APRC Multi-Family Housing and Retail

City of Flagstaff, Arizona

Traffic Impact Analysis

Lee Engineering Project No. 1081.02

September 2018

Prepared for:

Shepard-Wesnitzer, Inc.
110 W. Dale Avenue
Flagstaff, AZ 86001

Prepared by:

Lee Engineering, LLC
3610 N. 44th Street
Suite 100
Phoenix, AZ 85018
(602) 955-7206

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. Introduction and Summary

1.1 Purpose of Report and Study Objectives

The purpose of this report is to provide a traffic impact analysis for a proposed multi-family housing development with a separate retail component situated at the southeast corner of Butler Avenue and Sawmill Road in Flagstaff, Arizona. The study objectives are to follow the procedures and methodologies outlined in the City of Flagstaff *Engineering Design Standards* (Title 13, Section 5), as well as address any concerns that the City of Flagstaff may have in regards to the proposed development plans. This study is to evaluate the traffic impacts of the proposed development and evaluate mitigation measures, if required, to provide acceptable transportation operations to vehicle and alternative travel modes to the satisfaction of the City of Flagstaff and the client.

1.2 Executive Summary

Site Location and Study Area

The proposed site development is to be situated at the southeast corner of Butler Avenue and Sawmill Road in Flagstaff, Arizona. The site currently functions as an operating warehouse.

The area of significant traffic impact has been determined as the localized area adjacent to the subject site based on the proposed development plan that is expected to generate more than 100 but less than 500 peak hour trips. The study area is bounded by and includes the following seven intersections:

1. Butler Avenue and Sawmill Road
2. Sawmill Road and Kensington Drive / Site Access D3
3. Sawmill Road and Lone Tree Road
4. Lone Tree Road and Franklin Avenue
5. Butler Avenue and Lone Tree Road / Colorado Street

D1. Butler Avenue and Greyhound driveway / Site Access D1

D2. Sawmill Road and Whole Foods driveway / Site Access D2

Development Description

The proposed site is to be developed in a single construction phase, planned for opening in 2020. The site is to accommodate a 238 unit (854 bedroom) housing development and two outparcel retail buildings totaling 22,300 SF that includes a fast-food restaurant with drive-through window. Access to the site is to be provided through existing/relocated driveways, one on Butler Avenue east of Sawmill Road and two on Sawmill Road, one opposite the existing Whole Foods driveway and the other opposite Kensington Drive.

Principal Findings

The proposed site is planned for opening in 2020. The site is estimated to generate 4,877 daily, 316 AM and 494 PM peak hour vehicle trips, comprised of internal, pass-by, and new trips. In total, the site is estimate to generate 263 new AM (128 in, 135 out) and 388 new PM (197 in, 191 out) peak hour vehicle trips onto the adjacent roadway network.

Analysis indicates the adjacent study area signalized intersections and individual movements are expected to operate in an acceptable manner (LOS D or better) in both AM and PM peak hour conditions, although some locations are shown to have long vehicle queues. The only movement showing poor operation is the minor-street STOP controlled Lone Tree Road/Sawmill Road intersection, operating at LOS E during

the AM peak hour and LOS F in the PM peak hour under existing conditions. In the PM peak hour, demand exceeds capacity (v/c >1.0). Site-generated traffic will contribute the deterioration of movement performance upon site opening.

The following recommendations are based on the analysis, guidelines and conclusions of the traffic study:

Site Development

- Based on City warrants and turn volume estimates, a right-turn deceleration lane is warranted at the site's Butler Avenue driveway. Per design guidelines, the deisable turn lane should include a 90-foot taper and a 180-foot storage area, however, the client/City agreed upon 109-foot storage and 90-foot reverse taper design to minimize utility conflits exceed minimum design requirements, is appropriate for conditions, and is recommended. This design is indicated on the site layout plan.
- Sight visibility for drivers exiting at the planned Butler Avenue site driveway may have their line of sight obscured, when looking to the right (east), due to an existing electrical cabinet located near the site driveway. Analysis indicated drivers that stop with a driver eye postion 14 feet from the traveled way will have about 3.5 feet of clearance from the transformer to view approaching vehicles. AASHTO indicated drivers would move closer to the traveled way, if needed, to eliminate the obstruction. The driveway as located is appropriate and is the recommended location (aligned with the driveway on the north side of the street.
- Internally, the site driveways, internal drive aisles, parking stalls, and the overall vehicle and pedestrian accommodations appear appropriately designed meeting City guidelines without areas of noticeable conflict points.

City Recommendations

Existing and future background traffic volumes in the PM peak hour indicate the westbound Sawmill Road to southbound Lone Tree Road operates poorly. Vehicles contributing to this condition are likely drivers by-passing the Butler Avenue/Lone Tree Road left-turn movement where observations indicate the left-turn storage area can extend into the westbound through lane at times. The following considerations to improve the network performance are listed below:

- Near-term. Consider a pavement marking design modification to allow a westbound to southbound storage/acceleration lane at the Lone Tree/Sawmill intersection. The addition of a raised median island could also be beneficial to separate opposing vehicle flows. Additional trips created by the multi-family housing development that are destined to areas within or near the NAU south campus could utilize Franklin Avenue as an alternative route, if excessive delays are repeatable. *The City has indicated a willingness to accept this solution, but additional discussion and design details are required. Depending upon performance, a traffic signal may still be necessary at this location in the near or longer term that will also require the developer to pay their share of improvement cost associated with this option as well.*
- Near-term. Accelerate the Lone Tree Road widening project north of Pine Knoll Drive as outlined in the Flagstaff Metropolitan Planning Organization *Blueprint 2040: Regional Transportation Plan* (May 2017). This will reduce vehicle queue at locations, allow for dual westbound to southbound left turn lanes to be installed at the Butler/Lone Tree intersection, and may improve the operation and reduce the side-street volumes at the Lone Tree Road/Sawmill Road intersection.
- Long-term. The City's future consideration of the J.W. Powell Boulevard extension project that would extend the roadway east and tie-in near the I-40/Butler Avenue interchange may help

eliminate a percentage of vehicles on Butler Avenue and Sawmill Road destined south on Lone Tree Road.

- Long-term. Consider the City contemplated I-40/Lone Tree interchange to help reduce indirect driver travel.

2. Project Description

2.1. Site Location

The proposed site is situated at the southeast corner of Butler Avenue and Sawmill Road in Flagstaff, Arizona (physical address 829 E. Butler Avenue). The development is to be constructed on a 14.57-acre site (APN 104-03-005B and 104-13-002B) currently being utilized as a warehouse distribution site identified as the Wendt Business Park. **Figure 1** shows the general vicinity of the site.

2.2 Site Plan

The proposed site layout plan is provided in **Figure 2**. As indicated on the site plan, the entire parcel will be serviced through three full access driveways, each of which currently exist. The Butler Avenue access on the north side of the property will be relocated slightly to the east to align with a bus only driveway (greyhound bus station) on the opposite side of the street. The north Sawmill driveway is located opposite an existing driveway serving the Whole Foods store and the south Sawmill driveway is to be relocated to align with Kensington Drive.

Internally, the concept plan indicates two-way paved drive aisles that interconnect each access point. The south driveway will serve only the residential parking area while the other driveways will serve both the residential and retail land uses. The paved parking area is to accommodate 99 retail spaces and 751 residential spaces, 318 of which are to be structured spaces located on the east side (rear) of the property.

2.3. Land Use and Intensity

From the City of Flagstaff (COF) GIS website, the site has two zonings, a Light Industrial and a Heavy Industrial zoning as highlighted in red in the snippet shown at right. A change to the zoning will be sought to accommodate the proposed development.

The site is proposed to accommodate a 238 unit (854 bedroom) housing development on a gross parcel area of 12.39 acres and a total of 22,300 SF retail area contained in two outparcel buildings. The residential portion of the development will result in a dwelling unit density of 19.21 units per acre while the retail will have a calculated floor to area ratio (FAR) equal to 0.23 (22,300 SF / 92,972 SF).

Due to the site's location the City identified a likelihood that this development may accommodate a high percentage of NAU students, the analysisis to assume a student housing land use for the residential portion of this development. Based on this information, the land uses proposed for this site corresponds with the Institute of Transportation Engineers (ITE) Land Use Codes:

- LUC #225 Student Housing,
- LUC #934 Fast-Food Restaurant with Drive-Thru Window, and
- LUC #814 Variety.

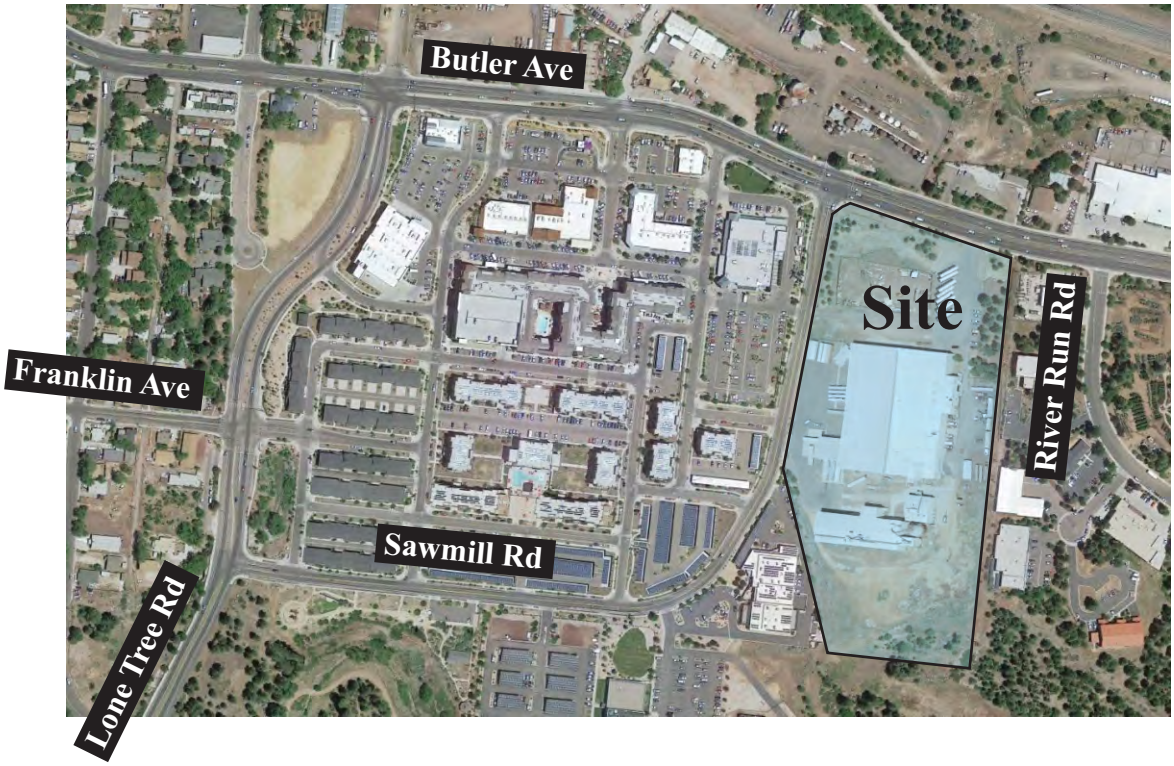
For trip generation and analysis purposes, the student housing portion of the site is to use information gathered from independent data collection near the NAU campus, provided by the City of Flagstaff.

2.3. Phasing and Timing

The proposed site is to be developed in a single construction phase, planned for opening in 2020. Based on COF TIA requirements and trip generation estimates matching a Category 1 – Small Development, anticipated to generate less than 500 peak hour directional trips, requiring analysis of the opening year conditions for a study area that includes the site access points and adjacent signalized and unsignalized major street intersections.

Site Location, Flagstaff

Enlargement



Not to scale

Vicinity Map

Figure 1

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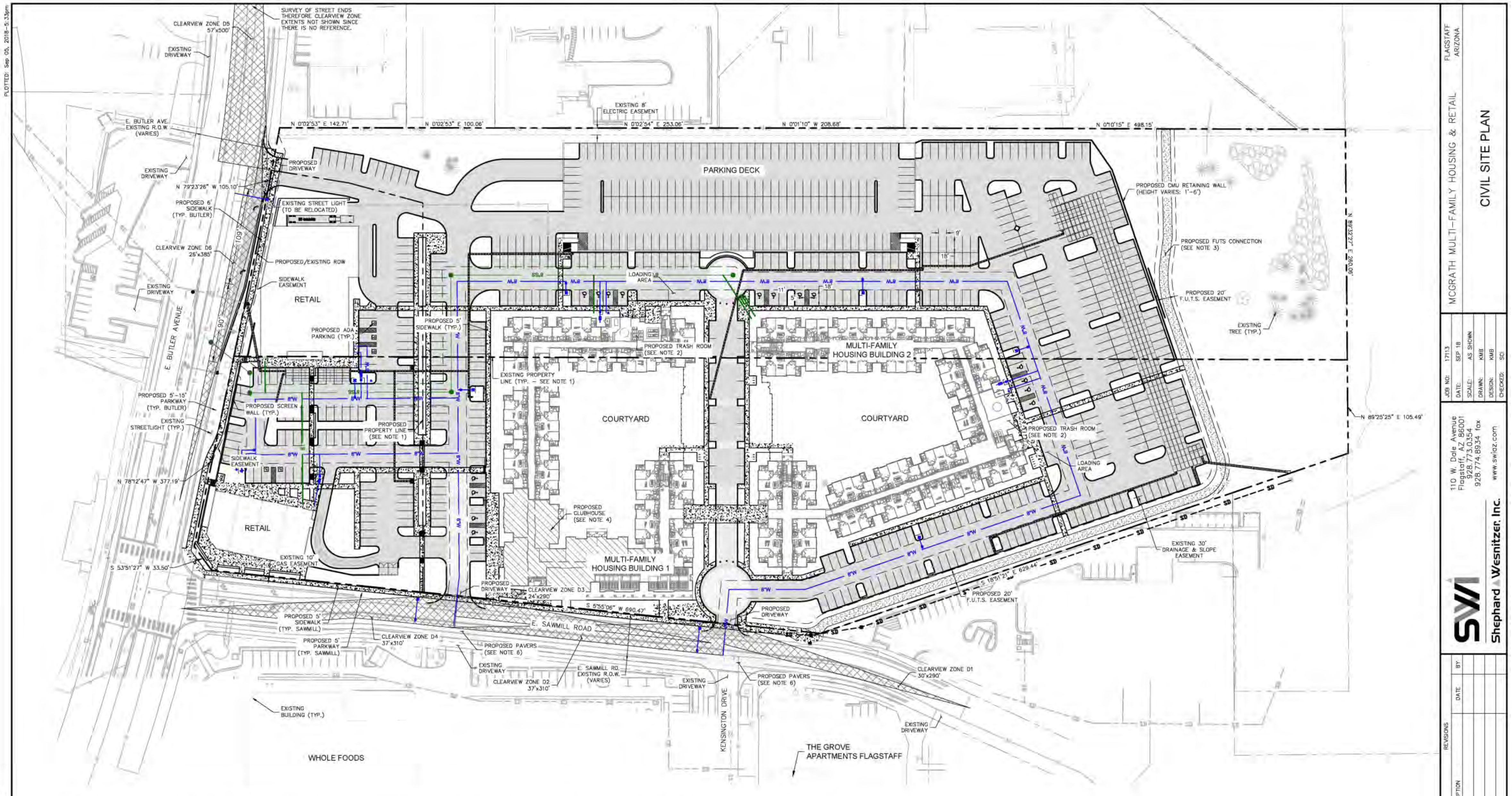


DRIVEWAY CLEAR VIEW ZONE CALCULATIONS

ID #	MAJOR STREET	MANEUVER DIRECTION	DESIGN SPEED (VMAJOR)1	TIME GAP tg (unadjusted)2	Grade ≤ 3%	MULTIPLE LANE CROSSINGS	NO. OF LANES4	TIME GAP tg(adjusted) 2	INTERSECTION SIGHT DISTANCE (ISD3)	STOPPING SIGHT DISTANCE (SSD)
D1	East Sawmill Road	Right	30	6.5	Yes	No	1	6.5	290	200
D2	East Sawmill Road	Left	30	7.5	Yes	Yes	2	7.0	310	200
D3	East Sawmill Road	Right	30	6.5	Yes	No	1	6.5	290	200
D4	East Sawmill Road	Left	30	7.5	Yes	Yes	2	7	310	200
D5	East Butler Avenue	Left	40	7.5	Yes	Yes	3	8.5	500	200
D6	East Butler Avenue	Right	40	6.5	Yes	No	1	6.5	385	200

Notes:

(1) The major road speed limits (VMAJOR in MPH) are based on existing conditions in the project vicinity.

(2) The time gap values, adjusted (tg (adjusted) in seconds) and unadjusted (tg (unadjusted) in seconds), are based on the current site plan and the AASHTO-Geometric Design of Highways and Streets Exhibits 9-54 and 9-57. The first lane crossed does not warrant an adjustment to the time gap.

(3) The intersection site distance (ISD in feet) calculations are based on Equation 9-1 in the AASHTO-Geometric Design of Highways and Streets. Equation 9-1: ISD=1.47*VMAJOR*tg

(4) The number of lanes crossed may include medians converted to equivalent lanes. The number of lanes provided in the table includes the first lane crossed.

MULTI-FAMILY HOUSING PROJECT DATA:

GROSS PARCEL AREA: 539,672 SF

TOTAL SQUARE FOOTAGE (MULTI-FAMILY HOUSING): 397,000 SF

GROSS AREA (MULTI-FAMILY HOUSING): 370,000 SF
GROSS AREA (INCLUDING AMENITIES): 397,000 SF

NET AREA (MULTI-FAMILY HOUSING): 306,000 SF
NET AREA (INCLUDING AMENITIES): 321,000 SF

TOTAL UNITS 238

PARKING
TOTAL PARKING REQUIRED = 606 MIN
= 636 MAX (5% OVERPARKED)

TOTAL PARKING PROVIDED = 749 SPACES
431 SURFACE SPACES
318 STRUCTURED SPACES

TOTAL BIKE STORAGE PROVIDED = 256 SPACES (INTERIOR) & 22 SPACES (EXTERIOR)

RETAIL PROJECT DATA:

GROSS PARCEL AREA: 92,383 SF

PAD A BUILDING AREA: 15,000 SF
PAD B BUILDING AREA: 7,300 SF
TOTAL: 22,300 SF

PARKING
PAD A (GENERAL RETAIL) = 1 PER 300 SF
PAD A REQUIRED PARKING = 50 SPACES

PAD B (RESTAURANT) = 1 PER 100 SF + 1 PER EMPLOYEE
PAD B REQUIRED PARKING = 27 SPACES
PAD B (GENERAL RETAIL) = 1 PER 300 SF
PAD B REQUIRED PARKING = 18 SPACES

INDIVIDUAL PARKING STANDARD	REQUIRED	PROVIDED
ACCESSIBLE PER ADA	5	5
TOTAL PARKING	95	99

TOTAL BIKE STORAGE PROVIDED = 5 EXTERIOR SPACES

NOTES:
1. A LOT COMBINATION WILL BE COMPLETED WITH FINAL DESIGN.
2. TRASH WILL BE COLLECTED AND COMPACTED INTERNALLY WITHIN A TRASH ROOM, AND TRASH-PICK UP WILL BE ACCOMMODATED ON-SITE IN AN AREA REMOTE FROM ADJACENT FRONTAGES ALONG BUTLER AND SAWMILL.
3. THE PROPOSED 10' FUTS TRAIL IS SHOWN CONCEPTUALLY. ASSET PLUS AND THE CITY SHALL COORDINATE GRADING AND TRAIL ALIGNMENT.
4. BIKE STORAGE WILL BE PROVIDED WITHIN THE CLUBHOUSE LAYOUT.
5. ROOF DRAIN LOCATIONS WILL BE FINALIZED DURING FINAL DESIGN.
6. COLORED PAVERS WILL BE PROVIDED IN THE PROPOSED INTERSECTIONS AS SHOWN TO PROVIDE A SAFER CROSSING FOR PEDESTRIANS BETWEEN THE PROPOSED PROJECT AND THE EXISTING DEVELOPMENT TO TO THE WEST.

SCALE 1" : 50'

PRELIMINARY

NOT FOR CONSTRUCTION, BIDDING OR RECORDING

C.O.F. Project #PZ-17-00089

DRAWING NO. SP01

SHT NO. 2 OF 3

Preliminary Site Concept Plan

Figure 2

3. Study Area Conditions

3.1 Study Area

The area of significant traffic impact has been determined based on the site's development characteristics, trip generation estimates, traffic impact analysis (TIA) documentation and discussions with a COF Traffic Engineering representative. As outlined in the COF *Pre-Scope of Work Meeting Form* (Appendix B), this analysis is to include adjacent signalized intersections and/or major unsignalized street intersections adjacent to the site and includes the following intersections within the influence area:

1. Butler Avenue and Sawmill Road
2. Sawmill Road and Kensington Drive / Site Access D3
3. Sawmill Road and Lone Tree Road
4. Lone Tree Road and Franklin Avenue
5. Butler Avenue and Lone Tree Road / Colorado Street
6. Butler Avenue and Greyhound driveway / Site Access D1
7. Sawmill Road and Whole Foods driveway / Site Access D2

Based on the site's land use, weekday AM and PM peak-period conditions are to be analyzed.

3.2 Existing Land Use & Anticipated Future Development

Adjacent to the subject site a mixture of residential properties, commercial developments, and undeveloped areas exist. The following briefly describes the land uses immediately adjacent to the subject parcel:

- South of site: Undeveloped (public facility zoned)
- Southeast of site: Coconino County Juvenile Court / municipal buildings
- West of site: Sawmill Road, Aspen Place at the Sawmill, Whole Foods
- North of site: Railyard, Greyhound Bus Lines
- East of site: Rio De Flag Business Park

From a field visit to the study area, no properties within the study area appear to be under construction or being prepared for development. Additionally, it is understood from City staff that no roadway projects are programmed or anticipated prior to site opening that would impact the study area significantly.

3.3 Site Accessibility

Motorists originating from or destined to the residential portion of the site will be able to utilize any of the three full movement driveways that are most advantageous to them. Drivers to and from the retail area will use either the north Sawmill Road driveway or the Butler Avenue driveway to access the parking spaces or drive-thru area associated with these land uses.

3.4 Existing and Future Roadway System

No modifications are anticipated to the existing study area roadway network, with the exception of the relocated site access points. The following is a description of the existing (and future) roadway network contained within the study area.

Butler Avenue

Butler Avenue is a 4-lane east/west minor arterial originating within the residential areas east of I-40 and terminating in the west at Milton Road. Near the subject site, the roadway has a center two-way left-turn lane (TWLTL) east of Sawmill Road and a raised median landscape island to its west. Many driveways and intersections exist along its corridor serving the developments fronting the street. Curb and gutter, bike lanes, and sidewalks exist on both sides of the street. The roadway is posted 40 mph.

Lone Tree Road

Lone Tree Road is a 2-lane north/south roadway designated as a minor arterial. This roadway originates at Butler Avenue and traverses southward along the east edge of the Northern Arizona University (NAU) campus. North of Sawmill Road the roadway is divided with raised median while to the south of Sawmill Road, a TWLTL exists to Woodland Drive where it transitions to an undivided roadway. Curb and gutter, bike lanes, and sidewalks exist on both sides of the street (curb and gutter and sidewalk does not exist on the east side of Lone Tree Road south of Sawmill Road). The roadway is posted 35 mph.

Sawmill Road

Sawmill Road is an undivided 2-lane major collector roadway that curves from a north/south alignment to east/west connecting Butler Avenue and Lone Tree Road. The roadway is only one-half mile in length serving the Sawmill Place subdivision (Aspen Place, Whole Foods) to its north and west, county and municipal buildings to its south and the subject site property to its east (current warehouse). The roadway has curb and gutter and bike lanes on both sides of the road. Detached sidewalks exist on both side of the road except in front of the subject site property. The posted speed limit on this road is 30 mph.

Franklin Avenue

Franklin Avenue is a two-lane east/west minor collector serving the Groves student housing development and areas within the Sawmill Place subdivision on its east side to the northern area of the NAU campus to its west. Franklin Avenue serves as a pedestrian route between the two areas. Parking exists along the street and sidewalks are provided on each side of the street. The speed limit on this roadway is 25 mph.

Intersection of Butler Avenue and Lone Tree Road/Colorado Street

The intersection is signalized with protected/permissive left-turn phasing, video detection at each approach and pedestrian countdown signals with push button activation at each approach. Marked crosswalks, ADA ramps (with truncated dome tactile strips) and corner street lighting exists on all approach corners. The intersection has the following lane configurations:

Northbound Lone Tree Road
1 left-turn lane (225 feet storage)
1 shared thru/right lane

Southbound Colorado Street
1 left-turn lane (90 feet striped storage)
1 shared thru/right-turn lane

Eastbound Butler Avenue
1 left-turn lane (60 feet storage)
2 thru lanes

Westbound Butler Avenue
1 left-turn lane (280 feet storage)
1 thru lane

1 right-turn lane (50 feet storage)

1 shared thru/right-turn lane

Intersection of Butler Avenue and Sawmill Road

The intersection is signalized with protected/permissive left-turn phasing in the westbound direction, video detection at each approach and pedestrian countdown signals with push button activation at each approach. Marked crosswalks, ADA ramps (with truncated dome tactile strips) and corner street lighting exists on all approach corners. The intersection have has following lane configurations:

Northbound Sawmill Road
1 left-turn lane
1 right-turn lane (90 feet striped storage)

Eastbound Butler Avenue
2 thru lanes
1 right-turn lane (110 feet storage)

Westbound Butler Avenue
1 left-turn lane (210 feet striped storage)
2 thru lanes

Intersection of Lone Tree Road and Franklin Avenue

The intersection is signalized with protected/permissive left-turn phasing, video detection at each approach and pedestrian countdown signals with push button activation at each approach. Marked crosswalks, ADA ramps (with truncated dome tactile strips) and corner street lighting exists on all approach corners. The intersection has the following lane configurations:

Northbound Lone Tree Road
1 left-turn lane (85 feet storage)
1 thru lane
1 right-turn lane (85 feet storage)

Southbound Lone Tree Road
1 left-turn lane (140 feet striped storage)
1 thru lane
1 right-turn lane (125 feet storage)

Eastbound Franklin Avenue
1 left-turn lane (80 feet storage)
1 shared thru/right-turn lane

Westbound Franklin *Avenue*
1 left-turn lane (75 feet storage)
1 shared thru/right-turn lane

Intersection of Lone Tree Road and Sawmill Road

This is a "T-type" intersection with STOP control and crosswalk markings are provided across the westbound approach. Ramps with truncated dome tactile strips exist on the northeast corner and also on the west side of the north crossing. Street lights exist at the northwest and southeast corners. The intersection has the following lane configurations:

Northbound Lone Tree Road
1 shared left/thru/right lane

Southbound Lone Tree Road
1 left-turn lane (100 feet striped storage)
1 thru lane

Westbound Sawmill Road
1 left-turn lane
1 right-turn lane (85 feet storage)

4. Projected Traffic

4.1 Site Traffic Forecasts

The first step in estimating traffic from the proposed development is to calculate trip generation, which is the total vehicle trips to and from the site over a given time period. To estimate the site's trip generation characteristics, Trip Generation, Tenth Edition, published by the Institute of Transportation Engineers (ITE) in 2017, was used to calculate average weekday, AM peak hour, and PM peak hour number of trips for the planned fast-food restaurant and retail area while data provided within the COF *Student Housing Trip Generation Study* has been used to estimate traffic generated from the residential portion of the site.

A number trip reduction factors can be applied to the total estimated number of vehicle trip ends based on the site's mix of land uses (internal site interaction), vehicles already on the adjacent roadway that will be attracted to the site due to the convenience offered by the site (pass-by trips), and based on the availability of alternative travel modes that may be used.

Internal Site Interaction

The ITE Trip Generation Handbook (3rd edition) provides a methodology (NCHRP 684 Trip Capture Estimation Tool) to estimate the number of vehicles trips that may be captured internally, reducing the number of external vehicle trips generated by the site. From use of the NCHRP spreadsheet tool (appendix), the results indicate 13% of the AM peak hour trips, 23% of the PM peak hour trips, and 18% of the daily trips (average of AM and PM) will be generated internally. This reduction percentage was only applied to the trips generated by the fast-food and retail components since the COF trips for the student housing may already include a site interaction reduction as part of its base values.

Pass-by Trips

The ITE Trip Generation Handbook also identifies the percent of site generated trips a land use may generate due to vehicles that are already on the roadway. From Tables E-5, E-31, and E-32, peak period pass-by trip percentage reductions were applied to the retail and fast-food componets, where applicable. Pass-by trips are not applicable to the trips generated by the residential land use. It is noted that pass-by trips do not reduce the number of vehicles entering or exiting the driveways, just to the number of new vehicles to be experienced on the adjacent roadway network.

Alternative Travel Modes

No vehicle reduction for bus, bike, walk or other type of alternative travel modes have been taken into account for this site, although a small percentage of trips generated by the retail and restaurant may be made by non-automotive modes that would reduce the number of vehicle trips to and from this site. An alternative travel mode reduction to the residential portion has assumed to have been accounted for in the trip generation rates as walk/bike/transit rates have been captured separately from the COF student housing vehicle trip rates utilized. These alternative travel modes are discussed later in this report.

Trip Generation

Table 1 presents the trip generation data for the site. In total, 297 AM peak hour, 448 PM peak hour, and 4,476 daily trip ends (external vehicle trip ends) are estimated to enter and exit this new development during typical weekday conditions.

Table 1. Trip Generation

			FLAGSTAFF	Shops	Shops	Anchor	
Description	Land Use		Residential	Services	Retail	Retail	
	ITE Land Use Code		(ITE #225)	934	814	814	
	ITE Land Use Title		Off-Campus Student Apartment	Fast-Food Restaurant with Drive-Thru Window	Variety	Variety	
	Land Use Variable		Bedrooms	1000 SF GFA	1000 SF GFA	1000 SF GFA	
	Variable Amount (X)		854	2.000	5.300	15.000	
Trip Rates	Weekday		3.10	470.95	63.47	63.47	
	AM Peak Hour		0.20	40.19	3.18	3.18	
	PM Peak Hour		0.34	32.67	6.84	6.84	
Inbound %	Weekday		50%	50%	50%	50%	
	AM Peak Hour		45%	51%	57%	57%	
	PM Peak Hour		50%	52%	52%	52%	**Parcel Total Full Build-out**
Total Trips	Weekday		2647	942	336	952	**4877**
	AM Peak Hour Inbound		77	41	10	27	**155**
	AM Peak Hour Outbound		94	39	7	21	**161**
	PM Peak Hour Inbound		145	34	19	53	**251**
	PM Peak Hour Outbound		145	31	17	50	**243**
Internal Site Interaction Reduction Percent [1]		Daily	0%	18%	18%	18%	
		AM	0%	13%	13%	13%	
		PM	0%	23%	23%	23%	
External Trips	Weekday		2647	772	276	781	**4476**
	AM Peak Hour Inbound		77	36	9	23	**145**
	AM Peak Hour Outbound		94	34	6	18	**152**
	PM Peak Hour Inbound		145	26	15	41	**227**
	PM Peak Hour Outbound		145	24	13	39	**221**
Pass-by Traffic	AM Peak Hour Pass-by Percentage (2)		0%	49%	0%	0%	
	PM Peak Hour Pass-by Percentage (2)		0%	50%	34%	34%	
	AM Peak Hour Trip Ends		0	34	0	0	**34**
	PM Peak Hour Trip Ends		0	25	10	27	**62**
New Trips	Weekday (3)		2647	476	279	790	**4192**
	AM Peak Hour Inbound		77	19	9	23	**128**
	AM Peak Hour Outbound		94	17	6	18	**135**
	PM Peak Hour Inbound		145	14	10	28	**197**
	PM Peak Hour Outbound		145	12	8	26	**191**

Sources:

1 NCHRP Report 684 Estimation spreadsheet for internal site interaction (daily assumed as the average of AM + PM values). Site average values used for the individual land uses, excluding COF Student Housing.

2 Trip Generation Handbook, 3rd Edition, 2017

3 Daily pass-by trips assumed as the average of AM + PM values

Trip Distribution and Assignment

The site generated trips have been distributed onto the adjacent roadway network in a composite manner noting the majority of new site trips are being generated by the multi-family housing development. The percentages below have been modified slightly from the original TIA and Pre-Scope submittal to account for the land use change from student housing to multi-family by reducing the travel demand to/from NAU campus (Franklin Avenue and Lone Tree Road) and increasing the demand to and from Butler Avenue, better reflecting existing study area volume demand.

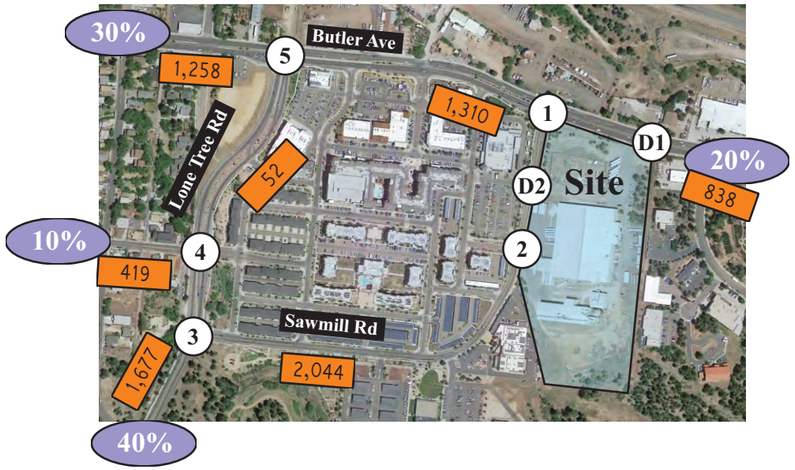
Site Traffic Distribution Percentage:

East (Butler Avenue):	20%
South (Lone Tree Rd):	40%
West (Butler Avenue):	30%
West (Franklin Avenue):	10%

The top half of **Figure 3** displays how the new vehicles generated by the site are to be distributed in relation to the site. The middle portion of the figure assigns the newly generated site trips to the study area intersections. Vehicles were assigned to the site driveways and travel route based on ease of access to and from the roadway network and their origination and destination within the site.

The bottom half of Figure 3 shows how the pass-by vehicle component of the site trips have been accounted for. For simplicity, it was assumed all pass-by vehicles were generated from the higher volume Butler Avenue, equally distributed between the eastbound and westbound directions. Per definition, vehicles exit toward the same direction from which they were originally traveling prior to entering the site. Engineering judgement was used to assign the pass-by trips to the most convenient site access and routing path. Pass-by vehicles do not contribute to a an overall change in roadway volume, but do account for changes to individual movements.

The addition of the two volume components in Figure 3 is equal to the total number of vehicle trip ends expected to be generated by the site.

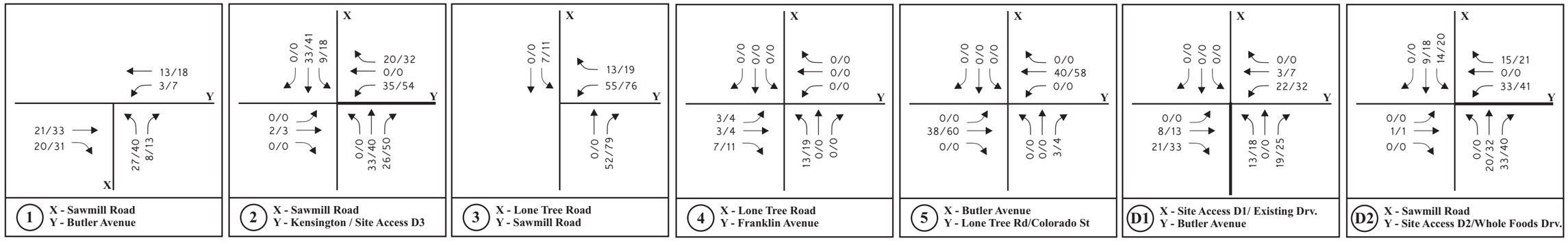


LEGEND

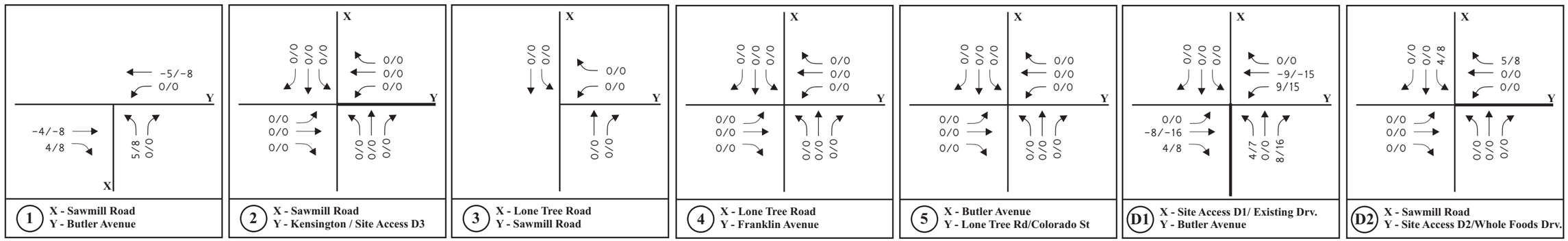
(#)	Intersection Identifier
XX/XX	AM/PM Peak Hour Volume
X,XXX	Estimated New Site Generated 24-hour Traffic Volume
	Vehicle Movement
XX%	Distribution Percentage

Notes:
1. Pass-by trips are only applicable to the retail land use, equal to 34 trip ends in the morning peak and 62 trip ends in the evening peak (rounded). Pass-by trips have been equally distributed to/from Butler Avenue only. One vehicle generates trip ends (1 entering and 1 exiting).

New Trip Assignment



Pass-by Trip Assignment



Not to scale

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Site Traffic Distribution and Assignment and Pass-by Trips

Figure 3

4.2 Non-Site Traffic

Historical Traffic Volume

The City of Flagstaff provided the latest weekday traffic count data they have obtained for the study area roadway network, which includes the following locations:

- Butler Avenue between Sawmill and River Run (May 2017)
  Eastbound, 24-hour volume = 15000, AM peak hour = 741 (8:00), PM Peak hour = 1453 (4:45PM)
  Westbound, 24-hour volume = 13944, AM peak hour = 1116 (7:30), PM Peak hour = 1132 (3:30PM)

- Lone Tree Road between Butler and Franklin (May 2017)
  Northbound, 24-hour volume = 7283, AM peak hour = 518 (7:30), PM Peak hour = 694 (3:45PM)
  Southbound, 24-hour volume = 6656, AM peak hour = 524 (7:30), PM Peak hour = 578 (5:00PM)

- Peak period intersection turning movement count information at the intersection of Butler Avenue and Lone Tree Road (April 2017, appendix). This information will be adjusted and used for this study based on the count data collected at the other adjacent intersections.

Additionally, a review of the ADOT Multimodal Planning Division website indicates a 2-way daily traffic count on Lone Tree Road between Franklin and Butler, captured in 2013, of 13,489 daily vehicles. When comparing to the recently collected COF 24-hour volume of 13,939, this is a total daily increase of only 450 vehicles or less than 1% increase per year.

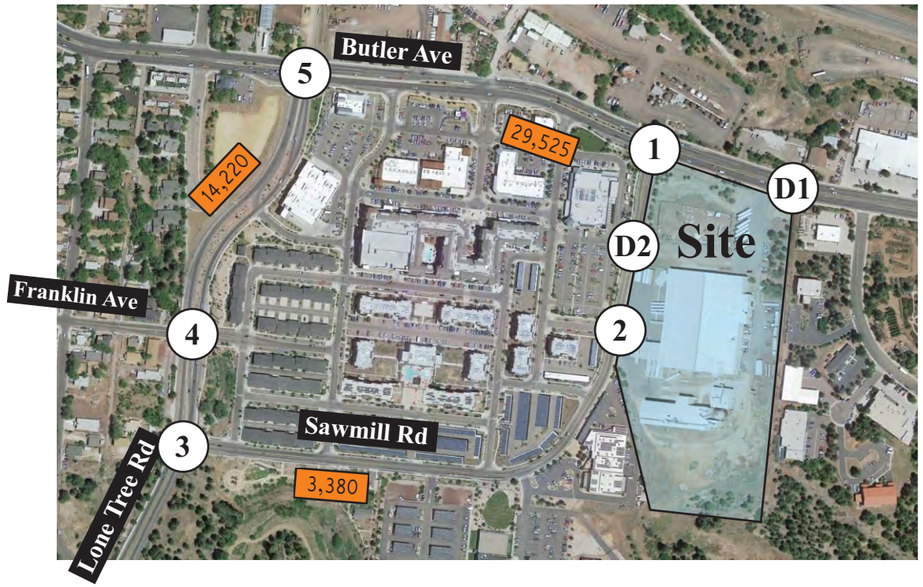
Study Collected Intersection Turning Movement Count Data

Intersection turning movement counts (TMC) were collected from 7AM to 9AM and from 4PM to 6PM on Tuesday, March 27, 2018 at the following study area locations:

- Butler Avenue and Sawmill Road
- Sawmill Road and Kensington Drive
- Sawmill Road and Lone Tree Road
- Lone Tree Road and Franklin Avenue

A review of the count data revealed that the system-wide peak hours started at 7:30 AM and 4:45 PM, resulting in an overall PHF of 0.88 in the morning and 0.97 in the evening, an indication that the roadways have a relatively consistent traffic demand during the two peak hours.

From review of the count data, the southbound Lone Tree Road right-turn movement to Franklin Avenue was not captured. Noting a driveway into the commercial/residential area of Aspen Place at the Sawmill/Groves exists between Butler and Franklin Avenue, calculating the simple difference between the two intersections would not be appropriate. To determine the right-turn volume, the video of the last 4 15-minute periods (5PM to 6PM) was reviewed. The results identified the right-turn volume to be about 70% of the northbound left-turn volume towards Franklin Avenue and therefore this percentage was assumed for all 15-minute intervals. The top half of **Figure 4** shows the existing 2018 conditions diagram of the study area intersections and the captured peak-hour intersection turning movement counts. All raw count data can be found in the appendix.

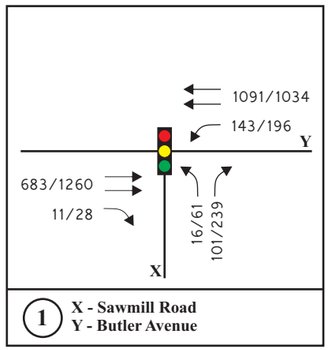


LEGEND

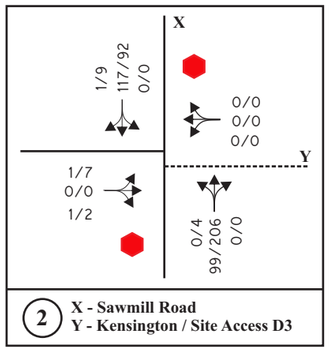
(#)	Intersection Identifier
X,XXX	Estimated 24-hour Traffic Volume (2018)
XX/XX	AM / PM Peak Hour Begins 7:30 AM and 4:45 PM
	Lane Configuration

Notes:
1. Site Driveways D1, D2, and D3 are to be aligned opposite existing driveways/approaches on the opposite side of the road.
2. Daily traffic volumes assumed to be a 2% increase above 2017 volumes.
3. Daily volume on Sawmill Road assumed to be 10X PM peak hour volume.
4. The 2018 volumes have been increased by a factor of 1.0404 (4.4%) to develop 2020 Background volumes.

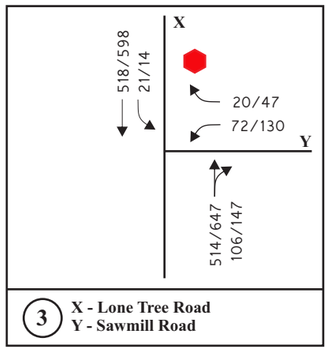
2018 Existing



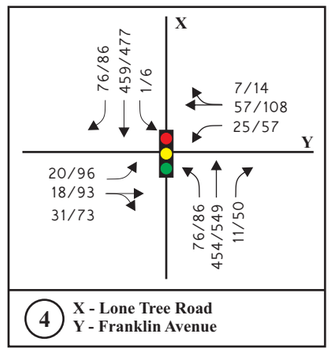
1 X - Sawmill Road
Y - Butler Avenue



2 X - Sawmill Road
Y - Kensington / Site Access D3

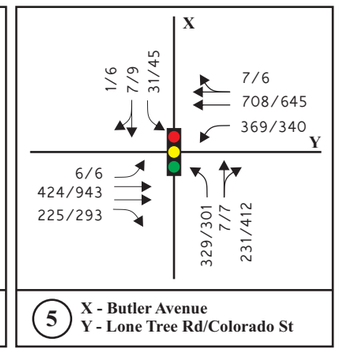


3 X - Lone Tree Road
Y - Sawmill Road



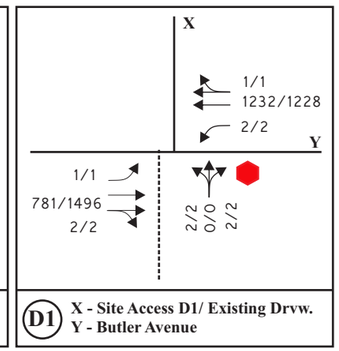
4 X - Lone Tree Road
Y - Franklin Avenue

Note: SB right-turn volume estimated.



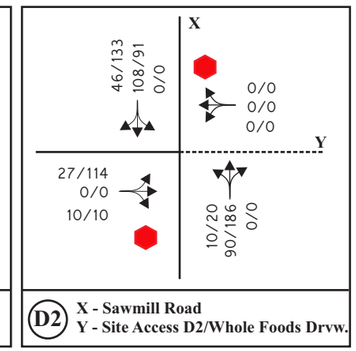
5 X - Butler Avenue
Y - Lone Tree Rd/Colorado St

Note: Intersection volumes increased by 3.6% to account for background from 2017 to 2018.



D1 X - Site Access D1/ Existing Drvw.
Y - Butler Avenue

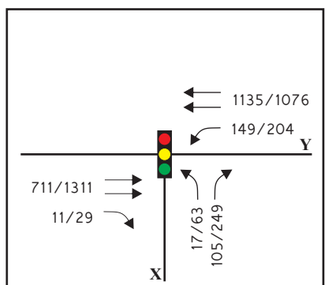
Note: Flowed from Int. #1. Existing driveway movement volumes estimated. North driveway to Greyhound bus depot is an inbound only driveway for buses only.



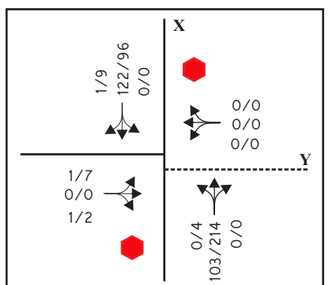
D2 X - Sawmill Road
Y - Site Access D2/Whole Foods Drvw.

Note: Flowed from Int. #1 & 2, driveway turn movement volumes estimated.

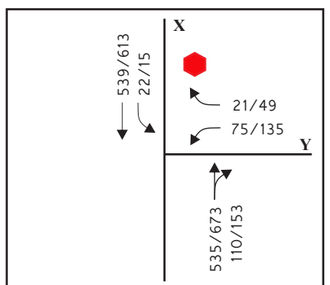
2020 Background



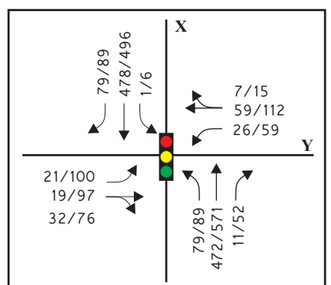
1 X - Sawmill Road
Y - Butler Avenue



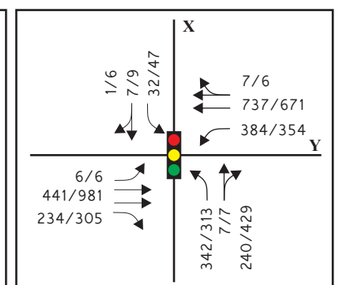
2 X - Sawmill Road
Y - Kensington / Site Access D3



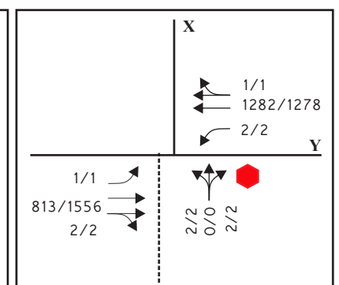
3 X - Lone Tree Road
Y - Sawmill Road



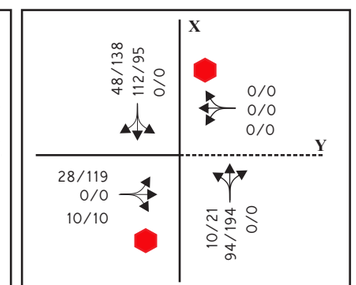
4 X - Lone Tree Road
Y - Franklin Avenue



5 X - Butler Avenue
Y - Lone Tree Rd/Colorado St



D1 X - Site Access D1/ Existing Drvw.
Y - Butler Avenue



D2 X - Sawmill Road
Y - Site Access D2/Whole Foods Drvw.

Not to scale

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Existing Conditions Diagram and 2018 Peak Period Traffic Volumes and 2020 Background Traffic

Figure 4

Seasonal Traffic Volume Adjustment Considerations

Weekday traffic volumes were collected during fair weather spring conditions while NAU students were in classes. March is identified to be representative of peak season volume conditions within the study area, therefore no seasonal adjustment factor has been applied to the collected count data shown in Figure 4.

Intersection Adjustment, 2017 to 2018 Conditions

When comparing the 2017 City provided count data at the Butler Avenue/Lone Tree Road intersection with the recently collected count data at Butler/Sawmill Road intersection, the difference between the departure and approach volumes of the two intersections were calculated for two AM and PM count periods. The results indicate the 2018 volumes to be 3.6% higher than the 2017 City provided volumes. Therefore, the peak hour volumes at the Butler Avenue/Lone Tree Road intersection were increased by a factor of 1.036 to account for one-year of traffic growth. This increase is reflected in the Figure 4 volumes.

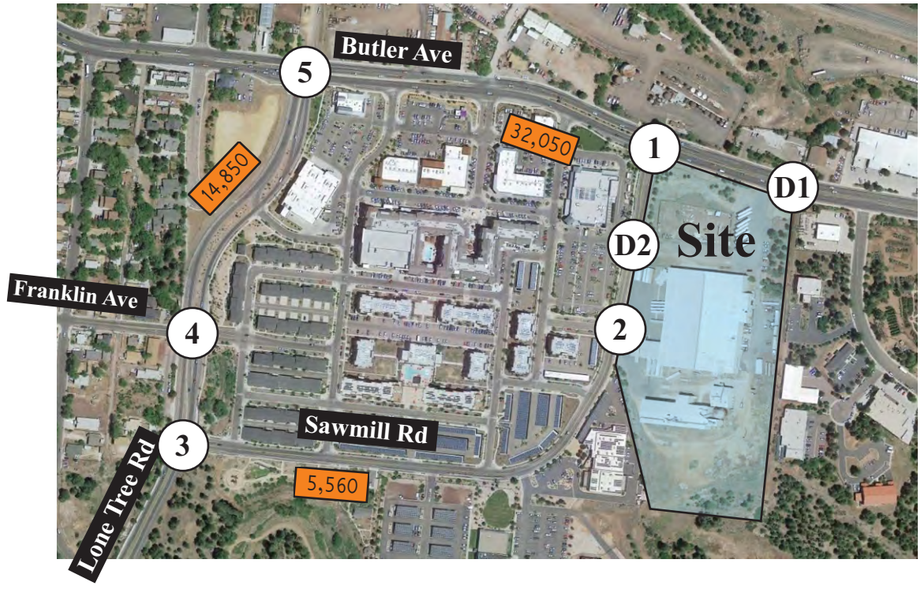
Background Traffic Growth

From review of the 2040 Regional Transportation Plan (May 2017), population in the general Flagstaff region is estimated to grow at about 1 to 1.5% per year, this is less than the 1-year calculated Butler Avenue growth rate of 3.6%. For the purposes of this study, a 2% per year growth rate or a total growth of 4.04% (growth factor of 1.0404) will be assumed for ambient traffic growth of the project area roadways. The bottom half of Figure 4 shows the 2020 background traffic for the study area.

4.3 Total Traffic

2020 Total Traffic Volume

The addition of the new site generated traffic shown in the top half of Figure 3 plus the pass-by trip component shown in the bottom half of Figure 3 plus the 2020 background traffic as displayed in the bottom of Figure 4 results in the total traffic volume estimated for the study area intersection for the opening year of the subject site. **Figure 5** presents the total traffic volume estimated for 2020 conditions.

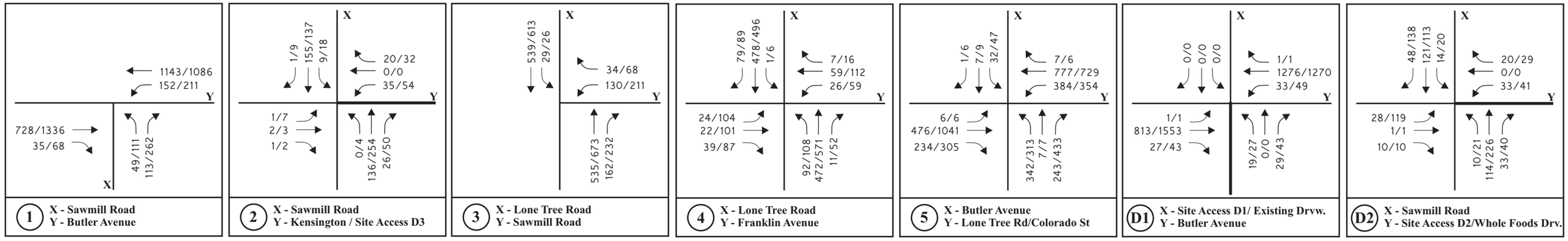


LEGEND

(#)	Intersection Identifier
X,XXX	Estimated 24-hour Traffic Volume (2020)
XX/XX	AM / PM Peak Hour Begins 7:30 AM and 4:45 PM
	Vehicle Movement

Notes:
1. 2020 Total traffic volumes includes ambient background traffic growth, and the site-generated traffic assuming full build-out and full site occupancy.

Total Traffic



Not to scale

2020 Total Traffic Volumes

Figure 5

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4.4 Level of Service

Intersection Capacity Analysis

The study area intersections were analyzed based on the methodologies presented in the Highway Capacity Manual 6th Edition (2017) and evaluated using the Synchro software package (version 9). To provide an indication of intersection performance, signalized and un-signalized intersections are typically reported in terms of Levels of Service (LOS). The analysis of signalized intersections is based on the approach control delay, which includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay for all movements. Un-signalized STOP-controlled intersection analysis is based on the minor street approach or critical movement, whichever is applicable. The capacity criteria for signalized and unsignalized intersection analysis are presented in ***Table 2***.

***Table 2*. Level of Service Criteria for Signalized/Unsignalized Intersections**

Level of Service	Average Control Delay (seconds/vehicle)	
LOS	**Signalized**	**Unsignalized**
A	≤10.0	≤10.0
B	>10.0 and ≤20.0	>10.0 and ≤15.0
C	>20.0 and ≤35.0	>15.0 and ≤25.0
D	>35.0 and ≤55.0	>25.0 and ≤35.0
E	>55.0 and ≤80.0	>35.0 and ≤50.0
F	>80.0	>50.0

Source: *Highway Capacity Manual, HCM 6th Edition*, Transportation Research Board, 2017.

Additional performance measures such as volume to capacity (v/c) ratios and queue lengths also provide an indication of operational conditions. For example, at two-way STOP-controlled intersections, main street traffic volumes may impose longer average delays for a small number of side-street vehicles, thus creating vehicle delays which correspond to a poor Level of Service. Motorists and agencies will typically accept longer delays (LOS E or F) if gaps in the traffic stream are anticipated within a reasonable time frame and the side street traffic volumes do not warrant a traffic signal. As a general guide, gap acceptance thresholds for the longer delay values can be defined when the v/c ratios are under 0.80, which corresponds to 80 percent capacity usage for that movement. Therefore, a traffic movement with a poor Level of Service (F) and a v/c value under 0.80 will be considered as operating in an acceptable manner.

For analysis purposes, all movements will be assumed having a peak-hour factor of 0.90. Signal timing and coordination data was provided and/or estimated from city provided data (appendix).

Intersection Level of Service, 2018 Existing and 2020 Background Traffic Conditions

Information pertaining to the study area intersections including movement volumes, lane configurations, approach control, traffic signal data, and other information were input into the Synchro software program to estimate LOS conditions for the signalized and STOP-controlled locations. The results of the intersection analyses for the 2018 existing and 2020 background conditions are presented in ***Table* 3.** Noting no programmed roadway improvements to the study area are anticipated between 2018 and 2020, the 2020 LOS results are based on the volume changes associated with the community growth factor. All Synchro output sheets are contained in the appendix.

Table 3. Intersection Capacity Analysis Summary, 2018 Existing and 2020 Background

	2018 Existing								2020 Background							
	AM Peak				PM Peak				AM Peak				PM Peak			
Intersection / Movement	LOS	Delay	V/C	Queue	LOS	Delay	V/C	Queue	LOS	Delay	V/C	Queue	LOS	Delay	V/C	Queue
Int 1. Butler Ave and Sawmill Rd	A	6.5			B	18.4			A	7.4			C	21.8		
EB Thru	B	10.9		246	C	26.0		427	B	13.2		257	C	32.0		451
EB Right	A	7.5		<50	B	14.8		<50	A	8.2		<50	B	16.5		<50
WB Left	A	2.4		<50	B	15.6		123	A	2.5		<50	C	21.5		175
WB Thru	A	2.7		114	A	4.8		188	A	2.8		123	A	5.3		209
NB Left	D	44.8		<50	D	40.0		72	D	44.9		<50	D	38.8		72
NB Right	B	18.9		50	C	34.4		139	B	18.8		51	D	35.8		149
Int 2. Sawmill Rd and Kensigton/Site Drwy D3 (MSS)																
EB Left/Thru/Right	A	9.5		<50	B	10.5		<50	A	9.6		<50	B	10.6		<50
WB Left/Thru/Right	Movement does not exist in this condition								Movement does not exist in this condition							
NB Left	A	7.5		<50	A	7.4		<50	A	7.5		<50	A	7.5		<50
SB Left	Movement does not exist in this condition								Movement does not exist in this condition							
Int 3. Lone Tree Rd and Sawmill Rd (MSS)																
WB Left	E	38.5	0.43	50	F	171.3	1.09	205	E	44.2	0.48	50	F	219.7	>1.2	235
WB Right	B	12.8		<50	C	15.8		<50	B	13.2		<50	C	16.4		<50
SB Left	A	9.1		<50	A	9.8		<50	A	9.2		<50	A	10.0		<50
Int 4. Lone Tree Rd and Franklin Ave	B	13.8			C	22.1			B	15.1			C	22.9		
EB Left	B	19.3		<50	B	17.7		65	B	19.8		<50	B	17.8		68
EB Thru/Right	B	16.4		<50	C	27.7		121	B	16.6		<50	C	28.6		128
WB Left	B	19.3		<50	B	16.9		<50	B	19.8		<50	B	16.9		<50
WB Thru/Right	C	26.0		70	C	32.1		107	C	24.7		72	C	32.4		112
NB Left	A	7.2		<50	B	11.6		57	A	7.6		<50	B	11.9		59
NB Thru	B	10.7		339	C	20.7		543	B	11.9		357	C	21.5		575
NB Right	A	0.0		<50	A	0.1		<50	A	0.0		<50	A	0.2		<50
SB Left	A	8.0		<50	B	11.0		<50	A	8.0		<50	B	11.0		<50
SB Thru	B	17.7		375	C	28.4		495	B	19.4		397	C	29.8		525
SB Right	A	2.6		<50	A	3.2		<50	A	2.9		<50	A	3.5		<50
Int 5. Lone Tree Rd and Butler Ave	B	15.7			C	27.8			B	16.1			C	30.0		
EB Left	A	6.3		<50	B	15.3		<50	A	6.2		<50	B	16.3		<50
EB Thru	B	13.2		105	D	40.2		534	B	13.0		106	D	47.3		563
EB Right	A	3.6		<50	C	20.4		180	A	4.6		<50	C	22.0		189
WB Left	B	10.7		146	D	39.9		333	B	10.4		132	D	39.6		386
WB Thru/Right	B	11.0		217	A	8.3		137	B	11.1		225	A	9.4		143
NB Left	D	46.2		274	D	44.9		229	D	48.2		288	D	38.6		225
NB Thru/Right	A	9.7		68	B	13.1		116	A	9.6		70	B	15.9		139
SB Left	C	33.4		<50	C	29.6		<50	C	33.6		<50	C	29.1		<50
SB Thru/Right	D	36.4		<50	C	27.2		<50	D	36.2		<50	C	26.5		<50
Int D1. Butler Ave and Greyhound/Site Drwy D1 (MSS)																
EB Left	B	12.3		<50	B	12.2		<50	B	12.6		<50	B	12.6		<50
WB Left	A	8.3		<50	B	10.1		<50	A	8.2		<50	B	10.5		<50
NB Left/Thru/Right	B	13.7		<50	C	17.7		<50	B	13.9		<50	C	18.5		<50
Int D2. Sawmill Rd and Whole Foods/Site Drwy D2 (MSS)																
EB Left/Thru/Right	B	10.2		<50	B	13.8		<50	B	10.3		<50	B	14.2		<50
WB Left/Thru/Right	Movement does not exist in this condition								Movement does not exist in this condition							
SB Left/Thru/Right	A	0.0		<50	A	0.0		<50	A	0.0		<50	A	0.0		<50
NB Left/Thru/Right	A	7.6		<50	A	7.8		<50	A	7.6		<50	A	7.8		<50

Notes:

1. MSS - Minor Street Stop control, Delay show n in seconds, Queue is the reported 95th percentile length in feet, V/C reported if LOS E/F.

Because only slight changes to LOS and delay conditions exist between existing and background conditions, the following can be concluded about the 2018 existing and 2020 background conditions from Table 3 above:

- The overall operation of the signalized study area intersections are shown to operate at LOS C or better conditions (acceptable) in both the AM and PM peak hours. The most delayed movements are associated with the Lone Tree Road northbound left turn movement at Butler Avenue, operating at LOS D in both the AM and PM peak hours with delays approaching 50 seconds per

vehicle, which are also considered acceptable during peak hour conditions. All other individual movements are shown to operate at LOS D or better.

- At the unsignalized locations, the only movement showing elevated delays (LOS E/F) is the Sawmill Road westbound left turn movement to southbound Lone Tree Road in both the AM and PM peak hours. At the Sawmill Road approach, analysis indicates LOS E operation in the morning, with a v/c ratio below 0.80. This is an indication capacity is available, but longer than desirable delays may occur until the appropriate gap in the Lone Tree traffic stream occurs. In the PM peak hour, volume exceeds capacity, resulting in excessive delays. Although a review of video taken during the data collection effort did not indicate the excessive delays, the ability to complete the turn movement during the time period can be difficult. It is unclear if the majority of these vehicles are associated with drivers using Sawmill Road as a Butler/Lone Tree intersection by-pass or employees associated with the county facilities leaving work for the day.

2018 Existing / 2020 Background Sawmill Road/Lone Tree Road Mitigation Options

A potential mitigation option for the westbound to southbound left-turn movement that could be considered by the City would be to permit a center storage area in Lone Tree Road south of Sawmill for drivers to conduct a two-stage left-turn movement. Since no driveways are present on either side of Lone Tree Road over a 500-foot distance between Sawmill Road and O'Leary Street, the storage area/acceleration lane could be installed. Without curb and gutter on the east side of the road, the roadway could be shifted eastward slightly if a wider lane width is needed or to install a potential 2-foot wide raised median to help separate opposing traffic flows. In this mitigation scenario, the 2020 PM peak hour left turn operation would improve to a LOS E operation with 35.9 seconds of delay and a v/c ratio of 0.58 (AM LOS C).

5. Traffic and Improvement Analysis

5.1 Site Access

As indicated on the site plan, the site's three existing access points are to remain, but be repositioned to align with align with driveways/roadway across the street. Below are the site driveway characteristics:

- Site Driveway D1. A full access driveway on Butler Avenue to be repositioned about 70 feet east of its current location to be approximately aligned with the Greyhound Bus terminal driveway on the north side of the street. The centerline of the 30-foot wide driveway is to be located approximately 507 feet east of the Sawmill Road centerline and about 265 feet west of the unsignalized River Run Road intersection. This driveway is to accommodate the majority of site related trips to and from Butler Road east and a portion of site vehicles to and from the west. No other driveways exist on the south side of Butler Avenue, while a driveway to a low-volume U-Haul site is positioned on the north side of Butler Avenue about 115 feet east of the proposed site driveway as well as a second commercial driveway positioned an additional 80 feet east of the U-Haul driveway. Left turn movements into the site driveway will be made from the existing two-way left turn lane (TWLTL) while right turns into the site will be made from a proposed right-turn deceleration lane.
- Site Driveway D2. An existing driveway on Sawmill Road that will be widened to 26 feet and aligned with the existing full Whole Foods driveway to the west. This driveway is located about 290 feet south of the Sawmill Road stop line to Butler Avenue. This driveway is anticipated to accommodate Sawmill Road drivers into the retail area and a percentage of multi-family housing traffic destined to Butler Avenue and south toward the NAU area. All movements into and out of the driveway are to be made from the existing travel lanes. No turn lanes area planned.
- Site Driveway D3. This driveway is to be repositioned north about 50 feet to align with Kensington Drive. This 24-foot driveway is strictly for vehicles destined to or from the residential units; it is anticipated to serve the majority of the multi-family housing traffic to and from the NAU campus. All movements into and out of the driveway are to be made from the existing travel lanes. No turn lanes area planned.

5.2 Level of Service Analysis, 2020 Total Traffic Conditions

The same methodology used to evaluate the existing and background conditions was applied to the total traffic volume scenario. The AM and PM peak hour volumes shown in Figure 5 were substituted into the appropriate Synchro software file and analyzed. The results of the intersection analyses for the 2020 total traffic conditions are presented in ***Table 4***. The analysis of the Sawmill/Lone Tree intersection assumes the mitigated 2-stage westbound left-turn movement.

The results of the table indicate:

- All intersections and all individual movements continue to operate at LOS D or better during both AM and PM peak hour conditions with the added site-generated traffic. The only movement showing poor operation is the Sawmill Road westbound left-turn movement to southbound Lone Tree Road in the PM peak hour. However, the movement under the mitigated condition performs better than under the current intersection design, although the movement is shown to operate with a LOS F and v/c of 0.96. It is anticipated that if delays become excessive at this location the following will occur:

- A reduced number of motorists would use Sawmill Road as a by-pass to the Butler/Lone Tree intersection.
- Some County employees, Whole Foods, or Groves/Aspen Place at the Sawmill traffic would choose to use Franklin Avenue to turn south onto Lone Tree Road instead of using Sawmill Road.
- The site-generated trips, of which 76% are identified to be generated by the residential component of the site (or 58 projected vehicles) could possibly use Franklin Avenue to San Francisco Street to access the south campus area instead of Lone Tree Road, if destined to the NAU campus.
- Although a signal may be warranted, a traffic signal at this intersection, 370 feet south of the signal at Franklin Avenue, may not be appropriate.

Table 4. Intersection Capacity Analysis Summary, 2020 Total Condition

	2020 Total						
	AM Peak			PM Peak			
Intersection / Movement	LOS	Delay	Queue	LOS	Delay	V/C	Queue
Int 1. Butler Ave and Sawmill Rd	A	8.9		C	22.0		
EB Thru	B	15.3	267	C	30.2		440
EB Right	A	8.7	<50	B	14.9		<50
WB Left	A	2.8	<50	C	26.6		216
WB Thru	A	3.1	129	A	5.8		222
NB Left	D	51.1	68	D	43.2		114
NB Right	B	16.7	52	D	36.6		160
Int 2. Sawmill Rd and Kensigton/Site Drwy D3 (MSS)							
EB Left/Thru/Right	B	10.9	<50	B	12.9		<50
WB Left/Thru/Right	B	10.9	<50	B	13.3		<50
NB Left	A	7.6	<50	A	7.5		<50
SB Left	A	7.6	<50	A	8.0		<50
Int 3. Lone Tree Rd and Sawmill Rd (MSS)							
WB Left	D	27.7	63	F	90.1	0.96	218
WB Right	B	13.8	<50	C	18.2		<50
SB Left	A	9.4	<50	B	10.5		<50
Int 4. Lone Tree Rd and Franklin Ave	B	15.1		C	24.9		
EB Left	C	20.2	<50	B	18.3		72
EB Thru/Right	B	16.5	<50	C	27.5		140
WB Left	C	20.2	<50	B	17.3		<50
WB Thru/Right	C	27.9	73	C	33.6		114
NB Left	A	7.7	53	B	13.0		70
NB Thru	B	11.9	357	C	22.1		577
NB Right	A	0.0	<50	A	0.2		<50
SB Left	A	8.0	<50	B	11.2		<50
SB Thru	B	19.7	400	D	36.5		539
SB Right	A	2.9	<50	A	3.6		<50
Int 5. Lone Tree Rd and Butler Ave	B	16.6		C	31.1		
EB Left	A	6.5	<50	B	16.0		<50
EB Thru	B	14.8	135	D	51.3		611
EB Right	A	4.9	<50	C	21.5		185
WB Left	B	10.7	127	D	38.8		378
WB Thru/Right	B	11.2	240	A	9.2		160
NB Left	D	49.2	296	D	39.2		229
NB Thru/Right	A	9.7	70	B	15.4		135
SB Left	C	33.9	<50	C	29.2		<50
SB Thru/Right	D	36.5	<50	C	26.4		<50
Int D1. Butler Ave and Greyhound/Site Drwy D1 (MSS)							
EB Left	B	12.6	<50	C	12.6		<50
WB Left	A	8.4	<50	B	11.4		<50
NB Left/Thru/Right	B	14.8	<50	C	22.9		<50
Int D2. Sawmill Rd and Whole Foods/Site Drwy D2 (MSS)							
EB Left/Thru/Right	B	10.9	<50	C	18.5		<50
WB Left/Thru/Right	B	11.2	<50	B	13.4		<50
SB Left/Thru/Right	A	7.6	<50	A	7.9		<50
NB Left/Thru/Right	A	7.6	<50	A	7.9		<50

Notes:

1. MSS - Minor Street Stop control, Delay shown in seconds, Queue is the reported 95th percentile length in feet, V/C reported if LOS E/F.

5.3 Roadway Improvements

Based on the LOS analysis presented above, no roadway improvements (capacity increases) are necessary to improve the operational conditions at the study area intersections. The City may wish to consider a change in pavement marking conditions at the Sawmill/Lone Tree Roads intersection to better accommodate existing and future traffic conditions.

Future mitigation of the Sawmill Road/Lone Tree Road intersection, as well as the heavy volume demand along Butler Avenue may be resolved with the City's future consideration of the J.W. Powell Boulevard extension project that would extend the roadway east and tie-in near the I-40/Butler Avenue interchange, I-40/Lone Tree interchange, and/or Lone Tree Road widening project north of Pine Knoll Drive as outlined in the Flagstaff Metropolitan Planning Organization *Blueprint 2040: Regional Transportation Plan* (May 2017).

5.4 Driveway Operational Analysis

In addition to the LOS conditions at the site driveway locations, the following topics at each site driveway were reviewed.

Driveway Spacing

From scaling of the site layout plan, all driveways exceed the minimum driveway spacing requirement to intersections as outlined in Table 10-06-01 (curb return to inside pavement edge of driveway) of the City's *Engineering Design Standards and Specifications for New Infrastructure*, as shown at right.

Table 10-06-01

Minimum Spacing of Driveways to Intersections	
SIGNALIZED	
Posted Speed (mph)	Minimum Spacing to Intersection (ft)
< or =30	230
35	275
40	320
45	365
UNSIGNALIZED	
30	115
35	135
40	155
45	180

In a similar manner, the site driveways are to be positioned in an appropriate manner in regards to the minimum driveway spacing to adjacent property driveways, as outlined in Table 13-10-010-0001 of the City's Engineering Design Standards. The only driveway/condition that could be considered in non-conformance would be Site Driveway D1 under the existing and proposed driveway locations. In the planned scenario, the site is relocating the existing driveway east to align with a driveway on the opposite side of the street. The numerous driveway curb cuts on the north side of the roadway severely limits the location of any site driveway accessing Butler Avenue. Based on this, Site Driveway D1 is identified to be appropriately located, meeting the intent of this requirement and improving existing conditions.

Table 13-10-010-0001

Minimum Drive Spacing (Measured Edge to Edge) on Arterials and Collector Streets	
Street Type	Minimum Spacing (ft.)
Major Arterial	230
Minor Arterial and Major Collector	150
Minor Collector	125

Driveway Sight Visibility

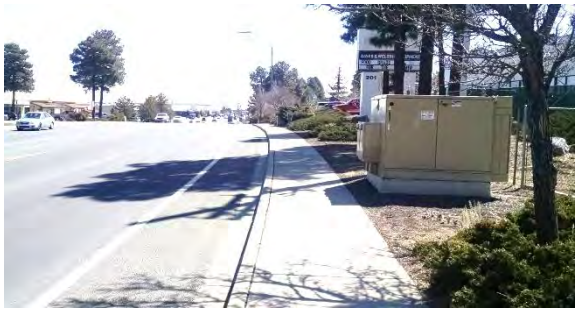
Per AASHTO guidelines and existing roadway conditions, passenger car drivers exiting the site driveways require the following intersection sight distance (ISD) to safely accomplish a right, through, or left-turn movement from a STOP-controlled condition. For the purposes of this analysis, it is assumed the greater sight visibility distance need (left-turn movement) is required. The driver's eye is assumed to be positioned 14.5 feet back from the traveled way.

Butler Avenue (5-lane cross-section, 40 mph)
ISD (Left-turn movement) = 1.47 * 40 mph * (7.5 + (0.5 * 2)) = 500 feet (rounded)

Sawmill Road (2-lane cross-section, 30 mph)
ISD (Left-turn movement) = 1.47 * 30 mph * (7.5 + (0.5 * 0)) = 335 feet (rounded)

A review of the proposed driveway locations was conducted during the data collection to identify if adequate sight visibility could be provided at each site driveway. Below are comments relating to each location:

- Site Driveway D1. An existing electrical transformer exists at the east end of the site's property, adjacent to the proposed relocated site driveway. The approximate 6-foot by 6-foot transformer is located directly south of the 5-foot sidewalk or 10.5 feet south of the Butler Road traveled way, as pictured right. This may create a visibility obstruction for drivers as they look east (right) to view approaching vehicles and pedestrians when the exiting driver's eye is positioned at 14.5 to 18.5 feet (AASHTO identified typical driver eye position when a vehicle is stopped relatively close to the major road) behind of the traveled way. Under this scenario, AASHTO states (Section 9.5.3, Case B1, Paragraph 2): "*Field observations of vehicle stopping postions found that, where needed, drivers will stop with the front of their vehicle 6.5 feet or less from the edge of the major-road traveled way. Measurements of passenger cars indicated that the distance from the front of the vehicle to the driver's eye is nearly always 8 feet or less*". Therefore, at this location, drivers are expected to pull slightly forward from their 14.5- to 18.5-foot typical location, if needed, to eliminate the line of sight obstruction. The site plan shows a driver eye position 14 feet from the Butler Avenue edge of traveled way, when looking to the right (19 feet from traveled way when looking to the left). At this location, the driver's line of sight is 3.5 feet infront of the transformer, providing adequate visibility to approaching vehicles from the east. No other visibility concerns are noted at this location when looking to the east (right) or west (left), as more than 500 feet of sight visibility can be provided to exiting motorists at this driveway.



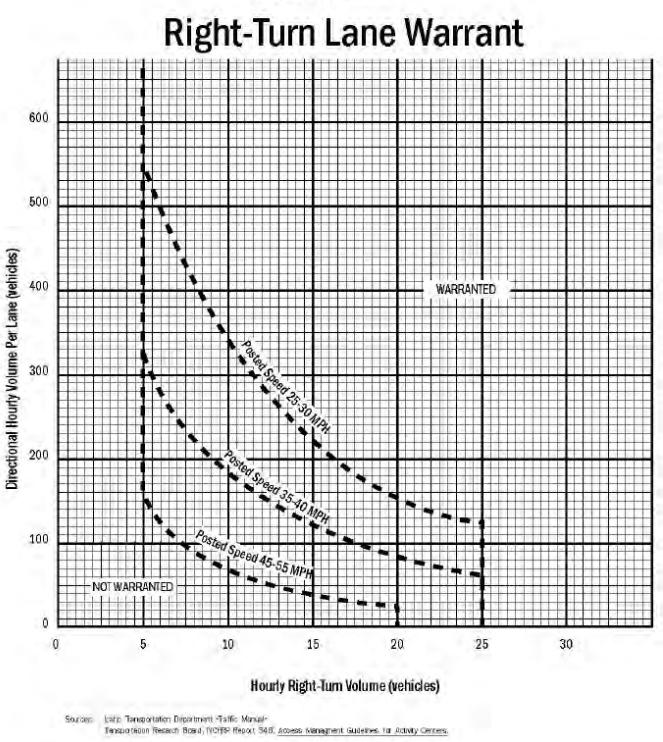
- Site Driveway D2. Sawmill Road in the vicinity of this driveway is a relatively straight roadway. No existing visibility constraints are noted at this location. Drivers can have an unobstructed line of sight to the Butler Road intersection (looking right) and over 550 feet of sight visibility when looking to the south (left) along Sawmill Road.

- Site Driveway D3. This driveway is to be located opposite Kensington Drive on the outside of the northern, large radii curve on Sawmill Road. No existing sight visibility constraints are noted for drivers exiting this location as over 500 feet of visibility can be provided to approaching vehicles at this location when looking to the north or south, exceeding the 335 feet of visibility required.

Right-Turn Deceleration Lanes

The City identifies right-turn deceleration lanes are required based on a set of curve equations involving peak hour volumes in the curb lane, the posted speed limit of the roadway, and the right-turn volume projected to enter the driveway. Based on City turn lane warrants, as shown in Figure 10-10-01 (right) and the 2020 total traffic volume conditions indicated in Table 5, a right-turn deceleration lane is required at all site driveway locations. However, noting the low travel speed conditions on Sawmill Road (30 mph), adverse impact on pedestrians and bicyclists, and lack of right-turn deceleration lanes at other driveway locations on this roadway, it is recommended that right-turn deceleration lanes not be required at the two Sawmill Road site driveways (D2 and D3).

Figure 10-10-01



Sources: Utah Transportation Department -Traffic Manual-
Transportation Research Board, NCHRP Report 348, Access Management Guidelines for Activity Centers.

At the Butler Avenue D1 Site Driveway, 27 AM and 43 PM peak hour vehicles are projected to enter via right-turn movement, warranting a deceleration lane. The design of the turn lane is based on ADOT turn lane design criteria since the posted speed of Butler Avenue is 40 mph. The total length of the turn lane is equal the taper (gap) plus the storage length which is equal to the braking distance plus queue. Based on the ADOT guidelines, the following design parameters are provided:

- Taper = 90 feet [ADOT Table 420-1]
- Braking Distance = 150 feet (desirable), 50 feet (minimum) [ADOT Table 430-2]
- Braking distance reduction due to continuous turn condition = -20 feet
- Queue Length = 43 vehicles per hour / 30 2-minute periods = 1.5 vehicles or 50 feet (minimum) [calculation per non-signal controlled locations]

The total length of the desirable right-turn deceleration lane is calculated to equal 270 feet (90'+150'-20'+50'). It is noted use of the minimum braking length (resulting in a total turn lane length of 170 feet), is normally used for retrofits or minor intersection improvements.

Currently, the site plan indicates a 199-foot turn lane design (109-foot storage with a 90-foot reverse curve taper), an agreed upon design with the City (per client comment) to minimize utility conflicts. This design exceeds the ADOT minimum turn lane design for the volume conditions anticiatped.

Deceleration Lanes, Left-Turn Lanes

Currently, a TWLTL exists within the Butler Avenue cross-section that will accommodate the 49 peak-hour vehicles (50-foot storage) projected to enter the site via left turn movement from westbound Butler Avenue. The 115 feet of storage area between the site driveway and the low volume U-Haul driveway on the north side of street is believed to be adequate to accommodate the left-turn movements to both driveways.

Sawmill Road is currently a 2-lane undivided roadway serving limited traffic volume. The need for exclusive left turn lanes into the subject site to serve a projected 24 peak-hour vehicles at Site Driveway D2 and 21 vehicles at Site Driveway D3 (Int. #2) does not appear to be beneficial based on the 30 mph posted speed limit, low volume conditions, LOS results, and roadway widening impacts it would have on the adjacent/developed properties.

Vehicle Queue

A review of the 95th percentile vehicle queue lengths as reported in the Synchro output sheets and as indicated in Table 4, identify:

- Vehicle queue along Butler Avenue, especially in the eastbound direction in the evening can be extensive.
- Vehicle queue for the westbound Butler Avenue left-turn movement to southbound Lone Tree Road can exceed the available left-turn storage space in the PM peak hour (potential reason for Sawmill Road pass-by traffic). It appears that the left-turn lane could be extended 100 feet, however, this would be the maximum it could be extended without impacting the left-turn lane at Regent Street and would eliminate the existing median landscaping. With a left-turn demand of over 350 vehicles estimated for the 2020 AM and PM peak hours, this movement should be considered for dual left-turn lanes, if the existing median width permits and Lone Tree Road is widened to two lanes south of Butler Avenue.
- With over 300 vehicle demand in the AM and PM peak hours, the northbound Lone Tree Road to westbound Butler Avenue movement could benefit from dual left-turn lanes, although vehicle queue is only identified to be less than 300 feet (12 vehicles).
- The PM peak hour indicates a northbound Lone Tree Road through movement queue of over 500 feet generating from the Franklin Avenue signal in the PM peak hour. Consideration to add a second northbound lane to a location south of Sawmill Road would help eliminate the queue that was observed in this area.
- At the Butler Avenue/Sawmill Road intersection, neither the westbound nor northbound 95th percentile vehicle queue is shown to extend more than 222 feet. With the nearest APRC driveways located about 275 feet from the intersection's stop lines, the site driveways are estimated to operate without vehicle queue spillover from the adjacent signal.

Adequacy of Location and Driveway Design

The site driveways are proposed at a 90 degree angle to the intersecting roadway and appear to follow the MAG driveway design details. The width of the driveways are scaled to accommodate simultaneous, single-lane ingress and egress movements to and from Sawmill Road (24 to 26 foot widths) and Butler Avenue (30-foot width).

No City guidance could be found in regards to required driveway throat distance. From scaling the site plan, the Butler Avenue driveway (D1) provides about 100 feet of throat length to the first internal drive aisle while 50 feet of distance is provided at the D2 driveway to the first parking spaces. Both distances are identified to be adequate, permitting 2 vehicles to store internally prior to blocking parking maneuvers and permitting inbound vehicles to store completely on-site without the rear of the vehicles extending into the travel lanes or sidewalks.

On-Site Circulation Considerations

From review of the site layout plan indicated in Figure 2, the following comments are provided:

- The site plan indicates 850 parking spaces are to be provided for the entire site while 701 spaces are required.
- The circular pick-up/drop-off area at Site Driveway D3 is scaled to have a diameter of 60 feet. This exceeds AASHTO design passenger vehicle swept path (25.5 feet) and is considered to be an acceptable design.
- Parking spaces (9' x 19' without overhang) and drive aisle widths (24-foot minimum) meet or exceed the COF parking design requirements.
- The restaurant drive-through aisle provides a 100-foot storage area (5 vehicles) from pick-up window to the back of the aisle. An additional 65 feet of storage (2 vehicles) is available prior to the main circulatory aisle. Other routing/storage provisions could be implemented, if needed.
- Pedestrian paths into the retail area from the 5-foot wide Sawmill Road and 6-foot wide Butler Avenue sidewalks are provided.
- From the layout of parking areas and drive aisles, no unusual vehicle-vehicle conflicts points are identified.

5.5 Alternative Travel Modes

Pedestrian and Bicycle Trips

From other work conducted for and by the City, it has been identified that non-vehicular trips generated from student housing developments peak outside of the traditional roadway peak periods of 7-9AM and 4-6PM. From observations conducted by Civ-Tech of the Groves I and II apartment developments in early December of 2013, the following pedestrian and bicycle trip rates for the AM peak hour (afternoon or PM peak rates not collected, PM peak rate assumed to be less than the AM rate) are generated (the higher of Mon/Wed/Fri and Tue/Thr conditions):

Assumed pedestrian/bicycle trip rates

- Pedestrians (walk trips) = 0.143 per bed
- Bicyclists (bike trips) = 0.018 per bed

Based on the proposed 854-bedroom housing plan for this site (and assuming the development is comprised entirely of student housing), the following number of peak-hour walk and bike trips are anticipated between NAU and the subject site:

Estimated Peak-Hour Walk and Bike Trips by the Multi-family Housing Development

- Pedestrians = 0.143 trips per bed * 854 beds = 123 walk trips
- Bicyclists = 0.018 trips per bed * 854 beds = 16 bike trips

Assuming both pedestrian and bike trips are evenly distributed throughout a 30-minute period due to one standard class start time (say 9:00AM), different distance in their class destination, and different travel speed, 4.1 walk trips per minute and 1 bike trip per minute can be assumed. Depending upon where classes are located, it is assumed 30 percent of NAU students are projected to cross Lone Tree Road at Franklin Avenue by walking through the Groves/Aspen Place development to the north campus area. The route the remaining 70 percent will travel is projected along the south side of Sawmill Road, using the Arizona Trail to cross Lone Tree Road at Brannen Circle. This location provides an existing pedestrian activated beacon crossing to assist students toward their classes on the south side of campus.

To get to the north campus, an estimated 37 students are anticipated to cross Sawmill Road at the site driveways and meander through the Groves development to Franklin Road where signalized control and pedestrian crossings are accommodated. The site proposed construction of a 5-foot sidewalk along the site's Sawmill Road frontage will connect to an existing 5-foot wide sidewalk south of the site, connecting to the Arizona Trail and accommodating the estimated 86 total walk trips (3 pedestrians per minute) toward the south campus. A site planned 6-foot wide sidewalk fronting the Butler Avenue arterial will accommodate off-site pedestrian travel on this roadway. The planned and existing pedestrian facilities appear appropriate to accommodate pedestrian demand, no modifications are recommended.

Existing bike lanes exist in both directions on Butler Avenue, Sawmill Road, Lone Tree Road, and Franklin Avenue to accommodate bicyclists. No modifications to the existing bike facilities are proposed.

Transit

A number of transit options exist in the subject area including Mountain Line (Route 4 and 12) stops at Butler Avenue and Cambridge Lane in the eastbound direction and at the Greyhound station in the westbound direction. Routes 4 and 14 travel Lone Tree Road with stops at Franklin Avenue. The NAU campus shuttle can be accessed at Franklin Avenue and Beaver Street (0.8 mile from the site or a 12-minute walk at 4 mph). No modification or request to change transit operations are proposed.

The Northern Arizona Intergovernmental Public Transportation Authority (NAIPTA) has provided a transit capacity report for this site and is provided in the appendix. In summary, the report appears to indicate about 5 people per hour can be expected to demand transit service and concludes that with 4 routes in close proximity, the site has some of the best transit access in Flagstaff. Also, there is currently unused transit capacity to capture additional passengers during most times of the day.

5.6 Traffic Control Needs

Site access points are proposed to be STOP-controlled. No changes to speed limits, alignment, or signing is proposed. Modification to pavement markings at the site driveways, if needed, should follow standard City standard details.

5.7 Traffic Signal Needs

Analysis indicates poor operation currently exists at the minor-street STOP-controlled intersection of Lone Tree Road and Sawmill Road (LOS F, v/c = 1.09). Although the capacity analysis indicates the westbound left turn movement delays of about 3 minutes per vehicle during the PM peak hour, a review of the video taken during the data collection effort identifies delays to be significantly less than indicated.

A full 13 hours of intersection counts were not analyzed for this location. The 4 hours of count data indicated volumes at the minor street Sawmill Road approach peaked during the 5PM hour with 182 westbound approach vehicles (total left plus right turn vehicles) and 1,424 total vehicles on the major street approaches (the minor-street volume for the other 3 hours were 142 at 4PM, 85 vehicles at 8AM, and 63 at 7AM). Utilizing the ADOT hourly adjustment factors to estimate the 4th and 8th highest volume hour, 0.851 and 0.742 of the highest hour, MUTCD Warrant 1B (minimum 750 major, 100 minor) and Warrant 2 (1,056 major, 115 minor) would be met at the 100% threshold levels.

Under a more detailed warrant analysis, the volumes warrant may or may not be met under the existing conditions. However, with the projected increase in approach volume generated from the subject site, it is likely that one or more signal warrants would be met. The City has requested the site to share in the cost of the traffic signal installation.

The City has also indicated that the previously identified mitigation option to re-stripe Lone Tree Road south of Sawmill Road to include a two-stage left-turn operation may work in a satisfactory manner and is open to considering such a design, however, more discussion and additional detailed analysis would be required to determine its feasibility and design requirements. The City identified if the installed modification does not perform in a satisfactory manner, or is not projected to accommodate traffic demand in the mid to long-term condition, a traffic signal would be required. In this scenario, the development would be responsible for the improvement costs to implement the two-stage left-turn operation and would also be required to share in the traffic signal installation cost.

5.8 Conclusions

Based on the results of the data that was analyzed in this study, the following conclusions are presented:

<u>Subject Site</u>

- The proposed 854 bedroom (238 unit) multi-family housing development and a 22,300 SF retail area at the southeast corner of Butler Avenue and Sawmill Road intersection is planned for opening in 2020. The site is estimated to generate 4,877 daily, 316 AM and 494 PM peak hour vehicle trips, comprised of internal, pass-by, and new trips. In total, the site is estimate to generate 263 new AM (128 in, 135 out) and 388 new PM (197 in, 191 out) peak hour vehicle trips onto the adjacent roadway network.
- No new driveways are planned for the site, but plans to relocated or improve the three existing driveways to better serve the site, aligning with driveways and roadways on the opposite side of the street. All driveways are to be full movement access points. The south Sawmill Road driveway would serve only the residential portion of the site while the other driveways will serve both the residential and retail traffic.
- The site plan includes sidewalks installed along both Butler Avenue and Sawmill Road frontages to accommodate pedestrian trips while existing bike lanes and near-by transit stops will accommodate other alternative travel mode demands.

<u>Existing Study Area Conditions</u>

- Intersection tuning movement counts were collected during the traditional AM and PM peak periods in March to estimate the operational conditions of the study area intersections. No seasonal

adjustments were made to the volume counts as the count data was collected during typical week conditions with NAU students in school and weather conditions were good.

- Traffic volumes were increased by 2% per year for two years to estimate 2020 background traffic volumes prior to the site opening.
- Intersection analysis of the 2020 background conditions indicated the adjacent study area signalized intersections and individual movements are projected to operate in an acceptable manner (LOS D or better) in both AM and PM peak hour conditions, although some locations indicated long vehicle queues. The only movement showing poor operational conditions was the minor-street STOP controlled Lone Tree Road/Sawmill Road intersection, operating at LOS E during the AM peak hour and LOS F in the PM peak hour under existing conditions. In the PM peak hour, demand exceeds capacity (v/c >1.0). To mitigate the poor operation of the westbound left-turn movement (a percentage of traffic likely using Sawmill Road as a by-pass to the Butler Avenue/Lone Tree intersection), pavement markings could be modified to create a median storage area/acceleration lane on the south leg of the approach allowing the movement to operate at LOS E in the PM peak hour.

Study Area Conditions with Proposed Site Traffic

- With the added site-generated traffic, the study area signalized intersections and individual movements are shown to operate in an acceptable manner, similar to current conditions (LOS D or better) in both AM and PM peak hours.
- The STOP controlled intersection of Lone Tree Road and Sawmill, under the background mitigated condition is identified to operate better than existing conditions, but at LOS F with a v/c ratio of 0.96. All other study area intersections and site driveways are estimated to operate in an acceptable manner as indicated on the site plan.

6. Recommendations

Based on study analysis, guidelines and conclusions, the following recommendations are provided:

Site Recommendations

- Based on City warrants and turn volume estimates, a right-turn deceleration lane is warranted at the site's Butler Avenue driveway. The site plan indicates a 90-foot taper design and 109-foot storge length, a design that exceeds minimum requirements, but is less than desirable. The indicated design, per client comment, has been agreed upon with the City to minimize utility conflicts while still exceeding minimum design requirements. Under these conditions, the indicated turn lane design is appropriate and recommended.
- Sight visibility at the Butler Avenue driveway may be obscured to approaching traffic from the east by an existing electrical cabinet located near the site driveway. Analysis of the site layout indicates drivers may stop 17.5 feet or closer to the traveled way to have the adequate sight visibility to approaching vehicles when looking to the east (right). The site plan shows a driver eye position 14 feet from the traveled way, permitting a scaled 3.5 feet of clearance from the transformer. AASHTO indicates driver would move closer to the traveled way, if needed, to eliminate the obscured view. The location of the driveway is appropriate as located, no modifications are recommended.

- In general the site driveways, internal drive aisles, parking stalls, and the overall vehicle and pedestrian accommodations appear appropriately designed meeting City guidelimes without areas of noticeable conflict points. No modifications or changes are recommended.

City Recommendations

- Existing and future background traffic volumes in the PM peak hour indicate the westbound Sawmill Road to southbound Lone Tree Road operates poorly. Vehicles contributing to this condition are likely drivers by-passing the Butler Avenue/Lone Tree Road left-turn movement where observations indicate the left-turn storage area can extend into the westbound through lane at times. The following considerations to improve the network performance are listed below:
  - Near-term. Consider a pavement marking design modification to allow a westbound to southbound storage/acceleration lane at the Lone Tree/Sawmill intersection. The addition of a raised median island could also be beneficial to separate opposing vehicle flows. Additional trips created by the multi-family housing development that are destined to areas within or near the NAU south campus could utilize Franklin Avenue as an alternative route, if excessive delays are repeatable. *The City has indicated a willingness to accept this solution, but additional discussion and design details are required. Depending upon performance, a traffic signal may still be necessary at this location in the mid or longer term that will also require the developer to pay their share of improvement cost associated with both options.*
  - Near-term. Accelerate the Lone Tree Road widening project north of Pine Knoll Drive as outlined in the Flagstaff Metropolitan Planning Organization *Blueprint 2040: Regional Transportation Plan* (May 2017). This will reduce vehicle queue at locations, allow for dual westbound to southbound left turn lanes to be installed at the Butler/Lone Tree intersection, and may improve the operation and reduce the side-street volumes at the Lone Tree Road/Sawmill Road intersection.
  - Long-term. The City's future consideration of the J.W. Powell Boulevard extension project that would extend the roadway east and tie-in near the I-40/Butler Avenue interchange may help eliminate a percentage of vehicles on Butler Avenue and Sawmill Road destined south on Lone Tree Road.
  - Long-term. Consider the City contemplated I-40/Lone Tree interchange to help reduce indirect driver travel.

Appendix

- **Appendix A. City Comments and Lee Engineering Responses**
- **Appendix B. Pre TIA Submittal Form and NCHRP Trip Capture Estimation Tool**
- **Appendix C. Raw Count Data**
- **Appendix D. Intersection Signal Timing Data**
- **Appendix E. Synchro Output Sheets**

Appendix A.
City Comments and Lee Engineering Responses

MEMORANDUM

Transportation Engineering Program

To: **Elaine Averitt, Development Planning Manager**

From: **Alan Sanderson, Transportation Project Manager**

Date: **June 14, 2018**

RE: **Review Comments for APRC Multi-Family Housing and Retail Traffic Impact Analysis sealed 05/01/2018**

CC: **Jeff Bauman, Traffic Engineer; Reid Miller, Transportation Project Manager; Stephanie Sarty, Transportation Project Manager**

The Transportation Engineering Program has reviewed the submitted Traffic Impact Analysis (TIA). This is the first review of the TIA, and Transportation Engineering's comments are below. Some corrections and clarifications are needed. Also the project should modify striping at Lone Tree Road and Sawmill Road, and should contribute half the cost of a future traffic signal at Lone Tree Road and Sawmill Road, a contribution of $200,000.

Item	Page #	Comment
1	1	Please use same labels for site access here as well in figures. Access A, B, C used here and elsewhere in text, but labeled as D1, D2, 2 in figures.
2	2	Comment about sight visibility at Butler Avenue driveway needing to be verified and addressed prior to being permitted: Clarify that this must be addressed in design, not a later permitting stage.
3	6	Should be City of Flagstaff, not ADOT. Also Flagstaff's form is Pre-Scope, not Pre-Submittal. Also be aware COF never received the final Pre-Scope form with corrections prior to receiving this TIA report. The Pre-Scope form included in the report does have all the corrections, and is acceptable.
4	10	In calculation of new trips, it appears pass-by reduction was applied before subtracting internal trips. Shouldn't the internal trips be subtracted before applying pass-by reduction? Please check and advise.
5	10	Having two sets of footnotes with numbers 1, 2, & 3 is confusing. Please use unique designations on the notes.
6	10	The note 1 that indicates "Bus Trips – None" is misleading. The Flagstaff trip rates used exclude transit trips.
7	11	The traffic assignment was developed when the housing was anticipated as being student housing. Is this assignment still appropriate given this is now a Multi-Family Housing project?

Item	Page #	Comment
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12	24	Should use desirable length for right turn lane of 270’.
13	26	In section 5.5 the project is listed as having 883 beds in one spot and 851 beds elsewhere on the page.
14	26	The assumed trail underpass is really a drainage culvert, not a trail underpass. Although it is shown in some planning documents as a future trail underpass, it has not been improved to trail crossing standards. There is an at grade trail crossing of Lone Tree Road with pedestrian activated beacons. Some people may be able to use this culvert part of the year, but it should not be considered an improved, all-weather under crossing, and the analysis should be based on pedestrians using the at grade crossing.
15	27	NAIPTA did a transit capacity analysis for this project, a copy of which is attached. Please add a reference to this analysis and its conclusions in the Transit paragraph.
16	29	The pavement markings on the south leg of Lone Tree Road and Sawmill Road should be modified with this project to expressly allow a two-stage left turn. Right now it’s got a striped nose with double yellow lines on both sides. Whether it should be an open two-way-left-turn lane or a storage/acceleration lane needs additional review and discussion. In either case, this modification should be done with the project.
17	29	Even though the distance between Franklin Avenue and Sawmill Road is relatively short, it appears the intersection of Sawmill Road and Lone Tree Road will need to be signalized in the mid to long-term future, and sooner if the striping modification does not have the desired impact. This development should contribute half the cost of a future signal.
18	Appendix Index Sheet & Appendix A Cover Sheet	Should say City of Flagstaff, not ADOT.

If you have any questions, or would like to schedule a time to discuss these comments, please contact me.

Transit Capacity Analysis: Asset Plus Campus Housing

Located at 825 E Butler Ave, Asset Plus Companies has submitted a conceptual plan to the City of Flagstaff for a single-story grocery store and a 5-story student housing building with 234 units or 834 beds, a clubhouse, leasing office, and fitness center on 14.57 acres in the light industrial and heavy industrial zoning districts.

Considering the size and purpose of the proposal, a transit capacity analysis has been completed to understand how well transit can absorb new activity at this location. Currently the site is served by four routes and two sets of bus stops: Butler/ Cambridge/ Sawmill and Lone Tree/ Franklin. At best, these stops rank at 73 of 156 in terms of existing boardings by stop – so, these stops are more successful than about half of the system (see additional characteristics in the table below). In terms of access to transit, the site ranks much higher than average with 20-minute frequencies on Route 4, and 30-minute frequencies on Routes 3, 7, and 14 or overall about 9 buses per hour.

An analysis of the passenger loads was conducted for these locations during the month of October 2017 . The transit capacity analysis evaluates the number of passengers that are on the bus at these stop locations and identifies the average capacity remaining. The peak passenger loads at this location occurs in the afternoon hours, approximately between 3:00 PM - 7:00 PM. On average, buses are about a third full throughout the day for both the Butler/ Cambridge and Lone Tree/ Franklin stops. At their maximum, Routes 3 and 4 are impacted the most and reach about two thirds capacity in the afternoon. Route 3 is unique in that it services Northland Preparatory Academy (NPA), a local charter school, and experiences crush loads at the end of the school day. These loads on Route 3 travel by the Asset Plus Campus Housing site approximately 3:00 PM - 4:00 PM. The inbound Route 3 bus reaches capacity at the NPA stop and sustains at capacity until it reaches the Downtown Connection Center (DCC).

Stop Name	Number of Routes	Highest Frequency	Residents[1] within ¼ mi	Jobs[2] served within ¼ mi	Oct 2017 Boardings[3]	Oct 2017 Alightings[4]	Stop Ranking
Butler	3, 7	30 min	251	1,056	770	877	73/156 (47%)
Lone Tree	4, 14	20 min	885	715	449	769	80/156 (51%)
Total	**3, 4, 7, 14**	**20 min**	**1,070**	**1,453**	**1,219**	**1,646**	**73/156 (47%)**

Using these routes, some key locations that can be accessed directly; popular destinations include: Walmart (Huntington), Flagstaff Mall, DCC/downtown, Harkins Theatres, Northern Arizona University (north campus), Coconino Community College (CCC) (Lone Tree Campus), and Foxglenn Park. Popular destinations that require a transfer between one or more routes include Target (Milton) and Northern

[1] American Community Survey, 2015 (Census). Note: Aspen Place at the Sawmill residential component was likely not included in this survey as the development broke ground approximately August 2014; number of residents may be underrepresented.
[2] Longitudinal Employer-Household Dynamics, 2014 (Census). Note: Aspen Place at the Sawmill was likely not fully operating during the time of this estimate; number of jobs served may be underrepresented.
[3] Signifies total number of persons entering the bus at the pair of stops named; for example, Butler would encompass stops at Butler/ Cambridge and Butler/ Sawmill.
[4] Signifies total number of persons exiting the bus at the pair of stops named; for example, Butler would encompass stops at Butler/ Cambridge and Butler/ Sawmill.

Arizona University (south campus). These destinations may take additional travel time to access; or may require walking or bicycling for similar travel times to a personal vehicle.

Travel time and costs are compared for both transit and car trips to key locations from the Asset Plus Campus Housing site location. Looking at a variety of locations, driving on average is about two times faster. However, driving is about 22 times[5] more expensive than transit on an annual basis. This analysis accounts for in-vehicle travel time from the site to the various key locations. For transit and driving, added time for activities such as walking, waiting, parking, maintaining, and fueling are not incorporated.

According to the FMPO's *Trip Diary Survey of Community Travel Patterns* conducted in 2012, an existing transit mode share of about 10%[6] exists in this area. With that, at most Asset Plus Campus Housing can be expected to add about 84 passengers to transit at a single given time, using the number of beds proposed. Likely these residents would take more than one trip per day, have guests, and any transit trips would be spread throughout the day. Nonetheless, the ability for transit to accommodate some of the trips generated by this development can be further analyzed with information from the Transportation Impact Analysis process (i.e. number of trips generated). Averaged throughout the transit span, about five people per hour can be expected to demand transit service.

Conclusions: With four routes in close proximity to the student housing site location, the proposed Asset Plus Campus Housing concept has some of the best transit access in Flagstaff. With the high number of routes serving this area, buses are about two thirds full at their peak in the afternoon with 20-30 minute frequencies. There is availability to capture additional passengers during most times of the day.

[5] The annual cost ratio of driving a car to riding transit for a passenger is based on an annual student transit pass of $239 dollars and a mileage reimbursement rate of $0.54 dollars per mile from the U.S. General Services Administrations' (GSA's) for a privately-owned vehicle (POV) and 10,000 miles driven per year or about 27 miles driven per day. According to the FMPO's *Trip Diary Survey of Community Travel Patterns* conducted in 2012, the average number of miles traveled per day per person is 26.9 miles.

[6] According to the FMPO's 2012 Trip Diary Survey of Community Travel Patterns, in the Core of Flagstaff the mode share of all trips by transit is 11.3% and the non-chained/unlinked trip mode share by transit is 9.3%. The current site falls within the Core of Flagstaff. Therefore, an order of magnitude of 10% for existing transit mode share for the site is reasonable.

Lee Engineering Responses to the COF 1st Review Comments - APRC Multi-Family Housing and Retail

By: Paul Guzek Date: Sept. 14, 2018

ITEM	Page #	Comment/Lee Engineering Response	
1	1	City Comment:	Please use same labels for site access here as well in figures. Access A, B, C used here and elsewhere in text, but labeled as D1, D2, 2 in figures.
		Lee Eng. Response:	The labels have been modified through out the report to be consistent
2	2	City Comment:	Comment about sight visibility at Butler Avenue driveway needing to be verified and addressed prior to being permitted: Clarify that this must be addressed in design, not a later permitting stage.
		Lee Eng. Response:	The site plan includes a survey data of field items. Analysis shows at a driver's eye location 14 feet from edge of traveled way (as depicted on the site plan), 3.5 feet of clearance is provided to the transformer. Motorists could move 4 feet closer, driver eye positioned 10 feet from the traveled way, to see around the existing transformer if needed.
3	6	City Comment:	Should be City of Flagstaff, not ADOT. Also Flagstaff's form is Pre-Scope, not Pre-Submittal. Also be aware COF never received the final Pre-Scope form with corrections prior to receiving this TIA report. The Pre-Scope form included in the report does have all the corrections, and is acceptable.
		Lee Eng. Response:	The text has been modified to idenitfy the COF form and not ADOT. It is noted that some land use modificaitons have occurred since the original submittal, reflected in the revised report.
4	10	City Comment:	In calculation of new trips, it appears pass-by reduction was applied before subtracting internal trips. Shouldn't the internal trips be subtracted before applying pass-by reduction? Please check and advise.
		Lee Eng. Response:	The trip generation methodology has been reviewed and discussed with the City and deemed appropriate.
5	10	City Comment:	Having two sets of footnotes with numbers 1, 2, & 3 is confusing. Please use unique designations on the notes.
		Lee Eng. Response:	Agreed. The footnotes have been modified.
6	10	City Comment:	The note 1 that indicates "Bus Trips – None" is misleading. The Flagstaff trip rates used exclude transit trips.
		Lee Eng. Response:	Agreed. The footnote has been modified.
7	11	City Comment:	The traffic assignment was developed when the housing was anticipated as being student housing. Is Is this assignment still appropriate given this is now a Multi-Family Housing project?
		Lee Eng. Response:	Further discussion with the City concluded that the trip generation under multi-family or student housing was similar. However, to account for less student demand vehicle distribution was modified slightly. Demand to Lone Tree Road and Franklin Avenue have been decreased by 10% (each) and increase 10% to both Butler Avenue east and west
8	11	City Comment:	Next to last paragraph is confusing where it talks about dividing the number of pass-by vehicles by two. Are we really talking about dividing the number of trip ends by two to arrive at the number of vehicles to be assigned?
		Lee Eng. Response:	Yes. One vehicle would be responsible for 1 entering trip end and 1 exiting trip end, a net zero volume change to the adjacent roadway volume.
9	13	City Comment:	Looks like the next to last sentence on the page should have a figure or table number instead of "Error! Reference source not found."
		Lee Eng. Response:	The cross-reference text has been updated.
10	19	City Comment:	It's O'Leary Street, not Road.
		Lee Eng. Response:	The report text has been updated.
11	20	City Comment:	Re location for D1, there's also a commercial driveway on the north side of Butler Avenue about 180 feet east of the proposed location of D1 that isn't mentioned.
		Lee Eng. Response:	The indicated second driveway east of the site driveway on the north side of Butler Avenue has been included in the text.
12	24	City Comment:	Should use desirable length for right turn lane of 270'.
		Lee Eng. Response:	Per comments identified by the client, it is understood that utilities and other concerns exist and that the site plan indicated 109-foot storage + 90-foot taper is being proposed, an agreed upon design with the City.
13	26	City Comment:	In section 5.5 the project is listed as having 883 beds in one spot and 851 beds elsewhere on the page.
		Lee Eng. Response:	The site plan and report has been modified to represent an 854 bedrooms development.

Lee Engineering Responses to the COF 1st Review Comments - APRC Multi-Family Housing and Retail

By: Paul Guzek Date: Sept. 14, 2018

ITEM	Page #	Comment/Lee Engineering Response	
14	26	City Comment:	The assumed trail underpass is really a drainage culvert, not a trail underpass. Although it is shown in some planning documents as a future trail underpass, it has not been improved to trail crossing standards. There is an at grade trail crossing of Lone Tree Road with pedestrian activated beacons. Some people may be able to use this culvert part of the year, but it should not be considered an improved, all-weather under crossing, and the analysis should be based on pedestrians using the at grade crossing.
		Lee Eng. Response:	The pedestrians are now assumed to cross Lone Tree at-grade using the existing pedestrian beacon crossing at Brennen Circle, located just to the south of the drainage culvert.
15	27	City Comment:	NAIPTA did a transit capacity analysis for this project, a copy of which is attached. Please add a reference to this analysis and its conclusions in the Transit paragraph.
		Lee Eng. Response:	A reference to the NAIPTA report has been added. A copy of the report added to the appendix.
16	29	City Comment:	The pavement markings on the south leg of Lone Tree Road and Sawmill Road should be modified with this project to expressly allow a two-stage left turn. Right now it's got a striped nose with double yellow lines on both sides. Whether it should be an open two-way-left-turn lane or a storage/acceleration lane needs additional review and discussion. In either case, this modification should be done with the project.
		Lee Eng. Response:	Text has been added to the report indicating more detailed analysis would be required before this alterantive could be implemented, borne by the developer.
17	29	City Comment:	Even though the distance between Franklin Avenue and Sawmill Road is relatively short, it appears the intersection of Sawmill Road and Lone Tree Road will need to be signalized in the mid to long-term future, and sooner if the striping modification does not have the desired impact. This development should contribute half the cost of a future signal.
		Lee Eng. Response:	Text has been added to the report indicating the developer would be responsible for a portion of the traffic signal installation.
18	Appendix	City Comment:	Should say City of Flagstaff, not ADOT.
		Lee Eng. Response:	The report text has been changed.

Appendix B.
Pre TIA Submittal Form and NCHRP Trip Capture Estimation Tool

City of Flagstaff
211 W. Aspen Ave.
Flagstaff, AZ 86001

PRE-SCOPE OF WORK MEETING FORM

Information on the Project
Traffic Impact Analysis Base Assumptions

The applicant is responsible for entering the relevant information and submitting the form to the City of Flagstaff and the locality no less than three (3) business days prior to the scheduled meeting. If a form is not received by this deadline, the scope of work meeting may be postponed.

Contact Information	
Consultant Name:	Paul Guzek, Lee Engineering
Telephone:	602.955.7206
E-Mail:	pguzek@lee-eng.com
Developer/Owner Name:	Asset Plus Campus Housing, Contact: Barrett Kirk
Telephone:	713.782.5800
Email:	bkirk@assetpluscorp.com

Project Information				
Project Name:	Asset Plus Campus Housing			
Project Location: (Attach regional and site specific location map)	SEC of Bulter Avenue and Sawmill Road (see attached)			
Project Description: Including type of application (rezoning, subdivision, site plan), acreage, business square ft., number of dwelling units, access location, etc. Attach additional sheet if necessary.	224 Student Housing Apartment Units, 851 beds. Grocery Store – 22,245 SF. Three proposed full access points. Butler approx. 460 east of Sawmill (CL to CL), Sawmill 340 feet and 650 feet south of Butler.			
Locality/County:	Flagstaff/Coconico County			
Trip Generation (Attach calculation summary)	Residential ☐	Commercial ☐	Mixed Use ☒	Other ☐
Proposed Use: Number of Units: ITE Code(s):	Off-Campus Student Housing 224 Units, 851 beds None – Use COF Off-Campus Student Housing Data			
Proposed Use: Number of Units: ITE Code(s):	Grocery Store 22,245 SF 850 – Supermarket			
Proposed Use: Number of Units: ITE Code(s):	Click here to enter text. Click here to enter text. Click here to enter text.			
Proposed Use: Number of Units: ITE Code(s):	Click here to enter text. Click here to enter text. Click here to enter text.			

It is important for the applicant to provide sufficient information to the City of Flagstaff so questions regarding geographic scope, alternate methodology, or other issues can be answered at the scoping meeting.

Traffic Impact Analysis Assumptions

Study Period:	Existing: 2018		Opening: 2020		Phase 1:
	Phase 2:		Phase 3:		Build-Out:
Study Area Boundaries: (Attach map)	North: Butler Ave			South: Lone Tree Road	
	East: River Run Road			West: Lone Tree Road	
External Factors That Could Affect Project: (Planned road improvements, other nearby developments)	Unknown				
Available Traffic Data: (Historical, forecasts)	Butler bet. Sawmill and River Run (5/2/2017) and Lone Tree bet. Butler and Franklin (5/2/2017)				
Trip Distribution: (Attach sketch)	Road Name: Butler	N ____%	S ____%	E 10%	W 20%
	Road Name: Lone Tree	N ____%	S 50%	E ____%	W ____%
	Road Name: Franklin	N ____%	S ____%	E ____%	W 20%
	Road Name:	N ____%	S ____%	E ____%	W ____%
Annual Vehicle Trip Growth Rate:	1% per year - Site in developed, mature area				
Peak Period for Study: (Check all that apply)	☒ AM	☐ Midday	☒ PM	☐ SAT	
Study Intersections and/or Road Segments: (Attach additional sheets as necessary)	1. Butler and Saw Mill		2. Saw Mill and Kensington		
	3. Saw Mill and Lone Tree		4. Lone Tree and Franklin		
	5. Butler and Lone Tree		6. Click here to enter text.		
	7. Click here to enter text.		8. Click here to enter text.		
	9. Click here to enter text.		10. Click here to enter text.		
Trip Adjustment Factors: (Attach calculations and assumptions)	Internal allowance: ☒ Yes ☐ No Reduction: Grocery only: AM-2%, PM-15%, Daily-9% of trips		Pass-by allowance: ☒ Yes ☐ No Reduction: Grocery only 36% of trips		
Software Methodology:	☒ Synchro ☐ HCS (v.2010) ☐ aaSIDRA ☐ CORSIM ☐ Other: _____				
Traffic Signal Proposed or Affected: (analysis software to be used, progression speed, cycle length)	Signalized Intersections - Butler/Saw Mill, Butler/Lone Tree and Lone Tree/Franklin Unsignalized Intersection – Saw Mill/Lone Tree				
Improvement(s) Assumed or to be Considered:	None				
Relevant Traffic Studies Considered:	None				
Plan Submission:	☐ Master Development Plan		☒ Generalized Development Plan		
	☐ Preliminary / Sketch Plan		☐ Other Plan Type (Final Site, Subd. Plan)		
Analysis Types:	☒ Queuing Analysis	☐ Actuation / Coordination		☐ Weaving Analysis	
	☐ Merge Analysis	☒ Bike / Ped Accommodations		☒ Intersection(s)	
	☐ TDM Measures	☒ LOS Analysis		☐ Delay Analysis	
	☐ Other: _____	☐ Other: _____			

It is important for the applicant to provide sufficient information to the City of Flagstaff so questions regarding geographic scope, alternate methodology, or other issues can be answered at the scoping meeting.

Notes on Assumptions

ANALYSIS CATEGORY – TYPE 1, less than 500 peak hour trips. Opening year 2020.

TRIP GENERATION – The new ITE rates for student housing appear to be similar to NAU values, however, per City comment use Flagstaff specific rates found in Student Housing Trip Generation Study (Dec. 2016).

For Bike and Walk Trips – Generalized from Flagstaff Student Housing Trip Gen Study and previous Milltown TIA (no reduction to vehicle trips, see bottom of Trip Generation Estimate).
No Adjacent Transit Routes – Assume students walk to Lone Tree for Campus Bus (no reduction to vehicle trips).

Assume no reduction to student housing trips due to grocery store, however, assume reduction of grocery store trips due to adjacent site and non-site student housing and apartments (2% AM, 15% PM, 9% Daily).

TRIP DISTRIBUTION - Most student trips to/from NAU, although a percentage of trips and grocery store trips to/from Butler Ave.

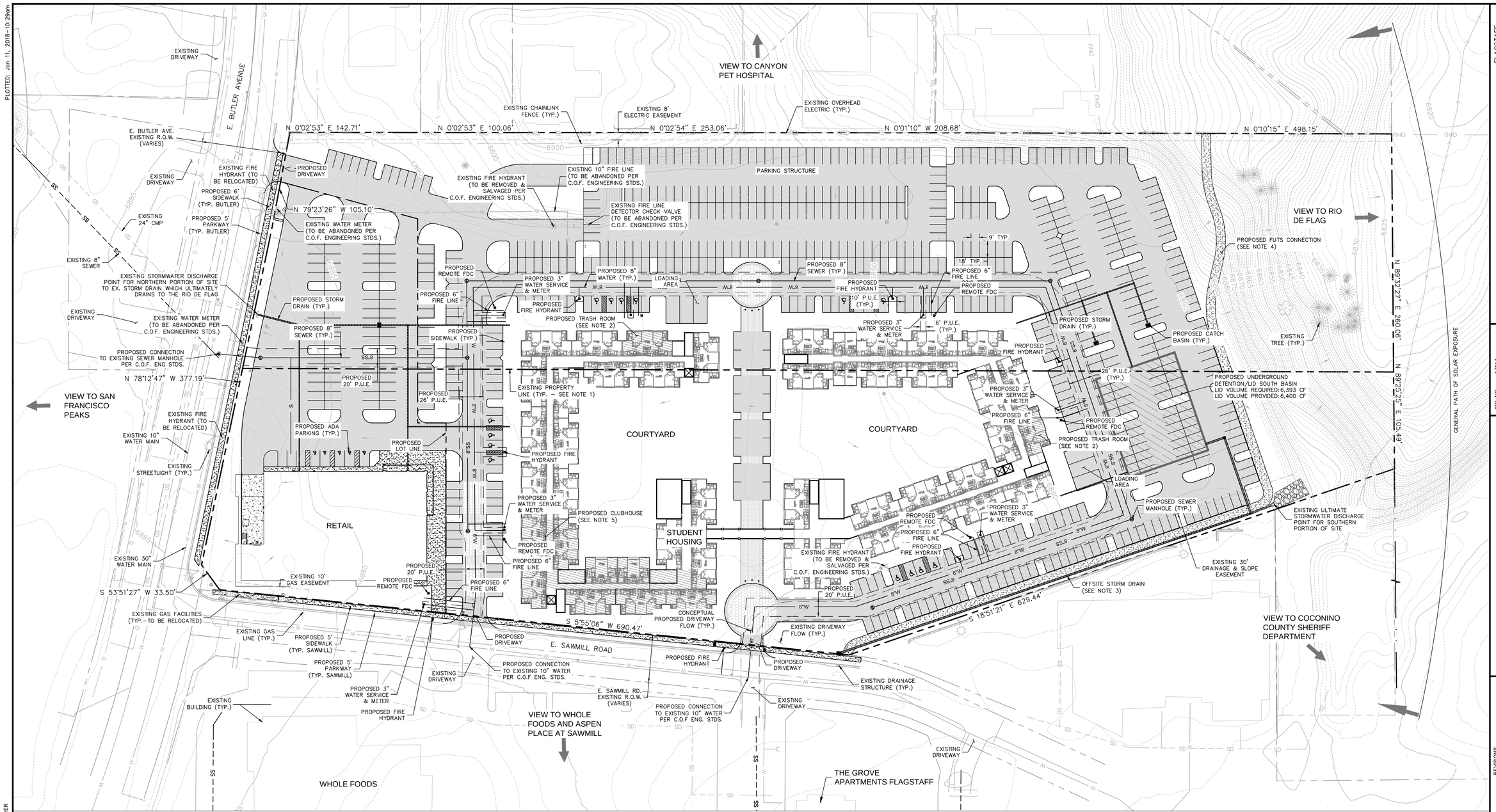
WALK/BIKE TRAVEL - Assume most students to walk/bike directly west through the developed "Groves" area to reach Franklin Avenue, along Saw Mill east to/from South Campus.

REQUEST from CITY: Latest signal timing/coordination data for Butler/Saw Mill, Butler/Lone Tree, and Lone Tree/Franklin. Latest Intersection tuning movement counts.

SIGNED: _____ DATE: 3/30/18
Applicant or Consultant

PRINT NAME: Paul Gutek
Applicant or Consultant

It is important for the applicant to provide sufficient information to the City of Flagstaff so questions regarding geographic scope, alternate methodology, or other issues can be answered at the scoping meeting.



STUDENT HOUSING PROJECT DATA:

GROSS PARCEL AREA: 539,672 SF

TOTAL SQUARE FOOTAGE (STUDENT HOUSING): 393,925 SF

GROSS AREA (STUDENT HOUSING): 368,000 SF
GROSS AREA (INCLUDING AMENITIES): 394,000 SF

NET AREA (STUDENT HOUSING): 304,000 SF
NET AREA (INCLUDING AMENITIES): 320,000 SF

TOTAL UNITS 224 (851 BEDS)
198 – 4 BEDROOM
10 – 3 BEDROOM
6 – 2 BEDROOM
10 – 1 BEDROOM
7 – EFFICIENCY

PARKING
TOTAL PARKING REQUIRED = 604 MIN
= 635 MAX (5% OVERPARKED)

TOTAL PARKING PROVIDED = 751 SPACES
431 SURFACE SPACES
320 STRUCTURED SPACES

TOTAL BIKE STORAGE PROVIDED = ~400 SPACES

RETAIL PROJECT DATA:

GROSS PARCEL AREA: 92,383 SF

BUILDING AREA: 22,245 SF
STORAGE AREA: 3,458 SF
TOTAL: 18,787 SF

PARKING
REQUIRED PARKING RATIO 1 SPACE PER 250 SF
18,787 SF/250 SF = 75 SPACES

INDIVIDUAL PARKING STANDARD	REQUIRED	PROVIDED
ACCESSIBLE PER ADA	4	5
TOTAL PARKING	75	77

CONCEPT PLAN IMPERVIOUS AREAS & LID ANALYSIS

						LID Required Depth (ft)	
						0.0833	
Basin ID	Existing Basin Area (sf)	Proposed Basin Area (sf)	Existing Basin Impervious Area for LID (sf)	Proposed Basin Impervious Area for LID (sf)	Area Difference (sf)	Required LID Volume (cf)	Provided LID Volume (cf)
North Basin	262,140	207,020	167,598	152,420	-15,178	-1,265	0
South Basin	369,915	425,035	148,552	225,267	76,715	6,393	6,400
TOTAL	632,055	632,055	316,150	377,687	61,537	5,128	6,400

Notes:
1) Gross required 1" LID volume is for impervious area including proposed streets, parking, sidewalks and buildings.

SITE ANALYSIS:
- EXISTING LAND USE IS LIGHT & HEAVY INDUSTRIAL. WENDT BUSINESS PARK WAREHOUSE IS LOCATED ON SITE.
- EXISTING TOPOGRAPHY AS SHOWN
- EXISTING VEGETATION AS SHOWN
- NOTICEABLE SITE VIEWS INCLUDE THE SAN FRANCISCO PEAKS (NORTH) AND THE RIO DE FLAG (SOUTH).
- THE PREVAILING WINDS ARE GENERALLY FROM THE SOUTHWEST. AT 7,000 FEET FLAGSTAFF EXPERIENCES SNOW AND LARGE TEMPERATURE SWINGS. AS A RESULT OF REOCCURRING FREEZE/THAW CYCLES, PEDESTRIAN WALKWAYS WILL AVOID THE NORTH SIDE OF BUILDINGS AS MUCH AS POSSIBLE.
- FLAGSTAFF SUBSURFACE CONDITIONS GENERALLY CONSIST OF ROCK AND/OR CLAY MATERIAL, IT IS EXPECTED THAT THIS SITE WILL BE THE SAME. ALL DESIGN WILL BE PER THE RECOMMENDATIONS OF THE GEOTECHNICAL REPORT.
- SITE EXPERIENCES A GOOD AMOUNT OF SUN EXPOSURE. PRECIPITATION NATURALLY RUNS INTO THE RIO DE FLAG.
- SITE ACCESSIBLE AND VIEWABLE FROM E. BUTLER AVE AND E. SAWMILL RD.

NOTES:
1. A LOT COMBINATION WILL BE COMPLETED WITH FINAL DESIGN.
2. TRASH WILL BE COLLECTED AND COMPACTED INTERNALLY WITHIN A TRASH ROOM, AND TRASH–PICK UP WILL BE ACCOMMODATED ON–SITE IN AN AREA REMOTE FROM ADJACENT FRONTAGES ALONG BUTLER AND SAWMILL.
3. THE RUNOFF FROM THE SOUTH PORTION OF THE STUDENT HOUSING PARCEL WILL BE ROUTED THROUGH PRIVATE STORM DRAIN. THE PORTION OF THE RUNOFF FROM SAWMILL ROAD, WHICH ENTERS AN EXISTING CATCH BASIN THAT WILL BE REBUILT WITH THIS PROJECT, WILL BE CONVEYED THROUGH A PUBLIC STORM STORM DRAIN NEAR THE SOUTHWEST BOUNDARY OF THE SITE INSTEAD OF THE EXISTING DRAINAGE SWALE.
4. THE PROPOSED 10' FUTS TRAIL IS SHOWN CONCEPTUALLY. ASSET PLUS AND THE CITY SHALL COORDINATE GRADING AND TRAIL ALIGNMENT.
5. BIKE STORAGE WILL BE PROVIDED WITHIN THE CLUBHOUSE LAYOUT.

NORTH
SCALE 1" : 50'
0 25 50

PRELIMINARY

NOT FOR CONSTRUCTION, BIDDING OR RECORDING

FLAGSTAFF ARIZONA

ASSET PLUS STUDENT HOUSING

CONCEPT PLAN

JOB NO: 17113
DATE: JAN 18
SCALE: AS SHOWN
DRAWN: EGT
DESIGN: KMB
CHECKED: SCI

REVISIONS

NO.	DESCRIPTION	DATE	BY

Shepard Wesnitzer, Inc.
SWI
110 W. Dale Avenue
Flagstaff, AZ 86001
928.773.0354
928.774.6934 fax
www.SWIAZ.com

DRAWING NO.
CP01

SHT NO. 2 OF 2

Table 1. Trip Generation Estimate

			FLAGSTAFF	Grocery Store	
Description	Land Use		Residential	Retail	
	ITE Land Use Code		X	850	
	ITE Land Use Title		Off-Campus Student Apartment	Supermarket	
	Land Use Variable		Beds	1000 SF GFA	
	Variable Amount (X)		851	22.245	
Trip Rates	Weekday		3.10	106.78	
	AM Peak Hour		0.20	3.82	
	PM Peak Hour		0.34	9.24	
Inbound %	Weekday		50%	50%	
	AM Peak Hour		45%	60%	
	PM Peak Hour		50%	51%	**Parcel Total Full Build-out**
Total Trips	Weekday		2638	2375	**5013**
	AM Peak Hour Inbound		77	51	**128**
	AM Peak Hour Outbound		93	34	**127**
	PM Peak Hour Inbound		145	105	**250**
	PM Peak Hour Outbound		144	101	**245**
Internal Site Interaction Reduction Percent [1]		Daily	0%	9%	
		AM	0%	2%	
		PM	0%	15%	
External Trips	Weekday		2638	2173	**4811**
	AM Peak Hour Inbound		77	50	**127**
	AM Peak Hour Outbound		93	33	**126**
	PM Peak Hour Inbound		145	89	**234**
	PM Peak Hour Outbound		144	86	**230**
Pass-by Traffic	AM Peak Hour Pass-by Percentage (2)		0%	36%	
	PM Peak Hour Pass-by Percentage (2)		0%	36%	
	AM Peak Hour Trip Ends		0	30	**30**
	PM Peak Hour Trip Ends		0	63	**63**
New Trips	Weekday (3)		2638	1520	**4158**
	AM Peak Hour Inbound		77	35	**112**
	AM Peak Hour Outbound		93	18	**111**
	PM Peak Hour Inbound		145	58	**203**
	PM Peak Hour Outbound		144	55	**199**

Alternative Travel Modes for Student Housing - CITY OF FLAGSTAFF

1 Bus Trips - None

2 Walk Trips (% of total residents) - Daily = 50% (424 total trips, 212 in, 212 out), AM Peak = 9% (77 total trips, 15 in, 62 out), PM Peak = 9% (77 total trips, 39 in, 38 out)

3 Bike Trips (% of total residents) - Daily = 25% (212 total trips, 106 in, 106 out), AM Peak = 1% (9 total trips, 2 in, 7 out), PM Peak = 9% (9 total trips, 4 in, 5 out)

Sources:

1 NCHRP Report 684 Estimation spreadsheet for internal site interaction (daily assumed as the average of AM + PM values)

2 Trip Generation Handbook, 3rd Edition, 2017

3 Daily pass-by trips assumed as the average of AM + PM values

NCHRP 684 Internal Trip Capture Estimation Tool			
Project Name:	Asset Plus Housing	**Organization:**	Lee Engineering
Project Location:	Flagstaff	**Performed By:**	PG
Scenario Description:		**Date:**	3.30.18
Analysis Year:	2020	**Checked By:**	
Analysis Period:	**AM Street Peak Hour**	**Date:**	

Table 1-A: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)

Land Use	Development Data (*For Information Only*)			Estimated Vehicle-Trips[3]		
	ITE LUCs[1]	Quantity	Units	Total	Entering	Exiting
Office				0		
Retail				85	51	34
Restaurant				0		
Cinema/Entertainment				0		
Residential				170	77	93
Hotel				0		
All Other Land Uses[2]				0		
				255	128	127

Table 2-A: Mode Split and Vehicle Occupancy Estimates

Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.[4]	% Transit	% Non-Motorized	Veh. Occ.[4]	% Transit	% Non-Motorized
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						
All Other Land Uses[2]						

Table 3-A: Average Land Use Interchange Distances (Feet Walking Distance)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-A: Internal Person-Trip Origin-Destination Matrix*

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		0	0	2	0
Restaurant	0	0		0	0	0
Cinema/Entertainment	0	0	0		0	0
Residential	0	1	0	0		0
Hotel	0	0	0	0	0	

Table 5-A: Computations Summary

	Total	Entering	Exiting
All Person-Trips	255	128	127
Internal Capture Percentage	2%	2%	2%
External Vehicle-Trips[5]	249	125	124
External Transit-Trips[6]	0	0	0
External Non-Motorized Trips[6]	0	0	0

Table 6-A: Internal Trip Capture Percentages by Land Use

Land Use	Entering Trips	Exiting Trips
Office	N/A	N/A
Retail	2%	6%
Restaurant	N/A	N/A
Cinema/Entertainment	N/A	N/A
Residential	3%	1%
Hotel	N/A	N/A

[1]Land Use Codes (LUCs) from *Trip Generation Manual*, published by the Institute of Transportation Engineers.

[2]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator.

[3]Enter trips assuming no transit or non-motorized trips (as assumed in ITE *Trip Generation Manual*).

[4]Enter vehicle occupancy assumed in Table 1-A vehicle trips. If vehicle occupancy changes for proposed mixed-use project, manual adjustments must be made to Tables 5-A, 9-A (O and D). Enter transit, non-motorized percentages that will result with proposed mixed-use project complete.

[5]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A.

[6]Person-Trips

*Indicates computation that has been rounded to the nearest whole number.

Estimation Tool Developed by the Texas A&M Transportation Institute - Version 2013.1

NCHRP 684 Internal Trip Capture Estimation Tool			
Project Name:	Asset Plus Campus Housing	**Organization:**	Lee Engineering
Project Location:	Flagstaff	**Performed By:**	PG
Scenario Description:		**Date:**	3.30.18
Analysis Year:	2020	**Checked By:**	
Analysis Period:	**PM Street Peak Hour**	**Date:**	

Table 1-P: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)

Land Use	Development Data (*For Information Only*)			Estimated Vehicle-Trips[3]		
	ITE LUCs[1]	Quantity	Units	Total	Entering	Exiting
Office				0		
Retail				206	105	101
Restaurant				0		
Cinema/Entertainment				0		
Residential				289	145	144
Hotel				0		
All Other Land Uses[2]				0		
				495	250	245

Table 2-P: Mode Split and Vehicle Occupancy Estimates

Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.[4]	% Transit	% Non-Motorized	Veh. Occ.[4]	% Transit	% Non-Motorized
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						
All Other Land Uses[2]						

Table 3-P: Average Land Use Interchange Distances (Feet Walking Distance)

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-P: Internal Person-Trip Origin-Destination Matrix*

Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		0	0	26	0
Restaurant	0	0		0	0	0
Cinema/Entertainment	0	0	0		0	0
Residential	0	11	0	0		0
Hotel	0	0	0	0	0	

Table 5-P: Computations Summary

	Total	Entering	Exiting
All Person-Trips	495	250	245
Internal Capture Percentage	15%	15%	15%
External Vehicle-Trips[5]	421	213	208
External Transit-Trips[6]	0	0	0
External Non-Motorized Trips[6]	0	0	0

Table 6-P: Internal Trip Capture Percentages by Land Use

Land Use	Entering Trips	Exiting Trips
Office	N/A	N/A
Retail	10%	26%
Restaurant	N/A	N/A
Cinema/Entertainment	N/A	N/A
Residential	18%	8%
Hotel	N/A	N/A

[1]Land Use Codes (LUCs) from *Trip Generation Manual* , published by the Institute of Transportation Engineers.

[2]Total estimate for all other land uses at mixed-use development site is not subject to internal trip capture computations in this estimator.

[3]Enter trips assuming no transit or non-motorized trips (as assumed in ITE *Trip Generation Manual*).

[4]Enter vehicle occupancy assumed in Table 1-P vehicle trips. If vehicle occupancy changes for proposed mixed-use project, manual adjustments must be made

[5]Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P.

[6]Person-Trips

*Indicates computation that has been rounded to the nearest whole number.

Estimation Tool Developed by the Texas A&M Transportation Institute - Version 2013.1

LEGEND

XX%	Est. Distribution Percentage
#	Intersection Turning Movement Count Location to be collected by Lee Engineering
#	Intersection Turning Movement Count Location to be provided by City.

Not to scale

Vicinity Map

Figure 1

LEE ENGINEERING

Appendix C. Raw Count Data

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States
pguzek@lee-eng.com

Count Name: Asset Plus
Site Code: 1
Start Date: 03/27/2018

Turning Movement Data

Start Time	Westbound Approach				Northbound Approach				Eastbound Approach				
	Westbound				Northbound				Eastbound				
	Left	Thru	Peds	App. Total	Left	Right	Peds	App. Total	Thru	Right	Peds	App. Total	Int. Total
7:00 AM	16	128	0	144	1	14	0	15	142	3	0	145	304
7:15 AM	15	190	0	205	1	21	0	22	155	3	0	158	385
7:30 AM	35	257	0	292	2	28	1	30	164	1	0	165	487
7:45 AM	38	338	0	376	2	39	4	41	175	4	0	179	596
8:00 AM	40	264	0	304	3	17	3	20	192	4	1	196	520
8:15 AM	30	232	0	262	9	17	2	26	152	2	0	154	442
8:30 AM	32	229	0	261	2	28	1	30	164	6	2	170	461
8:45 AM	26	210	0	236	6	28	1	34	168	10	1	178	448
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-
4:00 PM	41	222	0	263	8	43	5	51	305	5	0	310	624
4:15 PM	33	222	0	255	9	33	4	42	273	10	0	283	580
4:30 PM	34	239	0	273	7	46	1	53	273	8	0	281	607
4:45 PM	39	243	0	282	13	48	3	61	290	11	0	301	644
5:00 PM	47	263	0	310	20	68	1	88	314	4	1	318	716
5:15 PM	62	271	0	333	15	57	2	72	337	5	0	342	747
5:30 PM	48	257	0	305	13	66	0	79	319	8	0	327	711
5:45 PM	40	226	0	266	18	45	0	63	273	6	2	279	608
Grand Total	576	3791	0	4367	129	598	28	727	3696	90	7	3786	8880
Approach %	13.2	86.8	-	-	17.7	82.3	-	-	97.6	2.4	-	-	-
Total %	6.5	42.7	-	49.2	1.5	6.7	-	8.2	41.6	1.0	-	42.6	-
Lights	570	3685	-	4255	127	591	-	718	3573	89	-	3662	8635
% Lights	99.0	97.2	-	97.4	98.4	98.8	-	98.8	96.7	98.9	-	96.7	97.2
Buses	0	28	-	28	1	2	-	3	31	0	-	31	62
% Buses	0.0	0.7	-	0.6	0.8	0.3	-	0.4	0.8	0.0	-	0.8	0.7
Trucks	4	74	-	78	1	5	-	6	81	1	-	82	166
% Trucks	0.7	2.0	-	1.8	0.8	0.8	-	0.8	2.2	1.1	-	2.2	1.9
Bicycles on Road	2	4	-	6	0	0	-	0	11	0	-	11	17
% Bicycles on Road	0.3	0.1	-	0.1	0.0	0.0	-	0.0	0.3	0.0	-	0.3	0.2
Bicycles on Crosswalk	-	-	0	-	-	-	6	-	-	-	1	-	-
% Bicycles on Crosswalk	-	-	-	-	-	-	21.4	-	-	-	14.3	-	-
Pedestrians	-	-	0	-	-	-	22	-	-	-	6	-	-
% Pedestrians	-	-	-	-	-	-	78.6	-	-	-	85.7	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States
pguzek@lee-eng.com

Count Name: Asset Plus
Site Code: 2
Start Date: 03/27/2018

Turning Movement Data

Start Time	Southbound Approach				Westbound Approach					Northbound Approach					Eastbound Approach				
	Southbound				Westbound					Northbound					Eastbound				
	Left	Thru	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	App. Total	Int. Total
7:01 AM	1	44	1	45	0	7	1	0	8	2	75	3	2	80	7	6	7	20	153
7:16 AM	1	75	2	76	1	10	0	0	11	14	96	7	3	117	5	2	5	12	216
7:31 AM	0	91	11	91	10	20	1	0	31	26	131	1	9	158	4	3	7	14	294
7:46 AM	0	122	8	122	5	20	1	1	26	28	136	4	9	168	5	6	4	15	331
8:01 AM	1	122	7	123	4	8	3	4	15	13	100	3	1	116	5	4	13	22	276
8:16 AM	0	124	3	124	6	9	2	1	17	9	87	3	2	99	6	5	7	18	258
8:31 AM	1	89	4	90	4	8	1	1	13	12	110	10	7	132	5	4	7	16	251
8:46 AM	2	81	8	83	7	18	2	2	27	20	91	9	22	120	10	12	10	32	262
9:01 AM	0	3	0	3	1	2	0	0	3	1	2	1	0	4	0	0	0	0	10
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3:46 PM	0	8	1	8	0	1	1	0	2	0	9	1	3	10	0	0	3	3	23
4:01 PM	4	122	2	126	12	14	3	0	29	17	138	8	23	163	14	28	10	52	370
4:16 PM	1	121	3	122	6	16	6	0	28	11	105	6	7	122	14	15	10	39	311
4:31 PM	1	104	1	105	8	19	1	0	28	13	105	7	7	125	18	32	12	62	320
4:46 PM	1	105	3	106	9	14	5	1	28	15	125	8	12	148	13	14	11	38	320
5:01 PM	2	113	7	115	23	39	3	0	65	22	148	9	9	179	37	17	23	77	436
5:16 PM	2	127	4	129	11	29	5	0	45	24	129	20	19	173	23	32	21	76	423
5:31 PM	1	132	5	133	14	26	1	1	41	25	147	13	10	185	23	30	18	71	430
5:46 PM	3	127	8	130	7	21	0	1	28	14	96	12	7	122	21	18	7	46	326
Grand Total	21	1710	78	1731	128	281	36	12	445	266	1830	125	152	2221	210	228	175	613	5010
Approach %	1.2	98.8	-	-	28.8	63.1	8.1	-	-	12.0	82.4	5.6	-	-	34.3	37.2	28.5	-	-
Total %	0.4	34.1	-	34.6	2.6	5.6	0.7	-	8.9	5.3	36.5	2.5	-	44.3	4.2	4.6	3.5	12.2	-
Lights	21	1665	-	1686	125	271	35	-	431	265	1776	124	-	2165	205	213	171	589	4871
% Lights	100.0	97.4	-	97.4	97.7	96.4	97.2	-	96.9	99.6	97.0	99.2	-	97.5	97.6	93.4	97.7	96.1	97.2
Buses	0	14	-	14	0	0	0	-	0	0	25	0	-	25	0	0	2	2	41
% Buses	0.0	0.8	-	0.8	0.0	0.0	0.0	-	0.0	0.0	1.4	0.0	-	1.1	0.0	0.0	1.1	0.3	0.8
Trucks	0	26	-	26	1	0	1	-	2	0	26	1	-	27	3	1	2	6	61
% Trucks	0.0	1.5	-	1.5	0.8	0.0	2.8	-	0.4	0.0	1.4	0.8	-	1.2	1.4	0.4	1.1	1.0	1.2
Bicycles on Road	0	5	-	5	2	10	0	-	12	1	3	0	-	4	2	14	0	16	37
% Bicycles on Road	0.0	0.3	-	0.3	1.6	3.6	0.0	-	2.7	0.4	0.2	0.0	-	0.2	1.0	6.1	0.0	2.6	0.7
Bicycles on Crosswalk	-	-	1	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-
% Bicycles on Crosswalk	-	-	1.3	-	-	-	-	8.3	-	-	-	-	0.7	-	-	-	-	-	-
Pedestrians	-	-	77	-	-	-	-	11	-	-	-	-	151	-	-	-	-	-	-
% Pedestrians	-	-	98.7	-	-	-	-	91.7	-	-	-	-	99.3	-	-	-	-	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States
pguzek@lee-eng.com

Count Name: Asset Plus
Site Code: 3
Start Date: 03/27/2018

Turning Movement Data

Start Time	Southbound Approach Southbound				Westbound Approach Westbound				Northbound Approach Northbound				
	Left	Thru	Peds	App. Total	Left	Right	Peds	App. Total	Thru	Right	Peds	App. Total	Int. Total
7:00 AM	7	48	0	55	8	4	0	12	80	14	0	94	161
7:15 AM	3	71	0	74	12	0	0	12	120	25	0	145	231
7:30 AM	6	94	1	100	13	4	0	17	147	30	0	177	294
7:45 AM	6	132	0	138	18	4	0	22	161	46	0	207	367
8:00 AM	6	142	0	148	19	7	3	26	114	14	0	128	302
8:15 AM	3	150	2	153	22	5	1	27	92	16	0	108	288
8:30 AM	2	97	0	99	10	5	2	15	122	23	0	145	259
8:45 AM	5	97	1	102	10	7	2	17	117	26	0	143	262
*** BREAK ***	-	-	-	-	-	-	-	-	-	-	-	-	-
4:00 PM	5	135	0	140	27	12	1	39	153	26	0	179	358
4:15 PM	1	143	2	144	24	7	1	31	113	26	0	139	314
4:30 PM	5	120	0	125	22	13	1	35	116	23	0	139	299
4:45 PM	2	114	1	116	31	6	1	37	149	23	0	172	325
5:00 PM	1	167	0	168	32	15	0	47	156	45	0	201	416
5:15 PM	2	153	0	155	33	11	1	44	169	42	0	211	410
5:30 PM	9	164	0	173	34	15	1	49	173	37	0	210	432
5:45 PM	5	148	0	153	33	9	0	42	121	32	0	153	348
Grand Total	68	1975	7	2043	348	124	14	472	2103	448	0	2551	5066
Approach %	3.3	96.7	-	-	73.7	26.3	-	-	82.4	17.6	-	-	-
Total %	1.3	39.0	-	40.3	6.9	2.4	-	9.3	41.5	8.8	-	50.4	-
Lights	66	1923	-	1989	340	123	-	463	2047	442	-	2489	4941
% Lights	97.1	97.4	-	97.4	97.7	99.2	-	98.1	97.3	98.7	-	97.6	97.5
Buses	2	17	-	19	0	0	-	0	24	2	-	26	45
% Buses	2.9	0.9	-	0.9	0.0	0.0	-	0.0	1.1	0.4	-	1.0	0.9
Trucks	0	28	-	28	1	0	-	1	28	2	-	30	59
% Trucks	0.0	1.4	-	1.4	0.3	0.0	-	0.2	1.3	0.4	-	1.2	1.2
Bicycles on Road	0	7	-	7	7	1	-	8	4	2	-	6	21
% Bicycles on Road	0.0	0.4	-	0.3	2.0	0.8	-	1.7	0.2	0.4	-	0.2	0.4
Bicycles on Crosswalk	-	-	1	-	-	-	0	-	-	-	0	-	-
% Bicycles on Crosswalk	-	-	14.3	-	-	-	0.0	-	-	-	-	-	-
Pedestrians	-	-	6	-	-	-	14	-	-	-	0	-	-
% Pedestrians	-	-	85.7	-	-	-	100.0	-	-	-	-	-	-

Lee Engineering, LLC
Phoenix, Arizona - Dallas, Texas
Oklahoma City, Oklahoma - San Antonio, Texas
Albuquerque, New Mexico, United States
pguzek@lee-eng.com

Count Name: Asset Plus
Site Code: 4
Start Date: 03/27/2018

Turning Movement Data

Start Time	Southbound Approach Southbound			Northbound Approach Northbound			Eastbound Approach Eastbound			
	Thru	Right	App. Total	Left	Thru	App. Total	Left	Right	App. Total	Int. Total
7:15 AM	16	0	16	1	21	22	0	0	0	38
7:30 AM	33	1	34	0	24	24	0	0	0	58
7:45 AM	31	0	31	0	40	40	1	1	2	73
8:00 AM	30	0	30	0	18	18	0	0	0	48
8:15 AM	23	0	23	0	17	17	0	0	0	40
8:30 AM	19	0	19	0	27	27	0	0	0	46
8:45 AM	21	0	21	0	28	28	1	2	3	52
*** BREAK ***	-	-	-	-	-	-	-	-	-	-
4:00 PM	23	3	26	0	31	31	1	0	1	58
4:15 PM	18	2	20	1	33	34	1	0	1	55
4:30 PM	22	1	23	1	41	42	4	3	7	72
4:45 PM	17	3	20	0	49	49	3	1	4	73
5:00 PM	23	2	25	1	58	59	1	1	2	86
5:15 PM	28	1	29	2	45	47	1	0	1	77
5:30 PM	24	3	27	1	54	55	2	0	2	84
5:45 PM	26	1	27	2	32	34	2	2	4	65
Grand Total	354	17	371	9	518	527	17	10	27	925
Approach %	95.4	4.6	-	1.7	98.3	-	63.0	37.0	-	-
Total %	38.3	1.8	40.1	1.0	56.0	57.0	1.8	1.1	2.9	-
All Vehicles (no classification)	354	17	371	9	518	527	17	10	27	925
% All Vehicles (no classification)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Appendix D. Intersection Signal Timing Data

CITY OF FLAGSTAFF

TRAFFIC SIGNAL TIMING CARD

LOCATION: Butler & San Francisco **SIGNAL NUMBER: 261**

DATE: 4/11/2018 **Updated card & widths**

PHASE	1	2	3	4	5	6	7	8
MOVEMENT		EB			EBLT	WB		NB
FLASH		R				R		R
START-UP		G				G		
MIN. GREEN		15			5	15		10
PASSAGE TIME (EXT)		2.5			2.5	2.5		2.0
MAX 1		60			15	60		20
MAX 2								
MAX 3								
YELLOW		3.6			3.0	3.6		3.0
RED CLEARANCE		1.5			1.0	1.5		3.1
WALK		4				4		4
PED CLEARANCE		12				8		23
RECALL MODE		MinV				MinV		
DUAL ENTRY		ON				ON		
DET MEMORY (lock)								
DET ASSIGNMENT								
DET ASSIGNMENT (17-24)								
DETECTOR CROSS SWITCH					6			
LOOP/CAMERA DELAY								
LOOP/CAMERA EXTEND								
CONTROLLER DELAY								
CONTROLLER EXTEND								
BACKUP PROTECT					Yes			
LEFT TURN OPERATION					PP3C			

Flash Start-up timing: 0 seconds
All Red Start-up timing: 6 seconds
Coordination: Yes
Intersection Notes: UPS system, Video detection
Set Ped Reservice phase 2 & 6
Set Actuated Rest in Walk phase 2 & 6

CITY OF FLAGSTAFF
TRAFFIC SIGNAL TIMING CARD

LOCATION: Butler & Lone Tree/Colorado **SIGNAL NUMBER: 315**

DATE: 4/18/2018 **Updated card & widths**

PHASE	1	2	3	4	5	6	7	8
MOVEMENT	WBLT	EB	NBLT	SB	EBLT	WB	SBLT	NB
FLASH	R	R	R	R	R	R	R	R
START-UP		G				G		
MIN. GREEN	5	15	5	10	5	15	5	10
PASSAGE TIME (EXT)	2.5	2.5	2.5	1.5	2.5	2.5	2.5	1.5
MAX 1	20	40	20	20	15	40	15	30
MAX 2								
MAX 3								
YELLOW	3.0	4.0	3.0	3.0	3.0	4.0	3.0	3.0
RED CLEARANCE	1.5	2.0	1.0	3.4	1.5	2.0	1.0	3.4
WALK		4		4		4		4
PED CLEARANCE		16		24		11		21
RECALL MODE		MinV				MinV		
DUAL ENTRY		ON		ON		ON		ON
DETECTOR MEM (lock)								
DUAL ENTRY		ON		ON		ON		ON
DET MEMORY (lock)								
DET ASSIGNMENT								
LOOP/CAMERA DELAY								
LOOP/CAMERA EXTEND								
CONTROLLER DELAY								
CONTROLLER EXTEND								
BACKUP PROTECT	YES		YES		YES		YES	
LEFT TURN OPERATION	PP3C		PP3C		PP3C		PP3C	

Flash Start-up timing: 0 seconds
All Red Start-up timing: 6 seconds
Coordination: Yes
Intersection Notes: UPS system, Video detection
Set Ped Reservice phase 2 & 6
Set Actuated Rest in Walk phase 2 & 6

CITY OF FLAGSTAFF
TRAFFIC SIGNAL TIMING CARD

LOCATION: Butler and Sawmill **SIGNAL NUMBER: 353**

DATE: 4/18/2018 Updated card & widths

PHASE	1	2	3	4	5	6	7	8
MOVEMENT	WBLT	EB				WB		NB
FLASH		R				R		R
START-UP		G				G		
MIN. GREEN	5	15				15		5
PASSAGE TIME (EXT)	2.5	2.5				2.5		1.5
MAX 1	15	45				45		20
MAX 2								
MAX 3								
YELLOW	3.0	4.0				4.0		3.3
RED CLEARANCE	1.0	1.8				1.8		1.0
WALK		4						4
PED CLEARANCE		12						22
RECALL MODE		min V				min V		
DUAL ENTRY		ON				ON		
DET MEMORY (lock)								
DET ASSIGNMENT								
DET CROSS SWITCH								
LOOP/CAMERA DELAY								15 RT
LOOP/CAMERA EXTEND								
CONTROLLER DELAY								3
CONTROLLER EXTEND	1							
BACKUP PROTECT	YES							
LEFT TURN OPERATION	PP3C							

Flash Start-up timing: 0 Seconds
All Red Start-up timing: 6 Seconds
Coordination: Yes
Intersection Notes: UPS system, Video detection
Set Ped Reservice phase 2 & 6
Set Actuated Rest in Walk phase 2 & 6

CITY OF FLAGSTAFF
TRAFFIC SIGNAL TIMING CARD

LOCATION: Lone Tree/Franklin **SIGNAL NUMBER: 314**

DATE: 9/14/2011 Update

PHASE	1	2	3	4	5	6	7	8
MOVEMENT	SBLT	NB	WBLT	EB	NBLT	SB	EBLT	WB
FLASH	R	R	R	R	R	R	R	R
START-UP		G				G		
MIN. GREEN	5	15	5	5	5	15	5	5
PASSAGE TIME (EXT)	2.5	3.0	2.5	1.5	2.5	3.0	2.5	1.5
MAX 1	15	40	15	20	15	40	15	20
MAX 2	16	30	16	40	16	26	26	40
MAX 3								
YELLOW	3.0	3.6	3.0	3.0	3.0	3.6	3.0	3.0
RED CLEARANCE	1.0	2.0	1.0	2.9	1.0	2.0	1.0	2.9
WALK		4		4		4		4
PED CLEARANCE		13		19		13		19
RECALL MODE		MinV				MinV		
CNA I								
CNA II								
DUAL ENTRY		ON		ON		ON		ON
DETECTOR MEMORY								
DETECTOR ASSIGNMENT								
LOOP/CAMERA DELAY								
LOOP/CAMERA EXTEND								
CONTROLLER DELAY				10				10
CONTROLLER EXTEND								

Flash Start-up timing: 0 seconds
All Red Start-up timing: 5 seconds
Coordination: None
Intersection Notes: Back-up protection, third car left turn, UPS system

Appendix E. Synchro Output Sheets

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	683	11	143	1091	16	101
Future Volume (vph)	683	11	143	1091	16	101
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.335		0.950	
Satd. Flow (perm)	3539	1583	624	3539	1770	1583
Satd. Flow (RTOR)		12				112
Lane Group Flow (vph)	759	12	159	1212	18	112
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm
Protected Phases	2		1	6	8	
Permitted Phases		2	6			8
Total Split (s)	52.0	52.0	14.0	66.0	30.0	30.0
Total Lost Time (s)	5.8	5.8	4.0	5.8	4.3	4.3
Act Effct Green (s)	69.1	69.1	81.6	79.8	6.1	6.1
Actuated g/C Ratio	0.72	0.72	0.85	0.83	0.06	0.06
v/c Ratio	0.30	0.01	0.26	0.41	0.16	0.55
Control Delay	10.9	7.5	2.4	2.7	44.8	18.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	10.9	7.5	2.4	2.7	44.8	18.9
LOS	B	A	A	A	D	B
Approach Delay	10.8			2.6	22.5	
Approach LOS	B			A	C	
Queue Length 50th (ft)	130	0	9	61	11	0
Queue Length 95th (ft)	246	m11	24	114	32	50
Internal Link Dist (ft)	393			419	268	
Turn Bay Length (ft)		110	210			90
Base Capacity (vph)	2547	1143	649	2942	473	505
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.30	0.01	0.24	0.41	0.04	0.22

Intersection Summary	
Cycle Length: 96	
Actuated Cycle Length: 96	
Offset: 6 (6%), Referenced to phase 2:EBT and 6:WBTL, Start of Green	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.55	
Intersection Signal Delay: 6.5	Intersection LOS: A
Intersection Capacity Utilization 42.7%	ICU Level of Service A
Analysis Period (min) 15	

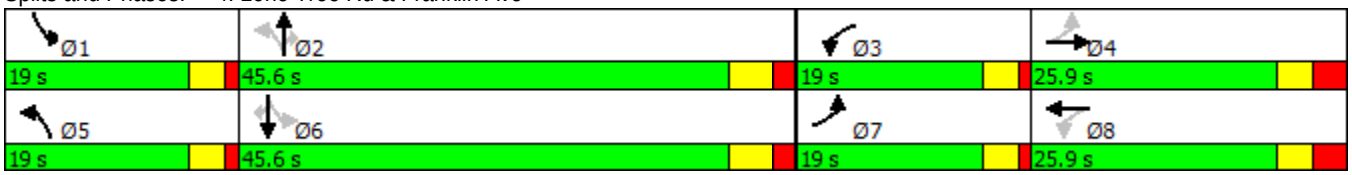
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 1: Sawmill & Butler Ave

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	20	18	31	25	57	7	76	454	11	1	459	76
Future Volume (vph)	20	18	31	25	57	7	76	454	11	1	459	76
Satd. Flow (prot)	1770	1688	0	1770	1831	0	1770	1863	1583	1770	1863	1583
Flt Permitted	0.714			0.722			0.322			0.478		
Satd. Flow (perm)	1330	1688	0	1345	1831	0	600	1863	1583	890	1863	1583
Satd. Flow (RTOR)		34			5				109			109
Lane Group Flow (vph)	22	54	0	28	71	0	84	504	12	1	510	84
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2		2	6		6
Total Split (s)	19.0	25.9		19.0	25.9		19.0	45.6	45.6	19.0	45.6	45.6
Total Lost Time (s)	4.0	5.9		4.0	5.9		4.0	5.6	5.6	4.0	5.6	5.6
Act Effct Green (s)	11.6	8.9		11.7	9.2		39.9	40.8	40.8	34.6	30.1	30.1
Actuated g/C Ratio	0.21	0.16		0.21	0.16		0.71	0.73	0.73	0.62	0.54	0.54
v/c Ratio	0.07	0.18		0.09	0.23		0.14	0.37	0.01	0.00	0.51	0.09
Control Delay	19.3	16.4		19.3	26.0		7.2	10.7	0.0	8.0	17.7	2.6
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	19.3	16.4		19.3	26.0		7.2	10.7	0.0	8.0	17.7	2.6
LOS	B	B		B	C		A	B	A	A	B	A
Approach Delay		17.3			24.1			10.0			15.5	
Approach LOS		B			C			B			B	
Queue Length 50th (ft)	5	5		7	17		6	58	0	0	113	0
Queue Length 95th (ft)	25	41		30	70		46	339	0	3	375	19
Internal Link Dist (ft)		600			332			299			479	
Turn Bay Length (ft)	95			100			85		85	140		125
Base Capacity (vph)	641	749		642	796		801	1439	1248	914	1423	1235
Starvation Cap Reductn	0	0		0	0		0	0	0	0	0	0
Spillback Cap Reductn	0	0		0	0		0	0	0	0	0	0
Storage Cap Reductn	0	0		0	0		0	0	0	0	0	0
Reduced v/c Ratio	0.03	0.07		0.04	0.09		0.10	0.35	0.01	0.00	0.36	0.07

Intersection Summary		
Cycle Length: 109.5		
Actuated Cycle Length: 56.1		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.51		
Intersection Signal Delay: 13.8	Intersection LOS: B	
Intersection Capacity Utilization 49.3%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 4: Lone Tree Rd & Franklin Ave

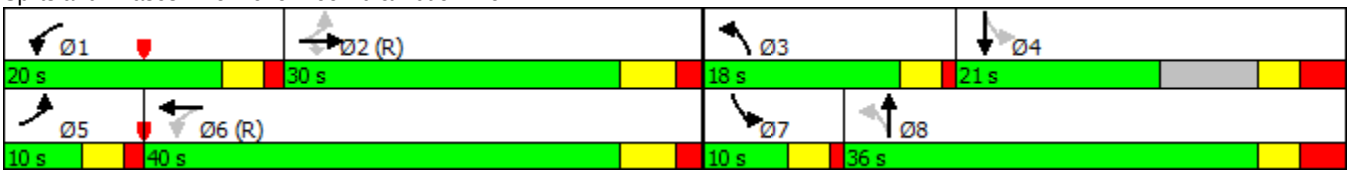


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	6	424	225	369	708	7	329	7	231	31	7	1
Future Volume (vph)	6	424	225	369	708	7	329	7	231	31	7	1
Satd. Flow (prot)	1770	3539	1583	1770	3532	0	1770	1593	0	1770	1831	0
Flt Permitted	0.351			0.351			0.667			0.930		
Satd. Flow (perm)	654	3539	1583	654	3532	0	1242	1593	0	1732	1831	0
Satd. Flow (RTOR)			232		1			257			1	
Lane Group Flow (vph)	7	471	250	410	795	0	366	265	0	34	9	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6			8			4		
Total Split (s)	10.0	30.0	30.0	20.0	40.0		18.0	36.0		10.0	21.0	
Total Lost Time (s)	2.7	4.2	6.0	4.5	4.2		1.7	4.1		1.7	4.1	
Act Effct Green (s)	48.1	39.6	37.8	64.1	54.8		25.7	16.5		11.7	12.3	
Actuated g/C Ratio	0.50	0.41	0.39	0.67	0.57		0.27	0.17		0.12	0.13	
v/c Ratio	0.02	0.32	0.33	0.61	0.39		0.81	0.55		0.16	0.04	
Control Delay	6.3	13.2	3.6	10.1	11.0		46.2	9.7		33.4	36.4	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	6.3	13.2	3.6	10.1	11.0		46.2	9.7		33.4	36.4	
LOS	A	B	A	B	B		D	A		C	D	
Approach Delay		9.8			10.7			30.9			34.0	
Approach LOS		A			B			C			C	
Queue Length 50th (ft)	1	77	0	67	133		207	4		19	4	
Queue Length 95th (ft)	m4	105	29	146	217		274	68		34	m18	
Internal Link Dist (ft)		303			1089			322			612	
Turn Bay Length (ft)	60		60	300			225					
Base Capacity (vph)	414	1459	764	678	2015		454	700		220	456	
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0	
Storage Cap Reductn	0	0	0	0	0		0	0		0	0	
Reduced v/c Ratio	0.02	0.32	0.33	0.60	0.39		0.81	0.38		0.15	0.02	

Intersection Summary

Cycle Length: 96
Actuated Cycle Length: 96
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green, Master Intersection
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.81
Intersection Signal Delay: 15.7 — Intersection LOS: B
Intersection Capacity Utilization 69.1% — ICU Level of Service C
Analysis Period (min) 15
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lone Tree Rd & Butler Ave



Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⇕			⇕			⇕			⇕	
Traffic Vol, veh/h	1	0	1	0	0	0	1	99	0	0	117	1
Future Vol, veh/h	1	0	1	0	0	0	1	99	0	0	117	1
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	0	1	0	0	0	1	110	0	0	130	1

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	243	243	131	243	243	110	131	0	0	110	0	0
Stage 1	131	131	-	112	112	-	-	-	-	-	-	-
Stage 2	112	112	-	131	131	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	711	659	919	711	659	943	1454	-	-	1480	-	-
Stage 1	873	788	-	893	803	-	-	-	-	-	-	-
Stage 2	893	803	-	873	788	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	710	658	919	710	658	943	1454	-	-	1480	-	-
Mov Cap-2 Maneuver	710	658	-	710	658	-	-	-	-	-	-	-
Stage 1	872	788	-	892	802	-	-	-	-	-	-	-
Stage 2	892	802	-	872	788	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	9.5	0	0.1	0
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1454	-	-	801	-	1480	-	-
HCM Lane V/C Ratio	0.001	-	-	0.003	-	-	-	-
HCM Control Delay (s)	7.5	0	-	9.5	0	0	-	-
HCM Lane LOS	A	A	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0	-	0	-	-

Intersection	
Int Delay, s/veh	2.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	72	20	514	106	21	518
Future Vol, veh/h	72	20	514	106	21	518
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	110	-	-	100	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	80	22	571	118	23	576

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1252	630	0	0	689	0
Stage 1	630	-	-	-	-	-
Stage 2	622	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	190	482	-	-	905	-
Stage 1	531	-	-	-	-	-
Stage 2	535	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	185	482	-	-	905	-
Mov Cap-2 Maneuver	185	-	-	-	-	-
Stage 1	531	-	-	-	-	-
Stage 2	521	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	32.9	0	0.4
HCM LOS	D		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	185	482	905	-
HCM Lane V/C Ratio	-	-	0.432	0.046	0.026	-
HCM Control Delay (s)	-	-	38.5	12.8	9.1	-
HCM Lane LOS	-	-	E	B	A	-
HCM 95th %tile Q(veh)	-	-	2	0.1	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	1	781	2	2	1232	1	2	0	2	0	0	0
Future Vol, veh/h	1	781	2	2	1232	1	2	0	2	0	0	0
Conflicting Peds, #/hr	0	0	0	0	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	100	-	-	100	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	1	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	868	2	2	1369	1	2	0	2	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	1370	0	0	870	0	0	1560	2245	435	1810	2246	685
Stage 1	-	-	-	-	-	-	871	871	-	1374	1374	-
Stage 2	-	-	-	-	-	-	689	1374	-	436	872	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	497	-	-	1108	-	-	138	45	*789	*77	45	391
Stage 1	-	-	-	-	-	-	672	604	-	*153	211	-
Stage 2	-	-	-	-	-	-	402	211	-	*744	603	-
Platoon blocked, %		-	-	1	-	-	1	1	1	1	1	
Mov Cap-1 Maneuver	497	-	-	1108	-	-	138	45	*789	*77	45	391
Mov Cap-2 Maneuver	-	-	-	-	-	-	286	157	-	*77	45	-
Stage 1	-	-	-	-	-	-	670	603	-	*153	211	-
Stage 2	-	-	-	-	-	-	401	211	-	*740	602	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	13.7	0
HCM LOS			B	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	420	497	-	-	1108	-	-	-
HCM Lane V/C Ratio	0.011	0.002	-	-	0.002	-	-	-
HCM Control Delay (s)	13.7	12.3	-	-	8.3	-	-	0
HCM Lane LOS	B	B	-	-	A	-	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	1.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	27	0	10	0	0	0	10	90	0	0	108	46
Future Vol, veh/h	27	0	10	0	0	0	10	90	0	0	108	46
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	30	0	11	0	0	0	11	100	0	0	120	51

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	268	268	146	273	293	100	171	0	0	100	0	0
Stage 1	146	146	-	122	122	-	-	-	-	-	-	-
Stage 2	122	122	-	151	171	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	685	638	901	679	618	956	1406	-	-	1493	-	-
Stage 1	857	776	-	882	795	-	-	-	-	-	-	-
Stage 2	882	795	-	851	757	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	681	633	901	667	613	956	1406	-	-	1493	-	-
Mov Cap-2 Maneuver	681	633	-	667	613	-	-	-	-	-	-	-
Stage 1	850	776	-	875	789	-	-	-	-	-	-	-
Stage 2	875	789	-	841	757	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	10.2	0	0.8	0
HCM LOS	B	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1406	-	-	729	-	1493	-	-
HCM Lane V/C Ratio	0.008	-	-	0.056	-	-	-	-
HCM Control Delay (s)	7.6	0	-	10.2	0	0	-	-
HCM Lane LOS	A	A	-	B	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0.2	-	0	-	-

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1260	26	196	1034	61	239
Future Volume (vph)	1260	26	196	1034	61	239
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.108		0.950	
Satd. Flow (perm)	3539	1583	201	3539	1770	1583
Satd. Flow (RTOR)		16				159
Lane Group Flow (vph)	1400	29	218	1149	68	266
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm
Protected Phases	2		1	6	8	
Permitted Phases		2	6			8
Total Split (s)	55.0	55.0	11.0	66.0	30.0	30.0
Total Lost Time (s)	5.8	5.8	4.0	5.8	4.3	4.3
Act Effct Green (s)	55.7	55.7	76.1	74.3	11.6	11.6
Actuated g/C Ratio	0.58	0.58	0.79	0.77	0.12	0.12
v/c Ratio	0.68	0.03	0.55	0.42	0.32	0.80
Control Delay	26.0	14.8	15.6	4.8	40.0	34.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	26.0	14.8	15.6	4.8	40.0	34.4
LOS	C	B	B	A	D	C
Approach Delay	25.8			6.5	35.5	
Approach LOS	C			A	D	
Queue Length 50th (ft)	315	3	31	94	39	63
Queue Length 95th (ft)	427	m13	123	188	72	139
Internal Link Dist (ft)	393			419	268	
Turn Bay Length (ft)		110	210			90
Base Capacity (vph)	2054	925	396	2737	473	540
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.68	0.03	0.55	0.42	0.14	0.49

Intersection Summary

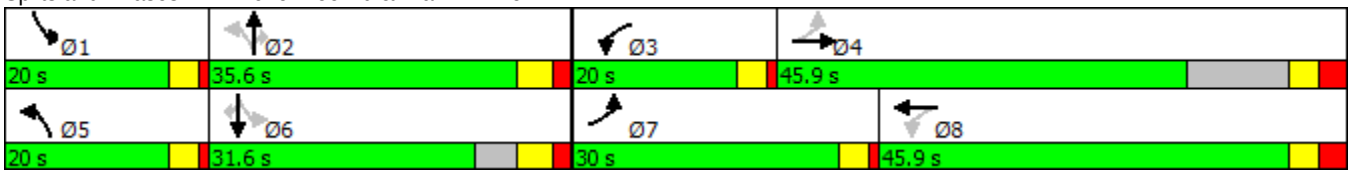
Cycle Length: 96
Actuated Cycle Length: 96
Offset: 94 (98%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.80
Intersection Signal Delay: 18.4 Intersection LOS: B
Intersection Capacity Utilization 61.6% ICU Level of Service B
Analysis Period (min) 15
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 1: Sawmill & Butler Ave

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	96	93	73	57	108	14	86	549	50	6	477	86
Future Volume (vph)	96	93	73	57	108	14	86	549	50	6	477	86
Satd. Flow (prot)	1770	1740	0	1770	1829	0	1770	1863	1583	1770	1863	1583
Flt Permitted	0.594			0.641			0.250			0.308		
Satd. Flow (perm)	1106	1740	0	1194	1829	0	466	1863	1583	574	1863	1583
Satd. Flow (RTOR)		35			5				124			124
Lane Group Flow (vph)	107	184	0	63	136	0	96	610	56	7	530	96
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2		2	6		6
Total Split (s)	30.0	45.9		20.0	45.9		20.0	35.6	35.6	20.0	31.6	31.6
Total Lost Time (s)	4.0	5.9		4.0	5.9		4.0	5.6	5.6	4.0	5.6	5.6
Act Effct Green (s)	20.6	12.4		17.9	11.0		38.5	35.4	35.4	33.7	28.2	28.2
Actuated g/C Ratio	0.30	0.18		0.26	0.16		0.56	0.51	0.51	0.49	0.41	0.41
v/c Ratio	0.26	0.54		0.17	0.46		0.24	0.64	0.06	0.02	0.70	0.13
Control Delay	17.7	27.7		16.9	32.1		11.6	20.7	0.1	11.0	28.4	3.2
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	17.7	27.7		16.9	32.1		11.6	20.7	0.1	11.0	28.4	3.2
LOS	B	C		B	C		B	C	A	B	C	A
Approach Delay		24.0			27.3			18.0			24.4	
Approach LOS		C			C			B			C	
Queue Length 50th (ft)	32	60		18	53		18	168	0	1	193	0
Queue Length 95th (ft)	65	121		42	107		57	#543	0	9	#495	22
Internal Link Dist (ft)		600			332			299			479	
Turn Bay Length (ft)	95			100			85		85	140		125
Base Capacity (vph)	726	1303		562	1104		574	954	872	608	842	783
Starvation Cap Reductn	0	0		0	0		0	0	0	0	0	0
Spillback Cap Reductn	0	0		0	0		0	0	0	0	0	0
Storage Cap Reductn	0	0		0	0		0	0	0	0	0	0
Reduced v/c Ratio	0.15	0.14		0.11	0.12		0.17	0.64	0.06	0.01	0.63	0.12

Intersection Summary		
Cycle Length: 131.5		
Actuated Cycle Length: 69.1		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.70		
Intersection Signal Delay: 22.1	Intersection LOS: C	
Intersection Capacity Utilization 62.8%	ICU Level of Service B	
Analysis Period (min) 15		
# 95th percentile volume exceeds capacity, queue may be longer.		
Queue shown is maximum after two cycles.		

Splits and Phases: 4: Lone Tree Rd & Franklin Ave

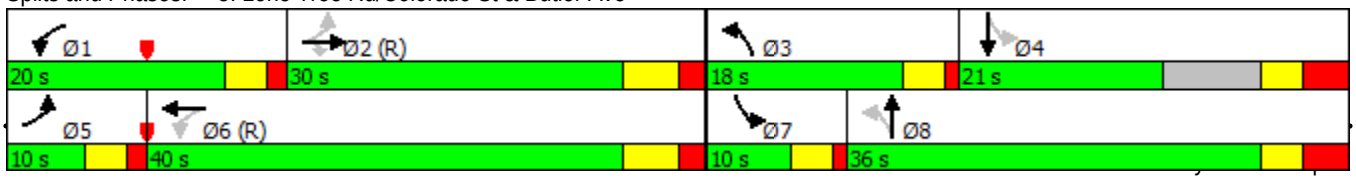


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	6	943	293	340	645	6	301	7	412	45	9	6
Future Volume (vph)	6	943	293	340	645	6	301	7	412	45	9	6
Satd. Flow (prot)	1770	3539	1583	1770	3536	0	1770	1589	0	1770	1747	0
Flt Permitted	0.376			0.110			0.605			0.548		
Satd. Flow (perm)	700	3539	1583	205	3536	0	1127	1589	0	1021	1747	0
Satd. Flow (RTOR)			232		1			419			7	
Lane Group Flow (vph)	7	1048	326	378	724	0	334	466	0	50	17	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6			8			4		
Total Split (s)	10.0	30.0	30.0	20.0	40.0		18.0	36.0		10.0	21.0	
Total Lost Time (s)	2.7	4.2	6.0	4.5	4.2		1.7	4.1		1.7	4.1	
Act Effct Green (s)	45.9	37.6	35.8	64.2	62.6		25.6	17.2		14.9	13.3	
Actuated g/C Ratio	0.48	0.39	0.37	0.67	0.65		0.27	0.18		0.16	0.14	
v/c Ratio	0.02	0.76	0.44	0.75	0.31		0.80	0.74		0.23	0.07	
Control Delay	15.3	40.2	20.4	39.9	8.3		44.9	13.1		29.6	27.2	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	15.3	40.2	20.4	39.9	8.3		44.9	13.1		29.6	27.2	
LOS	B	D	C	D	A		D	B		C	C	
Approach Delay		35.4			19.1			26.4			29.0	
Approach LOS		D			B			C			C	
Queue Length 50th (ft)	2	307	75	164	70		187	26		29	5	
Queue Length 95th (ft)	m6	#534	180	#333	137		229	116		43	m23	
Internal Link Dist (ft)		303			1089			322			612	
Turn Bay Length (ft)	60		60	290			225					
Base Capacity (vph)	419	1386	736	502	2307		420	807		226	440	
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0	
Storage Cap Reductn	0	0	0	0	0		0	0		0	0	
Reduced v/c Ratio	0.02	0.76	0.44	0.75	0.31		0.80	0.58		0.22	0.04	

Intersection Summary

Cycle Length: 96
Actuated Cycle Length: 96
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green, Master Intersection
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.80
Intersection Signal Delay: 27.8 Intersection LOS: C
Intersection Capacity Utilization 87.9% ICU Level of Service E
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lone Tree Rd/Colorado St & Butler Ave



Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	7	0	2	0	0	0	4	206	0	0	92	9
Future Vol, veh/h	7	0	2	0	0	0	4	206	0	0	92	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	8	0	2	0	0	0	4	229	0	0	102	10

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	345	345	107	346	350	229	112	0	0	229	0	0
Stage 1	107	107	-	238	238	-	-	-	-	-	-	-
Stage 2	238	238	-	108	112	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	609	578	947	608	574	810	1478	-	-	1339	-	-
Stage 1	898	807	-	765	708	-	-	-	-	-	-	-
Stage 2	765	708	-	897	803	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	608	576	947	605	572	810	1478	-	-	1339	-	-
Mov Cap-2 Maneuver	608	576	-	605	572	-	-	-	-	-	-	-
Stage 1	895	807	-	763	706	-	-	-	-	-	-	-
Stage 2	763	706	-	895	803	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	10.5	0	0.1	0
HCM LOS	B	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1478	-	-	661	-	1339	-	-
HCM Lane V/C Ratio	0.003	-	-	0.015	-	-	-	-
HCM Control Delay (s)	7.4	0	-	10.5	0	0	-	-
HCM Lane LOS	A	A	-	B	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0	-	0	-	-

Intersection	
Int Delay, s/veh	14.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	130	47	647	147	14	598
Future Vol, veh/h	130	47	647	147	14	598
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	110	-	-	100	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	144	52	719	163	16	664

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1497	801	0	0	882	0
Stage 1	801	-	-	-	-	-
Stage 2	696	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	~ 135	384	-	-	767	-
Stage 1	442	-	-	-	-	-
Stage 2	495	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	~ 132	384	-	-	767	-
Mov Cap-2 Maneuver	~ 132	-	-	-	-	-
Stage 1	442	-	-	-	-	-
Stage 2	485	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	130	0	0.2
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	132	384	767	-
HCM Lane V/C Ratio	-	-	1.094	0.136	0.02	-
HCM Control Delay (s)	-	-	171.3	15.8	9.8	-
HCM Lane LOS	-	-	F	C	A	-
HCM 95th %tile Q(veh)	-	-	8.2	0.5	0.1	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	1	1496	2	2	1228	1	2	0	2	0	0	0
Future Vol, veh/h	1	1496	2	2	1228	1	2	0	2	0	0	0
Conflicting Peds, #/hr	0	0	0	0	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	100	-	-	100	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	1	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	1662	2	2	1364	1	2	0	2	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	1366	0	0	1664	0	0	2353	3036	832	2202	3036	683
Stage 1	-	-	-	-	-	-	1666	1666	-	1369	1369	-
Stage 2	-	-	-	-	-	-	687	1370	-	833	1667	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	499	-	-	*704	-	-	*36	*5	*470	*65	*5	392
Stage 1	-	-	-	-	-	-	*443	*389	-	*154	*213	-
Stage 2	-	-	-	-	-	-	*403	*212	-	*443	*389	-
Platoon blocked, %		-	-	1	-	-	1	1	1	1	1	
Mov Cap-1 Maneuver	499	-	-	*704	-	-	*36	*5	*470	*65	*5	392
Mov Cap-2 Maneuver	-	-	-	-	-	-	*209	*126	-	*65	*5	-
Stage 1	-	-	-	-	-	-	*443	*388	-	*154	*212	-
Stage 2	-	-	-	-	-	-	*402	*211	-	*441	*388	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	17.7	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	289	499	-	-	* 704	-	-	-
HCM Lane V/C Ratio	0.015	0.002	-	-	0.003	-	-	-
HCM Control Delay (s)	17.7	12.2	-	-	10.1	-	-	0
HCM Lane LOS	C	B	-	-	B	-	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	3.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⇕			⇕			⇕			⇕	
Traffic Vol, veh/h	114	0	10	0	0	0	20	186	0	0	91	133
Future Vol, veh/h	114	0	10	0	0	0	20	186	0	0	91	133
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	127	0	11	0	0	0	22	207	0	0	101	148

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	426	426	175	432	500	207	249	0	0	207	0	0
Stage 1	175	175	-	251	251	-	-	-	-	-	-	-
Stage 2	251	251	-	181	249	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	539	520	868	534	473	833	1317	-	-	1364	-	-
Stage 1	827	754	-	753	699	-	-	-	-	-	-	-
Stage 2	753	699	-	821	701	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	531	510	868	520	464	833	1317	-	-	1364	-	-
Mov Cap-2 Maneuver	531	510	-	520	464	-	-	-	-	-	-	-
Stage 1	811	754	-	739	686	-	-	-	-	-	-	-
Stage 2	739	686	-	810	701	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	13.8	0	0.8	0
HCM LOS	B	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1317	-	-	548	-	1364	-	-
HCM Lane V/C Ratio	0.017	-	-	0.251	-	-	-	-
HCM Control Delay (s)	7.8	0	-	13.8	0	0	-	-
HCM Lane LOS	A	A	-	B	A	A	-	-
HCM 95th %tile Q(veh)	0.1	-	-	1	-	0	-	-

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	711	11	149	1135	17	105
Future Volume (vph)	711	11	149	1135	17	105
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.322		0.950	
Satd. Flow (perm)	3539	1583	600	3539	1770	1583
Satd. Flow (RTOR)		11				117
Lane Group Flow (vph)	790	12	166	1261	19	117
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm
Protected Phases	2		1	6	8	
Permitted Phases		2	6			8
Total Split (s)	52.0	52.0	14.0	66.0	30.0	30.0
Total Lost Time (s)	5.8	5.8	4.0	5.8	4.3	4.3
Act Effct Green (s)	68.7	68.7	81.6	79.8	6.1	6.1
Actuated g/C Ratio	0.72	0.72	0.85	0.83	0.06	0.06
v/c Ratio	0.31	0.01	0.28	0.43	0.17	0.56
Control Delay	13.2	8.5	2.5	2.8	44.9	18.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	13.2	8.5	2.5	2.8	44.9	18.8
LOS	B	A	A	A	D	B
Approach Delay	13.1			2.7	22.4	
Approach LOS	B			A	C	
Queue Length 50th (ft)	169	1	9	65	11	0
Queue Length 95th (ft)	257	m10	26	123	33	51
Internal Link Dist (ft)	393			419	268	
Turn Bay Length (ft)		110	210			90
Base Capacity (vph)	2531	1135	631	2940	473	509
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.31	0.01	0.26	0.43	0.04	0.23

Intersection Summary

Cycle Length: 96
Actuated Cycle Length: 96
Offset: 6 (6%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.56
Intersection Signal Delay: 7.4 — Intersection LOS: A
Intersection Capacity Utilization 44.0% — ICU Level of Service A
Analysis Period (min) 15
m Volume for 95th percentile queue is metered by upstream signal.

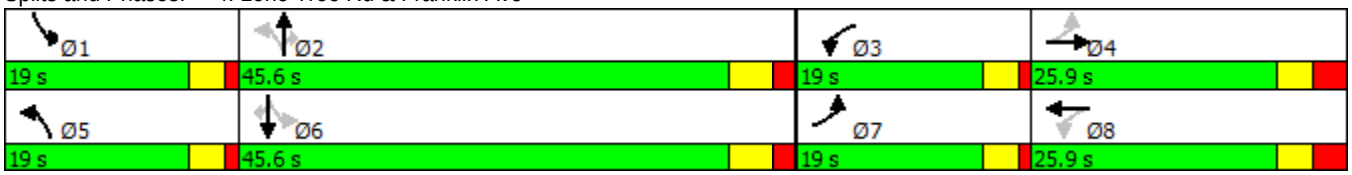
Splits and Phases: 1: Sawmill & Butler Ave

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	21	19	32	26	59	7	79	472	11	1	479	79
Future Volume (vph)	21	19	32	26	59	7	79	472	11	1	479	79
Satd. Flow (prot)	1770	1686	0	1770	1833	0	1770	1863	1583	1770	1863	1583
Flt Permitted	0.709			0.720			0.295			0.454		
Satd. Flow (perm)	1321	1686	0	1341	1833	0	550	1863	1583	846	1863	1583
Satd. Flow (RTOR)		36			5				109			109
Lane Group Flow (vph)	23	57	0	29	74	0	88	524	12	1	532	88
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2		2	6		6
Total Split (s)	19.0	25.9		19.0	25.9		19.0	45.6	45.6	19.0	45.6	45.6
Total Lost Time (s)	4.0	5.9		4.0	5.9		4.0	5.6	5.6	4.0	5.6	5.6
Act Effct Green (s)	12.4	9.1		12.5	9.1		39.7	38.6	38.6	34.5	30.5	30.5
Actuated g/C Ratio	0.21	0.15		0.21	0.15		0.67	0.65	0.65	0.58	0.51	0.51
v/c Ratio	0.07	0.20		0.09	0.26		0.17	0.43	0.01	0.00	0.56	0.10
Control Delay	19.8	16.6		19.8	27.4		7.6	11.9	0.0	8.0	19.4	2.9
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	19.8	16.6		19.8	27.4		7.6	11.9	0.0	8.0	19.4	2.9
LOS	B	B		B	C		A	B	A	A	B	A
Approach Delay		17.5			25.2			11.1			17.0	
Approach LOS		B			C			B			B	
Queue Length 50th (ft)	6	6		7	19		7	62	0	0	122	0
Queue Length 95th (ft)	26	42		31	72		47	357	0	3	397	20
Internal Link Dist (ft)		600			332			299			479	
Turn Bay Length (ft)	95			100			85		85	140		125
Base Capacity (vph)	585	679		586	719		718	1401	1218	831	1384	1204
Starvation Cap Reductn	0	0		0	0		0	0	0	0	0	0
Spillback Cap Reductn	0	0		0	0		0	0	0	0	0	0
Storage Cap Reductn	0	0		0	0		0	0	0	0	0	0
Reduced v/c Ratio	0.04	0.08		0.05	0.10		0.12	0.37	0.01	0.00	0.38	0.07

Intersection Summary

Cycle Length: 109.5
Actuated Cycle Length: 59.4
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.56
Intersection Signal Delay: 15.1 — Intersection LOS: B
Intersection Capacity Utilization 50.6% — ICU Level of Service A
Analysis Period (min) 15

Splits and Phases: 4: Lone Tree Rd & Franklin Ave

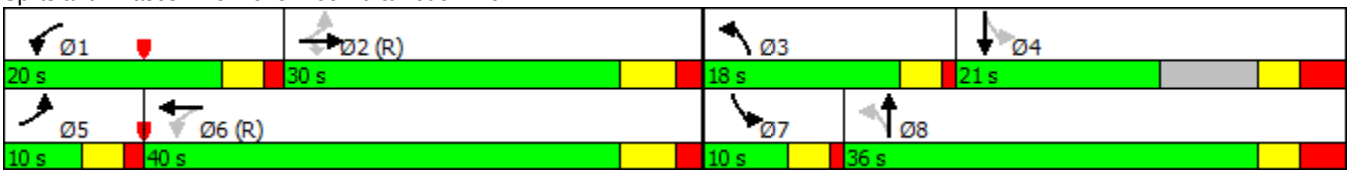


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	6	441	234	384	737	7	342	7	240	32	7	1
Future Volume (vph)	6	441	234	384	737	7	342	7	240	32	7	1
Satd. Flow (prot)	1770	3539	1583	1770	3536	0	1770	1591	0	1770	1831	0
Flt Permitted	0.340			0.323			0.667			0.930		
Satd. Flow (perm)	633	3539	1583	602	3536	0	1242	1591	0	1732	1831	0
Satd. Flow (RTOR)			232		1			267			1	
Lane Group Flow (vph)	7	490	260	427	827	0	380	275	0	36	9	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6			8			4		
Total Split (s)	10.0	30.0	30.0	20.0	40.0		18.0	36.0		10.0	21.0	
Total Lost Time (s)	2.7	4.2	6.0	4.5	4.2		1.7	4.1		1.7	4.1	
Act Effct Green (s)	45.6	37.1	35.3	63.9	54.5		25.9	16.8		11.7	12.3	
Actuated g/C Ratio	0.48	0.39	0.37	0.67	0.57		0.27	0.18		0.12	0.13	
v/c Ratio	0.02	0.36	0.36	0.63	0.41		0.83	0.55		0.17	0.04	
Control Delay	6.2	13.0	4.6	10.4	11.1		48.2	9.6		33.6	36.2	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	6.2	13.0	4.6	10.4	11.1		48.2	9.6		33.6	36.2	
LOS	A	B	A	B	B		D	A		C	D	
Approach Delay		10.1			10.9			32.0			34.1	
Approach LOS		B			B			C			C	
Queue Length 50th (ft)	1	102	11	70	141		217	4		20	4	
Queue Length 95th (ft)	m5	106	47	132	225		288	70		m35	m17	
Internal Link Dist (ft)		303			1089			322			612	
Turn Bay Length (ft)	60		60	300			225					
Base Capacity (vph)	389	1371	730	675	2009		459	706		219	456	
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0	
Storage Cap Reductn	0	0	0	0	0		0	0		0	0	
Reduced v/c Ratio	0.02	0.36	0.36	0.63	0.41		0.83	0.39		0.16	0.02	

Intersection Summary

Cycle Length: 96
Actuated Cycle Length: 96
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green, Master Intersection
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.83
Intersection Signal Delay: 16.1 — Intersection LOS: B
Intersection Capacity Utilization 70.8% — ICU Level of Service C
Analysis Period (min) 15
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lone Tree Rd & Butler Ave



Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	1	0	1	0	0	0	1	103	0	0	122	1
Future Vol, veh/h	1	0	1	0	0	0	1	103	0	0	122	1
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	0	1	0	0	0	1	114	0	0	136	1

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	253	253	136	254	254	114	137	0	0	114	0	0
Stage 1	136	136	-	117	117	-	-	-	-	-	-	-
Stage 2	117	117	-	137	137	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	700	650	913	699	650	939	1447	-	-	1475	-	-
Stage 1	867	784	-	888	799	-	-	-	-	-	-	-
Stage 2	888	799	-	866	783	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	699	649	913	698	649	939	1447	-	-	1475	-	-
Mov Cap-2 Maneuver	699	649	-	698	649	-	-	-	-	-	-	-
Stage 1	866	784	-	887	798	-	-	-	-	-	-	-
Stage 2	887	798	-	865	783	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	9.6	0	0.1	0
HCM LOS	A	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1447	-	-	792	-	1475	-	-
HCM Lane V/C Ratio	0.001	-	-	0.003	-	-	-	-
HCM Control Delay (s)	7.5	0	-	9.6	0	0	-	-
HCM Lane LOS	A	A	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0	-	0	-	-

Intersection	
Int Delay, s/veh	2.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	75	21	535	110	22	539
Future Vol, veh/h	75	21	535	110	22	539
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	110	-	-	100	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	83	23	594	122	24	599

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1304	656	0	0	717	0
Stage 1	656	-	-	-	-	-
Stage 2	648	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	177	465	-	-	884	-
Stage 1	516	-	-	-	-	-
Stage 2	521	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	172	465	-	-	884	-
Mov Cap-2 Maneuver	172	-	-	-	-	-
Stage 1	516	-	-	-	-	-
Stage 2	507	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	37.4	0	0.4
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	172	465	884	-
HCM Lane V/C Ratio	-	-	0.484	0.05	0.028	-
HCM Control Delay (s)	-	-	44.2	13.2	9.2	-
HCM Lane LOS	-	-	E	B	A	-
HCM 95th %tile Q(veh)	-	-	2.3	0.2	0.1	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	1	813	2	2	1282	1	2	0	2	0	0	0
Future Vol, veh/h	1	813	2	2	1282	1	2	0	2	0	0	0
Conflicting Peds, #/hr	0	0	0	0	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	100	-	-	100	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	1	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	903	2	2	1424	1	2	0	2	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	1426	0	0	906	0	0	1624	2337	453	1883	2337	713
Stage 1	-	-	-	-	-	-	907	907	-	1429	1429	-
Stage 2	-	-	-	-	-	-	717	1430	-	454	908	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	473	-	-	1129	-	-	131	38	*757	*70	38	374
Stage 1	-	-	-	-	-	-	709	622	-	*142	199	-
Stage 2	-	-	-	-	-	-	387	199	-	*714	621	-
Platoon blocked, %		-	-	1	-	-	1	1	1	1	1	
Mov Cap-1 Maneuver	473	-	-	1129	-	-	130	38	*757	*70	38	374
Mov Cap-2 Maneuver	-	-	-	-	-	-	280	149	-	*70	38	-
Stage 1	-	-	-	-	-	-	708	621	-	*142	199	-
Stage 2	-	-	-	-	-	-	386	199	-	*710	620	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	13.9	0
HCM LOS			B	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	409	473	-	-	1129	-	-	-
HCM Lane V/C Ratio	0.011	0.002	-	-	0.002	-	-	-
HCM Control Delay (s)	13.9	12.6	-	-	8.2	-	-	0
HCM Lane LOS	B	B	-	-	A	-	-	A
HCM 95th %tile Q(veh)	0	0	-	-	0	-	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	1.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	28	0	10	0	0	0	10	94	0	0	112	48
Future Vol, veh/h	28	0	10	0	0	0	10	94	0	0	112	48
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	31	0	11	0	0	0	11	104	0	0	124	53

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	278	278	151	284	305	104	178	0	0	104	0	0
Stage 1	151	151	-	127	127	-	-	-	-	-	-	-
Stage 2	127	127	-	157	178	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	674	630	895	668	608	951	1398	-	-	1488	-	-
Stage 1	851	772	-	877	791	-	-	-	-	-	-	-
Stage 2	877	791	-	845	752	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	670	625	895	656	603	951	1398	-	-	1488	-	-
Mov Cap-2 Maneuver	670	625	-	656	603	-	-	-	-	-	-	-
Stage 1	844	772	-	870	785	-	-	-	-	-	-	-
Stage 2	870	785	-	835	752	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	10.3	0	0.7	0
HCM LOS	B	A		

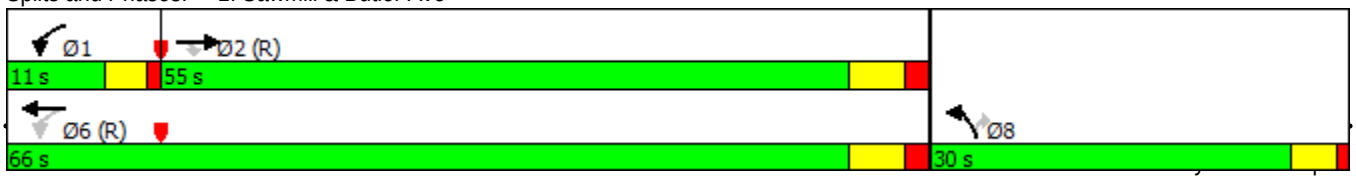
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1398	-	-	717	-	1488	-	-
HCM Lane V/C Ratio	0.008	-	-	0.059	-	-	-	-
HCM Control Delay (s)	7.6	0	-	10.3	0	0	-	-
HCM Lane LOS	A	A	-	B	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0.2	-	0	-	-

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1311	29	204	1076	63	249
Future Volume (vph)	1311	29	204	1076	63	249
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.088		0.950	
Satd. Flow (perm)	3539	1583	164	3539	1770	1583
Satd. Flow (RTOR)		17				156
Lane Group Flow (vph)	1457	32	227	1196	70	277
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm
Protected Phases	2		1	6	8	
Permitted Phases		2	6			8
Total Split (s)	55.0	55.0	11.0	66.0	30.0	30.0
Total Lost Time (s)	5.8	5.8	4.0	5.8	4.3	4.3
Act Effct Green (s)	53.6	53.6	75.3	73.5	12.4	12.4
Actuated g/C Ratio	0.56	0.56	0.78	0.77	0.13	0.13
v/c Ratio	0.74	0.04	0.58	0.44	0.31	0.81
Control Delay	30.1	15.6	21.5	5.3	38.8	35.8
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.1	15.6	21.5	5.3	38.8	35.8
LOS	C	B	C	A	D	D
Approach Delay	29.8			7.9	36.4	
Approach LOS	C			A	D	
Queue Length 50th (ft)	341	6	56	107	39	71
Queue Length 95th (ft)	450	m12	#175	209	72	149
Internal Link Dist (ft)	393			419	268	
Turn Bay Length (ft)		110	210			90
Base Capacity (vph)	1977	892	393	2708	473	538
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.74	0.04	0.58	0.44	0.15	0.51

Intersection Summary

Cycle Length: 96
Actuated Cycle Length: 96
Offset: 94 (98%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.81
Intersection Signal Delay: 21.0 Intersection LOS: C
Intersection Capacity Utilization 63.5% ICU Level of Service B
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 1: Sawmill & Butler Ave

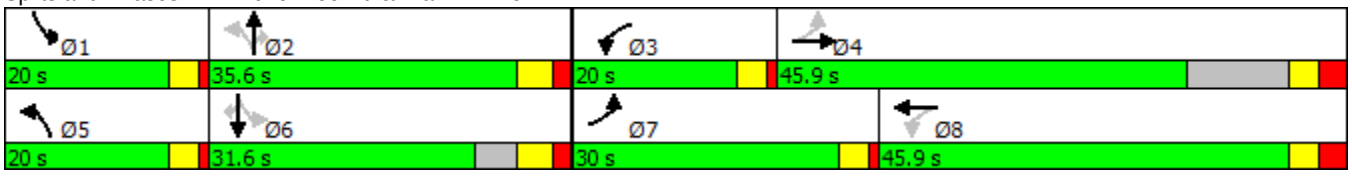


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	100	97	76	59	112	15	89	571	52	6	496	89
Future Volume (vph)	100	97	76	59	112	15	89	571	52	6	496	89
Satd. Flow (prot)	1770	1740	0	1770	1829	0	1770	1863	1583	1770	1863	1583
Flt Permitted	0.593			0.637			0.229			0.284		
Satd. Flow (perm)	1105	1740	0	1187	1829	0	427	1863	1583	529	1863	1583
Satd. Flow (RTOR)		34			5				124			124
Lane Group Flow (vph)	111	192	0	66	141	0	99	634	58	7	551	99
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2		2	6		6
Total Split (s)	30.0	45.9		20.0	45.9		20.0	35.6	35.6	20.0	31.6	31.6
Total Lost Time (s)	4.0	5.9		4.0	5.9		4.0	5.6	5.6	4.0	5.6	5.6
Act Effct Green (s)	21.0	12.6		18.2	11.2		38.6	35.5	35.5	33.7	28.2	28.2
Actuated g/C Ratio	0.30	0.18		0.26	0.16		0.56	0.51	0.51	0.48	0.41	0.41
v/c Ratio	0.27	0.56		0.18	0.47		0.26	0.67	0.07	0.02	0.73	0.14
Control Delay	17.8	28.6		16.9	32.4		11.9	21.5	0.2	11.0	29.8	3.5
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	17.8	28.6		16.9	32.4		11.9	21.5	0.2	11.0	29.8	3.5
LOS	B	C		B	C		B	C	A	B	C	A
Approach Delay		24.6			27.5			18.8			25.7	
Approach LOS		C			C			B			C	
Queue Length 50th (ft)	33	64		19	55		19	181	0	1	207	0
Queue Length 95th (ft)	68	128		44	112		59	#575	0	9	#525	24
Internal Link Dist (ft)		600			332			299			479	
Turn Bay Length (ft)	95			100			85		85	140		125
Base Capacity (vph)	723	1296		563	1097		559	952	869	591	836	779
Starvation Cap Reductn	0	0		0	0		0	0	0	0	0	0
Spillback Cap Reductn	0	0		0	0		0	0	0	0	0	0
Storage Cap Reductn	0	0		0	0		0	0	0	0	0	0
Reduced v/c Ratio	0.15	0.15		0.12	0.13		0.18	0.67	0.07	0.01	0.66	0.13

Intersection Summary

Cycle Length: 131.5
Actuated Cycle Length: 69.5
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.73
Intersection Signal Delay: 22.9 — Intersection LOS: C
Intersection Capacity Utilization 64.4% — ICU Level of Service C
Analysis Period (min) 15
\# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Lone Tree Rd & Franklin Ave

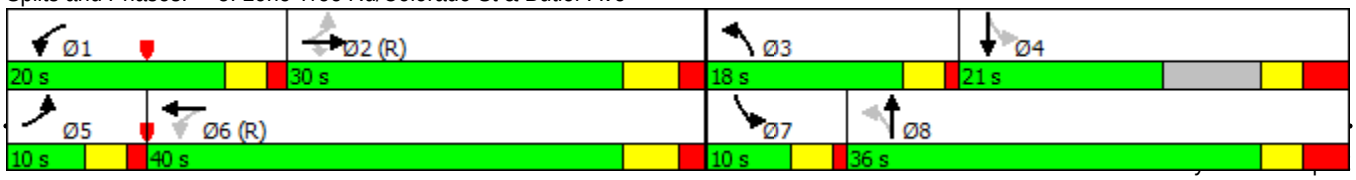


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	6	981	305	354	671	6	313	7	439	47	9	6
Future Volume (vph)	6	981	305	354	671	6	313	7	439	47	9	6
Satd. Flow (prot)	1770	3539	1583	1770	3536	0	1770	1587	0	1770	1747	0
Flt Permitted	0.366			0.122			0.616			0.500		
Satd. Flow (perm)	682	3539	1583	227	3536	0	1147	1587	0	931	1747	0
Satd. Flow (RTOR)			232		1			415			7	
Lane Group Flow (vph)	7	1090	339	393	753	0	348	496	0	52	17	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6			8			4		
Total Split (s)	10.0	30.0	30.0	20.0	40.0		18.0	36.0		10.0	21.0	
Total Lost Time (s)	2.7	4.2	6.0	4.5	4.2		1.7	4.1		1.7	4.1	
Act Effct Green (s)	42.1	33.8	32.0	61.4	59.8		28.4	18.0		15.6	14.0	
Actuated g/C Ratio	0.44	0.35	0.33	0.64	0.62		0.30	0.19		0.16	0.15	
v/c Ratio	0.02	0.87	0.50	0.75	0.34		0.74	0.78		0.24	0.07	
Control Delay	16.3	47.3	22.0	39.6	9.4		38.6	15.9		29.1	26.5	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	16.3	47.3	22.0	39.6	9.4		38.6	15.9		29.1	26.5	
LOS	B	D	C	D	A		D	B		C	C	
Approach Delay		41.1			19.8			25.2			28.4	
Approach LOS		D			B			C			C	
Queue Length 50th (ft)	2	321	80	181	83		190	45		30	5	
Queue Length 95th (ft)	m7	#563	189	#386	143		225	139		42	m22	
Internal Link Dist (ft)		303			1089			322			612	
Turn Bay Length (ft)	60		60	290			225					
Base Capacity (vph)	385	1246	682	522	2204		469	804		226	440	
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0	
Storage Cap Reductn	0	0	0	0	0		0	0		0	0	
Reduced v/c Ratio	0.02	0.87	0.50	0.75	0.34		0.74	0.62		0.23	0.04	

Intersection Summary

Cycle Length: 96
Actuated Cycle Length: 96
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green, Master Intersection
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.87
Intersection Signal Delay: 30.0 Intersection LOS: C
Intersection Capacity Utilization 91.4% ICU Level of Service F
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lone Tree Rd/Colorado St & Butler Ave



Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	7	0	2	0	0	0	4	214	0	0	96	9
Future Vol, veh/h	7	0	2	0	0	0	4	214	0	0	96	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	8	0	2	0	0	0	4	238	0	0	107	10

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	359	359	112	360	364	238	117	0	0	238	0	0
Stage 1	112	112	-	247	247	-	-	-	-	-	-	-
Stage 2	247	247	-	113	117	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	596	568	941	596	564	801	1471	-	-	1329	-	-
Stage 1	893	803	-	757	702	-	-	-	-	-	-	-
Stage 2	757	702	-	892	799	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	595	566	941	593	562	801	1471	-	-	1329	-	-
Mov Cap-2 Maneuver	595	566	-	593	562	-	-	-	-	-	-	-
Stage 1	890	803	-	755	700	-	-	-	-	-	-	-
Stage 2	755	700	-	890	799	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	10.6	0	0.1	0
HCM LOS	B	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1471	-	-	648	-	1329	-	-
HCM Lane V/C Ratio	0.003	-	-	0.015	-	-	-	-
HCM Control Delay (s)	7.5	0	-	10.6	0	0	-	-
HCM Lane LOS	A	A	-	B	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0	-	0	-	-

Intersection	
Int Delay, s/veh	18.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	135	49	673	153	15	613
Future Vol, veh/h	135	49	673	153	15	613
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	110	-	-	100	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	150	54	748	170	17	681

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1547	833	0	0	918	0
Stage 1	833	-	-	-	-	-
Stage 2	714	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	~ 126	369	-	-	743	-
Stage 1	427	-	-	-	-	-
Stage 2	485	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	~ 123	369	-	-	743	-
Mov Cap-2 Maneuver	~ 123	-	-	-	-	-
Stage 1	427	-	-	-	-	-
Stage 2	474	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	165.6	0	0.2
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	123	369	743	-
HCM Lane V/C Ratio	-	-	1.22	0.148	0.022	-
HCM Control Delay (s)	-	-	219.7	16.4	10	-
HCM Lane LOS	-	-	F	C	A	-
HCM 95th %tile Q(veh)	-	-	9.4	0.5	0.1	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	1	1556	2	2	1278	1	2	0	2	0	0	0
Future Vol, veh/h	1	1556	2	2	1278	1	2	0	2	0	0	0
Conflicting Peds, #/hr	0	0	0	0	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	25	-	-	100	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	1	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	1729	2	2	1420	1	2	0	2	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	1421	0	0	1731	0	0	2446	3158	866	2292	3158	711
Stage 1	-	-	-	-	-	-	1732	1732	-	1425	1425	-
Stage 2	-	-	-	-	-	-	714	1426	-	867	1733	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	475	-	-	659	-	-	25	3	*470	*46	3	375
Stage 1	-	-	-	-	-	-	399	359	-	*142	200	-
Stage 2	-	-	-	-	-	-	388	199	-	*443	358	-
Platoon blocked, %		-	-	1	-	-	1	1	1	1	1	
Mov Cap-1 Maneuver	475	-	-	659	-	-	25	3	*470	*45	3	375
Mov Cap-2 Maneuver	-	-	-	-	-	-	190	117	-	*45	3	-
Stage 1	-	-	-	-	-	-	398	358	-	*142	199	-
Stage 2	-	-	-	-	-	-	387	198	-	*440	358	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0	18.5	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	271	475	-	-	659	-	-	-
HCM Lane V/C Ratio	0.016	0.002	-	-	0.003	-	-	-
HCM Control Delay (s)	18.5	12.6	-	-	10.5	-	-	0
HCM Lane LOS	C	B	-	-	B	-	-	A
HCM 95th %tile Q(veh)	0.1	0	-	-	0	-	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	3.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⇕			⇕			⇕			⇕	
Traffic Vol, veh/h	119	0	10	0	0	0	21	194	0	0	95	138
Future Vol, veh/h	119	0	10	0	0	0	21	194	0	0	95	138
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	132	0	11	0	0	0	23	216	0	0	106	153

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	444	444	182	450	521	216	259	0	0	216	0	0
Stage 1	182	182	-	262	262	-	-	-	-	-	-	-
Stage 2	262	262	-	188	259	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	524	508	861	519	460	824	1306	-	-	1354	-	-
Stage 1	820	749	-	743	691	-	-	-	-	-	-	-
Stage 2	743	691	-	814	694	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	516	498	861	504	451	824	1306	-	-	1354	-	-
Mov Cap-2 Maneuver	516	498	-	504	451	-	-	-	-	-	-	-
Stage 1	804	749	-	728	677	-	-	-	-	-	-	-
Stage 2	728	677	-	803	694	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	14.2	0	0.8	0
HCM LOS	B	A		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1306	-	-	533	-	1354	-	-
HCM Lane V/C Ratio	0.018	-	-	0.269	-	-	-	-
HCM Control Delay (s)	7.8	0	-	14.2	0	0	-	-
HCM Lane LOS	A	A	-	B	A	A	-	-
HCM 95th %tile Q(veh)	0.1	-	-	1.1	-	0	-	-

Intersection	
Int Delay, s/veh	1.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	75	21	535	110	22	539
Future Vol, veh/h	75	21	535	110	22	539
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	110	-	-	100	-
Veh in Median Storage, #	1	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	83	23	594	122	24	599

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1304	656	0	0	717	0
Stage 1	656	-	-	-	-	-
Stage 2	648	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	177	465	-	-	884	-
Stage 1	516	-	-	-	-	-
Stage 2	521	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	172	465	-	-	884	-
Mov Cap-2 Maneuver	312	-	-	-	-	-
Stage 1	516	-	-	-	-	-
Stage 2	507	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	19.1	0	0.4
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	312	465	884	-
HCM Lane V/C Ratio	-	-	0.267	0.05	0.028	-
HCM Control Delay (s)	-	-	20.7	13.2	9.2	-
HCM Lane LOS	-	-	C	B	A	-
HCM 95th %tile Q(veh)	-	-	1.1	0.2	0.1	-

Intersection	
Int Delay, s/veh	3.5

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	135	49	673	153	15	613
Future Vol, veh/h	135	49	673	153	15	613
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	110	-	-	100	-
Veh in Median Storage, #	1	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	150	54	748	170	17	681

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1547	833	0	0	918	0
Stage 1	833	-	-	-	-	-
Stage 2	714	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	~ 126	369	-	-	743	-
Stage 1	427	-	-	-	-	-
Stage 2	485	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	~ 123	369	-	-	743	-
Mov Cap-2 Maneuver	261	-	-	-	-	-
Stage 1	427	-	-	-	-	-
Stage 2	474	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	30.7	0	0.2
HCM LOS	D		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	261	369	743	-
HCM Lane V/C Ratio	-	-	0.575	0.148	0.022	-
HCM Control Delay (s)	-	-	35.9	16.4	10	-
HCM Lane LOS	-	-	E	C	A	-
HCM 95th %tile Q(veh)	-	-	3.3	0.5	0.1	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	728	35	152	1143	49	113
Future Volume (vph)	728	35	152	1143	49	113
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.312		0.950	
Satd. Flow (perm)	3539	1583	581	3539	1770	1583
Satd. Flow (RTOR)		36				126
Lane Group Flow (vph)	809	39	169	1270	54	126
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm
Protected Phases	2		1	6	8	
Permitted Phases		2	6			8
Total Split (s)	52.0	52.0	14.0	66.0	30.0	30.0
Total Lost Time (s)	5.8	5.8	4.0	5.8	4.3	4.3
Act Effct Green (s)	67.5	67.5	80.6	78.8	7.1	7.1
Actuated g/C Ratio	0.70	0.70	0.84	0.82	0.07	0.07
v/c Ratio	0.33	0.03	0.29	0.44	0.41	0.54
Control Delay	15.3	8.7	2.8	3.1	51.1	16.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	15.3	8.7	2.8	3.1	51.1	16.7
LOS	B	A	A	A	D	B
Approach Delay	15.0			3.1	27.1	
Approach LOS	B			A	C	
Queue Length 50th (ft)	203	5	12	80	32	0
Queue Length 95th (ft)	267	31	27	129	68	52
Internal Link Dist (ft)	393			419	268	
Turn Bay Length (ft)		110	210			90
Base Capacity (vph)	2487	1123	612	2903	473	516
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.33	0.03	0.28	0.44	0.11	0.24

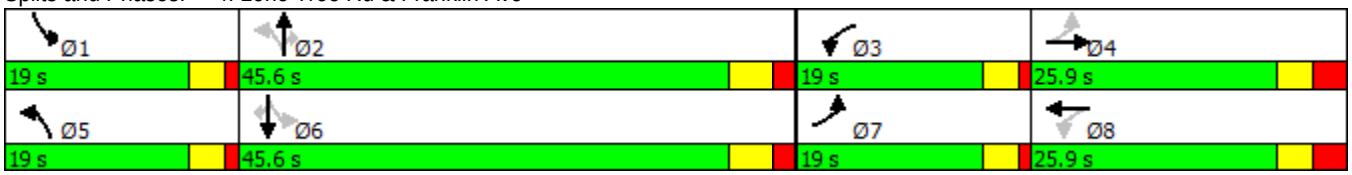
Intersection Summary	
Cycle Length: 96	
Actuated Cycle Length: 96	
Offset: 6 (6%), Referenced to phase 2:EBT and 6:WBTL, Start of Green	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.54	
Intersection Signal Delay: 8.9	Intersection LOS: A
Intersection Capacity Utilization 44.5%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 1: Sawmill & Butler Ave

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	24	22	39	26	59	7	92	472	11	1	478	79
Future Volume (vph)	24	22	39	26	59	7	92	472	11	1	478	79
Satd. Flow (prot)	1770	1684	0	1770	1833	0	1770	1863	1583	1770	1863	1583
Flt Permitted	0.700			0.713			0.295			0.458		
Satd. Flow (perm)	1304	1684	0	1328	1833	0	550	1863	1583	853	1863	1583
Satd. Flow (RTOR)		43			5				109			109
Lane Group Flow (vph)	27	67	0	29	74	0	102	524	12	1	531	88
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2		2	6		6
Total Split (s)	19.0	25.9		19.0	25.9		19.0	45.6	45.6	19.0	45.6	45.6
Total Lost Time (s)	4.0	5.9		4.0	5.9		4.0	5.6	5.6	4.0	5.6	5.6
Act Effct Green (s)	12.6	9.2		12.5	9.2		40.4	39.3	39.3	34.8	30.9	30.9
Actuated g/C Ratio	0.21	0.15		0.21	0.15		0.67	0.65	0.65	0.58	0.51	0.51
v/c Ratio	0.08	0.23		0.09	0.26		0.19	0.43	0.01	0.00	0.56	0.10
Control Delay	20.2	16.5		20.2	27.9		7.7	11.9	0.0	8.0	19.7	2.9
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	20.2	16.5		20.2	27.9		7.7	11.9	0.0	8.0	19.7	2.9
LOS	C	B		C	C		A	B	A	A	B	A
Approach Delay		17.5			25.7			11.0			17.3	
Approach LOS		B			C			B			B	
Queue Length 50th (ft)	7	7		8	20		8	64	0	0	126	0
Queue Length 95th (ft)	29	47		31	73		53	357	0	3	400	21
Internal Link Dist (ft)		600			332			299			479	
Turn Bay Length (ft)	95			100			85		85	140		125
Base Capacity (vph)	578	675		580	709		716	1391	1209	832	1367	1190
Starvation Cap Reductn	0	0		0	0		0	0	0	0	0	0
Spillback Cap Reductn	0	0		0	0		0	0	0	0	0	0
Storage Cap Reductn	0	0		0	0		0	0	0	0	0	0
Reduced v/c Ratio	0.05	0.10		0.05	0.10		0.14	0.38	0.01	0.00	0.39	0.07

Intersection Summary		
Cycle Length: 109.5		
Actuated Cycle Length: 60.2		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.56		
Intersection Signal Delay: 15.1	Intersection LOS: B	
Intersection Capacity Utilization 51.3%	ICU Level of Service A	
Analysis Period (min) 15		

Splits and Phases: 4: Lone Tree Rd & Franklin Ave

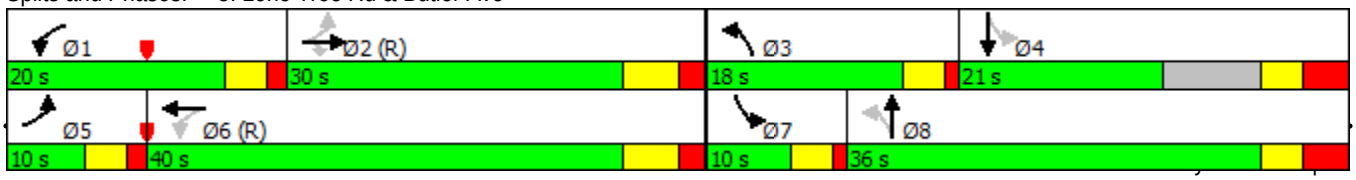


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	6	476	234	384	777	7	342	7	243	32	7	1
Future Volume (vph)	6	476	234	384	777	7	342	7	243	32	7	1
Satd. Flow (prot)	1770	3539	1583	1770	3536	0	1770	1591	0	1770	1831	0
Flt Permitted	0.326			0.289			0.667			0.930		
Satd. Flow (perm)	607	3539	1583	538	3536	0	1242	1591	0	1732	1831	0
Satd. Flow (RTOR)			232		1			270			1	
Lane Group Flow (vph)	7	529	260	427	871	0	380	278	0	36	9	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6			8			4		
Total Split (s)	10.0	30.0	30.0	20.0	40.0		18.0	36.0		10.0	21.0	
Total Lost Time (s)	2.7	4.2	6.0	4.5	4.2		1.7	4.1		1.7	4.1	
Act Effct Green (s)	44.3	35.9	34.1	64.1	54.8		25.7	16.7		11.6	12.3	
Actuated g/C Ratio	0.46	0.37	0.36	0.67	0.57		0.27	0.17		0.12	0.13	
v/c Ratio	0.02	0.40	0.37	0.64	0.43		0.84	0.56		0.17	0.04	
Control Delay	6.5	14.8	4.9	10.7	11.2		49.2	9.7		33.9	36.5	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	6.5	14.8	4.9	10.7	11.2		49.2	9.7		33.9	36.5	
LOS	A	B	A	B	B		D	A		C	D	
Approach Delay		11.5			11.1			32.5			34.4	
Approach LOS		B			B			C			C	
Queue Length 50th (ft)	1	135	9	73	77		217	4		20	4	
Queue Length 95th (ft)	m5	116	45	127	240		#296	70		m36	m17	
Internal Link Dist (ft)		303			1089			322			612	
Turn Bay Length (ft)	60		60	300			225					
Base Capacity (vph)	371	1322	711	668	2017		455	708		216	456	
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0	
Storage Cap Reductn	0	0	0	0	0		0	0		0	0	
Reduced v/c Ratio	0.02	0.40	0.37	0.64	0.43		0.84	0.39		0.17	0.02	

Intersection Summary

Cycle Length: 96
Actuated Cycle Length: 96
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green, Master Intersection
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.84
Intersection Signal Delay: 16.6 Intersection LOS: B
Intersection Capacity Utilization 71.7% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lone Tree Rd & Butler Ave



Intersection	
Int Delay, s/veh	1.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⇕			⇕			⇕			⇕	
Traffic Vol, veh/h	1	2	1	35	0	20	1	136	26	9	155	1
Future Vol, veh/h	1	2	1	35	0	20	1	136	26	9	155	1
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	2	1	39	0	22	1	151	29	10	172	1

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	372	375	173	362	361	166	173	0	0	180	0	0
Stage 1	193	193	-	168	168	-	-	-	-	-	-	-
Stage 2	179	182	-	194	193	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	585	556	871	594	566	878	1404	-	-	1396	-	-
Stage 1	809	741	-	834	759	-	-	-	-	-	-	-
Stage 2	823	749	-	808	741	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	566	551	871	587	561	878	1404	-	-	1396	-	-
Mov Cap-2 Maneuver	566	551	-	587	561	-	-	-	-	-	-	-
Stage 1	808	735	-	833	758	-	-	-	-	-	-	-
Stage 2	801	748	-	798	735	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	10.9	10.9	0	0.4
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1404	-	-	611	667	1396	-	-
HCM Lane V/C Ratio	0.001	-	-	0.007	0.092	0.007	-	-
HCM Control Delay (s)	7.6	0	-	10.9	10.9	7.6	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	0.3	0	-	-

Intersection	
Int Delay, s/veh	3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	130	34	535	162	29	539
Future Vol, veh/h	130	34	535	162	29	539
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	110	-	-	100	-
Veh in Median Storage, #	1	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	144	38	594	180	32	599

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1347	684	0	0	774	0
Stage 1	684	-	-	-	-	-
Stage 2	663	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	167	449	-	-	842	-
Stage 1	501	-	-	-	-	-
Stage 2	512	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	161	449	-	-	842	-
Mov Cap-2 Maneuver	300	-	-	-	-	-
Stage 1	501	-	-	-	-	-
Stage 2	493	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	24.8	0	0.5
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	300	449	842	-
HCM Lane V/C Ratio	-	-	0.481	0.084	0.038	-
HCM Control Delay (s)	-	-	27.7	13.8	9.4	-
HCM Lane LOS	-	-	D	B	A	-
HCM 95th %tile Q(veh)	-	-	2.5	0.3	0.1	-

Intersection	
Int Delay, s/veh	0.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	1	813	27	33	1276	1	19	0	29	0	0	0
Future Vol, veh/h	1	813	27	33	1276	1	19	0	29	0	0	0
Conflicting Peds, #/hr	0	0	0	0	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	100	-	-	100	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	1	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	903	30	37	1418	1	21	0	32	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	1419	0	0	933	0	0	1703	2413	467	1946	2428	709
Stage 1	-	-	-	-	-	-	921	921	-	1492	1492	-
Stage 2	-	-	-	-	-	-	782	1492	-	454	936	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	476	-	-	1093	-	-	108	33	*757	*59	31	377
Stage 1	-	-	-	-	-	-	690	610	-	*129	185	-
Stage 2	-	-	-	-	-	-	353	185	-	*714	597	-
Platoon blocked, %		-	-	1	-	-	1	1	1	1	1	
Mov Cap-1 Maneuver	476	-	-	1093	-	-	105	32	*757	*55	30	377
Mov Cap-2 Maneuver	-	-	-	-	-	-	249	136	-	*55	30	-
Stage 1	-	-	-	-	-	-	689	608	-	*129	179	-
Stage 2	-	-	-	-	-	-	341	179	-	*682	596	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.2	14.8	0
HCM LOS			B	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	419	476	-	-	1093	-	-	-
HCM Lane V/C Ratio	0.127	0.002	-	-	0.034	-	-	-
HCM Control Delay (s)	14.8	12.6	-	-	8.4	-	-	0
HCM Lane LOS	B	B	-	-	A	-	-	A
HCM 95th %tile Q(veh)	0.4	0	-	-	0.1	-	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	2.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	28	1	10	33	0	20	10	114	33	14	121	48
Future Vol, veh/h	28	1	10	33	0	20	10	114	33	14	121	48
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	31	1	11	37	0	22	11	127	37	16	134	53

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	370	378	161	365	386	145	188	0	0	163	0	0
Stage 1	192	192	-	167	167	-	-	-	-	-	-	-
Stage 2	178	186	-	198	219	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	587	554	884	591	548	902	1386	-	-	1416	-	-
Stage 1	810	742	-	835	760	-	-	-	-	-	-	-
Stage 2	824	746	-	804	722	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	563	542	884	573	536	902	1386	-	-	1416	-	-
Mov Cap-2 Maneuver	563	542	-	573	536	-	-	-	-	-	-	-
Stage 1	803	732	-	827	753	-	-	-	-	-	-	-
Stage 2	796	739	-	782	713	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	11.2	10.9	0.5	0.6
HCM LOS	B	B		

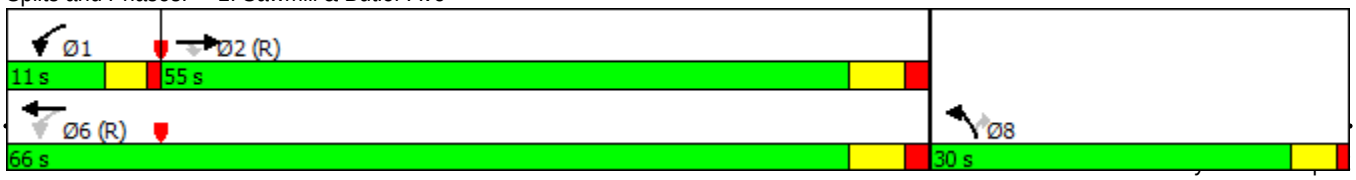
Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1386	-	-	620	664	1416	-	-
HCM Lane V/C Ratio	0.008	-	-	0.07	0.089	0.011	-	-
HCM Control Delay (s)	7.6	0	-	11.2	10.9	7.6	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.2	0.3	0	-	-

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (vph)	1336	68	211	1086	111	262
Future Volume (vph)	1336	68	211	1086	111	262
Satd. Flow (prot)	3539	1583	1770	3539	1770	1583
Flt Permitted			0.077		0.950	
Satd. Flow (perm)	3539	1583	143	3539	1770	1583
Satd. Flow (RTOR)		40				154
Lane Group Flow (vph)	1484	76	234	1207	123	291
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm
Protected Phases	2		1	6	8	
Permitted Phases		2	6			8
Total Split (s)	55.0	55.0	11.0	66.0	30.0	30.0
Total Lost Time (s)	5.8	5.8	4.0	5.8	4.3	4.3
Act Effct Green (s)	52.4	52.4	74.2	72.4	13.5	13.5
Actuated g/C Ratio	0.55	0.55	0.77	0.75	0.14	0.14
v/c Ratio	0.77	0.09	0.61	0.45	0.50	0.82
Control Delay	30.2	14.9	26.6	5.8	43.2	36.6
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.2	14.9	26.6	5.8	43.2	36.6
LOS	C	B	C	A	D	D
Approach Delay	29.4			9.2	38.5	
Approach LOS	C			A	D	
Queue Length 50th (ft)	308	11	71	115	71	82
Queue Length 95th (ft)	m440	m27	#216	222	114	160
Internal Link Dist (ft)	393			419	268	
Turn Bay Length (ft)		110	210			90
Base Capacity (vph)	1932	882	381	2669	473	536
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.77	0.09	0.61	0.45	0.26	0.54

Intersection Summary

Cycle Length: 96
Actuated Cycle Length: 96
Offset: 94 (98%), Referenced to phase 2:EBT and 6:WBTL, Start of Green
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.82
Intersection Signal Delay: 22.0 Intersection LOS: C
Intersection Capacity Utilization 66.5% ICU Level of Service C
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

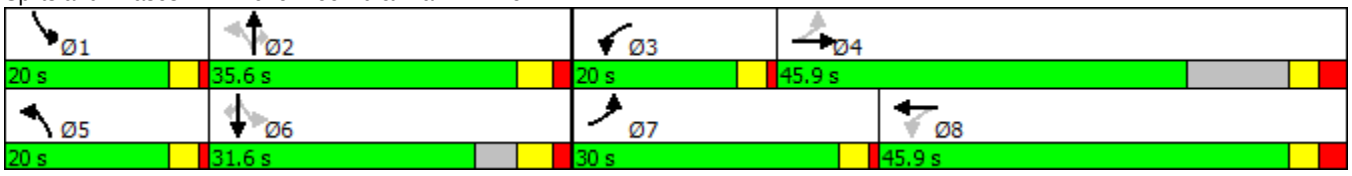
Splits and Phases: 1: Sawmill & Butler Ave



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	104	101	87	59	112	16	108	571	52	6	496	89
Future Volume (vph)	104	101	87	59	112	16	108	571	52	6	496	89
Satd. Flow (prot)	1770	1732	0	1770	1827	0	1770	1863	1583	1770	1863	1583
Flt Permitted	0.531			0.627			0.193			0.289		
Satd. Flow (perm)	989	1732	0	1168	1827	0	360	1863	1583	538	1863	1583
Satd. Flow (RTOR)		38			6				124			124
Lane Group Flow (vph)	116	209	0	66	142	0	120	634	58	7	551	99
Turn Type	pm+pt	NA		pm+pt	NA		pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases	4			8			2		2	6		6
Total Split (s)	30.0	45.9		20.0	45.9		20.0	35.6	35.6	20.0	31.6	31.6
Total Lost Time (s)	4.0	5.9		4.0	5.9		4.0	5.6	5.6	4.0	5.6	5.6
Act Effct Green (s)	24.1	15.3		19.6	11.3		39.9	36.8	36.8	33.1	26.4	26.4
Actuated g/C Ratio	0.33	0.21		0.27	0.15		0.54	0.50	0.50	0.45	0.36	0.36
v/c Ratio	0.28	0.54		0.18	0.50		0.35	0.68	0.07	0.02	0.83	0.15
Control Delay	18.3	27.5		17.3	33.6		13.0	22.1	0.2	11.2	36.5	3.6
Queue Delay	0.0	0.0		0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	18.3	27.5		17.3	33.6		13.0	22.1	0.2	11.2	36.5	3.6
LOS	B	C		B	C		B	C	A	B	D	A
Approach Delay		24.2			28.5			19.2			31.3	
Approach LOS		C			C			B			C	
Queue Length 50th (ft)	36	71		20	57		23	183	0	1	214	0
Queue Length 95th (ft)	72	140		45	114		70	#577	0	9	#539	25
Internal Link Dist (ft)		600			332			299			479	
Turn Bay Length (ft)	95			100			85		85	140		125
Base Capacity (vph)	667	1205		538	1010		506	931	853	563	770	727
Starvation Cap Reductn	0	0		0	0		0	0	0	0	0	0
Spillback Cap Reductn	0	0		0	0		0	0	0	0	0	0
Storage Cap Reductn	0	0		0	0		0	0	0	0	0	0
Reduced v/c Ratio	0.17	0.17		0.12	0.14		0.24	0.68	0.07	0.01	0.72	0.14

Intersection Summary		
Cycle Length: 131.5		
Actuated Cycle Length: 73.6		
Control Type: Actuated-Uncoordinated		
Maximum v/c Ratio: 0.83		
Intersection Signal Delay: 24.9	Intersection LOS: C	
Intersection Capacity Utilization 65.3%	ICU Level of Service C	
Analysis Period (min) 15		
# 95th percentile volume exceeds capacity, queue may be longer.		
Queue shown is maximum after two cycles.		

Splits and Phases: 4: Lone Tree Rd & Franklin Ave

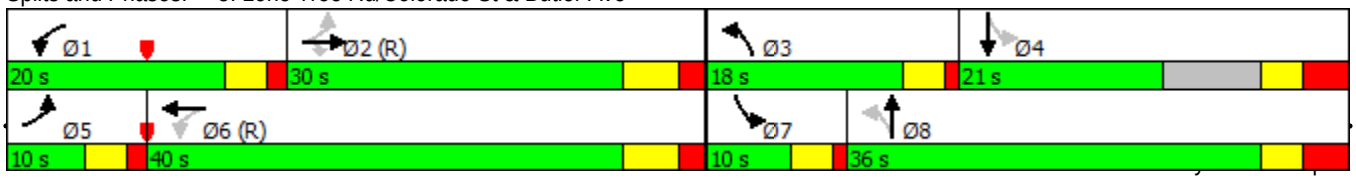


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	6	1041	305	354	729	6	313	7	433	47	9	6
Future Volume (vph)	6	1041	305	354	729	6	313	7	433	47	9	6
Satd. Flow (prot)	1770	3539	1583	1770	3536	0	1770	1587	0	1770	1747	0
Flt Permitted	0.344			0.122			0.613			0.513		
Satd. Flow (perm)	641	3539	1583	227	3536	0	1142	1587	0	956	1747	0
Satd. Flow (RTOR)			232		1			415			7	
Lane Group Flow (vph)	7	1157	339	393	817	0	348	489	0	52	17	0
Turn Type	pm+pt	NA	Perm	pm+pt	NA		pm+pt	NA		pm+pt	NA	
Protected Phases	5	2		1	6		3	8		7	4	
Permitted Phases	2		2	6			8			4		
Total Split (s)	10.0	30.0	30.0	20.0	40.0		18.0	36.0		10.0	21.0	
Total Lost Time (s)	2.7	4.2	6.0	4.5	4.2		1.7	4.1		1.7	4.1	
Act Effct Green (s)	42.2	33.9	32.1	61.7	60.1		28.1	17.7		15.4	13.8	
Actuated g/C Ratio	0.44	0.35	0.33	0.64	0.63		0.29	0.18		0.16	0.14	
v/c Ratio	0.02	0.92	0.50	0.75	0.37		0.75	0.78		0.24	0.07	
Control Delay	16.0	51.3	21.5	38.8	9.2		39.2	15.4		29.2	26.4	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Delay	16.0	51.3	21.5	38.8	9.2		39.2	15.4		29.2	26.4	
LOS	B	D	C	D	A		D	B		C	C	
Approach Delay		44.4			18.8			25.3			28.5	
Approach LOS		D			B			C			C	
Queue Length 50th (ft)	2	341	79	179	90		192	41		30	5	
Queue Length 95th (ft)	m6	#611	185	#378	160		229	135		43	m22	
Internal Link Dist (ft)		303			1089			322			612	
Turn Bay Length (ft)	60		60	290			225					
Base Capacity (vph)	371	1251	684	524	2214		465	804		227	440	
Starvation Cap Reductn	0	0	0	0	0		0	0		0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0		0	0	
Storage Cap Reductn	0	0	0	0	0		0	0		0	0	
Reduced v/c Ratio	0.02	0.92	0.50	0.75	0.37		0.75	0.61		0.23	0.04	

Intersection Summary

Cycle Length: 96
Actuated Cycle Length: 96
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBTL, Start of 1st Green, Master Intersection
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.92
Intersection Signal Delay: 31.1 Intersection LOS: C
Intersection Capacity Utilization 92.9% ICU Level of Service F
Analysis Period (min) 15
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Lone Tree Rd/Colorado St & Butler Ave



Intersection	
Int Delay, s/veh	2.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⇕			⇕			⇕			⇕	
Traffic Vol, veh/h	7	3	2	54	0	32	4	254	50	18	137	9
Future Vol, veh/h	7	3	2	54	0	32	4	254	50	18	137	9
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	8	3	2	60	0	36	4	282	56	20	152	10

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	534	544	157	519	521	310	162	0	0	338	0	0
Stage 1	197	197	-	319	319	-	-	-	-	-	-	-
Stage 2	337	347	-	200	202	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	457	446	889	467	460	730	1417	-	-	1221	-	-
Stage 1	805	738	-	693	653	-	-	-	-	-	-	-
Stage 2	677	635	-	802	734	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	427	436	889	455	450	730	1417	-	-	1221	-	-
Mov Cap-2 Maneuver	427	436	-	455	450	-	-	-	-	-	-	-
Stage 1	802	725	-	690	650	-	-	-	-	-	-	-
Stage 2	641	632	-	782	721	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	12.9	13.3	0.1	0.9
HCM LOS	B	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1417	-	-	470	529	1221	-	-
HCM Lane V/C Ratio	0.003	-	-	0.028	0.181	0.016	-	-
HCM Control Delay (s)	7.5	0	-	12.9	13.3	8	0	-
HCM Lane LOS	A	A	-	B	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.1	0.7	0.1	-	-

Intersection	
Int Delay, s/veh	11.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	211	68	673	232	26	613
Future Vol, veh/h	211	68	673	232	26	613
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	110	-	-	100	-
Veh in Median Storage, #	1	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	234	76	748	258	29	681

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1616	877	0	0	1006	0
Stage 1	877	-	-	-	-	-
Stage 2	739	-	-	-	-	-
Critical Hdwy	6.42	6.22	-	-	4.12	-
Critical Hdwy Stg 1	5.42	-	-	-	-	-
Critical Hdwy Stg 2	5.42	-	-	-	-	-
Follow-up Hdwy	3.518	3.318	-	-	2.218	-
Pot Cap-1 Maneuver	~ 114	348	-	-	689	-
Stage 1	407	-	-	-	-	-
Stage 2	472	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	~ 109	348	-	-	689	-
Mov Cap-2 Maneuver	245	-	-	-	-	-
Stage 1	407	-	-	-	-	-
Stage 2	452	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	72.6	0	0.4
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	245	348	689	-
HCM Lane V/C Ratio	-	-	0.957	0.217	0.042	-
HCM Control Delay (s)	-	-	90.1	18.2	10.5	-
HCM Lane LOS	-	-	F	C	B	-
HCM 95th %tile Q(veh)	-	-	8.7	0.8	0.1	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	1	1553	46	33	1276	1	27	0	43	0	0	0
Future Vol, veh/h	1	1553	46	33	1276	1	27	0	43	0	0	0
Conflicting Peds, #/hr	0	0	0	0	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	25	-	-	100	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	1	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	1	1726	51	37	1418	1	30	0	48	0	0	0

Major/Minor	Major1			Major2			Minor1			Minor2		
Conflicting Flow All	1419	0	0	1777	0	0	2535	3245	888	2357	3271	709
Stage 1	-	-	-	-	-	-	1753	1753	-	1492	1492	-
Stage 2	-	-	-	-	-	-	782	1492	-	865	1779	-
Critical Hdwy	4.14	-	-	4.14	-	-	7.54	6.54	6.94	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.22	-	-	3.52	4.02	3.32	3.52	4.02	3.32
Pot Cap-1 Maneuver	476	-	-	603	-	-	~ 17	3	*470	*35	2	377
Stage 1	-	-	-	-	-	-	374	342	-	*129	185	-
Stage 2	-	-	-	-	-	-	353	185	-	*443	323	-
Platoon blocked, %		-	-	1	-	-	1	1	1	1	1	
Mov Cap-1 Maneuver	476	-	-	603	-	-	~ 17	2	*470	*30	2	377
Mov Cap-2 Maneuver	-	-	-	-	-	-	168	106	-	*30	2	-
Stage 1	-	-	-	-	-	-	373	342	-	*129	174	-
Stage 2	-	-	-	-	-	-	331	174	-	*398	322	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	0	0.3	22.9	0
HCM LOS			C	A

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1
Capacity (veh/h)	278	476	-	-	603	-	-	-
HCM Lane V/C Ratio	0.28	0.002	-	-	0.061	-	-	-
HCM Control Delay (s)	22.9	12.6	-	-	11.4	-	-	0
HCM Lane LOS	C	B	-	-	B	-	-	A
HCM 95th %tile Q(veh)	1.1	0	-	-	0.2	-	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	4.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	119	1	10	41	0	29	21	226	40	20	113	138
Future Vol, veh/h	119	1	10	41	0	29	21	226	40	20	113	138
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	2	2	2
Mvmt Flow	132	1	11	46	0	32	23	251	44	22	126	153

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	583	589	202	573	643	273	279	0	0	296	0	0
Stage 1	247	247	-	320	320	-	-	-	-	-	-	-
Stage 2	336	342	-	253	323	-	-	-	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-	4.12	-	-
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	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-	2.218	-	-
Pot Cap-1 Maneuver	424	421	839	430	392	766	1284	-	-	1265	-	-
Stage 1	757	702	-	692	652	-	-	-	-	-	-	-
Stage 2	678	638	-	751	650	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	393	403	839	410	375	766	1284	-	-	1265	-	-
Mov Cap-2 Maneuver	393	403	-	410	375	-	-	-	-	-	-	-
Stage 1	740	687	-	677	638	-	-	-	-	-	-	-
Stage 2	635	624	-	724	636	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	18.5	13.4	0.6	0.6
HCM LOS	C	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1284	-	-	410	508	1265	-	-
HCM Lane V/C Ratio	0.018	-	-	0.352	0.153	0.018	-	-
HCM Control Delay (s)	7.9	0	-	18.5	13.4	7.9	0	-
HCM Lane LOS	A	A	-	C	B	A	A	-
HCM 95th %tile Q(veh)	0.1	-	-	1.6	0.5	0.1	-	-