Vertical Curvature (K-value)	Crest	10.5	19	61	84
		Sag		37	79	96
	*Maximum Grade	Level	10.3	7%	7%	6%
		Rolling		10%	9%	8%
Mountainous		10%		10%	10%	
*Minimum Vertical Clearance (9)		10.6	14.5'			

* Controlling design criteria (see Section 8.8).

Figure 12-6

**GEOMETRIC DESIGN CRITERIA FOR RURAL LOCAL ROADS
(Off-System BR Projects) Metric**

Design Element		Manual Section	Design Criteria			
Design Controls	Current ADT	N/A	≤ 300 (1)			
	*Design Speed	Paved Surface	80 km/h (2)			
		Gravel Surface	70 km/h (2)			
Roadway Elements	*Minimum Roadway Width	11.2	7.2 m (3)			
	Cross Slope	*Travel Lane	Paved: 2% Gravel: 3%			
		Shoulder	Paved: 2% Gravel: 3%			
Median Width	11.3	Varies (4)				
Earth Cut Sections	Inslope	11.4	4:1			
	Ditch (5)	11.4	V-Ditch (0.3 m Depth)			
	Back Slope; Cut Depth at Slope Stake (6)	0 - 1.5 m	11.4	4:1		
		1.5 m - 3.0 m		Level/Rolling: 3:1; Mountainous: 2:1		
		3.0 m – 4.50 m		Level/Rolling: 2:1; Mountainous: 1.5:1		
> 4.50 m		1.5:1				
Earth Fill Slopes	Fill Height at Slope Stake (7)	0 - 3.0 m	4:1			
		3.0 – 6.0 m	3:1			
		> 6.0 m	1.5:1			
Alignment Elements	DESIGN SPEED		N/A	50 km/h	70 km/h	80 km/h
	*Stopping Sight Distance		8.6	65 m	105 m	130 m
	Passing Sight Distance		8.6	350 m	490 m	550 m
	*Minimum Radius (e=8.0%)		9.2	85 m	175 m	230 m
	*Superelevation Rate (8)		9.3	e _{max} = 8.0%		
	*Vertical Curvature (K-value)	Crest	10.5	7	17	26
		Sag		13	23	30
	*Maximum Grade	Level	10.3	7%	7%	6%
		Rolling		10%	9%	8%
Mountainous		10%		10%	10%	
*Minimum Vertical Clearance (9)		10.6	4.40 m			

Controlling design criteria (see Section 8.8).

GEOMETRIC DESIGN CRITERIA FOR RURAL LOCAL ROADS (Off-System BR Projects)

Footnotes to Figure 12-6

- (1) AADT. For local rural roads with current AADT > 300 and/or functionally classified as a rural collector, the design criteria for rural collector roads should be used (Figure 12-5). For local roads with current AADT < 300 design the project using one of the following:
 - a. County standards – note that many counties do not have standards
 - b. The design criteria provided in Figure 12-6
 - c. AASHTO's *Guidelines for Geometric Design of Very Low-Volume Local Roads*. Use these guidelines only if it is not practical to meet the criteria in figure 12-6.
- (2) Design Speed. See Section 8.3 for selection of design speed. For local roads requiring a higher design speed, the criteria for rural collector roads should be used (Figure 12-5). The 30 mph (50 km/h) design speed should only be used if the adjacent terrain presents obstacles that render the use of a higher design speed impractical. A formal design exception for design speed is not required for rural local roads. However, deviation from the design speeds in Figure 12-6 must be documented in the PFR, AGR and SOW reports.
- (3) Roadway Width. The bridge width, adjacent paved traveled way width and county standards should be considered when establishing a roadway width, if greater than the minimum. Bridges will typically provide a minimum roadway width of 28' (8.4 m). This width should be utilized to the end of the approach guardrail.
- (4) Median Width. For two-way, left-turn lanes in rural conditions, the minimum width is 14' (4.2 m). See Section 11.3 for additional information on median widths.
- (5) Ditch. V-ditches can be used without prior approval. The designer should attempt to make the ditch traversable or locate it outside of the clear zone.
- (6) Cut Slopes (Rock). The back slope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the back slope typically will not exceed 0.25:1. For large cuts, benching of the back slope may be required.
- (7) Fill Slopes. In rock fills over 3.0 m high, the typical fill slope is 1.5:1. In rock fills ≤ 3.0 m, the typical fill slope is 4:1. In earth fills where the fill depth > 6.0 m, the use of steeper than 1.5:1 slopes may be used if justified by a slope stability analysis.
- (8) Superelevation Rate. See Section 9.3 for superelevation rates based on design speed and curve radii.
- (9) Minimum Vertical Clearance. The clearances apply to the local road passing under a bridge. The minimum clearance includes a 150 mm additional allowance for future overlays.

Figure 12-7

**GEOMETRIC DESIGN CRITERIA FOR URBAN PRINCIPAL ARTERIALS
(National Highway System — Non Interstate) U.S. Customary**

Design Element		Manual Section	2-Lane		Multi-lane		
			Curbed	Uncurbed	Curbed	Uncurbed	
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)		20 Years (1)		
	*Design Speed (2)	8.3	40-45 mph	40-50 mph	40-45 mph	40-55 mph	
	Level of Service	8.4	Desirable: B Minimum: C		Desirable: B	Minimum: C	
Roadway Elements	*Travel Lane Width	11.2	12'		12'		
	*Shoulder Width (3)	Outside	11.2	varies	varies	varies	varies
		Inside		N/A		2.0'	4'
	Cross Slope	*Travel Lane	11.2	2% Typical (4)	2%	2% Typical (4)	2%
		Shoulder		2% Typical (4)	2%	2% Typical (4)	2%
	Median Width	11.3	N/A		Flush: 4' - 16' (5) Raised: 20'(5)		
TWLTW Width	11.2	16'		16'			
Earth Cut Sections	Ditch	Inslope	11.4	N/A	6:1 (Des\4:1 Min)	N/A	6:1(Des\ 4:1 Min)
		Width		N/A	10' Min. (6)	N/A	10' (6)
		Slope	11.4	N/A	20:1 towards back slope	N/A	20:1 towards back slope
	Back Slope; Cut Depth at Slope Stake (7)	0' - 5'	11.4	5:1		5:1	
		5' - 10'		L/R: 4:1 Mt: 3:1		3:1	
		10' - 15'		L/R: 3:1 Mt: 2:1		2:1	
		15' - 20'		L/R: 2:1 Mt: 1.5:1		1.5:1	
		> 20'		1.5:1		1.5:1	
Earth Fill Slopes	Fill Height at Slope Stake (8)	0' - 10'	11.4	6:1	6:1	6:1	6:1
		10' - 20'		4:1	4:1	4:1	4:1
		20' - 30'		3:1	3:1	3:1	3:1
		> 30'		2:1	2:1	2:1	2:1
Alignment Elements (11)	DESIGN SPEED	N/A	40 mph	45 mph	50 mph	55 mph	
	*Stopping Sight Distance	8.6	305'	360'	425'	495'	
	*Minimum Radius	9.2	533'	711'	760'	960'	
	*Superelevation Rate (9)	9.3 & 9.4	emax = 4.0%		emax = 8.0%		
	*Vertical Curvature (K-value)	Crest	10.5	44	61	84	114
		Sag		64	79	96	115
	*Maximum Grade	Level	10.3	6%	6%	6%	5%
		Rolling		7%	7%	7%	6%
Mountainous		9%		9%	9%	8%	
*Minimum Vertical Clearance (10)	10.6	17.0'					

* Controlling design criteria (see Section 8.8).

L/R: Level/Rolling

Mt: Mountainous

Figure 12-7

**GEOMETRIC DESIGN CRITERIA FOR URBAN PRINCIPAL ARTERIALS
(National Highway System — Non Interstate) Metric**

Design Element		Manual Section	2-Lane		Multi-lane		
			Curbed	Uncurbed	Curbed	Uncurbed	
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)		20 Years (1)		
	*Design Speed (2)	8.3	60-70 km/h	70-80 km/h	60-70 km/h	60-90 km/h	
	Level of Service	8.4	Desirable: B Minimum: C		Desirable: B Minimum: C		
Roadway Elements	*Travel Lane Width (3)	11.2	3.6 m		3.6 m		
	*Shoulder Width	Outside	11.2	0.6 m	2.4 m	0.6 m	2.4 m
		Inside		N/A		0.6 m	1.2 m
	Cross Slope	*Travel Lane	11.2	2% Typical (4)	2%	2% Typical (4)	2%
		Shoulder		2% Typical (4)	2%	2% Typical (4)	2%
	Median Width	11.3	N/A		Flush: 1.2 m - 5.0 m (5) Raised: 6.0 m (5)		
TWLTW Width	11.2	4.8 m		4.8 m			
Earth Cut Sections	Ditch	Inslope	11.4	N/A	6:1(Des\4:1 Min)	N/A	6:1(Des\4:1 Min)
		Width	11.4	N/A	3.0 m Min. (6)	N/A	3.0 m (6)
		Slope		N/A	20:1 towards back slope	N/A	20:1 towards back slope
	Back Slope; Cut Depth at Slope Stake (7)	0 - 1.5 m	11.4	5:1		5:1	
		1.5 m - 3.0 m		L/R: 4:1 Mt: 3:1		3:1	
		3.0 m - 4.5 m		L/R: 3:1 Mt: 2:1		2:1	
		4.5 m - 6.0 m		L/R: 2:1 Mt: 1.5:1		1.5:1	
> 6.0 m		1.5:1		1.5:1			
Earth Fill Slopes	Fill Height at Slope Stake (8)	0 - 3.0 m	11.4	6:1	6:1	6:1	6:1
		3.0 m - 6.0 m		4:1	4:1	4:1	4:1
		6.0 m - 9.0 m		3:1	3:1	3:1	3:1
		> 9.0 m		2:1	2:1	2:1	2:1
Alignment Elements (11)	DESIGN SPEED		N/A	60 km/h	70 km/h	80 km/h	90 km/h
	*Stopping Sight Distance		8.6	85 m	105 m	130 m	160 m
	*Minimum Radius		9.2	125 m	190 m	230 m	305 m
	*Superelevation Rate (9)		9.3 & 9.4	emax = 4.0%		emax = 8.0%	
	*Vertical Curvature (K-value)	Crest	10.5	11	17	26	39
		Sag		18	23	30	38
	*Maximum Grade	Level	10.3	6%	6%	6%	5%
		Rolling		7%	7%	7%	6%
Mountainous		9%		9%	9%	8%	
*Minimum Vertical Clearance (10)		10.6	5.20 m				

* Controlling design criteria (see Section 8.8).

L/R: Level/Rolling

Mt: Mountainous

GEOMETRIC DESIGN CRITERIA FOR URBAN PRINCIPAL ARTERIALS (National Highway System — Non Interstate))

Footnotes to Figure 12-7

- (1) Design Forecast Year (Geometrics). For overlay and widening projects, the design year for geometrics is based on the design analysis period used for the pavement design, with 8 years as a minimum design forecast year.
- (2) Design Speed. The design speed for urban principal arterials should match the conditions and driver expectancy. The lower design speed should be used in more crowded business areas and areas where signalization at successive intersections regulates speed. The higher design speed should be used in all other non-transitional urban areas. In the transitional areas between rural and urban sections of roadway, the use of the criteria for rural principal arterials is generally appropriate. However, the determination of the design speed for transitional areas should be based on consideration of roadside development, number and type of approaches, lane configuration and traffic control devices.
- (3) Travel Lane Width. The shoulder width is measured to the face of the curb. The shoulder width should correspond to the Route Segment Plan widths. Other considerations such as bicycle use and parking should be evaluated in determining shoulder width. An 8' (2.4 m) outside shoulder is preferred on all multilane facilities.
- (4) Cross Slopes (Curbed). The cross slope may be between 1% and 4%, depending on site conditions.
- (5) Median Width. See Section 11.3 for more information on median width.
- (6) Ditch. The preferred ditch width is 10' (3 m). However, site constraints often make the use of this width impractical. If the use of a v-ditch is necessary, it should be traversable or the hinge point should be located outside of the clear zone. A design exception is required for the use of a narrower ditch.
- (7) Cut Slopes. For curbed sections, see the typical section figures in Section 11.7. The back slope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the back slope typically will not exceed 0.25:1. For large cuts, benching of the back slope may be required.
- (8) Fill Slopes. For curbed sections, see the typical section figures in Section 11.7. In rock fills over 3.0 m high, the typical fill slope is 1.5:1. In rock fills \leq 3.0 m, the typical slope is 6:1.
- (9) Superelevation Rate. See Section 9.3 or 9.4 for superelevation rates based on design speed and curve radii.
- (10) Minimum Vertical Clearance. The clearances apply to the arterial passing under a bridge. The minimum clearance includes a 150 mm additional allowance for future overlays.
- (11) Alignment Elements. If 25% or more of an overlay and widening project or pavement preservation project requires intermittent reconstruction, then reconstruct the entire alignment to meet the criteria in Figure 12-7.

- (12) If the route is a principal arterial but is not on the National Highway System, refer to the *Montana Department of Transportation Geometric Design Standards for Urban and Developed Areas*.

Figure 12-8

**GEOMETRIC DESIGN CRITERIA FOR URBAN MINOR ARTERIALS
(Non-NHS) U.S. Customary**

Design Element		Manual Section	2-Lane		Multi-lane		
			Curbed	Uncurbed	Curbed	Uncurbed	
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)		20 Years (1)		
	*Design Speed (2)	8.3	35 mph	35 mph	35 mph	35 mph	
	Level of Service	8.4	Desirable: B Minimum: C		Desirable: B Minimum: C		
Roadway Elements	*Travel Lane Width	11.2	11' (3)		11' (3)		
	*Shoulder Width	Outside	11.2	0'	4'	0'	4'
		Inside		N/A		0'	4'
	Cross Slope	*Travel Lane	11.2	2% Typical (4)	2%	2% Typical (4)	2%
		Shoulder		2% Typical (4)	2%	2% Typical (4)	2%
Median Width	11.3	N/A		Flush: 4' - 16' (5) Raised: 4 - 16 (5)			
TWLT Width	11.2	11'		11'			
Earth Cut Slopes	Ditch	Inslope	11.4	N/A	6:1(Des\4:1 Min)	N/A	6:1(Des\4:1 Min)
		Width	11.4	N/A	10' (6)	N/A	10' (6)
		Slope		N/A	20:1 towards back slope	N/A	20:1 towards back slope
	Back Slope; Cut Depth at Slope Stake (7)	0' - 5'	11.4	5:1		5:1	
		5' - 10'		L/R:4:1 Mt: 3:1		3:1	
		10' - 15'		L/R:3:1 Mt: 2:1		2:1	
		15' - 20'		L/R: 2:1 Mt:1.5:1		1.5:1	
> 20'		1.5:1		1.5:1			
Earth Fill Slopes	Fill Height at Slope Stake (8)	0' - 10'	11.4	6:1	6:1	6:1	6:1
		10' - 20'		4:1	4:1	4:1	4:1
		20' - 30'		3:1	3:1	3:1	3:1
		> 30'		2:1	2:1	2:1	2:1
Alignment Elements (11)	DESIGN SPEED		N/A	30 mph	40 mph	50 mph	
	*Stopping Sight Distance		8.6	200'	305'	425'	
	*Minimum Radius		9.2	250'	533'	760'	
	*Superelevation Rate (9)		9.3 & 9.4	emax = 4.0%		emax = 8.0%	
	*Vertical Curvature (K-value)	Crest	10.5	19	44	84	
		Sag		37	64	96	
	*Maximum Grade	Level	10.3	7%	6%	6%	
		Rolling		8%	7%	7%	
Mountainous		10%		9%	9%		
*Minimum Vertical Clearance (10)		10.6	17.0'				

* Controlling design criteria (see Section 8.8).

L/R: Level/Rolling

Mt: Mountainous

Figure 12-8
GEOMETRIC DESIGN CRITERIA FOR URBAN MINOR ARTERIALS
(Non-NHS) Metric

Design Element		Manual Section	2-Lane		Multi-lane		
			Curbed	Uncurbed	Curbed	Uncurbed	
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)		20 Years (1)		
	*Design Speed (2)	8.3	50 km/h	60 km/h	60 km/h	60 km/h	
	Level of Service	8.4	Desirable: B Minimum: C		Desirable: B Minimum: C		
Roadway Elements	*Travel Lane Width	11.2	3.6 m (3)		3.6 m		
	*Shoulder Width	Outside	11.2	0 m	1.2 m	0 m	D: 1.2m
		Inside		N/A		0 m	1.0 m
	Cross Slope	*Travel Lane	11.2	2% Typical (4)	2%	2% Typical (4)	2%
		Shoulder		2% Typical (4)	2%	2% Typical (4)	2%
	Median Width	11.3	N/A		Flush: 1.2 m - 5.0 m (5) Raised: 1.2m – 5.0 m (5)		
TWLT Width	11.2	3.3 m		3.3 m			
Earth Cut Slopes	Ditch	Inslope	11.4	N/A	6:1(Des\4:1 Min)	N/A	6:1 (Des\4:1 Min)
		Width	11.4	N/A	3.0 m (6)	N/A	3.0 m
		Slope		N/A	20:1 towards back slope	N/A	20:1 towards back slope
	Back Slope; Cut Depth at Slope Stake (7)	0 - 1.5 m	11.4	5:1		5:1	
		1.5 m - 3.0 m		L/R:4:1 Mt: 3:1		3:1	
		3.0 m - 4.5 m		L/R:3:1 Mt: 2:1		2:1	
		4.5 M – 6.0 m		L/R: 2:1 Mt:1.5:1		1.5:1	
	> 6.0 m		1.5:1		1.5:1		
Earth Fill Slopes	Fill Height at Slope Stake (8)	0 - 3.0 m	11.4	6:1	6:1	6:1	6:1
		3.0 m - 6.0 m		4:1	4:1	4:1	4:1
		6.0 m - 9.0 m		3:1	3:1	3:1	3:1
		> 9.0 m		2:1	2:1	2:1	2:1
Alignment Elements (11)	DESIGN SPEED	N/A	60 km/h		70 km/h	80 km/h	
	*Stopping Sight Distance	8.6	85 m		105 m	130 m	
	*Minimum Radius	9.2	125 m		190 m	230 m	
	*Superelevation Rate (9)	9.3 & 9.4	emax = 4.0%			emax = 8.0%	
	*Vertical Curvature (K-value)	Crest	10.5	11		17	26
		Sag		18		23	30
	*Maximum Grade	Level	10.3	7%		6%	6%
		Rolling		8%		7%	7%
Mountainous		10%		9%	9%		
*Minimum Vertical Clearance (10)	10.6	5.20 m					

* Controlling design criteria (see Section 8.8).

L/R: Level/Rolling

Mt: Mountainous

GEOMETRIC DESIGN CRITERIA FOR URBAN MINOR ARTERIALS (Non-NHS)

Footnotes to Figure 12-8

- (1) Design Forecast Year (Geometrics). For overlay and widening projects, the design year for geometrics is based on the design analysis period used for the pavement design, with 8 years as a minimum design forecast year.
- (2) Design Speed. The design speed for urban minor arterials should match the conditions and driver expectancy. In the transitional areas between rural and urban sections of roadway the use of the criteria for rural minor arterials is generally appropriate. However, the determination of the design speed for transitional areas should be based on consideration of roadside development, number and type of approaches, lane configuration and traffic control devices.
- (3) Travel Lane Width. The lane width does not include the gutter section. 12' (3.6 m) lanes should be used on roadways that have curb without a gutter section.
- (4) Cross Slopes (Curbed). The cross slope may be between 1% and 4%, depending on site conditions.
- (5) Median Width. The median width is 4' (1.2 m) plus the width of the exclusive left-turn lane. See Section 11.3 for more information on median width.
- (6) Ditch. The preferred ditch width is 10' (3 m). However, site constraints often make the use of this width impractical. If the use of a v-ditch is necessary, it should be traversable or the hinge point should be located outside of the clear zone. A design exception is not required for the use of a narrower ditch. However, the ditch configuration must be documented in the Scope of Work Report.
- (7) Cut Slopes. For curbed sections, see the typical section figures in Section 11.7. The back slope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the back slope typically will not exceed 0.25:1. For large cuts, benching of the back slope may be required.
- (8) Fill Slopes. For curbed sections, see the typical section figures in Section 11.7. In rock fills over 3.0 m high, the typical fill slope is 1.5:1. In rock fills \leq 3.0 m, the typical slope is 6:1.
- (9) Superelevation Rate. See Section 9.3 or 9.4 for superelevation rates based on design speed and curve radii.
- (10) Minimum Vertical Clearance. The clearances apply to the arterial passing under a bridge. The minimum clearance includes a 150 mm additional allowance for future overlays.
- (11) Alignment Elements. If 25% or more of an overlay and widening project or pavement preservation project requires intermittent reconstruction, then reconstruct the entire alignment to meet the criteria in Figure 12-8.

Figure 12-9

**GEOMETRIC DESIGN CRITERIA FOR URBAN COLLECTOR STREETS
(Non-NHS) U.S. Customary**

Design Element		Manual Section	Design Criteria		
			Curbed	Uncurbed	
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)		
	*Design Speed (2)	8.3	30 mph	30 mph	
	Level of Service	8.4	Desirable: C Minimum: D		
Roadway Elements	*Travel Lane Width	11.2	10' (3)		
	*Shoulder Width	Outside	0'	4'	
		Inside	N/A		
	Cross Slope	*Travel Lane	11.2	2% Typical (4)	2%
		Shoulder		2% Typical (4)	2%
TWLTL Width		11.2	11'		
Earth Cut Sections	Ditch	Inslope	11.4	N/A	4:1
		Width	11.4	N/A	10' (5) Min.
		Slope		N/A	20:1 towards back slope (5)
	Back Slope; Cut Depth at Slope Stake (6)	0 - 5'	11.4	5:1	
		5' - 10'		L/R: 4:1 Mt: 3:1	
		10' - 15'		L/R: 3:1 Mt: 2:1	
		15' - 20'		L/R: 2:1 Mt: 1.5:1	
> 20'		1.5:1			
Earth Fill Sections	Fill Height at Slope Stake (7)	0 - 10'	11.4	6:1	6:1
		10' - 20'		4:1	4:1
		20' - 30'		3:1	3:1
		> 30'		2:1	2:1
Alignment Elements (10)	DESIGN SPEED		N/A	30 mph	35 mph
	*Stopping Sight Distance		8.6	200'	250'
	*Minimum Radius (@ $e_{max} = 4\%$)		9.2	250'	371'
	*Superelevation Rate (8)		9.4	$e_{max} = 4.0\%$	
	*Vertical Curvature (K-value)	Crest	10.5	19	29
		Sag		37	49
	*Maximum Grade	Level	10.3	9%	9%
		Rolling		10%	10%
Mountainous		10%		10%	
*Minimum Vertical Clearance (9)		10.6	16.5'		

* Controlling design criteria (see Section 8.8).

L/R: Level/Rolling

Mt: Mountainous

Figure 12-9
GEOMETRIC DESIGN CRITERIA FOR URBAN COLLECTOR STREETS
(Non-NHS) Metric

Design Element		Manual Section	Design Criteria		
			Curbed	Uncurbed	
Design Controls	Design Forecast Year (Geometrics)	8.4	20 Years (1)		
	*Design Speed	8.3	50 km/h	50 km/h	
	Level of Service	8.4	Desirable: C Minimum: D		
Roadway Elements	* Travel Lane Width	11.2	3.0 m (2)		
	*Shoulder Width	Outside	11.2	0 m (3)	D: 1.2 m
		Inside		N/A	
	Cross Slope	*Travel Lane	11.2	2% Typical (4)	2%
		Shoulder		2% Typical (4)	2%
TWLTL Width		11.2	3.3 m		
Earth Cut Sections	Ditch	Inslope	11.4	N/A	4:1
		Width	11.4	N/A	3.0 m (5)
		Slope		N/A	20:1 towards back slope (5)
	Back Slope; Cut Depth at Slope Stake (6)	0 - 1.5 m	11.4	5:1	
		1.5 m - 3.0 m		L/R: 4:1 Mt: 3:1	
		3.0 m - 4.5 m		L/R: 3:1 Mt: 2:1	
		4.5 m - 6.0 m		L/R: 2:1 Mt: 1.5:1	
> 6.0 m		1.5:1			
Earth Fill Sections	Fill Height at Slope Stake (7)	0 - 3.0 m	11.4	6:1	6:1
		3.0 m - 6.0 m		4:1	4:1
		6.0 m - 9.0 m		3:1	3:1
		> 9.0 m		2:1	2:1
Alignment Elements (10)	DESIGN SPEED		N/A	50 km/h	60 km/h
	*Stopping Sight Distance		8.6	65 m	85 m
	*Minimum Radius (@ e _{max} = 4%)		9.2	80 m	125 m
	*Superelevation Rate (8)		9.4	e _{max} = 4.0%	
	*Vertical Curvature (K-value)	Crest	10.5	7	11
		Sag		13	18
	*Maximum Grade	Level	10.3	9%	9%
		Rolling		10%	10%
Mountainous		10%		10%	
*Minimum Vertical Clearance (9)		10.6	5.05 m		

* Controlling design criteria (see Section 8.8).

L/R: Level/Rolling

Mt: Mountainous

GEOMETRIC DESIGN CRITERIA FOR URBAN COLLECTOR STREETS (Non-NHS)

Footnotes to Figure 12-9

- (1) Design Forecast Year (Geometrics). For overlay and widening projects, the design year for geometrics is based on the design analysis period used for the pavement design, with 8 years as a minimum design forecast year.
- (2) Design Speed. The design speed for urban major collectors should match the conditions and driver expectancy. In the transitional areas between rural and urban sections of roadway the use of the criteria for rural major collectors is generally appropriate. However, the determination of the design speed for transitional areas should be based on consideration of roadside development, number and type of approaches, lane configuration and traffic control devices
- (3) Travel Lane Width. The lane width for curbed roadways does not include the gutter section. 11' (3.3 m) lanes should be used on roadways that have curb without a gutter section. A minimum 11' (3.3 m) lane width and 2' (0.6m) clearance to the face of the curb should be used for collectors that primarily serve commercial/industrial areas.
- (4) Cross Slopes (Curbed). The cross slope may be between 1% and 4%, depending on site conditions.
- (5) Ditch. The preferred ditch width is 10' (3 m). However, site constraints often make the use of this width impractical. If the use of a v-ditch is necessary, it should be traversable or the hinge point should be located outside of the clear zone. A design exception is not required for the use of a narrower ditch. However, the ditch width must be documented in the Scope of Work Report.
- (6) Cut Slopes. For curbed sections, see the typical section figures in Section 11.7. The back slope through rock cut sections will be determined by the Geotechnical Section based on its field investigation. At a maximum, the back slope typically will not exceed 0.25:1. For large cuts, benching of the back slope may be required.
- (7) Fill Slopes. For curbed sections, see the typical section figures in Section 11.7. In rock fills over 3.0 m high, the typical fill slope is 1.5:1. In rock fills \leq 3.0 m, the typical slope is 6:1.
- (8) Superelevation Rate. See Section 9.4 for superelevation rates based on design speed and curve radii.
- (9) Minimum Vertical Clearance. The clearances apply to the collector street passing under a bridge. The minimum clearance includes a 150 mm additional allowance for future overlays.
- (10) Alignment Elements. If 25% or more of an overlay and widening project or pavement preservation project requires intermittent reconstruction, then reconstruct the entire alignment to meet the criteria in Figure 12-9.