

MARCH 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 March 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: 23847 | Passenger Vehicles: 17402 | Heavy Commercial Vehicles: 6445

Monthly Average Daily Traffic (MADT): 769 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 208

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 Tuesdays, with lowest volumes reported on Saturdays. WB vehicles typically reached highest volume levels on Thursdays, with lowest volumes reported on Mondays (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 6445 HCVs, 153 of them were overweight<sup>3</sup>. These overweight HCVs contributed to 0.7% of total monthly volume, and 2.5% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on Sundays. See Figure 3 .

The top two overweight violators by class were the class 10 and class 5 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 58.3% 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 ,43 EB vehicles exceeded 88,000 pounds (41 vehicles were Class 10's; 2 vehicles were Class 9's). Of vehicles traveling WB,

24 EB vehicles exceeded 88,000 pounds (19 vehicles were Class 10's; 4 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from March 2018.

**Loaded vs. Unloaded HCVs.** Figure 10 shows the GVW distributions of Class 9s and 10s in March 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 13744 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (56.3%) than WB (43.7%). 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 23847 vehicles with a combined GVW of 178428 kips (1 kip = 1,000 pounds = 0.5 tons) in March 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

**Pavement Design.** A total of 1157 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 53.4% of all ESALs were recorded EB while 46.6% was observed WB. In particular, 36% of all ESALs were generated by the Class 5's (Class 5's were also responsible for generating 29% 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).

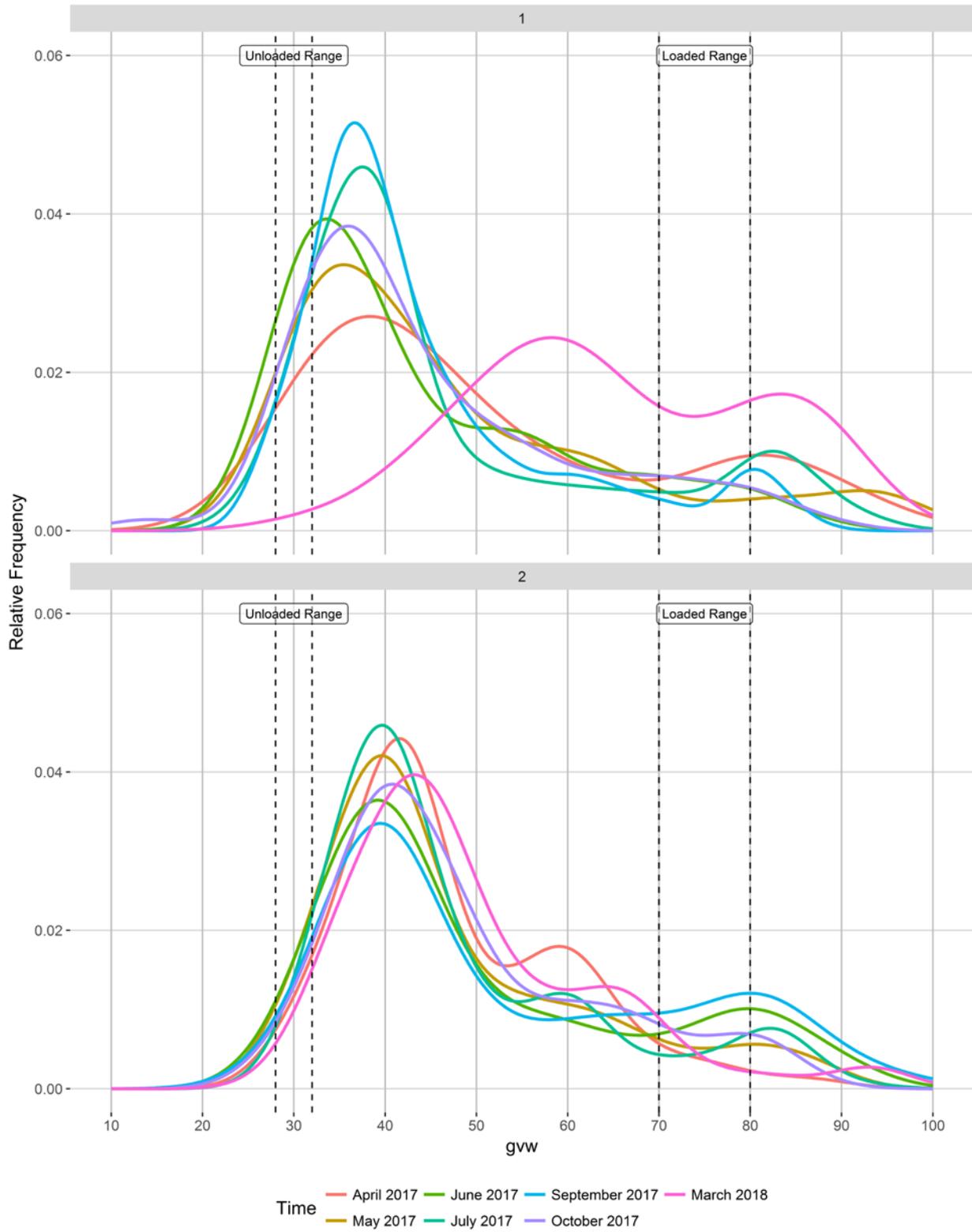
*WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>*

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.

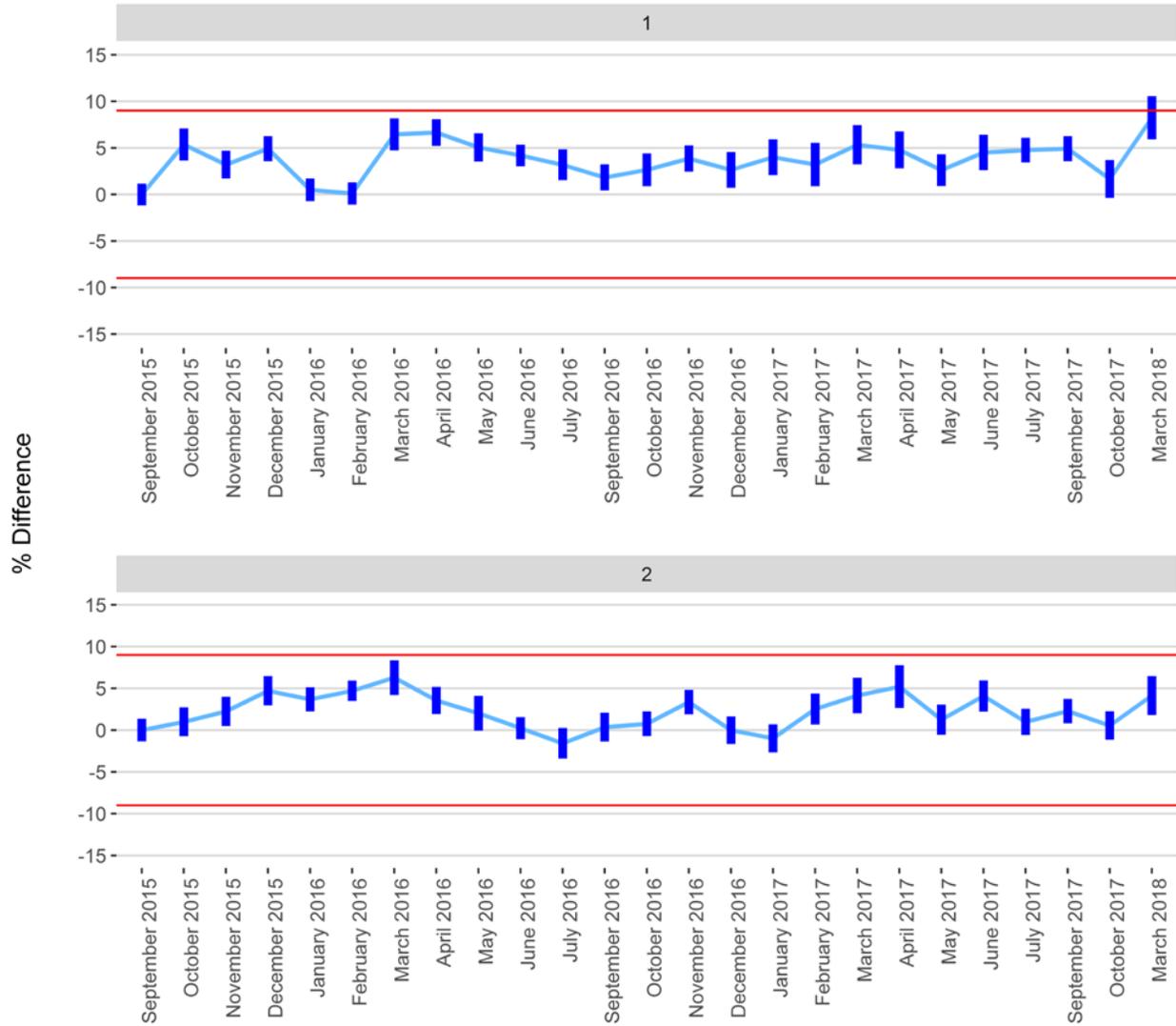
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Figure 1 - Monthly Class 9 GVW Histogram



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

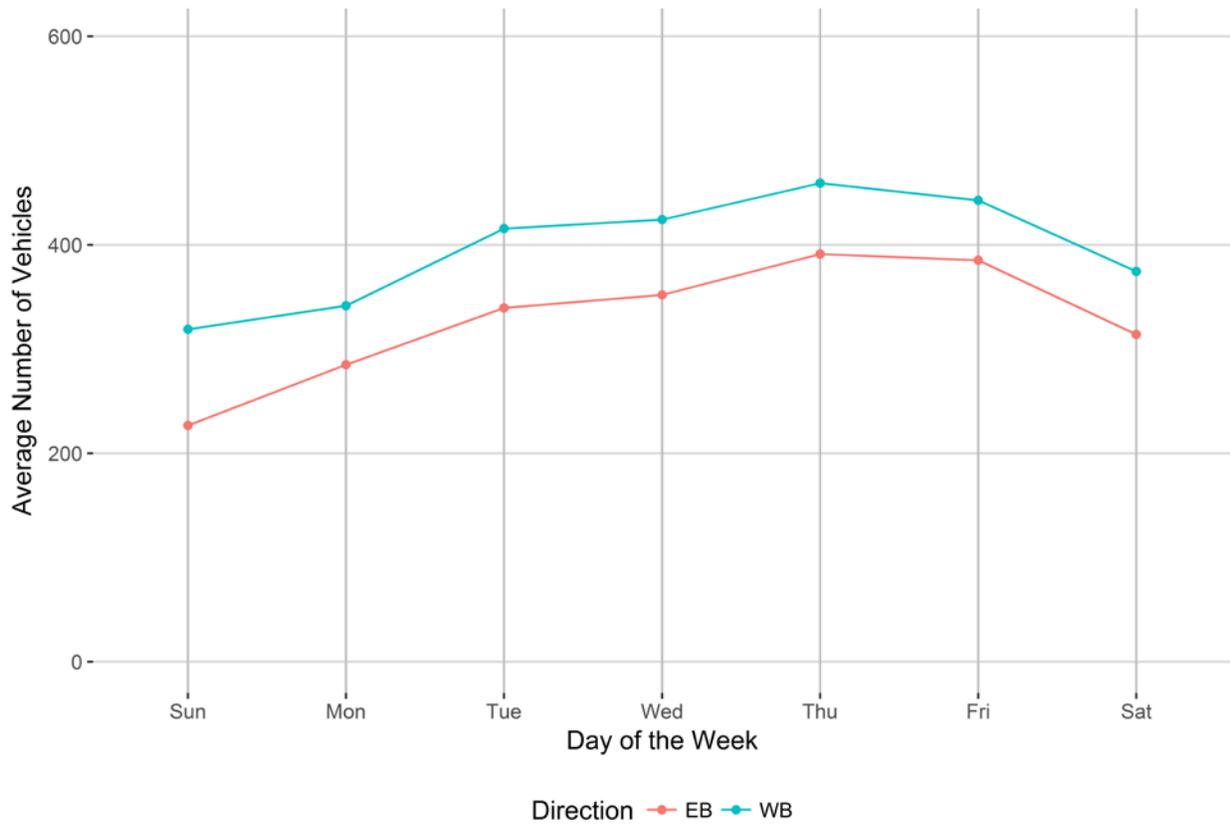


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

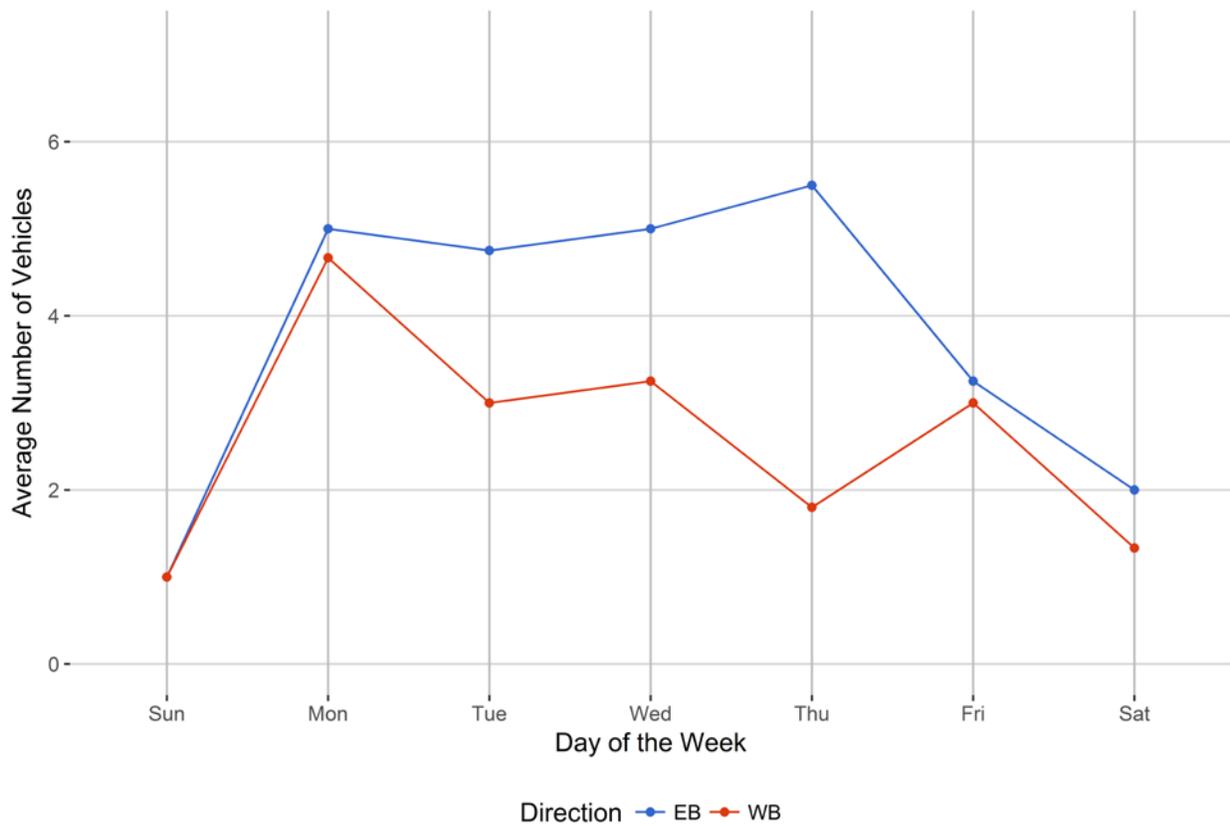


Figure 4 - Passenger Vehicles vs. Hour of the Day

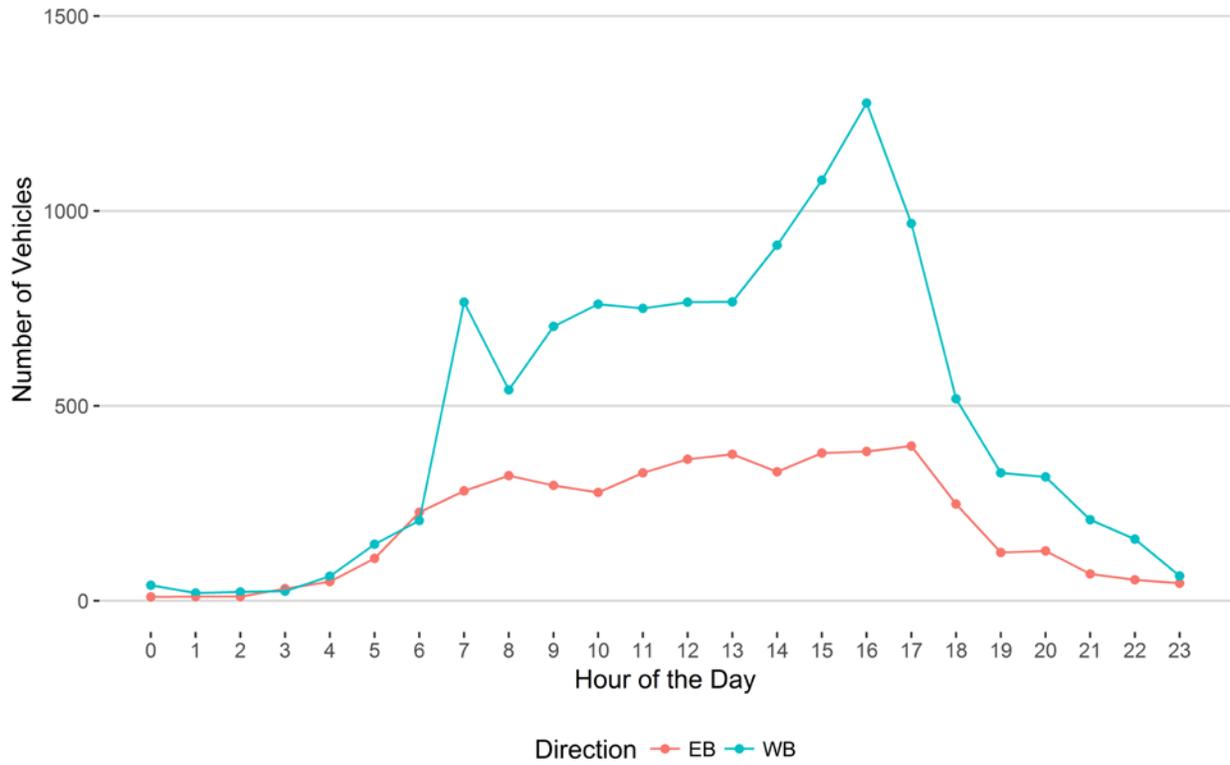


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

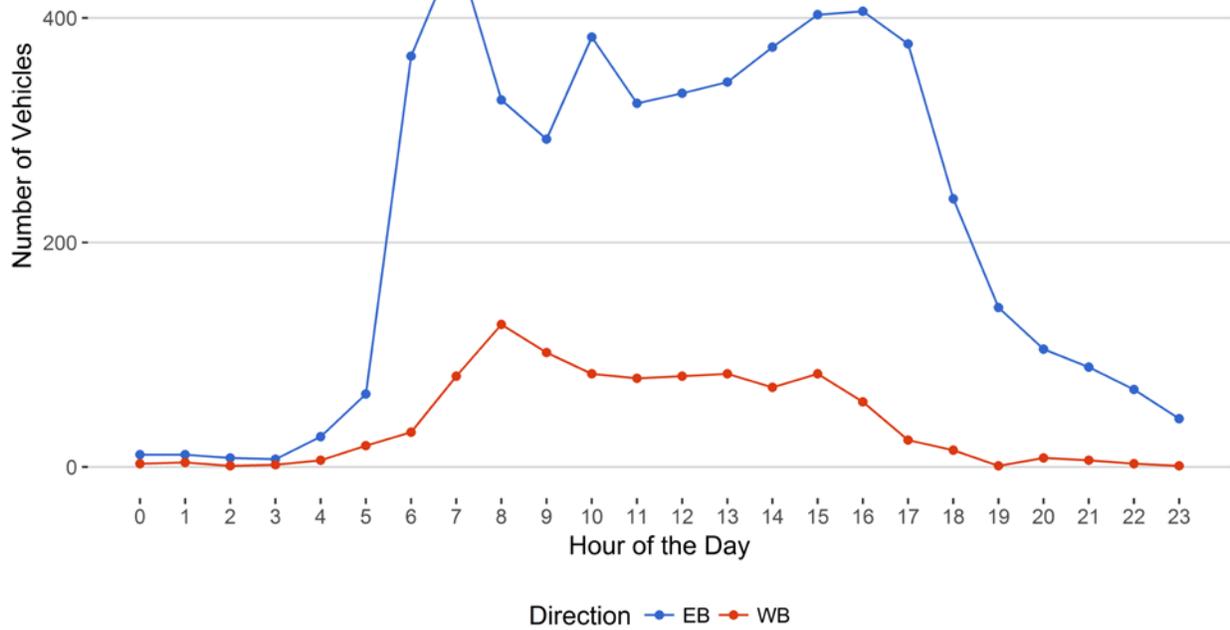




Figure 7 - Overweight Vehicles by Direction  
Hour of the Day

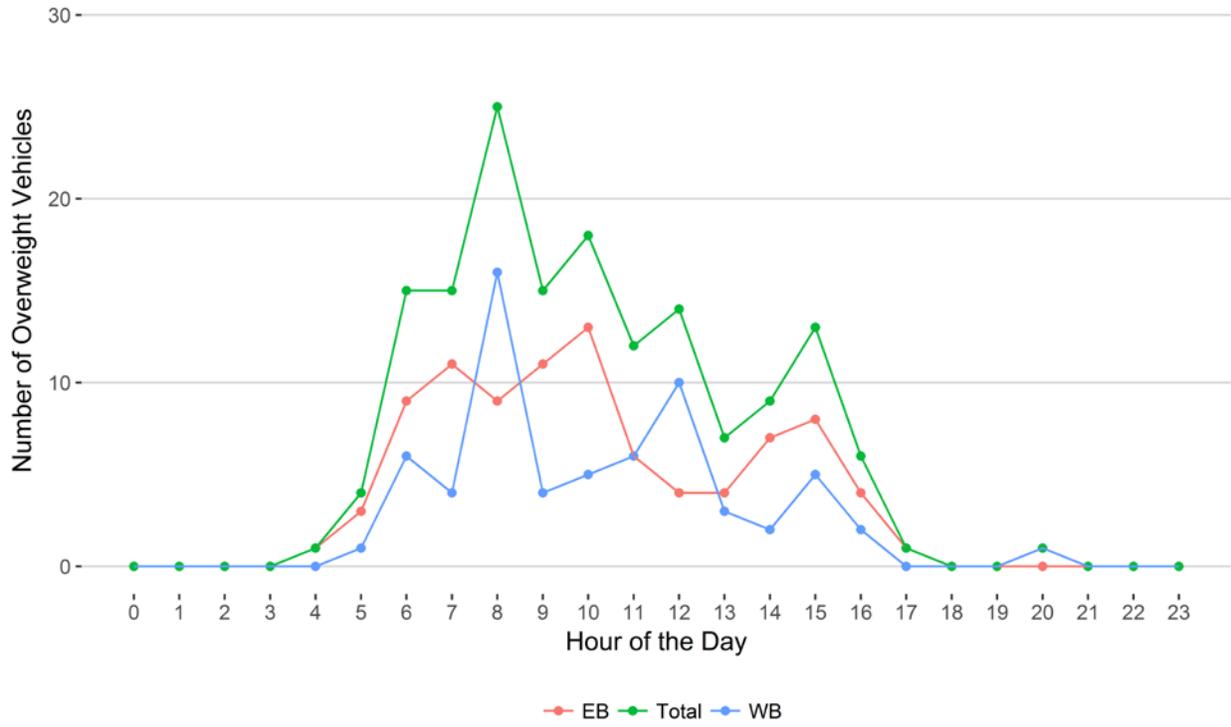
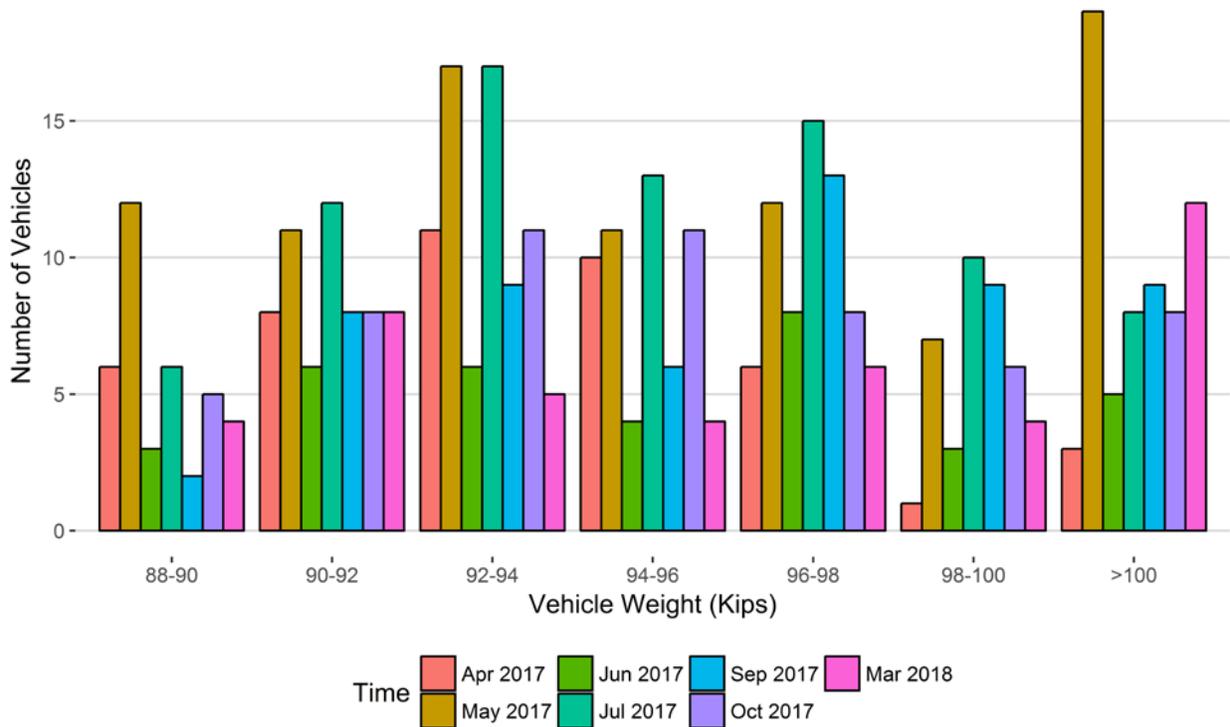


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Apr 2017	May 2017	Jun 2017	Jul 2017	Sep 2017	Oct 2017	Mar 2018
88-90	6	12	3	6	2	5	4
90-92	8	11	6	12	8	8	8
92-94	11	17	6	17	9	11	5
94-96	10	11	4	13	6	11	4
96-98	6	12	8	15	13	8	6
98-100	1	7	3	10	9	6	4
>100	3	19	5	8	9	8	12
<b>Total</b>	<b>45</b>	<b>89</b>	<b>35</b>	<b>81</b>	<b>56</b>	<b>57</b>	<b>43</b>

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



Vehicle Weights (Kips)	Apr 2017	May 2017	Jun 2017	Jul 2017	Sep 2017	Oct 2017	Mar 2018
88-90	1	7	12	8	2	1	4
90-92	0	6	9	2	5	2	3
92-94	1	10	2	9	5	2	2
94-96	0	6	4	8	1	3	5
96-98	1	3	11	9	6	5	1
98-100	1	2	10	15	2	11	2
>100	3	13	16	64	20	33	7
<b>Total</b>	<b>7</b>	<b>47</b>	<b>64</b>	<b>115</b>	<b>41</b>	<b>57</b>	<b>24</b>

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

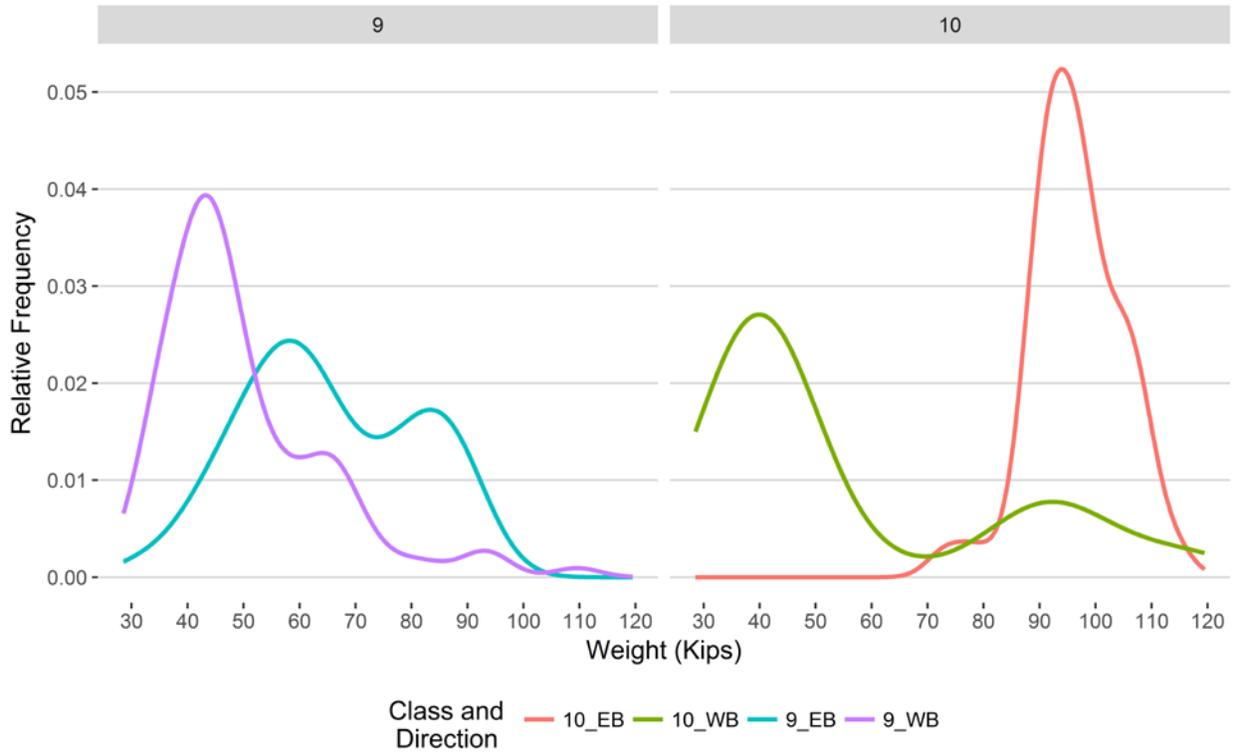


Figure 9 - Freight Percentage by Direction and Class

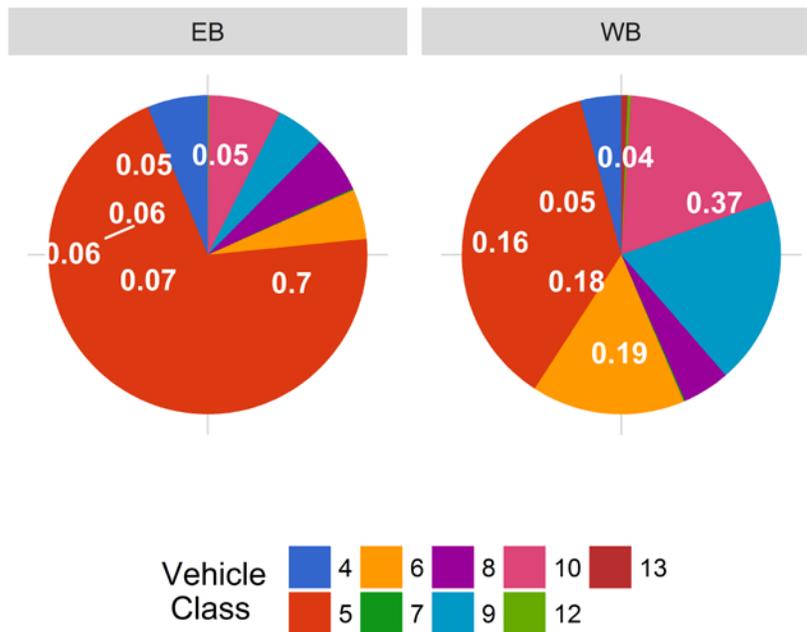


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

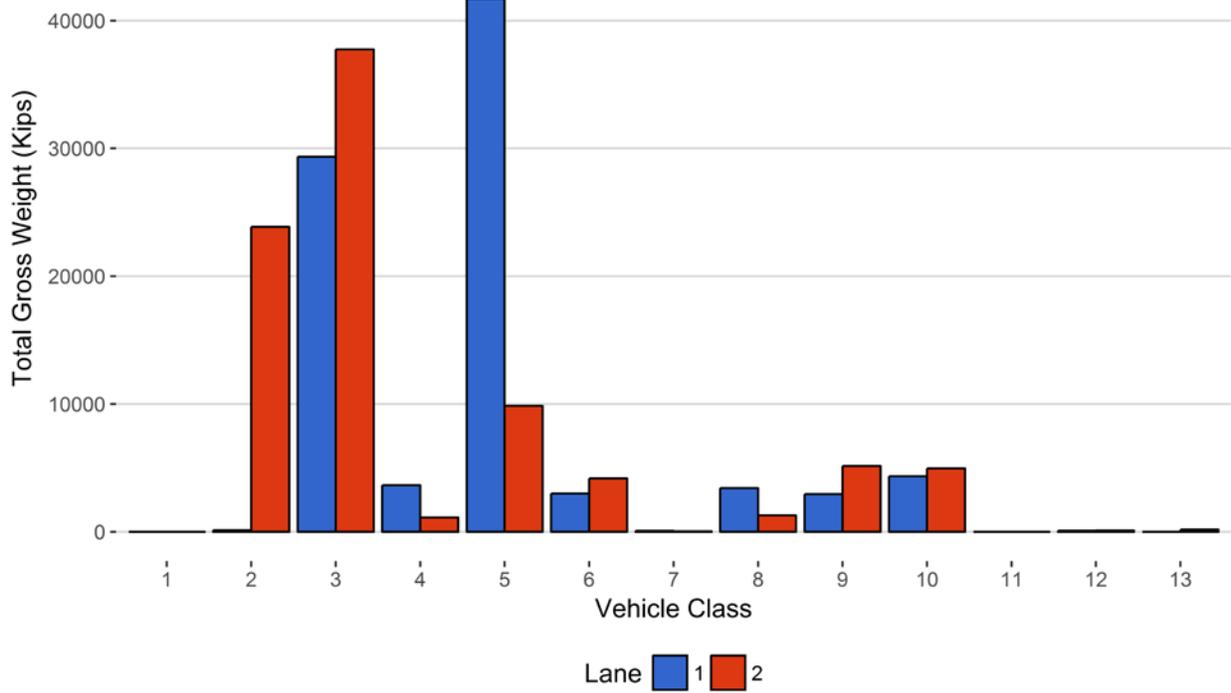


Figure 11 - Total Gross Vehicle Weight I

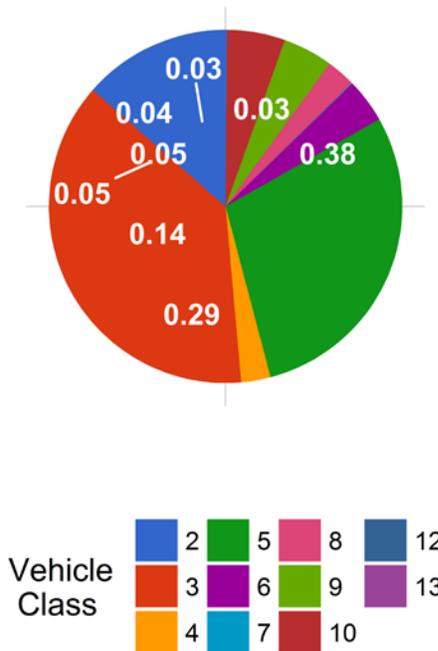


Figure 12 - Total ESALs by Class and Lane

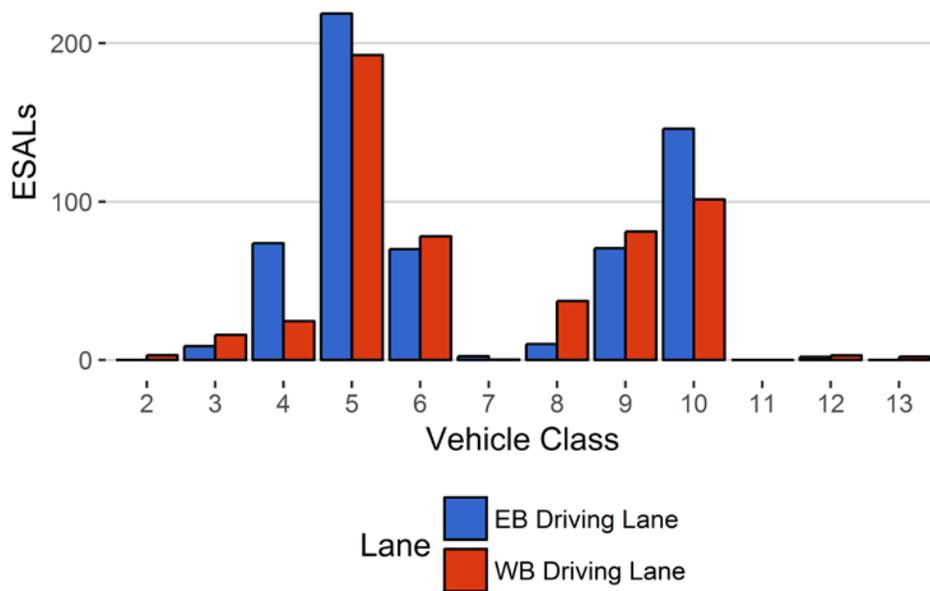
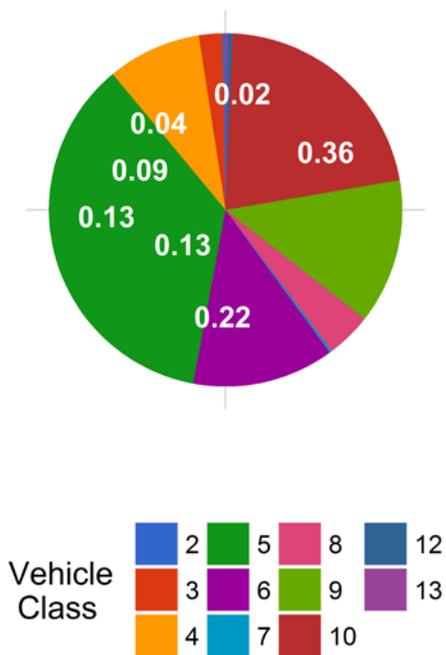


Figure 13 - ESALs by Class



**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
March 2018	11.38	8.24	11.13	4.13

**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	208	6436	27	0	0
3	354	10966	46	0	0
4	6	188	0.8	7	4.6
5	178	5508	23.1	30	19.6
6	6	197	0.8	15	9.8
7	0	2	0	1	0.7
8	8	251	1.1	8	5.2
9	5	154	0.6	22	14.4
10	5	140	0.6	66	43.1
11	0	0	0	0	0
12	0	2	0	2	1.3
13	0	2	0	2	1.3
<b>TOTAL</b>	<b>769</b>	<b>23847</b>	<b>100</b>	<b>153</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>
2018-03-01	Thursday	12:46:12	10	WB	2	119.49
2018-03-02	Friday	13:52:14	10	WB	2	118.41
2018-03-04	Sunday	11:02:15	10	WB	2	116.44
2018-03-03	Saturday	15:20:02	10	WB	2	115.95
2018-03-13	Tuesday	06:06:23	10	EB	1	114.2
2018-03-07	Wednesday	17:48:23	10	EB	1	109.6
2018-03-02	Friday	20:50:12	9	WB	2	109.58
2018-03-02	Friday	12:08:21	10	WB	2	109.38
2018-03-04	Sunday	16:43:08	10	EB	1	108.21
2018-03-07	Wednesday	12:44:05	10	EB	1	107.99

**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	145	2	1.4	3622	20	738
5	EB	8	4688	2654	56.6	24158	17565	3943
6	EB	19	74	0	0	3001	0	798
7	EB	11.5	1	0	0	75	0	32
8	EB	31	207	194	93.7	525	2892	61
9	EB	33	45	1	2.2	2909	32	729
10	EB	33.5	45	0	0	4339	0	1416
12	EB	36.5	1	0	0	87	0	25
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>5206</b>	<b>2851</b>	<b>****</b>	<b>38715</b>	<b>****</b>	<b>7741</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	35	5	14.3	1047	68	299
5	WB	8	592	54	9.1	9450	403	2573
6	WB	19	115	1	0.9	4161	17	997
7	WB	11.5	1	0	0	39	0	14
8	WB	31	34	8	23.5	1143	145	168
9	WB	33	103	3	2.9	5056	92	878
10	WB	33.5	89	2	2.2	4903	61	994
12	WB	36.5	1	0	0	89	0	26
13	WB	31.5	2	0	0	170	0	54
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>972</b>	<b>73</b>	<b>****</b>	<b>26058</b>	<b>****</b>	<b>6003</b>
<b>GRAND TOTAL</b>	<b>****</b>	<b>****</b>	<b>6178</b>	<b>2924</b>	<b>207</b>	<b>64773</b>	<b>21294</b>	<b>13744</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	116	23868	23984	13.5
3	29343	37748	67092	37.9
4	3641	1115	4757	2.7
5	41722	9852	51575	29.1
6	3001	4178	7179	4.1
7	75	39	114	0.1
8	3417	1288	4704	2.7
9	2942	5148	8090	4.6
10	4339	4964	9303	5.3
12	87	89	176	0.1
13	0	170	170	0.1
<b>TOTAL</b>	<b>88683</b>	<b>88460</b>	<b>177143</b>	<b>100</b>
<b>GVW/LANE</b>	<b>50.06</b>	<b>49.94</b>	<b>100</b>	<b>0.06</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	0.3	0.0015
3	9	16	25	2.2	0.0052
4	74	24	98	8.6	1.14
5	219	192	411	36	0.16
6	70	78	148	13	1.62
7	2	0	3	0.2	1.38
8	10	37	47	4.1	0.43
9	71	81	152	13.3	2.07
10	146	101	247	21.7	3.66
12	2	3	5	0.4	1.59
13	0	2	2	0.2	1.16
<b>TOTAL</b>	<b>602</b>	<b>539</b>	<b>1141</b>	<b>100</b>	<b>13</b>
<b>ESALS/LANE</b>	<b>52.8</b>	<b>47.2</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>
Apr 2017	27459	915	64	25542	93	1917.2	7
May 2017	36813	1188	93	33921	92.1	2891.8	7.9
Jun 2017	39195	1306	100	36191	92.3	3004.1	7.7
Jul 2017	44467	1434	115	40917	92	3550.3	8
Sep 2017	35473	1182	92	32700	92.2	2773	7.8
Oct 2017	31525	1017	95	28567	90.6	2957.8	9.4
Mar 2018	23847	769	208	17402	73	6445	27
<b>TOTAL</b>	<b>238779</b>	--	--	<b>215240</b>	--	<b>23539</b>	--
<b>AVERAGE</b>	<b>34111</b>	<b>1116</b>	<b>110</b>	<b>30749</b>	<b>89</b>	<b>3363</b>	<b>11</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>
Apr 2017	541	490	1031	40.3
May 2017	978	1012	1990	19.5
Jun 2017	752	1070	1821	25.9
Jul 2017	1643	1291	2934	25.4
Sep 2017	877	1083	1959	22.1
Oct 2017	909	1075	1983	29.6
Mar 2018	618	539	1157	40.2
<b>TOTAL</b>	<b>6315</b>	<b>--</b>	<b>--</b>	<b>--</b>
<b>AVERAGE</b>	<b>902</b>	<b>937</b>	<b>1839</b>	<b>29</b>

## Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Apr 2017	89941	88487	178428
May 2017	90373	98683	189056
Jun 2017	128367	143432	271799
Jul 2017	126323	154528	280851
Sep 2017	146289	177523	323812
Oct 2017	121395	140110	261505
Mar 2018	116073	133692	249765
<b>TOTAL</b>	<b>818762</b>	<b>936456</b>	<b>1755217</b>
<b>AVERAGE</b>	<b>116966</b>	<b>133779</b>	<b>250745</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>
Apr 2017	146	0.5	7.7	52	8
May 2017	361	1	12.6	136	41
Jun 2017	317	0.8	10.6	99	34
Jul 2017	640	1.5	18.9	196	97
Sep 2017	323	0.9	11.5	98	40
Oct 2017	344	1.1	10.3	115	58
Mar 2018	156	0.7	2.4	67	25
<b>TOTAL</b>	<b>2287</b>	<b>--</b>	<b>--</b>	<b>763</b>	<b>303</b>
<b>AVERAGE</b>	<b>326.7</b>	<b>0.9</b>	<b>10.6</b>	<b>109</b>	<b>43.3</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>
Apr 2017	6492	5734	12225	53.1	46.9
May 2017	10567	11297	21864	48.3	51.7
Jun 2017	8485	11479	19964	42.5	57.5
Jul 2017	14839	13532	28371	52.3	47.7
Sep 2017	9454	10945	20399	46.3	53.7
Oct 2017	10009	11716	21725	46.1	53.9
Mar 2018	7741	6003	13744	56.3	43.7
<b>TOTAL</b>	<b>67586</b>	<b>70706</b>	<b>138292</b>	--	--
<b>AVERAGE</b>	<b>9655.2</b>	<b>10100.8</b>	<b>19756</b>	<b>49.3</b>	<b>50.7</b>