

MCNETT FLATS SUBDIVISION

Major Subdivision Application

Section 9: Traffic Impact Study

<i>Revision</i>	<i>Date</i>
1 st Element Review Copy	August 25, 2020
1 st Sufficiency Review Copy	September 1, 2020
2 nd Sufficiency Review Copy	October 16, 2020
Governing Body Review	December 4, 2020



Mcnett Flats Subdivision Traffic Impact Study UPDATE

Missoula, Montana



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October, 2020

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Mcnett Flats Subdivision

Traffic Impact Study – 2020 Update

Missoula, Montana

A. EXECUTIVE SUMMARY

The Mcnett Flats Subdivision is a 20-acre mixed-use project proposed north of Mullan Road at the north end of George Elmer Drive in Missoula, Montana. Upon completion in 2022, the development may contain up to 660 living units if the maximum density permitted by the proposed zoning were realized, and could produce up to a maximum of 3,600 new daily vehicle trips in this area. As proposed, the Mcnett Flats Subdivision will increase traffic volumes on the surrounding road network and roadway improvements may be warranted with this project and the other planned developments in this area. The approval and design of a traffic signal for the intersection of George Elmer Drive and Mullan Road is currently underway to meet the current traffic demands for future traffic volume growth. The developers should contribute to the installation of a roundabout at the intersection of Cattle Drive and George Elmer Drive.

B. PROJECT DESCRIPTION

This document studies the possible effects on the surrounding road system from the proposed Mcnett Flats Subdivision located at the north end of George Elmer Drive in Missoula. The document provides information regarding possible traffic impacts in the area and identifies mitigation efforts that the development may require. The project could include up to 660 residential units at full development. The City of Missoula has requested an analysis of George Elmer Drive and Chuck Wagon Drive intersecting with Mullan Road to the south, plus the intersection of George Elmer Drive and Cattle Drive.

C. EXISTING CONDITIONS

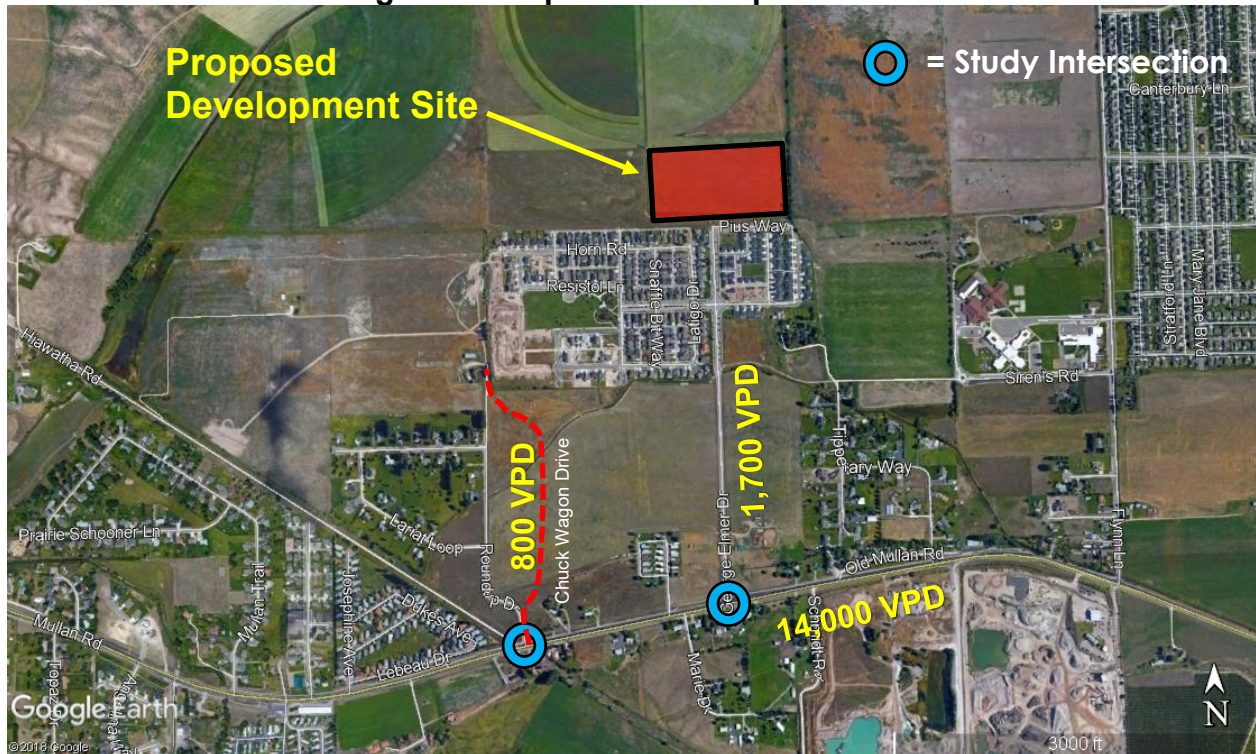
The Mcnett Flats Subdivision is proposed on a 20-acre parcel of land located at the northern end of George Elmer Drive. The site is located in a residential area north of Mullan Road. The 44 Ranch subdivision is located just south of the property and the Flynn Ranch subdivision is located to the east. See **Figure 1** for a location map of the proposed development.

Adjacent Roadways

Mullan Road (MT 263) is an east/west minor arterial route that extends through the western portion of Missoula. This section of the roadway has a two-lane cross-section with additional deceleration lanes at some intersections. The road has a rural cross-section with a paved width of 40 feet. The Mullan Road pedestrian trail is located to the north of the roadway and runs

from Mullan Trail to Flynn Lane. The posted speed limit is 45 MPH. According to traffic counts conducted by the Montana Department of Transportation (MDT) in 2019, the roadway currently carries 13,000 Vehicles per Day (VPD).

Figure 1- Proposed Development Site



George Elmer Drive is a north/south local route that extends north from Mullan Road. The road provides access to the 44 Ranch Subdivision and the Flynn Ranch Subdivision. The road has a paved width of 32 feet with bike lanes. At the intersection with Mullan Road, George Elmer Drive widens to include separated right and left-turn lanes for southbound traffic. The intersection also has a right-turn deceleration lane for westbound traffic on Mullan Road. The posted speed limit on George Elmer Drive is 45 MPH. Traffic data collected by Abelin Traffic Services (ATS) indicates that the road currently carries 1,700 VPD Vehicles per Day (VPD).

Chuck Wagon Drive is a newly constructed north/south route that provides access to the 44 Ranch Subdivision and 44 Ranch Estates Subdivision. Chuck Wagon Drive was constructed just to the east of Roundup Drive which is now closed except for its connection with Chuck Wagon Drive. Chuck Wagon Drive temporarily connects to Roundup Drive north of Mullan Road. Chuck Wagon Drive has a paved width of 36-feet with bike lanes and a posted speed limit of 30 MPH. Traffic data collected by ATS indicates that the road currently carries 800 VPD Vehicles per Day (VPD).

Traffic Data

In October 2019, ATS collected traffic data at area intersections to evaluate current operational characteristics. These counts included peak-hour turning movement counts and 24-hour volume counts along George Elmer Drive and Chuck Wagon Drive. The peak-hour turning movement counts were performed at the intersections of Mullan Road with George Elmer Drive and Chuck Wagon Drive. The raw traffic data is included in **Appendix A** of this report.

Traffic data was also collected at these intersections in the spring and summer of 2019 by WGM Group for the Heron's Landing project to the south. The original 2019 TIS prepared for the Mcnett Flats Subdivision (George Elmer Tollefson development) used the October 2019 ATS data. This report uses the WGM Group data for the traffic analysis in order to provide more continuity between the traffic analysis for the two projects.

Additional Projects

Construction of the 44 Ranch subdivision is currently underway just to the south of the proposed Remington Flats development. This subdivision currently has 200 homes occupied or platted with an additional 345 homes set to be platted and constructed over the next six years. The subdivision is also accessed from George Elmer Drive and Chuck Wagon Drive.

The Remington Flats Residential Development is currently proposed at the north end of George Elmer Drive and Chuck Wagon Drive. The project would include 152 single-family dwelling units constructed on 20 acres of land. The project would connect into the north side of the 44 Ranch Estates at Riata Road and Chuck Wagon Drive. The Remington Flats Residential Development would be developed in six phases over the next six years and would be expected to be completed in 2026.

The Heron's Landing development is also planned for construction north of Mullan Road between Chuck Wagon Drive and George Elmer drive. This development would include 289 single-family dwelling units and 58 multi-family units. This project is planned for completion in 2030.

The projected traffic from the above-mentioned developments was included in the future traffic projections for this analysis.

Historic Traffic Data

Abelin Traffic Services obtained historic traffic data for Mullan Road from MDT which is presented in **Table 1**. The traffic data history indicates that traffic volumes on this section of Mullan Road increased at an average rate of 1% annually over this time period.

Table 1 – Historic Average Daily Traffic Data

Location	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mullan Road E of Flynn #32-3A-313	12,050	12,000	12,280	12,090	12,160	12,320	12,923	14,432	13,941	12,946
Mullan Road W of Reserve #32-3A-134	19,980	19,410	17,410	16,450	19,600	20,490	17,178	21,963	19,577	19,694

Missoula Signal Warrant Study and LRTP

In June of 2019, WGM group produced a traffic signal warrant study for the intersection of George Elmer Drive and Mullan Road. The study indicated that a traffic signal will be immanently warranted at this location and that the city should begin the design and approval process for the installation of a traffic signal at this location.

The 2017 Missoula Long Range Transportation Plan includes recommendations for improvements to the roadways and pedestrian facilities on the road network within this area. The list of committed and recommended roadway improvement projects includes extending the Mullan Road Trail from Flynn Lane to Reserve Street (Project #475, estimated cost \$775,000). The plan also includes recommendation for the installation of the traffic signal at the intersection of George Elmer Drive and Mullan Road (Project #48, estimated cost \$450,000) on the list of committed and recommended safety projects.

Level of Service

Using the data collected for this project, ATS conducted a Level of Service (LOS) analysis at area intersections. This analysis was conducted in accordance with the procedures outlined in the Transportation Research Board's *Highway Capacity Manual (HCM) - Special Report 209* and the Highway Capacity Software (HCS) version 7.8. Intersections are given a LOS grade of A to F representing the average delay that a vehicle entering an intersection can expect. Typically, a LOS of C or better is considered acceptable for peak-hour conditions. The LOS values for unsignalized and signalized intersections is shown in **Tables 2 and 3**. Note that the LOS criteria for signalized and unsignalized intersections are different. Drivers will typically accept a higher level of total delay in exchange for the guarantee of service through a signalized intersection.

Table 2 - LOS Criteria for Stop-Controlled Intersections

LOS	Average Control Delay (Seconds/Vehicle)
A	0-10
B	>10-15
C	>15-25
D	>25-35
E	>35-50
F	>50

Transportation Research Board *Highway Capacity Manual*, Special Report #209

Table 3 - LOS Criteria for Signalized Intersections

LOS	Average Control Delay (Seconds/Vehicle)
A	0-10
B	>10-20
C	>20-35
D	>35-55
E	>55-80
F	>80

Transportation Research Board *Highway Capacity Manual*, Special Report #209

Table 4 shows the existing LOS for the AM, and PM peak hours without the traffic from the proposed development or any additional development. The LOS calculations are included in **Appendix C**. The table shows that the Chuck Wagon Drive intersection with Mullan Road and the intersection of George Elmer Drive and Cattle Drive are currently operating within acceptable limits, but the intersection of George Elmer Drive and Mullan Road is experiencing some operational deficiencies associated with vehicles turning left onto Mullan Road, particularly during the morning peak hour. This issue was identified in the 2017 Missoula Long Range Transportation Plan and a traffic signal was recommended to correct this issue. The June 2019 signal warrant study prepared for this intersection indicated that the signal is immanently warranted and recommended that the design and approval of this signal be initiated. This project is currently underway.

Table 4 – 2019 Level of Service Summary

Intersection	AM Peak Hour		PM Peak Hour	
	Delay (Sec.)	LOS	Delay (Sec.)	LOS
Mullan Road & Chuck Wagon Drive*	18.4	C	26.1	D
Mullan Road & George Elmer Drive*	27.4	D	35.4	E
George Elmer Drive & Cattle Drive*	8.8/10.0	A/B	8.7/11.5	A/B

*Northbound/Southbound or Eastbound/Westbound Side Street LOS and Delay.

D. PROPOSED DEVELOPMENT

The Mcnett Flats Subdivision is currently proposed at the north end of George Elmer Drive. The project may contain up to 660 living units on 20 acres of land if the maximum density permitted by the proposed zoning were realized. The project would connect into the north side of the 44 Ranch at George Elmer Drive and would connect to the Remington Flats Residential Development to the west. The project is expected to be completed in 2022. The proposed development site plan is shown in **Figure 2**.

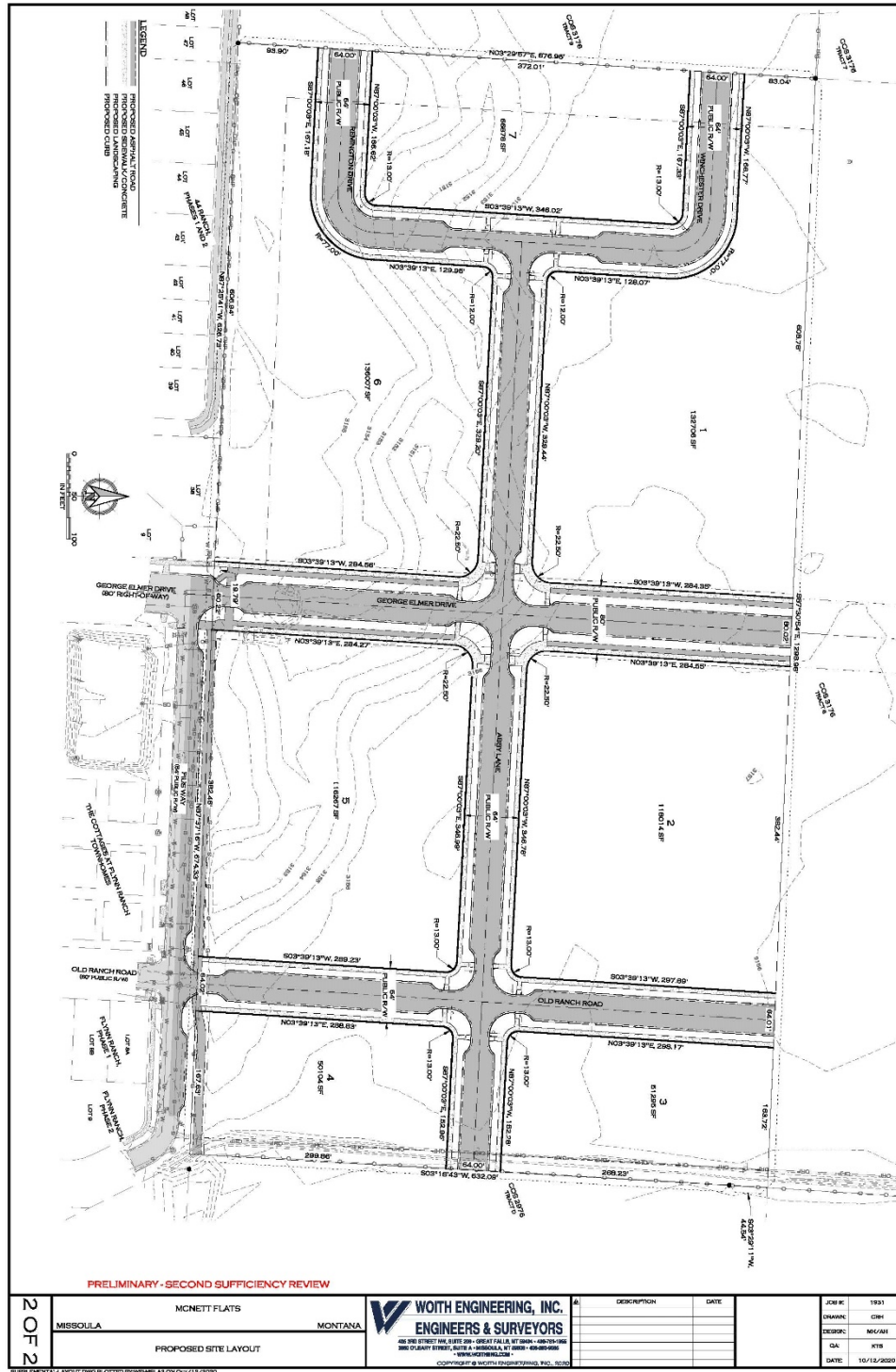
E. TRIP GENERATION AND ASSIGNMENT

ATS performed a trip generation analysis to determine the anticipated future traffic volumes from the proposed development using the trip generation rates contained in *Trip Generation* (Institute of Transportation Engineers, Tenth Edition). These rates are the national standard and are based on the most current information available to planners. A vehicle “trip” is defined as any trip that either begins or ends at the development site. ATS determined that the critical traffic impacts on the intersections and roadways would occur during the weekday morning and evening peak hours. According to the ITE trip generation rates, at full build-out the Mcnett Flats Subdivision could produce up to 238 AM peak hour trips, 290 PM peak hour trips, and 3,590 daily trips. See **Table 5** for detailed trip generation information

Table 5 - Trip Generation Rates Mcnett Flats Subdivision

Land Use	Units	AM Peak Hour Trip Ends per Unit	Total AM Peak Hour Trip Ends	PM Peak Hour Trip Ends per Unit	Total PM Peak Hour Trip Ends	Weekday Trip Ends per Unit	Total Weekday Trip Ends
Apartment #221	660	0.36	238	0.44	290	5.44	3,590

Figure 2- Proposed Development



The additional developments planned for this area will contribute almost 8,000 new vehicle trips when the projects are completed in 2030. The anticipated trip generation from these developments is shown in **Table 6**. The traffic from these projects was included in the future growth projections for this analysis.

Table 6 - Trip Generation Additional Developments

Land Use	Units	Total AM Peak Hour Trip Ends	Total PM Peak Hour Trip Ends	Total Weekday Trip Ends
Remington Flats	152	112	150	1,435
44 Ranch Estates	345	255	342	3,257
Heron's Landing	347	241	318	3,153
TOTAL	844	608	810	7,845

The proposed zoning for the Mcnett Flats subdivision is B2-2, which allows for a variety of residential and mixed-use land uses within the subdivision. The proposed B2-2 zoning allows for flexibility in future land uses depending on market needs. The City of Missoula requested an analysis of the potential impacts to the trip generation for the development if a portion of the development was constructed as a mixed-use development according to the B2-2 allowed uses. Without looking at specific potential land uses for each lot, segments of the property can be analyzed using mixed use office park (land use code #750) or business park (land use code #760). These two commercial land uses generate trips at a rate of 149 to 195 daily trips per acre. If half or all of the 20-acre site was developed using these land uses and the number of residential units was decreased accordingly, the total daily trip generation from the development would be in the range of 3,000 to 4,000 vehicle trips per day. This is similar to the projected trip generation of the proposed subdivision.

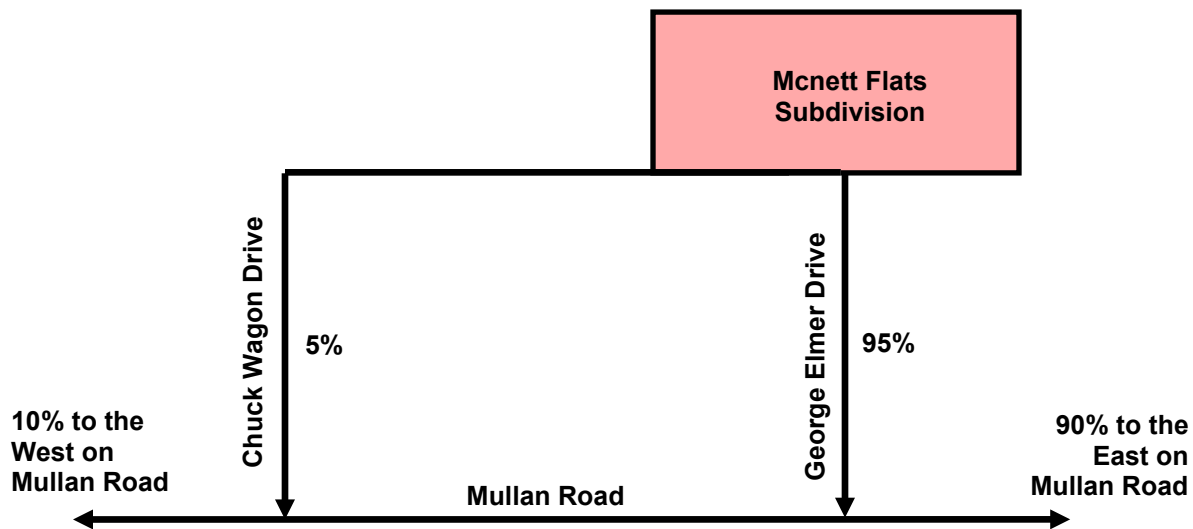
If the project was developed with a portion mixed-use commercial, the daily vehicle flow patterns would change significantly. Currently this entire area is comprised mainly of residential land uses which creates heavy vehicle flows to the east into Missoula in the morning and back home in the evening. A typical mixed-use business park on the site may produce as many or slightly more vehicle trips than the proposed residential land uses, but the vehicle flow would generally be in the opposite direction of the existing residential traffic flows. Overall, traffic operations in this area would be improved with the inclusion of mixed-uses on the site by decreasing traffic from the heavy residential flow directions and taking advantage of the relatively low flow of traffic entering

the area in the morning and leaving the area in the afternoon. More mixed land-uses would also provide a greater opportunity for traffic to be captured within the development area by providing nearby employment and retail/service opportunities for all of the residential developments within the area. While it is possible that including a greater mix of land uses within the development could increase the overall vehicle trip generation for the site, the overall traffic impacts created by mixed-uses within the development would be less than the projected impacts for residential land uses only. In this case, analyzing the development as residential only, assuming the maximum density permitted by the requested B2-2 zoning, provides a review of the highest potential overall traffic impacts from the site.

F. TRIP DISTRIBUTION

The traffic distribution and assignment for the proposed development was based upon the existing ADT volumes along the adjacent roadways and the peak-hour turning volumes. Due to the project's location, most of the traffic would use George Elmer Drive to connect with Mullan Road to the south. A smaller portion of traffic would likely use Chuck Wagon Drive to reach Mullan Road heading to the west. The estimated split in traffic between George Elmer Drive and Chuck Wagon Drive is 95% vs. 5%. Traffic is expected to distribute onto the surrounding road network as shown on **Figure 3**. See the model in **Appendix B** for detailed trip distribution information.

Figure 3 – Trip Distribution



G. TRAFFIC IMPACTS OUTSIDE OF THE DEVELOPMENT

Using the trip generation and trip distribution numbers, ATS determined the future Level of Service for the area intersections with and without the Mcnett Flats Subdivision. The projected no-build traffic conditions for 2025 and the anticipated intersection LOS with the Mcnett Flats

Subdivision are shown in **Tables 7 & 8**. The traffic volume calculations are included in **Appendix B** of this report and include a 6% background traffic volume growth rate to forecast regional traffic volume growth trends through full buildout in 2025. The projections also include traffic from the 345 additional residential planned for construction in the 44 Ranch subdivision, the planned 152 residential units from the proposed Remington Flats Residential Development, and 347 units from the Heron's Landing Subdivision. The projected LOS for the study intersections without the Mcnett Flats Subdivision are shown in **Table 7** and the LOS with the proposed development are shown in **Table 8**.

Table 7 – Projected No-Build Level of Service

Intersection	AM Peak Hour		PM Peak Hour	
	Delay (Sec.)	LOS	Delay (Sec.)	LOS
Mullan Road & Chuck Wagon Drive*	38.9	E	91	F
Mullan Road & George Elmer Drive**	12.9	B	11.8	B
George Elmer Drive & Cattle Drive (Stop Control)	9.9/15.5	A/C	9.4/28.0	A/D

*Northbound/Southbound Side Street LOS and Delay.

**LOS with traffic signal.

Table 7 indicates that the planned traffic signal at the intersection of Mullan Road and George Elmer Drive will largely correct the delay at this location. The traffic signal at George Elmer Drive will provide safe and efficient access onto to Mullan Road from the residential developments in this area and will allow the traffic signal to operate at LOS B past 2026. As development pressure increases in this area, the traffic signal will likely draw traffic from Chuck Wagon Drive onto George Elmer Drive to access the traffic signal. Traffic at the Chuck Wagon Drive intersection will increase to capacity and the remaining demand will shift to the traffic signal at George Elmer Drive. Based on the location of these two intersections (1,700-foot separation) it is unlikely that MDT would approve an additional traffic signal at Chuck Wagon Drive given the current roadway characteristics and short intersection separation. However, the traffic signal will also create significant gaps in the westbound traffic stream on Mullan Road which will facilitate improved access onto the roadway from Chuck Wagon Drive.

By 2026, traffic volumes on Chuck Wagon Drive will be approximately 2,200 VPD and traffic on George Elmer Drive will be approximately 8,500 VPD. **Table 8** shows the projected LOS at the study intersections with the recommended improvements to the road network. With the projected traffic from the Mcnett Flats Subdivision, the intersection of George Elmer Drive and Cattle Drive will likely require additional traffic controls to function properly through full build-out of the projects in this area. This intersection should be reconfigured as a roundabout before full-buildout of the project.

The table shows that the George Elmer Drive intersection with Mullan Road will continue to function at LOS B with the Mcnett Flats Subdivision and the other projects in this area. The total vehicle delay at the signal will increase by 3-8 seconds per vehicle with the apartment project and will have additional capacity to serve vehicles from Chuck Wagon Drive as needed. In total, the Mcnett Flats Subdivision will account for 11.1% of traffic at the new traffic signal on Mullan Road, 32.7% of traffic at the proposed roundabout at Cattle Drive, and 1.1% of traffic at the Chuck Wagon Drive intersection.

Table 8 – Projected Level of Service with Developments

Intersection	AM Peak Hour		PM Peak Hour	
	Delay (Sec.)	LOS	Delay (Sec.)	LOS
Mullan Road & Chuck Wagon Drive*	42.7	E	110	F
Mullan Road & George Elmer Drive**	19.2	B	14.5	B
George Elmer Drive & Cattle Drive (Stop Control)	12.1/22.9	B/C	10.6/43.0	B/E
George Elmer Drive & Cattle Drive (Roundabout)	5.1	A	6.3	A

*Northbound/Southbound Side Street LOS and Delay.

**LOS with traffic signal.

ATS also reviewed the left- and right-turn lane warrants for the intersections of Chuck Wagon Drive and George Elmer Drive based on the recommended practices from the MDT Road Design Manual with the additional traffic from the Mcnett Flats Subdivision, Remington Flats subdivision, the 44 Ranch subdivision, and the Heron's Landing subdivision. This analysis showed that there may be sufficient traffic to warrant a right-turn lane at Chuck Wagon Drive. The lane will likely be warranted by Phase II of the Remington Flats subdivision, but will be dependent on the construction rate for both the Remington Flats subdivision and the 44 Ranch development. The Mcnett Flats Subdivision will not contribute to the need for a right-turn lane at Chuck Wagon Drive as very little traffic from the development would benefit from using this turn lane. The intersection of George Elmer Drive already has a westbound right-turn lane which will likely be integrated into the traffic signal at this location. An eastbound left-turn lane will also be included with the traffic signal installation. The turn-lane warrant calculations are included in **Appendix D** of this report.

The total traffic generation from the Mcnett Flats subdivision will be in the range of 3,600 to 4,000 vehicle trips per day. According to the City of Missoula Subdivision Regulations Article 3-020 Table .2A, urban roadways with projected traffic volumes up to 2,500 VPD may be constructed as local street. Streets with up to 7,500 VPD may be considered urban collector roadways and should be constructed to an urban collector standard. Based on the layout of the development site, traffic from the various sections of the development will generally flow towards the middle of the project

along Abby Lane and Pius Way and then flow to the south along George Elmer Drive. Traffic on these road segments will generally be in the range of 500 to 2,000 VPD as shown in **Table 9**. It is possible that traffic volumes on George Elmer Drive may exceed 2,500 south of Abby Lane depending on how much traffic flows through the Mcnett Flats Development from the Remington Flats development to the west, but total traffic volumes will not exceed 7,500 trips per day on any road within the development. As such, George Elmer Drive south of Abby Lane should be constructed to an urban collector standard per the City of Missoula Subdivision regulations.

Table 9 – Projected Average Daily Traffic Within Mcnett Flats

Road Segment	Projected Daily Traffic
Winchester Drive	600 VPD
Remington Drive	600 VPD
Abby Lane West	2,000 VPD
Abby Lane East	1,000 VPD
Pius Way	600 VPD
George Elmer Drive	3,000 VPD
Old Ranch Road	400 VPD

Multi-Modal Consideration

The Mullan Road pedestrian trail is located to the north of Mullan Road and runs from Mullan Trail to Flynn Lane. This trail will likely be connected through to Reserve Street in the future (City of Missoula Project #475, estimated cost \$775,000). Once the developments to the south of 44 Ranch Estates subdivision and Heron's Landing Subdivision are completed, pedestrians will have access to the Mullan Road pedestrian trail using the internal sidewalk networks. All developers in this area are encouraged to provide sidewalk and trail connections, where possible, to encourage bicycle and pedestrian activity and decrease dependence on vehicles. Trail and sidewalk connections to the east towards Hellgate Elementary School are also encouraged. At this time there are no specific opportunities for the developers of the Mcnett Flats Subdivision to provide additional trails within the project boundary beyond the planned sidewalk network included with the current development plans.

The Missoula Mountain Line Bus does not currently provide any routes along Mullan Road to the west of Reserve Street. As residential areas in the portion of Missoula continue to develop, it is encouraged that bus routes to serve this portion of Missoula be created. Providing space for a future bus pull-out near the George Elmer Mullan Road intersection should be a part of future development plans in this area.

H. IMPACT SUMMARY & RECOMMENDATIONS

As proposed, the Mcnett Flats Subdivision development will increase traffic volumes on the surrounding road network and roadway improvements may be warranted with this project and the other planned developments in this area. The approval and design of a traffic signal for the intersection of George Elmer Drive and Mullan Road is underway to meet the current traffic demands for future traffic volume growth. The developers should contribute to the installation of a roundabout at the intersection of Cattle Drive and George Elmer Drive.

APPENDIX A

Traffic Data

Abelin Traffic Services

130 S. Howie Street
Helena, MT 59601

File Name : GeorgeEtmc
Site Code : 00000000
Start Date : 10/23/2019
Page No : 1

Groups Printed- Class 1 - New Group

	George E Southbound					Mullan Westbound					George E Northbound					Mullan Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
*** BREAK ***																					
07:30 AM	2	0	31	0	33	4	31	0	0	35	0	0	0	0	0	0	265	1	0	266	334
07:45 AM	2	0	28	0	30	6	66	0	0	72	0	0	0	0	0	0	211	1	0	212	314
Total	4	0	59	0	63	10	97	0	0	107	0	0	0	0	0	0	476	2	0	478	648
08:00 AM	2	0	25	1	28	9	65	0	0	74	0	0	0	0	0	0	171	1	0	172	274
08:15 AM	2	0	20	1	23	11	85	0	0	96	0	0	0	0	0	0	125	4	0	129	248
*** BREAK ***																					
Total	4	0	45	2	51	20	150	0	0	170	0	0	0	0	0	0	296	5	0	301	522
*** BREAK ***																					
04:30 PM	0	0	12	0	12	20	175	0	0	195	0	0	0	0	0	0	104	2	0	106	313
04:45 PM	2	0	9	0	11	21	187	0	0	208	0	0	0	0	0	0	115	0	0	115	334
Total	2	0	21	0	23	41	362	0	0	403	0	0	0	0	0	0	219	2	0	221	647
05:00 PM	1	0	9	1	11	25	187	0	0	212	0	0	0	0	0	0	127	4	0	131	354
05:15 PM	2	0	12	0	14	36	212	0	0	248	0	0	0	0	0	0	121	0	0	121	383
*** BREAK ***																					
Total	3	0	21	1	25	61	399	0	0	460	0	0	0	0	0	0	248	4	0	252	737
Grand Total	13	0	146	3	162	132	1008	0	0	1140	0	0	0	0	0	0	1239	13	0	1252	2554
Apprch %	8	0	90.1	1.9		11.6	88.4	0	0		0	0	0	0		0	99	1	0		
Total %	0.5	0	5.7	0.1	6.3	5.2	39.5	0	0	44.6	0	0	0	0	0	0	48.5	0.5	0	49	
Class 1	12	0	144	3	159	129	999	0	0	1128	0	0	0	0	0	0	1227				
% Class 1	92.3	0	98.6	100	98.1	97.7	99.1	0	0	98.9	0	0	0	0	0	0	99	92.3	0	99	98.9
New Group																					
% New Group	7.7	0	1.4	0	1.9	2.3	0.9	0	0	1.1	0	0	0	0	0	0	1	7.7	0	1	1.1

Abelin Traffic Services

130 S. Howie Street
Helena, MT 59601

File Name : Chucktmc
Site Code : 00000000
Start Date : 10/23/2019
Page No : 1

Groups Printed- Class 1

	Chuck Wagon Southbound					Mullan Westbound					Chuck Wagon Northbound					Mullan Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:30 AM	1	0	16	0	17	0	30	0	0	30	0	0	0	0	0	0	263	0	0	263	310
07:45 AM	3	0	12	0	15	4	62	0	0	66	0	0	0	0	0	0	207	1	0	208	289
Total	4	0	28	0	32	4	92	0	0	96	0	0	0	0	0	0	470	1	0	471	599
08:00 AM	1	0	7	0	8	4	61	0	0	65	0	0	0	0	0	0	168	1	0	169	242
08:15 AM	2	0	8	0	10	6	80	0	0	86	0	0	0	0	0	0	126	2	0	128	224
*** BREAK ***																					
Total	3	0	15	0	18	10	141	0	0	151	0	0	0	0	0	0	294	3	0	297	466
*** BREAK ***																					
04:45 PM	1	0	5	0	6	13	161	0	0	174	0	0	0	0	0	0	105	0	0	105	285
Total	1	0	5	0	6	13	161	0	0	174	0	0	0	0	0	0	105	0	0	105	285
05:00 PM	3	0	8	0	11	3	186	0	0	189	0	0	0	0	0	0	113	1	0	114	314
05:15 PM	4	0	5	0	9	4	183	0	0	187	0	0	0	0	0	0	129	2	0	131	327
05:30 PM	3	0	9	0	12	4	210	0	0	214	0	0	0	0	0	0	120	1	0	121	347
Grand Total	18	0	70	0	88	38	973	0	0	1011	0	0	0	0	0	0	1231	8	0	1239	2338
Apprch %	20.5	0	79.5	0		3.8	96.2	0	0		0	0	0	0		0	99.4	0.6	0		
Total %	0.8	0	3	0	3.8	1.6	41.6	0	0	43.2	0	0	0	0		0	52.7	0.3	0	53	

Basic Volume Report: ROUNDUP

Station ID : ROUNDUP

Info Line 1 : ATS
Info Line 2 : Unicorn #6

GPS Lat/Lon :
DB File : ROUNDUP.DB

Last Connected Device Type : Unic-L

Version Number : 1.50

Serial Number :

Number of Lanes : 1

Posted Speed Limit : 0.0 mph

Lane #1 Configuration

#	Dir.	Information	Volume Mode	Volume Sensors	Divide By 2	Comment
1.	NB		Normal	Axle	Yes	

Lane #1 Basic Volume Data From: 16:00 - 10/23/2019 To: 16:59 - 10/24/2019

Date	DW	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
102319	W																	66	75	33	25	14	10	6	0	229
102419	T	0	0	1	1	0	5	13	58	72	62	53	57	67	59	51	55									554
Month Total :		0	0	1	1	0	5	13	58	72	62	53	57	67	59	51	55	66	75	33	25	14	10	6	0	783
Percent :		0%	0%	0%	0%	0%	1%	2%	7%	9%	8%	7%	7%	9%	8%	7%	7%	8%	10%	4%	3%	2%	1%	1%	0%	
ADT :		0	0	1	1	0	5	13	58	72	62	53	57	67	59	51	55	66	75	33	25	14	10	6	0	783

	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Total	Percent
DW Totals :	0	0	0	229	554	0	0	783	100%
# Days :	0.0	0.0	0.0	0.3	0.7	0.0	0.0	783	
ADT :	0	0	0	687	831	0	0	783	
Percent :	0%	0%	0%	29%	71%	0%	0%	0	0%
Weekday (Mon-Fri) :								783	100%
ADT :								783	
Weekend (Sat-Sun) :								0	0%
ADT :								0	

Basic Volume Report: GEORGE

Station ID : GEORGE

Info Line 1 : ATS

Info Line 2 : UNICORN 5

GPS Lat/Lon :

DB File : GEORGE.DB

Last Connected Device Type : Unic-L

Version Number : 1.50

Serial Number :

Number of Lanes : 1

Posted Speed Limit : 0.0 mph

Lane #1 Configuration

#	Dir.	Information	Volume Mode	Volume Sensors	Divide By 2	Comment
1.	NB		Normal	Axle	Yes	

Lane #1 Basic Volume Data From: 16:00 - 10/23/2019 To: 16:59 - 10/24/2019

Date	DW	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	Total
102319	W																	121	173	147	101	70	36	19	9	676
102419	T	1	2	1	1	12	12	79	130	139	88	74	118	99	90	83	117									1046
Month Total :		1	2	1	1	12	12	79	130	139	88	74	118	99	90	83	117	121	173	147	101	70	36	19	9	1722
Percent :		0%	0%	0%	0%	1%	1%	5%	8%	8%	5%	4%	7%	6%	5%	5%	7%	7%	10%	9%	6%	4%	2%	1%	1%	
ADT :		1	2	1	1	12	12	79	130	139	88	74	118	99	90	83	117	121	173	147	101	70	36	19	9	1722

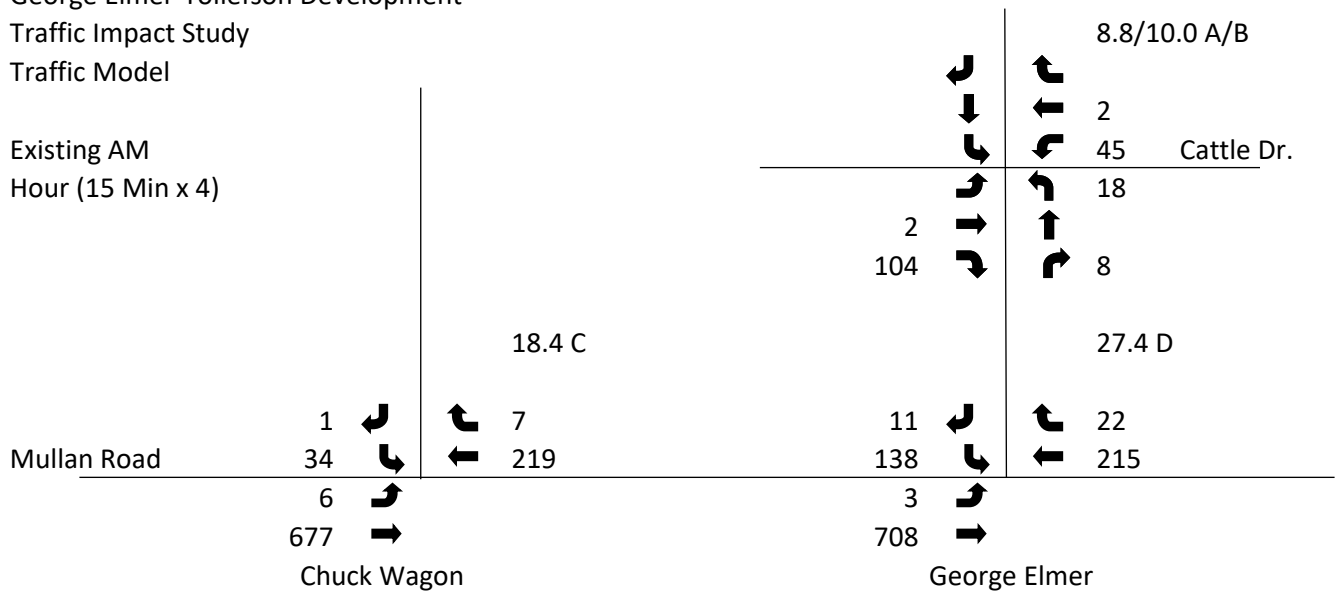
	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Total	Percent
DW Totals :	0	0	0	676	1046	0	0	Weekday (Mon-Fri) :	1722 100%
# Days :	0.0	0.0	0.0	0.3	0.7	0.0	0.0	ADT :	1722
ADT :	0	0	0	2028	1569	0	0	Weekend (Sat-Sun) :	0 0%
Percent :	0%	0%	0%	39%	61%	0%	0%	ADT :	0

APPENDIX B

Traffic Model

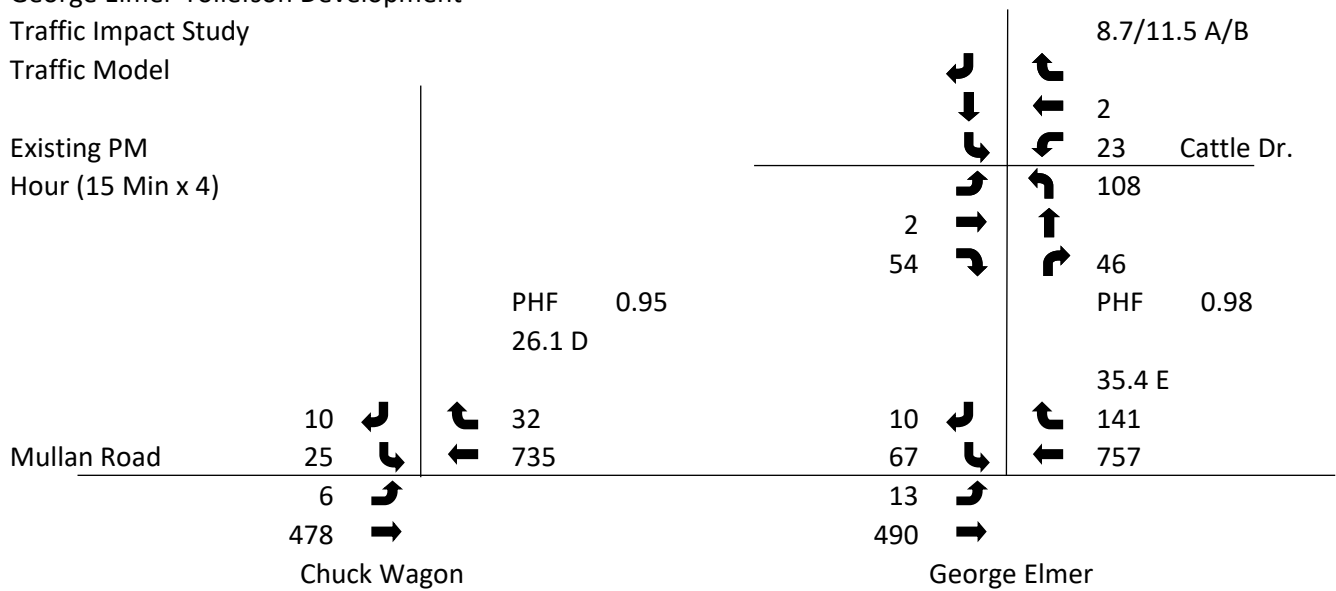
George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

Existing AM
Hour (15 Min x 4)



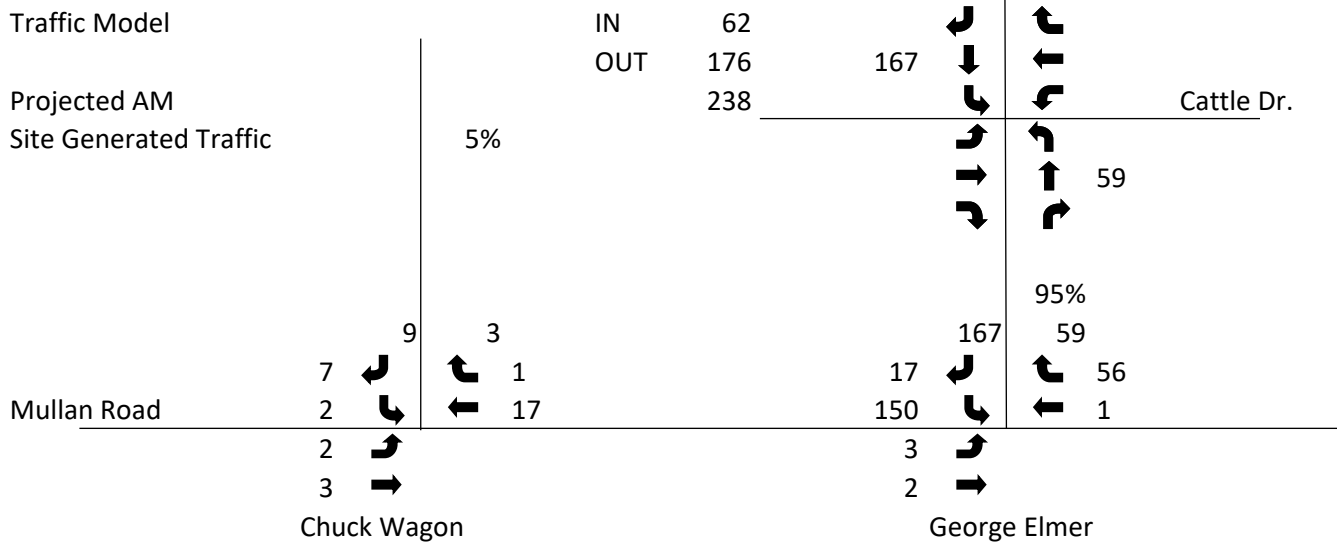
George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

Existing PM
Hour (15 Min x 4)



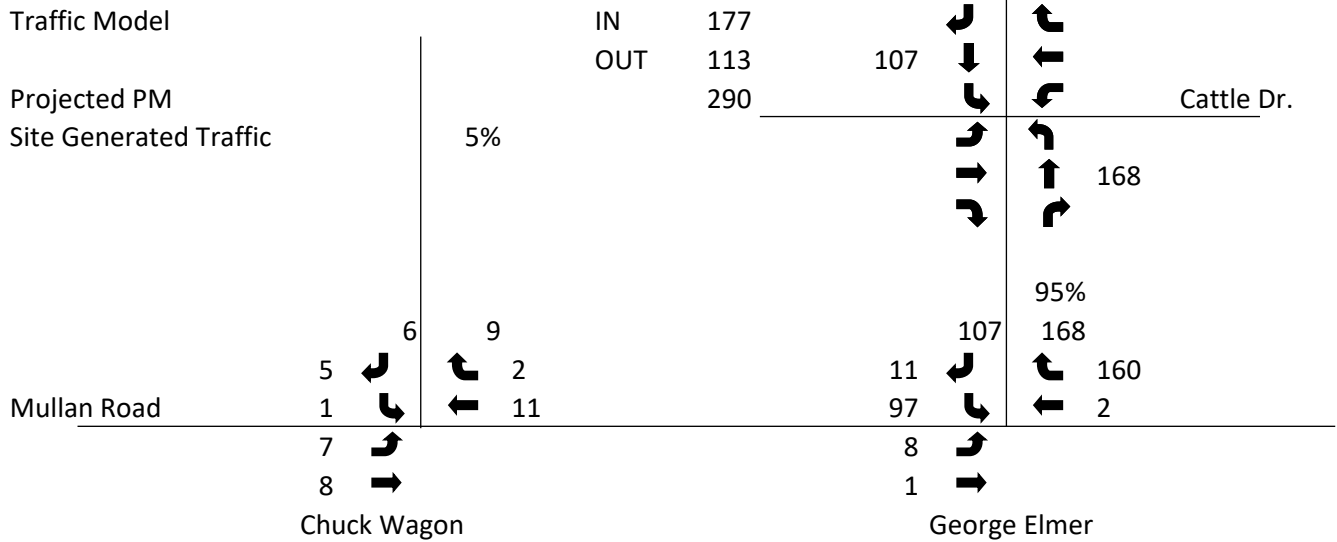
George Elmer-Tollefson Development
 Traffic Impact Study
 Traffic Model

Projected AM
 Site Generated Traffic



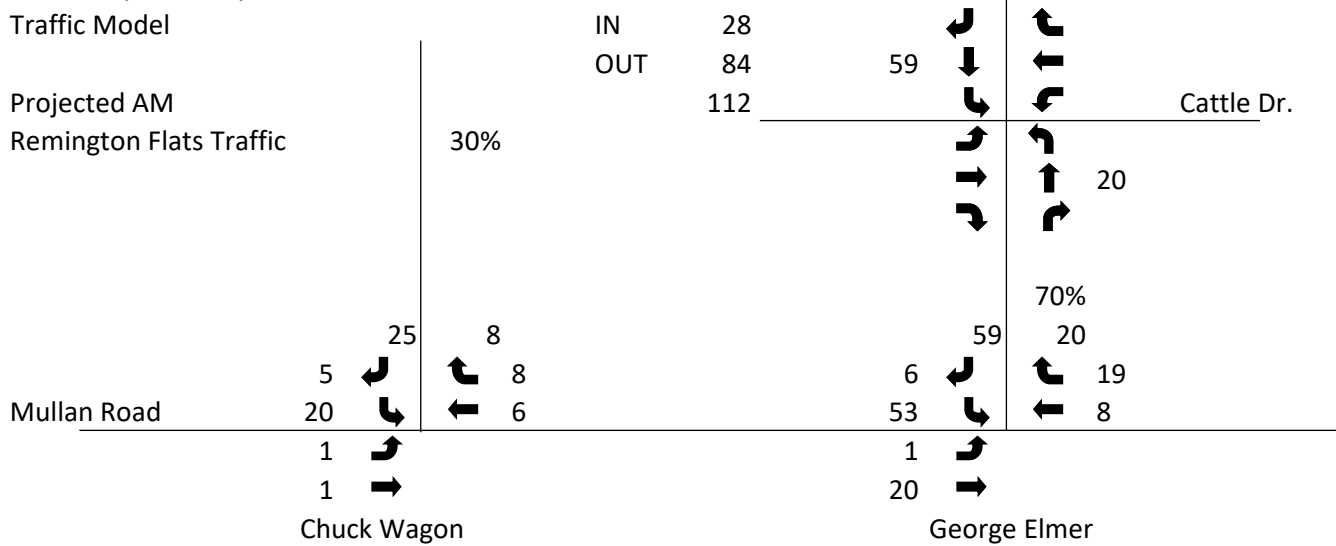
George Elmer-Tollefson Development
 Traffic Impact Study
 Traffic Model

Projected PM
 Site Generated Traffic



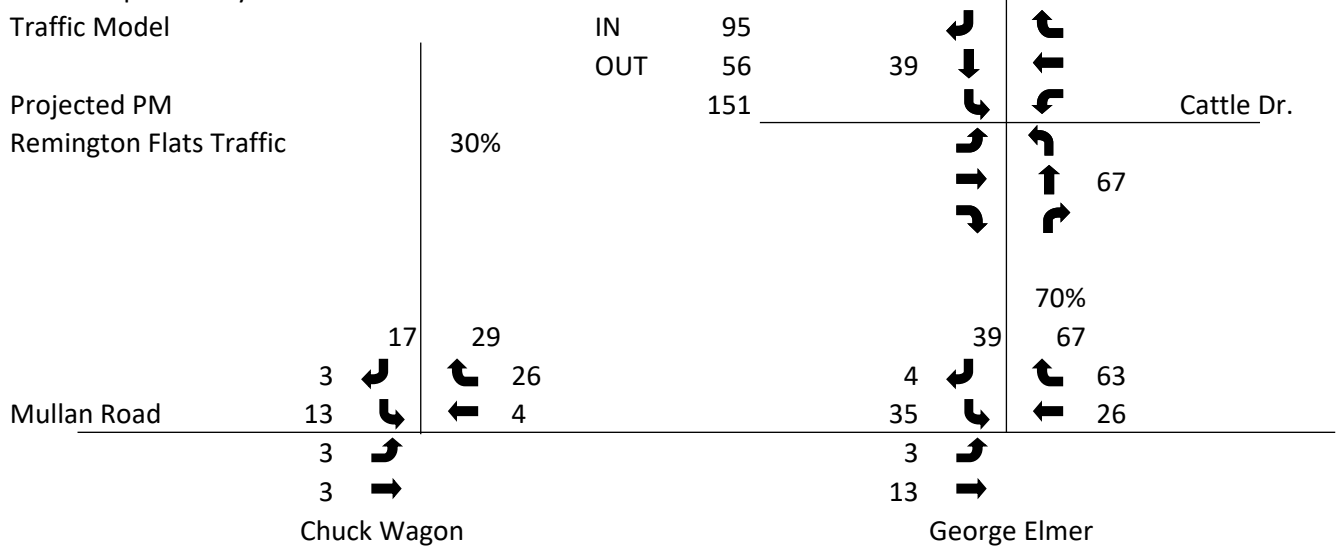
George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

Projected AM
Remington Flats Traffic



George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

Projected PM
Remington Flats Traffic

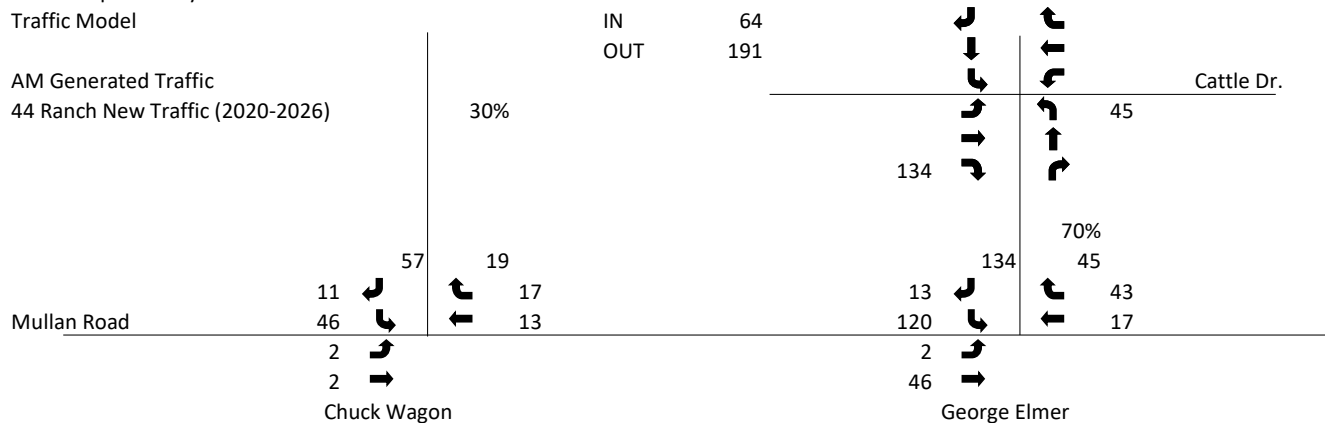


Remington Flats

Land Use	Units	AM Trip Ends per Unit	AM Trip Ends	% Entering	% Exiting	PM Trip Ends per Unit	PM Trip Ends	% Entering	% Exiting	Trip Ends per Unit	Week day Trip Ends
Single	152	0.74	112	25%	75%	0.99	150	63%	37%	9.44	1,435

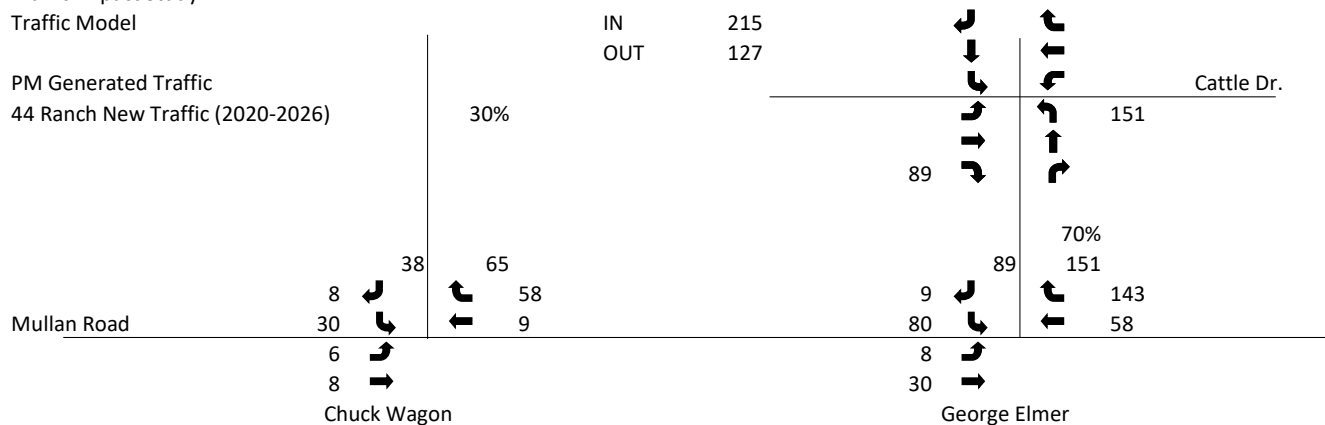
George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

AM Generated Traffic
44 Ranch New Traffic (2020-2026)



George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

PM Generated Traffic
44 Ranch New Traffic (2020-2026)

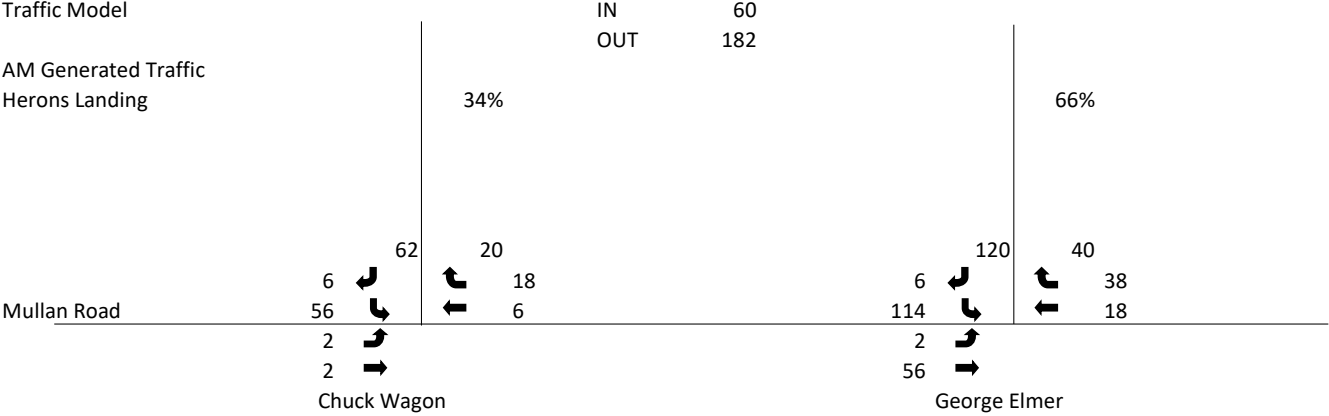


44 Ranch

Land Use	Units	AM Trip Ends per Unit	AM Trip Ends	% Entering	% Exiting	IN	OUT	PM Trip Ends per Unit	PM Trip Ends	% Entering	% Exiting	IN	OUT	Trip Ends per Unit	Weekday Trip Ends
Single Family	345	0.74	255	25%	64	75%	191	0.99	342	63%	215	37%	127	9.44	3,257

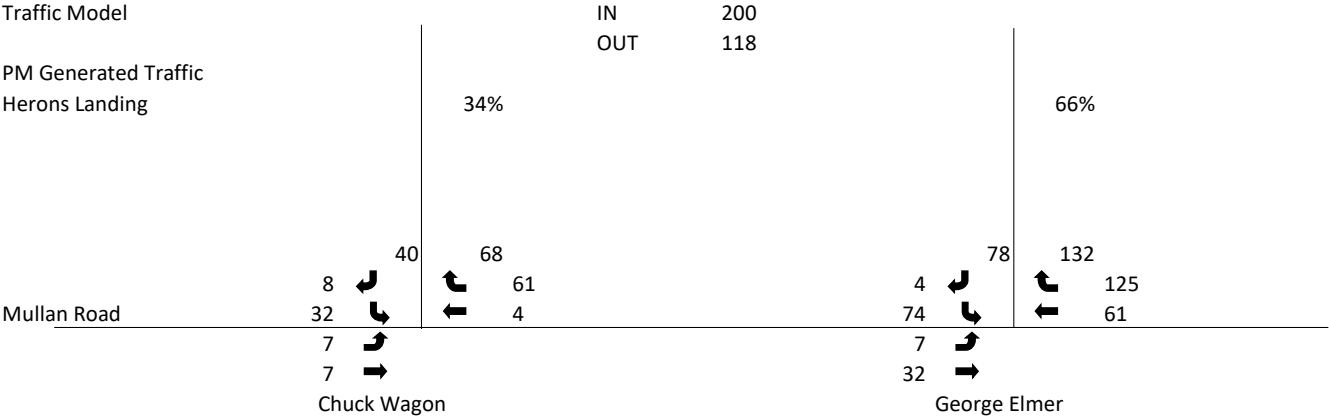
George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

AM Generated Traffic
Herons Landing



George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

PM Generated Traffic
Herons Landing



Herons Landing

Land Use	Units	AM Trip Ends per Unit	AM Trip Ends	% Entering	% Exiting	PM Trip Ends per Unit	PM Trip Ends	% Entering	% Exiting	Trip Ends per Unit	Weekday Trip Ends
Single Family	289	0.74	214	25%	54	0.99	286	63%	180	9.44	2,728
Multi-Family	58	0.46	27	23%	6	0.56	32	63%	20	7.32	425
	347		241		60		318		200		3153

George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

Growth Factor

1.06

9.9/15.5 A/C

No-Build Traffic Volumes
AM Peak Hour
2025

			38.9 E
	24	↶	51
Mullan Road	158	↷	257
	11	↷	
	723	→	
			Chuck Wagon

0	↶	0
0	↷	2
0	↷	47
0	↷	83
2	→	0
303	↷	8

Cattle Dr.

		12.9 B
37	↶	122
434	↷	271
8	↷	
872	→	
		George Elmer

George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

9.4/28.0 A/D

No-Build Traffic Volumes
PM Peak Hour
2025

			91 F
	30	↶	179
Mullan Road	103	↷	796
	22	↷	
	524	→	
			Chuck Wagon

0	↶	0
0	↷	2
0	↷	24
0	↷	332
2	→	0
185	↷	49

Cattle Dr.

		11.8 B
27	↶	481
260	↷	947
31	↷	
595	→	
		George Elmer

George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

Growth Factor

1.06

5.1 A Roundal
12.1/22.9 B/C

Total Projected Traffic
AM Peak Hour
2025

			42.7 E
	31	↶	↷ 51
Mullan Road	159	↷	↶ 274
	14	↶	
	726	↷	
			Chuck Wagon

0	↶	↷ 0
226	↷	↶ 2
0	↶	↷ 47
0	↷	↶ 63
2	↶	↷ 79
244	↷	↶ 8
472		199
		19.2 B
54	↶	↷ 178
584	↷	↶ 272
11	↶	
874	↷	
		George Elmer

George Elmer-Tollefson Development
Traffic Impact Study
Traffic Model

6.3 A Roundal
10.6/43.0 B/E

Total Projected Traffic
PM Peak Hour
2025

			110 F
	34	↶	↷ 181
Mullan Road	104	↷	↶ 807
	30	↶	
	533	↷	
			Chuck Wagon

0	↶	↷ 0
147	↷	↶ 2
0	↶	↷ 24
0	↷	↶ 265
2	↶	↷ 235
146	↷	↶ 49
295		575
		14.5 B
38	↶	↷ 641
357	↷	↶ 949
40	↶	
597	↷	
		George Elmer

APPENDIX C

LOS Calculations

HCS7 Two-Way Stop-Control Report

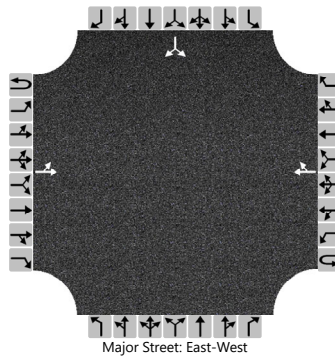
General Information

Analyst	RLA
Agency/Co.	ATS
Date Performed	11/7/2019
Analysis Year	2019
Time Analyzed	AM Peak Hour
Intersection Orientation	East-West
Project Description	George Elmer-Tollefson

Site Information

Intersection	Chuck Wagon & Mullan
Jurisdiction	City of Missoula
East/West Street	Mullan Road
North/South Street	Chuck Wagon Drive
Peak Hour Factor	0.98
Analysis Time Period (hrs)	0.25

Lanes



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	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		6	667				219	7						34		1
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized																
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

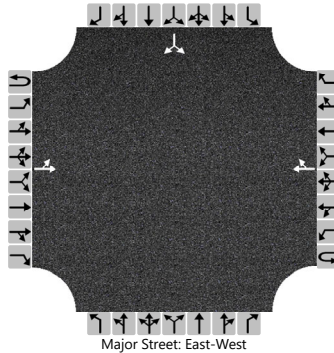
Flow Rate, v (veh/h)		6													36	
Capacity, c (veh/h)		1337													304	
v/c Ratio		0.00													0.12	
95% Queue Length, Q ₉₅ (veh)		0.0													0.4	
Control Delay (s/veh)		7.7													18.4	
Level of Service (LOS)		A													C	
Approach Delay (s/veh)	0.1												18.4			
Approach LOS													C			

HCS7 Two-Way Stop-Control Report

General Information

Analyst	RLA	Intersection	Chuck Wagon & Mullan
Agency/Co.	ATS	Jurisdiction	City of Missoula
Date Performed	11/7/2019	East/West Street	Mullan Road
Analysis Year	2019	North/South Street	Chuck Wagon Drive
Time Analyzed	PM Peak Hour	Peak Hour Factor	0.95
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	George Elmer-Tollefson		

Lanes



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	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		6	478				735	32						25		10
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized																
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		6													37	
Capacity, c (veh/h)		818													207	
v/c Ratio		0.01													0.18	
95% Queue Length, Q ₉₅ (veh)		0.0													0.6	
Control Delay (s/veh)		9.4													26.1	
Level of Service (LOS)		A													D	
Approach Delay (s/veh)	0.2												26.1			
Approach LOS													D			

HCS7 Two-Way Stop-Control Report

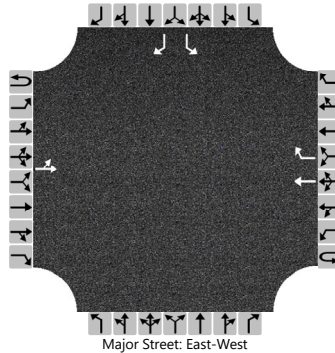
General Information

Analyst	RLA
Agency/Co.	ATS
Date Performed	11/7/2019
Analysis Year	2019
Time Analyzed	AM Peak Hour
Intersection Orientation	East-West
Project Description	George Elmer-Tollefson

Site Information

Intersection	George Elmer & Mullan
Jurisdiction	City of Missoula
East/West Street	Mullan Road
North/South Street	George Elmer Drive
Peak Hour Factor	0.98
Analysis Time Period (hrs)	0.25

Lanes



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	0	1	0	0	0	1	1		0	0	0		1	0	1
Configuration		LT					T	R						L		R
Volume (veh/h)		3	708				215	22						138		11
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized					No								No			
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		3												141		11
Capacity, c (veh/h)		1325												288		820
v/c Ratio		0.00												0.49		0.01
95% Queue Length, Q ₉₅ (veh)		0.0												2.5		0.0
Control Delay (s/veh)		7.7												28.8		9.4
Level of Service (LOS)		A												D		A
Approach Delay (s/veh)	0.1												27.4			
Approach LOS													D			

HCS7 Two-Way Stop-Control Report

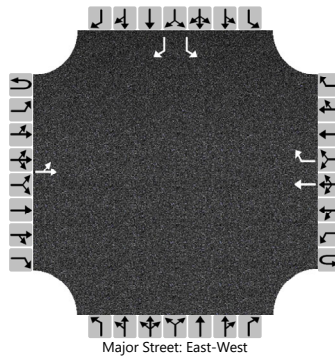
General Information

Analyst	RLA
Agency/Co.	ATS
Date Performed	11/7/2019
Analysis Year	2019
Time Analyzed	PM Peak Hour
Intersection Orientation	East-West
Project Description	George Elmer-Tollefson

Site Information

Intersection	George Elmer & Mullan
Jurisdiction	City of Missoula
East/West Street	Mullan Road
North/South Street	George Elmer Drive
Peak Hour Factor	0.98
Analysis Time Period (hrs)	0.25

Lanes



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	0	1	0	0	0	1	1		0	0	0		1	0	1
Configuration		LT					T	R						L		R
Volume (veh/h)		13	490				757	141						67		10
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized					No								No			
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

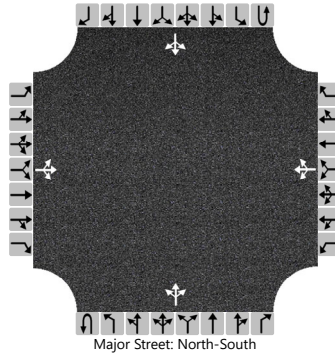
Flow Rate, v (veh/h)		13												68		10
Capacity, c (veh/h)		744												174		399
v/c Ratio		0.02												0.39		0.03
95% Queue Length, Q ₉₅ (veh)		0.1												1.7		0.1
Control Delay (s/veh)		9.9												38.6		14.3
Level of Service (LOS)		A												E		B
Approach Delay (s/veh)	0.5												35.4			
Approach LOS													E			

HCS7 Two-Way Stop-Control Report

General Information

Analyst	RLA	Intersection	George Elmer & Cattle Dr.
Agency/Co.	ATS	Jurisdiction	City of Missoula
Date Performed	8/13/2020	East/West Street	Cattle Drive
Analysis Year	2019	North/South Street	George Elmer Drive
Time Analyzed	Existing AM Peak Hour	Peak Hour Factor	0.90
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	George Elmer-Tollefson		

Lanes



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 (veh/h)		1	2	104		45	2	1		18	1	8		1	1	1
Percent Heavy Vehicles (%)		3	3	3		3	3	3		3				3		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized																
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)		7.13	6.53	6.23		7.13	6.53	6.23		4.13				4.13		
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)		3.53	4.03	3.33		3.53	4.03	3.33		2.23				2.23		

Delay, Queue Length, and Level of Service

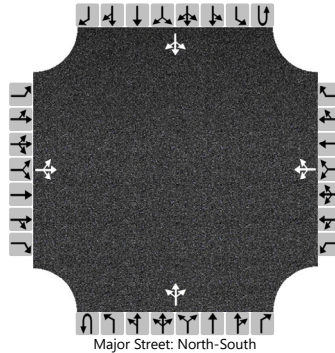
Flow Rate, v (veh/h)			119				53			20				1		
Capacity, c (veh/h)			1072				773			1614				1603		
v/c Ratio			0.11				0.07			0.01				0.00		
95% Queue Length, Q ₉₅ (veh)			0.4				0.2			0.0				0.0		
Control Delay (s/veh)			8.8				10.0			7.3				7.2		
Level of Service (LOS)			A				B			A				A		
Approach Delay (s/veh)	8.8				10.0				4.9				2.4			
Approach LOS	A				B											

HCS7 Two-Way Stop-Control Report

General Information

Analyst	RLA	Intersection	George Elmer & Cattle Dr.
Agency/Co.	ATS	Jurisdiction	City of Missoula
Date Performed	8/13/2020	East/West Street	Cattle Drive
Analysis Year	2019	North/South Street	George Elmer Drive
Time Analyzed	Existing PM Peak Hour	Peak Hour Factor	0.90
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	George Elmer-Tollefson		

Lanes



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 (veh/h)		1	2	54		23	2	1		108	1	46		1	1	1
Percent Heavy Vehicles (%)		3	3	3		3	3	3		3				3		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized																
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)		7.13	6.53	6.23		7.13	6.53	6.23		4.13				4.13		
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)		3.53	4.03	3.33		3.53	4.03	3.33		2.23				2.23		

Delay, Queue Length, and Level of Service

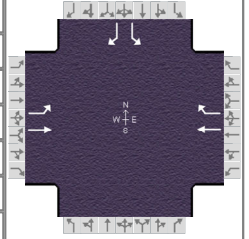
Flow Rate, v (veh/h)			63				29			120				1		
Capacity, c (veh/h)			1034				585			1614				1547		
v/c Ratio			0.06				0.05			0.07				0.00		
95% Queue Length, Q ₉₅ (veh)			0.2				0.2			0.2				0.0		
Control Delay (s/veh)			8.7				11.5			7.4				7.3		
Level of Service (LOS)			A				B			A				A		
Approach Delay (s/veh)	8.7				11.5				5.3				2.4			
Approach LOS	A				B											

HCS7 Signalized Intersection Results Summary

General Information

Agency	ATS		
Analyst	RLA	Analysis Date	Dec 13, 2019
Jurisdiction		Time Period	AM Peak Hour
Urban Street	Mullan Road	Analysis Year	2025 No Build
Intersection	George Ulmer	File Name	GeorgeSignalAMr
Project Description	George Elmer-Tollefson		

Intersection Information



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	8	874			271	122				434		37

Signal Information

Cycle, s	51.3	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	26.8	14.5	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	4.0	4.0	0.0	0.0	0.0	0.0		
				Red	1.0	1.0	0.0	0.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6				4
Case Number		6.0		7.0				9.0
Phase Duration, s		31.8		31.8				19.5
Change Period, ($Y+R_c$), s		5.0		5.0				5.0
Max Allow Headway (MAH), s		3.0		3.0				3.0
Queue Clearance Time (g_s), s		24.5		6.3				13.5
Green Extension Time (g_e), s		2.0		0.0				0.9
Phase Call Probability		1.00		1.00				1.00
Max Out Probability		0.00		1.00				0.00

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (v), veh/h	8	892			277	124				443		38
Adjusted Saturation Flow Rate (s), veh/h/ln	1120	1870			1870	1585				1867		1662
Queue Service Time (g_s), s	0.2	22.5			4.3	2.1				11.5		0.9
Cycle Queue Clearance Time (g_c), s	4.1	22.5			4.3	2.1				11.5		0.9
Green Ratio (g/C)	0.52	0.52			0.52	0.52				0.28		0.28
Capacity (c), veh/h	640	977			977	828				530		472
Volume-to-Capacity Ratio (X)	0.013	0.912			0.283	0.150				0.835		0.080
Back of Queue (Q), ft/ln (50 th percentile)	0.9	152.4			27.3	11.4				103.3		6.6
Back of Queue (Q), veh/ln (50 th percentile)	0.0	6.0			1.1	0.4				4.1		0.3
Queue Storage Ratio (RQ) (50 th percentile)	0.00	0.00			0.00	0.00				0.00		0.00
Uniform Delay (d_1), s/veh	8.0	11.3			6.9	6.4				17.4		13.6
Incremental Delay (d_2), s/veh	0.0	1.5			0.1	0.0				1.4		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (d), s/veh	8.0	12.8			7.0	6.4				18.7		13.6
Level of Service (LOS)	A	B			A	A				B		B
Approach Delay, s/veh / LOS	12.7	B		6.8	A		0.0			18.3	B	
Intersection Delay, s/veh / LOS	12.9						B					

Multimodal Results

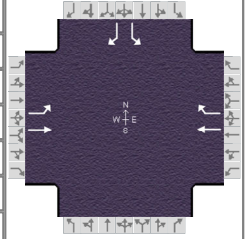
	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	0.67	A		1.87	B		1.94	B		1.94	B	
Bicycle LOS Score / LOS	1.97	B		1.15	A						F	

HCS7 Signalized Intersection Results Summary

General Information

Agency	ATS		
Analyst	RLA	Analysis Date	Dec 13, 2019
Jurisdiction		Time Period	PM Peak Hour
Urban Street	Mullan Road	Analysis Year	2025 No Build
Intersection	George Ulmer	File Name	GeorgeSignalPMr
Project Description	George Elmer-Tollefson		

Intersection Information



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	31	595			947	481				260		27

Signal Information

Cycle, s	44.0	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	25.7	8.4	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	4.0	4.0	0.0	0.0	0.0	0.0		
				Red	1.0	1.0	0.0	0.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6				4
Case Number		6.0		7.0				9.0
Phase Duration, s		30.7		30.7				13.4
Change Period, ($Y+R_c$), s		5.0		5.0				5.0
Max Allow Headway (MAH), s		3.0		3.0				3.0
Queue Clearance Time (g_s), s		23.8		21.8				7.9
Green Extension Time (g_e), s		1.6		0.0				0.5
Phase Call Probability		1.00		1.00				0.97
Max Out Probability		0.01		1.00				0.00

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (v), veh/h	32	607			966	491				265		28
Adjusted Saturation Flow Rate (s), veh/h/ln	591	1870			1870	1585				1867		1662
Queue Service Time (g_s), s	2.2	8.9			19.8	8.3				5.9		0.6
Cycle Queue Clearance Time (g_c), s	21.8	8.9			19.8	8.3				5.9		0.6
Green Ratio (g/C)	0.58	0.58			0.58	0.58				0.19		0.19
Capacity (c), veh/h	245	1091			1091	925				357		318
Volume-to-Capacity Ratio (X)	0.129	0.556			0.886	0.531				0.743		0.087
Back of Queue (Q), ft/ln (50 th percentile)	6	37.2			146.1	30.3				52.8		4.6
Back of Queue (Q), veh/ln (50 th percentile)	0.2	1.5			5.8	1.2				2.1		0.2
Queue Storage Ratio (RQ) (50 th percentile)	0.00	0.00			0.00	0.00				0.00		0.00
Uniform Delay (d_1), s/veh	17.3	5.7			8.0	5.6				16.9		14.8
Incremental Delay (d_2), s/veh	0.1	0.2			8.6	0.3				1.2		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (d), s/veh	17.4	5.9			16.6	5.9				18.1		14.8
Level of Service (LOS)	B	A			B	A				B		B
Approach Delay, s/veh / LOS	6.4	A		13.0	B		0.0			17.8		B
Intersection Delay, s/veh / LOS	11.8						B					

Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	0.65	A		1.85	B		1.93	B		1.93		B
Bicycle LOS Score / LOS	1.54	B		2.89	C							F

HCS7 Two-Way Stop-Control Report

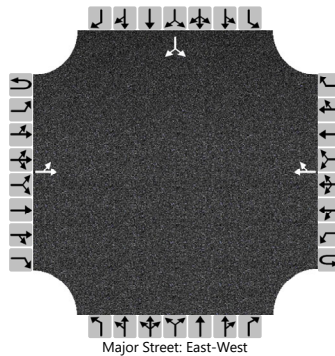
General Information

Analyst	RLA
Agency/Co.	ATS
Date Performed	11/7/2019
Analysis Year	2025
Time Analyzed	AM Peak No Build
Intersection Orientation	East-West
Project Description	George Elmer-Tollefson

Site Information

Intersection	Chuck Wagon & Mullan
Jurisdiction	City of Missoula
East/West Street	Mullan Road
North/South Street	Chuck Wagon Drive
Peak Hour Factor	1.00
Analysis Time Period (hrs)	0.25

Lanes



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	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		11	723				257	51						158		24
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized																
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		11													182	
Capacity, c (veh/h)		1253													280	
v/c Ratio		0.01													0.65	
95% Queue Length, Q ₉₅ (veh)		0.0													4.2	
Control Delay (s/veh)		7.9													38.9	
Level of Service (LOS)		A													E	
Approach Delay (s/veh)	0.2												38.9			
Approach LOS													E			

HCS7 Two-Way Stop-Control Report

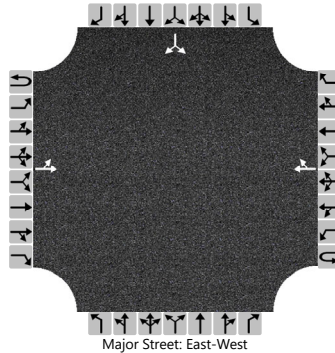
General Information

Analyst	RLA
Agency/Co.	ATS
Date Performed	11/7/2019
Analysis Year	2025
Time Analyzed	PM Peak No Build
Intersection Orientation	East-West
Project Description	George Elmer-Tollefson

Site Information

Intersection	Chuck Wagon & Mullan
Jurisdiction	City of Missoula
East/West Street	Mullan Road
North/South Street	Chuck Wagon Drive
Peak Hour Factor	1.00
Analysis Time Period (hrs)	0.25

Lanes



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	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		22	524				796	179						103		30
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized																
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

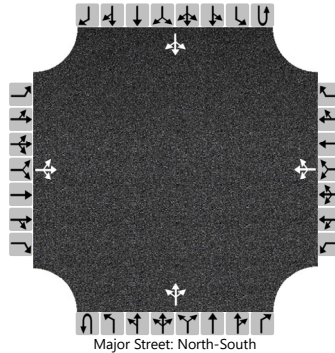
Flow Rate, v (veh/h)		22													133	
Capacity, c (veh/h)		707													159	
v/c Ratio		0.03													0.84	
95% Queue Length, Q ₉₅ (veh)		0.1													5.6	
Control Delay (s/veh)		10.3													90.7	
Level of Service (LOS)		B													F	
Approach Delay (s/veh)	0.8												90.7			
Approach LOS													F			

HCS7 Two-Way Stop-Control Report

General Information

Analyst	RLA	Intersection	George Elmer & Cattle Dr.
Agency/Co.	ATS	Jurisdiction	City of Missoula
Date Performed	8/13/2020	East/West Street	Cattle Drive
Analysis Year	2025	North/South Street	George Elmer Drive
Time Analyzed	AM Peak Hour No Build	Peak Hour Factor	0.90
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	George Elmer-Tollefson		

Lanes



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 (veh/h)		1	2	303		47	2	1		83	0	8		1	1	1
Percent Heavy Vehicles (%)		3	3	3		3	3	3		3				3		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized																
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)		7.13	6.53	6.23		7.13	6.53	6.23		4.13				4.13		
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)		3.53	4.03	3.33		3.53	4.03	3.33		2.23				2.23		

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			340				56			92				1		
Capacity, c (veh/h)			1074				400			1614				1605		
v/c Ratio			0.32				0.14			0.06				0.00		
95% Queue Length, Q ₉₅ (veh)			1.4				0.5			0.2				0.0		
Control Delay (s/veh)			9.9				15.5			7.4				7.2		
Level of Service (LOS)			A				C			A				A		
Approach Delay (s/veh)	9.9				15.5				6.8				2.4			
Approach LOS	A				C											

HCS7 Two-Way Stop-Control Report

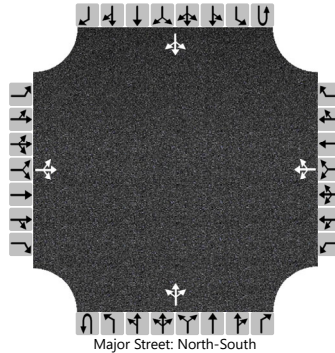
General Information

Analyst	RLA
Agency/Co.	ATS
Date Performed	8/13/2020
Analysis Year	2025
Time Analyzed	PM Peak Hour No Build
Intersection Orientation	North-South
Project Description	George Elmer-Tollefson

Site Information

Intersection	George Elmer & Cattle Dr.
Jurisdiction	City of Missoula
East/West Street	Cattle Drive
North/South Street	George Elmer Drive
Peak Hour Factor	0.90
Analysis Time Period (hrs)	0.25

Lanes



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 (veh/h)		1	2	185		24	2	1		332	1	49		1	1	1
Percent Heavy Vehicles (%)		3	3	3		3	3	3		3				3		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized																
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)		7.13	6.53	6.23		7.13	6.53	6.23		4.13				4.13		
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)		3.53	4.03	3.33		3.53	4.03	3.33		2.23				2.23		

Delay, Queue Length, and Level of Service

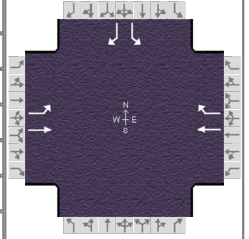
Flow Rate, v (veh/h)			209				30			369				1		
Capacity, c (veh/h)			1025				187			1614				1543		
v/c Ratio			0.20				0.16			0.23				0.00		
95% Queue Length, Q ₉₅ (veh)			0.8				0.6			0.9				0.0		
Control Delay (s/veh)			9.4				28.0			7.9				7.3		
Level of Service (LOS)			A				D			A				A		
Approach Delay (s/veh)	9.4				28.0				7.1				2.4			
Approach LOS	A				D											

HCS7 Signalized Intersection Results Summary

General Information

Agency	ATS		
Analyst	RLA	Analysis Date	Dec 13, 2019
Jurisdiction		Time Period	AM Peak Hour
Urban Street	Mullan Road	Analysis Year	2025 With Dev.
Intersection	George Ulmer	File Name	GeorgeSignalAMa
Project Description	George Elmer-Tollefson		

Intersection Information



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	11	874			272	178				584		54

Signal Information

Cycle, s	73.0	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	37.2	25.8	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	4.0	4.0	0.0	0.0	0.0	0.0		
				Red	1.0	1.0	0.0	0.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6				4
Case Number		6.0		7.0				9.0
Phase Duration, s		42.2		42.2				30.8
Change Period, ($Y+R_c$), s		5.0		5.0				5.0
Max Allow Headway (MAH), s		3.0		3.0				3.0
Queue Clearance Time (g_s), s		34.8		8.3				24.3
Green Extension Time (g_e), s		2.0		0.0				1.2
Phase Call Probability		1.00		1.00				1.00
Max Out Probability		0.00		1.00				0.00

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (v), veh/h	11	892			278	182				596		55
Adjusted Saturation Flow Rate (s), veh/h/ln	1119	1870			1870	1585				1867		1662
Queue Service Time (g_s), s	0.4	32.8			6.3	4.7				22.3		1.6
Cycle Queue Clearance Time (g_c), s	6.3	32.8			6.3	4.7				22.3		1.6
Green Ratio (g/C)	0.51	0.51			0.51	0.51				0.35		0.35
Capacity (c), veh/h	580	955			955	809				660		588
Volume-to-Capacity Ratio (X)	0.019	0.934			0.291	0.225				0.902		0.094
Back of Queue (Q), ft/ln (50 th percentile)	2.3	295.9			53.8	34				230.8		13.9
Back of Queue (Q), veh/ln (50 th percentile)	0.1	11.6			2.1	1.3				9.2		0.6
Queue Storage Ratio (RQ) (50 th percentile)	0.00	0.00			0.00	0.00				0.00		0.00
Uniform Delay (d_1), s/veh	12.1	16.9			10.4	10.0				22.6		15.9
Incremental Delay (d_2), s/veh	0.0	2.4			0.1	0.1				3.8		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (d), s/veh	12.1	19.2			10.4	10.0				26.4		15.9
Level of Service (LOS)	B	B			B	B				C		B
Approach Delay, s/veh / LOS	19.1	B		10.3	B		0.0			25.5		C
Intersection Delay, s/veh / LOS	19.2						B					

Multimodal Results

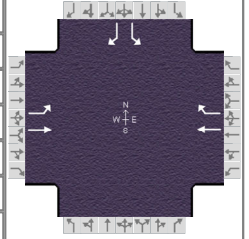
	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	0.69	A		1.88	B		1.95	B		1.95		B
Bicycle LOS Score / LOS	1.98	B		1.25	A							F

HCS7 Signalized Intersection Results Summary

General Information

Agency	ATS		
Analyst	RLA	Analysis Date	Dec 13, 2019
Jurisdiction		Time Period	PM Peak Hour
Urban Street	Mullan Road	Analysis Year	2025 With Dev.
Intersection	George Ulmer	File Name	GeorgeSignalPMa
Project Description	George Elmer-Tollefson		

Intersection Information



Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (v), veh/h	40	597			949	641				357		38

Signal Information

Cycle, s	56.5	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	Yes	Simult. Gap E/W	On	Green	33.0	13.4	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	4.0	4.0	0.0	0.0	0.0	0.0		
				Red	1.0	1.0	0.0	0.0	0.0	0.0		

Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6				4
Case Number		6.0		7.0				9.0
Phase Duration, s		38.0		38.0				18.4
Change Period, ($Y+R_c$), s		5.0		5.0				5.0
Max Allow Headway (MAH), s		3.1		3.1				3.0
Queue Clearance Time (g_s), s		31.0		27.3				12.5
Green Extension Time (g_e), s		1.7		0.0				0.7
Phase Call Probability		1.00		1.00				1.00
Max Out Probability		0.03		1.00				0.00

Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate (v), veh/h	41	609			968	654				364		39
Adjusted Saturation Flow Rate (s), veh/h/ln	590	1870			1870	1585				1867		1662
Queue Service Time (g_s), s	3.6	11.4			25.3	16.6				10.5		1.0
Cycle Queue Clearance Time (g_c), s	29.0	11.4			25.3	16.6				10.5		1.0
Green Ratio (g/C)	0.59	0.59			0.59	0.59				0.24		0.24
Capacity (c), veh/h	210	1096			1096	929				446		397
Volume-to-Capacity Ratio (X)	0.194	0.556			0.884	0.704				0.817		0.098
Back of Queue (Q), ft/ln (50 th percentile)	11.2	70			219.1	98.5				101.3		8.6
Back of Queue (Q), veh/ln (50 th percentile)	0.4	2.8			8.6	3.9				4.0		0.3
Queue Storage Ratio (RQ) (50 th percentile)	0.00	0.00			0.00	0.00				0.00		0.00
Uniform Delay (d_1), s/veh	22.6	7.2			10.1	8.3				20.5		16.9
Incremental Delay (d_2), s/veh	0.2	0.2			8.5	2.1				1.4		0.0
Initial Queue Delay (d_3), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay (d), s/veh	22.7	7.4			18.6	10.4				22.0		17.0
Level of Service (LOS)	C	A			B	B				C		B
Approach Delay, s/veh / LOS	8.4	A		15.3	B		0.0			21.5	C	
Intersection Delay, s/veh / LOS	14.5						B					

Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	0.66	A		1.86	B		1.94	B		1.94	B	
Bicycle LOS Score / LOS	1.56	B		3.16	C						F	

HCS7 Two-Way Stop-Control Report

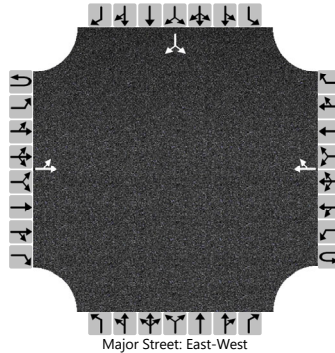
General Information

Analyst	RLA
Agency/Co.	ATS
Date Performed	11/7/2019
Analysis Year	2025
Time Analyzed	AM Peak With Developments
Intersection Orientation	East-West
Project Description	George Elmer-Tollefson

Site Information

Intersection	Chuck Wagon & Mullan
Jurisdiction	City of Missoula
East/West Street	Mullan Road
North/South Street	Chuck Wagon Drive
Peak Hour Factor	1.00
Analysis Time Period (hrs)	0.25

Lanes



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	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		14	726				274	51						159		31
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized																
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

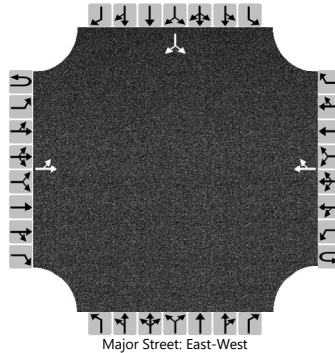
Flow Rate, v (veh/h)		14													190	
Capacity, c (veh/h)		1235													276	
v/c Ratio		0.01													0.69	
95% Queue Length, Q ₉₅ (veh)		0.0													4.6	
Control Delay (s/veh)		7.9													42.7	
Level of Service (LOS)		A													E	
Approach Delay (s/veh)	0.3												42.7			
Approach LOS													E			

HCS7 Two-Way Stop-Control Report

General Information

Analyst	RLA	Intersection	Chuck Wagon & Mullan
Agency/Co.	ATS	Jurisdiction	City of Missoula
Date Performed	11/7/2019	East/West Street	Mullan Road
Analysis Year	2025	North/South Street	Chuck Wagon Drive
Time Analyzed	PM Peak With Development	Peak Hour Factor	1.00
Intersection Orientation	East-West	Analysis Time Period (hrs)	0.25
Project Description	George Elmer-Tollefson		

Lanes



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	0	1	0	0	0	1	0		0	0	0		0	1	0
Configuration		LT						TR							LR	
Volume (veh/h)		30	533				807	181						104		34
Percent Heavy Vehicles (%)		2												2		2
Proportion Time Blocked																
Percent Grade (%)													0			
Right Turn Channelized																
Median Type Storage	Undivided															

Critical and Follow-up Headways

Base Critical Headway (sec)		4.1												7.1		6.2
Critical Headway (sec)		4.12												6.42		6.22
Base Follow-Up Headway (sec)		2.2												3.5		3.3
Follow-Up Headway (sec)		2.22												3.52		3.32

Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)		30													138	
Capacity, c (veh/h)		699													151	
v/c Ratio		0.04													0.91	
95% Queue Length, Q ₉₅ (veh)		0.1													6.4	
Control Delay (s/veh)		10.4													110.3	
Level of Service (LOS)		B													F	
Approach Delay (s/veh)	1.2												110.3			
Approach LOS													F			

HCS7 Two-Way Stop-Control Report

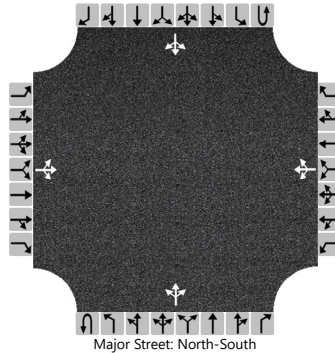
General Information

Analyst	RLA
Agency/Co.	ATS
Date Performed	8/13/2020
Analysis Year	2025
Time Analyzed	AM Peak Hour With Dev.
Intersection Orientation	North-South
Project Description	George Elmer-Tollefson

Site Information

Intersection	George Elmer & Cattle Dr.
Jurisdiction	City of Missoula
East/West Street	Cattle Drive
North/South Street	George Elmer Drive
Peak Hour Factor	0.90
Analysis Time Period (hrs)	0.25

Lanes



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 (veh/h)		1	2	244		47	2	1		63	79	8		1	226	1
Percent Heavy Vehicles (%)		3	3	3		3	3	3		3				3		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized																
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)		7.13	6.53	6.23		7.13	6.53	6.23		4.13				4.13		
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)		3.53	4.03	3.33		3.53	4.03	3.33		2.23				2.23		

Delay, Queue Length, and Level of Service

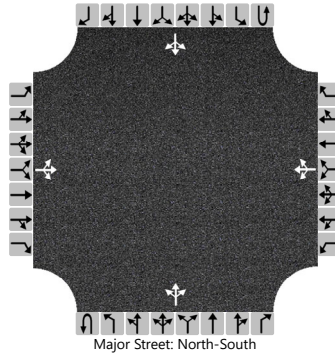
Flow Rate, v (veh/h)			274				56			70				1		
Capacity, c (veh/h)			778				256			1307				1491		
v/c Ratio			0.35				0.22			0.05				0.00		
95% Queue Length, Q ₉₅ (veh)			1.6				0.8			0.2				0.0		
Control Delay (s/veh)			12.1				22.9			7.9				7.4		
Level of Service (LOS)			B				C			A				A		
Approach Delay (s/veh)	12.1				22.9				3.6				0.0			
Approach LOS	B				C											

HCS7 Two-Way Stop-Control Report

General Information

Analyst	RLA	Intersection	George Elmer & Cattle Dr.
Agency/Co.	ATS	Jurisdiction	City of Missoula
Date Performed	8/13/2020	East/West Street	Cattle Drive
Analysis Year	2025	North/South Street	George Elmer Drive
Time Analyzed	PM Peak Hour With Dev.	Peak Hour Factor	0.90
Intersection Orientation	North-South	Analysis Time Period (hrs)	0.25
Project Description	George Elmer-Tollefson		

Lanes



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 (veh/h)		1	2	146		24	2	1		265	235	49		1	147	1
Percent Heavy Vehicles (%)		3	3	3		3	3	3		3				3		
Proportion Time Blocked																
Percent Grade (%)	0				0											
Right Turn Channelized																
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)		7.13	6.53	6.23		7.13	6.53	6.23		4.13				4.13		
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)		3.53	4.03	3.33		3.53	4.03	3.33		2.23				2.23		

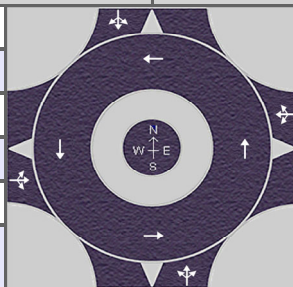
Delay, Queue Length, and Level of Service

Flow Rate, v (veh/h)			166				30			294				1		
Capacity, c (veh/h)			807				124			1408				1239		
v/c Ratio			0.21				0.24			0.21				0.00		
95% Queue Length, Q ₉₅ (veh)			0.8				0.9			0.8				0.0		
Control Delay (s/veh)			10.6				43.0			8.2				7.9		
Level of Service (LOS)			B				E			A				A		
Approach Delay (s/veh)	10.6				43.0				5.1				0.1			
Approach LOS	B				E											

HCS7 Roundabouts Report

General Information

Analyst	RLA
Agency or Co.	ATS
Date Performed	8/13/2020
Analysis Year	2025
Time Analyzed	AM Peak Hour With Dev.
Project Description	George Elmer - Tollefson



Site Information

Intersection	George Elmer & Cattle Dr.
E/W Street Name	Cattle Drive
N/S Street Name	George Elmer Drive
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	City of Missoula

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment	LTR				LTR				LTR				LTR			
Volume (V), veh/h	0	1	2	244	0	47	2	1	0	63	79	8	0	1	226	0
Percent Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Flow Rate (V_{PCE}), pc/h	0	1	2	273	0	53	2	1	0	71	88	9	0	1	253	0
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		276			56			168			254	
Entry Volume, veh/h		268			54			163			247	
Circulating Flow (v_c), pc/h	307			160			4			126		
Exiting Flow (v_{ex}), pc/h	12			73			90			579		
Capacity (C_{PCE}), pc/h		1009			1172			1374			1214	
Capacity (c), veh/h		980			1138			1334			1178	
v/c Ratio (x)		0.27			0.05			0.12			0.21	

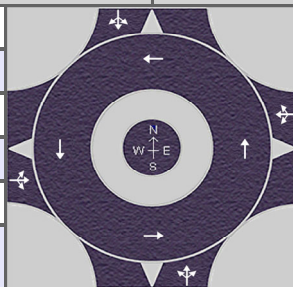
Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		6.4			3.6			3.7			4.9	
Lane LOS		A			A			A			A	
95% Queue, veh		1.1			0.2			0.4			0.8	
Approach Delay, s/veh	6.4			3.6			3.7			4.9		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh LOS	5.1						A					

HCS7 Roundabouts Report

General Information

Analyst	RLA
Agency or Co.	ATS
Date Performed	8/13/2020
Analysis Year	2025
Time Analyzed	PM Peak Hour With Dev.
Project Description	George Elmer - Tollefson



Site Information

Intersection	George Elmer & Cattle Dr.
E/W Street Name	Cattle Drive
N/S Street Name	George Elmer Drive
Analysis Time Period (hrs)	0.25
Peak Hour Factor	0.92
Jurisdiction	City of Missoula

Volume Adjustments and Site Characteristics

Approach	EB				WB				NB				SB			
Movement	U	L	T	R	U	L	T	R	U	L	T	R	U	L	T	R
Number of Lanes (N)	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0
Lane Assignment	LTR				LTR				LTR				LTR			
Volume (V), veh/h	0	1	2	146	0	24	2	1	0	265	235	49	0	1	147	1
Percent Heavy Vehicles, %	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Flow Rate (V_{PCE}), pc/h	0	1	2	163	0	27	2	1	0	297	263	55	0	1	165	1
Right-Turn Bypass	None				None				None				None			
Conflicting Lanes	1				1				1				1			
Pedestrians Crossing, p/h	0				0				0				0			

Critical and Follow-Up Headway Adjustment

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Critical Headway (s)		4.9763			4.9763			4.9763			4.9763	
Follow-Up Headway (s)		2.6087			2.6087			2.6087			2.6087	

Flow Computations, Capacity and v/c Ratios

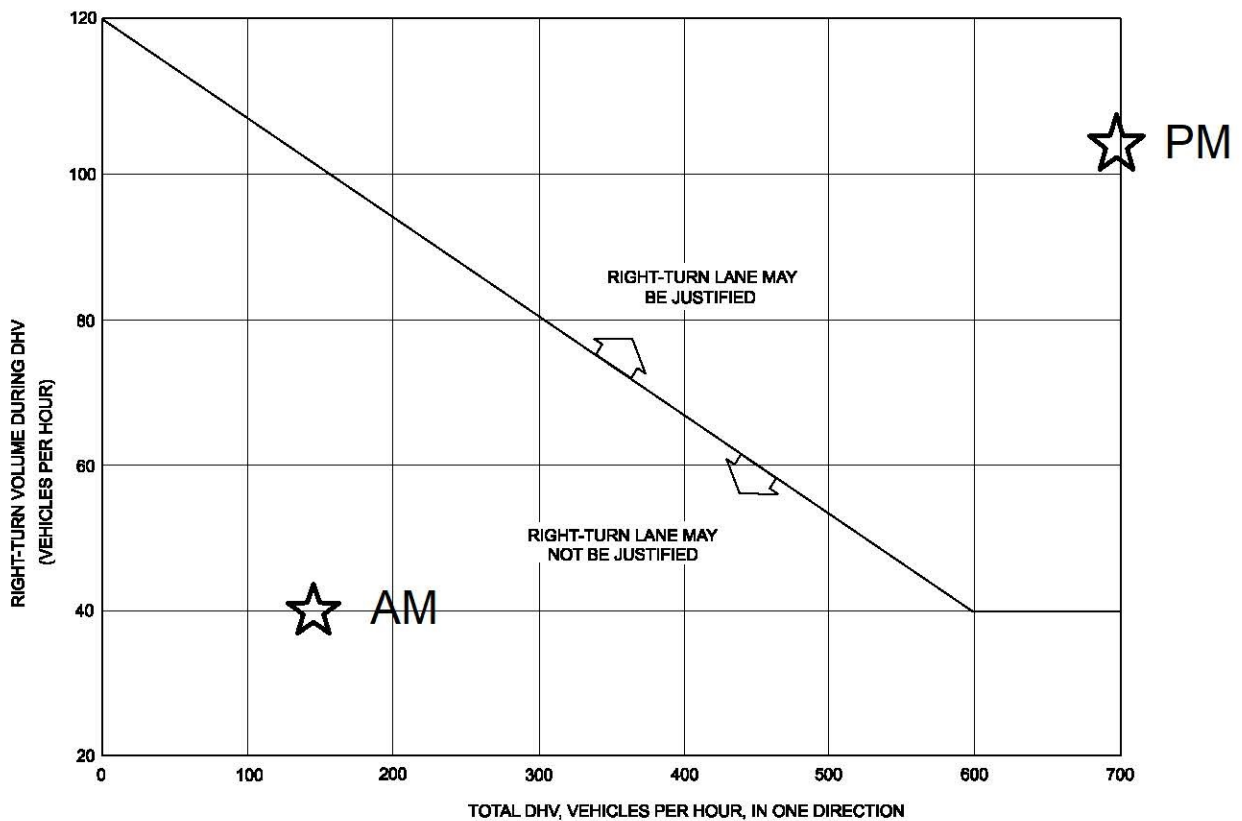
Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Entry Flow (v_e), pc/h		166			30			615			167	
Entry Volume, veh/h		161			29			597			162	
Circulating Flow (v_c), pc/h	193			561			4			326		
Exiting Flow (v_{ex}), pc/h	58			300			265			355		
Capacity (C_{PCE}), pc/h		1133			779			1374			990	
Capacity (c), veh/h		1100			756			1334			961	
v/c Ratio (x)		0.15			0.04			0.45			0.17	

Delay and Level of Service

Approach	EB			WB			NB			SB		
Lane	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass	Left	Right	Bypass
Lane Control Delay (d), s/veh		4.6			5.1			7.1			5.3	
Lane LOS		A			A			A			A	
95% Queue, veh		0.5			0.1			2.4			0.6	
Approach Delay, s/veh	4.6			5.1			7.1			5.3		
Approach LOS	A			A			A			A		
Intersection Delay, s/veh LOS	6.3						A					

APPENDIX D

Turn- Lane Warrants



Note: For highways with a design speed below 50 mph (80 km/h) with a DHV < 300 and where right turns > 40, an adjustment should be used. To read the vertical axis of the chart, subtract 20 from the actual number of right turns.

Example

Given: Design Speed = 35 mph (60 km/h)
 DHV = 250 vph
 Right Turns = 100 vph

Problem: Determine if a right-turn lane is necessary.

Solution: To read the vertical axis, use $100 - 20 = 80$ vph. The figure indicates that a right-turn lane is not necessary, unless other factors (e.g., high accident rate) indicate a lane is needed.

GUIDELINES FOR RIGHT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON 2-LANE HIGHWAYS

Figure 13.3A