

MARCH 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 March 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 ¹. 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 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: 9969 | Passenger Vehicles: 8878 | Heavy Commercial Vehicles: 1091

Monthly Average Daily Traffic (MADT): 322 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 35

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 Fridays, with lowest volumes reported on Tuesdays. SB 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), NB PVs generally reached peak volume levels between 07 AM and 05 PM. Similarly, SB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 07 AM and 05 PM, while volume going SB peaked between 03 PM 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 1091 HCVs, 201 of them were overweight³. These overweight HCVs contributed to 2.2% of total monthly volume, and 19.7% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on NAs. 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 58.4% of all overweight vehicles traveling SB 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 October.

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, 38 NB vehicles exceeded 88,000 pounds (28 vehicles were Class 9's; 6 vehicles were Class 10's). Of vehicles traveling SB,

67 NB vehicles exceeded 88,000 pounds (34 vehicles were Class 9's; 17 vehicles were Class 13'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 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 8204 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (56.9%) than NB (43.1%). 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 9969 vehicles with a combined GVW of 85360 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 922 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 56.4% of all ESALs were recorded SB while 43.6% was observed NB. In particular, 61% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 28% 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).

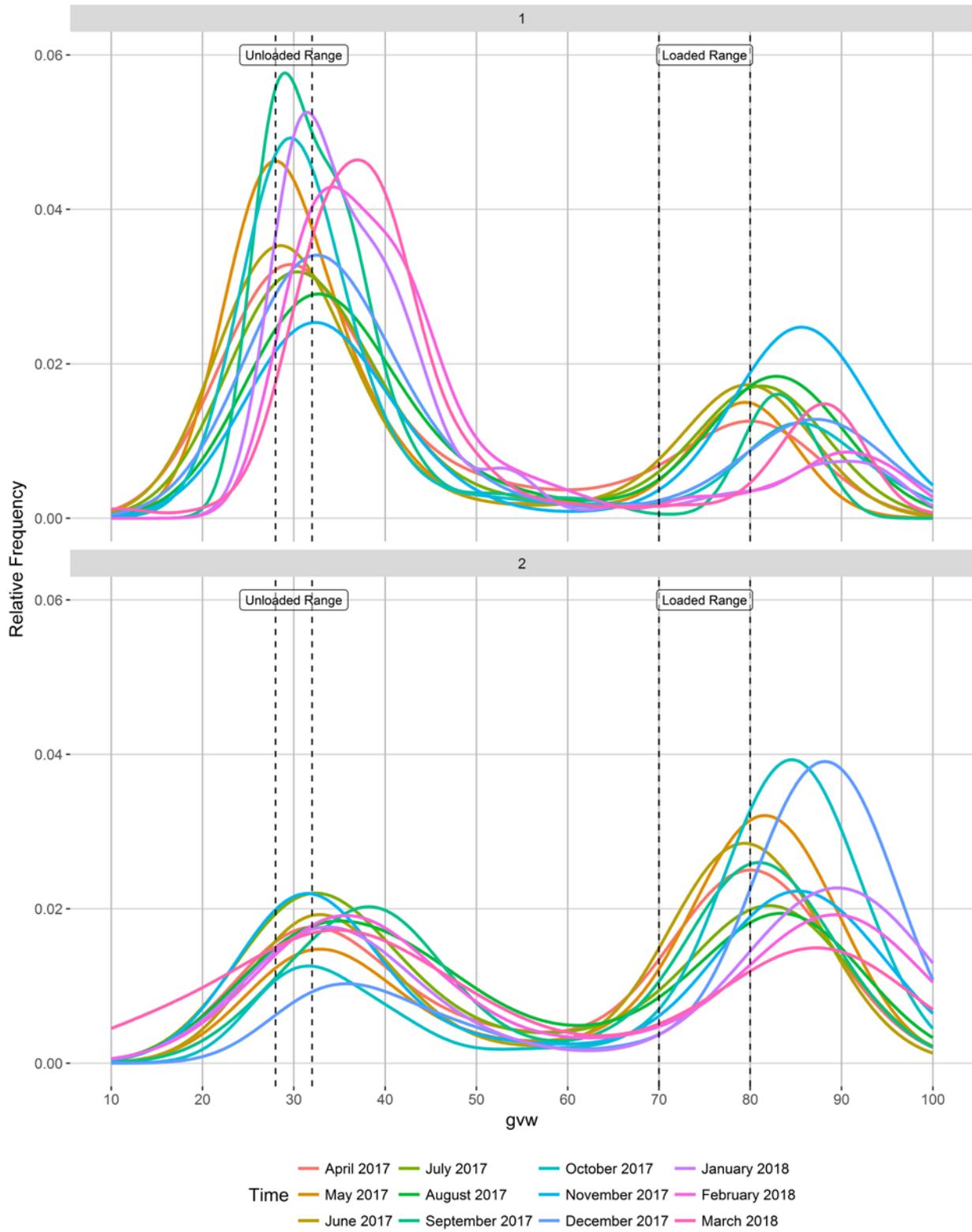
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

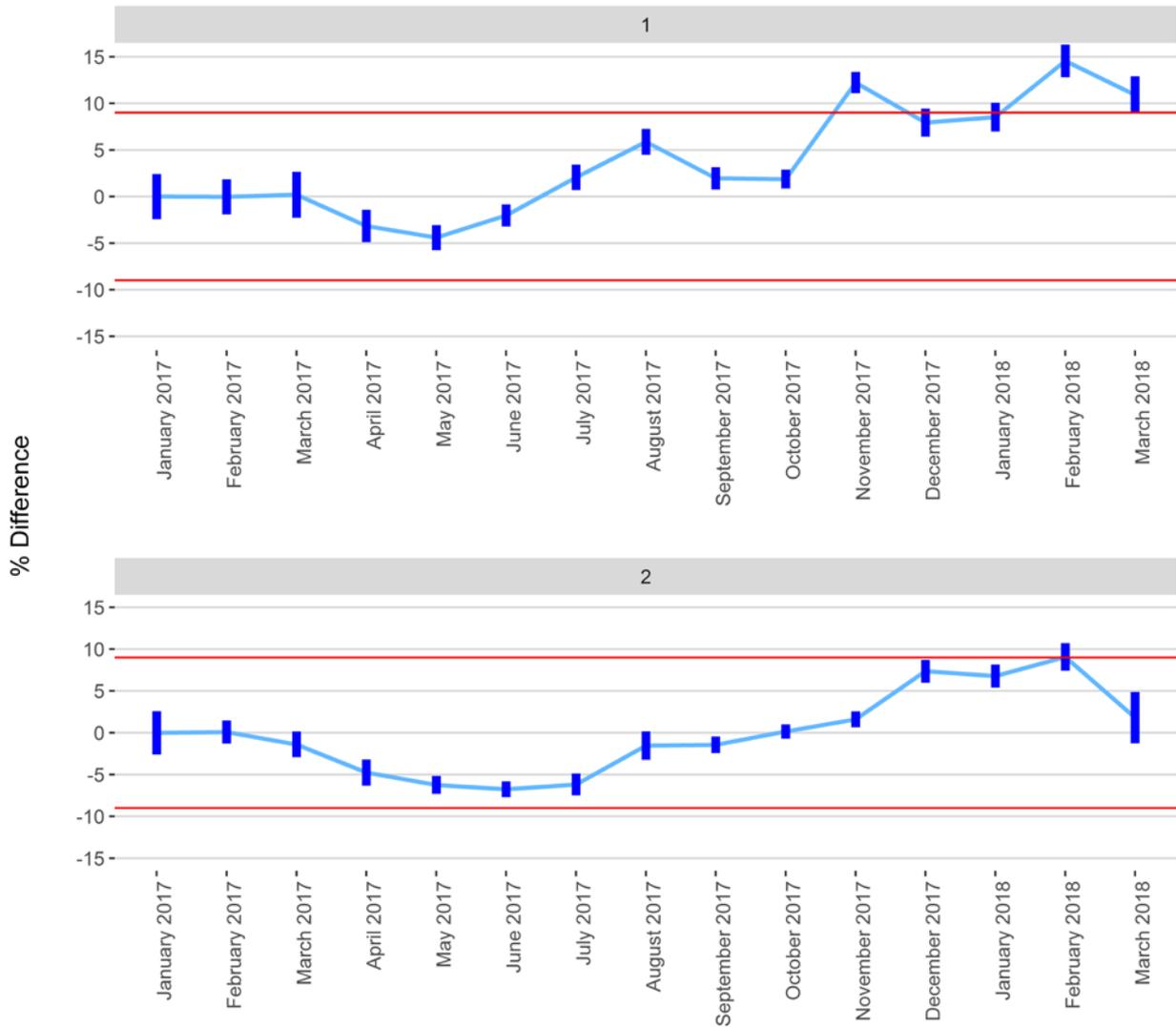
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

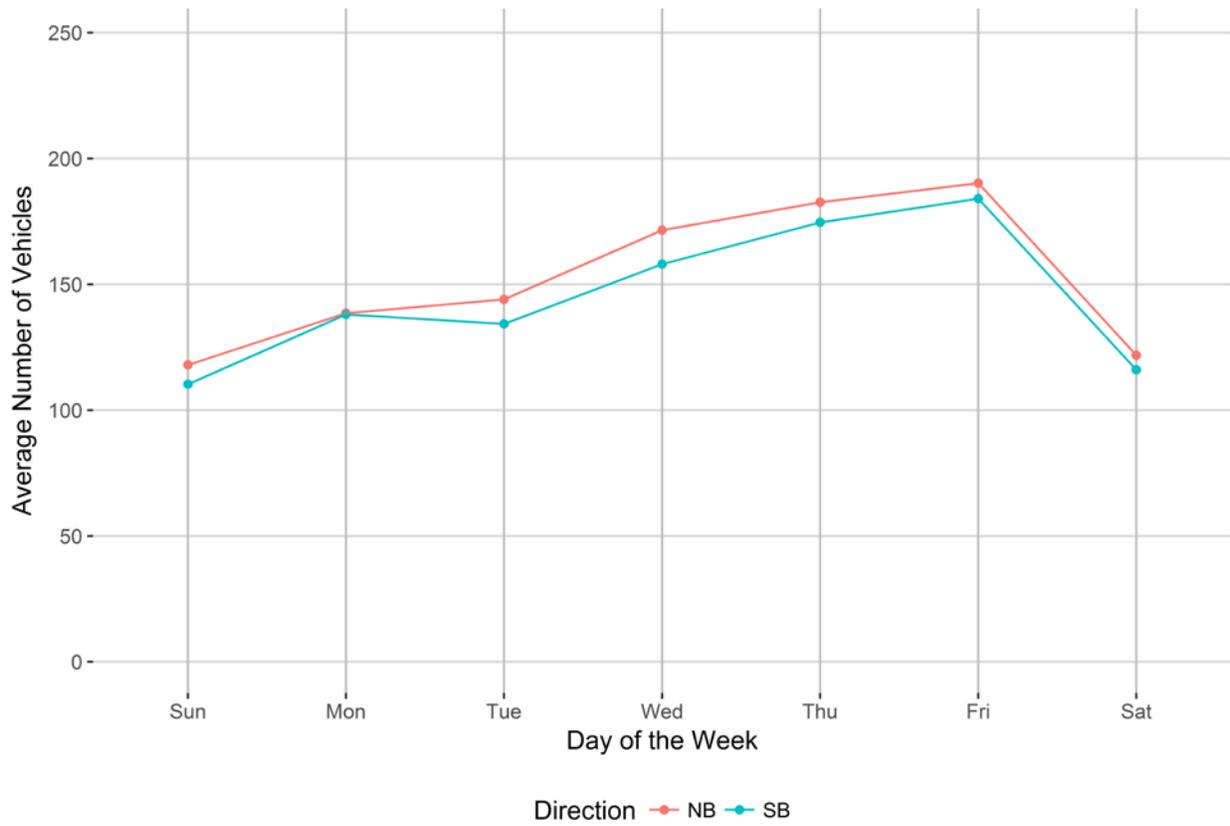


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

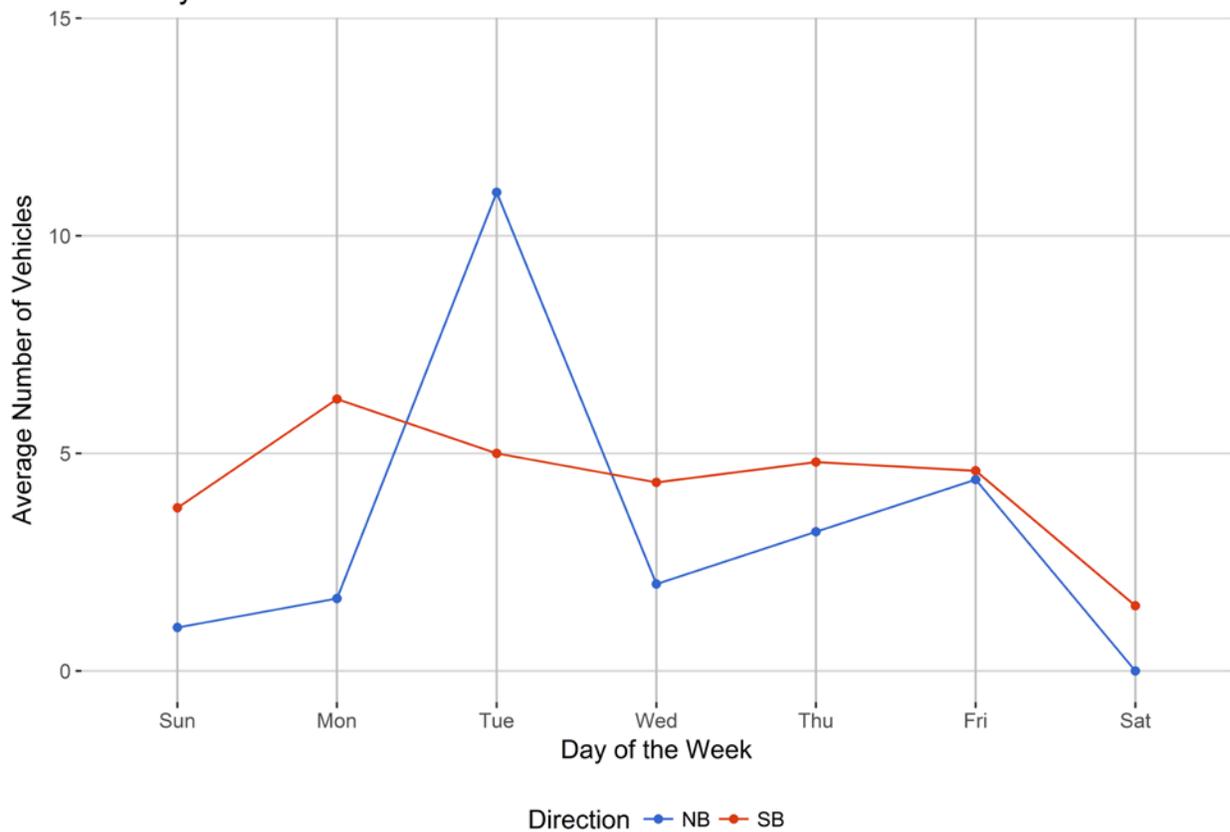


Figure 4 - Passenger Vehicles vs. Hour of the Day

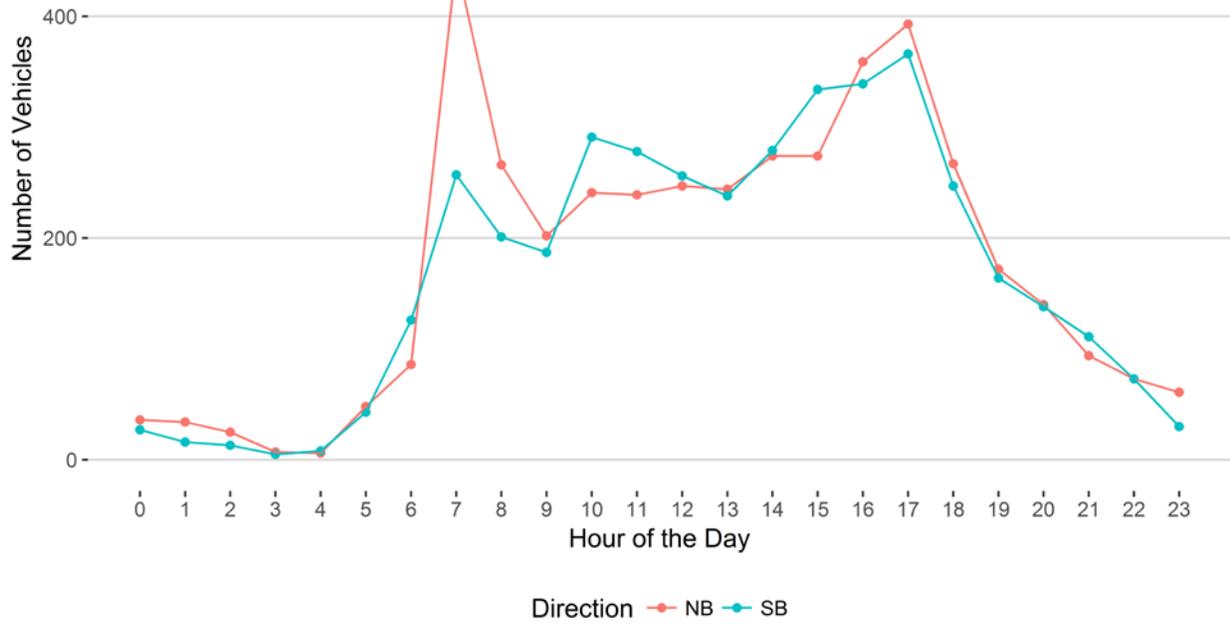


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

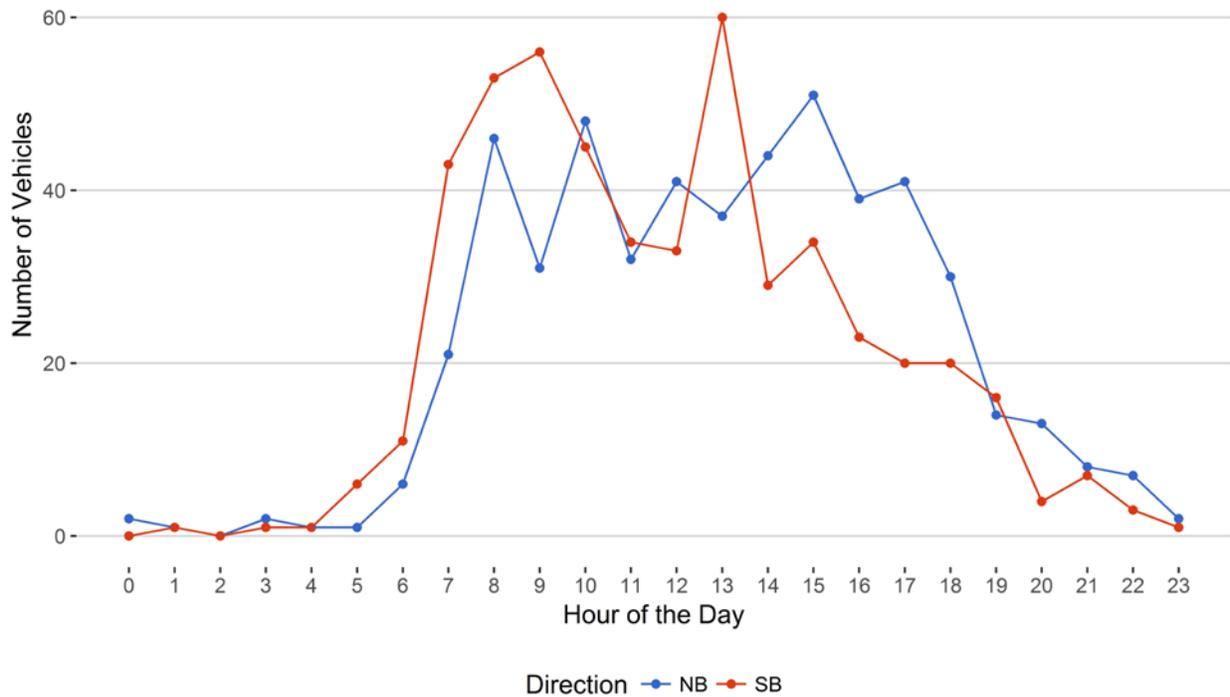


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

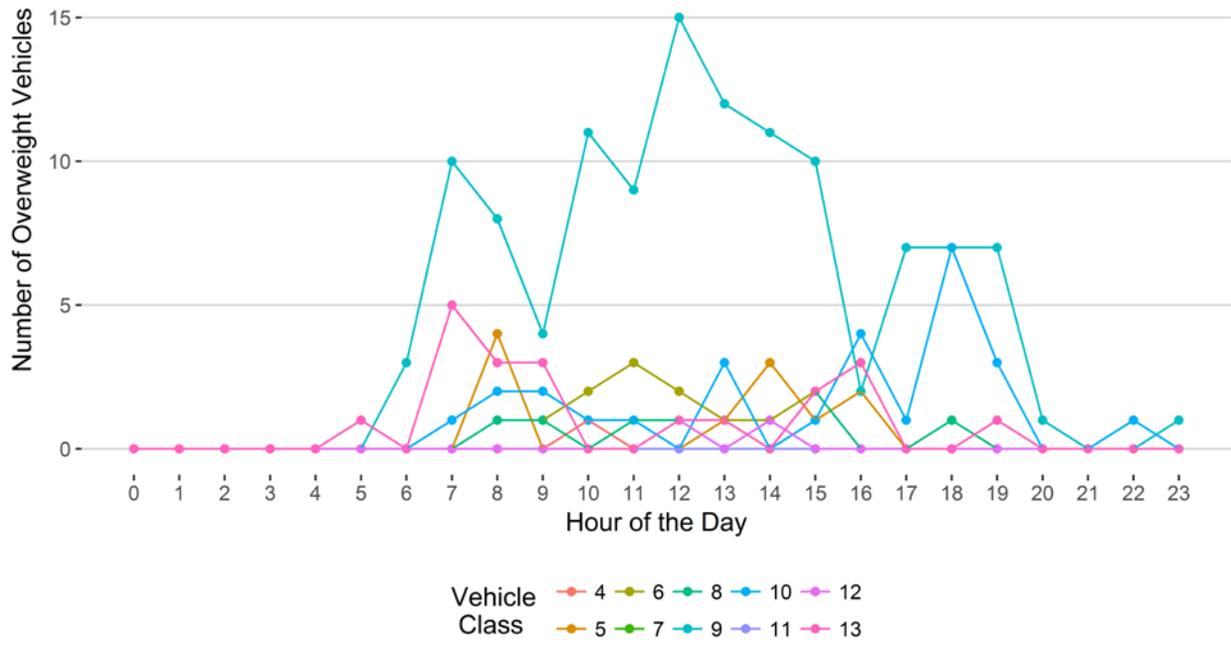


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

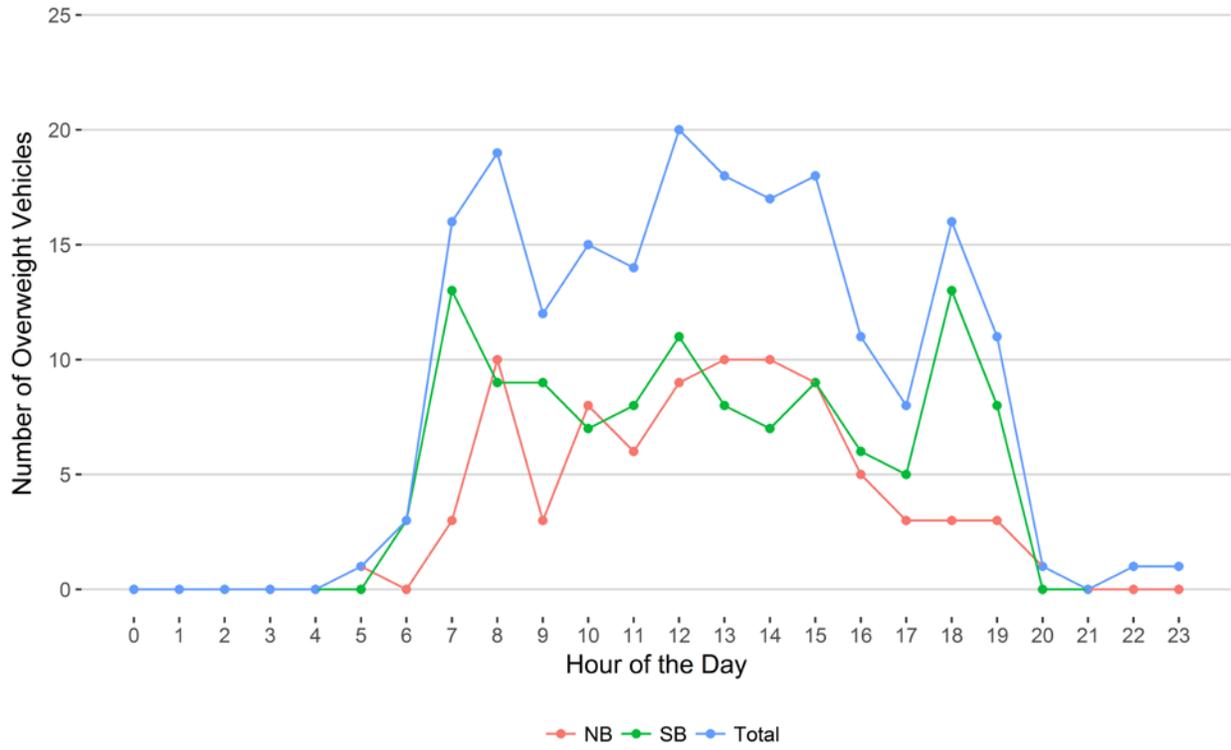
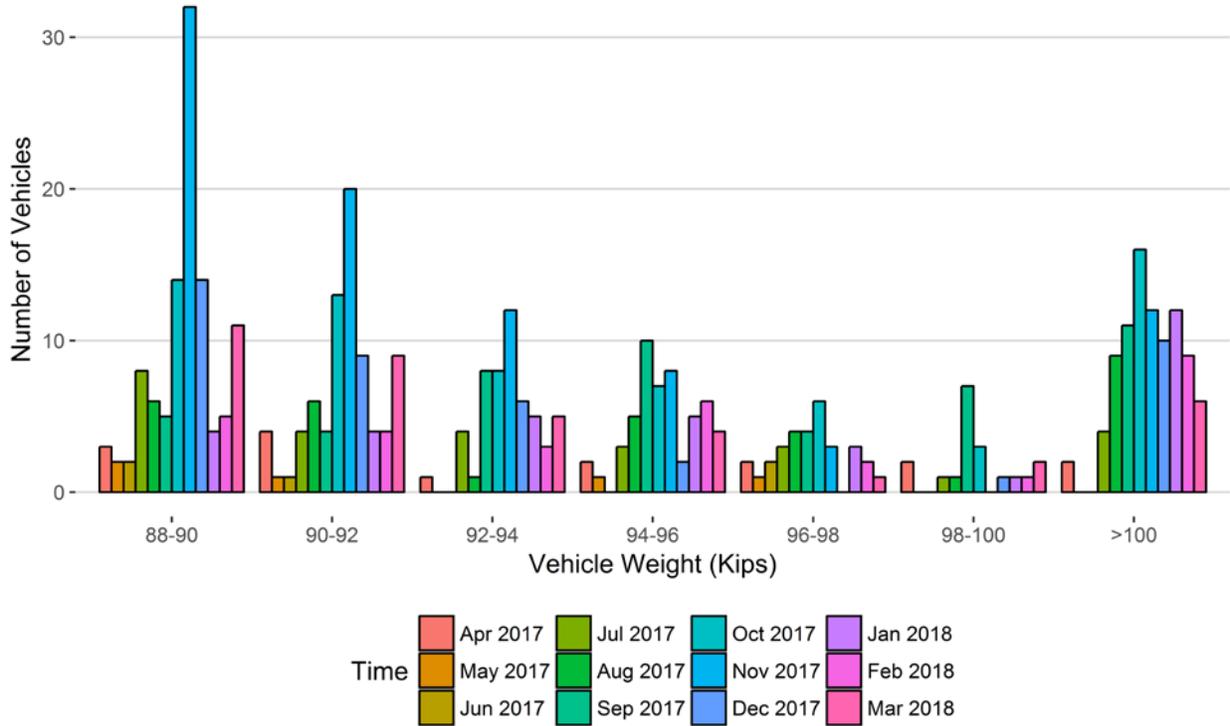
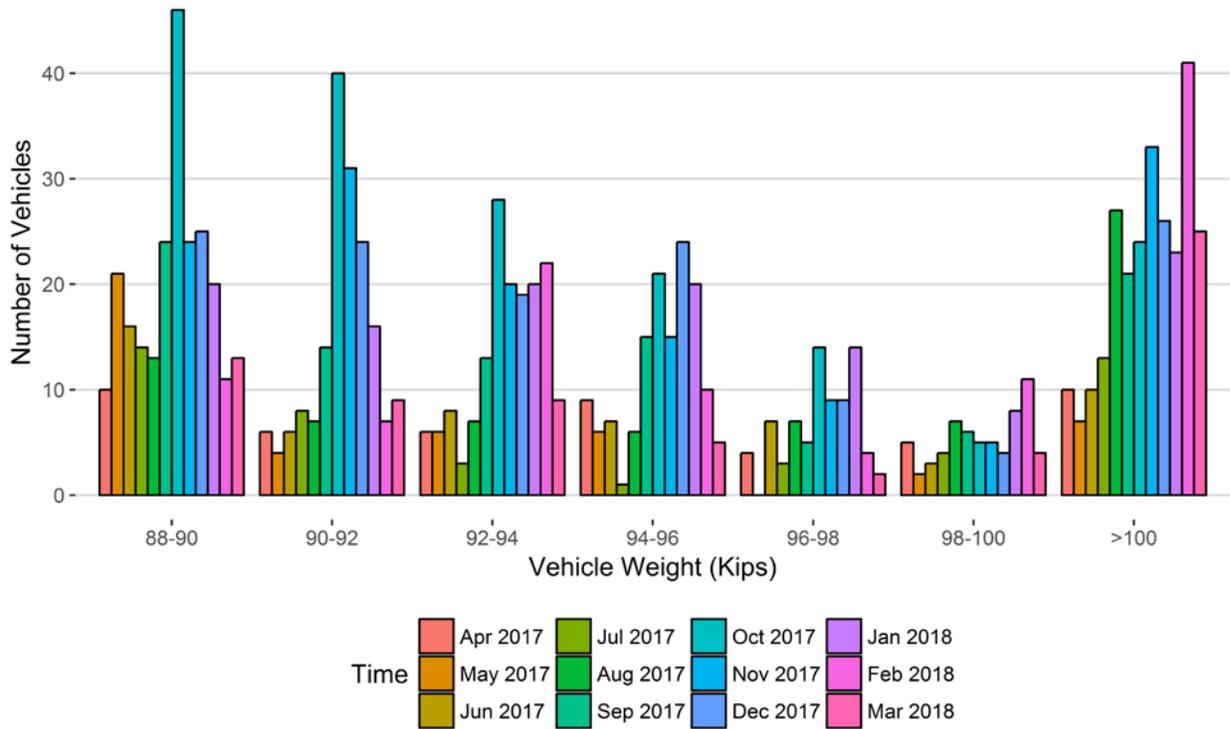


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Apr 2017	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018
88-90	3	2	2	8	6	5	14	32	14	4	5	11
90-92	4	1	1	4	6	4	13	20	9	4	4	9
92-94	1	0	0	4	1	8	8	12	6	5	3	5
94-96	2	1	0	3	5	10	7	8	2	5	6	4
96-98	2	1	2	3	4	4	6	3	0	3	2	1
98-100	2	0	0	1	1	7	3	0	1	1	1	2
>100	2	0	0	4	9	11	16	12	10	12	9	6
Total	16	5	5	27	32	49	67	87	42	34	30	38

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



Vehicle Weights (Kips)	Apr 2017	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018
88-90	10	21	16	14	13	24	46	24	25	20	11	13
90-92	6	4	6	8	7	14	40	31	24	16	7	9
92-94	6	6	8	3	7	13	28	20	19	20	22	9
94-96	9	6	7	1	6	15	21	15	24	20	10	5
96-98	4	0	7	3	7	5	14	9	9	14	4	2
98-100	5	2	3	4	7	6	5	5	4	8	11	4
>100	10	7	10	13	27	21	24	33	26	23	41	25
Total	50	46	57	46	74	98	178	137	131	121	106	67

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

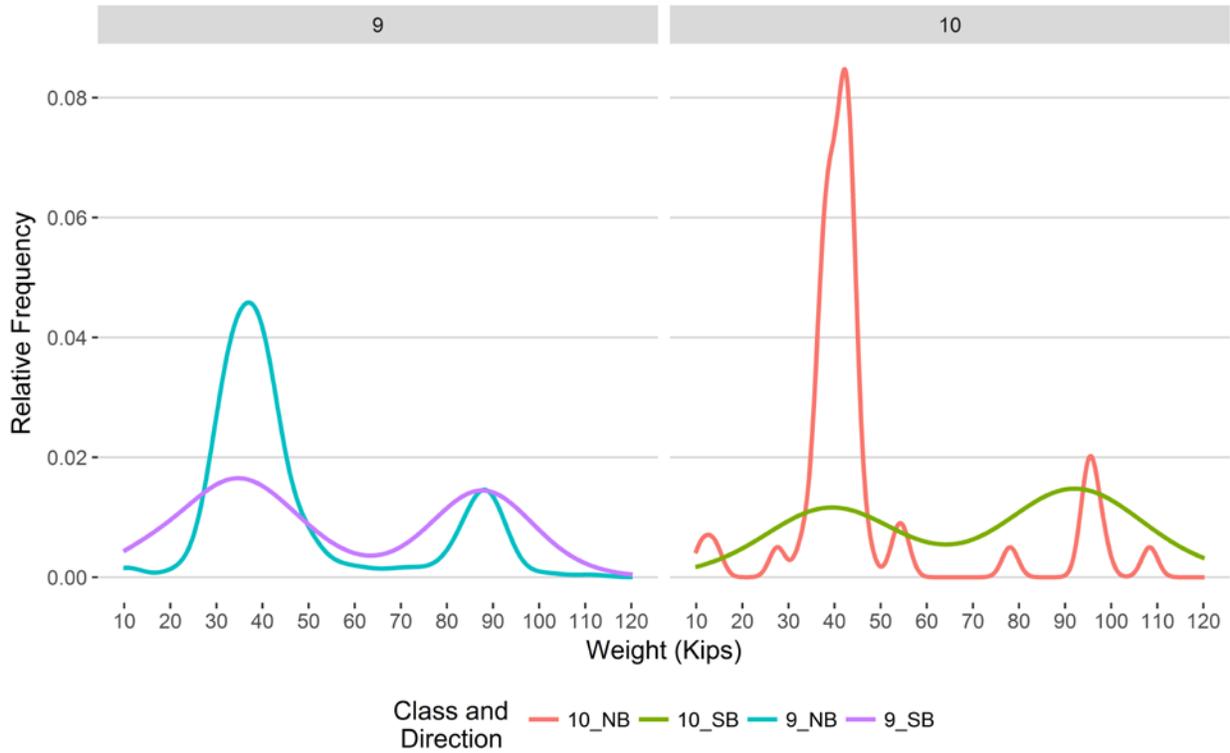


Figure 9 - Freight Percentage by Direction and Class

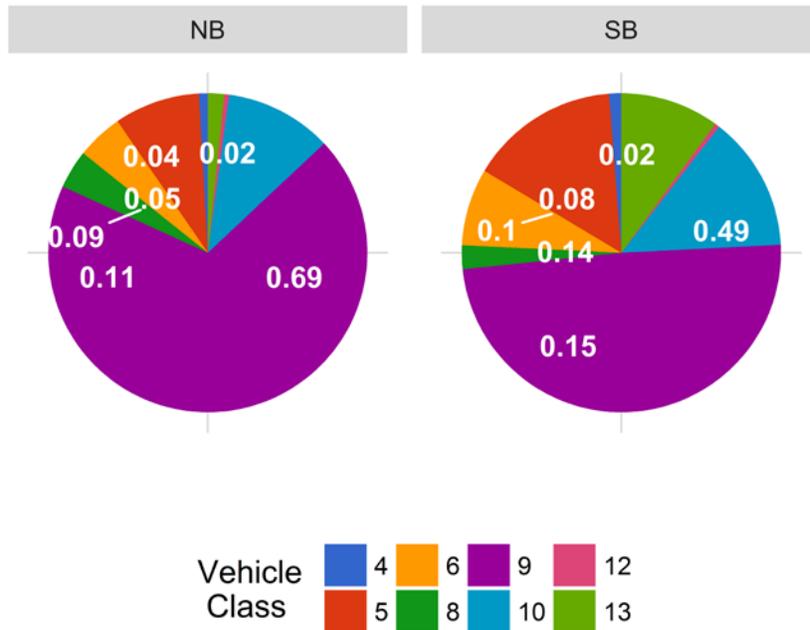


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

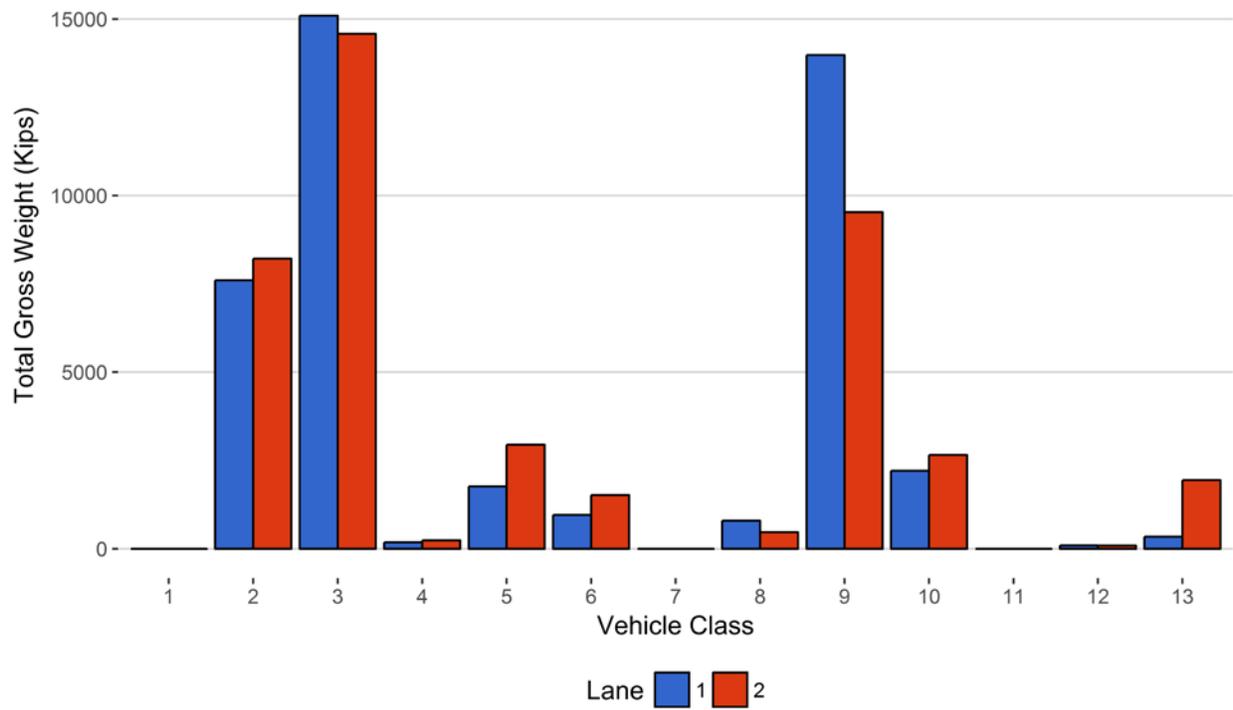


Figure 11 - Total Gross Vehicle Weight by

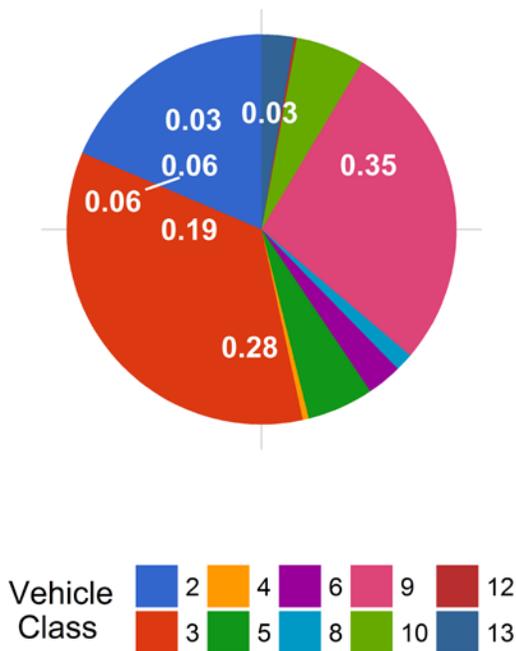


Figure 12 - Total ESALs by Class and Lane

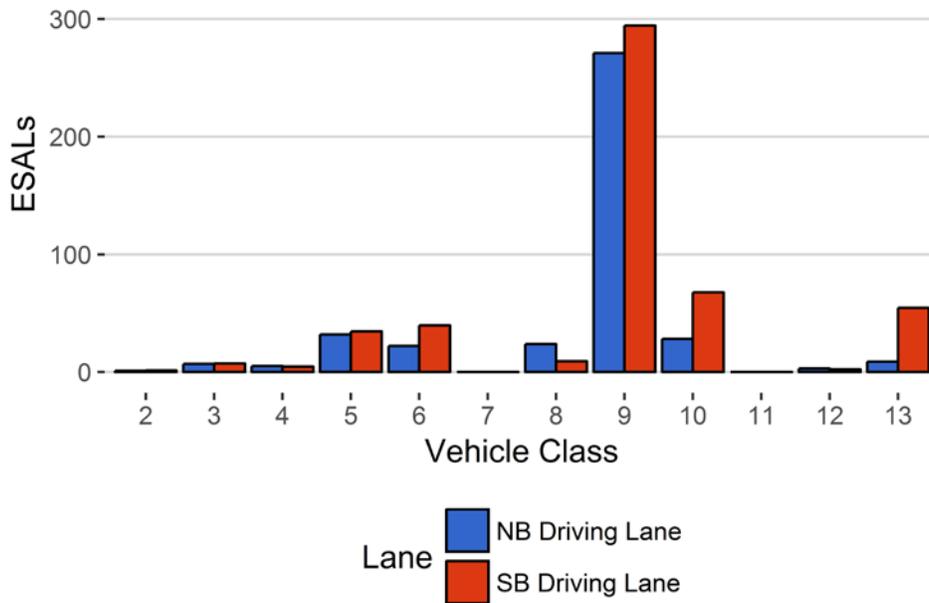


Figure 13 - ESALs by Class

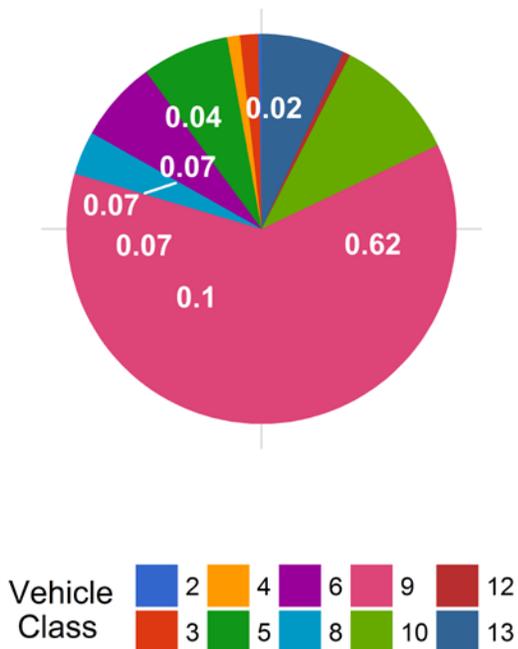


Table 1 Class 9 Front Axle Weight by Lane

<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

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	129	4002	40.1	0	0
3	157	4876	48.9	0	0
4	1	17	0.2	2	1
5	11	350	3.5	11	5.5
6	2	74	0.7	14	7
7	0	0	0	0	0
8	1	40	0.4	7	3.5
9	16	496	5	118	58.7
10	3	90	0.9	27	13.4
11	0	0	0	0	0
12	0	2	0	2	1
13	1	22	0.2	20	10
TOTAL	322	9969	100	201	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>
2018-03-09	Friday	10:18:34	10	SB	2	120.27
2018-03-14	Wednesday	19:06:27	9	SB	2	112.25
2018-03-16	Friday	07:18:27	9	NB	1	111.25
2018-03-12	Monday	22:32:29	10	SB	2	109.3
2018-03-16	Friday	18:53:18	10	NB	1	108.35
2018-03-14	Wednesday	19:54:02	9	SB	2	105.57
2018-03-01	Thursday	07:19:06	9	SB	2	104.36
2018-03-17	Saturday	15:26:36	9	SB	2	103.77
2018-03-11	Sunday	17:30:44	9	SB	2	103.1
2018-03-15	Thursday	13:10:11	9	NB	1	103.09

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	5	1	20	168	14	54
5	NB	8	120	8	6.7	1707	56	406
6	NB	19	28	1	3.6	948	9	217
8	NB	31	21	5	23.8	677	117	90
9	NB	33	294	58	19.7	12302	1676	2257
10	NB	33.5	46	4	8.7	2120	86	357
12	NB	36.5	1	0	0	94	0	29
13	NB	31.5	3	0	0	340	0	123
TOTAL	****	****	518	77	****	18356	****	3533
<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	11	0	0	238	0	37
5	SB	8	207	5	2.4	2912	35	648
6	SB	19	41	1	2.4	1499	18	370
8	SB	31	16	9	56.2	287	181	35
9	SB	33	169	45	26.6	8421	1111	2164
10	SB	33.5	38	2	5.3	2609	47	701
12	SB	36.5	1	0	0	91	0	27
13	SB	31.5	18	0	0	1946	0	690
TOTAL	****	****	501	62	****	18003	****	4672
GRAND TOTAL	****	****	1019	139	175	36359	3351	8204

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>
2	7604	8218	15822	18.6
3	15096	14581	29677	34.8
4	182	238	420	0.5
5	1763	2947	4710	5.5
6	957	1517	2474	2.9
8	794	469	1263	1.5
9	13979	9531	23510	27.6
10	2206	2656	4862	5.7
12	94	91	185	0.2
13	340	1946	2286	2.7
TOTAL	43015	42195	85210	100
GVW/LANE	50.48	49.52	100	0.12

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>
2	1	1	2	0.3	0.0019
3	7	7	14	1.5	0.0072
4	5	5	10	1.1	1.22
5	32	35	66	7.2	0.44
6	22	40	62	6.7	1.81
8	24	9	33	3.6	1.72
9	271	294	566	61.7	2.55
10	28	68	96	10.4	2.26
12	3	2	5	0.6	1.66
13	9	54	63	6.9	4.31
TOTAL	402	515	917	100	16
ESALS/LANE	43.8	56.2	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>
Apr 2017	11479	383	40	10284	89.6	1195.4	10.4
May 2017	13129	424	50	11582	88.2	1547	11.8
Jun 2017	12884	430	62	11025	85.6	1858.7	14.4
Jul 2017	12346	398	50	10803	87.5	1543.1	12.5
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
TOTAL	138343	--	--	120504	--	17839	--
AVERAGE	11529	379	49	10042	87	1487	13

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>
Apr 2017	372	554	926	32.3
May 2017	489	879	1369	15.4
Jun 2017	682	1058	1740	14.6
Jul 2017	645	705	1350	16.2
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
TOTAL	7187	--	--	--
AVERAGE	599	966	1565	40

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Apr 2017	41930	48655	90585
May 2017	37098	43044	80142
Jun 2017	43050	42310	85360
Jul 2017	46643	48401	95044
Aug 2017	56104	62800	118905
Sep 2017	64178	69477	133655
Oct 2017	57644	58281	115925
Nov 2017	54657	54121	108778
Dec 2017	57117	68759	125876
Jan 2018	68560	88970	157531
Feb 2018	71826	70084	141910
Mar 2018	42975	50948	93923
TOTAL	641782	705851	1347633
AVERAGE	53482	58821	112303

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	230	2.1	20.4	68	21
May 2017	362	2.9	24.4	51	9
Jun 2017	433	3.6	24.4	62	13
Jul 2017	342	2.9	23	73	22
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
TOTAL	4609	--	--	1545	436
AVERAGE	384.1	3.5	26.4	128.8	36.3

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>
Apr 2017	4425	5796	10220	43.3	56.7
May 2017	5141	8302	13443	38.2	61.8
Jun 2017	7334	10263	17597	41.7	58.3
Jul 2017	6266	7022	13288	47.2	52.8
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
TOTAL	66351	102483	168834	--	--
AVERAGE	5529.2	8540.3	14069.5	39.3	60.7