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## MEMORANDUM

TO: Chad Hanson

FROM: Graham Johnson  
Chris Hiniker

DATE: May 29, 2014

RE: Red Wing Bridge Project - Purpose and Need Minnesota Approach Mobility Issues Memo  
SEH No. MNT06 119112 14.00

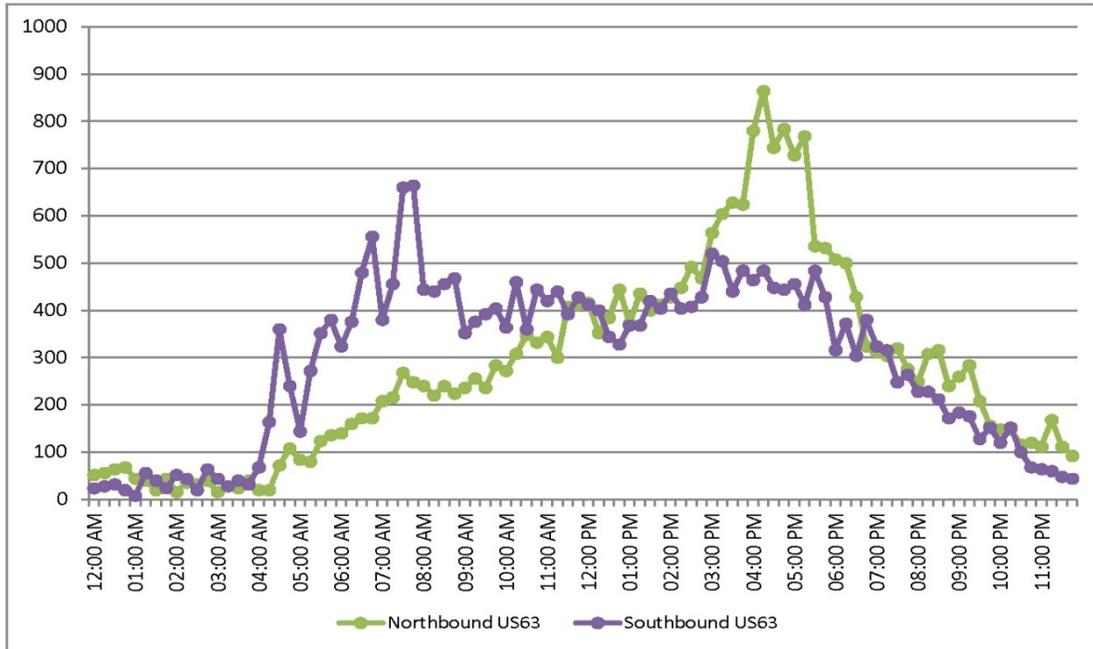
The purpose of this memorandum is to provide additional reference and detail regarding the mobility related information included in the Red Wing US 63 Bridge Project Purpose and Need statement. Prior to the initiation of the Red Wing Bridge Project two traffic studies were conducted in the study area. The Downtown Red Wing Transportation Study was completed in May 2005; it examined travel patterns and traffic circulation in the downtown Red Wing area. The US 63 Bridge Origin-Destination (O-D) and Traffic Circulation Study was completed in 2011; it examined travel patterns and traffic circulation in relation to the bridge traffic. Both previous studies serve as additional reference for traffic conditions in and around the US 63 river bridge.

### BACKGROUND/EXISTING CONDITIONS

The existing conditions were documented in the US 63 Bridge Origin-Destination (O-D) and Traffic Circulation Study; it examined travel patterns and traffic circulation in relation to the bridge traffic concerns at the downtown intersections. For more detailed information please see the final report. Since the 2011 document, the crash history was updated for the latest 5-years of data including 2008 through 2012.

The 2010 existing 24-hour directional traffic information was analyzed to determine the existing duration of peak hours in the project area. Two locations were analyzed; US 63 on the river bridge and US 61, west of Fulton Street. The following graphs show the 15-minute traffic demands, represented as an hourly flow rate (Y-axis) from the 2010 traffic counts.

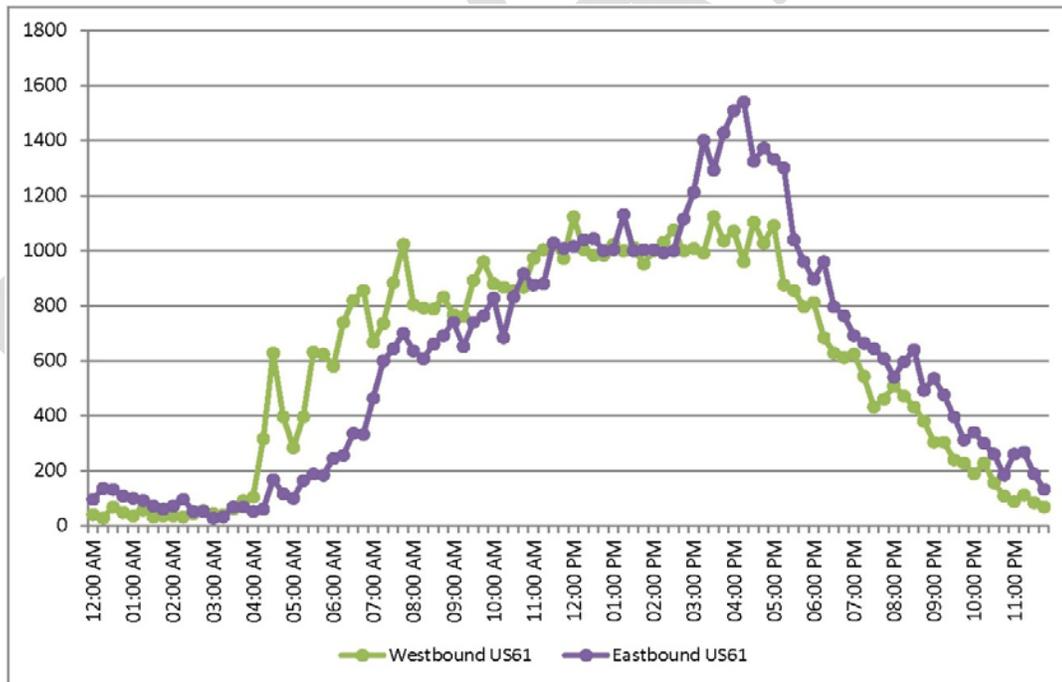
The US 63 bridge volume has a high directional split. There is a southbound jump in traffic during the AM peak hour. During the evening peak period, higher traffic volumes last from approximately 2:00 pm to 6:00 pm.



Note: 15-minute traffic demands represented as Hourly Flow Rates

**US 63 2010 Peak Spreading**

The US 61 volume has a more evenly distributed traffic demand west of downtown Red Wing; with the exception of the increase in demand for eastbound US 61 during the PM peak period from approximately 2:30 pm to 6:00 pm.



Note: 15-minute traffic demands represented as Hourly Flow Rates

**US 61 2010 Peak Spreading**

The volume increase along eastbound US 61 in the PM peak period corresponds to the same increase on the US 63 river bridge. With an increase in background traffic over time, it should be expected that the peak congested periods will spread out to occupy more time of the day.

### MOBILITY ISSUE 1 - QUEUE LENGTHS

Queue spill-back can have a substantial impact on traffic operations, especially for closely spaced intersections and for intersections with short turn lanes, which are common in the downtown Red Wing area. The SimTraffic program accounts for queue spill-back effects, and, for this reason, the SimTraffic results were used for reporting level of service (LOS) and queuing information.

Vehicle queues in the downtown commercial/historic district have been observed to extend through many intersections and disrupt traffic operations, pedestrian activity, local traffic, and on-street parking maneuvers. The high number of semi-trailer vehicles can quickly absorb the short stacking distance between intersections and the tight turns make their maneuvers very slow and extend the queues.

Traffic approaching the Plum Street and 3rd Street intersection, the main intersection accessing to and from the US 63 River Bridge, has been observed to extend into adjacent intersections in all directions at times. The most impacted route was in the PM peak hour for eastbound traffic along US 61 that must turn right at Plum Street and then an immediate left at 3rd Street. The queues along this route continually extend beyond the US 61 and East/West Avenue intersection.

In 2022, Synchro/SimTraffic modeling indicates that the eastbound route to the US 63 Bridge would extend approximately 1,200 feet from the intersection; the US 63 River Bridge approach to Plum Street would also have a long queue of 600 feet. In 2042, the eastbound route would extend further to approximately 2,000 feet and the US 63 approach would extend to 900 feet.

Figures A and B represent the extents of the queuing that extend from the Plum/3rd Street intersection for both 2022 and 2042. These queue lengths provide the basis for establishing the boundaries for the overall traffic mobility analysis study area, and the 'logical termini' for the Minnesota approach portion of the US 63 project. That is, US 61 from West/East Avenue to the US 63 overpass, US 63 from 500 feet south of the south end of the river bridge, and MN 58 from US 61 to 4th Street.

**Figure A – Year 2022 Peak Hour Traffic Queue Lengths**

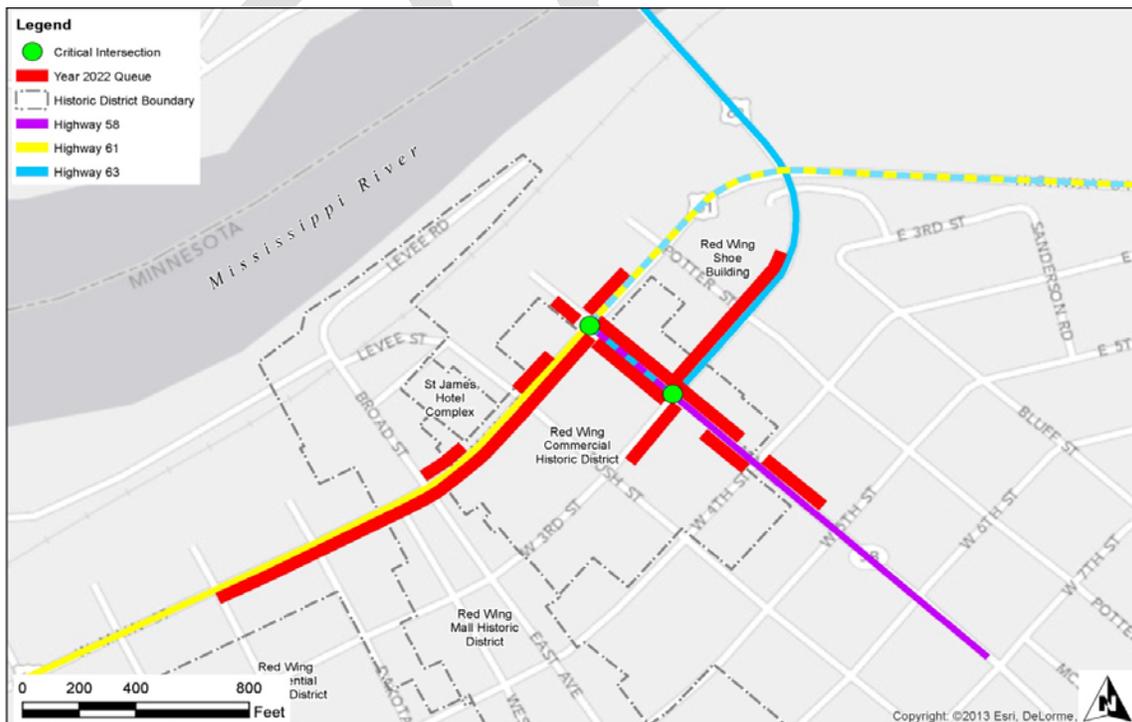
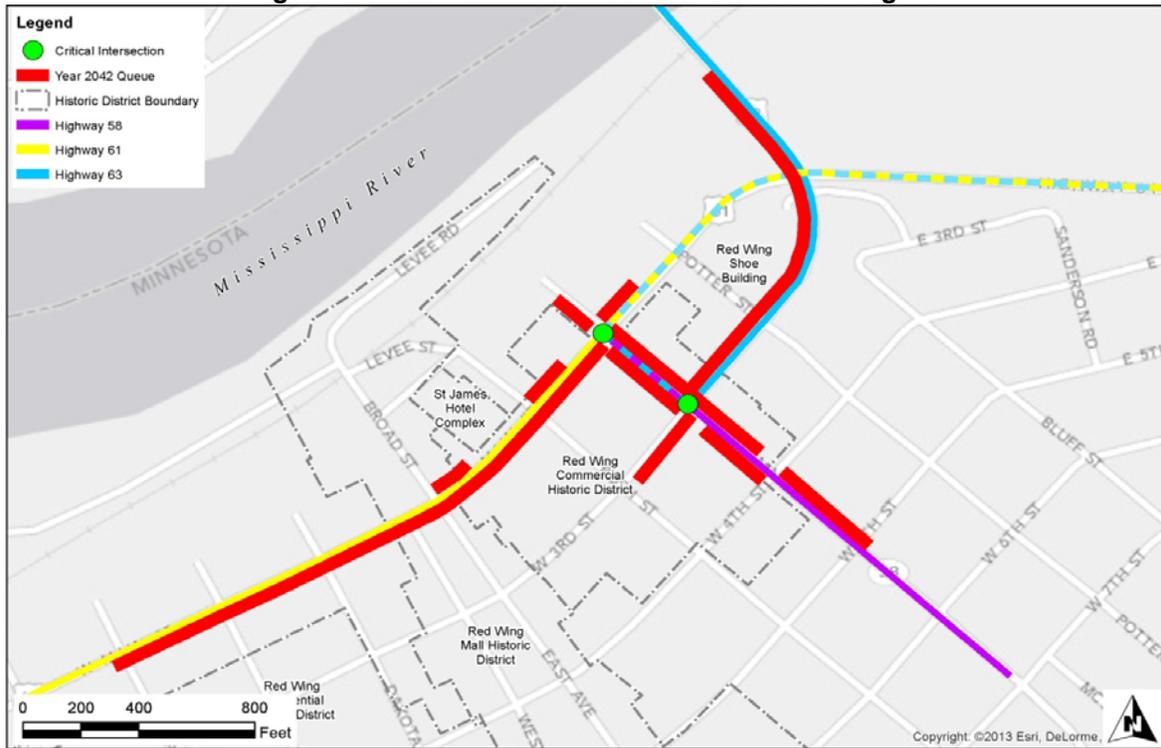


Figure B – Year 2042 Peak Hour Traffic Queue Lengths



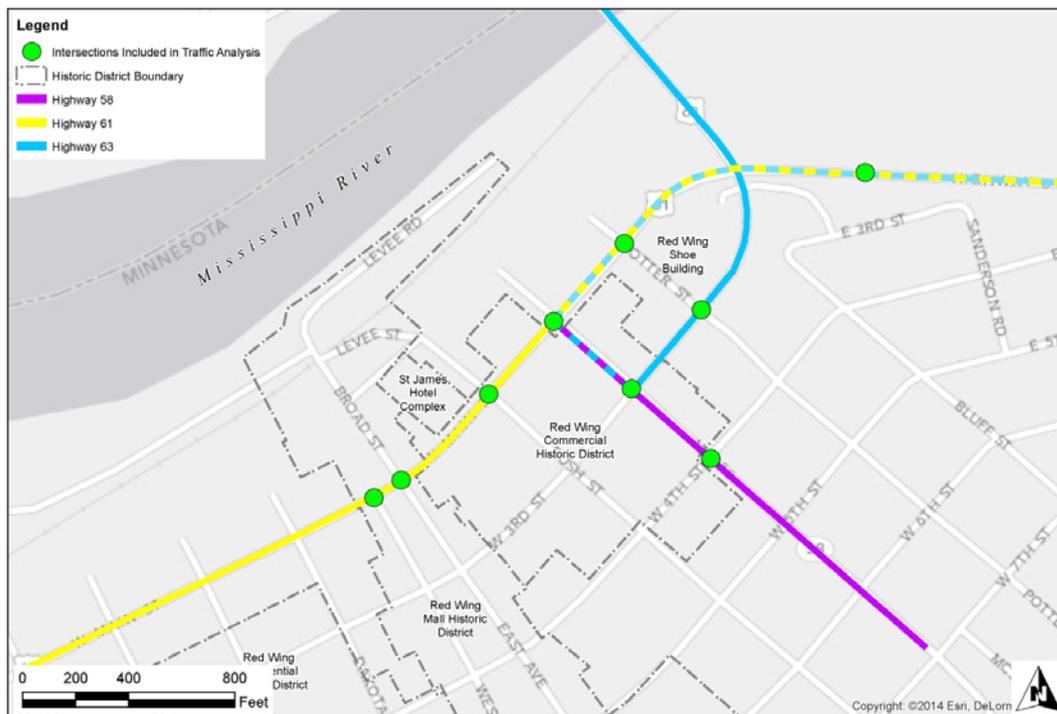
## MOBILITY ISSUE 2 - OVERLAPPING TRUNK HIGHWAYS

The existing roadway network in Downtown Red Wing not only includes high traffic demands, heavy trucks and pedestrians, but the network includes overlapping highway designations. This configuration makes many of the long range, commercial routes cross in a tight downtown roadway network.

US 61 (Main Street) parallels the Mississippi River through Red Wing, but extends from north of the Twin Cities down to the state of Louisiana. US 63 begins in Wisconsin and crosses the Mississippi River into Red Wing, then it continues along US 61 into Lake City, where it continues south into the state of Louisiana as well. MN 58 extends from US 61 in Downtown Red Wing to Zumbrota and US 52.

In downtown Red Wing, all three of these highways converge together as shown in Figure C. As traffic comes together in the tight downtown roadway network, both the vehicular and heavy truck traffic must combine and navigate the tight turns and high pedestrian demands.

**Figure C – Trunk Highway Network and Intersections Analyzed**



**MOBILITY ISSUE 3 - NETWORK TRAFFIC ANALYSIS**

Due to the closely spaced intersections in the downtown grid network, intersection operations inside the modeled network could show acceptable operations even when there are network-wide issues. That is because only the delay and queuing between each intersection is included in the modelled intersection operations results. Even if a queue extends through an adjacent intersection, the max queue reported in the model is only the distance between each intersection. The same is true for the delay, only the delay incurred on the segment between the intersections is counted. In a grid of closely spaced intersections, the outside intersections tend to incur the most delay as their operations essentially meter traffic into the network.

While the traffic operations model has the typical intersection operations outputs, it also includes a network-wide summary that includes all of the roadways (trunk highway and non-trunk highway) included in the network. The network wide performance measures include total delay time for all vehicles, travel time for all vehicles (includes both moving time and delay times), and average speeds across all roads.

Table 1 represents the No Build conditions for the 2022 and 2042 forecast years. While the AM peak hour has only a modest increase in total delay, the PM peak hour has a substantial increase of approximately 600% delay. This relates directly to the decrease in average speeds on all of the roads in the network.

**Table 1 - Network Performance**

Forecast Year	Peak Hour	Total Delay (Hours)	Travel Time (Hours)	Average Speed (mph)
2022	AM	27.9	81.2	18
	PM	74.4	155.3	14
2042	AM	38.0	99.3	17
	PM	563.7	642.7	7

**MOBILITY ISSUE 4 - EXAMPLE TRIP ROUTES**

To better illustrate how the increase in delay on the network wide performance impacts users, individual routes were looked at to determine the increase for specific trips.

Based on existing traffic patterns and the origin-destination study, the through trip with the highest demand is between west of Downtown Red Wing and the US 63 River Bridge (see attached O-D study graphics – Figures C3 and C4). For this reason, this trip was used as the “example” trip.

Table 2 shows the change in travel time and queues a vehicle would encounter on this route.

**Table 2 - Year 2022 Travel Between River Bridge and US 61/Broad Street**

	River Bridge to US 61/Broad Street		US 61/Broad Street to River Bridge	
	Total Traffic Queue Length (feet)	Total Travel Time (sec)	Traffic Queue Length (feet)	Total Travel Time (sec)
AM Peak Hour	1,080	40	840	53
PM Peak Hour	1,340	64	1,730	144

**Year 2042 Travel Between River Bridge and US 61/Broad Street**

	River Bridge to US 61/Broad Street		US 61/Broad Street to River Bridge	
	Total Traffic Queue Length (feet)	Total Travel Time (sec)	Traffic Queue Length (feet)	Total Travel Time (sec)
AM Peak Hour	1,460	58	940	59
PM Peak Hour	1,850	145	9,650	1291 <sup>1/</sup>

Note: 1/ Total travel time reflects impact of network breaking down resulting in gridlock through cross-streets.

2/ Travel time reflected in tables is total travel time for the routes, including stopped plus moving time.

**ISSUE 5 - ROADWAY GEOMETRICS AND DESIGN ISSUES**

Field reviews were conducted in 2012 as part of the previous project to determine any design or operational deficiencies, including sight distance and turning radii. The following issues were raised for the three main intersections of concern:

**US 61 (Main Street) & US 63 (Plum Street)**

- On the eastbound US 61 approach, the outside thru lane is wide enough for two lanes, and motorists use the approach as if there were a thru and a right turn lane.
- The curb radius in the southwest and southeast corners of the intersection are too short for right-turning trucks. To compensate for the short radius in the southwest corner, the southbound accepting lane on Plum Street is very wide (wide enough for two lanes), which leads to vehicle positioning issues on Plum Street.

**US 63 (Plum Street) & 3rd Street**

- The curb radius in the northeast and southeast corners of the intersection are too short for right-turning trucks. To compensate for the short radius in the northeast corner, the southbound approach stop line has been marked at a location approximately 50 feet north of the intersection. However, field observations indicated not all traffic was complying with this marked stop line location.
- On the west leg of the intersection, there are no centerline or lane line markings. This leads to vehicle positioning confusion for motorists.
- On the east leg of the intersection, both the eastbound and westbound directions have very wide lanes. This leads to vehicle positioning confusion for motorists.
- For vehicles on the eastbound and northbound approaches, sight distance for vehicles attempting to make a right-turn-on-red can be limited by on-street parking on the west and south legs of the intersection.

#### US 63 & Potter Street

- Potter Street north of the intersection is a one-way street southbound and the southbound Potter Street approach at the intersection is over 50 feet wide. There are no lane line markings on this section of Potter Street, which leads to vehicle positioning confusion for motorists on this approach.
- Intersection sight distance for southbound Potter Street looking east along US 63 is about 250 feet. Though this distance provides sufficient stopping sight distance for westbound vehicles on US 63 (Note the posted speed limit on US 63 is 30 mph.), it does not provide the desirable intersection sight distance (approximately 400 feet) for Potter Street vehicles crossing US 63. Improving sight distance in the northeast corner of the intersection will prove difficult since the sight distance is being limited by a building in this corner.

#### MOBILITY ISSUE 6 - INTERSECTION OPERATIONS ANALYSIS

The traffic operations analyses were performed using the Synchro/SimTraffic (version 7) software package for stop sign controlled and signalized intersections. For signalized and unsignalized intersections, Synchro/SimTraffic uses the methods outlined in the 2000 Highway Capacity Manual (HCM).

The analysis indicates the major traffic bottleneck appears to be the segment of Plum Street between Main Street and 3rd Street. The problems are worse during the PM peak hour. The concerns at the US 61/East Avenue/West Avenue intersection and US 61/Bush Street intersection are primarily due to traffic backups from the US 61/Plum Street intersection.

The study area includes four signalized intersections in downtown Red Wing including the 3 signals along US 61 at East/West Avenue, Bush Street and Plum Street; the fourth signal is at the Plum/3rd Street intersection. Additional intersections included Plum Street at 4th Street and Potter Street at both 3rd Street and US 61. All of the intersections were included based on the main routes to and from the US 63 River Bridge. Traffic operations analyses were conducted for the seven study intersections to determine the level of service (LOS), delay, and queuing information for No Build (2022 and 2042) conditions during the AM and PM peak hour.

The study intersections included in the traffic operations analysis are as follows:

- MN 58 (Plum Street) & 4th Street
- US 61 (Main Street) & East Avenue/West Avenue
- US 61 (Main Street) & Bush Street
- US 61 (Main Street) & US 63/MN 58 (Plum Street)
- US 61/US 63 (Main Street) & Potter Street
- US 63/MN 58 (Plum Street) & US 63/3rd Street
- US 63 (3<sup>rd</sup> Street) & Potter Street

The intersection of Plum Street and 3rd Street has a very high demand of traffic in the PM peak hour making a left turn from Plum Street to US 63; the majority of this traffic comes from eastbound US 61. The combination of movements from the eastbound US 61 to Plum Street right turn, and from the Plum Street to US 63 left turn cause a large stacking effect along both roadways. The stacking queue along US 61 spills upstream through the East/West Avenue intersection and beyond.

The intersection operations for the No Build forecast years show the AM peak hour functioning adequately for both the 2022 and 2042 forecast years. In 2022, the PM peak has acceptable operations at all intersections; however there are some left turn movements that have delays that operate at a LOS E; these include the eastbound and westbound lefts at US 61/East/West Avenue, the westbound left turn at US 61/Plum Street, and the southbound and eastbound left turns at Plum Street/3rd Street.

In 2042 during the PM peak, when all of the turning movements are high, traffic operations suffer substantially. Five of the seven intersections operate with failing levels of service, with the East/West Avenue intersection having an average of 8 minutes of delay for every vehicle at the intersection.

#### No-Build Failure Analysis

Based on the previous traffic work for both the 2022 year of opening and the 2042 design year, the AM peak hour intersection operations are better than the PM peak hour, with a few exceptions. Since the majority of the poor operations occur in the PM, this analysis focuses on the PM peak hour.

Traffic volumes were developed for interim years between 2022 and 2042 in four year increments, based on linear growth. Traffic simulation models were created for the PM peak hour to determine when each concept has a failing intersection.

The previous analysis indicated that the primary issues occurring during the 2022 PM peak hour under the No Build condition would be traffic queues exceeding their available storage lengths at intersections. The No Build does include the programmed changes that have or will occur to the network in the next 5-years or less; the main improvement being a southbound left turn phase at the Plum Street and 3rd Street intersection.

Based on the incremental analysis, 2026 is the first forecast year a downtown intersection reaches LOS E, which would be at the US 61 and East/West Avenue intersection. The same intersection reaches LOS F by 2030 as traffic from downtown spills back through the intersection. Between 2030 and 2042 many of the intersection approaches will fail and the queuing between intersections will become severe. As noted previously, by 2042, five of the seven downtown intersections would operate under failing conditions during the PM peak hour.

Although 2026 is the first year an intersection would reach LOS E, there are operational problems that occur under existing conditions and show up as early as the 2022 analysis. The first issue is at the intersection of 3rd Street and Potter Street where the southbound approach has too few gaps to enter onto 3rd Street and the approach operates at a LOS F by 2022. This is a fairly low volume road and traffic would most likely change their route.

The second issue is the queuing and stacking that would occur between intersections. The maximum queues along US 61 heading eastbound into downtown Red Wing would spill back between intersections as early as 2022, but really would become an issue by 2026 and beyond. In 2022, the eastbound approach to Plum Street would occasionally spill into the Bush Street intersection. By 2026, that queue would extend to the East/West Avenue intersection, causing major delays.

A third issue is the influence of the queuing from the northbound approach of Plum Street to 3rd Street. The queue would constantly impact the Plum Street and 4th Street intersection where traffic destined north on Plum Street is controlled by the queue stack. This problem would become prevalent by 2034 where the northbound Plum Street approach to 4th Street would operate at a LOS F; by 2038 the intersection would fail.

Table 3 summarizes the intersection delay and level of service for the No Build conditions

**Table 3 - Intersection Traffic Operations  
 Delay (sec)/LOS**

Intersection	Traffic Control	2022		2042	
		AM Peak	PM Peak	AM Peak	PM Peak
US 61 at East/West Ave	Signal	13.1 / B	25.1 / C	13.2 / B	<b>419.3 / F</b>
US 61 at Bush St	Signal	10.6 / B	20.0 / C	11.1 / B	<b>86.3 / F</b>
US 61 at Plum St	Signal	20.6 / C	29.3 / C	24.7 / C	<b>57.1 / E</b>
US 61 at Potter St	Two-Way	1.3 / A	2.0 / A	1.3 / A	20.3 / C
Plum St at 3 <sup>rd</sup> St	Signal	15.1 / B	34.8 / D	19.9 / B	<b>125.2 / F</b>
Plum St at 4 <sup>th</sup> ST	All-Way	8.3 / A	14.0 / B	9.5 / A	<b>117.0 / F</b>
3 <sup>rd</sup> St at Potter St	Two-Way	3.9 / A	6.4 / A	7.8 / A	17.7 / C

Note: 1/ Delay times reflected in Table 3 include total delay for all approaches.

Although the traffic operations outputs from Synchro/SimTraffic, described above, show operational problems occur as early as 2022, the actual existing conditions observed in the field are worse than the analysis shows due to several factors. These are factors that have an impact on traffic operations that are not fully accounted for in the Synchro/SimTraffic model. These factors include:

- **Network:** The overlapping of highways and closely spaced intersections with high-volume turning movements are accounted for in the model. However the many access driveways throughout the network are not accounted for and can result in worse operations at the different intersections.
- **Geometrics:** Several corner radii are very tight for trucks, which results in encroachment and difficulties in turning. Turning speeds were adjusted in the model to reflect some of the tight radii; however there are times when trucks cannot proceed due to their turn being blocked, which is not accounted for in the model.
- **Pedestrian conflicts:** The relatively high volume of pedestrians results in pedestrian/vehicle conflicts which affects both traffic capacity and pedestrian safety. Pedestrian conflicts are accounted for in the model; however this may not represent the sporadic nature of pedestrians crossing during the entire phase.

#### MOBILITY ISSUE 7 - TRUCK TURNING

Existing counts show approximately 1,200 trucks utilize the US 63 River Bridge on a daily basis. All of these trucks must utilize the Plum Street and 3rd Street intersection in downtown Red Wing to get to and from the bridge; which require left and right turn movements at a geometrically tight intersection. These trucks comprise approximately 9% of the daily bridge traffic. Given the potential for growth in the silica sand mining industry, an additional 300 trucks per day was added to both the 2022 and 2042 forecast traffic demands, based on discussions with the City of Red Wing. This volume is much lower than what could actually occur in the future if most of the potential silica sand mining locations begin operation. This volume was chosen to avoid overestimating the number of trucks while still trying to estimate the potential increase in truck traffic above background growth. Based on the existing data of 6% of the truck traffic occurring in the both the AM and PM peak hours, an increase of 300 daily trucks would result in 18 additional trucks in the peak hours; 10 in the AM peak hour and eight in the PM peak hour.

The increase in semi-truck traffic in the peak hours would result in reduced travel times and increased delays for all vehicles in the downtown Red Wing roadway grid as the trucks make their way through the tight network of streets.

Truck turning movements, particularly the right-turns, are especially problematic at the southwest quadrant at US 61/MN 58 and the northeast quadrant at MN 58/3rd Street intersections because the constrained geometry forces semi-trucks to ride onto the adjacent sidewalks and/or encroach into the opposing traffic lanes. This represents both a substantial safety issue and a mobility constraint. While

truck traffic in the AM and PM peak hours were included in the analysis, oversized trucks were not. While not a regular occurrence, these trucks have a substantial impact on mobility as they may require closing intersections along their path in order to navigate through the downtown

#### **MOBILITY ISSUE 8 - PEDESTRIAN CONFLICT**

Currently, three of the four downtown signalized intersections (US 61/Plum Street, US 61/Bush Street, and US 61/Broad Street) operate with pre-timed control and simple 2-phase signal operations. This means that the pedestrian walk phase comes up every cycle during the corresponding phase and allows pedestrians to cross the intersection. Since these signals have only a green ball for the vehicle traffic, there is no protected phase for the vehicular turning movements. This adds delay time to the vehicular traffic waiting for a pedestrian in the cross walk and can have a substantial impact on mobility given the high number of pedestrians in the downtown area.

The Plum Street/3rd Street intersection is the only downtown signalized intersection that has a protected left turn phase, which is for the southbound Plum Street left turn. As noted by city staff, this is one of the main intersections in the downtown for pedestrian volumes. The heavy pedestrian volumes at this intersection increases delay for the two phases that are not protected, which further degrades traffic operations on the overall network

#### **MOBILITY ISSUE 9 - LOCAL STREET DELAYS**

As congestion builds in the downtown grid network, many of the local routes also become blocked by traffic on the major routes to and from the bridge. As can be seen in from Figures A and B, the trunk highway queues spill back through several intersections and block vehicles on the local streets from entering the trunk highway network. In 2022, this would occur at seven intersections and by 2042 nine intersections along the trunk highway network would be affected. This would increase delay on the local streets and impacts mobility throughout the downtown street network.

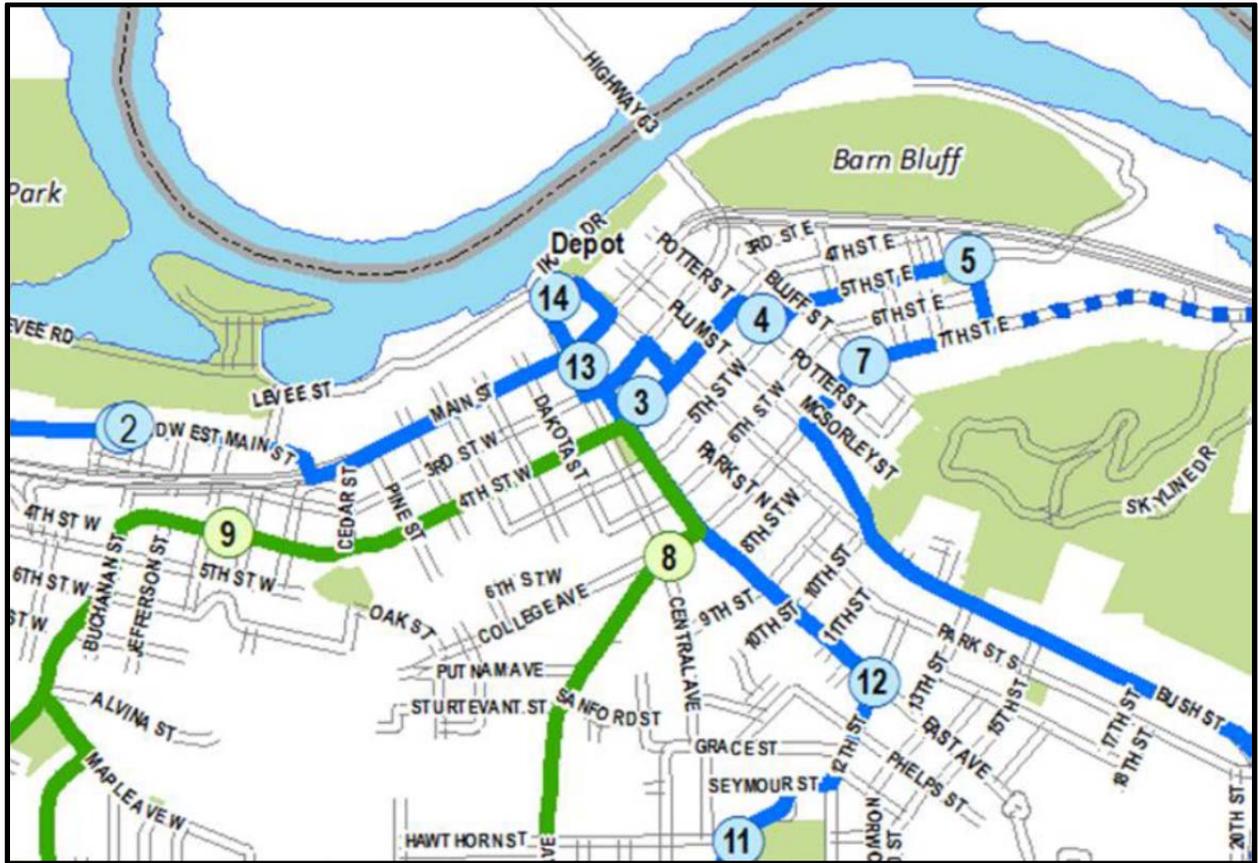
In addition to the direct impacts from trunk highway queues, the mobility challenges often causes local traffic to divert to alternate routes off of the highway network to access the US 63 bridge. This would lead to even more delays in the downtown network.

One of the biggest impacts from the highway queues is to trips from the bridge that want to cross US 61 or Plum Street to local streets in order to access employment and retail destinations in the downtown core. These local trips can be substantially delayed due to the congestion from the bridge traffic.

#### **MOBILITY ISSUE 10 – TRANSIT SERVICE**

The City of Red Wing's Hiawathaland Transit service runs weekday regular route bus operations throughout the community, including the downtown area (see Figure D). Two of the routes (blue and green routes on figure) serve downtown destinations. The bus routing provides a further illustration of the substantial mobility challenges in the downtown area in that the bus routes have been designed to avoid Highways 58, 61, and 63 in the core downtown commercial/historic district area.

Figure D – Hiawathaland Bus Routes



### MOBILITY ISSUE 11 – PEDESTRIAN AND BICYCLIST ACCOMMODATIONS

City staff have identified and documented a substantial amount of pedestrian traffic in the commercial/historic district due to shopping, businesses, and tourism. City staff anticipates the amount of pedestrian traffic will continue to increase because of on-going coordinated efforts to attract non-motorized traffic in downtown. These efforts are documented in a broad set of planning documents including the Bicycle and Pedestrian Master Plan completed in 2011.

In these documents, the City of Red Wing has identified several barriers to pedestrian mobility in the downtown, as documented in the Bicycle and Pedestrian Master Plan. Three of the primary problems specifically identified are 1) wide intersections, 2) automobiles turning into pedestrians, and 3) high volumes of automobile traffic. The four intersections identified as difficult crossings are US 61/Plum Street, US 61/Bush Street, US 61/Broad Street, and Plum/3rd Street.

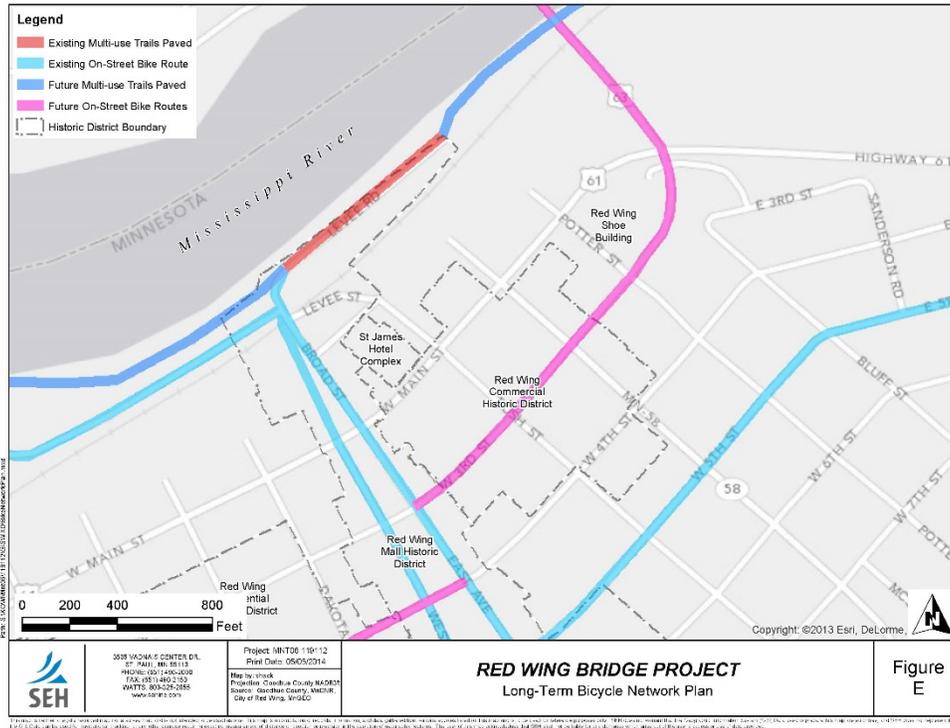
Figure E (Difficult Pedestrian Crossings Locations) highlights the critical pedestrian crossing intersections and shows some of the pedestrian destinations besides the downtown businesses. The city parks are noted in green, the difficult crossing intersections are in red, and the school is in blue.

In addition, the city has developed an existing and future bicycle plan. Figure F (Long Term Bicycle Plan) illustrates the challenges with bicycle mobility in the downtown as the routes have been designed to avoid the area. The Mississippi River Trail has also been designed to avoid US 61 in the downtown as can be seen on Figure G – Mississippi River Trail. However, since Highway 35 in Wisconsin is also a destination for bicyclists they must access US 63 at some point in the downtown area to use the river crossing.

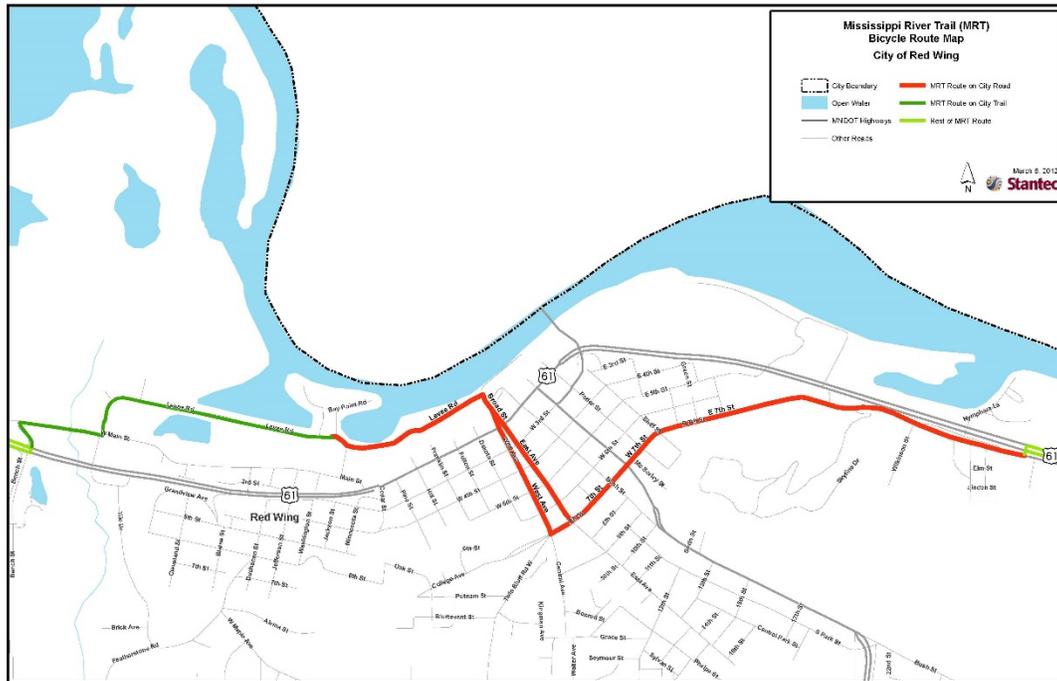
**Figure E – Difficult Pedestrian Crossing Locations**



**Figure F – Long-Term Bicycle Network Plan**



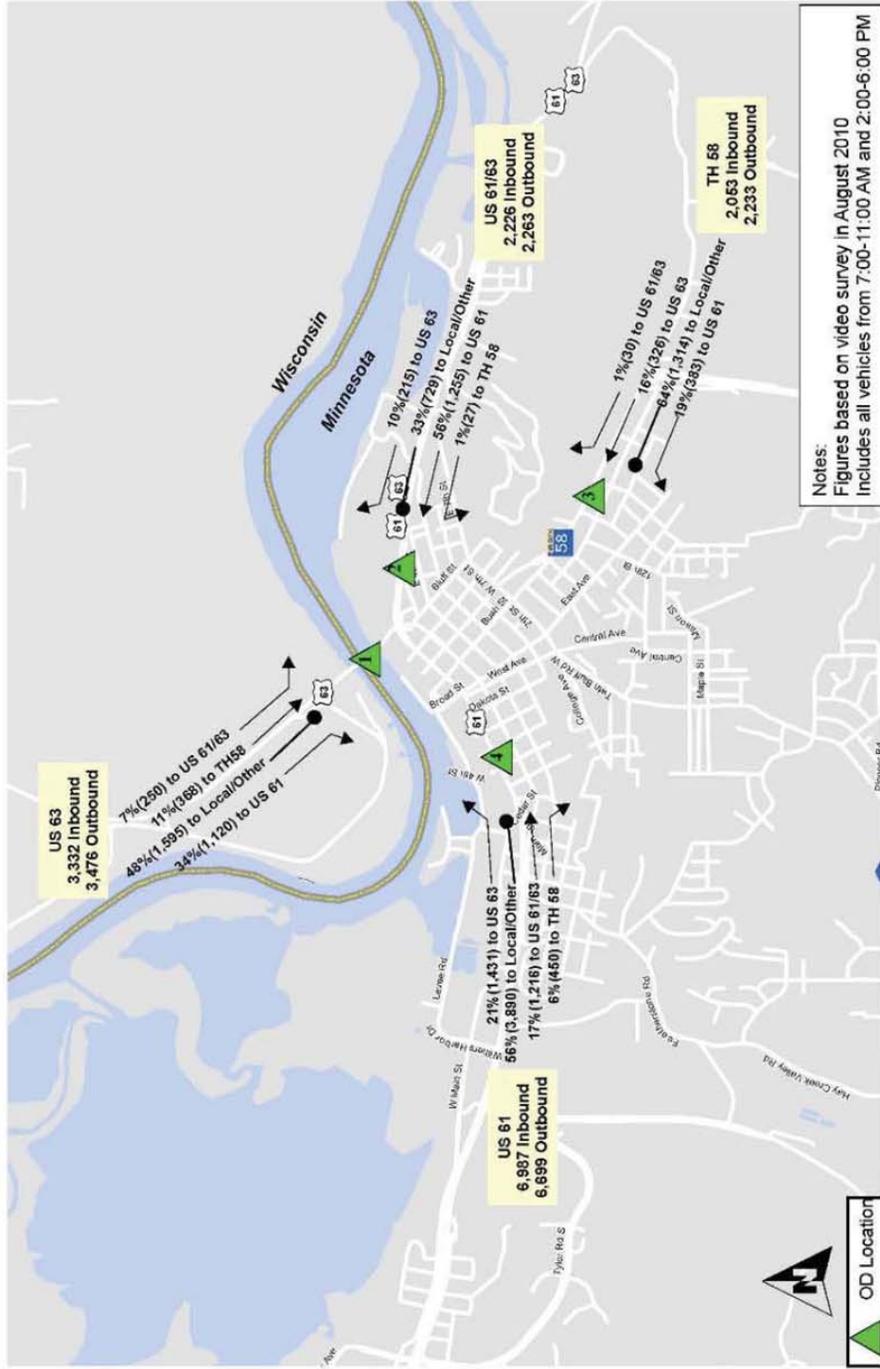
**Figure G – Mississippi River Trail**



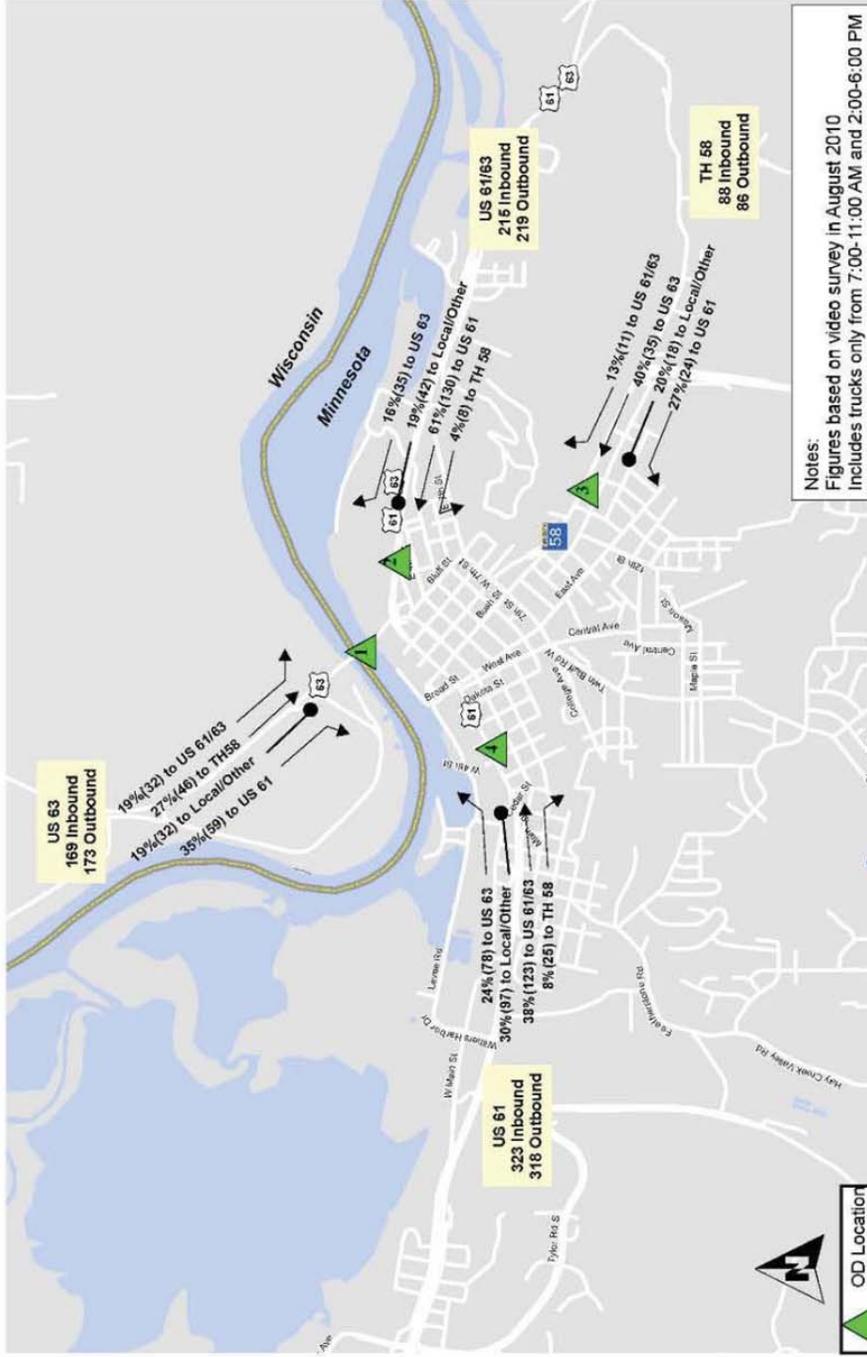
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**FIGURE C3**  
US 63 Bridge Area Origin - Destination and Traffic Circulation Study OD Survey Results for All Vehicles  
Red Wing, Minnesota



**FIGURE C4**  
US 63 Bridge Area Origin - Destination and Traffic Circulation Study  
Red Wing, Minnesota  
OD Survey Results for Trucks

