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Technical Memorandum

To/Attention	Mike Giampa, City of Ottawa Transportation Project Manager	**Date**	March 30, 2023
From	David Hook	**Project No**	136974
Cc	Marcel Denomme		
Subject	Riverside South Employment Lands and Blocks 13, 14, Transportation Impact Assessment, Addendum #1		

Introduction

Arcadis IBI Group (Arcadis) was retained by Riverside South Development Corporation (RSDC) to undertake a Transportation Impact Assessment (TIA) in support of a Draft Plan of Subdivision application for a proposed industrial subdivision to be located on the west side of Limebank Road, north of Mosquito Creek on a property municipally known as 3700 Twin Falls Place.

A Transportation Impact Assessment (TIA) Step 4 report was previously prepared and submitted to the City of Ottawa on August 2, 2022. Since this time, the Draft Plan of Subdivision has undergone several changes in response to circulation comments received following the First Submission of the application. The purpose of this TIA Addendum is to summarize the relevant changes to the Draft Plan of Subdivision, including a modification to the future realignment of Leitrim Road, and to assess their impact on the conclusions of the TIA.

Draft Plan of Subdivision

The revised Draft Plan of Subdivision is shown below in **Figure 1**. Since the initial submission, the following changes have been made with respect to the TIA:

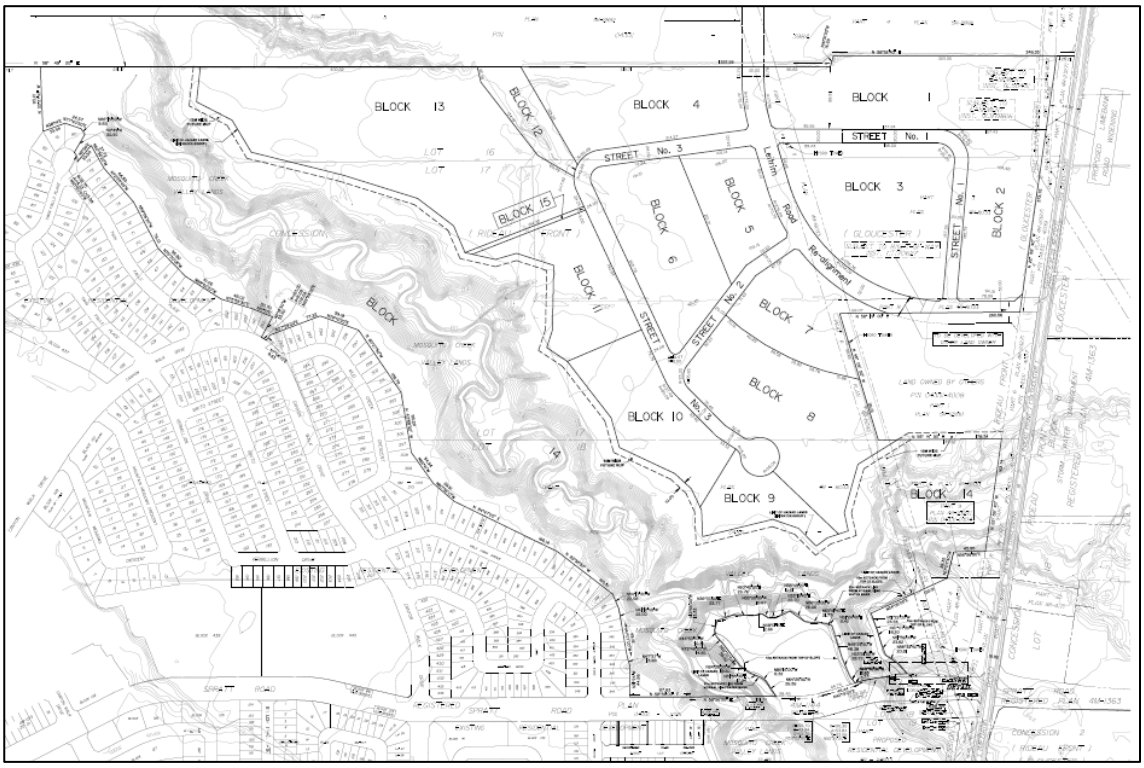
- The residential and institutional/fire hall blocks that were previously included in the TIA are no longer included as part of this Draft Plan of Subdivision application.
- Block 15, the Multi-Use Path (MUP) block providing a connection between Street #3 and Mosquito Creek, has been relocated further north.
- The future realignment of Leitrim Road has been modified and shifted towards the east to make more efficient use of the development blocks by locating the roadway closer to the hydro corridor.

Despite the Official Plan requirement for local roads to have a sidewalk on at least one side within the Suburban Transect, the subject lands are within an area designated as Industrial/Logistics and are therefore proposed to have rural cross-sections. The portion of the re-aligned Leitrim Road within the proposed development is to be classified as a Collector Road, referred to as Collector ‘K’ in the Riverside South CDP. The Official Plan requires sidewalks on both sides of a collector road; however, the road will initially be constructed with a 2-lane rural cross-section that includes paved shoulders. Ultimately, this road is contemplated to become a 4-lane roadway with sidewalks

and cycle tracks, however the timing of this is unknown and may be determined through the Transportation Master Plan update which is currently underway.

Consistent with the Riverside South CDP and Draft Secondary Plan, active transportation connections are proposed along the southern boundary of the subdivision and alongside Mosquito Creek in the form of a Multi-Use Pathway, with a connection to the subdivision via Block 15.

Figure 1 – Revised Draft Plan of Subdivision



Leitrim Road Realignment

As indicated in the TIA, the realigned Leitrim Road will be initially constructed with a 2-lane rural cross-section but is expected to be ultimately widened to a 4-lane urban cross-section in the future. The timing of this widening is related to the potential long-term needs of the Ottawa International Airport.

The Leitrim Road Realignment and Widening Planning and Environmental Assessment Study – Environmental Study Report (ESR) (Parsons, August 2018) identified the need for a 32.1m wide right-of-way (ROW) to accommodate the realigned Leitrim Road west of Limebank Road, while the ESR's preferred functional design drawings illustrate a variable ROW ranging from 34 to 40 metres through the subject lands. It has been confirmed that a reduced 32.0m ROW can sufficiently accommodate the required elements of the ultimate 4-lane urban cross-section, complete with active transportation elements. **Figure 2** illustrates the modified cross-section proposed.

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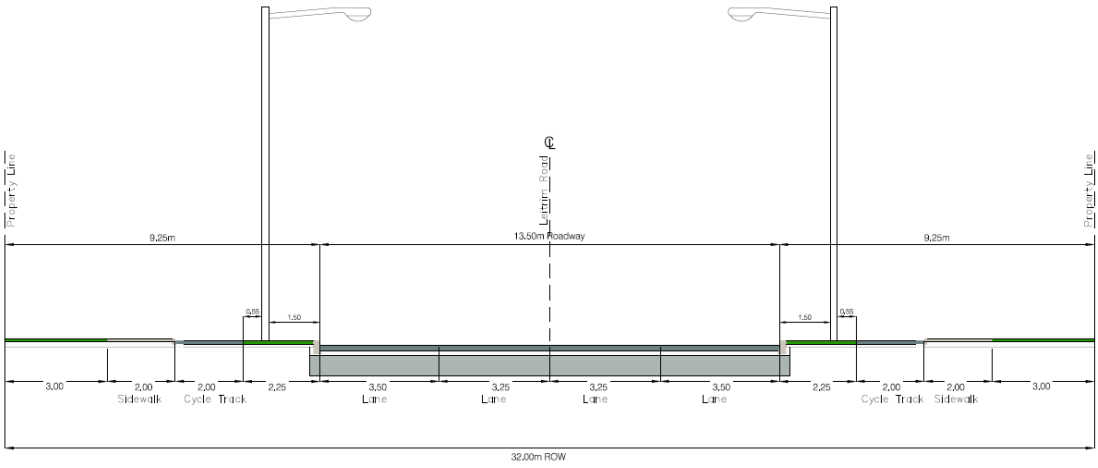
Figure 2 – Realigned Leitrim Road: Ultimate Configuration



As a result of proposed changes to the right-of-way, alignment and eventual intersection location at existing Leitrim Road, an addendum to the ESR will be required to provide a technical review of the deviations from the ESR's functional design. This addendum will be prepared in parallel with the Draft Plan of Subdivision application.

Trip Generation

The removal of the residential and institutional/fire hall land uses from the proposed development is expected to result in a reduction of approximately 12 two-way vehicle trips during the weekday morning and afternoon peak hours. The amount of land dedicated to industrial land uses has also decreased from 42.257 hectares to 39.463 hectares, resulting in a further reduction in site-generated traffic. As the total trip generation of the proposed development is expected to decrease only marginally, the overall intersection capacity analysis results of the TIA remain valid.

Interim Limebank Access Requirements

As there is currently no timeline for the extension of re-aligned Leitrim Road north of the site or east of Limebank Road, this road will initially only provide access to the subject lands, thus its planned configuration as a 2-lane rural roadway.

Supplemental analysis has been undertaken to determine the appropriate access control on Limebank Road and identify auxiliary lane requirements. This analysis conservatively assumes a 3-leg intersection with no development on the east side of Limebank Road and has been evaluated based on existing traffic volumes.

Figure 3 below illustrates the turning movement volumes at the intersection under the interim access configuration, assuming full build-out of the industrial subdivision.

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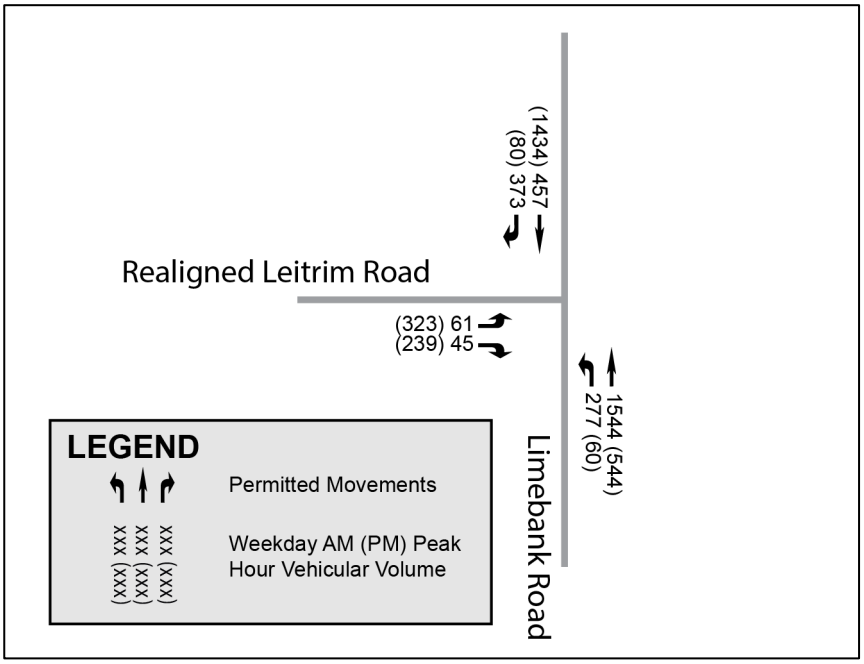
Figure 3 - Existing Plus Site-Generated Traffic



The intersection has been assessed under two alternative configurations: as a stop-controlled intersection and as a signalized intersection. The results of the intersection capacity analysis are summarized in **Table 1**. The detailed intersection capacity analysis reports have been provided in **Appendix A**.

Table 1 - Intersection Capacity Analysis Results: Interim Access Configuration

Intersection	Traffic Control	AM Peak Hour		PM Peak Hour	
		Overall LOS (v/c or delay)	Critical Movement (v/c or delay)	Overall LOS (v/c or delay)	Critical Movement (v/c or delay)
Limebank & Realigned Leitrim	Unsignalized	**F (651.5s)**	**EBRL (651.5s)**	**F (5094.7s)**	**EBRL (5094.7s)**
	Signalized	A (0.58)	NBT (0.58)	D (0.84)	EBL (0.85)

As shown above, the intersection is expected to significantly exceed its theoretical capacity as a stop-controlled intersection but would operate at an acceptable Level of Service (i.e., LOS 'D' or better) as a signalized intersection. Traffic signal warrant analysis also indicates that traffic signals would be warranted at this location, see **Appendix B**. It is therefore recommended that the intersection be constructed as a signalized intersection prior to full build-out. As it was not contemplated in the ESR, a roundabout was not considered in this analysis. The point in which signalization becomes triggered (either operationally and/or by signal warrants) will be identified through TIA's in support of subsequent site plan applications for the various blocks within the subdivision, however, based on sensitivity analysis any amount of traffic on the eastbound approach to this intersection is expected to result in unacceptable delays (i.e., LOS 'F') as a stop-controlled intersection. Furthermore, there are significant safety concerns associated with

implementing stop-controlled intersections on high speed 4-lane roadways. As noted in Section 9.1.2.6 of the Transportation Association of Canada (TAC) Geometric Design Guide for Canadian Roads, it is difficult for drivers to accurately estimate the speed of oncoming traffic, particularly when vehicles are further away. As larger gaps are required to safely complete left-turns onto high speed 4-lane roads, drivers on the stop-controlled approach would have more difficulty estimating the speed of oncoming traffic. Combined with the high time pressure drivers would be facing due to long delays and the presence of other vehicles in queue, it becomes increasingly likely that drivers will select unsafe gaps at the intersection, resulting in potentially severe collisions given the operating speeds on Limebank Road.

In the absence of traffic signals, potential solutions that would permit this intersection to operate safely through the initial stages of development would be to restrict the intersection to right-in/right-out, or to physically restrict left-out movements (i.e., a ‘3/4’ access).

Based on first-principles calculations, auxiliary lane analysis indicates that the intersection may require the following auxiliary turning lanes as a signalized intersection to support the full build-out of the development, with consideration of increased likelihood of truck traffic:

- Northbound left-turn lane: minimum 105m of storage
- Southbound right-turn lane: minimum 15m of storage
- Eastbound left-turn lane: minimum 125m of storage

This interim intersection configuration would be partially funded by the Applicant for any components deemed to be interim, as compared to the ultimate functional design presented in the ESR.

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Conclusion

Following the submission of the TIA in August 2022, the Draft Plan of Subdivision has undergone several changes, including the removal of the residential and institutional/fire hall land uses from the application, and adjustments to the future re-aligned Leitrim Road. Overall, the total trip generation of the proposed development is expected to be marginally reduced as a result of these changes, therefore, the transportation impacts described in the TIA are not significantly affected.

A decrease in the ROW of the realigned Leitrim Road has been proposed, however a modified cross-section illustrates that the functional elements described in the Leitrim Road ESR can still be accommodated. An addendum to the ESR will be required to provide a technical review of the changes to the Leitrim Road realignment functional design and will proceed in parallel to the Draft Plan of Subdivision application.

The configuration of the Limebank & Realigned Leitrim intersection has been reviewed to determine the access requirements in the interim until the roadway is extended further east or north in the future. The results of the analysis indicate that traffic signals are likely to be both warranted and operationally required based on the full buildout of the subject development, assuming a 3-leg interim intersection configuration. Auxiliary lane analysis further indicates that the intersection may require a northbound left-turn, southbound right-turn, and eastbound left-turn lane with minimum storage of 105m, 15m and 125m, respectively.

Overall, the conclusions and recommendations of the TIA remain unchanged. It is the opinion of Arcadis IBI Group that the proposed industrial development will integrate well with and can be safely accommodated by the adjacent transportation network.

Appendix A - Intersection Capacity Analysis Results

Intersection	
Int Delay, s/veh	26.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	61	45	277	1544	457	373
Future Vol, veh/h	61	45	277	1544	457	373
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	90	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	12	12	12	3	9	12
Mvmt Flow	61	45	277	1544	457	373

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1970	415	830	0	-	0
Stage 1	644	-	-	-	-	-
Stage 2	1326	-	-	-	-	-
Critical Hdwy	7.04	7.14	4.34	-	-	-
Critical Hdwy Stg 1	6.04	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.62	3.42	2.32	-	-	-
Pot Cap-1 Maneuver	~ 49	559	737	-	-	-
Stage 1	459	-	-	-	-	-
Stage 2	195	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 31	559	737	-	-	-
Mov Cap-2 Maneuver	~ 31	-	-	-	-	-
Stage 1	286	-	-	-	-	-
Stage 2	195	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	$ 651.5	1.9	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	737	-	52	-	-
HCM Lane V/C Ratio	0.376	-	2.038	-	-
HCM Control Delay (s)	12.8	-	$ 651.5	-	-
HCM Lane LOS	B	-	F	-	-
HCM 95th %tile Q(veh)	1.8	-	10.5	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	948.1

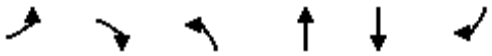
Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Vol, veh/h	323	239	60	644	1675	80
Future Vol, veh/h	323	239	60	644	1675	80
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	90	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	12	12	12	6	1	12
Mvmt Flow	323	239	60	644	1675	80

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	2157	878	1755	0	-	0
Stage 1	1715	-	-	-	-	-
Stage 2	442	-	-	-	-	-
Critical Hdwy	7.04	7.14	4.34	-	-	-
Critical Hdwy Stg 1	6.04	-	-	-	-	-
Critical Hdwy Stg 2	6.04	-	-	-	-	-
Follow-up Hdwy	3.62	3.42	2.32	-	-	-
Pot Cap-1 Maneuver	~ 36	272	312	-	-	-
Stage 1	~ 117	-	-	-	-	-
Stage 2	587	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 29	272	312	-	-	-
Mov Cap-2 Maneuver	~ 29	-	-	-	-	-
Stage 1	~ 95	-	-	-	-	-
Stage 2	587	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, $	5094.7	1.6	0
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	312	-	47	-	-
HCM Lane V/C Ratio	0.192	-	11.957	-	-
HCM Control Delay (s)	19.3	-	$ 5094.7	-	-
HCM Lane LOS	C	-	F	-	-
HCM 95th %tile Q(veh)	0.7	-	67.5	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

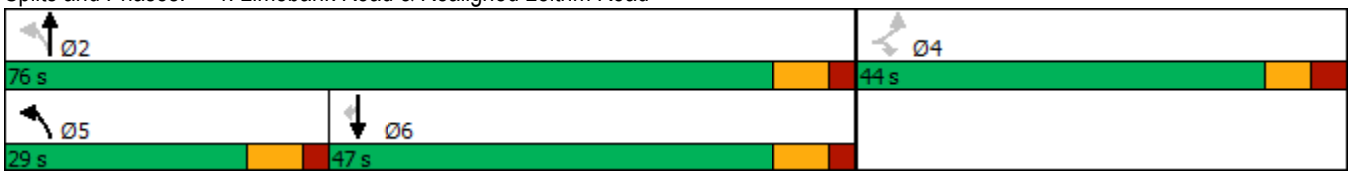


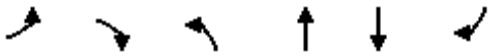
Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	61	45	277	1544	457	373
Future Volume (vph)	61	45	277	1544	457	373
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800
Storage Length (m)	90.0	0.0	90.0			35.0
Storage Lanes	1	1	1			1
Taper Length (m)	7.6		7.6			
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt		0.850				0.850
Flt Protected	0.950		0.950			
Satd. Flow (prot)	1544	1381	1544	3357	3172	1381
Flt Permitted	0.950		0.427			
Satd. Flow (perm)	1544	1381	694	3357	3172	1381
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		45				373
Link Speed (k/h)	48			80	80	
Link Distance (m)	472.7			635.3	509.3	
Travel Time (s)	35.5			28.6	22.9	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	12%	12%	12%	3%	9%	12%
Adj. Flow (vph)	61	45	277	1544	457	373
Shared Lane Traffic (%)						
Lane Group Flow (vph)	61	45	277	1544	457	373
Turn Type	Perm	Perm	pm+pt	NA	NA	Perm
Protected Phases			5	2	6	
Permitted Phases	4	4	2			6
Detector Phase	4	4	5	2	6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	5.0	10.0	10.0	10.0
Minimum Split (s)	43.5	43.5	12.4	39.4	39.4	39.4
Total Split (s)	44.0	44.0	29.0	76.0	47.0	47.0
Total Split (%)	36.7%	36.7%	24.2%	63.3%	39.2%	39.2%
Maximum Green (s)	36.5	36.5	21.6	68.6	39.6	39.6
Yellow Time (s)	4.1	4.1	5.0	5.0	5.0	5.0
All-Red Time (s)	3.4	3.4	2.4	2.4	2.4	2.4
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.5	7.5	7.4	7.4	7.4	7.4
Lead/Lag			Lead		Lag	Lag
Lead-Lag Optimize?			Yes		Yes	Yes
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	None	Max	Max	Max
Walk Time (s)	7.0	7.0		7.0	7.0	7.0
Flash Dont Walk (s)	29.0	29.0		25.0	25.0	25.0
Pedestrian Calls (#/hr)	0	0		0	0	0
Act Effct Green (s)	8.9	8.9	69.1	70.8	51.3	51.3
Actuated g/C Ratio	0.10	0.10	0.77	0.79	0.57	0.57
v/c Ratio	0.40	0.25	0.44	0.58	0.25	0.39
Control Delay	47.0	15.6	6.2	6.5	12.0	2.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0

Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Total Delay	47.0	15.6	6.2	6.5	12.0	2.9
LOS	D	B	A	A	B	A
Approach Delay	33.7			6.5	7.9	
Approach LOS	C			A	A	
Queue Length 50th (m)	10.4	0.0	12.8	56.8	21.3	0.0
Queue Length 95th (m)	22.5	9.7	24.4	86.2	36.1	14.1
Internal Link Dist (m)	448.7			611.3	485.3	
Turn Bay Length (m)	90.0		90.0			35.0
Base Capacity (vph)	631	591	739	2645	1809	948
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.10	0.08	0.37	0.58	0.25	0.39

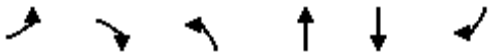
Intersection Summary			
Area Type:	Other		
Cycle Length: 120			
Actuated Cycle Length: 89.9			
Natural Cycle: 100			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.58			
Intersection Signal Delay: 7.9		Intersection LOS: A	
Intersection Capacity Utilization 61.6%		ICU Level of Service B	
Analysis Period (min) 15			

Splits and Phases: 4: Limebank Road & Realigned Leitrim Road





Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (vph)	323	239	60	644	1675	80
Future Volume (vph)	323	239	60	644	1675	80
Ideal Flow (vphpl)	1800	1800	1800	1800	1800	1800
Storage Length (m)	90.0	0.0	90.0			35.0
Storage Lanes	1	1	1			1
Taper Length (m)	7.6		7.6			
Lane Util. Factor	1.00	1.00	1.00	0.95	0.95	1.00
Frt		0.850				0.850
Flt Protected	0.950		0.950			
Satd. Flow (prot)	1544	1381	1544	3262	3424	1381
Flt Permitted	0.950		0.075			
Satd. Flow (perm)	1544	1381	122	3262	3424	1381
Right Turn on Red		Yes				Yes
Satd. Flow (RTOR)		20				36
Link Speed (k/h)	60			80	80	
Link Distance (m)	472.7			635.3	509.3	
Travel Time (s)	28.4			28.6	22.9	
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00
Heavy Vehicles (%)	12%	12%	12%	6%	1%	12%
Adj. Flow (vph)	323	239	60	644	1675	80
Shared Lane Traffic (%)						
Lane Group Flow (vph)	323	239	60	644	1675	80
Turn Type	Perm	Perm	Perm	NA	NA	Perm
Protected Phases				2	6	
Permitted Phases	4	4	2			6
Detector Phase	4	4	2	2	6	6
Switch Phase						
Minimum Initial (s)	5.0	5.0	10.0	10.0	10.0	10.0
Minimum Split (s)	43.5	43.5	39.4	39.4	39.4	39.4
Total Split (s)	44.0	44.0	76.0	76.0	76.0	76.0
Total Split (%)	36.7%	36.7%	63.3%	63.3%	63.3%	63.3%
Maximum Green (s)	36.5	36.5	68.6	68.6	68.6	68.6
Yellow Time (s)	4.1	4.1	5.0	5.0	5.0	5.0
All-Red Time (s)	3.4	3.4	2.4	2.4	2.4	2.4
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	7.5	7.5	7.4	7.4	7.4	7.4
Lead/Lag						
Lead-Lag Optimize?						
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Recall Mode	None	None	Max	Max	Max	Max
Walk Time (s)	7.0	7.0	7.0	7.0	7.0	7.0
Flash Dont Walk (s)	29.0	29.0	25.0	25.0	25.0	25.0
Pedestrian Calls (#/hr)	0	0	0	0	0	0
Act Effct Green (s)	27.6	27.6	68.8	68.8	68.8	68.8
Actuated g/C Ratio	0.25	0.25	0.62	0.62	0.62	0.62
v/c Ratio	0.85	0.67	0.80	0.32	0.79	0.09
Control Delay	59.8	43.9	87.1	11.5	20.7	6.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0

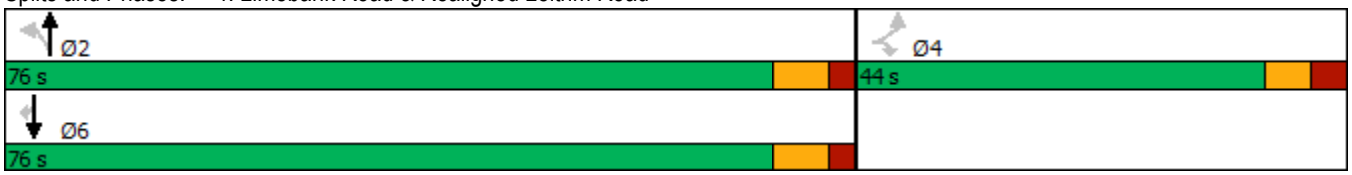


Lane Group	EBL	EBR	NBL	NBT	SBT	SBR
Total Delay	59.8	43.9	87.1	11.5	20.7	6.6
LOS	E	D	F	B	C	A
Approach Delay	53.1			17.9	20.1	
Approach LOS	D			B	C	
Queue Length 50th (m)	66.8	43.1	9.3	33.1	135.2	3.6
Queue Length 95th (m)	99.8	69.1	#40.3	52.2	200.6	11.4
Internal Link Dist (m)	448.7			611.3	485.3	
Turn Bay Length (m)	90.0		90.0			35.0
Base Capacity (vph)	507	467	75	2015	2116	867
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.64	0.51	0.80	0.32	0.79	0.09

Intersection Summary			
Area Type:	Other		
Cycle Length: 120			
Actuated Cycle Length: 111.4			
Natural Cycle: 95			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.85			
Intersection Signal Delay: 25.7		Intersection LOS: C	
Intersection Capacity Utilization 83.9%		ICU Level of Service E	
Analysis Period (min) 15			

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Limebank Road & Realigned Leitrim Road



Appendix B – Traffic Signal Warrants

IBI

OTM BOOK 12* - TRAFFIC SIGNAL WARRANT

Project: Riverside South Employment Lands & Blocks 13, 14 **Date:** March 30, 2023

Project #: 136974

Location: Limebank Road (Major Roadway) at Realigned Leitrim Road (Minor Roadway)

Orientation: North/South East/West

Municipality: City of Ottawa **Scenario:** Interim Access Configuration

Justification 1 - Minimum Vehicle Volume

WARRANT	MINIMUM REQUIREMENT				COMPLIANCE								SECTIONAL PERCENT
	FREE FLOW	RESTR. FLOW	ADJUST. FREE FLOW	ADJUST. RESTR. FLOW	7:00 AM	8:00 AM	9:00 AM	10:00 AM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	
A. Vehicle volumes, all approaches	480	720	**720**	1080	2757 100%	1379 100%	1379 100%	1379 100%	2680 100%	1340 100%	1340 100%	1340 100%	100%
B. Vehicle volume along minor roads	120	170	**216**	306	106 49%	53 25%	53 25%	53 25%	562 100%	281 100%	281 100%	281 100%	65%

Justification 2 - Delay to Cross Traffic

WARRANT	MINIMUM REQUIREMENT				COMPLIANCE								SECTIONAL PERCENT
	FREE FLOW	RESTR. FLOW	ADJUST. FREE FLOW	ADJUST. RESTR. FLOW	7:00 AM	8:00 AM	9:00 AM	10:00 AM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	
A. Vehicle volumes, along artery	480	720	**720**	1080	2651 100%	1326 100%	1326 100%	1326 100%	2118 100%	1059 100%	1059 100%	1059 100%	100%
B. Combined vehicle and pedestrian volume crossing artery from minor roads	50	70	**60**	84	199 100%	30 51%	30 51%	30 51%	323 100%	161 100%	161 100%	161 100%	82%

Justification 3 - Volume/Delay Combination

JUSTIFICATION	SATISFIED TO 80% OR MORE?	BOTH SATISFIED TO 80% OR MORE?
Justification 1 - Minimum Vehicular Volume	N/A	N/A
Justification 2 - Delay to Cross Traffic	N/A	

Justification 7 - Projected Volumes

WARRANT	DESCRIPTION	MINIMUM REQUIREMENT				COMPLIANCE		
		FREE FLOW	RESTRICTED FLOW	ADJUSTED FREE FLOW	ADJUSTED RESTRICTED FLOW	SECTIONAL AHV	SECTIONAL %	ENTIRE %
1. MINIMUM VEHICULAR VOLUME	A. Vehicle volumes, all approaches (Average Hour)	480	720	**900**	1350	1359	100%	62%
	B. Vehicle volume along minor roads (Average Hour)	120	170	**270**	383	167	62%	
2. DELAY TO CROSS TRAFFIC	A. Vehicle volumes, along artery (Average Hour)	480	720	**900**	1350	1192	100%	100%
	B. Combined vehicle and pedestrian volume crossing artery from minor roads (Average Hour)	50	75	**75**	113	96	100%	

Projected Traffic Volumes:

Average Hourly Volume (AHV) Equation: AHV = (amPHV + pmPHV)/4

AM Peak Hour Volumes

			↖	↑	0			
373	457	0	←		0			
↙	↓	↘	↙		0			
	61	↗	↖	↑	↗			
	0	→	277	1544	0			
	45	↘						

PM Peak Hour Volumes

			↖	↑	0			
81	1434	0	←		0			
↙	↓	↘	↙		0			
	323	↗	↖	↑	↗			
	0	→	60	544	0			
	239	↘						

Average Hourly Volumes (AHV)

			↖	↑	0			
113	473	0	←		0			
↙	↓	↘	↙		0			
	96	↗	↖	↑	↗			
	0	→	84	522	0			
	71	↘						

Eight Hour Traffic Volumes:**

Hour	Major Road						Minor Road						Ped*
	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR	
7:00 AM	277	1544	0	0	457	373	61	0	45	0	0	0	0
8:00 AM	138	772	0	0	229	187	30	0	23	0	0	0	0
9:00 AM	138	772	0	0	229	187	30	0	23	0	0	0	0
10:00 AM	138	772	0	0	229	187	30	0	23	0	0	0	0
3:00 PM	60	544	0	0	1434	81	323	0	239	0	0	0	0
4:00 PM	30	272	0	0	717	40	161	0	120	0	0	0	0
5:00 PM	30	272	0	0	717	40	161	0	120	0	0	0	0
6:00 PM	30	272	0	0	717	40	161	0	120	0	0	0	0

** Number of pedestrians crossing the major road*
*** These are projected 8-hour traffic volumes.*

Notes:

1. Vehicle volume warrant (1A) and (2A) for intersections of roadways having two or more moving lanes in one direction should be 25% higher than the values given above.

2+ Lanes per Direction

2. Warrant values for free flow apply when the 85th percentile speed of artery traffic equals or exceeds 70 km/h or when the intersection lies within the built-up area of an isolated community having a population of less than 10,000. Warrant values for restricted flow apply to large urban communities when the 85th percentile speed of artery traffic does not exceed 70 km/h.

Free Flow

3. The lowest sectional percentage governs the entire warrant.

4. For "T" intersections the warrant values for the minor road should be increased by 50% (Warrant 1B only).

3-legged Intersection

5. All flow values for Justification 1 and 2 are to be increased by 20% in the case of new intersections, Justification 3 is to only be used for existing intersections and all flow values for Warrant 1 and Warrant 2 of Justification 7 are to be increased by 20% for existing intersections and by 50% in the case of new intersections.

New Intersection

6. The crossing volumes are defined as the sum of:
   (a) Left-turns from both minor road approaches.
   (b) The heaviest through volume from the minor road.
   (c) 50% of the heavier left turn movement from major road when both of the following are met:
      (i) the left-turn volume >120 vph
      (ii) the left-turn volume plus the opposing volume >720 vph
   (d) Pedestrians crossing the main road.

CONCLUSION: **Based on Justification 7, the intersection meets the minimum warrants for traffic control signals.**

* "Ontario Traffic Manual, Book 12 (March 2012)", Ontario Ministry of Transportation.