

Staff to the Boston Region Metropolitan Planning Organization

MEMORANDUM

To: Jay Fink Commissioner of Public Works, City of Lynn July 8, 2010

From: Chen-Yuan Wang

Re: Boston Region MPO Congested and High-Crash Intersections Study: Western Avenue at Eastern Avenue/Stanwood Street and Western Avenue at Waitt Avenue/Maple Street in Lynn

This memorandum summarizes safety and operations analyses and proposes improvement strategies for the intersections of Western Avenue at Eastern Avenue/Stanwood Street and at Waitt Avenue/Maple Street in Lynn. The two intersections are located in close proximity and should therefore be examined together. The memorandum contains the following sections:

- Intersection Layout and Traffic Control
- Issues and Concerns
- Crash Data Analysis
- Intersection Capacity Analysis
- Preliminary Analysis of Traffic Signal Warrants
- Analyses of Improvement Alternatives
- Improvement Recommendations

The memorandum also includes a collection of technical appendices that contain methods and data applied in the study and detailed reports of intersection capacity analysis.

INTERSECTION LAYOUT AND TRAFFIC CONTROL

The two intersections are located in the northeast part of the city near its border with Swampscott and Salem. Western Avenue is a part of state Route 107, which reaches downtown Salem in the north and connects Revere Beach Parkway (Route 16) in the south. Route 107 functions as an urban principal arterial and carries a high proportion of the regional traffic. Eastern Avenue is a part of state Route 129A, which diverges from Route 129 near Flax Pond and rejoins Route 129 in the coastal area of Lynn and Swampscott. It basically functions as an urban collector for its adjacent neighborhoods.

As Figure 1 shows, the two intersections are located about 300 feet from each other. The northern intersection, Western Avenue at Eastern Avenue/Stanwood Street, is currently under a two-way stop control with stop signs installed on Eastern Avenue and Stanwood Street. The southern intersection, Western Avenue at Waitt Avenue/Maple Street, is currently under traffic



signal control with pedestrian signal heads.¹ East of Western Avenue, Eastern Avenue and Waitt Avenue merge together, with a stop control on Waitt Avenue. West of Western Avenue, Stanwood Street and Maple Street also meet, at a recently constructed modern roundabout.

All of the streets running into the two intersections are two-lane roadways. All of the approaches have only a single travel lane shared by all movements, which flares somewhat near the intersection. On-street parking on Western Avenue is permitted in both directions between the two intersections. Crosswalks exist at all four approaches at the southern intersection. At the northern intersection, where Eastern Avenue and Stanwood Street are not aligned, crosswalks are installed only across Stanwood Street and on the northbound approach of Western Avenue.

The area is multi-family and single-family mixed residential, with commercial uses mainly along Western Avenue. At the northern intersection, a popular gas station is located on the northeastern corner, with curb cuts on Western Avenue and Eastern Avenue. Further north, Western Avenue is situated on a bridge over Floating Bridge Pond.

ISSUES AND CONCERNS

During peak periods, traffic is heavy on almost all of the approaches at the two intersections. Traffic is especially heavy on Route 107, which has four lanes north of the city border in Salem, but has only two lanes in this area. The area south of these two intersections is densely settled, with a number of signalized intersections located on Western Avenue. The two intersections essentially become a junction area where the southbound regional traffic diverges and the northbound regional traffic merges.

At the intersection of Western Avenue at Eastern Avenue/Stanwood Street, the southbound traffic is the heaviest among all approaches, with a high percentage of left and right turns. The left turns frequently back up due to heavy traffic in the opposite direction. Although the through and right-turn traffic sometimes can proceed around left turns, the entire approach can often be blocked when traffic is heavy from all approaches.

The right turns usually proceed without impedance if they are not blocked. The high volume of traffic includes a major portion of regional traffic seeking alternative paths to reach major highways in the west (such as Route 129 and Interstate 95) via local streets, such as Stanwood and Maple.

Under the two-way stop control, traffic on Eastern Avenue and Stanwood Street frequently forms extensive queues and experiences extensive delays. At times, aggressive drivers force themselves into the intersection, causing traffic blockages and near collisions. Crash data analysis indicates that this intersection has a much higher crash rate than similar intersections in the region (see the next section for details).

The intersection of Western Avenue at Waitt Avenue/Maple Street is under traffic signal control. Traffic on the minor streets (Waitt Avenue and Maple Street) moves fairly well, with reasonable delays. In order to prevent Maple Street traffic from spilling over to the roundabout upstream of

¹ Although President Street is also located very close to the intersection, it is a one-way eastbound street that carries a relatively low volume of traffic. The intersection operates as a regular four-legged intersection.

this intersection, the signal currently allocates a higher portion of phase time for the minor streets than the major street. As a result, traffic on the major street (Western Avenue), especially in the northbound direction, experiences more delays than the minor streets.

Based on field observations and a quick review of the available crash and traffic data, the issues and concerns for these two intersections can be summarized as:

- High number of crashes at the intersection of Western Avenue at Eastern Avenue/Stanwood Street.
- Traffic congestion at the two intersections during the peak hours.
- Extensive traffic queues and delays on Eastern Avenue and Stanwood Street during the peak periods. Aggressive traffic from the two approaches causes intersection blockages and near collisions.
- Southbound left turns to Eastern Avenue at times block the through traffic.
- Noticeable delays for the northbound traffic at the intersection of Western Avenue at Waitt Avenue/Maple Street.
- East-west drivers prefer to use the signalized intersection in order to avoid crossing Western Avenue at the northern unsignalized intersection.

CRASH DATA ANALYSIS

Based on the 2004–2006 Massachusetts Registry of Motor Vehicle (RMV) crash data, Table 1 shows that on average, 10 crashes occurred annually at the intersection of Western Avenue at Eastern Avenue/Stanwood Street. About 20% of the crashes resulted in personal injuries. The crash types consist of about 70% angle collisions and about 20% rear-end collisions. The high proportion of angle-type collisions is likely due to the lack of signal control coupled with the offset design between Eastern Avenue and Stanwood Street.

The crash rate² is another effective tool for examining the relative safety of a particular location. Based on the crash data and the available recent traffic counts, the crash rate for this intersection is calculated as 1.07 (see Appendix A for the calculation). The rate is much higher than the average rate for the unsignalized locations in MassHighway District 4, which is estimated as 0.58.³

Table 2 shows that an average of five crashes occurred at the intersection of Western Avenue at Waitt Avenue/Maple Street each year. Most of the crashes (80%) resulted in property damage only. The crash types consist of about 60% angle collisions and about 40% rear-end collisions. Field observations indicate that traffic is congested at this intersection during the peak hours, with no major safety concerns. The crash rate for this intersection is calculated as 0.53 (see the Appendix A for the calculation). The rate is lower than the average rate for the signalized locations in MassHighway District 4, which is estimated as 0.78.

² Crash rates are estimated based on crash frequency (crashes per year) and vehicle exposure (traffic volume or miles traveled). Crash rates are expressed as "crashes per million entering vehicles" for intersection locations and as "crashes per million miles traveled" for roadway segments.

³ The average crash rates estimated by the MassDOT Highway Division are based on a database that contains intersection crash rates submitted to the Highway Division as part of review process for an environmental impact report or functional design report. The most recent average crash rates, which are updated on a nearly yearly basis, are based on all entries in the database, not just those entries made within the past year.

Statistics Period		2004	2005	2006	3-Year	Average
Total number of cra	ashes	10	10	10	30	10
	Property damage	7	7	9	23	8
Severity	Personal injury	2	3	1	6	2
	Fatality	0	0	0	0	0
Not reported		1	0	0	1	0
	Angle	5	8	7	20	7
Collision Type	Rear-end	4	1	2	7	2
	Sideswipe	1	0	0	1	0
	Head-on	0	1	0	1	0
	Single vehicle	0	0	0	0	0
	Not reported	0	0	1	1	0
Crashes involved p	pedestrian(s)	0	0	0	0	0
Crashes involved cyclist(s)		0	0	1	1	0
Occurred during weekday peak periods*		2	4	2	8	3
Wet or icy pavement conditions		2	4	4	10	3
Dark/lighted condit	5	5	4	14	5	

TABLE 1 Summary of RMV Crash Data (2004–2006) Western Avenue at Eastern Avenue/Stanwood Street, Lynn

* Peak periods are defined as 7:00–10:00 AM and 3:30–6:30.

TABLE 2

Summary of RMV Crash Data (2004–2006) Western Avenue at Waitt Avenue/Maple Street, Lynn

	2004	2005	2006	3-Year	Average
ishes	3	6	5	14	5
Property damage	3	5	4	12	4
Personal injury	0	1	0	1	0
Fatality	0	0	0	0	0
Not reported		0	1	1	0
Angle	1	3	4	8	3
Rear-end	1	3	1	5	2
Sideswipe	1	0	0	1	0
Head-on	0	0	0	0	0
Single vehicle	0	0	0	0	0
Not reported	0	0	0	0	0
edestrian(s)	0	0	0	0	0
Crashes involved cyclist(s)		0	0	0	0
Occurred during weekday peak periods*		2	4	6	2
Wet or icy pavement conditions			2	2	1
Dark/lighted conditions			0	0	0
	shes Property damage Personal injury Fatality Not reported Angle Rear-end Sideswipe Head-on Single vehicle Not reported edestrian(s) yclist(s) ekday peak periods* at conditions ons	2004shes3Property damage3Personal injury0Fatality0Not reported0Angle1Rear-end1Sideswipe1Head-on0Single vehicle0Not reported0vclist(s)0vclist(s)0vclist(s)0ons0	2004 2005 shes 3 6 Property damage 3 5 Personal injury 0 1 Fatality 0 0 Not reported 0 0 Angle 1 3 Rear-end 1 3 Sideswipe 1 0 Head-on 0 0 Not reported 0 0 Single vehicle 0 0 Not reported 0 0 vclist(s) 0 0 vclist(s) 0 0 ons 0 0	2004 2005 2006 shes 3 6 5 Property damage 3 5 4 Personal injury 0 1 0 Fatality 0 0 0 1 Not reported 0 0 1 1 Angle 1 3 4 Rear-end 1 3 1 Sideswipe 1 0 0 Head-on 0 0 0 Single vehicle 0 0 0 Not reported 0 0 0 Victist(s) 0 0 0 wictist(s) 0 0 0 wickday peak periods* 0 2 4 th conditions 0 0 0	2004 2005 2006 3-Year shes 3 6 5 14 Property damage 3 5 4 12 Personal injury 0 1 0 1 Fatality 0 0 0 0 0 Not reported 0 0 1 1 1 Angle 1 3 4 8 Rear-end 1 3 1 5 Sideswipe 1 0 0 1 Head-on 0 0 0 0 Not reported 0 0 0 0 Single vehicle 0 0 0 0 Not reported 0 0 0 0 vclist(s) 0 0 0 0 vclist(s) 0 0 0 0 vclist(s) 0 0 0 0 vcons 0

* Peak periods are defined as 7:00–10:00 AM and 3:30–6:30.

INTERSECTION CAPACITY ANALYSIS

Staff collected turning movement counts at the two intersections on June 3, 2009. The data were recorded in 15-minute intervals for peak traffic periods in the morning, from 7:00 to 9:00, and in the evening, from 4:00 to 6:00. Meanwhile, 24-hour automatic traffic counts for 3 midweek days were collected by the MassDOT Highway Division in the week beginning May 11, 2009. Based on the 24-hour traffic counts, the turning movement counts at the two intersections were adjusted and balanced.

As seen in Table 3, the intersection of Western Avenue at Eastern Avenue/Stanwood Street carried about 2,000 vehicles in the morning peak hour, from 7:45 to 8:45, and about 2,200 vehicles in the evening peak hour, from 4:45 to 5:45. About 2 and 20 pedestrians crossed the intersection during the AM and PM peak hour, respectively.

As Table 4 shows, the intersection of Western Avenue at Waitt Avenue/Maple Street carried about 2,000 vehicles in the morning peak hour, from 7:45 to 8:45, and about 2,150 vehicles in

TABLE 3
AM and PM Peak Hour Traffic Volumes and Pedestrian Crossings
Western Avenue at Eastern Avenue/Stanwood Street, Lynn

Street	Street name Western Avenue ((Route 107) Stanwood Street		street	Eastern Avenue					
Direction		Northbound Southbound		ınd	Eastbound			Westbound			Total			
Turni	ng movement	LT	TH	RT	LT	TH	RT	LT	TH	RT	T LT TH R		RT	1
АМ	Turning volume	0	575	16	207	541	243	134	41	2	8	74	163	2004
peak	Approach volume		591			991		177		245			2001	
hour	Ped. crossings	2		0		0		0			2			
РМ	Turning volume	1	637	30	175	546	287	147	70	5	17	51	241	2207
peak hour	Approach volume		668			1008		222			309			2207
	Ped. crossings	6		10		1		2			19			

TABLE 4AM and PM Peak Hour Traffic Volumes and Pedestrian Crossings
Western Avenue at Waitt Avenue/Maple Street, Lynn

Street name Western Avenue (Rou						oute 10	7)	Maple Street			Waitt Avenue			
Direction		Northbound Southbound		Eastbound			Westbound			Total				
Turning movement		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
АМ	Turning volume	10	485	100	2	540	9	113	280	9	109	334	3	1004
peak	Approach volume	595			551		402		446			1994		
hour	Ped. crossings		3		1		2		2			8		
РМ	Turning volume	10	595	111	9	557	2	68	364	1	74	357	5	2152
peak	Approach volume		716			568		433			436			2100
hour	Ped. crossings		3		1		1		10			15		

the evening peak hour, from 4:45 to 5:45. About 10 and 15 pedestrians crossed the intersection during the AM and PM peak hour, respectively. Fewer than five cyclists were observed in both peak hours combined (not shown in the table).

Based on the adjusted turning movement counts, staff performed capacity analyses for the two intersections using the computer program Synchro.⁴ The intersection of Western Avenue at Eastern Avenue/Stanwood Street was analyzed according to the unsignalized intersection capacity analysis method of the Highway Capacity Manual.⁵

Analysis indicates that traffic on the stop-control approaches (Eastern Avenue and Stanwood Street) endures extensive delays (much more than 3 minutes) at level of service (LOS) F in both the AM and PM peak hours (see Table 5). Details of the analysis for both the AM and PM peak hours are included in Appendix B.

The intersection capacity analysis of Western Avenue at Waitt Avenue/Maple Street indicates that the intersection operates at LOS D in the AM peak hour and at LOS E in the PM peak hour (see Table 6). Analysis indicates a noticeably high average delay for traffic on Western Avenue,

TABLE 5Existing Intersection Capacity AnalysisWestern Avenue at Eastern Avenue/Stanwood Street, Lynn

Street	name	V	Western Avenue (Route 107)						Stanwood Street			Eastern Avenue		
Direction		Northbound		Southbound		Eastbound			Westbound					
Turning movement		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS		Α			Α		F			F			
hour	Delay (sec/veh)		0			6		> 180			> 180			
PM	LOS		Α			Α		F			F			
peak hour	Delay (sec/veh)		0			8		> 180		> 180				

TABLE 6Existing Intersection Capacity AnalysisWestern Avenue at Waitt Avenue/Maple Street, Lynn

Street	Street name Western Ave				ue (Route 107)			Maple Street			Waitt Avenue			
Direction		Northbound Southbound		Eastbound		Westbound			Overall					
Turning movement		LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT	
AM	LOS		Ε			D			С			С		D
hour	Delay (sec/veh)		70		44		25		26		44			
PM	LOS		F			D		В		С			Е	
peak hour	Delay (sec/veh)		114			43		20		21		58		

⁴ Synchro is intersection capacity analysis and traffic signal coordination software developed and distributed by Trafficware Ltd. It can be combined with SimTraffic to perform traffic simulation for an individual intersection or a series of intersections.

⁵ Transportation Research Board, *Highway Capacity Manual 2000*, National Research Council, Washington D.C., 2000.

especially in the northbound direction. Details of the analysis for both the AM and PM peak hours are included in Appendix C.

PRELIMINARY ANALYSIS OF TRAFFIC SIGNAL WARRANTS

One of the potential improvements for the intersection of Western Avenue at Eastern Avenue/Stanwood Street is to introduce traffic signal control. According to the Manual for Uniform Traffic Control Devices (MUTCD),⁶ an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location must be performed to determine whether installation of a traffic signal is justified at a particular location. The investigation must include criteria related to the following traffic signal warrants and other factors related to existing operations and safety at the study location:

- 1. Eight-Hour Vehicular Volume Warrant
- 2. Four-Hour Vehicular Volume Warrant
- 3. Peak Hour Warrant
- 4. Pedestrian Volume Warrant
- 5. School Crossing Warrant
- 6. Coordinated Signal System Warrant
- 7. Crash Experience Warrant
- 8. Roadway Network Warrant

A traffic control signal should not be installed unless two or more of the factors contained in these warrants are met. Moreover, the satisfaction of a warrant or warrants in itself does not justify the installation of a signal unless an engineering study indicates that the installation will improve the overall safety and/or operation of the intersection.

In this study, we performed a preliminary analysis of the applicable traffic signal warrants based on the hourly volumes averaged from the available 24-hour traffic counts. The applicable factors are contained in Warrants 1, 2, and 7, assuming that the intersection operates as an isolated location. Warrant 3 is intended for unusual cases, such as office complexes or manufacturing plants that attract or discharge large numbers of vehicles over a short time. The intersection does not carry a high pedestrian volume and is not close to any schools. As such, factors related to Warrants 3, 4, 5, and 8 were not considered.

Analysis found that the intersection meets Warrants 1 and 2 at a relatively high satisfaction level. Although Warrant 7 is also satisfied according to the reported crashes (see Table 1), it was applied as a supportive reason, not as the principal reason, for the signalization.

ANALYSIS OF IMPROVEMENT ALTERNATIVES

Analysis of traffic signal warrants indicates that the intersection of Western Avenue at Eastern Avenue/Stanwood Street qualifies for the installation of a traffic signal. The traffic signal would reduce traffic flow conflicts, thus improving safety, delays, and queues. In addition, this signal should be coordinated with the adjacent signal at the intersection of Western Avenue at Waitt

⁶ Federal Highway Administration, U.S. Department of Transportation, *Chapter 4C. Traffic Control Signal Needs*, 2003 edition with revision numbers 1 and 2 incorporated, December 2007.

Avenue/Maple Street. The coordination would improve traffic movements and thus reduce delays and conflicts at both intersections.

Staff used Synchro to perform a two-stage traffic signal optimization analysis. In the first stage, the two intersections were analyzed and optimized separately as individual locations. Once the most suitable operation was identified for each of the two intersections, we then conducted the second stage analysis, in which the two intersections were coordinated and analyzed as one network system.

In the first stage, a number of signal operation and geometric design strategies were tested for the intersection of Western Avenue at Eastern Avenue/Stanwood Street. The alternatives tested for this intersection include:

- 1) Two-phase permissive LT (left-turn)/ RT (right-turn) operation on all approaches, under the existing geometry
- 2) NB/SB (northbound/southbound) permissive phase and EB/WB (eastbound/westbound) split phase,⁷ under the existing geometry
- 3) NB/SB permissive phase led by SB traffic with protected LT and EB/WB permissive phase, with the addition of an SB exclusive LT lane and a WB-RT exclusive lane

At this intersection, the SB traffic is the heaviest among all approaches and the SB left turns frequently back up. Although through and right-turn traffic sometimes can proceed around the left turns, the entire approach can be blocked when traffic is heavy from all approaches. Synchro analyses reflect these observations and show that only Alternative 3 can operate at acceptable levels of service for all approaches. The results from Alternative 3 are summarized and included in Table 7 (capacity analyses for selected alternatives in both stages), and detailed Synchro analyses are attached in Appendix D.

Based on the State Roadway Inventory file, Western Avenue has a right-of-way (ROW) of 56 feet and a pavement width of 45 feet for about 150 feet north of this intersection before the bridge section. It appears feasible to add an 11-foot SB LT lane within the existing pavement width. Analyses indicate that a storage length of about 240 feet is desirable for the LT lane.⁸ As the space in the area is limited, we consider a storage length of 120 feet acceptable at this intersection.⁹ Meanwhile, the WB approach has an ROW of 64 feet and a pavement width of 42 feet for about 800 feet east of this intersection. It is feasible to insert an RT exclusive lane on the approach, which would be beneficial for the intersection operation. Analysis indicates that a storage length of 80 feet would be sufficient for the RT lane.

A similar procedure was applied to the intersection of Western Avenue at Waitt Avenue/Maple Street. It was found that intersection operations could be improved by increasing slightly the cycle length under the existing signal phasing sequence and adding an exclusive RT lane on the

⁷ The split phase operation is considered helpful at this intersection, as Eastern Avenue and Stanwood Street are not aligned across each other. However, it was not evaluated as favorable due to heavy traffic on Western Avenue and limited space available for lane additions in desirable lengths for almost all approaches.

⁸ The estimation is based on the 95th percentile queue from the worst case among alternatives under the future year traffic conditions.

⁹ The estimation is based on one and a half times the 50th percentile queue from the worst case among alternatives under the future year traffic conditions.

NB approach (by removing two on-street parking spaces). The capacity analyses for this intersection are summarized and included in Table 8. Detailed analyses are in Appendix E.

TABLE 7 Intersection Capacity Analysis of Selected Alternatives Existing Traffic Conditions Western Avenue at Eastern Avenue/Stanwood Street, Lynn

Street	Name	Western Ave	e. (Route 107)	Eastern Ave.	Eastern Ave./Stanwood St.			
Approach		Northbound Southbound Eas		Eastbound	Westbound	Overall		
AM Existing		A/0	A/6	F/>180	F/>180	NA		
peak	Stage 1	D/36	C/22	D/46	B/16	C/28		
hour	Stage 2	B/13	C/22	D/54	B/17	C/21		
РМ	Existing	A/0	A/8	F/>180	F/>180	NA		
peak	Stage 1	D/49	C/21	D/55	B/14	C/32		
hour	Stage 2	A/9	C/25	D/47	B/14	C/21		

Note: Performance Measures: Level of Service (A to F)/Average Delay (seconds per vehicle)

Selected Alternative in Stage 1: NB/SB Permissive Phase Led by SB with a Protected LT and EB/WB Permissive Phase, with the Addition of an SB-LT Lane and a WB-RT Lane

Selected Alternative in Stage 2: Coordinated with the Signal at Waitt Avenue/Maple Street under the Same Signal Phasing Sequence as in Stage 1

TABLE 8 Intersection Capacity Analysis of Selected Alternatives Existing Traffic Conditions Western Avenue at Waitt Avenue/Maple Street, Lynn

Street	name	Western Ave	e. (Route 107)	Waitt Ave	Waitt Ave./Maple St.			
Approach		Northbound	Southbound	Eastbound	Westbound	Overall		
AM	Existing	E/70	D/44	C/25	C/26	D/44		
peak	Stage 1	C/31	E/58	C/31	C/31	D/39		
hour	Stage 2	C/30	C/29	D/35	D/36	C/32		
РМ	Existing	E/114	D/43	B/20	C/21	E/58		
peak hour	Stage 1	C/29	E/55	C/32	C/33	D/37		
	Stage 2	C/29	C/20	C/34	D/35	C/29		

Note: Performance Measures: Level of Service (A to F)/Average Delay (seconds per vehicle)

Selected Alternative in Stage 1: Two-Phase Permissive Operation for All Approaches with the Addition of an NB RT Lane Selected Alternative in Stage 2: Coordinated with the Signal at Eastern Avenue/Stanwood Street under the Same Signal Phasing Sequence as Stage 1

In the second stage, we tested different combinations of network cycle lengths and offsets for the two intersections through applications of the Synchro network optimization functions. To reduce the possibilities of traffic backing up to the upstream roundabout, we selected a relatively short cycle length of 90 seconds (including the pedestrian signal time) and assigned a higher percentage of green phase times for the EB/WB approaches at the intersection of Western Avenue at Waitt Avenue/Maple Street. The signal at Eastern Avenue is selected as the master intersection as it has a higher traffic volume than the other signal.

As Tables 7 and 8 show, with the coordination (Stage 2), both intersections would operate at a better overall level of service with less delay than the alternative without coordination (Stage 1). Detailed network settings and Synchro analyses of the two intersections in the second stage are in Appendices F and G.

With the installation of the new signal and its coordination with the existing one, traffic at the two intersections is expected to shift between the two intersections and rebalance. To reflect this phenomenon, this study also examined a scenario of a 50% shift of the left-turning traffic from Maple Street to Stanwood Street and found that the two intersections would still operate at the same level of service (LOS) as in the original case.

In addition, a future-year scenario of 8% growth over a 20-year planning horizon was tested for the selected alternatives. The growth assumption is based on a review of the traffic projections in the North Shore area from the recent Boston Region MPO transportation-planning model. Higher numbers (than in existing conditions) of pedestrian calls (20% growth) were assumed for both intersections in the future-year analysis.

Results from Synchro analyses with the projected traffic growth are summarized in Tables 9 and 10 for the two intersections separately. With the coordination (Stage 2), both intersections would still operate at an overall acceptable LOS D under the projected traffic conditions.

TABLE 9 Intersection Capacity Analysis of Selected Alternatives 2030 Projected Traffic Conditions Western Avenue at Eastern Avenue/Stanwood Street, Lynn

Street	Name	Western Ave	e. (Route 107)	Eastern Ave.	Overall		
Approach		Northbound Southbound		Eastbound	Westbound	Overan	
AM Existing		A/0	A/7	F/>180	F/>180	NA	
peak	Stage 1	F/97	C/27	D/55	B/16	D/49	
hour	Stage 2	C/33	D/41	D/51	B/16	D/36	
РМ	Existing	A/0	A/7	F/>180	F/>180	NA	
peak	Stage 1	F/86	C/25	E/69	B/14	D/46	
hour	Stage 2	D/43	B/13	E/68	B/18	D/43	

Note: Performance measures: Level of Service (A to F)/Average Delay (seconds per vehicle)

Selected Alternative in Stage 1: NB/SB Permissive Phase led by SB with a Protected LT and EB/WB Permissive Phase, with the Addition of an SB-LT Lane and a WB-RT Lane

Selected Alternative in Stage 2: Coordinated with the Signal at Waitt Avenue/Maple Street under the Same Signal Phasing Sequence as Stage 1

		Western Aven	ue at Waitt Av	enue/Maple S	treet, Lynn	
Street	reet name Western Ave. (Route 107) Waitt Ave./Maple St.		Overall			
Appro	ach	Northbound	Southbound	Eastbound	Westbound	Overall
AM	Existing	F/97	E/59	C/31	C/32	E/59
peak	Stage 1	C/30	E/66	D/51	D/51	D/49
hour	Stage 2	D/44	D/43	D/41	D/42	D/43
PM	Existing	F/155	E/60	C/22	C/23	E/76
peak	Stage 1	C/31	F/92	D/43	D/47	D/53
hour	Stage 2	D/40	E/66	D/35	D/36	D/45

TABLE 10Intersection Capacity Analysis of Selected Alternatives
2030 Projected Traffic ConditionsWestern Avenue at Waitt Avenue/Maple Street, Lynn

Note: Performance Measures: Level of Service (A to F)/Average Delay (seconds per vehicle)

Selected Alternative in Stage 1: Two-Phase Permissive Operation for All Approaches with the Addition of an NB RT Lane Selected Alternative in Stage 2: Coordinated with the Signal at Eastern Avenue/Stanwood Street under the Same Signal Phasing Sequence as Stage 1

IMPROVEMENT RECOMMENDATIONS

A series of analyses were conducted for the two intersections in this study. We first performed the signal warrant analysis for the intersection of Western Avenue at Eastern Avenue/Stanwood Street and made sure that the installation of a traffic signal control is justified. We then used Synchro to perform a two-stage traffic signal optimization analysis. In the first stage, the two intersections were analyzed and optimized as isolated intersections. Once the most suitable operation was selected for each of them, we performed the second stage analysis, in which the two intersections were coordinated and analyzed as one network system.

Based on the analyses, we propose the following improvements for the two intersections:

Western Avenue at Eastern Avenue/Stanwood Street

- Modify the southbound approach to include a left-turn exclusive lane.¹⁰
- Modify the westbound approach to include an exclusive right-turn exclusive lane.¹¹
- Signalize the intersection.
- Coordinate this traffic signal with the signal at Waitt Avenue/Maple Street.

Western Avenue at Waitt Avenue/Maple Street

- Add a short northbound right-turn lane by removing two on-street parking spaces.
- Coordinate this traffic signal with the signal at Eastern Avenue/Stanwood Street.

¹⁰ As the space in the area is limited, the modifications have to be achieved by restriping travel lanes or slightly expanding the pavement surface under the existing right-of-way. Based on the Synchro queuing estimation, we consider a storage length of 120 feet to be acceptable.

¹¹ A storage length of 80 feet is sufficient based on Synchro queuing estimation.

As mentioned, the two intersections are essentially a junction area where the southbound regional traffic diverges and the northbound regional traffic merges. The coordination would synchronize and balance traffic movements at both intersections and thus improve operations and safety with reduced delays and conflicts.

With the installation of the new signal and its coordination with the existing one, traffic at the two intersections is expected to shift between the two intersections and rebalance. To reflect this phenomenon, this study also examined a scenario of a 50% shift of the left-turning traffic from Maple Street to Stanwood Street and found that the two intersections would still operate at the same LOS and with the same delays as in the original case. We recommend that traffic volumes at the two intersections and applicable signal timing parameters be monitored during the early stages of implementation until traffic volume shifts stabilize and the operation of the coordinated traffic signals is optimal.

The coordinated signals would also provide an exclusive pedestrian signal phase separately for pedestrians to safely cross either intersection. Sidewalks and crosswalks should be considered for all approaches when the intersection at Eastern Avenue/Stanwood Street is reconstructed for the installation of a traffic signal. The signal system should include pedestrian signal heads with an accessible (audible) pedestrian signal.

Appendix A

Intersection Crash Rate Calculation

Western Avenue at Eastern Avenue/Stanwood Street, Lynn Western Avenue at Waitt Avenue/Maple Street, Lynn



INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Lynn				COUNT DA	TE :	5/26/09
DISTRICT : 4	UNSIGN	ALIZED :	Х	SIGNA	LIZED :	
		~ IN	ITERSECTION	I DATA ~		
MAJOR STREET :	Western Ave	nue				
MINOR STREET(S) :	Eastern Aver	nue				
	Stanwood St	reet				
		1				
			Western			
INTERSECTION	North		Avenue	- ·	•	
DIAGRAM (Label Approaches)				Eastern /	Avenue	
		Stanwood S	Street			
				Western		
	N			Avenue		
			PEAK HOU	R VOLUMES		
APPROACH :	1	2	3	4	5	Total Peak Hourly
DIRECTION :	NB	SB	EB	WB		Approach Volume
PEAK HOURLY VOLUMES (AM/PM) :	668	1108	222	309		2,307
"K "FACTOR :	0.090	INTERS	SECTION ADT APPROACH	(V)= TOT# I VOLUME:	AL DAILY	25,633
TOTAL # OF CRASHES :	30	# OF YEARS :	3	AVERA CRASHES A	GE # OF PER YEAR(、):	10.00
CRASH RATE CALCU	JLATION :	1.07	RATE =	<u>(A*1,0</u> (V	000,000) * 365)	
Comments :						
Project Title & Date:	Boston MPO	Congested	and High-Cras	h Intersection	ns Study	



INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Lynn				COUNT DA	TE:	5/26/09				
DISTRICT : 4	UNSIGNALIZED : X			SIGNALIZED :						
~ INTERSECTION DATA ~										
MAJOR STREET :	Western Ave	/estern Avenue								
MINOR STREET(S) :	Waitt Avenue	Naitt Avenue								
	Maple Street	Vaple Street								
			Western							
INTERSECTION	North		Avenue							
DIAGRAM		Avenue								
		Maple Stre	eet							
	▲									
	N		Avenue							
			PEAK HOUP							
APPROACH :	1	2	3	4	5	Total Peak Hourly				
DIRECTION :	NB	SB	EB	WB		Approach Volume				
PEAK HOURLY VOLUMES (AM/PM) :	716	568	433	436		2,153				
"K "FACTOR :	0.090	INTERS	ECTION ADT APPROACH	(V)= TOT/ I VOLUME:	AL DAILY	23,922				
TOTAL # OF CRASHES :	14	# OF YEARS :	3	AVERA CRASHES A	GE # OF PER YEAR(、):	4.67				
CRASH RATE CALCU	JLATION :	0.53	RATE =	<u>(A*1,</u> (V	000,000) * 365)					
Comments :										
Project Title & Date: Boston MPO Congested and High-Crash Intersections Study										

Appendix B

AM/PM Peak Hour Intersection Capacity Analysis Existing Traffic Conditions Western Avenue at Eastern Avenue/Stanwood Street, Lynn

HCM Unsignalized Intersection Analysis Western Ave @ Eastern Ave/Stanwood St

2/10/2010	2/1	6/2010
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	_#	-*	7	F	•	ť	•	*	~	í,	¥	*
Movement	EBL	EBR	EBR2	NWL2	NWL	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	M				M			÷			\$	
Volume (veh/h)	134	41	2	8	74	163	0	575	16	207	541	243
Sign Control	Stop				Stop			Free			Free	
Grade	0%				0%			0%			0%	
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Hourly flow rate (vph)	143	44	2	9	79	173	0	612	17	220	576	259
Pedestrians								2				
Lane Width (ft)								16.0				
Walking Speed (ft/s)								4.0				
Percent Blockage								0				
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								302				
pX, platoon unblocked	0.70	0.70		0.70	0.70	0.70				0.70		
vC, conflicting volume	1978	1774	707	1791	1895	620	834			629		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2179	1889	707	1914	2061	250	834			262		
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 %	0	0	100	0	0	69	100			76		
cM capacity (veh/h)	0	37	433	0	29	552	791			912		
Direction, Lane #	EB 1	NW 1	NE 1	SW 1								
Volume Total	188	261	629	1054								
Volume Left	143	9	0	220								
Volume Right	2	173	17	259								
cSH	0	0	791	912								
Volume to Capacity	Err	Err	0.00	0.24								
Queue Length 95th (ft)	Err	Err	0	24								
Control Delay (s)	Err	Err	0.0	6.0								
Lane LOS	F	F		А								
Approach Delay (s)	Err	Err	0.0	6.0								
Approach LOS	F	F										
Intersection Summary												
Average Delay			Err									
Intersection Capacity Utilization	n		136.4%	IC	U Level	of Service			Н			
Analysis Period (min)			15									

HCM Unsignalized Intersection Analysis Western Ave @ Eastern Ave/Stanwood St

2/16/2010	
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Movement	EBL	EBR	EBR2	NWL2	NWL	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations	M				M			4			\$	
Volume (veh/h)	147	70	5	17	51	241	1	637	30	175	546	287
Sign Control	Stop				Stop			Free			Free	
Grade	0%				0%			0%			0%	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Hourly flow rate (vph)	152	72	5	18	53	248	1	657	31	180	563	296
Pedestrians	1				2			10			10	
Lane Width (ft)	15.0				15.0			16.0			16.0	
Walking Speed (ft/s)	4.0				4.0			4.0			4.0	
Percent Blockage	0				0			1			1	
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								302				
pX, platoon unblocked	0.69	0.69		0.69	0.69	0.69				0.69		
vC, conflicting volume	2032	1764	722	1799	1897	684	860			690		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	2272	1884	722	1935	2077	315	860			323		
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 %	0	0	99	0	0	50	100			79		
cM capacity (veh/h)	0	38	423	0	29	495	789			854		
Direction, Lane #	EB 1	NW 1	NE 1	SW 1								
Volume Total	229	319	689	1039								
Volume Left	152	18	1	180								
Volume Right	5	248	31	296								
cSH	0	0	789	854								
Volume to Capacity	Err	Err	0.00	0.21								
Queue Length 95th (ft)	Err	Err	0	20								
Control Delay (s)	Err	Err	0.0	5.4								
Lane LOS	F	F	А	А								
Approach Delay (s)	Err	Err	0.0	5.4								
Approach LOS	F	F										
Intersection Summary												
Average Delay			Err									
Intersection Capacity Utilization	ו		150.0%	IC	U Level o	of Service			Н			
Analysis Period (min)			15									

Appendix C

AM/PM Peak Hour Intersection Capacity Analysis Existing Traffic Conditions Western Avenue at Waitt Avenue/Maple Street, Lynn

Intersection Capacity Analysis Western Ave @ Waitt Ave/Maple St

	_#	-	7	۴	+	۲	3	×	/	6	¥	*
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		4			\$			4			\$	
Volume (vph)	113	280	9	109	334	3	10	485	100	2	540	9
Confl. Peds. (#/hr)	1		3	3		1	1		2	2		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)									0			0
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	428	0	0	474	0	0	633	0	0	586	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4			8		
Detector Phase	2	2		6	6		4	4		8	8	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Minimum Split (s)	16.0	16.0		16.0	16.0		20.0	20.0		20.0	20.0	
Total Split (s)	29.0	29.0	0.0	29.0	29.0	0.0	24.0	24.0	0.0	24.0	24.0	0.0
Total Split (%)	41.4%	41.4%	0.0%	41.4%	41.4%	0.0%	34.3%	34.3%	0.0%	34.3%	34.3%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		None	None		Max	Max		None	None	
Act Effct Green (s)		24.3			24.3			19.2			19.2	
Actuated g/C Ratio		0.43			0.43			0.34			0.34	
v/c Ratio		0.73			0.76			1.04			0.92	
Control Delay		25.4			25.9			69.5			43.8	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		25.4			25.9			69.5			43.8	
LOS		С			С			Е			D	
Approach Delay		25.4			25.9			69.5			43.8	
Approach LOS		С			С			Е			D	
Queue Length 50th (ft)		100			112			191			167	
Queue Length 95th (ft)		#342			#375			#545			#489	
Internal Link Dist (ft)		236			49			618			222	
Turn Bay Length (ft)												
Base Capacity (vph)		584			627			611			634	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		0.73			0.76			1.04			0.92	
Intersection Summary												
Cycle Length: 70												

Lane Configurations Volume (uph) Confi. Peds. (#hr) Confi. Peds. (#hr) Parking (#hr) Parking (#hr) Parking (#hr) Parking (#hr) MuGBlock Traffic (%) Shared Lane Traffic (%) Lane Group Flow (uph) Tum Type Protected Phases 9 Permitted Phase 9 Permitted Phases 9 Permitted Phase 9 Permitted Phas	Lane Group	ø9	
Volume (vph) Confl. Peds. (#rh) Confl. Bikes (#rh) Peak Hour Factor Gröwth Factor Gröwth Factor Heavy Vehicles (%) Busses Bus Blockages (#rh) Parking (#rh) Parking (#rh) Mid-Biock Traffic (%) Stared Lane Traffic (%) Lane Group Flow (vph) Tum Type Protected Phases Protected Phases 9 Protected Phases 9 Permited Phases 9 Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 17.0 Total Split (%) 2.4% Yellow Time (s) 3.0 AlAread Time (s) 2.0 Lost Time Adjust (s) 2.0 Lost Time (s) 2.0 Lost Time Adjust (s) 7.0 Total Lost Time (s) 2.0 Lead Lag Optimize? Reacel Mode None Act Eft C Green (s) Actuated gr C Raio Vic Ratio Control Delay Oureue Delay Oureue Delay Oureue Delay Oureue Delay Oureue Delay Oureu Delay Oureue Delay Delay Oureu Delay Oureu D	Lane Configurations		
Conf. Bikes (#hr) Conf. Bikes (#hr) Peak Hour Factor Facto	Volume (vph)		
Confl. Bikes (#/m) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/m) Parking (wfm) Mid-Block Traffic (%) Stared Lane Traffic (%) Stared Lane Traffic (%) Lane Group Flow (vph) Tum Type Protected Phases Detector Phase Switch Phase Minimum Initial (\$) 4.0 Minimum Split (\$) 17.0 Total Split (\$) 17.0 Total Split (\$) 17.0 Total Split (\$) 2.0 Lost Time 4() 2.0 Lost Time (\$) 2.4% Yellow Time (\$) 2.0 Lead'Lag Optimize? Recall Mode None Act Eff Green (\$) Actuated g/C Ratio Vice Ratio Vice Ratio Queue Delay Total Delay Queue Delay Total Delay Queue Delay Queue Delay Queue Delay Total Delay Queue Delay Total Delay Queue Delay Total Delay Queue Delay Min (\$)	Confl. Peds. (#/hr)		
Peak Hour Factor Growth Factor Heavy Venicles (%) Bus Blockages (#hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Tum Type Protected Phases 9 Permitted Phases 9 Permitted Phases 9 Permitted Phases 9 Detector Phase 9 Minimum Initial (s) 4.0 Minimum Split (s) 17.0 Total Split (s) 17.0 Total Split (s) 2.0 Lost Time Agust (s) 2.0 Lost Time Agust (s) 2.0 Lead-Lag Optimize? Recall Mode Recall Mode None Act EdfG Green (s) Actuated g/C Ratio Vic Ratio Control Delay Queue Delay Control Delay Couter Longth Sthi (ft) Time Agust (s) Total Delay Control Delay Queue Length Sthi (ft) Control Delay Queue Length Sthi (ft) Control Delay Queue Length Sthi (ft) Time Agust (b) Time Agust (b)	Confl. Bikes (#/hr)		
Growth Factor Heavy Vehicles (%) Biockages (#rhr) Parking (#rhr) Mid-Block Traffic (%) Shared Lane Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Tum Type Protected Phases Switch Phase Detector Phase Switch Phase Minimum Split (s) 17.0 Total Split (%) 2.4% Yellow Time (s) 3.0 All-Red Time (s) 2.0 Last Time Adjust (s) Total Split (%) Total Split (%) 2.4% Yellow Time (s) 3.0 All-Red Time (s) 2.0 Lead-Lag Optimize? Lead-Lag Optimize? Recall Mode None Act Effic Green (s) Actuated gic Ratio Actuated gic Ratio Vic Ratio Control Delay Queue Delay Total Delay Queue Delay Control Delay Queue Length Sthi (h) Internatium Link Dit (h) Internatume Link Dit (h) Tum Bay Length (th) Sac	Peak Hour Factor		
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Turn Type Protected Phases Detector Phase Switch Phase Minimun Initial (s) 4.0 Minimun Spit (s) 17.0 Total Spit (s) 17.0 Total Spit (s) 2.0 Last Time Adjust (s) Total Spit (s) 2.0 Last Time Adjust (s) Total Lost Time (s) Lead-Lag Optimize? Recall Mode None Act Lated C Ratio Vic Ratio Control Delay Queue Delay Total Delay Queue Length SDth (th) Queue Delay Turn Bay Length (th) Base Capacity (vph) Starvation Cap Reductn Spitaeck Vic Ratio	Lane Group Flow (vph)		
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Detector Phase Switch Phase Minimum Initial (s) 4.0 Minimum Split (s) 17.0 Total Split (s) 17.0 Total Split (s) 2.4% Yellow Time (s) 3.0 All-Red Time (s) 2.0 Lost Time Adjust (s) Total Lost Time (s) Total Lost Time (s) 2.0 Lead/Lag Ead/Lag Lead/Lag (Cation vice (Cation v	Permitted Phases		
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Minimum Initial (s) 4.0 Minimum Split (s) 17.0 Total Split (s) 17.0 Total Split (%) 24% Yellow Time (s) 3.0 All-Red Time (s) 2.0 Lost Time Adjust (s) Total Lost Time (s) Total Lost Time (s) 2.0 Lost Time (s) 2.0 Lost Time (s) 2.0 Lead/Lag Valle Cast Time (s) Act Effet Green (s) Actuated g/C Ratio Actuated g/C Ratio Vic Ratio Control Delay Queue Delay Total Delay Queue Delay Total Delay Queue Length Soth (ft) Queue Length Soth (ft) Queue Length Soth (ft) Internal Link Dist (ft) Tum Bay Length (ft) Base Capacity (wph) Starvation Cap Reductn Storage Cap Reductn Storage Cap Reductn Sporage Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Switch Phase		
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Total Split (%) 24% Yellow Time (s) 3.0 All-Red Time (s) 2.0 Lost Time Adjust (s) Total Lost Time (s) Lead/Lag Total Lost Time (s) Lead/Lag Optimize? Recall Mode Recall Mode None Act Effct Green (s) Actuated g/C Ratio Vic Ratio Vic Ratio Control Delay Control Delay Queue Delay Total Delay LOS Approach Delay Approach Delay Queue Length 50th (ft) Internal Link Dist (ft) Internal Link Dist (ft) Tum Bay Length (ft) Base Capacity (wph) Starvation Cap Reductn Storage Cap Reductn Storage Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Total Split (s)	17.0	
Yellow Time (s) 3.0 All-Red Time (s) 2.0 Lost Time Adjust (s) Total Lost Time (s) Lead/Lag Lead/Lag Lead/Lag Lead/Lag Lead/Lag None Act Effct Green (s) Actuated g/C Ratio Actuated g/C Ratio V/c Ratio V/c Ratio Control Delay Queue Delay Total Delay LOS Approach Delay Queue Length 50th (ft) Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Tum Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Storage Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary Intersection Summary	Total Split (%)	24%	
All-Red Time (s) 2.0 Lost Time Adjust (s) Total Lost Time (s) Lead/Lag Lead/Lag Lead-Lag Optimize? Recall Mode Recall Mode None Act Effct Green (s) Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay LOS Approach LOS Queue Length 50th (ft) Internal Link Dist (ft) Turm Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Sorage Cap Reductn Spillback Cap Reductn Reduced v/c Ratio Intersection Summary Intersection Summary	Yellow Time (s)	3.0	
Lost Time Adjust (s) Total Lost Time (s) Lead/Lag Lead-Lag Optimize? Recall Mode None Act Effct Green (s) Actuated g/C Ratio V/C Ratio Control Delay Queue Delay Total Delay LOS Approach Delay Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 50th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced V/C Ratio Intersection Summary	All-Red Time (s)	2.0	
Total Lost Time (s) Lead/Lag Lead-Lag Optimize? Recall Mode None Act Effct Green (s) Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay LOS Approach Delay Queue Length 50th (ft) Queue Length 50th (ft) Queue Length 50th (ft) Sase Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Lost Time Adjust (s)		
Lead/Lag Dptimize? Recall Mode None Act Effct Green (s) Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Total Lost Time (s)		
Lead-Lag Optimize? Recall Mode None Act Effct Green (s) Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay Queue Delay Total Delay Queue Delay LOS Approach Delay Queue Length 50th (ft) Queue Length 50th (ft) Internal Link Dist (ft) Turm Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Lead/Lag		
Recall Mode None Act Effct Green (s) Actuated g/C Ratio Actuated g/C Ratio V/c Ratio Control Delay Oucue Delay Queue Delay Total Delay LOS Approach Delay Approach Delay Oucue Delay Queue Length S0th (ft) Oucue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Spillback Cap Reductn Reduced v/c Ratio Intersection Summary Intersection Summary	Lead-Lag Optimize?		
Act Effct Green (s) Actuated g/C Ratio V/c Ratio Control Delay Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Recall Mode	None	
Actuated g/C Ratio v/c Ratio Control Delay Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Act Effct Green (s)		
v/c Ratio Control Delay Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Actuated g/C Ratio		
Control Delay Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	v/c Ratio		
Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (tt) Queue Length 95th (tt) Internal Link Dist (tt) Turn Bay Length (tt) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Spillback Cap Reductn Reduced v/c Ratio Intersection Summary	Control Delay		
Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Queue Delay		
LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Total Delay		
Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	LOS		
Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Approach Delay		
Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Approach LOS		
Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Queue Length 50th (ft)		
Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Queue Length 95th (ft)		
Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Internal Link Dist (ft)		
Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Turn Bay Length (ft)		
Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Base Capacity (vph)		
Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Starvation Cap Reductn		
Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Spillback Cap Reductn		
Reduced v/c Ratio Intersection Summary	Storage Cap Reductn		
Intersection Summary	Reduced v/c Ratio		
	Intersection Summary		

Actuated Cycle Length: 56.4				
Natural Cycle: 90				
Control Type: Actuated-Uncoordinated				
Maximum v/c Ratio: 1.04				
Intersection Signal Delay: 43.8	Intersection LOS: D			
Intersection Capacity Utilization 85.3%	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: 5: Int	-	
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Intersection Capacity Analysis Western Ave @ Waitt Ave/Maple St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		\$			\$			4			\$	
Volume (vph)	68	364	1	74	357	5	10	595	111	9	557	2
Confl. Peds. (#/hr)	1		3	3		1	1		10	10		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)									0			0
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	446	0	0	449	0	0	737	0	0	585	0
Turn Type	Perm			Perm			Perm			Perm		
Protected Phases		2			6			4			8	
Permitted Phases	2			6			4			8		
Detector Phase	2	2		6	6		4	4		8	8	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0		4.0	4.0	
Minimum Split (s)	16.0	16.0		16.0	16.0		20.0	20.0		20.0	20.0	
Total Split (s)	29.0	29.0	0.0	29.0	29.0	0.0	24.0	24.0	0.0	24.0	24.0	0.0
Total Split (%)	41.4%	41.4%	0.0%	41.4%	41.4%	0.0%	34.3%	34.3%	0.0%	34.3%	34.3%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	4.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	Max	Max		None	None		Max	Max		None	None	
Act Effct Green (s)		24.3			24.3			19.2			19.2	
Actuated g/C Ratio		0.43			0.43			0.34			0.34	
v/c Ratio		0.63			0.65			1.17			0.92	
Control Delay		19.9			20.6			114.2			43.0	
Queue Delay		0.0			0.0			0.0			0.0	
Total Delay		19.9			20.6			114.2			43.0	
LOS		В			С			F			D	
Approach Delay		19.9			20.6			114.2			43.0	
Approach LOS		В			С			F			D	
Queue Length 50th (ft)		98			99			~276			166	
Queue Length 95th (ft)		#317			#326			#642			#486	
Internal Link Dist (ft)		236			45			618			222	
Turn Bay Length (ft)												
Base Capacity (vph)		705			693			632			636	
Starvation Cap Reductn		0			0			0			0	
Spillback Cap Reductn		0			0			0			0	
Storage Cap Reductn		0			0			0			0	
Reduced v/c Ratio		0.63			0.65			1.17			0.92	
Intersection Summary												
Cycle Length: 70												

Lane Group	Ø۶	
Lane Configurations		
Volume (vph)		
Confl. Peds. (#/hr)		
Confl. Bikes (#/hr)		
Peak Hour Factor		
Growth Factor		
Heavy Vehicles (%)		
Bus Blockages (#/hr)		
Parking (#/hr)		
Mid-Block Traffic (%)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	9	
Permitted Phases		
Detector Phase		
Switch Phase		
Minimum Initial (s)	4.0	
Minimum Split (s)	17.0	
Total Split (s)	17.0	
Total Split (%)	24%	
Yellow Time (s)	3.0	
All-Red Time (s)	2.0	
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Recall Mode	None	
Act Effct Green (s)		
Actuated g/C Ratio		
v/c Ratio		
Control Delay		
Queue Delay		
Total Delay		
LOS		
Approach Delay		
Approach LOS		
Queue Length 50th (ft)		
Queue Length 95th (ft)		
Internal Link Dist (ft)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

Ac	tuated Cycle Length: 56.4					
Na	latural Cycle: 90					
Со	Control Type: Actuated-Uncoordinated					
Ma	ximum v/c Ratio: 1.17					
Intersection Signal Delay: 57.5 Intersection LOS: E						
Intersection Capacity Utilization 92.3% ICU Level of Service F						
An	alysis Period (min) 15					
~	Volume exceeds capacity, queue is theoretically infinite.					
	Queue shown is maximum after two cycles.					
#	95th percentile volume exceeds capacity, queue may be long	ger.				
	Queue shown is maximum after two cycles.					

Splits and Phases: 5: Int

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Appendix D

AM/PM Peak Hour Intersection Capacity Analysis

Stage 1 Selected Alternative: NB/SB Permissive Phase Led by SB with Protected LT and EB/WB Permissive Phase, with the Additions of a SB-LT Lane and a WB-RT Exclusive Lane

Western Avenue at Eastern Avenue/Stanwood Street, Lynn

2/16/2010

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Lane Group	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		\$			ર્સ	1		4		ሻ	t,	
Volume (vph)	134	41	2	8	74	163	0	575	16	207	541	243
Confl. Peds. (#/hr)			2	2								
Confl. Bikes (#/hr)												
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	3%	3%	3%	4%	4%	4%	4%	4%	4%	3%	3%	3%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)						0						0
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	189	0	0	88	173	0	629	0	220	835	0
Turn Type	Perm			Perm		Perm	Perm			pm+pt		_
Protected Phases		2			6			8		7	4	
Permitted Phases	2			6	-	6	8			4		
Detector Phase	2	2		6	6	6	8	8		7	4	
Switch Phase	_	_		•	· ·	· ·	, C	•		-		
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	20.0	20.0		20.0	20.0	20.0	20.0	20.0		8.0	29.0	
Total Split (s)	20.0	20.0	0.0	20.0	20.0	20.0	41.0	41.0	0.0	12.0	53.0	0.0
Total Split (%)	22.2%	22.2%	0.0%	22.2%	22.2%	22.2%	45.6%	45.6%	0.0%	13.3%	58.9%	0.0%
Yellow Time (s)	3.0	3.0	0.070	3.0	3.0	3.0	3.0	3.0	0.070	3.5	3.0	0.070
All-Bed Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		0.5	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4 0	5.0	5.0	5.0	5.0	5.0	4.0	4.0	5.0	4 0
Lead/Lag	0.0	0.0	110	0.0	0.0	0.0	Lag	Lag		Lead	0.0	
Lead-Lag Optimize?							Yes	Yes		Yes		
Becall Mode	None	None		None	None	None	Min	Min		None	Min	
Act Effct Green (s)		14.4		110110	14.4	14.4		31.9		45.2	44.2	
Actuated g/C Batio		0.20			0.20	0.20		0.45		0.63	0.62	
v/c Batio		0.71			0.25	0.41		0.76		0.69	0.84	
Control Delay		46.4			29.7	8.8		25.1		22.1	22.0	
Queue Delay		0.0			0.0	0.0		11 1		0.0	0.0	
Total Delay		46.4			29.7	8.8		36.2		22.1	22.0	
		D			20.7 C	0.0 A		00. <u></u>		C	C	
Approach Delay		46.4			15.8	7.		36.2		Ŭ	22.0	
Approach LOS		D			10.0 B			00. <u></u>			C	
Queue Length 50th (ft)		79			33	0		205		32	220	
Queue Length 95th (ft)		#228			89	55		#514		#155	#699	
Internal Link Dist (ft)		1			441	00		223		1100	733	
Turn Bay Length (ft)		•						220		200	100	
Base Canacity (vnh)		284			376	434		960		319	1102	
Starvation Can Beductn		0			0/0	0		306		010	0	
Snillback Can Reductn		0			0	0		000		0	0	
Storage Can Reductin		0			0	0		0		0	0	
Beduced v/c Batio		0.67			0.55	0.40		90 0		0 60	0.76	
		0.07			0.20	0.40		0.30		0.03	0.70	
Intersection Summary												
Cycle Length: 90												

Stage 1 Selected Alternative (AM) CTPS

Lane Configurations Volume (vph) Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases 9 Permitted Phases Detector Phase Switch Phase
Volume (vph) Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Switch Phase Switch Phase
Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Minimum Initial (n)
Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases 9 Permitted Phases Detector Phase Switch Phase
Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a) Minimum Initial (a) A D
Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Protected Phases Detector Phase Switch Phase Minimum Initial (a) 4 0
Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Protected Phases Detector Phase Switch Phase Minimum Initial (a) 4 0
Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase
Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Protected Phases 9 Permitted Phases Detector Phase Switch Phase
Permitted Phases Detector Phase Switch Phase
Detector Phase Switch Phase
Switch Phase
Minimum Initial (a) 4.0
IVIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
Minimum Split (s) 17.0
Total Split (s) 17.0
Total Split (%) 19%
Yellow Time (s) 3.0
All-Red Time (s) 2.0
Lost Time Adjust (s)
Total Lost Time (s)
Lead/Lag
Lead-Lag Optimize?
Recall Mode None
Act Effct Green (s)
Actuated g/C Ratio
v/c Ratio
Control Delay
Queue Delay
Total Delay
LOS
Approach Delay
Approach LOS
Queue Length 50th (ft)
Queue Length 95th (ft)
Internal Link Dist (ft)
Turn Bay Length (ft)
Base Capacity (vph)
Starvation Cap Reductn
Spillback Cap Reductn
Storage Cap Reductn
Reduced v/c Ratio
Intersection Summary

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Actuated Cycle Length: 71.6	
Natural Cycle: 90	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.84	
Intersection Signal Delay: 27.6	Intersection LOS: C
Intersection Capacity Utilization 112.7%	ICU Level of Service H
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be long	jer.
Queue shown is maximum after two cycles.	

Splits and Phases: 1: Int

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2/16/2010

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Lane Group	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations					ર્સ	1		4		ሻ	ĥ	
Volume (vph)	147	70	5	17	51	241	1	637	30	175	546	287
Confl. Peds. (#/hr)	10		6	10		2	1		2	2		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)						0						0
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	229	0	0	71	248	0	689	0	180	859	0
Turn Type	Perm			Perm		Perm	Perm			pm+pt		
Protected Phases		2			6			8		7	4	
Permitted Phases	2			6		6	8	-		4		
Detector Phase	2	2		6	6	6	8	8		7	4	
Switch Phase	_	_		-	-	-	-					
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		3.5	4.0	
Minimum Split (s)	20.0	20.0		20.0	20.0	20.0	20.0	20.0		7.0	29.0	
Total Split (s)	20.0	20.0	0.0	20.0	20.0	20.0	45.0	45.0	0.0	8.0	53.0	0.0
Total Split (%)	22.2%	22.2%	0.0%	22.2%	22.2%	22.2%	50.0%	50.0%	0.0%	8.9%	58.9%	0.0%
Yellow Time (s)	3.0	3.0	0.0,0	3.0	3.0	3.0	3.0	3.0	0.070	2.5	3.0	0.070
All-Bed Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		1.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	5.0	5.0	5.0	4.0	3.5	5.0	4.0
Lead/Lag							Lag	Lao		Lead		
Lead-Lag Optimize?							Yes	Yes		Yes		
Recall Mode	None	None		None	None	None	Min	Min		None	Min	
Act Effct Green (s)		15.2			15.2	15.2		38.5		48.1	46.6	
Actuated g/C Ratio		0.20			0.20	0.20		0.52		0.64	0.62	
v/c Ratio		0.81			0.23	0.55		0.70		0.48	0.85	
Control Delay		55.0			29.9	9.6		19.8		11.8	22.4	
Queue Delav		0.0			0.0	0.0		29.2		0.0	0.0	
Total Delay		55.0			29.9	9.6		49.0		11.8	22.4	
LOS		D			C	A		D		B	C	
Approach Delay		55.0			14.1			49.0			20.6	
Approach LOS		D			В			D			C	
Queue Length 50th (ft)		99			27	0		201		25	230	
Queue Length 95th (ft)		#280			76	69		#506		84	#724	
Internal Link Dist (ft)		1			441			223			733	
Turn Bay Length (ft)										200		
Base Capacity (vph)		281			311	454		1031		376	1050	
Starvation Cap Reductn		0			0	0		368		0	0	
Spillback Cap Reductn		Ū			0	0		0		Ū	0	
Storage Cap Reductn		0			0	0		0		0	0	
Reduced v/c Ratio		0.81			0.23	0.55		1.04		0.48	0.82	
Intersection Summary												
Cycle Length: 90												

Stage 1 Selected Alternative (PM) CTPS

Lane Configurations Volume (vph) Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases 9 Permitted Phases Detector Phase Switch Phase
Volume (vph) Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Switch Phase Switch Phase
Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Minimum Initial (n)
Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases 9 Permitted Phases Detector Phase Switch Phase
Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a) Minimum Initial (a) A D
Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Protected Phases Detector Phase Switch Phase Minimum Initial (a) 4 0
Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Protected Phases Detector Phase Switch Phase Minimum Initial (a) 4 0
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Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase
Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
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Permitted Phases Detector Phase Switch Phase
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Switch Phase
Minimum Initial (a) 4.0
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Minimum Split (s) 17.0
Total Split (s) 17.0
Total Split (%) 19%
Yellow Time (s) 3.0
All-Red Time (s) 2.0
Lost Time Adjust (s)
Total Lost Time (s)
Lead/Lag
Lead-Lag Optimize?
Recall Mode None
Act Effct Green (s)
Actuated g/C Ratio
v/c Ratio
Control Delay
Queue Delay
Total Delay
LOS
Approach Delay
Approach LOS
Queue Length 50th (ft)
Queue Length 95th (ft)
Internal Link Dist (ft)
Turn Bay Length (ft)
Base Capacity (vph)
Starvation Cap Reductn
Spillback Cap Reductn
Storage Cap Reductn
Reduced v/c Ratio
Intersection Summary

2/16/2010)
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Actuated Cycle Length: 74.7	
Natural Cycle: 90	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.85	
Intersection Signal Delay: 31.8	Intersection LOS: C
Intersection Capacity Utilization 123.4%	ICU Level of Service H
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be long	jer.
Queue shown is maximum after two cycles.	

Splits and Phases: 1: Int

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20 s	53 s	17 s	
× 26	k σ7 🗡 σ8		
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Appendix E

AM/PM Peak Hour Intersection Capacity Analysis

Stage 1 Selected Alternative: Two-Phase Permissive Operation for All Approaches, with the Addition of a NB RT Lane

Western Avenue at Waitt Avenue/Maple Street, Lynn

Intersection Capacity Analysis Western Ave @ Waitt Ave/Maple St

	_#	→	7	۲	+	۲	•	×	/	6	*	*
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		\$			\$			र्भ	1		\$	
Volume (vph)	113	280	9	109	334	3	10	485	100	2	540	9
Confl. Peds. (#/hr)	1		3	3		1	1		2	2		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)									0			0
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	428	0	0	474	0	0	527	106	0	586	0
Turn Type	Perm			Perm			Perm		Perm	Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8		8	4		
Detector Phase	2	2		6	6		8	8	8	4	4	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Minimum Split (s)	20.0	20.0		20.0	20.0		20.0	20.0	20.0	29.0	29.0	
Total Split (s)	36.0	36.0	0.0	36.0	36.0	0.0	37.0	37.0	37.0	37.0	37.0	0.0
Total Split (%)	40.0%	40.0%	0.0%	40.0%	40.0%	0.0%	41.1%	41.1%	41.1%	41.1%	41.1%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	5.0	5.0	5.0	4.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None		None	None		Min	Min	Min	Min	Min	
Act Effct Green (s)		31.5			31.5			28.8	28.8		28.8	
Actuated g/C Ratio		0.43			0.43			0.39	0.39		0.39	
v/c Ratio		0.75			0.77			0.82	0.22		0.80	
Control Delay		30.9			31.3			33.8	17.3		30.7	
Queue Delay		0.0			0.0			0.0	0.0		27.2	
Total Delay		30.9			31.3			33.8	17.3		57.8	
LOS		С			С			С	В		Е	
Approach Delay		30.9			31.3			31.1			57.8	
Approach LOS		С			С			С			E	
Queue Length 50th (ft)		157			177			190	28		209	
Queue Length 95th (ft)		#420			#461			#479	82		#507	
Internal Link Dist (ft)		236			49			618			223	
Turn Bay Length (ft)									40			
Base Capacity (vph)		569			612			719	545		824	
Starvation Cap Reductn		0			0			0	0		255	
Spillback Cap Reductn		0			0			0	0		0	
Storage Cap Reductn		0			0			0	0		0	
Reduced v/c Ratio		0.75			0.77			0.73	0.19		1.03	
Intersection Summary												
Cycle Length: 90												

Stage 1 Selected Alternative (AM) CTPS

Lane Configurations Volume (wh) Confi. Peds. (#hr) Confi. Peds. (#hr) Pack Hour Factor Pack Hour Factor Pack Hour Factor Pack Hour Factor Pack Mour Factor Pack Mour Factor Parking (#hr) MindBiok Traffic (%i) Shared Lane Traffic (%i) Lane Group Flow (wh) Tum Type Protected Phases Protected Phases Detector Phase Minimum Split (s) 17.0 Total Split (s) 17.0 Total Split (s) 17.0 Total Split (s) 17.0 Total Split (s) 2.0 Lead-Lag Optimize? Recal Mode None AL Effic Green (s) Actuated go Ratio Lead-Lag Optimize? Recal Mode None Act Effic Green (s) Actuated go Ratio Vic Ratio Control Delay Control Delay Approach LOS Cueue Length Stoth (fi) Linemal Link Dist (fi) Tum Bay Length (stot) Storage Packuta Storage Cap Reducta Reduced Vic Ratio Factore Packuta Factore Factore Factore Factore Factore Factore Factore Factore Factore Facto	Lane Group	ø9	
Volume (vph) Confl. Pads. (#n/) Confl. Bikes (#hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#hr) Parking (#hr) Mid-Block Traffic (%) Shared Laen Erfler (%) Lane Group Flow (vph) Tum Type Protected Phases 9 Permited Phase 9 Permited Phase 9 P	Lane Configurations		
Confl. Pices (#hr) Confl. Pices (#hr) Peak Hour Factor Feasy Vehicles (%) Bus Blockages (#hr) Peaking (#hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Fhases Shared Lane Traffic (%) Lane Group Fhases Permitted Phases Permitted Phase Permitted Phases Permitted Phases Permitted Phases Permitted Phases Permitted Phases Permitted Phase Per	Volume (vph)		
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Control Delay Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	v/c Ratio		
Queue Delay Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Syllback Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	Control Delay		
Total Delay LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Intersection Summary	Queue Delay		
LOS Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Total Delay		
Approach Delay Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio Intersection Summary	LOS		
Approach LOS Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Approach Delay		
Queue Length 50th (ft) Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Approach LOS		
Queue Length 95th (ft) Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Queue Length 50th (ft)		
Internal Link Dist (ft) Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Queue Length 95th (ft)		
Turn Bay Length (ft) Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Internal Link Dist (ft)		
Base Capacity (vph) Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Turn Bay Length (ft)		
Starvation Cap Reductn Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Base Capacity (vph)		
Spillback Cap Reductn Storage Cap Reductn Reduced v/c Ratio	Starvation Cap Reductn		
Storage Cap Reductn Reduced v/c Ratio	Spillback Cap Reductn		
Reduced v/c Ratio	Storage Cap Reductn		
Intersection Summary	Reduced v/c Ratio		
· · · · · · · · · · · · · · · · · · ·	Intersection Summary		

Actuated Cycle Length: 73.2						
Natural Cycle: 90						
Control Type: Actuated-Uncoordinated						
Maximum v/c Ratio: 0.82						
Intersection Signal Delay: 38.5	Intersection LOS: D					
Intersection Capacity Utilization 78.4%	ICU Level of Service D					
Analysis Period (min) 15						
# 95th percentile volume exceeds capacity, queue may be longer.						

Queue shown is maximum after two cycles.

Splits and Phases: 5: Int

ø2	ø4	🍂 ø9
36 s	37 s	17 s
ø6	8 0	
36 s	37 s	

Intersection Capacity Analysis Western Ave @ Waitt Ave/Maple St

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Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		4			\$			ર્સ	1		4	
Volume (vph)	68	364	1	74	357	5	10	595	111	9	557	2
Confl. Peds. (#/hr)	1		3	3		1	1		10	10		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)									0			0
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	446	0	0	449	0	0	623	114	0	585	0
Turn Type	Perm			Perm			Perm		Perm	Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8		8	4		
Detector Phase	2	2		6	6		8	8	8	4	4	
Switch Phase				-			-	-				
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Minimum Split (s)	20.0	20.0		20.0	20.0		20.0	20.0	20.0	29.0	29.0	
Total Split (s)	34.0	34.0	0.0	34.0	34.0	0.0	39.0	39.0	39.0	39.0	39.0	0.0
Total Split (%)	37.8%	37.8%	0.0%	37.8%	37.8%	0.0%	43.3%	43.3%	43.3%	43.3%	43.3%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	5.0	5.0	5.0	4.0
Lead/Lag												-
Lead-Lag Optimize?												
Recall Mode	None	None		None	None		Min	Min	Min	Min	Min	
Act Effct Green (s)		28.6			28.6			33.7	33.7		33.7	
Actuated g/C Ratio		0.38			0.38			0.45	0.45		0.45	
v/c Ratio		0.75			0.78			0.83	0.20		0.69	
Control Delay		31.8			33.4			31.5	15.6		23.7	
Queue Delay		0.0			0.0			0.0	0.0		31.6	
Total Delay		31.8			33.4			31.5	15.6		55.4	
LOS		С			С			С	В		Е	
Approach Delay		31.8			33.4			29.0			55.4	
Approach LOS		С			С			С			E	
Queue Length 50th (ft)		165			168			227	29		195	
Queue Length 95th (ft)		#416			#429			#572	84		#475	
Internal Link Dist (ft)		236			49			618			223	
Turn Bay Length (ft)									40			
Base Capacity (vph)		606			592			765	571		858	
Starvation Cap Reductn		0			0			0	0		297	
Spillback Cap Reductn		0			0			0	0		0	
Storage Cap Reductn		0			0			0	0		0	
Reduced v/c Ratio		0.74			0.76			0.81	0.20		1.04	
Intersection Summary												
Cycle Length: 90												

Lane Group	Ø۶	
Lane Configurations		
Volume (vph)		
Confl. Peds. (#/hr)		
Confl. Bikes (#/hr)		
Peak Hour Factor		
Growth Factor		
Heavy Vehicles (%)		
Bus Blockages (#/hr)		
Parking (#/hr)		
Mid-Block Traffic (%)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	9	
Permitted Phases		
Detector Phase		
Switch Phase		
Minimum Initial (s)	4.0	
Minimum Split (s)	17.0	
Total Split (s)	17.0	
Total Split (%)	19%	
Yellow Time (s)	3.0	
All-Red Time (s)	2.0	
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Recall Mode	None	
Act Effct Green (s)		
Actuated g/C Ratio		
v/c Ratio		
Control Delay		
Queue Delay		
Total Delay		
LOS		
Approach Delay		
Approach LOS		
Queue Length 50th (ft)		
Queue Length 95th (ft)		
Internal Link Dist (ft)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

Actuated Cycle Length: 75.2						
Natural Cycle: 90						
Control Type: Actuated-Uncoordinated						
Maximum v/c Ratio: 0.83						
Intersection Signal Delay: 37.4	Intersection LOS: D					
Intersection Capacity Utilization 84.6%	ICU Level of Service E					
Analysis Period (min) 15						
# 95th percentile volume exceeds capacity, queue may be longer.						
 # 95th percentile volume exceeds capacity, queue may be long 	jer.					

Queue shown is maximum after two cycles.

Splits and Phases: 5: Int

o2	ø4	🤼 ø9	
34 s	39 s	17 s	
ø6	ø 8		
34 s	39 s		

Appendix F

AM/PM Peak Hour Intersection Capacity Analysis

Stage 2 Selected Alternative: Coordinated with the Signal at Waitt Avenue/Maple Street under the Same Signal Phasing Sequence as Stage 1

Western Avenue at Eastern Avenue/Stanwood Street, Lynn

2/16/2010

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Lane Group	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		\$			ર્સ	1		4		ሻ	t,	
Volume (vph)	134	41	2	8	74	163	0	575	16	207	541	243
Confl. Peds. (#/hr)			2	2								
Confl. Bikes (#/hr)												
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	3%	3%	3%	4%	4%	4%	4%	4%	4%	3%	3%	3%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)						0						0
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	189	0	0	88	173	0	629	0	220	835	0
Turn Type	Perm			Perm		Perm	Perm		-	pm+pt		_
Protected Phases		2			6			8		7	4	
Permitted Phases	2			6	-	6	8			4		
Detector Phase	2	2		6	6	6	8	8		7	4	
Switch Phase	_	_		•	· ·	· ·	, e	•		-		
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	20.0	20.0		20.0	20.0	20.0	20.0	20.0		8.0	29.0	
Total Split (s)	20.0	20.0	0.0	20.0	20.0	20.0	40.0	40.0	0.0	13.0	53.0	0.0
Total Split (%)	22.2%	22.2%	0.0%	22.2%	22.2%	22.2%	44.4%	44 4%	0.0%	14 4%	58.9%	0.0%
Yellow Time (s)	3.0	3.0	0.070	3.0	3.0	3.0	3.0	3.0	01070	3.5	3.0	0.070
All-Bed Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		0.5	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4 0	5.0	5.0	5.0	5.0	5.0	4.0	4.0	5.0	4 0
Lead/Lag	0.0	0.0	110	0.0	0.0	0.0	Lag	Lag		Lead	0.0	
Lead-Lag Optimize?							Yes	Yes		Yes		
Becall Mode	None	None		None	None	None	C-Min	C-Min		None	C-Min	
Act Effct Green (s)		17.3		110110	17.3	17.3	0 1111	43.0		60.3	59.3	
Actuated g/C Batio		0 19			0.19	0.19		0.48		0.67	0.66	
v/c Batio		0.74			0.26	0.43		0.71		0.61	0.79	
Control Delay		53.5			32.8	8.8		12.0		17.2	19.9	
Queue Delay		0.0			0.0	0.0		0.8		0.0	2.9	
Total Delay		53.5			32.8	8.8		12.9		17.2	22.8	
		D			C.20	0.0 A		0 B		B	C	
Approach Delay		53.5			16.9	7.		12.9		5	21.6	
Approach LOS		D			- 10.0 B			0 B			C	
Queue Length 50th (ft)		98			41	0		77		41	277	
Queue Length 95th (ft)		#228			89	55		#499		#160	#699	
Internal Link Dist (ft)		1			441	00		223		1100	733	
Turn Bay Length (ft)		•						220		200	100	
Base Canacity (vnh)		261			345	412		888		362	1055	
Starvation Can Beductn		0			0-10	0		80		002	0	
Snillback Can Reductn		0			0	0		0		0	120	
Storage Can Reducto		0			0	0		0		0	0	
Beduced v/c Batio		0 72			0.26	0 42		0 78		0.61	0 00	
		0.72			0.20	0.42		0.70		0.01	0.30	
Intersection Summary												
Cycle Length: 90												

Stage 2 Selected Alternative (AM) CTPS

Lane Configurations Volume (vph) Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases 9 Permitted Phases Detector Phase Switch Phase
Volume (vph) Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Switch Phase Switch Phase
Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Minimum Initial (n)
Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases 9 Permitted Phases Detector Phase Switch Phase
Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a) Minimum Initial (a) A D
Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Protected Phases Detector Phase Switch Phase Minimum Initial (a) 4 0
Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Protected Phases Detector Phase Switch Phase Minimum Initial (a) 4 0
Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase
Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Protected Phases 9 Permitted Phases Detector Phase Switch Phase
Permitted Phases Detector Phase Switch Phase
Detector Phase Switch Phase
Switch Phase
IVIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
Minimum Split (s) 17.0
Total Split (s) 17.0
Total Split (%) 19%
Yellow Time (s) 3.0
All-Red Time (s) 2.0
Lost Time Adjust (s)
Total Lost Time (s)
Lead/Lag
Lead-Lag Optimize?
Recall Mode None
Act Effct Green (s)
Actuated g/C Ratio
v/c Ratio
Control Delay
Queue Delay
Total Delay
LOS
Approach Delay
Approach LOS
Queue Length 50th (ft)
Queue Length 95th (ft)
Internal Link Dist (ft)
Turn Bay Length (ft)
Base Capacity (vph)
Starvation Cap Reductn
Spillback Cap Reductn
Storage Cap Reductn
Reduced v/c Ratio
Intersection Summary

Actuated Cycle Length: 90 Offset: 0 (0%), Referenced to phase 4:SWTL and 8:NETL, Start of Green, Master Intersection Natural Cycle: 90 Control Type: Actuated-Coordinated Maximum v/c Ratio: 0.79 Intersection Signal Delay: 21.3 Intersection LOS: C Intersection Capacity Utilization 112.7% ICU Level of Service H Analysis Period (min) 15 # 95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.

2/16/2010

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Lane Group	SEL	SET	SER	NWL	NWT	NWR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		\$			ર્સ	1		4		ሻ	4	
Volume (vph)	147	70	5	17	51	241	1	637	30	175	546	287
Confl. Peds. (#/hr)	10		6	10		2	1		2	2		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)						0						0
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	229	0	0	71	248	0	689	0	180	859	0
Turn Type	Perm			Perm		Perm	Perm			pm+pt		
Protected Phases		2			6			8		7	4	
Permitted Phases	2			6		6	8			4		
Detector Phase	2	2		6	6	6	8	8		7	4	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		3.5	4.0	
Minimum Split (s)	20.0	20.0		20.0	20.0	20.0	20.0	20.0		7.0	29.0	
Total Split (s)	20.0	20.0	0.0	20.0	20.0	20.0	45.0	45.0	0.0	8.0	53.0	0.0
Total Split (%)	22.2%	22.2%	0.0%	22.2%	22.2%	22.2%	50.0%	50.0%	0.0%	8.9%	58.9%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		2.5	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		1.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	5.0	5.0	5.0	4.0	3.5	5.0	4.0
Lead/Lag							Lag	Lag		Lead		
Lead-Lag Optimize?							Yes	Yes		Yes		
Recall Mode	None	None		None	None	None	C-Min	C-Min		None	C-Min	
Act Effct Green (s)		20.8			20.8	20.8		44.3		57.3	55.8	
Actuated g/C Ratio		0.23			0.23	0.23		0.49		0.64	0.62	
v/c Ratio		0.72			0.20	0.51		0.73		0.48	0.86	
Control Delay		47.2			30.4	8.6		7.9		13.5	25.1	
Queue Delay		0.0			0.0	0.0		0.9		0.0	2.3	
Total Delay		47.2			30.4	8.6		8.8		13.5	27.4	
LOS		D			С	Α		Α		В	С	
Approach Delay		47.2			13.5			8.8			25.0	
Approach LOS		D			В			А			С	
Queue Length 50th (ft)		115			31	0		49		36	331	
Queue Length 95th (ft)		#280			76	69		m#77		84	#724	
Internal Link Dist (ft)		1			441			223			733	
Turn Bay Length (ft)										200		
Base Capacity (vph)		320			356	483		939		375	1004	
Starvation Cap Reductn		0			0	0		77		0	0	
Spillback Cap Reductn		0			0	0		0		0	63	
Storage Cap Reductn		0			0	0		0		0	0	
Reduced v/c Ratio		0.72			0.20	0.51		0.80		0.48	0.91	
Intersection Summary												
Cycle Length: 90												

Stage 2 Selected Alternative (PM) CTPS

Lane Configurations Volume (vph) Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases 9 Permitted Phases Detector Phase Switch Phase
Volume (vph) Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Switch Phase Switch Phase
Confl. Peds. (#/hr) Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Minimum Initial (n)
Confl. Bikes (#/hr) Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases 9 Permitted Phases Detector Phase Switch Phase
Peak Hour Factor Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a) Minimum Initial (a) A D
Growth Factor Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Protected Phases Detector Phase Switch Phase Minimum Initial (a) 4 0
Heavy Vehicles (%) Bus Blockages (#/hr) Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Protected Phases Detector Phase Switch Phase Minimum Initial (a) 4 0
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Parking (#/hr) Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Mid-Block Traffic (%) Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Shared Lane Traffic (%) Lane Group Flow (vph) Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase
Lane Group Flow (vph) Turn Type Protected Phases Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Turn Type Protected Phases 9 Permitted Phases Detector Phase Switch Phase Minimum Initial (a)
Protected Phases 9 Permitted Phases Detector Phase Switch Phase
Permitted Phases Detector Phase Switch Phase
Detector Phase Switch Phase
Switch Phase
Minimum Initial (a) 4.0
IVIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
Minimum Split (s) 17.0
Total Split (s) 17.0
Total Split (%) 19%
Yellow Time (s) 3.0
All-Red Time (s) 2.0
Lost Time Adjust (s)
Total Lost Time (s)
Lead/Lag
Lead-Lag Optimize?
Recall Mode None
Act Effct Green (s)
Actuated g/C Ratio
v/c Ratio
Control Delay
Queue Delay
Total Delay
LOS
Approach Delay
Approach LOS
Queue Length 50th (ft)
Queue Length 95th (ft)
Internal Link Dist (ft)
Turn Bay Length (ft)
Base Capacity (vph)
Starvation Cap Reductn
Spillback Cap Reductn
Storage Cap Reductn
Reduced v/c Ratio
Intersection Summary

Actuated Cycle Length: 90	
Offset: 0 (0%), Referenced to phase 4:SWTL and 8:NETL, Start	of Green, Master Intersection
Natural Cycle: 90	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.86	
Intersection Signal Delay: 20.7	Intersection LOS: C
Intersection Capacity Utilization 123.4%	ICU Level of Service H
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be long	jer.
Queue shown is maximum after two cycles.	
m Volume for 95th percentile queue is metered by upstream si	gnal.

Splits and Phases: 1: Int

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20 s	53 s	17 s	
× 06	έ ₀₇ γ ₀₈		
20 s	8s 45s		

Appendix G

AM/PM Peak Hour Intersection Capacity Analysis

Stage 2 Selected Alternative: Coordinated with the Signal at Eastern Avenue/Stanwood Street under the Same Signal Phasing Sequence as Stage 1

Western Avenue at Waitt Avenue/Maple Street, Lynn

Intersection Capacity Analysis Western Ave @ Waitt Ave/Maple St

	_#	→	7	۲	+	۲	•	*	/	6	*	~
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		\$			\$			र्स	1		\$	
Volume (vph)	113	280	9	109	334	3	10	485	100	2	540	9
Confl. Peds. (#/hr)	1		3	3		1	1		2	2		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	4%	4%	4%	4%	4%	4%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)									0			0
Mid-Block Traffic (%)		0%			0%			0%			0%	
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	428	0	0	474	0	0	527	106	0	586	0
Turn Type	Perm			Perm			Perm		Perm	Perm		
Protected Phases		2			6			8			4	
Permitted Phases	2			6			8		8	4		
Detector Phase	2	2		6	6		8	8	8	4	4	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Minimum Split (s)	20.0	20.0		20.0	20.0		20.0	20.0	20.0	29.0	29.0	
Total Split (s)	36.0	36.0	0.0	36.0	36.0	0.0	37.0	37.0	37.0	37.0	37.0	0.0
Total Split (%)	40.0%	40.0%	0.0%	40.0%	40.0%	0.0%	41.1%	41.1%	41.1%	41.1%	41.1%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	5.0	5.0	5.0	4.0
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None		None	None		C-Min	C-Min	C-Min	C-Min	C-Min	
Act Effct Green (s)		37.7			37.7			38.9	38.9		38.9	
Actuated g/C Ratio		0.42			0.42			0.43	0.43		0.43	
v/c Ratio		0.78			0.80			0.75	0.20		0.73	
Control Delay		35.4			36.0			31.4	18.5		18.4	
Queue Delay		0.0			0.0			0.5	0.0		10.1	
Total Delay		35.4			36.0			31.9	18.5		28.6	
LOS		D			D			С	В		С	
Approach Delay		35.4			36.0			29.6			28.6	
Approach LOS		D			D			С			С	
Queue Length 50th (ft)		199			223			233	35		174	
Queue Length 95th (ft)		#422			#463			#479	82		m#478	
Internal Link Dist (ft)		236			49			618			223	
Turn Bay Length (ft)									40			
Base Capacity (vph)		550			594			700	531		802	
Starvation Cap Reductn		0			0			0	0		189	
Spillback Cap Reductn		0			0			27	0		0	
Storage Cap Reductn		0			0			0	0		0	
Reduced v/c Ratio		0.78			0.80			0.78	0.20		0.96	
Intersection Summary												
Cycle Length: 90												

Stage 2 Selected Alternative (AM) CTPS

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Lane Group	Ø۶	
Lane Configurations		
Volume (vph)		
Confl. Peds. (#/hr)		
Confl. Bikes (#/hr)		
Peak Hour Factor		
Growth Factor		
Heavy Vehicles (%)		
Bus Blockages (#/hr)		
Parking (#/hr)		
Mid-Block Traffic (%)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	9	
Permitted Phases		
Detector Phase		
Switch Phase		
Minimum Initial (s)	4.0	
Minimum Split (s)	17.0	
Total Split (s)	17.0	
Total Split (%)	19%	
Yellow Time (s)	3.0	
All-Red Time (s)	2.0	
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Recall Mode	None	
Act Effct Green (s)		
Actuated g/C Ratio		
v/c Ratio		
Control Delay		
Queue Delay		
Total Delay		
LOS		
Approach Delay		
Approach LOS		
Queue Length 50th (ft)		
Queue Length 95th (ft)		
Internal Link Dist (ft)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

Actuated Cycle Length: 90	
Offset: 88 (98%), Referenced to phase 4:SWTL and 8:NETL, Sta	art of Green
Natural Cycle: 90	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.80	
Intersection Signal Delay: 31.9	Intersection LOS: C
Intersection Capacity Utilization 82.1%	ICU Level of Service E
Analysis Period (min) 15	
# 95th percentile volume exceeds capacity, queue may be long	ger.
Queue shown is maximum after two cycles.	
m Volume for 95th percentile queue is metered by upstream si	gnal.

Splits and Phases: 5: Int

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36 s	37 s	17 s	
ø6	2 8		
36 s	37 s		

Intersection Capacity Analysis Western Ave @ Waitt Ave/Maple St

	_#	-	7	۲	+	۲	3	×	/	6	¥	*
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NEL	NET	NER	SWL	SWT	SWR
Lane Configurations		4			\$			ર્સ	1		\$	
Volume (vph)	68	364	1	74	357	5	10	595	111	9	557	2
Confl. Peds. (#/hr)	1		3	3		1	1		10	10		1
Confl. Bikes (#/hr)												
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Growth Factor	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	1%	1%	1%	2%	2%	2%
Bus Blockages (#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Parking (#/hr)									0			0
Mid-Block Traffic (%)		0%			0%			0%			0%	-
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	446	0	0	449	0	0	623	114	0	585	0
Turn Type	Perm			Perm	-		Perm		Perm	Perm		-
Protected Phases		2			6			8			4	
Permitted Phases	2			6	-		8	-	8	4		
Detector Phase	2	2		6	6		8	8	8	4	4	
Switch Phase	_			-	-		-	-	-	-	-	
Minimum Initial (s)	4.0	4.0		4.0	4.0		4.0	4.0	4.0	4.0	4.0	
Minimum Split (s)	20.0	20.0		20.0	20.0		20.0	20.0	20.0	29.0	29.0	
Total Split (s)	33.0	33.0	0.0	33.0	33.0	0.0	40.0	40.0	40.0	40.0	40.0	0.0
Total Split (%)	36.7%	36.7%	0.0%	36.7%	36.7%	0.0%	44.4%	44.4%	44.4%	44.4%	44.4%	0.0%
Yellow Time (s)	3.0	3.0		3.0	3.0		3.0	3.0	3.0	3.0	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0		2.0	2.0	2.0	2.0	2.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0	5.0	5.0	5.0	4.0
Lead/Lag												-
Lead-Lag Optimize?												
Recall Mode	None	None		None	None		C-Min	C-Min	C-Min	C-Min	C-Min	
Act Effct Green (s)		34.8			34.8			41.8	41.8		41.8	
Actuated g/C Ratio		0.39			0.39			0.46	0.46		0.46	
v/c Ratio		0.73			0.76			0.80	0.20		0.68	
Control Delay		33.7			35.0			31.4	16.5		14.1	
Queue Delav		0.0			0.0			0.2	0.0		6.3	
Total Delay		33.7			35.0			31.6	16.5		20.4	
LOS		С			D			С	В		С	
Approach Delay		33.7			35.0			29.2			20.4	
Approach LOS		С			D			С			С	
Queue Length 50th (ft)		206			210			278	35		82	
Queue Length 95th (ft)		#424			#437			#561	82		m244	
Internal Link Dist (ft)		236			49			618			223	
Turn Bay Length (ft)									40			
Base Capacity (vph)		607			593			779	582		860	
Starvation Cap Reductn		0			0			0	0		221	
Spillback Cap Reductn		0			0			8	0		0	
Storage Cap Reductn		0			0			0	0		0	
Reduced v/c Ratio		0.73			0.76			0.81	0.20		0.92	
Intersection Summary												
Cycle Length: 90												

Lane Group	ø9	
Lane Configurations		
Volume (vph)		
Confl. Peds. (#/hr)		
Confl. Bikes (#/hr)		
Peak Hour Factor		
Growth Factor		
Heavy Vehicles (%)		
Bus Blockages (#/hr)		
Parking (#/hr)		
Mid-Block Traffic (%)		
Shared Lane Traffic (%)		
Lane Group Flow (vph)		
Turn Type		
Protected Phases	9	
Permitted Phases		
Detector Phase		
Switch Phase		
Minimum Initial (s)	4.0	
Minimum Split (s)	17.0	
Total Split (s)	17.0	
Total Split (%)	19%	
Yellow Time (s)	3.0	
All-Red Time (s)	2.0	
Lost Time Adjust (s)		
Total Lost Time (s)		
Lead/Lag		
Lead-Lag Optimize?		
Recall Mode	None	
Act Effct Green (s)		
Actuated g/C Ratio		
v/c Ratio		
Control Delay		
Queue Delay		
Total Delay		
LOS		
Approach Delay		
Approach LOS		
Queue Length 50th (ft)		
Queue Length 95th (ft)		
Internal Link Dist (ft)		
Turn Bay Length (ft)		
Base Capacity (vph)		
Starvation Cap Reductn		
Spillback Cap Reductn		
Storage Cap Reductn		
Reduced v/c Ratio		
Intersection Summary		

Actuated Cycle Length: 90						
Offset: 0 (0%), Referenced to phase 4:SWTL and 8:NETL, Start	of Green					
Natural Cycle: 90						
Control Type: Actuated-Coordinated						
Maximum v/c Ratio: 0.80						
Intersection Signal Delay: 29.0	Intersection LOS: C					
Intersection Capacity Utilization 84.6%	ICU Level of Service E					
Analysis Period (min) 15						
# 95th percentile volume exceeds capacity, queue may be long	jer.					
Queue shown is maximum after two cycles.						
m Volume for 95th percentile queue is metered by upstream sig	gnal.					

Splits and Phases: 5: Int

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33 s	40 s	17 s
ø6	ø8	
33 s	40 s	