Geometric Design Tables

A. General

~~The following sections present two sets of design criteria tables - Preferred Roadway Elements (Table 5C-1.01) and Acceptable Roadway Elements (Table 5C-1.02). In general, the "Preferred"~~The values presented in section~~ table~~ summarize~~s~~ design values ~~taken~~ from the AASHTO's "Green Book" and other national guidance noted in the reference section. ~~that may be considered "preferred" while the "Acceptable" table represents AASHTO minimums or practical minimums not covered in AASHTO.~~

Values are described as "preferred" or "acceptable" allowing for design flexibility based on the roadway context. When a value is described as "preferred" ~~D~~designers should strive to provide a design that meets or exceeds the criteria~~ established in the "Preferred" table~~. For designs where this is not practical, values between the "Preferred" and "Acceptable" tables may be utilized, with approval of the Engineer. When pedestrians or bicyclists are expected, designers should consider narrower widths for travel lanes and on-street parking to balance the roadway design between modes. In addition, reducing wide travel lanes can discourage higher motor vehicle operating speeds and improve safety for all users without reducing roadway capacity or increasing congestion. Right-sizing lane widths also reduces pedestrian crossing distances and can create spaces for sidewalks and bikeways. In retrofit situations where excess pavement cannot be reduced, travels lanes can be visually narrowed with pavement markings or contrasting materials. This space could be used for a buffer for bike lanes, a marked center median, or to provide space for a designated shoulder or bike lane. For designing multimodal roadways, refer to Section 5M-1.

The Federal Highway Administration has modified some of the controlling geometric design criteria for projects on the National Highway System (NHS). These changes were based on an analysis of the 13 controlling criteria reported in NCHRP Report 783 and are incorporated in 23 CFR 625. The changes include reducing the number of criteria to 10 by eliminating bridge width, vertical alignment, and horizontal clearance since those elements were covered under another criteria or they were found not to have significant operational or safety impacts. For lower speed facilities with a design speed of less than 50 mph, the controlling criteria only includes design speed and structural capacity.

~~However, since a~~All projects on the NHS, regardless of funding source, must meet the design guidelines in the Iowa DOT Design Manual, which includes the FHWA criteria.~~, SUDAS has not modified the geometric design criteria contained herein that is used for locally funded and non-NHS Federal-Aid projects.~~

The SUDAS geometric design criteria has been updated to reflect the new design values, concepts, criteria, and approaches presented in the 2018 edition of the AASHTO "Green Book." That edition provides a new framework for geometric design. It expands the land use contexts from two (urban or rural) to five (rural, rural town, suburban, urban, or urban core). It encourages flexible design and introduces a performance-based approach to geometric design, which will be further incorporated into future editions of the Green Book.

B. Design Controls and Criteria

The selection of various values for roadway design elements is dependent upon three general design criteria: functional classification, land use context, and design speed, and adjacent land use.

1. **Functional Classification:** The first step in establishing design criteria for a roadway is to define the function that the roadway will serve (refer to Section 5B-1 for street classifications). The functional classification of the roadway is the one basis for the cross-sectional design criteria shown in Tables 5C-1.01 and 5C-1.02. It also serves as the basis for the ultimate selection of design speed and geometric criteria.

   Under a functional classification system, design criteria and level of service vary according to the intended function of the roadway system. Arterials are expected to provide a high level of mobility for longer trip length; therefore, they should provide a higher design speed and level of service. Since access to abutting property is not their main function, some degree of access control is desirable to enhance mobility. Collectors serve the dual function of accommodating shorter trips and providing access to abutting property. Thus, an intermediate design speed and level of service is important. Local streets serve relatively short trip lengths and function primarily for property access; therefore, there is little need for mobility or high operating speeds. This function is reflected by use of lower design speeds and an intermediate level of service.

2. **Context Sensitive Design:**
   The 2018 Green Book recognizes five laned use context classifications for geometric design: rural; rural town; suburban, urban, and urban core. The five context classifications are generally defined by development density (existence of structures and structure types), land use types (e.g., residential, commercial, industrial, or agricultural), and building setbacks (distance of structures to adjacent roadways). Understanding the context classification is important to conduct a more thorough assessment of multimodal needs and to identify priorities among transportation modes within a corridor. While a street may have one functional classification, it may pass through multiple context classifications, and the transitions between those classifications is often gradual. Possible changes in context classification resulting from future development must also be considered in design.

   Designers should assume that pedestrians and bicyclists will be present in Urban, Suburban, and Rural Town context classifications; residential or commercial land use types; and along roadways with transit. For these locations, designers should refer to Section 5M-1 Complete Streets. For all other locations, designers should use the values presented in Section 5C. Some local jurisdictions have Complete Streets policies that require road or street projects to consider bicycle and pedestrian accommodations that is independent of context.

   a. Land Use Context Classifications: Context classifications can be generally summarized as follows:
   - The rural context applies to roads in rural areas with few houses or structures.
   - The rural town context applies to roads in rural towns, which generally have diverse land uses, on-street parking, sidewalks in some locations, and small building setbacks.
   - The suburban context applies to roads and streets with low to medium development density, typically in the outlying portions of urban areas. Building setbacks are varied with mostly off-street parking. Drivers have higher speed expectations than the urban context. Pedestrian, bicyclist, and transit are more prevalent than the rural context but may not be as high as found in urban areas, or in rural towns.
   - The urban context has high-density development, mixed land uses, and on-street parking. Driver speed expectations are generally lower and pedestrian and bicyclist flows higher

than in suburban areas. Transit routes are prevalent in this context and should be considered in design.

- The urban core context includes areas of the highest density in major cities, with high-rise structures and may have a combination of on-street parking and other curbside uses and large off-street parking ~~ramps~~structures. Pedestrian and bicyclist flows are generally highest in these areas and a high density of transit is also prevalent. In Iowa, very few cities have "urban cores," so SUDAS does not include criteria for that context.

b. Land Use Types: ~~**3. Adjacent Land Use:** In addition to functional classification and design speed, the surrounding land use can impact the design elements of the roadway corridor as well.~~ Within each land use context classification, areas can be further described by the specific land use types. Land use types influence travel patterns and travel demand of all modes and should be considered when selecting design values. Land use can be categorized into three groups: residential, commercial, and industrial.

- Residential areas are regions defined by residential or multi-family zoning districts where single-family houses, apartment buildings, condominium complexes and townhome developments are located. ~~Because these~~ These facilities typically have lower overall traffic volumes, low truck volumes, and are utilized primarily by drivers who are familiar with the roadway~~, some design values can be set at a lower level than for commercial or industrial areas~~.
- Commercial areas includ~~ing~~e entertainment, cultural, recreational, and institutional ~~areas~~uses and can range from low to high density ~~regions and~~developments. These often ~~generally~~ consist of restaurants, local shops, convenience or grocery stores, museums, theatres, hospitals, schools and universities, government agencies, and offices. In urban and rural town contexts, commercial and residential land uses are often integrated and described as mixed use.
- Industrial and ~~L~~large commercial ~~Commercial and industrial~~ areas are highly developed regions generally defined by commercial and industrial zoning districts where factories, office ~~buildings~~ parks, strip malls, and large shopping centers are ~~or will be~~ located. These areas typically ~~require higher level design values due to increased~~ experience higher motor vehicle traffic volumes, increased truck volumes, and may ~~experience decreased~~have less driver familiarity.

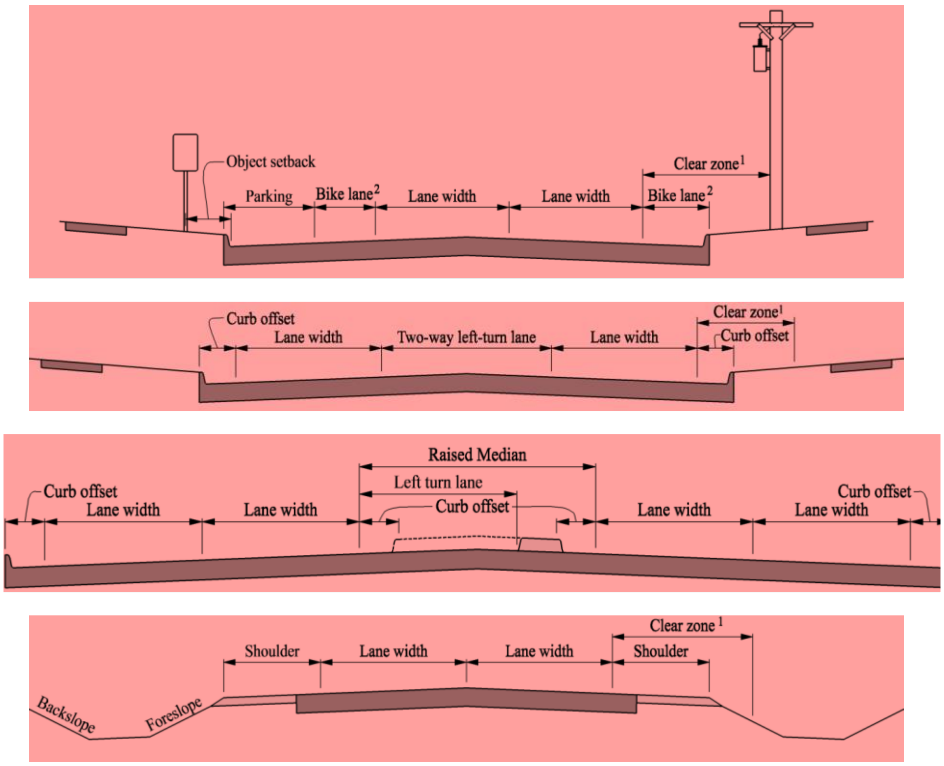
~~2~~3. **Design Speed:** Design speed is the selected speed used to determine various geometric features of the roadway, including horizontal and vertical alignment. The design speed ~~selected should be as high as practical~~ should be selected considering functional classification, context classification, and surrounding land uses to attain the desired degree of safety, mobility, and efficiency. ~~It is preferred to~~ It has been past practice to select a design speed that is at least 5 mph greater than the anticipated posted speed limit of the roadway. However, in urban, suburban and rural town areas, the design of the street should generally be such that it limits the maximum speed ~~at~~to that which drivers can operate comfortably, ~~as needed~~in order to balance the needs of all users. For roadways with posted speed limits of 35 mph or less, the design speed should match the posted speed. For roadways with posted speeds of 40-45 mph, ~~S~~selecting a design speed equal to the posted speed limit may also ~~be acceptable~~be appropriate and should be evaluated on a ~~project~~ project-~~by~~ by-project basis, subject to approval of the Engineer. Once ~~the~~ a design speed is selected, all pertinent roadway features should be related to ~~it~~ that speed to obtain a balanced design. Additional discussion of design speed can be found in Section 5M-1.

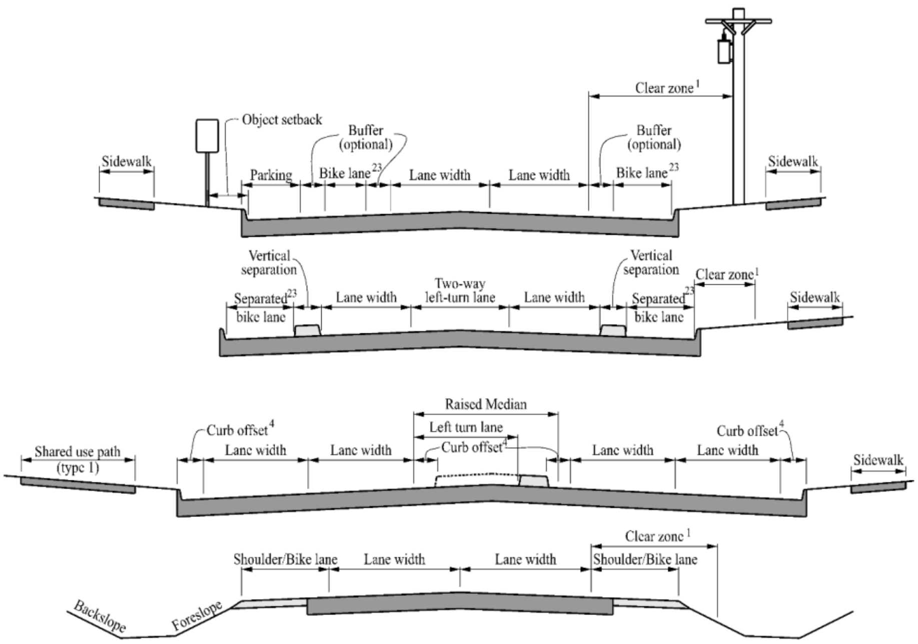
In some situations, it may be impractical to conform with the desired design speed for all elements of the roadway (e.g. horizontal radius or clear zone). In these situations, warning signs or additional safety treatments may be required (e.g. warning signs or guard rail).

C. Roadway Design Tables

The following figures illustrate the location of various design elements of the roadway cross-section as specified in Tables 5C-1.01 and 5C-1.02.

Figure 5C-1.01: Roadway Design Elements





[1] Clear zone is measured from the edge of the traveled way.
[2] See Chapter 12 for bike lane requirements.
[3] Bikes may be placed between the curb and parking on corridors with higher traffic volume and speed, see Sections 12B-1 and 12B-3 for separated bicycle lane design with on-street parking buffers.
[4] For low-speed street conditions in urban and rural town areas, curbs may be placed at the edge of the traveled way.

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Table 5C-1.01A: Preferred Roadway Cross Section Values~~Roadway Elements~~

Elements Related to Functional Classification

Design Element	Local		Collector		Arterial	
	Res./C	***~~C/~~I***	***Res./C***	***~~C/~~I***	***Res./C***	***~~C/~~I***
General						
Design level of service[1]	D	D	C/D	C/D	C/D	C/D
Lane width (single lane) (ft)[~~1,~~ 2]	10.5	12	11~~12~~	12	11~~2~~	12
Two-way left-turn lanes (TWLTL) (ft)	N/A	N/A	11~~14~~	12~~14~~	11~~14~~	12~~14~~
Width of new bridges (ft)[3]	See Footnote 3					
Width of bridges to remain in place (ft)[4]	----------	----------	----------	----------	----------	----------
Vertical clearance (ft)[5]	14.5	14.5	14.5	14.5	16.5	16.5
Object setback (ft)[6]	N/A~~3~~					
Clear zone (ft)	Refer to Table 5C-1.03, Table 5C-1.04, and 5C-1, C, 1					
Sidewalk (ft)	Refer to Section 12A					
Bikeway (ft)	Refer to Section 12B					
Curbed Roadways ~~Urban~~						
Curb offset (ft)[7]	0~~2~~	0~~2~~	0~~2~~	0~~3~~	2~~3~~	2~~3~~
Parking lane width (ft)[8]	8	8	8	~~10~~9	~~N/A~~9	N/A
~~Roadway width with parking on one side[8]~~	~~26/27/31[9]~~	~~34~~	~~34~~	~~37~~	~~N/A~~	~~N/A~~
~~Roadway width without parking[10]~~	~~26~~	~~31~~	~~31~~	~~31~~	~~31~~	~~31~~
~~Raised median with left-turn lane (ft)[11]~~	~~N/A~~	~~N/A~~	~~19.5~~	~~20.5~~	~~20.5~~	~~20.5~~
Cul-de-sac radius (ft)	45/48[9~~12~~]	45/48[9~~12~~]	N/A	N/A	N/A	N/A
~~Rural Sections in Urban Areas~~Uncurbed Roadways						
Shoulder width (ft)						
ADT: under 400	4	4	6	6	10	10
ADT: 400 to 1,500	6	6	6	6	10	10
ADT: 1,500 to 2000	8	8	8	8	10	10
ADT: above 2,000	8	8	8	8	10	10
Foreslope (H:V)	4:1	4:1	4:1	4:1	6:1	6:1
Backslope (H:V)	4:1	4:1	4:1	4:1	4:1	4:1

Res. = Residential, C = Commercial, ~~/~~I = ~~Commercial/~~Industrial

Table 5C-1.01B Preferred General Roadway Design Values

Elements Related to Design Speed

Design Element	Design Speed, mph[10~~3~~]							
	25	***30***	***35***	***40***	***45***	***50***	***55***	***60***
Stopping sight distance (ft)	155	200	250	305	360	425	495	570
Passing sight distance (ft)	900	1090	1,280	1,470	1,625	1,835	1,985	2,135
Min. horizontal curve radius (ft)[11~~4~~]	198	333	510	762	1,039	926	1,190	1,500
Min. vertical curve length (ft)	50	75	105	120	135	150	165	180
Min. rate of vertical curvature, Crest (K)[12~~5~~]	18	30	47	71	98	136	185	245
Min. rate of vertical curvature, Sag (K)	26	37	49	64	79	96	115	136
Minimum gradient (percent)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Maximum gradient (percent)	5	5	5	5	5	5	5	5

Note: ~~For federal-aid projects, documentation must be provided to explain why the preferred values are not being met. For non-federal aid projects, the designer must contact the Jurisdiction to determine what level of documentation, if any, is required prior to utilizing design values between the "Preferred" and "Acceptable" tables.~~The use of wider lane width values as presented above is discouraged where pedestrians and bicyclists are

Commented [A1]: Both the preferred and acceptable values listed are within the ranges that the AASHTO greenbook allows so no exceptions are necessary. A statement along the lines of the following could be added: "FHWA no longer considers lane and shoulder width as controlling criteria for roadways on the National Highway System (NHS) with less than 50 mph design speeds, allowing for increased flexibility to implement narrower lanes on those roadways."

expected as wider roadways can lead to higher motor vehicle operating speeds and degrade safety for all roadway users. The use of maximum values may be appropriate on higher speed roadways or where there is a higher volume of truck traffic

Table 5C-1.01 Footnotes:

[1] Number of traffic lanes, turn lanes, intersection configuration, etc. should be designed to provide the overall specified LOS at the design year ADT. Two LOS values are shown for collectors and arterials. The first indicates the minimum overall LOS for the roadway as a whole; the second is the minimum LOS for individual movements at intersections.

[2] Width shown is for through lanes and turn lanes. For local, low volume residential streets, two free flowing lanes are not required and a 21 foot or 28 foot wide (back to back) roadway may be used where parking is allowed on one side or both sides respectively. The minimum street width with parking on one side stipulated in the 2018 International Fire Code is 27 foot back to back. Some jurisdictions allow narrower street widths in low density residential areas due to the size of their firefighting apparatus.

[3] Bridge width is measured as the clear width between curbs or railings. Minimum bridge width is based upon the width of the traveled way (lane widths) plus 4 feet clearance on each side; but no less than the curb-face to curb-face width of the approaching roadway. Minimum bridge widths do not include medians, turn lanes, parking, or sidewalks. At least one sidewalk should be extended across the bridge.

[4] See Table 5C-1.02, for acceptable minimum values for width of bridges to remain in place.

[5] Vertical clearance includes a 0.5 foot allowance for future resurfacing.

[6] Object setback does not apply to mailboxes constructed and installed according to US Postal Service regulations, including breakaway supports.

[7] Values shown are measured from the edge of the traveled way to the back of curb. Curb offset is not required for turn lanes. On roadways with an anticipated posted speed of 45 mph or greater, mountable curbs are required. For pavements with gutterline jointing, the curb offset should be equal to or greater than the distance between the back of curb and longitudinal gutterline joint, but should not exceed the values shown.

[8] Parking is allowed along one side of local or collector streets unless restricted by the Jurisdiction. Some jurisdictions allow parking on both sides of the street. When this occurs, each jurisdiction will set their own standards to allow for proper clearances, including passage of large emergency vehicles. Parking is normally not allowed along arterial roadways.

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[10] Some minimum roadway widths have been increased to match standard roadway widths. Unless approved by the Jurisdiction, all two lane roadways must comply with standard widths of 26, 31, 34, or 37 feet.

[11] Median width is measured between the edges of the traveled way of the inside lanes and includes the curb offset on each side of the median. Values include a left turn lane with a 6 foot raised median as required to accommodate a pedestrian access route (refer to Chapter 12) through the median (crosswalk cut through). At locations where a crosswalk does not cut through the median, the widths shown can be reduced by 2 feet to provide a 4 foot raised median.

[912] The minimum cul-de-sac radius stipulated by the 2018 International Fire Code is 48 feet. Some jurisdictions allow lesser radii due to the size of their firefighting apparatus.

[1013] For roadways with posted limits of 35 mph or less, the design speed should match the posted speed. For roadways with posted speeds of 40-45, selecting a design speed equal to the posted speed limit may also be appropriate and should be evaluated on a project by project basis, subject to approval of the Engineer. It is preferred to select a design speed that is at least 5 mph greater than the anticipated posted speed limit of the roadwayfor roadways with posted speeds of 50mph or greater. Selecting a design speed equal to the posted speed limit may also be acceptable and should be evaluated on a project by project basis, subject to approval of the Engineer.

[1114] Values for low design speed (<50 mph) assume no removal of crown (i.e. negative 2% superelevation on outside of curve). Radii for design speeds of 50 mph or greater are based upon a superelevation rate of 4%. For radii corresponding to other superelevation rates, refer to the AASHTO's "Green Book."

[125] Assumes stopping sight distance with 6 inch object.

Commented [A2]: The text responds to Paul's note and states the fire code while also stating that some jurisdictions allow narrower.

Table 5C-1.02A: Acceptable Roadway Cross Section ValuesRoadway Elements

Elements Related to Functional Classification

Design Element	Local		Collector		Arterial	
	Res./C	*C/II*	*Res./C*	*C/II*	*Res./C*	*C/II*
General						
Design Level-of-Service[1]	D	D	D/E	D/E	D/E	D/E
Lane width (single lane) (ft)[1,2]	10	11	1110	11	10	11
Two-Way Left-Turn Lanes (TWLTL) (ft)	N/A	N/A	1210	1211	10	1211
Width of new bridges, (ft)[3]	See Footnote 3					
Width of bridges to remain in place (ft)[4]	20	202	2224	24	2624	26
Vertical clearance (ft)[5]	14.5	14.5	14.5	14.5	14.5	14.5
Object setback (ft)[6]	1.5	1.5	1.5	1.5	1.5	1.5
Clear zone (ft)	Refer to Table 5C-1.03, Table 5C-1.04, and 5C-1, C, 1					
Sidewalk (ft)	Refer to Section 12A					
Bikeway (ft)	Refer to Section 12B					
UrbanCurbed Roadways						
Curb offset (ft)[7, 8]	1.5[8]0	1.5[8]0	1.5[8]0	1.5[8]0	02	02
Parking lane width (ft)	7.57	7.58	7.57	98	108	108
Roadway width with parking[9, 11]	26/31[10]	31	31	34[11]	34	34
Roadway width without parking[11]	26[10]	26	26	26	26	26
Raised median with left-turn lane (ft)[12]	N/A	N/A	18	18	18.5	18.5
Cul-de-sac radius (ft)	45	45	N/A	N/A	N/A	N/A
Rural Sections in Urban AreasUncurbed Roadways						
Shoulder width (ft)						
ADT: under 400	2	2	2	2	8	8
ADT: 400 to 1,500	5	5	5	5	8	8
ADT: 1,500 to 2,000	6	6	6	6	8	8
ADT: over 2,000	8	8	8	8	8	8
Foreslope (H:V)[139]	3:1	3:1	3:1	3:1	4:1	4:1
Backslope (H:V)	3:1	3:1	3:1	3:1	3:1	3:1

Res. = Residential, C = Commercial, I = IndustrialRes. = Residential, C/I = Commercial/Industrial

Table 5C-1.02B Acceptable General Roadway Design Values

Elements Related to Design Speed

Design Element	Design Speed, mph[1410]															
	25		*30*		*35*		*40*		*45*		*50*		*55*		*60*	
Stopping sight distance (ft)	155		200		250		305		360		425		495		570	
Passing sight distance (ft)	900		1,090		1,280		1,470		1,625		1,835		1,985		2,135	
Min. horizontal curve radius (ft)[1511]	198		333		510		762		1,039		833		1,060		1,330	
Min. vertical curve length (ft)	50		75		105		120		135		150		165		180	
Min. rate of vert. curve, Crest (K)[1612]	12		19		29		44		61		84		114		151	
Min. rate of vert. curve, Sag (K)	26		37		49		64		79		96		115		136	
Min. rate of vert. curve, Sag (K) based on driver comfort/overhead lighting[1713]	14		20		27		35		44		54		66		78	
Minimum gradient (percent)[1814]	0.5		0.5		0.5		0.5		0.5		0.5		0.5		0.5	
Maximum gradient (percent)[1915]	R	C/I	R	C/I	R	C/I	R	C/I	R	C/I	R	C/I	R	C/I	R	C/I
Local	12	10	12	9	11	9	11	9	10	8	9	8	N/A	N/A	N/A	N/A
Collector	12	9	11	9	10	9	10	9	9	8	8	7	N/A	N/A	N/A	N/A

Commented [A3]: The preferred is 11FT. We agree that this can be narrow where higher volumes of buses and heavy vehicles are present and have stated as much in the foot note. Given that this covers residential and commercial though this may not always be an issue and should be considered on a case by case basis. It's also not necessary to make all lanes 11ft – just one in each direction

Commented [A4]: The preferred is 11FT. We agree that this can be narrow where higher volumes of buses and heavy vehicles are present and have stated as much in the foot note. Given that this covers residential and commercial though this may not always be an issue and should be considered on a case by case basis. It's also not necessary to make all lanes 11ft – just one in each direction

Arterial	N/A	N/A	9	9	8	8	8	8	N/A	7	N/A	7	N/A	6	N/A	6

R = Residential, C/I = Commercial/Industrial

Note: For federal-aid projects, proposed design values that do not meet the "Acceptable" table may require design exceptions. Design exceptions will be considered on a project-by-project basis and must have concurrence of the Iowa DOT when applicable. For non-federal aid projects, the designer should contact the Jurisdiction to determine what level of documentation, if any, is required prior to utilizing design values that do not meet the "Acceptable" table.

Table 5C-1.02 Footnotes:

1 ~~Where roadway speed is greater than 30mph and transit is present, at least one 10.5 ft or 11 ft lane in each direction may be appropriate depending on the roadway cross section. For example, if a street buffer or on street parking is present, additional lane width may not be necessary for buses to reliably operate at the posted speed.~~ Number of traffic lanes, turn lanes, intersection configuration, etc. should be designed to provide the specified LOS at the design year ADT.

2 Width shown is for through lanes and turn lanes. Where roadway speed is greater than 30mph and transit or heavy truck volumes are~~is~~ present, at least one 10.5 ft or 11 ft lane in each direction may be appropriate depending on the roadway cross section. For example, if a street buffer or on street parking is present, additional lane width may not be necessary for buses to reliably operate at the posted speed. For pavements with gutterline jointing, ~~the curb offset should be equal to or greater than the distance between the back of curb and longitudinal gutterline joint~~ lane widths are exclusive of the gutter. For local, low volume residential streets, two free flowing lanes are not required and a 21 foot or 28 foot wide (back to back) roadway may be used where parking is allowed on one side or both sides respectively. The minimum street width with parking on one side stipulated in the 2018 International Fire Code is 27 foot back to back. Some jurisdictions allow narrower street widths in low density residential areas due to the size of their firefighting apparatus.

Commented [A5]: The text responds to Paul's note and states the fire code while also stating that some jurisdictions allow narrower.

3 Bridge width is measured as the clear width between curbs or railings. Minimum bridge width is based upon the width of the traveled way (lane widths) plus 3 feet clearance on each side; but no less than the curb-face to curb-face width of the approaching roadway. Minimum bridge widths do not include medians, turn lanes, parking, or sidewalks. It is preferable that sidewalks be provided on both sides in urban, suburban, and rural town contexts. In constrained conditions, a minimum of ~~At least~~ one sidewalk should be extended across the bridge.

4 The values shown are the clear width across the bridge between curbs or railings. Values are based upon the width of the traveled way (lane width) and include a 1 foot and 2 foot offset on each side for collectors and arterials respectively. Values do not include medians, turn lanes, parking, or sidewalks. In no case should the minimum clear width across the bridge be less than the width of the traveled way of the approach road.

5 Vertical clearance includes a 0.5 foot allowance for future resurfacing. Vertical clearance of 14.5 feet on arterials is allowed only if an alternate route with 16 feet of clearance is available.

6 Object setback does not apply to mailboxes constructed and installed according to US Postal Service regulations, including breakaway supports.

7 ~~Values shown are measured from the edge of the traveled way to the back of curb.~~ Curb offset is not required for travel or turn lanes. On roadways with an anticipated posted speed of 45 mph or greater and where curbs are present, mountable curbs are required. ~~For pavements with gutterline jointing, the curb offset should be equal to or greater than the distance between the back of curb and longitudinal gutterline joint.~~

8 Curb offset is not required for ~~S~~side opening inlets ~~should be used~~ without a grate. At locations with an intake box, a curb offset is required equal to the grate width. It is preferable to ~~where a 1.5 foot curb offset is used, an alternative intake boxout, with the intake~~ set back the intake box a minimum of 6 inches from the curb line~~, must be used~~ to reduce or prevent intake grates from encroaching into the traveled way.

9 ~~Some jurisdictions allow parking on both sides of the street. When this occurs, each jurisdiction will set their own standards to allow for proper clearances, including passage of large emergency vehicles.~~

~~10 For low volume residential streets, two free flowing lanescenterline markings are not required and an 1826 and 24 foot wide roadway may be used where parking is allowed on one side or two sides respectively, only assuming that parking utilization is low or there are enough gaps in parking for cars to safely yield and pass one another. For higher volume residential streets, which require two continuously free flowing traffic lanes, a 31foot roadway should be used.~~

~~11 Some minimum roadway widths have been increased to match standard roadway widths. Unless approved by Jurisdiction, all two lane roadways must comply with standard widths of 26, 31, 34, or 37 feet.~~

~~12 Median width is measured between the edges of the traveled way of the inside lanes and includes the curb offset on each side of the median. Values include a left turn lane with a 6 foot raised median as required to accommodate a pedestrian~~

access route (refer to Chapter 12) through the median (crosswalk cut through). At locations where a crosswalk does not cut through the median, the widths shown can be reduced by 2 feet to provide a 4 foot raised median.

[139] The use of 3:1 foreslopes is allowed, as shown, but may require a wider clear zone as slopes steeper than 4:1 are not considered recoverable by errant vehicles.

[140] For roadways with posted limits of 35 mph or less, the design speed should match the posted speed. For roadways with posted speeds of 40-45, selecting a design speed equal to the posted speed limit may also be appropriate and should be evaluated on a project–by–project basis, subject to approval of the Engineer. It is preferred to select a design speed that is at least 5 mph greater than the anticipated posted speed limit of the roadway for roadways with posted speeds of 50 mph or greater. Selecting a design speed equal to the posted speed limit may also be acceptable and should be evaluated on a project by project basis, subject to approval of the Engineer

[151] Values for low design speed (<50 mph) assume no removal of crown (i.e. negative 2% superelevation on outside of curve). According to the AASHTO Green Book (Table 3-1 and 3-13b) for low volume roadways with 10 or less units beyond the curve and projected traffic volumes of less than 100 vehicles per day beyond the curve, the horizontal curve radius may be a minimum of 107 feet if at least 115 feet of stopping sight distance is provided or the radius may be a minimum of 50 feet if at least 80 feet of stopping sight distance is available. Radii for design speeds of 50 mph or greater are based upon a superelevation rate of 6%. For radii corresponding to other superelevation rates, refer to the AASHTO's "Green Book."

[162] Assumes stopping sight distance with 2 foot high object.

[173] Use only if roadway has continuous overhead lighting.

[184] A typical minimum grade is 0.5%, but a grade of 0.4% may be used in isolated areas where the pavement is accurately crowned and supported on firm subgrade.

[195] Maximum gradient may be steepened by 2% for short distances and for one way downgrades.

Table 5C-1.03: Preferred Clear Zone Distances~~ for Rural and Urban Roadways~~

Design Speed mph	Design Traffic ADT	Foreslope			Backslope or Parking		
		6:1 or flatter	*5:1 to 4:1*	*3:1*	*6:1 or flatter*	*5:1 to 4:1*	*3:1*
		In feet from edge of traveled way					
~~Urban~~Curbed Roadways 40 or less[1]	All	For low-speed urban roadways, refer to 5C-1, C, 1.					
~~Rural~~Uncurbed Roadways 40 or less	Under 750	10	10	*	10	10	10
	750 to 1,500	12	14	*	14	14	14
	1,500 to 6,000	14	16	*	16	16	16
	Over 6,000	16	18	*	18	18	18
~~Rural and Urban~~ All Roadways 45 to 50	Under 750	12	14	*	12	10	10
	750 to 1,500	16	20	*	16	14	12
	1,500 to 6,000	18	26	*	18	16	14
	Over 6,000	22	28	*	22	20	16
All Roadways ~~Rural and Urban~~ 55	Under 750	14	18	*	12	12	10
	750 to 1,500	18	24	*	18	16	12
	1,500 to 6,000	22	30	*	22	18	16
	Over 6,000	24	32	*	24	22	18
All Roadways ~~Rural and Urban~~ 60	Under 750	18	24	*	16	14	12
	750 to 1,500	24	32	*	22	18	14
	1,500 to 6,000	30	40	*	26	22	18
	Over 6,000	32	44	*	28	26	22

Source: Adapted from the *Roadside Design Guide*, 2011

Table 5C-1.04: Acceptable Clear Zone Distances~~ for Rural and Urban Roadways~~

Design Speed mph	Design Traffic ADT	Foreslope			Backslope or Parking		
		6:1 or flatter	*5:1 to 4:1*	*3:1*	*6:1 or flatter*	*5:1 to 4:1*	*3:1*
		In feet from edge of traveled way					
~~Urban~~Curbed Roadways 40 or less	All	For low-speed urban roadways, refer to 5C-1, C, 1.					
~~Rural~~ Uncurbed Roadways 40 or less	Under 750	7	7	*	7	7	7
	750 to 1,500	10	12	*	12	12	12
	1,500 to 6,000	12	14	*	14	14	14
	Over 6,000	14	16	*	16	16	16
All Roadways ~~Rural and Urban~~ 45 to 50	Under 750	10	12	*	10	8	8
	750 to 1,500	14	16	*	14	12	10
	1,500 to 6,000	16	20	*	16	14	12
	Over 6,000	20	24	*	20	18	14
All Roadways ~~Rural and Urban~~ 55	Under 750	12	14	*	10	10	8
	750 to 1,500	16	20	*	16	14	10
	1,500 to 6,000	20	24	*	20	16	14
	Over 6,000	22	26	*	22	20	16
All Roadways ~~Rural and Urban~~ 60	Under 750	16	20	*	14	12	10
	750 to 1,500	20	26	*	20	16	12
	1,500 to 6,000	26	32	*	24	18	14
	Over 6,000	30	36	*	26	24	20

Source: Adapted from the *Roadside Design Guide*, 2011

* Foreslopes steeper than 4:1 are considered traversable, but not recoverable. An errant vehicle can safely travel across a 3:1 slope, but it is unlikely the driver would recover control of the vehicle before reaching the bottom of the slope; therefore, fixed objects should not be present on these slopes or at the toe of these slopes.

1. **Clear Zone for Low-speed (40 mph or less Design Speed) Urban Roadways with Curbs:** A minimum clear zone behind the back of curb of 6 feet (preferred) or 4 feet (acceptable) should be provided regardless of roadway classification. Clear zone requirements also apply along medians of divided roadways (Maze, 2008; AASHTO *Roadside Design Guide*, 4th Edition).

Table 5C-1.05 Motor Vehicle Design Level of Service

Targets[1]	Local	Collector	Arterial
Preferred	D	C/D	C/D
Acceptable	D	D/E	D/E

[1]Number of traffic lanes, turn lanes, intersection configuration, etc. should be designed to provide the overall specified LOS at the design year ADT. Two LOS values are shown for collectors and arterials. The first indicates the minimum overall LOS for the roadway as a whole; the second is the minimum LOS for individual movements at intersections.

D. References

American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets* ("Green Book"). Washington, DC. 2018.

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Maze T. Hawkins N. et al. Clear Zone - A Synthesis of Practice and an Evaluation of the Benefits of Meeting the 10ft Clear Zone Goal on Urban Streets. Center for Transportation Research and Education. Iowa State University. 2008.

National Cooperative Highway Research Program Report 330 *Effective Utilization of Street Width on Urban Arterials*. Transportation Research Board. Washington, D.C. 1990

Potts, Ingrid & Harwood, Douglas & Richard, Karen. *Relationship of Lane Width to Safety for Urban and Suburban Arterials*. Transportation Research Record. 2007.