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MEMORANDUM

DATE: 3/4/2022

TO: Caitlin Dopher
Senior Entitlement Manager
Arbor Homes

FROM: Matt Brown, PE/PTOE
A&F Engineering Co., LLC

RE: Turn Lane Analysis along CR 100 S, Crow Property – Lebanon, Indiana

At the request of the City of Lebanon, A&F Engineering has conducted a turn lane warrant analysis on behalf of Arbor Homes to determine if turn lanes will be needed at the access drives along CR 100 S of the proposed "Crow Property" residential development. As proposed, the development will consist of 547 single-family homes and will be served by two full access drives along CR 100 S.

EXISTING TRAFFIC DATA

As part of this analysis, A&F Engineering conducted a peak hour turning movement traffic count at the intersection of CR 100 S & CR 300 E during a typical weekday in February 2022 under good weather conditions. From this traffic count, the existing eastbound and westbound traffic volumes along CR 100 S were determined for the AM and PM peak hours. The peak hour counts along CR 100 S are summarized in the following table.

Table 1 – Peak Hour Existing Traffic Volumes along CR 100 S

DIRECTION	AM PEAK	PM PEAK
Eastbound	19	48
Westbound	46	36

GENERATED TRAFFIC DATA FROM PROPOSED DEVELOPMENT

An estimate of the generated peak hour traffic volumes from the proposed 547 single-family homes was conducted per the methods published in the ITE *Trip Generation Manual*[1]. **Table 2** shows the estimated AM and PM peak hour trips for the proposed development.

Table 2 – Total Generated New Trips for the Proposed Development

DEVELOPMENT INFORMATION			GENERATED TRIPS			
LAND USE	ITE CODE	SIZE	AM PEAK		PM PEAK	
			ENTER	EXIT	ENTER	EXIT
SINGLE-FAMILY RESIDENTIAL	210	547 DU	91	259	309	182

An assignment and distribution of generated traffic volumes to the access drives was estimated based on existing traffic data, land-use type, and location of the site. The assignment and distribution of generated trips from the proposed development is shown in the following table.

Table 3 – Assignment & Distribution of Generated Trips for the Proposed Development

INTERSECTION	SBL	SBR	EBL	EBT	WBT	WBR
CR 100 S & West Access Drive	28%	62%	62%	5%	5%	28%
CR 100 S & East Access Drive	5%	5%	5%	28%	28%	5%

Note: Black text denotes inbound traffic while red text denotes outbound traffic.

The assignment and distribution percentages were applied to the generated traffic volumes shown in **Table 2** to yield the generated trips along CR 100 S at the proposed access drives. **Table 4** is a summary of these generated trips.

Table 4 – Generated Trips at Proposed Development Access Drives

INTERSECTION	AM PEAK					
	SBL	SBR	EBL	EBT	WBT	WBR
CR 100 S & West Access Drive	72	161	56	5	13	25
CR 100 S & East Access Drive	13	13	5	72	25	5
INTERSECTION	PM PEAK					
	SBL	SBR	EBL	EBT	WBT	WBR
CR 100 S & West Access Drive	51	113	192	15	9	87
CR 100 S & East Access Drive	9	9	15	51	87	15

Note: Black text denotes inbound traffic while red text denotes outbound traffic.

[1] *Trip Generation Manual*, Institute of Transportation Engineers, Eleventh Edition, 2021.

The existing traffic volumes and the generated traffic volumes were summed to yield the total future traffic volumes along CR 100 S at the proposed access drives. The following tables are summaries of the existing, generated, and total future traffic volumes at each access drive.

Table 5 – Traffic Volume Summary: CR 100 S & West Access Drive

TRAFFIC VOLUMES	AM PEAK					
	SBL	SBR	EBL	EBT	WBT	WBR
Existing Traffic Volumes	---	---	---	19	48	---
Generated Traffic Volumes	72	161	56	5	13	25
Total Future Traffic Volumes	72	161	56	24	61	25
TRAFFIC VOLUMES	PM PEAK					
	SBL	SBR	EBL	EBT	WBT	WBR
Existing Traffic Volumes	---	---	---	46	36	---
Generated Traffic Volumes	51	113	192	15	9	87
Total Future Traffic Volumes	51	113	192	61	45	87

Table 6 – Traffic Volume Summary: CR 100 S & East Access Drive

TRAFFIC VOLUMES	AM PEAK					
	SBL	SBR	EBL	EBT	WBT	WBR
Existing Traffic Volumes	---	---	---	19	48	---
Generated Traffic Volumes	13	13	5	72	25	5
Total Future Traffic Volumes	13	13	5	91	73	5
TRAFFIC VOLUMES	PM PEAK					
	SBL	SBR	EBL	EBT	WBT	WBR
Existing Traffic Volumes	---	---	---	46	36	---
Generated Traffic Volumes	9	9	15	51	87	15
Total Future Traffic Volumes	9	9	15	97	123	15

TURN LANE ANALYSIS

The total future traffic volumes were analyzed to determine if turn lanes would be required along CR 100 S at the access drive locations. This analysis was done in accordance with the INDOT *Driveway Permit Manual*[2]. The results are summarized in the following table.

Table 7 – Turn Lane Warrant Results

LOCATION	SCENARIO	RIGHT-TURN	LEFT-TURN LANE
CR 100 S & PROPOSED WEST ACCESS DRIVE	EXISTING TRAFFIC VOLUMES + PROPOSED DEVELOPMENT TRAFFIC VOLUMES	✗	✔
CR 100 S & PROPOSED EAST ACCESS DRIVE	EXISTING TRAFFIC VOLUMES + PROPOSED DEVELOPMENT TRAFFIC VOLUMES	✗	✗

✔ =TURN LANE WARRANTED; ✗ = TURN LANE NOT WARRANTED

Where turn lanes are not shown to be warranted, it should be noted that the City of Lebanon could require turn treatments at these locations based on local standards. The graphs that show the left-turn lane and right-turn lane warrant criteria for each intersection are attached at the end of this memorandum.

RECOMMENDATIONS

Based on the existing traffic volume data, trip generation, assignment and distribution of generated traffic and turn lane analysis the following recommendations are formulated.

CR 100 S & Proposed West Access Drive

- Construction of the southbound access drive with at least one inbound and two outbound lanes that will stop for CR 100 S.
- According to the turn lane analysis, a right-turn lane is not warranted at this location.
- Construction of an exclusive eastbound left-turn lane or passing blister along CR 100 S at the access drive location.

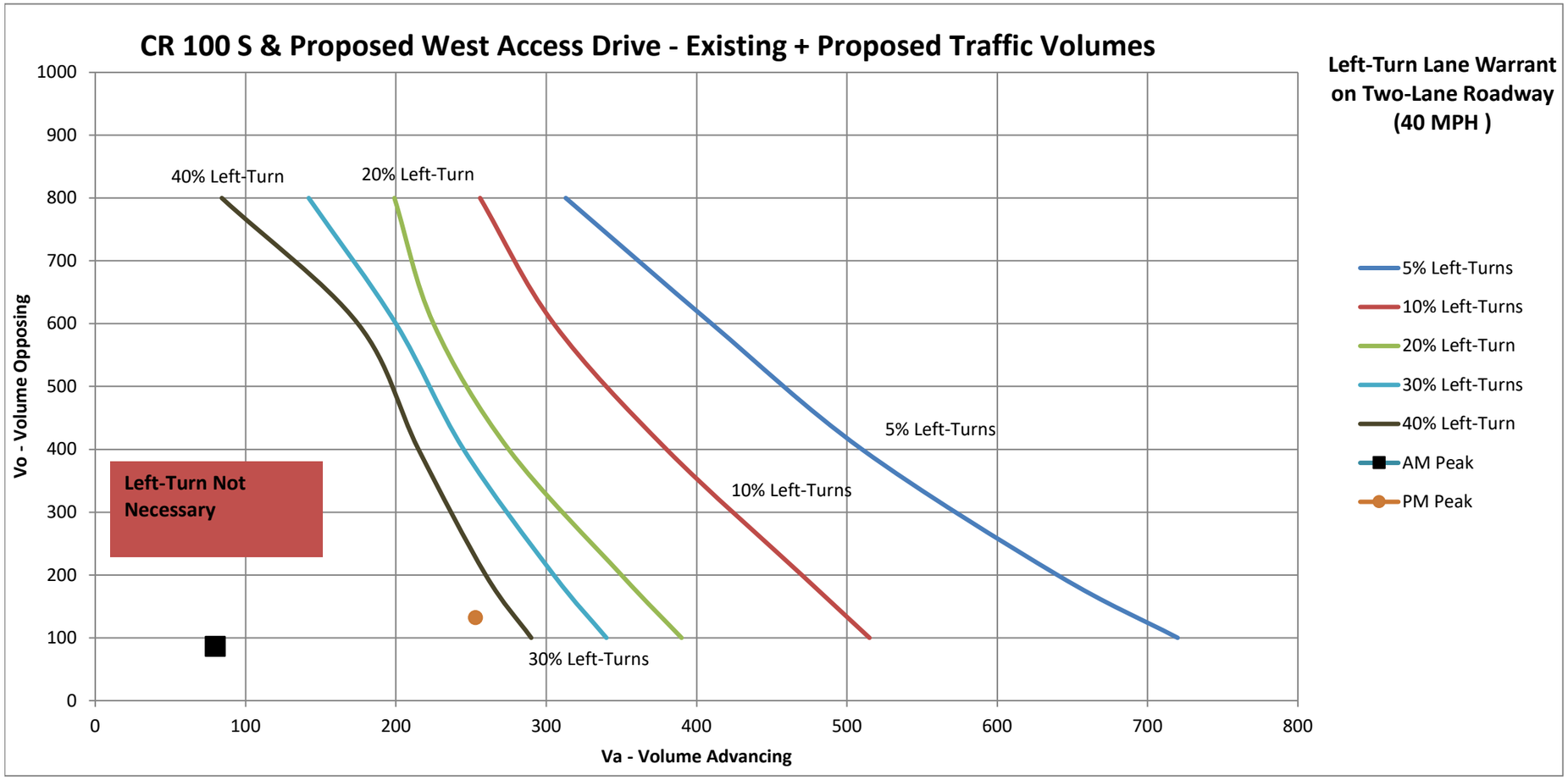
CR 100 S & Proposed East Access Drive

- Construction of the southbound access drive with at least one inbound and one outbound lane that will stop for CR 100 S.
- According to the turn lane analysis, a right-turn lane is not warranted at this location.
- According to the turn lane analysis, a left-turn lane is not warranted at this location.

[2] INDOT *Driveway Permit Manual*, Indiana Department of Transportation, 2018

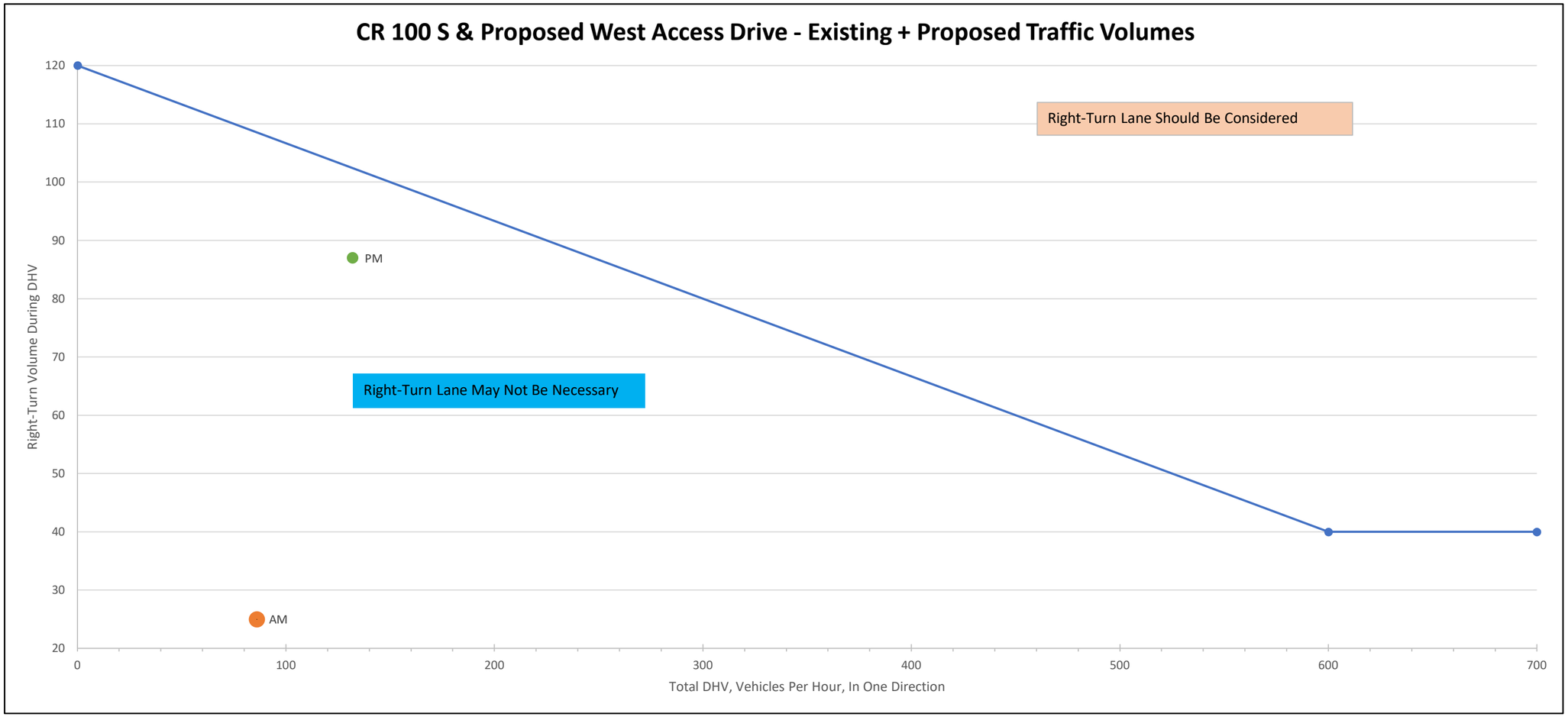
Operating Speed (mph)	Opposing Volume (veh/h)	Advancing Volume (veh/h)							
		5% Left Turns	10% Left Turns	15% Left Turns	20% Left Turns	25% Left Turns	30% Left Turns	35% Left Turns	40% Left Turns
40	800	313	256	228	199	171	142	113	84
	600	410	305	265	225	213	200	187	175
	400	510	380	328	275	260	245	230	215
	200	640	470	410	350	328	305	282	260
	100	720	515	453	390	365	340	315	290

INPUT AM		INPUT PM	
Advancing Volume (Va)	80	**Advancing Volume (Va)**	253
Opposing Volume (Vo)	86	**Opposing Volume (Vo)**	132
Left-Turn Volume	56	**Left-Turn Volume**	192
% Left-Turn	70%	**% Left-Turn**	76%
WARRANTED?	NO	**WARRANTED?**	YES



Total Volume	RT Volume
0	120
600	40
700	40

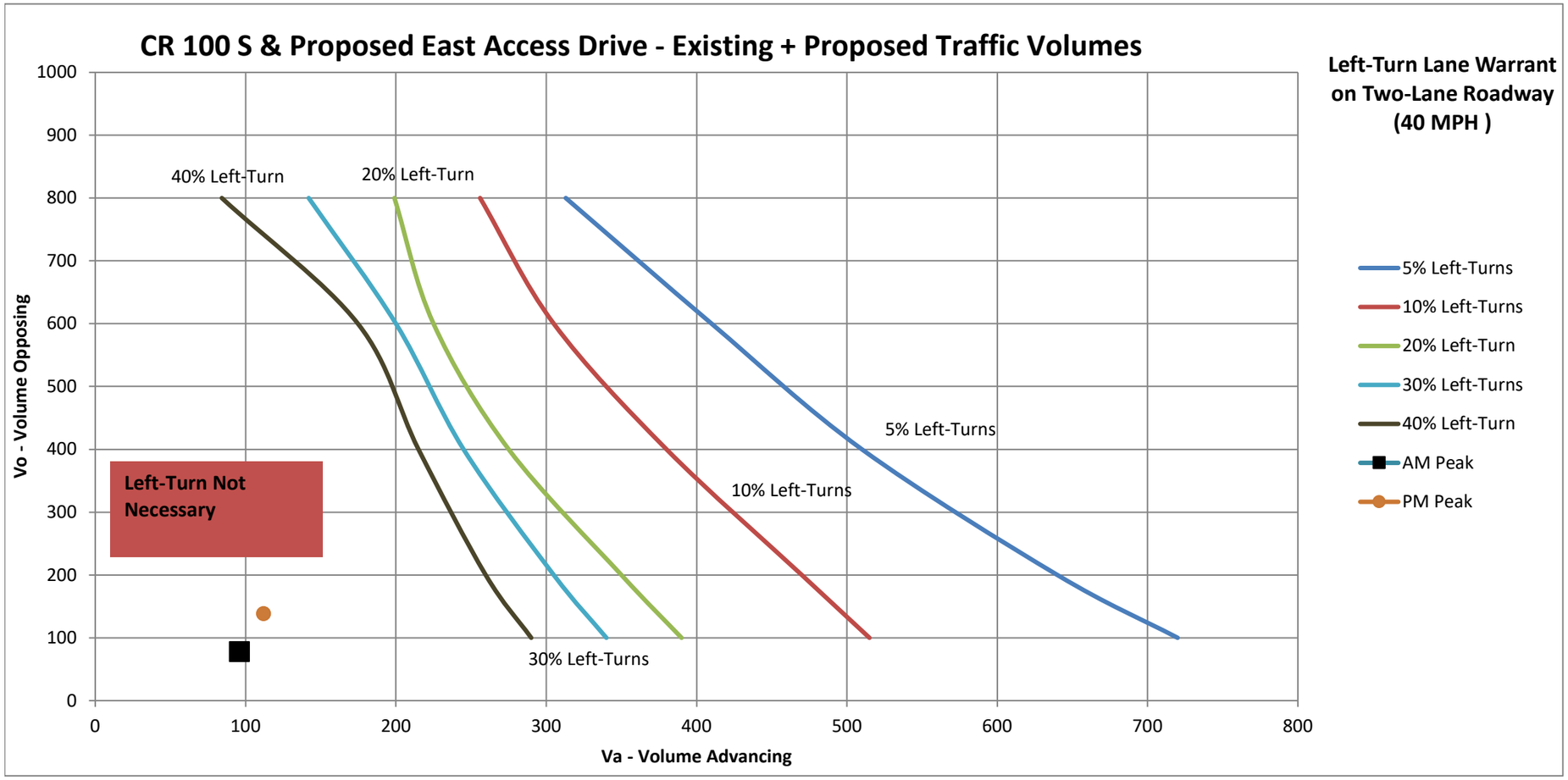
Time	Input		Met?
AM	**RT Volume**	25	NO
	Total Volume	86	
PM	**RT Volume**	87	NO
	Total Volume	132	



NOTE : For highways with a design speed below 80 km/h (50 mph) with a DHV < 300 and where right turns > 40, an adjustment should be used. To read the vertical axis of the chart, subtract 20 from the actual number of right turns.

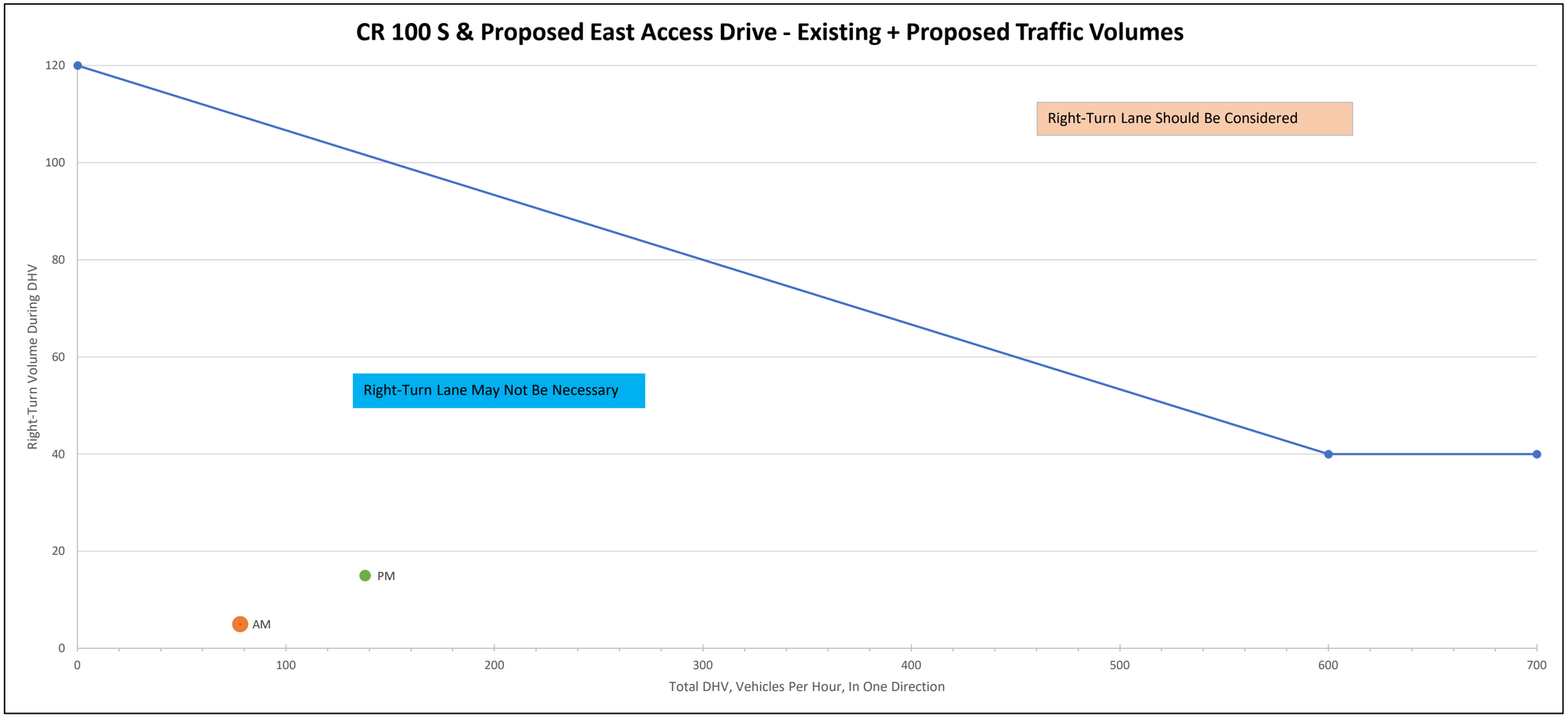
Operating Speed (mph)	Opposing Volume (veh/h)	Advancing Volume (veh/h)							
		5% Left Turns	10% Left Turns	15% Left Turns	20% Left Turns	25% Left Turns	30% Left Turns	35% Left Turns	40% Left Turns
40	800	313	256	228	199	171	142	113	84
	600	410	305	265	225	213	200	187	175
	400	510	380	328	275	260	245	230	215
	200	640	470	410	350	328	305	282	260
	100	720	515	453	390	365	340	315	290

INPUT AM		INPUT PM	
Advancing Volume (Va)	96	**Advancing Volume (Va)**	112
Opposing Volume (Vo)	78	**Opposing Volume (Vo)**	138
Left-Turn Volume	5	**Left-Turn Volume**	15
% Left-Turn	5%	**% Left-Turn**	13%
WARRANTED?	NO	**WARRANTED?**	NO



Total Volume	RT Volume
0	120
600	40
700	40

Time	Input		Met?
AM	**RT Volume**	5	NO
	Total Volume	78	
PM	**RT Volume**	15	NO
	Total Volume	138	



NOTE : For highways with a design speed below 80 km/h (50 mph) with a DHV < 300 and where right turns > 40, an adjustment should be used. To read the vertical axis of the chart, subtract 20 from the actual number of right turns.