SIGHT DISTANCE AT INTERSECTIONS

FIGURE: 6-A

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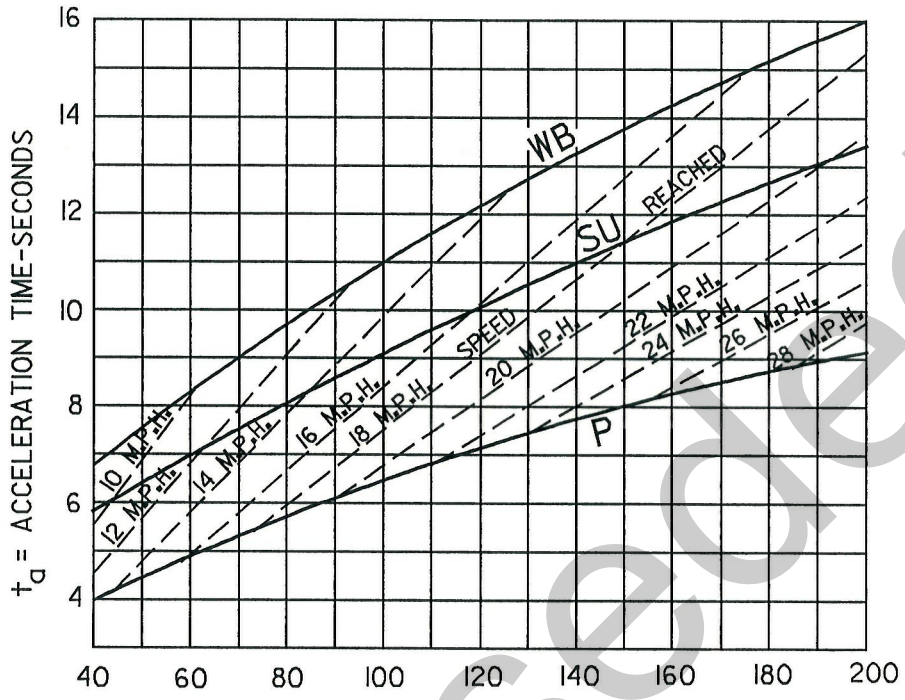
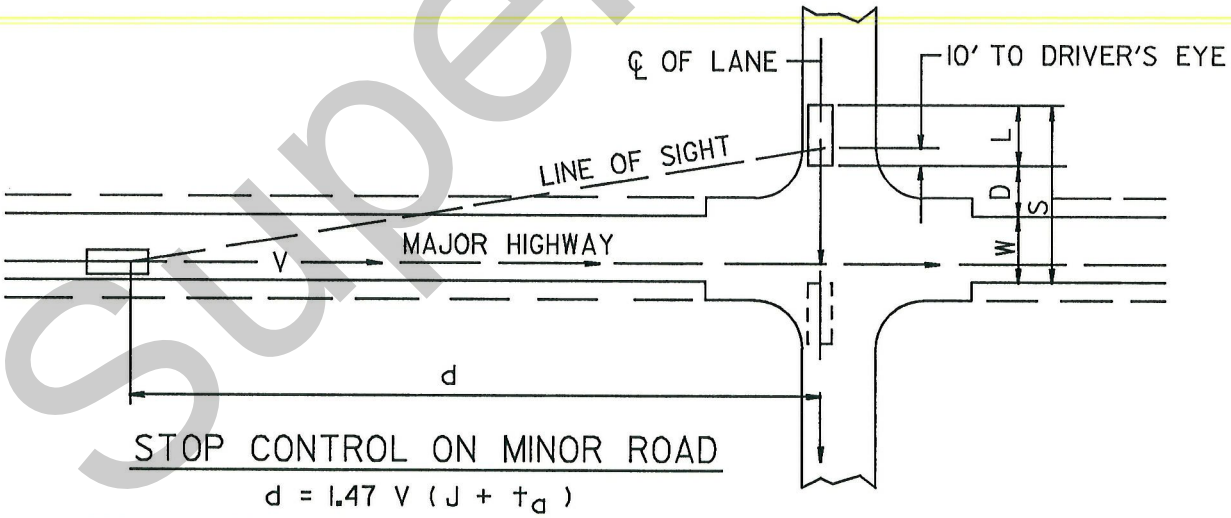


SIGHT DISTANCE AT INTERSECTIONS

DATA ON ACCELERATION FROM STOP



STOP CONTROL ON MINOR ROAD

$$d = 1.47\ V\ (J + t_a)$$

WHERE, V = DESIGN SPEED ON MAJOR HIGHWAY, MPH

J = PERCEPTION AND REACTION TIME, USE 2 SECONDS

t_a = TIME REQUIRED TO TRAVERSE DISTANCE 'S', SECONDS. USE GRAPH ABOVE.

S = D+W+L, FEET.

D = 10 FEET

W = WIDTH OF TRAVELED WAY, FEET.

L = OVERALL LENGTH OF VEHICLE, FEET. SEE TABLE 2-1.

SOURCE: A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS, A.A.S.H.T.O., 1990.

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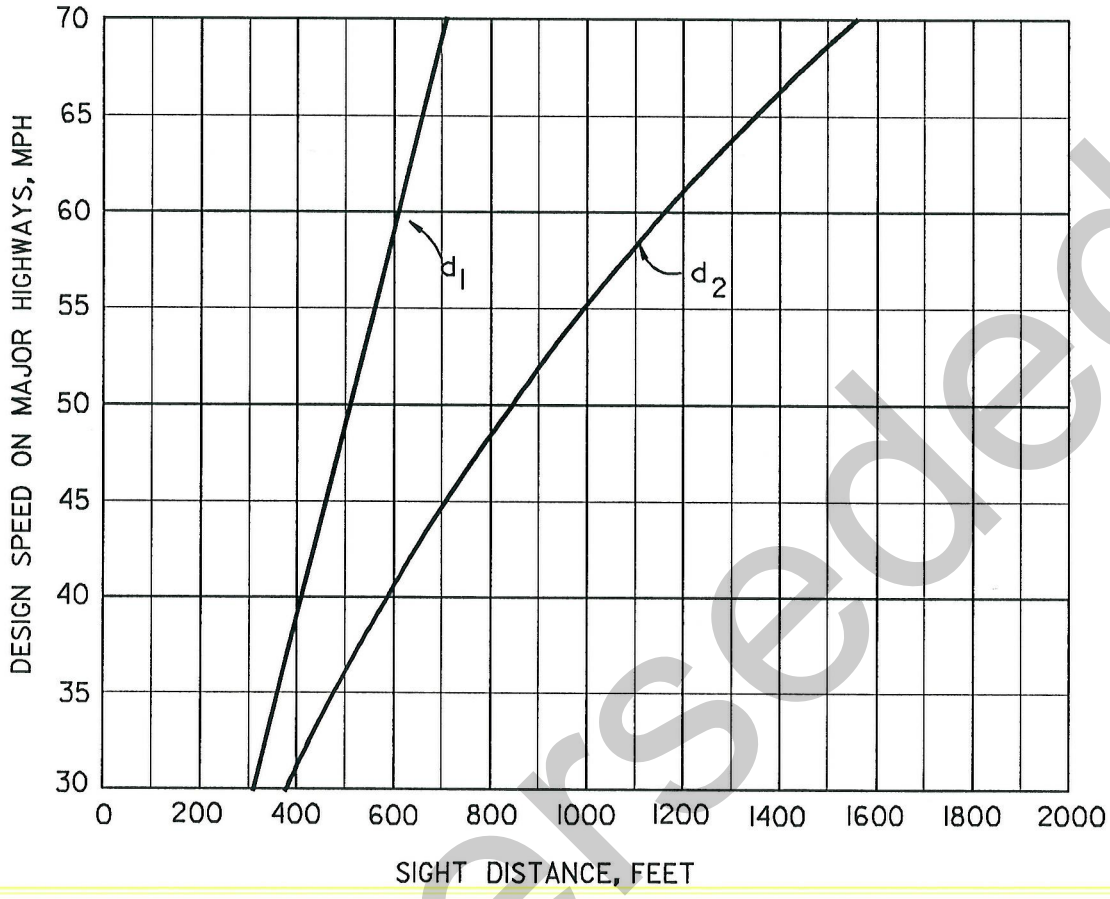
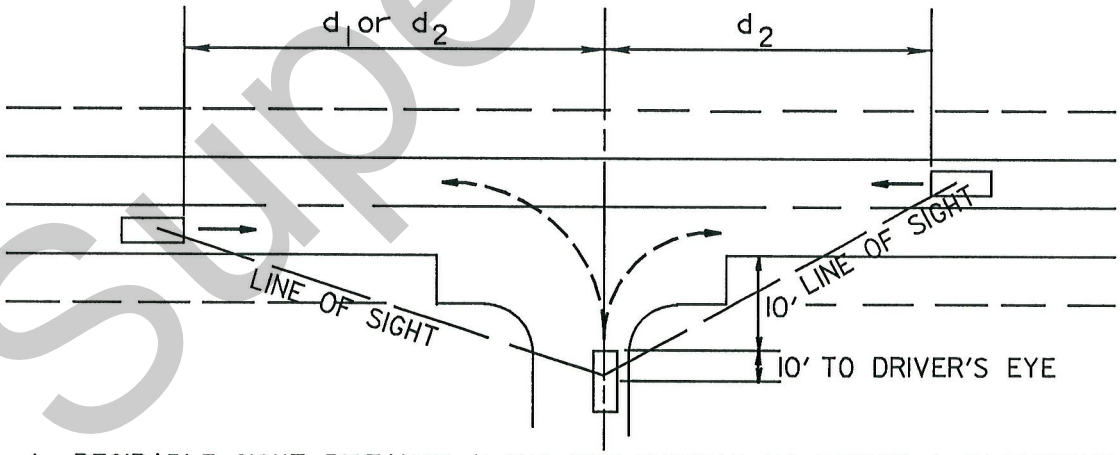
SIGHT DISTANCE AT INTERSECTIONS FOR LEFT OR RIGHT TURNING VEHICLES WITH STOP CONTROL

FIGURE: 6-B

DATE: 02/06/98





d_1, DESIRABLE SIGHT DISTANCE ALONG THE HIGHWAY TO PERMIT A PASSENGER VEHICLE TO TURN LEFT AND CLEAR THE VEHICLE APPROACHING FROM THE LEFT.

d_2, DESIRABLE SIGHT DISTANCE ALONG THE HIGHWAY TO PERMIT A PASSENGER VEHICLE TO TURN LEFT OR RIGHT BEFORE BEING OVERTAKEN BY A VEHICLE TRAVELING IN THE SAME DIRECTION.

SOURCE: A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS, A.A.S.H.T.O. 1990

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Table 6-2

Jughandle Design Speeds

Jughandle Type	Minimum Design Speed
A	25 mph
B-one lane	15 mph
B-one lane with T-intersection	20 mph
B-two lane	25 mph
C-loop ramp	15 mph 20 mph (Des.)
C-finger ramp	25 mph

When initially providing jughandles at locations where there are no existing cross streets or there is an intersecting street on only one side, the designer should evaluate the future development potential of the property adjacent to the jughandle. Consideration should be given to designing the jughandle for future expansion to accommodate the access needs of the adjacent property.

The design of Type "B" jughandles should generally be limited to locations where the development of the adjacent land is limited due to topography, environmental constraints, zoning restrictions, etc.

6-08.5 Superelevation And Cross Slope

It is desirable to provide as much superelevation as practical on jughandles, particularly where the ramp curve is sharp and on a downgrade. Table 6-3 provides a suggested range of superelevation rates in percent for various ramp radii. Rates in the upper half or third of the indicated range are preferred. The cross slope on tangent sections of ramps is normally sloped one-way at 2 percent, which is considered a practical minimum for effective drainage across the surface (see Figure 5-J).

Table 6-3

Jughandle (Ramp) Superelevation (%)

Design Speed (MPH)	Radius (Feet)					
	50	90	150	230	310	430
15	2-6	2-6	2-5	2-4	2-3	2-3
20	---	2-6	2-6	2-6	2-4	2-3
25	---	---	4-6	3-6	3-6	3-5
30	---	---	---	6	5-6	4-6

Exceptions to the use of full superelevation are at street intersections where a stop oryield condition is in effect.

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The length of superelevation transition should be based on a maximum distribution rate of 2 percent per second of time for the design speed. With respect to the beginning and ending of a curve on the ramp proper (not including terminals), two-thirds of the full superelevation rate should be provided at the beginning and ending of the curve. This may be altered as required to adjust for flat spots or unsightly sags and humps when alignment is tight. The principal criteria is the development of smooth-edge profiles that do not appear distorted to the driver.

See Section 7-06.2, "Ramp Terminals", for a discussion on development of superelevation at free-flow ramp terminals and the maximum algebraic difference in cross slope at crossover line.

6-09 OTHER CONSIDERATIONS

6-09.1 Parking Restrictions At Intersections

Vehicular parking should not be permitted within the immediate limits of at-grade intersections; see Section 6-03, "Sight Distance", for sight distance requirements at intersections.

6-09.2 Lighting At Intersections

Lighting affects the safety of highway and street intersections and the ease and comfort of traffic operations. In urban and suburban areas where there are concentrations of pedestrians and roadside and intersection interferences, fixed-source lighting tends to reduce accidents. Whether or not rural at-grade intersections should be lighted depends on the planned geometrics and the turning traffic volumes involved. Intersections that generally do not require channelization are seldom lighted. However, for the benefit of non-local highway users, lighting at rural intersections is desirableto aid the driver in ascertaining sign messages during non-daylight period.

Intersections with channelization, particularly with multiple-road geometrics, should include lighting Large channelized intersections especially need illumination because of the higher range of turning radii that are not within the lateral range of vehicular headlight beams. Vehicles approaching the intersection also must reduce speed. The indication of this need should be definite and visible at a distance from the intersection that may be beyond the range of headlights. Illumination of at-grade intersections with fixed-source lighting accomplishes this need.

See Section 11, "Roadway Lighting Systems, "for guidelines in theplanning and design of roadway lighting systems.

6-10 BUS TURNOUTS

6-10.1 Introduction

To reduce conflicts on state highways between through traffic and buses stopped to receive and/or discharge passengers, bus turnouts may be provided on landservice highways when the outside shoulders on the highway are less than 10 feet in width. The designer shall, in conjunction with the transit agency providing service along the highway, determine the locations of the bus turnouts.

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6-10.2 Location Criteria

When it has been determined that bus turnouts are warranted, the following criteria should be used to select the bus turnout location(s):

1. Desirably there should not be any driveways within the bus turnout. As a minimum, there shall be no driveways located within the bus stopping area. Driveways may be located within the acceleration and deceleration portion of the bus turnout including the taper. However to minimize conflicts between the vehicles using the drivewayand the bus, the bus stopping area should desirably be located on the far side of the driveway.
2. The vertical and horizontal highway geometry meets current stopping sight distance criteria
3. The bus turnouts can be located where patrons can park and cross roadways legally and safely. Desirably, bus turnouts should be located within 400 feet of an intersection or parking areas used by the bus patrons. Alternatives including review and possible modification of parking regulations may be considered.
4. There is sufficient right-of-way available, or if required, would not involve the acquisition of developed parcels or environmentally sensitive parcels.
5. The bus stop is close to the points of origins and/or destinations of the transit rider. Locations convenient to park "n" ride facilities, intermodal transfer facilities and transfer facilities between bus services are desirable.
6. Access to and from the bus stop is convenient to well lit pedestrian crossings, crosswalks, or signalized crossings.
7. A bus turnout may be placed on the far side or near side of an intersection, or at mid-block. When placed at intersections, locating the bus turnout on the far side is preferred. Near side bus turnouts create conflicts with right turningtraffic, obscures pedestrian view of oncoming traffic, and may obscure a driver's view of signs, traffic control devices and pedestrians. Mid-block turnouts may be provided when there is a need to service a major pedestrian traffic generator (i.e. shopping mall, school, railroad station, hospital, etc.)
8. The location of the bus turnouts conform to local ordinances.

6-10.3 Other Considerations

In addition to the location criteria noted in Section 6-10.2, the following features should be considered when selecting bus turnout locations:

1. Utility and signal poles - The relocation of utility poles could require the acquisition of additional right-of-way, and depending upon the type of service provided, involve excessive relocation costs. The location of the bus turnouts at intersections could involve costly signal relocations and when placed on the near side of the intersection stopped buses could obscure the signals.
2. Drainage - To avoid splashing of bus riders turnouts should not be located at low points in the vertical alignment. Also, additional inlets may be necessary to limit the spread in the gutter to 3 feet. Grades should be checked to avoid ponding where pavement cross slope exceeds the longitudinal slope in the turnout.
3. Guide rail - Openings in guide rail located along the curbline may not be permitted due to inadequate length of need or the inability to provide the proper end treatment.

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4. Signing - The location of the bus turnout could interfere with the visibility of regulatory, warning and/or directional signs. The relocation of existing signs and/or the installation of new signs including bus stop sign shall be coordinated with the Bureau of Traffic Signals and Safety.
5. Handicapped ramps - When the construction of a bus turnout impacts an existing handicapped ramp(s) at an intersection, the designer shall assess the entire intersection to determine if the remaining handicapped ramps will be compatible.
6. Curb - Curb shall be provided at all bus turnouts. The curb height shall conform to Section 5-06.
7. The pavement section for widening or reconstruction of shoulders for bus turnouts should be determined by Geotechnical Engineering.

6-10.4 Bus Turnout Design Criteria

Figure 6-X illustrates typical bus turnout designs for a far side and an alternate far side bus turnout. Figure 6-Y illustrates a typical near side and mid-block bus turnout. When a far side bus turnout is to be provided, the alternate far side bus turnout should be considered at intersections where there is a high volume of traffic making right turns that may use the bus turnout as an auxiliary lane.

The bus stopping areas shall be a minimum of 50 feet in length for each standard 40 foot bus and 70 feet in length for each 60 foot bus expected to use the bus turnout. When more than one bus is expected to use the turnout simultaneously, the length of the bus stopping area should be adjusted accordingly. Desirably the width of the bus stopping area including the acceleration and deceleration lanes should be 12 feet. Where it is not practical to provide the 12 foot width, a minimum width of 10 feet may be provided to reduce right-of-way or environmental impacts.

Bus turnouts generally consist of entrance and exit tapers, deceleration and acceleration lanes, and a bus stopping area. The length of the tapers and the deceleration and acceleration lanes vary depending on the posted speed of the highway. Table 6-4 provides the desirable lengths. The use of lengths less than those shown in Table 6-4 may cause delays to the transit service and adversely impact the traffic flow on the highway.

Table 6-4

Posted Speed (mph)	Length of Acceleration Lane (feet)	Length of Deceleration Lane (feet)	Length of Entrance and Exit Tapers (feet)
35	250	185	170
40	400	265	190
45	700	360	210
50	975	470	230
55	1400	595	250

Source: TCRP Report 19, Guidelines for the Location and Design of Bus Stops

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TYPICAL BUS TURNOUTS

FIGURE: 6-X

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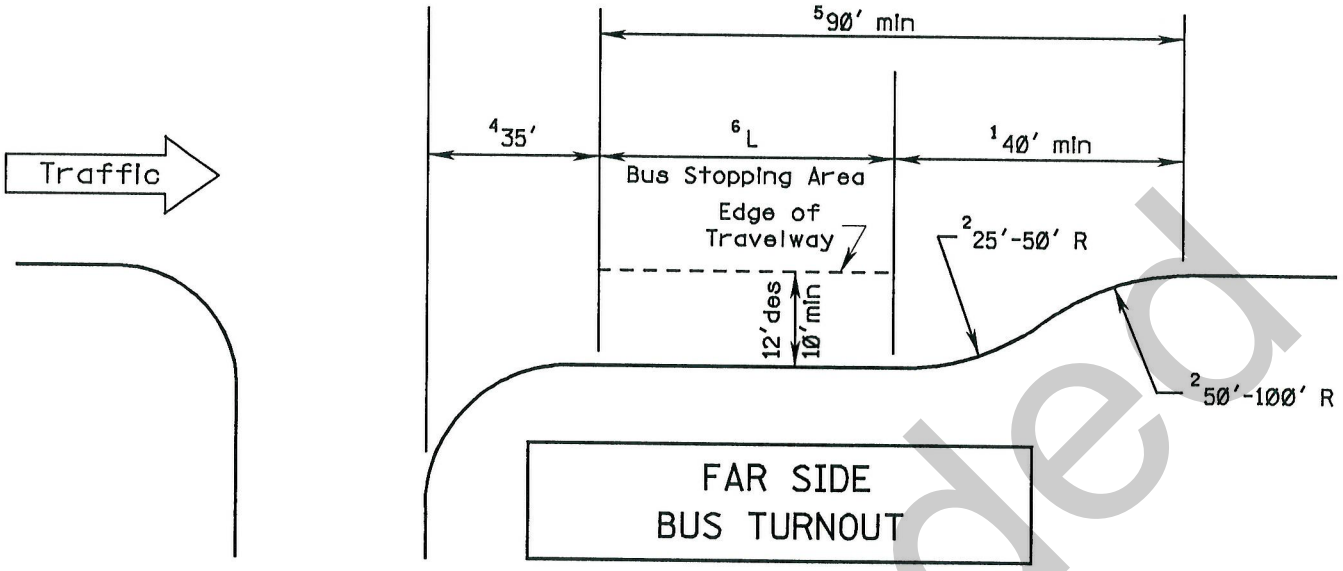
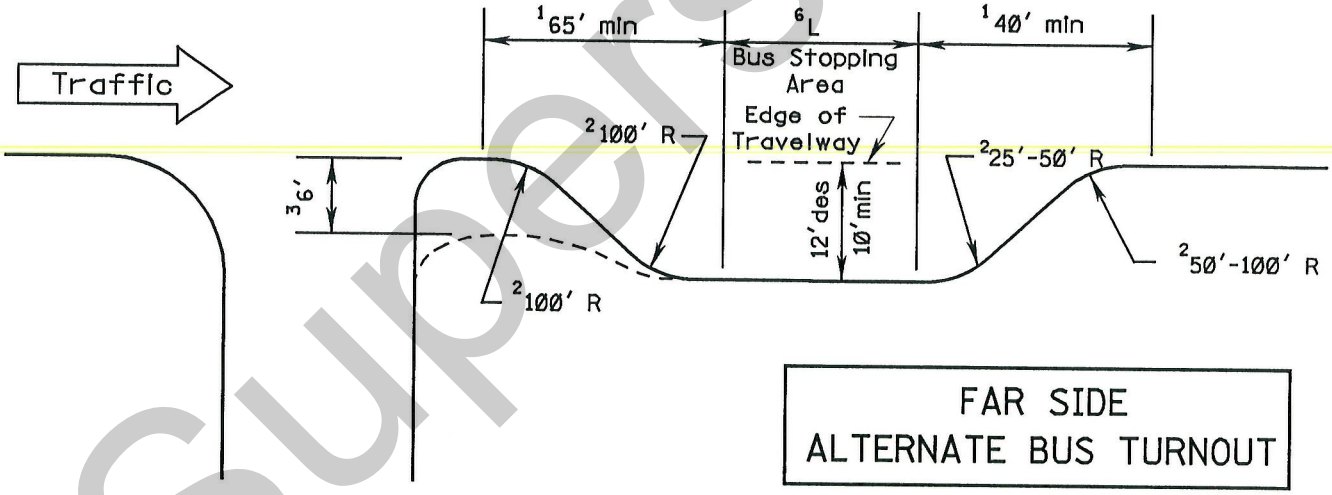


FAR SIDE
BUS TURNOUT



FAR SIDE
ALTERNATE BUS TURNOUT

[1] Desirable taper and acceleration/deceleration lengths are shown in Table 6-4

[2] Use 300'R with 100' tangent separation when providing taper lengths

[3] A partial corner projection may be used in lieu of extending the curbline to the edge of the through lane

[4] NJSA 39:4.138e No stopping or standing within 25' of a crosswalk or side line of a street at least 35' from the curbline

[5] Bus turnout standards based on recommendations of the Institute of Traffic Engineering and studies conducted by the Bureau of Traffic Engineering

[6] See Section 6-10.4 to determine minimum length (L) of bus stopping area

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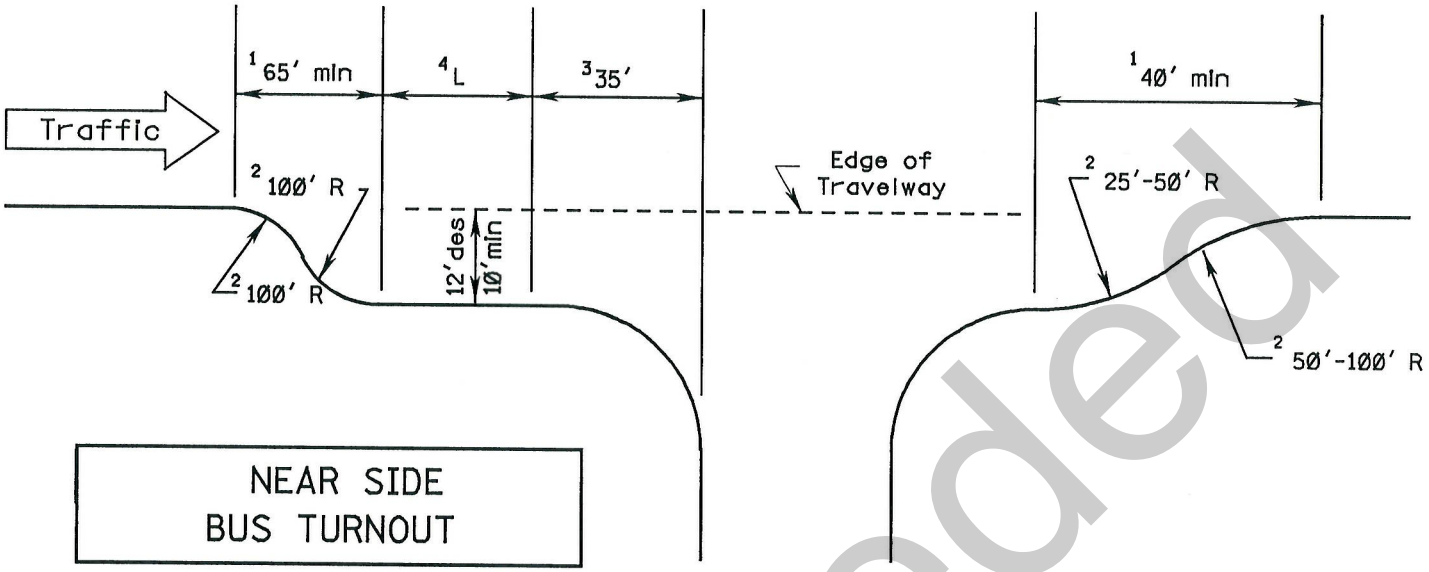
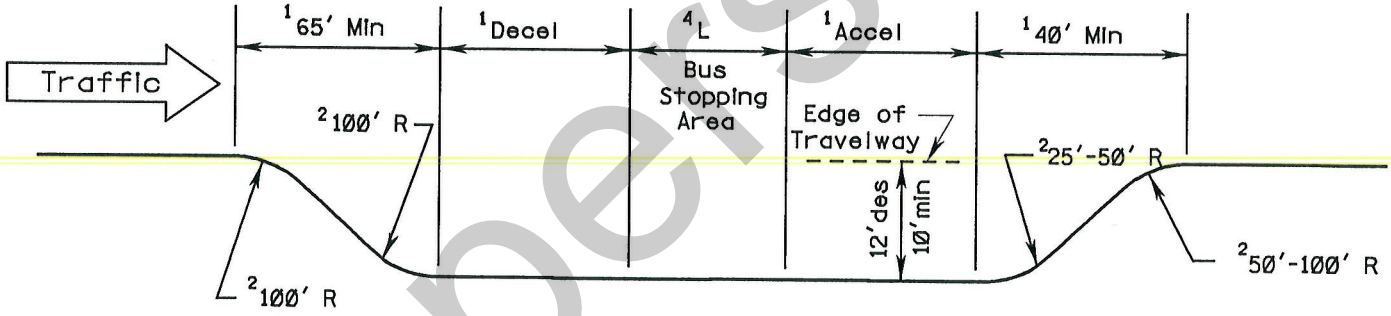
TYPICAL BUS TURNOUTS

FIGURE: 6-Y

DATE: 02/06/98



NEAR SIDE BUS TURNOUT



MID-BLOCK BUS TURNOUT

[1] Desirable taper and acceleration/deceleration lengths are shown in Table 6-4

[2] Use 300'R with 100' tangent separation when providing taper lengths

[3] NJSA 39:4.138e No stopping or standing within 25' of a crosswalk or side line of a street at least 35' from the curbline

[4] See Section 6-10.4 to determine minimum length (L) of bus stopping area

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As a minimum, bus turnouts may be constructed without acceleration and deceleration lanes when it is not practical to provide the above lengths. However, the designer should attempt to provide as much acceleration and deceleration lane length as practical.

The taper lengths shown in the Table are desirable. Minimum entrance and exit tapers shown in Figure 6-X and 6-Y may be provided when it is not practical to provide those shown in the Table. The minimum lengths of taper are applicable with or without acceleration or deceleration lanes.

The pavement cross slope in the bus turnout shall be one half (1/2) percent greater than the adjacent through lane. On superelevated roadway sections, the pavement cross slope shall be the same as the adjacent through lane. When conditions dictate maintaining drainage flow in the existing gutter, the bus turnout may be sloped toward the gutter line at 1.5 to 2.0 percent.

The width of the sidewalk in the bus loading area shall be a minimum of 7 feet and desirably 12 feet The width of the sidewalk approaching the loading area shall conform to Section 5-07.2. Sidewalk shall be provided where there is no existing sidewalk approaching the bus loading area. A survey of pedestrian traffic should be used in establishing a reasonable limit for the proposed sidewalk..

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Table 6-3
Jughandle (Ramp) Superelevation (%)

Design Speed km/h	Radius (meters)					
	15	25	45	70	100	150
	Superelevation (%)					
20	2-6	2-6	2-5	2-4	2-3	2-3
30	---	2-6	2-6	2-6	2-4	2-3
40	---	---	4-6	3-6	3-6	3-5
50	---	---	---	6	5-6	4-6

Exceptions to the use of full superelevation are at street intersections where a stop or yield condition is in effect.

The length of superelevation transition should be based on a maximum distribution rate of 2 percent per second of time for the design speed. With respect to the beginning and ending of a curve on the ramp proper (not including terminals), two-thirds of the full superelevation rate should be provided at the beginning and ending of the curve. This may be altered as required to adjust for flat spots or unsightly sags and humps when alignment is tight. The principal criteria is the development of smooth-edge profiles that do not appear distorted to the driver.

See Section 7-06.2, "Ramp Terminals", for a discussion on development of superelevation at free-flow ramp terminals and the maximum algebraic difference in cross slope at crossover line.

6-09 OTHER CONSIDERATIONS

6-09.1 Parking Restrictions At Intersections

Vehicular parking should not be permitted within the immediate limits of at-grade intersections; see Section 6-03, "Sight Distance", for sight distance requirements at intersections.

6-09.2 Lighting At Intersections

Lighting affects the safety of highway and street intersections and the ease and comfort of traffic operations. In urban and suburban areas where there are concentrations of pedestrians and roadside and intersection interferences, fixed-source lighting tends to reduce accidents. Whether or not rural at-grade intersections should be lighted depends on the planned geometrics and the turning traffic volumes involved. Intersections that generally do not require channelization are seldom lighted. However, for the benefit of non-local highway users, lighting at rural intersections is desirable to aid the driver in ascertaining sign messages during non-daylight period.

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Intersections with channelization, particularly with multiple-road geometrics, should include lighting. Large channelized intersections especially need illumination because of the higher range of turning radii that are not within the lateral range of vehicular headlight beams. Vehicles approaching the intersection also must reduce speed. The indication of this need should be definite and visible at a distance from the intersection that may be beyond the range of headlights. Illumination of at-grade intersections with fixed-source lighting accomplishes this need.

See Section 11, "Roadway Lighting Systems", for guidelines in the planning and design of roadway lighting systems.

6-10 BUS TURNOUTS

6-10.1 Introduction

To reduce conflicts on state highways between through traffic and buses stopped to receive and/or discharge passengers, bus turnouts may be provided on landservice highways when the outside shoulders on the highway are less than 3 m in width. The designer shall in conjunction with the transit agency providing service along the highway determine the locations of the bus turnouts.

6-10.2 Location Criteria

When it has been determined that bus turnouts are warranted, the following criteria should be used to select the bus turnout location(s):

1. Desirably there should not be any driveways within the bus turnout. As a minimum, there shall be no driveways located within the bus stopping area. Driveways may be located within the acceleration and deceleration portion of the bus turnout including the taper. However to minimize conflicts between the vehicles using the driveway and the bus, the bus stopping area should desirably be located on the far side of the driveway.
2. The vertical and horizontal highway geometry meets current stopping sight distance criteria.
3. The bus turnouts should be located where patrons may park and cross roadways legally and safely. Desirably bus turnouts should be located within 120 m of an intersection or parking areas used by the bus patrons. Alternatives including review and possible modification of parking regulations may be considered.
4. There is sufficient right-of-way available, or if required, would not involve the acquisition of developed parcels or environmentally sensitive parcels.
5. The bus stop is close to the points of origins and/or destinations of the transit rider. Locations convenient to park "n" ride facilities, intermodal transfer facilities and transfer facilities between bus services are desirable.
6. Access to and from the bus stop is convenient to well lit pedestrian crossings, crosswalks or signalized crossings.

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7. A bus turnout may be placed on the far side or near side of an intersection, or at mid-block. When placed at intersections, locating the bus turnout on the far side is preferred. Near side bus turnouts create conflicts with right turning traffic, obscures pedestrian view of oncoming traffic, and may obscure a driver's view of signs, traffic control devices and pedestrians. Mid-block turnouts may be provided when there is a need to service a major pedestrian traffic generator (i.e. shopping mall, school, railroad station, hospital, etc.).
8. The location of the bus turnouts conform to local ordinances.

6-10.3 Other Considerations

In addition to the location criteria noted in Section 6-10.2, the following features should be considered when selecting bus turnout locations:

1. Utility and signal poles - The relocation of utility poles could require the acquisition of additional right-of-way, and depending upon the type of service provided involve excessive relocation costs. The location of the bus turnouts at intersections could involve costly signal relocations and when placed on the near side of the intersection stopped buses could obscure the signals.
2. Drainage - To avoid splashing of bus riders turnouts should not be located at low points in the vertical alignment. Also, additional inlets may be necessary to limit the spread in the gutter to 1 m. Grades should be checked to avoid ponding where pavement cross slope exceeds the longitudinal slope in the turnout.
3. Guide rail - Openings in guide rail located along the curbline may not be permitted due to inadequate length of need or the inability to provide the proper end treatment.
4. Signing - The location of the bus turnout could interfere with the visibility of regulatory, warning and/or directional signs. The relocation of existing signs and/or the installation of new signs including bus stop signs shall be coordinated with the Bureau of Traffic Signals and Safety.
5. Handicapped ramps - When the construction of a bus turnout impacts an existing handicapped ramp(s) at an intersection, the designer shall assess the entire intersection to determine if the remaining handicapped ramps will be compatible.
6. Curb - Curb shall be provided at all bus turnouts. The curb height shall conform to Section 5-06.
7. The pavement section for widening or reconstruction of shoulders for bus turnouts should be determined by Geotechnical Engineering.

6-10.4 Bus Turnout Design Criteria

Figure 6-X illustrates typical bus turnout designs for a far side and an alternate far side bus turnout. Figure 6-Y illustrates a typical near side and mid-block bus turnout. When a far side bus turnout is to be provided, the alternate far side bus turnout should

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be considered at intersections where there is a high volume of traffic making right turns that may use the bus turnout as an auxiliary lane.

The bus stopping areas shall be a minimum of 15 m in length for each standard 12 m bus and 21 m for every 18 m bus expected to use the bus turnout. When more than one bus is expected to use the turnout simultaneously, the length of the bus stopping area should be adjusted accordingly. Desirably the width of the bus stopping area including the acceleration and deceleration lanes should be 3.6 m. Where it is not practical to provide the 3.6 m width, a minimum width of 3 m may be provided to reduce right-of-way or environmental impacts.

Bus turnouts generally consist of entrance and exit tapers, deceleration and acceleration lanes, and a bus stopping area. The length of the tapers and the deceleration and acceleration lanes vary depending on the posted speed of the highway. Table 6-4 provides the desirable lengths. The use of lengths less than those shown in Table 6-4 may cause delays to the transit service and adversely impact the traffic flow on the highway.

Table 6-4

Posted Speed (mph)	Length of Acceleration Lane	Length of Deceleration Lane	Length of Entrance and Exit Tapers
35	75 m	55 m	50 m
40	120 m	80 m	55 m
45	210 m	110 m	65 m
50	295 m	140 m	70 m
55	420 m	180 m	75 m

Source: TCRP Report 19, Guidelines for the Location and Design of Bus Stops

As a minimum bus turnouts may be constructed without acceleration and deceleration lanes when it is not practical to provide the above lengths. However, the designer should attempt to provide as much acceleration and deceleration lane length as practical.

The taper lengths shown in the Table are desirable. Minimum entrance and exit tapers shown in Figure 6-X and 6-Y may be provided when it is not practical to provide those shown in the Table. The minimum lengths of taper are applicable with or without acceleration or deceleration lanes.

The pavement cross slope in the bus turnout shall be one half (½) percent greater than the adjacent through lane. On superelevated roadway sections, the pavement cross slope shall be the same as the adjacent through lane. When conditions dictate

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TYPICAL BUS TURNOUTS

FIGURE: 6-X

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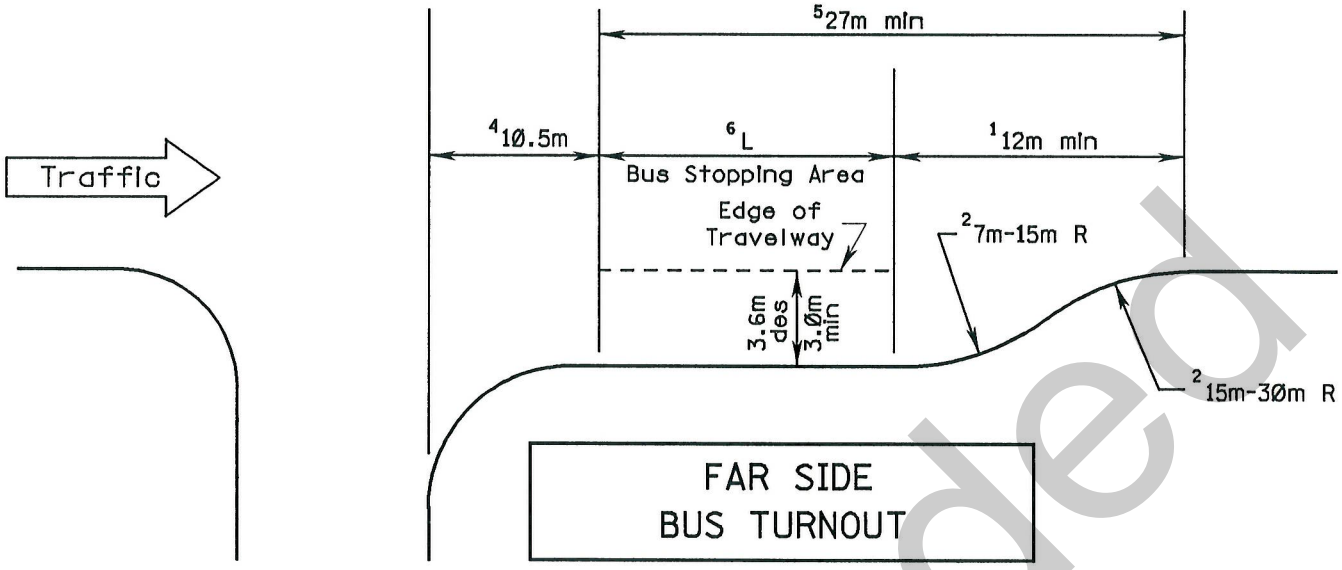
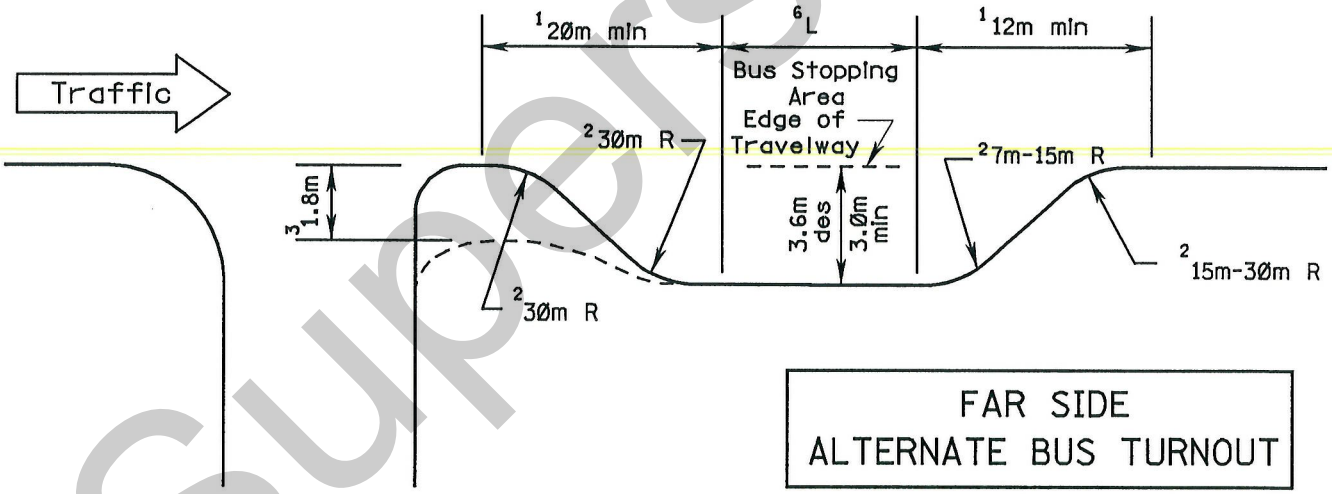


FAR SIDE
BUS TURNOUT



FAR SIDE
ALTERNATE BUS TURNOUT

[1] Desirable taper and acceleration/deceleration lengths are shown in Table 6-4

[2] Use 90m R with 30m tangent separation when providing taper lengths

[3] A partial corner projection may be used in lieu of extending the curbline to the edge of the through lane

[4] NJSA 39:4.138e No stopping or standing within 7.5m of a crosswalk or side line of a street at least 10.5m from the curbline

[5] Bus turnout standards based on recommendations of the Institute of Traffic Engineering and studies conducted by the Bureau of Traffic Engineering

[6] See Section 6-10.4 to determine minimum length (L) of bus stopping area

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TYPICAL BUS TURNOUTS

FIGURE: 6-Y

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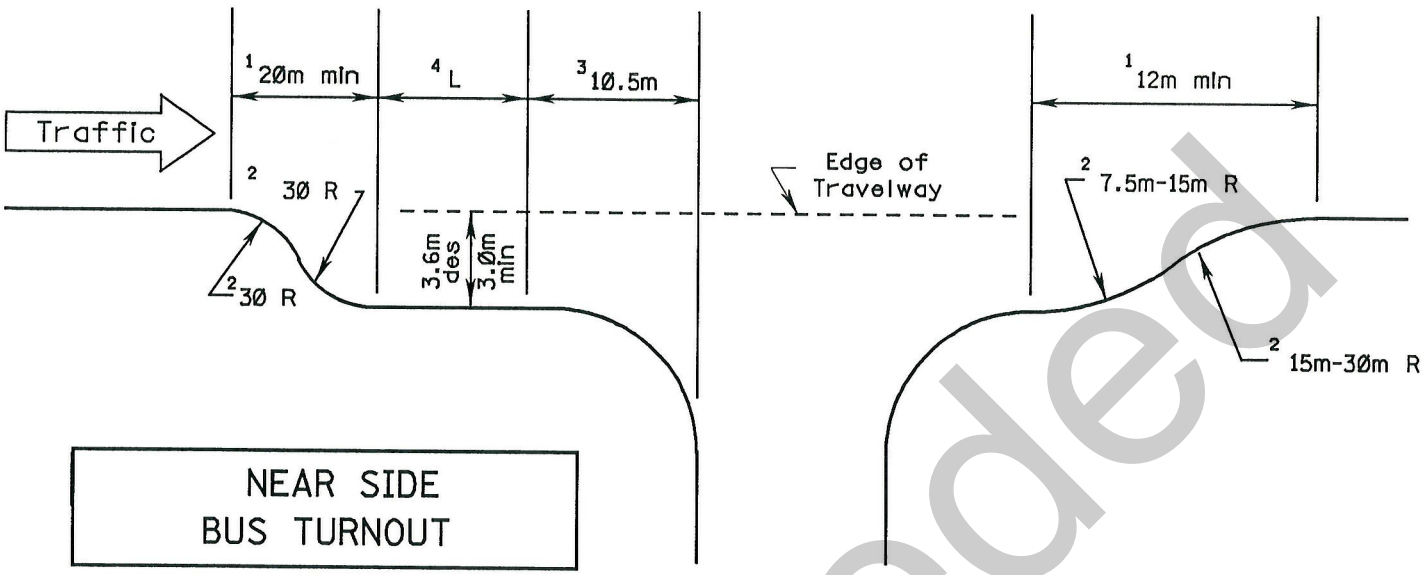
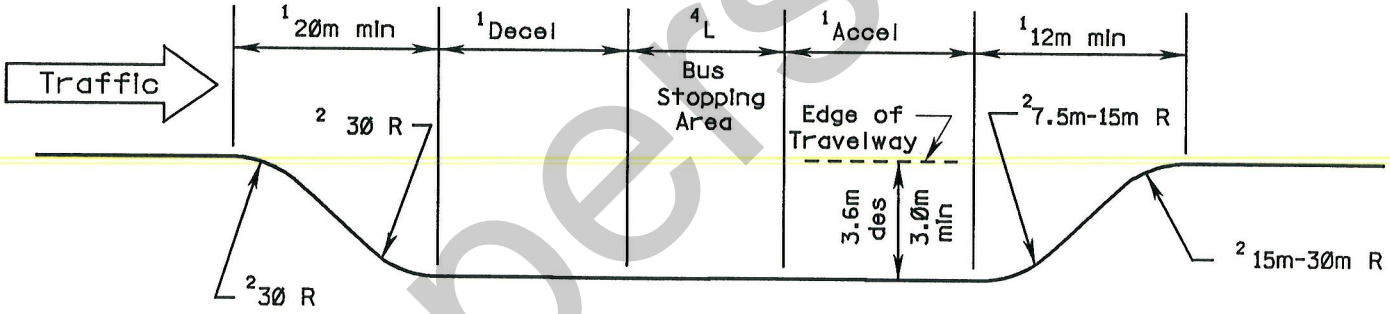


NEAR SIDE
BUS TURNOUT



MID-BLOCK
BUS TURNOUT

[1] Desirable taper and acceleration/deceleration lengths are shown in Table 6-4

[2] Use 90m with 30m tangent separation when providing taper lengths

[3] NJSA 39:4.138e No stopping or standing within 7.5m of a crosswalk or side line of a street at least 10.5m from the curbline

[4] See Section 6-10.4 to determine minimum length (L) of bus stopping area

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maintaining drainage flow in the existing gutter, the bus turnout may be sloped toward the gutter line at 1.5 to 2.0 percent.

The width of the sidewalk in the bus loading area shall be a minimum of 2.1 m and desirably 3.6 m. The width of the sidewalk approaching the loading area shall conform to Section 5-07.2. Sidewalk shall be provided where there is no existing sidewalk approaching the bus loading area. A survey of pedestrian traffic should be used in establishing a reasonable limit for the proposed sidewalk.

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