

MARCH 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 March 2019. Volume was computed using all monthly data.

System Calibration

WIM #39 was most recently calibrated on 2018-11-28. 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: 292495 | Passenger Vehicles: 277981 | Heavy Commercial Vehicles: 14514

Monthly Average Daily Traffic (MADT): 9435 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 468

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 07 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 07 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 14514 HCVs, 1520 of them were overweight ³. These overweight HCVs contributed to 0.5% of total monthly volume, and 10.6% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Tuesdays, with lowest volumes reported on Saturdays. See Figure 3 . The top two overweight violators by class were the class 9 and class 7 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 72.2% 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 October.

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 ,23 NB vehicles exceeded 88,000 pounds (9 vehicles were Class 12's; 8 vehicles were Class 9's). Of vehicles traveling SB,

23 NB vehicles exceeded 88,000 pounds (12 vehicles were Class 10's; 9 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from March 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in March 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 empty Class 9's than fully_loaded 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 109635 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (60.4%) than SB (39.6%). 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 292495 vehicles with a combined GVW of 1789041 kips (1 kip = 1,000 pounds = 0.5 tons) in March 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 9599 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 62.4% of all ESALs were recorded NB while 37.6% was observed SB. In particular, 69% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 22% 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).

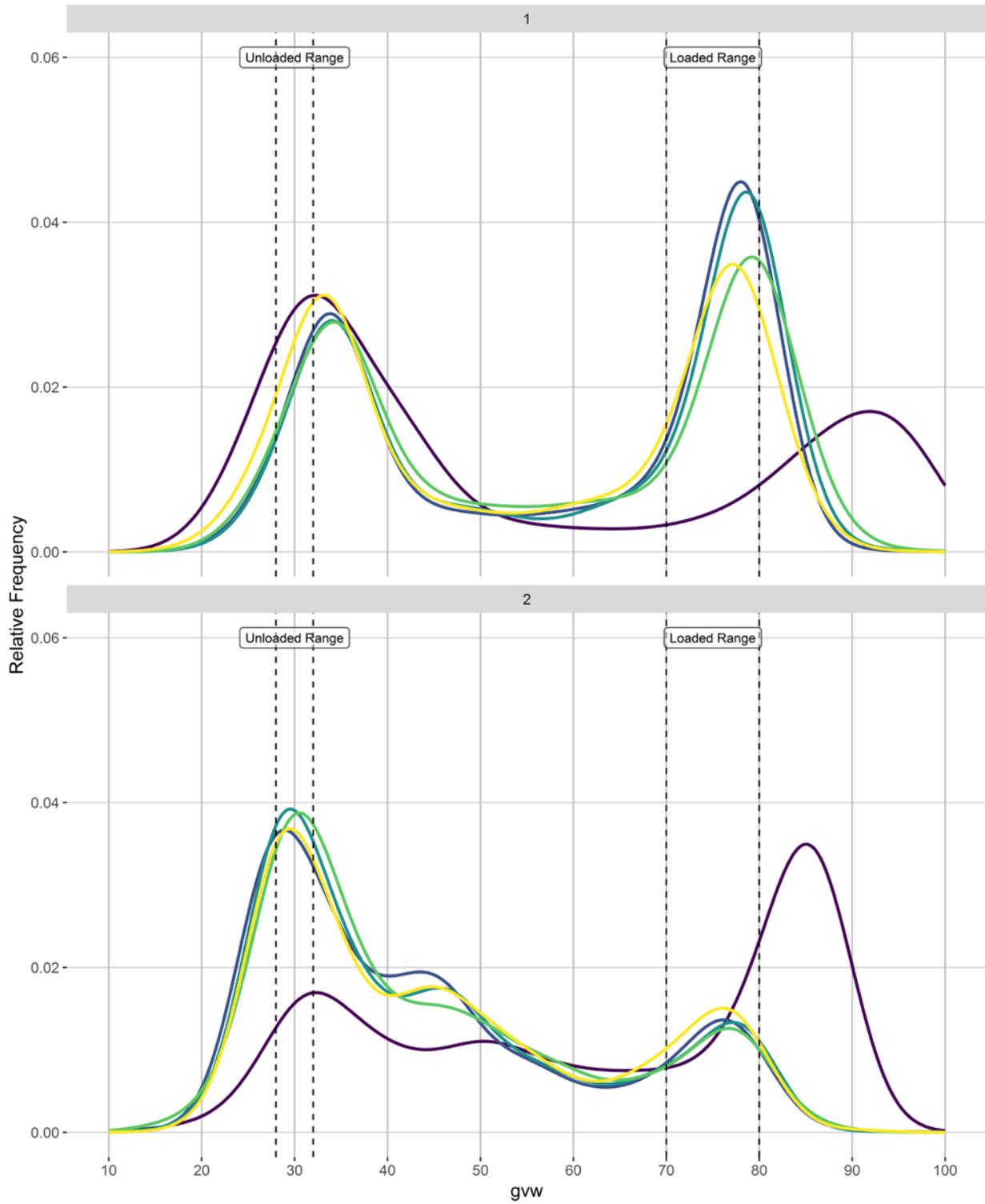
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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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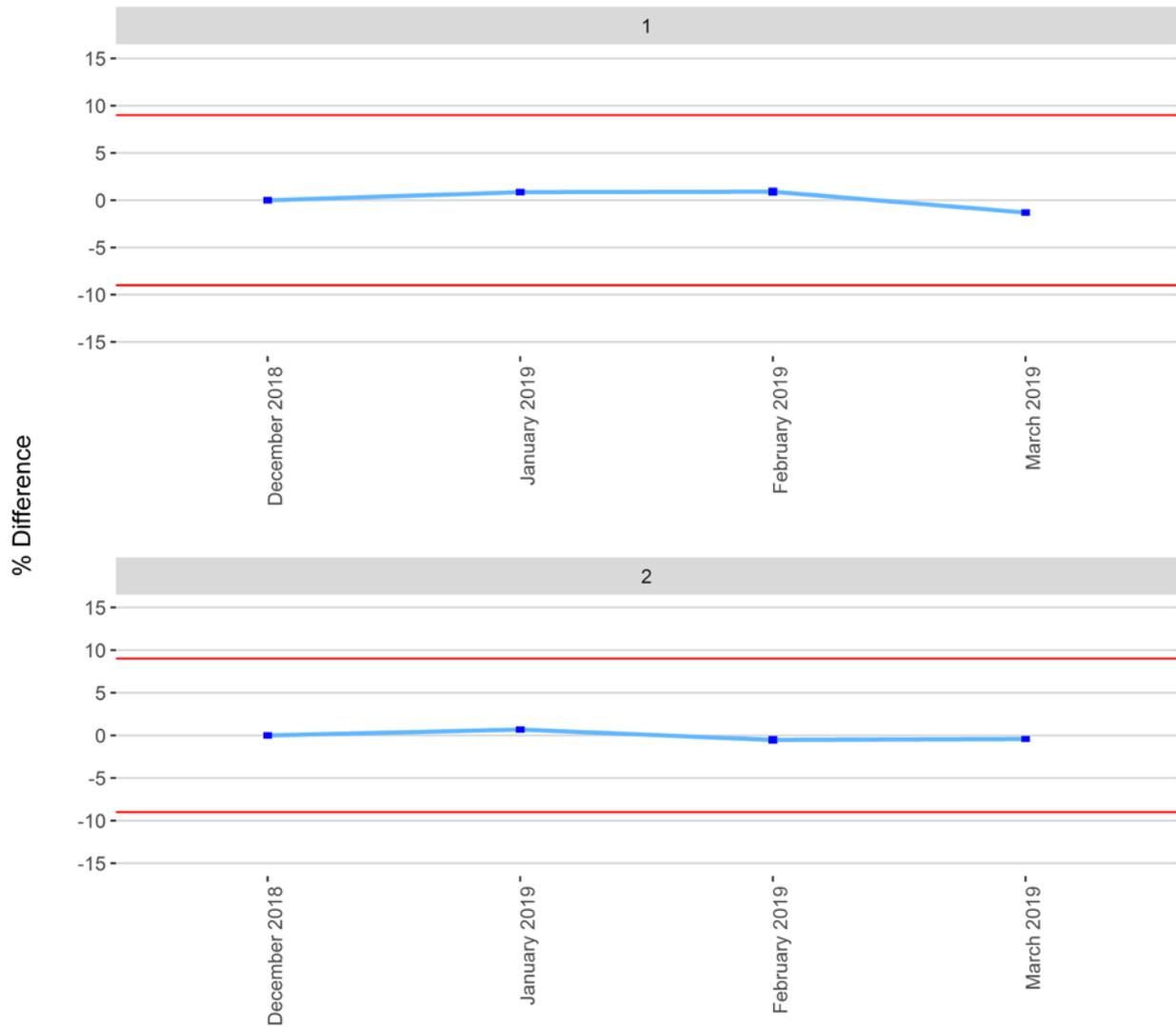
Figure 1 - Monthly Class 9 GVW Histogram



Time — April 2018 — December 2018 — January 2019 — February 2019 — March 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

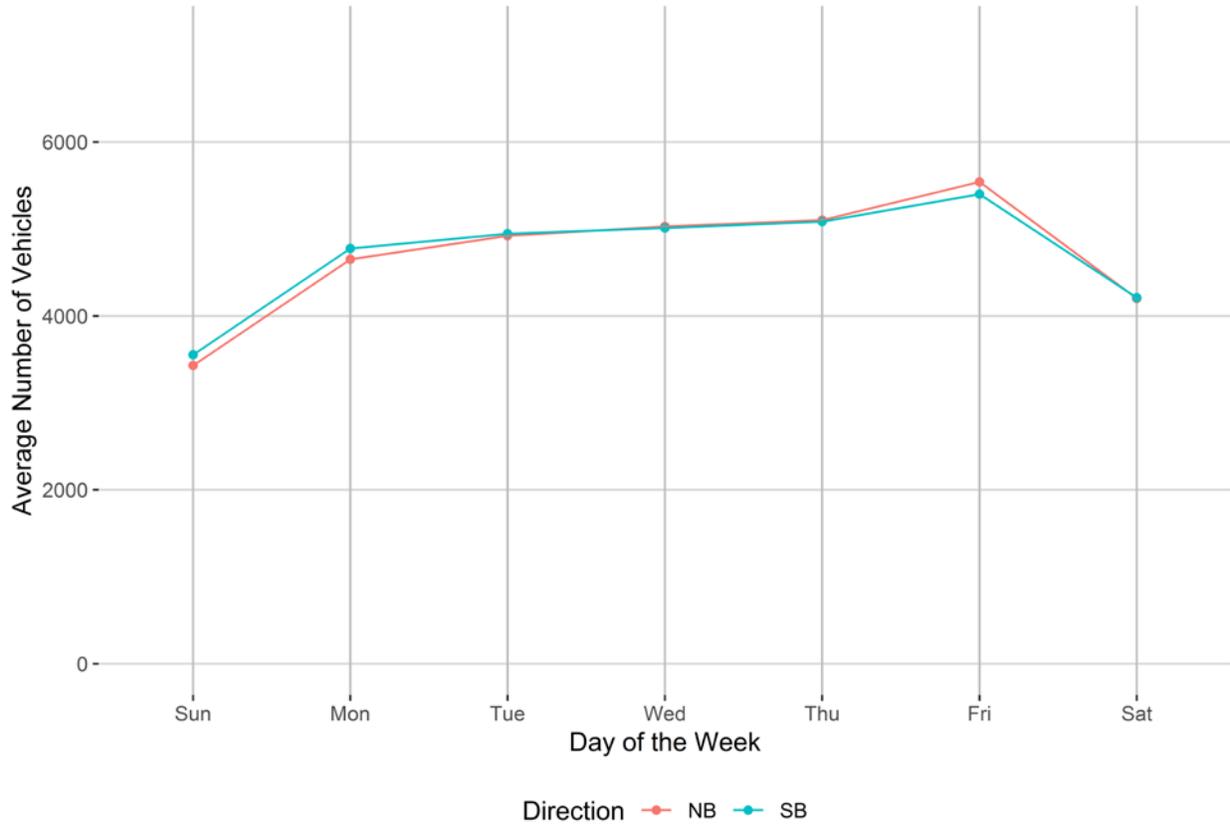


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

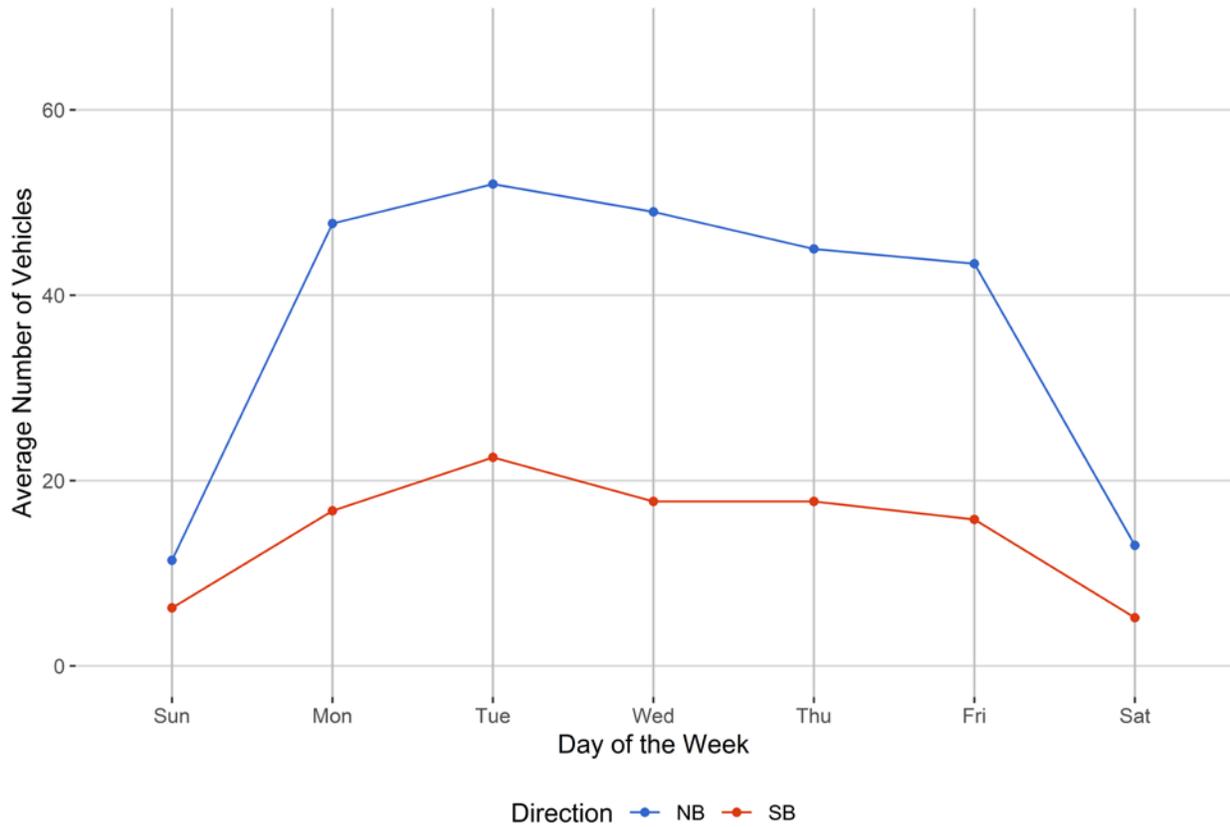


Figure 4 - Passenger Vehicles vs. Hour of the Day

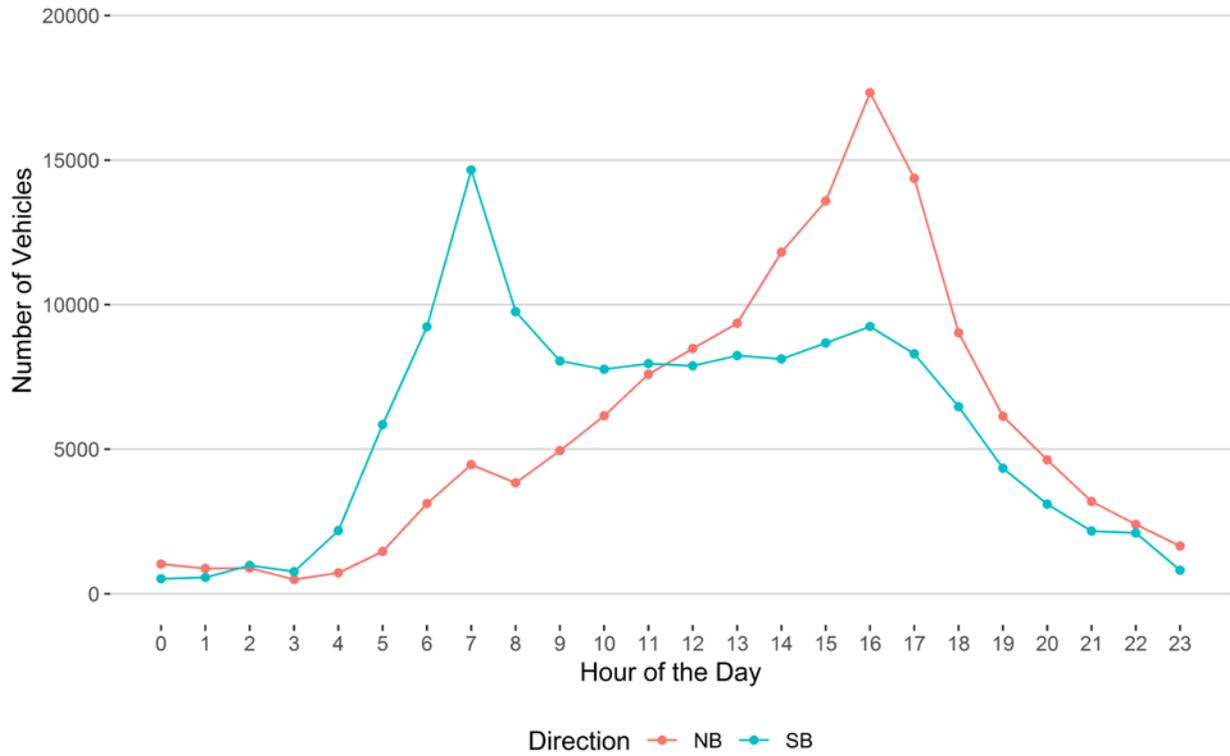


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

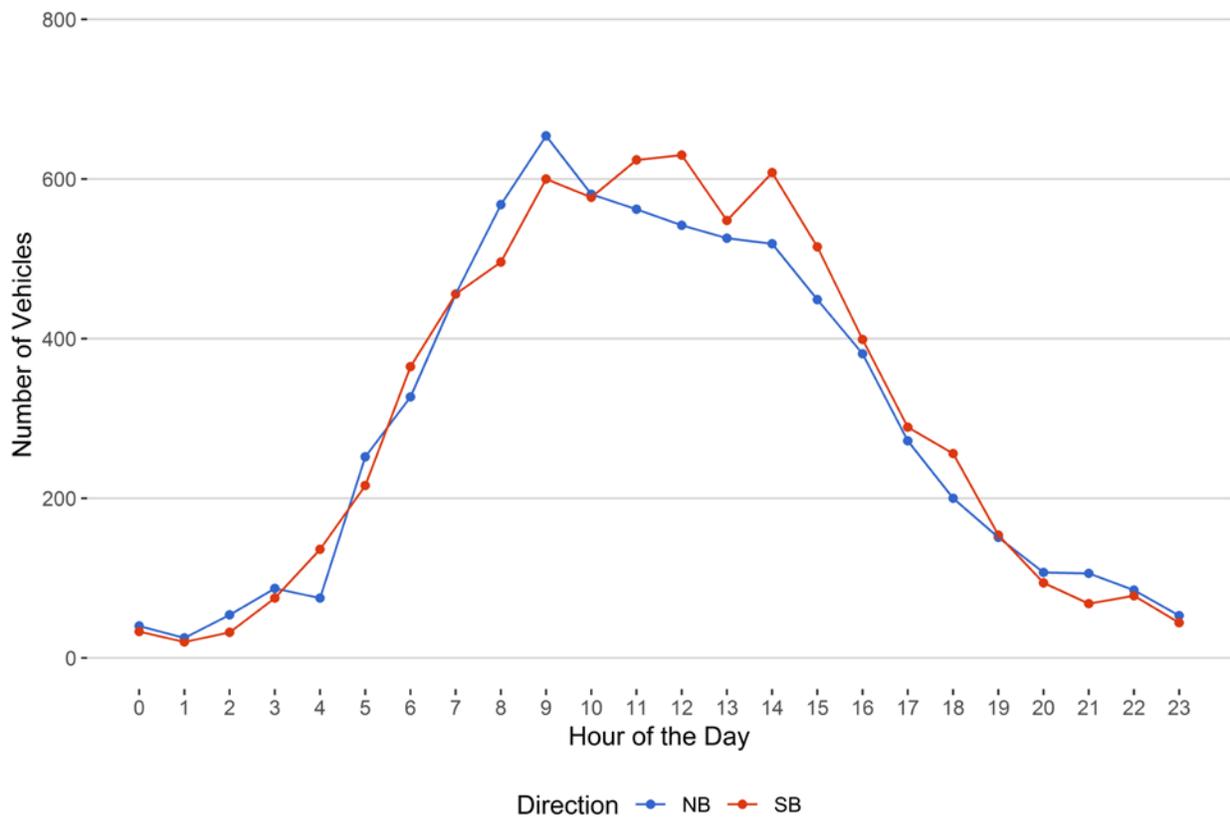


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

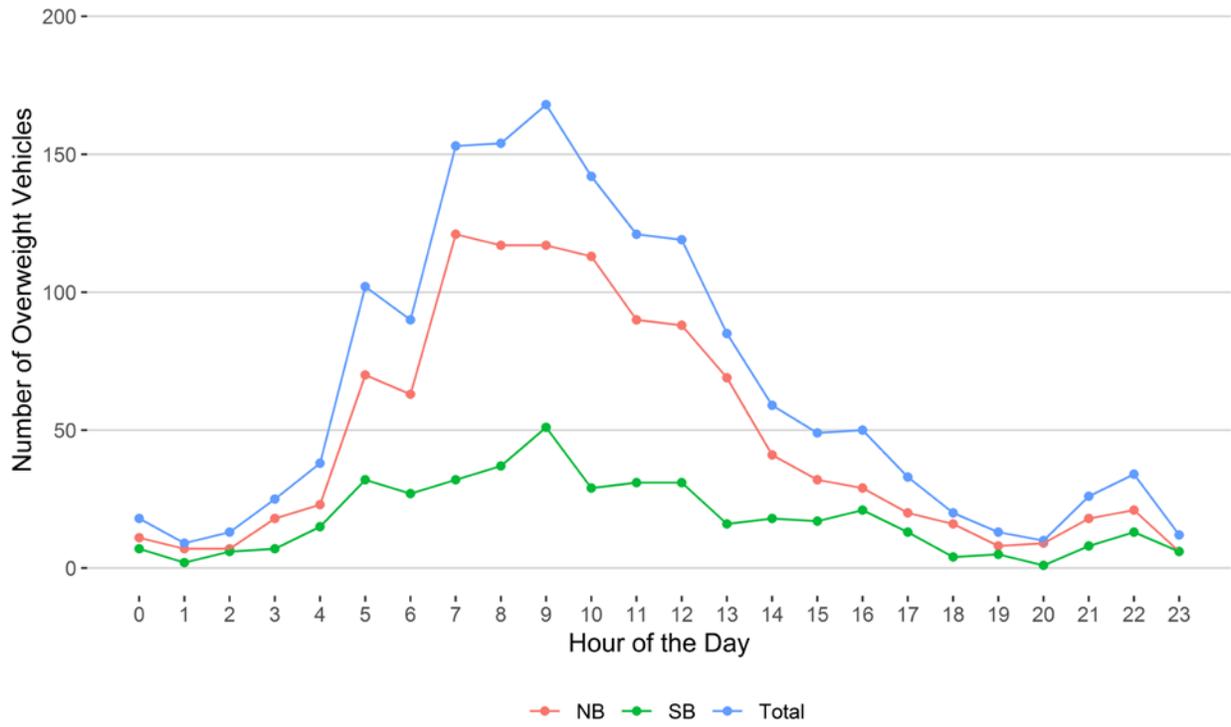
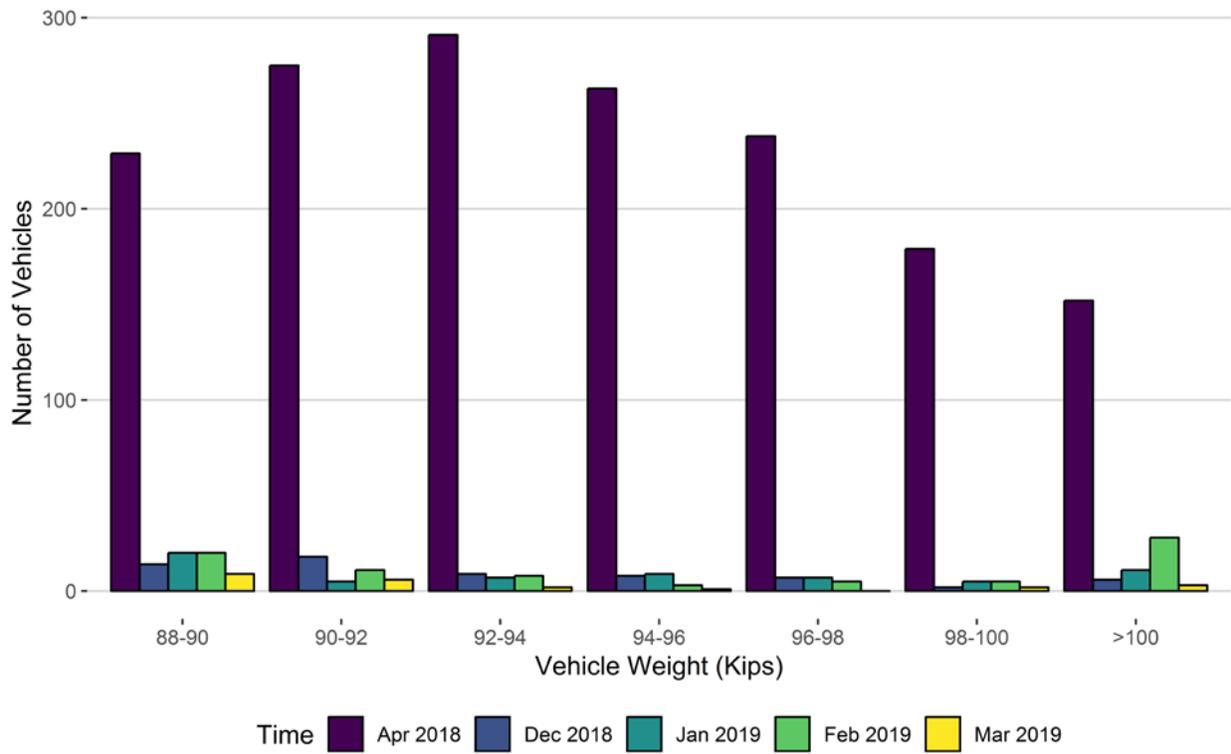
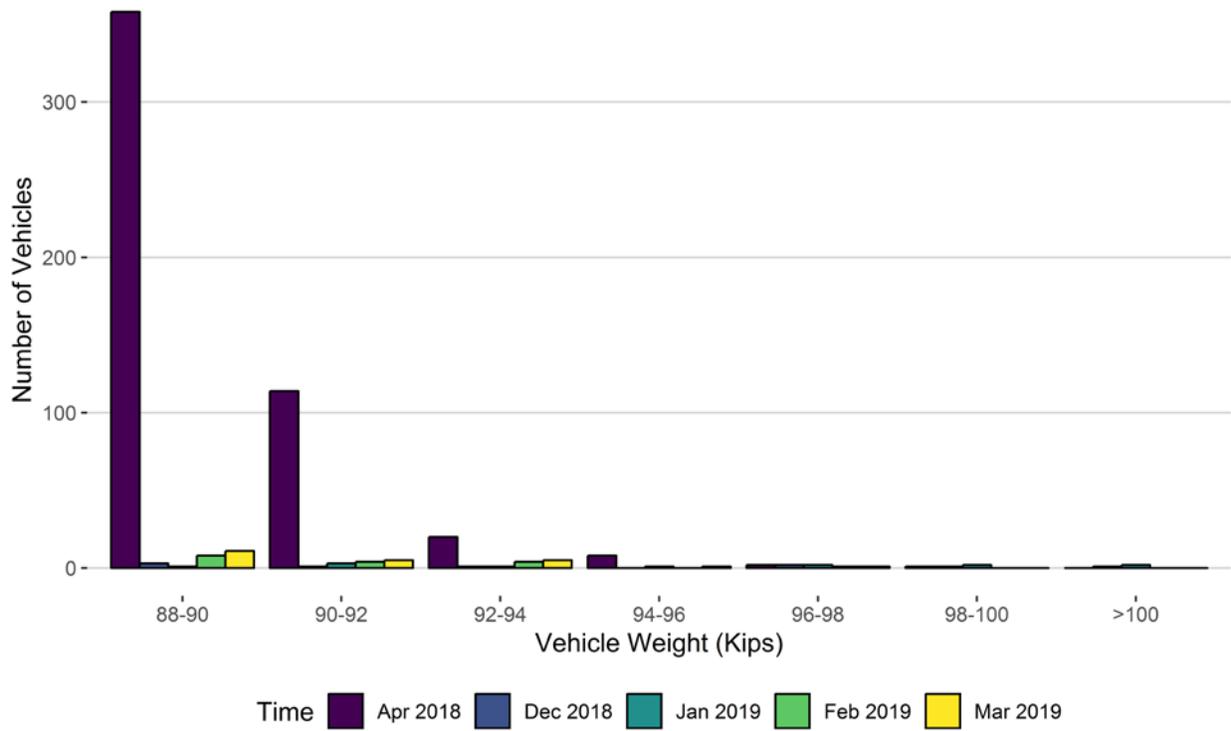


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Apr 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019
88-90	229	14	20	20	9
90-92	275	18	5	11	6
92-94	291	9	7	8	2
94-96	263	8	9	3	1
96-98	238	7	7	5	0
98-100	179	2	5	5	2
>100	152	6	11	28	3
Total	1627	64	64	80	23

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



<i>Vehicle Weights (Kips)</i>	<i>Apr 2018</i>	<i>Dec 2018</i>	<i>Jan 2019</i>	<i>Feb 2019</i>	<i>Mar 2019</i>
88-90	358	3	1	8	11
90-92	114	1	3	4	5
92-94	20	1	1	4	5
94-96	8	0	1	0	1
96-98	2	2	2	1	1
98-100	1	1	2	0	0
>100	0	1	2	0	0
Total	503	9	12	17	23

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

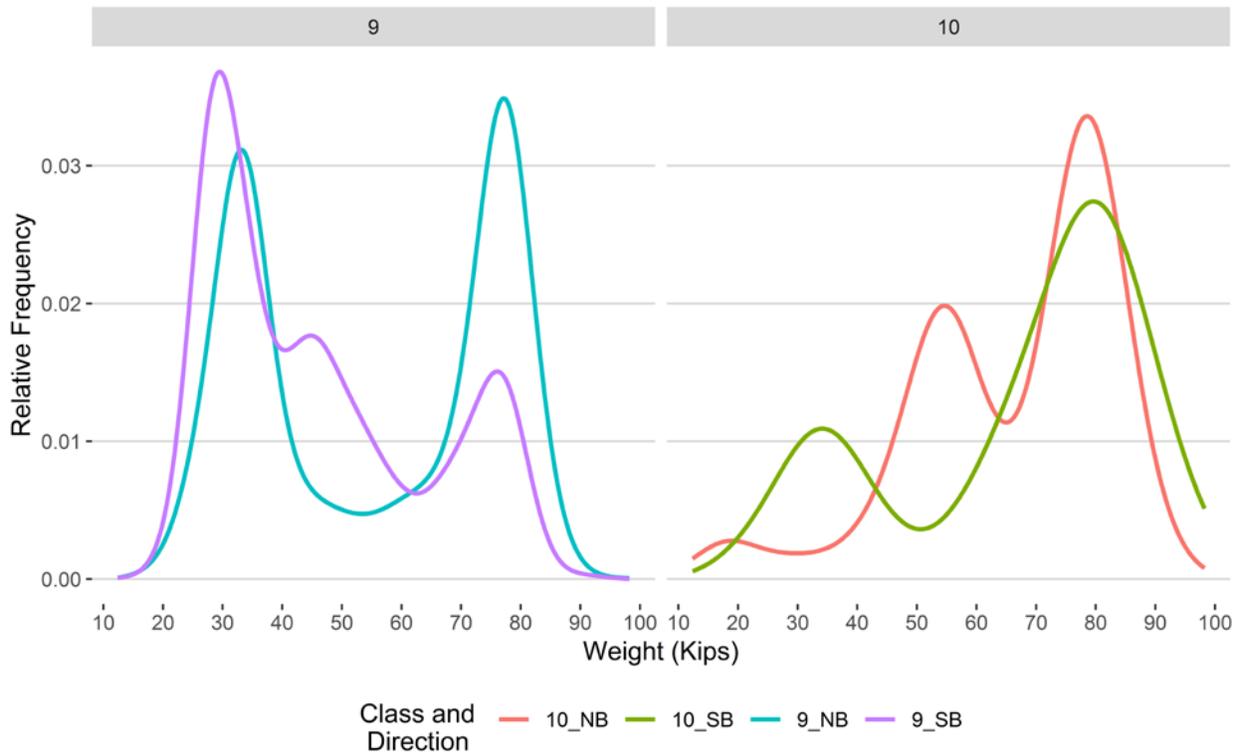


Figure 9 - Freight Percentage by Direction and Class

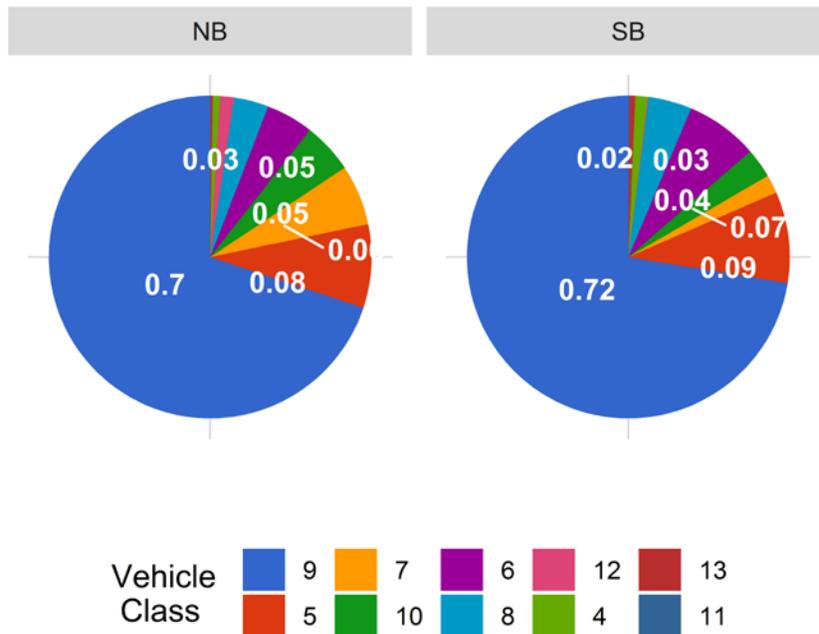


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

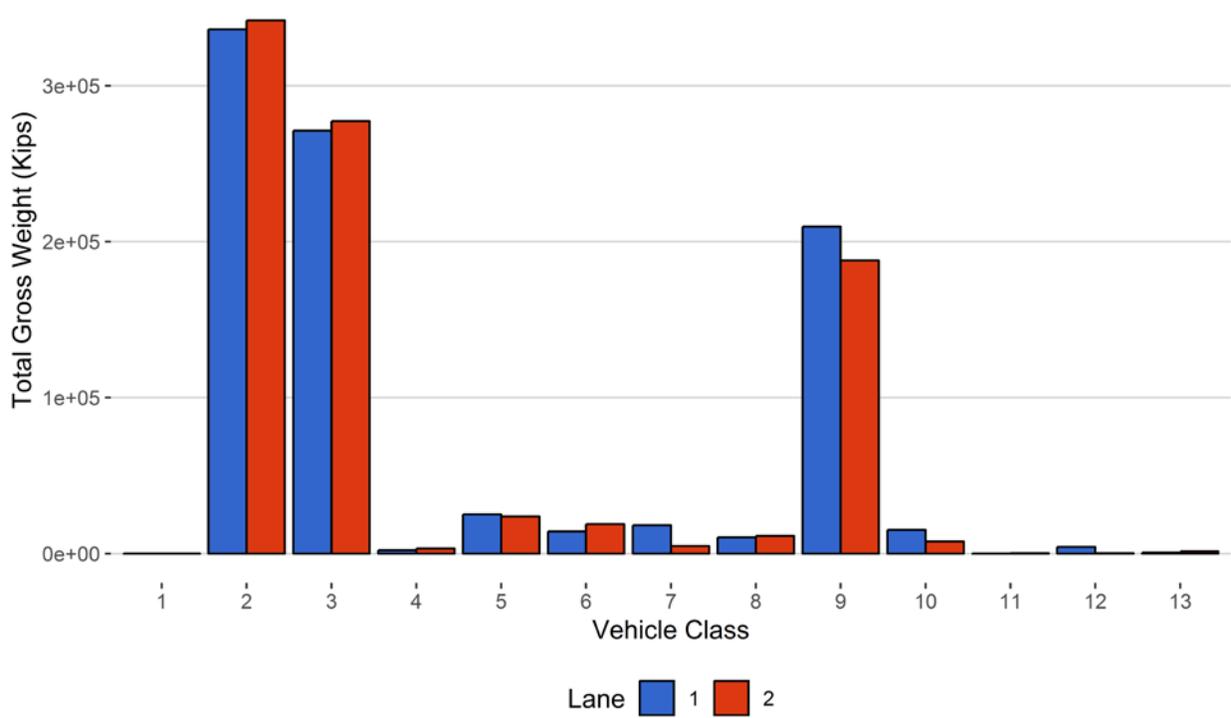


Figure 11 - Total Gross Vehicle Weight t

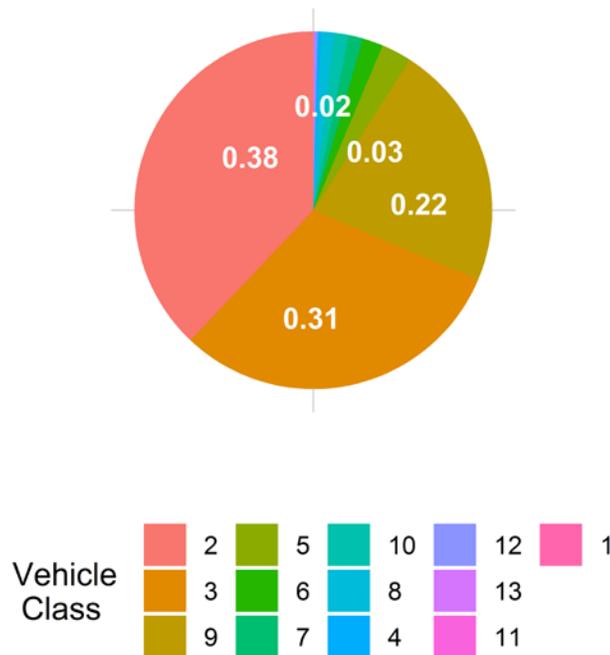


Figure 12 - Total ESALs by Class and Lane

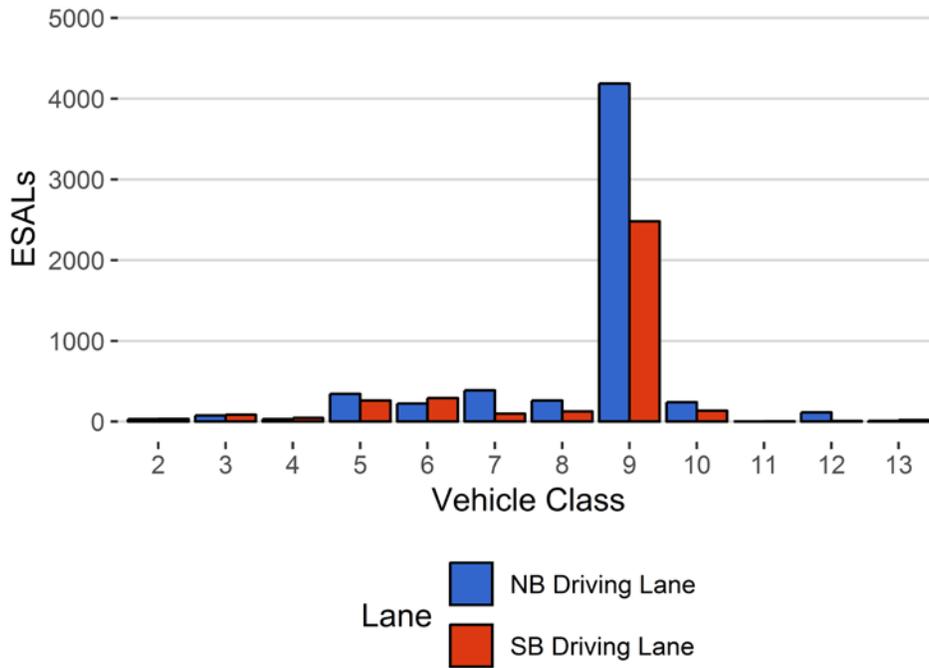


Figure 13 - ESALs by Class

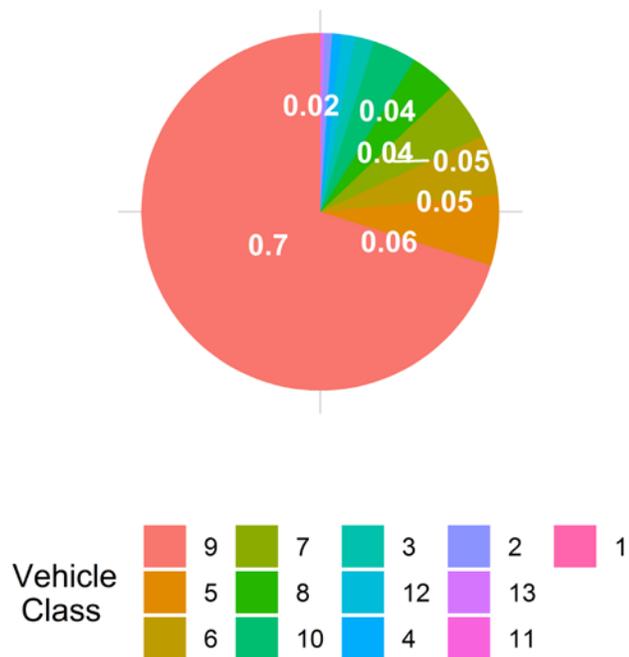


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
December 2018	10.79	0.00	10.54	0.00
January 2019	10.88	0.85	10.62	0.68
February 2019	10.89	0.90	10.49	-0.53
March 2019	10.65	-1.30	10.50	-0.41

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	1	24	0	0	0
2	5840	181031	61.9	0	0
3	3127	96926	33.1	0	0
4	7	212	0.1	9	0.6
5	122	3785	1.3	54	3.6
6	38	1167	0.4	65	4.3
7	11	336	0.1	154	10.1
8	21	641	0.2	59	3.9
9	256	7935	2.7	1040	68.4
10	11	346	0.1	92	6.1
11	0	8	0	0	0
12	2	55	0	44	2.9
13	1	29	0	3	0.2
TOTAL	9435	292495	100	1520	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>
2019-03-05	Tuesday	07:53:41	9	NB	1	98.25
2019-03-12	Tuesday	13:45:38	10	SB	2	97.55
2019-03-26	Tuesday	09:22:32	10	SB	2	95.03
2019-03-13	Wednesday	13:12:47	9	NB	1	93.84
2019-03-02	Saturday	00:38:43	10	SB	2	93.79
2019-03-20	Wednesday	22:12:09	10	SB	2	93.46
2019-03-16	Saturday	05:12:25	9	SB	2	93.4
2019-03-06	Wednesday	07:00:18	10	NB	1	92.54
2019-03-02	Saturday	00:26:36	10	SB	2	92.36
2019-03-28	Thursday	07:47:19	9	SB	2	91.97

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	87	24	27.6	1828	316	441
5	NB	8	1899	355	18.7	22502	2607	5075
6	NB	19	501	138	27.5	11846	2360	2474
7	NB	11.5	254	0	0	18198	0	7638
8	NB	31	278	80	28.8	8662	1743	1262
9	NB	33	3761	765	20.3	187128	22585	44130
10	NB	33.5	229	12	5.2	14972	262	3851
11	NB	36.5	2	1	50	48	33	6
12	NB	36.5	52	1	1.9	4235	19	1187
13	NB	31.5	9	0	0	667	0	192
TOTAL	****	****	7072	1376	****	270087	****	66257
<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	123	21	17.1	2962	273	716
5	SB	8	1852	343	18.5	21239	2501	4583
6	SB	19	656	152	23.2	16261	2627	3342
7	SB	11.5	79	1	1.3	4798	9	1951
8	SB	31	357	174	48.7	7084	4186	706
9	SB	33	4103	1423	34.7	147605	40411	29583
10	SB	33.5	114	13	11.4	7311	383	1964
11	SB	36.5	6	0	0	302	0	41
12	SB	36.5	3	0	0	244	0	67
13	SB	31.5	20	0	0	1481	0	425
TOTAL	****	****	7313	2127	****	209286	****	43378
GRAND TOTAL	****	****	14385	3503	335	479373	80313	109635

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	14	16	30	0
2	336145	341960	678105	38
3	271240	277327	548567	30.7
4	2144	3235	5379	0.3
5	25109	23740	48849	2.7
6	14206	18888	33093	1.9
7	18198	4807	23005	1.3
8	10405	11270	21675	1.2
9	209713	188016	397729	22.3
10	15233	7693	22926	1.3
11	82	302	383	0
12	4254	244	4498	0.3
13	667	1481	2148	0.1
TOTAL	907410	878978	1786388	100
GVW/LANE	50.8	49.2	100	0.01

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	0.04
2	32	34	66	0.7	8e-04
3	76	86	162	1.7	0.0034
4	32	47	80	0.8	0.77
5	344	263	607	6.4	0.33
6	223	294	516	5.4	0.9
7	387	99	486	5.1	2.9
8	262	126	388	4.1	1.23
9	4188	2480	6668	70.2	1.7
10	240	136	376	4	2.17
11	1	4	5	0	1.1
12	115	7	122	1.3	3.85
13	10	20	30	0.3	1.74
TOTAL	5910	3595	9505	100	17
ESALS/LANE	62.2	37.8	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>
Apr 2018	295692	9856	706	274499	92.8	21192.8	7.2
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
TOTAL	1367062	-	-	1289519	-	77543	-
AVERAGE	273412	9043	514	257904	94	15509	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>
Apr 2018	13423	12893	26316	74.2
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
TOTAL	39515	-	-	-
AVERAGE	7903	5217	13120	16

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Apr 18	1173322	1114993	2288315
Dec 18	897732	839106	1736837
Jan 19	877835	821194	1699029
Feb 19	799415	718048	1517463
Mar 19	909278	879764	1789041
TOTAL	4657581	4373105	9030686
AVERAGE	931516	874621	1806137

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>
Apr 2018	5931	2	27.9	2151	333
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
TOTAL	13347	-	-	2443	401
AVERAGE	2669.4	1	16.2	488.6	80.2

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>
Apr 2018	104039	121316	225355	46.2	53.8
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
TOTAL	389115	278062	667177	-	-
AVERAGE	77822.9	55612.5	133435.4	60.8	39.2