

# Technical Memorandum

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Project: Omaha Bus Rapid Transit – Traffic Simulation (Task Order 3)

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Subject: Traffic Simulation Technical Memorandum

## Introduction

This memorandum summarizes the traffic microscopic simulation (micro-simulation) analysis that was completed for the Omaha Bus Rapid Transit (BRT) along the West Dodge Road/Dodge Street alignment. Analysis was completed for two areas of West Dodge Road/Dodge Street; referred to as “West Model” and “East Model” in the analysis/documentation completed for this project. The study intersections for each model are listed below.

### West Model

- West Dodge Road/93<sup>rd</sup> Street
- West Dodge Road/90<sup>th</sup> Street
- West Dodge Road/Cass Street
- West Dodge Road/84<sup>th</sup> Street
- Dodge Street/78<sup>th</sup> Street
- Dodge Street/76<sup>th</sup> Street
- Dodge Street/74<sup>th</sup> Street
- Dodge Street/72<sup>nd</sup> Street
- Dodge Street/69<sup>th</sup> Street

### East Model

- Dodge Street/35<sup>th</sup> Avenue
- Dodge Street/33<sup>rd</sup> Street
- Dodge Street/Turner Boulevard
- Dodge Street/30<sup>th</sup> Street
- Dodge Street/Park Avenue
- Dodge Street/29<sup>th</sup> Street
- Dodge Street/28<sup>th</sup> Street
- Dodge Street/24<sup>th</sup> Street
- Dodge Street/20<sup>th</sup> Street

- Dodge Street/19<sup>th</sup> Street

The following scenarios were modeled.

- Existing conditions – West Model and East Model
- Existing conditions plus BRT – West Model and East Model
- Existing conditions plus BRT with transit signal priority (TSP) – West Model only
- Existing conditions plus BRT with TSP and queue jump lanes – West Model only

## Volume Development

Counts at study area intersections that were conducted within the past five years were provided by City of Omaha Public Works. These counts were used to develop AM and PM peak hour balanced turning movement volumes between study intersections for each model area. The provided counts were also used to capture existing AM and PM peak hour pedestrian volumes at the West Dodge Road/Dodge Street intersections with 90<sup>th</sup>, 84<sup>th</sup> and 72<sup>nd</sup> Streets. Balanced existing turning movement volumes and pedestrian volumes are shown in **Figure 1**.

For scenarios that include the BRT, all background vehicular traffic volumes (non-BRT vehicles) were reduced by 3% to account for a shift in background traffic onto the new BRT. BRT buses were then added to the reduced background traffic volumes. BRT buses are planned to have 10 minute headways (6 buses in each direction per hour). In the East Model area the BRT buses will use a dedicated eastbound bus lane on Dodge Street east of 31<sup>st</sup> Street. The reduction of 3% was used to establish BRT ridership entering the model areas and the boardings/alightings at each planned BRT station. An assumed 1.2 passengers per vehicle for background traffic was used when calculating BRT ridership, boardings and alightings. Balanced turning movement volumes and pedestrian volumes for the BRT scenarios are shown in **Figure 2**. BRT station locations and boarding/alighting volumes per BRT station are summarized in **Table 1**. The resulting BRT ridership per BRT bus by model intersection are shown in **Table 2**.

**Table 1: BRT Boarding/Alighting Volumes for West and East Model Stations**

BRT Station	AM Peak Hour		PM Peak Hour	
	Boardings	Alightings	Boardings	Alightings
<b>West Model</b>				
90 <sup>th</sup> Street EB – Far side	18	54	18	30
90 <sup>th</sup> Street WB – Far side	24	12	54	12
84 <sup>th</sup> Street EB – Near side	12	42	18	42
84 <sup>th</sup> Street WB – Far side	30	12	42	18
72 <sup>nd</sup> Street EB – Far side	36	24	24	48
72 <sup>nd</sup> Street WB – Far side	12	18	24	42
<b>East Model</b>				
33 <sup>rd</sup> Street EB – Near side	6	12	12	6
33 <sup>rd</sup> Street WB – Far side	6	6	6	6
Turner Blvd EB – Far side	30	30	24	30
Turner Blvd WB – Near side	30	24	30	30
24 <sup>th</sup> Street EB – Far side	6	30	6	18
24 <sup>th</sup> Street WB – Far side	18	6	30	6
20 <sup>th</sup> Street EB – Near side	6	18	6	12
20 <sup>th</sup> Street WB – Near side	12	6	18	6

*Note: Boardings/alightings reflect total hourly boarding/alightings. Boardings/alightings per BRT bus are divided by 6 buses per hour (10 minute headways).*





**Table 2: BRT Ridership at West and East Model Study Intersections**

BRT Station	AM Peak Hour		PM Peak Hour	
	EB BRT	WB BRT	EB BRT	WB BRT
<b>West Model</b>				
93 <sup>rd</sup> Street	27	12	20	24
90 <sup>th</sup> Street	27	10	20	17
Cass Street	21	10	18	17
84 <sup>th</sup> Street	16	7	14	13
78 <sup>th</sup> Street	16	7	14	13
76 <sup>th</sup> Street	16	7	14	13
74 <sup>th</sup> Street	16	7	14	13
72 <sup>nd</sup> Street	16	8	14	16
69 <sup>th</sup> Street	18	8	10	16
<b>East Model</b>				
35 <sup>th</sup> Avenue	10	6	9	12
33 <sup>rd</sup> Street	9	6	10	12
Turner Blvd	9	6	10	12
30 <sup>th</sup> Street	9	5	9	12
Park Avenue	9	5	9	12
29 <sup>th</sup> Street	9	5	9	12
28 <sup>th</sup> Street	9	5	9	12
24 <sup>th</sup> Street	9	3	9	8
20 <sup>th</sup> Street	3	3	6	8
19 <sup>th</sup> Street	3	2	6	6

Note: Ridership is per BRT bus.

## Methodology

Micro-simulation analysis was completed using VISSIM 7 software. For each of the scenarios, AM and PM peak hour conditions were analyzed. Details of the scenarios are provided below.

### Existing Conditions – West and East Models

- Existing geometrics.
- Existing traffic volumes.
- Existing pedestrian volumes.
- Existing signal timings.

### Existing Conditions plus BRT – West and East Models

- Existing geometrics in West Model area.
- Existing geometrics in East Model area west of 31<sup>st</sup> Street; Eastbound BRT east of 31<sup>st</sup> Street would use a contraflow lane on Dodge Street that travels eastbound in the southernmost lane; Westbound BRT east of 28<sup>th</sup> Street would use a business access and transit (BAT) lane on Dodge Street that travels westbound in the northernmost lane.
- Existing traffic volumes reduced by 3% to account for shift to BRT.
- Increased pedestrian volumes to account for increased pedestrian activity resulting from BRT at the West Dodge Road/Dodge Street intersections at 90<sup>th</sup>, 84<sup>th</sup> and 72<sup>nd</sup> Streets.
- Existing signal timings.

- Signals in the East Model area along Dodge Street where a contraflow lane is created would operate with existing signal timings and eastbound BRT buses would have a green indication at the same time as the westbound approach; westbound left turns would yield to the BRT buses.

Existing Conditions plus BRT with TSP – West Model

- Existing geometrics.
- Existing traffic volumes reduced by 3% to account for shift to BRT.
- Increased pedestrian volumes to account for increased pedestrian activity resulting from BRT.
- Existing signal timings as the foundation for signal timings.
  - TSP at all signalized intersections – TSP modeling methodology is described below.

Existing Conditions plus BRT with TSP and Queue Jump Lanes – West Model

- Existing geometrics except at approaches modified with queue jump lanes.
- Existing traffic volumes reduced by 3% to account for shift to BRT.
- Increased pedestrian volumes to account for increased pedestrian activity resulting from BRT.
- Existing signal timings as the foundation for signal timings.
  - TSP at all signalized intersections – TSP modeling methodology is described below.
- Queue jump lanes added at:
  - Eastbound approach to 90<sup>th</sup> Street
  - Eastbound approach to 72<sup>nd</sup> Street
  - Westbound approach to 72<sup>nd</sup> Street
- Exclusive right-turn lanes added at:
  - Eastbound approach to 90<sup>th</sup> Street
  - Eastbound approach to 72<sup>nd</sup> Street
- Two-stage pedestrian crossings for pedestrian movements crossing West Dodge Road/Dodge Street at 90<sup>th</sup>, 84<sup>th</sup> and 72<sup>nd</sup> Streets. This includes pedestrian refuge in the West Dodge Road/Dodge Street median at these locations and results in pedestrians crossing one direction of West Dodge Road/Dodge Street during the pedestrian phase.

BRT dwell times per station were established based on the number of boarding passengers. For 0-5 boardings, the dwell time used was 12.2 seconds. For 6-10 boardings, the dwell time used was 24.7 seconds.

Adaptive signal control is planned for West Dodge Road/Dodge Street along the West Model area. The analysis completed for the effort that is documented in this memorandum did not include adaptive signal control. The results documented in this memorandum are primarily for a comparative analysis with varying levels of transit improvement.

## TSP Methodology

- TSP allows for green extension and early green.
- Existing signal cycle/split/offset times were used as the foundation for the signal timings and allow for TSP or pedestrian activities to modify these times as needed.
- TSP was not allowed to skip phases. Split times were reduced to values that accommodate the amount of time used for green extension or early green.
- The amount of time that the coordinated phase was allowed to begin early or be extended was limited to 10% of the cycle length. The increase in time for the coordinated movements resulted in shorter split times for the side street signal phases.
- For TSP at intersections without queue jump lanes
  - For Dodge approaches to intersections that do not have a bus stop or have a far side stop, detection of a transit vehicle occurred at the following locations:
    - For intersections spaced greater than 1,500 feet, detection occurred 1,500 feet upstream of the stop bar.
    - For intersections spaced less than 1,500 feet, detection occurred immediately downstream of the nearest upstream intersection stop bar.
  - Dodge approaches to intersections with a near side stop had TSP detection immediately downstream of the nearside stop.
  - Transit detection was also included downstream of the stop bar to end a request for TSP.
- For TSP at intersections with queue jump lanes
  - The location in the signal cycle where the transit-only phase was served was after the side street signal phases (before the Dodge signal phases).
  - Buses would be allowed to travel through the intersection during the Dodge through traffic signal phase and stay in the general purpose lane during these instances. For the purpose of modeling, the buses were directed through the queue jump lanes at all times, but were allowed to travel through the intersection during both the transit only phase or Dodge through signal phase. This coding methodology was needed because of the challenges to code the bus path (bus using the queue jump lane versus the through lane) conditionally based on the current signal phasing. Model coding at the queue jump locations allowed the bus to maintain its approximate location within the flow of traffic when traveling through the intersection during the through signal phase.
  - Detection of a transit vehicle occurred at multiple locations to approximate the position in advance of a signal that the controller would receive information about an upcoming BRT arrival.
    - For Dodge approaches to intersections that do not have a bus stop or have a far side stop, the first location for transit vehicle detection occurred at the following locations:
      - For intersections spaced greater than 1,500 feet, detection occurred 1,500 feet upstream of the stop bar.



- For intersections spaced less than 1,500 feet, detection occurred immediately downstream of the nearest upstream intersection stop bar.
- Similar to the locations without queue jump lanes, these detectors were used to bring up an early green or extend through movement signal phases on Dodge depending on the point in the cycle that the bus arrived.
  - For locations with queue jump lanes, the second location for transit vehicle detection occurred at the start of the taper into the queue jump lane. This detection was used to call the transit only phase for times during the cycle when the bus is arriving at the approach during a red indication for the through movement.
  - For times when the bus activated the further upstream detection while arriving on a red for the through traffic and is unable to reach the queue jump lane because of a queue in the through lane, the TSP operated similar to locations without queue jump lanes. For these instances, it was allowed to bring up the through movement signal phase early and the bus used the through signal phase to travel through the intersection.
  - Transit detection was also included downstream of the stop bar to end a request for TSP.
    - The length of time for the transit only phase was set to ensure that a bus that had entered the queue jump lane (and is not served by the through movement phase) was served during the first available transit only phase.
- For instances with buses arriving from both directions in the same or back-to-back cycles, the model attempted to provide for early green or green extension as desired for each bus but utilized the restrictions to split reductions when making these decisions.
- If a transit vehicle was detected but was unable to be served as a result of a max-out or cycle failure condition (transit vehicle stuck in a long queue) a call for TSP continued to be placed until the transit vehicle crossed the stop bar.

## Micro-Simulation Analysis Results

The VISSIM micro-simulation models were run 10 times using different random seeds and results were averaged. The measures of effectiveness (MOEs) reported from the micro-simulation models include the following:

- Intersection vehicular delay and level of service (LOS) (for each signalized intersection).
- Intersection total person delay (for each signalized intersection).
  - Calculated based on vehicle occupancy (BRT occupancy based on estimated ridership between stops as shown in **Table 2**; assumed 1.2 people per vehicle for all other vehicles).
- Intersection max queues by movement.
- Travel time between each signalized intersection and between signals on each end of the model areas.
- Number of times that the transit only phase served during the peak hour.

A summary of the overall intersection vehicular delay and LOS for each scenario are shown in **Tables 3 and 4** for the AM and PM peak hours, respectively.

**Table 3: Intersection Vehicular Delay and LOS – AM Peak Hour**

Intersection	Existing		Existing plus BRT		Existing plus BRT w/ TSP		Existing plus BRT w/ TSP and Queue Jump Lanes	
	Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS
<b>West Model</b>								
93 <sup>rd</sup> Street	18.18	B	83.84	F	76.79	E	7.96	A
90 <sup>th</sup> Street	54.98	D	85.17	F	93.69	F	49.75	D
Cass Street	9.23	A	11.17	B	11.14	B	11.16	B
84 <sup>th</sup> Street	21.51	C	39.38	D	40.45	D	36.65	D
78 <sup>th</sup> Street	10.69	B	22.82	C	22.12	C	24.24	C
76 <sup>th</sup> Street	9.39	A	11.99	B	11.96	B	11.19	B
74 <sup>th</sup> Street	2.22	A	4.46	A	4.08	A	4.05	A
72 <sup>nd</sup> Street	30.97	C	42.17	D	42.75	D	39.02	D
69 <sup>th</sup> Street	9.31	A	12.93	B	12.81	B	12.65	B
<b>Average Volume-Weighted Delay at Signalized Intersections</b>	<b>21.39</b>	<b>-</b>	<b>40.72</b>	<b>-</b>	<b>41.14</b>	<b>-</b>	<b>23.96</b>	<b>-</b>
<b>East Model</b>								
35 <sup>th</sup> Avenue	3.52	A	3.54	A	-	-	-	-
33 <sup>rd</sup> Street	3.59	A	3.69	A	-	-	-	-
Turner Blvd	8.80	A	9.15	A	-	-	-	-
Park Avenue	6.08	A	6.05	A	-	-	-	-
28 <sup>th</sup> Street	10.06	B	10.13	B	-	-	-	-
24 <sup>th</sup> Street	11.60	B	11.58	B	-	-	-	-
20 <sup>th</sup> Street	9.33	A	9.92	A	-	-	-	-
19 <sup>th</sup> Street	9.63	A	9.54	A	-	-	-	-
<b>Average Volume-Weighted Delay at Signalized Intersections</b>	<b>6.88</b>	<b>-</b>	<b>7.01</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

<sup>1</sup> Delay units are seconds/vehicle

**Table 4: Intersection Vehicular Delay and LOS – PM Peak Hour**

Intersection	Existing		Existing plus BRT		Existing plus BRT w/ TSP		Existing plus BRT w/ TSP and Queue Jump Lanes	
	Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS
<b>West Model</b>								
93 <sup>rd</sup> Street	5.92	A	13.82	B	20.52	C	10.45	B
90 <sup>th</sup> Street	94.26	F	124.37	F	127.69	F	111.65	F
Cass Street	20.79	C	36.01	D	33.56	C	29.91	C
84 <sup>th</sup> Street	24.02	C	75.83	E	63.91	E	46.89	D
78 <sup>th</sup> Street	44.23	D	46.29	D	51.55	D	50.39	D
76 <sup>th</sup> Street	29.60	C	29.01	C	30.70	C	27.30	C
74 <sup>th</sup> Street	13.10	B	17.56	B	16.95	B	13.75	B
72 <sup>nd</sup> Street	35.22	D	59.22	E	62.64	E	43.04	D
69 <sup>th</sup> Street	12.37	B	12.56	B	16.18	B	11.02	B
<b>Average Volume-Weighted Delay at Signalized Intersections</b>	<b>34.46</b>	<b>-</b>	<b>50.91</b>	<b>-</b>	<b>52.31</b>	<b>-</b>	<b>42.52</b>	<b>-</b>
<b>East Model</b>								
35 <sup>th</sup> Avenue	3.52	A	3.54	A	-	-	-	-
33 <sup>rd</sup> Street	3.59	A	3.69	A	-	-	-	-
Turner Blvd	8.80	A	9.15	A	-	-	-	-
Park Avenue	6.08	A	6.05	A	-	-	-	-
28 <sup>th</sup> Street	10.06	B	10.13	B	-	-	-	-
24 <sup>th</sup> Street	11.60	B	11.58	B	-	-	-	-
20 <sup>th</sup> Street	9.33	A	9.92	A	-	-	-	-
19 <sup>th</sup> Street	9.63	A	9.54	A	-	-	-	-
<b>Average Volume-Weighted Delay at Signalized Intersections</b>	<b>7.22</b>	<b>-</b>	<b>7.34</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>

<sup>1</sup> Delay units are seconds/vehicle

### Summary of West Model Vehicular Delay and LOS

- Vehicle delay and LOS are generally higher at intersections for scenarios that include the BRT.
  - This is caused by the increase in pedestrian volumes, triggering additional pedestrian actuations that hold side street signal phases longer. This results in added delay for intersection movements and signals running out of coordination for much of the peak hour.
  - Average volume-weighted signalized intersection delay for the 'Existing plus BRT' and 'Existing plus BRT with TSP' scenarios is greater than existing conditions by approximately 90% and 50% during the AM and PM peak hours, respectively.
  - Average volume-weighted signalized intersection delay for the 'Existing plus BRT with TSP and Queue Jump Lanes' scenario is greater than existing conditions by approximately 10% and 20% during the AM and PM peak hours, respectively.
- High delays at 93<sup>rd</sup> Street for the 'Existing plus BRT' and 'Existing plus BRT with TSP' scenarios during the AM are the result of excessive queuing at 90<sup>th</sup> Street that extend through 93<sup>rd</sup> Street.
- The 'Existing plus BRT with TSP and Queue Jump Lanes' scenario would provide the best operations out of the scenarios that include BRT.
  - This is primarily the result of added right-turn lanes and providing a two-stage crossing for pedestrians crossing West Dodge Road/Dodge Street at 72<sup>nd</sup>, 84<sup>th</sup> and 90<sup>th</sup> Streets. Providing the two-stage crossing allows for less time added to the side street through movements and a higher percentage of time with signals maintaining coordination.

### Summary of East Model Vehicular Delay and LOS

- Vehicle delay and LOS are similar between 'Existing' and 'Existing plus BRT' conditions.

A summary of the BRT bus delay for the BRT scenarios are shown in **Tables 5 and 6** for the AM and PM peak hours, respectively.

**Table 5: Intersection BRT Delay and LOS – AM Peak Hour**

Intersection	Approach	Existing plus BRT		Existing plus BRT w/ TSP		Existing plus BRT w/ TSP and Queue Jump Lanes	
		Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS
West Model							
93 <sup>rd</sup> Street	EB	222.51	F	207.79	F	2.28	A
	WB	30.57	C	22.18	C	20.49	C
90 <sup>th</sup> Street	EB	195.36	F	144.34	F	25.28	C
	WB	61.45	E	39.53	D	37.51	D
Cass Street	EB	17.95	B	17.86	B	17.73	B
	WB	33.63	C	20.28	C	19.21	B
84 <sup>th</sup> Street	EB	59.74	E	55.59	E	60.38	E
	WB	36.38	D	31.73	C	40.08	D
78 <sup>th</sup> Street	EB	30.36	C	14.81	B	13.70	B
	WB	7.09	A	4.37	A	5.20	A
76 <sup>th</sup> Street	EB	2.67	A	3.64	A	4.12	A
	WB	21.65	C	19.60	B	18.15	B
74 <sup>th</sup> Street	EB	7.35	A	5.62	A	4.66	A
	WB	16.22	B	15.66	B	14.91	B
72 <sup>nd</sup> Street	EB	42.03	D	31.52	C	24.27	C
	WB	29.65	C	24.94	C	20.63	C
69 <sup>th</sup> Street	EB	25.05	C	19.36	B	21.53	C
	WB	2.98	A	3.09	A	2.69	A
Average BRT Delay at Signalized Intersections		46.81	-	37.88	-	19.60	-
East Model							
35 <sup>th</sup> Avenue	EB	2.52	A	-	-	-	-
	WB	17.90	B	-	-	-	-
33 <sup>rd</sup> Street	EB	18.48	B	-	-	-	-
	WB	5.76	A	-	-	-	-
Turner Blvd	EB	6.50	A	-	-	-	-
	WB	38.24	D	-	-	-	-
Park Avenue	EB	21.86	C	-	-	-	-
	WB	2.25	A	-	-	-	-
28 <sup>th</sup> Street	EB	22.34	C	-	-	-	-
	WB	52.03	D	-	-	-	-
24 <sup>th</sup> Street	EB	2.88	A	-	-	-	-
	WB	11.85	B	-	-	-	-
20 <sup>th</sup> Street	EB	32.04	C	-	-	-	-
	WB	22.36	C	-	-	-	-
19 <sup>th</sup> Street	EB	1.04	A	-	-	-	-
	WB	1.62	A	-	-	-	-
Average BRT Delay at Signalized Intersections		16.23	-	-	-	-	-

<sup>1</sup> Delay units are seconds/vehicle

Note: BRT dwell times at stations are included in delays.

**Table 6: Intersection BRT Delay and LOS – PM Peak Hour**

Intersection	Approach	Existing plus BRT		Existing plus BRT w/ TSP		Existing plus BRT w/ TSP and Queue Jump Lanes	
		Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS	Delay <sup>1</sup>	LOS
West Model							
93 <sup>rd</sup> Street	EB	2.03	A	1.59	A	0.69	A
	WB	27.21	C	22.79	C	22.17	C
90 <sup>th</sup> Street	EB	55.70	E	45.67	D	23.18	C
	WB	52.64	D	45.81	D	39.56	D
Cass Street	EB	17.56	B	17.67	B	17.50	B
	WB	47.44	D	42.98	D	38.88	D
84 <sup>th</sup> Street	EB	52.31	D	45.00	D	40.90	D
	WB	152.20	F	111.50	F	64.47	E
78 <sup>th</sup> Street	EB	28.78	C	23.39	C	33.29	C
	WB	13.94	B	10.12	B	4.89	A
76 <sup>th</sup> Street	EB	3.82	A	5.56	A	3.55	A
	WB	14.65	B	10.12	B	13.53	B
74 <sup>th</sup> Street	EB	8.59	A	6.09	A	6.65	A
	WB	28.63	C	20.92	C	20.28	C
72 <sup>nd</sup> Street	EB	57.09	E	40.94	D	15.60	B
	WB	64.80	E	59.95	E	37.54	D
69 <sup>th</sup> Street	EB	16.91	B	15.82	B	15.51	B
	WB	13.46	B	17.63	B	9.54	A
Average BRT Delay at Signalized Intersections		36.54	-	30.20	-	22.65	-
East Model							
35 <sup>th</sup> Avenue	EB	9.13	A	-	-	-	-
	WB	21.26	C	-	-	-	-
33 <sup>rd</sup> Street	EB	25.81	C	-	-	-	-
	WB	11.12	B	-	-	-	-
Turner Blvd	EB	10.74	B	-	-	-	-
	WB	34.45	C	-	-	-	-
Park Avenue	EB	4.91	A	-	-	-	-
	WB	1.24	A	-	-	-	-
28 <sup>th</sup> Street	EB	28.76	C	-	-	-	-
	WB	44.63	D	-	-	-	-
24 <sup>th</sup> Street	EB	5.17	A	-	-	-	-
	WB	8.40	A	-	-	-	-
20 <sup>th</sup> Street	EB	41.93	D	-	-	-	-
	WB	40.36	D	-	-	-	-
19 <sup>th</sup> Street	EB	2.71	A	-	-	-	-
	WB	1.70	A	-	-	-	-
Average BRT Delay at Signalized Intersections		18.27	-	-	-	-	-

<sup>1</sup> Delay units are seconds/vehicle

Note: BRT dwell times at stations are included in delays.

### Summary of West Model BRT Delays and LOS

- The addition of TSP to the corridor would generally reduce BRT delay at signalized intersections.
  - Average signalized intersection BRT delay for the 'Existing plus BRT with TSP' scenario would be reduced from the 'Existing plus BRT' scenario by approximately 20% during the AM and PM peak hours.
- The addition of queue jump lanes would further reduce BRT delay at locations where they are installed.
  - Average signalized intersection BRT delay for the 'Existing plus BRT with TSP and Queue Jump Lanes' scenario would be reduced from the 'Existing plus BRT' scenario by approximately 60% and 40% during the AM and PM peak hours, respectively.
- High BRT delays reported at 93<sup>rd</sup> Street for the 'Existing plus BRT' and 'Existing plus BRT with TSP' scenarios during the AM are the result of excessive queuing at 90<sup>th</sup> Street that extend through 93<sup>rd</sup> Street. There are multiple instances where the BRT bus would experience cycle failure (waiting through multiple cycles to travel through an intersection) at 90<sup>th</sup> Street during the AM peak hour.

### Summary of East Model BRT Delays and LOS

- The highest BRT delays are generally at locations with a BRT station upstream of the signal. The reported delay at these intersections includes the BRT dwell times for the upstream stations.

Total person delay for each scenario is shown in **Table 7**. Person delay assumes an average of 1.2 passengers per car/truck and includes the BRT ridership estimates shown in **Table 2**.

**Table 7: Intersection Person Delay**

Intersection	Person Delay (hours)							
	Existing		Existing plus BRT		Existing plus BRT w/ TSP		Existing plus BRT w/ TSP and Queue Jump Lanes	
	AM	PM	AM	PM	AM	PM	AM	PM
<b>West Model</b>								
93 <sup>rd</sup> Street	40.95	14.94	169.57	32.91	157.95	48.63	17.56	25.36
90 <sup>th</sup> Street	138.39	263.19	196.27	323.76	217.81	332.45	122.92	296.95
Cass Street	16.44	40.95	18.20	67.39	18.50	62.89	19.60	57.27
84 <sup>th</sup> Street	37.33	43.81	62.78	132.54	65.56	112.34	62.47	83.21
78 <sup>th</sup> Street	17.09	80.67	33.67	81.83	32.95	91.04	37.92	89.55
76 <sup>th</sup> Street	13.46	50.86	15.78	48.40	15.92	51.13	15.72	45.73
74 <sup>th</sup> Street	2.73	19.04	5.09	24.64	4.71	23.76	4.94	19.48
72 <sup>nd</sup> Street	64.64	85.14	82.97	137.91	84.55	145.87	79.45	100.70
69 <sup>th</sup> Street	13.98	18.43	18.21	18.24	18.14	23.39	18.60	16.01
<b>East Model</b>								
35 <sup>th</sup> Avenue	3.24	14.11	3.20	13.32	-	-	-	-
33 <sup>rd</sup> Street	3.10	8.40	3.14	8.39	-	-	-	-
Turner Blvd	5.59	8.57	5.74	5.95	-	-	-	-
Park Avenue	2.26	2.54	2.26	3.16	-	-	-	-
28 <sup>th</sup> Street	4.59	8.68	4.63	9.19	-	-	-	-
24 <sup>th</sup> Street	4.56	9.47	4.47	9.25	-	-	-	-
20 <sup>th</sup> Street	3.76	4.57	3.95	4.92	-	-	-	-
19 <sup>th</sup> Street	2.51	5.93	2.46	6.01	-	-	-	-

#### Summary of West Model Person Delay

- Person delay is generally higher at intersections for scenarios that include the BRT.
  - As mentioned previously, this is caused by the increase in pedestrian volumes, triggering additional pedestrian actuations that hold side street signal phases longer. This results in added delay for intersection movements and signals running out of coordination for much of the peak hour.
  - Total signalized intersection person delay for the 'Existing plus BRT' and 'Existing plus BRT with TSP' scenarios is greater than existing conditions by approximately 80% and 40% during the AM and PM peak hours, respectively.
  - Total signalized intersection delay for the 'Existing plus BRT with TSP and Queue Jump Lanes' scenario is greater than existing conditions by approximately 10% and 20% during the AM and PM peak hours, respectively.
- High delays at 93<sup>rd</sup> Street for the 'Existing plus BRT' and 'Existing plus BRT with TSP' scenarios during the AM are the result of excessive queuing at 90<sup>th</sup> Street that extend through 93<sup>rd</sup> Street.

#### Summary of East Model Vehicular Delay and LOS

- Person delay and LOS are similar between 'Existing' and 'Existing plus BRT' conditions.



Travel time results for the West Model area are shown in **Tables 8 and 9**.

**Table 8: West Model Corridor Travel Times – AM Peak Hour**

Travel Time Segment	Travel Time (seconds)							
	Existing		Existing plus BRT		Existing plus BRT w/ TSP		Existing plus BRT w/ TSP and Queue Jump Lanes	
	Background Traffic	BRT	Background Traffic	BRT	Background Traffic	BRT	Background Traffic	BRT
<b>Eastbound</b>								
93 <sup>rd</sup> to 90 <sup>th</sup>	79.45	-	126.99	223.21	119.74	171.71	55.56	43.42
90 <sup>th</sup> to Cass	24.68	-	25.17	56.22	25.02	56.09	25.45	56.09
Cass to 84 <sup>th</sup>	24.10	-	53.01	87.11	51.83	83.06	53.08	87.89
84 <sup>th</sup> to 78 <sup>th</sup>	39.96	-	62.56	67.73	60.59	52.61	64.08	51.53
78 <sup>th</sup> to 76 <sup>th</sup>	19.55	-	20.5	21.70	20.77	22.27	20.60	22.92
76 <sup>th</sup> to 74 <sup>th</sup>	24.73	-	26.31	27.14	26.27	27.03	26.20	26.79
74 <sup>th</sup> to 72 <sup>nd</sup>	26.01	-	53.35	58.02	52.94	46.16	49.63	38.34
72 <sup>nd</sup> to 69 <sup>th</sup>	27.11	-	34.59	75.89	34.19	70.33	34.10	72.52
<b>93<sup>rd</sup> to 69<sup>th</sup></b>	<b>253.8</b>	<b>-</b>	<b>395.60</b>	<b>612.82</b>	<b>384.49</b>	<b>528.29</b>	<b>328.93</b>	<b>399.50</b>
<b>Westbound</b>								
69 <sup>th</sup> to 72 <sup>nd</sup>	50.70	-	53.06	52.06	53.04	47.38	51.35	42.97
72 <sup>nd</sup> to 74 <sup>th</sup>	17.06	-	17.87	45.42	17.26	44.88	17.51	44.33
74 <sup>th</sup> to 76 <sup>th</sup>	35.18	-	40.26	45.05	40.07	42.96	39.05	41.40
76 <sup>th</sup> to 78 <sup>th</sup>	21.16	-	22.27	25.61	22.05	23.02	22.23	23.79
78 <sup>th</sup> to 84 <sup>th</sup>	60.97	-	64.31	71.10	63.36	66.28	57.88	74.75
84 <sup>th</sup> to Cass	31.08	-	32.82	65.16	32.84	52.25	32.89	51.25
Cass to 90 <sup>th</sup>	42.49	-	74.41	82.70	75.23	60.42	70.47	58.30
90 <sup>th</sup> to 93 <sup>rd</sup>	21.33	-	33.33	64.62	32.73	56.60	32.11	55.07
<b>69<sup>th</sup> to 93<sup>rd</sup></b>	<b>276.77</b>	<b>-</b>	<b>337.99</b>	<b>451.71</b>	<b>337.36</b>	<b>393.79</b>	<b>325.56</b>	<b>391.86</b>

Note: BRT dwell times at stations are included in travel times.

**Table 9: West Model Corridor Travel Times – PM Peak Hour**

Travel Time Segment	Travel Time (seconds)							
	Existing		Existing plus BRT		Existing plus BRT w/ TSP		Existing plus BRT w/ TSP and Queue Jump Lanes	
	Background Traffic	BRT	Background Traffic	BRT	Background Traffic	BRT	Background Traffic	BRT
<b>Eastbound</b>								
93 <sup>rd</sup> to 90 <sup>th</sup>	58.63	-	87.74	74.04	90.83	63.21	67.57	40.48
90 <sup>th</sup> to Cass	25.01	-	25.27	55.82	25.43	55.91	25.20	55.86
Cass to 84 <sup>th</sup>	38.67	-	54.65	79.83	55.35	72.56	50.07	68.37
84 <sup>th</sup> to 78 <sup>th</sup>	50.24	-	68.75	66.42	68.56	61.15	65.99	71.21
78 <sup>th</sup> to 76 <sup>th</sup>	19.86	-	20.16	22.69	20.39	24.17	20.32	22.24
76 <sup>th</sup> to 74 <sup>th</sup>	35.41	-	35.62	31.18	34.23	28.71	33.40	29.44
74 <sup>th</sup> to 72 <sup>nd</sup>	30.28	-	53.71	70.38	50.44	54.56	34.29	29.12
72 <sup>nd</sup> to 69 <sup>th</sup>	38.16	-	29.93	55.55	30.49	54.45	33.20	54.16
<b>93<sup>rd</sup> to 69<sup>th</sup></b>	<b>286.93</b>	<b>-</b>	<b>356.48</b>	<b>456.02</b>	<b>354.06</b>	<b>412.38</b>	<b>318.69</b>	<b>370.82</b>
<b>Westbound</b>								
69 <sup>th</sup> to 72 <sup>nd</sup>	48.22	-	78.00	88.11	79.80	83.70	59.60	59.92
72 <sup>nd</sup> to 74 <sup>th</sup>	16.93	-	28.83	57.58	28.52	50.02	18.39	49.37
74 <sup>th</sup> to 76 <sup>th</sup>	30.13	-	36.27	38.39	38.30	40.81	31.16	37.40
76 <sup>th</sup> to 78 <sup>th</sup>	21.34	-	26.46	30.14	25.76	28.01	21.15	23.47
78 <sup>th</sup> to 84 <sup>th</sup>	48.72	-	160.90	188.68	130.99	146.30	94.44	98.23
84 <sup>th</sup> to Cass	28.80	-	51.92	91.13	47.27	85.67	45.50	82.25
Cass to 90 <sup>th</sup>	102.84	-	130.58	75.10	123.47	67.94	116.48	62.08
90 <sup>th</sup> to 93 <sup>rd</sup>	22.73	-	32.91	73.31	32.35	68.69	33.86	68.35
<b>69<sup>th</sup> to 93<sup>rd</sup></b>	<b>321.74</b>	<b>-</b>	<b>529.81</b>	<b>625.52</b>	<b>497.87</b>	<b>560.88</b>	<b>420.51</b>	<b>476.61</b>

Note: BRT dwell times at stations are included in travel times.

### Summary of West Model Travel Times

- Travel times for background traffic are generally longer for scenarios that include the BRT.
- Travel times for BRT buses are improved by adding TSP and queue jump lanes.
- A summary of travel time comparisons for the West Model area is provided in **Table 10**.

**Table 10: Summary of Travel Time Comparisons for West Model**

Scenario Comparison	Change in Travel Time (seconds)					
	Existing plus BRT		Existing plus BRT w/ TSP		Existing plus BRT w/ TSP and Queue Jump Lanes	
	AM	PM	AM	PM	AM	PM
<b>Eastbound – 93<sup>rd</sup> to 69<sup>th</sup></b>						
Change in Travel Time for Background Traffic compared to Existing Conditions	142	70	131	67	75	32
Change in Travel Time for BRT compared to Existing plus BRT Conditions	-	-	-85	-44	-213	-85
<b>Westbound – 69<sup>th</sup> to 93<sup>rd</sup></b>						
Change in Travel Time for Background Traffic compared to Existing Conditions	61	208	61	176	49	99
Change in Travel Time for BRT compared to Existing plus BRT Conditions	-	-	-58	-65	-60	-149

Travel time results for the East Model area are shown in **Table 11**.

**Table 11: East Model Corridor Travel Times**

Travel Time Segment	Travel Time (seconds)							
	AM				PM			
	Existing		Existing plus BRT		Existing		Existing plus BRT	
	Background Traffic	BRT	Background Traffic	BRT	Background Traffic	BRT	Background Traffic	BRT
<b>Eastbound</b>								
35 <sup>th</sup> to 33 <sup>rd</sup>	21.42	-	21.51	48.66	24.94	-	25.28	56.05
33 <sup>rd</sup> to 31 <sup>st</sup>	19.63	-	19.63	-	20.42	-	20.46	-
33 <sup>rd</sup> to Turner	-	-	-	36.80	-	-	-	40.11
Turner to Park	-	-	-	54.90	-	-	-	38.56
Park to 28 <sup>th</sup>	-	-	-	41.44	-	-	-	46.49
28 <sup>th</sup> to 24 <sup>th</sup>	-	-	-	31.06	-	-	-	33.31
24 <sup>th</sup> to 20 <sup>th</sup>	-	-	-	78.91	-	-	-	88.59
20 <sup>th</sup> to 19 <sup>th</sup>	-	-	-	8.73	-	-	-	10.49
<b>35<sup>th</sup> to 31<sup>st</sup></b>	<b>41.02</b>	-	<b>41.02</b>	-	<b>45.47</b>	-	<b>45.69</b>	-
<b>35<sup>th</sup> to 19<sup>th</sup></b>	-	-	-	<b>300.49</b>	-	-	-	<b>313.6</b>
<b>Westbound</b>								
19 <sup>th</sup> to 20 <sup>th</sup>	15.93	-	15.57	40.50	12.02	-	12.49	58.50
20 <sup>th</sup> to 24 <sup>th</sup>	29.37	-	29.33	33.49	29.27	-	29.21	30.13
24 <sup>th</sup> to 28 <sup>th</sup>	35.54	-	35.37	92.75	31.75	-	32.82	85.47
28 <sup>th</sup> to Park	21.68	-	21.62	24.65	19.64	-	21.28	21.53
Park to Turner	12.22	-	12.74	60.41	15.17	-	15.82	58.18
Turner to 33 <sup>rd</sup>	24.89	-	24.98	27.79	28.48	-	28.25	33.01
33 <sup>rd</sup> to 35 <sup>th</sup>	22.73	-	22.99	51.51	23.47	-	45.69	54.88
<b>19<sup>th</sup> to 35<sup>th</sup></b>	<b>160.72</b>	-	<b>160.22</b>	<b>331.11</b>	<b>156.77</b>	-	<b>160.28</b>	<b>341.71</b>

Note: BRT dwell times at stations are included in travel times.

### Summary of East Model Travel Times

- Travel times for background traffic are similar between the 'Existing' and 'Existing plus BRT' scenarios.
- The longest BRT travel times are generally along segments with a BRT station. The reported travel times for these segments include the BRT dwell times for the stations along these segments.

The average number of transit only phase activations for the 'Existing plus BRT with TSP and Queue Jump Lanes' scenario that was recorded by the micro-simulation runs are shown in **Table 12**.

**Table 12: Transit Only Phase Activation**

Intersection	AM		PM	
	EB	WB	EB	WB
72 <sup>nd</sup> Street	1.6	2.5	0.7	0.2
90 <sup>th</sup> Street	2.7	-	2.5	-

*Note: Average number of transit only phase activations out of 6 potential activations (6 BRT buses per hour per direction).*

### Summary of Transit Only Phase Activation

- Nearly half of the eastbound BRT buses at 90<sup>th</sup> take advantage of the queue jump lane to call the transit only phase.
- Eastbound BRT buses at 72<sup>nd</sup> Street typically arrive in a platoon of traffic that continued through the intersection on the eastbound through phase. The number of transit only phase activation is also minimized by the use of TSP to extend the through phase.
- Westbound BRT buses at 72<sup>nd</sup> Street during the PM peak hour are not able to enter the queue jump lane because of queues in the westbound through lanes that extend past the entry into the queue jump lane.

Additional detailed output results for study intersections are provided at the back of this document.

## Conclusions

The addition of the BRT would have an increase on delay and travel time along West Dodge Road/Dodge Street. However, the level of increase to delay and travel time are largely dependent on the level of increase in pedestrian activity at intersections. The increase to pedestrian activity at intersections included in this study was based on a mode shift of 3% background traffic to the BRT. The methodology used to generate the change in pedestrian activity also assumed a uniform shift of background traffic to the BRT along the corridor, rather than certain areas having a larger shift based on surrounding development. Variations to the percentage of mode shift and the locations of mode shift will result in different impacts than what was assessed for this study. It should be noted that any mode shift from passenger cars to other transportation means along West Dodge Road/Dodge Street will likely result in increased pedestrian activity and have an impact on traffic operations. Providing two-stage pedestrian crossings at locations with high pedestrian volumes will minimize any increases to delay and travel time along the corridor.

Providing TSP would improve delays and travel times associated with the BRT. The addition of queue jump lanes at select locations in conjunction with two-stage pedestrian crossings would further improve the delays and travel times associated with the BRT. This study did not

explicitly evaluate the construction of queue jump lanes without two-stage pedestrian crossings. Therefore, it is difficult to quantify the benefits provided by queue jump lanes versus two-stage pedestrian crossings.

Adaptive signal control is planned for West Dodge Road/Dodge Street along the West Model area. The analysis completed for the effort that is documented in this memorandum did not include adaptive signal control. Adaptive signal control would allow for a higher level of communication between signals along the corridor. This would allow for signals to adjust signal timings to maintain coordination and platooning of traffic during times when there is increased pedestrian activity. The planned adaptive system would likely produce lower delays and travel times than those documented in this memorandum for similar volume conditions.

Intersection					Existing							Existing plus BRT										Existing plus BRT w/ TSP								Existing plus BRT w/ TSP and Queue Jumps							
Name	Node	Direction	Balanced Volume (w/o BRT)	Balanced Volume (w/ BRT)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)	
West Dodge Rd/ 93rd Street	940	WBT	2019	1958	1.02	A	18.18	B	26			147423	11.87	B	83.84	F	672	30.57	C	610440	11.57	B	76.79	E	662	22.18	C	568609	11.15	B	7.96	A	643	20.49	C	63226	
		WBR	89	86	1.49	A			55				8.26	A			725				7.81	A			714				7.03	A			696				
		EBL	582	565	50.39	D			340				105.19	F			341				100.87	F			325				42.45	D			318				
		EBT	3907	3790	23.25	C			1101				129.35	F			2070	222.51	F		115.03	F			2069	207.79	F		1.36	A			83	2.28	A		
		SBR	172	167	5.63	A			90				5.67	A			100				5.65	A			95				5.67	A			98				
West Dodge Rd/ 90th Street	510	WBL	146	142	68.67	E	54.98	D	133			498212	85.77	F	85.17	F	163			706586	85.45	F	93.69	F	166			784105	89.48	F	49.75	D	169			442507	
		WBT	1629	1580	23.88	C			483				51.23	D			733	61.45	E		51.75	D			724	39.53	D		46.61	D			602	37.51	D		
		WBR	131	127	14.02	B			491				41.06	D			741				40.3	D			732				38.32	D			610				
		EBL	303	294	62.43	E			179				101.32	F			191				96.61	F			193				59.31	E			229				
		EBT	3017	2926	57.44	E			1396				100.61	F			1408	195.36	F		93.85	F			1410	144.34	F		35.86	D			1191	25.28	C		
		EBR	587	569	95.46	F			1399				174.7	F			1411				160.51	F			1413				23.15	C			1089				
		NBL	349	339	81.21	F			306				124.04	F			475				339.28	F			1227				149.86	F			654				
		NBT	329	319	55.65	E			272				50.94	D			295				61.86	E			505				57.69	E			399				
		NBR	74	72	43.43	D			278				41.21	D			301				54.98	D			510				50.97	D			400				
		SBL	396	384	56.56	E			256				76.03	E			328				102.39	F			420				81.74	F			423				
		SBT	510	495	74.45	E			558				50.06	D			409				52.65	D			473				59.54	E			567				
		SBR	130	126	70.58	E			558				45.85	D			410				47.32	D			474				55.88	E			567				
West Dodge Rd/ Cass Street	802	WBT	1449	1406	14.34	B	9.23	A	465			59201	15.1	B	11.17	B	531	33.63	C	65527	15.05	B	11.14	B	514	20.28	C	66598	15.15	B	11.16	B	455	19.21	B	70547	
		EBL	468	454	24.32	C			167				35.5	D			274				36.73	D			286				37.32	D			290				
		EBT	3019	2928	0.6	A			0				1.34	A			63	17.95	B		1.31	A			30	17.86	B		1.8	A			17	17.73	B		
		SBR	457	443	34.77	C			245				34.56	C			248				35.09	D			249				34.75	C			248				
West Dodge Rd/ 84th Street	491	WBL	145	141	162.64	F	21.51	C	392			134378	230.6	F	39.38	D	523			225991	309.28	F	40.45	D	658			236017	164.26	F	36.65	D	411			224879	
		WBT	1260	1222	22.26	C			460				27.04	C			565	36.38	D		25.86	C			704	31.73	C		20.51	C			480	40.08	D		
		WBR	30	29	21.34	C			472				28.15	C			578				21.11	C			717				17.42	B			492				
		EBL	27	26	80.62	F			87				107.48	F			86				99.99	F			85				91.85	F			91				
		EBT	2600	2522	7.15	A			209				35.84	D			1047	59.74	E		34.59	C			1054	55.59	E		35.74	D			1015	60.38	E		
		EBR	392	380	4.35	A			227				15.91	B			1066				15.24	B			1072				25	C			1038				
		NBL	178	173	49.86	D			254				43.28	D			279				45.98	D			265				47.09	D			257				
		NBT	226	219	36.86	D			151				37.31	D			168				38.14	D			168				39.17	D			178				
		NBR	26	25	29.08	C			155				29.87	C			172				34.81	C			172				34.11	C			179				
		SBL	58	56	59.43	E			151				49.95	D			155				49.81	D			142				51.21	D			156				
		SBT	293	284	54.65	D			216				50	D			210				51.39	D			257				52.74	D			225				
		SBR	11	11	44.48	D			217				46.11	D			210				39.32	D			258				47.22	D			225				
West Dodge Rd/ 78th Street	467	WBL	72	70	47.44	D	10.69	B	144			61522	46.64	D	22.82	C	141			121220	46.57	D	22.12	C	144			118634	47.51	D	24.24	C	154			136506	
		WBT	1294	1255	2.88	A			109				3.91	A			145	7.09	A		3.69	A			146	4.37	A		3.91	A			132	5.20	A		
		WBR	57	55	2.31	A			128				3.83	A			164				3.52	A			165				2.87	A			151				
		EBL	29	28	86.48	F			82				80.86	F			72				85.86	F			83				85.74	F			78				
		EBT	2487	2412	3.66	A			109				25.62	C			1194	30.36	C		23.76	C			1132	14.81	B		27.21	C			1284	13.70	B		
		EBR	168	163	5.65	A			128				29.09	C			1222				27.47	C			1160				32.58	C			1311				
		NBL	75	73	85.26	F			219				79.7	E			216				87.59	F			229				84.04	F			213				
		NBT	164	159	49.4	D			239				50.48	D			234				51.7	D			234				51.36	D			234				
		NBR	129	125	33.16	C			263				34.48	C			257				36.04	D			257				35.6	D			258				
		SBL	83	81	46.35	D			132				44.82	D			133				45.69	D			128				45.34	D			133				
		SBT	200	194	43.04	D			294				43.58	D			263				44.66	D			283				44.89	D			266				
		SBR	66	64	5.95	A			315				5.93	A			284				5.93	A			305				5.91	A			287				
West Dodge Rd/ 76th Street	463	WBL	37	36	59.31	E	9.39	A	110			48453	61.05	E	11.99	B	92			56803	58.2	E	11.96	B	92			57323	65.89	E	11.19	B	93			56589	
		WBT	1265	1227	11.31	B			382				16.3	B			429	21.65	C		16.12	B			425	19.60	B		15.1	B			394	18.15	B		
		WBR	31	30	10.46	B			419				15.07	B			466				15.76	B			462				13.76	B			431				
		EBL	96	93	34.05	C			182				35.98	D			179				36.24	D			174				36.44	D			207				
		EBT	2314	2245	1.64	A			83				2.57	A			173	2.67	A		2.83	A			247	3.64	A		2.61	A			222	4.12	A		
		EBR	289	280	3.03	A			53				3.44	A			82				3.53	A			76				3.63	A			80				
		NBL	107	104	57.53	E			126				58.84	E			122				58.89	E			124				58.81	E			124				
		NBT	25	24	45.6	D			74				45.52	D			74				45.2	D			74				44.85	D			74				
		NBR	4	4	11.09	B			106				12.01	B			107				11.18	B			107				11.54	B			107				
		SBL	15	15	39.29	D			43				39.67	D			44				39.81	D			44				39.77	D			44				
		SBT	95	92	54.62	D			198				54.45	D			183				54.49	D			183				54.56	D			184				
		SBR	51	49	53.55	D			103				54.32	D			102				54.57	D			102				54.07	D			102				
West Dodge Rd/ 74th Street	458	WBL	8	8	41.33	D	2.22	A	40			9842	64.2	E	4.46	A	42			18315	63.38	E	4.08	A	37			16973	69.4	E	4.05	A	41			17781	
		WBT	1318	1278	1.63	A			153				2.5	A			261	16.22	B		1.93	A			204	15.66	B		2.13	A			255	14.91	B		
		WBR	41	40	1.14	A			26				2.08	A			33				1.91	A			29				2.28	A			37				
		EBL	17	16	58.8	E			63				61.01	E			63				60.03	E			49				58.69	E			57				
		EBT	2294	2225	1.49	A			78				4.54	A			278	7.35	A		4.27	A			238	5.62	A		4.07	A			273	4.66	A		
		EBR	22	21	1.44	A			99				2.14	A			302				2.4	A			261				2.46	A			297				
		NBL	7	7	64.29	E			40				66.37	E			34				65.1	E			34				64.69	E			34				
		NBT	3	3	56.13	E			29				75.97	E			32				62.13	E			32				64.29	E			32				
		NBR	4	4	8.26	A			51				14.47	B			53				11.65	B			53				10.39	B			53				
		SBL	12	12	59.65	E			37				62.49	E			37				63.86	E			37				64.32	E			37				
		SBT	1	1	57.75	E			13				59.09	E			15				49.08	D			13				50.42	D			13				
		SBR	8	8	5.69	A			60				6.66	A			60				6.3	A			60				5.72	A			60	</			

Intersection					Existing							Existing plus BRT							Existing plus BRT w/ TSP								Existing plus BRT w/ TSP and Queue Jumps									
Name	Node	Direction	Balanced Volume (w/o BRT)	Balanced Volume (w/ BRT)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)
West Dodge Rd/ 93rd Street	940	WBT	3941	3823	3.29	A	5.92	A	461			53798	11.47	B	13.82	B	1188	27.21	C	118484	10.84	B	20.52	C	1258	22.79	C	175064	12.05	B	10.45	B	1264	22.17	C	91295
		WBR	54	52	2.2	A			514				6.67	A			1290				7.5	A			1317											
		EBL	265	257	57.94	E			211				65.65	E			203				58.41	E			209											
		EBT	2975	2886	3.02	A			280				11.86	B			943	2.03	A		27.12	C			1387	1.59	A		3.32	A			421	0.69	A	
		SBR	496	481	16.16	B			337				15.82	B			308				15.95	B			300				15.92	B			317			
West Dodge Rd/ 90th Street	510	WBL	102	99	123.12	F	94.26	F	114			947493	182.82	F	124.37	F	122			1165553	170.41	F	127.69	F	122			1196816	159.46	F	111.65	F	124			1069004
		WBT	2991	2901	77.09	E			1572				105.04	F			1613	52.64	D		98.37	F			1611	45.81	D		91.5	F			1609	39.56	D	
		WBR	208	202	28.41	C			1580				48.26	D			1621				48.1	D			1619				44.18	D			1617			
		EBL	412	400	173.46	F			970				242.79	F			1192				297.76	F			1336				184.63	F			1089			
		EBT	2293	2224	38.8	D			1248				66.78	E			1370	55.70	E		69.33	E			1385	45.67	D		47.6	D			1361	23.18	C	
		EBR	270	262	23.89	C			1251				44.52	D			1373				42.12	D			1388				8.28	A			278			
		NBL	780	757	248.91	F			2048				378.15	F			2056				419.2	F			2053				403.3	F			2049			
		NBT	584	566	152.85	F			2048				208.95	F			2056				223.56	F			2051				230.09	F			2050			
		NBR	115	112	137.76	F			2051				188.27	F			2058				197.28	F			2051				206.99	F			2051			
		SBL	314	305	90.24	F			274				100.59	F			304				110.39	F			330				107.89	F			328			
		SBT	374	363	147.49	F			910				71.47	E			505				71.55	E			538				76.79	E			532			
		SBR	224	217	142.65	F			910				66.53	E			505				65.87	E			538				78.74	E			533			
West Dodge Rd/ Cass Street	802	WBT	2719	2637	14.09	B	20.79	C	776			147436	34.76	C	36.01	D	1040	47.44	D	242610	30.21	C	33.56	C	1027	42.98	D	226418	28.01	C	29.91	C	1018	38.88	D	206181
		EBL	770	747	55.95	E			476				63.93	E			537				67.79	E			617				63.54	E			552			
		EBT	1952	1893	0.9	A			0				1.14	A			0	17.56	B		1.28	A			0	17.67	B		1.17	A			0	17.50	B	
		SBR	582	565	74.39	E			548				128.87	F			799				118.75	F			757				95.57	F			563			
West Dodge Rd/ 84th Street	491	WBL	42	41	78.06	E	24.02	C	97			157699	180.53	F	75.83	E	124			477158	153.42	F	63.91	E	131			404407	111.78	F	46.89	D	121			299550
		WBT	2356	2285	13.49	B			716				122.65	F			2029	152.20	F		93.05	F			1819	111.50	F		57.14	E			1345	64.47	E	
		WBR	63	61	12.87	B			728				131	F			2031				103.28	F			1829				62.19	E			1357			
		EBL	95	92	78.31	E			215				100.68	F			235				103.45	F			240				91.19	F			215			
		EBT	1722	1670	21.81	C			644				37.67	D			844	52.31	D		38.4	D			828	45.00	D		33.19	C			782	40.90	D	
		EBR	135	131	3.24	A			662				9.18	A			862				9.39	A			847				11.63	B			805			
		NBL	333	323	53.49	D			485				42.48	D			425				45.71	D			462				47.61	D			449			
		NBT	391	379	33.2	C			392				31.76	C			353				33.04	C			407				35	C			412			
		NBR	66	64	29.92	C			397				25.88	C			357				25.04	C			411				29.59	C			413			
		SBL	60	58	65.87	E			150				50.97	D			114				50.76	D			124				56.84	E			129			
		SBT	236	229	54.3	D			192				48.3	D			193				49.2	D			187				52.13	D			196			
		SBR	30	29	43.34	D			193				42.01	D			194				42.12	D			188				43.75	D			197			
West Dodge Rd/ 78th Street	467	WBL	143	139	36.95	D	44.23	D	226			290404	39.72	D	46.29	D	297			294577	39.39	D	51.55	D	237			327750	35.74	D	50.39	D	228			322383
		WBT	2204	2138	5.1	A			158				10.95	B			559	13.94	B		9.54	A			398	10.12	B		4.85	A			177	4.89	A	
		WBR	163	158	4.96	A			177				9.62	A			578				8.51	A			411				4.7	A			196			
		EBL	78	76	85.97	F			178				94.67	F			171				94.9	F			183				87.2	F			221			
		EBT	1694	1643	15.6	B			742				31.84	C			934	28.78	C		31.56	C			978	23.39	C		29.05	C			892	33.29	C	
		EBR	76	74	15.08	B			770				33.34	C			962				32.93	C			1006				30.66	C			920			
		NBL	150	146	491.33	F			1267				405.56	F			1085				512.73	F			1260				574.17	F			1249			
		NBT	336	326	252.47	F			1265			184.37	F	1083			242.56	F	1258			255.22	F	1247												
West Dodge Rd/ 76th Street	463	NBR	165	160	207.46	F	1289			150.18	F	1106			199.12	F	1282			204.99	F	1271														
		SBL	182	177	59.89	E	521			74	E	617			62.45	E	446			60.18	E	428														
		SBT	284	275	42.28	D	460			53.17	D	643			44.65	D	470			44.6	D	483														
		SBR	107	104	9.63	A	481			14.62	B	664			11.22	B	491			8.57	A	504														
		WBL	79	77	74.4	E	166			70.83	E	160			69.75	E	164			72.44	E	165														
		WBT	2192	2126	8.05	A	441			14.01	B	793	14.65	B	15.91	B	822	16.88	B	8.98	A	592	13.53	B												
		WBR	83	81	7.98	A	478			14.52	B	830			15.99	B	859			8.67	A	629														
		EBL	210	204	63.7	E	374			65.34	E	381			67.39	E	390			68.3	E	448														
West Dodge Rd/ 74th Street	458	EBT	1497	1452	2.64	A	112			2.75	A	131	3.82	A	3.04	A	152	5.56	A	2.99	A	167	3.55	A												
		EBR	334	324	4.1	A	69			4.27	A	98			4.37	A	95			4.52	A	79														
		NBL	251	243	117.32	F	587			94.58	F	373			96.89	F	393			96.43	F	392														
		NBT	222	215	133.89	F	918			107.15	F	812			109.21	F	823			108.95	F	810														
		NBR	20	19	110.28	F	951			81.12	F	845			86.01	F	856			86.25	F	843														
		SBL	68	66	143.74	F	444			116.28	F	357			125.77	F	368			120.39	F	374														
		SBT	177	172	180.46	F	713			161.71	F	682			171.37	F	718			165.38	F	689														
		SBR	67	65	160.11	F	260			141.32	F	230			147.42	F	294			146.56	F	232														
West Dodge Rd/ 72nd Street	443	WBL	29	28	48.22	D	13.10	B	83			68539	58.93	E	17.56	B	81			88718	62.22	E	16.95	B	84			85530	46.84	D	13.75	B	86			70116
		WBT	2159	2094	6.33	A			348				13.35	B			766	28.63	C		13	B			835	20.92	C		6.26	A			516	20.28	C	
		WBR	201	195	3.49	A			74				9.36	A			99				8.8	A			107				4.85	A			81			
		EBL	141	137	62.05	E			227				67.28	E			243				69.25	E			264				100.24	F			290			
		EBT	1413	1371	11.72	B			442				13	B			509	8.59	A		11.18	B			463	6.09	A		9.79	A			470	6.65	A	
		EBR	31	30	10.27	B			466				8.89	A			533				8.61	A			487				9.29	A			494			
		NBL	61	59	57.13	E			131				54.3	D			150				56.64	E			150				55.3	E			151			
		NBT	16	16	60.09	E			99				58.83	E			88				58.63	E			93				62.1	E			95			
		NBR	36	35	17.28	B			119				18.42	B			108				17.78	B			113				18.06	B			115			
		SBL	148	144	55.36	E			127			55.74	E	130			57.43	E	132			56.79	E	132												
West Dodge Rd/ 69th Street	437	SBT	9	9	56.64	E	178			55.06	E	182			55.98	E	186			57.58	E	187														
		SBR	134	130	17.47	B	224			18.86	B																									



Intersection					Existing							Existing plus BRT								
Name	Node	Direction	Balanced Volume (w/o BRT)	Balanced Volume (w/ BRT)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)
Dodge Street/ 35th Street	289	WBT	1050	1019	3.23	A	3.52	A	174			11654.54	3.34	A	3.54	A	190	17.90	B	11530.12
		WBR	6	6	1.65	A			201				4.14	A			217			
		EBT	1392	1350	2.53	A			115				2.55	A			135	2.52	A	
		EBR	252	244	3.09	A			76				2.85	A			90			
		NBL	12	12	37.83	D			54				36.52	D			52			
		NBT	6	6	29.32	C			54				33.8	C			52			
		NBR	2	2	7.58	A			78				4.86	A			77			
		SBL	15	15	37.85	D			91				34.73	C			87			
		SBT	22	21	36.91	D			91				37.93	D			87			
		SBR	9	9	11	B			114				10.88	B			110			
Dodge Street/ 33th Street	279	WBT	1030	999	3.06	A	3.59	A	160			11150.10	3.31	A	3.69	A	154	5.76	A	11321.23
		WBR	28	27	2.69	A			181				2.9	A			176			
		EBT	1367	1326	2	A			105				2.05	A			126	18.48	B	
		EBR	42	41	2.07	A			131				2.54	A			152			
		NBL	15	15	37.85	D			45				34.36	C			48			
		NBT	34	33	35.65	D			100				33.84	C			81			
		NBR	25	24	10.34	B			132				11	B			114			
		SBL	13	13	36.72	D			39				36.93	D			41			
		SBT	19	18	36.21	D			70				37.98	D			68			
		SBR	12	12	9.27	A			90				8.33	A			87			
Dodge Street/ Turner Blvd	79	WBL	153	148	2.43	A	8.80	A	122			20132.98	8.11	A	9.15	A	126			20676.85
		WBT	606	588	6.27	A			114				6.59	A			126	38.24	D	
		EB Contraflow		6									6.5	A			70	6.50	A	
		SBT	678	658	10.46	B			259				10.03	B			263			
		SBR	452	438	12.07	B			280				11.76	B			284			
Dodge Street/ Park Ave	61	WBT	834	809	4.43	A	6.08	A	100			8128.33	4.26	A	6.05	A	106	2.25	A	8120.92
		WBR	17	16	1.64	A			126				1.47	A			132			
		EB Contraflow		6									21.86	C			71	21.86	C	
		NBL	217	210	12.61	B			135				12.89	B			131			
		NBT	8	8	15.18	B			135				13.47	B			131			
		SBR	32	31	5.68	A			53				5.01	A			47			
Dodge Street/ 28th Street	232	WBT	722	700	14.22	B	10.06	B	196			16521.16	14.49	B	10.13	B	215	52.03	D	16669.57
		WBR	161	156	2.64	A			53				2.47	A			46			
		EB Contraflow		6									22.34	C			71	22.34	C	
		NBL	204	198	1.49	A			64				0.87	A			20			
		NBT	281	273	9.77	A			92				9.54	A			100			
Dodge Street/ 24th Street	195	WBT	511	496	8.37	A	11.60	B	118			16411.90	8.41	A	11.58	B	120	11.85	B	16105.15
		WBR	39	38	5.59	A			147				3.12	A			149			
		EB Contraflow		6									2.88	A			0	2.88	A	
		NBL	77	75	23.53	C			76				24.59	C			74			
		NBT	254	246	8.84	A			84				8.85	A			80			
		SBR	295	286	17.43	B			126				17.57	B			125			
Dodge Street/ 20th Street	173	WBL	69	67	4.1	A	9.33	A	114			13543.13	12.52	B	9.92	A	105			14231.50
		WBT	401	389	10.8	B			80				10.78	B			105	22.36	C	
		EB Contraflow		6									32.04	C			89	32.04	C	
		SBT	585	567	10.17	B			100				10.18	B			101			
		SBR	149	145	4.11	A			130				4.3	A			128			
Dodge Street/ 19th Street	164	WBT	332	322	9.62	A	9.63	A	95			9046.30	9.84	A	9.54	A	88	1.62	A	8856.15
		WBR	37	36	4.96	A			128				2.75	A			120			
		EB Contraflow		6									1.04	A			0	1.04	A	
		NBL	138	134	3.98	A			102				3.84	A			69			
		NBT	281	273	13.16	B			82				13.2	B			82			

Intersection					Existing							Existing plus BRT								
Name	Node	Direction	Balanced Volume (w/o BRT)	Balanced Volume (w/ BRT)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)	Delay (sec/veh)	LOS	Overall Delay (sec/veh)	Overall LOS	Max Queue (feet)	BRT Delay (sec/veh)	BRT LOS	Intersection Person Delay (seconds)
Dodge Street/ 35th Street	289	WBT	1909	1852	4.12	A	10.99	B	167			50781.37	4.16	A	10.56	B	185	21.26	C	47966.71
		WBR	13	13	2.92	A			194				3.24	A			212			
		EBT	1507	1462	10.56	B			404				9.98	A			391	9.13	A	
		EBR	35	34	4.59	A			45				4.75	A			46			
		NBL	171	166	49.01	D			504				47.34	D			455			
		NBT	22	21	50	D			504				45.48	D			455			
		NBR	189	183	43.21	D			530				40.99	D			480			
		SBL	24	23	29.77	C			77				29.34	C			74			
		SBT	9	9	28.86	C			77				30.44	C			74			
		SBR	6	6	8.7	A			100				9.39	A			97			
Dodge Street/ 33th Street	279	WBT	1874	1818	6.09	A	6.70	A	263			30242.69	5.98	A	6.78	A	279	11.12	B	30212.13
		WBR	25	24	4.86	A			284				6.15	A			300			
		EBT	1679	1629	5.03	A			283				5.31	A			337	25.81	C	
		EBR	41	40	4.61	A			309				6.38	A			365			
		NBL	28	27	37.79	D			66				37.18	D			61			
		NBT	29	28	33.84	C			80				32.9	C			80			
		NBR	23	22	14.43	B			112				13.95	B			111			
		SBL	38	37	35.83	D			78				38.38	D			88			
		SBT	38	37	34.12	C			82				32.14	C			82			
		SBR	20	19	13.24	B			102				12.55	B			100			
Dodge Street/ Turner Blvd	79	WBL	192	186	2.65	A	9.66	A	241			30866.18	6.21	A	9.90	A	228			31424.35
		WBT	1395	1353	5.12	A			215				5.55	A			228	34.45	C	
		EB Contraflow		6									10.74	B			71	10.74	B	
		SBT	575	558	14.6	B			352				14.02	B			314			
		SBR	504	489	19.41	B			372				18.8	B			335			
Dodge Street/ Park Ave	61	WBT	1607	1559	2.71	A	4.01	A	80			9144.97	3.94	A	5.08	A	102	1.24	A	11391.29
		WBR	14	14	1.51	A			101				1.96	A			128			
		EB Contraflow		6									4.91	A			0	4.91	A	
		NBL	254	246	11.95	B			105				12.05	B			111			
		NBT	10	10	12.09	B			105				13.25	B			111			
		SBR	20	19	6.32	A			41				7.95	A			50			
Dodge Street/ 28th Street	232	WBT	1615	1567	8.64	A	8.79	A	161			31243.73	9.84	A	9.34	A	211	44.63	D	33099.52
		WBR	390	378	6.27	A			151				6.32	A			140			
		EB Contraflow		6									28.76	C			71	28.76	C	
		NBL	182	177	2.89	A			94				1.31	A			17			
		NBT	779	756	11.72	B			203				11.49	B			199			
Dodge Street/ 24th Street	195	WBT	1309	1270	7.54	A	12.16	B	149			34085.51	7.63	A	12.12	B	148	8.40	A	33315.48
		WBR	51	49	7.87	A			178				4.38	A			177			
		EB Contraflow		6									5.17	A			0	5.17	A	
		NBL	162	157	26.43	C			113				27.03	C			121			
		NBT	279	271	9.17	A			95				9.28	A			92			
		SBR	534	518	21.27	C			202				21.08	C			197			
Dodge Street/ 20th Street	173	WBL	102	99	5.93	A	7.74	A	195			16437.82	8.54	A	8.30	A	245			17703.67
		WBT	1204	1168	7.69	A			161				8.01	A			245	40.36	D	
		EB Contraflow		6									41.93	D			89	41.93	D	
		SBT	312	303	9.7	A			99				9.69	A			89			
		SBR	156	151	5.53	A			128				6.37	A			116			
Dodge Street/ 19th Street	164	WBT	1036	1005	12.74	B	11.39	B	152			21340.20	13.89	B	11.79	B	165	1.70	A	21621.15
		WBR	31	30	8.8	A			186				3.54	A			198			
		EB Contraflow		6									2.71	A			14	2.71	A	
		NBL	270	262	6.61	A			125				4.86	A			72			
		NBT	230	223	11.35	B			115				11.75	B			88			