

JUNE 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 June 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. 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: 13021 | Passenger Vehicles: 11020 | Heavy Commercial Vehicles: 2001

Monthly Average Daily Traffic (MADT): 434 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 67

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 Saturdays. SB vehicles typically reached highest volume levels on Sundays, with lowest volumes reported on Thursdays (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 11 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 11 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 2001 HCVs, 601 of them were overweight³. These overweight HCVs contributed to 4.9% of total monthly volume, and 31.7% 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 64.3% 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 May.

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, 97 NB vehicles exceeded 88,000 pounds (78 vehicles were Class 9's; 9 vehicles were Class 13's). Of vehicles traveling SB,

216 NB vehicles exceeded 88,000 pounds (134 vehicles were Class 9's; 60 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from June 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in June 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 empty Class 10's than fully_loaded traveling in the NB direction. In the SB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 20678 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (61.3%) than NB (38.7%). 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 13021 vehicles with a combined GVW of 151415 kips (1 kip = 1,000 pounds = 0.5 tons) in June 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 2494 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 63.3% of all ESALs were recorded SB while 36.7% was observed NB. In particular, 70% 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).

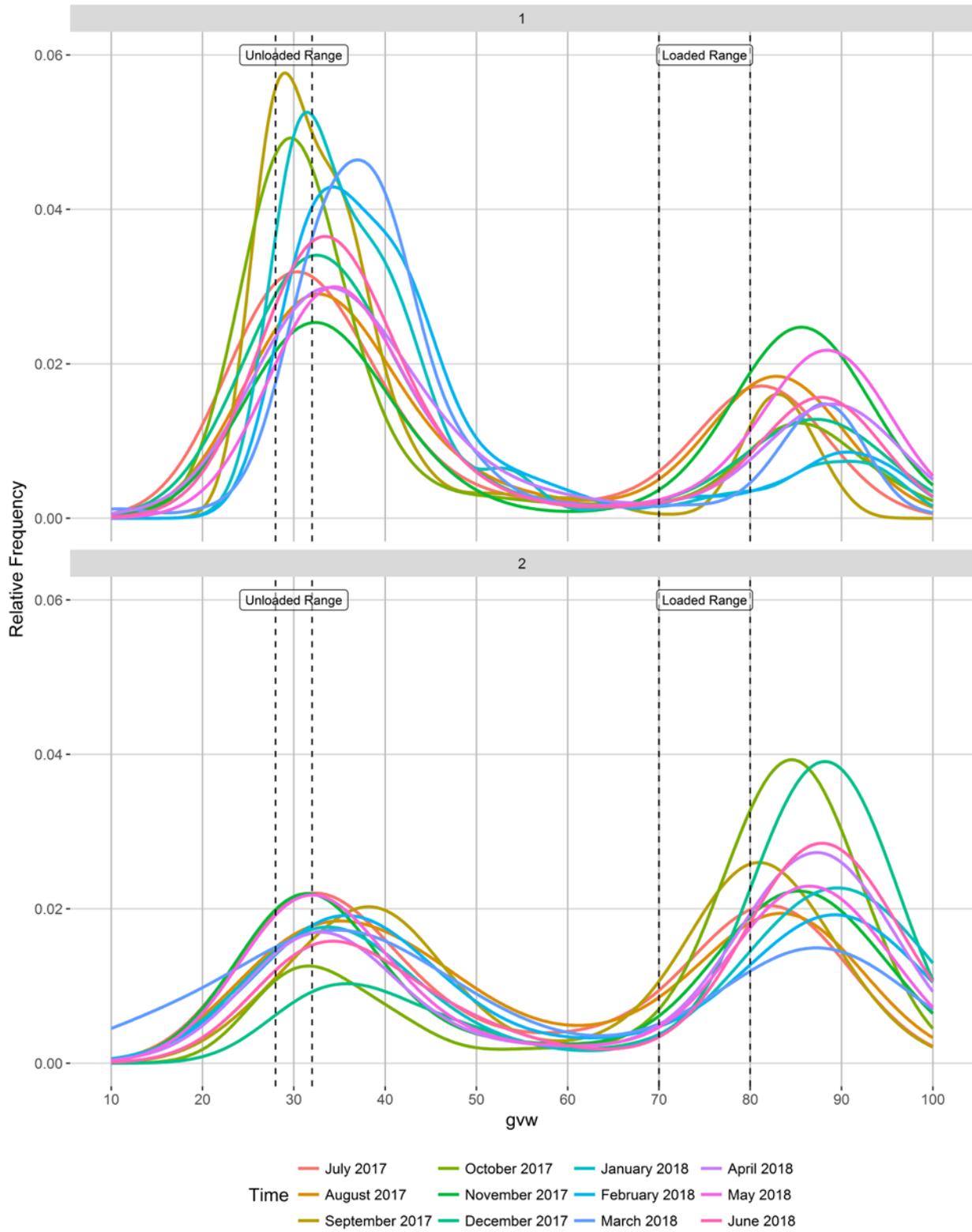
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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>

- 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.

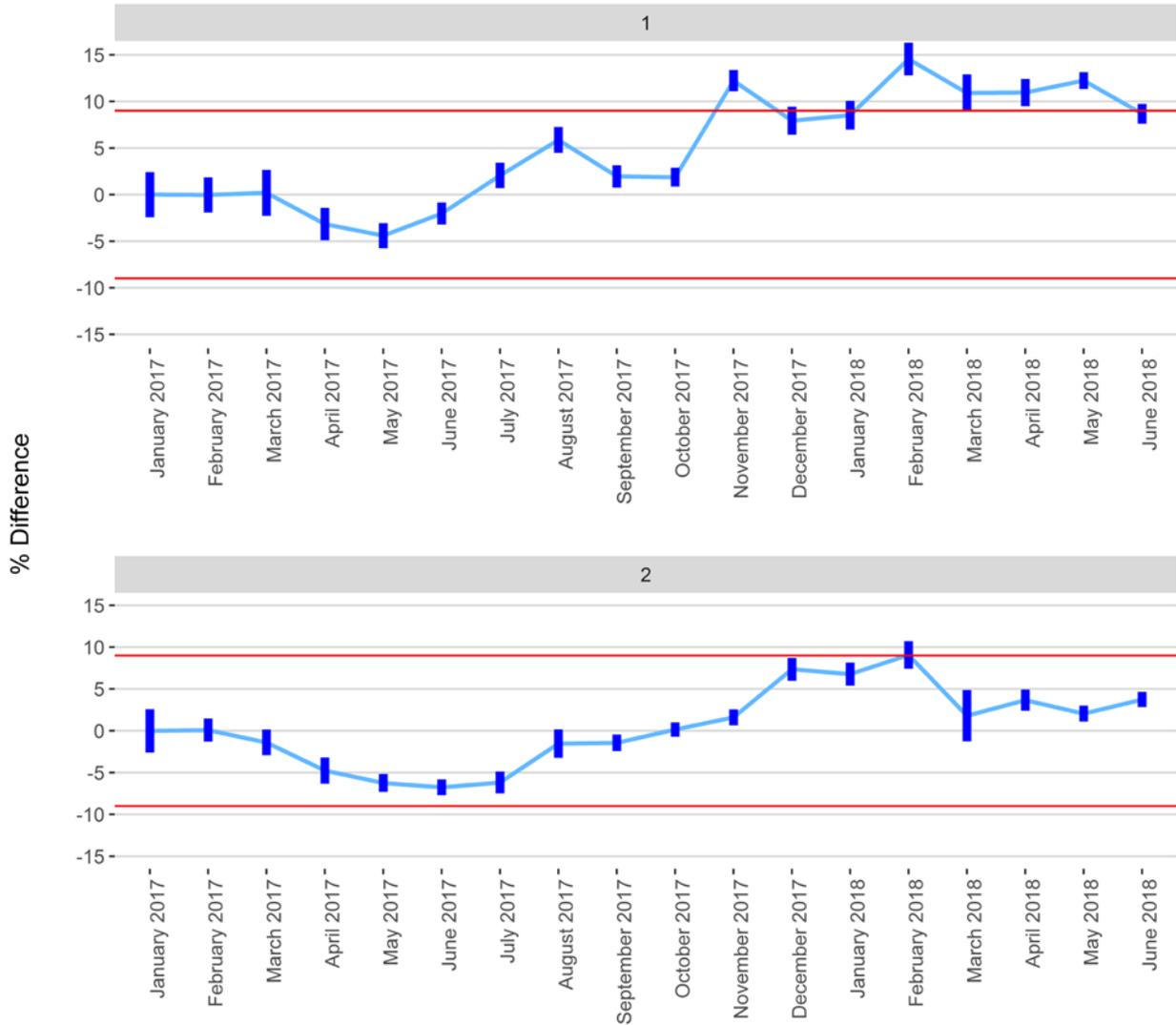
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

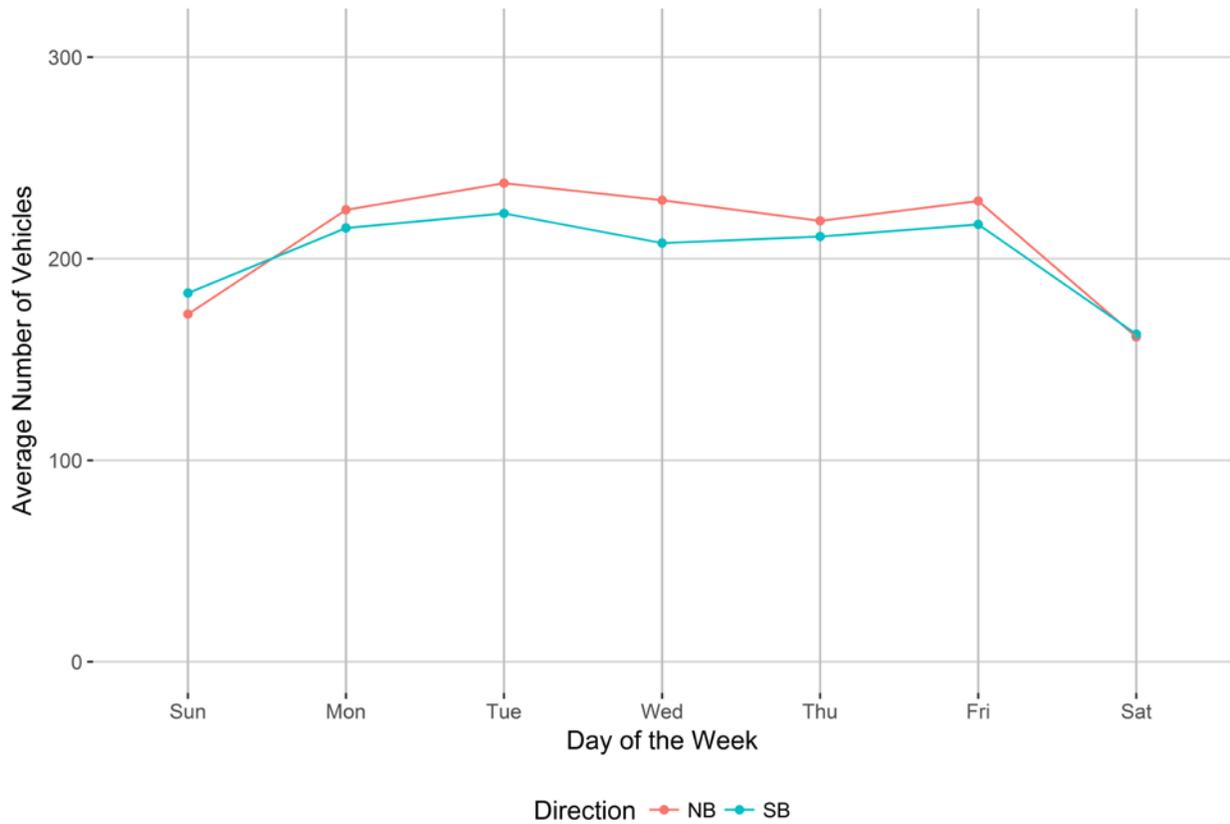


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

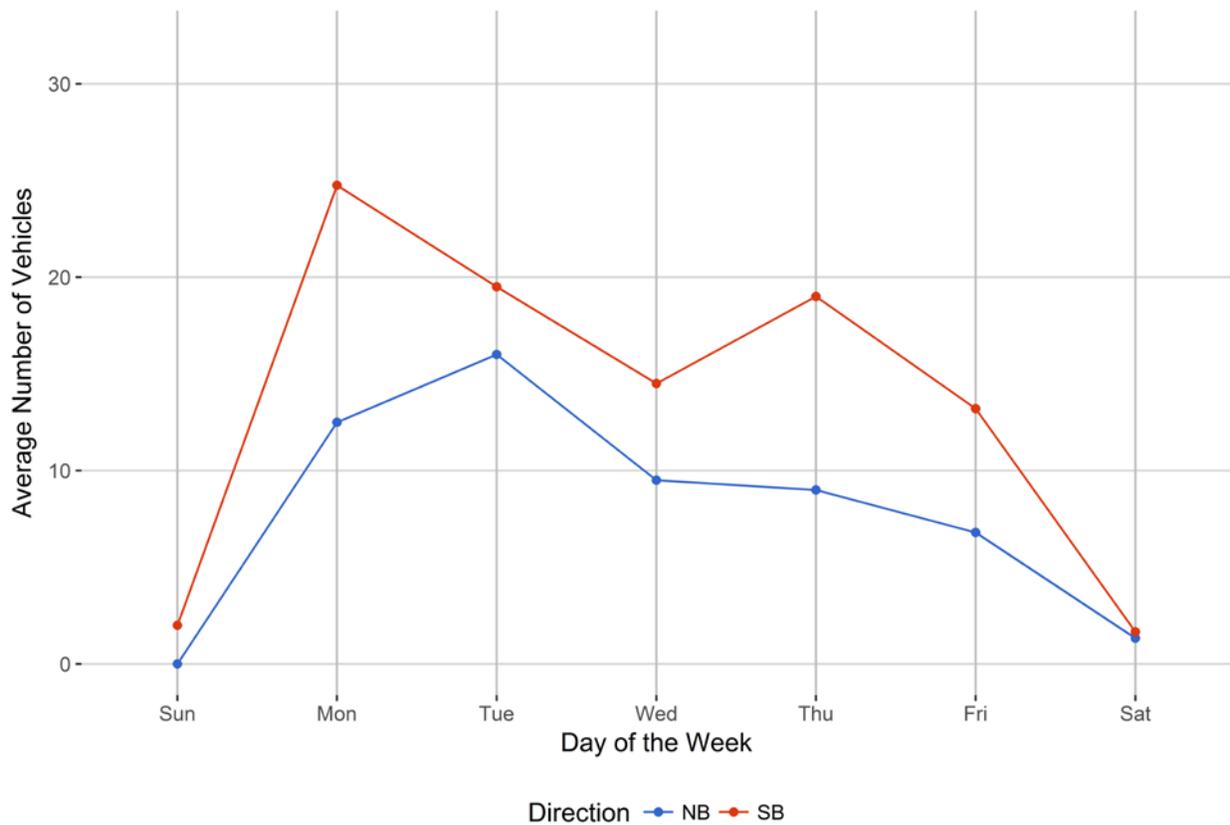


Figure 4 - Passenger Vehicles vs. Hour of the Day

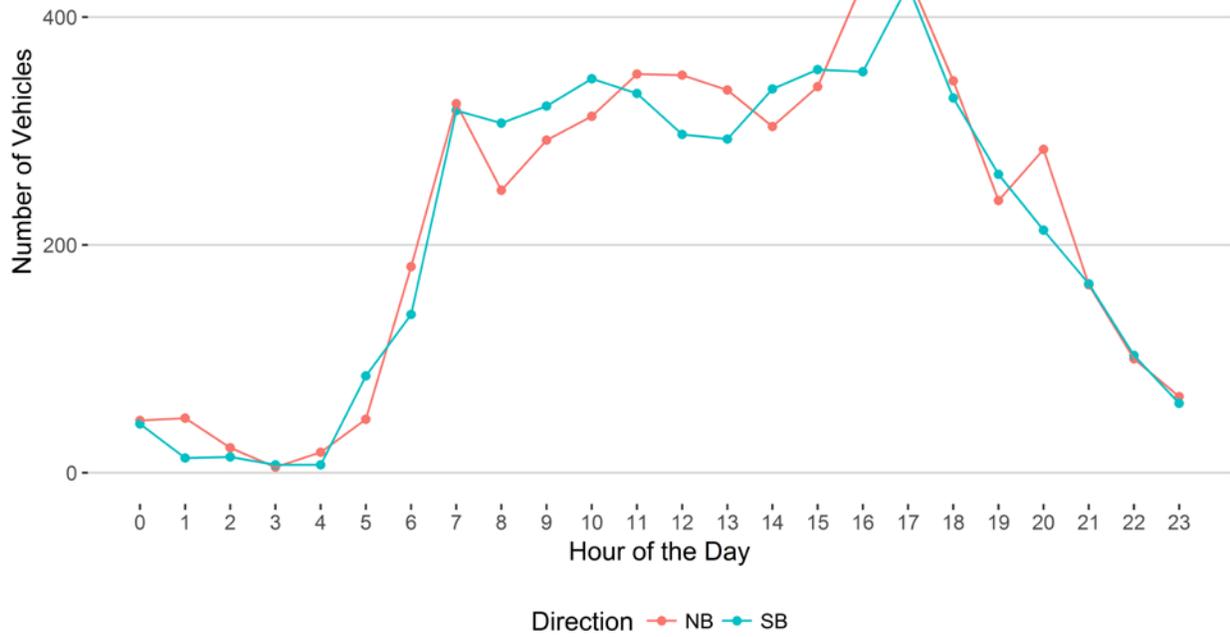


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

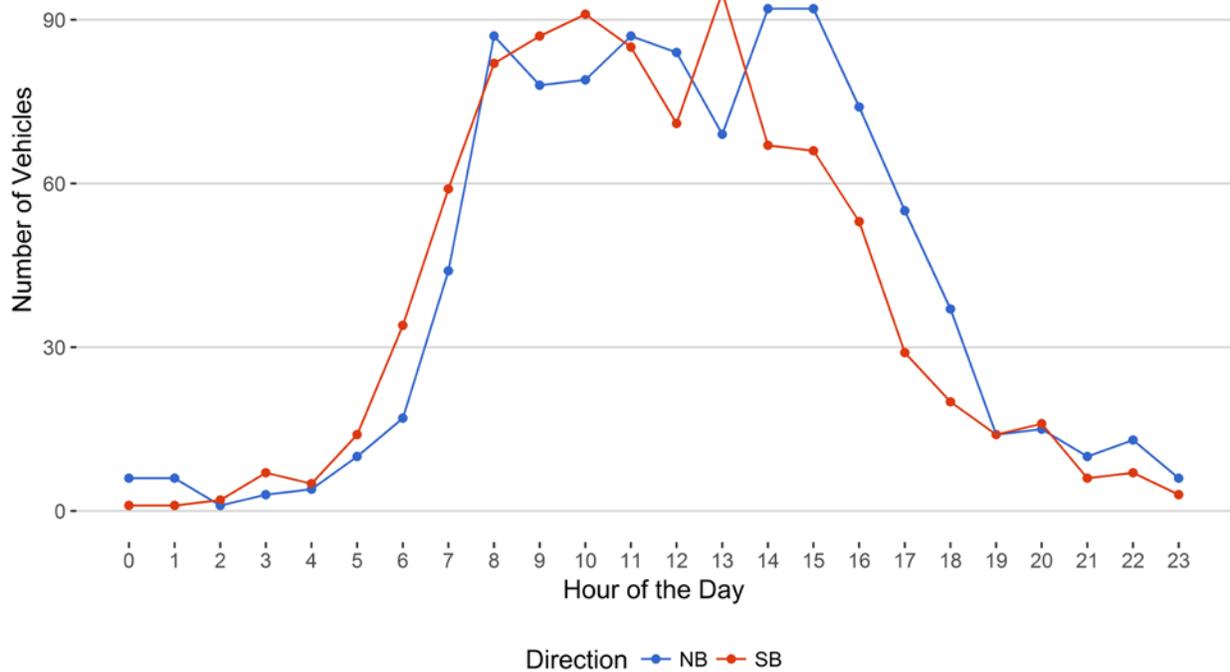


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

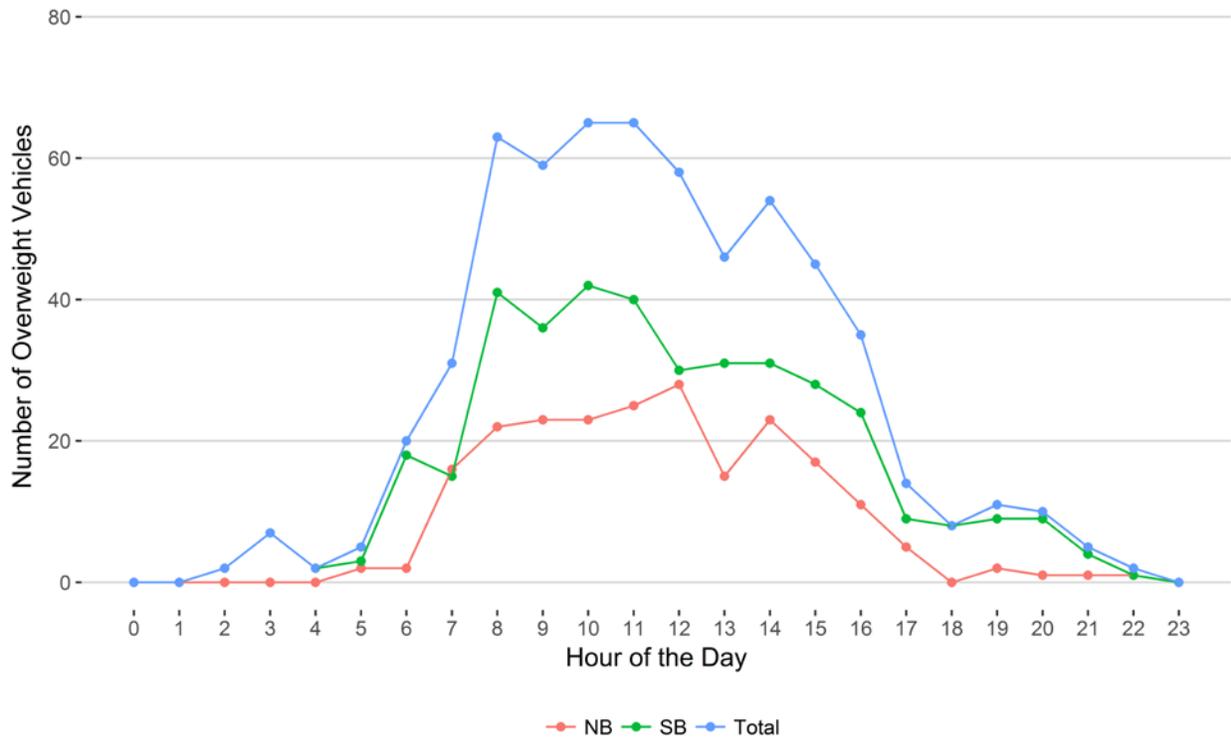
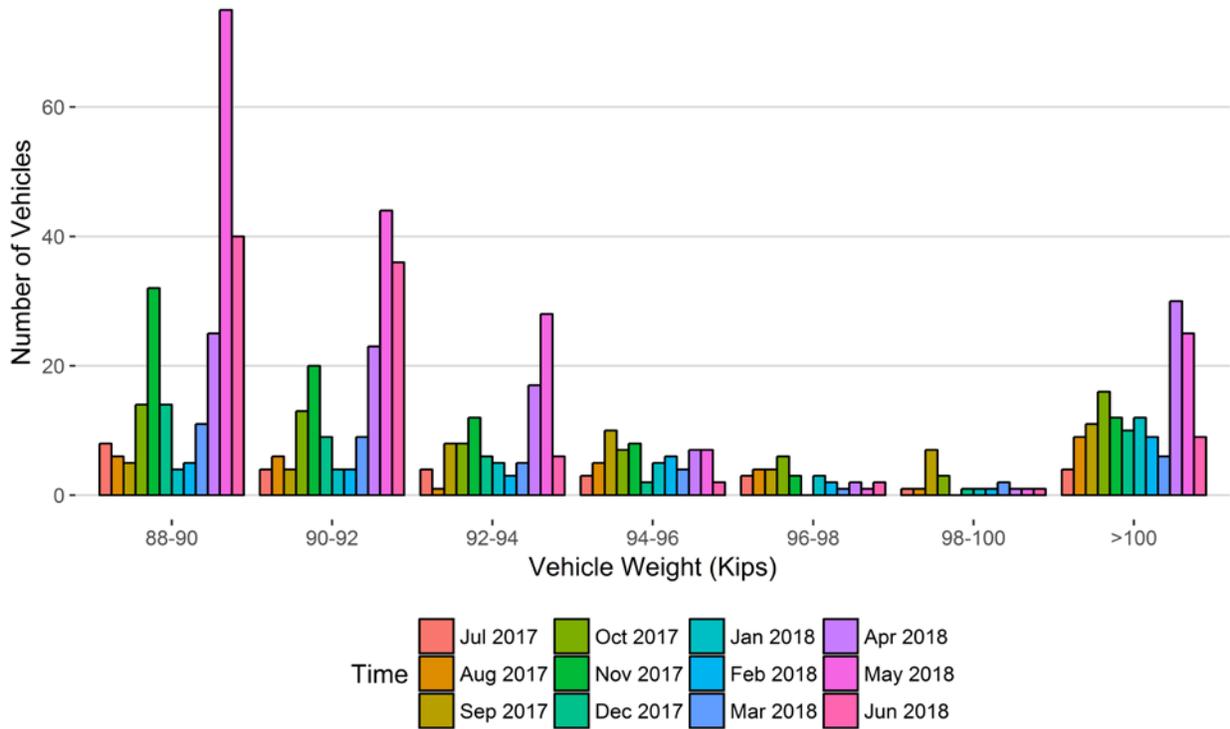
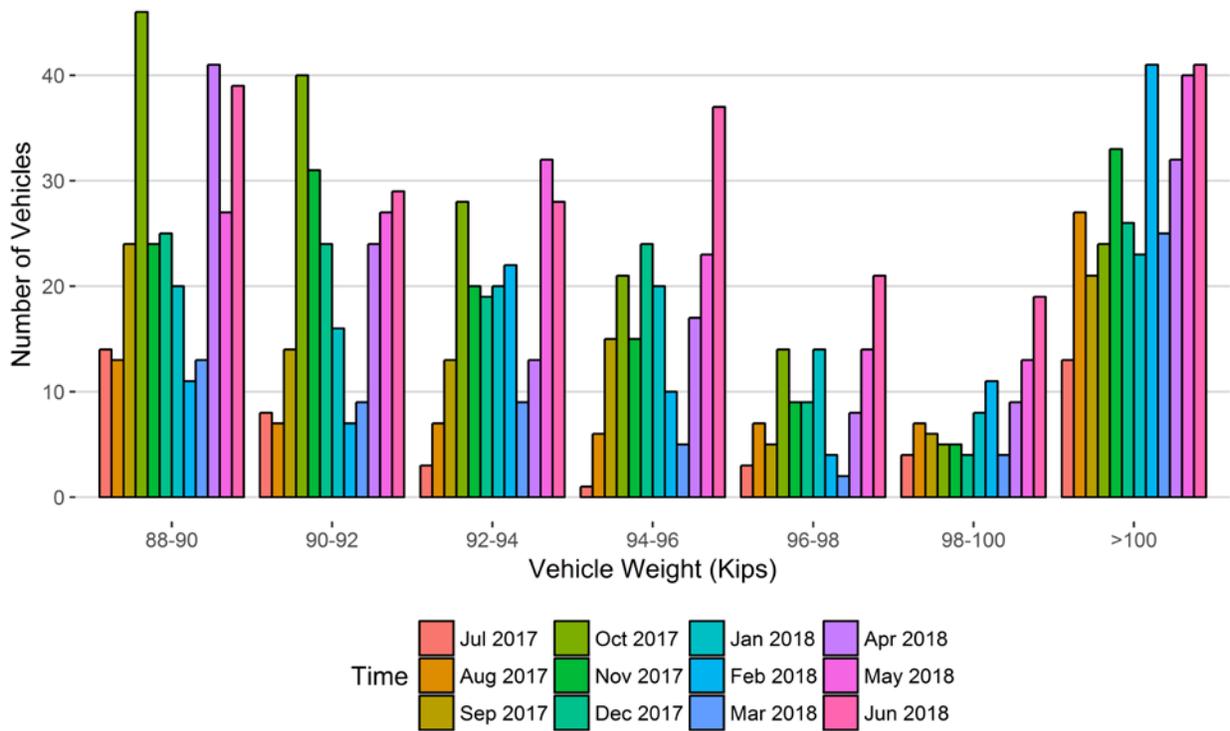


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018
88-90	8	6	5	14	32	14	4	5	11	25	75	40
90-92	4	6	4	13	20	9	4	4	9	23	44	36
92-94	4	1	8	8	12	6	5	3	5	17	28	6
94-96	3	5	10	7	8	2	5	6	4	7	7	2
96-98	3	4	4	6	3	0	3	2	1	2	1	2
98-100	1	1	7	3	0	1	1	1	2	1	1	1
>100	4	9	11	16	12	10	12	9	6	30	25	9
Total	27	32	49	67	87	42	34	30	38	105	181	96

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



Vehicle Weights (Kips)	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018
88-90	14	13	24	46	24	25	20	11	13	41	27	39
90-92	8	7	14	40	31	24	16	7	9	24	27	29
92-94	3	7	13	28	20	19	20	22	9	13	32	28
94-96	1	6	15	21	15	24	20	10	5	17	23	37
96-98	3	7	5	14	9	9	14	4	2	8	14	21
98-100	4	7	6	5	5	4	8	11	4	9	13	19
>100	13	27	21	24	33	26	23	41	25	32	40	41
Total	46	74	98	178	137	131	121	106	67	144	176	214

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

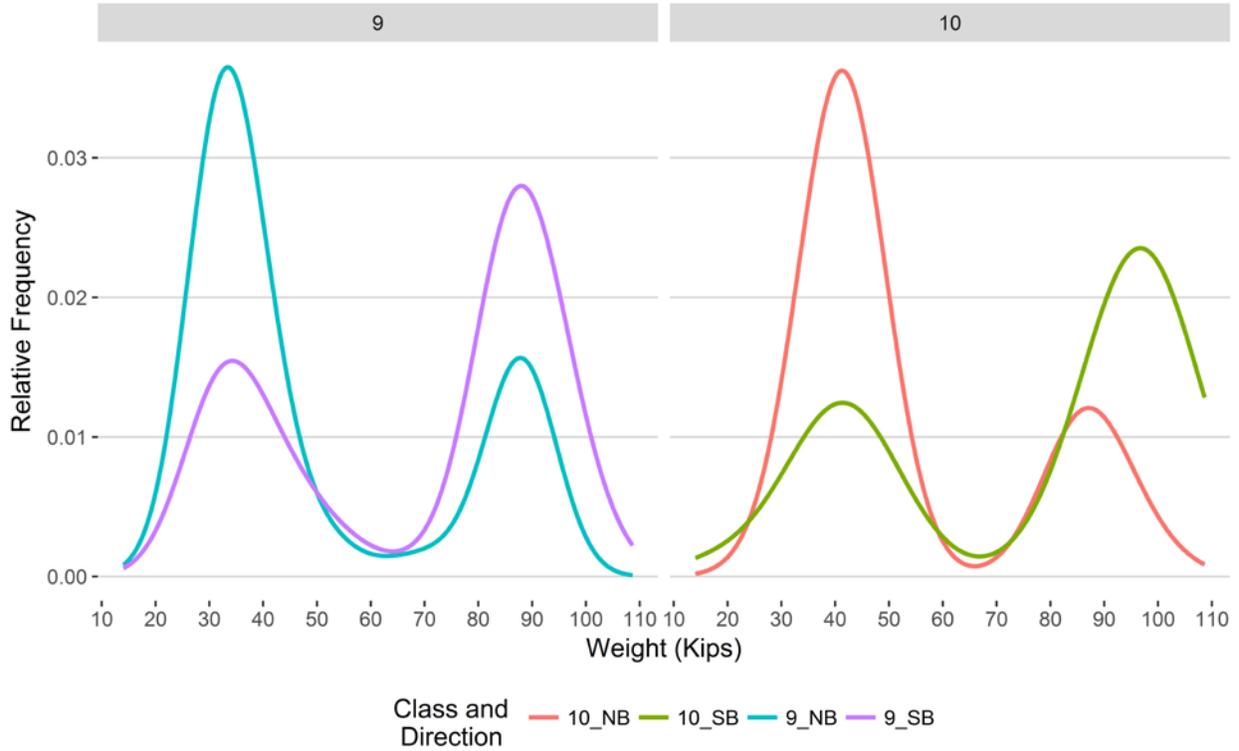


Figure 9 - Freight Percentage by Direction and Class

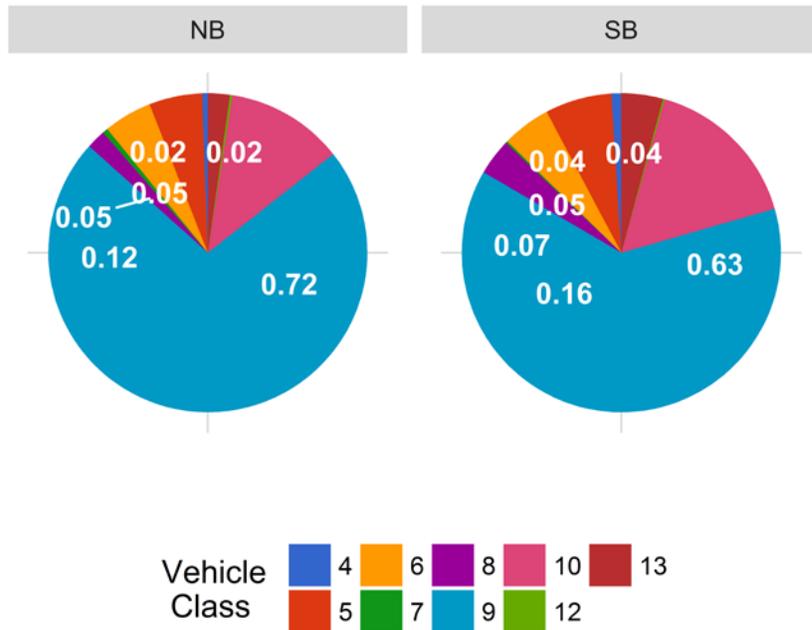


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

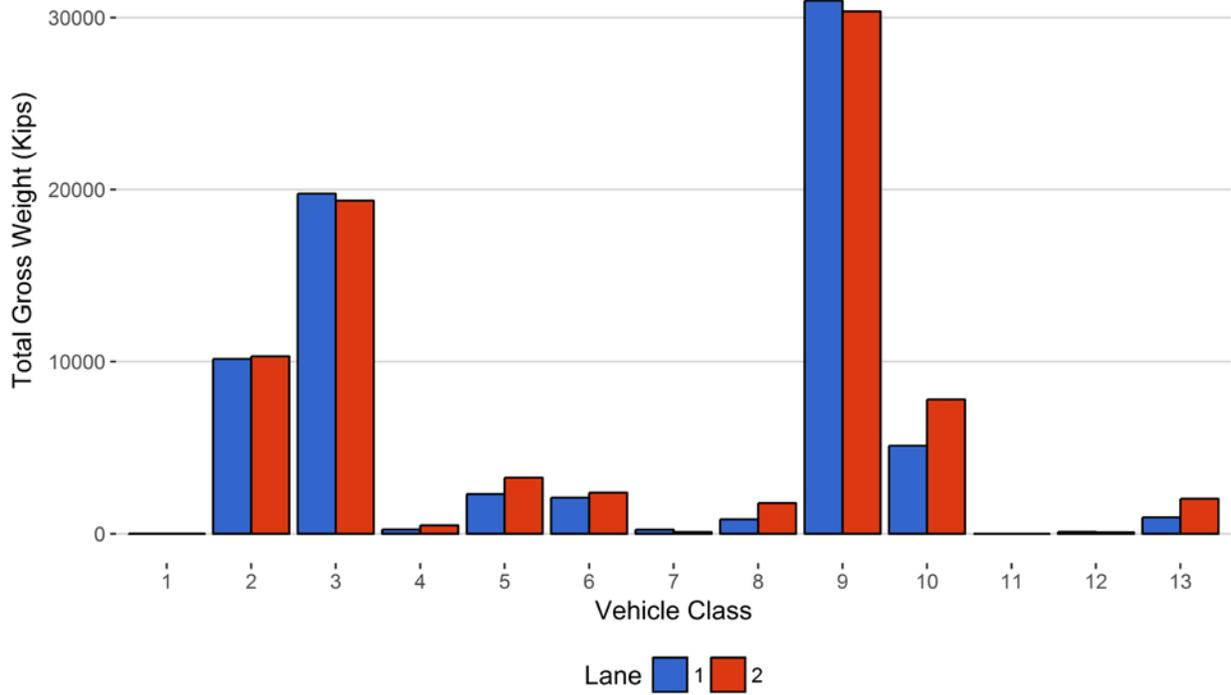


Figure 11 - Total Gross Vehicle Weight I

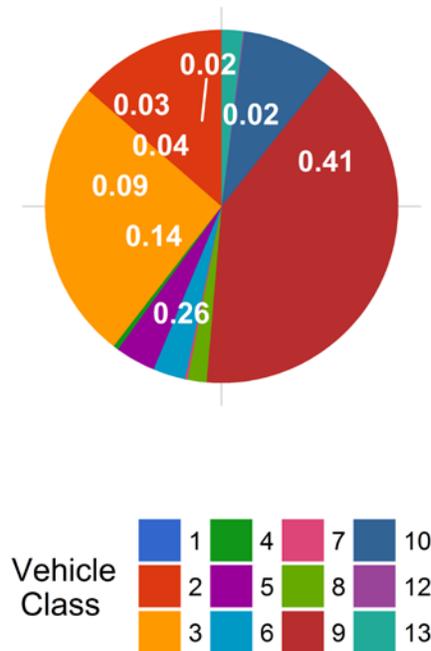


Figure 12 - Total ESALs by Class and Lane

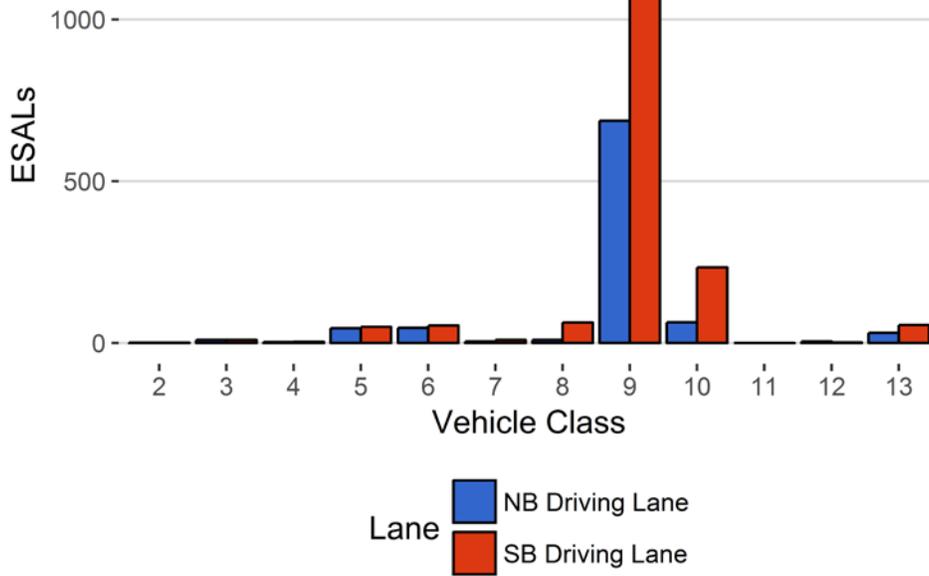


Figure 13 - ESALs by Class

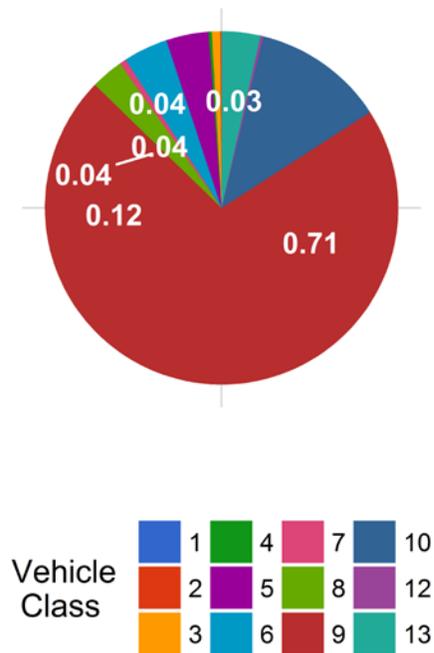


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
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

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	16	0.1	0	0
2	167	5019	38.5	0	0
3	200	5985	46	0	0
4	1	35	0.3	0	0
5	13	394	3	15	2.5
6	4	131	1	16	2.7
7	0	5	0	3	0.5
8	2	71	0.5	15	2.5
9	37	1125	8.6	431	71.7
10	7	209	1.6	91	15.1
11	0	0	0	0	0
12	0	2	0	2	0.3
13	1	30	0.2	28	4.7
TOTAL	434	13021	100	601	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>
2018-06-13	Wednesday	05:43:05	10	SB	2	111.52
2018-06-11	Monday	05:32:25	10	SB	2	110.22
2018-06-28	Thursday	18:03:09	10	SB	2	108.67
2018-06-22	Friday	03:39:03	10	SB	2	106.9
2018-06-01	Friday	03:43:50	10	SB	2	106.43
2018-06-07	Thursday	11:21:54	10	SB	2	106.31
2018-06-07	Thursday	17:04:54	10	SB	2	104.48
2018-06-11	Monday	11:04:22	10	SB	2	104.28
2018-06-18	Monday	11:08:57	9	SB	2	103.78
2018-06-18	Monday	19:52:43	10	SB	2	103.65

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	11	2	18.2	225	24	45
5	NB	8	150	4	2.7	2275	31	554
6	NB	19	59	2	3.4	2067	36	492
7	NB	11.5	4	0	0	238	0	96
8	NB	31	27	17	63	424	409	57
9	NB	33	626	184	29.4	25475	5508	5444
10	NB	33.5	96	2	2.1	5057	62	954
12	NB	36.5	1	0	0	102	0	33
13	NB	31.5	9	0	0	950	0	333
TOTAL	****	****	983	211	****	36812	****	8008
<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	22	3	13.6	441	41	78
5	SB	8	224	10	4.5	3193	72	740
6	SB	19	65	2	3.1	2346	36	575
7	SB	11.5	1	0	0	95	0	42
8	SB	31	40	9	22.5	1555	229	297
9	SB	33	441	62	14.1	28475	1883	7984
10	SB	33.5	102	3	2.9	7746	60	2215
12	SB	36.5	1	0	0	82	0	23
13	SB	31.5	19	0	0	2035	0	718
TOTAL	****	****	915	89	****	45967	****	12671
GRAND TOTAL	****	****	1898	300	180	82779	8391	20678

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	10	7	17	0
2	10160	10308	20468	13.6
3	19763	19362	39124	25.9
4	250	482	732	0.5
5	2306	3265	5571	3.7
6	2103	2383	4485	3
7	238	95	332	0.2
8	834	1784	2617	1.7
9	30982	30358	61340	40.7
10	5119	7805	12924	8.6
12	102	82	184	0.1
13	950	2035	2985	2
TOTAL	72815	77964	150779	100
GVW/LANE	48.29	51.71	100	0.07

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	0.0625
2	1	2	3	0.1	0.0017
3	10	10	19	0.8	0.0074
4	3	4	7	0.3	0.49
5	46	50	96	3.9	0.53
6	47	54	100	4.1	1.62
7	5	10	15	0.6	3.09
8	10	64	73	3	2.1
9	687	1071	1758	71.4	3.34
10	64	234	298	12.1	2.97
12	5	2	6	0.3	1.79
13	32	56	87	3.5	4.67
TOTAL	909	1554	2463	100	21
ESALS/LANE	36.9	63.1	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>
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
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
TOTAL	138608	--	--	119682	--	18926	--
AVERAGE	11551	379	52	9974	87	1577	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>
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
Apr 2018	724	1023	1747	55.4
May 2018	1396	1406	2801	50.4
Jun 2018	916	1578	2494	67.8
TOTAL	8680	--	--	--
AVERAGE	723	1092	1815	49

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Jul 2017	41930	48655	90585
Aug 2017	37098	43044	80142
Sep 2017	43050	42310	85360
Oct 2017	54740	56400	111139
Nov 2017	86626	80895	167521
Dec 2017	72965	78450	151415
Jan 2018	57644	58281	115925
Feb 2018	54657	54121	108778
Mar 2018	57117	68759	125876
Apr 2018	68560	88970	157531
May 2018	71826	70084	141910
Jun 2018	42975	50948	93923
TOTAL	689188	740917	1430104
AVERAGE	57432	61743	119175

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>
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
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
TOTAL	5279	--	--	2286	620
AVERAGE	439.9	4	28.5	190.5	51.7

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>
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
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
TOTAL	75089	111558	186647	--	--
AVERAGE	6257.5	9296.5	15553.9	39.8	60.2