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AASHTO

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ERRATA for *Guide for the Development of Bicycle Facilities*, 4th Edition (GBF-4)

February 2017

TO: AASHTO Members

FROM: Erin Grady, Director
AASHTO Publications Production

RE: February 2013 and 2017 Erratum to the *Guide for the Development of Bicycle Facilities*, 4th Edition

AASHTO has issued an errata that includes technical revisions to the *Guide for the Development of Bicycle Facilities*, 4th Edition.

To ensure that your editions are accurate and current, we are providing you with the attached summary of the errata changes, as well as the revised pages to which they apply. Those items with a green header are from the 2017 Errata, those items with a red header are from the 2013 Errata. Following the summary pages, you will find the replacement pages that include all revisions to be inserted into your book.

Should you need additional copies of the errata, you can download them free of charge on the AASHTO Online Bookstore at the following URL: http://downloads.transportation.org/GBF-4-Errata.pdf

We apologize for any inconvenience. Please feel free to contact us if you have questions or need any additional information.

Thank you.

5-21, 5-22	Shaded area represents $S > L$	Revise to read: Shaded area represents $S < L$

Summary of Errata Changes, GBF-4
February 2013

<table>
<tr><th>Page</th><th>Existing Text</th><th>Corrected Text</th></tr>
<tr><td colspan="3">Chapter 3</td></tr>
<tr>
<td>3-4</td>
<td>
Table 3-2 in Row 1, Typical Upright Adult Cyclists, Feature column reads:
<table>
<tr><th></th><th colspan="2">Value</th></tr>
<tr><th>Feature</th><th>U.S. Customary</th><th>Metric</th></tr>
<tr><td>Deceleration rate (dry level pavement)</td><td>0.16 ft/s^2</td><td>4.8 m/s^2</td></tr>
<tr><td>Deceleration rate for wet conditions (50–80% reduction in efficiency)</td><td>8.0–10.0 ft/s^2</td><td>2.4–3.0 m/s^2</td></tr>
</table>
</td>
<td>
Revise to read:
<table>
<tr><th></th><th colspan="2">Value</th></tr>
<tr><th>Feature</th><th>U.S. Customary</th><th>Metric</th></tr>
<tr><td>Deceleration rate (dry level pavement)</td><td>8–10 ft/s^2</td><td>2.4–3 m/s^2</td></tr>
<tr><td>Deceleration rate for wet conditions (50–80% reduction in efficiency)</td><td>2–5 ft/s^2</td><td>0.6–1.5 m/s^2</td></tr>
</table>
Add new sixth row to read:
<table>
<tr><th></th><th colspan="2">Value</th></tr>
<tr><th>Feature</th><th>U.S. Customary</th><th>Metric</th></tr>
<tr><td>Coefficient of friction for braking, wet level pavement</td><td>0.16</td><td>0.16</td></tr>
</table>
</td>
</tr>
</table>

Summary of Errata Changes, GBF-4
February 2013

Page	Existing Text	Corrected Text
Chapter 5		
5-7	Figure 5-3 top illustration, the drop dimension reads: Drop is 6 ft 1(.8 m)	Revise to read: Drop is 6 ft (1.8 m)
5-20	Table 5-5 top formulas for U.S. Customary and Metric read: $S < L \quad L = 2S - \frac{200\left(\sqrt{h_1} + \sqrt{h_2}\right)^2}{A}$ The bottom formulas for U.S. Customary and Metric read: $S < L \quad L = 2S - \frac{AS^2}{100\left(\sqrt{2h_1} + \sqrt{2h_1}\right)^2}$	Revise to read: $\text{when } S > L \quad L = 2S - \frac{200\left(\sqrt{h_1} + \sqrt{h_2}\right)^2}{A}$ Revise to read: $\text{when } L = \frac{AS^2}{100\left(\sqrt{2h_1} + \sqrt{2h_1}\right)^2}$
5-21, 5-22	Figure 5-8, the notes at the bottom of the U.S. Customary and Metric tables read: Shaded area represents $S = L$ The Metric cell for A = 5 and S = 55 (i.e., value = 54) reads: 54	Revise to read: Shaded area represents $S > L$ Revise to read: 54 [without shading]
5-23	Table 5-6, the bottom formulas for U.S. Customary and Metric read: $HSO = \frac{R}{28.65}\left[1 - \cos^{-1}\left(\frac{R - HSO}{R}\right)\right]$	Revise to read: $S = \frac{R}{28.65}\left[\cos^{-1}\left(\frac{R - HSO}{R}\right)\right]$
5-36	Table 5-8, the definition for term "a_i" for U.S. Customary and Metric reads: **U.S. Customary** a_i = motorist deceleration rate (ft/s^2) **in** intersection approach when braking to a stop is not initiated (assume -5.0 ft/s^2) **Metric** a_i = motorist deceleration rate (m/s^2) **in** intersection approach when braking to a stop is not initiated (assume -1.5 m/s^2)	Revise to read: **U.S. Customary** a_i = motorist deceleration rate (ft/s^2) **on** intersection approach when braking to a stop is not initiated (assume –5.0 ft/s^2) **Metric** a_i = motorist deceleration rate (m/s^2) **on** intersection approach when braking to a stop is not initiated (assume –1.5 m/s^2)

Table 3-1. Key Dimensions (continued)

User Type	Feature	Dimension	
		U.S. Customary	Metric
Recumbent bicyclist	Physical length	82 in.	2.2 m
	Eye height	46 in.	1.2 m
Tandem bicyclist	Physical length (typical dimension)	96 in.	2.4 m
Bicyclist with child trailer	Physical width	30 in.	0.75 m
	Physical length	117 in.	3.0 m
Hand bicyclist	Eye height	34 in.	0.9 m
Inline skater	Sweep width	60 in.	1.5 m

As with bicycle dimensions, bicyclist performance can vary considerably based upon operator ability and vehicle design. Table 3-2 lists various performance criteria for typical upright adult bicyclists as well as key performance criteria for other types of bicyclists (*1*), (*4*), (*11*).

Bicyclist speeds vary based on age and ability and are a function of many factors, including bicyclist skill, bicyclist physical and cognitive abilities, bicycle design, traffic, lighting, wind conditions, transportation facility design, and terrain. Adults typically ride at 8–15 mph (13–24 km/h) on level terrain, while children ride more slowly. Experienced, physically fit riders can ride up to 30 mph (50 km/h); very fit riders can ride at speeds in excess of 30 mph (50 km/h) but will typically only ride at such speeds on roads.

Table 3-2. Key Performance Criteria

Bicyclist Type	Feature	Value	
		U.S. Customary	Metric
Typical upright adult bicyclist	Speed, paved level terrain	8–15 mph	13–24 km/h
	Speed, downhill	20–30 plus mph	32-50 plus km/h
	Speed, uphill	5–12 mph	8-19 km/h
	Perception reaction time	1.0–2.5s	1.0–2.5s
	Acceleration rate	1.5–5.0 ft/s^2	0.5–1.5 m/s^2
	Coefficient of friction for braking, wet level pavement	0.16	0.16
	Coefficient of friction for braking, dry level pavement	0.32	0.32
	Deceleration rate (dry level pavement)	8–10 ft/s^2	2.4–3 m/s^2
	Deceleration rate for wet conditions (50–80% reduction in efficiency)	2–5 ft/s^2	0.6–1.5 m/s^2
Recumbent bicyclist	Speed, level terrain	11–18 mph	18–29 km/h
	Acceleration rate	3.0–6.0 ft/s^2	1.0–1.8 m/s^2
	Deceleration rate	10.0–13.0 ft/s^2	3.0–4.0 m/s^2

Note: The speeds reported are for bicyclists on shared use paths. Experience suggests that maximum speeds on roadways can be considerably higher.

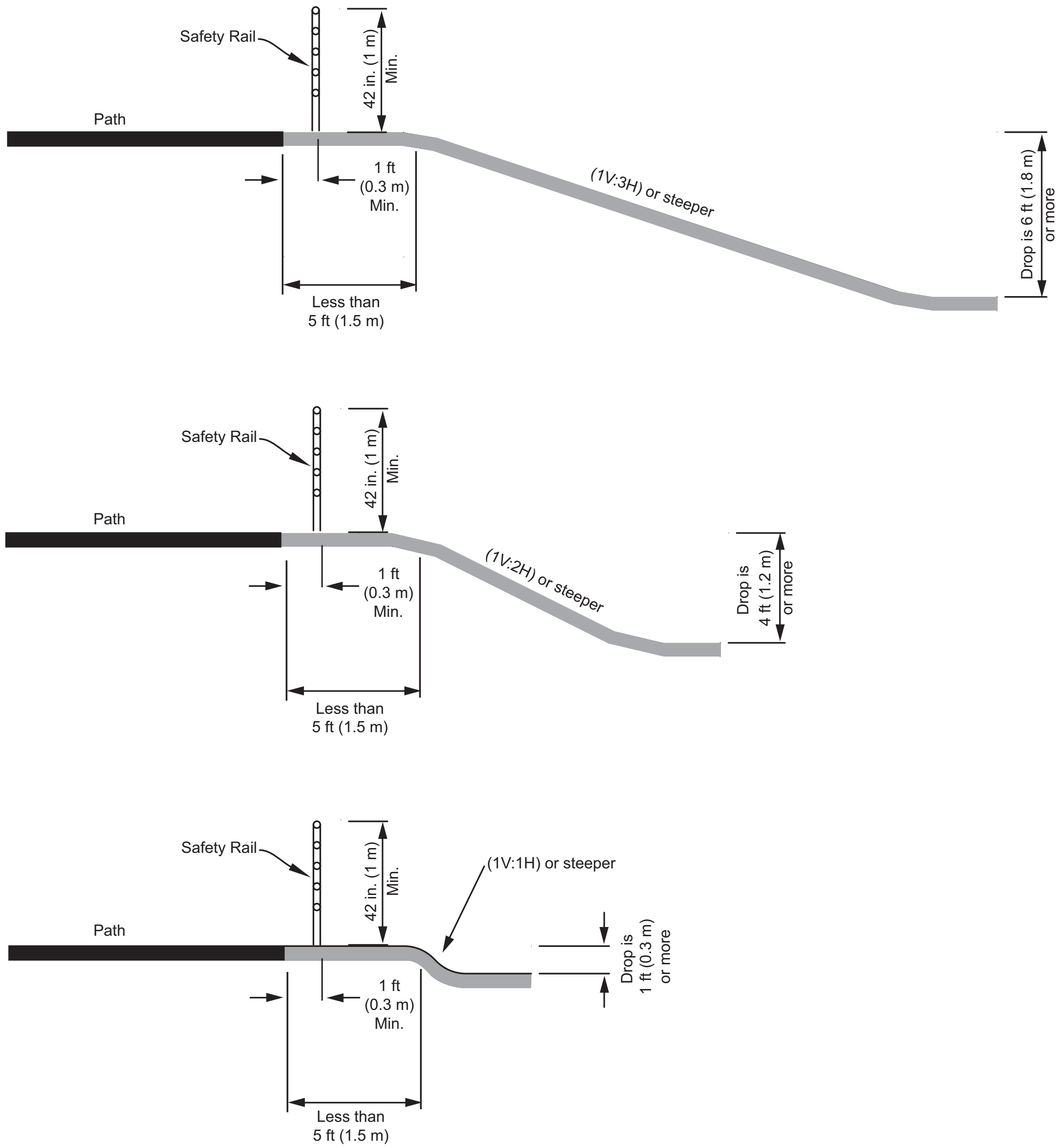

Figure 5-3. Safety Rail Between Path and Adjacent Slope

Research indicates that, under dry conditions, the coefficient of friction of various other path users range from 0.20 for inline skaters to 0.30 for recumbent bicyclists. If users with lower coefficients of friction such as inline skaters or recumbent bicyclists are expected to make up a relatively large percentage of path users, stopping sight distances should be increased. For two-way shared use paths, the sight distance in the descending direction, that is, where "G" is defined as negative, will control the design.

Figure 5-8 is used to select the minimum length of vertical curve needed to provide minimum stopping sight distance at various speeds on crest vertical curves. The eye height of the typical adult bicyclist is assumed to be 4.5 ft (1.4 m), and the object height is assumed to be 0 in. (0 mm) to recognize that impediments to bicycle travel exist at pavement level. The minimum length of vertical curve can also be calculated using the following equation as shown in Table 5-5.

Table 5-5. Length of Crest Vertical Curve to Provide Sight Distance

U.S. Customary		
when $S > L$ $L = 2S - \frac{200\left(\sqrt{h_1}+\sqrt{h_2}\right)^2}{A}$ when $S < L$ $L = \frac{AS^2}{100\left(\sqrt{2h_1}+\sqrt{2h_2}\right)^2}$		
where:		
L	=	minimum length of vertical curve (ft)
A	=	algebraic grade difference (percent)
S	=	stopping sight distance (ft)
h_1	=	eye height (4.5 ft for a typical bicyclist)
h_2	=	object height (0 ft)

Metric		
when $S > L$ $L = 2S - \frac{200\left(\sqrt{h_1}+\sqrt{h_2}\right)^2}{A}$ when $S < L$ $L = \frac{AS^2}{100\left(\sqrt{2h_1}+\sqrt{2h_2}\right)^2}$		
where:		
L	=	minimum length of vertical curve (m)
A	=	algebraic grade difference (percent)
S	=	stopping sight distance (m)
h_1	=	eye height (1.4 m for a typical bicyclist)
h_2	=	object height (0 m)

U.S. Customary

A	S = Stopping Sight Distance (ft)														
(%)	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300
2												30	70	110	150
3								20	60	100	140	180	220	260	300
4						15	55	95	135	175	215	256	300	348	400
5					20	60	100	140	180	222	269	320	376	436	500
6				10	50	90	130	170	210	267	323	384	451	523	600
7				31	71	111	151	191	231	311	376	448	526	610	700
8			8	48	88	128	168	208	248	356	430	512	601	697	800
9			20	60	100	140	180	220	260	400	484	576	676	784	900
10			30	70	110	150	190	230	270	444	538	640	751	871	1000
11			38	78	118	158	198	238	278	489	592	704	826	958	1100
12		5	45	85	125	165	205	245	285	533	645	768	901	1045	1200
13		11	51	91	131	171	211	251	291	578	699	832	976	1132	1300
14		16	56	96	136	176	216	256	296	622	753	896	1052	1220	1400
15		20	60	100	140	180	220	260	300	667	807	960	1127	1307	1500
16		24	64	104	144	184	224	264	304	711	860	1024	1202	1394	1600
17		27	67	107	147	187	227	267	307	756	914	1088	1277	1481	1700
18		30	70	110	150	190	230	270	310	800	968	1152	1352	1568	1800
19		33	73	113	153	193	233	273	313	844	1022	1216	1427	1655	1900
20		35	75	115	155	195	235	275	315	889	1076	1280	1502	1742	2000
21		37	77	117	157	197	237	277	317	933	1129	1344	1577	1829	2100
22		39	79	119	159	199	239	279	319	978	1183	1408	1652	1916	2200
23		41	81	121	161	201	241	281	321	1022	1237	1472	1728	2004	2300
24	3	43	83	123	163	203	243	283	323	1067	1291	1536	1803	2091	2400
25	4	44	84	124	164	204	244	284	324	1111	1344	1600	1878	2178	2500

Shaded area represents S < L
Minimum length of vertical curve = 3 ft

Figure 5-8. Minimum Length of Crest Vertical Curve Based on Stopping Sight Distance

Metric

A	S = Stopping Sight Distance (m)																	
(%)	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
2														10	20	30	40	50	60
3									7	17	27	37	47	57	67	77	87	97	107
4						0	10	20	30	40	50	60	70	80	91	103	116	129	143
5					4	14	24	34	44	54	64	75	88	100	114	129	145	161	179
6				3	13	23	33	43	54	65	77	91	105	121	137	155	174	193	214
7				10	20	30	40	51	63	76	90	106	123	141	160	181	203	226	250
8			5	15	25	35	46	58	71	86	103	121	140	161	183	206	231	258	286
9			9	19	29	39	51	65	80	97	116	136	158	181	206	232	260	290	321
10		2	12	22	32	44	57	72	89	108	129	151	175	201	229	258	289	322	357
11		5	15	25	35	48	63	80	98	119	141	166	193	221	251	284	318	355	393
12		7	17	27	39	53	69	87	107	130	154	181	210	241	274	310	347	387	429
13		8	18	29	42	57	74	94	116	140	167	196	228	261	297	335	376	419	464
14		10	20	31	45	61	80	101	125	151	180	211	245	281	320	361	405	451	500
15	1	11	21	33	48	66	86	108	134	162	193	226	263	301	343	387	434	483	536
16	3	13	23	36	51	70	91	116	143	173	206	241	280	321	366	413	463	516	571
17	4	14	24	38	55	74	97	123	152	184	219	257	298	342	389	439	492	548	607
18	4	14	26	40	58	79	103	130	161	194	231	272	315	362	411	464	521	580	643
19	5	15	27	42	61	83	109	137	170	205	244	287	333	382	434	490	550	612	679
20	6	16	29	45	64	88	114	145	179	216	257	302	350	402	457	516	579	645	714
21	7	17	30	47	68	92	120	152	188	227	270	317	368	422	480	542	608	677	750
22	7	18	31	49	71	96	126	159	196	238	283	332	385	442	503	568	636	709	786
23	8	18	33	51	74	101	131	166	205	248	296	347	403	462	526	593	665	741	821
24	8	19	34	54	77	105	137	174	214	259	309	362	420	482	549	619	694	774	857
25	9	20	36	56	80	109	143	181	223	270	321	377	438	502	571	645	723	806	893

Shaded area represents S < L
Minimum length of vertical curve = 1 m

Figure 5-8. Minimum Length of Crest Vertical Curve Based on Stopping Sight Distance (continued)

Other path users such as child bicyclists, hand bicyclists, recumbent bicyclists, and others have lower eye heights than a typical adult bicyclist. Eye heights are approximately 2.6 ft (0.85 m) for hand bicyclists and 3.9 ft (1.2 m) for recumbent bicyclists. When compared to the eye heights of typical bicyclists, these lower eye heights limit sight distance over crest vertical curves. However, since most hand bicyclists and child bicyclists travel slower than typical adult bicyclists, their needs are met by using the values in Figure 5-8. Recumbent bicyclists generally travel faster than typical upright bicyclists, so if they are expected to make up a relatively large percentage of path users, crest vertical curve lengths should be increased accordingly (operating characteristics of recumbent bicyclists are found in Chapter 3).

Figures 5-9, 5-10, and Table 5-6 indicate the minimum clearance that should be used for line-of-sight obstructions for horizontal curves. The lateral clearance (horizontal sight line offset or HSO) is obtained by using the table in Figure 5-9 with the stopping sight distance (Figure 5-6) and the proposed horizontal radius of curvature.

Path users typically travel side-by-side on shared use paths. On narrow paths, bicyclists have a tendency to ride near the middle of the path. For these reasons, and because of the higher likelihood for crashes on curves, lateral clearances on horizontal curves should be calculated based on the sum of the stopping sight distances for path users traveling in opposite directions around the curve. Where this is not practical, consideration should be given to widening the path through the curve, installing a yellow center line stripe, installing turn or curve warning signs (W1 series) in accordance with the MUTCD (*7*), or a combination of these alternatives. See Sections 5.4.1 and 5.4.2 for more information about center line pavement markings and signs.

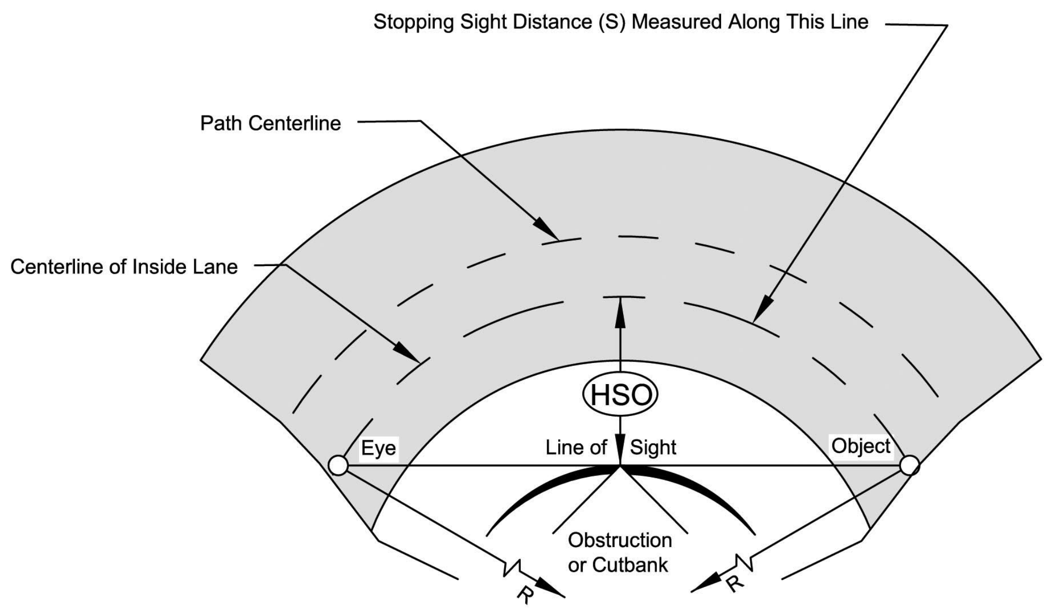

Figure 5-9. Diagram Illustrating Components for Determining Horizontal Sight Distance

Table 5-6. Horizontal Sight Distance

U.S. Customary		
$HSO = R\left[1 - \cos\left(\dfrac{28.65S}{R}\right)\right]$ $S = \dfrac{R}{28.65}\left[\cos^{-1}\left(\dfrac{R - HSO}{R}\right)\right]$		
where:		
S	=	stopping sight distance (ft)
R	=	radius of centerline of lane (ft)
HSO	=	horizontal sightline offset, distance from centerline of lane to obstruction (ft)
Note: Angle is expressed in degrees; line of sight is 2.3 ft above centerline of inside lane at point of obstruction.		

Metric		
$HSO = R\left[1 - \cos\left(\dfrac{28.65S}{R}\right)\right]$ $S = \dfrac{R}{28.65}\left[\cos^{-1}\left(\dfrac{R - HSO}{R}\right)\right]$		
where:		
S	=	stopping sight distance (m)
R	=	radius of centerline of lane (m)
HSO	=	horizontal sightline offset, distance from centerline of lane to obstruction (m)
Note: Angle is expressed in degrees; line of sight is 0.7 m above centerline of inside lane at point of obstruction.		

Table 5-8. Length of Path Leg of Sight Triangle

U.S. Customary		
$t_a = \dfrac{1.47V_e - 1.47V_b}{a_i}$ $t_g = t_a + \dfrac{w + L_a}{0.88V_{road}}$ $b = 1.47V_{path}t_g$		
where:		
t_g	=	travel time to reach and clear the path (s)
b	=	length of leg sight triangle along the path approach (ft)
t_a	=	travel time to reach the path from the decision point for a motorist that doesn't stop (s). For road approach grades that exceed 3 percent, value should be adjusted in accordance with AASHTO's *A Policy on Geometric Design of Highways and Streets* (5)
V_e	=	speed at which the motorist would enter the intersection after decelerating (mph) (assumed 0.60 × road design speed)
V_b	=	speed at which braking by the motorist begins (mph) (same as road design speed)
a_i	=	motorist deceleration rate (ft/s^2) on intersection approach when braking to a stop not initiated (assume –5.0 ft/s^2)
w	=	width of the intersection to be crossed (ft)
L_a	=	length of the design vehicle (ft)
V_{path}	=	design speed of the path (mph)
V_{road}	=	design speed of the road (mph)

Metric		
$t_a = \dfrac{0.278V_e - 0.278V_b}{a_i}$ $t_g = t_a + \dfrac{w + L_a}{0.167V_{road}}$ $b = 0.278V_{path}t_g$		
where:		
t_g	=	travel time to reach and clear the path (s)
b	=	length of leg sight triangle along the path approach (m)
t_a	=	travel time to reach the path from the decision point for a motorist that doesn't stop (s). For road approach grades that exceed 3 percent, value should be adjusted in accordance with AASHTO's *A Policy on Geometric Design of Highways and Streets* (5)
V_e	=	speed at which the motorist would enter the intersection after decelerating (km/h) (assumed 0.60 × road design speed)
V_b	=	speed at which braking by the motorist begins (km/h) (same as road design speed)
a_i	=	motorist deceleration rate (m/s^2) on intersection approach when braking to a stop not initiated (assume –1.5 m/s^2)
w	=	width of the intersection to be crossed (m)
L_a	=	length of the design vehicle (m)
V_{path}	=	design speed of the path (km/h)
V_{road}	=	design speed of the road (km/h)

Note: This table accounts for reduced motor vehicle speeds per standard practice in AASHTO's *A Policy on Geometric Design of Highways and Streets* (5).