

Appendix B Level of Service (LOS)

APPENDIX B LEVEL-OF-SERVICE CONCEPT

Level of service (LOS) is a concept developed to quantify the degree of comfort (including such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles) afforded to drivers as they travel through an intersection or roadway segment. Six grades are used to denote the various level of service from “A” to “F”.¹

SIGNALIZED INTERSECTIONS

The six level-of-service grades are described qualitatively for signalized intersections in Table B1. Additionally, Table B2 identifies the relationship between level of service and average control delay per vehicle. Control delay is defined to include initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Using this definition, Level of Service “D” is generally considered to represent the minimum acceptable design standard.

Table AB1 Level-of-Service Definitions (Signalized Intersections)

Level of Service	Average Delay per Vehicle
A	Very low average control delay, less than 10 seconds per vehicle. This occurs when progression is extremely favorable, and most vehicles arrive during the green phase. Most vehicles do not stop at all. Short cycle lengths may also contribute to low delay.
B	Average control delay is greater than 10 seconds per vehicle and less than or equal to 20 seconds per vehicle. This generally occurs with good progression and/or short cycle lengths. More vehicles stop than for a level of service A, causing higher levels of average delay.
C	Average control delay is greater than 20 seconds per vehicle and less than or equal to 35 seconds per vehicle. These higher delays may result from fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping.
D	Average control delay is greater than 35 seconds per vehicle and less than or equal to 55 seconds per vehicle. The influence of congestion becomes more noticeable. Longer delays may result from some combination of unfavorable progression, long cycle length, or high volume/capacity ratios. Many vehicles stop, and the proportion of vehicles not stopping declines. Individual cycle failures are noticeable.
E	Average control delay is greater than 55 seconds per vehicle and less than or equal to 80 seconds per vehicle. This is usually considered to be the limit of acceptable delay. These high delay values generally (but not always) indicate poor progression, long cycle lengths, and high volume/capacity ratios. Individual cycle failures are frequent occurrences.
F	Average control delay is in excess of 80 seconds per vehicle. This is considered to be unacceptable to most drivers. This condition often occurs with oversaturation. It may also occur at high volume/capacity ratios below 1.0 with many individual cycle failures. Poor progression and long cycle lengths may also contribute to such high delay values.

¹ Most of the material in this appendix is adapted from the Transportation Research Board, *2000 Highway Capacity Manual*, (2000).

Table B2 Level-of-Service Criteria for Signalized Intersections

Level of Service	Average Control Delay per Vehicle (Seconds)
A	<10.0
B	>10 and ≤20
C	>20 and ≤35
D	>35 and ≤55
E	>55 and ≤80
F	>80

UNSIGNALIZED INTERSECTIONS

Unsignalized intersections include two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections. The *2000 Highway Capacity Manual* (HCM) provides models for estimating control delay at both TWSC and AWSC intersections. A qualitative description of the various service levels associated with an unsignalized intersection is presented in Table B3. A quantitative definition of level of service for unsignalized intersections is presented in Table B4. Using this definition, Level of Service “E” is generally considered to represent the minimum acceptable design standard.

Table B3 Level-of-Service Criteria for Unsignalized Intersections

Level of Service	Average Delay per Vehicle to Minor Street
A	<ul style="list-style-type: none"> Nearly all drivers find freedom of operation. Very seldom is there more than one vehicle in queue.
B	<ul style="list-style-type: none"> Some drivers begin to consider the delay an inconvenience. Occasionally there is more than one vehicle in queue.
C	<ul style="list-style-type: none"> Many times there is more than one vehicle in queue. Most drivers feel restricted, but not objectionably so.
D	<ul style="list-style-type: none"> Often there is more than one vehicle in queue. Drivers feel quite restricted.
E	<ul style="list-style-type: none"> Represents a condition in which the demand is near or equal to the probable maximum number of vehicles that can be accommodated by the movement. There is almost always more than one vehicle in queue. Drivers find the delays approaching intolerable levels.
F	<ul style="list-style-type: none"> Forced flow. Represents an intersection failure condition that is caused by geometric and/or operational constraints external to the intersection.

Table B4 Level-of-Service Criteria for Unsignalized Intersections

Level of Service	Average Control Delay per Vehicle (Seconds)
A	<10.0
B	>10.0 and ≤ 15.0
C	>15.0 and ≤ 25.0
D	>25.0 and ≤ 35.0
E	>35.0 and ≤ 50.0
F	>50.0

It should be noted that the level-of-service criteria for unsignalized intersections are somewhat different than the criteria used for signalized intersections. The primary reason for this difference is that drivers expect different levels of performance from different kinds of transportation facilities. The expectation is that a signalized intersection is designed to carry higher traffic volumes than an unsignalized intersection. Additionally, there are a number of driver behavior considerations that combine to make delays at signalized intersections less galling than at unsignalized intersections. For example, drivers at signalized intersections are able to relax during the red interval, while drivers on the minor street approaches to TWSC intersections must remain attentive to the task of identifying acceptable gaps and vehicle conflicts. Also, there is often much more variability in the amount of delay experienced by individual drivers at unsignalized intersections than signalized intersections. For these reasons, it is considered that the control delay threshold for any given level of service is less for an unsignalized intersection than for a signalized intersection. While overall intersection level of service is calculated for AWSC intersections, level of service is only calculated for the minor approaches and the major street left turn movements at TWSC intersections. No delay is assumed to the major street through movements. For TWSC intersections, the overall intersection level of service remains undefined: level of service is only calculated for each minor street lane.

In the performance evaluation of TWSC intersections, it is important to consider other measures of effectiveness (MOEs) in addition to delay, such as v/c ratios for individual movements, average queue lengths, and 95th-percentile queue lengths. By focusing on a single MOE for the worst movement only, such as delay for the minor-street left turn, users may make inappropriate traffic control decisions. The potential for making such inappropriate decisions is likely to be particularly pronounced when the HCM level-of-service thresholds are adopted as legal standards, as is the case in many public agencies.

Appendix C Updated Phase 1 Trip Generation



Table 1: Trip Generation Estimate – Phase 1 (Approved)

Land Use	ITE Code	Size	Daily	Weekday AM Peak Hour			Weekday PM Peak Hour		
				Total	In	Out	Total	In	Out
Single-Family Detached Housing	210	215 units	2,050	160	40	120	215	135	80

Table 2: Trip Generation Estimate – Phase 1 (Updated)

Land Use	ITE Code	Size	Daily	Weekday AM Peak Hour			Weekday PM Peak Hour		
				Total	In	Out	Total	In	Out
Single-Family Detached Housing	210	201 units	1,915	150	40	110	200	125	75

Appendix D Phase 2 Trip Assignment



Total Estimated Trip Assignment - Phase 2
Weekday AM Peak Hour
Camas, Washington

Figure
C-1



Total Estimated Trip Assignment - Phase 2
Weekday PM Peak Hour
Camas, Washington

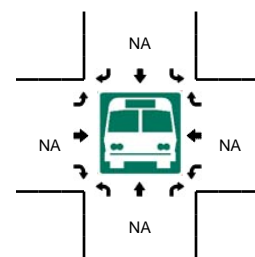
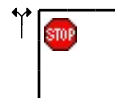
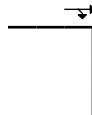
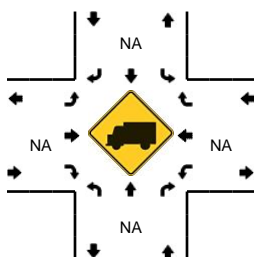
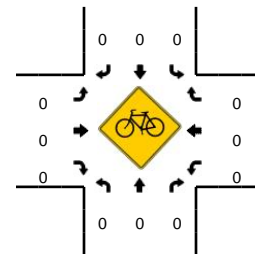
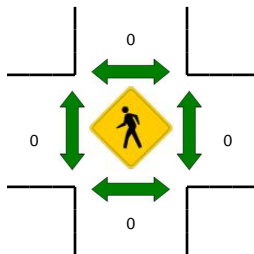
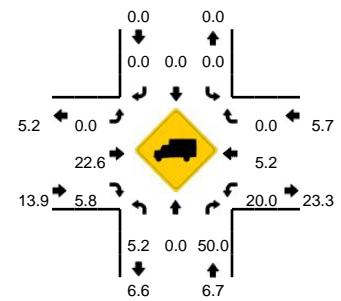
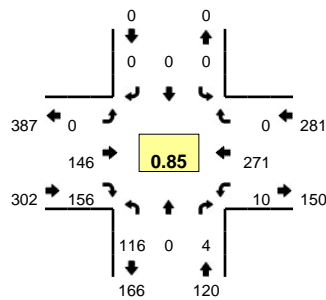
Figure
C-2

Appendix E Traffic Counts

LOCATION: NE 199th Ave -- NE 58th St
CITY/STATE: Vancouver, WA

QC JOB #: 13932001
DATE: Tue, Oct 11 2016

Peak-Hour: 7:10 AM -- 8:10 AM
Peak 15-Min: 7:40 AM -- 7:55 AM



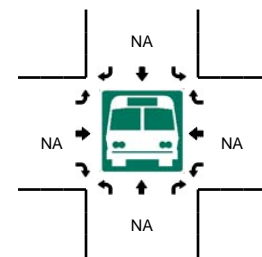
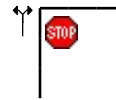
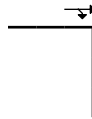
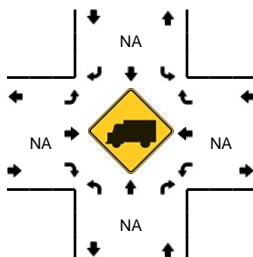
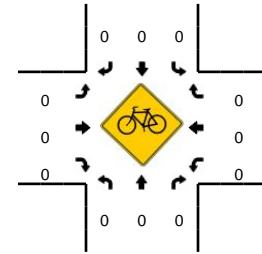
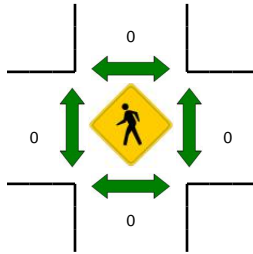
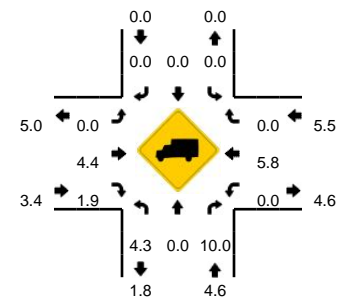
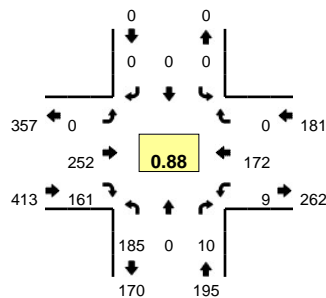
5-Min Count Period Beginning At	NE 199th Ave (Northbound)				NE 199th Ave (Southbound)				NE 58th St (Eastbound)				NE 58th St (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	7	0	0	0	0	0	0	0	0	10	5	0	1	17	0	0	40	
7:05 AM	7	0	1	0	0	0	0	0	0	7	9	0	1	13	0	0	38	
7:10 AM	7	0	0	0	0	0	0	0	0	6	9	0	1	23	0	0	46	
7:15 AM	8	0	0	0	0	0	0	0	0	14	5	0	0	32	0	0	59	
7:20 AM	14	0	1	0	0	0	0	0	0	11	11	0	1	20	0	0	58	
7:25 AM	5	0	1	0	0	0	0	0	0	8	13	0	0	21	0	0	48	
7:30 AM	11	0	0	0	0	0	0	0	0	13	9	0	0	20	0	0	53	
7:35 AM	16	0	0	0	0	0	0	0	0	6	20	0	2	29	0	0	73	
7:40 AM	7	0	0	0	0	0	0	0	0	13	16	0	2	26	0	0	64	
7:45 AM	12	0	0	0	0	0	0	0	0	17	13	0	1	22	0	0	65	
7:50 AM	16	0	0	0	0	0	0	0	0	17	15	0	1	28	0	0	77	
7:55 AM	8	0	0	0	0	0	0	0	0	15	16	0	0	14	0	0	53	674
8:00 AM	6	0	2	0	0	0	0	0	0	16	17	0	2	20	0	0	63	697
8:05 AM	6	0	0	0	0	0	0	0	0	10	12	0	0	16	0	0	44	703
8:10 AM	3	0	0	0	0	0	0	0	0	6	13	0	1	18	0	0	41	698
8:15 AM	9	0	1	0	0	0	0	0	0	11	16	0	1	24	0	0	62	701
8:20 AM	7	0	1	0	0	0	0	0	0	10	22	0	0	14	0	0	54	697
8:25 AM	6	0	0	0	0	0	0	0	0	4	11	0	0	18	0	0	39	688
8:30 AM	8	0	0	0	0	0	0	0	0	8	18	0	0	26	0	0	60	695
8:35 AM	9	0	0	0	0	0	0	0	0	9	11	0	0	18	0	0	47	669
8:40 AM	15	0	0	0	0	0	0	0	0	14	7	0	0	14	0	0	50	655
8:45 AM	12	0	0	0	0	0	0	0	0	10	8	0	0	16	0	0	46	636
8:50 AM	5	0	0	0	0	0	0	0	0	12	10	0	1	19	0	0	47	606
8:55 AM	5	0	0	0	0	0	0	0	0	10	13	0	3	13	0	0	44	597
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	140	0	0	0	0	0	0	0	0	188	176	0	16	304	0	0	824	
Heavy Trucks	4	0	0	0	0	0	0	0	0	56	8	0	0	24	0	0	92	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

Comments:

LOCATION: NE 199th Ave -- NE 58th St
CITY/STATE: Vancouver, WA

QC JOB #: 13932002
DATE: Tue, Oct 11 2016

Peak-Hour: 4:40 PM -- 5:40 PM
Peak 15-Min: 5:15 PM -- 5:30 PM

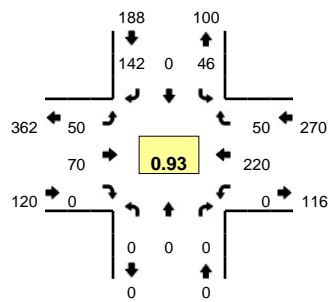


5-Min Count Period Beginning At	NE 199th Ave (Northbound)				NE 199th Ave (Southbound)				NE 58th St (Eastbound)				NE 58th St (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	12	0	0	0	0	0	0	0	0	26	8	0	1	18	0	0	65	
4:05 PM	11	0	0	0	0	0	0	0	0	17	13	0	0	19	0	0	60	
4:10 PM	9	0	0	0	0	0	0	0	0	30	13	0	1	15	0	0	68	
4:15 PM	17	0	3	0	0	0	0	0	0	20	8	0	0	14	0	0	62	
4:20 PM	13	0	2	0	0	0	0	0	0	26	8	0	0	14	0	0	63	
4:25 PM	9	0	2	0	0	0	0	0	0	19	7	0	1	19	0	0	57	
4:30 PM	12	0	0	0	0	0	0	0	0	15	11	0	0	5	0	0	43	
4:35 PM	11	0	1	0	0	0	0	0	0	22	8	0	2	25	0	0	69	
4:40 PM	9	0	0	0	0	0	0	0	0	30	10	0	1	7	0	0	57	
4:45 PM	7	0	0	0	0	0	0	0	0	22	13	0	0	23	0	0	65	
4:50 PM	15	0	0	0	0	0	0	0	0	19	14	0	2	14	0	0	64	
4:55 PM	16	0	4	0	0	0	0	0	0	15	13	0	2	23	0	0	73	746
5:00 PM	17	0	1	0	0	0	0	0	0	14	15	0	1	14	0	0	62	743
5:05 PM	14	0	0	0	0	0	0	0	0	22	8	0	3	10	0	0	57	740
5:10 PM	20	0	0	0	0	0	0	0	0	12	15	0	0	12	0	0	59	731
5:15 PM	17	0	0	0	0	0	0	0	0	20	16	0	0	12	0	0	65	734
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5:35 PM	14	0	1	0	0	0	0	0	0	24	24	0	0	7	0	0	70	789
5:40 PM	9	0	2	0	0	0	0	0	0	13	6	0	0	15	0	0	45	777
5:45 PM	8	0	3	0	0	0	0	0	0	28	7	0	0	10	0	0	56	768
5:50 PM	9	0	0	0	0	0	0	0	0	17	13	0	0	18	0	0	57	761
5:55 PM	9	0	2	0	0	0	0	0	0	22	17	0	0	11	0	0	61	749
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
All Vehicles	248	0	8	0	0	0	0	0	0	284	148	0	0	204	0	0	892	
Heavy Trucks	0	0	0	0	0	0	0	0	0	8	4	0	0	8	0	0	20	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad																		
Stopped Buses																		

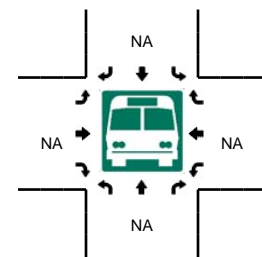
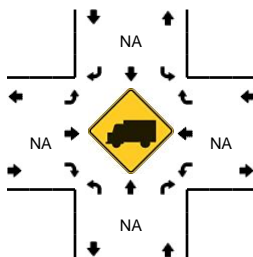
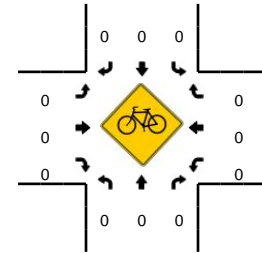
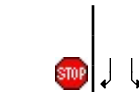
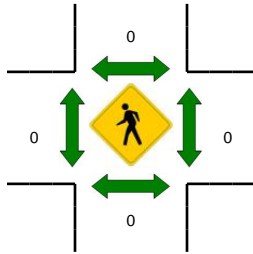
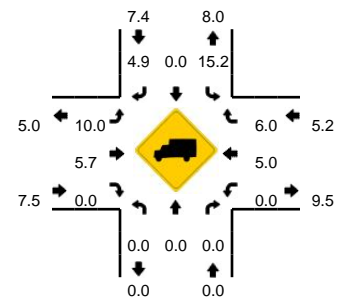
Comments:

LOCATION: NE Ingle Rd -- NE Goodwin Rd
CITY/STATE: Vancouver, WA

QC JOB #: 13932003
DATE: Tue, Oct 11 2016



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Peak 15-Min: 7:45 AM -- 8:00 AM

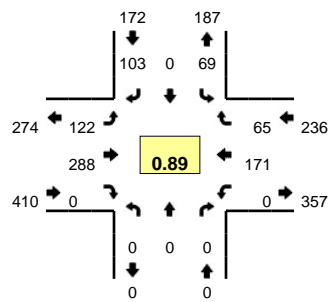


5-Min Count Period Beginning At	NE Ingle Rd (Northbound)				NE Ingle Rd (Southbound)				NE Goodwin Rd (Eastbound)				NE Goodwin Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
7:00 AM	0	0	0	0	3	0	7	0	4	5	0	0	0	17	1	0	37	
7:05 AM	0	0	0	0	6	0	6	0	1	4	0	0	0	15	7	0	39	
7:10 AM	0	0	0	0	6	0	2	0	1	5	0	0	0	19	5	0	38	
7:15 AM	0	0	0	0	2	0	3	0	1	6	0	0	0	13	9	0	34	
7:20 AM	0	0	0	0	3	0	3	0	4	4	0	0	0	18	5	0	37	
7:25 AM	0	0	0	0	4	0	3	0	4	5	0	0	0	16	10	0	42	
7:30 AM	0	0	0	0	8	0	6	0	2	5	0	0	0	12	9	0	42	
7:35 AM	0	0	0	0	4	0	9	0	3	3	0	0	0	17	9	0	45	
7:40 AM	0	0	0	0	4	0	15	0	2	4	0	0	0	19	8	0	52	
7:45 AM	0	0	0	0	3	0	16	0	3	5	0	0	0	20	8	0	55	
7:50 AM	0	0	0	0	4	0	14	0	7	7	0	0	0	19	2	0	53	
7:55 AM	0	0	0	0	2	0	13	0	3	4	0	0	0	21	4	0	47	521
8:00 AM	0	0	0	0	6	0	13	0	6	9	0	0	0	11	1	0	46	530
8:05 AM	0	0	0	0	5	0	14	0	2	4	0	0	0	22	2	0	49	540
8:10 AM	0	0	0	0	3	0	13	0	3	6	0	0	0	12	5	0	42	544
8:15 AM	0	0	0	0	2	0	7	0	4	2	0	0	0	23	2	0	40	550
8:20 AM	0	0	0	0	3	0	15	0	4	5	0	0	0	18	2	0	47	560
8:25 AM	0	0	0	0	6	0	12	0	2	5	0	0	0	16	6	0	47	565
8:30 AM	0	0	0	0	3	0	8	0	3	6	0	0	0	16	5	0	41	564
8:35 AM	0	0	0	0	5	0	8	0	7	13	0	0	0	17	7	0	57	576
8:40 AM	0	0	0	0	4	0	9	0	6	4	0	0	0	25	6	0	54	578
8:45 AM	0	0	0	0	3	0	4	0	2	6	0	0	0	14	3	0	32	555
8:50 AM	0	0	0	0	4	0	3	0	3	5	0	0	0	13	5	0	33	535
8:55 AM	0	0	0	0	0	0	9	0	0	4	0	0	0	11	3	0	27	515
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	36	0	172	0	52	64	0	0	0	240	56	0	620	
Heavy Trucks	0	0	0	0	4	0	4	0	0	4	0	0	0	16	0	0	28	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

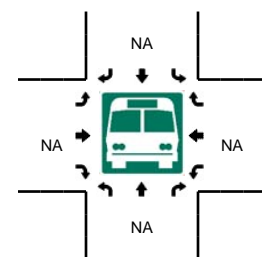
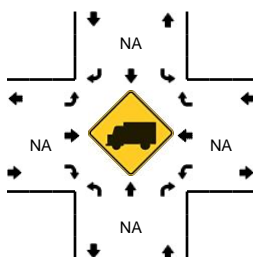
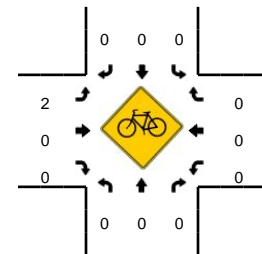
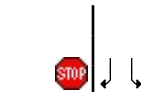
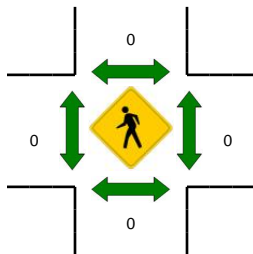
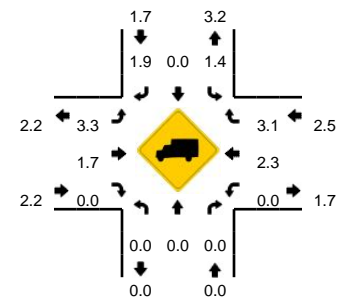
Comments:

LOCATION: NE Ingle Rd -- NE Goodwin Rd
CITY/STATE: Vancouver, WA

QC JOB #: 13932004
DATE: Tue, Oct 11 2016



Peak-Hour: 4:50 PM -- 5:50 PM
Peak 15-Min: 5:10 PM -- 5:25 PM



5-Min Count Period Beginning At	NE Ingle Rd (Northbound)				NE Ingle Rd (Southbound)				NE Goodwin Rd (Eastbound)				NE Goodwin Rd (Westbound)				Total	Hourly Totals
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
4:00 PM	0	0	0	0	3	0	1	0	4	26	0	0	0	14	7	0	55	
4:05 PM	0	0	0	0	9	0	5	0	5	15	0	0	0	12	6	0	52	
4:10 PM	0	0	0	0	5	0	4	0	15	20	0	0	0	17	3	0	64	
4:15 PM	0	0	0	0	7	0	2	0	8	26	0	0	0	16	6	0	65	
4:20 PM	0	0	0	0	4	0	5	0	6	24	0	0	0	7	5	0	51	
4:25 PM	0	0	0	0	2	0	7	0	8	25	0	0	0	11	3	0	56	
4:30 PM	0	0	0	0	5	0	3	0	10	30	0	0	0	13	4	0	65	
4:35 PM	0	0	0	0	7	0	6	0	6	19	0	0	0	9	3	0	50	
4:40 PM	0	0	0	0	7	0	6	0	3	24	0	0	0	12	5	0	57	
4:45 PM	0	0	0	0	5	0	9	0	5	19	0	0	0	24	5	0	67	
4:50 PM	0	0	0	0	4	0	8	0	8	22	0	0	0	19	5	0	66	
4:55 PM	0	0	0	0	8	0	16	0	10	17	0	0	0	14	2	0	67	715
5:00 PM	0	0	0	0	6	0	8	0	8	19	0	0	0	15	9	0	65	725
5:05 PM	0	0	0	0	7	0	6	0	9	18	0	0	0	9	6	0	55	728
5:10 PM	0	0	0	0	5	0	10	0	12	30	0	0	0	21	4	0	82	746
5:15 PM	0	0	0	0	8	0	10	0	14	21	0	0	0	10	10	0	73	754
5:20 PM	0	0	0	0	3	0	5	0	17	28	0	0	0	15	6	0	74	777
5:25 PM	0	0	0	0	5	0	6	0	4	28	0	0	0	12	7	0	62	783
5:30 PM	0	0	0	0	5	0	5	0	13	20	0	0	0	16	2	0	61	779
5:35 PM	0	0	0	0	8	0	13	0	10	22	0	0	0	15	7	0	75	804
5:40 PM	0	0	0	0	8	0	10	0	10	21	0	0	0	9	3	0	61	808
5:45 PM	0	0	0	0	2	0	6	0	7	42	0	0	0	16	4	0	77	818
5:50 PM	0	0	0	0	3	0	1	0	9	16	0	0	0	10	4	0	43	795
5:55 PM	0	0	0	0	10	0	10	0	3	33	0	0	0	17	0	0	73	801
Peak 15-Min Flowrates	Northbound				Southbound				Eastbound				Westbound				Total	
	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U	Left	Thru	Right	U		
All Vehicles	0	0	0	0	64	0	100	0	172	316	0	0	0	184	80	0	916	
Heavy Trucks	0	0	0	0	0	0	0	0	0	4	0	0	0	4	4	0	12	
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Bicycles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Railroad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Stopped Buses	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Comments:

Appendix F In-Process Developments

Kelly Laustsen

From: Norm Wurzer <NWurzer@cityofcamas.us>
Sent: Wednesday, October 12, 2016 4:44 PM
To: Curleigh (Jim) Carothers
Subject: RE: In process traffic for Green Mountain Phase 2
Attachments: CJ Dens Sub.pdf

Curleigh,
Please see the fill-ins below and the attachment.

Norm Wurzer
Engineer I
City of Camas
Office: 360.817.7235
Cell: 360.772.2945
nwurzer@cityofcamas.us



From: Curleigh (Jim) Carothers
Sent: Tuesday, October 11, 2016 9:33 AM
To: Norm Wurzer
Cc: Wes Heigh
Subject: FW: In process traffic for Green Mountain Phase 2

Norm,
I am seeking your assistance on the request below. We need percentage of buildout on each of the developments listed below. Also, if there are any additional developments that have been preliminarily approved, they should be added to the list.

Let's discuss. Thank you.

James E. Carothers, P.E.
Engineering Manager/City Engineer



616 NE 4th Avenue
Camas, WA 98607
360-817-7230
360-834-1535 FAX
jcarothers@cityofcamas.us

From: Kelly Laustsen [<mailto:klaustsen@kittelson.com>]
Sent: Monday, October 10, 2016 3:07 PM
To: Curleigh (Jim) Carothers <jcarothers@cityofcamas.us>

Cc: Chris Brehmer <CBREHMER@kittelson.com>

Subject: In process traffic for Green Mountain Phase 2

Hi Curleigh,

We are working on the supplemental analysis for Phase 2 of the Green Mountain Master Plan we recently discussed with you. Could you provide an update on which of the following in-process developments have been completed since our original TIA and no longer need to be included? We'll plan to use the same growth rates applied in the original TIA.

- Lake Hills 60%
- Two Creeks 50%
- The Summit at Columbia Vista 82%
- Parker Village 45%
- The Hills at Round Lake Approx. 50%
- North Hills Subdivision 10%
- Brady Road Subdivision (Kate's Cove) 86%
- Deerhaven Subdivision 22%
- Hadley's Glen 73%
- Millshore Downs(Windust) 0%
- Fisher Creek Campus (bldg. 1,2,3 done, bldg. 5 proposed)
- Lacamas Prairie ??
- 192nd Plaza West City of Vancouver

Thanks!

Kelly M Laustsen
Senior Engineer

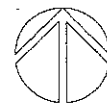
[Kittelson & Associates, Inc.](#)

Transportation Engineering / Planning
610 SW Alder St, Suite 700
Portland, Oregon 97205
503.228.5230
503.535.7439 (direct)
214.886.5338 (cell)

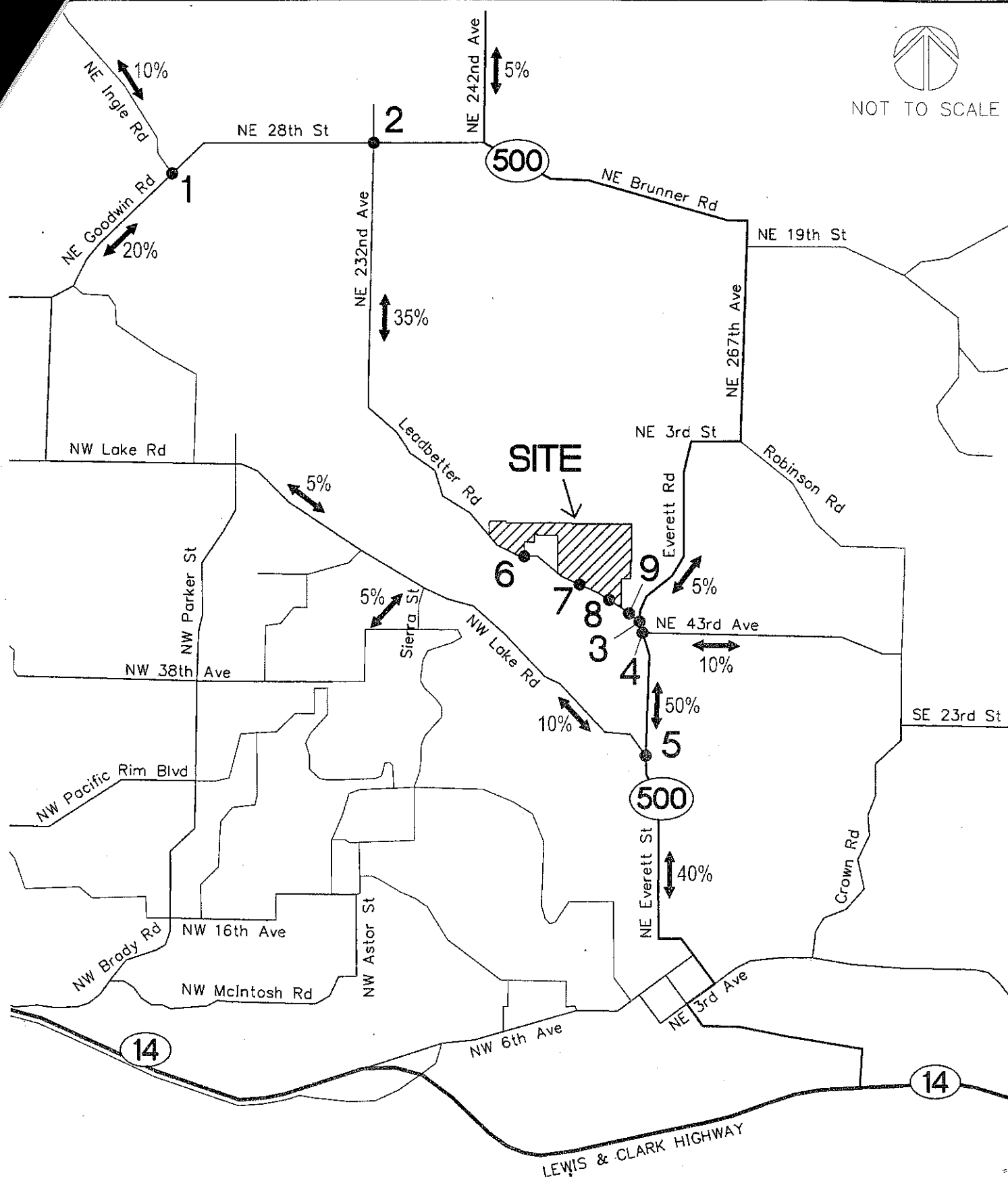
[Streetwise](#) [Twitter](#) [Facebook](#)



**SUSTAINABILITY AT WORK
GOLD CERTIFIED**



NOT TO SCALE



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DATE: 08.03.10

DRAWN BY: DAH

CHECKED BY: BTA

JOB NO:

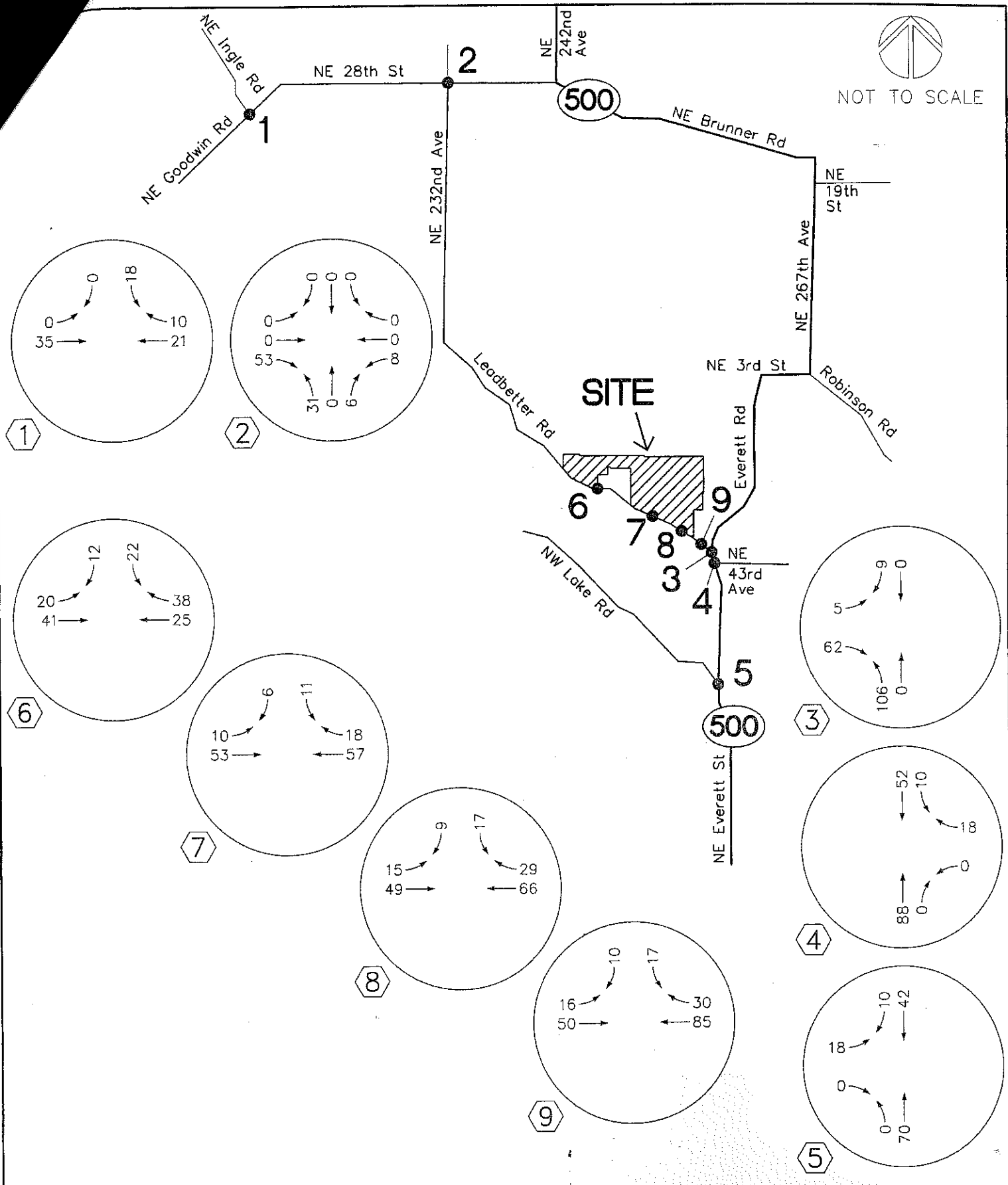
2050186.01

SITE TRIP DISTRIBUTION

CJ DENS RESIDENTIAL SUBDIVISION
CAMAS, WASHINGTON

FIGURE

8



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DATE: 08.03.10

DRAWN BY: DAH/KLA

CHECKED BY: BTA

JOB NO:

2050186.01

**SITE TRIP ASSIGNMENTS -
PM PEAK HOUR**

**CJ DENS RESIDENTIAL SUBDIVISION
CAMAS, WASHINGTON**

FIGURE










9B

Appendix G 2018 Total Traffic Conditions Worksheets

HCM Unsignalized Intersection Capacity Analysis

101: NE 199th Ave & NE 58th St

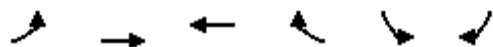
11/3/2016






						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	146	187	10	271	167	5
Future Volume (Veh/h)	146	187	10	271	167	5
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85
Hourly flow rate (vph)	172	220	12	319	196	6
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			392		625	282
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			392		625	282
tC, single (s)			4.3		6.4	6.7
tC, 2 stage (s)						
tF (s)			2.4		3.5	3.8
p0 queue free %			99		55	99
cM capacity (veh/h)			1075		439	655
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	392	331	202			
Volume Left	0	12	196			
Volume Right	220	0	6			
cSH	1700	1075	443			
Volume to Capacity	0.23	0.01	0.46			
Queue Length 95th (ft)	0	1	58			
Control Delay (s)	0.0	0.4	19.7			
Lane LOS		A	C			
Approach Delay (s)	0.0	0.4	19.7			
Approach LOS			C			
Intersection Summary						
Average Delay		4.5				
Intersection Capacity Utilization		38.6%		ICU Level of Service		A
Analysis Period (min)		15				

HCM Unsignalized Intersection Capacity Analysis

104: NE Goodwin Rd & NE Ingle Rd

11/3/2016












Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	82	126	319	62	76	221
Future Volume (Veh/h)	82	126	319	62	76	221
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	88	135	343	67	82	238
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	410				688	376
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	410				688	376
tC, single (s)	4.2				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.3				3.6	3.3
p0 queue free %	92				77	64
cM capacity (veh/h)	1107				362	663
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	88	135	410	82	238	
Volume Left	88	0	0	82	0	
Volume Right	0	0	67	0	238	
cSH	1107	1700	1700	362	663	
Volume to Capacity	0.08	0.08	0.24	0.23	0.36	
Queue Length 95th (ft)	6	0	0	21	41	
Control Delay (s)	8.5	0.0	0.0	17.8	13.4	
Lane LOS	A			C	B	
Approach Delay (s)	3.4		0.0	14.6		
Approach LOS				B		
Intersection Summary						
Average Delay			5.7			
Intersection Capacity Utilization			40.9%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

101: NE 199th St & NE 58th St

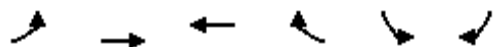
11/3/2016






						
Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	252	235	11	172	219	11
Future Volume (Veh/h)	252	235	11	172	219	11
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Hourly flow rate (vph)	286	267	13	195	249	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			553		640	420
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			553		640	420
tC, single (s)			4.1		6.4	6.2
tC, 2 stage (s)						
tF (s)			2.2		3.5	3.3
p0 queue free %			99		42	98
cM capacity (veh/h)			1027		431	638
Direction, Lane #	EB 1	WB 1	NB 1			
Volume Total	553	208	262			
Volume Left	0	13	249			
Volume Right	267	0	13			
cSH	1700	1027	438			
Volume to Capacity	0.33	0.01	0.60			
Queue Length 95th (ft)	0	1	95			
Control Delay (s)	0.0	0.6	24.8			
Lane LOS		A	C			
Approach Delay (s)	0.0	0.6	24.8			
Approach LOS			C			
Intersection Summary						
Average Delay			6.5			
Intersection Capacity Utilization			47.1%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

104: NE Goodwin Rd & NE Ingle Rd

11/3/2016



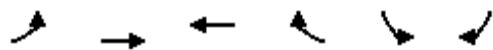
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	213	419	249	86	104	160
Future Volume (Veh/h)	213	419	249	86	104	160
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	239	471	280	97	117	180
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	377				1278	328
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	377				1278	328
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	80				20	75
cM capacity (veh/h)	1176				147	713
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	239	471	377	117	180	
Volume Left	239	0	0	117	0	
Volume Right	0	0	97	0	180	
cSH	1176	1700	1700	147	713	
Volume to Capacity	0.20	0.28	0.22	0.80	0.25	
Queue Length 95th (ft)	19	0	0	125	25	
Control Delay (s)	8.8	0.0	0.0	87.9	11.7	
Lane LOS	A			F	B	
Approach Delay (s)	3.0		0.0	41.7		
Approach LOS				E		
Intersection Summary						
Average Delay			10.5			
Intersection Capacity Utilization			45.9%		ICU Level of Service	
Analysis Period (min)			15			
					A	

Appendix H NE Ingle Road/NE Goodwin Road
Mitigation Worksheets

HCM Unsignalized Intersection Capacity Analysis

104: NE Goodwin Rd & NE Ingle Rd

11/3/2016



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	82	126	319	62	76	221
Future Volume (Veh/h)	82	126	319	62	76	221
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	88	135	343	67	82	238
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	410				654	343
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	410				654	343
tC, single (s)	4.2				6.5	6.2
tC, 2 stage (s)						
tF (s)	2.3				3.6	3.3
p0 queue free %	92				78	66
cM capacity (veh/h)	1107				379	693
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	88	135	343	67	82	238
Volume Left	88	0	0	0	82	0
Volume Right	0	0	0	67	0	238
cSH	1107	1700	1700	1700	379	693
Volume to Capacity	0.08	0.08	0.20	0.04	0.22	0.34
Queue Length 95th (ft)	6	0	0	0	20	38
Control Delay (s)	8.5	0.0	0.0	0.0	17.1	12.9
Lane LOS	A				C	B
Approach Delay (s)	3.4		0.0		14.0	
Approach LOS					B	
Intersection Summary						
Average Delay			5.5			
Intersection Capacity Utilization			37.1%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

104: NE Goodwin Rd & NE Ingle Rd

11/3/2016



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	82	126	319	62	76	221
Future Volume (Veh/h)	82	126	319	62	76	221
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Hourly flow rate (vph)	88	135	343	67	82	238
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	TWLTL			
Median storage (veh)			2			
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	410				654	343
vC1, stage 1 conf vol					343	
vC2, stage 2 conf vol					311	
vCu, unblocked vol	410				654	343
tC, single (s)	4.2				6.5	6.2
tC, 2 stage (s)					5.5	
tF (s)	2.3				3.6	3.3
p0 queue free %	92				85	66
cM capacity (veh/h)	1107				561	693
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	88	135	343	67	82	238
Volume Left	88	0	0	0	82	0
Volume Right	0	0	0	67	0	238
cSH	1107	1700	1700	1700	561	693
Volume to Capacity	0.08	0.08	0.20	0.04	0.15	0.34
Queue Length 95th (ft)	6	0	0	0	13	38
Control Delay (s)	8.5	0.0	0.0	0.0	12.5	12.9
Lane LOS	A				B	B
Approach Delay (s)	3.4		0.0		12.8	
Approach LOS					B	
Intersection Summary						
Average Delay			5.1			
Intersection Capacity Utilization			37.1%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

104: NE Goodwin Rd & NE Ingle Rd

11/3/2016

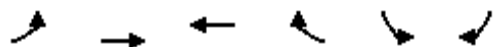


Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	213	419	249	86	104	160
Future Volume (Veh/h)	213	419	249	86	104	160
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	239	471	280	97	117	180
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage (veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	377				1229	280
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	377				1229	280
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	80				26	76
cM capacity (veh/h)	1176				157	759
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	239	471	280	97	117	180
Volume Left	239	0	0	0	117	0
Volume Right	0	0	0	97	0	180
cSH	1176	1700	1700	1700	157	759
Volume to Capacity	0.20	0.28	0.16	0.06	0.74	0.24
Queue Length 95th (ft)	19	0	0	0	114	23
Control Delay (s)	8.8	0.0	0.0	0.0	75.1	11.2
Lane LOS	A				F	B
Approach Delay (s)	3.0		0.0		36.4	
Approach LOS					E	
Intersection Summary						
Average Delay			9.3			
Intersection Capacity Utilization			40.7%		ICU Level of Service	A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

104: NE Goodwin Rd & NE Ingle Rd

11/3/2016



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	213	419	249	86	104	160
Future Volume (Veh/h)	213	419	249	86	104	160
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89
Hourly flow rate (vph)	239	471	280	97	117	180
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	TWLTL			
Median storage (veh)			2			
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	377				1229	280
vC1, stage 1 conf vol					280	
vC2, stage 2 conf vol					949	
vCu, unblocked vol	377				1229	280
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)					5.4	
tF (s)	2.2				3.5	3.3
p0 queue free %	80				59	76
cM capacity (veh/h)	1176				288	759
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2
Volume Total	239	471	280	97	117	180
Volume Left	239	0	0	0	117	0
Volume Right	0	0	0	97	0	180
cSH	1176	1700	1700	1700	288	759
Volume to Capacity	0.20	0.28	0.16	0.06	0.41	0.24
Queue Length 95th (ft)	19	0	0	0	47	23
Control Delay (s)	8.8	0.0	0.0	0.0	25.8	11.2
Lane LOS	A				D	B
Approach Delay (s)	3.0		0.0		17.0	
Approach LOS					C	
Intersection Summary						
Average Delay			5.2			
Intersection Capacity Utilization			40.7%		ICU Level of Service	A
Analysis Period (min)			15			

Appendix I Proportion Share Calculations
at NE 192nd Avenue/NE 13th Street

Proposed Proportionate Share Contribution at NE 192nd Avenue/NE 13th Avenue

Cost Estimate:

Item	Unit Cost	Length	Cost	Notes
Northbound right-turn lane and westbound right-turn lane	\$ 280,000	1	\$ 280,000	Cost estimate attached.
Total			\$ 280,000	

Note: Cost estimate may not account for all ROW impacts

Proportionate Share Calculation:

Intersection volume without development (2029 Background Scenario)	1901
Intersection volume with development (2029 Total Traffic Scenario)	2346
Trips added by development (2346-1901)	445
Capacity of intersection with improvement (see attached Synchro output sheet)	2487
Additional volume accommodated with improvements (2487-1901)	586
Proportionate share cost per trip (\$280,000/586)	\$ 478
Proportionate share of capacity used by development (445/586)	0.759
Proposed proportionate share contribution (\$478 per trip * 445 trips)	\$ 212,600

Note: Assumed proportion of total volume by movement stays consistent with 2029

OLSON ENGINEERING INC.

1111 BROADWAY, VANCOUVER, WA 98660 (360) 695-1385

Green Mtn. - Right Turn Lane @ NE 192nd Avenue & NE 13th Street - Cost Estimate (Option I) North Bound Right & West Bound Right

Item #	Description	Unit Of Measure	Quantity	Unit Price	Total Price
GENERAL CONDITIONS					
1	Mobilization	LS	1	\$ 10,000.00	\$ 10,000.00
2	Clearing & Grubbing (Remove Hedge & Trees, etc.)	LS	1	\$ 2,400.00	\$ 2,400.00
3	Stripping 6" & Haul Off	CY	235	\$ 9.00	\$ 2,115.00
				Total	\$ 14,515.00
DEMOLITION					
4	AC Removal (Exist'g Edge Road & Exist'g Driveways To Ba	SF	2,070	\$ 1.00	\$ 2,070.00
5	Remove Exist'g Driveway Culvert (24 LF)	LS	1	\$ 300.00	\$ 300.00
6	Relocate Exist'g Mail Boxes	EA	5	\$ 125.00	\$ 625.00
7	Relocate Exist'g Signs	EA	3	\$ 125.00	\$ 375.00
				Total	\$ 3,370.00
EROSION CONTROL					
8	Silt Fence	LF	700	\$ 1.75	\$ 1,225.00
9	Hydroseed & Mulch Right - Of - Way	SF	14,000	\$ 0.30	\$ 4,200.00
10	Erosion Control Maintenance	LS	1	\$ 1,600.00	\$ 1,600.00
				Total	\$ 7,025.00
SITWORK					
<u>North Bound Right & West Bound Right</u>					
11	Sawcut	LF	930	\$ 2.00	\$ 1,860.00
12	Mass Grading & Haul Off	CY	480	\$ 10.00	\$ 4,800.00
13	Finish Grade	SF	6,345	\$ 0.30	\$ 1,903.50
14	Geotextile Fabric	SY	765	\$ 0.90	\$ 688.50
15	1½"- Crushed Rock (0.85')	TN	385	\$ 20.00	\$ 7,700.00
16	Asphaltic Concrete (0.85') Class ½" 64-22 HMA	TN	410	\$ 135.00	\$ 55,350.00
17	Curb & Gutter	LF	840	\$ 10.00	\$ 8,400.00
18	Sidewalk / Pedestrian Ramp	SF	4,275	\$ 4.00	\$ 17,100.00
19	Detectable Warning Surface	SF	10	\$ 25.00	\$ 250.00
20	Driveway Drop	EA	5	\$ 25.00	\$ 125.00
21	Driveway Approach (5)	SF	560	\$ 4.50	\$ 2,520.00
22	Pedestrian/Signal Modifications	LS	1	\$ 33,000.00	\$ 33,000.00
23	Traffic Control	LS	1	\$ 10,000.00	\$ 10,000.00
				Total	\$ 143,697.00
SITWORK					
<u>Pave Existing Driveways To Right - Of -Way</u>					
24	Removal AC / Gravel (Back Of Sidewalk To Right - Of - Wa	SF	1,435	\$ 1.00	\$ 1,435.00
25	Finish Grade	SF	1,435	\$ 0.30	\$ 430.50
26	Geotextile Fabric	SY	175	\$ 0.90	\$ 157.50
27	1½"- Crushed Rock (0.67')	TN	70	\$ 20.00	\$ 1,400.00
28	Asphaltic Concrete (0.25') Class ½" 64-22 HMA	TN	30	\$ 135.00	\$ 4,050.00
				Total	\$ 7,473.00

STORM

29	Stormfilter Catch Basin (2 - Cart.)	EA	2	\$	12,000.00	\$	24,000.00
30	Infiltration Trench (50 LF)	EA	2	\$	2,500.00	\$	5,000.00
Total							\$ 29,000.00

STRIPING & SIGNAGE













31	Solid Double Yellow Line	LF	470	\$	1.00	\$	470.00
32	Solid White Line	LF	810	\$	0.50	\$	405.00
33	White Thermoplastic Stop Bar (Extend Existing)	EA	1	\$	660.00	\$	660.00
34	Crosswalk Marking (Extend Existing	EA	1	\$	750.00	\$	750.00
Total							\$ 2,285.00













Subtotal Construction Costs	\$	207,365.00
Soft Cost (20%)	\$	41,473.00
Contingency (15%)	\$	31,104.75
Total Construction Costs	\$	279,942.75

Proportionate Share Calculations
102: NE 13th St & NE 192nd Ave

Intersection Capacity with Improvements

6/17/2014

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	262	217	730	445	318	515
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.8	5.7	5.4	5.8	5.7	5.4
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.99	1.00	0.96	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1595	1863	1527	1787	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1595	1863	1527	1787	1863
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.86	0.86
Adj. Flow (vph)	305	252	849	517	370	599
RTOR Reduction (vph)	0	54	0	41	0	0
Lane Group Flow (vph)	305	198	849	476	370	599
Confl. Peds. (#/hr)		2		8	8	
Heavy Vehicles (%)	2%	0%	2%	2%	1%	2%
Turn Type	pm+ov		pm+ov		Prot	
Protected Phases	6	3	4	6	3	8
Permitted Phases		6		4		
Actuated Green, G (s)	25.6	55.5	63.7	89.3	29.9	99.3
Effective Green, g (s)	25.6	55.5	63.7	89.3	29.9	99.3
Actuated g/C Ratio	0.19	0.41	0.47	0.66	0.22	0.73
Clearance Time (s)	5.8	5.7	5.4	5.8	5.7	5.4
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lane Grp Cap (vph)	333	650	872	1002	393	1359
v/s Ratio Prot	c0.17	0.07	c0.46	0.09	c0.21	0.32
v/s Ratio Perm		0.06		0.22		
v/c Ratio	0.92	0.30	0.97	0.48	0.94	0.44
Uniform Delay, d1	54.2	27.3	35.4	11.7	52.2	7.3
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	28.3	0.1	23.9	0.1	30.5	0.1
Delay (s)	82.4	27.4	59.3	11.8	82.7	7.4
Level of Service	F	C	E	B	F	A
Approach Delay (s)	57.5		41.3			36.2
Approach LOS	E		D			D
Intersection Summary						
HCM Average Control Delay			42.7		HCM Level of Service	D
HCM Volume to Capacity ratio			0.95			
Actuated Cycle Length (s)			136.1		Sum of lost time (s)	16.9
Intersection Capacity Utilization			84.7%		ICU Level of Service	E
Analysis Period (min)			15			
c Critical Lane Group						












						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	252	209	674	428	306	476
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.8	5.7	5.4	5.8	5.7	5.4
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frpb, ped/bikes	1.00	0.99	1.00	0.97	1.00	1.00
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1595	1863	1531	1787	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (perm)	1770	1595	1863	1531	1787	1863
Peak-hour factor, PHF	0.86	0.86	0.86	0.86	0.86	0.86
Adj. Flow (vph)	293	243	784	498	356	553
RTOR Reduction (vph)	0	65	0	46	0	0
Lane Group Flow (vph)	293	178	784	452	356	553
Confl. Peds. (#/hr)		2		8	8	
Heavy Vehicles (%)	2%	0%	2%	2%	1%	2%
Turn Type	pm+ov		pm+ov		Prot	
Protected Phases	6	3	4	6	3	8
Permitted Phases		6		4		
Actuated Green, G (s)	23.9	51.8	56.8	80.7	27.9	90.4
Effective Green, g (s)	23.9	51.8	56.8	80.7	27.9	90.4
Actuated g/C Ratio	0.19	0.41	0.45	0.64	0.22	0.72
Clearance Time (s)	5.8	5.7	5.4	5.8	5.7	5.4
Vehicle Extension (s)	1.0	1.0	1.0	1.0	1.0	1.0
Lane Grp Cap (vph)	337	658	843	984	397	1342
v/s Ratio Prot	c0.17	0.06	c0.42	0.09	c0.20	0.30
v/s Ratio Perm		0.05		0.21		
v/c Ratio	0.87	0.27	0.93	0.46	0.90	0.41
Uniform Delay, d1	49.3	24.4	32.5	11.3	47.4	7.0
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	19.9	0.1	16.3	0.1	21.6	0.1
Delay (s)	69.2	24.4	48.8	11.5	69.0	7.1
Level of Service	E	C	D	B	E	A
Approach Delay (s)	48.9		34.3			31.3
Approach LOS	D		C			C
Intersection Summary						
HCM Average Control Delay			36.2		HCM Level of Service	D
HCM Volume to Capacity ratio			0.91			
Actuated Cycle Length (s)			125.5		Sum of lost time (s)	16.9
Intersection Capacity Utilization			80.5%		ICU Level of Service	D
Analysis Period (min)			15			
c Critical Lane Group						

Appendix J Phase 2 Access Operations Worksheets

HCM Unsignalized Intersection Capacity Analysis

204: NE Ingle Rd & Access D

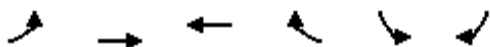
11/3/2016






						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	68	36	110	26	13	204
Future Volume (Veh/h)	68	36	110	26	13	204
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	76	40	122	29	14	227
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None		None	
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	392	136			151	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	392	136			151	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	88	96			99	
cM capacity (veh/h)	611	917			1442	
Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2	
Volume Total	76	40	151	14	227	
Volume Left	76	0	0	14	0	
Volume Right	0	40	29	0	0	
cSH	611	917	1700	1442	1700	
Volume to Capacity	0.12	0.04	0.09	0.01	0.13	
Queue Length 95th (ft)	11	3	0	1	0	
Control Delay (s)	11.7	9.1	0.0	7.5	0.0	
Lane LOS	B	A		A		
Approach Delay (s)	10.8		0.0	0.4		
Approach LOS	B					
Intersection Summary						
Average Delay			2.7			
Intersection Capacity Utilization			21.2%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

209: NE Goodwin Rd & Access (Ph 2)

11/3/2016














Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	31	172	292	6	17	89
Future Volume (Veh/h)	31	172	292	6	17	89
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	34	191	324	7	19	99
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	331				586	328
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	331				586	328
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	97				96	86
cM capacity (veh/h)	1240				463	718
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	34	191	331	19	99	
Volume Left	34	0	0	19	0	
Volume Right	0	0	7	0	99	
cSH	1240	1700	1700	463	718	
Volume to Capacity	0.03	0.11	0.19	0.04	0.14	
Queue Length 95th (ft)	2	0	0	3	12	
Control Delay (s)	8.0	0.0	0.0	13.1	10.8	
Lane LOS	A			B	B	
Approach Delay (s)	1.2		0.0	11.2		
Approach LOS				B		
Intersection Summary						
Average Delay			2.4			
Intersection Capacity Utilization			32.4%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

204: NE Ingle Rd & Access D

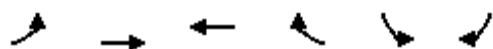
11/3/2016






						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	47	24	194	78	40	201
Future Volume (Veh/h)	47	24	194	78	40	201
Sign Control	Stop		Free			Free
Grade	0%		0%			0%
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	52	27	216	87	44	223
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type			None		None	
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	570	260			303	
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	570	260			303	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)						
tF (s)	3.5	3.3			2.2	
p0 queue free %	89	97			97	
cM capacity (veh/h)	469	784			1269	
Direction, Lane #	WB 1	WB 2	NB 1	SB 1	SB 2	
Volume Total	52	27	303	44	223	
Volume Left	52	0	0	44	0	
Volume Right	0	27	87	0	0	
cSH	469	784	1700	1269	1700	
Volume to Capacity	0.11	0.03	0.18	0.03	0.13	
Queue Length 95th (ft)	9	3	0	3	0	
Control Delay (s)	13.6	9.8	0.0	7.9	0.0	
Lane LOS	B	A		A		
Approach Delay (s)	12.3		0.0	1.3		
Approach LOS	B					
Intersection Summary						
Average Delay			2.0			
Intersection Capacity Utilization			31.6%	ICU Level of Service		A
Analysis Period (min)			15			

HCM Unsignalized Intersection Capacity Analysis

209: NE Goodwin Rd & Access (Ph 2)

11/3/2016



Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Volume (veh/h)	100	423	276	19	11	58
Future Volume (Veh/h)	100	423	276	19	11	58
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	111	470	307	21	12	64
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	328				1010	318
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	328				1010	318
tC, single (s)	4.1				6.4	6.2
tC, 2 stage (s)						
tF (s)	2.2				3.5	3.3
p0 queue free %	91				95	91
cM capacity (veh/h)	1243				244	728
Direction, Lane #	EB 1	EB 2	WB 1	SB 1	SB 2	
Volume Total	111	470	328	12	64	
Volume Left	111	0	0	12	0	
Volume Right	0	0	21	0	64	
cSH	1243	1700	1700	244	728	
Volume to Capacity	0.09	0.28	0.19	0.05	0.09	
Queue Length 95th (ft)	7	0	0	4	7	
Control Delay (s)	8.2	0.0	0.0	20.5	10.4	
Lane LOS	A			C	B	
Approach Delay (s)	1.6		0.0	12.0		
Approach LOS				B		
Intersection Summary						
Average Delay			1.8			
Intersection Capacity Utilization			34.6%	ICU Level of Service		A
Analysis Period (min)			15			