4-6.04 Clear Zones

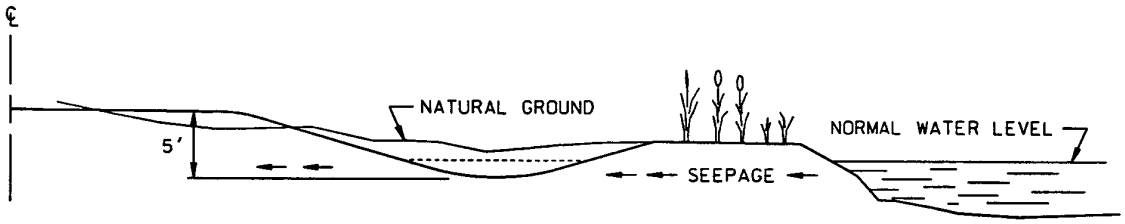
The roadside clear zone is the distance from the edge of the travel lane which should be free of any non-traversable hazard such as steep slopes or fixed objects. The clear zone distances are targeted towards allowing approximately 80 to 85 percent of all run-off-the-road vehicles to recover or come to a safe stop. The width of a clear zone along the horizontal alignment is dependent on roadside geometry, design speed, radius of horizontal curve, and the ADT. Higher speeds mean vehicles will travel farther before recovering. Horizontal curvature increases the likelihood of a vehicle leaving the highway and increases the distance it will travel off the highway, as will steeper fill slopes. In general, hazards within the clear zone which cannot be removed, relocated, or made breakaway will warrant guardrail.

The designer should not apply rigid adherence to the calculated clear zone distance. If a formidable hazard lies just beyond the clear zone, it should be removed or shielded if costs are reasonable. Conversely, the designer should not have the philosophy that the clear zone should be achieved at all costs. Limited right of way or unacceptable construction costs may lead to installation of a barrier or, perhaps, no protection at all if there are many hazards along the entire length of the roadway inside the calculated clear zone.

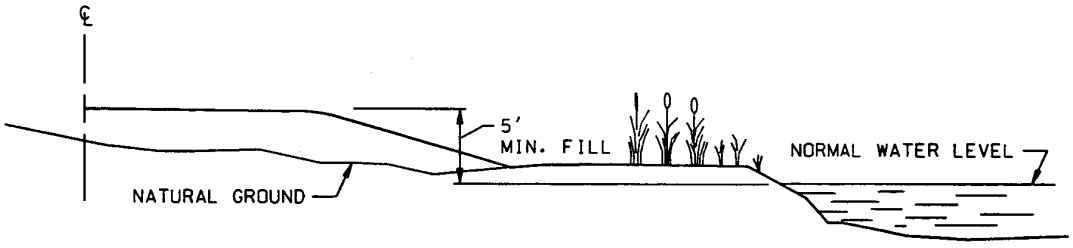
The designer should not use the clear zone distances as boundaries for introducing roadside hazards such as bridge piers, non-breakaway sign supports, or trees. These should be placed as far from the roadway as practical.

4-6.04.01 Clear Zone Design Criteria

1. Guardrail itself is considered a hazard, every effort should be made to maintain a sufficient clear zone recovery area so that guardrail is not needed.
2. When a hazard has to be relocated, provide sufficient clearance from the edge of the traveled roadway to eliminate the need for a protective barrier.
3. Where the clear distance from the edge of the traveled roadway to a hazard cannot be achieved, attenuation devices or guardrail may be required.
4. It is desirable to extend culverts beyond the clear zone distances given in the tables. For all traffic volumes, culvert ends within the clear zone should be protected with safety aprons, grates or guardrail.
5. Although it is desirable to extend large culverts, (42 in. diameter and larger), it is normally not necessary to extend existing large culverts for an existing ADT of less than 1000 vpd. For an existing ADT greater than 1000 vpd, these large culverts should be extended beyond the clear zones given in the tables or protected with safety grates. For all traffic volumes, large culvert ends within the clear zone should be protected with safety grates or guardrail.
6. On many highways, the run-off-the-road crash rate is too low to justify the cost of providing hazard free clear zones. If the grading limits on the proposed project will not result in the desirable hazard free clear zones, an analysis of the accident history within the project should determine if providing a hazard-free clear zone is cost effective.
7. In evaluating the accident history, the designer should look for possible concentrations of accidents that may justify construction of wider clear zones over a short section of the project. If only a few isolated hazards exist within the desirable clear zone and if these hazards can be removed or relocated at a low cost, the plan should provide for their removal or relocation. Normally, acquisition of right of way just to obtain the desirable clear zone is not cost effective.
8. For new construction/reconstruction projects, hazards such as culvert headwalls, utility poles, large trees, structures, sign supports, luminaire standards, guardrails, curbs, bridge piers and similar features should be removed, relocated or designed to provide an optimum degree of safety for traffic.
9. For preservation projects, locations of hazards such as culvert headwalls, utility poles, large trees, structures, sign supports, luminaire standards, guardrails, curbs, bridge piers, road approaches and entrances with steep sideslopes, and similar features should be identified. If, based on accident history, these features are found to be unsafe, they should be removed, relocated, or redesigned.

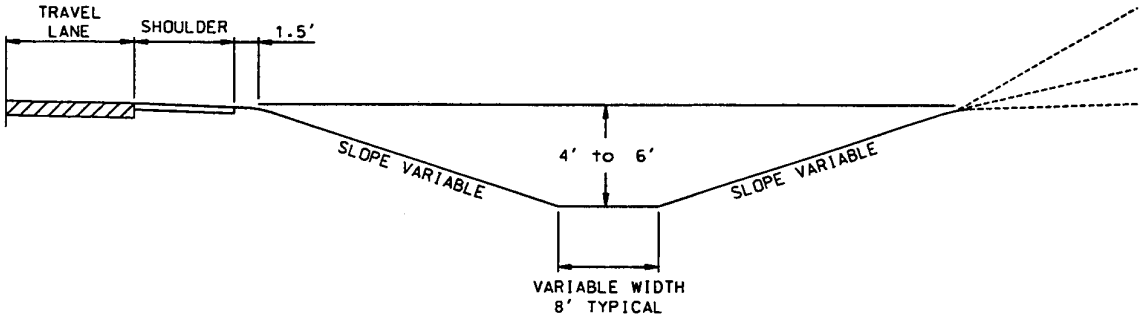


UNDESIRABLE GRADE LINE



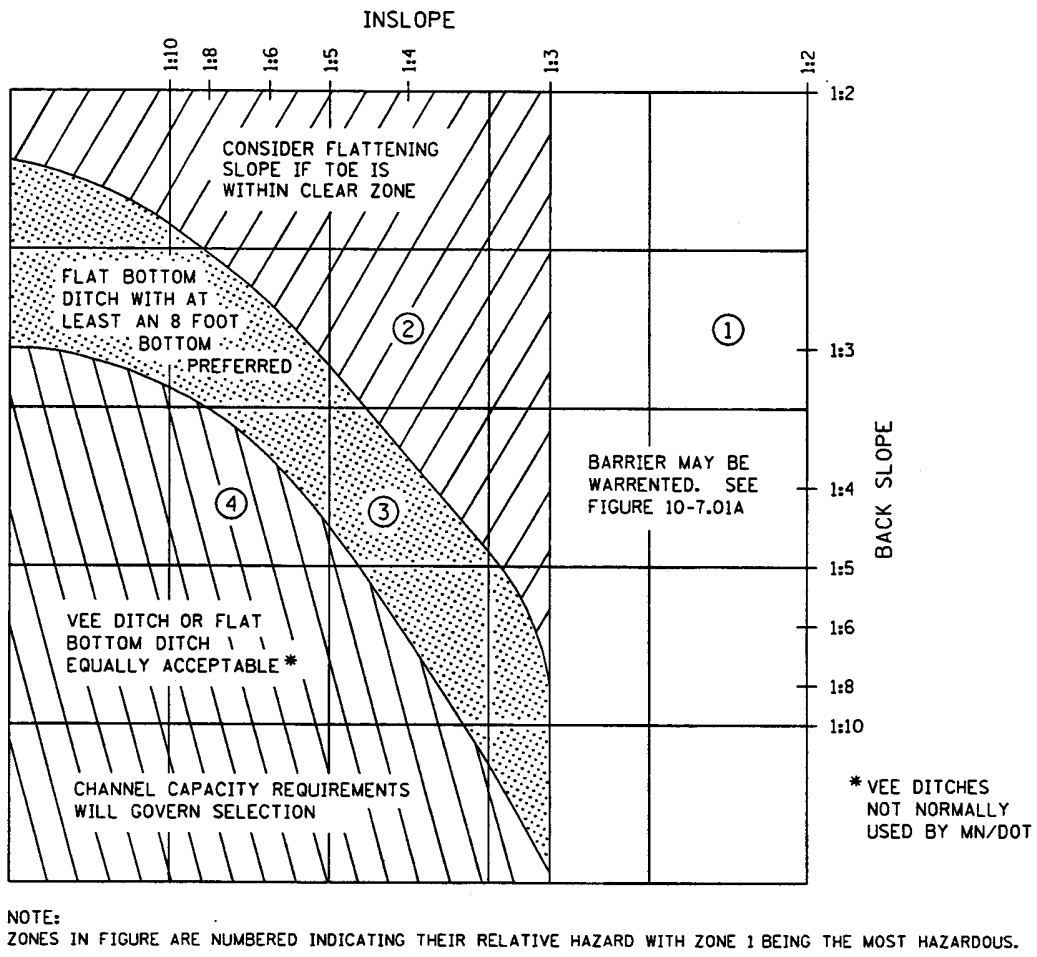
DESIRABLE GRADE LINE

HIGHWAY ADJACENT TO SWAMP
Figure 4-6.03B



NOTES:
1. THE DIMENSIONS OF THE TRAPEZOIDAL DITCH WILL DEPEND ON THE NEED FOR HYDRAULIC CAPACITY AND TRAVERSABILITY CHARACTERISTICS.
2. ROUNDING AT THE DITCH BOTTOM IS DESIRABLE DURING CONSTRUCTION.
3. THE TOPSOIL DEPTH VARIES FROM 3 IN. TO 12 IN. THE OUTLET OR INLET OF A CULVERT WILL BE STAKED TO TOP OF TOPSOIL. THE DITCH ELEVATIONS WILL BE REFERENCED TO THE BOTTOM OF TOPSOIL.

TYPICAL DITCH SECTION
Figure 4-6.03C



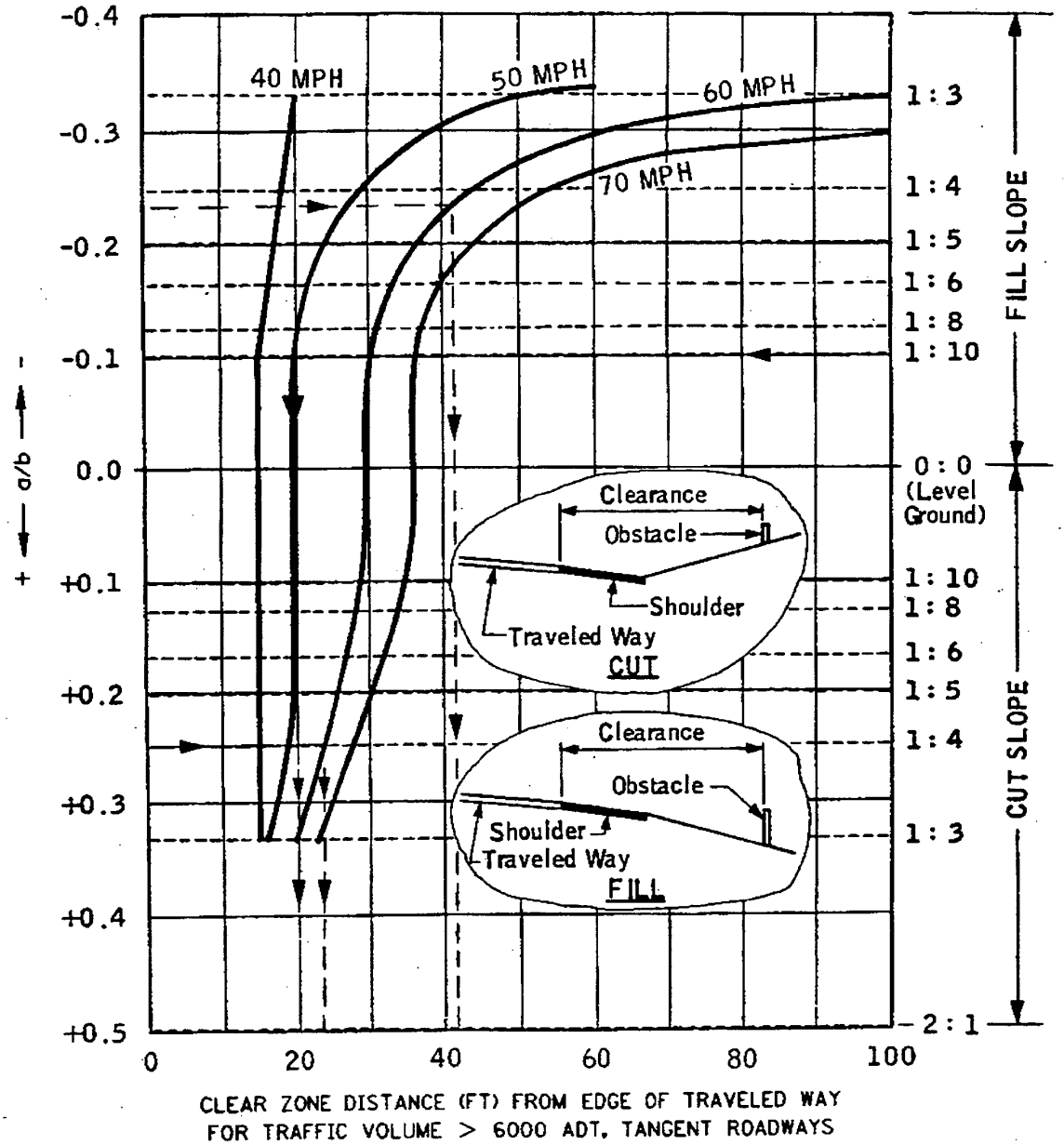
TRAVERSABILITY OF DITCHES
Figure 4-6.03D

4-6.04.02 Design Application

Figure 4-6.04A provides the appropriate clear zone distances for various design speeds and side slopes on tangent roadway sections with an ADT greater than 6000. Table 4-6.04A is a tabulation of clear zone distances for various combinations of design speed, ADT and side slope. These values should be used on tangent sections and on the inside of horizontal curves as shown in Section 4-6.04.03.

Adjustments to clear zones distances are necessary where conditions other than the above 'standard' exist. The adjustments are as follows:

1. If the roadside fill slope varies but all slopes are recoverable, a weighted average approach should be used as shown in Example 1, Section 4-6.04.03. Non-recoverable slopes cannot be used in averaging slope. If slope is non-recoverable, use the steepest recoverable slope (whether it is before or after the recoverable slope) to calculate the required width of the clear zone. See Example 2, Section 4-6.04.03.
2. If the roadside cut section contains a ditch as shown in Example 3, the algebraic weighted average of the inslope and backslope should not be calculated. Example 3 should be treated as a ditch section and checked for traversability and then checked for hazards within the clear zone on the backslope. (The inslope clear zone should be calculated for a fill section and the back slope clear zone should be calculated for a cut section. The clear zone for traversability of ditch sections is based on the inslope or fill section calculations. The clear zone for an object located on the back slope is based on a combination of the fill and cut section calculations.)



NOTE: Reduce clear zone for ADT ≤ 6000. Increase for outside of curves as shown in Tables 4-6.0 B through K.

CLEAR ZONE DISTANCES - SPEED AND SLOPE CRITERIA - TANGENT ALIGNMENT
Figure 4-6.04A

3. Clear Zones should be increased on the outside of horizontal curves. Tables 4-6.04B through 4-6.04K give clear zone widths for various design speeds, ADT and sideslopes for the outside of horizontal curves with deg of horizontal curve up to 11 deg. Values given in these tables are based on equations developed by the FHWA. The equations are as follows:

$Czc = (Lc)(Kcz)$

where:

Czc = adjusted clear zone for curve, ft

Lc = clear zone for tangent, ft

K_{cz} = curve correction factor

$$K_{cz} = \frac{(L_o + W_r)}{W_r}$$

L_o = Increase in lateral encroachment, ft

$$L_o = \sqrt{\left(\frac{5729.6}{D^o}\right)^2 + \left(\frac{(0.9V + 15)^2}{13}\right)^2} - \frac{5729.6}{D^o}$$

W_r = theoretical maximum encroachment, from finite limit of roadside shown below:

FINITE LIMIT OF ROADSIDE

Design Speed V, mph	Roadside Width Wr, ft
40	94
45	100
50	107
55	116
60	126
65	134
70	143

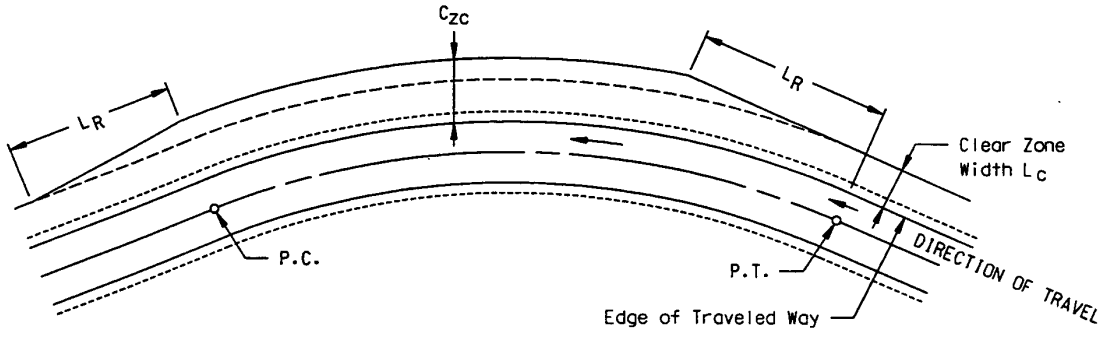
V = Design speed, mph

R = Radius of curvature, ft

Not all deg of curve values are tabulated. The recommended clear zone distance for deg of curve not shown in the tables is found by the equations developed by the FHWA or by interpolating between the clear zone distance tables. An example of clear zone adjustment for horizontal curvature is included in Section 4-6.04.04.

4. The additional clear zone width on the outside of the horizontal curve is introduced using a taper which starts at the approach curve terminus and continues for a length known as the "runout length", abbreviated L_R. The additional clear zone width is removed by using a taper which begins at the leaving curve terminus and extends the runout length, L_R (see Figure 4-6.04B). The runout length dimension, L_R is the theoretical distance needed for a vehicle that has run off the roadway to come to a stop. The placement shown in Figure 4-6.04B accommodates the anticipated path of the vehicle leaving the roadway on a curve. L_R varies with the speed of the vehicle. Mn/DOT has chosen to vary L_R by the design speed and the ADT, as shown in Figure 10-7.03B. Although Figure 10-7.03B is commonly used to determine roadside barrier layout, the L_R in this Figure is the same L_R used when placing the clear zone width on the outside of horizontal curves.

5. Adjustments in clear zones for traffic volumes below 6,000 ADT are also appropriate. The adjustments are made from a ratio of the guardrail runout lengths (L_R) from Figure 10-7.03B. At low traffic volumes, even though the percentage of vehicles leaving the highway may be about the same as for high volumes, the absolute number of run-off-the-road vehicles is so low that it is impractical to provide the same clear recovery area as for high-volume highways. Therefore, downward adjustments in clear zone distances are in order. A ratio of the guardrail runout lengths for the ADT in question and the ADT of 6000 multiplied by the clear zone distance from Figure 4-6.04A will give the appropriate downward adjustment.



INCREASED CLEAR ZONE ON HORIZONTAL CURVES
Figure 4-6.04B

6. Another adjustment to the clear zone that should be considered is when a curb greater than 4 in. high is located within the clear zone. These curbs can cause vaulting and instability of a vehicle. Appendix F of the AASHTO Guide For Selecting, Locating and Designing Traffic Barriers provides trajectory data for various curb configurations. The 6 in. Type C and 4 in. Type H curbs are the closest configurations to the standard curb types used by Mn/DOT. On the basis of the trajectory data, and with curb heights of 6 to 8 in., the following additions to the calculated clear zone should be made:

Speed, mph	Increase in width of clear zone, ft
45	10
50	11
55	13
60	15
70	16

4-6.04.03 Calculating Clear Zones on Tangents (using Table 4-6.04A)

Example 1 - Clear zone, weighted slope average

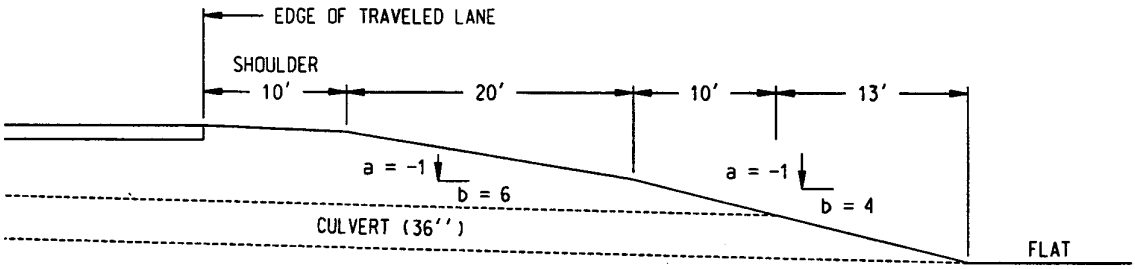


Figure 4-6.04C

Design ADT: 5000
Design speed: 60 mph

Recommended clear zone for 1:6 slope (fill): 32 ft (Table 4-6.04A).

The clear zone needed for 1:6 slope is 32 ft. The break point of the two slopes, however, is located at 30 ft. Therefore, the 1:4 slope must be taken into account in the clear zone computation. Since both slopes are traversable and recoverable, the weighted average of the two slopes can be used to determine the clear zone.

Average slope of clear zone beyond shoulder:

$$\text{(a/b) average} = \frac{20(-1/6) + 23(-1/4)}{20 + 23} = -0.21$$

Recommended clear zone for -0.21 slope (fill): 37 ft (Table 4-6.04A)

Since the top of the culvert (10+20+10 = 40 ft) is located beyond the weighted average clear zone (37 ft), no protection is needed.

Example 2 - clear zone, non-recoverable slope

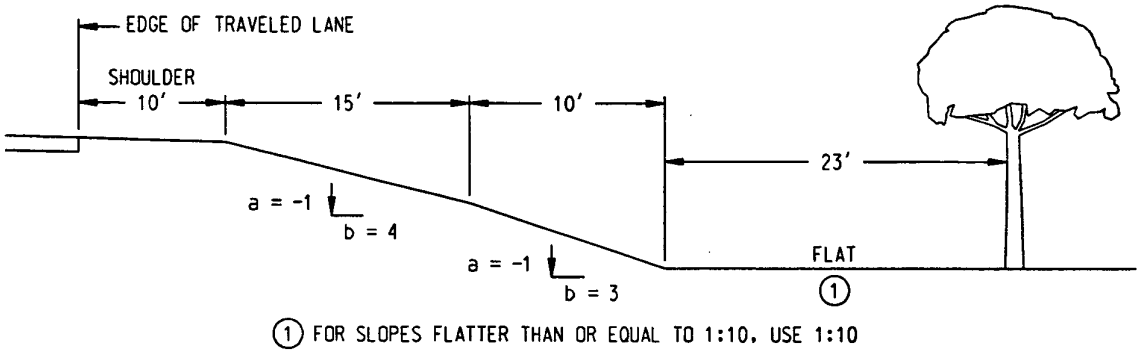


Figure 4-6.04D

Design ADT: 6100
Design Speed: 60 mph
From Table 4-6.04A (ADT =6100, speed = 60 mph and 1:4 slope), clear zone = 46 ft

Available clear zone (before the non-recoverable slope) is 10 + 15 = 25 ft. This is insufficient.

Since the 1:3 slope is traversable but not recoverable, a weighted average side slope can not be used. When a traversable, non-recoverable slope (the 1:3 area) is used in combination with a recoverable slope (the 1:4 area), it is necessary to provide a clear run-out area beyond the toe of the non-recoverable slope. In such cases, use the steepest recoverable side slope (whether it is before or after the non-recoverable slope) to determine the width of the clear zone. In this example, the steepest recoverable slope is 1:4, therefore the clear zone width needed is 46 ft.

The total recoverable width (10 + 15 + 23) is 48 ft which exceeds the clear zone requirements.

Example 3 - Clear Zone, Ditch Traversability

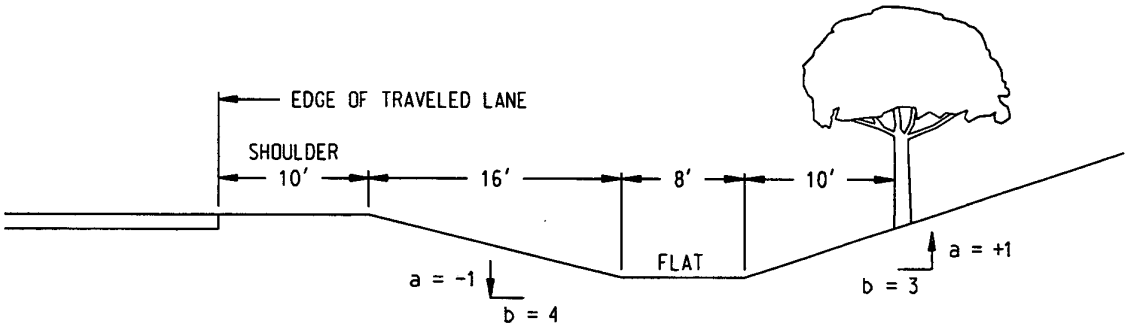


Figure 4-6.04E

Design ADT = 6500
Design Speed: 60 mph

First, determine if the clear zone lies within the 1:4 slope.
Recommended clear zone for 1:4 slope (fill) = 46 ft (Table or Figure 4-6.04A).
26 ft < 46 ft (20 ft short of required clear zone)

Next, determine if the clear zone lies within the ditch section. (Note that for the flat section we will use 1:10 slope.)
Average slope of clear zone beyond shoulder:

$$(a / b)\ average = \frac{16\left(\frac{-1}{4}\right) + 8\left(\frac{-1}{10}\right)}{16 + 8} = -0.20$$

Recommended clear zone for a –0.20 slope (fill) = 38 ft (Table or Figure 4-6.04A).
34 ft < 38 ft (4 ft short of required clear zone)

Discussion: The 1:4 slope in this example is traversable and recoverable. However, the slope does not provide the recommended clear zone distance from Table 4-6.04A (20 ft short). The weighted average slope of the 1:4 inslope and the runout area of the flat ditch bottom is also insufficient (4 ft short).

Recommended clear zone for a 1:3 slope (cut) = 21ft (Table 4-6.04A).
Calculating an adjusted clear zone by considering the backslope

(34/38) = 0.89 = 89% of clear zone available

100 – 89 = 11% of backslope clear zone needed

0.11 x 21 ft = 2 ft

34 ft + 2 ft = 36 ft clear zone required

44 ft available to the tree. The adjusted clear zone is adequate

Key To Clear Zone Distance Tables

- Curves flatter than 2° do not require an adjustment (use tangent values).
- For slopes flatter than 1:10, use 1:10.
- For slopes not listed in the tables (for example 1:3.5), and for degree of curve not shown (for example 2.5°), designers should interpolate clear zones distances.

Table 4-6.04A
CLEAR ZONE DISTANCES (ft)

Degree of curve TANGENT

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	11	11	11	11	11	11	11	12	13	14	16
	1500 - 6000	13	13	13	13	13	13	13	14	15	16	17
	> 6000	14	14	14	14	14	14	14	15	16	17	19
45 mph	< 1500	11	13	14	14	14	14	14	15	17	20	37
	1500 - 6000	13	14	15	15	15	15	15	17	19	22	41
	> 6000	14	16	17	17	17	17	17	19	21	25	45
50 mph	< 1500	13	14	15	16	16	16	16	18	19	23	42
	1500 - 6000	14	16	17	18	18	18	18	20	21	26	47
	> 6000	16	18	19	20	20	20	20	22	24	29	52
55 mph	< 1500	15	18	19	20	22	23	23	25	29	33	76
	1500 - 6000	17	20	21	22	24	25	25	28	31	36	84
	> 6000	19	22	24	25	27	28	28	31	34	40	93
60 mph	< 1500	17	21	23	24	25	26	26	29	31	38	87
	1500 - 6000	19	23	25	26	28	29	29	32	35	42	95
	> 6000	21	26	28	29	31	31	31	35	38	46	105
70 mph	< 1500	20	23	25	25	28	29	29	32	35	43	96
	1500 - 6000	22	25	27	28	30	31	31	35	39	47	106
	> 6000	24	28	30	31	33	34	34	38	42	51	116

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04B
CLEAR ZONE DISTANCES (ft)

Degree of curve 2°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	12	12	12	12	12	12	12	13	14	15	17
	1500 - 6000	13	13	13	13	13	13	13	15	16	17	18
	> 6000	15	15	15	15	15	15	15	16	17	18	20
45 mph	< 1500	12	14	15	15	15	15	15	17	19	22	40
	1500 - 6000	13	16	16	16	16	16	16	19	20	24	45
	> 6000	15	17	18	18	18	18	18	20	23	27	49
50 mph	< 1500	14	16	17	18	18	18	18	20	22	26	48
	1500 - 6000	16	18	19	20	20	20	20	22	24	29	53
	> 6000	18	20	21	22	22	22	22	24	27	32	59
55 mph	< 1500	18	21	23	24	26	26	26	29	33	38	88
	1500 - 6000	20	23	25	26	28	29	29	32	36	42	97
	> 6000	22	25	28	29	31	32	32	35	40	47	107
60 mph	< 1500	21	25	27	29	31	31	31	35	38	46	104
	1500 - 6000	23	28	30	31	33	34	34	39	42	50	115
	> 6000	25	31	33	34	37	38	38	43	46	56	127
70 mph	< 1500	25	29	31	32	35	36	36	40	44	54	122
	1500 - 6000	27	32	34	35	38	40	40	44	49	59	134
	> 6000	30	35	37	38	42	44	44	48	53	65	147

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04C
CLEAR ZONE DISTANCES (ft)

Degree of curve 3°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	12	12	12	12	12	12	12	14	15	15	17
	1500 - 6000	14	14	14	14	14	14	14	15	16	17	19
	> 6000	15	15	15	15	15	15	15	16	17	18	20
45 mph	< 1500	13	14	16	16	16	16	16	17	19	23	42
	1500 - 6000	14	16	17	17	17	17	17	19	21	25	46
	> 6000	16	18	19	19	19	19	19	21	23	28	51
50 mph	< 1500	15	17	18	19	19	19	19	21	23	28	50
	1500 - 6000	17	19	20	21	21	21	21	23	25	31	56
	> 6000	19	21	22	23	23	23	23	26	28	34	62
55 mph	< 1500	19	22	24	25	27	28	28	31	35	41	94
	1500 - 6000	21	25	26	28	30	31	31	34	39	45	104
	> 6000	23	27	29	30	33	34	34	38	43	50	115
60 mph	< 1500	22	28	30	31	33	34	34	38	41	50	114
	1500 - 6000	25	30	33	34	36	37	37	42	46	55	125
	> 6000	27	33	36	37	40	41	41	46	50	61	138
70 mph	< 1500	28	32	34	35	39	40	40	44	49	59	134
	1500 - 6000	30	35	37	39	42	44	44	49	54	65	148
	> 6000	33	38	41	42	46	48	48	53	59	71	162

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04D
CLEAR ZONE DISTANCES (ft)

Degree of curve 4°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	13	13	13	13	13	13	13	14	15	16	18
	1500 - 6000	14	14	14	14	14	14	14	15	17	18	20
	> 6000	15	15	15	15	15	15	15	17	18	19	21
45 mph	< 1500	13	15	16	16	16	16	16	18	20	24	44
	1500 - 6000	15	17	18	18	18	18	18	20	22	26	48
	> 6000	16	19	20	20	20	20	20	22	24	29	53
50 mph	< 1500	16	18	19	20	20	20	20	22	24	29	53
	1500 - 6000	18	20	21	22	22	22	22	25	27	32	59
	> 6000	20	22	23	25	25	25	25	27	30	35	65
55 mph	< 1500	20	23	26	27	29	30	30	33	38	44	100
	1500 - 6000	23	26	28	30	31	33	33	36	41	48	110
	> 6000	25	29	31	32	35	36	36	40	46	53	122
60 mph	< 1500	24	30	32	33	36	36	36	41	44	53	122
	1500 - 6000	26	33	35	36	39	40	40	45	49	59	135
	> 6000	29	36	39	40	43	44	44	50	54	65	148
70 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04E
CLEAR ZONE DISTANCES (ft)

Degree of curve 5°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	13	13	13	13	13	13	13	14	15	16	18
	1500 - 6000	15	15	15	15	15	15	15	16	17	18	20
	> 6000	16	16	16	16	16	16	16	17	18	19	22
45 mph	< 1500	13	16	17	17	17	17	17	19	21	24	45
	1500 - 6000	15	18	18	18	18	18	18	21	23	27	50
	> 6000	17	19	20	20	20	20	20	23	25	30	55
50 mph	< 1500	17	19	20	21	21	21	21	23	25	31	55
	1500 - 6000	19	21	22	23	23	23	23	26	28	34	62
	> 6000	21	23	24	26	26	26	26	28	31	37	68
55 mph	< 1500	22	25	27	29	31	31	31	35	40	46	106
	1500 - 6000	24	28	30	31	33	35	35	38	44	51	117
	> 6000	26	30	33	34	37	38	38	43	48	56	129
60 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
70 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04F
CLEAR ZONE DISTANCES (ft)

Degree of curve 6°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	13	13	13	13	13	13	13	15	16	17	19
	1500 - 6000	15	15	15	15	15	15	15	16	17	19	21
	> 6000	16	16	16	16	16	16	16	17	19	20	22
45 mph	< 1500	14	16	17	17	17	17	17	19	22	26	47
	1500 - 6000	16	18	19	19	19	19	19	22	24	28	52
	> 6000	17	20	21	21	21	21	21	24	26	31	57
50 mph	< 1500	17	20	21	22	22	22	22	24	27	32	58
	1500 - 6000	20	22	23	24	24	24	24	27	29	35	65
	> 6000	22	24	26	27	27	27	27	30	32	39	71
55 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
60 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
70 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04G
CLEAR ZONE DISTANCES (ft)

Degree of curve 7°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	14	14	14	14	14	14	14	15	16	17	19
	1500 - 6000	15	15	15	15	15	15	15	17	18	19	21
	> 6000	17	17	17	17	17	17	17	18	19	20	23
45 mph	< 1500	14	17	18	18	18	18	18	20	22	26	48
	1500 - 6000	16	19	20	20	20	20	20	22	24	29	53
	> 6000	18	21	22	22	22	22	22	24	27	32	59
50 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
55 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
60 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
70 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04H
CLEAR ZONE DISTANCES (ft)

Degree of curve 8°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	14	14	14	14	14	14	14	15	17	17	20
	1500 - 6000	16	16	16	16	16	16	16	17	18	20	22
	> 6000	17	17	17	17	17	17	17	18	20	21	23
45 mph	< 1500	15	17	18	18	18	18	18	21	23	27	50
	1500 - 6000	17	19	20	20	20	20	20	23	25	30	55
	> 6000	18	21	23	23	23	23	23	25	28	33	61
50 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
55 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
60 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
70 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04I
CLEAR ZONE DISTANCES (ft)

Degree of curve 9°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	14	14	14	14	14	14	14	16	17	18	20
	1500 - 6000	16	16	16	16	16	16	16	17	19	20	22
	> 6000	17	17	17	17	17	17	17	19	20	21	24
45 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
50 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
55 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
60 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
70 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04J
CLEAR ZONE DISTANCES (ft)

Degree of curve 10°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	15	15	15	15	15	15	15	16	17	18	20
	1500 - 6000	17	17	17	17	17	17	17	18	19	20	23
	> 6000	18	18	18	18	18	18	18	19	20	22	24
45 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
50 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
55 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
60 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
70 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											

*These slopes are considered to be traversable but non-recoverable and require special considerations.

Table 4-6.04K
CLEAR ZONE DISTANCES (ft)

Degree of curve 11°

DESIGN SPEED	ADT	CUT SECTION					FLAT	FILL SECTION				
		1:3	1:4	1:5	1:6	1:10		1:10	1:6	1:5	1:4	1:3*
40 mph	< 1500	15	15	15	15	15	15	15	17	18	19	21
	1500 - 6000	17	17	17	17	17	17	17	18	20	21	23
	> 6000	18	18	18	18	18	18	18	20	21	22	25
45 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
50 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
55 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
60 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											
70 mph	< 1500											
	1500 - 6000			Exceeds Maximum Allowable Curvature								
	> 6000											

*These slopes are considered to be traversable but non-recoverable and require special considerations.

4-6.04.04 Calculating clear zone distances on horizontal curves (using Tables 4-6.04B through K)

Example

Determine the appropriate clear zone for a given deg of curve, ADT, design speed and sideslope:

Degree of curve = 2° L_o = Increase in lateral encroachment (see page 4-6(10))

ADT = 1000

V = Design Speed = 50 mph L_c, C_{ZC}, K_{CZ} (see page 4-6(10))

Inslope = 1:10

Using the equation method:

$$L_o = \sqrt{\left(\frac{5729.6}{D^o}\right)^2 + \left(\frac{(0.9V + 15)^2}{13}\right)^2} - \frac{5729.6}{D^o}$$

$$= \sqrt{\left(\frac{5729.6}{2}\right)^2 + \left(\frac{(0.9 \times 50 + 15)^2}{13}\right)^2} - \frac{5729.6}{2}$$

$$= \sqrt{8,207,079.04 + 76,686.39} - 2864.80$$

L_o = 13.35 ft

K_{CZ} = $\frac{L_O + W_r}{W_r}$, W_r = 107 ft (finite limit of roadside, Section 4-6.04.02)

= $\frac{13.35 + 107}{107}$ = 1.125

From Figure 4-6.04A, with 50 mph, 6000 ADT and slope 1:10

L_C = 20 ft

C_{ZC} = 1.125 x 20 = 22.5 ft

But the figure is only for ADT > 6000, therefore we have to correct the clear zone for ADT of 1000 by multiplying this last value by the ratio of the appropriate runout lengths from Figure 10-7.03B.

(L_{R1000} = 260 and L_{R6000} = 320 for 50 mph)

$$C_{ZC} = 22.5 \times \frac{260}{320}$$

= 18.28 ft, use 18 ft

The same answer can be arrived at by using Table 4-6.04B (instead of Figure 4-6.04A). Interpolating between the appropriate tables may be necessary for other calculations.

4-6.05 Horizontal Clearance to Obstruction

Horizontal clearance to obstructions is the lateral distance from the edge of the traveled way to any unyielding object along the roadside. The concept of horizontal clearance to obstructions is often used interchangeably with the roadside clear zone concept; however, these terms do not represent the same thing. A clear zone is the distance from the edge of the travel way, including shoulders, that a recoverable slope and/or clear zone runout area should be free of any non-traversable hazards. Section 10-7.01.05 of this manual and AASHTO's "A Policy on Geometric Design of Highways and Streets" contain clear zone recommendations for various functional classes and cross section designs.

As Section 4-6.04 of this manual discusses, the AASHTO "Roadside Design Guide" advocates the clear roadside concept as the guiding principle in the design of arterial roadways. In order to create reasonable and judicious solutions, however, the clear roadside criteria may have to be compromised in some cases. This is especially true in urban and suburban settings where curbside parking and common unyielding items are prevalent.

To establish a standard for minimum horizontal clearance to obstructions, the FHWA has stated, "Criteria from the AASHTO "Roadside Design Guide" should be treated as guidance for setting individual project or statewide criteria or policies, not as a national standard requiring a design exception if not met" (Federal Aid Policy Guide NS 23 CFR 625, Non-regulatory Supplement dated 6/17/98). Based on this statement, Mn/DOT and the FHWA have collaboratively adopted the policies that follow.

If a recommended clear zone from Section 4-6.04 is impractical, use the minimum horizontal clearance to obstructions widths as follows. However, designers should strive to exceed these minimums wherever practicable. Formal design exceptions will not be required when prescribed clear zone widths are not provided.

1. For new construction/reconstruction projects on rural highways, urban freeways, and urban expressways, the minimum horizontal clearance to obstructions is the edge of the travel lane to the edge of the shoulder. Measure this distance at the prevailing shoulder width on that section of highway. Narrowing shoulders to accommodate obstructions (e.g., existing bridge piers that will remain in place) will necessitate a design exception.
2. For new construction/reconstruction projects on urban arterials, collectors and local streets with curbs, the minimum horizontal clearance is a distance of 0.5 m (**1.5 ft**) from the face of the curb. This distance represents an operational offset that permits curbside parking, but does not adversely affect traffic flow. It does not apply to an approved traffic barrier where one is deployed; barriers should be installed at an offset consistent with standard practice, with parking prohibited accordingly.
3. For preservation projects on urban sections, the minimum horizontal clearance to obstructions in the existing condition or the minimum for new construction/reconstruction, whichever is less.