

MAY 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 May 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 ¹. 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 ². 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: 37496 | Passenger Vehicles: 26766 | Heavy Commercial Vehicles: 10730

Monthly Average Daily Traffic (MADT): 1210 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 346

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 Tuesdays. WB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Tuesdays (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 02 PM and 04 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 02 PM and 04 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 10730 HCVs, 312 of them were overweight³. These overweight HCVs contributed to 0.9% of total monthly volume, and 3% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Mondays, with lowest volumes reported on Saturdays. 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 6 and class 10 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 56.6% of all overweight vehicles traveling WB 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 report⁴.

Using normal load limits ,41 EB vehicles exceeded 88,000 pounds (34 vehicles were Class 10's; 5 vehicles were Class 9's). Of vehicles traveling WB,

28 EB vehicles exceeded 88,000 pounds (24 vehicles were Class 10's; 3 vehicles were Class 12's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from May 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in May 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 23374 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (51.3%) than WB (48.7%). 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 37496 vehicles with a combined GVW of 290675 kips (1 kip = 1,000 pounds = 0.5 tons) in May 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 1912 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 53.5% of all ESALs were recorded WB while 46.5% was observed EB. In particular, 26% of all ESALs were generated by the Class 6's (Class 6's were also responsible for generating 7% 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).

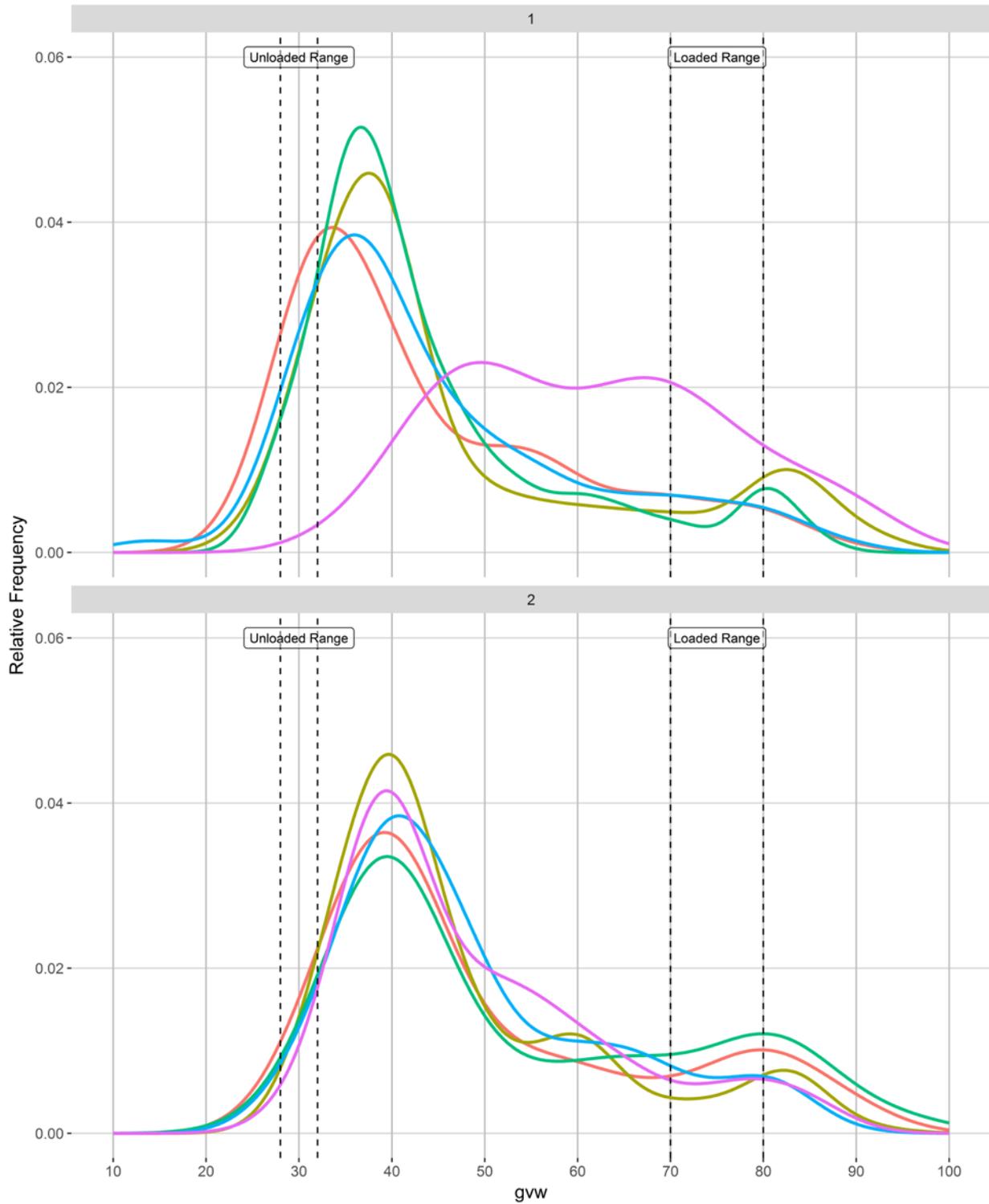
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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>

- ¹ 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
- ² 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.
- ³ 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
- ⁴ 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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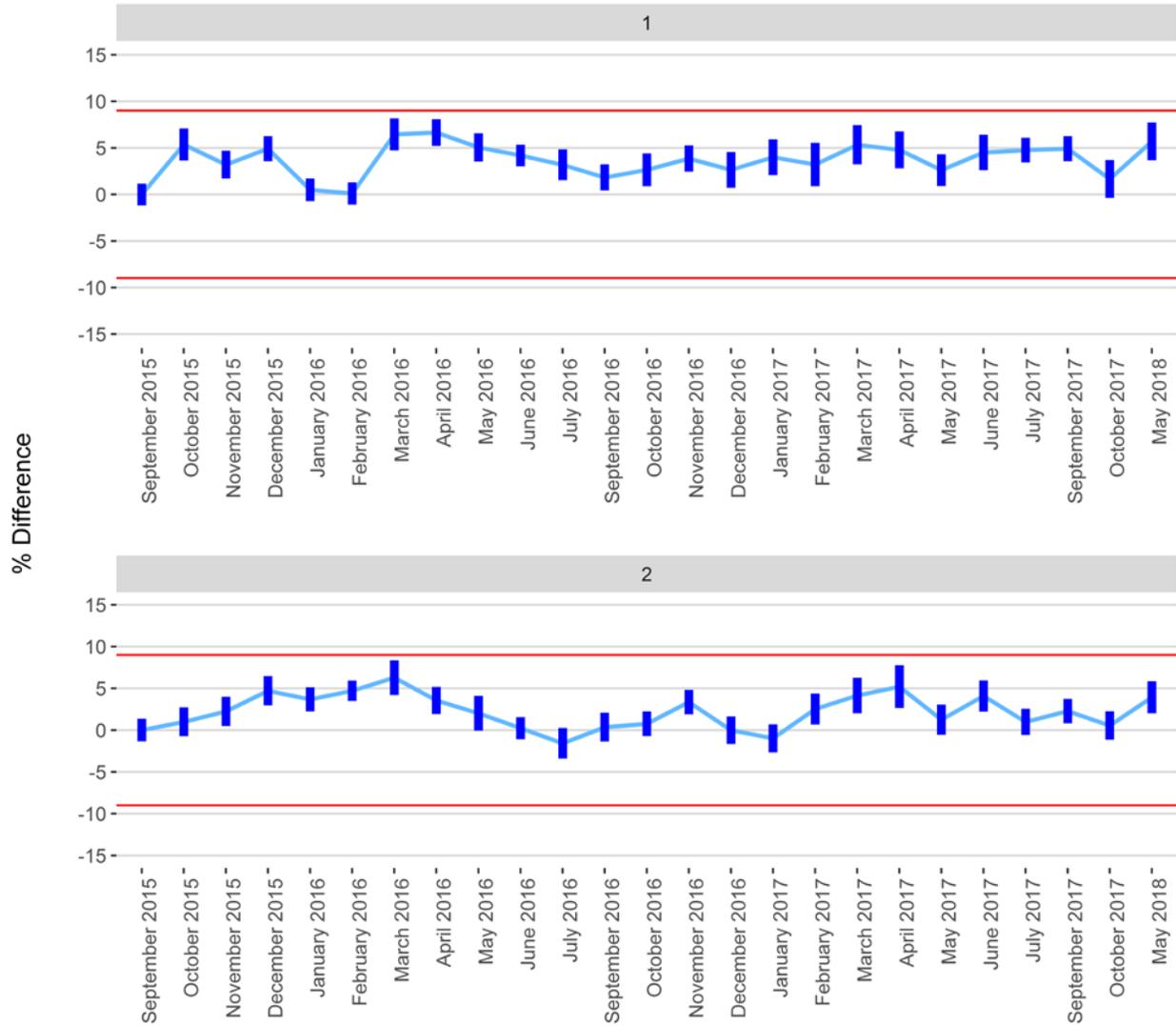
Figure 1 - Monthly Class 9 GVW Histogram



Time — June 2017 — July 2017 — September 2017 — October 2017 — May 2018

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

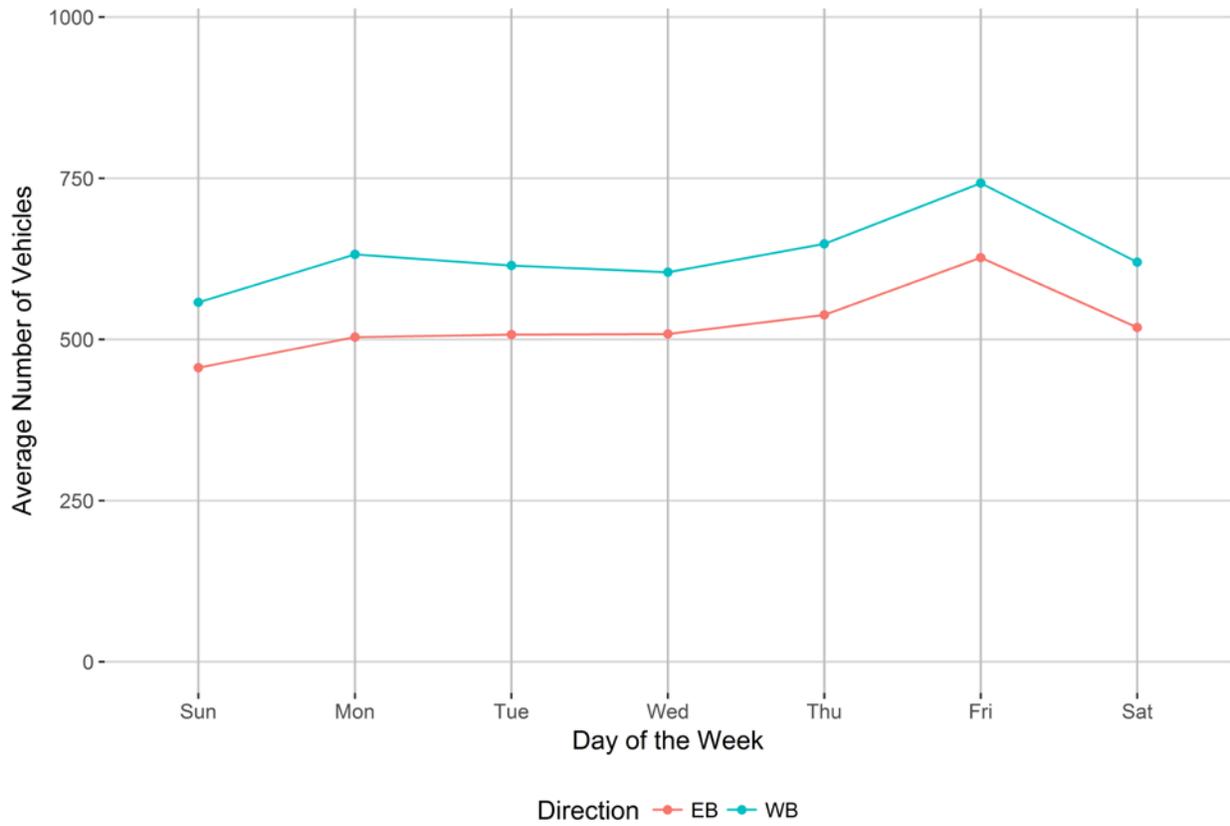


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

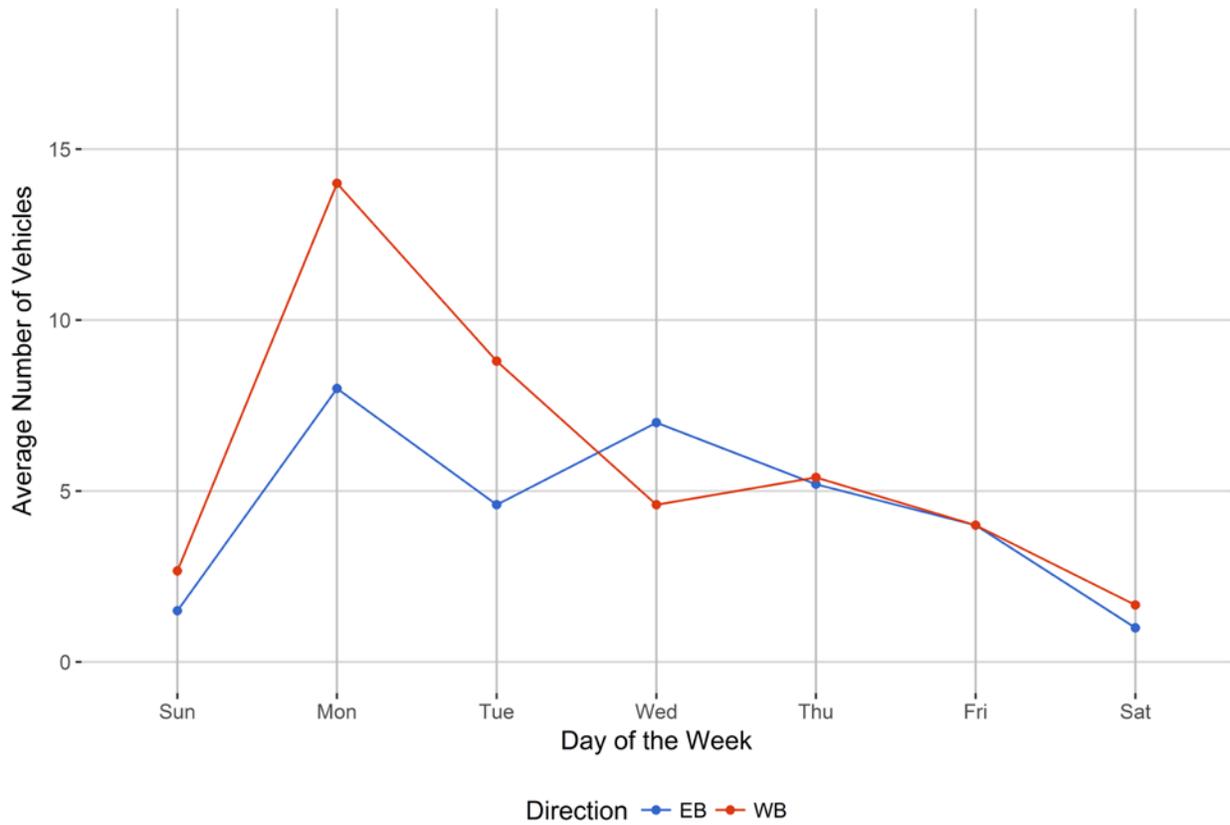


Figure 4 - Passenger Vehicles vs. Hour of the Day

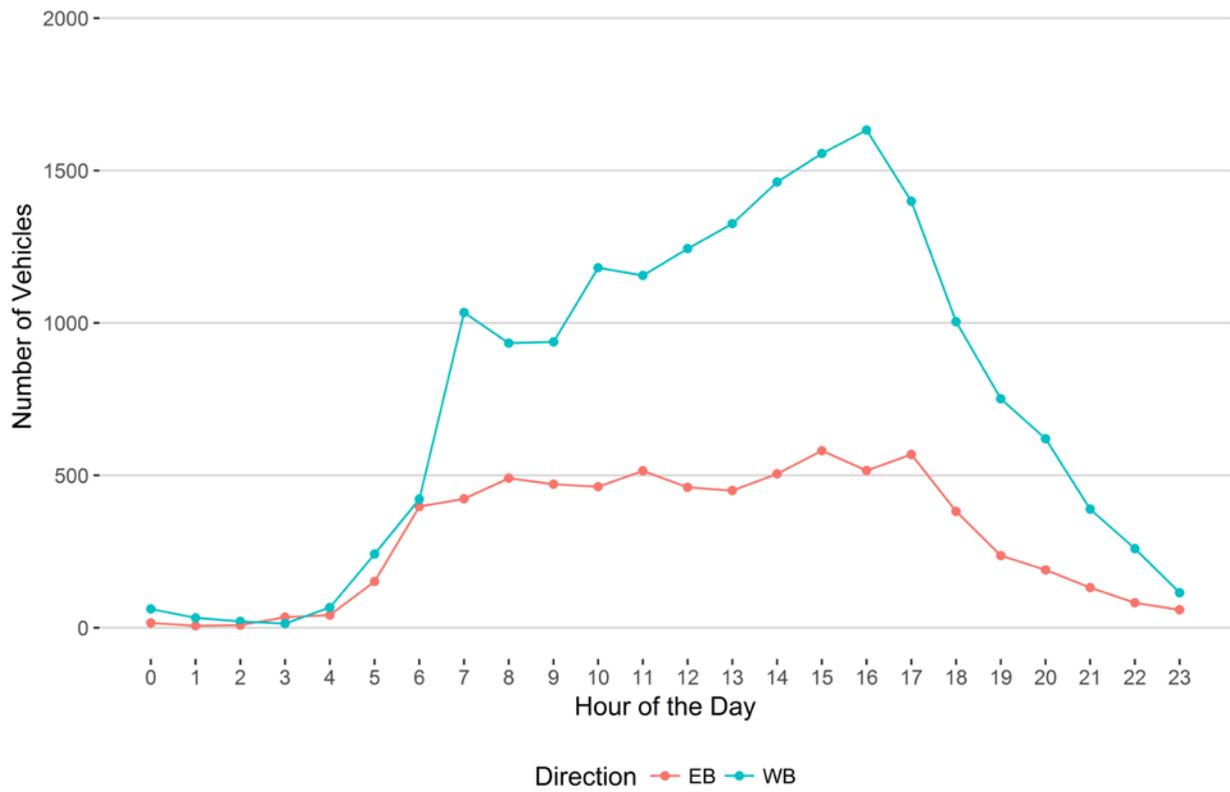


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

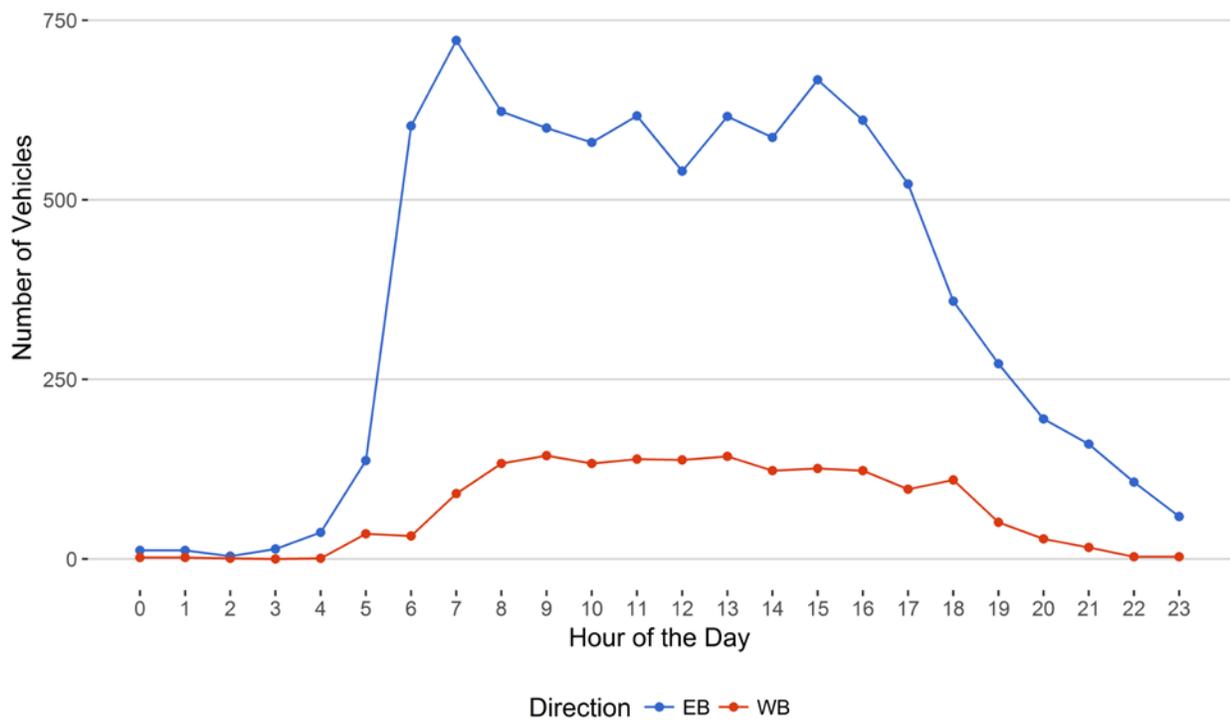


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

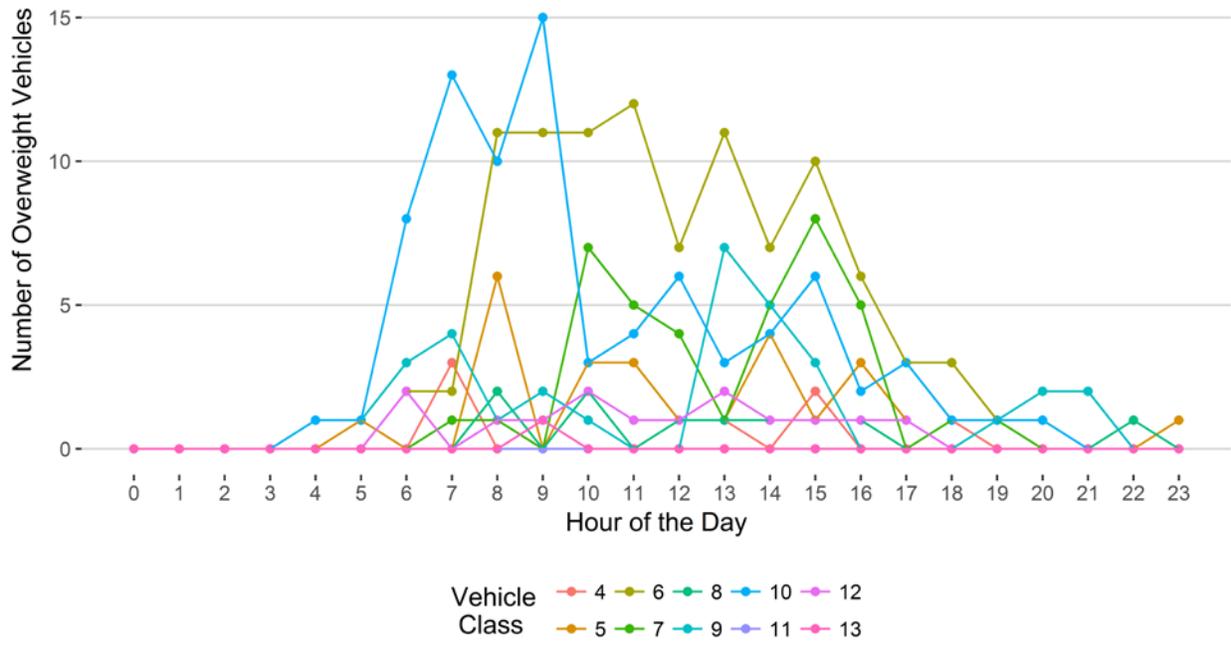


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

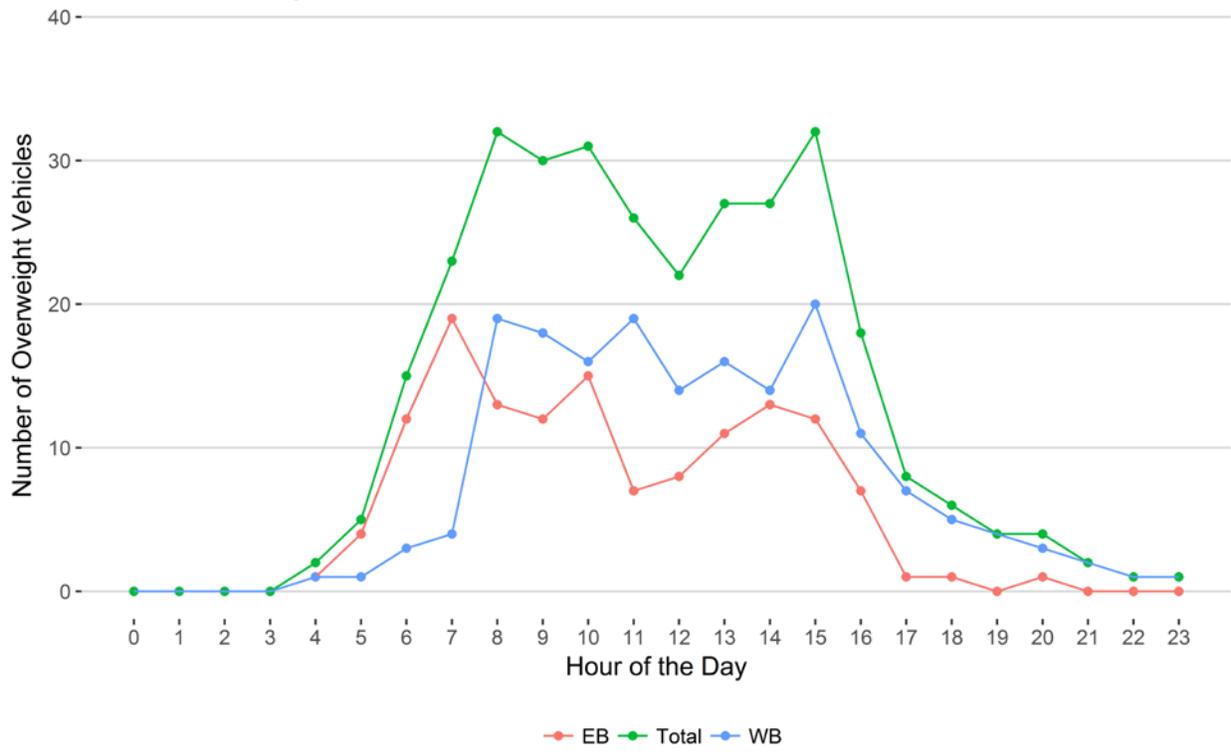
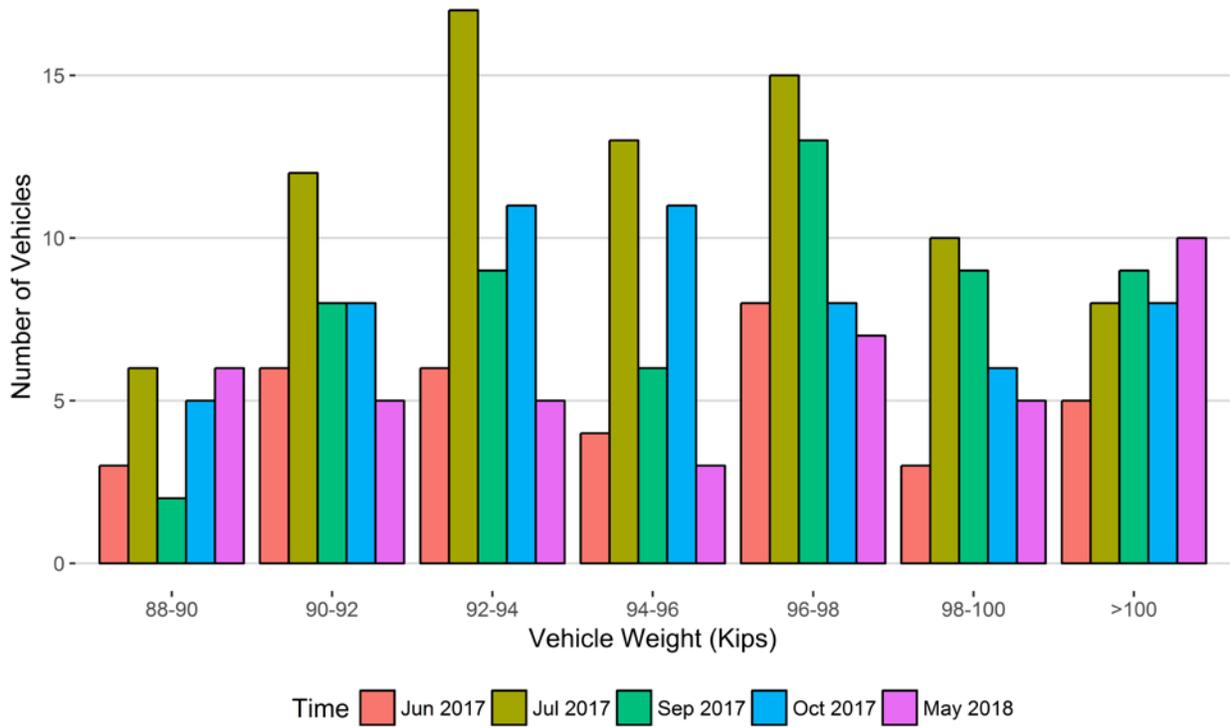
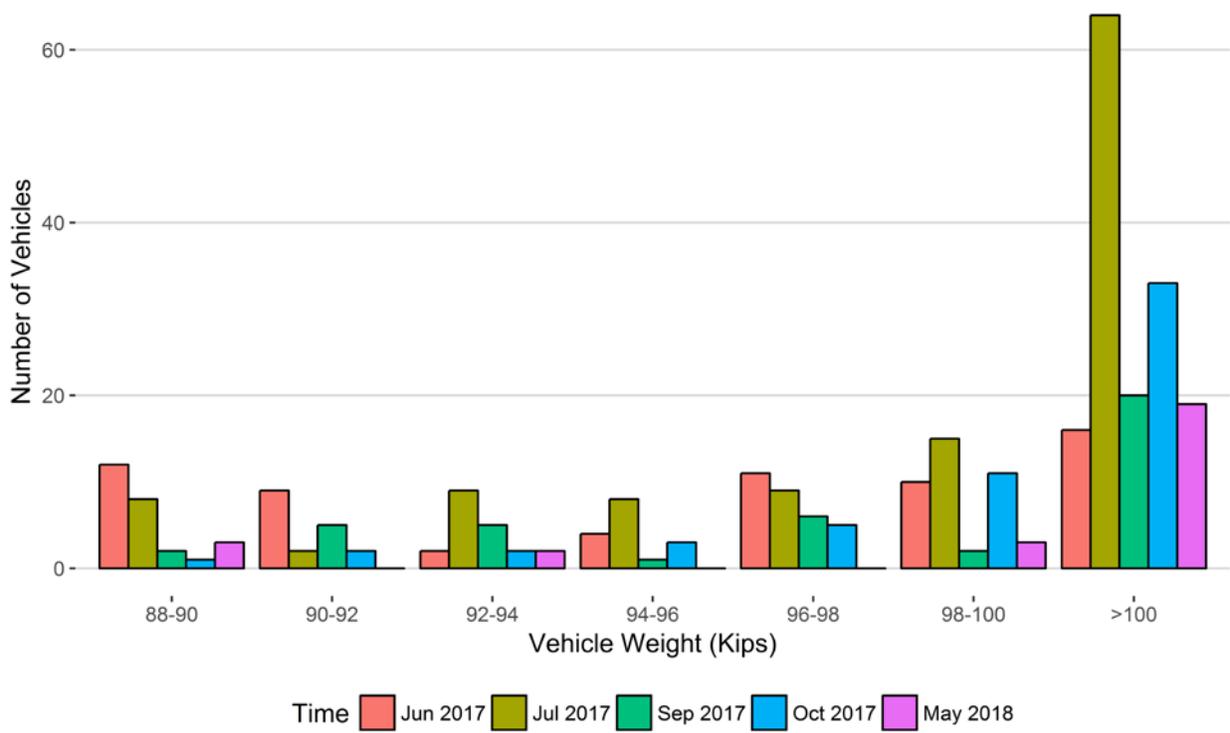


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Jun 2017</i>	<i>Jul 2017</i>	<i>Sep 2017</i>	<i>Oct 2017</i>	<i>May 2018</i>
88-90	3	6	2	5	6
90-92	6	12	8	8	5
92-94	6	17	9	11	5
94-96	4	13	6	11	3
96-98	8	15	13	8	7
98-100	3	10	9	6	5
>100	5	8	9	8	10
Total	35	81	56	57	41

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



<i>Vehicle Weights (Kips)</i>	<i>Jun 2017</i>	<i>Jul 2017</i>	<i>Sep 2017</i>	<i>Oct 2017</i>	<i>May 2018</i>
88-90	12	8	2	1	3
90-92	9	2	5	2	0
92-94	2	9	5	2	2
94-96	4	8	1	3	0
96-98	11	9	6	5	0
98-100	10	15	2	11	3
>100	16	64	20	33	19
Total	64	115	41	57	27

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

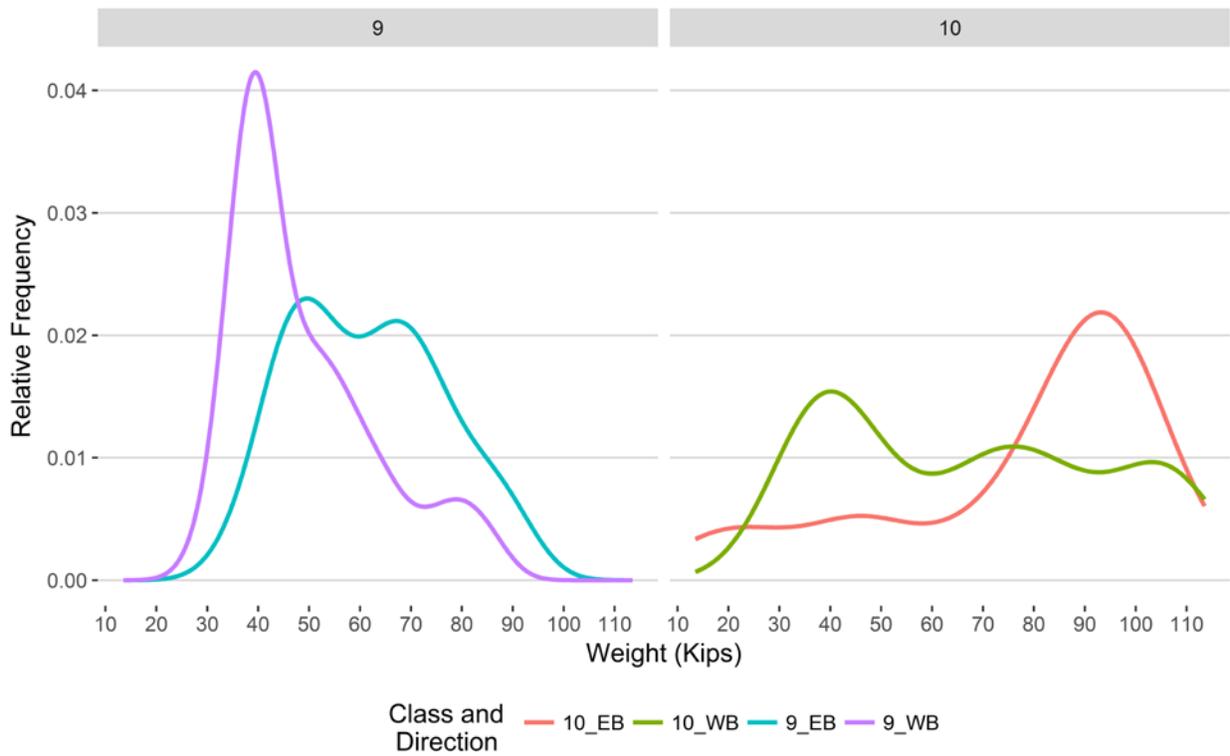


Figure 9 - Freight Percentage by Direction and Class

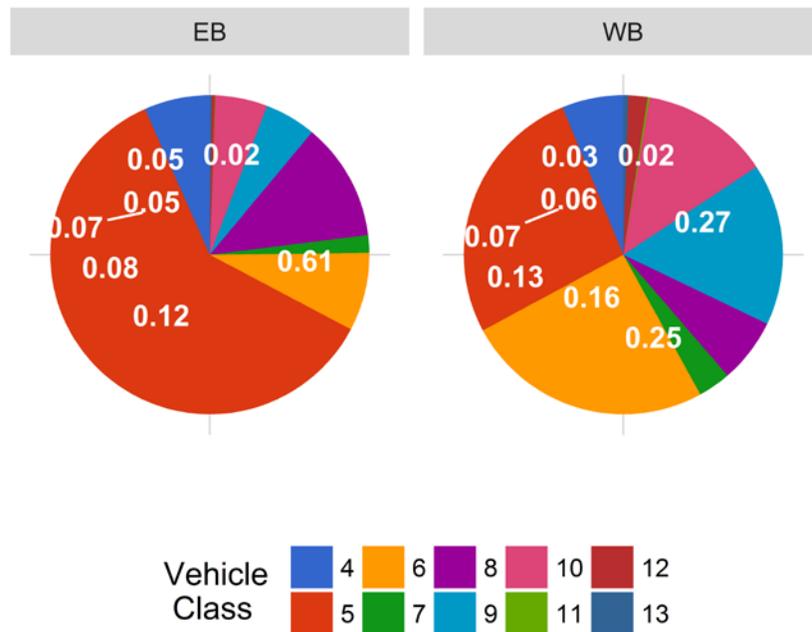


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

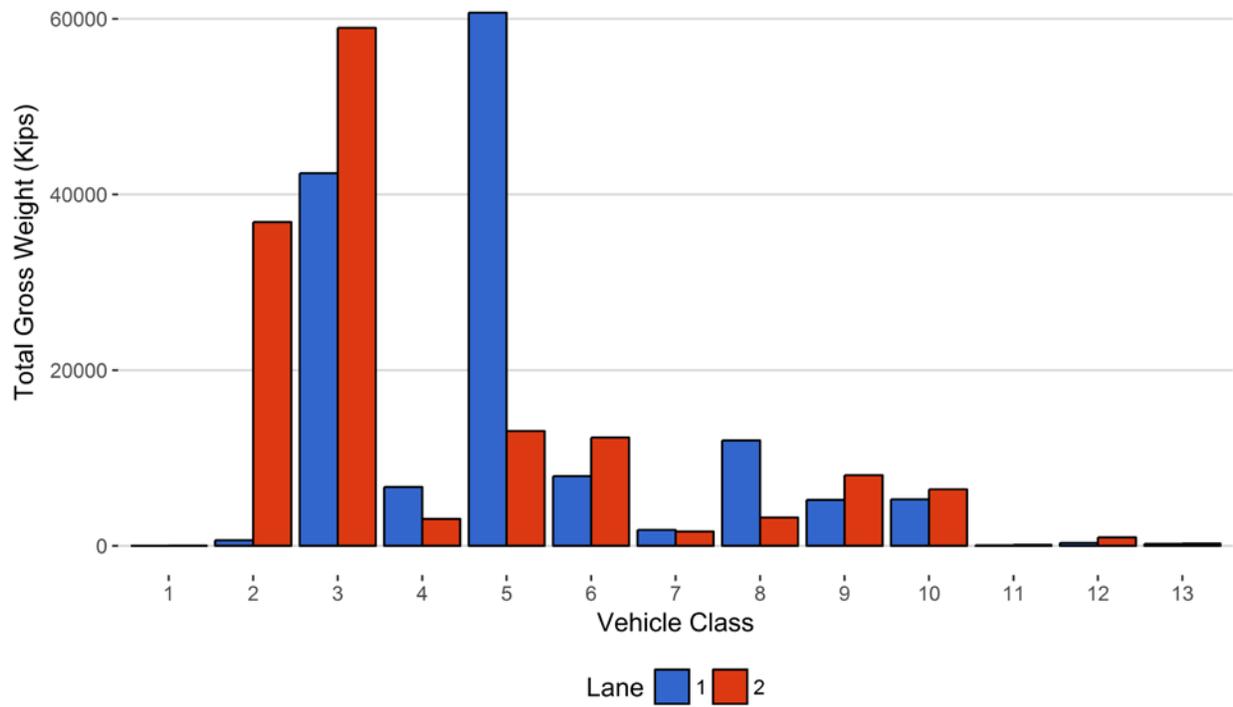


Figure 11 - Total Gross Vehicle Weight I

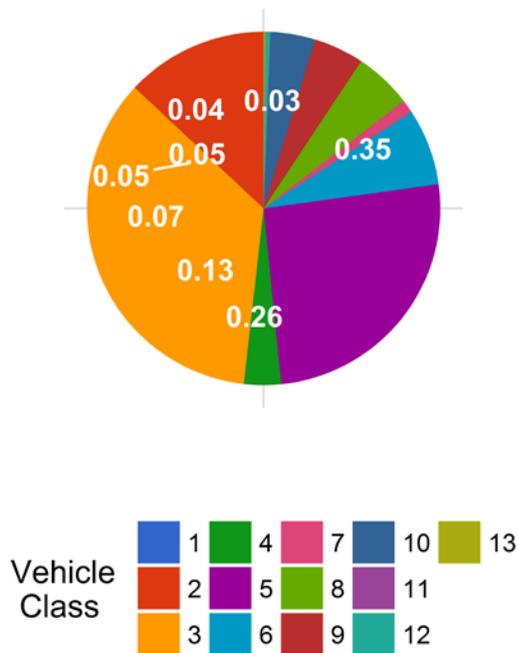


Figure 12 - Total ESALs by Class and Lane

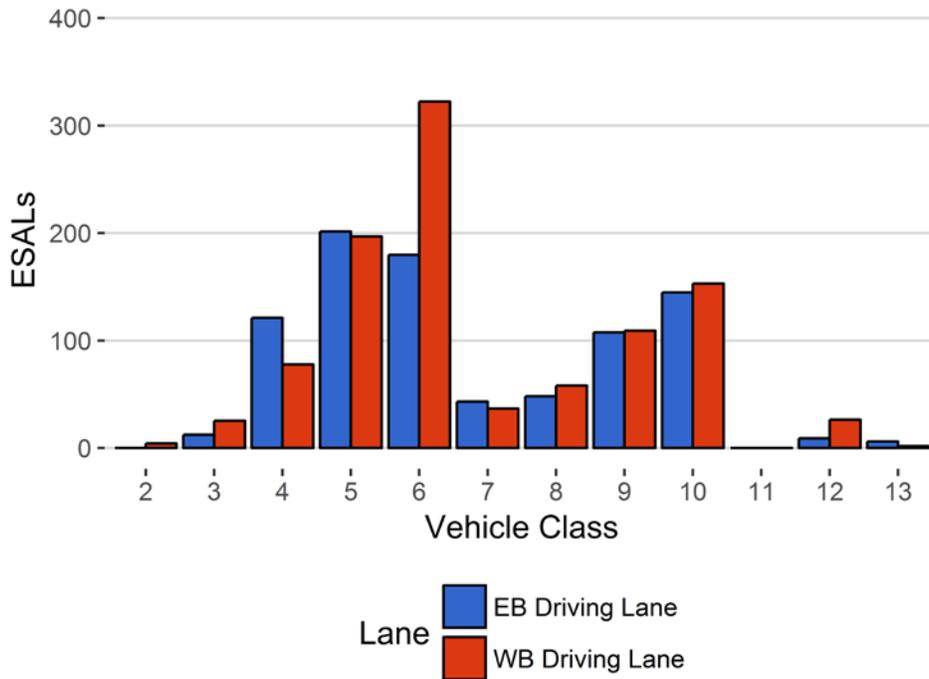


Figure 13 - ESALs by Class

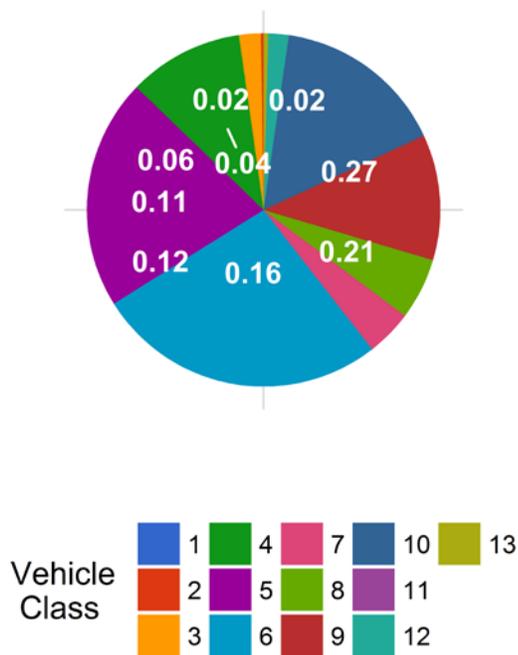


Table 1 Class 9 Front Axle Weight by Lane

<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
May 2018	11.11	5.70	11.11	3.93

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	8	0	0	0
2	336	10428	27.8	0	0
3	527	16329	43.5	0	0
4	11	344	0.9	10	3.2
5	272	8437	22.5	25	8
6	18	548	1.5	98	31.4
7	2	55	0.1	39	12.5
8	29	888	2.4	10	3.2
9	8	259	0.7	33	10.6
10	5	169	0.5	82	26.3
11	0	7	0	0	0
12	1	17	0	14	4.5
13	0	6	0	1	0.3
TOTAL	1210	37496	100	312	100

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>
2018-05-03	Thursday	09:04:36	10	EB	1	113.54
2018-05-03	Thursday	14:32:12	10	EB	1	112.62
2018-05-03	Thursday	14:03:28	10	EB	1	111.07
2018-05-03	Thursday	09:14:42	10	WB	2	110.19
2018-05-07	Monday	17:13:45	10	WB	2	109.59
2018-05-03	Thursday	16:01:09	10	WB	2	109.29
2018-05-17	Thursday	17:21:01	10	WB	2	108.34
2018-05-07	Monday	16:23:30	10	WB	2	108.08
2018-05-07	Monday	13:25:46	10	WB	2	107.65
2018-05-06	Sunday	15:15:46	10	WB	2	107.38

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	250	3	1.2	6640	44	1467
5	EB	8	7258	4503	62	31201	29513	4581
6	EB	19	205	0	0	7934	0	2019
7	EB	11.5	27	0	0	1800	0	745
8	EB	31	755	723	95.8	1497	10487	252
9	EB	33	85	0	0	5230	0	1212
10	EB	33.5	68	8	11.8	5101	170	1546
11	EB	36.5	2	2	100	0	44	0
12	EB	36.5	4	0	0	337	0	95
13	EB	31.5	2	0	0	200	0	69
TOTAL	****	****	8656	5239	****	59939	****	11986
<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	81	14	17.3	2867	186	931
5	WB	8	864	95	11	12356	707	3102
6	WB	19	323	0	0	12334	0	3098
7	WB	11.5	26	0	0	1622	0	661
8	WB	31	100	36	36	2632	578	324
9	WB	33	164	5	3	7887	153	1320
10	WB	33.5	95	1	1.1	6389	29	1620
11	WB	36.5	5	5	100	0	94	0
12	WB	36.5	12	1	8.3	945	10	272
13	WB	31.5	4	0	0	244	0	59
TOTAL	****	****	1674	157	****	47277	****	11388
GRAND TOTAL	****	****	10330	5396	448	107216	42014	23374

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	626	36860	37486	13
3	42432	58973	101405	35.2
4	6683	3054	9737	3.4
5	60714	13063	73777	25.6
6	7934	12334	20268	7
7	1800	1622	3422	1.2
8	11984	3210	15194	5.3
9	5230	8040	13270	4.6
10	5271	6418	11689	4.1
11	44	94	138	0
12	337	955	1291	0.4
13	200	244	444	0.2
TOTAL	143254	144877	288131	100
GVW/LANE	49.72	50.28	100	0.03

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	25	38	2	0.0051
4	121	78	199	10.5	1.23
5	201	197	398	21.1	0.1
6	180	322	502	26.6	1.94
7	43	37	80	4.2	2.85
8	48	58	106	5.6	0.26
9	108	109	217	11.5	1.76
10	145	153	298	15.8	3.59
11	0	0	0	0	0.62
12	9	26	35	1.9	3.01
13	6	2	8	0.4	1.54
TOTAL	874	1012	1885	100	17
ESALS/LANE	46.4	53.7	100	--	--

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>
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
May 2018	37496	1210	346	26766	71.4	10730.4	28.6
TOTAL	188156	--	--	165141	--	23016	--
AVERAGE	37631	1230	150	33028	88	4603	12

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>
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
May 2018	889	1023	1912	19.5
TOTAL	5069	--	--	--
AVERAGE	1014	1108	2122	24

Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Jun 2017	145644	145031	290675
Jul 2017	126323	154528	280851
Sep 2017	146289	177523	323812
Oct 2017	121395	140110	261505
May 2018	116073	133692	249765
TOTAL	655725	750883	1406609
AVERAGE	131145	150177	281322

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>
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
May 2018	316	0.9	3	69	37
TOTAL	1940	--	--	577	266
AVERAGE	388	1	10.9	115.4	53.2

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>
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
May 2018	11986	11388	23374	51.3	48.7
TOTAL	54773	59060	113833	--	--
AVERAGE	10954.6	11811.9	22766.5	47.7	52.3