

SEPTEMBER 2018



**WIM #44  
CSAH 1, MP 8.1  
MANHATTAN  
BEACH, MN**

**MONTHLY  
REPORT**

*Your Destination... Our Priority*



## WIM Site Location

WIM #44 is located on CSAH 1 near Manhattan Beach in Crow Wing county.

## System Operation

WIM #44 was operational for the entire month of September 2018. Volume was computed using all monthly data.

## System Calibration

WIM #44 was most recently calibrated on 2015-08-10. Table 1 summarizes the front axle weights of class 9s by lane <sup>1</sup>. Table 1 indicates that the class 9 front axle weights were all within +/- 9% of baseline calibration values for all lanes. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation <sup>2</sup>. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

## Summary of Volume Statistics

Total Monthly Volume: 36027 | Passenger Vehicles: 27091 | Heavy Commercial Vehicles: 8936

Monthly Average Daily Traffic (MADT): 1201 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 298

See Table 2 for vehicle class breakdown

## Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

**Volume trends.** EB vehicles typically reached highest volume levels on Sundays, with lowest volumes reported on Fridays. WB vehicles typically reached highest volume levels on Saturdays, with lowest volumes reported on Thursdays (see Figure 3 and 4).

## Passenger Vehicles (PVs)

**Volume trends.** On an average 24-hour day (see Figure 5), EB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, WB PVs peaked in volume between 03 PM and 05 PM

## Heavy Commercial Vehicles (HCVs)

**Volume trends.** On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 03 PM and 05 PM, while volume going WB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 5's and Class 8's.

## Overweight HCVs

**Volume trends.** Of a total of 8936 HCVs, 390 of them were overweight<sup>3</sup>. These overweight HCVs contributed to 1.2% of total monthly volume, and 4.7% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Wednesdays, with lowest volumes reported on Sundays. See Figure 3 .

The top two overweight violators by class were the class 10 and class 6 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 55% of all overweight vehicles traveling EB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in January.

WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report<sup>4</sup>.

Using normal load limits ,107 EB vehicles exceeded 88,000 pounds (106 vehicles were Class 10's; 1 vehicles were Class 12's). Of vehicles traveling WB,

62 EB vehicles exceeded 88,000 pounds (59 vehicles were Class 10's; 1 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from September 2018.

**Loaded vs. Unloaded HCVs.** Figure 10 shows the GVW distributions of Class 9s and 10s in September 2018. Data suggests that there were greater numbers of fully\_loaded Class 9's than empty Class 9's traveling EB, while there were more fully\_loaded Class 9's than empty traveling WB. Data also suggests that there were more fully\_loaded Class 10's than empty traveling in the EB direction. In the WB direction, there were more fully\_loaded class 10 vehicles.

**Freight Totals.** A total of 23023 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (53.9%) than WB (46.1%). See Table 4 and Figure 11 for more freight information.

## Infrastructure Considerations

**Bridge.** Bridge No. 95425 (a precast pipe arch) is approximately 3.45 miles south west from WIM #44. Bridge No. 95426 (a precast pipe arch) is approximately .08 miles sw of WIM #44. WIM #44 recorded a total of 36027 vehicles with a combined GVW of 271251 kips (1 kip = 1,000 pounds = 0.5 tons) in September 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

**Pavement Design.** A total of 1953 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 51.2% of all ESALs were recorded WB while 48.8% was observed EB. In particular, 29% of all ESALs were generated by the Class 10's (Class 10's were also responsible for generating 8% of total GVW observed this month). See Table

6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

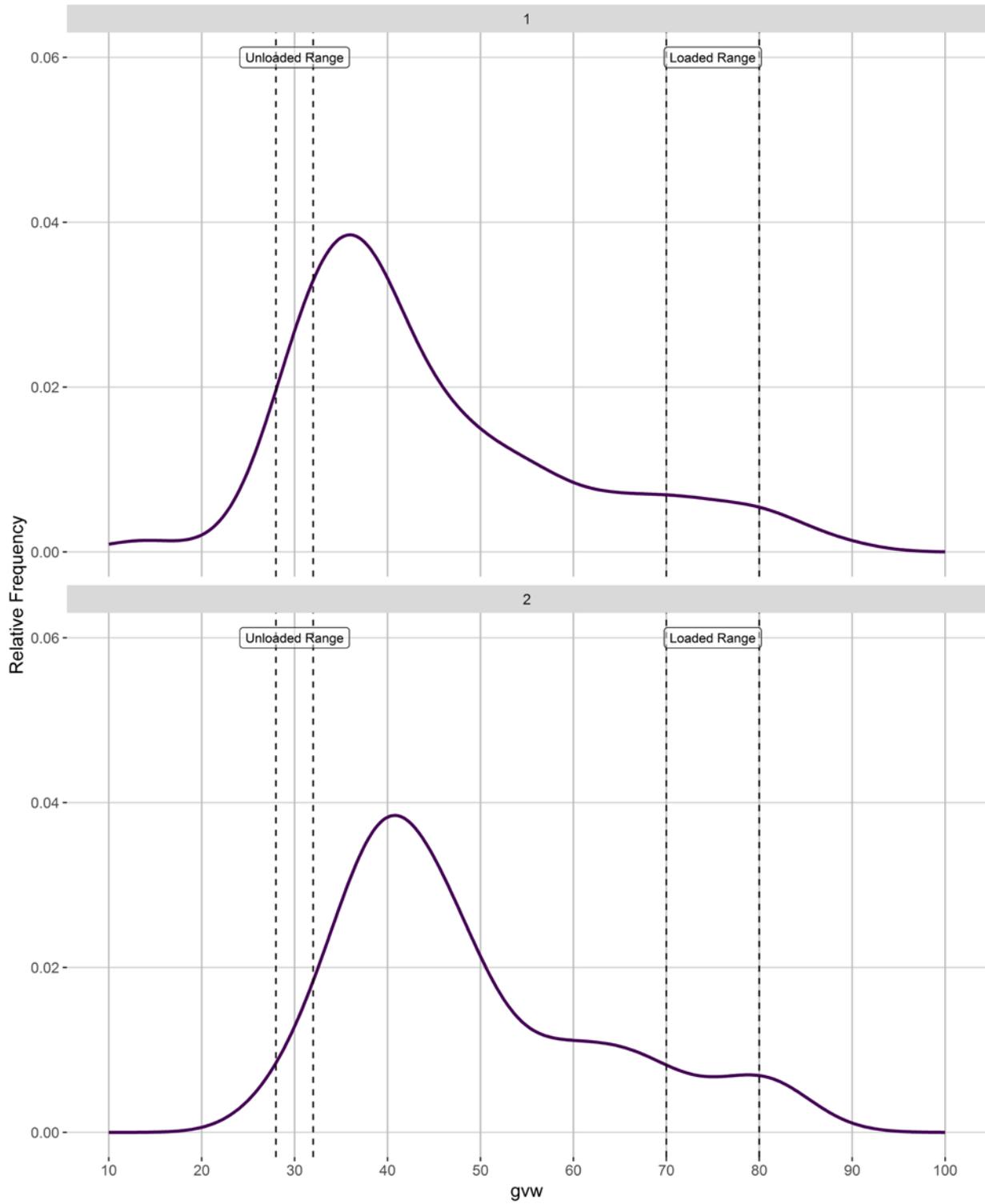
*WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>*

MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at: <http://www.dot.state.mn.us/traffic/data/data-products.html#weight>

- <sup>1</sup> Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ±9% of baseline calibration values
- <sup>2</sup> Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.
- <sup>3</sup> An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: [http://www.mrr.dot.state.mn.us/research/seasonal\\_load\\_limits/sllindex.asp](http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp)
- <sup>4</sup> For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

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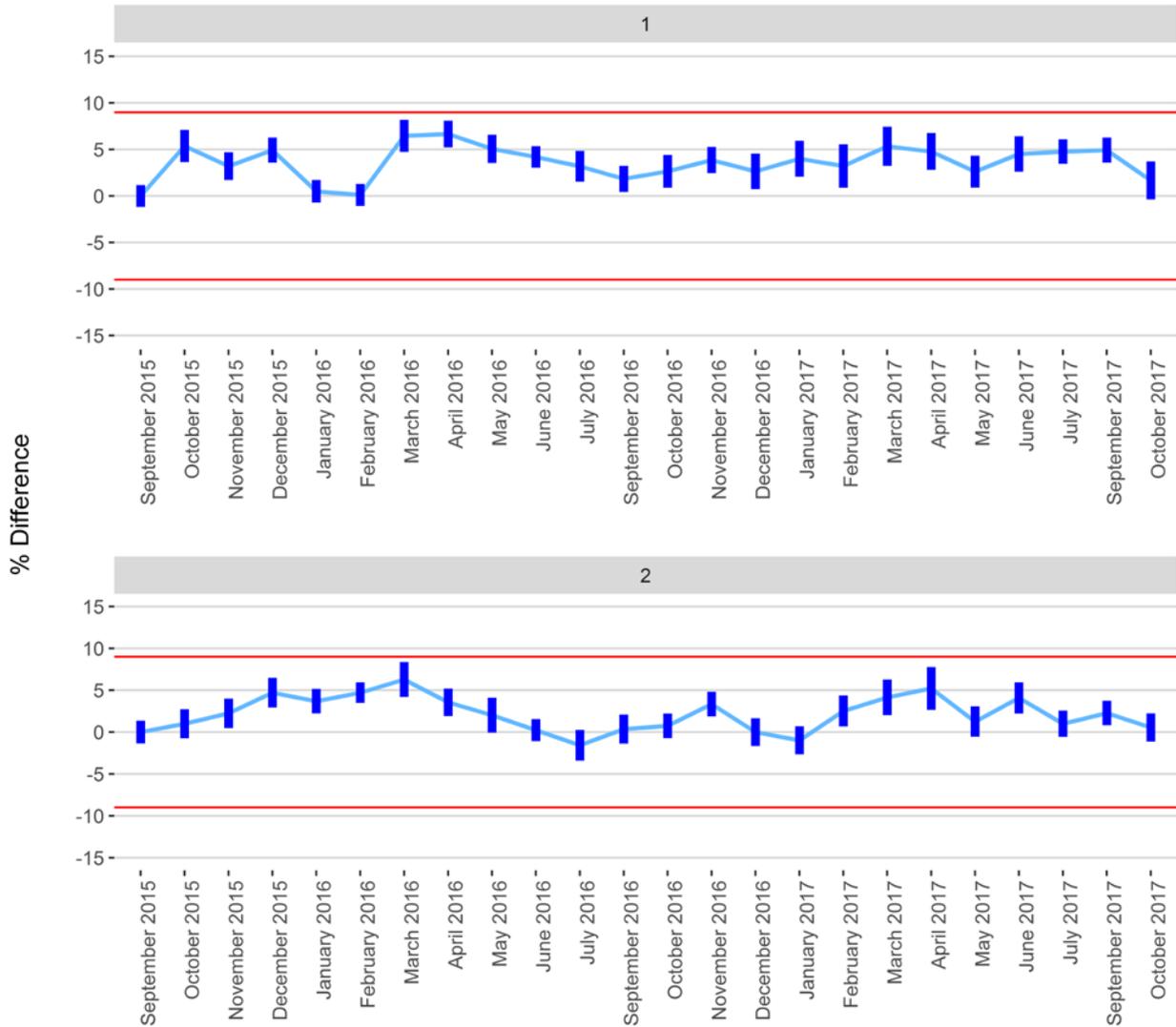
Figure 1 - Monthly Class 9 GVW Histogram



Time — October 2017

Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume vs. Day of the Week

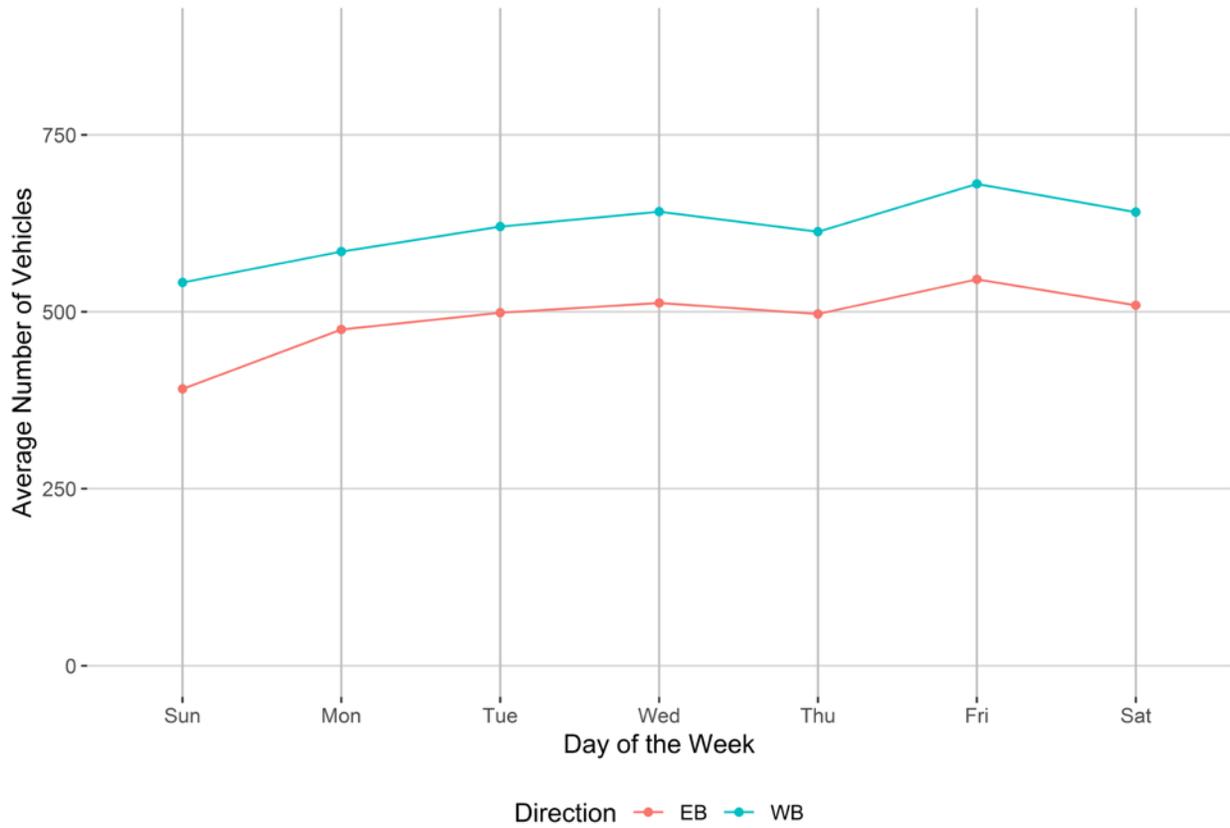


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

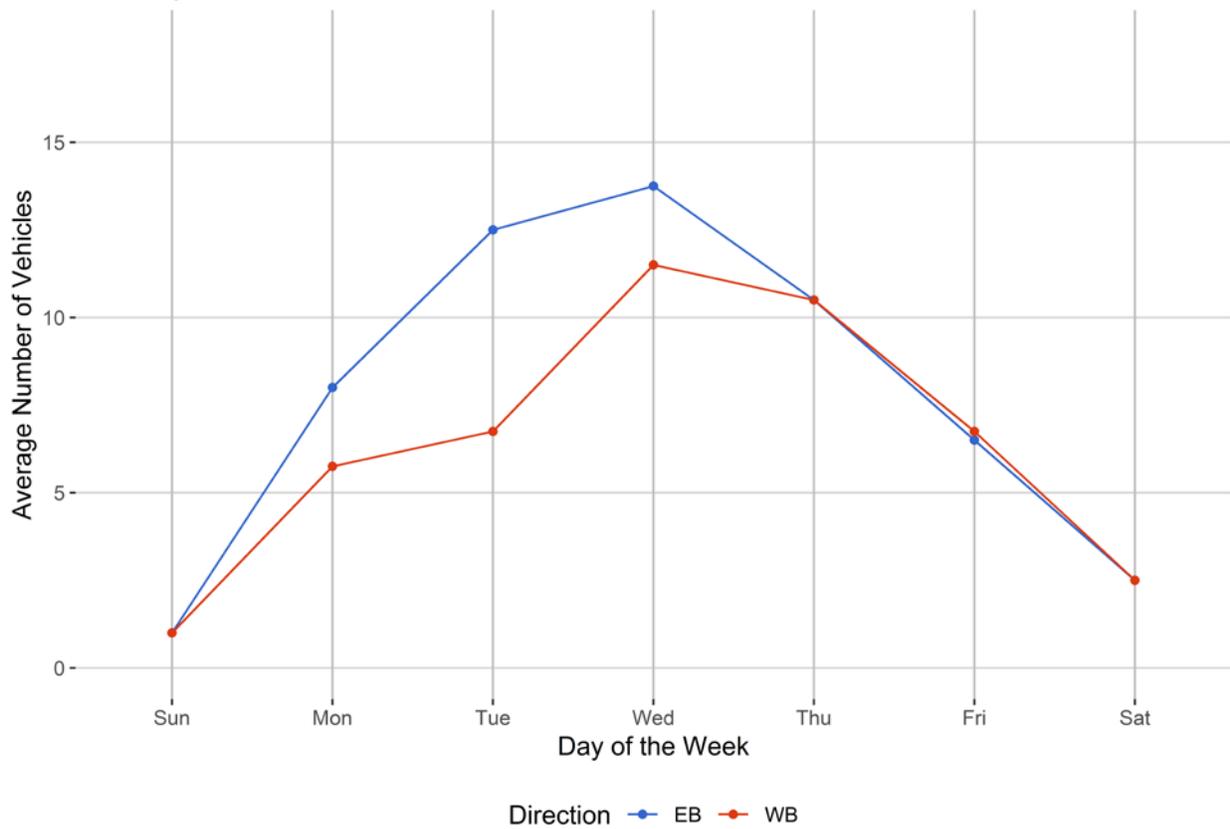


Figure 4 - Passenger Vehicles vs. Hour of the Day

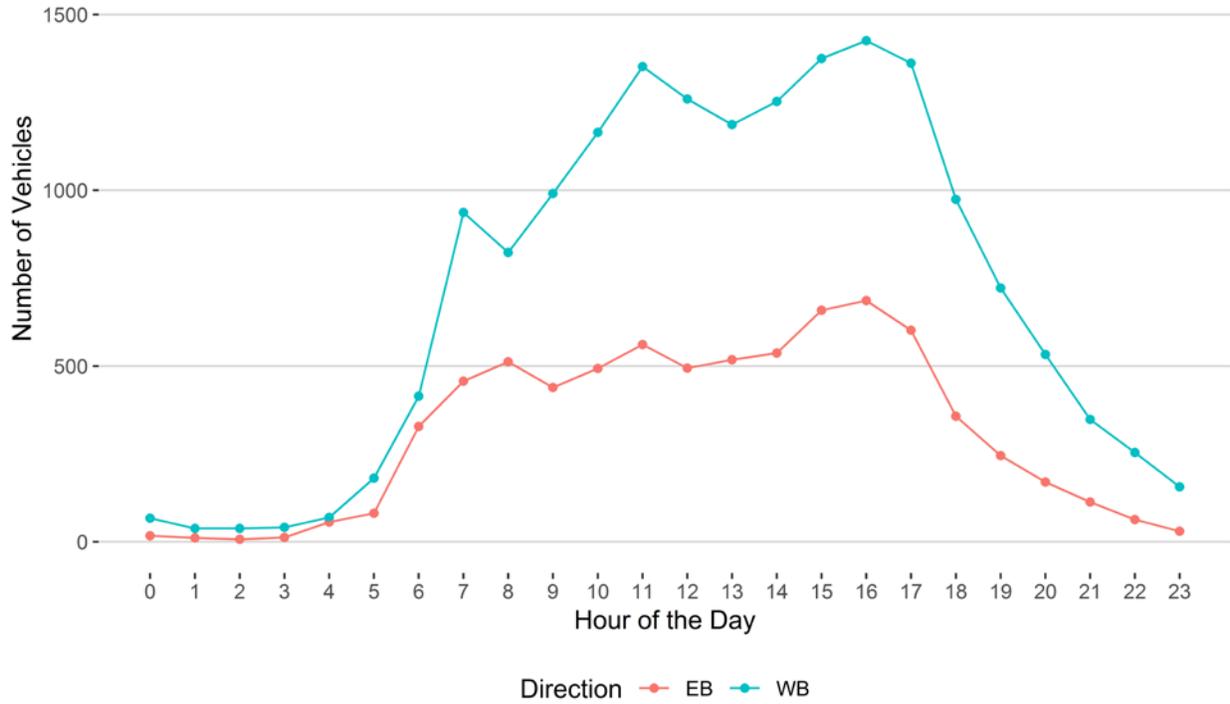


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

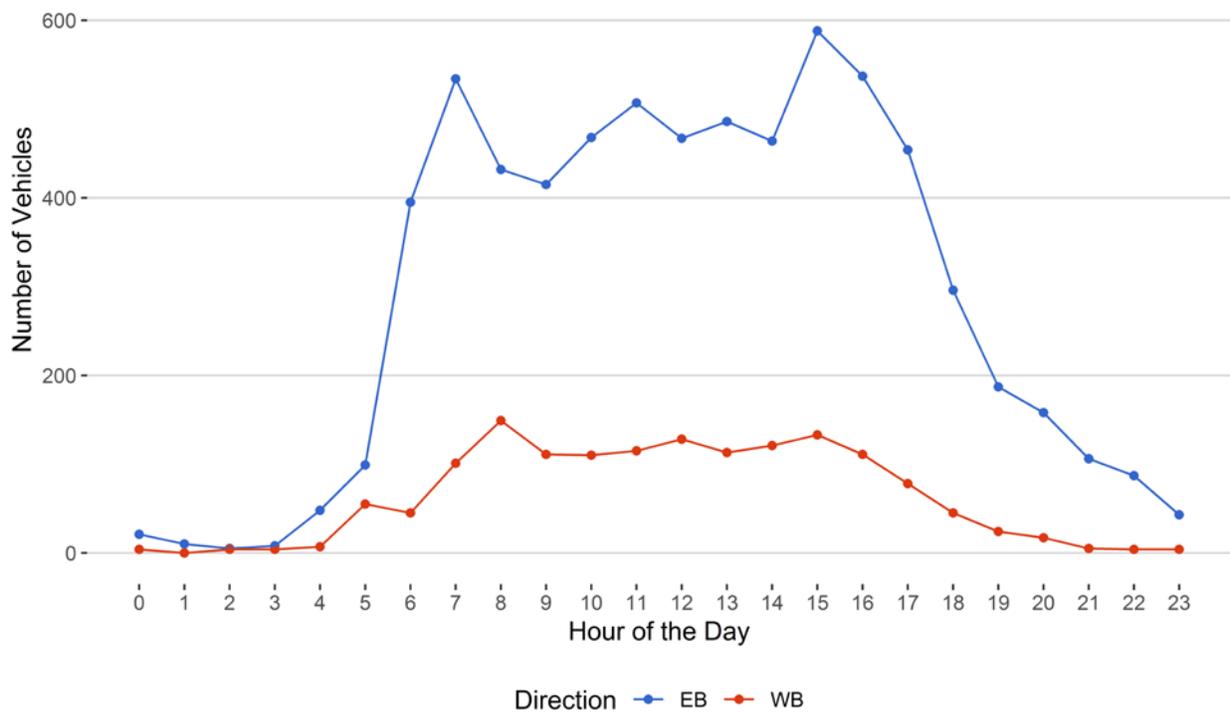




Figure 7 - Overweight Vehicles by Direction  
Hour of the Day

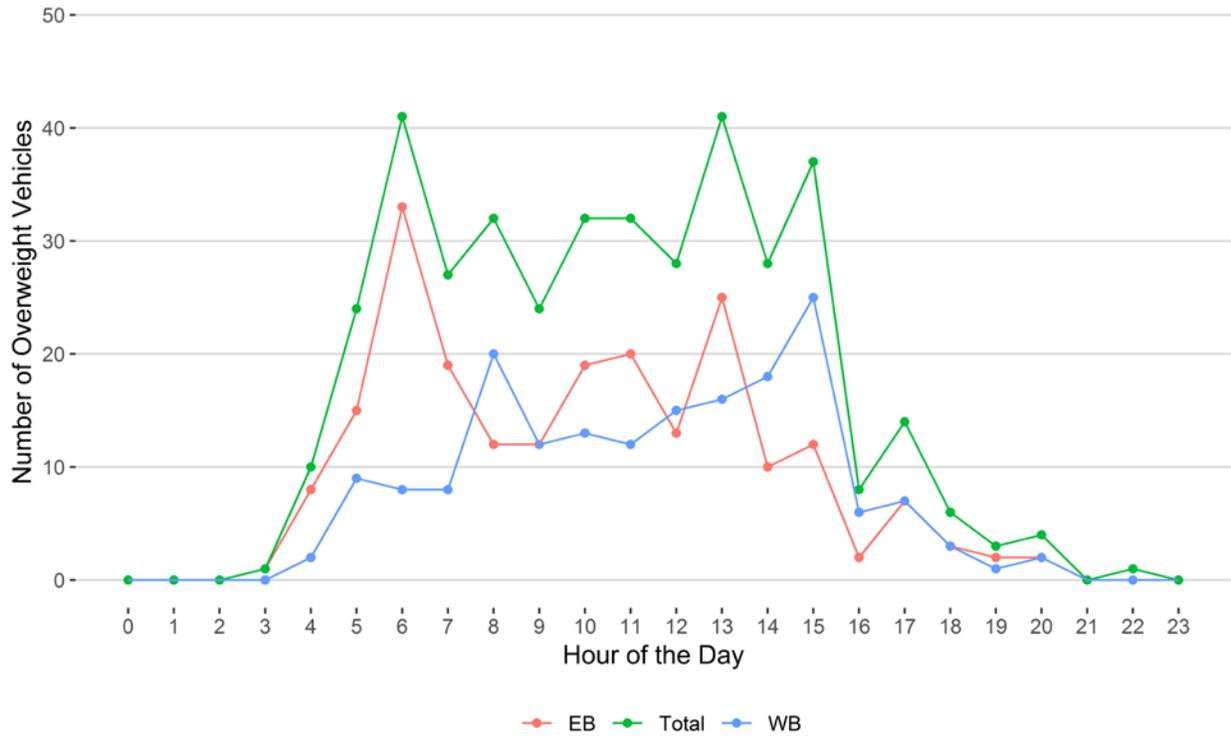
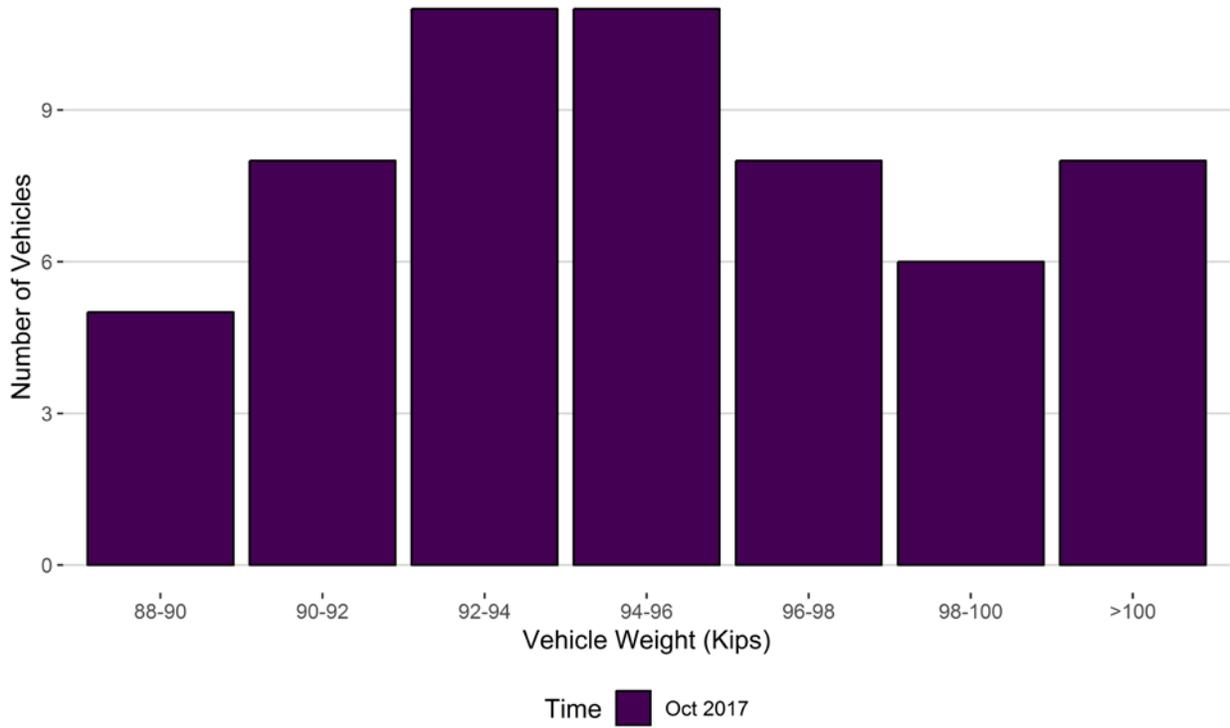
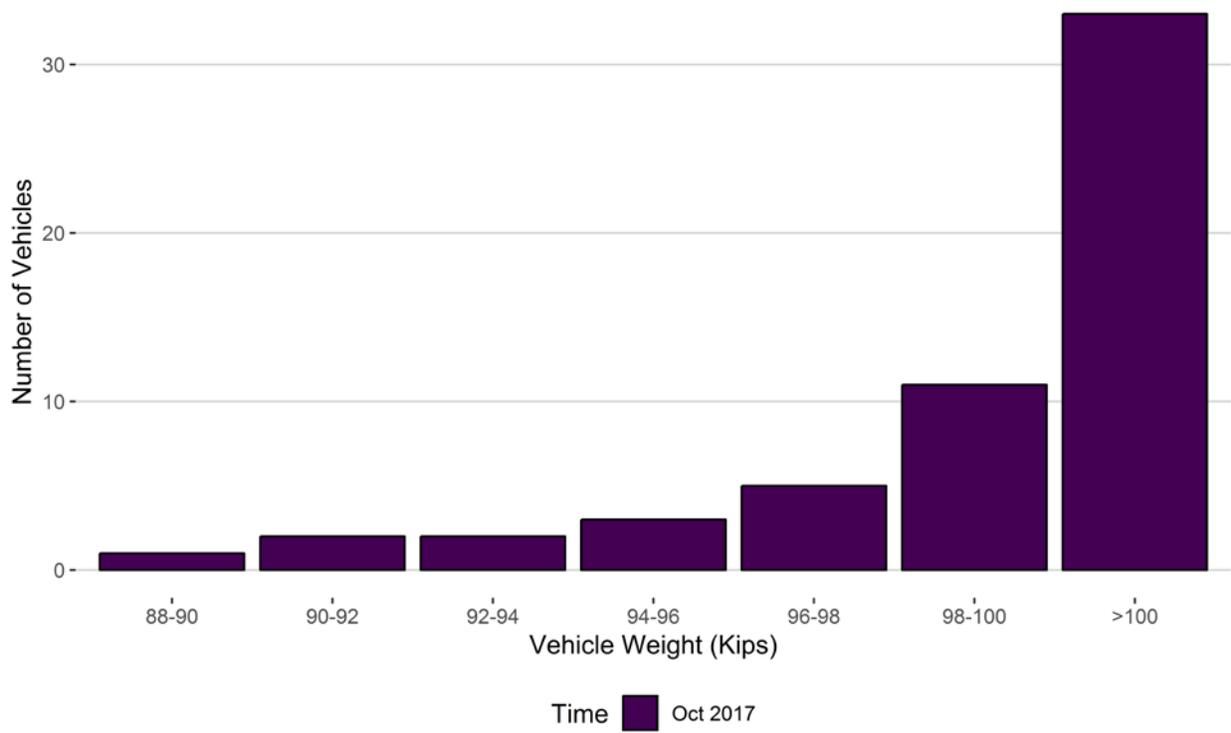


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Oct 2017</i>
88-90	5
90-92	8
92-94	11
94-96	11
96-98	8
98-100	6
>100	8
Total	57

Figure 8 - Histogram of WB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Oct 2017</i>
88-90	1
90-92	2
92-94	2
94-96	3
96-98	5
98-100	11
>100	33
Total	57

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

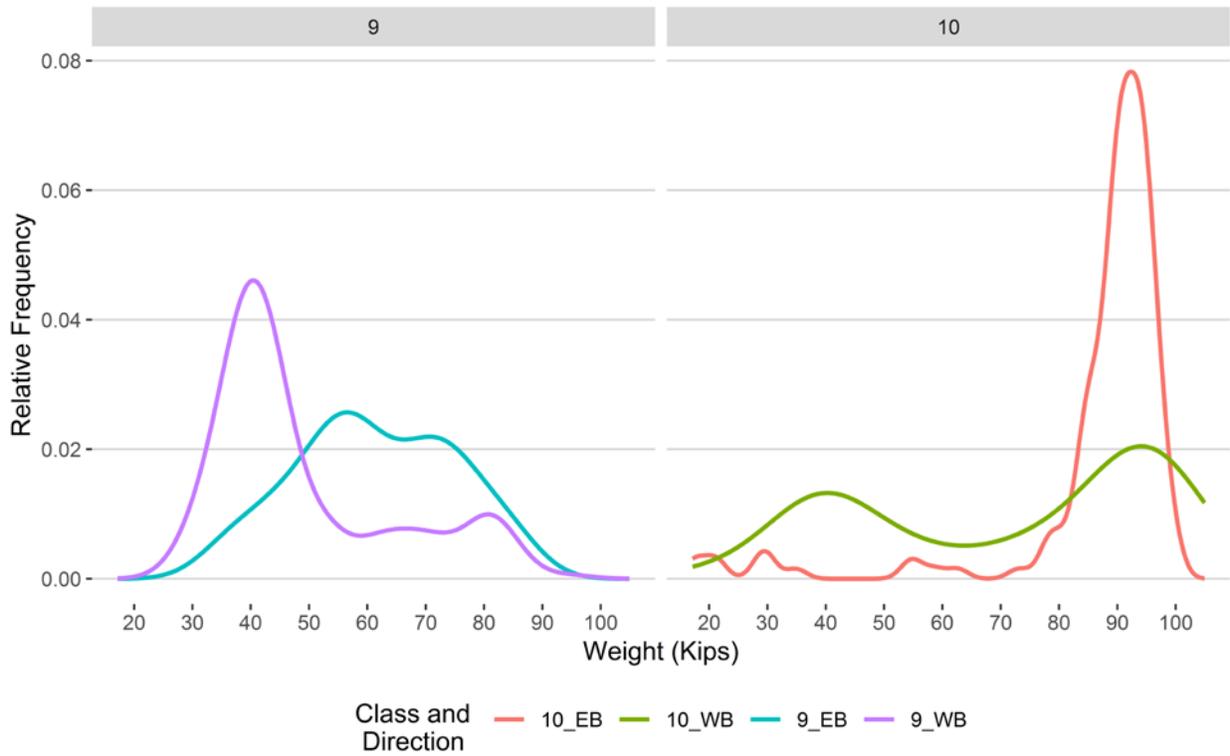


Figure 9 - Freight Percentage by Direction and Class

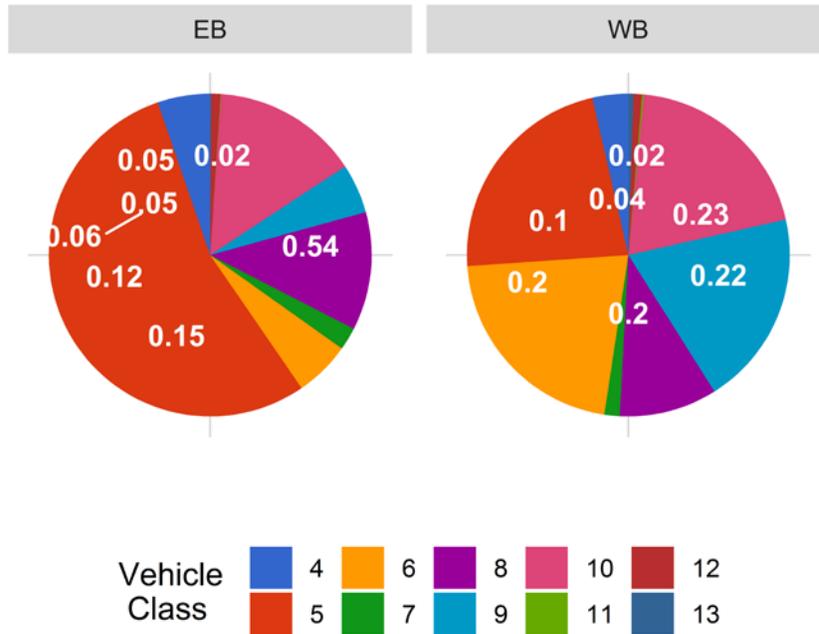


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

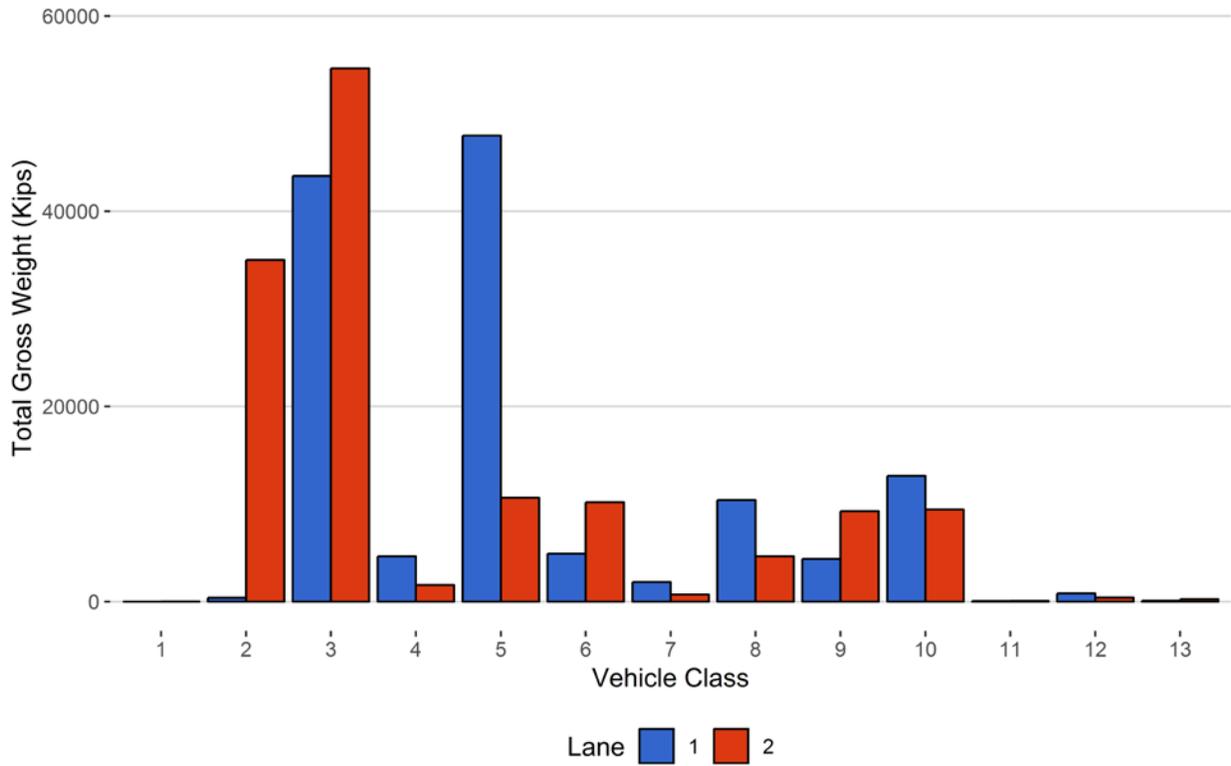


Figure 11 - Total Gross Vehicle Weight t

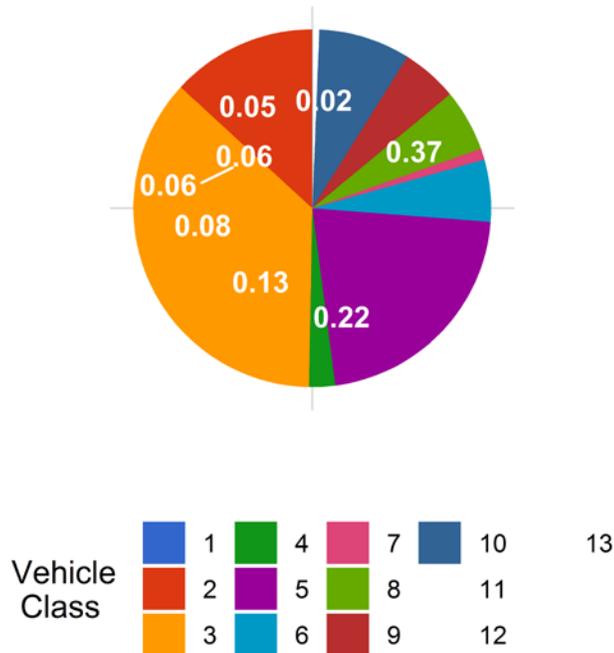


Figure 12 - Total ESALs by Class and Lane

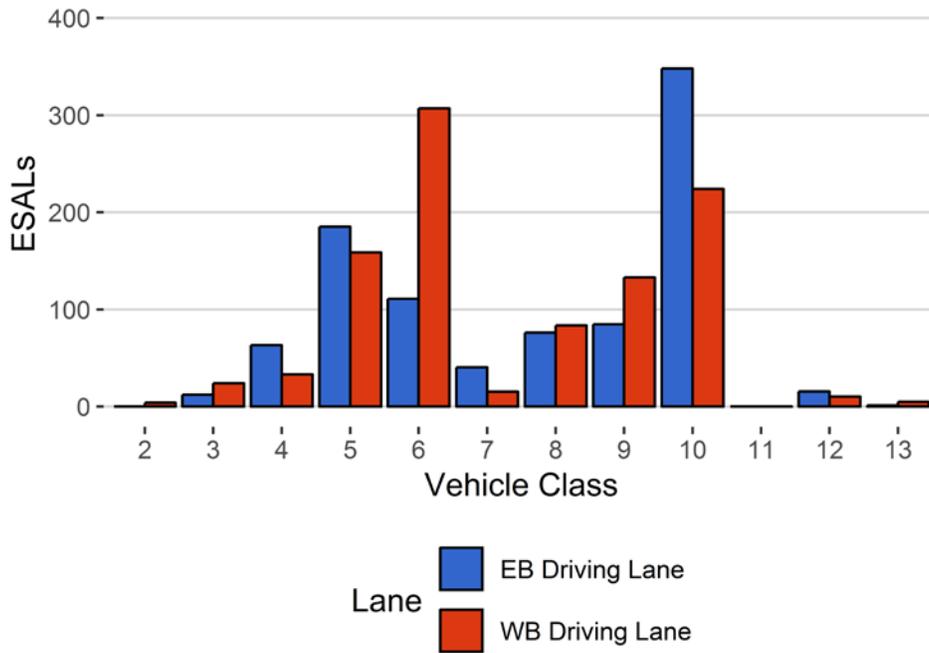
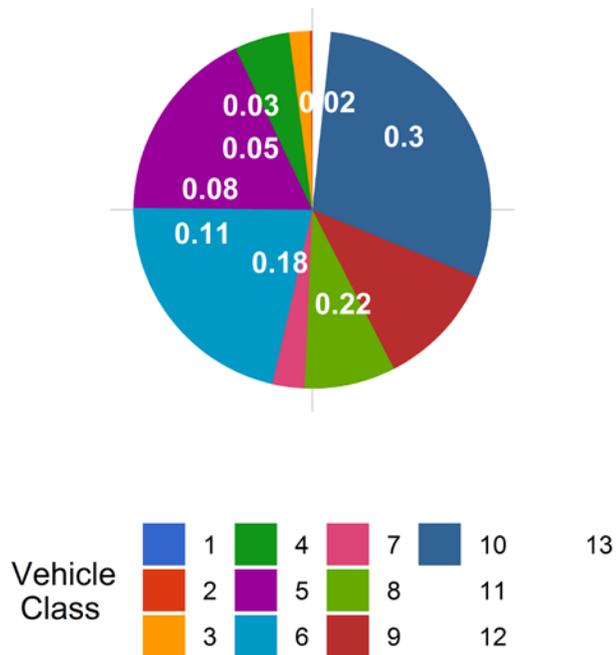


Figure 13 - ESALs by Class



**Table 1 Class 9 Front Axle Weight by Lane**

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
September 2015	10.51	0.00	10.69	0.00
October 2015	11.07	5.36	10.79	0.99
November 2015	10.85	3.20	10.93	2.24
December 2015	11.03	4.92	11.19	4.71
January 2016	10.56	0.50	11.08	3.69
February 2016	10.52	0.10	11.19	4.71
March 2016	11.19	6.46	11.36	6.28
April 2016	11.21	6.66	11.07	3.55
May 2016	11.04	5.06	10.90	2.02
June 2016	10.95	4.18	10.71	0.24
July 2016	10.84	3.19	10.52	-1.58
September 2016	10.70	1.83	10.72	0.36
October 2016	10.79	2.64	10.77	0.75
November 2016	10.92	3.86	11.04	3.35
December 2016	10.79	2.64	10.69	0.00
January 2017	10.93	4.00	10.58	-0.98
February 2017	10.85	3.21	10.96	2.52
March 2017	11.07	5.33	11.13	4.15
April 2017	11.01	4.78	11.24	5.21
May 2017	10.78	2.61	10.82	1.25
June 2017	10.98	4.51	11.12	4.08
July 2017	11.01	4.77	10.79	0.99
September 2017	11.03	4.93	10.93	2.27
October 2017	10.68	1.65	10.74	0.55

**Table 2 Vehicle Classification Data**

<i>Vehicle Class</i>	<i>Monthly Average Daily Volume</i>	<i>Monthly Total Volume</i>	<i>Monthly Total Volume Percentage</i>	<i>Monthly Total Overweight Vehicles</i>	<i>Monthly Total Overweight Percentage</i>
1	0	9	0	0	0
2	346	10394	28.9	0	0
3	556	16688	46.3	0	0
4	9	272	0.8	4	1
5	226	6792	18.9	16	4.1
6	14	421	1.2	66	16.9
7	2	46	0.1	30	7.7
8	26	794	2.2	26	6.7
9	9	280	0.8	33	8.5
10	10	302	0.8	203	52.1
11	0	6	0	0	0
12	1	17	0	9	2.3
13	0	4	0	3	0.8
<b>TOTAL</b>	<b>1201</b>	<b>36027</b>	<b>100</b>	<b>390</b>	<b>100</b>

**Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10**

<i>Date</i>	<i>Day of Week</i>	<i>Time</i>	<i>Vehicle Class</i>	<i>Direction</i>	<i>Lane</i>	<i>GVW (lbs)</i>
2018-09-11	Tuesday	09:50:39	10	EB	1	105.29
2018-09-26	Wednesday	05:22:43	10	WB	2	104.94
2018-09-17	Monday	05:40:07	10	WB	2	104.61
2018-09-06	Thursday	05:36:49	10	WB	2	103.71
2018-09-23	Sunday	14:00:19	10	EB	1	102.32
2018-09-12	Wednesday	05:28:37	10	WB	2	100.79
2018-09-18	Tuesday	11:43:49	10	WB	2	100.76
2018-09-08	Saturday	12:04:51	10	EB	1	99.88
2018-09-25	Tuesday	18:27:22	10	WB	2	99.88
2018-09-11	Tuesday	12:46:15	10	WB	2	99.8

**Table 4 Freight Summary**

<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	EB	15	189	7	3.7	4540	94	905
5	EB	8	5629	3535	62.8	24215	23523	3731
6	EB	19	124	0	0	4913	0	1279
7	EB	11.5	32	0	0	2003	0	817
8	EB	31	607	557	91.8	2449	7957	449
9	EB	33	71	0	0	4365	0	1011
10	EB	33.5	149	7	4.7	12716	166	3979
11	EB	36.5	2	2	100	0	49	0
12	EB	36.5	11	0	0	830	0	214
13	EB	31.5	1	0	0	81	0	25
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>6815</b>	<b>4108</b>	<b>****</b>	<b>56112</b>	<b>****</b>	<b>12411</b>
<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	WB	15	64	12	18.8	1536	162	378
5	WB	8	682	82	12	10027	611	2614
6	WB	19	267	2	0.7	10140	37	2553
7	WB	11.5	11	0	0	725	0	299
8	WB	31	131	35	26.7	4049	589	536
9	WB	33	189	12	6.3	8887	366	1523
10	WB	33.5	132	4	3	9337	86	2524
11	WB	36.5	4	4	100	0	81	0
12	WB	36.5	5	0	0	402	0	110
13	WB	31.5	3	0	0	243	0	74
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>1488</b>	<b>151</b>	<b>****</b>	<b>45346</b>	<b>****</b>	<b>10611</b>
<b>GRAND TOTAL</b>	<b>****</b>	<b>****</b>	<b>8303</b>	<b>4259</b>	<b>430</b>	<b>101458</b>	<b>33722</b>	<b>23023</b>

**Table 5 Gross Vehicle Weight by Class and Lane**

<i>Vehicle Class</i>	<i>EB</i>	<i>WB</i>	<i>Total</i>	<i>Percentage</i>
1	0	10	10	0
2	384	34992	35376	13.2
3	43607	54637	98243	36.5
4	4634	1698	6332	2.4
5	47738	10638	58376	21.7
6	4913	10177	15091	5.6
7	2003	725	2728	1
8	10406	4638	15044	5.6
9	4365	9253	13619	5.1
10	12881	9423	22304	8.3
11	49	81	130	0
12	830	402	1233	0.5
13	81	243	324	0.1
<b>TOTAL</b>	<b>131892</b>	<b>136918</b>	<b>268810</b>	<b>100</b>
<b>GVW/LANE</b>	<b>49.07</b>	<b>50.93</b>	<b>100</b>	<b>0.04</b>

**Table 6 ESALs by Class and Lane and Flexible ESAL Factors**

<i>Vehicle Class</i>	<i>EB</i>	<i>WB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.1111
2	0	4	4	0.2	0.0012
3	12	24	36	1.9	0.005
4	63	33	97	5	0.79
5	185	159	344	17.8	0.11
6	111	307	418	21.6	2.18
7	40	16	56	2.9	2.44
8	76	84	160	8.2	0.45
9	85	133	218	11.2	1.7
10	348	224	572	29.5	4.07
11	0	0	0	0	0.66
12	16	10	26	1.3	2.32
13	1	5	6	0.3	1.52
<b>TOTAL</b>	<b>938</b>	<b>999</b>	<b>1937</b>	<b>100</b>	<b>16</b>
<b>ESALS/LANE</b>	<b>48.4</b>	<b>51.6</b>	<b>100</b>	-	-

**Table 7 Site Summary: Volume and Vehicle Class**

<i>Month</i>	<i>Total Volume</i>	<i>Monthly ADT</i>	<i>Monthly HCADT</i>	<i>Passenger Vehicles</i>	<i>Passenger Vehicles %</i>	<i>Heavy Commercial Vehicles</i>	<i>Heavy Commercial Vehicles %</i>
Oct 2017	31525	1017	95	28567	90.6	2957.8	9.4
<b>TOTAL</b>	<b>31525</b>	<b>-</b>	<b>-</b>	<b>28567</b>	<b>-</b>	<b>2958</b>	<b>-</b>
<b>AVERAGE</b>	<b>31525</b>	<b>1017</b>	<b>95</b>	<b>28567</b>	<b>91</b>	<b>2958</b>	<b>9</b>

## ESALS

<i>Month</i>	<i>ESALS EB Driving Lane</i>	<i>ESALS WB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Oct 2017	909	1075	1983	29.6
<b>TOTAL</b>	<b>909</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>AVERAGE</b>	<b>908</b>	<b>1075</b>	<b>1984</b>	<b>30</b>

## Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Oct 2017	116073	133692	249765
<b>TOTAL</b>	<b>116073</b>	<b>133692</b>	<b>249765</b>
<b>AVERAGE</b>	<b>116073</b>	<b>133692</b>	<b>249765</b>

## Overweight Vehicles

<i>Month</i>	<i>Total Number of Overweight Vehicles</i>	<i>Overweight / Total Volume</i>	<i>Overweight / Heavy Commercial Volume</i>	<i>Number Over 88,000 lbs</i>	<i>Number Over 98,000 lbs</i>
Oct 2017	344	1.1	10.3	115	58
<b>TOTAL</b>	<b>344</b>	<b>-</b>	<b>-</b>	<b>115</b>	<b>58</b>
<b>AVERAGE</b>	<b>344</b>	<b>1.1</b>	<b>10.3</b>	<b>115</b>	<b>58</b>

## Freight

<i>Month</i>	<i>EB Freight Tons</i>	<i>WB Freight Tons</i>	<i>Total Freight</i>	<i>EB Freight %</i>	<i>WB Freight %</i>
Oct 2017	10009	11716	21725	46.1	53.9
<b>TOTAL</b>	<b>10009</b>	<b>11716</b>	<b>21725</b>	-	-
<b>AVERAGE</b>	<b>10008.8</b>	<b>11716.1</b>	<b>21725</b>	<b>46.1</b>	<b>53.9</b>