JUNE 2019

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 June 2019. Volume was computed using all monthly data.

System Calibration

WIM #26 was most recently calibrated on 2018-11-09. Table 1 summarizes the front axle weights of class 9s by 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: 686644 | Passenger Vehicles: 537990 | Heavy Commercial Vehicles: 148654

Monthly Average Daily Traffic (MADT): 23677 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 4955

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 Tuesdays (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 02 PM and 04 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 02 PM and 04 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 148654 HCVs, 21034 of them were overweight [3]. These overweight HCVs contributed to 3.1% of total monthly volume, and 14.5% 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 Tuesdays, 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 93.6% 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 January.
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 ,890 NB vehicles exceeded 88,000 pounds (526 vehicles were Class 9's; 192 vehicles were Class 13's). Of vehicles traveling SB,

191 NB vehicles exceeded 88,000 pounds (114 vehicles were Class 13's; 61 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from June 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in June 2019. 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 1579516 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (59.8%) than SB (40.2%). 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 686644 vehicles with a combined GVW of 10042257 kips (1 kip = 1,000 pounds = 0.5 tons) in June 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 143228 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 64.7% of all ESALs were recorded NB while 35.3% was observed SB. In particular, 83% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 61% 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

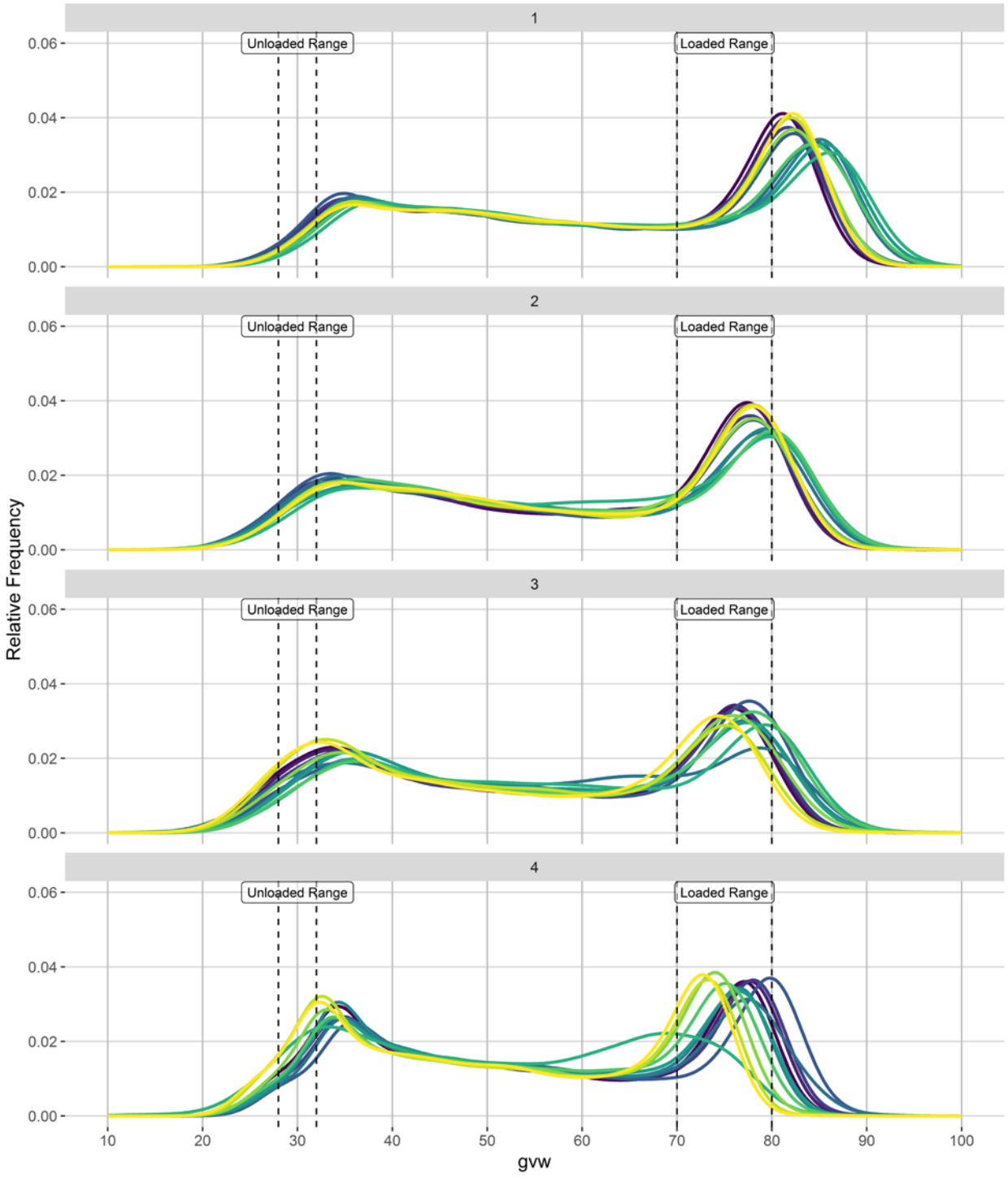
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [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

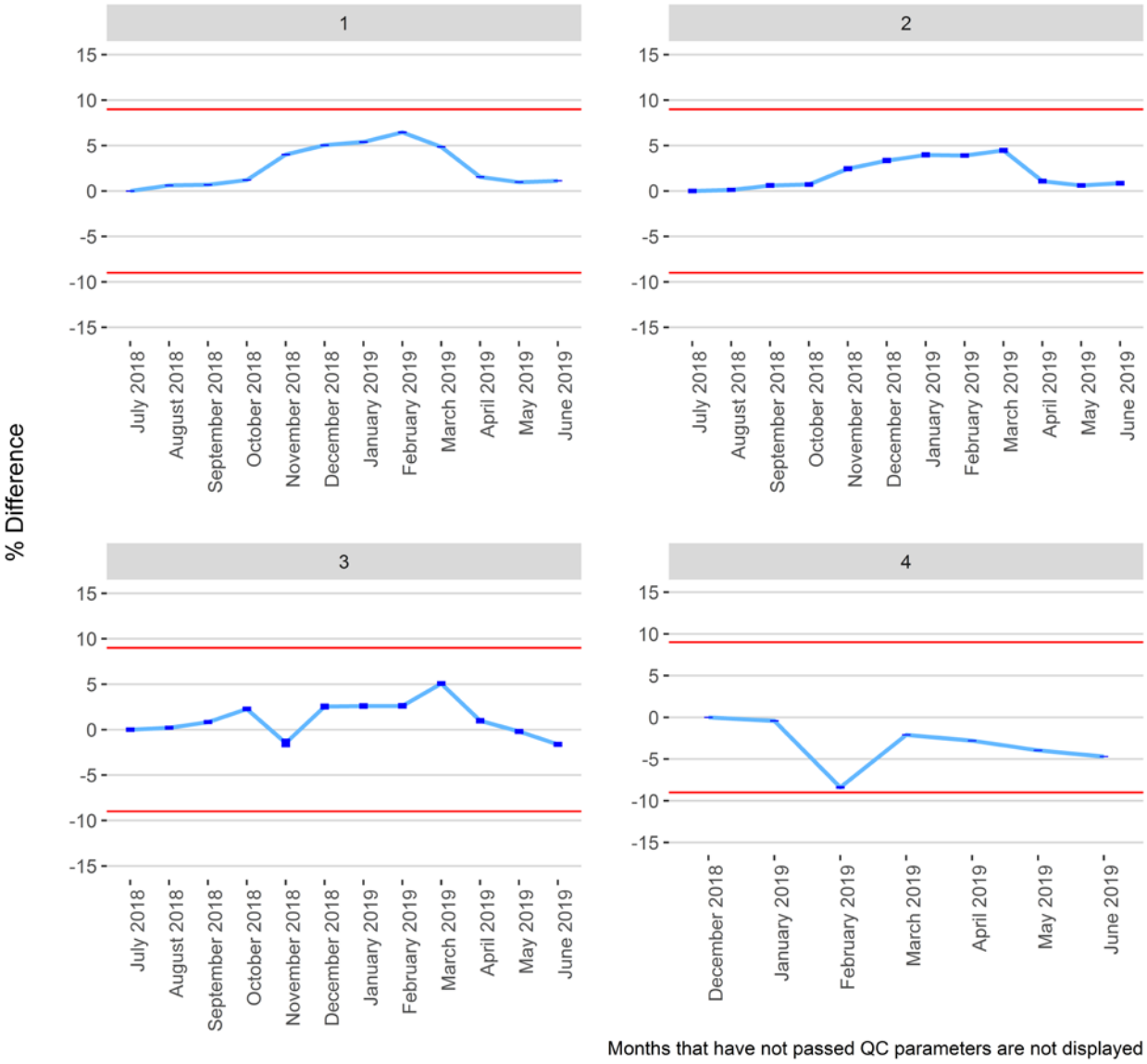
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened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

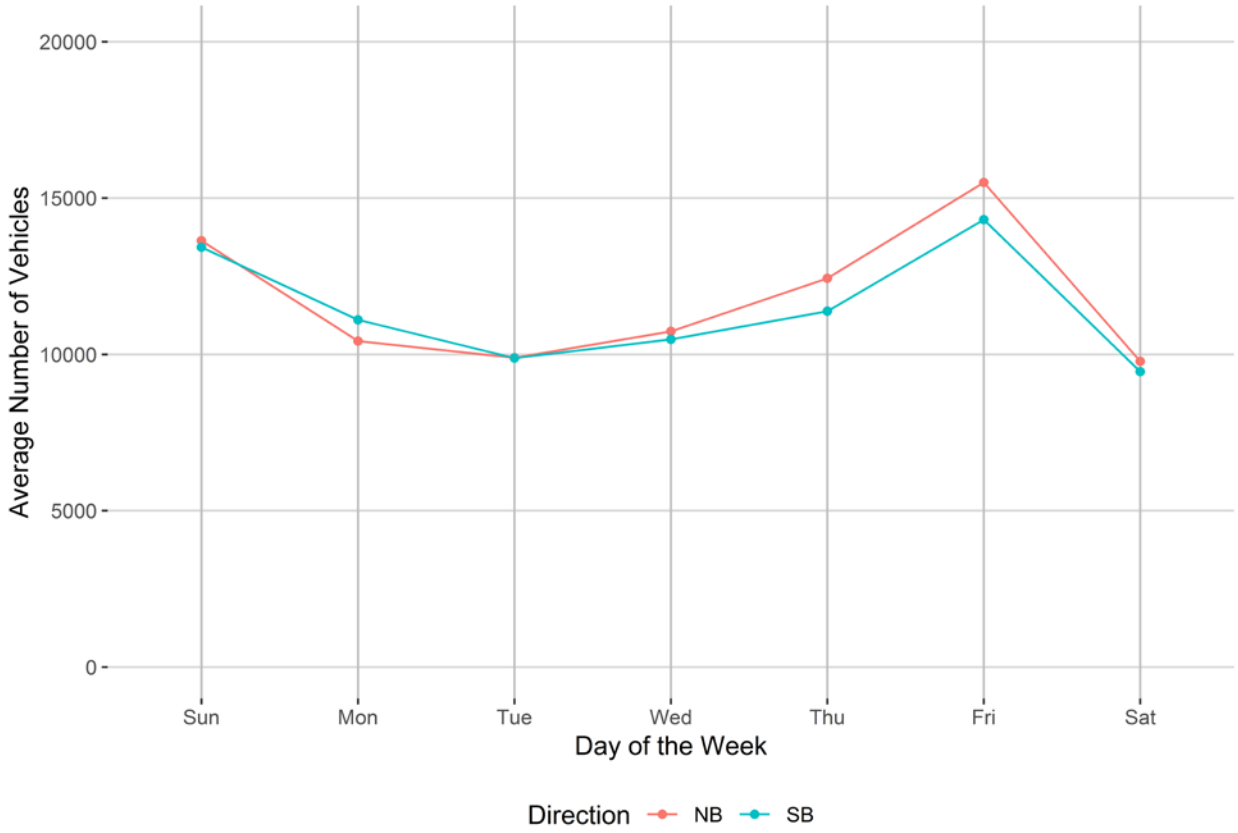


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

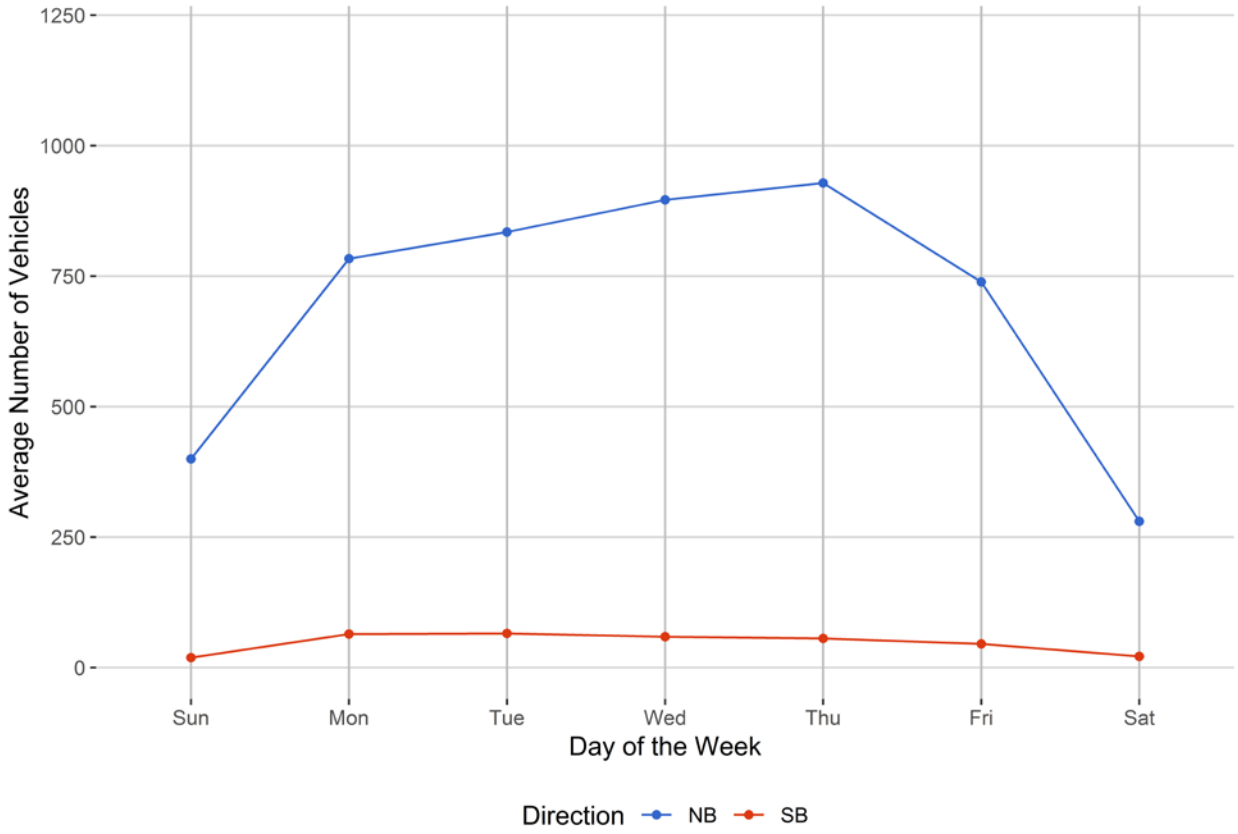


Figure 4 - Passenger Vehicles vs. Hour of the Day

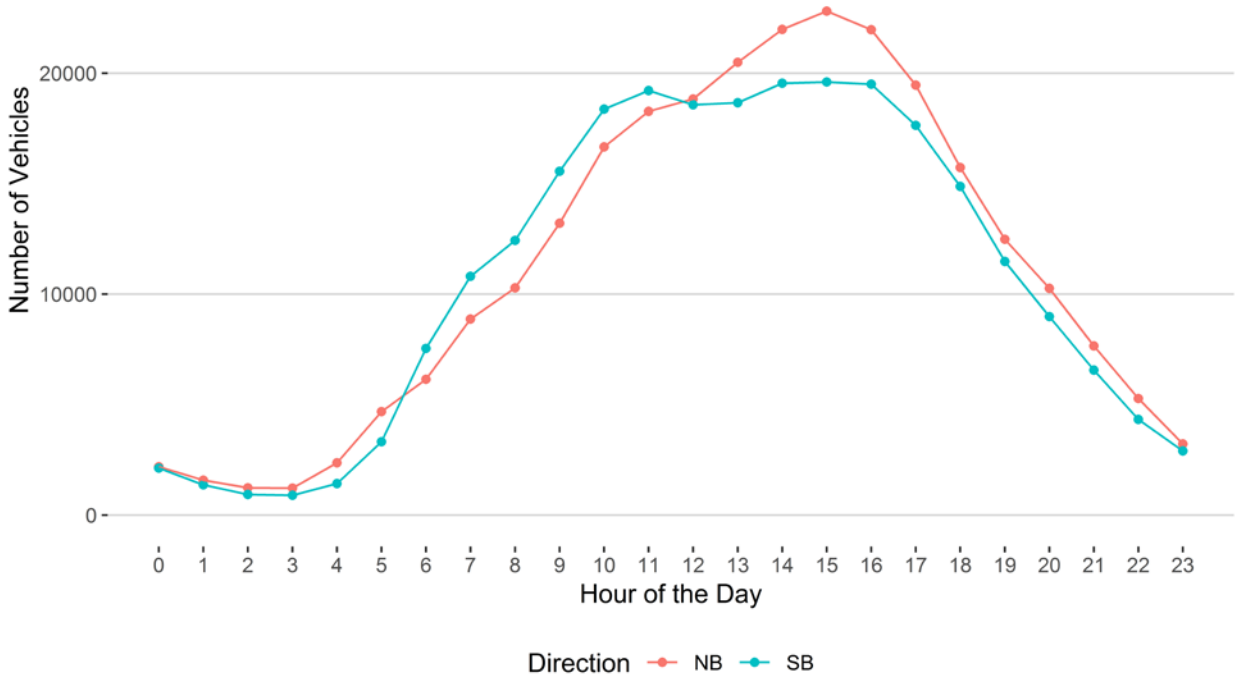


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

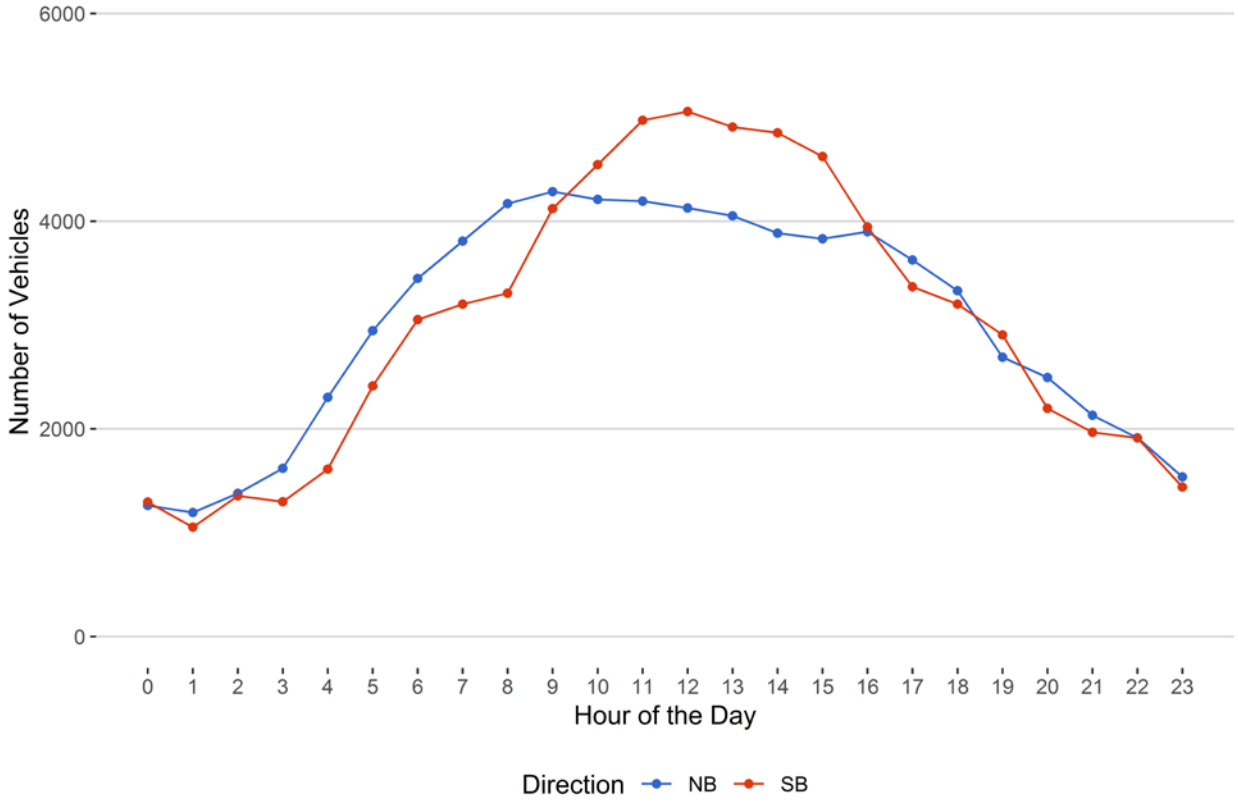


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

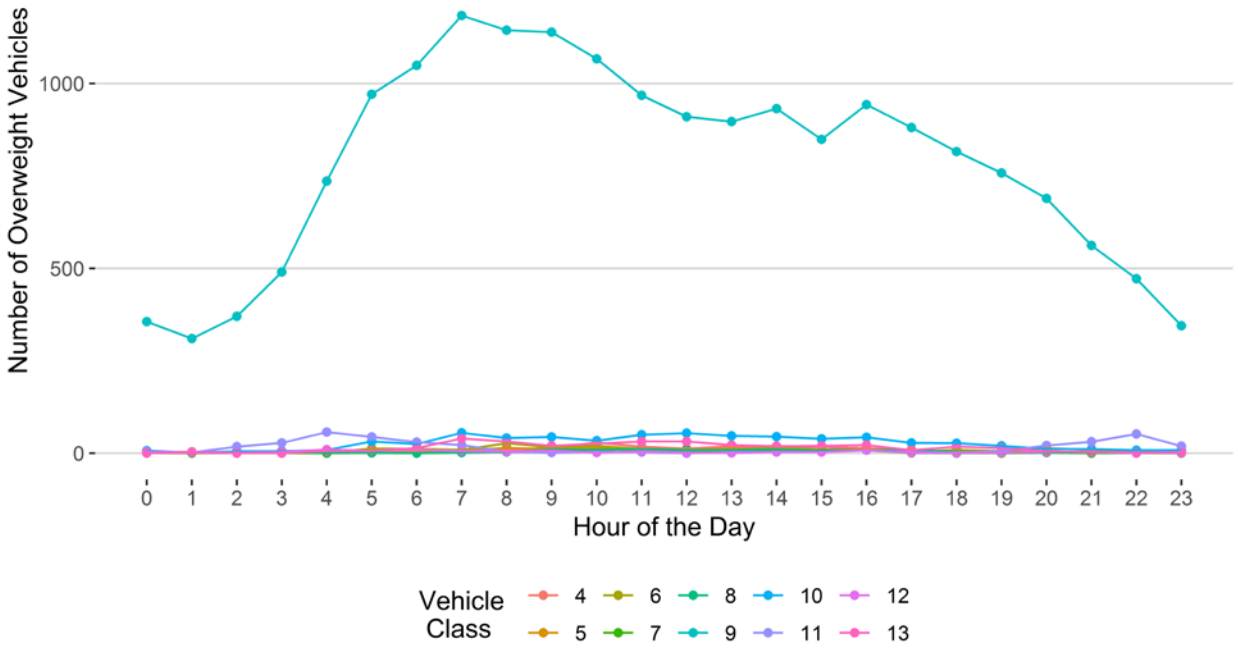


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

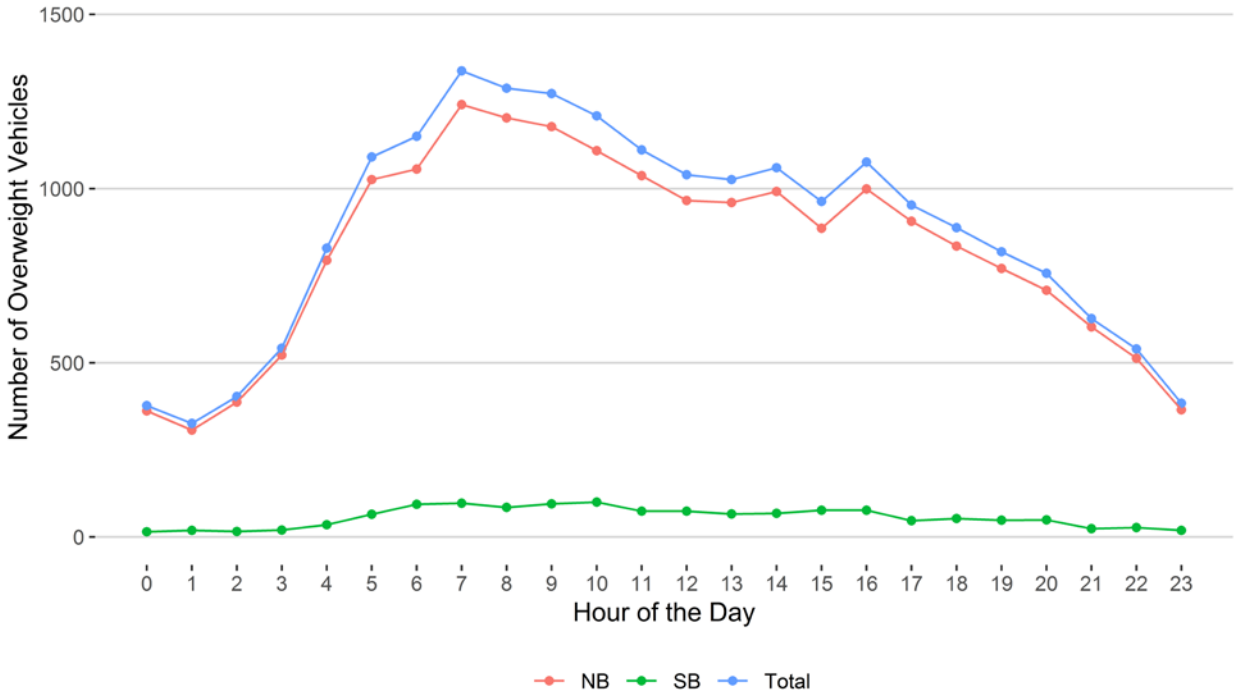
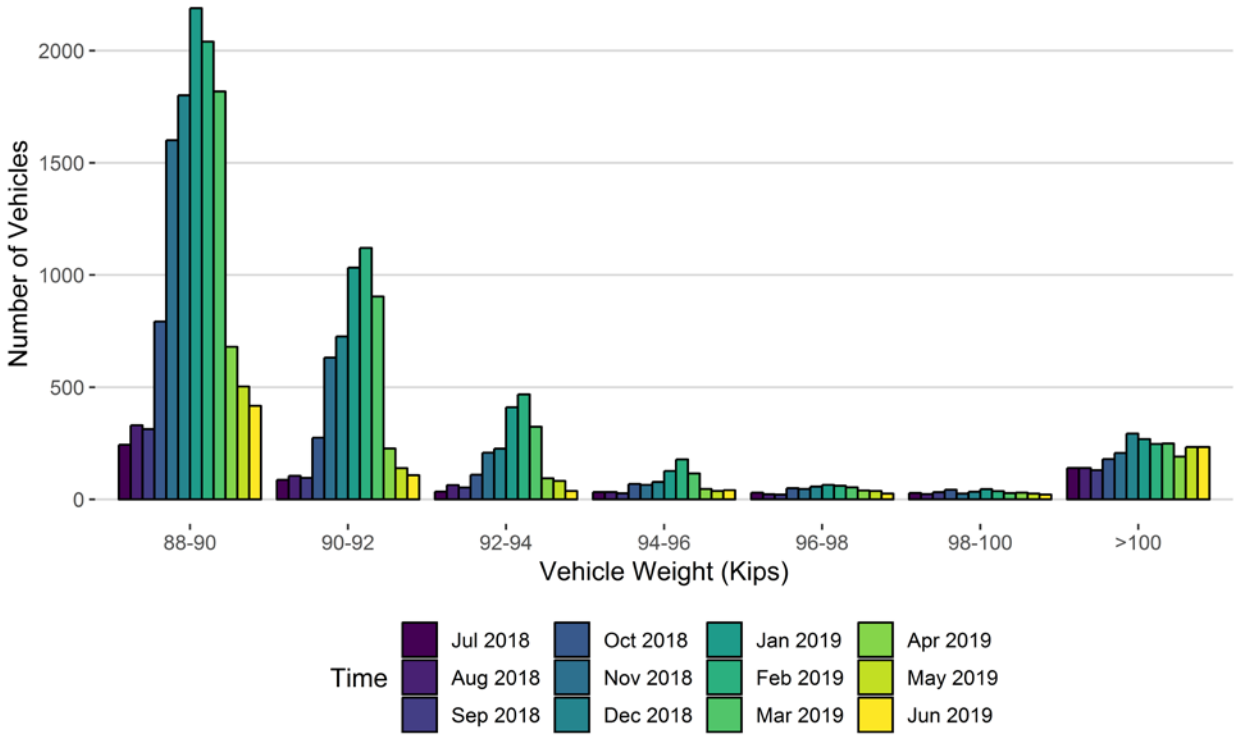
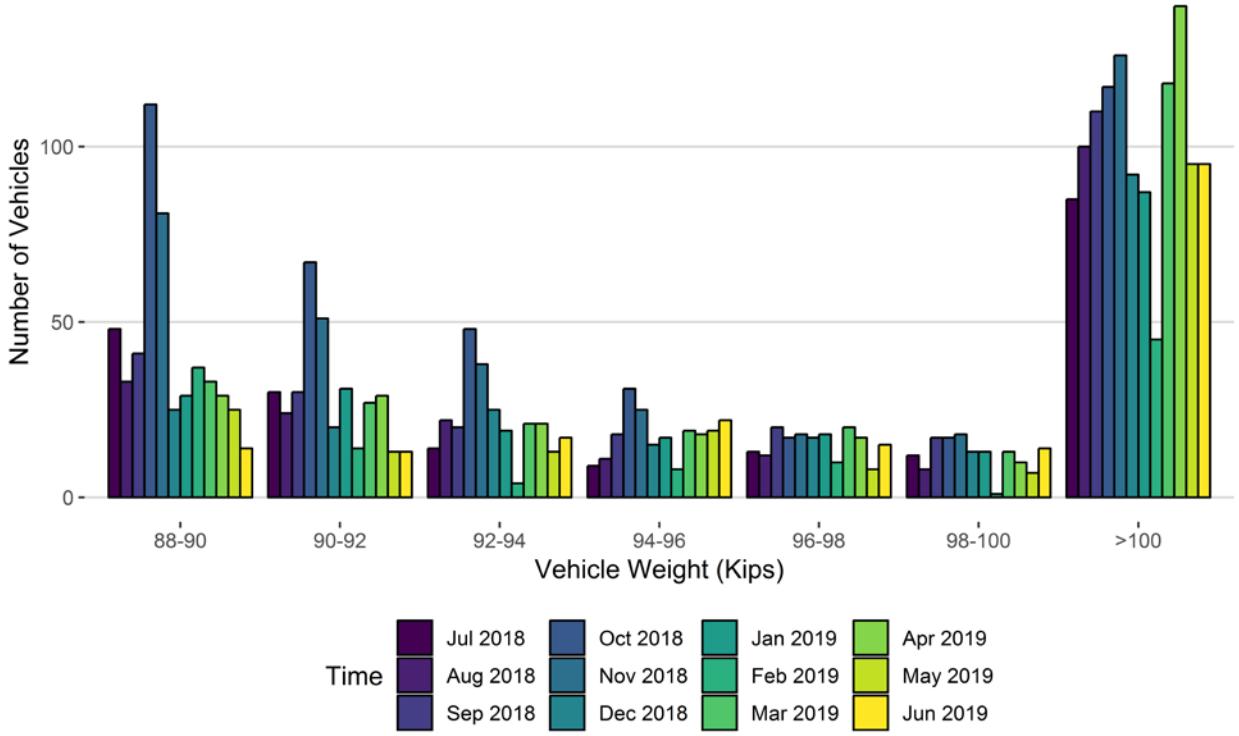


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Jul 2018*	*Aug 2018*	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*
88-90	244	331	313	793	1601	1801	2189	2040	1818	680	503	417
90-92	87	105	96	275	632	726	1033	1121	904	227	139	108
92-94	35	64	53	110	208	226	411	468	324	94	82	38
94-96	33	33	27	69	65	78	127	178	116	47	38	41
96-98	30	23	22	50	47	57	65	61	54	40	38	26
98-100	29	24	32	43	26	34	46	37	28	30	26	22
>100	140	140	130	180	207	293	269	247	249	191	233	233
Total	598	720	673	1520	2786	3215	4140	4152	3493	1309	1059	885

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



Vehicle Weights (Kips)	*Jul 2018*	*Aug 2018*	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*
88-90	48	33	41	112	81	25	29	37	33	29	25	14
90-92	30	24	30	67	51	20	31	14	27	29	13	13
92-94	14	22	20	48	38	25	19	4	21	21	13	17
94-96	9	11	18	31	25	15	17	8	19	18	19	22
96-98	13	12	20	17	18	17	18	10	20	17	8	15
98-100	12	8	17	17	18	13	13	1	13	10	7	14
>100	85	100	110	117	126	92	87	45	118	140	95	95
Total	211	210	256	409	357	207	214	119	251	264	180	190

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

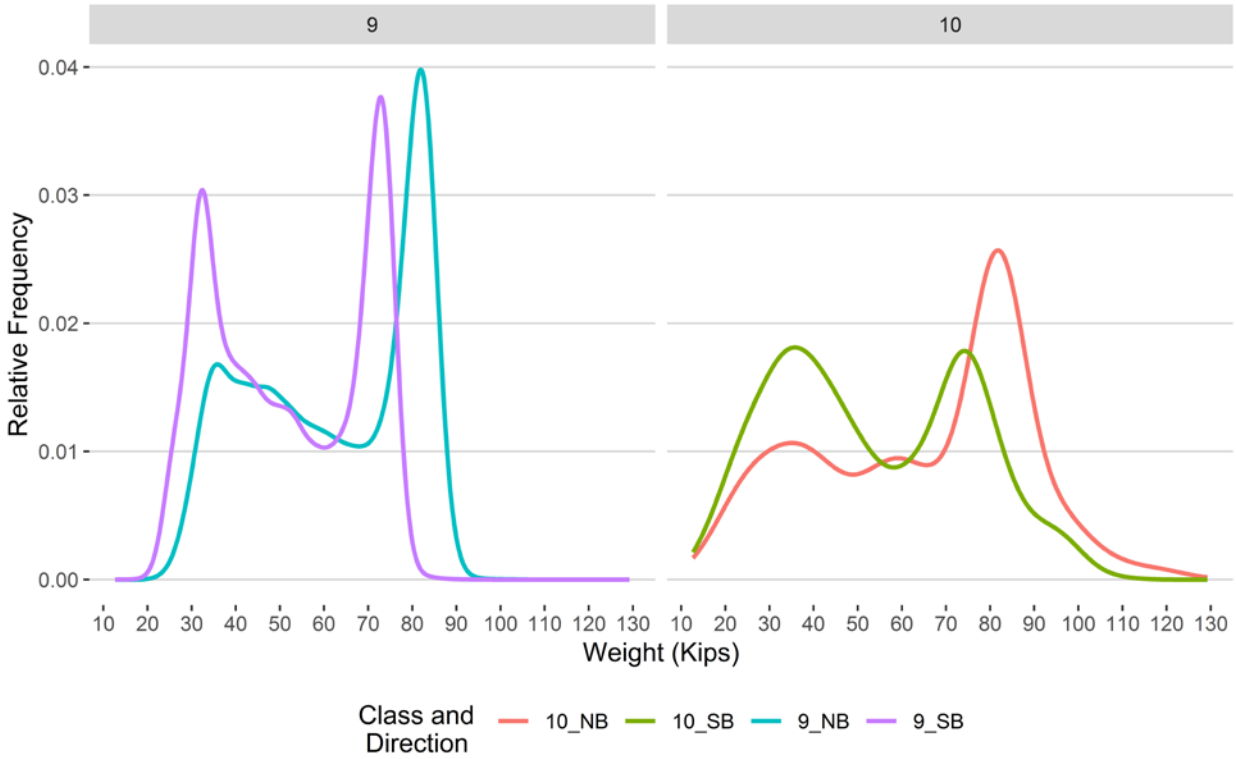


Figure 9 - Freight Percentage by Direction and Class

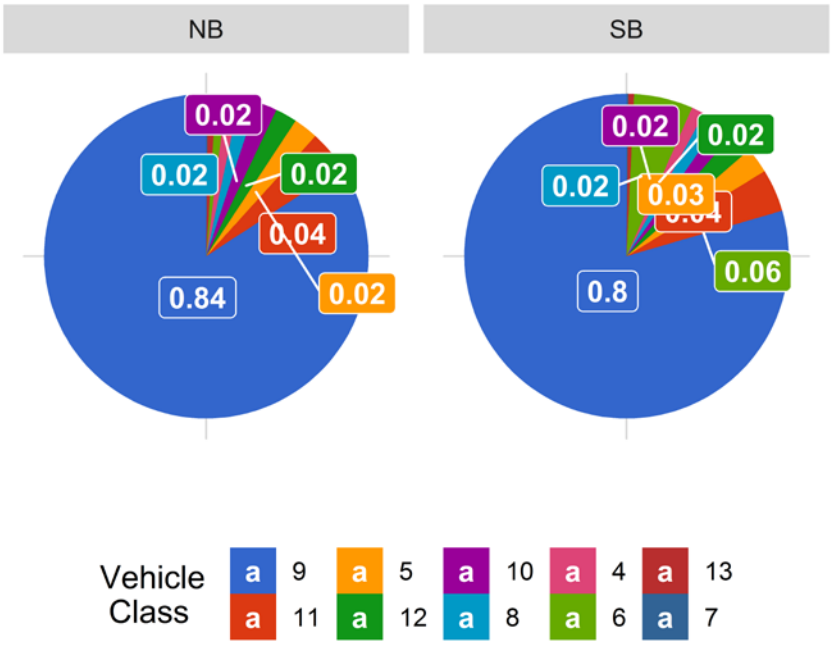


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

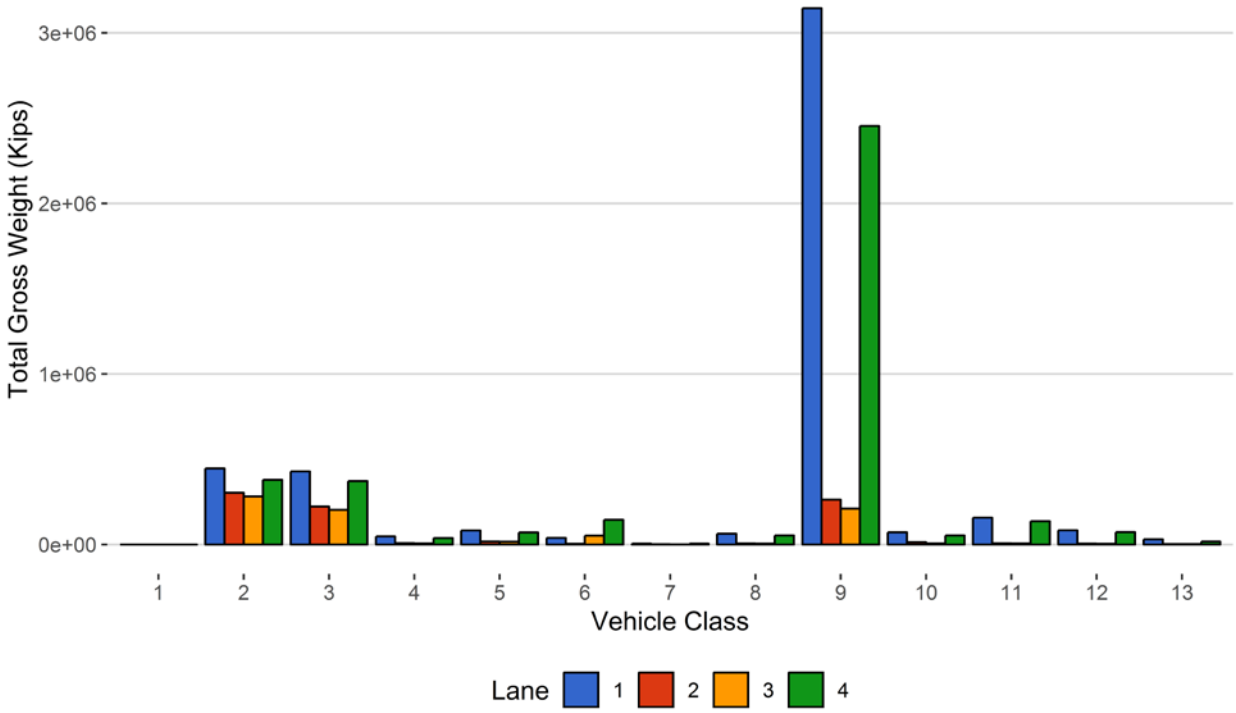


Figure 11 - Total Gross Vehicle Weight b

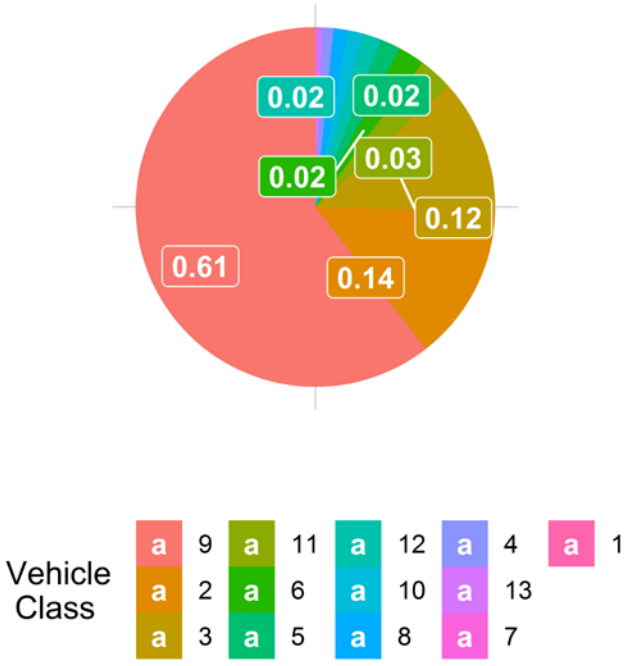


Figure 12 - Total ESALs by Class and Lane

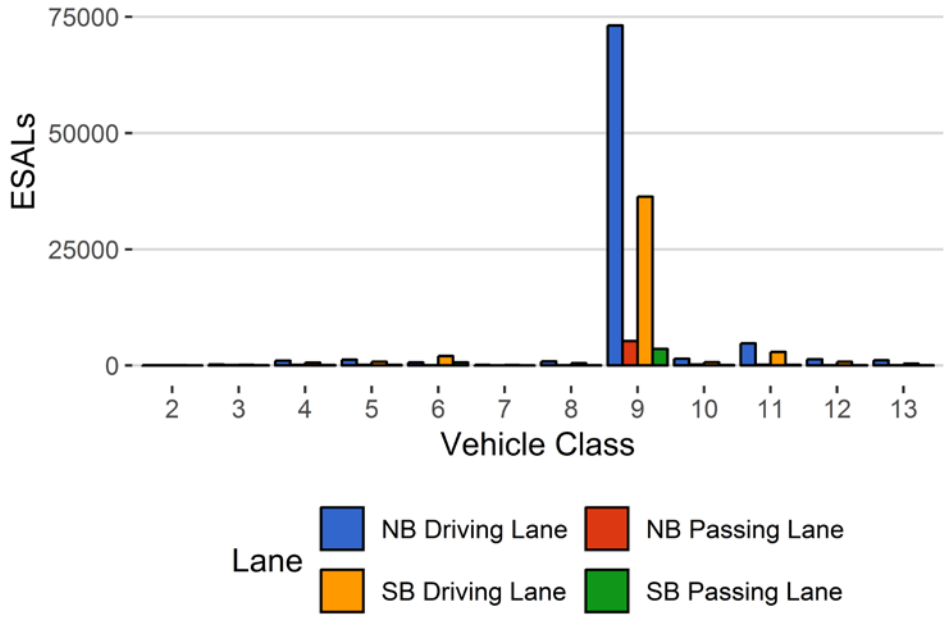


Figure 13 - ESALs by Class

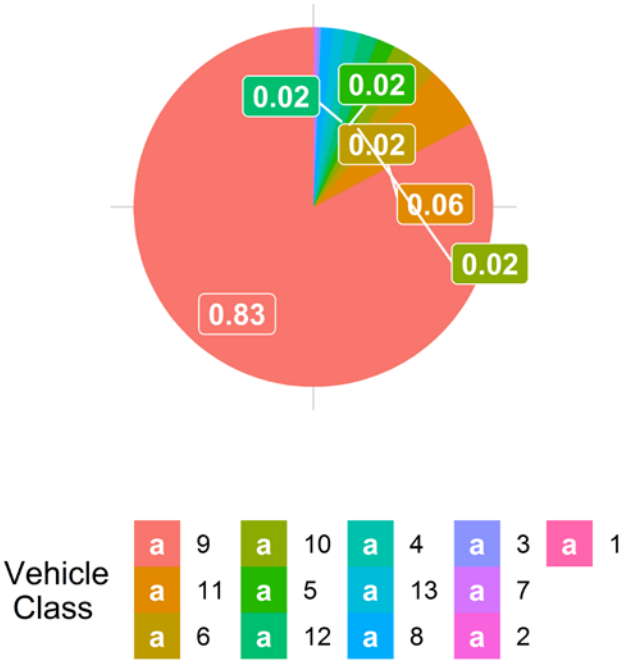


Table 1 Class 9 Front Axle Weight by Lane

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	0.00	11.30	0.00	11.46	0.00	NA	NA
August 2018	11.75	0.62	11.31	0.12	11.49	0.20	NA	NA
September 2018	11.75	0.68	11.37	0.61	11.56	0.83	NA	NA
October 2018	11.82	1.21	11.38	0.71	11.72	2.28	NA	NA
November 2018	12.14	4.01	11.58	2.45	11.30	-1.46	NA	NA
December 2018	12.26	5.04	11.68	3.35	11.75	2.54	11.30	0.00
January 2019	12.30	5.39	11.75	3.97	11.76	2.60	11.25	-0.42
February 2019	12.43	6.46	11.74	3.90	11.76	2.61	10.35	-8.40
March 2019	12.24	4.85	11.80	4.47	12.05	5.08	11.06	-2.10
April 2019	11.86	1.55	11.42	1.09	11.58	0.99	10.98	-2.80
May 2019	11.79	0.98	11.37	0.61	11.44	-0.19	10.85	-3.96
June 2019	11.81	1.12	11.40	0.86	11.28	-1.62	10.77	-4.70

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	3	93	0	0	0
2	11719	351579	51.2	0	0
3	6211	186317	27.1	0	0
4	117	3506	0.5	215	1
5	433	12988	1.9	155	0.7
6	278	8354	1.2	206	1
7	9	259	0	52	0.2
8	141	4237	0.6	105	0.5
9	3617	108498	15.8	18838	89.6
10	82	2454	0.4	651	3.1
11	172	5149	0.7	367	1.7
12	89	2685	0.4	100	0.5
13	17	523	0.1	345	1.6
TOTAL	**22888**	**686644**	**100**	**21034**	**100**

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

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-06-27	Thursday	23:22:40	10	NB	1	129.25
2019-06-05	Wednesday	08:32:32	10	NB	1	123.08
2019-06-06	Thursday	19:14:17	10	NB	1	121.21
2019-06-08	Saturday	13:18:41	10	NB	1	120.91
2019-06-15	Saturday	04:39:22	10	NB	1	120.58
2019-06-06	Thursday	19:41:21	10	NB	1	120.41
2019-06-13	Thursday	18:42:55	10	NB	1	119.46
2019-06-11	Tuesday	08:41:49	10	NB	1	118.64
2019-06-15	Saturday	12:10:52	10	NB	1	117.7
2019-06-06	Thursday	15:05:32	10	NB	1	117.07

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	1866	181	9.7	52347	2391	13536
5	NB	8	6521	493	7.6	95127	3555	23451
6	NB	19	1487	281	18.9	36799	4949	6943
7	NB	11.5	129	0	0	6049	0	2283
8	NB	31	2163	982	45.4	46732	22320	5060
9	NB	33	54692	3025	5.5	3315004	91692	804996
10	NB	33.5	1303	191	14.7	79311	4907	21030
11	NB	36.5	2537	43	1.7	163164	1150	36067
12	NB	36.5	1349	8	0.6	87657	212	19355
13	NB	31.5	295	0	0	32418	0	11563
TOTAL	****	****	**72342**	**5204**	****	**3914608**	****	**944284**
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	1553	199	12.8	40669	2612	10179
5	SB	8	6143	778	12.7	80826	5563	18953
6	SB	19	6659	614	9.2	185864	10883	35505
7	SB	11.5	124	0	0	5851	0	2212
8	SB	31	1968	1090	55.4	33265	24565	3023
9	SB	33	51102	9618	18.8	2381423	283321	506226
10	SB	33.5	1090	242	22.2	52279	6366	11936
11	SB	36.5	2484	219	8.8	135246	7423	26287
12	SB	36.5	1269	17	1.3	74855	490	14578
13	SB	31.5	215	0	0	19439	0	6333
TOTAL	****	****	**72607**	**12777**	****	**3009716**	****	**635232**
GRAND TOTAL	****	****	**144949**	**17981**	**245**	**6924324**	**472397**	**1579516**

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	70	31	12	18	131	0
2	445446	302286	281705	378502	1407938	14
3	427768	222390	203070	371703	1224931	12.2
4	47130	7608	6421	36859	98018	1
5	81681	17001	16192	70197	185070	1.8
6	37790	3958	52258	144490	238495	2.4
7	4968	1080	500	5351	11899	0.1
8	62830	6221	5083	52746	126881	1.3
9	3144298	262398	210652	2454091	6071440	60.5
10	71196	13022	6225	52421	142863	1.4
11	157481	6833	6152	136517	306983	3.1
12	83146	4723	3754	71592	163214	1.6
13	30163	2255	2498	16940	51857	0.5
TOTAL	**4593966**	**849807**	**794521**	**3791427**	**10029721**	**100**
GVW/LANE	**45.8**	**8.47**	**7.92**	**37.8**	**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	0.0109
2	59	43	34	40	177	0.12	0.001
3	230	88	69	152	539	0.38	0.006
4	1072	134	105	626	1937	1.35	1.13
5	1256	134	127	792	2309	1.62	0.37
6	668	57	691	2037	3452	2.41	0.85
7	128	19	9	100	256	0.18	1.99
8	882	67	45	522	1515	1.06	0.73
9	73128	5278	3580	36328	118314	82.76	2.24
10	1481	222	84	735	2523	1.77	2.11
11	4784	192	139	2927	8042	5.63	3.2
12	1334	73	47	807	2261	1.58	1.72
13	1127	48	63	395	1633	1.14	6.27
TOTAL	**86150**	**6355**	**4992**	**45461**	**142958**	**100**	**21**
ESALS/LANE	**60.3**	**4.4**	**3.5**	**31.8**	**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 %*
Jul 2018	778261	25105	4938	625188	80.3	153073.3	19.7	90	10
Aug 2018	761407	24562	5156	601556	79	159850.7	21	87.3	12.7
Sep 2018	657910	21930	4758	515162	78.3	142748	21.7	89	11
Oct 2018	661987	21354	5213	500370	75.6	161617.4	24.4	89.5	10.5
Nov 2018	597456	20602	4368	466424	78.1	131032	21.9	91.9	8.1
Dec 2018	589786	19025	4062	463876	78.7	125910	21.3	91.5	8.5
Jan 2019	487834	15737	4015	363372	74.5	124461.6	25.5	90.2	9.8
Feb 2019	416210	14865	3548	316874	76.1	99336	23.9	79.5	20.5
Mar 2019	613996	19806	4476	475238	77.4	138757.9	22.6	89.2	10.8
Apr 2019	622152	20738	5022	471497	75.8	150655.1	24.2	90.2	9.8
May 2019	709546	22876	5082	552005	77.8	157540.7	22.2	90.2	9.8
Jun 2019	686644	23677	4955	537990	78.4	148654.3	21.6	89.9	10.1
TOTAL	**7583189**	**–**	**–**	**5889552**	**–**	**1693637**	**–**	**–**	**–**
AVERAGE	**63193**	**20856**	**4633**	**490796**	**77**	**141136**	**23**	**89**	**11**

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*
Jul 2018	84400	6449	5875	59420	156145	92	8	3.5
Aug 2018	87730	8168	7986	62288	166172	90	10	4
Sep 2018	78475	5239	7369	58608	149690	92	8	4.4
Oct 2018	90986	6433	8273	76282	181974	92	8	8.5
Nov 2018	82693	5342	3406	58572	150013	94	6	16.2
Dec 2018	81402	4851	4543	49094	139891	93	7	19.3
Jan 2019	86706	5499	5287	42673	140165	92	8	24.5
Feb 2019	72647	9385	9155	15133	106321	83	17	28.9
Mar 2019	92512	6184	7553	47486	153736	91	9	18.4
Apr 2019	86654	6423	6036	53023	152135	92	8	7.3
May 2019	91061	6964	5033	49183	152240	92	8	5.3
Jun 2019	86274	6363	5031	45560	143228	92	8	4.5
TOTAL	**1021538**	**77300**	**75546**	**617324**	**1791708**	**–**	**–**	**–**
AVERAGE	**85128**	**6442**	**6296**	**51444**	**149309**	**91**	**9**	**12**

Gross Vehicle Weight

Month	*GVW NB Passing Lane*	*GVW NB Driving Lane*	*GVW SB Passing Lane*	*GVW SB Driving Lane*	*Total GVW Kips*
Jul 18	4721860	908715	910021	4255066	10795661
Aug 18	4778193	996057	1037615	4252269	11064134
Sep 18	4333349	700326	885304	3901307	9820285
Oct 18	4750482	755225	896476	4525612	10927794
Nov 18	4161406	658051	585158	3812142	9216758
Dec 18	4046068	610727	643364	3568946	8869105
Jan 19	4012005	511041	576641	3010193	8109880
Feb 19	3284544	700572	739086	1454897	6179098
Mar 19	4500785	709560	829970	3433877	9474191
Apr 19	4509898	742684	726991	3902059	9881632
May 19	4834262	867450	774463	4004308	10480483
Jun 19	4598462	850151	796231	3797413	10042257
TOTAL	**52531314**	**9010558**	**9401318**	**43918088**	**114861278**
AVERAGE	**4377609**	**750880**	**783443**	**3659841**	**9571773**

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*
Jul 2018	25547	3.4	17	823	274
Aug 2018	28197	3.8	17.9	935	276
Sep 2018	26035	4	18.5	932	289
Oct 2018	36341	5.6	22.9	1950	369
Nov 2018	27732	4.7	21.4	3156	384
Dec 2018	23996	4.1	19.3	3432	435
Jan 2019	25015	5.4	21.2	4357	418
Feb 2019	19560	5.3	21.9	4272	330
Mar 2019	25828	4.4	19.3	3752	416
Apr 2019	22712	3.8	15.5	1573	371
May 2019	22698	3.3	14.8	1245	366
Jun 2019	21070	3.1	14.5	1081	368
TOTAL	**304731**	**–**	**–**	**27508**	**4296**
AVERAGE	**25394.2**	**4.2**	**18.7**	**2292.3**	**358**

Freight

Month	*NB Freight Tons*	*SB Freight Tons*	*Total Freight*	*NB Freight %*	*SB Freight %*
Jul 2018	944419	750020	1694439	55.7	44.3
Aug 2018	986853	794470	1781322	55.4	44.6
Sep 2018	864472	740989	1605461	53.8	46.2
Oct 2018	986542	909358	1895900	52	48
Nov 2018	857231	693612	1550843	55.3	44.7
Dec 2018	830135	627727	1457862	56.9	43.1
Jan 2019	875454	561053	1436507	60.9	39.1
Feb 2019	776077	299212	1075289	72.2	27.8
Mar 2019	950521	649726	1600246	59.4	40.6
Apr 2019	937775	716687	1654462	56.7	43.3
May 2019	996962	675840	1672802	59.6	40.4
Jun 2019	944284	635232	1579516	59.8	40.2
TOTAL	**10950725**	**8053925**	**19004651**	**–**	**–**
AVERAGE	**912560.5**	**671160.4**	**1583720.9**	**58.2**	**41.8**