

## **ATKINS**



Source: Google Earth



## City of Loveland, Colorado

Crossroads Boulevard Corridor Analysis Report

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## 1. Introduction

## 1.1 Project need

Crossroads Boulevard between Larimer County Road 5/Fairgrounds Avenue/Centerra Parkway (CR 5) and Larimer County Road 3 (CR 3) has a wide-ranging mix of land uses and traffic generators that create challenges for driveway and intersection access. Intersection control is being evaluated at the intersection of Crossroads Boulevard and the Resurrection Fellowship Church/Christian School (RCS) access, as well as at the Crossroads Boulevard/Ward Avenue intersection, and the Crossroads Boulevard/Highland Meadows Parkway intersection. The current traffic flows at these intersections have met the numerical criteria for warranting a traffic signal.

An engineering study is needed to examine and compare the traffic operations of alternative intersection controls in a corridor wide context. This study seeks to balance the needs of all users by being attentive to:

- The needs of the corridor to serve the current and projected mobility (walk, bike, car, or truck) and access needs of all roadway users, including but not limited to: the residents; Walmart Distribution Center (Walmart); local business access; employee access, and school site traffic
- Accommodation of pedestrian access in the vicinity of the nearby residential subdivisions and the church/school
- The desire to promote improved driveway and intersection access while not degrading the travel time and corridor function for Crossroads Boulevard east of Centerra Parkway
- The ease of alternate access for minor intersections that would be restricted to partial turns; and, the
  possible interconnection of access for businesses better served by either traffic signals or roundabouts at
  the major intersections
- The traffic flow effects of combining traffic signals and roundabouts in the same corridor (travel time and delay)

The City of Loveland (the City) retained GHD Inc. (GHD) and Atkins Global (ATKINS) to evaluate the Crossroads Boulevard corridor, as illustrated in Figure 1. This report documents the intersection and access control options for the Crossroads Boulevard corridor, between CR 5 and CR 3. This document is intended to guide the progress of improvements as additional development occurs and traffic flow increases pressure for improved access.

Although this report makes recommendations on the preferred intersection control and associated access restrictions, the final decision on the preferred option has not been made. Staging of the improvements is likely as the City has not programmed any construction at the time of this report. Implementation of the recommended corridor access plan will depend upon funding and the pace of traffic growth in the area, subject to Council approval.

## 1.2 Study method

The City undertook an engineering study of Crossroads Boulevard and public engagement using the following study methodology:

 Define the possible existing and future access locations, the type of access (right-in/right-out, threequarter, full movement, roundabouts, signalized/unsignalized), and any modifications needed to the existing accesses. Several intersection configurations were considered including roundabouts. This is based on background traffic, existing traffic/access issues, traffic accident data and projected traffic in year 2035.

- 2. Two public participation opportunities were provided for directly affected land owners and interested parties through focus group sessions with the key land-owners and by offering open house public meetings. The first series of stakeholder meetings were on held December 11th and the second set of focus group and public open house meetings were held on January 29th.
- 3. Generate intersection control alternatives and undertake level of service (LOS) modelling, assuming a four-lane corridor for the purpose of lane configurations. Perform a technical analysis optimizing intersection choice for operations. Recommend a combination of access, intersection control and lane configurations to optimize operations and safety for all users. Options have been evaluated based on traffic counts and crash data provided by the City of Loveland. Analysis was run based on design year 2035 AM and PM peak traffic projections.
- 4. Generate preliminary cost estimates for the recommended ultimate corridor access and intersection control plan. The pavement structure assumed for cost purposes is 12-inches of asphalt over a 12-inch aggregate base. The need for bike lanes, drainage facilities and sidewalks was also assumed.
- 5. Report phase including preparation of a draft report for circulation to the City and interested parties.
- 6. Final report and presentation by staff to Council.

A complete description of the Study scope and terms of reference established by GHD and the City, refer to Appendix F.

During this study, it became evident that using roundabouts, traffic signals and access control, up to sixteen different combinations of intersection control and access restriction were feasible at the four key intersections. As the public and stakeholder consultation ensued it became apparent that there are strong preferences for pedestrian accessibility at the RCS access; and, efficient truck egress at the Walmart distribution facility. Accordingly, a set of two corridor options were developed for further evaluation. These options were established from input of the City, stakeholders, and the public regarding the observed issues occurring within this corridor. These two options employ a mixture of traffic signals, access restriction, and roundabouts to control traffic along the corridor.

## 1.3 Study scope and limitations

This report: has been prepared by GHD for City of Loveland, Colorado and may only be used and relied on by City of Loveland, Colorado for the purpose agreed between GHD and the City of Loveland, Colorado. GHD otherwise disclaims responsibility to any person other than City of Loveland, Colorado arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by City of Loveland, Colorado, ATKINS and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Figure 1 Project study limits 11 9 E County Rd 30 13 Project Start CR 5 Budweiser Events Center W 50th St 26 W 43rd St Boyd Lake State Park Project End 25 CR 3 1 60 15 CENTERRA W 18th St 17 (34) (34) (34) 287 E Co Rd 20C 1 56 15 18

E Co Rd 16

E Co Rd 16

52

Source: Google

17

## 2. Data collection and access alternatives

## 2.1 Existing conditions

The existing intersections on Crossroads Boulevard between CR 5 on the west and CR 3 on the east are two-way stop-controlled. The north and south approaches are stop controlled and the east and west approaches are free movements. Crossroads Boulevard has one through lane in each direction, with the exception of the approach to the intersection with Centerra Parkway, where there are two through lanes in each direction, and left and right turn lanes. Crossroads Boulevard has a speed limit of 45 mph. The intersections considered in this study are shown in Figure 2. CR 5 is the western limit of the project; however, it is already a signalized intersection.

## 2.2 Traffic and collision history

The City of Loveland provided peak hour volumes which were conducted in September and October of 2014. There is a school located at the RCS access, so it was important to collect traffic counts when school was in session. The peak AM period for all intersections occurs between about 7:00 AM – 9:00 AM. The peak PM period for all intersections occurs between about 3:00 PM – 6:00 PM. Appendix A contains the raw traffic count data.

Based on the traffic count data, a signal warrant analysis was completed for all intersections in the study area in November 2014. Additionally, a Traffic Impact Study (TIS) for the Walmart Distribution Center was provided. The traffic counts at the Walmart entrance reported in the TIS were used for this analysis. The analysis determined that traffic signals are warranted at the intersection of Crossroads Boulevard and:

- The RCS access
- The intersection of Crossroads Boulevard and Highland Meadows Parkway.
- The intersection of Crossroads Boulevard and Ward Avenue

A copy of the signal warrant analysis can be found in Appendix B. The truck percentage for the Walmart entrance was 100% and the truck volumes were distributed to the other volumes throughout the corridor.

## 2.2.1 Collision history

Collision history was sourced for the period from June, 2006 to June 2014 as documented in Appendix B. The recorded collision history is unremarkable in any way except that it is minimal for two-way stop controlled intersections on moderate speed roadways. A summary of the available history for the intersections examined for change in access or control is as follows:

- RCS access: no records
- Woods Avenue & Crossroads Boulevard: one injury collision in 8 years
- Ward Avenue & Crossroads Boulevard: 2 injury collisions in 8 years
- Greenfield Drive & Crossroads Boulevard: no records
- Highland Meadows Drive & Crossroads Boulevard: no records
- CR 3 & Crossroads Boulevard: 2 injury collisions in 8 years

Collision prediction modeling was undertaken for the subject intersections but again the predictions for collisions in the design year of the project were too low to be of concern.

## 2.3 Access alternatives

The first round of public consultation meetings was facilitated using several displays of the corridor including one, that illustrates the possible alternative traffic controls or access restrictions in the corridor (see Figure 3).

The signal control and roundabout alternatives are common to intersection in Loveland. The roundabout alternative shown on Figure 3 has no exclusive turn lanes and two lanes in each direction. Similarly, the traffic signal configuration has two lanes east and west with single lanes north and south. These lane configuration alternatives were later tested for each intersection and validated.

Two types of restricted access are shown on Figure 3, a High-T configuration, which provides for full turning movements on one side of the minor street approaches, while the opposite side of Crossroads Boulevard would be restricted to right-in right-out movements. This configuration can be beneficial for locations where one of the minor approaches has access to a controlled intersection through a parallel street network, while the other minor approach does not have any alternate access. Another benefit of the High-T is the left-out movement has an auxiliary acceleration lane to merge into traffic easier.

A similar access restriction option is the ¾-movement intersection, which allows only right-in, right-out, and left-in movements. Later in process of evaluating alternatives, this configuration was not preferred for Crossroads Boulevard because there are a large number of left out movements that would have to be re-routed and would add out-of-direction travel.

## 2.4 Stakeholder and public input

Two public participation opportunities were provided for directly affected land owners and interested parties through focus group sessions with the key land-owners and by offering open house public meetings. The first series of stakeholder meetings were on held December 11<sup>th</sup>, 2014 and the second set of focus group and public open house meetings were held on January 29<sup>th</sup>, 2015.

Reports of traffic deficiency, conflicts, delay and queuing was readily available from the local constituents. Although much of the commentary was anecdotal, the repetitive nature of the conditions associated with school times and Walmart distribution activity combined with the City's records of complaints and observations made for a fairly reliable description of the project context. Included below is a synopsis of the concerns and ideas arising from the first set of focus group meetings held on December 11<sup>th</sup>, 2014.

## 2.4.1 Walmart Distribution Center

- Eastbound right-turns need a curb lane for staging turns into their site deceleration and queue storage
- October and November are the peak months, where trucks sometimes even stack all the way out onto Crossroads. Some kind of dedicated right-turn option would be necessary to not cause back up on Crossroads Boulevard.
- CR 3 is a transition area for the WB traffic
- RV folks needing to make U-turns would have to make a lane change and go through the roundabout
- There is the potential to connect to CR 3 through the back-lot of Walmart in the future
- Roundabout could be installed before the signal warrant is met
- Possible negative public perception with a roundabout at Ward Avenue might be that the trucks are hogging the roundabout since they would occupy both lanes
- Trucks sometimes miss the Walmart gate and make U-turns on CR 3 a roundabout at Highland Meadows Parkway would allow those trucks to make that U-turn before getting to CR 3

- Key Walmart time periods
  - o 7-8 AM employees
  - o 4-5 PM employees with overlap
  - o 5-8 PM drop time

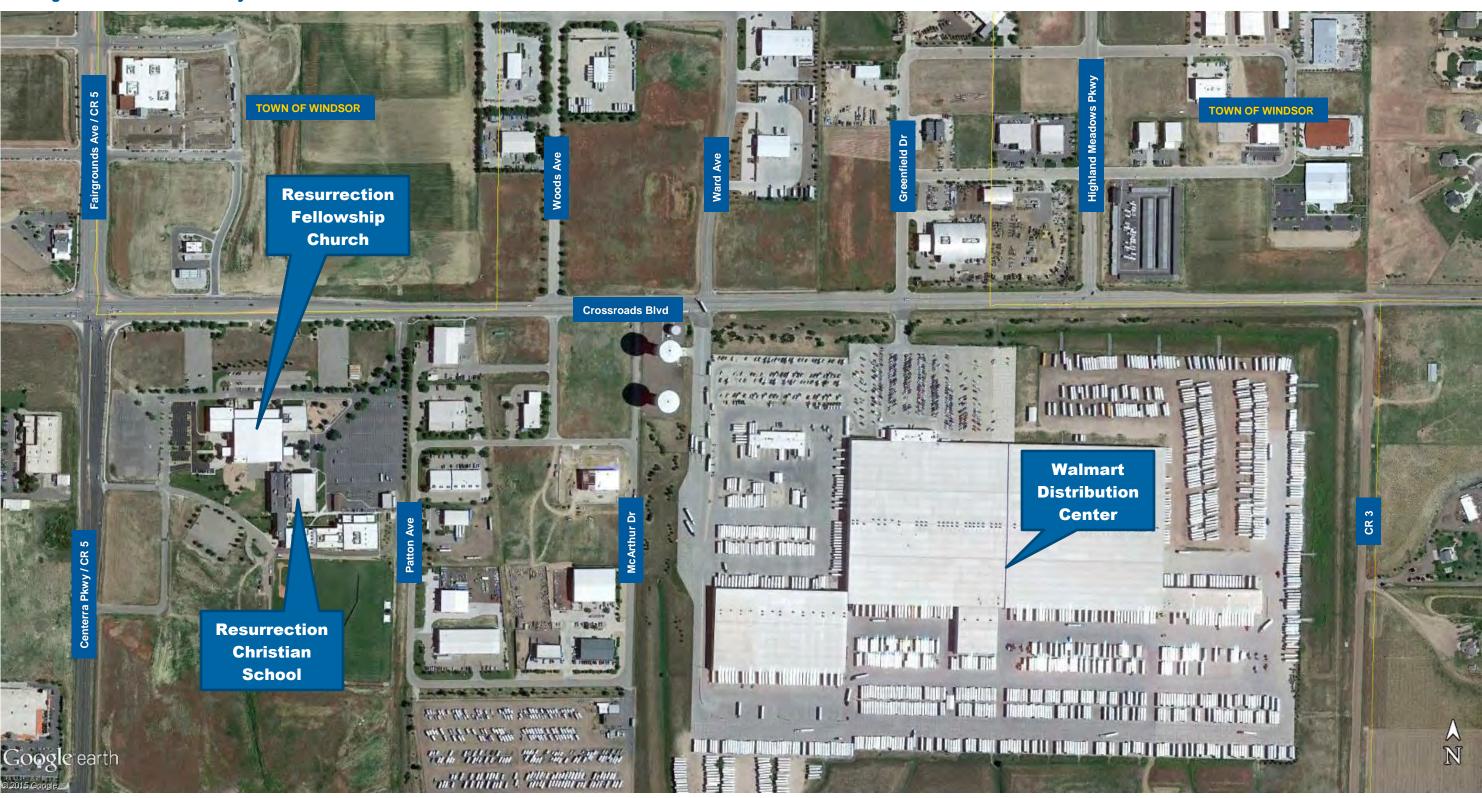
#### 2.4.2 Resurrection Christian School

- Future land uses on the north side of Crossroads Boulevard will create even more desire lines for the students to the north side developments. Some form of a signal installation is a given. Multilane roundabouts require signals by ADA draft guidelines.
- Could a half-cycled signal be run on the RCS access?
- Consider pedestrian crossing on the east leg of the roundabout?
- If we had a roundabout with heavy lefts into the RCS, that's where roundabouts typically work best
- Due diligence suggests we need to thoroughly evaluate a roundabout many factors complicate the use of a roundabout
- Speeds are lower at the roundabout therefore collision severity will be lower for all users. Although, the perception is that a signal would be safer for the pedestrians crossing the intersection at this location
- There is a high level of transient traffic not familiar with the roundabout if placed at RCS
- Adding congestion resulting from Centerra Parkway impacts could compound the delay between intersections

#### 2.4.3 Town of Windsor

- Operations and safety will drive the interim options
- The 2035 scenario will have to be divided up to examine stages of implementation
- Windsor is not familiar with a channelized tee [High-T], but is not opposed to the idea
- At the RCS access, the road will eventually push through to the north, so the Town would like to get involved in the next steps of the project

Figure 2 Aerial view of study area



Source: Google Earth

Figure 3 Public meeting exhibit



**CONTROL ALTERNATIVES** 

EXHIBIT: 2.0

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## 3. Operational analysis methodology

## 3.1 Corridor options

Based on input from the initial public outreach, two alternative corridor control options were developed. Option 1 and 2 exhibits were created with potential solutions for the corridor (see Figure 4 and Figure 5). In order to improve operations throughout the corridor, access to some of the minor cross streets must be restricted.

## 3.1.1 Option 1

Option 1 (Figure 4) features signalized control at the RCS access and CR 3 intersections with Crossroads Boulevard; right-only restrictions out of the intersections with Woods Avenue and Greenfield Drive/Walmart; and roundabout control at the intersections with Ward Avenue and Highland Meadows Parkway. The roundabout at Highland Meadows Parkway would provide a safe and efficient place for U-turns to be executed, for traffic desiring to turn left out of the Walmart access.

## 3.1.2 Option 2

Option 2 (Figure 5) features signalized control at the RCS access and Ward Avenue intersections with Crossroads Boulevard; right-only restrictions out of the intersections with Woods Avenue and Greenfield Drive/Walmart; and roundabout control at the intersections with Highland Meadows Parkway and CR 3. The roundabouts would provide a safe and efficient place for U-turns to be executed, for traffic desiring to turn left from Woods Avenue or out of the Walmart access.

## 3.2 Analysis Methodology

In order to determine the optimal solution for Crossroads Boulevard, the corridor was modeled using Synchro 8 traffic analysis software. Existing geometry, traffic counts, truck percentages, and signal timing were entered into the model and created the base conditions. In order to develop the No Action model for the year 2035, it was assumed that only the traffic volumes would change and no other improvements would be made to the existing corridor. The traffic volumes were increased with a two percent yearly growth rate. This growth rate was based on the City of Loveland 2035 Transportation Plan. Additionally, this is the same growth rate that the Walmart TIS used. Once the Base Conditions and No Action 2035 traffic models were created, the intersection alternatives were modeled using the 2035 predicted volumes.

To compare the options based on operations, traffic engineers define the quality of traffic flow on a roadway or intersection congestion as a level of service (LOS). LOS considers factors such as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. The LOS is described by a letter designation from "A" to "F," with LOS A representing nearly uninterrupted flow with minimal delays and LOS F representing a breakdown of traffic flow with excessive congestion and delay. LOS at intersections is based on the average control delay per vehicle (sec/veh) and the definitions for each level for signalized intersections, unsignalized intersections are shown in Table 1. Unsignalized intersections include two-way and all-way stop control, yield control, and roundabouts. Full results from the Synchro analysis can be found in Appendix C.

Table 1 LOS definitions

LOS	Signalized (sec/veh)	Unsignalized (sec/veh)
Α	0-10	0-10
В	10-20	10-15
С	20-35	15-25
D	35-55	25-35
Е	55-80	35-50
F	> 80	> 50

Source: 2010 Highway Capacity Manual - Signalized and Unsignalized Intersections

## 3.3 Signalized intersection control

The signal timing for the proposed signals for both Option 1 and Option 2 were based on the timing that had been accepted by the City of Loveland for the intersection of Centerra Parkway and Crossroads Boulevard. The recommended signals were timed to be coordinated with the Centerra Parkway signal and optimized for splits and offsets. In both options, at the RCS access, the westbound left movement was modeled as a single left turn lane with protected-permissive phasing, in order to maximize operations. The same logic was used for the intersection of Ward Avenue and Crossroads Boulevard in Option 1 and CR 3 and Crossroads Boulevard in Option 2, where all single lane left turns are permissive.

## 3.4 Roundabout intersection control

The proposed roundabout intersection controls were analyzed in Synchro 8 as part of the overall corridor model. The roundabouts were analyzed utilizing revised HCM candidate critical headway and follow-up headway values, as provided by Kittleson and Associates. These values are revised 2010 HCM values, based on the latest observed roundabout behaviors in the United States. These values are summarized in Table 2

Table 2 HCM candidate values

		HCM Candidate 2014										
		t <sub>c</sub>	t <sub>f</sub>	А	В							
Single-lane entering with single-lane conflicting		4.977	2.609	1380	0.00102							
Single-lane entering with two lanes conflicting		4.328	2.535	1420	0.00085							
Two lanes entering with	Left lane	4.544	2.535	1420	0.00091							
single-lane conflicting	Right lane	4.544	2.535	1420	0.00091							
Two lanes entering with	Left lane	4.645	2.667	1350	0.00092							
two lanes conflicting	Right lane	4.328	2.535	1420	0.00085							

As an additional check, ARCADY (Assessment of Roundabout Capacity and Delay) software was used to check the "worst-case" roundabout to ensure the soundness of the base roundabout design. ARCADY is a highly-

regarded roundabout analysis software program which based on U.K. empirical research into geometry-capacity relationships.

Based on the highest entering volumes, the Crossroads Boulevard and Ward Avenue intersection was selected to conduct the ARCADY operational analysis. The model was created in Junctions 8 roundabout design and capacity analysis software. A 10% capacity reduction was used in the ARCADY analysis to correlate the results to recent US observations.

The results for each of the analyses represent the most probable capacity of the roundabout and employ capacity measures of level of service, delay and queuing, consistent with typical unsignalized LOS ranges (Highway Capacity Manual, 2010). The overall intersection LOS was calculated by averaging the total delay of the intersection by the total vehicles using the intersection. A summary of the ARCADY analysis are shown in Table 3. The complete ARCADY analysis can be found in Appendix D.

Table 3 ARCADY analysis of Crossroads Blvd/Ward Ave intersection

2035		Intorn	ection	Average Delay By Approach											
	Analysis Condition		ection	SB W	ard Ave	EB Cross	roads Blvd	NB W	ard Ave	WB Crossroads Blvc					
Hour		Level of Service	A verage Delav	Level of Service	Average Delav	Level of Service	A verage Delay	Level of Service		Level of Service	Average Delay				
AM	10% Reduction	Α	3.6	Α	7.7	Α	2.9	В	11.0	Α	3.8				
PM	10% Reduction	Α	3.7	Α	6.9	Α	3.8	Α	5.9	A	3.5				
LOS So	urce: 2010 Highway	Capacity I	Manual - Ui	nsignalized	Intersection	ns				Delay ii	n Seconds				

Based on the results shown in Table 3, the roundabout intersection control option should work well in the other proposed locations in the corridor. Note: further analysis of each intersection should be undertaken before a roundabout is constructed, to ensure the most optimal design is used for the specific location. The above analysis was a broad overview examination to prove the concept of a roundabout control at the locations shown in Options

1 and 2.

Figure 4 Option 1



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NOT TO SCALE

**OPTION 1** 

Figure 5 Option 2 go the though the one of the CROSSROADS BOULEVARD coin code or contacte to





**ATKINS** 



CROSSROADS BOULEVARD
CITY OF LOVELAND, COLORADO

CROSSROADS BOULEVARD CORRIDOR
OPTION 2



## 4. Alternatives analysis and consultation

## 4.1 Corridor analysis

The LOS for Base conditions, No Action conditions, Option 1 and Option 2 at each intersection within the study area are shown in Table 4

Table 4 LOS comparison at peak hours (AM/PM)

		CR 5	RCS Access	Woods Ave	Ward Ave	Walmart/ Greenfield Dr	Highland Meadows Pkwy	CR 3						
Existing	Intersection Treatment	Signal			_	nalized								
	LOS	C/C	F/F	C/D	F/F	C/F	C/B	D/C						
No Action	Intersection Treatment	Signal		Unsignalized Full-movement										
71011011	LOS	C/C	F/F	F/F F/F		F/F	F/D	F/F						
Option 1	Intersection Treatment	No Change	Signalized	High-T	Signalized	High-T	Roundabout	Roundabout						
	LOS	C/C	D/C	B/C	B/C	C/C	B/A	A/A						
Option 2	Intersection Treatment	No Change	Signalized	3/4 movement	Roundabout	High-T	Roundabout	Signalized						
	LOS	C/C	D/C	C/B	A/A	C/E	B/A	C/B						

#### 4.1.1 Corridor travel time comparisons

The travel time analysis is a useful measure of the effectiveness of a series of alternative intersection controls. Combinations of signals and roundabouts pose a challenge for traffic signal timing and the effects of roundabouts on arrival patterns.

The travel times along Crossroads Boulevard from CR 5 to CR 3 were determined from the Synchro 8 model and SimTraffic simulation, and are shown in Table 5. Currently, the operations along Crossroads Boulevard during the peak hours are acceptable at most of the corridor study intersections. However, the intersections at the RCS access, Ward Avenue, and the Walmart entrance currently reach LOS F during the peak hours. By 2035, with no additional improvements made along the corridor, operations throughout the corridor deteriorate to LOS F at almost every intersection. The travel times for westbound travel in the 2035 No Action AM peak period are over four times as long as they are currently.

Table 5 Travel time comparison (seconds)

	А	M	PM					
	Eastbound	Westbound	Eastbound	Westbound				
Existing	90.4	109.3	95.5	107.3				
No Action	92.2	486.5	108.0	214.0				
Option 1	135.3	145.7	159.8	151.4				
Option 2	137.6	141.6	161.6	147.0				

The results indicate minimal operational differences between Option 1 and Option 2. Therefore travel time is not a factor in determining the preferred corridor control option.

### 4.2 Evaluation of corridor control alternatives

Figure 4 and Figure 5 were then shown at the second public meeting on January 29<sup>th</sup>, for further comment. Input gathered from the second meeting was then used to narrow the improvements to two options to be used for final evaluation of alternative access and traffic control.

4.2.1 Public and stakeholder feedback (January 29<sup>th</sup>, 2015)

#### **Walmart Distribution Center**

- Could a right-turn lane bypassing the roundabout be added in Option 2? The signal provides this option but the roundabout could also be developed with this option too.
- There is concern with RVs using the High-T channelized lane
- Employee traffic in High-T lane requires merging and could cause sideswipe crashes
- There is the potential to interconnect the parking lot to Highland Meadows Parkway as a contingency this allows for the High-T to be eliminated
- There is the potential to connect to CR 3 through the back-lot of Walmart in the future
- Both options work well enough to be viable solutions
- Interim solutions are most important to have something implemented sooner
  - o After having a preferred ultimate solution we can back up to interim design conditions.
  - o If one intersection is converted then it helps adjacent access
- Walmart favors Option 1 Stacking and gap seeking for trucks into the roundabout is more uncertain than signals which give a positive anticipated gap

#### Resurrection Christian School

- Full signal versus a roundabout with a HAWK signal: High speed approaching traffic does not set up well for the HAWK. Most HAWKS are in lower speed environments, < 40 mph</li>
- Could a half-cycled signal be run on the RCS driveway?
- Connecting to Patton Avenue is considered viable again and would be a great opportunity the new street has to be set up across the private ownership on the east side of Patton Avenue

- The Woods Avenue intersection could be made right-in/right-out if the connection to Patton Avenue was made
- Not a public road dedication but an easement for access rights to anyone plus a connection to the eastwest public road for egress from RCS
- Consider pedestrian crossing on the east leg of the roundabout?
- Any westbound dual-left requires a complimentary site design to accommodate the platoons of left turners
- If we had a roundabout with heavy lefts into the RCS, that's where roundabouts typically work best
- A roundabout is an option if the HAWK is on the downstream side of the roundabout, where speeds would be lower
- Speeds are lower at the roundabout therefore collision severity will be lower for all users. Although, the perception is that a signal would be safer for the pedestrians crossing the intersection at this location.
- Crossroads Church/School likes the traffic signal but appreciates the roundabout benefits
  - Placing a walkway or tunnel for a pedestrian crossing would ease concern about which intersection treatment is chosen
  - Consider a pedestrian tunnel if daylighting creates a better sightline through the tunnel

## **Town of Windsor**

- Operations and safety will drive the interim options
- The 2035 scenario will have to be divided up to examine stages of implementation
- Windsor is not familiar with a channelized tee [High-T], but is not opposed to the idea
- At the RCS access, the road will eventually push through to the north, so the Town would like to get involved in the next steps of the project

#### 4.2.2 Evaluation of control Options 1 and 2

Both Option 1 and Option 2 show improved operations at all intersections, except Centerra, which is not recommended to change. Although the travel times for Option 1 and Option 2 are higher than the existing travel times, they are more consistent between the eastbound and westbound directions. The additional capacity along the corridor in Option 1 and Option 2 helps to handle the increased future traffic volumes. Option 2 could include placing a roundabout at CR 3 as in Option 1. This would be ideal in terms of expected safety of the CR 3 intersection since it is the first intersection in a long distance for the high speed westbound approach.

A roundabout at the Ward Avenue intersection shows better operational results than a signal at that intersection and is considered the long term preferred intersection control. A traffic signal could be installed in the interim to address the short term traffic demands for Walmart. A signal at Ward Avenue maintains acceptable short term operations, and provides an opportunity for the Walmart entrance intersection to have a better LOS. Additionally, advanced detection and other timing strategies could be used to improve the operations for the truck traffic.

The City of Loveland and representatives from the church and school emphasized the large number of pedestrians at the RCS Access due to the students being drawn to the developments on the north side of that intersection. In order to improve the safety of the pedestrians, a roundabout was considered at this intersection. Due to the high number of pedestrians, a roundabout is expected to have unacceptable LOS at this intersection which is expected to spill over to adjacent intersections. In order for a roundabout to accommodate the high number of pedestrians, a hybrid pedestrian signal would be recommended at this location. The pedestrian signal would function similar to a traditional signal, but with less predictability, which would not achieve the goal of

improving corridor-wide operations. Therefore, a roundabout at the RCS Access was not considered for further analysis.

Another alternative at the RCS access intersection is a pedestrian bridge or underpass on the west leg of the RCS Access intersection. This would provide a protected path for pedestrians to cross Crossroads Boulevard and remove the delay caused by pedestrian crossings. With a grade separated pedestrian crossing a roundabout could be installed and expected to improve driveway operations; however, the effects of mixing roundabout control with the adjacent Centerra traffic signal control make this scenario unattractive. The Centerra traffic signal operation depends upon platoon arrivals, which roundabouts tend to disperse.

The High-T access restriction was further evaluated by the City and based on experience with this configuration elsewhere; it will not be utilized in the final corridor access management plan. Instead, right-in and right-out movements; and, possibly a left-turn inbound channelization, will be used on Woods Avenue and Greenfield Drive in conjunction with internal street pattern interconnections, e.g. RCS to Powell Street and Walmart employee access to Highland Meadows Parkway. These changes and a combination of interim and ultimate intersection control strategies have been formulated into a preferred corridor plan as shown on Figure 6 and discussed in Section 6 of this report.

## 5. Cost Estimate

A conceptual cost estimate was developed for Option 1 and Option 2. The cost estimate covers the entire length of the project (from CR 5 to CR 3). In addition to quantities of new pavement to replace the existing pavement to complete the project, the cost estimate also includes required widening on the north and south sides of Crossroads Boulevard. Although the conceptual design fits within the existing pavement limits, in order to provide a shoulder on both sides of the road, the cost estimate included an estimate of 10 feet of widening on both the north and south sides in both options. The cost estimate takes curb and gutter into account, on the outside edges of the roadway, as well as in the median. Since both options include a two-way left-turn lane between intersections, the additional quantity of curb and gutter from the median was retained to account for the curb and gutter for the islands at the restricted access intersections and at the roundabouts. The cost estimate includes the number of signalized intersections, but since both options have two signalized intersections, two roundabouts, and two restricted access intersections (right-in and right-out, or a ¾-movement), the conceptual cost estimate shows both options as having the same overall cost of \$7,140,000. Additional items such as concrete sidewalk, utilities, signing and striping, lighting, landscaping, mobilization, contingencies, engineering and final design were also included in the cost estimate, as percentages of the total item costs, and are all included in the total project cost.

The cost of the roundabouts is included in the overall estimate, as components of the landscaping, lighting, signing and striping. It should be noted that the designs for the roundabouts are conceptual only, and would need to be refined further – optimizing tie-ins to the corridor and site-specific needs of each proposed intersection. Such changes will have an effect on the overall estimate, but the magnitude cannot be calculated at this overall study level.

Summary cost estimates are shown in Table 6. Additional details on how the estimates were calculated can be found in Appendix E.

**Crossroads Corridor Study Estimate of Conceptual Project Costs** from LCR5 (Centerra/Fairgrounds) to LCR3 Date Prepared: February 26, 2015 Input Factors Notes Length of Improvements LF 5,600 Approximate Width of Widening (North Side) Feet 10 Approximate Width of Widening (South Side) Feet 10 Approximate Width of Proposed ROW (North Side) Feet 0 Approximate Width of Proposed ROW (South Side) Feet Number of Major Drainageways SF Required Bridge Widening **Number of Signalized Intersections Output Factors** (In 2013\$) Notes \$7,140,000 <sup>8</sup> Urban Typical Section Project Costs Rural Typical Section Project Costs \$5,700,000

Table 6 Cost estimate summary

## 6. Preferred Corridor Plan and Implementation

After meeting with the City and project stakeholders (Walmart, RCS, and Town of Windsor) to present the options, the consensus among the stakeholders was that Option 1 was preferred. This study recommends Option 1 in the short term, including the traffic signal at Ward Avenue, but Option 2 in the long term with a future roundabout at County Road 3. Thus a hybrid corridor plan (see Figure 6) is the recommended solution to future access with interim measures that relieve current congestion and improve the safety of existing access. The final determination of the preferred combination of traffic controls and the timing of their implementation is subject to the City's Council and budget deliberations.

Implementation of the preferred corridor plan will be completed in stages, as needs warrant or as redevelopment triggers. In either case, it is recommended that construction generally begin on the west end progressing easterly (See Figure 6). Future restriction of access to right-in and right-out at Greenfield Drive is contingent on placement of roundabouts at Ward Avenue and at Highland Meadows Parkway. The needs of the RCS and Walmart access points should be addressed at the earliest financial opportunity as an interim solution.

After an interim design is constructed, the additional recommended improvements to construct the ultimate design in the future include: the remaining access restriction treatments, subject to interconnection of Powell Street with RCS; and, a connection to Highland Meadows Parkway from the Walmart employee access. Those improvements will take place with building out the entire length of the corridor to four and five lanes consisting of two lanes in each direction with a two-way left-turn lane in the center, except where access is to be restricted.

The ultimate design for this corridor considers 2035 traffic conditions. Implementing the ultimate design within the next five to seven years may result in an over-designed corridor for the current and short-term future traffic volumes. However, an interim design option including traffic signals at RCS and Ward Avenue will help alleviate current operational concerns of the two key access points; and, may be more effective for the short term needs.

The roundabouts conceptualized in this study will need further refinement before they are implemented. The tradeoffs between operational needs and right-of-way impacts have not been addressed as part of this report and will dictate the ultimate configurations of the proposed intersection improvements.

## 6.1 RCS Driveway

Timing of the installation of traffic signals at RCS will depend upon timing of development from the north side of Crossroads Boulevard in the Town of Windsor. The Windsor development plan and local site plan approval for future development opposite RCS can include traffic signal installation at the RCS driveway shared with that development. Both Windsor and Loveland should pursue development agreements for their respective jurisdictions, to provide for funding and construction of the proposed traffic signal and the proposed internal driveway interconnection with Powell Street.

The preferred corridor plan includes a future interconnection between RCS and Powell Street will be pursued through development agreements. Based on feedback from the property owners south of Crossroads Boulevard and west of Woods Avenue, there is a willingness to interconnect RCS with Powell Street. This will allow for the ultimate restriction of access at Woods Avenue to right-in and right-out movements without adverse impacts to traffic circulation. Such a restriction will be less impactful when a roundabout is ultimately installed at Ward Avenue to provide for U-turns of Woods Avenue northbound left-turns.

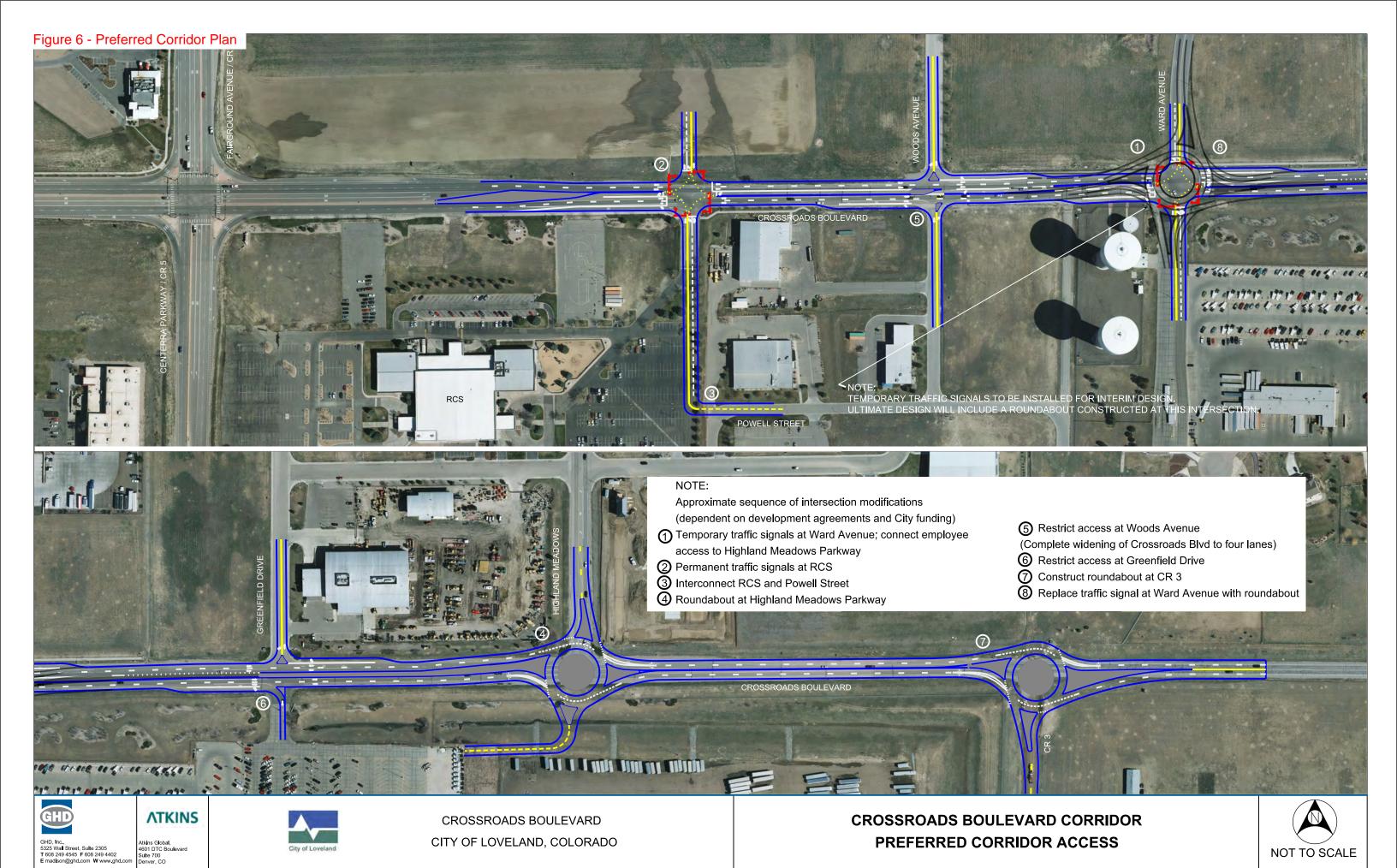
## 6.2 Walmart Access

A similar interconnection of the Walmart employee parking access to Highland Meadows Parkway will allow for a future restriction of access at Greenfield Drive to right-in and right-out only. In the interim condition, the interconnection will be pursued through development agreements, but the employee access will remain open until the City places a roundabout at Highland Meadows Parkway.

At the primary truck access to the Walmart distribution center opposite Ward Avenue, an interim traffic signal is proposed for an indefinite period. It will ultimately be replaced by a roundabout when Crossroads Boulevard is widened to two lanes in each direction. Future development agreements will address the timing and funding associated with the interim traffic signal improvements. Figure 6 shows the preferred corridor plan including the future restriction of access to right-in and right-out at Greenfield Drive, contingent on placement of roundabouts at Ward Avenue and at Highland Meadows Parkway.

The access restrictions at Walmart employee access/Greenfield Drive and at the Woods Avenue intersection will be delayed in the interim - their timing is subject to developer agreements and widening of Crossroads Boulevard including the centerline dividing median. The intersection of Highland Meadows Parkway is currently warranted for a traffic signal, however, preferred installation of a roundabout there is also dependent on City funding and timing.

The City will pursue a Walmart access to CR 3 in the long term when a roundabout is placed at CR 3 and Crossroads Boulevard. The benefit to Walmart is more permeable site access, providing relief to operations at the primary truck access and elsewhere on Crossroads Boulevard.





## **Appendix A** – Traffic counts

Intersection: Centerra-Crossroads

AM

PM

 Date:
 9/9/2014
 Date:
 9/16/2014

 Time:
 7:00-9:00
 Time:
 4:00-6:00

 Day:
 Tuesday
 Day:
 Tuesday

 Observer(s):
 SP & AP
 Observer(s):
 SP & SF

Transportation Development Review Division
City of Loveland
500 E. 3rd St.

Time	Dogina	N	orthbound: Ce	enterra Pkwy		Sou	thbound: Fa	airgrounds A	√ve	Total	Ea	stbound: Cro	ossroads Blv	vd	We	estbound: Cr	ossroads Bl	vd	Total East/West
Time	Begins	L	S	R	Total	L	S	R	Total	North/South	L	S	R	Total	L	S	R	Total	Total East/West
	7:00	8	18	15	41	6	7	14	27	68	22	78	11	111	10	130	8	148	259
	7:15	13	18	15	46	18	14	30	62	108	16	96	23	135	10	119	6	135	270
	7:30	38	18	25	81	31	30	27	88	169	27	130	23	180	26	109	8	143	323
	7:45	66	25	25	116	30	24	28	82	198	21	116	33	170	19	152	8	179	349
	8:00	23	16	17	56	14	20	20	54	110	9	88	9	106	15	123	11	149	255
	8:15	12	10	11	33	9	13	18	40	73	9	78	10	97	15	111	11	137	234
	8:30	5	14	15	34	7	9	19	35	69	12	62	6	80	10	99	10	119	199
	8:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
_																			
7:15-8	3:15	140	77	82	299	93	88	105	286	585	73	430	88	591	70		33	606	1197
PHF		0.53	0.77	0.82	0.64	0.75	0.73	0.88	0.81	0.74	0.68	0.83	0.67	0.82	0.67	0.83	0.75	0.85	0.86
			-		-		_						=			_	_	-	
	4:10	16	36	30	82	16	25	9	50	132	33		39	166	35		9	148	
	4:25	20	25	25	70	18	23	16	57	127	43		44	238	31		11	153	391
	4:40	21	38	22	81	12	29	11	52	133	28		21	168	26		11	188	356
	4:55	18	40	32	90	12	34	15	61	151	37		28	181	22		22	161	342
	5:10	38	52	33	123	8	28	26	62	185	43	146	44	233	25		17	167	400
	5:25	30	38	35	103	17	27	20	64	167	41	152	38	231	23		18	183	414
	5:40	20	29	20	69	17	38	20	75	144	30	118	34	182	27		12	153	335
	5:55	33	32	30	95	5	38	24	67	162	56	114	38	208	32	82	14	128	336
E 40.0		40.1	,1	4.0	202	,_ <b>I</b>	40.1	0.0	0.00	2-2	4-0	<b>500</b>	4	05.	40-1	163	C. I		4:0-
5:10-6	5:10	121	151	118	390	47	131	90	268	658	170	530	154	854	107	463	61	631	1485
PHF		0.80	0.73	0.84	0.79	0.65	0.86	0.87	0.89	0.89	0.76	0.87	0.88	0.90	0.76	0.77	0.69	0.84	0.90

## Pedestrians and Bicyclists

	N	S	Е	W
AM	0	0	0	0
PM	4	30	7	4

Footnote:

L= Left

R= Right

Intersection: RCS-Crossroads

AM F

 Date:
 9/16/2014 Date:
 10/8/2014

 Time:
 7:00-9:00 Time:
 3:15-4:15

 Day:
 Tuesday Day:
 Wednesday

 Observer(s):
 SP & AP Observer(s):
 SF & SK

Transportation Development Review Division
City of Loveland
500 E. 3rd St.

Time Begins		Northbound:	RCS Access			Southbo	ound: N/A		Total	E	astbound: Cro	ound: Crossroads Blvd			Westbound: Crossroads Blvd			
Time Begins	L	S	R	Total	L	S	R	Total	North/South	L	S	R	Total	L	S	R	Total	Total East/West
7:00	1	0	) 1	2	C	(	0	0	2	C	123	14	137	12	110	0	122	259
7:15	1	0	16	17	C	)	0	0	17	C	93	14	107	15	141	0	156	
7:30	5	0	13	18	C	(	0	0	18	C	118	21	139	37	160	0	197	
7:45	6	0	60	66		(	) (	0	66	C	145	71	216			0	276	
8:00	28	0	65	93	C	(	0	0	93	C	125	49	174	53	195	0	248	
8:15	12	0	5	17	C	(	0	0	17	C	77	9	86	5	123		128	
8:30	12	0	) 4	16	C	(	0	0	16	C	84	4	88	6	115		121	
8:45	1	0	) 1	2	C	(	0	0	2	C	64	10	74	14	95	0	109	183
	-									1		=						
7:15-8:15	40	0	154			<u> </u>	) (	) (	194		481	155	636		666		0,,	
PHF	0.36	n/a	0.59	0.52	n/a	n/a	n/a	n/a	0.52	n/a	0.83	0.55	0.74	0.50	0.85	n/a	0.79	0.77
2.20	22		5.4						77		126	74	207	27	407		444	254
3:30	23	0	54			) (	) (		77	C	136	71		37			144	
3:45	16	0	28	44	_				) 44	0	146	32	178				146	
4:00	23	0	29	52 26					52		124 143	14 13	138 156	12 8	135 156		147	
4:15 4:30	14 0	0	12	20					26		143	13	120	0	130	0	164	320
4:45	0	0	0	0					0	0	0	0	0	0	0	0	0	
5:00	0	0	0	0					0		0	0	0	0	0	0	0	
5:15	0	0	) 0	n						(	) 0	0	0	0	0	0	0	
5.15	U		0	0		<b>'</b>	<u> </u>	<u> </u>	,		, 0	U	U	U	0	U	U	
3:30-4:30	76	0	123	199	C	) (	) (	) (	199	C	549	130	679	88	513	0	601	1280
PHF	0.83	n/a	0.57	0.65		n/a	n/a	n/a	0.65		0.94	0.46	0.82	0.59			0.92	

## Pedestrians and Bicyclists

	N	S	Е	W
AM	0	0	1	0
PM	1	0	0	2

Footnote:

L= Left

R= Right

Intersection: Woods-Crossroads

AM

PM

 Date:
 9/30/2014 Date:
 10/9/2014

 Time:
 7:15-9:15 Time:
 4-5:45

 Day:
 Tuesday Day:
 Thursday

 Observer(s):
 SP
 Observer(s):
 SP & SF

Transportation Development Review Division
City of Loveland
500 E. 3rd St.

Time	Begins		Northbound:	Woods Ave			Southbound	: Woods Ave	9	Total	Ea	stbound: Cr	ossroads Bl	vd	We	estbound: C	rossroads B	lvd	Total East/West
Tille	Degins	L	S	R	Total	L	S	R	Total	North/South	L	S	R	Total	L	S	R	Total	Total Last/ West
	7:15	1	0	) 1	2	. 0	0	1	1	3	1	91	8	100	3	136	0	139	239
	7:30	4	0	0	4	0	0	3	3	7	4	116	5	125	4	193	0	197	322
	7:45	1	0	) 4	5	0	0	8	8	13	6	160	6	172	5	259	1	265	437
	8:00	4	0	) 1	5	0	0	8	8	13	8	162	14	184	0	189	1	190	
	8:15	3	0	) 2	5	0	0	1	1	6	1	86	8	95	9	132	0	141	
	8:30	2	C	3	5	0	0	5	5	10	4	66	5	75	5	121	0	126	201
	8:45	3	0	2	5	1	0	2	3	8	3	60	5	68	1	99	2	102	
	9:00	2	0	0	2	1	0	1	2	4	3	79	3	85	3	107	1	111	196
7:45-8:4	45	10	C	10			0	22	22		19		33	526			2	722	
PHF		0.63	n/a	0.63	1.00	n/a	n/a	0.69	0.69	0.81	0.59	0.73	0.59	0.71	0.53	0.68	0.25	0.68	0.71
						•	_					-							
	4:00	16	0	) 2	18		0	4	4	22	1	129	1	131	5	125	0	130	
	4:15	9	0	2	11		0	1	1	12	1	195	9	205	0	139	0	139	
	4:30	17	0	11	28	0	0	5	5	33	0	167	4	171	0	156	0	156	
	4:45	5	0	) 2	7	0	0	3	3	10	4	179	4	187	2	160	0	162	
	5:00	7	0	8	15		0	5	5	20	2	138	6	146	0	110		149	
	5:15	8	0	) 4	12	1	0	5	6	18	3	207	1	211	1	186	0	187	
	5:30	/	0	0	/	0	0	2	2	9	3	190	1	194	0	175	0	175	
	5:45	0	C	0	C	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.20 5.2	20	27		35	<u></u>	1	0	10	40	04	0	601	4.5	74.5	2	CE4	0	C T A	4200
4:30-5:3	3U	37	- /-	25			0	18		81	9	691	15	715	0.45	651	0	654	
PHF		0.54	n/a	0.57	0.55	0.25	n/a	0.90	0.79	0.61	0.56	0.83	0.42	0.85	0.15	0.88	n/a	0.87	0.86

## Pedestrians and Bicyclists

	N	S	Е	W
AM	0	0	0	0
PM	0	0	0	0

Footnote:

L= Left

R= Right

Intersection: Walmart Employee Access-Crossroads

AM PM

Date: 10/8/2014 Date: 10/7/2014

Time: 7:05-8:35 Time: 4-5:30

Day: Wednesday Day: Tuesday

Observer(s): SP Observer(s): SP & SF

Transportation Development Review Division
City of Loveland
500 E. 3rd St.

Time Degine	North	nbound: Walm	art Employee A	access	S	outhbound:	Greenfield I	Dr	Total	Ea	stbound: Cr	ossroads Bl	vd	We	estbound: C	rossroads B	lvd	Total
Time Begins	L	S	R	Total	L	S	R	Total	North/South	L	S	R	Total	L	S	R	Total	East/West
7:05	0	0	0	0	0	0	11	11	11	10	74	3	87	2	111	4	117	204
7:20	1	0	0	1	0	0	7	7	8	11	71	5	87	1	148	0	149	236
7:35	0	0	0	0	3	0	6	9	9	7	87	4	98	1	208	2	211	309
7:50	0	0	0	0	2	0	3	5	5	10	153	4	167	2	263	3	268	435
8:05	1	0	1	2	1	0	3	4	6	7	120	0	127	3	172	1	176	303
8:20	0	0	0	0	1	0	7	8	8	4	65	2	71	0	125	0	125	196
8:35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8:50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7:20-8:20	2	0	1	3	6	0	19	25	28	35	431	13	479	7	791	6	804	1283
PHF	0.50	n/a	0.25	0.38	0.50	n/a	0.43	0.57	0.64	0.80	0.70	0.65	0.72	0.58	0.75	0.38	0.75	0.74
4:00	20	0	42	62	2	0	6	8	70	3	144			33			121	291
4:15	28	0	41	69	0	0	13	13	82	5	128	13		32		1	133	279
4:30	17	0	7	24	3	0	15	18	42	1	172	3	176	1	132	2	135	311
4:45	7	0	4	11	3	0	7	10	21	1	125	1	127	1	124	0	125	252
5:00	3	0	4	7	1	0	10	11	18	3	190	2	195	0	141	1	142	337
5:15	2	0	1	3	0	0	9	9	12	0	148	1	149	3	137	0	140	289
5:30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5:45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4:00-5:00	72	0	94		8	0	41	49	215	10	569	40	619	67	444	3	514	1133
PHF	0.64	n/a	0.56	0.60	0.67	n/a	0.68	0.68	0.66	0.50	0.75	0.43	0.79	0.51	0.79	0.38	0.90	0.84

## Pedestrians and Bicyclists

	N	S	E	W
AM	0	0	0	0
PM	0	0	4	2

Footnote:

L= Left

R= Right

Intersection: Highland Meadows-Crossroads

AM PN

 Date:
 10/9/2014 Date:
 10/1/2014

 Time:
 7:00-9:00 Time:
 4:15-6:15

 Day:
 Thursday Day:
 Wednesday

 Observer(s):
 SP
 Observer(s):
 SP & SF

Transportation Development Review Division
City of Loveland
500 E. 3rd St.

Timo Dogi	200		Northbou	nd: N/A		Southbo	ound: Highl	and Meadov	vs Pkwy	Total	Ea	stbound: Cr	ossroads Bl	vd	W	estbound: C	rossroads Bl	vd	Total East/West
Time Begii	L L		S	R	Total	L	S	R	Total	North/South	L	S	R	Total	L	S	R	Total	TOTAL EAST/WEST
7:0	00	0	0	(	0	9	0	30	39	39	18	45	0	63	0	97	14	111	174
7:1	15	0	0	(	0	11	0	32	43	43	8	56	0	64	0	110	7	117	181
7:3	30	0	0	(	0	9	0	35	44	44	12	66	0	78	0	166	8	174	252
7:4	45	0	0	(	0	11	0	48	59	59	35	129	0	164	0	207	9	216	380
8:0	00	0	0	(	0	9	0	35	44	44	39	100	0	139	0	148	16	164	303
8:1	15	0	0	(	0	8	0	21	29	29	19	58	0	77	0	83	11	94	171
8:3	30	0	0	(	0	7	0	25	32	32	19	45	0	64	0	73	9	82	146
8:4	45	0	0	(	0	15	0	21	36	36	18	33	0	51	0	76	12	88	139
7:15-8:15		0	0	(	0	40	0	150	190	190	94	351	0	445	0	631	40	671	1116
PHF	n/a	n/a	9	n/a	n/a	0.67	n/a	0.78	0.81	0.81	0.60	0.68	n/a	0.68	n/a	0.76	0.63	0.78	0.73
				_	_														
4:1	_	0	0	(	0	10	0	24	34	34	11		0	154	0	94	11	105	259
4:3	30	0	0	(	0	9	0	14	23	23	20		0	150	0	119	17	136	286
4:4		0	0	(	0	8	0	14	22	22	20		0	164	0	81	6	87	251
5:0	00	0	0	(	0	7	0	21	28	28	27		0	145	0	104	5	109	254
5:1	15	0	0	(	0	15	0	23	38	38	30	162	0	192	0	112	12	124	316
5:3	30	0	0	(	0	8	0	37	45	45	27	157	0	184	0	119	7	126	310
5:4		0	0	(	0	3	0	19	22	22	25	141	0	166	0	99		111	277
6:0	00	0	0	(	0	6	0	12	18	18	30	87	0	117	0	76	6	82	199
				-															
4:45-5:45		0	0	(	0	38	0	95	133	133	104	581	0	685	0	416		446	1131
PHF	n/a	n/a	a	n/a	n/a	0.63	n/a	0.64	0.74	0.74	0.87	0.90	n/a	0.89	n/a	0.87	0.44	0.82	0.89

## Pedestrians and Bicyclists

	N	S	Е	W
AM	0	0	0	0
PM	0	0	0	0

## Footnote:

L= Left

R= Right

Intersection: CR3-Crossroads

AM

 Date:
 9/23/2014 Date:
 10/2/2014

 Time:
 7:00-9:00 Time:
 4:07-5:37

 Day:
 Tuesday Day: Thursday

 Observer(s):
 SP Observer(s):
 SF

Transportation Development Review Division
City of Loveland

500 E. 3rd St.

Time Degine	N	orthbound: Co	ounty Road 3			Southbo	und: N/A		Total	Ea	astbound: Cr	ossroads Bl	vd	We	estbound: C	rossroads B	lvd	Total
Time Begins	L	S	R	Total	L	S	R	Total	North/South	L	S	R	Total	L	S	R	Total	East/West
7:00	4	0	1	5	0	0	0	0	5	0	58	1	59	1	100	0	101	16
7:15	3	0	2	5	0	0	0	0	5	0	74	0	74	1	149	0	150	22
7:30	3	0	1	4	0	0	0	0	4	0	91	0	91	0	180	0	180	27
7:45	7	0	2	9	0	0	0	0	9	0	122	5	127	0	218	0	218	34.
8:00	2	0	1	3	0	0	0	0	3	0	86	0	86	0	128	0	128	214
8:15	3	0	0	3	0	0	0	0	3	0	70	1	71	0	77	0	77	148
8:30	1	0	0	1	0	0	0	0	1	0	54	2	56	0	68	0	68	124
8:45	6	0	1	7	0	0	0	0	7	0	65	2	67	0	84	0	84	15:
7:00-8:00	17	0	6	23	0	0	0	0	23	0	345	6	351	2	647	0	649	100
PHF	0.61	n/a	0.75	0.64	n/a	n/a	n/a	n/a	0.64	n/a	0.71	0.30	0.69	0.50	0.74	n/a	0.74	0.72
4:07	0	0	2	2	0	0	0	0	2	0	153	5	158	1	117	0	118	276
4:22	2	0	2	4	0	0	0	C	4	0	140	5	145	0	109	0	109	254
4:37	5	0	2	7	0	0	0	0	7	0	129	3	132	0	123	0	123	255
4:52	2	0	2	4	0	0	0	0	4	0	153	4	157	0	119	0	119	276
5:07	1	0	0	1	0	0	0	0	1	0	165	1	166	1	135	0	136	302
5:22	0	0	0	0	0	0	0	0	0	0	155	2	157	2	124	0	126	283
5:37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(
5:52	0	0	0	0	0	0	0	C	0	0	0	0	0	0	0	0	0	(
4:07-5:07	9	0	8	17	0	0	0	C	17	0	575	17	592	1	468	0	469	106:
PHF	0.45	n/a	1.00	0.61	n/a	n/a	n/a	n/a	0.61	n/a	0.87	0.85	0.89	0.13	0.87	n/a	0.86	0.88

## Pedestrians and Bicyclists

	N	S	Е	W
AM	0	0	1	0
PM	1	0	1	1

## Footnote:

L= Left

R= Right

**Appendix B** – Signal warrants and crash data

## Memo

To: City of Loveland, CO

From: Jim Hanson, PE, PTOE Date: November 6, 2014

**Subject:** Crossroads Boulevard Warrant Analysis

## Overview

The City of Loveland has a goal to transform the Crossroads Boulevard corridor between Larimer County Road 5 (Centerra Parkway / Fairgrounds Avenue) and Larimer County Road 3 without compromising truck access to the Walmart distribution facility. The original purpose and function of Crossroads Boulevard is evolving through the pressure of new development or redevelopment accompanied by physical changes in the roadway and roadside environment. As part of this study, Atkins analyzed whether traffic signals are warranted at the intersections within the project limits along Crossroads Boulevard. The intersections analyzed in this report are the following:

- Crossroads Blvd & RCS Access
- Crossroads Blvd & Woods Ave
- Crossroads Blvd & Greenfield Dr
- Crossroads Blvd & Highland Meadows Pkwy
- Crossroads Blvd & CR 3

The following report summarizes the conducted warrant analysis.



Crossroads Blvd Warrant Analysis
Page 2 of 5

## A. Existing conditions

The existing intersections on Crossroads Blvd between Centerra Parkway / Fairground Avenue on the west and Larimer County Road 3 (CR 3) on the east are two-way stop-controlled. The north and south approaches are stop controlled and the east and west approaches are free movements. Crossroads Blvd has one through lane in each direction, with the exception of the approach to the intersection with Centerra Parkway, where there are two through lanes in each direction, and left and right turn lanes. Crossroads Blvd has a speed limit of 45 mph. Analysis was conducted to determine whether traffic signals are warranted at the intersections within the project limits, and are shown in Figure 1. Centerra Parkway / Fairground Avenue is the western limit of the project, however it is already a signalized intersection.



Figure 1: Aerial View of the Study Area

Source: City of Loveland

With the data provided, it is possible to evaluate Warrant 3, Warrant 4, and Warrant 8. Two of the warrants (eight-hour vehicular volume and four-hour vehicular volume) were not able to be evaluated because the required data (24-hour traffic volumes on the minor-street approaches) was not available. Warrant 7, Crash Experience, was not evaluated because all three of the criterion must be met, and the number of crashes per year at each of the intersections was below the number of crashes required to meet one of the criterion. The other three warrants (school crossing, coordinated signal system, and intersection near a grade crossing) were not evaluated because they were not applicable to the intersections in the study. A summary of the warrant analysis is shown in Table 1.

**Table 1: Warrant Analysis Summary** 

Intersection	Warrant 1	Warrant 2	Warrant 3	Warrant 4	Warrant 5	Warrant 6	Warrant 7	Warrant 8	Warrant 9
RCS Access			Yes	No				No	
Woods Ave			No	No				No	
Greenfield Dr	Need More	Need More	No	No	Not	Not	Not	No	Not
Highland Meadows	Information	Information			Applicable	Applicable	Applicable		Applicable
Pkwy			Yes	No				Yes	
CR 3			No	No				No	

#### B. Data

The City of Loveland provided peak hour volumes and a summary of accidents for all of the intersections analyzed in this study. Traffic counts were conducted in September and October of 2014, when school was in session. The peak AM period for all intersections occurs between about 7:00 AM – 9:00 AM. The peak PM period for all intersections occurs between about 3:00 PM – 6:00 PM. Appendix A contains the raw traffic count data. Appendix B contains the accident summaries that were provided.

#### C. Traffic control signal analysis

There are a total of nine traffic control signal warrants included in Section 4C.01, Studies and Factors for Justifying Traffic Control Signals, in the MUTCD. The nine signal warrants include:

- Warrant 1, Eight-Hour Vehicular Volume
- Warrant 2, Four-Hour Vehicular Volume
- Warrant 3, Peak Hour
- Warrant 4, Pedestrian Volume
- Warrant 5, School Crossing
- Warrant 6, Coordinated Signal System
- Warrant 7, Crash Experience
- Warrant 8, Roadway Network
- Warrant 9, Intersection Near a Grade Crossing

Crossroads Blvd Warrant Analysis
Page 4 of 5

## Warrant 3: Peak Hour

Warrant 3 specifies that a traffic control signal shall be considered if an engineering study finds that the plotted point representing the vehicles per hour on a major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour of an average day falls above the curve in Figure 2 for existing combination of approach lanes. Additionally, if the speed limit of the major street exceeds 40 mph, Figure 3 may be used in place of Figure 2. The speed limit of Crossroads Blvd is 45 mph, so Figure 3 from the MUTCD was used for this warrant.

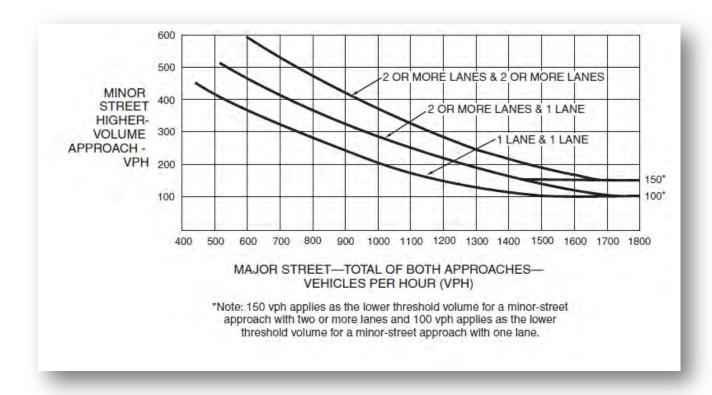


Figure 2: Warrant 3, Peak Hour from MUTCD 2009

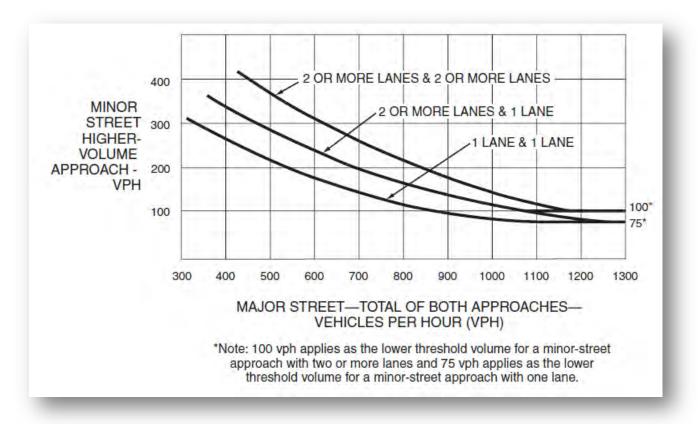


Figure 3: Warrant 3, Peak Hour (70% Factor) from MUTCD 2009

Of the five intersections analyzed for this warrant, only the RCS Access and Highland Meadows Pkwy met the conditions of the warrant. The RCS Access intersection had a total of 1513 vehicles during the AM peak hour on Crossroads Blvd and 194 vehicles during the AM peak hour on the RCS Access road, as shown in Figure 4.

Crossroads Blvd Warrant Analysis
Page 5 of 5

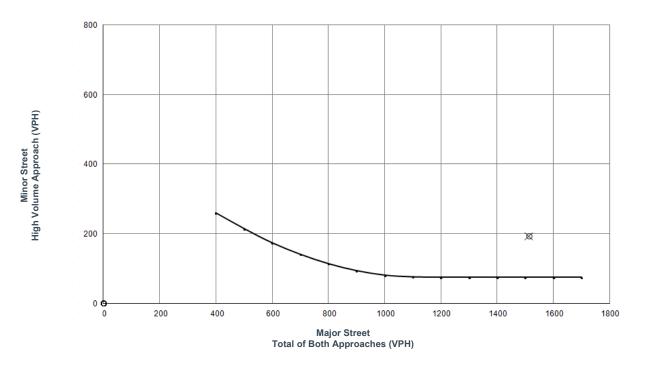


Figure 4: Peak Hour Volumes at Crossroads Blvd and RCS Access

At Highland Meadows Pkwy, Crossroads Blvd had 1116 vehicles during the AM peak hour and Highland Meadows Pkwy had 190 vehicles during the peak hour, as shown in Figure 5.

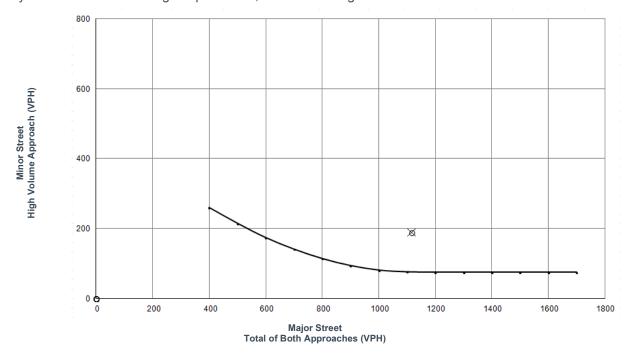


Figure 5: Peak Hour Volumes at Crossroads Blvd and Highland Meadows Pkwy

Warrant 4 specifies that a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that for 1 hour of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) falls above the curve in Figure 6. Additionally, if the speed limit of the major street exceeds 35 mph, Figure 7 may be used in place of Figure 6. The speed limit of Crossroads Blvd is 45 mph, so Figure 7 from the MUTCD was used for this warrant.

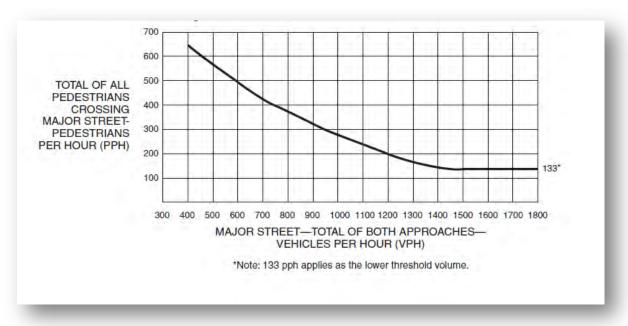


Figure 6: Warrant 4, Pedestrian Peak Hour from MUTCD 2009

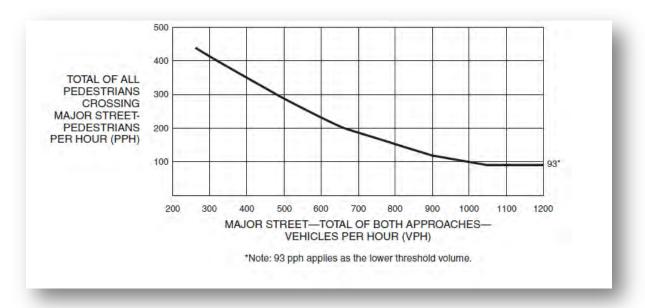


Figure 7: Warrant 4, Pedestrian Peak Hour (70 % Factor) from MUTCD 2009

The number of pedestrians at each of the intersections was less than 10 so none of the intersections met this warrant.

Crossroads Blvd Warrant Analysis

Page 6 of 5

#### Warrant 8: Roadway Network

Warrant 8 specifies that a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that the common intersection of two or more major routes has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during a peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1,2, and 3 during an average weekday.

A major route as used in this signal warrant shall have at least one of the following characteristics:

- A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow.
- B. It includes rural or suburban highways outside, entering, or traversing a city.
- C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

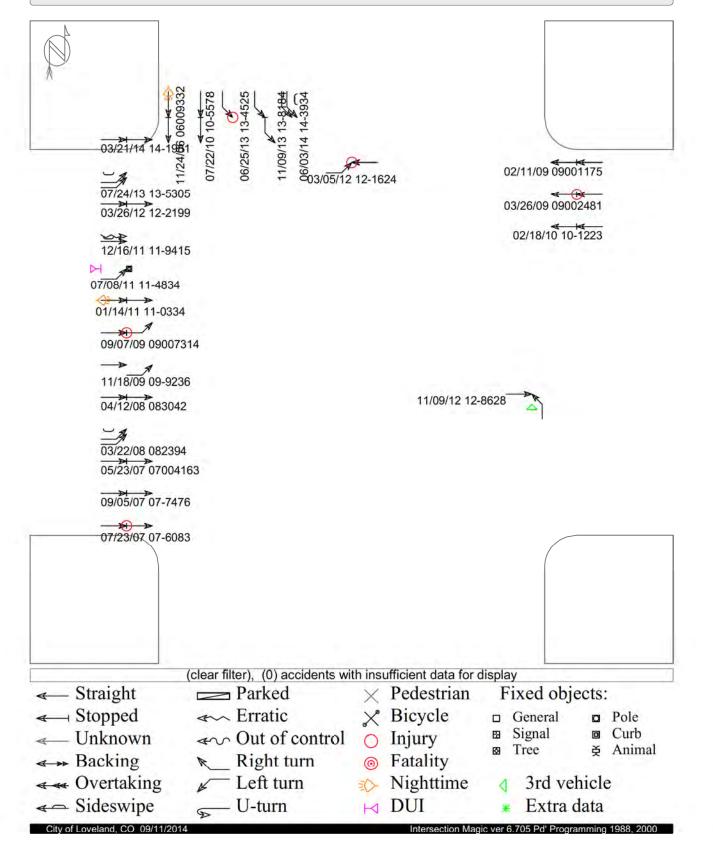
The only intersection that met the criteria for 2 major intersecting routes is Crossroads Blvd and Highland Meadows Pkwy. This intersection met the warrant threshold of 1,000 vehicles per hour during a peak hour. Additionally, the current volumes meet the criteria for Warrant 3 so it can be assumed that the 5-year projected traffic volumes will also meet the criteria for Warrant 3, therefore this intersection meets Warrant 8.

## **E.** Conclusions

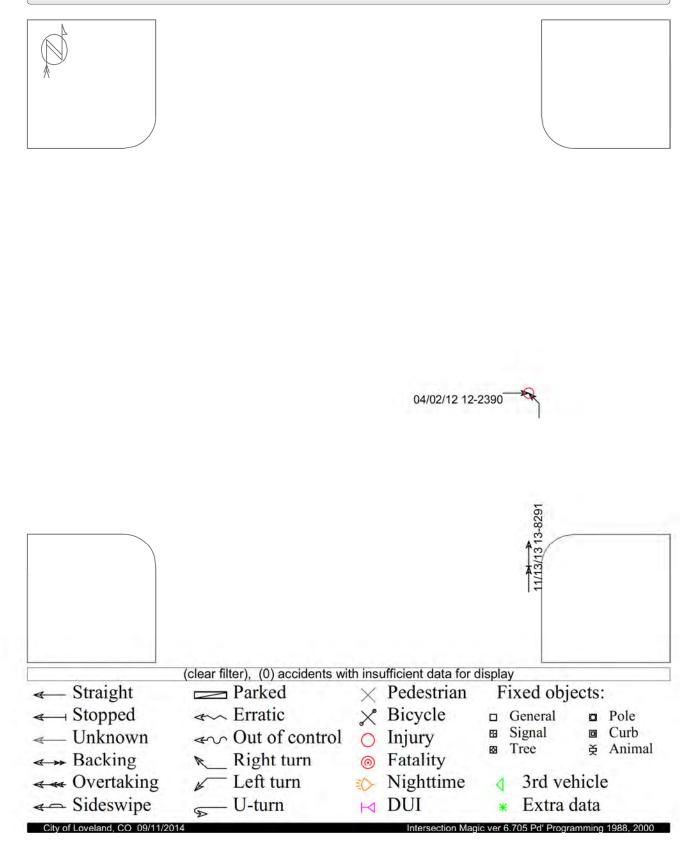
A traffic signal is warranted at the intersection of Crossroads Blvd and the RCS Access, as well as at the intersection of Crossroads Blvd and Highland Meadows Pkwy. When an intersection meets a traffic signal warrant, it does not necessarily indicate that a signal should be installed at that location, but that the location should be further analyzed, and this project will examine these locations where traffic signal warrants were met. The other intersections in this study do not warrant a traffic signal.

Another traffic study was recently completed by others for the intersection of Crossroads Blvd and Ward Avenue and determined that a traffic signal is warranted at that location.

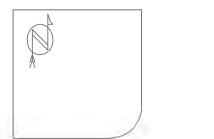
# Crossroads Blvd & Fairgrounds Ave 23 Accidents 06/30/06 - 06/30/14



# Crossroads Blvd & Woods Ave 2 Accidents 06/30/06 - 06/30/14



# Crossroads Blvd & Ward Ave 06/30/06 - 06/30/14



2 Accidents

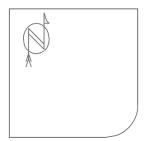


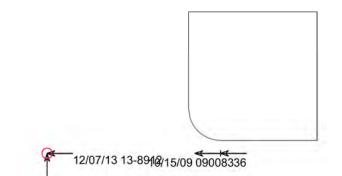


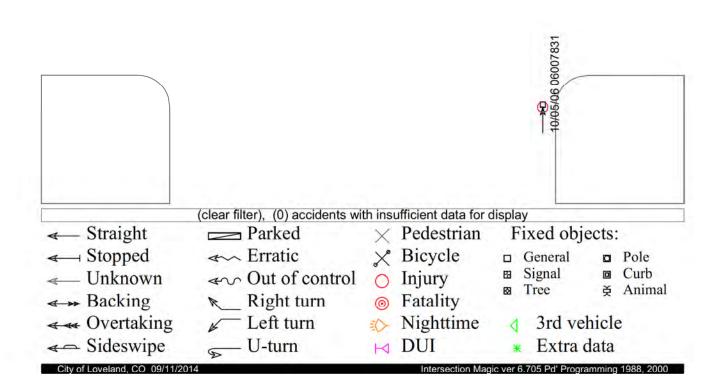
#### 05/27/14 14-00370\_ (clear filter), (0) accidents with insufficient data for display ← Straight Parked Fixed objects: × Pedestrian **←** Stopped ← Erratic × Bicycle □ General D Pole Curb O Injury ← Out of control < Unknown ☑ Tree ≯ Animal → Backing **№**\_ Right turn Fatality Left turn Nighttime ← Overtaking 3rd vehicle — U-turn ⋈ DUI \* Extra data ← Sideswipe

## 3 Accidents

# Cr 03 & Crossroads Blvd 06/30/06 - 06/30/14







## **Appendix C** – Synchro output

HCM Signalized Intersection Capacity Analysis 139: Centerra Pkwy/Fairgrounds & Crossroads

c Critical Lane Group

2/24/2015

	1	-	7	1	+	1	1	1	-	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	ሻሻ	<b>^</b>	7	ሻሻ	<b>^</b>	7	77	<b>^</b>	7	ሻሻ	<b>^</b>	1
Volume (vph)	73	430	88	70	503	33	140	77	82	93	88	105
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.68	0.83	0.67	0.67	0.83	0.75	0.53	0.77	0.82	0.75	0.73	0.88
Adj. Flow (vph)	107	518	131	104	606	44	264	100	100	124	121	119
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	107	518	131	104	606	44	264	100	100	124	121	119
Heavy Vehicles (%)	2%	4%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			Free			Free			Free
Actuated Green, G (s)	8.8	82.7	140.0	8.6	82.5	140.0	15.1	15.3	140.0	9.4	9.6	140.0
Effective Green, g (s)	9.8	87.7	140.0	9.6	87.5	140.0	16.1	20.3	140.0	10.4	14.6	140.0
Actuated g/C Ratio	0.07	0.63	1.00	0.07	0.62	1.00	0.12	0.15	1.00	0.07	0.10	1.00
Clearance Time (s)	4.0	8.0		4.0	8.0		4.0	8.0		4.0	8.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	240	2174	1583	235	2169	1583	394	513	1583	255	369	1583
v/s Ratio Prot	c0.03	0.15		0.03	c0.17		c0.08	0.03		0.04	c0.03	
v/s Ratio Perm			c0.08			0.03			0.06			0.08
v/c Ratio	0.45	0.24	0.08	0.44	0.28	0.03	0.67	0.19	0.06	0.49	0.33	0.08
Uniform Delay, d1	62.5	11.5	0.0	62.6	11.9	0.0	59.4	52.7	0.0	62.2	58.1	0.0
Progression Factor	1.00	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.5	0.0	0.1	0.5	0.3	0.0	3.5	0.1	0.1	0.5	0.2	0.1
Delay (s)	63.0	9.8	0.1	63.1	12.2	0.0	62.9	52.7	0.1	62.8	58.3	0.1
Level of Service	E	Α	Α	E	В	Α	E	D	Α	E	E	A
Approach Delay (s)		15.7			18.6			47.2			40.8	
Approach LOS		В			В			D			D	
Intersection Summary												
HCM 2000 Control Delay			26.8	Н	CM 2000	Level of	Service		С			
HCM 2000 Volume to Capa	acity ratio		0.35						15.677			
Actuated Cycle Length (s)			140.0		um of los				12.0			
Intersection Capacity Utiliza	ation		41.5%	IC	U Level	of Service			Α			
Analysis Period (min)			15									
a Critical Lana Croun												

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# HCM Unsignalized Intersection Capacity Analysis 29: RCS Access & Crossroads

2/24/2015

	-	+	1	+	1	1	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	<b>^</b>	7		4	W		
Volume (veh/h)	481	155	211	566	40	154	
Sign Control	Free		2.40	Free	Stop	300	
Grade	0%			0%	0%		
Peak Hour Factor	0.83	0.55	0.50	0.85	0.36	0.59	
Hourly flow rate (vph)	580	282	422	666	111	261	
Pedestrians	100				100		
Lane Width (ft)	12.0				12.0		
Walking Speed (ft/s)	4.0				4.0		
Percent Blockage	8				8		
Right turn flare (veh)							
Median type	None			TWLTL			
Median storage veh)	22722			2			
Upstream signal (ft)	1275						
pX, platoon unblocked			0.92		0.92	0.92	
vC, conflicting volume			961		2289	680	
vC1, stage 1 conf vol					680		
vC2, stage 2 conf vol					1610		
vCu, unblocked vol			917		2355	611	
tC, single (s)			4.1		6.4	6.2	
tC, 2 stage (s)					5.4		
tF(s)			2.2		3.5	3.3	
p0 queue free %			33		0	38	
cM capacity (veh/h)			630		53	418	
Direction, Lane #	EB 1	EB 2	WB 1	NB 1			
Volume Total	580	282	1088	372			
Volume Left	0	0	422	111			
Volume Right	0	282	0	261			
cSH	1700	1700	630	136			
Volume to Capacity	0.34	0.17	0.67	2.73			
Queue Length 95th (ft)	0	0	127	841			
Control Delay (s)	0.0	0.0	21.5	850.4			
Lane LOS			С	F			
Approach Delay (s)	0.0		21.5	850.4			
Approach LOS				F			
Intersection Summary							
Average Delay			146.4				
Intersection Capacity Utiliza	ition		88.5%	IC	U Level o	of Service	E
Analysis Period (min)			15				

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HCM Unsignalized Intersection Capacity Analysis 31: Woods Ave & Crossroads 2/24/2015

	•	-	7	1	+	1	1	1	1	-	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		4	7	7	<b>↑</b>	7		4			4	
Volume (veh/h)	19	574	33	19	701	2	10	0	10	0	0	22
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.59	0.73	0.59	0.53	0.68	0.25	0.63	0.85	0.63	0.85	0.85	0.69
Hourly flow rate (vph)	32	786	56	36	1031	8	16	0	16	0	0	32
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1039			842			1985	1961	786	1969	2009	1031
vC1, stage 1 conf vol							851	851		1103	1103	
vC2, stage 2 conf vol							1134	1111		867	907	
vCu, unblocked vol	1039			842			1985	1961	786	1969	2009	1031
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5		6.1	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	95			95			90	100	96	100	100	89
cM capacity (veh/h)	669			794			155	201	392	184	204	283
Direction, Lane #	EB1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1					
Volume Total	819	56	36	1031	8	32	32					
Volume Left	32	0	36	0	0	16	0					
Volume Right	0	56	0	0	8	16	32					
cSH	669	1700	794	1700	1700	222	283					
Volume to Capacity	0.05	0.03	0.05	0.61	0.00	0.14	0.11					
Queue Length 95th (ft)	4	0	4	0	0	12	9					
Control Delay (s)	1.3	0.0	9.8	0.0	0.0	23.9	19.3					
Lane LOS	Α		Α			С	C					
Approach Delay (s)	1.2		0.3			23.9	19.3					
Approach LOS						C	С					
Intersection Summary												1
Average Delay			1.4									
Intersection Capacity Utilization	1		60.1%	10	U Level	of Service			В			
Analysis Period (min)			15									

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# HCM Unsignalized Intersection Capacity Analysis 34: Ward Ave & Crossroads

	•	-	1	1	+	1	1	1	-	-	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	7	<b>*</b>	7	7	<b>↑</b>	7	7	₽		7	1	
Volume (veh/h)	12	475	21	3	693	8	16	2	3	2	0	9
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.75	0.89	0.75	0.38	0.86	0.40	0.67	0.25	0.38	0.50	0.25	0.75
Hourly flow rate (vph)	16	534	28	8	806	20	24	8	8	4	0	12
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	826			562			1399	1407	534	1399	1415	806
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	826			562			1399	1407	534	1399	1415	806
tC, single (s)	4.1			5.1			8.1	7.5	7.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF(s)	2.2			3.1			4.4	4.9	4.2	3.5	4.0	3.3
p0 queue free %	98			99			66	91	98	96	100	97
cM capacity (veh/h)	805			661			69	85	396	105	133	382
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB3	NB 1	NB 2	SB 1	SB 2		
Volume Total	16	534	28	8	806	20	24	16	4	12		
Volume Left	16	0	0	8	0	0	24	0	4	0		
Volume Right	0	0	28	0	0	20	0	8	0	12		
cSH	805	1700	1700	661	1700	1700	69	140	105	382		
Volume to Capacity	0.02	0.31	0.02	0.01	0.47	0.01	0.34	0.11	0.04	0.03		
Queue Length 95th (ft)	2	0	0	1	0	0	32	9	3	2		
Control Delay (s)	9.6	0.0	0.0	10.5	0.0	0.0	82.1	34.1	40.7	14.7		
Lane LOS	Α			В			F	D	E	В		
Approach Delay (s)	0.3			0.1			62.9		21.2			
Approach LOS							F		C			
Intersection Summary												
Average Delay			2.1				_					
Intersection Capacity Utilization			50.7%	IC	CU Level	of Service			Α			
Analysis Period (min)			15									
Contract to the contract of th												

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# HCM Unsignalized Intersection Capacity Analysis 37: Walmart Entrance/Greenfield Dr & Crossroads

2/2/	mn.	15
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	*	-	7	1	+		1	1	1	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	7	<b>↑</b>	7	7	<b>↑</b>	7		4			4	
Volume (veh/h)	35	431	13	7	791	6	2	0	1	6	0	19
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.80	0.70	0.65	0.58	0.75	0.38	0.50	0.85	0.25	0.50	0.85	0.43
Hourly flow rate (vph)	44	616	20	12	1055	16	4	0	4	12	0	44
Pedestrians		737			177.5							
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)		110110			2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1070			636			1826	1798	616	1786	1802	1055
vC1, stage 1 conf vol				10.50			703	703		1079	1079	
vC2, stage 2 conf vol							1123	1095		707	723	
vCu, unblocked vol	1070			636			1826	1798	616	1786	1802	1055
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5		6.1	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	93			99			97	100	99	94	100	84
cM capacity (veh/h)	651			948			151	213	491	217	238	274
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB3	NB 1	SB 1				
Volume Total	44	616	20	12	1055	16	8	56				
Volume Left	44	0	0	12	0	0	4	12				
Volume Right	0	0	20	0	0	16	4	44				
cSH	651	1700	1700	948	1700	1700	231	260				
Volume to Capacity	0.07	0.36	0.01	0.01	0.62	0.01	0.03	0.22				
Queue Length 95th (ft)	5	0	0	1	0	0	3	20				
Control Delay (s)	10.9	0.0	0.0	8.8	0.0	0.0	21.2	22.7				
Lane LOS	В			Α			С	С				
Approach Delay (s)	0.7			0.1			21.2	22.7				
Approach LOS							С	С				
Intersection Summary												
Average Delay			1.1									
Intersection Capacity Utilization	1		51.6%	10	CU Level	of Service			Α			
Analysis Period (min)			15									

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

# HCM Unsignalized Intersection Capacity Analysis 40: Crossroads & Highland Meadows Pkwy

	1	<b>→</b>	-	*	1	1		
Movement	EBL	EBT	WBT	WBR	SBL	SBR		
Lane Configurations	7	<b>^</b>	1	7	7	7		
Volume (veh/h)	94	351	631	40	40	150		
Sign Control	34	Free	Free	40	Stop	100		
Grade		0%	0%		0%			
Peak Hour Factor	0.60	0.68	0.76	0.63	0.67	0.78		
Hourly flow rate (vph)	157	516	830	63	60	192		
Pedestrians	101	310	000	00	00	132		
Lane Width (ft)								
Walking Speed (ft/s)								
Percent Blockage								
Right turn flare (veh)								
		TWLTL	None					
Median type			None					
Median storage veh)		2						
Upstream signal (ft)								
pX, platoon unblocked	004				1000	020		
vC, conflicting volume	894				1660	830		
vC1, stage 1 conf vol					830			
vC2, stage 2 conf vol	004				830	000		
vCu, unblocked vol	894				1660	830		
tC, single (s)	4.1				6.4	6.2		
tC, 2 stage (s)					5.4	-		
tF(s)	2.2				3.5	3.3		
p0 queue free %	79				78	48		
cM capacity (veh/h)	759				272	370		
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2		
Volume Total	157	516	830	63	60	192		
Volume Left	157	0	0	0	60	0		
Volume Right	0	0	0	63	0	192		
cSH	759	1700	1700	1700	272	370		
Volume to Capacity	0.21	0.30	0.49	0.04	0.22	0.52		
Queue Length 95th (ft)	19	0	0	0	20	72		
Control Delay (s)	11.0	0.0	0.0	0.0	21.9	24.8		
Lane LOS	В				С	С		
Approach Delay (s)	2.6		0.0		24.1			
Approach LOS					С			
Intersection Summary								
Average Delay			4.3					
Intersection Capacity Utiliza	ition		51.8%	IC	U Level o	of Service	Α	

## Base Model AM

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# HCM Unsignalized Intersection Capacity Analysis 42: LCR 3 & Crossroads

	-	1	1	+	1	-	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	1			4	A		
Volume (veh/h)	345	6	2	647	17	6	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	0.71	0.30	0.50	0.74	0.61	0.75	
Hourly flow rate (vph)	486	20	4	874	28	8	
Pedestrians					1		
ane Width (ft)					12.0		
Walking Speed (ft/s)					4.0		
Percent Blockage					0		
Right turn flare (veh)							
Median type	None			None			
Median storage veh)							
Upstream signal (ft)							
X, platoon unblocked							
vC, conflicting volume			507		1379	497	
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol			507		1379	497	
tC, single (s)			4.1		6.4	6.2	
tC, 2 stage (s)							
tF(s)			2.2		3.5	3.3	
p0 queue free %			100		82	99	
cM capacity (veh/h)			1057		159	573	
Direction, Lane#	EB 1	WB 1	NB 1				
Volume Total	506	878	36				
Volume Left	0	4	28				
Volume Right	20	0	8				
cSH	1700	1057	189				
Volume to Capacity	0.30	0.00	0.19				
Queue Length 95th (ft)	0	0	17				
Control Delay (s)	0.0	0.1	28.5				
Lane LOS		Α	D				
Approach Delay (s)	0.0	0.1	28.5				
Approach LOS			D				
Intersection Summary							
Average Delay			0.8				
Intersection Capacity Utiliza	ation		45.6%	IC	U Level o	of Service	Α
Analysis Period (min)	1000000		15				

Synchro 8 Report TRIANGLE EXISTING 8/31/1998 Baseline



HCM Signalized Intersection Capacity Analysis 139: Centerra Pkwy/Fairgrounds & Crossroads

	1	-	7	1	+		1	1	-	-	ļ	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	44	<b>^</b>	7	44	<b>^</b>	7	44	<b>^</b>	7	44	<b>^</b>	7
Volume (vph)	170	530	154	107	463	61	121	151	118	47	131	90
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1561	3433	3505	1562	3433	3539	1562	3433	3539	1550
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1561	3433	3505	1562	3433	3539	1562	3433	3539	1550
Peak-hour factor, PHF	0.76	0.87	0.88	0.76	0.77	0.69	0.80	0.73	0.84	0.65	0.86	0.87
Adj. Flow (vph)	224	609	175	141	601	88	151	207	140	72	152	103
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	224	609	175	141	601	88	151	207	140	72	152	103
Confl. Peds. (#/hr)	4		7	7		4	30		4	4		30
Heavy Vehicles (%)	2%	2%	2%	2%	3%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			Free			Free			Free
Actuated Green, G (s)	13.5	83.9	140.0	10.2	80.6	140.0	10.5	15.6	140.0	6.3	11.4	140.0
Effective Green, g (s)	14.5	88.9	140.0	11.2	85.6	140.0	11.5	20.6	140.0	7.3	16.4	140.0
Actuated g/C Ratio	0.10	0.64	1.00	0.08	0.61	1.00	0.08	0.15	1.00	0.05	0.12	1.00
Clearance Time (s)	4.0	8.0		4.0	8.0		4.0	8.0		4.0	8.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	355	2247	1561	274	2143	1562	281	520	1562	179	414	1550
v/s Ratio Prot	c0.07	0.17		0.04	c0.17		c0.04	c0.06		0.02	0.04	
v/s Ratio Perm			0.11			0.06			0.09			0.07
v/c Ratio	0.63	0.27	0.11	0.51	0.28	0.06	0.54	0.40	0.09	0.40	0.37	0.07
Uniform Delay, d1	60.2	11.3	0.0	61.8	12.8	0.0	61.7	54.1	0.0	64.2	57.0	0.0
Progression Factor	0.94	0.91	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.5	0.0	0.1	0.7	0.3	0.1	1.0	0.2	0.1	0.5	0.2	0.1
Delay (s)	59.3	10.3	0.1	62.5	13.1	0.1	62.7	54.3	0.1	64.8	57.2	0.1
Level of Service	E	В	Α	E	В	Α	E	D	Α	E	E	Α
Approach Delay (s)		19.4			20.1			41.6			40.9	
Approach LOS		В			C			D			D	
Intersection Summary												
HCM 2000 Control Delay			26.4	Н	CM 2000	Level of	Service		C			
HCM 2000 Volume to Capa	acity ratio		0.37									
Actuated Cycle Length (s)			140.0		um of los				12.0			
Intersection Capacity Utiliza	ation		61.8%	IC	CU Level	of Service			В			
Analysis Period (min)			15									
c Critical Lane Group												

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

## HCM Unsignalized Intersection Capacity Analysis 29: RCS Access & Crossroads

2/24/2015

	-	+	1	+	1	1	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	<b>^</b>	7		4	W		
Volume (veh/h)	549	130	88	575	76	123	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	0.94	0.46	0.59	0.82	0.83	0.57	
Hourly flow rate (vph)	584	283	149	701	92	216	
Pedestrians	100			1	100		
Lane Width (ft)	12.0			12.0	12.0		
Walking Speed (ft/s)	4.0			4.0	4.0		
Percent Blockage	8			0	8		
Right turn flare (veh)							
Median type	None			TWLTL			
Median storage veh)	25-11-4			2			
Upstream signal (ft)	1275						
pX, platoon unblocked	WEAT ST		0.91		0.91	0.91	
vC, conflicting volume			967		1784	685	
vC1, stage 1 conf vol			1000		684	1000	
vC2, stage 2 conf vol					1100		
vCu, unblocked vol			911		1813	600	
tC, single (s)			4.1		6.4	6.2	
tC, 2 stage (s)					5.4		
tF (s)			2.2		3.5	3.3	
p0 queue free %			76		54	48	
cM capacity (veh/h)			621		198	415	
Direction, Lane #	EB 1	EB 2	WB 1	NB 1			
Volume Total	584	283	850	307			
Volume Left	0	0	149	92			
Volume Right	0	283	0	216			
cSH	1700	1700	621	313			
Volume to Capacity	0.34	0.17	0.24	0.98			
Queue Length 95th (ft)	0	0	23	260			
Control Delay (s)	0.0	0.0	6.5	83.9			
Lane LOS		7,750	Α	F			
Approach Delay (s)	0.0		6.5	83.9			
Approach LOS			4.1	F			
Intersection Summary							
Average Delay			15.5				
Intersection Capacity Utiliza	ation		85.9%	IC	U Level o	of Service	E
Analysis Period (min)			15				

### HCM Unsignalized Intersection Capacity Analysis

0.5

Approach Delay (s)

31: Woods Ave & Crossroads 2/24/2015 EBL EBT EBR WBL WBT WBR NBL NBT NBR SBT SBR Movement Lane Configurations 37 18 Volume (veh/h) 691 15 651 0 0 25 0 Sign Control Free Stop Stop Free Grade 0% 0% 0% 0% Peak Hour Factor 0.56 0.83 0.42 0.25 0.88 0.85 0.54 0.85 0.57 0.25 0.85 0.90 16 833 36 12 740 69 20 Hourly flow rate (vph) 0 44 Pedestrians Lane Width (ft) Walking Speed (ft/s) Percent Blockage Right turn flare (veh) Median type TWLTL None Median storage veh) 2 Upstream signal (ft) pX, platoon unblocked vC, conflicting volume 740 1648 1628 833 1672 1664 vC1, stage 1 conf vol 865 865 764 764 vC2, stage 2 conf vol 784 764 909 900 868 vCu, unblocked vol 740 1628 740 1648 833 1672 1664 4.1 4.1 7.1 6.5 6.2 7.1 6.5 6.2 tC, single (s) 5.5 6.1 5.5 tC, 2 stage (s) 6.1 2.2 2.2 3.5 tF(s) 4.0 3.3 3.5 4.0 3.3 98 98 72 100 88 98 100 95 p0 queue free % cM capacity (veh/h) 776 867 248 277 369 226 269 417 EB1 SB 1 Direction, Lane # EB 2 WB 1 WB 2 WB 3 NB 1 849 Volume Total 740 112 24 36 12 Volume Left 16 12 69 0 0 0 Volume Right 0 36 20 0 0 44 cSH 867 1700 776 1700 1700 284 365 Volume to Capacity 0.02 0.02 0.02 0.44 0.00 0.40 0.07 Queue Length 95th (ft) 45 0 0 1 0 5 Control Delay (s) 0.0 9.7 0.0 0.0 25.7 15.5 Lane LOS A A D C

Approach LOS		D	C		
Intersection Summary					1
Average Delay	2.1				
Intersection Capacity Utilization	60.5%	ICU Level of Service		В	
Analysis Period (min)	15				

0.2

15.5

25.7

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

## LICA Unaignalized Interpostion Consoity Analysis

34: Ward Ave & Ci		10									_	24/2015
	1	-	*	1	+	*	1	1	-	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	7	<b>*</b>	7	7	<b>^</b>	7	7	1		7	1	
Volume (veh/h)	5	650	17	4	619	2	21	0	4	7	1	6
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.62	0.84	0.71	0.50	0.81	0.25	0.58	0.85	0.50	0.88	0.25	0.50
Hourly flow rate (vph)	8	774	24	8	764	8	36	0	8	8	4	12
Pedestrians		4.00					117.0		-	18	7	
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)		110110			110110							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	772			798			1584	1578	774	1578	1594	764
vC1, stage 1 conf vol				100			1001	1010		1010	1001	, , ,
vC2, stage 2 conf vol												
vCu, unblocked vol	772			798			1584	1578	774	1578	1594	764
tC, single (s)	4.1			5.1			8.1	7.5	7.2	7.1	6.5	6.2
tC, 2 stage (s)	21,1			0.1			0.1	7.0	7.2		0.0	0.2
tF(s)	2.2			3.1			4.4	4.9	4.2	3.5	4.0	3.3
p0 queue free %	99			98			25	100	97	91	96	97
cM capacity (veh/h)	843			519			48	65	277	84	104	404
	7.00							-			101	101
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB3	NB 1	NB 2	SB 1	SB 2		
Volume Total	8	774	24	8	764	8	36	8	8	16		
Volume Left	8	0	0	8	0	0	36	0	8	0		
Volume Right	0	0	24	0	0	8	0	8	0	12		
cSH	843	1700	1700	519	1700	1700	48	277	84	235		
Volume to Capacity	0.01	0.46	0.01	0.02	0.45	0.00	0.75	0.03	0.09	0.07		
Queue Length 95th (ft)	1	0	0	1	0	0	75	2	8	5		
Control Delay (s)	9.3	0.0	0.0	12.1	0.0	0.0	190.5	18.4	52.1	21.4		
Lane LOS	Α			В			F	C	F	C		
Approach Delay (s)	0.1			0.1			159.4		31.6			
Approach LOS							F		D			
Intersection Summary												
Average Delay			4.8									
Intersection Capacity Utiliza	ation		48.7%	IC	CU Level	of Service			Α			

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15

Analysis Period (min)

HCM Unsignalized Intersection Capacity Analysis 37: Walmart Entrance/Greenfield Dr & Crossroads

2/24/2	015
	7.17

	•	-	7	1	+	1	1	1	-	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	7	<b>↑</b>	7	7	<b>*</b>	7		4			4	
Volume (veh/h)	10	569	40	67	444	3	72	0	94	8	0	4
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.50	0.75	0.43	0.51	0.79	0.38	0.64	0.85	0.56	0.67	0.85	0.68
Hourly flow rate (vph)	20	759	93	131	562	8	112	0	168	12	0	60
Pedestrians								4			2	
Lane Width (ft)								12.0			12.0	
Walking Speed (ft/s)								4.0			4.0	
Percent Blockage								0			0	
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	572			856			1688	1637	763	1793	1722	564
vC1, stage 1 conf vol							803	803		827	827	
vC2, stage 2 conf vol							885	835		967	896	
vCu, unblocked vol	572			856			1688	1637	763	1793	1722	564
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5		6.1	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	98			83			43	100	58	72	100	88
cM capacity (veh/h)	999			782			196	243	403	42	188	524
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB 3	NB 1	SB 1				
Volume Total	20	759	93	131	562	8	280	72				
Volume Left	20	0	0	131	0	0	112	12				
Volume Right	0	0	93	0	0	8	168	60				
cSH	999	1700	1700	782	1700	1700	283	182				
Volume to Capacity	0.02	0.45	0.05	0.17	0.33	0.00	0.99	0.40				
Queue Length 95th (ft)	2	0	0	15	0	0	252	44				
Control Delay (s)	8.7	0.0	0.0	10.5	0.0	0.0	90.6	37.1				
Lane LOS	Α			В			F	Е				
Approach Delay (s)	0.2			2.0			90.6	37.1				
Approach LOS							F	Е				
Intersection Summary												
Average Delay			15.4									
Intersection Capacity Utilization	1		60.1%	10	CU Level	of Service			В			
Analysis Period (min)			15	,								

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# HCM Unsignalized Intersection Capacity Analysis 40: Crossroads & Highland Meadows Pkwy

& Highland Meadows Pkwy 2/24/2015

	1	<b>→</b>	+	1	1	1	
Movement	EBL	EBT	WBT	WBR	SBL	SBR	
Lane Configurations	7	1	<b>^</b>	7	7	7	
Volume (veh/h)	104	581	416	30	38	95	
Sign Control		Free	Free		Stop		
Grade		0%	0%		0%		
Peak Hour Factor	0.87	0.90	0.87	0.44	0.63	0.64	
Hourly flow rate (vph)	120	646	478	68	60	148	
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL	None				
Median storage veh)		2	100100				
Upstream signal (ft)							
pX, platoon unblocked							
vC, conflicting volume	546				1363	478	
vC1, stage 1 conf vol					478		
vC2, stage 2 conf vol					885		
vCu, unblocked vol	546				1363	478	
tC, single (s)	4.1				6.4	6.2	
tC, 2 stage (s)					5.4		
tF(s)	2.2				3.5	3.3	
p0 queue free %	88				81	75	
cM capacity (veh/h)	1023				323	587	
Direction, Lane #	EB1	EB 2	WB 1	WB 2	SB 1	SB 2	
Volume Total	120	646	478	68	60	148	
Volume Left	120	0	0	0	60	0	
Volume Right	0	0	0	68	0	148	
cSH	1023	1700	1700	1700	323	587	
Volume to Capacity	0.12	0.38	0.28	0.04	0.19	0.25	
Queue Length 95th (ft)	10	0	0	0	17	25	
Control Delay (s)	9.0	0.0	0.0	0.0	18.7	13.2	
Lane LOS	Α				С	В	
Approach Delay (s)	1.4		0.0		14.8		
Approach LOS					В		
Intersection Summary							
Average Delay			2.7				
Intersection Capacity Utiliza	ation		41.0%	IC	U Level o	of Service	A
Analysis Period (min)			15				

## Base Model PM

# HCM Unsignalized Intersection Capacity Analysis 42: LCR 3 & Crossroads

2/24/2015

	-	1	1	-	1	-	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	1			4	W		
Volume (veh/h)	575	17	1	468	9	8	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	0.87	0.85	0.25	0.87	0.45	1.00	
Hourly flow rate (vph)	661	20	4	538	20	8	
Pedestrians				1	1		
Lane Width (ft)				12.0	12.0		
Walking Speed (ft/s)				4.0	4.0		
Percent Blockage				0	0		
Right turn flare (veh)							
Median type	None			None			
Median storage veh)	110110			110110			
Upstream signal (ft)							
pX, platoon unblocked							
vC, conflicting volume			682		1218	673	
vC1, stage 1 conf vol			002		1210	010	
vC2, stage 2 conf vol							
vCu, unblocked vol			682		1218	673	
tC, single (s)			4.1		6.4	6.2	
tC, 2 stage (s)					0.1	0.2	
tF (s)			2.2		3.5	3.3	
p0 queue free %			100		90	98	
cM capacity (veh/h)			910		198	454	
		VI COTO			100	101	
Direction, Lane #	EB 1	WB 1	NB 1				
Volume Total	681	542	28				
Volume Left	0	4	20				
Volume Right	20	0	8				
cSH	1700	910	237				
Volume to Capacity	0.40	0.00	0.12				
Queue Length 95th (ft)	0	0	10				
Control Delay (s)	0.0	0.1	22.3				
Lane LOS		Α	С				
Approach Delay (s)	0.0	0.1	22.3				
Approach LOS			C				
Intersection Summary							
Average Delay			0.6				
Intersection Capacity Utilizati	ion		41.6%	IC	U Level o	of Service	A
Analysis Period (min)			15				

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HCM Signalized Intersection Capacity Analysis 139: Centerra Pkwy/Fairgrounds & Crossroads

c Critical Lane Group

2/24/2015

	1	-	7	1	+	1	1	1	1	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	77	<b>^</b>	7	ሻሻ	<b>^</b>	7	77	<b>^</b> ^	7	ሻሻ	<b>^</b>	7
Volume (vph)	110	645	132	105	755	50	210	116	123	140	132	158
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.68	0.83	0.67	0.67	0.83	0.75	0.53	0.77	0.82	0.75	0.73	0.88
Adj. Flow (vph)	162	777	197	157	910	67	396	151	150	187	181	180
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	162	777	197	157	910	67	396	151	150	187	181	180
Heavy Vehicles (%)	2%	4%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			Free			Free			Free
Actuated Green, G (s)	11.0	76.7	140.0	10.8	76.5	140.0	16.8	16.5	140.0	12.0	11.7	140.0
Effective Green, g (s)	12.0	81.7	140.0	11.8	81.5	140.0	17.8	21.5	140.0	13.0	16.7	140.0
Actuated g/C Ratio	0.09	0.58	1.00	0.08	0.58	1.00	0.13	0.15	1.00	0.09	0.12	1.00
Clearance Time (s)	4.0	8.0		4.0	8.0		4.0	8.0		4.0	8.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	294	2025	1583	289	2020	1583	436	543	1583	318	422	1583
v/s Ratio Prot	c0.05	0.22		0.05	c0.26		c0.12	0.04		0.05	c0.05	
v/s Ratio Perm			c0.12			0.04			0.09			0.11
v/c Ratio	0.55	0.38	0.12	0.54	0.45	0.04	0.91	0.28	0.09	0.59	0.43	0.11
Uniform Delay, d1	61.4	15.6	0.0	61.5	16.6	0.0	60.3	52.4	0.0	60.9	57.2	0.0
Progression Factor	1.09	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	0.0	0.2	1.1	0.7	0.1	21.9	0.1	0.1	1.8	0.3	0.1
Delay (s)	68.1	11.8	0.2	62.6	17.3	0.1	82.2	52.5	0.1	62.7	57.5	0.1
Level of Service	E	В	Α	E	В	A	F	D	Α	E	E	Α
Approach Delay (s)		17.8			22.6			58.1			40.4	
Approach LOS		В			C			E			D	
Intersection Summary												
HCM 2000 Control Delay			30.9	Н	CM 2000	Level of	Service		С			
HCM 2000 Volume to Capa	acity ratio		0.52									
Actuated Cycle Length (s)			140.0		um of los				12.0			
Intersection Capacity Utiliza	ation		51.0%	IC	U Level	of Service	)		Α			
Analysis Period (min)			15									
a Critical Lana Croun												

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# HCM Unsignalized Intersection Capacity Analysis 29: RCS Access & Crossroads

2/24/2015

	-	+	1	+	1	-	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	_
Lane Configurations	<b>↑</b>	7		4	W		
Volume (veh/h)	722	233	317	849	60	231	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	0.83	0.55	0.50	0.85	0.36	0.59	
Hourly flow rate (vph)	870	424	634	999	167	392	
Pedestrians	100				100		
Lane Width (ft)	12.0				12.0		
Walking Speed (ft/s)	4.0				4.0		
Percent Blockage	8				8		
Right turn flare (veh)							
Median type	None			TWLTL			
Median storage veh)				2			
Upstream signal (ft)	1275						
pX, platoon unblocked			0.85		0.85	0.85	
vC, conflicting volume			1394		3337	970	
vC1, stage 1 conf vol					970		
vC2, stage 2 conf vol					2367		
vCu, unblocked vol			1375		3660	876	
tC, single (s)			4.1		6.4	6.2	
tC, 2 stage (s)					5.4		
tF(s)			2.2		3.5	3.3	
p0 queue free %			0		0	0	
cM capacity (veh/h)			389		0	271	
Direction, Lane #	EB1	EB 2	WB 1	NB 1			
Volume Total	870	424	1633	558			
Volume Left	0	0	634	167			
Volume Right	0	424	0	392			
cSH	1700	1700	389	0			
Volume to Capacity	0.51	0.25	1.63	Err			
Queue Length 95th (ft)	0	0	926	Err			
Control Delay (s)	0.0	0.0	320.1	Err			
Lane LOS			F	F			
Approach Delay (s)	0.0		320.1	Err			
Approach LOS				F			
Intersection Summary							
Average Delay			Err				
Intersection Capacity Utiliza	ation		127.8%	IC	U Level o	f Service	Н
Analysis Period (min)			15				

HCM Unsignalized Intersection Capacity Analysis 31: Woods Ave & Crossroads

	1	-	1	1	+	1	1	1	-	-	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		र्स	7	7	<b>↑</b>	7		4			4	
Volume (veh/h)	30	861	50	29	1052	3	15	0	15	0	0	33
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.59	0.73	0.59	0.53	0.68	0.25	0.63	0.85	0.63	0.85	0.85	0.69
Hourly flow rate (vph)	51	1179	85	55	1547	12	24	0	24	0	0	48
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1559			1264			2985	2950	1179	2961	3022	1547
vC1, stage 1 conf vol							1281	1281		1656	1656	
vC2, stage 2 conf vol							1704	1668		1305	1366	
vCu, unblocked vol	1559			1264			2985	2950	1179	2961	3022	1547
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5		6.1	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	88			90			0	100	90	100	100	66
cM capacity (veh/h)	424			550			18	78	232	71	93	141
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	WB 3	NB 1	SB1					
Volume Total	1230	85	55	1547	12	48	48					
Volume Left	51	0	55	0	0	24	0					
Volume Right	0	85	0	0	12	24	48					
cSH	424	1700	550	1700	1700	33	141					
Volume to Capacity	0.12	0.05	0.10	0.91	0.01	1.46	0.34					
Queue Length 95th (ft)	10	0	8	0	0	132	35					
Control Delay (s)	6.1	0.0	12.3	0.0	0.0	506.9	43.3					
Lane LOS	Α		В			F	Е					
Approach Delay (s)	5.7		0.4			506.9	43.3					
Approach LOS						F	Е					
Intersection Summary												
Average Delay			11.4									
Intersection Capacity Utilization	on		84.6%	IC	U Level	of Service			Е			
Analysis Period (min)			15									

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# HCM Unsignalized Intersection Capacity Analysis 34: Ward Ave & Crossroads

	1	-	-	1	-	1	1	1	-	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBF
Lane Configurations	*	<b>^</b>	7	7	<b>†</b>	7	*	1		7	B	
Volume (veh/h)	18	713	32	5	1040	12	24	3	5	3	0	14
Sign Control		Free	-		Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.75	0.89	0.75	0.38	0.86	0.40	0.67	0.25	0.38	0.50	0.25	0.7
Hourly flow rate (vph)	24	801	43	13	1209	30	36	12	13	6	0	1
Pedestrians			,,,		1200				, ,		-	
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)		110110			110110							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1239			844			2103	2115	801	2104	2127	1209
vC1, stage 1 conf vol	1200			011			2100	2110	001	2101	2121	120
vC2, stage 2 conf vol												
vCu, unblocked vol	1239			844			2103	2115	801	2104	2127	1209
tC, single (s)	4.1			5.1			8.1	7.5	7.2	7.1	6.5	6.2
tC, 2 stage (s)				0.1			0.1	7.0	,	***	0.0	
tF (s)	2.2			3.1			4.4	4.9	4.2	3.5	4.0	3.3
p0 queue free %	96			97			0	53	95	72	100	92
cM capacity (veh/h)	562			494			17	25	266	21	46	223
	EB 1	EB 2	EB 3	WB 1	WB 2	WB3		NB 2	SB 1	SB 2	,,,	
Direction, Lane #							NB 1					
Volume Total	24	801	43	13	1209	30	36	25	6	19		
Volume Left	24	0	0	13	0	0	36	0	6	0		
Volume Right	0		43	0	0	30	0	13	0	19		
cSH	562	1700	1700	494	1700	1700	17	48	21	223		
Volume to Capacity	0.04	0.47	0.03	0.03	0.71	0.02	2.06	0.52 49	0.28	0.08		
Queue Length 95th (ft)	3	0	0	2	0		125		20	7		
Control Delay (s)	11.7	0.0	0.0	12.5	0.0	0.0	947.7	142.1	228.1	22.6		
Lane LOS	В			В			F	F	F	С		
Approach Delay (s)	0.3			0.1			615.3		72.6			
Approach LOS							F		F			
Intersection Summary												
Average Delay			18.0									
Intersection Capacity Utilizatio	n		69.4%	IC	U Level	of Service	1		С			
Analysis Period (min)			15									

# HCM Unsignalized Intersection Capacity Analysis 37: Walmart Entrance/Greenfield Dr & Crossroads

the fact that he was a first	
2/24/2015	а
212412015	,

	•	-	1	1		-	1	1	1	-	+	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	7	1	7	7	<b>↑</b>	7		4			4	
Volume (veh/h)	53	647	20	11	1187	9	3	0	2	9	0	29
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.80	0.70	0.65	0.58	0.75	0.38	0.50	0.85	0.25	0.50	0.85	0.43
Hourly flow rate (vph)	66	924	31	19	1583	24	6	0	8	18	0	67
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1606			955			2745	2701	924	2685	2708	1583
vC1, stage 1 conf vol							1057	1057		1621	1621	
vC2, stage 2 conf vol							1688	1644		1065	1088	
vCu, unblocked vol	1606			955			2745	2701	924	2685	2708	1583
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5		6.1	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	84			97			0	100	98	82	100	50
cM capacity (veh/h)	407			720			6	80	326	103	124	134
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB3	NB 1	SB 1				
Volume Total	66	924	31	19	1583	24	14	85				
Volume Left	66	0	0	19	0	0	6	18				
Volume Right	0	0	31	0	0	24	8	67				
cSH	407	1700	1700	720	1700	1700	13	126				
Volume to Capacity	0.16	0.54	0.02	0.03	0.93	0.01	1.11	0.68				
Queue Length 95th (ft)	14	0	0	2	0	0	60	92				
Control Delay (s)	15.6	0.0	0.0	10.1	0.0	0.0	697.2	79.6				
Lane LOS	C			В			F	F				
Approach Delay (s)	1.0			0.1			697.2	79.6				
Approach LOS							F	F				
Intersection Summary												
Average Delay			6.5									
Intersection Capacity Utilization			72.5%	IC	U Level	of Service	)		С			
Analysis Period (min)			15									

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# HCM Unsignalized Intersection Capacity Analysis 40: Crossroads & Highland Meadows Pkwy

2	DA	IDE	м	П
2	24	ZU	П	ŀ

	1	<b>→</b>	+	1	1	1	
Movement	EBL	EBT	WBT	WBR	SBL	SBR	_
Lane Configurations	7	1	•	7	7	7	
Volume (veh/h)	141	527	947	60	60	225	
Sign Control		Free	Free		Stop		
Grade		0%	0%		0%		
Peak Hour Factor	0.60	0.68	0.76	0.63	0.67	0.78	
Hourly flow rate (vph)	235	775	1246	95	90	288	
Pedestrians							
Lane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL	None				
Median storage veh)		2	74-10-2				
Upstream signal (ft)							
pX, platoon unblocked							
vC, conflicting volume	1341				2491	1246	
vC1, stage 1 conf vol					1246		
vC2, stage 2 conf vol					1245		
vCu, unblocked vol	1341				2491	1246	
tC, single (s)	4.1				6.4	6.2	
tC, 2 stage (s)					5.4		
tF(s)	2.2				3.5	3.3	
p0 queue free %	54				28	0	
cM capacity (veh/h)	514				125	212	
Direction, Lane #	EB 1	EB 2	WB 1	WB 2	SB 1	SB 2	
Volume Total	235	775	1246	95	90	288	
Volume Left	235	0	0	0	90	0	
Volume Right	0	0	0	95	0	288	
cSH	514	1700	1700	1700	125	212	
Volume to Capacity	0.46	0.46	0.73	0.06	0.72	1.36	
Queue Length 95th (ft)	59	0	0	0	100	406	
Control Delay (s)	17.8	0.0	0.0	0.0	85.5	233.6	
Lane LOS	C				F	F	
Approach Delay (s)	4.1		0.0		198.5		
Approach LOS					F		
Intersection Summary							
Average Delay			29.0				
Intersection Capacity Utiliza	ation		71.0%	IC	U Level	of Service	С
Analysis Period (min)			15				

# HCM Unsignalized Intersection Capacity Analysis 42: LCR 3 & Crossroads

2/24/2015

	-	1	1	+	1	-	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	7			4	W		
Volume (veh/h)	518	9	3	971	26	9	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	0.71	0.30	0.50	0.74	0.61	0.75	
Hourly flow rate (vph)	730	30	6	1312	43	12	
Pedestrians					1		
Lane Width (ft)					12.0		
Walking Speed (ft/s)					4.0		
Percent Blockage					0		
Right turn flare (veh)							
Median type	None			None			
Median storage veh)				0.02015			
Upstream signal (ft)							
pX, platoon unblocked							
vC, conflicting volume			761		2070	746	
vC1, stage 1 conf vol							
vC2, stage 2 conf vol							
vCu, unblocked vol			761		2070	746	
tC, single (s)			4.1		6.4	6.2	
tC, 2 stage (s)					75.0	20.77	
tF(s)			2.2		3.5	3.3	
p0 queue free %			99		28	97	
cM capacity (veh/h)			851		59	413	
Direction, Lane#	EB 1	WB 1	NB 1				
Volume Total	760	1318	55				
Volume Left	0	6	43				
Volume Right	30	0	12				
cSH	1700	851	73				
Volume to Capacity	0.45	0.01	0.75				
Queue Length 95th (ft)	0.43	1	88				
Control Delay (s)	0.0	0.3	139.4				
Lane LOS	0.0	A	F				
Approach Delay (s)	0.0	0.3	139.4				
Approach LOS	0.0	0.0	F				
Intersection Summary							
Average Delay			3.8				
Intersection Capacity Utiliza	tion		63.5%	IC	Ulevelo	of Service	В
Analysis Period (min)	uon		15	10	J LOVOI C		5

HCM Signalized Intersection Capacity Analysis 139: Centerra Pkwy/Fairgrounds & Crossroads

	1	-	7	1	+	1	1	1	-	-	ļ	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	ሻሻ	<b>^</b>	7	44	<b>^</b>	7	44	<b>^</b>	7	44	<b>^</b>	7
Volume (vph)	255	795	231	161	695	92	182	227	177	71	197	135
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frpb, ped/bikes	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.99	1.00	1.00	0.98
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3539	1561	3433	3505	1562	3433	3539	1562	3433	3539	1550
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3539	1561	3433	3505	1562	3433	3539	1562	3433	3539	1550
Peak-hour factor, PHF	0.76	0.87	0.88	0.76	0.77	0.69	0.80	0.73	0.84	0.65	0.86	0.87
Adj. Flow (vph)	336	914	262	212	903	133	228	311	211	109	229	155
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	336	914	262	212	903	133	228	311	211	109	229	155
Confl. Peds. (#/hr)	4		7	7		4	30		4	4		30
Heavy Vehicles (%)	2%	2%	2%	2%	3%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			Free			Free			Free
Actuated Green, G (s)	18.0	76.2	140.0	13.0	71.2	140.0	13.3	18.0	140.0	8.8	13.5	140.0
Effective Green, g (s)	19.0	81.2	140.0	14.0	76.2	140.0	14.3	23.0	140.0	9.8	18.5	140.0
Actuated g/C Ratio	0.14	0.58	1.00	0.10	0.54	1.00	0.10	0.16	1.00	0.07	0.13	1.00
Clearance Time (s)	4.0	8.0		4.0	8.0		4.0	8.0		4.0	8.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	465	2052	1561	343	1907	1562	350	581	1562	240	467	1550
v/s Ratio Prot	c0.10	0.26		0.06	c0.26		c0.07	c0.09		0.03	0.06	
v/s Ratio Perm			0.17			0.09			0.14			0.10
v/c Ratio	0.72	0.45	0.17	0.62	0.47	0.09	0.65	0.54	0.14	0.45	0.49	0.10
Uniform Delay, d1	58.0	16.6	0.0	60.4	19.6	0.0	60.5	53.6	0.0	62.5	56.4	0.0
Progression Factor	1.16	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.6	0.0	0.2	2.3	0.8	0.1	3.3	0.5	0.2	0.5	0.3	0.1
Delay (s)	70.8	11.7	0.2	62.8	20.4	0.1	63.7	54.1	0.2	63.0	56.7	0.1
Level of Service	E	В	Α	E	C	Α	E	D	Α	E	E	Α
Approach Delay (s)		22.8			25.5			41.9			40.3	
Approach LOS		C			C			D			D	
Intersection Summary												
HCM 2000 Control Delay			29.4	Н	CM 2000	Level of	Service		C			
HCM 2000 Volume to Capa	acity ratio		0.55									
Actuated Cycle Length (s)			140.0	S	um of los	time (s)			12.0			
Intersection Capacity Utiliza	ation		65.3%		CU Level				C			
Analysis Period (min)			15									
c Critical Lane Group												

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

# HCM Unsignalized Intersection Capacity Analysis 29: RCS Access & Crossroads

2/24/2015

	-	+	1	+	1	-	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	_
Lane Configurations	<b>↑</b>	7		4	N/		
Volume (veh/h)	824	195	132	863	114	185	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	0.94	0.46	0.59	0.82	0.83	0.57	
Hourly flow rate (vph)	877	424	224	1052	137	325	
Pedestrians	100			1	100		
Lane Width (ft)	12.0			12.0	12.0		
Walking Speed (ft/s)	4.0			4.0	4.0		
Percent Blockage	8			0	8		
Right turn flare (veh)							
Median type	None			TWLTL			
Median storage veh)	2 2 2 2 2 2 2			2			
Upstream signal (ft)	1275						
pX, platoon unblocked			0.81		0.81	0.81	
vC, conflicting volume			1401		2576	978	
vC1, stage 1 conf vol					977		
vC2, stage 2 conf vol					1600		
vCu, unblocked vol			1378		2823	858	
tC, single (s)			4.1		6.4	6.2	
tC, 2 stage (s)					5.4		
tF(s)			2.2		3.5	3.3	
p0 queue free %			40		0	0	
cM capacity (veh/h)			371		63	266	
Direction, Lane #	EB1	EB 2	WB 1	NB 1			
Volume Total	877	424	1276	462			
Volume Left	0	0	224	137			
Volume Right	0	424	0	325			
cSH	1700	1700	371	135			
Volume to Capacity	0.52	0.25	0.60	3.41			
Queue Length 95th (ft)	0	0	94	Err			
Control Delay (s)	0.0	0.0	28.4	Err			
Lane LOS			D	F			
Approach Delay (s)	0.0		28.4	Err			
Approach LOS				F			
Intersection Summary							
Average Delay			1531.9				
Intersection Capacity Utiliz	ation		123.8%	IC	U Level o	f Service	Н
Analysis Period (min)			15				

HCM Unsignalized Intersection Capacity Analysis 31: Woods Ave & Crossroads

	•	-	•	1	+	1	1	1	1	-	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		4	7	7	<b>↑</b>	7		4			4	
Volume (veh/h)	14	1037	23	5	977	0	56	0	38	2	0	27
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.56	0.83	0.42	0.25	0.88	0.85	0.54	0.85	0.57	0.25	0.85	0.90
Hourly flow rate (vph)	25	1249	55	20	1110	0	104	0	67	8	0	30
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			None							
Median storage veh)		2										
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1110			1304			2480	2450	1249	2516	2504	1110
vC1, stage 1 conf vol							1299	1299	1207	1150	1150	
vC2, stage 2 conf vol							1180	1150		1366	1354	
vCu, unblocked vol	1110			1304			2480	2450	1249	2516	2504	1110
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5		6.1	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	96			96			16	100	68	91	100	88
cM capacity (veh/h)	629			531			123	159	211	88	150	255
Direction, Lane #	EB1	EB 2	WB 1	WB 2	WB 3	NB 1	SB 1					
Volume Total	1274	55	20	1110	0	170	38					
Volume Left	25	0	20	0	0	104	8					
Volume Right	0	55	0	0	0	67	30					
cSH	629	1700	531	1700	1700	147	182					
Volume to Capacity	0.04	0.03	0.04	0.65	0.00	1.16	0.21					
Queue Length 95th (ft)	3	0	3	0	0	240	19					
Control Delay (s)	1.8	0.0	12.0	0.0	0.0	184.1	29.9					
Lane LOS	Α		В			F	D					
Approach Delay (s)	1.8		0.2			184.1	29.9					
Approach LOS						F	D					
Intersection Summary												
Average Delay			13.1									
Intersection Capacity Utilizatio	n		84.5%	IC	U Level	of Service			Е			
Analysis Period (min)			15									

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# HCM Unsignalized Intersection Capacity Analysis 34: Ward Ave & Crossroads

2/24/2015

	1	-	1	1	+	1	1	1	-	-	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	7	<b>^</b>	7	7	<b>↑</b>	7	7	F)		7	1	
Volume (veh/h)	8	975	26	6	929	3	32	0	6	11	2	9
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.62	0.84	0.71	0.50	0.81	0.25	0.58	0.85	0.50	0.88	0.25	0.50
Hourly flow rate (vph)	13	1161	37	12	1147	12	55	0	12	12	8	18
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1159			1197			2379	2369	1161	2369	2394	1147
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1159			1197			2379	2369	1161	2369	2394	1147
tC, single (s)	4.1			5.1			8.1	7.5	7.2	7.1	6.5	6.2
tC, 2 stage (s)												
tF(s)	2.2			3.1			4.4	4.9	4.2	3.5	4.0	3.3
p0 queue free %	98			96			0	100	92	42	75	93
cM capacity (veh/h)	603			341			9	17	154	21	32	242
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB3	NB 1	NB 2	SB 1	SB 2		
Volume Total	13	1161	37	12	1147	12	55	12	12	26		
Volume Left	13	0	0	12	0	0	55	0	12	0		
Volume Right	0	0	37	0	0	12	0	12	0	18		
cSH	603	1700	1700	341	1700	1700	9	154	21	80		
Volume to Capacity	0.02	0.68	0.02	0.04	0.67	0.01	6.48	0.08	0.58	0.33		
Queue Length 95th (ft)	2	0	0	3	0	0	Err	6	42	31		
Control Delay (s)	11.1	0.0	0.0	15.9	0.0	0.0	Err	30.4	309.9	70.6		
Lane LOS	В			C			F	D	F	F		
Approach Delay (s)	0.1			0.2			8218.2		148.3			
Approach LOS							F		F			
Intersection Summary												
Average Delay			224.4									
Intersection Capacity Utilization	n		66.4%	10	CU Level	of Service	е		С			
Analysis Period (min)			15									

## HCM Unsignalized Intersection Capacity Analysis

Intersection Summary
Average Delay

Intersection Capacity Utilization Analysis Period (min)

	1	-	>	-	+	1	4	1	-	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBF
Lane Configurations	ሻ	<b>†</b>	7	*	<b>†</b>	7		4			4	
Volume (veh/h)	15	854	60	101	666	5	108	0	141	12	0	62
Sign Control	10	Free		101	Free		,,,,	Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.50	0.75	0.43	0.51	0.79	0.38	0.64	0.85	0.56	0.67	0.85	0.68
Hourly flow rate (vph)	30	1139	140	198	843	13	169	0	252	18	0	9
Pedestrians		1100	1.10	,00	0,10		,,,,	4			2	
Lane Width (ft)								12.0			12.0	
Walking Speed (ft/s)								4.0			4.0	
Percent Blockage								0			0	
Right turn flare (veh)								•				
Median type		None			TWLTL							
Median storage veh)		110110			2							
Upstream signal (ft)					_							
pX, platoon unblocked												
vC, conflicting volume	858			1282			2533	2457	1143	2692	2583	845
vC1, stage 1 conf vol				1272			1203	1203		1241	1241	
vC2, stage 2 conf vol							1330	1254		1450	1342	
vCu, unblocked vol	858			1282			2533	2457	1143	2692	2583	845
tC, single (s)	4.1			4.1			7.1	6.5	6.2	7.1	6.5	6.2
tC, 2 stage (s)							6.1	5.5		6.1	5.5	
tF (s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	96			63			0	100	0	0	100	75
cM capacity (veh/h)	781			539			57	108	243	0	15	362
Direction, Lane #	EB 1	EB 2	EB3	WB 1	WB 2	WB 3	NB 1	SB 1				
Volume Total	30	1139	140	198	843	13	421	109				
Volume Left	30	0	0	198	0	0	169	18				
Volume Right	0	0	140	0	0	13	252	91				
cSH	781	1700	1700	539	1700	1700	105	0				
Volume to Capacity	0.04	0.67	0.08	0.37	0.50	0.01	4.02	Err				
Queue Length 95th (ft)	3	0	0	42	0	0	Err	Err				
Control Delay (s)	9.8	0.0	0.0	15.5	0.0	0.0	Err	Err				
Lane LOS	Α			С			F	F				
Approach Delay (s)	0.2			2.9			Err	Err				
Approach LOS							F	F				

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ICU Level of Service

Err

15

81.8%

## HCM Unsignalized Intersection Capacity Analysis 40: Crossroads & Highland Meadows Pkwy

2/24/2015

	1	-	-	1	1	1	
Movement	EBL	EBT	WBT	WBR	SBL	SBR	
Lane Configurations	7	<b>↑</b>	<b>*</b>	7	7	7	
Volume (veh/h)	156	872	624	45	57	143	
Sign Control		Free	Free		Stop		
Grade		0%	0%		0%		
Peak Hour Factor	0.87	0.90	0.87	0.44	0.63	0.64	
Hourly flow rate (vph)	179	969	717	102	90	223	
Pedestrians							
ane Width (ft)							
Walking Speed (ft/s)							
Percent Blockage							
Right turn flare (veh)							
Median type		TWLTL	None				
Median storage veh)		2					
Jpstream signal (ft)							
X, platoon unblocked							
C, conflicting volume	820				2045	717	
C1, stage 1 conf vol					717		
vC2, stage 2 conf vol					1328		
vCu, unblocked vol	820				2045	717	
C, single (s)	4.1				6.4	6.2	
C, 2 stage (s)					5.4		
F(s)	2.2				3.5	3.3	
00 queue free %	78				49	48	
cM capacity (veh/h)	809				177	429	
Direction, Lane #	EB1	EB 2	WB 1	WB 2	SB 1	SB 2	
/olume Total	179	969	717	102	90	223	
/olume Left	179	0	0	0	90	0	
Volume Right	0	0	0	102	0	223	
SH	809	1700	1700	1700	177	429	
Volume to Capacity	0.22	0.57	0.42	0.06	0.51	0.52	
Queue Length 95th (ft)	21	0	0	0	63	73	
Control Delay (s)	10.7	0.0	0.0	0.0	44.7	22.1	
ane LOS	В				Е	С	
Approach Delay (s)	1.7		0.0		28.6		
Approach LOS					D		
ntersection Summary							
Average Delay			4.8				
ntersection Capacity Utilization	1		55.9%	IC	U Level o	of Service	В
Analysis Period (min)			15				

# HCM Unsignalized Intersection Capacity Analysis 42: LCR 3 & Crossroads

2/24/2015

	-	1	1	+	1	-	
Movement	EBT	EBR	WBL	WBT	NBL	NBR	
Lane Configurations	1			4	W		
Volume (veh/h)	863	26	2	702	14	12	
Sign Control	Free			Free	Stop		
Grade	0%			0%	0%		
Peak Hour Factor	0.87	0.85	0.25	0.87	0.45	1.00	
Hourly flow rate (vph)	992	31	8	807	31	12	
Pedestrians	218			1	1		
Lane Width (ft)				12.0	12.0		
Walking Speed (ft/s)				4.0	4.0		
Percent Blockage				0	0		
Right turn flare (veh)							
Median type	None			None			
Median storage veh)	7,5,15						
Upstream signal (ft)							
pX, platoon unblocked							
vC, conflicting volume			1024		1831	1009	
vC1, stage 1 conf vol			111				
vC2, stage 2 conf vol							
vCu, unblocked vol			1024		1831	1009	
tC, single (s)			4.1		6.4	6.2	
tC, 2 stage (s)							
tF(s)			2.2		3.5	3.3	
p0 queue free %			99		62	96	
cM capacity (veh/h)			678		83	291	
Direction, Lane #	EB 1	WB 1	NB 1				
Volume Total	1023	815	43	1			
Volume Left	0	8	31				
Volume Right	31	0	12				
cSH	1700	678	103				
Volume to Capacity	0.60	0.01	0.42				
Queue Length 95th (ft)	0	1	44				
Control Delay (s)	0.0	0.3	62.7				
Lane LOS		Α	F				
Approach Delay (s)	0.0	0.3	62.7				
Approach LOS			F				
Intersection Summary							
Average Delay			1.6				
Intersection Capacity Utiliz	ation		57.3%	IC	U Level o	of Service	В
Analysis Period (min)			15				

HCM Signalized Intersection Capacity Analysis 139: Centerra Pkwy/Fairgrounds & Crossroads

c Critical Lane Group

2/24/2015

	•	-	+	1	+	1	1	1	1	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBF
Lane Configurations	ሻሻ	<b>^</b>	7	ሻሻ	<b>^</b>	7	77	<b>^</b>	7	ሻሻ	<b>^</b>	7
Volume (vph)	110	645	132	105	755	50	210	116	123	140	132	158
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.68	0.83	0.67	0.67	0.83	0.75	0.53	0.77	0.82	0.75	0.73	0.88
Adj. Flow (vph)	162	777	197	157	910	67	396	151	150	187	181	180
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	162	777	197	157	910	67	396	151	150	187	181	180
Heavy Vehicles (%)	2%	4%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			Free			Free			Free
Actuated Green, G (s)	11.0	76.7	140.0	10.8	76.5	140.0	16.8	16.5	140.0	12.0	11.7	140.0
Effective Green, g (s)	12.0	81.7	140.0	11.8	81.5	140.0	17.8	21.5	140.0	13.0	16.7	140.0
Actuated g/C Ratio	0.09	0.58	1.00	0.08	0.58	1.00	0.13	0.15	1.00	0.09	0.12	1.00
Clearance Time (s)	4.0	8.0		4.0	8.0		4.0	8.0		4.0	8.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	294	2025	1583	289	2020	1583	436	543	1583	318	422	1583
v/s Ratio Prot	c0.05	0.22		0.05	c0.26		c0.12	0.04		0.05	c0.05	
v/s Ratio Perm			c0.12			0.04			0.09			0.11
v/c Ratio	0.55	0.38	0.12	0.54	0.45	0.04	0.91	0.28	0.09	0.59	0.43	0.11
Uniform Delay, d1	61.4	15.6	0.0	61.5	16.6	0.0	60.3	52.4	0.0	60.9	57.2	0.0
Progression Factor	1.09	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	0.0	0.2	1.1	0.7	0.1	21.9	0.1	0.1	1.8	0.3	0.1
Delay (s)	68.1	11.8	0.2	62.6	17.3	0.1	82.2	52.5	0.1	62.7	57.5	0.1
Level of Service	E	В	Α	E	В	A	F	D	Α	E	E	A
Approach Delay (s)		17.8			22.6			58.1			40.4	
Approach LOS		В			С			E			D	
Intersection Summary												
HCM 2000 Control Delay			30.9	Н	CM 2000	Level of	Service		С			
HCM 2000 Volume to Capa	acity ratio		0.52									
Actuated Cycle Length (s)			140.0			t time (s)			12.0			
Intersection Capacity Utiliza	ation		51.0%	IC	U Level	of Service	)		Α			
Analysis Period (min)			15									

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# HCM Signalized Intersection Capacity Analysis 29: RCS Access & Crossroads

2/24/2015

	-	+	1	+	1	-		
Movement	EBT	EBR	WBL	WBT	NBL	NBR		
Lane Configurations	<b>^</b>	7	7	<b>^</b>	7	7		
Volume (vph)	722	233	317	849	60	231		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900		
Total Lost time (s)	8.0	8.0	8.0	8.0	8.0	8.0		
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00		
Frpb, ped/bikes	1.00	0.69	1.00	1.00	1.00	1.00		
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00		
Frt	1.00	0.85	1.00	1.00	1.00	0.85		
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00		
Satd. Flow (prot)	3471	1086	1770	3539	1770	1583		
Flt Permitted	1.00	1.00	0.13	1.00	0.95	1.00		
Satd. Flow (perm)	3471	1086	240	3539	1770	1583		
Peak-hour factor, PHF	0.83	0.55	0.50	0.85	0.36	0.59		
Adj. Flow (vph)	870	424	634	999	167	392		
RTOR Reduction (vph)	0	316	0	0	0	327		
Lane Group Flow (vph)	870	108	634	999	167	65		
Confl. Peds. (#/hr)		100	1		100			
Heavy Vehicles (%)	4%	2%	2%	2%	2%	2%		
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm		
Protected Phases	4		3	8	2			
Permitted Phases		4	8			2		
Actuated Green, G (s)	23.0	23.0	59.0	59.0	15.0	15.0		
Effective Green, g (s)	23.0	23.0	59.0	59.0	15.0	15.0		
Actuated g/C Ratio	0.26	0.26	0.66	0.66	0.17	0.17		
Clearance Time (s)	8.0	8.0	8.0	8.0	8.0	8.0		
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		
Lane Grp Cap (vph)	887	277	633	2320	295	263		
v/s Ratio Prot	0.25		c0.31	0.28	c0.09			
v/s Ratio Perm		0.10	c0.34			0.04		
v/c Ratio	0.98	0.39	1.00	0.43	0.57	0.25		
Uniform Delay, d1	33.3	27.7	24.6	7.4	34.5	32.6		
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		
Incremental Delay, d2	25.9	4.1	36.2	0.6	7.7	2.2		
Delay (s)	59.2	31.8	60.7	8.0	42.2	34.8		
Level of Service	E	С	E	Α	D	С		
Approach Delay (s)	50.2			28.5	37.0			
Approach LOS	D			C	D			
ntersection Summary								
HCM 2000 Control Delay			37.9	Н	CM 2000	Level of Service	D	
HCM 2000 Volume to Capa	acity ratio		0.95					
Actuated Cycle Length (s)			90.0	S	um of los	t time (s)	24.0	
Intersection Capacity Utiliza	ation		60.9%			of Service	В	
Analysis Period (min)			15					
Critical Lane Group								

HCM Unsignalized Intersection Capacity Analysis 31: Woods Ave & Crossroads

	•	-	+	1	+	1	1	1	1	-	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		<b>^</b>	7	7	11	7	7		7			7
Volume (veh/h)	0	891	50	29	1052	3	15	0	15	0	0	33
Sign Control		Free	7.61	G-68	Free			Stop	-		Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.59	0.73	0.59	0.53	0.68	0.25	0.63	0.85	0.63	0.85	0.85	0.69
Hourly flow rate (vph)	0	1221	85	55	1547	12	24	0	24	0	0	48
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)		633			627							
pX, platoon unblocked	0.73			0.76			0.85	0.85	0.76	0.85	0.85	0.73
vC, conflicting volume	1559			1305			2104	2889	610	2291	2962	774
vC1, stage 1 conf vol							1221	1221	-	1656	1656	
vC2, stage 2 conf vol							883	1668		634	1305	
vCu, unblocked vol	1021			784			688	1617	0	910	1703	0
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)							6.5	5.5		6.5	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			91			92	100	97	100	100	94
cM capacity (veh/h)	492			635			304	164	829	136	156	789
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB 3	WB 4	NB 1	NB 2	SB 1		
Volume Total	610	610	85	55	774	774	12	24	24	48		
Volume Left	0	0	0	55	0	0	0	24	0	0		
Volume Right	0	0	85	0	0	0	12	0	24	48		
cSH	1700	1700	1700	635	1700	1700	1700	304	829	789		
Volume to Capacity	0.36	0.36	0.05	0.09	0.46	0.46	0.01	0.08	0.03	0.06		
Queue Length 95th (ft)	0	0	0	7	0	0	0	6	2	5		
Control Delay (s)	0.0	0.0	0.0	11.2	0.0	0.0	0.0	17.8	9.5	9.9		
Lane LOS				В				C	Α	Α		
Approach Delay (s)	0.0			0.4				13.6		9.9		
Approach LOS								В		Α		
Intersection Summary												1
Average Delay			0.6									
Intersection Capacity Utilization	n		45.7%	10	CU Level	of Service			Α			
Analysis Period (min)			15									

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# HCM Signalized Intersection Capacity Analysis 34: Ward Ave & Crossroads

2/24/2015

Lane Group Flow (vph)         64         801         21         13         1209         15         36         15         0         6           Heavy Vehicles (%)         2%         2%         100%         100%         2%         2%         100%         100%         2%           Turn Type         Perm         NA         Perm         Perm         NA         Perm         NA         Perm           Protected Phases         4         4         8         8         2         6           Actuated Green, G (s)         29.0         29.0         29.0         29.0         29.0         15.0         15.0         15.0           Effective Green, g (s)         29.0         29.0         29.0         29.0         29.0         15.0         15.0         15.0           Actuated g/C Ratio         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.80         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0		1	-	-	1	+	*	1	1	-	1	1	1
Lane Configurations	lovement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBF
Volume (vph)	ane Configurations	7	**	7	7	44	7	7	f)		7	1	
Ideal Flow (vphpl)		1000								5		0	14
Lane Util. Factor		1900			1900	1900		1900	1900	1900	1900	1900	1900
Fit Protected	otal Lost time (s)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0		8.0	8.0	
Fit Protected 0.95 1.00 1.00 0.95 1.00 1.00 0.95 1.00 0.95 1.00 0.95 Satd. Flow (prot) 1770 3539 808 902 3539 1583 902 876 1770 1770 Fit Permitted 0.16 1.00 1.00 0.33 1.00 1.00 0.75 1.00 0.74 Satd. Flow (perm) 300 3539 808 315 3539 1583 708 876 1380 Peak-hour factor, PHF 0.75 0.89 0.75 0.38 0.86 0.40 0.67 0.25 0.38 0.50 Adj. Flow (vph) 64 801 43 13 1209 30 36 12 13 6 RTOR Reduction (vph) 0 0 0 22 0 0 0 16 0 10 0 0 0 0 0 0 0 0 0 0 0 0 0	ane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00		1.00	1.00	
Satd. Flow (prot)         1770         3539         808         902         3539         1583         902         876         1770           FIP Permitted         0.16         1.00         1.00         0.33         1.00         1.00         0.75         1.00         0.74           Satd. Flow (perm)         300         3539         808         315         3539         1583         708         876         1380           Peak-hour factor, PHF         0.75         0.89         0.75         0.38         0.86         0.40         0.67         0.25         0.38         0.50           Adj. Flow (vph)         64         801         43         13         1209         30         36         12         13         6           RTOR Reduction (vph)         0         0         22         0         0         16         0         10         0         0           Leave (roup Flow (vph)         64         801         21         13         1209         15         36         15         0         6           Heavy Vehicles (%)         2%         2%         100%         100%         2%         2%         100%         100%         100%         2%	rt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.92		1.00	0.85	
Fit Permitted	It Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)         300         3539         808         315         3539         1583         708         876         1380           Peak-hour factor, PHF         0.75         0.89         0.75         0.38         0.86         0.40         0.67         0.25         0.38         0.50           Adj. Flow (vph)         64         801         43         13         1209         30         36         12         13         6           RTOR Reduction (vph)         64         801         21         13         1209         15         36         15         0         6           Heavy Vehicles (%)         2%         20         100%         100%         2%         2%         100%         100%         2%         100%         100%         2%           Turn Type         Perm         NA         Perm         Perm	atd. Flow (prot)		3539		902	3539	1583		876			1583	
Peak-hour factor, PHF	Statement of the Statem	0.16	1.00	1.00	0.33	1.00	1.00	0.75	1.00		0.74	1.00	
Peak-hour factor, PHF	atd. Flow (perm)	300	3539	808	315	3539	1583	708	876		1380	1583	
Adj. Flow (vph)         64         801         43         13         1209         30         36         12         13         6           RTOR Reduction (vph)         0         0         22         0         0         16         0         10         0         0           Heavy Vehicles (%)         2%         2%         100%         100%         2%         2%         100%         100%         20         2%         100% <td< td=""><td></td><td>0.75</td><td>0.89</td><td>0.75</td><td>0.38</td><td>0.86</td><td>0.40</td><td>0.67</td><td>0.25</td><td>0.38</td><td>0.50</td><td>0.25</td><td>0.75</td></td<>		0.75	0.89	0.75	0.38	0.86	0.40	0.67	0.25	0.38	0.50	0.25	0.75
RTOR Reduction (vph)         0         0         22         0         0         16         0         10         0         0           Lane Group Flow (vph)         64         801         21         13         1209         15         36         15         0         6           Heavy Vehicles (%)         2%         2%         100%         100%         2%         2%         100%         100%         2%         2%         100%         100%         2%         2%         100%         100%         2%         2%         100%         100%         2%         2%         100%         100%         2%         2%         100%         100%         2%         2%         100%         100%         2%         2%         100%         100%         2%         2%         100%         100%         2%         2%         100%         2%         100%         100%         15.0         15.0         15.0         15.0         15.0         15.0												0	19
Lane Group Flow (vph)         64         801         21         13         1209         15         36         15         0         6           Heavy Vehicles (%)         2%         2%         100%         100%         2%         2%         100%         100%         2%           Turn Type         Perm         NA         Perm         Perm         NA         Perm         NA         Perm           Protected Phases         4         4         8         8         2         6           Actuated Green, G (s)         29.0         29.0         29.0         29.0         29.0         15.0         15.0         15.0           Effective Green, g (s)         29.0         29.0         29.0         29.0         29.0         15.0         15.0         15.0           Actuated g/C Ratio         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.80         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0         8.0	TOR Reduction (vph)										-	14	0
Heavy Vehicles (%)												5	0
Turn Type												2%	2%
Protected Phases         4         8         2           Permitted Phases         4         4         8         8         2         6           Actuated Green, G (s)         29.0         29.0         29.0         29.0         29.0         15.0         15.0         15.0           Effective Green, g (s)         29.0         29.0         29.0         29.0         29.0         15.0         15.0         15.0           Actuated g/C Ratio         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.25         0.25         0.25           Clearance Time (s)         8.0 <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>NA</td><td></td></td<>												NA	
Permitted Phases         4         4         8         8         2         6           Actuated Green, G (s)         29.0         29.0         29.0         29.0         29.0         15.0         15.0         15.0           Effective Green, g (s)         29.0         29.0         29.0         29.0         29.0         29.0         15.0         15.0         15.0           Actuated g/C Ratio         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.25         0.25         0.25           Clearance Time (s)         8.0<					3, 2,,,,		2 21111					6	
Actuated Green, G (s)		4		4	8		8	2			6		
Effective Green, g (s)         29.0         29.0         29.0         29.0         29.0         29.0         29.0         15.0         15.0         15.0           Actuated g/C Ratio         0.48         0.48         0.48         0.48         0.48         0.48         0.48         0.25         0.25         0.25           Clearance Time (s)         8.0 </td <td></td> <td></td> <td>29.0</td> <td></td> <td></td> <td>29.0</td> <td></td> <td></td> <td>15.0</td> <td></td> <td></td> <td>15.0</td> <td></td>			29.0			29.0			15.0			15.0	
Actuated g/C Ratio 0.48 0.48 0.48 0.48 0.48 0.48 0.25 0.25 0.25 Clearance Time (s) 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0 8.0												15.0	
Clearance Time (s)         8.0			- A - A - A - A - A - A - A - A - A - A									0.25	
Vehicle Extension (s)         3.0         3.5         2.0         3.4         2.0         3.0         3.1         3.0         3.1         3.0         3.0							8.0					8.0	
Lane Grp Cap (vph)         145         1710         390         152         1710         765         177         219         345           v/s Ratio Prot         0.23         c0.34         0.02         0.02         0.00         1.00         1.00 </td <td></td> <td>3.0</td> <td></td>												3.0	
v/s Ratio Prot         0.23         c0.34         0.02           v/s Ratio Perm         0.21         0.03         0.04         0.01         c0.05         0.00           v/c Ratio         0.44         0.47         0.05         0.09         0.71         0.02         0.20         0.07         0.02           Uniform Delay, d1         10.2         10.4         8.2         8.4         12.2         8.1         17.8         17.2         16.9           Progression Factor         1.00		145	1710	390	152	1710	765	177	219		345	395	
v/s Ratio Perm         0.21         0.03         0.04         0.01         c0.05         0.00           v/c Ratio         0.44         0.47         0.05         0.09         0.71         0.02         0.20         0.07         0.02           Uniform Delay, d1         10.2         10.4         8.2         8.4         12.2         8.1         17.8         17.2         16.9           Progression Factor         1.00												0.00	
v/c Ratio         0.44         0.47         0.05         0.09         0.71         0.02         0.20         0.07         0.02           Uniform Delay, d1         10.2         10.4         8.2         8.4         12.2         8.1         17.8         17.2         16.9           Progression Factor         1.00 <t< td=""><td></td><td>0.21</td><td></td><td>0.03</td><td>0.04</td><td>1000</td><td>0.01</td><td>c0.05</td><td></td><td></td><td>0.00</td><td></td><td></td></t<>		0.21		0.03	0.04	1000	0.01	c0.05			0.00		
Uniform Delay, d1 10.2 10.4 8.2 8.4 12.2 8.1 17.8 17.2 16.9 Progression Factor 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0	told segregation and desired		0.47			0.71		2.404.5	0.07			0.01	
Progression Factor         1.00 <td></td> <td>16.9</td> <td></td>												16.9	
Incremental Delay, d2												1.00	
Delay (s)         19.6         11.3         8.5         9.5         14.7         8.1         20.4         17.8         17.0           Level of Service         B         B         A         A         B         A         C         B         B           Approach Delay (s)         11.7         14.4         19.3           Approach LOS         B         B         B           Intersection Summary         B         B         B           HCM 2000 Control Delay         13.5         HCM 2000 Level of Service         B           HCM 2000 Volume to Capacity ratio         0.54           Actuated Cycle Length (s)         60.0         Sum of lost time (s)         16.0							0.0	2.6				0.1	
Level of Service         B         B         A         A         B         A         C         B         B           Approach Delay (s)         11.7         14.4         19.3           Approach LOS         B         B         B           Intersection Summary         B         B         B           HCM 2000 Control Delay         13.5         HCM 2000 Level of Service         B           HCM 2000 Volume to Capacity ratio         0.54         Actuated Cycle Length (s)         50.0         Sum of lost time (s)         16.0												17.0	
Approach Delay (s)         11.7         14.4         19.3           Approach LOS         B         B         B           Intersection Summary           HCM 2000 Control Delay         13.5         HCM 2000 Level of Service         B           HCM 2000 Volume to Capacity ratio         0.54           Actuated Cycle Length (s)         60.0         Sum of lost time (s)         16.0												В	
Approach LOS         B         B         B           Intersection Summary           HCM 2000 Control Delay         13.5         HCM 2000 Level of Service         B           HCM 2000 Volume to Capacity ratio         0.54           Actuated Cycle Length (s)         60.0         Sum of lost time (s)         16.0	THE REAL PROPERTY AND ADDRESS OF THE PERSON NAMED IN COLUMN TWO PERSONS AND ADDRESS OF THE PERSON NAMED IN COLUMN TWO PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO PERSON NAMED IN COLUMN TRANSPORT NAMED IN COLUMN TWO PERSON NAMED I					14.4						17.0	
HCM 2000 Control Delay 13.5 HCM 2000 Level of Service B HCM 2000 Volume to Capacity ratio 0.54 Actuated Cycle Length (s) 60.0 Sum of lost time (s) 16.0												В	
HCM 2000 Volume to Capacity ratio 0.54 Actuated Cycle Length (s) 60.0 Sum of lost time (s) 16.0													
Actuated Cycle Length (s) 60.0 Sum of lost time (s) 16.0					Н	CM 2000	Level of	Service		В			
	CM 2000 Volume to Capa	city ratio											
	ctuated Cycle Length (s)			60.0	S	um of los	t time (s)			16.0			
Intersection Capacity Utilization 60.1% ICU Level of Service B Analysis Period (min) 15		ation			IC	U Level	of Service			В			

c Critical Lane Group

HCM Unsignalized Intersection Capacity Analysis 37: Walmart Entrance/Greenfield Dr & Crossroads

	•	-	7	1	+		1	1	-	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		<b>^</b>	7	7	<b>^</b>	7	ħ		7			7
Volume (veh/h)	0	700	20	11	1187	9	3	0	2	0	0	29
Sign Control		Free	1000		Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.80	0.70	0.65	0.58	0.75	0.38	0.50	0.85	0.25	0.50	0.85	0.43
Hourly flow rate (vph)	0	1000	31	19	1583	24	6	0	8	0	0	67
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			TWLTL							
Median storage veh)		2			2							
Upstream signal (ft)		810										
pX, platoon unblocked				0.86			0.86	0.86	0.86	0.86	0.86	
vC, conflicting volume	1606			1000			1829	2644	500	2129	2621	791
vC1, stage 1 conf vol							1000	1000		1621	1621	
vC2, stage 2 conf vol							829	1644		508	1000	
vCu, unblocked vol	1606			680			1642	2587	99	1989	2560	791
tC, single (s)	4.1			4.1			*5.8	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)							4.8	5.5		6.5	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			98			98	100	99	100	100	80
cM capacity (veh/h)	403			783			309	137	807	102	140	332
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB3	WB 4	NB 1	NB 2	SB 1		
Volume Total	500	500	31	19	791	791	24	6	8	67	-	
Volume Left	0	0	0	19	0	0	0	6	0	0		
Volume Right	0	0	31	0	0	0	24	0	8	67		
cSH	1700	1700	1700	783	1700	1700	1700	309	807	332		
Volume to Capacity	0.29	0.29	0.02	0.02	0.47	0.47	0.01	0.02	0.01	0.20		
Queue Length 95th (ft)	0	0	0	2	0	0	0	1	1	19		
Control Delay (s)	0.0	0.0	0.0	9.7	0.0	0.0	0.0	16.9	9.5	18.6		
Lane LOS	2000			Α				С	Α	С		
Approach Delay (s)	0.0			0.1				12.7		18.6		
Approach LOS								В		C		
Intersection Summary												1
Average Delay			0.6									
Intersection Capacity Utilization			49.5%	IC	U Level	of Service			Α			
Analysis Period (min)			15									
And the second of the second o												

<sup>\*</sup> User Entered Value

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### HCM 2010 Roundabout 40: Crossroads & Highland Meadows Pkwy

2/24/2015

Intersection							
Intersection Delay, s/veh	11.8						
Intersection LOS	В						
Approach		EB		WB		SB	
Entry Lanes		2		2		2	
Conflicting Circle Lanes		2		2		2	
Adj Approach Flow, veh/h		1085		1341		391	
Demand Flow Rate, veh/h		1106		1368		399	
Vehicles Circulating, veh/h		105		329		1271	
Vehicles Exiting, veh/h		1565		882		426	
Follow-Up Headway, s		2.535		2.535		2.667	
Ped Vol Crossing Leg, #/h		0		0		0	
Ped Cap Adj		1.000		1.000		1.000	
Approach Delay, s/veh		7,1		13.1		20.5	
Approach LOS		Α		В		С	
Lane	Left	Right	Left	Right	Left	Right	
Designated Moves	LT	TR	LT	TR	L	TR	
Assumed Moves	LT	TR	LT	TR	L	TR	
RT Channelized							
_ane Util	0.470	0.530	0.470	0.530	0.263	0.737	
Critical Headway, s	4.544	4.544	4.544	4.544	4.645	4.328	
Entry Flow, veh/h	520	586	643	725	105	294	
Cap Entry Lane, veh/h	1291	1291	1053	1053	419	469	
Entry HV Adj Factor	0.980	0.981	0.980	0.980	0.981	0.980	
Flow Entry, veh/h	510	575	630	711	103	288	
Cap Entry, veh/h	1265	1266	1032	1032	411	459	
V/C Ratio	0.403	0.454	0.611	0.689	0.250	0.627	
Control Delay, s/veh	6.8	7.5	11.9	14.3	12.9	23.2	
LOS	Α	Α	В	В	В	C	
95th %tile Queue, veh	2	2	4	6	1	4	

## Option 1 AM

## HCM 2010 Roundabout 42: LCR 3 & Crossroads

2/24/2015

Intersection							
Intersection Delay, s/veh	6.7						
Intersection LOS	Α						
Approach		EB		WB		NB	
Entry Lanes		2		2		1	
Conflicting Circle Lanes		2		2		2	
Adj Approach Flow, veh/h		760		1318		55	
Demand Flow Rate, veh/h		776		1344		56	
Vehicles Circulating, veh/h		6		44		745	
Vehicles Exiting, veh/h		1382		757		37	
Follow-Up Headway, s		2.535		2.535		2.535	
Ped Vol Crossing Leg, #/h		0		0		1	
Ped Cap Adj		1.000		1.000		1.000	
Approach Delay, s/veh		5.0		7.8		5.6	
Approach LOS		Α		Α		Α	
Lane	Left	Right	Left	Right	Left		
Designated Moves	LT	TR	LT	TR	LR		
Assumed Moves	LT	TR	LT	TR	LR		
RT Channelized							
Lane Util	0.470	0.530	0.470	0.530	1.000		
Critical Headway, s	4.544	4.544	4.544	4.544	4.328		
Entry Flow, veh/h	365	411	632	712	56		
Cap Entry Lane, veh/h	1412	1412	1364	1364	754		
Entry HV Adj Factor	0.979	0.981	0.980	0.981	0.982		
Flow Entry, veh/h	357	403	619	698	55		
Cap Entry, veh/h	1383	1385	1337	1338	740		
V/C Ratio	0.258	0.291	0.463	0.522	0.074		
		F 4	7.3	8.2	5.6		
Control Delay, s/veh	4.8	5.1	1.3	0.2	0.0		
Control Delay, s/veh LOS	4.8 A	5.1 A	7.5 A	Α.2	A.		



HCM Signalized Intersection Capacity Analysis 139: Centerra Pkwy/Fairgrounds & Crossroads

c Critical Lane Group

2/24/2015

	•	+	*	1	+	1	1	1	-	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	ሻሻ	<b>^</b>	7	77	<b>^</b>	7	44	1	7	ሻሻ	<b>^</b>	7
Volume (vph)	255	795	231	161	695	92	182	227	177	71	197	135
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.76	0.87	0.88	0.76	0.77	0.69	0.80	0.73	0.84	0.65	0.86	0.87
Adj. Flow (vph)	336	914	262	212	903	133	228	311	211	109	229	155
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	336	914	262	212	903	133	228	311	211	109	229	155
Heavy Vehicles (%)	2%	4%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free
Protected Phases	1	6	1155	5	2		7	4	4.415.6	3	8	0.050
Permitted Phases			Free			Free			Free			Free
Actuated Green, G (s)	18.0	76.2	140.0	13.0	71.2	140.0	13.3	18.0	140.0	8.8	13.5	140.0
Effective Green, g (s)	19.0	81.2	140.0	14.0	76.2	140.0	14.3	23.0	140.0	9.8	18.5	140.0
Actuated g/C Ratio	0.14	0.58	1.00	0.10	0.54	1.00	0.10	0.16	1.00	0.07	0.13	1.00
Clearance Time (s)	4.0	8.0		4.0	8.0		4.0	8.0		4.0	8.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	465	2013	1583	343	1889	1583	350	581	1583	240	467	1583
v/s Ratio Prot	c0.10	0.26		0.06	c0.26		c0.07	c0.09		0.03	0.06	
v/s Ratio Perm			0.17			0.08			0.13			0.10
v/c Ratio	0.72	0.45	0.17	0.62	0.48	0.08	0.65	0.54	0.13	0.45	0.49	0.10
Uniform Delay, d1	58.0	16.8	0.0	60.4	19.6	0.0	60.5	53.6	0.0	62.5	56.4	0.0
Progression Factor	1.17	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.6	0.0	0.2	2.3	0.9	0.1	3.3	0.5	0.2	0.5	0.3	0.1
Delay (s)	71.2	11.8	0.2	62.8	20.5	0.1	63.7	54.1	0.2	63.0	56.7	0.1
Level of Service	E	В	Α	E	C	A	E	D	Α	E	E	A
Approach Delay (s)		23.0			25.5			41.9			40.3	
Approach LOS		C			C			D			D	
Intersection Summary												
HCM 2000 Control Delay			29.4	Н	CM 2000	Level of	Service		С			
HCM 2000 Volume to Capa	acity ratio		0.55									
Actuated Cycle Length (s)			140.0	S	um of los	t time (s)			12.0			
Intersection Capacity Utiliza	ation		51.8%	IC	U Level	of Service	)		Α			
Analysis Period (min)			15									
a Critical Lana Craun												

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# HCM Signalized Intersection Capacity Analysis 29: RCS Access & Crossroads

2/24/2015

	-	+	1	-	1	-		
Movement	EBT	EBR	WBL	WBT	NBL	NBR		
Lane Configurations	<b>^</b>	7	7	<b>^</b>	7	7		
Volume (vph)	824	195	132	863	114	185		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900		
Total Lost time (s)	8.0	8.0	8.0	8.0	8.0	8.0		
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00		
Frpb, ped/bikes	1.00	0.78	1.00	1.00	1.00	1.00		
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00		
Frt	1.00	0.85	1.00	1.00	1.00	0.85		
FIt Protected	1.00	1.00	0.95	1.00	0.95	1.00		
Satd. Flow (prot)	3471	1241	1770	3539	1770	1583		
FIt Permitted	1.00	1.00	0.16	1.00	0.95	1.00		
Satd. Flow (perm)	3471	1241	298	3539	1770	1583		
Peak-hour factor, PHF	0.94	0.46	0.59	0.82	0.83	0.57		
Adj. Flow (vph)	877	424	224	1052	137	325		
RTOR Reduction (vph)	0	304	0	0	0	159		
Lane Group Flow (vph)	877	120	224	1052	137	166		
Confl. Peds. (#/hr)		100	1		100			
Heavy Vehicles (%)	4%	2%	2%	2%	2%	2%		
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm		_
Protected Phases	4		3	8	2			
Permitted Phases		4	8			2		
Actuated Green, G (s)	17.0	17.0	29.0	29.0	15.0	15.0		
Effective Green, g (s)	17.0	17.0	29.0	29.0	15.0	15.0		
Actuated g/C Ratio	0.28	0.28	0.48	0.48	0.25	0.25		
Clearance Time (s)	8.0	8.0	8.0	8.0	8.0	8.0		
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		
Lane Grp Cap (vph)	983	351	242	1710	442	395		_
v/s Ratio Prot	0.25		0.06	c0.30	0.08			
v/s Ratio Perm		0.10	c0.39			c0.10		
v/c Ratio	0.89	0.34	0.93	0.62	0.31	0.42		
Uniform Delay, d1	20.6	17.1	13.0	11.4	18.3	18.9		
Progression Factor	1.00	1.00	2.07	1.15	1.00	1.00		
Incremental Delay, d2	12.1	2.6	33.6	1.4	1.8	3.3		
Delay (s)	32.7	19.7	60.6	14.5	20.1	22.1		
Level of Service	C	В	Е	В	С	С		
Approach Delay (s)	28.5			22.6	21.5			
Approach LOS	C			C	С			
Intersection Summary								
HCM 2000 Control Delay			25.0	H	CM 2000	Level of Service	C	
HCM 2000 Volume to Capa	city ratio		0.84					
Actuated Cycle Length (s)			60.0	St	um of lost	t time (s)	24.0	
Intersection Capacity Utiliza	ation		56.4%			of Service	В	
Analysis Period (min)			15					
c Critical Lane Group								

HCM Unsignalized Intersection Capacity Analysis 31: Woods Ave & Crossroads

Lane Configurations		•	-	7	1	+	1	1	1	-	-	1	1
Volume (veh/h)         0         1051         23         5         977         0         56         0         38         0         0           Sign Control         Free         Free         Stop         0% <td< th=""><th>Movement</th><th>EBL</th><th>EBT</th><th>EBR</th><th>WBL</th><th>WBT</th><th>WBR</th><th>NBL</th><th>NBT</th><th>NBR</th><th>SBL</th><th>SBT</th><th>SBR</th></td<>	Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (veh/h)	Lane Configurations		<b>^</b>	7	7	<b>^</b>	7	7		7			7
Sign Control   Free	Volume (veh/h)	0		23				56	0	38	0	0	27
Grade 0,% 0,% 0,% 0,% 0,% 0,% 0,% 0,% 0,% 0,%			Free			Free			Stop			Stop	
Hourly flow rate (vph)	Grade		0%			0%						0%	
Pedestrians   Lane Width (ff)	Peak Hour Factor	0.56	0.83	0.42	0.25	0.88	0.85	0.54	0.85	0.57	0.25	0.85	0.90
Lane Width (ft) Walking Speed (ft/s) Percent Blockage Right turn flare (veh) Median storage veh) Upstream signal (ft)	Hourly flow rate (vph)	0	1266	55	20	1110	0	104	0	67	0	0	30
Walking Speed (ft/s) Percent Blookage Right turn flare (veh) Median storage veh) Upstream signal (ft) Sp., platon unblocked VC, conflicting volume 1110 1321 1861 2416 633 1850 2471 VC1, stage 1 conf vol VC2, stage 2 conf vol VC2, stage 2 conf vol VC3, stage 2 conf vol VC4, unblocked vol 595 1150 700 1321 VC1, stage 1 conf vol VC2, stage 2 conf vol VC3, stage 2 conf vol VC4, unblocked vol 595 1150 700 1321 VC1, stage 1 conf vol VC2, stage 2 conf vol VC3, stage 2 conf vol VC4, unblocked vol 513 808 501 1134 0 488 1196 1170 1180 1180 1180 1180 1180 1180 1180	Pedestrians												
Percent Blockage         Right turn flare (veh)           Median type         None         TWLTL           Median storage veh)         2           Upstream signal (ft)         633         627           pX, platoon unblocked         0.76         0.77         0.88         0.88         0.77         0.88         0.88           vC, conflicting volume         1110         1321         1861         2416         633         1850         2471           vC1, stage 1 conf vol         1266         1266         226         1150         1150         vC2, stage 2 conf vol         595         1150         700         1321           vC2, stage 2 conf vol         595         1150         700         1321         146         633         1850         2471           vC1, stage (s)         4.1         4.1         7.5         6.5         6.9         7.5         6.5           tC, 2 stage (s)         4.1         4.1         7.5         6.5         6.9         7.5         6.5           tC, 2 stage (s)         2.2         2.2         2.2         3.5         4.0         3.3         3.5         4.0           tC, single (s)         2.2         2.2         2.2	Lane Width (ft)												
Right turn flare (veh)   Median type   None   TWLTL   Median storage veh   2   2   2   3   5   4   0   3   3   5   5   5   5   5   5   5   5	Walking Speed (ft/s)												
Median type         None         TWLTL           Median storage veh)         2           Upstream signal (ft)         633           pX, platoon unblocked         0.76           0.77         0.88         0.88         0.77         0.88         0.88         0.88           vC, conflicting volume         1110         1321         1861         2416         633         1850         2471           vC1, stage 1 conf vol         1266         1266         1150         700         1321           vC2, stage 2 conf vol         595         11150         700         1321           vC2, stage 2 conf vol         595         1150         700         1321           vC1, stage 2 conf vol         4.1         7.5         6.5         6.9         7.5         6.5           tC2, stage (s)         4.1         4.1         7.5         6.5         6.9         7.5         6.5           tC, 2 stage (s)         6.5         5.5         6.5         5.5         6.5         5.5         6.5         5.5           tC, 2 stage (s)         6.6         9.7         6.6         4.0         3.3         3.5         4.0         3.3         3.5         4.0         3.3	Percent Blockage												
Median storage veh   2   Upstream signal (ft)   633   627	Right turn flare (veh)												
Median storage veh   2   Upstream signal (ft)   633   627	Median type		None			TWLTL							
Upstream signal (ft) pX, platoon unblocked 0.76 0.77 0.88 0.88 0.87 0.77 0.88 0.88 vC, conflicting volume 1110 1321 1861 2416 633 1850 2471 vC1, stage 1 conf vol 1266 1266 1266 1150 1150 vC2, stage 2 conf vol 595 1150 700 1321 vCu, unblocked vol 513 808 501 1134 0 488 1196 tC, single (s) 4.1 4.1 7.5 6.5 6.5 6.9 7.5 6.5 tC, 2 stage (s) 6.5 5.5 6.5 5.5 tF (s) 2.2 2.2 3.5 4.0 3.3 3.5 4.0 p0 queue free % 100 97 6.4 100 92 100 100 cM capacity (veh/h) 797 623 288 279 831 342 253 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0						2							
vC, conflicting volume         1110         1321         1861         2416         633         1850         2471           vC1, stage 1 conf vol         1266         1266         1150         1150         vC2, stage 2 conf vol         595         1150         700         1321           vCu, unblocked vol         513         808         501         1134         0         488         1196           tC, single (s)         4.1         4.1         7.5         6.5         6.9         7.5         6.5         5.5         6.5         5.5           tC, 2 stage (s)         6.5         5.5         6.5         5.5         6.5         5.5         6.5         5.5           tF (s)         2.2         2.2         2.2         3.5         4.0         3.3         3.5         4.0           p0 queue free %         100         97         64         100         92         100         100           cM capacity (veh/h)         797         623         288         279         831         342         253           Direction, Lane #         EB1         EB2         EB3         WB1         WB2         WB3         WB4         NB1         NB2         SB1			633			627							
vC, conflicting volume         1110         1321         1861         2416         633         1850         2471           vC1, stage 1 conf vol         1266         1266         1150         1150         vC2, stage 2 conf vol         595         1150         700         1321           vCu, unblocked vol         513         808         501         1134         0         488         1196           tC, single (s)         4.1         4.1         7.5         6.5         6.9         7.5         6.5         5.5         6.5         5.5         16.5         5.5         6.5	pX, platoon unblocked	0.76			0.77			0.88	0.88	0.77	0.88	0.88	0.76
vC1, stage 1 conf vol vC2, stage 2 conf vol vC3, stage 2 conf vol vC4, unblocked vol 513 808 501 1134 0 488 1196 tC, single (s) 4.1 4.1 7.5 6.5 6.9 7.5 6.5 tC, 2 stage (s) 6.5 5.5 6.5 5.5 6.5 5.5 tC, 2 stage (s) 6.5 5.5 6.5 5.5 6.5 5.5 tC, 2 stage (s) 6.5 5.5 6.5 5.5 6.5 5.5 5.5 6.5 5.5 5.5		1110			1321			1861	2416	633	1850	2471	555
vCu, unblocked vol         513         808         501         1134         0         488         1196           tC, single (s)         4.1         4.1         7.5         6.5         6.9         7.5         6.5           tC, 2 stage (s)         6.5         5.5         6.5         5.5         6.5         5.5           tF (s)         2.2         2.2         2.2         3.5         4.0         3.3         3.5         4.0           p0 queue free %         100         97         64         100         92         100         100           cM capacity (veh/h)         797         623         288         279         831         342         253           Direction, Lane #         EB1         EB2         EB3         WB1         WB2         WB3         WB4         NB1         NB2         SB1           Volume Total         633         633         55         20         555         555         0         104         67         30           Volume Left         0         0         0         2         0         0         0         0         0         0         0         0         0         0         0         0 <td></td> <td></td> <td></td> <td></td> <td>100000</td> <td></td> <td></td> <td>1266</td> <td>1266</td> <td></td> <td>1150</td> <td>1150</td> <td></td>					100000			1266	1266		1150	1150	
tC, single (s) 4.1 4.1 7.5 6.5 6.9 7.5 6.5 tC, 2 stage (s) 6.5 5.5 6.5 5.5 tF (s) 2.2 2.2 3.5 4.0 3.3 3.5 4.0 p0 queue free % 100 97 64 100 92 100 100 cM capacity (veh/h) 797 623 288 279 831 342 253     Direction, Lane # EB 1 EB 2 EB 3 WB 1 WB 2 WB 3 WB 4 NB 1 NB 2 SB 1								595	1150		700	1321	
tc, 2 stage (s)  tc, 2 stage (s)  2.2  2.2  3.5  4.0  3.3  3.5  4.0  p0 queue free %  100  97  64  100  92  100  100  cM capacity (veh/h)  797  623  288  279  831  342  253   Direction, Lane #  EB 1  EB 2  EB 3  WB 1  WB 2  WB 3  WB 4  NB 1  NB 2  SB 1  Volume Total  Volume Total  633  633  55  20  555  555  0  104  67  30  Volume Left  0  0  0  0  0  0  0  0  0  0  0  0  0	vCu, unblocked vol	513			808			501	1134	0	488	1196	0
tF(s) 2.2 2.2 3.5 4.0 3.3 3.5 4.0 p0 queue free % 100 97 64 100 92 100 100 cM capacity (veh/h) 797 623 288 279 831 342 253 288 279 831 342 253 288 279 831 342 253 288 279 831 342 253 288 279 831 342 253 288 279 831 342 253 288 279 831 342 253 288 279 831 342 253 288 279 831 342 253 288 279 831 342 253 288 279 831 342 253 288 279 283 288 279 2831 342 253 288 279 2831 342 253 288 279 2831 342 253 288 279 2831 342 253 288 279 2831 342 253 288 279 2831 342 253 288 279 2831 282 253 2831 282 253 2531 282 253 2831 282 253 251 2512 2512 2512 2512 2512 2512	tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tF (s)       2.2       2.2       3.5       4.0       3.3       3.5       4.0         p0 queue free %       100       97       64       100       92       100       100         cM capacity (veh/h)       797       623       288       279       831       342       253         Direction, Lane #       EB 1       EB 2       EB 3       WB 1       WB 2       WB 3       WB 4       NB 1       NB 2       SB 1         Volume Total       633       633       55       20       555       555       0       104       67       30         Volume Left       0       0       0       20       0       0       0       0       0         Volume Right       0       0       55       0       0       0       0       67       30         cSH       1700       1700       1700       623       1700       1700       288       831       824         Volume to Capacity       0.37       0.37       0.03       0.03       0.33       0.33       0.00       0.36       0.08       0.04         Queue Length 95th (ft)       0       0       0	tC, 2 stage (s)							6.5	5.5		6.5	5.5	
cM capacity (veh/h)         797         623         288         279         831         342         253           Direction, Lane #         EB 1         EB 2         EB 3         WB 1         WB 2         WB 3         WB 4         NB 1         NB 2         SB 1           Volume Total         633         633         55         20         555         555         0         104         67         30           Volume Left         0         0         0         20         0         0         0         104         0         0           Volume Right         0         0         55         0         0         0         0         67         30           cSH         1700         1700         1700         1700         1700         1700         1700         288         831         824           Volume to Capacity         0.37         0.37         0.03         0.03         0.33         0.33         0.00         0.36         0.08         0.04           Queue Length 95th (ft)         0         0         0         0         0         0         0         0         0         0         0         0         0         0		2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
cM capacity (veh/h)         797         623         288         279         831         342         253           Direction, Lane #         EB 1         EB 2         EB 3         WB 1         WB 2         WB 3         WB 4         NB 1         NB 2         SB 1           Volume Total         633         633         55         20         555         555         0         104         67         30           Volume Left         0         0         0         20         0         0         0         104         0         0           Volume Right         0         0         55         0         0         0         0         67         30           cSH         1700         1700         1700         1700         1700         1700         1700         288         831         824           Volume to Capacity         0.37         0.37         0.03         0.03         0.33         0.33         0.00         0.36         0.08         0.04           Queue Length 95th (ft)         0         0         0         0         0         0         0         0         0         0         0         0         0         0	p0 queue free %	100			97			64	100	92	100	100	96
Volume Total         633         633         55         20         555         555         0         104         67         30           Volume Left         0         0         0         20         0         0         0         104         0         0           Volume Right         0         0         55         0         0         0         0         67         30           cSH         1700         1700         1700         1700         1700         1700         288         831         824           Volume to Capacity         0.37         0.37         0.03         0.03         0.33         0.33         0.00         0.36         0.08         0.04           Queue Length 95th (ft)         0         0         0         2         0		797			623			288	279	831	342	253	824
Volume Left         0         0         0         20         0         0         104         0         0           Volume Right         0         0         55         0         0         0         0         67         30           cSH         1700         1700         1700         1700         1700         288         831         824           Volume to Capacity         0.37         0.37         0.03         0.03         0.33         0.03         0.06         0.08         0.04           Queue Length 95th (ft)         0         0         0         2         0	Direction, Lane #	EB1	EB 2	EB 3	WB 1	WB 2	WB 3	WB 4	NB 1	NB 2	SB 1		
Volume Right         0         0         55         0         0         0         0         67         30           cSH         1700         1700         1700         623         1700         1700         288         831         824           Volume to Capacity         0.37         0.37         0.03         0.03         0.33         0.33         0.00         0.36         0.08         0.04           Queue Length 95th (ft)         0         0         0         2         0         0         0         0.0 </td <td>Volume Total</td> <td>633</td> <td>633</td> <td>55</td> <td>20</td> <td>555</td> <td>555</td> <td>0</td> <td>104</td> <td>67</td> <td>30</td> <td></td> <td></td>	Volume Total	633	633	55	20	555	555	0	104	67	30		
Volume Right         0         0         55         0         0         0         0         67         30           cSH         1700         1700         1700         623         1700         1700         288         831         824           Volume to Capacity         0.37         0.37         0.03         0.03         0.33         0.33         0.00         0.36         0.08         0.04           Queue Length 95th (ft)         0         0         0         2         0         0         0         0.0 </td <td>Volume Left</td> <td>0</td> <td>0</td> <td>0</td> <td></td> <td>0</td> <td>0</td> <td></td> <td>104</td> <td>0</td> <td></td> <td></td> <td></td>	Volume Left	0	0	0		0	0		104	0			
cSH         1700         1700         1700         623         1700         1700         1700         288         831         824           Volume to Capacity         0.37         0.37         0.03         0.03         0.33         0.33         0.00         0.36         0.08         0.04           Queue Length 95th (ft)         0         0         0         2         0         0         0         40         7         3           Control Delay (s)         0.0         0.0         0.0         11.0         0.0         0.0         0.0         24.4         9.7         9.5           Lane LOS         B         C         A         A           Approach Delay (s)         0.0         0.2         18.7         9.5           Approach LOS         C         A         A    Intersection Summary  Average Delay  1.4  Intersection Capacity Utilization  43.7%  ICU Level of Service  A	Volume Right			55		0	0	0			30		
Volume to Capacity         0.37         0.37         0.03         0.03         0.33         0.33         0.00         0.36         0.08         0.04           Queue Length 95th (ft)         0         0         0         2         0         0         0         40         7         3           Control Delay (s)         0.0         0.0         0.0         0.0         0.0         24.4         9.7         9.5           Lane LOS         B         C         A         A           Approach Delay (s)         0.0         0.2         18.7         9.5           Approach LOS         C         A           Intersection Summary         1.4         Intersection Capacity Utilization         43.7%         ICU Level of Service         A		1700	1700	1700	623	1700	1700	1700	288	831	824		
Queue Length 95th (ft)       0       0       0       2       0       0       0       40       7       3         Control Delay (s)       0.0       0.0       11.0       0.0       0.0       24.4       9.7       9.5         Lane LOS       B       C       A       A         Approach Delay (s)       0.0       0.2       18.7       9.5         Approach LOS       C       A         Intersection Summary         Average Delay       1.4         Intersection Capacity Utilization       43.7%       ICU Level of Service       A													
Control Delay (s) 0.0 0.0 0.0 11.0 0.0 0.0 0.0 24.4 9.7 9.5  Lane LOS B C A A  Approach Delay (s) 0.0 0.2 18.7 9.5  Approach LOS C A  Intersection Summary  Average Delay 1.4  Intersection Capacity Utilization 43.7% ICU Level of Service A		0	0	0	2	0	0	0	40	7	3		
Lane LOS         B         C         A         A           Approach Delay (s)         0.0         0.2         18.7         9.5           Approach LOS         C         A           Intersection Summary         A         Intersection Capacity Utilization         1.4           Intersection Capacity Utilization         43.7%         ICU Level of Service         A		0.0	0.0	0.0	11.0	0.0	0.0	0.0	24.4	9.7	9.5		
Approach LOS C A  Intersection Summary  Average Delay 1.4 Intersection Capacity Utilization 43.7% ICU Level of Service A	The Control of the Co				В				С	Α	Α		
Approach LOS C A  Intersection Summary  Average Delay 1.4 Intersection Capacity Utilization 43.7% ICU Level of Service A		0.0											
Average Delay 1.4 Intersection Capacity Utilization 43.7% ICU Level of Service A									C		Α		
Intersection Capacity Utilization 43.7% ICU Level of Service A	Intersection Summary												1
Intersection Capacity Utilization 43.7% ICU Level of Service A	Average Delay			1.4						•	•		
		1		43.7%	10	CU Level	of Service			Α			
the state of the s	Analysis Period (min)			15									

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

# HCM Signalized Intersection Capacity Analysis 34: Ward Ave & Crossroads

2/24/2015

	1	-	-	1	+	*	1	1	-	-	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBF
Lane Configurations	7	44	7	7	44	7	7	4		7	7	
Volume (vph)	22	975	26	6	929	3	32	0	6	13	2	9
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0		8.0	8.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00		1.00	1.00	
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.85		1.00	0.90	
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	808	902	3539	1583	902	808		1770	1669	
Flt Permitted	0.18	1.00	1.00	0.18	1.00	1.00	0.74	1.00		0.75	1.00	
Satd. Flow (perm)	340	3539	808	168	3539	1583	703	808		1397	1669	
Peak-hour factor, PHF	0.62	0.84	0.71	0.50	0.81	0.25	0.58	0.85	0.50	0.88	0.25	0.50
Adj. Flow (vph)	35	1161	37	12	1147	12	55	0	12	15	8	18
RTOR Reduction (vph)	0	0	19	0	0	6	0	9	0	0	14	0
Lane Group Flow (vph)	35	1161	18	12	1147	6	55	3	0	15	13	0
Heavy Vehicles (%)	2%	2%	100%	100%	2%	2%	100%	100%	100%	2%	2%	2%
Turn Type	Perm	NA	Perm	Perm	NA	Perm	Perm	NA		Perm	NA	
Protected Phases		4			8			2			6	
Permitted Phases	4		4	8		8	2			6		
Actuated Green, G (s)	29.0	29.0	29.0	29.0	29.0	29.0	15.0	15.0		15.0	15.0	
Effective Green, g (s)	29.0	29.0	29.0	29.0	29.0	29.0	15.0	15.0		15.0	15.0	
Actuated g/C Ratio	0.48	0.48	0.48	0.48	0.48	0.48	0.25	0.25		0.25	0.25	
Clearance Time (s)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0		8.0	8.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	164	1710	390	81	1710	765	175	202		349	417	
v/s Ratio Prot		c0.33	-		0.32			0.00			0.01	
v/s Ratio Perm	0.10		0.02	0.07		0.00	c0.08			0.01		
v/c Ratio	0.21	0.68	0.05	0.15	0.67	0.01	0.31	0.01		0.04	0.03	
Uniform Delay, d1	8.9	11.9	8.2	8.6	11.9	8.0	18.3	16.9		17.1	17.0	
Progression Factor	1.99	1.97	23.93	1.00	1.00	1.00	1.00	1.00		1.00	1.00	
Incremental Delay, d2	2.1	1.5	0.2	3.8	2.1	0.0	4.6	0.1		0.2	0.1	
Delay (s)	19.9	25.1	196.1	12.5	14.0	8.1	23.0	17.1		17.3	17.1	
Level of Service	В	C	F	В	В	Α	C	В		В	В	
Approach Delay (s)		30.0			13.9			21.9		- 13	17.2	
Approach LOS		C			В			С			В	
Intersection Summary												
HCM 2000 Control Delay			22.1	Н	CM 2000	Level of	Service		С			
HCM 2000 Volume to Capa	city ratio		0.55									
Actuated Cycle Length (s)			60.0	S	um of los	t time (s)			16.0			
Intersection Capacity Utiliza	ation		48.7%			of Service	1		Α			
Analysis Period (min)			15									
0.10 11 0												

c Critical Lane Group

Synchro 8 Report TRIANGLE EXISTING 8/31/1998 Baseline

HCM Unsignalized Intersection Capacity Analysis 37: Walmart Entrance/Greenfield Dr & Crossroads

	*	-	7	1	+	1	1	1	-	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBF
Lane Configurations		<b>^</b>	7	7	<b>^</b>	7	7		7			7
Volume (veh/h)	0	854	60	101	666	5	108	0	141	0	0	62
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.50	0.75	0.43	0.51	0.79	0.38	0.64	0.25	0.56	0.67	0.85	0.68
Hourly flow rate (vph)	0	1139	140	198	843	13	169	0	252	0	0	91
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			TWLTL							
Median storage veh)		2			2							
Upstream signal (ft)		810										
pX, platoon unblocked				0.76			0.76	0.76	0.76	0.76	0.76	
vC, conflicting volume	856			1139			1956	2391	569	2060	2378	422
vC1, stage 1 conf vol							1139	1139		1239	1239	
vC2, stage 2 conf vol							818	1252		821	1139	
vCu, unblocked vol	856			560			1632	2202	0	1768	2184	422
tC, single (s)	4.1			4.1			*5.8	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)							4.8	5.5		6.5	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			74			36	100	70	100	100	84
cM capacity (veh/h)	780			768			264	158	827	118	129	581
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB3	WB 4	NB 1	NB 2	SB 1		
Volume Total	569	569	140	198	422	422	13	169	252	91		
Volume Left	0	0	0	198	0	0	0	169	0	0		
Volume Right	0	0	140	0	0	0	13	0	252	91		
cSH	1700	1700	1700	768	1700	1700	1700	264	827	581		
Volume to Capacity	0.33	0.33	0.08	0.26	0.25	0.25	0.01	0.64	0.30	0.16		
Queue Length 95th (ft)	0	0	0	26	0	0	0	100	32	14		
Control Delay (s)	0.0	0.0	0.0	11.3	0.0	0.0	0.0	40.0	11.2	12.4		
Lane LOS	2000			В				Е	В	В		
Approach Delay (s)	0.0			2.1				22.8		12.4		
Approach LOS								С		В		
Intersection Summary												
Average Delay			4.5									
Intersection Capacity Utilization	1		45.2%	10	U Level	of Service			Α			
Analysis Period (min)			15									

<sup>\*</sup> User Entered Value

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

### HCM 2010 Roundabout 40: Crossroads & Highland Meadows Pkwy

2/24/2015

Intersection						
Intersection Delay, s/veh	7.2					
Intersection LOS	Α					
Approach		EB		WB		SB
Entry Lanes		2		2		2
Conflicting Circle Lanes		2		2		2
Adj Approach Flow, veh/h		1153		819		313
Demand Flow Rate, veh/h		1176		835		319
Vehicles Circulating, veh/h		92		201		731
Vehicles Exiting, veh/h		958		1067		305
Follow-Up Headway, s		2.535		2.535		2.667
Ped Vol Crossing Leg, #/h		0		0		0
Ped Cap Adj		1.000		1.000		1.000
Approach Delay, s/veh		7.4		6.6		8.2
Approach LOS		Α		Α		Α
Lane	Left	Right	Left	Right	Left	Right
Designated Moves	LT	TR	LT	TR	L	TR
Assumed Moves	LT	TR	LT	TR	L	TR
RT Channelized						
Lane Util	0.470	0.530	0.469	0.531	0.288	0.712
Critical Headway, s	4.544	4.544	4.544	4.544	4.645	4.328
Entry Flow, veh/h	553	623	392	443	92	227
Cap Entry Lane, veh/h	1306	1306	1183	1183	689	735
Entry HV Adj Factor	0.980	0.981	0.982	0.979	0.978	0.982
Flow Entry, veh/h	542	611	385	434	90	223
Cap Entry, veh/h	1280	1281	1161	1158	674	722
V/C Ratio	0.423	0.477	0.331	0.375	0.134	0.309
Control Delay, s/veh	7.0	7.7	6.3	6.8	6.8	8.7
LOS	Α	Α	Α	Α	Α	Α
95th %tile Queue, veh	2	3	1	2	0	1

## Option 1 PM

## HCM 2010 Roundabout 42: LCR 3 & Crossroads

2/24/2015

Intersection							
Intersection Delay, s/veh	5.7						
Intersection LOS	Α						
Approach		EB		WB		NB	
Entry Lanes		2		2		1	
Conflicting Circle Lanes		2		2		2	
Adj Approach Flow, veh/h		1023		815		43	
Demand Flow Rate, veh/h		1044		831		44	
Vehicles Circulating, veh/h		8		32		1012	
Vehicles Exiting, veh/h		855		1024		40	
Follow-Up Headway, s		2.535		2.535		2.535	
Ped Vol Crossing Leg, #/h		0		0		1	
Ped Cap Adj		1.000		1.000		1.000	
Approach Delay, s/veh		6.0		5.3		7.0	
Approach LOS		Α		Α		Α	
Lane	Left	Right	Left	Right	Left		
Designated Moves	LT	TR	LT	TR	LR		
Assumed Moves	LT	TR	LT	TR	LR		
RT Channelized							
Lane Util	0.470	0.530	0.471	0.529	1.000		
Critical Headway, s	4.544	4.544	4.544	4.544	4.328		
Entry Flow, veh/h	491	553	391	440	44		
Cap Entry Lane, veh/h	1410	1410	1379	1379	601		
Entry HV Adj Factor	0.979	0.981	0.980	0.982	0.977		
Flow Entry, veh/h	481	542	383	432	43		
Cap Entry, veh/h	1381	1382	1351	1354	587		
V/C Ratio	0.348	0.392	0.283	0.319	0.073		
Control Delay, s/veh	5.7	6.2	5.1	5.5	7.0		
LOS	Α	Α	Α	Α	Α		
LUG	/ \						



HCM Signalized Intersection Capacity Analysis 139: Centerra Pkwy/Fairgrounds & Crossroads

c Critical Lane Group

2/24/2015

	•	-	+	1	+	1	1	1	1	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBF
Lane Configurations	ሻሻ	<b>^</b>	7	ሻሻ	<b>^</b>	7	77	<b>^</b>	7	ሻሻ	<b>^</b>	7
Volume (vph)	110	645	132	105	755	50	210	116	123	140	132	158
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.68	0.83	0.67	0.67	0.83	0.75	0.53	0.77	0.82	0.75	0.73	0.88
Adj. Flow (vph)	162	777	197	157	910	67	396	151	150	187	181	180
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	162	777	197	157	910	67	396	151	150	187	181	180
Heavy Vehicles (%)	2%	4%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			Free			Free			Free
Actuated Green, G (s)	11.0	76.7	140.0	10.8	76.5	140.0	16.8	16.5	140.0	12.0	11.7	140.0
Effective Green, g (s)	12.0	81.7	140.0	11.8	81.5	140.0	17.8	21.5	140.0	13.0	16.7	140.0
Actuated g/C Ratio	0.09	0.58	1.00	0.08	0.58	1.00	0.13	0.15	1.00	0.09	0.12	1.00
Clearance Time (s)	4.0	8.0		4.0	8.0		4.0	8.0		4.0	8.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	294	2025	1583	289	2020	1583	436	543	1583	318	422	1583
v/s Ratio Prot	c0.05	0.22		0.05	c0.26		c0.12	0.04		0.05	c0.05	
v/s Ratio Perm			c0.12			0.04			0.09			0.11
v/c Ratio	0.55	0.38	0.12	0.54	0.45	0.04	0.91	0.28	0.09	0.59	0.43	0.11
Uniform Delay, d1	61.4	15.6	0.0	61.5	16.6	0.0	60.3	52.4	0.0	60.9	57.2	0.0
Progression Factor	1.09	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	0.0	0.2	1.1	0.7	0.1	21.9	0.1	0.1	1.8	0.3	0.1
Delay (s)	68.1	11.8	0.2	62.6	17.3	0.1	82.2	52.5	0.1	62.7	57.5	0.1
Level of Service	E	В	Α	E	В	A	F	D	Α	E	E	A
Approach Delay (s)		17.8			22.6			58.1			40.4	
Approach LOS		В			С			E			D	
Intersection Summary												
HCM 2000 Control Delay			30.9	Н	CM 2000	Level of	Service		С			
HCM 2000 Volume to Capa	acity ratio		0.52									
Actuated Cycle Length (s)			140.0			t time (s)			12.0			
Intersection Capacity Utiliza	ation		51.0%	IC	U Level	of Service	)		Α			
Analysis Period (min)			15									

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

# HCM Signalized Intersection Capacity Analysis 29: RCS Access & Crossroads

2/24/2015

	-	+	1	+	1	-		
Movement	EBT	EBR	WBL	WBT	NBL	NBR		
Lane Configurations	<b>^</b>	7	7	<b>^</b>	7	7		
Volume (vph)	722	233	317	849	60	231		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900		
Total Lost time (s)	8.0	8.0	8.0	8.0	8.0	8.0		
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00		
Frpb, ped/bikes	1.00	0.69	1.00	1.00	1.00	1.00		
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00		
Frt	1.00	0.85	1.00	1.00	1.00	0.85		
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00		
Satd. Flow (prot)	3471	1086	1770	3539	1770	1583		
Flt Permitted	1.00	1.00	0.13	1.00	0.95	1.00		
Satd. Flow (perm)	3471	1086	240	3539	1770	1583		
Peak-hour factor, PHF	0.83	0.55	0.50	0.85	0.36	0.59		
Adj. Flow (vph)	870	424	634	999	167	392		
RTOR Reduction (vph)	0	316	0	0	0	327		
Lane Group Flow (vph)	870	108	634	999	167	65		
Confl. Peds. (#/hr)		100	1		100			
Heavy Vehicles (%)	4%	2%	2%	2%	2%	2%		
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm		
Protected Phases	4		3	8	2			
Permitted Phases		4	8			2		
Actuated Green, G (s)	23.0	23.0	59.0	59.0	15.0	15.0		
Effective Green, g (s)	23.0	23.0	59.0	59.0	15.0	15.0		
Actuated g/C Ratio	0.26	0.26	0.66	0.66	0.17	0.17		
Clearance Time (s)	8.0	8.0	8.0	8.0	8.0	8.0		
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		
Lane Grp Cap (vph)	887	277	633	2320	295	263		
v/s Ratio Prot	0.25		c0.31	0.28	c0.09			
v/s Ratio Perm		0.10	c0.34			0.04		
v/c Ratio	0.98	0.39	1.00	0.43	0.57	0.25		
Uniform Delay, d1	33.3	27.7	24.6	7.4	34.5	32.6		
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		
Incremental Delay, d2	25.9	4.1	36.2	0.6	7.7	2.2		
Delay (s)	59.2	31.8	60.7	8.0	42.2	34.8		
Level of Service	E	С	E	Α	D	С		
Approach Delay (s)	50.2			28.5	37.0			
Approach LOS	D			C	D			
ntersection Summary								
HCM 2000 Control Delay			37.9	Н	CM 2000	Level of Service	D	
HCM 2000 Volume to Capa	acity ratio		0.95					
Actuated Cycle Length (s)			90.0	S	um of los	t time (s)	24.0	
Intersection Capacity Utiliza	ation		60.9%			of Service	В	
Analysis Period (min)			15					
Critical Lane Group								

# HCM Unsignalized Intersection Capacity Analysis 31: Woods Ave & Crossroads

2/24/2015

Movement Lane Configurations Volume (veh/h) Sign Control	EBL 29	<b>EBT ↑↑</b> 861	EBR	WBL	WBT		-					
Volume (veh/h)			7	_		WBR	NBL	NBT	NBR	SBL	SBT	SBR
				7	<b>^</b>	7			7			7
			50	29	1052	3	0	0	30	0	0	48
olgii oolilioi		Free	0.2.2.		Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.59	0.73	0.59	0.53	0.68	0.25	0.63	0.85	0.63	0.85	0.85	0.69
Hourly flow rate (vph)	49	1179	85	55	1547	12	0	0	48	0	0	70
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)		633										
pX, platoon unblocked				0.77			0.77	0.77	0.77	0.77	0.77	
vC, conflicting volume	1559			1264			2161	2946	590	2345	3019	774
vC1, stage 1 conf vol							1278	1278		1656	1656	
vC2, stage 2 conf vol							883	1668		688	1363	
vCu, unblocked vol	1559			741			1908	2930	0	2147	3025	774
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)							6.5	5.5		6.5	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	88			92			100	100	94	100	100	80
cM capacity (veh/h)	420			662			139	83	833	90	108	341
Direction, Lane #	EB1	EB 2	EB 3	EB 4	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1		
Volume Total	49	590	590	85	55	774	774	12	48	70		
Volume Left	49	0	0	0	55	0	0	0	0	0		
Volume Right	0	0	0	85	0	0	0	12	48	70		
cSH	420	1700	1700	1700	662	1700	1700	1700	833	341		
Volume to Capacity	0.12	0.35	0.35	0.05	0.08	0.46	0.46	0.01	0.06	0.20		
Queue Length 95th (ft)	10	0	0	0	7	0	0	0	5	19		
Control Delay (s)	14.7	0.0	0.0	0.0	10.9	0.0	0.0	0.0	9.6	18.2		
Lane LOS	В				В				Α	С		
Approach Delay (s)	0.6				0.4				9.6	18.2		
Approach LOS									Α	С		
Intersection Summary												1
Average Delay			1.0									
Intersection Capacity Utilization			39.1%	10	CU Level	of Service			Α			
Analysis Period (min)			15									

Synchro 8 Report TRIANGLE EXISTING 8/31/1998 Baseline

## HCM 2010 Roundabout 34: Ward Ave & Crossroads

2/24/2015

Intersection	12.2							
Intersection Delay, s/veh	8.2							
Intersection LOS	Α							
Approach		EB		WB		NB		SB
Entry Lanes		2		2		2		1
Conflicting Circle Lanes		2		2		2		2
Adj Approach Flow, veh/h		888		1252		61		25
Demand Flow Rate, veh/h		948		1290		122		25
Vehicles Circulating, veh/h		32		141		868		1331
Vehicles Exiting, veh/h		1324		849		112		100
Follow-Up Headway, s		2.535		2.667		2.667		2.535
Ped Vol Crossing Leg, #/h		0		0		0		0
Ped Cap Adj		1.000		1.000		1.000		1.000
Approach Delay, s/veh		6.0		9.5		13.2		8.6
Approach LOS		Α		Α		В		Α
Lane	Left	Right	Left	Right	Left	Right	Left	
Designated Moves	LT	TR	LT	TR	L	LTR	LTR	
Assumed Moves	LT	TR	LT	TR	L	LTR	LTR	
RT Channelized								
Lane Util	0.470	0.530	0.470	0.530	0.533	0.467	1.000	
Critical Headway, s	4.544	4.544	4.645	4.328	4.645	4.328	4.328	
Entry Flow, veh/h	446	502	606	684	65	57	25	
Cap Entry Lane, veh/h	1379	1379	1186	1200	607	656	458	
Entry HV Adj Factor	0.936	0.938	0.971	0.970	0.497	0.503	1.000	
Flow Entry, veh/h	417	471	588	663	32	29	25	
Cap Entry, veh/h	1291	1293	1151	1164	302	330	458	
V/C Ratio	0.323	0.364	0.511	0.570	0.107	0.087	0.055	
Control Delay, s/veh	5.7	6.2	8.9	10.0	13.9	12.4	8.6	
LOS	Α	Α	Α	Α	В	В	Α	
95th %tile Queue, veh	1	2	3	4	0	0	0	

Synchro 8 Report TRIANGLE EXISTING 8/31/1998 Baseline

HCM Unsignalized Intersection Capacity Analysis 37: Walmart Entrance/Greenfield Dr & Crossroads

Movement  Lane Configurations  Volume (veh/h)  Sign Control  Grade  Peak Hour Factor  Hourly flow rate (vph)  Pedestrians  Lane Width (ft)  Walking Speed (ft/s)  Percent Blockage  Right turn flare (veh)  Median type	0 0.80 0	Free 0% 0.70 1000	20 0.65 31	0.58 19	WBT  1187 Free 0% 0.75 1583	9 0.38 24	3 0.50 6	0 Stop 0% 0.85	NBR 2 0.25 8	0 0.50 0	0 Stop 0% 0.85 0	SBR 29 0.43 67
Volume (veh/h) Sign Control Grade Peak Hour Factor Hourly flow rate (vph) Pedestrians Lane Width (ft) Walking Speed (ft/s) Percent Blockage Right turn flare (veh)	0.80	700 Free 0% 0.70 1000	0.65	0.58	1187 Free 0% 0.75	0.38	0.50	Stop 0% 0.85	0.25	0.50	Stop 0% 0.85	0.43
Sign Control Grade Peak Hour Factor Hourly flow rate (vph) Pedestrians Lane Width (ft) Walking Speed (ft/s) Percent Blockage Right turn flare (veh)	0.80	Free 0% 0.70 1000	0.65	0.58	Free 0% 0.75	0.38	0.50	Stop 0% 0.85	0.25	0.50	Stop 0% 0.85	0.43
Grade Peak Hour Factor Hourly flow rate (vph) Pedestrians Lane Width (ft) Walking Speed (ft/s) Percent Blockage Right turn flare (veh)	0	0% 0.70 1000			0% 0.75			0% 0.85			0% 0.85	
Peak Hour Factor Hourly flow rate (vph) Pedestrians Lane Width (ft) Walking Speed (ft/s) Percent Blockage Right turn flare (veh)	0	0.70 1000			0.75			0.85			0.85	
Hourly flow rate (vph) Pedestrians Lane Width (ft) Walking Speed (ft/s) Percent Blockage Right turn flare (veh)	0	1000										
Pedestrians Lane Width (ft) Walking Speed (ft/s) Percent Blockage Right turn flare (veh)			31	19	1583	24	6	0	8	0	0	67
Pedestrians Lane Width (ft) Walking Speed (ft/s) Percent Blockage Right turn flare (veh)		TWLTL										
Walking Speed (ft/s) Percent Blockage Right turn flare (veh)		TWLTL										
Percent Blockage Right turn flare (veh)		TWLTL										
Right turn flare (veh)		TWLTL										
		TWLTL										
Median type		TWLTL										
modian type					TWLTL							
Median storage veh)		2			2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1606			1000			1829	2644	500	2129	2621	791
vC1, stage 1 conf vol							1000	1000		1621	1621	
vC2, stage 2 conf vol							829	1644		508	1000	
vCu, unblocked vol	1606			1000			1829	2644	500	2129	2621	791
tC, single (s)	4.1			4.1			*5.8	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)							4.8	5.5		6.5	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			97			98	100	98	100	100	80
cM capacity (veh/h)	403			688			290	133	516	100	135	332
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB3	WB 4	NB 1	NB 2	SB 1		
Volume Total	500	500	31	19	791	791	24	6	8	67		
Volume Left	0	0	0	19	0	0	0	6	0	0		
Volume Right	0	0	31	0	0	0	24	0	8	67		
cSH	1700	1700	1700	688	1700	1700	1700	290	516	332		
Volume to Capacity	0.29	0.29	0.02	0.03	0.47	0.47	0.01	0.02	0.02	0.20		
Queue Length 95th (ft)	0	0	0	2	0	0	0	2	1	19		
Control Delay (s)	0.0	0.0	0.0	10.4	0.0	0.0	0.0	17.7	12.1	18.6		
Lane LOS				В				C	В	C		
Approach Delay (s)	0.0			0.1				14.5		18.6		
Approach LOS								В		C		
Intersection Summary												
Average Delay			0.6									
Intersection Capacity Utilization			49.5%	IC	U Level of	of Service			Α			
Analysis Period (min)			15									

<sup>\*</sup> User Entered Value

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

### HCM 2010 Roundabout 40: Crossroads & Highland Meadows Pkwy

2/24/2015

ntersection							
ntersection Delay, s/veh	11.8						
ntersection LOS	В						
Approach		EB		WB		SB	
Entry Lanes		2		2		2	
Conflicting Circle Lanes		2		2		2	
Adj Approach Flow, veh/h		1085		1341		391	
Demand Flow Rate, veh/h		1106		1368		399	
/ehicles Circulating, veh/h		105		329		1271	
Vehicles Exiting, veh/h		1565		882		426	
Follow-Up Headway, s		2.535		2.535		2.667	
Ped Vol Crossing Leg, #/h		0		0		0	
Ped Cap Adj		1.000		1.000		1.000	
pproach Delay, s/veh		7.1		13.1		20.5	
pproach LOS		Α		В		С	
ane	Left	Right	Left	Right	Left	Right	
esignated Moves	LT	TR	LT	TR	L	TR	
ssumed Moves	LT	TR	LT	TR	L	TR	
T Channelized							
ane Util	0.470	0.530	0.470	0.530	0.263	0.737	
Critical Headway, s	4.544	4.544	4.544	4.544	4.645	4.328	
entry Flow, veh/h	520	586	643	725	105	294	
Cap Entry Lane, veh/h	1291	1291	1053	1053	419	469	
Entry HV Adj Factor	0.980	0.981	0.980	0.980	0.981	0.980	
low Entry, veh/h	510	575	630	711	103	288	
ap Entry, veh/h	1265	1266	1032	1032	411	459	
//C Ratio	0.403	0.454	0.611	0.689	0.250	0.627	
control Delay, s/veh	6.8	7.5	11.9	14.3	12.9	23.2	
OS	Α	Α	В	В	В	C	
.03	Α.	11		U	U	0	

HCM Signalized Intersection Capacity Analysis 42: LCR 3 & Crossroads

	-	1	1	+	1	-		
Movement	EBT	EBR	WBL	WBT	NBL	NBR		
Lane Configurations	<b>↑</b> }		7	<b>*</b>	A			
Volume (vph)	518	9	3	971	26	9		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900		
Total Lost time (s)	8.0		8.0	8.0	8.0			
Lane Util. Factor	0.95		1.00	1.00	1.00			
Frpb, ped/bikes	1.00		1.00	1.00	1.00			
Flpb, ped/bikes	1.00		1.00	1.00	1.00			
Frt	0.99		1.00	1.00	0.97			
FIt Protected	1.00		0.95	1.00	0.96			
Satd. Flow (prot)	3515		1768	1863	1740			
Flt Permitted	1.00		0.36	1.00	0.96			
Satd. Flow (perm)	3515		668	1863	1740			
Peak-hour factor, PHF	0.71	0.30	0.50	0.74	0.61	0.75		
Adj. Flow (vph)	730	30	0.50	1312	43	12		
RTOR Reduction (vph)	3	0	0	0	10	0		
	757	0	6	1312	45	0		
Lane Group Flow (vph)	131		1	1312	40	0		
Confl. Peds. (#/hr)	N/A	1						
Turn Type	NA		Perm	NA	Prot			
Protected Phases	4			8	2			
Permitted Phases			8					
Actuated Green, G (s)	69.0		69.0	69.0	15.0			
Effective Green, g (s)	69.0		69.0	69.0	15.0			
Actuated g/C Ratio	0.69		0.69	0.69	0.15			
Clearance Time (s)	8.0		8.0	8.0	8.0			
Vehicle Extension (s)	3.0		3.0	3.0	3.0			
Lane Grp Cap (vph)	2425		460	1285	261			
v/s Ratio Prot	0.22			c0.70	c0.03			
v/s Ratio Perm			0.01					
v/c Ratio	0.31		0.01	1.02	0.17			
Uniform Delay, d1	6.1		4.8	15.5	37.1			
Progression Factor	1.00		1.00	1.00	1.00			
Incremental Delay, d2	0.3		0.1	30.5	1.4			
Delay (s)	6.5		4.9	46.0	38.5			
Level of Service	Α		Α	D	D			
Approach Delay (s)	6.5			45.8	38.5			
Approach LOS	A			D	D			
Intersection Summary								
HCM 2000 Control Delay			31.6	Н	CM 2000	Level of Service	С	
HCM 2000 Volume to Capa	city ratio		0.87					
Actuated Cycle Length (s)	,		100.0	S	um of lost	time (s)	16.0	
Intersection Capacity Utiliza	ition		67.8%			of Service	C	
Analysis Period (min)			15		5 257010	3011100		

Synchro 8 Report TRIANGLE EXISTING 8/31/1998 Baseline



HCM Signalized Intersection Capacity Analysis 139: Centerra Pkwy/Fairgrounds & Crossroads

c Critical Lane Group

2/24/2015

	•	-	1	1	+	1	1	1	1	1	Ţ	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	ሻሻ	<b>^</b>	7	77	<b>^</b>	7	77	1	7	77	<b>^</b>	7
Volume (vph)	255	795	231	161	695	92	182	227	177	71	197	135
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (perm)	3433	3471	1583	3433	3471	1583	3433	3539	1583	3433	3539	1583
Peak-hour factor, PHF	0.76	0.87	0.88	0.76	0.77	0.69	0.80	0.73	0.84	0.65	0.86	0.87
Adj. Flow (vph)	336	914	262	212	903	133	228	311	211	109	229	155
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0
Lane Group Flow (vph)	336	914	262	212	903	133	228	311	211	109	229	155
Heavy Vehicles (%)	2%	4%	2%	2%	4%	2%	2%	2%	2%	2%	2%	2%
Turn Type	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free	Prot	NA	Free
Protected Phases	1	6		5	2		7	4		3	8	
Permitted Phases			Free			Free			Free			Free
Actuated Green, G (s)	18.0	76.2	140.0	13.0	71.2	140.0	13.3	18.0	140.0	8.8	13.5	140.0
Effective Green, g (s)	19.0	81.2	140.0	14.0	76.2	140.0	14.3	23.0	140.0	9.8	18.5	140.0
Actuated g/C Ratio	0.14	0.58	1.00	0.10	0.54	1.00	0.10	0.16	1.00	0.07	0.13	1.00
Clearance Time (s)	4.0	8.0		4.0	8.0		4.0	8.0		4.0	8.0	
Vehicle Extension (s)	2.0	2.0		2.0	2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	465	2013	1583	343	1889	1583	350	581	1583	240	467	1583
v/s Ratio Prot	c0.10	0.26		0.06	c0.26		c0.07	c0.09		0.03	0.06	
v/s Ratio Perm			0.17			0.08			0.13		-	0.10
v/c Ratio	0.72	0.45	0.17	0.62	0.48	0.08	0.65	0.54	0.13	0.45	0.49	0.10
Uniform Delay, d1	58.0	16.8	0.0	60.4	19.6	0.0	60.5	53.6	0.0	62.5	56.4	0.0
Progression Factor	1.17	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	3.6	0.0	0.2	2.3	0.9	0.1	3.3	0.5	0.2	0.5	0.3	0.1
Delay (s)	71.2	11.8	0.2	62.8	20.5	0.1	63.7	54.1	0.2	63.0	56.7	0.1
Level of Service	E	В	Α	E	C	Α	E	D	Α	E	E	A
Approach Delay (s)		23.0			25.5			41.9			40.3	
Approach LOS		C			C			D			D	
Intersection Summary												
HCM 2000 Control Delay			29.4	Н	CM 2000	Level of	Service		С			
HCM 2000 Volume to Capa	acity ratio		0.55									
Actuated Cycle Length (s)			140.0			t time (s)			12.0			
Intersection Capacity Utiliza	ation		51.8%	IC	U Level	of Service	)		Α			
Analysis Period (min)			15									

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

# HCM Signalized Intersection Capacity Analysis 29: RCS Access & Crossroads

2/24/2015

	-	+	1	-	1	-		
Movement	EBT	EBR	WBL	WBT	NBL	NBR		
Lane Configurations	<b>^</b>	7	7	<b>^</b>	7	7		
Volume (vph)	824	195	132	863	114	185		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900		
Total Lost time (s)	8.0	8.0	8.0	8.0	8.0	8.0		
Lane Util. Factor	0.95	1.00	1.00	0.95	1.00	1.00		
Frpb, ped/bikes	1.00	0.78	1.00	1.00	1.00	1.00		
Flpb, ped/bikes	1.00	1.00	1.00	1.00	1.00	1.00		
Frt	1.00	0.85	1.00	1.00	1.00	0.85		
Flt Protected	1.00	1.00	0.95	1.00	0.95	1.00		
Satd. Flow (prot)	3471	1241	1770	3539	1770	1583		
FIt Permitted	1.00	1.00	0.16	1.00	0.95	1.00		
Satd. Flow (perm)	3471	1241	298	3539	1770	1583		
Peak-hour factor, PHF	0.94	0.46	0.59	0.82	0.83	0.57		
Adj. Flow (vph)	877	424	224	1052	137	325		
RTOR Reduction (vph)	0	304	0	0	0	159		
Lane Group Flow (vph)	877	120	224	1052	137	166		
Confl. Peds. (#/hr)	-	100	1		100			
Heavy Vehicles (%)	4%	2%	2%	2%	2%	2%		
Turn Type	NA	Perm	pm+pt	NA	Prot	Perm		
Protected Phases	4	1 01111	3	8	2	7 01111		
Permitted Phases		4	8		-	2		
Actuated Green, G (s)	17.0	17.0	29.0	29.0	15.0	15.0		
Effective Green, g (s)	17.0	17.0	29.0	29.0	15.0	15.0		
Actuated g/C Ratio	0.28	0.28	0.48	0.48	0.25	0.25		
Clearance Time (s)	8.0	8.0	8.0	8.0	8.0	8.0		
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0		
Lane Grp Cap (vph)	983	351	242	1710	442	395		
v/s Ratio Prot	0.25	001	0.06	c0.30	0.08	000		
v/s Ratio Perm	0.20	0.10	c0.39	00.00	0.00	c0.10		
v/c Ratio	0.89	0.34	0.93	0.62	0.31	0.42		
Uniform Delay, d1	20.6	17.1	13.0	11.4	18.3	18.9		
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00		
Incremental Delay, d2	12.1	2.6	37.9	1.7	1.8	3.3		
Delay (s)	32.7	19.7	50.9	13.1	20.1	22.1		
Level of Service	C	В	D	В	C	C		
Approach Delay (s)	28.5			19.7	21.5			
Approach LOS	C			В	C			
ntersection Summary								
HCM 2000 Control Delay			23.7	H	CM 2000	Level of Service	С	
HCM 2000 Volume to Capa	acity ratio		0.84					
Actuated Cycle Length (s)			60.0		um of los		24.0	
Intersection Capacity Utiliza	ation		56.4%			of Service	В	
Analysis Period (min)			15					
c Critical Lane Group								

# HCM Unsignalized Intersection Capacity Analysis 31: Woods Ave & Crossroads

2/24/2015

	•	-	-	1	+	1	1	1	-	-	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	7	<b>^</b>	7	7	<b>^</b>	7			7			7
Volume (veh/h)	14	1037	23	5	921	0	0	0	94	0	0	65
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.59	0.83	0.42	0.25	0.88	0.85	0.54	0.85	0.57	0.25	0.85	0.90
Hourly flow rate (vph)	24	1249	55	20	1047	0	0	0	165	0	0	72
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		None			TWLTL							
Median storage veh)					2							
Upstream signal (ft)		633										
pX, platoon unblocked				0.77			0.77	0.77	0.77	0.77	0.77	
vC, conflicting volume	1047			1304			1860	2383	625	1759	2438	523
vC1, stage 1 conf vol							1297	1297		1087	1087	
vC2, stage 2 conf vol							563	1087		672	1352	
vCu, unblocked vol	1047			795			1518	2198	0	1386	2269	523
tC, single (s)	4.1			4.1			7.5	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)							6.5	5.5		6.5	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	96			97			100	100	80	100	100	86
cM capacity (veh/h)	661			633			213	190	834	207	184	498
Direction, Lane #	EB1	EB 2	EB3	EB4	WB 1	WB 2	WB 3	WB 4	NB 1	SB 1		
Volume Total	24	625	625	55	20	523	523	0	165	72		
Volume Left	24	0	0	0	20	0	0	0	0	0		
Volume Right	0	0	0	55	0	0	0	0	165	72		
cSH	661	1700	1700	1700	633	1700	1700	1700	834	498		
Volume to Capacity	0.04	0.37	0.37	0.03	0.03	0.31	0.31	0.00	0.20	0.14		
Queue Length 95th (ft)	3	0	0	0	2	0	0	0	18	13		
Control Delay (s)	10.7	0.0	0.0	0.0	10.9	0.0	0.0	0.0	10.4	13.4		
Lane LOS	В				В				В	В		
Approach Delay (s)	0.2				0.2				10.4	13.4		
Approach LOS									В	В		
Intersection Summary												
Average Delay			1.2									
Intersection Capacity Utilization			41.2%	10	CU Level	of Service			Α			
Analysis Period (min)			15									

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

## HCM 2010 Roundabout 34: Ward Ave & Crossroads

2/24/2015

Intersection								
Intersection Delay, s/veh	8.9							
Intersection LOS	Α							
Approach		EB		WB		NB		SB
Entry Lanes		2		2		2		1
Conflicting Circle Lanes		2		2		2		2
Adj Approach Flow, veh/h		1272		1171		67		41
Demand Flow Rate, veh/h		1333		1206		134		41
Vehicles Circulating, veh/h		47		185		1274		1304
Vehicles Exiting, veh/h		1298		1223		106		87
Follow-Up Headway, s		2.535		2.667		2.667		2.535
Ped Vol Crossing Leg, #/h		0		0		0		0
Ped Cap Adj		1.000		1.000		1.000		1.000
Approach Delay, s/veh		7.9		9.4		20.1		8.9
Approach LOS		Α		Α		С		Α
Lane	Left	Right	Left	Right	Left	Right	Left	
Designated Moves	LT	TR	LT	TR	L	LTR	LTR	
Assumed Moves	LT	TR	LT	TR	L	LTR	LTR	
RT Channelized								
Lane Util	0.470	0.530	0.470	0.530	0.530	0.470	1.000	
Critical Headway, s	4.544	4.544	4.645	4.328	4.645	4.328	4.328	
Entry Flow, veh/h	627	706	567	639	71	63	41	
Cap Entry Lane, veh/h	1361	1361	1139	1157	418	468	469	
Entry HV Adj Factor	0.953	0.955	0.971	0.971	0.500	0.500	0.996	
Flow Entry, veh/h	598	674	550	621	36	31	41	
Cap Entry, veh/h	1297	1299	1105	1124	209	234	467	
V/C Ratio	0.461	0.519	0.498	0.552	0.170	0.135	0.087	
Control Delay, s/veh	7.4	8.3	8.9	9.8	21.6	18.5	8.9	
LOS	Α	Α	Α	Α	C	C	Α	
95th %tile Queue, veh	2	3	3	4	4	0	0	

Synchro 8 Report TRIANGLE EXISTING 8/31/1998 Baseline

HCM Unsignalized Intersection Capacity Analysis 37: Walmart Entrance/Greenfield Dr & Crossroads

	•	-	+	1	+	1	1	1	1	1	1	1
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBF
Lane Configurations		<b>^</b>	7	7	<b>^</b> ^	7	7		7			7
Volume (veh/h)	0	869	60	101	666	5	108	0	141	0	0	62
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.50	0.75	0.43	0.51	0.79	0.38	0.64	0.85	0.56	0.67	0.85	0.68
Hourly flow rate (vph)	0	1159	140	198	843	13	169	0	252	0	0	9
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type		TWLTL			TWLTL							
Median storage veh)		2			2							
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	856			1159			1976	2411	579	2070	2398	422
vC1, stage 1 conf vol							1159	1159		1239	1239	
vC2, stage 2 conf vol							818	1252		831	1159	
vCu, unblocked vol	856			1159			1976	2411	579	2070	2398	422
tC, single (s)	4.1			4.1			*5.8	6.5	6.9	7.5	6.5	6.9
tC, 2 stage (s)							4.8	5.5		6.5	5.5	
tF(s)	2.2			2.2			3.5	4.0	3.3	3.5	4.0	3.3
p0 queue free %	100			67			25	100	45	100	100	84
cM capacity (veh/h)	780			599			224	135	458	10	65	58
Direction, Lane #	EB1	EB 2	EB3	WB 1	WB 2	WB3	WB 4	NB 1	NB 2	SB 1		
Volume Total	579	579	140	198	422	422	13	169	252	91		
Volume Left	0	0	0	198	0	0	0	169	0	0		
Volume Right	0	0	140	0	0	0	13	0	252	91		
cSH	1700	1700	1700	599	1700	1700	1700	224	458	581		
Volume to Capacity	0.34	0.34	0.08	0.33	0.25	0.25	0.01	0.75	0.55	0.16		
Queue Length 95th (ft)	0	0	0	36	0	0	0	130	81	14		
Control Delay (s)	0.0	0.0	0.0	14.0	0.0	0.0	0.0	57.8	22.0	12.4		
Lane LOS				В				F	С	В		
Approach Delay (s)	0.0			2.6				36.4		12.4		
Approach LOS								E		В		
Intersection Summary												
Average Delay			6.7									
Intersection Capacity Utilization			45.6%	IC	CU Level	of Service			Α			
Analysis Period (min)			15									

<sup>\*</sup> User Entered Value

TRIANGLE EXISTING 8/31/1998 Baseline Synchro 8 Report

### HCM 2010 Roundabout 40: Crossroads & Highland Meadows Pkwy

2/24/2015

Intersection						
Intersection Delay, s/veh	7.2					
Intersection LOS	Α					
Approach		EB		WB		SB
Entry Lanes		2		2		2
Conflicting Circle Lanes		2		2		2
Adj Approach Flow, veh/h		1139		819		313
Demand Flow Rate, veh/h		1162		835		319
Vehicles Circulating, veh/h		92		201		731
Vehicles Exiting, veh/h		958		1053		305
Follow-Up Headway, s		2.535		2.535		2.667
Ped Vol Crossing Leg, #/h		0		0		0
Ped Cap Adj		1.000		1.000		1.000
Approach Delay, s/veh		7.3		6.6		8.2
Approach LOS		Α		Α		Α
Lane	Left	Right	Left	Right	Left	Right
Designated Moves	LT	TR	LT	TR	L	TR
Assumed Moves	LT	TR	LT	TR	L	TR
RT Channelized						
Lane Util	0.470	0.530	0.469	0.531	0.288	0.712
Critical Headway, s	4.544	4.544	4.544	4.544	4.645	4.328
Entry Flow, veh/h	546	616	392	443	92	227
Cap Entry Lane, veh/h	1306	1306	1183	1183	689	735
Entry HV Adj Factor	0.981	0.980	0.982	0.979	0.978	0.982
Flow Entry, veh/h	535	604	385	434	90	223
Cap Entry, veh/h	1281	1280	1161	1158	674	722
V/C Ratio	0.418	0.472	0.331	0.375	0.134	0.309
Control Delay, s/veh	6.9	7.7	6.3	6.8	6.8	8.7
LOS	Α	Α	Α	Α	Α	Α
95th %tile Queue, veh	2	3	1	2	0	1

HCM Signalized Intersection Capacity Analysis 42: LCR 3 & Crossroads

	-	7	1	•	1	1		
Movement	EBT	EBR	WBL	WBT	NBL	NBR		
Lane Configurations	<b>↑</b> ₽		7	<b>^</b>	W			
Volume (vph)	863	26	2	702	14	12		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900		
Total Lost time (s)	8.0		8.0	8.0	8.0			
Lane Util. Factor	0.95		1.00	1.00	1.00			
Frpb, ped/bikes	1.00		1.00	1.00	1.00			
Flpb, ped/bikes	1.00		1.00	1.00	1.00			
Frt	1.00		1.00	1.00	0.96			
Flt Protected	1.00		0.95	1.00	0.97			
Satd. Flow (prot)	3521		1769	1863	1730			
Flt Permitted	1.00		0.24	1.00	0.97			
Satd. Flow (perm)	3521		452	1863	1730			
Peak-hour factor, PHF	0.87	0.85	0.25	0.87	0.45	1.00		
Adj. Flow (vph)	992	31	8	807	31	12		
RTOR Reduction (vph)	3	0	0	0	9	0		
Lane Group Flow (vph)	1020	0	8	807	34	ő		
Confl. Peds. (#/hr)	1020	1	1	001	-04	0		
Turn Type	NA	- 1	Perm	NA	Prot			
Protected Phases	4		Cilli	8	2			
Permitted Phases	4		8	0	2			
Actuated Green, G (s)	39.0		39.0	39.0	15.0			
Effective Green, g (s)	39.0		39.0	39.0	15.0			
Actuated g/C Ratio	0.56		0.56	0.56	0.21			
Clearance Time (s)	8.0		8.0	8.0	8.0			
Vehicle Extension (s)	3.0		3.0	3.0	3.0			
	1961		251	1037	370			
Lane Grp Cap (vph)			251					
v/s Ratio Prot	0.29		0.00	c0.43	c0.02			
v/s Ratio Perm	0.50		0.02	0.70	0.00			
v/c Ratio	0.52		0.03	0.78	0.09			
Uniform Delay, d1	9.7		7.0	12.1	22.0			
Progression Factor	1.00		1.00	1.00	1.00			
Incremental Delay, d2	1.0		0.2	5.8	0.5			
Delay (s)	10.7		7.2	17.9	22.5			
Level of Service	B		Α	B	C			
Approach Delay (s)	10.7			17.8	22.5			
Approach LOS	В			В	С			
Intersection Summary								
HCM 2000 Control Delay			14.0	Н	CM 2000	Level of Service	В	
HCM 2000 Volume to Capa	city ratio		0.59					
Actuated Cycle Length (s)			70.0		um of lost		16.0	
Intersection Capacity Utiliza	ation		53.6%	IC	CU Level c	of Service	A	
Analysis Period (min)			15					

Synchro 8 Report TRIANGLE EXISTING 8/31/1998 Baseline

## **Appendix D** – ARCADY output

## Ward Ave and Crossroads Blvd

### 2035 - AM Peak Period

### Volumes

		. 0.400			
From \ To	1st exit	2nd exit	3rd exit	U-Turn	Total
SB_Ward Ave	14.000	0.000	3,000	0.000	17.00
EB_Crossroads Blvd	32,000	713.000	33,000	0.000	778,00
NB_Ward Ave	4.000	3.000	24,000	0.000	31.00
WB_Crossroads Blvd	12.000	1040.000	5.000	0.000	1057.00
Total	62.00	1756.00	65.00	0.00	-

### Truck Percentages

From \ To	1st exit	2nd exit	3rd exit	U-Turn	Average
SB_Ward Ave	2.0	2.0	2.0	0.0	1.50
EB_Crossroads Blvd	100.0	2.0	2.0	0.0	26.00
NB_Ward Ave	100.0	100.0	100.0	0.0	75.00
WB_Crossroads Blvd	2.0	2.0	100.0	0.0	26.00
Average	51.00	26.50	51.00	0.00	-

### Geometry and Analysis Results

Leg	SB_Ward Ave	EB_Crossroads Blvd	NB_Ward Ave	WB_Crossroads Bl
V - Approach road half-width (ft)	12.00	24.00	12.00	24.00
E - Entry width (ft)	14.00	26.00	14.00	26,00
l' - Effective flare length (ft)	130.00	130.00	130.00	130.00
R - Entry radius (ft)	75.00	75.00	75.00	75.00
D - Inscribed circle diameter (ft)	145.00	145.00	145.00	145.00
PHI - Conflict (entry) angle (deg)	20.00	20.00	20.00	20,00
Exit Only				
Leg Has Bypass				
Percentage Intercept Adjustment (%)	90.00	90.00	90.00	90.00
Average Demand (Veh/hr)	17.00	778.00	31.00	1057.00
Max V/C Ratio	0.04	0.41	0.09	0.55
Max Delay (s)	7.65	2.89	11.00	3.79
Max LOS	А	А	В	А
Max 95th percentile Queue (Yeh)	~1	1.00	~1	1.00



## Ward Ave and Crossroads Blvd

### 2035 - PM Peak Period

### Volumes

From \ To	1st exit	2nd exit	3rd exit	U-Turn	Total
SB_Ward Ave	9.000	2.000	12,000	0.000	23.00
EB_Crossroads Blvd	26.000	975.000	64.000	0.000	1065.00
NB_Ward Ave	6.000	0.000	32,000	0.000	38.00
WB_Crossroads Blvd	3.000	929.000	6.000	0.000	938.00
Total	44.00	1906.00	114.00	0.00	-

### Truck Percentages

From \ To	1st exit	2nd exit	3rd exit	U-Turn	Average		
SB_Ward Ave	2.0	2.0	2.0	0.0	1.50		
EB_Crossroads Blvd	100.0	2.0	2.0	0.0	26.00		
NB_Ward Ave	100.0	100.0	100.0	0.0	75.00		
WB_Crossroads Blvd	2.0	2.0	100.0	0.0	26.00		
Average	51.00	26,50	51.00	0.00	-		

### Geometry and Analysis Results

		,		
Leg	SB_Ward Ave	EB_Crossroads Blvd	NB_Ward Ave	WB_Crossroads Bl
V - Approach road half-width (ft)	12.00	24.00	24.00	24.00
E - Entry width (ft)	14.00	26.00	26.00	26.00
l' - Effective flare length (ft)	130.00	130.00	130.00	130.00
R - Entry radius (ft)	75.00	75.00	75.00	75.00
D - Inscribed circle diameter (ft)	145.00	145.00	145.00	145.00
PHI - Conflict (entry) angle (deg)	20.00	20.00	20.00	20.00
Exit Only				
Leg Has Bypass				
Percentage Intercept Adjustment (%)	90.00	90.00	90.00	90.00
Average Demand (Veh/hr)	23.00	1065.00	38.00	938.00
Max V/C Ratio	0.05	0.55	0.06	0.50
Max Delay (s)	6.88	3.78	5.92	3.46
Max LOS	А	А	Α	Α
Max 95th percentile Queue (Veh)	~1	1.00	~1	?



## **Appendix E** – Cost estimate

## **Crossroads Corridor Study**

## **Estimate of Conceptual Project Costs**

**Urban Typical Section w/ Curb & Gutter** 



February 26, 2015



Date Prepared:

ltem		Unit Cost	Quantity	Extended Cost	Notes	
1 Earthwork	CY	\$13.77	11,615	\$159,936		
<sup>2</sup> Aggregate Base Course (Class 6)	TON	\$18.09	7,448	\$134,734	12-Inch Depth	
<sup>3</sup> Hot Mix Asphalt (Grade S)(100)(PG 64-22)	TON	\$65.99	8,213	\$541,998	8 12-Inch Depth	
4 Curb and Gutter	LF	\$24.40	22,400	\$546,560	ncludes Median & Outside Edge C&G	
5 Concrete Sidewalk	SY	\$34.69	12,444	\$431,698	10-Foot Shared Use Path	
6 Concrete Box Culvert	Each	\$500,000.00	0	\$0	181-Foot Length (\$2,700/If Unit Price)	
<sup>7</sup> Bridge Widening	SF	\$125.00	0	\$0		
8 Traffic Signal	Each	\$250,000.00	2	\$500,000		
9				\$0		
10				\$0		
				\$2,314,926		
		0/ D				, <b> </b>
D : 10 1 1 D: 11		% Range		% Used	Cost	
Project Construction Bid Items		Project Dependent		N/A	\$2,314,926	(A)
Contingencies		(15 - 30%) of <b>A</b>		30.0%	\$694,478	(B)
Utilities		(5 - 20%) of ( <b>A+B</b> )		10.0%	\$300,940	(D)
Drainage / Irrigation		(4 - 10%) of ( <b>A+B</b> )		10.0%	\$300,940	(E)
Signing and Striping		(1 - 5%) of ( <b>A+B</b> )		3.0%	\$90,282	(F)
Construction Signing & Traffic Control		(5 - 30%) of ( <b>A+B</b> )		20.0%	\$601,881	(G)
Lighting		(1 - 5%) of ( <b>A+B</b> )		2.0%	\$60,188	(H)
Landscaping		(1 - 20%) of ( <b>A+B</b> )		20.0%	\$601,881	(1)
Mobilization		(4 - 20%) of (A+B+C+	D+E+F+G+H+I)	15.0%	\$744,827	(J)
Total of Construction Bid Items		(A+B+C+D+E+F+G-	+H+I+J)		\$5,710,000	(K)
Engineering						
Construction Engineering		15% of ( <b>K</b> )		15.0%	\$856,500	(L)
Preliminary & Final Design		10% of ( <b>K</b> )		10.0%	\$571,000	( M )
ROW (Unit Price - \$5/sf)		0	SF	\$5	\$0	(N)
Total Project Cost (K+L+M+N)					\$7,140,000	

## **Crossroads Corridor Study**

## **Estimate of Conceptual Project Costs**

## Rural Typical Section w/ Roadside Ditches





Date Prepared:

February 26, 2015

ltem		Unit Cost	Quantity	Extended Cost	Notes	
1 Earthwork	CY	\$13.77	29,867	\$411,264		
Aggregate Base Course (Class 6)	TON	\$18.09	7,448	\$134,734	12-Inch Depth	
Hot Mix Asphalt (Grade S)(100)(PG 64-22)	TON	\$65.99	8,213	\$541,998	12-Inch Depth	
4 Concrete Sidewalk	SY	\$34.69	12,444	\$431,698	10-Foot Shared Use Path	
5 Concrete Box Culvert	Each	\$500,000.00	0	\$0	181-Foot Length (\$2,700/If Unit Price)	
Bridge Widening	SF	\$125.00	0	\$0		
Traffic Signal	Each	\$250,000.00	2	\$500,000		
8				\$0		
9				\$0		
10				\$0		
				\$2,019,694		
						1
		% Range		% Used	Cost	
Project Construction Bid Items		Project Dependent		N/A	\$2,019,694	(A)
Contingencies		(15 - 30%) of <b>A</b>		30.0%	\$605,908	(B)
Utilities		(5 - 20%) of ( <b>A+B</b> )		10.0%	\$262,560	(D)
Drainage / Irrigation		(4 - 10%) of ( <b>A+B</b> )		6.0%	\$157,536	(E)
Signing and Striping		(1 - 5%) of ( <b>A+B</b> )		3.0%	\$78,768	(F)
Construction Signing & Traffic Control		(5 - 30%) of ( <b>A+B</b> )		20.0%	\$525,120	(G)
Lighting		(1 - 5%) of ( <b>A+B</b> )		2.0%	\$52,512	(H)
Landscaping		(1 - 20%) of ( <b>A+B</b> )		10.0%	\$262,560	(1)
Mobilization		(4 - 20%) of ( <b>A+B+C+</b>	D+E+F+G+H+I)	15.0%	\$594,699	(J)
Total of Construction Bid Items		(A+B+C+D+E+F+G-	+H+I+J)		\$4,559,000	(K)
Engineering						
Construction Engineering		15% of ( <b>K</b> )		15.0%	\$683,850	(L)
Preliminary & Final Design		10% of ( <b>K</b> )		10.0%	\$455,900	(M)
ROW (Unit Price - \$5/sf)		0	SF	\$5	\$0	(N)
Total Project Cost (K+L+M+N)					\$5,700,000	
				-		

## **Appendix F** – Term of reference



### CITY OF LOVELAND

Public Works

### Transportation Development Review

500 East Third Street • Loveland, Colorado 80537 (970)962-2501 • (970)962-2945 FAX • (970)962-2620 TDD

June 9, 2014

The City of Loveland Engineering Division is seeking a consulting engineering firm experienced and qualified in developing corridor access management plans. The following is a Request for Proposal (RFP) for a Corridor Access Management Plan for Crossroads Boulevard between Larimer County Road 5 (Fairgrounds Avenue) and Larimer County Road 3.

### **Project Goals:**

- Summarize background traffic, existing traffic/access issues, traffic accident data and projected traffic in year 2035
- Define existing and future access locations, the type of access (right-in/right-out, three-quarter, full movement, roundabouts, signalized/unsignalized), and any modifications needed to the existing accesses. Several intersection configurations should be considered including roundabouts.
- 3. Provide traffic signal warrant analysis (existing and future) for key intersections
- 4. Provide public input from adjacent property owners including but not limited to the Resurrection Christian School, Wal-Mart distribution center, Town of Windsor, etc..
- Provide level of service (LOS) modeling to show the recommended future access/intersection configurations will function appropriately in the year 2035 per Loveland's criteria in the Larimer County Urban Area Street Standards (LCUASS)
- 6. Provide preliminary cost estimates of the access/intersection improvements

### Information to be provided by the City of Loveland:

- 1. Current traffic counts (including daily volumes and peak hours)
- 2. City of Loveland 2035 Transportation Plan data including traffic analysis zones used for projected
- 3. Most current Aerial Photography available and LIDAR
- 4. Property Ownership data for area inside City of Loveland boundaries.
- 5. Accident data and collision diagrams for intersections
- Any relevant public improvement plans and/or traffic impact studies. Traffic impact study for truck access to Walmart distribution center will be provided which includes traffic signal warrant analysis for that intersection.

### Statement of Interest and Work Plan Instructions:

The Consultant is encouraged to follow the outline and page distribution indicated below. The selection committee will have limited time to review the submittals. If the committee has difficulty finding desired information, there will be a tendency to consider the submittal as non-responsive with a corresponding score. Brevity and clarity responding to the information required and explaining your key concepts is encouraged. The right is also reserved to reject any and all submittals. A digital copy of the Statement of Interest and Work Plan (including the cover letter) must be submitted.

### STATEMENT OF INTEREST AND WORK PLAN FORMAT

1.	COVER	ITEM LETTER	RECOMMENDED PAGE DISTRIBUTION 1 page (maximum)	RELATIVE WEIGHT FOR RATING
2.	STATEM	ENT OF INTEREST	2 pages (maximum)	
	A.	Project Team		15%
	В.	Firm Capability		15%
	C.	Past Performance	e and Experience	15%
3.	WORK P	LAN	2 pages (maximum)	
	D.	Project Goals and	Concept	15%
	E.	Project Controls		5%
	F.	Critical Issues (Pr	roblems/Solutions)	15%
	J.	Schedule		10%
4.	FEE PRO	POSAL 1 page (m	naximum) – the spreadsheet may be 11" X 17	711
	K.	Fee Estimate	Man-hour/Task Spreadsheet and assumption	ns) <u>10%</u>
			TOTAL	100%

### STATEMENT OF INTEREST AND WORK PLAN

### FORMAT AND CRITERIA EXPLANATION

- 1. COVER LETTER (1 page maximum)
  - A. The letter should be addressed to:

Mr. Shawn Fetzer, PE, Civil Engineer City of Loveland - Public Works 500 East Third St. Suite 310 Loveland, CO 80537

- B. It should contain, at the minimum, the following elements of information:
  - i) Identify the project name and project location:
  - ii) An expression of the firm's interest in the project.
  - iii) A summary of the key information and concepts contained in the submittal.
  - iv) The name, telephone number, and e-mail address of the individual to contact regarding the Statement of Interest and Work Plan submittal.
  - v) A certification that the information and data submitted is true and complete to the best knowledge of the individual signing the letter.
  - vi) The letter shall be signed by a representative of the firm fully authorized to submit proposals and sign contracts on the company's behalf. The letter shall include a statement to that effect.

THE FOLLOWING IS A GENERAL DESCRIPTION TO AID YOU IN PREPARING THE STATEMENT OF INTEREST AND WORK PLAN. THE GENERAL OUTLINE AND CONTENT SHOULD BE FOLLOWED. HOWEVER, THE DISCUSSION OF THE SPECIFIC ELEMENTS SHOULD BE DETERMINED BY YOUR INTERPRETATION OF THE SPECIFIC PROJECT. THE LISTED ELEMENTS ARE PRESENTED TO HELP YOU DETERMINE THE DISCUSSION CONTENT. THE SELECTION COMMITTEE WILL EVALUATE YOUR INTERPRETATION OF THE MOST IMPORTANT FACTORS TO ADDRESS FOR THIS PROJECT WITHIN THE PAGE LIMITS TO ARRIVE AT ITS RATING FOR YOU.

### 2. STATEMENT OF INTEREST (2 pages maximum)

#### A. PROJECT TEAM

Identify the Project team members that will be involved with this study. Present a brief bio of the key team members with information relevant to their experience and qualifications to do the work on this specific project.

- i) Qualifications and relevant individual experience for providing Corridor Access Management analysis and recommendations.
- ii) Unique knowledge that key team members will provide relating to the project.
- iii) Experience on similar projects including the experience involving roundabout corridor design.
- iv) Time commitment of key staff.

### B. FIRM CAPABILITIES

- i) Size and discipline of the technical staff and Firm's familiarity with the project area.
- Address the firm's capacity to do the project work concurrent with other work load commitments.
- iii) The capability of the firm to use traffic analysis software and other required software to interpret

### C. PAST PERFORMANCE

Address each of the following:

- i) Recent (past 3 years) experience providing transportation planning or transportation engineering services for the City of Loveland or nearby municipalities.
- Coordination process that has been used in the past to make sure all stakeholder concerns are addressed.

### 3. WORK PLAN (2 pages maximum)

### A. PROJECT GOALS AND CONCEPT

- i) Demonstrate a clear understanding of the project goals.
- ii) Describe concept on how these goals will be accomplished
- iii) Include the list of deliverables that will meet the goals of this study.

### B. PROJECT CONTROL

Describe how you plan to accomplish the following:

- i) Cost Control
  - (1) Controlling the Consultant contract costs.
  - (2) Controlling the future construction costs to stay within the budget.

### ii) Quality Control

- (1) Insuring that City of Loveland procedures are followed where appropriate.
- (2) Insuring that project plans, specifications and estimates are free of errors and meet the City of Loveland standards.
- iii) Schedule Control

### C. CRITICAL ISSUES (Problems/Solutions)

This is your analysis of the <u>most significant problems</u> that will need to be addressed for this project and their possible solutions.

### D. SCHEDULE

Provide a schedule that identifies the approximate time periods required to accomplish the key tasks on the project.

- i) Explain capability to complete this study within 4 months of being awarded contract.
- ii) Designate project milestones and anticipated completion dates of stated milestones.

From the information provided, the committee will evaluate to what extent the consultant's proposed Work Plan will address the project's goals, meet the project's time frames, and help secure the needed approvals with the least effort on the part of the City, at the minimum cost, and in the quickest time frame.

4. FEE PROPOSAL (1 page maximum - the spreadsheet may be 11" X 17")

#### A. Fee estimate

- i) Provide a fee proposal that is within the anticipated budget of \$30,000
- ii) Provide a clear description of what that fee includes
  - (1) Submit a task/man-hour spreadsheet showing the costs to provide the work needed for each key task for this project. Those key tasks are: Summarizing existing traffic, Providing existing/future access locations and configurations, Public Involvement, Providing LOS modeling, and Cost Estimates. Ancillary costs such as project management, and reimbursable expenses, should be included in the key tasks above, not separately.
  - (2) The spreadsheet may be reported in as much detail as the consultant deems appropriate. However, provide in an easy to read format, a summary of the costs by the key tasks above, and a grand total for the project.
  - (3) Clearly identify the key assumptions as to what work is, and is not, assumed for the costs quoted. While cost is an issue, the City is most interested in securing the "best value" more so than simply low cost. Prepare your fee estimate with that in mind.

#### SHORT-LISTING PROCESS IN GENERAL

- Other information (in addition to the Statement of Interest and Qualification) will be used by the Selection Committee. This information will include reference checks of work done by the consultants for the City of Loveland and others.
- 2. The Selection Committee will score the firms based on their Statement of Interest and Work Plan submittals and other information.
- 3. The City at its sole discretion may decide to choose the consultant based on the SOI and Work Plan submitted if a clear winner emerges; or, it may decide to Short List two or more consultant teams and request interviews if consultant scores on the SOI and Work Plan are close. All firms submitting Statements of Interest and Work Plan will be notified in writing regarding the results of the consultant selection or Short List decision.
- If an interview is deemed appropriate, Short Listed firms will be asked to attend an interview. Details
  regarding time allotted, format, what the City will expect to be presented at the interview will be
  transmitted with the notice of Short List.

PROPOSALS RECEIVED AFTER THE TIME AND DATE SPECIFIED WILL BE REJECTED. The City of Loveland assumes no obligation of any kind for expenses incurred by any respondent to this solicitation. The City of Loveland reserves the right to reject any and all submittals.

Please send Cover Letter, Statement of Interest, Work Plan and Fee Proposal to Shawn Fetzer with the City of Loveland by 5:00 PM on August 8th to the contact information below.

Email Address: Shawn.fetzer@cityofloveland.org

Mailing Address: Attn: Shawn Fetzer

**Public Works Department** 

Transportation Development Review

Civic Center

500 East Third Street, Suite 310

Loveland, CO 80537

Thank you for your attention and cooperation.

Respectfully,

Shawn Fetzer, P.E. Civil Engineer

Cc: Dave Klockeman, P.E. Bill Hange, P.E.

> Jeff Bailey, P.E. Sean Kellar, P.E.

File



## Exhibit A

04 September 2014

City of Loveland - Public Works 500 East Third St. Suite 310 Loveland CO 80537 Dear Mr. Shawn Fetzer, PE

Corridor Access Management Plan for Crossroads Boulevard between Larimer County Road 5 (Fairgrounds Avenue) and Larimer County Road 3, Loveland, CO Proposal

GHD Inc. and our subconsultant, Atkins North America Inc. (Atkins), are proposing to provide the City of Loveland with the analysis and technical documentation to formulate a corridor plan of traffic controls and access for the subject corridor. Within this team effort we include a public engagement campaign that is both strategic and systematic, beginning with internal stakeholders before engaging external stakeholders and the general public. We propose a traceable, defensible and transparent decision-making process to objectify the selection of intersection controls.

### **WORK PLAN**

### **PROJECT GOALS AND CONCEPT - STUDY PROCESS**

Our work plan provides a sequential framework for selecting roundabouts or traditional forms of traffic control (traffic signals or stop signs) for the intersection control type. In the context of this study, a corridor is considered to be an arterial street with three or more "major" intersections that could potentially be controlled with a roundabout or a traffic signal. We propose to employ components of the NCHRP 772 - Evaluating the Performance of Corridors with Roundabouts.

#### 1. SUMMARIZE BACKGROUND TRAFFIC DATA

Work Plan: Using the current traffic counts and the 2035 Transportation Plan data provided by the City of Loveland, we will compile the data into graphics and tables that present the data in an easy-tounderstand format. Graphics and tables will be provided for the existing conditions, as well as for the 2035 projected traffic data.

Deliverable: Graphics and tables showing the existing and projected 2035 traffic; Turning Movement Count (TMC), Average Daily Traffic (ADT), and Level of Service (LOS) graphics; Compiled appendices of existing traffic/access issues, traffic accident data and methodology for projected traffic in year 2035.

#### 2. INTERSECTION DESIGN ALTERNATIVES

Work Plan: Two levels of design investigation will take place during the study. The first will generate concepts at a strategic level, identifying alignment and location alternatives that can be quickly screened down to a short list or even one preferred alternative for each type of intersection (e.g., signal versus

5325 Wall Street Suite 2305 Madison WI 53718 USA T 1 508 249 4545 F 1 608 249 4402 E madison@ghd.com Www.ghd.com roundabout). We envision two concept package alternatives for the corridor: a signals package and a roundabouts package.

Deliverables: Sketch level diagrams showing intersection footprint or access alternative for preliminary screening and well-developed or functional layouts of the preferred intersection/access control for rough cost estimates, public meeting exhibits and report documentation.

### 3. DEFINE EXISTING AND FUTURE ACCESS LOCATIONS (Latter Reporting Phase)

Goal: Determine the type of access (right-in/right-out, three-quarter, full movement, roundabouts, signalized/unsignalized), and any modifications needed to the existing accesses. Several intersection configurations should be considered, including roundabouts.

Work Plan: The evaluation of alternative intersection control should be based on quantitative measures of performance and qualitative measures. The following is a draft list of the performance measures to be used in our evaluation effort:

### Quantitative measures:

- Safety
- · Operational analysis
- · Construction cost
- Right-of-way cost

### **Qualitative Measures:**

- Constructability
- Environmental
- Practical feasibility
- · Pedestrian and bicyclists

Deliverables: A draft report for review by the City and a final report containing the technical analysis results, public engagement and feedback, City comments, cost estimates and technical appendices.

### 4. PUBLIC ENGAGEMENT

Public Participation Strategy and Goals: A traceable transparent decision making process with strategic public engagement that provides input from adjacent property owners including but not limited to: the Resurrection Christian School, Wal-Mart distribution center, Town of Windsor, etc. The outreach strategy involves a three phase systematic development of informed consent that follows our study process (see flow chart exhibit on this proposal cover).

### First Public Meeting (Drop-in center)

Phase 1 Project Initiation: Establish what the problems are that need to be addressed by the project; establish credibility with the stakeholders, and, establish that our approach/solution to the problem/s are sensible and reasonable.

#### Second Public Meeting (Drop-in center)

Phase 2 Concept Development - Planning Consensus and Phase 3 Alternatives Analysis and Evaluation Consensus: Establish and evaluate intersection and access control alternates that meet the corridor vision, context sensitively and gain consent on preferred alternative.

Deliverables: A public engagement blueprint matrix that identifies the audience, the engagement tools and the timing of engagement; and, public meeting materials and presentations for two milestone meetings.

///GHD-14264\_ML\_Sept 04\_2014 Final (2)

### 5. TRAFFIC SIGNAL WARRANT ANALYSIS (existing and future)

Goal: Provide traffic signal warrant analysis (existing and future) for key intersections.

**Work Plan:** For key intersections, traffic signal warrant analyses may need to be completed for either the existing conditions traffic, or for the projected 2035 traffic volumes.

**Deliverables:** Summary of the traffic signal warrant analysis; Compiled appendices with the full analysis.

### 6. LEVEL OF SERVICE (LOS) MODELING

Goal: Show that the recommended future access/intersection configurations will function appropriately in the year 2035 per Loveland's criteria in the Larimer County Urban Area Street Standards (LCUASS).

**Work Plan:** We propose to predict capacity, queuing, v/c ratios for opening year and the design year (2035) using a two level analysis:

- Deterministic models for operational analysis (e.g. HCM, Synchro and Arcady) to obtain a high confidence for standalone intersection operations, then;
- Stochastic (simulation) modeling for time-step effects of traffic (Synchro/Sim-Traffic) to predict the
  performance measures that cannot be acquired from deterministic models, e.g. MOE's including
  corridor travel times.

**Deliverables:** A capacity comparison of installing a new traffic signal or a roundabout will be generated for each of the critical intersections (up to five intersections are assumed for the purpose of budgeting) and the effects on access for: AM and PM peaks.

### 7. PRELIMINARY COST ESTIMATES OF THE ACCESS/INTERSECTION IMPROVEMENTS

Goal: Provide preliminary cost estimates of the access/intersection improvements.

**Work Plan:** The project team will use the preliminary design concepts and drawings to develop a preliminary cost estimate for the access and intersection improvements identified as a result of the traffic analysis.

**Deliverables:** Summary of preliminary costs associated with the identified improvements – a high-level summary of the data; compiled appendices with backup data.

### PROJECT CONTROL

GHD Inc. shares the City's commitment to quality as evidenced by our ISO 9001: 2008 certification. During the certification process for ISO 9001, GHD developed a Quality Manual and proprietary quality and project delivery systems that reside on the GHD intranet. The integration of these systems requires that quality control (QC) and quality assurance (QA) are considered throughout project delivery. Our quality policy covers adherence to schedules and budgets as well. GHD's project manager Mark Lenters, will be responsible to enter records of QC checks into the project delivery system and internal QA is accomplished through periodic reviews by senior staff and internal audits. By specific corporate policy, every project deliverable prepared by Atkins must undergo a quality control review to assure that the product was prepared in accordance with accepted standards of our professional practice.

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SCHEDULE (from the date of notice to proceed	ed)
1. Summarize background traffic data	Week 1
2. Traffic Signal Warrant Analysis	Week 3
3. Intersection Design Alternatives	Week 5
4. Public Engagement #1	Week 6
5. Level of Service (LOS) Modelling	Week 10
6. Preliminary Cost Estimates	Week 11
7. Public Engagement #2	Week 12
8. Define existing and future access locations (draft and final report)	Weeks 14-16
Total Duration: 4 months	

Our combined larger team makes possible the achievement of this schedule. It assumes that we will have City involvement in setting up meeting space and inviting contacts for public engagement.

Yours truly

GHD Inc.

Mark Lenters

Manyentes

Principal

608-216-2059

///GHD-14264\_ML\_Sept 04\_2014 Final (2)

GHD Inc

5325 Wall Street Suite 2305 Madison WI 53718

T: 1 608 249 4545 F: 1 608 249 4402 E: madison@ghd.com

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### Document Status

Rev Author		Reviewer		Approved for Issue			
No.		Name	Signature	Name	Signature	Date	
				M. Lenters, P.E.	M	04/03/15	

www.ghd.com

