

TRAFFIC IMPACT STUDY

FOR

**PICKLE BARREL RESTAURANT**  
BILLINGS, MONTANA

PREPARED FOR  
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**PICKLE BARREL RESTAURANT**



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## INTRODUCTION

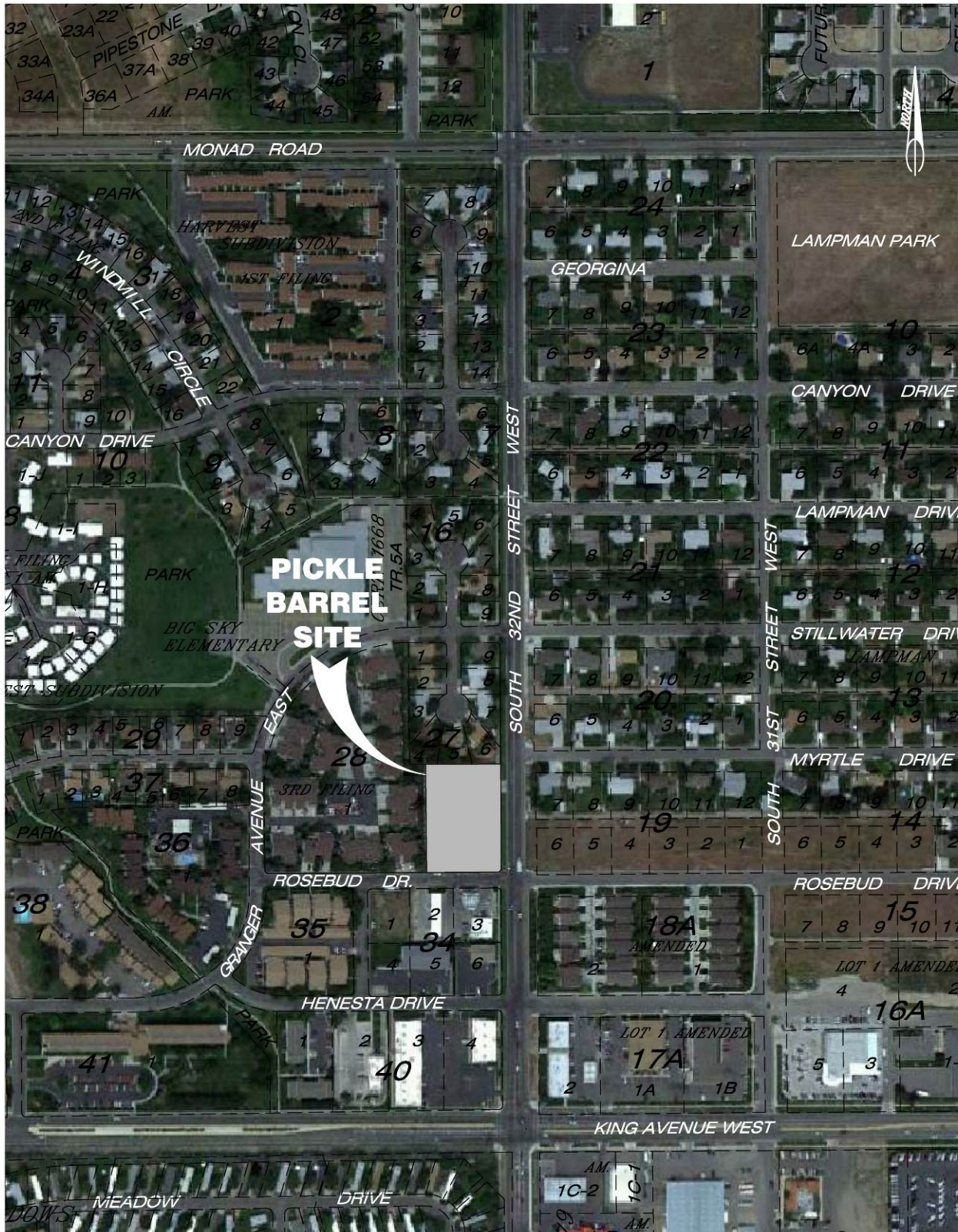
This traffic impact study summarizes the potential impacts of the proposed development of a Pickle Barrel Restaurant in Billings, Montana. The proposed project is located on the northwest corner of the intersection of 32nd Street West and Rosebud Drive on the west end of Billings.

The purpose of this traffic impact study (TIS) is to assess the impacts that this development may have on the surrounding transportation system, and to provide recommendations to mitigate any impacts identified. The methodology and analysis procedures used in this study employ the latest technology and nationally accepted standards in the area of site development and transportation impact assessment. Recommendations made in this report are based on professional judgment and these principles.

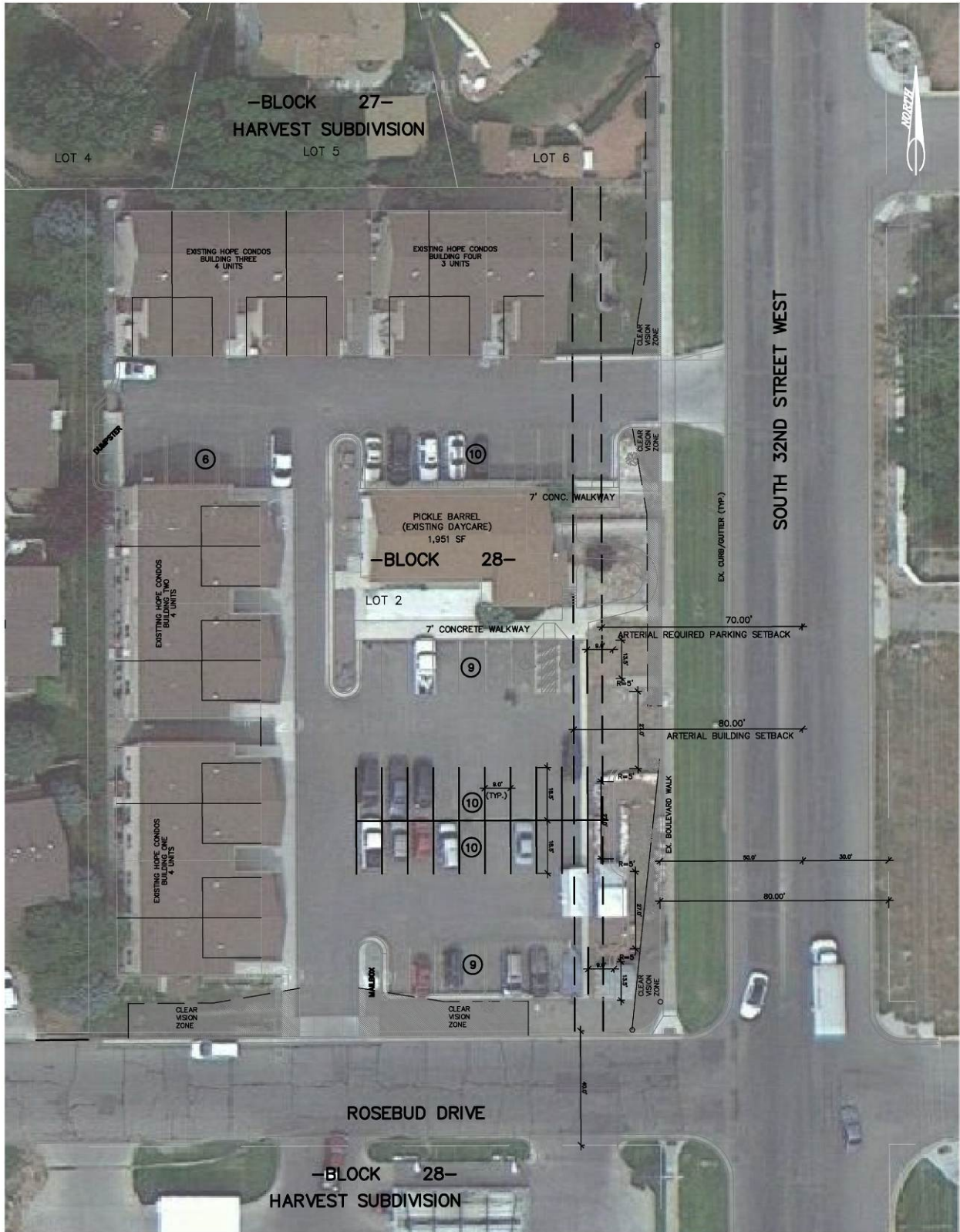
## SITE LOCATION AND DESCRIPTION

The proposed project would consist of redevelopment of the existing day care building located on the northwest corner of 32nd Street West and Rosebud Drive. The project site is located on Lot 2, Block 28 of Harvest Subdivision, 3rd Filing, which is shared with several existing residential condominiums. The site is bordered by 32nd Street West to the east, Rosebud Drive to the south and existing residential development to the north and west. Figure 1 shows the vicinity of the proposed development.

The site currently consists of a 2000 square-foot day care building and 15 residential condominium units. The condo units are occupied, but the day care is currently vacant. Pending a zone change application, the vacant day care building will be remodeled for the Pickle Barrel Restaurant. The new restaurant will have approximately 2000 square feet of interior space and an outdoor patio estimated at approximately 500 square feet. The site is accessed by an existing driveway along Rosebud Drive, as well as a direct access to 32nd Street West on the north side of the restaurant. Because of the location of the customer parking and the building entrance on the south side of the building, it is likely that most of the customer traffic would enter via the Rosebud access. When the Rosebud intersection is congested, it is possible that some drivers will use the 32nd Street access instead, particularly to exit the site. Figure 2 shows the proposed site layout.



**FIGURE 1: SITE LOCATION**



**FIGURE 2: SITE LAYOUT**

## EXISTING CONDITIONS

### **Streets**

The proposed redevelopment of the Pickle Barrel site may have a direct impact on the adjacent streets and intersections. The following paragraphs describe the existing area roadways that are most likely to be affected by the traffic volumes generated by this development.

#### 32nd Street West

Classified as a principal arterial in the City of Billings functional classification system, 32nd Street West provides north-south access from Hesper Road at the south end to Broadwater Avenue where it becomes Zimmerman Trail and continues to the north side of the Rimrocks where it intersects US Highway 3 west of the airport. Near the project vicinity, 32nd Street West has a three-lane cross section with a two-way left-turn lane and traffic signals at major intersections. Traffic count data recently collected by the City of Billings shows Average Annual Daily Traffic (AADT) volumes of 16,600 vehicles per day (vpd) in August 2012 and 15,500 vpd in November 2012. The posted speed limit on 32nd Street West is 35 mph.

#### Rosebud Drive

Rosebud Drive is classified as a local street in the Billings functional classification system. It provides access to primarily residential properties located on both the west and east sides of 32nd Street West. Rosebud Drive is a two-lane roadway with stop control at 32nd Street West and uncontrolled intersections within the neighborhoods on either side. There is not a posted speed limit on 32nd Street West, but it is generally considered to be 25 mph, as with all local residential streets.

#### King Avenue West

King Avenue West is classified as a principal arterial in the Billings functional classification system. It provides east-west access between the West Billings Interstate 90 Interchange and its terminus near 80th Street West on the far west end of the Billings area. Within the vicinity of 32nd Street West, King Avenue West consists of a five-lane section with raised median and provides access to a mix of commercial and residential development. Traffic volumes on King Avenue West range from approximately 10,000 vpd near 32nd Street West to 25,000 vpd near 24th Street West where the

commercial traffic increases significantly. King Avenue West has a posted speed limit of 35 mph near the project vicinity.

#### Monad Road

Monad Road is classified as a minor arterial in the Billings functional classification system. It provides east-west access from Shiloh Road on the west end to Moore Lane near its intersection with Laurel Road on the east end. It generally consists of a single lane in each direction with dedicated turn lanes at major intersections. Monad Road has a posted speed limit of 35 mph.

#### **Intersections**

The following paragraphs describe the existing area intersections that are most likely to be impacted by the redevelopment of the proposed Pickle Barrel site.

#### 32nd Street West & Rosebud Drive

The intersection of 32nd Street West and Rosebud Drive is a two-way stop-controlled intersection with stop signs located on the eastbound and westbound Rosebud Drive approaches. The northbound and southbound approaches consist of dedicated left-turn lanes provided by the newly striped two-way left-turn lane. The eastbound and westbound approaches provide a single lane for all movements, although adequate width is available for a right-turning vehicle to get around another vehicle waiting to turn left.

#### 32nd Street West & King Avenue West

The intersection of 32nd Street West and King Avenue West is controlled by an existing fully-actuated traffic signal. The northbound and southbound approaches consist of three separate approach lanes to accommodate left-turn, thru, and right-turn movements. The westbound approach consists of a dedicated left-turn lane, two thru lanes, and a dedicated right-turn lane. The eastbound approach consists of a dedicated left-turn lane, one thru lane and one shared thru/right-turn lane. The existing traffic signal provides for protected/permitted left-turn phasing for all approaches with an overall peak-hour cycle length of approximately 100 seconds.

### 32nd Street West & Monad Road

The intersection of 32nd Street West and Monad Road is also controlled by a fully-actuated traffic signal. The northbound, southbound, and eastbound approaches all consist of a dedicated left-turn lane and a shared thru/right-turn lane. The westbound approach has three separate lanes for left-turn, thru and right-turn movements. The existing traffic signal provides for protected/permitted left-turn phasing for the northbound and southbound approaches, but does not provide a protected phase for eastbound or westbound left-turn movements. The overall peak-hour cycle length was measured to be approximately 80 seconds.

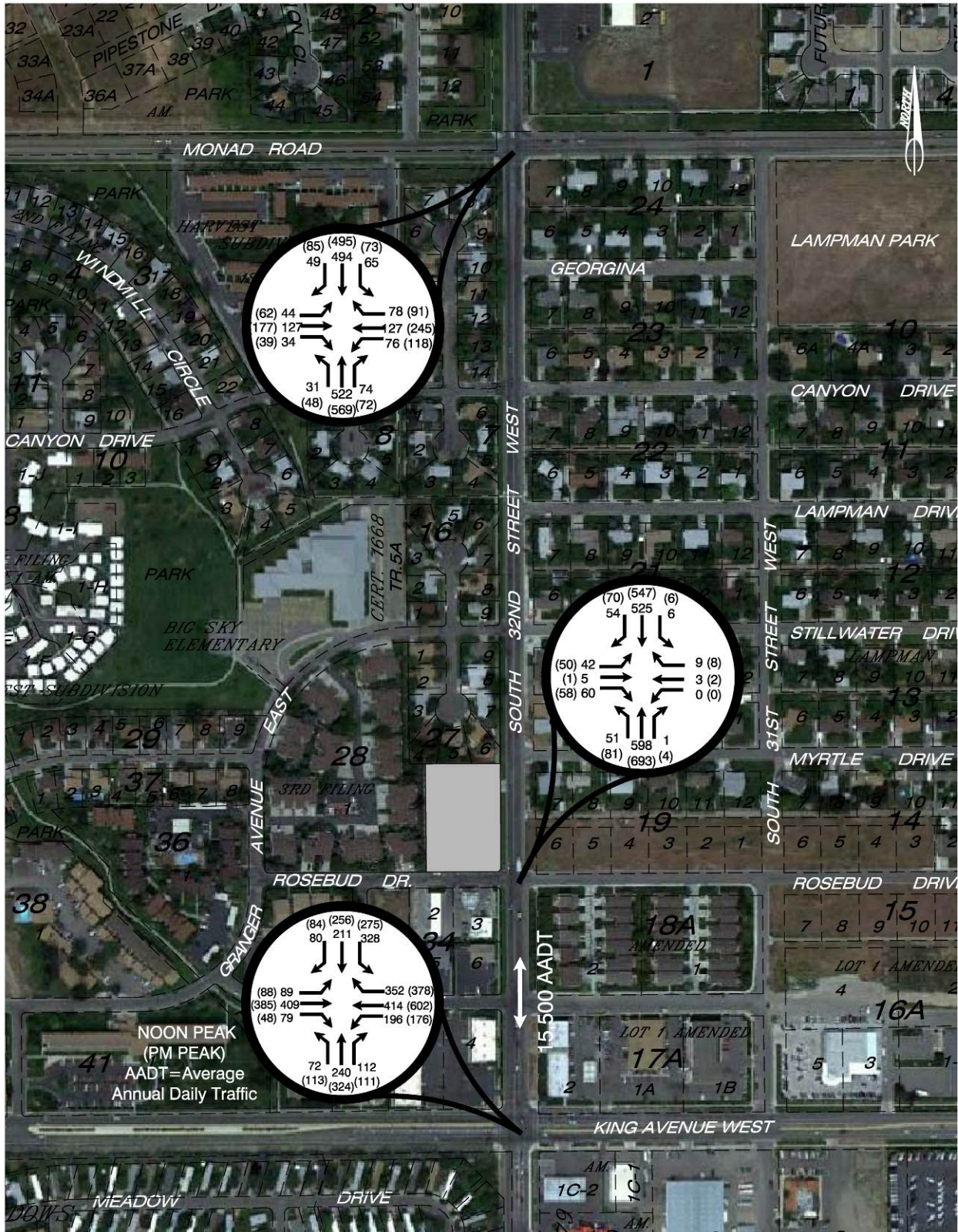
### **Traffic Volumes**

Existing weekday noon and PM peak hour turning movement counts were collected for the study area intersections in November 2012. The noon peak hour was assumed to be from 12:00 to 1:00 PM and the PM peak hour was assumed to be from 4:30 to 5:30 PM. MDT seasonal adjustment factors for the month of November were applied to the existing traffic volumes. Figure 3 summarizes the peak hour turning movement volumes, and detailed traffic count data are included in Appendix A.

### **Intersection Capacity**

Capacity calculations were performed for the study area intersections using Synchro 8 (Version 8.0.802.685), which is based on *2010 Highway Capacity Manual (HCM2010)* methodologies. The *HCM2010* defines level of service (LOS) as “a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience.” LOS is a qualitative measure of the performance of an intersection with values ranging from LOS A, indicating good operation and low vehicle delays, to LOS F, which indicates congestion and longer vehicle delays.

The City of Billings generally considers LOS C as the minimum standard for acceptable peak hour intersection operations. As shown by the results in Table 1, most of the study area intersection approaches currently operate at LOS C or better during both the noon and PM peak hours. The one exception is the eastbound approach to the intersection of 32nd Street West and Rosebud Drive, which currently operates at LOS F during both peak periods. Detailed capacity calculation worksheets for existing conditions are provided in Appendix B.



**FIGURE 3: EXISTING TRAFFIC VOLUMES**

**Table 1. Capacity Calculation Summary - Existing Conditions**

Intersection	Approach	Existing (2012)			
		Noon Peak		PM Peak	
		Avg Delay (s/veh)	LOS	Avg Delay (s/veh)	LOS
<i>Intersection Control</i>		<i>Traffic Signal</i>			
Monad Rd & 32nd St W	EB	26.2	C	26.5	C
	WB	26.3	C	27.6	C
	NB	13.7	B	21.8	C
	SB	11.5	B	18.5	B
	Intersection	16.3	B	22.6	C
<i>Intersection Control</i>		<i>Stop Control</i>			
Rosebud Dr & 32nd St W	EB	131.0	F	793.9	F
	WB	21.6	C	32.9	D
	NB	0.7	A	1.0	A
	SB	0.1	A	0.1	A
	Intersection	11.6	--	67.0	--
<i>Intersection Control</i>		<i>Traffic Signal</i>			
King Ave W & 32nd St W	EB	31.5	C	31.2	C
	WB	32.0	C	34.0	C
	NB	29.1	C	32.6	C
	SB	22.0	C	23.0	C
	Intersection	28.9	C	30.9	C

## TRIP GENERATION

An accurate estimate of site-generated traffic must be made in order to analyze the impacts of a new development. The most common source for determining trip generation rates is *Trip Generation, 8th Edition*, published by the Institute of Transportation Engineers (ITE). The land use categories available in this manual that would be the closest to the characteristics of a Pickle Barrel Restaurant would be the Fast-Food Restaurant with Drive-through Window (ITE Land Use 934) and the High-turnover (Sit-down) Restaurant (ITE Land Use 932). Through discussions with the City of Billings Engineering Department it was agreed that neither of these categories fully represent a sandwich shop like the Pickle Barrel, which does not have a drive-through window and where customers order at the counter and then sit down or take the food to go. It was anticipated that the trip generation characteristics of this type of restaurant would fall somewhere between the trip generation rates of a fast-food restaurant and a high-turnover sit-down restaurant.

Therefore, trip generation data was collected at two local restaurants that are similar in nature to the Pickle Barrel. The selection of restaurants was approved ahead of time by the City of Billings Engineering Department and included the Pita Pit Restaurant on Grand Avenue (west of 24th Street West) and the Spicy Pickle Restaurant on 24th Street West (south of King Avenue West). As shown by the results provided in Appendix C, trip generation data was collected during both of the peak periods used for this study, the weekday noon peak hour and the weekday PM peak hour. Data was also collected during the Saturday noon peak hour at the Pita Pit and has been provided for comparison purposes even though this peak hour was not considered for further analysis.

The resulting noon and PM peak hour trip generation rates were then used to estimate the number of trips that will be generated by the proposed Pickle Barrel Restaurant, as shown in Table 2 below. In order to be conservative, the maximum peak hour trip generation rate of the two restaurants discussed above was used to estimate the peak hour trip generation for the Pickle Barrel, as opposed to using the average of the two. The Spicy Pickle data was higher for the weekday noon peak hour, but the Pita Pit was higher for the weekday PM peak hour. The average weekday rate shown in Table 2 was based on the proportion of average weekday and PM peak hour trip generation estimates in the ITE Trip Generation manual.

Land Use	Units	Average Weekday			Noon Peak Hour			PM Peak Hour		
		total	enter	exit	total	enter	exit	total	enter	exit
Pickle Barrel Restaurant	2.50	310	155	155	75	37	38	21	11	10
Internal Capture	0%	0	0	0	0	0	0	0	0	0
Pass-by Trips	43%	133	67	66	32	16	16	9	5	4
Alternate Mode (External)	0%	0	0	0	0	0	0	0	0	0
New External Personal Vehicle		177	88	89	43	21	22	12	6	6
Billings Sandwich Shop Counts (See attached data)		Units = 1000 SF Gross Floor Area								
Average Weekday:		Average Rate = 124.03			(50% entering, 50% exiting)					
Weekday Noon Peak Hour:		Average Rate = 30.00			(49% entering, 51% exiting)					
Weekday PM Peak Hour:		Average Rate = 8.46			(53% entering, 47% exiting)					

In order to estimate the net number of new trips made by personal vehicles external to the site, adjustments should often be made to account for internal capture trips, pass-by trips and trips made

by alternate modes. Internal capture trips are those that are made from one on-site development to another using internal roadways. Mixed-use developments often have a high number of internal trips made between the various land uses. For this site in particular, it is possible that internal trips would be generated between the residential condos and the Pickle Barrel Restaurant, but these trips are not expected to make up a significant portion of the average weekday trips and were therefore not accounted for in this analysis.

Pass-by trips are trips made to a development as a secondary destination, but the primary trip path is on the adjacent street system. Commercial developments often generate a significant amount of pass-by trips. As shown in Table 2, pass-by rates were estimated for the restaurant based on data summarized in the ITE *Trip Generation Handbook, 2<sup>nd</sup> Edition*. The pass-by rate used for the Pickle Barrel restaurant was the lower (and more conservative) of the rates provided for fast-food restaurant with drive-through window and high-turnover sit-down restaurant.

Typically, it is also important to estimate the number of new trips that would be made by alternate modes of travel (pedestrian, bicycle and transit). These trips would not involve new external personal vehicles accessing the site. The Pickle Barrel site will likely generate quite a bit of pedestrian and bicycle traffic from nearby residential neighborhoods, but it is not anticipated that it would have a significant effect on the results of this analysis. In order to add a measure of conservatism to the study, no reductions were made for alternate mode trips.

Table 2 provides a breakdown of each of these trip types. Results of this analysis show that the redevelopment of the proposed Pickle Barrel site would generate approximately 310 new personal vehicle trips during the average weekday (combination of new external trips and pass-by trips). Approximately 75 (37 entering and 38 exiting) of those trips would be generated during the noon peak hour and 21 (11 entering and 10 exiting) would be generated during the PM peak hour.

### **Comparison to Other Land Use Scenarios**

As noted previously, it was anticipated that the trip generation rates for the Pickle Barrel Restaurant should fall somewhere in the middle of what would have been estimated using either of the restaurant land uses available in the ITE Trip Generation manual (fast-food restaurant with drive-through window or high-turnover sit-down restaurant). Therefore, it is relevant to compare the

results of the trip generation data collection effort to determine if that was indeed the case. The ITE Trip Generation manual does not include data specifically for the noon peak hour, but a general comparison can be made for the PM peak hour data. The PM peak hour rate estimated for the Pickle Barrel Restaurant in Table 2 is on the same order of magnitude as the PM peak hour average rate for a high-turnover sit-down restaurant in the ITE manual (8.46 vs. 11.15). Interestingly, the noon peak hour rate shown in Table 2 is very close to the PM peak hour rate for fast-food restaurant with drive-through window in the ITE manual (30.00 vs. 33.84). What this tells us is that the trip generation data collection effort completed for this analysis produced reasonable results compared to the ITE data. However, had we used the ITE data, we would not have been able to adequately estimate trips generated during the noon peak hour, which clearly represents the worst-case scenario for a sandwich shop located on Billings' West End.

It is also relevant to compare the trip generation estimates for the Pickle Barrel Restaurant to the original day care center land use. This site was previously approved for a 2000 square-foot day care center for up to 72 children under the current zoning designation. The ITE Trip Generation manual shows that a Day Care Center (ITE Land Use 565) could be estimated to generate 12.46 trips per 1000 square feet of gross floor area or 0.82 trips per student in the PM peak hour. Based on gross floor area, the Pickle Barrel Restaurant will generate very close to the same number of trips during the PM peak hour (25 trips for the day care vs. 21 trips for the Pickle Barrel). If trip generation for the day care were estimated using the rate based on number of students, we would see a significantly higher number of trips for the day care center (59 trips for the day care vs. 21 trips for the Pickle Barrel). Either way, this analysis shows that the Pickle Barrel Restaurant should generate the same or fewer trips than the previous land use of day care center.

## **TRIP DISTRIBUTION**

Trip distribution is an estimate of site-generated trip origin and destination locations, which can be determined by several methods from computerized travel demand models to simple inspection of existing traffic volumes. For this study, the trip distribution was primarily based on the distribution of existing traffic volumes at the study area intersections and existing driveways, as well as the location of regional highways and commercial areas. Although a portion of the traffic generated by the site will use the driveway north of the proposed Pickle Barrel building, for the purposes of this

analysis, it was assumed that this driveway would primarily be used by employees accessing the back of the building during non-peak periods. The noon and PM peak hour traffic generated by the site is expected to be made up entirely of customer traffic and would therefore access the site via the Rosebud driveway. The trip distribution for the proposed development is illustrated in Figure 4.

## **TRAFFIC ASSIGNMENT**

Traffic assignment is the procedure where site-generated vehicle trips are assigned to the study area intersections and site access driveways. The assignment of site-generated traffic is based on the development's trip distribution, physical attributes of the development site, and the surrounding street system. Based on this approach, the site-generated trips were assigned to the study area roadway network as illustrated in Figure 4.

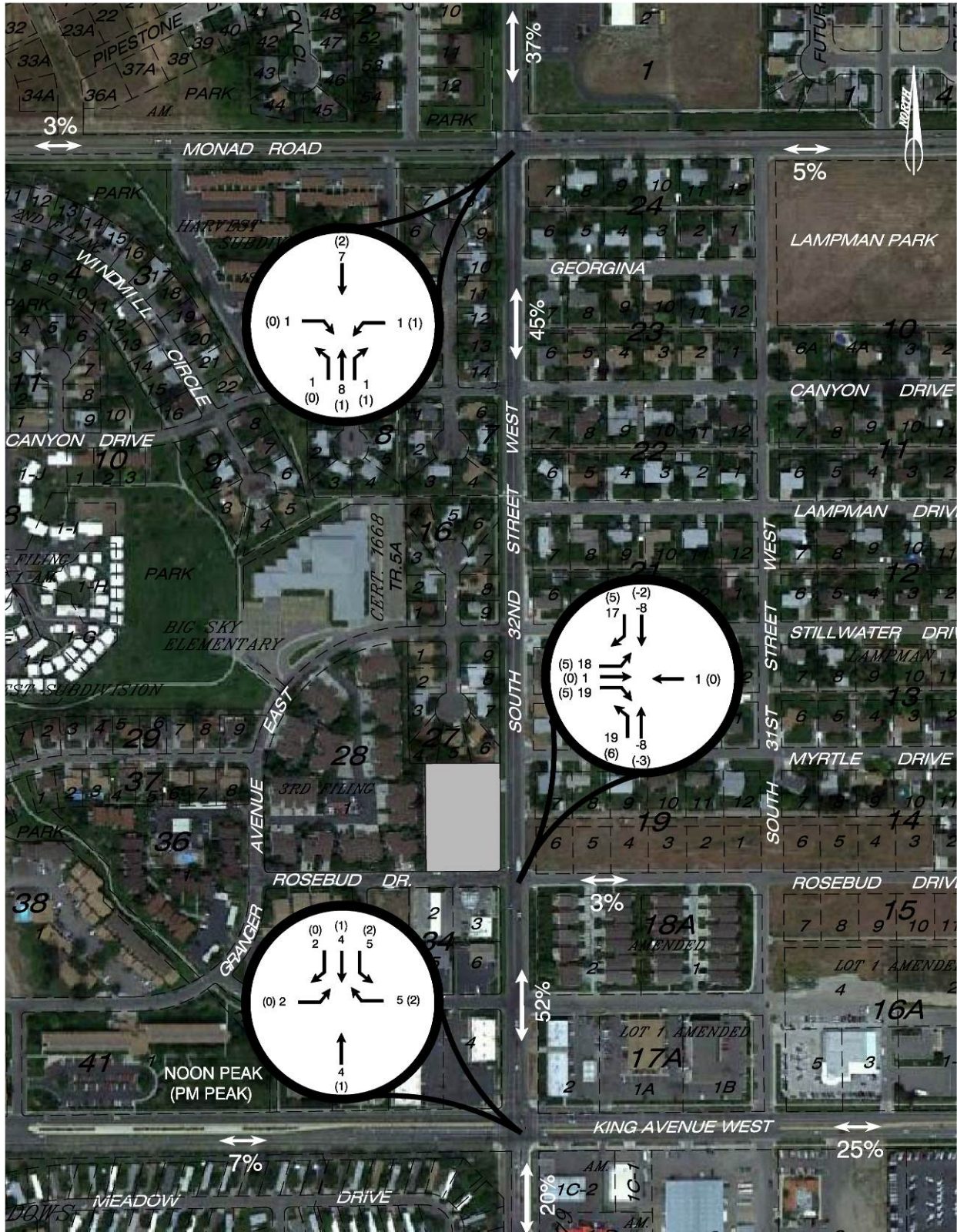
## **TRAFFIC IMPACTS**

### **Existing + Project Traffic Volumes**

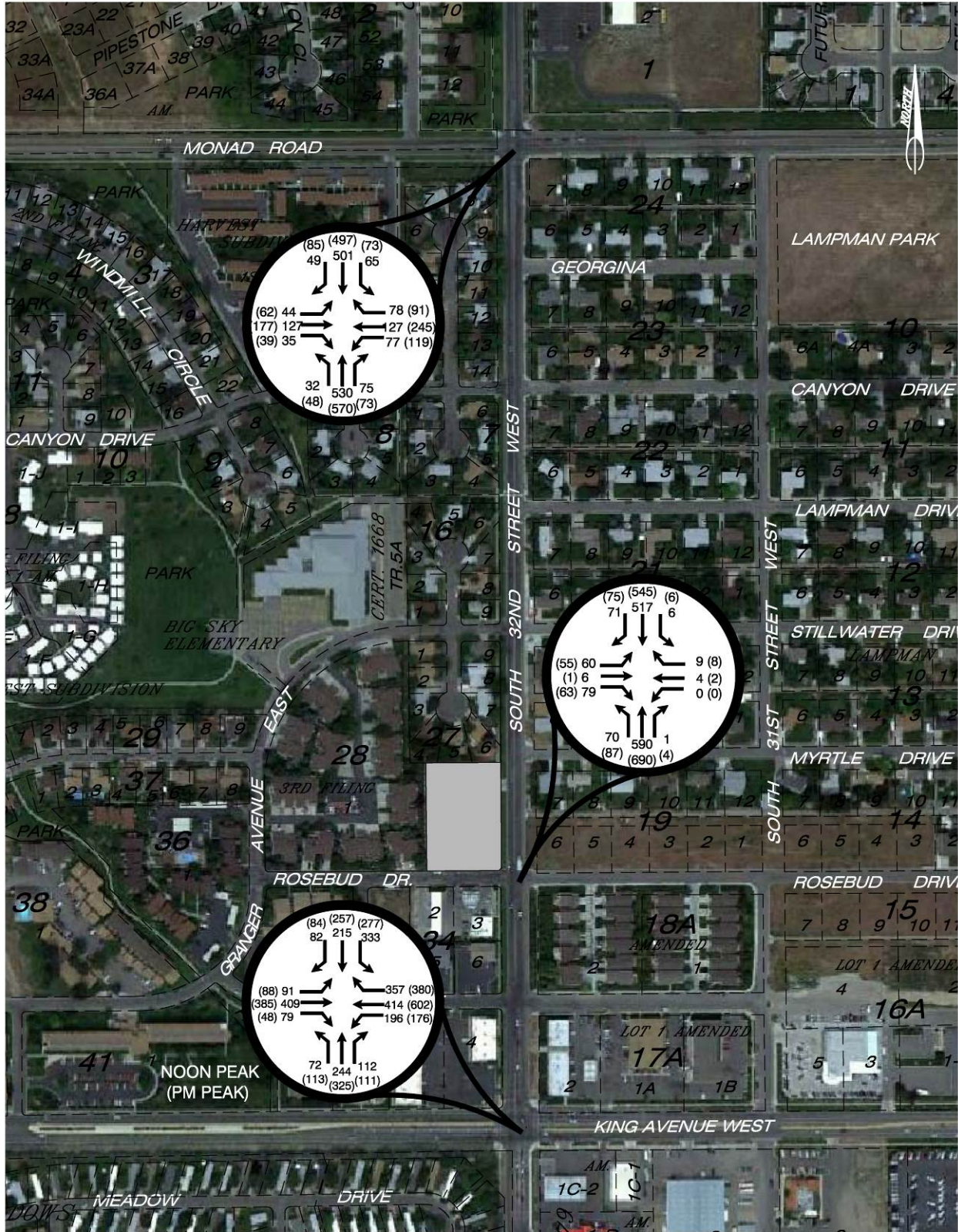
Existing + Project traffic volumes represent an estimate of the traffic volumes forecasted to be on the street network at the time period when the site is expected to be reconstructed. The resulting combination of existing traffic volumes and the new site-generated traffic volumes is illustrated in Figure 5. Because the redevelopment of the site is expected to occur in the immediate future, it was not necessary to consider future background traffic growth in this analysis.

### **Existing + Project Capacity Analysis**

Existing + Project intersection operations were evaluated using the same methodologies discussed in the evaluation of existing conditions. The LOS analysis is based on the Existing + Project traffic volumes shown in Figure 5, utilizing existing intersection geometry and traffic control at all intersections. Table 3 summarizes the noon and PM peak hour Existing + Project LOS at the study area intersections. The results for existing conditions are also provided for comparison purposes.



**FIGURE 4: TRIP DISTRIBUTION & ASSIGNMENT**



**FIGURE 5: EXISTING + PROJECT TRAFFIC VOLUMES**

**Table 3. Capacity Calculation Summary - Existing + Project**

Intersection	Approach	Existing (2012)				Existing + Project			
		Noon Peak		PM Peak		Noon Peak		PM Peak	
		Avg Delay (s/veh)	LOS	Avg Delay (s/veh)	LOS	Avg Delay (s/veh)	LOS	Avg Delay (s/veh)	LOS
<i>Intersection Control</i>		<i>Traffic Signal</i>				<i>Traffic Signal</i>			
Monad Rd & 32nd St W	EB	26.2	C	26.5	C	26.2	C	26.5	C
	WB	26.3	C	27.6	C	26.3	C	27.6	C
	NB	13.7	B	21.8	C	14.0	B	22.0	C
	SB	11.5	B	18.5	B	11.7	B	18.6	B
	Intersection	16.3	B	22.6	C	16.5	B	22.7	C
<i>Intersection Control</i>		<i>Stop Control</i>				<i>Stop Control</i>			
Rosebud Dr & 32nd St W	EB	131.0	F	793.9	F	333.0	F	960.5	F
	WB	21.6	C	32.9	D	27.3	D	34.5	D
	NB	0.7	A	1.0	A	1.0	A	1.0	A
	SB	0.1	A	0.1	A	0.1	A	0.1	A
	Intersection	11.6	--	67.0	--	37.1	--	87.2	--
<i>Intersection Control</i>		<i>Traffic Signal</i>				<i>Traffic Signal</i>			
King Ave W & 32nd St W	EB	31.5	C	31.2	C	31.5	C	31.2	C
	WB	32.0	C	34.0	C	32.0	C	34.0	C
	NB	29.1	C	32.6	C	29.2	C	32.7	C
	SB	22.0	C	23.0	C	22.4	C	23.2	C
	Intersection	28.9	C	30.9	C	29.0	C	30.9	C

As shown in Table 3, the addition of traffic generated by the proposed Pickle Barrel Restaurant would result in only very minor increases in approach delay. The existing capacity issue at the intersection of 32nd Street West and Rosebud Drive would get even worse with the addition of site-generated traffic, but none of the other impacts would be significant enough to result in degradation in level of service. Detailed capacity calculation worksheets for the Existing + Project scenario are provided in Appendix D.

**Mitigation Measures**

Improvement alternatives were evaluated to mitigate capacity concerns at the intersection of 32nd Street West and Rosebud Drive. The most logical options for improvement include the installation of a traffic signal or the installation of a raised median to limit the intersection to three-quarter access. These options are discussed in greater detail in the following paragraphs. Capacity calculations were performed for both of these alternatives as summarized in Table 4 on page 17. Detailed capacity calculation reports and signal warrant worksheets are provided in Appendix E.

### Improvement Alternative 1: Traffic Signal at 32nd Street West & Rosebud Drive

The first improvement alternative evaluated at the intersection of 32nd Street West and Rosebud Drive was the installation of a traffic signal. For the purposes of this analysis, it was assumed that the lane configurations would stay the same as existing conditions, and the signal would provide for permitted left-turn movements only with the overall cycle length on the order of 80 seconds. Capacity calculation results provided in Table 4 show that the eastbound approach to the intersection would be improved from LOS F to LOS B for both peak periods, while the northbound and southbound approaches could still be expected to operate at LOS A.

The need for a traffic signal at this intersection was further evaluated using the traffic signal warrants provided in the *Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition*. The three volume warrants (warrants 1-3) were fairly easy to consider using the data collected for this study. Additional data will need to be collected in order to complete a comprehensive warrant analysis that addresses the remaining warrants. Results of this preliminary analysis of warrants 1-3 (see worksheets provided in Appendix E) show that the intersection of 32nd Street West and Rosebud Drive would meet all three of the volume warrants for a traffic signal under existing conditions. The need for a traffic signal (or some other form of intersection control) would only increase with the addition of site-generated traffic.

Although the proposed traffic signal is likely warranted and capacity calculation results show that it would provide for significant improvement over existing conditions, there are some valid concerns associated with the signalized alternative. The primary concern is related to the close proximity to the signalized intersection of 32nd Street West and King Avenue West. The distance between the two intersections is approximately 600 feet and queues at the King Avenue West intersection have occasionally backed up beyond the Henesta Drive intersection and near the Rosebud Drive intersection. Therefore, if the signalized alternative is pursued, a critical component of the design will be the need for coordination between these two intersections and throughout the 32nd Street West corridor. While this alternative may be less desirable to the City of Billings due to the close proximity between signals, it will certainly be the much more desirable alternative to nearby property owners due the improved access and ease of getting onto 32nd Street West from Rosebud Drive.

Table 4. Capacity Calculation Summary - Improvement Alternatives													
Intersection	Approach	Existing + Project				Existing + Project				Existing + Project			
		Noon Peak		PM Peak		Noon Peak		PM Peak		Noon Peak		PM Peak	
		Avg Delay (s/veh)	LOS	Avg Delay (s/veh)	LOS	Avg Delay (s/veh)	LOS	Avg Delay (s/veh)	LOS	Avg Delay (s/veh)	LOS	Avg Delay (s/veh)	LOS
<i>Intersection Control</i>		<i>Traffic Signal</i>				<i>Traffic Signal</i>				<i>Traffic Signal</i>			
Monad Rd & 32nd St W	EB	26.2	C	26.5	C	26.2	C	26.5	C	26.2	C	26.5	C
	WB	26.3	C	27.6	C	26.3	C	27.6	C	26.3	C	27.6	C
	NB	14.0	B	22.0	C	14.0	B	22.0	C	14.0	B	22.0	C
	SB	11.7	B	18.6	B	11.7	B	18.6	B	11.7	B	18.6	B
	Intersection	16.5	B	22.7	C	16.5	B	22.7	C	16.5	B	22.7	C
<i>Intersection Control</i>		<i>Stop Control</i>				<i>Traffic Signal</i>				<i>Stop Control with 3/4 Access</i>			
Rosebud Dr & 32nd St W	EB	333.0	F	960.5	F	17.4	B	18.9	B	11.6	B	11.4	B
	WB	27.3	D	34.5	D	14.5	B	16.0	B	9.4	A	10.2	B
	NB	1.0	A	1.0	A	4.9	A	5.0	A	1.0	A	1.0	A
	SB	0.1	A	0.1	A	4.7	A	4.3	A	0.1	A	0.1	A
	Intersection	37.1	--	87.2	--	6.3	A	6.1	A	1.9	--	1.7	--
<i>Intersection Control</i>		<i>Traffic Signal</i>				<i>Traffic Signal</i>				<i>Traffic Signal</i>			
King Ave W & 32nd St W	EB	31.5	C	31.2	C	31.5	C	31.2	C	31.5	C	31.2	C
	WB	32.0	C	34.0	C	32.0	C	34.0	C	32.0	C	34.0	C
	NB	29.2	C	32.7	C	29.2	C	32.7	C	29.2	C	32.7	C
	SB	22.4	C	23.2	C	22.4	C	23.2	C	22.4	C	23.2	C
	Intersection	29.0	C	30.9	C	29.0	C	30.9	C	29.0	C	30.9	C

### Improvement Alternative 2: Three-Quarter Access at 32nd Street West & Rosebud Drive

The second alternative evaluated for improvement to the intersection of 32nd Street West and Rosebud Drive consists of installing a raised median within the vicinity of the intersection to implement what is commonly referred to as three-quarter access control. All of the existing northbound and southbound movements would still be allowed, but the eastbound and westbound movements would be limited to right-turn only. The eastbound/westbound thru and left-turn movements would be eliminated. With this type of treatment, the minor approach delay can be improved significantly by eliminating the wait time associated with making a left-turn onto the higher-volume arterial roadway. As shown by the results in Table 4, this would be the case with this particular intersection. The eastbound approach could be improved from LOS F to LOS B for both the noon and PM peak periods.

This improvement alternative would likely be the more desirable alternative for the City of Billings given their concerns about closely spaced signalized intersections. However, it will most definitely be the less desirable alternative for surrounding property owners due to common complaints about reduced access and overall effectiveness of these types of treatments for individual intersections when the rest of the corridor does not have raised median. Results of this analysis show that either improvement alternative would result in acceptable intersection operations for the Existing + Site traffic volume scenario. The final decision regarding which of the options would be most appropriate for this intersection will have to be based on input provided by the City of Billings and the adjacent property owners.

## **CONCLUSIONS AND RECOMMENDATIONS**

The preceding analysis provides a summary of existing conditions, as well as trip generation, traffic assignment, and the resultant capacity analysis for the proposed Pickle Barrel Restaurant on 32nd Street West. The new site is expected to generate approximately 310 new average weekday trips with 75 and 21 new vehicle trips occurring during the noon and PM peak hours, respectively. Capacity analysis results show that the proposed project would have only minor impacts to traffic operations on the surrounding roadways. However, an existing traffic capacity issue at the

intersection of 32nd Street West and Rosebud Drive would be made even worse with the addition of traffic generated by the new Pickle Barrel Restaurant.

Two different improvement options were considered to alleviate the capacity concerns at this intersection. The first option is the installation of a new traffic signal at the intersection and the second is the installation of a raised median to limit access at the intersection to three-quarter access. MUTCD traffic signal warrants would likely be met for both the existing and existing + site traffic volume scenarios. Capacity calculation results show that either improvement alternative would result in acceptable intersection operations for the Existing + Site traffic volume scenario. Therefore, it is recommended that the final decision regarding which of the improvement alternatives would be most appropriate for this location be based on input provided by the City of Billings and the adjacent property owners.

The City of Billings will often times consider a developer contribution toward the cost of improvements at an impacted intersection based on the development's portion of the total entering volume at the intersection. The Pickle Barrel's portion of the total entering volume at the intersection of 32nd Street West and Rosebud Drive is 4% during the noon peak hour and 1% during the PM peak hour. Therefore, based on this method of calculating developer contribution, the developer of the Pickle Barrel Restaurant should not be responsible for more than 4% of the cost of improvements.

It is recommended that a more comprehensive signal warrant analysis be completed for this intersection prior to the installation of a traffic signal. Regardless of which improvement alternative is ultimately selected, it is also recommended that the City of Billings consider an evaluation of potential signal timing coordination for the 32nd Street West corridor. With better traffic progression between signalized intersections, overall corridor operations could likely be improved significantly. These and any other improvements made shall be completed in accordance with City of Billings standards and the *Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition*. If these improvements are implemented as recommended, traffic on area roadways should continue to operate in a safe and efficient manner.

**APPENDIX A**  
**TRAFFIC VOLUME DATA**



Street: : 32nd St West  
 Location: : Btw Hennesta Dr and Rosebud Ln  
 Counted By: : jhg

Site: Station 134

Weekly Volume, per Channel

Interval Start	NB/SB							Mon - Fri Average	Weekly Average
	Mon 8/20/2012	Tue 8/21/2012	Wed 8/22/2012	Thu 8/23/2012	Fri 8/24/2012	Sat 8/25/2012	Sun 8/26/2012		
12:00 AM	-	105	80	83	-	-	-	89.3	89.3
1:00 AM	-	72	60	36	-	-	-	56.0	56.0
2:00 AM	-	48	36	48	-	-	-	44.0	44.0
3:00 AM	-	43	42	48	-	-	-	44.3	44.3
4:00 AM	-	68	74	62	-	-	-	68.0	68.0
5:00 AM	-	202	160	166	-	-	-	176.0	176.0
6:00 AM	-	398	388	406	-	-	-	397.3	397.3
7:00 AM	-	776	834	890	-	-	-	833.3	833.3
8:00 AM	-	820	954	852	-	-	-	875.3	875.3
9:00 AM	-	820	812	36	-	-	-	786.8	786.8
10:00 AM	-	952	972	-	-	-	-	962.0	962.0
11:00 AM	1050	1169	1074	-	-	-	-	1113.1	1113.1
12:00 PM	1282	1336	1274	-	-	-	-	1297.3	1297.3
1:00 PM	1316	1234	1198	-	-	-	-	1249.3	1249.3
2:00 PM	1253	1180	1264	-	-	-	-	1232.3	1232.3
3:00 PM	1200	1185	1234	-	-	-	-	1206.3	1206.3
4:00 PM	1335	1314	1304	-	-	-	-	1317.7	1317.7
5:00 PM	1376	1378	1411	-	-	-	-	1388.3	1388.3
6:00 PM	1038	1136	1053	-	-	-	-	1075.7	1075.7
7:00 PM	893	954	886	-	-	-	-	911.0	911.0
8:00 PM	722	706	670	-	-	-	-	699.3	699.3
9:00 PM	460	472	428	-	-	-	-	453.3	453.3
10:00 PM	232	226	243	-	-	-	-	233.7	233.7
11:00 PM	152	128	102	-	-	-	-	127.3	127.3
<b>Totals</b>	<b>12309</b>	<b>16722</b>	<b>16553</b>	<b>2627</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>16637.3</b>	<b>16637.3</b>

**Peak Hours**

12:00 AM - 12:00 PM	11:02 AM	11:00 AM	11:00 AM	7:00 AM	-	-	-	11:00 AM	11:00 AM
Volume	1050	1169	1074	890	-	-	-	1097.7	1097.7
12:00 PM - 12:00 AM	5:00 PM	5:00 PM	5:00 PM	-	-	-	-	5:00 PM	5:00 PM
Volume	1376	1378	1411	-	-	-	-	1388.3	1388.3

Street : 32nd St W  
 Location : South of Rosebud Dr  
 Counted By: ZH :

Weekly Volume, per Channel

NB/SB									
Interval Start	Mon 11/5/2012	Tue 11/6/2012	Wed 11/7/2012	Thu 11/8/2012	Fri 11/9/2012	Sat 11/10/2012	Sun 11/11/2012	Mon - Fri Average	Weekly Average
12:00 AM	-	-	-	59	64	110	0	61.5	58.3
1:00 AM	-	-	-	34	34	41	0	34.0	27.3
2:00 AM	-	-	-	33	36	61	0	34.5	32.5
3:00 AM	-	-	-	26	36	32	0	31.0	23.5
4:00 AM	-	-	-	61	52	60	0	56.5	43.3
5:00 AM	-	-	-	171	144	84	0	157.5	99.8
6:00 AM	-	-	-	390	337	162	0	363.5	222.3
7:00 AM	-	-	-	770	720	240	0	745.0	432.5
8:00 AM	-	-	-	882	865	349	0	873.5	524.0
9:00 AM	-	-	-	794	801	65	0	797.5	415.0
10:00 AM	-	-	-	853	956	0	0	904.5	452.3
11:00 AM	-	-	-	1054	1144	0	0	1099.0	549.5
12:00 PM	-	-	-	1238	1286	0	0	1262.0	631.0
1:00 PM	-	-	-	1153	1212	0	0	1182.5	591.3
2:00 PM	-	-	-	1172	1286	0	0	1229.0	614.5
3:00 PM	-	-	172	1226	1328	0	0	1275.3	658.9
4:00 PM	-	-	1317	1286	1346	0	0	1316.3	789.8
5:00 PM	-	-	1258	1298	1268	0	0	1274.7	764.8
6:00 PM	-	-	976	923	1014	0	0	971.0	582.6
7:00 PM	-	-	641	646	722	0	0	669.7	401.8
8:00 PM	-	-	522	468	512	0	0	500.7	300.4
9:00 PM	-	-	315	308	435	0	0	352.7	211.6
10:00 PM	-	-	178	172	288	0	0	212.7	127.6
11:00 PM	-	-	102	114	182	0	0	132.7	79.6

Totals 0 0 5481 15131 16068 1204 0 15537.2 8633.8

**Peak Hours**

12:00 AM - 12:00 PM	-	-	-	11:00 AM	11:00 AM	8:00 AM	-	11:00 AM	11:00 AM
Volume	-	-	-	1054	1144	349	-	1099.0	549.5
12:00 PM - 12:00 AM	-	-	4:00 PM	5:00 PM	4:00 PM	-	-	4:00 PM	4:00 PM
Volume	-	-	1317	1298	1346	-	-	1316.3	789.8

# Sanderson Stewart

1300 North Transtech Way  
Billings, MT 59102

Counted by: J. Sheets

File Name : Monad-32nd\_Noon\_60min\_110812

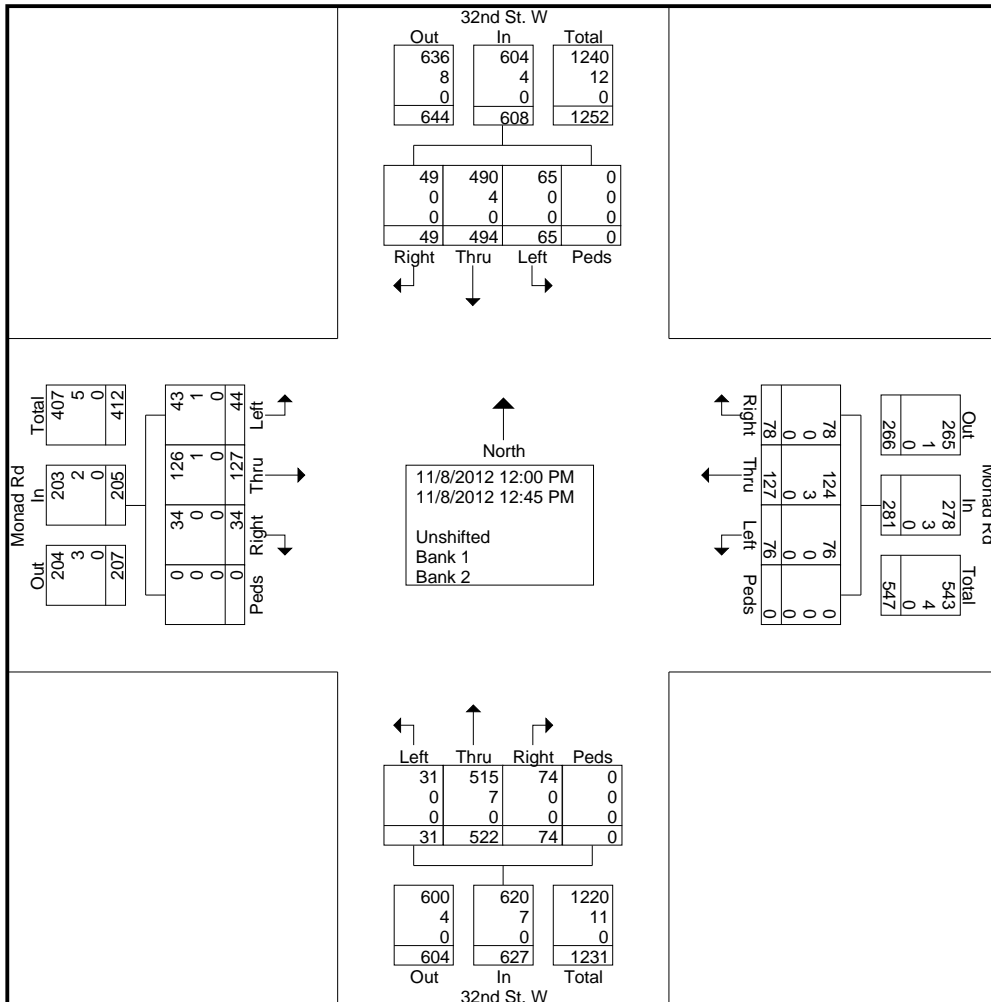
Site Code : 00000000

Start Date : 11/8/2012

Page No : 1

## Groups Printed- Unshifted - Bank 1 - Bank 2

Start Time	32nd St. W From North					Monad Rd From East					32nd St. W From South					Monad Rd From West					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
12:00 PM	9	121	22	0	152	17	38	17	0	72	13	123	5	0	141	9	28	7	0	44	409
12:15 PM	16	130	16	0	162	19	29	18	0	66	23	135	11	0	169	9	25	12	0	46	443
12:30 PM	14	109	14	0	137	25	32	19	0	76	20	139	7	0	166	8	35	14	0	57	436
12:45 PM	10	134	13	0	157	17	28	22	0	67	18	125	8	0	151	8	39	11	0	58	433
<b>Total</b>	<b>49</b>	<b>494</b>	<b>65</b>	<b>0</b>	<b>608</b>	<b>78</b>	<b>127</b>	<b>76</b>	<b>0</b>	<b>281</b>	<b>74</b>	<b>522</b>	<b>31</b>	<b>0</b>	<b>627</b>	<b>34</b>	<b>127</b>	<b>44</b>	<b>0</b>	<b>205</b>	<b>1721</b>
Grand Total	49	494	65	0	608	78	127	76	0	281	74	522	31	0	627	34	127	44	0	205	1721
Apprch %	8.1	81.2	10.7	0		27.8	45.2	27	0		11.8	83.3	4.9	0		16.6	62	21.5	0		
Total %	2.8	28.7	3.8	0	35.3	4.5	7.4	4.4	0	16.3	4.3	30.3	1.8	0	36.4	2	7.4	2.6	0	11.9	
Unshifted	49	490	65	0	604	78	124	76	0	278	74	515	31	0	620	34	126	43	0	203	1705
% Unshifted	100	99.2	100	0	99.3	100	97.6	100	0	98.9	100	98.7	100	0	98.9	100	99.2	97.7	0	99	99.1
Bank 1	0	4	0	0	4	0	3	0	0	3	0	7	0	0	7	0	1	1	0	0	2
% Bank 1	0	0.8	0	0	0.7	0	2.4	0	0	1.1	0	1.3	0	0	1.1	0	0.8	2.3	0	0	0.9
Bank 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bank 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



# Sanderson Stewart

1300 North Transtech Way  
Billings, MT 59102

Counted by: J. Sheets

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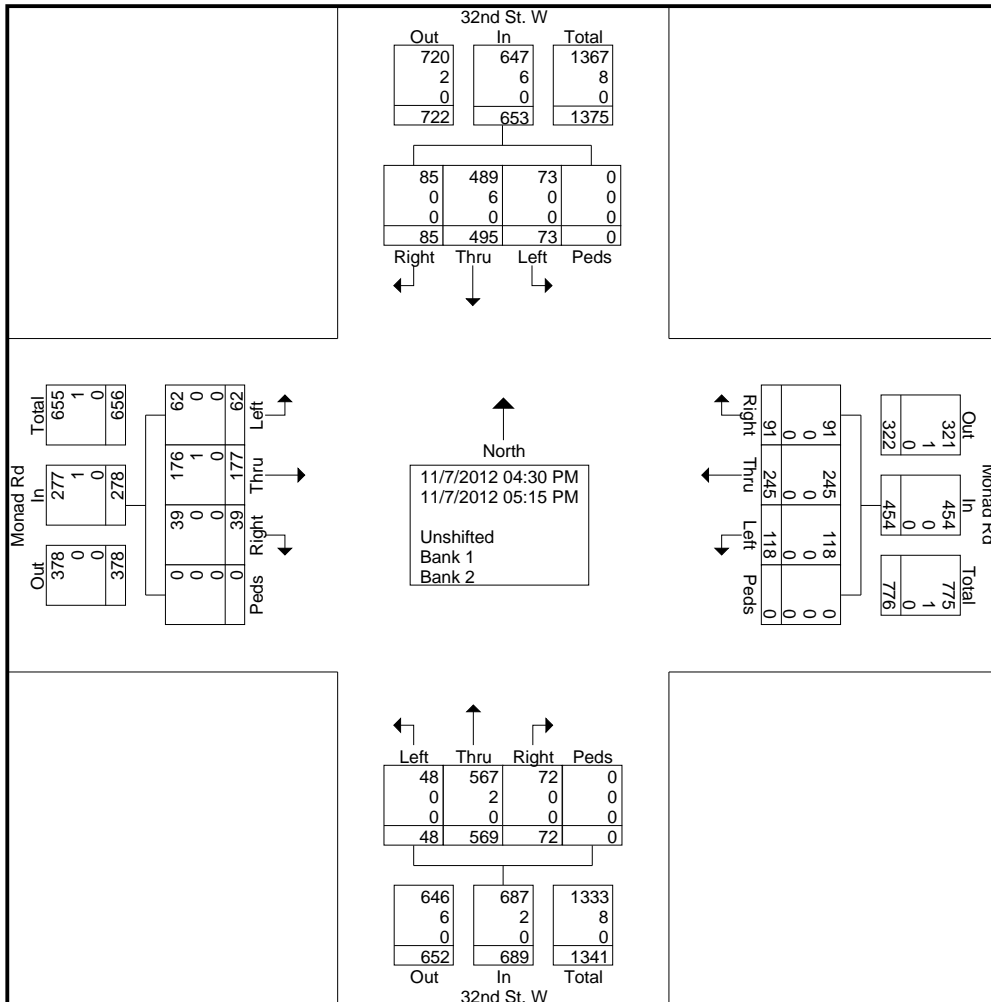
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Start Date : 11/7/2012

Page No : 1

## Groups Printed- Unshifted - Bank 1 - Bank 2

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04:30 PM	25	139	23	0	187	23	45	25	0	93	18	138	13	0	169	9	36	15	0	60	509	
04:45 PM	20	114	25	0	159	20	65	26	0	111	10	139	11	0	160	14	45	21	0	80	510	
<b>Total</b>	<b>45</b>	<b>253</b>	<b>48</b>	<b>0</b>	<b>346</b>	<b>43</b>	<b>110</b>	<b>51</b>	<b>0</b>	<b>204</b>	<b>28</b>	<b>277</b>	<b>24</b>	<b>0</b>	<b>329</b>	<b>23</b>	<b>81</b>	<b>36</b>	<b>0</b>	<b>140</b>	<b>1019</b>	
05:00 PM	20	127	14	0	161	24	73	37	0	134	16	167	10	0	193	11	42	13	0	66	554	
05:15 PM	20	115	11	0	146	24	62	30	0	116	28	125	14	0	167	5	54	13	0	72	501	
<b>Grand Total</b>	<b>85</b>	<b>495</b>	<b>73</b>	<b>0</b>	<b>653</b>	<b>91</b>	<b>245</b>	<b>118</b>	<b>0</b>	<b>454</b>	<b>72</b>	<b>569</b>	<b>48</b>	<b>0</b>	<b>689</b>	<b>39</b>	<b>177</b>	<b>62</b>	<b>0</b>	<b>278</b>	<b>2074</b>	
Apprch %	13	75.8	11.2	0		20	54	26	0		10.4	82.6	7	0		14	63.7	22.3	0			
Total %	4.1	23.9	3.5	0	31.5	4.4	11.8	5.7	0	21.9	3.5	27.4	2.3	0	33.2	1.9	8.5	3	0	13.4		
Unshifted	85	489	73	0	647	91	245	118	0	454	72	567	48	0	687	39	176	62	0	277	2065	
% Unshifted	100	98.8	100	0	99.1	100	100	100	0	100	100	99.6	100	0	99.7	100	99.4	100	0	99.6	99.6	
Bank 1	0	6	0	0	6	0	0	0	0	0	0	2	0	0	2	0	1	0	0	0	1	9
% Bank 1	0	1.2	0	0	0.9	0	0	0	0	0	0	0.4	0	0	0.3	0	0.6	0	0	0	0.4	0.4
Bank 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bank 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



# Sanderson Stewart

1300 North Transtech Way  
Billings, MT 59102

Counted by: H. Grubb

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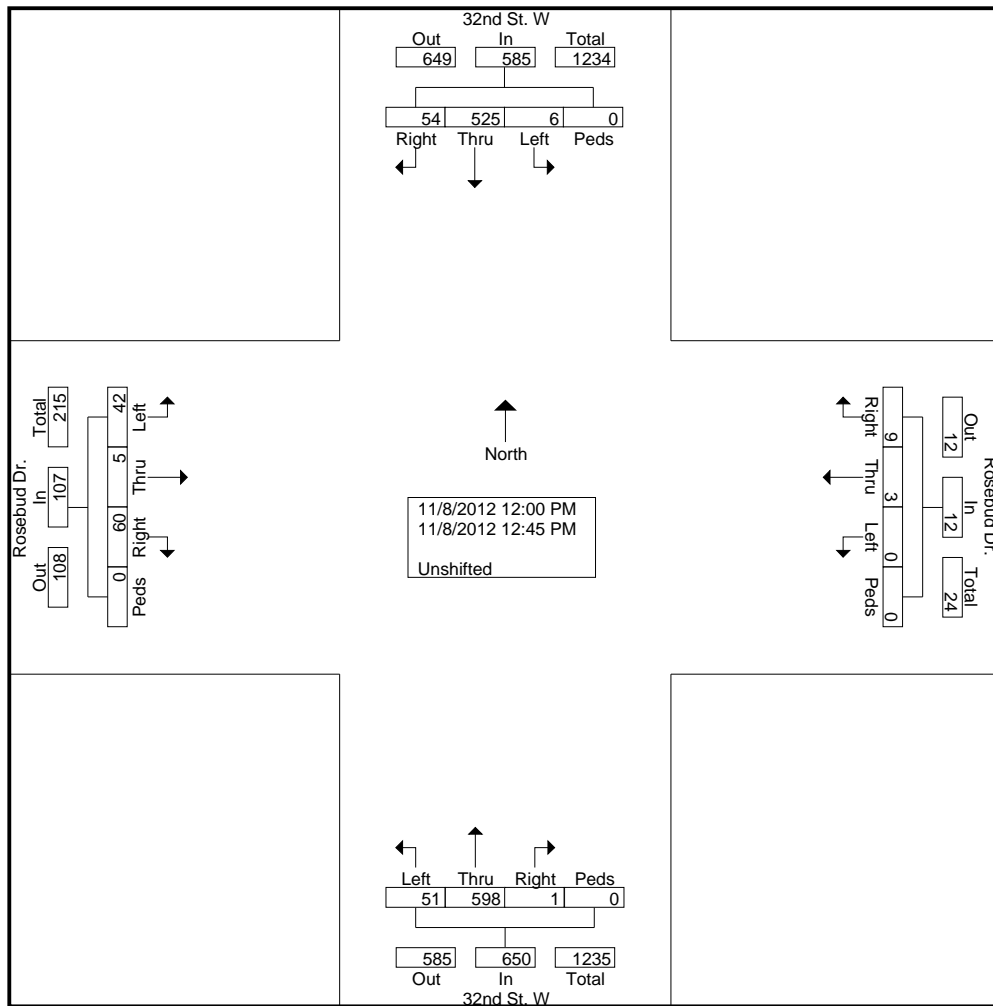
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Start Date : 11/8/2012

Page No : 1

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12:00 PM	17	128	1	0	146	1	1	0	0	2	1	163	17	0	181	18	3	6	0	27	356
12:15 PM	15	130	1	0	146	1	1	0	0	2	0	152	15	0	167	21	1	10	0	32	347
12:30 PM	12	117	2	0	131	3	1	0	0	4	0	153	8	0	161	11	1	14	0	26	322
12:45 PM	10	150	2	0	162	4	0	0	0	4	0	130	11	0	141	10	0	12	0	22	329
Total	54	525	6	0	585	9	3	0	0	12	1	598	51	0	650	60	5	42	0	107	1354
Grand Total	54	525	6	0	585	9	3	0	0	12	1	598	51	0	650	60	5	42	0	107	1354
Apprch %	9.2	89.7	1	0		75	25	0	0		0.2	92	7.8	0		56.1	4.7	39.3	0		
Total %	4	38.8	0.4	0	43.2	0.7	0.2	0	0	0.9	0.1	44.2	3.8	0	48	4.4	0.4	3.1	0	7.9	



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1300 North Transtech Way  
Billings, MT 59102

Counted by: H. Grubb

File Name : 32nd-Rosebud\_PM\_60min\_110712

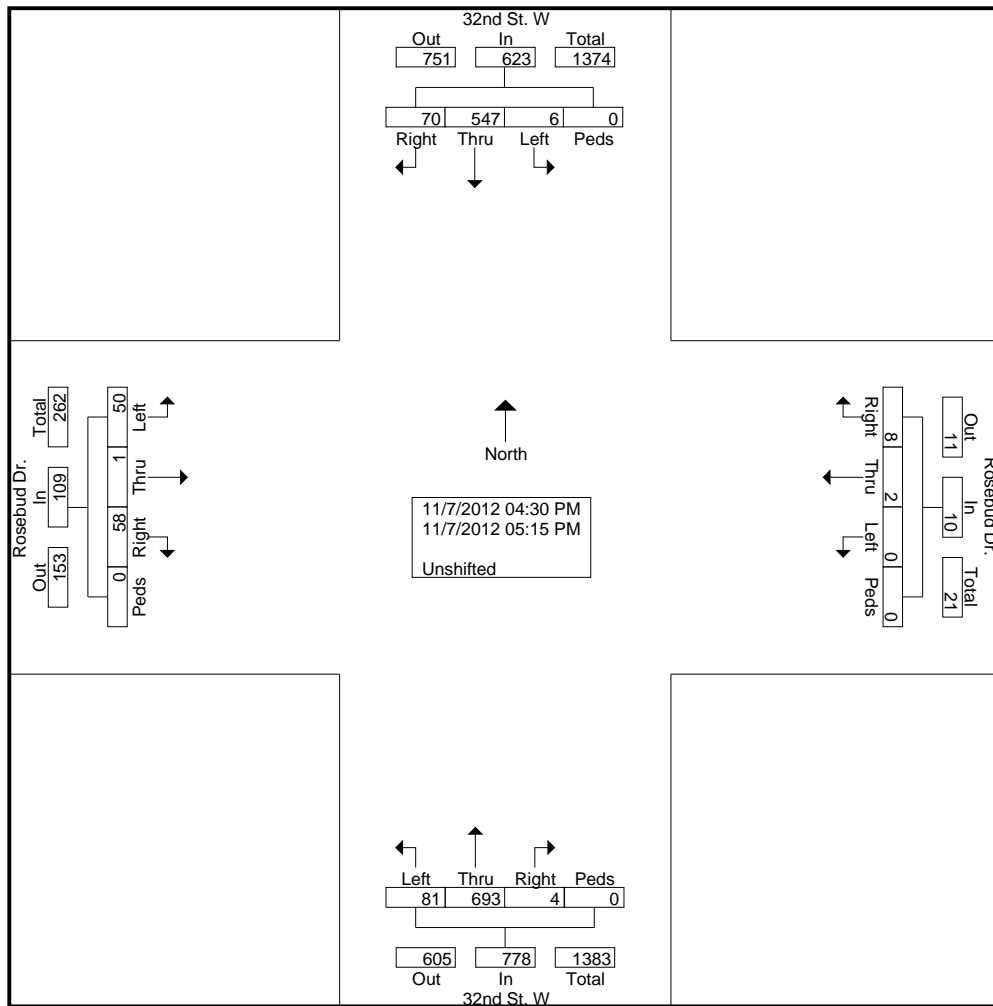
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Start Date : 11/7/2012

Page No : 1

## Groups Printed- Unshifted

Start Time	32nd St. W From North					Rosebud Dr. From East					32nd St. W From South					Rosebud Dr. From West					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
04:30 PM	22	135	0	0	157	1	0	0	0	1	0	159	16	0	175	20	0	15	0	35	368
04:45 PM	13	145	1	0	159	4	1	0	0	5	1	173	21	0	195	13	1	9	0	23	382
<b>Total</b>	<b>35</b>	<b>280</b>	<b>1</b>	<b>0</b>	<b>316</b>	<b>5</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>6</b>	<b>1</b>	<b>332</b>	<b>37</b>	<b>0</b>	<b>370</b>	<b>33</b>	<b>1</b>	<b>24</b>	<b>0</b>	<b>58</b>	<b>750</b>
05:00 PM	17	145	2	0	164	3	1	0	0	4	1	198	17	0	216	11	0	12	0	23	407
05:15 PM	18	122	3	0	143	0	0	0	0	0	2	163	27	0	192	14	0	14	0	28	363
<b>Grand Total</b>	<b>70</b>	<b>547</b>	<b>6</b>	<b>0</b>	<b>623</b>	<b>8</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>10</b>	<b>4</b>	<b>693</b>	<b>81</b>	<b>0</b>	<b>778</b>	<b>58</b>	<b>1</b>	<b>50</b>	<b>0</b>	<b>109</b>	<b>1520</b>
Apprch %	11.2	87.8	1	0		80	20	0	0		0.5	89.1	10.4	0		53.2	0.9	45.9	0		
Total %	4.6	36	0.4	0	41	0.5	0.1	0	0	0.7	0.3	45.6	5.3	0	51.2	3.8	0.1	3.3	0	7.2	



# Sanderson Stewart

1300 North Transtech Way  
Billings, MT 59102

Counted by: J. Staszczuk

File Name : King-32nd\_Noon\_60min\_110812

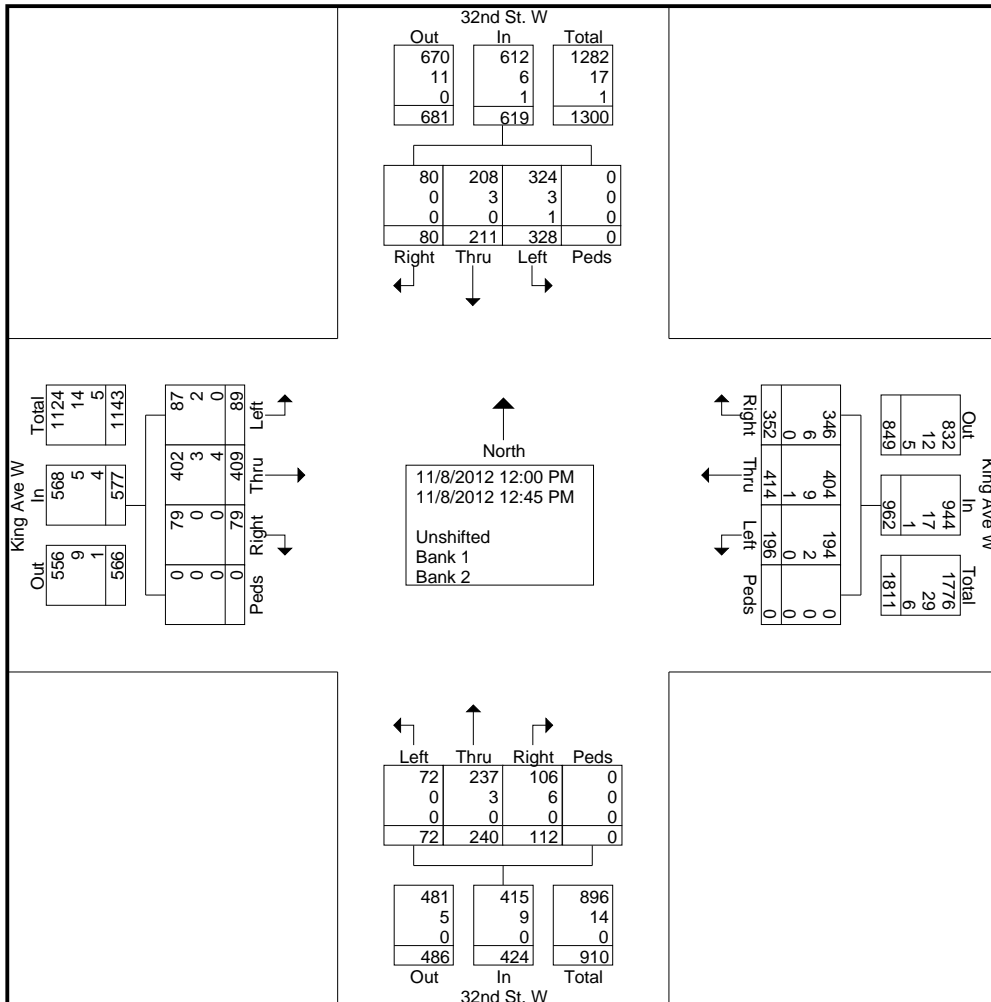
Site Code : 00000000

Start Date : 11/8/2012

Page No : 1

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	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
12:00 PM	26	47	81	0	154	95	105	44	0	244	34	70	31	0	135	16	109	27	0	152	685
12:15 PM	26	53	78	0	157	90	110	52	0	252	35	67	12	0	114	20	79	23	0	122	645
12:30 PM	16	45	82	0	143	89	101	50	0	240	22	47	16	0	85	20	116	19	0	155	623
12:45 PM	12	66	87	0	165	78	98	50	0	226	21	56	13	0	90	23	105	20	0	148	629
<b>Total</b>	<b>80</b>	<b>211</b>	<b>328</b>	<b>0</b>	<b>619</b>	<b>352</b>	<b>414</b>	<b>196</b>	<b>0</b>	<b>962</b>	<b>112</b>	<b>240</b>	<b>72</b>	<b>0</b>	<b>424</b>	<b>79</b>	<b>409</b>	<b>89</b>	<b>0</b>	<b>577</b>	<b>2582</b>
<b>Grand Total</b>	<b>80</b>	<b>211</b>	<b>328</b>	<b>0</b>	<b>619</b>	<b>352</b>	<b>414</b>	<b>196</b>	<b>0</b>	<b>962</b>	<b>112</b>	<b>240</b>	<b>72</b>	<b>0</b>	<b>424</b>	<b>79</b>	<b>409</b>	<b>89</b>	<b>0</b>	<b>577</b>	<b>2582</b>
Apprch %	12.9	34.1	53	0		36.6	43	20.4	0		26.4	56.6	17	0		13.7	70.9	15.4	0		
Total %	3.1	8.2	12.7	0	24	13.6	16	7.6	0	37.3	4.3	9.3	2.8	0	16.4	3.1	15.8	3.4	0	22.3	
Unshifted	80	208	324	0	612	346	404	194	0	944	106	237	72	0	415	79	402	87	0	568	2539
% Unshifted	100	98.6	98.8	0	98.9	98.3	97.6	99	0	98.1	94.6	98.8	100	0	97.9	100	98.3	97.8	0	98.4	98.3
Bank 1	0	3	3	0	6	6	9	2	0	17	6	3	0	0	9	0	3	2	0	5	37
% Bank 1	0	1.4	0.9	0	1	1.7	2.2	1	0	1.8	5.4	1.2	0	0	2.1	0	0.7	2.2	0	0.9	1.4
Bank 2	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	0	4	0	0	4	6
% Bank 2	0	0	0.3	0	0.2	0	0.2	0	0	0.1	0	0	0	0	0	0	1	0	0	0.7	0.2



# Sanderson Stewart

1300 North Transtech Way  
Billings, MT 59102

Counted by: J. Staszczuk

File Name : King-32nd\_PM\_60min\_110712

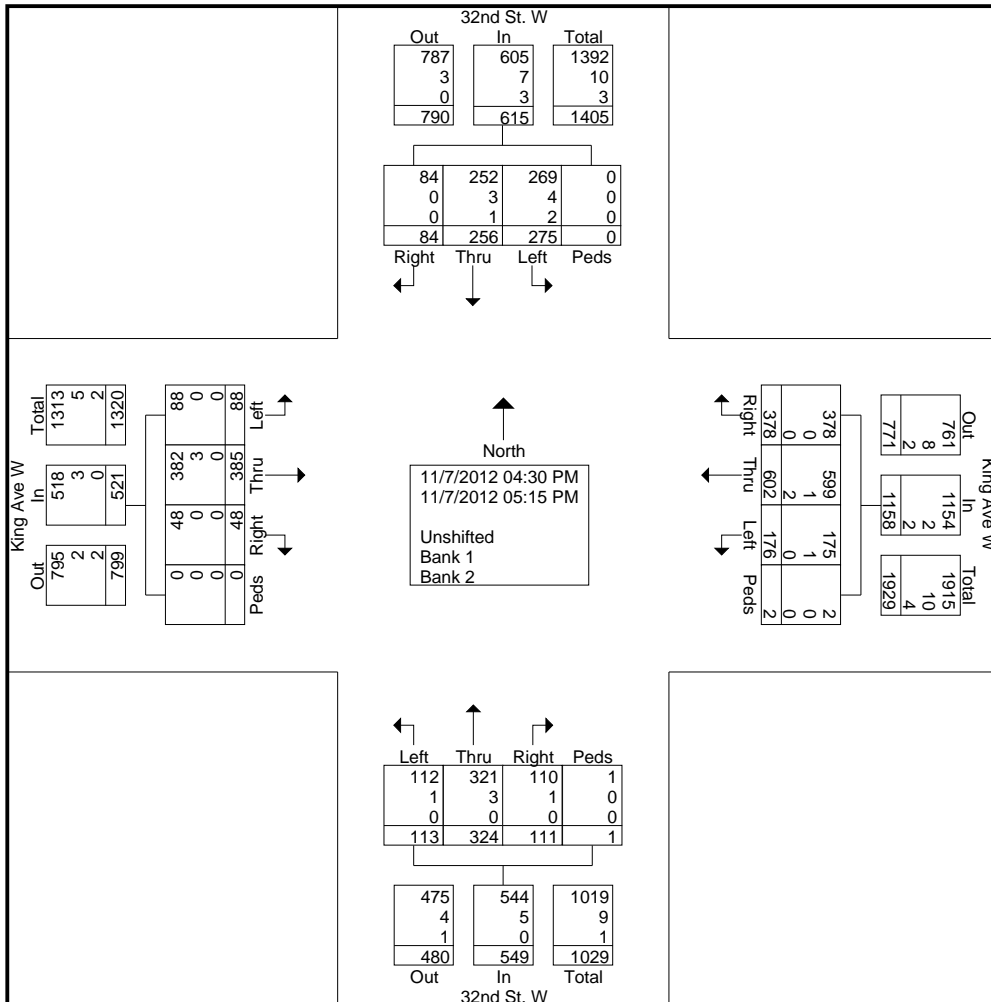
Site Code : 00000000

Start Date : 11/7/2012

Page No : 1

## Groups Printed- Unshifted - Bank 1 - Bank 2

Start Time	32nd St. W From North					King Ave W From East					32nd St. W From South					King Ave W From West					Int. Total
	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	
04:30 PM	15	56	90	0	161	92	133	36	0	261	36	68	31	0	135	20	94	18	0	132	689
04:45 PM	13	63	72	0	148	81	138	50	1	270	24	86	16	0	126	10	77	16	0	103	647
<b>Total</b>	<b>28</b>	<b>119</b>	<b>162</b>	<b>0</b>	<b>309</b>	<b>173</b>	<b>271</b>	<b>86</b>	<b>1</b>	<b>531</b>	<b>60</b>	<b>154</b>	<b>47</b>	<b>0</b>	<b>261</b>	<b>30</b>	<b>171</b>	<b>34</b>	<b>0</b>	<b>235</b>	<b>1336</b>
05:00 PM	22	76	63	0	161	101	153	42	1	297	28	104	36	1	169	7	104	27	0	138	765
05:15 PM	34	61	50	0	145	104	178	48	0	330	23	66	30	0	119	11	110	27	0	148	742
<b>Grand Total</b>	<b>84</b>	<b>256</b>	<b>275</b>	<b>0</b>	<b>615</b>	<b>378</b>	<b>602</b>	<b>176</b>	<b>2</b>	<b>1158</b>	<b>111</b>	<b>324</b>	<b>113</b>	<b>1</b>	<b>549</b>	<b>48</b>	<b>385</b>	<b>88</b>	<b>0</b>	<b>521</b>	<b>2843</b>
Apprch %	13.7	41.6	44.7	0		32.6	52	15.2	0.2		20.2	59	20.6	0.2		9.2	73.9	16.9	0		
Total %	3	9	9.7	0	21.6	13.3	21.2	6.2	0.1	40.7	3.9	11.4	4	0	19.3	1.7	13.5	3.1	0	18.3	
Unshifted	84	252	269	0	605	378	599	175	2	1154	110	321	112	1	544	48	382	88	0	518	2821
% Unshifted	100	98.4	97.8	0	98.4	100	99.5	99.4	100	99.7	99.1	99.1	99.1	100	99.1	100	99.2	100	0	99.4	99.2
Bank 1	0	3	4	0	7	0	1	1	0	2	1	3	1	0	5	0	3	0	0	3	17
% Bank 1	0	1.2	1.5	0	1.1	0	0.2	0.6	0	0.2	0.9	0.9	0.9	0	0.9	0	0.8	0	0	0.6	0.6
Bank 2	0	1	2	0	3	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	5
% Bank 2	0	0.4	0.7	0	0.5	0	0.3	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0.2

























**APPENDIX B**  
**CAPACITY CALCULATIONS - EXISTING**
























HCM 2010 Signalized Intersection Summary  
 8: 32nd St W & Monad Rd

Existing - Weekday Noon Peak

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	44	127	34	76	127	78	31	522	74	65	494	49
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1863	1885	1885	1900	1863	1900	1900	1884	1884	1900	1883	1883
Lanes	1	1	0	1	1	1	1	1	0	1	1	0
Capacity, veh/h	278	294	79	244	383	332	446	888	126	410	954	95
Arriving On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.02	0.55	0.55	0.03	0.57	0.57
Sat Flow, veh/h	1245.9	1433.6	383.8	1219.9	1862.7	1615.0	1809.5	1614.3	228.8	1809.5	1686.1	167.2
Grp Volume(v), veh/h	50.0	0.0	183.0	82.6	138.0	42.4	33.3	0.0	640.9	69.1	0.0	577.7
Grp Sat Flow(s),veh/h/ln	1245.9	0.0	1817.4	1219.9	1862.7	1615.0	1809.5	0.0	1843.1	1809.5	0.0	1853.4
Q Serve(g_s), s	2.5	0.0	6.3	4.5	4.5	1.5	0.6	0.0	17.0	1.1	0.0	13.9
Cycle Q Clear(g_c), s	7.1	0.0	6.3	10.9	4.5	1.5	0.6	0.0	17.0	1.1	0.0	13.9
Proportion In Lane	1.000		0.211	1.000		1.000	1.000		0.124	1.000		0.090
Lane Grp Cap(c), veh/h	278.2	0.0	373.2	243.6	382.5	331.6	446.4	0.0	1014.0	409.7	0.0	1048.2
V/C Ratio(X)	0.180	0.000	0.490	0.339	0.361	0.128	0.075	0.000	0.632	0.169	0.000	0.551
Avail Cap(c_a), veh/h	408.9	0.0	564.0	371.6	578.1	501.2	516.8	0.0	1014.0	452.2	0.0	1048.2
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	0.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.000	1.000
Uniform Delay (d), s/veh	27.2	0.0	24.9	29.7	24.2	23.0	8.0	0.0	11.0	8.5	0.0	9.7
Incr Delay (d2), s/veh	0.3	0.0	1.0	0.8	0.6	0.2	0.1	0.0	3.0	0.2	0.0	2.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	27.5	0.0	25.9	30.5	24.7	23.2	8.0	0.0	14.0	8.7	0.0	11.8
Lane Group LOS	C		C	C	C	C	A		B	A		B
Approach Volume, veh/h		233			263			674			647	
Approach Delay, s/veh		26.2			26.3			13.7			11.5	
Approach LOS		C			C			B			B	
<b>Timer</b>												
Assigned Phase		4			8		5	2		1		6
Phase Duration (G+Y+Rc), s		19.56			19.56		6.24	44.00		7.34		45.09
Change Period (Y+Rc), s		5.00			5.00		5.00	5.00		5.00		5.00
Max Green Setting (Gmax), s		22.00			22.00		4.00	39.00		4.00		39.00
Max Q Clear Time (g_c+I1), s		9.05			12.86		2.58	19.00		3.13		15.95
Green Extension Time (p_c)		2.04			1.70		0.00	8.61		0.01		9.20
<b>Intersection Summary</b>												
HCM 2010 Control Delay				16.3								
HCM 2010 Level of Service				B								

HCM 2010 Signalized Intersection Summary  
 8: 32nd St W & Monad Rd

Existing - Weekday PM Peak

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	62	177	39	118	245	91	48	569	72	73	495	85
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1900	1885	1885	1900	1900	1900	1900	1883	1883	1900	1884	1884
Lanes	1	1	0	1	1	1	1	1	0	1	1	0
Capacity, veh/h	245	402	88	268	510	433	325	819	104	298	802	138
Arriving On Green	0.27	0.27	0.27	0.27	0.27	0.27	0.03	0.50	0.50	0.04	0.51	0.51
Sat Flow, veh/h	1108.2	1496.6	329.8	1149.4	1900.0	1615.0	1809.5	1639.3	207.4	1809.5	1567.3	269.1
Grp Volume(v), veh/h	71.3	0.0	248.3	138.8	288.2	54.1	53.9	0.0	720.2	83.9	0.0	666.7
Grp Sat Flow(s),veh/h/ln	1108.2	0.0	1826.4	1149.4	1900.0	1615.0	1809.5	0.0	1846.7	1809.5	0.0	1836.4
Q Serve(g_s), s	4.6	0.0	9.0	9.1	10.2	2.0	1.1	0.0	25.0	1.7	0.0	21.7
Cycle Q Clear(g_c), s	14.8	0.0	9.0	18.1	10.2	2.0	1.1	0.0	25.0	1.7	0.0	21.7
Proportion In Lane	1.000		0.181	1.000		1.000	1.000		0.112	1.000		0.147
Lane Grp Cap(c), veh/h	244.6	0.0	490.0	268.3	509.8	433.3	325.0	0.0	922.8	298.0	0.0	939.8
V/C Ratio(X)	0.291	0.000	0.507	0.517	0.565	0.125	0.166	0.000	0.780	0.282	0.000	0.709
Avail Cap(c_a), veh/h	259.6	0.0	514.8	284.0	535.6	455.3	367.6	0.0	922.8	318.8	0.0	939.8
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	0.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.000	1.000
Uniform Delay (d), s/veh	31.0	0.0	24.2	31.8	24.6	21.6	12.0	0.0	16.0	13.1	0.0	14.6
Incr Delay (d2), s/veh	0.7	0.0	0.8	1.5	1.3	0.1	0.2	0.0	6.5	0.5	0.0	4.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	31.7	0.0	25.0	33.4	25.9	21.7	12.2	0.0	22.5	13.6	0.0	19.1
Lane Group LOS	C		C	C	C	C	B		C	B		B
Approach Volume, veh/h		320			481			774			751	
Approach Delay, s/veh		26.5			27.6			21.8			18.5	
Approach LOS		C			C			C			B	
<b>Timer</b>												
Assigned Phase		4			8		5	2		1		6
Phase Duration (G+Y+Rc), s		25.94			25.94		7.16	44.00		8.11		44.94
Change Period (Y+Rc), s		5.00			5.00		5.00	5.00		5.00		5.00
Max Green Setting (Gmax), s		22.00			22.00		4.00	39.00		4.00		39.00
Max Q Clear Time (g_c+I1), s		16.84			20.06		3.13	26.96		3.70		23.72
Green Extension Time (p_c)		2.00			0.88		0.01	7.30		0.00		8.61
<b>Intersection Summary</b>												
HCM 2010 Control Delay					22.6							
HCM 2010 Level of Service					C							

HCM 2010 TWSC  
1: 32nd St W & Rosebud Dr

Existing - Weekday Noon Peak

Intersection

Intersection Delay (sec/veh): 11.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	42	5	60	0	3	9	51	598	1	6	525	54
Conflicting Peds.(#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
Right Turn Channelized	None	None	None	None	None	None	None	None	None	None	None	None
Storage Length	0		0	0		0	100		0	100		0
Median Width		0			0			12			12	
Grade (%)		0%			0%			0%			0%	
Peak Hour Factor	0.84	0.84	0.84	0.75	0.75	0.75	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles(%)	0	0	0	0	0	0	0	1	0	0	1	0
Movement Flow Rate	50	6	71	0	4	12	57	664	1	7	583	60
Number of Lanes	0	1	0	0	1	0	1	1	0	1	1	0

Major/Minor	Minor 2			Minor 1			Major 1			Major 2		
Conflicting Flow Rate - All	1414	1406	322	1445	1436	333	643	0	0	665	0	0
Stage 1	627	627	-	779	779	-	-	-	-	-	-	-
Stage 2	787	779	-	666	657	-	-	-	-	-	-	-
Follow-up Headway	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Capacity-1 Maneuver	71	86	724	65	80	*824	951	-	-	*824	-	-
Stage 1	475	479	-	450	412	-	-	-	-	-	-	-
Stage 2	442	411	-	452	465	-	-	-	-	-	-	-
Time blocked-Platoon(%)	45	45	0	45	45	45	0	-	-	45	-	-
Mov Capacity-1 Maneuver	64	80	724	53	74	*824	951	-	-	*824	-	-
Mov Capacity-2 Maneuver	64	80	-	53	74	-	-	-	-	-	-	-
Stage 1	447	475	-	423	387	-	-	-	-	-	-	-
Stage 2	405	386	-	399	461	-	-	-	-	-	-	-

Approach	EB			WB			NB			SB		
HCM Control Delay (s)	131			21.6			0.7			0.1		
HCM LOS	F			C			A			A		

Lane	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (vph)				*133	*233			
HCM Control Delay (s)	9.025	0	-	131	21.6	9.405	0	-
HCM Lane VC Ratio	0.06	-	-	0.958	0.069	0.008	-	-
HCM Lane LOS	A	A	-	F	C	A	A	-
HCM 95th Percentile Queue (veh)	0.19	-	-	6.569	0.219	0.024	-	-

HCM 2010 TWSC  
 1: 32nd St W & Rosebud Dr

Existing - Weekday PM Peak

**Intersection**

Intersection Delay (sec/veh): 67

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	50	1	58	0	2	8	81	693	4	6	547	70
Conflicting Peds.(#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
Right Turn Channelized	None	None	None	None	None	None	None	None	None	None	None	None
Storage Length	0		0	0		0	100		0	100		0
Median Width		0			0			12			12	
Grade (%)		0%			0%			0%			0%	
Peak Hour Factor	0.78	0.78	0.78	0.50	0.50	0.50	0.90	0.90	0.90	0.95	0.95	0.95
Heavy Vehicles(%)	0	0	0	0	0	0	0	1	0	0	1	0
Movement Flow Rate	64	1	74	0	4	16	90	770	4	6	576	74
Number of Lanes	0	1	0	0	1	0	1	1	0	1	1	0
























Major/Minor	Minor 2			Minor 1			Major 1			Major 2		
Conflicting Flow Rate - All	1587	1579	325	1615	1614	387	650	0	0	774	0	0
Stage 1	625	625	-	952	952	-	-	-	-	-	-	-
Stage 2	962	954	-	663	662	-	-	-	-	-	-	-
Follow-up Headway	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Capacity-1 Maneuver	# 35	45	721	31	40	*691	946	-	-	*691	-	-
Stage 1	476	480	-	324	305	-	-	-	-	-	-	-
Stage 2	316	304	-	454	462	-	-	-	-	-	-	-
Time blocked-Platoon(%)	54	54	0	54	54	54	0	-	-	54	-	-
Mov Capacity-1 Maneuver	# 28	40	721	25	36	*691	946	-	-	*691	-	-
Mov Capacity-2 Maneuver	# 28	40	-	25	36	-	-	-	-	-	-	-
Stage 1	431	476	-	293	276	-	-	-	-	-	-	-
Stage 2	275	275	-	403	458	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay (s)	\$ 793.9	32.9	1	0.1
HCM LOS	F	D	A	A

Lane	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (vph)				*58	*149			
HCM Control Delay (s)	9.205	0	-	\$ 32.9	32.9	10.258	0	-
HCM Lane VC Ratio	0.095	-	-	2.409	0.134	0.009	-	-
HCM Lane LOS	A	A	-	F	D	B	A	-
HCM 95th Percentile Queue (veh)	0.314	-	-	13.969	0.452	0.028	-	-
























HCM 2010 Signalized Intersection Summary  
 2: 32nd St W & King Ave W

Existing - Weekday Noon Peak

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	89	409	79	196	414	352	72	240	112	328	211	80
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1863	1869	1869	1881	1863	1863	1900	1881	1810	1881	1881	1900
Lanes	1	2	0	1	2	1	1	1	1	1	1	1
Capacity, veh/h	359	884	170	329	1026	459	509	583	477	514	771	662
Arriving On Green	0.06	0.29	0.29	0.06	0.29	0.29	0.04	0.31	0.31	0.14	0.41	0.41
Sat Flow, veh/h	1774.0	3049.4	584.8	1791.6	1583.3	1583.3	1809.5	1538.1	1538.1	1791.6	1615.0	1615.0
Grp Volume(v), veh/h	95.7	268.3	256.5	206.3	435.8	185.3	91.1	303.8	70.9	348.9	224.5	42.6
Grp Sat Flow(s),veh/h/ln	1774.0	1868.7	1765.5	1791.6	1769.6	1583.3	1809.5	1881.2	1538.1	1791.6	1881.2	1615.0
Q Serve(g_s), s	3.7	11.9	12.1	6.0	10.0	9.4	3.4	13.3	3.3	10.4	8.0	1.6
Cycle Q Clear(g_c), s	3.7	11.9	12.1	6.0	10.0	9.4	3.4	13.3	3.3	10.4	8.0	1.6
Proportion In Lane	1.000		0.331	1.000		1.000	1.000		1.000	1.000		1.000
Lane Grp Cap(c), veh/h	359.0	541.9	512.0	329.0	1026.4	459.2	508.5	583.2	476.8	514.4	771.3	662.1
V/C Ratio(X)	0.267	0.495	0.501	0.627	0.425	0.403	0.179	0.521	0.149	0.678	0.291	0.064
Avail Cap(c_a), veh/h	359.0	541.9	512.0	329.0	1026.4	459.2	508.5	583.2	476.8	514.4	771.3	662.1
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Uniform Delay (d), s/veh	22.9	29.4	29.5	28.1	28.7	28.5	22.2	28.4	25.0	16.2	19.8	17.9
Incr Delay (d2), s/veh	1.8	3.2	3.5	8.7	1.3	2.6	0.8	3.3	0.7	7.0	1.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	24.7	32.6	33.0	36.9	30.0	31.2	23.0	31.7	25.6	23.2	20.7	18.1
Lane Group LOS	C	C	C	D	C	C	C	C	C	C	C	B
Approach Volume, veh/h		620			827			466			616	
Approach Delay, s/veh		31.5			32.0			29.1			22.0	
Approach LOS		C			C			C			C	
<b>Timer</b>												
Assigned Phase	7	4		3	8		5	2		1	6	
Phase Duration (G+Y+Rc), s	11.00	34.00		11.00	34.00		9.00	36.00		19.00	46.00	
Change Period (Y+Rc), s	5.00	5.00		5.00	5.00		5.00	5.00		5.00	5.00	
Max Green Setting (Gmax), s	6.00	29.00		6.00	29.00		4.00	31.00		14.00	41.00	
Max Q Clear Time (g_c+I1), s	5.71	14.07		8.00	11.97		5.45	15.29		12.40	9.99	
Green Extension Time (p_c)	0.01	6.04		0.00	6.45		0.00	3.20		0.20	3.82	
<b>Intersection Summary</b>												
HCM 2010 Control Delay	28.9											
HCM 2010 Level of Service	C											

HCM 2010 Signalized Intersection Summary  
 2: 32nd St W & King Ave W

Existing - Weekday PM Peak

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	88	385	48	176	602	378	113	324	111	275	256	84
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1900	1883	1883	1881	1881	1900	1881	1881	1881	1863	1863	1900
Lanes	1	2	0	1	2	1	1	1	1	1	1	1
Capacity, veh/h	274	953	118	344	1037	468	490	583	496	442	764	662
Arriving On Green	0.06	0.29	0.29	0.06	0.29	0.29	0.04	0.31	0.31	0.14	0.41	0.41
Sat Flow, veh/h	1809.5	3287.0	407.6	1791.6	1615.0	1615.0	1791.6	1599.0	1599.0	1774.0	1615.0	1615.0
Grp Volume(v), veh/h	100.0	249.7	242.4	200.0	684.1	214.8	139.5	400.0	69.1	289.5	269.5	44.2
Grp Sat Flow(s),veh/h/ln	1809.5	1883.3	1811.3	1791.6	1787.1	1615.0	1791.6	1881.2	1599.0	1774.0	1862.7	1615.0
Q Serve(g_s), s	3.8	10.9	11.0	6.0	16.8	10.9	4.0	18.6	3.1	8.4	10.0	1.7
Cycle Q Clear(g_c), s	3.8	10.9	11.0	6.0	16.8	10.9	4.0	18.6	3.1	8.4	10.0	1.7
Proportion In Lane	1.000		0.225	1.000		1.000	1.000		1.000	1.000		1.000
Lane Grp Cap(c), veh/h	274.4	546.1	525.3	343.6	1036.5	468.3	489.7	583.2	495.7	441.6	763.7	662.1
V/C Ratio(X)	0.364	0.457	0.461	0.582	0.660	0.459	0.285	0.686	0.139	0.655	0.353	0.067
Avail Cap(c_a), veh/h	274.4	546.1	525.3	343.6	1036.5	468.3	489.7	583.2	495.7	441.6	763.7	662.1
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Uniform Delay (d), s/veh	24.0	29.1	29.1	27.2	31.2	29.1	23.0	30.2	24.9	17.7	20.3	17.9
Incr Delay (d2), s/veh	3.7	2.7	2.9	7.0	3.3	3.2	1.5	6.4	0.6	7.4	1.3	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	27.7	31.8	32.0	34.2	34.5	32.3	24.5	36.7	25.5	25.1	21.6	18.1
Lane Group LOS	C	C	C	C	C	C	C	D	C	C	C	B
Approach Volume, veh/h		592			1099			609			603	
Approach Delay, s/veh		31.2			34.0			32.6			23.0	
Approach LOS		C			C			C			C	
<b>Timer</b>												
Assigned Phase	7	4		3	8		5	2		1	6	
Phase Duration (G+Y+Rc), s	11.00	34.00		11.00	34.00		9.00	36.00		19.00	46.00	
Change Period (Y+Rc), s	5.00	5.00		5.00	5.00		5.00	5.00		5.00	5.00	
Max Green Setting (Gmax), s	6.00	29.00		6.00	29.00		4.00	31.00		14.00	41.00	
Max Q Clear Time (g_c+I1), s	5.80	12.97		8.00	18.81		6.00	20.63		10.38	11.98	
Green Extension Time (p_c)	0.00	7.76		0.00	5.80		0.00	3.32		0.31	4.92	
<b>Intersection Summary</b>												
HCM 2010 Control Delay	30.9											
HCM 2010 Level of Service	C											

**APPENDIX C**  
**TRIP GENERATION COUNT SUMMARIES**



Trip Generation Counts  
 Pita Pit Restaurant  
 2228 Grand Avenue  
 Billings, MT 59102

11/7/2012

Weekday PM

	In	Out	Total
<b>4:30-4:45</b>	5	6	11
<b>4:45-5:00</b>	2	3	5
<b>5:00-5:15</b>	3	2	5
<b>5:15-5:30</b>	0	1	1
<b>Total</b>	10	12	22
<b>Percent</b>	45%	55%	100%

Gross Floor Area = 2600 SF  
 Average Rate = 8.46 trips/1000 SF

Weekday Noon

	In	Out	Total
<b>12:00-12:15</b>	3	6	9
<b>12:15-12:30</b>	4	5	9
<b>12:30-12:45</b>	6	3	9
<b>12:45-1:00</b>	7	10	17
<b>Total</b>	20	24	44
<b>Percent</b>	45%	55%	100%

Gross Floor Area = 2600 SF  
 Average Rate = 16.92 trips/1000 SF

Weekend Noon

	In	Out	Total
<b>12:00-12:15</b>	3	3	6
<b>12:15-12:30</b>	4	3	7
<b>12:30-12:45</b>	5	3	8
<b>12:45-1:00</b>	3	6	9
<b>Total</b>	15	15	30
<b>Percent</b>	50%	50%	100%

Gross Floor Area = 2600 SF  
 Average Rate = 11.54 trips/1000 SF

Trip Generation Counts  
Spicy Pickle Restaurant  
900 S 24th St W, #6  
Billings, MT 59102

11/7/2012

Weekday PM

	<b>In</b>	<b>Out</b>	<b>Total</b>
<b>4:30-4:45</b>	3	3	6
<b>4:45-5:00</b>	1	0	1
<b>5:00-5:15</b>	0	0	0
<b>5:15-5:30</b>	2	1	3
<b>Total</b>	6	4	10
<b>Percent</b>	60%	40%	100%

Gross Floor Area = 1800 SF  
Average Rate = 5.56 trips/1000 SF

Weekday Noon

	<b>In</b>	<b>Out</b>	<b>Total</b>
<b>12:00-12:15</b>	10	6	16
<b>12:15-12:30</b>	7	9	16
<b>12:30-12:45</b>	9	6	15
<b>12:45-1:00</b>	2	5	7
<b>Total</b>	28	26	54
<b>Percent</b>	52%	48%	100%

Gross Floor Area = 1800 SF  
Average Rate = 30.00 trips/1000 SF






















**APPENDIX D**  
**CAPACITY CALCULATIONS – EXISTING + PROJECT**



# HCM 2010 Signalized Intersection Summary

## 8: 32nd St W & Monad Rd






















Existing + Site - Weekday Noon Peak

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	44	127	35	77	127	78	32	530	75	65	501	49
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1863	1885	1885	1900	1863	1900	1900	1884	1884	1900	1883	1883
Lanes	1	1	0	1	1	1	1	1	0	1	1	0
Capacity, veh/h	280	294	81	244	385	334	440	887	125	402	952	93
Arriving On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.02	0.55	0.55	0.03	0.56	0.56
Sat Flow, veh/h	1245.9	1423.7	392.3	1218.7	1862.7	1615.0	1809.5	1614.7	228.5	1809.5	1688.6	165.1
Grp Volume(v), veh/h	50.0	0.0	184.1	83.7	138.0	42.4	34.4	0.0	650.5	69.1	0.0	585.1
Grp Sat Flow(s),veh/h/ln	1245.9	0.0	1816.0	1218.7	1862.7	1615.0	1809.5	0.0	1843.2	1809.5	0.0	1853.7
Q Serve(g_s), s	2.5	0.0	6.4	4.6	4.5	1.5	0.6	0.0	17.5	1.1	0.0	14.3
Cycle Q Clear(g_c), s	7.1	0.0	6.4	11.0	4.5	1.5	0.6	0.0	17.5	1.1	0.0	14.3
Proportion In Lane	1.000		0.216	1.000		1.000	1.000		0.124	1.000		0.089
Lane Grp Cap(c), veh/h	279.7	0.0	375.3	244.2	384.9	333.8	440.2	0.0	1012.2	401.7	0.0	1045.6
V/C Ratio(X)	0.179	0.000	0.491	0.343	0.359	0.127	0.078	0.000	0.643	0.172	0.000	0.560
Avail Cap(c_a), veh/h	408.2	0.0	562.6	369.8	577.0	500.3	509.4	0.0	1012.2	444.0	0.0	1045.6
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	0.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.000	1.000
Uniform Delay (d), s/veh	27.2	0.0	24.9	29.7	24.1	23.0	8.1	0.0	11.2	8.6	0.0	9.9
Incr Delay (d2), s/veh	0.3	0.0	1.0	0.8	0.6	0.2	0.1	0.0	3.1	0.2	0.0	2.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	27.5	0.0	25.9	30.5	24.7	23.1	8.1	0.0	14.3	8.8	0.0	12.0
Lane Group LOS	C		C	C	C	C	A		B	A		B
Approach Volume, veh/h		234			264			685			654	
Approach Delay, s/veh		26.2			26.3			14.0			11.7	
Approach LOS		C			C			B			B	
<b>Timer</b>												
Assigned Phase		4			8		5	2		1		6
Phase Duration (G+Y+Rc), s		19.68			19.68		6.28	44.00		7.34		45.06
Change Period (Y+Rc), s		5.00			5.00		5.00	5.00		5.00		5.00
Max Green Setting (Gmax), s		22.00			22.00		4.00	39.00		4.00		39.00
Max Q Clear Time (g_c+I1), s		9.05			12.98		2.60	19.46		3.14		16.28
Green Extension Time (p_c)		2.05			1.70		0.00	8.65		0.01		9.31
<b>Intersection Summary</b>												
HCM 2010 Control Delay				16.5								
HCM 2010 Level of Service				B								

# HCM 2010 Signalized Intersection Summary

## 8: 32nd St W & Monad Rd

Existing + Site - Weekday PM Peak

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	62	177	39	119	245	91	48	570	73	73	497	85
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1900	1885	1885	1900	1900	1900	1900	1883	1883	1900	1884	1884
Lanes	1	1	0	1	1	1	1	1	0	1	1	0
Capacity, veh/h	245	402	89	269	511	434	323	817	105	296	802	137
Arriving On Green	0.27	0.27	0.27	0.27	0.27	0.27	0.03	0.50	0.50	0.04	0.51	0.51
Sat Flow, veh/h	1108.2	1496.6	329.8	1149.4	1900.0	1615.0	1809.5	1636.7	209.6	1809.5	1568.4	268.2
Grp Volume(v), veh/h	71.3	0.0	248.3	140.0	288.2	54.1	53.9	0.0	722.5	83.9	0.0	669.0
Grp Sat Flow(s),veh/h/ln	1108.2	0.0	1826.4	1149.4	1900.0	1615.0	1809.5	0.0	1846.3	1809.5	0.0	1836.6
Q Serve(g_s), s	4.6	0.0	9.0	9.2	10.2	2.0	1.1	0.0	25.1	1.7	0.0	21.9
Cycle Q Clear(g_c), s	14.8	0.0	9.0	18.2	10.2	2.0	1.1	0.0	25.1	1.7	0.0	21.9
Proportion In Lane	1.000		0.181	1.000		1.000	1.000		0.114	1.000		0.146
Lane Grp Cap(c), veh/h	245.1	0.0	490.9	268.9	510.7	434.1	323.0	0.0	922.0	296.0	0.0	939.3
V/C Ratio(X)	0.291	0.000	0.506	0.521	0.564	0.125	0.167	0.000	0.784	0.284	0.000	0.712
Avail Cap(c_a), veh/h	259.4	0.0	514.5	283.7	535.2	454.9	365.5	0.0	922.0	316.6	0.0	939.3
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	0.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000	0.000	1.000
Uniform Delay (d), s/veh	31.0	0.0	24.2	31.8	24.6	21.6	12.0	0.0	16.1	13.2	0.0	14.7
Incr Delay (d2), s/veh	0.6	0.0	0.8	1.6	1.3	0.1	0.2	0.0	6.6	0.5	0.0	4.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	31.7	0.0	25.0	33.4	25.9	21.7	12.3	0.0	22.7	13.7	0.0	19.2
Lane Group LOS	C		C	C	C	C	B		C	B		B
Approach Volume, veh/h		320			482			776			753	
Approach Delay, s/veh		26.5			27.6			22.0			18.6	
Approach LOS		C			C			C			B	
<b>Timer</b>												
Assigned Phase		4			8		5	2		1		6
Phase Duration (G+Y+Rc), s		25.99			25.99		7.17	44.00		8.11		44.94
Change Period (Y+Rc), s		5.00			5.00		5.00	5.00		5.00		5.00
Max Green Setting (Gmax), s		22.00			22.00		4.00	39.00		4.00		39.00
Max Q Clear Time (g_c+I1), s		16.84			20.15		3.13	27.14		3.70		23.86
Green Extension Time (p_c)		2.00			0.84		0.01	7.25		0.00		8.58
<b>Intersection Summary</b>												
HCM 2010 Control Delay					22.7							
HCM 2010 Level of Service					C							

HCM 2010 TWSC  
 1: 32nd St W & Rosebud Dr

Existing + Site - Weekday Noon Peak

**Intersection**

Intersection Delay (sec/veh): 37.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	60	6	79	0	4	9	70	590	1	6	517	71
Conflicting Peds.(#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
Right Turn Channelized	None	None	None	None	None	None	None	None	None	None	None	None
Storage Length	0		0	0		0	100		0	100		0
Median Width		0			0			12			12	
Grade (%)		0%			0%			0%			0%	
Peak Hour Factor	0.84	0.84	0.84	0.75	0.75	0.75	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles(%)	0	0	0	0	0	0	0	1	0	0	1	0
Movement Flow Rate	71	7	94	0	5	12	78	656	1	7	574	79
Number of Lanes	0	1	0	0	1	0	1	1	0	1	1	0

Major/Minor	Minor 2			Minor 1			Major 1			Major 2		
Conflicting Flow Rate - All	1449	1441	327	1491	1480	329	653	0	0	657	0	0
Stage 1	628	628	-	813	813	-	-	-	-	-	-	-
Stage 2	821	813	-	678	667	-	-	-	-	-	-	-
Follow-up Headway	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Capacity-1 Maneuver	# 65	79	719	57	71	*824	943	-	-	*824	-	-
Stage 1	474	479	-	417	387	-	-	-	-	-	-	-
Stage 2	409	387	-	445	460	-	-	-	-	-	-	-
Time blocked-Platoon(%)	45	45	0	45	45	45	0	-	-	45	-	-
Mov Capacity-1 Maneuver	# 56	71	719	43	65	*824	943	-	-	*824	-	-
Mov Capacity-2 Maneuver	# 56	71	-	43	65	-	-	-	-	-	-	-
Stage 1	435	475	-	383	355	-	-	-	-	-	-	-
Stage 2	364	355	-	378	456	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay (s)	\$ 333	27.3	1	0.1
HCM LOS	F	D	A	A

Lane	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (vph)				*115	*179			
HCM Control Delay (s)	9.16	0	-	\$ 27.3	27.3	9.405	0	-
HCM Lane VC Ratio	0.082	-	-	1.501	0.097	0.008	-	-
HCM Lane LOS	A	A	-	F	D	A	A	-
HCM 95th Percentile Queue (veh)	0.269	-	-	12.416	0.317	0.024	-	-

HCM 2010 TWSC  
 1: 32nd St W & Rosebud Dr

Existing + Site - Weekday PM Peak

**Intersection**

Intersection Delay (sec/veh): 87.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	55	1	63	0	2	8	87	690	4	6	545	75
Conflicting Peds.(#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
Right Turn Channelized	None	None	None	None	None	None	None	None	None	None	None	None
Storage Length	0		0	0		0	100		0	100		0
Median Width		0			0			12			12	
Grade (%)		0%			0%			0%			0%	
Peak Hour Factor	0.78	0.78	0.78	0.50	0.50	0.50	0.90	0.90	0.90	0.95	0.95	0.95
Heavy Vehicles(%)	0	0	0	0	0	0	0	1	0	0	1	0
Movement Flow Rate	71	1	81	0	4	16	97	767	4	6	574	79
Number of Lanes	0	1	0	0	1	0	1	1	0	1	1	0
























Major/Minor	Minor 2			Minor 1			Major 1			Major 2		
Conflicting Flow Rate - All	1599	1591	327	1630	1628	386	653	0	0	771	0	0
Stage 1	626	626	-	963	963	-	-	-	-	-	-	-
Stage 2	973	965	-	667	665	-	-	-	-	-	-	-
Follow-up Headway	3.5	4	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Capacity-1 Maneuver	# 33	43	719	29	38	*691	943	-	-	*691	-	-
Stage 1	475	480	-	315	298	-	-	-	-	-	-	-
Stage 2	307	297	-	451	461	-	-	-	-	-	-	-
Time blocked-Platoon(%)	54	54	0	54	54	54	0	-	-	54	-	-
Mov Capacity-1 Maneuver	# 27	38	719	23	34	*691	943	-	-	*691	-	-
Mov Capacity-2 Maneuver	# 27	38	-	23	34	-	-	-	-	-	-	-
Stage 1	426	476	-	283	267	-	-	-	-	-	-	-
Stage 2	265	266	-	396	457	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay (s)	\$ 960.5	34.5	1	0.1
HCM LOS	F	D	A	A

Lane	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (vph)				*55	*142			
HCM Control Delay (s)	9.253	0	-	\$ 34.5	34.5	10.258	0	-
HCM Lane VC Ratio	0.103	-	-	2.774	0.141	0.009	-	-
HCM Lane LOS	A	A	-	F	D	B	A	-
HCM 95th Percentile Queue (veh)	0.342	-	-	15.813	0.477	0.028	-	-

HCM 2010 Signalized Intersection Summary  
 2: 32nd St W & King Ave W
























Existing + Site - Weekday Noon Peak

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	91	409	79	196	414	357	72	244	112	333	215	82
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1863	1869	1869	1881	1863	1863	1900	1881	1810	1881	1881	1900
Lanes	1	2	0	1	2	1	1	1	1	1	1	1
Capacity, veh/h	359	884	170	329	1026	459	507	583	477	511	771	662
Arriving On Green	0.06	0.29	0.29	0.06	0.29	0.29	0.04	0.31	0.31	0.14	0.41	0.41
Sat Flow, veh/h	1774.0	3049.4	584.8	1791.6	1583.3	1583.3	1809.5	1538.1	1538.1	1791.6	1615.0	1615.0
Grp Volume(v), veh/h	97.8	268.3	256.5	206.3	435.8	188.4	91.1	308.9	70.9	354.3	228.7	43.6
Grp Sat Flow(s),veh/h/ln	1774.0	1868.7	1765.5	1791.6	1769.6	1583.3	1809.5	1881.2	1538.1	1791.6	1881.2	1615.0
Q Serve(g_s), s	3.8	11.9	12.1	6.0	10.0	9.6	3.4	13.6	3.3	10.6	8.2	1.6
Cycle Q Clear(g_c), s	3.8	11.9	12.1	6.0	10.0	9.6	3.4	13.6	3.3	10.6	8.2	1.6
Proportion In Lane	1.000		0.331	1.000		1.000	1.000		1.000	1.000		1.000
Lane Grp Cap(c), veh/h	359.0	541.9	512.0	329.0	1026.4	459.2	507.1	583.2	476.8	510.7	771.3	662.1
V/C Ratio(X)	0.273	0.495	0.501	0.627	0.425	0.410	0.180	0.530	0.149	0.694	0.297	0.066
Avail Cap(c_a), veh/h	359.0	541.9	512.0	329.0	1026.4	459.2	507.1	583.2	476.8	510.7	771.3	662.1
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Uniform Delay (d), s/veh	22.9	29.4	29.5	28.1	28.7	28.6	22.2	28.5	25.0	16.4	19.8	17.9
Incr Delay (d2), s/veh	1.9	3.2	3.5	8.7	1.3	2.7	0.8	3.4	0.7	7.6	1.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	24.8	32.6	33.0	36.9	30.0	31.3	23.0	31.9	25.6	24.0	20.8	18.1
Lane Group LOS	C	C	C	D	C	C	C	C	C	C	C	B
Approach Volume, veh/h		623			831			471			627	
Approach Delay, s/veh		31.5			32.0			29.2			22.4	
Approach LOS		C			C			C			C	
<b>Timer</b>												
Assigned Phase	7	4		3	8		5	2		1	6	
Phase Duration (G+Y+Rc), s	11.00	34.00		11.00	34.00		9.00	36.00		19.00	46.00	
Change Period (Y+Rc), s	5.00	5.00		5.00	5.00		5.00	5.00		5.00	5.00	
Max Green Setting (Gmax), s	6.00	29.00		6.00	29.00		4.00	31.00		14.00	41.00	
Max Q Clear Time (g_c+I1), s	5.79	14.07		8.00	11.97		5.45	15.55		12.60	10.17	
Green Extension Time (p_c)	0.00	6.05		0.00	6.46		0.00	3.24		0.18	3.89	
<b>Intersection Summary</b>												
HCM 2010 Control Delay	29.0											
HCM 2010 Level of Service	C											

# HCM 2010 Signalized Intersection Summary

## 2: 32nd St W & King Ave W

Existing + Site - Weekday PM Peak



















												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	88	385	48	176	602	380	113	325	111	277	257	84
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1900	1883	1883	1881	1881	1900	1881	1881	1881	1863	1863	1900
Lanes	1	2	0	1	2	1	1	1	1	1	1	1
Capacity, veh/h	274	953	118	344	1037	468	489	583	496	441	764	662
Arriving On Green	0.06	0.29	0.29	0.06	0.29	0.29	0.04	0.31	0.31	0.14	0.41	0.41
Sat Flow, veh/h	1809.5	3287.0	407.6	1791.6	1615.0	1615.0	1791.6	1599.0	1599.0	1774.0	1615.0	1615.0
Grp Volume(v), veh/h	100.0	249.7	242.4	200.0	684.1	215.9	139.5	401.2	69.1	291.6	270.5	44.2
Grp Sat Flow(s),veh/h/ln	1809.5	1883.3	1811.3	1791.6	1787.1	1615.0	1791.6	1881.2	1599.0	1774.0	1862.7	1615.0
Q Serve(g_s), s	3.8	10.9	11.0	6.0	16.8	11.0	4.0	18.7	3.1	8.5	10.0	1.7
Cycle Q Clear(g_c), s	3.8	10.9	11.0	6.0	16.8	11.0	4.0	18.7	3.1	8.5	10.0	1.7
Proportion In Lane	1.000		0.225	1.000		1.000	1.000		1.000	1.000		1.000
Lane Grp Cap(c), veh/h	274.4	546.1	525.3	343.6	1036.5	468.3	489.1	583.2	495.7	440.8	763.7	662.1
V/C Ratio(X)	0.364	0.457	0.461	0.582	0.660	0.461	0.285	0.688	0.139	0.661	0.354	0.067
Avail Cap(c_a), veh/h	274.4	546.1	525.3	343.6	1036.5	468.3	489.1	583.2	495.7	440.8	763.7	662.1
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Uniform Delay (d), s/veh	24.0	29.1	29.1	27.2	31.2	29.1	23.0	30.3	24.9	17.8	20.4	17.9
Incr Delay (d2), s/veh	3.7	2.7	2.9	7.0	3.3	3.2	1.5	6.5	0.6	7.6	1.3	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	27.7	31.8	32.0	34.2	34.5	32.3	24.5	36.8	25.5	25.4	21.6	18.1
Lane Group LOS	C	C	C	C	C	C	C	D	C	C	C	B
Approach Volume, veh/h		592			1100			610			606	
Approach Delay, s/veh		31.2			34.0			32.7			23.2	
Approach LOS		C			C			C			C	
<b>Timer</b>												
Assigned Phase	7	4		3	8		5	2		1	6	
Phase Duration (G+Y+Rc), s	11.00	34.00		11.00	34.00		9.00	36.00		19.00	46.00	
Change Period (Y+Rc), s	5.00	5.00		5.00	5.00		5.00	5.00		5.00	5.00	
Max Green Setting (Gmax), s	6.00	29.00		6.00	29.00		4.00	31.00		14.00	41.00	
Max Q Clear Time (g_c+I1), s	5.80	12.97		8.00	18.81		6.00	20.71		10.46	12.02	
Green Extension Time (p_c)	0.00	7.76		0.00	5.81		0.00	3.32		0.31	4.94	
<b>Intersection Summary</b>												
HCM 2010 Control Delay			30.9									
HCM 2010 Level of Service			C									

**APPENDIX E**  
**CAPACITY CALCULATIONS – PROPOSED  
IMPROVEMENT ALTERNATIVES**





















HCM 2010 Signalized Intersection Summary  
 1: 32nd St W & Rosebud Dr

Existing + Site - Weekday Noon Peak - Imp 1

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	60	6	79	0	4	9	70	590	1	6	517	71
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1900	1900	1900	0	1900	1900	1900	1881	1881	1900	1883	1883
Lanes	0	1	0	0	1	0	1	1	0	1	1	0
Capacity, veh/h	188	32	116	0	89	200	519	1195	2	522	1032	142
Arriving On Green	0.17	0.17	0.17	0.00	0.17	0.17	0.64	0.64	0.64	0.64	0.64	0.64
Sat Flow, veh/h	515.2	46.9	678.3	0.0	521.0	1172.2	791.6	1877.5	3.2	789.1	1621.5	222.7
Grp Volume(v), veh/h	172.6	0.0	0.0	0.0	0.0	17.3	77.8	0.0	656.7	6.7	0.0	653.3
Grp Sat Flow(s),veh/h/ln	1245.0	0.0	0.0	0.0	0.0	1693.1	791.6	0.0	1880.7	789.1	0.0	1844.1
Q Serve(g_s), s	4.1	0.0	0.0	0.0	0.0	0.4	2.6	0.0	8.1	0.2	0.0	8.3
Cycle Q Clear(g_c), s	5.4	0.0	0.0	0.0	0.0	0.4	10.8	0.0	8.1	8.3	0.0	8.3
Proportion In Lane	0.414		0.545	0.000		0.692	1.000		0.002	1.000		0.121
Lane Grp Cap(c), veh/h	335.2	0.0	0.0	0.0	0.0	289.5	519.3	0.0	1197.4	521.7	0.0	1174.2
V/C Ratio(X)	0.515	0.000	0.000	0.000	0.000	0.060	0.150	0.000	0.548	0.013	0.000	0.556
Avail Cap(c_a), veh/h	577.4	0.0	0.0	0.0	0.0	651.2	1080.8	0.0	2531.5	1081.5	0.0	2482.3
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	0.000	0.000	0.000	0.000	1.000	1.000	0.000	1.000	1.000	0.000	1.000
Uniform Delay (d), s/veh	16.2	0.0	0.0	0.0	0.0	14.4	7.3	0.0	4.2	6.5	0.0	4.3
Incr Delay (d2), s/veh	1.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.4	0.0	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	17.4	0.0	0.0	0.0	0.0	14.5	7.4	0.0	4.6	6.5	0.0	4.7
Lane Group LOS	B					B	A		A	A		A
Approach Volume, veh/h		173			17			734			660	
Approach Delay, s/veh		17.4			14.5			4.9			4.7	
Approach LOS		B			B			A			A	
<b>Timer</b>												
Assigned Phase		4			8			2			6	
Phase Duration (G+Y+Rc), s		11.11			11.11			30.49			30.49	
Change Period (Y+Rc), s		4.00			4.00			4.00			4.00	
Max Green Setting (Gmax), s		16.00			16.00			56.00			56.00	
Max Q Clear Time (g_c+I1), s		7.37			2.36			12.84			10.31	
Green Extension Time (p_c)		0.64			0.85			13.65			13.84	
<b>Intersection Summary</b>												
HCM 2010 Control Delay			6.3									
HCM 2010 Level of Service			A									

HCM 2010 Signalized Intersection Summary  
 1: 32nd St W & Rosebud Dr

Existing + Site - Weekday PM Peak - Imp 1

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	55	1	63	0	2	8	87	690	4	6	545	75
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking, Bus Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow Rate	1900	1900	1900	0	1900	1900	1900	1881	1881	1900	1883	1883
Lanes	0	1	0	0	1	0	1	1	0	1	1	0
Capacity, veh/h	185	22	99	0	52	208	542	1238	7	467	1074	148
Arriving On Green	0.16	0.16	0.16	0.00	0.16	0.16	0.66	0.66	0.66	0.66	0.66	0.66
Sat Flow, veh/h	553.5	9.2	634.1	0.0	333.0	1332.0	792.1	1868.5	10.8	709.3	1621.0	223.1
Grp Volume(v), veh/h	152.6	0.0	0.0	0.0	0.0	20.0	96.7	0.0	771.1	6.3	0.0	652.6
Grp Sat Flow(s),veh/h/ln	1197.7	0.0	0.0	0.0	0.0	1664.9	792.1	0.0	1879.4	709.3	0.0	1844.1
Q Serve(g_s), s	4.1	0.0	0.0	0.0	0.0	0.5	3.2	0.0	10.4	0.2	0.0	8.2
Cycle Q Clear(g_c), s	5.3	0.0	0.0	0.0	0.0	0.5	11.4	0.0	10.4	10.6	0.0	8.2
Proportion In Lane	0.462		0.529	0.000		0.800	1.000		0.006	1.000		0.121
Lane Grp Cap(c), veh/h	306.1	0.0	0.0	0.0	0.0	259.9	541.7	0.0	1245.6	466.7	0.0	1222.2
V/C Ratio(X)	0.498	0.000	0.000	0.000	0.000	0.077	0.178	0.000	0.619	0.014	0.000	0.534
Avail Cap(c_a), veh/h	530.9	0.0	0.0	0.0	0.0	603.2	1021.0	0.0	2382.9	896.0	0.0	2338.2
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.000	0.000	0.000	0.000	0.000	1.000	1.000	0.000	1.000	1.000	0.000	1.000
Uniform Delay (d), s/veh	17.6	0.0	0.0	0.0	0.0	15.9	6.9	0.0	4.3	7.3	0.0	3.9
Incr Delay (d2), s/veh	1.3	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.5	0.0	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lane Group Delay (d), s/veh	18.9	0.0	0.0	0.0	0.0	16.0	7.0	0.0	4.8	7.3	0.0	4.3
Lane Group LOS	B					B	A		A	A		A
Approach Volume, veh/h		153			20			868			659	
Approach Delay, s/veh		18.9			16.0			5.0			4.3	
Approach LOS		B			B			A			A	
<b>Timer</b>												
Assigned Phase		4			8			2			6	
Phase Duration (G+Y+Rc), s		10.89			10.89			33.27			33.27	
Change Period (Y+Rc), s		4.00			4.00			4.00			4.00	
Max Green Setting (Gmax), s		16.00			16.00			56.00			56.00	
Max Q Clear Time (g_c+I1), s		7.27			2.45			13.36			12.59	
Green Extension Time (p_c)		0.56			0.75			15.91			16.00	
<b>Intersection Summary</b>												
HCM 2010 Control Delay			6.1									
HCM 2010 Level of Service			A									

HCM 2010 TWSC  
1: 32nd St W & Rosebud Dr

Existing + Site - Weekday Noon Peak - Imp 2

**Intersection**

Intersection Delay (sec/veh): 1.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	0	0	145	0	0	13	70	590	1	6	517	71
Conflicting Peds.(#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
Right Turn Channelized	None	None	None	None	None	None	None	None	None	None	None	None
Storage Length	0		0	0		0	100		0	100		0
Median Width		0			0			12			12	
Grade (%)		0%			0%			0%			0%	
Peak Hour Factor	0.84	0.84	0.84	0.75	0.75	0.75	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles(%)	0	0	0	0	0	0	0	1	0	0	1	0
Movement Flow Rate	0	0	173	0	0	17	78	656	1	7	574	79
Number of Lanes	0	0	1	0	0	1	1	1	0	1	1	0

Major/Minor	Minor 2			Minor 1			Major 1			Major 2		
Conflicting Flow Rate - All	~	~	327	~	~	329	653	0	0	657	0	0
Stage 1	-	-	-	-	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-	-	-	-	-
Follow-up Headway	0	0	3.3	0	0	3.3	2.2	-	-	2.2	-	-
Pot Capacity-1 Maneuver	0	0	719	0	0	*838	943	-	-	*838	-	-
Stage 1	0	0	-	0	0	-	-	-	-	-	-	-
Stage 2	0	0	-	0	0	-	-	-	-	-	-	-
Time blocked-Platoon(%)	0	0	0	0	0	44	0	-	-	44	-	-
Mov Capacity-1 Maneuver	0	-	719	0	-	*838	943	-	-	*838	-	-
Mov Capacity-2 Maneuver	0	-	-	0	-	-	-	-	-	-	-	-
Stage 1	0	-	-	0	-	-	-	-	-	-	-	-
Stage 2	0	-	-	0	-	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay (s)	11.6	9.4	1	0.1
HCM LOS	B	A	A	A

Lane	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (vph)				*719	*838			
HCM Control Delay (s)	9.16	0	-	11.6	9.4	9.33	0	-
HCM Lane VC Ratio	0.082	-	-	0.24	0.021	0.008	-	-
HCM Lane LOS	A	A	-	B	A	A	A	-
HCM 95th Percentile Queue (veh)	0.269	-	-	0.935	0.063	0.024	-	-

HCM 2010 TWSC  
1: 32nd St W & Rosebud Dr

Existing + Site - Weekday PM Peak - Imp 2

**Intersection**

Intersection Delay (sec/veh): 1.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Volume (vph)	0	0	119	0	0	10	87	690	4	6	545	75
Conflicting Peds.(#/hr)	0	0	0	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
Right Turn Channelized	None	None	None	None	None	None	None	None	None	None	None	None
Storage Length	0		0	0		0	100		0	100		0
Median Width		0			0			12			12	
Grade (%)		0%			0%			0%			0%	
Peak Hour Factor	0.78	0.78	0.78	0.50	0.50	0.50	0.90	0.90	0.90	0.95	0.95	0.95
Heavy Vehicles(%)	0	0	0	0	0	0	0	1	0	0	1	0
Movement Flow Rate	0	0	153	0	0	20	97	767	4	6	574	79
Number of Lanes	0	0	1	0	0	1	1	1	0	1	1	0

Major/Minor	Minor 2			Minor 1			Major 1			Major 2		
Conflicting Flow Rate - All	~	~	327	~	~	386	653	0	0	771	0	0
Stage 1	-	-	-	-	-	-	-	-	-	-	-	-
Stage 2	-	-	-	-	-	-	-	-	-	-	-	-
Follow-up Headway	0	0	3.3	0	0	3.3	2.2	-	-	2.2	-	-
Pot Capacity-1 Maneuver	0	0	719	0	0	*708	943	-	-	*708	-	-
Stage 1	0	0	-	0	0	-	-	-	-	-	-	-
Stage 2	0	0	-	0	0	-	-	-	-	-	-	-
Time blocked-Platoon(%)	0	0	0	0	0	53	0	-	-	53	-	-
Mov Capacity-1 Maneuver	0	-	719	0	-	*708	943	-	-	*708	-	-
Mov Capacity-2 Maneuver	0	-	-	0	-	-	-	-	-	-	-	-
Stage 1	0	-	-	0	-	-	-	-	-	-	-	-
Stage 2	0	-	-	0	-	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay (s)	11.4	10.2	1	0.1
HCM LOS	B	B	A	A

Lane	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (vph)				*719	*708			
HCM Control Delay (s)	9.253	0	-	11.4	10.2	10.131	0	-
HCM Lane VC Ratio	0.103	-	-	0.212	0.028	0.009	-	-
HCM Lane LOS	A	A	-	B	B	B	A	-
HCM 95th Percentile Queue (veh)	0.342	-	-	0.799	0.087	0.027	-	-

## Warrant 1: Eight-Hour Vehicular Volume

### General Information

Agency/Company: Sanderson Stewart  
 Date: 11/27/2012  
 Project Number: 76176.86  
 Project Description: Pickle Barrel - Lot 2, Block 28 of Harvest Sub, 3rd Filing  
 Jurisdiction: City of Billings  
 Major Street Speed Limit: 35 mph  
 Major Street (Approach Lanes): 32nd St W (1 lane)  
 Minor Street (Approach Lanes): Rosebud Dr (1 lane)  
 Analysis Year/Case: Existing (2012)

Hour Begin	Avg. Entering Volume				Major Street Total (Both Approaches)	Higher Volume Minor Approach
	NB/SB		EB	WB		
0:00	62		5	1	62	5
1:00	34		3	0	34	3
2:00	35		3	0	35	3
3:00	31		3	0	31	3
4:00	57		5	1	57	5
5:00	158		13	1	158	13
6:00	364		31	3	364	31
7:00	745		63	7	745	63
8:00	874		74	8	874	74
9:00	798		68	8	798	68
10:00	905		77	9	905	77
11:00	1099		93	10	1099	93
12:00	1262		107	12	1262	107
13:00	1183		100	11	1183	100
14:00	1229		104	12	1229	104
15:00	1275		108	12	1275	108
16:00	1316		112	13	1316	112
17:00	1275		108	12	1275	108
18:00	971		82	9	971	82
19:00	670		57	6	670	57
20:00	501		42	5	501	42
21:00	353		30	3	353	30
22:00	213		18	2	213	18
23:00	133		11	1	133	11
<b>TOTAL</b>	<b>15537</b>	<b>0</b>	<b>1317</b>	<b>148</b>	<b>15537</b>	<b>1317</b>

**Condition A - Minimum Vehicular Volume (100% Columns):**

Major Street Total > 500 and Minor Street Total > 150 for 8 hours? No (0 hrs)

**Condition B - Interruption of Continuous Traffic (100% Columns):**

Major Street Total > 750 and Minor Street Total > 75 for 8 hours? Yes (9 hrs)

**Combination of Conditions A & B (80% Columns):**

Major Street Total > 400 and Minor Street Total > 120 for 8 hours? No (0 hrs)

Major Street Total > 600 and Minor Street Total > 60 for 8 hours? Yes (12 hrs)

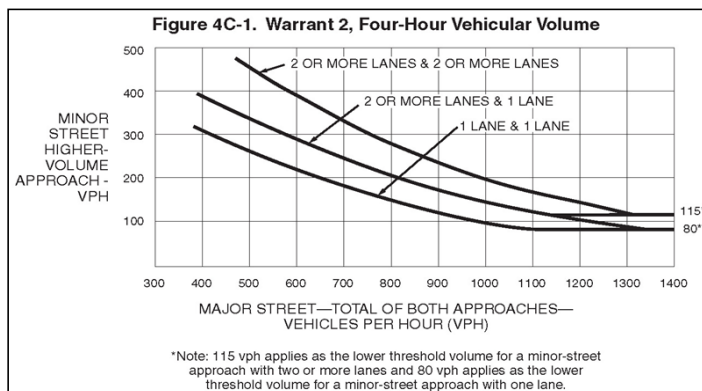
**Warrant 1 Satisfied?** Yes

## Warrant 2: Four-Hour Vehicular Volume

### General Information

Agency/Company: Sanderson Stewart  
 Date: 11/27/2012  
 Project Number: 76176.86  
 Project Description: Pickle Barrel - Lot 2, Block 28 of Harvest Sub, 3rd Filing  
 Jurisdiction: City of Billings  
 Major Street Speed Limit: 35 mph  
 Major Street (Approach Lanes): 32nd St W (1 lane)  
 Minor Street (Approach Lanes): Rosebud Dr (1 lane)  
 Analysis Year/Case: Existing (2012)

Hour Begin	Avg. Entering Volume			Major Street Total (Both Approaches)	Higher Volume Minor Approach
	NB/SB		EB WB		
0:00	62		5 1	62	5
1:00	34		3 0	34	3
2:00	35		3 0	35	3
3:00	31		3 0	31	3
4:00	57		5 1	57	5
5:00	158		13 1	158	13
6:00	364		31 3	364	31
7:00	745		63 7	745	63
8:00	874		74 8	874	74
9:00	798		68 8	798	68
10:00	905		77 9	905	77
11:00	1099		93 10	1099	93
12:00	1262		107 12	1262	107
13:00	1183		100 11	1183	100
14:00	1229		104 12	1229	104
15:00	1275		108 12	1275	108
16:00	1316		112 13	1316	112
17:00	1275		108 12	1275	108
18:00	971		82 9	971	82
19:00	670		57 6	670	57
20:00	501		42 5	501	42
21:00	353		30 3	353	30
22:00	213		18 2	213	18
23:00	133		11 1	133	11
<b>TOTAL</b>	<b>15537</b>	<b>0</b>	<b>1317 148</b>	<b>15537</b>	<b>1317</b>



Meets warrant criteria on graph for minimum of 4 hours (100% thresholds)?  
**Warrant 2 Satisfied?**

**Yes (7 hrs)**  
**Yes**

## Warrant 3: Peak Hour

### General Information

Agency/Company: Sanderson Stewart  
 Date: 11/27/2012  
 Project Number: 76176.86  
 Project Description: Pickle Barrel - Lot 2, Block 28 of Harvest Sub, 3rd Filing  
 Jurisdiction: City of Billings  
 Major Street Speed Limit: 35 mph  
 Major Street (Approach Lanes): 32nd St W (1 lane)  
 Minor Street (Approach Lanes): Rosebud Dr (1 lane)  
 Analysis Year/Case: Existing (2012)

#### Noon Peak Hour 12:00-1:00 PM

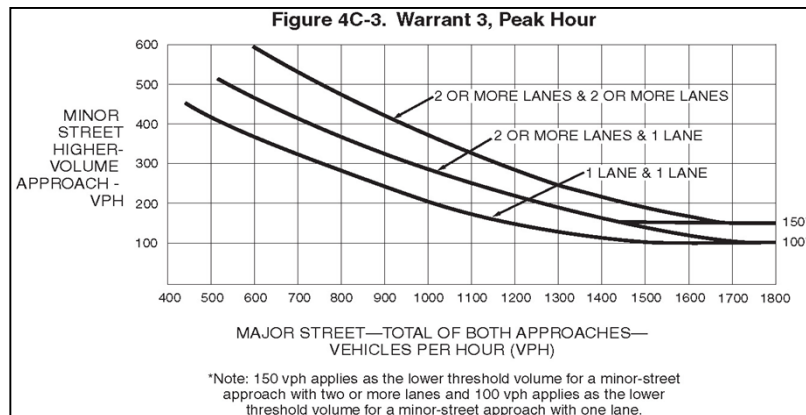
High Minor Total Stopped Time Delay (hrs)	0.04
Total Volume of Major Approaches (vehs)	1235
High Minor Approach Volume (vehs)	107
Total Entering Volume (vehs)	1354

#### PM Peak Hour 4:30-5:30 PM

High Minor Total Stopped Time Delay (hrs)	0.22
Total Volume of Major Approaches (vehs)	1401
High Minor Approach Volume (vehs)	109
Total Entering Volume (vehs)	1520

**Category A:** Peak Period: PM  
 Total stopped time delay for minor approach > 4 hrs? No  
 High minor approach volume > 100 for peak hour? Yes (109)  
 Total entering volume > 800 for peak hour? Yes (1520)  
 Category A warrant satisfied? No

**Category B:**



Meets warrant criteria on graph for minimum of one hour (100% thresholds)? Yes

**Warrant 3 Satisfied?** **Yes**