Alexan Central Park Apartments

Phase 2: Traffic Impact Analysis

February 2016
Update 01: May 2016
Update 02: June 2016

Prepared for:
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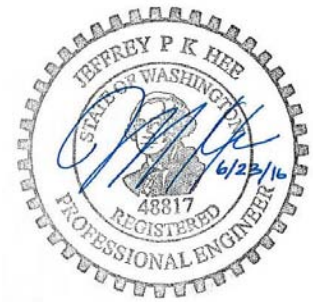

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Executive Summary

This report documents traffic conditions associated with development of Alexan Central Park (the Project), a proposed mid-rise apartment building located at 16160 NE 80th Street.

The Project site is in Downtown Redmond within Town Square Zone. The underlying property is zoned for mixed-use development. The proposal includes redevelopment of two existing properties:

- 16160 NE 80th Street (parcel no. 022505-9103), 7,467 sq. ft. Redmond General Insurance office
- 8040 161st Avenue NE (parcel no. 022505-9179), 9,695 sq. ft. of strip mall retail

The Project is proposed with 195 multifamily units, including four live-work units, within a mid-rise structure, 4,100 sq. ft. of dedicated street level commercial retail space, and onsite parking for 192 vehicles. Garage access is proposed off the future extension of NE 81st Street, to the north of the property and between the site and the Veloce apartments. As part of this proposal NE 81st Street will be extended from its terminus, just west of 162nd Avenue NE, to 161st Avenue NE. The road extension will incorporate the existing garage access to Veloce.

Site development is anticipated to be built-out and occupied by 2018.

The Project generates:

- 420 new daily trips, split 210 in and out;
- 45 new PM peak hour trips split 33 in and 12 out.

The study intersections operate within the City's level of service threshold (LOS D).

Vehicle queues are not projected to significantly affect traffic circulation with the Project.

The onsite parking supply is sufficient to meet the needs of future tenants. A request for a variance from the City's minimum parking requirements for multifamily uses was prepared on January 22, 2016.

A Transportation Concurrency Application was prepared and submitted to the City on February 17, 2016.

Traffic impact fees will be computed and are due at the time of building permit issuance.

Introduction

This report represents Phase 2: Traffic Impact Analysis requirements of the 60% PREP Land Use Application checklist. The report format generally follows the outline provided in the application.

On February 17, 2016 an updated Phase 1: Trip Generation Study was prepared and submitted to Redmond staff. Staff feedback on the Phase 1 study was incorporated into this report.

Project Location

Alexan Central Park (the Project) is located at 16160 NE 80th Street. The site includes redevelopment of two existing land parcels bound by Redmond Way, NE 80th Street and 161st Avenue NE:

- 16160 NE 80th Street (parcel no. 022505-9103), 7,467 sq. ft. Redmond General Insurance office
- 8040 161st Avenue NE (parcel no. 022505-9179), 9,695 sq. ft. of strip mall retail

The site is within the Town Square Zone in downtown Redmond. A vicinity map is provided as **Figure 1**.

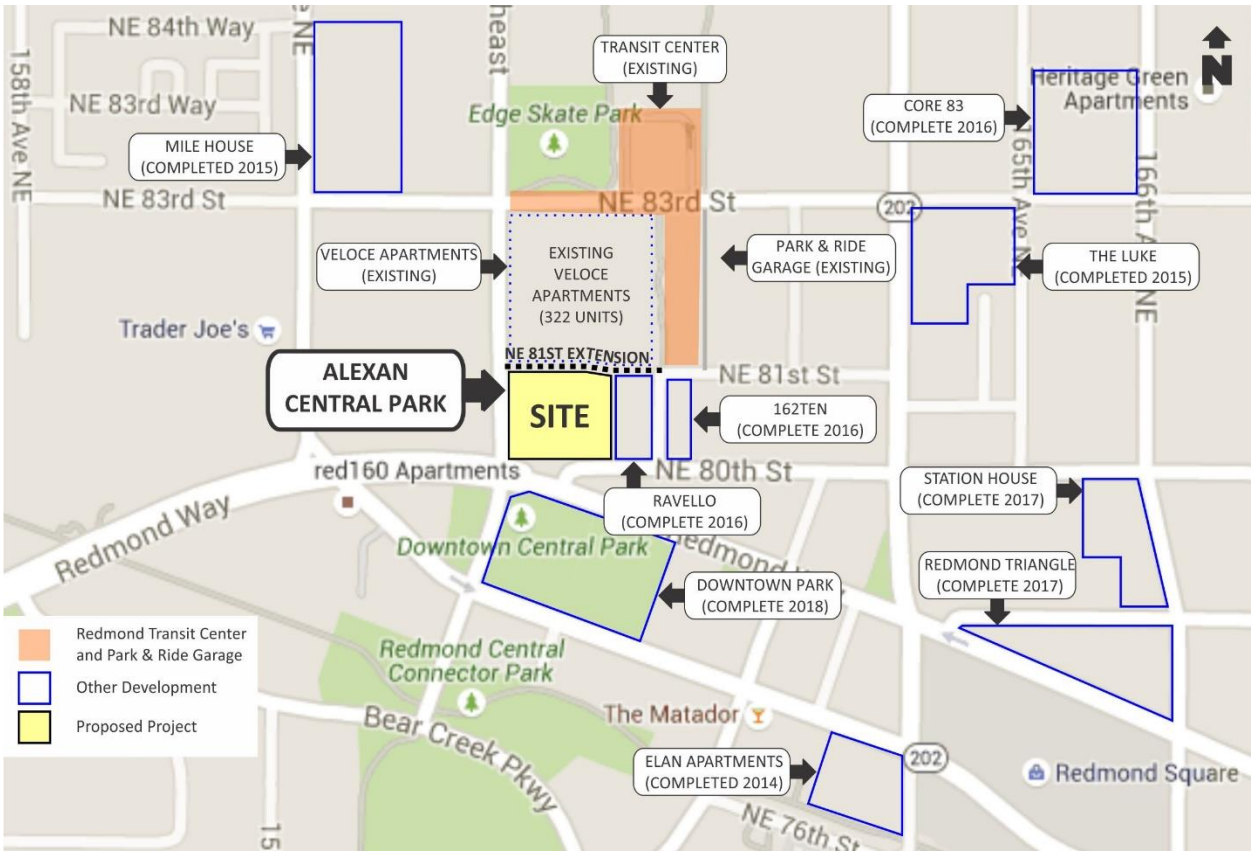


Figure 1: Vicinity Map

Project Description

The Project includes 195 multifamily units, including four live-work units, up to 4,100 sq. ft. of retail space, and 192 onsite parking stalls.

The applicant will extend NE 81st Street from its terminus, just west of 162nd Avenue NE, to 161st Avenue NE. The road extension will incorporate the existing garage access to Veloce. Site garage access will be off of NE 81st Street.

Existing uses will be removed prior to site development.

The Project is anticipated to be fully occupied by 2018. A preliminary site plan is included as **Figure 2**.

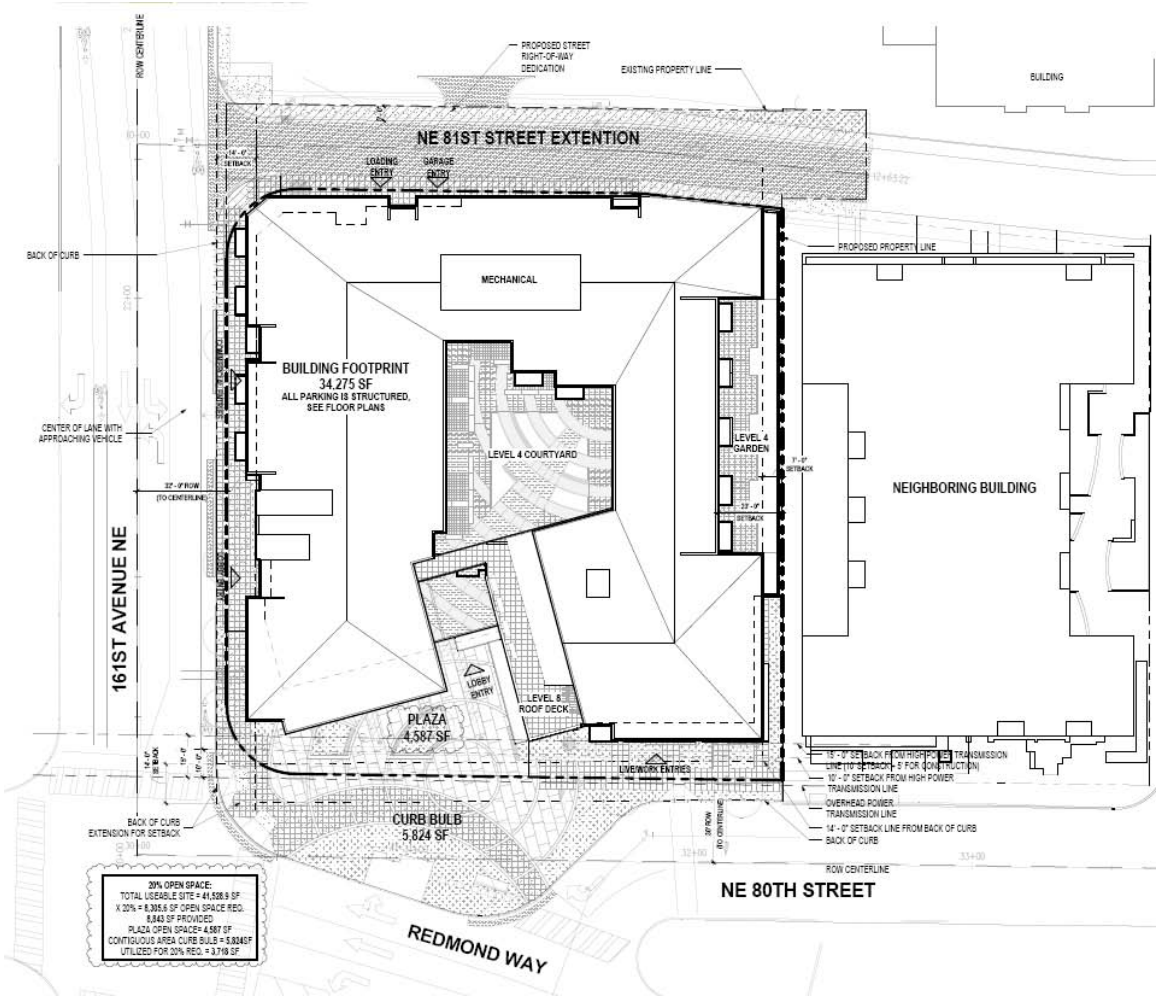


Figure 2: Preliminary Site Plan

Existing Conditions

Study Area

Study intersections include:

1. 161st Ave NE at Redmond Way (signal)
2. 161st Ave NE at Future NE 81st Street Extension (stop control)
3. Site access at Future NE 81st Street Extension (stop control)

Physical Characteristics of Study Area Street System

Streets within Study Area

Major roadways within the study area described below:

- Redmond Way (SR 202) is classified as a Minor Arterial in downtown Redmond. The road is oriented for westbound traffic flow east of 161st Ave NE. The road includes curb, gutter and sidewalk, and the posted speed limit is 30 mph. The south side of the road includes 2 hour on-street parking fronting the existing Downtown Central Park.
- 161st Ave NE is a classified as a Collector Arterial from NE 90th Street to Bear Creek Parkway. Near the site the road includes a northbound travel lane, a center two-way left turn lane, a southbound travel lane and a southbound right turn pocket at the Redmond Way intersection. The road includes curb, gutter, sidewalk and bicycle lanes and the posted speed limit of 30 mph.
- 162nd Ave NE is two lane local access road between NE 80th Street and NE 81st Street.
- NE 81st Street is a two lane local access road that currently dead-ends at 162nd Ave NE. The park and ride garage is located on the north side of the road and east of the Veloce apartments.
- NE 80th Street is a two lane local access road between Redmond Way and 164 Ave NE. Curb, gutter, sidewalk and 2 hour on-street parking line the road.

Non-Motorized & Transit Facilities

Information on Redmond's urban walk routes can be found on the City's webpage. The 1.7 mile Old Town Loop and 3.1 mile Pathways to Wellness Walk routes are located within a quarter mile of the Project site. A non-motorized path between NE 81st Street and NE 83rd Street provides direct access to the transit center and the park and ride garage.

Marked bike lanes are on 161st Ave NE. Both NE 80th and NE 83rd Street include shared roadway markings to notify motorists that bicyclists are on the road. A bicycle map is provided in the **Appendix**.

Redmond Transit Center and the park and ride garage are located one block north and west of the Project site. The transit center provides access to local commuter centers as well as to Seattle and other east King County municipalities. A transit map is provided in the **Appendix**.

Figure 3 illustrates the school walk routes plan between the site and Redmond Elementary. The local area includes sufficient walk routes to Redmond Elementary.

Operational Characteristics of Study Area Street System

Traffic Volumes

Figure 4 illustrates the current Average Weekday Daily Traffic volumes in the vicinity of the site.

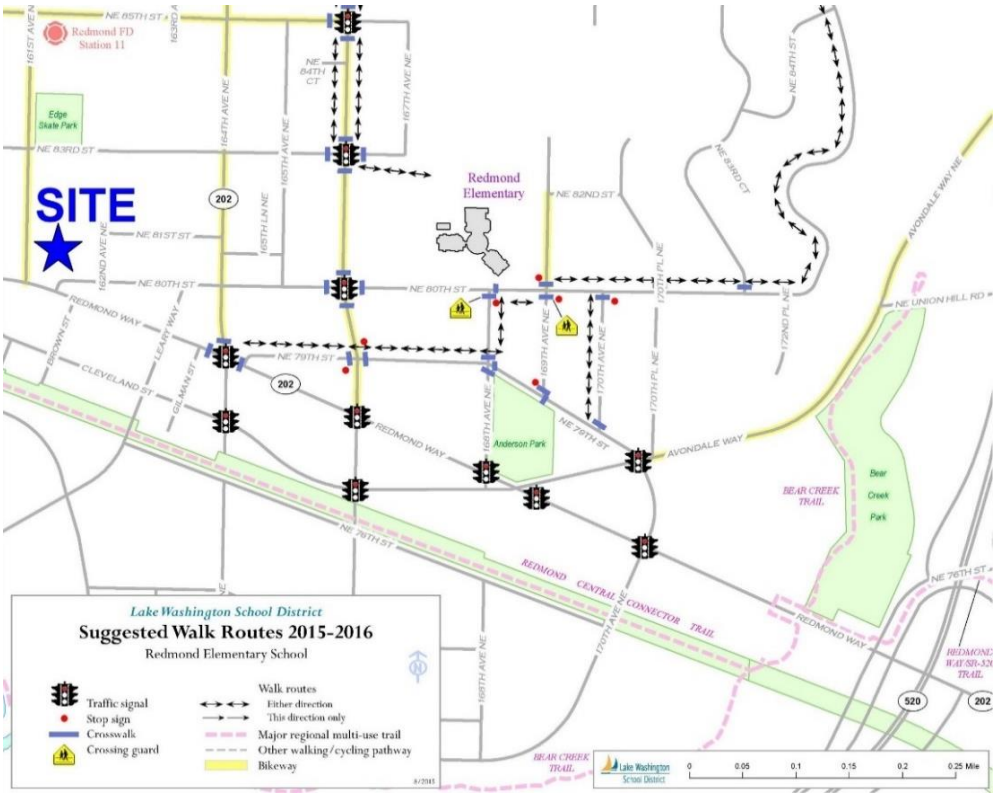


Figure 3: Average Weekday Daily Traffic Volumes

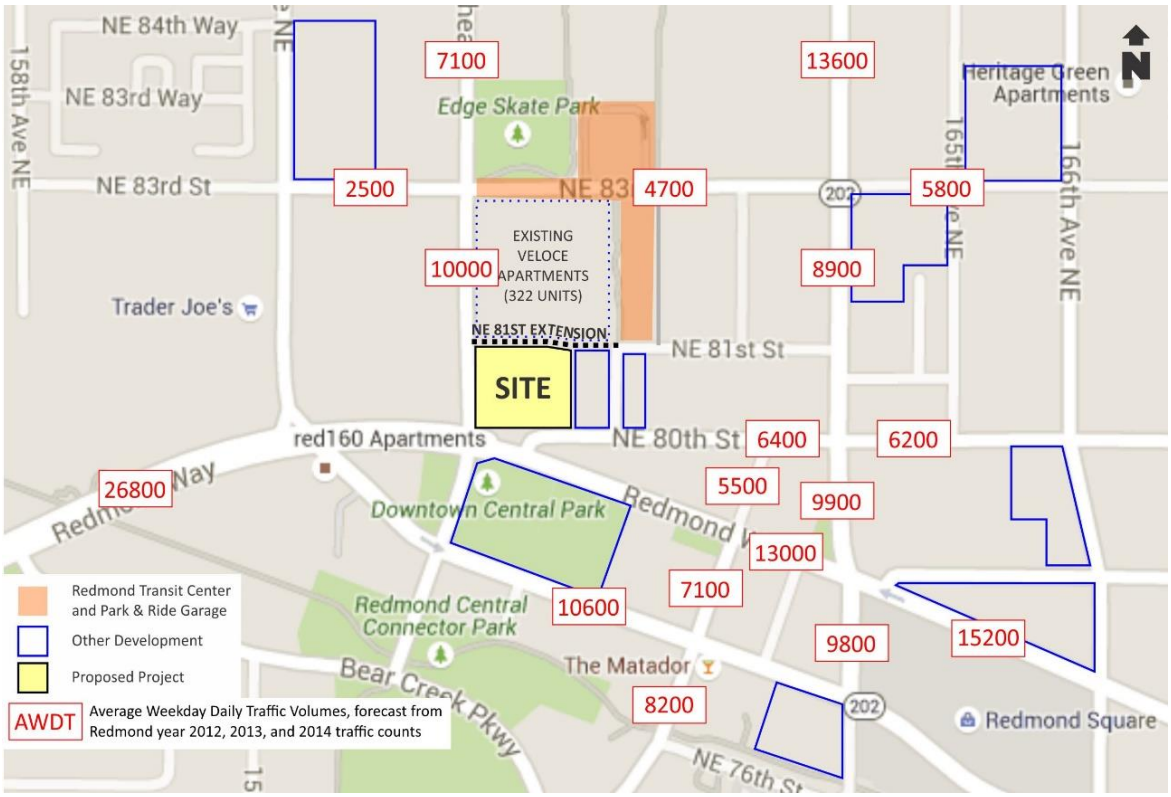


Figure 4: Average Weekday Daily Traffic Volumes

Afternoon (PM) peak hour turning movement volumes were collected at the study intersections on Thursday, November 5, 2015. **Figure 5** illustrates the existing PM peak hour study intersection traffic volumes and the traffic counts are provided in the **Appendix**. The volumes are rounded to the nearest multiple of 5 to account for the typical day-to-day fluctuations in traffic volumes.

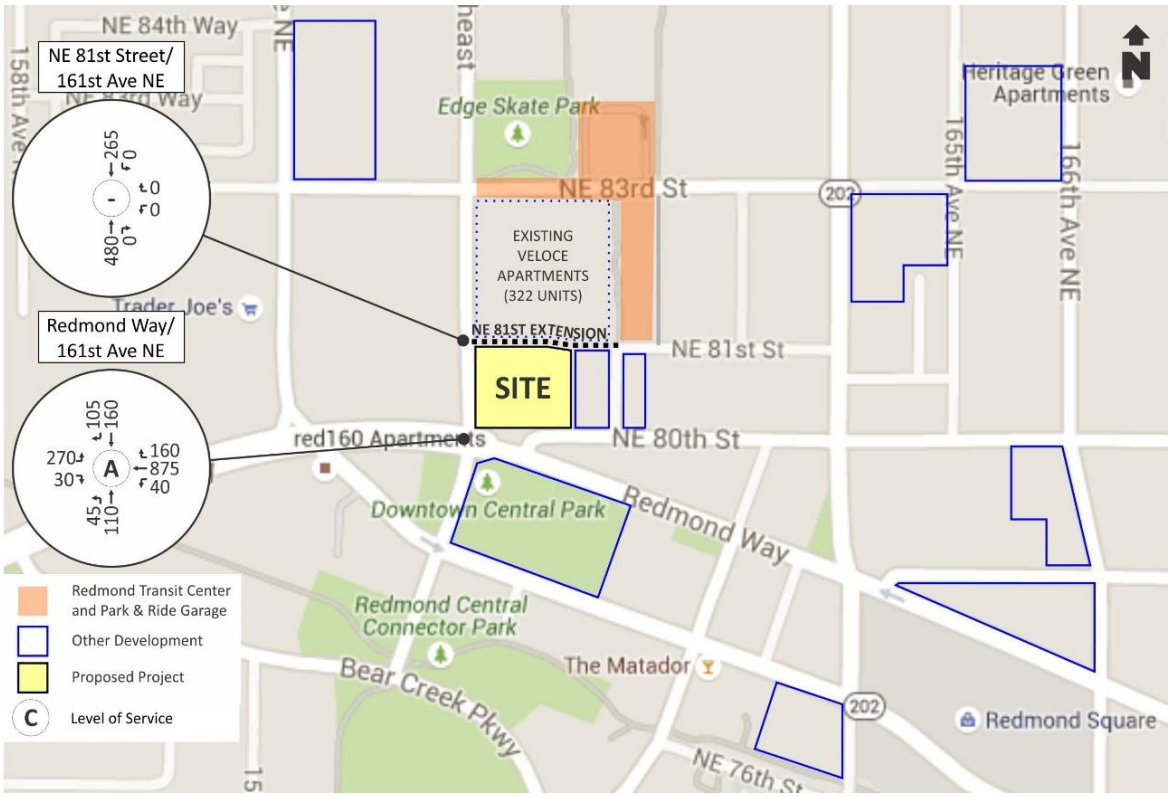


Figure 5: Existing PM Peak Hour Traffic Volumes

Traffic Operations

Level of service (LOS) at signalized intersections was computed using Circular 212 Critical Sum methodology. At unsignalized intersections the Synchro, version 8, software package was used to report the LOS results per the 2010 Highway Capacity Manual methodologies. **Table 1** summarizes existing LOS at the study intersections. The Critical Sum worksheets and the intersection capacity reports are provided in the **Appendix**.

Table 1: 2015 Existing PM Peak Hour Intersection Level of Service

Intersection	Control	LOS Method	LOS	Vol. [1]	V/C [2]
Redmond Way / 161st Ave NE	Signal	Circular 212	A	948	0.67

1. Critical Volume
2. Volume-to-Capacity Ratio

The City of Redmond LOS standard is LOS D. The Redmond Way and 161st Ave NE intersection operates at LOS A and satisfies the City's LOS standard.

Crash History

A four year crash history from 2012 through 2015 was provided by WSDOT on 161st Ave NE from Redmond Way to the existing Veloce apartment's driveway; on Redmond Way from 161st Ave NE to NE 80th Street; on NE 80th Street to west of 164th Ave NE; and on 164th Ave NE from NE 81st St to NE 80th St. **Table 2** summarizes the crash history.

Table 2: Crash History

Location	Average Annual Crashes by Type							Average Crashes	Average Injuries
	Left Turn	Side swipe	Rear End	Ped/ Bike	Pole/ Sign	At Angle	Other		
161st Ave at Red. Way	0.8	0.5	1.0	0.5	0.3	0.0	0.5	3.5	1.3
Red. Way: 161st to 80th	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0
80th at Red. Way	0.0	0.0	0.3	0.0	0.3	0.5	0.0	1.0	0.3
80th: Red. Way to 162nd	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0
80th: 162nd to Leary Way	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.5	0.5
164th Ave at 81st St	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
164th Ave: 81st to 80th	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.3

In total there were twenty three crashes between 2012 and 2015:

- No recent crashes were reported at the 164th Ave NE and NE 81st Street intersection.
- Rear end and pedestrian/bicyclist related crashes each made up 22% of the total crashes.
- Left turn, sideswipe and other crashes each made up 13% of the total crashes.
- Entering at angle crashes and crashes involving utility poles, sign posts or street light poles each made up 9% of the total crashes.
- About 57% of total crashes includes at least one possible or evident injury.
- No fatalities were reported.

With future changes proposed on Redmond Way and Cleveland Street, conversion of both roadways from one-way to two-way traffic flow, traffic circulation through the downtown is forecast, by the City, to improve. Safety within the downtown should also benefit with improved traffic flow.

Forecasted Conditions

Forecast Year

The horizon year for this analysis is 2018. Year 2018 coincides with the anticipated full build-out and occupancy of the Project.

General Traffic Growth

Future year 2018 conditions include changes in traffic patterns generated by funded transportation facility improvements and non-Project-related traffic growth.

The City's 2016-2021 Six Year Transportation Improvement Program lists the following five planned public transportation improvements near the site:

- Cleveland Street East (164th Ave NE to Avondale Way) - Enhance pedestrian facilities and modify signals to complete buildout of Cleveland Street per the Downtown East West Corridor Study. Complete by 2021, unfunded. (Project ID. B43)
- 159th Pl NE Sidewalk (Bear Creek Pkwy to Leary Way) – Construct sidewalk on 159th Place from Leary Way to Bear Creek Parkway. Complete by 2021, not fully funded. (Project ID. B47)
- Redmond Way and Cleveland Street Couplet Conversion (160th Ave NE to 170th Ave NE) – Convert Redmond Way to one through lane in each direction and center turn lane. Convert Cleveland Street to one through lane in each direction. A realignment of the streets at eastern and western ends will improve traffic flow and include gateway treatments. Pedestrian improvements will be constructed on Redmond Way. A BAT lane will be completed from the Bear Creek Bridge near SR 520 to 168th Ave with a queue jump at Avondale Way. Complete 2018, not fully funded. (Project ID. C53)
- NE 90th St Bridge Deck (along Sammamish River Trial) - Bridge deck preventative maintenance study. Construct per study (anticipating overlay). Complete 2021, unfunded. (Project ID. P20)

In addition to the public improvements, the following private improvements will be implemented:

- 162nd Ave NE Woonerf – 162nd Ave NE will be converted into a one-way southbound woonerf, or pedestrian oriented street, between NE 81st Street and NE 80th Street. The 162Ten developer is leading this road improvement which is anticipated to be complete by 2017.
- NE 81st Street Extension – This Project (Alexan Central Park) will extend NE 81st Street from its current terminus at 162nd Ave NE to 161st Ave NE, as a condition of approval. The new road will include 5 foot sidewalks with no curb and two ten foot drive lanes. The extension will function primarily as an access way. The new two-way road extension will require relocating the current Veloce apartment's driveway south to the new local access road. The road extension is anticipated to be complete by 2018.

The road improvements are incorporated into the future year 2018 conditions. A traffic model with year 2016 conditions with the complete Redmond Way and Cleveland Street Couplet Conversion was provided by Redmond staff. The city's model was adjusted manually to calibrate the existing volumes to with those modeled with the Couplet Conversion. Additionally, existing and Redmond modeled traffic volumes were increased by a 2% annual growth rate to adjusted the baseline conditions to year 2018.

The NE 81st Street Extension shifts all Veloce trips from an existing midblock driveway to NE 81st Street. In addition, the extension allows Veloce traffic to head east on NE 81st Street to 162nd Ave NE, 164th Ave NE and NE 80th Street. The year 2018 without-Project conditions include reassignment of the PM peak hour trips generated by the Veloce apartments with the NE 81st Street extension complete.

Figure 6 graphically illustrates the transportation facility improvements.

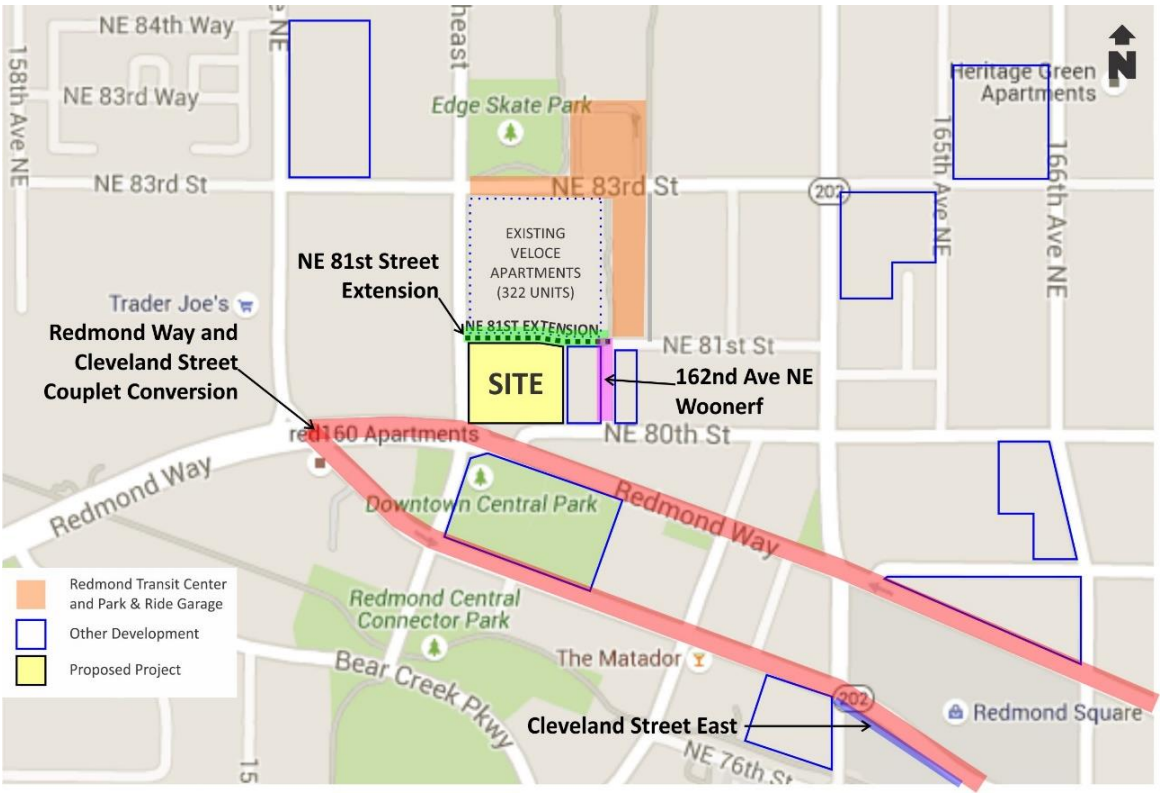


Figure 6: Transportation Facility Improvements

Non-Project traffic growth includes trips generated by pipeline projects forecasted to affect traffic flow at the study intersections. Pipeline projects included in this analysis include:

1. Mile House – 177 multifamily units located at 160th Ave NE and NE 83rd Street. Completed in 2015.
2. The Luke – 208 multifamily units located at NE 83rd Street and 164th Ave NE. Completed in 2015.
3. Echelon – 120 multifamily units located at NE 83rd Street and 165th Ave NE. Complete by 2016.
4. Village Square – 96 multifamily units located to the north of Echelon. Complete by 2016.
5. Redmond Elementary School Addition – Capacity improvements for 269 students at Redmond Elementary School. Complete by 2016.
6. 162Ten – 96 residential units located at NE 80th Street and 162nd Ave NE. Complete by 2017.
7. Ravello – 102 multifamily units and 900 sq. ft. of commercial space at located west of 162Ten and east of this Project (Alexan Central Park). Complete by 2017.
8. Station House – 197 multifamily units located at NE 79th Street and 166th Ave NE. Complete by 2017.
9. Redmond Triangle – 197 multifamily units and 5,800 sq. ft. of commercial space located at Redmond Way and 166th Ave NE. Complete by 2017.
10. Downtown Central Park – Civic improvements at 16101 Redmond Way. Complete by 2018.
11. Redmond Hotel – 177 room hotel to replace Barclay Village at Redmond Way and 166th Ave NE. Completion date unknown, project is still in feasibility stages.
12. Veloce – existing 322 apartment units located at Redmond NE 83rd Street and 161st Ave. Existing trips to be reassigned to the NE 81st Street extension, which will vacate the existing driveway and relocated garage accesses to the new roadway.

Pipeline project trips were distributed to the study area based on past work in the City. Pipeline project trips are illustrated in **Figure 7**.

Figure 8 the year 2018 without-Project traffic conditions.

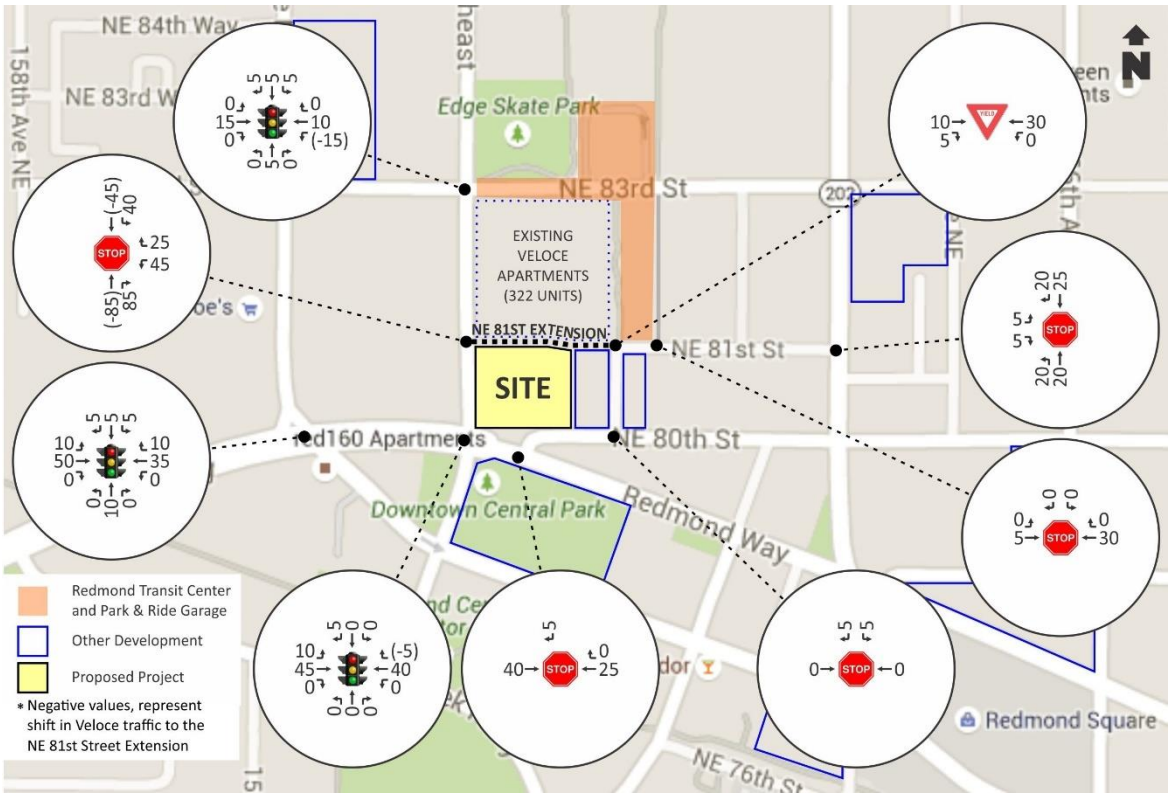


Figure 7: Pipeline Trips

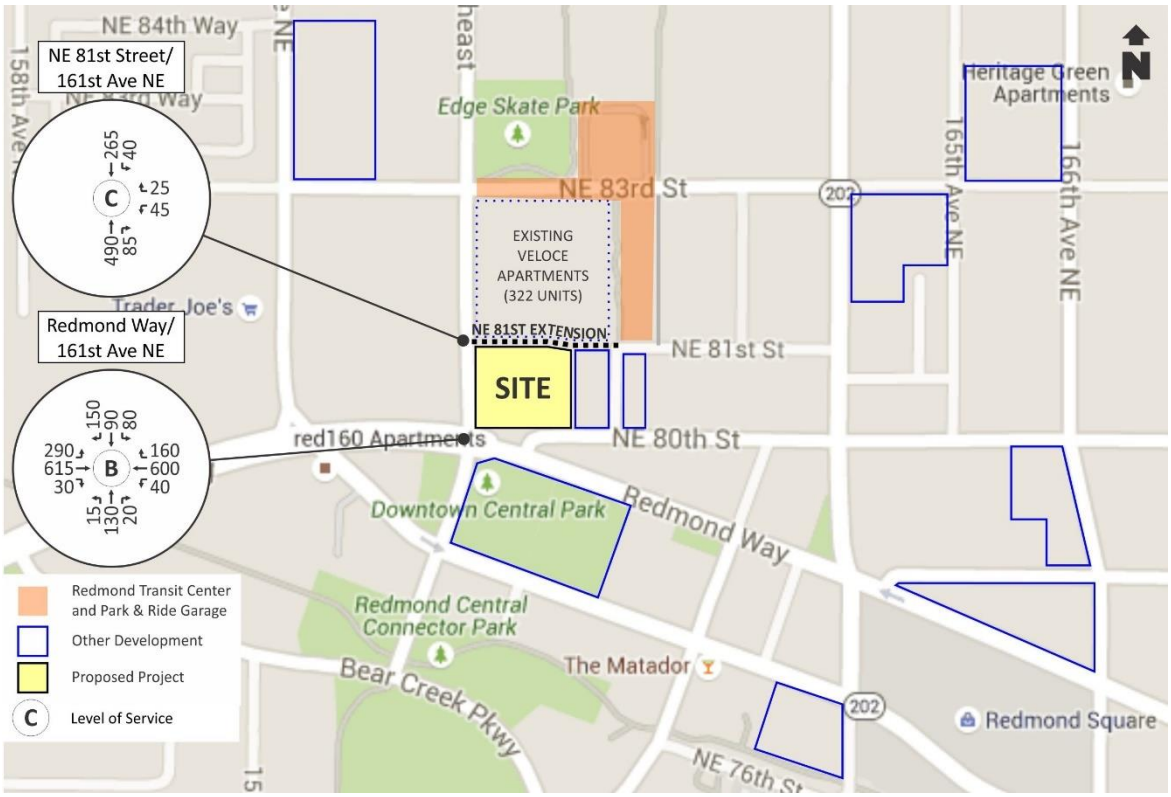


Figure 8: 2018 Without-Project PM Peak Hour Traffic Volumes

Forecast of Development Generated Traffic Volumes

Trip Generation

Table 3 summarizes the trip generation forecast for the proposed Project and for the existing uses bring replaced by the Project. The trip generation forecast was based on data compiled in the ITE *Trip Generation Manual, 9th Edition (2012)*. The project generates 420 new daily trips, split 210 in and out, and 45 new PM peak hour trips, split 33 in and 12 out.

Table 3: Trip Generation

Land Use	Size	Trip Rate	Total Trips	Shared Trips	Trips Generated		
					In	Out	Total
LU 223 Apartment	195 units	4.05[1]	790	5%	375	375	750
LU 820 Retail	4.100 k SF	42.70	175	5%	83	83	166
Proposed Daily Trips:			*965*	*49*	*458*	*458*	*916*
LU 710 Office	7.467 k SF	(11.03)	(82)	-	(41)	(41)	(82)
LU 820 Retail	9.695 k SF	(42.70)	(414)	-	(207)	(207)	(414)
Existing Daily Trips:			*(496)*	-	*(248)*	*(248)*	*(496)*
Total Daily Trips			469	-	210	210	420
LU 223 Apartment	195 units	Eqn.[2]	82	5%	45	33	78
LU 820 Retail	4.100 k SF	3.71	15	5%	6	8	14
Proposed PM Trips:			*97*	*5*	*51*	*41*	*92*
LU 710 Office	7.467 k SF	(1.49)	(11)	-	(2)	(9)	(11)
LU 820 Retail	9.695 k SF	(3.71)	(36)	-	(16)	(20)	(36)
Existing PM Trips:			*(47)*	-	*(18)*	*(29)*	*(47)*
Total PM Trips			50	5	33	12	45

1. ITE data does not include a daily trip rate for LU 223; the rate computed by taking the average ratio of Daily, AM and PM peak hour trips rates for LU 220 "Apartment" and LU 223.
2. Trips computed using fitted curve equation. T=0.48(X)-11.07, where T = trips and X = number of dwellings

Mode Spilt

The *American Fact Finder* application from the *US Census Bureau* provides estimates of year 2014 travel modes for worker aged persons within King County Census Tract 323.09, which includes the Project site. **Table 4** summarizes the project's trip generation by mode of travel.

Table 4: Travel Modes

Travel Mode	Proportion	Daily Trips	PM Trips
Drove/Carpooled	78%	916	92
Public Transportation	13%	153	15
Walked/Bicycled	6%	70	7
Worked at Home	3%	35	4
Total Trips	100%	1,174	118

Trip Assignment

The Project's PM peak hour trips were distributed to the future roadway network based on feedback from City staff on the Phase 1: Trip Generation analysis. **Figures 9** illustrate the trips generated by the existing uses on site, Project-generated trips, and net new trips within the study area.

The net new PM peak hour trips were superimposed onto the without-Project volumes to project future 2018 with-Project conditions. The future with-Project volumes are illustrated in **Figure 10**.

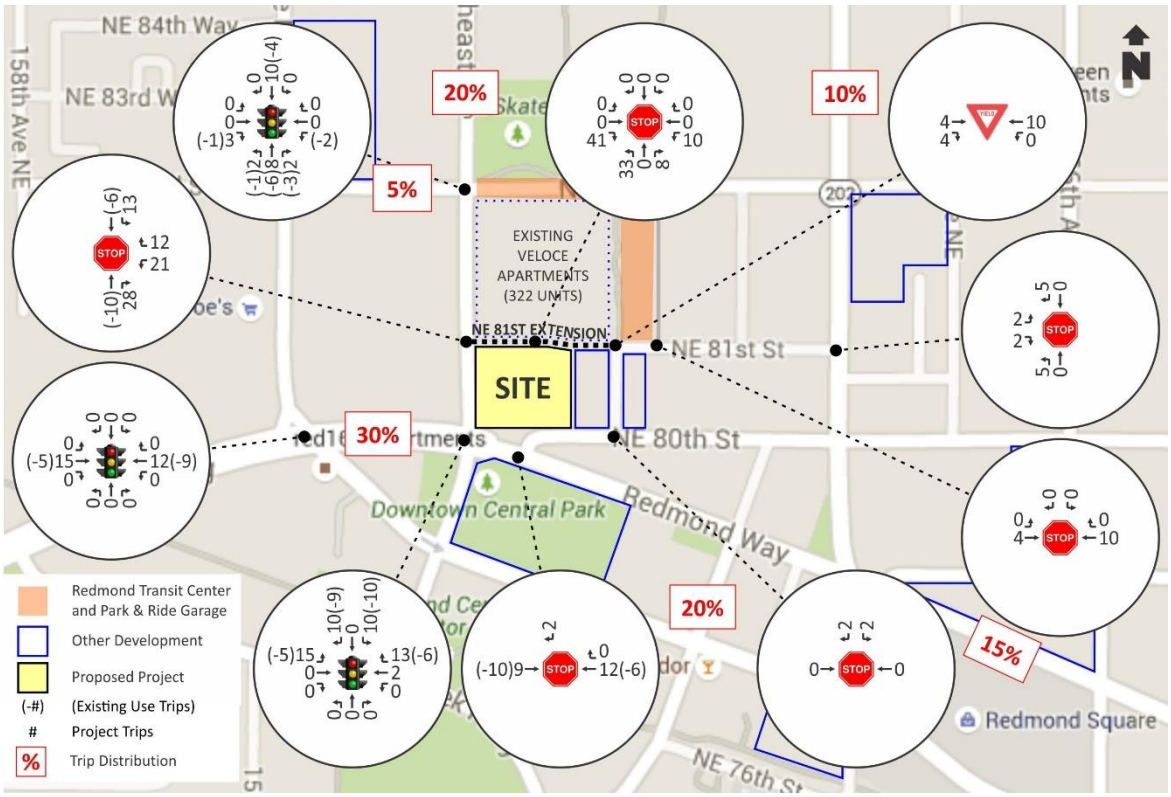


Figure 9: PM Peak Hour Distribution and Assignment

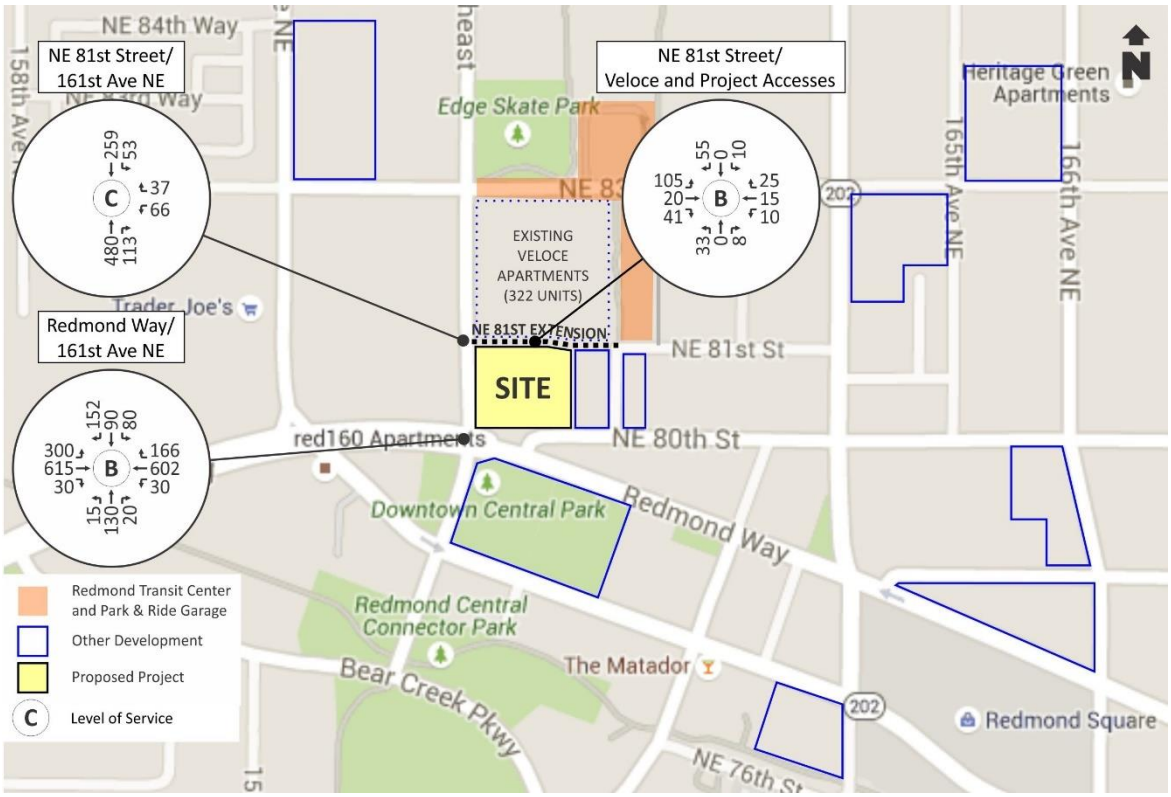


Figure 10: 2018 With-Project PM Peak Hour Volumes

Analysis of Forecast Year Traffic Operations "Without" and "With" the Project

Level of Service

Table 5 summarizes the PM peak hour intersection LOS for future without and with the development conditions. With the Project the study intersections satisfy the City of Redmond's LOS D standard.

Table 5: 2018 Without- and With-Project Traffic Level of Service

Intersection	Control	LOS Method	2018 Without Project			2018 With Project		
			LOS	Vol. or Delay [1]	V/C or Mvmt. [2]	LOS	Vol. or Delay [1]	V/C or Mvmt. [2]
Redmond Way / 161st Ave NE	Signal	Circular 212	B	925	0.67	B	926	0.67
NE 81st Street / 161st Ave NE	Stop	2010 HCM	C	16.1	EB	C	18.0	EB
NE 81st Street / Site Access	Stop	2010 HCM	-	-	-	B	12.7	NB

1. Critical Volume (Circular 212) or Delay (2010 HCM)
2. Volume-to-Capacity Ratio (Circular 212) or Worst Controlled Movement (2010 HCM)

Queue Analysis

Synchro was used to model vehicle queues at the study intersections. **Table 6** summarizes average and 95th-percentile vehicle queues in 2018 without and with the Project. Vehicle queues are not projected to impact or impede Project trips and local traffic circulations.

Table 6: 2018 Future Project Queue Analysis

Intersection	Mvmt.	Storage [1]	Without-Project Queue		With-Project Queue	
			Average [2]	95th [3]	Average [2]	95th [3]
Redmond Way / 161st Ave NE	EB L	150	80	125	80	130
	WB L	125	10	20	10	20
	WB T	-	185	240	185	245
	SB L	200	40	80	30	65
	SB T	-	85	165	90	170
NE 81st Street / 161st Ave NE	WB	-	-	15	-	25
	SB L	50	-	5	-	5
NE 81st Street / Site Access	WB	-	-	-	-	5
	EB	-	-	-	-	<5
	NB	-	-	-	-	10
	SB	-	-	-	-	5

1. Storage bay length (feet)
2. Average vehicle queue (feet), measure of driver experience
3. 95th-percentile vehicle queue (feet) based on 95th-percentile volumes

Site Access

Project access is on NE 81st Street and is forecast to operate at LOS B. Queues exiting the site are not significant and are not anticipated to impede the onsite circulation.

Parking Requirements

The Project proposes 192 onsite parking stalls. On street parking is available in the local area; however, these public stalls are not adjacent to the site. The Project proposes 195 multifamily units and 4,100 sq. ft. of commercial space. **Table 7** summarizes the parking requirements.

A parking variance was approved by Redmond Planning on February 3, 2016 to reduce the City's multifamily parking requirement from 1.25 stalls per unit to 0.945 stalls per unit.

It is noted that King County's Right Size Parking recommendations, updated based on the current site plan, shows some additional flexibility with the 0.945 stalls per unit parking ratio. The Right Size Parking output, see Appendix, suggests the parking ratio for this particular site is 0.93 stalls per unit, or as low as 0.81 stalls per unit if all of the onsite parking is unbundled, or separate from, the unit leases.

Table 7: Parking Requirements

Land Use	Units	Parking Ratio	Parking Required
Multifamily	195 dwellings	0.945 stalls / unit [1]	184 stalls
General Sales or Services	4.100 k SF	2.0 stalls / k SF	8 stalls
Required:			192 stalls

1. Parking ratio approved by Redmond Planning Department

The Project is proposed with 192 onsite parking stalls and will meets the parking requirements.

Transit Service and Non-Motorized Facilities

The Project is located in downtown and one block from the transit center. Daily transit ridership is projected to increase by 140 work-commuters and PM peak hour transit ridership is projected to increase by 14 work-commuters with the Project, refer to Table 4. The current transit service is anticipated to reasonably accommodate future ridership.

Frontage improvements will improve the sidewalks along 161st Ave NE and NE 80th Street and provide new sidewalks along NE 81st Street.

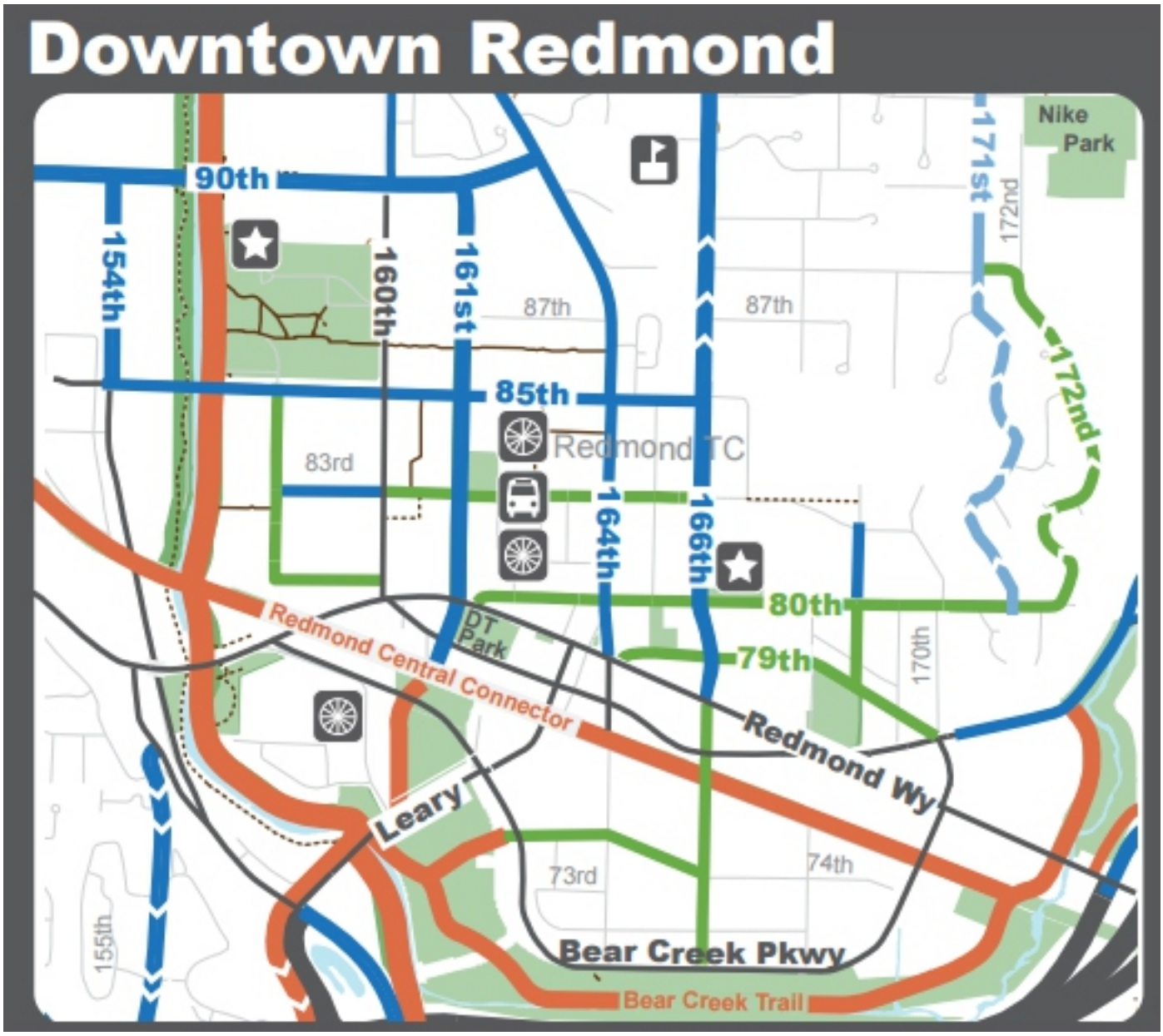
Mitigation

The study intersections and site access satisfy the City of Redmond's LOS standards and vehicle queues are not projected to adversely affect Project trip circulation. No offsite mitigation is required.

As indicated above, the applicant will complete the road extension of NE 81st Street and will provide their frontage improvements as required by the City of Redmond.

Traffic impact fees will be computed by the city and are due at the time of building permit issuance.

Appendix



Multi-Use Trail
Paved

Bike Lanes

Wide Shoulders

Shared Roadway
Lower Traffic

Multi-Use Trail
Un-Paved

Multi-Use Trail
Un-Paved (Non-Bikable)

Major Arterial

Uphill Grade

Other Arterial

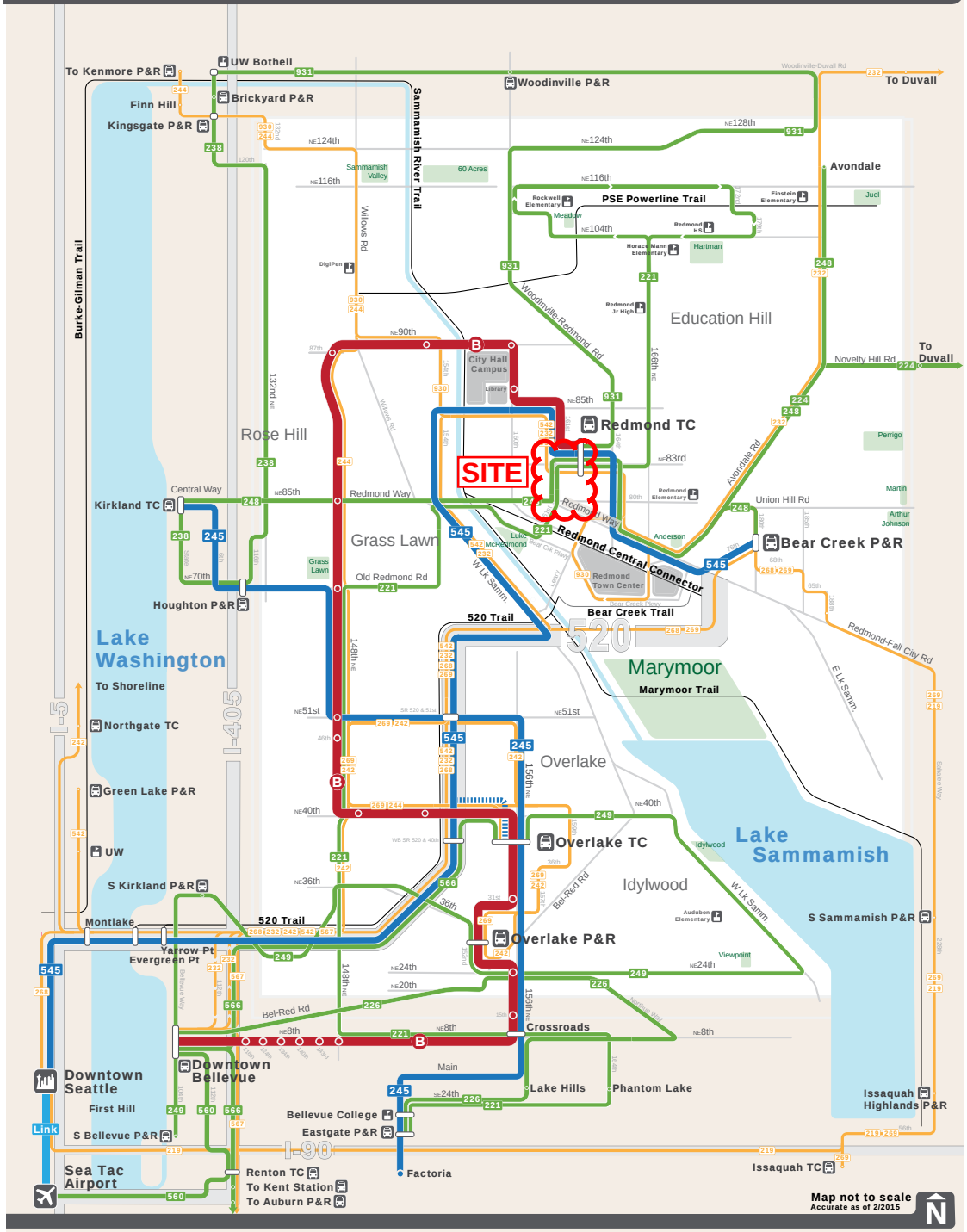
Transit Center or Park and Ride

Bike Shop

Civic Center or Library

Redmond Downtown Bicycle Map

Redmond Transit Connections



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Metro.KingCounty.gov
SoundTransit.org

Get a transit pass

Get an ORCA card to speed up boarding and get transfers for KC Metro and Sound Transit service. Load a monthly pass, or use an "e-purse" for individual fares. Senior and reduced-fare cards available for those who qualify.
OrcaCard.com

OneBusAway.org

OneBusAway provides easy access to real-time transit information for the Puget Sound and beyond. Go online or use their smart phone application.

Transit Centers

Below is a list of all routes serving nearby Transit Centers and Park and Rides:

Text color matches service frequency

Redmond

Redmond TC B Line, 545, 221, 248, 931, 232, 542, 232	**Bear Creek** 545, 248, 216, 268, 269
Overlake TC B Line, 545, 245, 249, 566, 232, 244, 245, 268, 269, 542	**Overlake P&R** B Line, 249, 242, 269

Kirkland

S Kirkland P&R 234, 235, 255, 249, 540	**Kirkland TC** 245, 255, 234, 235, 238, 248, 540
Houghton P&R 245, 238, 277, 342, 952	**Kingsgate P&R** 255, 235, 237, 238, 255, 244, 252, 257, 277, 311, 532, 535, 930, 952

Bellevue

Bellevue TC B Line, 234, 235, 271, 550, 226, 237, 240, 241, 246, 249, 560, 566, 232, 280, 342, 555, 567	**Eastgate P&R** 245, 221, 226, 240, 241, 246, 271, 554, 211, 212, 216, 217, 218, 555, 556
	S Bellevue TC 550, 241, 249, 560, 555, 556

East King

Issaquah TC 200, 208, 271, 554, 214, 269, 555, 556	**S Sammamish P&R** 216, 219, 269, 554
Woodinville P&R 236, 931, 372, 522, 237, 311	**Issaquah Highlands P&R** 554, 216, 218, 219, 269, 555, 556

All Day Frequent Routes

Every 10-15 minutes during the weekdays
Every 30-60 minutes on nights and weekends

Rapid Ride B Line (Stop)
Redmond-Overlake-Bellevue

(Major Destination or Terminus — Afternoons Only)
245 Kirkland-Overlake-Factoria
545 Seattle-Overlake-Redmond

Other All Day Routes

Every 30-60 minutes during the weekdays
Every 30-60 minutes on most nights and weekends

(Major Destination or Terminus)
221 Education Hill-Grasslawn-Factoria
224 Redmond-Novelty Hill Road-Duvall (Service Every 90 Minutes)
238 Kirkland-Rose Hill-Bothell
248 Avondale-Redmond-Kirkland
249 Overlake-Idylwood-Bellevue
931 Redmond-Woodinville-Bothell (No Sunday Service)
560 Bellevue-Renton-Sea Tac
566 Overlake-Bellevue-Auburn (No Weekend Service)

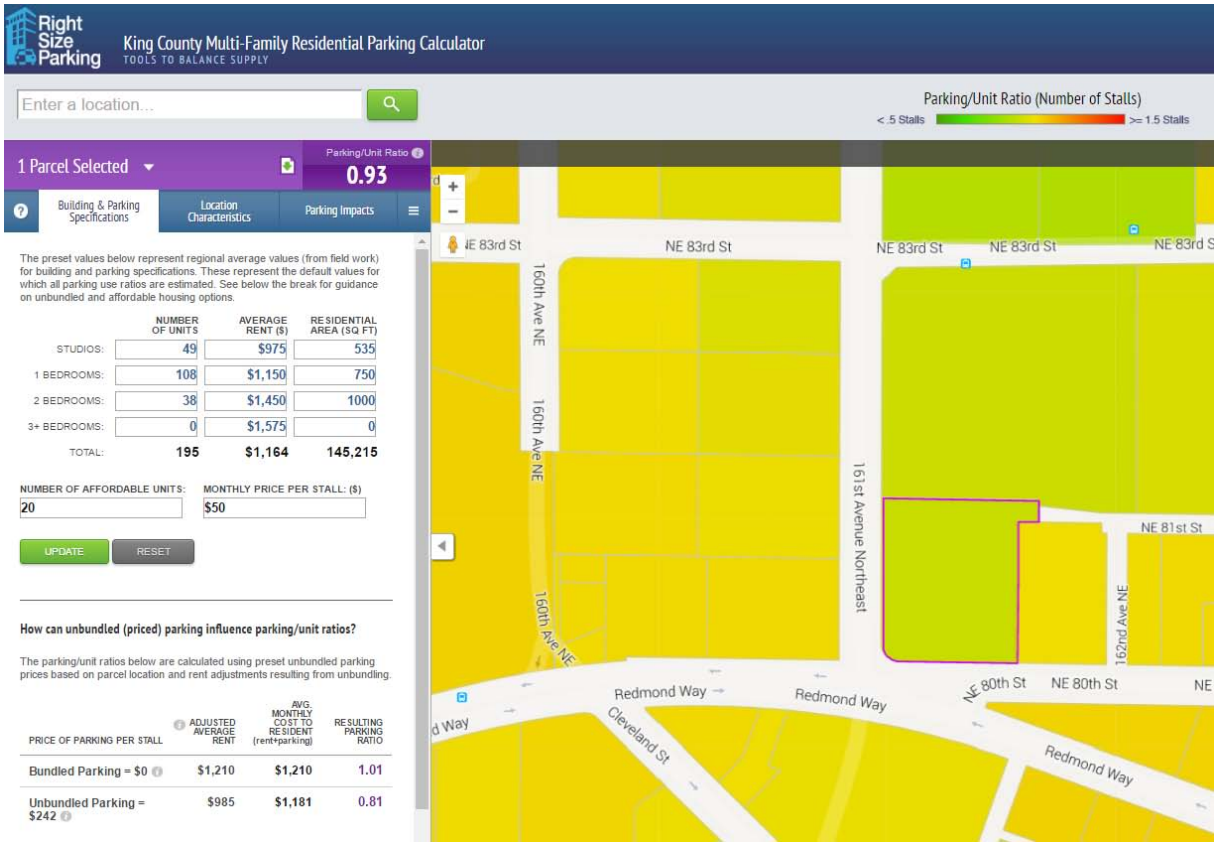
Peak Only Routes

Weekday peak hour (6-9am, 3-6pm) service connecting major destinations
Some routes run only one direction during peak hours
See ↔ below

(Major Destination or Terminus)
219 AM ↑ PM ↓ Redmond-Issaquah-Seattle
232 AM ↓ PM ↑ Duvall-Redmond-Bellevue (One Direction Between Duvall-Redmond)
242 AM ↓ PM ↑ Ridgecrest-Northgate-Overlake
244 AM ↓ PM ↑ Bothell-Totem Lake-Overlake
268 AM ↓ PM ↑ SE Redmond-Overlake-Seattle
269 AM ↓ PM ↑ Issaquah-Sammamish-Overlake
542 AM ↓ PM ↑ Redmond-UW-Greenlake
567 AM ↑ PM ↓ Kent-Bellevue-Overlake
930 AM ↑ PM ↓ Redmond-Willows-Totem Lake

Major Connection Point
Major Regional Trail
Redmond Boundaries
Point of Interest
Park
School or College
Transit Center /Park & Ride

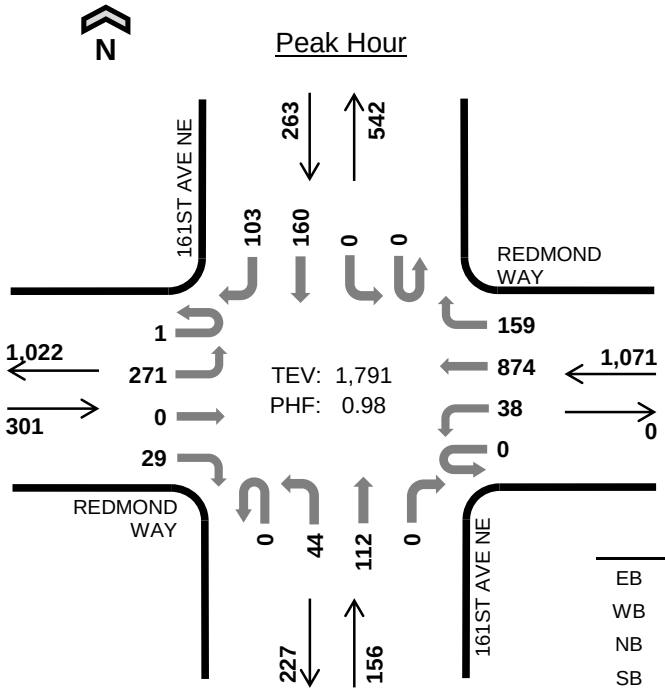
Parking ratio 0.93. Note: If parking unbundled from unit leases then an 0.81 parking ratio would work.

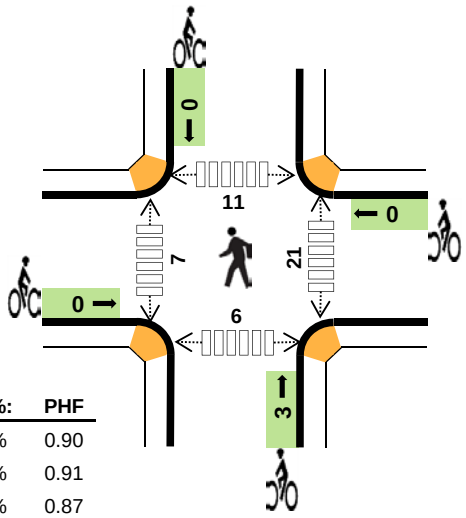


161ST AVE NE
REDMOND WAY

Peak Hour

Date: Thu, Nov 05, 2015
Count Period: 4:00 PM to 6:00 PM
Peak Hour: 5:00 PM to 6:00 PM





	HV %:	PHF
EB	1.0%	0.90
WB	0.7%	0.91
NB	1.9%	0.87
SB	1.9%	0.93
TOTAL	1.0%	0.98

Two-Hour Count Summaries

Interval Start	REDMOND WAY Eastbound				REDMOND WAY Westbound				161ST AVE NE Northbound				161ST AVE NE Southbound				15-min Total	Rolling One Hour
	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT	UT	LT	TH	RT		
4:00 PM	0	48	0	5	0	13	274	26	0	8	19	0	0	0	33	30	456	0
4:15 PM	0	42	0	4	0	11	227	43	0	11	24	0	0	0	32	36	430	0
4:30 PM	0	43	0	2	0	4	210	34	0	7	17	0	0	0	31	32	380	0
4:45 PM	1	62	0	3	0	5	188	38	0	5	27	0	0	0	32	32	393	1,659
5:00 PM	**0**	**60**	**0**	**9**	**0**	**8**	**243**	**42**	**0**	**12**	**20**	**0**	**0**	**0**	**37**	**26**	**457**	1,660
5:15 PM	**0**	**69**	**0**	**5**	**0**	**6**	**223**	**41**	**0**	**11**	**33**	**0**	**0**	**0**	**40**	**25**	**453**	1,683
5:30 PM	**1**	**67**	**0**	**6**	**0**	**11**	**190**	**41**	**0**	**11**	**34**	**0**	**0**	**0**	**43**	**28**	**432**	1,735
5:45 PM	**0**	**75**	**0**	**9**	**0**	**13**	**218**	**35**	**0**	**10**	**25**	**0**	**0**	**0**	**40**	**24**	**449**	**1,791**
Count Total	2	466	0	43	0	71	1,773	300	0	75	199	0	0	0	288	233	3,450	0
Peak Hour	**1**	**271**	**0**	**29**	**0**	**38**	**874**	**159**	**0**	**44**	**112**	**0**	**0**	**0**	**160**	**103**	**1,791**	**0**

Note: Two-hour count summary volumes include heavy vehicles but exclude bicycles in overall count.

Interval Start	Heavy Vehicle Totals					Bicycles					Pedestrians (Crossing Leg)				
	EB	WB	NB	SB	Total	EB	WB	NB	SB	Total	East	West	North	South	Total
4:00 PM	2	8	2	0	*12*	0	0	0	0	*0*	1	2	0	1	*4*
4:15 PM	1	1	1	4	*7*	0	0	0	0	*0*	4	4	4	4	*16*
4:30 PM	1	4	1	0	*6*	0	0	0	0	*0*	2	4	6	4	*16*
4:45 PM	2	2	0	2	*6*	0	0	0	0	*0*	3	0	2	0	*5*
5:00 PM	**2**	**3**	**2**	**0**	***7***	**0**	**0**	**0**	**0**	***0***	**6**	**1**	**5**	**0**	*12*
5:15 PM	**0**	**1**	**0**	**1**	***2***	**0**	**0**	**1**	**0**	***1***	**8**	**0**	**2**	**1**	*11*
5:30 PM	**0**	**2**	**0**	**3**	***5***	**0**	**0**	**1**	**0**	***1***	**4**	**1**	**2**	**2**	*9*
5:45 PM	**1**	**1**	**1**	**1**	***4***	**0**	**0**	**1**	**0**	***1***	**3**	**5**	**2**	**3**	***13***
Count Total	9	22	7	11	*49*	0	0	3	0	*3*	31	17	23	15	*86*
Peak Hour	**3**	**7**	**3**	**5**	***18***	**0**	**0**	**3**	**0**	***3***	**21**	**7**	**11**	**6**	***45***

Timings
1: 161 AVE NE & RED WAY

6/23/2016

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	290	615	40	600	15	130	80	90
Future Volume (vph)	290	615	40	600	15	130	80	90
Turn Type	pm+pt	NA	pm+pt	NA	Perm	NA	pm+pt	NA
Protected Phases	1	6	5	2		8	7	4
Permitted Phases	6		2		8		4	
Detector Phase	1	6	5	2	8	8	7	4
Switch Phase								
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	9.5	22.5	9.5	22.5	22.5	22.5	9.5	22.5
Total Split (s)	20.2	59.6	9.6	49.0	22.8	22.8	10.0	32.8
Total Split (%)	19.8%	58.4%	9.4%	48.0%	22.4%	22.4%	9.8%	32.2%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	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)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lag	Lead	
Lead-Lag Optimize?								
Recall Mode	None	C-Min	None	C-Min	None	None	None	None

Intersection Summary

Cycle Length: 102
Actuated Cycle Length: 102
Offset: 90 (88%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 1: 161 AVE NE & RED WAY

Queues
1: 161 AVE NE & RED WAY

6/23/2016

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	296	659	41	775	15	153	82	245
v/c Ratio	0.65	0.65	0.11	0.51	0.11	0.67	0.36	0.58
Control Delay	15.5	19.8	9.3	20.3	38.1	53.7	33.0	26.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.5	19.8	9.3	20.3	38.1	53.7	33.0	26.7
Queue Length 50th (ft)	81	322	9	183	9	92	40	87
Queue Length 95th (ft)	123	452	22	242	27	153	80	167
Internal Link Dist (ft)		475		64		435		233
Turn Bay Length (ft)	150		125		75		200	
Base Capacity (vph)	471	1045	366	1546	181	296	229	486
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	0.63	0.63	0.11	0.50	0.08	0.52	0.36	0.50

Intersection Summary

HCM Signalized Intersection Capacity Analysis
1: 161 AVE NE & RED WAY

6/23/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	290	615	30	40	600	160	15	130	20	80	90	150
Future Volume (vph)	290	615	30	40	600	160	15	130	20	80	90	150
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Lane Util. Factor	1.00	1.00		1.00	0.95		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	0.99		1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.99	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.97		1.00	0.98		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1608	1678		1608	3082		1579	1627		1593	1497	
Flt Permitted	0.25	1.00		0.33	1.00		0.61	1.00		0.37	1.00	
Satd. Flow (perm)	428	1678		565	3082		1009	1627		621	1497	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	296	628	31	41	612	163	15	133	20	82	92	153
RTOR Reduction (vph)	0	2	0	0	22	0	0	5	0	0	61	0
Lane Group Flow (vph)	296	657	0	41	753	0	15	148	0	82	184	0
Confl. Peds. (#/hr)			6			11	7		21			7
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA		pm+pt	NA	
Protected Phases	1	6		5	2			8		7	4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	67.4	59.3		52.2	48.6		14.1	14.1		25.6	25.6	
Effective Green, g (s)	67.4	59.3		52.2	48.6		14.1	14.1		25.6	25.6	
Actuated g/C Ratio	0.66	0.58		0.51	0.48		0.14	0.14		0.25	0.25	
Clearance Time (s)	4.5	4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	448	975		325	1468		139	224		222	375	
v/s Ratio Prot	c0.09	c0.39		0.00	0.24			c0.09		0.03	c0.12	
v/s Ratio Perm	0.34			0.06			0.01			0.07		
v/c Ratio	0.66	0.67		0.13	0.51		0.11	0.66		0.37	0.49	
Uniform Delay, d1	9.5	14.7		12.9	18.5		38.4	41.7		30.5	32.6	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.6	3.7		0.2	1.3		0.3	6.9		1.0	1.0	
Delay (s)	13.2	18.4		13.1	19.8		38.8	48.5		31.6	33.7	
Level of Service	B	B		B	B		D	D		C	C	
Approach Delay (s)		16.8			19.4			47.7			33.1	
Approach LOS		B			B			D			C	

Intersection Summary				
HCM 2000 Control Delay	22.4	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.69			
Actuated Cycle Length (s)	102.0	Sum of lost time (s)	18.0	
Intersection Capacity Utilization	77.3%	ICU Level of Service	D	
Analysis Period (min)	15			

c Critical Lane Group

HCM 2010 Signalized Intersection Summary
1: 161 AVE NE & RED WAY

6/23/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	290	615	30	40	600	160	15	130	20	80	90	150
Future Volume (veh/h)	290	615	30	40	600	160	15	130	20	80	90	150
Number	1	6	16	5	2	12	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.99	1.00		0.99	0.99		0.96	0.98		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1693	1693	1710	1693	1693	1710	1676	1676	1710	1676	1676	1710
Adj Flow Rate, veh/h	296	628	31	41	612	163	15	133	20	82	92	153
Adj No. of Lanes	1	1	0	1	2	0	1	1	0	1	1	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	1	1	1	1	1	1	2	2	2	2	2	2
Cap, veh/h	471	952	47	359	1319	351	160	199	30	212	134	223
Arrive On Green	0.10	0.60	0.60	0.03	0.53	0.53	0.14	0.14	0.14	0.05	0.24	0.24
Sat Flow, veh/h	1612	1600	79	1612	2509	667	1003	1414	213	1597	562	934
Grp Volume(v), veh/h	296	0	659	41	392	383	15	0	153	82	0	245
Grp Sat Flow(s),veh/h/ln	1612	0	1679	1612	1608	1567	1003	0	1627	1597	0	1495
Q Serve(g_s), s	8.1	0.0	26.7	1.2	15.6	15.6	1.4	0.0	9.1	4.3	0.0	15.2
Cycle Q Clear(g_c), s	8.1	0.0	26.7	1.2	15.6	15.6	6.6	0.0	9.1	4.3	0.0	15.2
Prop In Lane	1.00		0.05	1.00		0.43	1.00		0.13	1.00		0.62
Lane Grp Cap(c), veh/h	471	0	999	359	846	824	160	0	229	212	0	357
V/C Ratio(X)	0.63	0.00	0.66	0.11	0.46	0.46	0.09	0.00	0.67	0.39	0.00	0.69
Avail Cap(c_a), veh/h	553	0	999	385	846	824	199	0	292	212	0	415
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.6	0.0	13.8	12.2	15.2	15.2	42.9	0.0	41.6	33.8	0.0	35.3
Incr Delay (d2), s/veh	1.7	0.0	3.4	0.1	1.8	1.9	0.3	0.0	3.9	1.1	0.0	3.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.8	0.0	13.2	0.5	7.3	7.1	0.4	0.0	4.3	2.0	0.0	6.6
LnGrp Delay(d),s/veh	12.3	0.0	17.2	12.3	17.0	17.1	43.2	0.0	45.5	35.0	0.0	39.2
LnGrp LOS	B		B	B	B	B	D		D	C		D
Approach Vol, veh/h		955			816			168			327	
Approach Delay, s/veh		15.7			16.8			45.3			38.1	
Approach LOS		B			B			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.0	58.1		28.9	7.9	65.2	10.0	18.9
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	15.7	44.5		28.3	5.1	55.1	5.5	18.3
Max Q Clear Time (g_c+I1), s	10.1	17.6		17.2	3.2	28.7	6.3	11.1
Green Ext Time (p_c), s	0.4	11.4		1.9	0.0	11.3	0.0	1.4

Intersection Summary		
HCM 2010 Ctrl Delay	21.5	
HCM 2010 LOS	C	

HCM Unsignalized Intersection Capacity Analysis
2: 161 AVE NE & NE 81 EXT

6/23/2016

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	45	20	490	85	40	265
Future Volume (Veh/h)	45	20	490	85	40	265
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)	50	22	544	94	44	294
Pedestrians	40					
Lane Width (ft)	12.0					
Walking Speed (ft/s)	3.5					
Percent Blockage	4					
Right turn flare (veh)						
Median type			TWLTL			TWLTL
Median storage veh)			2			2
Upstream signal (ft)			313			
pX, platoon unblocked	0.85	0.85			0.85	
vC, conflicting volume	1013	631			678	
vC1, stage 1 conf vol	631					
vC2, stage 2 conf vol	382					
vCu, unblocked vol	925	473			529	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	89	95			95	
cM capacity (veh/h)	443	483			850	

Direction, Lane #	WB 1	NB 1	SB 1	SB 2
Volume Total	72	638	44	294
Volume Left	50	0	44	0
Volume Right	22	94	0	0
cSH	454	1700	850	1700
Volume to Capacity	0.16	0.38	0.05	0.17
Queue Length 95th (ft)	14	0	4	0
Control Delay (s)	14.4	0.0	9.5	0.0
Lane LOS	B		A	
Approach Delay (s)	14.4	0.0	1.2	
Approach LOS	B			

Intersection Summary			
Average Delay	1.4		
Intersection Capacity Utilization	47.7%	ICU Level of Service	A
Analysis Period (min)	15		

HCM 2010 TWSC
2: 161 AVE NE & NE 81 EXT

6/23/2016

Intersection	
Int Delay, s/veh	1.5

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	45	20	490	85	40	265
Future Vol, veh/h	45	20	490	85	40	265
Conflicting Peds, #/hr	0	0	0	40	40	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	50	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	1	1	1	1	1	9
Mvmt Flow	50	22	544	94	44	294

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1015	632	0	0	679	0
Stage 1	632	-	-	-	-	-
Stage 2	383	-	-	-	-	-
Critical Hdwy	6.41	6.21	-	-	4.11	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	-	-	2.209	-
Pot Cap-1 Maneuver	265	482	-	-	918	-
Stage 1	532	-	-	-	-	-
Stage 2	691	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	243	464	-	-	918	-
Mov Cap-2 Maneuver	371	-	-	-	-	-
Stage 1	512	-	-	-	-	-
Stage 2	658	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	16.1	0	1.2
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	395	918	-
HCM Lane V/C Ratio	-	-	0.183	0.048	-
HCM Control Delay (s)	-	-	16.1	9.1	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	0.7	0.2	-

Timings
1: 161 AVE NE & RED WAY

6/23/2016

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Configurations								
Traffic Volume (vph)	300	615	40	602	15	130	60	90
Future Volume (vph)	300	615	40	602	15	130	60	90
Turn Type	pm+pt	NA	pm+pt	NA	Perm	NA	pm+pt	NA
Protected Phases	1	6	5	2		8	7	4
Permitted Phases	6		2		8		4	
Detector Phase	1	6	5	2	8	8	7	4
Switch Phase								
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Minimum Split (s)	9.5	22.5	9.5	22.5	22.5	22.5	9.5	22.5
Total Split (s)	20.2	59.6	9.6	49.0	22.8	22.8	10.0	32.8
Total Split (%)	19.8%	58.4%	9.4%	48.0%	22.4%	22.4%	9.8%	32.2%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	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)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Lead/Lag	Lead	Lag	Lead	Lag	Lag	Lag	Lead	
Lead-Lag Optimize?								
Recall Mode	None	C-Min	None	C-Min	None	None	None	None

Intersection Summary

Cycle Length: 102
Actuated Cycle Length: 102
Offset: 90 (88%), Referenced to phase 2:WBTL and 6:EBTL, Start of Green
Natural Cycle: 80
Control Type: Actuated-Coordinated

Splits and Phases: 1: 161 AVE NE & RED WAY

Queues
1: 161 AVE NE & RED WAY

6/23/2016

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	306	659	41	783	15	153	61	247
v/c Ratio	0.67	0.64	0.11	0.52	0.11	0.67	0.28	0.59
Control Delay	15.9	19.4	9.1	20.3	38.1	53.7	31.2	27.5
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.9	19.4	9.1	20.3	38.1	53.7	31.2	27.5
Queue Length 50th (ft)	81	313	9	185	9	92	30	89
Queue Length 95th (ft)	131	452	22	245	27	153	63	169
Internal Link Dist (ft)		475		64		435		233
Turn Bay Length (ft)	150		125		75		200	
Base Capacity (vph)	472	1049	373	1543	180	296	218	483
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	0.65	0.63	0.11	0.51	0.08	0.52	0.28	0.51

Intersection Summary

HCM Signalized Intersection Capacity Analysis
1: 161 AVE NE & RED WAY

6/23/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	300	615	30	40	602	166	15	130	20	60	90	152
Future Volume (vph)	300	615	30	40	602	166	15	130	20	60	90	152
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Lane Util. Factor	1.00	1.00		1.00	0.95		1.00	1.00		1.00	1.00	
Frpb, ped/bikes	1.00	1.00		1.00	0.99		1.00	0.99		1.00	0.99	
Flpb, ped/bikes	1.00	1.00		1.00	1.00		0.99	1.00		1.00	1.00	
Frt	1.00	0.99		1.00	0.97		1.00	0.98		1.00	0.91	
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1608	1678		1608	3079		1579	1627		1593	1496	
Flt Permitted	0.25	1.00		0.34	1.00		0.61	1.00		0.37	1.00	
Satd. Flow (perm)	421	1678		578	3079		1007	1627		621	1496	
Peak-hour factor, PHF	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Adj. Flow (vph)	306	628	31	41	614	169	15	133	20	61	92	155
RTOR Reduction (vph)	0	2	0	0	23	0	0	5	0	0	62	0
Lane Group Flow (vph)	306	657	0	41	760	0	15	148	0	61	185	0
Confl. Peds. (#/hr)			6			11	7		21			7
Heavy Vehicles (%)	1%	1%	1%	1%	1%	1%	2%	2%	2%	2%	2%	2%
Turn Type	pm+pt	NA		pm+pt	NA		Perm	NA		pm+pt	NA	
Protected Phases	1	6		5	2			8		7	4	
Permitted Phases	6			2			8			4		
Actuated Green, G (s)	68.0	59.8		52.2	48.5		14.1	14.1		25.0	25.0	
Effective Green, g (s)	68.0	59.8		52.2	48.5		14.1	14.1		25.0	25.0	
Actuated g/C Ratio	0.67	0.59		0.51	0.48		0.14	0.14		0.25	0.25	
Clearance Time (s)	4.5	4.5		4.5	4.5		4.5	4.5		4.5	4.5	
Vehicle Extension (s)	3.0	3.0		3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	455	983		333	1464		139	224		213	366	
v/s Ratio Prot	c0.10	0.39		0.00	0.25			c0.09		0.02	c0.12	
v/s Ratio Perm	c0.35			0.06			0.01			0.05		
v/c Ratio	0.67	0.67		0.12	0.52		0.11	0.66		0.29	0.51	
Uniform Delay, d1	9.5	14.4		12.9	18.6		38.4	41.7		30.6	33.2	
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	3.9	3.6		0.2	1.3		0.3	6.9		0.7	1.1	
Delay (s)	13.4	18.0		13.0	19.9		38.8	48.5		31.3	34.3	
Level of Service	B	B		B	B		D	D		C	C	
Approach Delay (s)		16.5			19.6			47.7			33.7	
Approach LOS		B			B			D			C	

Intersection Summary				
HCM 2000 Control Delay	22.3	HCM 2000 Level of Service	C	
HCM 2000 Volume to Capacity ratio	0.69			
Actuated Cycle Length (s)	102.0	Sum of lost time (s)	18.0	
Intersection Capacity Utilization	78.3%	ICU Level of Service	D	
Analysis Period (min)	15			

c Critical Lane Group

HCM 2010 Signalized Intersection Summary
1: 161 AVE NE & RED WAY

6/23/2016

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	300	615	30	40	602	166	15	130	20	60	90	152
Future Volume (veh/h)	300	615	30	40	602	166	15	130	20	60	90	152
Number	1	6	16	5	2	12	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.99	0.99		0.96	0.98		0.98
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1693	1693	1710	1693	1693	1710	1676	1676	1710	1676	1676	1710
Adj Flow Rate, veh/h	306	628	31	41	614	169	15	133	20	61	92	155
Adj No. of Lanes	1	1	0	1	2	0	1	1	0	1	1	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	1	1	1	1	1	1	2	2	2	2	2	2
Cap, veh/h	478	971	48	372	1336	367	145	199	30	194	126	213
Arrive On Green	0.10	0.61	0.61	0.03	0.54	0.54	0.14	0.14	0.14	0.04	0.23	0.23
Sat Flow, veh/h	1612	1600	79	1612	2489	684	1002	1415	213	1597	556	937
Grp Volume(v), veh/h	306	0	659	41	396	387	15	0	153	61	0	247
Grp Sat Flow(s),veh/h/ln	1612	0	1679	1612	1608	1564	1002	0	1627	1597	0	1494
Q Serve(g_s), s	8.1	0.0	25.9	1.1	15.5	15.5	1.4	0.0	9.1	3.2	0.0	15.6
Cycle Q Clear(g_c), s	8.1	0.0	25.9	1.1	15.5	15.5	8.3	0.0	9.1	3.2	0.0	15.6
Prop In Lane	1.00		0.05	1.00		0.44	1.00		0.13	1.00		0.63
Lane Grp Cap(c), veh/h	478	0	1019	372	863	840	145	0	229	194	0	339
V/C Ratio(X)	0.64	0.00	0.65	0.11	0.46	0.46	0.10	0.00	0.67	0.31	0.00	0.73
Avail Cap(c_a), veh/h	559	0	1019	399	863	840	183	0	292	213	0	414
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.2	0.0	13.0	11.5	14.5	14.5	44.4	0.0	41.6	34.4	0.0	36.5
Incr Delay (d2), s/veh	1.9	0.0	3.2	0.1	1.8	1.8	0.3	0.0	3.9	0.9	0.0	5.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.8	0.0	12.8	0.5	7.2	7.1	0.4	0.0	4.3	1.5	0.0	6.9
LnGrp Delay(d),s/veh	12.1	0.0	16.1	11.6	16.3	16.3	44.7	0.0	45.5	35.3	0.0	41.5
LnGrp LOS	B		B	B	B	B	D		D	D		D
Approach Vol, veh/h		965			824			168			308	
Approach Delay, s/veh		14.9			16.1			45.4			40.3	
Approach LOS		B			B			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.1	59.3		27.7	7.9	66.4	8.8	18.9
Change Period (Y+Rc), s	4.5	4.5		4.5	4.5	4.5	4.5	4.5
Max Green Setting (Gmax), s	15.7	44.5		28.3	5.1	55.1	5.5	18.3
Max Q Clear Time (g_c+I1), s	10.1	17.5		17.6	3.1	27.9	5.2	11.1
Green Ext Time (p_c), s	0.5	11.5		1.9	0.0	11.6	0.0	1.4

Intersection Summary		
HCM 2010 Ctrl Delay	21.0	
HCM 2010 LOS	C	

HCM Unsignalized Intersection Capacity Analysis
2: 161 AVE NE & NE 81 EXT

6/23/2016

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Volume (veh/h)	66	37	480	113	53	259
Future Volume (Veh/h)	66	37	480	113	53	259
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)	73	41	533	126	59	288
Pedestrians	40					
Lane Width (ft)	12.0					
Walking Speed (ft/s)	3.5					
Percent Blockage	4					
Right turn flare (veh)						
Median type			TWLTL			TWLTL
Median storage veh)			2			2
Upstream signal (ft)			313			
pX, platoon unblocked	0.84	0.84			0.84	
vC, conflicting volume	1042	636			699	
vC1, stage 1 conf vol	636					
vC2, stage 2 conf vol	406					
vCu, unblocked vol	957	476			550	
tC, single (s)	6.4	6.2			4.1	
tC, 2 stage (s)	5.4					
tF (s)	3.5	3.3			2.2	
p0 queue free %	83	91			93	
cM capacity (veh/h)	432	480			831	

Direction, Lane #	WB 1	NB 1	SB 1	SB 2
Volume Total	114	659	59	288
Volume Left	73	0	59	0
Volume Right	41	126	0	0
cSH	448	1700	831	1700
Volume to Capacity	0.25	0.39	0.07	0.17
Queue Length 95th (ft)	25	0	6	0
Control Delay (s)	15.8	0.0	9.7	0.0
Lane LOS	C		A	
Approach Delay (s)	15.8	0.0	1.6	
Approach LOS	C			

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	56.3%	ICU Level of Service	B
Analysis Period (min)	15		

HCM 2010 TWSC
2: 161 AVE NE & NE 81 EXT

6/23/2016

Intersection	
Int Delay, s/veh	2.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	66	37	480	113	53	259
Future Vol, veh/h	66	37	480	113	53	259
Conflicting Peds, #/hr	0	0	0	40	40	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	50	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	1	1	1	1	1	9
Mvmt Flow	73	41	533	126	59	288

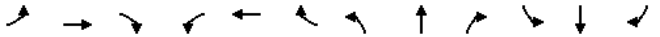
Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1042	636	0	0	699	0
Stage 1	636	-	-	-	-	-
Stage 2	406	-	-	-	-	-
Critical Hdwy	6.41	6.21	-	-	4.11	-
Critical Hdwy Stg 1	5.41	-	-	-	-	-
Critical Hdwy Stg 2	5.41	-	-	-	-	-
Follow-up Hdwy	3.509	3.309	-	-	2.209	-
Pot Cap-1 Maneuver	256	480	-	-	902	-
Stage 1	529	-	-	-	-	-
Stage 2	675	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	230	462	-	-	902	-
Mov Cap-2 Maneuver	360	-	-	-	-	-
Stage 1	509	-	-	-	-	-
Stage 2	631	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	18	0	1.6
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	391	902	-
HCM Lane V/C Ratio	-	-	0.293	0.065	-
HCM Control Delay (s)	-	-	18	9.3	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	1.2	0.2	-

HCM Unsignalized Intersection Capacity Analysis
3: Site Access & NE 81 EXT

6/23/2016



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	105	20	41	10	15	25	33	0	8	10	0	55
Future Volume (Veh/h)	105	20	41	10	15	25	33	0	8	10	0	55
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.90	0.90	0.90	0.90	0.92	0.90	0.92	0.90	0.92	0.92	0.92
Hourly flow rate (vph)	114	22	46	11	17	27	37	0	9	11	0	60
Pedestrians								50				
Lane Width (ft)								12.0				
Walking Speed (ft/s)								3.5				
Percent Blockage								5				
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	44			118			436	389	95	334	398	30
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	44			118			436	389	95	334	398	30
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			99			91	100	99	98	100	94
cM capacity (veh/h)	1564			1400			431	478	916	555	472	1044

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	182	55	46	71
Volume Left	114	11	37	11
Volume Right	46	27	9	60
cSH	1564	1400	481	918
Volume to Capacity	0.07	0.01	0.10	0.08
Queue Length 95th (ft)	6	1	8	6
Control Delay (s)	4.9	1.6	13.3	9.2
Lane LOS	A	A	B	A
Approach Delay (s)	4.9	1.6	13.3	9.2
Approach LOS			B	A

Intersection Summary				
Average Delay			6.3	
Intersection Capacity Utilization			32.4%	ICU Level of Service
Analysis Period (min)			15	

HCM 2010 TWSC
3: Site Access & NE 81 EXT

6/23/2016

Intersection	
Int Delay, s/veh	6.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	105	20	41	10	15	25	33	0	8	10	0	55
Future Vol, veh/h	105	20	41	10	15	25	33	0	8	10	0	55
Conflicting Peds, #/hr	0	0	50	50	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	92	90	90	90	90	92	90	92	90	92	92	92
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	114	22	46	11	17	27	37	0	9	11	0	60

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	44	0	0	118	0	0	405	389	95	330	398	30
Stage 1	-	-	-	-	-	-	323	323	-	52	52	-
Stage 2	-	-	-	-	-	-	82	66	-	278	346	-
Critical Hdwy	4.12	-	-	4.12	-	-	7.12	6.52	6.22	7.12	6.52	6.22
Critical Hdwy Stg 1	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.12	5.52	-	6.12	5.52	-
Follow-up Hdwy	2.218	-	-	2.218	-	-	3.518	4.018	3.318	3.518	4.018	3.318
Pot Cap-1 Maneuver	1564	-	-	1470	-	-	556	546	962	623	540	1044
Stage 1	-	-	-	-	-	-	689	650	-	961	852	-
Stage 2	-	-	-	-	-	-	926	840	-	728	635	-
Platoon blocked, %		-	-		-	-						
Mov Cap-1 Maneuver	1564	-	-	1470	-	-	467	477	916	578	471	1044
Mov Cap-2 Maneuver	-	-	-	-	-	-	467	477	-	578	471	-
Stage 1	-	-	-	-	-	-	606	572	-	888	845	-
Stage 2	-	-	-	-	-	-	866	833	-	666	559	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	4.7	1.5	12.7	9.2
HCM LOS			B	A

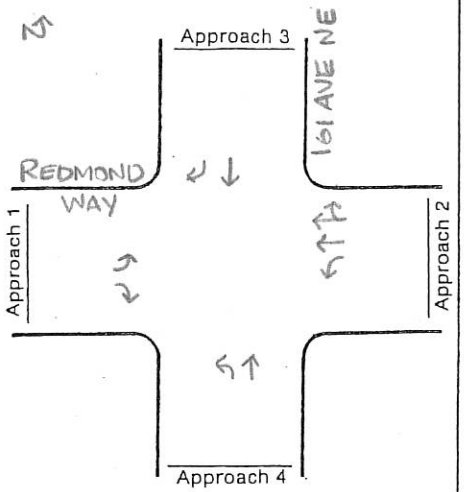
Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	516	1564	-	-	1470	-	-	929
HCM Lane V/C Ratio	0.088	0.073	-	-	0.008	-	-	0.076
HCM Control Delay (s)	12.7	7.5	0	-	7.5	0	-	9.2
HCM Lane LOS	B	A	A	-	A	A	-	A
HCM 95th %tile Q(veh)	0.3	0.2	-	-	0	-	-	0.2

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection 161 AVE NE / REDMOND WAY **Design Hour** PM

Problem Statement 2015 EXISTING

Step 1. Identify Lane Geometry



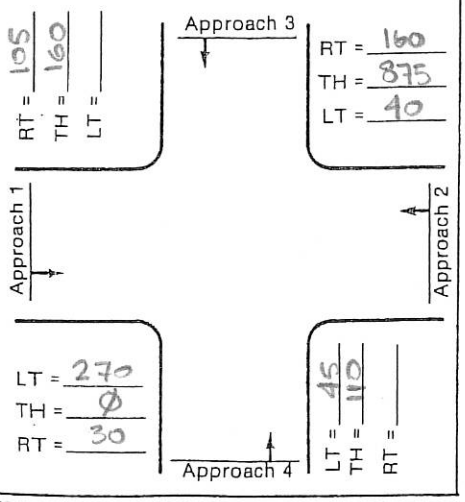
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour				
b. Left turn capacity on change interval, in vph				
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

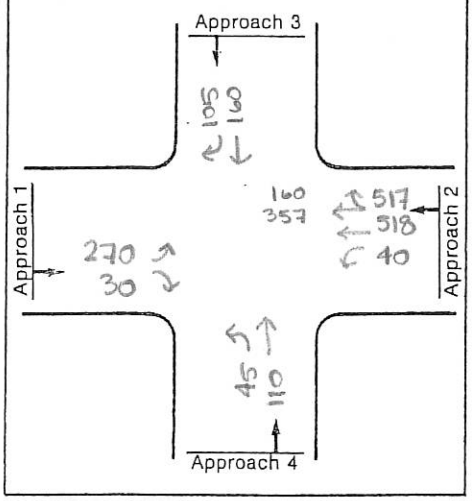
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
A2B1	518 (A2)		
B2	270 (B2)		
A3A4	160 (A3)		

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

518 + 270 + 160 + Ø

= 948 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

A

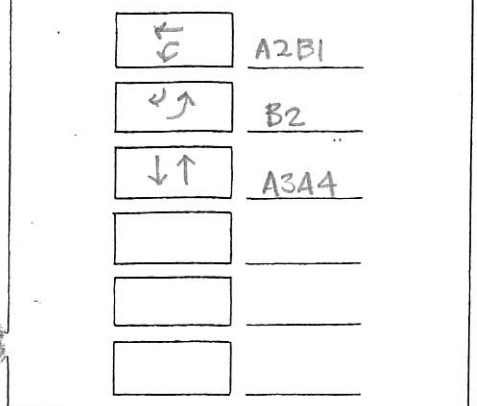
Step 9. Recalculate

Geometric Change _____

Signal Change _____

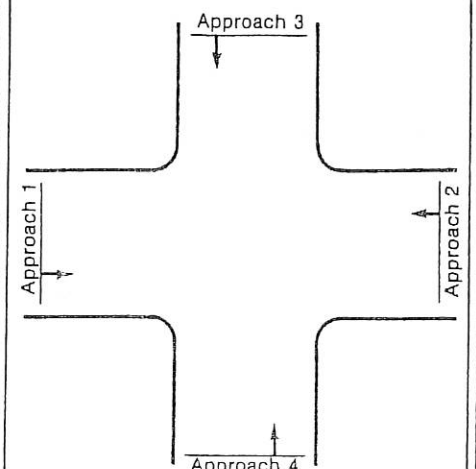
Volume Change _____

Step 3. Identify Phasing 3φ



A1 →	A3 ↓	B1 ←	B3 ↑
A2 ←	A4 ↑	B2 →	B4 ↓

Step 6a. Critical Volumes, in vph (two phase signal)



Comments

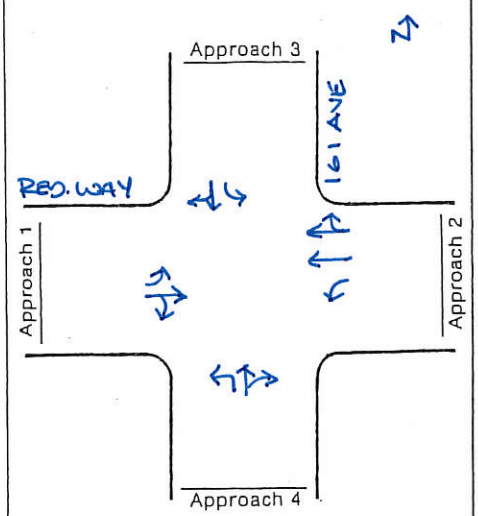
V/C = 0.67

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection 161 AVE NE / REDMOND WAY **Design Hour** PM

Problem Statement 2018 WITH-PROJECT OUT

Step 1. Identify Lane Geometry



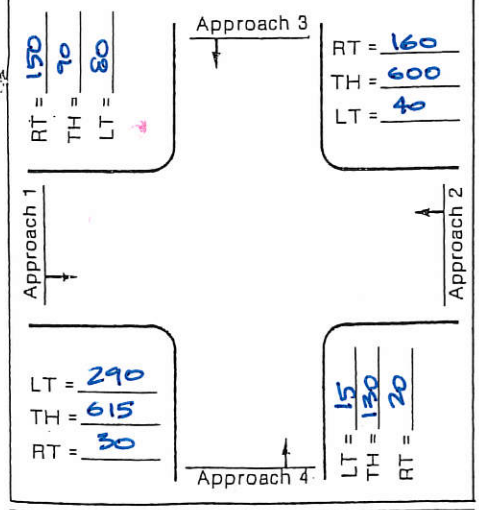
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour				
b. Left turn capacity on change interval, in vph				
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

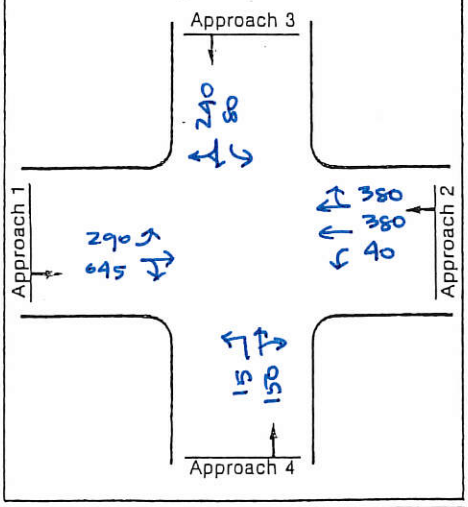
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
B1B2	40 (B1)		
A1B2	250 (B2)		
A1A2	395 (A1) OR 380 (A2)		
A3B4	80 (B4)		
A3A4	160 (A3)		

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

290 + 395 + 80 + 160

= 925 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

B

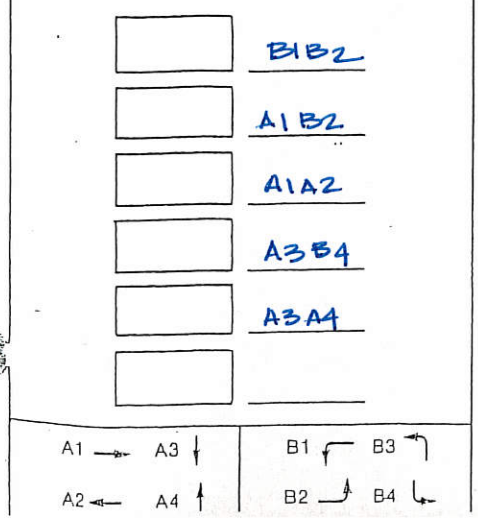
Step 9. Recalculate

Geometric Change _____

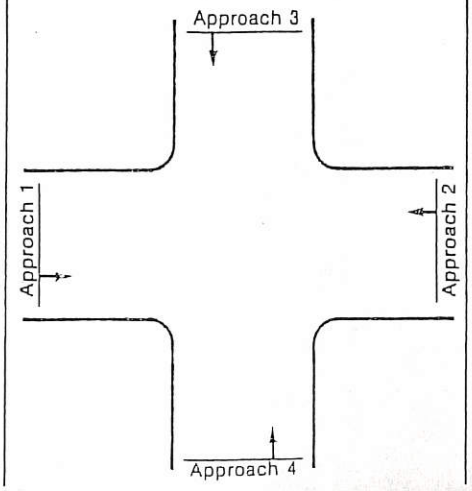
Signal Change _____

Volume Change _____

Step 3. Identify Phasing 5φ



Step 6a. Critical Volumes, in vph (two phase signal)



Comments

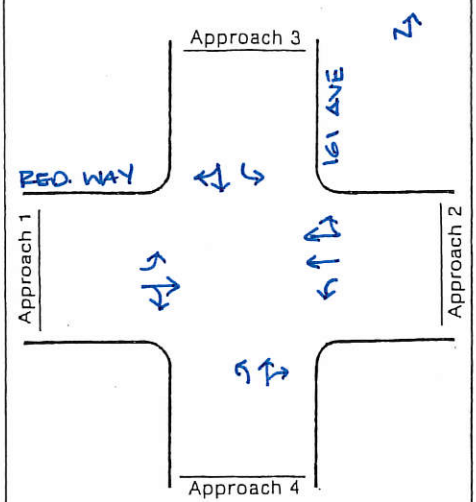
V/C = 0.67

Critical Movement Analysis: PLANNING
Calculation Form 1

Intersection 161 AVE NE/ REDMOND WAY **Design Hour** PM

Problem Statement 2018 WITH-PROJECT

Step 1. Identify Lane Geometry



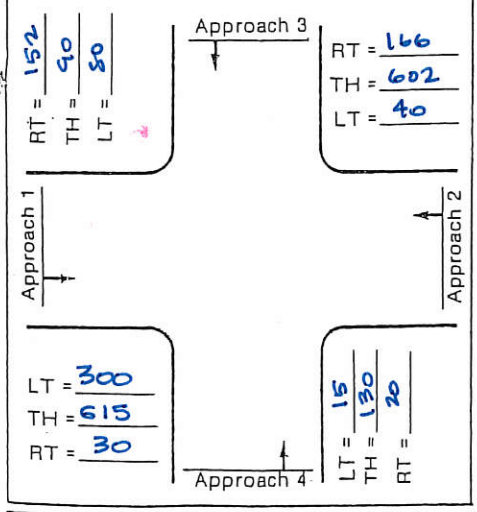
Step 4. Left Turn Check

	Approach 1	2	3	4
a. Number of change intervals per hour				
b. Left turn capacity on change interval, in vph				
c. G/C Ratio				
d. Opposing volume in vph				
e. Left turn capacity on green, in vph				
f. Left turn capacity in vph (b + e)				
g. Left turn volume in vph				
h. Is volume > capacity (g > f)?				

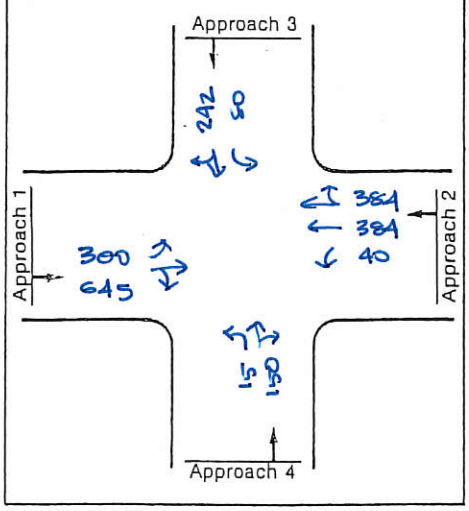
Step 6b. Volume Adjustment for Multiphase Signal Overlap

Probable Phase	Possible Critical Volume in vph	Volume Carryover to next phase	Adjusted Critical Volume in vph
B1B2	40 (B1)		
A1B2	260 (B2)		
A1A2	385 (A1) OR 384 (A2)		
A3B4	80 (B4)		
A3A4	162 (A3)		

Step 2. Identify Volumes, in vph



Step 5. Assign Lane Volumes, in vph



Step 7. Sum of Critical Volumes

40 + 260 + 385 + 242

= 927 vph

Step 8. Intersection Level of Service

(compare Step 7 with Table 6)

B

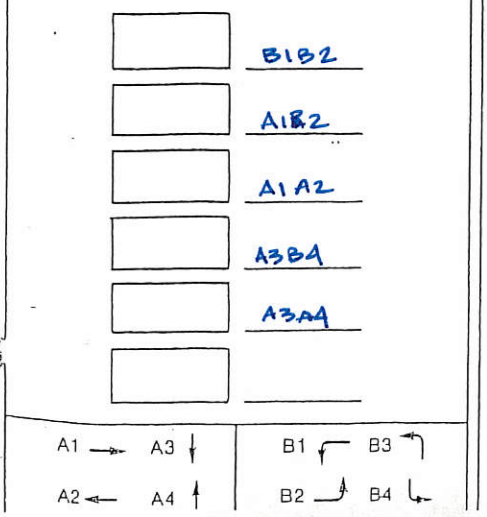
Step 9. Recalculate

Geometric Change _____

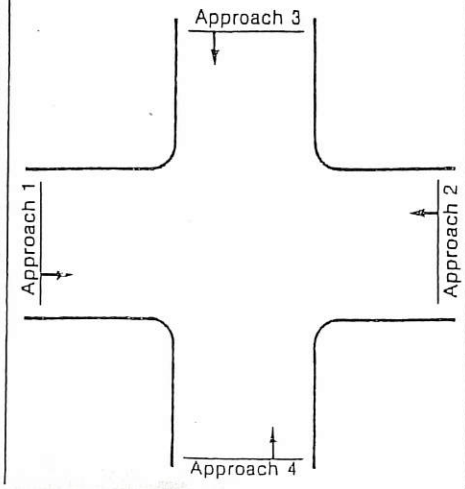
Signal Change _____

Volume Change _____

Step 3. Identify Phasing 5φ



Step 6a. Critical Volumes, in vph (two phase signal)



Comments

V/C = 0.67