A Viable Surface Alternative for Rutherford Avenue at Austin Street

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The City of Boston is planning now for a project intended to convert Rutherford Avenue in Charlestown from a wide highway into a boulevard with a linear park. Near the Austin Street intersection, the curb to curb width is 135 ft, including two surface roadways and a 6-lane underpass. This highway-style layout dates from the 1960s, when I-93 ended in Medford and dumped all its Boston-bound traffic onto Rutherford Ave. With completion of the Zakim Bridge in 2002, we have the opportunity to downsize Rutherford Ave.

A Greenway Vision

The vision first presented to the public around 2010 was a boulevard with a wide linear park on the neighborhood side that would buffer the neighborhood from traffic, add a much-needed recreation amenity, and fill in a missing link in the regional greenway network.

Underpass Option versus a Poisoned Surface Option

But city officials and others started worrying that the underpasses might still be needed, especially after the decision to build a casino in nearby Everett. So they had their engineering consultant create two options, one with a surface layout and one that retains the underpass at Austin Street.

In the underpass option, the number of lanes in the underpass is reduced from 6 to 3 (two lanes southbound, where traffic is heavier, and one northbound). However, because of needed surface roads, shoulders, and retaining structures, the curb-to-curb width in this option is 123 ft, only 12 ft narrower than the highway we have today. That leaves no space for the promised greenway; instead, for the majority of corridor, there is only a glorified sidewalk – a single path for pedestrians and bikes to share, with a narrow strip of grass on either side.

About 900 ft north of Austin Street, the proposed road shrinks to a 5+1-lane cross section (5 through lanes and a median that is sometimes used for a turning pocket); from that point north to where a new underpass at Sullivan Square begins, there is room for a linear park. However, that amounts to only 1/3 of the corridor. For 2/3 of the corridor, the underpass option completely undercuts the original vision and goals of the project.

The surface option they analyzed looks ideal – the road has a trim 4+1-lane cross section (2 lanes per direction plus a median / left turn lane), leaving 65 ft of parkland on the neighborhood side. But it's a poisoned option, because less than a minute of calculations will show that 4 through lanes could never carry the present traffic – much less future traffic – through the intersection at Austin Street.

Sure enough, the City's analysis of the surface option shows enormous delays and queues, because that option just doesn't have enough capacity. Does that mean an underpass must be needed? Of course not. With so much land available, the designers could have tried again, adding another lane or two, which would still have left ample space for a linear park. But they didn't; instead, the surface option was simply declared a failure, and in May of 2017, the City announced that it was going with the underpass option because only it could provide the needed traffic capacity.

Charlestown residents and advocates for walking, bicycling, and safer streets are dismayed to see the vision of human-scale boulevard with a continuous linear park summarily withdrawn. They are particularly angered that the underpass option was chosen without considering a *realistic* surface option. How can anybody – residents or City officials – know whether the underpass option is better if they haven't had a chance to compare it with a realistic surface option?

To help meet that need, we offer this analysis.

Projected Traffic Volume Scenarios

The City's consultant has done counts of existing traffic and has projected future demand accounting for expected casino traffic and other growth.

For the base scenario, we use their projections. However, there are two factors built into the projections that are questionable:

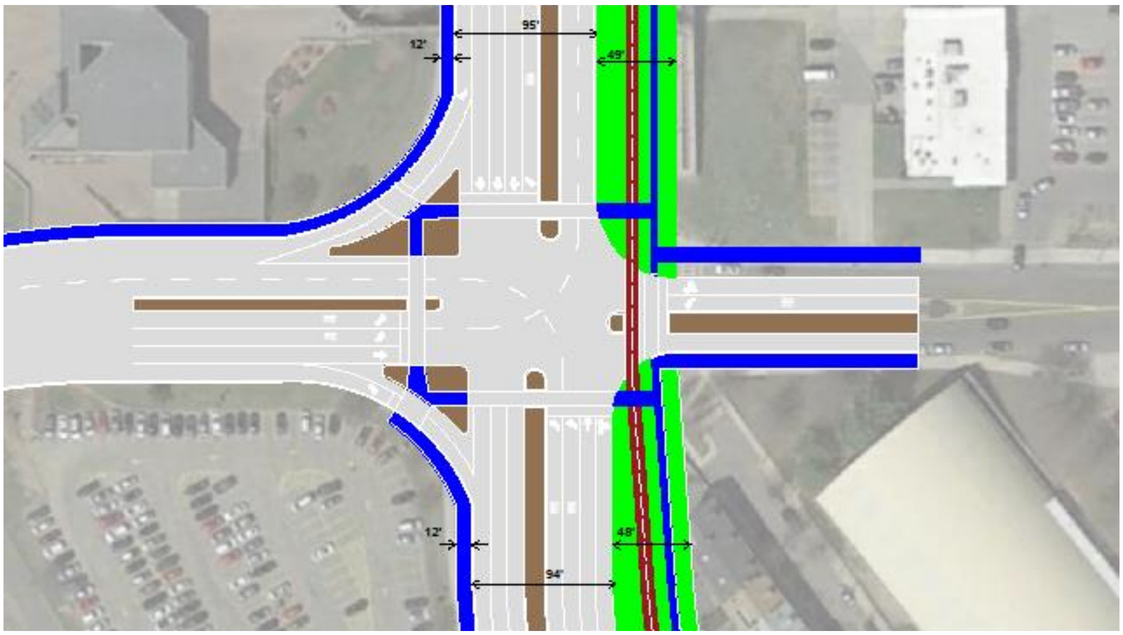
- One is a 6% inflation factor that inflates the peak hour flow rates into a still-higher flow rate representing the peak 15-minute period. While this is routinely a part of intersection capacity analysis, many planners believe that sizing roads for the busiest 15-minute period of the day is a poor tradeoff that results in overly wide and dangerous roads. In a thriving city like Boston, it is more appropriate to size roads for the average peak hour flow, even if that means there will be slightly worse congestion during the busiest 15 minute period.
- The other is a 5% increase in traffic volumes projected to materialize between 2030 and 2040. The 2030 volume estimates account for the casino and other expected development; this further 5% increase is questionable. Since 2008, there has been a trend of traffic volumes decreasing, not increasing, on roads in the inner parts of the Boston urban area. Changes in technology and auto ownership patterns are likely to make this trend even stronger. To lose parkland because of traffic projected to arise in the distant future is a tradeoff that seems hard to defend.

For now, we have only analyzed the base demand scenario. We hope to soon also offer an analysis of a demand scenario that omits these questionable inflation factors.

Alternative Layouts for a Surface Roadway

We have developed two surface alternatives for Rutherford Avenue at the Austin Street intersection: a 5+2-lane option and a 5+1-lane option, the difference being that the 5+2-lane option has dual left turn lanes for traffic turning left onto the Gilmore Bridge, while the 5+1-lane option has 1. The 5+2-lane option is designed for the fully inflated volumes as projected in the City's study; the 5+1-lane option is for the uninflated volumes, as described earlier.

The 5+2-lane option is shown below. As shown in the sketch, it still leaves 48 to 49 ft on the neighborhood side for a linear park. In the two western corners, there are delta islands and slip lanes for right turns, because the very high right-turning volumes make it unsafe to allow right turns concurrently with a pedestrian crossing. However, the right turn slip lanes will not run "free;" they will be controlled by traffic signals.



5+2-Lane Surface Layout

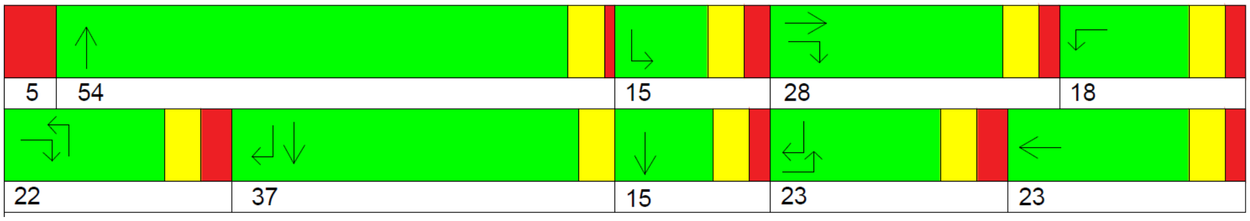
Signal Timing Design

A signal timing plan was designed using Synchro, a standard intersection analysis software. It uses a 120 s cycle (130 s in the p.m. peak) with protected-only left turns and no turn on red for the two heavy right turn movements onto and off of western leg (leading to Gilmore Bridge). It uses lead-lag phase sequencing, which improves service for the pedestrian crossings and slightly reduces the required length of some of the all-red clearance intervals. Minimum green periods are set long enough to permit pedestrian phases to be automatic.

The signal timing has multistage crossings; to complement it, the proposed layout has a 13-ft wide median for pedestrians who may have to wait in the middle. However, the pedestrian phases are coordinated so that pedestrians leaving at the right time in the cycle can cross without waiting at the median for more than a few seconds.

The traffic signals controlling the right turn slip lanes alternate twice per cycle between a right turn phase and a pedestrian phase. That means pedestrians there get two phases per cycle, which are coordinated with the other crosswalks so that most pedestrians don't have to wait on the delta islands at all.

Below is the signal timing plan for the dual-left alternative under the fully inflated demand scenario in the a.m. peak. A similar timing plan was developed for the p.m. peak.



Timing Plan for the Dual-Left Alternative with Full Projected Demand, a.m. Peak

Intersection Capacity and Pedestrian Delay Analysis

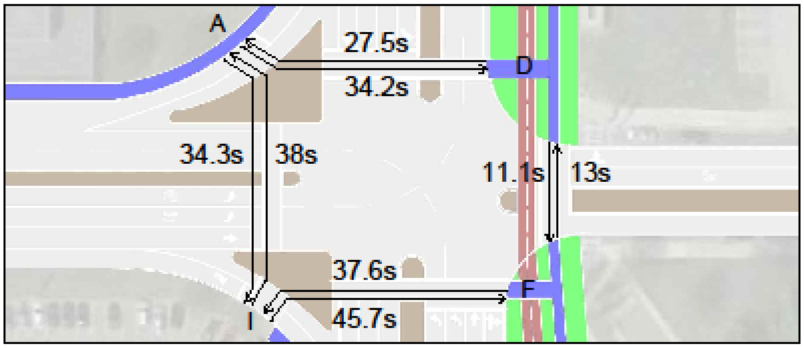
Intersection capacity analysis was done using Synchro. Pedestrian crossing delay was determined using the Northeastern University Ped/Bike Crossing Delay Calculator. Key results are given in the table below. For vehicular traffic, no approach has a volume / capacity ratio greater than 0.95; that is, there is enough capacity for every traffic movement. Average vehicular delay (48-50 s, resulting in Level of Service D) is a reasonable value for a busy urban intersection. Pedestrian delay, averaging 30 s, is also reasonable. "Average pedestrian delay" is a simple average over the 8 possible crossings (4 legs to be crossed in 2 directions each). Average delay by crossing is given in the figure that follows.

Maximum volume/capacity ratio	**a.m. peak 15 minutes**	**p.m. peak 15 minutes**
Maximum volume/capacity ratio	0.93	0.95
Average vehicular delay (s)	48	50
Level of Service	D	D
Pedestrians' average crossing delay (s)	30	*
Worst crossing delay (s)	45.7	*

Summary Performance Measures: 5+2-lane Surface Option with Fully Inflated Demand. (* = not yet analyzed)

Detailed results on pedestrian crossings are shown in the following figure. Crossing times shown are for full crossings, and include any waiting that pedestrians might have to do at an intermediate island.

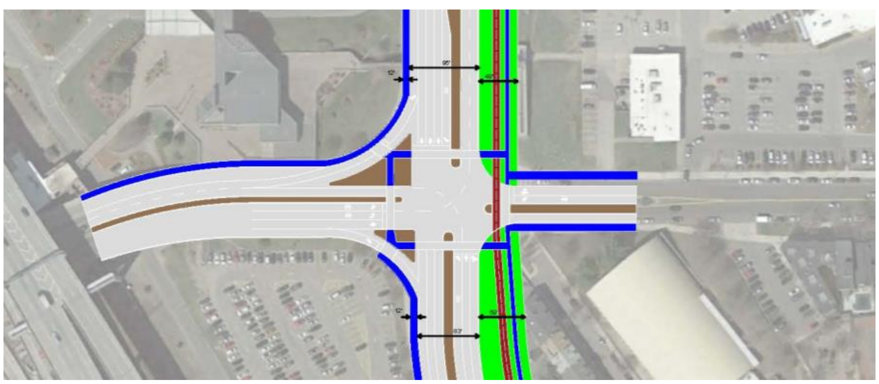
Calculating crossing delay is not a routine task in the industry. An appendix to this report shows the timing for all of the pedestrian phases in the a.m., and sample output from the program used to determine average pedestrian delay was calculated. The Synchro report showing vehicular performance measures is also provided in an appendix.



Crossing Delay for Each of the 8 Crossings, a.m. peak hour, 5+2-lane Surface Option

The 5+1-Lane Surface Option: A Smaller Footprint Intersection for Non-Inflated Demand Values

Omitting the questionable inflation factors mentioned earlier – and thus providing sufficient capacity for traffic projected in 2030 for the peak hour – it becomes possible to carry the traffic with a smaller footprint road, shown below. This option has only one left turn lane, and the linear park south of Austin Street is 11 ft wider. (North of Austin Street, the road footprint is unchanged.) In the a.m. peak, the most congested approach has a volume/capacity ratio of 0.94, and average delay is 52 s.



Smaller footprint layout that could be used if volumes with uninflated 2030 volumes

Conclusion

A surface option can, indeed, provide sufficient capacity for the projected traffic volumes while still leaving ample space for a linear park and offering reasonable service for crossing pedestrians.

This report is based on results for the a.m. peak. Because traffic volumes in the p.m. peak are less, the surface option will work then, too.

The table below compares how much space each option leaves for a linear park and green space on the neighborhood side of Rutherford Ave. The measurement is made just north of Austin Street, where the right of way is 156 ft wide. The existing road has only a 10’ sidewalk on the neighborhood side. The underpass option leaves 21’ available on the neighborhood side; allowing 12’ for a paved shared use path, that leaves two 4.5 ft strips of grass on either side, or perhaps a 6 ft strip with trees on one side and 3-ft grass strip on the other. The 7-lane surface option leaves 49 ft for a linear park that can host separate walking and bicycling paths, rows of trees, and whatever else the neighborhood wants to put there.

	existing	underpass option	7-lane surface option
Road width, curb-to-curb	135 ft	123 ft	95 ft
Width on the neighborhood side from curb to edge of right-of-way, allowing for 12' path on Community College side	9 ft	21 ft	49 ft
green space on neighborhood side, allowing for 14' of combined sidewalk and path on the neighborhood side (ft)	0 ft	7 ft	35 ft

Right-of-Way Remaining for Green Space in Different Alternatives

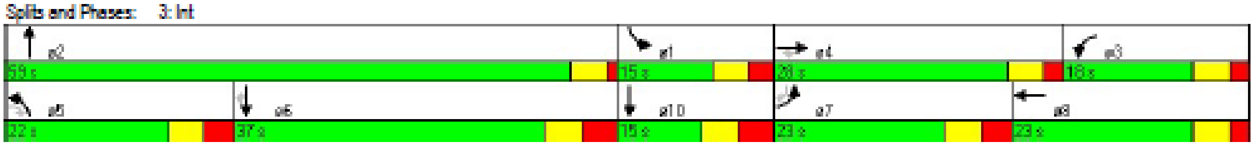
The underpass option has been analyzed in a separate document, which also includes a more thorough comparison of impacts between the underpass option and the 7-lane surface option.

Appendix A: Synchro output for the 5+2-lane Surface Option

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	ø6	ø10
Lane Configurations														
Volume (vph)	336	239	353	138	180	35	370	609	100	59	1801	630		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900		
Lane Width (ft)	11	11	11	11	11	11	11	11	11	11	11	11		
Storage Length (ft)	220		0	0		0	220		0	120		0		
Storage Lanes	1		1	1		0	1		0	1		1		
Taper Length (ft)	25		25	25		25	25		25	25		25		
Lane Util. Factor	*0.97	1.00	1.00	1.00	1.00	1.00	0.97	*1.00	0.95	1.00	*1.00	1.00		
Frt			0.850		0.976			0.979				*0.920		
Flt Protected	0.950			0.950			0.950			0.950				
Satd. Flow (prot)	3319	1801	1531	1711	1757	0	3319	3526	0	1711	5402	1657		
Flt Permitted	0.950			0.950			0.950			0.950				
Satd. Flow (perm)	3319	1801	1531	1711	1757	0	3319	3526	0	1711	5402	1657		
Right Turn on Red			No			No			No			No		
Satd. Flow (RTOR)														
Link Speed (mph)		30			30			30			30			
Link Distance (ft)		616			871			366			531			
Travel Time (s)		14.0			19.8			8.3			12.1			
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		
Adj. Flow (vph)	357	254	376	147	191	37	394	648	106	63	1916	670		
Shared Lane Traffic (%)														
Lane Group Flow (vph)	357	254	376	147	228	0	394	754	0	63	1916	670		
Turn Type	Prot		custom	Prot			custom			Prot		custom		
Protected Phases	7	4		3	8		5	2		1	6 10		6	10
Permitted Phases			4 5				5					6 7		
Minimum Split (s)	11.0	23.5		12.0	24.0		11.0	23.0		11.0			23.0	23.0
Total Split (s)	23.0	28.0	50.0	18.0	23.0	0.0	22.0	59.0	0.0	15.0	52.0	60.0	37.0	15.0
Total Split (%)	19.2%	23.3%	41.7%	15.0%	19.2%	0.0%	18.3%	49.2%	0.0%	12.5%	43.3%	50.0%	31%	13%
Maximum Green (s)	16.5	22.5		12.5	17.5		15.5	54.5		9.0			30.0	8.0
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5			3.5	3.5
All-Red Time (s)	3.0	2.0		2.0	2.0		3.0	1.0		2.5			3.5	3.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.5	-3.0		
Total Lost Time (s)	6.5	5.5	5.5	5.5	5.5	4.0	6.5	4.5	4.0	6.0	5.5	4.0		
Lead/Lag	Lead	Lead		Lag	Lag		Lead	Lead		Lag			Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes			Yes	
Walk Time (s)		5.0			5.0			5.0					5.0	5.0
Flash Dont Walk (s)		11.0			11.0			11.0					11.0	11.0
Pedestrian Calls (#/hr)		0			0			0					0	0
Act Effct Green (s)	16.5	22.5	39.0	12.5	17.5		15.5	54.5		9.0	46.5	52.0		
Actuated g/C Ratio	0.14	0.19	0.32	0.10	0.15		0.13	0.45		0.08	0.39	0.43		
v/c Ratio	0.78	0.75	0.76	0.83	0.89		0.92	0.47		0.49	0.92	0.93		
Control Delay	63.0	61.2	33.1	86.9	84.8		79.1	24.0		66.9	42.9	42.4		
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0		
Total Delay	63.0	61.2	33.1	86.9	84.8		79.1	24.0		66.9	42.9	42.4		
LOS	E	E	C	F	F		E	C		E	D	D		
Approach Delay		51.1			85.6			42.9			43.4			
Approach LOS		D			F			D			D			

Intersection Summary	
Area Type: Other	
Cycle Length: 120	
Actuated Cycle Length: 120	
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green	
Natural Cycle: 125	
Control Type: Pretimed	
Maximum v/c Ratio: 0.93	
Intersection Signal Delay: 47.8	Intersection LOS: D
Intersection Capacity Utilization 86.5%	ICU Level of Service E
Analysis Period (min) 15	
* User Entered Value	

Splits and Phases: 3: Int



Intersection Capacity Analysis
Rutherford Ave@Austin St

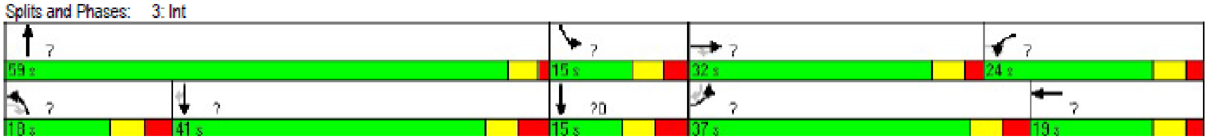
p.m. peak

At grade concept
PM Peak Hour

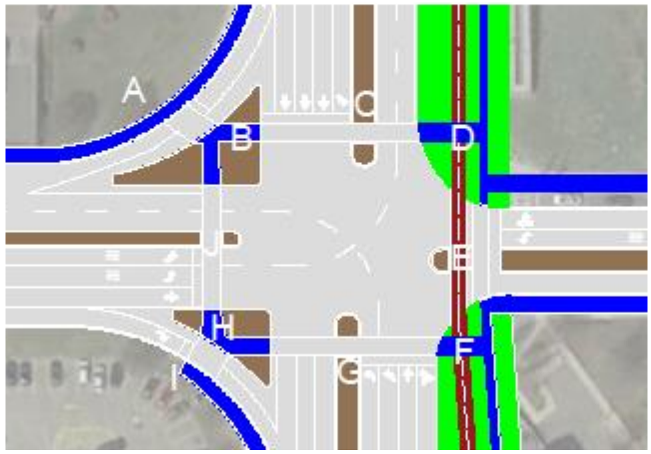
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	?	?0
Lane Configurations														
Volume (vph)	695	300	566	144	58	75	240	969	170	63	1879	490		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900		
Lane Width (ft)	11	11	11	11	11	11	11	11	11	11	11	11		
Storage Length (ft)	220		0	0		0	220		0	120		0		
Storage Lanes	1		1	1		0	1		0	1		1		
Taper Length (ft)	25		25	25		25	25		25	25		25		
Lane Util. Factor	*0.97	1.00	1.00	1.00	1.00	1.00	0.97	*1.00	0.95	1.00	*1.00	1.00		
Frt			0.850		0.915			0.978				*0.920		
Flt Protected	0.950			0.950			0.950			0.950				
Satd. Flow (prot)	3319	1801	1531	1711	1648	0	3319	3522	0	1711	5402	1657		
Flt Permitted	0.950			0.950			0.950			0.950				
Satd. Flow (perm)	3319	1801	1531	1711	1648	0	3319	3522	0	1711	5402	1657		
Right Turn on Red			No			No			No			No		
Satd. Flow (RTOR)														
Link Speed (mph)		30			30			30			30			
Link Distance (ft)		616			871			366			531			
Travel Time (s)		14.0			19.8			8.3			12.1			
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		
Adj. Flow (vph)	739	319	602	153	62	80	255	1031	181	67	1999	521		
Shared Lane Traffic (%)														
Lane Group Flow (vph)	739	319	602	153	142	0	255	1212	0	67	1999	521		
Turn Type	Prot		custom	Prot			custom			Prot		custom		
Protected Phases	7	4		3	8		5	2		1	6 10		6	10
Permitted Phases			3 4 5				5					6 7		
Minimum Split (s)	11.0	23.5		12.0	24.0		11.0	23.0		11.0			23.0	23.0
Total Split (s)	37.0	32.0	74.0	24.0	19.0	0.0	18.0	59.0	0.0	15.0	56.0	78.0	41.0	15.0
Total Split (%)	28.5%	24.6%	56.9%	18.5%	14.6%	0.0%	13.8%	45.4%	0.0%	11.5%	43.1%	60.0%	32%	12%
Maximum Green (s)	30.5	26.5		18.5	13.5		11.5	54.5		9.0			34.0	8.0
Yellow Time (s)	3.5	3.5		3.5	3.5		3.5	3.5		3.5			3.5	3.5
All-Red Time (s)	3.0	2.0		2.0	2.0		3.0	1.0		2.5			3.5	3.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.5	-3.0		
Total Lost Time (s)	6.5	5.5	5.5	5.5	5.5	4.0	6.5	4.5	4.0	6.0	5.5	4.0		
Lead/Lag	Lead	Lead		Lag	Lag		Lead	Lead		Lag			Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes		Yes	Yes		Yes			Yes	
Walk Time (s)		5.0			5.0			5.0					5.0	5.0
Flash Dont Walk (s)		11.0			11.0			11.0					11.0	11.0
Pedestrian Calls (#/hr)		0			0			0					0	0
Act Effct Green (s)	30.5	26.5	68.5	18.5	13.5		11.5	54.5		9.0	50.5	70.0		
Actuated g/C Ratio	0.23	0.20	0.53	0.14	0.10		0.09	0.42		0.07	0.39	0.54		
v/c Ratio	0.95	0.87	0.75	0.63	0.83		0.87	0.82		0.57	0.95	0.58		
Control Delay	71.0	73.9	31.1	65.0	92.7		86.0	39.1		77.6	50.1	14.6		
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0		
Total Delay	71.0	73.9	31.1	65.0	92.7		86.0	39.1		77.6	50.1	14.6		
LOS	E	E	C	E	F		F	D		E	D	B		
Approach Delay		57.1			78.3			47.3			43.6			
Approach LOS		E			E			D			D			

Intersection Summary	
Area Type: Other	
Cycle Length: 130	
Actuated Cycle Length: 130	
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBT, Start of Green	
Natural Cycle: 125	
Control Type: Pretimed	
Maximum v/c Ratio: 0.95	
Intersection Signal Delay: 49.9	Intersection LOS: D
Intersection Capacity Utilization 93.1%	ICU Level of Service F
Analysis Period (min) 15	
* User Entered Value	

Splits and Phases: 3: Int

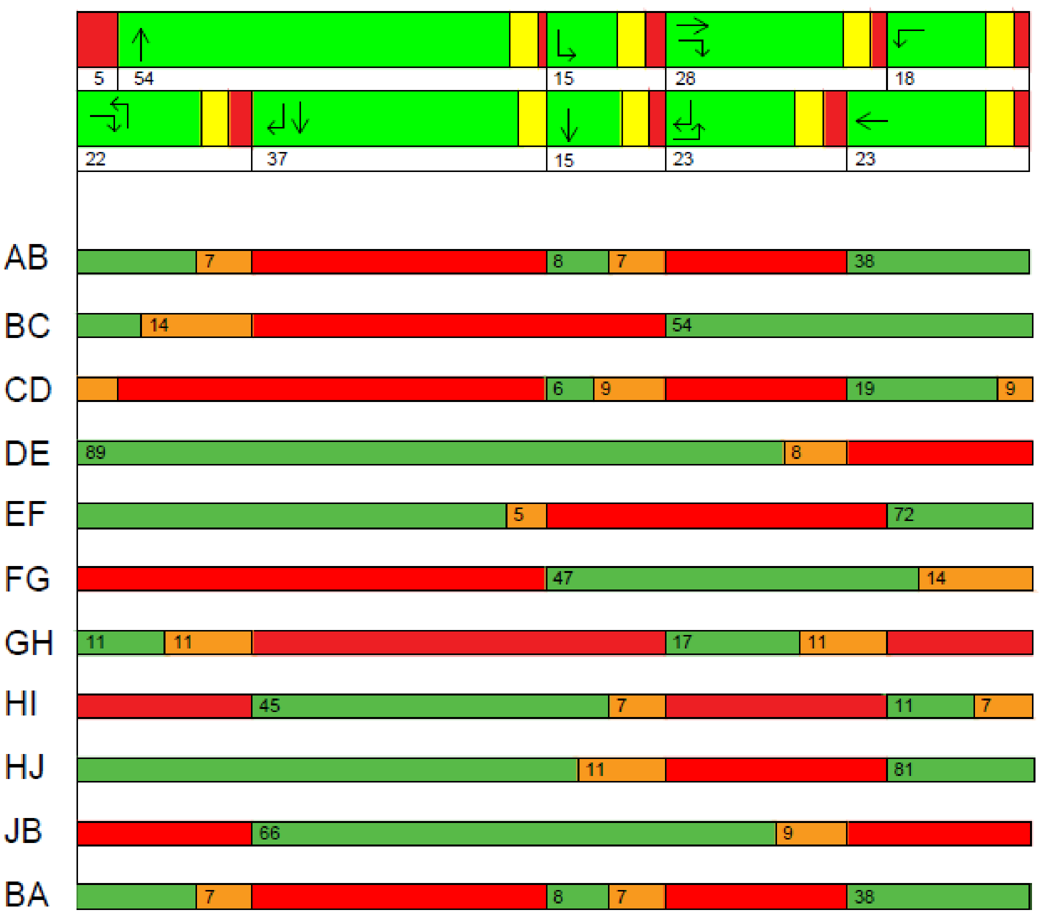


Appendix B: Pedestrian Phase Timing and Example Pedestrian Delay Calculation (a.m. peak)

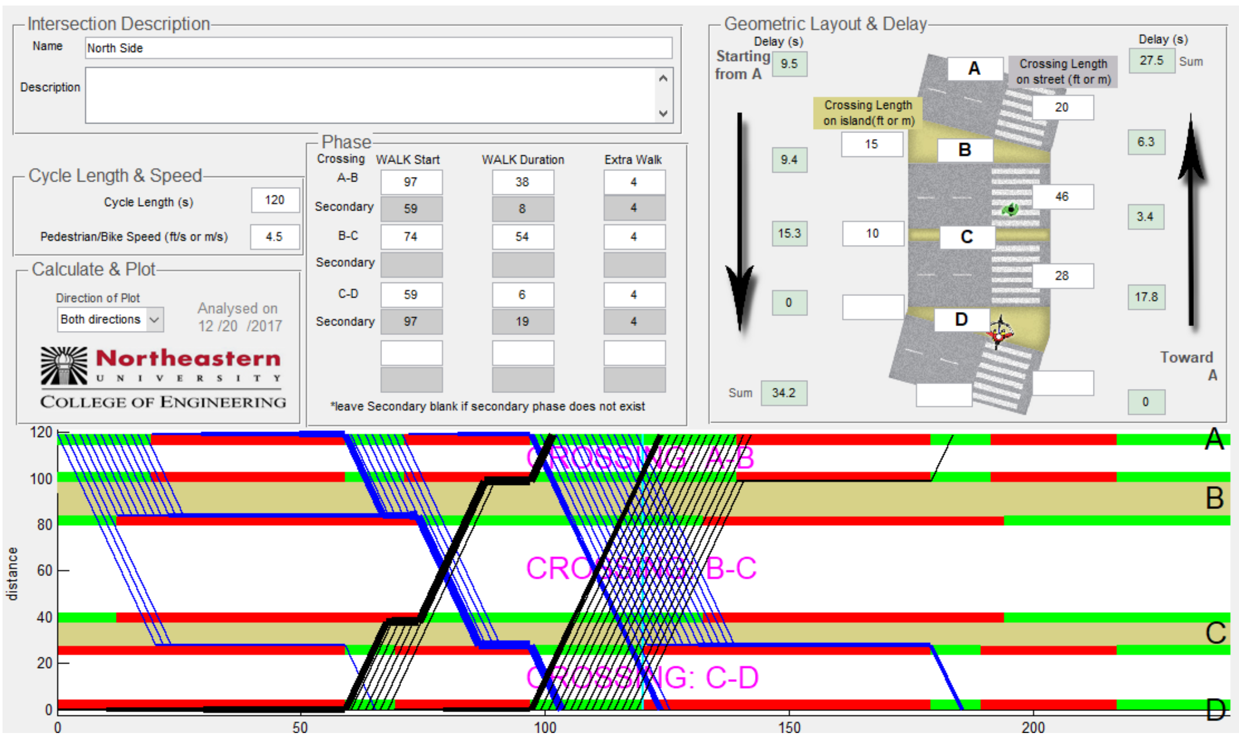


Above: Intersection layout with corners and islands labeled A, B, …, J

Below: Timing plan for each vehicular movement and each crosswalk



Average delay for all the crossings is shown in the body of the report. Here is an example output from the program used to determine pedestrian delay, applied to crossing the north leg of the intersection.



Report from the Northeastern University Ped/Bike Crossing Delay Calculator for the north leg crossing. When crossing from A-D, average delay is 34.2 s; crossing from D-A, average delay is 27.5 s. Blue lines indicate pedestrians walking from A toward D; black lines, pedestrians walking from D toward A.