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June 12, 2019

VIA EMAIL

Mr. Tim Loughrin
Director of Land Acquisition
Robertson Brothers Homes
6905 Telegraph Road, Suite 200
Bloomfield Hills, MI 48301

RE: Proposed Residential Development
Rochester Hills, Michigan
Left-turn Lane Analysis Summary

Dear Mr. Loughrin,

The professional staff of Fleis & VandenBrink (F&V) previously completed a Traffic Impact Study (TIS) for the proposed residential development on Brewster Road dated August 28, 2018. The proposed residential development is located generally in the northwest quadrant of the Brewster Road and Walton Blvd. intersection, with one proposed site driveway on Brewster Road. Key findings from this study regarding the evaluation of a left-turn lane at the proposed site driveway are summarized herein:

LAND USE

The proposed land use that was evaluated in the study included Multi-Family Housing, which the Institute of Transportation Engineers (ITE) classifies as an attached dwelling unit (not single family detached homes). Multi-family homes operate in a manner similar to single-family homes, where-in the peak periods occur during the typical AM (7-9AM) and PM (4-6PM) peak periods.

Through further discussions it was determined that this development will be targeted toward an active adult lifestyle, or an age 55+ resident. This type of use is classified as a Senior Adult Housing-Detached. These households have an AM peak hour around 10AM and a PM peak hour around 3PM, which does not correspond with the adjacent street traffic. In addition, the proposed development has reduced in the size from the August 2018 study; the proposed development now includes only 30 Senior Detached units.

Therefore, the peak operations for this development is expected to be less than was what evaluated in the TIS and will now have peak operations that occur during the off-peak hours of the adjacent street, resulting in less impact on the adjacent roadway network and the peak period traffic.

LEFT-TURNING VOLUMES

The northbound left-turns at the site driveway were evaluated in accordance with the Road Commission for Oakland County (RCOC) left-turn lane requirements. The analysis shows that the left-turns generated by the development using the higher Multi-Family land use are below the left-turn lane requirement threshold. This is due to:

1) The low volume of left-turn turns at the site drive.
2) The corresponding volume on traffic on Brewster Road.

Furthermore, the operations of the adjacent intersection of Brewster Road & Walton Road were evaluated to determine if the queue lengths at this intersection would impact the future operations of the proposed site

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driveway. The results of the analysis shows that although the queues are long on Brewster Road, especially in the PM peak hour, they will not impact the operations of the proposed site driveway.

In addition, the highest conflicting traffic volumes for left-turns at the site driveway occur southbound during the AM peak period when the majority of vehicles are exiting the site.

SIGHT DISTANCE

The intersection sight distance was reviewed at the proposed site driveway and Brewster Road intersection since there is a slight grade change between the Brewster Road & Walton Road intersection and the proposed site driveway.

The AASHTO stopping sight distance requirement for the proposed site driveway is 305 feet for a northbound vehicle to stop before reaching a vehicle turning left at the site driveway. The results of the sight distance analysis show that there is adequate stopping sight distance for a northbound driver to stop for a vehicle making a left-turn at the site driveway.

SUMMARY

Based on the results of the TIS and key findings summarized herein, we offer the following conclusions:

- This development will be targeted toward an active adult lifestyle, or an age 55+ resident. These households have an AM peak hour around 10AM and a PM peak hour around 3PM, which does not correspond with the adjacent street traffic. In addition, the proposed development has reduced in size from the August 2018 study; the proposed development now includes only 30 Senior Detached units. Therefore, the trips generated by the proposed development are expected to be *less* that those included in the August TIS.
- The traffic volumes and operations of the Brewster Road & Walton Road intersection are not expected to impact the operations of the proposed site driveway on Brewster Road.
- The RCOC left-turn lane analysis shows that the left-turns generated by the development are below the threshold for a left-turn lane.
- The highest conflicting traffic volumes for left-turns at the site driveway occur southbound during the AM peak period when the majority of vehicles are exiting the site.
- The results of the sight distance analysis show that there is adequate stopping sight distance for a northbound driver to stop for a vehicle making a left-turn at the site driveway.
- **The proposed development will not have a significant impact on the adjacent roadway network, the site driveway intersection and the adjacent study intersection of Walton Boulevard & Brewster Road. The overall vehicle delays at the Walton Boulevard & Brewster Road intersection will increase by approximately one second during the peak periods which will not be discernable. Additionally, the proposed development will only increase traffic at this intersection by less than 1% during both peak periods, which is not significant.**

If you have any questions, please do not hesitate to contact us at your convenience.

Sincerely,

FLEIS & VANDENBRINK

Julie M. Kroll

Julie M. Kroll, PE, PTOE
Sr. Project Manager

JMK:jmk

Attachments

FLEIS&VANDENBRINK
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MEMO

To:	**Mr. Tim Loughrin** **Robertson Brothers Homes**
From:	**Julie M. Kroll, PE, PTOE** **Fleis & VandenBrink**
Date:	**August 28, 2018**
Re:	**Proposed Residential Development** **Rochester Hills, Michigan** **Traffic Impact Study**

INTRODUCTION

This memorandum presents the results of a Traffic Impact Study (TIS) for the proposed multi-family residential development in Rochester Hills, Michigan. The project site is located generally in the northwest quadrant of the Brewster Road & Walton Boulevard intersection and is currently undeveloped. The proposed development includes construction of 32 attached condominium units. Site access for the development is proposed via one site access drive on Brewster Road. Brewster Road is under City jurisdiction and Walton Boulevard is under the jurisdiction of the Road Commission for Oakland County (RCOC).

In accordance with City Ordinance, Rochester Hills has requested a TIS for permitting of site access and site plan approval. The purpose of this study is to identify the traffic related impacts, if any, from the proposed development at the intersection of Walton Boulevard & Brewster Road as well as the proposed site access points with Brewster Road.

The scope of the study was developed based on Fleis & VandenBrink's (F&V) knowledge of the study area, understanding of the development program, accepted traffic engineering practice, and methodologies published by the Institute of Transportation Engineers (ITE). Additionally, the City of Rochester Hills provided input regarding the scope of work for the TIS included herein.

DATA COLLECTION

The existing weekday turning movement traffic volume data were collected by F&V subconsultant Traffic Data Collection, Inc. (TDC) on Thursday, October 26, 2017. Intersection turning movement counts were collected during the weekday AM (7:00 AM to 9:00 AM) and PM (4:00 PM to 6:00 PM) peak periods at the intersection of Walton Boulevard & Brewster Road. In addition, SCATS counts were obtained from the RCOC at this intersection and were used to validate the 2017 data for use in this analysis. Overall, the 2018 SCATS counts were lower than the 2017 turning movement counts collected, except the AM southbound right-turn traffic volume. Therefore, the southbound AM right-turn traffic volume was updated to reflect the current traffic volumes in this study. This data was used as a baseline to establish existing traffic conditions without the proposed development. Additionally, F&V collected an inventory of existing lane use and traffic controls, shown on the attached **Figure 1**. The existing AM and PM peak hour traffic volumes are shown on the attached **Figure 2** and were identified to occur between 8:00 AM to 9:00 AM and 5:00 PM to 6:00 PM.

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EXISTING CONDITIONS

Existing peak hour vehicle delays and Levels of Service (LOS) were calculated at the study intersections using Synchro (Version 10) traffic analysis software. This analysis was based on the existing lane use and traffic control shown on the attached **Figure 1**, the existing peak hour traffic volumes shown on the attached **Figure 2**, and the methodologies presented in the *Highway Capacity Manual, 6th Edition* (HCM6). Typically, LOS D is considered acceptable, with LOS A representing minimal delay, and LOS F indicating failing conditions. Additionally, SimTraffic network simulations were reviewed to evaluate network operations and vehicle queues. The existing conditions results are attached and summarized in **Table 1**.

Table 1: Existing Intersection Operations

Intersection		Control	Approach	AM Peak		PM Peak	
				Delay (s/veh)	LOS	Delay (s/veh)	LOS
1	Walton Boulevard & Brewster Road	Signalized	EB LT	14.2	B	51.5	D
			EB T	9.9	A	9.0	A
			WB	19.6	B	28.0	C
			SB LT	45.0	D	73.8	E
			SB RT	66.8	E	32.9	C
			Overall	26.8	C	26.6	C

The results of the existing conditions analysis show that all approaches and movements at the study intersection currently operate acceptably at a LOS D or better during both peak periods with the exception of the SB right- and left-turn movements which currently operate at a LOS E during the AM and PM peak hours, respectively.

Review of SimTraffic network simulations indicates acceptable traffic operations during the AM peak hour with vehicle queues processed during each signal cycle and minimal residual queues. During the PM peak hour, a long vehicle queue is observed for the SB left turn movement throughout the duration of the peak hour which blocks the right turn storage bay for approximately 5 minutes of the peak period. The existing vehicle queue lengths are summarized in **Table 2**.

Table 2: Existing Intersection Queues

Intersection		Calculation Method	Approach	AM Peak		PM Peak	
				Avg. Queue	95th Queue	Avg. Queue	95th Queue
1	Walton Boulevard & Brewster Road	SimTraffic	EB LT	41	82	140	228
			EB T	79	144	130	207
			WB	187	301	330	464
			SB LT	219	390	269	510
			SB RT	147	280	81	261

BACKGROUND CONDITIONS

In order to determine the applicable traffic growth rate for the existing traffic volumes to the project build-out year of 2020, historical traffic data for the study intersection was obtained from the RCOC SCATS system. The historical traffic volume data indicates traffic volumes at the intersection increased at an annual rate of 2.3% per year between 2011 and 2018. Therefore, a growth rate of 2.3% per year was utilized in this study for the analysis of background conditions ***without the proposed development.***

In addition to background growth, it is important to account for traffic that is expected to be generated by approved developments within the vicinity of the study area that have yet to be constructed or are currently under construction. No background developments were identified near the study area that are expected to be completed prior to the site buildout of the proposed development.

Background Operations

Background peak hour vehicle delays and LOS were calculated based on the existing lane use and traffic control shown on the attached **Figure 1**, the background traffic volumes shown on the attached **Figure 3**, and the methodologies presented in the HCM. The results of the background conditions assessment are attached and summarized in **Table 3**.

Table 3: Background Intersection Operations

Intersection		Control	Approach	Existing Conditions (2018)				Background Conditions (2020)			
				AM Peak		PM Peak		AM Peak		PM Peak	
				Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS
1	Walton Boulevard & Brewster Road	Signalized	EB LT	14.2	B	51.5	D	15.1	B	63.1	E
			EB T	9.9	A	9.0	A	10.0	A	9.9	A
			WB	19.6	B	28.0	C	20.4	C	37.0	C
			SB LT	45.0	D	73.8	E	46.5	D	73.3	E
			SB RT	66.8	E	32.9	C	75.9	E	30.4	C
			Overall	26.8	C	26.6	C	28.8	C	31.5	C

The results of the background conditions analysis show that all approaches and movements at the study intersection of Walton Boulevard & Brewster Road will continue to operate acceptably at a LOS D or better during both peak periods with the exception of the SB right- and left-turn movements which will continue to operate at a LOS E during the AM and PM peak hours, respectively.

Review of SimTraffic network simulations continues to indicate generally acceptable traffic operations during the AM peak hour. During the PM peak hour, a long vehicle queue is observed for the SB left turn movement throughout the duration of the peak hour which blocks the right turn storage bay for approximately 20 minutes of the peak period. The background vehicle queue lengths are summarized in **Table 4**.

Table 4: Background Intersection Queues

Intersection		Control	Approach	Existing Conditions (2018)				Background Conditions (2020)			
				AM Peak		PM Peak		AM Peak		PM Peak	
				Avg. Queue	95th Queue	Avg. Queue	95th Queue	Avg. Queue	95th Queue	Avg. Queue	95th Queue
1	Walton Boulevard & Brewster Road	SimTraffic	EB LT	41	82	140	228	48	90	172	302
			EB T	79	144	130	207	86	158	143	229
			WB	187	301	330	464	217	347	396	587
			SB LT	219	390	269	510	228	400	244	398
			SB RT	147	280	81	261	172	306	79	246

SITE TRIP GENERATION

The number of AM and PM peak hour vehicle trips that would be generated by the proposed development was determined based on data published by the Institute of Transportation Engineers (ITE) in *Trip Generation, 10th Edition* and is summarized in **Table 5**.

Table 5: Site Trip Generation

Land Use	ITE Code	Amount	Units	Average Daily Traffic	AM Peak Hour			PM Peak Hour		
					In	Out	Total	In	Out	Total
Multi-Family Housing	220	32	D.U.	201	4	12	16	13	8	21

The peak hour site generated trips shown in **Table 5** were assigned to the adjacent road network based on existing traffic patterns in the surrounding area and the proposed site access plan. These patterns indicate the site trip distribution summarized in **Table 6**.

Table 6: Site Trip Distribution

To / From	via	AM / PM
North	Brewster Road	10%
East	Walton Boulevard	40%
West	Walton Boulevard	50%
Total		100%

The site generated trips are shown on **Figure 4** and were added to the background traffic volumes shown on **Figure 3** to calculate the future peak hour traffic volumes shown on **Figure 5**.

FUTURE CONDITIONS

Future peak hour vehicle delays and LOS ***with the proposed development*** were calculated based on the existing lane use and traffic control shown on **Figure 1**, the proposed site access plan, the future traffic volumes shown on **Figure 5**, and the methodologies presented in the HCM6. Additionally, SimTraffic simulations were utilized to evaluate network operations and vehicle queues. The results of the analysis of total future conditions are attached and are summarized in **Table 7**.

Table 7: Future Intersection Operations

Intersection		Control	Approach	Background Conditions (2020)				Future Conditions (2020)			
				AM Peak		PM Peak		AM Peak		PM Peak	
				Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS	Delay (s/veh)	LOS
1	Walton Boulevard & Brewster Road	Signalized	EB LT	15.1	B	63.1	E	15.2	B	63.2	E
			EB T	10.0	A	9.9	A	10.0	A	9.9	A
			WB	20.4	C	37.0	C	20.5	C	39.1	D
			SB LT	46.5	D	73.3	E	47.1	D	76.2	E
			SB RT	75.9	E	30.4	C	78.4	E	29.9	C
			Overall	28.8	C	31.5	C	29.3	C	32.8	C
2	Site Drive & Brewster Road	Unsignalized	NB					9.4	A	13.1	B
			EB					15.1	C	8.4	A
			SB					Free	A	Free	A

The results of this analysis indicate that the proposed development will not have a significant impact on the study intersection of Walton Boulevard & Brewster Road. Overall vehicle delays at the intersection will increase by less than one second during the AM peak hour and approximately two seconds during the PM peak hour which will not be discernable to existing traffic. **Additionally, the proposed development will only increase traffic at this intersection by less than 1% during both peak periods, which is not significant.** At the proposed site roads to Brewster Road, all approaches and movements will operate acceptably at a LOS B or better during both peak periods.

Review of SimTraffic network simulations indicates future traffic operations will be similar to background conditions with generally acceptable traffic operations during the AM peak hour. During the PM peak hour a long vehicle queue is continued to be observed for the SB left turn movement throughout the duration of the peak hour which blocks the right turn storage bay for approximately 40 minutes of the peak period. The future vehicle queue lengths are summarized in **Table 8**.

Table 8: Future Intersection Queues

Intersection		Control	Approach	Background Conditions (2020)				Future Conditions (2020)			
				AM Peak		PM Peak		AM Peak		PM Peak	
				Avg. Queue	95th Queue	Avg. Queue	95th Queue	Avg. Queue	95th Queue	Avg. Queue	95th Queue
1	Walton Boulevard & Brewster Road	SimTraffic	EB LT	48	90	172	302	48	92	149	244
			EB T	86	158	143	229	91	171	141	231
			WB	217	347	396	587	226	369	378	538
			SB LT	228	400	244	398	255	425	342	722
			SB RT	172	306	79	246	193	337	111	323
2	Site Drive & Brewster Road	Unsignalized	NB					3	18	7	39
			EB					9	33	5	25

AUXILIARY LANES

In order to determine the configuration of the proposed site access locations with Brewster Road, the City of Rochester Hills warrants for right and left turn lanes were evaluated. According to City standards, RCOC turn lane warrant criteria shall be utilized in order to determine where turn lanes shall be required. The 2018 SCATS count data provided by RCOC were utilized in this evaluation. The results of the analysis indicate that neither a left turn treatment nor right turn treatments are necessary at the proposed site access drive to Brewster Road. The RCOC turn lane warrant analysis worksheets are attached.

INTERSECTION SIGHT DISTANCE

The intersection sight distance was reviewed at the proposed site driveway and Brewster Road intersection. According to *Section 9.5 – Intersection Sight Distance* of the AASHTO design manual *A Policy on Geometric Design of Highways and Streets, 2011,* an intersection sight distance of 445 feet is required for a left turn from a complete stop. Also, a stopping sight distance of 305 feet is required for northbound vehicles enable a vehicle traveling at or near the design speed to stop before reaching a vehicle turning left at the site driveway. The intersection and stopping sight distances are based on the existing 40 mph design speed (35 mph speed limit).

The intersection sight distance measurements are shown on the attached **Figure 6**.

The results of the sight distance analysis show that there is adequate distance for a northbound driver on Brewster to stop for a vehicle waiting to make a left-turn into the site driveway. In addition, there is adequate distance for vehicles exiting onto northbound Brewster Road to make a left-turn the site drive without any visual obstruction from south.

CONCLUSIONS

The conclusions of this Traffic Impact Study are as follows:

1. Currently all approaches and movements at the study intersection of Walton Boulevard & Brewster Road will operate acceptably at a LOS D or better except the SB right- and left-turn movements which currently operate at a LOS E during the AM and PM peak hours, respectively.
2. Based on historical traffic volume data, a 2.3% per year growth rate was applied to the existing traffic volumes to the project build-out year of 2020.
3. Under background conditions ***without the proposed development***, all approaches and movements at the study intersection of Walton Boulevard & Brewster Road will continue to operate in a manner similar to existing conditions with minor increases in vehicle delays.
4. **The proposed development will not have a significant impact on the study intersection of Walton Boulevard & Brewster Road. Overall vehicle delays at the intersection will increase by approximately one second during the peak periods which will not be discernable. Additionally, the proposed development will only increase traffic at this intersection by less than 1% during both peak periods, which is not significant.**

5. The proposed site access drives to Brewster Road will operate acceptably at a LOS C or better during both peak periods.
6. Neither a left turn nor right turn treatment is required at the proposed site access drive to Brewster Road.
7. There is adequate intersection sight distance and stopping sight distance provided at the proposed site driveway on Brewster Road
8. No improvements are recommended to mitigate traffic generated by the proposed development at the site driveway intersection or the intersection of Walton Blvd. & Brewster Road.

Any questions related to this memorandum, study, analysis, and results should be addressed to Fleis & VandenBrink.

Attached: Figures 1 – 6
Traffic Volume Data
Synchro / SimTraffic Results
RCOC Turn Lane Warrants

JMK:eep

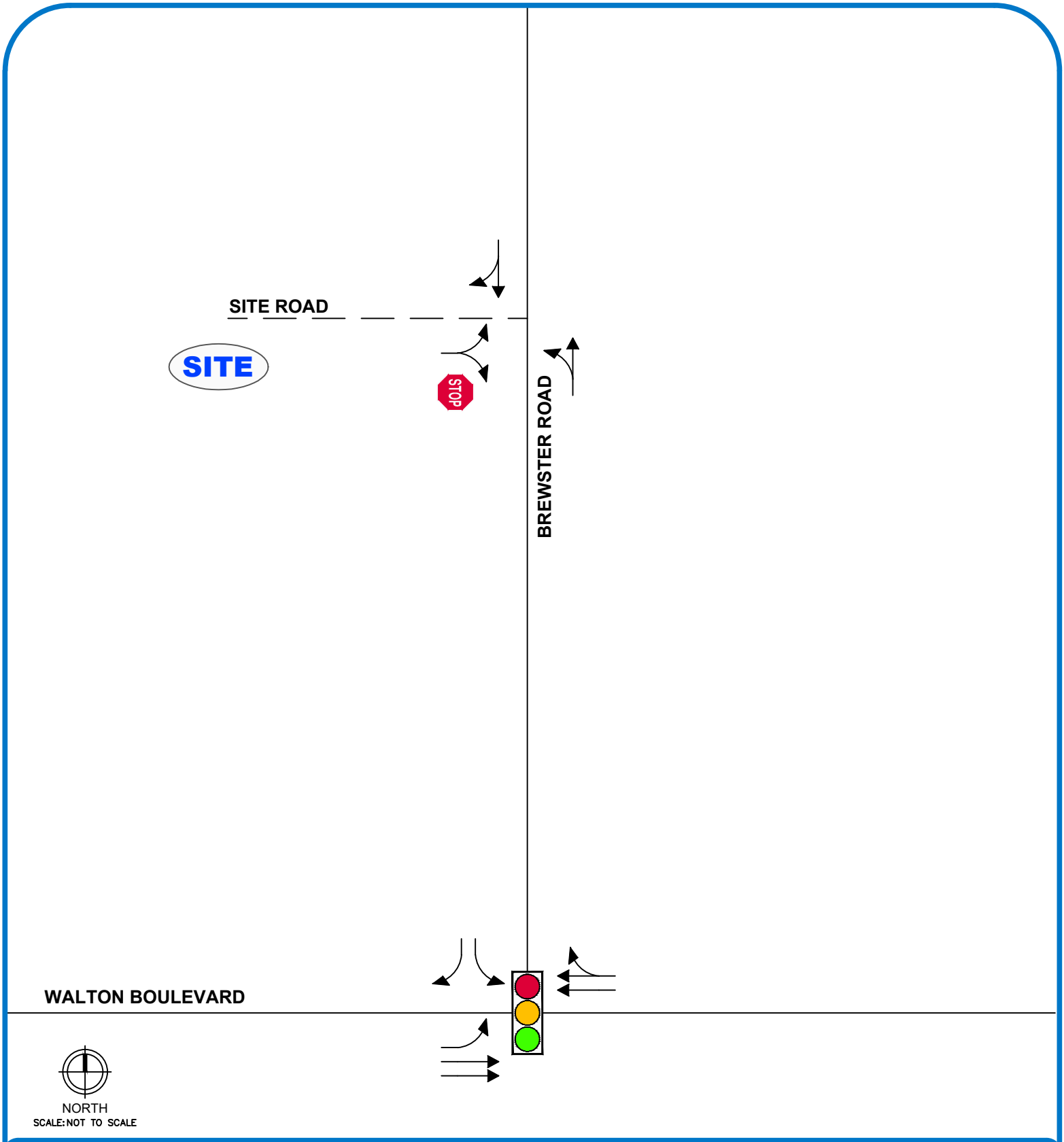


FIGURE 1
LANE USE AND TRAFFIC CONTROL

MULTI-FAMILY RESIDENTIAL TIS - ROCHESTER HILLS, MI

LEGEND

- ROADS
- LANE USE
- SIGNALIZED INTERSECTION
- UNSIGNALIZED INTERSECTION

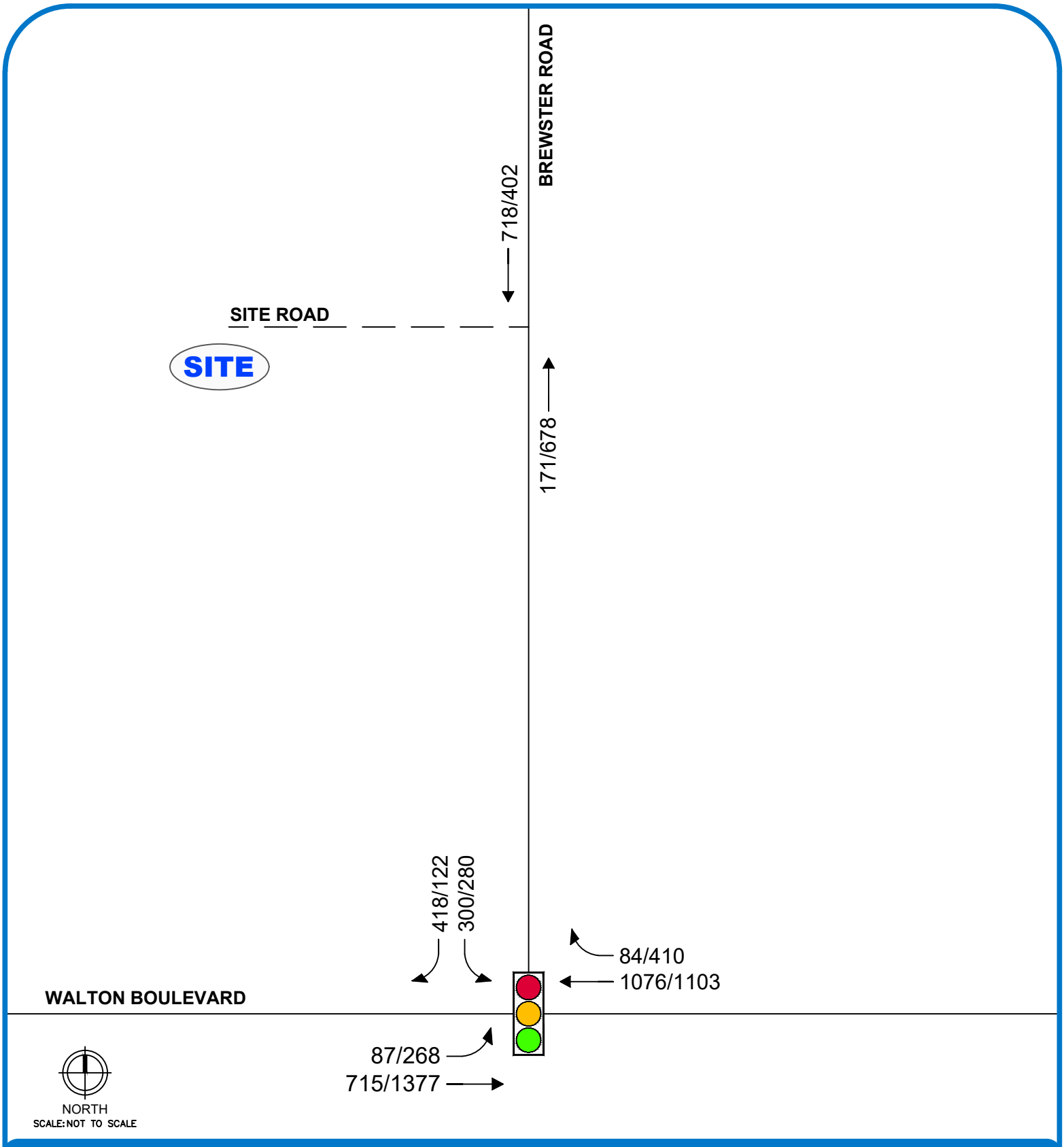


FIGURE 2
EXISTING TRAFFIC VOLUMES

MULTI-FAMILY RESIDENTIAL TIS - ROCHESTER HILLS, MI

LEGEND

- ROADS
- TRAFFIC VOLUMES (AM/PM)
- SIGNALIZED INTERSECTION
- UNSIGNALIZED INTERSECTION

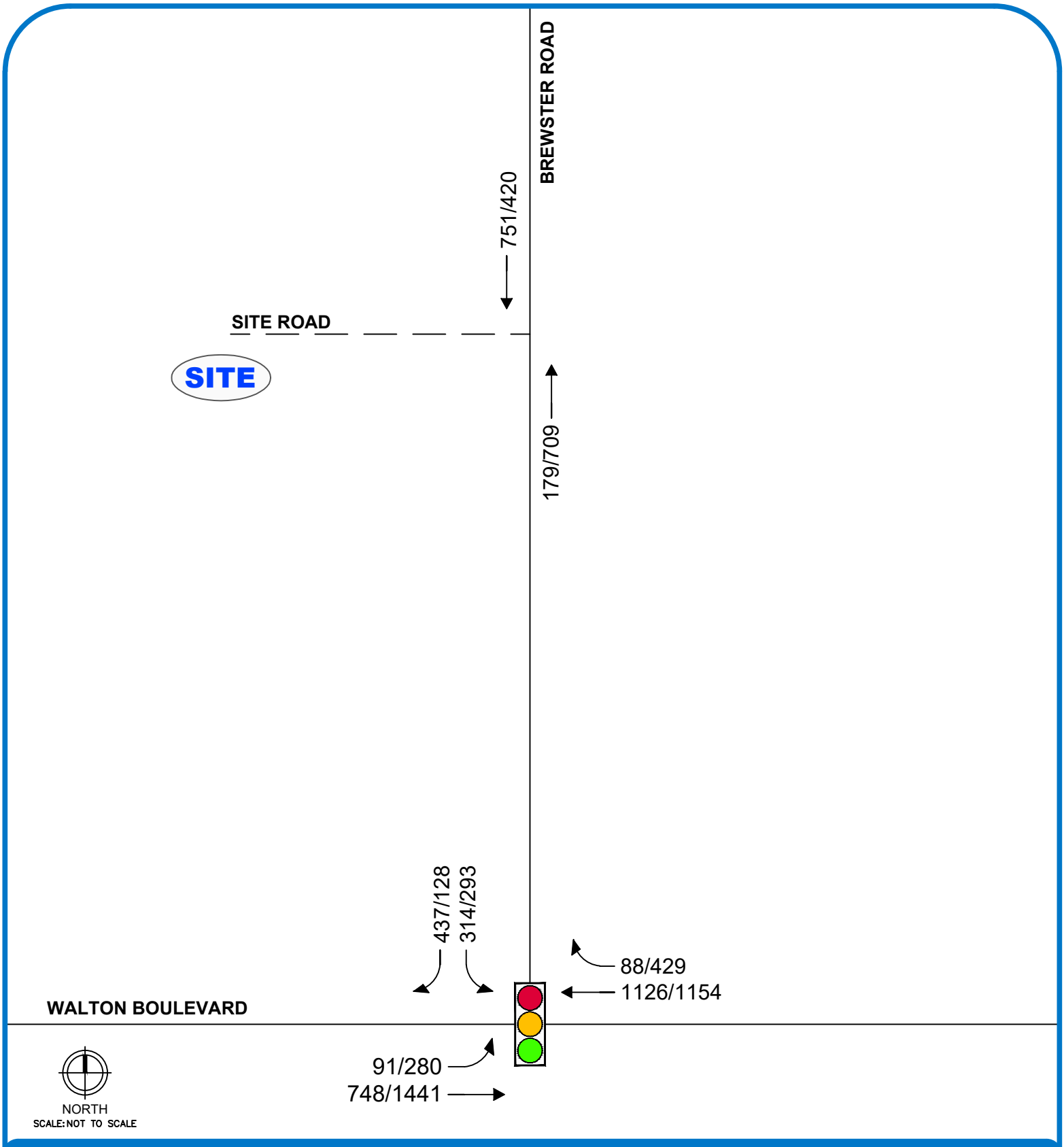


FIGURE 3
BACKGROUND TRAFFIC VOLUMES

MULTI-FAMILY RESIDENTIAL TIS - ROCHESTER HILLS, MI

LEGEND

- ROADS
- TRAFFIC VOLUMES (AM/PM)
- SIGNALIZED INTERSECTION
- UNSIGNALIZED INTERSECTION

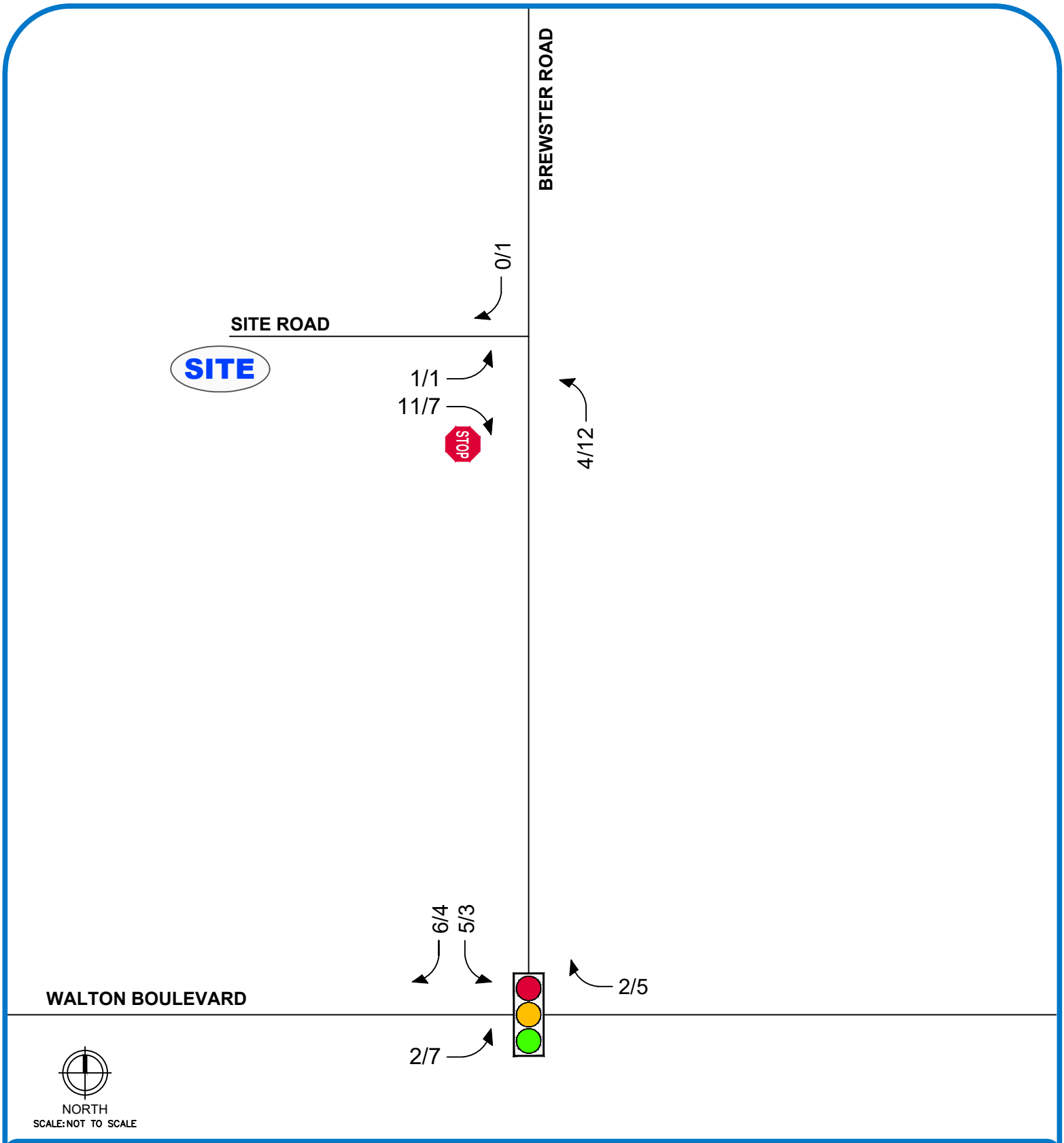


FIGURE 4
SITE-GENERATED TRAFFIC VOLUMES

MULTI-FAMILY RESIDENTIAL TIS - ROCHESTER HILLS, MI

LEGEND

- ROADS
- TRAFFIC VOLUMES (AM/PM)
- SIGNALIZED INTERSECTION
- UNSIGNALIZED INTERSECTION

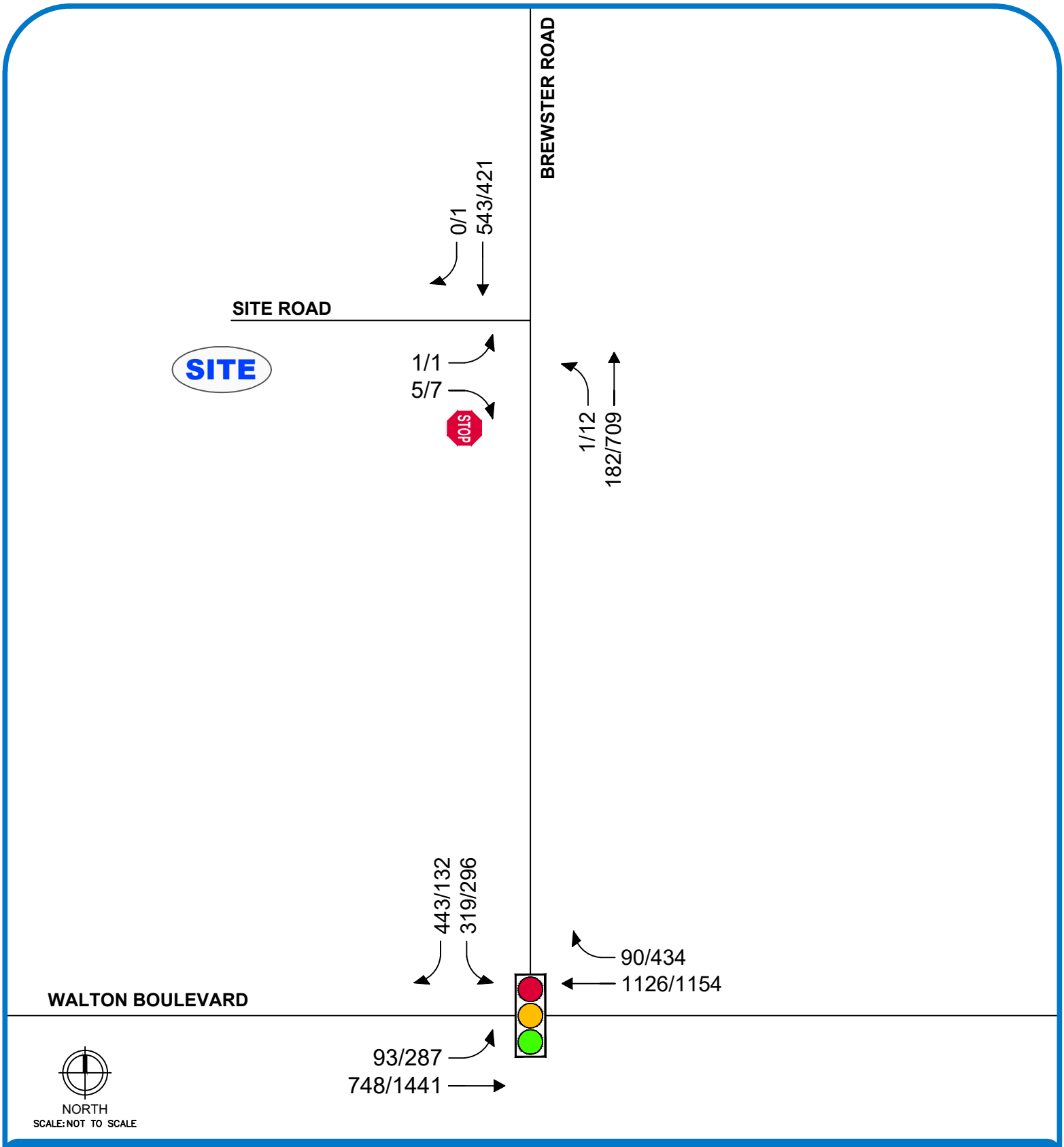


FIGURE 5
FUTURE TRAFFIC VOLUMES

MULTI-FAMILY RESIDENTIAL TIS - ROCHESTER HILLS, MI

LEGEND

- ROADS
- TRAFFIC VOLUMES (AM/PM)
- SIGNALIZED INTERSECTION
- UNSIGNALIZED INTERSECTION

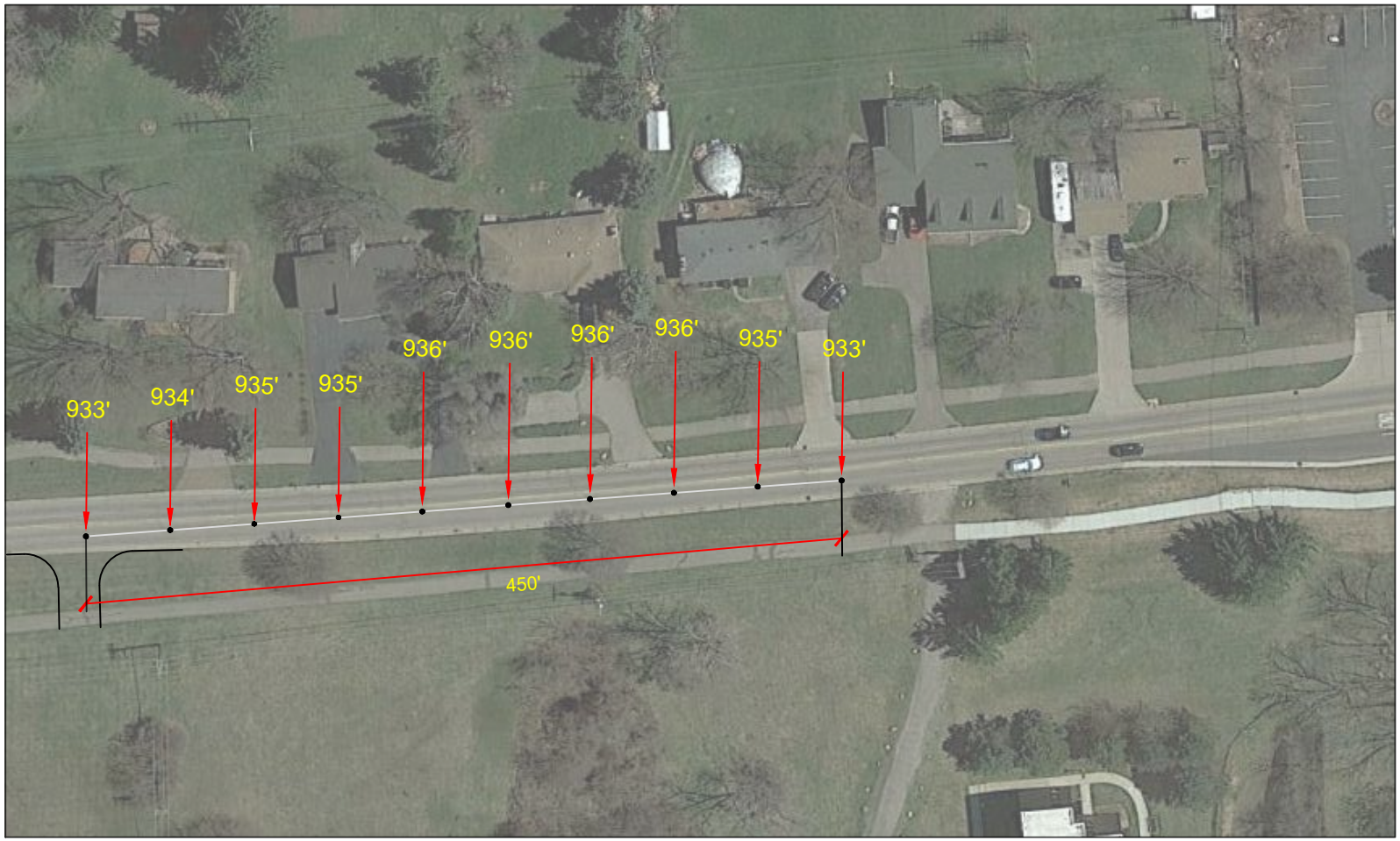


FIGURE 6
SITE DRIVE INTERSECTION SIGHT DISTANCE

MULTI-FAMILY RESIDENTIAL TIS - ROCHESTER HILLS, MI

LEGEND

SITE — SITE LOCATION

ELEVATION (FEET)

NORTH

SCALE: NOT TO SCALE

Traffic Data Collection, LLC

tdccounts.com

Phone: (586) 786-5407

Traffic Study Peformed For:

Fleis & VandenBrink

Project: Rochester Hills Traffic Study
Type: 4 Hr. Video Turning Movement Count
Weather:Sunny/Cldy, Dry Deg. 50's
Count By: Miovision Video SCU 24L NE

File Name : TMC_1 WaltonBlvd & Brewster_10-26-17
Site Code : TMC_1
Start Date : 10/26/2017
Page No : 1

Groups Printed- Pass Cars - Single Units - Heavy Trucks - Peds.

	Brewster Road Southbound				Walton Blvd. Westbound				Walton Blvd. Eastbound				
Start Time	Rgt	Left	Peds	App. Total	Rgt	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	115	69	1	185	12	310	0	322	161	24	0	185	692
07:15 AM	111	89	0	200	20	311	0	331	150	25	0	175	706
07:30 AM	77	63	0	140	16	387	0	403	174	25	0	199	742
07:45 AM	76	94	0	170	18	344	0	362	181	32	1	214	746
Total	379	315	1	695	66	1352	0	1418	666	106	1	773	2886
08:00 AM	60	72	0	132	18	281	0	299	165	24	0	189	620
08:15 AM	55	81	1	137	15	293	0	308	161	23	0	184	629
08:30 AM	42	63	0	105	20	283	0	303	188	14	0	202	610
08:45 AM	54	84	0	138	31	219	0	250	201	26	0	227	615
Total	211	300	1	512	84	1076	0	1160	715	87	0	802	2474
**** BREAK ****													
04:00 PM	25	49	0	74	78	285	0	363	311	74	0	385	822
04:15 PM	24	51	0	75	75	246	0	321	258	78	2	338	734
04:30 PM	18	52	0	70	60	269	1	330	273	72	0	345	745
04:45 PM	30	68	1	99	83	279	0	362	284	63	0	347	808
Total	97	220	1	318	296	1079	1	1376	1126	287	2	1415	3109
05:00 PM	30	49	1	80	104	309	0	413	321	76	0	397	890
05:15 PM	31	72	0	103	104	283	0	387	360	49	1	410	900
05:30 PM	37	65	0	102	96	257	1	354	366	72	1	439	895
05:45 PM	24	94	1	119	106	254	0	360	330	71	1	402	881
Total	122	280	2	404	410	1103	1	1514	1377	268	3	1648	3566
Grand Total	809	1115	5	1929	856	4610	2	5468	3884	748	6	4638	12035
Apprch %	41.9	57.8	0.3		15.7	84.3	0		83.7	16.1	0.1		
Total %	6.7	9.3	0	16	7.1	38.3	0	45.4	32.3	6.2	0	38.5	
Pass Cars	800	1099	0	1899	837	4554	0	5391	3819	736	0	4555	11845
% Pass Cars	98.9	98.6	0	98.4	97.8	98.8	0	98.6	98.3	98.4	0	98.2	98.4
Single Units	8	16	0	24	18	46	0	64	50	10	0	60	148
% Single Units	1	1.4	0	1.2	2.1	1	0	1.2	1.3	1.3	0	1.3	1.2
Heavy Trucks	1	0	0	1	1	10	0	11	15	2	0	17	29
% Heavy Trucks	0.1	0	0	0.1	0.1	0.2	0	0.2	0.4	0.3	0	0.4	0.2
Peds.	0	0	5	5	0	0	2	2	0	0	6	6	13
% Peds.	0	0	100	0.3	0	0	100	0	0	0	100	0.1	0.1

Comments: 4 hour traffic study conducted during typical weekday (Thursday) from 7:00-9:00 AM morning & 4:00-6:00 PM afternoon peak hours while school was in session. SCATS Signalized "T" intersection, with ped. signals for all quadrants. Push buttons for east & west legs. Video SCU camera was located within NE intersection quadrant.

Traffic Data Collection, LLC

tdccounts.com

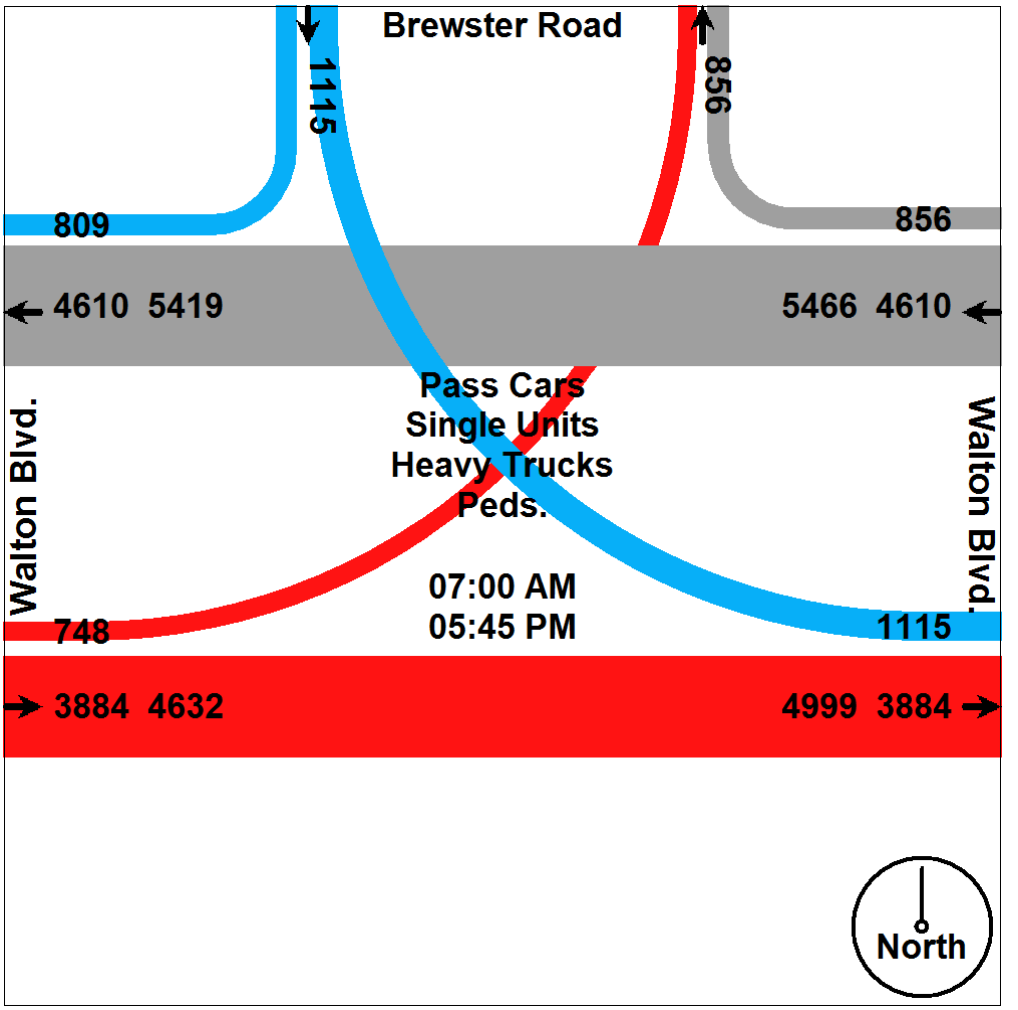
Phone: (586) 786-5407

Traffic Study Peformed For:

Fleis & VandenBrink

Project: Rochester Hills Traffic Study
Type: 4 Hr. Video Turning Movement Count
Weather:Sunny/Cldy, Dry Deg. 50's
Count By: Miovision Video SCU 24L NE

File Name : TMC_1 WaltonBlvd & Brewster_10-26-17
Site Code : TMC_1
Start Date : 10/26/2017
Page No : 2



Traffic Data Collection, LLC

tdccounts.com

Phone: (586) 786-5407

Traffic Study Peformed For:

Fleis & VandenBrink

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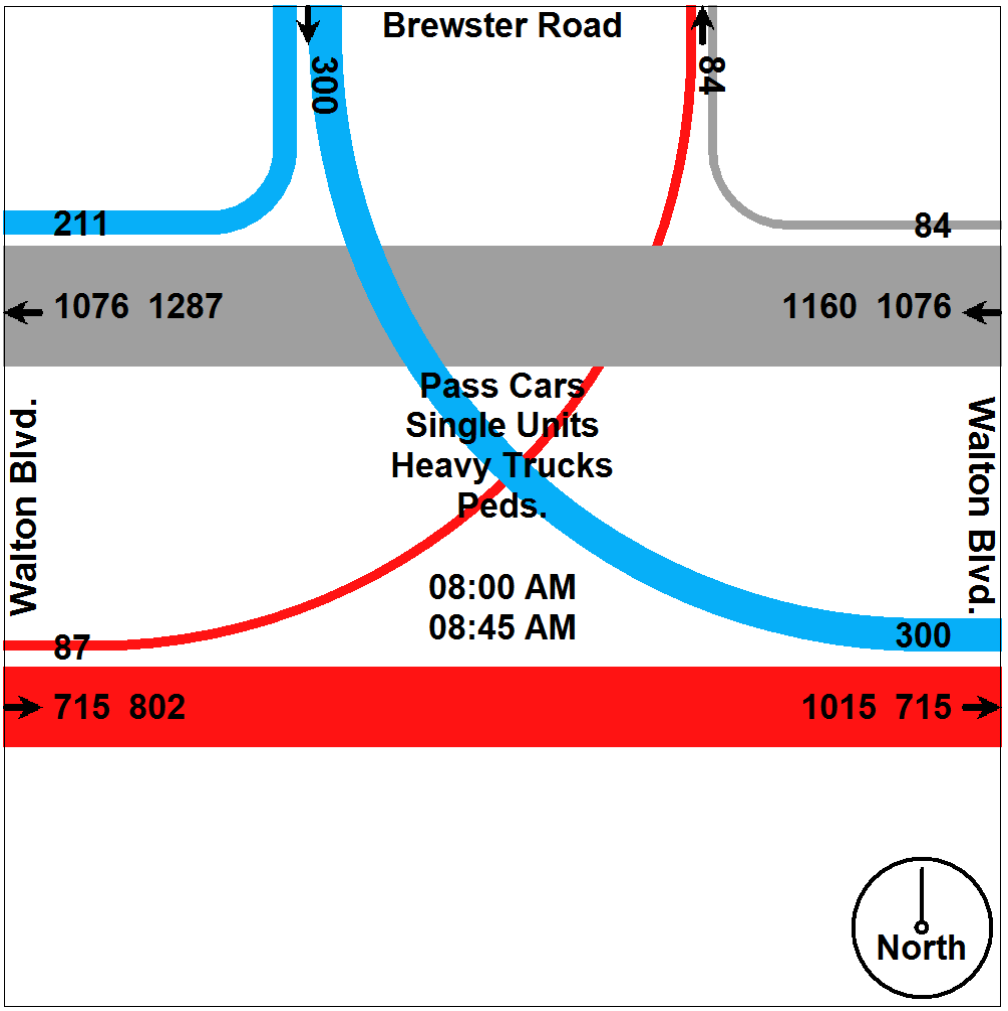
File Name : TMC_1 WaltonBlvd & Brewster_10-26-17
Site Code : TMC_1
Start Date : 10/26/2017
Page No : 3

	Brewster Road Southbound			Walton Blvd. Westbound			Walton Blvd. Eastbound			
Start Time	Rgt	Left	App. Total	Rgt	Thru	App. Total	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 08:00 AM to 12:30 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 08:00 AM										
08:00 AM	**60**	72	132	18	281	299	165	24	189	620
08:15 AM	55	81	136	15	**293**	**308**	161	23	184	**628**
08:30 AM	42	63	105	20	283	303	188	14	202	610
08:45 AM	54	**84**	**138**	**31**	219	250	**201**	**26**	**227**	615
Total Volume	211	300	511	84	1076	1160	715	87	802	2473
% App. Total	41.3	58.7		7.2	92.8		89.2	10.8		
PHF	.879	.893	.926	.677	.918	.942	.889	.837	.883	.984
Pass Cars	208	294	502	76	1058	1134	689	85	774	2410
% Pass Cars	98.6	98.0	98.2	90.5	98.3	97.8	96.4	97.7	96.5	97.5
Single Units	2	6	8	8	15	23	20	2	22	53
% Single Units	0.9	2.0	1.6	9.5	1.4	2.0	2.8	2.3	2.7	2.1
Heavy Trucks	1	0	1	0	3	3	6	0	6	10
% Heavy Trucks	0.5	0	0.2	0	0.3	0.3	0.8	0	0.7	0.4
Peds.	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0



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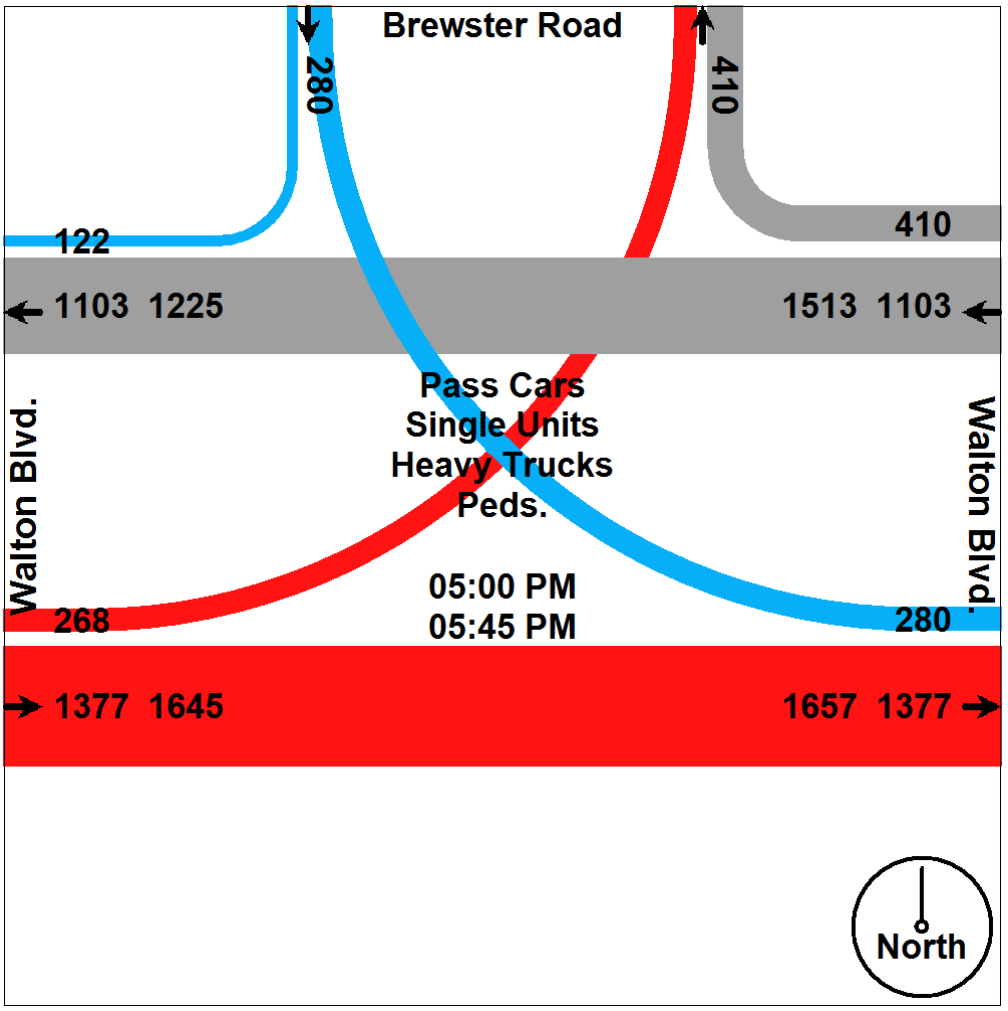
Count By: Miovision Video SCU 24L NE

File Name : TMC_1 WaltonBlvd & Brewster_10-26-17
Site Code : TMC_1
Start Date : 10/26/2017
Page No : 4

	Brewster Road Southbound			Walton Blvd. Westbound			Walton Blvd. Eastbound			
Start Time	Rgt	Left	App. Total	Rgt	Thru	App. Total	Thru	Left	App. Total	Int. Total
Peak Hour Analysis From 12:45 PM to 05:45 PM - Peak 1 of 1										
Peak Hour for Entire Intersection Begins at 05:00 PM										
05:00 PM	30	49	79	104	**309**	**413**	321	**76**	397	889
05:15 PM	31	72	103	104	283	387	360	49	409	**899**
05:30 PM	**37**	65	102	96	257	353	**366**	72	**438**	893
05:45 PM	24	**94**	**118**	**106**	254	360	330	71	401	879
Total Volume	122	280	402	410	1103	1513	1377	268	1645	3560
% App. Total	30.3	69.7		27.1	72.9		83.7	16.3		
PHF	.824	.745	.852	.967	.892	.916	.941	.882	.939	.990
Pass Cars	120	280	400	410	1099	1509	1374	267	1641	3550
% Pass Cars	98.4	100	99.5	100	99.6	99.7	99.8	99.6	99.8	99.7
Single Units	2	0	2	0	4	4	2	1	3	9
% Single Units	1.6	0	0.5	0	0.4	0.3	0.1	0.4	0.2	0.3
Heavy Trucks	0	0	0	0	0	0	1	0	1	1
% Heavy Trucks	0	0	0	0	0	0	0.1	0	0.1	0.0
Peds.	0	0	0	0	0	0	0	0	0	0
% Peds.	0	0	0	0	0	0	0	0	0	0



Level of Service Criteria for Stop Sign Controlled Intersections

The level of service criteria are given in Table 17-2. As used here, control delay is defined as the total elapsed time from the time a vehicle stops at the end of the queue until the vehicle departs from the stop line; this time includes the time required for the vehicle to travel from the last-in-queue position to the first-in-queue position, including deceleration of vehicles from free-flow speed to the speed of vehicles in queue.

The average total delay for any particular minor movement is a function of the service rate or capacity of the approach and the degree of saturation. . . .

Exhibit 17-2. Level of Service Criteria for TWSC Intersections

LEVEL OF SERVICE	AVERAGE CONTROL DELAY (sec/veh)
A	≤ 10
B	> 10 and ≤ 15
C	> 15 and ≤ 25
D	> 25 and ≤ 35
E	> 35 and ≤ 50
F	> 50

Average total delay less than 10 sec/veh is defined as Level of Service (LOS) A. Follow-up times of less than 5 sec have been measured when there is no conflicting traffic for a minor street movement, so control delays of less than 10 sec/veh are appropriate for low flow conditions. To remain consistent with the AWSC intersection analysis procedure described later in this chapter, a total delay of 50 sec/veh is assumed as the break point between LOS E and F.

The proposed level of service criteria for TWSC intersections are somewhat different from the criteria used in Chapter 16 for signalized intersections. The primary reason for this difference is that drivers expect different levels of performance from different kinds of transportation facilities. The expectation is that a signalized intersection is designed to carry higher traffic volumes than an unsignalized intersection. Additionally, several driver behavior considerations combine to make delays at signalized intersections less onerous than at unsignalized intersections. For example, drivers at signalized intersections are able to relax during the red interval, where drivers on the minor approaches to unsignalized intersections must remain attentive to the task of identifying acceptable gaps and vehicle conflicts. Also, there is often much more variability in the amount of delay experienced by individual drivers at unsignalized than signalized intersections. For these reasons, it is considered that the total delay threshold for any given level of service is less for an unsignalized intersection than for a signalized intersection. . . .

LOS F exists when there are insufficient gaps of suitable size to allow a side street demand to cross safely through a major street traffic stream. This level of service is generally evident from extremely long total delays experienced by side street traffic and by queueing on the minor approaches. The method, however, is based on a constant critical gap size - that is, the critical gap remains constant, no matter how long the side street motorist waits. LOS F may also appear in the form of side street vehicles' selecting smaller-than-usual gaps. In such cases, safety may be a problem and some disruption to the major traffic stream may result. It is important to note that LOS F may not always result in long queues but may result in adjustments to normal gap acceptance behavior. The latter is more difficult to observe on the field than queueing, which is more obvious.

Source: Highway Capacity Manual, 2010. Transportation Research Board, National Research Council

Level of Service for Signalized Intersections

Level of service for signalized intersections is defined in terms of delay, which is a measure of driver discomfort and frustration, fuel consumption, and lost travel time. Specifically, level-of-service (LOS) criteria are stated in terms of the average stopped delay per vehicle for a 15-min analysis period. The criteria are given in Exhibit 16-2. Delay may be measured in the field or estimated using procedures presented later in this chapter. Delay is a complex measure and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the *v/c* ratio for the lane group in question.

LOS A describes operations with very low delay, up to 10 sec per vehicle. This level of service occurs when progression is extremely favorable and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.

LOS B describes operations with delay greater than 10 and up to 20 sec per vehicle. This level generally occurs with good progression, short cycle lengths, or both. More vehicles stop than with LOS A, causing higher levels of average delay.

Exhibit 16-2. Level-of-Service Criteria for Signalized Intersections

LEVEL OF SERVICE	STOPPED DELAY PER VEHICLE (SEC)
A	≤10.0
B	> 10.0 and ≤20.0
C	> 20.0 and ≤ 35.0
D	> 35.0 and ≤ 55.0
E	> 55.0 and ≤ 80.0
F	>80.0

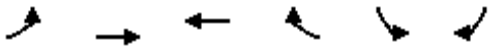
LOS C describes operations with delay greater than 20 and up to 35 sec per vehicle. These higher delays may result from fair progression, longer cycle lengths, or both. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, though many still pass through the intersection without stopping.

LOS D describes operations with delay greater than 35 and up to 55 sec per vehicle. At level D, the influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle lengths, or high *v/c* ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.

LOS E describes operations with delay greater than 55 and up to 80 sec per vehicle. This level is considered by many agencies to be the limit of acceptable delay. These high delay values generally indicate poor progression, long cycle lengths, and high *v/c* ratios. Individual cycle failures are frequent occurrences.

LOS F describes operations with delay in excess of 80 sec per vehicle. This level, considered to be unacceptable to most drivers, often occurs with oversaturation, that is, when arrival flow rates exceed the capacity of the intersection. It may also occur at high *v/c* ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also be major contributing causes to such delay levels.

Source: Highway Capacity Manual, 2010. Transportation Research Board, National Research Council



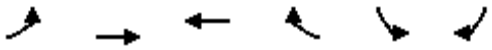
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	87	715	1076	84	300	418
Future Volume (veh/h)	87	715	1076	84	300	418
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1938	1938	1969	1969	1969	1969
Adj Flow Rate, veh/h	99	812	1145	89	323	449
Peak Hour Factor	0.88	0.88	0.94	0.94	0.93	0.93
Percent Heavy Veh, %	4	4	2	2	2	2
Cap, veh/h	285	2390	1969	153	469	481
Arrive On Green	0.04	0.65	0.56	0.56	0.25	0.25
Sat Flow, veh/h	1845	3778	3615	273	1875	1668
Grp Volume(v), veh/h	99	812	608	626	323	449
Grp Sat Flow(s),veh/h/ln	1845	1841	1870	1920	1875	1668
Q Serve(g_s), s	2.6	11.9	25.5	25.5	18.7	30.0
Cycle Q Clear(g_c), s	2.6	11.9	25.5	25.5	18.7	30.0
Prop In Lane	1.00			0.14	1.00	1.00
Lane Grp Cap(c), veh/h	285	2390	1047	1075	469	481
V/C Ratio(X)	0.35	0.34	0.58	0.58	0.69	0.93
Avail Cap(c_a), veh/h	536	2390	1047	1075	469	481
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.5	9.5	17.2	17.2	40.8	41.6
Incr Delay (d2), s/veh	0.7	0.4	2.4	2.3	4.2	25.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	4.4	10.7	11.0	9.1	29.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	14.2	9.9	19.6	19.6	45.0	66.8
LnGrp LOS	B	A	B	B	D	E
Approach Vol, veh/h		911	1234		772	
Approach Delay, s/veh		10.3	19.6		57.7	
Approach LOS		B	B		E	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		84.0		36.0	10.7	73.3
Change Period (Y+Rc), s		* 6.1		6.0	* 6.1	* 6.1
Max Green Setting (Gmax), s		* 78		30.0	* 21	* 51
Max Q Clear Time (g_c+I1), s		13.9		32.0	4.6	27.5
Green Ext Time (p_c), s		6.1		0.0	0.2	8.2

Intersection Summary	
HCM 6th Ctrl Delay	26.8
HCM 6th LOS	C

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	268	1377	1103	410	280	122
Future Volume (veh/h)	268	1377	1103	410	280	122
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	2000	2000	2000	2000	1984	1984
Adj Flow Rate, veh/h	285	1465	1199	446	329	144
Peak Hour Factor	0.94	0.94	0.92	0.92	0.85	0.85
Percent Heavy Veh, %	0	0	0	0	1	1
Cap, veh/h	317	2696	1513	546	359	496
Arrive On Green	0.11	0.71	0.55	0.55	0.19	0.19
Sat Flow, veh/h	1905	3900	2834	987	1890	1682
Grp Volume(v), veh/h	285	1465	822	823	329	144
Grp Sat Flow(s),veh/h/ln	1905	1900	1900	1820	1890	1682
Q Serve(g_s), s	10.2	21.9	40.9	44.2	20.5	7.9
Cycle Q Clear(g_c), s	10.2	21.9	40.9	44.2	20.5	7.9
Prop In Lane	1.00			0.54	1.00	1.00
Lane Grp Cap(c), veh/h	317	2696	1052	1007	359	496
V/C Ratio(X)	0.90	0.54	0.78	0.82	0.92	0.29
Avail Cap(c_a), veh/h	401	2696	1052	1007	378	513
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	32.3	8.2	21.1	21.8	47.7	32.6
Incr Delay (d2), s/veh	19.2	0.8	5.8	7.3	26.1	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.8	7.6	18.1	19.0	12.1	8.2
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	51.5	9.0	26.9	29.2	73.8	32.9
LnGrp LOS	D	A	C	C	E	C
Approach Vol, veh/h		1750	1645		473	
Approach Delay, s/veh		15.9	28.0		61.4	
Approach LOS		B	C		E	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		91.2		28.8	18.7	72.5
Change Period (Y+Rc), s		* 6.1		6.0	* 6.1	* 6.1
Max Green Setting (Gmax), s		* 84		24.0	* 18	* 60
Max Q Clear Time (g_c+I1), s		23.9		22.5	12.2	46.2
Green Ext Time (p_c), s		15.3		0.3	0.4	8.9

Intersection Summary	
HCM 6th Ctrl Delay	26.6
HCM 6th LOS	C

Notes

User approved pedestrian interval to be less than phase max green.
* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Intersection: 1: Walton Boulevard & Brewster Road

Movement	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	T	T	T	TR	L	R
Maximum Queue (ft)	103	170	168	349	345	572	325
Average Queue (ft)	41	79	67	187	172	219	147
95th Queue (ft)	82	144	139	301	297	390	280
Link Distance (ft)		2104	2104	1975	1975	1758	
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)	500						225
Storage Blk Time (%)						8	2
Queuing Penalty (veh)						35	5

Network Summary

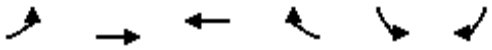
Network wide Queuing Penalty: 40

Intersection: 1: Walton Boulevard & Brewster Road (Push-Buttons)

Movement	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	T	T	T	TR	L	R
Maximum Queue (ft)	260	231	238	464	514	595	350
Average Queue (ft)	140	125	130	309	330	269	81
95th Queue (ft)	228	202	207	447	464	510	261
Link Distance (ft)		2104	2104	1975	1975	1758	
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)	500						250
Storage Blk Time (%)						20	
Queuing Penalty (veh)						25	

Network Summary

Network wide Queuing Penalty: 25



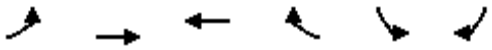
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	91	748	1126	88	314	437
Future Volume (veh/h)	91	748	1126	88	314	437
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1938	1938	1969	1969	1969	1969
Adj Flow Rate, veh/h	103	850	1198	94	338	470
Peak Hour Factor	0.88	0.88	0.94	0.94	0.93	0.93
Percent Heavy Veh, %	4	4	2	2	2	2
Cap, veh/h	272	2390	1963	154	469	483
Arrive On Green	0.04	0.65	0.56	0.56	0.25	0.25
Sat Flow, veh/h	1845	3778	3613	275	1875	1668
Grp Volume(v), veh/h	103	850	637	655	338	470
Grp Sat Flow(s),veh/h/ln	1845	1841	1870	1919	1875	1668
Q Serve(g_s), s	2.7	12.6	27.3	27.5	19.8	30.0
Cycle Q Clear(g_c), s	2.7	12.6	27.3	27.5	19.8	30.0
Prop In Lane	1.00			0.14	1.00	1.00
Lane Grp Cap(c), veh/h	272	2390	1045	1072	469	483
V/C Ratio(X)	0.38	0.36	0.61	0.61	0.72	0.97
Avail Cap(c_a), veh/h	505	2390	1045	1072	469	483
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	14.2	9.6	17.7	17.7	41.2	42.1
Incr Delay (d2), s/veh	0.9	0.4	2.6	2.6	5.4	33.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.1	4.6	11.5	11.9	9.7	31.3
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	15.1	10.0	20.4	20.3	46.5	75.9
LnGrp LOS	B	B	C	C	D	E
Approach Vol, veh/h		953	1292		808	
Approach Delay, s/veh		10.6	20.4		63.6	
Approach LOS		B	C		E	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		84.0		36.0	10.9	73.1
Change Period (Y+Rc), s		* 6.1		6.0	* 6.1	* 6.1
Max Green Setting (Gmax), s		* 78		30.0	* 20	* 52
Max Q Clear Time (g_c+I1), s		14.6		32.0	4.7	29.5
Green Ext Time (p_c), s		6.5		0.0	0.2	8.6

Intersection Summary	
HCM 6th Ctrl Delay	28.8
HCM 6th LOS	C

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	280	1441	1154	429	293	128
Future Volume (veh/h)	280	1441	1154	429	293	128
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	2000	2000	2000	2000	1984	1984
Adj Flow Rate, veh/h	298	1533	1254	466	345	151
Peak Hour Factor	0.94	0.94	0.92	0.92	0.85	0.85
Percent Heavy Veh, %	0	0	0	0	1	1
Cap, veh/h	327	2664	1436	514	375	546
Arrive On Green	0.13	0.70	0.52	0.52	0.20	0.20
Sat Flow, veh/h	1905	3900	2840	981	1890	1682
Grp Volume(v), veh/h	298	1533	855	865	345	151
Grp Sat Flow(s),veh/h/ln	1905	1900	1900	1821	1890	1682
Q Serve(g_s), s	13.0	24.3	46.7	51.7	21.5	8.0
Cycle Q Clear(g_c), s	13.0	24.3	46.7	51.7	21.5	8.0
Prop In Lane	1.00			0.54	1.00	1.00
Lane Grp Cap(c), veh/h	327	2664	995	954	375	546
V/C Ratio(X)	0.91	0.58	0.86	0.91	0.92	0.28
Avail Cap(c_a), veh/h	355	2664	995	954	394	563
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	37.4	9.0	24.7	25.9	47.2	30.1
Incr Delay (d2), s/veh	25.6	0.9	9.6	13.8	26.1	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.8	8.6	21.8	23.9	12.7	8.5
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	63.1	9.9	34.3	39.7	73.3	30.4
LnGrp LOS	E	A	C	D	E	C
Approach Vol, veh/h		1831	1720		496	
Approach Delay, s/veh		18.6	37.0		60.2	
Approach LOS		B	D		E	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		90.2		29.8	21.2	69.0
Change Period (Y+Rc), s		* 6.1		6.0	* 6.1	* 6.1
Max Green Setting (Gmax), s		* 83		25.0	* 17	* 60
Max Q Clear Time (g_c+I1), s		26.3		23.5	15.0	53.7
Green Ext Time (p_c), s		16.5		0.3	0.2	4.9

Intersection Summary	
HCM 6th Ctrl Delay	31.5
HCM 6th LOS	C

Notes

User approved pedestrian interval to be less than phase max green.
* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Intersection: 1: Walton Boulevard & Brewster Road

Movement	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	T	T	T	TR	L	R
Maximum Queue (ft)	112	179	165	448	451	501	346
Average Queue (ft)	48	86	78	217	209	228	172
95th Queue (ft)	90	158	145	347	345	400	306
Link Distance (ft)		2104	2104	1975	1975	1758	
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)	500						250
Storage Blk Time (%)						7	2
Queuing Penalty (veh)						32	6

Network Summary

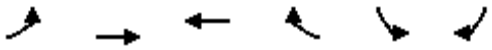
Network wide Queuing Penalty: 38

Intersection: 1: Walton Boulevard & Brewster Road (Push-Buttons)

Movement	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	T	T	T	TR	L	R
Maximum Queue (ft)	348	249	246	583	622	438	299
Average Queue (ft)	172	140	143	374	396	244	79
95th Queue (ft)	302	227	229	563	587	398	246
Link Distance (ft)		2104	2104	1975	1975	1758	
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)	500						250
Storage Blk Time (%)						15	
Queuing Penalty (veh)						20	

Network Summary

Network wide Queuing Penalty: 20



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	93	748	1126	90	319	443
Future Volume (veh/h)	93	748	1126	90	319	443
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	1938	1938	1969	1969	1969	1969
Adj Flow Rate, veh/h	106	850	1198	96	343	476
Peak Hour Factor	0.88	0.88	0.94	0.94	0.93	0.93
Percent Heavy Veh, %	4	4	2	2	2	2
Cap, veh/h	272	2390	1957	157	469	485
Arrive On Green	0.04	0.65	0.56	0.56	0.25	0.25
Sat Flow, veh/h	1845	3778	3606	281	1875	1668
Grp Volume(v), veh/h	106	850	638	656	343	476
Grp Sat Flow(s),veh/h/ln	1845	1841	1870	1918	1875	1668
Q Serve(g_s), s	2.8	12.6	27.5	27.6	20.1	30.0
Cycle Q Clear(g_c), s	2.8	12.6	27.5	27.6	20.1	30.0
Prop In Lane	1.00			0.15	1.00	1.00
Lane Grp Cap(c), veh/h	272	2390	1043	1070	469	485
V/C Ratio(X)	0.39	0.36	0.61	0.61	0.73	0.98
Avail Cap(c_a), veh/h	504	2390	1043	1070	469	485
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	14.3	9.6	17.8	17.8	41.3	42.3
Incr Delay (d2), s/veh	0.9	0.4	2.7	2.6	5.8	36.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.1	4.6	11.6	11.9	9.9	32.0
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	15.2	10.0	20.5	20.5	47.1	78.4
LnGrp LOS	B	B	C	C	D	E
Approach Vol, veh/h		956	1294		819	
Approach Delay, s/veh		10.6	20.5		65.3	
Approach LOS		B	C		E	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		84.0		36.0	11.0	73.0
Change Period (Y+Rc), s		* 6.1		6.0	* 6.1	* 6.1
Max Green Setting (Gmax), s		* 78		30.0	* 20	* 52
Max Q Clear Time (g_c+I1), s		14.6		32.0	4.8	29.6
Green Ext Time (p_c), s		6.5		0.0	0.2	8.6

Intersection Summary	
HCM 6th Ctrl Delay	29.3
HCM 6th LOS	C

Notes

* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

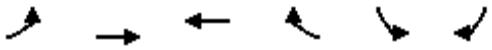
Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	1	11	4	179	751	0
Future Vol, veh/h	1	11	4	179	751	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	91	91	93	93
Heavy Vehicles, %	0	0	0	3	2	0
Mvmt Flow	1	12	4	197	808	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1013	808	808	0	-	0
Stage 1	808	-	-	-	-	-
Stage 2	205	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.2	-	-	-
Pot Cap-1 Maneuver	267	384	826	-	-	-
Stage 1	442	-	-	-	-	-
Stage 2	834	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	266	384	826	-	-	-
Mov Cap-2 Maneuver	266	-	-	-	-	-
Stage 1	440	-	-	-	-	-
Stage 2	834	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	15.1	0.2	0
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	826	-	370	-	-
HCM Lane V/C Ratio	0.005	-	0.035	-	-
HCM Control Delay (s)	9.4	0	15.1	-	-
HCM Lane LOS	A	A	C	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	287	1441	1154	434	296	132
Future Volume (veh/h)	287	1441	1154	434	296	132
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00			1.00	1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No	No		No	
Adj Sat Flow, veh/h/ln	2000	2000	2000	2000	1984	1984
Adj Flow Rate, veh/h	305	1533	1254	472	348	155
Peak Hour Factor	0.94	0.94	0.92	0.92	0.85	0.85
Percent Heavy Veh, %	0	0	0	0	1	1
Cap, veh/h	334	2664	1414	512	374	556
Arrive On Green	0.13	0.70	0.52	0.52	0.20	0.20
Sat Flow, veh/h	1905	3900	2831	989	1890	1682
Grp Volume(v), veh/h	305	1533	858	868	348	155
Grp Sat Flow(s),veh/h/ln	1905	1900	1900	1820	1890	1682
Q Serve(g_s), s	13.7	24.3	47.6	52.8	21.7	8.2
Cycle Q Clear(g_c), s	13.7	24.3	47.6	52.8	21.7	8.2
Prop In Lane	1.00			0.54	1.00	1.00
Lane Grp Cap(c), veh/h	334	2664	984	942	374	556
V/C Ratio(X)	0.91	0.58	0.87	0.92	0.93	0.28
Avail Cap(c_a), veh/h	366	2664	984	942	378	559
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	38.1	9.0	25.4	26.7	47.3	29.6
Incr Delay (d2), s/veh	25.2	0.9	10.5	15.6	29.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	11.0	8.6	22.5	24.9	13.1	8.7
Unsig. Movement Delay, s/veh						
LnGrp Delay(d),s/veh	63.3	9.9	36.0	42.3	76.2	29.9
LnGrp LOS	E	A	D	D	E	C
Approach Vol, veh/h		1838	1726		503	
Approach Delay, s/veh		18.8	39.1		62.0	
Approach LOS		B	D		E	

Timer - Assigned Phs		2		4	5	6
Phs Duration (G+Y+Rc), s		90.2		29.8	22.0	68.2
Change Period (Y+Rc), s		* 6.1		6.0	* 6.1	* 6.1
Max Green Setting (Gmax), s		* 84		24.0	* 18	* 60
Max Q Clear Time (g_c+I1), s		26.3		23.7	15.7	54.8
Green Ext Time (p_c), s		16.6		0.1	0.2	4.1

Intersection Summary	
HCM 6th Ctrl Delay	32.8
HCM 6th LOS	C

Notes

User approved pedestrian interval to be less than phase max green.
* HCM 6th computational engine requires equal clearance times for the phases crossing the barrier.

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	1	7	12	709	421	1
Future Vol, veh/h	1	7	12	709	421	1
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	92	92	93	93	85	85
Heavy Vehicles, %	0	0	0	0	1	0
Mvmt Flow	1	8	13	762	495	1

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1284	496	496	0	-	0
Stage 1	496	-	-	-	-	-
Stage 2	788	-	-	-	-	-
Critical Hdwy	6.4	6.2	4.1	-	-	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.3	2.2	-	-	-
Pot Cap-1 Maneuver	184	578	1078	-	-	-
Stage 1	616	-	-	-	-	-
Stage 2	452	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	180	578	1078	-	-	-
Mov Cap-2 Maneuver	180	-	-	-	-	-
Stage 1	603	-	-	-	-	-
Stage 2	452	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	13.1	0.1	0
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1078	-	453	-	-
HCM Lane V/C Ratio	0.012	-	0.019	-	-
HCM Control Delay (s)	8.4	0	13.1	-	-
HCM Lane LOS	A	A	B	-	-
HCM 95th %tile Q(veh)	0	-	0.1	-	-

Intersection: 1: Walton Boulevard & Brewster Road

Movement	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	T	T	T	TR	L	R
Maximum Queue (ft)	125	205	205	431	422	535	350
Average Queue (ft)	48	91	81	226	217	255	193
95th Queue (ft)	92	171	168	367	369	425	337
Link Distance (ft)		2104	2104	1975	1975	893	
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)	500						250
Storage Blk Time (%)						9	2
Queuing Penalty (veh)						40	7

Intersection: 2: Brewster Road & Site Drive

Movement	EB	NB
Directions Served	LR	LT
Maximum Queue (ft)	40	35
Average Queue (ft)	9	3
95th Queue (ft)	33	18
Link Distance (ft)	329	893
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 46

Intersection: 1: Walton Boulevard & Brewster Road

Movement	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	T	T	T	TR	L	R
Maximum Queue (ft)	281	278	279	573	595	647	350
Average Queue (ft)	149	132	141	356	378	342	111
95th Queue (ft)	244	224	231	515	538	722	323
Link Distance (ft)		2104	2104	1975	1975	926	
Upstream Blk Time (%)						1	
Queuing Penalty (veh)						6	
Storage Bay Dist (ft)	500						250
Storage Blk Time (%)						28	
Queuing Penalty (veh)						38	

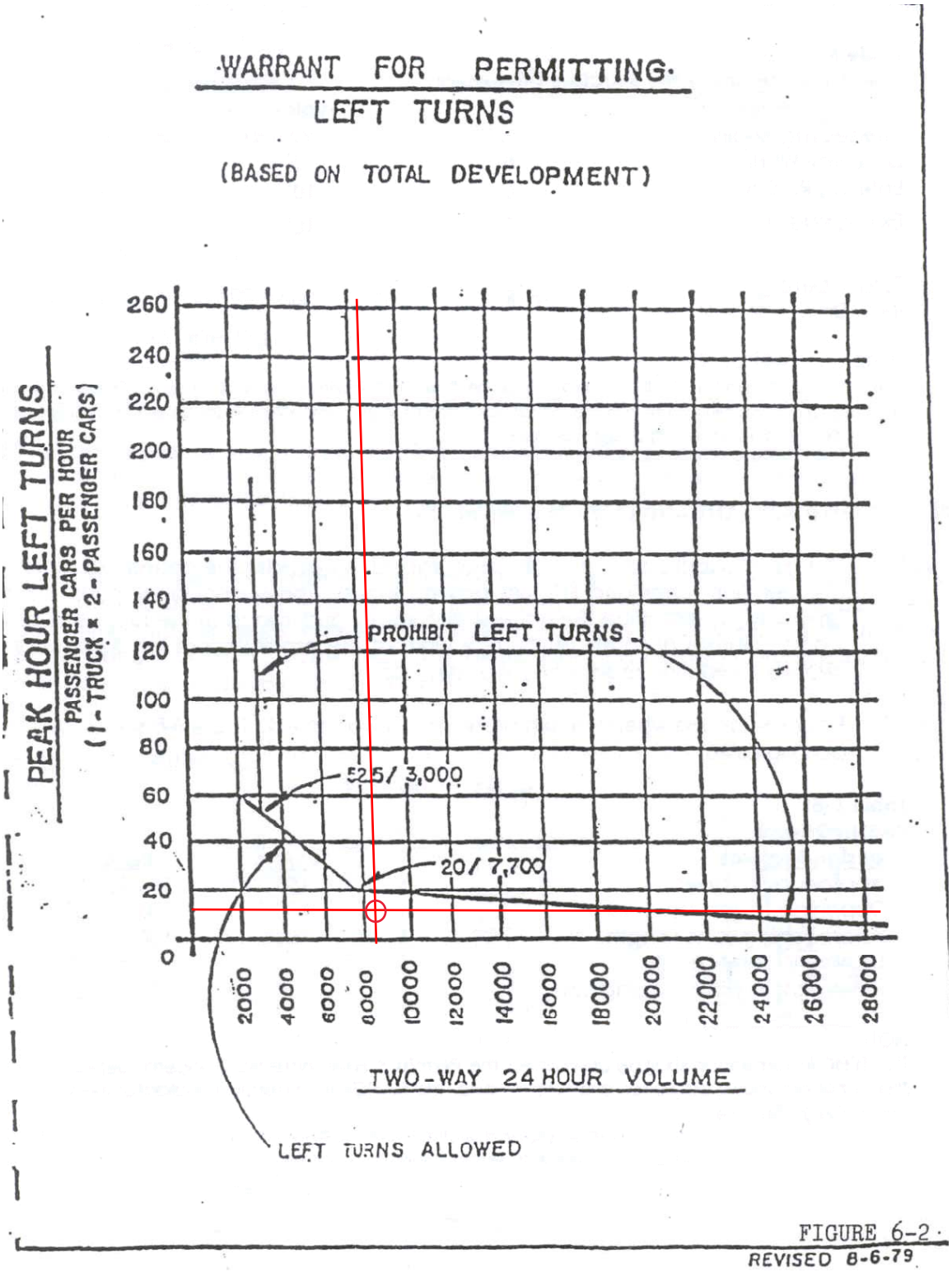
Intersection: 2: Brewster Road & S. Site Drive

Movement	EB	NB	SB
Directions Served	LR	LT	TR
Maximum Queue (ft)	31	79	54
Average Queue (ft)	5	7	5
95th Queue (ft)	25	39	59
Link Distance (ft)	328	926	317
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 45

BREWSTER ROAD & N. SITE DRIVE LT LANE WARRANT



AM: 4
PM: 12

LT PASSING LANE NOT REQUIRED

PROJECTED 2020 ADT
8,600 FUTURE 24-HOUR TWO-WAY

BREWSTER ROAD & N. SITE DRIVE RT LANE WARRANT

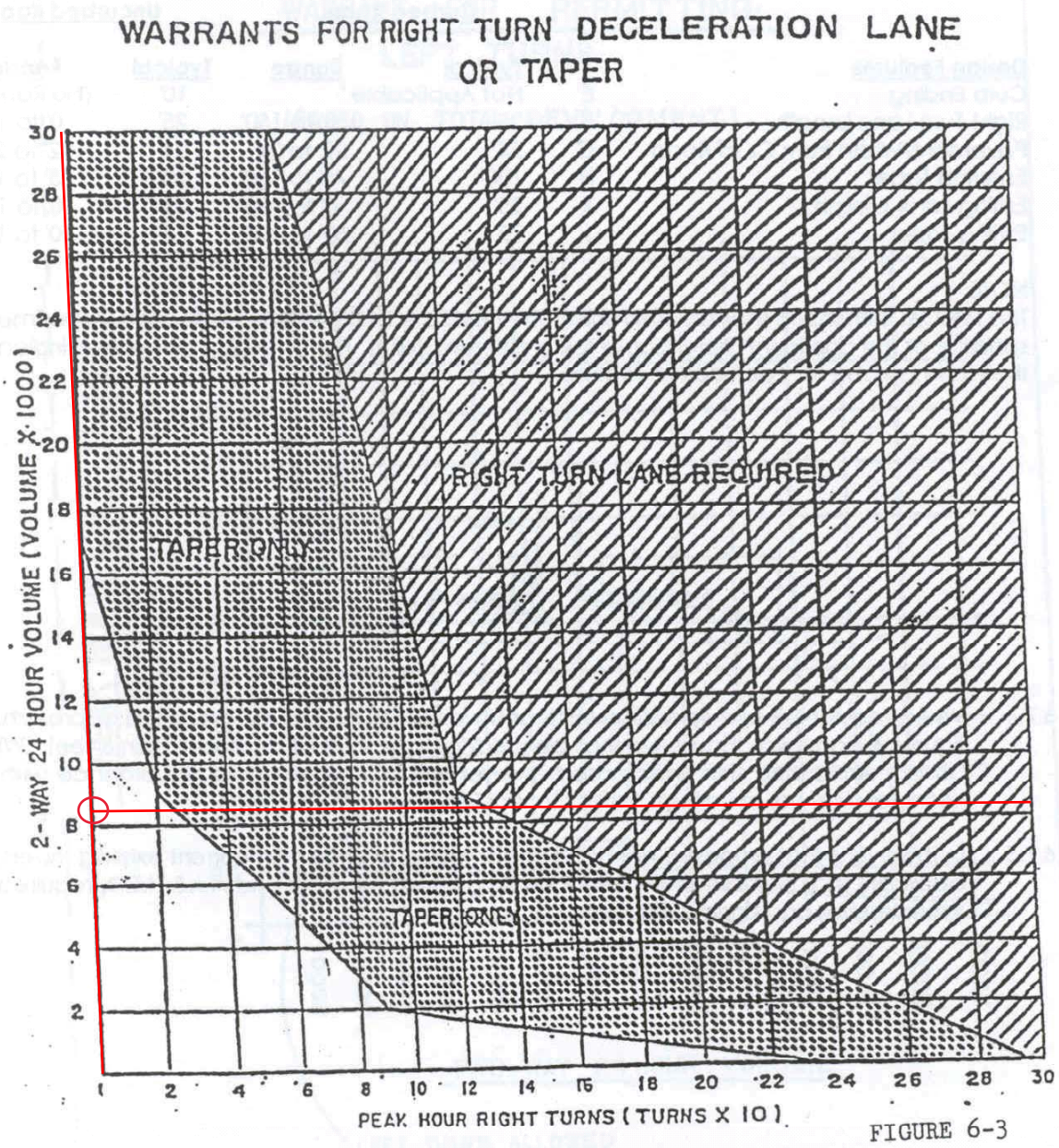


FIGURE 6-3

AM: 0
PM: 1

RT TREATMENT NOT REQUIRED

PROJECTED 2020 ADT
8,600 FUTURE 24-HOUR TWO-WAY