

DECEMBER 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 December 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: 23636 | Passenger Vehicles: 17392 | Heavy Commercial Vehicles: 6244

Monthly Average Daily Traffic (MADT): 762 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 201

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 Thursdays, with lowest volumes reported on Sundays. WB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays (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 6244 HCVs, 273 of them were overweight<sup>3</sup>. These overweight HCVs contributed to 1.2% of total monthly volume, and 4.5% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on Saturdays. 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 74.7% 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 ,134 EB vehicles exceeded 88,000 pounds (128 vehicles were Class 10's; 4 vehicles were Class 9's). Of vehicles traveling WB,

27 EB vehicles exceeded 88,000 pounds (24 vehicles were Class 10's; 2 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from December 2018.

**Loaded vs. Unloaded HCVs.** Figure 10 shows the GVW distributions of Class 9s and 10s in December 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 empty Class 9's than fully\_loaded 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 16731 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (66.5%) than WB (33.5%). 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 23636 vehicles with a combined GVW of 186891 kips (1 kip = 1,000 pounds = 0.5 tons) in December 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

**Pavement Design.** A total of 1545 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 64.2% of all ESALs were recorded EB while 35.8% was observed WB. In particular, 34% of all ESALs were generated by the Class 10's (Class 10's were also responsible for generating 9% 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).

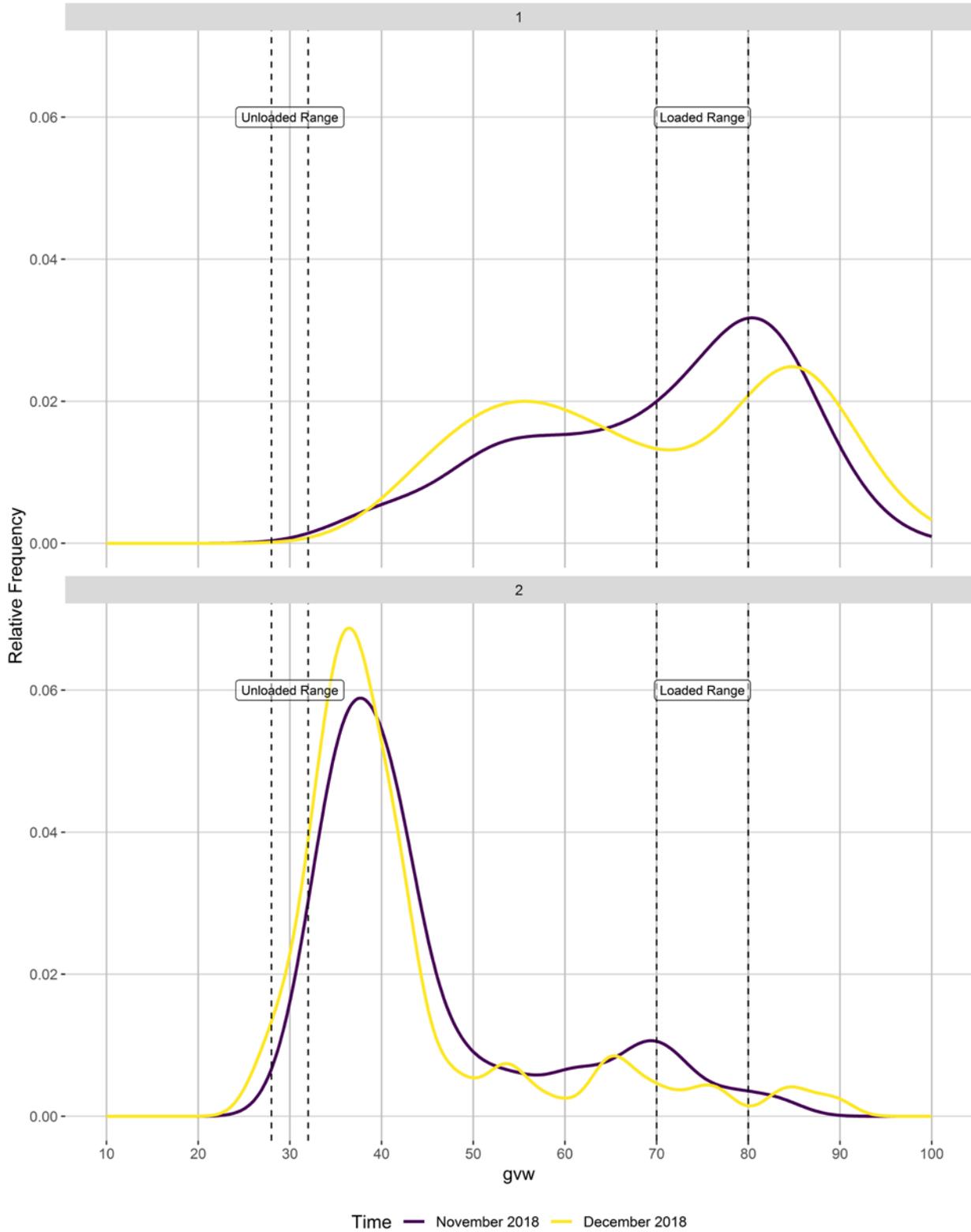
*WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>*

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.

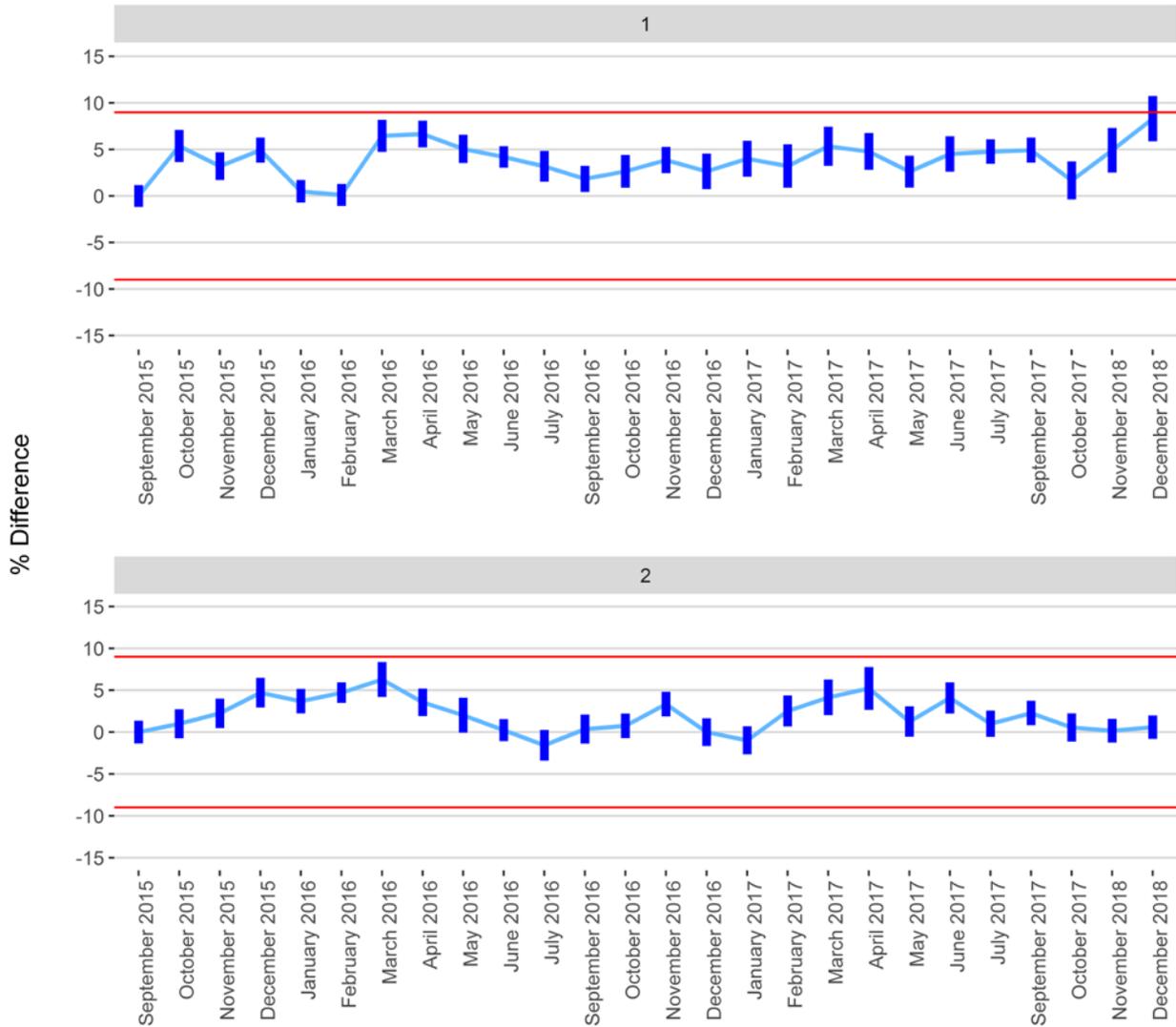
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Figure 1 - Monthly Class 9 GVW Histogram



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

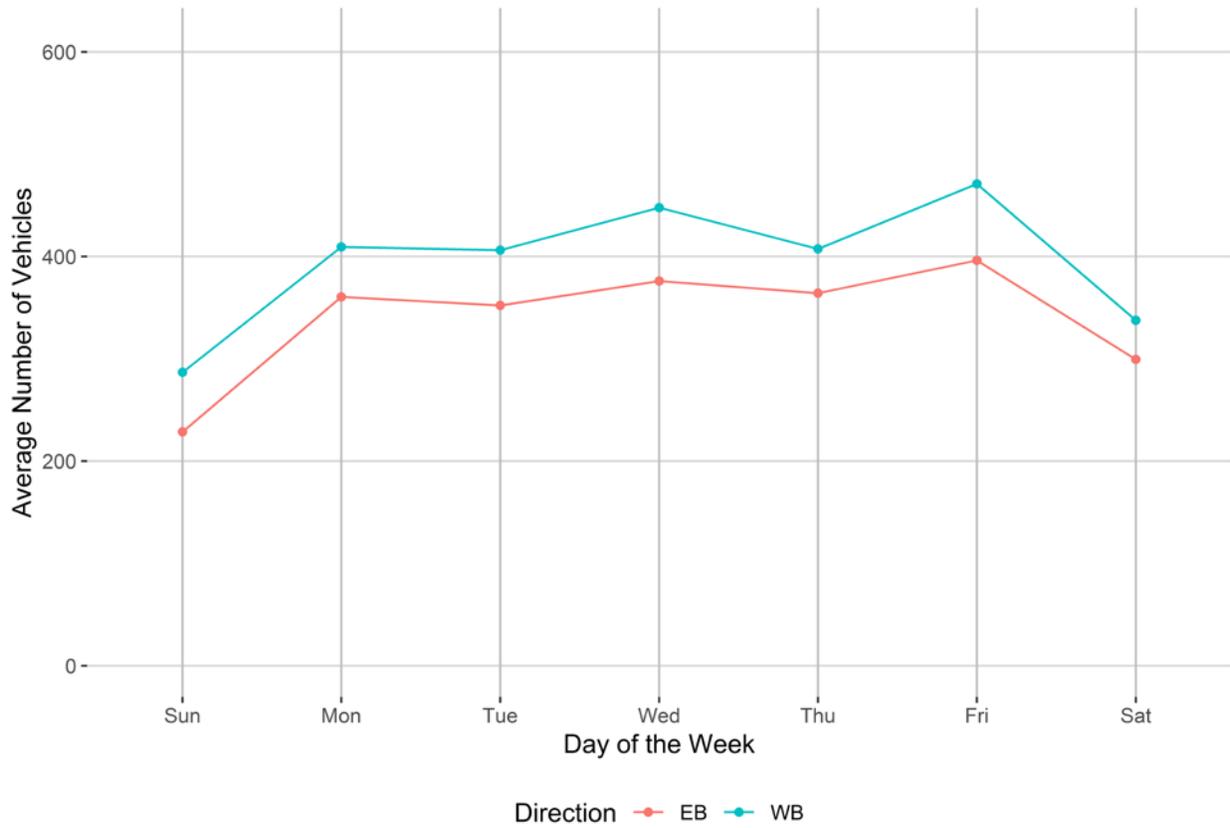


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

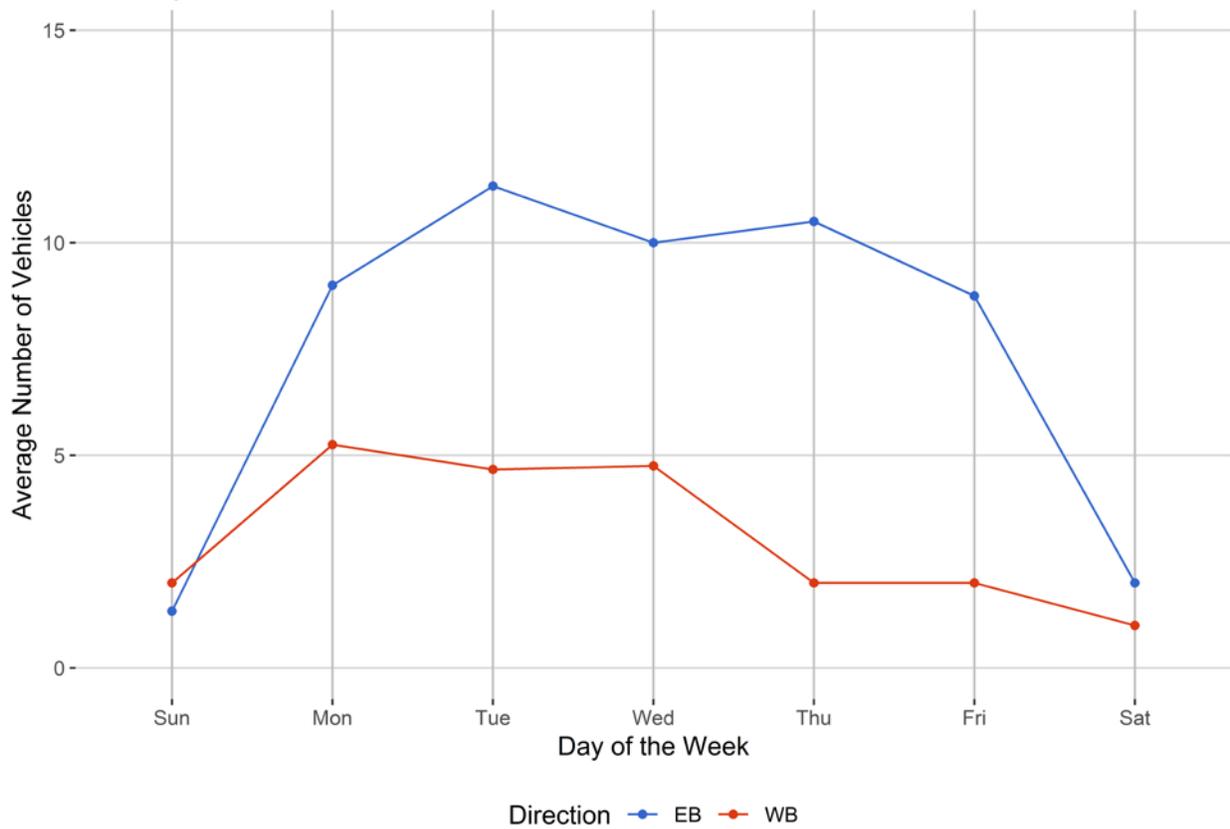


Figure 4 - Passenger Vehicles vs. Hour of the Day

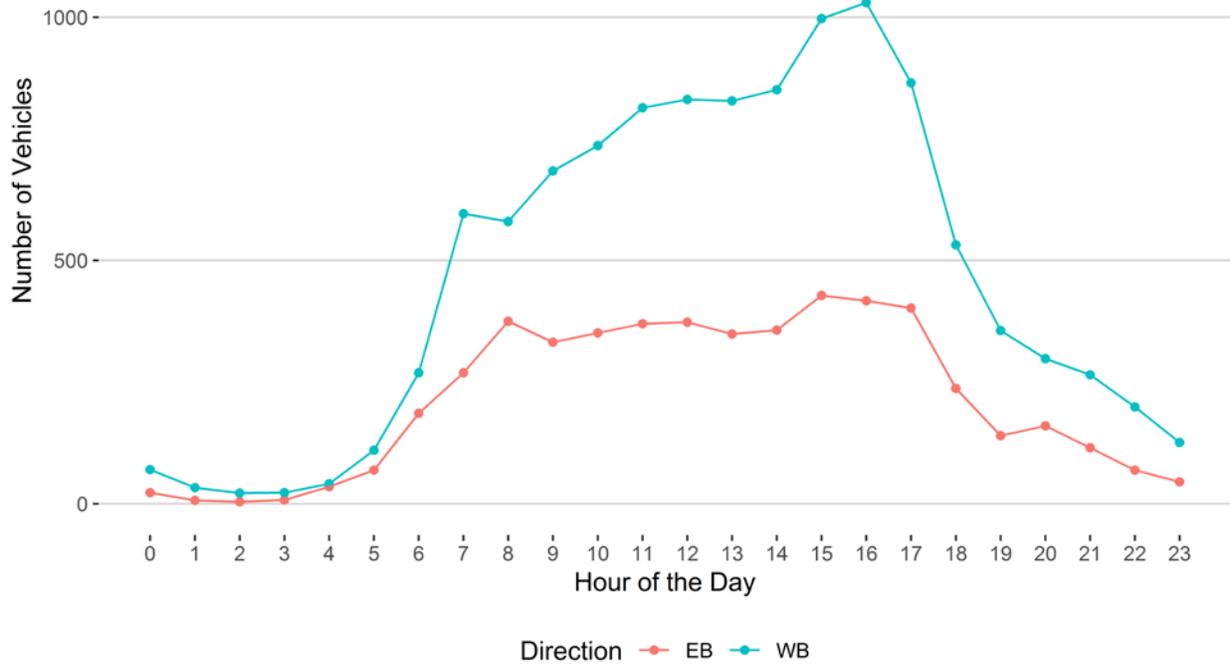


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

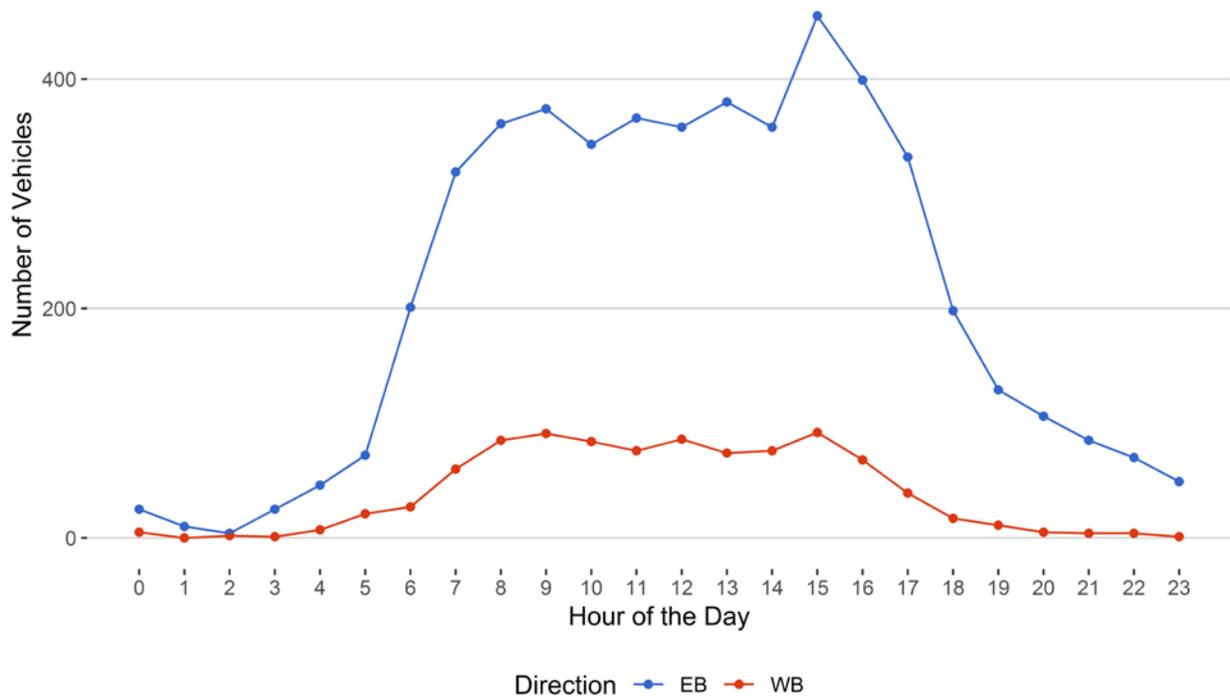


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

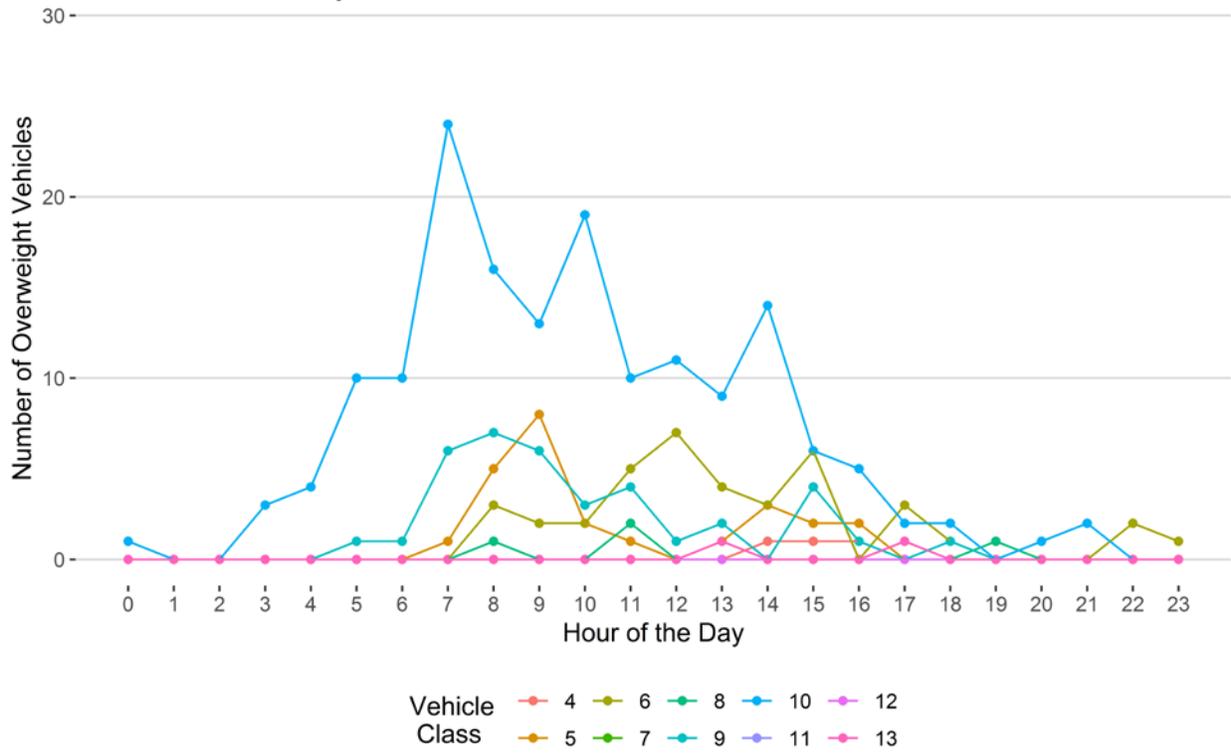


Figure 7 - Overweight Vehicles by Direction  
Hour of the Day

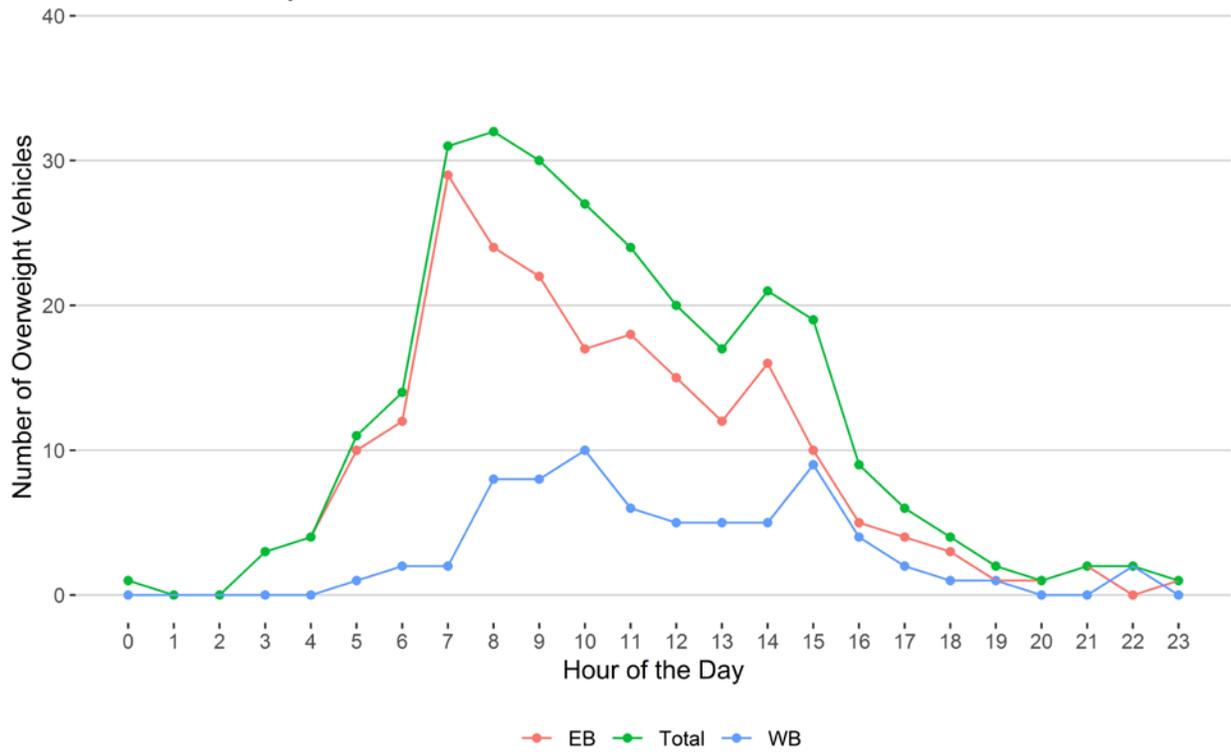
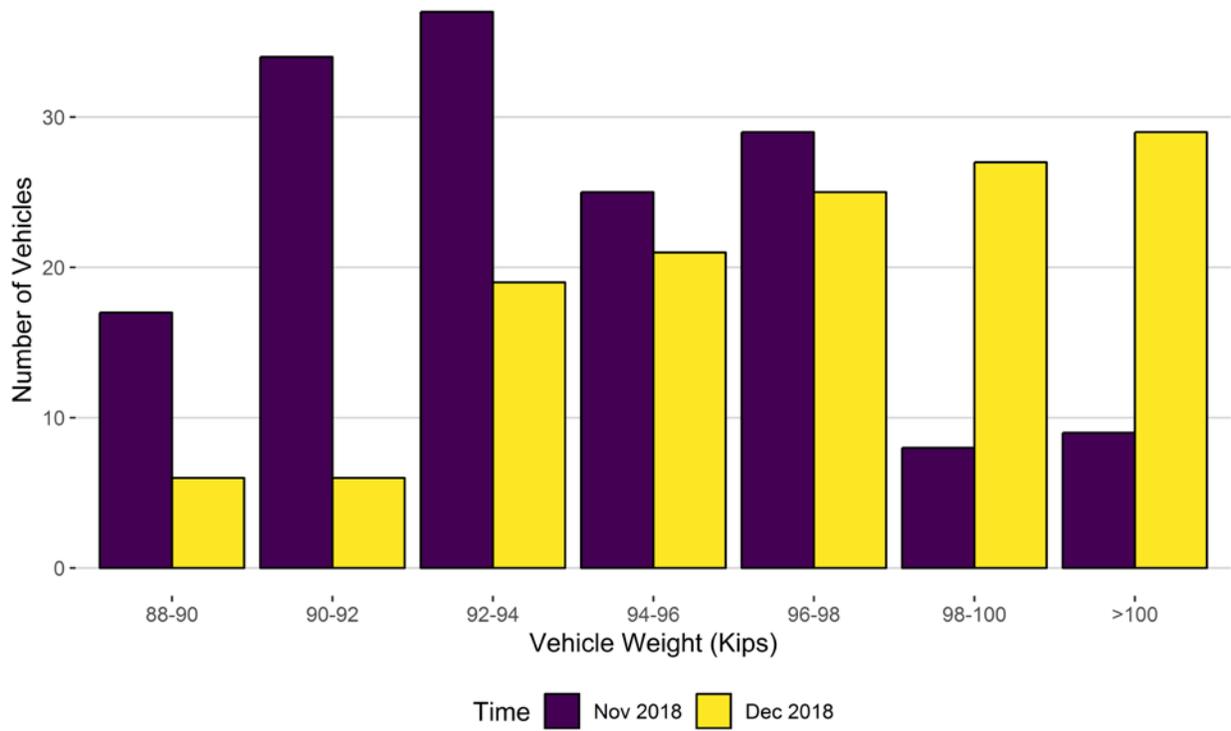
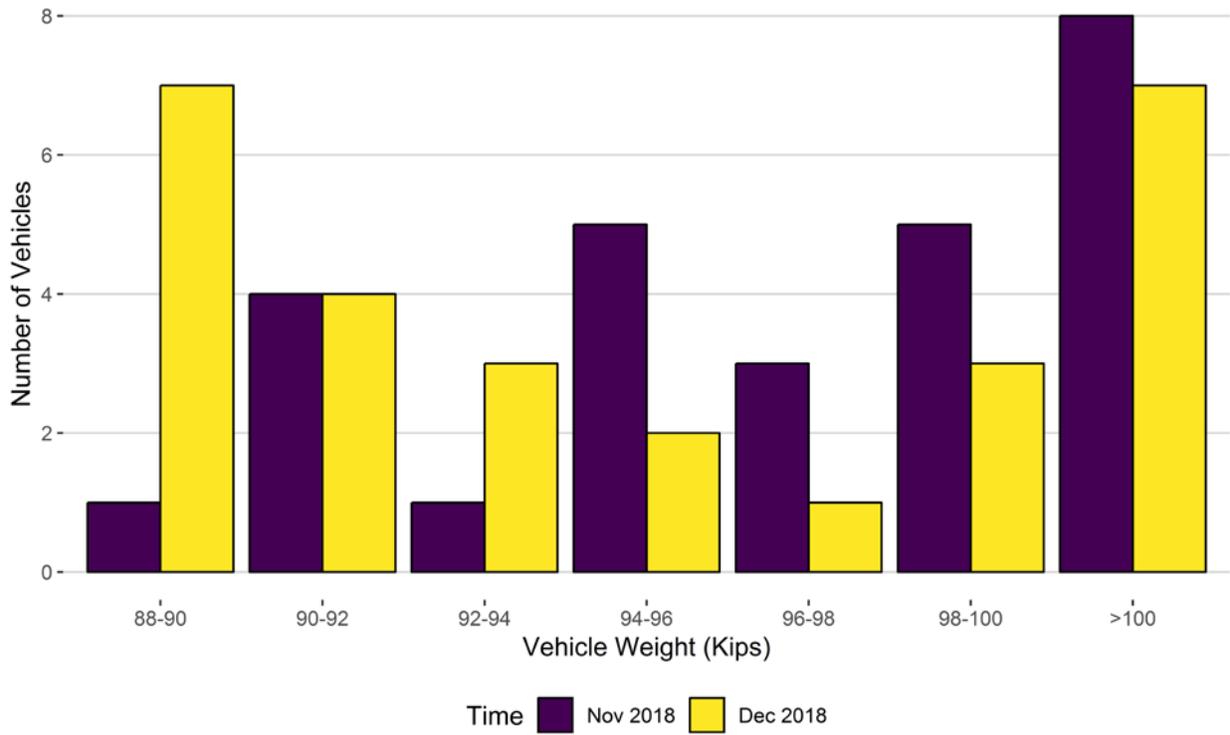


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Nov 2018</i>	<i>Dec 2018</i>
88-90	17	6
90-92	34	6
92-94	37	19
94-96	25	21
96-98	29	25
98-100	8	27
>100	9	29
<b>Total</b>	<b>159</b>	<b>133</b>

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



<i>Vehicle Weights (Kips)</i>	<i>Nov 2018</i>	<i>Dec 2018</i>
88-90	1	7
90-92	4	4
92-94	1	3
94-96	5	2
96-98	3	1
98-100	5	3
>100	8	7
<b>Total</b>	<b>27</b>	<b>27</b>

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

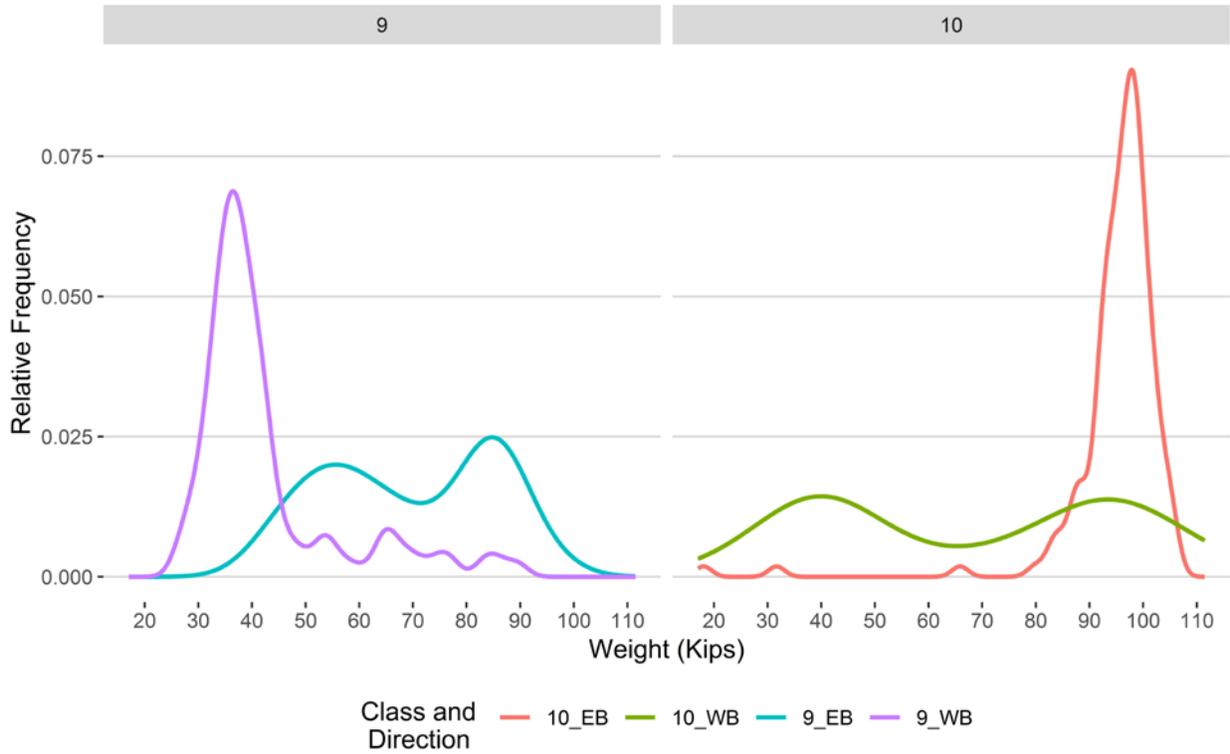


Figure 9 - Freight Percentage by Direction and Class

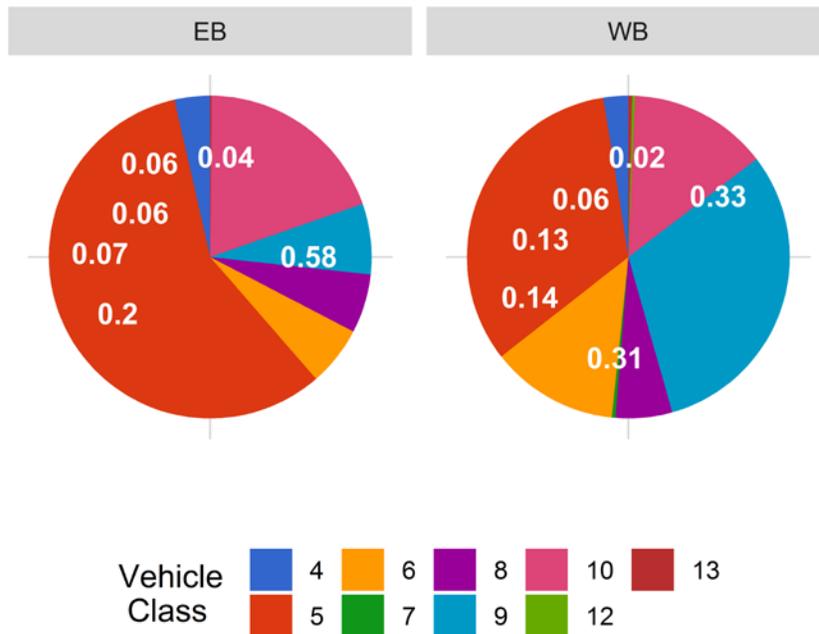


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

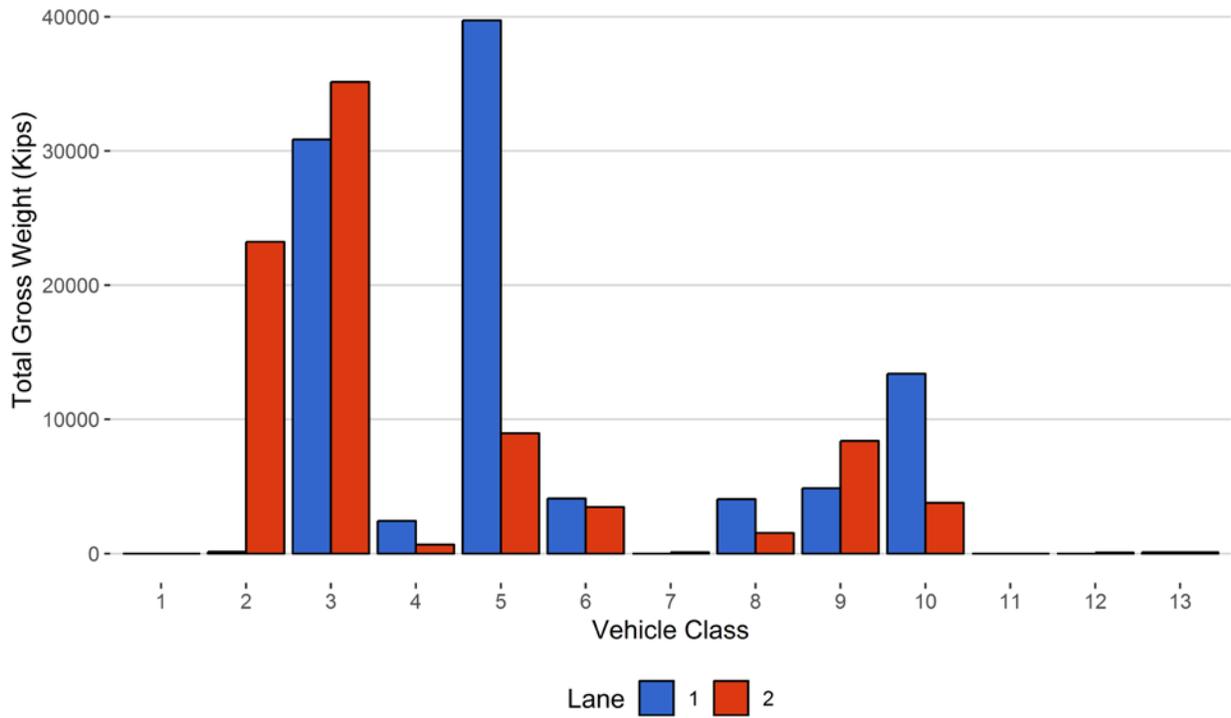


Figure 11 - Total Gross Vehicle Weight t

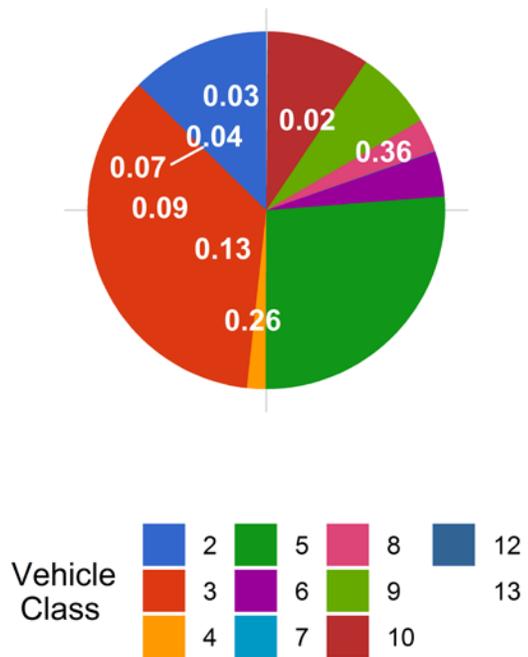


Figure 12 - Total ESALs by Class and Lane

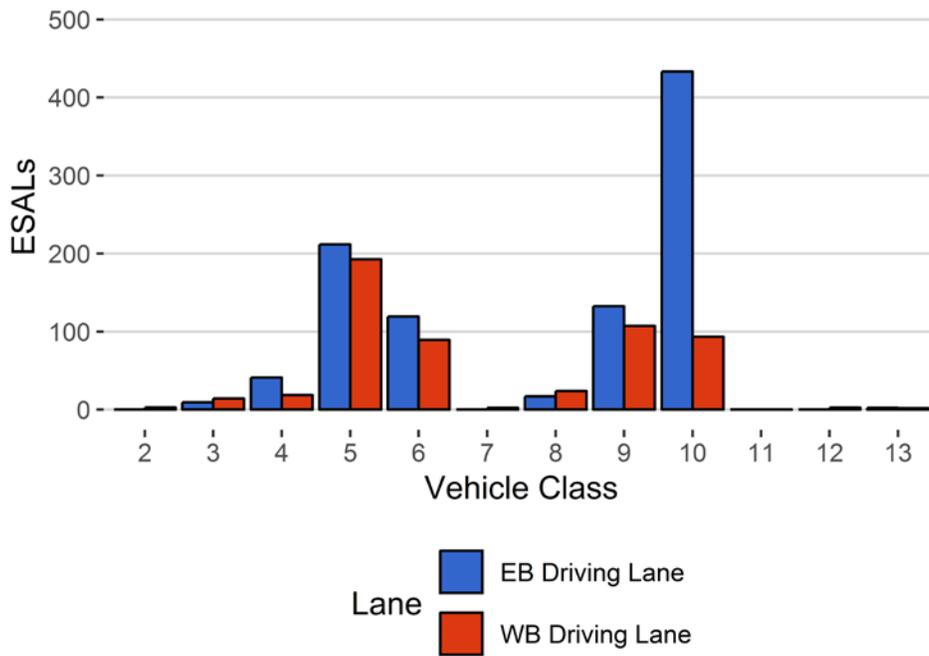
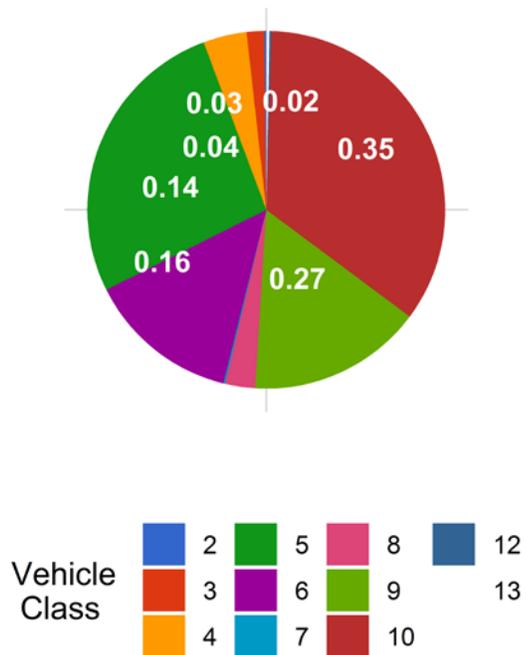


Figure 13 - ESALs by Class



**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
November 2018	11.03	4.91	10.70	0.17
December 2018	11.38	8.30	10.75	0.59

**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	0	0	0	0
2	205	6366	26.9	0	0
3	356	11026	46.6	0	0
4	4	134	0.6	3	1.1
5	165	5114	21.6	26	9.5
6	6	196	0.8	39	14.3
7	0	2	0	0	0
8	10	312	1.3	4	1.5
9	9	278	1.2	37	13.6
10	7	205	0.9	162	59.3
11	0	0	0	0	0
12	0	1	0	0	0
13	0	2	0	2	0.7
<b>TOTAL</b>	<b>762</b>	<b>23636</b>	<b>100</b>	<b>273</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>
2018-12-16	Sunday	15:12:53	10	WB	2	111.5
2018-12-10	Monday	14:35:11	10	WB	2	110.01
2018-12-10	Monday	11:38:15	10	WB	2	109.94
2018-12-13	Thursday	12:25:06	10	EB	1	105.85
2018-12-28	Friday	09:18:30	10	EB	1	105.13
2018-12-11	Tuesday	13:44:54	10	EB	1	105.05
2018-12-19	Wednesday	11:45:23	10	EB	1	105.01
2018-12-22	Saturday	07:19:33	10	EB	1	104.93
2018-12-28	Friday	05:29:39	10	EB	1	104.46
2018-12-05	Wednesday	10:10:11	10	WB	2	103.8

**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	106	4	3.8	2388	55	429
5	EB	8	4402	2480	56.3	22990	16747	3807
6	EB	19	96	0	0	4106	0	1141
8	EB	31	249	235	94.4	607	3451	86
9	EB	33	70	0	0	4865	0	1278
10	EB	33.5	141	2	1.4	13352	50	4348
13	EB	31.5	1	0	0	101	0	35
<b>TOTAL</b>	****	****	<b>5065</b>	<b>2721</b>	****	<b>48409</b>	****	<b>11124</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	23	7	30.4	579	92	170
5	WB	8	513	46	9	8620	342	2442
6	WB	19	92	1	1.1	3444	18	858
7	WB	11.5	2	0	0	101	0	39
8	WB	31	51	18	35.3	1214	318	96
9	WB	33	197	28	14.2	7548	849	985
10	WB	33.5	56	3	5.4	3699	78	962
12	WB	36.5	1	0	0	78	0	21
13	WB	31.5	1	0	0	102	0	35
<b>TOTAL</b>	****	****	<b>936</b>	<b>103</b>	****	<b>25386</b>	****	<b>5607</b>
<b>GRAND TOTAL</b>	****	****	<b>6001</b>	<b>2824</b>	<b>251</b>	<b>73795</b>	<b>21999</b>	<b>16731</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>
2	132	23235	23367	12.6
3	30864	35137	66001	35.6
4	2443	671	3114	1.7
5	39737	8962	48699	26.3
6	4106	3462	7568	4.1
7	0	101	101	0.1
8	4058	1532	5590	3
9	4865	8397	13262	7.2
10	13402	3777	17179	9.3
12	0	78	78	0
13	101	102	203	0.1
<b>TOTAL</b>	<b>99706</b>	<b>85455</b>	<b>185162</b>	<b>100</b>
<b>GVW/LANE</b>	<b>53.85</b>	<b>46.15</b>	<b>100</b>	<b>0.05</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>
2	0	3	3	0.2	0.0014
3	10	14	24	1.6	0.0049
4	41	19	60	3.9	0.96
5	212	193	404	26.7	0.17
6	119	89	209	13.8	2.25
7	0	2	2	0.2	1.34
8	17	24	41	2.7	0.3
9	132	107	240	15.8	1.83
10	433	93	526	34.7	5.3
12	0	2	2	0.2	1.32
13	2	2	4	0.3	1.45
<b>TOTAL</b>	<b>967</b>	<b>549</b>	<b>1516</b>	<b>100</b>	<b>15</b>
<b>ESALS/LANE</b>	<b>63.8</b>	<b>36.2</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>
Nov 2018	26981	899	251	19445	72.1	7536.5	27.9
Dec 2018	23636	762	201	17392	73.6	6244	26.4
<b>TOTAL</b>	<b>50617</b>	<b>-</b>	<b>-</b>	<b>36837</b>	<b>-</b>	<b>13781</b>	<b>-</b>
<b>AVERAGE</b>	<b>25308</b>	<b>831</b>	<b>226</b>	<b>18418</b>	<b>73</b>	<b>6890</b>	<b>27</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>
Nov 2018	1037	608	1645	66.6
Dec 2018	992	553	1545	71.2
<b>TOTAL</b>	<b>2029</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>AVERAGE</b>	<b>1014</b>	<b>580</b>	<b>1595</b>	<b>69</b>

## Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Nov 2018	110328	94957	205285
Dec 2018	101248	85643	186891
<b>TOTAL</b>	<b>211576</b>	<b>180600</b>	<b>392176</b>
<b>AVERAGE</b>	<b>105788</b>	<b>90300</b>	<b>196088</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>
Nov 2018	331	1.4	4.6	186	30
Dec 2018	281	1.2	4.5	161	66
<b>TOTAL</b>	<b>612</b>	<b>-</b>	<b>-</b>	<b>347</b>	<b>96</b>
<b>AVERAGE</b>	<b>306</b>	<b>1.3</b>	<b>4.5</b>	<b>173.5</b>	<b>48</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>
Nov 2018	12439	6561	19000	65.5	34.5
Dec 2018	11124	5607	16731	66.5	33.5
<b>TOTAL</b>	<b>23563</b>	<b>12169</b>	<b>35731</b>	-	-
<b>AVERAGE</b>	<b>11781.3</b>	<b>6084.3</b>	<b>17865.5</b>	<b>66</b>	<b>34</b>