Chapter 6
SOUTHWEST REGION SUMMARY
FREEWAY CONGESTION & RELIABILITY REPORT > Southwest Region

PROLOGUE

Since 2014, the Michigan Department of Transportation (MDOT) has used probe vehicle data to create an annual Freeway Congestion and Reliability Report. The probe vehicle data is collected anonymously from GPS enabled devices and in-vehicle telematics to provide real time speeds on roadways nationwide. Probe vehicles provide an enormous amount of data which can be difficult to manage, maintain, and analyze. The University of Maryland Center for Advanced Transportation Technology (CATT) Lab developed a visual analytics platform called the Regional Integrated Transportation Information System, or RITIS. This tool allows MDOT to monitor speeds, incidents, weather, special events, and many other data sources. Using the RITIS platform, the data was processed and compiled into a report summarizing all freeway routes in Michigan.

This report is composed of eight chapters. The first chapter summarizes the performance measures and statewide metrics. The remaining seven chapters use those performance metrics to characterize congestion in each of MDOT’s seven regions. This document is for internal use to help MDOT regions, Transportation Service Centers (TSC), and planners understand how Michigan freeways are operating over time, as well as where potential improvement projects may be necessary. This report is typically used as a starting point for more detailed analysis incorporating additional probe data, as well as other MDOT resources. If your area has plans to share this information externally, please contact the Congestion and Mobility Unit to ensure the correct measures are being used.

The report was prepared by the Wayne State University Transportation Research Group under the guidance of the Congestion and Mobility Unit at MDOT. Please contact the Congestion and Mobility Unit if you have any questions/comments or would like to have the actual data for further analysis.

ACKNOWLEDGEMENTS

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INTRODUCTION

The purpose of this document is to provide an overview of performance on Michigan freeways. Using probe vehicle data and systematic performance measures, a series of visualizations were created for each region in the state. Chapter 6 of this report provides an overview of the Southwest Region. Southwest Region is made up of 7 counties and contains the city of Kalamazoo. Five freeways are analyzed in the section below.
PERFORMANCE MEASURES DEFINITIONS

The probe data alone provides representative speeds on predefined segments of roadway every minute. Although this data is rich, it provides limited use to engineers and practitioners without well-defined aggregation techniques. Performance measures are growing in the transportation arena to better monitor traffic conditions, improve traveler information, and identify congested areas with the aim of improving operations on roadways. A summary of the performance measures used in this report can be seen in Table 1.

The goal of these performance measures are to quantify both the delay and reliability of the freeway network in Michigan. In this report, delay is quantified when the speed drops below 60 MPH, which is at least 10 MPH lower than the posted speed limit for the freeways (Figure 4). On segments with a speed limit of 55 MPH, delay is calculated when speed falls below that threshold. The lower the value is, the better the freeway segment is operating. The other element of interest is reliability. Reliability is a measure of the consistency of a travel time on a roadway. A roadway that has the same travel time every day is said to be reliable, while a roadways where the travel time varies greatly is said to be unreliable. MDOT’s goal is to provide reliable travel times with minimal delay. This is done through roadway improvement projects including additional lanes, pavement improvements, and adding intelligent transportation systems. These projects can reduce the travel time and also improve the travel time reliability. An example of this is shown in Figure 5.
Delay can also be represented by converting the user delay into a cost. The delay is multiplied by the number of vehicle that experience that delay. The hourly volumes are derived from Average Daily Traffic (ADT) and Commercial Average Daily Traffic (CADT). Hourly user costs are based on Federal Highway Administration (FHWA) publication number FHWA-SA-98-079, “Life-Cycle Cost Analysis in Pavement Design.” The values used in this report are shown in Table 2.
**TABLE 1. Performance Measures of Interest**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL DELAY</strong></td>
<td>Total delay is calculated by taking the difference between actual speeds when they fall below 60 MPH and the posted speed limit for freeways posted at 70 MPH. This is to take out the delay caused by the lower average speeds from commercial vehicles.</td>
</tr>
<tr>
<td><strong>TOTAL DELAY PER MILE</strong></td>
<td>Total delay per mile is calculated by taking the total delay and dividing it by the length of the freeway. This was performed for each route in each county.</td>
</tr>
<tr>
<td><strong>USER DELAY COST</strong></td>
<td>User Delay Costs (UDC) is calculated by multiplying delay x hourly volume per hourly user cost. Delay is calculated by taking the difference between actual speeds when they fall below 60 MPH and the posted speed limit.</td>
</tr>
<tr>
<td><strong>AVERAGE SPEED</strong></td>
<td>Average speed is determined by calculating the space mean speed of the worst ranked hour in the weekday AM peak (6:00 AM - 9:00 AM) and weekday PM peak (3:00 PM - 7:00 PM) periods for each segment of roadway. This is compared to the space mean speed of the previous five year period for the same hour.</td>
</tr>
<tr>
<td><strong>CONGESTION SEVERITY</strong></td>
<td>Congestion severity is calculated based on the worst hourly average speed experienced during the AM or PM peak period per traffic message channel (TMC) segment. A TMC segment is a standard for delivering real-time traffic information. They vary from tenths of a mile long to several miles long.</td>
</tr>
<tr>
<td><strong>TRAVEL TIME RELIABILITY</strong></td>
<td>Travel time reliability is a measure of travel time consistency over a period of time. When travel times are unreliable, customers are more likely to experience unexpected delays. Travel times are shown to be reliable when the 95th percentile travel time remains close to the average travel time.</td>
</tr>
<tr>
<td><strong>AVERAGE TRAVEL TIME</strong></td>
<td>The amount of time a customer should budget to be on-time on average.</td>
</tr>
<tr>
<td><strong>95TH PERCENTILE TRAVEL TIME</strong></td>
<td>The amount of time a customer should budget to be on-time 19 out of 20 days (95% of the time). The 95th percentile travel time is also known as the planning time.</td>
</tr>
</tbody>
</table>

*Note: May 1st through September 30th were used for the summer reliability calculations.*

**TABLE 2. Historical Hourly User Costs**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>$17.09</td>
<td>$17.44</td>
<td>$17.70</td>
<td>$17.98</td>
<td>$18.00</td>
<td>$18.23</td>
</tr>
<tr>
<td>Commercial</td>
<td>$30.14</td>
<td>$30.77</td>
<td>$31.22</td>
<td>$31.73</td>
<td>$31.76</td>
<td>$32.26</td>
</tr>
</tbody>
</table>
PERFORMANCE MEASURES VISUALIZATIONS

Performance measure visualizations provide an easy to use graphic representation of the performance measures listed above. In this report four main visualizations are used, which are explained in detail below.

USER DELAY COST

Figure 3 is an example of the user delay cost graph. This figure represents US-131 through Kalamazoo County in the Southwest Region. The user delay cost visualization displays which months are incurring the most UDC, while comparing how UDC patterns change from a 5-year historical average to the current year. Figure 3 shows the following:

- a) 5-year historical average user delay cost (2012-2016).
- b) Current year user delay cost (2017).
- c) Total user delay cost in dollars.
- d) Month of year.
- e) Poor weather conditions in winter months severely impact the user delay cost.
- f) Example of the current year outperforming the 5-year historical average in UDC.
- g) Example of summer months where construction may impact the delay of a corridor.
- h) Example of the current year underperforming the 5-year historical average in UDC.

![Figure 3. Example User Delay Cost Graph](image-url)
Figure 4 is an example of the average speed graph. This figure represents westbound I-94 through the Southwest Region. This performance metric visualizes the speeds on a given corridor during the AM and PM peak periods, along with a 5-year historical average of those speeds. Average speed graphs can display how morning and evening peak speeds can vary by time and magnitude. The following criteria was used in the making of these graphs:

a) Only weekdays (Monday – Friday) are included in the calculations.
b) The AM peak hour is the worst ranked hour between 6:00 AM – 9:00 AM.
c) The PM peak hour is the worst ranked hour between 3:00 PM – 7:00 PM.
d) The worst ranked hour is based on the lowest average speed and minimum speed experienced during the peak hours.

Figure 4 shows the following:

a) Legend.
b) Location of interchanges by exit/mile marker number.
c) Specific significant interchanges.
d) Direction of travel.
e) Average speed in MPH.
f) Example of low speed area during the PM peak while approaching US-131 interchange.
g) Example of location where PM peak speeds are lower than AM peak speeds.
h) Example of limited change in speed from year to year and time period to time period.
i) 2017 AM peak average speed is approximately 66 MPH at Exit 34.
j) Example of improvement in the current year as compared to the 5-year historical average.
FIGURE 4. Example Average Speed Graph
TRAVEL TIME RELIABILITY

Figure 5 is an example of the travel time reliability graph. This figure represents a portion of westbound I-94 through the Southwest Region. This performance metric displays the reliability of a given corridor over time. A segment is deemed “reliable” when the average and 95th percentile travel times are constant. A segment is deemed “unreliable” when the average and 95th percentile travel times differ by a large amount of time. Figure 5 shows the following:

a) The 95th percentile travel time reliability and the average (50th percentile) travel time reliability.
b) Amount of time it will take a vehicle to drive the entire corridor in minutes.
c) Time of day.
d) Small difference between average and 95th percentile travel times (reliable).
e) Large difference between average and 95th percentile travel times (unreliable).

FIGURE 5. Example Travel Time Reliability Graph
CONGESTION SEVERITY

Figure 6 shows an example of the congestion severity figure. This figure represents Southwest Region during the AM peak hour. This performance metric displays the amount of congestion on corridors during AM and PM peak periods by representing speeds in a color gradient. The color gradient consists of three different categories to distinguish severity levels:

a) Low (≥55 MPH).
b) Moderate (≥35 MPH & <55 MPH).
c) Severe (<35 MPH).

Figure 6 shows the following:

a) Location of no congestion in either direction during the AM peak hour.
b) Moderate congestion due to vehicles exiting US-31 through the off-ramp.

![2017 Congestion Severity](image_url)

**FIGURE 6. Example Congestion Severity Figure**
FIGURE 7. 2017 Southwest Region AM Peak Congestion Severity
2017 Congestion Severity

- **Low** ($\geq 55$ MPH)
- **Moderate** ($\geq 35$ MPH & $<55$ MPH)
- **Severe** ($<35$ MPH)

**FIGURE 8. 2017 Southwest Region PM Peak Congestion Severity**
### SOUTHWEST REGION: CONGESTION SEVERITY

#### TABLE 3. 2017 Congestion Miles by Severity - AM Peak

<table>
<thead>
<tr>
<th>Region</th>
<th>Low</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bay</td>
<td>788.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Grand</td>
<td>667.6</td>
<td>31.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Metro</td>
<td>391.6</td>
<td>189.4</td>
<td>39.0</td>
</tr>
<tr>
<td>Southwest</td>
<td>484.0</td>
<td>5.0</td>
<td>0.0</td>
</tr>
<tr>
<td>University</td>
<td>721.1</td>
<td>35.4</td>
<td>11.4</td>
</tr>
<tr>
<td>North</td>
<td>392.6</td>
<td>1.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Superior</td>
<td>99.1</td>
<td>2.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Total</td>
<td>3544.1</td>
<td>264.6</td>
<td>51.7</td>
</tr>
</tbody>
</table>

#### TABLE 4. 2017 Congestion Miles by Severity - PM Peak

<table>
<thead>
<tr>
<th>Region</th>
<th>Low</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bay</td>
<td>788.1</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Grand</td>
<td>659.3</td>
<td>27.9</td>
<td>11.7</td>
</tr>
<tr>
<td>Metro</td>
<td>364.0</td>
<td>167.5</td>
<td>88.4</td>
</tr>
<tr>
<td>Southwest</td>
<td>482.9</td>
<td>6.2</td>
<td>0.0</td>
</tr>
<tr>
<td>University</td>
<td>704.5</td>
<td>53.9</td>
<td>9.5</td>
</tr>
<tr>
<td>North</td>
<td>392.6</td>
<td>1.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Superior</td>
<td>97.8</td>
<td>3.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Total</td>
<td>3489.2</td>
<td>260.3</td>
<td>110.9</td>
</tr>
</tbody>
</table>
SOUTHWEST REGION: USER DELAY COST

FIGURE 9. Southwest Region User Delay Cost Trend
### TABLE 5. 2017 Southwest Region User Delay Cost Data

<table>
<thead>
<tr>
<th>Rank</th>
<th>Location (Route, County)</th>
<th>2017 Total UDC ($)</th>
<th>2012-2016 Average Total UDC ($)</th>
<th>Change in Total UDC ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I-94 Kalamazoo Co.</td>
<td>$5,082,000</td>
<td>$5,279,000</td>
<td>-$197,000</td>
</tr>
<tr>
<td>2</td>
<td>I-94 Berrien Co.</td>
<td>$4,691,000</td>
<td>$7,862,000</td>
<td>-$3,171,000</td>
</tr>
<tr>
<td>3</td>
<td>I-94 Calhoun Co.</td>
<td>$2,210,000</td>
<td>$4,161,000</td>
<td>-$1,951,000</td>
</tr>
<tr>
<td>4</td>
<td>I-94 Van Buren Co.</td>
<td>$1,875,000</td>
<td>$3,276,000</td>
<td>-$1,401,000</td>
</tr>
<tr>
<td>5</td>
<td>US-131 Kalamazoo Co. (70 MPH Section)</td>
<td>$1,229,000</td>
<td>$2,477,000</td>
<td>-$1,248,000</td>
</tr>
<tr>
<td>6</td>
<td>US-31 Berrien Co. (70 MPH Section)</td>
<td>$611,000</td>
<td>$794,000</td>
<td>-$183,000</td>
</tr>
<tr>
<td>7</td>
<td>I-196 Van Buren Co.</td>
<td>$357,000</td>
<td>$715,000</td>
<td>-$358,000</td>
</tr>
<tr>
<td>8</td>
<td>I-69 Calhoun Co.</td>
<td>$338,000</td>
<td>$988,000</td>
<td>-$650,000</td>
</tr>
<tr>
<td>9</td>
<td>I-69 Branch Co.</td>
<td>$295,000</td>
<td>$711,000</td>
<td>-$416,000</td>
</tr>
<tr>
<td>10</td>
<td>I-196 Berrien Co.</td>
<td>$274,000</td>
<td>$535,000</td>
<td>-$261,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>$16,962,000</strong></td>
<td><strong>$26,798,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Minor differences may occur due to rounding.*
### SOUTHWEST REGION: USER DELAY COST

**TABLE 6. 2017 Southwest Region User Delay Cost Data per Mile**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Location (Route, County)</th>
<th>2017 UDC Per Mile ($)</th>
<th>2012-2016 Average UDC Per Mile ($)</th>
<th>Change in UDC Per Mile ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I-94 Kalamazoo Co.</td>
<td>$98,000</td>
<td>$102,000</td>
<td>-$4,000</td>
</tr>
<tr>
<td>2</td>
<td>I-94 Berrien Co.</td>
<td>$52,000</td>
<td>$86,000</td>
<td>-$34,000</td>
</tr>
<tr>
<td>3</td>
<td>I-94 Calhoun Co.</td>
<td>$33,000</td>
<td>$62,000</td>
<td>-$29,000</td>
</tr>
<tr>
<td>4</td>
<td>I-94 Van Buren Co.</td>
<td>$31,000</td>
<td>$55,000</td>
<td>-$24,000</td>
</tr>
<tr>
<td>5</td>
<td>US-131 Kalamazoo Co. (70 MPH Section)</td>
<td>$29,000</td>
<td>$59,000</td>
<td>-$30,000</td>
</tr>
<tr>
<td>6</td>
<td>US-31 Berrien Co. (70 MPH Section)</td>
<td>$13,000</td>
<td>$17,000</td>
<td>-$4,000</td>
</tr>
<tr>
<td>7</td>
<td>I-196 Van Buren Co.</td>
<td>$12,000</td>
<td>$24,000</td>
<td>-$12,000</td>
</tr>
<tr>
<td>8</td>
<td>I-196 Berrien Co.</td>
<td>$11,000</td>
<td>$22,000</td>
<td>-$11,000</td>
</tr>
<tr>
<td>9</td>
<td>I-69 Branch Co.</td>
<td>$7,000</td>
<td>$16,000</td>
<td>-$9,000</td>
</tr>
<tr>
<td>10</td>
<td>I-69 Calhoun Co.</td>
<td>$5,000</td>
<td>$16,000</td>
<td>-$11,000</td>
</tr>
</tbody>
</table>

*Note: Minor differences may occur due to rounding.*
SOUTHWEST REGION: CORRIDOR GLOSSARY

- Interstate 69: Branch and Calhoun
  - Pg. 20
- Interstate 94: Berrien, Van Buren, Kalamazoo, and Calhoun
  - Pg. 24
- Interstate 196: Berrien and Van Buren
  - Pg. 32
- US-31: Berrien (70 MPH Section)
  - Pg. 36
- US-131: Kalamazoo (70 MPH Section)
  - Pg. 39
INTERSTATE 69: BRANCH AND CALHOUN

**a) Segment Map**

- **2012-2016 Average User Delay Cost - $711,000**
- **2017 User Delay Cost - $295,000**

**b) UDC Graph**

**FIGURE 10.** Branch County I-69 Corridor Total User Delay Cost
INTERSTATE 69: BRANCH AND CALHOUN

a) Segment Map

b) UDC Graph

FIGURE 11. Calhoun County I-69 Corridor Total User Delay Cost
FIGURE 12. Southwest Region I-69 Northbound
FIGURE 13. Southwest Region I-69 Southbound
INTERSTATE 94: BERRIEN, VAN BUREN, KALAMAZOO, AND CALHOUN

a) Segment Map

b) UDC Graph

FIGURE 14. Berrien County I-94 Corridor Total User Delay Cost
INTERSTATE 94: BERRIEN, VAN BUREN, KALAMAZOO, AND CALHOUN

a) Segment Map

2012-2016 Average User Delay Cost - $3,276,000
2017 User Delay Cost - $1,875,000

b) UDC Graph

FIGURE 15. Van Buren County I-94 Corridor Total User Delay Cost
INTERSTATE 94: BERRIEN, VAN BUREN, KALAMAZOO, AND CALHOUN

a) Segment Map

2012-2016 Average User Delay Cost - $5,279,000
2017 User Delay Cost - $5,082,000

b) UDC Graph

FIGURE 16. Kalamazoo County I-94 Corridor Total User Delay Cost
INTERSTATE 94: BERRIEN, VAN BUREN, KALAMAZOO, AND CALHOUN

a) Segment Map

b) UDC Graph

FIGURE 17. Calhoun County I-94 Corridor Total User Delay Cost
**FIGURE 18. Southwest Region I-94 Eastbound**
FIGURE 19. Southwest Region I-94 Westbound
INTERSTATE 94: TRAVEL TIME RELIABILITY

a) Southwest Region

b) Kalamazoo, Michigan

FIGURE 20. Travel Time Reliability: I-94
INTERSTATE 94: TRAVEL TIME RELIABILITY

a) Eastbound

b) Westbound

**FIGURE 21.** Segment 1 - I-94 between I-94/US-131/Exit 74 and I-94/Exit 81
INTERSTATE 196: BERRIEN AND VAN BUREN

a) Segment Map

b) UDC Graph

FIGURE 22. Berrien County I-196 Corridor Total User Delay Cost
INTERSTATE 196: BERRIEN AND VAN BUREN

a) Segment Map

b) UDC Graph

FIGURE 23. Van Buren County I-196 Corridor Total User Delay Cost
FIGURE 25. Southwest Region I-196 Southbound
US-31: BERRIEN (70 MPH SECTION)

a) Segment Map

b) UDC Graph

FIGURE 26. Berrien County US-31 Corridor Total User Delay Cost
FIGURE 27. Southwest Region US-31 Northbound
FIGURE 28. Southwest Region US-31 Southbound
**US-131: KALAMAZOO (70 MPH SECTION)**

**a) Segment Map**

- 2012-2016 Average User Delay Cost - $2,477,000
- 2017 User Delay Cost - $1,229,000

**b) UDC Graph**

*FIGURE 29. Kalamazoo County US-131 Corridor Total User Delay Cost*
FIGURE 30. Southwest Region US-131 Northbound
FIGURE 31. Southwest Region US-131 Southbound
CONCLUSION

This chapter summarizes the performance of the Southwest Region. It is the Congestion and Mobility Unit's goal that these performance measures are not just numbers and figures, but information to help MDOT personnel understand how traffic is operating on its freeways and make actionable decisions on improving traffic. They could be used to help prioritize projects, determine where and when problems are occurring, and how significant they are. We intend to provide these performance measures on an annual basis to help identify trends on the system and to keep MDOT up to date on freeway operations. Various performance measures may change due to changing federal requirements or MDOT needs. As probe data improves, this may expand to non-freeway routes as well. The Congestion and Mobility Unit welcomes any feedback on this report to help us improve it in the future and maximize its usefulness.

CONTACT INFORMATION

Please contact the Congestion and Mobility unit if you have any questions/comments or would like to have the actual data for further analysis.

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