Turn Lane Warrant Analysis for Proposed Entrance

Multi-Family Development
30-R at CRC
Research Center Drive

Town of Blacksburg, Virginia

March 30, 2018

PREPARED FOR:
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Introduction

This study was completed by Parker Design Group, Inc. (PDG) for SAS Construction to support the multi-family development known as 30-R at CRC. This study was completed to determine if a right and/or left turn lane is warranted for the proposed development to be located on Research Center drive in Blacksburg, VA. Included herein is a description of the analysis completed and conclusions made by PDG.

Existing Conditions

Existing Traffic Data – Research Center Drive
Considering the only VDOT published traffic data available represented traffic at the interchange of US-460, PDG engaged their consultant to acquire traffic data at the proposed entrance location. This data was acquired over a 24-hour period in which Virginia Tech students were in session on Tuesday, January 22, 2018. This data can be found in Appendix A along with the computations that resulted in the following:

Annual Average Daily Traffic	AADT:	3,003
Peak Hour Factor	K:	0.111888
Peak Hour Traffic Volume (Calculated)	PHV:	336
Peak Directional Factor	D:	0.699324
Peak Hour Directional Volume (Calculated)		235

In an effort to further support the acquired traffic data, PDG compared the acquired data with published data at the interchange. We believe the data that was acquired is reflective of what is published, considering it is approximately 50% of the volumes at the interchange. With intersections of Kraft Drive and Knollwood Community between the interchange and the proposed development, we have concluded the above data is a good representation of the existing traffic volumes.

This section of Research Center Drive is posted 25 mph.

Existing Site Trip Generation
The existing site is undeveloped and generates no traffic.

Existing Traffic Patterns
The existing site is located on the western side of Research Center Drive. The lane configuration on Research Center Drive consists of a two-lane road with no median or limited access.

Analysis and Results

Proposed Site Trip Generation

The proposed use is a 207-unit multi-family development consisting of three separate buildings with maximum of five stories each. More specifically described as ITE use #221, Multi-Family Housing (Mid-rise). The 10th Edition ITE Trip Generation values stated below are used to generate the proposed trips.

Per Unit:		
Weekday:	5.44	trips per day
Saturday:	4.91	trips per day
Sunday:	4.09	trips per day
AM Peak Hour:	0.36	trips per hour
Weekday AM:	0.32	trips per hour
PM Peak Hour:	0.44	trips per hour
Weekday PM:	0.41	trips per hour
Sat. Peak Hour:	0.44	trips per hour
Sun. Peak Hour:	0.39	trips per hour

The proposed trips entering/exiting the site are as follows.

Proposed Trips for New Development		
1,126	Weekday	
1,016	Saturday	
847	Sunday	
75	Peak Hour AM (7-9)	
66	AM	
91	Peak Hour PM (4-6)	
85	PM	
91	per hour (Saturday)	
81	per hour (Sunday)	

Proposed Directional Splits

Directional volumes were determined for left and right turn movements or Weekday AM and PM peak hours by applying the following:

- In order to calculate the directional splits for this development the following steps were used during peak travel hours (7-9AM & 4-6PM):
    - During peak travel hours, trips from the northbound and southbound lanes were recorded in 15-minute intervals.
    - The percentage of trips in both directions were calculated and averaged in order to determine the peak direction.
    - The Total peak hour volume was calculated by dividing the total trips within the two-hour span.
    - The AM peak hour factor was calculated by dividing the total peak hour volume by the total daily trips.

- The peak direction for this development in the AM & PM is North & South respectively. Summary of calculations are located in Appendix A.

- Entering/Exiting Split: The ITE Trip Generation Manual specifies the splits for this use is as follows:
  - Weekday Peak Hour AM Adjacent Traffic: 26% entering / 74% Exiting
  - Weekday Peak Hour PM Adjacent Traffic: 61% entering / 39% Exiting
  - Saturday Peak Hour Generator: 51% entering / 49% Exiting

Turning Movements for Design

Applying the ITE Trips generated and the directional splits for the proposed development, the turning trips for use in evaluating the left turn and right turn lane warrants were calculated as follows:

Right Turn Lane

Determine Peak Hour Volume Turning Right into Site during AM Peak Hour			
Directional Split for AM Peak:	Entering	0.26	(from ITE Manual)
	Exiting	0.74	(from ITE Manual)
Generated AM Peak Hour Traffic:		75	(from Trip Generation Calcs)
Trips Entering Site:		19	
Split for Right Turns into Site:		0.30	(based on directional factor)
Calculated Right Turn Volume:		**6**	vph
Approaching Volume:		**101**	vph

Determine Peak Hour Volume Turning Right into Site during PM Peak Hour			
Directional Split for PM Peak:	Entering	0.61	(from ITE Manual)
	Exiting	0.39	(from ITE Manual)
Generated PM Peak Hour Traffic:		91	(from Trip Generation Calcs)
Trips Entering Site:		56	
Split for Right Turns into Site:		0.70	(based on directional factor)
Calculated Right Turn Volume:		**39**	vph
Approaching Volume:		**235**	vph

Left Turn Lane

Determine Peak Hour Volume Turning Left into Site during AM Peak Hour			
Directional Split for PM Peak:	Entering	0.26	(from ITE Manual)
	Exiting	0.74	(from ITE Manual)
Generated AM Peak Hour Traffic:		75	(from Trip Generation Calcs)
Trips Entering Site:		19	
Split for Left Turns into Site:		0.70	(based on directional factor)
Calculated Left Turn Volume:		14	vph
Advancing Volume:		**235**	vph
Opposing Volume:		**101**	vph
% Left Turn Volume (L):		**6**	%

Determine Peak Hour Volume Turning Left into Site during PM Peak Hour					
Directional Split for PM Peak:	Entering	0.61	(from ITE Manual)		
	Exiting	0.39	(from ITE Manual)		
Generated PM Peak Hour Traffic:		91	(from Trip Generation Calcs)		
Trips Entering Site:		56			
Split for Left Turns into Site:		0.30	(based on directional factor)		
Calculated Left Turn Volume:		17	vph		
Advancing Volume:		**101**	vph		
Opposing Volume:		**235**	vph		
% Left Turn Volume (L):		**17**	%		

Left Turn Lane Warrant Analysis & Recommendation
Entering the parameters into Figure 3-5 *"Warrants for Left Turn Storage Lanes on Two-Lane Highways"*, using the A.M. left-turn volume of 14 vph (V_L) and opposing volume of 101 vph (V_O), results in a left-turn lane not being required. The VDOT warrant figures are found in Appendix C.

Entering the parameters into Figure 3-8 *"Warrants for Left Turn Storage Lanes on Two-Lane Highways"*, using the P.M. left-turn volume of 17 vph (V_L) and opposing volume of 235 vph (V_O), results a left-turn lane not being required. The VDOT warrant figures are found in Appendix C.

Right Turn Lane Warrant Analysis & Recommendation
Entering the parameters into Figure 3-26 *"Warrants for Right Turn Treatment (2-Lane Highway)"*, using the A.M. right-turn volume of 6 vph and approach volume of 101 vph, results in a taper and right-turn lane not being required. The VDOT warrant figures are found in Appendix C.

Entering the parameters into Figure 3-27 *"Warrants for Right Turn Treatment (2-Lane Highway)"*, using the P.M. right-turn volume of 39 vph and approach volume of 235 vph, results in a taper and right-turn lane not being required. The VDOT warrant figures are found in Appendix C.

Conclusion

Based on estimations, assumptions, and calculations presented herein, the need for right turn lanes, left turn lanes, and tapers are not warranted.

Appendix A

Existing Traffic Data

Prepared for Parker Design Group

WEEKLY SUMMARY FOR LANE 1 Page: 1
Starting: 1/23/2018

Station: 000000010739
ID: 000000010739
Location: Research Ctr, btw Knollwood & Sheliah
Direction: NORTH

File: Research Ctr, btw Knollwood & Sheliah.PRN
City: 18-018 TO Min
County: 37.20284, -80.40584

TIME	MON		TUE		WED		THU		FRI		SAT		SUN		WK TOT		WK AVG	
			23															
Lane 1	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
00:15			1	22											1	22	1	22
00:30			0	34											0	34	0	34
00:45			1	15											1	15	1	15
01:00			2	34											2	34	2	34
01:15			0	30											0	30	0	30
01:30			0	20											0	20	0	20
01:45			1	23											1	23	1	23
02:00			0	24											0	24	0	24
02:15			0	14											0	14	0	14
02:30			0	20											0	20	0	20
02:45			0	10											0	10	0	10
03:00			0	19											0	19	0	19
03:15			0	23											0	23	0	23
03:30			0	23											0	23	0	23
03:45			1	17											1	17	1	17
04:00			3	19											3	19	3	19
04:15			0	23											0	23	0	23
04:30			0	21											0	21	0	21
04:45			2	24											2	24	2	24
05:00			3	28											3	28	3	28
05:15			2	33											2	33	2	33
05:30			2	33											2	33	2	33
05:45			4	45											4	45	4	45
06:00			2	28											2	28	2	28
06:15			4	9											4	9	4	9
06:30			3	12											3	12	3	12
06:45			6	6											6	6	6	6
07:00			17	12											17	12	17	12
07:15			19	13											19	13	19	13
07:30			22	11											22	11	22	11
07:45			68	7											68	7	68	7
08:00			90	4											90	4	90	4
08:15			60	5											60	5	60	5
08:30			49	8											49	8	49	8
08:45			56	6											56	6	56	6
09:00			50	6											50	6	50	6
09:15			41	5											41	5	41	5
09:30			38	7											38	7	38	7
09:45			18	4											18	4	18	4
10:00			23	2											23	2	23	2
10:15			13	2											13	2	13	2
10:30			25	7											25	7	25	7
10:45			14	6											14	6	14	6
11:00			14	5											14	5	14	5
11:15			7	1											7	1	7	1
11:30			11	2											11	2	11	2
11:45			14	4											14	4	14	4
12:00			20	1											20	1	20	1
TOTALS			1433												1433		1433	
AM Times			07:45												07:45		07:45	
AM Peaks			267												267		267	
AM PHF			0.74												0.74		0.74	
PM Times			17:00												17:00		17:00	
PM Peaks			139												139		139	
PM PHF			0.77												0.77		0.77	

WEEKLY SUMMARY FOR LANE 2 Page: 2
Starting: 1/23/2018

Station: 000000010739
ID: 000000010739
Location: Research Ctr, btw Knollwood & Sheliah
Direction: SOUTH

File: Research Ctr, btw Knollwood & Sheliah.PRN
City: 18-018 TO Min
County: 37.20284, -80.40584

TIME	MON		TUE		WED		THU		FRI		SAT		SUN		WK TOT		WK AVG	
			23															
Lane 2	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm
00:15			7	42											7	42	7	42
00:30			4	24											4	24	4	24
00:45			1	38											1	38	1	38
01:00			0	29											0	29	0	29
01:15			1	19											1	19	1	19
01:30			2	19											2	19	2	19
01:45			0	18											0	18	0	18
02:00			2	19											2	19	2	19
02:15			0	18											0	18	0	18
02:30			1	15											1	15	1	15
02:45			3	26											3	26	3	26
03:00			0	20											0	20	0	20
03:15			0	19											0	19	0	19
03:30			2	23											2	23	2	23
03:45			1	41											1	41	1	41
04:00			0	35											0	35	0	35
04:15			0	35											0	35	0	35
04:30			1	42											1	42	1	42
04:45			0	54											0	54	0	54
05:00			1	68											1	68	1	68
05:15			0	117											0	117	0	117
05:30			0	97											0	97	0	97
05:45			1	67											1	67	1	67
06:00			2	58											2	58	2	58
06:15			2	26											2	26	2	26
06:30			0	13											0	13	0	13
06:45			2	14											2	14	2	14
07:00			2	14											2	14	2	14
07:15			14	14											14	14	14	14
07:30			6	16											6	16	6	16
07:45			20	10											20	10	20	10
08:00			24	5											24	5	24	5
08:15			27	13											27	13	27	13
08:30			25	11											25	11	25	11
08:45			23	4											23	4	23	4
09:00			18	13											18	13	18	13
09:15			28	8											28	8	28	8
09:30			22	4											22	4	22	4
09:45			12	9											12	9	12	9
10:00			13	5											13	5	13	5
10:15			14	6											14	6	14	6
10:30			8	3											8	3	8	3
10:45			16	4											16	4	16	4
11:00			10	3											10	3	10	3
11:15			18	4											18	4	18	4
11:30			16	3											16	3	16	3
11:45			17	2											17	2	17	2
12:00			55	2											55	2	55	2
TOTALS			1570												1570		1570	
AM Times			12:00												12:00		12:00	
AM Peaks			159												159		159	
AM PHF			0.72												0.72		0.72	
PM Times			17:00												17:00		17:00	
PM Peaks			349												349		349	
PM PHF			0.75												0.75		0.75	

Average Peak Hour Factor and Directional Factor Calculation

		AM Peak Hour		
		Total	North %	South %
1/23/2018	7:15 AM	33	57.58%	42.42%
1/23/2018	7:30 AM	28	78.57%	21.43%
1/23/2018	7:45 AM	88	77.27%	22.73%
1/23/2018	8:00 AM	114	78.95%	21.05%
1/23/2018	8:15 AM	87	68.97%	31.03%
1/23/2018	8:30 AM	74	66.22%	33.78%
1/23/2018	8:45 AM	79	70.89%	29.11%
1/23/2018	9:00 AM	68	73.53%	26.47%
			71.50%	28.50%
	Total AM Peak Hour Ave Volume			285.5
		AM Peak Hour Factor		9.51%

		PM Peak Hour		
		Total	North %	South %
1/23/2018	4:15 PM	58	39.66%	60.34%
1/23/2018	4:30 PM	63	33.33%	66.67%
1/23/2018	4:45 PM	78	30.77%	69.23%
1/23/2018	5:00 PM	96	29.17%	70.83%
1/23/2018	5:15 PM	150	22.00%	78.00%
1/23/2018	5:30 PM	130	25.38%	74.62%
1/23/2018	5:45 PM	112	40.18%	59.82%
1/23/2018	6:00 PM	86	32.56%	67.44%
			31.63%	68.37%
	Total PM Peak Hour Ave Volume			386.5
		PM Peak Hour Factor		12.87%

$$Average\ Peak\ Hour\ Factor\ (K) = \frac{AM\ Peak\ Hour\ Factor + PM\ Peak\ Hour\ Factor}{2}$$

$$= \frac{0.0951 + 0.1287}{2} = 0.111888$$

$$Peak\ Direction\ AM: North$$
$$Peak\ Direction\ PM: South$$

$$Directional\ Factor = \frac{AM\ Peak\ Direction\ Trip\ Percentage + PM\ Peak\ Direction\ \ Trip\ Percentage}{2} =$$

$$\frac{0.7150 + 0.6837}{2} = 0.699324$$

Appendix B

Trip Generation Calculations

Trip Generation Calculation

Date: 11-Jan-2018
WO #: 17-0117
By: SLR

R30 CRC Residential - Town of Blacksburg

Use Classification	Future Trips			Daily Trips vs. Unit			Calculated Daily Trips			Peak Hour Trips vs. Units						Calculated Peak Hour Trips					
	ITE Use #	ITE Use Description	Number of Units	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday	Weekday 7-9AM [1]	Weekday AM Gen.	Weekday 4-6PM [2]	Weekday PM Gen.	Saturday	Sunday	Weekday 7-9AM [1]	Weekday AM Gen.	Weekday 4-6PM [2]	Weekday PM Gen.	Saturday	Sunday
Residential	221	Multifamily Housing (Mid-Rise)	207	5.44	4.91	4.09	1,126	1,016	847	0.36	0.32	0.44	0.41	0.44	0.39	75	66	91	85	91	81
		Totals					1,126	1,016	847							75	66	91	85	91	81

	Existing Trips			Daily Trips vs. Occupied Units			Calculated Daily Trips			Peak Hour Trips vs. Occupied Units						Calculated Peak Hour Trips					
	ITE Use #	ITE Use Description	Occupied Units	Weekday	Saturday	Sunday	Weekday	Saturday	Sunday	Weekday 7-9AM [1]	Weekday AM Gen.	Weekday 4-6PM [2]	Weekday PM Gen.	Saturday	Sunday	Weekday 7-9AM [1]	Weekday AM Gen.	Weekday 4-6PM [2]	Weekday PM Gen.	Saturday	Sunday
Vacant																					
		Totals																			
	Trip Increase						1,126	1,016	847							75	66	91	85	91	81

[1] Peak Hour of Adjacent Street Traffic, One Hour Between 7 and 9AM
[2] Peak Hour of Adjacent Street Traffic, One Hour Between 4 and 6PM
[3] Trip Generation based on total square footage of use

###	ITE Trip Generation Manual requires caution when utilizing these values because of small data sets
###	ITE

Appendix C

Left/Right Warrant Analysis

WARRANT FOR LEFT-TURN STORAGE LANES ON TWO-LANE HIGHWAY

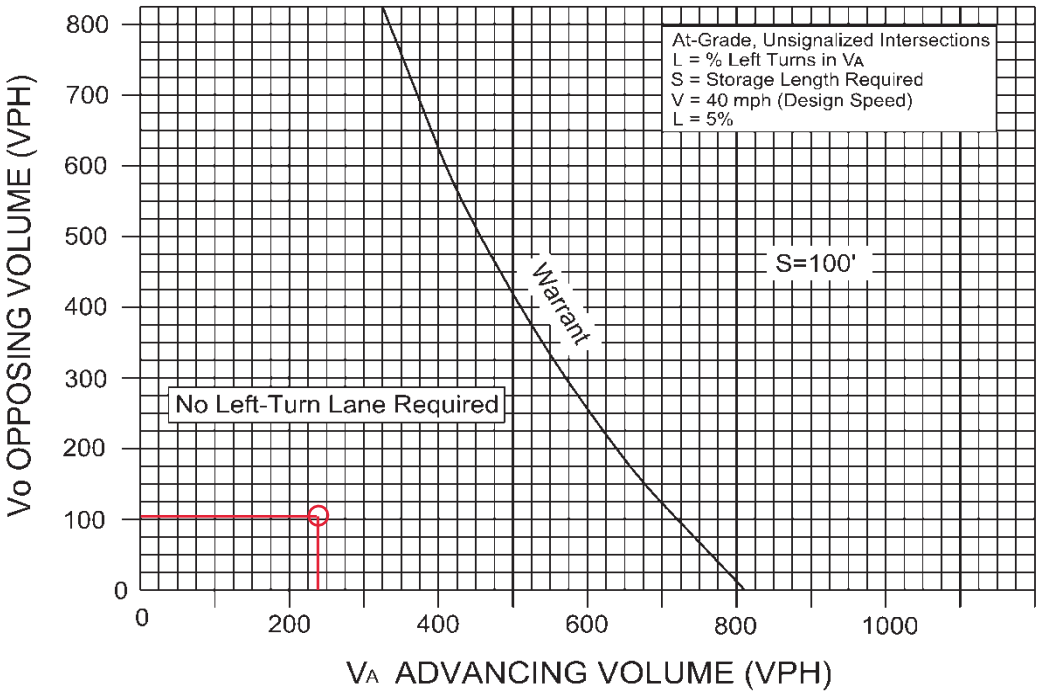


FIGURE 3-5

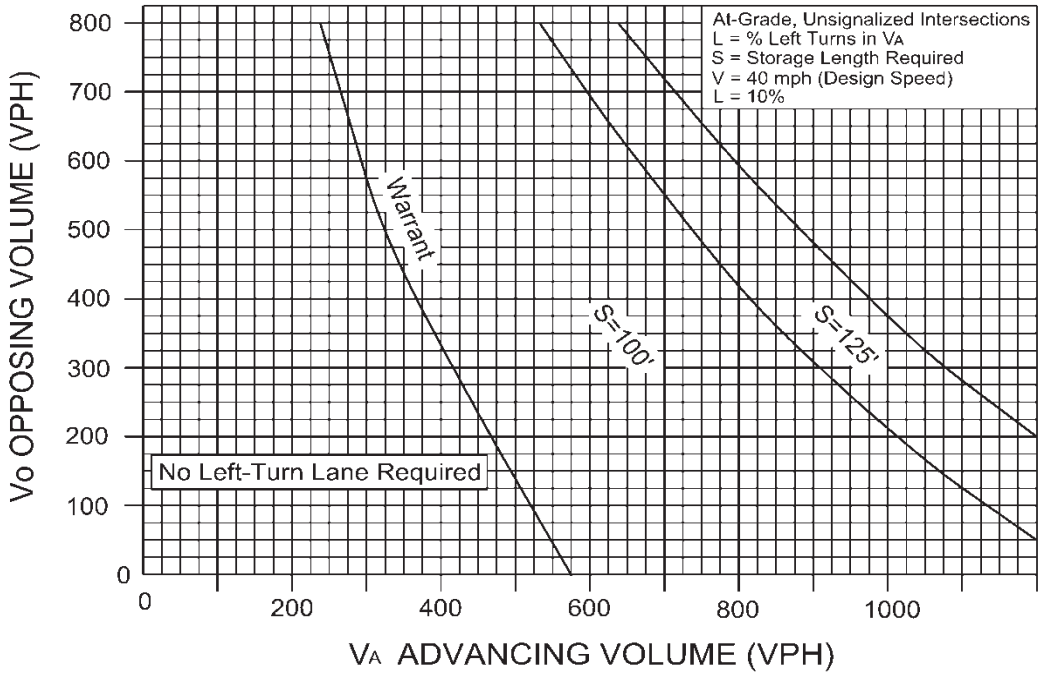


FIGURE 3-6

WARRANT FOR LEFT-TURN STORAGE LANES ON TWO-LANE HIGHWAY

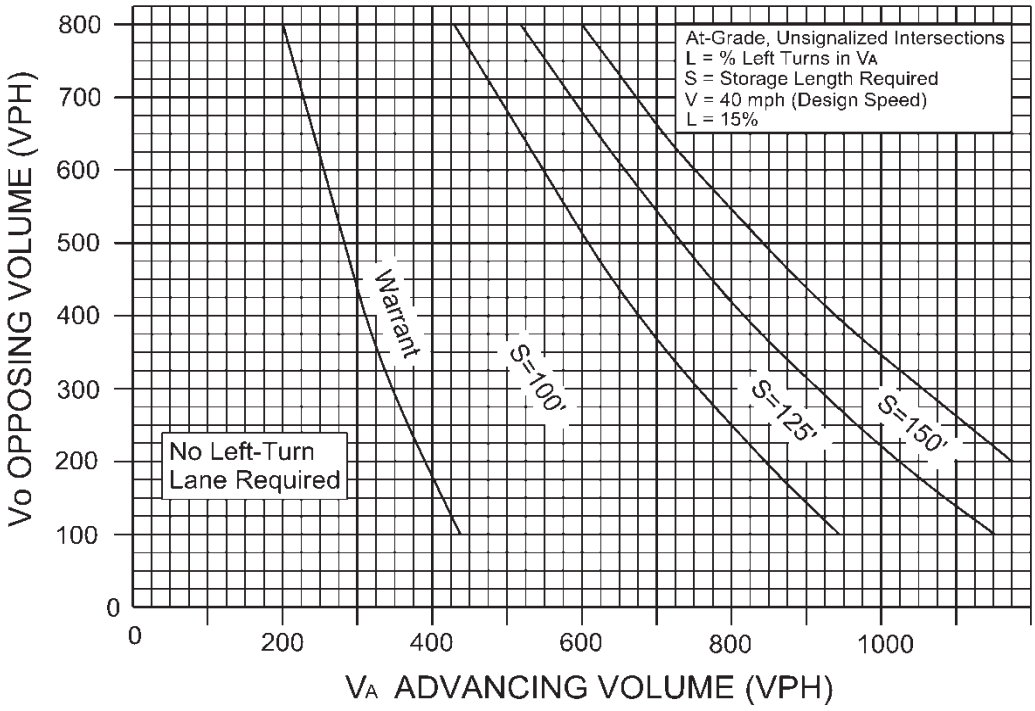


FIGURE 3-7

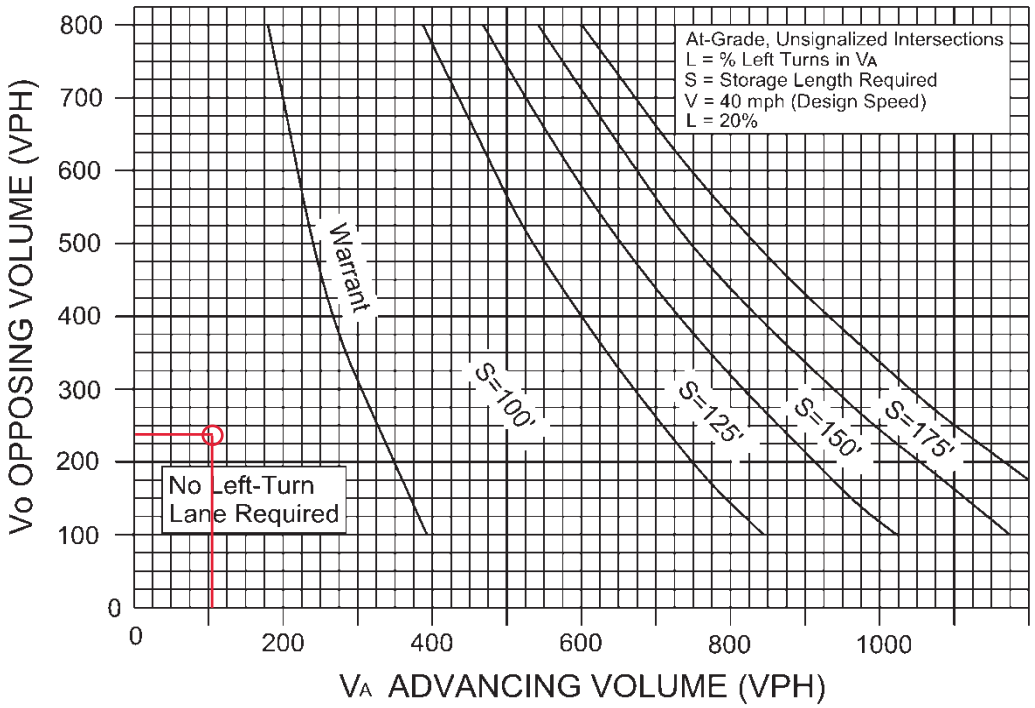
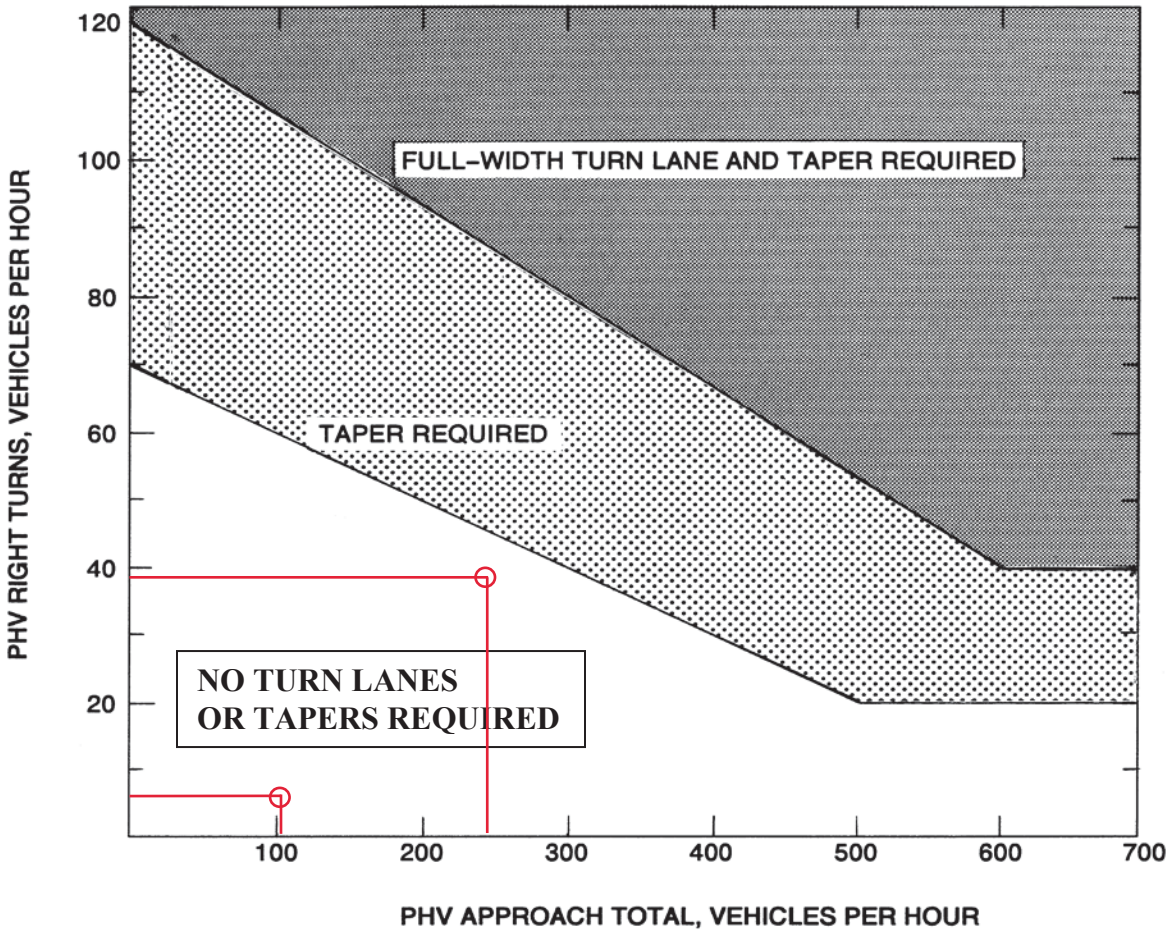


FIGURE 3-8



Appropriate Radius required at all Intersections and Entrances (Commercial or Private).

LEGEND

PHV - Peak Hour Volume (also Design Hourly Volume equivalent)

Adjustment for Right Turns

For posted speeds at or under 45 mph, PHV right turns > 40, and PHV total < 300.
Adjusted right turns = PHV Right Turns - 20
If PHV is not known use formula: PHV = ADT x K x D

K = the percent of AADT occurring in the peak hour
D = the percent of traffic in the peak direction of flow

Note: An average of 11% for K x D will suffice.

When right turn facilities are warranted, see Figure 3-1 for design criteria.*

FIGURE 3-26 WARRANTS FOR RIGHT TURN TREATMENT (2-LANE HIGHWAY)

* Rev. 1/15