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To: James Merten, P.E., City of Neenah

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From: Kenneth H. Voigt, P.E. Transportation Engineer

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Date: April 13, 2021

Project No.: 49-0123.00

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Re: Final Report on Hewitt Parking Structure Traffic Signal Engineering Study

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This Technical Memorandum serves as a companion to the Hewitt Lot Parking Structure Traffic Analysis Memorandum. The following engineering study analyzes the feasibility of signaling the driveway to both a 5-level, 578 space and a 3-level, 298 space Hewitt parking structure. The analysis focuses on year 2040 traffic conditions to evaluate how a parking structure may impact Commercial Street peak hour operation. There are two analyses required as part of an engineering study to determine if the installation of traffic signals at the Hewitt parking structure driveway provides a safe, operational improvement on Commercial Street:

1. Do traffic signals provide satisfactory peak hour Level of Service operation?
2. Do traffic signals satisfy the Warrants for traffic signal installation published in the *Manual on Uniform Traffic Control Devices*?

1. Peak Hour Traffic Signal Operation:

Year 2040 peak hour traffic volumes with a 5-level, 578 space, single access Hewitt parking structure were analyzed for its impact on the Commercial Street intersections with the parking structure driveway and with Wisconsin Avenue. Under a traffic signal-controlled driveway, the structure would be designed with a combined 2-lane entrance with separate left and right turn exit lanes located approximately 600 feet north of Wisconsin Avenue and 700 feet south of North Water Street. For coordination with the progressive traffic flow system on Commercial Street, the analysis assumes that the parking structure driveway traffic signals are operated with a 50-second cycle length with the Wisconsin Avenue signals operating at its existing 100-second cycle length. The Appendix to this study contains year 2020 and year 2040 peak hour traffic volume projections for a 578-space and a 298-space parking structure. Table A summarizes the morning and evening intersection operation analysis for a 578-space, 5-level parking structure.

**Table A: Year 2040 Commercial Street Peak Hour Operation Summary with a 578-Space Hewitt Parking Structure**

2040 5-Level Signal Driveway AM Peak Hour Traffic Operations - Commercial Street															
Scenario	Control	MOE	Movement												OVERALL
			EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Wisconsin Avenue	Signal	LOS	D	C	C	C	E	C	C	D	D	**F		D	
		Delay (sec)	52.4	29.5	24.6	30.7	56.8	34.1	25.2	52.7	49.0	47.3		46.9	
		Queue (ft)	*200	100'	25'	50'	*275	50'	25'	*700	25'	*475		--	
Hewitt Driveway Entrance	Signal	LOS				C		C		A		F		E	
		Delay (sec)				22.2		22.3		3.2		117.2		70.5	
		Queue (ft)				25'		25'		100'		*400		--	
* 95th percentile volume exceeds capacity, queue may be longer															
** Volume to Capacity ratio above 1 = LOS 'F'															
2040 5-Level Signal Driveway PM Peak Hour Traffic Operations - Commercial Street															
Scenario	Control	MOE	Movement												OVERALL
			EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Wisconsin Avenue	Signal	LOS	E	D	C	C	E	D	C	D	C	C		D	
		Delay (sec)	69.6	37.9	28.4	31.2	55.0	35.2	20.3	47.0	33.7	25.7		39.5	
		Queue (ft)	*300	*250	25'	100'	*250	50'	50'	*850	50'	*650		--	
Hewitt Driveway Entrance	Signal	LOS				C		B		A		A		B	
		Delay (sec)				20.6		16.5		9.4		10.0		11.3	
		Queue (ft)				150'		100'		200'		175'		--	
* 95th percentile volume exceeds capacity, queue may be longer															

As shown on Table A, year 2040 operation of the Commercial Street driveway intersection with a 578-space parking structure signalized driveway is expected to experience LOS 'F' morning peak hour operation on the southbound intersection approach. The average southbound vehicle delay is calculated at 117.2 seconds per vehicle with maximum queues exceeding 400 feet. During the morning peak hour, the southbound approach of Wisconsin Avenue is expected to be oversaturated, operating at LOS 'F' with a maximum queue exceeding 475 feet. In comparison, during the evening peak hour, all traffic movements at a Hewitt parking structure driveway are expected to operate at LOS 'C' or better with internal parking structure queues ranging between 100 feet to 150 feet. The Wisconsin Avenue intersection with Commercial Street is expected to operate with all movements at LOS 'D' or better except for the eastbound left turn and the westbound through movements on Wisconsin Avenue.

Due to the year 2040 morning peak hour failing Level of Service at the parking structure driveway, an analysis was conducted for a smaller 3-level parking structure with 298-spaces. Table B summarizes the year 2040 peak hour operation for a 298-space parking structure with driveway traffic signal control.

**Table B: Year 2040 Commercial Street Peak Hour Operation Summary with a 298-Space Hewitt Parking Structure**

2040 3-Level Signal Driveway AM Peak Hour Traffic Operations - Commercial Street															
Scenario	Control	MOE	Movement												OVERALL
			EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Wisconsin Avenue	Signal	LOS	D	C	C	C	E	C	C	D	D	F		D	
		Delay (sec)	38.5	30.0	24.9	30.7	56.8	34.1	25.2	35.0	40.2	57.5		45.4	
		Queue (ft)	175'	75'	25'	50'	*275	50'	25'	*600	25'	*575		--	
Hewitt Driveway Entrance	Signal	LOS				C		C		A		B		A	
		Delay (sec)				23.7		23.3		2.4		11.2		7.9	
		Queue (ft)				25'		25'		75'		*300		--	
*95th percentile volume exceeds capacity, queue may be longer															
2040 3-Level Signal Driveway PM Peak Hour Traffic Operations - Commercial Street															
Scenario	Control	MOE	Movement												OVERALL
			EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Wisconsin Avenue	Signal	LOS	E	D	C	C	E	D	B	D	C	B		D	
		Delay (sec)	65.9	37.9	28.4	31.2	55.0	35.2	16.2	44.5	32.5	16.6		35.8	
		Queue (ft)	*275	*250	25'	100'	*250	50'	50'	*850	50'	*550		--	
Hewitt Driveway Entrance	Signal	LOS				B		B		A		A		A	
		Delay (sec)				19.9		18.8		6.6		6.3		7.8	
		Queue (ft)				75'		50'		200'		150'		--	
*95th percentile volume exceeds capacity, queue may be longer															

As shown on Table B, year 2040 operation of the Commercial Street signalized driveway intersection with a 298-space parking structure driveway is expected to operate with all traffic movements at LOS 'C' or better during the morning peak hour and at LOS 'B' or better during the evening peak hour.

During the morning peak hour, the southbound approach of Wisconsin Avenue at its intersection with Commercial Street is expected to operate with the westbound through movement at LOS 'E' with a maximum queue exceeding 275 feet. The southbound shared through/right turn movement is expected to operate at LOS 'F' with a maximum queue exceeding 575 feet.

Table C provides a summary of the comparison of selected traffic movement operating conditions at the Commercial Street intersection with a 578-space and a 298-space parking structure driveway and the adjacent Wisconsin Avenue intersection for year 2020 and year 2040 traffic projections.

**Table C: Year 2020 and 2040 Comparison of Stop Sign and Traffic Signal Controlled Commercial Street Intersection Selected Traffic Movement Operation**

578 Space Structure		Year 2020				Year 2040			
		Morning Peak Hour		Evening Peak Hour		Morning Peak Hour		Evening Peak Hour	
Control	Location	LOS	Queue	LOS	Queue	LOS	Queue	LOS	Queue
Driveway Stop Sign Control	WBLT Structure Driveway Exit	F	50'	F	600'	F	50'	F	675'
	<b>SB Commercial Street:</b>								
	Structure Driveway Entrance	C	100'	B	25'	C	125'	B	25'
	Wisconsin Avenue	D	*500	D	*575	F	575'	D	650'
Driveway Traffic Signal Control	WBLT Structure Driveway	C	25'	C	150'	C	25'	C	150'
	<b>SB Commercial Street:</b>								
	Structure Driveway	F	*375	A	150'	F	*400	A	175'
	Wisconsin Avenue	C	*450	B	*600	**F	*475	C	*650

\* 95th percentile volume exceeds capacity, queue may be longer

\*\* Volume to Capacity ratio above 1 = LOS 'F'

298 Space Structure		Year 2020				Year 2040			
		Morning Peak Hour		Evening Peak Hour		Morning Peak Hour		Evening Peak Hour	
Control	Location	LOS	Queue	LOS	Queue	LOS	Queue	LOS	Queue
Driveway Stop Sign Control	WBLT Structure Driveway Exit	E	25'	F	225'	E	25'	F	275'
	<b>SB Commercial Street:</b>								
	Structure Driveway Entrance	B	50'	B	25'	B	50'	B	25'
	Wisconsin Avenue	D	*475	C	475*	F	*575	D	*550
Driveway Traffic Signal Control	WBLT Structure Driveway	C	25'	B	75'	C	25'	B	75'
	<b>SB Commercial Street:</b>								
	Structure Driveway	A	*225	A	125'	B	*300	A	150'
	Wisconsin Avenue	C	*475	B	*475	F	*575	B	*550

\* 95th percentile volume exceeds capacity, queue may be longer

**Parking Structure Driveway Operation**

As shown on Table C, STOP sign control of the westbound left turn driveway exiting traffic for a 598-space parking structure indicates LOS 'F' operation during both the morning and evening peak hours with maximum evening peak hour queues of 600 feet in 2020 increasing to 675 feet by 2040.

Compared to operation of a 578-space structure, the westbound driveway left turn exit movement for a 298-space structure under STOP sign control is expected to operate at LOS 'E' during the morning and LOS 'F' during the evening peak hours with significantly shorter evening maximum queues between 225 feet to 275 feet.

For a 578-space structure, upgrading driveway control with traffic signals is expected to improve the exiting westbound left turn operation to LOS 'C' during both the morning and evening peak hours with a maximum evening peak hour queue of 150 feet under year 2020 and 2040 traffic levels. In comparison, a 298-space signalized driveway structure is expected to operate with a maximum exiting queue of 75 feet.

**Southbound Commercial Street Operation at Structure Driveway**

As shown on Table C, southbound Commercial Street operation at a Stop sign controlled 578-space entering driveway condition is expected to operate at LOS 'B' and 'C' in both the year 2020 and year 2040 with maximum southbound queues during the morning peak hour of 125 feet.

In comparison a 298-space parking structure is expected to experience southbound Commercial Street LOS 'B' operation at the structure driveway in 2020 and 2040 with maximum southbound Commercial Street queues of 50 feet.

Upgrading driveway control to traffic signals for a 578-space structure is expected to worsen southbound operation to LOS 'F' during the year 2020 and 2040 morning peak hours, with southbound queues ranging between 375 feet to 400 feet. In comparison, southbound Commercial Street operation with a 298-space parking structure is expected to operate at LOS 'A' and 'B' during peak traffic periods with maximum southbound queues of 225 feet to 300 feet.

#### Southbound Commercial Street Operation at Wisconsin Avenue

For a 578-space structure with westbound STOP sign controlled exit driveway, Table C indicates in 2020, the southbound Commercial Street approach to Wisconsin Avenue is expected to operate at LOS 'D' during both peak hours with maximum southbound queues of 500 feet to 575 feet. By the year 2040, operation of the southbound Commercial Street approach to Wisconsin Avenue is expected to worsen to LOS 'F' during the morning peak hour with a maximum queue of 575 feet and operate at LOS 'D' during evening peak hour with a maximum queue of 650 feet.

Upgrading the 578-space parking structure driveway control with traffic signals is expected to improve southbound Commercial Street operation at its intersection with Wisconsin Avenue to LOS 'C' and 'B' during the year 2020 morning and evening peak hours with maximum queues ranging between 450 feet to 600 feet. By the year 2040, the southbound approach of Commercial Street operation is expected to worsen to LOS 'F' operation during the morning peak hour with a maximum southbound queue of 475 feet at Wisconsin Avenue.

In comparison, southbound Commercial Street operation with a 298-space parking structure is expected to operate in the year 2020 at LOS 'B' and 'C' during peak traffic periods with maximum southbound queues of 475 feet. By the year 2040, the southbound Commercial Street approach to Wisconsin Avenue is expected to worsen to LOS 'F' during the morning peak hour with a maximum southbound queue of 575 feet.

Although the parking structure driveway exit operates at acceptable levels with traffic signal control, the Commercial Street southbound queue analysis at its intersections with the structure driveway and with Wisconsin Avenue indicates several time periods of LOS 'F' operation with queues up to 650 feet long with a 578-space structure and up to 575 feet long with a 298-space structure. However, traffic signal progression simulation modeling indicates the reported queuing condition can be managed with traffic signal timing coordination between the parking structure driveway and the Wisconsin Avenue intersections to avoid intersection gridlock.

#### 2. Traffic Signal Warrants:

In order to determine if the installation of traffic signals is a viable traffic control improvement option, it is necessary to conduct a traffic signal warrant analysis documented in the national Manual on Uniform Traffic Control Devices (MUTCD). There are nine warrants that may justify the safe installation of traffic signals at an intersection. Table D summarizes an evaluation of the MUTCD Warrants for the Installation of Traffic Signals at the Commercial Street intersection with a 578-space and 298-space Hewitt parking structure driveway.

**Table D: Year 2040 Hewitt Parking Structure Traffic Signal Warrant Evaluation Summary**

<b>Warrant</b>	<b>5-Level 578 Spaces</b>	<b>3-Level 298 Spaces</b>
<b>Warrant 1: Eight-Hour Volume</b>		
Condition A: Minimum Vehicular Volume	No	No
Condition B: Interruption of Continuous Traffic	No	No
Condition C: Combination: 80% of A and B	No	No
<b>Warrant 2: Four-Hour Volume</b>	No	No
<b>Warrant 3: Peak Hour Volume</b>	YES	YES
<b>Warrant 4: Pedestrian Volume</b>		
Criterion A: Four-Hour	N/A	N/A
Criterion B: Peak Hour	N/A	N/A
<b>Warrant 5: School Crossing</b>	N/A	N/A
<b>Warrant 6: Coordinated Signal System</b>	N/A	N/A
<b>Warrant 7: Crash Experience</b>	N/A	N/A
<b>Warrant 8: Roadway Network</b>	N/A	N/A
<b>Warrant 9: Intersection Near a Grade Crossing</b>	N/A	N/A

As shown on Table D, the ‘Peak Hour’ Warrant is satisfied during the evening peak hour for a 598 space or a 298-space parking structure. The following summary indicates that 270 exiting evening peak hour vehicles associated with a 298-space structure option is the minimum threshold required to consider installing traffic signals at the structure driveway.

According to the *Manual on Uniform Traffic Control Devices*, ‘the ‘Peak Hour’ Warrant shall only be applied for unusual cases, such as office complexes, manufacturing plants, or high occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time. The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following categories are met:

- A. *If all of the three following conditions exist for the same 1-hour of an average day:*
  1. *The total stopped time delay experienced by traffic on one minor street approach (parking structure driveway) controlled by a STOP sign equals or exceeds 5 vehicle hours; and*
  2. *The volume on the same minor-street approach equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and*
  3. *The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches of an average day.*
  
- B. *The plotted point representing the vehicles per hour on the major street (total both approaches) and the corresponding vehicles per hour on the minor street approach for 1 hour of an average day falls above the curve on the following graph.*

*If this warrant is the only warrant satisfied and a traffic control signal is justified by an engineering study, the traffic control signal may be operated in the flashing mode during the hours that that the volume criteria of this warrant are not satisfied’.*

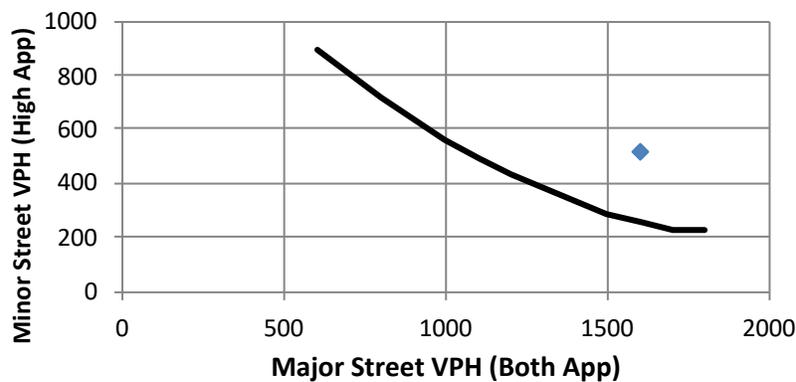
As shown on Table E, application of Peak Hour Warrant Criteria A is satisfied for both a 578-space and a 298-space Hewitt parking structure with year 2040 Commercial Street evening peak hour traffic discharge of a 90% occupied parking structure.

**Table E: Year 2040 Peak Hour Warrant Criteria ‘A’ Summary**

<b>Peak Hour Criteria</b>	<b>578-spaces</b>	<b>298 spaces</b>
A.1. Total Stopped Time Delay Exceeds 5-Vehicle Hours	72 veh-hrs	13 veh-hrs
A.2. Minor Street Volume Exceeds 150 vph	520 vph	270 vph
A.3. Total Entering Volume Exceeds 650 vph	2,000 vph	1,970 vph

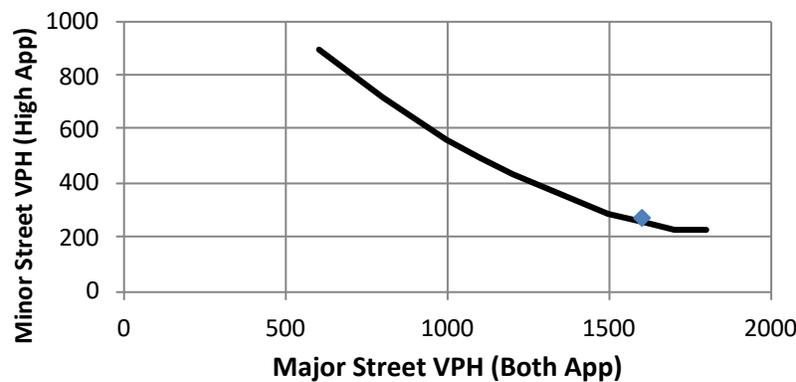
Figures A and B illustrate that both a 578-space parking structure and a 298-space parking structure satisfy the Peak Hour Warrant Criteria B.

**Figure A: Year 2040 Peak Hour Volume Warrant Curve for 578-Space Parking Structure**



Source: Manual on Uniform Control Devices

**Figure B: Year 2040 Peak Hour Volume Warrant Curve for 298-Space Parking Structure**



Source: Manual on Uniform Control Devices

**Conclusions**

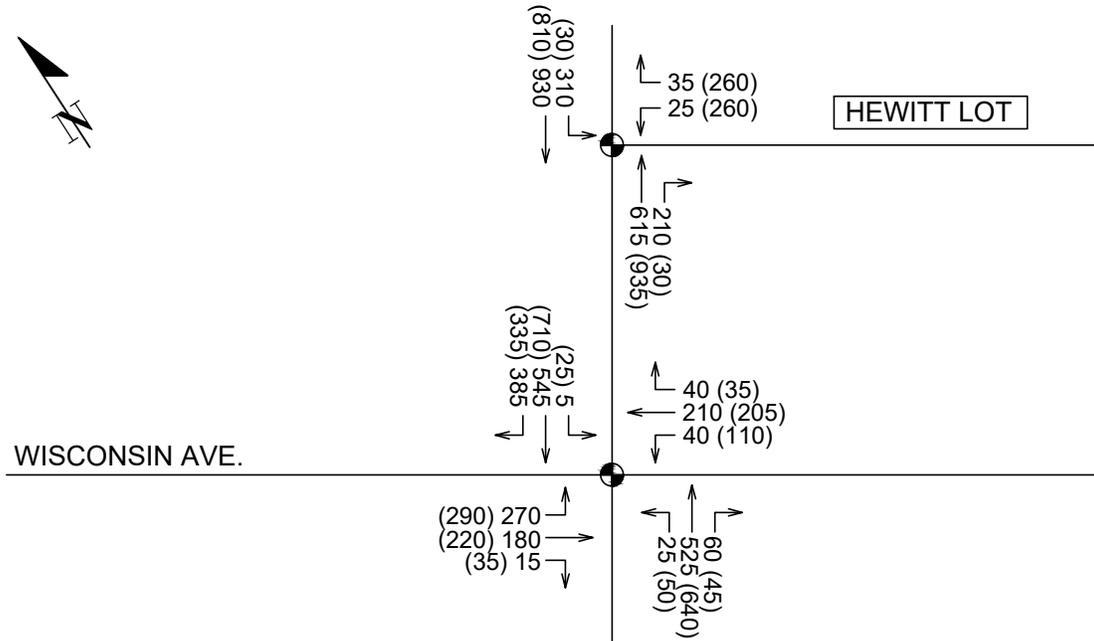
The analysis of a 578-space, 5-level and a 298-space, 3-level parking structure at the Hewitt surface parking lot are based on the assumption of a 90 percent occupied structure. As expected, the analysis indicates that a 298-space parking structure will operate with reduced impacts on Commercial Street Levels of Service and parking structure exiting delays during

evening peak traffic periods compared to a larger 578-space structure. The City of Neenah will need to consider the probability of a 578-space parking structure experiencing capacity operation on a weekly basis by the year 2040 to determine the most cost-effective infrastructure parking structure size improvement to meet the needs of the Downtown central business district.

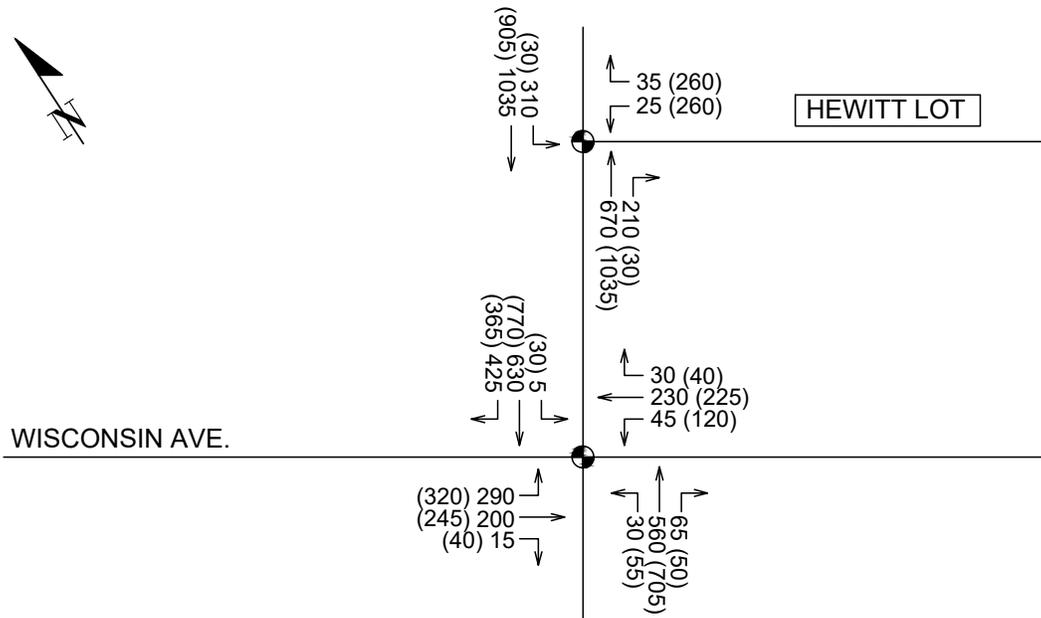
Based on the analyses of Commercial Street traffic impacts, Year 2040 peak hour operation at its intersections with a Hewitt parking structure driveway and with Wisconsin Avenue, it is concluded that a traffic-signal controlled driveway is warranted. Without a signalized parking structure driveway, Commercial Street may be expected to experience failing peak hour operating conditions along with extensive evening peak hour delays exiting the parking structure driveway. This conclusion is supported by simulation modeling of the segment of Commercial Street between the parking structure driveway and Wisconsin Avenue. According to the evaluation criteria for the Peak Hour Warrant in the *Manual on Uniform Traffic Control Devices*, it is recommended that the traffic signal should be operated on 'Yellow Flashing' mode during non-peak hour time periods.

# Attachment A

## Year 2020 Peak Hour Traffic Volumes for a 578-Space Hewitt Parking Structure



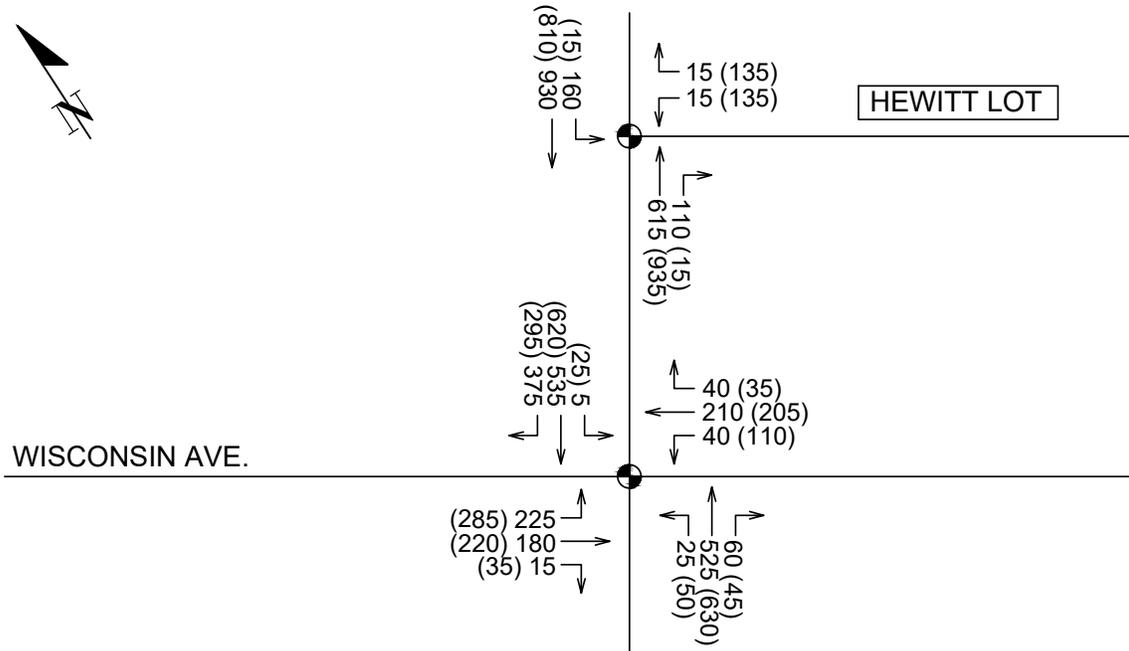
## Year 2040 Peak Hour Traffic Volumes for a 578-Space Hewitt Parking Structure



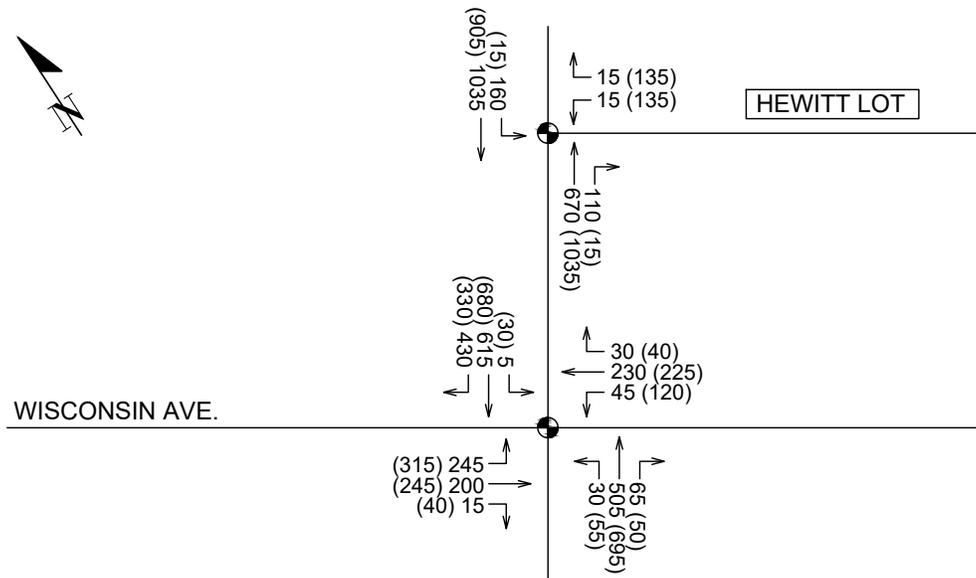
LEGEND	
	Traffic Signal
AM	7:15AM - 8:15 AM
PM	(4:30PM - 5:30PM)

# Attachment B

## Year 2020 Peak Hour Traffic Volumes for a 298-Space Hewitt Parking Structure



## Year 2040 Peak Hour Traffic Volumes for a 298-Space Hewitt Parking Structure



LEGEND	
	Traffic Signal
AM	7:15AM - 8:15 AM
PM	(4:30PM - 5:30PM)