JULY 2018

WIM #26
I-35, MP 30.1
OWATONNA, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #26 is located on I-35 near Owatonna in Steele county.

System Operation

WIM #26 was operational for the entire month of July 2018. Volume was computed using all monthly data.

System Calibration

WIM #26 was most recently calibrated on 2018-06-21. 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: 778261 | Passenger Vehicles: 625188 | Heavy Commercial Vehicles: 153073

Monthly Average Daily Traffic (MADT): 25105 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 4938

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 Sundays, with lowest volumes reported on Tuesdays. SB vehicles typically reached highest volume levels on Sundays, 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 02 PM and 04 PM. Similarly, SB PVs peaked in volume between 11 AM and 03 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 02 PM and 04 PM, while volume going SB peaked between 11 AM and 03 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 153073 HCVs, 25482 of them were overweight [3]. These overweight HCVs contributed to 3.4% of total monthly volume, and 17.1% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Saturdays. SB overweight vehicles tended to reach highest volumes on Thursdays, with lowest volumes reported on Sundays. 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 73.7% 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 [4].
Using normal load limits ,609 NB vehicles exceeded 88,000 pounds (325 vehicles were Class 9's; 165 vehicles were Class 10's). Of vehicles traveling SB,

214 NB vehicles exceeded 88,000 pounds (96 vehicles were Class 13's; 74 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 fully_loaded Class 9's than empty Class 9's traveling NB, while there were more fully_loaded Class 9's than empty 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 1694439 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (55.7%) than SB (44.3%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 91086 (a box culvert) is approximately 0.5 miles north of WIM #26, and Bridge No. 91095 (also a box culvert) is 6.9 miles south of WIM #26. WIM #26 recorded a total of 778261 vehicles with a combined GVW of 10795661 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 156145 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 58.2% of all ESALs were recorded NB while 41.8% was observed SB. In particular, 81% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 58% 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

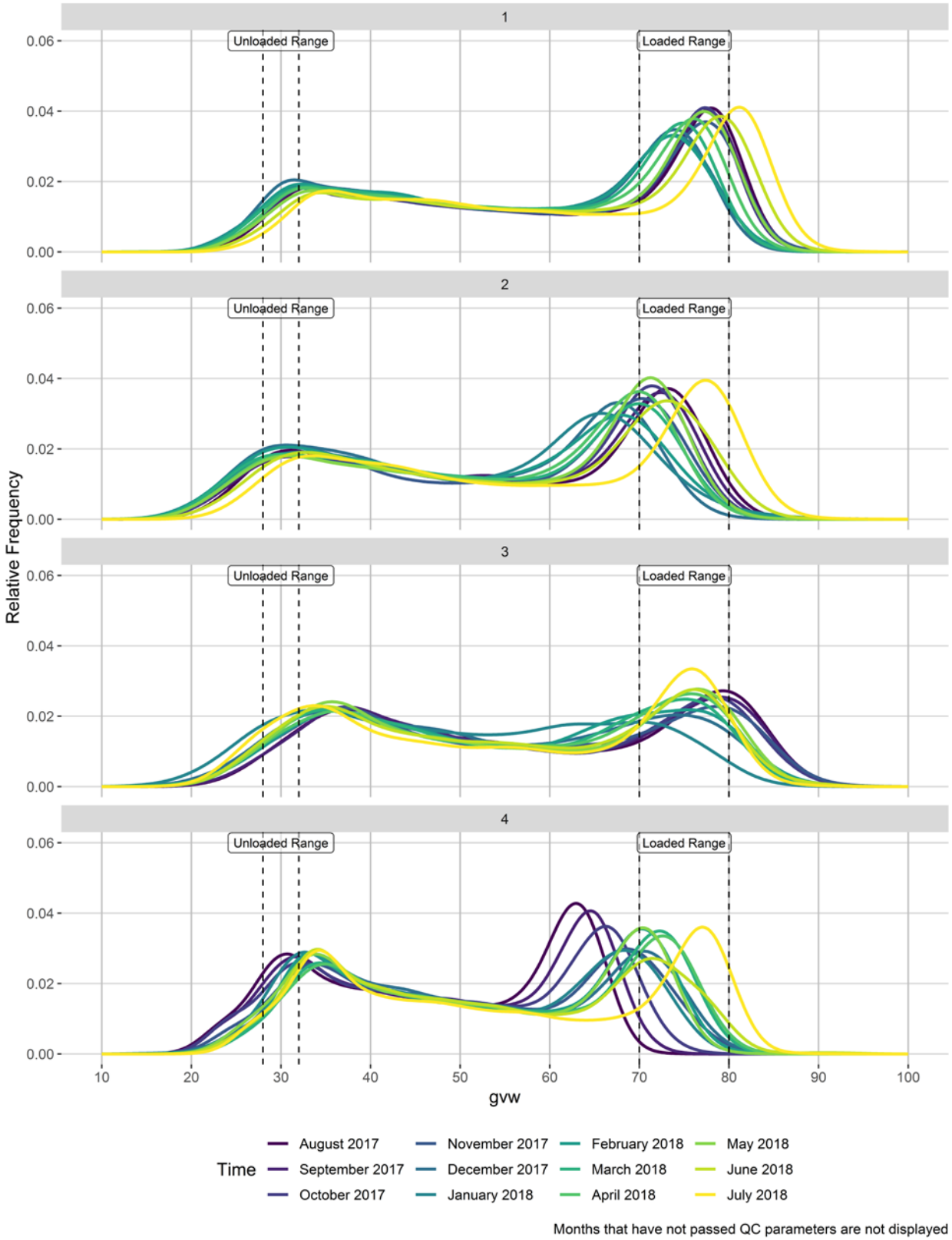
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [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

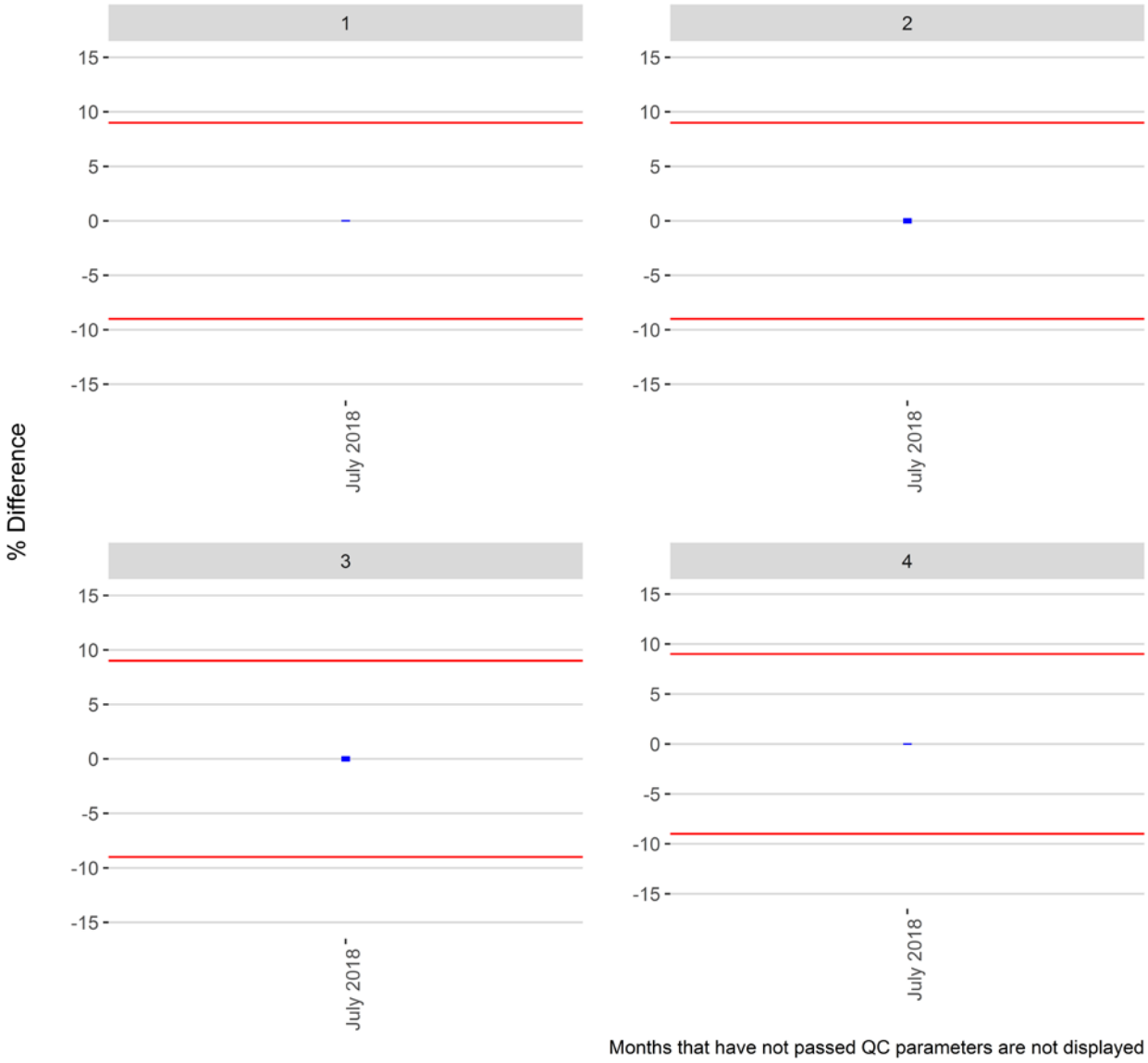
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

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

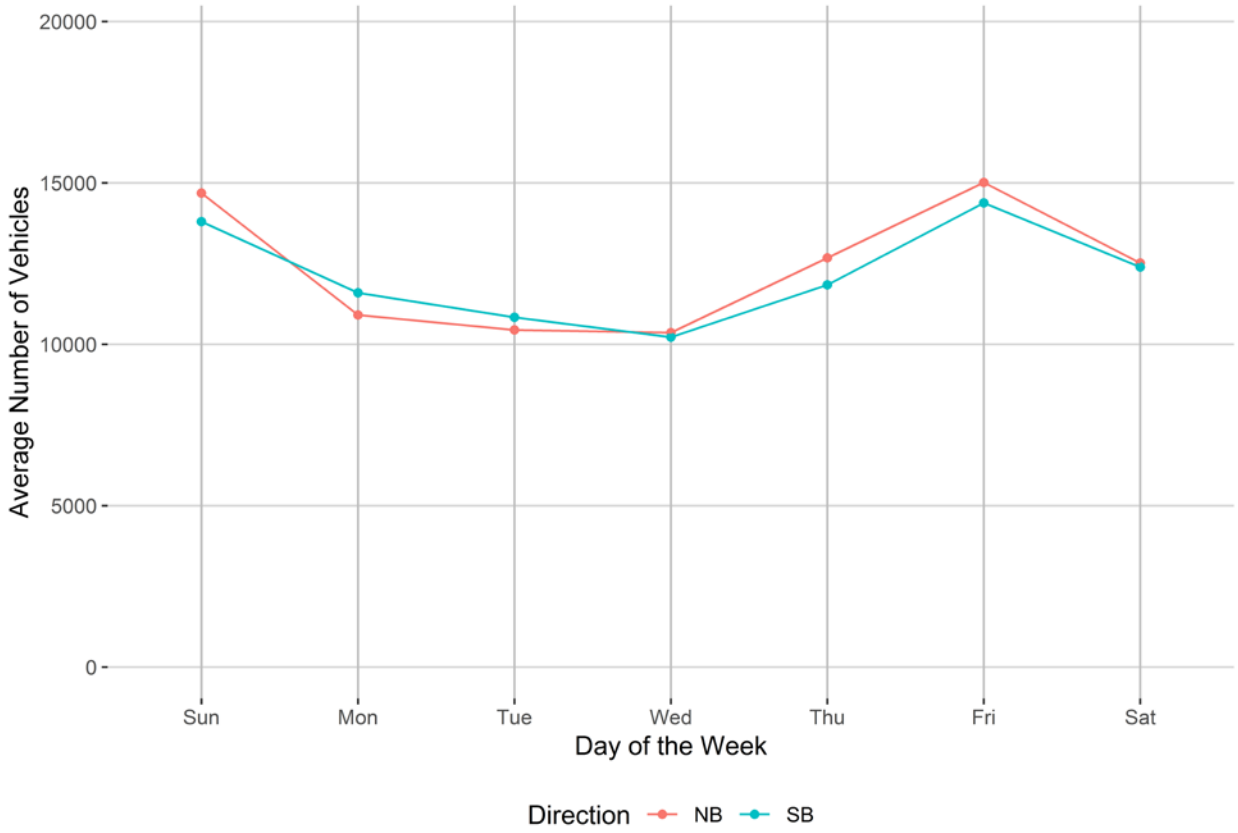


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

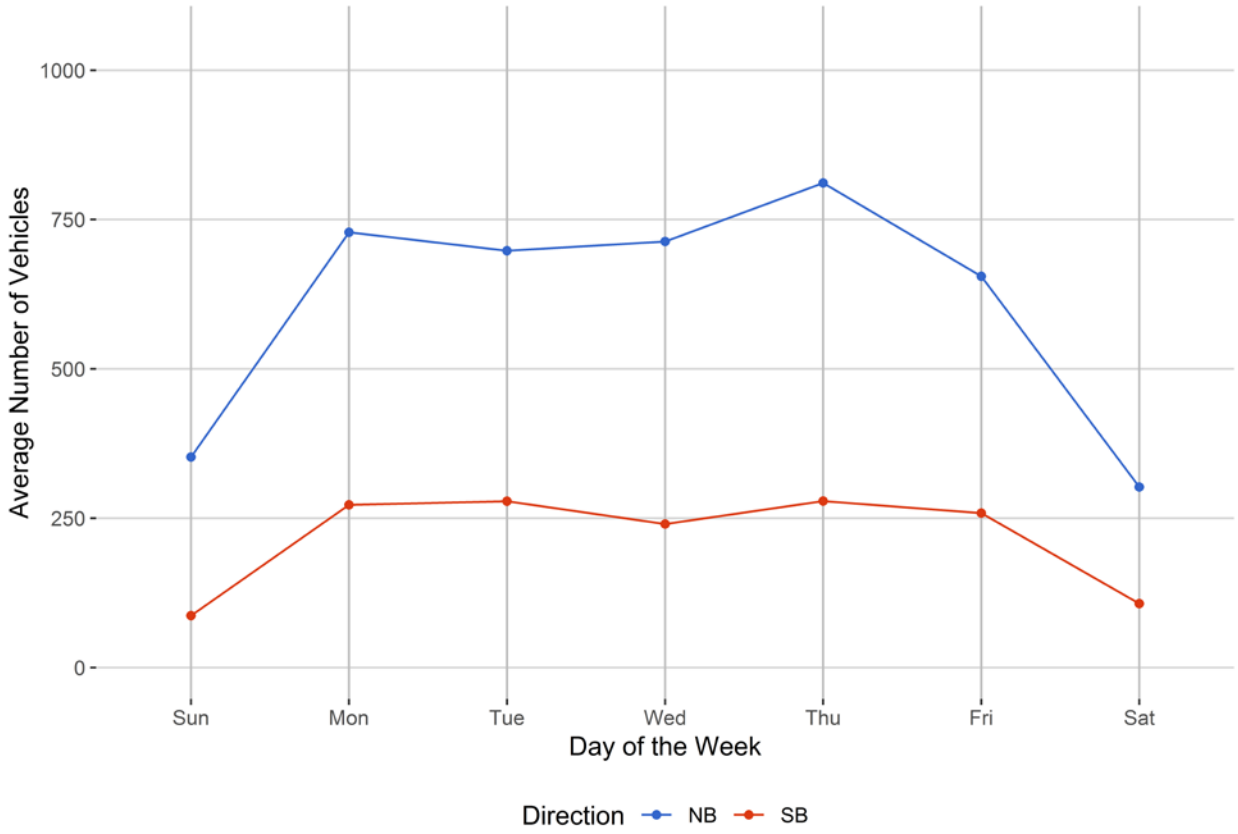


Figure 4 - Passenger Vehicles vs. Hour of the Day

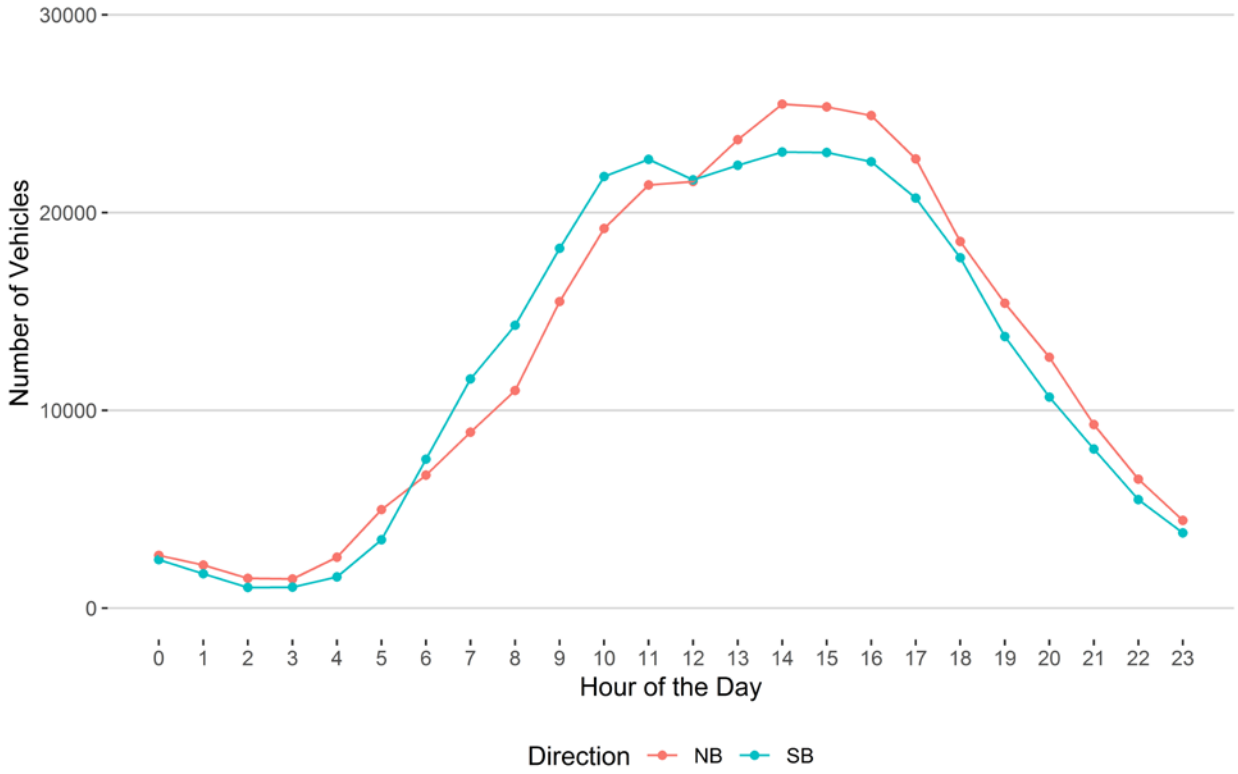


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

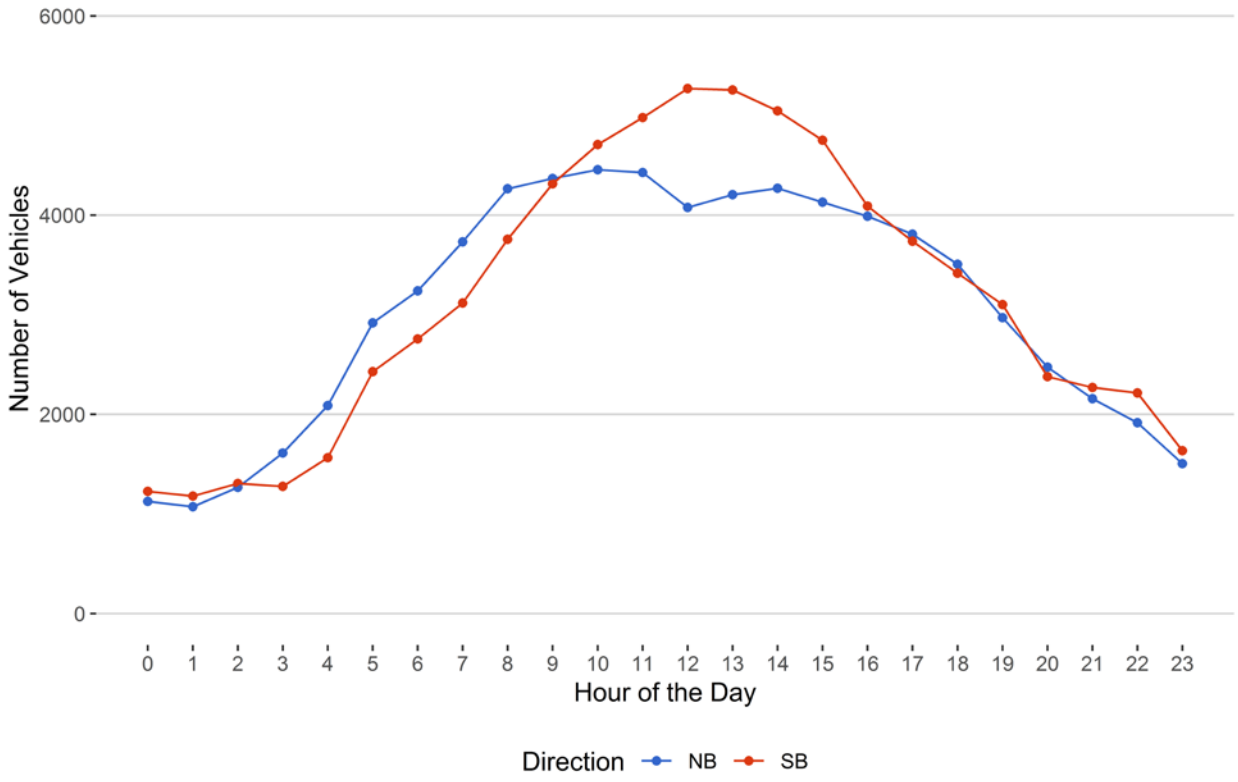


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

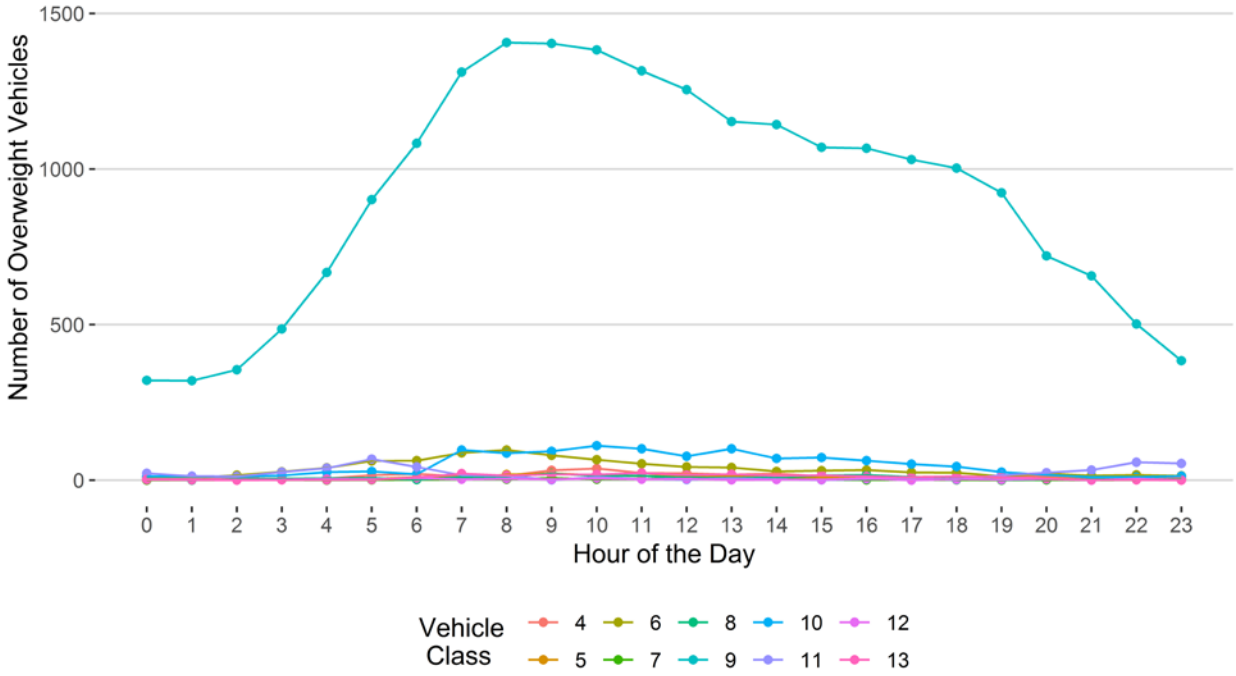


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

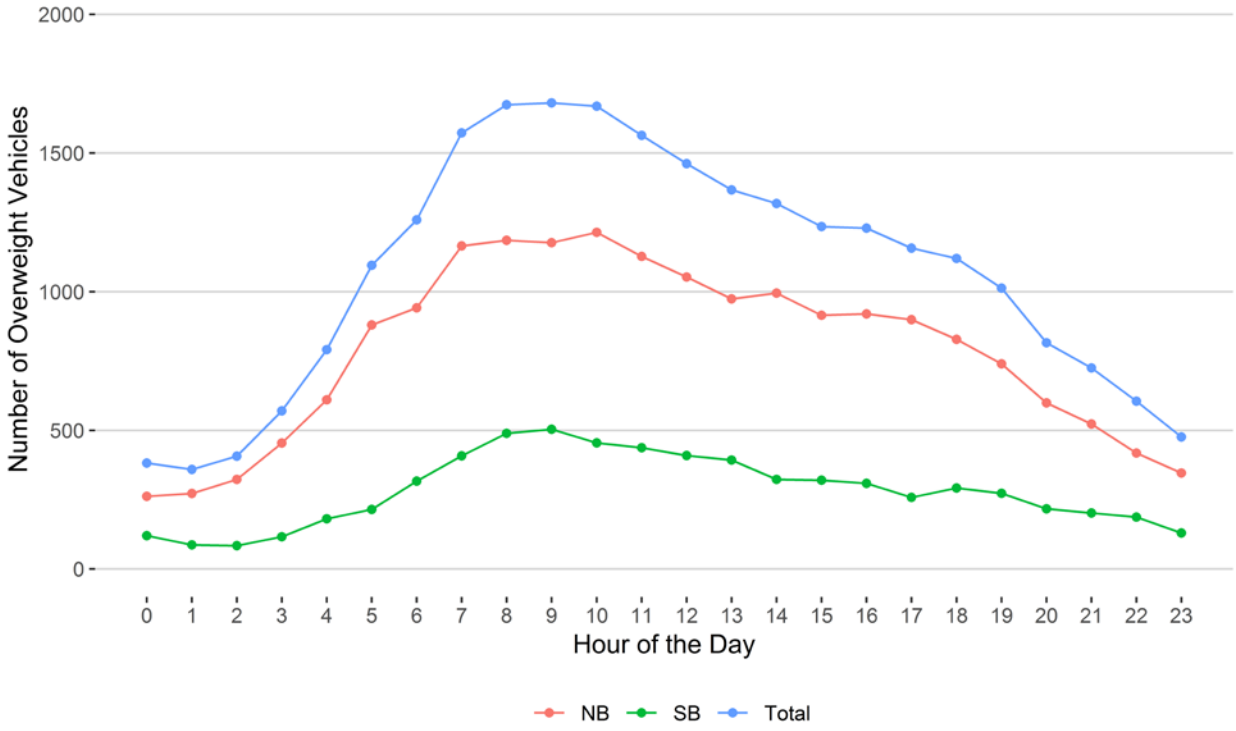
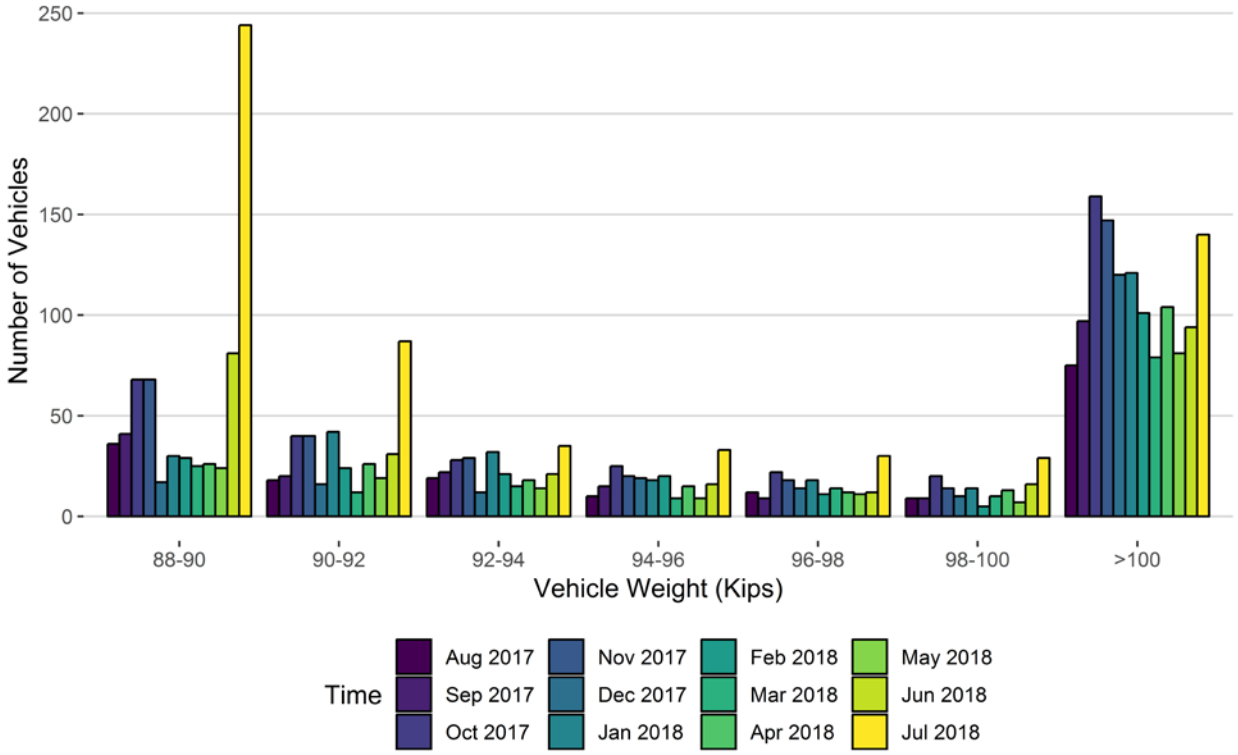
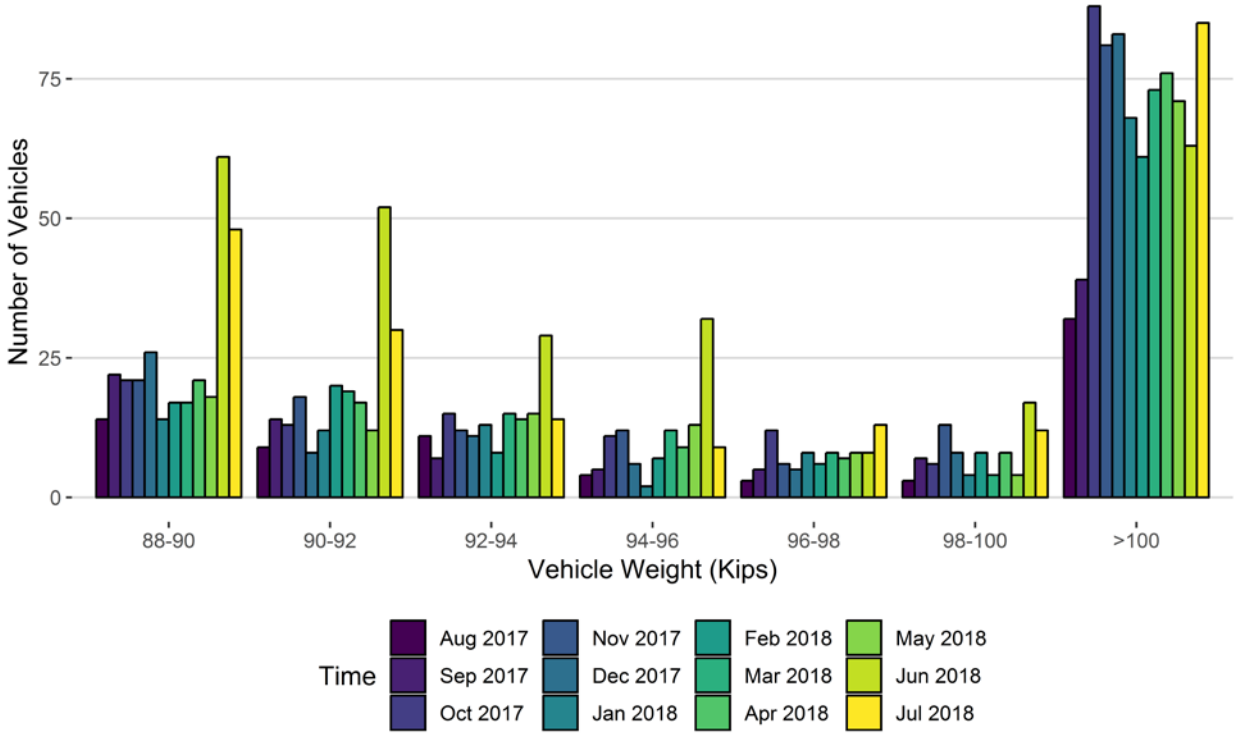


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



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	36	41	68	68	17	30	29	25	26	24	81	244
90-92	18	20	40	40	16	42	24	12	26	19	31	87
92-94	19	22	28	29	12	32	21	15	18	14	21	35
94-96	10	15	25	20	19	18	20	9	15	9	16	33
96-98	12	9	22	18	14	18	11	14	12	11	12	30
98-100	9	9	20	14	10	14	5	10	13	7	16	29
>100	75	97	159	147	120	121	101	79	104	81	94	140
Total	179	213	362	336	208	275	211	164	214	165	271	598

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	14	22	21	21	26	14	17	17	21	18	61	48
90-92	9	14	13	18	8	12	20	19	17	12	52	30
92-94	11	7	15	12	11	13	8	15	14	15	29	14
94-96	4	5	11	12	6	2	7	12	9	13	32	9
96-98	3	5	12	6	5	8	6	8	7	8	8	13
98-100	3	7	6	13	8	4	8	4	8	4	17	12
>100	32	39	88	81	83	68	61	73	76	71	63	85
Total	76	99	166	163	147	121	127	148	152	141	262	211

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

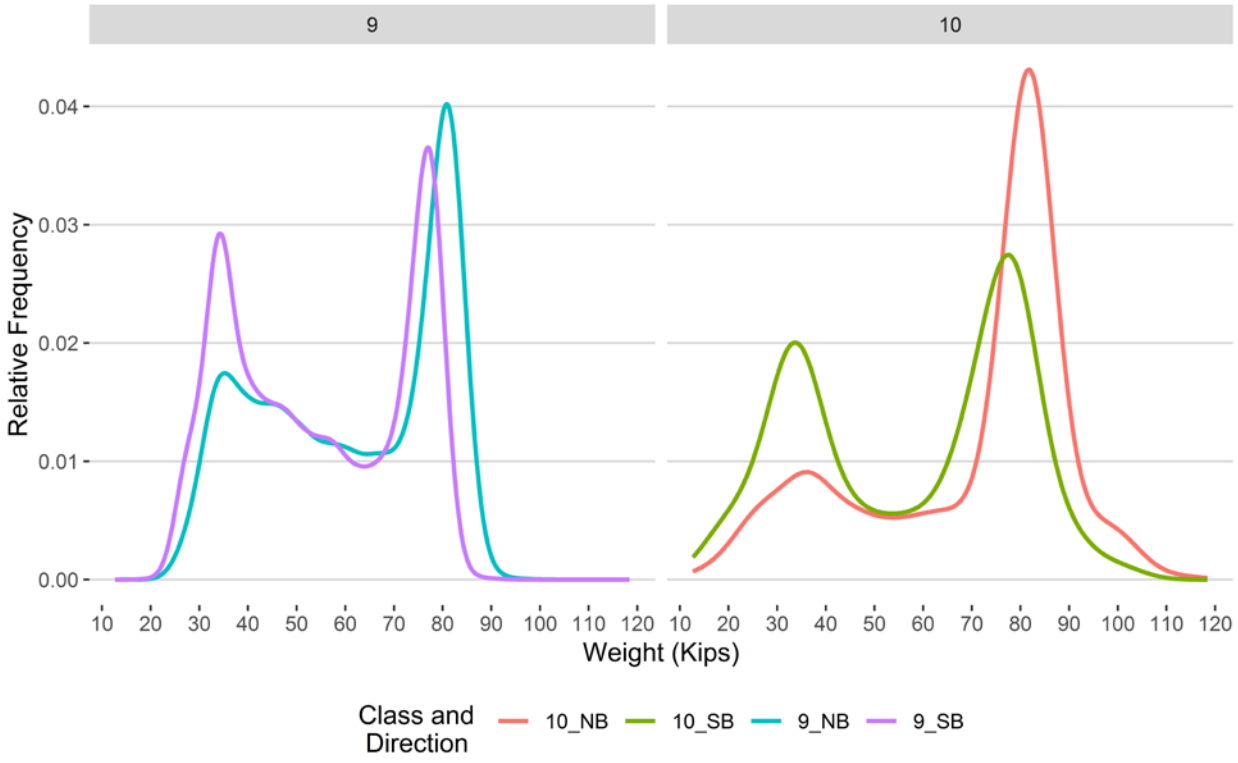


Figure 9 - Freight Percentage by Direction and Class

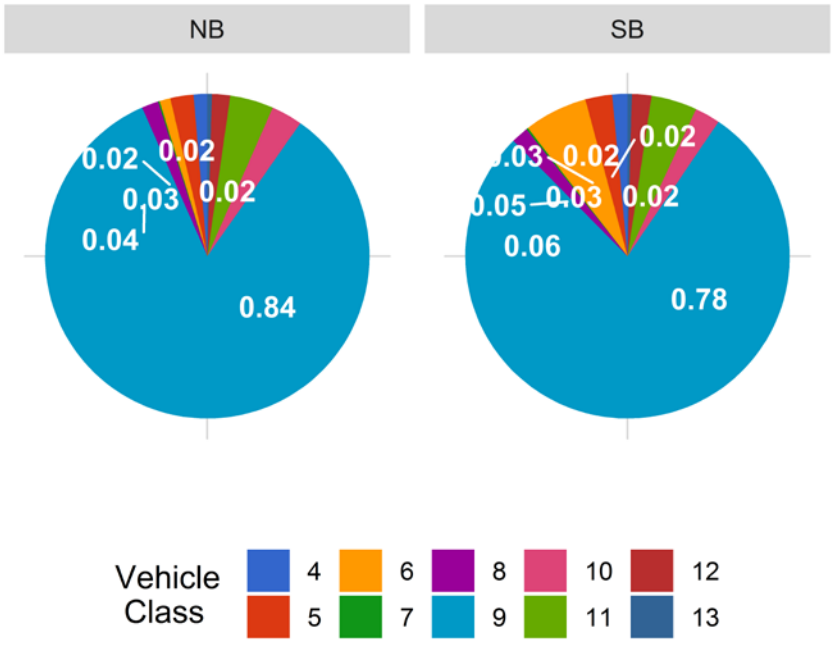


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

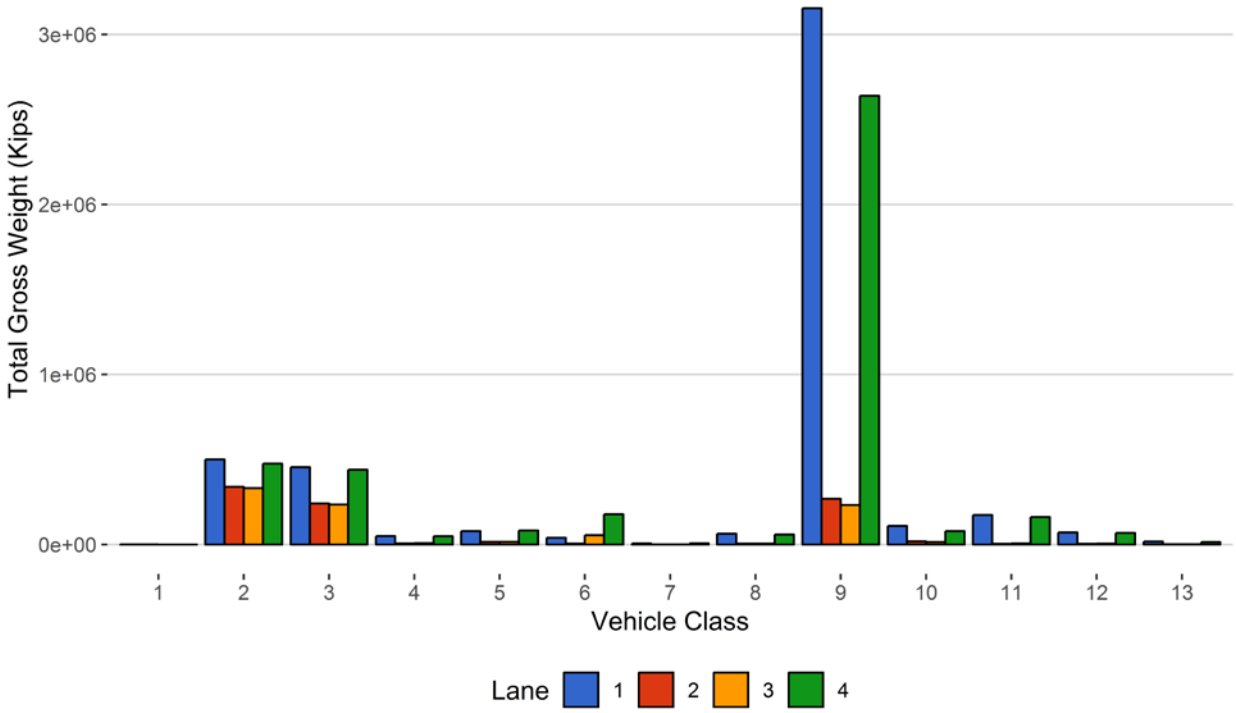


Figure 11 - Total Gross Vehicle Weight b

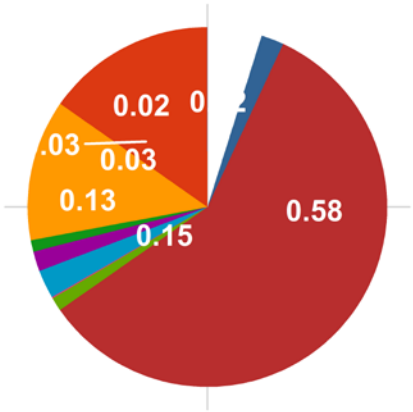


Figure 12 - Total ESALs by Class and Lane

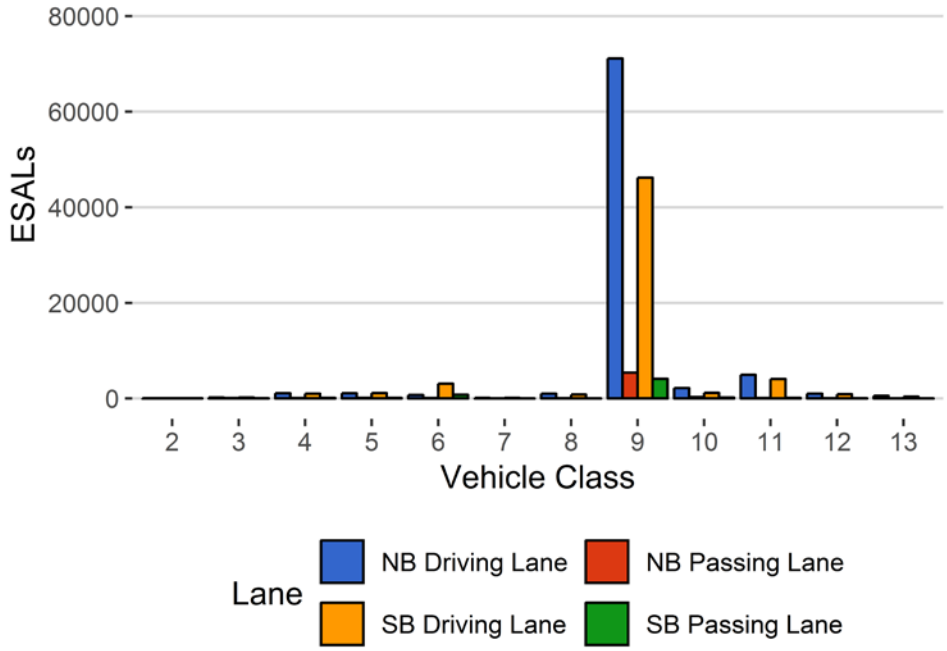


Figure 13 - ESALs by Class

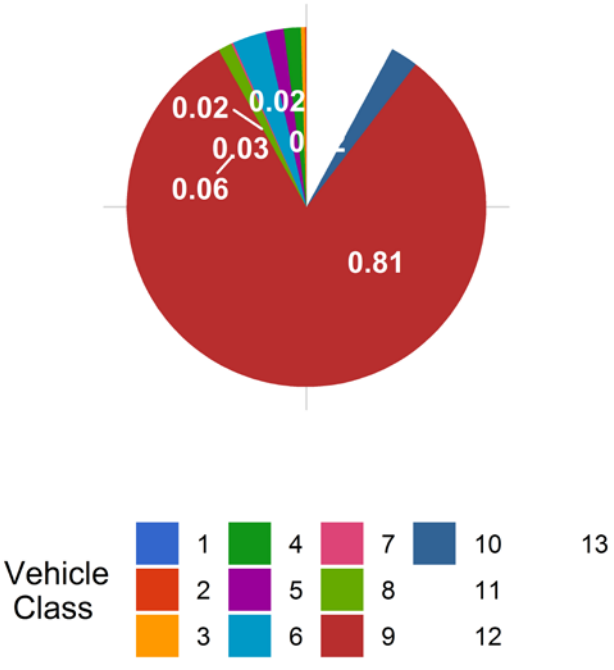


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*	*Lane 3 (Kips)*	*Front Axle +/- 9%*	*Lane 4 (kips)*	*Front Axle +/- 9%*
July 2018	11.67	0	11.3	0	11.46	0	11.42	0

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
1	7	222	0	0	0
2	13378	414733	53.3	0	0
3	6782	210232	27	0	0
4	125	3890	0.5	324	1.3
5	423	13100	1.7	198	0.8
6	294	9125	1.2	913	3.6
7	10	295	0	51	0.2
8	136	4202	0.5	186	0.7
9	3564	110470	14.2	21867	85.8
10	113	3503	0.5	1168	4.6
11	185	5744	0.7	475	1.9
12	77	2383	0.3	74	0.3
13	12	361	0	226	0.9
TOTAL	**25105**	**778261**	**100**	**25482**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2018-07-28	Saturday	15:30:44	10	NB	2	118.41
2018-07-08	Sunday	09:13:53	10	NB	1	114.12
2018-07-28	Saturday	06:47:22	10	NB	1	112.86
2018-07-13	Friday	09:15:35	10	NB	1	112.55
2018-07-12	Thursday	02:53:10	10	NB	1	110.6
2018-07-18	Wednesday	19:43:16	10	NB	1	110.08
2018-07-09	Monday	18:15:04	10	NB	1	108.05
2018-07-27	Friday	12:41:02	10	SB	4	106.76
2018-07-13	Friday	12:44:12	10	NB	1	106.35
2018-07-26	Thursday	08:37:04	10	NB	1	105.6

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	NB	15	1905	151	7.9	53866	1982	13778
5	NB	8	6294	491	7.8	90667	3541	22121
6	NB	19	1536	284	18.5	39436	5025	7824
7	NB	11.5	137	1	0.7	6212	11	2324
8	NB	31	2108	929	44.1	47678	20809	5564
9	NB	33	55608	3739	6.7	3310168	112866	799246
10	NB	33.5	1822	164	9	122959	4303	33708
11	NB	36.5	2812	75	2.7	175534	1999	37817
12	NB	36.5	1180	14	1.2	73933	329	15687
13	NB	31.5	189	0	0	18654	0	6350
TOTAL	****	****	**73591**	**5848**	****	**3939106**	****	**944419**
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	SB	15	1891	168	8.9	53719	2230	13937
5	SB	8	6491	538	8.3	94026	3898	23201
6	SB	19	7369	322	4.4	227117	5752	46612
7	SB	11.5	151	0	0	7010	0	2637
8	SB	31	1993	953	47.8	41148	21583	4454
9	SB	33	52203	6487	12.4	2678187	192151	584779
10	SB	33.5	1597	327	20.5	83762	8958	20608
11	SB	36.5	2794	100	3.6	164956	3023	33312
12	SB	36.5	1146	11	1	71685	246	15129
13	SB	31.5	163	1	0.6	15805	26	5351
TOTAL	****	****	**75798**	**8907**	****	**3437414**	****	**750020**
GRAND TOTAL	****	****	**149389**	**14755**	**206**	**7376520**	**388735**	**1694439**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*NB Driving Lane*	*NB Passing Lane*	*SB Passing Lane*	*SB Driving Lane*	*Total*	*Percentage*
1	151	97	17	45	309	0
2	499977	338190	331654	475742	1645563	15.3
3	454581	240867	234640	439244	1369333	12.7
4	49455	6393	7724	48225	111798	1
5	79023	15184	15363	82561	192131	1.8
6	39478	4984	55146	177723	277331	2.6
7	5651	571	377	6633	13233	0.1
8	63396	5091	4678	58052	131218	1.2
9	3154412	268622	231757	2638581	6293373	58.4
10	108944	18317	14227	78493	219981	2
11	173118	4414	6409	161570	345512	3.2
12	70313	3949	4765	67167	146193	1.4
13	17238	1416	1227	14605	34486	0.3
TOTAL	**4715739**	**908096**	**907984**	**4248640**	**10780459**	**100**
GVW/LANE	**43.74**	**8.42**	**8.42**	**39.41**	**100**	**0**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*NB Driving Lane*	*NB Passing Lane*	*SB Passing Lane*	*SB Driving Lane*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0	0	0.0046
2	62	40	41	56	199	0.13	0.001
3	220	81	77	203	582	0.37	0.0057
4	1101	108	151	1027	2386	1.53	1.26
5	1113	133	138	1134	2517	1.62	0.39
6	730	87	783	3122	4722	3.03	1.06
7	130	13	8	156	307	0.2	2.11
8	1008	52	37	823	1920	1.23	0.94
9	71123	5422	4138	46209	126892	81.48	2.35
10	2193	306	204	1168	3871	2.49	2.26
11	4961	111	138	4100	9310	5.98	3.32
12	1026	56	70	884	2037	1.31	1.75
13	564	25	25	373	988	0.63	5.45
TOTAL	**84231**	**6435**	**5812**	**59256**	**155733**	**100**	**21**
ESALS/LANE	**54.1**	**4.1**	**3.7**	**38**	**100**	**–**	**–**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*	*Heavy Commercial Vehicles in Driving Lane %*	*Heavy Commercial Vehicles in Passing Lane %*
Aug 2017	757566	24438	4575	615745	81.3	141821.5	18.7	92	8
Sep 2017	664495	22150	4449	531039	79.9	133456.3	20.1	92.4	7.6
Oct 2017	667623	21536	4620	524413	78.5	143210	21.5	92.4	7.6
Nov 2017	630878	21029	4385	499321	79.1	131556.6	20.9	92.9	7.1
Dec 2017	598759	19315	3752	482443	80.6	116315.6	19.4	91.9	8.1
Jan 2018	498163	16070	3966	375222	75.3	122941	24.7	88.4	11.6
Feb 2018	464482	16589	4150	348276	75	116206.3	25	92	8
Mar 2018	610968	19709	4160	482021	78.9	128946.7	21.1	93.1	6.9
Apr 2018	580205	19340	4325	450468	77.6	129736.9	22.4	91.8	8.2
May 2018	719401	23206	4783	571124	79.4	148276.5	20.6	91.1	8.9
Jun 2018	747544	24918	4473	613365	82.1	134179	17.9	90.9	9.1
Jul 2018	778261	25105	4938	625188	80.3	153073.3	19.7	90	10
TOTAL	**7718345**	**–**	**–**	**6118625**	**–**	**1599720**	**–**	**–**	**–**
AVERAGE	**643195**	**21117**	**4381**	**509885**	**79**	**133310**	**21**	**92**	**8**

ESALs

Month	*ESALS NB Passing Lane*	*ESALS NB Driving Lane*	*ESALS SB Driving Lane*	*ESALS SB Passing Lane*	*Total ESALS*	*Driving Lane ESALS %*	*Passing Lane ESALS %*	*Pavement Life Decrease Months*
Aug 2017	69080	3469	6450	25712	104710	91	9	1.1
Sep 2017	61593	3080	5710	28145	98528	91	9	1.3
Oct 2017	66601	3451	5521	34297	109870	92	8	2.1
Nov 2017	60237	2750	4767	39203	106958	93	7	2.4
Dec 2017	151523	2537	4138	37192	195390	97	3	1.5
Jan 2018	46740	3145	5747	31738	87370	90	10	2.6
Feb 2018	45003	2704	4412	36670	88789	92	8	1.3
Mar 2018	51869	2660	4158	45512	104199	93	7	0.8
Apr 2018	53425	3150	5206	45592	107375	92	8	1.2
May 2018	65022	3953	6376	43927	119277	91	9	0.8
Jun 2018	65146	4085	5477	43627	118334	92	8	1.6
Jul 2018	84400	6449	5875	59420	156145	92	8	3.5
TOTAL	**820640**	**41432**	**63837**	**471035**	**1396944**	**–**	**–**	**–**
AVERAGE	**68387**	**3453**	**5320**	**39253**	**116412**	**92**	**8**	**2**

Gross Vehicle Weight

Month	*GVW NB Passing Lane*	*GVW NB Driving Lane*	*GVW SB Passing Lane*	*GVW SB Driving Lane*	*Total GVW Kips*
Aug 2017	3275872	466854	698236	2966421	7407383
Sep 2017	3170037	420956	496963	3061183	7149139
Oct 2017	3711268	525438	606268	3615881	8458855
Nov 2017	3624977	545528	630879	3546495	8347880
Dec 2017	4186867	740631	818945	3906425	9652869
Jan 2018	4025326	788976	859885	3638548	9312736
Feb 2018	4721860	908715	910021	4255066	10795661
Mar 2018	4432717	728852	896071	3276409	9334050
Apr 2018	3995653	604537	753105	3271699	8624994
May 2018	4193508	627103	742411	3610520	9173542
Jun 2018	3855881	557231	673377	3560603	8647091
Jul 2018	3245594	531065	608746	3263953	7649358
TOTAL	**46439561**	**7445886**	**8694907**	**41973203**	**104553557**
AVERAGE	**3869963**	**620490**	**724576**	**3497767**	**8712796**

Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
Aug 2017	9790	1.4	7.2	259	120
Sep 2017	8219	1.3	6.4	314	154
Oct 2017	8706	1.4	6.3	535	276
Nov 2017	8945	1.5	7	502	256
Dec 2017	3916	0.7	3.4	479	326
Jan 2018	4115	0.9	3.5	400	207
Feb 2018	4373	1	3.9	340	176
Mar 2018	5137	0.9	4.1	314	166
Apr 2018	6713	1.2	5.4	367	201
May 2018	8892	1.3	6.2	310	163
Jun 2018	13748	1.9	10.7	534	191
Jul 2018	25547	3.4	17	823	274
TOTAL	**108101**	**–**	**–**	**5177**	**2510**
AVERAGE	**9008.4**	**1.4**	**6.8**	**431.4**	**209.2**

Freight

Month	*NB Freight Tons*	*SB Freight Tons*	*Total Freight*	*NB Freight %*	*SB Freight %*
Aug 2017	804558	481610	1286168	62.6	37.4
Sep 2017	725921	495253	1221175	59.4	40.6
Oct 2017	790336	566563	1356900	58.2	41.8
Nov 2017	707648	586202	1293850	54.7	45.3
Dec 2017	542161	526583	1068744	50.7	49.3
Jan 2018	600277	513278	1113555	53.9	46.1
Feb 2018	574758	537046	1111805	51.7	48.3
Mar 2018	650592	625947	1276539	51	49
Apr 2018	658557	636211	1294768	50.9	49.1
May 2018	777383	660394	1437777	54.1	45.9
Jun 2018	752229	604505	1356734	55.4	44.6
Jul 2018	944419	750020	1694439	55.7	44.3
TOTAL	**8528840**	**6983613**	**15512454**	**–**	**–**
AVERAGE	**710736.7**	**581967.8**	**1292704.5**	**54.9**	**45.1**