City of Regina

REGINA DOWNTOWN TRANSPORTATION STUDY
PHASE 1

APPENDIX B: EVALUATION OF ALTERNATIVES

MAY 2012

TABLE OF CONTENTS

TABLE OF EXHIBITS

APPENDICES

1. INTRODUCTION

The Downtown Transportation Study was commissioned by the City of Regina to assess transportation related needs and opportunities in the area between 13th Avenue and Saskatchewan Drive, and between Broad Street and Albert Street. The Study has been divided into two Phases, with Phase 1 focusing on the 11th Avenue and 12th Avenue corridors. This report follows the *Downtown Transportation Study Phase 1 Existing Conditions Report, May 2012.* The Existing Conditions Report detailed the development of a VISSIM micro-simulation model of the 11th Avenue and 12th Avenue corridors, and provided an overview of traffic and transit operations along the corridors.

1.1 Purpose of Report

This report provides the evaluation of options for 12th Avenue at City Square Plaza. Three overall alternatives were defined in the study scope: opening the 12th Avenue Plaza to traffic one-way eastbound, one-way westbound, and two-way. Potential sub-alternatives include time-of-day or seasonal openings and alternative lane configurations. This report provides an operational assessment of these three alternatives, plus a fourth alternative. As detailed in the primary Phase 1 report, the emerging preferred alternative is to open the Plaza to traffic one-way westbound, with limited accessibility provided by limiting access to the Plaza to Scarth Street from the south or to Cornwall Street from the north.

Additionally, select items from the list of potential network improvements are chosen and implemented on the preferred alternative. This report provides the details regarding what was changed, and the results of the changes.

1.2 Network Alternatives

Development and validation of the base model was detailed in the Existing Conditions Report. The base model represents PM peak hour, with 12th Avenue closed between Lorne Street and Scarth Street, which is the stretch adjacent to City Square Plaza. This decision was based on the fact that the closure reflected the state of current operations at the plaza, and that PM peak hour was observed to have the highest auto volumes and congestion levels in the study area.

In **Exhibit 1-1**, the map of Downtown Regina is shown with three boundaries. The area enclosed in the red boundary represents the stretch of 12th Avenue that is closed under current operations, but is subject to alternative operations. The area enclosed in the dark blue boundary represents the study area for Phase 1 of the project. The area enclosed by the light blue boundary represents the study area for Phase 2 of the project.

Exhibit 1-1: Regina Downtown Transportation Study Area

Given the base model with the City Square Plaza closed to traffic, the main network alternatives reviewed in this report are:

- The **one-way eastbound** alternative would allow continuous eastbound movement along 12th Avenue. Based on a review of potential traffic operations in the plaza, the eastbound movement would be restricted to a single lane at Lorne Street, with a posted speed in the Plaza of 20km/h. Under this alternative Cornwall Street is extended to connect 11th Avenue and 12th Avenue, operating as a two-way north-south street with one lane per direction. At 12th Avenue and Cornwall Street, eastbound cars can either continue eastbound through or take a left turn into Cornwall Street. Southbound cars must take a left turn to merge into 12th Avenue eastbound. 12th Avenue has priority in the intersection, and southbound Cornwall traffic must stop and yield to 12th Avenue traffic. At 12th Avenue and Scarth Street, eastbound cars must continue eastbound. Northbound cars on Scarth Street must take northbound right.

- The **one-way westbound** alternative would provide for continuous movement along 12th Avenue from Broad Street to Albert Street and beyond. Again, the westbound movement is restricted to a single lane, and the designated speed is 20km/h. Cornwall Street is extended to connect 11th Avenue and 12th Avenue, operating as a two-way

north-south street with one lane per direction. At 12th Avenue and Cornwall Street, westbound cars can either continue westbound through or take a right turn into Cornwall Street. Southbound cars must take a right turn to merge into 12th Avenue westbound. 12th Avenue has priority in the intersection, and southbound Cornwall traffic must stop and yield to 12th Avenue traffic. At 12th Avenue and Scarth Street, the northbound left turn is enabled, allowing traffic from Scarth Street to merge into 12th Avenue westbound as well as turn east. In this configuration, the easternmost part of the Plaza is two-way.

- The **two-way alternative** allows both eastbound and westbound through movements of cars on 12th Avenue between Lorne Street and Hamilton street, providing a continuous movement on 12th Avenue in both directions. Traffic is limited to a single lane in each direction, and the designated speed is 20km/h. Cornwall Street is again extended to connect 11th Avenue and 12th Avenue, operating as a two-way north-south street with one lane per direction. At 12th Avenue and Cornwall Street, all available movements are enabled: EBL, EBT, WBT, WBR, SBL, and SBR. At 12th Avenue and Scarth Street, northbound left turn is enabled, allowing traffic from Scarth Street to merge into 12th Avenue westbound.

- The fourth alternative, following from the evaluation and traffic planning for the Plaza is a restricted one-way westbound configuration. This configuration is based on the one-way westbound alternative but imposes two additional limitations on the network:

    - At 12th Avenue and Scarth Street, there is no westbound access. Westbound vehicles must exit into the alleyway or take a u-turn to proceed in the eastbound direction. Northbound left is still enabled, and it is the only access to 12th Avenue westbound from Scarth Street to Cornwall Street.

    - The intersection of 12th Avenue and Cornwall Street operates as a forced right-in right-out. Westbound traffic on 12th Avenue must take right turn into Cornwall Street northbound, and southbound traffic on Cornwall Street must take right turn into 12th Avenue westbound.

- The one-way westbound configuration with these additional restrictions provides the benefit of limiting westbound traffic in the Plaza to local traffic only. No through traffic from Hamilton Street or east of Hamilton Street can travel into the Plaza and use it as a through-route.

2. MODEL DEVELOPMENT

Development of VISSIM models, for detailed evaluation of alternatives, followed a process of demand definition, network coding, and model runs. Demand definition was based on application of the City's regional demand model, and adjustments for routing, balancing, and logic checks. Network coding followed the standards set out in the Existing Conditions Report. Model runs and calibration were undertaken to ensure that each alternative modelled the anticipated traffic levels and that operations were correct for the scenario.

2.1 EMME Models

All alternatives were assigned a separate scenario in the City's regional demand model, using the base 2009 matrix for assignment. The base matrix is the closest in terms of demand to the current

year, and network edits were made to reflect each scenario. A pivot-based approach was used, where the EMME model was used to assess vehicle routing and diversion potential. This approach cancels out some of the inherent model error for a local area transportation study of collector roads, as the absolute forecasts from the model are not used, only relative differences between scenarios are used to adjust traffic flows. Exhibit 2-1 provides EMME forecasts (unadjusted) from the City's demand model.

Exhibit 2-1: PM Peak EMME Assigned Volumes, Westbound and Eastbound

E-W Links				EMME Assigned Volume			
E-W Street	East of	West of	Direction	Base	1-Way EB	1-Way WB	2-Way
11th Avenue	Albert Street	Mcintyre Street	Westbound	439	471	458	465
			Eastbound	160	170	167	172
	Mcintyre Street	Smith Street	Westbound	231	254	266	291
			Eastbound	187	196	193	197
	Smith Street	Lorne Street	Westbound	454	451	402	409
			Eastbound	162	173	171	176
	Lorne Street	Cornwall Street	Westbound	1223	1057	930	897
			Eastbound	241	223	236	225
	Cornwall Street	Scarth Street	Westbound	197	191	171	183
			Eastbound	1035	884	802	767
	Scarth Street	Hamilton Street	Westbound	197	191	171	183
			Eastbound	1035	884	802	767
	Hamilton Street	Rose Street	Westbound	196	201	183	200
			Eastbound	517	516	467	477
	Rose Street	Broad Street	Westbound	147	143	154	161
			Eastbound	515	495	505	493
12th Avenue	Albert Street	Mcintyre Street	Westbound	357	341	376	369
			Eastbound	125	124	87	121
	Mcintyre Street	Smith Street	Westbound	305	309	283	266
			Eastbound	238	251	202	230
	Smith Street	Lorne Street	Westbound	213	229	413	386
			Eastbound	116	151	121	150
	Lorne Street	Cornwall Street	Westbound	0	0	589	550
			Eastbound	0	44	0	58
	Cornwall Street	Scarth Street	Westbound	0	0	94	237
			Eastbound	0	336	0	308
	Scarth Street	Hamilton Street	Westbound	0	0	60	51
			Eastbound	711	1040	719	819
	Hamilton Street	Rose Street	Westbound	18	16	77	67
			Eastbound	483	509	471	449
	Rose Street	Broad Street	Westbound	77	86	118	114
			Eastbound	485	488	484	474

Exhibit 2-2: PM Peak EMME Assigned Volumes, Southbound and Northbound

N-S Links				EMME Assigned Volume			
South of	North of	N-S Street	Direction	Base	1-Way EB	1-Way WB	2-Way
11th Avenue	12th Avenue	Albert Street	Southbound	687	670	592	615
			Northbound	1151	1134	1139	1137
		Mcintyre Street	Southbound	0	0	0	0
			Northbound	413	420	392	389
		Smith Street	Southbound	783	758	681	669
			Northbound	0	0	0	0
		Lorne Street	Southbound	0	0	0	0
			Northbound	307	341	494	497
		Cornwall Street	Southbound	0	335	562	639
			Northbound	0	43	68	76
		Hamilton Street	Southbound	982	812	845	779
			Northbound	0	0	0	0
		Rose Street	Southbound	0	0	0	0
			Northbound	763	787	781	757
		Broad Street	Southbound	967	955	982	981
			Northbound	1034	1041	1028	1032

The large trends in EMME models are as follows:

- On 11th Avenue, eastbound and westbound volumes west of Smith Street and east of Hamilton Street do not change significantly from one alternative to another.

- On 11th Avenue, eastbound and westbound volumes between Smith Street and Hamilton Street change significantly from one alternative to another. Eastbound and westbound volumes for one-way alternatives are about 150-200 vehicles less than the base model. Eastbound and westbound volumes for two-way alternative are about 200-350 vehicles less than the base model.

- On 12th Avenue, volumes are adjusted accordingly to the 12th Avenue operations at City Square Plaza.

- For north-south streets, the volumes are generally within the same vicinity between all models, with the exception of Lorne Street and Cornwall Street. For Lorne Street, volumes are 50-70% higher for the one-way westbound alternative and the two-way alternative compare to the base model. In the EMME base model, Cornwall Street is closed for the base model (cars enter the Cornwall parkade directly using a centroid connector), and it is open for the alternatives.

Due to the fact that the alternative featuring one-way westbound preferred was developed largely based on the one-way westbound alternative, a separate EMME analysis was not conducted for that particular alternative.

Full maps of the alternatives in EMME are available in Appendix B-1.

2.2 Synchro Models

For each alternative, including the one-way westbound with limitations, a Synchro model was developed. The Synchro model provides a simple method of calculating service levels at intersections and in comparing those service levels against the VISSIM model. The intersection turning movement volumes and configurations, signal timings and signage, and desired speeds are identical between the Synchro model and the VISSIM model. Transit vehicles and routes, parking manoeuvres, and pedestrian-vehicle conflicts in the link (not at intersections) are not modelled in Synchro.

Exhibit 2-3 through to Exhibit 2-7 illustrate the Synchro models and turning movement forecasts. Further details on establishing the traffic volumes are provided in Section 2.4 of this report. The Synchro-generated output reports provided in the appendix contain evaluations for each intersection turning movement's delay, level of service (LOS), and queue lengths.

Exhibit 2-3: Downtown Regina: Synchro Model, PM Base Closed

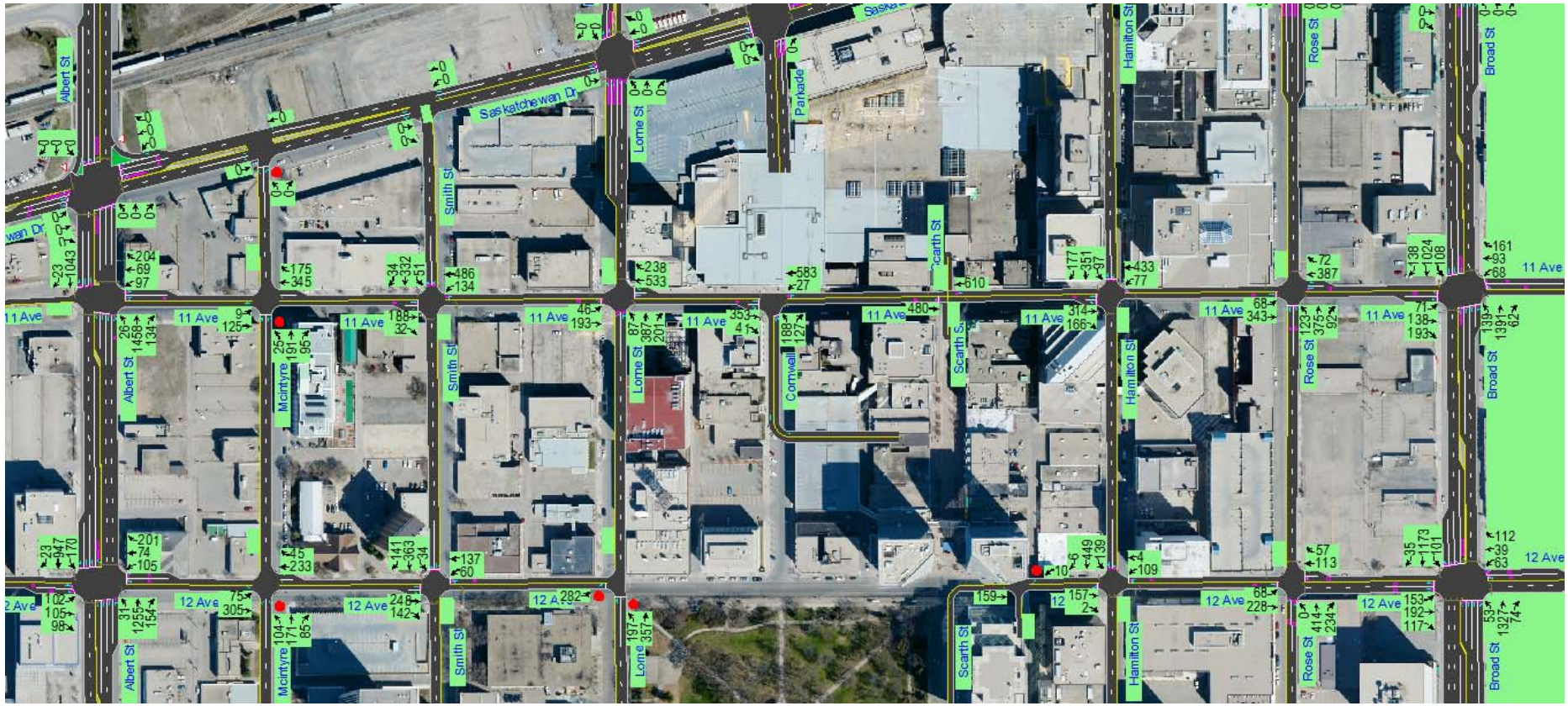


Exhibit 2-4: Downtown Regina: Synchro Model, PM One-Way Eastbound

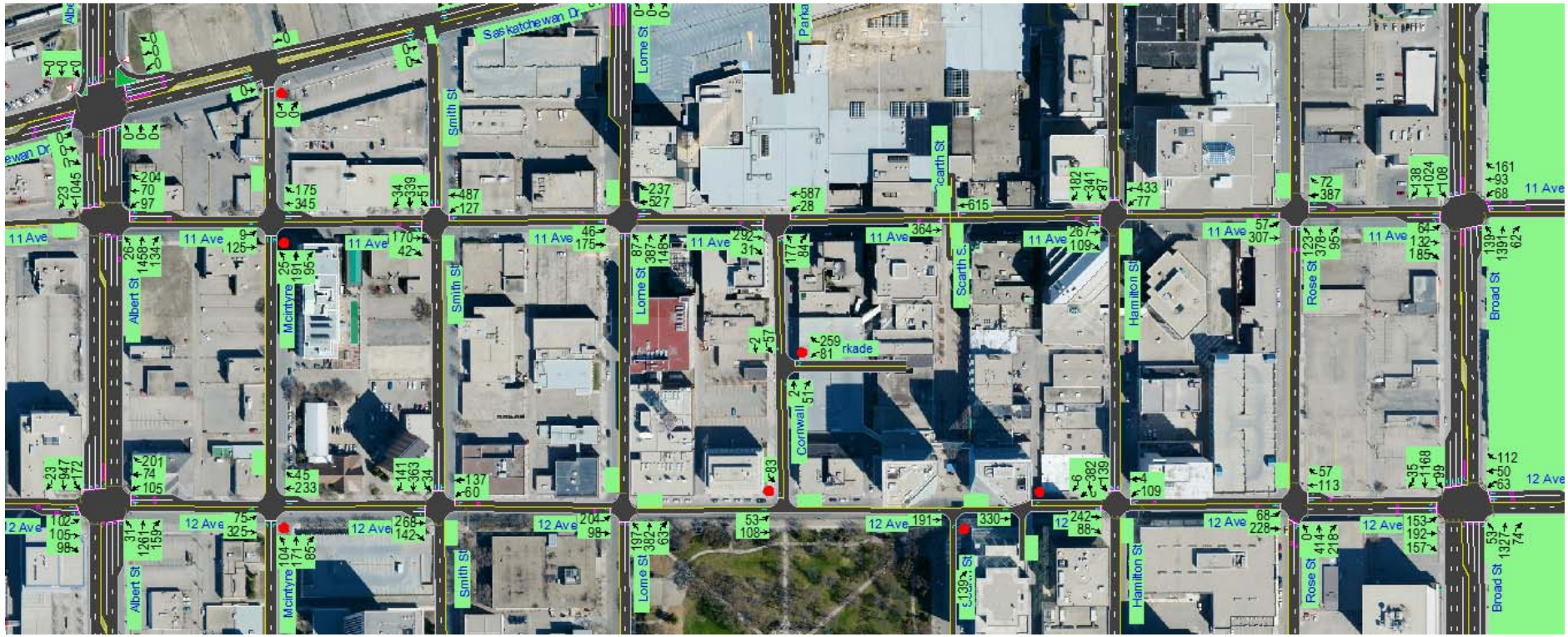


Exhibit 2-5: Downtown Regina: Synchro Model, PM One-Way Westbound

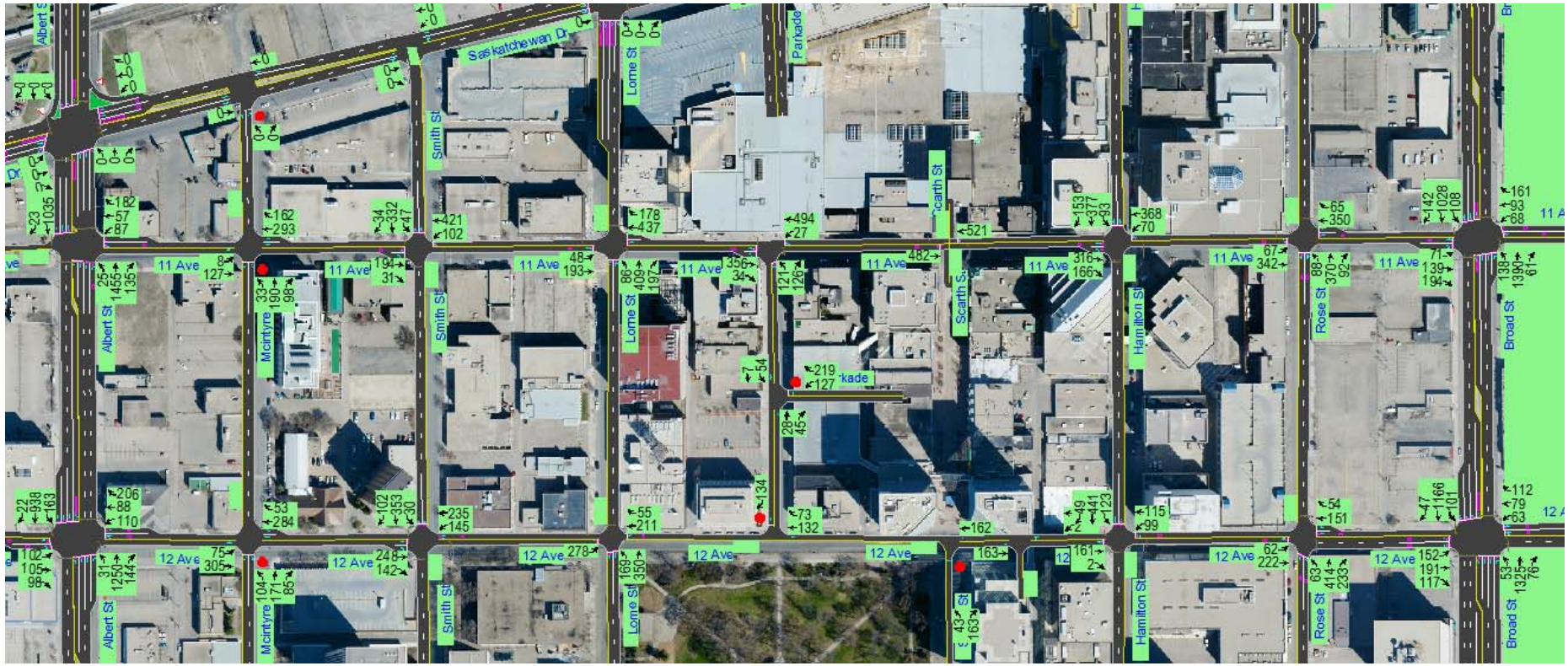


Exhibit 2-6: Downtown Regina: Synchro Model, PM Two-Way

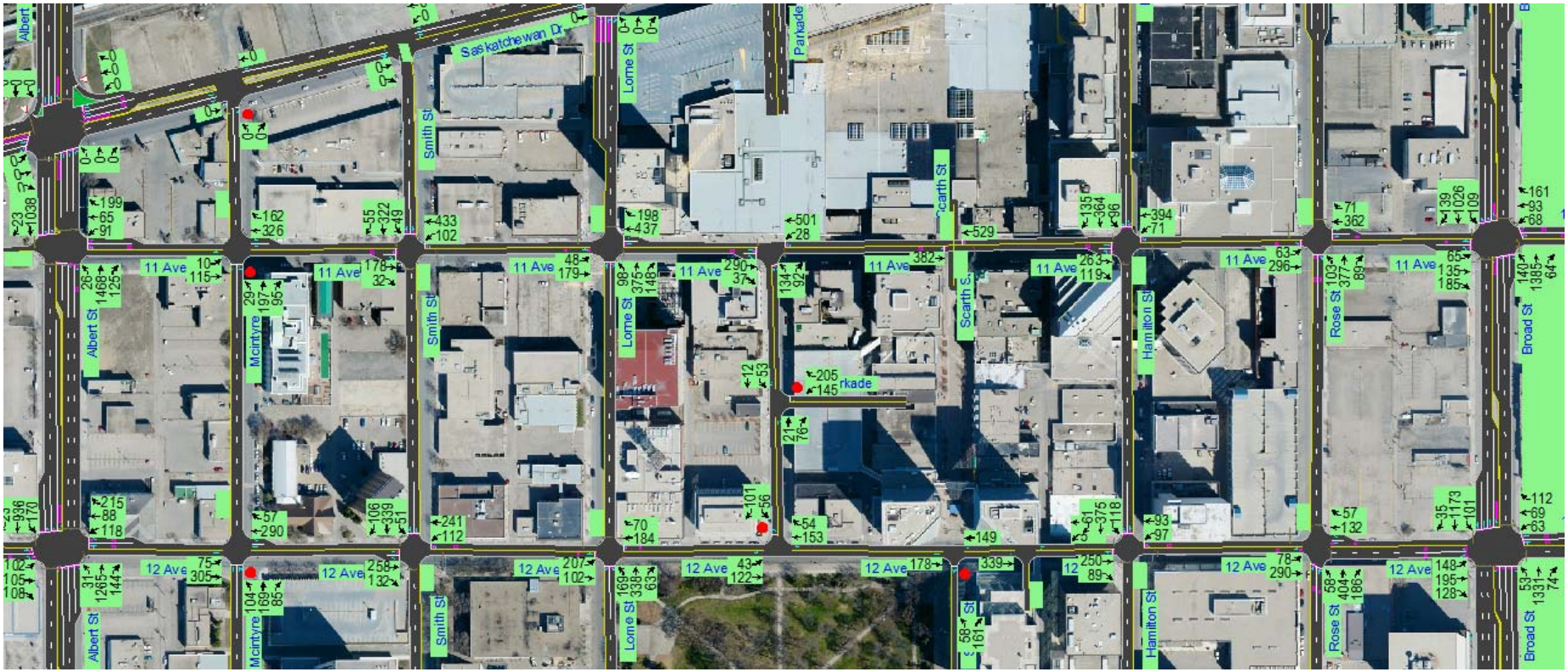
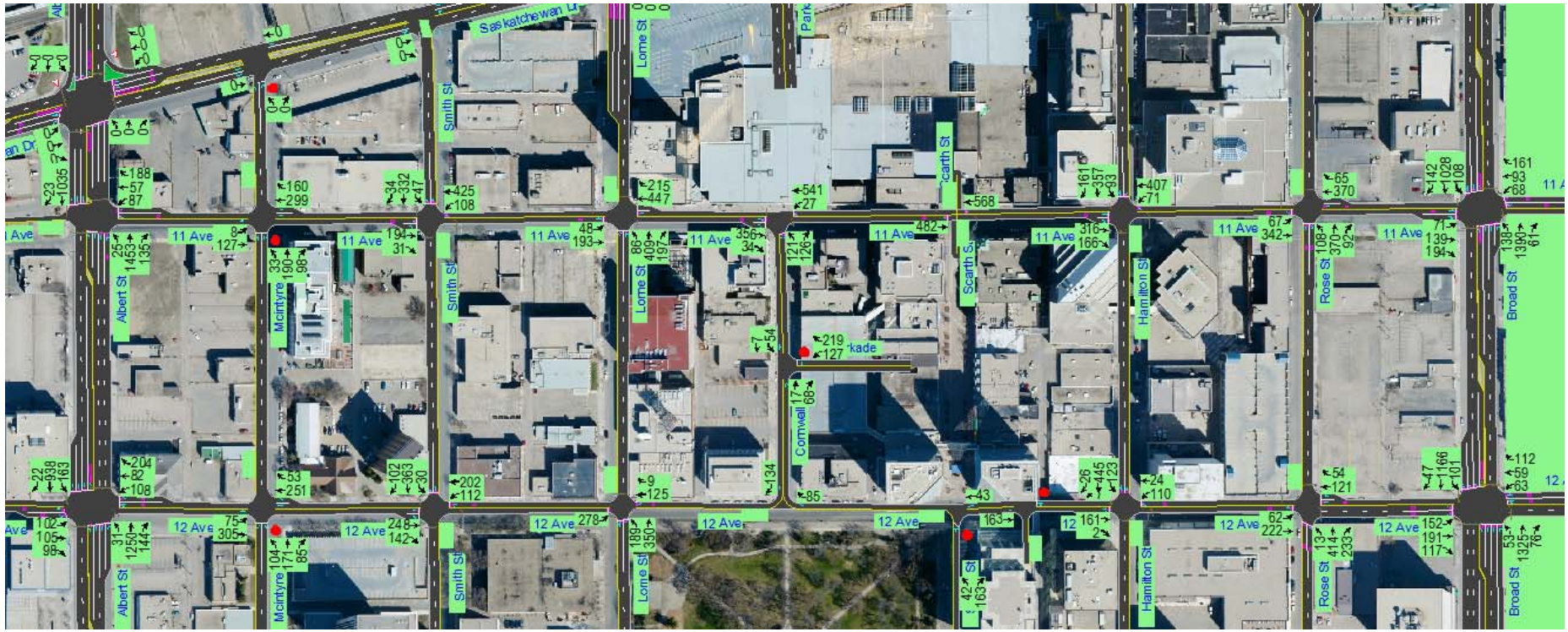


Exhibit 2-7: Downtown Regina: Synchro Model, PM One-Way Westbound Preferred



2.3 VISSIM Models

A VISSIM model was developed for each alternative. The intersection turning movement volumes and configurations, signal timings and signage, and desired speeds are identical between the Synchro model and the VISSIM model. Transit routes and vehicles are modelled fully in VISSIM. For details regarding transit in VISSIM, see section 1.

Exhibit 2-8: Downtown Regina: VISSIM Model, PM Base Closed Network

Exhibit 2-9: 12th Avenue at City Square Plaza, One-Way Eastbound

Exhibit 2-10: 12th Avenue at City Square Plaza, One-Way Westbound

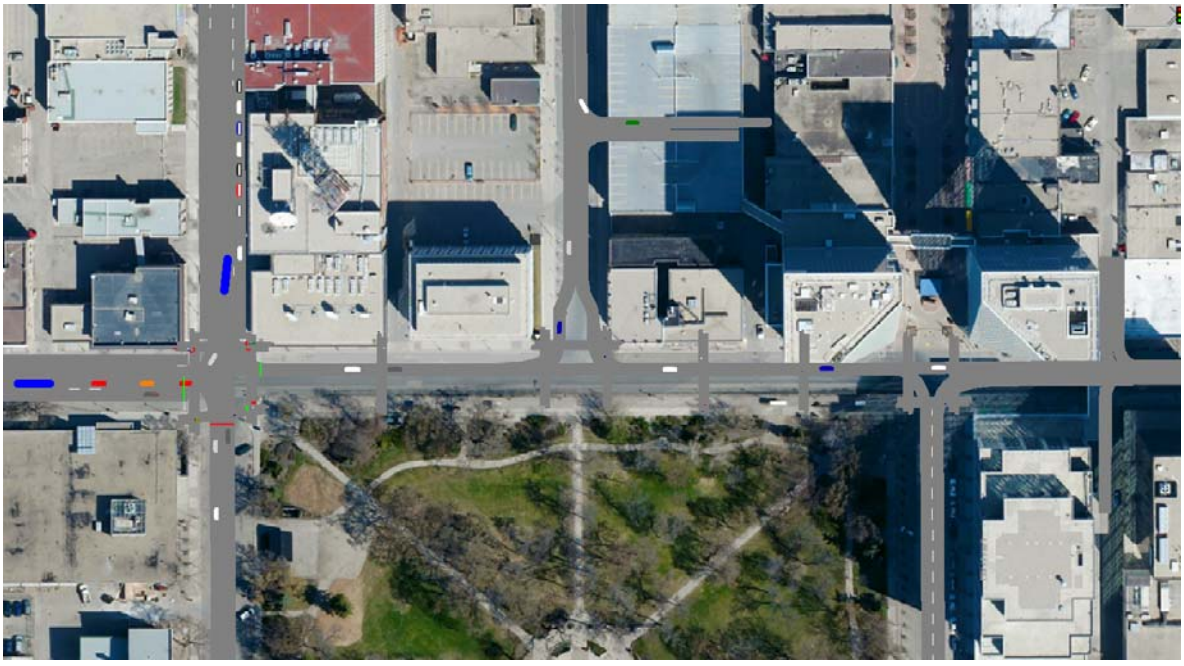


Exhibit 2-11: 12th Avenue at City Square Plaza, Two-Way

Exhibit 2-12: 12th Avenue at City Square Plaza, One-Way Westbound Preferred

Vehicle speeds are controlled with desired speed decision points and reduced speed areas. The following desired speed categories are set for various movements in the model, in order to best reflect realistic driving behaviour. Desired speed decisions and reduced speed areas are the same between all models.

Exhibit 2-13: Model Desired Speeds

Link	*Desired Speed Category*	*Speed Distribution*
12th Avenue at City Square Plaza	20 km/h	20.0 km/h – 25.0 km/h
All left turn movements	15 km/h	15.0 km/h – 20.0 km/h
All right turn movements	12 km/h	12.0 km/h – 15.0 km/h
Everywhere else	50 km/h	48.0 km/h – 58.0 km/h

Priority Rules and conflict areas were defined in various places of the network to achieve the following objectives:

- Prevent cars from blocking the intersection;
- Prioritize pedestrian movement above all else, given that the pedestrian movement is allowed for that phase;
- Force cars (and trucks) making a permitted left turn to check for clearances in all of: opposite direction through traffic, crossing pedestrians, and downstream lane availability; and
- Force cars (and trucks) making a permitted right turn to check for crossing pedestrians and downstream lane availability.
- For 12th Avenue at City Square Plaza, cars always yield to freely crossing pedestrians.

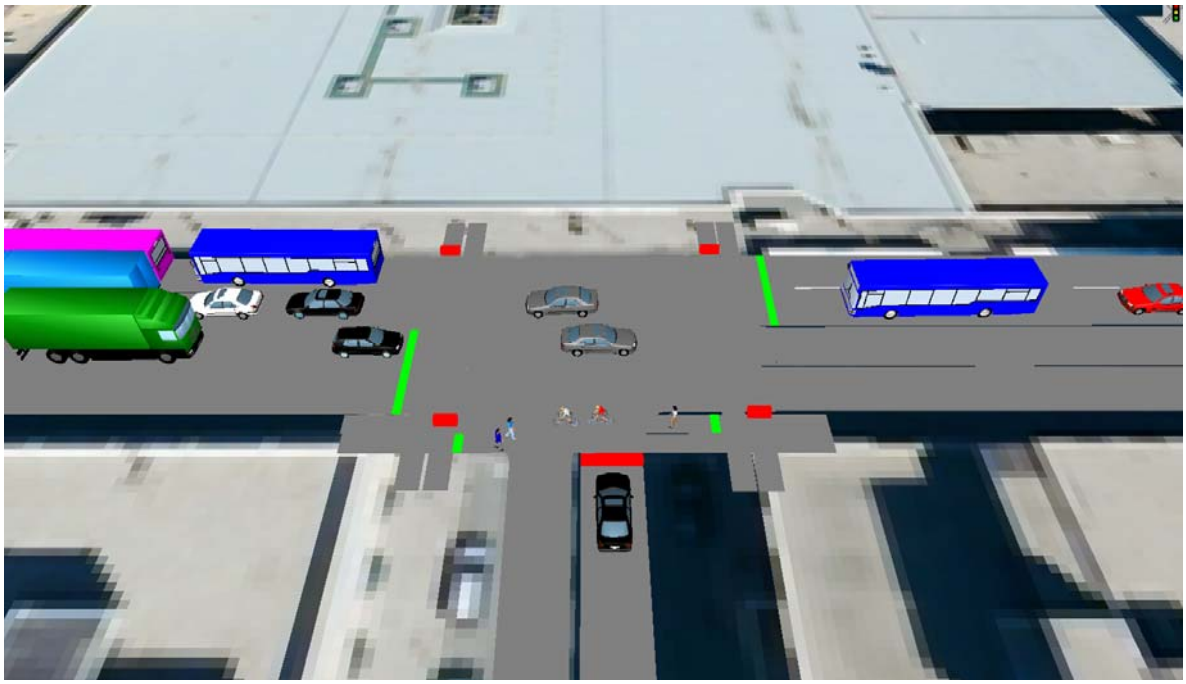
Right Turn on Red (RTOR) was permitted for all right-turning movements on the following intersections: 11th Avenue & Albert Street, 12th Avenue & Albert Street, 11th & Broad Street, 12th Avenue & Broad Street, 11th Avenue & Lorne Street, and 11th Avenue & Cornwall Street.

On-street parking was made available for select stretches along 11th Avenue, 12th Avenue, Albert Street, Broad Street, Smith Street, Lorne Street, and Hamilton Street.

For each alternative and time period, ten simulation runs of one simulated hour were completed to provide a statistical average. The simulation included a 15 minute seeding period, in which the network was populated with appropriate flow of vehicles. Data measurements were taken after the seeding period, for 60 minutes of simulation time, making the total simulation time 75 minutes per iteration. This approach ensured that the network was sufficiently loaded with vehicles prior to collecting measures of performance.

The VISSIM model is also capable of producing 3D videos of the simulation runs.

Exhibit 2-14: VISSIM 3D Model, at 11th Avenue and Cornwall Street



2.4 Volume Balancing and Assignment

2.4.1 BASE MODEL

Due to the fact that approach volumes and turning movement counts were collected from different sources on different days, the following approach was taken to ensure that volumes were balanced across the network:

- All available vehicle volume data was tabulated together.
- Turning movement ratios were finalized for each intersection, based on given data. In cases where multiple resources were available for a single intersection, traffic movement counts (TMC) took precedent over turning movements from the reference Synchro files (from section 1.3.6).
- Where available, TMCs for intersection volumes were used as given for the appropriate hour. The peak hour was determined by picking the hour with the highest total volume, to 15-minute accuracy scale.
- Approach volumes were multiplied by turning movement ratios for intersections without TMCs. Where neither TMC nor approach counts were available, the reference Synchro volumes were used.
- Between intersections, if there was a volume discrepancy between upstream and downstream volume, and a parking lot and/or parkade was available in the link, the difference in volume was balanced by adding/subtracting appropriate number of vehicles to/from the parking lots and parkades.

- Between intersections, if there was a volume discrepancy between upstream and downstream volume, and there weren't any parking lots or parkades available in the link, information based on observations and intuition was used to determine a suitable reference volume, then both the upstream and downstream volumes were adjusted accordingly. For most cases, the lower volume was bumped up to match the higher volume.

It was found that for all locations, approach counts yielded higher volumes than TMCs. Volumes were then balanced across the network, using the TMC as lower-bound cap. At few locations, balanced volumes resulted in higher approach totals than those from approach counts.

2.4.2 ALTERNATIVE MODELS

Re-balancing network volumes for the four alternative models were based on EMME and VISSIM model results. For the full list of reference volumes and simulated volumes, refer to Appendix B-3.

- From EMME, the link volume differentials for each of the alternatives compared to the base model was calculated for all links within the phase 1 boundary.

- Due to the use of centroids (not real vehicle sources such as parking lots, parkades, etc.), the EMME adjustments did not result in a balanced network.

- For the portion of the volume that entered or exited centroids that are in the phase 1 boundary, the trip differential percentages compared to the base case was noted, then distributed accordingly to the connected links.

- Results from specific select-link analysis in EMME was used to determine turning movement ratios and paths for newly added trips. Similar, the same analysis results were useful in determining the number of trips to be subtracted from the appropriate intersections.

- After EMME-related adjustments, similar balancing approach from section 2.4.1 above was taken to balance volumes between upstream and downstream intersections.

- The balanced volume was tested on the corresponding VISSIM network (i.e. one-way eastbound volumes on one-way eastbound network) for detection of any major new problems or issues.

- If the simulated volumes in VISSIM for any of the movements were off by more than 25% of the target reference volumes, the reference volumes were edited and balanced with the same approach from section 2.4.1 above. Then, appropriate changes to VISSIM routing decisions were made, then the entire network was re-simulated.

- The above were repeated in multiple iterations until all of the following criteria were met:

    - Non-minor movements (with turning movement volume of at least 60) were within +/- 20% of the target reference volumes;

    - Major movements (with turning movement volume of at least 300) were within +/- 15% of the target reference volumes; and

    - The total simulated turning movement count for the entire network was within 2.5% of the total reference turning movement count.

- All buses were accounted for in the volume balancing process.

3. AUTO OPERATIONS

Intersection capacity analyses were undertaken using the Highway Capacity Manual (HCM) methodology. The level of service (LOS) and corresponding delay per vehicle is provided in the following tables:

Signalized Intersection LOS

LOS	Control Delay Per Vehicle
A	≤10
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

Unsignalized Intersection LOS

LOS	Control Delay Per Vehicle
A	≤10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	>50

Exhibit 3-1: Overall Model Results

VISSIM Models - Traffic Results	Total Network Delay (hrs)	Difference from Base/Closed (hrs)	% Difference
Base (Closed)	160.0	n/a	n/a
1-Way Eastbound	152.7	-7.3	-5%
1-Way Westbound	140.7	-19.3	-13%
2-Way	137.8	-22.2	-14%
1-Way Westbound, Preferred	143.9	-16.1	-10%
1-Way Westbound Preferred Improved	142.1	-17.9	-12%

On average, all five models operate smoothly, with majority of intersection turning movements operating at LOS A, B, or C. With the average delay under 20 seconds and queues no longer than 5 cars long, the averages for all the models suggest that in general, the Regina downtown road network is functioning well. There are few turning movements that operate at LOS D or worse, and they are discussed in section 3.3.

3.1 Intersection Operations

For each signalized and unsignalized intersections on 11th Avenue and 12th Avenue, intersection average delay was collected in both Synchro and VISSIM.

Exhibit 3-2: Intersection Operations, Base Model

Base (Closed)					
East-West Street	North-South Street	LOS		Average Delay (s)	
		Synchro	VISSIM	Synchro	VISSIM
11th Avenue	Albert Street	C	B	34	14
	Mcintyre Street	A	A	6	7
	Smith Street	B	B	18	12
	Lorne Street	B	C	19	22
	Cornwall Street	B	D	16	37
	Scarth Street	B	C	17	29
	Hamilton Street	B	C	19	30
	Rose Street	B	C	20	29
	Broad Street	C	C	32	23
12th Avenue	Albert Street	C	C	34	21
	Mcintyre Street	B	A	11	7
	Smith Street	B	B	13	14
	Lorne Street	B	B	13	17
	Cornwall Street				
	Scarth Street				
	Hamilton Street	B	B	13	14
	Rose Street	B	B	16	17
	Broad Street	B	C	17	20

Exhibit 3-3: Intersection Operations, One-Way Eastbound Model

1-Way Eastbound					
East-West Street	North-South Street	LOS		Average Delay (s)	
		Synchro	VISSIM	Synchro	VISSIM
11th Avenue	Albert Street	C	B	35	15
	Mcintyre Street	A	A	6	7
	Smith Street	B	B	17	12
	Lorne Street	B	C	19	23
	Cornwall Street	B	C	15	35
	Scarth Street	B	C	18	32
	Hamilton Street	B	C	19	32
	Rose Street	B	C	20	26
	Broad Street	C	C	33	21
12th Avenue	Albert Street	C	C	35	21
	Mcintyre Street	B	A	12	7
	Smith Street	B	B	13	13
	Lorne Street	B	B	12	16
	Cornwall Street	A	A	5	6
	Scarth Street	A	B	4	12
	Hamilton Street	B	B	13	14
	Rose Street	B	B	16	13
	Broad Street	C	B	23	19

Exhibit 3-4: Intersection Operations, One-Way Westbound Model

1-Way Westbound					
East-West Street	North-South Street	LOS		Average Delay (s)	
		Synchro	VISSIM	Synchro	VISSIM
11th Avenue	Albert Street	C	B	34	14
	Mcintyre Street	A	A	6	7
	Smith Street	B	B	14	12
	Lorne Street	B	C	17	22
	Cornwall Street	B	C	13	22
	Scarth Street	B	B	14	18
	Hamilton Street	B	B	15	16
	Rose Street	C	B	20	18
	Broad Street	C	C	34	21
12th Avenue	Albert Street	D	C	37	23
	Mcintyre Street	B	A	13	8
	Smith Street	B	B	13	16
	Lorne Street	C	C	25	25
	Cornwall Street	A	A	4	6
	Scarth Street	A	A	5	5
	Hamilton Street	B	B	13	14
	Rose Street	B	B	18	14
	Broad Street	C	B	22	19

Exhibit 3-5: Intersection Operations, Two-Way Model

2-Way					
East-West Street	North-South Street	LOS		Average Delay (s)	
		Synchro	VISSIM	Synchro	VISSIM
11th Avenue	Albert Street	D	B	36	15
	Mcintyre Street	A	A	6	7
	Smith Street	B	B	14	12
	Lorne Street	B	C	17	22
	Cornwall Street	B	C	13	21
	Scarth Street	B	B	14	16
	Hamilton Street	B	B	15	14
	Rose Street	B	B	20	16
	Broad Street	C	B	33	19
12th Avenue	Albert Street	D	C	40	24
	Mcintyre Street	B	B	13	10
	Smith Street	B	B	13	15
	Lorne Street	C	C	21	21
	Cornwall Street	A	A	4	6
	Scarth Street	A	A	5	5
	Hamilton Street	B	B	13	14
	Rose Street	B	B	17	13
	Broad Street	C	B	22	19

Exhibit 3-6: Intersection Operations, One-Way Westbound Preferred

1-Way Westbound - Preferred					
East-West Street	North-South Street	LOS		Average Delay (s)	
		Synchro	VISSIM	Synchro	VISSIM
11th Avenue	Albert Street	C	B	34	14
	Mcintyre Street	A	A	6	7
	Smith Street	B	B	15	12
	Lorne Street	B	C	18	22
	Cornwall Street	B	C	14	25
	Scarth Street	B	C	16	21
	Hamilton Street	B	B	16	19
	Rose Street	B	C	20	21
	Broad Street	C	C	34	21
12th Avenue	Albert Street	D	C	35	23
	Mcintyre Street	B	A	12	9
	Smith Street	B	B	12	15
	Lorne Street	C	B	21	18
	Cornwall Street				
	Scarth Street	A	A	10	7
	Hamilton Street	B	B	13	14
	Rose Street	B	B	16	14
	Broad Street	C	B	22	20

With the exception of the two intersections on Albert Street, the Synchro results and VISSIM results agree with each other. On 11th Avenue and 12th Avenue in between Albert Street and Broad Street, the intersections operate in LOS C or better. Generally, 11th Avenue is heavier than 12th Avenue in volume, and the intersection operations reflect that; intersections on 11th Avenue have slightly higher delays than their counterparts on 12th Avenue.

The two intersections on Albert Street show a major discrepancy between Synchro (LOS C or D) and VISSIM (LOS B or C). The average delays between Synchro and VISSIM range from 12 seconds to 22 seconds, depending on the alternative. In particular, Synchro calculates the southbound and northbound movements on Albert Street to experience major delays (LOS E), but in VISSIM the corresponding movements were found to operate with no major delays (LOS B or C).

Despite the overall network averages in the range of LOS B and intersection average in the range of LOS A to D, there are several movements that suffer from major delays. Movements that exit the phase 1 boundary at Albert Street and Broad Street suffer LOS D or E. For example, at the intersection of 11th Avenue and Broad Street, the eastbound through movement and eastbound left movement share a single lane. The total volume from the two movements are considerably large for a single lane to process (240-320 depending on the alternative). Additionally, due to the left turning movement being restricted to permitted (not protected) turns only, the clearance of the lane is highly dependent on the volume of opposing direction through movement (WBT). Lane reconfiguration to separate the two movements, via methods such as adding a storage lane for the left turns only, is recommended for these intersections.

The full list of delays, broken down into individual movements at every intersection, can be found in Appendix B-4.

Exhibit 3-7: Intersection Operations Comparisons

East-West Street	North-South Street	VISSIM Delays					
		Base	1-Way EB	1-Way WB	2-Way	1-Way WB Pref	1-WBP Imp
11th Avenue	Albert Street	14	15	14	15	14	14
	Mcintyre Street	7	7	7	7	7	7
	Smith Street	12	12	12	12	12	12
	Lorne Street	22	23	22	22	22	21
	Cornwall Street	37	35	22	21	25	24
	Scarth Street	29	32	18	16	21	19
	Hamilton Street	30	32	16	14	19	15
	Rose Street	29	26	18	16	21	14
	Broad Street	23	21	21	19	21	23
12th Avenue	Albert Street	21	21	23	24	23	23
	Mcintyre Street	7	7	8	10	9	9
	Smith Street	14	13	16	15	15	14
	Lorne Street	17	16	25	21	18	18
	Cornwall Street	0	6	6	6	0	0
	Scarth Street	0	12	5	5	7	7
	Hamilton Street	14	14	14	14	14	14
	Rose Street	17	13	14	13	14	14
	Broad Street	20	19	19	19	20	24

Exhibit 3-8: Comparison of Intersection Delays on 11th Avenue

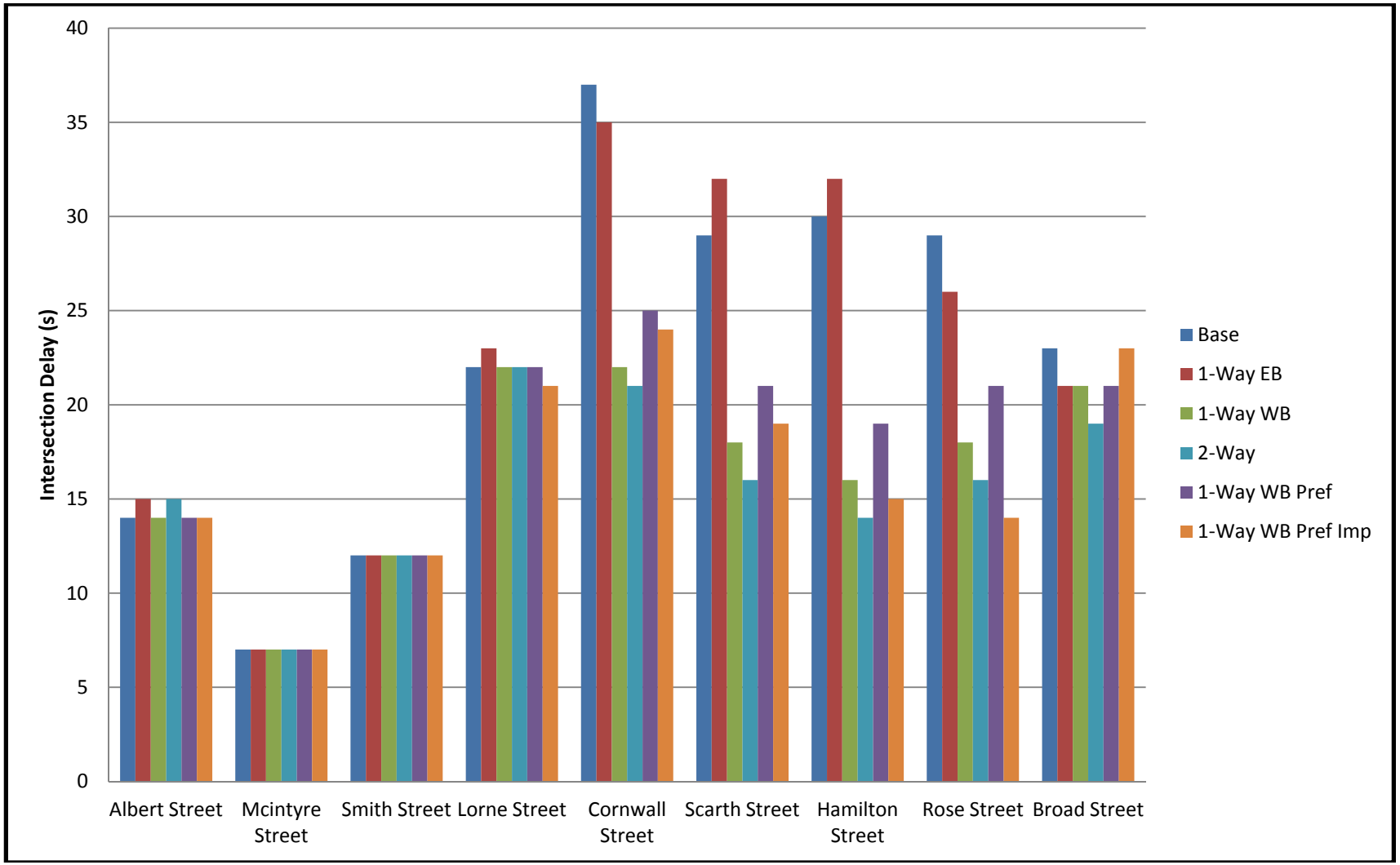
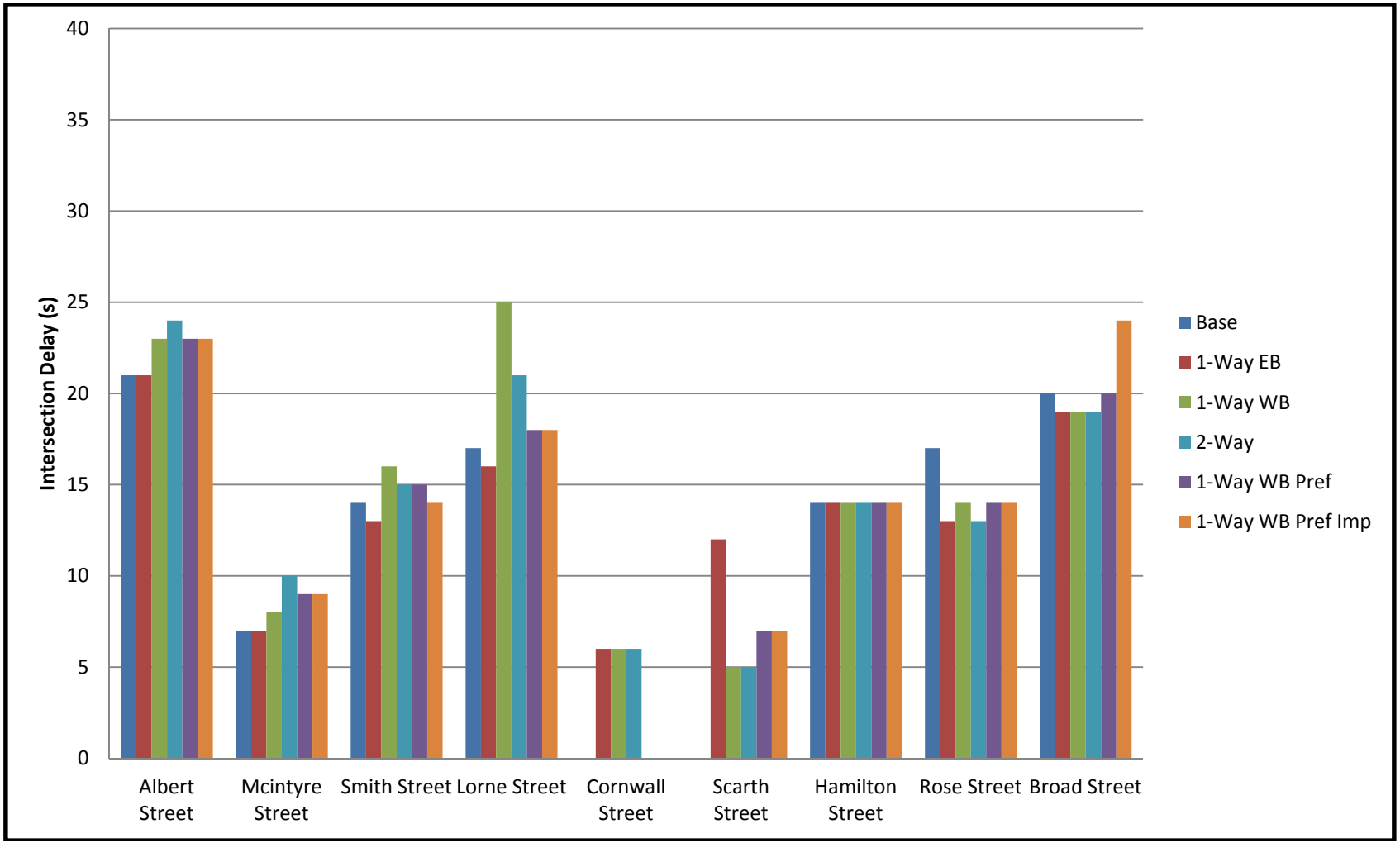


Exhibit 3-9: Comparison of Intersection Delays on 12th Avenue



Overall, between the five alternatives, the intersection delays are within reasonable ranges of each other. On 11th Avenue, one-way eastbound option results in greater delays than even the base option. One-way westbound option and two-way option result in similar sized delay reductions, but do not result in significant reductions compared to the base model. One-way westbound preferred option falls somewhere in between the one-way westbound option and the base case.

On 12th Avenue, delays stay very similar between the five alternatives. The delays on intersections of 12th Avenue with Lorne Street, Cornwall Street, and Scarth Street are highly dependent on the road configurations of the alternative, and it is sometimes not available due to the intersection not being existent in particular alternatives.

3.2 Critical Movements

There were several critical movements identified in the base model. Movements with LOS D or worse were identified in the base model and the alternatives models, and compared against their corresponding counterparts in the other models.

Exhibit 3-10: Critical Intersection Turning Movements

Location			Delay					
East-West Street	North-South Street	Movement	Base	1WayEB	1WayWB	2Way	1WayWBPref	1WBPImp
11th Avenue	Cornwall Street	NBL	67	45	37	29	40	33
		NBR	59	38	31	25	32	29
11th Avenue	Hamilton Street	SBR	70	72	13	12	24	25
11th Avenue	Rose Street	WBT	42	46	14	13	23	13
11th Avenue	Broad Street	EBL	83	70	76	67	75	36
		EBT	77	64	69	62	69	33
		WBL	61	56	52	53	54	43
		WBT	60	57	50	51	52	38
12th Avenue	Albert Street	EBL	49	48	51	51	53	56
		WBL	69	63	76	85	79	79
		WBT	64	58	74	84	74	76
12th Avenue	Broad Street	SBL	58	47	44	44	48	31

- On 11th Avenue and Cornwall Street, the northbound left movement is no longer critical in the alternatives with 11th Avenue westbound traffic reduced.
- On 11th Avenue and Hamilton Street, the southbound right movement experiences enormous improvement in the alternatives with 11th Avenue westbound traffic reduced.
- On 11th Avenue and Rose Street, the westbound through movement is critical for the one-way eastbound option. The changes in vehicle routing and volumes generally result in higher delays westbound for the entire one-way eastbound option.
- On 11th Avenue and Broad Street, the critical movements are not completely relieved in any of the alternatives. High volumes in all directions and select movements operating well over capacity are some of the factors contributing to the poor service at this location.

- Similar problems are found in 12th Avenue and Albert Street, where critical movements are not completely relieved in any of the alternatives. Some movements improve and others degrade for all alternatives.

- On 12th Avenue and Broad Street, the southbound left movement experiences high delays for all alternatives, largely unaffected by any of the volume, path, or operational changes in the alternatives.

- The one-way westbound preferred-improved model features significant improvement on some of the previously critical locations, such 11th Avenue & Broad Street and 12th Avenue & Broad Street. While according to Exhibit 3-7 the overall intersection delay increased in this model, the select critical movements were improved as a result of the changes to signal timing plan and lane configurations. More details regarding the improvements are available in Section 6.

3.3 Individual Vehicle Delays

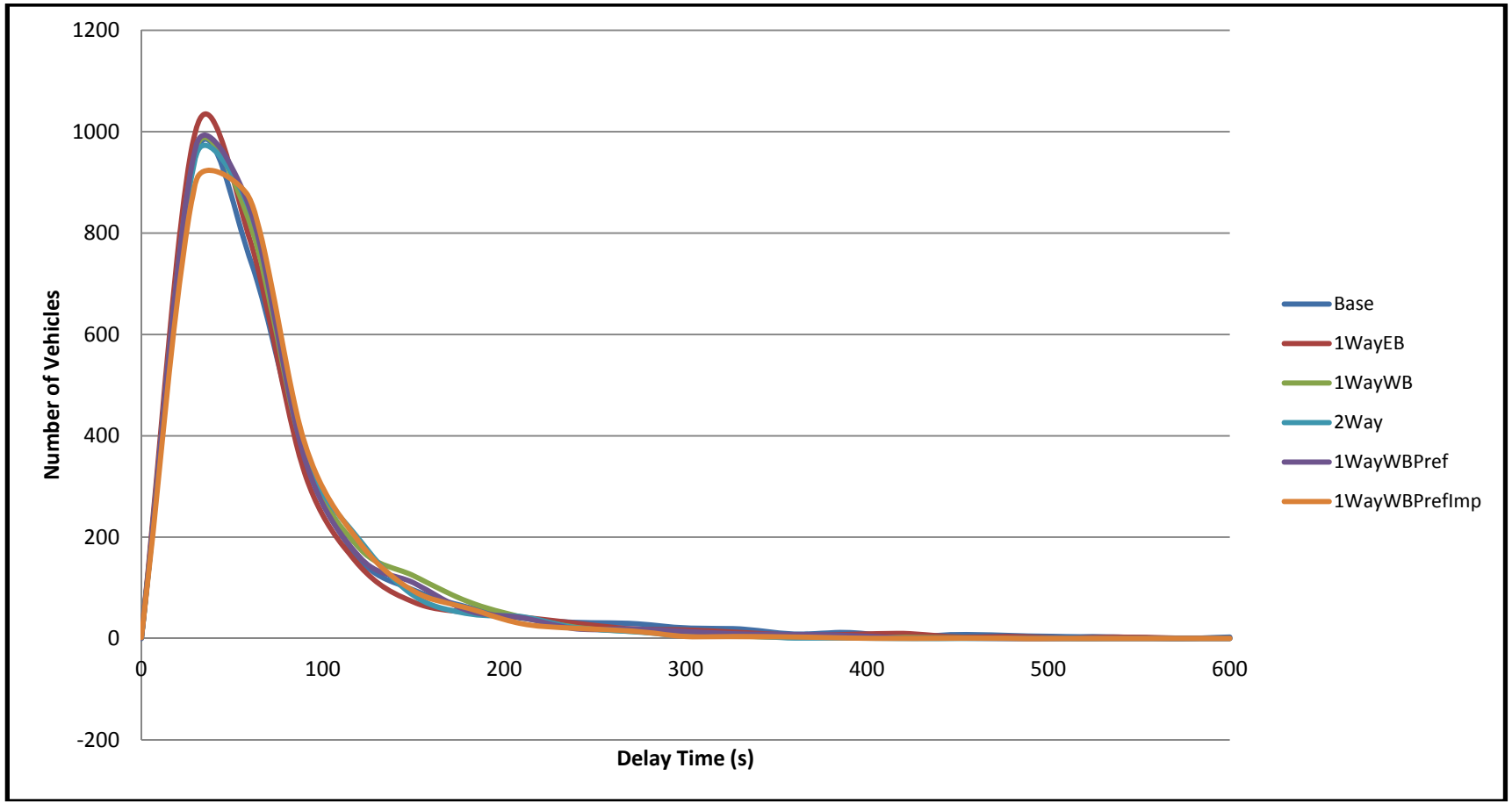
In VISSIM, it is possible to extract the total delay incurred by a single vehicle through its journey in the network. This delay includes delay at signals, delays due to queues, and other 'obstacles' such as pedestrians or dwelling buses. This delay does not include the time spent parking in a designated parking spot. The sampled vehicles have all completed their trip, each from an entry point to an exit point in the network.

A sample of ~2500 vehicles were extracted from each of the models and grouped into bins of 30, then graphed.

Exhibit 3-11: 30-Second Bin Counts, Vehicle Trip Total Delay

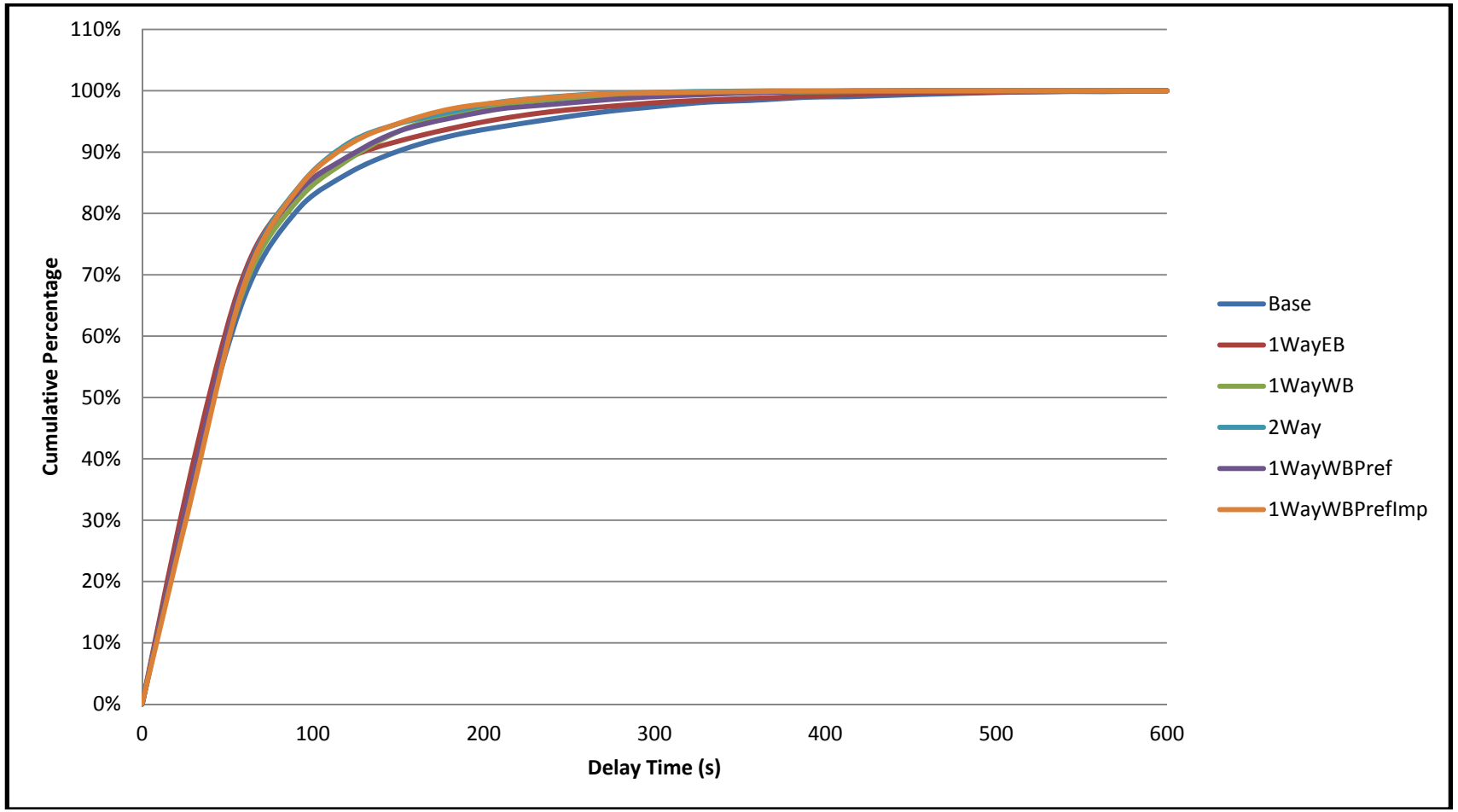
Base		1WayEB		1WayWB		2Way		1WayWBPref		1WBPImp	
0	0	0	2	0	1	0	1	0	1	0	2
30	955	30	1003	30	964	30	951	30	970	30	901
60	748	60	785	60	818	60	844	60	847	60	866
90	354	90	327	90	360	90	367	90	355	90	386
120	158	120	145	120	179	120	196	120	162	120	191
150	96	150	72	150	124	150	85	150	110	150	94
180	62	180	51	180	73	180	49	180	55	180	60
210	40	210	42	210	42	210	43	210	41	210	29
240	32	240	30	240	22	240	21	240	19	240	20
270	30	270	19	270	14	270	14	270	19	270	15
300	21	300	17	300	9	300	5	300	14	300	4
330	19	330	12	330	5	330	5	330	9	330	4
360	9	360	7	360	2	360	1	360	8	360	3
390	12	390	8	390	3	390	1	390	6	390	1
420	3	420	10	420	2	420	0	420	1	420	0
450	8	450	3	450	1	450	0	450	1	450	1
480	6	480	4	480	1	480	0	480	0	480	0
510	4	510	1	510	0	510	0	510	0	510	0
540	3	540	3	540	0	540	0	540	0	540	0
570	0	570	1	570	0	570	0	570	0	570	0
600	3	600	1	600	0	600	0	600	0	600	0

Exhibit 3-12: Vehicle Trip Total Delay



From Exhibit 3-12, the one-way eastbound alternative peaks the highest at around 50 seconds, then falls off quickly like the other alternatives. The higher peak at the low delay range means that higher portion of the vehicles experienced delays within that range. In other words, the higher peak relates to more vehicles experiencing relatively low total delay. The one-way eastbound alternative is a close winner in this analysis: compared to other options, it has about 30-50 more cars in the low delay range. All models follow a similar curve, indicating that the overall traffic pattern will be similar between no matter the option.

Exhibit 3-13: Cumulative Percentages for Vehicle Trip Total Delay



In the cumulative percentages graph, two-way and one-way westbound preferred-improved options have the “highest” curves, reaching higher percentage of vehicles under certain delay time thresholds, and reaching the 100% at the fastest pace. Base model has the “lowest” curve, and it does not reach completion until the 450s mark. This means that the base model potentially has the most vehicles in the high delay range, and all other alternatives will have less vehicles in the high delay range.

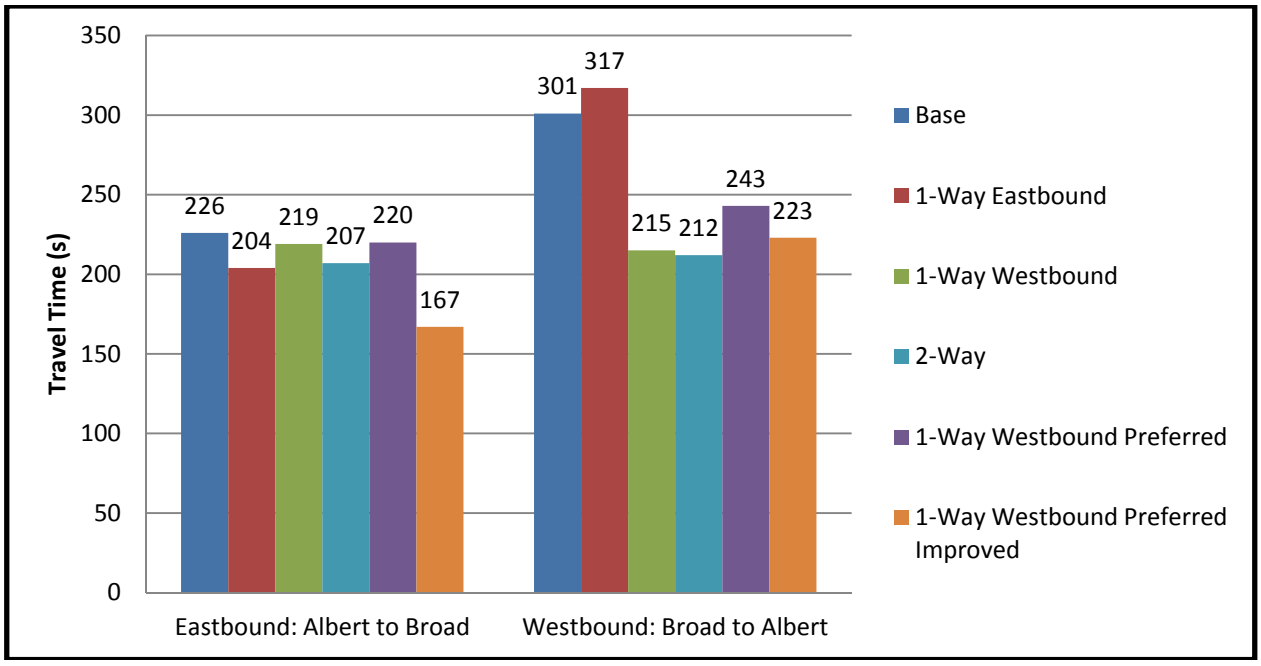
3.4 Auto Travel Times

To calculate the total travel time between two observation points, appropriate travel time measurements from individual segments are added together.

Exhibit 3-14: 11th Avenue Travel Times, All Models

11th Avenue		Closed	1WayEB	1WayWB	2Way	1WayWBPref	1WBPImp
From	To	TT (s)	TT (s)	TT (s)	TT (s)	TT (s)	TT (s)
Albert Street	Mcintyre Street	12	12	12	13	13	12
Mcintyre Street	Smith Street	16	16	16	16	16	16
Smith Street	Lorne Street	25	21	21	18	19	19
Lorne Street	Cornwall Street	21	19	18	18	19	18
Cornwall Street	Scarth Street	20	18	20	19	20	19
Scarth Street	Hamilton Street	19	19	22	22	23	19
Hamilton Street	Rose Street	27	27	31	28	32	22
Rose Street	Broad Street	86	72	79	73	78	42
Eastbound Total		226	204	219	207	220	167
Broad Street	Rose Street	45	50	21	20	28	20
Rose Street	Hamilton Street	50	49	28	25	33	24
Hamilton Street	Scarth Street	48	51	28	26	34	31
Scarth Street	Cornwall Street	49	55	31	34	38	38
Cornwall Street	Lorne Street	34	37	32	33	34	33
Lorne Street	Smith Street	18	17	17	17	18	18
Smith Street	Mcintyre Street	12	12	12	12	12	12
Mcintyre Street	Albert Street	45	46	46	45	46	47
Westbound Total		301	317	215	212	243	223

Exhibit 3-15: 11th Avenue Total Eastbound and Westbound Travel Times



In the eastbound direction, all five options result in similar travel times. The changes in volume and vehicle paths that come with the different options have very little affect in travel time. From the base (226 seconds) to the one-way eastbound model (204 seconds), the improvement is less than 10%. Major travel time improvement is achieved by the one-way westbound preferred-improved model: at the intersection of 11th Avenue and Broad Street, an eastbound left turn storage lane is added, accompanied by a new eastbound left protected phase. This reduces the eastbound delays at that intersection by about 50%, resulting in major travel time savings.

In the westbound direction, the differences in travel time is more apparent. The one-way eastbound alternative results in higher travel time westbound than the base model. The one-way eastbound is aimed at improving the conditions eastbound, and there are no major changes in the road configuration that warrant a penalty to the westbound traffic. The increase of travel time in the one-way eastbound option is focused in the east end of 11th Avenue within the phase 1 boundary (at intersections with Hamilton Street, Rose Street, and Broad Street), which suggest that the change in vehicle volumes and paths result in higher levels of congestion at those intersections.

All models with the exception of base and one-way eastbound involve reduction of volume in the 11th Avenue westbound direction. As a result, the previously congested corridor is relieved to varying degrees, and westbound travel times are improved accordingly.

Exhibit 3-16: 12th Avenue Travel Times, All Models

12th Avenue		Closed	1WayEB	1WayWB	2Way	1WayWBPref	1WBPImp
From	To	TT (s)	TT (s)	TT (s)	TT (s)	TT (s)	TT (s)
Albert Street	Mcintyre Street	9	9	9	9	9	9
Mcintyre Street	Smith Street	20	19	24	22	22	20
Smith Street	Lorne Street	29	22	65	43	36	35
Lorne Street	Cornwall Street	n/a	20	n/a	13	n/a	n/a
Cornwall Street	Scarth Street	n/a	31	n/a	15	n/a	n/a
Scarth Street	Hamilton Street	22	20	17	19	17	17
Hamilton Street	Rose Street	18	18	18	18	18	18
Rose Street	Broad Street	42	44	44	44	43	40
Broad Street	Rose Street	16	16	16	16	16	16
Rose Street	Hamilton Street	21	10	23	24	27	25
Hamilton Street	Scarth Street	n/a	n/a	9	9	10	10
Scarth Street	Cornwall Street	n/a	n/a	22	22	22	21
Cornwall Street	Lorne Street	n/a	n/a	30	31	29	28
Lorne Street	Smith Street	25	20	22	22	20	21
Smith Street	Mcintyre Street	10	10	12	12	12	12
Mcintyre Street	Albert Street	72	65	82	82	83	85

Due to some of the options not having continuous roads between Lorne Street and Hamilton Street, a full end-to-end travel time was not calculated on 12th Avenue. Instead, on an individual segment basis, all five options experience similar travel times between each other. Against corresponding segments on 11th Avenue, the segments in 12th Avenue experience similar travel times as well.

On both 11th Avenue and 12th Avenue, the segments leading up to Albert Street or Broad Street experience significant congestion. Heavy volumes and insufficient intersection capacity at those locations are the main factors that contribute to high travel times.

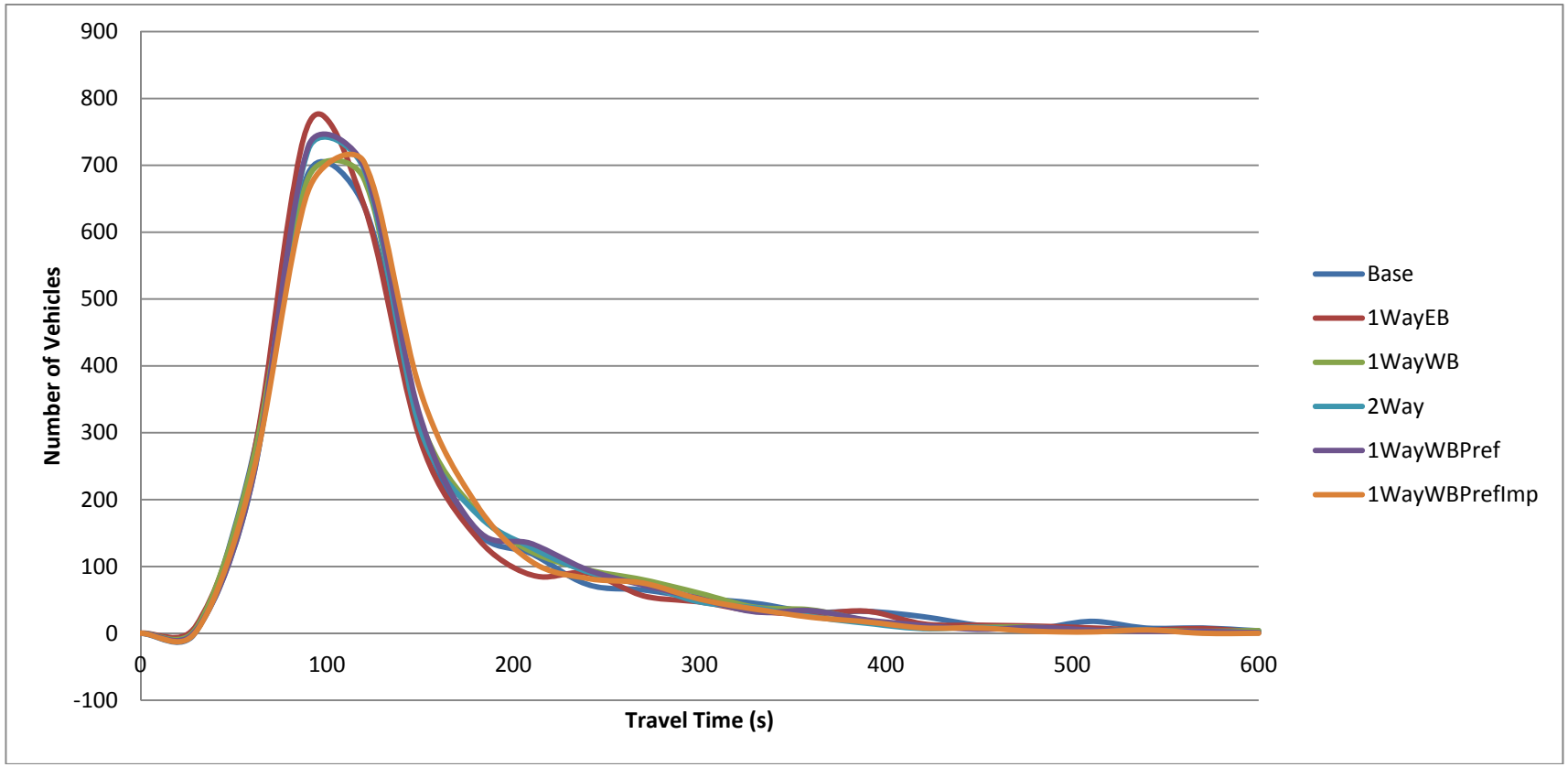
3.5 Individual Travel Times

In VISSIM, it is possible to extract the travel time of a single vehicle through its journey in the network. This travel time is the difference between the end trip time of the vehicle and the start trip time of the vehicle. This travel time does not include the time spent parking in a designated parking spot. The sampled vehicles have all completed their trip, each from an entry point to an exit point in the network.

Exhibit 3-17: 30-Second Bin Counts, Vehicle Trip Travel Time

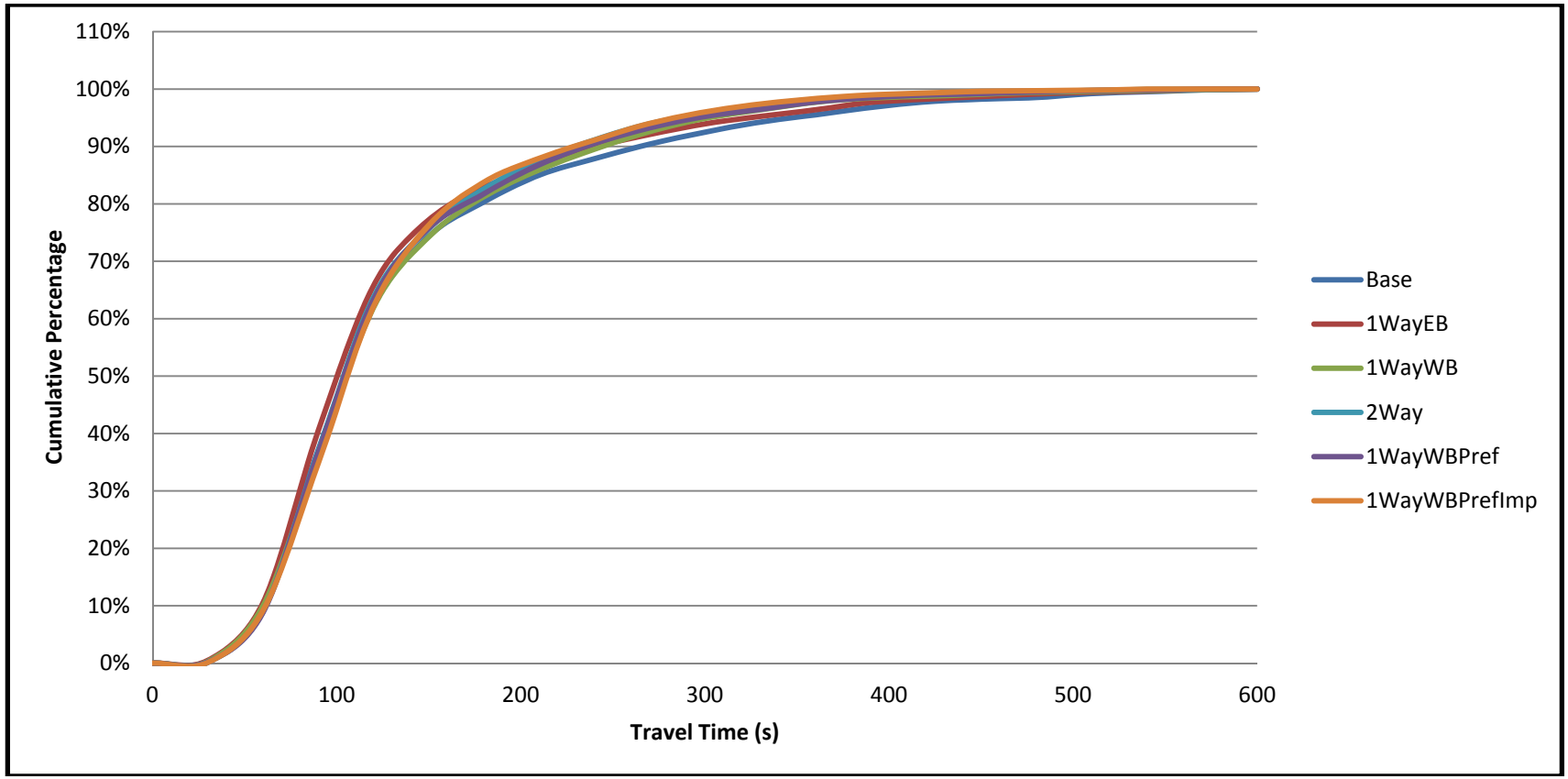
Base		1WayEB		1WayWB		2Way		1WayWBPref		1WayWBPrefImp	
0	0	0	0	0	0	0	0	0	0	0	0
30	3	30	12	30	8	30	5	30	5	30	3
60	260	60	256	60	254	60	227	60	227	60	234
90	688	90	761	90	681	90	723	90	728	90	662
120	639	120	640	120	680	120	694	120	698	120	705
150	310	150	290	150	321	150	307	150	325	150	364
180	153	180	145	180	183	180	180	180	157	180	194
210	119	210	87	210	122	210	128	210	134	210	107
240	73	240	90	240	95	240	92	240	95	240	82
270	65	270	56	270	80	270	73	270	72	270	75
300	53	300	47	300	60	300	47	300	52	300	51
330	45	330	33	330	39	330	38	330	32	330	36
360	32	360	29	360	35	360	25	360	34	360	24
390	33	390	33	390	19	390	15	390	20	390	17
420	25	420	14	420	8	420	7	420	12	420	8
450	12	450	12	450	9	450	9	450	6	450	8
480	7	480	11	480	9	480	4	480	9	480	3
510	18	510	8	510	4	510	4	510	5	510	2
540	8	540	5	540	4	540	5	540	3	540	5
570	8	570	7	570	3	570	1	570	3	570	0
600	4	600	2	600	4	600	1	600	1	600	0

Exhibit 3-18: Vehicle Trip Travel Time



Similar to the delays, the graph peaks at a low range then falls off towards the end. Surprisingly, the base option peaks at similar heights as three of the four options, indicating that there is no significant improvement from the base to most of the alternatives. One-way eastbound peaks the highest, suggesting that there are large number of cars taking short, relatively delay-free trips in that particular option. However, all other models peak at similar range and retain similar graph curve, which means that the travel time differences are most likely very small between the models.

Exhibit 3-19: Cumulative Percentages for Vehicle Trip Travel Time



Similar to Exhibit 3-13, Exhibit 3-19 has all five options in a similar trend. All options are virtually equal: 60-70% of all trips are completed within 2 minutes (120 seconds), and only 5-8% trips take longer than 5 minutes. As it was noted in the EMME analysis, the small percentage of 5+ minute trips are likely those of the vehicles using 11th Avenue or 12th Avenue as a through corridor, from one end of the model to the other.

4. TRANSIT OPERATIONS

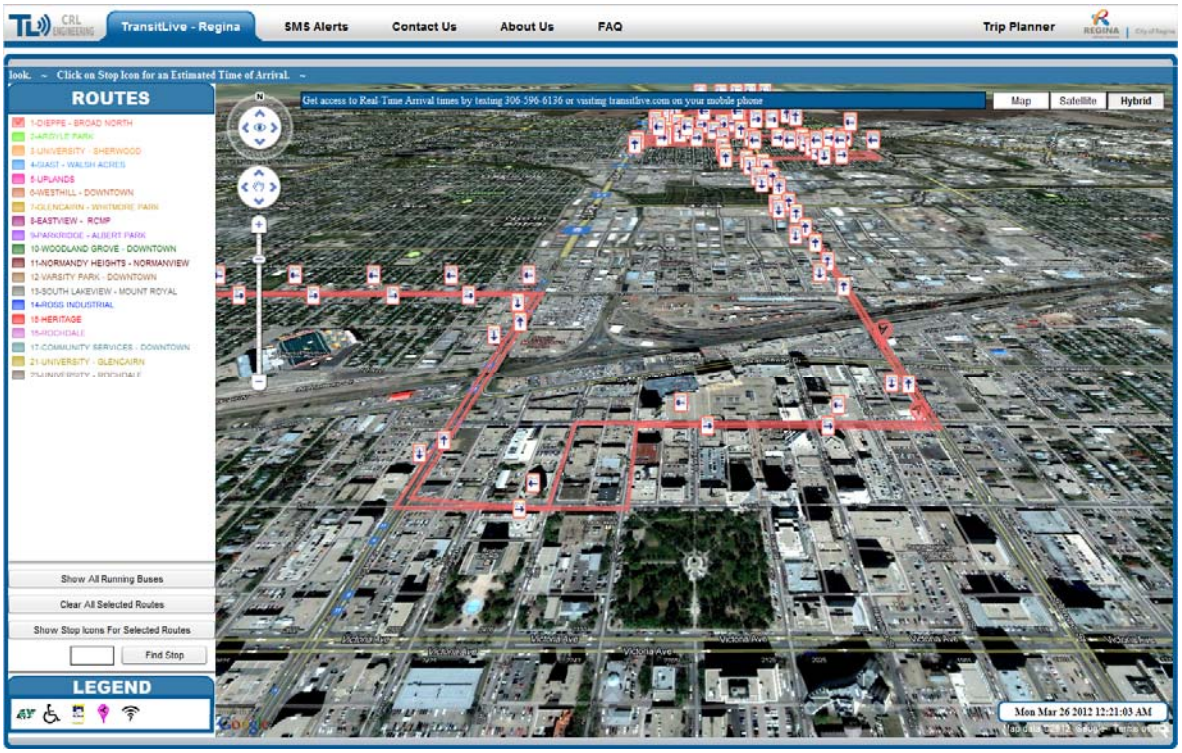
The existing transit operations are based on the base model, which represents the PM peak hour with 12th Avenue closed between Lorne Street and Scarth Street. Transit routes were modelled only for the VISSIM model – detailed transit modelling is not possible in EMME and Synchro. Due to the fact that all Regina public transit routes do not use 12th Avenue between Lorne Street and Hamilton Street, all bus routes are identical between the five options.

4.1 Transit Routes in the VISSIM Model

The full list of bus lines and schedules were obtained from the transit section of City of Regina official website, at http://regina.ca/residents/transit-services/regina-transit. All listed routes, from 1 – Dieppe – Broad North to 23 – University – Rochdale, were included in the model if any portion of their route is present inside or on the phase 1 boundary. Any transit lines that do not have any portion of their route present inside or on the phase 1 boundary were not included in the model.

TransitLive is an automatic vehicle location pilot project from Canadian Research Logistics (CRL), a Regina-based company. In addition to the schedules obtained from City of Regina's official website, TransitLive was used to verify routes and stop locations. TransitLive is accessible to the public, and can be found online at http://transitlive.com.

Exhibit 4-1: TransitLive, Showing Route 1 Stops and Buses



For the purposes of bus schedules and arrival times,

- The AM model was assumed to run from 6:45 AM to 8:00 AM;
- The off-peak model was assumed to run from 12:45 PM to 2:00 PM; and

- The PM peak model was assumed to run from 3:45 PM to 5:00 PM.

Bus dwell times at bus stations were given static distributions, and thus do not vary by passenger occupancy, boarding, or alighting volumes. Dwell time distributions range from short (normal, 15 +/- 5 seconds) to long (empirical, 30 to 240 seconds), depending on the observed significance of the stop.

All bus routes were modelled individually. Bus routes start and end where they cross the VISSIM model boundary (different from phase 1 boundary). The routes do not share a common time and headway. The individual routes' starting times were coordinated to best match the first scheduled departure time at the City Hall stop within the model's time frame. For routes that do not use the City Hall stop, the nearest station was used as the point of reference.

Bus-only routes were modelled at appropriate segments along 11th Avenue and 12th Avenue. Lane violations by automobiles were modelled as well: at 11th Avenue and Scarth Street, a small static chance was coded into the routing decisions to have westbound automobiles make a short stop (dwell time is based on a static normal distribution), which disrupt and/or delay the buses trying to make a stop or pass through.

For major stops used by several bus lines (such as the City Hall eastbound stop or the Cornwall Plaza westbound stop), bus stops were elongated to accommodate for up to 4 buses to dwell simultaneously. In the case for Cornwall Plaza westbound stop, the stop was split into nearside and farside stops – each with capacity for 3 buses to dwell simultaneously – and the bus lines that use the stop were assigned to either one of the stops according to the information from TransitLive.

4.2 Intersection Level of Service – for Transit Vehicles

Select segments were modelled as bus-only routes in the model. This was accomplished either by placing restrictions the outside lane of a 2-lane link for vehicles, or modelling the road as two separate 1-lane links.

Exhibit 4-2: Overall Model Results, for Transit-Only Movements

VISSIM Models - Transit Results	Average Delay (s)	Level of Service	Average Queue (m)
Base (Closed)	20	B	12
1-Way Eastbound	21	C	11
1-Way Westbound	18	B	8
2-Way	18	B	8
1-Way Westbound, Preferred	20	B	10
1-Way Westbound, Preferred, Improved	19	B	8

The delays on transit-only movements are similar to those of mixed traffic. With delays less than 30 seconds, buses are usually able to proceed through the intersection within one signal cycle.

4.3 Transit Travel Times

The travel time measurement segments for buses start at the downstream end of a bus stop and end at the upstream end of a bus stop. This ensures that dwell times at bus stops have no effect on the travel times. Unlike regular traffic, bus travel times are measured from stop to stop, and total travel time between selected points is calculated by the sum of appropriate stop-to-stop times.

Exhibit 4-3: Transit Travel Time for Selected Routes

Transit Routes		Closed	1WayEB	1WayWB	2Way	1WayWBPref	1WBPImp
From	To	TT (s)	TT (s)	TT (s)	TT (s)	TT (s)	TT (s)
11th & Broad	City Hall, WB	251	253	227	216	235	237
11th & Albert	City Hall, EB	73	74	77	75	78	75
City Hall, EB	11th & Broad	273	235	293	267	260	217
11th & Broad	11th & Broad	560	532	521	505	529	492

Exhibit 4-4: Bus Route A, Westbound, from 11th Avenue & Broad Street to City Hall

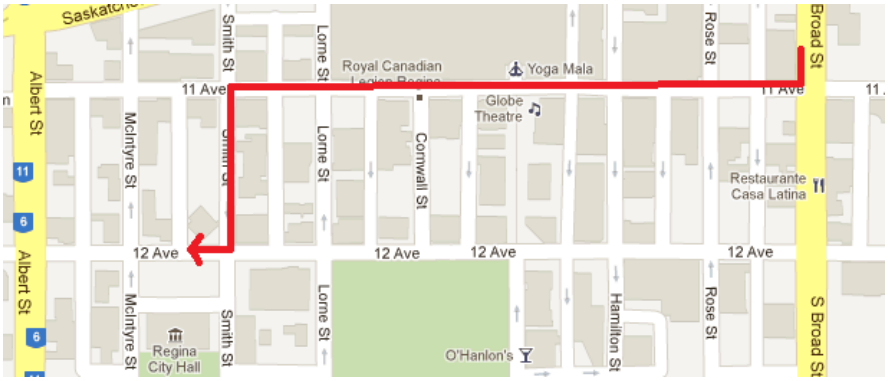


Exhibit 4-5: Bus Route B, Southbound, from 11th Avenue & Albert Street to City Hall

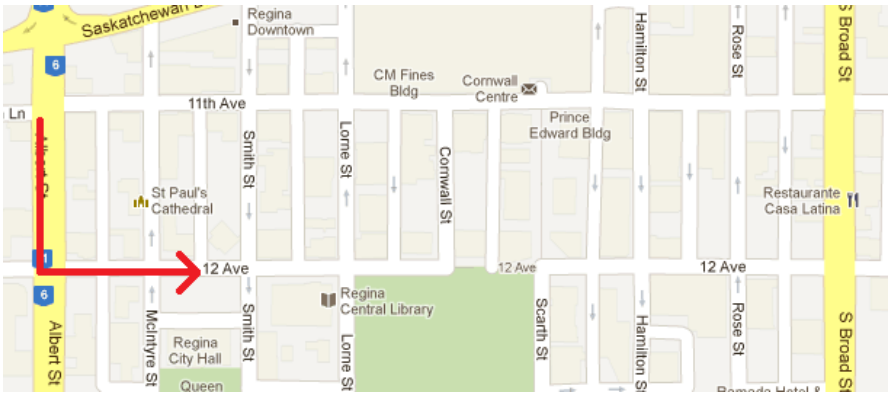


Exhibit 4-6: Bus Route C, Eastbound, from City Hall to 11th Avenue & Broad Street

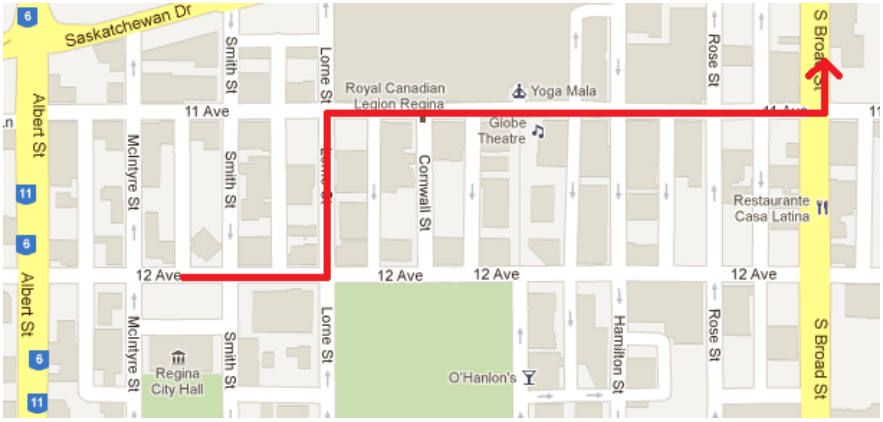


Exhibit 4-7: Bus Route, D, Loop, from and to 11th Avenue & Broad Street

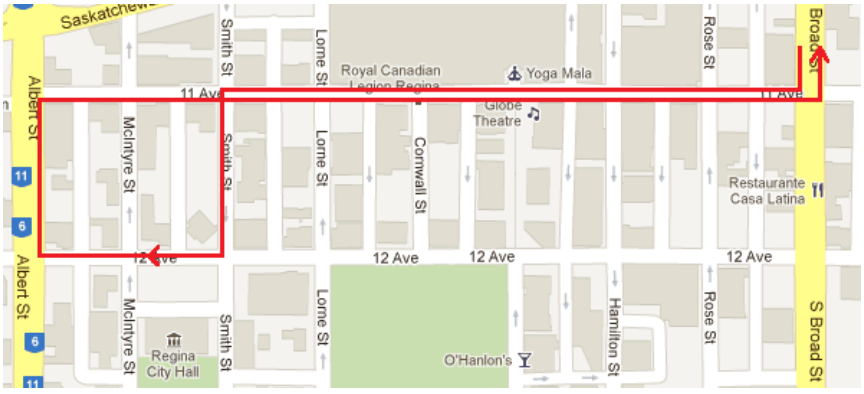
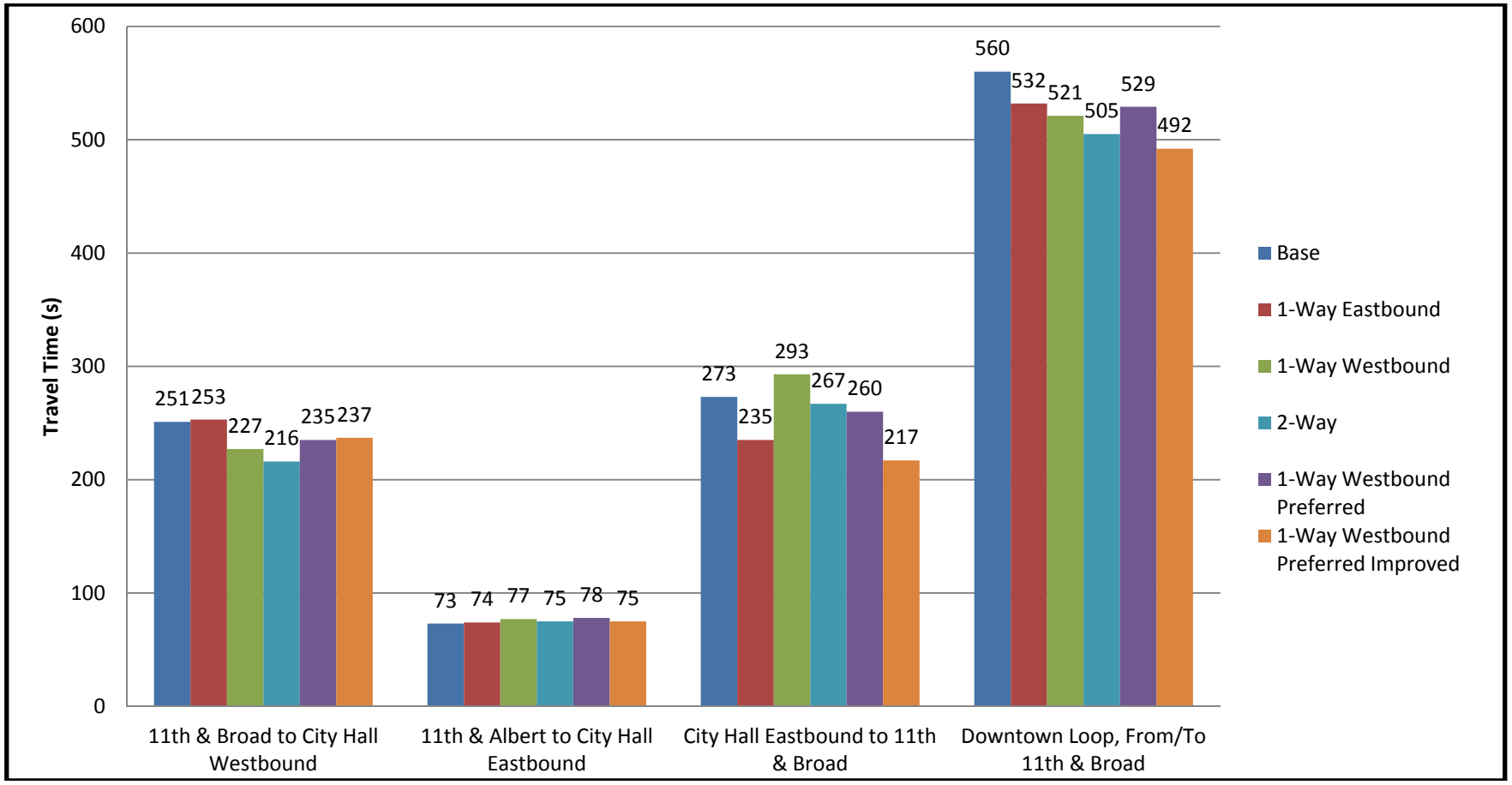


Exhibit 4-8: Transit Travel Times for Selected Routes



Bus travel times are somewhat longer than auto travel times, despite having the advantage of the bus-only lanes on most of 11th Avenue between Albert Street and Broad Street. Routes that require the bus to take an eastbound left turn at 11th Avenue and Broad Street incur large travel times due to the fact that the particular movement suffers a LOS E (~80s delay). The exception is the one-way westbound preferred-improved option, where that same movement only suffers a LOS D (~36s delay).

Between the alternatives, bus travel time does not differ by a significant margin. Based on the longest route measured – the loop around downtown - the two-way option has a 9% travel time improvement compared to the base conditions. Imposing further network improvements with on the preferred design did improve the bus travel times by 27-43 seconds, but only for the routes that use the eastbound left turn at 11th Avenue and Broad Street.

The intended vehicle disruptions at 11th Avenue and Scarth Street, as well as several patches of illegal roadside parking, all contribute to slower travel times for buses.

Additionally, due to the bus schedules, bus arrivals tend to be in large clumps, rather than spread out evenly throughout the simulation hour. Although the chances of it happening is low, buses arriving in large packs consisting of 4 buses or more can cause minor queuing at smaller bus stops.

5. PEDESTRIAN AND CYCLIST OPERATIONS

5.1 Pedestrians

Pedestrian crossings were implemented on every leg of all signalized intersections. Pedestrian crossings were also implemented at the two unsignalized intersections on McIntyre Street, but not for the parkade entrances.

Pedestrian volumes, walking speeds, and crossing locations are identical between all alternatives.

5.2 Cyclists

Cycle paths were not modelled.

Isolated network tests were done on a stand-alone replica of the 12th Avenue at City Square Plaza. Bike lanes parallel to the 12th Avenue traffic made no impact on the adjacent traffic. Bike path crossings across 12th Avenue achieved essentially the same effect as the pedestrian crossings; when necessary, traffic came to a stop at a safe distance to allow cyclists across. Since the model only incorporates a finite number of crossing paths across 12th Avenue at City Square Plaza, and because it was possible to include cyclists in the same paths as pedestrians, explicit cycle paths were not modelled.

All pedestrian movements across the network consist of 94% pedestrian and 6% bicycle composition, a ratio based on the received City of Regina counts.

5.3 Operations and Conflicts

All modelled pedestrian crossings were observed to operate with no major problems. Although total pedestrian volumes were not measured in the model, all observed pedestrians and cyclists cleared the crossings within the appropriate green phases.

Due to pedestrians being given the highest priority within their green phase, no pedestrian delays or problems were observed during the simulation. Vehicles making permitted right turns yielded to pedestrians, and vehicles looking to make permitted left turns waited until sufficient space was cleared in the pedestrian link before making the turn. From the opposing perspective, high pedestrian volumes did not allow the cars to make the left turn despite having no opposite direction through-movement vehicle traffic.

At some intersections, the queue spillback and vehicle blockages resulted in vehicles being stuck fully or partially on pedestrian crossings. As an unintended bi-product of the various priorities set in the network, pedestrians walk straight across and through the blocking vehicles if they have the signal right-of-way. Additionally, once the upstream clears up, those blocking vehicles sometimes proceed through the intersection despite not having the signal right-of-way. In real life, the blocking cars would remain in place until the next green signal with all conflicting pedestrians and vehicles clear, and pedestrians would walk around the blocking vehicles (it is physically impossible to walk through a vehicle).

6. NETWORK IMPROVEMENTS

Following model development and evaluations, critical movements were identified in both Synchro and VISSIM models. For selected few of these movements, the recommended improvements were incorporated into the preferred (one-way westbound preferred) model.

- 11th Avenue at Hamilton Street: westbound left turns in this intersection was found to be blocking the heavy volume of westbound through movements, since they share the same lane. There was no provision of protected phase for the left turn, making it difficult for vehicles to find a sufficient safe gap in the opposing through traffic in order to make the turn. Additionally, the left turning cars yielded to pedestrians, yet another challenge added to the already difficult turn. Thus, the left turn was removed entirely – to be prohibited via signage and enforcement. This left turn should be prohibited in correspondence with the transit lane hours.

- 11th Avenue at Broad Street: eastbound movements were experiencing heavy delays (LOS E or F) for several reasons, such as high volume, limited number of lanes, and lack of protected phasing for left turns. Similar to the case of 11th Avenue at Hamilton Street, left turning vehicles were waiting a long time to find a safe gap, while all the through-movement vehicles had to wait in the same line. In the new signal timing plan, the cycle (120s) is maintained, but a new eastbound left turn protected phase is introduced to relieve the queue more effectively.

- 12th Avenue at Broad Street: the problem is similar with 11th Avenue at Broad Street. Likewise, an EBL protected phase is introduced to the signal timing plan. Additionally, a right turn bay is added for westbound approach.

As a result, delays for the aforementioned movements were reduced significantly. In particular, for 11th Avenue at Broad Street, the EBL and EBT delays were each reduced by about 50%. In the larger picture, this improvement also benefits the bus routes that use those movements.

Overall, the network delay between one-way westbound preferred model and the one-way westbound preferred-improved model are the very similar. The traffic diverted from 11th Avenue at Hamilton Street WBL are distributed to Broad Street southbound, Cornwall Street southbound, and Smith Street southbound, adding some delay to those streets. Changes in signal timing plans that benefit targeted movements also degraded other movements of the same intersection, resulting in a net gain or loss of near zero for the intersection operations.

For transit operations, the eastbound improvement for 11th Avenue at Broad Street is critical. The savings in delay translate directly to savings in travel time. As shown in Exhibit 4-8, the bus travel time improves noticeably for routes that use the eastbound left movement.

7. CONCLUSIONS

Upon the completion of the development and validation of the existing conditions (base) model, three main alternatives were developed: one-way eastbound, one-way westbound, and two-way, each named for the operational scheme of 12th Avenue at City Square Plaza. Additionally, after studies and discussions about streetscape and public safety, the fourth alternative was developed, based on the one-way westbound model, but with additional limitations on traffic movements. Each alternative was modelled in three different modelling platforms: EMME, Synchro, and VISSIM, with the exception of one-way westbound preferred alternative which did not need an EMME model.

Overall, all four alternatives and the base model were found to be operating at LOS B. Individual intersections were found to be operating at LOS A to LOS D, with few individual movements being at overcapacity and LOS E. Although all the models were experiencing low delays on average, some movements still require attention and improvements.

Individual vehicle delay and travel time analyses yielded trends suggesting that the two-way model provided the best operations, but only by a slight margin. All alternatives and the base model performed at similar levels. Majority of vehicles were found to complete their trips within 5 minutes.

Transit travel times were found to be slightly higher than their auto equivalents on the same routes, for the base model and the four alternatives. Illegal car movements were found to be creating minor blockages on bus lanes. All transit routes use at least one turning movement that is shared with cars, and is operating at LOS D or E. Due to the size and speed differences, buses need wider safe gaps for left turns and thus have a harder time compared to cars.

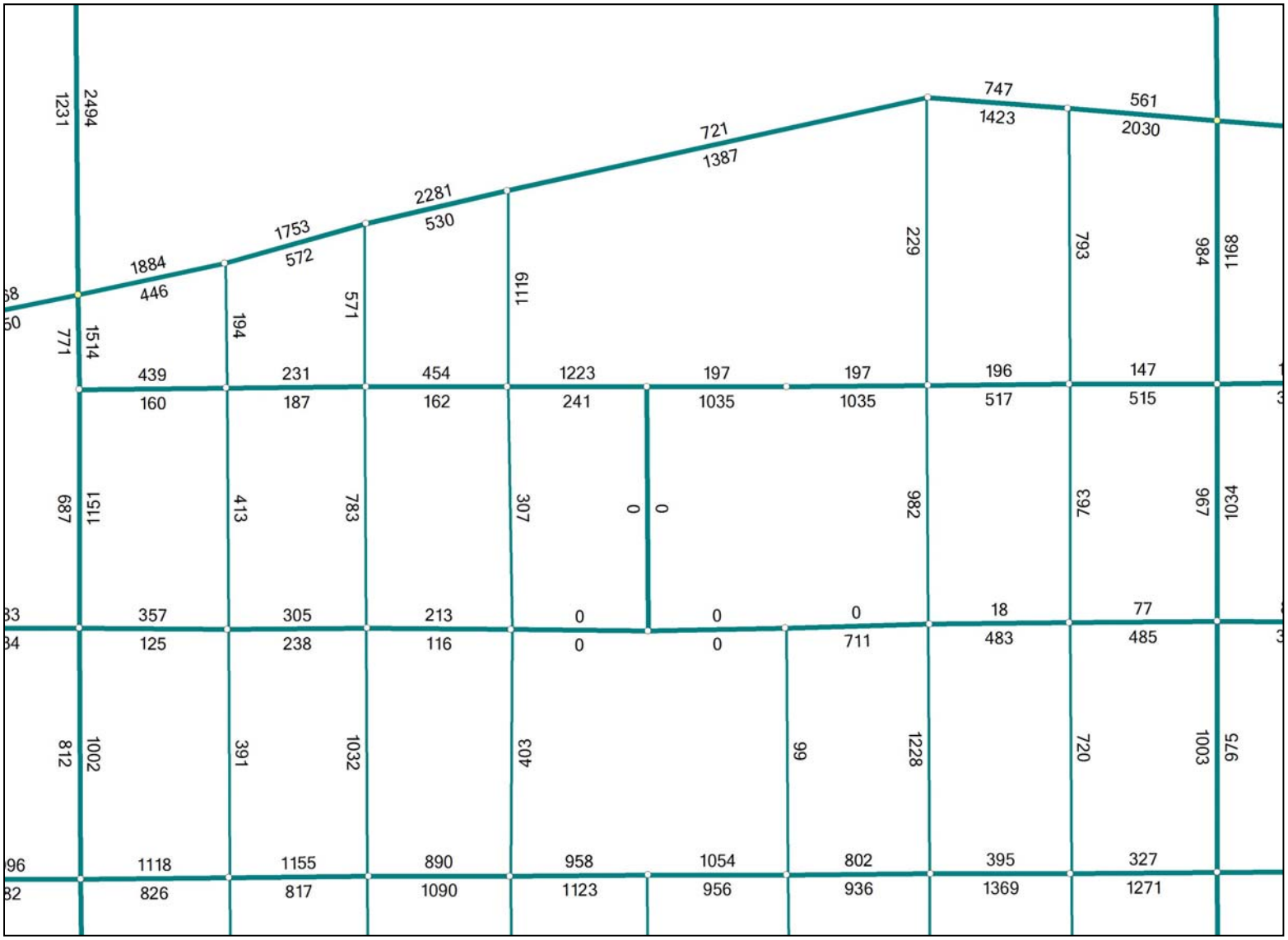
Pedestrians and cyclists were modelled at pedestrian crossings all analyzed intersections within the phase 1 boundary, and also at the City Square Plaza. Those two modes shared the same crossings, and were given highest priority in potential conflict zones with cars and buses. Based on visual observations, modelled pedestrians and cyclists did not experience any delays or crashes (other than the signal delay at signalized intersections).

Network improvements were found to benefit select transit routes, but did not provide a significant reduction in delay or travel time for majority of the vehicles in the network.

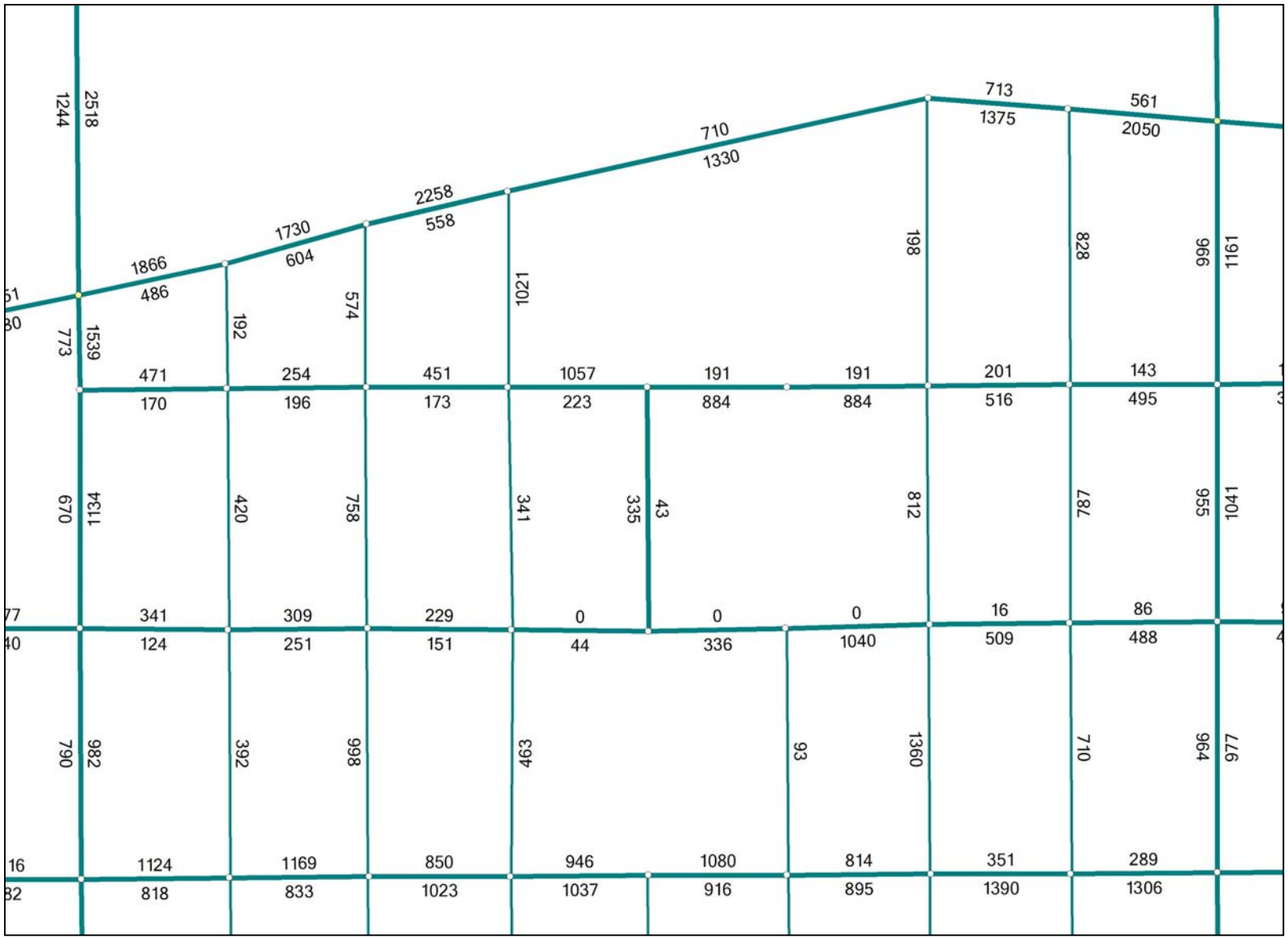
APPENDIX B-1

EMME OUTPUT

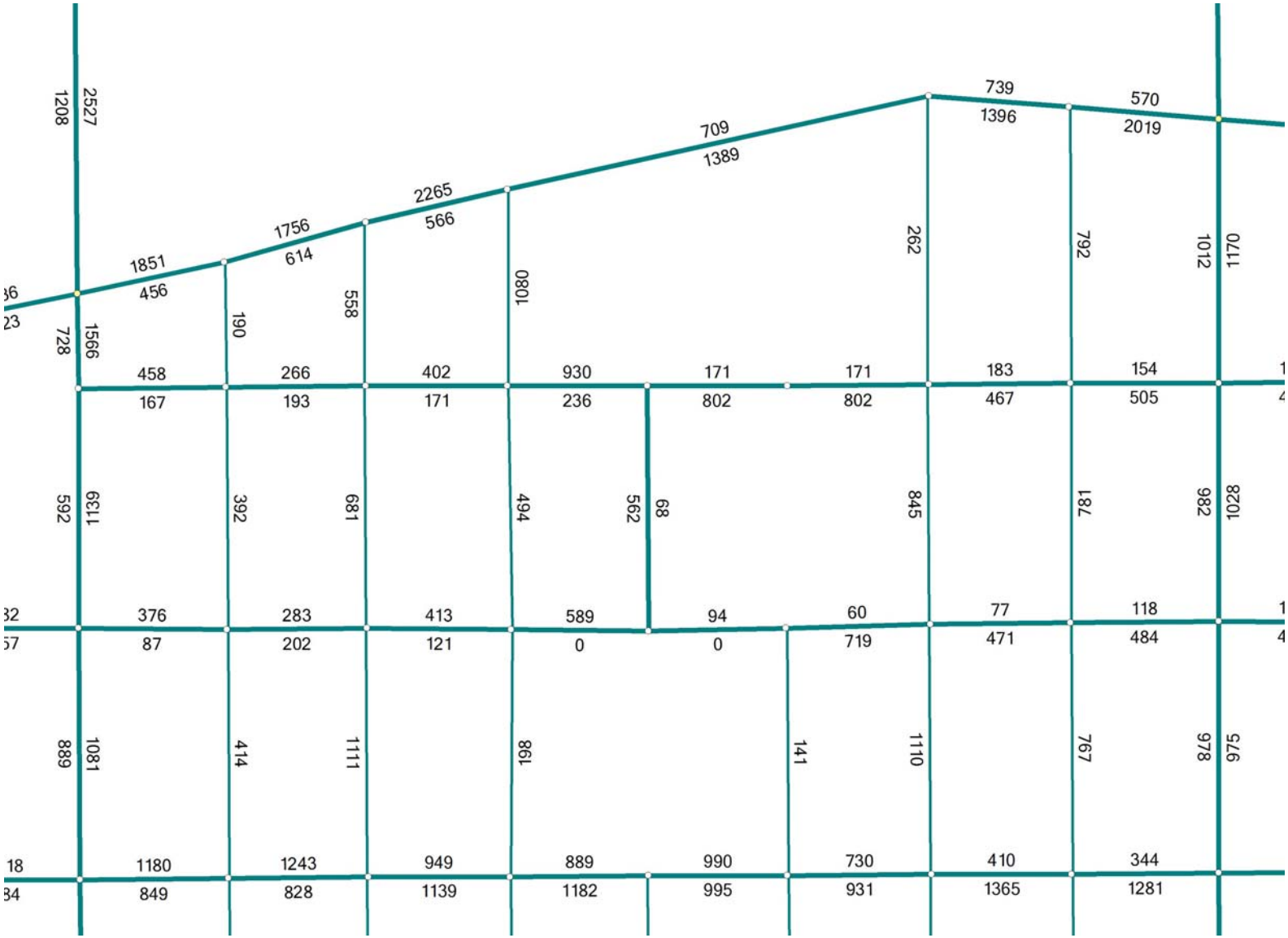
PM Base Closed



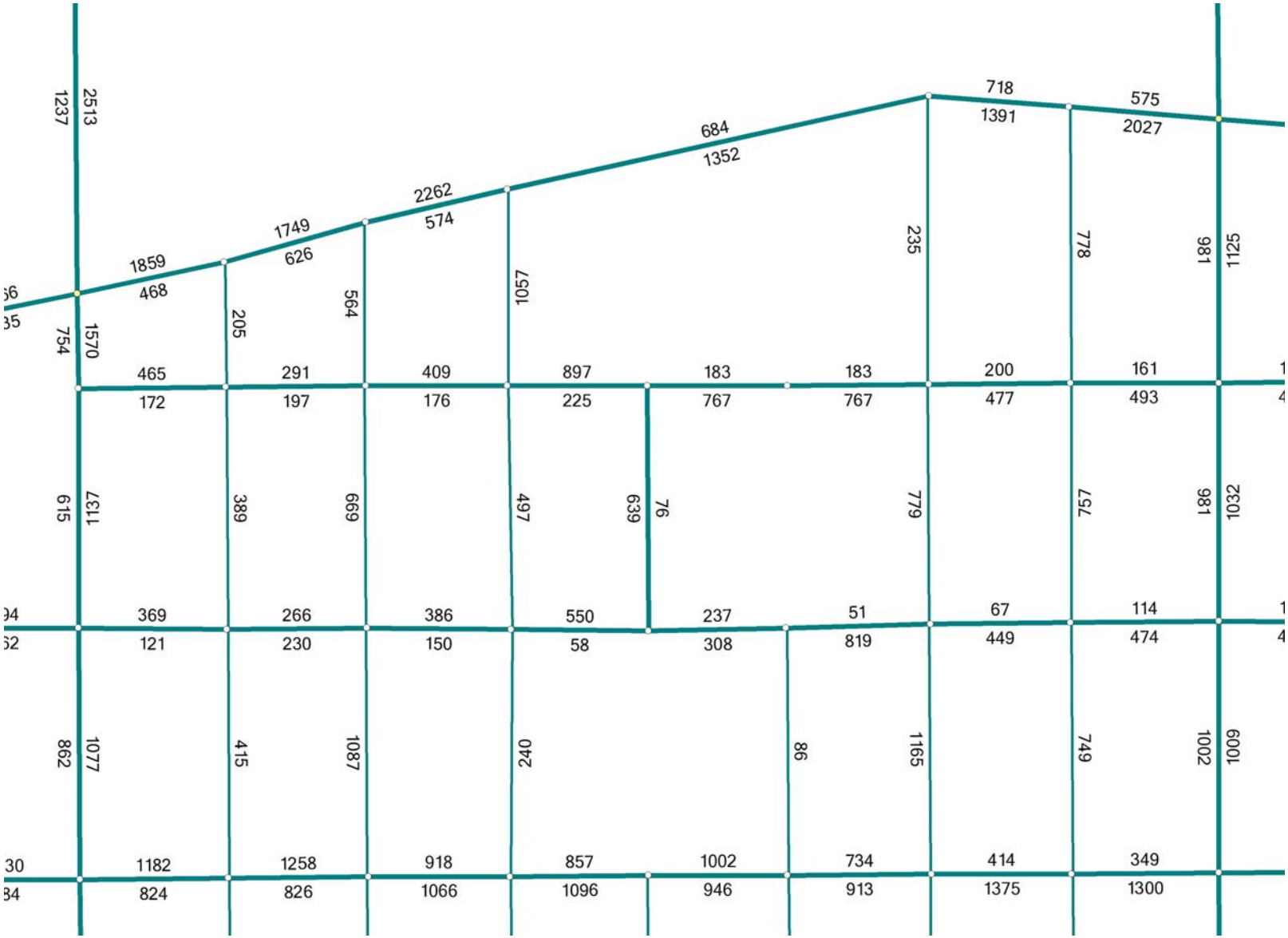
PM One-Way Eastbound



PM One-Way Westbound



PM Two-Way


1237
2513
1859
468
1749
626
2262
574
684
1352
718
1391
575
2027
754
1570
205
564
1057
235
778
981
1125
465
172
291
197
409
176
897
225
183
767
183
767
200
477
161
493
615
1137
389
669
497
639
76
779
757
981
1032
369
121
266
230
386
150
550
58
237
308
51
819
67
449
114
474
862
1077
415
1087
240
86
1165
749
1002
1001
1182
824
1258
826
918
1066
857
1096
1002
946
734
913
414
1375
349
1300

APPENDIX B-2

REFERENCE AND SIMULATED VOLUMES

		Base (Closed)		One-Way EB		One-Way WB		Two-Way		One-Way WB Pref		One-Way WB Pref Imp	
NodeID	Direction	Reference	Simulated	Reference	Simulated	Reference	Simulated	Reference	Simulated	Reference	Simulated	Reference	Simulated
101	EBL												
	EBT												
	EBR												
	WBL	97	92	97	96	87	85	91	91	87	87	87	86
	WBT	69	71	70	73	57	60	65	65	57	61	57	60
	WBR	204	195	204	203	182	184	199	203	188	188	188	185
	NBL	26	28	26	28	25	27	26	30	25	26	25	27
	NBT	1458	1462	1460	1452	1455	1457	1468	1466	1453	1464	1453	1462
	NBR	134	138	128	132	135	138	125	132	135	136	135	135
	SBL												
	SBT	1043	1050	1045	1051	1035	1044	1038	1044	1035	1041	1035	1045
	SBR	23	24	23	24	23	24	23	24	23	24	23	24
102	EBL	9	9	11	10	8	8	10	10	8	8	8	7
	EBT	125	129	117	122	127	130	115	122	127	128	127	127
	EBR												
	WBL												
	WBT	345	334	346	346	293	296	326	329	299	303	299	299
	WBR	175	179	175	176	162	167	162	166	160	168	160	162
	NBL	25	23	25	25	33	33	29	28	33	32	33	32
	NBT	191	201	191	204	190	204	197	207	190	199	190	196
	NBR	95	93	95	91	98	96	95	90	98	99	98	96
	SBL												
	SBT												
	SBR												
103	EBL												
	EBT	188	192	170	176	194	197	178	181	194	200	194	196
	EBR	32	31	42	38	31	29	32	31	31	29	31	27
	WBL	134	145	127	118	102	112	102	115	108	114	108	112
	WBT	486	478	487	490	421	430	433	440	425	437	425	428
	WBR												
	NBL												
	NBT												
	NBR												
	SBL	51	51	51	52	47	48	49	51	47	53	47	51
	SBT	332	322	339	331	332	324	322	311	332	329	332	331
	SBR	34	35	34	33	34	34	55	56	34	35	34	34
104	EBL	46	47	46	48	48	51	48	47	48	50	48	50
	EBT	193	196	175	180	193	195	179	184	193	203	193	196
	EBR												
	WBL												
	WBT	533	536	527	524	437	457	437	459	447	463	447	456
	WBR	238	234	237	220	178	177	198	192	215	211	215	210
	NBL	87	87	87	83	86	85	98	95	86	88	86	84
	NBT	387	364	387	377	409	413	375	385	409	414	409	408
	NBR	201	206	148	151	197	205	148	157	197	198	197	195
	SBL												

	SBT												
	SBR												
105	EBL												
	EBT	353	366	292	299	356	363	290	304	356	366	356	361
	EBR	41	36	31	31	34	36	37	37	34	34	34	30
	WBL	27	26	28	24	27	26	28	29	27	29	37	38
	WBT	583	586	587	571	494	515	501	518	541	554	541	549
	WBR												
	NBL	188	187	177	172	121	117	134	132	121	121	121	118
	NBT												
	NBR	127	124	84	83	126	127	92	93	126	127	126	127
	SBL												
	SBT												
	SBR												
106	EBL												
	EBT	480	491	376	384	482	491	382	396	482	492	482	488
	EBR												
	WBL												
	WBT	610	613	615	597	521	542	529	545	568	585	578	586
	WBR												
	NBL												
	NBT												
	NBR												
	SBL												
	SBT												
	SBR												
107	EBL												
	EBT	314	327	267	272	316	326	263	270	316	324	316	319
	EBR	166	164	109	111	166	164	119	125	166	169	166	169
	WBL	77	73	77	70	70	65	71	65	71	73		
	WBT	433	432	433	426	368	387	394	407	407	419	427	435
	WBR												
	NBL												
	NBT												
	NBR												
	SBL	97	99	97	103	93	98	96	100	93	101	93	96
	SBT	351	357	341	347	377	387	364	374	357	365	389	388
	SBR	177	183	182	173	153	156	135	138	161	166	151	152
108	EBL	68	67	57	57	67	69	63	60	67	69	67	67
	EBT	343	357	307	316	342	356	296	311	342	356	342	348
	EBR												
	WBL												
	WBT	387	390	387	376	350	359	362	366	370	379	333	340
	WBR	72	66	72	67	65	63	71	71	65	64	65	62
	NBL	123	121	123	126	88	93	103	109	108	113	94	96
	NBT	375	361	378	372	370	366	377	364	370	372	370	370
	NBR	92	95	95	96	92	90	89	90	92	95	92	95
	SBL												
	SBT												
	SBR												

109	EBL	71	71	64	64	71	73	65	66	71	75	71	73
	EBT	138	131	132	122	139	140	135	125	139	143	139	136
	EBR	193	197	185	188	194	198	185	184	194	195	194	198
	WBL	68	70	68	67	68	69	68	69	68	70	68	66
	WBT	93	93	93	92	93	91	93	91	93	91	93	93
	WBR	161	159	161	158	161	160	161	159	161	160	161	160
	NBL	139	147	139	145	138	140	140	143	138	142	138	141
	NBT	1391	1383	1391	1386	1390	1382	1385	1397	1390	1383	1390	1380
	NBR	62	65	62	64	61	67	64	69	61	67	61	67
	SBL	108	108	108	109	108	109	109	109	108	109	108	108
	SBT	1024	1027	1024	1022	1028	1033	1026	1031	1028	1032	1028	1039
	SBR	138	149	138	144	142	149	139	148	142	152	142	147
201	EBL	102	99	102	99	102	99	102	102	102	102	102	100
	EBT	105	107	105	107	105	107	105	110	105	106	105	106
	EBR	98	97	98	97	98	96	108	100	98	98	98	98
	WBL	105	104	105	107	110	110	118	115	108	109	108	108
	WBT	74	69	74	68	88	82	88	77	82	79	82	76
	WBR	201	203	201	202	206	208	215	219	204	208	204	204
	NBL	31	31	31	34	31	34	31	34	31	34	31	34
	NBT	1255	1267	1261	1264	1250	1251	1265	1262	1250	1259	1250	1254
	NBR	154	163	159	169	144	156	144	155	144	151	144	149
	SBL	170	154	172	166	163	155	170	156	163	160	163	160
	SBT	947	964	947	957	938	947	936	956	938	943	938	944
	SBR	23	23	23	23	22	23	23	21	22	23	22	22
202	EBL	75	73	75	76	75	74	75	72	75	72	75	73
	EBT	305	306	325	320	305	318	305	320	305	317	305	309
	EBR												
	WBL												
	WBT	233	234	233	232	284	279	290	282	251	257	251	253
	WBR	45	49	45	47	53	57	57	57	53	56	53	54
	NBL	104	102	104	102	104	103	104	102	104	102	104	101
	NBT	171	175	171	175	171	177	169	175	171	176	171	176
	NBR	85	86	85	86	85	84	85	84	85	85	85	85
	SBL												
	SBT												
	SBR												
203	EBL												
	EBT	248	258	268	270	248	262	258	268	248	260	248	258
	EBR	142	133	142	135	142	140	132	137	142	142	142	136
	WBL	60	60	60	61	145	146	112	127	112	120	112	118
	WBT	137	140	137	141	235	231	241	229	202	208	202	203
	WBR												
	NBL												
	NBT												
	NBR												
	SBL	34	34	34	32	30	29	51	53	30	29	30	28
	SBT	353	353	363	350	353	345	339	329	363	359	363	359
	SBR	141	144	141	137	102	105	106	110	102	105	102	105
204	EBL	282	294	204	209	278	285	207	214	278	284	278	282
	EBT			98	91			102	104				

	EBR												
	WBL												
	WBT					211	206	184	183	125	136	125	128
	WBR					55	56	70	78	9	10	9	8
	NBL	197	200	197	202	169	173	169	173	189	194	189	194
	NBT	377	359	382	381	350	354	338	338	350	355	350	355
	NBR			63	64			63	66				
	SBL												
	SBT												
	SBR												
205	EBL			53	52			43	43				
	EBT			108	104			122	129				
	EBR												
	WBL												
	WBT					132	130	153	155				
	WBR					73	71	54	56	85	90	85	85
	NBL												
	NBT												
	NBR												
	SBL			83	80			56	52				
	SBT												
	SBR					134	132	101	106	134	146	134	136
206	EBL												
	EBT			191	185			178	181				
	EBR												
	WBL												
	WBT					162	154	149	149	43	47	43	42
	WBR												
	NBL					43	47	58	61	42	43	42	43
	NBT												
	NBR	159	163	139	140	163	165	161	162	163	167	163	167
	SBL												
	SBT												
	SBR												
207	EBL												
	EBT	157	162	242	239	161	162	250	255	161	166	161	166
	EBR	2	2	88	86	2	2	89	87	2	2	2	2
	WBL	109	111	109	110	99	107	97	105	110	117	125	128
	WBT	4	4	4	4	115	108	93	95	24	24	24	22
	WBR												
	NBL												
	NBT												
	NBR												
	SBL	139	141	139	139	123	134	118	126	123	128	123	122
	SBT	449	443	382	379	441	430	375	379	445	448	406	407
	SBR	6	5	6	6	49	48	61	57	26	28	26	25
208	EBL	68	64	84	83	62	60	78	75	62	62	62	62
	EBT	228	238	297	295	222	236	290	304	222	232	222	225
	EBR												
	WBL												

	WBT	113	116	113	114	151	155	132	142	121	128	136	136
	WBR	57	58	57	54	54	53	57	51	54	53	54	52
	NBL					63	61	58	58	13	14	13	14
	NBT	414	411	414	420	414	407	404	410	414	421	406	408
	NBR	234	231	218	218	233	233	186	188	233	238	233	236
	SBL												
	SBT												
	SBR												
209	EBL	153	163	152	157	152	164	146	160	152	163	152	155
	EBT	192	195	196	203	191	192	195	206	191	194	191	189
	EBR	117	119	157	164	117	121	128	131	117	121	117	118
	WBL	63	70	63	66	63	66	63	67	63	67	63	65
	WBT	39	34	50	49	79	77	69	72	59	60	59	59
	WBR	112	114	112	112	112	115	112	108	112	115	112	112
	NBL	53	57	53	58	53	59	53	53	53	57	53	58
	NBT	1327	1335	1327	1332	1325	1325	1331	1347	1325	1330	1325	1335
	NBR	74	76	74	75	76	78	74	74	76	79	76	80
	SBL	101	97	99	95	101	97	101	95	101	101	101	101
	SBT	1173	1178	1168	1172	1166	1181	1177	1178	1166	1170	1166	1184
	SBR	35	37	35	36	47	46	35	37	47	49	47	52
		27863	27971	28168	28111	28320	28621	28598	28961	27897	28374	27820	28023

APPENDIX B-3

VISSIM OUTPUT – INTERSECTION OPERATIONS

Node #	Intersection
101	11th Avenue & Albert Street
102	11th Avenue & Mcintyre Street
103	11th Avenue & Smith Street
104	11th Avenue & Lorne Street
105	11th Avenue & Cornwall Street
106	11th Avenue & Scarth Street
107	11th Avenue & Hamilton Street
108	11th Avenue & Rose Street
109	11th Avenue & Broad Street
201	12th Avenue & Albert Street
202	12th Avenue & Mcintyre Street
203	12th Avenue & Smith Street
204	12th Avenue & Lorne Street
205	12th Avenue & Cornwall Street
206	12th Avenue & Scarth Street
207	12th Avenue & Hamilton Street
208	12th Avenue & Rose Street
209	12th Avenue & Broad Street
801	Parkade on Cornwall Street
802	Parkade on Rose Street
901	City Square Plaza west of Cornwall Street
902	City Square Plaza east of Cornwall Street

Delays for Mixed Traffic Movements

VISSIM			Delay						LOS					
Intersection	Movement	Type	Base	1-EB	1-WB	2-W	1-WBP	1-WBPI	Base	1-EB	1-WB	2-W	1-WBP	1-WBPI
Total	All	Veh	20	19	17	16	17	17	B	B	B	B	B	B
101	All	Veh	14	15	14	15	14	14	B	B	B	B	B	B
101	NBL	Veh	25	23	22	25	22	23	C	C	C	C	C	C
101	NBR	Veh	16	18	17	21	17	17	B	B	B	C	B	B
101	NBT	Veh	0	0	14	20	12	16	A	A	B	B	B	B
101	NBT	Veh	16	15	15	17	15	14	B	B	B	B	B	B
101	SBR	Veh	11	9	9	9	9	9	B	A	A	A	A	A
101	SBT	Veh	10	10	10	10	10	10	B	B	A	B	B	B
101	WBL	Mix	40	39	39	39	37	37	D	D	D	D	D	D
101	WBR	Mix	9	9	10	9	9	8	A	A	A	A	A	A
101	WBT	Mix	34	36	36	35	35	36	C	D	D	D	C	D
102	All	Veh	7	7	7	7	7	7	A	A	A	A	A	A
102	EBL	Mix	3	5	3	3	4	4	A	A	A	A	A	A
102	EBT	Mix	1	2	1	1	2	2	A	A	A	A	A	A
102	EBT	Mix	5	5	4	5	5	5	A	A	A	A	A	A
102	NBL	Veh	15	17	15	16	15	15	B	B	B	B	B	B

102	NBR	Veh	15	16	16	15	15	15	B	B	B	B	B	B
102	NBT	Veh	17	17	16	15	16	16	B	B	B	B	B	B
102	WBR	Mix	3	3	3	3	3	3	A	A	A	A	A	A
102	WBT	Mix	2	2	2	2	2	2	A	A	A	A	A	A
103	All	Veh	12	12	12	12	12	12	B	B	B	B	B	B
103	EBR	Bus	8	9	9	9	9	11	A	A	A	A	A	B
103	EBT	Bus	24	23	23	23	19	22	C	C	C	C	B	C
103	EBT	Veh	8	8	9	8	9	9	A	A	A	A	A	A
103	SBL	Veh	17	18	17	17	17	17	B	B	B	B	B	B
103	SBR	Veh	16	17	15	16	16	16	B	B	B	B	B	B
103	SBT	Veh	16	15	15	15	15	16	B	B	B	B	B	B
103	WBL	Veh	13	11	10	9	11	11	B	B	B	A	B	B
103	WBT	Veh	11	10	10	10	11	10	B	A	A	A	B	B
103	WBT	Bus	0	0	0	0	0	0	A	A	A	A	A	A
104	All	Veh	22	23	22	22	22	21	C	C	C	C	C	C
104	EBL	Mix	26	20	16	18	16	16	C	C	B	B	B	B
104	EBT	Mix	17	14	13	13	12	12	B	B	B	B	B	B
104	EBT	Mix	7	8	7	7	9	7	A	A	A	A	A	A
104	NBL	Veh	23	24	29	28	28	27	C	C	C	C	C	C
104	NBR	Veh	14	10	19	16	16	14	B	A	B	B	B	B
104	NBR	Veh	15	15	19	17	18	17	B	B	B	B	B	B
104	NBT	Veh	19	19	23	21	21	21	B	B	C	C	C	C
104	WBR	Mix	26	29	24	25	25	24	C	C	C	C	C	C
104	WBT	Mix	32	40	33	35	36	35	C	D	C	C	D	C
104	WBT	Mix	27	29	25	26	27	26	C	C	C	C	C	C
105	All	Veh	37	35	22	21	25	24	D	C	C	C	C	C
105	EBR	Bus	13	14	13	12	12	13	B	B	B	B	B	B
105	EBT	Veh	13	12	11	11	11	11	B	B	B	B	B	B
105	EBT	Bus	12	11	14	14	14	13	B	B	B	B	B	B
105	NBL	Veh	67	45	37	29	40	33	E	D	D	C	D	C
105	NBR	Veh	59	38	31	25	32	29	E	D	C	C	C	C
105	WBL	Mix	36	43	26	24	30	30	D	D	C	C	C	C
105	WBT	Mix	41	45	23	24	30	30	D	D	C	C	C	C
106	All	Veh	29	32	18	16	21	19	C	C	B	B	C	B
106	EBT	Mix	12	11	13	11	13	12	B	B	B	B	B	B
106	EBT	Mix	25	24	22	22	23	22	C	C	C	C	C	C
106	WBT	Veh	42	47	21	19	27	24	D	D	C	B	C	C
106	WBT	Mix	29	29	21	20	22	21	C	C	C	B	C	C
107	All	Veh	30	32	16	14	19	15	C	C	B	B	B	B
107	EBR	Bus	8	7	8	7	9	7	A	A	A	A	A	A
107	EBT	Veh	11	12	14	12	14	11	B	B	B	B	B	B
107	EBT	Bus	12	13	13	13	15	15	B	B	B	B	B	B
107	SBL	Veh	22	25	16	14	19	15	C	C	B	B	B	B
107	SBR	Veh	70	72	13	12	24	25	E	E	B	B	C	C
107	SBT	Veh	25	24	14	12	15	14	C	C	B	B	B	B
107	WBL	Veh	39	40	23	20	26	27	D	D	C	C	C	C
107	WBT	Bus	26	28	27	28	29	18	C	C	C	C	C	B
107	WBT	Veh	42	41	21	18	26	0	D	D	C	B	C	0
108	All	Veh	29	26	18	16	21	14	C	C	B	B	C	B
108	EBL	Mix	30	26	26	21	28	18	C	C	C	C	C	B

108	EBT	Mix	22	22	25	20	26	17	C	C	C	C	C	B
108	NBL	Veh	50	28	18	17	20	16	D	C	B	B	C	B
108	NBR	Veh	22	16	16	16	16	14	C	B	B	B	B	B
108	NBT	Veh	20	14	13	13	14	12	B	B	B	B	B	B
108	WBR	Mix	25	25	16	14	18	13	C	C	B	B	B	B
108	WBT	Mix	42	46	14	13	23	13	D	D	B	B	C	B
108	WBT	Mix	24	27	14	14	17	14	C	C	B	B	B	B
109	All	Veh	23	21	21	19	21	23	C	C	C	B	C	C
109	EBL	Mix	83	70	76	67	75	36	F	E	E	E	E	D
109	EBR	Mix	16	11	12	10	10	10	B	B	B	B	B	B
109	EBT	Mix	77	64	69	62	69	33	E	E	E	E	E	C
109	NBL	Veh	37	41	31	32	32	38	D	D	C	C	C	D
109	NBR	Veh	23	22	26	22	23	33	C	C	C	C	C	C
109	NBT	Veh	15	14	15	13	15	21	B	B	B	B	B	C
109	SBL	Veh	24	27	25	26	26	27	C	C	C	C	C	C
109	SBR	Veh	22	22	18	17	18	23	C	C	B	B	B	C
109	SBT	Veh	18	18	16	16	16	20	B	B	B	B	B	C
109	WBL	Veh	61	56	52	53	54	43	E	E	D	D	D	D
109	WBR	Veh	7	7	7	7	7	19	A	A	A	A	A	B
109	WBT	Veh	60	57	50	51	52	38	E	E	D	D	D	D
201	All	Veh	21	21	23	24	23	23	C	C	C	C	C	C
201	EBL	Veh	49	48	51	51	53	56	D	D	D	D	D	E
201	EBR	Veh	11	11	13	13	13	13	B	B	B	B	B	B
201	EBT	Veh	49	50	51	49	52	54	D	D	D	D	D	D
201	EBT	Veh	0	0	0	0	0	0	A	A	A	A	A	A
201	NBL	Veh	21	20	20	21	20	20	C	C	C	C	C	B
201	NBR	Veh	14	15	14	14	14	16	B	B	B	B	B	B
201	NBT	Veh	17	18	17	17	17	17	B	B	B	B	B	B
201	SBL	Veh	33	33	32	33	33	35	C	C	C	C	C	C
201	SBR	Veh	14	13	12	13	12	13	B	B	B	B	B	B
201	SBT	Veh	13	12	13	14	13	12	B	B	B	B	B	B
201	WBL	Mix	69	63	76	85	79	79	E	E	E	F	E	E
201	WBR	Mix	20	17	28	37	29	29	B	B	C	D	C	C
201	WBT	Mix	64	58	74	84	74	76	E	E	E	F	E	E
202	All	Veh	7	7	8	10	9	9	A	A	A	B	A	A
202	EBL	Mix	3	3	4	4	4	4	A	A	A	A	A	A
202	EBT	Mix	2	2	2	2	2	2	A	A	A	A	A	A
202	NBL	Veh	13	15	16	22	18	18	B	B	B	C	B	B
202	NBR	Veh	10	12	13	15	15	13	B	B	B	B	B	B
202	NBT	Veh	15	16	17	18	19	17	B	B	B	B	B	B
202	WBR	Mix	3	3	5	7	4	4	A	A	A	A	A	A
202	WBT	Mix	6	5	7	11	7	8	A	A	A	B	A	A
203	All	Veh	14	13	16	15	15	14	B	B	B	B	B	B
203	EBR	Mix	12	11	15	13	13	13	B	B	B	B	B	B
203	EBT	Mix	16	14	20	17	17	16	B	B	B	B	B	B
203	SBL	Veh	18	18	18	19	18	18	B	B	B	B	B	B
203	SBR	Veh	17	18	17	17	17	17	B	B	B	B	B	B
203	SBT	Veh	15	16	16	16	16	16	B	B	B	B	B	B
203	WBL	Mix	14	9	18	18	14	14	B	A	B	B	B	B
203	WBT	Mix	9	4	10	10	8	8	A	A	B	A	A	A

204	All	Veh	17	16	25	21	18	18	B	B	C	C	B	B
204	EBL	Mix	20	15	56	39	27	26	B	B	E	D	C	C
204	EBT	Mix	0	15	0	37	0	0	0	B	0	D	0	0
204	NBL	Veh	10	20	18	18	18	18	B	B	B	B	B	B
204	NBR	Veh	0	17	0	16	0	0	0	B	0	B	0	0
204	NBT	Veh	18	15	14	14	14	14	B	B	B	B	B	B
204	WBR	Veh	0	0	11	11	10	13	0	0	B	B	B	B
204	WBT	Veh	0	0	9	9	10	10	0	0	A	A	A	A
205	All	Veh	0	6	6	6	6	6	A	A	A	A	A	A
205	EBL	Veh	0	4	0	6	0	0	0	A	0	A	0	0
205	EBT	Veh	0	3	0	4	0	0	0	A	0	A	0	0
205	SBL	Veh	0	10	0	15	0	0	0	A	0	B	0	0
205	SBR	Veh	0	0	9	12	8	7	0	0	A	B	A	A
205	WBR	Veh	0	0	3	3	3	3	0	0	A	A	A	A
205	WBT	Veh	0	0	3	3	0	0	0	0	A	A	0	0
206	All	Veh	8	12	5	5	7	7	A	B	A	A	A	A
206	EBT	Veh	0	9	0	2	0	0	0	A	0	A	0	0
206	NBL	Veh	0	0	7	8	6	6	0	0	A	A	A	A
206	NBR	Veh	8	17	8	9	8	8	A	B	A	A	A	A
206	WBT	Veh	0	0	2	2	2	2	0	0	A	A	A	A
207	All	Veh	14	14	14	14	14	14	B	B	B	B	B	B
207	EBR	Veh	6	11	9	11	10	10	A	B	A	B	A	A
207	EBT	Veh	10	12	9	11	9	9	A	B	A	B	A	A
207	SBL	Veh	18	18	19	19	19	18	B	B	B	B	B	B
207	SBR	Veh	17	17	18	18	18	17	B	B	B	B	B	B
207	SBT	Veh	17	16	17	17	17	17	B	B	B	B	B	B
207	WBL	Veh	6	8	9	11	8	8	A	A	A	B	A	A
207	WBT	Veh	3	4	8	8	6	6	A	A	A	A	A	A
208	All	Veh	17	13	14	13	14	14	B	B	B	B	B	B
208	EBL	Veh	8	7	6	8	7	6	A	A	A	A	A	A
208	EBT	Veh	9	9	9	8	9	9	A	A	A	A	A	A
208	NBL	Veh	0	0	16	17	17	16	A	A	B	B	B	B
208	NBR	Veh	24	19	20	19	21	20	C	B	C	B	C	C
208	NBT	Veh	22	16	17	16	16	16	C	B	B	B	B	B
208	WBR	Veh	12	9	11	10	10	10	B	A	B	B	A	B
208	WBT	Veh	8	9	9	8	9	9	A	A	A	A	A	A
209	All	Veh	20	19	19	19	20	24	C	B	B	B	B	C
209	EBL	Veh	39	41	41	41	40	33	D	D	D	D	D	C
209	EBR	Veh	25	24	23	24	23	22	C	C	C	C	C	C
209	EBT	Veh	34	35	35	34	34	31	C	D	D	C	C	C
209	NBL	Veh	27	29	31	31	29	39	C	C	C	C	C	D
209	NBR	Veh	13	12	13	12	13	24	B	B	B	B	B	C
209	NBT	Veh	15	15	15	15	15	26	B	B	B	B	B	C
209	SBL	Veh	58	47	44	44	48	31	E	D	D	D	D	C
209	SBR	Veh	14	11	11	9	12	16	B	B	B	A	B	B
209	SBT	Veh	14	11	11	10	12	18	B	B	B	A	B	B
209	WBL	Veh	46	45	52	52	48	40	D	D	D	D	D	D
209	WBR	Veh	32	31	36	38	35	12	C	C	D	D	D	B
209	WBT	Veh	43	44	48	47	45	42	D	D	D	D	D	D
801	All	Veh	16	11	11	9	11	10	B	B	B	A	B	A

801	NBR	Veh	0	0	2	1	0	0	0	A	A	A	A	A
801	NBT	Veh	0	1	6	2	2	1	0	A	A	A	A	A
801	SBL	Veh	1	1	1	1	1	1	A	A	A	A	A	A
801	SBT	Veh	0	1	2	2	2	2	0	A	A	A	A	A
801	WBL	Veh	0	13	13	13	14	14	0	B	B	B	B	B
801	WBR	Veh	19	14	14	13	15	13	B	B	B	B	B	B
802	All	Veh	5	1	0	1	1	1	A	A	A	A	A	A
802	EBL	Veh	8	1	1	1	1	1	A	A	A	A	A	A
802	NBL	Veh	0	1	0	1	0	0	A	A	A	A	A	A
802	NBR	Veh	0	0	0	0	0	0	A	A	A	A	A	A
802	NBT	Veh	4	1	0	1	1	1	A	A	A	A	A	A
802	WBR	Veh	0	0	0	0	0	0	A	A	A	A	A	A
901	All	Veh	0	3	5	4	2	2	A	A	A	A	A	A
901	EBT	Veh	0	3	0	3	0	0	0	A	0	A	0	0
901	WBT	Veh	0	0	5	5	2	2	0	0	A	A	A	A
902	All	Veh	0	5	5	5	3	3	A	A	A	A	A	A
902	EBT	Veh	0	5	0	4	0	0	0	A	0	A	0	0
902	WBT	Veh	0	0	5	5	3	3	0	0	A	A	A	A

Queues for Mixed Traffic Movements

VISSIM			Queue					
Intersection	Movement	Type	Base	1-EB	1-WB	2-W	1-WBP	1-WBPI
Total	All	Veh	13	11	9	9	10	9
101	All	Veh	10	10	10	11	10	9
101	NBL	Veh	1	1	1	1	1	1
101	NBR	Veh	23	22	21	25	22	21
101	NBT	Veh	1	1	1	1	1	1
101	NBT	Veh	27	26	25	29	26	25
101	SBR	Veh	3	3	3	3	3	3
101	SBT	Veh	7	7	7	7	7	7
101	WBL	Mix	11	12	10	10	9	9
101	WBR	Mix	11	12	10	10	9	9
101	WBT	Mix	11	12	10	10	9	9
102	All	Veh	2	2	2	2	2	2
102	EBL	Mix	0	0	0	0	0	0
102	EBT	Mix	0	0	0	0	0	0
102	EBT	Mix	0	0	0	0	0	0
102	NBL	Veh	5	5	5	5	5	5
102	NBR	Veh	5	5	5	5	5	5
102	NBT	Veh	5	5	5	5	5	5
102	WBR	Mix	0	0	0	0	0	0
102	WBT	Mix	0	0	0	0	0	0
103	All	Veh	5	4	4	4	4	4
103	EBR	Bus	1	1	1	1	1	1
103	EBT	Bus	1	1	1	1	1	1
103	EBT	Veh	2	2	2	2	2	2
103	SBL	Veh	6	6	6	6	6	6

103	SBR	Veh	6	6	6	6	6	6
103	SBT	Veh	6	6	6	6	6	6
103	WBL	Veh	11	8	8	8	9	8
103	WBT	Veh	11	8	8	8	9	8
103	WBT	Bus	0	0	0	0	0	0
104	All	Veh	22	22	20	19	21	20
104	EBL	Mix	6	5	4	4	4	4
104	EBT	Mix	6	5	4	4	4	4
104	EBT	Mix	6	5	4	4	4	4
104	NBL	Veh	12	12	18	15	17	15
104	NBR	Veh	9	9	14	12	13	12
104	NBR	Veh	9	9	14	12	13	12
104	NBT	Veh	12	12	18	15	17	15
104	WBR	Mix	53	56	41	43	46	44
104	WBT	Mix	53	56	41	43	46	44
104	WBT	Mix	53	56	41	43	46	44
105	All	Veh	28	23	13	11	17	16
105	EBR	Bus	3	2	2	2	2	2
105	EBT	Veh	6	4	5	4	5	5
105	EBT	Bus	3	2	2	2	2	2
105	NBL	Veh	45	22	16	10	18	14
105	NBR	Veh	45	22	16	10	18	14
105	WBL	Mix	47	56	26	26	36	35
105	WBT	Mix	47	56	26	26	36	35
106	All	Veh	22	22	12	9	15	14
106	EBT	Mix	14	9	14	10	13	13
106	EBT	Mix	14	9	14	10	13	13
106	WBT	Veh	52	55	16	13	26	22
106	WBT	Mix	11	14	4	3	6	7
107	All	Veh	22	23	8	6	11	8
107	EBR	Bus	4	3	4	3	5	1
107	EBT	Veh	5	4	6	4	7	4
107	EBT	Bus	3	2	4	3	5	2
107	SBL	Veh	37	37	8	7	12	15
107	SBR	Veh	32	33	5	4	8	12
107	SBT	Veh	37	37	8	7	12	15
107	WBL	Veh	40	41	15	13	21	7
107	WBT	Bus	6	6	6	6	6	10
107	WBT	Veh	40	41	15	13	21	0
108	All	Veh	18	18	10	9	13	8
108	EBL	Mix	14	17	20	14	21	14
108	EBT	Mix	14	17	20	14	21	14
108	NBL	Veh	17	10	7	8	8	7
108	NBR	Veh	17	10	7	8	8	7
108	NBT	Veh	17	10	7	8	8	7
108	WBR	Mix	23	26	7	7	12	6
108	WBT	Mix	23	26	7	7	12	6
108	WBT	Mix	23	26	7	7	12	6
109	All	Veh	21	18	19	16	18	15
109	EBL	Mix	35	27	33	25	32	11

109	EBR	Mix	35	27	33	25	32	1
109	EBT	Mix	35	27	33	25	32	11
109	NBL	Veh	16	14	12	11	12	23
109	NBR	Veh	20	17	18	14	18	27
109	NBT	Veh	22	19	20	17	20	29
109	SBL	Veh	3	3	3	3	3	4
109	SBR	Veh	19	20	16	15	16	20
109	SBT	Veh	22	24	19	19	19	24
109	WBL	Veh	17	16	14	15	15	11
109	WBR	Veh	10	9	8	8	8	5
109	WBT	Veh	17	16	14	15	15	11
201	All	Veh	12	11	13	15	14	14
201	EBL	Veh	18	18	20	20	20	21
201	EBR	Veh	1	1	1	1	1	0
201	EBT	Veh	18	18	20	20	20	21
201	EBT	Veh	1	1	1	1	1	0
201	NBL	Veh	1	1	1	1	1	1
201	NBR	Veh	9	10	9	9	9	9
201	NBT	Veh	16	17	15	15	16	16
201	SBL	Veh	8	9	8	8	8	9
201	SBR	Veh	5	5	5	6	5	5
201	SBT	Veh	9	9	8	9	9	8
201	WBL	Mix	23	21	29	34	29	29
201	WBR	Mix	23	21	29	34	29	29
201	WBT	Mix	23	21	29	34	29	29
202	All	Veh	4	5	5	6	5	5
202	EBL	Mix	0	0	0	0	0	0
202	EBT	Mix	0	0	0	0	0	0
202	NBL	Veh	5	6	6	7	7	6
202	NBR	Veh	2	2	3	4	3	3
202	NBT	Veh	5	6	6	7	7	6
202	WBR	Mix	10	9	10	11	10	11
202	WBT	Mix	10	9	10	11	10	11
203	All	Veh	13	12	14	14	13	13
203	EBR	Mix	31	30	33	32	31	31
203	EBT	Mix	31	30	33	32	31	31
203	SBL	Veh	7	7	7	7	7	7
203	SBR	Veh	7	7	7	7	7	7
203	SBT	Veh	7	7	7	7	7	7
203	WBL	Mix	2	1	5	5	3	3
203	WBT	Mix	2	1	5	5	3	3
204	All	Veh	8	9	11	11	7	7
204	EBL	Mix	10	7	27	20	13	12
204	EBT	Mix	0	7	0	20	0	0
204	NBL	Veh	12	11	8	8	8	8
204	NBR	Veh	0	11	0	8	0	0
204	NBT	Veh	4	11	8	8	8	8
204	WBR	Veh	0	0	5	6	3	2
204	WBT	Veh	0	0	5	6	3	2
205	All	Veh	0	1	1	2	0	0

205	EBL	Veh	0	0	0	0	0	0
205	EBT	Veh	0	0	0	0	0	0
205	SBL	Veh	0	1	0	6	0	0
205	SBR	Veh	0	0	0	2	0	0
205	WBR	Veh	0	0	1	1	0	0
205	WBT	Veh	0	0	1	1	0	0
206	All	Veh	3	4	2	2	2	2
206	EBT	Veh	0	4	0	0	0	0
206	NBL	Veh	0	0	2	3	3	3
206	NBR	Veh	3	3	3	4	3	3
206	WBT	Veh	0	0	0	0	0	0
207	All	Veh	5	5	5	6	5	4
207	EBR	Veh	2	5	2	5	2	2
207	EBT	Veh	2	5	2	5	2	2
207	SBL	Veh	9	8	9	9	9	8
207	SBR	Veh	9	8	9	9	9	8
207	SBT	Veh	9	8	9	9	9	8
207	WBL	Veh	1	1	2	2	1	1
207	WBT	Veh	1	1	2	2	1	1
208	All	Veh	10	6	6	6	6	6
208	EBL	Veh	3	3	2	3	2	2
208	EBT	Veh	3	3	2	3	2	2
208	NBL	Veh	19	10	12	10	11	11
208	NBR	Veh	19	10	12	10	11	11
208	NBT	Veh	19	10	12	10	11	11
208	WBR	Veh	2	2	2	2	2	2
208	WBT	Veh	2	2	2	2	2	2
209	All	Veh	11	11	12	11	11	11
209	EBL	Veh	17	19	17	18	17	14
209	EBR	Veh	11	13	11	12	11	9
209	EBT	Veh	17	19	17	18	17	14
209	NBL	Veh	2	2	2	2	2	4
209	NBR	Veh	9	9	9	9	9	19
209	NBT	Veh	13	13	13	13	13	24
209	SBL	Veh	9	7	6	6	7	4
209	SBR	Veh	6	3	3	2	5	10
209	SBT	Veh	11	8	8	7	9	15
209	WBL	Veh	13	14	19	19	16	9
209	WBR	Veh	8	8	12	12	10	0
209	WBT	Veh	13	14	19	19	16	9
801	All	Veh	1	0	0	0	0	0
801	NBR	Veh	0	0	0	0	0	0
801	NBT	Veh	0	0	0	0	0	0
801	SBL	Veh	0	0	0	0	0	0
801	SBT	Veh	0	0	0	0	0	0
801	WBL	Veh	0	1	1	1	1	1
801	WBR	Veh	3	1	1	1	1	1
802	All	Veh	1	0	0	0	0	0
802	EBL	Veh	0	0	0	0	0	0
802	NBL	Veh	2	0	0	0	0	0

802	NBR	Veh	2	0	0	0	0	0
802	NBT	Veh	2	0	0	0	0	0
802	WBR	Veh	0	0	0	0	0	0
901	All	Veh	0	0	1	0	0	0
901	EBT	Veh	0	0	0	0	0	0
901	WBT	Veh	0	0	1	1	0	0
902	All	Veh	0	0	0	0	0	0
902	EBT	Veh	0	0	0	0	0	0
902	WBT	Veh	0	0	0	0	0	0

Results for Transit-Only Movements

Base					
Node	Vehicles	Delay	Queue	Mvmt	LOS
102	8	5	0	EBT	A
103	8	24	1	EBT	C
104	8	7	6	EBT	A
104	19	32	53	WBT	C
105	41	12	3	EBT	B
106	41	25	14	EBT	C
107	38	12	3	EBT	B
107	36	26	6	WBT	C
108	36	24	23	WBT	C
One-Way EB					
Node	Vehicles	Delay	Queue	Mvmt	LOS
102	8	5	0	EBT	A
103	9	23	1	EBT	C
104	9	8	5	EBT	A
104	16	40	56	WBT	D
105	41	11	2	EBT	B
106	41	24	9	EBT	C
107	38	13	2	EBT	B
107	35	28	6	WBT	C
108	35	27	26	WBT	C
One-Way WB					
Node	Vehicles	Delay	Queue	Mvmt	LOS
102	8	4	0	EBT	A
103	9	23	1	EBT	C
104	9	7	4	EBT	A
104	16	33	41	WBT	C
105	40	14	2	EBT	B
106	40	22	14	EBT	C
107	37	13	4	EBT	B
107	36	27	6	WBT	C
108	36	14	7	WBT	B
Two-Way					
Node	Vehicles	Delay	Queue	Mvmt	LOS
102	9	5	0	EBT	A
103	9	23	1	EBT	C

104	9	7	4	EBT	A
104	16	35	43	WBT	C
105	41	14	2	EBT	B
106	41	22	10	EBT	C
107	38	13	3	EBT	B
107	36	28	6	WBT	C
108	36	14	7	WBT	B
One-Way WB Preferred					
Node	Vehicles	Delay	Queue	Mvmt	LOS
102	8	5	0	EBT	A
103	9	19	1	EBT	B
104	9	9	4	EBT	A
104	16	36	46	WBT	D
105	41	14	2	EBT	B
106	40	23	13	EBT	C
107	38	15	5	EBT	B
107	36	29	6	WBT	C
108	35	17	12	WBT	B
One-Way WB Preferred Improved					
Node	Vehicles	Delay	Queue	Mvmt	LOS
102	8	5	0	EBT	A
103	8	22	1	EBT	C
104	9	7	4	EBT	A
104	16	35	44	WBT	C
105	41	13	2	EBT	B
106	41	22	13	EBT	C
107	38	15	2	EBT	B
107	36	28	6	WBT	C
108	36	14	6	WBT	B

APPENDIX B-4

VISSIM OUTPUT – TRAVEL TIMES

VISSIM Travel Time Measurement Segment	Average Travel Time (s)					
	Base	1Way EB	1Way WB	2Way	1Way WBP	1WBP-Imp
No. 601 (Sask SB Input to S..): from link 1 at 0.7 m to link 52 at 33.4 m, Distance 554.1 m	53	58	55	55	56	57
No. 602 (Stop 0037 to Stop ..): from link 52 at 63.9 m to link 99 at 9.5 m, Distance 212.7 m	73	74	77	75	78	75
No. 603 (Stop 0038 to Stop ..): from link 99 at 65.0 m to link 83 at 1.5 m, Distance 401.5 m	92	78	135	115	99	98
No. 604 (Stop 1354 to Stop ..): from link 83 at 46.8 m to link 110 at 0.8 m, Distance 160.4 m	38	37	36	37	39	38
No. 605 (Stop 1355 to Stop ..): from link 110 at 46.3 m to link 98 at 94.0 m, Distance 257.8 m	143	120	122	115	122	81
No. 606 (Broad SB Input to ..): from link 12 at 0.4 m to link 12 at 334.1 m, Distance 333.7 m	25	25	25	25	25	25
No. 607 (Stop 0112 to Stop ..): from link 12 at 374.6 m to link 46 at 34.2 m, Distance 227.9 m	70	72	56	55	58	64
No. 608 (Stop 0114 to Stop ..): from link 46 at 79.4 m to link 206 at 37.3 m, Distance 160.1 m	41	37	35	31	36	36
No. 609 (Stop 0114 to Stop ..): from link 46 at 79.4 m to link 84 at 0.7 m, Distance 228.1 m	144	139	123	122	128	136
No. 610 (Stop 0180 to Stop ..): from link 206 at 82.6 m to link 97 at 15.3 m, Distance 403.5 m	140	143	136	130	140	137
No. 611 (Stop 0115 to Stop ..): from link 84 at 46.2 m to link 97 at 15.4 m, Distance 335.3 m	69	68	68	63	69	68
No. 612 (Stop 1356 to Stop ..): from link 97 at 70.8 m to link 102 at 74.3 m, Distance 196.5 m	49	43	57	57	54	57
No. 613 (Stop 1360 to Stop ..): from link 102 at 104.7 m to link 310 at 1.1 m, Distance 160.3 m	24	24	24	24	25	25
No. 614 (Stop 1357 to Stop ..): from link 310 at 31.3 m to link 83 at 1.5 m, Distance 276.6 m	55	55	55	56	54	54
No. 615 (Stop 1355 to Stop ..): from link 110 at 46.3 m to link 95 at 36.1 m, Distance 180.9 m	53	46	49	46	46	45
No. 616 (Stop 0041 to Stop ..): from link 136 at 86.9 m to link 46 at 34.2 m, Distance 224.4 m	97	109	85	86	89	96
No. 617 (Stop 1356 to Stop ..): from link 97 at 71.0 m to link 57 at 29.6 m, Distance 167.8 m	101	87	108	110	119	119
No. 618 (Stop 1354 to Stop ..): from link 83 at 46.8 m to link 124 at 13.8 m, Distance 333.5 m	72	71	67	69	70	64
No. 619 (12th WB Input to S..): from link 16 at 0.7 m to link 136 at 61.2 m, Distance 321.5 m	0	0	0	0	0	0
No. 620 (Broad NB Input to ..): from link 11 at 2.3 m to link 136 at 61.4 m, Distance 442.3 m	63	64	64	66	65	71
No. 621 (11th WB Input to S..): from link 14 at 0.4 m to link 14 at 190.9 m, Distance 190.6 m	17	17	17	17	17	18
No. 622 (Stop 0690 to Stop ..): from link 14 at 206.2 m to link 46 at 34.2 m, Distance 184.9 m	97	86	78	78	87	82
No. 1101 (11th Albert to Mci..): from link 13 at 1.2 m to link 44 at 0.4 m, Distance 101.0 m	12	12	12	13	13	12
No. 1102 (11th Mcintyre to S..): from link 44 at 0.5 m to link 73 at 0.5 m, Distance 102.5 m	16	16	16	16	16	16
No. 1103 (11th Smith to Lorne): from link 73 at 0.5 m to link 79 at 0.6 m, Distance 102.9 m	25	21	21	18	19	19
No. 1104 (11th Lorne to Corn..): from link 79 at 0.8 m to link 83 at 1.0 m, Distance 101.7 m	21	19	18	18	19	18
No. 1105 (11th Cornwall to S..): from link 83 at 1.1 m to link	20	18	20	19	20	19

207 at 0.6 m, Distance 101.9 m						
No. 1106 (11th Scarth to Ham..): from link 207 at 0.8 m to link 110 at 4.4 m, Distance 107.6 m	19	19	22	22	23	19
No. 1107 (11th Hamilton to R..): from link 110 at 4.6 m to link 90 at 1.0 m, Distance 97.5 m	27	27	31	28	32	22
No. 1108 (11th Rose to Broad): from link 90 at 1.3 m to link 96 at 0.4 m, Distance 111.6 m	86	72	79	73	78	42
No. 1109 (11th Broad to Rose): from link 308 at 0.4 m to link 91 at 2.3 m, Distance 102.8 m	45	50	21	20	28	20
No. 1110 (11th Rose to Hamil..): from link 91 at 2.4 m to link 137 at 0.2 m, Distance 100.0 m	50	49	28	25	33	24
No. 1111 (11th Hamilton to S..): from link 137 at 0.2 m to link 206 at 0.8 m, Distance 100.4 m	48	51	28	26	34	31
No. 1112 (11th Scarth to Cor..): from link 206 at 1.0 m to link 84 at 0.6 m, Distance 104.3 m	49	55	31	34	38	38
No. 1113 (11th Cornwall to L..): from link 84 at 0.7 m to link 80 at 0.9 m, Distance 102.7 m	34	37	32	33	34	33
No. 1114 (11th Lorne to Smith): from link 80 at 1.1 m to link 75 at 0.7 m, Distance 102.2 m	18	17	17	17	18	18
No. 1115 (11th Smith to Mcin..): from link 75 at 0.8 m to link 45 at 0.8 m, Distance 102.5 m	12	12	12	12	12	12
No. 1116 (11th Mcintyre to A..): from link 45 at 1.0 m to link 51 at 0.8 m, Distance 116.4 m	45	46	46	45	46	47
No. 1120 (11th Rose to Broad..): from link 90 at 1.2 m to link 95 at 1.3 m, Distance 90.1 m	26	20	21	19	19	19
No. 1121 (11th Mcintyre to A..): from link 45 at 1.1 m to link 54 at 1.1 m, Distance 89.3 m	21	21	21	20	20	20
No. 1201 (12th Albert to Mci..): from link 104 at 3.8 m to link 99 at 0.7 m, Distance 99.0 m	9	9	9	9	9	9
No. 1202 (12th Mcintyre to S..): from link 99 at 1.0 m to link 114 at 0.4 m, Distance 101.4 m	20	19	24	22	22	20
No. 1203 (12th Smith to Lorne): from link 114 at 0.7 m to link 309 at 0.5 m, Distance 102.8 m	29	22	65	43	36	35
No. 1204 (12th Lorne to Corn..): from link 309 at 0.7 m to link 318 at 1.0 m, Distance 102.2 m		20		13		
No. 1205 (12th Cornwall to S..): from link 318 at 1.3 m to link 122 at 0.4 m, Distance 99.4 m		31		15		
No. 1206 (12th Scarth to Ham..): from link 122 at 0.7 m to link 125 at 0.7 m, Distance 104.0 m	22	20	17	19	17	17
No. 1207 (12th Hamilton to R..): from link 125 at 0.9 m to link 127 at 0.5 m, Distance 102.9 m	18	18	18	18	18	18
No. 1208 (12th Rose to Broad): from link 127 at 0.6 m to link 134 at 1.3 m, Distance 112.8 m	42	44	44	44	43	40
No. 1209 (12th Broad to Rose): from link 133 at 1.0 m to link 128 at 1.1 m, Distance 101.4 m	16	16	16	16	16	16
No. 1210 (12th Rose to Hamil..): from link 128 at 1.3 m to link 107 at 0.3 m, Distance 102.3 m	21	10	23	24	27	25
No. 1211 (12th Hamilton to S..): from link 107 at 0.6 m to link 317 at 0.6 m, Distance 102.2 m			9	9	10	10
No. 1212 (12th Scarth to Cor..): from link 317 at 0.9 m to link 123 at 0.5 m, Distance 102.4 m			22	22	22	21
No. 1213 (12th Cornwall to L..): from link 123 at 0.8 m to link 121 at 0.7 m, Distance 101.2 m			30	31	29	28
No. 1214 (12th Lorne to Smith): from link 121 at 1.1 m to link 97 at 0.4 m, Distance 103.3 m	25	20	22	22	20	21
No. 1215 (12th Smith to Mcin..): from link 97 at 0.5 m to link	10	10	12	12	12	12

111 at 1.1 m, Distance 102.4 m						
No. 1216 (12th Mcintyre to B..): from link 111 at 1.2 m to link 103 at 0.5 m, Distance 111.7 m	72	65	82	82	83	85
No. 1220 (12th Rose to Broad..): from link 127 at 0.7 m to link 135 at 3.3 m, Distance 92.6 m	35	34	33	34	33	32
No. 1221 (12th Mcintyre to A..): from link 111 at 1.3 m to link 102 at 0.8 m, Distance 90.7 m	28	26	36	38	37	37