Land Use: 220
Apartment

Description

Apartments are rental dwelling units located within the same building with at least three other dwelling units, for example, quadraplexes and all types of apartment buildings. The studies included in this land use did not identify whether the apartments were low-rise, mid-rise, or high-rise. Low-rise apartment (Land Use 221), high-rise apartment (Land Use 222) and mid-rise apartment (Land Use 223) are related uses.

Additional Data

This land use included data from a wide variety of units with different sizes, price ranges, locations and ages. Consequently, there was a wide variation in trips generated within this category. As expected, dwelling units that were larger in size, more expensive, or farther away from the central business district (CBD) had a higher rate of trip generation per unit than those smaller in size, less expensive, or closer to the CBD. Other factors, such as geographic location and type of adjacent and nearby development, may also have had an effect on the site trip generation.

The peak hour of the generator typically coincided with the peak hour of the adjacent street traffic.

The sites were surveyed between the late 1960s and the 2000s throughout the United States and Canada.

Many of the studies included in this land use did not indicate the total number of bedrooms. To assist in the future analysis of this land use, it is important that this information be collected and included in trip generation data submissions.

Source Numbers

2, 4, 5, 6, 9, 10, 11, 12, 13, 14, 16, 19, 20, 34, 35, 40, 72, 91, 100, 108, 188, 192, 204, 211, 253, 283, 357, 436, 525, 530, 579, 583, 638

Apartment
(220)

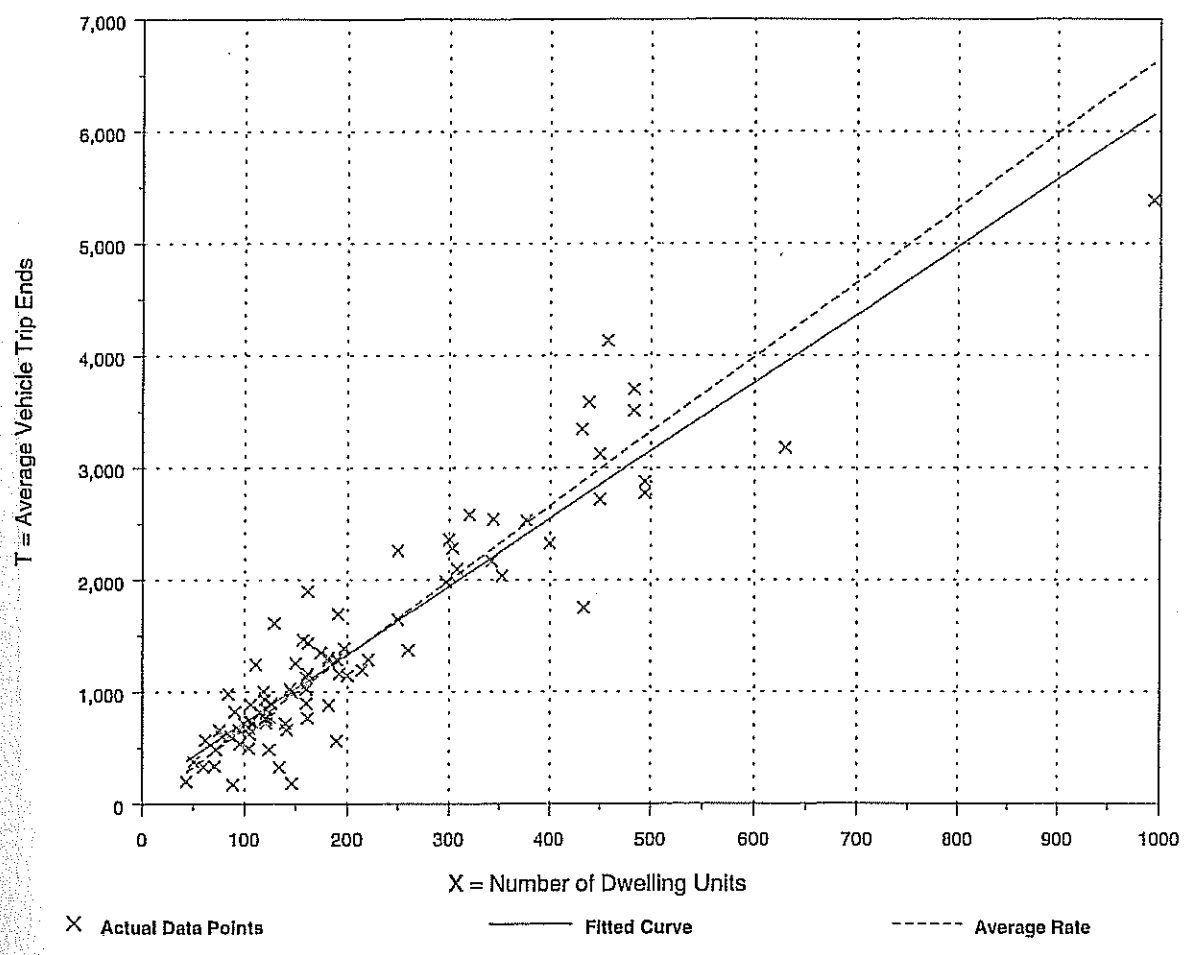
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 88
Avg. Number of Dwelling Units: 210
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
6.65	1.27 - 12.50	3.07

Data Plot and Equation



Fitted Curve Equation: T = 6.06(X) + 123.56 $R^2 = 0.87$

Apartment
(220)

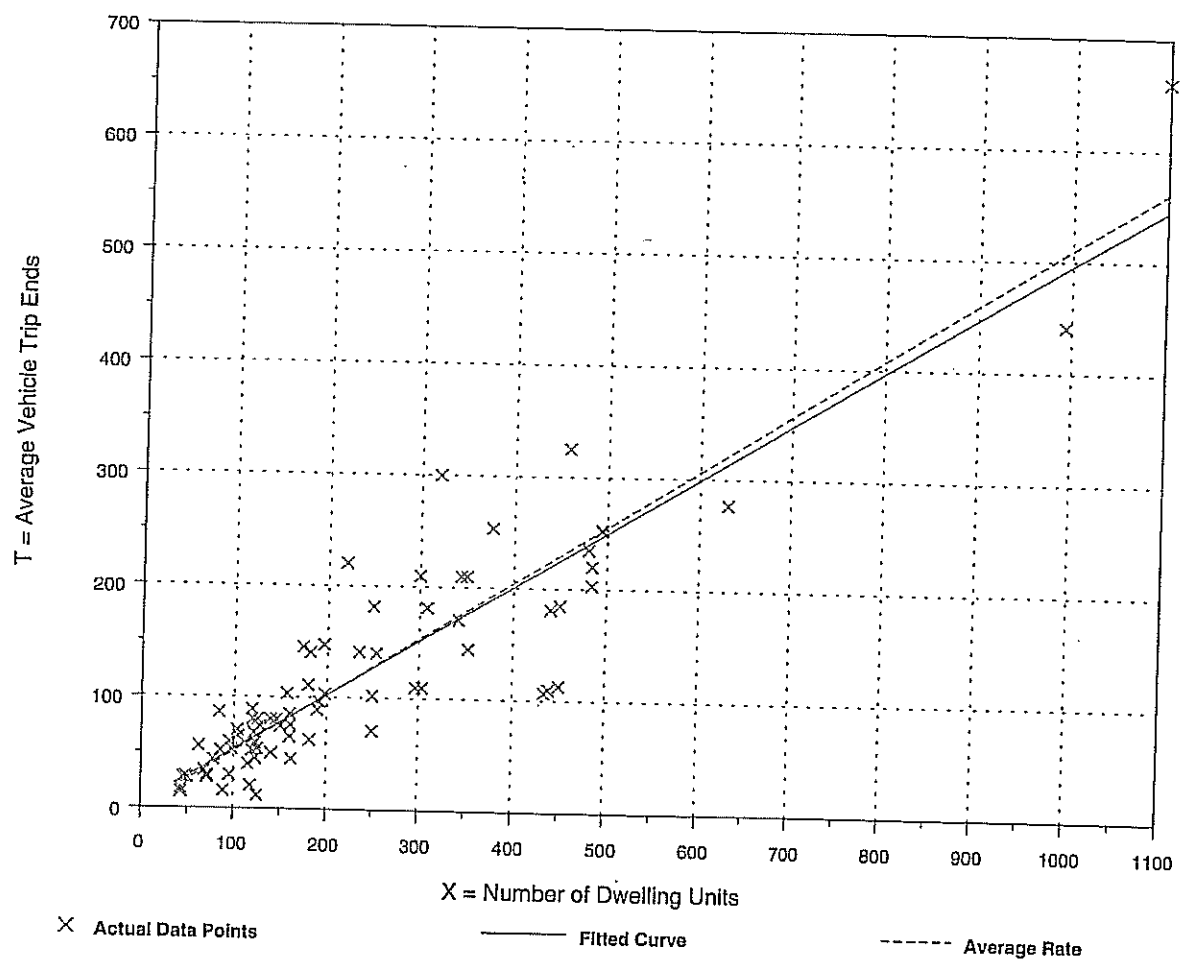
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Number of Studies: 78
Avg. Number of Dwelling Units: 235
Directional Distribution: 20% entering, 80% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.51	0.10 - 1.02	0.73

Data Plot and Equation



× Actual Data Points ——— Fitted Curve ------ Average Rate

Fitted Curve Equation: $T = 0.49(X) + 3.73$

$R^2 = 0.83$

Apartment
(220)

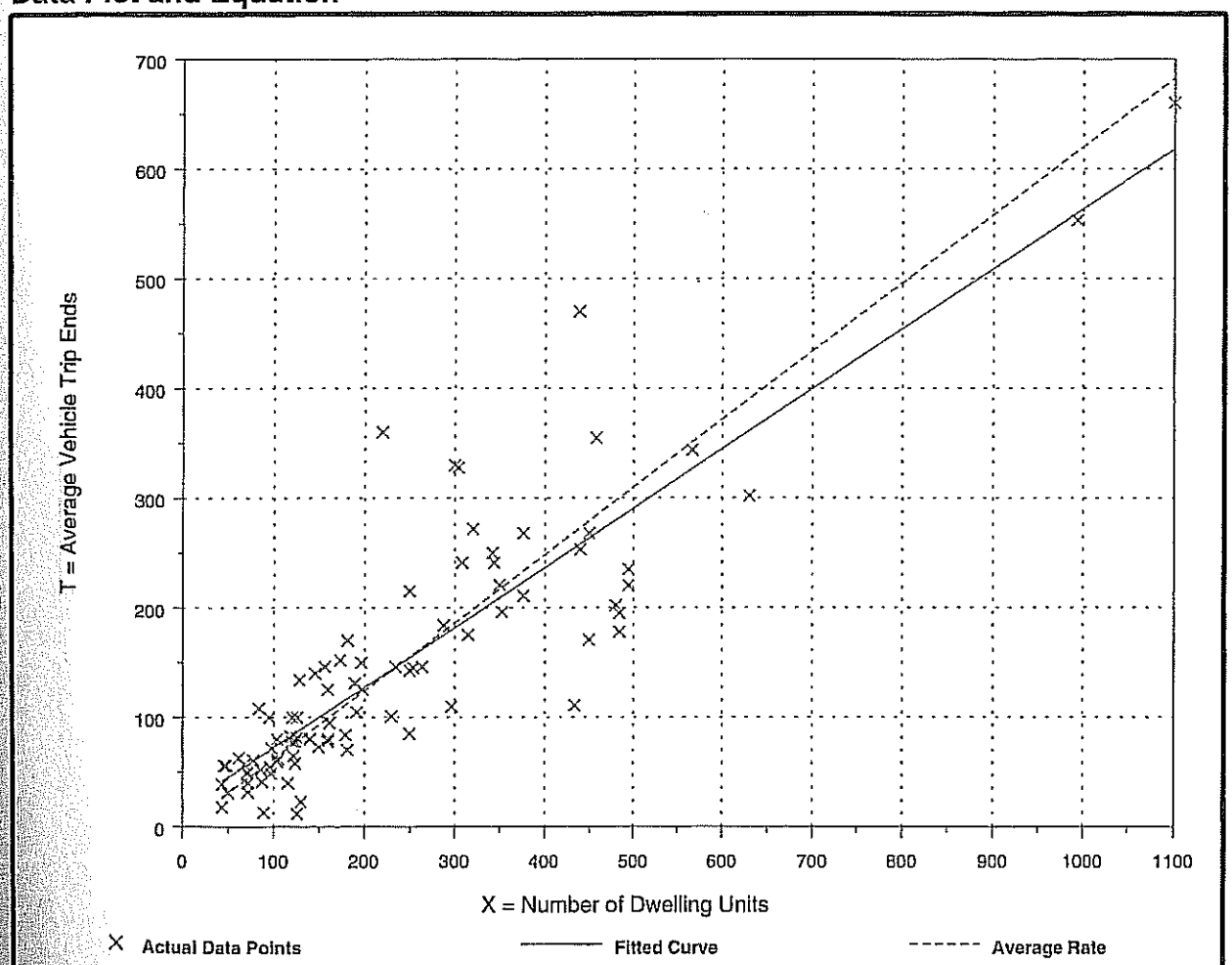
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 90
Avg. Number of Dwelling Units: 233
Directional Distribution: 65% entering, 35% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.62	0.10 - 1.64	0.82

Data Plot and Equation



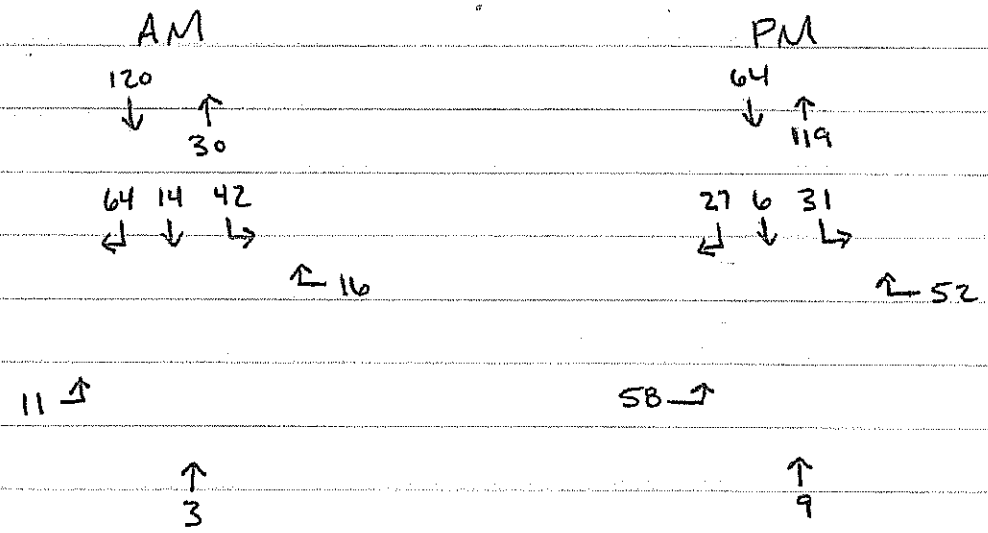
Fitted Curve Equation: T = 0.55(X) + 17.65 **R^2 = 0.77**

FARMVIEW ROAD TRAFFIC STUDY

APARTMENT - ITE 220

295 DWELLING UNITS

AM			PM			
IN	OUT	TOTAL	IN	OUT	TOTAL	WEEKDAY
30	120	150	119	64	183	1962



LONG REPORT

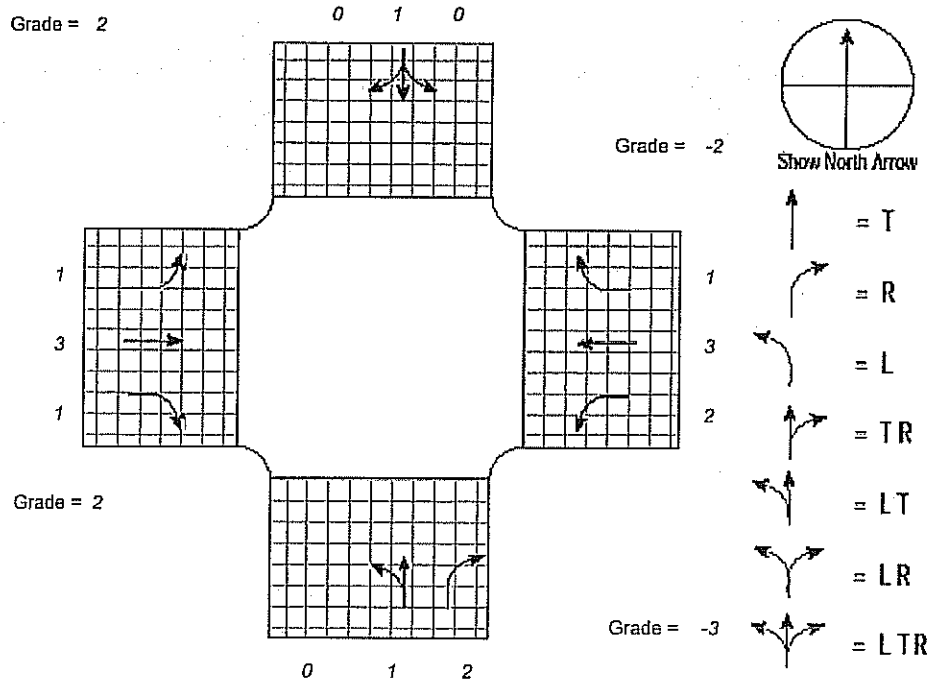
General Information

Analyst *CPB*
Agency or Co. *Balzer & Associates, Inc.*
Date Performed *1/17/2012*
Time Period *AM Peak Hr*

Site Information

Intersection *Rte 460/Farmview Rd*
Area Type *All other areas*
Jurisdiction *Town of Christiansburg*
Analysis Year *Existing 2009*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	9	351	34	101	528	21	59	3	38	9	1	7
% Heavy Veh	0	5	0	0	5	0	0	0	0	0	0	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	A	A	A	A	A	A	A	A	A	A	A	A
Startup Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
ExtenSion of Effective Green	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Arrival type	3	3	3	5	5	5		3	3		3	
Unit Extension	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	
Ped/Bike/RTOR Volume	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/Hour												
Bus Stops/Hour	0	0	0	0	0	0		0	0		0	
Pedestrian Timing	3.2			3.2			3.2			3.2		

	Excl. Left	Thru & RT	03	04	NB Only	SB Only	07	08
Timing	G = 12.0	G = 30.0	G = 0.0	G = 0.0	G = 15.0	G = 13.0	G = 0.0	G = 0.0
	Y = 5	Y = 5	Y = 0	Y = 0	Y = 5	Y = 5	Y = 0	Y = 0
Duration of Analysis (hrs) = 0.25						Cycle Length C = 90.0		

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	9	351	34	101	528	21	59	3	38	9	1	7
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adjusted Flow Rate	10	390	38	112	587	23	66	3	42	10	1	8
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	10	390	38	112	587	23		69	42		19	
Proportion of LT or RT	1.000	--	1.000	1.000	--	1.000	0.957	--	1.000	0.526	--	0.421

Saturation Flow Rate

Base Satflow	1900	1900	1900	1900	1900	1900		1900	1900		1900	
Number of Lanes	1	3	1	2	3	1	0	1	2	0	1	0
f_W	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{HV}	1.000	0.952	1.000	1.000	0.952	1.000		1.000	1.000		1.000	
f_g	0.990	0.990	0.990	1.010	1.010	1.010		1.015	1.015		0.990	
f_p	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{bb}	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_a	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{LU}	1.000	0.908	1.000	0.971	0.908	1.000		1.000	0.885		1.000	
f_{LT}	0.950	1.000	--	0.950	1.000	--		0.954	--		0.974	--
Secondary f_{LT}			--			--			--			--
f_{RT}	--	1.000	0.850	--	1.000	0.850	--	1.000	0.850	--	0.943	
f_{Lpb}	1.000	1.000	--	1.000	1.000	--		1.000	--		1.000	--
f_{Rpb}	--	1.000	1.000	--	1.000	1.000	--	1.000	1.000	--	1.000	
Adjusted Satflow	1787	4880	1599	3540	4978	1631		1840	2901		1729	
Secondary Adjusted Satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description

Capacity Analysis

	EB			WB				NB			SB	
Lane Group	*L*	*T*	*R*	*L*	*T*	*R*		*LT*	*R*		*LTR*	
Adjusted Flow Rate	*10*	*390*	*38*	*112*	*587*	*23*		*69*	*42*		*19*	
Satflow Rate	*1787*	*4880*	*1599*	*3540*	*4978*	*1631*		*1840*	*2901*		*1729*	
Lost Time	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*		*2.0*	*2.0*		*2.0*	
Green Ratio	*0.13*	*0.33*	*0.56*	*0.13*	*0.33*	*0.48*		*0.17*	*0.17*		*0.14*	
Lane Group Capacity	*238*	*1627*	*888*	*472*	*1659*	*779*		*307*	*484*		*250*	
v/c Ratio	*0.04*	*0.24*	*0.04*	*0.24*	*0.35*	*0.03*		*0.22*	*0.09*		*0.08*	
Flow Ratio	*0.01*	*0.08*	*0.02*	*0.03*	*0.12*	*0.01*		*0.04*	*0.01*		*0.01*	
Critical Lane Group	*N*	*N*	*N*	*Y*	*Y*	*N*		*Y*	*N*		*Y*	
Sum Flow Ratios	*0.20*											
Lost Time/Cycle	*20.00*											
Critical v/c Ratio	*0.25*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB				NB			SB	
Lane Group	*L*	*T*	*R*	*L*	*T*	*R*		*LT*	*R*		*LTR*	
Adjusted Flow Rate	*10*	*390*	*38*	*112*	*587*	*23*		*69*	*42*		*19*	
Lane Group Capacity	*238*	*1627*	*888*	*472*	*1659*	*779*		*307*	*484*		*250*	
v/c Ratio	*0.04*	*0.24*	*0.04*	*0.24*	*0.35*	*0.03*		*0.22*	*0.09*		*0.08*	
Green Ratio	*0.13*	*0.33*	*0.56*	*0.13*	*0.33*	*0.48*		*0.17*	*0.17*		*0.14*	
Uniform Delay d_1	*34.0*	*21.7*	*9.1*	*34.9*	*22.7*	*12.4*		*32.5*	*31.7*		*33.3*	
Delay Factor k	*0.11*	*0.11*	*0.11*	*0.11*	*0.11*	*0.11*		*0.11*	*0.11*		*0.11*	
Incremental Delay d_2	*0.1*	*0.1*	*0.0*	*0.3*	*0.1*	*0.0*		*0.4*	*0.1*		*0.1*	
PF Factor	*1.000*	*1.000*	*1.000*	*0.897*	*0.667*	*0.390*		*1.000*	*1.000*		*1.000*	
Control Delay	*34.1*	*21.8*	*9.1*	*31.6*	*15.2*	*4.9*		*32.8*	*31.8*		*33.4*	
Lane Group LOS	*C*	*C*	*A*	*C*	*B*	*A*		*C*	*C*		*C*	
Approach Delay	*21.0*			*17.5*			*32.4*			*33.4*		
Approach LOS	*C*			*B*			*C*			*C*		
Intersection Delay	*20.2*			Intersection LOS						*C*		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description

v/c Ratio Computation

	EB	WB	NB	SB
Cycle Length, C (s)	*90.0*			
Prot. Phase Eff. Green Interval, g (s)				
Opposed Queue Eff. Green Interval, g_q (s)				
Unopposed green interval, g_u (s)				
Red Time, r(s)				
Arrival Rate, q_a (veh/s)				
Protected Phase Departure Rate, s_p (veh/s)				
Perm. Phase Departure Rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for Lagging Left-turns)				

Uniform Queue Size and Delay Computations

Queue at Start of Green Arrow, Q_a				
Queue at Start of Unsaturated Green, Q_u				
Residual Queue, Q_r				
Uniform Delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(S_p - q_s)} + g_q Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(S_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(S_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Initial Queue/Lane	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	
Flow Rate/Lane	10	390	38	112	587	23		69	42		19	
Satflow/Lane	1787	1791	1599	1823	1827	1631		1840	1639		1729	
Capacity/Lane	238	1627	888	472	1659	779		307	484		250	
Flow Ratio	0.0	0.1	0.0	0.0	0.1	0.0		0.0	0.0		0.0	
v/c Ratio	0.04	0.24	0.04	0.24	0.35	0.03		0.22	0.09		0.08	
I Factor	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
Arrival Type	3	3	3	5	5	5		3	3		3	
Platoon Ratio	1.00	1.00	1.00	1.67	1.67	1.67		1.00	1.00		1.00	
PF Factor	1.00	1.00	1.00	0.92	0.73	0.39		1.00	1.00		1.00	
Q_1	0.2	2.6	0.4	1.2	3.0	0.1		1.5	0.5		0.4	
k_B	0.3	0.5	0.6	0.3	0.5	0.6		0.3	0.3		0.3	
Q_2	0.0	0.2	0.0	0.1	0.3	0.0		0.1	0.0		0.0	
Q Average	0.2	2.7	0.5	1.3	3.2	0.1		1.6	0.5		0.4	

Percentile Back of Queue (95th percentile)

$f_{B\%}$	2.1	2.0	2.1	2.1	2.0	2.1		2.0	2.1		2.1	
BOQ, $Q_{\%}$	0.5	5.5	1.0	2.6	6.5	0.3		3.3	1.1		0.9	

Queue Storage Ratio

Q Spacing	25.0	25.0	25.0	25.0	25.0	25.0		25.0	25.0		25.0	
Q Storage	0	0	0	0	0	0		0	0		0	
Average R_Q												
95% $R_{Q\%}$												

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LONG REPORT

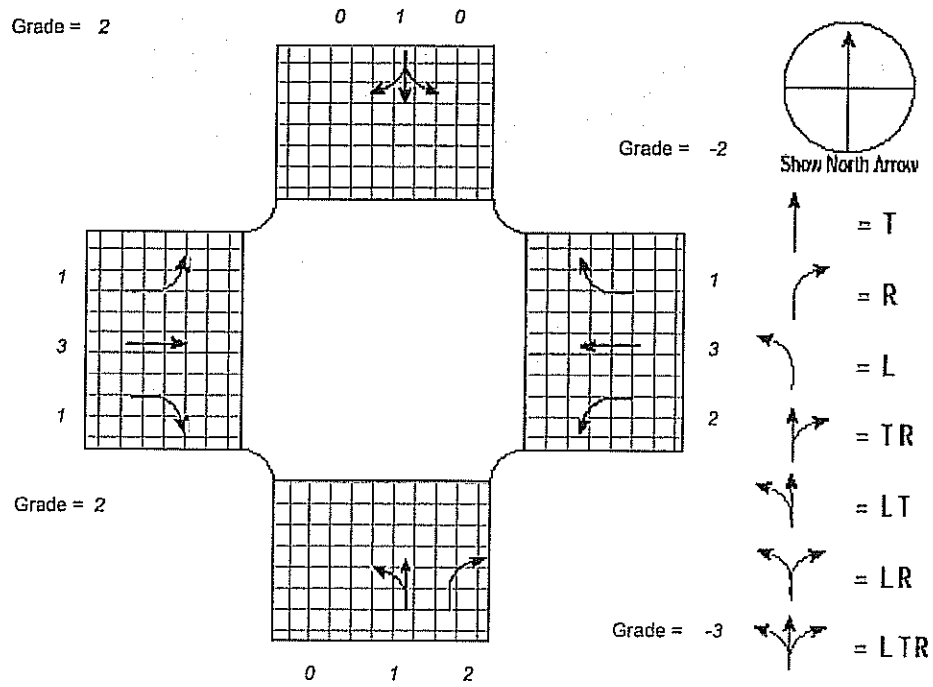
General Information

Analyst	*CPB*
Agency or Co.	*Balzer & Associates, Inc.*
Date Performed	*1/17/2012*
Time Period	*PM Peak Hr*

Site Information

Intersection	*Rte 460/Farmview Rd*
Area Type	*All other areas*
Jurisdiction	*Town of Christiansburg*
Analysis Year	*Existing 2009*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	29	1046	133	122	962	13	69	0	101	14	2	14
% Heavy Veh	0	5	0	0	5	0	0	0	0	0	0	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	A	A	A	A	A	A	A	A	A	A	A	A
Startup Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
ExtenSion of Effective Green	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Arrival type	3	3	3	5	5	5		3	3		3	
Unit Extension	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	
Ped/Bike/RTOR Volume	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/Hour												
Bus Stops/Hour	0	0	0	0	0	0		0	0		0	
Pedestrian Timing	3.2			3.2			3.2			3.2		

	Excl. Left	Thru & RT	03	04	NB Only	SB Only	07	08
Timing	G = 12.0	G = 30.0	G = 0.0	G = 0.0	G = 15.0	G = 13.0	G = 0.0	G = 0.0
	Y = 5	Y = 5	Y = 0	Y = 0	Y = 5	Y = 5	Y = 0	Y = 0
Duration of Analysis (hrs) = 0.25						Cycle Length C = 90.0		

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	29	1046	133	122	962	13	69	0	101	14	2	14
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adjusted Flow Rate	32	1162	148	136	1069	14	77	0	112	16	2	16
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	32	1162	148	136	1069	14		77	112		34	
Proportion of LT or RT	1.000	--	1.000	1.000	--	1.000	1.000	--	1.000	0.471	--	0.471

Saturation Flow Rate

Base Satflow	1900	1900	1900	1900	1900	1900		1900	1900		1900	
Number of Lanes	1	3	1	2	3	1	0	1	2	0	1	0
f_W	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{HV}	1.000	0.952	1.000	1.000	0.952	1.000		1.000	1.000		1.000	
f_g	0.990	0.990	0.990	1.010	1.010	1.010		1.015	1.015		0.990	
f_p	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{bb}	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_a	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{LU}	1.000	0.908	1.000	0.971	0.908	1.000		1.000	0.885		1.000	
f_{LT}	0.950	1.000	--	0.950	1.000	--		0.952	--		0.977	--
Secondary f_{LT}			--			--			--			--
f_{RT}	--	1.000	0.850	--	1.000	0.850	--	1.000	0.850	--	0.936	
f_{Lpb}	1.000	1.000	--	1.000	1.000	--		1.000	--		1.000	--
f_{Rpb}	--	1.000	1.000	--	1.000	1.000	--	1.000	1.000	--	1.000	
Adjusted Satflow	1787	4880	1599	3540	4978	1631		1837	2901		1721	
Secondary Adjusted Satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description

Capacity Analysis

	EB			WB			NB			SB		
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	32	1162	148	136	1069	14		77	112		34	
Satflow Rate	1787	4880	1599	3540	4978	1631		1837	2901		1721	
Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Green Ratio	0.13	0.33	0.56	0.13	0.33	0.48		0.17	0.17		0.14	
Lane Group Capacity	238	1627	888	472	1659	779		306	484		249	
v/c Ratio	0.13	0.71	0.17	0.29	0.64	0.02		0.25	0.23		0.14	
Flow Ratio	0.02	0.24	0.09	0.04	0.21	0.01		0.04	0.04		0.02	
Critical Lane Group	N	Y	N	Y	N	N		Y	N		Y	
Sum Flow Ratios	0.34											
Lost Time/Cycle	20.00											
Critical v/c Ratio	0.43											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	32	1162	148	136	1069	14		77	112		34	
Lane Group Capacity	238	1627	888	472	1659	779		306	484		249	
v/c Ratio	0.13	0.71	0.17	0.29	0.64	0.02		0.25	0.23		0.14	
Green Ratio	0.13	0.33	0.56	0.13	0.33	0.48		0.17	0.17		0.14	
Uniform Delay d_1	34.4	26.2	9.8	35.2	25.5	12.4		32.6	32.5		33.6	
Delay Factor k	0.11	0.28	0.11	0.11	0.22	0.11		0.11	0.11		0.11	
Incremental Delay d_2	0.3	1.5	0.1	0.3	0.9	0.0		0.4	0.2		0.3	
PF Factor	1.000	1.000	1.000	0.897	0.667	0.390		1.000	1.000		1.000	
Control Delay	34.7	27.8	9.9	31.9	17.9	4.8		33.1	32.7		33.9	
Lane Group LOS	C	C	A	C	B	A		C	C		C	
Approach Delay	26.0			19.3			32.9			33.9		
Approach LOS	C			B			C			C		
Intersection Delay	23.6			Intersection LOS						C		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description

v/c Ratio Computation

	EB	WB	NB	SB
Cycle Length, C (s)	*90.0*			
Prot. Phase Eff. Green Interval, g (s)				
Opposed Queue Eff. Green Interval, g_q (s)				
Unopposed green interval, g_u (s)				
Red Time, r(s)				
Arrival Rate, q_a (veh/s)				
Protected Phase Departure Rate, s_p (veh/s)				
Perm. Phase Departure Rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for Lagging Left-turns)				

Uniform Queue Size and Delay Computations

Queue at Start of Green Arrow, Q_a				
Queue at Start of Unsaturated Green, Q_u				
Residual Queue, Q_r				
Uniform Delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(S_p - q_s)} + g_q Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(S_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(S_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Initial Queue/Lane	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	
Flow Rate/Lane	32	1162	148	136	1069	14		77	112		34	
Satflow/Lane	1787	1791	1599	1823	1827	1631		1837	1639		1721	
Capacity/Lane	238	1627	888	472	1659	779		306	484		249	
Flow Ratio	0.0	0.2	0.1	0.0	0.2	0.0		0.0	0.0		0.0	
v/c Ratio	0.13	0.71	0.17	0.29	0.64	0.02		0.25	0.23		0.14	
I Factor	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
Arrival Type	3	3	3	5	5	5		3	3		3	
Platoon Ratio	1.00	1.00	1.00	1.67	1.67	1.67		1.00	1.00		1.00	
PF Factor	1.00	1.00	1.00	0.92	0.82	0.39		1.00	1.00		1.00	
Q_1	0.7	9.3	1.8	1.5	6.8	0.1		1.7	1.4		0.7	
k_B	0.3	0.5	0.6	0.3	0.5	0.6		0.3	0.3		0.3	
Q_2	0.0	1.2	0.1	0.1	0.9	0.0		0.1	0.1		0.0	
Q Average	0.8	10.5	1.9	1.6	7.7	0.1		1.8	1.5		0.8	

Percentile Back of Queue (95th percentile)

$f_{B\%}$	2.1	1.8	2.0	2.0	1.9	2.1		2.0	2.1		2.1	
BOQ, $Q_{\%}$	1.6	19.3	4.0	3.2	14.5	0.2		3.7	3.0		1.6	

Queue Storage Ratio

Q Spacing	25.0	25.0	25.0	25.0	25.0	25.0		25.0	25.0		25.0	
Q Storage	0	0	0	0	0	0		0	0		0	
Average R_Q												
95% $R_{Q\%}$												

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File Name: I:\TE Safety\Salem District Turning Movements\Montgomery\PPD Files\40060460 Farmview 460.ppd
Start Date: 11/12/2009
Start Time: 7:00:00 AM
Site Code: 40060460
Comment 1: Default Comments
Comment 2: Change These in The Preferences Window
Comment 3: Select File/Preference in the Main Scree
Comment 4: Then Click the Comments Tab

	From North			From East			From South			From West			
Start Time	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Total
04:00 PM	3	0	4	3	195	31	21	2	18	28	223	2	530
04:15 PM	3	1	2	0	196	36	13	0	16	25	206	1	499
04:30 PM	6	1	8	5	226	40	18	0	23	34	242	6	609
04:45 PM	4	0	4	3	210	22	23	0	22	22	253	4	567
05:00 PM	4	2	8	7	212	34	25	0	23	36	249	5	605
05:15 PM	6	0	3	3	268	33	28	0	12	32	272	9	666
05:30 PM	1	0	1	1	227	22	27	0	16	33	284	7	619
05:45 PM	3	0	2	2	255	33	21	0	18	32	241	8	615
PM Peak Hr	14	2	14	13	962	122	101	0	69	133	1046	29	2505

File Name: I:\TE Safety\Salem District Turning Movements\Montgomery\PPD Files\40060460 Farmview 460.ppd
Start Date: 11/12/2009
Start Time: 7:00:00 AM
Site Code: 40060460
Comment 1: Default Comments
Comment 2: Change These in The Preferences Window
Comment 3: Select File/Preference in the Main Scree
Comment 4: Then Click the Comments Tab

	From North			From East			From South			From West			
Start Time	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Right	Thru	Left	Total
07:00 AM	2	0	2	1	73	26	5	0	15	9	64	1	198
07:15 AM	1	3	2	3	125	12	9	0	14	15	92	2	278
07:30 AM	2	0	1	6	115	26	10	0	12	11	92	2	277
07:45 AM	4	0	1	11	162	19	4	2	20	4	80	2	309
08:00 AM	0	0	3	3	122	27	8	0	11	12	79	2	267
08:15 AM	1	0	3	2	101	25	15	0	11	6	96	1	261
08:30 AM	2	1	2	5	143	30	11	1	17	12	98	4	324
08:45 AM	0	0	0	1	137	30	8	1	23	10	92	4	306
AM Peak Hr	7	1	9	21	528	101	38	3	59	34	351	9	1161

LONG REPORT

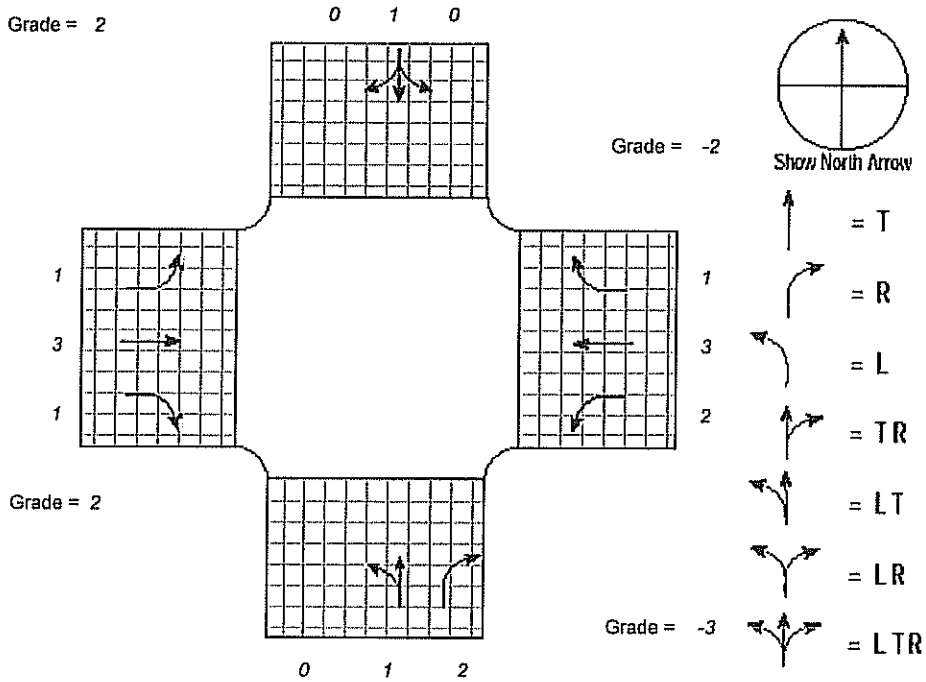
General Information

Analyst *CPB*
Agency or Co. *Balzer & Associates, Inc.*
Date Performed *1/26/2012*
Time Period *AM Peak Hr*

Site Information

Intersection *Rte 460/Farmview Rd*
Area Type *All other areas*
Jurisdiction *Town of Christiansburg*
Analysis Year *Apartment Buildout 2009*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	20(11)	351	34	101	528	37(16)	59	6(3)	38	51(42)	15(14)	71(64)
% Heavy Veh	0	5	0	0	5	0	0	0	0	0	0	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	A	A	A	A	A	A	A	A	A	A	A	A
Startup Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
ExtenSion of Effective Green	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Arrival type	3	3	3	5	5	5		3	3		3	
Unit Extension	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	
Ped/Bike/RTOR Volume	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/Hour												
Bus Stops/Hour	0	0	0	0	0	0		0	0		0	
Pedestrian Timing	3.2			3.2			3.2			3.2		

	Excl. Left	Thru & RT	03	04	NB Only	SB Only	07	08
Timing	G = 12.0	G = 30.0	G = 0.0	G = 0.0	G = 15.0	G = 13.0	G = 0.0	G = 0.0
	Y = 5	Y = 5	Y = 0	Y = 0	Y = 5	Y = 5	Y = 0	Y = 0

Duration of Analysis (hrs) = *0.25*

Cycle Length C = *90.0*

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	20	351	34	101	528	37	59	6	38	51	15	71
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adjusted Flow Rate	22	390	38	112	587	41	66	7	42	57	17	79
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	22	390	38	112	587	41		73	42		153	
Proportion of LT or RT	1.000	--	1.000	1.000	--	1.000	0.904	--	1.000	0.373	--	0.516

Saturation Flow Rate

Base Satflow	1900	1900	1900	1900	1900	1900		1900	1900		1900	
Number of Lanes	1	3	1	2	3	1	0	1	2	0	1	0
f_W	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{HV}	1.000	0.952	1.000	1.000	0.952	1.000		1.000	1.000		1.000	
f_g	0.990	0.990	0.990	1.010	1.010	1.010		1.015	1.015		0.990	
f_p	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{bb}	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_a	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{LU}	1.000	0.908	1.000	0.971	0.908	1.000		1.000	0.885		1.000	
f_{LT}	0.950	1.000	--	0.950	1.000	--		0.957	--		0.982	--
Secondary f_{LT}			--			--			--			--
f_{RT}	--	1.000	0.850	--	1.000	0.850	--	1.000	0.850	--	0.930	
f_{Lpb}	1.000	1.000	--	1.000	1.000	--		1.000	--		1.000	--
f_{Rpb}	--	1.000	1.000	--	1.000	1.000	--	1.000	1.000	--	1.000	
Adjusted Satflow	1787	4880	1599	3540	4978	1631		1845	2901		1718	
Secondary Adjusted Satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description

Capacity Analysis

	EB			WB			NB			SB		
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	22	390	38	112	587	41		73	42		153	
Satflow Rate	1787	4880	1599	3540	4978	1631		1845	2901		1718	
Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Green Ratio	0.13	0.33	0.56	0.13	0.33	0.48		0.17	0.17		0.14	
Lane Group Capacity	238	1627	888	472	1659	779		308	484		248	
v/c Ratio	0.09	0.24	0.04	0.24	0.35	0.05		0.24	0.09		0.62	
Flow Ratio	0.01	0.08	0.02	0.03	0.12	0.03		0.04	0.01		0.09	
Critical Lane Group	N	N	N	Y	Y	N		Y	N		Y	
Sum Flow Ratios	0.28											
Lost Time/Cycle	20.00											
Critical v/c Ratio	0.36											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	22	390	38	112	587	41		73	42		153	
Lane Group Capacity	238	1627	888	472	1659	779		308	484		248	
v/c Ratio	0.09	0.24	0.04	0.24	0.35	0.05		0.24	0.09		0.62	
Green Ratio	0.13	0.33	0.56	0.13	0.33	0.48		0.17	0.17		0.14	
Uniform Delay d_1	34.2	21.7	9.1	34.9	22.7	12.6		32.5	31.7		36.2	
Delay Factor k	0.11	0.11	0.11	0.11	0.11	0.11		0.11	0.11		0.20	
Incremental Delay d_2	0.2	0.1	0.0	0.3	0.1	0.0		0.4	0.1		4.6	
PF Factor	1.000	1.000	1.000	0.897	0.667	0.390		1.000	1.000		1.000	
Control Delay	34.4	21.8	9.1	31.6	15.2	4.9		32.9	31.8		40.7	
Lane Group LOS	C	C	A	C	B	A		C	C		D	
Approach Delay	21.4			17.1			32.5			40.7		
Approach LOS	C			B			C			D		
Intersection Delay	22.1			Intersection LOS						C		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description

v/c Ratio Computation

	EB	WB	NB	SB
Cycle Length, C (s)	*90.0*			
Prot. Phase Eff. Green Interval, g (s)				
Opposed Queue Eff. Green Interval, g_q (s)				
Unopposed green interval, g_u (s)				
Red Time, r(s)				
Arrival Rate, q_a (veh/s)				
Protected Phase Departure Rate, s_p (veh/s)				
Perm. Phase Departure Rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for Lagging Left-turns)				

Uniform Queue Size and Delay Computations

Queue at Start of Green Arrow, Q_a				
Queue at Start of Unsaturated Green, Q_u				
Residual Queue, Q_r				
Uniform Delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(S_p - q_s)} + g_q Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(S_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(S_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Initial Queue/Lane	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	
Flow Rate/Lane	22	390	38	112	587	41		73	42		153	
Satflow/Lane	1787	1791	1599	1823	1827	1631		1845	1639		1718	
Capacity/Lane	238	1627	888	472	1659	779		308	484		248	
Flow Ratio	0.0	0.1	0.0	0.0	0.1	0.0		0.0	0.0		0.1	
v/c Ratio	0.09	0.24	0.04	0.24	0.35	0.05		0.24	0.09		0.62	
I Factor	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
Arrival Type	3	3	3	5	5	5		3	3		3	
Platoon Ratio	1.00	1.00	1.00	1.67	1.67	1.67		1.00	1.00		1.00	
PF Factor	1.00	1.00	1.00	0.92	0.73	0.40		1.00	1.00		1.00	
Q_1	0.5	2.6	0.4	1.2	3.0	0.2		1.6	0.5		3.6	
k_B	0.3	0.5	0.6	0.3	0.5	0.6		0.3	0.3		0.3	
Q_2	0.0	0.2	0.0	0.1	0.3	0.0		0.1	0.0		0.5	
Q Average	0.5	2.7	0.5	1.3	3.2	0.3		1.7	0.5		4.1	

Percentile Back of Queue (95th percentile)

$f_{B\%}$	2.1	2.0	2.1	2.1	2.0	2.1		2.0	2.1		2.0	
BOQ, $Q_{\%}$	1.1	5.5	1.0	2.6	6.5	0.5		3.5	1.1		8.0	

Queue Storage Ratio

Q Spacing	25.0	25.0	25.0	25.0	25.0	25.0		25.0	25.0		25.0	
Q Storage	145	1000	40	310	1000	170		350	350		300	
Average R_Q	0.1	0.1	0.3	0.1	0.1	0.0		0.1	0.0		0.3	
95% $R_{Q\%}$	0.2	0.1	0.6	0.2	0.2	0.1		0.2	0.1		0.7	

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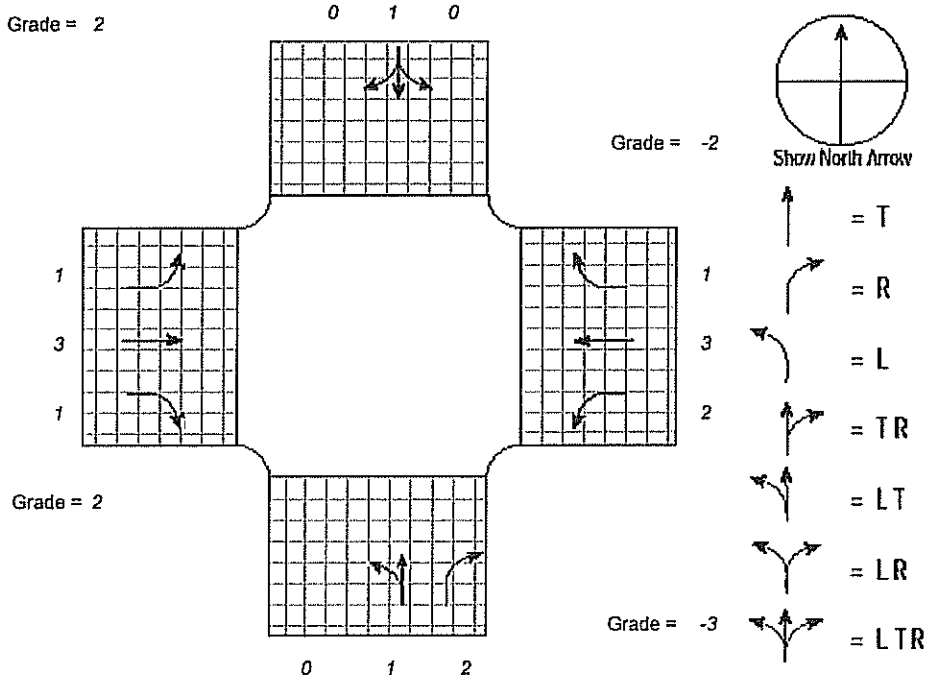
LONG REPORT

General Information		Site Information	
Analyst	*CPB*	Intersection	*Rte 460/Farmview Rd*
Agency or Co.	*Balzer & Associates, Inc.*	Area Type	*All other areas*
Date Performed	*1/17/2012*	Jurisdiction	*Town of Christiansburg*
Time Period	*PM Peak Hr*	Analysis Year	*Apartment Buildout 2009*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	87(58)	1046	133	122	962	65(52)	69	9(9)	101	45(31)	8(6)	41(27)
% Heavy Veh	0	5	0	0	5	0	0	0	0	0	0	0
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Actuated (P/A)	A	A	A	A	A	A	A	A	A	A	A	A
Startup Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
ExtenSion of Effective Green	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Arrival type	3	3	3	5	5	5		3	3		3	
Unit Extension	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	
Ped/Bike/RTOR Volume	0	0	0	0	0	0	0	0	0	0	0	0
Lane Width	12.0	12.0	12.0	12.0	12.0	12.0		12.0	12.0		12.0	
Parking (Y or N)	N		N	N		N	N		N	N		N
Parking/Hour												
Bus Stops/Hour	0	0	0	0	0	0		0	0		0	
Pedestrian Timing	3.2			3.2			3.2			3.2		

	Excl. Left	Thru & RT	03	04	NB Only	SB Only	07	08
Timing	G = 12.0	G = 30.0	G = 0.0	G = 0.0	G = 15.0	G = 13.0	G = 0.0	G = 0.0
	Y = 5	Y = 5	Y = 0	Y = 0	Y = 5	Y = 5	Y = 0	Y = 0
Duration of Analysis (hrs) = 0.25						Cycle Length C = 90.0		

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	87	1046	133	122	962	65	69	9	101	45	8	41
PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adjusted Flow Rate	97	1162	148	136	1069	72	77	10	112	50	9	46
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	97	1162	148	136	1069	72		87	112		105	
Proportion of LT or RT	1.000	--	1.000	1.000	--	1.000	0.885	--	1.000	0.476	--	0.438

Saturation Flow Rate

Base Satflow	1900	1900	1900	1900	1900	1900		1900	1900		1900	
Number of Lanes	1	3	1	2	3	1	0	1	2	0	1	0
f_W	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{HV}	1.000	0.952	1.000	1.000	0.952	1.000		1.000	1.000		1.000	
f_g	0.990	0.990	0.990	1.010	1.010	1.010		1.015	1.015		0.990	
f_p	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{bb}	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_a	1.000	1.000	1.000	1.000	1.000	1.000		1.000	1.000		1.000	
f_{LU}	1.000	0.908	1.000	0.971	0.908	1.000		1.000	0.885		1.000	
f_{LT}	0.950	1.000	--	0.950	1.000	--		0.958	--		0.977	--
Secondary f_{LT}			--			--			--			--
f_{RT}	--	1.000	0.850	--	1.000	0.850	--	1.000	0.850	--	0.941	
f_{Lpb}	1.000	1.000	--	1.000	1.000	--		1.000	--		1.000	--
f_{Rpb}	--	1.000	1.000	--	1.000	1.000	--	1.000	1.000	--	1.000	
Adjusted Satflow	1787	4880	1599	3540	4978	1631		1847	2901		1729	
Secondary Adjusted Satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description

Capacity Analysis

	EB			WB				NB			SB	
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	97	1162	148	136	1069	72		87	112		105	
Satflow Rate	1787	4880	1599	3540	4978	1631		1847	2901		1729	
Lost Time	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0		2.0	
Green Ratio	0.13	0.33	0.56	0.13	0.33	0.48		0.17	0.17		0.14	
Lane Group Capacity	238	1627	888	472	1659	779		308	484		250	
v/c Ratio	0.41	0.71	0.17	0.29	0.64	0.09		0.28	0.23		0.42	
Flow Ratio	0.05	0.24	0.09	0.04	0.21	0.04		0.05	0.04		0.06	
Critical Lane Group	Y	Y	N	N	N	N		Y	N		Y	
Sum Flow Ratios	0.40											
Lost Time/Cycle	20.00											
Critical v/c Ratio	0.51											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB				NB			SB	
Lane Group	L	T	R	L	T	R		LT	R		LTR	
Adjusted Flow Rate	97	1162	148	136	1069	72		87	112		105	
Lane Group Capacity	238	1627	888	472	1659	779		308	484		250	
v/c Ratio	0.41	0.71	0.17	0.29	0.64	0.09		0.28	0.23		0.42	
Green Ratio	0.13	0.33	0.56	0.13	0.33	0.48		0.17	0.17		0.14	
Uniform Delay d_1	35.7	26.2	9.8	35.2	25.5	12.8		32.8	32.5		35.1	
Delay Factor k	0.11	0.28	0.11	0.11	0.22	0.11		0.11	0.11		0.11	
Incremental Delay d_2	1.1	1.5	0.1	0.3	0.9	0.1		0.5	0.2		1.1	
PF Factor	1.000	1.000	1.000	0.897	0.667	0.390		1.000	1.000		1.000	
Control Delay	36.9	27.8	9.9	31.9	17.9	5.1		33.3	32.7		36.2	
Lane Group LOS	D	C	A	C	B	A		C	C		D	
Approach Delay	26.5			18.6			33.0			36.2		
Approach LOS	C			B			C			D		
Intersection Delay	23.9			Intersection LOS						C		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description

v/c Ratio Computation

	EB	WB	NB	SB
Cycle Length, C (s)	*90.0*			
Prot. Phase Eff. Green Interval, g (s)				
Opposed Queue Eff. Green Interval, g_q (s)				
Unopposed green interval, g_u (s)				
Red Time, r(s)				
Arrival Rate, q_a (veh/s)				
Protected Phase Departure Rate, s_p (veh/s)				
Perm. Phase Departure Rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for Lagging Left-turns)				

Uniform Queue Size and Delay Computations

Queue at Start of Green Arrow, Q_a				
Queue at Start of Unsaturated Green, Q_u				
Residual Queue, Q_r				
Uniform Delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(S_p - q_s)} + g_q Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(S_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(S_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(S_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(S_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(S_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(S_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane Group	*L*	*T*	*R*	*L*	*T*	*R*		*LT*	*R*		*LTR*	
Initial Queue/Lane	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*		*0.0*	*0.0*		*0.0*	
Flow Rate/Lane	*97*	*1162*	*148*	*136*	*1069*	*72*		*87*	*112*		*105*	
Satflow/Lane	*1787*	*1791*	*1599*	*1823*	*1827*	*1631*		*1847*	*1639*		*1729*	
Capacity/Lane	*238*	*1627*	*888*	*472*	*1659*	*779*		*308*	*484*		*250*	
Flow Ratio	*0.1*	*0.2*	*0.1*	*0.0*	*0.2*	*0.0*		*0.0*	*0.0*		*0.1*	
v/c Ratio	*0.41*	*0.71*	*0.17*	*0.29*	*0.64*	*0.09*		*0.28*	*0.23*		*0.42*	
I Factor	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*		*1.000*	*1.000*		*1.000*	
Arrival Type	*3*	*3*	*3*	*5*	*5*	*5*		*3*	*3*		*3*	
Platoon Ratio	*1.00*	*1.00*	*1.00*	*1.67*	*1.67*	*1.67*		*1.00*	*1.00*		*1.00*	
PF Factor	*1.00*	*1.00*	*1.00*	*0.92*	*0.82*	*0.40*		*1.00*	*1.00*		*1.00*	
Q_1	*2.2*	*9.3*	*1.8*	*1.5*	*6.8*	*0.4*		*1.9*	*1.4*		*2.4*	
k_B	*0.3*	*0.5*	*0.6*	*0.3*	*0.5*	*0.6*		*0.3*	*0.3*		*0.3*	
Q_2	*0.2*	*1.2*	*0.1*	*0.1*	*0.9*	*0.1*		*0.1*	*0.1*		*0.2*	
Q Average	*2.4*	*10.5*	*1.9*	*1.6*	*7.7*	*0.5*		*2.0*	*1.5*		*2.6*	

Percentile Back of Queue (95th percentile)

$f_{B\%}$	*2.0*	*1.8*	*2.0*	*2.0*	*1.9*	*2.1*		*2.0*	*2.1*		*2.0*	
BOQ, $Q_{\%}$	*4.9*	*19.3*	*4.0*	*3.2*	*14.5*	*1.0*		*4.1*	*3.0*		*5.3*	

Queue Storage Ratio

Q Spacing	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*		*25.0*	*25.0*		*25.0*	
Q Storage	*145*	*1000*	*40*	*310*	*1000*	*170*		*350*	*350*		*300*	
Average R_Q	*0.4*	*0.3*	*1.2*	*0.1*	*0.2*	*0.1*		*0.1*	*0.1*		*0.2*	
95% $R_{Q\%}$	*0.8*	*0.5*	*2.5*	*0.3*	*0.4*	*0.1*		*0.3*	*0.2*		*0.4*	

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