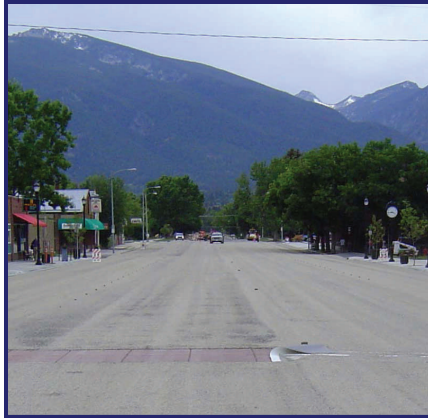


Hamilton Area Transportation Plan (2009 Update)

Level of Service Technical Memorandum

Working Draft



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2.3 Existing Levels of Service

Urban road systems are ultimately controlled by the function of the major intersections. Intersection failure directly reduces the number of vehicles that can be accommodated during the peak hours that have the highest demand and the total daily capacity of a corridor. As a result of this strong impact on corridor function, intersection improvements can be a very cost-effective means of increasing a corridor's traffic volume capacity. In some circumstances, corridor expansion projects may be able to be delayed with correct intersection improvements. Due to the significant portion of total expense for road construction projects used for project design, construction, mobilization, and adjacent area rehabilitation, a careful analysis must be made of the expected service life from intersection-only improvements. If adequate design life can be achieved with only improvements to the intersection, then a corridor expansion may not be the most efficient solution. With that in mind, it is important to determine how well the major intersections are functioning by determining their Level of Service (LOS).

Level of Service (LOS) is a qualitative measure developed by the transportation profession to quantify driver perception for such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles. It provides a scale that is intended to match the perception by motorists of the operation of the intersection. Level of Service provides a means for identifying intersections that are experiencing operational difficulties, as well as providing a scale to compare intersection with each other. The level of service scale represents the full range of operating conditions. The scale is based on the ability of an intersection or street segment to accommodate the amount of traffic using it. The scale ranges from "A" which indicates little, if any, vehicle delay, to "F" which indicates significant vehicle delay and traffic congestion. The LOS analysis was conducted according to the procedures outlined in the Transportation Research Board's *Highway Capacity Manual – Special Report 209* using the Highway Capacity Software, version 4.1f.

In order to calculate the LOS, 18 intersections on the major street network were counted during the spring of 2009. These intersections included 6 signalized intersections and 12 high-volume unsignalized intersections in the Hamilton area. Each intersection was counted between 7:00 a.m. to 9:00 a.m. and 4:00 p.m. and 6:00 p.m., to ensure that the intersection's peak volumes were represented. Based upon this data, the operational characteristics of each intersection were obtained.

2.3.1 Signalized Intersections

For signalized intersections, recent research has determined that average control delay per vehicle is the best available measure of level of service. Control delay takes into account uniform delay, incremental delay, and initial queue delay. The amount of control delay that a vehicle experiences is approximately equal to the time elapsed from when a vehicle joins a queue at the intersection (or arrives at the stop line when there is no queue) until the vehicle departs from the stopped position at the head of the queue. The control delay is primarily a function of volume, capacity, cycle length, green ratio, and the pattern of vehicle arrivals.

The following table identifies the relationship between level of service and average control delay per vehicle. The procedures used to evaluate signalized intersections use detailed information on geometry, lane use, signal timing, peak hour volumes, arrival types and other parameters. This information is then used to calculate delays and determine the capacity of each intersection. Generally, an intersection is

determined to be functioning adequately if operating at LOS C or better. **Table 2-1** shows the LOS by control delay for signalized intersections.

**Table 2-1
Level of Service Criteria (Signalized Intersections)**

	Control Delay per Vehicle (sec)
A	< 10
B	10 to 20
C	20 to 35
D	35 to 50
E	50 to 80
F	> 80

Source: The Transportation Research Board's *Highway Capacity Manual*

Using these techniques and the data collected in the spring of 2009, the LOS for the signalized intersections was calculated. **Table 2-2** shows the AM and PM peak hour LOS for each individual leg of the intersections, as well as the intersections as a whole. The intersection LOS is shown graphically in **Figure 2-5** and **Figure 2-6**.

**Table 2-2
Existing (2009) Level of Service for Signalized Intersections**

Intersection	AM Peak Hour					PM Peak Hour				
	EB	WB	NB	SB	INT	EB	WB	NB	SB	INT
US 93 & Adirondac Avenue/Fairgrounds Road	F	E	B	B	C	D	C	C	B	C
US 93 & Pine Street	F	-	A	A	B	F	-	A	A	D
US 93 & Main Street/Marcus Street	B	B	B	B	B	B	B	B	B	B
US 93 & Ravalli Street	D	D	A	A	A	E	C	A	A	B
US 93 & Golf Course Road/Hope Avenue	D	F	A	A	E	C	F	A	A	C
2 nd Street & Main Street	B	B	B	B	B	B	A	B	B	B

(Abbreviations used in the table are as follows: EB = eastbound; WB = westbound; NB = northbound; SB = southbound;

INT = intersections as a whole)

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2.3.2 Unsignalized Intersections

Level of service for unsignalized intersections is based on the delay experienced by each movement within the intersection, rather than on the overall stopped delay per vehicle at the intersection. This difference from the method used for signalized intersections is necessary since the operating characteristics of a stop-controlled intersection are substantially different. Driver expectations and perceptions are also entirely different. For two-way stop controlled intersections, the through traffic on the major (uncontrolled) street experiences no delay at intersection. Conversely, vehicles turning left from the minor street experience more delay than other movements and at times can experience significant delay. Vehicles on the minor street, which are turning right or going across the major street, experience less delay than those turning left from the same approach. Due to this situation, the level of service assigned to a two-way stop controlled intersection is based on the average delay for vehicles on the minor street approach.

Levels of service for all-way stop controlled intersections are also based on delay experienced by the vehicles at the intersection. Since there is no major street, the highest delay could be experienced by any of the approaching streets. Therefore, the level of service is based on the approach with the highest delay as shown in **Table 2-3**. This table shows the LOS criteria for both the all-way and two-way stop controlled intersections.

Table 2-3
Level of Service Criteria (Stop Controlled Intersections)

Level of Service	Delay (seconds/vehicle)
A	< 10
B	10 to 15
C	15 to 25
D	25 to 35
E	35 to 50
F	> 50

Source: The Transportation Research Board's *Highway Capacity Manual*

Using the above guidelines, the data collected in the spring of 2009 and calculation techniques for two-way stop controls and all-way stop controls, the LOS was calculated for 12 intersections. **Table 2-4** and **Table 2-5** show the detailed results of the performance level turning movement breakout for each unsignalized intersection. The intersection LOS is shown graphically in **Figure 2-5** and **Figure 2-6**.

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Table 2-4
Existing (2009) Level of Service for Unsignalized Intersections

Unsignalized Intersection	AM Peak Hour			PM Peak Hour		
	Delay	LOS	V/C	Delay	LOS	V/C
US 93 & Riverside Cutoff	-	-	-	-	-	-
<i>Westbound Left</i>	22.7	C	0.30	38.1	E	0.39
<i>Westbound Right</i>	9.9	A	0.02	11.6	B	0.09
<i>Southbound Left</i>	8.5	A	0.05	10.1	B	0.03
Old Corvallis Road/Mill Street & Fairgrounds Road	-	-	-	-	-	-
<i>Eastbound Left/Thru/Right</i>	8.1	A	0.06	8.0	A	0.05
<i>Westbound Left/Thru/Right</i>	7.8	A	0.01	8.1	A	0.01
<i>Northbound Left/Thru/Right</i>	15.4	C	0.07	16.5	C	0.13
<i>Southbound Left/Thru/Right</i>	13.9	B	0.18	19.5	C	0.38
Freeze Lane & Fairgrounds Road	-	-	-	-	-	-
<i>Westbound Left/Thru</i>	7.4	A	0.01	7.8	A	0.00
<i>Northbound Left</i>	10.4	B	0.04	11.1	B	0.02
<i>Northbound Right</i>	8.7	A	0.01	9.5	A	0.00
Eastside Highway & Fairgrounds Road	-	-	-	-	-	-
<i>Eastbound Left/Right</i>	13.9	B	0.20	20.8	C	0.47
<i>Northbound Left/Thru</i>	8.3	A	0.02	7.9	A	0.03
Eastside Highway & Kurtz Road	-	-	-	-	-	-
<i>Eastbound Left/Thru/Right</i>	8.5	A	0.20	7.6	A	0.01
<i>Westbound Left/Thru/Right</i>	7.7	A	0.02	8.2	A	0.02
<i>Northbound Left/Thru/Right</i>	61.5	F	0.68	25.2	D	0.48

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<i>Southbound Left</i>	41.4	E	0.04	17.9	C	0.01
<i>Southbound Thru/Right</i>	26.5	D	0.42	16.3	C	0.26
Eastside Highway & Black Lane/Bass Lane	-	-	-	-	-	-
<i>Eastbound Left/Thru/Right</i>	23.1	C	0.25	44.9	E	0.66
<i>Westbound Left/Thru/Right</i>	22.1	C	0.37	23.6	C	0.23
<i>Northbound Left/Thru/Right</i>	8.6	A	0.02	8.1	A	0.01
<i>Southbound Left/Thru/Right</i>	7.9	A	0.02	8.6	A	0.03
3rd Street & Main Street	-	-	-	-	-	-
<i>Eastbound Left/Thru/Right</i>	8.86	A		10.75	B	
<i>Westbound Left/Thru/Right</i>	8.70	A		9.34	A	
<i>Northbound Left/Thru/Right</i>	8.00	A		8.90	A	
<i>Southbound Left/Thru/Right</i>	8.03	A		9.07	A	
4th Street & Main Street	-	-	-	-	-	-
<i>Eastbound Left/Thru/Right</i>	9.45	A		10.79	B	
<i>Westbound Left/Thru/Right</i>	8.95	A		9.16	A	
<i>Northbound Left/Thru/Right</i>	8.78	A		9.12	A	
<i>Southbound Left/Thru/Right</i>	8.41	A		8.92	A	

**Table 2-5
Existing (2009) Level of Service for Unsignalized Intersections**

Unsignalized Intersection	AM Peak Hour			PM Peak Hour		
	Delay	LOS	V/C	Delay	LOS	V/C
Golf Course Road & Big Corral Road	-	-	-	-	-	-
<i>Eastbound Left/Thru</i>	8	A	0.29	7.7	A	0.06
<i>Southbound Left/Right</i>	11.2	B	0.14	11.9	B	0.22

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Golf Course Road & Kurtz Lane	-	-	-	-	-	-
<i>Eastbound Left/Thru</i>	8.3	A	0.07	7.8	A	0.02
<i>Southbound Left/Right</i>	13.8	B	0.18	12.9	B	0.23
Eastside Highway & Tammany Lane	-	-	-	-	-	-
<i>Westbound Left/Right</i>	12.1	B	0.12	16.3	C	0.27
<i>Southbound Left/Thru</i>	7.7	A	0.03	8.4	A	0.05
Eastside Highway & Airport Road	-	-	-	-	-	-
<i>Westbound Left/Right</i>	10.1	B	0.02	12.9	B	0.07
<i>Southbound Left/Thru</i>	7.7	A	0.01	8.4	A	0.02

The existing conditions LOS study in the Hamilton Area shows that two signalized and three unsignalized intersections are currently functioning at LOS D or lower. These five intersections indicate potential opportunities for closer examination and further intersection improvement measures to mitigate “operational” conditions. These are shown in **Table 2-6**.

**Table 2-6
Existing Intersections Functioning at a LOS D or Lower**

Intersection		AM Peak	PM Peak
US 93 & Pine Street	S	F	D
US 93 & Golf Course Road/Hope Avenue	S	E	C
US 93 & Riverside Cutoff	U	C	E
Kurtz Lane & Marcus Street/Eastside Highway	U	F	D
Eastside Highway & Black Lane/Bass Lane	U	C	E

(S)ignalized

(U)nsignalized

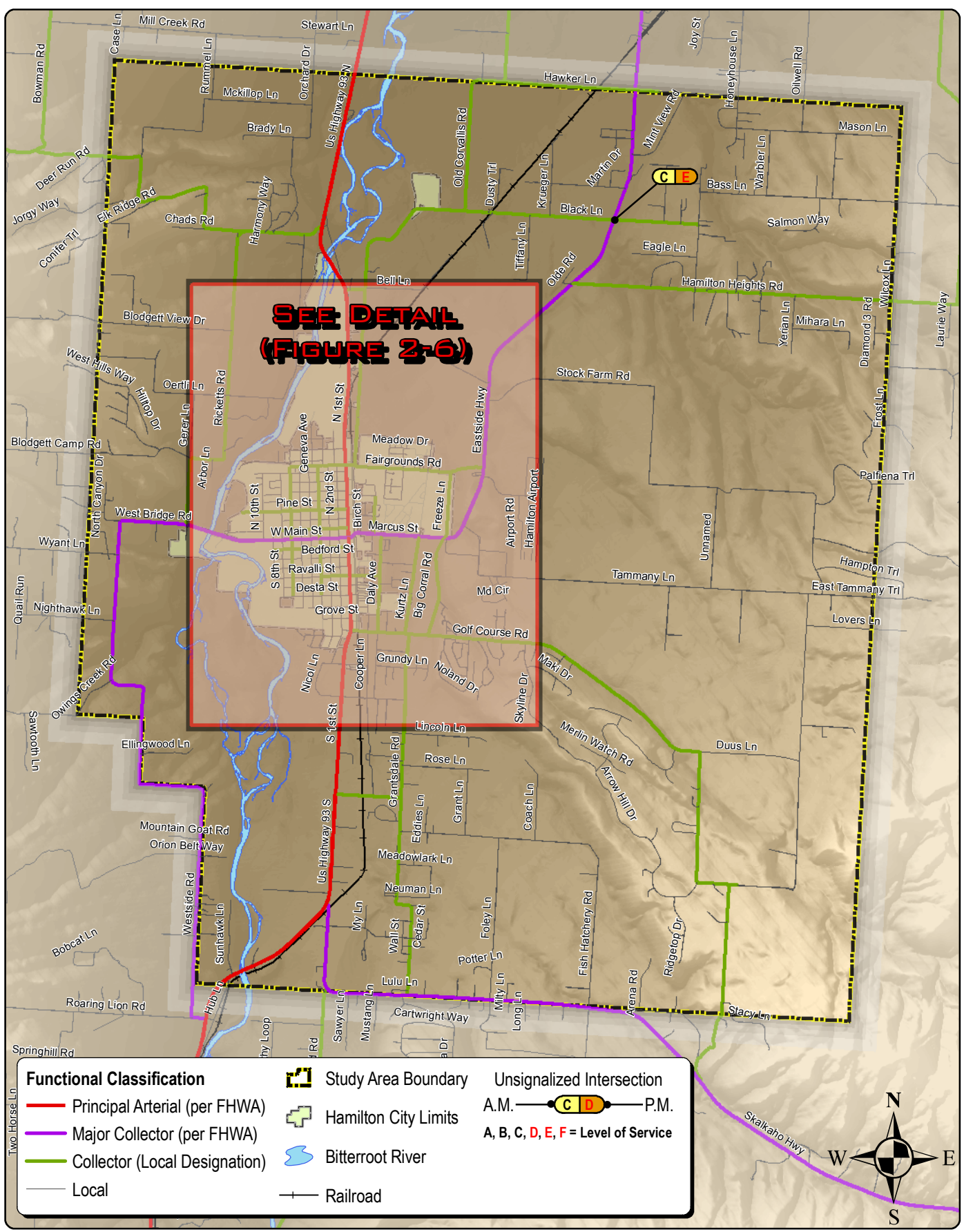
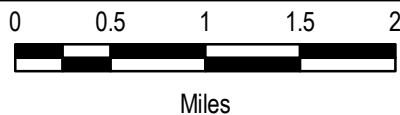


Figure 2-5
 Intersection Level of Service
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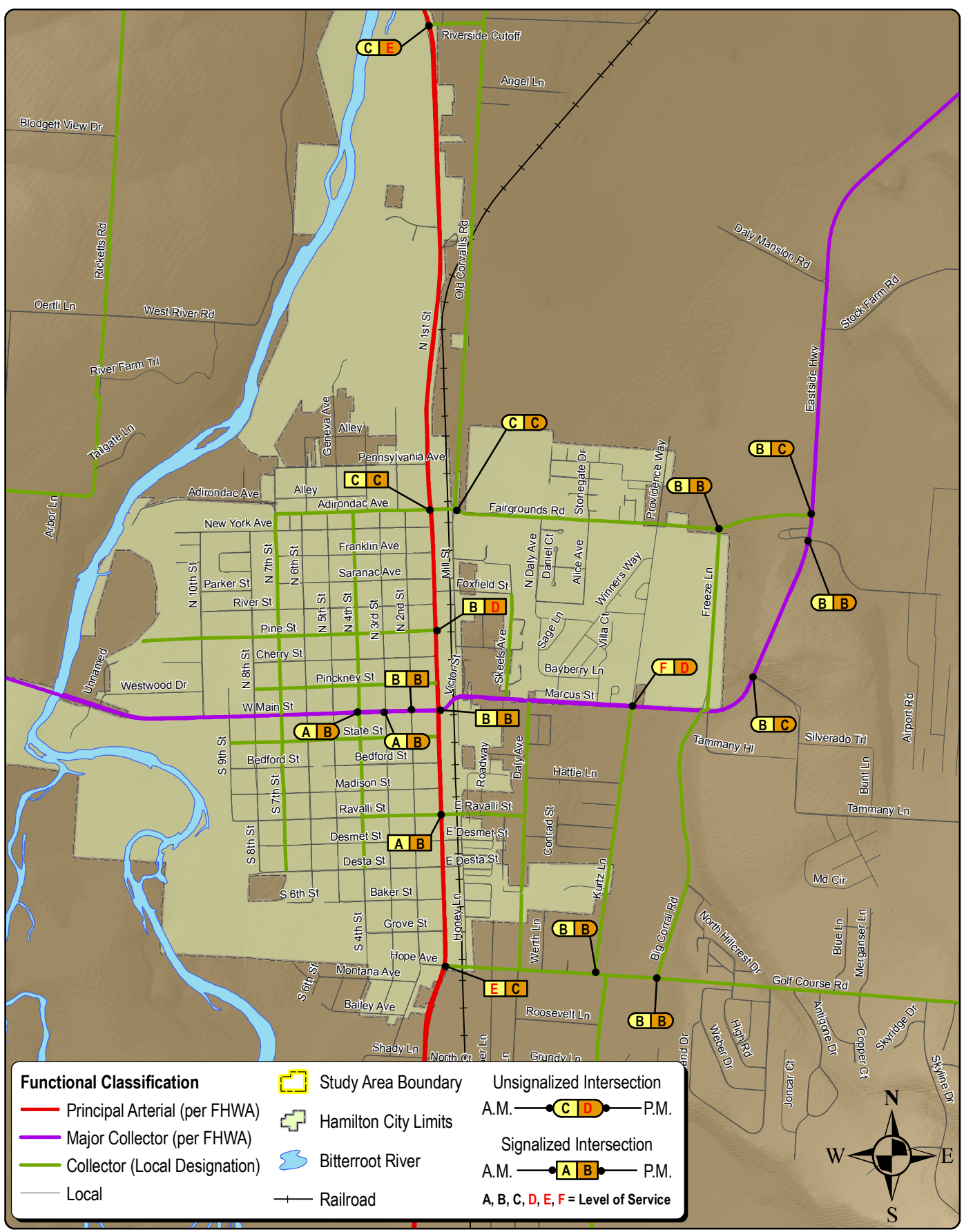
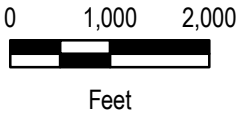


Figure 2-6
 Intersection Level of Service - Inset Area
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Intersection Study



US 93 & Adirondac Avenue/Fairgrounds Road



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US 93 & Pine Street



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US 93 & Main Street/Marcus Street



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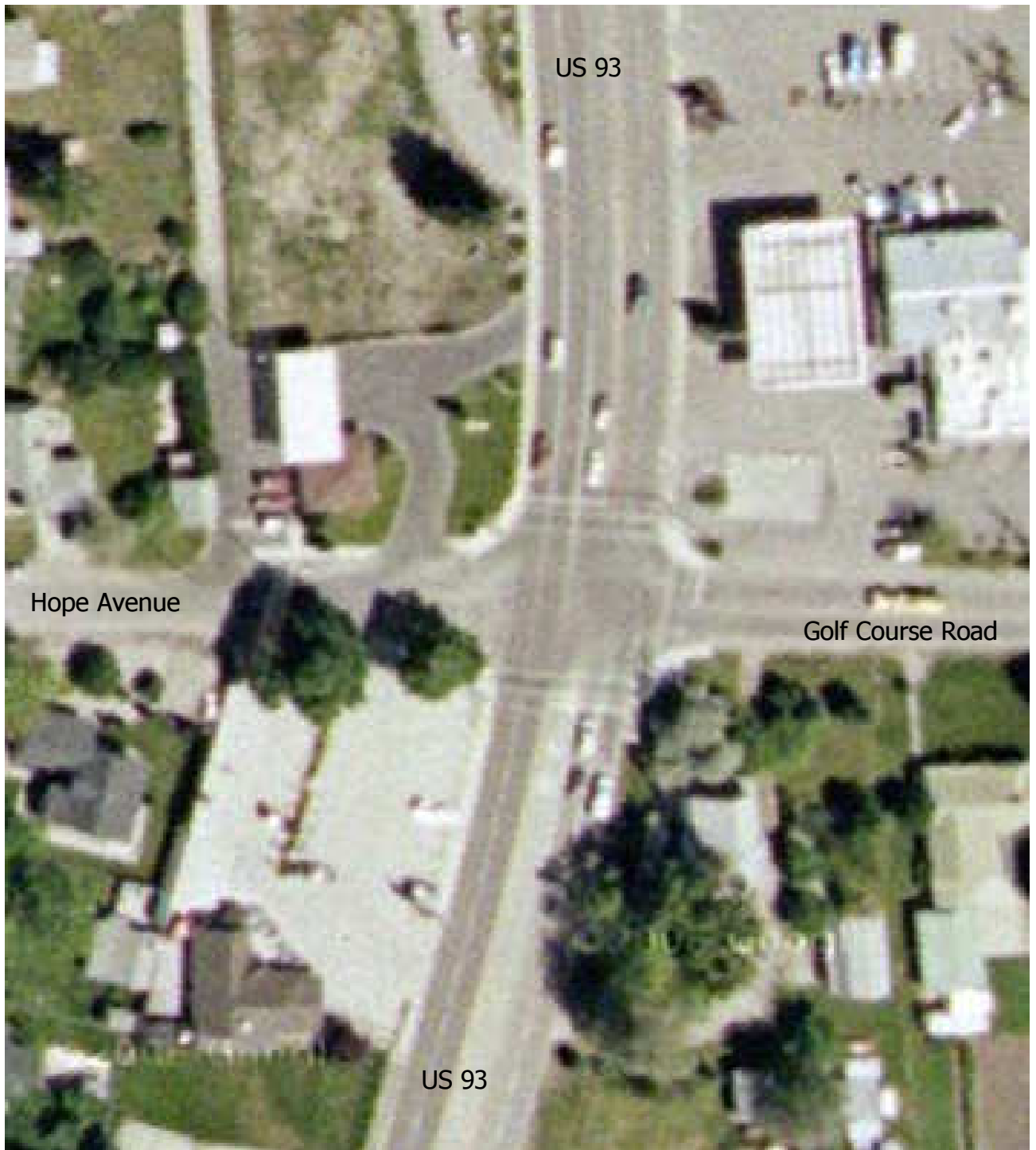
US 93 & Ravalli Street



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US 93 & Golf Course Road/Hope Avenue



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US 93 & Riverside Cutoff



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Old Corvallis Road/Mill Street & Fairgrounds Road



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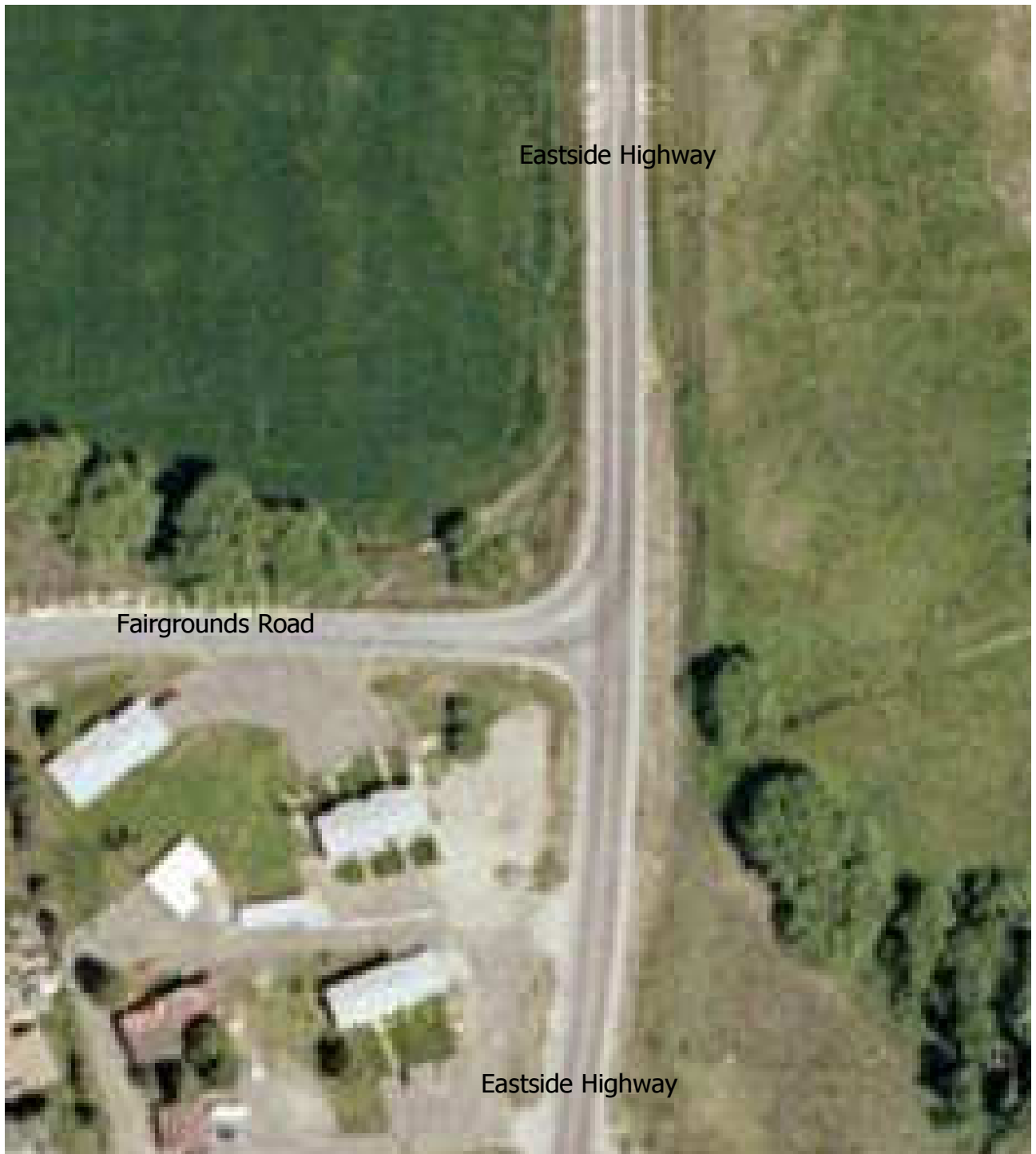
Freeze Lane & Fairgrounds Road



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Eastside Highway & Fairgrounds Road



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Kurtz Lane & Eastside Highway



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Eastside Highway & Black Lane/Bass Lane



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2nd Street & Main Street



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3rd Street & Main Street



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4th Street & Main Street



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Big Corral Road & Golf Course Road



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Kurtz Lane & Golf Course Road



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Eastside Highway & Tammany Lane



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Eastside Highway & Airport Road



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