

APPENDIX A

**Participants of Study Advisory Meetings
May 13 and November 3, 2015**

Participants of Study Advisory Meetings

Summer Street/George Washington Boulevard Corridor in Hingham and Hull
May 13 and November 3, 2015

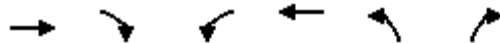
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APPENDIX B
Intersection Capacity Analyses
Weekday AM Peak Hour
2015 Existing Conditions

Intersection Capacity Analysis

1. Summer St @ North St

11/21/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	↑↑			↑↑	↘	↗	
Volume (vph)	572	50	262	1246	79	227	
Satd. Flow (prot)	3036	0	0	3082	1577	1411	
Flt Permitted				0.696	0.950		
Satd. Flow (perm)	3036	0	0	2164	1577	1411	
Satd. Flow (RTOR)	9					261	
Confl. Peds. (#/hr)		3	3				
Peak Hour Factor	0.95	0.95	0.93	0.93	0.87	0.87	
Heavy Vehicles (%)	2%	2%	1%	1%	3%	3%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	655	0	0	1622	91	261	
Turn Type	NA		D.P+P	NA	Prot	Perm	
Protected Phases	2		1	6	4		3
Permitted Phases			2			4	
Detector Phase	2		1	6	4	4	
Switch Phase							
Minimum Initial (s)	8.0		4.0	8.0	9.0	9.0	4.0
Minimum Split (s)	13.0		9.0	13.0	14.0	14.0	21.0
Total Split (s)	40.0		25.0	65.0	25.0	25.0	21.0
Total Split (%)	36.0%		22.5%	58.6%	22.5%	22.5%	19%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0		1.0	1.0	1.0	1.0	0.0
Lost Time Adjust (s)	0.0			0.0	0.0	0.0	
Total Lost Time (s)	5.0			5.0	5.0	5.0	
Lead/Lag	Lead		Lag		Lag	Lag	Lead
Lead-Lag Optimize?	Yes		Yes		Yes	Yes	Yes
Recall Mode	Min		None	Min	None	None	None
Act Effect Green (s)	61.2			61.2	11.0	11.0	
Actuated g/C Ratio	0.71			0.71	0.13	0.13	
v/c Ratio	0.30			1.05	0.45	0.64	
Control Delay	6.3			52.7	43.5	12.9	
Queue Delay	0.0			0.0	0.0	0.0	
Total Delay	6.3			52.7	43.5	12.9	
LOS	A			D	D	B	
Approach Delay	6.3			52.7	20.8		
Approach LOS	A			D	C		
Queue Length 50th (ft)	41			331	43	0	
Queue Length 95th (ft)	163			#904	104	65	
Internal Link Dist (ft)	764			218	85		
Turn Bay Length (ft)							
Base Capacity (vph)	2171			1546	373	533	
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	0.30			1.05	0.24	0.49	

Intersection Summary

Cycle Length: 111

Actuated Cycle Length: 85.6

Intersection Capacity Analysis

1. Summer St @ North St

11/21/2015

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.05

Intersection Signal Delay: 36.9

Intersection LOS: D

Intersection Capacity Utilization 86.1%

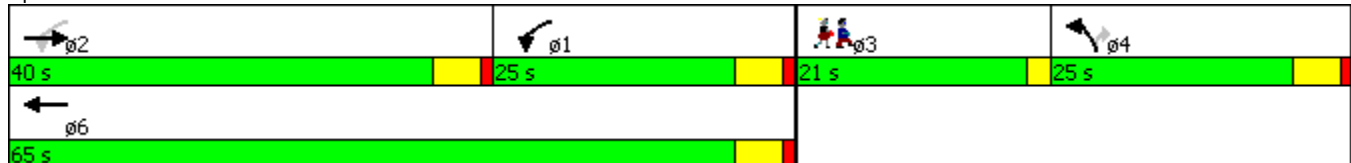
ICU Level of Service E

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: North St & Otis St/Summer St



HCM 2010 Roundabout
2. Route 3A Rotary

11/21/2015

Intersection						
Intersection Delay, s/veh	45.2					
Intersection LOS	E					
Approach	EB		WB		NB	NW
Entry Lanes	2		2		1	1
Conflicting Circle Lanes	2		2		2	2
Adj Approach Flow, veh/h	892		836		42	915
Demand Flow Rate, veh/h	927		844		44	934
Vehicles Circulating, veh/h	67		947		917	465
Vehicles Exiting, veh/h	1724		452		77	496
Follow-Up Headway, s	3.186		3.186		3.186	3.186
Ped Vol Crossing Leg, #/h	0		0		0	0
Ped Cap Adj	1.000		1.000		1.000	1.000
Approach Delay, s/veh	8.3		26.4		7.2	100.2
Approach LOS	A		D		A	F
Lane	Left	Right	Left	Right	Left	Left
Designated Moves	LT	TR	LT	TR	LR	LR
Assumed Moves	LT	R	LT	TR	LR	LR
RT Channelized						
Lane Util	0.454	0.546	0.470	0.530	1.000	1.000
Critical Headway, s	4.293	4.113	4.293	4.113	4.113	4.113
Entry Flow, veh/h	421	506	397	447	44	934
Cap Entry Lane, veh/h	1075	1078	555	582	595	816
Entry HV Adj Factor	0.962	0.962	0.990	0.991	0.955	0.980
Flow Entry, veh/h	405	487	393	443	42	915
Cap Entry, veh/h	1033	1038	550	577	568	799
V/C Ratio	0.392	0.469	0.715	0.768	0.074	1.145
Control Delay, s/veh	7.7	8.8	24.8	27.7	7.2	100.2
LOS	A	A	C	D	A	F
95th %tile Queue, veh	2	3	6	7	0	27

Intersection Capacity Analysis
 3. Summer St @ Rockland St

11/21/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	26	378	11	136	742	10	17	27	57	11	42	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	11	11	11	11	11	11	12	12	12	16	16	16
Storage Length (ft)	150		0	150		0	0		50	0		75
Storage Lanes	1		0	1		0	0		1	0		1
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1694	3374	0	1728	3448	0	0	1775	1538	0	2090	1794
Flt Permitted	0.338			0.437				0.852			0.923	
Satd. Flow (perm)	603	3374	0	795	3448	0	0	1542	1538	0	1949	1794
Right Turn on Red			No			No			No			No
Satd. Flow (RTOR)												
Link Speed (mph)		35			35			35			35	
Link Distance (ft)		458			438			329			717	
Travel Time (s)		8.9			8.5			6.4			14.0	
Peak Hour Factor	0.93	0.93	0.93	0.90	0.90	0.90	0.84	0.84	0.84	0.92	0.92	0.92
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	5%	5%	5%	2%	2%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	28	418	0	151	835	0	0	52	68	0	58	42
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3			3	
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	14.0	55.0		14.0	55.0		25.0	25.0	25.0	25.0	25.0	25.0
Total Split (%)	12.0%	47.0%		12.0%	47.0%		21.4%	21.4%	21.4%	21.4%	21.4%	21.4%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effct Green (s)	28.7	21.5		34.0	32.2			10.9	10.9		10.9	10.9
Actuated g/C Ratio	0.53	0.40		0.63	0.60			0.20	0.20		0.20	0.20
v/c Ratio	0.06	0.31		0.24	0.40			0.17	0.22		0.15	0.12
Control Delay	7.9	14.4		8.1	12.0			26.7	27.1		25.9	26.1
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	7.9	14.4		8.1	12.0			26.7	27.1		25.9	26.1
LOS	A	B		A	B			C	C		C	C
Approach Delay		14.0			11.4			27.0			26.0	
Approach LOS		B			B			C			C	
Queue Length 50th (ft)	2	41		14	52			11	15		12	9
Queue Length 95th (ft)	22	137		82	280			60	74		70	54
Internal Link Dist (ft)		378			358			249			637	
Turn Bay Length (ft)	150			150					50			75
Base Capacity (vph)	619	2991		714	3057			676	674		854	786

Intersection Capacity Analysis
 3. Summer St @ Rockland St

11/21/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Ideal Flow (vphpl)	
Lane Width (ft)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
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)	23.0
Total Split (s)	23.0
Total Split (%)	20%
Yellow Time (s)	2.0
All-Red Time (s)	0.0
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)	

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/21/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn	0	0		0	0			0	0		0	0
Spillback Cap Reductn	0	0		0	0			0	0		0	0
Storage Cap Reductn	0	0		0	0			0	0		0	0
Reduced v/c Ratio	0.05	0.14		0.21	0.27			0.08	0.10		0.07	0.05

Intersection Summary

Area Type:	Other
Cycle Length:	117
Actuated Cycle Length:	53.7
Natural Cycle:	65
Control Type:	Actuated-Uncoordinated
Maximum v/c Ratio:	0.40
Intersection Signal Delay:	14.1
Intersection LOS:	B
Intersection Capacity Utilization	46.7%
ICU Level of Service	A
Analysis Period (min)	15

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

ø1	ø2	ø3	ø9
14 s	55 s	25 s	23 s
ø5	ø6		
14 s	55 s		

Intersection Capacity Analysis

4. Rockland St @ G. W. Blvd

11/21/2015



Lane Group	WBL	WBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	180	21	359	87	10	688
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Satd. Flow (prot)	3290	0	3322	0	0	3418
Flt Permitted	0.957					0.946
Satd. Flow (perm)	3285	0	3322	0	0	3236
Right Turn on Red		Yes		Yes		
Satd. Flow (RTOR)	26		85			
Link Speed (mph)	35		35			35
Link Distance (ft)	180		737			669
Travel Time (s)	3.5		14.4			13.0
Confl. Peds. (#/hr)	1					
Peak Hour Factor	0.77	0.77	0.91	0.91	0.90	0.90
Shared Lane Traffic (%)						
Lane Group Flow (vph)	261	0	491	0	0	775
Turn Type	Prot		NA		Perm	NA
Protected Phases	3		2			6
Permitted Phases					6	
Detector Phase	3		2		6	6
Switch Phase						
Minimum Initial (s)	7.0		7.0		7.0	7.0
Minimum Split (s)	12.0		12.0		12.0	12.0
Total Split (s)	20.0		30.0		30.0	30.0
Total Split (%)	40.0%		60.0%		60.0%	60.0%
Yellow Time (s)	4.0		4.0		4.0	4.0
All-Red Time (s)	1.0		1.0		1.0	1.0
Lost Time Adjust (s)	0.0		0.0			0.0
Total Lost Time (s)	5.0		5.0			5.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Min		None		None	None
Act Effect Green (s)	10.0		14.7			14.7
Actuated g/C Ratio	0.29		0.42			0.42
v/c Ratio	0.27		0.34			0.57
Control Delay	10.6		6.2			9.5
Queue Delay	0.0		0.0			0.0
Total Delay	10.6		6.2			9.5
LOS	B		A			A
Approach Delay	10.6		6.2			9.5
Approach LOS	B		A			A
Queue Length 50th (ft)	17		23			51
Queue Length 95th (ft)	37		48			96
Internal Link Dist (ft)	100		657			589
Turn Bay Length (ft)						
Base Capacity (vph)	1468		2468			2382
Starvation Cap Reductn	0		0			0
Spillback Cap Reductn	0		0			0
Storage Cap Reductn	0		0			0
Reduced v/c Ratio	0.18		0.20			0.33

Intersection Capacity Analysis

4. Rockland St @ G. W. Blvd

11/21/2015

Intersection Summary

Area Type: Other

Cycle Length: 50

Actuated Cycle Length: 35

Natural Cycle: 40

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.57

Intersection Signal Delay: 8.6

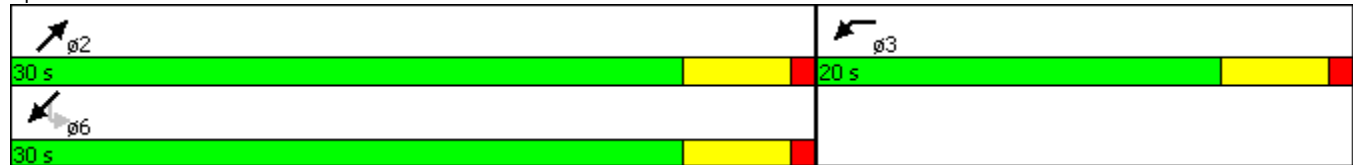
Intersection LOS: A

Intersection Capacity Utilization 40.3%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 13:



Intersection Capacity Analysis
5. G. W. Blvd @ Rockland Circle

11/21/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↵	↑↑	↵	
Volume (vph)	270	32	26	632	62	25
Satd. Flow (prot)	3270	0	1728	3455	1972	0
Flt Permitted			0.507		0.966	
Satd. Flow (perm)	3270	0	922	3455	1972	0
Satd. Flow (RTOR)	17				20	
Confl. Peds. (#/hr)						1
Peak Hour Factor	0.92	0.92	0.93	0.93	0.87	0.87
Heavy Vehicles (%)	5%	5%	1%	1%	1%	1%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	328	0	28	680	100	0
Turn Type	NA		pm+pt	NA	Prot	
Protected Phases	2		1	6	3	
Permitted Phases			6			
Detector Phase	2		1	6	3	
Switch Phase						
Minimum Initial (s)	40.0		8.0	40.0	8.0	
Minimum Split (s)	46.0		12.0	46.0	13.0	
Total Split (s)	46.0		24.0	70.0	25.0	
Total Split (%)	48.4%		25.3%	73.7%	26.3%	
Yellow Time (s)	4.0		3.0	4.0	3.0	
All-Red Time (s)	2.0		1.0	2.0	2.0	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	6.0		4.0	6.0	5.0	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Min		None	None	None	
Act Effect Green (s)	45.0		50.0	49.2	9.4	
Actuated g/C Ratio	0.68		0.76	0.75	0.14	
v/c Ratio	0.15		0.04	0.26	0.33	
Control Delay	6.1		3.0	3.9	25.4	
Queue Delay	0.0		0.0	0.0	0.0	
Total Delay	6.1		3.0	3.9	25.4	
LOS	A		A	A	C	
Approach Delay	6.1			3.9	25.4	
Approach LOS	A			A	C	
Queue Length 50th (ft)	17		2	42	26	
Queue Length 95th (ft)	57		9	74	72	
Internal Link Dist (ft)	1154			331	60	
Turn Bay Length (ft)			200			
Base Capacity (vph)	2244		949	3263	621	
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	0.15		0.03	0.21	0.16	

Intersection Summary

Cycle Length: 95
Actuated Cycle Length: 65.7

Intersection Capacity Analysis

5. G. W. Blvd @ Rockland Circle

11/21/2015

Natural Cycle: 75

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.33

Intersection Signal Delay: 6.4

Intersection LOS: A

Intersection Capacity Utilization 49.2%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 3: Rockland Cir & G W Blvd



Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/21/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕	↕		↕			↕	
Volume (vph)	2	0	5	15	4	16	1	276	12	22	634	5
Satd. Flow (prot)	0	1720	0	0	1621	1432	0	3447	0	0	3564	0
Flt Permitted		0.907						0.954			0.939	
Satd. Flow (perm)	0	1579	0	0	1682	1412	0	3288	0	0	3353	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	1		1	1		1			4	4		
Peak Hour Factor	0.88	0.88	0.88	0.80	0.80	0.80	0.88	0.88	0.88	0.92	0.92	0.92
Heavy Vehicles (%)	10%	10%	10%	9%	9%	9%	4%	4%	4%	1%	1%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	8	0	0	24	20	0	329	0	0	718	0
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		Perm	NA	
Protected Phases		4			8			2				6
Permitted Phases	4			8		8	2			6		
Detector Phase	4	4		8	8	8	2	2		6	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	33.0	33.0		33.0	33.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	38.0	38.0		38.0	38.0	
Total Split (s)	15.0	15.0		15.0	15.0	15.0	38.0	38.0		38.0	38.0	
Total Split (%)	21.4%	21.4%		21.4%	21.4%	21.4%	54.3%	54.3%		54.3%	54.3%	
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	
Total Lost Time (s)		5.0			5.0	5.0		5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	
Act Effect Green (s)		6.5			6.7	6.7		45.9			45.9	
Actuated g/C Ratio		0.12			0.12	0.12		0.83			0.83	
v/c Ratio		0.04			0.12	0.12		0.12			0.26	
Control Delay		23.7			24.5	24.8		4.3			4.7	
Queue Delay		0.0			0.0	0.0		0.0			0.0	
Total Delay		23.7			24.5	24.8		4.3			4.7	
LOS		C			C	C		A			A	
Approach Delay		23.7			24.6			4.3			4.7	
Approach LOS		C			C			A			A	
Queue Length 50th (ft)		2			7	6		0			0	
Queue Length 95th (ft)		14			26	23		61			141	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)												
Base Capacity (vph)		288			307	258		2723			2777	
Starvation Cap Reductn		0			0	0		0			0	
Spillback Cap Reductn		0			0	0		0			0	
Storage Cap Reductn		0			0	0		0			0	
Reduced v/c Ratio		0.03			0.08	0.08		0.12			0.26	

Intersection Summary

Cycle Length: 70

Actuated Cycle Length: 55.4

Intersection Capacity Analysis
 6. G. W. Blvd @ Wharf Ave

11/21/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
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)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effect 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	

Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/21/2015

Natural Cycle: 65

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.26

Intersection Signal Delay: 5.5

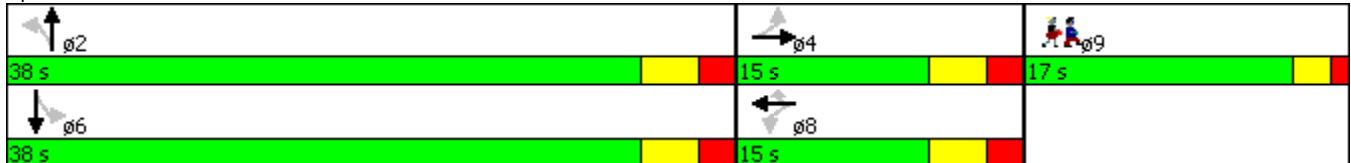
Intersection LOS: A

Intersection Capacity Utilization 46.7%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 7: G W Blvd & Wharf Ave



APPENDIX C
Intersection Capacity Analyses
Weekday PM Peak Hour
2015 Existing Conditions

Intersection Capacity Analysis

1. Summer St @ North St

11/21/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	↑↑			↑↑	↘	↗	
Volume (vph)	1137	53	182	617	118	412	
Satd. Flow (prot)	3085	0	0	3045	1608	1439	
Flt Permitted				0.521	0.950		
Satd. Flow (perm)	3085	0	0	1604	1584	1439	
Satd. Flow (RTOR)	4					509	
Confl. Peds. (#/hr)		1	1		9		
Peak Hour Factor	0.95	0.95	0.87	0.87	0.81	0.81	
Heavy Vehicles (%)	1%	1%	2%	2%	1%	1%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	1253	0	0	918	146	509	
Turn Type	NA		D.P+P	NA	Prot	Perm	
Protected Phases	2		1	6	4		3
Permitted Phases			2			4	
Detector Phase	2		1	6	4	4	
Switch Phase							
Minimum Initial (s)	8.0		4.0	8.0	9.0	9.0	4.0
Minimum Split (s)	13.0		9.0	13.0	14.0	14.0	21.0
Total Split (s)	40.0		25.0	65.0	25.0	25.0	21.0
Total Split (%)	36.0%		22.5%	58.6%	22.5%	22.5%	19%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0		1.0	1.0	1.0	1.0	0.0
Lost Time Adjust (s)	0.0			0.0	0.0	0.0	
Total Lost Time (s)	5.0			5.0	5.0	5.0	
Lead/Lag	Lead		Lag		Lag	Lag	Lead
Lead-Lag Optimize?	Yes		Yes		Yes	Yes	Yes
Recall Mode	Min		None	Min	None	None	None
Act Effect Green (s)	47.6			47.6	13.6	13.6	
Actuated g/C Ratio	0.64			0.64	0.18	0.18	
v/c Ratio	0.64			1.20dl	0.50	0.75	
Control Delay	11.8			27.4	38.3	11.5	
Queue Delay	0.0			0.0	0.0	0.0	
Total Delay	11.8			27.4	38.3	11.5	
LOS	B			C	D	B	
Approach Delay	11.8			27.4	17.5		
Approach LOS	B			C	B		
Queue Length 50th (ft)	128			131	55	0	
Queue Length 95th (ft)	435			#479	143	46	
Internal Link Dist (ft)	764			218	85		
Turn Bay Length (ft)							
Base Capacity (vph)	1963			1324	462	776	
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	0.64			0.69	0.32	0.66	

Intersection Summary

Cycle Length: 111
 Actuated Cycle Length: 74.8

Intersection Capacity Analysis

1. Summer St @ North St

11/21/2015

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.90

Intersection Signal Delay: 18.2

Intersection LOS: B

Intersection Capacity Utilization 81.6%

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.

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 1: North St & Otis St/Summer St

 ø2	 ø1	 ø3	 ø4
40 s	25 s	21 s	25 s
 ø6			
65 s			

HCM 2010 Roundabout
2. Route 3A Rotary

11/21/2015

Intersection						
Intersection Delay, s/veh	22.6					
Intersection LOS	C					
Approach	EB		WB		NB	NW
Entry Lanes	2		2		1	1
Conflicting Circle Lanes	2		2		2	2
Adj Approach Flow, veh/h	1824		720		14	508
Demand Flow Rate, veh/h	1842		734		14	519
Vehicles Circulating, veh/h	55		494		1875	900
Vehicles Exiting, veh/h	1173		925		22	989
Follow-Up Headway, s	3.186		3.186		3.186	3.186
Ped Vol Crossing Leg, #/h	0		0		0	0
Ped Cap Adj	1.000		1.000		1.000	1.000
Approach Delay, s/veh	23.3		11.0		12.6	37.2
Approach LOS	C		B		B	E
Lane	Left	Right	Left	Right	Left	Left
Designated Moves	LT	TR	LT	TR	LR	LR
Assumed Moves	LT	R	LT	TR	LR	LR
RT Channelized						
Lane Util	0.481	0.519	0.470	0.530	1.000	1.000
Critical Headway, s	4.293	4.113	4.293	4.113	4.113	4.113
Entry Flow, veh/h	886	956	345	389	14	519
Cap Entry Lane, veh/h	1084	1087	780	800	304	602
Entry HV Adj Factor	0.990	0.991	0.981	0.981	1.000	0.979
Flow Entry, veh/h	877	947	338	382	14	508
Cap Entry, veh/h	1074	1077	765	784	304	589
V/C Ratio	0.817	0.879	0.442	0.486	0.046	0.862
Control Delay, s/veh	20.4	26.0	10.6	11.3	12.6	37.2
LOS	C	D	B	B	B	E
95th %tile Queue, veh	10	12	2	3	0	10

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/21/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	58	745	24	110	474	8	15	29	85	7	23	30
Satd. Flow (prot)	1728	3435	0	1694	3378	0	0	1831	1583	0	2026	1743
Flt Permitted	0.433			0.229				0.888			0.926	
Satd. Flow (perm)	787	3435	0	408	3378	0	0	1654	1562	0	1898	1743
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)			2	2					1	1		
Peak Hour Factor	0.91	0.91	0.91	0.83	0.83	0.83	0.75	0.75	0.75	0.88	0.88	0.88
Heavy Vehicles (%)	1%	1%	1%	3%	3%	3%	2%	2%	2%	5%	5%	5%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	64	845	0	133	581	0	0	59	113	0	34	34
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3				3
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	14.0	55.0		14.0	55.0		25.0	25.0	25.0	25.0	25.0	25.0
Total Split (%)	12.0%	47.0%		12.0%	47.0%		21.4%	21.4%	21.4%	21.4%	21.4%	21.4%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effect Green (s)	34.8	26.9		38.7	35.6			12.9	12.9		12.9	12.9
Actuated g/C Ratio	0.57	0.44		0.63	0.58			0.21	0.21		0.21	0.21
v/c Ratio	0.12	0.56		0.32	0.30			0.17	0.34		0.09	0.09
Control Delay	8.1	17.0		9.7	12.8			28.5	30.8		28.0	28.2
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	8.1	17.0		9.7	12.8			28.5	30.8		28.0	28.2
LOS	A	B		A	B			C	C		C	C
Approach Delay		16.4			12.3			30.0			28.1	
Approach LOS		B			B			C			C	
Queue Length 50th (ft)	6	104		14	63			16	32		9	9
Queue Length 95th (ft)	43	317		72	181			62	105		48	48
Internal Link Dist (ft)		378			358			249			637	
Turn Bay Length (ft)	150			150					50			75
Base Capacity (vph)	693	2867		518	2820			646	610		741	681
Starvation Cap Reductn	0	0		0	0			0	0		0	0
Spillback Cap Reductn	0	0		0	0			0	0		0	0
Storage Cap Reductn	0	0		0	0			0	0		0	0
Reduced v/c Ratio	0.09	0.29		0.26	0.21			0.09	0.19		0.05	0.05

Intersection Summary

Cycle Length: 117

Actuated Cycle Length: 61.2

Intersection Capacity Analysis
 3. Summer St @ Rockland St

11/21/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
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)	23.0
Total Split (s)	23.0
Total Split (%)	20%
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effect 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	

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/21/2015

Natural Cycle: 65

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.56

Intersection Signal Delay: 16.5







Intersection LOS: B

Intersection Capacity Utilization 48.1%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

 ø1	 ø2	 ø3	 ø9
14 s	55 s	25 s	23 s
 ø5	 ø6		
14 s	55 s		

Intersection Capacity Analysis

4. Rockland St @ G. W. Blvd

11/21/2015



Lane Group	WBL	WBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	106	23	665	177	18	481
Satd. Flow (prot)	3173	0	3312	0	0	3414
Flt Permitted	0.961					0.906
Satd. Flow (perm)	3173	0	3312	0	0	3100
Satd. Flow (RTOR)	27		96			
Peak Hour Factor	0.85	0.85	0.90	0.90	0.83	0.83
Heavy Vehicles (%)	5%	5%	2%	2%	2%	2%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	152	0	936	0	0	602
Turn Type	Prot		NA		Perm	NA
Protected Phases	3		2			6
Permitted Phases					6	
Detector Phase	3		2		6	6
Switch Phase						
Minimum Initial (s)	7.0		7.0		7.0	7.0
Minimum Split (s)	12.0		12.0		12.0	12.0
Total Split (s)	20.0		30.0		30.0	30.0
Total Split (%)	40.0%		60.0%		60.0%	60.0%
Yellow Time (s)	4.0		4.0		4.0	4.0
All-Red Time (s)	1.0		1.0		1.0	1.0
Lost Time Adjust (s)	0.0		0.0			0.0
Total Lost Time (s)	5.0		5.0			5.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Min		None		None	None
Act Effct Green (s)	9.0		16.3			16.3
Actuated g/C Ratio	0.25		0.46			0.46
v/c Ratio	0.19		0.60			0.42
Control Delay	11.0		8.0			7.3
Queue Delay	0.0		0.0			0.0
Total Delay	11.0		8.0			7.3
LOS	B		A			A
Approach Delay	11.0		8.0			7.3
Approach LOS	B		A			A
Queue Length 50th (ft)	9		52			34
Queue Length 95th (ft)	28		96			58
Internal Link Dist (ft)	100		657			589
Turn Bay Length (ft)						
Base Capacity (vph)	1390		2419			2240
Starvation Cap Reductn	0		0			0
Spillback Cap Reductn	0		0			0
Storage Cap Reductn	0		0			0
Reduced v/c Ratio	0.11		0.39			0.27

Intersection Summary

Cycle Length: 50
 Actuated Cycle Length: 35.6
 Natural Cycle: 40

Intersection Capacity Analysis

4. Rockland St @ G. W. Blvd

11/21/2015

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.60

Intersection Signal Delay: 8.0

Intersection LOS: A

Intersection Capacity Utilization 40.6%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 13:



Intersection Capacity Analysis
 5. G. W. Blvd @ Rocklland Circle

11/21/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↙	↑↑	↘	
Volume (vph)	595	83	34	402	50	22
Satd. Flow (prot)	3393	0	1728	3455	1975	0
Flt Permitted			0.322		0.967	
Satd. Flow (perm)	3393	0	586	3455	1975	0
Satd. Flow (RTOR)	20				22	
Peak Hour Factor	0.89	0.89	0.92	0.92	0.72	0.72
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	762	0	37	437	100	0
Turn Type	NA		pm+pt	NA	Prot	
Protected Phases	2		1	6	3	
Permitted Phases			6			
Detector Phase	2		1	6	3	
Switch Phase						
Minimum Initial (s)	40.0		8.0	40.0	8.0	
Minimum Split (s)	46.0		12.0	46.0	13.0	
Total Split (s)	46.0		24.0	70.0	25.0	
Total Split (%)	48.4%		25.3%	73.7%	26.3%	
Yellow Time (s)	4.0		3.0	4.0	3.0	
All-Red Time (s)	2.0		1.0	2.0	2.0	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	6.0		4.0	6.0	5.0	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Min		None	None	None	
Act Effect Green (s)	45.0		50.0	49.2	9.5	
Actuated g/C Ratio	0.68		0.76	0.75	0.14	
v/c Ratio	0.33		0.06	0.17	0.33	
Control Delay	7.2		3.1	3.6	24.8	
Queue Delay	0.0		0.0	0.0	0.0	
Total Delay	7.2		3.1	3.6	24.8	
LOS	A		A	A	C	
Approach Delay	7.2			3.6	24.8	
Approach LOS	A			A	C	
Queue Length 50th (ft)	49		3	26	25	
Queue Length 95th (ft)	138		11	46	56	
Internal Link Dist (ft)	1154			331	60	
Turn Bay Length (ft)			200			
Base Capacity (vph)	2326		796	3263	622	
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	0.33		0.05	0.13	0.16	

Intersection Summary

Cycle Length: 95
 Actuated Cycle Length: 65.8
 Natural Cycle: 75

Intersection Capacity Analysis

5. G. W. Blvd @ Rocklland Circle

11/21/2015

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.33

Intersection Signal Delay: 7.2

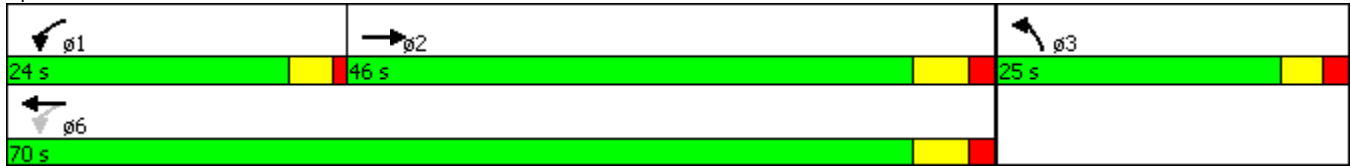
Intersection LOS: A

Intersection Capacity Utilization 49.2%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 3: Rockland Cir & G W Blvd



Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/21/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕	↕		↕			↕	
Volume (vph)	13	6	7	35	2	15	5	593	13	17	402	10
Satd. Flow (prot)	0	1920	0	0	1609	1432	0	3459	0	0	3553	0
Flt Permitted		0.815			0.762			0.953			0.925	
Satd. Flow (perm)	0	1602	0	0	1282	1412	0	3297	0	0	3293	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	1		1	1		1			2	2		
Peak Hour Factor	0.65	0.65	0.65	0.72	0.72	0.72	0.92	0.92	0.92	0.95	0.95	0.95
Heavy Vehicles (%)	5%	5%	5%	9%	9%	9%	4%	4%	4%	1%	1%	1%
Parking (#/hr)										0		
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	40	0	0	52	21	0	664	0	0	452	0
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Detector Phase	4	4		8	8	8	2	2		6	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	33.0	33.0		33.0	33.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	38.0	38.0		38.0	38.0	
Total Split (s)	15.0	15.0		15.0	15.0	15.0	38.0	38.0		38.0	38.0	
Total Split (%)	21.4%	21.4%		21.4%	21.4%	21.4%	54.3%	54.3%		54.3%	54.3%	
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	
Total Lost Time (s)		5.0			5.0	5.0		5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	
Act Effect Green (s)		7.5			7.6	7.6		41.8			41.8	
Actuated g/C Ratio		0.13			0.14	0.14		0.75			0.75	
v/c Ratio		0.19			0.30	0.11		0.27			0.18	
Control Delay		24.6			27.4	23.8		5.8			5.4	
Queue Delay		0.0			0.0	0.0		0.0			0.0	
Total Delay		24.6			27.4	23.8		5.8			5.4	
LOS		C			C	C		A			A	
Approach Delay		24.6			26.4			5.8			5.4	
Approach LOS		C			C			A			A	
Queue Length 50th (ft)		11			14	6		35			22	
Queue Length 95th (ft)		30			40	21		134			88	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)												
Base Capacity (vph)		292			233	257		2481			2478	
Starvation Cap Reductn		0			0	0		0			0	
Spillback Cap Reductn		0			0	0		0			0	
Storage Cap Reductn		0			0	0		0			0	
Reduced v/c Ratio		0.14			0.22	0.08		0.27			0.18	

Intersection Summary

Cycle Length: 70

Intersection Capacity Analysis
 6. G. W. Blvd @ Wharf Ave

11/21/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Parking (#/hr)	
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)	2.0
All-Red Time (s)	1.0
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	

Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/21/2015

Actuated Cycle Length: 55.6

Natural Cycle: 65

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.30

Intersection Signal Delay: 7.5






Intersection LOS: A

Intersection Capacity Utilization 46.7%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 7: G W Blvd & Wharf Ave

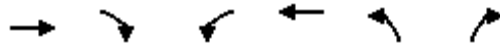
 ø2	 ø4	 ø9
38 s	15 s	17 s
 ø6	 ø8	
38 s	15 s	

APPENDIX D
Intersection Capacity Analyses
Summer Saturday Midday Peak Hour
2015 Existing Conditions

Intersection Capacity Analysis

1. Summer St @ North St

11/21/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	↑↑			↑↑	↗	↖	
Volume (vph)	1261	67	184	777	200	567	
Satd. Flow (prot)	3080	0	0	2899	1608	1439	
Flt Permitted				0.502	0.950		
Satd. Flow (perm)	3080	0	0	1468	1477	1380	
Satd. Flow (RTOR)	5					576	
Confl. Peds. (#/hr)		7	7		49	18	
Peak Hour Factor	0.94	0.94	0.93	0.93	0.94	0.94	
Heavy Vehicles (%)	1%	1%	2%	2%	1%	1%	
Parking (#/hr)				0			
Shared Lane Traffic (%)							
Lane Group Flow (vph)	1412	0	0	1033	213	603	
Turn Type	NA		D.P+P	NA	Prot	Perm	
Protected Phases	2		1	6	4		3
Permitted Phases			2			4	
Detector Phase	2		1	6	4	4	
Switch Phase							
Minimum Initial (s)	8.0		4.0	8.0	9.0	9.0	4.0
Minimum Split (s)	13.0		9.0	13.0	14.0	14.0	21.0
Total Split (s)	40.0		25.0	65.0	25.0	25.0	21.0
Total Split (%)	36.0%		22.5%	58.6%	22.5%	22.5%	19%
Yellow Time (s)	4.0		4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0		1.0	1.0	1.0	1.0	0.0
Lost Time Adjust (s)	0.0			0.0	0.0	0.0	
Total Lost Time (s)	5.0			5.0	5.0	5.0	
Lead/Lag	Lead		Lag		Lag	Lag	Lead
Lead-Lag Optimize?	Yes		Yes		Yes	Yes	Yes
Recall Mode	Min		None	Min	None	None	None
Act Effct Green (s)	59.6			59.6	16.7	16.7	
Actuated g/C Ratio	0.64			0.64	0.18	0.18	
v/c Ratio	0.72			1.69dl	0.74	0.84	
Control Delay	17.1			83.9	55.6	16.5	
Queue Delay	0.0			0.0	0.0	0.0	
Total Delay	17.1			83.9	55.6	16.5	
LOS	B			F	E	B	
Approach Delay	17.1			83.9	26.7		
Approach LOS	B			F	C		
Queue Length 50th (ft)	210			~327	109	12	
Queue Length 95th (ft)	537			#629	#253	#216	
Internal Link Dist (ft)	764			218	85		
Turn Bay Length (ft)							
Base Capacity (vph)	1962			965	352	752	
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	0.72			1.07	0.61	0.80	

Intersection Summary

Cycle Length: 111

Intersection Capacity Analysis

1. Summer St @ North St

11/21/2015

Actuated Cycle Length: 93.6

Natural Cycle: 130

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.11

Intersection Signal Delay: 40.6

Intersection LOS: D

Intersection Capacity Utilization 95.7%

ICU Level of Service F

Analysis 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 longer.

Queue shown is maximum after two cycles.

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 1: North St & Otis St/Summer St

 ø2	 ø1	 ø3	 ø4
40 s	25 s	21 s	25 s
 ø6			
65 s			

HCM 2010 Roundabout
2. Route 3A Rotary

11/21/2015

Intersection						
Intersection Delay, s/veh	42.2					
Intersection LOS	E					
Approach	EB		WB		NB	NW
Entry Lanes	2		2		1	1
Conflicting Circle Lanes	2		2		2	2
Adj Approach Flow, veh/h	1998		855		8	460
Demand Flow Rate, veh/h	2018		863		8	465
Vehicles Circulating, veh/h	56		465		2020	1485
Vehicles Exiting, veh/h	1272		1485		54	543
Follow-Up Headway, s	3.186		3.186		3.186	3.186
Ped Vol Crossing Leg, #/h	0		0		0	0
Ped Cap Adj	1.000		1.000		1.000	1.000
Approach Delay, s/veh	35.1		12.3		13.6	129.2
Approach LOS	E		B		B	F
Lane	Left	Right	Left	Right	Left	Left
Designated Moves	LT	TR	LT	TR	LR	LR
Assumed Moves	LT	TR	LT	TR	LR	LR
RT Channelized						
Lane Util	0.470	0.530	0.470	0.530	1.000	1.000
Critical Headway, s	4.293	4.113	4.293	4.113	4.113	4.113
Entry Flow, veh/h	948	1070	406	457	8	465
Cap Entry Lane, veh/h	1083	1087	797	816	275	400
Entry HV Adj Factor	0.991	0.990	0.990	0.991	1.000	0.989
Flow Entry, veh/h	939	1059	402	453	8	460
Cap Entry, veh/h	1073	1075	789	809	275	395
V/C Ratio	0.875	0.985	0.509	0.560	0.029	1.164
Control Delay, s/veh	25.6	43.5	11.7	12.8	13.6	129.2
LOS	D	E	B	B	B	F
95th %tile Queue, veh	12	19	3	4	0	18

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/21/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	55	1344	25	112	693	7	17	28	104	7	25	22
Satd. Flow (prot)	1728	3443	0	1728	3448	0	0	1864	1615	0	2088	1794
Flt Permitted	0.328			0.093				0.888			0.940	
Satd. Flow (perm)	596	3443	0	169	3448	0	0	1687	1593	0	1984	1794
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)			2	2					1	1		
Peak Hour Factor	0.95	0.95	0.95	0.89	0.89	0.89	0.85	0.85	0.85	0.90	0.90	0.90
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	0%	0%	0%	2%	2%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	58	1441	0	126	787	0	0	53	122	0	36	24
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3			3	
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	14.0	55.0		14.0	55.0		25.0	25.0	25.0	25.0	25.0	25.0
Total Split (%)	12.0%	47.0%		12.0%	47.0%		21.4%	21.4%	21.4%	21.4%	21.4%	21.4%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effect Green (s)	55.6	48.8		58.8	52.2			13.1	13.1		13.1	13.1
Actuated g/C Ratio	0.64	0.56		0.68	0.60			0.15	0.15		0.15	0.15
v/c Ratio	0.13	0.74		0.53	0.38			0.21	0.51		0.12	0.09
Control Delay	7.5	20.0		18.1	12.4			37.6	44.4		36.1	36.0
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	7.5	20.0		18.1	12.4			37.6	44.4		36.1	36.0
LOS	A	B		B	B			D	D		D	D
Approach Delay		19.5			13.2			42.3			36.1	
Approach LOS		B			B			D			D	
Queue Length 50th (ft)	7	245		15	96			24	59		16	11
Queue Length 95th (ft)	39	#721		91	274			68	136		54	41
Internal Link Dist (ft)		378			358			249			637	
Turn Bay Length (ft)	150			150					50			75
Base Capacity (vph)	546	2052		303	2092			402	379		473	427
Starvation Cap Reductn	0	0		0	0			0	0		0	0
Spillback Cap Reductn	0	0		0	0			0	0		0	0
Storage Cap Reductn	0	0		0	0			0	0		0	0
Reduced v/c Ratio	0.11	0.70		0.42	0.38			0.13	0.32		0.08	0.06

Intersection Summary

Cycle Length: 117

Actuated Cycle Length: 86.7

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/21/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
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)	23.0
Total Split (s)	23.0
Total Split (%)	20%
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effect 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	

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/21/2015

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.74

Intersection Signal Delay: 19.2

Intersection LOS: B

Intersection Capacity Utilization 64.9%







ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

 ø1	 ø2	 ø3	 ø9
14 s	55 s	25 s	23 s
 ø5	 ø6		
14 s	55 s		

Intersection Capacity Analysis

4. Rockland St @ G. W. Blvd

11/21/2015



Lane Group	WBL	WBR	NET	NER	SWL	SWT
Lane Configurations						
Volume (vph)	26	129	1223	202	23	718
Satd. Flow (prot)	3062	0	3383	0	0	3448
Flt Permitted	0.992					0.877
Satd. Flow (perm)	3062	0	3383	0	0	3030
Satd. Flow (RTOR)	30		53			
Peak Hour Factor	0.88	0.88	0.92	0.92	0.88	0.88
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	177	0	1549	0	0	842
Turn Type	Prot		NA		Perm	NA
Protected Phases	3		2			6
Permitted Phases					6	
Detector Phase	3		2		6	6
Switch Phase						
Minimum Initial (s)	7.0		7.0		7.0	7.0
Minimum Split (s)	12.0		12.0		12.0	12.0
Total Split (s)	20.0		30.0		30.0	30.0
Total Split (%)	40.0%		60.0%		60.0%	60.0%
Yellow Time (s)	4.0		4.0		4.0	4.0
All-Red Time (s)	1.0		1.0		1.0	1.0
Lost Time Adjust (s)	0.0		0.0			0.0
Total Lost Time (s)	5.0		5.0			5.0
Lead/Lag						
Lead-Lag Optimize?						
Recall Mode	Min		None		None	None
Act Effct Green (s)	9.4		24.4			24.4
Actuated g/C Ratio	0.21		0.56			0.56
v/c Ratio	0.26		0.81			0.50
Control Delay	13.2		12.9			7.5
Queue Delay	0.0		0.0			0.0
Total Delay	13.2		12.9			7.5
LOS	B		B			A
Approach Delay	13.2		12.9			7.5
Approach LOS	B		B			A
Queue Length 50th (ft)	15		133			56
Queue Length 95th (ft)	34		#260			98
Internal Link Dist (ft)	100		657			589
Turn Bay Length (ft)						
Base Capacity (vph)	1072		1960			1735
Starvation Cap Reductn	0		0			0
Spillback Cap Reductn	0		0			0
Storage Cap Reductn	0		0			0
Reduced v/c Ratio	0.17		0.79			0.49

Intersection Summary

Cycle Length: 50
 Actuated Cycle Length: 43.8
 Natural Cycle: 40

Intersection Capacity Analysis

4. Rockland St @ G. W. Blvd

11/21/2015

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.81

Intersection Signal Delay: 11.1

Intersection LOS: B

Intersection Capacity Utilization 54.4%

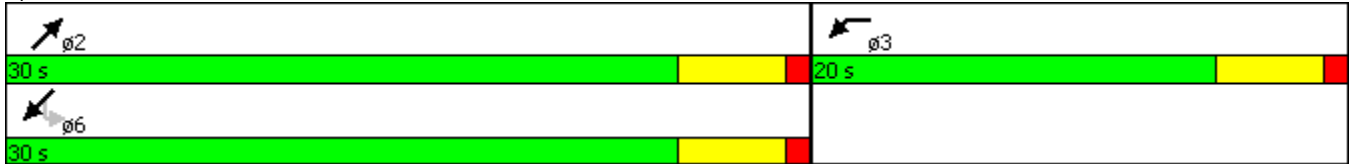
ICU Level of Service A

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 13:



Intersection Capacity Analysis
 5. G. W. Blvd @ Rockland Circle

11/21/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations	↑↑		↙	↑↑	↘	
Volume (vph)	1170	100	25	675	60	25
Satd. Flow (prot)	3410	0	1728	3455	1977	0
Flt Permitted			0.157		0.966	
Satd. Flow (perm)	3410	0	286	3455	1977	0
Satd. Flow (RTOR)	13				20	
Peak Hour Factor	1.00	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	1279	0	27	734	92	0
Turn Type	NA		pm+pt	NA	Prot	
Protected Phases	2		1	6	3	
Permitted Phases			6			
Detector Phase	2		1	6	3	
Switch Phase						
Minimum Initial (s)	40.0		8.0	40.0	8.0	
Minimum Split (s)	46.0		12.0	46.0	13.0	
Total Split (s)	46.0		24.0	70.0	25.0	
Total Split (%)	48.4%		25.3%	73.7%	26.3%	
Yellow Time (s)	4.0		3.0	4.0	3.0	
All-Red Time (s)	2.0		1.0	2.0	2.0	
Lost Time Adjust (s)	0.0		0.0	0.0	0.0	
Total Lost Time (s)	6.0		4.0	6.0	5.0	
Lead/Lag	Lag		Lead			
Lead-Lag Optimize?	Yes		Yes			
Recall Mode	Min		None	None	None	
Act Effect Green (s)	45.0		49.9	49.2	9.2	
Actuated g/C Ratio	0.69		0.76	0.75	0.14	
v/c Ratio	0.55		0.07	0.28	0.31	
Control Delay	9.3		3.1	3.9	24.9	
Queue Delay	0.0		0.0	0.0	0.0	
Total Delay	9.3		3.1	3.9	24.9	
LOS	A		A	A	C	
Approach Delay	9.3			3.9	24.9	
Approach LOS	A			A	C	
Queue Length 50th (ft)	99		2	45	23	
Queue Length 95th (ft)	285		8	79	69	
Internal Link Dist (ft)	1154			331	60	
Turn Bay Length (ft)			200			
Base Capacity (vph)	2344		663	3269	624	
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	0.55		0.04	0.22	0.15	

Intersection Summary

Cycle Length: 95
 Actuated Cycle Length: 65.5
 Natural Cycle: 75

Intersection Capacity Analysis

5. G. W. Blvd @ Rockland Circle

11/21/2015

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.55

Intersection Signal Delay: 8.1

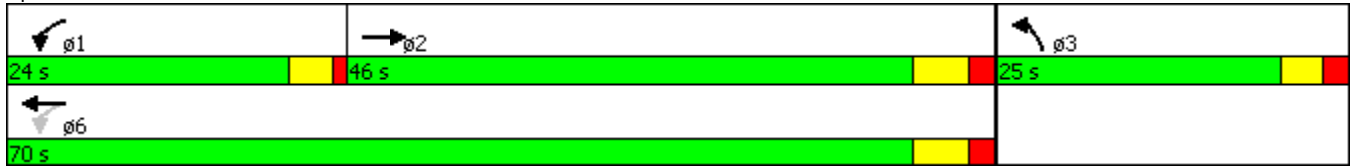
Intersection LOS: A

Intersection Capacity Utilization 51.4%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 3: Rockland Cir & G W Blvd



Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/21/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕	↕		↕			↕	
Volume (vph)	10	10	29	138	6	32	18	910	262	23	639	17
Satd. Flow (prot)	0	1709	0	0	1735	1546	0	3431	0	0	3549	0
Flt Permitted		0.912			0.688			0.940			0.889	
Satd. Flow (perm)	0	1567	0	0	1125	1476	0	3228	0	0	3161	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	16		55	55		16	22		9	9		22
Peak Hour Factor	0.75	0.75	0.75	0.88	0.88	0.88	0.95	0.95	0.95	0.91	0.91	0.91
Heavy Vehicles (%)	6%	6%	6%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)										0		
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	65	0	0	164	36	0	1253	0	0	746	0
Turn Type	Perm	NA		Perm	NA	Perm	Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4			8		8	2			6		
Detector Phase	4	4		8	8	8	2	2		6	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	33.0	33.0		33.0	33.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	38.0	38.0		38.0	38.0	
Total Split (s)	15.0	15.0		15.0	15.0	15.0	38.0	38.0		38.0	38.0	
Total Split (%)	21.4%	21.4%		21.4%	21.4%	21.4%	54.3%	54.3%		54.3%	54.3%	
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	
Total Lost Time (s)		5.0			5.0	5.0		5.0			5.0	
Lead/Lag												
Lead-Lag Optimize?												
Recall Mode	None	None		None	None	None	Min	Min		Min	Min	
Act Effect Green (s)		10.2			10.2	10.2		36.3			36.3	
Actuated g/C Ratio		0.16			0.16	0.16		0.58			0.58	
v/c Ratio		0.26			0.90	0.15		0.67			0.41	
Control Delay		27.4			77.9	26.3		13.6			9.8	
Queue Delay		0.0			0.0	0.0		0.0			0.0	
Total Delay		27.4			77.9	26.3		13.6			9.8	
LOS		C			E	C		B			A	
Approach Delay		27.4			68.6			13.6			9.8	
Approach LOS		C			E			B			A	
Queue Length 50th (ft)		18			49	10		104			50	
Queue Length 95th (ft)		49			#180	38		318			156	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)												
Base Capacity (vph)		253			182	239		1868			1829	
Starvation Cap Reductn		0			0	0		0			0	
Spillback Cap Reductn		0			0	0		0			0	
Storage Cap Reductn		0			0	0		0			0	
Reduced v/c Ratio		0.26			0.90	0.15		0.67			0.41	

Intersection Summary

Cycle Length: 70

Intersection Capacity Analysis
 6. G. W. Blvd @ Wharf Ave

11/21/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Parking (#/hr)	
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)	2.0
All-Red Time (s)	1.0
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	

Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/21/2015

Actuated Cycle Length: 62.8

Natural Cycle: 70

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.90

Intersection Signal Delay: 17.6

Intersection LOS: B

Intersection Capacity Utilization 69.8%

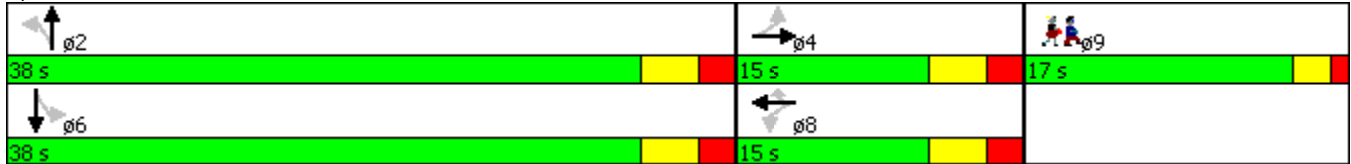
ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 7: G W Blvd & Wharf Ave



Intersection Capacity Analysis
 7. Otis St (Rt 3A) @ Hingham Bathing Beach

11/21/2015



Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	ø3
Lane Configurations							
Volume (vph)	132	98	832	177	76	1212	
Satd. Flow (prot)	1665	0	3365	0	0	3445	
Flt Permitted	0.972					0.743	
Satd. Flow (perm)	1660	0	3365	0	0	2567	
Satd. Flow (RTOR)			33				
Confl. Peds. (#/hr)	4						
Peak Hour Factor	0.91	0.91	0.89	0.89	0.95	0.95	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	253	0	1134	0	0	1356	
Turn Type	Prot		NA		Perm	NA	
Protected Phases	4		2			6	3
Permitted Phases					6		
Detector Phase	4		2		6	6	
Switch Phase							
Minimum Initial (s)	4.0		40.0		40.0	40.0	4.0
Minimum Split (s)	13.0		45.0		45.0	45.0	25.0
Total Split (s)	25.0		45.0		45.0	45.0	25.0
Total Split (%)	26.3%		47.4%		47.4%	47.4%	26%
Yellow Time (s)	4.0		4.0		4.0	4.0	4.0
All-Red Time (s)	1.0		1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0		0.0			0.0	
Total Lost Time (s)	5.0		5.0			5.0	
Lead/Lag	Lag						Lead
Lead-Lag Optimize?	Yes						Yes
Recall Mode	None		Max		Max	Max	None
Act Effect Green (s)	16.1		41.0			41.0	
Actuated g/C Ratio	0.23		0.58			0.58	
v/c Ratio	0.67		0.58			0.92	
Control Delay	36.6		13.2			27.8	
Queue Delay	0.0		0.0			0.0	
Total Delay	36.6		13.2			27.8	
LOS	D		B			C	
Approach Delay	36.6		13.2			27.8	
Approach LOS	D		B			C	
Queue Length 50th (ft)	91		122			213	
Queue Length 95th (ft)	#250		375			#675	
Internal Link Dist (ft)	1		775			511	
Turn Bay Length (ft)							
Base Capacity (vph)	480		1954			1480	
Starvation Cap Reductn	0		0			0	
Spillback Cap Reductn	0		0			0	
Storage Cap Reductn	0		0			0	
Reduced v/c Ratio	0.53		0.58			0.92	

Intersection Summary

Cycle Length: 95
 Actuated Cycle Length: 71.1

Intersection Capacity Analysis

7. Otis St (Rt 3A) @ Hingham Bathing Beach

11/21/2015

Natural Cycle: 125

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 0.92

Intersection Signal Delay: 22.6

Intersection LOS: C

Intersection Capacity Utilization 94.9%

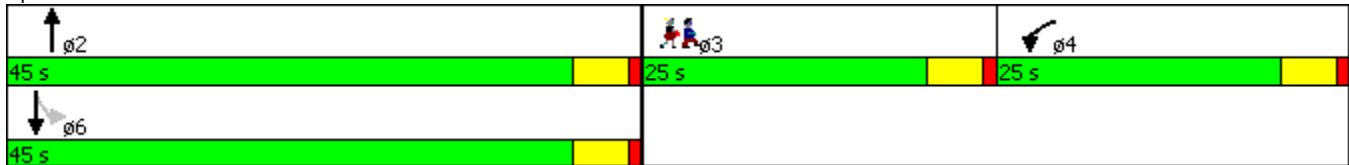
ICU Level of Service F

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 17:



APPENDIX E
Segment Crash Rate Worksheets

SEGMENT CRASH RATE WORKSHEET

CITY/TOWN : Hingham COUNT DATE : NA (2012)

DISTRICT : 5

~ SEGMENT DATA ~

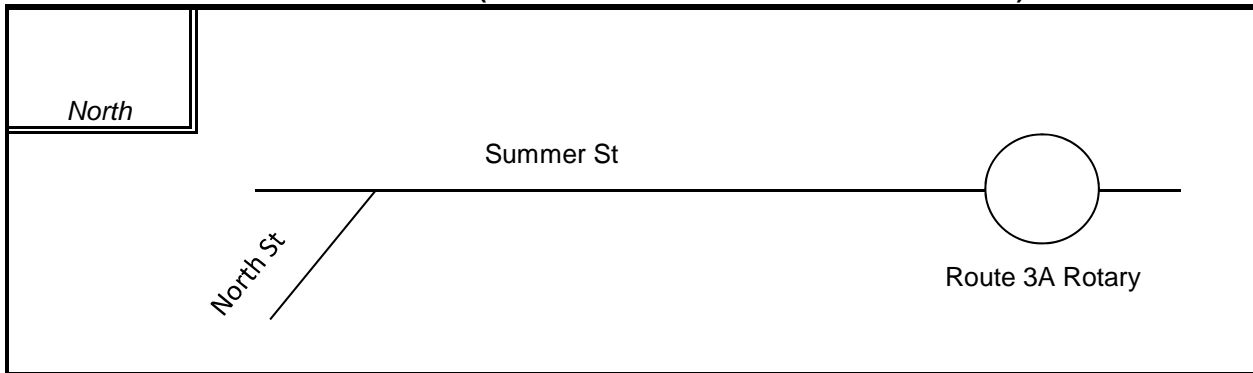
ROADWAY NAME: Summer Street between North Street and Route 3A Rotary

START POINT: West of North Street

END POINT: East of Route 3A Rotary

FUNCTIONAL CLASSIFICATION OF ROADWAY: Urban Principal Arterial - Other

ROADWAY DIAGRAM (LABEL ROADWAY AND CROSS STREETS)



AVERAGE DAILY TRAFFIC

SEGMENT LENGTH IN MILES (L): **0.26**

AVERAGE DAILY TRAFFIC VOLUME (V): 26,000

TOTAL # OF CRASHES: **105**

OF YEARS : **5**

AVERAGE # OF CRASHES PER YEAR (A): **21.00**

CRASH RATE CALCULATION : **8.51**

$$\text{RATE} = \frac{(A * 1,000,000)}{(L * V * 365)}$$

Comments : 2012 State Average for Urban Principal Arterial (Other) = 3.35

Project Title & Date: Summer St/G.W.Blvd Subregional Roadway Study

SEGMENT CRASH RATE WORKSHEET

CITY/TOWN : Hingham-Hull COUNT DATE : NA (2012)

DISTRICT : 5

~ SEGMENT DATA ~

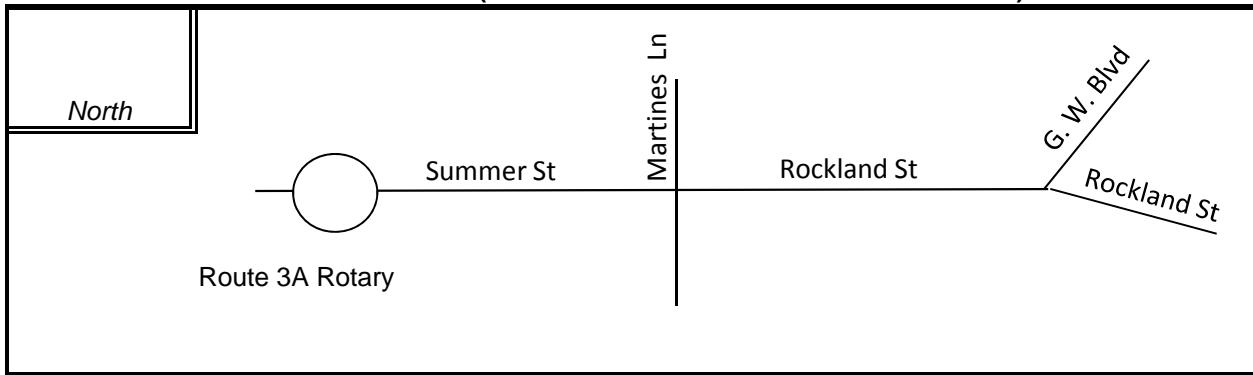
ROADWAY NAME: Summer Street/Rockland Street between Route 3A Rotary and G. W. Boulevard

START POINT: East of Route 3A Rotary

END POINT: East of Rockland Street

FUNCTIONAL CLASSIFICATION OF ROADWAY: Urban Minor Arterial - Other

ROADWAY DIAGRAM (LABEL ROADWAY AND CROSS STREETS)



AVERAGE DAILY TRAFFIC

SEGMENT LENGTH IN MILES (L): 0.74

AVERAGE DAILY TRAFFIC VOLUME (V): 16,000

TOTAL # OF CRASHES: 56 # OF YEARS : 5 AVERAGE # OF CRASHES PER YEAR (A): 11.20

CRASH RATE CALCULATION :

2.59

$$\text{RATE} = \frac{(A * 1,000,000)}{(L * V * 365)}$$

Comments : 2012 State Average for Urban Minor Arterial = 3.74

Project Title & Date: Summer St/G.W.Blvd Subregioanl Roadway Study

SEGMENT CRASH RATE WORKSHEET

CITY/TOWN : Hingham-Hull COUNT DATE : NA (2012)

DISTRICT : 5

~ SEGMENT DATA ~

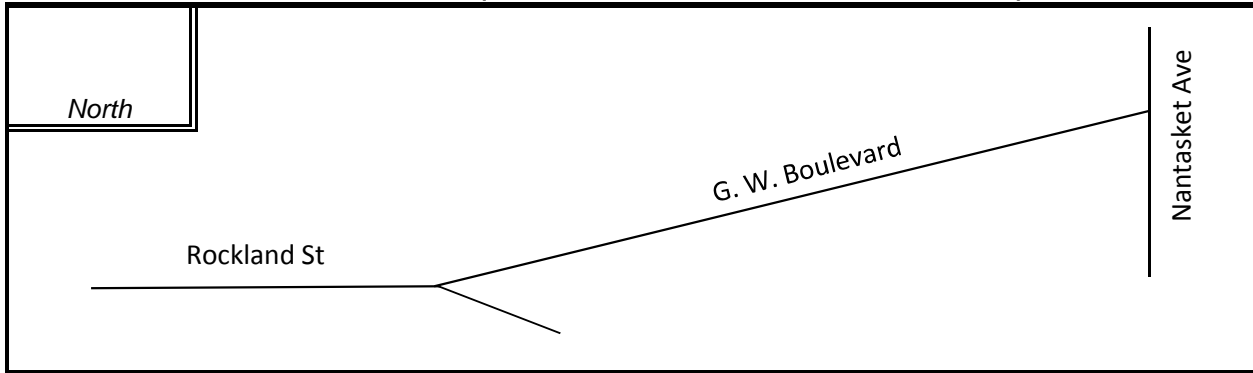
ROADWAY NAME: G. W. Boulevard from Rockland Street to Nantasket Avenue

START POINT: East of Rockland Street

END POINT: North of Nantasket Avenue

FUNCTIONAL CLASSIFICATION OF ROADWAY: Urban Minor Arterial - Other

ROADWAY DIAGRAM (LABEL ROADWAY AND CROSS STREETS)



AVERAGE DAILY TRAFFIC

SEGMENT LENGTH IN MILES (L): 1.8

AVERAGE DAILY TRAFFIC VOLUME (V): 11,500

TOTAL # OF CRASHES: 44 # OF YEARS: 5 AVERAGE # OF CRASHES PER YEAR (A): 8.80

CRASH RATE CALCULATION : 1.16 RATE = $\frac{(A * 1,000,000)}{(L * V * 365)}$

Comments : 2012 State Average for Urban Minor Arterial = 3.74

Project Title & Date: Summer St/G.W.Blvd Subregioanl Roadway Study

APPENDIX F
Intersection Crash Rate Worksheets

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Hull COUNT DATE : 9/3/2015

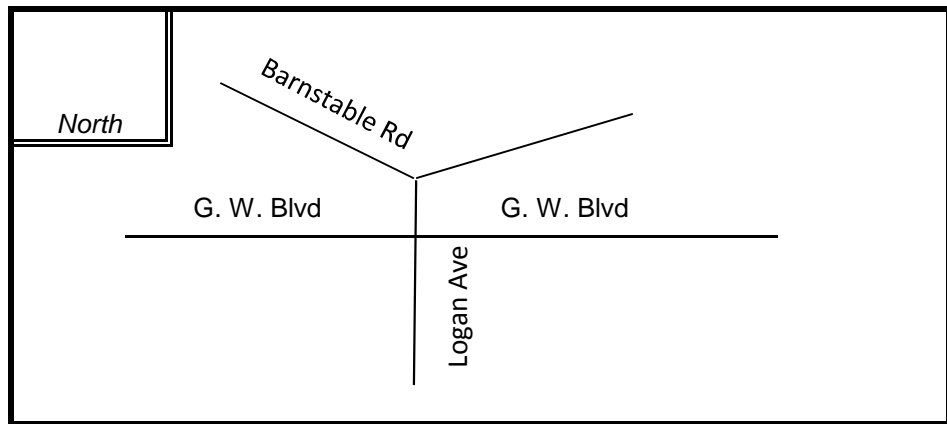
DISTRICT : 5 UNSIGNALIZED : SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : G. W. Blvd

MINOR STREET(S) : Logan Ave/Barnstable Rd

**INTERSECTION
 DIAGRAM
 (Label Approaches)**



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :						
PEAK HOURLY VOLUMES (AM/PM) :						1,165

" K " FACTOR : INTERSECTION ADT (V) = TOTAL DAILY APPROACH VOLUME :

TOTAL # OF CRASHES : # OF YEARS : AVERAGE # OF CRASHES PER YEAR (A) :

CRASH RATE CALCULATION :

0.29

$$\text{RATE} = \frac{(A * 1,000,000)}{(V * 365)}$$

Comments : 2010 Average Crash Rate for MassDOT District 5 Unsignalized Intersections = 0.58

Project Title & Date : Summer St/G.W.Blvd Subregioanl Roadway Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Hull COUNT DATE : 6/14/2015

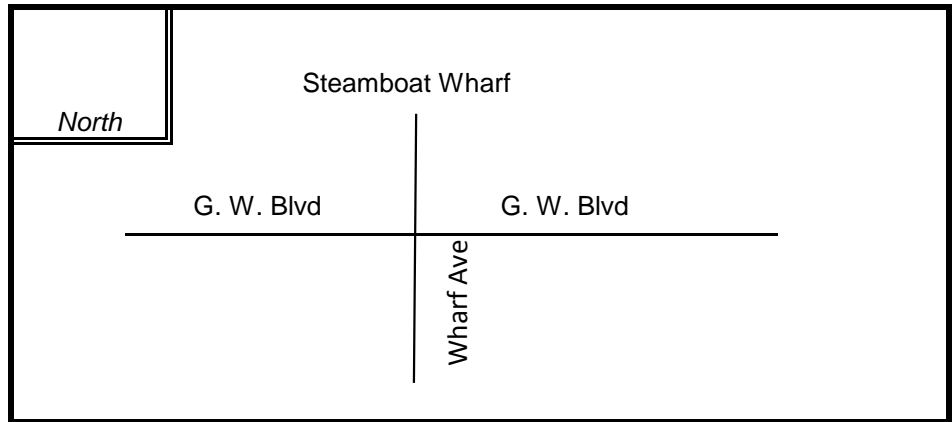
DISTRICT : 5 UNSIGNALIZED : SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : G. W. Blvd

MINOR STREET(S) : Wharf Ave

**INTERSECTION
 DIAGRAM
 (Label Approaches)**



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :						
PEAK HOURLY VOLUMES (AM/PM) :						1,056

" K " FACTOR : INTERSECTION ADT (V) = TOTAL DAILY APPROACH VOLUME :

TOTAL # OF CRASHES : # OF YEARS : AVERAGE # OF CRASHES PER YEAR (A) :

CRASH RATE CALCULATION :

0.54

$$\text{RATE} = \frac{(A * 1,000,000)}{(V * 365)}$$

Comments : 2010 Average Crash Rate for MassDOT District 5 Signalized Intersections = 0.77

Project Title & Date : Summer St/G.W.Blvd Subregioanl Roadway Study

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Hull COUNT DATE : 6/14/2015

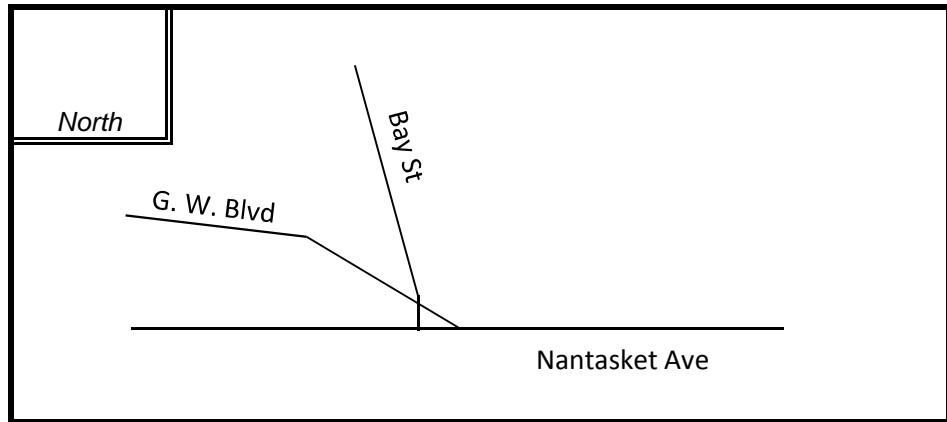
DISTRICT : 5 UNSIGNALIZED : SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : G. W. Blvd

MINOR STREET(S) : Bay St/Nantasket Ave

**INTERSECTION
 DIAGRAM
 (Label Approaches)**



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :						
PEAK HOURLY VOLUMES (AM/PM) :						906

" K " FACTOR :

0.090	INTERSECTION ADT (V) = TOTAL DAILY APPROACH VOLUME :	10,061
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TOTAL # OF CRASHES :

8	# OF YEARS :	5	AVERAGE # OF CRASHES PER YEAR (A) :	1.60
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CRASH RATE CALCULATION :

0.50

$$\text{RATE} = \frac{(A * 1,000,000)}{(V * 365)}$$

Comments : 2010 Average Crash Rate for MassDOT District 5 Unsignalized Intersections = 0.58

Project Title & Date: Summer St/G.W.Blvd Subregioanl Roadway Study

APPENDIX G
Crash Statistics
Major Intersections in the Study Corridor
MassDOT Crash Data 2008–12

TABLE G-1
Summer Street at North Street and at Water Street, Hingham

Statistics Period	2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes	7	15	10	11	3	46	9.2	100.0%
Severity								
Property damage only	5	13	9	8	2	37	7.4	80.4%
Non-fatal injury	2	2	0	3	1	8	1.6	17.4%
Fatality	0	0	0	0	0	0	0.0	0.0%
Not reported/unknown	0	0	1	0	0	1	0.2	2.2%
Collision type								
Single vehicle	0	2	3	3	1	9	1.8	19.6%
Rear-end	5	9	4	5	0	23	4.6	50.0%
Angle	2	2	0	1	0	5	1.0	10.9%
Sideswipe, same direction	0	1	2	0	1	4	0.8	8.7%
Sideswipe, opposite direction	0	1	0	1	0	2	0.4	4.3%
Head-on	0	0	1	1	0	2	0.4	4.3%
Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
Not reported/unknown	0	0	0	0	1	1	0.2	2.2%
Involved pedestrian(s)	0	2	0	1	0	3	0.6	6.5%
Involved cyclist(s)	0	0	0	0	0	0	0.0	0.0%
Occurred during weekday peak periods*	1	7	5	3	2	18	3.6	39.1%
Wet or icy pavement conditions	0	3	2	2	1	8	1.6	17.4%
Dark conditions (lit or unlit)	2	4	2	4	0	12	2.4	26.1%

* Peak periods are defined as 07:00–10:00 and 15:30–18:30.

TABLE G-2
Summer Street at Chief Justice Cushing Highway (Route 3A Rotary), Hingham

Statistics Period	2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes	14	8	17	6	4	49	9.8	100.0%
Severity								
Property damage only	8	6	12	4	4	34	6.8	69.4%
Non-fatal injury	6	2	5	2	0	15	3.0	30.6%
Fatality	0	0	0	0	0	0	0.0	0.0%
Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
Collision type								
Single vehicle	3	0	1	2	0	6	1.2	12.2%
Rear-end	2	1	4	1	2	10	2.0	20.4%
Angle	3	4	5	1	1	14	2.8	28.6%
Sideswipe, same direction	6	3	7	1	1	18	3.6	36.7%
Sideswipe, opposite direction	0	0	0	0	0	0	0.0	0.0%
Head-on	0	0	0	0	0	0	0.0	0.0%
Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
Not reported/unknown	0	0	0	1	0	1	0.2	2.0%
Involved pedestrian(s)	0	0	0	1	0	1	0.2	2.0%
Involved cyclist(s)	1	1	1	0	0	3	0.6	6.1%
Occurred during weekday peak periods*	5	3	7	1	0	16	3.2	32.7%
Wet or icy pavement conditions	1	3	3	2	0	9	1.8	18.4%
Dark conditions (lit or unlit)	4	0	0	1	3	8	1.6	16.3%

* Peak periods are defined as 07:00–10:00 and 15:30–18:30.

**TABLE G-3
Summer Street at Martins Lane, Hingham**

Statistics Period	2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes	5	4	2	3	4	18	3.6	100.0%
Severity								
Property damage only	2	3	2	2	3	12	2.4	66.7%
Non-fatal injury	3	1	0	1	0	5	1.0	27.8%
Fatality	0	0	0	0	0	0	0.0	0.0%
Not reported/unknown	0	0	0	0	1	1	0.2	5.6%
Collision type								
Single vehicle	1	1	0	0	1	3	0.6	16.7%
Rear-end	2	3	1	2	3	11	2.2	61.1%
Angle	1	0	1	0	0	2	0.4	11.1%
Sideswipe, same direction	0	0	0	0	0	0	0.0	0.0%
Sideswipe, opposite direction	0	0	0	1	0	1	0.2	5.6%
Head-on	1	0	0	0	0	1	0.2	5.6%
Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
Involved pedestrian(s)	0	0	0	0	0	0	0.0	0.0%
Involved cyclist(s)	0	0	0	0	0	0	0.0	0.0%
Occurred during weekday peak periods*	0	1	1	1	1	4	0.8	22.2%
Wet or icy pavement conditions	0	1	0	1	0	2	0.4	11.1%
Dark conditions (lit or unlit)	2	0	0	1	1	4	0.8	22.2%

* Peak periods are defined as 07:00–10:00 and 15:30–18:30.

TABLE G-4
Rockland Street at George Washington Boulevard, Hingham

Statistics Period	2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes	4	2	2	5	2	15	3.0	100.0%
Severity								
Property damage only	1	1	1	3	1	7	1.4	46.7%
Non-fatal injury	1	1	1	2	1	6	1.2	40.0%
Fatality	1	0	0	0	0	1	0.2	6.7%
Not reported/unknown	1	0	0	0	0	1	0.2	6.7%
Collision type								
Single vehicle	1	1	1	1	2	6	1.2	40.0%
Rear-end	0	1	1	1	0	3	0.6	20.0%
Angle	1	0	0	2	0	3	0.6	20.0%
Sideswipe, same direction	1	0	0	1	0	2	0.4	13.3%
Sideswipe, opposite direction	0	0	0	0	0	0	0.0	0.0%
Head-on	1	0	0	0	0	1	0.2	6.7%
Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
Involved pedestrian(s)	0	0	0	0	0	0	0.0	0.0%
Involved cyclist(s)	0	0	0	0	0	0	0.0	0.0%
Occurred during weekday peak periods*	1	1	0	0	1	3	0.6	20.0%
Wet or icy pavement conditions	0	0	0	1	1	2	0.4	13.3%
Dark conditions (lit or unlit)	2	1	1	2	1	7	1.4	46.7%

* Peak periods are defined as 07:00–10:00 and 15:30–18:30.

TABLE G-5
George Washington Boulevard at Rockland Circle, Hull

Statistics Period		2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes		1	1	0	1	0	3	0.6	100.0%
Severity	Property damage only	1	1	0	1	0	3	0.6	100.0%
	Non-fatal injury	0	0	0	0	0	0	0.0	0.0%
	Fatality	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
Collision type	Single vehicle	0	0	0	0	0	0	0.0	0.0%
	Rear-end	0	1	0	0	0	1	0.2	33.3%
	Angle	0	0	0	1	0	1	0.2	33.3%
	Sideswipe, same direction	0	0	0	0	0	0	0.0	0.0%
	Sideswipe, opposite direction	0	0	0	0	0	0	0.0	0.0%
	Head-on	0	0	0	0	0	0	0.0	0.0%
	Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	1	0	0	0	0	1	0.2	33.3%
Involved pedestrian(s)		0	0	0	0	0	0	0.0	0.0%
Involved cyclist(s)		0	0	0	0	0	0	0.0	0.0%
Occurred during weekday peak periods*		1	1	0	0	0	2	0.4	66.7%
Wet or icy pavement conditions		1	0	0	0	0	1	0.2	33.3%
Dark conditions (lit or unlit)		1	0	0	0	0	1	0.2	33.3%

* Peak periods are defined as 07:00–10:00 and 15:30–18:30.

TABLE G-6
George Washington Boulevard at Wharf Avenue, Hull

Statistics Period		2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes		4	2	1	3	0	10	2.0	100.0%
Severity	Property damage only	3	1	0	2	0	6	1.2	60.0%
	Non-fatal injury	1	1	1	1	0	4	0.8	40.0%
	Fatality	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	0	0	0	0	0	0.0	0.0%
Collision type	Single vehicle	0	1	1	0	0	2	0.4	20.0%
	Rear-end	1	0	0	2	0	3	0.6	30.0%
	Angle	0	1	0	0	0	1	0.2	10.0%
	Sideswipe, same direction	0	0	0	1	0	1	0.2	10.0%
	Sideswipe, opposite direction	2	0	0	0	0	2	0.4	20.0%
	Head-on	0	0	0	0	0	0	0.0	0.0%
	Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	1	0	0	0	0	1	0.2	10.0%
Involved pedestrian(s)		0	0	0	0	0	0	0.0	0.0%
Involved cyclist(s)		0	0	0	0	0	0	0.0	0.0%
Occurred during weekday peak periods*		0	0	1	2	0	3	0.6	30.0%
Wet or icy pavement conditions		0	1	0	0	0	1	0.2	10.0%
Dark conditions (lit or unlit)		1	0	0	1	0	2	0.4	20.0%

* Peak periods are defined as 07:00–10:00 and 15:30–18:30.

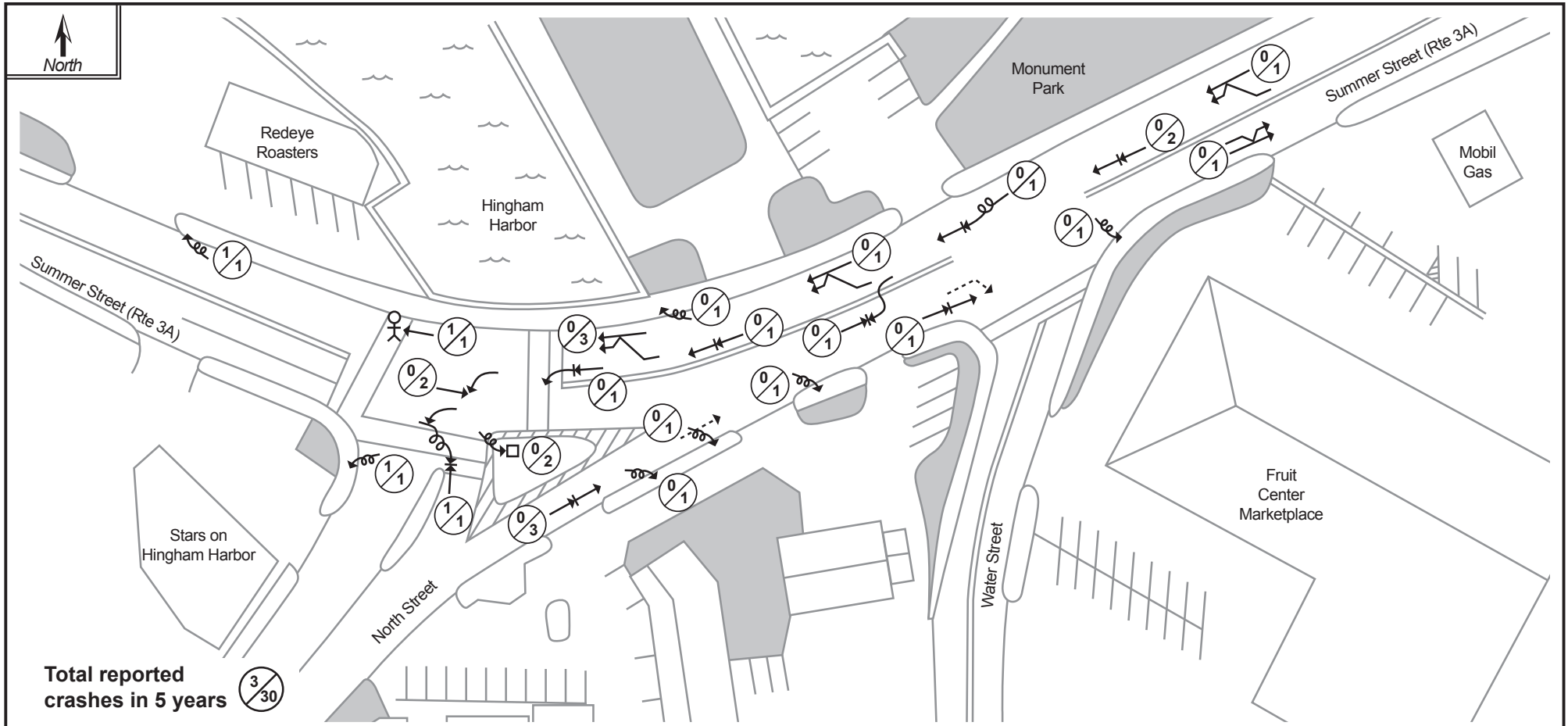
TABLE G-7
George Washington Boulevard at Nantasket Avenue and Bay Street, Hull

Statistics Period		2008	2009	2010	2011	2012	5-Yr. Total	Annual Avg.	Percentages
Total number of crashes		6	2	4	3	0	15	3.0	100.0%
Severity	Property damage only	4	1	4	3	0	12	2.4	80.0%
	Non-fatal injury	2	0	0	0	0	2	0.4	13.3%
	Fatality	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	0	1	0	0	0	1	0.2	6.7%
Collision type	Single vehicle	3	0	0	1	0	4	0.8	26.7%
	Rear-end	2	0	2	2	0	6	1.2	40.0%
	Angle	0	2	1	0	0	3	0.6	20.0%
	Sideswipe, same direction	0	0	1	0	0	1	0.2	6.7%
	Sideswipe, opposite direction	0	0	0	0	0	0	0.0	0.0%
	Head-on	0	0	0	0	0	0	0.0	0.0%
	Rear-to-rear	0	0	0	0	0	0	0.0	0.0%
	Not reported/unknown	1	0	0	0	0	1	0.2	6.7%
Involved pedestrian(s)		0	0	0	0	0	0	0.0	0.0%
Involved cyclist(s)		1	0	0	0	0	1	0.2	6.7%
Occurred during weekday peak periods*		1	1	0	2	0	4	0.8	26.7%
Wet or icy pavement conditions		1	0	2	0	0	3	0.6	20.0%
Dark conditions (lit or unlit)		2	0	1	0	0	3	0.6	20.0%

* Peak periods are defined as 07:00–10:00 and 15:30–18:30.

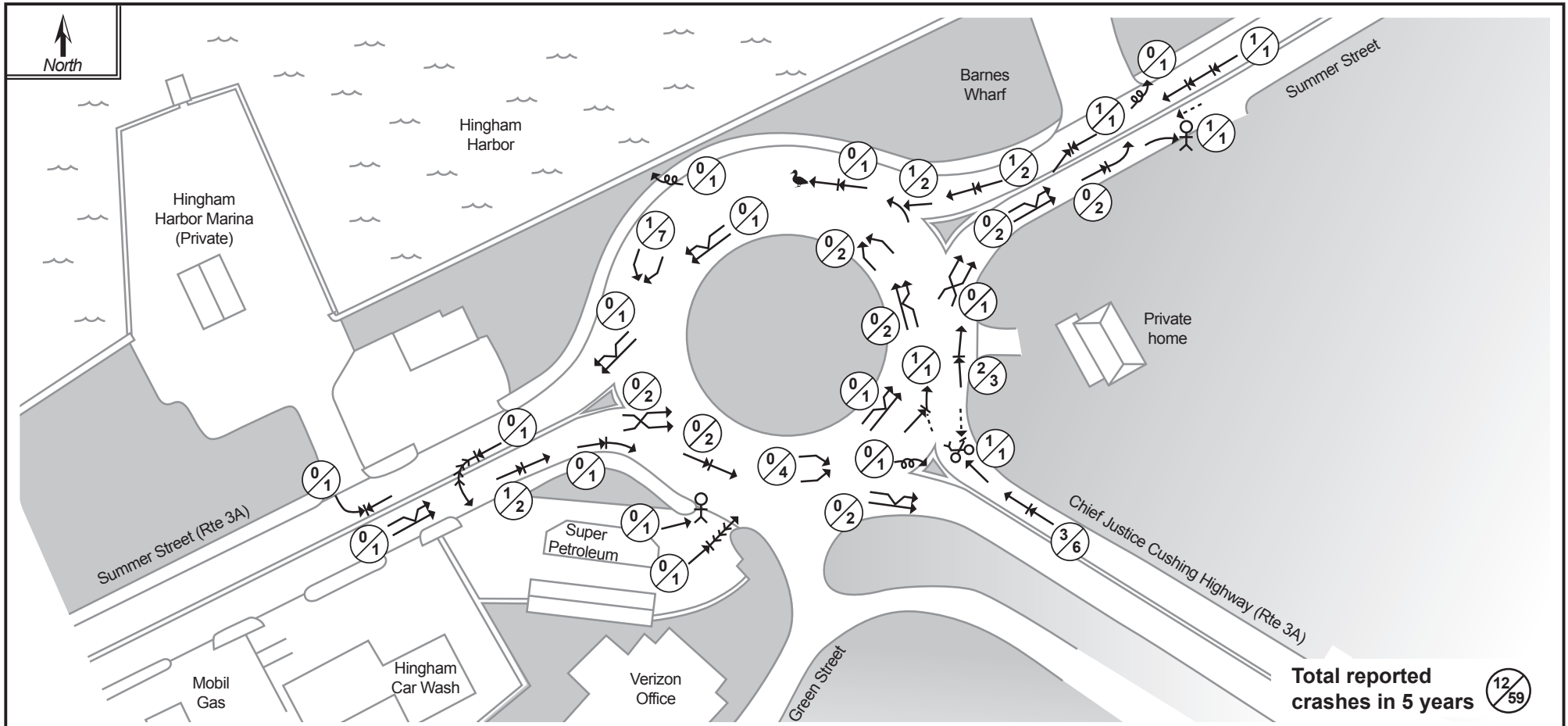
APPENDIX H
Collision Diagrams
Major Intersections and Segments in the Corridor

FIGURE H-1
Collision Diagram: Summer Street at North Street and at Water Street
Hingham Police Reports: March 2010–April 2015



SYMBOLS		TYPES OF CRASH		SEVERITY
Moving Vehicle	Parked Vehicle	Head On	Sideswipe	 A Number of Injury Crashes B Total Number of Crashes
Backing Vehicle	Fixed Object	Angle	Out of Control	
Non-Involved Vehicle	Bicycle	Rear End		
Pedestrian	Animal			

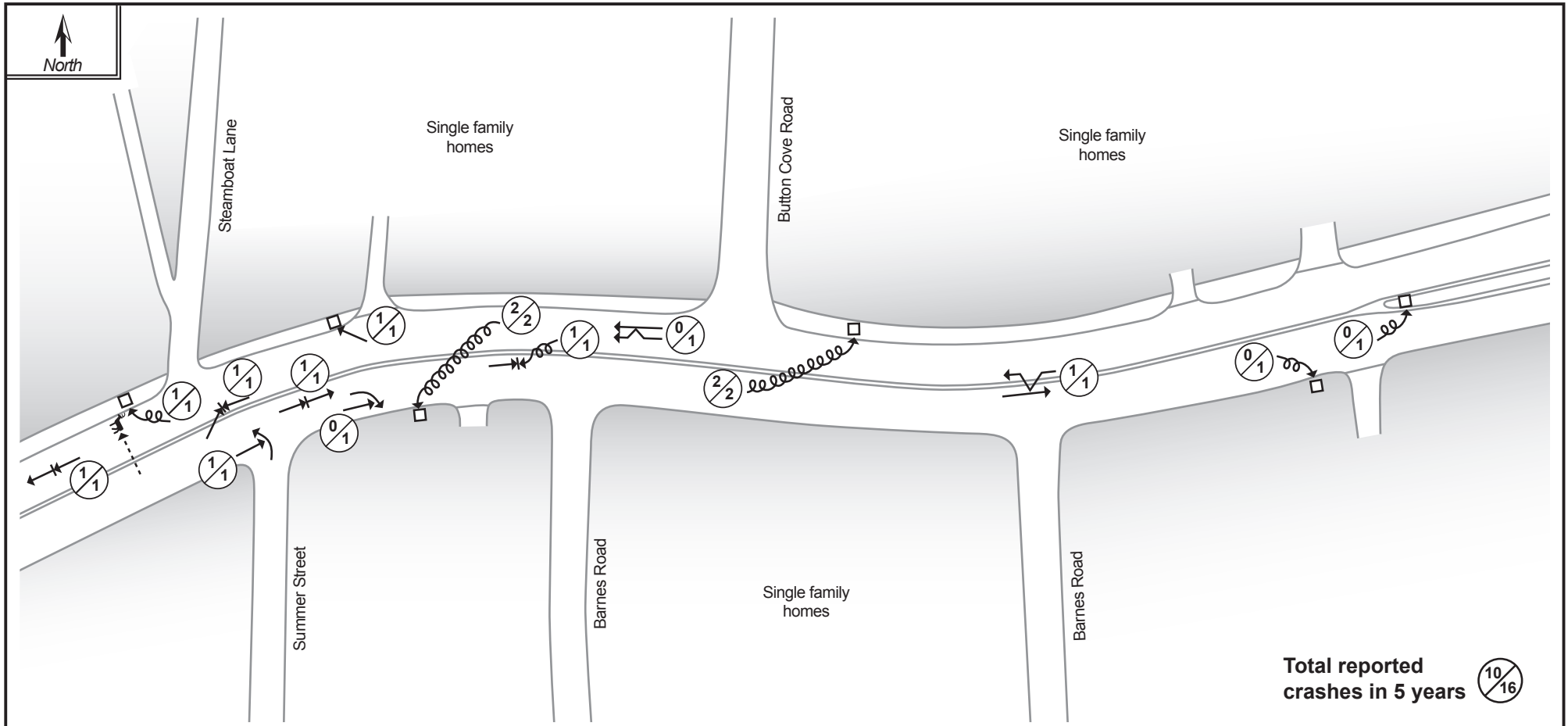
FIGURE H-2
Collision Diagram: Summer Street at Route 3A Rotary
Hingham Police Reports: March 2010–April 2015



Total reported crashes in 5 years $\frac{12}{59}$

SYMBOLS		TYPES OF CRASH		SEVERITY
Moving Vehicle	Parked Vehicle	Head On	Sideswipe	$\frac{A}{B}$ A Number of Injury Crashes B Total Number of Crashes
Backing Vehicle	Fixed Object	Angle	Out of Control	
Non-Involved Vehicle	Bicycle	Rear End		
Pedestrian	Animal			

FIGURE H-3
Collision Diagram: Summer Street between Route 3A Rotary and Martins Lane
Hingham Police Reports: March 2010–April 2015

















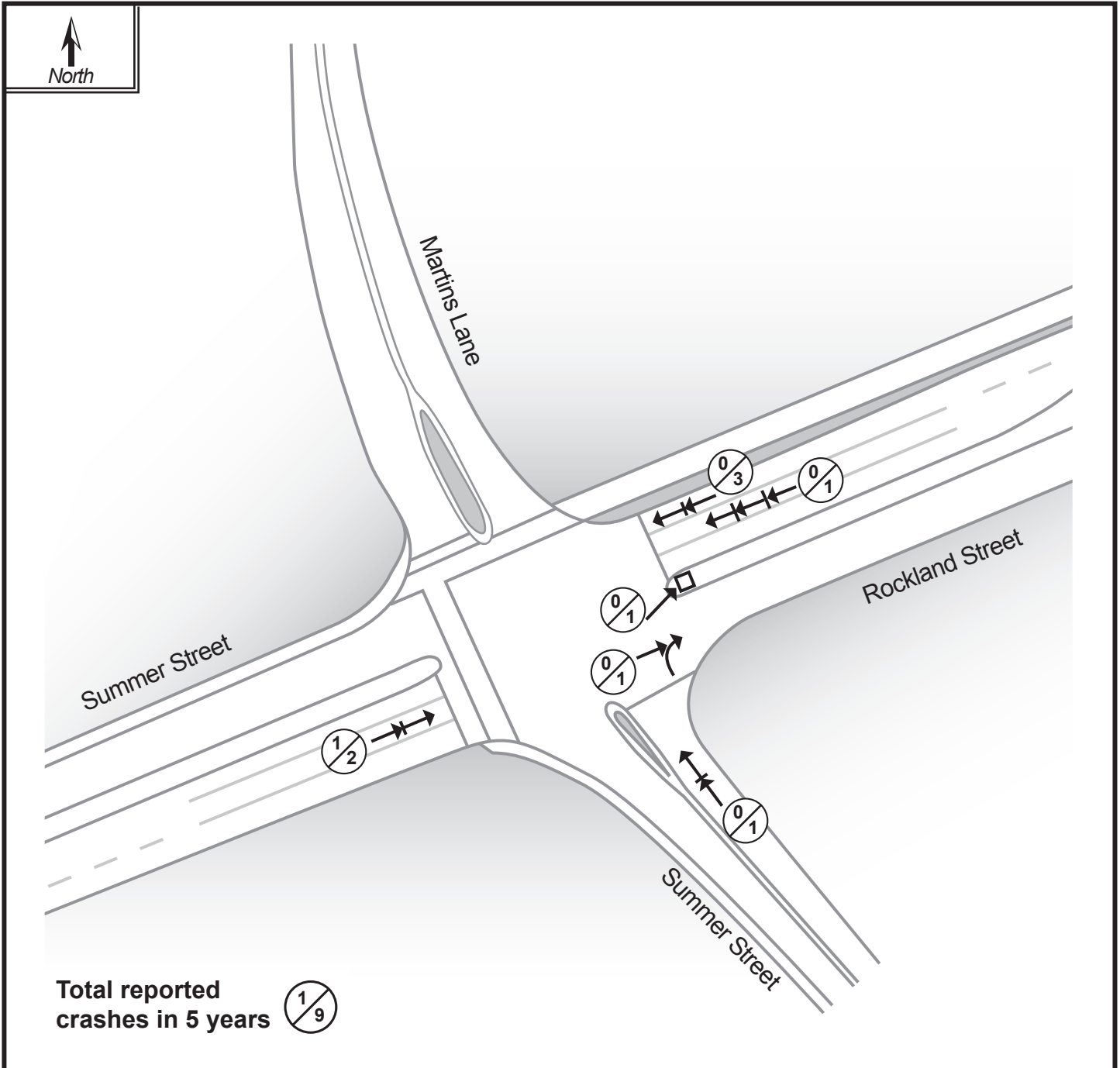
SYMBOLS		TYPES OF CRASH		SEVERITY
 Moving Vehicle	 Parked Vehicle	 Head On	 Sideswipe	 A Number of Injury Crashes B Total Number of Crashes
 Backing Vehicle	 Fixed Object	 Angle	 Out of Control	
 Non-Involved Vehicle	 Bicycle	 Rear End		
 Pedestrian	 Animal			

FIGURE H-4
Collision Diagram: Summer Street at Rockland Street/Martins Lane
Hingham Police Reports: March 2010–April 2015

















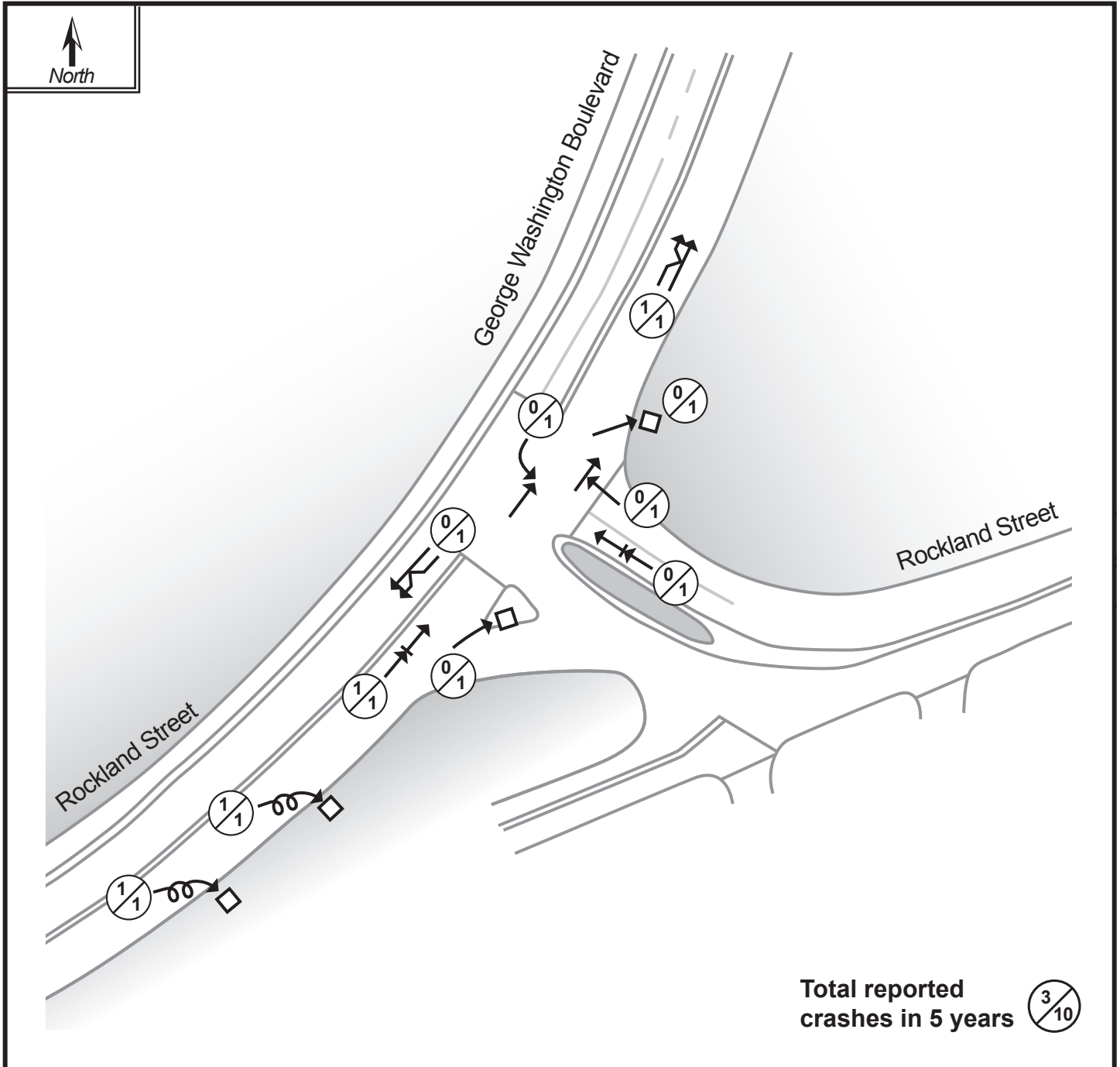
SYMBOLS	TYPES OF CRASH	SEVERITY
<ul style="list-style-type: none">  Moving Vehicle  Backing Vehicle  Non-Involved Vehicle  Pedestrian  Parked Vehicle  Fixed Object  Bicycle  Animal 	<ul style="list-style-type: none">  Head On  Angle  Rear End  Sideswipe  Out of Control 	<div style="text-align: center;">  </div> <p>A Number of Injury Crashes B Total Number of Crashes</p>

FIGURE H-5
Collision Diagram: Rockland Street at George Washington Boulevard
Hingham Police Reports: March 2010–April 2015



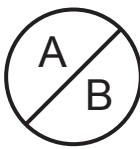
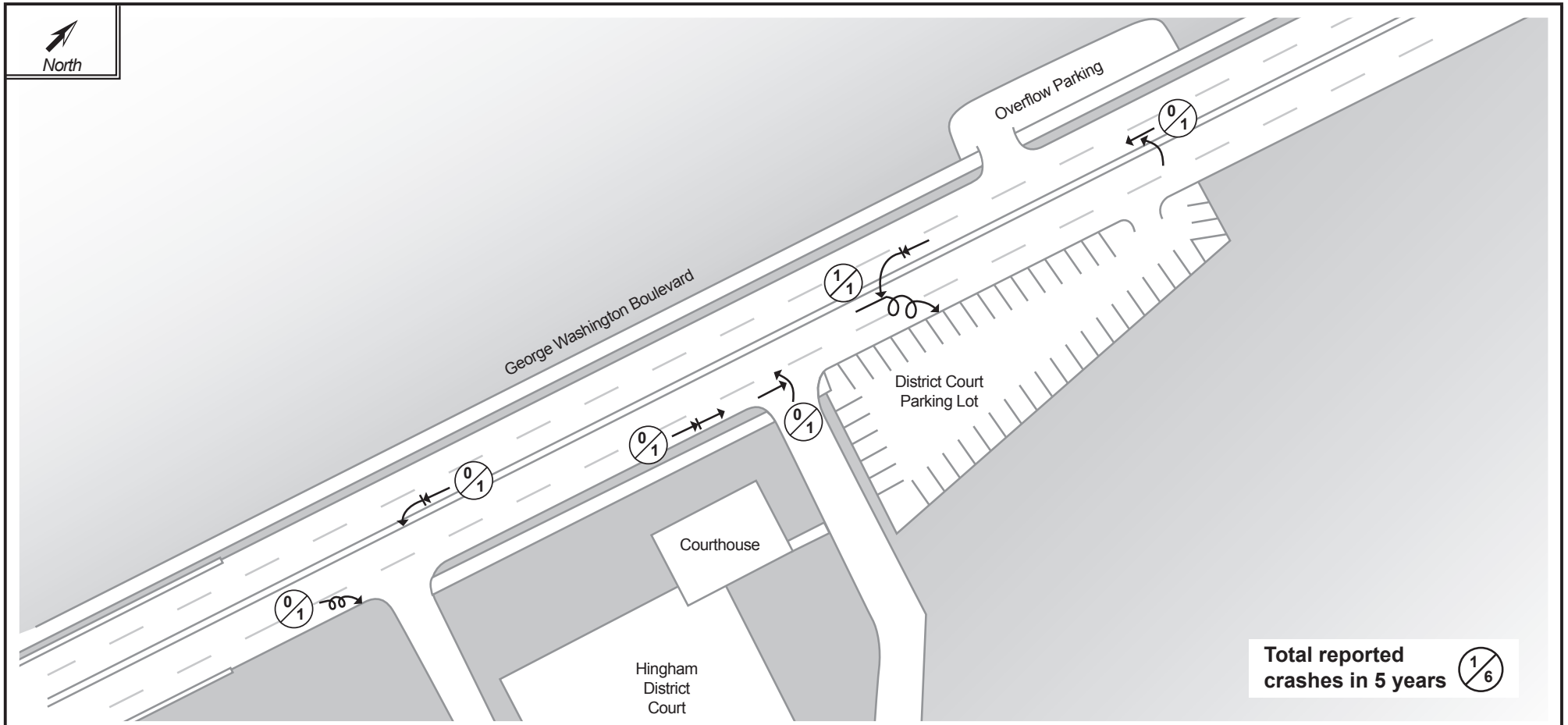
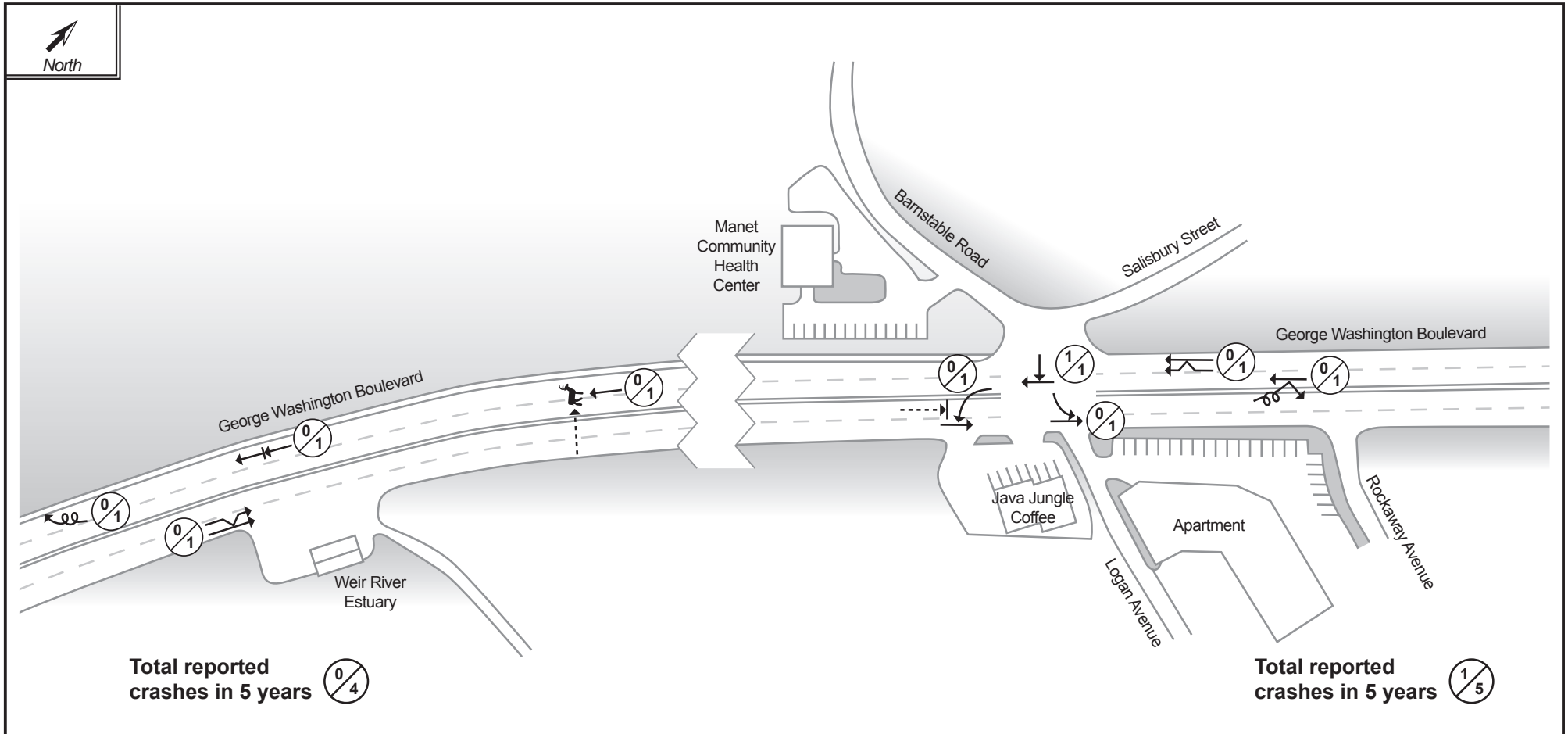
SYMBOLS	TYPES OF CRASH	SEVERITY
<ul style="list-style-type: none"> → Moving Vehicle ⇐ Backing Vehicle - - - Non-Involved Vehicle → Pedestrian → Parked Vehicle → Fixed Object → Bicycle → Animal 	<ul style="list-style-type: none"> ↔↔ Head On →↘ Angle →↔ Rear End ↔↔ Sideswipe →↻ Out of Control 	<div style="text-align: center;">  </div> <p>A Number of Injury Crashes B Total Number of Crashes</p>

FIGURE H-6
Collision Diagram: George Washington Boulevard in the Vicinity of District Court
Hingham Police Reports: March 2010–April 2015



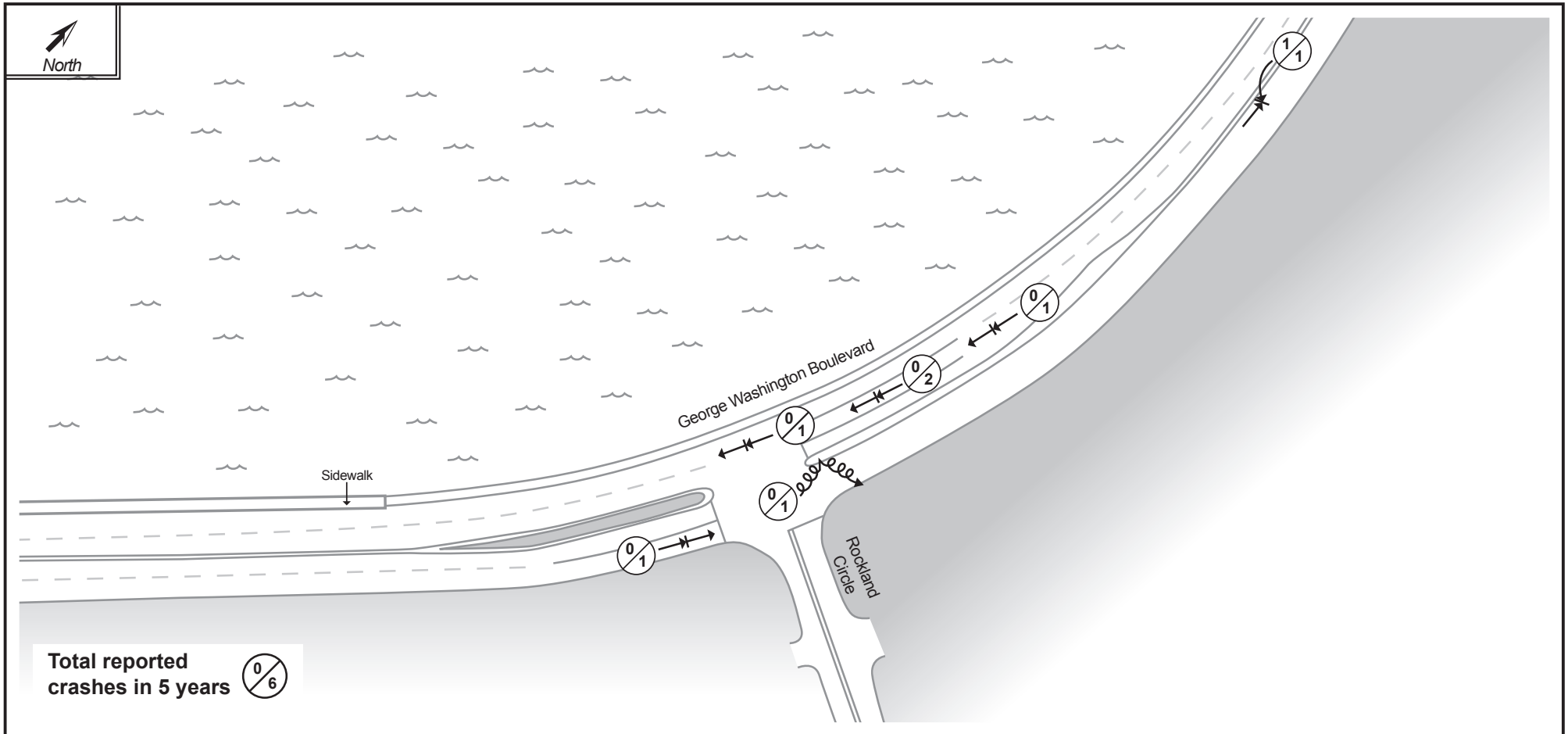
SYMBOLS		TYPES OF CRASH		SEVERITY
Moving Vehicle	Parked Vehicle	Head On	Sideswipe	 A Number of Injury Crashes B Total Number of Crashes
Backing Vehicle	Fixed Object	Angle	Out of Control	
Non-Involved Vehicle	Bicycle	Rear End		
Pedestrian	Animal			

FIGURE H-7
Collision Diagram: George Washington Boulevard between Weir River and Rockland Circle
Hull Police Reports: 2009–2011 and 2013–May 2015



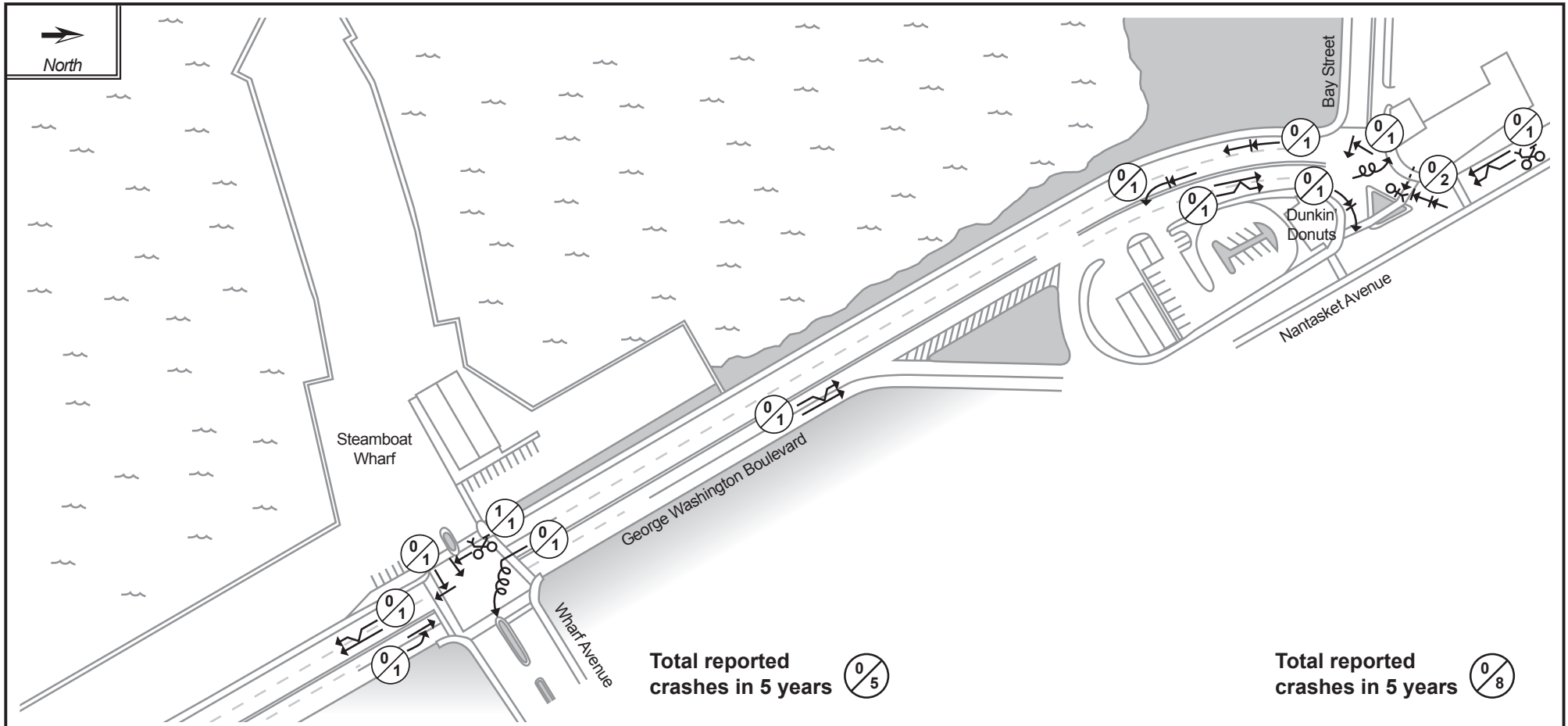
SYMBOLS		TYPES OF CRASH		SEVERITY
	Moving Vehicle		Head On	 A Number of Injury Crashes B Total Number of Crashes
	Backing Vehicle		Angle	
	Non-Involved Vehicle		Rear End	
	Pedestrian		Sideswipe	
	Parked Vehicle		Out of Control	
	Fixed Object			
	Bicycle			
	Animal			

FIGURE H-8
Collision Diagram: George Washington Boulevard at Rockland Circle
Hull Police Reports: 2009–2011 and 2013–May 2015



SYMBOLS		TYPES OF CRASH		SEVERITY
Moving Vehicle	Parked Vehicle	Head On	Sideswipe	 A Number of Injury Crashes B Total Number of Crashes
Backing Vehicle	Fixed Object	Angle	Out of Control	
Non-Involved Vehicle	Bicycle	Rear End		
Pedestrian	Animal			

FIGURE H-9
Collision Diagram: George Washington Boulevard at Wharf Avenue and at Bay Street/Nantasket Avenue
Hull Police Reports: 2009–2011 and 2013–May 2015





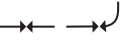
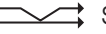









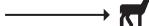
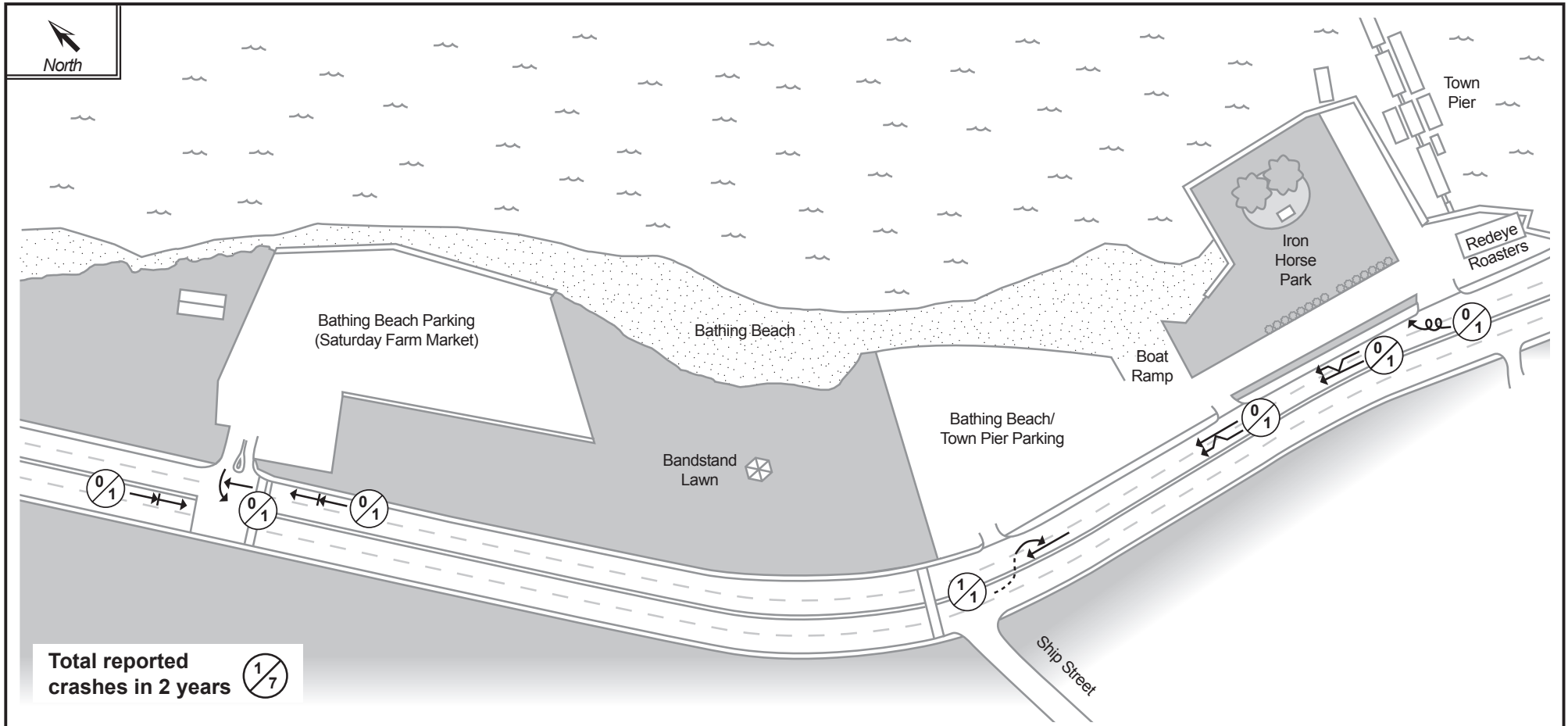













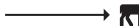
SYMBOLS		TYPES OF CRASH		SEVERITY
 Moving Vehicle	 Parked Vehicle	 Head On	 Sideswipe	 A Number of Injury Crashes B Total Number of Crashes
 Backing Vehicle	 Fixed Object	 Angle	 Out of Control	
 Non-Involved Vehicle	 Bicycle	 Rear End		
 Pedestrian	 Animal			

FIGURE H-10
Collision Diagram: Otis Street (Route 3A) between Bathing Beach Driveway and North Street
Hingham Police Reports: March 2013–April 2015



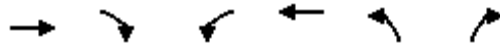
SYMBOLS		TYPES OF CRASH		SEVERITY
 Moving Vehicle	 Parked Vehicle	 Head On	 Sideswipe	 A Number of Injury Crashes B Total Number of Crashes
 Backing Vehicle	 Fixed Object	 Angle	 Out of Control	
 Non-Involved Vehicle	 Bicycle	 Rear End		
 Pedestrian	 Animal			

APPENDIX I
Intersection Capacity Analyses
Weekday AM Peak Hour
Projected 2040 Traffic Conditions with Proposed Improvements

Intersection Capacity Analysis

1. Summer St @ North St

11/19/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	↑↑			↑↑	↵	↵	
Volume (vph)	572	50	398	1246	79	227	
Confl. Peds. (#/hr)		3	3				
Peak Hour Factor	0.95	0.95	0.93	0.93	0.87	0.87	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	2%	2%	1%	1%	3%	3%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	687	0	0	1856	95	274	
Turn Type	NA		pm+pt	NA	Prot	pt+ov	
Protected Phases	2		1	6	4	4 1	3
Permitted Phases			6				
Detector Phase	2		1	6	4	4 1	
Switch Phase							
Minimum Initial (s)	8.0		4.0	8.0	9.0		4.0
Minimum Split (s)	13.0		9.0	13.0	14.0		21.0
Total Split (s)	55.0		20.0	75.0	14.0		21.0
Total Split (%)	50.0%		18.2%	68.2%	12.7%		19%
Yellow Time (s)	4.0		4.0	4.0	4.0		2.0
All-Red Time (s)	1.0		1.0	1.0	1.0		0.0
Lost Time Adjust (s)	0.0			0.0	0.0		
Total Lost Time (s)	5.0			5.0	5.0		
Lead/Lag	Lead		Lag		Lag		Lead
Lead-Lag Optimize?	Yes		Yes		Yes		Yes
Recall Mode	Min		None	Min	None		None
Act Effct Green (s)	27.7			70.6	9.1	51.2	
Actuated g/C Ratio	0.30			0.76	0.10	0.55	
v/c Ratio	0.76			0.99	0.62	0.35	
Control Delay	34.8			36.7	61.0	14.0	
Queue Delay	0.0			0.0	0.0	0.0	
Total Delay	34.8			36.7	61.0	14.0	
LOS	C			D	E	B	
Approach Delay	34.8			36.7	26.1		
Approach LOS	C			D	C		
Queue Length 50th (ft)	180			246	52	72	
Queue Length 95th (ft)	267			#1025	#145	159	
Internal Link Dist (ft)	764			218	85		
Turn Bay Length (ft)							
Base Capacity (vph)	1644			1871	153	773	
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	0.42			0.99	0.62	0.35	

Intersection Summary

Cycle Length: 110
 Actuated Cycle Length: 93.3
 Natural Cycle: 150
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.99

Intersection Capacity Analysis

1. Summer St @ North St

11/19/2015

Intersection Signal Delay: 34.9

Intersection LOS: C

Intersection Capacity Utilization 94.0%

ICU Level of Service F

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: North St & Otis St/Summer St

→ ϕ2	↙ ϕ1	↗ ϕ3	↘ ϕ4
55 s	20 s	21 s	14 s
← ϕ6			
75 s			

Intersection Capacity Analysis

2. Summer St @ CJC Hwy

11/22/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	334	414	60	689	10	871	5	24	5	5	20
Satd. Flow (prot)	1711	3355	1501	1728	3448	0	1681	1621	0	0	1757	1531
Flt Permitted	0.193			0.360			0.950	0.955			0.976	
Satd. Flow (perm)	348	3355	1501	655	3448	0	1681	1621	0	0	1757	1531
Satd. Flow (RTOR)			511		1			3				138
Peak Hour Factor	0.92	0.85	0.85	0.92	0.92	0.92	0.96	0.92	0.96	0.92	0.92	0.92
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	2%	4%	4%	1%	1%	2%	2%	2%	2%	2%	2%	2%
Shared Lane Traffic (%)							48%					
Lane Group Flow (vph)	11	413	511	68	797	0	496	489	0	0	12	23
Turn Type	pm+pt	NA	Perm	pm+pt	NA		Split	NA		Split	NA	Perm
Protected Phases	5	2		1	6		7	7		8	8	
Permitted Phases	2		2	6								8
Detector Phase	5	2	2	1	6		7	7		8	8	8
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		3.0	3.0	3.0
Minimum Split (s)	8.0	30.5	30.5	8.0	21.0		21.0	21.0		9.0	9.0	9.0
Total Split (s)	8.0	34.0	34.0	8.0	34.0		36.0	36.0		9.0	9.0	9.0
Total Split (%)	7.2%	30.6%	30.6%	7.2%	30.6%		32.4%	32.4%		8.1%	8.1%	8.1%
Yellow Time (s)	3.0	4.0	4.0	3.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)	4.0	5.0	5.0	4.0	5.0		5.0	5.0		5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead	Lead		Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes	Yes	Yes
Recall Mode	None	Min	Min	Min	Min		None	None		None	None	None
Act Effect Green (s)	22.7	17.5	17.5	26.3	24.7		32.3	32.3			4.2	4.2
Actuated g/C Ratio	0.30	0.23	0.23	0.35	0.32		0.42	0.42			0.06	0.06
v/c Ratio	0.06	0.54	0.69	0.24	0.71		0.70	0.71			0.12	0.11
Control Delay	19.9	29.3	8.3	21.4	28.7		29.0	29.6			45.4	1.0
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	0.0
Total Delay	19.9	29.3	8.3	21.4	28.7		29.0	29.6			45.4	1.0
LOS	B	C	A	C	C		C	C			D	A
Approach Delay		17.7			28.1			29.3			16.2	
Approach LOS		B			C			C			B	
Queue Length 50th (ft)	3	89	0	21	166		194	192			5	0
Queue Length 95th (ft)	17	158	57	62	#354		#586	#589			28	0
Internal Link Dist (ft)		641			654			102			1	
Turn Bay Length (ft)	100		150	100								
Base Capacity (vph)	178	1330	903	284	1367		712	688			96	214
Starvation Cap Reductn	0	0	0	0	0		0	0			0	0
Spillback Cap Reductn	0	0	0	0	0		0	0			0	0
Storage Cap Reductn	0	0	0	0	0		0	0			0	0
Reduced v/c Ratio	0.06	0.31	0.57	0.24	0.58		0.70	0.71			0.13	0.11

Intersection Summary

Cycle Length: 111

Actuated Cycle Length: 76.2

Intersection Capacity Analysis

2. Summer St @ CJC Hwy

11/22/2015

Lane Group	ø3
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	3
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	24.0
Total Split (s)	24.0
Total Split (%)	22%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effect 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	

Intersection Capacity Analysis

2. Summer St @ CJC Hwy

11/22/2015

Natural Cycle: 105

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.71

Intersection Signal Delay: 24.9

Intersection LOS: C

Intersection Capacity Utilization 68.2%








ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 3: Chief Justice Cushing Hwy & Summer St

 ø1	 ø2	 ø3	 ø7	 ø8
8 s	34 s	24 s	36 s	9 s
 ø5	 ø6			
8 s	34 s			

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/22/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	26	378	11	136	742	10	17	27	57	11	42	39
Satd. Flow (prot)	1694	3374	0	1728	1815	0	0	1775	1538	0	2088	1794
Flt Permitted	0.207			0.457				0.848			0.918	
Satd. Flow (perm)	369	3374	0	831	1815	0	0	1534	1538	0	1938	1794
Satd. Flow (RTOR)												
Peak Hour Factor	0.93	0.93	0.93	0.90	0.90	0.90	0.84	0.84	0.84	0.92	0.92	0.92
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	3%	3%	3%	1%	1%	1%	5%	5%	5%	2%	2%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	29	439	0	159	878	0	0	55	71	0	61	45
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3			3	
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	8.0	51.0		10.0	53.0		26.0	26.0	26.0	26.0	26.0	26.0
Total Split (%)	7.3%	46.4%		9.1%	48.2%		23.6%	23.6%	23.6%	23.6%	23.6%	23.6%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effect Green (s)	48.3	43.1		53.5	51.8			10.6	10.6		10.6	10.6
Actuated g/C Ratio	0.65	0.58		0.72	0.70			0.14	0.14		0.14	0.14
v/c Ratio	0.09	0.22		0.24	0.69			0.25	0.32		0.22	0.18
Control Delay	7.4	10.6		7.2	17.0			35.7	37.0		34.4	34.1
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	7.4	10.6		7.2	17.0			35.7	37.0		34.4	34.1
LOS	A	B		A	B			D	D		C	C
Approach Delay		10.4			15.5			36.5			34.3	
Approach LOS		B			B			D			C	
Queue Length 50th (ft)	3	43		16	163			21	27		23	17
Queue Length 95th (ft)	22	135		86	#889			66	81		75	60
Internal Link Dist (ft)		378			358			249			637	
Turn Bay Length (ft)	150			150					50			75
Base Capacity (vph)	317	2210		678	1274			458	460		579	536
Starvation Cap Reductn	0	0		0	0			0	0		0	0
Spillback Cap Reductn	0	0		0	0			0	0		0	0
Storage Cap Reductn	0	0		0	0			0	0		0	0
Reduced v/c Ratio	0.09	0.20		0.23	0.69			0.12	0.15		0.11	0.08

Intersection Summary

Cycle Length: 110

Actuated Cycle Length: 73.8

Intersection Capacity Analysis
 3. Summer St @ Rockland St

11/22/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
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)	23.0
Total Split (s)	23.0
Total Split (%)	21%
Yellow Time (s)	2.0
All-Red Time (s)	0.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effect 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	

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/22/2015

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.69

Intersection Signal Delay: 16.8

Intersection LOS: B

Intersection Capacity Utilization 67.5%


ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

 ø1	 ø2	 ø3	 ø9
10 s	51 s	26 s	23 s
 ø5	 ø6		
8 s	53 s		

Intersection Capacity Analysis
 4. Rockland St @ G. W. Blvd

11/22/2015



Lane Group	WBL	WBR	NET	NER	SWL	SWT	ø3
Lane Configurations							
Volume (vph)	180	21	359	87	10	688	
Satd. Flow (prot)	1711	1531	1801	1531	1711	1801	
Flt Permitted	0.950				0.457		
Satd. Flow (perm)	1706	1531	1801	1531	823	1801	
Satd. Flow (RTOR)		29		100			
Confl. Peds. (#/hr)	1						
Peak Hour Factor	0.77	0.77	0.91	0.91	0.90	0.90	
Growth Factor	105%	105%	105%	105%	105%	105%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	245	29	414	100	12	803	
Turn Type	Prot	Perm	NA	Perm	Perm	NA	
Protected Phases	4		2			6	3
Permitted Phases		4		2	6		
Detector Phase	4	4	2	2	6	6	
Switch Phase							
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	4.0
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0	12.0	23.0
Total Split (s)	20.0	20.0	52.0	52.0	52.0	52.0	23.0
Total Split (%)	21.1%	21.1%	54.7%	54.7%	54.7%	54.7%	24%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	
Lead/Lag	Lag	Lag					Lead
Lead-Lag Optimize?	Yes	Yes					Yes
Recall Mode	Min	Min	None	None	None	None	None
Act Effect Green (s)	15.5	15.5	34.6	34.6	34.6	34.6	
Actuated g/C Ratio	0.25	0.25	0.55	0.55	0.55	0.55	
v/c Ratio	0.58	0.07	0.42	0.11	0.03	0.82	
Control Delay	32.7	11.9	10.7	2.6	8.4	21.1	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	32.7	11.9	10.7	2.6	8.4	21.1	
LOS	C	B	B	A	A	C	
Approach Delay	30.5		9.1			20.9	
Approach LOS	C		A			C	
Queue Length 50th (ft)	75	0	71	0	2	192	
Queue Length 95th (ft)	#208	18	216	23	12	#630	
Internal Link Dist (ft)	100		657			589	
Turn Bay Length (ft)				250	50		
Base Capacity (vph)	426	403	1406	1217	642	1406	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.58	0.07	0.29	0.08	0.02	0.57	

Intersection Summary

Cycle Length: 95
 Actuated Cycle Length: 63.2

Intersection Capacity Analysis

4. Rockland St @ G. W. Blvd

11/22/2015

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.82

Intersection Signal Delay: 18.8

Intersection LOS: B

Intersection Capacity Utilization 56.8%

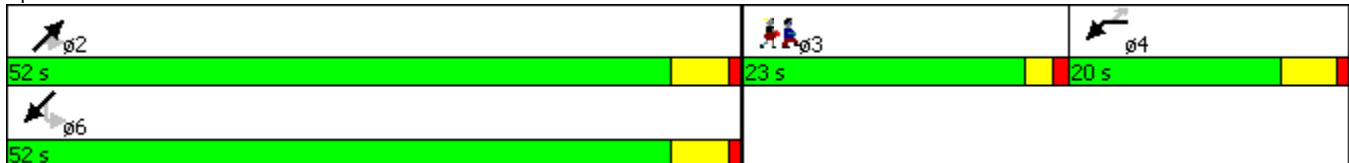
ICU Level of Service B

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 13: Rockland St & G W Blvd



Intersection Capacity Analysis
 5. G. W. Blvd @ Rockland Circle

11/22/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	↑	↑	↑	↑	↑	↑	
Volume (vph)	270	32	26	632	62	25	
Satd. Flow (prot)	1749	1487	1728	1818	2025	1812	
Flt Permitted			0.526		0.950		
Satd. Flow (perm)	1749	1487	957	1818	2025	1766	
Satd. Flow (RTOR)		37				30	
Confl. Peds. (#/hr)						1	
Peak Hour Factor	0.92	0.92	0.93	0.93	0.87	0.87	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	5%	5%	1%	1%	1%	1%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	308	37	29	714	75	30	
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm	
Protected Phases	2		1	6	4		3
Permitted Phases		2	6			4	
Detector Phase	2	2	1	6	4	4	
Switch Phase							
Minimum Initial (s)	40.0	40.0	4.0	40.0	8.0	8.0	4.0
Minimum Split (s)	46.0	46.0	8.0	46.0	13.0	13.0	21.0
Total Split (s)	66.0	66.0	8.0	74.0	15.0	15.0	21.0
Total Split (%)	60.0%	60.0%	7.3%	67.3%	13.6%	13.6%	19%
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	3.0	2.0
All-Red Time (s)	2.0	2.0	1.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	6.0	6.0	4.0	6.0	5.0	5.0	
Lead/Lag	Lag	Lag	Lead		Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes
Recall Mode	Min	Min	None	None	None	None	None
Act Effct Green (s)	46.2	46.2	49.7	49.0	9.0	9.0	
Actuated g/C Ratio	0.68	0.68	0.73	0.72	0.13	0.13	
v/c Ratio	0.26	0.04	0.04	0.54	0.28	0.12	
Control Delay	8.9	4.1	5.3	9.6	32.8	14.2	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	8.9	4.1	5.3	9.6	32.8	14.2	
LOS	A	A	A	A	C	B	
Approach Delay	8.4			9.4	27.5		
Approach LOS	A			A	C		
Queue Length 50th (ft)	36	0	2	113	24	0	
Queue Length 95th (ft)	172	16	18	413	81	25	
Internal Link Dist (ft)	1154			331	60		
Turn Bay Length (ft)		150	200				
Base Capacity (vph)	1580	1347	746	1722	306	292	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.19	0.03	0.04	0.41	0.25	0.10	

Intersection Summary

Cycle Length: 110

Intersection Capacity Analysis

5. G. W. Blvd @ Rockland Circle

11/22/2015

Actuated Cycle Length: 67.9

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.54

Intersection Signal Delay: 10.7




Intersection LOS: B

Intersection Capacity Utilization 50.8%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 3: Rockland Cir & G W Blvd

 $\phi 1$	 $\phi 2$	 $\phi 3$	 $\phi 4$
8 s	66 s	21 s	15 s
 $\phi 6$			
74 s			

Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/22/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕	↕	↕	↕↔		↕	↔	
Volume (vph)	2	0	5	15	4	16	1	276	12	22	634	5
Satd. Flow (prot)	0	1703	0	0	1621	1432	1736	3447	0	1787	1879	0
Flt Permitted							0.950			0.950		
Satd. Flow (perm)	0	1721	0	0	1675	1408	1736	3447	0	1726	1879	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	1		1	1		1			4	4		
Peak Hour Factor	0.88	0.88	0.88	0.80	0.80	0.80	0.88	0.88	0.88	0.92	0.92	0.92
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	10%	10%	10%	9%	9%	9%	4%	4%	4%	1%	1%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	8	0	0	25	21	1	343	0	25	730	0
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Detector Phase	4	4		8	8	8	5	2		1	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	33.0		4.0	33.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	8.0	38.0		8.0	38.0	
Total Split (s)	12.0	12.0		12.0	12.0	12.0	8.0	69.0		8.0	69.0	
Total Split (%)	10.9%	10.9%		10.9%	10.9%	10.9%	7.3%	62.7%		7.3%	62.7%	
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	1.0	2.0		1.0	2.0	
Lost Time Adjust (s)		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.0			5.0	5.0	4.0	5.0		4.0	5.0	
Lead/Lag							Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None	None	None	Min		None	Min	
Act Effect Green (s)		6.6			6.9	6.9	4.3	48.1		4.3	48.1	
Actuated g/C Ratio		0.12			0.12	0.12	0.08	0.84		0.08	0.84	
v/c Ratio		0.04			0.12	0.12	0.01	0.12		0.19	0.46	
Control Delay		29.4			29.4	30.0	34.0	4.2		33.8	7.3	
Queue Delay		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Delay		29.4			29.4	30.0	34.0	4.2		33.8	7.3	
LOS		C			C	C	C	A		C	A	
Approach Delay		29.4			29.7			4.3			8.2	
Approach LOS		C			C			A			A	
Queue Length 50th (ft)		2			4	4	0	0		5	0	
Queue Length 95th (ft)		18			35	31	6	71		40	439	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)							50			50		
Base Capacity (vph)		228			222	187	131	3238		135	1765	
Starvation Cap Reductn		0			0	0	0	0		0	0	
Spillback Cap Reductn		0			0	0	0	0		0	0	
Storage Cap Reductn		0			0	0	0	0		0	0	
Reduced v/c Ratio		0.04			0.11	0.11	0.01	0.11		0.19	0.41	

Intersection Summary

Cycle Length: 110

Intersection Capacity Analysis
 6. G. W. Blvd @ Wharf Ave

11/22/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
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)	21.0
Total Split (s)	21.0
Total Split (%)	19%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
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	

Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/22/2015

Actuated Cycle Length: 57.2

Natural Cycle: 80

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.46

Intersection Signal Delay: 8.0







Intersection LOS: A

Intersection Capacity Utilization 47.0%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 7: G W Blvd & Wharf Ave

 $\phi 1$	 $\phi 2$	 $\phi 4$	 $\phi 9$
8 s	69 s	12 s	21 s
 $\phi 5$	 $\phi 6$	 $\phi 8$	
8 s	69 s	12 s	

APPENDIX J

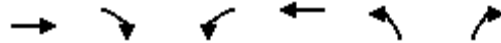
**Intersection Capacity Analyses
Weekday PM Peak Hour**

Projected 2040 Traffic Conditions with Proposed Improvements

Intersection Capacity Analysis

1. Summer St @ North St

11/19/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	↑↑			↑↑	↖	↗	
Volume (vph)	1137	53	298	617	118	412	
Satd. Flow (prot)	3085	0	0	3030	1608	1439	
Flt Permitted				0.516	0.950		
Satd. Flow (perm)	3085	0	0	1589	1572	1439	
Satd. Flow (RTOR)	5					332	
Confl. Peds. (#/hr)		1	1		9		
Peak Hour Factor	0.95	0.95	0.87	0.87	0.81	0.81	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	1%	1%	2%	2%	1%	1%	
Adj. Flow (vph)	1257	59	360	745	153	534	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	1316	0	0	1105	153	534	
Turn Type	NA		pm+pt	NA	Prot	pt+ov	
Protected Phases	2		1	6	4	4 1	3
Permitted Phases			6				
Detector Phase	2		1	6	4	4 1	
Switch Phase							
Minimum Initial (s)	8.0		4.0	8.0	9.0		4.0
Minimum Split (s)	13.0		9.0	13.0	14.0		21.0
Total Split (s)	51.0		20.0	71.0	18.0		21.0
Total Split (%)	46.4%		18.2%	64.5%	16.4%		19%
Yellow Time (s)	4.0		4.0	4.0	4.0		2.0
All-Red Time (s)	1.0		1.0	1.0	1.0		0.0
Lost Time Adjust (s)	0.0			0.0	0.0		
Total Lost Time (s)	5.0			5.0	5.0		
Lead/Lag	Lead		Lag		Lag		Lead
Lead-Lag Optimize?	Yes		Yes		Yes		Yes
Recall Mode	Min		None	Min	None		None
Act Effect Green (s)	46.5			65.3	12.4	30.4	
Actuated g/C Ratio	0.51			0.72	0.14	0.33	
v/c Ratio	0.84			1.08dl	0.70	0.76	
Control Delay	27.0			20.0	57.9	17.7	
Queue Delay	0.0			0.0	0.0	0.0	
Total Delay	27.0			20.0	57.9	17.7	
LOS	C			C	E	B	
Approach Delay	27.0			20.0	26.7		
Approach LOS	C			C	C		
Queue Length 50th (ft)	309			108	82	90	
Queue Length 95th (ft)	#656			#338	#181	142	
Internal Link Dist (ft)	764			218	85		
Turn Bay Length (ft)							
Base Capacity (vph)	1573			1377	231	709	
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	0.84			0.80	0.66	0.75	

Intersection Summary

Intersection Capacity Analysis

1. Summer St @ North St

11/19/2015

Cycle Length: 110

Actuated Cycle Length: 91.3

Natural Cycle: 110

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.84

Intersection Signal Delay: 24.4

Intersection LOS: C

Intersection Capacity Utilization 88.8%

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.

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 1: North St & Otis St/Summer St

→ ϕ2	↖ ϕ1	↗ ϕ3	↘ ϕ4
51 s	20 s	21 s	18 s
← ϕ6			
71 s			

Intersection Capacity Analysis

2. Summer St @ CJC Hwy

11/19/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	10	753	824	43	508	0	408	10	14	10	5	25
Satd. Flow (prot)	1711	3455	1546	1711	3421	0	1681	1621	0	0	1745	1531
Flt Permitted	0.373			0.199			0.950	0.957			0.969	
Satd. Flow (perm)	672	3455	1546	358	3421	0	1681	1621	0	0	1745	1531
Satd. Flow (RTOR)			759					3				139
Peak Hour Factor	0.92	0.87	0.87	0.80	0.80	0.92	0.85	0.92	0.85	0.92	0.92	0.92
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	2%	1%	1%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Adj. Flow (vph)	11	909	994	56	667	0	504	11	17	11	6	29
Shared Lane Traffic (%)							47%					
Lane Group Flow (vph)	11	909	994	56	667	0	267	265	0	0	17	29
Turn Type	pm+pt	NA	Perm	pm+pt	NA		Split	NA		Split	NA	Perm
Protected Phases	5	2		1	6		7	7		8	8	
Permitted Phases	2		2	6								8
Detector Phase	5	2	2	1	6		7	7		8	8	8
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0		4.0	4.0		4.0	4.0	4.0
Minimum Split (s)	8.0	20.0	20.0	8.0	20.0		9.0	9.0		9.0	9.0	9.0
Total Split (s)	8.0	46.0	46.0	8.0	46.0		23.0	23.0		9.0	9.0	9.0
Total Split (%)	7.3%	41.8%	41.8%	7.3%	41.8%		20.9%	20.9%		8.2%	8.2%	8.2%
Yellow Time (s)	3.0	4.0	4.0	3.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)	4.0	5.0	5.0	4.0	5.0		5.0	5.0		5.0	5.0	5.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lead	Lead		Lag	Lag	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes		Yes	Yes		Yes	Yes	Yes
Recall Mode	None	Min	Min	Min	Min		None	None		None	None	None
Act Effct Green (s)	43.1	38.0	38.0	46.6	45.0		18.6	18.6			4.1	4.1
Actuated g/C Ratio	0.52	0.46	0.46	0.56	0.54		0.22	0.22			0.05	0.05
v/c Ratio	0.03	0.58	0.89	0.21	0.36		0.71	0.73			0.20	0.14
Control Delay	11.5	19.6	17.1	12.4	13.8		45.6	46.5			49.6	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0			0.0	0.0
Total Delay	11.5	19.6	17.1	12.4	13.8		45.6	46.5			49.6	1.4
LOS	B	B	B	B	B		D	D			D	A
Approach Delay		18.3			13.7			46.1			19.2	
Approach LOS		B			B			D			B	
Queue Length 50th (ft)	2	175	90	12	94		144	142			9	0
Queue Length 95th (ft)	14	316	#501	37	197		#318	#355			35	0
Internal Link Dist (ft)		630			618			73			1	
Turn Bay Length (ft)	100		150	100								
Base Capacity (vph)	400	1760	1160	268	1939		375	364			86	208
Starvation Cap Reductn	0	0	0	0	0		0	0			0	0
Spillback Cap Reductn	0	0	0	0	0		0	0			0	0
Storage Cap Reductn	0	0	0	0	0		0	0			0	0
Reduced v/c Ratio	0.03	0.52	0.86	0.21	0.34		0.71	0.73			0.20	0.14

Intersection Summary

Cycle Length: 110

Intersection Capacity Analysis

2. Summer St @ CJC Hwy

11/19/2015

Lane Group	ø3
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	3
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	24.0
Total Split (s)	24.0
Total Split (%)	22%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
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	

Intersection Capacity Analysis

2. Summer St @ CJC Hwy

11/19/2015

Actuated Cycle Length: 83

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.89

Intersection Signal Delay: 21.9

Intersection LOS: C

Intersection Capacity Utilization 71.9%








ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 3: Chief Justice Cushing Hwy & Summer St

 ø1	 ø2	 ø3	 ø7	 ø8
8 s	46 s	24 s	23 s	9 s
 ø5	 ø6			
8 s	46 s			

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/19/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	58	745	24	110	474	8	15	29	85	7	23	30
Satd. Flow (prot)	1728	3435	0	1694	1780	0	0	1831	1583	0	2028	1743
Flt Permitted	0.309			0.232				0.884			0.926	
Satd. Flow (perm)	562	3435	0	413	1780	0	0	1647	1561	0	1898	1743
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)			2	2					1	1		
Peak Hour Factor	0.91	0.91	0.91	0.83	0.83	0.83	0.75	0.75	0.75	0.88	0.88	0.88
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	1%	1%	1%	3%	3%	3%	2%	2%	2%	5%	5%	5%
Adj. Flow (vph)	67	860	28	139	600	10	21	41	119	8	27	36
Shared Lane Traffic (%)												
Lane Group Flow (vph)	67	888	0	139	610	0	0	62	119	0	35	36
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm
Protected Phases	5	2		1	6			3			3	
Permitted Phases	2			6			3		3	3		3
Detector Phase	5	2		1	6		3	3	3	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0	8.0	8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0	13.0	13.0	13.0	13.0
Total Split (s)	10.0	57.0		10.0	57.0		20.0	20.0	20.0	20.0	20.0	20.0
Total Split (%)	9.1%	51.8%		9.1%	51.8%		18.2%	18.2%	18.2%	18.2%	18.2%	18.2%
Yellow Time (s)	3.0	4.0		3.0	4.0		4.0	4.0	4.0	4.0	4.0	4.0
All-Red Time (s)	1.0	1.0		1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0			5.0	5.0		5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None	None	None	None	None
Act Effect Green (s)	37.7	30.2		39.8	36.2			12.7	12.7		12.7	12.7
Actuated g/C Ratio	0.60	0.48		0.63	0.57			0.20	0.20		0.20	0.20
v/c Ratio	0.15	0.54		0.35	0.60			0.19	0.38		0.09	0.10
Control Delay	7.5	14.8		9.7	18.2			31.1	34.0		30.5	30.7
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	7.5	14.8		9.7	18.2			31.1	34.0		30.5	30.7
LOS	A	B		A	B			C	C		C	C
Approach Delay		14.3			16.6			33.0			30.6	
Approach LOS		B			B			C			C	
Queue Length 50th (ft)	7	112		15	165			19	37		10	11
Queue Length 95th (ft)	40	287		68	416			67	116		52	53
Internal Link Dist (ft)		378			358			249			637	
Turn Bay Length (ft)	150			150					50			75
Base Capacity (vph)	473	2844		404	1473			464	440		535	491
Starvation Cap Reductn	0	0		0	0			0	0		0	0
Spillback Cap Reductn	0	0		0	0			0	0		0	0
Storage Cap Reductn	0	0		0	0			0	0		0	0
Reduced v/c Ratio	0.14	0.31		0.34	0.41			0.13	0.27		0.07	0.07

Intersection Summary

Intersection Capacity Analysis
 3. Summer St @ Rockland St

11/19/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Adj. Flow (vph)	
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)	23.0
Total Split (s)	23.0
Total Split (%)	21%
Yellow Time (s)	2.0
All-Red Time (s)	0.0
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





Intersection Capacity Analysis

3. Summer St @ Rockland St

11/19/2015

Cycle Length: 110	
Actuated Cycle Length: 63.3	
Natural Cycle: 80	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.60	
Intersection Signal Delay: 17.5	Intersection LOS: B
Intersection Capacity Utilization 52.5%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

 ϕ1	 ϕ2	 ϕ3	 ϕ9
10 s	57 s	20 s	23 s
 ϕ5	 ϕ6		
10 s	57 s		

Intersection Capacity Analysis

4. G. W. Blvd @ Rockland St

11/19/2015



Lane Group	WBL	WBR	NET	NER	SWL	SWT	ø3
Lane Configurations							
Volume (vph)	106	23	665	177	18	481	
Satd. Flow (prot)	1662	1487	1801	1531	1711	1801	
Flt Permitted	0.950				0.187		
Satd. Flow (perm)	1662	1487	1801	1531	337	1801	
Satd. Flow (RTOR)		28		206			
Peak Hour Factor	0.85	0.85	0.90	0.90	0.83	0.83	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	5%	5%	2%	2%	2%	2%	
Adj. Flow (vph)	131	28	776	206	23	608	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	131	28	776	206	23	608	
Turn Type	Prot	Perm	NA	Perm	Perm	NA	
Protected Phases	4		2			6	3
Permitted Phases		4		2	6		
Detector Phase	4	4	2	2	6	6	
Switch Phase							
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	4.0
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0	12.0	23.0
Total Split (s)	16.0	16.0	56.0	56.0	56.0	56.0	23.0
Total Split (%)	16.8%	16.8%	58.9%	58.9%	58.9%	58.9%	24%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	
Lead/Lag	Lag	Lag					Lead
Lead-Lag Optimize?	Yes	Yes					Yes
Recall Mode	Min	Min	None	None	None	None	None
Act Effect Green (s)	11.4	11.4	30.2	30.2	30.2	30.2	
Actuated g/C Ratio	0.21	0.21	0.55	0.55	0.55	0.55	
v/c Ratio	0.38	0.08	0.78	0.22	0.12	0.61	
Control Delay	29.2	13.3	17.2	2.0	9.0	12.1	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	29.2	13.3	17.2	2.0	9.0	12.1	
LOS	C	B	B	A	A	B	
Approach Delay	26.4		14.0			12.0	
Approach LOS	C		B			B	
Queue Length 50th (ft)	32	0	142	0	3	96	
Queue Length 95th (ft)	#135	23	483	29	18	281	
Internal Link Dist (ft)	100		657			589	
Turn Bay Length (ft)				250	50		
Base Capacity (vph)	366	349	1622	1400	303	1622	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.36	0.08	0.48	0.15	0.08	0.37	

Intersection Summary

Cycle Length: 95

Intersection Capacity Analysis

4. G. W. Blvd @ Rockland St

11/19/2015

Actuated Cycle Length: 54.9

Natural Cycle: 75

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.78

Intersection Signal Delay: 14.4

Intersection LOS: B

Intersection Capacity Utilization 51.2%





ICU Level of Service A

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 13: Rockland St & G. W. Blvd

 02	 03	 04
56 s	23 s	16 s
 06		
56 s		

Intersection Capacity Analysis
 5. G. W. Blvd @ Rockland Circle

11/19/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	↑	↑	↑	↑	↑	↑	
Volume (vph)	595	83	34	402	50	22	
Satd. Flow (prot)	1818	1546	1728	1818	2025	1812	
Flt Permitted			0.267		0.950		
Satd. Flow (perm)	1818	1546	486	1818	2025	1812	
Satd. Flow (RTOR)		73				32	
Peak Hour Factor	0.89	0.89	0.92	0.92	0.72	0.72	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	
Adj. Flow (vph)	702	98	39	459	73	32	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	702	98	39	459	73	32	
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm	
Protected Phases	2		1	6	4		3
Permitted Phases		2	6			4	
Detector Phase	2	2	1	6	4	4	
Switch Phase							
Minimum Initial (s)	8.0	8.0	4.0	8.0	8.0	8.0	4.0
Minimum Split (s)	46.0	46.0	8.0	46.0	13.0	13.0	21.0
Total Split (s)	68.0	68.0	8.0	76.0	13.0	13.0	21.0
Total Split (%)	61.8%	61.8%	7.3%	69.1%	11.8%	11.8%	19%
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	3.0	2.0
All-Red Time (s)	2.0	2.0	1.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	6.0	6.0	4.0	6.0	5.0	5.0	
Lead/Lag	Lag	Lag	Lead		Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes
Recall Mode	Min	Min	None	None	None	None	None
Act Effct Green (s)	34.9	34.9	37.7	37.6	8.5	8.5	
Actuated g/C Ratio	0.68	0.68	0.73	0.73	0.17	0.17	
v/c Ratio	0.57	0.09	0.09	0.35	0.22	0.10	
Control Delay	9.9	2.7	2.9	4.8	24.9	11.1	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	9.9	2.7	2.9	4.8	24.9	11.1	
LOS	A	A	A	A	C	B	
Approach Delay	9.0			4.6	20.7		
Approach LOS	A			A	C		
Queue Length 50th (ft)	104	2	3	56	20	0	
Queue Length 95th (ft)	268	19	8	91	48	15	
Internal Link Dist (ft)	1154			331	60		
Turn Bay Length (ft)		150	200				
Base Capacity (vph)	1801	1532	458	1818	334	326	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.39	0.06	0.09	0.25	0.22	0.10	

Intersection Summary

Cycle Length: 110

Intersection Capacity Analysis

5. G. W. Blvd @ Rockland Circle

11/19/2015

Actuated Cycle Length: 51.5

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.57

Intersection Signal Delay: 8.4

Intersection LOS: A

Intersection Capacity Utilization 48.7%

ICU Level of Service A

Analysis Period (min) 15

Splits and Phases: 3: Rockland Cir & G W Blvd



Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/19/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕	↕	↕	↕↕		↕	↕	
Volume (vph)	13	6	7	35	2	15	5	593	13	17	402	10
Satd. Flow (prot)	0	1920	0	0	1609	1432	1736	3459	0	1608	1874	0
Flt Permitted		0.814			0.778		0.950			0.950		
Satd. Flow (perm)	0	1599	0	0	1307	1412	1736	3459	0	1596	1874	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	1		1	1		1			2	2		
Peak Hour Factor	0.65	0.65	0.65	0.72	0.72	0.72	0.92	0.92	0.92	0.95	0.95	0.95
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	5%	5%	5%	9%	9%	9%	4%	4%	4%	1%	1%	1%
Parking (#/hr)										0		
Adj. Flow (vph)	21	10	11	51	3	22	6	677	15	19	444	11
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	42	0	0	54	22	6	692	0	19	455	0
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Detector Phase	4	4		8	8	8	5	2		1	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	8.0		4.0	8.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	8.0	38.0		8.0	38.0	
Total Split (s)	22.0	22.0		22.0	22.0	22.0	10.0	64.0		10.0	64.0	
Total Split (%)	18.6%	18.6%		18.6%	18.6%	18.6%	8.5%	54.2%		8.5%	54.2%	
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.5	3.0		3.5	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	0.5	2.0		0.5	2.0	
Lost Time Adjust (s)		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.0			5.0	5.0	4.0	5.0		4.0	5.0	
Lead/Lag							Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None	None	None	Min		None	Min	
Act Effect Green (s)		8.3			8.5	8.5	6.5	27.9		6.7	27.9	
Actuated g/C Ratio		0.20			0.20	0.20	0.16	0.67		0.16	0.67	
v/c Ratio		0.13			0.20	0.08	0.02	0.30		0.07	0.36	
Control Delay		20.2			21.2	20.4	24.2	8.6		23.9	10.4	
Queue Delay		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Delay		20.2			21.2	20.4	24.2	8.6		23.9	10.4	
LOS		C			C	C	C	A		C	B	
Approach Delay		20.2			21.0			8.7			10.9	
Approach LOS		C			C			A			B	
Queue Length 50th (ft)		6			8	3	1	35		3	47	
Queue Length 95th (ft)		33			45	24	15	186		30	278	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)							50			50		
Base Capacity (vph)		755			617	667	289	3274		268	1774	
Starvation Cap Reductn		0			0	0	0	0		0	0	
Spillback Cap Reductn		0			0	0	0	0		0	0	
Storage Cap Reductn		0			0	0	0	0		0	0	
Reduced v/c Ratio		0.06			0.09	0.03	0.02	0.21		0.07	0.26	

Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/19/2015

Intersection Summary

Cycle Length: 118	
Actuated Cycle Length: 41.6	
Natural Cycle: 80	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 0.36	
Intersection Signal Delay: 10.6	Intersection LOS: B
Intersection Capacity Utilization 39.4%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 7: G W Blvd & Wharf Ave

 ρ1	 ρ2	 ρ4	 ρ9
10 s	64 s	22 s	22 s
 ρ5	 ρ6	 ρ8	
10 s	64 s	22 s	

Intersection Capacity Analysis
 6. G. W. Blvd @ Wharf Ave

11/19/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Parking (#/hr)	
Adj. Flow (vph)	
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)	22.0
Total Split (s)	22.0
Total Split (%)	19%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
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	

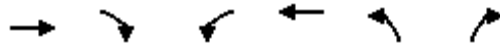
APPENDIX K

**Intersection Capacity Analyses
Summer Saturday Midday Peak Hour
Projected 2040 Traffic Conditions with Proposed Improvements**

Intersection Capacity Analysis

1. Summer St @ North St

11/22/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	↑↑			↑↑	↘	↗	
Volume (vph)	1261	67	316	777	200	567	
Satd. Flow (prot)	3080	0	0	2884	1608	1439	
Flt Permitted				0.521	0.950		
Satd. Flow (perm)	3080	0	0	1524	1442	1439	
Satd. Flow (RTOR)	5					308	
Confl. Peds. (#/hr)		7	7		49	18	
Peak Hour Factor	0.94	0.94	0.93	0.93	0.94	0.94	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	1%	1%	2%	2%	1%	1%	
Parking (#/hr)				0			
Shared Lane Traffic (%)							
Lane Group Flow (vph)	1484	0	0	1234	223	633	
Turn Type	NA		pm+pt	NA	Prot	pt+ov	
Protected Phases	2		1	6	4	4 1	3
Permitted Phases			6				
Detector Phase	2		1	6	4	4 1	
Switch Phase							
Minimum Initial (s)	8.0		4.0	8.0	9.0		4.0
Minimum Split (s)	13.0		9.0	13.0	14.0		21.0
Total Split (s)	55.0		22.0	77.0	22.0		21.0
Total Split (%)	45.8%		18.3%	64.2%	18.3%		18%
Yellow Time (s)	4.0		4.0	4.0	4.0		2.0
All-Red Time (s)	1.0		1.0	1.0	1.0		0.0
Lost Time Adjust (s)	0.0			0.0	0.0		
Total Lost Time (s)	5.0			5.0	5.0		
Lead/Lag	Lead		Lag		Lag		Lead
Lead-Lag Optimize?	Yes		Yes		Yes		Yes
Recall Mode	Min		None	Min	None		None
Act Effect Green (s)	50.4			72.6	17.2		37.6
Actuated g/C Ratio	0.47			0.68	0.16		0.35
v/c Ratio	1.02			1.30dl	0.87		0.90
Control Delay	59.5			46.5	77.2		33.2
Queue Delay	0.0			0.0	0.0		0.0
Total Delay	59.5			46.5	77.2		33.2
LOS	E			D	E		C
Approach Delay	59.5			46.5	44.7		
Approach LOS	E			D	D		
Queue Length 50th (ft)	448			165	137		195
Queue Length 95th (ft)	#856			#631	#335		#391
Internal Link Dist (ft)	764			213	85		
Turn Bay Length (ft)							
Base Capacity (vph)	1449			1247	256		703
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	1.02			0.99	0.87		0.90

Intersection Summary

Intersection Capacity Analysis

1. Summer St @ North St

11/22/2015

Cycle Length: 120

Actuated Cycle Length: 107.4

Natural Cycle: 130

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.02

Intersection Signal Delay: 51.5

Intersection LOS: D

Intersection Capacity Utilization 104.4%

ICU Level of Service G

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

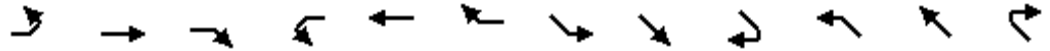
Splits and Phases: 1: North St & Otis St/Summer St

→ ø2	↙ ø1	↘ ø3	↘ ø4
55 s	22 s	21 s	22 s
← ø6			
77 s			

Intersection Capacity Analysis

2. Summer St @ CJC Hwy

11/22/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Volume (vph)	40	1357	501	48	679	10	10	10	40	387	10	4
Satd. Flow (prot)	1711	3455	1546	1728	3448	0	0	1757	1531	1698	1644	0
Flt Permitted	0.264			0.089				0.976		0.950	0.955	
Satd. Flow (perm)	475	3455	1546	162	3448	0	0	1757	1531	1698	1644	0
Satd. Flow (RTOR)			256		1				139		1	
Peak Hour Factor	0.92	0.94	0.94	0.85	0.85	0.92	0.92	0.92	0.92	0.85	0.92	0.85
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	2%	1%	1%	1%	1%	2%	2%	2%	2%	1%	2%	1%
Shared Lane Traffic (%)										48%		
Lane Group Flow (vph)	46	1516	560	59	850	0	0	22	46	249	245	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA		Split	NA	Perm	Split	NA	
Protected Phases	5	2		1	6		4	4		8	8	
Permitted Phases	2		2	6					4			
Detector Phase	5	2	2	1	6		4	4	4	8	8	
Switch Phase												
Minimum Initial (s)	4.0	8.0	8.0	4.0	8.0		4.0	4.0	4.0	8.0	8.0	
Minimum Split (s)	8.0	13.0	13.0	8.0	13.0		9.0	9.0	9.0	13.0	13.0	
Total Split (s)	8.0	46.0	46.0	8.0	46.0		9.0	9.0	9.0	23.0	23.0	
Total Split (%)	7.3%	41.8%	41.8%	7.3%	41.8%		8.2%	8.2%	8.2%	20.9%	20.9%	
Yellow Time (s)	3.0	4.0	4.0	3.0	4.0		4.0	4.0	4.0	4.0	4.0	
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0	
Total Lost Time (s)	4.0	5.0	5.0	4.0	5.0			5.0	5.0	5.0	5.0	
Lead/Lag	Lead	Lag	Lag	Lead	Lag		Lag	Lag	Lag			
Lead-Lag Optimize?												
Recall Mode	None	Min	Min	Min	Min		None	None	None	None	None	
Act Effect Green (s)	46.6	41.5	41.5	48.4	45.1			4.1	4.1	17.3	17.3	
Actuated g/C Ratio	0.53	0.48	0.48	0.56	0.52			0.05	0.05	0.20	0.20	
v/c Ratio	0.15	0.92	0.64	0.36	0.48			0.27	0.23	0.74	0.75	
Control Delay	12.0	33.8	14.5	17.3	17.4			52.6	2.6	49.4	50.5	
Queue Delay	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0	0.0	
Total Delay	12.0	33.8	14.5	17.3	17.4			52.6	2.6	49.4	50.5	
LOS	B	C	B	B	B			D	A	D	D	
Approach Delay		28.2			17.4			18.8			49.9	
Approach LOS		C			B			B			D	
Queue Length 50th (ft)	10	385	112	13	161			12	0	132	129	
Queue Length 95th (ft)	36	#758	318	41	282			41	0	#288	#318	
Internal Link Dist (ft)		610			627			20			83	
Turn Bay Length (ft)	100		150	100								
Base Capacity (vph)	311	1646	870	162	1782			81	203	355	344	
Starvation Cap Reductn	0	0	0	0	0			0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0			0	0	0	0	
Storage Cap Reductn	0	0	0	0	0			0	0	0	0	
Reduced v/c Ratio	0.15	0.92	0.64	0.36	0.48			0.27	0.23	0.70	0.71	

Intersection Summary

Cycle Length: 110

Actuated Cycle Length: 87.2

Intersection Capacity Analysis
 2. Summer St @ CJC Hwy

11/22/2015

Lane Group	ø3
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	3
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	24.0
Total Split (s)	24.0
Total Split (%)	22%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	Lead
Lead-Lag Optimize?	
Recall Mode	None
Act Effect 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	

Intersection Capacity Analysis

2. Summer St @ CJC Hwy

11/22/2015

Natural Cycle: 110

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.92

Intersection Signal Delay: 28.3

Intersection LOS: C

Intersection Capacity Utilization 68.5%








ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 3: Summer St

 ø1	 ø2	 ø3	 ø4	 ø8
8 s	46 s	24 s	9 s	23 s
 ø5	 ø6			
8 s	46 s			

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/22/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	55	1344	25	112	693	7	17	28	104	7	25	22
Satd. Flow (prot)	1728	3443	0	1728	1817	0	0	1866	1615	0	2088	1794
Flt Permitted	0.228			0.087				0.861			0.922	
Satd. Flow (perm)	415	3443	0	158	1817	0	0	1636	1615	0	1945	1794
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)			2	2					1	1		
Peak Hour Factor	0.95	0.95	0.95	0.89	0.89	0.89	0.85	0.85	0.85	0.90	0.90	0.90
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	0%	0%	0%	2%	2%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	61	1513	0	132	826	0	0	56	128	0	37	26
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA	pt+ov	Perm	NA	Prot
Protected Phases	5	2		1	6			3	31		3	3
Permitted Phases	2			6			3			3		
Detector Phase	5	2		1	6		3	3	31	3	3	3
Switch Phase												
Minimum Initial (s)	4.0	15.0		4.0	15.0		8.0	8.0		8.0	8.0	8.0
Minimum Split (s)	8.0	20.0		8.0	20.0		13.0	13.0		13.0	13.0	13.0
Total Split (s)	8.0	63.0		11.0	66.0		13.0	13.0		13.0	13.0	13.0
Total Split (%)	7.3%	57.3%		10.0%	60.0%		11.8%	11.8%		11.8%	11.8%	11.8%
Yellow Time (s)	3.5	4.0		3.0	4.0		4.0	4.0		4.0	4.0	4.0
All-Red Time (s)	0.5	1.0		1.0	1.0		1.0	1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0		0.0	0.0		0.0	0.0	0.0
Total Lost Time (s)	4.0	5.0		4.0	5.0		5.0	5.0		5.0	5.0	5.0
Lead/Lag	Lead	Lag		Lead	Lag							
Lead-Lag Optimize?	Yes	Yes		Yes	Yes							
Recall Mode	None	Min		Min	Min		None	None		None	None	None
Act Effect Green (s)	52.6	47.4		58.4	52.1			8.3	18.5		8.3	8.3
Actuated g/C Ratio	0.65	0.59		0.73	0.65			0.10	0.23		0.10	0.10
v/c Ratio	0.18	0.74		0.54	0.70			0.33	0.35		0.18	0.14
Control Delay	5.7	15.9		17.9	15.5			45.6	29.9		42.2	42.0
Queue Delay	0.0	0.0		0.0	0.0			0.0	0.0		0.0	0.0
Total Delay	5.7	15.9		17.9	15.5			45.6	29.9		42.2	42.0
LOS	A	B		B	B			D	C		D	D
Approach Delay		15.6			15.8			34.7			42.1	
Approach LOS		B			B			C			D	
Queue Length 50th (ft)	5	227		11	211			25	50		17	12
Queue Length 95th (ft)	31	558		#101	629			76	98		59	46
Internal Link Dist (ft)		424			358			249			637	
Turn Bay Length (ft)	150			150					50			75
Base Capacity (vph)	339	2584		257	1434			169	382		201	185
Starvation Cap Reductn	0	0		0	0			0	0		0	0
Spillback Cap Reductn	0	0		0	0			0	0		0	0
Storage Cap Reductn	0	0		0	0			0	0		0	0
Reduced v/c Ratio	0.18	0.59		0.51	0.58			0.33	0.34		0.18	0.14

Intersection Summary

Cycle Length: 110

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/22/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
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)	23.0
Total Split (s)	23.0
Total Split (%)	21%
Yellow Time (s)	2.0
All-Red Time (s)	0.0
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	

Intersection Capacity Analysis

3. Summer St @ Rockland St

11/22/2015

Actuated Cycle Length: 80.4

Natural Cycle: 90

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.74

Intersection Signal Delay: 17.5

Intersection LOS: B

Intersection Capacity Utilization 67.2%

ICU Level of Service C

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 4: Summer St & Rockland St & Martins Ln

 ø1	 ø2	 ø3	 ø9
11 s	63 s	13 s	23 s
 ø5	 ø6		
8 s	66 s		

Intersection Capacity Analysis

4. Rockland St @ G. W. Blvd

11/22/2015



Lane Group	WBL	WBR	NET	NER	SWL	SWT	ø3
Lane Configurations							
Volume (vph)	26	129	1223	202	23	718	
Satd. Flow (prot)	1728	1546	1818	1546	1728	1818	
Flt Permitted	0.950				0.072		
Satd. Flow (perm)	1728	1546	1818	1546	131	1818	
Satd. Flow (RTOR)		154		134			
Peak Hour Factor	0.88	0.88	0.92	0.92	0.88	0.88	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	31	154	1396	231	27	857	
Turn Type	Prot	Perm	NA	Perm	Perm	NA	
Protected Phases	4		2			6	3
Permitted Phases		4		2	6		
Detector Phase	4	4	2	2	6	6	
Switch Phase							
Minimum Initial (s)	7.0	7.0	7.0	7.0	7.0	7.0	4.0
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0	12.0	23.0
Total Split (s)	12.0	12.0	60.0	60.0	60.0	60.0	23.0
Total Split (%)	12.6%	12.6%	63.2%	63.2%	63.2%	63.2%	24%
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	2.0
All-Red Time (s)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	
Lead/Lag	Lag	Lag					Lead
Lead-Lag Optimize?	Yes	Yes					Yes
Recall Mode	Min	Min	None	None	None	None	None
Act Effect Green (s)	7.1	7.1	55.5	55.5	55.5	55.5	
Actuated g/C Ratio	0.09	0.09	0.73	0.73	0.73	0.73	
v/c Ratio	0.19	0.54	1.05	0.20	0.28	0.64	
Control Delay	37.4	14.6	52.8	2.6	15.6	9.7	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	37.4	14.6	52.8	2.6	15.6	9.7	
LOS	D	B	D	A	B	A	
Approach Delay	18.5		45.6			9.9	
Approach LOS	B		D			A	
Queue Length 50th (ft)	13	0	~472	8	3	124	
Queue Length 95th (ft)	44	54	#1276	52	32	486	
Internal Link Dist (ft)	100		459			589	
Turn Bay Length (ft)				200	50		
Base Capacity (vph)	161	283	1330	1167	96	1330	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.19	0.54	1.05	0.20	0.28	0.64	

Intersection Summary

Cycle Length: 95

Actuated Cycle Length: 75.8

Intersection Capacity Analysis

4. Rockland St @ G. W. Blvd

11/22/2015

Natural Cycle: 150

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 1.05

Intersection Signal Delay: 32.1

Intersection LOS: C

Intersection Capacity Utilization 84.3%

ICU Level of Service E

Analysis 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 longer.

Queue shown is maximum after two cycles.

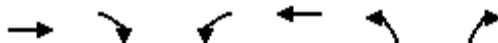
Splits and Phases: 13:

 ø2	 ø3	 ø4
60 s	23 s	12 s
 ø6		
60 s		

Intersection Capacity Analysis

5. G. W. Blvd @ Rockland Circle

11/22/2015



Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	ø3
Lane Configurations	↑	↑	↑	↑	↑	↑	
Volume (vph)	1170	100	25	675	60	25	
Satd. Flow (prot)	1818	1546	1728	1818	2025	1812	
Flt Permitted			0.057		0.950		
Satd. Flow (perm)	1818	1546	104	1818	2025	1812	
Satd. Flow (RTOR)		49				29	
Peak Hour Factor	1.00	0.92	0.92	0.92	0.92	0.92	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	1228	114	29	770	68	29	
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm	
Protected Phases	2		1	6	4		3
Permitted Phases		2	6			4	
Detector Phase	2	2	1	6	4	4	
Switch Phase							
Minimum Initial (s)	40.0	40.0	4.0	40.0	8.0	8.0	4.0
Minimum Split (s)	46.0	46.0	8.0	46.0	13.0	13.0	21.0
Total Split (s)	68.0	68.0	8.0	76.0	13.0	13.0	21.0
Total Split (%)	61.8%	61.8%	7.3%	69.1%	11.8%	11.8%	19%
Yellow Time (s)	4.0	4.0	3.0	4.0	3.0	3.0	2.0
All-Red Time (s)	2.0	2.0	1.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	
Total Lost Time (s)	6.0	6.0	4.0	6.0	5.0	5.0	
Lead/Lag	Lag	Lag	Lead		Lag	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes		Yes	Yes	Yes
Recall Mode	Min	Min	None	None	None	None	None
Act Effect Green (s)	67.2	67.2	70.9	70.1	8.1	8.1	
Actuated g/C Ratio	0.76	0.76	0.80	0.79	0.09	0.09	
v/c Ratio	0.89	0.10	0.18	0.53	0.37	0.15	
Control Delay	23.1	4.1	6.3	7.4	46.8	18.2	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	23.1	4.1	6.3	7.4	46.8	18.2	
LOS	C	A	A	A	D	B	
Approach Delay	21.5			7.3	38.3		
Approach LOS	C			A	D		
Queue Length 50th (ft)	343	6	2	121	33	0	
Queue Length 95th (ft)	#1276	45	16	424	91	29	
Internal Link Dist (ft)	1154			331	60		
Turn Bay Length (ft)		150	200			25	
Base Capacity (vph)	1382	1187	157	1513	185	192	
Starvation Cap Reductn	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	
Reduced v/c Ratio	0.89	0.10	0.18	0.51	0.37	0.15	

Intersection Summary

Cycle Length: 110
 Actuated Cycle Length: 88.4

Intersection Capacity Analysis

5. G. W. Blvd @ Rockland Circle

11/22/2015

Natural Cycle: 140

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.89

Intersection Signal Delay: 17.2

Intersection LOS: B

Intersection Capacity Utilization 80.5%



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: 3: Rockland Cir & G W Blvd

 ø1	 ø2	 ø3	 ø4
8 s	68 s	21 s	13 s
 ø6			
76 s			

Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/22/2015



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕	↕	↕	↕↔		↕	↔	
Volume (vph)	10	10	29	138	6	32	18	910	262	23	639	17
Satd. Flow (prot)	0	1665	0	0	1735	1546	1728	3430	0	1608	1872	0
Flt Permitted		0.927			0.752		0.950			0.950		
Satd. Flow (perm)	0	1553	0	0	1196	1487	1545	3430	0	1576	1872	0
Satd. Flow (RTOR)												
Confl. Peds. (#/hr)	16		55	55		16	22		9	9		22
Peak Hour Factor	0.75	0.75	0.75	0.88	0.88	0.88	0.95	0.95	0.95	0.91	0.91	0.91
Growth Factor	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%	105%
Heavy Vehicles (%)	6%	6%	6%	1%	1%	1%	1%	1%	1%	1%	1%	1%
Parking (#/hr)										0		
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	69	0	0	172	38	20	1296	0	27	757	0
Turn Type	Perm	NA		Perm	NA	Perm	Prot	NA		Prot	NA	
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4			8		8						
Detector Phase	4	4		8	8	8	5	2		1	6	
Switch Phase												
Minimum Initial (s)	4.0	4.0		4.0	4.0	4.0	4.0	8.0		4.0	8.0	
Minimum Split (s)	9.0	9.0		9.0	9.0	9.0	8.0	38.0		8.0	38.0	
Total Split (s)	25.0	25.0		25.0	25.0	25.0	8.0	56.0		8.0	56.0	
Total Split (%)	22.7%	22.7%		22.7%	22.7%	22.7%	7.3%	50.9%		7.3%	50.9%	
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.5	3.0		3.5	3.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	0.5	2.0		0.5	2.0	
Lost Time Adjust (s)		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Lost Time (s)		5.0			5.0	5.0	4.0	5.0		4.0	5.0	
Lead/Lag							Lead	Lag		Lead	Lag	
Lead-Lag Optimize?							Yes	Yes		Yes	Yes	
Recall Mode	None	None		None	None	None	None	Min		None	Min	
Act Effect Green (s)		18.2			18.2	18.2	4.4	43.9		4.4	45.3	
Actuated g/C Ratio		0.21			0.21	0.21	0.05	0.51		0.05	0.53	
v/c Ratio		0.21			0.67	0.12	0.23	0.73		0.33	0.76	
Control Delay		36.1			51.1	35.5	55.5	21.9		60.0	25.3	
Queue Delay		0.0			0.0	0.0	0.0	0.0		0.0	0.0	
Total Delay		36.1			51.1	35.5	55.5	21.9		60.0	25.3	
LOS		D			D	D	E	C		E	C	
Approach Delay		36.1			48.3			22.4			26.5	
Approach LOS		D			D			C			C	
Queue Length 50th (ft)		38			107	21	13	373		18	362	
Queue Length 95th (ft)		67			#211	50	39	464		#55	#664	
Internal Link Dist (ft)		20			82			386			422	
Turn Bay Length (ft)							100			100		
Base Capacity (vph)		399			307	382	88	2248		82	1243	
Starvation Cap Reductn		0			0	0	0	0		0	0	
Spillback Cap Reductn		0			0	0	0	0		0	0	
Storage Cap Reductn		0			0	0	0	0		0	0	
Reduced v/c Ratio		0.17			0.56	0.10	0.23	0.58		0.33	0.61	

Intersection Summary

Intersection Capacity Analysis
 6. G. W. Blvd @ Wharf Ave

11/22/2015

Lane Group	ø9
Lane Configurations	
Volume (vph)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Satd. Flow (RTOR)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Growth Factor	
Heavy Vehicles (%)	
Parking (#/hr)	
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)	21.0
Total Split (s)	21.0
Total Split (%)	19%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
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

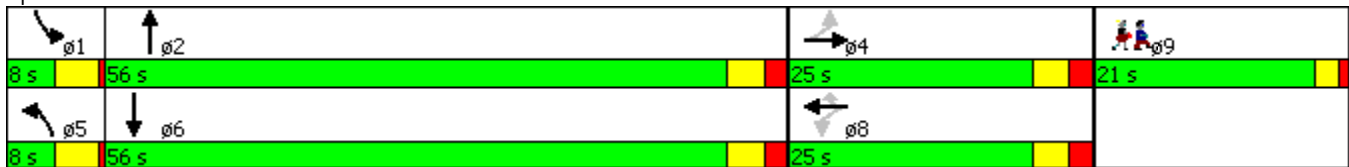
Intersection Capacity Analysis

6. G. W. Blvd @ Wharf Ave

11/22/2015

Cycle Length: 110
 Actuated Cycle Length: 85.4
 Natural Cycle: 90
 Control Type: Actuated-Uncoordinated
 Maximum v/c Ratio: 0.76
 Intersection Signal Delay: 26.4
 Intersection LOS: C
 Intersection Capacity Utilization 59.8%
 ICU Level of Service B
 Analysis Period (min) 15
 # 95th percentile volume exceeds capacity, queue may be longer.
 Queue shown is maximum after two cycles.

Splits and Phases: 7: G W Blvd & Wharf Ave



Intersection Capacity Analysis
 7. Otis St (Rt 3A) @ Hingham Bathing Beach

11/22/2015



Lane Group	WBL	WBR	NBT	NBR	SBL	SBT	ø3
Lane Configurations							
Volume (vph)	132	98	832	177	76	1212	
Satd. Flow (prot)	1665	0	3365	0	0	3445	
Flt Permitted	0.972					0.714	
Satd. Flow (perm)	1660	0	3365	0	0	2467	
Satd. Flow (RTOR)			33				
Confl. Peds. (#/hr)	4						
Peak Hour Factor	0.91	0.91	0.89	0.89	0.95	0.95	
Growth Factor	105%	105%	105%	105%	105%	105%	
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	265	0	1191	0	0	1424	
Turn Type	Prot		NA		Perm	NA	
Protected Phases	4		2			6	3
Permitted Phases					6		
Detector Phase	4		2		6	6	
Switch Phase							
Minimum Initial (s)	4.0		40.0		40.0	40.0	4.0
Minimum Split (s)	13.0		45.0		45.0	45.0	25.0
Total Split (s)	25.0		45.0		45.0	45.0	25.0
Total Split (%)	26.3%		47.4%		47.4%	47.4%	26%
Yellow Time (s)	4.0		4.0		4.0	4.0	4.0
All-Red Time (s)	1.0		1.0		1.0	1.0	1.0
Lost Time Adjust (s)	0.0		0.0			0.0	
Total Lost Time (s)	5.0		5.0			5.0	
Lead/Lag	Lag						Lead
Lead-Lag Optimize?	Yes						Yes
Recall Mode	None		Max		Max	Max	None
Act Effct Green (s)	16.7		41.0			41.0	
Actuated g/C Ratio	0.23		0.57			0.57	
v/c Ratio	0.68		0.62			1.01	
Control Delay	36.9		14.1			46.0	
Queue Delay	0.0		0.0			0.0	
Total Delay	36.9		14.1			46.0	
LOS	D		B			D	
Approach Delay	36.9		14.1			46.0	
Approach LOS	D		B			D	
Queue Length 50th (ft)	96		137			260	
Queue Length 95th (ft)	#268		403			#735	
Internal Link Dist (ft)	1		775			511	
Turn Bay Length (ft)							
Base Capacity (vph)	475		1936			1409	
Starvation Cap Reductn	0		0			0	
Spillback Cap Reductn	0		0			0	
Storage Cap Reductn	0		0			0	
Reduced v/c Ratio	0.56		0.62			1.01	

Intersection Summary

Cycle Length: 95

Intersection Capacity Analysis

7. Otis St (Rt 3A) @ Hingham Bathing Beach

11/22/2015

Actuated Cycle Length: 71.7

Natural Cycle: 145

Control Type: Semi Act-Uncoord

Maximum v/c Ratio: 1.01

Intersection Signal Delay: 32.0

Intersection LOS: C

Intersection Capacity Utilization 97.3%

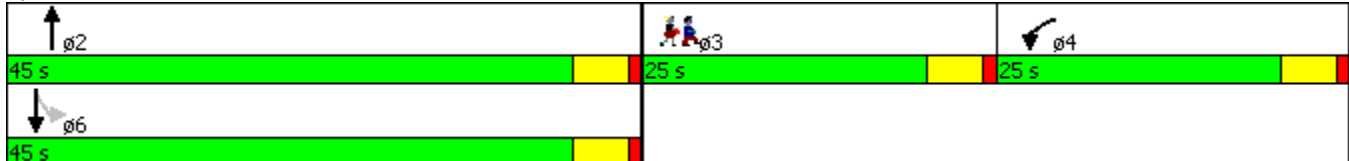
ICU Level of Service F

Analysis Period (min) 15

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 17:



APPENDIX L
MassDOT Project Development Process

Overview of the Project Development Process

Transportation decision-making is complex and can be influenced by legislative mandates, environmental regulations, financial limitations, agency programmatic commitments, and partnering opportunities. Decision-makers and reviewing agencies, when consulted early and often throughout the project development process, can ensure that all participants understand the potential impact these factors can have on project implementation. Project development is the process that takes a transportation improvement from concept through construction.

The MassDOT Highway Division has developed a comprehensive project development process which is contained in Chapter 2 of the *MassDOT Highway Division's Project Development and Design Guide*. The eight-step process covers a range of activities extending from identification of a project need, through completion of a set of finished contract plans, to construction of the project. The sequence of decisions made through the project development process progressively narrows the project focus and, ultimately, leads to a project that addresses the identified needs. The descriptions provided below are focused on the process for a highway project, but the same basic process will need to be followed for non-highway projects as well.

1. Needs Identification

For each of the locations at which an improvement is to be implemented, MassDOT leads an effort to define the problem, establishes project goals and objectives, and defines the scope of the planning needed for implementation. To that end, it has to complete a Project Need Form (PNF), which states in general terms the deficiencies or needs related to the transportation facility or location. The PNF documents the problems and explains why corrective action is needed. For this study, the information defining the need for the project will be drawn primarily, perhaps exclusively, from the present report. Also, at this point in the process, MassDOT meets with potential participants, such as the Metropolitan Planning Organization (MPO) and community members, to allow for an informal review of the project.

The PNF is reviewed by the MassDOT Highway Division district office whose jurisdiction includes the location of the proposed project. MassDOT also sends the PNF to the MPO, for informational purposes. The outcome of this step determines whether the project requires further planning, whether it is already well supported by prior planning studies, and, therefore, whether it is ready to move forward into the design phase, or whether it should be dismissed from further consideration.

2. Planning

This phase will likely not be required for the implementation of the improvements proposed in this planning study, as this planning report should constitute the outcome of this step. However, in general, the purpose of this implementation step is for the project proponent to identify issues, impacts, and approvals that may need to be obtained, so that the subsequent design and permitting processes are understood.

The level of planning needed will vary widely, based on the complexity of the project. Typical tasks include: define the existing context, confirm project need, establish goals and objectives, initiate public outreach, define the project, collect data, develop and analyze alternatives, make

recommendations, and provide documentation. Likely outcomes include consensus on the project definition to enable it to move forward into environmental documentation (if needed) and design, or a recommendation to delay the project or dismiss it from further consideration.

3. Project Initiation

At this point in the process, the proponent, MassDOT Highway Division, fills out a Project Initiation Form (PIF) for each improvement, which is reviewed by its Project Review Committee (PRC) and the MPO. The PRC is composed of the Chief Engineer, each District Highway Director, and representatives of the Project Management, Environmental, Planning, Right-of-Way, Traffic, and Bridge departments, and the MassDOT Federal Aid Program Office (FAPO). The PIF documents the project type and description, summarizes the project planning process, identifies likely funding and project management responsibility, and defines a plan for interagency and public participation. First the PRC reviews and evaluates the proposed project based on the MassDOT's statewide priorities and criteria. If the result is positive, MassDOT Highway Division moves the project forward to the design phase, and to programming review by the MPO. The PRC may provide a Project Management Plan to define roles and responsibilities for subsequent steps. The MPO review includes project evaluation based on the MPO's regional priorities and criteria. The MPO may assign project evaluation criteria score, a Transportation Improvement Program (TIP) year, a tentative project category, and a tentative funding category.

4. Environmental Permitting, Design, and Right-of-Way Process

This step has four distinct but closely integrated elements: public outreach, environmental documentation and permitting (if required), design, and right-of-way acquisition (if required). The outcome of this step is a fully designed and permitted project ready for construction. However, a project does not have to be fully designed in order for the MPO to program it in the TIP. The sections below provide more detailed information on the four elements of this step of the project development process.

Public Outreach

Continued public outreach in the design and environmental process is essential to maintain public support for the project and to seek meaningful input on the design elements. The public outreach is often in the form of required public hearings, but can also include less formal dialogues with those interested in and affected by a proposed project.

Environmental Documentation and Permitting

The project proponent, in coordination with the Environmental Services section of the MassDOT Highway Division, will be responsible for identifying and complying with all applicable federal, state, and local environmental laws and requirements. This includes determining the appropriate project category for both the Massachusetts Environmental Protection Act (MEPA) and the National Environmental Protection Act (NEPA). Environmental documentation and permitting is often completed in conjunction with the **Preliminary Design** phase described below.

Design

There are three major phases of design. The first is **Preliminary Design**, which is also referred to as the 25-percent submission. The major components of this phase include full survey of the project area, preparation of base plans, development of basic geometric layout, development of preliminary cost estimates, and submission of a functional design report. Preliminary Design, although not required to, is often completed in conjunction with the Environmental Documentation and Permitting. The next phase is **Final Design**, which is also referred to as the 75-percent and 100-percent submission. The major components of this phase include preparation of a subsurface exploratory plan (if required), coordination of utility relocations, development of traffic management plans through construction zones, development of final cost estimates, and refinement and finalization of the construction plans. Once Final Design is complete, a full set of **Plans, Specifications, and Estimates (PS&E)** is developed for the project.

Right-of-Way Acquisition

A separate set of Right-of-Way plans are required for any project that requires land acquisition or easements. The plans must identify the existing and proposed layout lines, easements, property lines, names of property owners, and the dimensions and areas of estimated takings and easements.

5. Programming (Identification of Funding)

Programming, which typically begins during the design phase, can actually occur at any time during the process, from planning to design. In this step, which is distinct from project initiation, the proponent requests that the MPO place the project in the region's Transportation Improvement Program (TIP). The proponent requesting the project's listing on the TIP can be the community or it can be one of the MPO member agencies (the Regional Planning Agency, MassDOT, and the Regional Transit Authority). The MPO then considers the project in terms of state and regional needs, evaluation criteria, and compliance with the regional Transportation Plan and decides whether to place it in the draft TIP for public review and then in the final TIP.

6. Procurement

Following project design and programming of a highway project, the MassDOT Highway Division publishes a request for proposals. It then reviews the bids and awards the contract to the qualified bidder with the lowest bid.

7. Construction

After a construction contract is awarded, MassDOT Highway Division and the contractor develop a public participation plan and a management plan for the construction process.

8. Project Assessment

The purpose of this step is to receive constituents' comments on the project development process and the project's design elements. MassDOT Highway Division can apply what is learned in this process to future projects.

Project Development Schematic Timetable

Description	Schedule Influence	Typical Duration
<p>Step I: Problem/Need/Opportunity Identification The proponent completes a Project Need Form (PNF). This form is then reviewed by the MassDOT Highway District office which provides guidance to the proponent on the subsequent steps of the process.</p>	<p>The Project Need Form has been developed so that it can be prepared quickly by the proponent, including any supporting data that is readily available. The District office shall return comments to the proponent within one month of PNF submission.</p>	<p>1 to 3 months</p>
<p>Step II: Planning Project planning can range from agreement that the problem should be addressed through a clear solution to a detailed analysis of alternatives and their impacts.</p>	<p>For some projects, no planning beyond preparation of the Project Need Form is required. Some projects require a planning study centered on specific project issues associated with the proposed solution or a narrow family of alternatives. More complex projects will likely require a detailed alternatives analysis.</p>	<p>Project Planning Report: 3 to 24+ months</p>
<p>Step III: Project Initiation The proponent prepares and submits a Project Initiation Form (PIF) and a Transportation Evaluation Criteria (TEC) form in this step. The PIF and TEC are informally reviewed by the Metropolitan Planning Organization (MPO) and MassDOT Highway District office, and formally reviewed by the PRC.</p>	<p>The PIF includes refinement of the preliminary information contained in the PNF. Additional information summarizing the results of the planning process, such as the Project Planning Report, are included with the PIF and TEC. The schedule is determined by PRC staff review (dependent on project complexity) and meeting schedule.</p>	<p>1 to 4 months</p>
<p>Step IV: Design, Environmental, and Right of Way The proponent completes the project design. Concurrently, the proponent completes necessary environmental permitting analyses and files applications for permits. Any right of way needed for the project is identified and the acquisition process begins.</p>	<p>The schedule for this step is dependent upon the size of the project and the complexity of the design, permitting, and right-of-way issues. Design review by the MassDOT Highway district and appropriate sections is completed in this step.</p>	<p>3 to 48+ months</p>
<p>Step V: Programming The MPO considers the project in terms of its regional priorities and determines whether or not to include the project in the draft Regional Transportation Improvement Program (TIP) which is then made available for public comment. The TIP includes a project description and funding source.</p>	<p>The schedule for this step is subject to each MPO's programming cycle and meeting schedule. It is also possible that the MPO will not include a project in its Draft TIP based on its review and approval procedures.</p>	<p>3 to 12+ months</p>
<p>Step VI: Procurement The project is advertised for construction and a contract awarded.</p>	<p>Administration of competing projects can influence the advertising schedule.</p>	<p>1 to 12 months</p>
<p>Step VII: Construction The construction process is initiated including public notification and any anticipated public involvement. Construction continues to project completion.</p>	<p>The duration for this step is entirely dependent upon project complexity and phasing.</p>	<p>3 to 60+ months</p>
<p>Step VIII: Project Assessment The construction period is complete and project elements and processes are evaluated on a voluntary basis.</p>	<p>The duration for this step is dependent upon the proponent's approach to this step and any follow-up required.</p>	<p>1 month</p>

Source: MassDOT Highway Division Project Development and Design Guide