

July 24, 2019

Cavan Gates
Deputy Manager of Operations and Sustainability
City of Grand Forks
7217 Fourth Street
Grand Forks, BC V0H 1H0

Re. 2nd Street and Market Avenue Traffic Control Analysis, Grand Forks BC

As requested, we have completed a thorough review of the traffic patterns and safety at the existing intersection of 2nd Street and Market Avenue in Downtown Grand Forks to determine if a four-way stop is justifiable. Our analysis has entailed a site visit, traffic counts, traffic analysis, and a safety review. The analysis and findings are outlined in the sections below.

A. Site Visit:

The existing intersection of 2nd Street and Market Avenue has existed as a two-way stop for decades (Figure 1). There are zebra (striped) crosswalks across all four approaches. The crosswalks across the Market Avenue approaches are at stop conditions, and have alternating red and white stripes. The crosswalks on the 2nd Street approaches are at a free-flow traffic condition, and do not currently have crosswalk signs.



Figure 1: Intersection of Second Street and Market Avenue



The intersection is on a skew of approximately 70 degrees. Sidewalk extensions (“corner bulbs”) are provided on all four corners to help manage traffic speeds on 2nd Street. On-street parking is available on 2nd Street immediately upstream and downstream of each sidewalk extension (Figure 2). Depending on the size of the vehicles parked adjacent to the sidewalk extensions, the sight distance for drivers on Market Avenue looking at approaching traffic on 2nd Street is approximately 40-50 metres in each direction, which corresponds to a 40 km/h design speed (based on guidelines from the Transportation Association of Canada (TAC)). Without vehicles parked on the corners, these sight distances increase to 60-70 metres, which corresponds to a 50 km/h design speed.



Figure 2: On-Street Parking Effect on Sight Lines – Looking North

B. Traffic Analysis:

The traffic volumes at the 2nd Street/Market Avenue intersection were counted on June 20-21, 2019 in the AM Peak, Noon, and PM Peak Hours. These volumes were then used in a Synchro traffic microsimulation model to determine the performance of the intersection with the existing two-way stop condition and the proposed four-way stop condition. The performance is measured in terms of delay (in seconds) and Level of Service (from excellent performance “A” to poor performance “F”).

The Synchro analysis revealed that the existing intersection currently performs at Level of Service “A”, with an average vehicle delay between 3 and 5 seconds in each peak hour. The traffic at the stop conditions on Market Avenue have between 10 and 13 seconds of delay on average, which equates to Level of Service “B”.

If the traffic control was converted to a four-way stop, the average vehicle delay in the peak hours would increase to 8 - 9 seconds, although the overall performance would remain at Level of Service “A”. The delay on Market Avenue would then decrease to 8 - 9 seconds, and improve to Level of Service “A”.



C. Safety Review:

Based on the last five years of available ICBC collision data (2013 to 2017), there were six collisions reported at the intersection of 2nd Street and Market Avenue. There were two collisions in 2016, and one in each of the other years. There were no trends in the months/seasons of the year or the days of the week. However, most collisions did occur between the late morning and the early afternoon, when downtown activity is greatest. All six collisions involved property damage only; none involved pedestrians or cyclists.

Three of the reported collisions were between a vehicle on 2nd Street and a vehicle on Market Avenue. One of these was attributed to obscured sight lines, and one to driving through the stop sign. The third was of unknown cause. The three remaining collisions appear to be related to parking maneuvers, especially involving vehicles backing out of the angle parking stalls along Market Avenue.

Based on the collision analysis, some candidate counter-measures include clearing the sight lines at the intersection and clarifying the stop condition (e.g. red reflective markers on the stop sign posts, parallel line crosswalks across the Market Avenue approaches, etc). Converting the angle parking to parallel parking would also reduce the potential for collisions.

D. Four-Way Stop Warrant Calculations:

According to the Section A2.2.1.2 of the Manual of Uniform Traffic Control Devices (TAC), a four-way stop condition is warranted when any one of the following conditions exists:

1. *Traffic volumes entering the intersection are approximately equal, and the combined pedestrian and vehicular volumes average 200 per hour for an eight hour period.* At the intersection, the volumes on 2nd Street are almost three times higher than those on Market Avenue. The total entering volumes for the AM, Noon, and PM Peak Hours are 76, 168, and 117 respectively.
2. *Average delay on the minor road exceeds 30 seconds per vehicle in the peak hours.* As noted in Section B, the average delay on Market Avenue is between 10 and 13 seconds in each peak hour.
3. *Five or more collisions per year which are preventable by a four-way stop condition.* As noted in Section C, there is an average of one collision per year at the intersection. Half of these are related to parking maneuvers.
4. *Interim measure prior to the installation of a traffic signal.* This intersection does not warrant traffic signals, and would therefore not be a candidate for this interim measure.
5. *Interim measure prior to changing the stop condition from one road to another.* As the highest traffic volumes are on 2nd Street, the existing stop condition is appropriately placed on Market Avenue.



Based on the TAC guidelines, none of the warrant criteria satisfy the conditions for a four-way stop control at the intersection. The installation of unwarranted stop signs risks inviting non-compliance from drivers who see no reason for the stop condition, which in turn may create safety concerns. The guidelines also state that four-way stops should not be used to control traffic speeds, which are more effectively managed with traffic calming measures.

E. Recommendations:

Based on the technical analysis, a four-way stop is not warranted at the intersection of 2nd Street and Market Avenue. If a four-way stop was installed, there would be a slight increase in the overall traffic delay, although the delays on the Market Avenue approaches would decrease. A four-way stop may also decrease some 90 degree collisions at the intersection. However, new collision trends may develop from non-compliance with the stop sign, especially on the 2nd Street approaches.

To improve the safety of the intersection, the following improvements are recommended for consideration:

1. Install post-reflectors on the existing stop signs on Market Avenue.
2. Convert the existing zebra crosswalks on the Market Avenue approaches to parallel lines to complement the stop conditions.
3. Install pedestrian crosswalk signs on 2nd Street, as warranted by the crosswalks.
4. Ensure the intersection sight lines are kept clear, especially for traffic on the Market Avenue approaches. If concerns arise, consider the removal of the on-street parking stalls on Second Avenue which are immediately next to the Market Avenue intersection and/or the formal reduction of the posted speed on 2nd Street to 40 km/h through the Downtown.

If you have any questions concerning the analysis or findings, please let me know.

Yours truly,

McElhanney Ltd.

Glenn Stanker PEng PTOE
Senior Transportation Engineer



















Attachments: Synchro Analysis Sheets

HCM Unsignalized Intersection Capacity Analysis

3: Market Ave & 2nd St

















07-24-2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	12	4	14	2	6	6	25	54	6	8	65	25
Future Volume (Veh/h)	12	4	14	2	6	6	25	54	6	8	65	25
Sign Control	Stop				Stop				Free			
Grade	0%				0%				0%			
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60	0.75	0.75	0.75	0.75	0.75	0.75
Hourly flow rate (vph)	20	7	23	3	10	10	33	72	8	11	87	33
Pedestrians	22				8				12			
Lane Width (m)	3.6				3.6				3.6			
Walking Speed (m/s)	1.2				1.2				1.2			
Percent Blockage	2				1				1			
Right turn flare (veh)												
Median type							None			None		
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	324	302	138	314	314	104	142				88	
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	324	302	138	314	314	104	142				88	
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1				4.1	
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2				2.2	
p0 queue free %	96	99	97	99	98	99	98				99	
cM capacity (veh/h)	567	578	885	581	569	929	1414				1498	
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	50	23	113	131								
Volume Left	20	3	33	11								
Volume Right	23	10	8	33								
cSH	682	686	1414	1498								
Volume to Capacity	0.07	0.03	0.02	0.01								
Queue Length 95th (m)	1.9	0.8	0.6	0.2								
Control Delay (s)	10.7	10.4	2.4	0.7								
Lane LOS	B	B	A	A								
Approach Delay (s)	10.7	10.4	2.4	0.7								
Approach LOS	B	B										
Intersection Summary												
Average Delay			3.6									
Intersection Capacity Utilization			27.0%	ICU Level of Service				A				
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis

3: Market Ave & 2nd St

















07-24-2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	20	13	28	16	13	17	33	93	19	18	103	34
Future Volume (Veh/h)	20	13	28	16	13	17	33	93	19	18	103	34
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60	0.75	0.75	0.75	0.75	0.75	0.75
Hourly flow rate (vph)	33	22	47	27	22	28	44	124	25	24	137	45
Pedestrians		22			8			12			20	
Lane Width (m)		3.6			3.6			3.6			3.6	
Walking Speed (m/s)		1.2			1.2			1.2			1.2	
Percent Blockage		2			1			1			2	
Right turn flare (veh)												
Median type								None			None	
Median storage veh												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	513	474	194	510	484	164	204			157		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	513	474	194	510	484	164	204			157		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	92	95	94	93	95	97	97			98		
cM capacity (veh/h)	401	453	824	400	447	860	1343			1413		
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	102	77	193	206								
Volume Left	33	27	44	24								
Volume Right	47	28	25	45								
cSH	543	516	1343	1413								
Volume to Capacity	0.19	0.15	0.03	0.02								
Queue Length 95th (m)	5.5	4.2	0.8	0.4								
Control Delay (s)	13.2	13.2	2.0	1.0								
Lane LOS	B	B	A	A								
Approach Delay (s)	13.2	13.2	2.0	1.0								
Approach LOS	B	B										
Intersection Summary												
Average Delay			5.1									
Intersection Capacity Utilization			30.8%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis

3: Market Ave & 2nd St

















07-24-2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	14	10	23	6	16	21	29	106	8	9	68	19
Future Volume (Veh/h)	14	10	23	6	16	21	29	106	8	9	68	19
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60	0.75	0.75	0.75	0.75	0.75	0.75
Hourly flow rate (vph)	23	17	38	10	27	35	39	141	11	12	91	25
Pedestrians		22			8			12			20	
Lane Width (m)		3.6			3.6			3.6			3.6	
Walking Speed (m/s)		1.2			1.2			1.2			1.2	
Percent Blockage		2			1			1			2	
Right turn flare (veh)												
Median type								None			None	
Median storage (veh)												
Upstream signal (m)												
pX, platoon unblocked												
vC, conflicting volume	442	388	138	418	394	174	138			160		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	442	388	138	418	394	174	138			160		
tC, single (s)	7.1	6.5	6.2	7.1	6.5	6.2	4.1			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.3	3.5	4.0	3.3	2.2			2.2		
p0 queue free %	95	97	96	98	95	96	97			99		
cM capacity (veh/h)	445	514	885	477	510	849	1419			1410		
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total	78	72	191	128								
Volume Left	23	10	39	12								
Volume Right	38	35	11	25								
cSH	611	625	1419	1410								
Volume to Capacity	0.13	0.12	0.03	0.01								
Queue Length 95th (m)	3.5	3.1	0.7	0.2								
Control Delay (s)	11.7	11.5	1.7	0.8								
Lane LOS	B	B	A	A								
Approach Delay (s)	11.7	11.5	1.7	0.8								
Approach LOS	B	B										
Intersection Summary												
Average Delay			4.6									
Intersection Capacity Utilization			30.5%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis

3: Market Ave & 2nd St

















07-24-2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Traffic Volume (vph)	12	4	14	2	6	6	25	54	6	8	65	25
Future Volume (vph)	12	4	14	2	6	6	25	54	6	8	65	25
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60	0.75	0.75	0.75	0.75	0.75	0.75
Hourly flow rate (vph)	20	7	23	3	10	10	33	72	8	11	87	33
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total (vph)	50	23	113	131								
Volume Left (vph)	20	3	33	11								
Volume Right (vph)	23	10	8	33								
Hadj (s)	-0.16	-0.20	0.05	-0.10								
Departure Headway (s)	4.3	4.3	4.2	4.1								
Degree Utilization, x	0.06	0.03	0.13	0.15								
Capacity (veh/h)	790	778	822	861								
Control Delay (s)	7.6	7.4	7.9	7.8								
Approach Delay (s)	7.6	7.4	7.9	7.8								
Approach LOS	A	A	A	A								
Intersection Summary												
Delay				7.8								
Level of Service				A								
Intersection Capacity Utilization				27.0%	ICU Level of Service	A						
Analysis Period (min)				15								

HCM Unsignalized Intersection Capacity Analysis

3: Market Ave & 2nd St

















07-24-2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Traffic Volume (vph)	20	13	28	16	13	17	33	93	19	18	103	34
Future Volume (vph)	20	13	28	16	13	17	33	93	19	18	103	34
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60	0.75	0.75	0.75	0.75	0.75	0.75
Hourly flow rate (vph)	33	22	47	27	22	28	44	124	25	24	137	45
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total (vph)	102	77	193	206								
Volume Left (vph)	33	27	44	24								
Volume Right (vph)	47	28	25	45								
Hadj (s)	-0.18	-0.11	0.00	-0.07								
Departure Headway (s)	4.8	4.9	4.6	4.5								
Degree Utilization, x	0.13	0.10	0.25	0.26								
Capacity (veh/h)	687	669	746	757								
Control Delay (s)	8.5	8.4	9.1	9.1								
Approach Delay (s)	8.5	8.4	9.1	9.1								
Approach LOS	A	A	A	A								
Intersection Summary												
Delay			8.9									
Level of Service			A									
Intersection Capacity Utilization			30.8%		ICU Level of Service				A			
Analysis Period (min)			15									

HCM Unsignalized Intersection Capacity Analysis

3: Market Ave & 2nd St

07-24-2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Sign Control		Stop			Stop			Stop			Stop	
Traffic Volume (vph)	14	10	23	6	16	21	29	106	8	9	68	19
Future Volume (vph)	14	10	23	6	16	21	29	106	8	9	68	19
Peak Hour Factor	0.60	0.60	0.60	0.60	0.60	0.60	0.75	0.75	0.75	0.75	0.75	0.75
Hourly flow rate (vph)	23	17	38	10	27	35	39	141	11	12	91	25
Direction, Lane #	EB 1	WB 1	NB 1	SB 1								
Volume Total (vph)	78	72	191	128								
Volume Left (vph)	23	10	39	12								
Volume Right (vph)	38	35	11	25								
Hadj (s)	-0.20	-0.23	0.04	-0.06								
Departure Headway (s)	4.5	4.5	4.4	4.4								
Degree Utilization, x	0.10	0.09	0.24	0.16								
Capacity (veh/h)	731	734	778	773								
Control Delay (s)	8.0	7.9	8.8	8.2								
Approach Delay (s)	8.0	7.9	8.8	8.2								
Approach LOS	A	A	A	A								
Intersection Summary												
Delay			8.4									
Level of Service			A									
Intersection Capacity Utilization			30.5%		ICU Level of Service				A			
Analysis Period (min)			15									