APRIL 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 April 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: 622152 | Passenger Vehicles: 471497 | Heavy Commercial Vehicles: 150655

Monthly Average Daily Traffic (MADT): 20738 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 5022

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 Wednesdays. SB vehicles typically reached highest volume levels on Fridays, 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 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 150655 HCVs, 22671 of them were overweight [3]. These overweight HCVs contributed to 3.8% of total monthly volume, and 15.5% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Saturdays. SB overweight vehicles tended to reach highest volumes on Wednesdays, 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 87% 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 ,1309 NB vehicles exceeded 88,000 pounds (927 vehicles were Class 9's; 192 vehicles were Class 10's). Of vehicles traveling SB,

264 NB vehicles exceeded 88,000 pounds (170 vehicles were Class 13's; 70 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from April 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in April 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 1654462 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (56.7%) than SB (43.3%). 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 622152 vehicles with a combined GVW of 9881632 kips (1 kip = 1,000 pounds = 0.5 tons) in April 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 152135 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 61.2% of all ESALs were recorded NB while 38.8% was observed SB. In particular, 83% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 64% 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

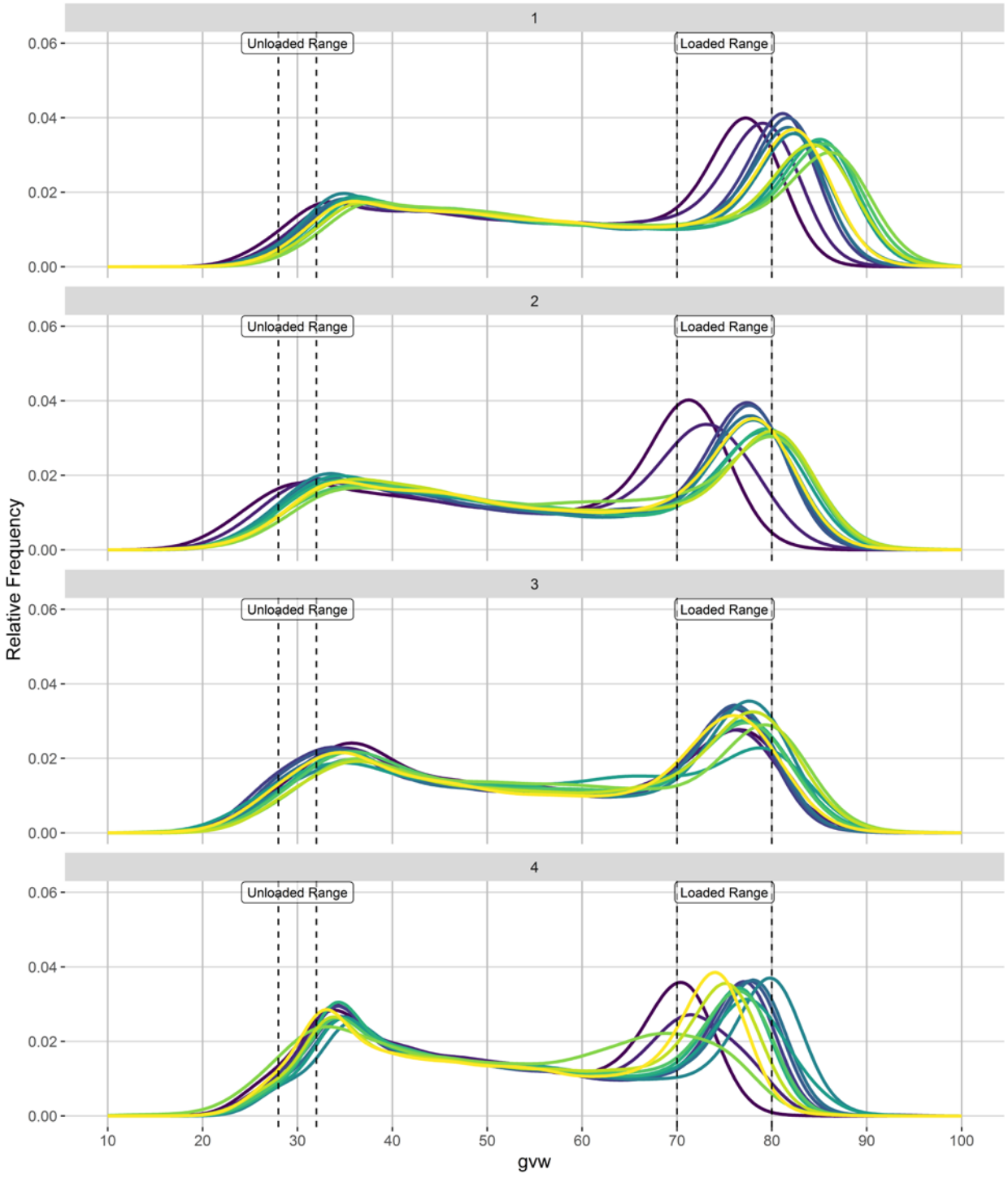
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [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

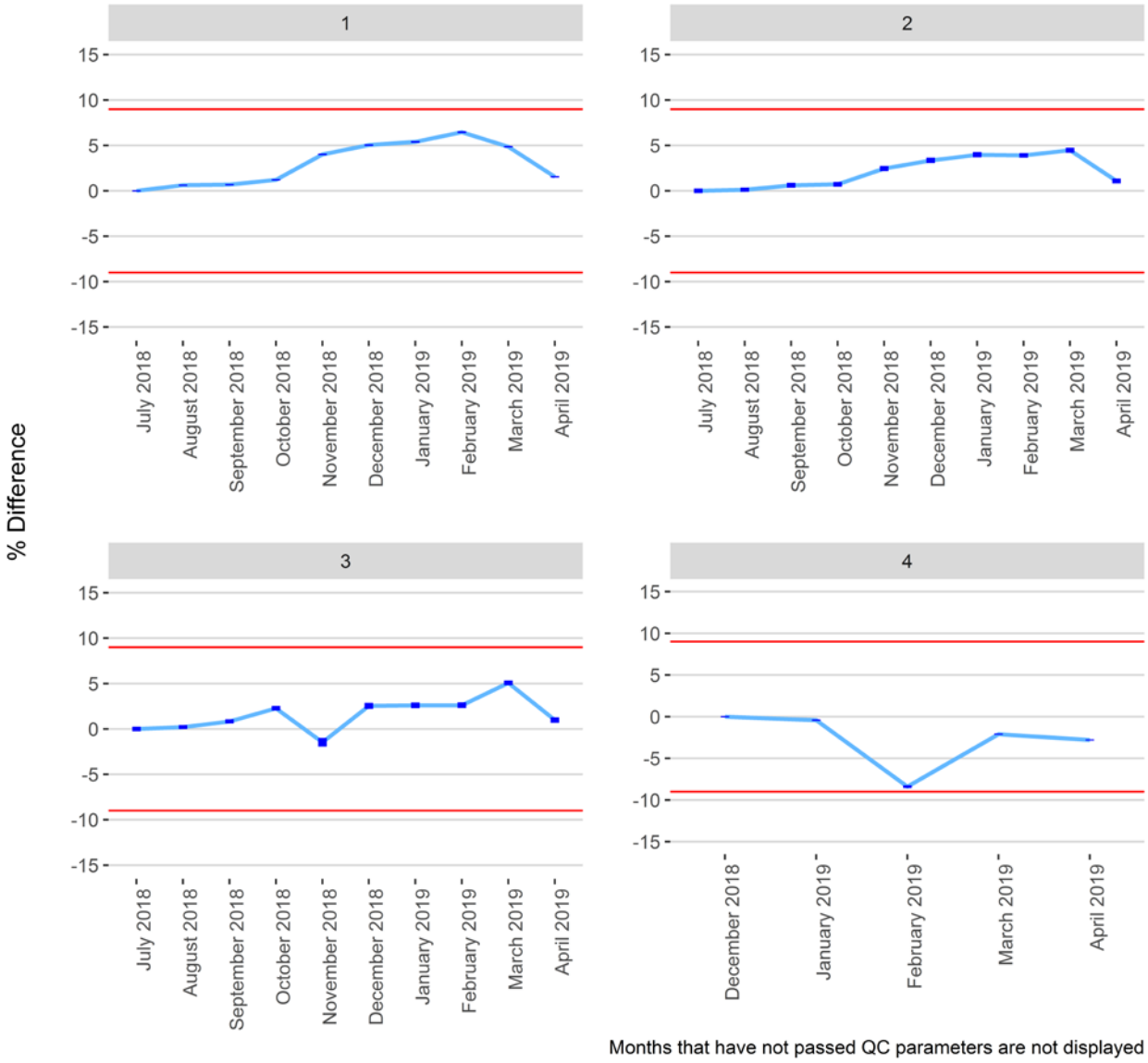
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened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

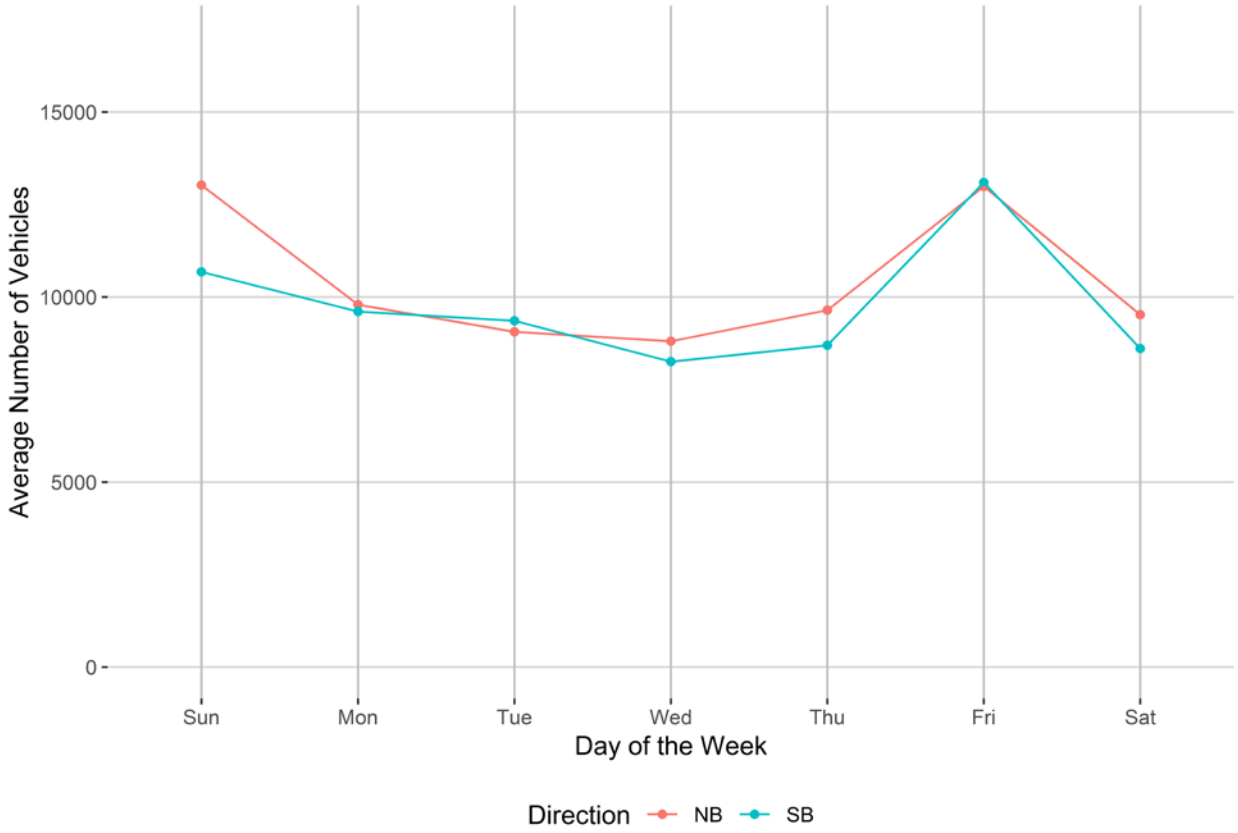


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

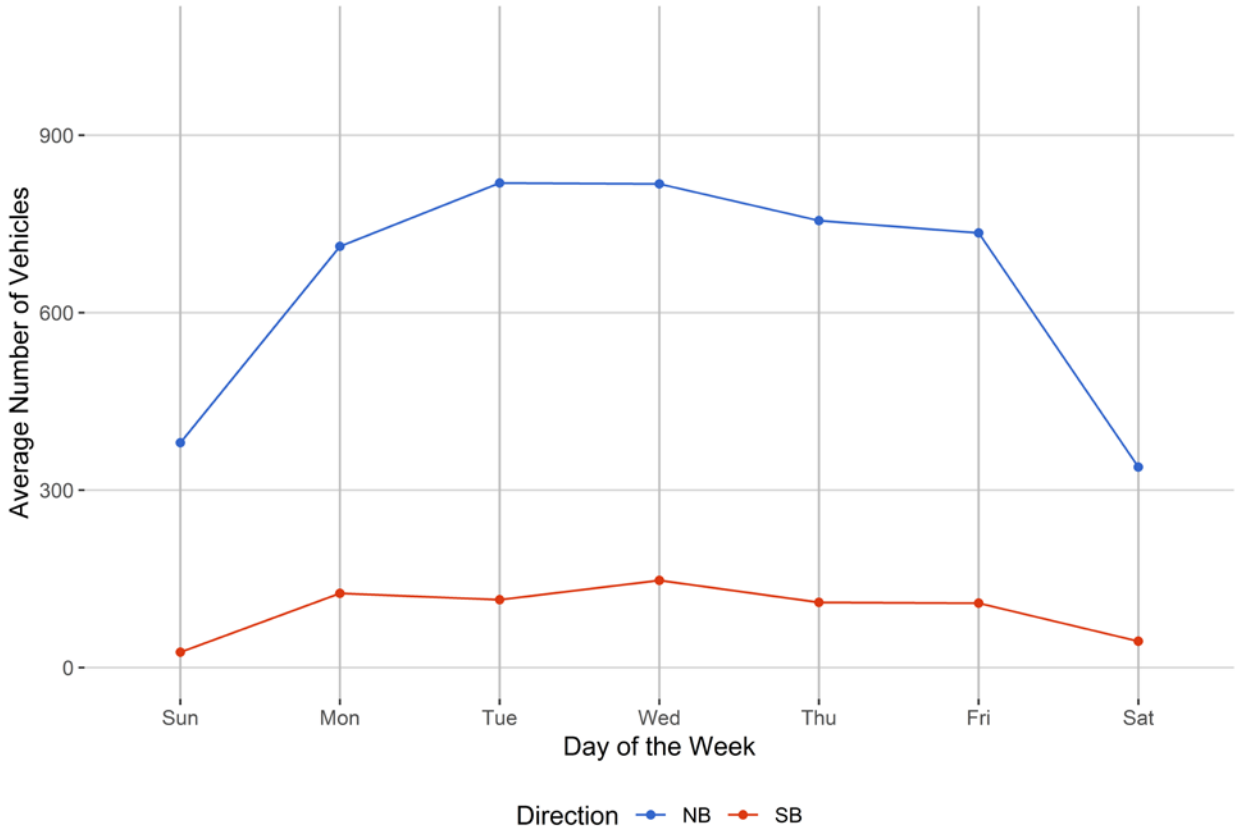


Figure 4 - Passenger Vehicles vs. Hour of the Day

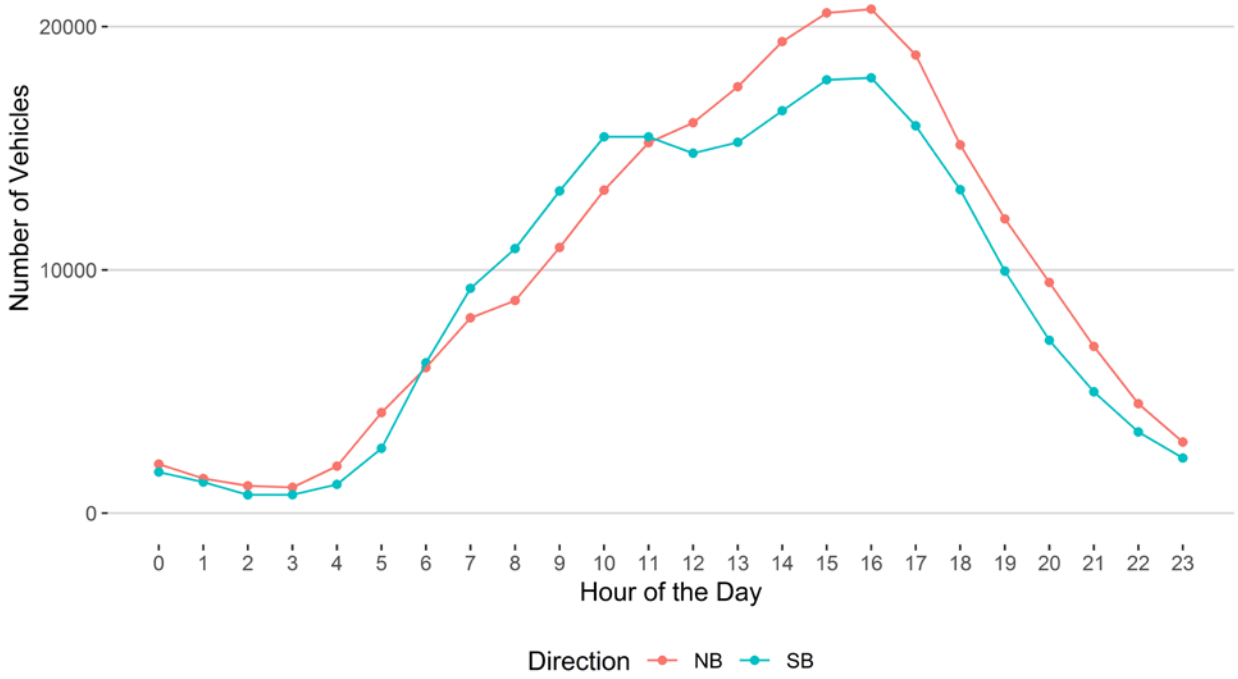


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

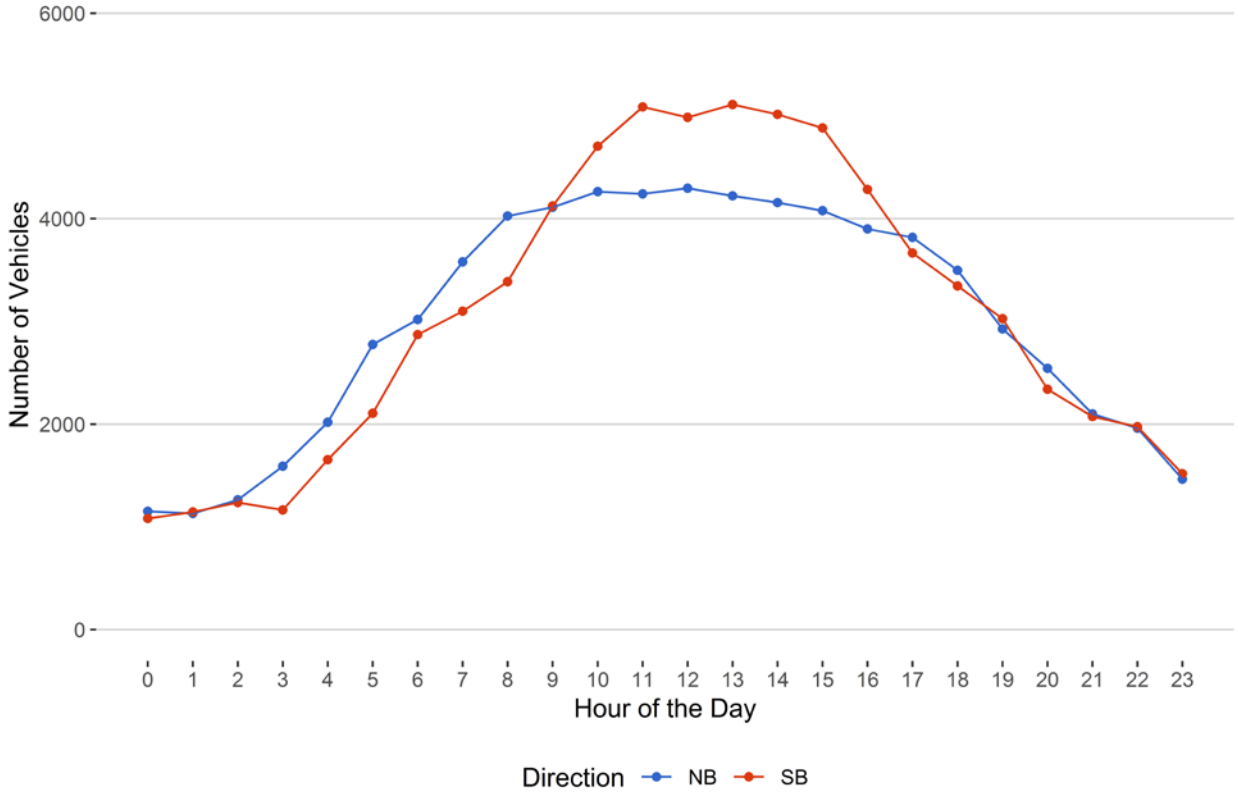


Figure 6 - Overweight Vehicles by Class
vs. Hour of the Day

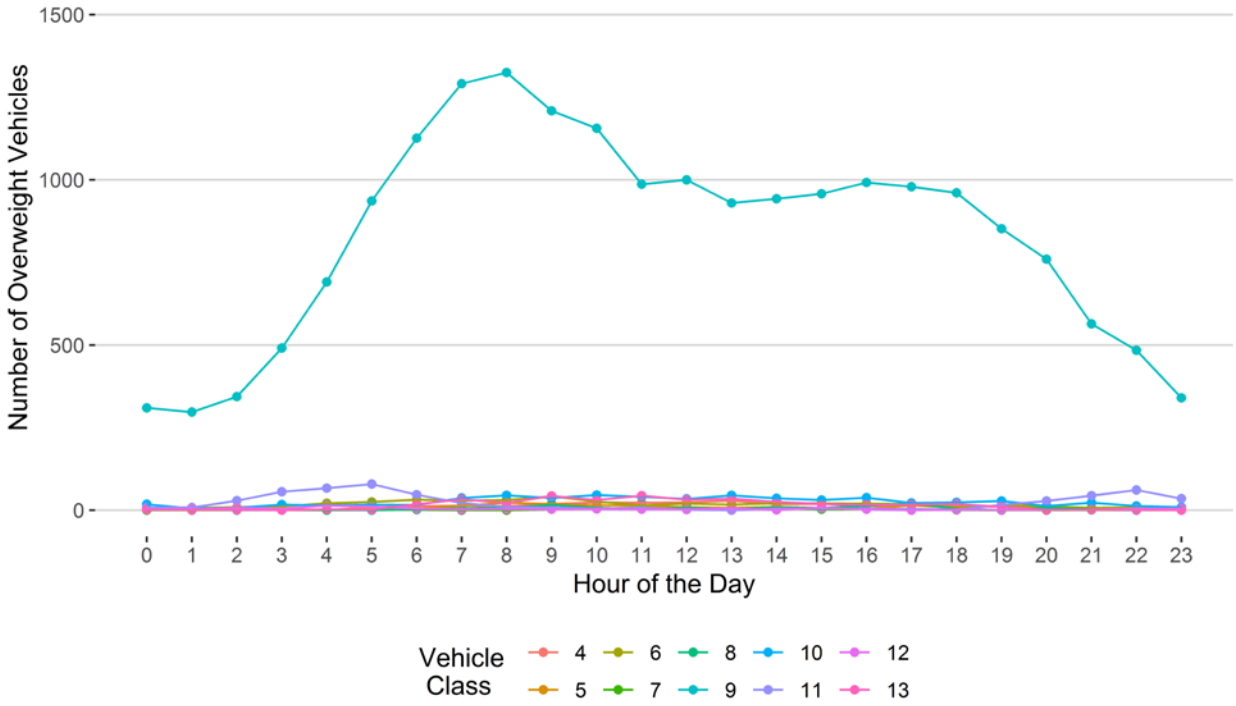


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

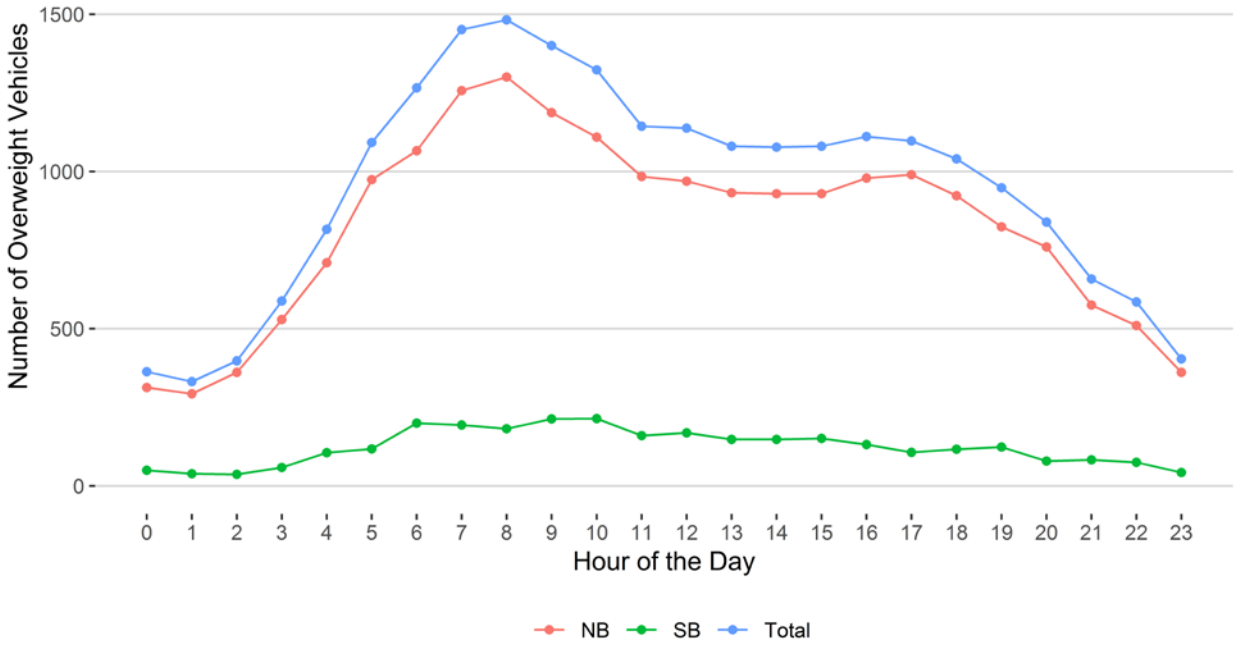
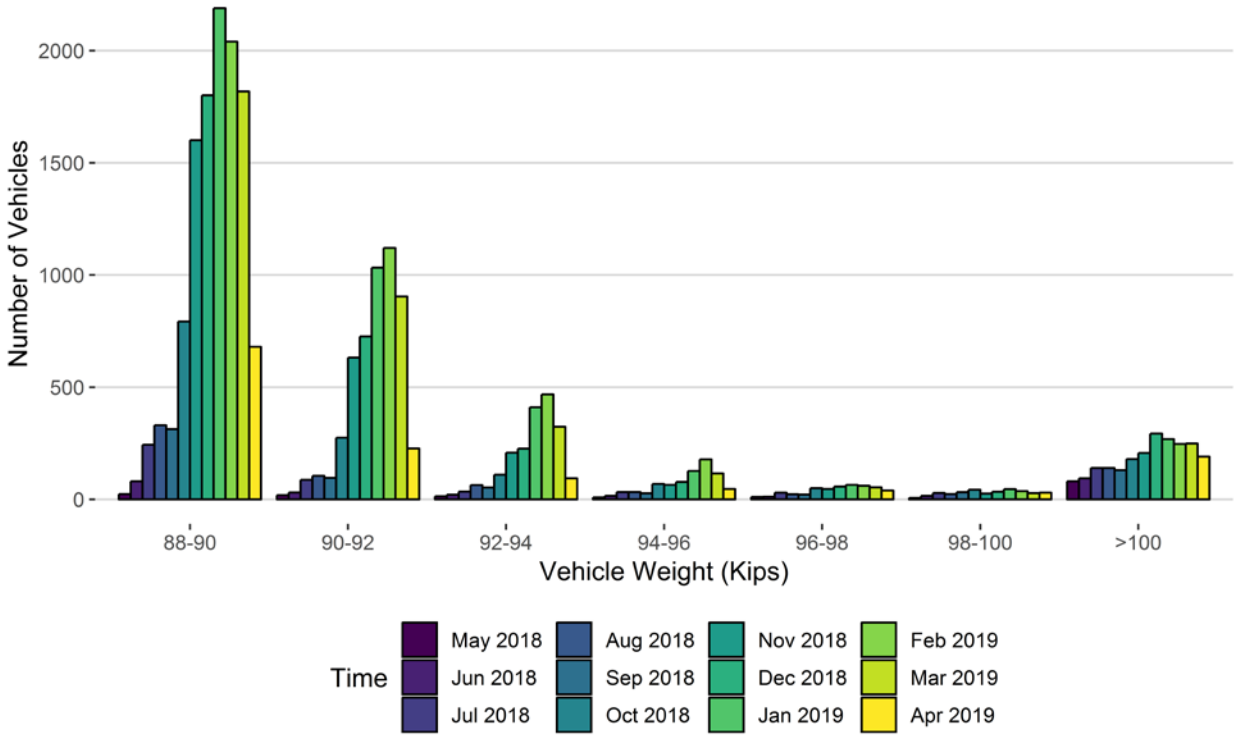
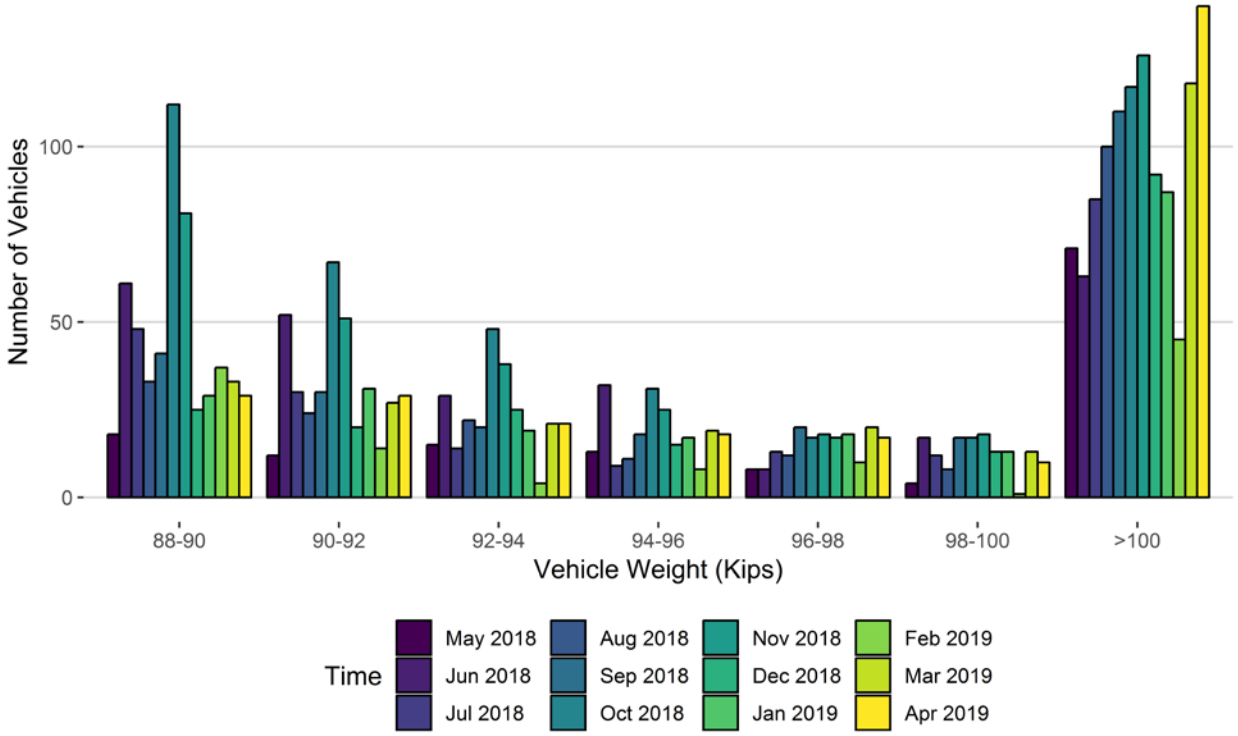


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*May 2018*	*Jun 2018*	*Jul 2018*	*Aug 2018*	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*
88-90	24	81	244	331	313	793	1601	1801	2189	2040	1818	680
90-92	19	31	87	105	96	275	632	726	1033	1121	904	227
92-94	14	21	35	64	53	110	208	226	411	468	324	94
94-96	9	16	33	33	27	69	65	78	127	178	116	47
96-98	11	12	30	23	22	50	47	57	65	61	54	40
98-100	7	16	29	24	32	43	26	34	46	37	28	30
>100	81	94	140	140	130	180	207	293	269	247	249	191
Total	165	271	598	720	673	1520	2786	3215	4140	4152	3493	1309

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



Vehicle Weights (Kips)	*May 2018*	*Jun 2018*	*Jul 2018*	*Aug 2018*	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*
88-90	18	61	48	33	41	112	81	25	29	37	33	29
90-92	12	52	30	24	30	67	51	20	31	14	27	29
92-94	15	29	14	22	20	48	38	25	19	4	21	21
94-96	13	32	9	11	18	31	25	15	17	8	19	18
96-98	8	8	13	12	20	17	18	17	18	10	20	17
98-100	4	17	12	8	17	17	18	13	13	1	13	10
>100	71	63	85	100	110	117	126	92	87	45	118	140
Total	141	262	211	210	256	409	357	207	214	119	251	264

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

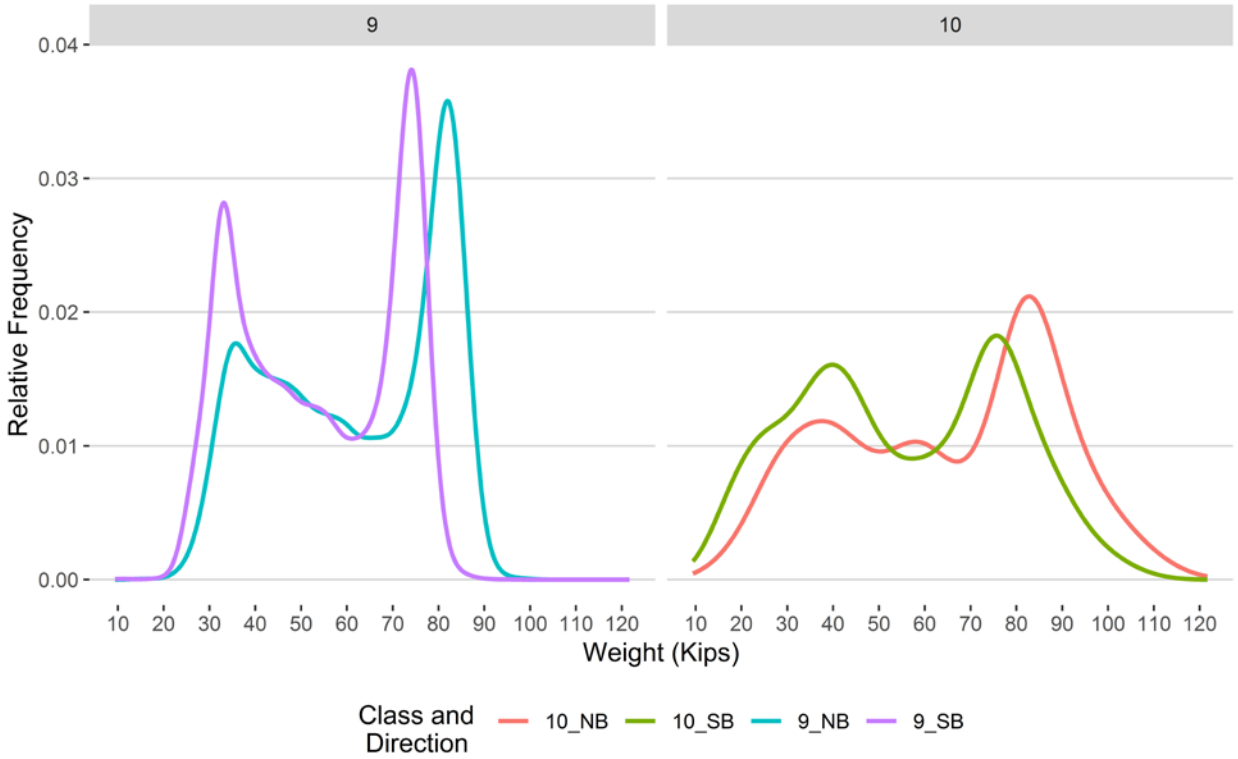


Figure 9 - Freight Percentage by Direction and Class

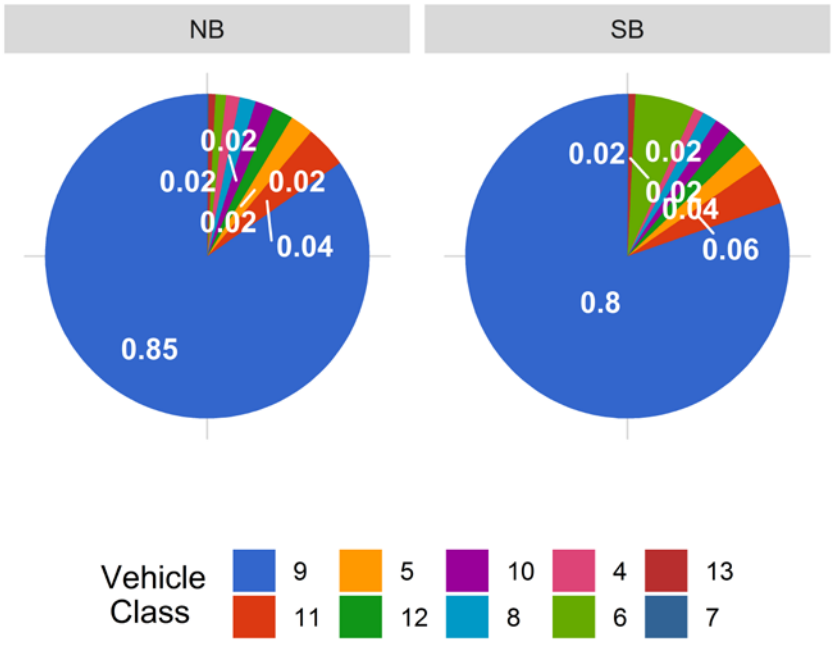


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

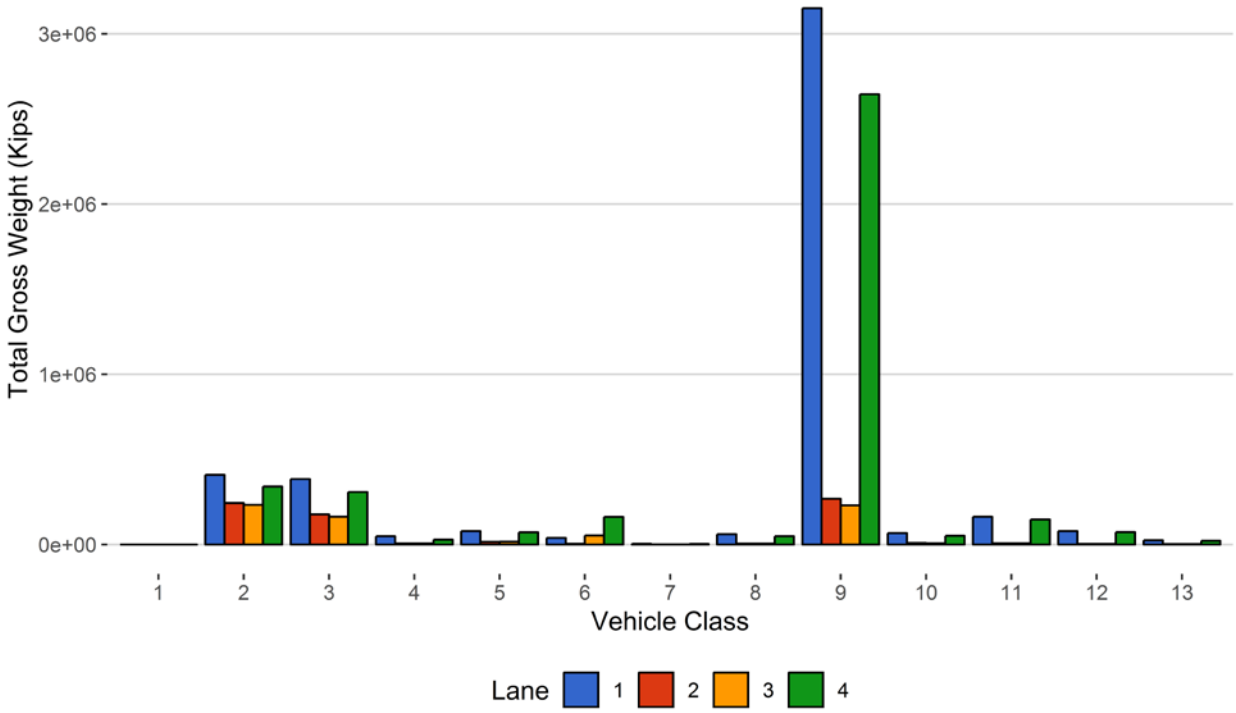


Figure 11 - Total Gross Vehicle Weight b

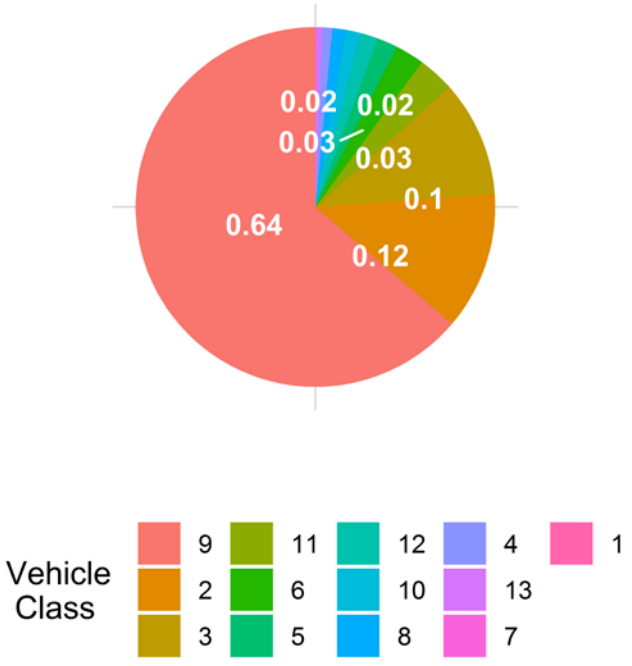


Figure 12 - Total ESALs by Class and Lane

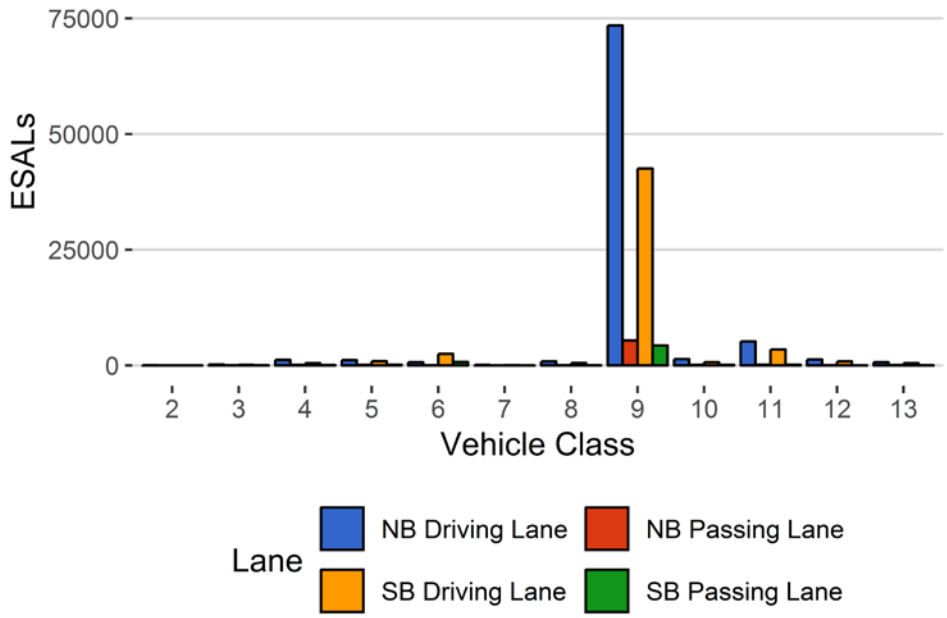


Figure 13 - ESALs by Class

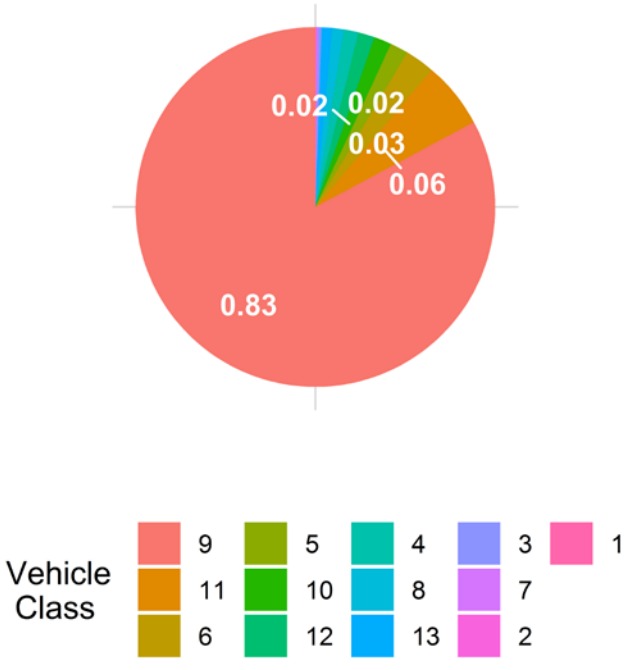


Table 1 Class 9 Front Axle Weight by Lane

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

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	1	29	0	0	0
2	10370	311102	50	0	0
3	5346	160366	25.8	0	0
4	102	3064	0.5	294	1.3
5	419	12581	2	206	0.9
6	294	8812	1.4	423	1.9
7	7	206	0	42	0.2
8	125	3749	0.6	129	0.6
9	3718	111535	17.9	19926	87.9
10	76	2278	0.4	617	2.7
11	178	5327	0.9	555	2.4
12	86	2572	0.4	102	0.4
13	18	531	0.1	377	1.7
TOTAL	**20738**	**622152**	**100**	**22671**	**100**

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

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-04-03	Wednesday	20:26:40	10	NB	1	121.69
2019-04-09	Tuesday	07:55:07	10	NB	1	114.52
2019-04-06	Saturday	16:27:51	10	NB	1	113.84
2019-04-04	Thursday	08:36:41	10	NB	1	113.24
2019-04-03	Wednesday	22:28:00	10	NB	1	113.14
2019-04-07	Sunday	14:39:06	10	NB	1	112.98
2019-04-02	Tuesday	11:15:12	10	NB	1	112.66
2019-04-18	Thursday	14:05:49	10	NB	2	112.42
2019-04-01	Monday	03:02:11	10	NB	1	112.12
2019-04-07	Sunday	14:21:28	10	NB	1	111.11

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	1826	146	8	52760	1969	13780
5	NB	8	6252	511	8.2	89870	3682	21971
6	NB	19	1523	299	19.6	37685	5267	7214
7	NB	11.5	118	0	0	5122	0	1883
8	NB	31	1962	754	38.4	47697	17375	5124
9	NB	33	55170	3318	6	3319123	99604	804004
10	NB	33.5	1157	151	13.1	71184	4055	18742
11	NB	36.5	2590	53	2	167830	1514	37615
12	NB	36.5	1267	16	1.3	81808	358	18073
13	NB	31.5	275	0	0	27402	0	9370
TOTAL	****	****	**72140**	**5248**	****	**3900481**	****	**937775**
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	1144	146	12.8	32693	1906	8861
5	SB	8	5943	619	10.4	82718	4470	20063
6	SB	19	7018	527	7.5	205436	9287	41054
7	SB	11.5	82	1	1.2	3847	10	1458
8	SB	31	1672	793	47.4	34315	18829	3533
9	SB	33	52941	7658	14.5	2645942	228137	575801
10	SB	33.5	1051	202	19.2	53646	4892	12602
11	SB	36.5	2573	131	5.1	148967	4555	29917
12	SB	36.5	1226	15	1.2	74173	424	14986
13	SB	31.5	240	0	0	24383	0	8412
TOTAL	****	****	**73890**	**10092**	****	**3306120**	****	**716687**
GRAND TOTAL	****	****	**146030**	**15340**	**216**	**7206602**	**406334**	**1654462**

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	13	11	2	10	35	0
2	409167	243693	232949	339543	1225352	12.4
3	383917	177075	162827	308289	1032108	10.5
4	48443	6287	6156	28443	89328	0.9
5	78662	14889	16108	71079	180739	1.8
6	38345	4607	52645	162078	257676	2.6
7	4645	477	373	3484	8979	0.1
8	59824	5248	4911	48233	118216	1.2
9	3150240	268487	229510	2644568	6292806	63.8
10	66459	8780	7232	51306	133777	1.4
11	162773	6572	6809	146713	322866	3.3
12	78717	3450	2833	71764	156763	1.6
13	24634	2768	2631	21752	51785	0.5
TOTAL	**4505839**	**742343**	**724986**	**3897263**	**9870431**	**100**
GVW/LANE	**45.65**	**7.52**	**7.35**	**39.48**	**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	0.0345
2	53	30	30	37	150	0.1	0.001
3	220	68	60	135	482	0.32	0.0062
4	1224	129	116	527	1996	1.31	1.34
5	1201	159	184	922	2467	1.62	0.4
6	710	70	773	2510	4063	2.68	0.95
7	134	10	8	65	217	0.14	2.13
8	910	66	60	558	1594	1.05	0.88
9	73468	5415	4328	42561	125772	82.82	2.33
10	1384	150	128	735	2398	1.58	2.17
11	5215	181	190	3484	9071	5.97	3.51
12	1288	49	37	873	2247	1.48	1.8
13	720	86	67	530	1403	0.92	5.34
TOTAL	**86527**	**6415**	**5980**	**52938**	**151861**	**100**	**21**
ESALS/LANE	**57**	**4.2**	**3.9**	**34.9**	**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 %*
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
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
TOTAL	**7653944**	**–**	**–**	**5984046**	**–**	**1669898**	**–**	**–**	**–**
AVERAGE	**637829**	**20987**	**4568**	**498670**	**78**	**139158**	**22**	**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*
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
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
TOTAL	**974372**	**72011**	**77335**	**610135**	**1733852**	**–**	**–**	**–**
AVERAGE	**81198**	**6001**	**6445**	**50844**	**144488**	**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*
May 18	4186867	740631	818945	3906425	9652869
Jun 18	4025326	788976	859885	3638548	9312736
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
TOTAL	**51310783**	**8822564**	**9509455**	**43661340**	**113304142**
AVERAGE	**4275899**	**735214**	**792455**	**3638445**	**9442012**

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*
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
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
TOTAL	**283603**	**–**	**–**	**26026**	**3916**
AVERAGE	**23633.6**	**4**	**17.6**	**2168.8**	**326.3**

Freight

Month	*NB Freight Tons*	*SB Freight Tons*	*Total Freight*	*NB Freight %*	*SB Freight %*
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
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
TOTAL	**10539091**	**8007753**	**18546844**	**–**	**–**
AVERAGE	**878257.6**	**667312.7**	**1545570.4**	**57.3**	**42.7**