

JULY 2018



**WIM #48  
CSAH 5,  
MP 15.05  
STORDEN, MN**

**MONTHLY  
REPORT**



*Your Destination...Our Priority*



## WIM Site Location

WIM #48 is located on CSAH 5 near Storden in Cottonwood county.

## System Operation

WIM #48 was operational for the entire month of July 2018. Volume was computed using all monthly data.

## System Calibration

WIM #48 was most recently calibrated on 2016-12-21. 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 except lane 1. 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: 13682 | Passenger Vehicles: 11271 | Heavy Commercial Vehicles: 2411

Monthly Average Daily Traffic (MADT): 441 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 78

See Table 2 for vehicle class breakdown

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

**Volume trends.** NB vehicles typically reached highest volume levels on Tuesdays, with lowest volumes reported on Wednesdays. SB vehicles typically reached highest volume levels on Saturdays, with lowest volumes reported on Wednesdays (see Figure 3 and 4).

### Passenger Vehicles (PVs)

**Volume trends.** On an average 24-hour day (see Figure 5), NB PVs generally reached peak volume levels between 01 PM and 05 PM. Similarly, SB PVs peaked in volume between 10 AM and 05 PM

### Heavy Commercial Vehicles (HCVs)

**Volume trends.** On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 01 PM and 05 PM, while volume going SB peaked between 10 AM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

## Overweight HCVs

**Volume trends.** Of a total of 2411 HCVs, 825 of them were overweight<sup>3</sup>. These overweight HCVs contributed to 6.5% of total monthly volume, and 37% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Sundays. SB 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 9 and class 10 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 50.5% of all overweight vehicles traveling NB 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 July.

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 ,279 NB vehicles exceeded 88,000 pounds (227 vehicles were Class 9's; 27 vehicles were Class 10's). Of vehicles traveling SB,

223 NB vehicles exceeded 88,000 pounds (163 vehicles were Class 9's; 32 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from July 2018.

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

**Freight Totals.** A total of 27995 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (50.4%) than SB (49.6%). See Table 4 and Figure 11 for more freight information.

## Infrastructure Considerations

**Bridge.** Bridge No. 97506 (a precast box culvert) is approximately 1.3 miles north of WIM #48. Bridge No. 97666 (a precast box culvert) is approximately .45 miles south of WIM #48. WIM #48 recorded a total of 13682 vehicles with a combined GVW of 178130 kips (1 kip = 1,000 pounds = 0.5 tons) in July 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

**Pavement Design.** A total of 3452 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 50.1% of all ESALs were recorded NB while 49.9% was observed SB. In particular, 77% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 48% 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).

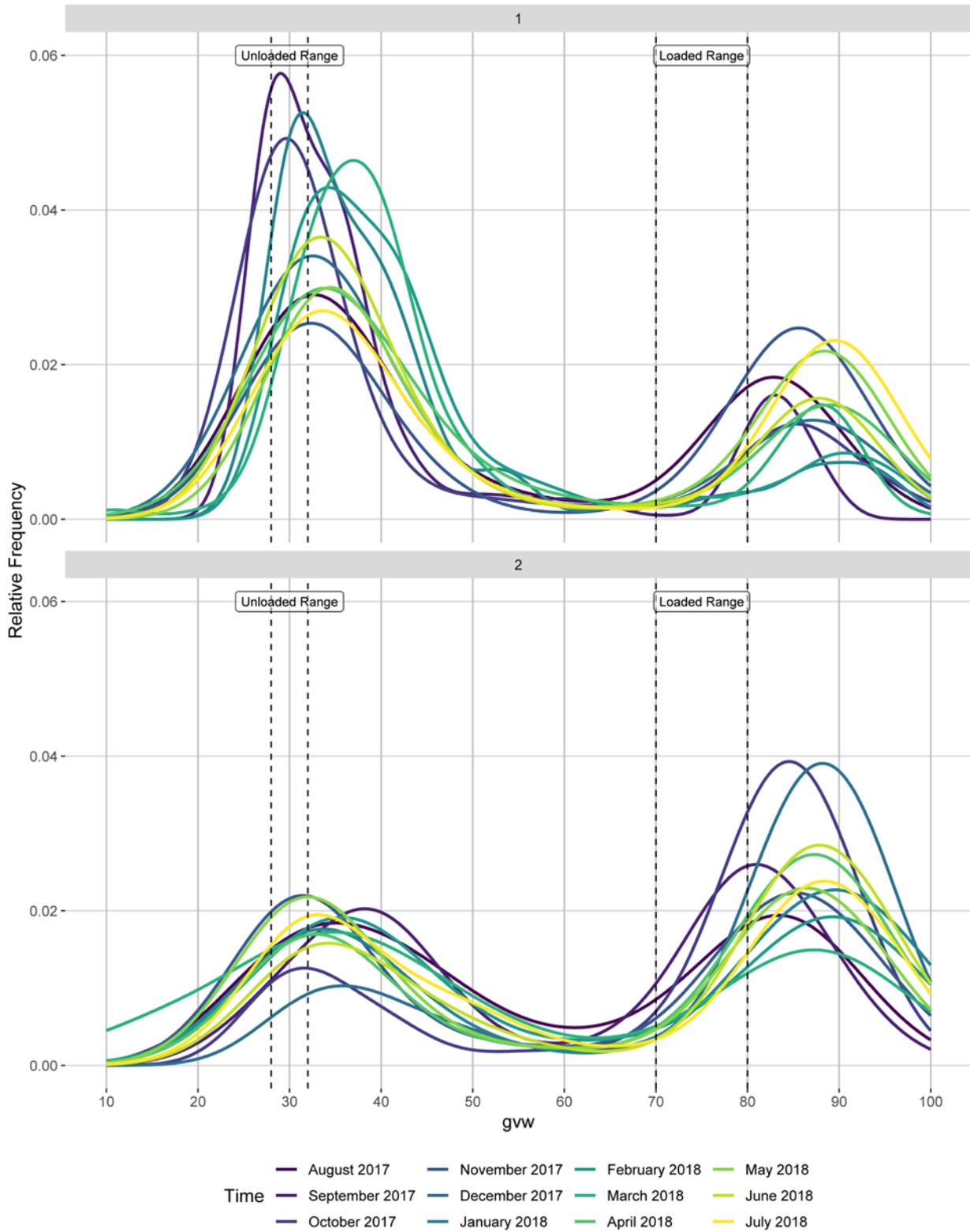
*WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>*

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.

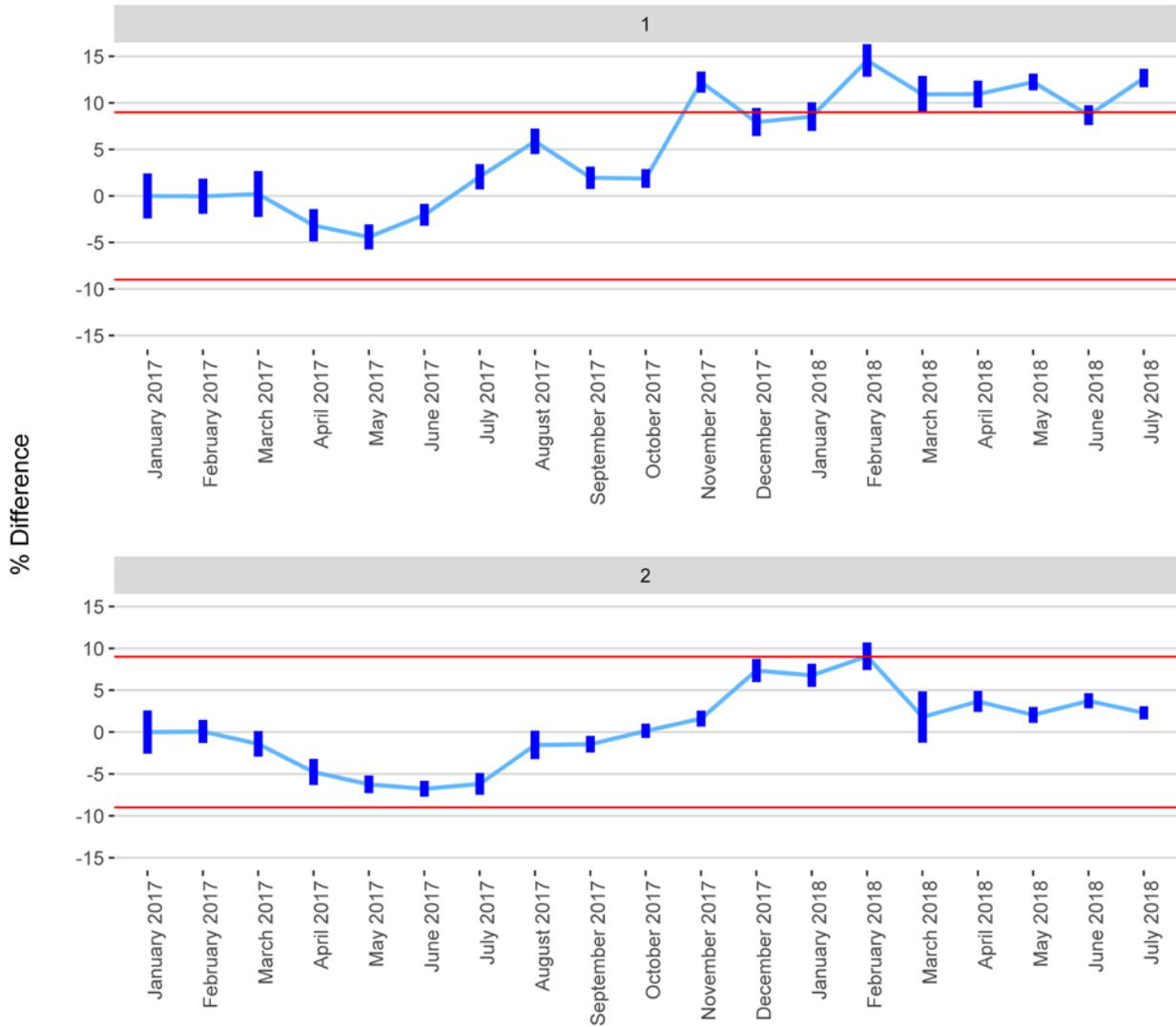
**To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to [ADArequest.dot@state.mn.us](mailto:ADArequest.dot@state.mn.us). Please request at least one week in advance.**

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

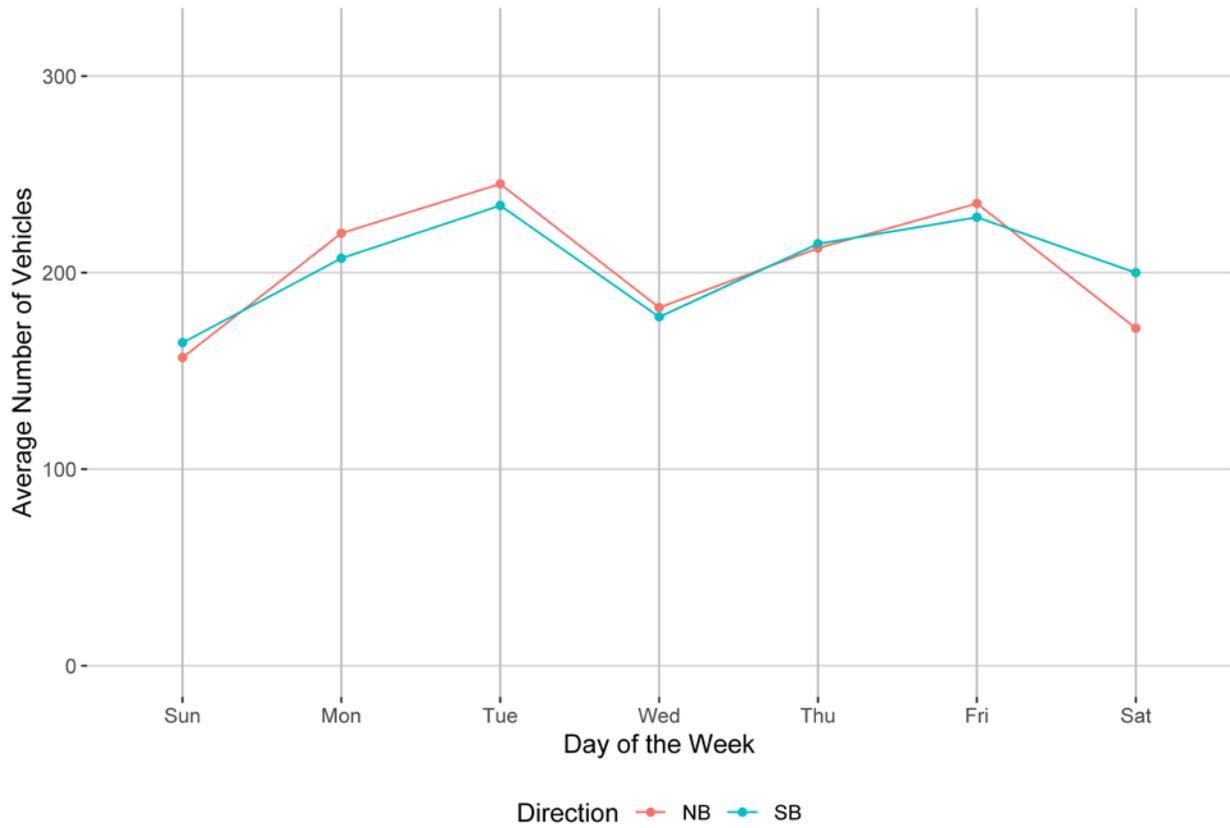


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

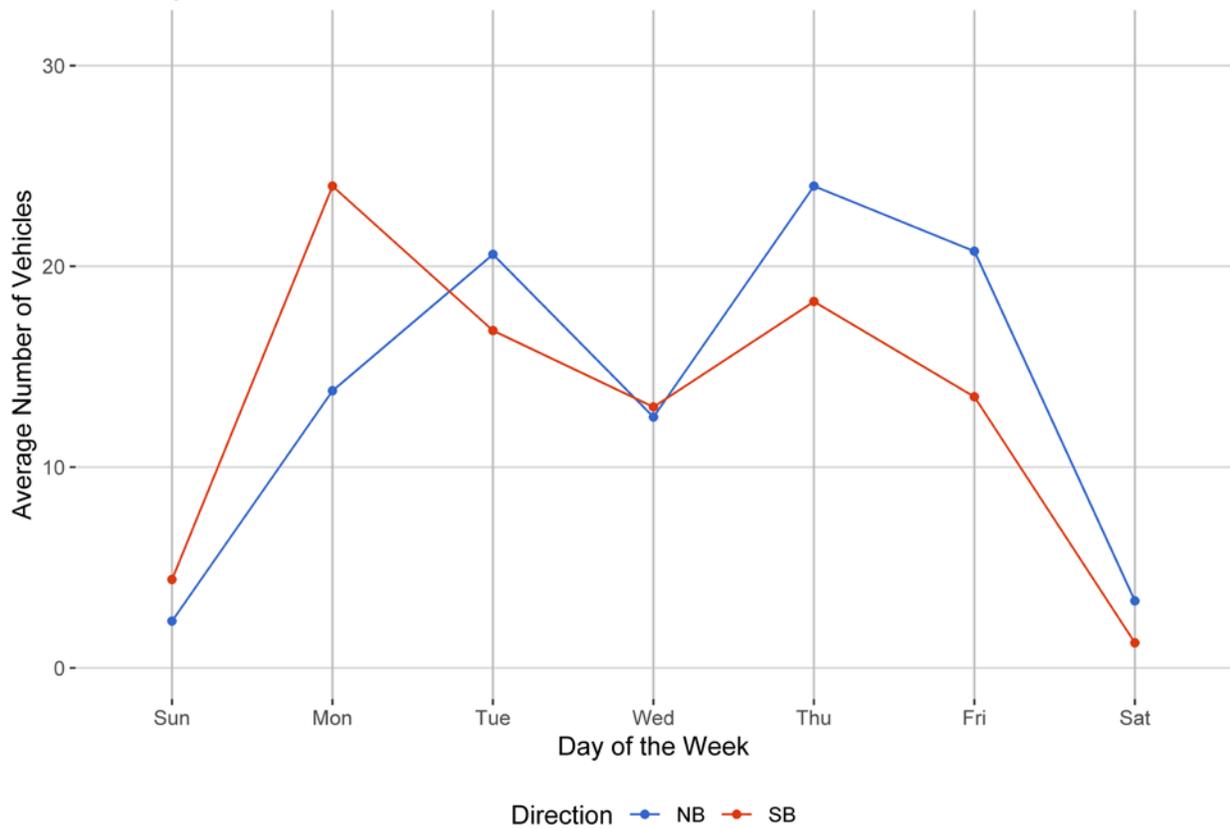


Figure 4 - Passenger Vehicles vs. Hour of the Day

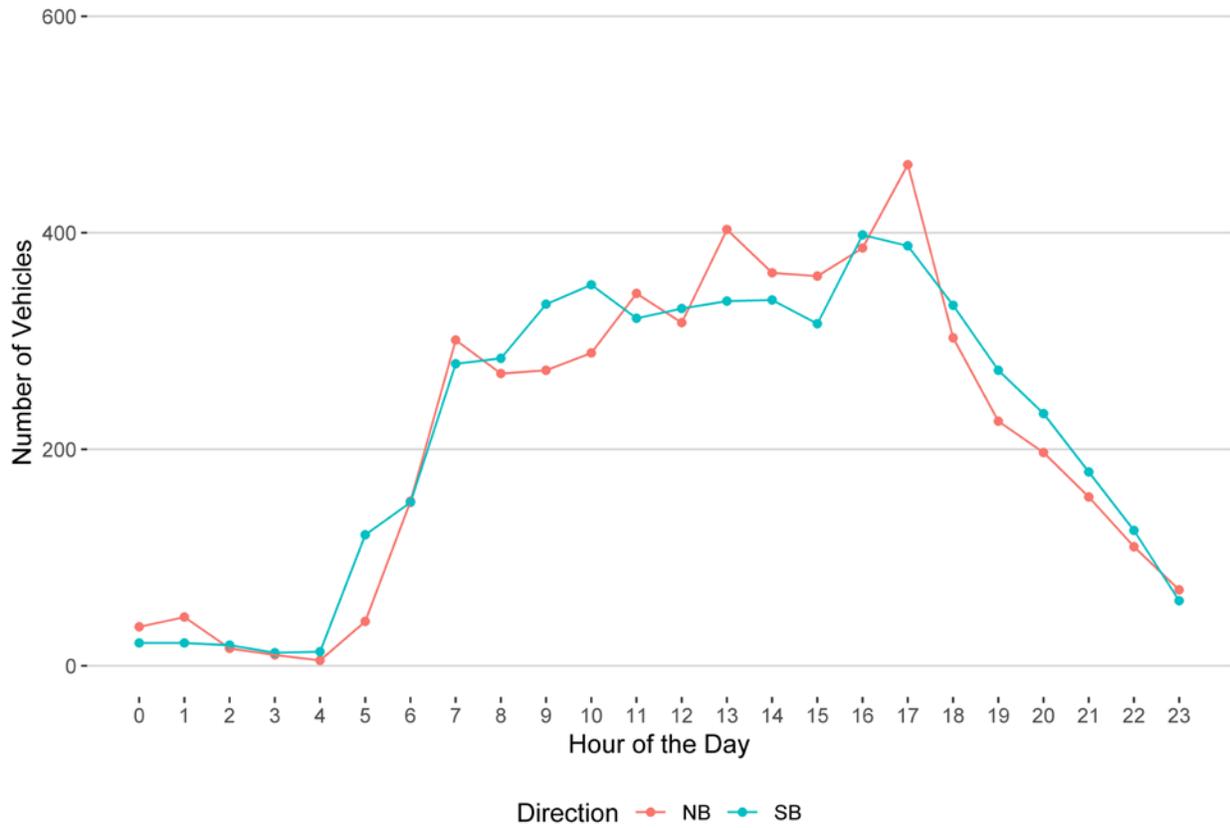


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

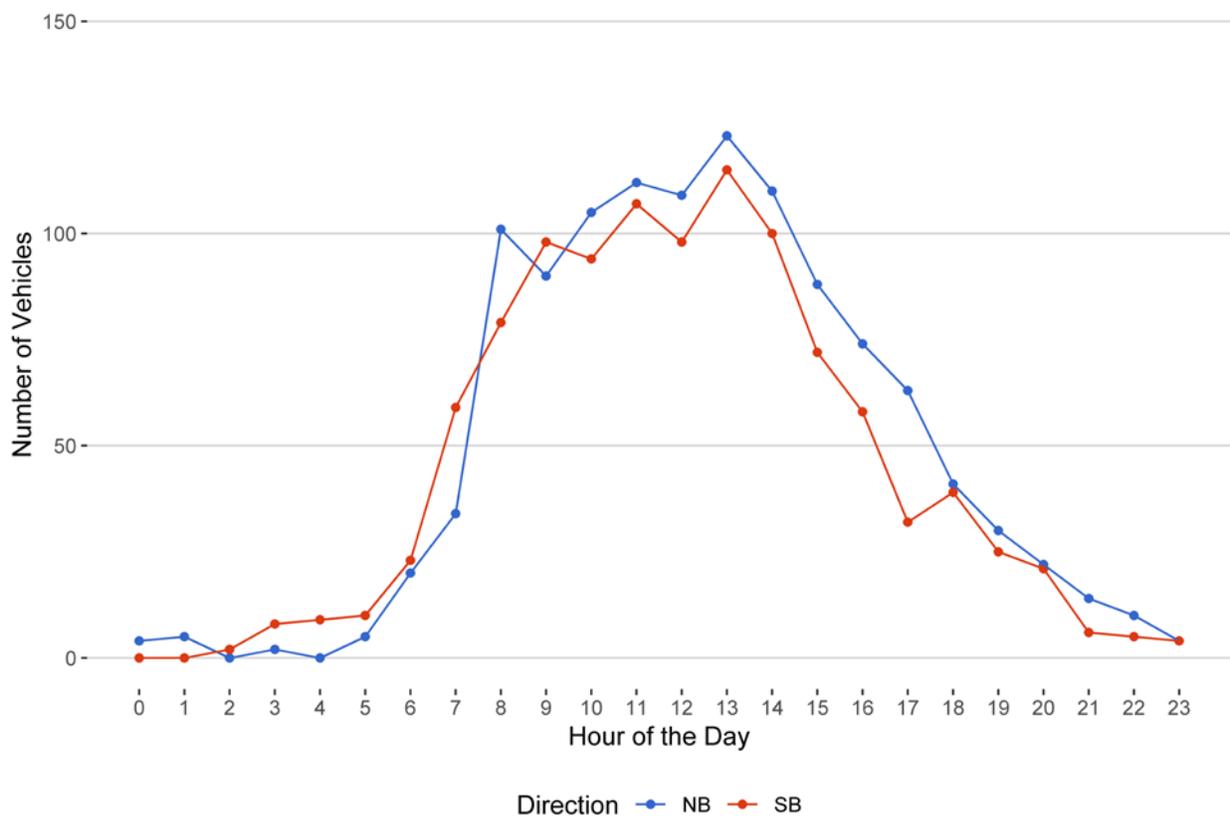


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

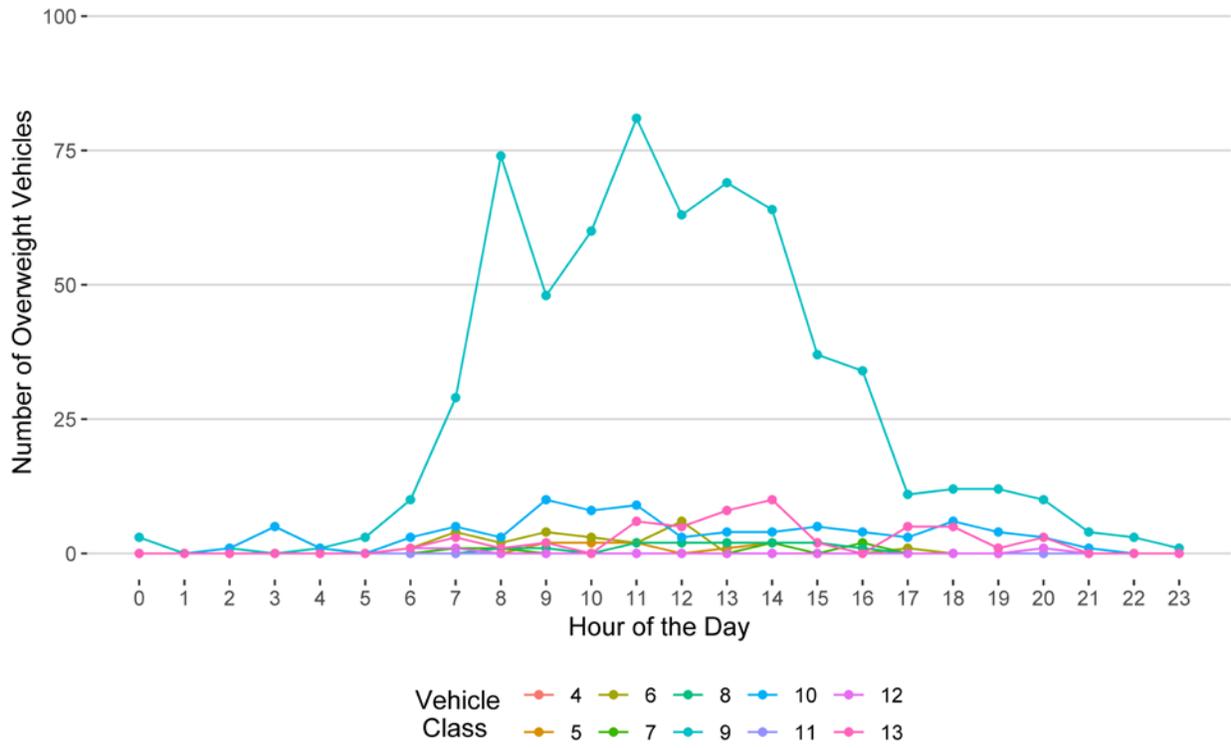


Figure 7 - Overweight Vehicles by Direction  
Hour of the Day

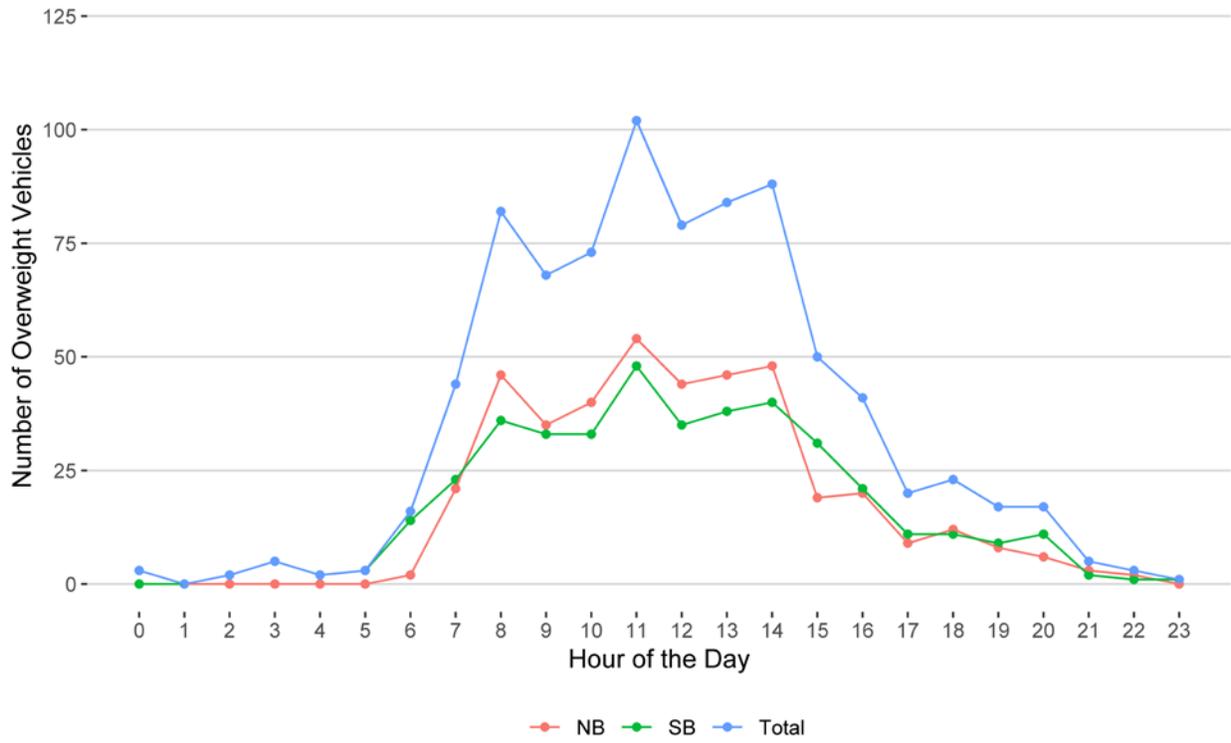
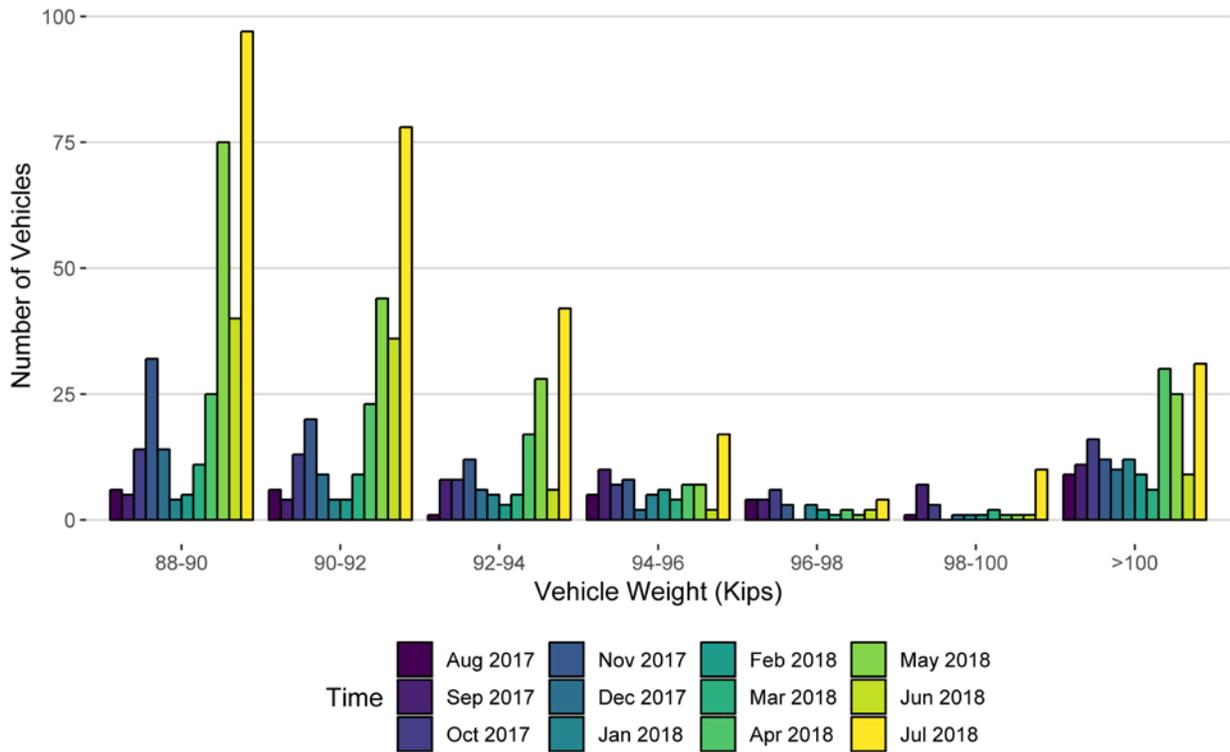
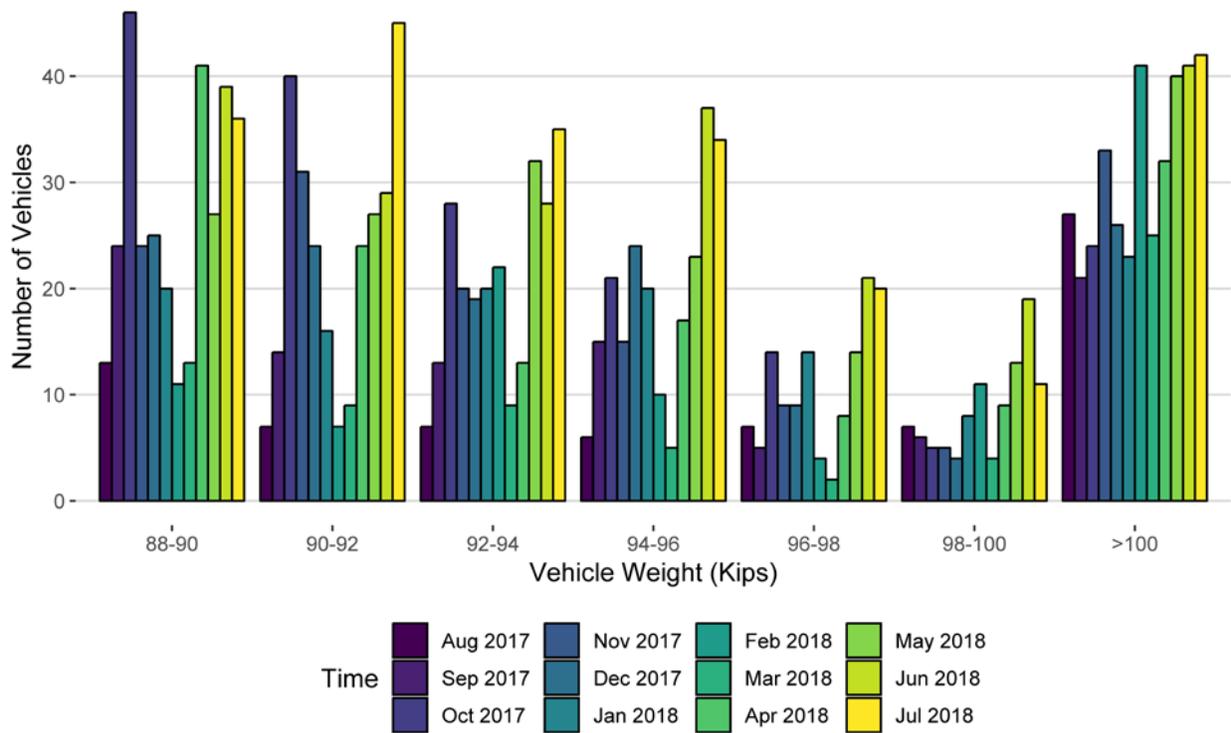


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018
88-90	6	5	14	32	14	4	5	11	25	75	40	97
90-92	6	4	13	20	9	4	4	9	23	44	36	78
92-94	1	8	8	12	6	5	3	5	17	28	6	42
94-96	5	10	7	8	2	5	6	4	7	7	2	17
96-98	4	4	6	3	0	3	2	1	2	1	2	4
98-100	1	7	3	0	1	1	1	2	1	1	1	10
>100	9	11	16	12	10	12	9	6	30	25	9	31
Total	32	49	67	87	42	34	30	38	105	181	96	279

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



Vehicle Weights (Kips)	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018
88-90	13	24	46	24	25	20	11	13	41	27	39	36
90-92	7	14	40	31	24	16	7	9	24	27	29	45
92-94	7	13	28	20	19	20	22	9	13	32	28	35
94-96	6	15	21	15	24	20	10	5	17	23	37	34
96-98	7	5	14	9	9	14	4	2	8	14	21	20
98-100	7	6	5	5	4	8	11	4	9	13	19	11
>100	27	21	24	33	26	23	41	25	32	40	41	42
Total	74	98	178	137	131	121	106	67	144	176	214	223

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

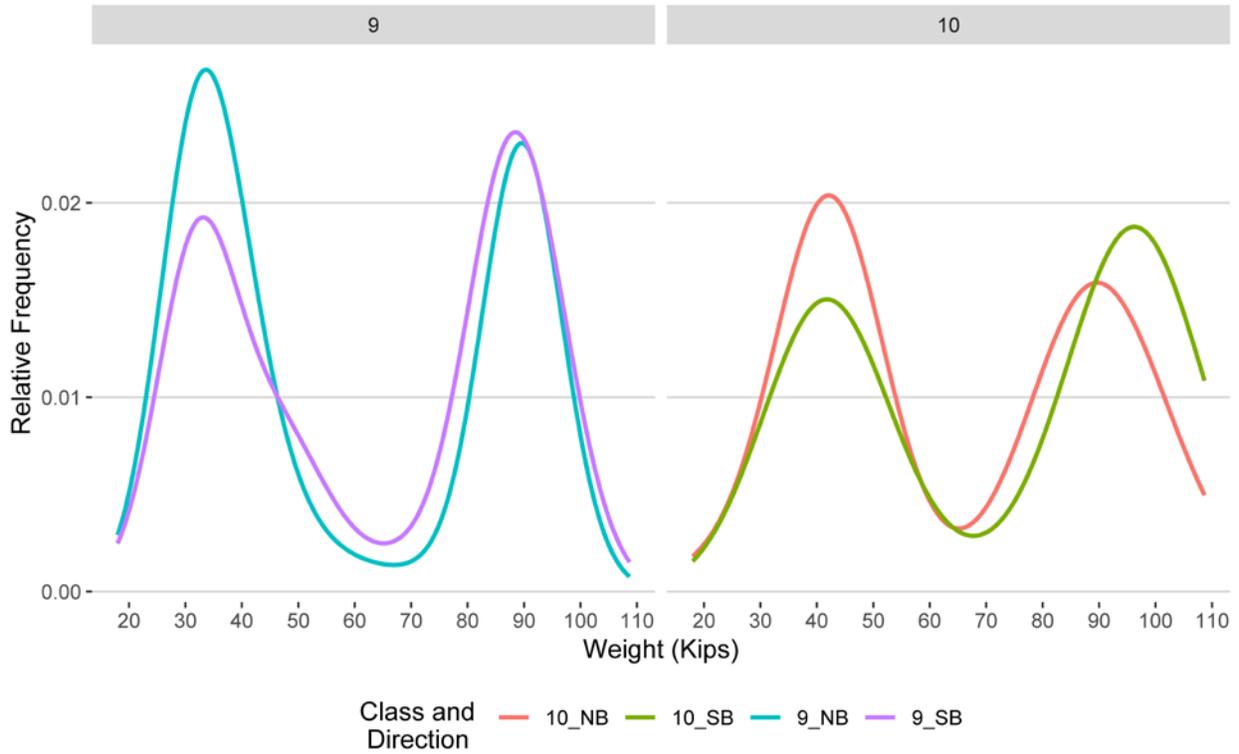


Figure 9 - Freight Percentage by Direction and Class

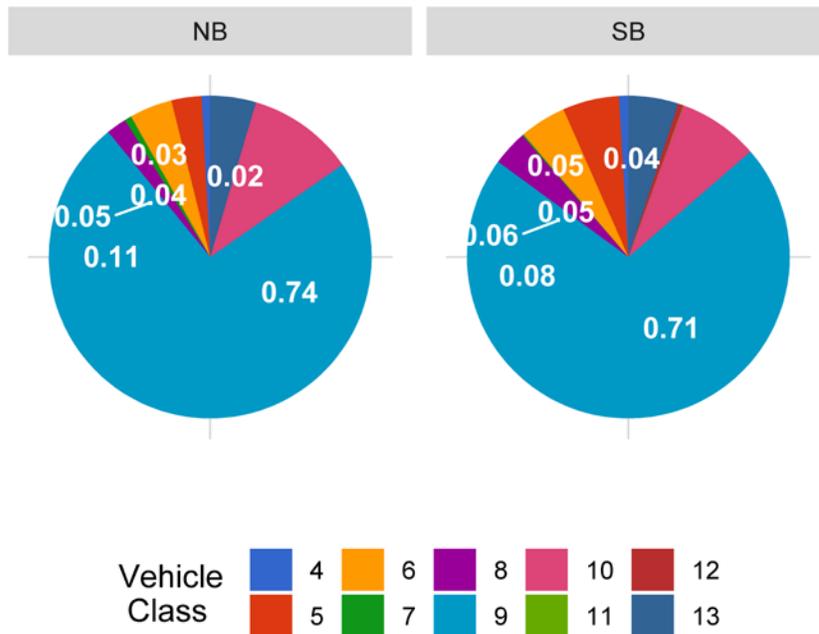


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

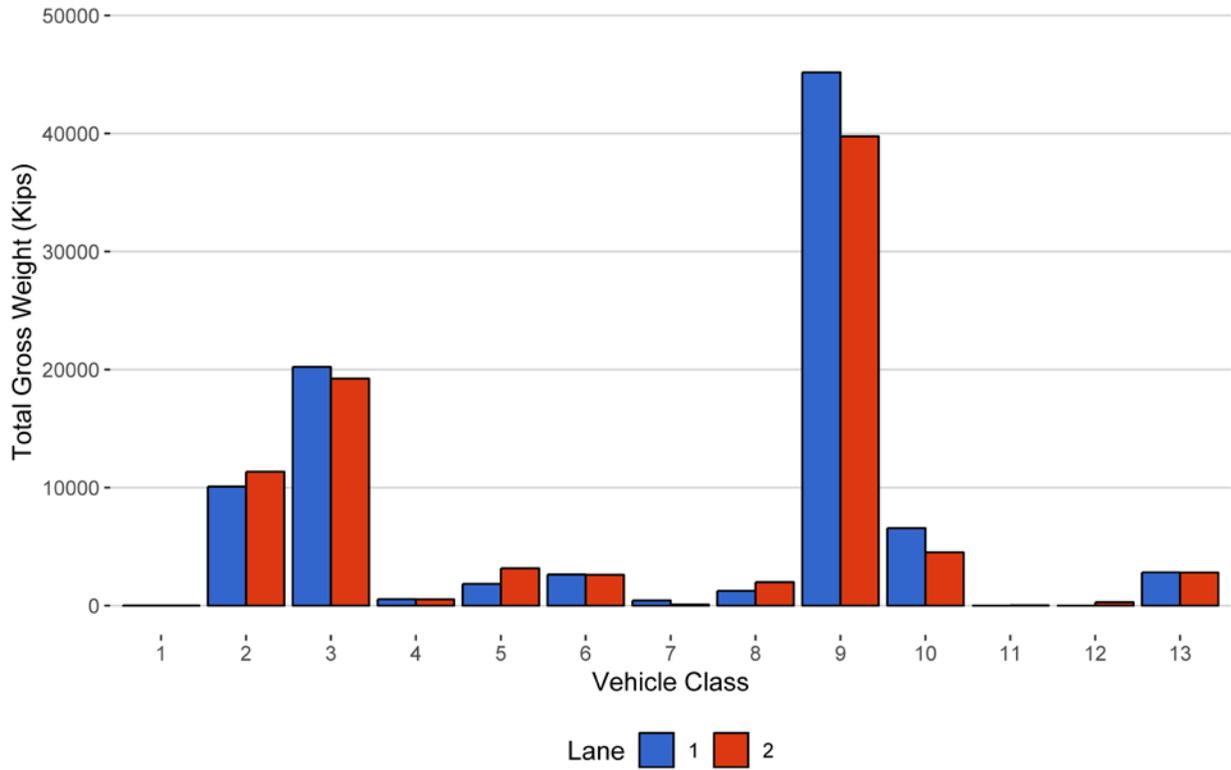


Figure 11 - Total Gross Vehicle Weight t

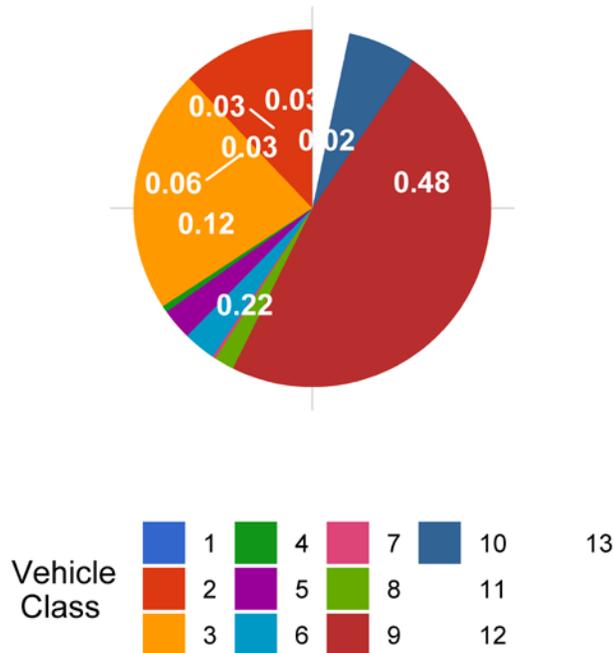


Figure 12 - Total ESALs by Class and Lane

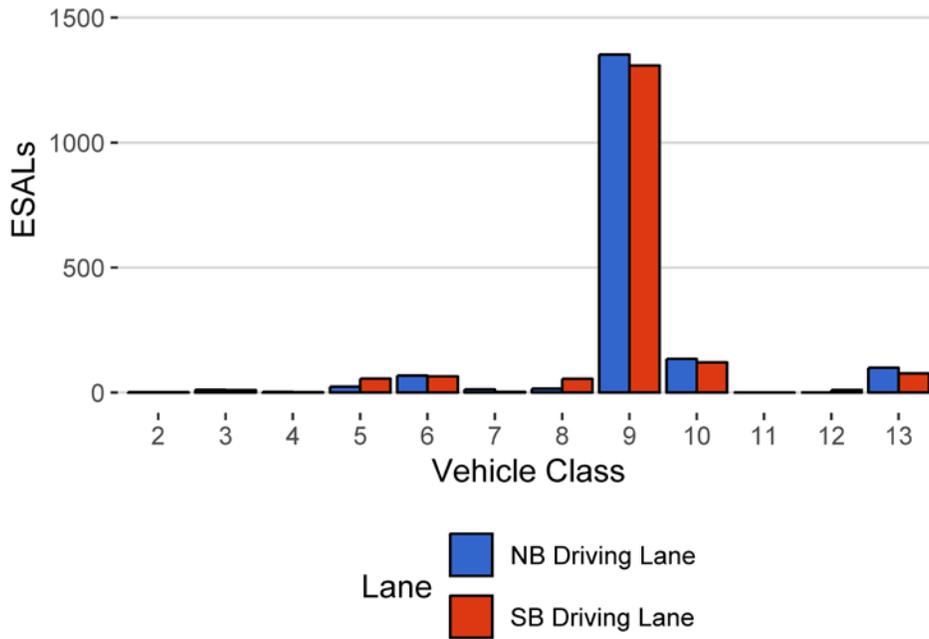
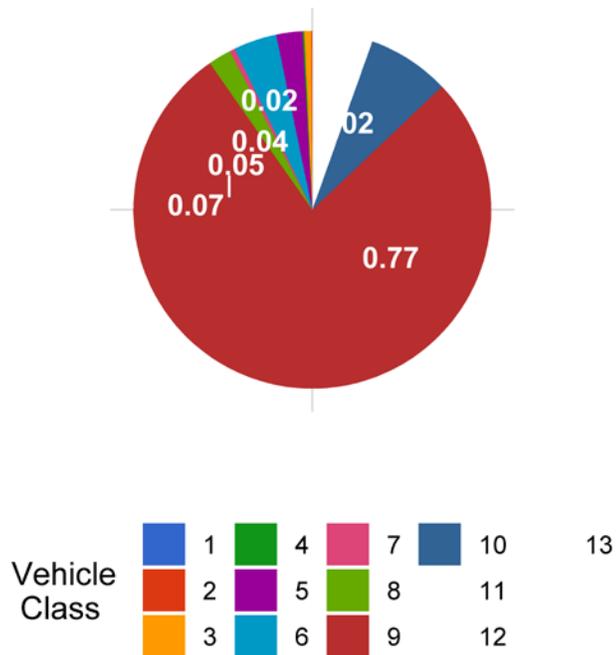


Figure 13 - ESALs by Class



**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>
January 2017	10.45	0.00	11.43	0.00
February 2017	10.44	-0.03	11.44	0.08
March 2017	10.47	0.20	11.27	-1.40
April 2017	10.12	-3.16	10.89	-4.76
May 2017	9.99	-4.40	10.72	-6.24
June 2017	10.24	-2.03	10.66	-6.76
July 2017	10.66	2.06	10.73	-6.18
August 2017	11.06	5.87	11.26	-1.53
September 2017	10.65	1.96	11.27	-1.44
October 2017	10.64	1.87	11.45	0.15
November 2017	11.73	12.23	11.62	1.61
December 2017	11.28	7.94	12.28	7.36
January 2018	11.34	8.53	12.21	6.78
February 2018	11.97	14.56	12.47	9.06
March 2018	11.59	10.91	11.64	1.80
April 2018	11.59	10.95	11.85	3.66
May 2018	11.73	12.24	11.67	2.05
June 2018	11.36	8.68	11.86	3.74
July 2018	11.77	12.67	11.70	2.29

**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	1	19	0.1	0	0
2	170	5282	38.6	0	0
3	193	5970	43.6	0	0
4	2	53	0.4	0	0
5	12	358	2.6	12	1.5
6	5	150	1.1	27	3.3
7	0	9	0.1	6	0.7
8	3	95	0.7	13	1.6
9	49	1509	11	630	76.4
10	6	176	1.3	82	9.9
11	0	1	0	0	0
12	0	3	0	3	0.4
13	2	56	0.4	52	6.3
<b>TOTAL</b>	<b>441</b>	<b>13682</b>	<b>100</b>	<b>825</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>
2018-07-03	Tuesday	19:00:36	10	NB	1	108.68
2018-07-19	Thursday	09:44:02	9	NB	1	108.43
2018-07-27	Friday	08:13:46	10	NB	1	108.39
2018-07-19	Thursday	11:17:55	9	SB	2	105.52
2018-07-19	Thursday	20:38:58	10	SB	2	105.2
2018-07-02	Monday	05:11:16	10	SB	2	104.76
2018-07-05	Thursday	10:10:45	10	SB	2	103.59
2018-07-09	Monday	20:54:17	10	SB	2	103.54
2018-07-06	Friday	10:07:17	10	SB	2	102.83
2018-07-05	Thursday	14:26:33	10	NB	1	102.44

**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	NB	15	24	3	12.5	490	42	88
5	NB	8	126	4	3.2	1811	29	418
6	NB	19	69	3	4.3	2573	55	659
7	NB	11.5	6	0	0	425	0	178
8	NB	31	41	22	53.7	774	467	92
9	NB	33	773	193	25	39307	5873	10083
10	NB	33.5	101	3	3	6487	70	1602
13	NB	31.5	26	0	0	2805	0	993
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>1166</b>	<b>228</b>	<b>****</b>	<b>54671</b>	<b>****</b>	<b>14113</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	SB	15	25	5	20	454	69	77
5	SB	8	205	2	1	3135	12	756
6	SB	19	70	2	2.9	2566	37	637
7	SB	11.5	2	0	0	80	0	29
8	SB	31	47	13	27.7	1725	250	335
9	SB	33	623	133	21.3	35687	4065	9759
10	SB	33.5	62	0	0	4505	0	1214
11	SB	36.5	1	1	100	0	26	0
12	SB	36.5	3	0	0	287	0	89
13	SB	31.5	26	0	0	2793	0	987
<b>TOTAL</b>	<b>****</b>	<b>****</b>	<b>1064</b>	<b>156</b>	<b>****</b>	<b>51233</b>	<b>****</b>	<b>13882</b>
<b>GRAND TOTAL</b>	<b>****</b>	<b>****</b>	<b>2230</b>	<b>384</b>	<b>275</b>	<b>105904</b>	<b>10995</b>	<b>27995</b>

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

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>
1	9	11	20	0
2	10080	11338	21418	12
3	20212	19235	39447	22.2
4	532	524	1056	0.6
5	1840	3147	4987	2.8
6	2628	2603	5232	2.9
7	425	80	505	0.3
8	1241	1975	3216	1.8
9	45179	39752	84932	47.8
10	6557	4505	11062	6.2
11	0	26	26	0
12	0	287	287	0.2
13	2805	2793	5598	3.1
<b>TOTAL</b>	<b>91509</b>	<b>86275</b>	<b>177784</b>	<b>100</b>
<b>GVW/LANE</b>	<b>51.47</b>	<b>48.53</b>	<b>100</b>	<b>0.06</b>

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

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.0526
2	2	2	3	0.1	0.0018
3	12	10	22	0.6	0.0085
4	3	2	5	0.2	0.28
5	24	57	81	2.4	0.5
6	68	66	134	3.9	1.92
7	13	4	17	0.5	2.74
8	16	56	72	2.1	1.59
9	1352	1308	2660	77.4	3.85
10	135	121	256	7.5	3.06
11	0	0	0	0	0.92
12	0	11	11	0.3	2.31
13	100	76	176	5.1	5.7
<b>TOTAL</b>	<b>1725</b>	<b>1712</b>	<b>3438</b>	<b>100</b>	<b>23</b>
<b>ESALS/LANE</b>	<b>50.2</b>	<b>49.8</b>	<b>100</b>	<b>-</b>	<b>-</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 2017	11998	387	44	10631	88.6	1366.8	11.4
Sep 2017	12700	423	55	11064	87.1	1636.5	12.9
Oct 2017	13498	435	74	11202	83	2295.5	17
Nov 2017	12370	412	64	10464	84.6	1905.8	15.4
Dec 2017	10135	327	36	9031	89.1	1103.7	10.9
Jan 2018	9405	303	40	8154	86.7	1251.5	13.3
Feb 2018	8430	301	37	7386	87.6	1043.9	12.4
Mar 2018	9969	322	35	8878	89.1	1091.2	10.9
Apr 2018	10062	335	48	8635	85.8	1427.4	14.2
May 2018	14674	473	73	12414	84.6	2259.8	15.4
Jun 2018	13021	434	67	11020	84.6	2001.1	15.4
Jul 2018	13682	441	78	11271	82.4	2410.8	17.6
<b>TOTAL</b>	<b>139944</b>	<b>-</b>	<b>-</b>	<b>120150</b>	<b>-</b>	<b>19794</b>	<b>-</b>
<b>AVERAGE</b>	<b>11662</b>	<b>383</b>	<b>54</b>	<b>10012</b>	<b>86</b>	<b>1650</b>	<b>14</b>

## ESALS

<i>Month</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Aug 2017	581	743	1325	23.9
Sep 2017	553	1065	1618	32.6
Oct 2017	948	2092	3040	31.3
Nov 2017	1287	1355	2642	43.3
Dec 2017	457	962	1419	65.7
Jan 2018	425	909	1334	73.5
Feb 2018	346	747	1093	68.9
Mar 2018	402	520	922	56.5
Apr 2018	724	1023	1747	55.4
May 2018	1396	1406	2801	50.4
Jun 2018	916	1578	2494	67.8
Jul 2018	1730	1722	3452	58.4
<b>TOTAL</b>	<b>9765</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>AVERAGE</b>	<b>814</b>	<b>1177</b>	<b>1991</b>	<b>52</b>

## Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Aug 2017	41930	48655	90585
Sep 2017	37098	43044	80142
Oct 2017	43050	42310	85360
Nov 2017	54740	56400	111139
Dec 2017	86626	80895	167521
Jan 2018	72965	78450	151415
Feb 2018	91632	86499	178130
Mar 2018	54657	54121	108778
Apr 2018	57117	68759	125876
May 2018	68560	88970	157531
Jun 2018	71826	70084	141910
Jul 2018	42975	50948	93923
<b>TOTAL</b>	<b>723175</b>	<b>769135</b>	<b>1492310</b>
<b>AVERAGE</b>	<b>60265</b>	<b>64095</b>	<b>124359</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 2017	355	3.1	26.8	106	44
Sep 2017	430	3.6	27.3	147	45
Oct 2017	756	6.1	35.3	245	48
Nov 2017	669	5.8	37.4	224	50
Dec 2017	324	3.4	31.4	173	41
Jan 2018	281	3.2	24.1	155	44
Feb 2018	225	2.9	23.1	136	62
Mar 2018	202	2.2	19.6	105	37
Apr 2018	419	4.4	31.2	249	72
May 2018	669	4.9	31.6	360	82
Jun 2018	607	4.9	31.7	313	73
Jul 2018	828	6.6	36.7	502	94
<b>TOTAL</b>	<b>5765</b>	<b>-</b>	<b>-</b>	<b>2715</b>	<b>692</b>
<b>AVERAGE</b>	<b>480.4</b>	<b>4.3</b>	<b>29.7</b>	<b>226.2</b>	<b>57.7</b>

## Freight

<i>Month</i>	<i>NB Freight Tons</i>	<i>SB Freight Tons</i>	<i>Total Freight</i>	<i>NB Freight %</i>	<i>SB Freight %</i>
Aug 2017	5751	6892	12643	45.5	54.5
Sep 2017	5415	10372	15787	34.3	65.7
Oct 2017	7488	16992	24481	30.6	69.4
Nov 2017	10635	10985	21620	49.2	50.8
Dec 2017	3645	7789	11434	31.9	68.1
Jan 2018	3514	7144	10657	33	67
Feb 2018	3205	6254	9460	33.9	66.1
Mar 2018	3533	4672	8204	43.1	56.9
Apr 2018	6268	8863	15130	41.4	58.6
May 2018	11363	11901	23264	48.8	51.2
Jun 2018	8008	12671	20678	38.7	61.3
Jul 2018	14113	13882	27995	50.4	49.6
<b>TOTAL</b>	<b>82937</b>	<b>118417</b>	<b>201354</b>	-	-
<b>AVERAGE</b>	<b>6911.4</b>	<b>9868.1</b>	<b>16779.5</b>	<b>40.1</b>	<b>59.9</b>