CHAPTER 13
ALTERNATE STANDARDS (LOW VOLUME ROADS)

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13.0 INTRODUCTION

Design guidelines for very low5-volume roads may differ from those of higher volume roads. AASHTO's *Geometric Design Guidelines for Very Low-Volume Roads (ADT ≤400)* **(1)** defines the needs of these roadways and the criteria to meet those needs. When defined as a low-volume roadway, this design guideline may be used in place of guidelines defined in the Green Book, *A Policy on Geometric Design of Highways and Streets (PGDHS)* **(2),** if applicable.

13.1 DEFINITION AND CHARACTERISTICS

A very low-volume local road has a functional classification of local road, and features a design average daily traffic volume of 400 vehicles per day, at most. Functionally classified collectors may also follow these guidelines so long as the design average daily traffic volume does not exceed 400 vehicles per day. These low volumes significantly reduce the opportunities for accidents to occur. Low volume roads also cater to local traffic familiar with the roadway; local drivers typically know and can anticipate design abnormalities. Design guidelines for very low-volumes roadways may be less strict than for roadways with higher volumes or less familiar drivers.

13.2 LOW-VOLUME FUNCTIONAL CLASSIFICATIONS

Very low-volume roads are divided into six rural functional classifications and three urban functional classifications. They are as follows:

Rural Roads

- Rural Major Access Roads
- Rural minor Access Roads
- Rural Industrial/Commercial Access Roads
- Rural Agricultural Access Roads
- Rural Recreational and Scenic Roads
- Rural Resource Recovery Roads

Urban Roads

- Urban Major Access Streets
- Urban Residential Streets
- Urban Industrial/Commercial Access Streets

13.2.1 Rural Major Access Roads

Rural major access roads are defined by the following characteristics:

- Provide through or connecting service between other local roads or higher type facilities.
- They have significant local continuity and may operate at relatively high speeds.
- Due to through traffic, some traffic may include unfamiliar drivers.

- Roads are usually paved.

Collector roads that meet the definition of a very low-volume local road should be classified as a rural major access road.

13.2.2 Rural Minor Access Roads

Rural minor access roads are defined by the following characteristics:

- Serve almost exclusively to provide access to adjacent property.
- Such roads are used predominantly by familiar drivers.
- Speeds are generally low for the local environments.
- Roads are frequently narrow and sometimes may function as one-lane roads.
- Roads can be either paved or unpaved.
- Traffic is primarily composed of passenger vehicles
- Roads need to be accessible to school buses, fire trucks, etc.

13.2.3 Rural Industrial/Commercial Access Roads

Rural industrial/commercial access roads are defined by the following characteristics:

- May generate a significant proportion of truck or other heavy vehicle traffic
- Generally, provide access from commercial land use to the regional highway network.
- Roads are typically very short and do not serve any through traffic.
- Roads may be either paved or unpaved.

13.2.4 Rural Agricultural Access Roads

Rural agricultural access roads are defined by the following characteristics:

- Primarily provide access to fields and farming operations.
- Vehicle types included slow-moving vehicles such as farm equipment
- Drivers typically consist of repeat users who are familiar with the roadway characteristics.
- Roads are often unpaved

13.2.5 Rural Recreational and Scenic Roads

Rural recreational and scenic roads are defined by the following characteristics:

- Serve specialized land uses, such as parks, tourist attractions, campsites, etc.
- Traffic consists primarily of unfamiliar drivers.
- Traffic consists of low volumes of truck traffic
- Roads may carry highly seasonal traffic volumes.
- May accommodate a wide range in speeds and trip lengths.
- Roads can be either paved or unpaved.

13.2.6 Rural Resource Recovery Roads

Rural resource recovery roads are defined by the following characteristics:

- Serve logging or mining operations.
- Typically found only in rural areas.
- Drivers are typically professional drivers with large vehicles.
- Traffic operations are typically enhanced with radio communication between drivers.
- Most roads are unpaved.

13.2.7 Urban Major Access Streets

Urban major access streets are defined by the following criteria:

- Provide access to adjacent property and through traffic to other local roads.
- Generally short but serve slightly more traffic than most local roads.

Collector roads that meet the definition of a very low-volume local road should be classified as an urban major access street.

13.2.8 Urban Residential Streets

Urban residential streets are defined by the following characteristics:

- Typically serve to provide access to single and multiple family residences in urban areas.
- Drivers generally include only residents and their visitors.
- Large trucks are rare.
- Provide accessibility for fire trucks and school buses

13.2.9 Urban Industrial/Commercial Access Streets

Urban industrial/commercial access streets are defined by the following characteristics:

- May generate a substantial volume of trucks or other heavy vehicles.
- Generally, provide access from commercial land use to the regional highway network.
- Roads are typically very short and may not carry traffic from smaller streets.
- Roads may be either paved or unpaved.

If a roadway definition meets more than one functional classification, the stricter guidelines shall be applied.

13.3 LOW VOLUME DESIGN APPLICATIONS

The design guidelines defined in the *Geometric Design Guidelines for Very Low-Volume Roads* **(1)** provide less strict design criteria however they do not compromise safety when applied to very low-volume roadways with familiar drivers. The purpose of the low volume guideline is to provide a recommended range of values, and not to be a replacement of detailed design manuals. These guidelines allow for flexibility in designs to accommodate specific needs.

13.3.1 Design and Operation Speed

The design guidelines presented are a function of speed, as follows:

- Low speed – 0 to 45 mph
- High speed – < 45 mph

13.3.2 Traffic Volumes

Traffic volumes on very low-volume roads are stratified into three levels for purposes of these design guidelines. The volume ranges are:

- 100 vehicles per day or less
- 100 to 250 vehicles per day
- 250 to 400 vehicles per day

13.4 CROSS SECTION DESIGN

Cross section design criteria for lower volume roads generally address total roadway width rather than having separate criteria for lane and shoulder width.

13.4.1 Very Low-Volume Local Roads in Rural Areas Cross Section

Table 13-1 illustrates the total roadway width for the six low volume functional classifications for rural conditions. These cross section widths are based on the expected user vehicles.

Total Roadway Width (ft) by Functional Classification						
Design Speed (mph)	**Major Access**	**Minor Access**	**Recreational and Scenic**	**Industrial/ Commercial Access**	**Resource Recovery**	**Agricultural Access**
15	-	18.0	18.0	20.0	20.0	22.0
20	-	18.0	18.0	20.0	20.0	24.0
25	18.0	18.0	18.0	21.0	21.0	24.0
30	18.0	18.0	18.0	22.5	22.5	24.0
35	18.0	18.0	18.0	22.5	22.5	24.0
40	18.0	18.0	20.0	22.5	-	24.0
45	20.0	20.0	20.0	23.0	-	26.0
50	20.0	20.0	20.0	24.5	-	-
55	22.0	-	22.0	-	-	-
60	22.0	-	-	-	-	-
Note: Total Roadway width includes the width of both traveled way and shoulders.						

Table 13-1 (Exhibit 1 of the *Geometric Design of Very Low-Volume Local Roads* (1))
Total Roadway Widths for Rural Conditions

13.4.2 Very Low-Volume Local Roads in Urban Areas Cross Section

Table 13-2 illustrates the total roadway width for the urban conditions based on development density.

Development Density	Total Roadway Width (ft)
Low	20 to 28
Medium	28 to 34
Note: Low density represents 2.0 or fewer dwelling units per acre; medium development density represents 2.1 to 6.0 dwelling units per acre.	

Table 13-2 (Exhibit 2 of the *Geometric Design of Very Low-Volume Local Roads* (1)) Total Roadway Widths for Urban Conditions

The lower end of the total roadway width range is intended for streets with mostly off-street parking such as driveways, typically in a subdivision setting. The upper end of the total roadway width range is intended for streets with recurrent parking on one side of the street. For streets with parking frequently occurring on both sides of the street, total roadway widths that exceed what is shown in Table 13-2 may be used.

13.5 HORIZONTAL DESIGN

13.5.1 Horizontal Curve Design

Horizontal roadway design is commonly illustrated as a relationship between design speed and roadway alignments. Curves are a function of speed, alignment, superelevation, and side friction. A key parameter that represents the friction demand for a vehicle traversing a horizontal curve is the side friction factor, which can be estimated using Equation 13-1.

$$f = \frac{V^2}{15R} - 0.01e \quad \text{[13-1]}$$

where,

f = side friction factor
V = vehicle speed (mph)
R = radius of curve (feet)
e = rate of roadway superelevation (percent)

A fundamental objective in horizontal curve design is to select a radius of curve, R, such that the side friction factor, *f*, of a vehicle traversing the curve at the design speed does not exceed a specified threshold value. To achieve this, Equation 13-2 can be used.

$$\boldsymbol{Rmin = \frac{V^2}{15(0.01emax+fmax)}} \quad \text{[13-2]}$$

where,

R_{min}= minimum curve radius (feet)

e_{max} = maximum rate of superelevation permitted

f_{max} = *maximum side friction factor*

Minimum curve radii for streets with higher volumes can be found in the *PGDHS* **(2)** and are shown in Table 13-3.

Design Speed (mph)	Maximum Design Side Friction Factor (f_{max})	Minimum Radius (ft), R_{min}				
		Maximum Superelevation, e_{max}				
		4%	6%	8%	10%	12%
15	0.320	42	39	38	36	34
20	0.270	86	81	76	72	68
25	0.230	154	144	134	126	119
30	0.200	250	231	214	200	188
35	0.180	371	340	314	292	272
40	0.160	533	485	444	410	381
45	0.150	711	643	587	540	500
50	0.140	926	833	758	694	641
55	0.130	1190	1060	960	877	807
60	0.120	1500	1330	1200	1090	1000

Table 13-3 [Developed from Table 3-7 of the *Geometric Design of Very Low-Volume Local Roads* (1)] Minimum Radius Using Limiting Values of *e* and *f*

Low speed urban streets are those urban roadways with design speeds of less than 45 mph. Superelevation rates greater than 6% are not recommended for such streets because higher rates would be inappropriate for low-speed conditions. Table 13-3 also illustrates the minimum curve radii for streets with higher volumes, but low speed (45 mph or less) in an urban setting.

The minimum radii for new construction of low volume roadways is provided in the *Geometric Design Guidelines for Very Low-Volume Roads* **(1).** Design guidelines are further refined for each category. See *Very-Low Volume Roads* **(1)** for design speed, recommended reduced design speed, and corresponding minimum radii as a function of maximum superelevation for:

- **Rural Major Access, Minor Access, and Recreations and Scenic Roads (250 Vehicles per Day or Less)**. See Exhibit 5 in the *Geometric Design Guidelines for Very Low-Volume Roads* **(1)**

- **Rural Major Access, Minor Access, and Recreational and Scenic Roads (250 to 400 Vehicles per Day)**. See Exhibit 6 in the *Geometric Design Guidelines for Very Low-Volume Roads* **(1)**
- **Rural Industrial/Commercial Access, Agricultural Access, and Resource Recovery Roads**. See Exhibit 7 in the *Geometric Design Guidelines for Very Low-Volume Roads* **(1)**
- **Urban Major Access Streets (250 Vehicles per Day or Less) and Urban Residential Streets**.
- **Urban Major Access Streets (250 to 400 Vehicles per Day)**.
- **Urban Industrial/Commercial Access Streets**.

13.5.1.1 Existing Roadways

The existing horizontal curve geometry should be considered acceptable for roadways with design speeds exceeding 45 mph with the nominal speed being within 10 mph of the operating speed, and so long as there is no documented safety concern. The existing horizontal curve geometry should be considered acceptable for roadways with design speeds equal to or less than 45 mph with the nominal speed being within 20 mph of the operating speed, and so long as there is no documented safety concern.

13.5.2 Superelevation and Superelevation Transitions

Superelevation and superelevation transitions shall follow criteria set forth in the *PGDHS* **(2)**. When using design criteria as discussed in Section 13.5.1, Horizontal Curve Design, use the reduced design speed when determining superelevation and superelevation transitions.

13.5.3 Stopping Sight Distance

Stopping sight distance for low-volume roadways differs from higher volume roadways where a vehicle must come to a complete stop, in that the driver may avoid an obstruction instead of needing to stop before it. The same stopping sight distance equation is used with alternative variables.

Low-volume roadways are categorized into two risk categories; lower risk and higher risk. “Lower risk” locations are locations away from intersections, narrow bridges, at grade railroad/highway crossings, sharp curves, and steep grades. “Higher risk” locations include intersections, narrow bridges, at grade railroad/highway crossings, sharp curves, and steep grades. Table 13-4 illustrates the design sight distance guidelines for new construction of very low-volume local roads.

Minimum Sight Distance (ft)				
Design Speed (mph)	0-100 veh/day	100-250 veh/day		250-400 veh/day
	All Locations	All Locations	Lower Risk Locations	Higher Risk Locations
15	65	65	65	65
20	90	90	95	95
25	115	115	125	125
30	135	135	165	165
35	170	170	205	205
40	215	215	250	250
45	260	260	300	300
50	310	310	350	350
55	365	365	405	405
60	435	435	470	470

Table 13-4 (Exhibit 8 of the *Geometric Design of Very Low-Volume Local Roads* (1)) Design Sight Distance Guidelines for New Construction of Very Low-Volume Local Roads

13.5.3.1 Sight Distance on Horizontal Curves

Similar to higher volume roadways, stopping sight distance on a horizontal curve is represented as a chord of a radius. Table 13-5 illustrates the minimum values of the middle ordinate for lower and higher risk low-volume roadways. The width on the inside of the curve is measured from the centerline of the inside lane. “Lower risk” locations are locations away from intersections, narrow bridges, at grade railroad/highway crossings, sharp curves, and steep grades. “Higher risk” locations include intersections, narrow bridges, at grade railroad/highway crossings, sharp curves, and steep grades.

Design Speed (mph)	Stopping Sight Distance (ft)	Width on Inside of Curve Clear of Sight Obstructions (ft)								
		Lower Risk (All locations 0-100 vpd and "low risk" locations for 100-250 vpd)								
		Radius of Curvature (ft)								
		50	100	200	500	1000	2000	5000	10000	20000
15	65	10.2	5.2	2.6	1.1	0.5	0.3	0.1	0.1	0.0
20	90	--	10.0	5.0	2.0	1.0	0.5	0.2	0.1	0.1
25	115	--	--	8.2	3.3	1.7	0.8	0.3	0.2	0.1
30	135	--	--	11.3	4.5	2.3	1.1	0.5	0.2	0.1
35	170	--	--	--	7.2	3.6	1.8	0.7	0.4	0.2
40	215	--	--	--	11.5	5.8	2.9	1.2	0.6	0.3
45	260	--	--	--	16.8	8.4	4.2	1.7	0.8	0.4
50	310	--	--	--	--	12.0	6.0	2.4	1.2	0.6
55	365	--	--	--	--	16.6	8.3	3.3	1.7	0.8
60	435	--	--	--	--	23.6	11.8	4.7	2.4	1.2
		Higher Risk ("high risk locations for 250-400 vpd and all locations 250-400 vpd)								
15	65	10.2	5.2	2.6	1.1	0.5	0.3	0.1	0.1	0.0
20	95	--	11.1	5.6	2.3	1.1	0.6	0.2	0.1	0.1
25	125	--	--	9.7	3.9	2.0	1.0	0.4	0.2	0.1
30	165	--	--	16.8	6.8	3.4	1.7	0.7	0.3	0.2
35	205	--	--	--	10.5	5.2	2.6	1.1	0.5	0.3
40	250	--	--	--	15.5	7.8	3.9	1.6	0.8	0.4
45	300	--	--	--	22.3	11.2	5.6	2.3	1.1	0.6
50	350	--	--	--	--	15.3	7.7	3.1	1.5	0.8
55	405	--	--	--	--	20.4	10.2	4.1	2.1	1.0
60	470	--	--	--	--		13.8	5.5	2.8	1.4

Table 13-5 (Exhibit 10 of the *Geometric Design of Very Low-Volume Local Roads* (1)) Design Guidelines for Sight Distance on Horizontal Curves for New Construction of Very Low-Volume Local Roads

Table 13-6 illustrates the rate of vertical curvature, K, for crest vertical curves on very low-volume roadways. Sag vertical curves should default to values identified in the *PGDHS* **(2)**.

Design Speed (mph)	Stopping Sight Distance (ft)	Rate of Vertical Curvature, K	
		Calculated	Design
		Lower Risk	
15	65	2.0	2
20	90	3.8	4
25	115	6.1	7
30	135	8.4	9
35	170	13.4	14
40	215	21.4	22
45	260	31.3	32
50	310	44.5	45
55	365	61.7	62
60	435	87.7	88
		Higher Risk	
15	65	2.0	2
20	95	4.2	5
25	125	7.2	8
30	165	12.6	13
35	205	19.5	20
40	250	29.0	29
45	300	41.7	42
50	350	56.8	57
55	405	76.0	76
60	470	102.4	103

Table 13-6 (Exhibit 12 of the *Geometric Design of Very Low-Volume Local Roads* (1)) Guidelines for Minimum Rate of Vertical Curvature to Provide Design Stopping Sight Distance on Crest Vertical Curves for New Construction of Very Low-Volume Local Roads

For additional information on vertical curve design, see the *PGDHS* **(2)**.

13.5.4 Intersection Sight Distance

Design guidelines for intersection sight distance for very low-volume roadways are only applicable for intersections where all roadways have less than 400 vehicles per day. Three types of intersections have been identified for clear sight triangle analysis:

- Intersections with no control (Case A)
- Intersections with stop control on the minor road (Case B)

- Intersections with yield control on the minor road (Case C)

13.5.4.1 Intersections with No Control (Case A)

Drivers of vehicles approaching an intersection with no control have been observed to decelerate regardless if views are obstructed or not, and regardless if a potential conflict is present or not. Drivers typically reduced their speed to approximately half of their running speed. With this in consideration, Table 13-7 illustrates the desired sight distance for each approach to an uncontrolled intersection. Table 13-8 illustrates adjustment factors to Table 13-7 values at intersections where an approach exceeds a 3% grade.

Design Speed (mph)	Sight Distance (ft)
15	70
20	90
25	115
30	140
35	165
40	195
45	220
50	245
55	285
60	325

Table 13-7 (Exhibit 14 of the *Geometric Design of Very Low-Volume Local Roads* (1)) Recommended Sight Distance Guidelines for New Construction of Intersections with No Traffic Control

Approach Grade (%)	Design Speed (mph)									
	15	20	25	30	35	40	45	50	55	60
-6	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2
-5	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
-4	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1
-3 to +3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
+4	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9
+5	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
+6	1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9

Table 13-8 (Exhibit 15 of the *Geometric Design of Very Low-Volume Local Roads* (1)) Adjustment Factors for Sight Distance Based on Approach Grade

13.5.4.2 Intersections with Stop Control on the Minor Road (Case B)

Approach sight triangles are not needed to minor roads approaching a stop control. This movement does require a departure sight triangle. The entire sight distance defined in the *PGDHS* **(2)** should

be accommodated along the major roadway; however, in constrained scenarios sight distances identified in Table 13-3 should be considered a minimum. The vertex of the triangle should be located 14.4 ft from the edge of the traveled way.

13.5.4.3 Intersections with Yield Control on the Minor Road (Case C)

The entire sight distance defined in the *PGDHS* **(2)** should be accommodated along the major roadway; however, in constrained scenarios sight distances identified in Table 13-3 should be considered a minimum. Departure sight triangles are not needed for intersections with yield control on the minor road. The minor road approach does require clear sight triangles.

13.5.5 Roadside Design

Clear zone and traffic barrier warrants are two main elements of roadside design. The information provided below provides guidelines that may be used in lieu of, or to supplement, the policies from the AASHTO *Roadside Design Guide* **(3)** and the *PGDHS* **(2)**.

13.5.5.1 Clear Zone Width

Roadside clear zones applied to low volume roadways per the AASHTO *Roadside Design Guide* **(3)** have shown to provide only limited safety benefits and are not cost effective; however, clear zones should be accommodated when practical. Clear zone guidelines for very low-volume roads are as follow:

- In areas where a 6-foot shoulder can be provided with minimal costs, and minimal social and environment impacts.
- In areas where a 6-foot shoulder cannot be provided at a reasonable cost, or with considerable social or environmental impacts, a shoulder of less than 6 feet should may be used including designs with no clear recovery areas.
- Clear zone improvements should be considered in locations of higher risk for accidents.
- Clear zone improvements should be considered for special circumstances such as areas with higher heavy vehicle traffic, crash history, or future growth.

Clear zone design is flexible where unique project characteristics should be considered.

13.5.5.2 Traffic Barrier

Traffic barrier should be considered at the discretion of the engineer. Generally, traffic barrier is not cost effective or practical for very low-volume roadways.

REFERENCES

1. AASHTO. *Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤ 400),* American Association of State Highway Transportation Officials, Washington, D.C.: 2001

2. AASHTO. *A Policy on Geometric Design of Highways and Streets,* American Association of State Highway and Transportation Officials, Washington, D.C.: 2011.

3. AASHTO. *Roadside Design Guide.* American Association of State Highway and Transportation Officials, Washington, D.C.: 2011.