JULY 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 July 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: 768661 | Passenger Vehicles: 610235 | Heavy Commercial Vehicles: 158426

Monthly Average Daily Traffic (MADT): 25019 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 5111

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 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 158426 HCVs, 22517 of them were overweight [3]. These overweight HCVs contributed to 3% of total monthly volume, and 14.6% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Wednesdays, 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 93.4% 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 ,1166 NB vehicles exceeded 88,000 pounds (842 vehicles were Class 9's; 177 vehicles were Class 13's). Of vehicles traveling SB,

163 NB vehicles exceeded 88,000 pounds (112 vehicles were Class 13's; 37 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from July 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in July 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 1669150 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (59.1%) than SB (40.9%). 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 768661 vehicles with a combined GVW of 10841395 kips (1 kip = 1,000 pounds = 0.5 tons) in July 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 152388 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 64.4% of all ESALs were recorded NB while 35.6% was observed SB. In particular, 82% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 59% 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

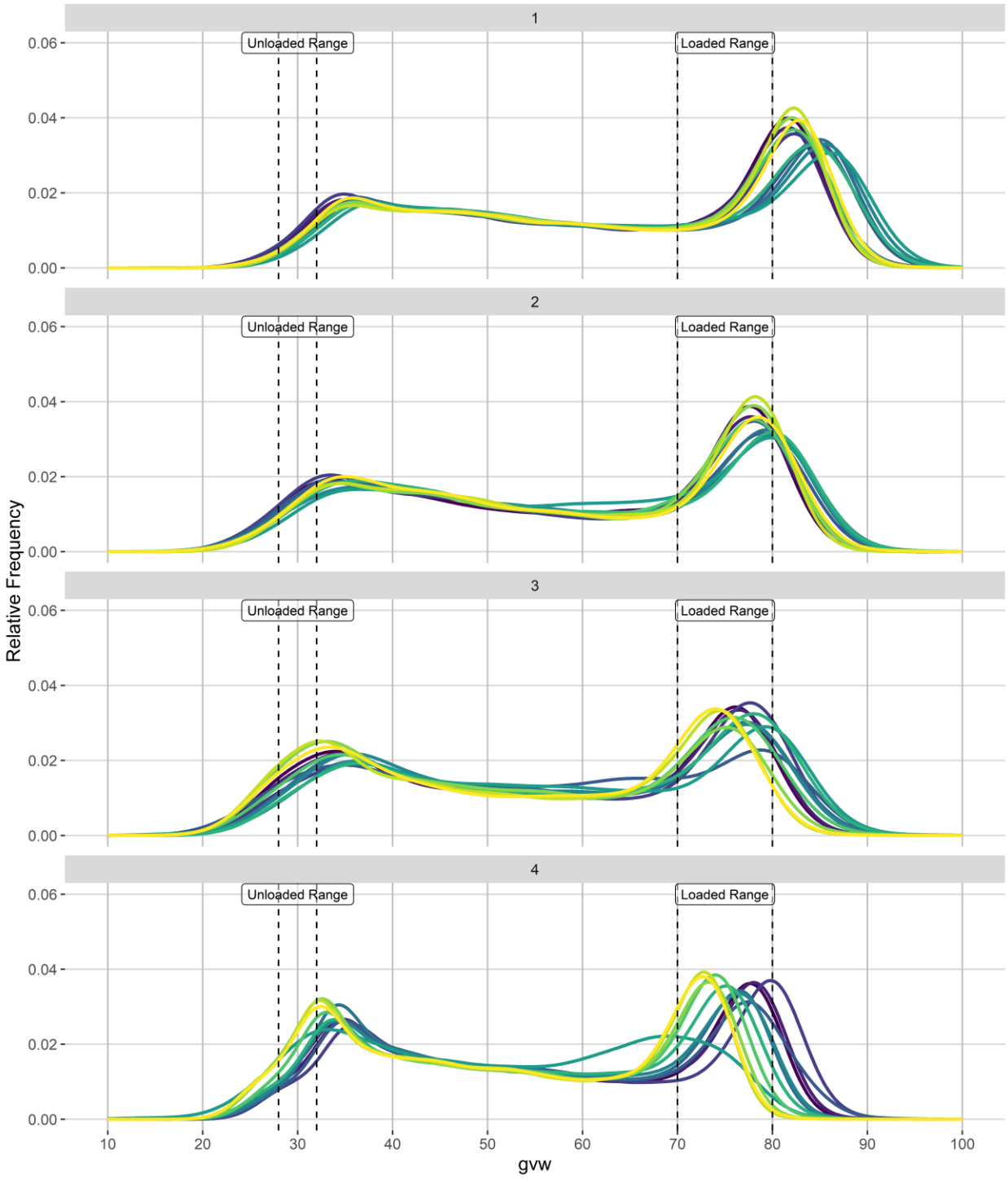
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [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

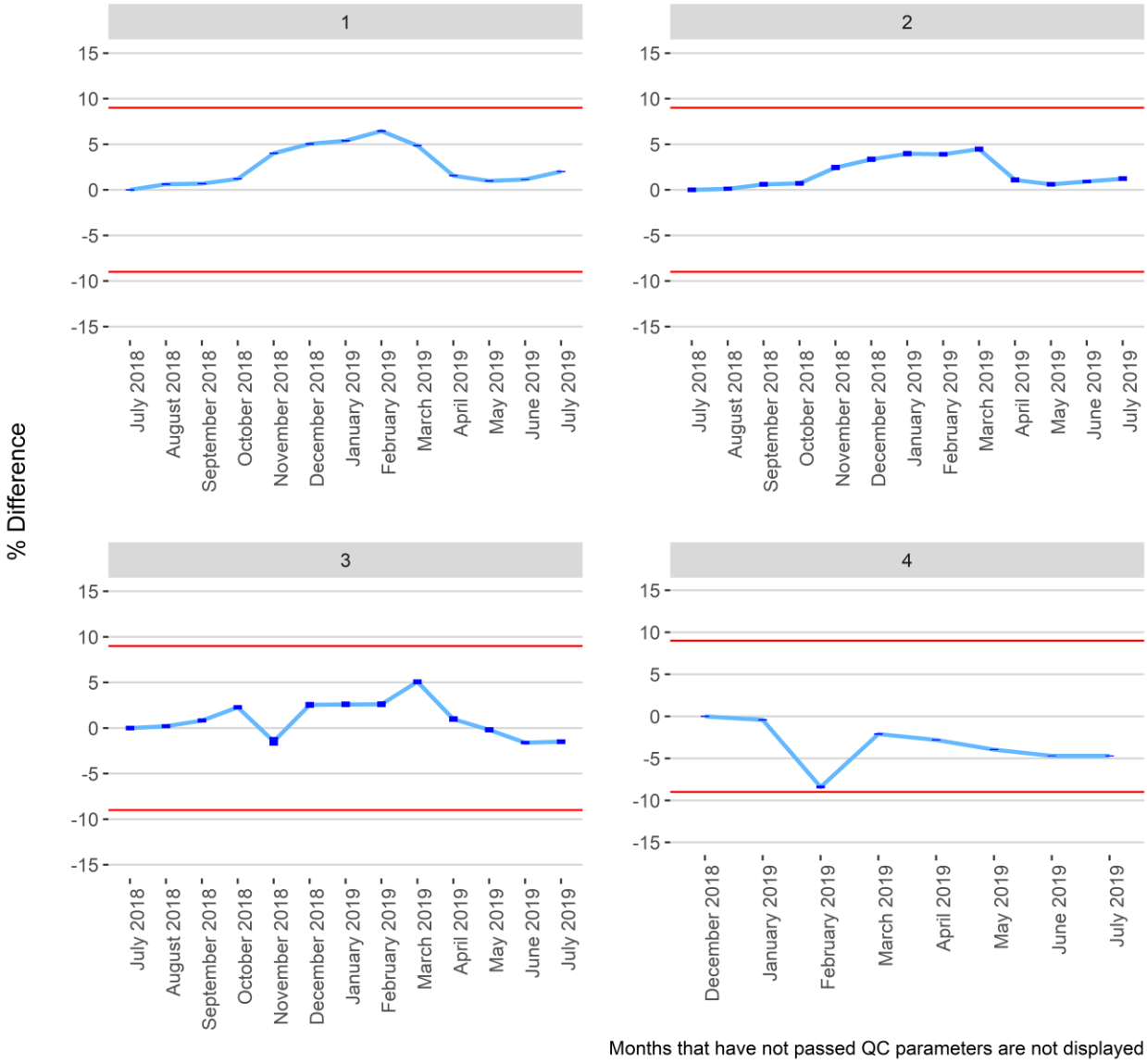
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened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

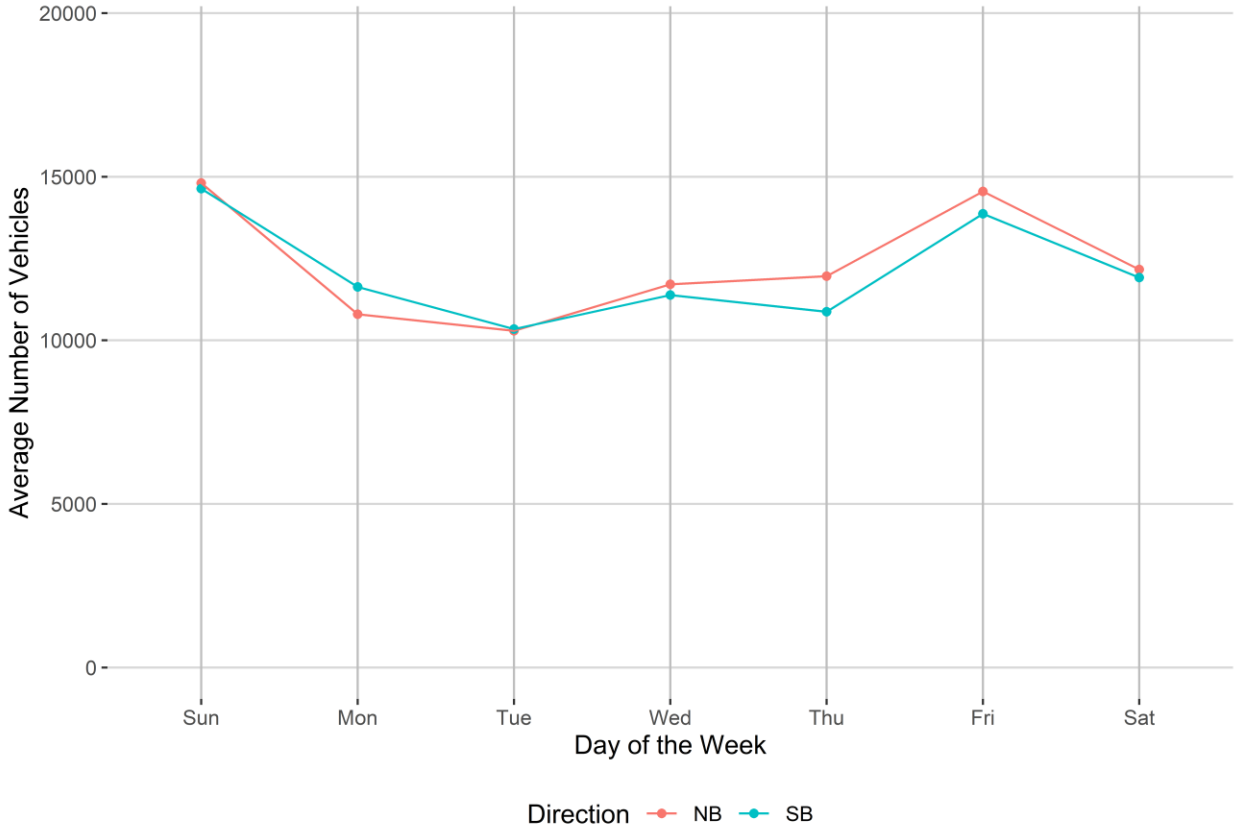


Figure 3 - Average Overweight Vehicle Volume
vs. Day of the Week

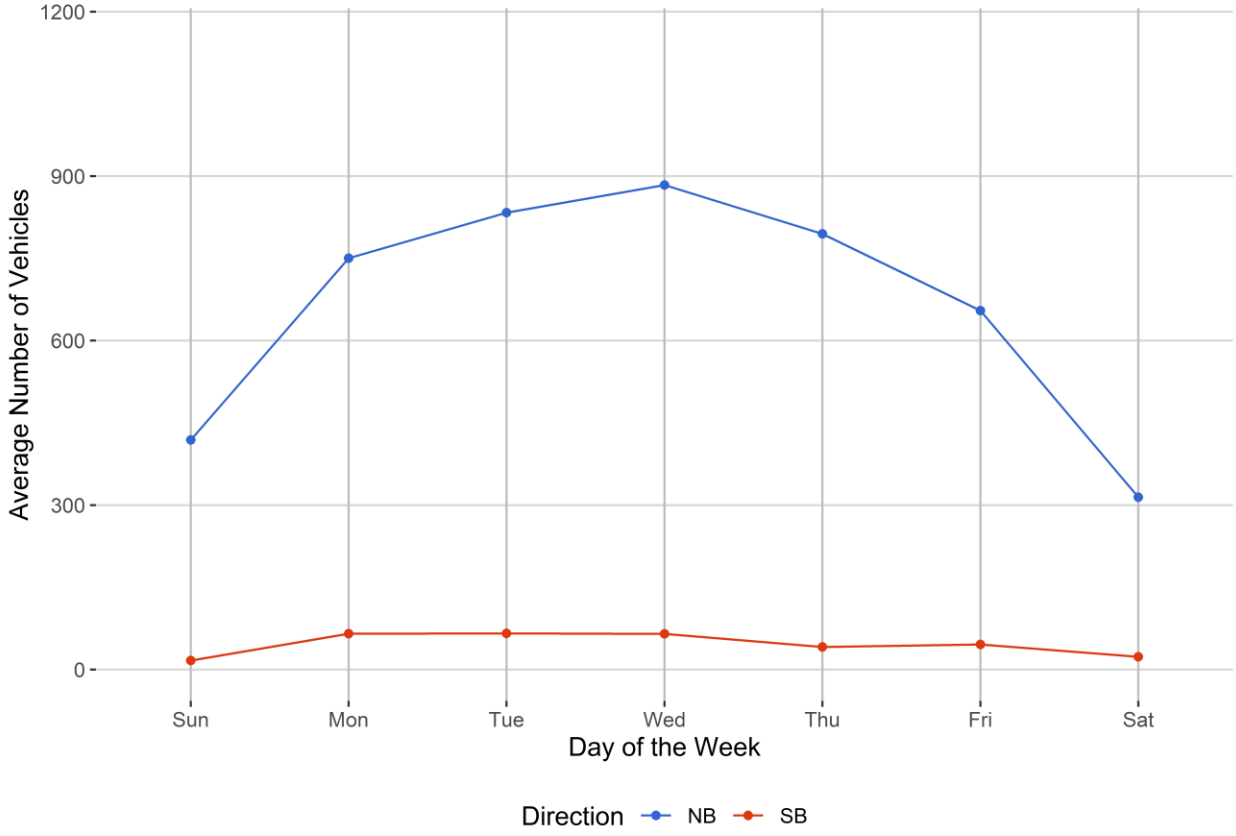


Figure 4 - Passenger Vehicles
vs. Hour of the Day

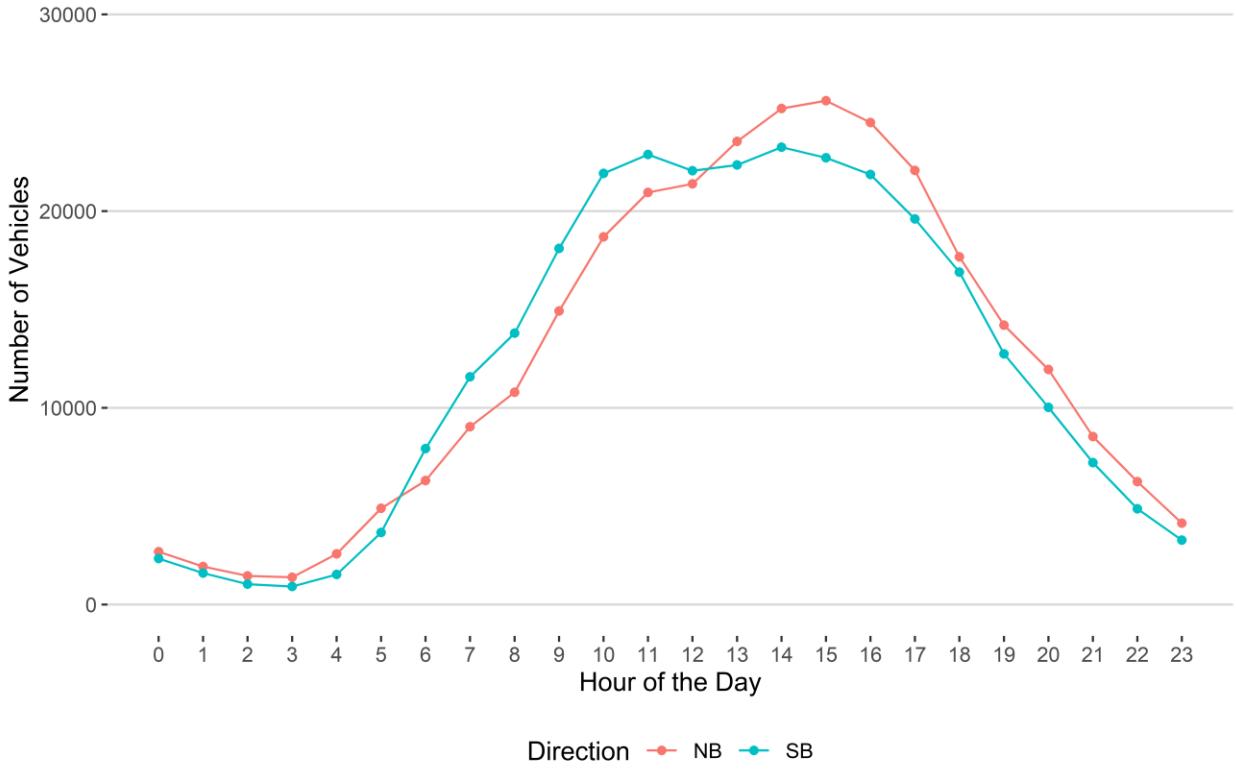


Figure 5 - Heavy Commercial Vehicles
vs. Hour of the Day

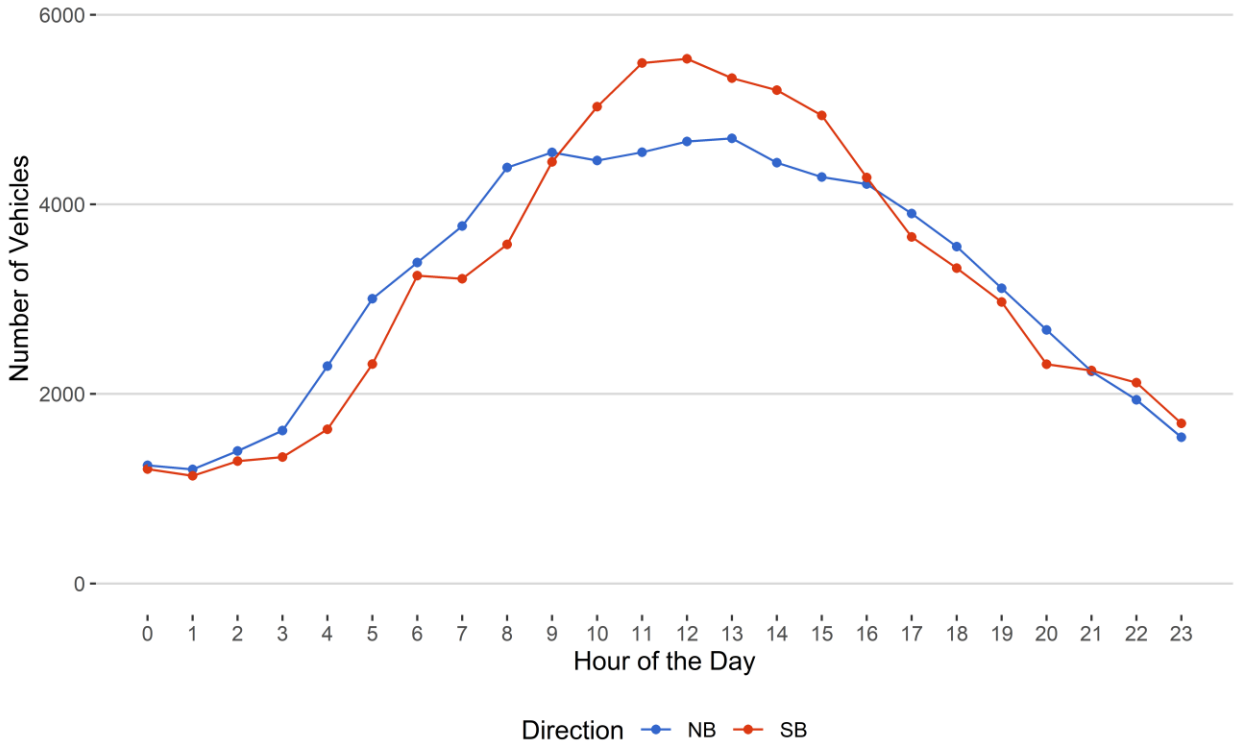


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

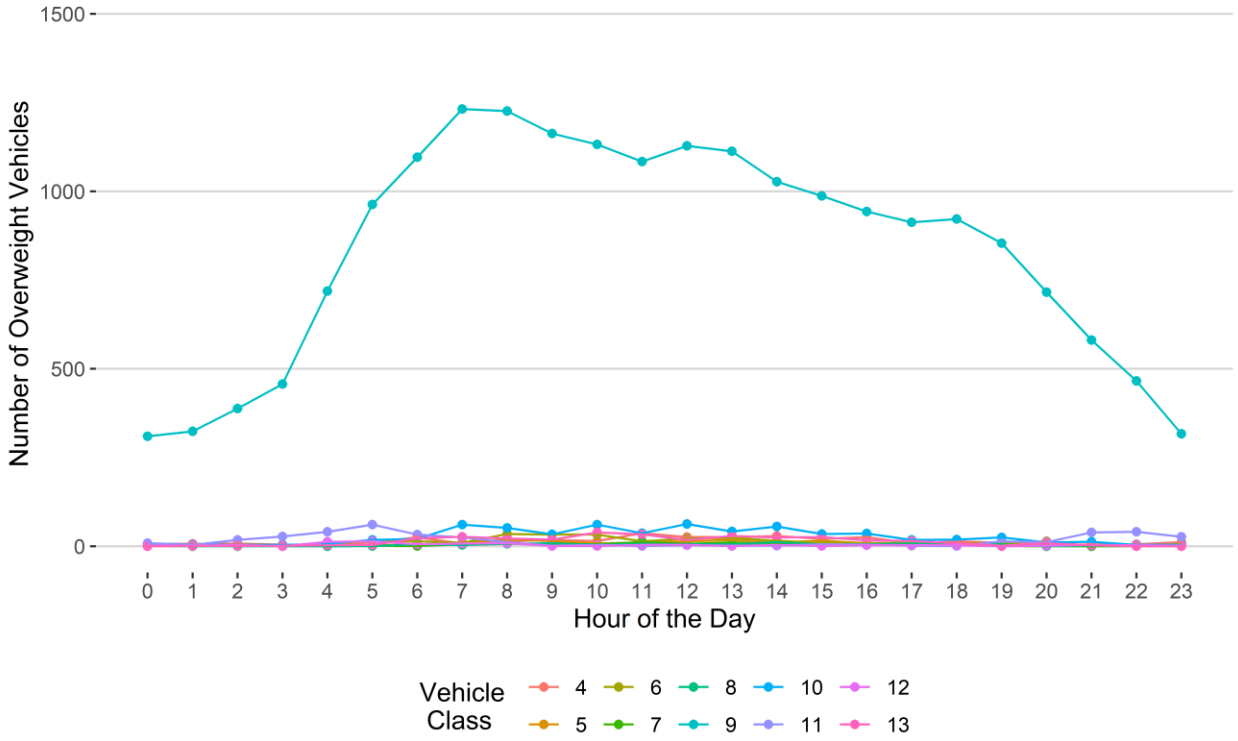


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

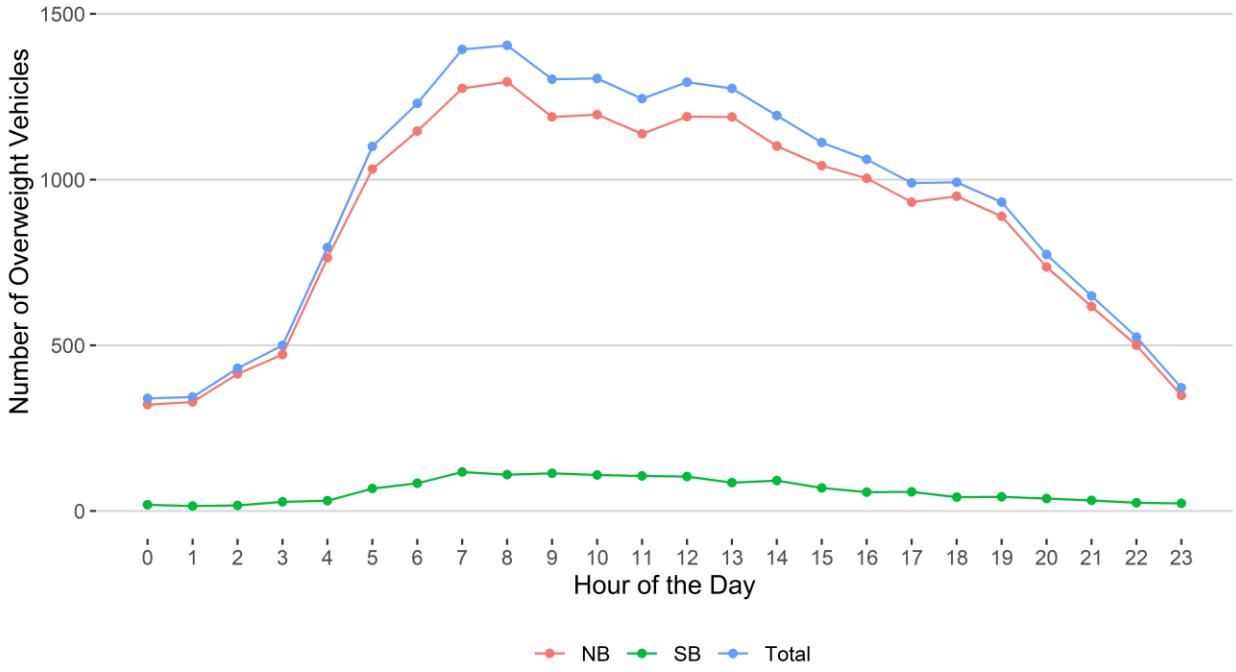
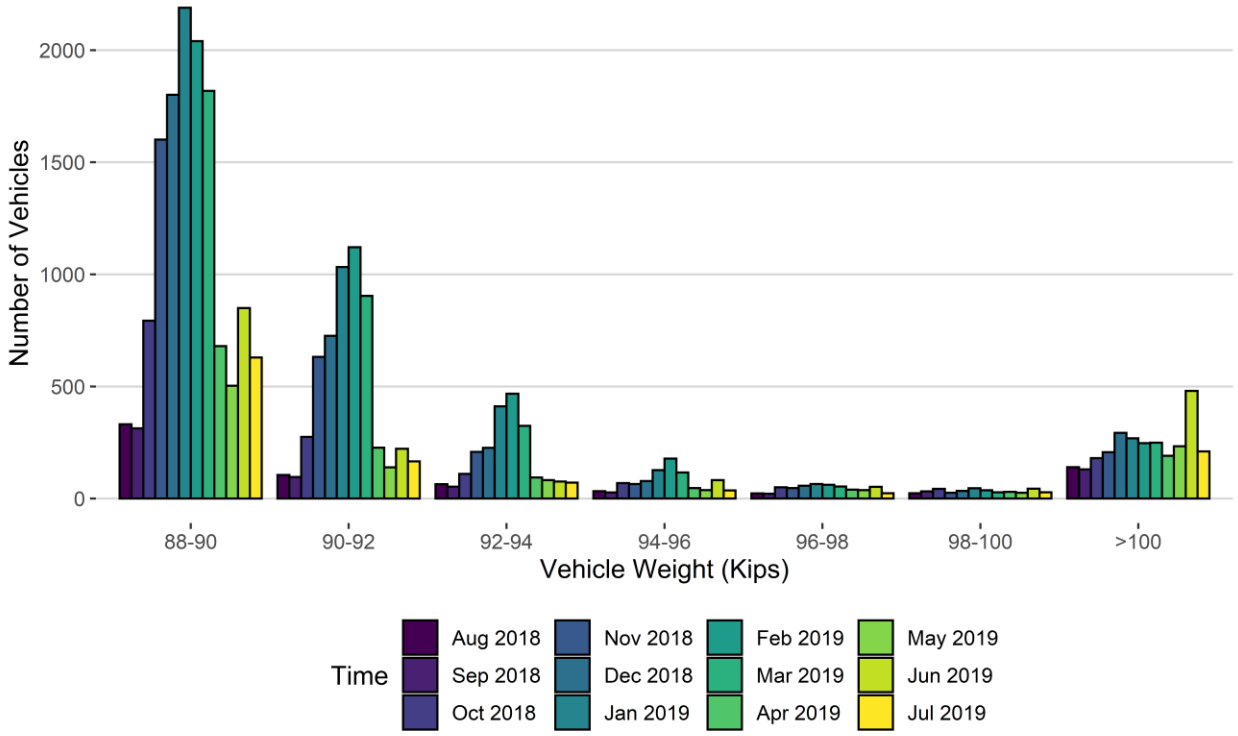
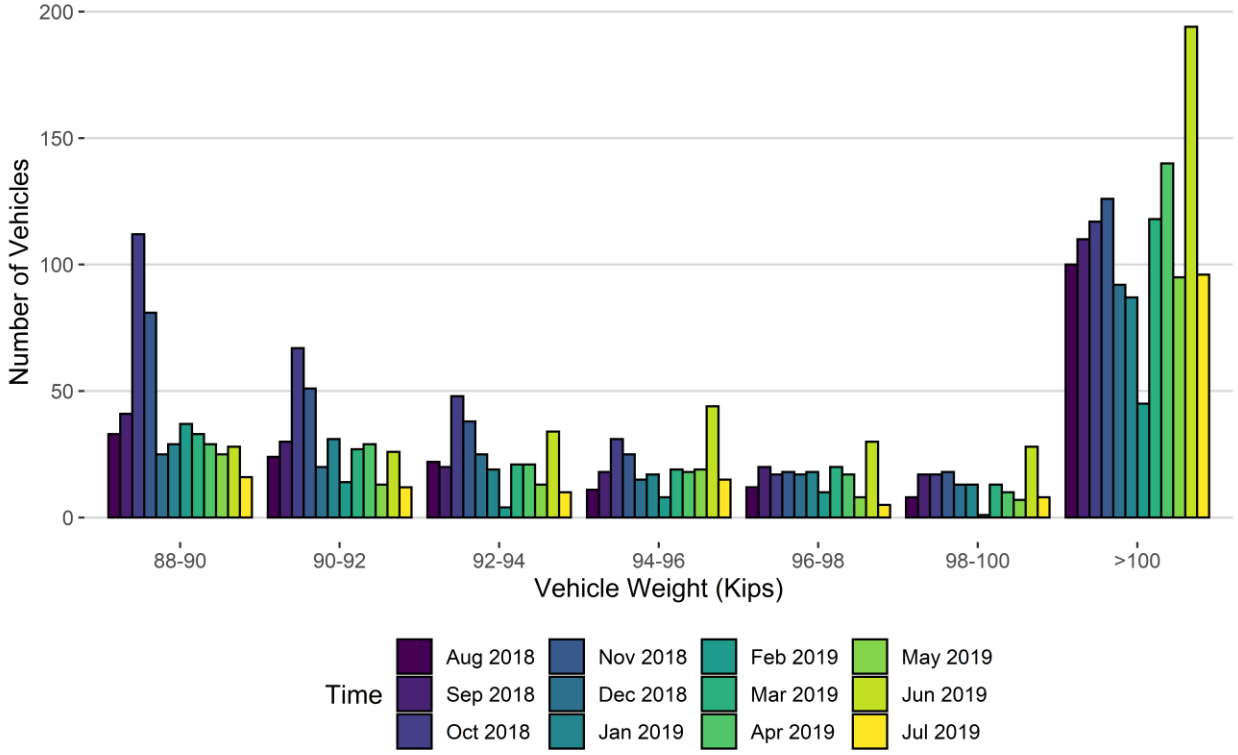


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Aug 2018*	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*
88-90	331	313	793	1601	1801	2189	2040	1818	680	503	850	629
90-92	105	96	275	632	726	1033	1121	904	227	139	222	166
92-94	64	53	110	208	226	411	468	324	94	82	76	71
94-96	33	27	69	65	78	127	178	116	47	38	82	36
96-98	23	22	50	47	57	65	61	54	40	38	52	24
98-100	24	32	43	26	34	46	37	28	30	26	44	28
>100	140	130	180	207	293	269	247	249	191	233	480	210
Total	720	673	1520	2786	3215	4140	4152	3493	1309	1059	1806	1164

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



Vehicle Weights (Kips)	*Aug 2018*	*Sep 2018*	*Oct 2018*	*Nov 2018*	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*
88-90	33	41	112	81	25	29	37	33	29	25	28	16
90-92	24	30	67	51	20	31	14	27	29	13	26	12
92-94	22	20	48	38	25	19	4	21	21	13	34	10
94-96	11	18	31	25	15	17	8	19	18	19	44	15
96-98	12	20	17	18	17	18	10	20	17	8	30	5
98-100	8	17	17	18	13	13	1	13	10	7	28	8
>100	100	110	117	126	92	87	45	118	140	95	194	96
Total	210	256	409	357	207	214	119	251	264	180	384	162

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

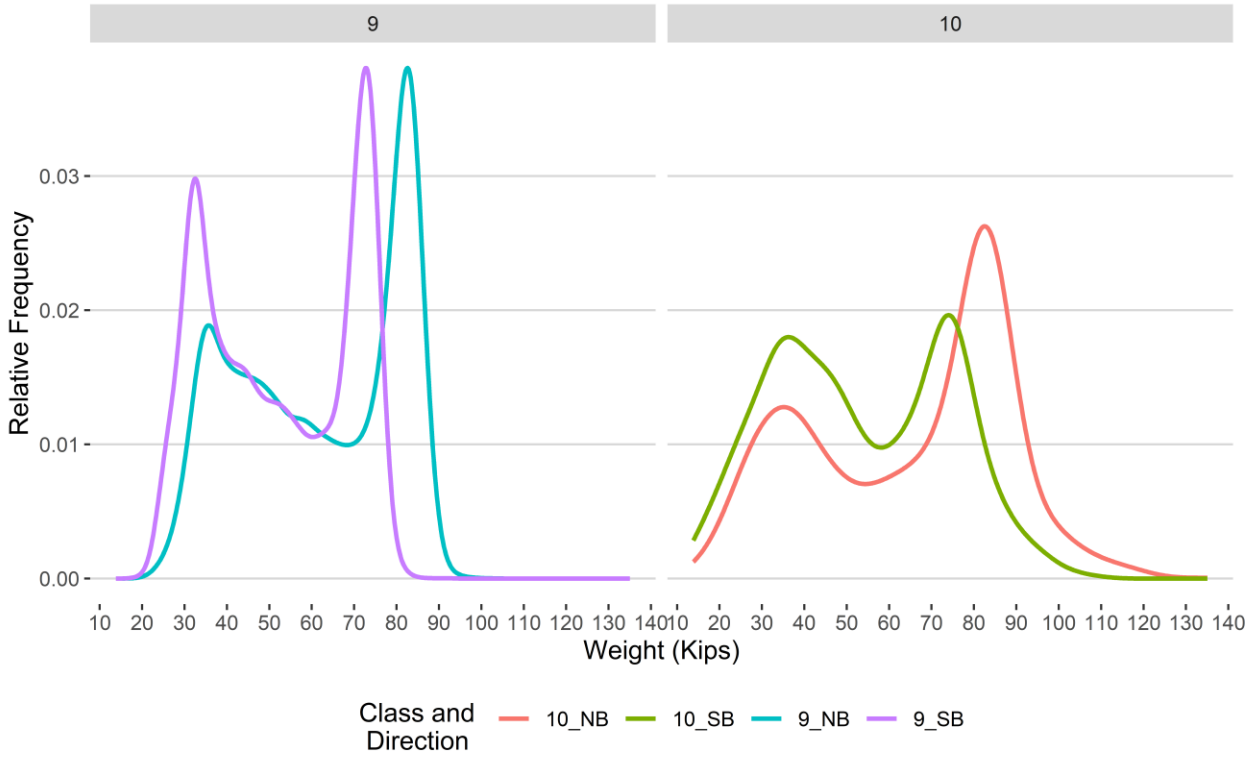


Figure 9 - Freight Percentage by Direction and Class

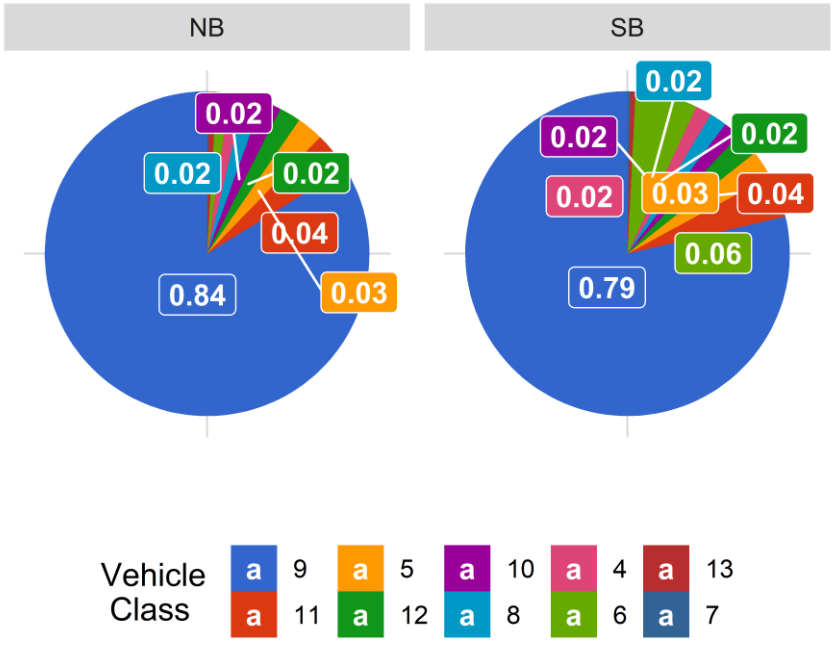


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

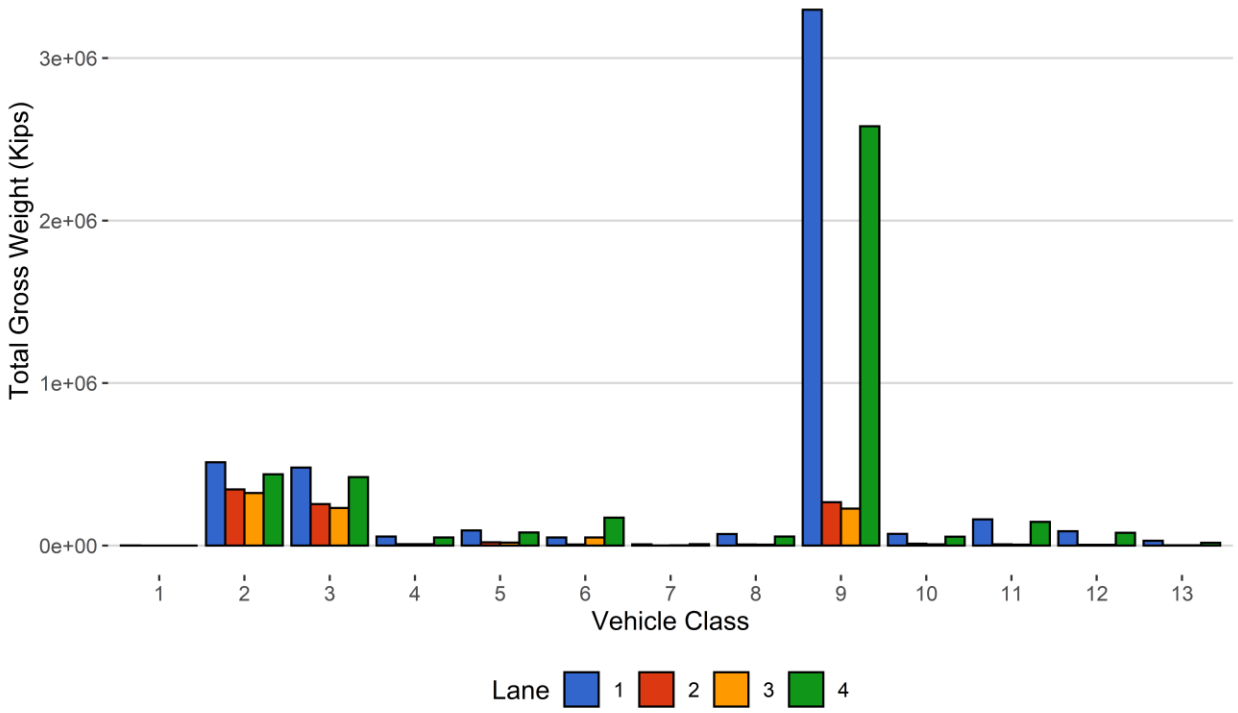


Figure 11 - Total Gross Vehicle Weight b

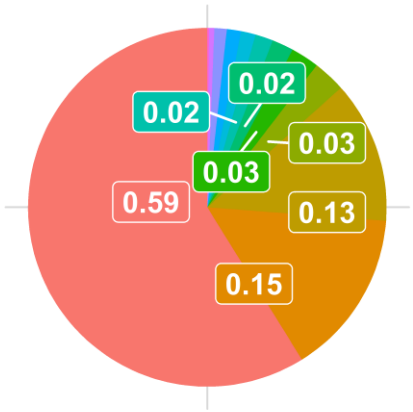


Figure 12 - Total ESALs by Class and Lane

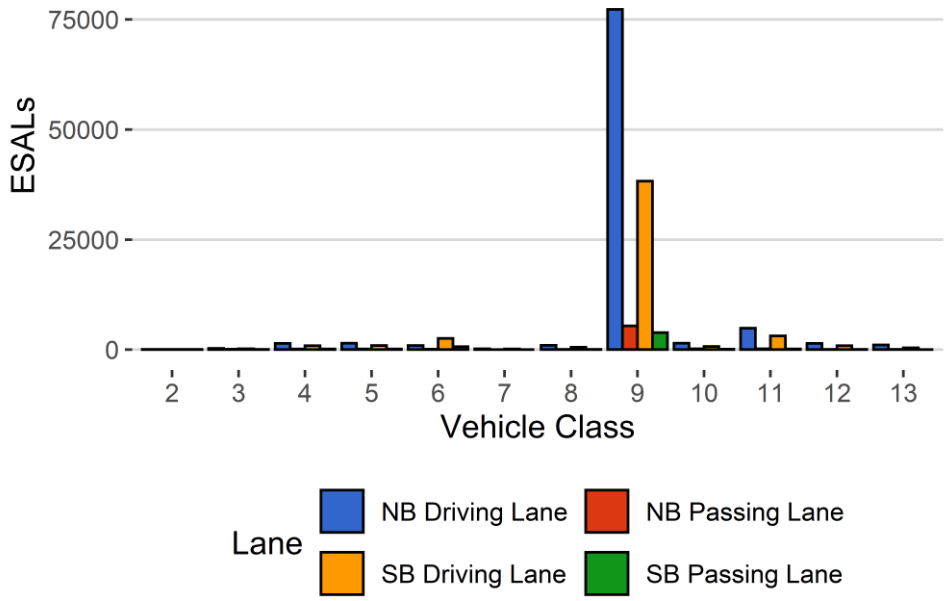


Figure 13 - ESALs by Class

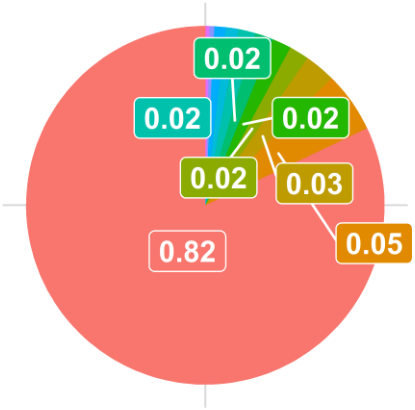


Table 1 Class 9 Front Axle Weight by Lane

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	1.15	11.40	0.92	11.28	-1.60	10.77	-4.69
July 2019	11.91	2.01	11.44	1.23	11.29	-1.50	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	4	114	0	0	0
2	12888	399529	52	0	0
3	6793	210592	27.4	0	0
4	135	4175	0.5	348	1.5
5	473	14677	1.9	185	0.8
6	307	9511	1.2	291	1.3
7	12	376	0	79	0.4
8	147	4557	0.6	100	0.4
9	3674	113901	14.8	20061	89.1
10	80	2469	0.3	639	2.8
11	173	5361	0.7	392	1.7
12	94	2900	0.4	94	0.4
13	16	501	0.1	328	1.5
TOTAL	**24796**	**768661**	**100**	**22517**	**100**

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

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-07-08	Monday	04:46:03	10	NB	1	135.05
2019-07-28	Sunday	16:01:20	10	NB	1	122.41
2019-07-02	Tuesday	18:08:49	10	NB	1	119.67
2019-07-11	Thursday	20:58:08	10	NB	1	119.41
2019-07-20	Saturday	13:06:28	10	NB	1	117.15
2019-07-10	Wednesday	19:51:38	10	NB	1	116.23
2019-07-27	Saturday	06:21:45	10	NB	1	116.04
2019-07-06	Saturday	20:11:50	10	NB	1	115.78
2019-07-12	Friday	10:03:39	10	NB	1	114.28
2019-07-17	Wednesday	13:21:16	10	NB	1	114.19

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	2065	164	7.9	61467	2166	16476
5	NB	8	7420	471	6.3	109102	3448	26755
6	NB	19	1922	314	16.3	49823	5476	9635
7	NB	11.5	164	0	0	8238	0	3176
8	NB	31	2359	1009	42.8	53511	22979	5830
9	NB	33	57628	3405	5.9	3462207	102482	836424
10	NB	33.5	1272	176	13.8	77798	4784	20541
11	NB	36.5	2603	66	2.5	166105	1808	36752
12	NB	36.5	1410	12	0.9	91412	289	20192
13	NB	31.5	297	0	0	31189	0	10917
TOTAL	****	****	**77140**	**5617**	****	**4110849**	****	**986698**
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	2011	229	11.4	54469	2986	13869
5	SB	8	6910	849	12.3	91774	6136	21643
6	SB	19	7364	667	9.1	209277	11773	41017
7	SB	11.5	203	0	0	9781	0	3723
8	SB	31	2090	1196	57.2	34086	27073	3186
9	SB	33	53582	9658	18	2523219	284596	536863
10	SB	33.5	1139	218	19.1	55444	5631	12295
11	SB	36.5	2631	263	10	142043	8636	27806
12	SB	36.5	1421	27	1.9	82470	634	15795
13	SB	31.5	192	0	0	18558	0	6255
TOTAL	****	****	**77543**	**13107**	****	**3221120**	****	**682452**
GRAND TOTAL	****	****	**154683**	**18724**	**235**	**7331970**	**490897**	**1669150**

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	77	34	8	37	157	0
2	511956	345524	322782	438442	1618704	14.9
3	479449	255421	231108	420652	1386631	12.8
4	55444	8189	7934	49521	121087	1.1
5	93124	19427	17686	80225	210461	1.9
6	49399	5899	49642	171408	276348	2.6
7	7361	876	1291	8490	18019	0.2
8	70223	6267	5710	55449	137649	1.3
9	3298118	266571	226693	2581122	6372504	58.9
10	71252	11329	6916	54158	143656	1.3
11	161137	6775	5360	145319	318591	2.9
12	87562	4139	4439	78666	174806	1.6
13	29335	1854	1529	17029	49747	0.5
TOTAL	**4914438**	**932307**	**881096**	**4100519**	**10828359**	**100**
GVW/LANE	**45.38**	**8.61**	**8.14**	**37.87**	**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	0.0089
2	70	52	39	47	208	0.14	0.0011
3	260	105	78	173	617	0.41	0.006
4	1421	159	129	908	2618	1.72	1.28
5	1466	162	138	940	2707	1.78	0.38
6	922	107	661	2538	4228	2.78	0.91
7	203	18	23	153	397	0.26	2.14
8	994	81	50	554	1679	1.1	0.76
9	77278	5398	3854	38271	124802	82.07	2.25
10	1472	199	97	730	2498	1.64	2.07
11	4885	194	136	3126	8340	5.48	3.18
12	1410	54	52	878	2394	1.57	1.69
13	1062	53	28	428	1572	1.03	6.29
TOTAL	**91445**	**6581**	**5287**	**48746**	**152059**	**100**	**21**
ESALS/LANE	**60.1**	**4.3**	**3.5**	**32.1**	**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 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	4860	540842	78.8	145802	21.2	89.9	10.1
Jul 2019	768661	25019	5111	610235	79.4	158425.9	20.6	90.1	9.9
TOTAL	**7573589**	**–**	**–**	**5877451**	**–**	**1696137**	**–**	**–**	**–**
AVERAGE	**631132**	**20849**	**4639**	**489788**	**77**	**141345**	**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*
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	176618	12961	10162	92490	292231	92	8	4.5
Jul 2019	91591	6594	5331	48872	152388	92	8	5.7
TOTAL	**1119073**	**84042**	**80133**	**653705**	**1936954**	**–**	**–**	**–**
AVERAGE	**93256**	**7004**	**6678**	**54475**	**161413**	**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*
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	9449507	1765631	1640133	7758002	20613273
Jul 19	4918947	932684	882748	4107016	10841395
TOTAL	**57579445**	**9950007**	**10217948**	**47730627**	**125478027**
AVERAGE	**4798287**	**829167**	**851496**	**3977552**	**10456502**

###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 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	43064	3.1	14.5	2202	754
Jul 2019	22559	3	14.5	1329	344
TOTAL	**323737**	**–**	**–**	**29135**	**4752**
AVERAGE	**26978.1**	**4.2**	**18.5**	**2427.9**	**396**

###Freight

Month	*NB Freight Tons*	*SB Freight Tons*	*Total Freight*	*NB Freight %*	*SB Freight %*
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	1933485	1289473	3222958	60	40
Jul 2019	986698	682452	1669150	59.1	40.9
TOTAL	**11982206**	**8640598**	**20622804**	**–**	**–**
AVERAGE	**998517.2**	**720049.8**	**1718567**	**58.4**	**41.6**