

APRIL 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 April 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 lane 2 but not 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: 11791 | Passenger Vehicles: 10090 | Heavy Commercial Vehicles: 1701

Monthly Average Daily Traffic (MADT): 393 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 57

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 Mondays, with lowest volumes reported on Sundays. SB vehicles typically reached highest volume levels on Thursdays, 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 06 AM and 11 AM. 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 06 AM and 11 AM, 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 1701 HCVs, 287 of them were overweight³. These overweight HCVs contributed to 2.5% of total monthly volume, and 17.3% 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 70.2% 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 report⁴.

Using normal load limits ,2 NB vehicles exceeded 88,000 pounds (2 vehicles were Class 9's; NA vehicles were Class NA's). Of vehicles traveling SB,

29 NB vehicles exceeded 88,000 pounds (21 vehicles were Class 9's; 4 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from April 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in April 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 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 13712 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (72.6%) than NB (27.4%). 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 11791 vehicles with a combined GVW of 122966 kips (1 kip = 1,000 pounds = 0.5 tons) in April 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 1251 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 69.7% of all ESALs were recorded SB while 30.3% was observed NB. In particular, 64% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 31% 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).

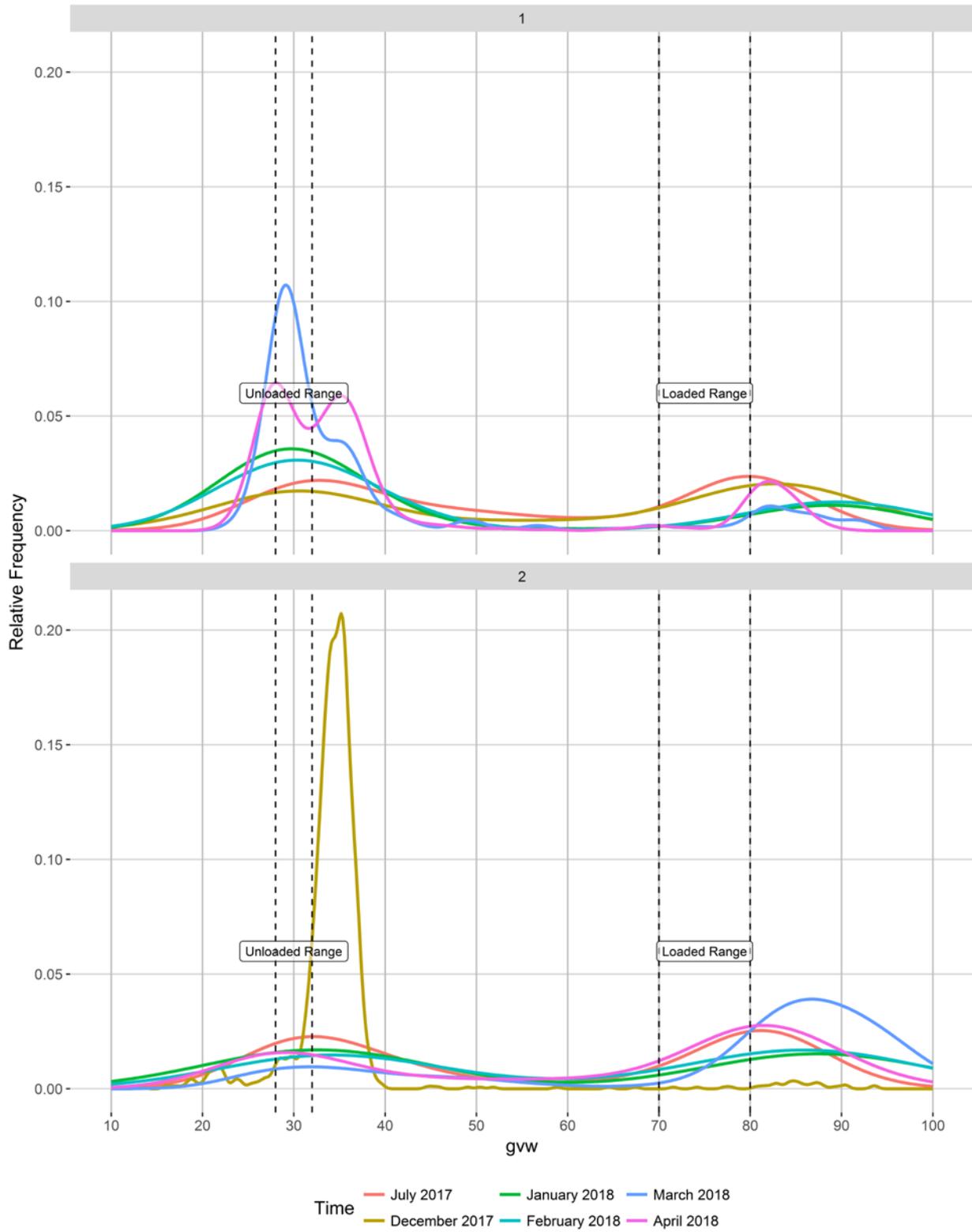
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

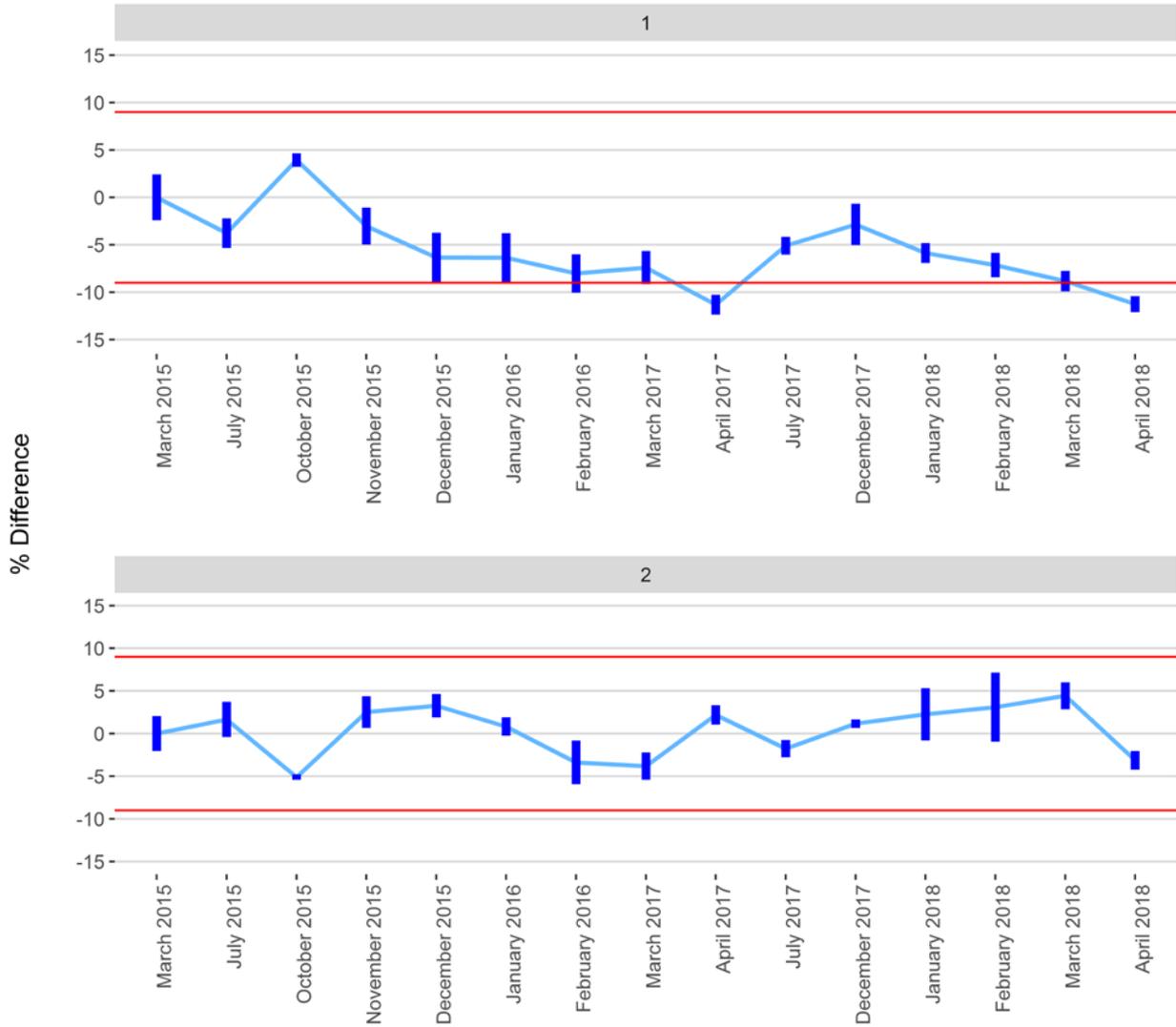
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

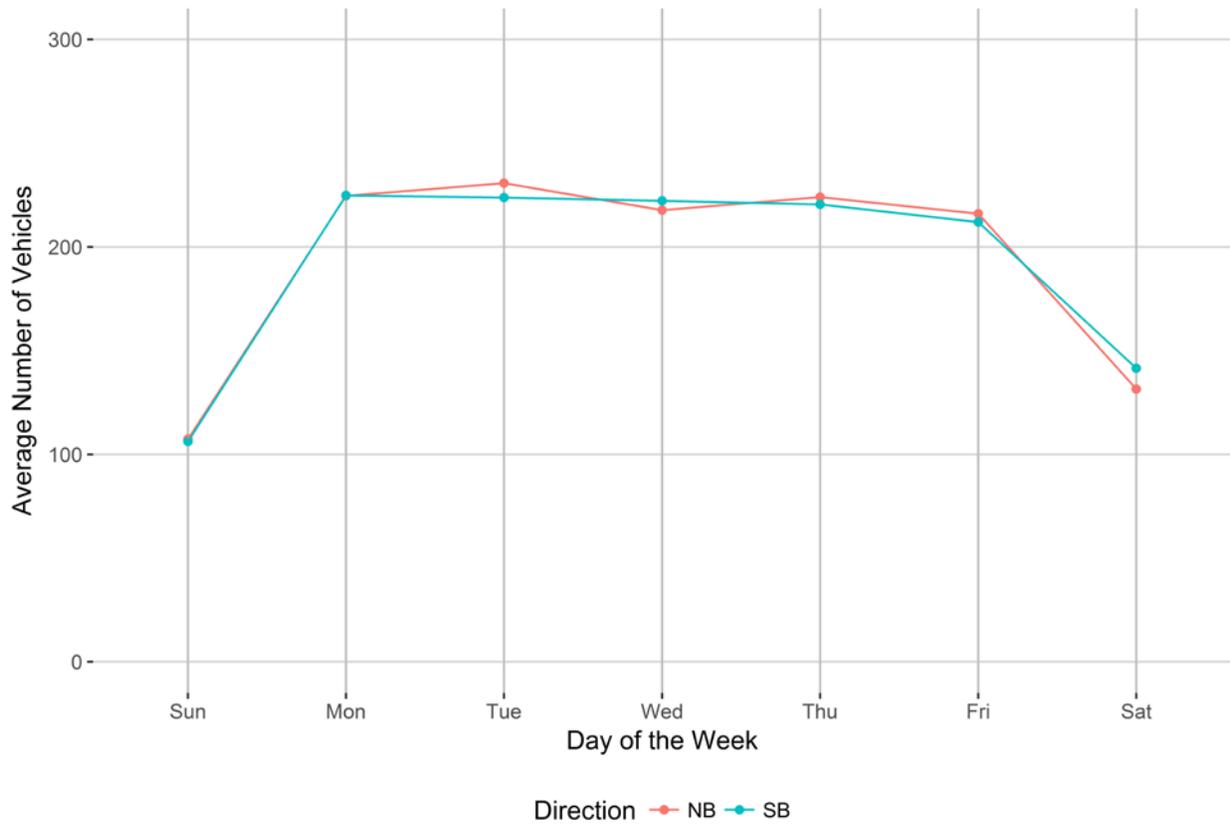


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

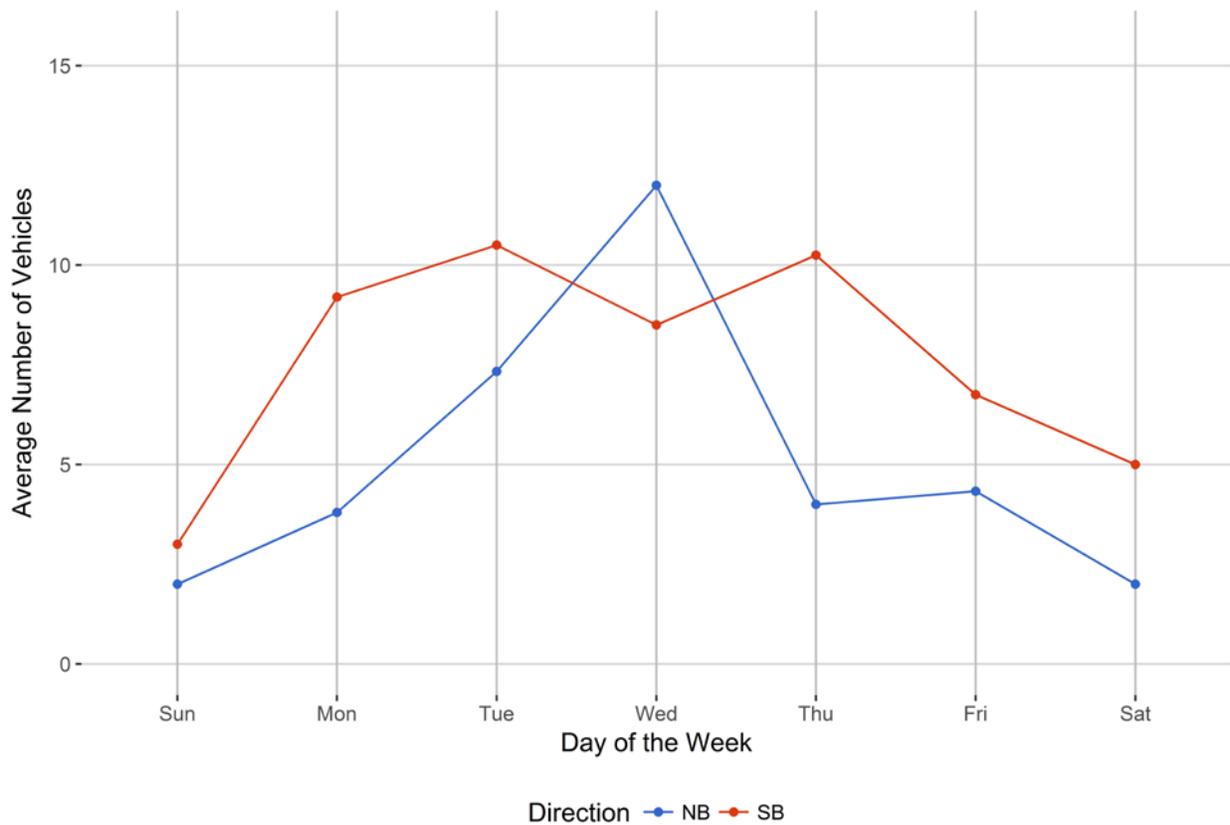


Figure 4 - Passenger Vehicles vs. Hour of the Day

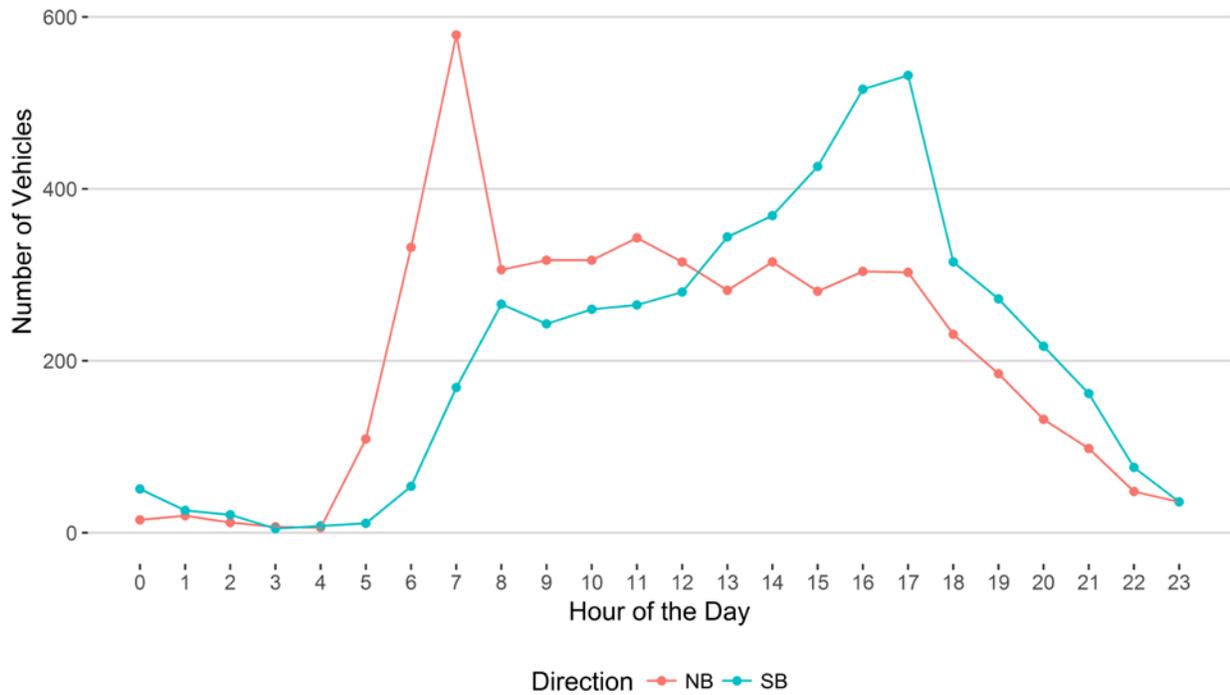


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

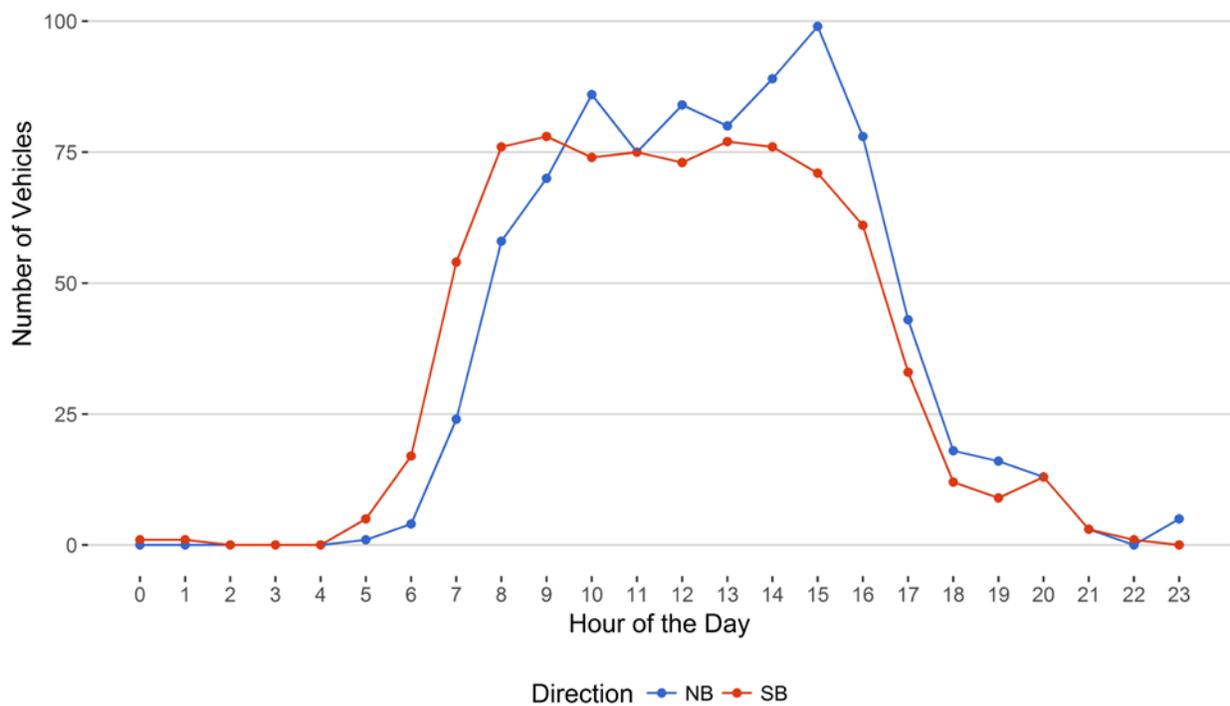


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

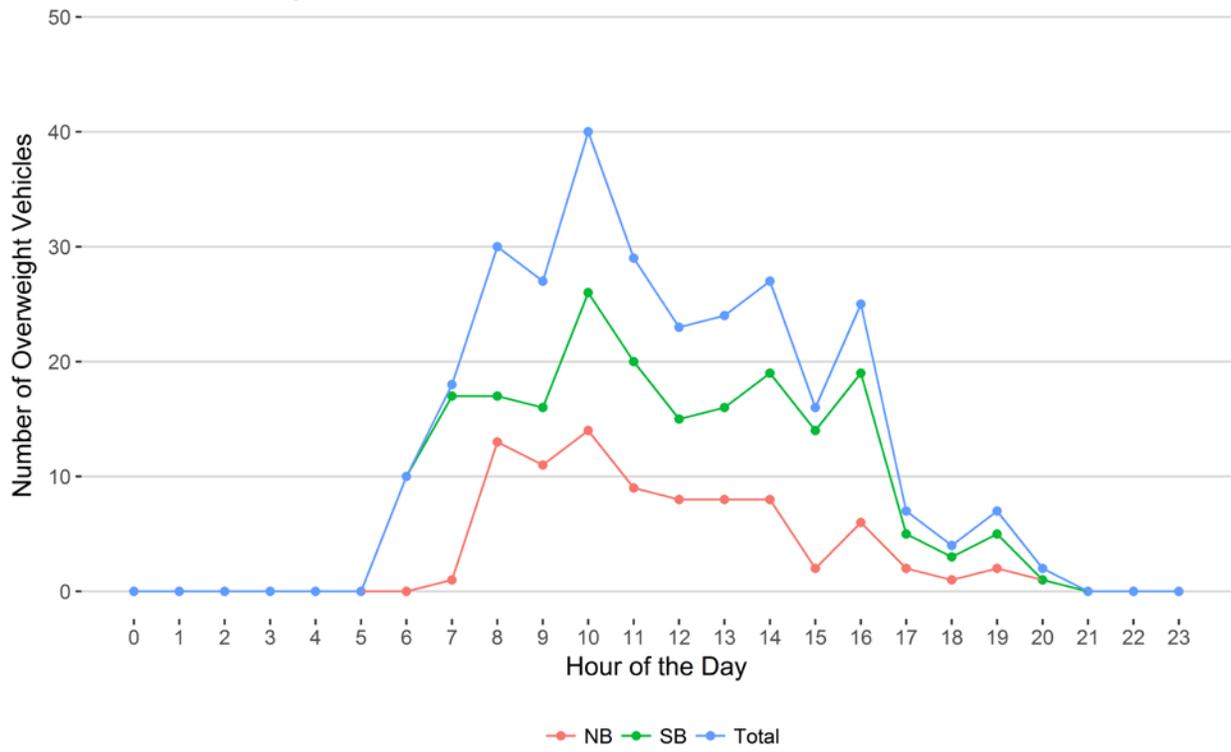
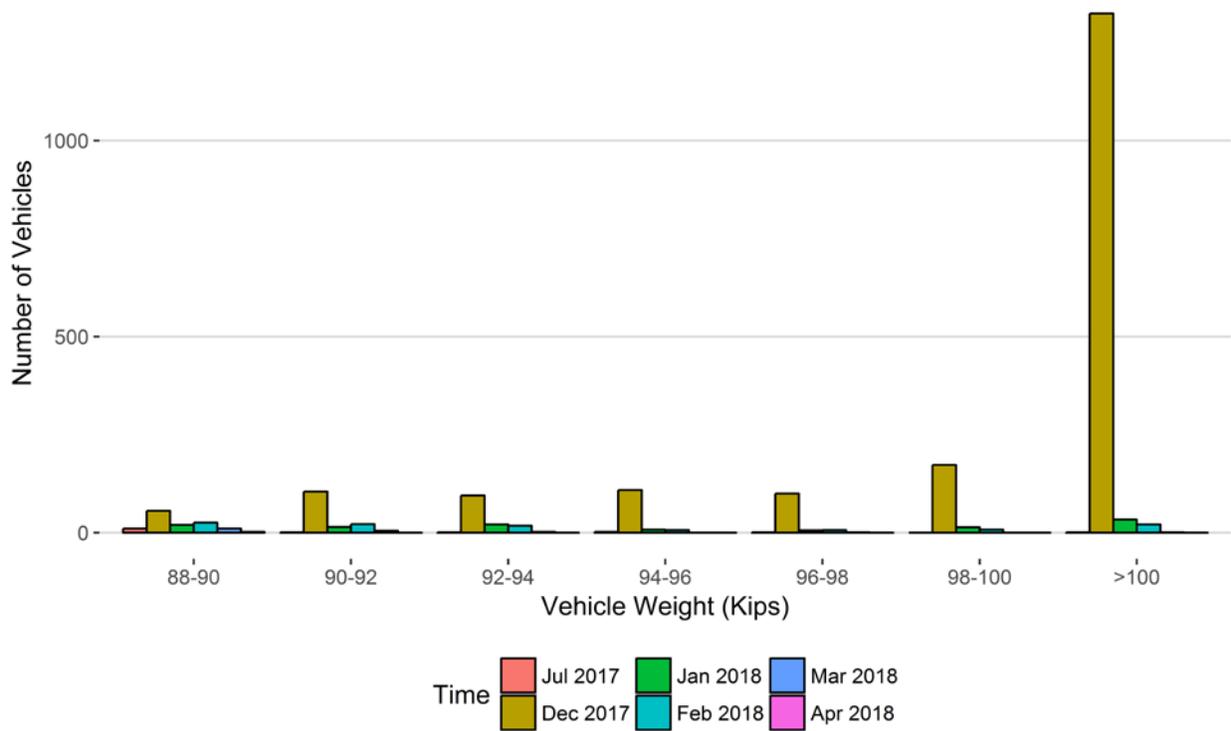
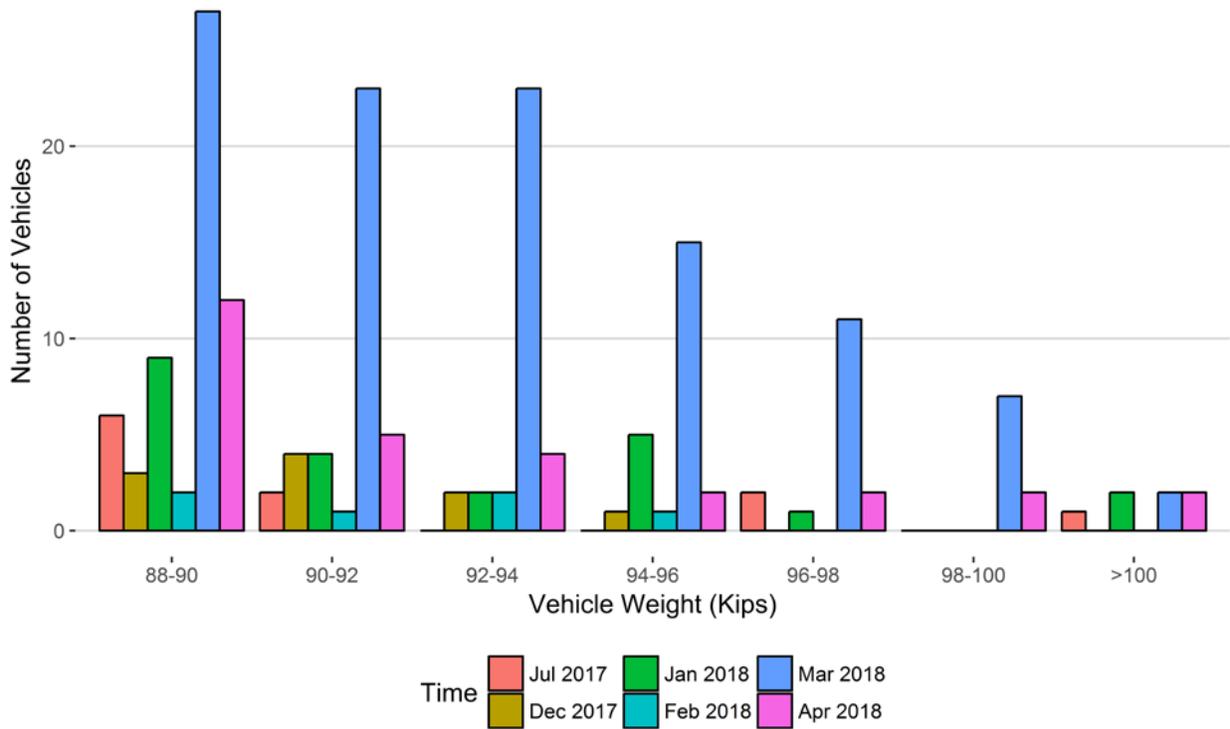


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Jul 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018
88-90	11	56	20	26	11	2
90-92	1	105	15	22	5	0
92-94	1	95	21	18	2	0
94-96	2	109	8	7	0	0
96-98	1	100	6	7	1	0
98-100	0	173	14	8	0	0
>100	1	1324	34	21	1	0
Total	17	1962	118	109	20	2

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



Vehicle Weights (Kips)	Jul 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018
88-90	6	3	9	2	27	12
90-92	2	4	4	1	23	5
92-94	0	2	2	2	23	4
94-96	0	1	5	1	15	2
96-98	2	0	1	0	11	2
98-100	0	0	0	0	7	2
>100	1	0	2	0	2	2
Total	11	10	23	6	108	29

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

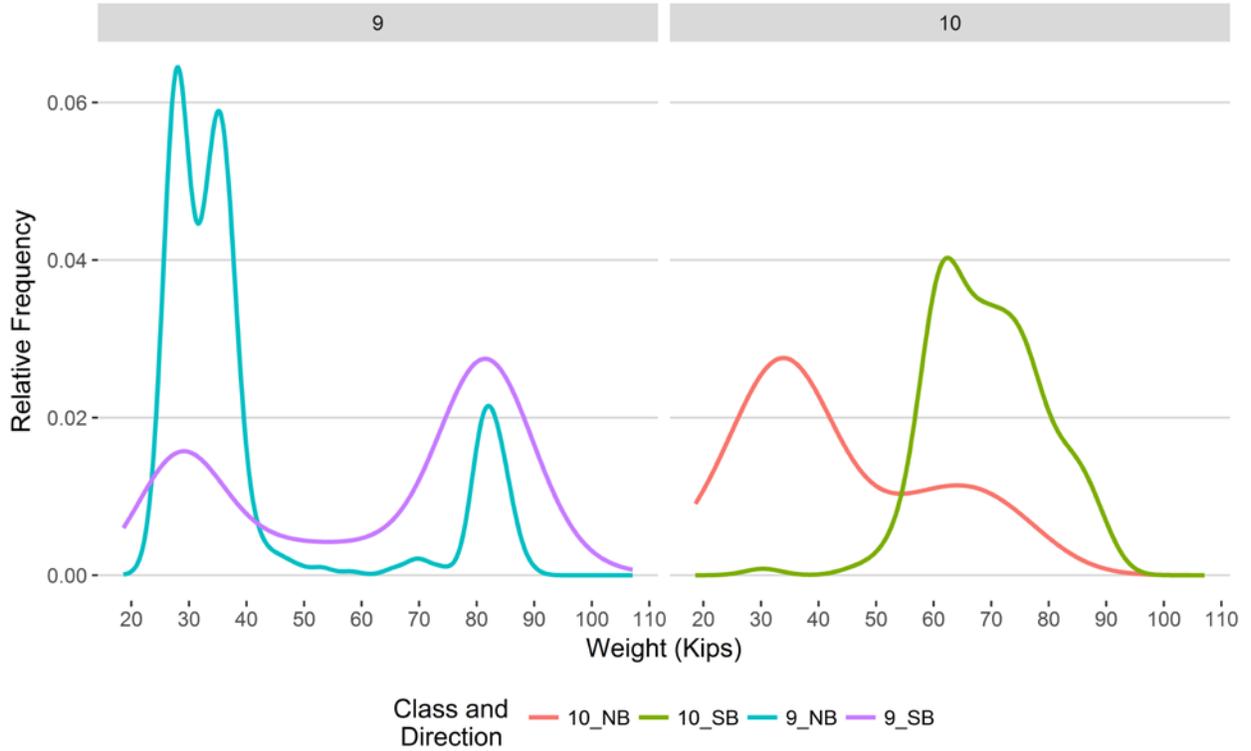


Figure 9 - Freight Percentage by Direction and Class

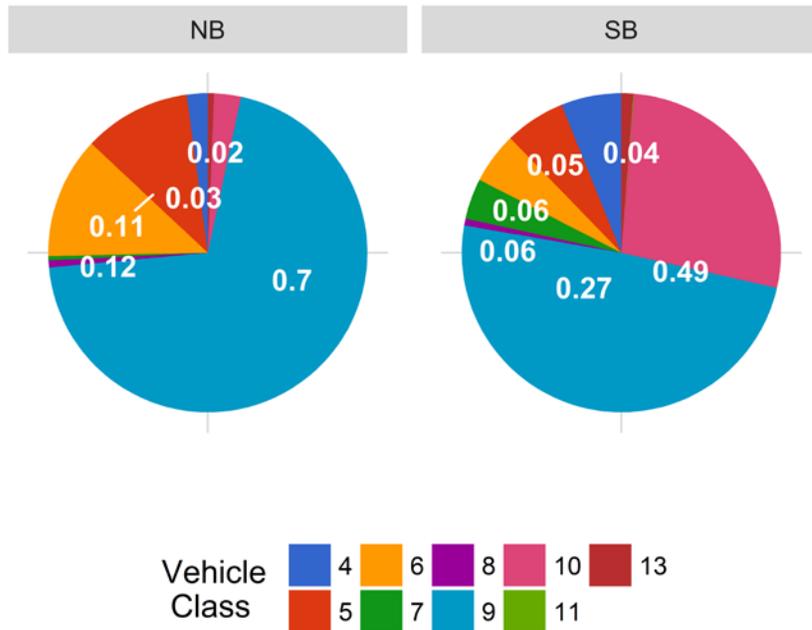


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

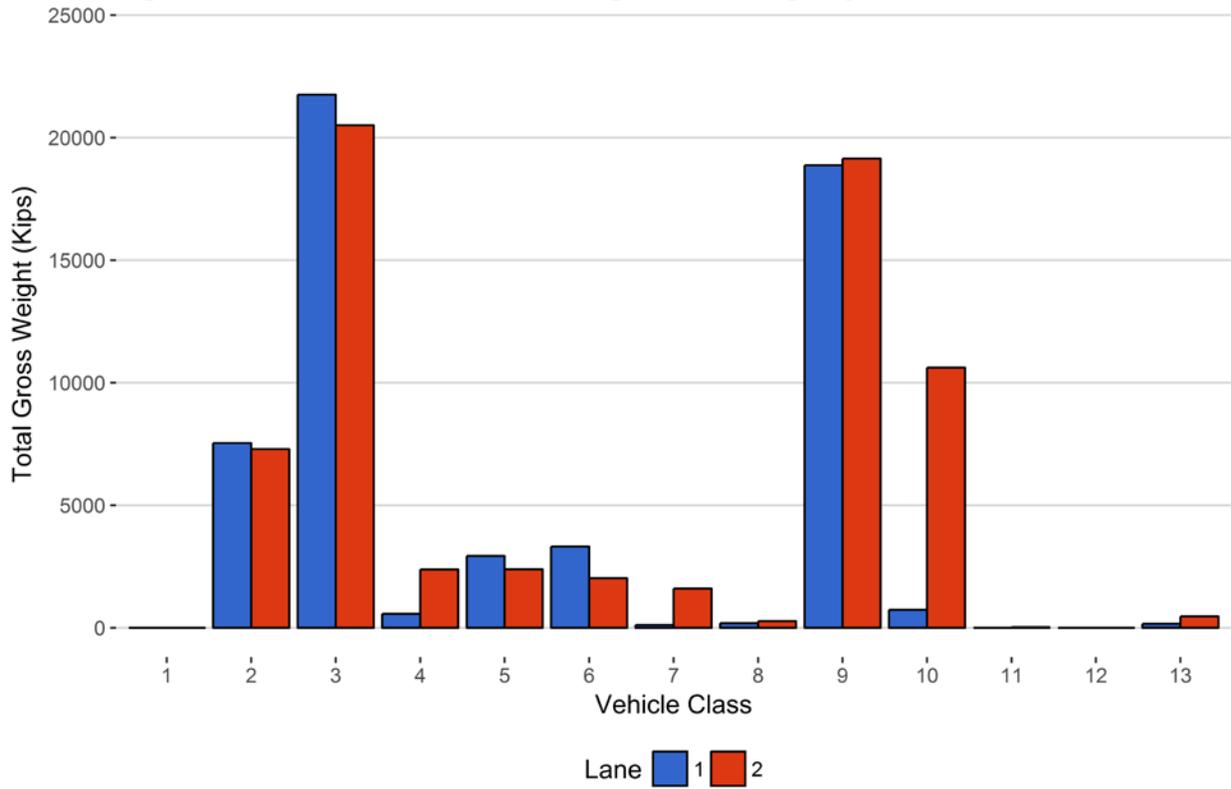


Figure 11 - Total Gross Vehicle Weight I

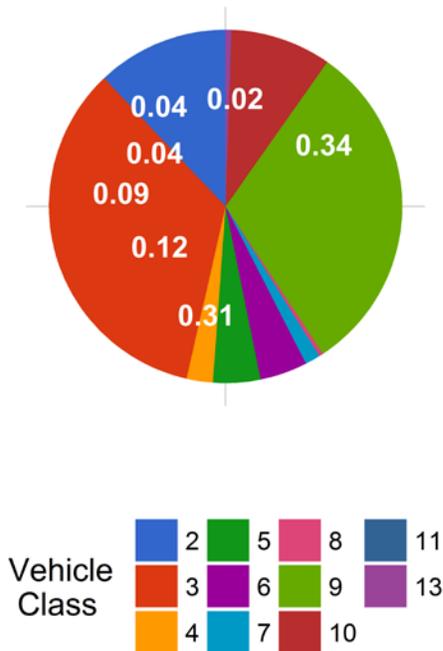


Figure 12 - Total ESALs by Class and Lane

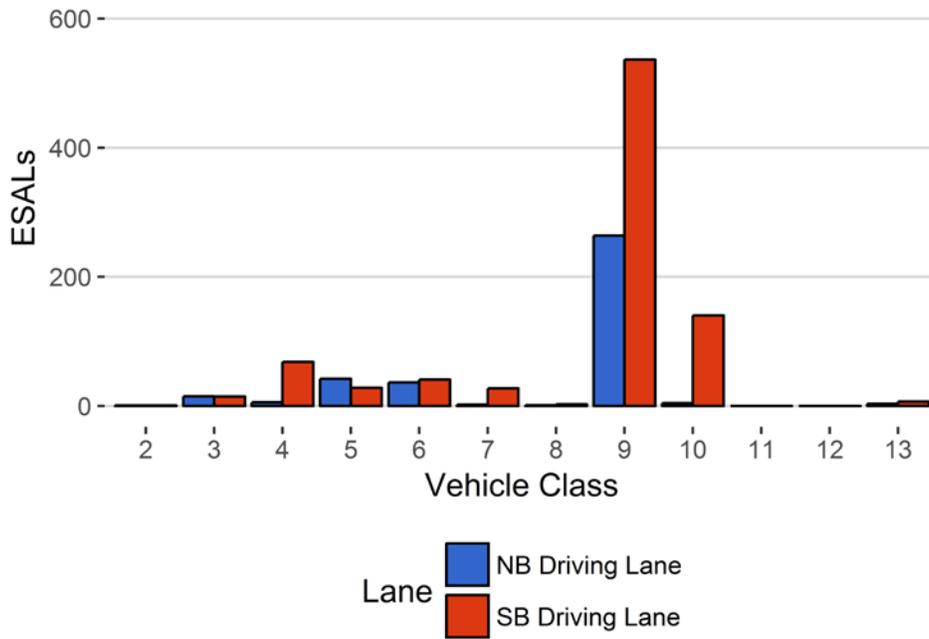


Figure 13 - ESALs by Class

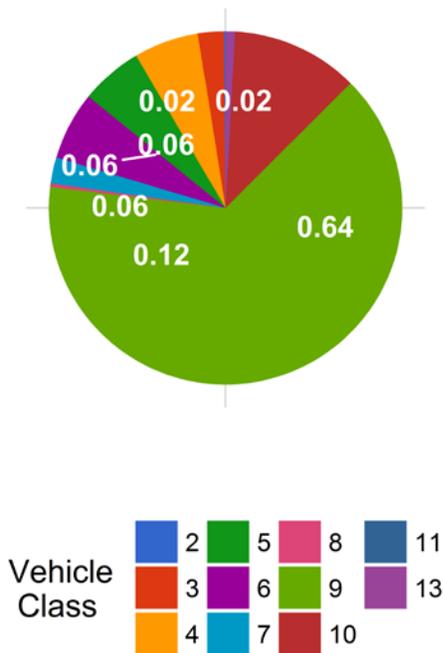


Table 1 Class 9 Front Axle Weight by Lane

<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
February 2018	11.14	-7.13	11.81	3.09
March 2018	10.94	-8.82	11.96	4.43
April 2018	10.65	-11.24	11.09	-3.13

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	123	3692	31.3	0	0
3	213	6397	54.3	0	0
4	2	66	0.6	15	5.2
5	14	430	3.7	10	3.5
6	6	191	1.6	12	4.2
7	1	29	0.2	2	0.7
8	1	16	0.1	0	0
9	26	786	6.7	215	74.9
10	6	175	1.5	26	9.1
11	0	1	0	0	0
12	0	0	0	0	0
13	0	7	0.1	7	2.4
TOTAL	393	11791	100	287	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>
2018-04-26	Thursday	17:54:16	9	SB	2	107.09
2018-04-18	Wednesday	06:49:44	9	SB	2	98.82
2018-04-19	Thursday	07:21:39	9	SB	2	97.34
2018-04-23	Monday	17:08:39	9	SB	2	96.05
2018-04-12	Thursday	10:27:59	9	SB	2	95.33
2018-04-18	Wednesday	14:03:55	9	SB	2	93.61
2018-04-12	Thursday	10:43:38	9	SB	2	93.04
2018-04-18	Wednesday	14:11:19	9	SB	2	92.69
2018-04-12	Thursday	06:53:21	9	SB	2	92.12
2018-04-02	Monday	16:48:04	9	SB	2	91.32

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	19	0	0	570	0	143
5	NB	8	219	8	3.7	2867	62	590
6	NB	19	119	10	8.4	3154	162	541
7	NB	11.5	2	0	0	114	0	45
8	NB	31	7	3	42.9	137	54	7
9	NB	33	461	208	45.1	12931	5941	2291
10	NB	33.5	17	4	23.5	624	110	94
13	NB	31.5	2	0	0	166	0	52
TOTAL	****	****	846	233	****	20564	****	3763
<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	45	1	2.2	2365	13	852
5	SB	8	200	18	9	2250	135	397
6	SB	19	67	13	19.4	1804	221	389
7	SB	11.5	26	0	0	1600	0	650
8	SB	31	9	3	33.3	226	44	20
9	SB	33	304	82	27	16811	2336	4742
10	SB	33.5	153	1	0.7	10581	30	2745
11	SB	36.5	1	1	100	0	25	0
13	SB	31.5	5	0	0	466	0	154
TOTAL	****	****	810	119	****	36102	****	9950
GRAND TOTAL	****	****	1656	352	315	56666	9133	13712

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	7535	7288	14823	12.1
3	21753	20505	42258	34.4
4	570	2377	2948	2.4
5	2929	2385	5314	4.3
6	3316	2025	5341	4.3
7	114	1600	1714	1.4
8	191	270	461	0.4
9	18872	19147	38018	30.9
10	734	10611	11345	9.2
11	0	25	25	0
13	166	466	632	0.5
TOTAL	56181	66699	122881	100
GVW/LANE	45.72	54.28	100	0.08

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	0.0017
3	15	15	29	2.4	0.0103
4	6	68	74	5.9	2.31
5	42	28	71	5.7	0.36
6	37	41	78	6.2	0.87
7	2	28	30	2.4	1.96
8	1	3	4	0.3	0.68
9	264	536	800	64.4	2.16
10	4	140	145	11.7	1.73
11	0	0	0	0	0.94
13	4	7	11	0.9	1.76
TOTAL	376	867	1243	100	13
ESALS/LANE	30.2	69.8	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>
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
Feb 2018	8344	298	26	7623	91.4	721.4	8.6
Mar 2018	9347	302	37	8199	87.7	1148.1	12.3
Apr 2018	11791	393	57	10090	85.6	1701.3	14.4
TOTAL	67849	--	--	56195	--	11655	--
AVERAGE	11308	372	64	9366	84	1942	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>
Jul 2017	844	812	1656	6.9
Dec 2017	5038	494	5532	9.3
Jan 2018	675	202	877	44.3
Feb 2018	628	248	876	53
Mar 2018	1032	825	1857	22.6
Apr 2018	379	871	1251	15.8
TOTAL	8597	--	--	--
AVERAGE	1433	575	2008	25

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Jul 2017	53516	26950	80466
Dec 2017	46043	18588	64631
Jan 2018	42984	48768	91752
Feb 2018	56222	66743	122966
Mar 2018	81844	70339	152183
Apr 2018	254680	79312	333992
TOTAL	535289	310701	845990
AVERAGE	89215	51784	140998

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>
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
Feb 2018	209	2.8	32	115	29
Mar 2018	305	3.4	27.2	128	10
Apr 2018	289	2.5	17.4	31	4
TOTAL	3680	--	--	2415	1592
AVERAGE	613.3	5.6	29.3	402.5	265.3

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>
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
Feb 2018	5819	802	6622	87.9	12.1
Mar 2018	2994	7001	9995	30	70
Apr 2018	3763	9950	13712	27.4	72.6
TOTAL	106657	30866	137523	--	--
AVERAGE	17776.2	5144.3	22920.5	62.6	37.4