

JANUARY 2018



**WIM #41
CSAH 14,
MP 14.9
CROOKSTON,
MINNESOTA**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #41 is located on CSAH 14 near Crookston in Polk county.

System Operation

WIM #41 was operational for the entire month of January 2018. Volume was computed using all monthly data.

System Calibration

WIM #41 was most recently calibrated on 2015-02-04. Table 1 summarizes the front axle weights of class 9s by lane ¹. Table 1 indicates that the class 9 front axle weights were all within +/- 9% of baseline calibration values for all lanes. 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: 9334 | Passenger Vehicles: 8364 | Heavy Commercial Vehicles: 970

Monthly Average Daily Traffic (MADT): 301 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 31

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 Tuesdays, with lowest volumes reported on Sundays. SB vehicles typically reached highest volume levels on Wednesdays, 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 09 AM and 11 AM. Similarly, SB PVs peaked in volume between 06 PM and 08 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 09 AM and 11 AM, while volume going SB peaked between 06 PM and 08 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 15's and Class 9's.

Overweight HCVs

Volume trends. Of a total of 970 HCVs, 245 of them were overweight ³. These overweight HCVs contributed to 2.9% of total monthly volume, and 28% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on NAs. SB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on NAs. 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 82% 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 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 ,118 NB vehicles exceeded 88,000 pounds (57 vehicles were Class 13's; 43 vehicles were Class 9's). Of vehicles traveling SB,

23 NB vehicles exceeded 88,000 pounds (15 vehicles were Class 9's; 8 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from January 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in January 2018. Data suggests that there were greater numbers of empty Class 9's than fully_loaded 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 8647 tons of freight was recorded to have crossed the WIM. More freight was shipped NB (79.2%) than SB (20.8%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 97559 is approximately 0.1 miles north of WIM #41, and Bridge No. 60K60 is 3.2 miles south of WIM #41. WIM #41 recorded a total of 9334 vehicles with a combined GVW of 80466 kips (1 kip = 1,000 pounds = 0.5 tons) in January 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 877 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 77% of all ESALs were recorded NB while 23% was observed SB. In particular, 48% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 21% 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).

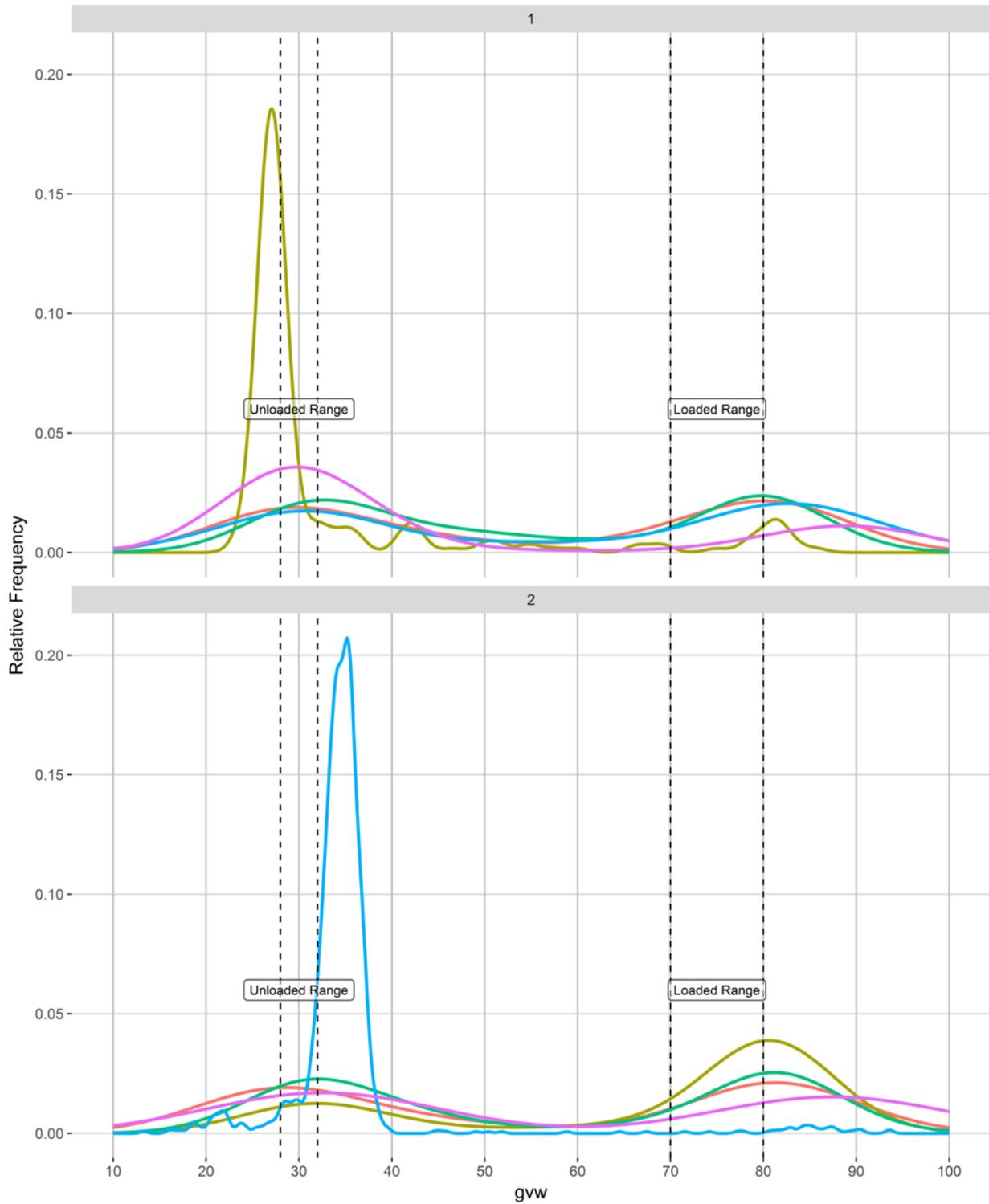
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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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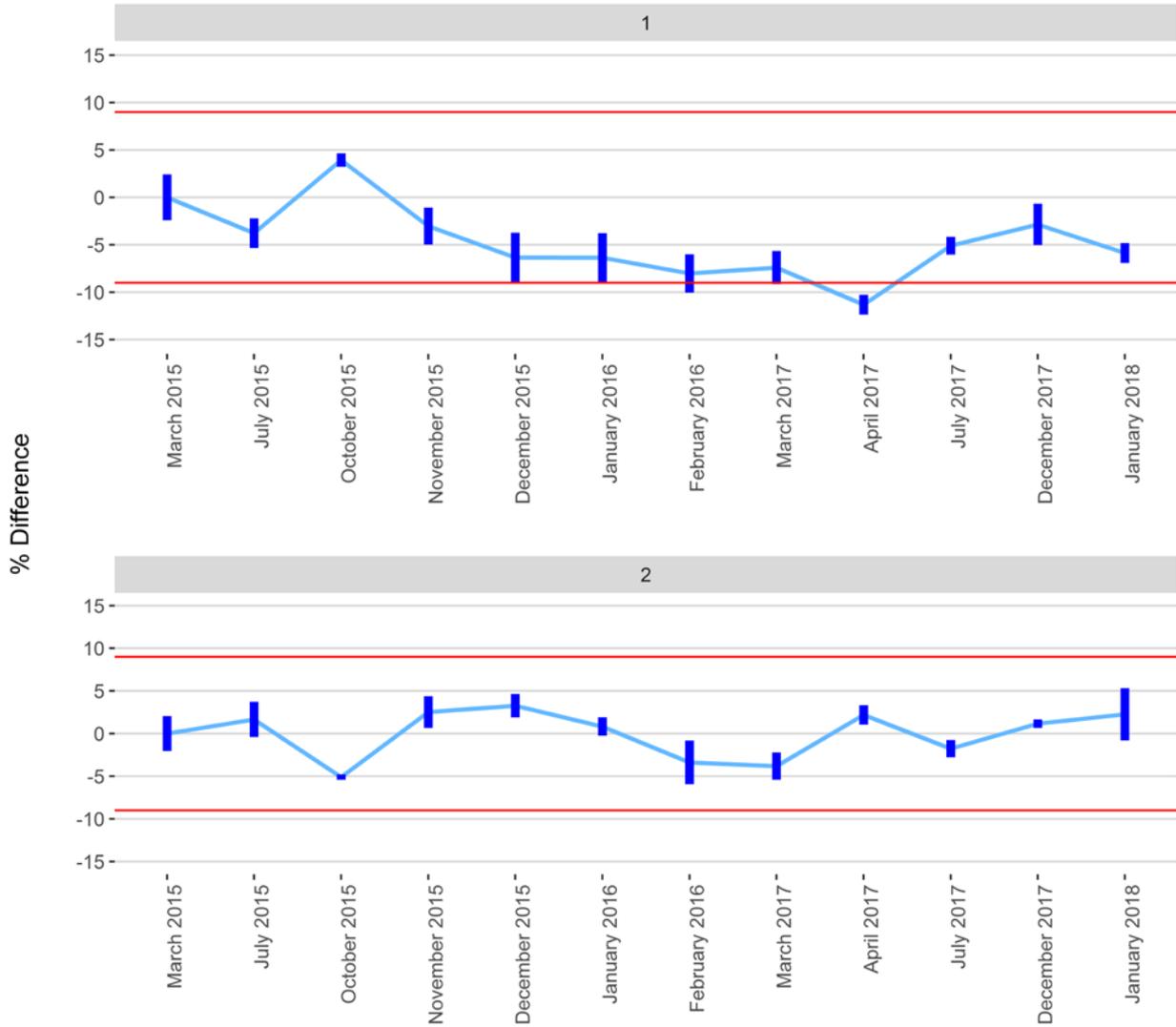
Figure 1 - Monthly Class 9 GVW Histogram



Time — March 2017 — April 2017 — July 2017 — December 2017 — January 2018

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

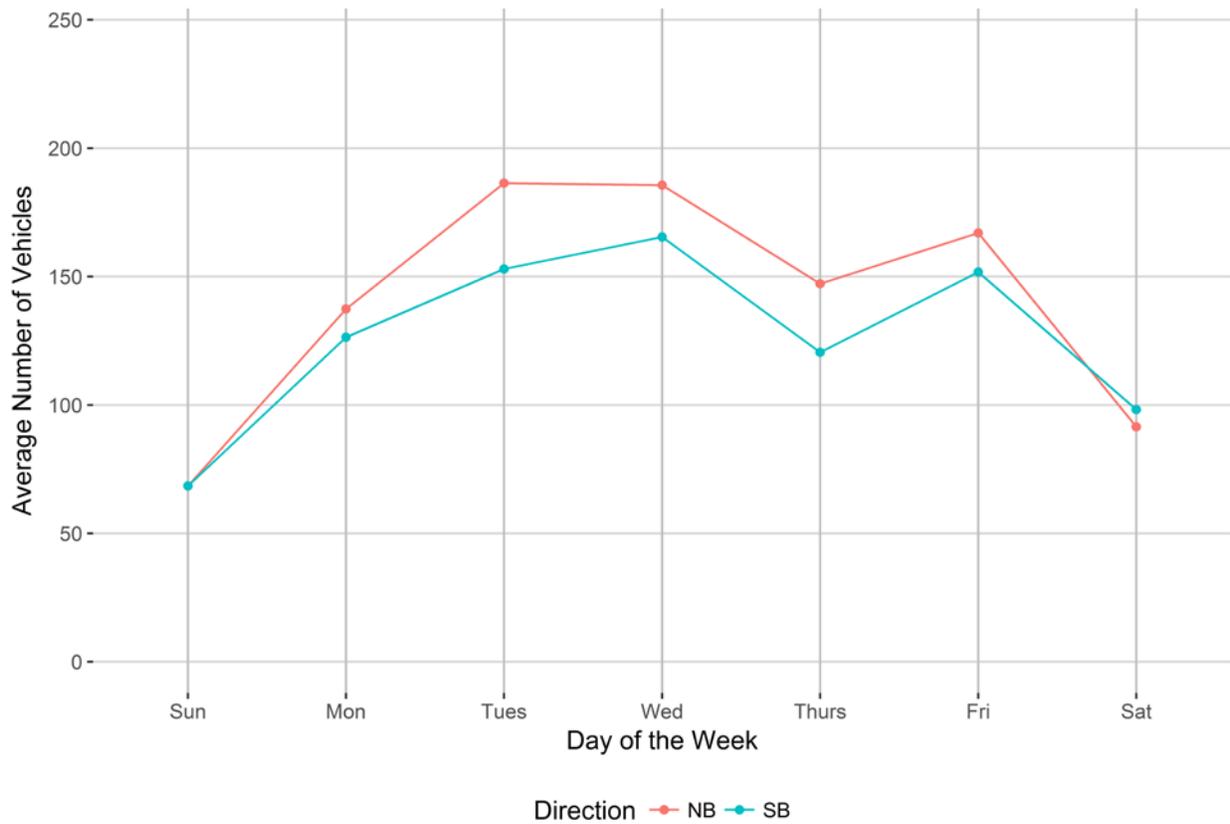


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

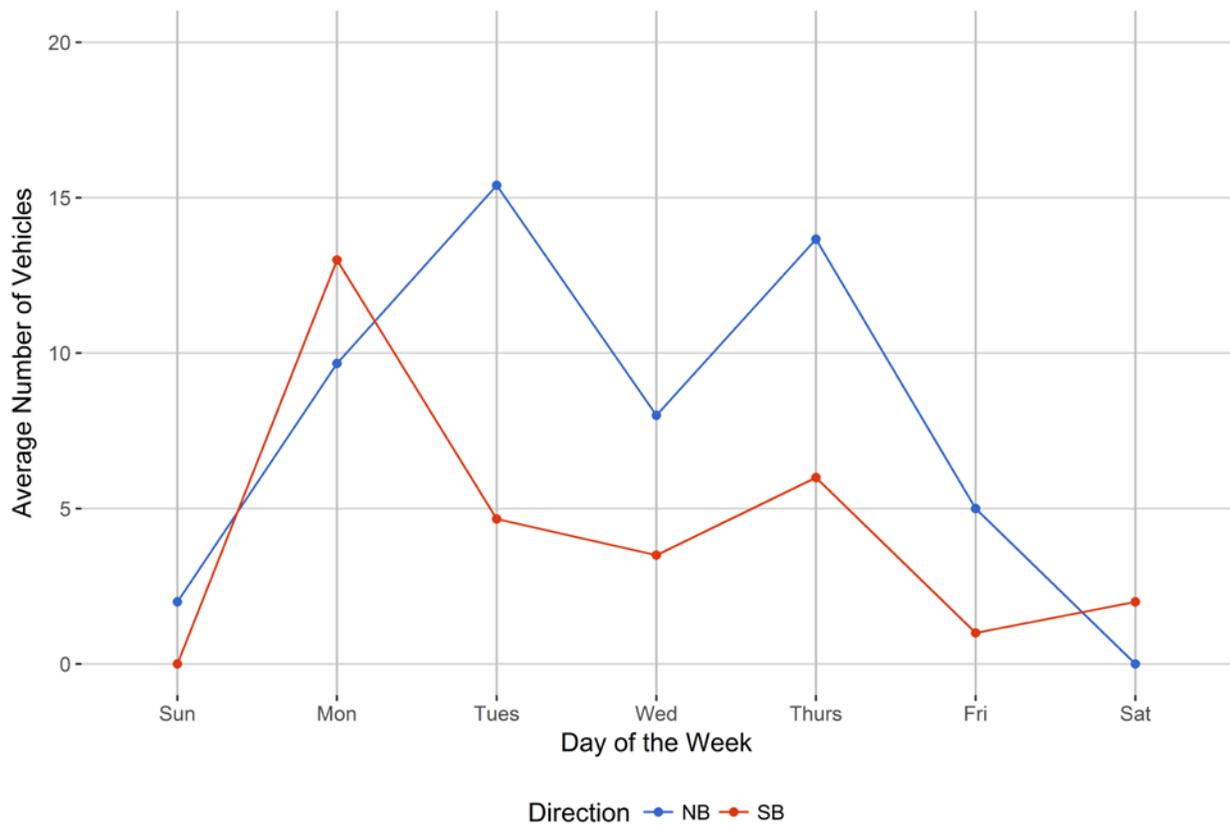


Figure 4 - Passenger Vehicles vs. Hour of the Day

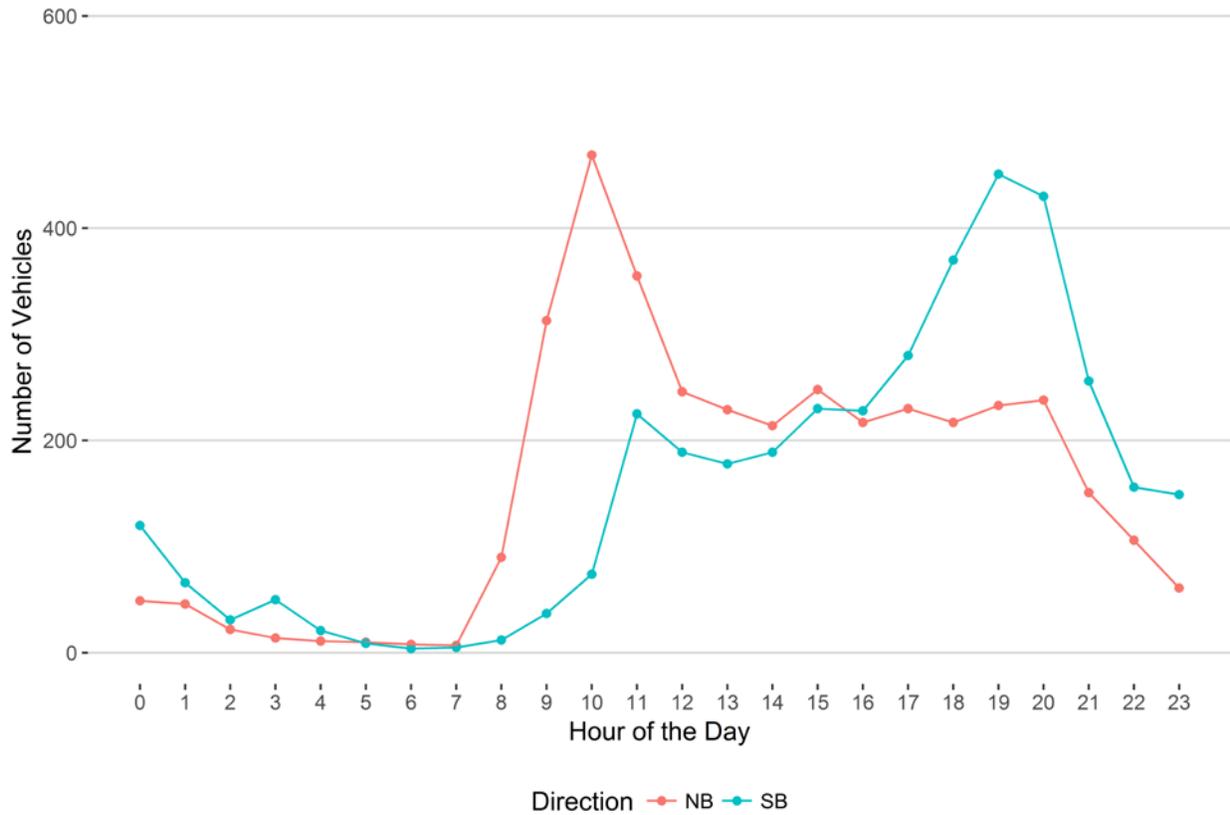


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

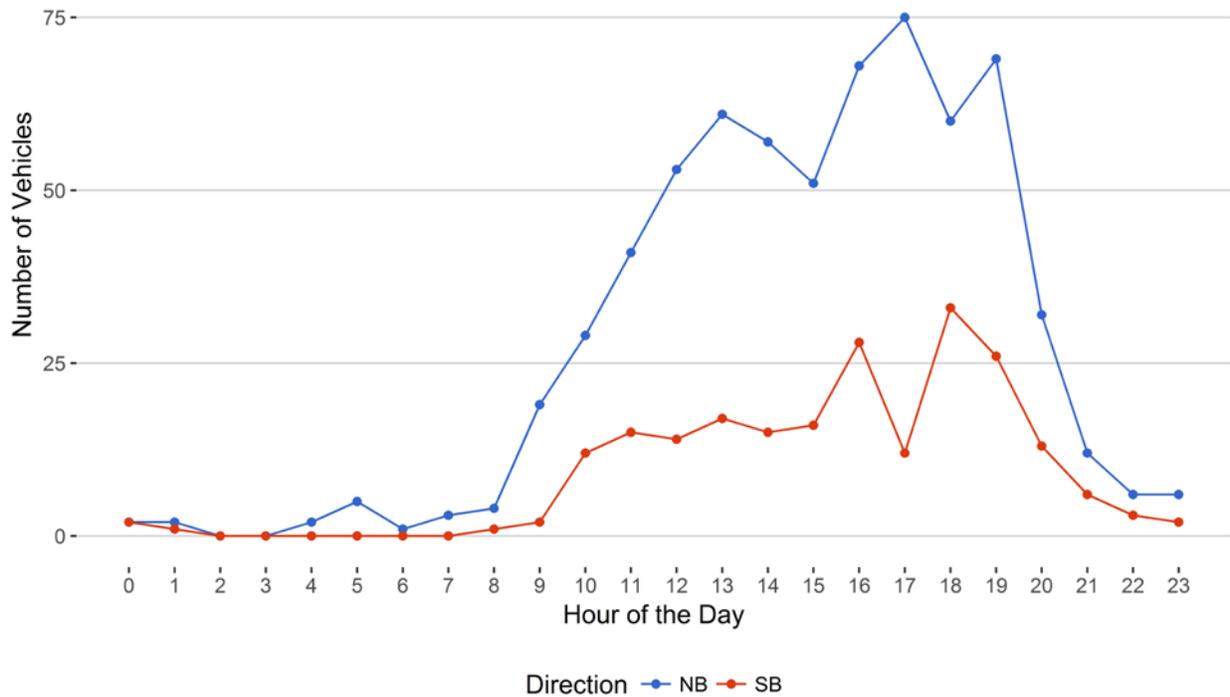


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

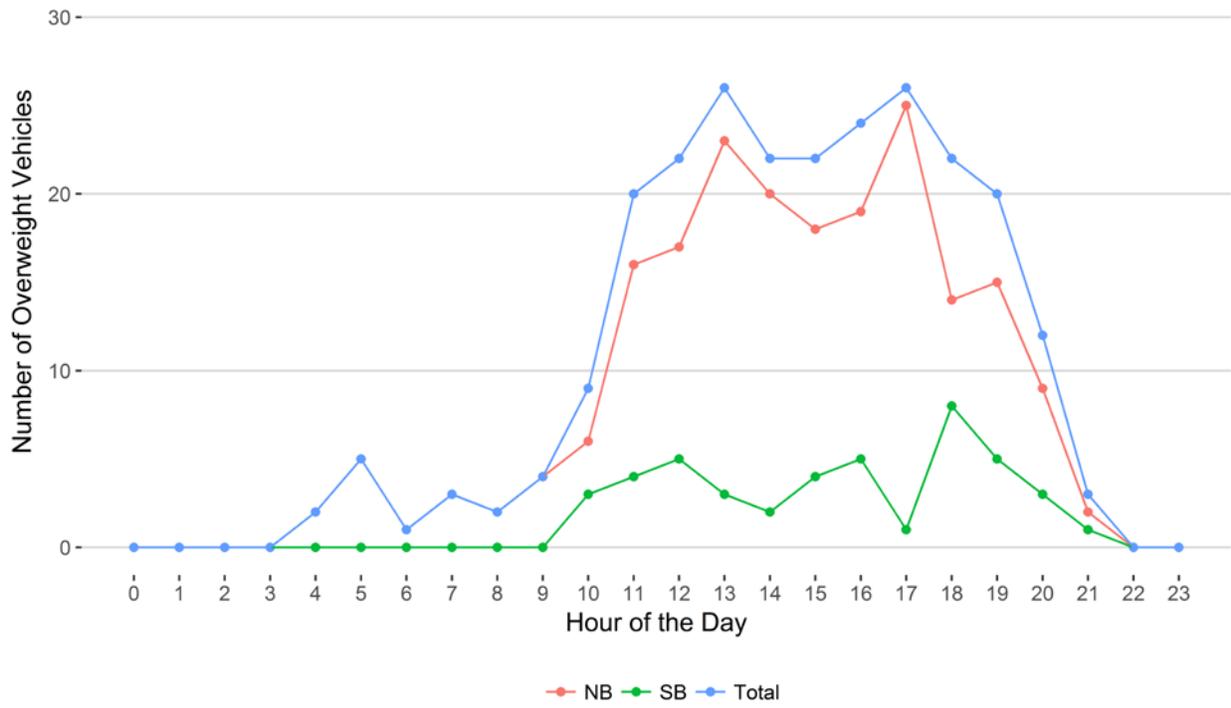
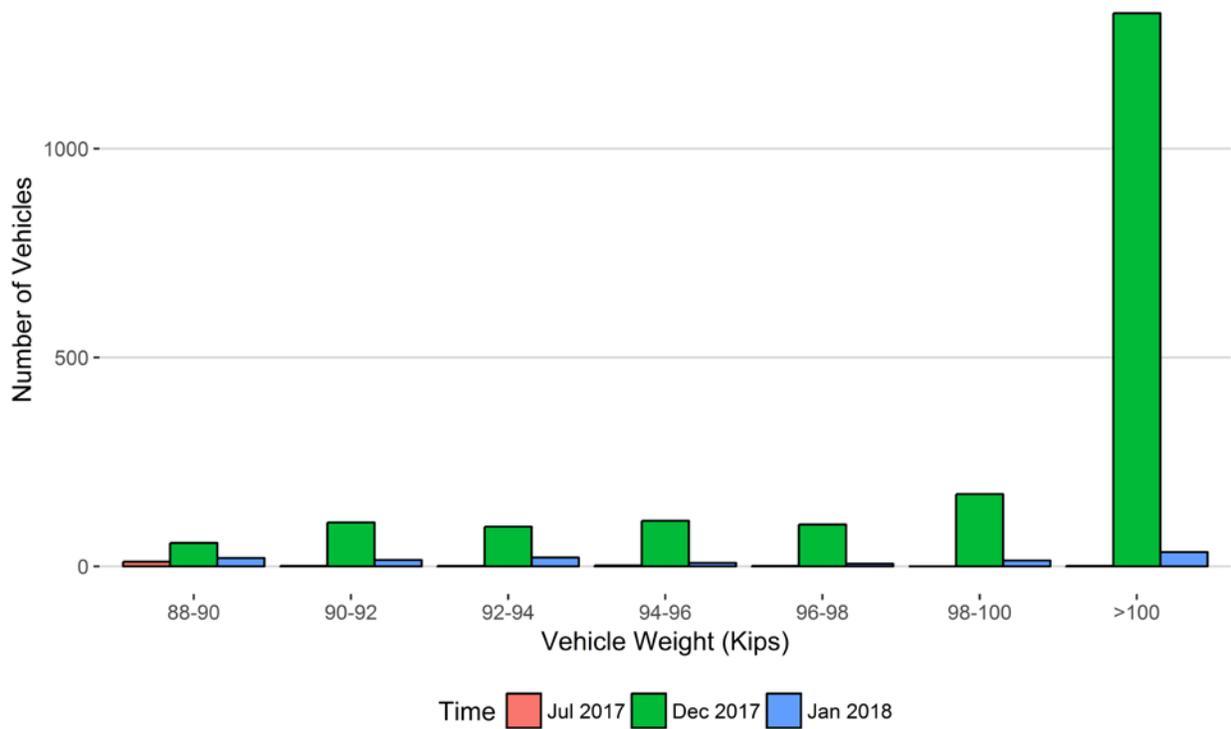
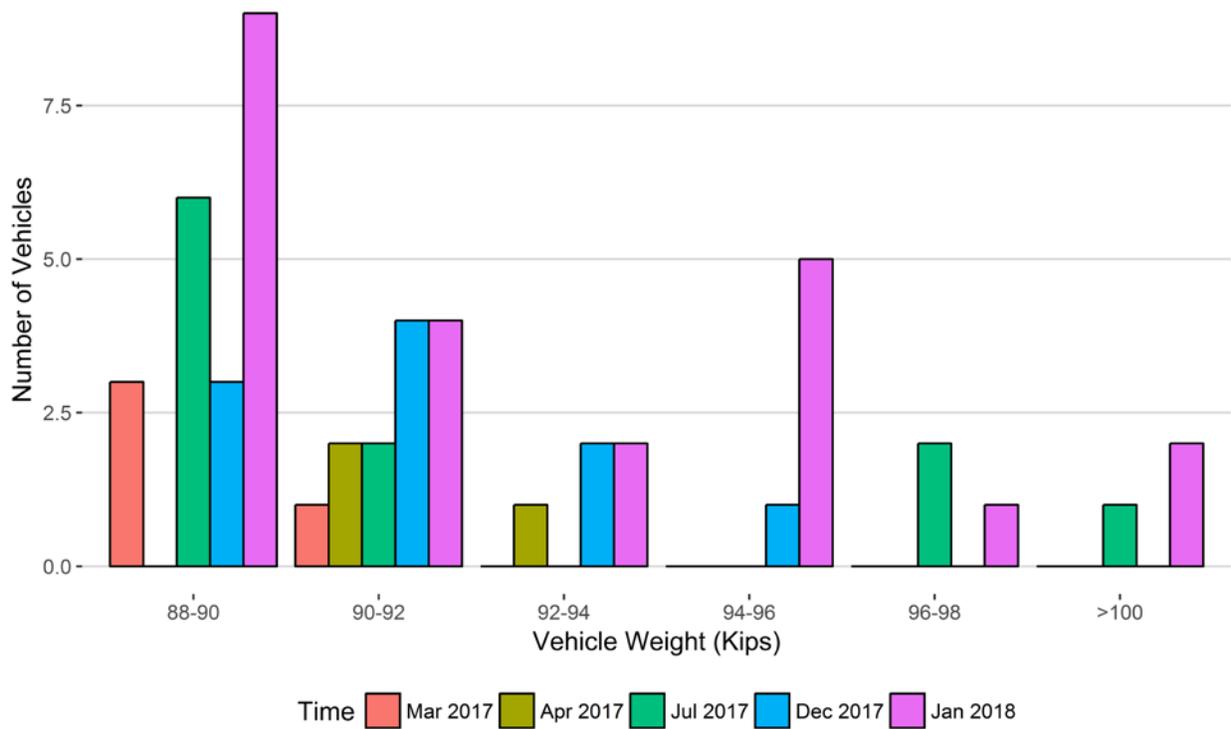


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Jul 2017</i>	<i>Dec 2017</i>	<i>Jan 2018</i>
88-90	11	56	20
90-92	1	105	15
92-94	1	95	21
94-96	2	109	8
96-98	1	100	6
98-100	0	173	14
>100	1	1324	34
Total	17	1962	118

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



<i>Vehicle Weights (Kips)</i>	<i>Mar 2017</i>	<i>Apr 2017</i>	<i>Jul 2017</i>	<i>Dec 2017</i>	<i>Jan 2018</i>
88-90	3	0	6	3	9
90-92	1	2	2	4	4
92-94	0	1	0	2	2
94-96	0	0	0	1	5
96-98	0	0	2	0	1
>100	0	0	1	0	2
Total	4	3	11	10	23

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

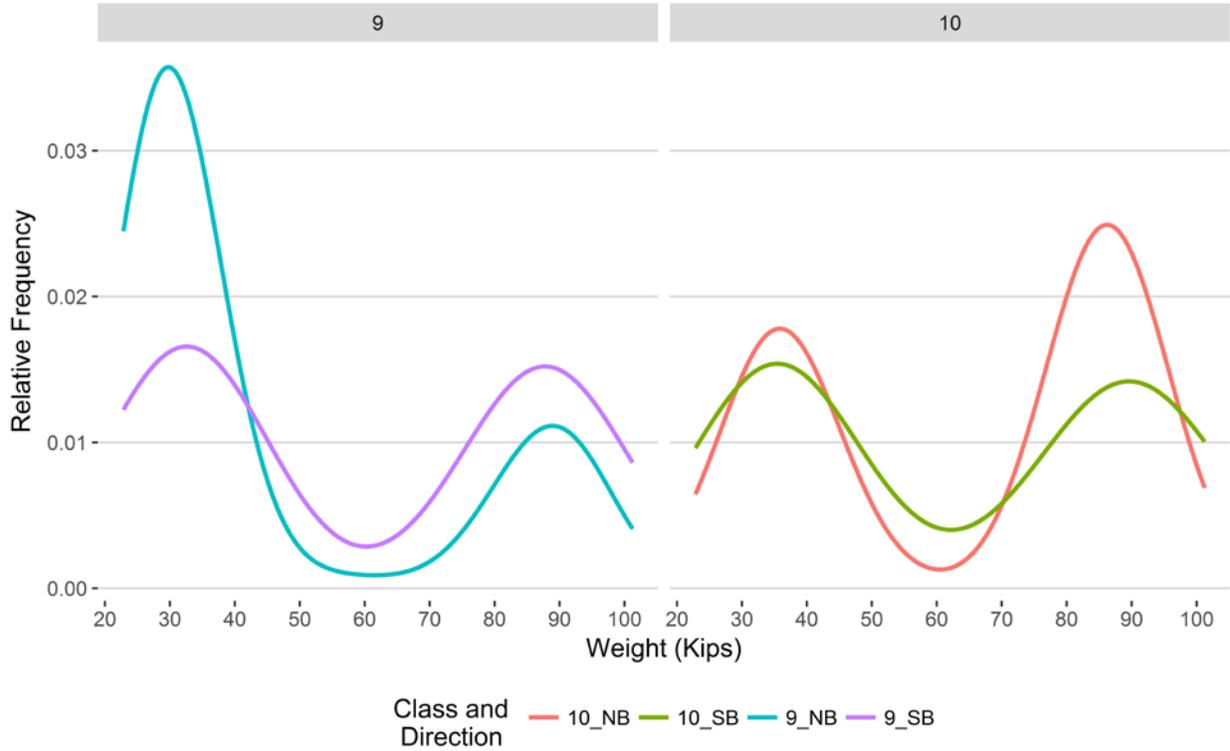


Figure 9 - Freight Percentage by Direction and Class

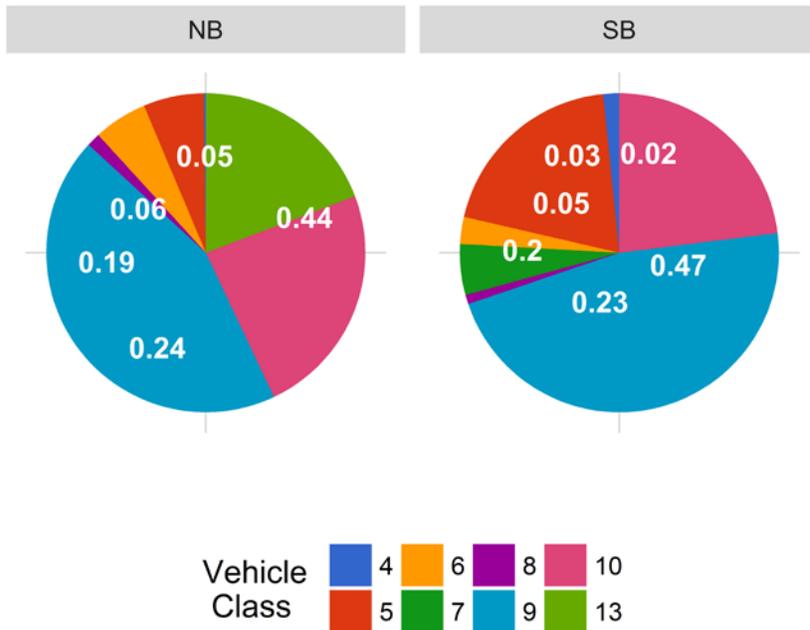


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

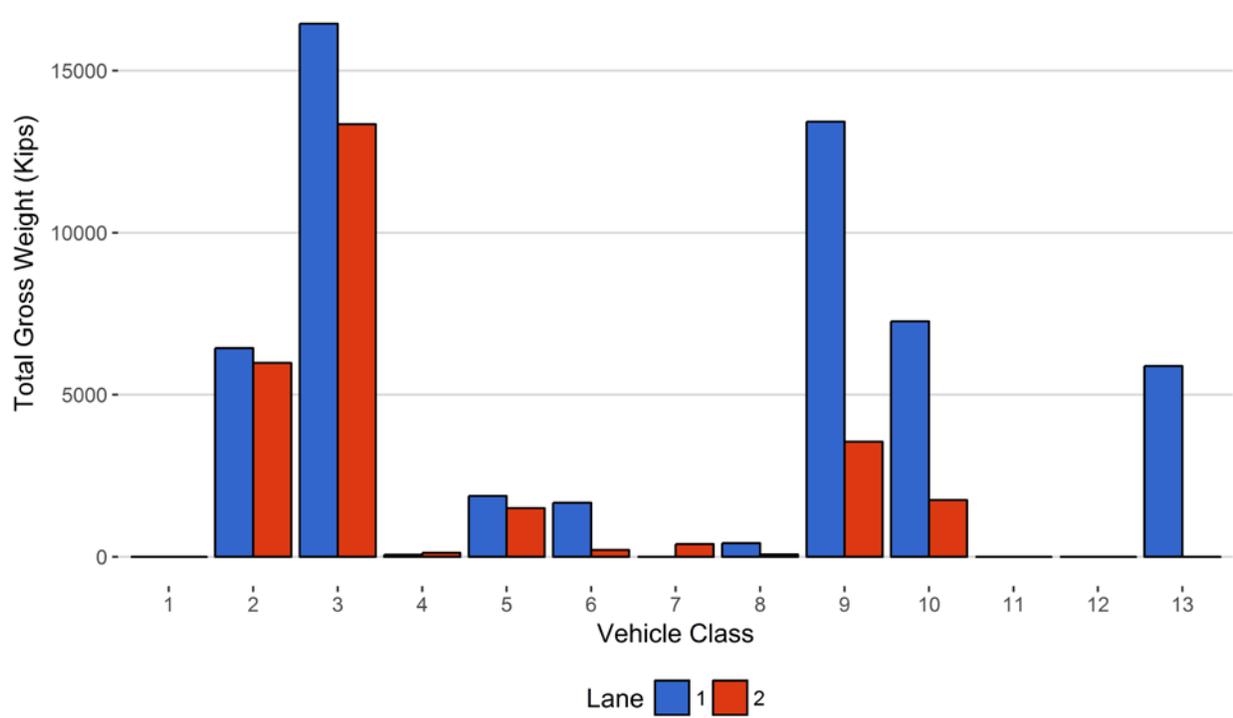


Figure 11 - Total Gross Vehicle Weight by

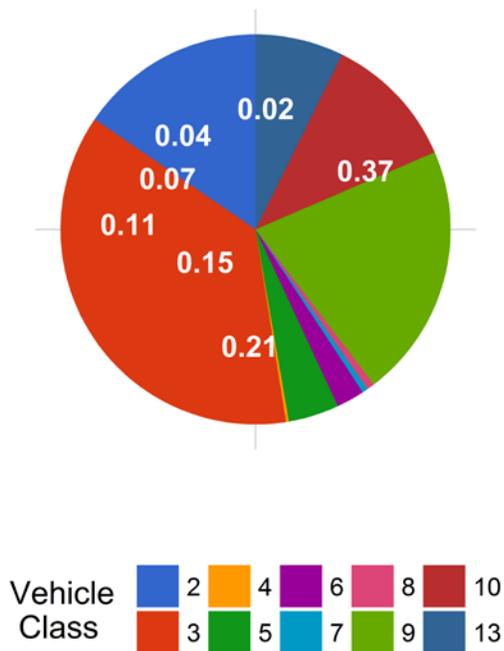


Figure 12 - Total ESALs by Class and Lane

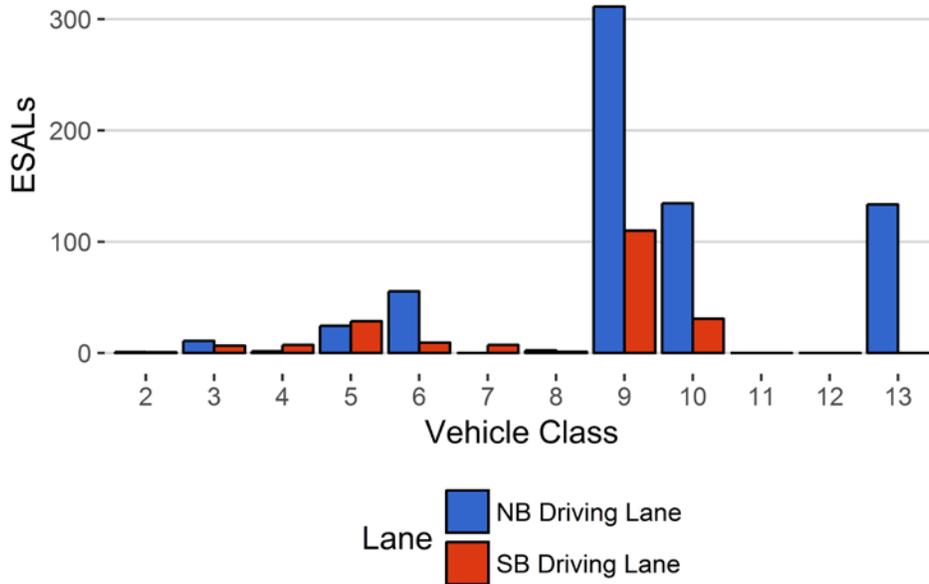


Figure 13 - ESALs by Class

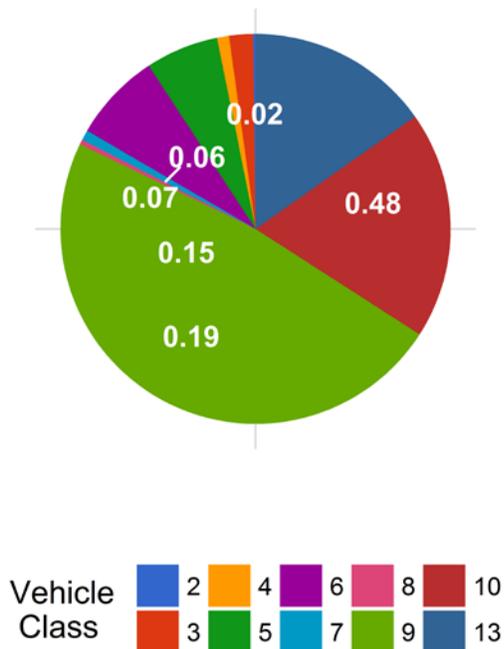


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
March 2015	12.00	0.00	11.45	0.00
July 2015	11.54	-3.77	11.64	1.65
October 2015	12.47	3.93	10.87	-5.10
November 2015	11.63	-3.03	11.74	2.52
December 2015	11.24	-6.34	11.83	3.27
January 2016	11.23	-6.36	11.55	0.82
February 2016	11.03	-8.02	11.06	-3.38
March 2017	11.11	-7.40	11.02	-3.81
April 2017	10.64	-11.31	11.70	2.19
July 2017	11.39	-5.09	11.25	-1.76
December 2017	11.65	-2.85	11.58	1.16
January 2018	11.29	-5.87	11.71	2.27

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	108	3338	35.8	0	0
3	162	5026	53.8	0	0
4	0	7	0.1	1	0.4
5	9	270	2.9	2	0.8
6	2	56	0.6	13	5.3
7	0	7	0.1	1	0.4
8	1	18	0.2	0	0
9	13	394	4.2	95	38.8
10	5	154	1.6	75	30.6
11	0	0	0	0	0
12	0	0	0	0	0
13	2	64	0.7	58	23.7
TOTAL	301	9334	100	245	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>
2018-01-04	Thursday	17:32:39	9	SB	2	117.03
2018-01-02	Tuesday	14:22:49	9	SB	2	116.45
2018-01-02	Tuesday	19:56:16	9	SB	2	116.24
2018-01-07	Sunday	17:12:21	10	SB	2	113.84
2018-01-05	Friday	12:46:29	9	SB	2	112.14
2018-01-04	Thursday	15:46:52	9	SB	2	111.34
2018-01-04	Thursday	18:23:24	9	SB	2	111.02
2018-01-07	Sunday	15:12:02	10	SB	2	110.64
2018-01-05	Friday	13:43:27	9	SB	2	109.47
2018-01-03	Wednesday	09:46:50	9	SB	2	109.4

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	3	1	33.3	50	13	10
5	NB	8	131	8	6.1	1817	60	416
6	NB	19	45	2	4.4	1629	36	406
8	NB	31	14	8	57.1	216	207	15
9	NB	33	296	170	57.4	8561	4863	2202
10	NB	33.5	111	6	5.4	7069	198	1776
13	NB	31.5	58	0	0	5884	0	2029
TOTAL	****	****	658	195	****	25225	****	6853
<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	3	0	0	123	0	39
5	SB	8	113	12	10.6	1428	73	310
6	SB	19	6	1	16.7	190	17	48
7	SB	11.5	6	0	0	391	0	161
8	SB	31	2	0	0	72	0	5
9	SB	33	60	15	25	3137	415	826
10	SB	33.5	28	1	3.6	1716	33	406
TOTAL	****	****	218	29	****	7057	****	1794
GRAND TOTAL	****	****	876	224	220	32283	5915	8647

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	6437	5981	12418	15.4
3	16452	13347	29800	37.1
4	63	123	186	0.2
5	1877	1501	3378	4.2
6	1665	208	1872	2.3
7	0	391	391	0.5
8	422	72	495	0.6
9	13424	3551	16975	21.1
10	7266	1749	9015	11.2
13	5884	0	5884	7.3
TOTAL	53491	26924	80415	100
GVW/LANE	66.52	33.48	100	0.12

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	0.2	0.0019
3	11	6	17	2	0.0087
4	2	7	9	1	2.25
5	24	28	53	6	0.47
6	55	9	65	7.4	2.51
7	0	7	7	0.8	1.73
8	2	1	4	0.4	0.65
9	311	110	421	48	2.46
10	135	31	166	18.9	2.41
13	134	0	134	15.2	4.16
TOTAL	675	202	877	100	17
ESALS/LANE	77	23	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>
Mar 2017	10074	325	30	9141	90.7	933.1	9.3
Apr 2017	10885	363	39	9709	89.2	1176.4	10.8
Jul 2017	15408	497	66	13371	86.8	2037.1	13.2
Dec 2017	13625	440	164	8548	62.7	5076.5	37.3
Jan 2018	9334	301	31	8364	89.6	970.2	10.4
TOTAL	59326	--	--	49133	--	10193	--
AVERAGE	11865	385	66	9827	84	2039	16

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>
Mar 2017	356	288	644	0
Apr 2017	163	595	757	2.3
Jul 2017	844	812	1656	6.9
Dec 2017	5038	494	5532	9.3
Jan 2018	675	202	877	44.3
TOTAL	7075	--	--	--
AVERAGE	1415	478	1893	13

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Mar 2017	53516	26950	80466
Apr 2017	43158	38706	81864
Jul 2017	40432	52112	92544
Dec 2017	81844	70339	152183
Jan 2018	254680	79312	333992
TOTAL	473629	267420	741049
AVERAGE	94726	53484	148210

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>
Mar 2017	146	1.5	15.9	4	0
Apr 2017	179	1.7	15.6	3	0
Jul 2017	411	2.8	20.8	28	2
Dec 2017	2221	19	50.7	1972	1497
Jan 2018	245	2.9	27.8	141	50
TOTAL	3202	--	--	2148	1549
AVERAGE	640.4	5.6	26.2	429.6	309.8

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>
Mar 2017	4109	2978	7086	58	42
Apr 2017	1899	6229	8128	23.4	76.6
Jul 2017	9795	7956	17750	55.2	44.8
Dec 2017	77434	3362	80796	95.8	4.2
Jan 2018	6853	1794	8647	79.2	20.8
TOTAL	100089	22319	122409	--	--
AVERAGE	20017.9	4463.9	24481.7	62.3	37.7