

AUGUST 2019



**WIM #39
MN 43, MP 45.2
WINONA, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #39 is located on MN 43 near Winona in Winona county.

System Operation

WIM #39 was operational for the entire month of August 2019. Volume was computed using all monthly data.

System Calibration

WIM #39 was most recently calibrated on 2019-06-02. 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: 357135 | Passenger Vehicles: 335033 | Heavy Commercial Vehicles: 22102

Monthly Average Daily Traffic (MADT): 11454 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 713

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. NB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays. SB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays (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 03 PM and 05 PM. Similarly, SB PVs peaked in volume between 06 AM and 04 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 03 PM and 05 PM, while volume going SB peaked between 06 AM 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 22102 HCVs, 4898 of them were overweight ³. These overweight HCVs contributed to 1.4% of total monthly volume, and 22.5% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Wednesdays, with lowest volumes reported on Saturdays. See Figure 3 .

The top two overweight violators by class were the class 9 and class 10 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 52.7% 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 April.

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 ,152 NB vehicles exceeded 88,000 pounds (72 vehicles were Class 9's; 50 vehicles were Class 12's). Of vehicles traveling SB,

110 NB vehicles exceeded 88,000 pounds (57 vehicles were Class 10's; 50 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from August 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in August 2019. Data suggests that there were greater numbers of empty Class 9's than fully_loaded 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 197227 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (51.6%) than NB (48.4%). See Table 4 and Figure 11 for more freight information.

####Infrastructure Considerations Bridge. Bridge No. 5930 is approximately 0.1 miles north of WIM #39, and Bridge No. 5900 is 0.3 miles south of WIM #39. WIM #39 recorded a total of 357135 vehicles with a combined GVW of 2464231 kips (1 kip = 1,000 pounds = 0.5 tons) in August 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 19667 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 50.4% of all ESALs were recorded NB while 49.6% was observed SB. In particular, 73% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 27% 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:

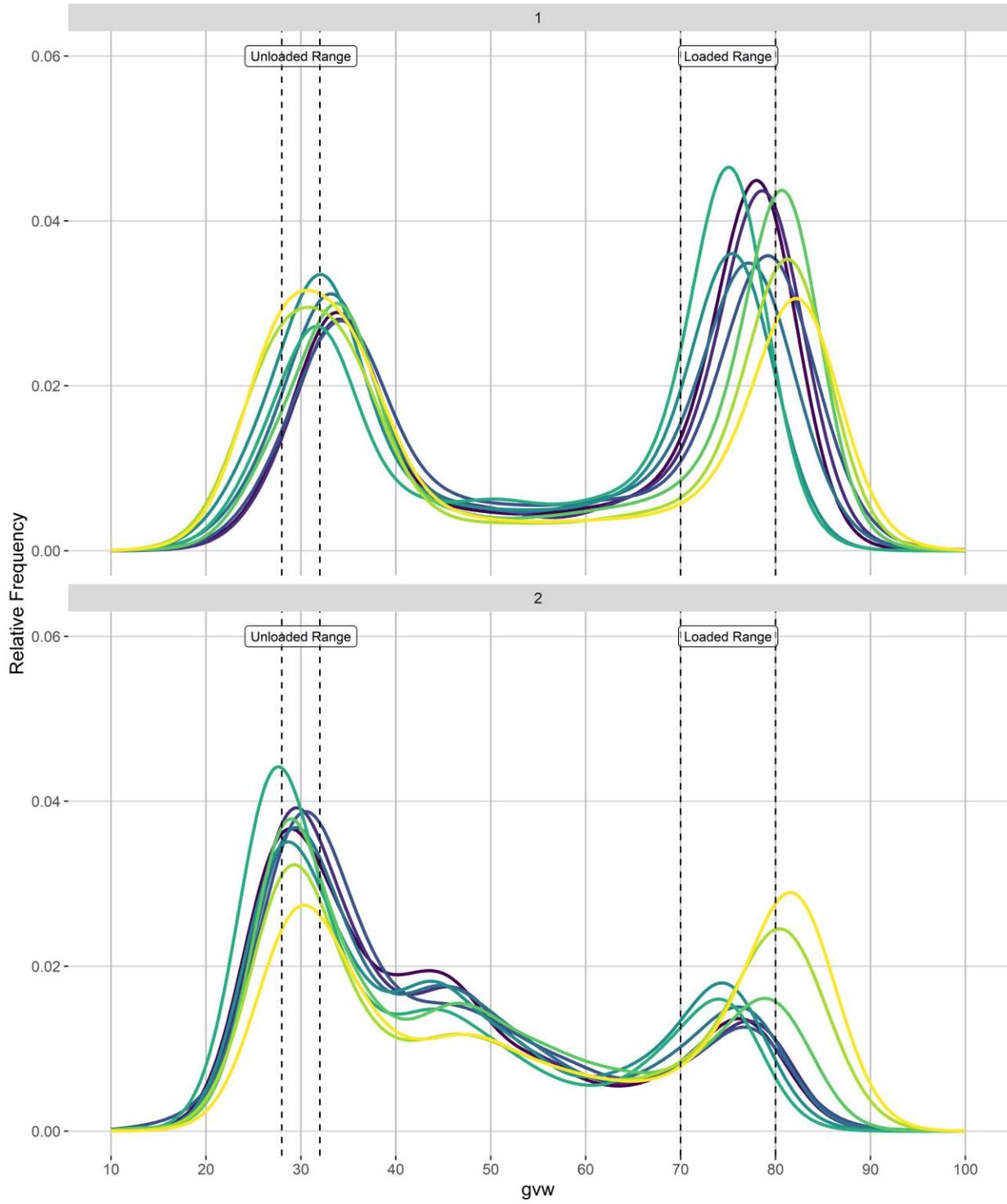
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

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.

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Figure 1 - Monthly Class 9 GVW Histogram

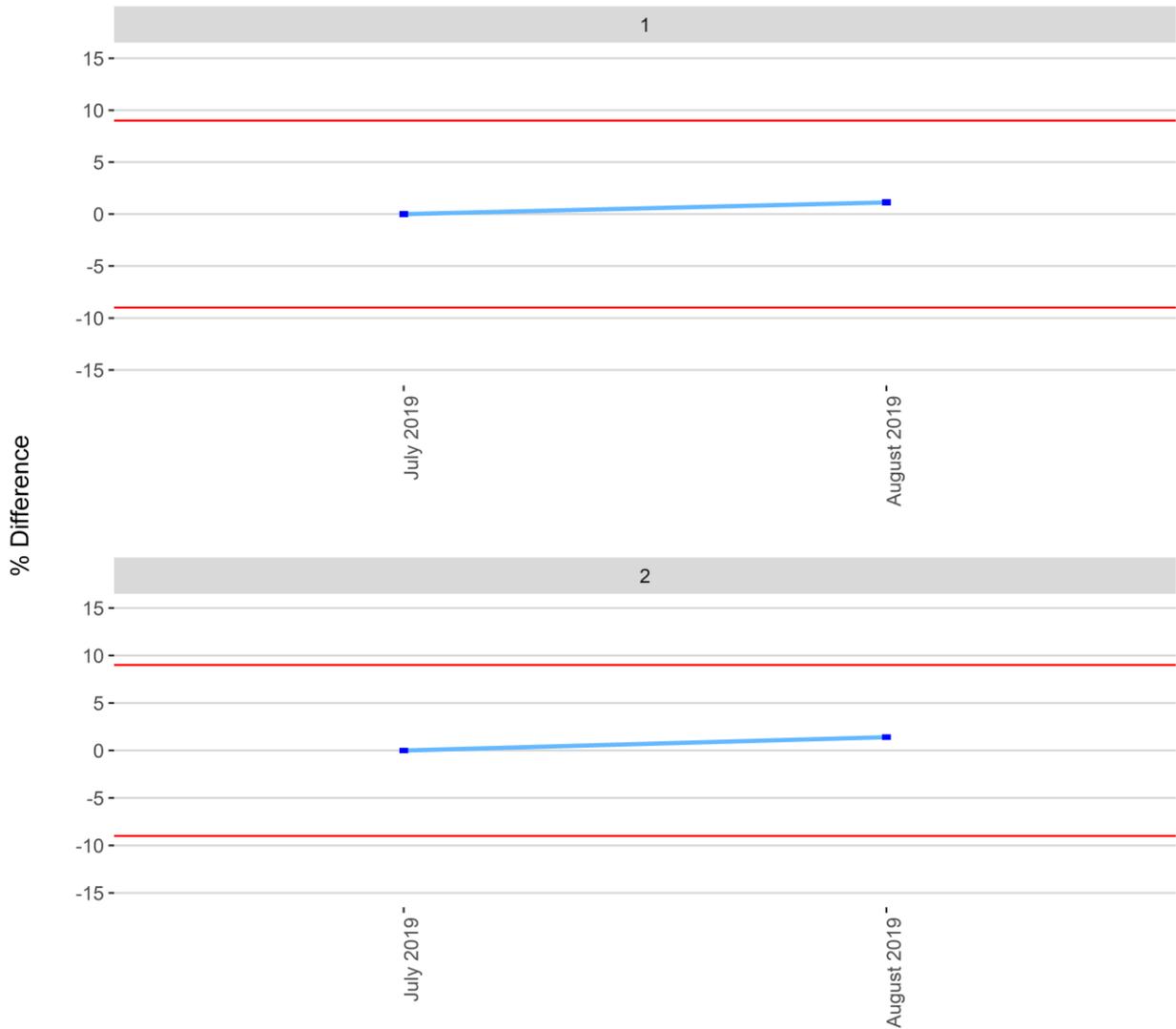


Time

December 2018	February 2019	April 2019	June 2019	August 2019
January 2019	March 2019	May 2019	July 2019	

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

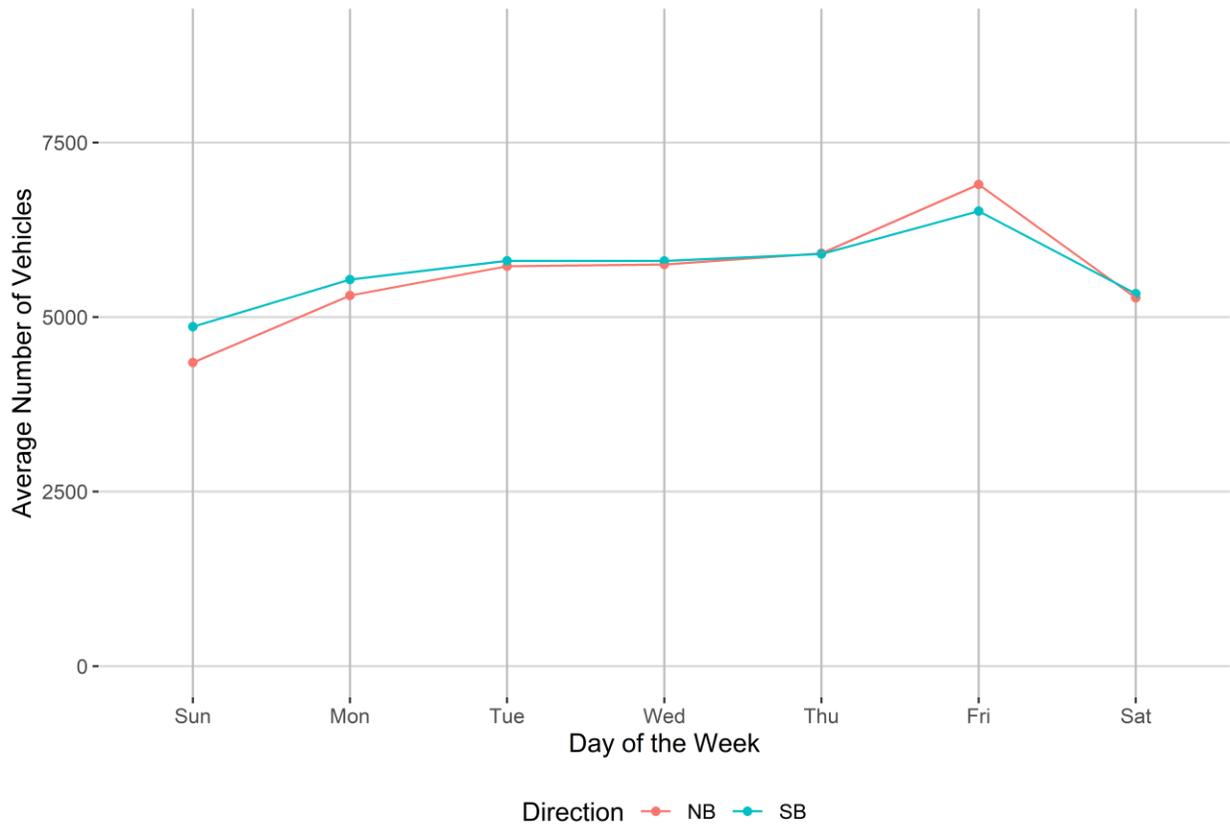


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

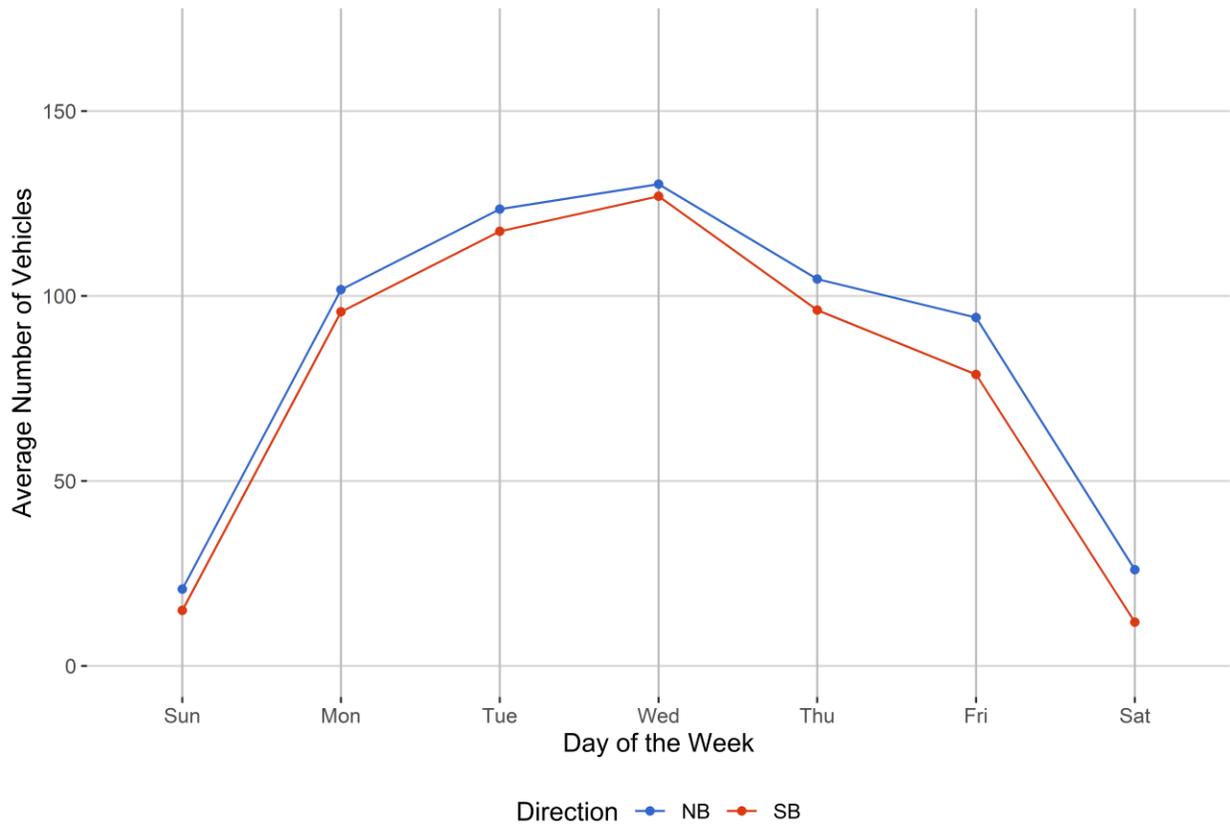


Figure 4 - Passenger Vehicles vs. Hour of the Day

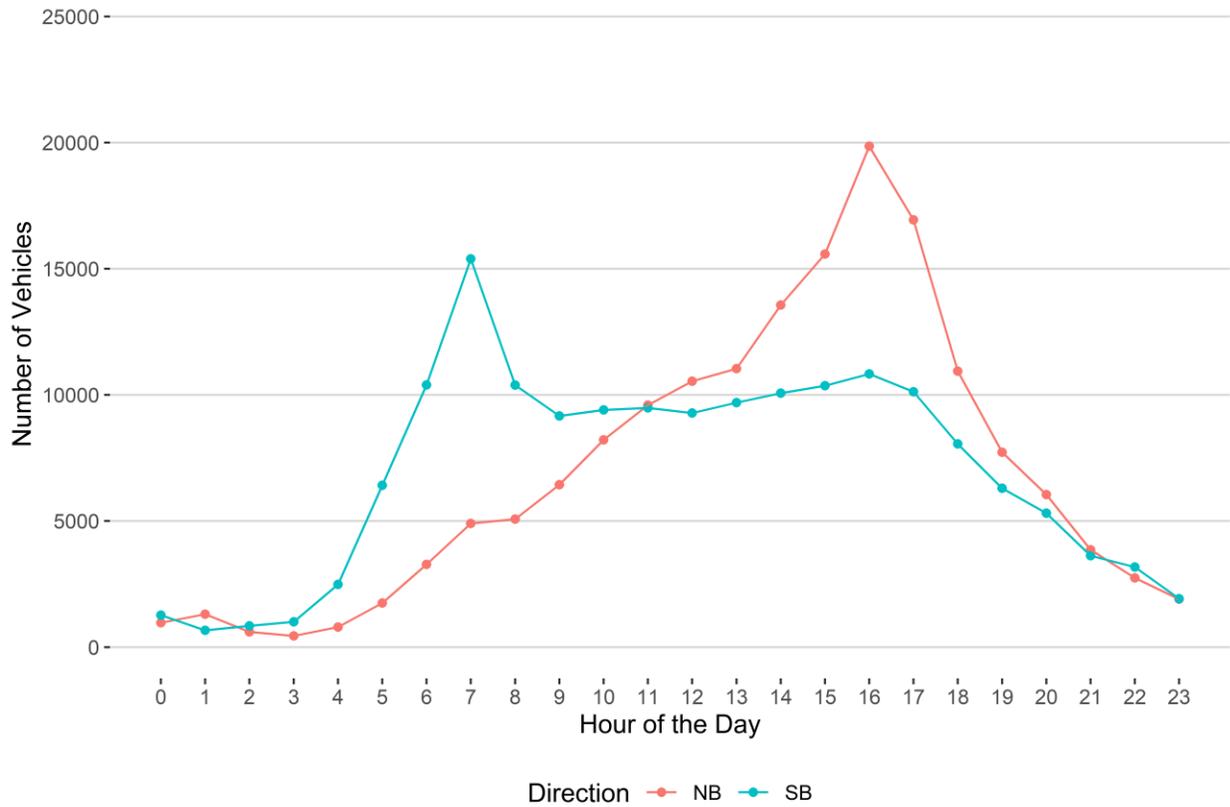


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

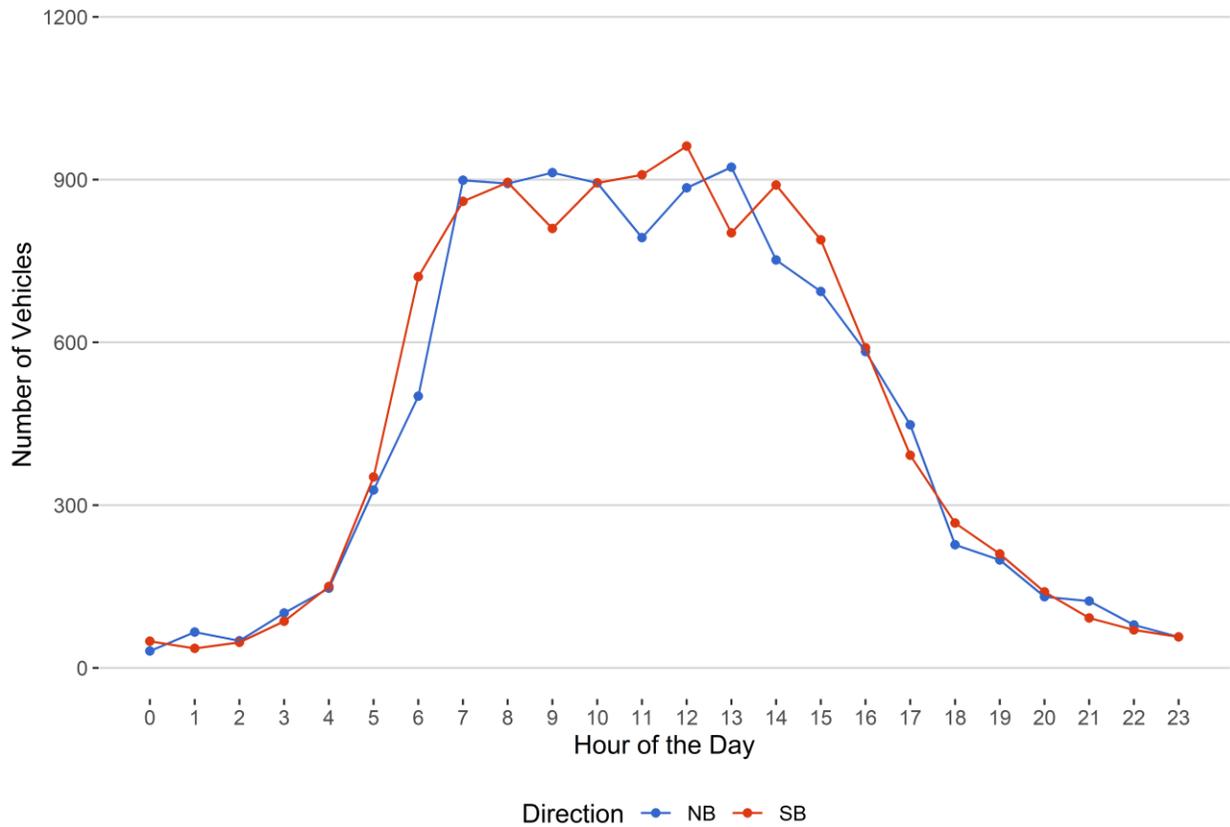


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

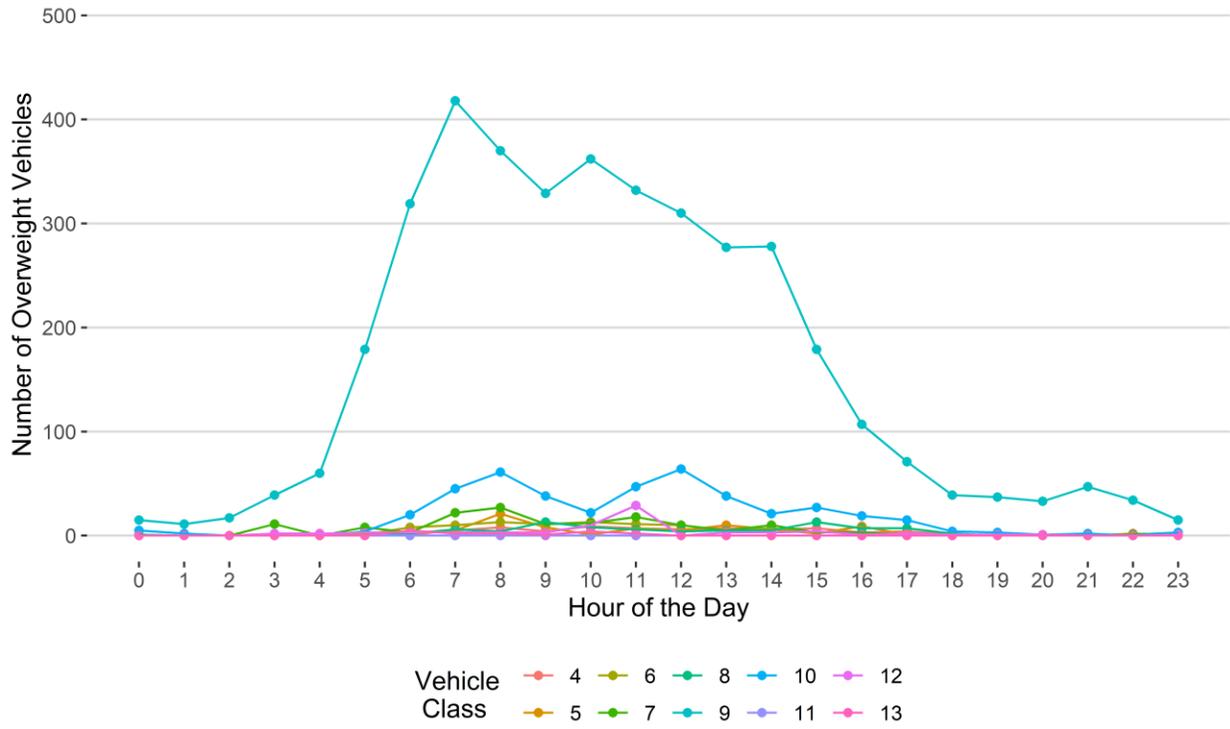


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

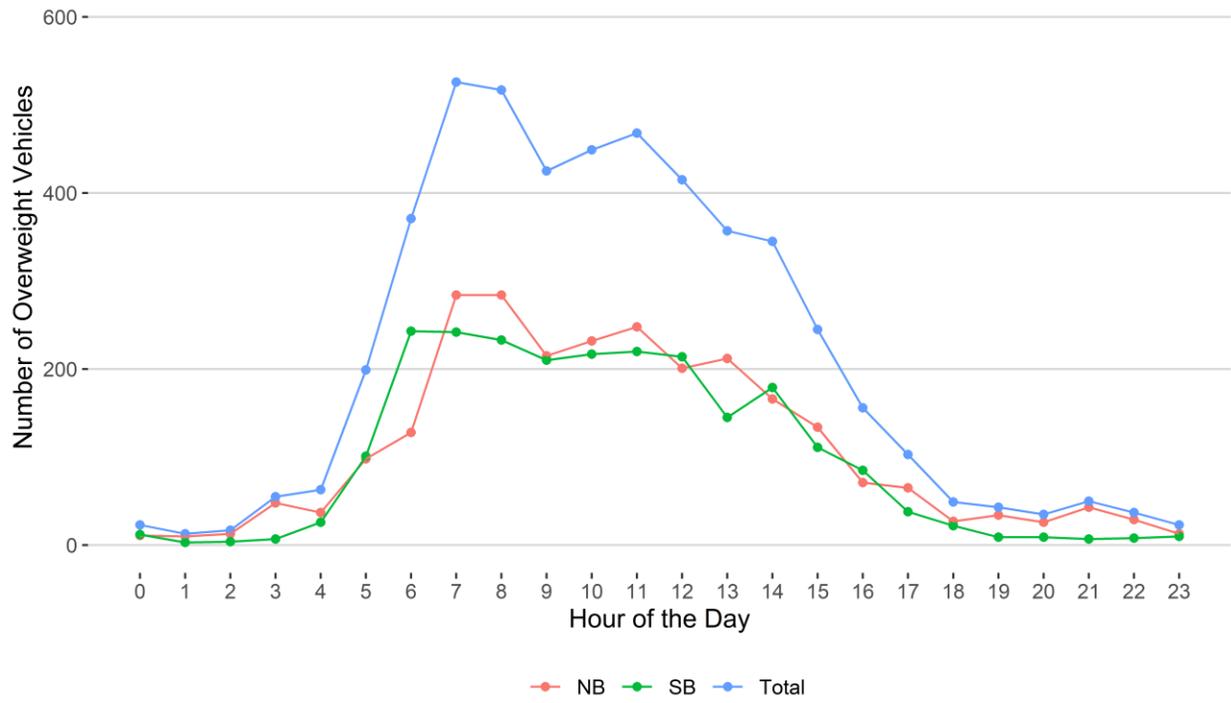
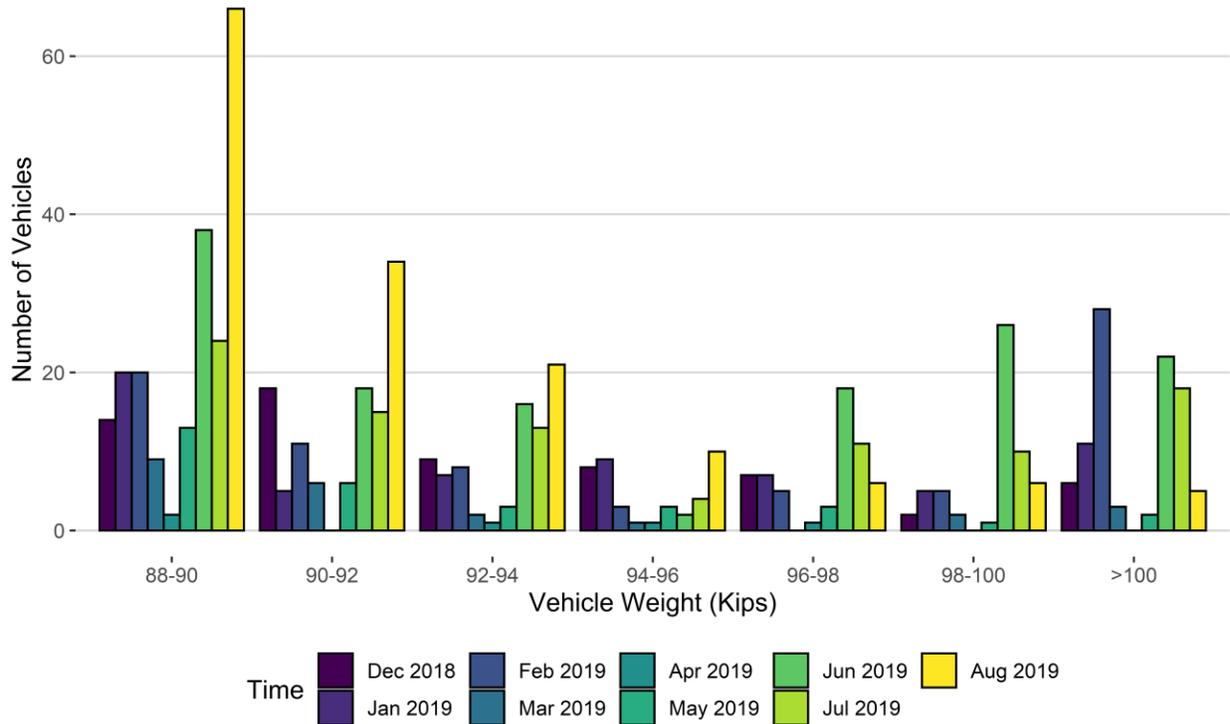
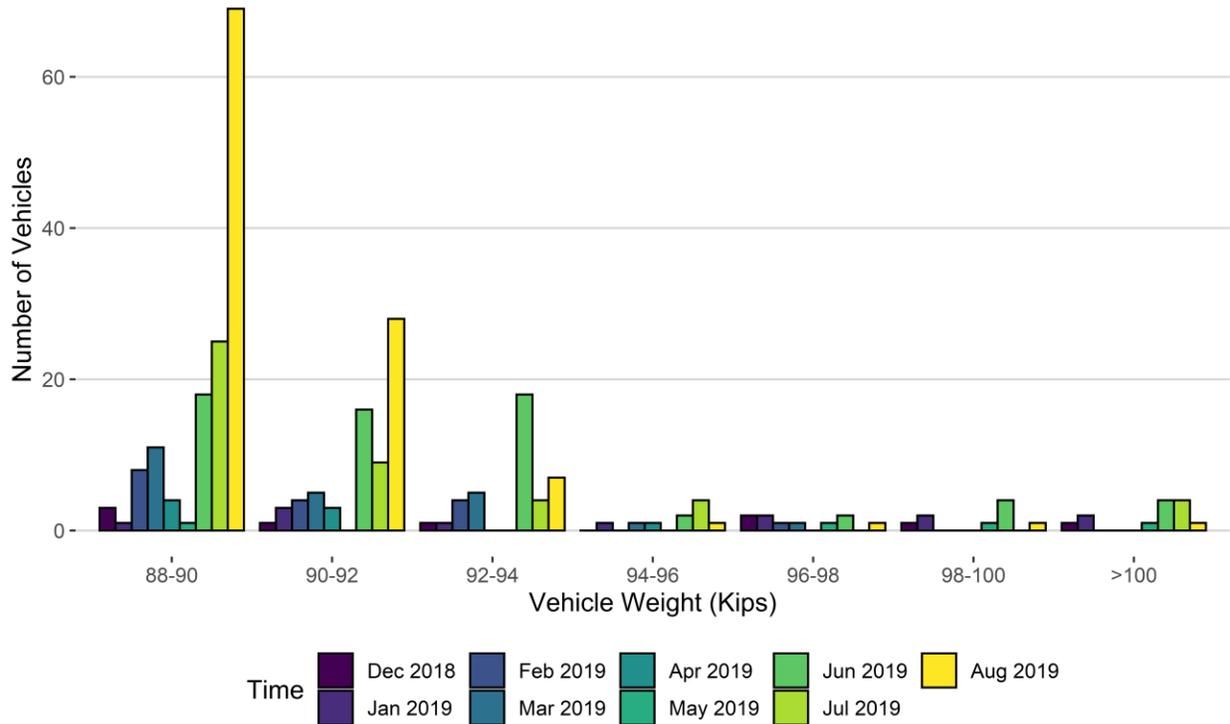


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019
88-90	14	20	20	9	2	13	38	24	66
90-92	18	5	11	6	0	6	18	15	34
92-94	9	7	8	2	1	3	16	13	21
94-96	8	9	3	1	1	3	2	4	10
96-98	7	7	5	0	1	3	18	11	6
98-100	2	5	5	2	0	1	26	10	6
>100	6	11	28	3	0	2	22	18	5
Total	64	64	80	23	5	31	140	95	148

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



Vehicle Weights (Kips)	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019
88-90	3	1	8	11	4	1	18	25	69
90-92	1	3	4	5	3	0	16	9	28
92-94	1	1	4	5	0	0	18	4	7
94-96	0	1	0	1	1	0	2	4	1
96-98	2	2	1	1	0	1	2	0	1
98-100	1	2	0	0	0	1	4	0	1
>100	1	2	0	0	0	1	4	4	1
Total	9	12	17	23	8	4	64	46	108

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

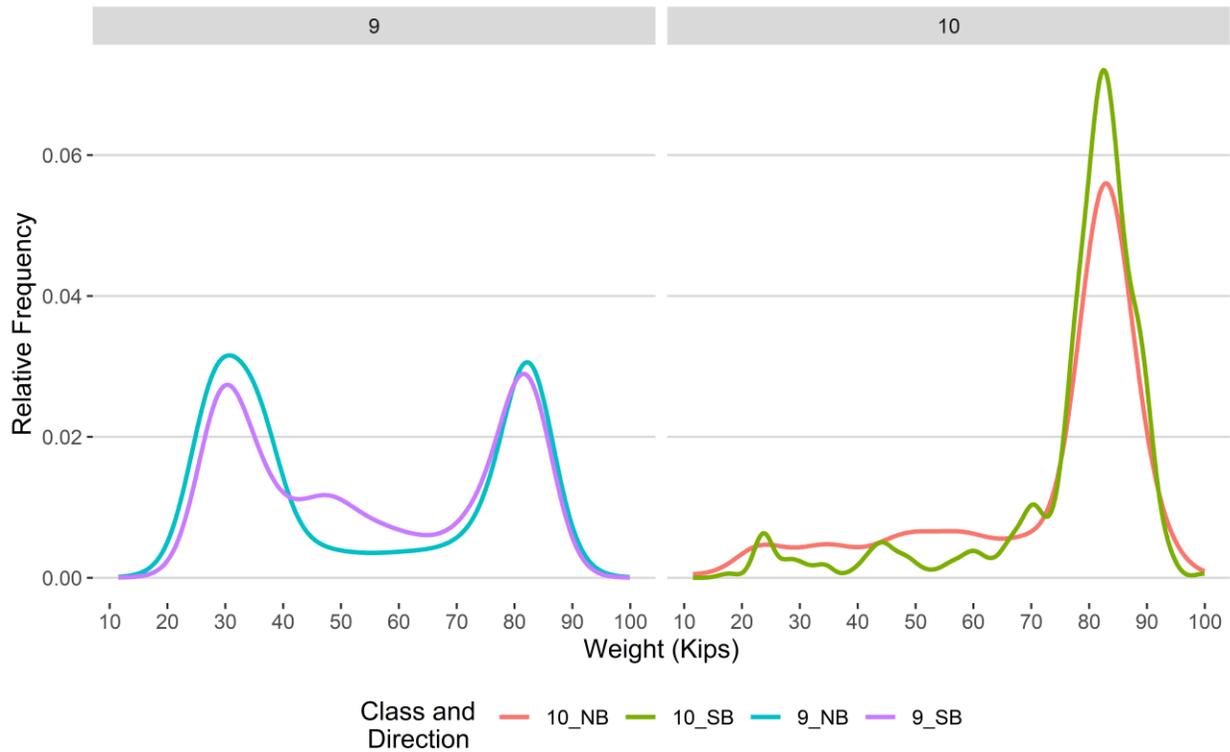


Figure 9 - Freight Percentage by Direction and Class

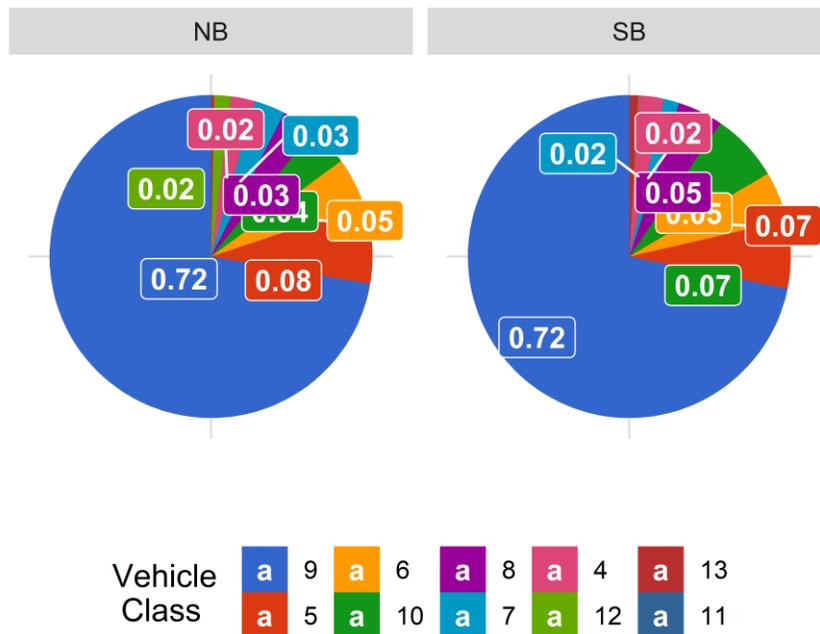


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

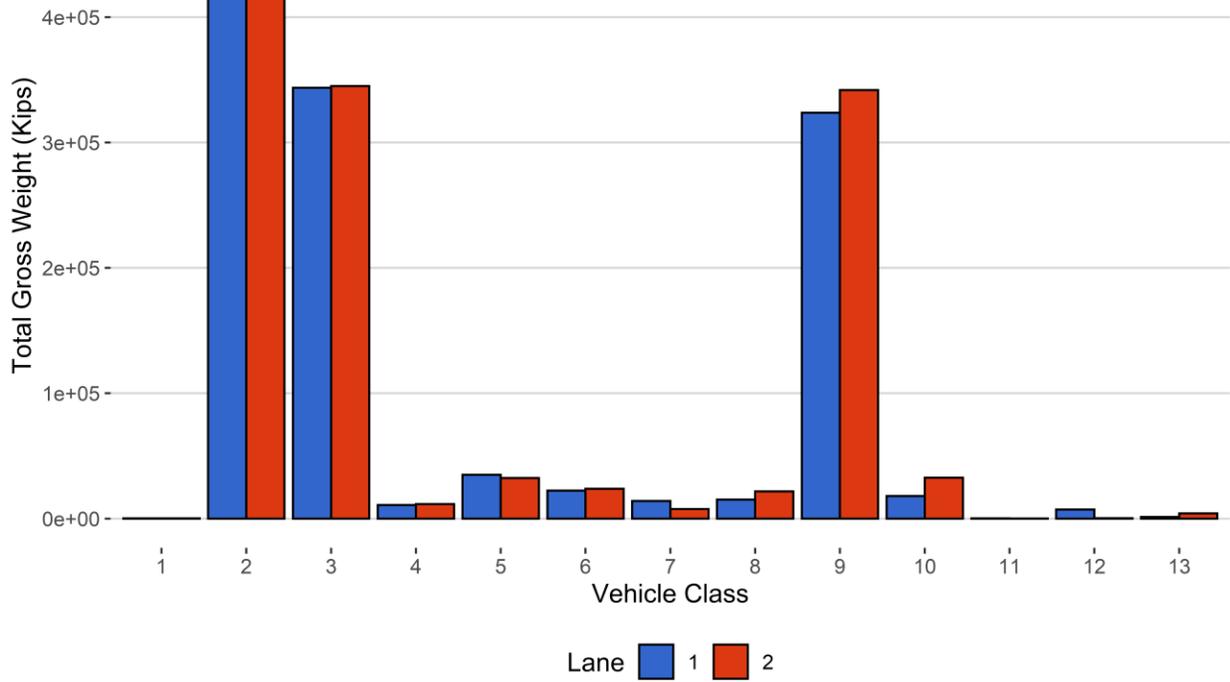


Figure 11 - Total Gross Vehicle Weight t

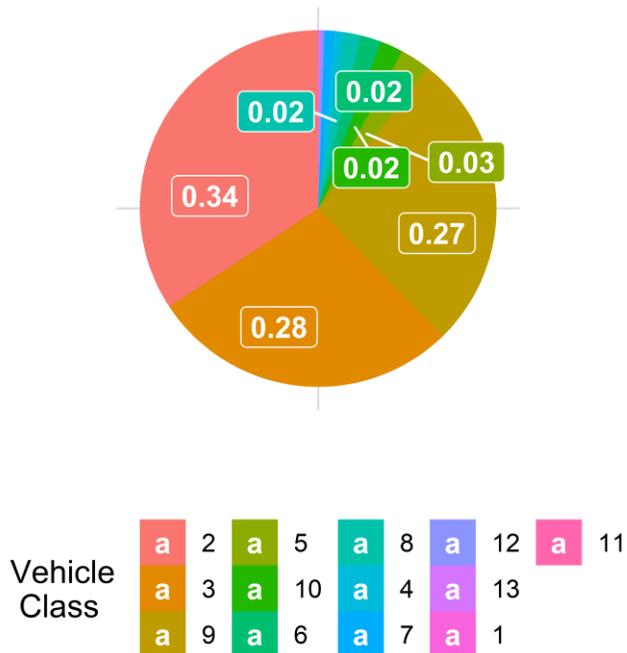


Figure 12 - Total ESALs by Class and Lane

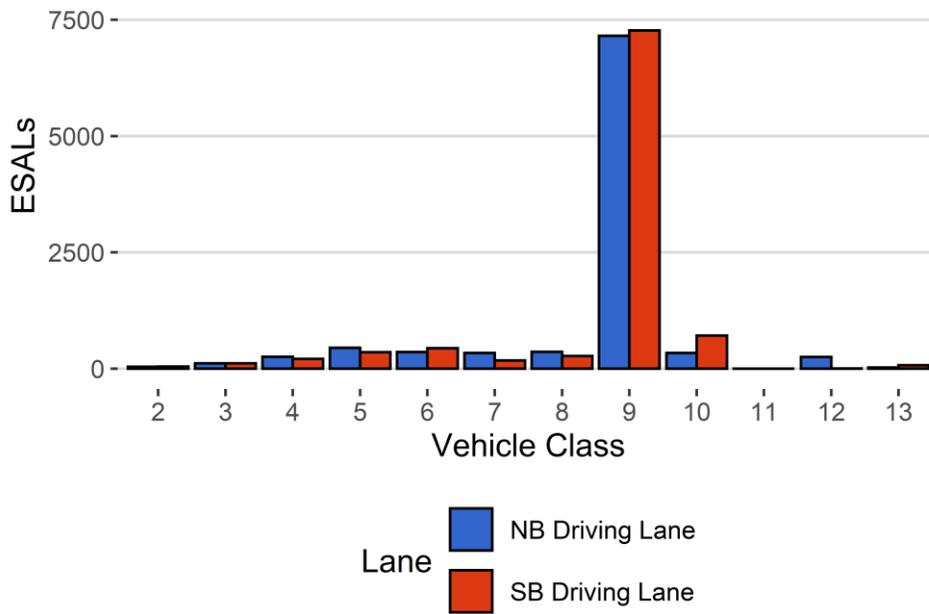


Figure 13 - ESALs by Class

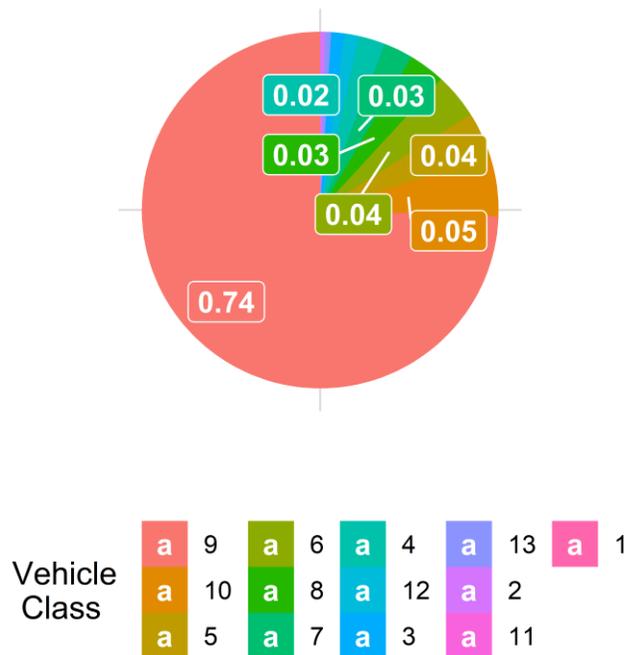


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
July 2019	10.82	0.00	10.95	0.00
August 2019	10.94	1.13	11.10	1.41

Table 2 Vehicle Classification Data

<i>Vehicle Class</i>	<i>Monthly Average Daily Volume</i>	<i>Monthly Total Volume</i>	<i>Monthly Total Volume Percentage</i>	<i>Monthly Total Overweight Vehicles</i>	<i>Monthly Total Overweight Percentage</i>
1	10	311	0.1	0	0
2	7088	219726	61.5	0	0
3	3710	114996	32.2	0	0
4	26	807	0.2	74	1.5
5	164	5078	1.4	85	1.7
6	49	1531	0.4	97	2
7	10	318	0.1	145	3
8	37	1134	0.3	87	1.8
9	399	12378	3.5	3878	79.2
10	22	683	0.2	441	9
11	0	10	0	0	0
12	3	92	0	75	1.5
13	2	70	0	16	0.3
TOTAL	11520	357135	100	4898	100

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

<i>Date</i>	<i>Day of Week</i>	<i>Time</i>	<i>Vehicle Class</i>	<i>Direction</i>	<i>Lane</i>	<i>GVW (lbs)</i>
2019-08-06	Tuesday	13:49:16	10	SB	2	99.94
2019-08-07	Wednesday	11:06:27	10	NB	1	98.42
2019-08-09	Friday	11:50:48	9	SB	2	97.29
2019-08-29	Thursday	11:33:05	9	NB	1	96.41
2019-08-30	Friday	08:40:30	9	NB	1	96.16
2019-08-30	Friday	03:20:31	10	NB	1	94.99
2019-08-23	Friday	06:53:08	9	NB	1	94.79
2019-08-18	Sunday	11:43:36	9	NB	1	94.53
2019-08-26	Monday	06:46:51	10	SB	2	94.39
2019-08-05	Monday	03:22:07	9	NB	1	93.99

Table 4 Freight Summary

<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	NB	15	369	67	18.2	9991	887	2730
5	NB	8	2549	278	10.9	32985	2023	7408
6	NB	19	739	90	12.2	20715	1600	4192
7	NB	11.5	194	2	1	13969	20	5880
8	NB	31	454	194	42.7	11140	3995	1540
9	NB	33	6056	1782	29.4	273679	50044	66318
10	NB	33.5	249	17	6.8	17619	416	4923
11	NB	36.5	6	5	83.3	37	95	0
12	NB	36.5	86	3	3.5	7213	62	2092
13	NB	31.5	15	0	0	1337	0	432
TOTAL	****	****	10717	2438	****	388684	****	95517
<i>Vehicle Class</i>	<i>Direction</i>	<i>Weight of Empty Vehicle (Kips)</i>	<i>Total Number of Vehicles</i>	<i>Number of Empty Vehicles</i>	<i>Percentage of Empty Vehicles</i>	<i>Total Weight of Vehicles with Freight (Kips)</i>	<i>Total Weight of Empty Vehicles (Kips)</i>	<i>Total Weight of Freight (Tons)</i>
4	SB	15	427	71	16.6	10682	920	2671
5	SB	8	2457	308	12.5	30125	2257	6467
6	SB	19	770	107	13.9	21903	1876	4653
7	SB	11.5	119	0	0	7585	0	3108
8	SB	31	664	272	41	15391	6322	1619
9	SB	33	6146	1539	25	297211	44636	72590
10	SB	33.5	424	18	4.2	32192	453	9296
11	SB	36.5	4	4	100	0	101	0
12	SB	36.5	5	0	0	325	0	71
13	SB	31.5	54	0	0	4169	0	1234
TOTAL	****	****	11070	2319	****	419584	****	101710
GRAND TOTAL	****	****	21787	4757	421	808268	115706	197227

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>
1	181	211	392	0
2	416554	424951	841505	34.3
3	343667	345008	688675	28.1
4	10878	11602	22480	0.9
5	35007	32382	67390	2.7
6	22315	23779	46094	1.9
7	13989	7585	21574	0.9
8	15135	21713	36848	1.5
9	323722	341847	665569	27.1
10	18034	32646	50680	2.1
11	132	101	233	0
12	7275	325	7600	0.3
13	1337	4169	5506	0.2
TOTAL	1208227	1246319	2454546	100
GVW/LANE	49.22	50.78	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.0033
2	43	45	88	0.5	8e-04
3	116	115	231	1.2	0.0041
4	256	213	469	2.4	1.18
5	450	356	806	4.2	0.32
6	359	441	800	4.1	1.06
7	339	176	515	2.7	3.25
8	363	273	636	3.3	1.14
9	7155	7268	14423	74.4	2.37
10	338	712	1050	5.4	3.1
11	0	0	1	0	0.58
12	251	4	255	1.3	5.08
13	27	74	100	0.5	2.61
TOTAL	9697	9678	19375	100	21
ESALS/LANE	50	50	100	-	-

Table 7 Site Summary: Volume and Vehicle Class

<i>Month</i>	<i>Total Volume</i>	<i>Monthly ADT</i>	<i>Monthly HCADT</i>	<i>Passenger Vehicles</i>	<i>Passenger Vehicles %</i>	<i>Heavy Commercial Vehicles</i>	<i>Heavy Commercial Vehicles %</i>
Dec 2018	283227	9136	450	269265	95.1	13962.3	4.9
Jan 2019	265163	8554	466	250711	94.5	14452.3	5.5
Feb 2019	230485	8232	479	217063	94.2	13422.1	5.8
Mar 2019	292495	9435	468	277981	95	14514.1	5
Apr 2019	304912	10164	510	289601	95	15311	5
May 2019	343068	10956	596	324607	94.6	18461.5	5.4
Jun 2019	324777	10826	573	307593	94.7	17184.2	5.3
Jul 2019	348634	11206	732	325932	93.5	22701.9	6.5
Aug 2019	357135	11454	713	335033	93.8	22101.6	6.2
TOTAL	2749896	-	-	2597786	-	152111	-
AVERAGE	305544	9996	554	288643	94	16901	6

###ESALS

<i>Month</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Dec 2018	6281	3102	9384	0.7
Jan 2019	6958	3377	10335	1.7
Feb 2019	6867	3100	9967	2.7
Mar 2019	5986	3613	9599	1.4
Apr 2019	5142	3547	8689	0.3
May 2019	6985	3777	10762	0.4
Jun 2019	15760	9229	24989	2.2
Jul 2019	10375	8533	18908	2.3
Aug 2019	9916	9751	19667	3.7
TOTAL	74270	-	-	-
AVERAGE	8252	5337	13589	2

###Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Dec 18	897732	839106	1736837
Jan 19	877835	821194	1699029
Feb 19	799415	718048	1517463
Mar 19	909278	879764	1789041
Apr 19	910165	897884	1808050
May 19	1065247	1008542	2073788
Jun 19	2088761	1979618	4068379
Jul 19	1206334	1199906	2406240

Aug 19	1215957	1248274	2464231
TOTAL	9970724	9592336	19563060
AVERAGE	1107858	1065815	2173673

###Overweight Vehicles

<i>Month</i>	<i>Total Number of Overweight Vehicles</i>	<i>Overweight / Total Volume</i>	<i>Overweight / Heavy Commercial Volume</i>	<i>Number Over 88,000 lbs</i>	<i>Number Over 98,000 lbs</i>
Dec 2018	1669	0.6	12	73	10
Jan 2019	2033	0.8	14.1	76	20
Feb 2019	2171	1	16.1	97	33
Mar 2019	1543	0.5	10.7	46	5
Apr 2019	878	0.3	5.8	13	0
May 2019	998	0.3	5.4	35	5
Jun 2019	5488	0.9	16.2	206	56
Jul 2019	4621	1.3	20.5	142	32
Aug 2019	4984	1.4	22.7	262	14
TOTAL	24385	-	-	950	175
AVERAGE	2709.4	0.8	13.7	105.6	19.4

###Freight

<i>Month</i>	<i>NB Freight Tons</i>	<i>SB Freight Tons</i>	<i>Total Freight</i>	<i>NB Freight %</i>	<i>SB Freight %</i>
Dec 2018	68684	36498	105183	65.3	34.7
Jan 2019	74186	39952	114137	65	35
Feb 2019	75948	36919	112867	67.3	32.7
Mar 2019	66257	43378	109635	60.4	39.6
Apr 2019	61073	46223	107296	56.9	43.1
May 2019	82977	48135	131113	63.3	36.7
Jun 2019	158224	107695	265919	59.5	40.5
Jul 2019	105124	92680	197804	53.1	46.9
Aug 2019	95517	101710	197227	48.4	51.6
TOTAL	787990	553190	1341180	-	-
AVERAGE	87554.5	61465.5	149020	59.9	40.1