

DECEMBER 2019



**WIM #46
CSAH 1,
MP 11.4
WEST
CONCORD, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #46 is located on CSAH 1 near West Concord in Dodge county.

System Operation

WIM #46 was operational for the entire month of December 2019. Volume was computed using all monthly data.

System Calibration

WIM #46 was most recently calibrated on 2015-06-16. 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: 11247 | Passenger Vehicles: 8387 | Heavy Commercial Vehicles: 2860

Monthly Average Daily Traffic (MADT): 372 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 92

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 Saturdays, with lowest volumes reported on Sundays. SB vehicles typically reached highest volume levels on Saturdays, 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 03 PM and 05 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 03 PM and 05 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 2860 HCVs, 1068 of them were overweight ³. These overweight HCVs contributed to 11.7% of total monthly volume, and 45.5% 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 Fridays, with lowest volumes reported on Saturdays. See Figure 3 .

The top two overweight violators by class were the class 9 and class 13 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 75.5% of all overweight vehicles traveling SB 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 December.

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 ,210 NB vehicles exceeded 88,000 pounds (164 vehicles were Class 9's; 43 vehicles were Class 13's). Of vehicles traveling SB,

522 NB vehicles exceeded 88,000 pounds (504 vehicles were Class 9's; 9 vehicles were Class 14's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from December 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in December 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 34348 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (72.1%) than NB (27.9%). See Table 4 and Figure 11 for more freight information.

####Infrastructure Considerations Bridge. Bridge No. 91587 (a precast pipe arch) is approximately 4.2 miles south of WIM #46. Bridge No. 91588 (a precast pipe arch) is approximately 7.8 miles south of WIM #46. WIM #46 recorded a total of 11247 vehicles with a combined GVW of 177089 kips (1 kip = 1,000 pounds = 0.5 tons) in December 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 5448 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 78.4% of all ESALs were recorded SB while 21.6% was observed NB. In particular, 77% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 69% 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).

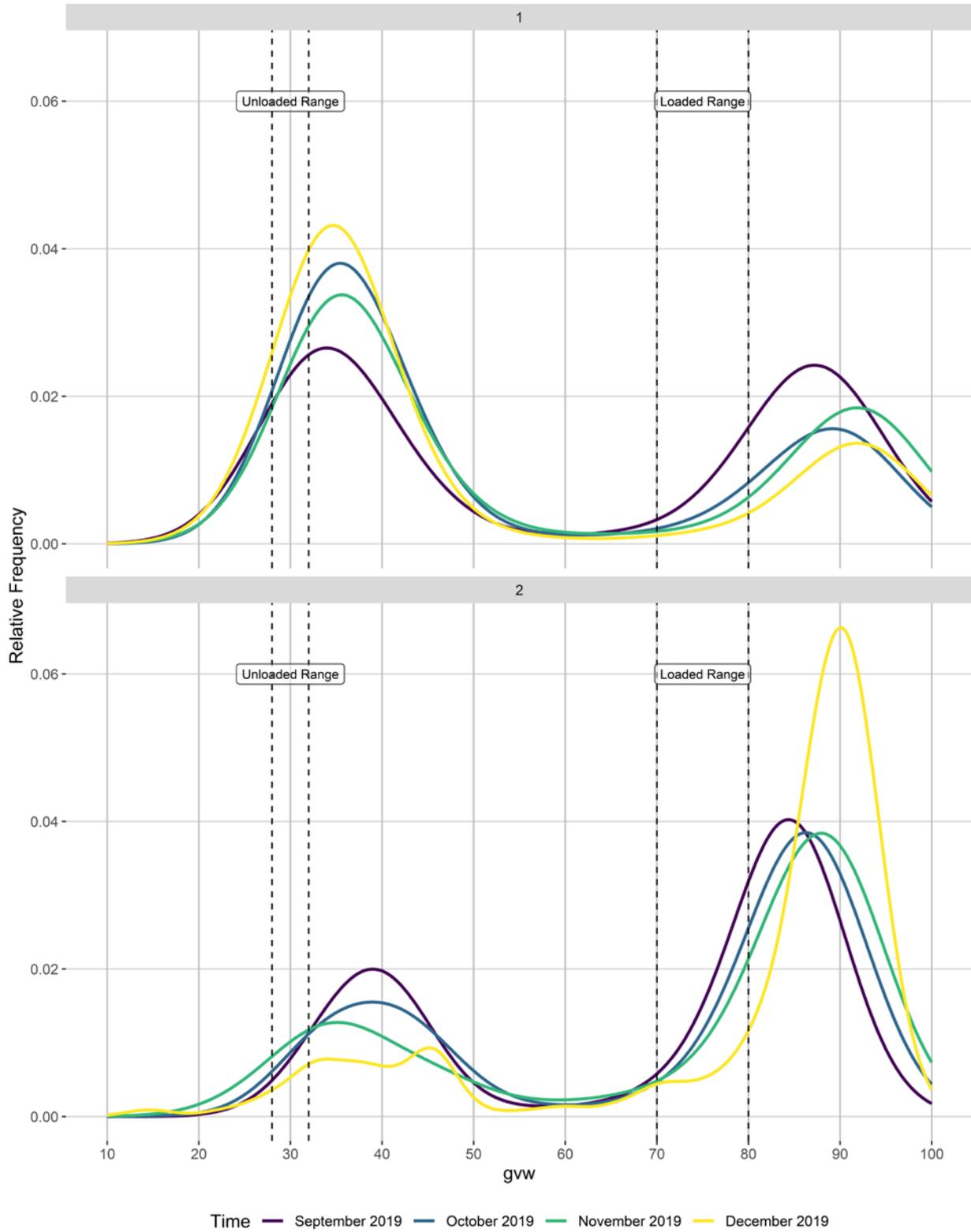
#####WIM monthly reports can be found at:

<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.

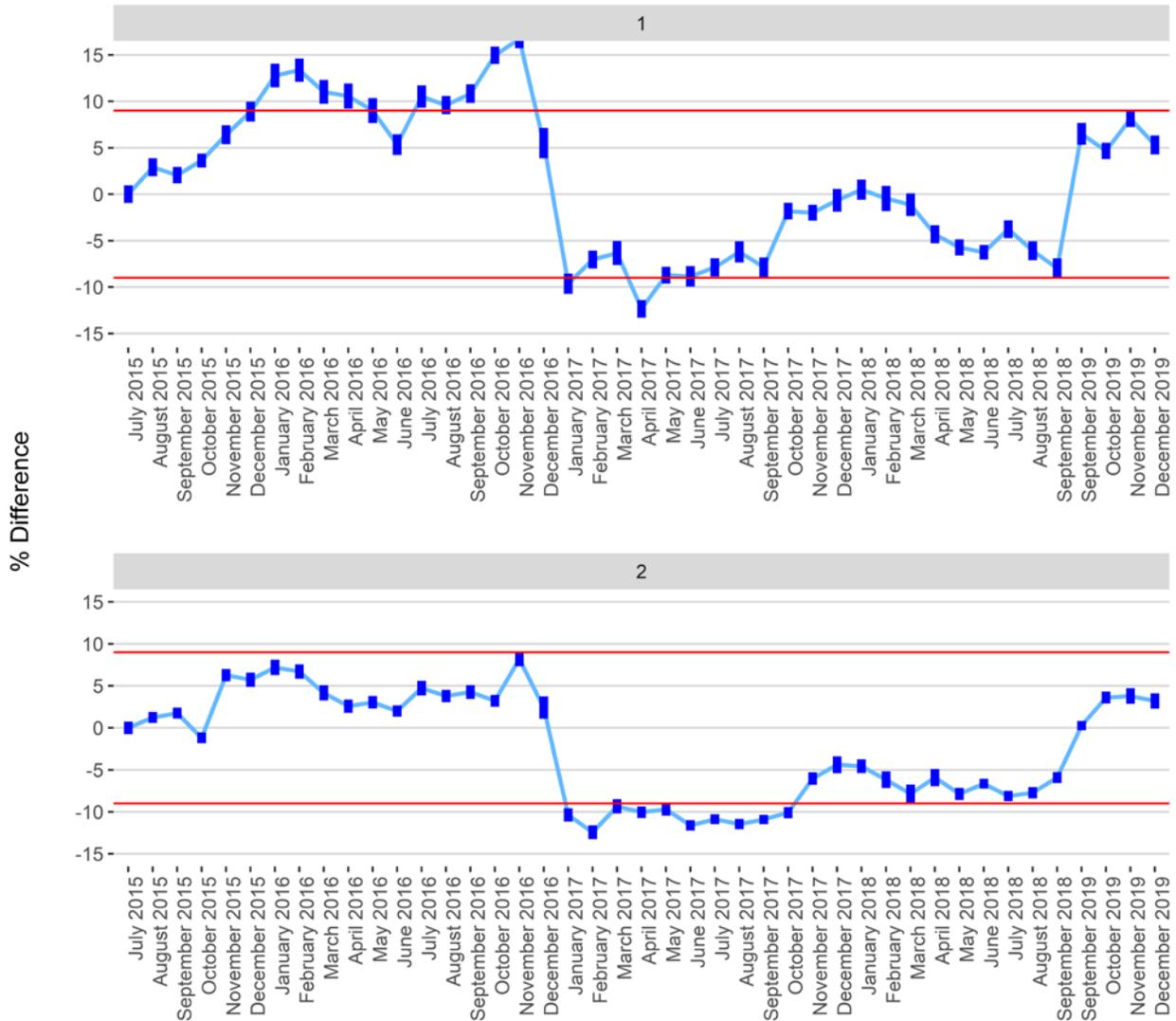
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

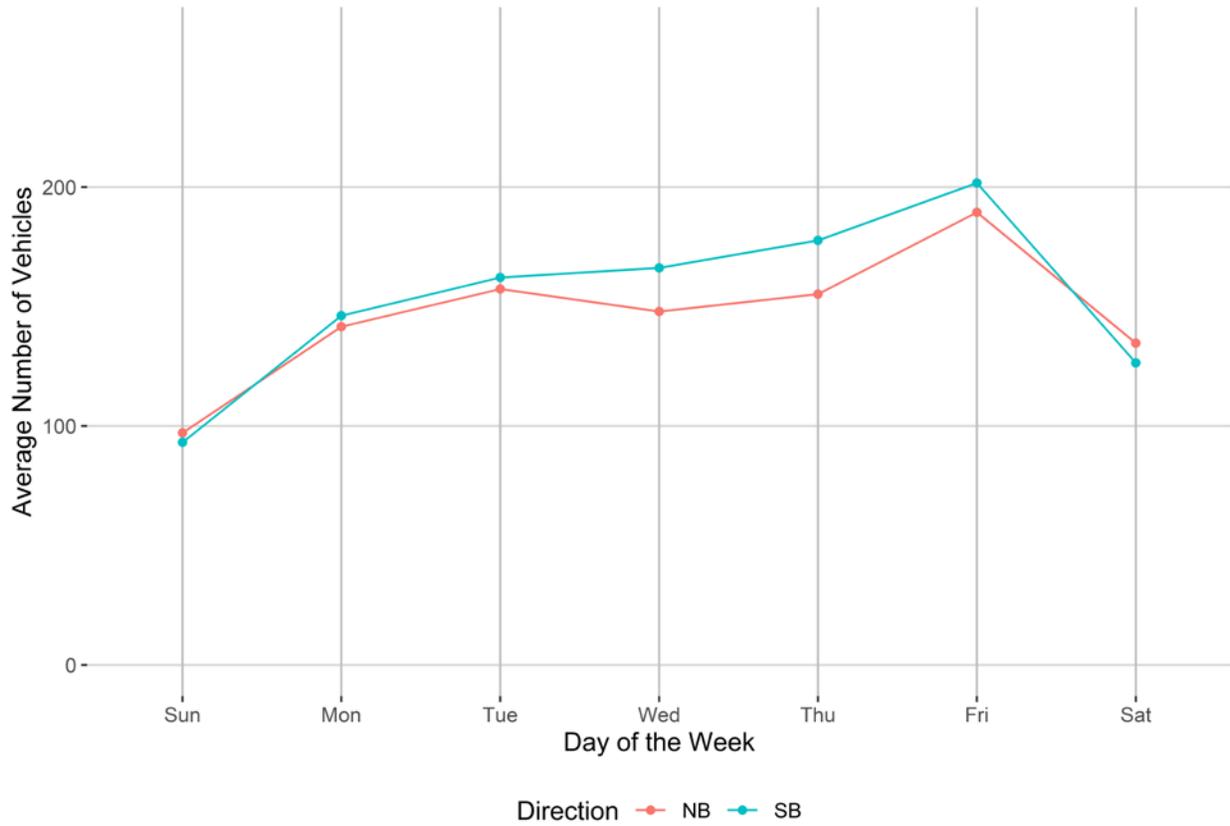


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

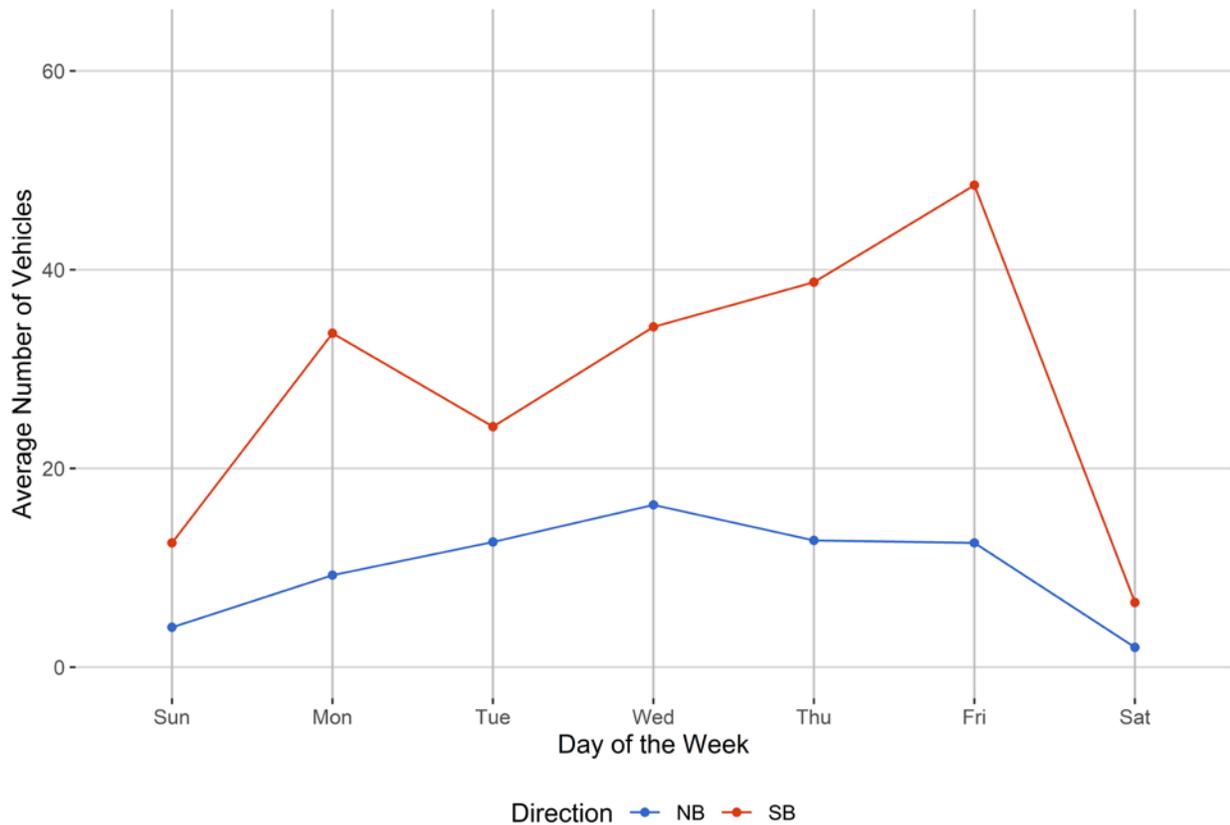


Figure 4 - Passenger Vehicles vs. Hour of the Day

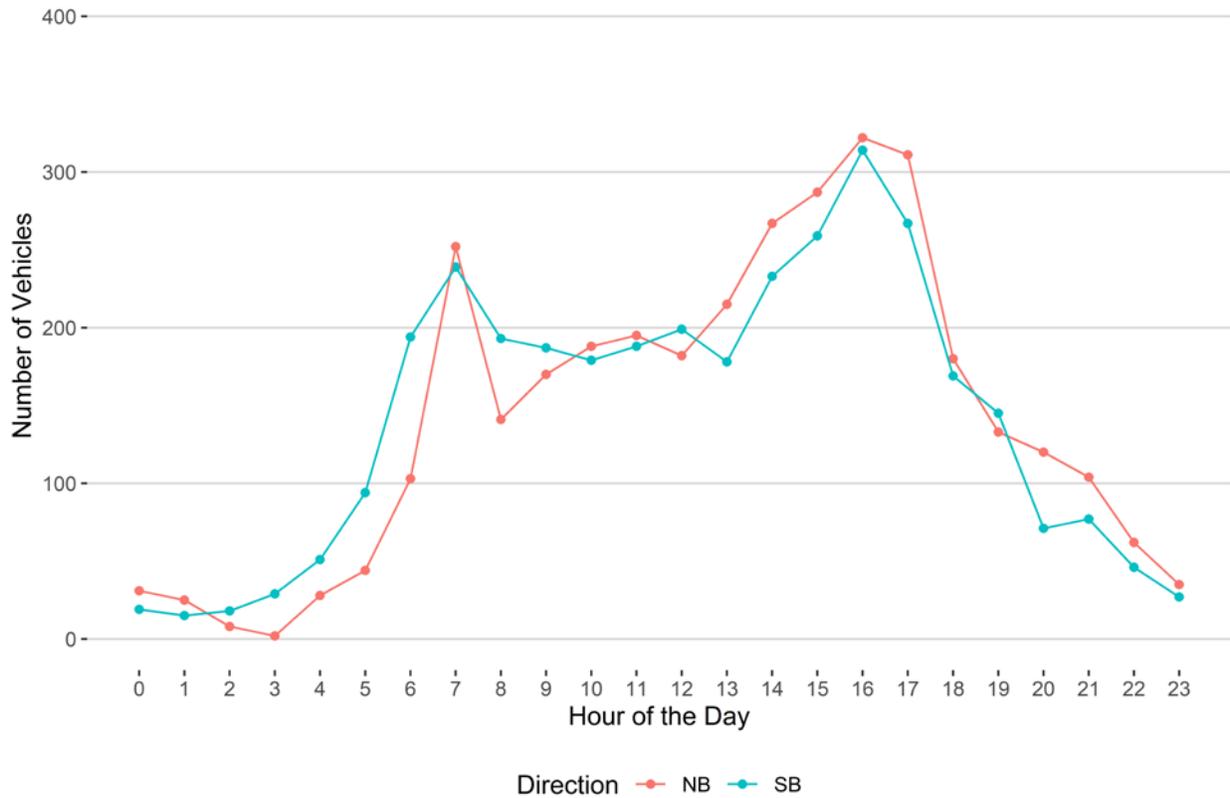


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

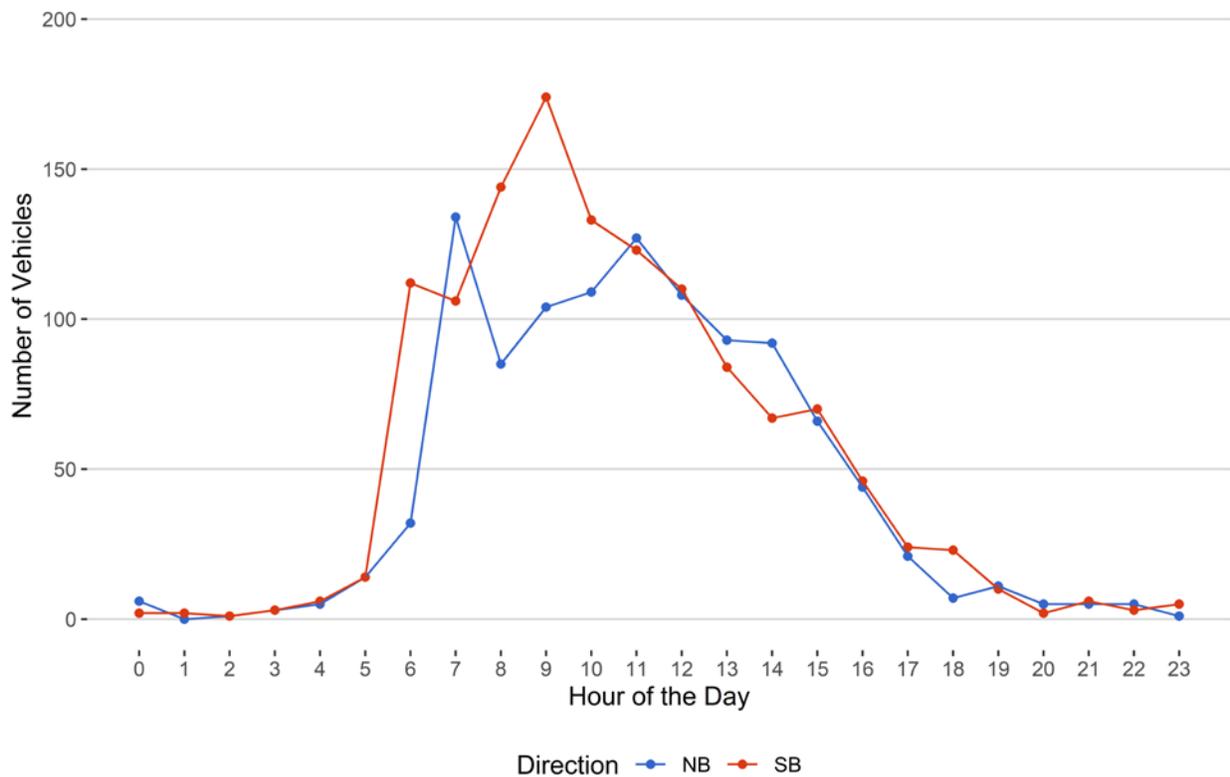


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

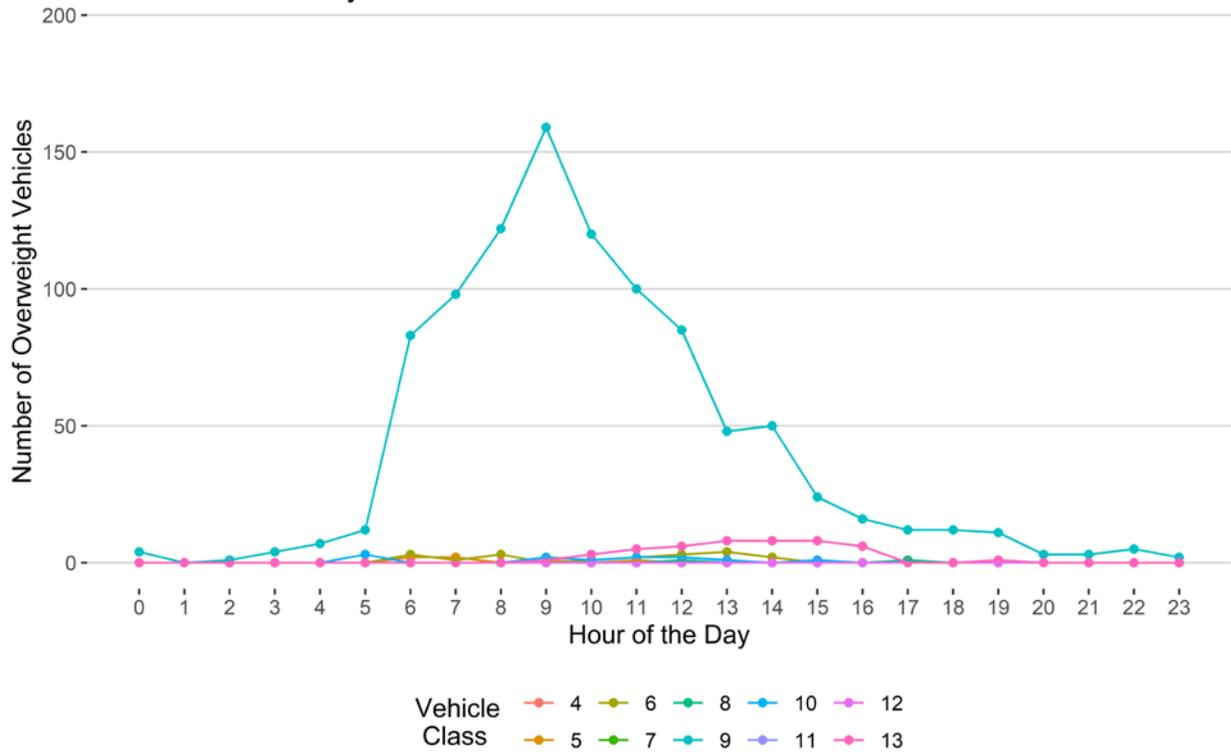


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

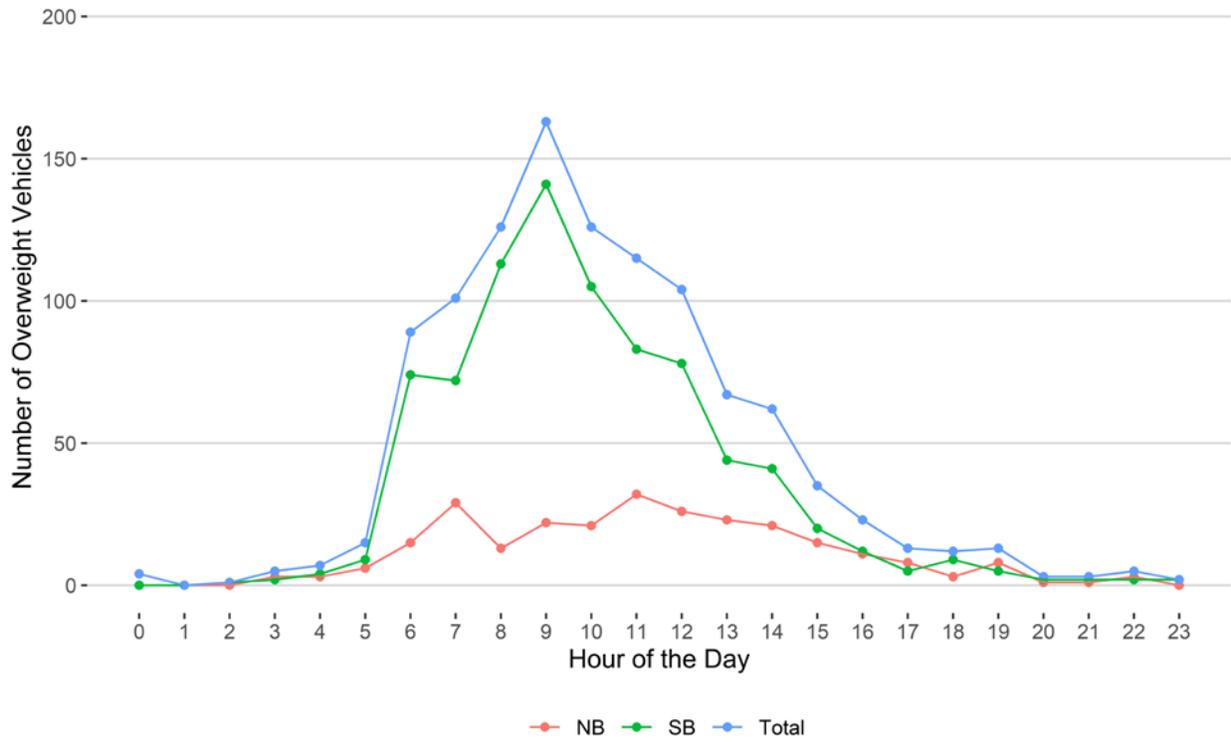
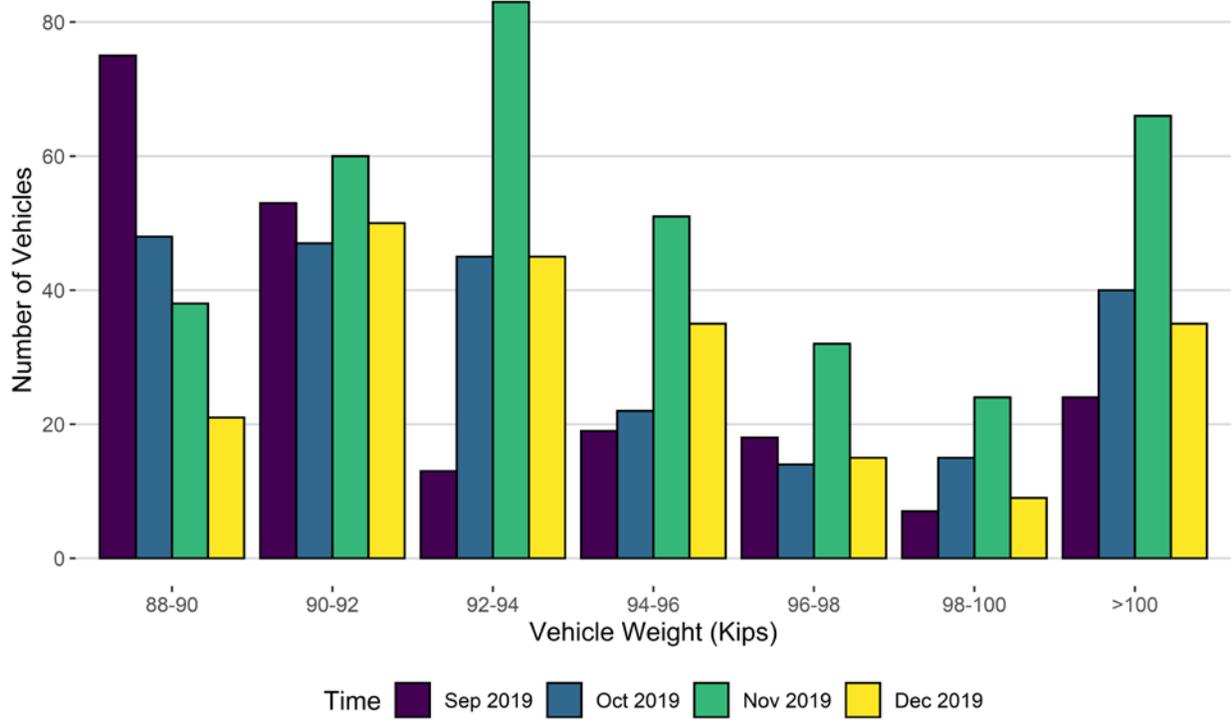
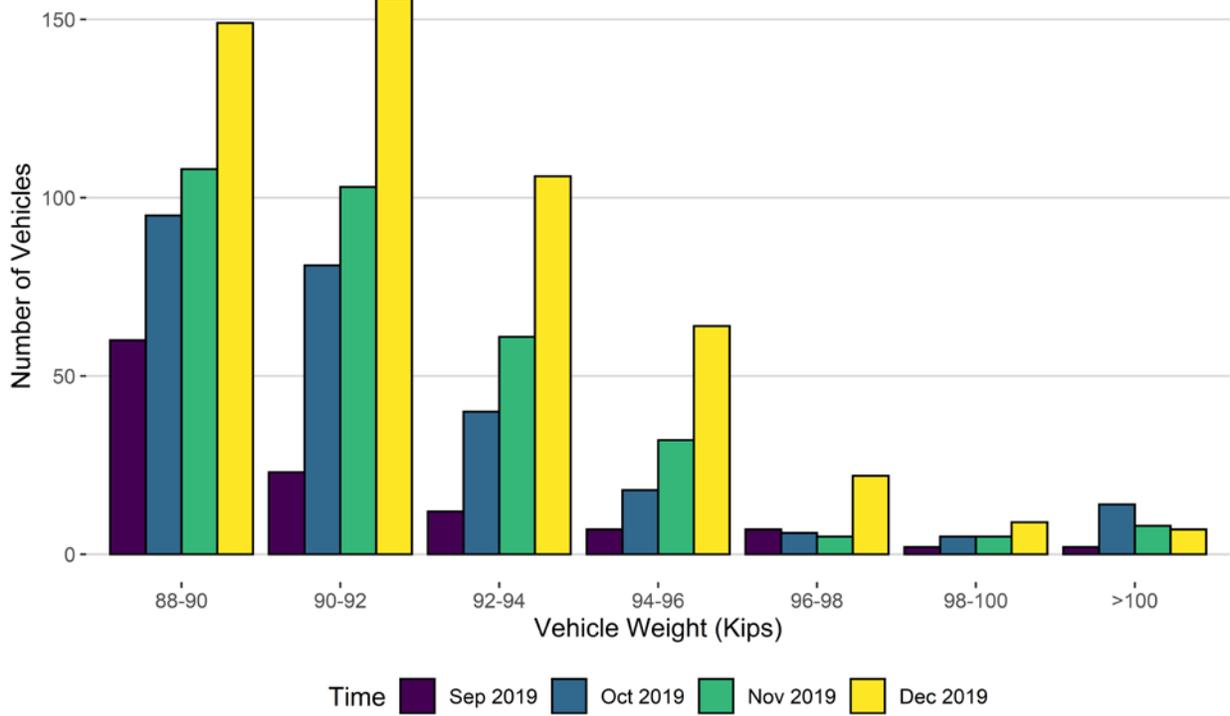


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Sep 2019</i>	<i>Oct 2019</i>	<i>Nov 2019</i>	<i>Dec 2019</i>
88-90	75	48	38	21
90-92	53	47	60	50
92-94	13	45	83	45
94-96	19	22	51	35
96-98	18	14	32	15
98-100	7	15	24	9
>100	24	40	66	35
Total	209	231	354	210

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



<i>Vehicle Weights (Kips)</i>	<i>Sep 2019</i>	<i>Oct 2019</i>	<i>Nov 2019</i>	<i>Dec 2019</i>
88-90	60	95	108	149
90-92	23	81	103	156
92-94	12	40	61	106
94-96	7	18	32	64
96-98	7	6	5	22
98-100	2	5	5	9
>100	2	14	8	7
Total	113	259	322	513

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

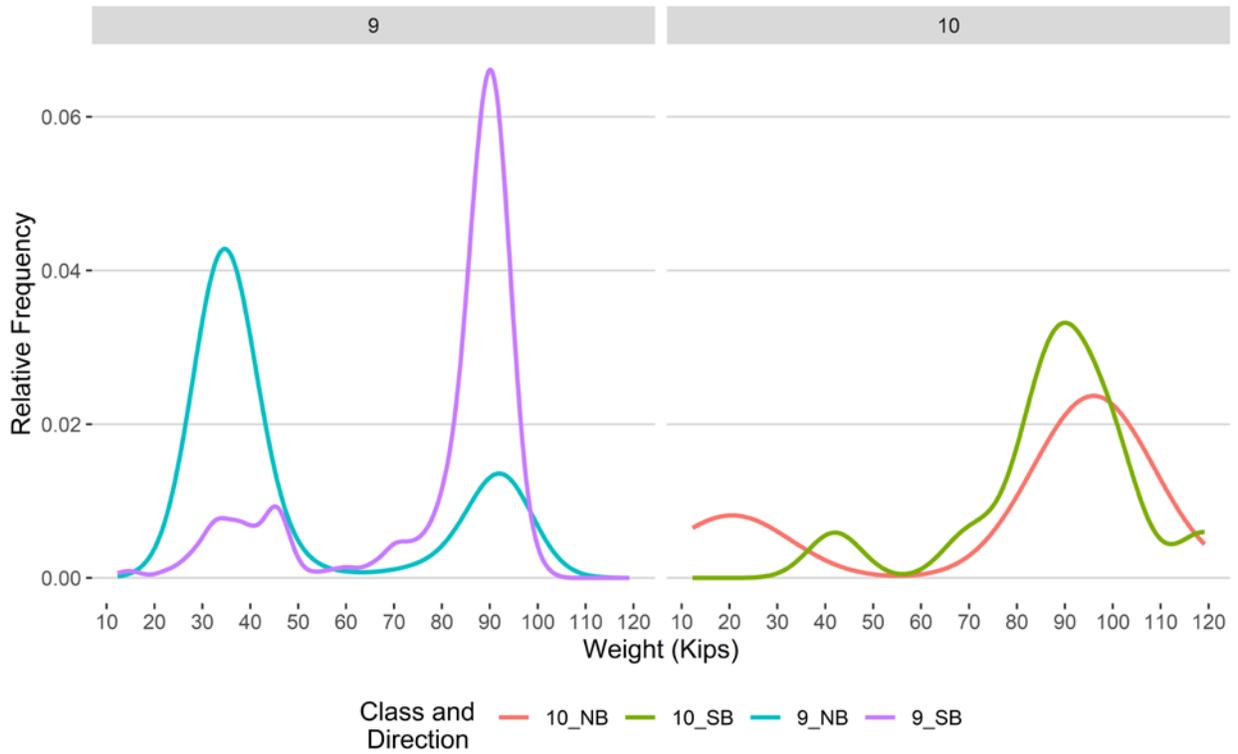


Figure 9 - Freight Percentage by Direction and Class

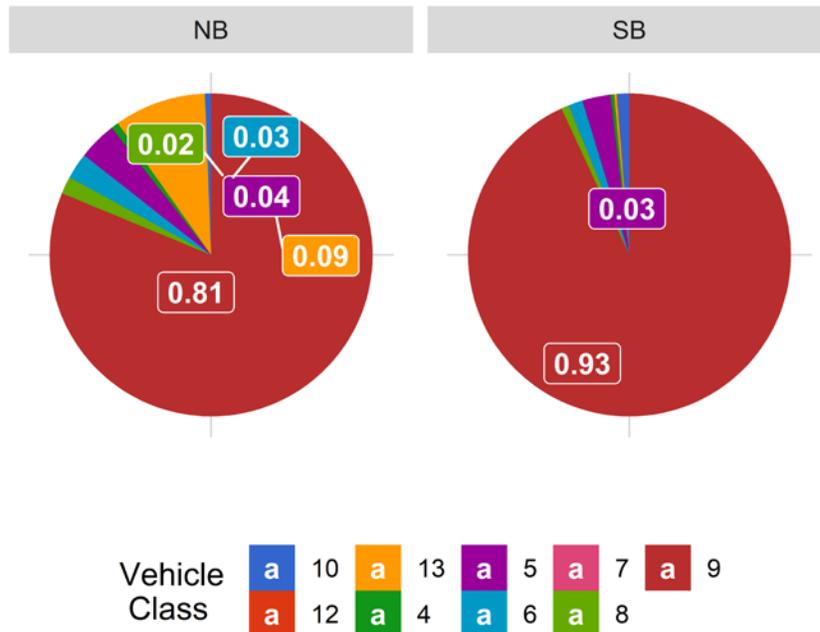


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

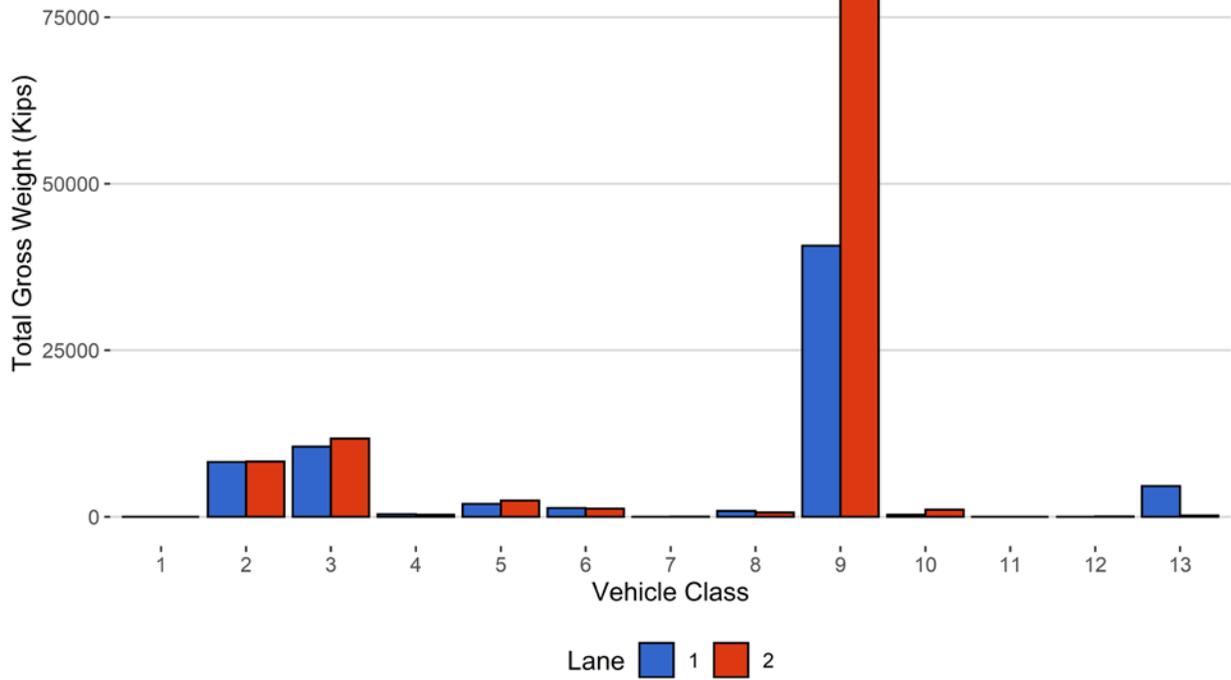


Figure 11 - Total Gross Vehicle Weight t

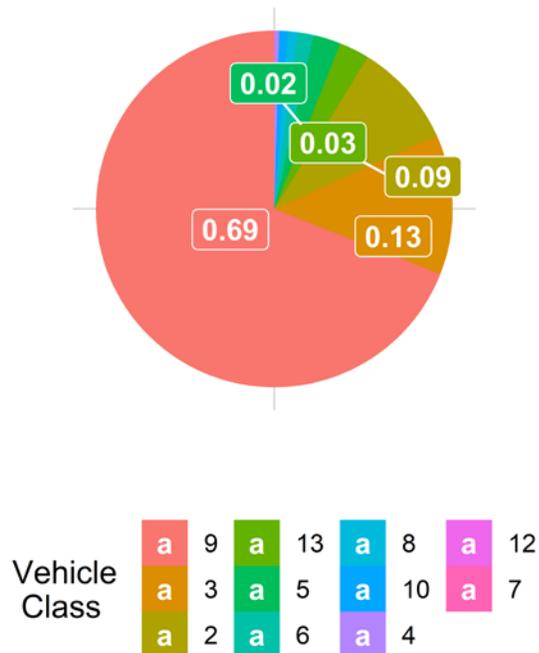


Figure 12 - Total ESALs by Class and Lane

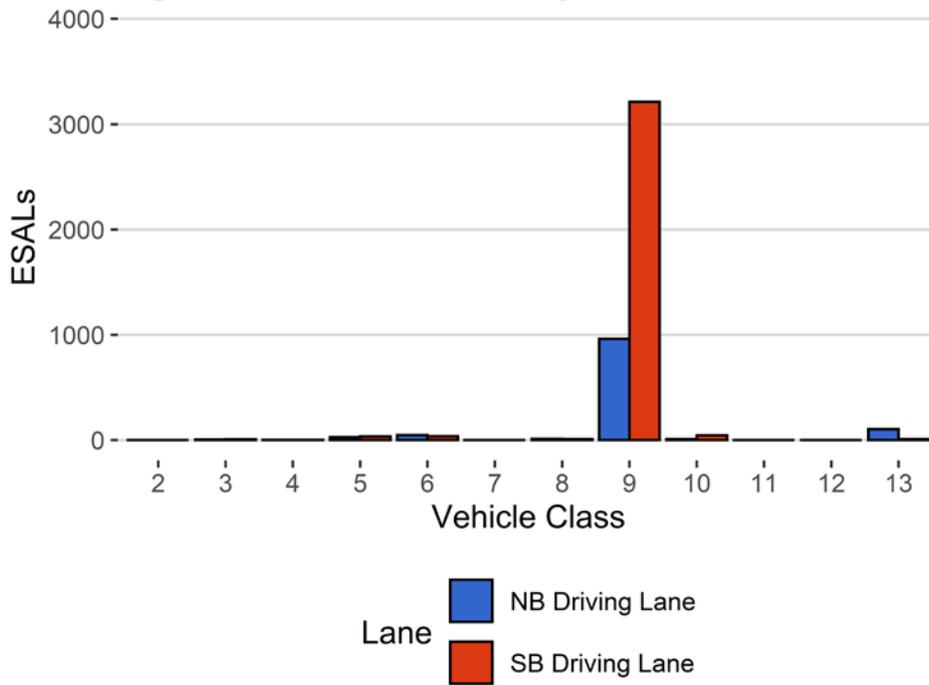


Figure 13 - ESALs by Class

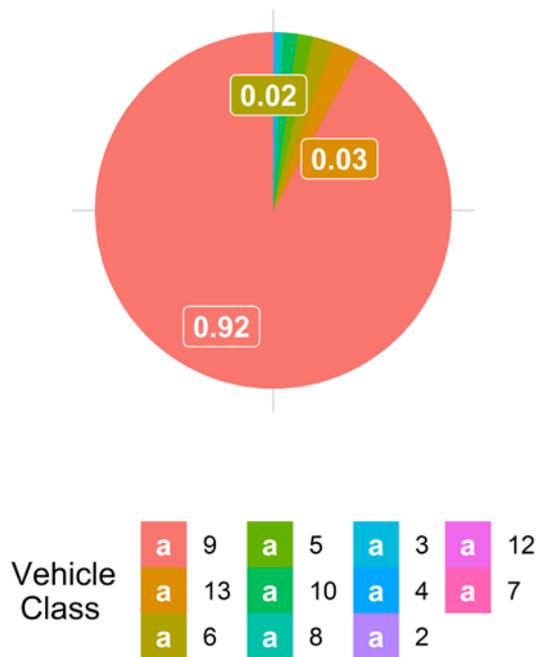


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
July 2015	10.71	0.00	11.00	0.00
August 2015	11.02	2.90	11.14	1.24
September 2015	10.93	2.05	11.19	1.76
October 2015	11.10	3.63	10.87	-1.20
November 2015	11.40	6.40	11.69	6.28
December 2015	11.67	8.89	11.63	5.72
January 2016	12.08	12.78	11.79	7.19
February 2016	12.15	13.37	11.74	6.70
March 2016	11.89	11.02	11.46	4.16
April 2016	11.85	10.57	11.29	2.58
May 2016	11.68	9.01	11.34	3.04
June 2016	11.29	5.34	11.22	2.00
July 2016	11.84	10.51	11.52	4.73
August 2016	11.74	9.59	11.42	3.78
September 2016	11.87	10.83	11.47	4.25
October 2016	12.32	14.97	11.36	3.22
November 2016	12.50	16.72	11.90	8.19
December 2016	11.30	5.50	11.27	2.41
January 2017	9.68	-9.64	9.86	-10.37
February 2017	9.96	-7.04	9.63	-12.43
March 2017	10.04	-6.33	9.97	-9.35
April 2017	9.39	-12.35	9.90	-10.04
May 2017	9.78	-8.72	9.93	-9.71
June 2017	9.77	-8.85	9.72	-11.62
July 2017	9.87	-7.87	9.80	-10.88
August 2017	10.05	-6.21	9.74	-11.45
September 2017	9.87	-7.84	9.80	-10.91
October 2017	10.52	-1.83	9.89	-10.10
November 2017	10.50	-1.99	10.34	-6.05
December 2017	10.64	-0.66	10.52	-4.40
January 2018	10.77	0.49	10.50	-4.57
February 2018	10.66	-0.46	10.32	-6.18
March 2018	10.59	-1.13	10.14	-7.85
April 2018	10.25	-4.32	10.35	-5.93
May 2018	10.10	-5.73	10.14	-7.87
June 2018	10.04	-6.25	10.27	-6.66
July 2018	10.31	-3.77	10.11	-8.12
August 2018	10.06	-6.08	10.15	-7.73
September 2018	9.86	-7.97	10.35	-5.92

September 2019	11.41	6.50	11.03	0.27
October 2019	11.21	4.66	11.40	3.60
November 2019	11.58	8.13	11.42	3.79
December 2019	11.28	5.31	11.35	3.20

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	0	0	0	0	0
2	151	4684	41.6	0	0
3	119	3702	32.9	0	0
4	1	37	0.3	0	0
5	12	372	3.3	7	0.7
6	2	76	0.7	19	1.8
7	0	1	0	0	0
8	2	57	0.5	2	0.2
9	72	2239	19.9	981	91.9
10	1	19	0.2	13	1.2
11	0	0	0	0	0
12	0	1	0	0	0
13	2	58	0.5	46	4.3
TOTAL	363	11247	100	1068	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>
2019-12-04	Wednesday	12:51:48	10	SB	2	119.16
2019-12-18	Wednesday	18:47:56	9	NB	1	103.9
2019-12-17	Tuesday	09:09:56	9	SB	2	102.68
2019-12-18	Wednesday	17:50:41	9	NB	1	102.18
2019-12-08	Sunday	16:12:16	9	SB	2	101.83
2019-12-26	Thursday	10:37:13	9	NB	1	101.46
2019-12-06	Friday	12:24:25	10	SB	2	101.28
2019-12-18	Wednesday	10:44:48	9	SB	2	101.18
2019-12-04	Wednesday	11:49:44	9	SB	2	101.01
2019-12-06	Friday	09:36:40	10	SB	2	100.27

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	15	1	6.7	361	14	76
5	NB	8	135	7	5.2	1879	52	428
6	NB	19	30	0	0	1309	0	370
8	NB	31	26	4	15.4	817	52	67
9	NB	33	823	162	19.7	35710	4979	6948
10	NB	33.5	4	1	25	288	21	94
13	NB	31.5	45	0	0	4606	0	1594
TOTAL	****	****	1078	175	****	44970	****	9576
<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	15	3	20	280	39	50
5	SB	8	170	8	4.7	2375	57	539
6	SB	19	32	1	3.1	1223	11	317
7	SB	11.5	1	0	0	21	0	5
8	SB	31	21	9	42.9	466	181	47
9	SB	33	1015	51	5	78661	1414	23425
10	SB	33.5	12	0	0	1055	0	326
12	SB	36.5	1	0	0	44	0	4
13	SB	31.5	3	1	33.3	181	28	59
TOTAL	****	****	1270	73	****	84305	****	24771
GRAND TOTAL	****	****	2348	248	181	129275	6850	34348

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>
2	8215	8283	16498	9.4
3	10531	11731	22262	12.7
4	375	320	695	0.4
5	1932	2432	4364	2.5
6	1309	1234	2543	1.5
7	0	21	21	0
8	869	646	1515	0.9
9	40689	80076	120765	69.1
10	308	1055	1363	0.8
12	0	44	44	0
13	4606	209	4815	2.8
TOTAL	68834	106050	174884	100
GVW/LANE	39.36	60.64	100	0.06

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>
2	1	1	2	0.1	0.0019
3	6	7	13	0.3	0.0098
4	3	3	6	0.1	0.48
5	28	35	63	1.4	0.43
6	48	36	85	1.9	2.6
7	0	0	0	0	0.88
8	11	9	21	0.4	0.9
9	962	3212	4173	92	4.57
10	10	47	57	1.2	4.8
12	0	0	0	0	0.95
13	105	9	114	2.5	3.99
TOTAL	1174	3361	4535	100	20
ESALS/LANE	25.9	74.1	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>
Sep 2019	11850	400	95	9013	76.1	2836.7	23.9
Oct 2019	12833	418	106	9551	74.4	3281.7	25.6
Nov 2019	12077	411	112	8708	72.1	3369	27.9
Dec 2019	11247	372	92	8387	74.6	2860.5	25.4
TOTAL	48007	-	-	35659	-	12348	-
AVERAGE	12002	400	101	8915	74	3087	26

###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>
Sep 2019	1475	2380	3855	21.5
Oct 2019	1519	3137	4656	45.6
Nov 2019	2314	4841	7155	55.5
Dec 2019	1175	4273	5448	78.3
TOTAL	6484	-	-	-
AVERAGE	1621	3658	5278	50

###Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Sep 19	75928	98761	174689
Oct 19	90639	113500	204139
Nov 19	102355	106537	208892
Dec 19	68955	108134	177089
TOTAL	337876	426932	764808
AVERAGE	84469	106733	191202

###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>
Sep 2019	1028	10.2	42.3	322	35
Oct 2019	1117	9.8	37.7	493	77
Nov 2019	1284	12.3	42.7	688	112
Dec 2019	1094	11.9	45.7	732	66
TOTAL	4523	-	-	2235	290
AVERAGE	1130.8	11.1	42.1	558.8	72.5

###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>
Sep 2019	12950	19331	32281	40.1	59.9
Oct 2019	13361	23154	36515	36.6	63.4
Nov 2019	17656	22028	39684	44.5	55.5
Dec 2019	9576	24771	34348	27.9	72.1
TOTAL	53544	89284	142828	-	-
AVERAGE	13385.9	22321	35706.9	37.3	62.7