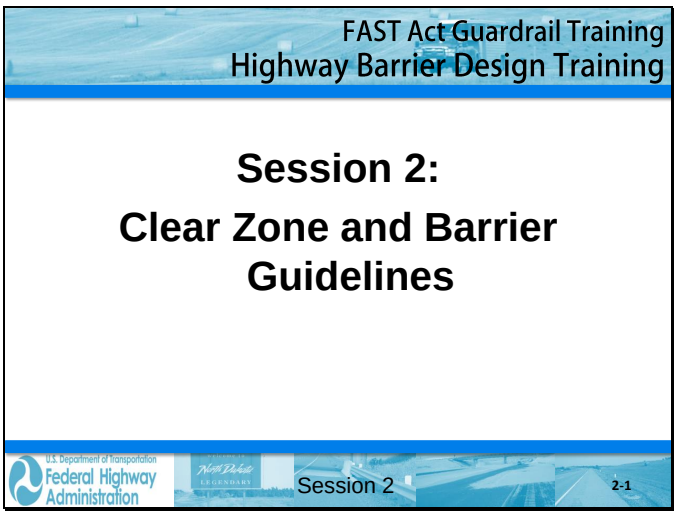
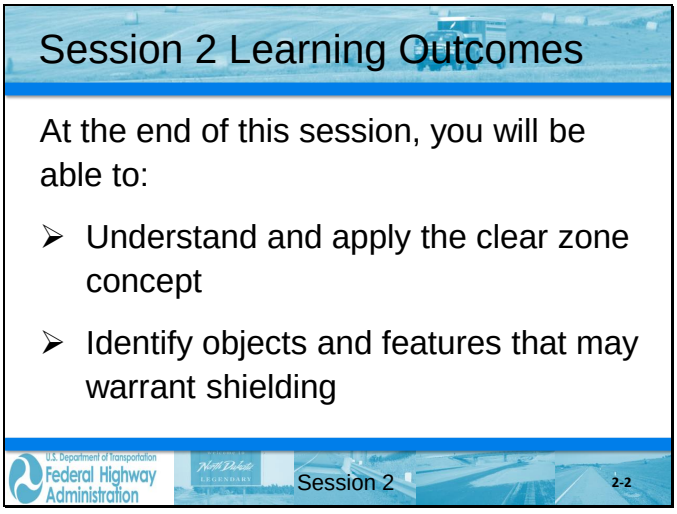
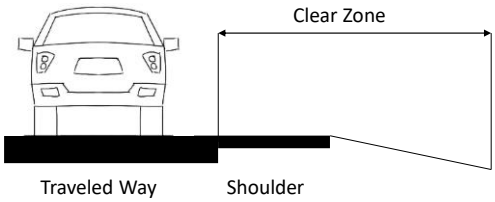
Session 2: Clear Zone and Barrier Guidelines


FAST Act Guardrail Training
Highway Barrier Design Training
Session 2:
Clear Zone and Barrier Guidelines
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-1


Session 2 Learning Outcomes
At the end of this session, you will be able to:
Understand and apply the clear zone concept
Identify objects and features that may warrant shielding
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-2

Clear Zone: A Definition



The unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of errant vehicles. The clear zone includes shoulders, bike lanes, and auxiliary lanes, except those auxiliary lanes that function like through lanes.

Ref: AASHTO ROADSIDE DESIGN GUIDE, 4th EDITION, Glossary

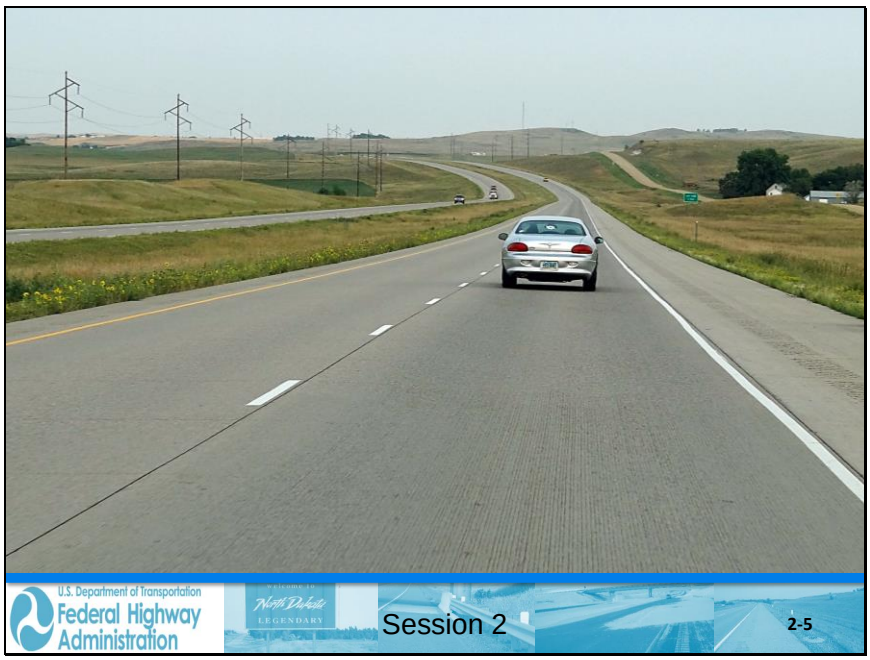
U.S. Department of Transportation Federal Highway Administration | Session 2 | 2-3

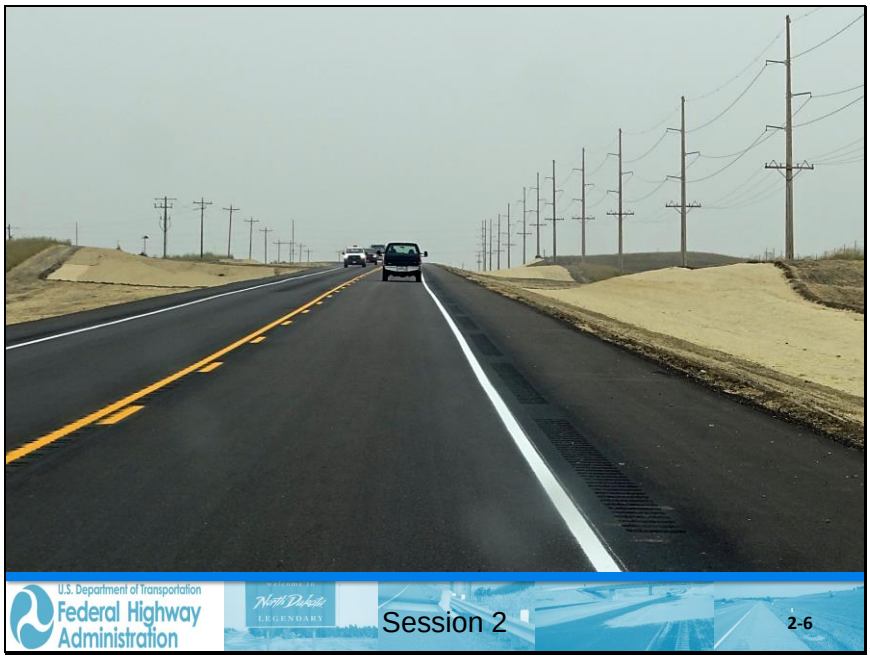
Important Distinction

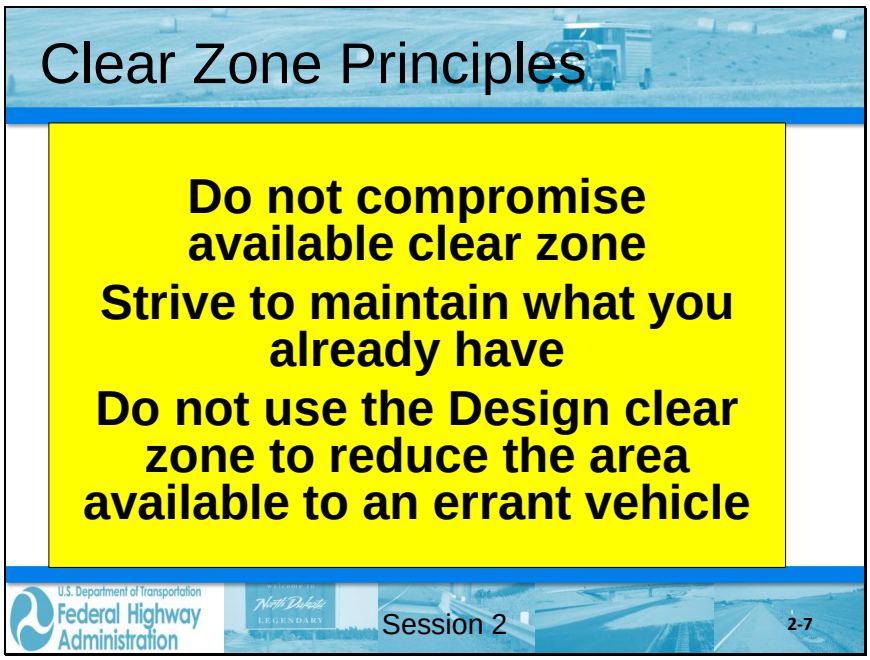
Available Clear Zone = Area Existing for recovery

Design Clear Zone = A selected value used for design to provide recovery area for the majority of errant drivers

U.S. Department of Transportation Federal Highway Administration | Session 2 | 2-4


U.S. Department of Transportation
Federal Highway Administration
Session 2
2-5


U.S. Department of Transportation
Federal Highway Administration
Session 2
2-6


Clear Zone Principles
Do not compromise available clear zone
Strive to maintain what you already have
Do not use the Design clear zone to reduce the area available to an errant vehicle
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-7

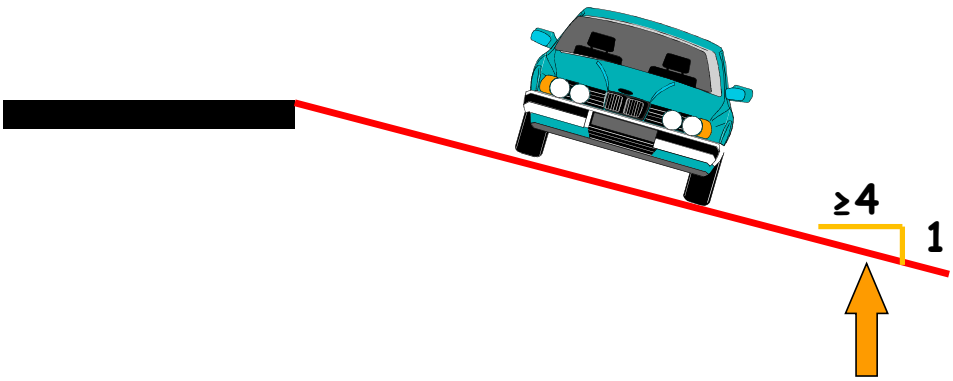

Do Not Compromise Clear Zone
Added trees in available clear zone
Vehicle encroachment
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-8

Clear Zone Factors

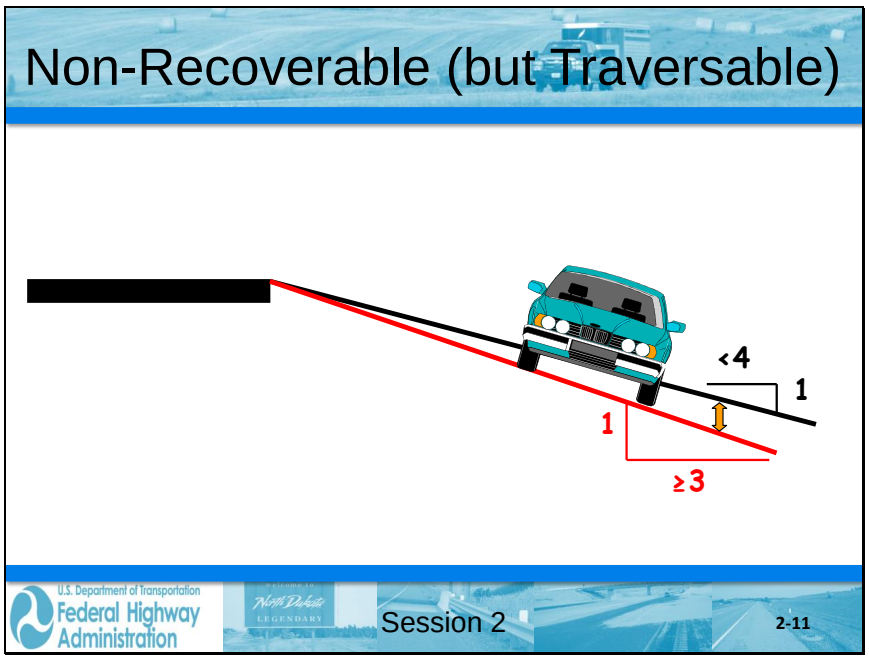
- Slope Type and Steepness
- Design Speed
- Traffic Volume
- Horizontal Curvature

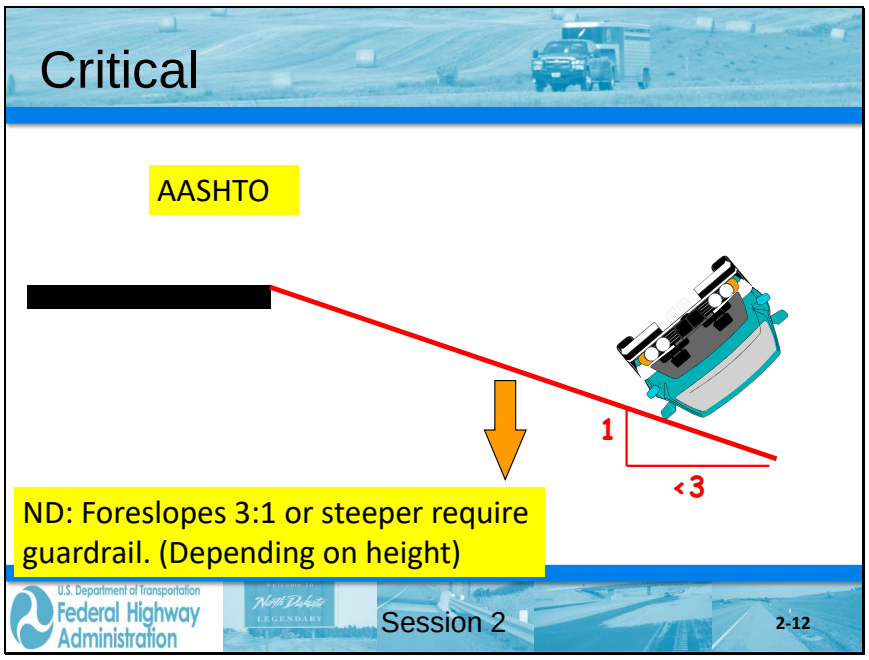
U.S. Department of Transportation Federal Highway Administration | Session 2 | 2-9

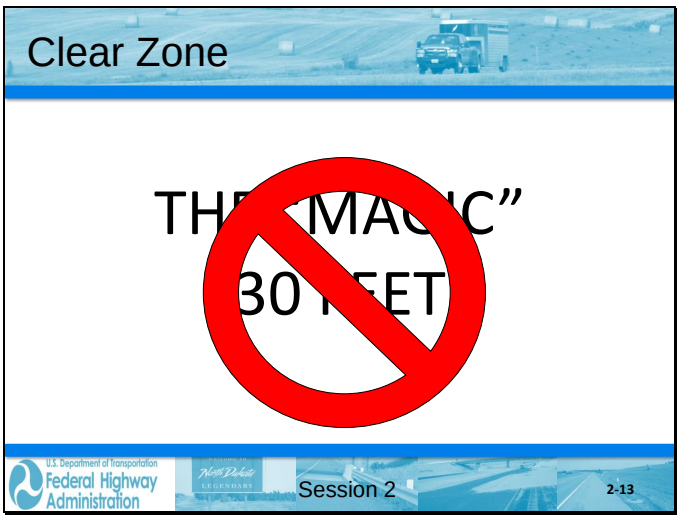
SLOPES – Recoverable

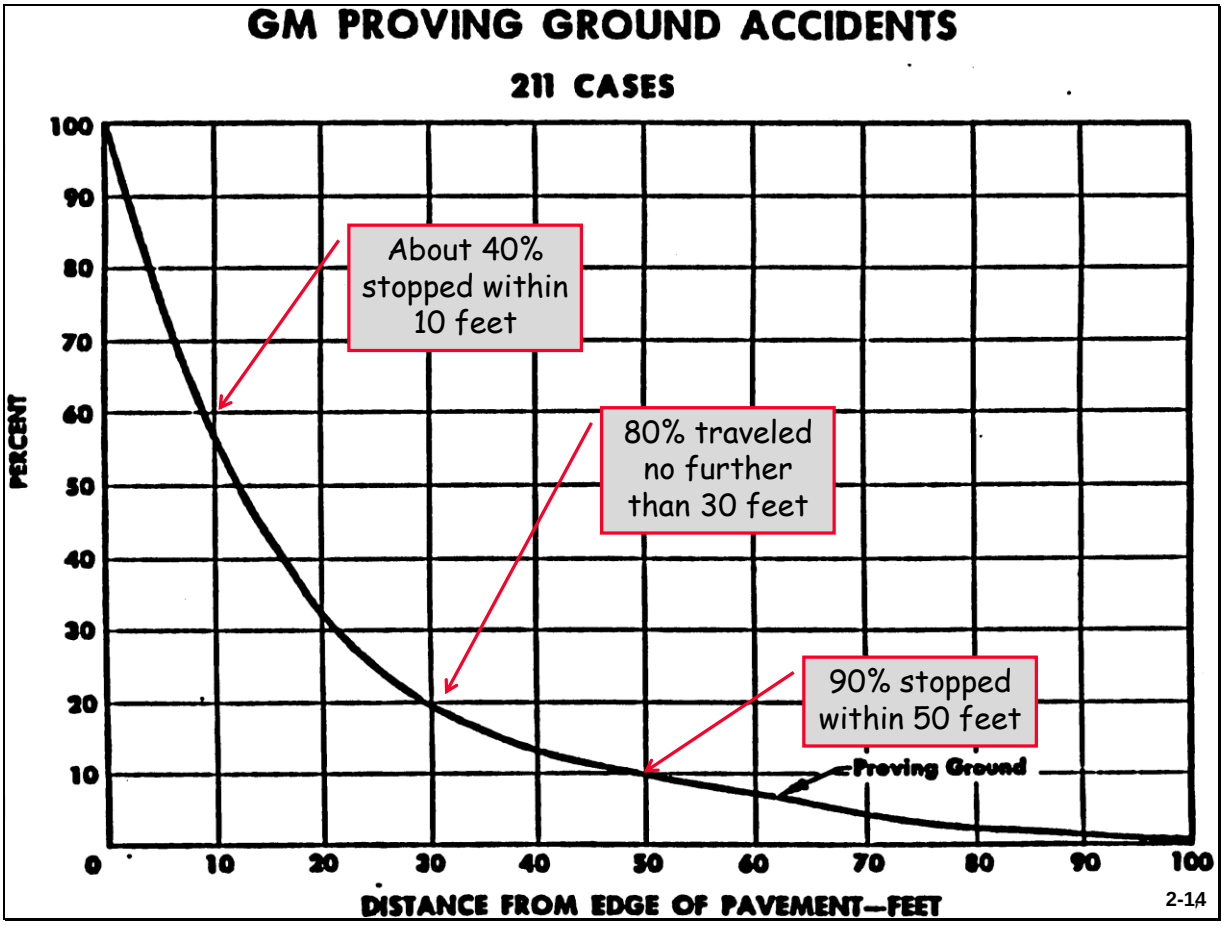


U.S. Department of Transportation Federal Highway Administration | Session 2 | 2-10


Non-Recoverable (but Traversable)
<4
1
1
≥3
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-11


Critical
AASHTO
1
<3
ND: Foreslopes 3:1 or steeper require guardrail. (Depending on height)
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-12


Clear Zone
THE "MAGIC"
30 FEET
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-13


GM PROVING GROUND ACCIDENTS
211 CASES
PERCENT
100
90
80
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80
90
100
About 40% stopped within 10 feet
80% traveled no further than 30 feet
90% stopped within 50 feet
Proving Ground
DISTANCE FROM EDGE OF PAVEMENT—FEET
2-14

Design Clear Zone Determination

Design Speed (mph)	Design ADT	Foreslopes			Backslopes		
		1V:6H or flatter	1V:5H to 1V:4H	1V:3H	1V:3H	1V:5H to 1V:4H	1V:6H or flatter
≤40	UNDER 750[c]	7-10	7-10	b	7-10	7-10	7-10
	750-1500	10-12	12-14	b	10-12	10-12	10-12
	1500-6000	12-14	14-16	b	12-14	12-14	12-14
	OVER 6000	14-16	16-18	b	14-16	14-16	14-16
45-50	UNDER 750[c]	10-12	12-14	b	8-10	8-10	10-12
55	UNDER 750[c]	12-14	14-18	b	8-10	10-12	10-12
	750-1500	16-18	20-24	b	10-12	14-16	16-18
	1500-6000	20-22	24-30	b	14-16	16-18	20-22
	OVER 6000	22-24	26-32[a]	b	16-18	20-22	22-24
60	UNDER 750[c]	16-18	20-24	b	10-12	12-14	14-16
	750-1500	20-24	26-32[a]	b	12-14	16-18	20-22
	1500-6000	26-30	32-40[a]	b	14-18	18-22	24-26
	OVER 6000	30-32[a]	36-44[a]	b	20-22	24-26	26-28
65-70[d]	UNDER 750[c]	18-20	20-26	b	10-12	14-16	14-16
	750-1500	24-26	28-36[a]	b	12-16	18-20	20-22
	1500-6000	28-32[a]	34-42[a]	b	16-20	22-24	26-28
	OVER 6000	30-34[a]	38-46[a]	b	22-24	26-30	28-30

b. 10’ minimum recoverable width at toe of slope

Ref: AASHTO ROADSIDE DESIGN GUIDE, 4th EDITION – TABLE 3.1, Pg. 3-3

NDDOT Design Clear Zone Determination

Design Speed (mph)	Design ADT***	Foreslopes					Backslopes				
		FLAT	1V:6H	1V:5H	1V:4H	1V:3H	1V:3H	1V:4H	1V:5H	1V:6H	FLAT
≤40	UNDER 750	7-10	7-10	7-10	7-10	**	7-10	7-10	7-10	7-10	7-10
	750-1500	10	12	12	14	**	12-14	12-14	12-14	12-14	12-14
	1500-6000	12	14	14	16	**	14-16	14-16	14-16	14-16	14-16
	OVER 6000	14	16	16	18	**	16-18	16-18	16-18	16-18	16-18
45-50	UNDER 750	10	12	12	14	**	8-10	8	10	10	12
	750-1500	14	16	16	20	**	10-12	12	14	14	15
	1500-6000	16	18	20	26	**	12-14	14	16	16	18
	OVER 6000	20	22	24	28	**	14-16	18	20	20	22
55	UNDER 750	12	14	14	18	**	8-10	10-12	10-12	10-12	10-12
	750-1500	16	18	20	24	**	10-12	14	16	16	18
	1500-6000	20	22	24	30	**	14-16	16	18	20	22
	OVER 6000	22	24	26	32*	**	16-18	20	22	22	24
60	UNDER 750	16	18	20	24	**	10-12	12	14	14	16
	750-1500	20	24	26	32*	**	12-14	16	18	20	22
	1500-6000	26	30	32*	40*	**	14-18	18	22	24	26
	OVER 6000	30	32*	36*	44*	**	20-22	24	26	26	28
65-75	UNDER 750	18	20	20	26	**	10-12	14-16	14-16	14-16	14-16
	750-1500	24	26	28	36*	**	12-16	18	20	20	22
	1500-6000	28	32*	34*	42*	**	16-20	22	24	26	28
	OVER 6000	30	34*	38*	46*	**	22-24	26	30	28	30

Ref: NDDOT DESIGN MANUAL, Appendix III-14-B, Revised Jan 26, 2016

Design Clear Zone Determination

North Dakota Design Manual, Chapter III-14.03, Clear Zone.

- Minor Rehabilitation clear zone = Use existing
- Structural Improvement clear zone = 20' NDDOT clear zone*
- Major Rehabilitation (ADT < 2000) clear zone = 20' NDDOT clear zone*
- Major Rehabilitation (ADT > 2000) clear zone = AASHTO clear zone, see Chapter 3 Section 14 Appendix B of the Design Manual (Section III-14B)

**If circumstances result in the AASHTO clear zone value less than the NDDOT 20' clear zone such as in urban/low speed areas, the AASHTO clear zone value may be used instead.*

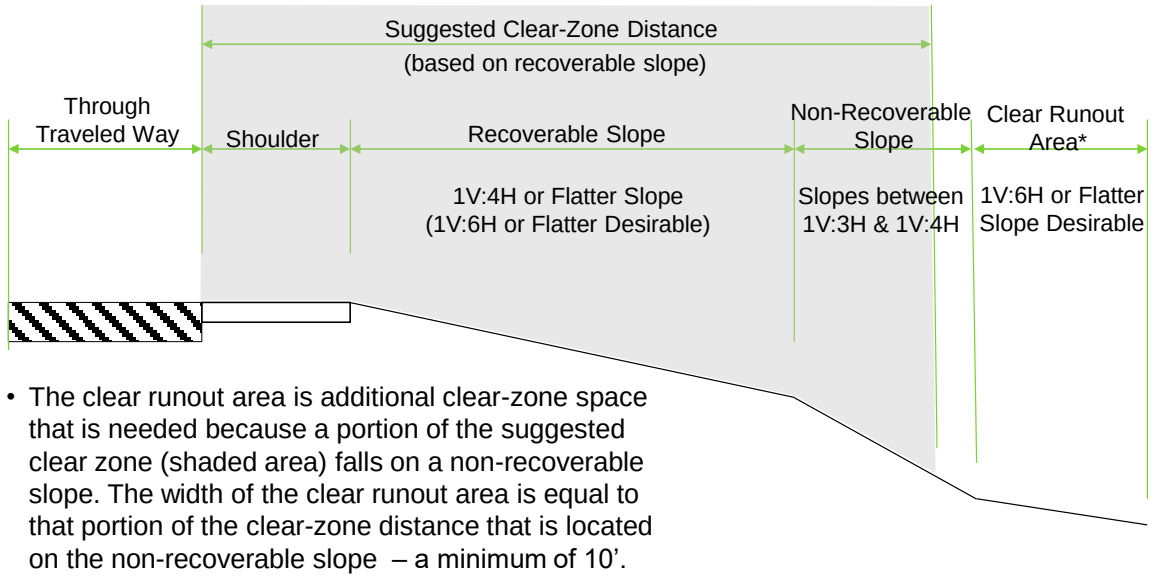
Ref: NDDOT DESIGN MANUAL, Appendix III-14-B, Revised Jan 26, 2016

U.S. Department of Transportation Federal Highway Administration

Session 2

2-17

Clear Zone Adjustments for Non-uniform Slopes



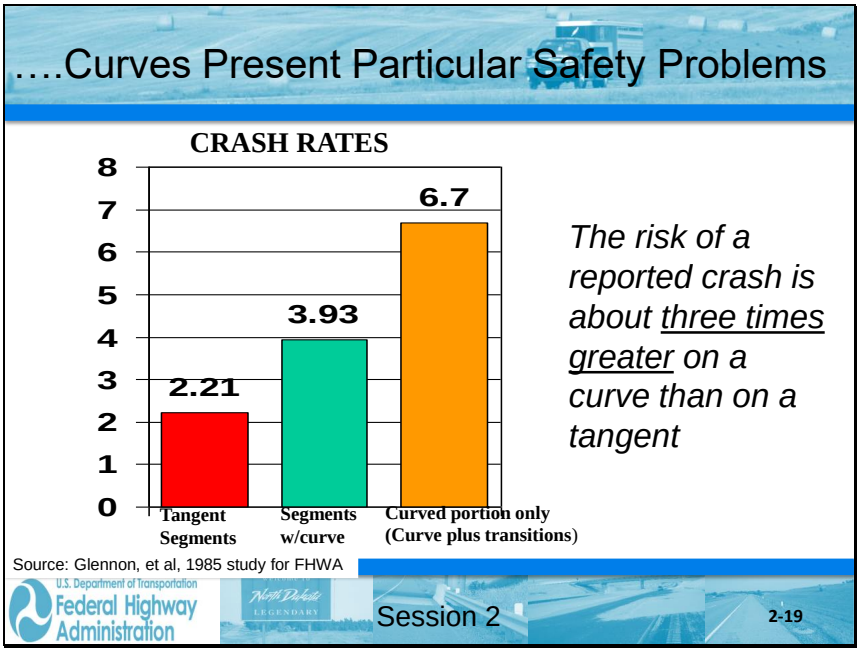
- The clear runout area is additional clear-zone space that is needed because a portion of the suggested clear zone (shaded area) falls on a non-recoverable slope. The width of the clear runout area is equal to that portion of the clear-zone distance that is located on the non-recoverable slope – a minimum of 10'.

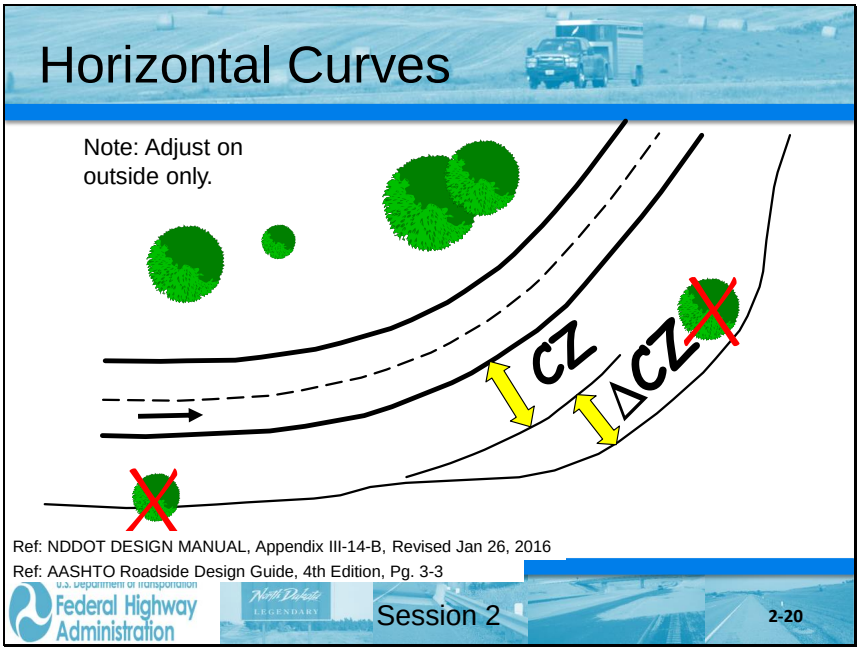
Ref: AASHTO ROADSIDE DESIGN GUIDE, 4th EDITION – FIGURE 3.2, Pg. 3-6

U.S. Department of Transportation Federal Highway Administration

Session 2

2-18


….Curves Present Particular Safety Problems
CRASH RATES
8
7
6
5
4
3
2
1
0
2.21
3.93
6.7
Tangent Segments
Segments w/curve
Curved portion only (Curve plus transitions)
The risk of a reported crash is about three times greater on a curve than on a tangent
Source: Glennon, et al, 1985 study for FHWA
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-19


Horizontal Curves
Note: Adjust on outside only.
CZ
ΔCZ
Ref: NDDOT DESIGN MANUAL, Appendix III-14-B, Revised Jan 26, 2016
Ref: AASHTO Roadside Design Guide, 4th Edition, Pg. 3-3
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-20

Horizontal Curve Adjustments

K_{CZ} (Curve Correction Factor)(U.S. Customary Units)

Radius (ft)	Design Speed (mph)					
	40	45	50	55	65	70
2,950	1.1	1.1	1.1	1.2	1.2	1.2
2,300	1.1	1.1	1.2	1.2	1.2	1.3
1,970	1.1	1.2	1.2	1.2	1.3	1.4
1,640	1.1	1.2	1.2	1.3	1.3	1.4
1,475	1.2	1.2	1.3	1.3	1.4	1.5
1,315	1.2	1.2	1.3	1.3	1.4	-
1,150	1.2	1.2	1.3	1.4	1.5	-
985	1.2	1.3	1.4	1.5	1.5	-
820	1.3	1.3	1.4	1.5	-	-
660	1.3	1.4	1.5	-	-	-
495	1.4	1.5	-	-	-	-
330	1.5	-	-	-	-	-

Ref: NDDOT DESIGN MANUAL, Appendix III-14-B, Revised Jan 26, 2016

Ref: AASHTO Roadside Design Guide, 4th Edition, Table 3-2.Pg. 3-4

Clear Zone and Curbs

Curbs do not have a significant redirectional capability. Obstructions behind the curb should ideally be located at or beyond the minimum recommended clear zone distance.

Clear Zone and Curbs

The minimum lateral offset of 1.5 ft should be provided beyond the face of curbs to any vertical objects.
This is called the Lateral Offset and ***should not be construed as an acceptable clear zone distance*.**

Ref: AASHTO Roadside Design Guide, Section 10.2.1.1 Curbs

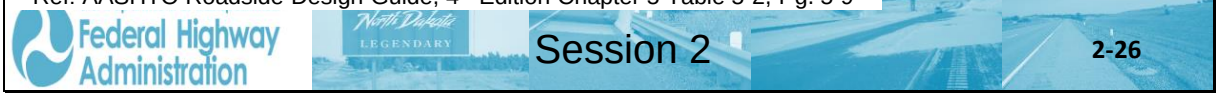
U.S. Department of Transportation Federal Highway Administration
Session 2
2-24

U.S. Department of Transportation Federal Highway Administration
Session 2
2-25

AASHTO Barrier Guidelines

Obstacle	Guidelines
Bridge piers, abutments, and railing ends	Shielding generally required
Boulders	Judgment decision based on nature of fixed object can likelihood of impact
Culverts, pipes, headwalls	Judgment decision based in size, shape and location of obstacle
Foreslopes and backslopes (smooth)	Shielding not generally required
Foreslopes and backslopes (rough)	Judgment decision based on likelihood of impact
Ditches (parallel)	Refer to Figures 3-6 and 3-7
Ditches (transverse)	Shielding generally required if likelihood of head-on impact is high
Embankment	Judgment decision based on fill height and slope (see Figure 5-1)
Retaining Walls	Judgment decision based on relative smoothness of wall and anticipated maximum angle of impact
Sign/Luminaire supports	Shielding generally required for non-breakaway supports
Traffic signal supports	Isolated traffic signals within clear zone on high-speed rural facilities may warrant shielding
Trees	Judgment decision based on site-specific circumstances
Utility poles	Shielding may be needed on a case by case basis.
Permanent bodies of water	Judgment decision based on location and depth of water and likelihood of encroachment.

Ref: AASHTO Roadside Design Guide, 4th Edition Chapter 5 Table 5-2, Pg. 5-9

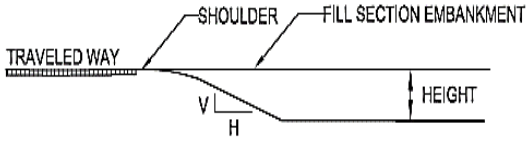


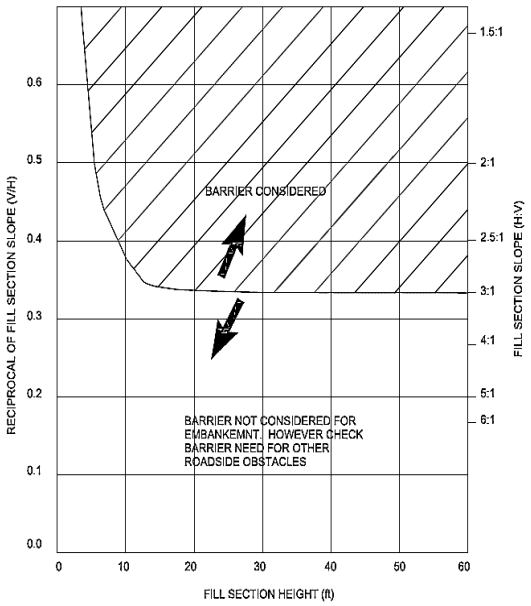
NDDOT Barrier Guidelines

Obstacle	Guidelines
Fill Slopes	Slopes 3:1 or steeper. Judgment decision based on fill height and slope (shielding / slope flattening based on cost effective.)*
Trees	Maximum allowable diameter 4 inches. Remove if in design clear zone.*
Mailboxes	If located in design clear zone, relocate or utilize approved supports.
Culvert Ends	Provide traversable end treatments. or extend beyond clear zone*
Sign Posts	Locate behind existing or planned barrier or use terrain features to reduce potential of impact; breakaway features *
Sign bridges and cantilever sign supports	Shielding generally required for non-breakaway supports in clear zone.*
Traffic signals	Relocate/ consider crash cushion.*
Utility poles	Relocate/ consider crash cushion.*
Light standards	Normally breakaway.*
Fixed Objects extending 4 inches above ground.	Shielding generally required if removal or relocation not feasible.* (E.g. boulders, bridge rails, cabinets, piers, retaining walls etc.)
Water	Depth of 2 feet or more for year or longer in clear zone.*

*Use traffic barriers when other measures cannot be accomplished and conditions are appropriate based on an engineering analysis. Ref. NDDOT Design Manual Section III

Embankment Guidelines





Ref: AASHTO Roadside Design Guide, 4th Edition – Figure 5.1b, Pg. 5-6

Design Options in Order of Preference

1. Remove the obstruction
2. Make the obstruction traversable
3. Relocate obstruction beyond the clear zone
4. Reduce impact severity by using an appropriate breakaway system
5. SHIELD the obstruction with a longitudinal barrier or crash cushion (only if obstruction cannot be removed, relocated, or redesigned)
6. Delineate obstruction (only if all above options are not appropriate.)

Ref: NDDOT DESIGN MANUAL Section III 14.05

Is barrier required at the locations shown in the following photographs?

If required, is it likely to be effective?


PRE-ASSESSMENT PHOTO
3:1 FILL SLOPE
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-31


PRE-ASSESSMENT PHOTO
WEST EAST
52 2
52
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-32

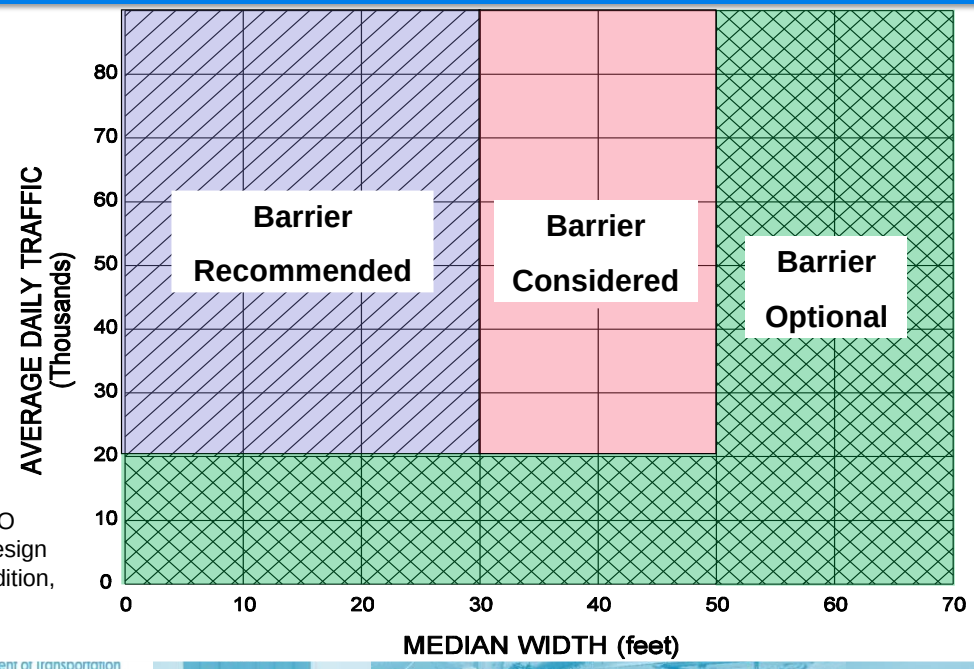

PRE-ASSESSMENT PHOTO
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-33


94 TO 6
Main St
½ MILE
EXIT
ONLY
94 WEST
PRE-ASSESSMENT PHOTO
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-34


U.S. Department of Transportation
Federal Highway Administration
Session 2
2-35

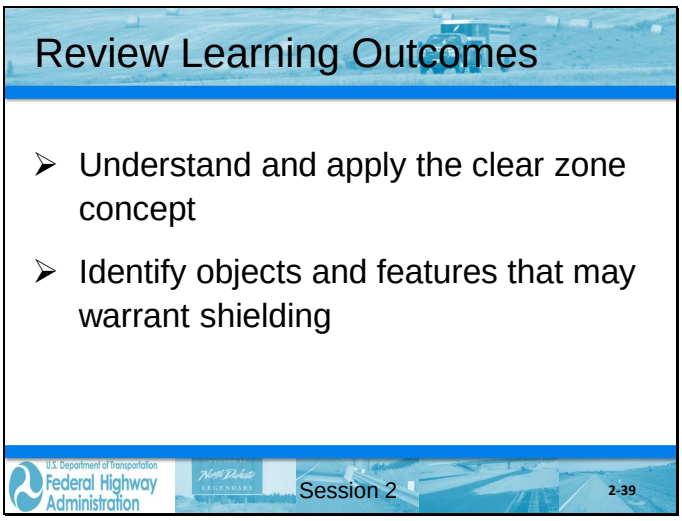

PRE-ASSESSMENT PHOTO
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-36

Median Width Guidelines



Ref: AASHTO Roadside Design Guide, 4th Edition, Figure 6-1

Last (or First) Option


Review Learning Outcomes
Understand and apply the clear zone concept
Identify objects and features that may warrant shielding
U.S. Department of Transportation
Federal Highway Administration
Session 2
2-39