

JULY 2019



**WIM #37  
I-94, MP 200.1  
OTSEGO, MN**

**MONTHLY  
REPORT**



*Your Destination...Our Priority*



## WIM Site Location

WIM #37 is located on I-94 near Otsego in Wright county. The WIM is located only on the westbound (WB) side of I-94, meaning that all data mentioned in this report pertains to WB traffic only (Lanes 1 and 2).

## System Operation

WIM #37 was operational for the entire month of July 2019. Volume was computed using all monthly data.

## System Calibration

WIM #37 was most recently calibrated on 2017-03-23. Table 1 summarizes the front axle weights of class 9s by lane <sup>1</sup>. Figure 1 shows the distribution of gross vehicle weights (GVW) in the Class 9s at this site for the last 12 months <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: 1118854 | Passenger Vehicles: 954202 | Heavy Commercial Vehicles: 164652

Monthly Average Daily Traffic (MADT): 36266 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 5311

See Table 2 for vehicle class breakdown

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

**Volume trends.** 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), WB PVs generally reached peak volume levels between 03 PM and 05 PM.

### Heavy Commercial Vehicles (HCVs)

**Volume trends.** On an average 24-hour day, HCVs traveling WB typically reached peak volume levels 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 9's.

### Overweight HCVs

**Volume trends.** Of a total of 164652 HCVs, 5114 of them were overweight <sup>3</sup>. These overweight HCVs contributed to 0.6% of total monthly volume, and 3.7% of total monthly HCV volume. WB overweight vehicles typically reached highest numbers on Fridays, with lowest volumes reported on Sundays See Figure 3 .

The top two overweight violators by class were the class 9 and class 14 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours (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 June.

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 ,1250 WB vehicles exceeded 88,000 pounds (591 vehicles were Class 14's; 369 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from July 2019.

**Loaded vs. Unloaded HCVs.** Figure 10 shows the GVW distributions of Class 9's and 10's in July 2019. Data suggests that there were greater numbers of fully\_loaded Class 9's than empty Class 9's traveling WB Data also suggests that there were more NA Class 10's than NA traveling in the WB direction.

**Freight Totals.** A total of 948115 tons of freight was recorded to have crossed the WIM. See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 86817 is approximately 1.2 miles east of WIM #37 and Bridge No. 86813 is approximately 4.7 miles west of WIM #37. WIM #37 recorded a total of 1118854 vehicles with a combined GVW of 9483430 kips (1 kip = 1,000 pounds = 0.5 tons) in July 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

**Pavement Design.** A total of 129570 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 45% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 41% 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>

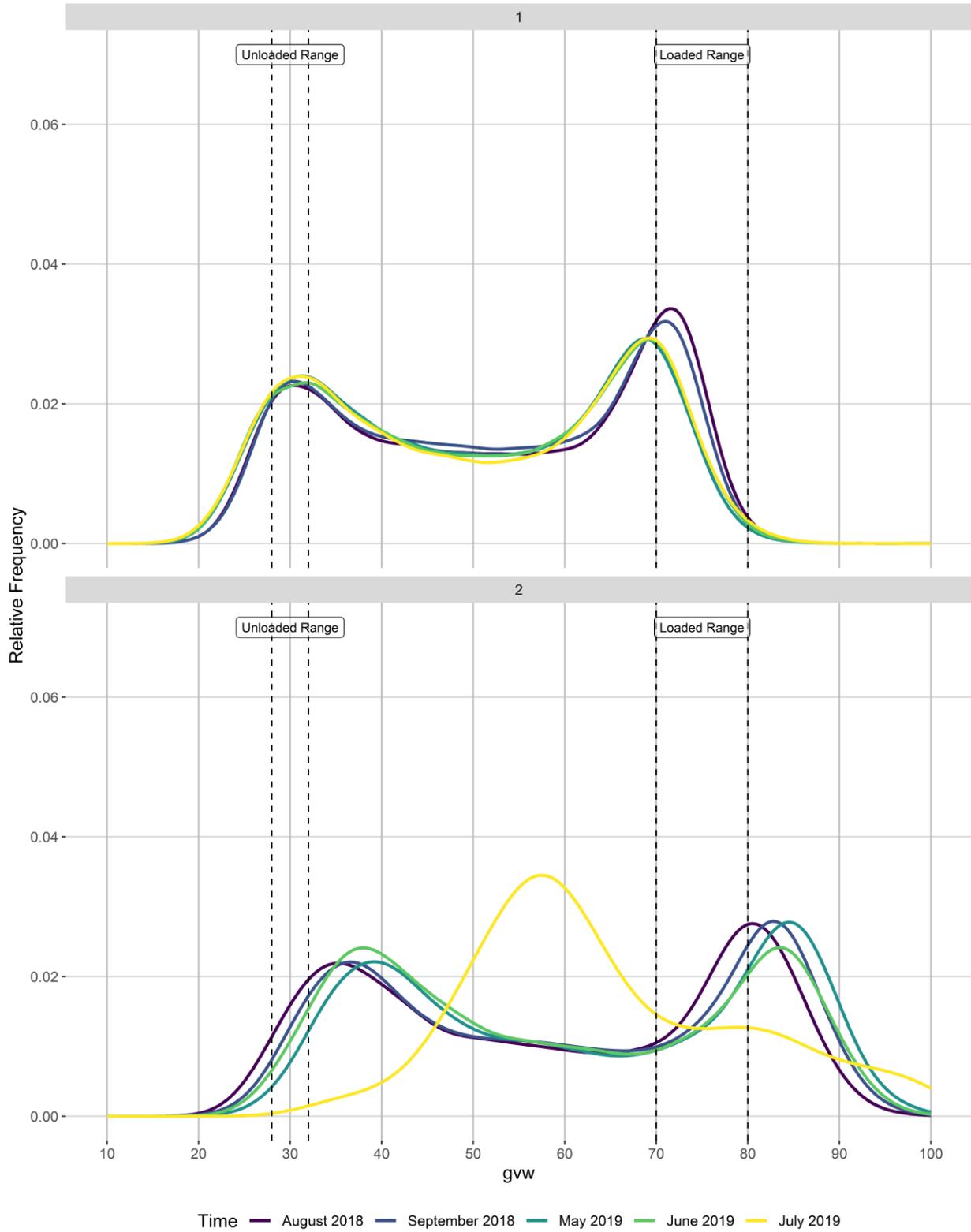
- <sup>1</sup> Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of +/-9% of baseline calibration values
- <sup>2</sup> Previous WIM research 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.

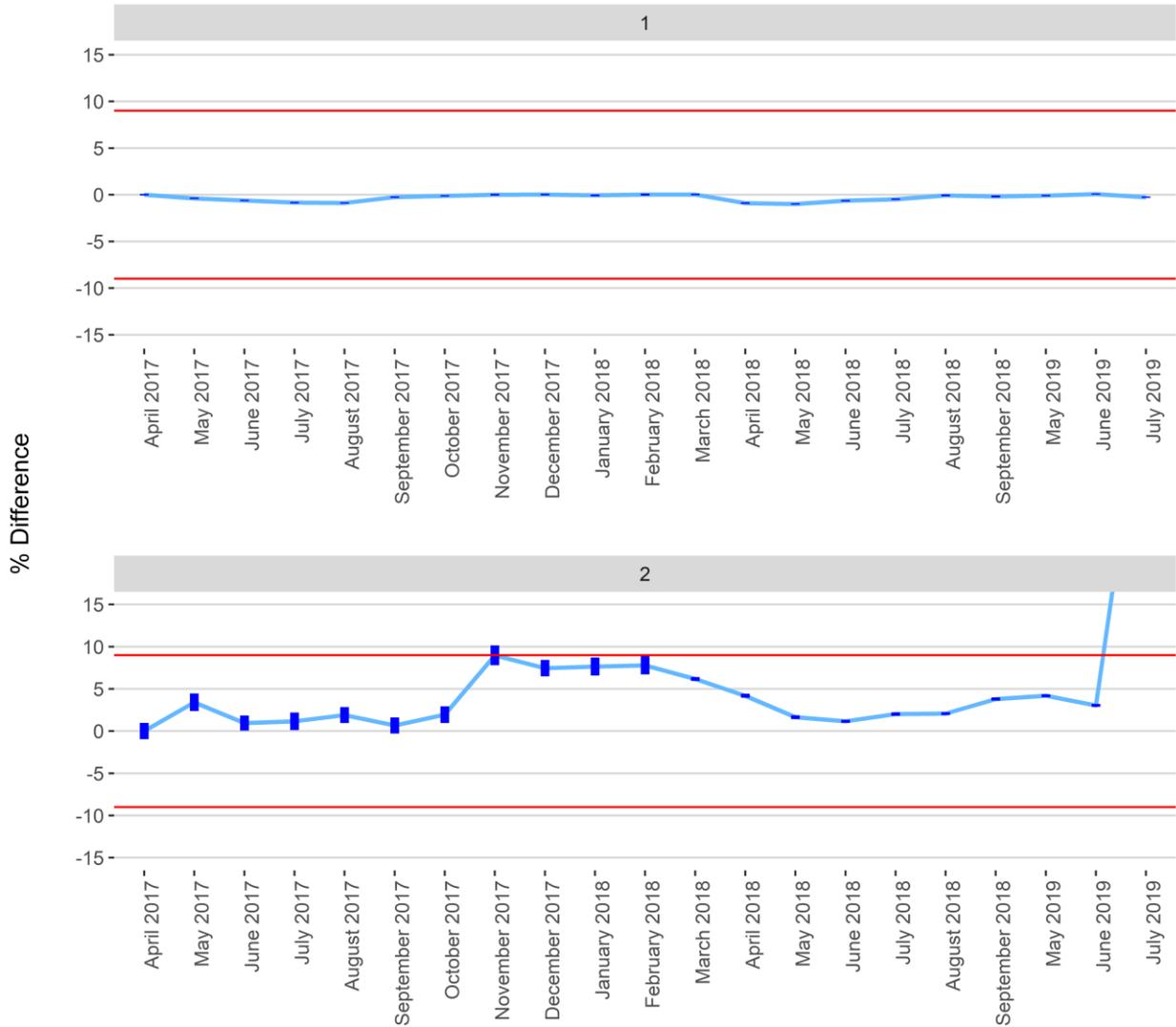
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Figure 1 - Monthly Class 9 GVW Histogram



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

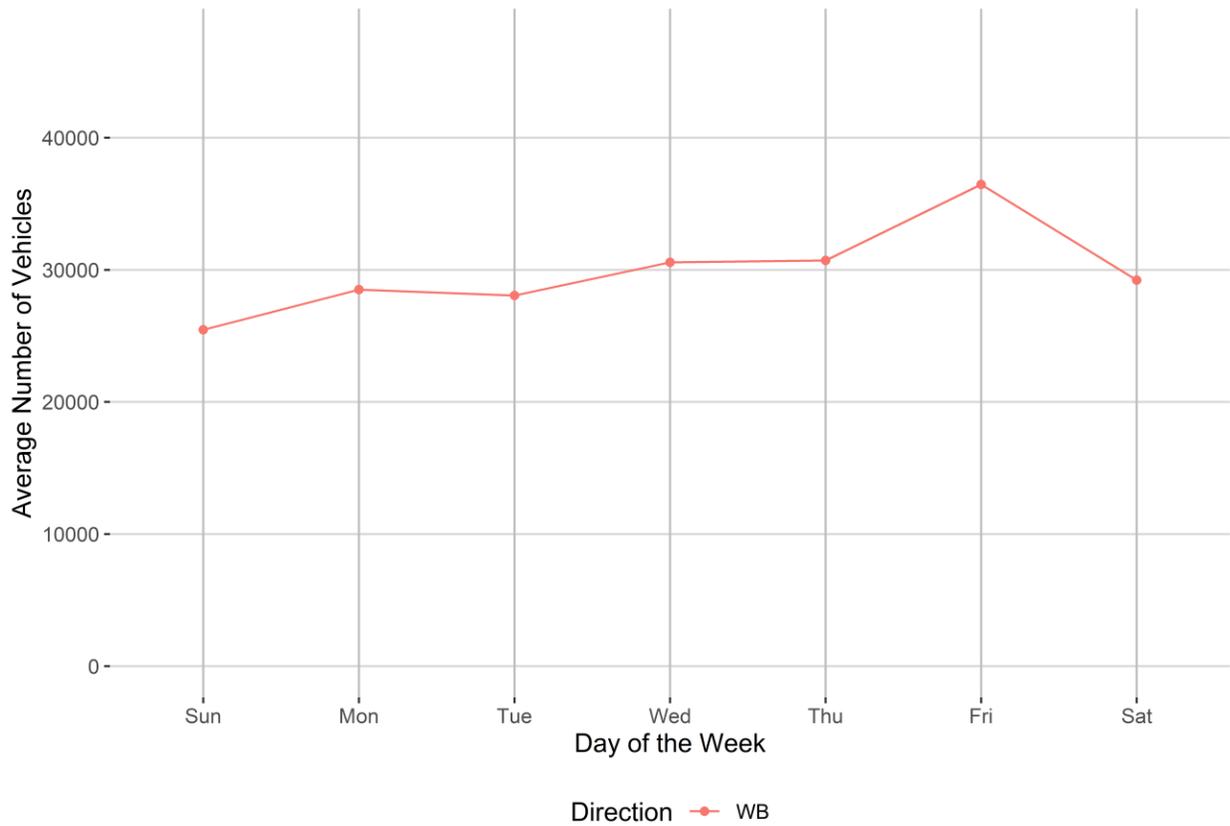


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

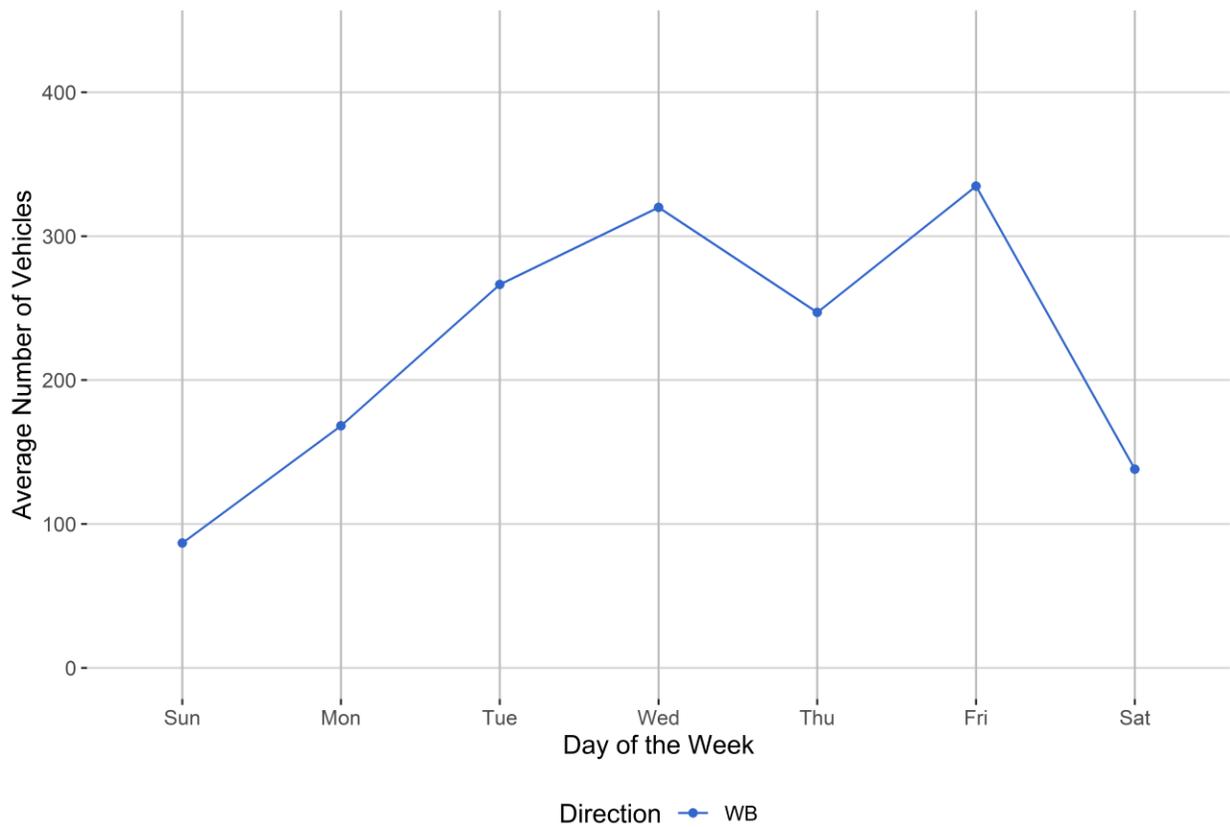


Figure 4 - Passenger Vehicles vs. Hour of the Day

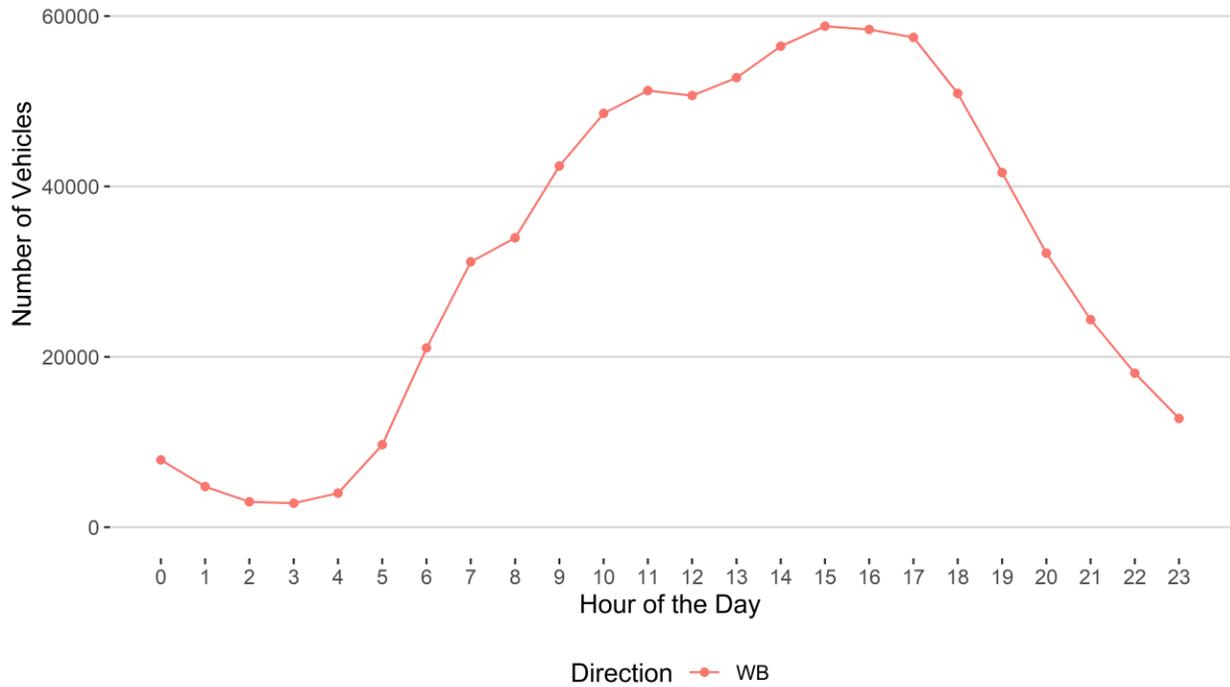


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

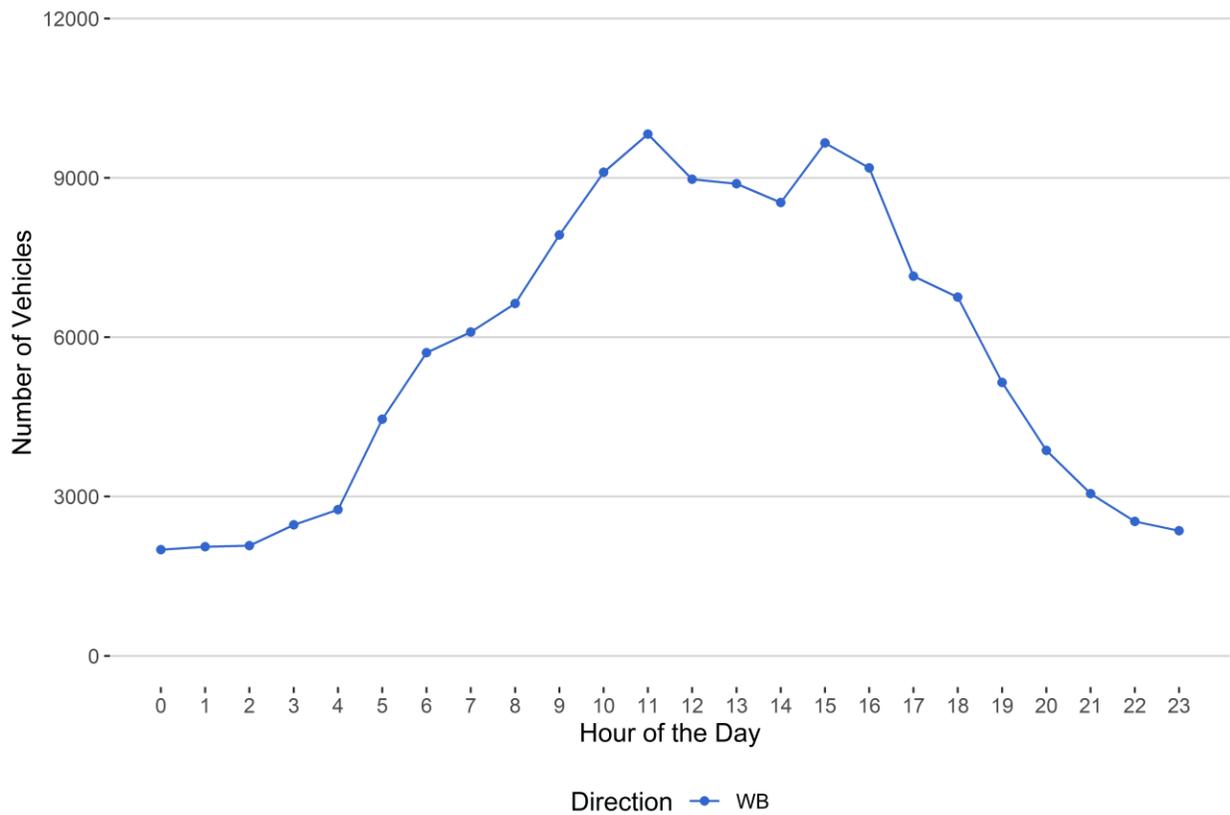


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

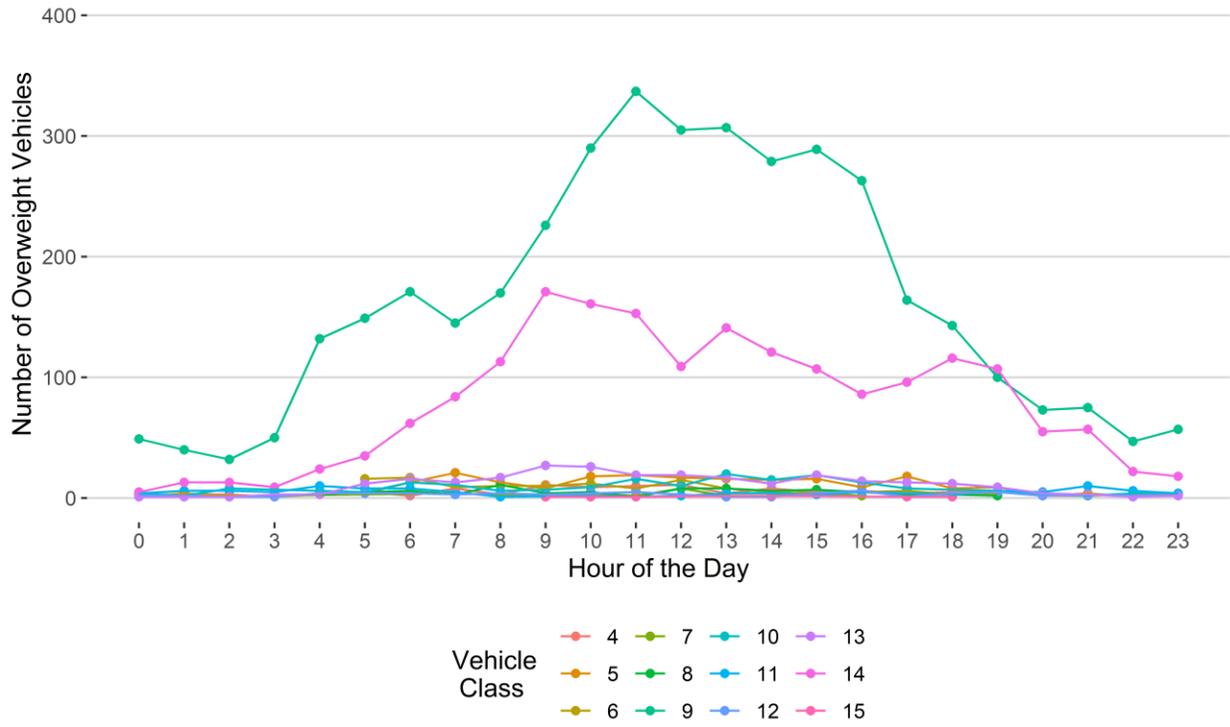


Figure 7 - Overweight Vehicles by Direction  
Hour of the Day

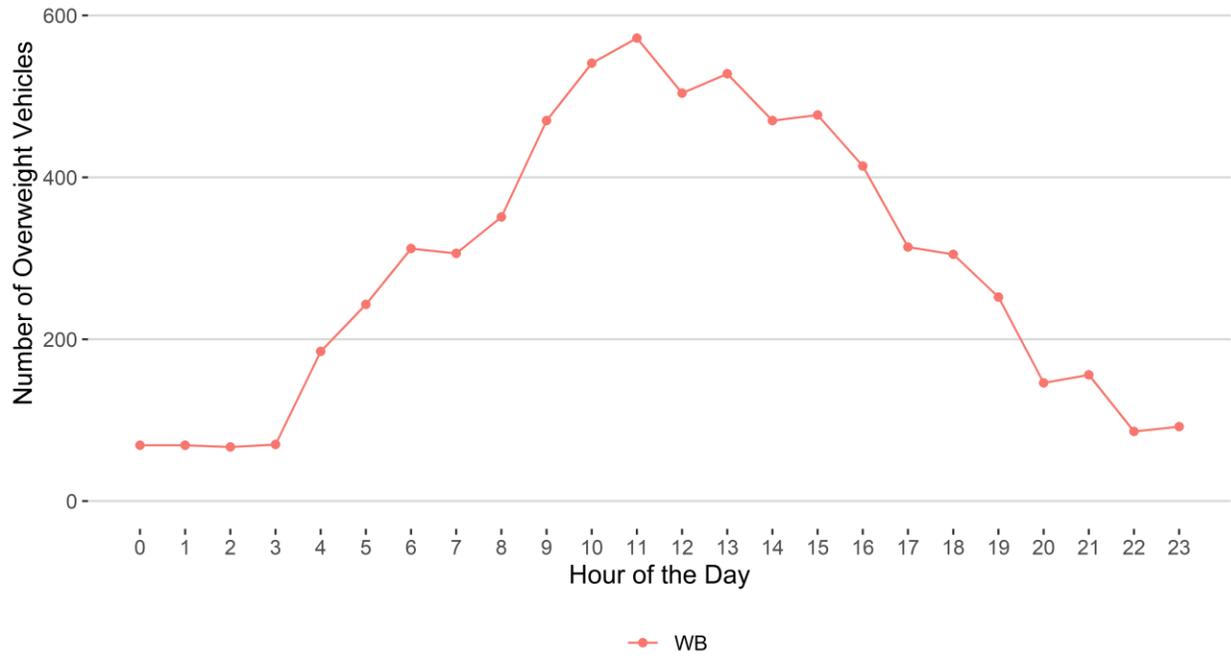
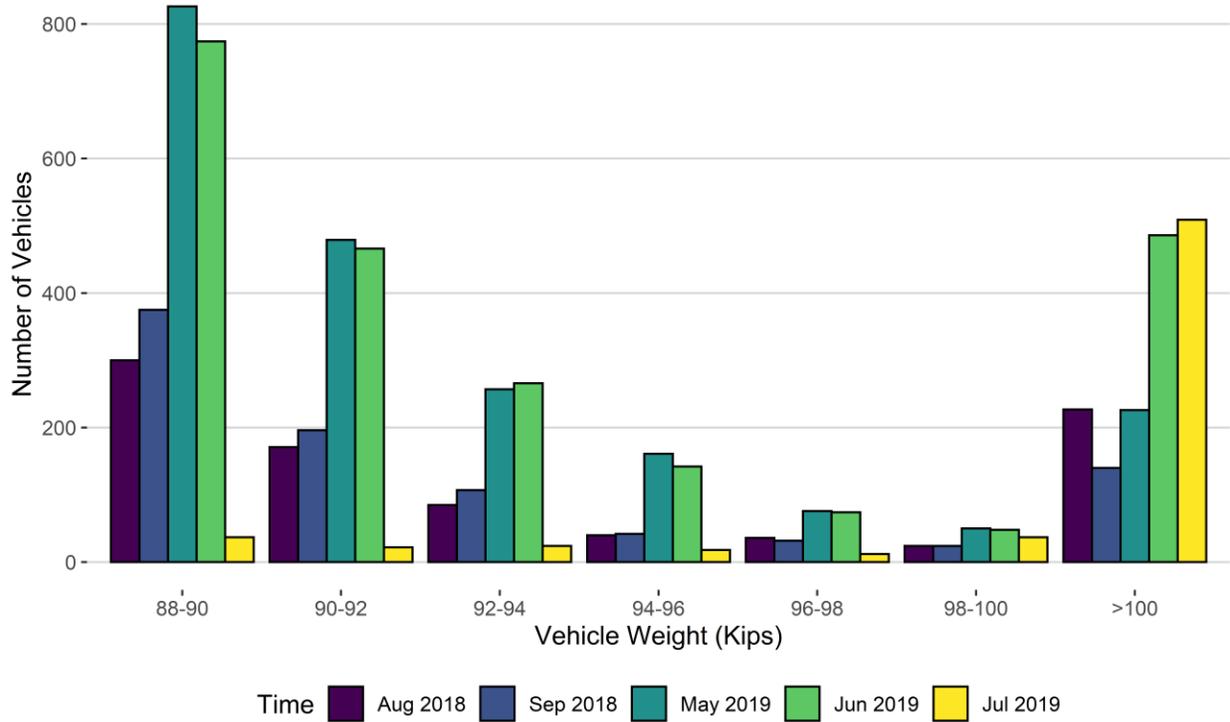


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Aug 2018	Sep 2018	May 2019	Jun 2019	Jul 2019
88-90	300	375	826	774	37
90-92	171	196	479	466	22
92-94	85	107	257	266	24
94-96	40	42	161	142	18
96-98	36	32	76	74	12
98-100	24	24	50	48	37
>100	227	140	226	486	509
<b>Total</b>	<b>883</b>	<b>916</b>	<b>2075</b>	<b>2256</b>	<b>659</b>

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

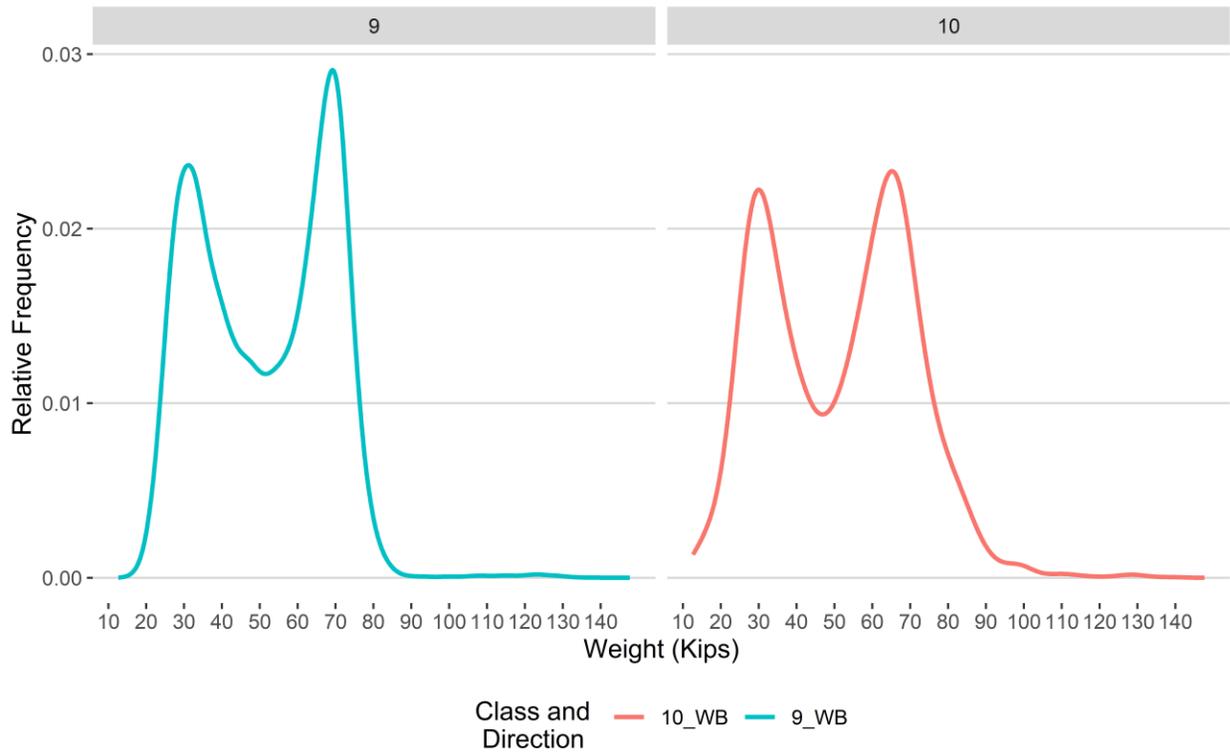
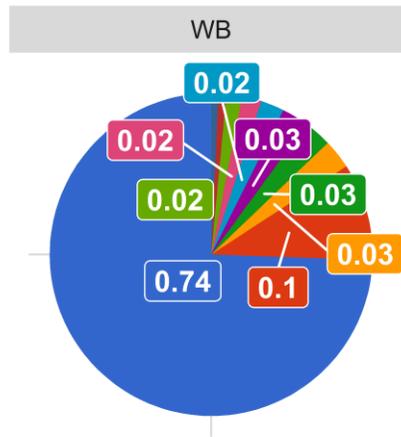


Figure 9 - Freight Percentage by Direction and Class



Vehicle Class	<span style="background-color: blue; color: white; padding: 2px;">a</span> 9	<span style="background-color: orange; color: white; padding: 2px;">a</span> 10	<span style="background-color: purple; color: white; padding: 2px;">a</span> 8	<span style="background-color: pink; color: white; padding: 2px;">a</span> 12	<span style="background-color: red; color: white; padding: 2px;">a</span> 13
	<span style="background-color: red; color: white; padding: 2px;">a</span> 5	<span style="background-color: green; color: white; padding: 2px;">a</span> 11	<span style="background-color: cyan; color: white; padding: 2px;">a</span> 6	<span style="background-color: lightgreen; color: white; padding: 2px;">a</span> 4	<span style="background-color: blue; color: white; padding: 2px;">a</span> 7

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

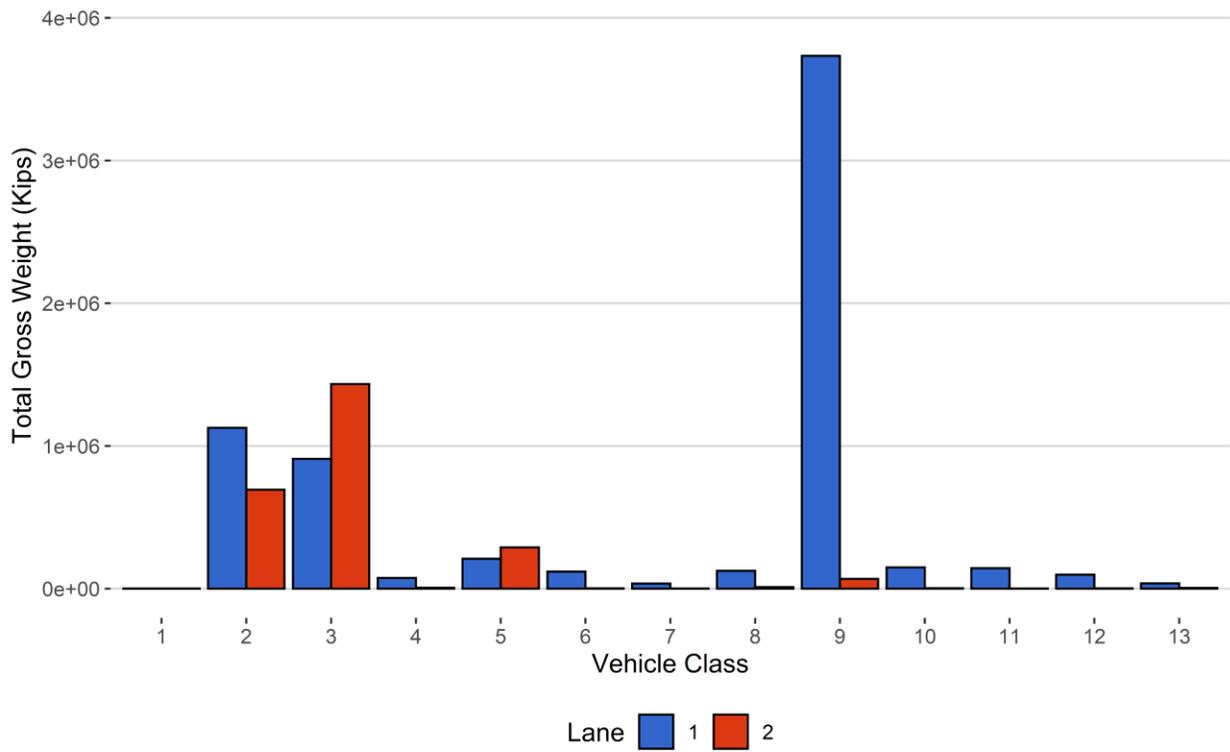


Figure 11 - Total Gross Vehicle Weight t

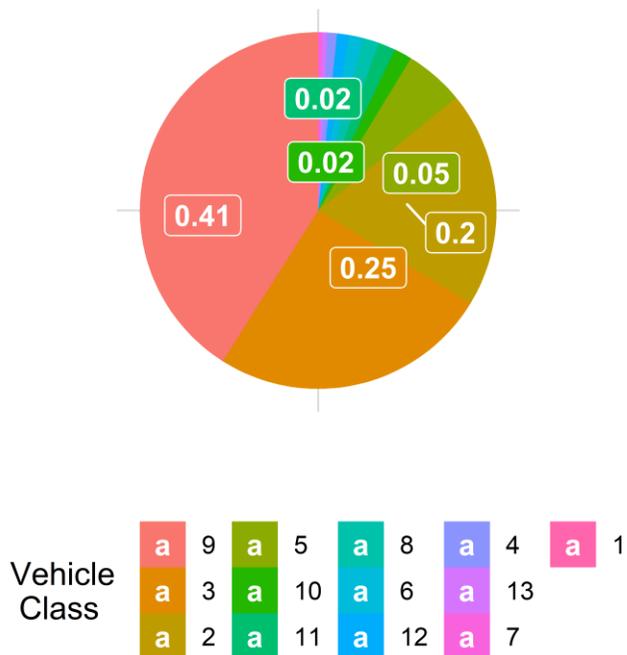


Figure 12 - Total ESALs by Class and Lane

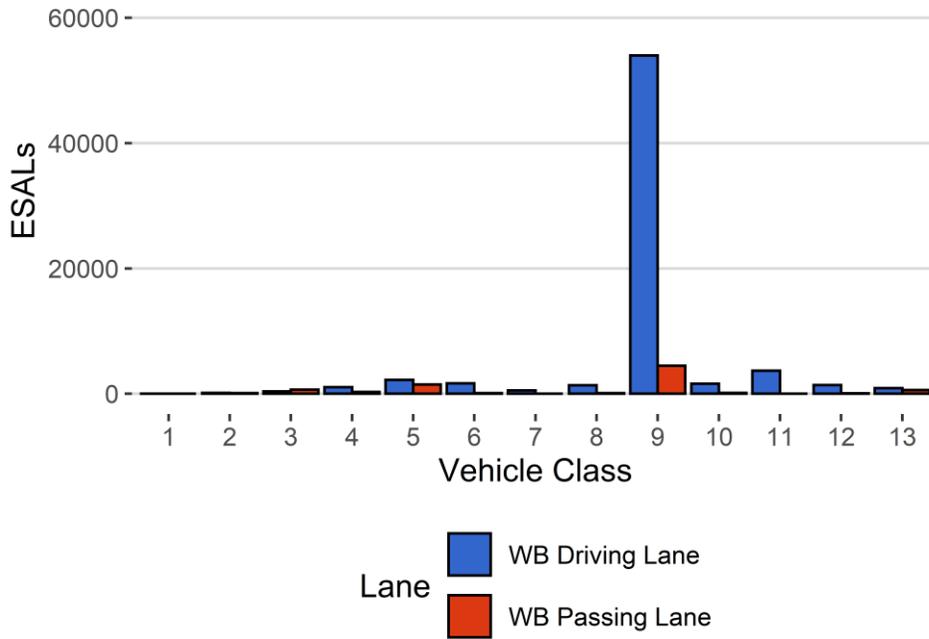
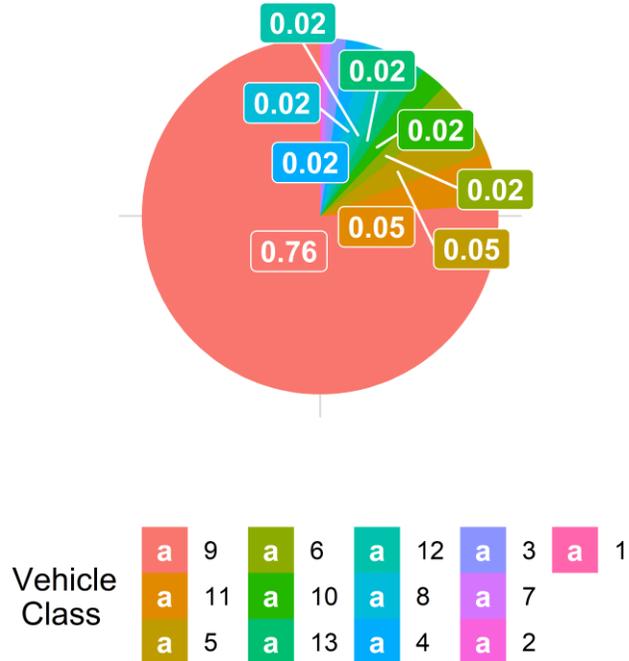


Figure 13 - ESALs by Class



**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>
April 2017	10.54	0.00	11.79	0.00
May 2017	10.50	-0.39	12.19	3.41
June 2017	10.48	-0.62	11.90	0.95
July 2017	10.45	-0.84	11.92	1.16
August 2017	10.45	-0.89	12.01	1.90
September 2017	10.52	-0.26	11.86	0.67
October 2017	10.53	-0.12	12.02	1.94
November 2017	10.54	0.00	12.84	8.98
December 2017	10.55	0.02	12.67	7.46
January 2018	10.54	-0.06	12.69	7.65
February 2018	10.55	0.02	12.70	7.79
March 2018	10.55	0.02	12.51	6.17
April 2018	10.45	-0.90	12.28	4.18
May 2018	10.44	-0.99	11.98	1.65
June 2018	10.48	-0.64	11.92	1.16
July 2018	10.49	-0.48	12.02	2.01
August 2018	10.54	-0.07	12.03	2.06
September 2018	10.52	-0.18	12.23	3.79
May 2019	10.53	-0.10	12.28	4.19
June 2019	10.55	0.07	12.14	3.04
July 2019	10.52	-0.26	16.99	44.14

**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	5	164	0	0	0
2	17485	542039	48.4	0	0
3	13290	411998	36.8	0	0
4	119	3702	0.3	113	2.2
5	1667	51665	4.6	224	4.4
6	159	4932	0.4	131	2.6
7	29	900	0.1	34	0.7
8	184	5711	0.5	81	1.6
9	2872	89045	8	3893	76.1
10	113	3518	0.3	198	3.9
11	89	2749	0.2	108	2.1
12	62	1932	0.2	68	1.3
13	16	499	0	264	5.2
<b>TOTAL</b>	<b>36092</b>	<b>1118854</b>	<b>100</b>	<b>5114</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>
2019-07-29	Monday	10:58:39	10	WB	2	168.83
2019-07-23	Tuesday	14:46:26	10	WB	2	165.4
2019-07-23	Tuesday	05:45:16	9	WB	2	164.35
2019-07-25	Thursday	13:34:00	9	WB	2	164.12
2019-07-29	Monday	08:49:15	9	WB	2	164.02
2019-07-22	Monday	12:31:59	9	WB	2	163.01
2019-07-30	Tuesday	07:14:01	9	WB	2	162.24
2019-07-30	Tuesday	09:22:25	9	WB	2	161.73
2019-07-03	Wednesday	15:35:20	9	WB	2	161.33
2019-07-23	Tuesday	06:29:28	9	WB	2	160.07

**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	WB	15	3085	429	13.9	75128	5566	17644
5	WB	8	43055	8306	19.3	438443	59200	80226
6	WB	19	4110	376	9.1	114357	6397	21706
7	WB	11.5	750	1	0.1	35730	8	13558
8	WB	31	4759	2969	62.4	69273	66330	6891
9	WB	33	74206	15822	21.3	3356976	445288	715152
10	WB	33.5	2932	778	26.5	129588	21322	28715
11	WB	36.5	2291	75	3.3	140896	1869	30006
12	WB	36.5	1610	12	0.7	98855	346	20264
13	WB	31.5	416	1	0.2	40979	19	13953
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>137214</b>	<b>28769</b>	<b>****</b>	<b>4500225</b>	<b>****</b>	<b>948115</b>

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

<i>Vehicle Class</i>	<i>WB Driving Lane</i>	<i>WB Passing Lane</i>	<i>Total</i>	<i>Percentage</i>
1	91	86	177	0
2	1127100	692583	1819683	19.6
3	909675	1433298	2342972	25.3
4	74251	6443	80694	0.9
5	208814	288830	497643	5.4
6	119357	1397	120754	1.3
7	35655	83	35738	0.4
8	124768	10835	135603	1.5
9	3733826	68437	3802263	41
10	148133	2777	150910	1.6
11	142590	176	142766	1.5
12	97764	1437	99201	1.1
13	36531	4467	40998	0.4
<b>TOTAL</b>	<b>6758554</b>	<b>2510849</b>	<b>9269403</b>	<b>100</b>
<b>GVW/LANE</b>	<b>72.91</b>	<b>27.09</b>	<b>100</b>	<b>0</b>

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

<i>Vehicle Class</i>	<i>WB Driving Lane</i>	<i>WB Passing Lane</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.0073
2	142	100	242	0.3	0.0011
3	381	639	1019	1.3	0.006
4	1058	302	1359	1.8	0.88
5	2209	1467	3676	4.8	0.17
6	1665	90	1755	2.3	0.85
7	537	0	538	0.7	1.43
8	1369	96	1465	1.9	0.62
9	53979	4474	58453	76	1.58
10	1603	140	1742	2.3	1.19
11	3675	11	3686	4.8	3.21
12	1393	76	1470	1.9	1.82
13	894	587	1480	1.9	6.94
<b>TOTAL</b>	<b>68905</b>	<b>7981</b>	<b>76885</b>	<b>100</b>	<b>19</b>
<b>ESALS/LANE</b>	<b>89.6</b>	<b>10.4</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>
Aug 2018	1122311	36204	4092	995460	88.7	126851.1	11.3
Sep 2018	762407	31767	2952	673849	88.4	88558.1	11.6
May 2019	1067629	34440	4742	920637	86.2	146992	13.8
Jun 2019	1087979	36266	4537	951857	87.5	136122.2	12.5
Jul 2019	1118854	36266	5311	954202	85.3	164652.3	14.7
<b>TOTAL</b>	<b>5159180</b>	-	-	<b>4496005</b>	-	<b>663176</b>	-
<b>AVERAGE</b>	<b>1031836</b>	<b>34989</b>	<b>4327</b>	<b>899201</b>	<b>87</b>	<b>132635</b>	<b>13</b>

###ESALS

<i>Month</i>	<i>ESALS WB Driving Lane</i>	<i>ESALS WB Passing Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Aug 2018	62410	29879	92289	1
Sep 2018	39826	23509	63334	1.2
May 2019	68732	35483	104215	0.8
Jun 2019	134817	56072	190889	1.3
Jul 2019	69071	60368	129439	1.2
<b>TOTAL</b>	<b>374855</b>	-	-	-
<b>AVERAGE</b>	<b>74971</b>	<b>41062</b>	<b>116033</b>	<b>1</b>

###Gross Vehicle Weight

<i>Month</i>	<i>GVW WB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>Total GVW Kips</i>
Aug 2018	6660185	4283216	10943402
Sep 2018	13081229	7191816	20273044
May 2019	6767177	2739319	9506497
Jun 2019	6040668	4371275	10411943
Jul 2019	3908977	3125851	7034828
<b>TOTAL</b>	<b>36458236</b>	<b>21711478</b>	<b>58169714</b>
<b>AVERAGE</b>	<b>7291647</b>	<b>4342296</b>	<b>11633943</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>
Aug 2018	9894	0.9	7.9	888	253
Sep 2018	7285	1	8.6	920	165
May 2019	11556	1.1	8	2156	290

Jun 2019	18260	0.9	6.6	2874	588
Jul 2019	6992	0.8	4.8	1250	1054
<b>TOTAL</b>	<b>53987</b>	<b>-</b>	<b>-</b>	<b>8088</b>	<b>2350</b>
<b>AVERAGE</b>	<b>10797.4</b>	<b>0.9</b>	<b>7.2</b>	<b>1617.6</b>	<b>470</b>

###Freight

<i>Month</i>	<i>WB Freight Tons</i>
Aug 2018	1105836
Sep 2018	748630
May 2019	1230391
Jun 2019	2139776
Jul 2019	948115
<b>TOTAL</b>	<b>6172748</b>
<b>AVERAGE</b>	<b>1234549.6</b>