

**Trail-Highway Crossing Guidance for Rural 2-Lane Highway Facilities ^{1,2}
Grade Separation Alternatives ^{3,4}**

Hourly Exposure Factor (In Thousands)	Trail Use	Does Not Meet WisDOT Warrants ⁶	May be Justified ⁶	Meets WisDOT Warrants ⁶
4th Highest Exposure Factor ⁵	Non-Motorized	<25	25-35	>35
	Motorized	<35	35-50	>50
Highest Exposure Factor ⁵	Non-Motorized	<40	40-60	>60
	Motorized	<55	55-80	>80

Notes:

1. For non-freeway, non-expressway divided highways with medians; each direction of traffic shall be considered separately. Exposure factors for divided highways to be 120% of the requirements listed above.
2. This table is applicable to rural highways with posed speed limits ranging from 40 to 55 mph.
3. Use existing box culvert, waterway structure, or roadway grade separation for trail, whenever practical.
4. Structure warrants: Minimum ADT on highway should be 3500 or greater.
5. Exposure factor is the product in thousands of the highway volume times the trail volume for the same hourly time period.
 - 4th Highest Exposure factor is the 4th Highest such product for a given counting period.
 - Highest Exposure Factor is the highest such product for a given counting period.
6. Trail Counts:
 - For Resurfacing, Reconditioning, or Spot Improvements to Include New or Existing Trail Crossings: Use existing highway and trail counts. For new trails, estimate trail counts based on similar trails in the local area.
 - For Reconstruct or New Alignments: Use projected highway and trail counts for the design year. Estimate a 1 – 2% per year-projected growth for the trail over the design year period.

GRADE SEPARATION WARRANT WORKSHEET

(Use link for a working copy of this worksheet: [FDM 11-46-20 A2 xls1](#))

Project ID		Road Description *		Date of count																								
Road Name		Lane width (ft)		Day of week																								
County		Shoulder width (ft)		Begin time																								
Project type		Median width (ft)		End time																								
Trail Name		Posted speed (mph)		weather cond.																								
Trail Owner		road ADT (current)		(year)																								
Crossing Location		road ADT (design year)		(year)																								
Rails-to-Trails? (Y or N)		road ADT (count year)		(year)		interpolated																						
		Trail description																										
		Trail width (ft)																										
* e.g. 2-lane roadway ; or 4-lane divided roadway ; or 4-lane undivided roadway																												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22							
Hour No.	From time	to time	UNADJ. Exposure factor (col. 7 x col. 18 / 1000)	ADJ. Exposure factor (col. 8 x col. 19 / 1000)	RANK of ADJ. Exposure factors	Road User Counts - cars, trucks, motorcycles		(3) Trail User Counts (ACTUAL)						(4) Hourly total - all trail users (UNADJ.) (sum col.'s 9 - 17)			(5) Hourly total - all trail users (ADJ.)		(6) Overall Trail Use (based on UNADJ. Counts)									
						(1) ACTUAL COUNTS (UNADJ)	(2) ADJUSTED	Low Speed (non-motorized)			Medium Speed (non-motorized)			High Speed (motorized)			non-motorized		motorized									
								Disabled / Ped	Equestrian	Jogger/ Runner	X Country Skiing	Roller Blader	Bicycle	ATV	other motorized vehicles	Snowmobile	Low Speed (sum col.'s 9-11)	Medium Speed (sum col.'s 12-14)	High Speed (sum col.'s 15-17)									
1																												
2																												
3																												
4																												
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TOTALS																												
SUMMARY						<table border="1"> <tr> <td colspan="2">HIGHEST EXPOSURE</td> <td colspan="2">4TH HIGHEST EXPOSURE</td> <td rowspan="4"> GRADE SEPARATION WARRANT DOES NOT MEET WISDOT WARRANTS MAY BE JUSTIFIED MEETS WISDOT WARRANTS </td> </tr> <tr> <td>NM</td><td>M</td><td>NM</td><td>M</td> </tr> <tr> <td>0</td><td>0</td><td>0</td><td>0</td> </tr> <tr> <td>40</td><td>55</td><td>25</td><td>35</td> </tr> </table>				HIGHEST EXPOSURE		4TH HIGHEST EXPOSURE		GRADE SEPARATION WARRANT DOES NOT MEET WISDOT WARRANTS MAY BE JUSTIFIED MEETS WISDOT WARRANTS	NM	M	NM	M	0	0	0	0	40	55	25	35	Percent of overall trail use	
HIGHEST EXPOSURE		4TH HIGHEST EXPOSURE		GRADE SEPARATION WARRANT DOES NOT MEET WISDOT WARRANTS MAY BE JUSTIFIED MEETS WISDOT WARRANTS																								
NM	M	NM	M																									
0	0	0	0																									
40	55	25	35																									
Trail speed:			4th Highest exposure factor:																									
Trail Use:			Grade separation Warrant																									
Highest exposure factor:			Controlling:																									
Hour No.																												
Grade separation Warrant																												
Controlling:																												

Notes:

1. Enter road user hourly counts in this column. See traffic count guidance below.
2. Adjust Road User hourly counts so that they are the same percentage of design year ADT as they are of count year ADT.
3. Enter trail user hourly counts in these columns. See traffic count guidance below.
4. Seasonal representative average daily count. This should be representative of normal usage on a typical day. Do not use counts for special events.
5. Adjust trail user hourly counts by applying the estimated yearly rate of growth for trail traffic.
6. The overall trail use is calculated by adding all trail uses within each trail use category (low, medium and high speed). The following thresholds determine the trail class for the at-grade grossing sight distance tables:

If more than 85% of the trail use is high speed, the trail is classified as HIGH SPEED, and trail use is MOTORIZED.

If more than 15% of the trail use is low speed, the trail is classified as LOW SPEED, and trail use is NON-MOTORIZED.

If neither of the above thresholds are met, the trail is classified as MEDIUM SPEED, and trail use is NON-MOTORIZED.

Traffic Counts

Define the appropriate (average) time period to take the counts.

- A. Summer-Use Trails: Take an average weekend day count between Memorial Day and Labor Day (no holiday times or special events). Take a minimum of one 14 hour period count between 6am to 8pm under appropriate weather conditions (i.e., not raining). Consult with the DNR, municipalities, district traffic section, and others as appropriate to determine when to take the count. The count should be taken as if done for a traffic signal.
- B. Winter-Use Trails: Take an average weekend day count between December 1st and April 1st (no holiday times or special events). Take a minimum of one 14-hour count between 10am and 2 am when there is enough snow to allow winter-use trails to be open. Determine how long the trail was in use or officially open for snowmobiles during the last 5-year period. Consult with the DNR, municipalities, district traffic section, and others as appropriate to determine when to take the count. The count should be taken as if done for a traffic signal.

If a trail is used during both summer and winter, take counts during both seasons.

EXAMPLE - Grade separation warrant determination for a resurfacing project using UNADJUSTED counts

Project ID	1000-00-00		Road Description *	2-lane asphalt			Date of count	May 4, 2002															
Road Name	USH 00		Lane width (ft)	12			Day of week	Saturday															
County	Dane		Shoulder width (ft)	6			Begin time	8:00 AM															
Project type	re-surface		Median width (ft)	NA			End time	10:00 PM															
Trail Name	Greenway		Posted speed (mph)	55			weather cond.	70-degrees, sunny, no-wind all-day															
Trail Owner	DNR		road ADT (current)	2000	(year)	2000	Traffic counts to use for determining grade separation warrants																
Crossing Location	2 mi. west of CTH OO		road ADT (design year)	2500	(year)	2020																	
Rails-to-Trails? (Y or N)	N		road ADT (count year)	2050	(year)	2002	interpolated		ACTUAL UNADJUSTED (enter Y or N)	Y													
			Trail description	asphalt bike / ped trail			DESIGN YEAR - ADJUST counts to reflect estimated traffic growth (enter Y or N)																
			Trail width (ft)	10			Estimated yearly rate of growth for trail traffic (%)																
* e.g. 2-lane roadway ; or 4-lane divided roadway ; or 4-lane undivided roadway																							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
Hour No.	From time	to time	UNADJ. Exposure factor (col. 7 x col. 18 / 1000)	ADJ. Exposure factor (col. 8 x col. 19 / 1000)	RANK of ADJ. Exposure factors	Road User Counts - cars, trucks, motorcycles		(3) Trail User Counts (ACTUAL)						(4) Hourly total - all trail users (UNADJ.) (sum col.'s 9 - 17)	(5) Hourly total - all trail users (ADJ.)	(6) Overall Trail Use (based on UNADJ. Counts)							
						(1) ACTUAL COUNTS (UNADJ.)	(2) ADJUSTED	Low Speed (non-motorized)		Medium Speed (non-motorized)		High Speed (motorized)				Low Speed (sum col.'s 9-11)	Medium Speed (sum col.'s 12-14)	High Speed (sum col.'s 15-17)					
						Disabled / Ped	Equestrian	Jogger/ Runner	X Country Skiing	Roller Blader	Bicycle	ATV	other motorized vehicles	Snowmobile									
1	8:00 AM	9:00 AM	3	3	3	100	100			10	2	10					22	22	10	12			
2	9:00 AM	10:00 AM	1	1	9	25	25			5		10					15	15	5	10			
3	10:00 AM	11:00 AM	1	1	9	32	32			1		15					16	16	1	15			
4	11:00 AM	12:00 PM	1	1	9	25	25			1		25					26	26	1	25			
5	12:00 PM	1:00 PM	5	5	2	100	100			10		10	25				45	45	10	35			
6	1:00 PM	2:00 PM	2	2	7	50	50					30					30	30		30			
7	2:00 PM	3:00 PM	2	2	7	50	50					35					35	35		35			
8	3:00 PM	4:00 PM	3	3	3	100	100					25					25	25		25			
9	4:00 PM	5:00 PM	6	6	1	200	200			5		25					30	30	5	25			
10	5:00 PM	6:00 PM	3	3	3	100	100			10		10	5				25	25	10	15			
11	6:00 PM	7:00 PM	3	3	3	75	75			15		10	5				30	30	15	15			
12	7:00 PM	8:00 PM	1	1	9	75	75					5	5				10	10		10			
13	8:00 PM	9:00 PM	1	1	9	75	75					5					5	5		5			
14	9:00 PM	10:00 PM	1	1	9	50	50					5					5	5		5			
TOTALS						1057	1057			57		37	225				319	319	57	262			
SUMMARY																					17.87%	82.13%	
Trail speed:	Low Speed																				Percent of overall trail use		
Trail Use:	Non-Motorized Use																						
Highest exposure factor:	6	4th Highest exposure factor:	3																				
Hour No.:	9	Hour No.:	1																				
Grade separation Warrant	DOES NOT MEET WISDOT WARRANTS		Grade separation Warrant	DOES NOT MEET WISDOT WARRANTS																			
Controlling:			Controlling:																				
						HIGHEST EXPOSURE				4TH HIGHEST EXPOSURE				GRADE SEPARATION WARRANT									
						NM	M	NM	M	DOES NOT MEET WISDOT WARRANTS													
						0	0	0	0	MAY BE JUSTIFIED													
						40	55	25	35	MEETS WISDOT WARRANTS													
						61	81	36	51														

EXAMPLE - Grade separation warrant determination for a reconstruction project using counts which have been adjusted for projected future traffic

Project ID	1000-00-00	Road Description *	2-lane asphalt				Date of count	January 5, 2002			
Road Name	STH 00	Lane width (ft)	12				Day of week	Saturday			
County	Washburn	Shoulder width (ft)	10				Begin time	10:00 AM			
Project type	reconstruct	Median width (ft)	NA				End time	12:00 AM			
Trail Name	arrow way	Posted speed (mph)	55				weather cond.	15 degrees, cloudy, no wind			
Trail Owner	Washburn County	road ADT (current)	3000	(year)	2000	Traffic counts to use for determining grade separation warrants					
Crossing Location	150 ft west of Red River	road ADT (design year)	4500	(year)	2020						
Rails-to-Trails? (Y or N)	Y	road ADT (count year)	3150	(year)	2002	interpolated	ACTUAL UNADJUSTED (enter Y or N)				N
		Trail description	Snow mobile				DESIGN YEAR - ADJUST counts to reflect estimated traffic growth (enter Y or N)				Y
		Trail width (ft)	12				Estimated yearly rate of growth for trail traffic (%)				1.0%

* e.g. 2-lane roadway ; or 4-lane divided roadway ; or 4-lane undivided roadway

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Hour No.	From time	to time	UNADJ. Exposure factor (col. 7 x col. 18 / 1000)	ADJ. Exposure factor (col. 8 x col. 19 / 1000)	RANK of ADJ. Exposure factors	Road User Counts - cars, trucks, motorcycles		(3) Trail User Counts (ACTUAL)									(4) Hourly total - all trail users (UNADJ.) (sum col.'s 9 - 17)	(5) Hourly total - all trail users (ADJ.)	(6) Overall Trail Use (based on UNADJ. Counts)			
						(1) ACTUAL COUNTS (UNADJ)	(2) ADJUSTED	Low Speed (non-motorized)			Medium Speed (non-motorized)			High Speed (motorized)					non-motorized	Medium Speed (sum col.'s 12-14)	High Speed (sum col.'s 15-17)	
								Disabled / Ped	Equestrian	Jogger/ Runner	X Country Skiing	Roller Blader	Bicycle	ATV	other motorized vehicles	Snowmobile						
1	10:00 AM	11:00 AM	8	13	12	100	143										75	75	90			75
2	11:00 AM	12:00 PM	15	26	10	150	214										100	100	120			100
3	12:00 PM	1:00 PM	40	69	4	200	286										200	200	239			200
4	1:00 PM	2:00 PM	45	77	2	200	286										225	225	269			225
5	2:00 PM	3:00 PM	45	76	3	222	317										200	200	239			200
6	3:00 PM	4:00 PM	69	118	1	345	493										200	200	239			200
7	4:00 PM	5:00 PM	25	43	5	250	357										100	100	120			100
8	5:00 PM	6:00 PM	25	43	5	250	357										100	100	120			100
9	6:00 PM	7:00 PM	21	36	7	125	179										166	166	199			166
10	7:00 PM	8:00 PM	20	35	8	100	143										200	200	239			200
11	8:00 PM	9:00 PM	20	35	8	100	143										200	200	239			200
12	9:00 PM	10:00 PM	15	26	10	100	143										150	150	179			150
13	10:00 PM	11:00 PM	2	3	13	100	143										15	15	18			15
14	11:00 PM	12:00 AM	1	1	14	100	143										5	5	6			5
TOTALS						2342	3347										1936	1936	2316			1936

SUMMARY			
Trail speed:	High Speed		
Trail Use:	Motorized Use		
Highest exposure factor:	118	4th Highest exposure factor:	69
Hour No.:	6	Hour No.:	3
Grade separation Warrant	MEETS WISDOT WARRANTS	Grade separation Warrant	MEETS WISDOT WARRANTS
Controlling:		Controlling:	

HIGHEST EXPOSURE		4TH HIGHEST EXPOSURE		GRADE SEPARATION WARRANT	
NM	M	NM	M		
0	0	0	0		DOES NOT MEET WISDOT WARRANTS
40	55	25	35		MAY BE JUSTIFIED
61	81	36	51	MEETS WISDOT WARRANTS	

Percent of overall trail use **100.0%**

Sight Distance for Trail Crossing (feet)

Highway Design Speed (mph)	No. of Lanes Crossed	(1) High Speed Trail Use			(2) Medium Speed Trail Use			(3) Low Speed Trail Use (85 th percentile users)			(4) Low Speed Trail Use (elderly or other slower pedestrians)		
		1	2	3	1	2	3	1	2	3	1	2	3
		7.0	7.0	7.5	7.8	9.0	10.2	7.6	11.0	14.4	8.3	12.3	16.3
30		310	310	330	350	400	450	340	490	640	370	550	720
35		360	360	390	410	470	530	400	570	740	430	640	840
40		420	420	440	460	530	600	450	650	850	490	730	960
45		470	470	500	520	600	680	510	730	960	550	820	1080
50		520	520	550	580	660	750	560	810	1060	610	910	1200
55		570	570	610	630	730	830	620	890	1170	670	1000	1320
60		620	620	660	690	800	900	670	970	1270	740	1090	1440

NOTE: Vision triangle distance on trail shall be 20 feet back from the traveled edge of pavement on highway.

- Based on Intersection Control Case B3 as shown on Page 668 of 2001 AASHTO GDHS, as modified to reflect the values used in the 1995 WisDNR Design Standards Handbook (time rounded up to 7.0 sec for 2-lane crossing).

- Based on formula** $t = \frac{S}{V} + \frac{V}{2a} + PRT$

t = total crossing time (sec)
 v = velocity (use 9.84 fps)
 a = acceleration (use 2.43 ft/s²)
 PRT = perception reaction time (use 3.5 sec)
 S = crossing width = D+W+L where:
 D = distance from near edge of traveled way to the front of the bicycle (use 4.0 ft assumed)
 W = traveled way width along path of crossing bicycle (ft) = no. of lanes x assumed 12 ft lane width
 L = overall length of bicycle (use 5.9 ft)

- Based on formula** $t = \frac{S}{V} + \frac{V}{2a} + PRT$

t = total crossing time (sec)
 v = velocity (use 3.5 fps)
 a = acceleration (use 300000 ft/s² basically instantaneous)
 PRT = perception reaction time (use 3 sec)
 S = crossing width = D+W+L where:
 D = distance from near edge of traveled way to the front of the bicycle (use 4.0 ft assumed)
 W = traveled way width along path of crossing bicycle (ft) = no. of lanes x assumed 12 ft lane width
 L = overall length of pedestrian (use 0.0 ft)

- Based on formula** $t = \frac{S}{V} + \frac{V}{2a} + PRT$

t = total crossing time (sec)
 v = velocity (use 3 fps)
 a = acceleration (use 300000 ft/s² basically instantaneous)
 PRT = perception reaction time (use 3 sec)
 S = crossing width = D+W+L where:
 D = distance from near edge of traveled way to the front of the bicycle (use 4.0 ft assumed)
 W = traveled way width along path of crossing bicycle (ft) = no. of lanes x assumed 12 ft lane width
 L = overall length of pedestrian (use 0.0 ft)

