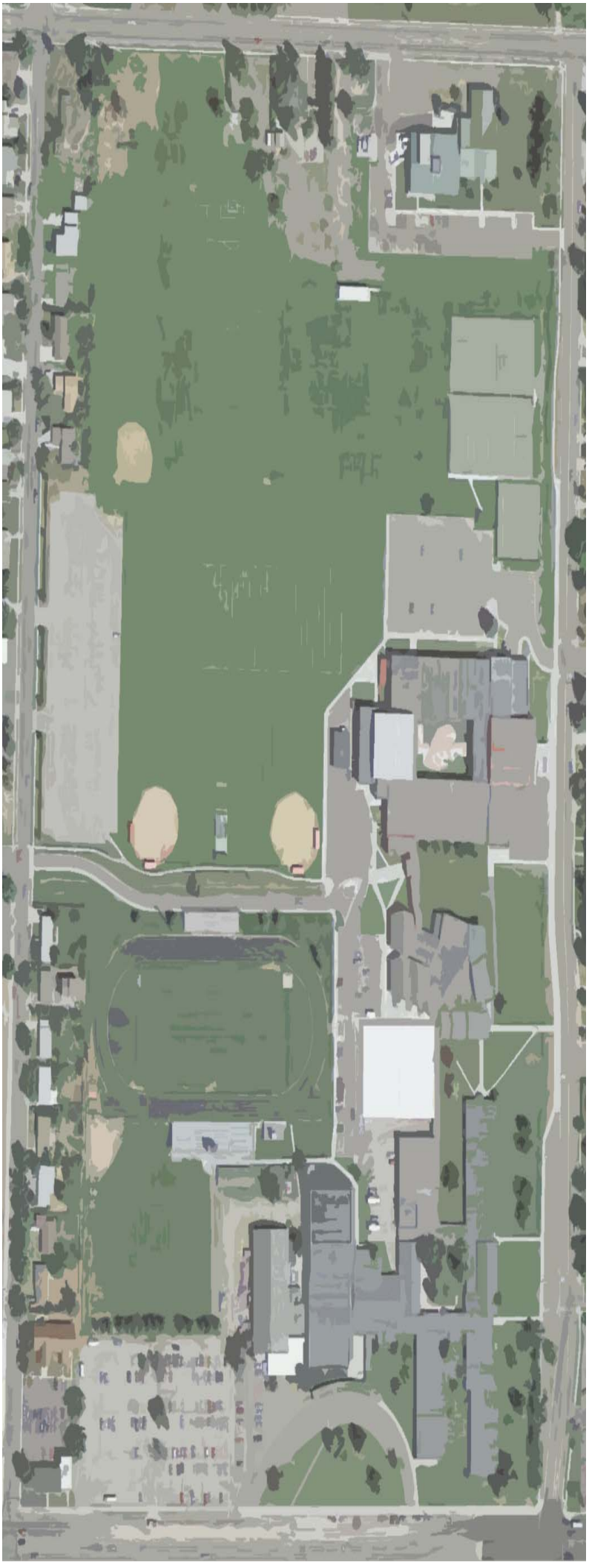

TRAFFIC ACCESS STUDY

for

EXISTING
BOZEMAN HIGH SCHOOL

Bozeman, Montana

Prepared for

TD&H ENGINEERING

Prepared by

MARVIN & ASSOCIATES
1300 North Transtech Way
Billings, MT 59102

February 14, 2017

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P.T.O.E. # 259

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INTRODUCTION

This report summarizes the findings of a traffic access study for improvements to the existing Bozeman High School (BHS) campus, which is located on the north side of Main Street between N 11th and N 15th Avenues in Bozeman, Montana. Marvin & Associates was retained by TD&H Engineers to provide analysis of potential site access improvements that could be implemented as a part of overall campus restructuring. Improvements to the exiting high school are being driven by planning efforts associated with the new high school, which will be located North of Durston Road between Flanders Mill Road and Cottonwood on the western fringe of the Bozeman city limits. The primary purpose of this study was to evaluate specific access and circulation improvement options that could be incorporated into the site design to improve traffic flow and safety on the adjacent streets. Traffic impact studies are required by the Bozeman Municipal Code (BMC) and analysis of arterial and collector intersections with a 0.5-mile radius of the development is required. This study is somewhat different since planned site improvements would not increase site traffic. In fact, future trips to and from the site will actually be reduced to 70% of existing site traffic. Since site improvements would result in improved efficiency at arterial and collector intersections, analysis of those intersections was not included in this study.

Having reviewed the proposed site plan, Marvin & Associates completed an extensive analysis of existing conditions, addressed trip generation, trip distribution and future traffic conditions. The traffic analysis evaluated existing intersection capacity and safety operations and developed potential improvement options based on public input and stated objectives of the high school staff. CTA Architects, as the lead planners on the campus improvements, provided guidance in development of options addressed herein.

Methodologies and analysis procedures within this study employ the latest technology and nationally accepted standards for site development and transportation impact assessment. Conclusions and recommendations made within this report are based on accepted standards and the professional judgment of the author, with consideration of the traveling public's interests as a primary objective

EXISTING CONDITIONS

Streets & Intersections

Streets surrounding the existing high school are Main Street, N 15th Avenue, and N 11th Avenue. Study intersections include all of the high school accesses to these three streets. There are three accesses to N 15th Avenue: North parking lot access, south parking lot access. and the Beall Street access. N 15th Street is a collector street that begins at Main Street and continues north to a point north of Oak Street. N 15th Avenue is approximately 36' wide and carries two lanes of traffic. Beall Street is a 36' wide local street that intersects N 15th Avenue at the main access to the BHS campus.

There are five school accesses to Main Street: the western parking lot access, which is 220' east of the N 15h Avenue – Main Street Intersection; the middle parking lot access; the eastern parking locate access; the loop road egress access, which is 50' east of the eastern access; and the loop road ingress access, which is approximately 360' west of the N 11th Avenue – Main Street intersection. Main Street is an east-west principal arterial street that spans the entire urban area of Bozeman. Main street carries two lanes of traffic in each direction and has a continuous two-way left-turn lane in the middle. Almost all of the adjacent land on Main Street consists of commercial properties.

There are two site access on N 11th Avenue: the northern parking lot access is at Villard Street and an on-street parking area that extends to the north and south of Mendenhall Street. N 11th Street is classified as a collector street which begins south of the Montana State University campus and continues north to an intersection with Durston Road. N 11th Avenue is approximately 50' wide and carries two lanes of traffic, with parking allowed on both sides of the street. All of land on the east side of N 11th Avenue is occupied by single family residential housing.

Existing Traffic Volumes

TD&H Engineering provided Mio-vision camera files for all of the existing BHS site accesses. The videos were processed and summaries of the traffic counts for both am and pm peak hour periods can be found in Appendix A of this report. The summaries are reported in 15 minute periods and the highest 4 consecutive periods determined the peak am and pm hours. Peak hour factors were calculated based on the total volumes entering the intersections during the peak hours. It was determined that the am peak hour is typically between 7:30 and 8:30 while the pm peak hour is between 3:15 and 4:15.

Figures 1 and 2, on the following pages illustrate the intersection turning movement counts at the eleven site access intersections during the am and pm hours respectively. Included in those figures is the intersection of N 15th and the commercial access just south of Beall Street. Peak 15 minute summaries are not included in Appendix A for this intersection because the variation in volumes during the peak hours are replicated by the summaries for the Beall Street intersection. Other counts not included in Figures 1 and 2 are on-street, pick-up and drop-off counts taken on N 11th Avenue intersections with Villard Street and Mendehall Street, as well as on-street pick-up and drop-off operations on Main Street.

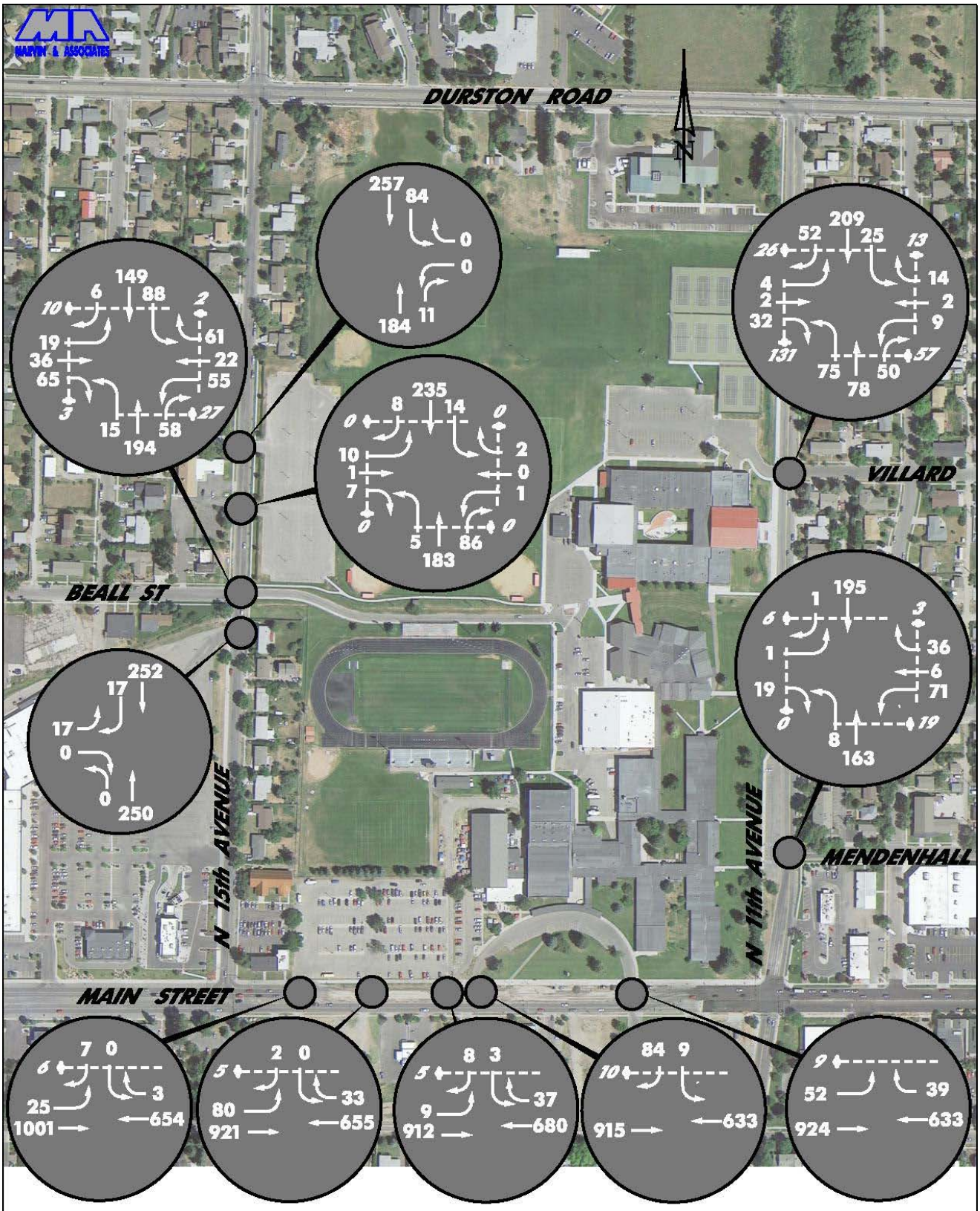


Figure 1. Peak AM Hour Traffic Counts November 2016

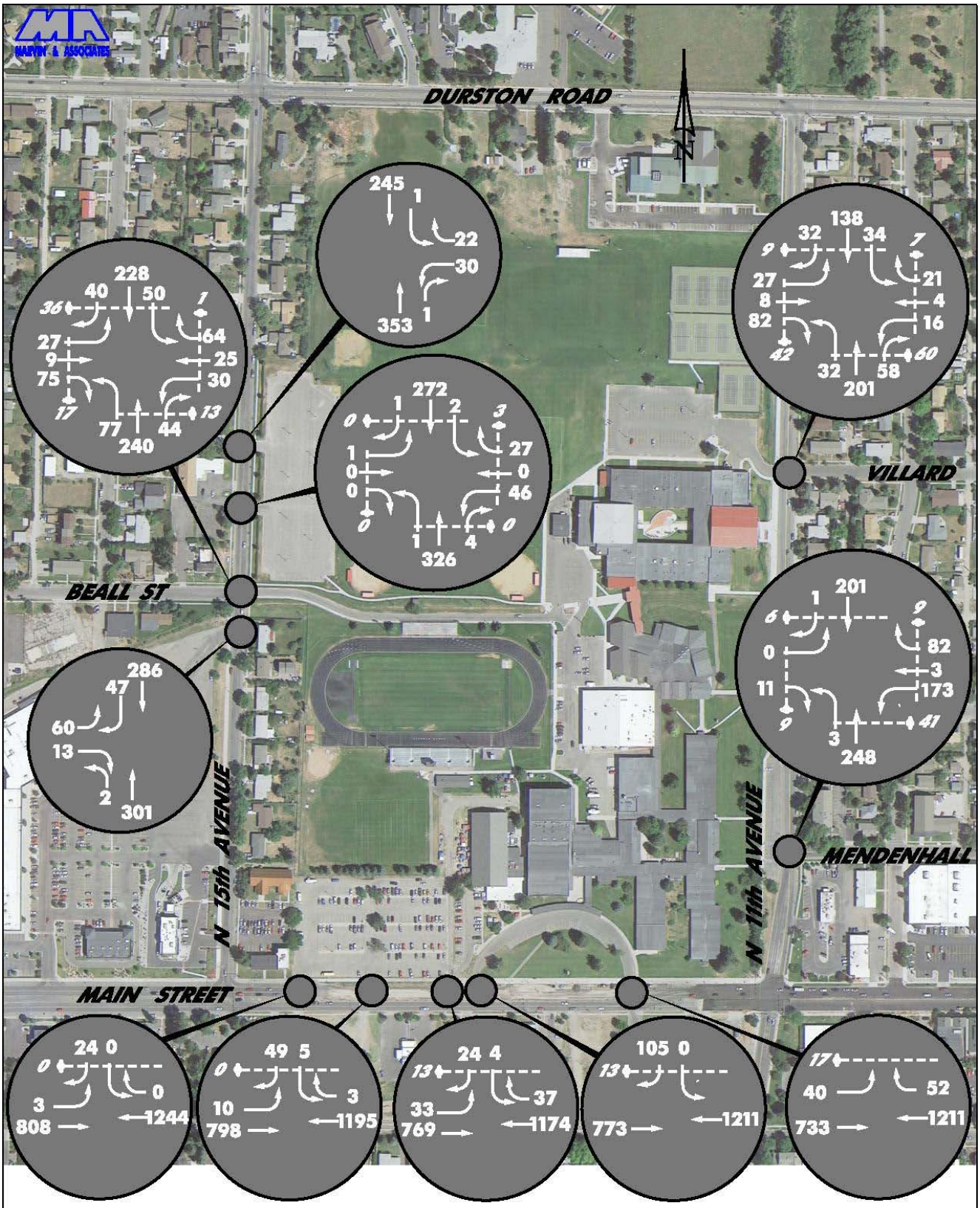


Figure 2. Peak PM Hour Traffic Counts November 2016

On-site Access Traffic

The summation of traffic accessing internal parking and circulations of the BHS campus can be seen in Table 1. There are three streets that provide access to the campus as detailed in Table 1. On N 11th Avenue there were 202 vehicle trips, 144 entering and 58 exiting the campus during the am hour and 203 during the pm hour. It was assumed that the difference between the vehicles entering and exiting the campus were pick-up and drop-off vehicles, as indicated in Table 1. The remainder of vehicles remained as parked vehicles within the campus. Overall, there were 1102 vehicle trips in the am hour and 947 trips in the pm hour. Of those totals there were 312 pick-up/drop-off trips in the am hour and 364 in the pm hour.

Table 1. Bozeman High School Existing Vehicular Access Traffic

	Peak AM 7:30-8:30		Peak PM 3:15-4:15		Net Vehicles Parked		Pick-up/Drop-off	
Access Location	**Enter**	**Exit**	**Enter**	**Exit**	**AM Hour**	**PM Hour**	**AM Hour**	**PM Hour**
Villard Street & N 11th Avenue	129	38	68	117	91	-49	38	68
Mendenhall Street & N 11th Avenue	15	20	7	11	-5	-4	20	7
Subtotal N 11th Avenue Accesses	**144**	**58**	**75**	**128**	**86**	**-53**	**58**	**75**
North Access on N 15th Avenue	95	0	2	52	95	-50	0	2
South Access on N 15th Avenue	101	3	6	73	98	-67	3	6
Beall Street & N 15th Avenue	182	138	103	119	44	-16	138	103
Subtotal N 15th Avenue Accesses	**378**	**141**	**111**	**244**	**237**	**-133**	**141**	**111**
West Parking Access on Main Street	28	7	3	24	21	-21	7	3
Middle Parking Access on Main Street	103	2	13	54	101	-41	2	13
East Parking Access on Main Street	46	11	70	28	35	42	11	70
Main Street Loop Road Exit	0	93	0	105	-93	-105	93	0
Main Street Loop Road Entrance	91	0	92	0	91	92	0	92
Subtotal Main Street Accesses	**268**	**113**	**178**	**211**	**155**	**-33**	**113**	**178**
Total Vehicular Access =	**790**	**312**	**364**	**583**	**478**	**-219**	**312**	**364**

On-street Pick-up & Drop-off Traffic

Table 2 provides a summary of pick-up and drop-off traffic volumes on Main Street and on N 11th Avenue. It can be seen that there were 133 vehicles on both streets during the am hour and 68 in the pm hour. It should be noted that each vehicle represents two trips, an arrival trip and a departure trip. Thus, in the am hour there were 133 vehicles arriving and 133 vehicles departing for a total of 266 trips.

Table 2. On-street Pick-up & Drop-off Vehicular Traffic

	AM Hour	PM Hour
N 11th Avenue		
West Side South of Villard	27	11
East Side South of Villard	51	21
West Side North of Mendenhall	31	4
East Side North of MendenHall	3	2
Subtotal N 11th Avenue	**112**	**38**
Main Street		
East of Loop Road Entrance	9	9
West of Loop Road Entrance	12	21
Subtotal Main Street	**21**	**30**
Total On-street Pick-up Drop-Off	**133**	**68**

Total Existing BHS Traffic

Table 3, on the following page, presents a summary of all trips associated with school operations. The total number of vehicles on-site and on-street are shown and the number of vehicles that do not park (i.e. pick-up and drop-off) vehicles are noted. These numbers are used to predict future trips that will be associated with enrollment at the existing and future high schools.

Table 3. Total Site Vehicular Access Traffic

	AM HOUR		PM HOUR	
	Enter	**Exit**	**Enter**	**Exit**
Parking Access	790	312	364	583
On-street Access	133	133	68	68
Total Vehicles	**923**	**445**	**432**	**651**
Parking Lot PU/DO	312	312	364	364
On-street PU/DO	133	133	68	68
Total PU/DO	**445**	**445**	**432**	**432**

Capacity

Peak am and pm hour existing capacity calculations were completed for the existing site access intersections using the *HCS7* software package (see Appendix B-1). Table 4, on the following page, summarizes the results of the capacity calculations. Since two of the Main Street accesses account for the majority of site traffic (eastern access and the loop road egress access) and the separation distance between them is minimal, the ingress and egress traffic at those accesses were combined and capacity calculations in Table 4 represent the worst case condition for Main Street access intersections.

Measures in Table 4 include control delay (seconds/vehicle), level of service (LOS), volume-to-capacity (v/c) ratio, and 95% queue length. The calculation results showed that all approach movements for each of the access intersections currently operate at or above a LOS "C", with the exception of the westbound leg of the Beall Street and N 15th Avenue intersection; the southbound left-turn movement at the Main Street access; and the westbound Mendenhall Street approach at N 11th Avenue during the peak pm hour. The eastbound Beall street approach operates at LOS "D"; the southbound left-turn movement at Main Street operates at LOS "E"; and the Mendenhall Street approach at N 11th Avenue operates at LOS "D".

Table 4. Existing Peak Hour Capacity Analysis Summary

Intersection	MOE	EB	WB	NB	SB	Intersection
Movement Group			*LR*		*L*	*Overall LOS*
North 15th Street & North Parking Access Peak AM Hour	*Control Delay (s/veh)*		14.1		8.1	
	LOS		B		A	B
	V/C Ratio		0.01		0.10	
	Queue Length (95%)		0		1	
Movement Group			*LR*		*L*	*Overall LOS*
North 15th Street & North Parking Access Peak PM Hour	*Control Delay (s/veh)*		16.9		8.5	
	LOS		C		A	B
	V/C Ratio		0.21		0.00	
	Queue Length (95%)		1		0	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 15th Street & South Parking Access Peak AM Hour	*Control Delay (s/veh)*	13.9	11.4	7.9	8.1	
	LOS	B	B	A	A	B
	V/C Ratio	0.06	0.01	0.01	0.02	
	Queue Length (95%)	1	0	0	1	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 15th Street & South Parking Access Peak PM Hour	*Control Delay (s/veh)*	17.5	17.3	8.0	8.2	
	LOS	C	C	A	A	B
	V/C Ratio	0.00	0.24	0.00	0.00	
	Queue Length (95%)	0	1	0	0	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 15th Street & Beall Street Peak AM Hour	*Control Delay (s/veh)*	17.5	24.7	7.6	8.1	
	LOS	C	C	A	A	C
	V/C Ratio	0.34	0.48	0.01	0.08	
	Queue Length (95%)	2	3	0	1	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 15th Street & Beall Street Peak PM Hour	*Control Delay (s/veh)*	22.2	25.4	8.2	8.1	
	LOS	C	D	A	A	C
	V/C Ratio	0.39	0.45	0.07	0.05	
	Queue Length (95%)	2	3	1	1	
Movement Group		*LTR*	*LTR*	*LTR*	*L* *R*	*Overall LOS*
Main Street & East -Loop Road Access Peak AM Hour	*Control Delay (s/veh)*	9.5	10.3	12.1	21.1 12.4	
	LOS	A	B	B	C B	C
	V/C Ratio	0.01	0.00	0.00	0.06 0.18	
	Queue Length (95%)	0	0	1	1 1	
Movement Group		*LTR*	*LTR*	*LTR*	*L* *R*	*Overall LOS*
Main Street & East -Loop Road Access Peak PM Hour	*Control Delay (s/veh)*	12.8	9.6	11.3	35.4 19.9	
	LOS	B	A	B	E C	C
	V/C Ratio	0.07	0.00	0.00	0.03 0.38	
	Queue Length (95%)	1	0	0	1 2	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 11th Street & Villard Street Peak AM Hour	*Control Delay (s/veh)*	13.7	14.6	8.6	7.6	
	LOS	B	B	A	A	B
	V/C Ratio	0.11	0.08	0.09	0.02	
	Queue Length (95%)	1	1	1	1	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 11th Street & Villard Street Peak PM Hour	*Control Delay (s/veh)*	15.0	16.2	7.8	8.0	
	LOS	C	C	A	A	B
	V/C Ratio	0.30	0.14	0.03	0.04	
	Queue Length (95%)	2	1	1	1	
Movement Group		*L* *R*	*LTR*	*L*		*Overall LOS*
North 11th Street & Mendenhall Street Peak AM Hour	*Control Delay (s/veh)*	12.9 9.8	13.7	7.7		
	LOS	B A	B	A		B
	V/C Ratio	0.00 0.03	0.25	0.01		
	Queue Length (95%)	0 1	1	0		
Movement Group		*L* *R*	*LTR*	*L*		*Overall LOS*
North 11th Street & Mendenhall Street Peak PM Hour	*Control Delay (s/veh)*	15.5 10.0	26.9	7.7		
	LOS	C B	D	A		C
	V/C Ratio	0.00 0.02	0.67	0.00		
	Queue Length (95%)	0 1	5	0		

Operational observations of the site access intersections generally confirm capacity calculation results. However, there are also operational conditions that are not reflected in the capacity calculations at two of the intersections. The intersection of Beall Street and N 15th Avenue has a significant a volume of pedestrian traffic during the peak pm hour which tends to make the intersection operate as an all-way stop for at least 20 minutes of the peak hour. In addition, the commercial access that enters N 15th Avenue from the west, approximately 75' south of Beall Street, acts like an operational encroachment on the intersection and operates as a fifth leg of the intersection. Therefore, conflicts created by the commercial access affect both the safety and efficiency of the intersection.

At the Mendenhall Street intersection with N 11th Avenue, access to and from the on-street school parking area has less than ideal geometrics and vehicles enter and exit N 11th Avenue at acute angles. When random vehicle positioning is combined with high pedestrian crossing numbers, there are both safety and efficiency concerns. Actual delays and vehicles queues on Mendenhall appear to be higher than the calculations would suggest, which is created by driver decision overload.

TRIP GENERATION

Table 5 shows the trip generation estimates that would be associated with both the existing high school and the new high school in future phases of development. An assessment of trip generation using the ITE Trip Generation Report, Ninth Edition was made and it was determined that existing BHS traffic counts are at least twice as high as the ITE rates would indicate. The reason for this is probably due to the fact that the average rates in ITE came from samples that are outdated. This is a common situation for most schools because of a tremendous increase in pick-up and drop-off rates that have occurred over the past 10 years. Thus, existing documentation of BHS traffic would

provide a more realistic estimate of future trip generation than the ITE rates. The trip generation estimates shown in Table 5 are associated with both the existing high school and the new high school for future phases of development.

Table 5. Bozeman High Schools Trip Generation by Phase

Base on Traafic Counts at Existing Bozeman High School Novemeber 2016			Ave. Weekday		Peak AM Hour				School PM Hour			
Land Use	No. of Units	Rate Units	Rate	Total Trips	Rate	Total Trips	Enter	Exit	Rate	Total Trips	Enter	Exit
Existing High School	2140	Students	1	6762	2	1370	918	452	3	1091	436	655
Year 2020 New School Opening												
Existing High School	1750	Students	*1*	5530	*2*	1120	750	370	*3*	893	357	536
New High School	650	Students	*1*	2054	*2*	416	279	137	*3*	332	133	199
Maximum Future Capacity												
Existing High School	1500	Students	*1*	4740	*2*	960	643	317	*3*	765	306	459
New High School	1500	Students	*1*	4740	*2*	960	643	317	*3*	765	306	459

1 - (T) = 3.16(X) *2 - T = 0.64(X)(71% Enter)* *3 - T=0.51(X) (38% Enter)*

The gross number of average weekday trips (AWT) for full occupancy of both the new school and the old school was projected to be approximately 4,740 and the initial occupancy of the new school of 650 students would leave the existing BHS with 1,750 students generating approximately 5,630 AWT. The future am peak hour would be the highest peak hour in the day with a maximum of 960 trips (643 entering and 317 exiting the site). The difference between entering and exiting trips in the am hour accounts for students, school employees, and staff that enter the site, but don't typically exit the site until the peak pm hour. During the am peak hour, most traffic enters and exits the site in a very short period since parents are dropping off students.

The second highest peak hour is the school pm peak hour, which typically occurs between 3:15 and 4:15 pm, with the maximum being 765 trips with 306 entering and 459 exiting the site. During this period of the day, many vehicles arrive over a 20 to 25-minute period

beginning prior to dismissal time. Once school is dismissed, vehicles exit the site as fast as capacity of the access facilities will allow. This is the period of time when vehicles need to be stored on-site or at locations that do not impact through traffic flows.

Table 6 presents the number of pick-up and drop-off trips that would be associated with the existing and new high schools in the future. Table 6 trips are already included in the total trips found in Table 5 and are separated for the purpose of estimating vehicle storage requirements for the pick-up and drop-off operations.

Table 6. Bozeman High Schools Pick-up Drop-off Trips by Phase

	Peak AM Hour			School PM Hour		
	Total Trips	Enter	Exit	Total Trips	Enter	Exit
Existing High School	890	445	445	864	432	432
Year 2020 New School Opening						
Existing High School	728	364	364	707	354	354
New High School	270	135	135	263	132	132
Maximum Future Capacity						
Existing High School	624	312	312	606	303	303
New High School	624	312	312	606	303	303

TRIP DISTRIBUTION

Volume counts were used to determine the directional distribution of traffic to the BHS campus. Figure 3 illustrates the percentage of total trip distribution on each street surrounding the BHS campus. The percentage trip distribution cannot be translated to trip distribution in the classical sense of a Traffic Impact Study, since the four intersections at each corner of the BHS property were not included in the scope of the traffic study, as was previously noted.

Figure 3. Peak AM & PM Hour School Traffic Distribution

FUTURE OPERATIONS 2035

Traffic Volumes

Land surrounding both N 15th Avenue and N 11th Avenue is fully developed and future traffic growth of those streets would be dependent upon developments far removed for the immediate area. Even though potential for future traffic growth is limited, it was assumed that through traffic would increase by approximately 10% over the next 15 years. Traffic on Main Street would have more potential for growth. If traffic on Main Street increased at a rate similar to Bozeman's population growth, an increase of 30% to 40% could be achieved. However, within the next 15 years parallel east-west arterials will have been extended and improved. It is anticipated that new arterial streets will provide some relief and it was assumed that Main Street growth will only increase by 20% in the next 15 years.

Figures 4 and 5 on the following pages illustrate year 2035 traffic projections at the study intersections. In comparing Figure 4 and 5 to Figures 1 and 2, it can be seen that traffic on N 15th Avenue and N 11th Avenue would not be significantly different because of the 30% decrease in student enrollment. Thus, increased background traffic would be partially offset by decreased localized school traffic. Future traffic projections shown in Figures 4 and 5 do not include any access improvements that could be implemented, as discussed within the improvement concepts section of this report.

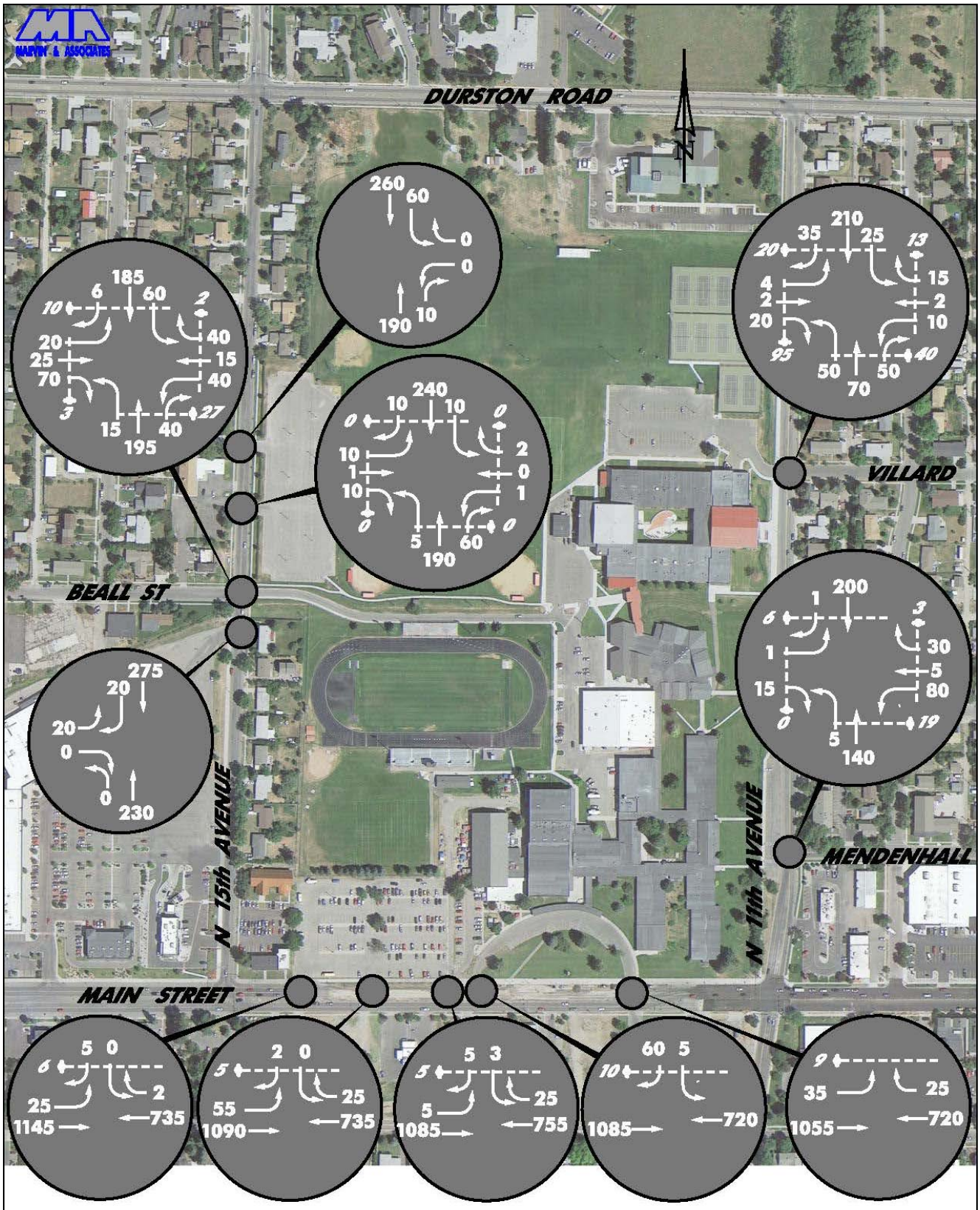


Figure 4. Future Peak AM Hour Traffic Year 2035

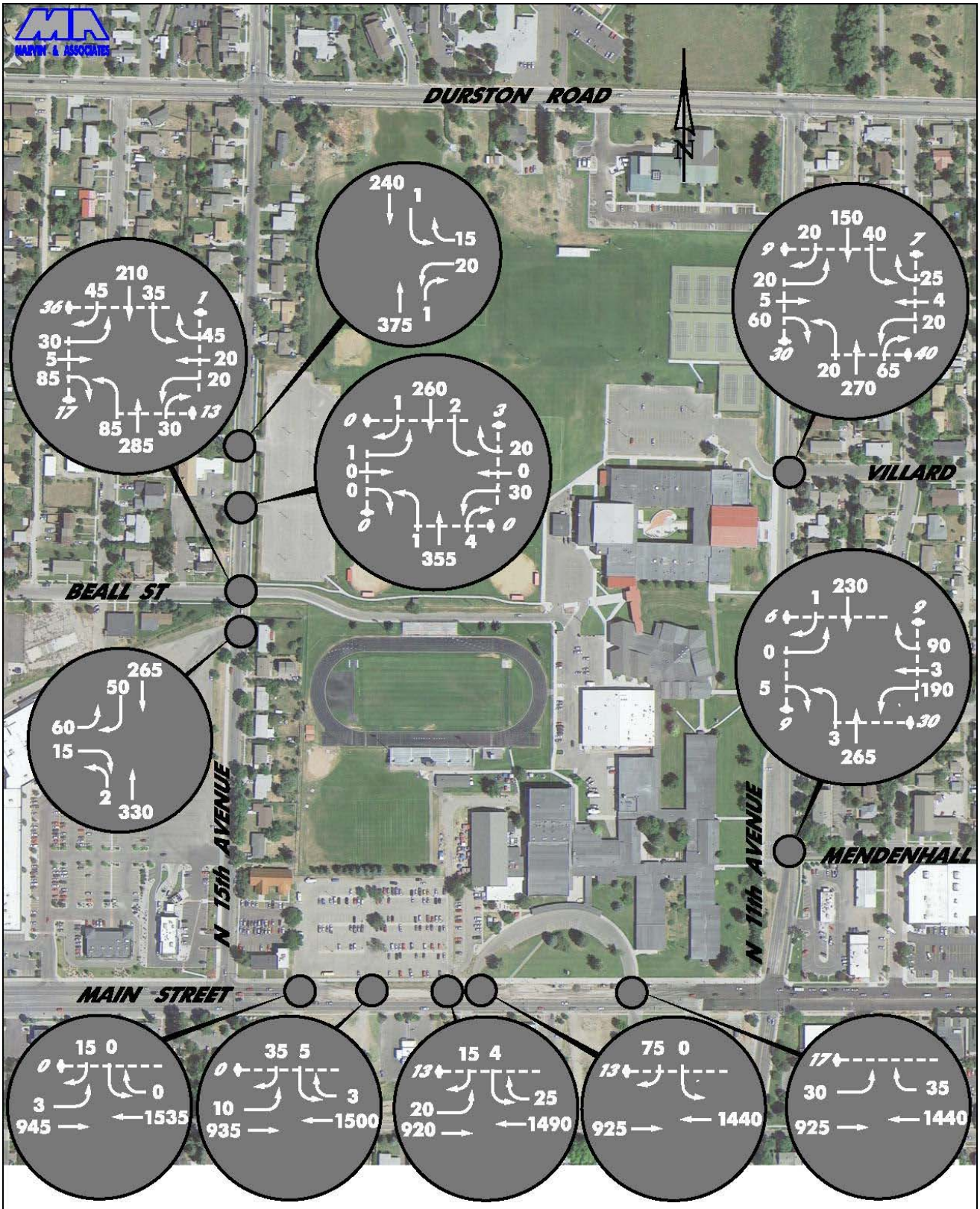


Figure 5. Future Peak PM Hour Traffic Year 2035

Capacity

Table 7, on the following page, presents capacity analysis results for future traffic projections. Capacity calculations can be found in Appendix B-2 of this report and were based on the traffic volumes shown in Figures 4 and 5. All of the intersections and all of the approaches would operate at LOS "C" or better with the exception of the Main Street Access (LOS "F") and the Mendenhall Street approach to N 11th Avenue (LOS "E"). The delay for the Mendenhall approach would be 35.2 seconds per vehicle with a maximum queue of 7 vehicles. The Main Street egress approach would have an average delay of 53.9 seconds with only 1 vehicle in the queue. Since the volume of traffic making the left turn onto Main Street is very low, it can be assumed that most of the drivers would turn right instead of waiting for a gap.

The westbound Beall Street approach to N 15th Avenue would operate at LOS "C", which would be an improvement over the LOS "D" that is currently experienced in the peak pm hour. Reduce egress traffic to and from the high school would be responsible for the improved LOS.

Table 7. Future Year 2035 Peak Hours Capacity Analysis Summary

Intersection	MOE	EB	WB	NB	SB	Intersection
Movement Group			*LR*		*L*	*Overall LOS*
North 15th Street & North Parking Access Peak AM Hour	*Control Delay (s/veh)*		13.4		8.1	
	LOS		B		A	B
	V/C Ratio		0.00		0.07	
	Queue Length (95%)		0		1	
Movement Group			*LR*		*L*	*Overall LOS*
North 15th Street & North Parking Access Peak PM Hour	*Control Delay (s/veh)*		16.5		8.6	
	LOS		C		A	B
	V/C Ratio		0.14		0.00	
	Queue Length (95%)		1		0	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 15th Street & South Parking Access Peak AM Hour	*Control Delay (s/veh)*	13.3	11.4	8.0	8.0	
	LOS	B	B	A	A	B
	V/C Ratio	0.06	0.01	0.01	0.01	
	Queue Length (95%)	1	0	0	0	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 15th Street & South Parking Access Peak PM Hour	*Control Delay (s/veh)*	17.6	16.4	7.9	8.3	
	LOS	C	C	A	A	B
	V/C Ratio	0.00	0.17	0.00	0.00	
	Queue Length (95%)	0	1	0	0	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 15th Street & Beall Street Peak AM Hour	*Control Delay (s/veh)*	15.3	19.1	7.7	8.0	
	LOS	C	C	A	A	C
	V/C Ratio	0.29	0.31	0.01	0.06	
	Queue Length (95%)	2	2	0	1	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 15th Street & Beall Street Peak PM Hour	*Control Delay (s/veh)*	20.8	22.7	8.2	8.1	
	LOS	C	C	A	A	C
	V/C Ratio	0.38	0.33	0.08	0.03	
	Queue Length (95%)	2	2	1	1	
Movement Group		*LTR*	*LTR*	*LTR*	*L* *R*	*Overall LOS*
Main Street & East -Loop Road Access Peak AM Hour	*Control Delay (s/veh)*	9.7	11.2	13.1	23.1 12.3	
	LOS	A	B	B	C B	C
	V/C Ratio	0.01	0.00	0.00	0.04 0.13	
	Queue Length (95%)	0	0	0	1 1	
Movement Group		*LTR*	*LTR*	*LTR*	*L* *R*	*Overall LOS*
Main Street & East -Loop Road Access Peak PM Hour	*Control Delay (s/veh)*	15.3	10.3	12.1	53.9 23.2	
	LOS	C	B	B	F C	C
	V/C Ratio	0.07	0.00	0.00	0.03 0.38	
	Queue Length (95%)	1	0	0	1 2	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 11th Street & Villard Street Peak AM Hour	*Control Delay (s/veh)*	13.0	13.1	8.3	7.6	
	LOS	B	B	A	A	B
	V/C Ratio	0.07	0.07	0.06	0.02	
	Queue Length (95%)	1	1	1	1	
Movement Group		*LTR*	*LTR*	*LTR*	*LTR*	*Overall LOS*
North 11th Street & Villard Street Peak PM Hour	*Control Delay (s/veh)*	14.5	17.4	7.8	8.3	
	LOS	B	C	A	A	B
	V/C Ratio	0.23	0.18	0.02	0.05	
	Queue Length (95%)	1	1	1	1	
Movement Group		*L* *R*	*LTR*	*L*		*Overall LOS*
North 11th Street & Mendenhall Street Peak AM Hour	*Control Delay (s/veh)*	12.4 9.8	13.5	7.7		
	LOS	B A	B	A		B
	V/C Ratio	0.00 0.02	0.25	0.00		
	Queue Length (95%)	0 1	1	0		
Movement Group		*L* *R*	*LTR*	*L*		*Overall LOS*
North 11th Street & Mendenhall Street Peak PM Hour	*Control Delay (s/veh)*	16.8 10.1	35.2	7.8		
	LOS	C B	E	A		D
	V/C Ratio	0.00 0.01	0.77	0.00		
	Queue Length (95%)	0 0	7	0		

EVALUATION OF IMPROVEMENT CONCEPTS

Concept Alternatives Considered and Ruled-out

There are three streets that are associated with existing high school traffic operations and concepts for improvements on those streets were evaluated. Various concepts have been set forth toward development of on-site pick-up/drop-off areas. A cursory evaluation of site development and operational function was completed for a number of concepts. The following narratives summarize our analysis of original concepts that were evaluated, but were determined to be not feasible for various reasons.

Beall Street Access - The Beall Street access currently accommodates the highest site traffic volumes of all accesses. The concept to further develop that access would include widening the road to accommodate bus and car parking and development of a circular turn-around at the eastern-most terminus of the street. This concept would minimize additional land use and be the least expensive alternative. However, it would have limitations in the number of parent pick-up/drop-off spaces that could be developed. In addition, there may be capacity concerns at the intersection of N 15th and Beall Street since it already operates at Level of service (LOS) “D” during the peak pm hour. Adding most of the pick-up/drop-off traffic demand could result in the need for a traffic signal.

Main Street to Beall Street Connection - A concept that would utilize the existing Main Street eastern parking lot access to connect with the eastern-most terminus of Beall Street using circuitous routing through the campus was proposed. The connection road would be a one-way route from Main street to Beall Street and continuing as a one-way street on the existing Beall Street access road to the intersection of Beall Street and N 15th Avenue. This concept has the benefit of providing an alternative egress for the Main Street parking lots and would provide ample storage for bus and parent pick-up/drop-off operations. However, the circuitous routing would appear to impact internal maintenance operations and parking areas. The one-way nature of the road would create a situation where almost

all of the pick-up/drop-off traffic would use the Main Street access for ingress movements and would be difficult for traffic approaching from the west, which has the highest directional demand. All of the egress traffic would go through the N15th and Beall Street intersection. Since that intersection currently has capacity issues, warrants for a traffic signal would probably be met. It would also appear that the redistribution of traffic would result in longer overall travel times. With the capital cost involved in building the roadway, geometric changes to parking and internal circulation, intersection geometry modifications, and signalization, this concept could possibly be the highest of all concepts evaluated.

Durston Road Access - An option that was suggested at the public meeting involved using an existing parking lot access to Durston Road and constructing a one-way loop road that heads south to the north side of the school and loops around the Villard Street parking lots and heads back north parallel to N 11th Street and connects back to the Durston Road access. This option would allow the highest number of bus parking and pick-up drop-off spaces. However, there are a number of negative impacts. It would introduce a high volume intersection on Durston Road within 400' of the N 11th Avenue intersection which could create conflicts between intersections. It would require replacement of a large number of parking spaces in the existing Durston Road parking lot. The concept reroutes school traffic onto Durston Road at a location where the majority of drivers don't want to be. The internal roadway would bisect the sports fields rendering them unusable.

N 15th to N 11th Avenue Connection - An option that was suggested early in the school planning process would involve constructing a connection road between N 15th Avenue and N 11th Avenue. Similar to other options, it would provide sufficient on-site storage for pick-up and drop-off operations. However, the connecting roadway would face difficult geometric challenges while trying to navigate around the existing school buildings and sporting fields. Traffic circulation patterns would result in additional traffic at the Villard Street access on N 11th Avenue and could result in the need for enhanced traffic controls at that intersection as well as at the Beall Street and N 15th Avenue intersection.

N 15th Avenue Design Options

N 15th Avenue One-Way Loop Road Option A - Presented to the design team at a public workshop by an area resident, this concept utilizes the existing Beall Street access road to act as a one-way ingress road, which would accommodate a single traffic lane and a parent pick-up/drop-off lane in the east bound direction. The road would then loop back to the west from the west side of the buildings through the existing parking lot to the existing southern parking lot access. In the westbound return lane, there would be sufficient storage distance to accommodate 12 buses. Figure 6, on the following page, illustrates this concept along with added detail for parking lot access and circulation and necessary modifications on N 15th Avenue. Figure 6 also indicates the traffic volume projections that would be associated with this design option along with traffic control features on N 15th Avenue that would be required.

N 15th Avenue One-Way Loop Road Option B - Subsequent evaluation of the N 15th Avenue loop road concept, it was suggested that impacts to the sports fields could be minimized by looping the one-way road at the eastern end so that the westbound roadway was in juxtaposition with the eastbound alignment as illustrated in Figure 7. Option B would provide similar storage lengths for cars and buses as Option A with significantly less encroachment on the sports fields. The circular drive at the eastern end of the loop road would be wide enough for bus maneuvers and during times when buses are not present passenger cars could use it for pick-up and drop-off operations. The circular drive could also provide access for maintenance vehicles at buildings to the north. Figure 7 shows the same traffic projections and traffic controls on N 15th Avenue as is shown in Option A.

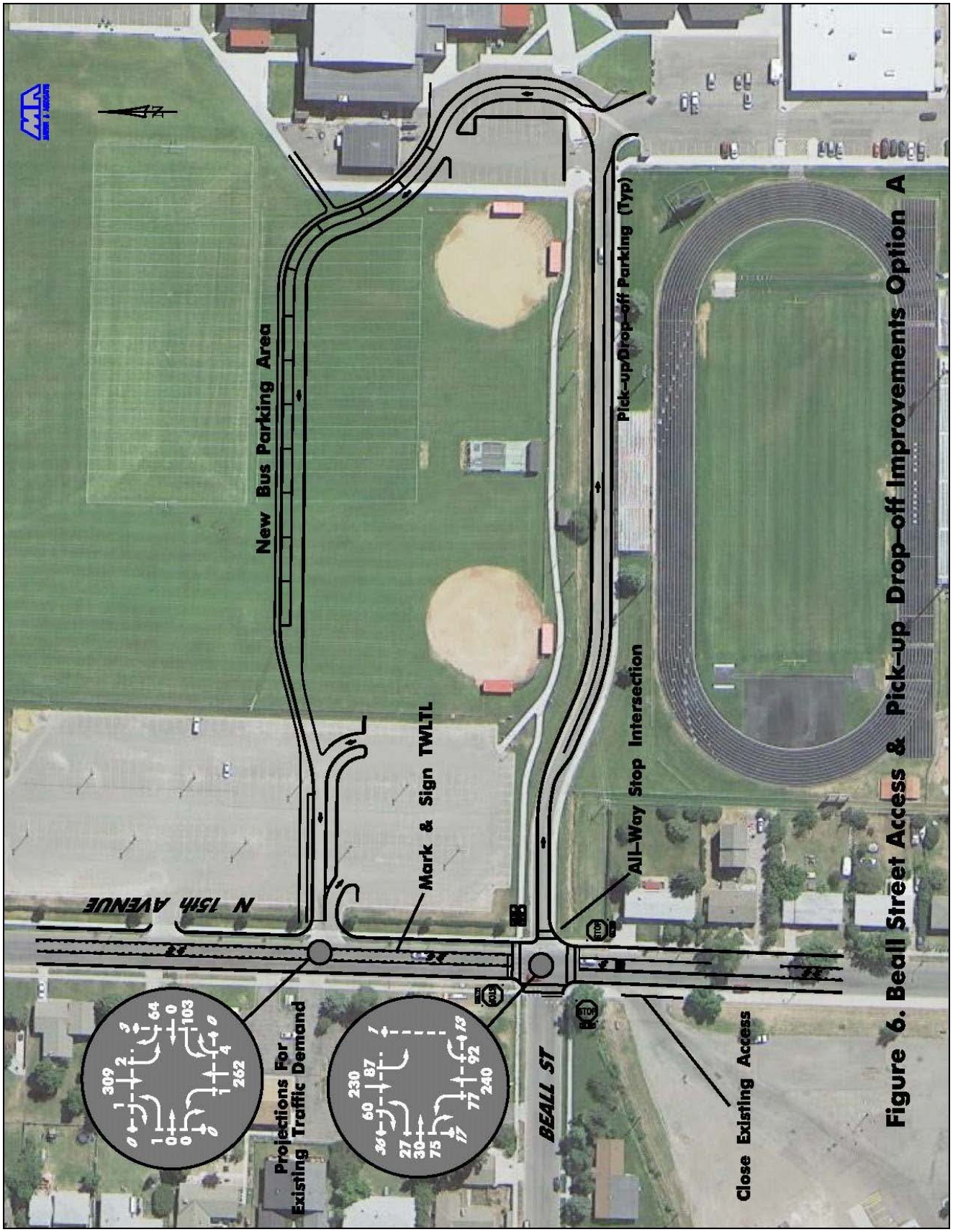


Figure 6. Beall Street Access & Pick-up Drop-off Improvements Option A

Figure 7. Beall Street Access & Pick-up Drop-off Improvements Option B

N 11th Avenue Improvement Options

The most congested and operationally challenged street is N 11th Avenue. Even though it has the least volume of school traffic, the geometrics contribute to conflicts which are exacerbated by having all 12 buses using the street for pick-up and drop-off operations. The most important modifications would be removal of the bus operations from the street and relocation to an internal campus area. The new location would need to have ease of access and sufficient storage for autos as well as busses if pick-up and drop-off activities on N 11th Avenue were to be minimized.

N 11th Avenue Option A - Figure 8 illustrates the construction of a loop road surrounding the Villard Street parking lot. Entrance to the loop road would be approximately 300' north of Villard Street while the exit would be at Villard Street. The loop road would provide storage for 11 to 12 buses with storage room for approximately 12 passenger cars. To improve safety of operations on N 11th Avenue, a left-turn lane could be developed on N 11th Avenue by eliminating parking on the west side of N 11th Avenue between the entrance and exit accesses. It was determined that the only traffic that would be added to the Villard Street intersection would be the bus traffic that currently park on the street near Mendenhall Avenue. That traffic would not impact the overall capacity of that intersection. The tennis courts shown in Figure 8 have already been removed and would therefore not be impacted by this design option.

N 11th Avenue Option B – Figure 9 illustrates a bus pick-up and drop-off concepts that extends from a point north of Lamme Street to a point south of Mendenhall Street approximately 100' west of N 11th Avenue. This loop road would be parallel to a new building being designed to replace an existing school structure north and west of Lamme Street. The bus parking area would accommodate 11 to 12 buses. The existing parking area could be modified to accommodate 13 passenger car angle parking spaces by constructing a medial separator as shown in Figure 9. The raised island needs to be continued across the west side of the Mendenhall Street intersection to eliminate conflicts at that intersection.

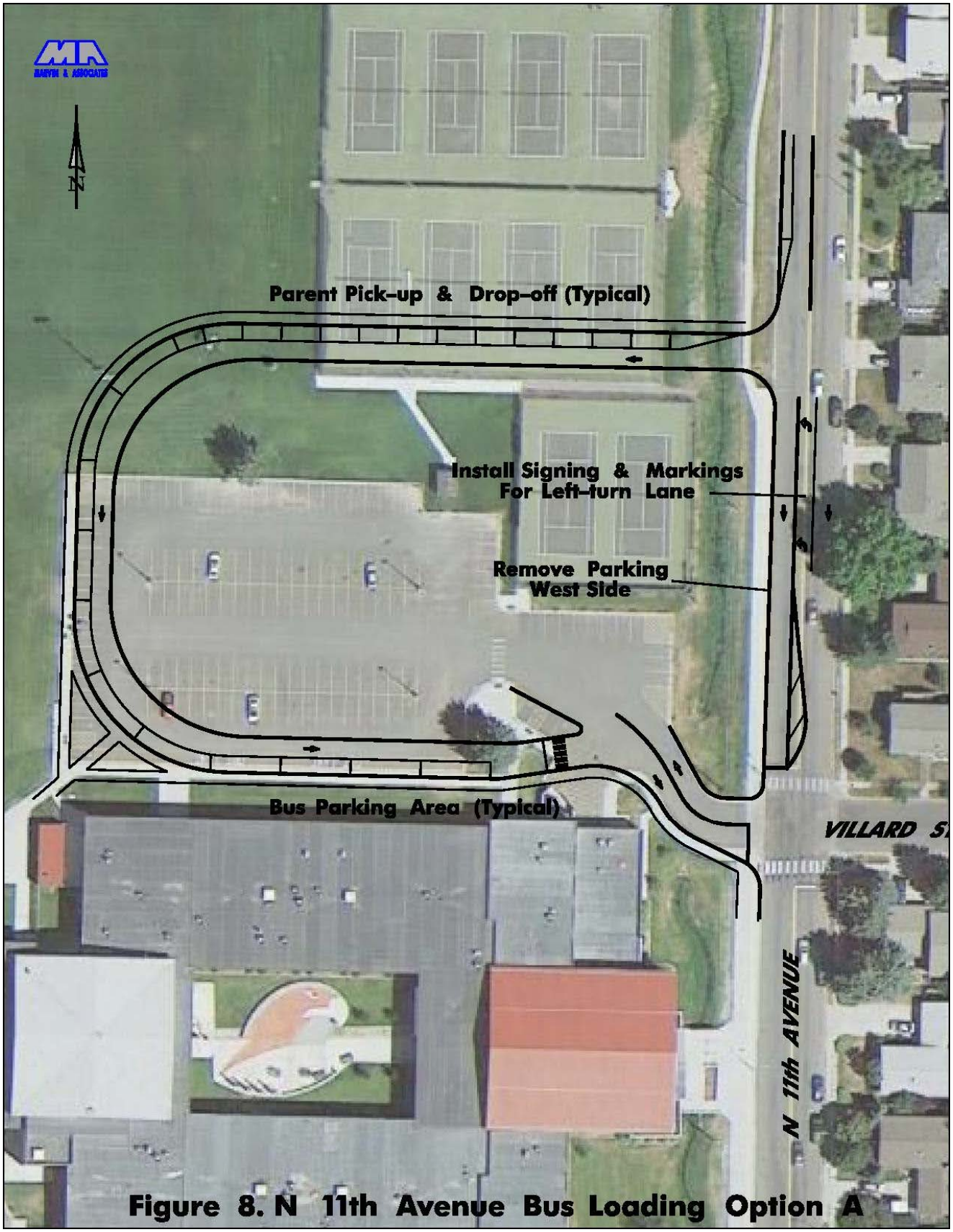


Figure 8. N 11th Avenue Bus Loading Option A

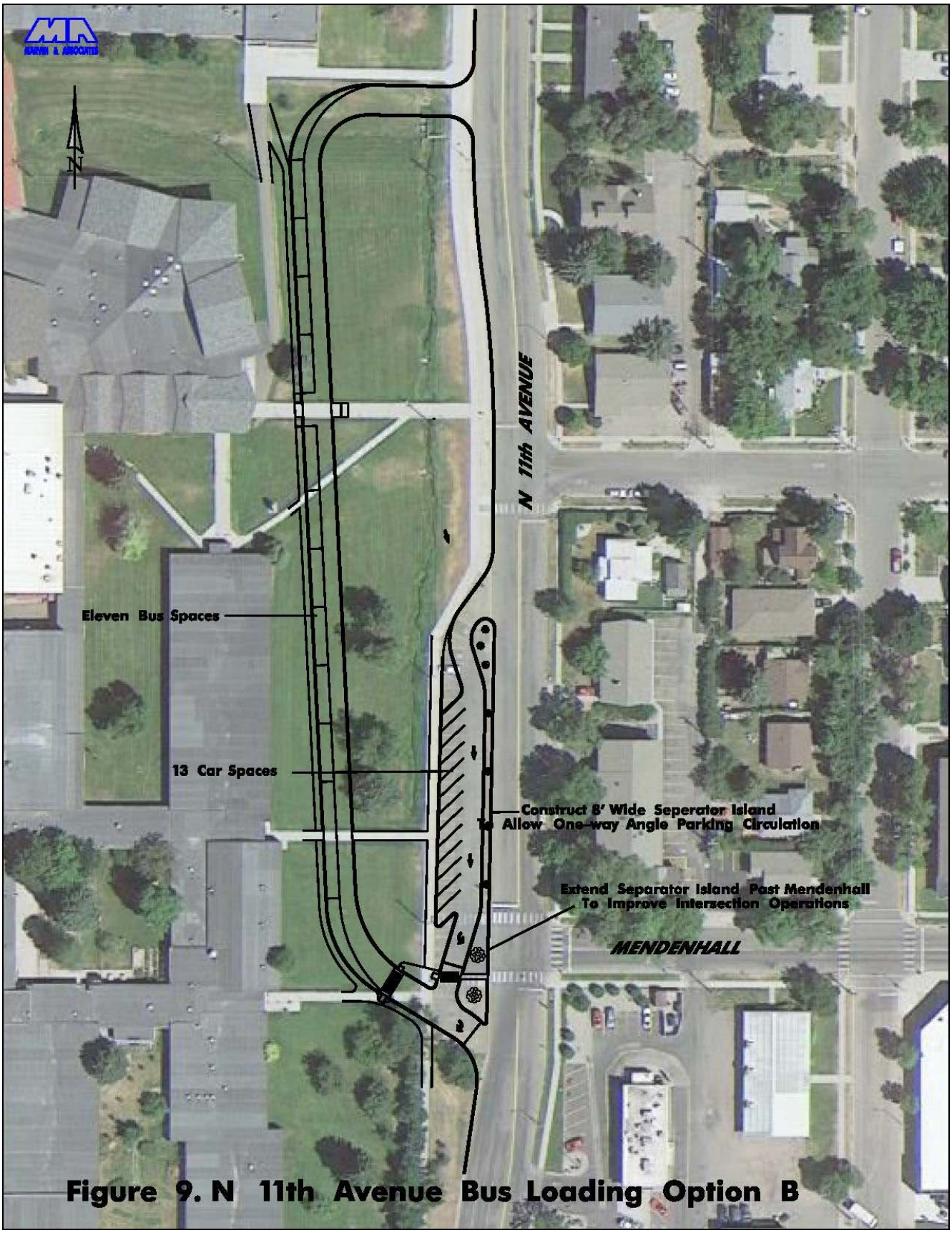


Figure 9. N 11th Avenue Bus Loading Option B

Main Street Access Improvements

Access to and from the Main Street parking lots and loop road is severely constrained by high traffic volumes on Main Street. At certain times of the day, vehicles accessing the school from the west experience long delays and vehicles entering Main Street to the eastbound direction is almost impossible, especially in the peak pm hour. The most obvious conflicts on Main Street is the proximity of the existing one-way loop-road to the eastern most parking access driveway. It has been proposed that the loop road be extended into the parking aisle access creating an internal intersection and combining both accesses onto Main Street. An evaluation of resulting traffic demand was completed and it was determined that this concept would work very well and should be pursued.

Design Options Capacity

Of all the design options investigated, only the Beall Street access would experience significant traffic demand increases. Design Option B on N 11th Avenue would impact operations at the Mendenhall intersection, since it would eliminate the western approach leg, which currently accesses the parking lot. Table 8 provides a summary of capacity calculations (see Appendix B-3) for design options with significant geometric and traffic demand changes. Capacity calculations were based on 2020 volumes with current school enrollment traffic, which would be the highest future traffic demand condition.

The intersection of N 15th Avenue and Beall street would become a three-legged approach with the 4th leg of the intersection becoming a departure leg. Table 8 capacity calculations indicate that if stop control on Beall Street is retained, the Beall Street approach would operate at LOS “D”. In addition, turn lane warrants indicate that auxiliary left-turn lanes at the Beall Street intersection are currently required and would still be required with this concept. Since left-turn lanes at this intersection would not elevate the LOS for the Beall Street approach, but could elevate safety concerns for the high number of pedestrians at this intersection, alternative control measures would be necessary.

Table 8. Optional Improvements Critical Intersections - Capacity Analysis Summary

Intersection	MOE	EB	WB	NB	SB	Intersection
Movement Group		*LTR*		*LTR*	*LTR*	*Overall LOS*
Beall Street Access Options A&B TWLT Stop On Beall PM Hour	*Control Delay (s/veh)*	25.7		8.4	8.4	
	LOS	D		A	A	C
	V/C Ratio	0.49		0.08	0.09	
	Queue Length (95%)	3		1	1	
Movement Group		*LTR*		*L TR*	*L TR*	*Overall LOS*
Beall Street Access Options A&B TWLT All-Way Stop PM Hour	*Control Delay (s/veh)*	8.8		9.7 15.5	10.0 13.9	13.0
	LOS	A		A C	A B	B
	V/C Ratio	0.21		0.16 0.60	0.18 0.53	
	Queue Length (95%)	1		1 5	1 4	
Movement Group		*LTR*	*LTR*	*L*	*L*	*Overall LOS*
N 15th Street & South Access Options A&B PM Hour	*Control Delay (s/veh)*	14.1	16.7	8.1	8.0	
	LOS	B	C	A	A	C
	V/C Ratio	0.00	0.41	0.00	0.00	
	Queue Length (95%)	0	2	0	0	
Movement Group			*L R*			*Overall LOS*
North 11th Avenue & Mendenhall Street Option B Future PM Hour	*Control Delay (s/veh)*		19.6 10.9			
	LOS		C B			B
	V/C Ratio		0.47 0.14			
	Queue Length (95%)		C B			

Table 8 indicates that an All-way stop intersection would function at a LOS "C" or better. Thus, a traffic signal would not be required at Beall and N 15th Avenue. Left turn lanes on N 15th Avenue should be developed using a continuous two-way left-turn lane (TWLTL). The TWLTL could be implemented within the existing curbed roadway section and could benefit other property owners along N 15th Avenue. Closure or relocation of the commercial access immediately south of the Beall Street intersection would be necessary to eliminate existing conflicts with intersection operations. Table 8 also indicates that the added egress traffic at the south parking lot access on N 15th Street would operate at an overall LOS "C" with a maximum queue of 2 vehicles on the westbound leg.

Table 8 shows that the N 11th & Mendenhall intersection would operate at LOS "B" and "C" for future year 2035 traffic conditions, if the medial separator on N 11th were constructed to eliminate the western leg of the intersection, as proposed in N 11th Design Option B.

CONCLUSIONS & RECOMMENDATIONS

Improvements to the existing Bozeman High School would not add traffic volumes to the surrounding street system during the am and pm peak hour periods. In fact, school generated vehicular traffic on the surrounding street system would be 30% less than existing by the year 2035. More importantly proposed improvements strive to relocate school related parking and circulation traffic from the street system to the internal site. The purpose of this traffic access study was to determine feasible improvements that could be incorporated in the overall site improvements. Two of the basic objectives were to remove bus parking from the street system and to remove parent drop-off and pick-up operations from streets and surrounding neighborhoods. Design options on both N 11th Avenue and N 15th Avenue were evaluated and condensed so that there appears to be two feasible options on both streets. On N 15th Avenue, internal land use impacts and relative costs would favor Design Option B as illustrated in Figure 7. On N 11th Avenue the two options are at two separate locations, but each option would serve the same number of buses and passenger car parking spaces. The most important operational difference between them involves improvements that would be required at the intersection of Mendenhall Street and N 11th Avenue. Option B provides a medial separator that would improve overall safety and efficiency of Mendenhall Street intersection while Option A does not. However, Option A could be built in conjunction with improvements to the on-street angle parking improvements portion of Option B.

Recommendations for access improvements at the existing high school are contained within report Figures 7, 8, and 9. The following narratives serve to clarify the illustrations:

1. Beall Street access, Design Option B, indicates that bus pick-up and drop-off lanes could be designated along the internal circulation roadway. The Bus lanes would not be required if it was decided that buses would better serve the school on N 11th Avenue instead. The bus lanes could then become additional parent pick-up and drop-off lanes, which would further enhance the internal storage capacity of the site.
2. If it is not possible to install TWLTL on the full extent of N 15th Street, they should be installed within the area of influence of the school accesses.
3. Closure or relocation of the commercial access south of Beall Street on N 15th is critical to existing and future traffic operations and should be pursued aggressively. All-way stop control at the Beall and N 15th Avenue intersection will exacerbate existing safety concerns if the commercial access cannot be moved.
4. Recommendations for bus loading options on N 11th Avenue are more dependent upon functionality of school operations than on traffic operations. Option B would automatically improve operations at the intersection of Mendenhall Street and N 11th Avenue. If Option A is deemed superior in terms of school operations, then parking improvements between Lamme Street and Mendenhall Street would also be required to eliminate the fourth uncontrolled approach to the Mendenhall Street intersection.

APPENDIX A

TRAFFIC VOLUME COUNTS

West Parking Access & Main Street - AM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
7:15	1	1	152		0	0		138	0	0						1	0		0	0	291	2
7:30	0	0	217		0	0		142	0	0						1	0		3	2	365	3
7:45	0	7	314		0	0		136	0	0						1	0		1	2	459	3
8:00	0	13	243		0	0		195	1	0						0	0		2	0	456	0
8:15	0	5	227		0	0		184	2	0						0	0		1	0	420	0
7:30 to 8:30	**0**	**25**	**1001**	**0**	**0**	**0**	**0**	**657**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**7**	**4**	**1700**	**6**

PHF = 0.93

West Parking Access & Main Street - PM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
3:15	0	2	189		0	0		288	0	0						0	0		0	0	479	0
3:30	0	0	214		0	0		308	0	0						0	0		9	0	540	0
3:45	0	0	217		0	0		391	0	0						0	0		13	0	634	0
4:00	0	1	188		0	0		257	0	0						0	0		2	0	450	0
3:15 to 4:15	**0**	**3**	**808**		**0**	**0**		**1244**	**0**	**0**						**0**	**0**		**24**	**0**	**2103**	**0**

PHF = 0.83

Middle Parking Access & Main Street - AM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
7:15	0	11	141		0	0		137	5	0						0	0		1	1	296	1
7:30	0	5	212		0	0		141	2	0						1	0		1	1	362	2
7:45	0	17	297		0	0		135	3	0						1	0		1	2	454	3
8:00	0	40	203		0	0		195	22	0						0	0		0	0	460	0
8:15	0	18	209		0	0		184	6	0						0	0		0	0	417	0
7:30 to 8:30	**0**	**80**	**921**	**0**	**0**	**0**	**0**	**655**	**33**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**2**	**3**	**1693**	**5**

PHF = 0.92

Middle Parking Access & Main Street - PM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
3:15	0	3	189		0	0		285	1	0						1	1		3	0	485	1
3:30	0	3	214		0	0		288	0	0						0	1		20	0	546	0
3:45	0	1	217		0	0		374	0	0						0	3		17	0	629	0
4:00	0	3	188		0	0		248	2	0						0	0		9	0	459	0
3:15 to 4:15	**0**	**10**	**808**		**0**	**0**		**1195**	**3**	**0**						**1**	**5**		**49**	**0**	**2119**	**1**

PHF = 0.84

East Parking Near Loop Road Access & Main Street - AM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
7:15	0	3	163		0	0		122	15	0						0	2		3	1	311	1
7:30	0	1	194		0	0		117	1	0						1	2		5	1	325	2
7:45	0	0	229		0	0		143	10	0						1	0		1	2	384	3
8:00	0	5	224		0	0		187	15	0						0	0		2	0	435	0
8:15	0	3	189		0	0		207	11	0						0	1		0	0	411	0
7:30 to 8:30	**0**	**9**	**836**	**0**	**0**	**0**	**0**	**654**	**37**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**0**	**8**	**3**	**1555**	**5**

PHF = 0.89

East Parking Near Loop Road Access & Main Street - PM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
3:15	0	2	186		0	0		248	4	0						2	2		9	0	460	2
3:30	0	15	211		0	0		298	14	0						7	1		1	0	541	7
3:45	0	14	181		0	0		316	11	0						1	1		8	0	539	1
4:00	0	2	215		0	0		259	8	0						3	0		6	0	496	3
3:15 to 4:15	**0**	**33**	**793**		**0**	**0**		**1121**	**37**	**0**						**13**	**4**		**24**	**0**	**2036**	**13**

PHF = 0.94

Loop Road Entrance & Main Street - AM Peak 11/22/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
7:15	0	11	165		0	0		137	15	0											328	0
7:30	1	10	196		0	0		118	5	1											329	2
7:45	1	10	229		0	0		153	8	1											400	2
8:00	2	24	224		0	0		202	18	1											468	3
8:15	1	8	190		0	0		218	8	1											424	2
7:30 to 8:30	**5**	**52**	**839**	**0**	**0**	**0**	**0**	**691**	**39**	**4**	**0**	**0**	**0**	**0**	**0**						**1621**	**9**

PHF = 0.87

Loop Road Entrance & Main Street - PM Peak 11/22/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
3:15	2	13	186		0	0		252	15	2											466	4
3:30	6	12	211		0	0		312	18	6											553	12
3:45	10	11	181		0	0		327	13	8											532	18
4:00	7	4	215		0	0		267	6	1											492	8
3:15 to 4:15	**25**	**40**	**793**		**0**	**0**		**1158**	**52**	**17**											**2043**	**42**

PHF = 0.92

Villard & N 11th Avenue - AM Peak 12/1/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
7:15	22	0	0	2	0	0	7	1	0	0	0	5	19	5	1	4	1	45	4	0	138	27
7:30	4	1	0	1	0	10	1	0	0	0	1	7	9	3	4	0	1	46	5	0	125	19
7:45	56	1	0	6	1	0	2	0	6	0	0	28	14	8	8	8	6	69	12	0	233	73
8:00	44	0	0	12	3	3	3	1	5	0	0	22	30	26	27	6	12	56	22	0	267	83
8:15	23	2	2	13	0	0	3	1	3	0	1	18	25	13	16	12	6	38	13	0	188	52
7:30 to 8:30	**127**	**4**	**2**	**32**	**4**	**13**	**9**	**2**	**14**	**0**	**2**	**75**	**78**	**50**	**55**	**26**	**25**	**209**	**52**	**0**	**813**	**227**

PHF = 0.76

Villard & N 11th Avenue - PM Peak 12/1/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
3:00	0	4	3	4	0	1	5	0	1	0	5	2	44	10	1	0	1	20	4	0	122	7
3:15	0	2	3	7	0	0	2	1	3	0	4	15	47	7	1	0	2	30	10	0	169	5
3:30	2	9	1	34	15	3	3	2	8	2	24	6	47	21	1	0	23	44	12	3	266	50
3:45	7	7	2	22	17	2	6	1	5	0	25	7	50	20	3	3	7	38	7	3	217	60
4:00	0	9	2	19	1	0	5	0	5	0	1	4	57	10	1	0	2	26	3	0	171	3
3:15 to 4:15	**9**	**27**	**8**	**82**	**33**	**5**	**16**	**4**	**21**	**2**	**54**	**32**	**201**	**58**	**6**	**3**	**34**	**138**	**32**	**6**	**823**	**118**

PHF = 0.77

Mendenhall & N 11th Avenue - AM Peak 11/22/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
7:15	0	0		3	0	0	18	0	8	0	0	1	18		0	0		43	1	0	136	0
7:30	0	0		2	0	1	15	1	5	0	0	1	19		0	1		30	0	0	103	2
7:45	0	0		4	0	0	15	3	5	0	0	5	36		3	0		54	1	1	178	4
8:00	0	0		4	0	0	21	1	18	0	4	1	67		3	2		64	0	1	240	10
8:15	0	1		9	0	0	20	1	8	2	0	1	41		9	1		47	0	0	175	12
7:15 to 8:15	**0**	**1**		**19**	**0**	**1**	**71**	**6**	**36**	**2**	**4**	**8**	**163**		**15**	**4**		**195**	**1**	**2**	**696**	**28**

PHF = 0.73

Mendenhall & N 11th Avenue - PM Peak 11/22/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
3:15	0	0		0	0	0	38	1	24	0	1	1	60		2	0		33	0	0	190	3
3:30	6	0		2	0	1	48	0	27	4	27	1	68		2	0		66	0	0	278	40
3:45	3	0		4	0	0	31	1	19	3	6	1	59		0	0		65	0	6	245	18
4:00	0	0		5	0	1	56	1	12	0	2	0	61		1	0		37	1	0	211	4
3:15 to 4:15	**9**	**0**		**11**	**0**	**2**	**173**	**3**	**82**	**7**	**36**	**3**	**248**		**5**	**0**		**201**	**1**	**6**	**924**	**65**

PHF = 0.83

North Parking Access & N 15th Avenue - AM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
7:15						1	0		0	0	0		41	0	1	0	7	67		1	182	3
7:30						0	0		0	0	0		21	0	0	0	2	49		0	121	0
7:45						0	0		0	0	0		38	3	0	0	14	73		0	201	0
8:00						0	0		0	0	0		67	5	0	0	44	92		0	300	0
8:15						0	0		0	0	0		44	3	0	0	24	53		0	177	0
7:30 to 8:30						**1**	**0**		**0**	**0**	**0**		**170**	**11**	**0**	**0**	**84**	**267**		**1**	**804**	**3**

PHF = 0.67

North Parking Access & N 15th Avenue - PM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
3:15						0	5		6	0	0		52	0	0	0	1	41		0	146	0
3:30						0	12		10	0	0		96	0	0	0	1	57		0	233	0
3:45						0	17		10	0	0		99	0	0	0	0	45		0	216	0
4:00						0	1		2	0	0		54	1	0	0	0	48		0	154	0
3:15 to 4:15						**0**	**30**		**22**	**0**	**0**		**249**	**1**	**0**	**0**	**1**	**150**		**0**	**603**	**0**

PHF = 0.65

South Parking Access & N 15th Avenue - AM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
7:15	0	0	0	0	0	0	0	0	0	0	0	0	41	19	0	1	7	67	3	0	207	1
7:30	0	3	0	0	0	0	0	0	1	0	0	1	20	2	0	0	5	49	2	0	134	0
7:45	0	2	0	4	0	0	1	0	0	0	0	1	36	12	0	0	2	73	5	0	214	0
8:00	0	3	1	1	0	0	0	0	1	0	0	2	63	52	0	0	6	92	1	0	315	0
8:15	0	2	0	2	0	0	0	0	0	0	0	1	42	20	0	0	1	83	0	0	234	0
7:30 to 8:30	**0**	**10**	**1**	**7**	**0**	**0**	**1**	**0**	**2**	**0**	**0**	**5**	**161**	**86**	**0**	**0**	**14**	**297**	**8**	**0**	**897**	**0**

PHF = 0.71

South Parking Access & N 15th Avenue - PM Peak 11/29/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
3:15	0	0	0	0	0	1	3	0	1	0	0	0	51	0	0	0	0	46	0	0	147	1
3:30	0	0	0	0	0	1	19	0	14	0	0	0	82	0	0	0	2	69	0	0	255	1
3:45	0	0	0	0	0	1	17	0	12	0	0	0	77	3	0	0	0	62	0	0	233	1
4:00	0	1	0	0	0	0	7	0	0	0	0	1	54	1	0	0	0	49	1	0	164	0
3:15 to 4:15	**0**	**1**	**0**	**0**	**0**	**3**	**46**	**0**	**27**	**0**	**0**	**1**	**264**	**4**	**0**	**0**	**2**	**226**	**1**	**0**	**799**	**3**

PHF = 0.78

Beall Street & N 15th Avenue - AM Peak 11/22/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
7:15	0	3	8	9	1	0	24	8	24	0	3	2	38	20	0	2	29	30	1	1	227	7
7:30	0	3	11	22	0	0	8	1	6	0	5	5	30	7	0	0	12	30	1	0	167	5
7:45	0	7	9	16	0	1	6	4	13	1	7	4	57	10	0	0	18	49	2	3	246	12
8:00	0	6	8	18	2	0	17	9	18	0	11	4	69	21	1	0	29	40	2	4	283	18
8:15	0	2	2	9	0	0	11	3	7	0	3	5	48	10	0	0	8	29	3	2	169	5
7:30 to 8:30	**0**	**19**	**36**	**65**	**3**	**1**	**55**	**22**	**61**	**1**	**26**	**15**	**194**	**58**	**1**	**2**	**88**	**149**	**6**	**8**	**923**	**42**

PHF = 0.82

Beall Street & N 15th Avenue - PM Peak 11/22/2016

Begin Time	Eastbound					Westbound					Northbound					Southbound					Total Vehicles	Total Peds
	SBp	Left	Thru	Right	NBp	NBp	Left	Thru	Right	SBp	Ebp	Left	Thru	Right	WBp	WBp	Left	Thru	Right	Ebp		
3:15	0	5	3	14	0	0	7	1	4	1	1	29	59	6	0	0	12	45	2	0	234	2
3:30	10	5	2	18	1	0	11	9	15	0	0	23	54	14	9	21	12	77	12	1	341	42
3:45	2	9	1	24	0	0	6	11	29	0	0	19	77	17	0	10	16	55	14	2	347	14
4:00	2	8	3	19	2	0	6	4	16	0	0	6	50	7	3	2	10	51	12	0	255	9
3:15 to 4:15	**14**	**27**	**9**	**75**	**3**	**0**	**30**	**25**	**64**	**1**	**1**	**77**	**240**	**44**	**12**	**33**	**50**	**228**	**40**	**3**	**1177**	**67**

PHF = 0.85

APPENDIX B-1

Existing Capacity Calculations

HCS7 Two-Way Stop-Control Report

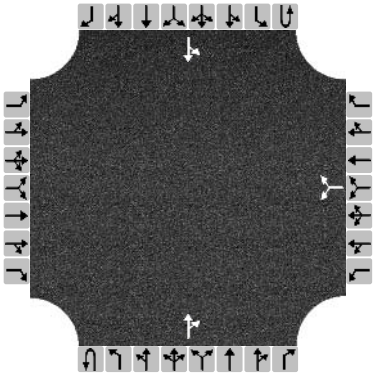
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th & North Access
Jurisdiction	City of Bozeman
East/West Street	North Parking Access
North/South Street	N 15th Avenue
Peak Hour Factor	0.67
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	0	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume, V (veh/h)						1		1			184	11		84	257	
Percent Heavy Vehicles (%)						0		0						0		
Proportion Time Blocked																
Percent Grade (%)						0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.40		6.20						4.10		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.50		3.30						2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)							2							125		
Capacity, c (veh/h)							399							1271		
v/c Ratio							0.01							0.10		
95% Queue Length, Q_{95} (veh)							0.0							0.3		
Control Delay (s/veh)							14.1							8.1		
Level of Service, LOS							B							A		
Approach Delay (s/veh)						14.1								2.8		
Approach LOS						B										

HCS7 Two-Way Stop-Control Report

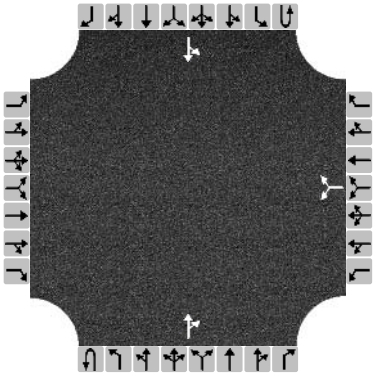
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th & North Access
Jurisdiction	City of Bozeman
East/West Street	North Parking Access
North/South Street	N 15th Avenue
Peak Hour Factor	0.67
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	0	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume, V (veh/h)						30		22			353	1		1	245	
Percent Heavy Vehicles (%)						0		0						0		
Proportion Time Blocked																
Percent Grade (%)						0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.40		6.20						4.10		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.50		3.30						2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)							78							1		
Capacity, c (veh/h)							380							1040		
v/c Ratio							0.21							0.00		
95% Queue Length, Q_{95} (veh)							0.8							0.0		
Control Delay (s/veh)							16.9							8.5		
Level of Service, LOS							C							A		
Approach Delay (s/veh)						16.9								0.0		
Approach LOS						C										

HCS7 Two-Way Stop-Control Report

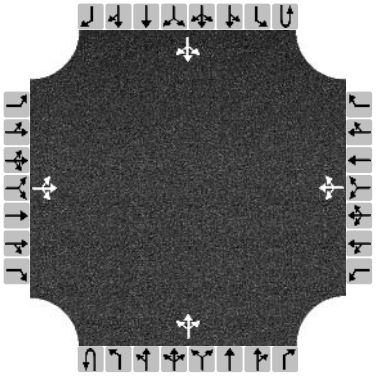
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th South Access
Jurisdiction	City of Bozeman
East/West Street	South Access
North/South Street	N 15th Avenue
Peak Hour Factor	0.71
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		10	1	7		1	0	2		5	183	86		14	235	8
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			25				4			7				20		
Capacity, c (veh/h)			431				563			1228				1191		
v/c Ratio			0.06				0.01			0.01				0.02		
95% Queue Length, Q_{95} (veh)			0.2				0.0			0.0				0.1		
Control Delay (s/veh)			13.9				11.4			7.9				8.1		
Level of Service, LOS			B				B			A				A		
Approach Delay (s/veh)		13.9				11.4				0.2				0.6		
Approach LOS		B				B										

HCS7 Two-Way Stop-Control Report

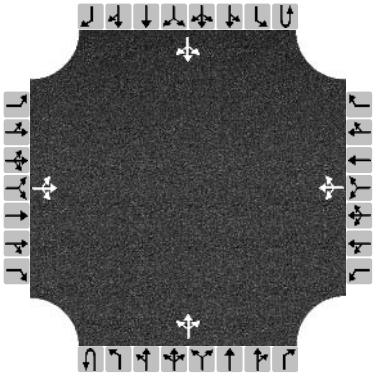
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th South Access
Jurisdiction	City of Bozeman
East/West Street	South Access
North/South Street	N 15th Avenue
Peak Hour Factor	0.78
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		1	0	0		46	0	27		1	326	4		2	272	1
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			1				94			1				3		
Capacity, c (veh/h)			290				385			1220				1141		
v/c Ratio			0.00				0.24			0.00				0.00		
95% Queue Length, Q_{95} (veh)			0.0				0.9			0.0				0.0		
Control Delay (s/veh)			17.5				17.3			8.0				8.2		
Level of Service, LOS			C				C			A				A		
Approach Delay (s/veh)		17.5				17.3				0.0				0.1		
Approach LOS		C				C										

HCS7 Two-Way Stop-Control Report

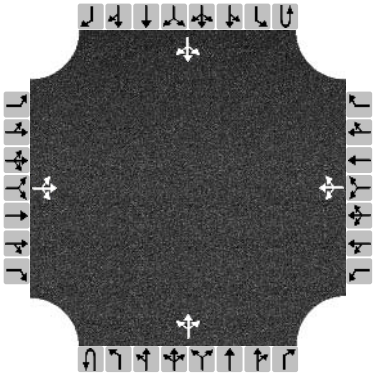
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th & Beall Street
Jurisdiction	City of Bozeman
East/West Street	Beall Street
North/South Street	N 15th Avenue
Peak Hour Factor	0.82
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		19	36	65		55	22	61		15	194	58		88	149	6
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			146				168			18				107		
Capacity, c (veh/h)			433				347			1390				1260		
v/c Ratio			0.34				0.48			0.01				0.08		
95% Queue Length, Q_{95} (veh)			1.5				2.5			0.0				0.3		
Control Delay (s/veh)			17.5				24.7			7.6				8.1		
Level of Service, LOS			C				C			A				A		
Approach Delay (s/veh)		17.5				24.7				0.5				3.4		
Approach LOS		C				C										

HCS7 Two-Way Stop-Control Report

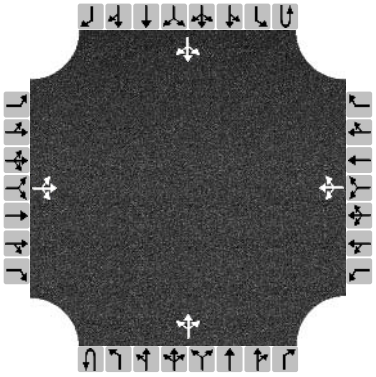
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th & Beall Street
Jurisdiction	City of Bozeman
East/West Street	Beall Street
North/South Street	N 15th Avenue
Peak Hour Factor	0.85
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		27	9	75		30	25	64		77	240	44		50	228	40
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			131				139			91				59		
Capacity, c (veh/h)			339				312			1219				1235		
v/c Ratio			0.39				0.45			0.07				0.05		
95% Queue Length, Q_{95} (veh)			1.8				2.2			0.2				0.2		
Control Delay (s/veh)			22.2				25.4			8.2				8.1		
Level of Service, LOS			C				D			A				A		
Approach Delay (s/veh)		22.2				25.4				2.3				1.7		
Approach LOS		C				D										

HCS7 Two-Way Stop-Control Report

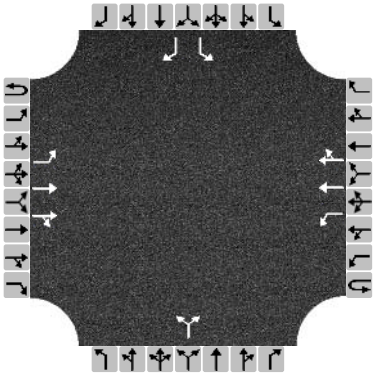
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing AM
Intersection Orientation	East-West
Project Description	Existing High School

Site Information

Intersection	Main & East Access Loop
Jurisdiction	City of Bozeman
East/West Street	Main Street
North/South Street	East AccessLoop Egress
Peak Hour Factor	0.89
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	2	0	0	1	2	0		0	0	0		1	0	1
Configuration		L	T	TR		L	T	TR			LR			L		R
Volume, V (veh/h)		9	912	1		0	680	37		0		2		12		92
Percent Heavy Vehicles (%)		0				0				0		0		0		0
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								1						

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.5		6.9		7.5		6.9
Critical Headway (sec)		4.10				4.10				7.50		6.90		7.50		6.90
Base Follow-Up Headway (sec)		2.2				2.2				3.5		3.3		3.5		3.3
Follow-Up Headway (sec)		2.20				2.20				3.50		3.30		3.50		3.30

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		10				0					2			13		103
Capacity, c (veh/h)		813				685					512			236		588
v/c Ratio		0.01				0.00					0.00			0.06		0.18
95% Queue Length, Q_{95} (veh)		0.0				0.0					0.0			0.2		0.6
Control Delay (s/veh)		9.5				10.3					12.1			21.1		12.4
Level of Service, LOS		A				B					B			C		B
Approach Delay (s/veh)		0.1				0.0				12.1				13.4		
Approach LOS										B				B		

HCS7 Two-Way Stop-Control Report

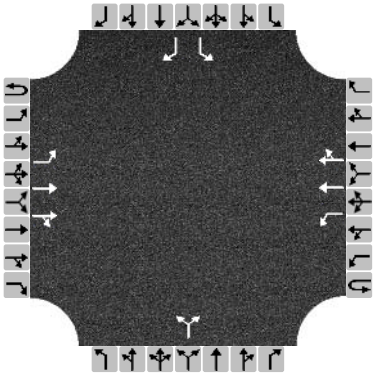
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing PM
Intersection Orientation	East-West
Project Description	Existing High School

Site Information

Intersection	Main & East Access Loop
Jurisdiction	City of Bozeman
East/West Street	Main Street
North/South Street	East AccessLoop Egress
Peak Hour Factor	0.89
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	2	0	0	1	2	0		0	0	0		1	0	1
Configuration		L	T	TR		L	T	TR			LR			L		R
Volume, V (veh/h)		33	769	1		1	1174	37		0		2		4		129
Percent Heavy Vehicles (%)		0				0				0		0		0		0
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								1						

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.5		6.9		7.5		6.9
Critical Headway (sec)		4.10				4.10				7.50		6.90		7.50		6.90
Base Follow-Up Headway (sec)		2.2				2.2				3.5		3.3		3.5		3.3
Follow-Up Headway (sec)		2.20				2.20				3.50		3.30		3.50		3.30

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		37				1					2			4		145
Capacity, c (veh/h)		500				787					577			122		385
v/c Ratio		0.07				0.00					0.00			0.03		0.38
95% Queue Length, Q_{95} (veh)		0.2				0.0					0.0			0.1		1.7
Control Delay (s/veh)		12.8				9.6					11.3			35.4		19.9
Level of Service, LOS		B				A					B			E		C
Approach Delay (s/veh)		0.5				0.0				11.3				20.3		
Approach LOS										B				C		

HCS7 Two-Way Stop-Control Report

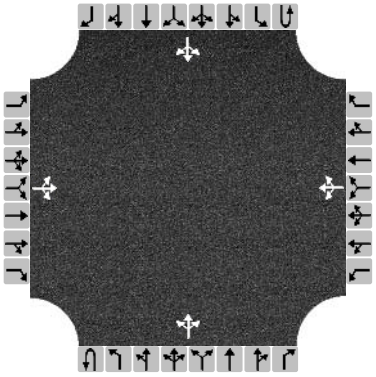
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 11th & Villard Street
Jurisdiction	City of Bozeman
East/West Street	Villard Street
North/South Street	N 11th Avenue
Peak Hour Factor	0.76
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		4	2	32		9	2	14		75	78	50		25	209	52
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)																
Critical Headway (sec)																
Base Follow-Up Headway (sec)																
Follow-Up Headway (sec)																

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			50				33			99				33		
Capacity, c (veh/h)			462				407			1096				1403		
v/c Ratio			0.11				0.08			0.09				0.02		
95% Queue Length, Q_{95} (veh)			0.4				0.3			0.3				0.1		
Control Delay (s/veh)			13.7				14.6			8.6				7.6		
Level of Service, LOS			B				B			A				A		
Approach Delay (s/veh)		13.7				14.6				3.7				0.9		
Approach LOS		B				B										

HCS7 Two-Way Stop-Control Report

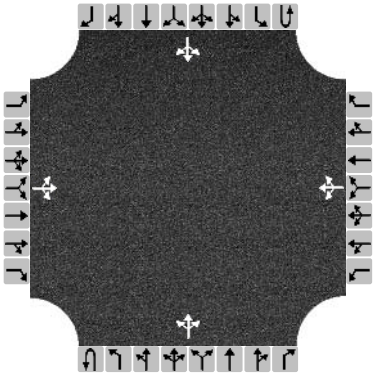
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 11th & Villard Street
Jurisdiction	City of Bozeman
East/West Street	Villard Street
North/South Street	N 11th Avenue
Peak Hour Factor	0.77
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		27	8	82		16	4	21		32	201	58		34	138	32
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)																
Critical Headway (sec)																
Base Follow-Up Headway (sec)																
Follow-Up Headway (sec)																

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			151				53			42				44		
Capacity, c (veh/h)			508				375			1309				1225		
v/c Ratio			0.30				0.14			0.03				0.04		
95% Queue Length, Q_{95} (veh)			1.2				0.5			0.1				0.1		
Control Delay (s/veh)			15.0				16.2			7.8				8.0		
Level of Service, LOS			C				C			A				A		
Approach Delay (s/veh)		15.0				16.2				1.1				1.6		
Approach LOS		C				C										

HCS7 Two-Way Stop-Control Report

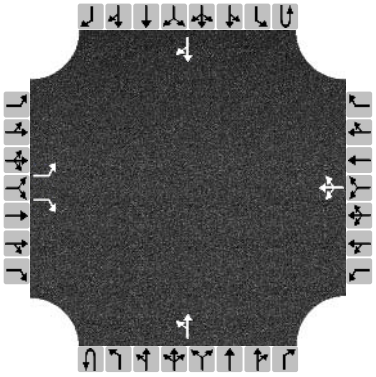
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 11th & Mendenhall
Jurisdiction	City of Bozeman
East/West Street	Mendenhall St
North/South Street	N 11th Avenue
Peak Hour Factor	0.83
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		1	0	1		0	1	0	0	0	1	0	0	0	1	0
Configuration		L		R			LTR			LT						TR
Volume, V (veh/h)		1		19		71	6	36		8	163				195	1
Percent Heavy Vehicles (%)		0		0		0	0	0		0						
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2		7.1	6.5	6.2		4.1						
Critical Headway (sec)		7.10		6.20		7.10	6.50	6.20		4.10						
Base Follow-Up Headway (sec)		3.5		3.3		3.5	4.0	3.3		2.2						
Follow-Up Headway (sec)		3.50		3.30		3.50	4.00	3.30		2.20						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		1		23			136			10						
Capacity, c (veh/h)		458		767			549			1339						
v/c Ratio		0.00		0.03			0.25			0.01						
95% Queue Length, Q_{95} (veh)		0.0		0.1			1.0			0.0						
Control Delay (s/veh)		12.9		9.8			13.7			7.7						
Level of Service, LOS		B		A			B			A						
Approach Delay (s/veh)	10.0				13.7				0.4							
Approach LOS	A				B											

HCS7 Two-Way Stop-Control Report

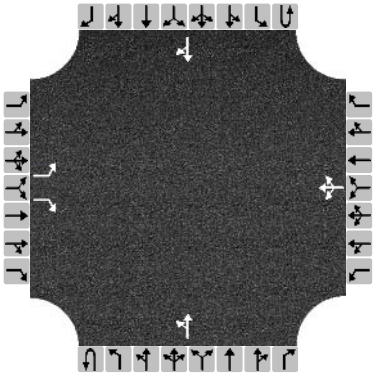
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2017
Time Analyzed	Existing PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 11th & Mendenhall
Jurisdiction	City of Bozeman
East/West Street	Mendenhall St
North/South Street	N 11th Avenue
Peak Hour Factor	0.83
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		1	0	1		0	1	0	0	0	1	0	0	0	1	0
Configuration		L		R			LTR			LT						TR
Volume, V (veh/h)		0		11		173	3	82		3	248				201	1
Percent Heavy Vehicles (%)		0		0		0	0	0		0						
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2		7.1	6.5	6.2		4.1						
Critical Headway (sec)		7.10		6.20		7.10	6.50	6.20		4.10						
Base Follow-Up Headway (sec)		3.5		3.3		3.5	4.0	3.3		2.2						
Follow-Up Headway (sec)		3.50		3.30		3.50	4.00	3.30		2.20						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		0		13			311			4						
Capacity, c (veh/h)		342		731			466			1321						
v/c Ratio		0.00		0.02			0.67			0.00						
95% Queue Length, Q_{95} (veh)		0.0		0.1			4.8			0.0						
Control Delay (s/veh)		15.5		10.0			26.9			7.7						
Level of Service, LOS		C		B			D			A						
Approach Delay (s/veh)	10.0				26.9				0.1							
Approach LOS	B				D											

APPENDIX B-2

Future Capacity Calculations

HCS7 Two-Way Stop-Control Report

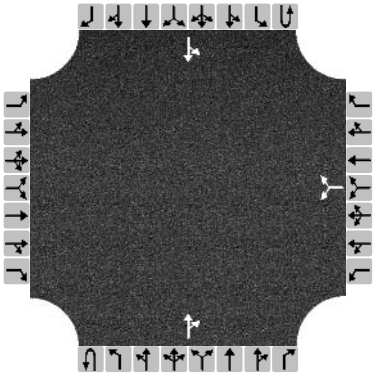
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th & North Access
Jurisdiction	City of Bozeman
East/West Street	North Parking Access
North/South Street	N 15th Avenue
Peak Hour Factor	0.67
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	0	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume, V (veh/h)						1		1			190	10		60	260	
Percent Heavy Vehicles (%)						0		0						0		
Proportion Time Blocked																
Percent Grade (%)						0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.40		6.20						4.10		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.50		3.30						2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)							2							90		
Capacity, c (veh/h)							430							1262		
v/c Ratio							0.00							0.07		
95% Queue Length, Q_{95} (veh)							0.0							0.2		
Control Delay (s/veh)							13.4							8.1		
Level of Service, LOS							B							A		
Approach Delay (s/veh)						13.4								2.1		
Approach LOS						B										

HCS7 Two-Way Stop-Control Report

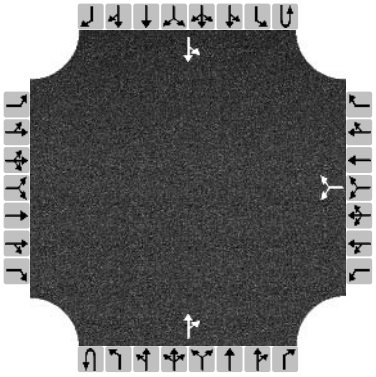
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th & North Access
Jurisdiction	City of Bozeman
East/West Street	North Parking Access
North/South Street	N 15th Avenue
Peak Hour Factor	0.67
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		0	0	0	0	0	1	0	0	0	1	0
Configuration							LR					TR		LT		
Volume, V (veh/h)						20		15			375	1		1	240	
Percent Heavy Vehicles (%)						0		0						0		
Proportion Time Blocked																
Percent Grade (%)						0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)						7.1		6.2						4.1		
Critical Headway (sec)						6.40		6.20						4.10		
Base Follow-Up Headway (sec)						3.5		3.3						2.2		
Follow-Up Headway (sec)						3.50		3.30						2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)							52							1		
Capacity, c (veh/h)							366							1011		
v/c Ratio							0.14							0.00		
95% Queue Length, Q_{95} (veh)							0.5							0.0		
Control Delay (s/veh)							16.5							8.6		
Level of Service, LOS							C							A		
Approach Delay (s/veh)						16.5								0.0		
Approach LOS						C										

HCS7 Two-Way Stop-Control Report

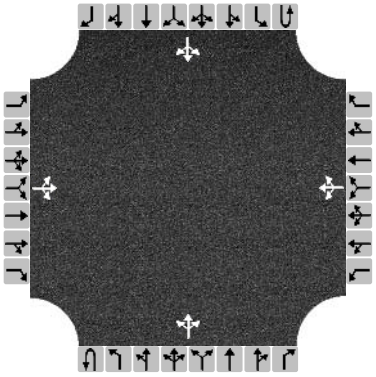
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th South Access
Jurisdiction	City of Bozeman
East/West Street	South Access
North/South Street	N 15th Avenue
Peak Hour Factor	0.71
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		10	1	10		1	0	2		5	190	60		10	240	10
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			29				4			7				14		
Capacity, c (veh/h)			461				570			1218				1217		
v/c Ratio			0.06				0.01			0.01				0.01		
95% Queue Length, Q_{95} (veh)			0.2				0.0			0.0				0.0		
Control Delay (s/veh)			13.3				11.4			8.0				8.0		
Level of Service, LOS			B				B			A				A		
Approach Delay (s/veh)		13.3				11.4				0.2				0.4		
Approach LOS		B				B										

HCS7 Two-Way Stop-Control Report

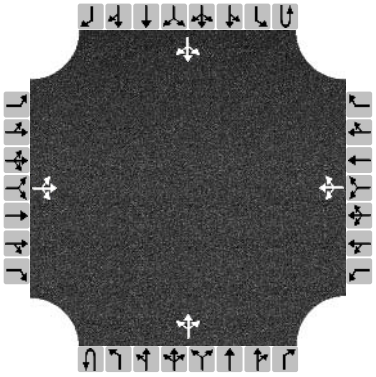
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th South Access
Jurisdiction	City of Bozeman
East/West Street	South Access
North/South Street	N 15th Avenue
Peak Hour Factor	0.78
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		1	0	0		30	0	20		1	355	4		2	260	1
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			1				64			1				3		
Capacity, c (veh/h)			286				380			1237				1106		
v/c Ratio			0.00				0.17			0.00				0.00		
95% Queue Length, Q_{95} (veh)			0.0				0.6			0.0				0.0		
Control Delay (s/veh)			17.6				16.4			7.9				8.3		
Level of Service, LOS			C				C			A				A		
Approach Delay (s/veh)		17.6				16.4				0.0				0.1		
Approach LOS		C				C										

HCS7 Two-Way Stop-Control Report

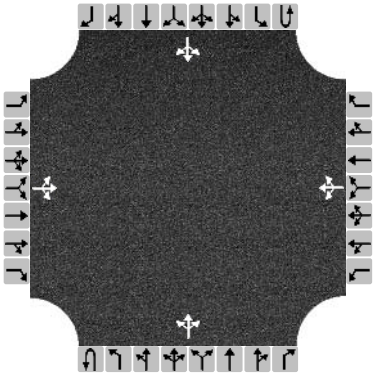
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th & Beall Street
Jurisdiction	City of Bozeman
East/West Street	Beall Street
North/South Street	N 15th Avenue
Peak Hour Factor	0.82
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		20	25	70		40	15	40		15	195	40		60	185	6
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			139				116			18				73		
Capacity, c (veh/h)			488				370			1339				1282		
v/c Ratio			0.29				0.31			0.01				0.06		
95% Queue Length, Q_{95} (veh)			1.2				1.3			0.0				0.2		
Control Delay (s/veh)			15.3				19.1			7.7				8.0		
Level of Service, LOS			C				C			A				A		
Approach Delay (s/veh)		15.3				19.1				0.6				2.3		
Approach LOS		C				C										

HCS7 Two-Way Stop-Control Report

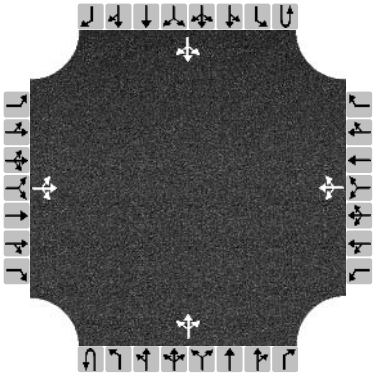
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th & Beall Street
Jurisdiction	City of Bozeman
East/West Street	Beall Street
North/South Street	N 15th Avenue
Peak Hour Factor	0.85
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		30	5	85		20	20	45		85	285	30		35	210	45
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			141				101			100				41		
Capacity, c (veh/h)			367				303			1234				1198		
v/c Ratio			0.38				0.33			0.08				0.03		
95% Queue Length, Q_{95} (veh)			1.8				1.4			0.3				0.1		
Control Delay (s/veh)			20.8				22.7			8.2				8.1		
Level of Service, LOS			C				C			A				A		
Approach Delay (s/veh)		20.8				22.7				2.4				1.3		
Approach LOS		C				C										

HCS7 Two-Way Stop-Control Report

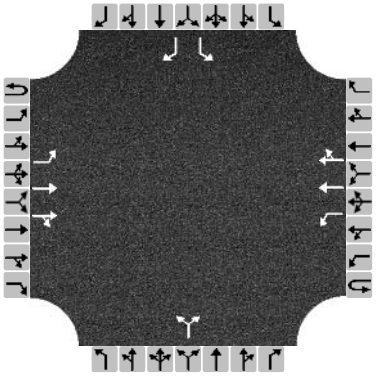
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future AM
Intersection Orientation	East-West
Project Description	Existing High School

Site Information

Intersection	Main & East Access Loop
Jurisdiction	City of Bozeman
East/West Street	Main Street
North/South Street	East AccessLoop Egress
Peak Hour Factor	0.90
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	2	0	0	1	2	0		0	0	0		1	0	1
Configuration		L	T	TR		L	T	TR			LR			L		R
Volume, V (veh/h)		5	1085	1		0	755	25		0		2		8		65
Percent Heavy Vehicles (%)		0				0				0		0		0		0
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								1						

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.5		6.9		7.5		6.9
Critical Headway (sec)		4.10				4.10				7.50		6.90		7.50		6.90
Base Follow-Up Headway (sec)		2.2				2.2				3.5		3.3		3.5		3.3
Follow-Up Headway (sec)		2.20				2.20				3.50		3.30		3.50		3.30

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		6				0					2			9		72
Capacity, c (veh/h)		771				585					446			207		562
v/c Ratio		0.01				0.00					0.00			0.04		0.13
95% Queue Length, Q_{95} (veh)		0.0				0.0					0.0			0.1		0.4
Control Delay (s/veh)		9.7				11.2					13.1			23.1		12.3
Level of Service, LOS		A				B					B			C		B
Approach Delay (s/veh)		0.0				0.0				13.1				13.5		
Approach LOS										B				B		

HCS7 Two-Way Stop-Control Report

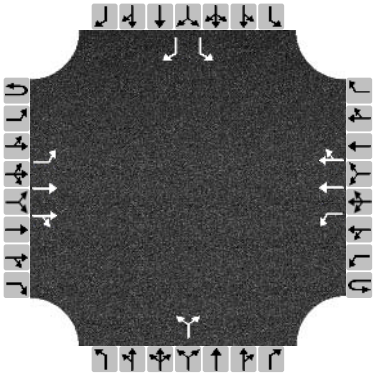
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future PM
Intersection Orientation	East-West
Project Description	Existing High School

Site Information

Intersection	Main & East Access Loop
Jurisdiction	City of Bozeman
East/West Street	Main Street
North/South Street	East AccessLoop Egress
Peak Hour Factor	0.89
Analysis Time Period (hrs)	0.25

Lanes



Major Street: East-West

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority	1U	1	2	3	4U	4	5	6		7	8	9		10	11	12
Number of Lanes	0	1	2	0	0	1	2	0		0	0	0		1	0	1
Configuration		L	T	TR		L	T	TR			LR			L		R
Volume, V (veh/h)		20	920	1		1	1490	25		0		2		4		90
Percent Heavy Vehicles (%)		0				0				0		0		0		0
Proportion Time Blocked																
Percent Grade (%)										0				0		
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								1						

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1				4.1				7.5		6.9		7.5		6.9
Critical Headway (sec)		4.10				4.10				7.50		6.90		7.50		6.90
Base Follow-Up Headway (sec)		2.2				2.2				3.5		3.3		3.5		3.3
Follow-Up Headway (sec)		2.20				2.20				3.50		3.30		3.50		3.30

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		22				1					2			4		101
Capacity, c (veh/h)		370				679					508			78		298
v/c Ratio		0.06				0.00					0.00			0.05		0.34
95% Queue Length, Q_{95} (veh)		0.2				0.0					0.0			0.2		1.5
Control Delay (s/veh)		15.3				10.3					12.1			53.9		23.2
Level of Service, LOS		C				B					B			F		C
Approach Delay (s/veh)		0.3				0.0				12.1				24.3		
Approach LOS										B				C		

HCS7 Two-Way Stop-Control Report

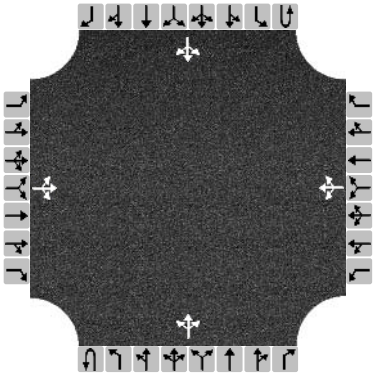
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 11th & Villard Street
Jurisdiction	City of Bozeman
East/West Street	Villard Street
North/South Street	N 11th Avenue
Peak Hour Factor	0.76
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		4	2	20		10	2	15		55	70	50		25	210	35
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			34				36			72				33		
Capacity, c (veh/h)			485				483			1150				1416		
v/c Ratio			0.07				0.07			0.06				0.02		
95% Queue Length, Q_{95} (veh)			0.2				0.2			0.2				0.1		
Control Delay (s/veh)			13.0				13.1			8.3				7.6		
Level of Service, LOS			B				B			A				A		
Approach Delay (s/veh)		13.0				13.1				3.0				0.9		
Approach LOS		B				B										

HCS7 Two-Way Stop-Control Report

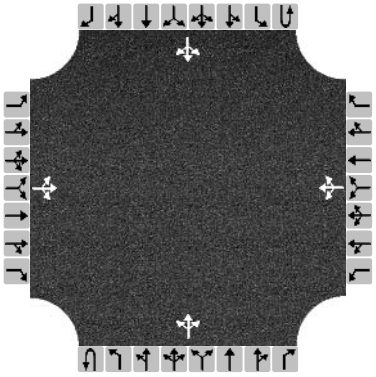
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 11th & Villard Street
Jurisdiction	City of Bozeman
East/West Street	Villard Street
North/South Street	N 11th Avenue
Peak Hour Factor	0.77
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	0	1	0	0	0	1	0
Configuration			LTR				LTR				LTR				LTR	
Volume, V (veh/h)		20	5	60		20	4	25		20	270	65		40	150	20
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			110				63			26				52		
Capacity, c (veh/h)			487				352			1323				1127		
v/c Ratio			0.23				0.18			0.02				0.05		
95% Queue Length, Q_{95} (veh)			0.9				0.6			0.1				0.1		
Control Delay (s/veh)			14.5				17.4			7.8				8.3		
Level of Service, LOS			B				C			A				A		
Approach Delay (s/veh)		14.5				17.4				0.6				1.9		
Approach LOS		B				C										

HCS7 Two-Way Stop-Control Report

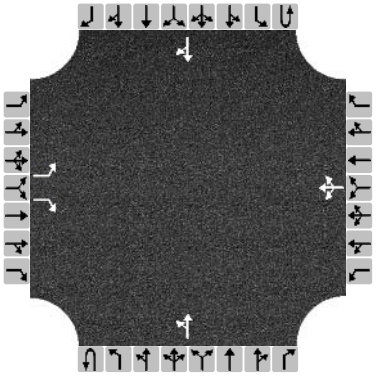
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future AM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 11th & Mendenhall
Jurisdiction	City of Bozeman
East/West Street	Mendenhall St
North/South Street	N 11th Avenue
Peak Hour Factor	0.83
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		1	0	1		0	1	0	0	0	1	0	0	0	1	0
Configuration		L		R			LTR			LT						TR
Volume, V (veh/h)		1		15		80	5	30		5	140				200	1
Percent Heavy Vehicles (%)		0		0		0	0	0		0						
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2		7.1	6.5	6.2		4.1						
Critical Headway (sec)		7.10		6.20		7.10	6.50	6.20		4.10						
Base Follow-Up Headway (sec)		3.5		3.3		3.5	4.0	3.3		2.2						
Follow-Up Headway (sec)		3.50		3.30		3.50	4.00	3.30		2.20						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		1		18			138			6						
Capacity, c (veh/h)		489		761			562			1333						
v/c Ratio		0.00		0.02			0.25			0.00						
95% Queue Length, Q_{95} (veh)		0.0		0.1			1.0			0.0						
Control Delay (s/veh)		12.4		9.8			13.5			7.7						
Level of Service, LOS		B		A			B			A						
Approach Delay (s/veh)	10.0				13.5				0.3							
Approach LOS	A				B											

HCS7 Two-Way Stop-Control Report

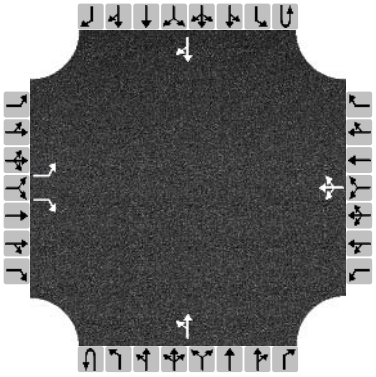
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2035
Time Analyzed	Future PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 11th & Mendenhall
Jurisdiction	City of Bozeman
East/West Street	Mendenhall St
North/South Street	N 11th Avenue
Peak Hour Factor	0.83
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		1	0	1		0	1	0	0	0	1	0	0	0	1	0
Configuration		L		R			LTR			LT						TR
Volume, V (veh/h)		0		5		190	3	90		3	265				230	1
Percent Heavy Vehicles (%)		0		0		0	0	0		0						
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized	No				No				No				No			
Median Type/Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1		6.2		7.1	6.5	6.2		4.1						
Critical Headway (sec)		7.10		6.20		7.10	6.50	6.20		4.10						
Base Follow-Up Headway (sec)		3.5		3.3		3.5	4.0	3.3		2.2						
Follow-Up Headway (sec)		3.50		3.30		3.50	4.00	3.30		2.20						

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		0		6			341			4						
Capacity, c (veh/h)		306		708			444			1283						
v/c Ratio		0.00		0.01			0.77			0.00						
95% Queue Length, Q_{95} (veh)		0.0		0.0			6.6			0.0						
Control Delay (s/veh)		16.8		10.1			35.2			7.8						
Level of Service, LOS		C		B			E			A						
Approach Delay (s/veh)	10.1				35.2				0.1							
Approach LOS	B				E											

APPENDIX B-3

Concept Capacity Calculations

HCS7 Two-Way Stop-Control Report

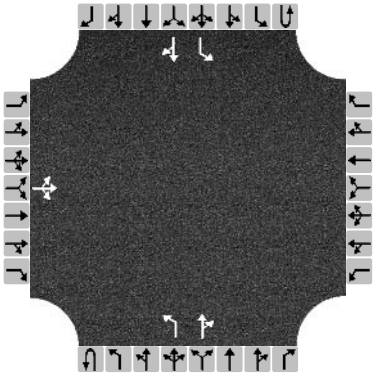
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/4/2017
Analysis Year	2020
Time Analyzed	Beall Options PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	Beall & N 15th EB Stop
Jurisdiction	City of Bozeman
East/West Street	Beall Street
North/South Street	N 15th Avenue
Peak Hour Factor	0.80
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	0	0	0	1	1	0	0	1	1	0
Configuration			LTR							L		TR		L		TR
Volume, V (veh/h)		27	30	75						77	240	92		87	230	60
Percent Heavy Vehicles (%)		0	0	0						0				0		
Proportion Time Blocked																
Percent Grade (%)		0														
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								1						

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2						4.1				4.1		
Critical Headway (sec)		6.40	6.50	6.20						4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3						2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30						2.20				2.20		

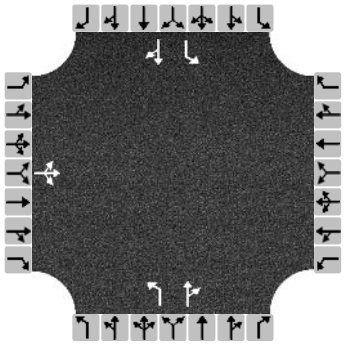
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			166							96				109		
Capacity, c (veh/h)			336							1170				1155		
v/c Ratio			0.49							0.08				0.09		
95% Queue Length, Q_{95} (veh)			2.6							0.3				0.3		
Control Delay (s/veh)			25.7							8.4				8.4		
Level of Service, LOS			D							A				A		
Approach Delay (s/veh)		25.7								1.6				1.9		
Approach LOS		D														

HCS 2010 All-Way Stop-Control Summary Report

General Information		Site Information	
Analyst	R Marvin	Intersection	Beall & N 15th Avenue
Agency/Co.	Marvin & Associates	Jurisdiction	City of Bozeman
Date Performed	2/6/2017	East/West Street	Beall Street
Analysis Year	2020	North/South Street	N 15th Avenue
Time Analyzed	0.25	Peak Hour Factor	0.80
Anaylysis Time Period (hrs)	Beall Options All-way PM		
Project Description	Existing Bozeman High School		

Lanes



Vehicle Volume and Adjustments

Approach	Eastbound			Westbound			Northbound			Southbound		
Movement	L	T	R	L	T	R	L	T	R	L	T	R
Volume	27	30	73				77	240	92	87	230	60
% Thrus in Shared Lane												
Lane	L1	L2	L3	L1	L2	L3	L1	L2	L3	L1	L2	L3
Configuration	LTR						L	TR		L	TR	
Flow Rate, v (veh/h)	163						96	415		109	363	
Percent Heavy Vehicles	0						0	0		0	0	

Departure Headway and Service Time

Initial Departure Headway, hd (s)	3.20						3.20	3.20		3.20	3.20	
Initial Degree of Utilization, x	0.144						0.086	0.369		0.097	0.322	
Final Departure Headway, hd (s)	4.58						5.92	5.22		5.95	5.30	
Final Degree of Utilization, x	0.207						0.158	0.602		0.180	0.534	
Move-Up Time, m (s)	2.0						2.3	2.3		2.3	2.3	
Service Time, ts (s)	2.58						3.62	2.92		3.65	3.00	

Capacity, Delay and Level of Service

Flow Rate, v (veh/h)	163						96	415		109	363	
Capacity	785						608	689		605	679	
95% Queue Length, Q_{95} (veh)	0.8						0.6	4.1		0.7	3.2	
Control Delay (s/veh)	8.8						9.7	15.5		10.0	13.9	
Level of Service, LOS	A						A	C		A	B	
Approach Delay (s/veh)	8.8						14.4			13.0		
Approach LOS	A						B			B		
Intersection Delay, s/veh | LOS	13.0						B					

HCS7 Two-Way Stop-Control Report

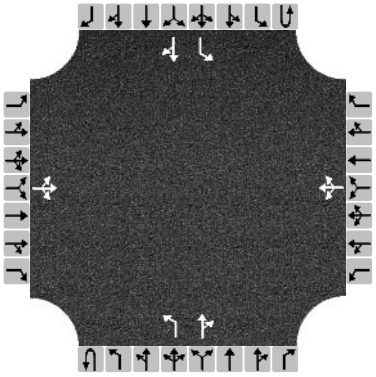
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/3/2017
Analysis Year	2020
Time Analyzed	Beall Options PM
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 15th South Access
Jurisdiction	City of Bozeman
East/West Street	South Access
North/South Street	N 15th Avenue
Peak Hour Factor	0.78
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	1	0		0	1	0	0	1	1	0	0	1	1	0
Configuration			LTR				LTR			L		TR		L		TR
Volume, V (veh/h)		1	0	0		103	0	64		1	262	4		2	309	1
Percent Heavy Vehicles (%)		0	0	0		0	0	0		0				0		
Proportion Time Blocked																
Percent Grade (%)		0				0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Left Only								1						

Critical and Follow-up Headways

Base Critical Headway (sec)		7.1	6.5	6.2		7.1	6.5	6.2		4.1				4.1		
Critical Headway (sec)		7.10	6.50	6.20		7.10	6.50	6.20		4.10				4.10		
Base Follow-Up Headway (sec)		3.5	4.0	3.3		3.5	4.0	3.3		2.2				2.2		
Follow-Up Headway (sec)		3.50	4.00	3.30		3.50	4.00	3.30		2.20				2.20		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			1				214			1				3		
Capacity, c (veh/h)			397				519			1173				1223		
v/c Ratio			0.00				0.41			0.00				0.00		
95% Queue Length, Q_{95} (veh)			0.0				2.0			0.0				0.0		
Control Delay (s/veh)			14.1				16.7			8.1				8.0		
Level of Service, LOS			B				C			A				A		
Approach Delay (s/veh)		14.1				16.7				0.0				0.1		
Approach LOS		B				C										

HCS7 Two-Way Stop-Control Report

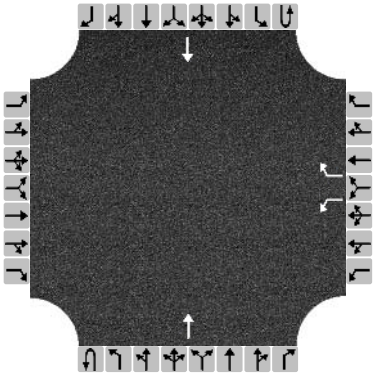
General Information

Analyst	R Marvin
Agency/Co.	Marvin & Associates
Date Performed	2/6/2017
Analysis Year	2035
Time Analyzed	Options B & C PM Hour
Intersection Orientation	North-South
Project Description	Existing Bozeman High School

Site Information

Intersection	N 11th Ave & Mendenhall
Jurisdiction	City of Bozeman
East/West Street	Mendenhall Street
North/South Street	N 11th Avenue
Peak Hour Factor	0.90
Analysis Time Period (hrs)	0.25

Lanes



Major Street: North-South

Vehicle Volumes and Adjustments

Approach	Eastbound				Westbound				Northbound				Southbound			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Priority		10	11	12		7	8	9	1U	1	2	3	4U	4	5	6
Number of Lanes		0	0	0		1	0	1	0	0	1	0	0	0	1	0
Configuration						L		R			T				T	
Volume, V (veh/h)						190		93			268				231	
Percent Heavy Vehicles (%)						0		3								
Proportion Time Blocked																
Percent Grade (%)						0										
Right Turn Channelized		No				No				No				No		
Median Type/Storage		Undivided														

Critical and Follow-up Headways

Base Critical Headway (sec)						7.1		6.2								
Critical Headway (sec)						6.40		6.23								
Base Follow-Up Headway (sec)						3.5		3.3								
Follow-Up Headway (sec)						3.50		3.33								

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)						211		103								
Capacity, c (veh/h)						454		714								
v/c Ratio						0.47		0.14								
95% Queue Length, Q_{95} (veh)						2.4		0.5								
Control Delay (s/veh)						19.6		10.9								
Level of Service, LOS						C		B								
Approach Delay (s/veh)						16.8										
Approach LOS						C										