

JULY 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 July 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 except 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: 12791 | Passenger Vehicles: 11011 | Heavy Commercial Vehicles: 1780

Monthly Average Daily Traffic (MADT): 413 | 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 Tuesdays. SB vehicles typically reached highest volume levels on Tuesdays, 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 07 AM 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 07 AM 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 6's and Class 5's.

Overweight HCVs

Volume trends. Of a total of 1780 HCVs, 175 of them were overweight³. These overweight HCVs contributed to 2.1% of total monthly volume, and 15.4% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on NAs. SB overweight vehicles tended to reach highest volumes on Tuesdays, with lowest volumes reported on NAs. 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 62% 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 (1 vehicles were Class 9's; 1 vehicles were Class 13's). Of vehicles traveling SB,

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

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in July 2018. Data suggests that there were greater numbers of fully_loaded Class 9's than empty 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 10118 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (54.8%) than NB (45.2%). 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 12791 vehicles with a combined GVW of 80312 kips (1 kip = 1,000 pounds = 0.5 tons) in July 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 800 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 61.5% of all ESALs were recorded SB while 38.5% was observed NB. In particular, 36% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 15% 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).

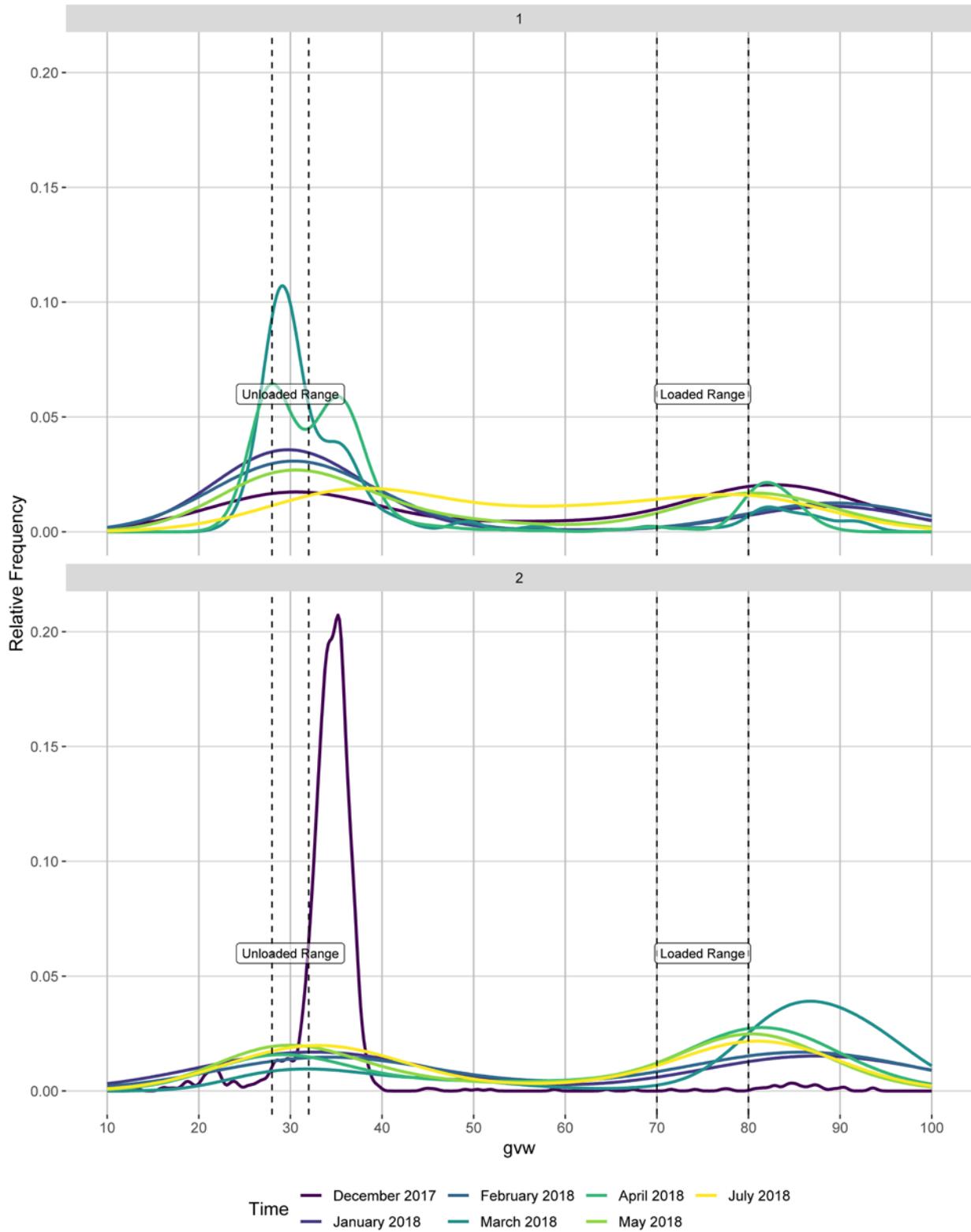
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

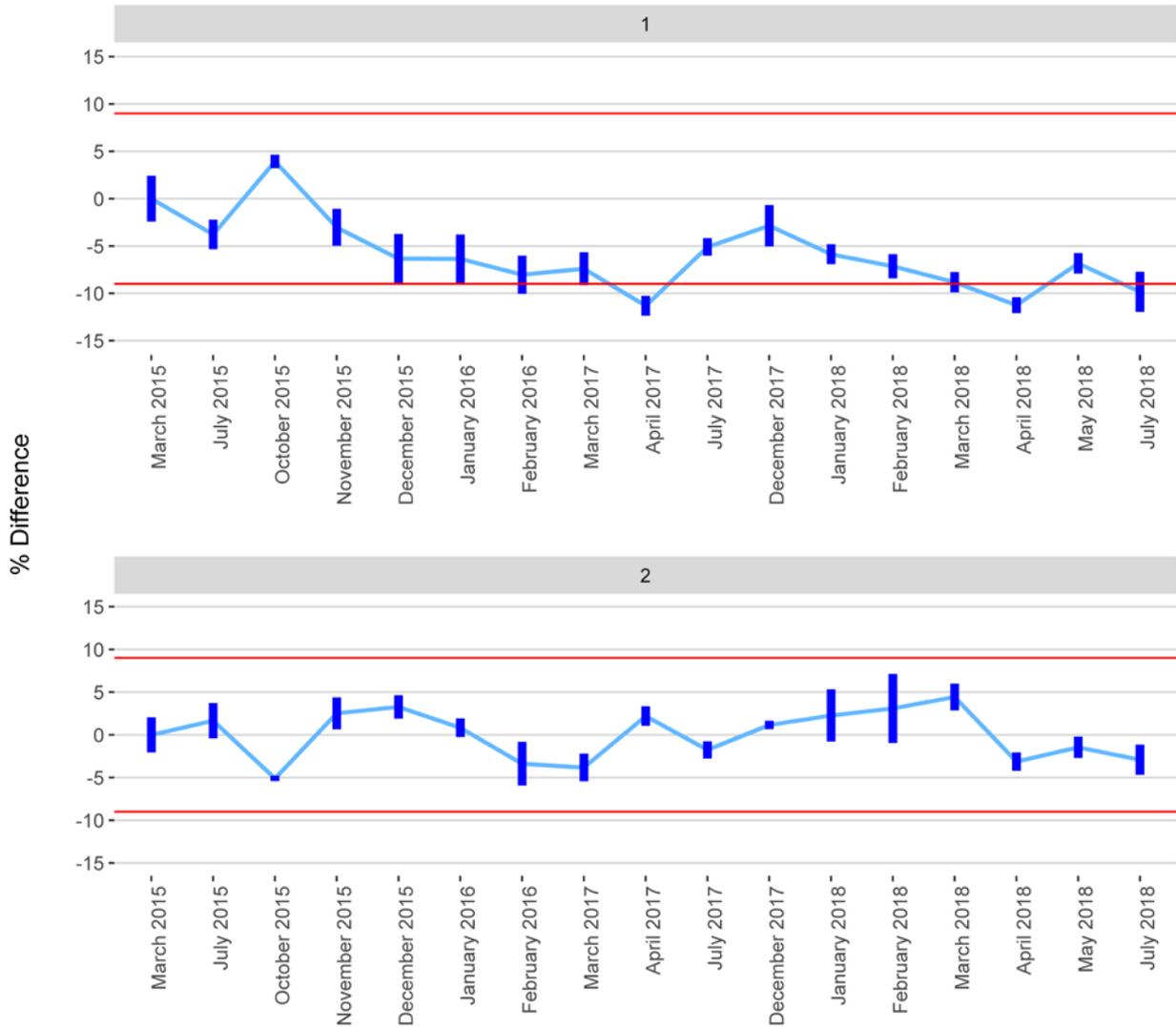
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

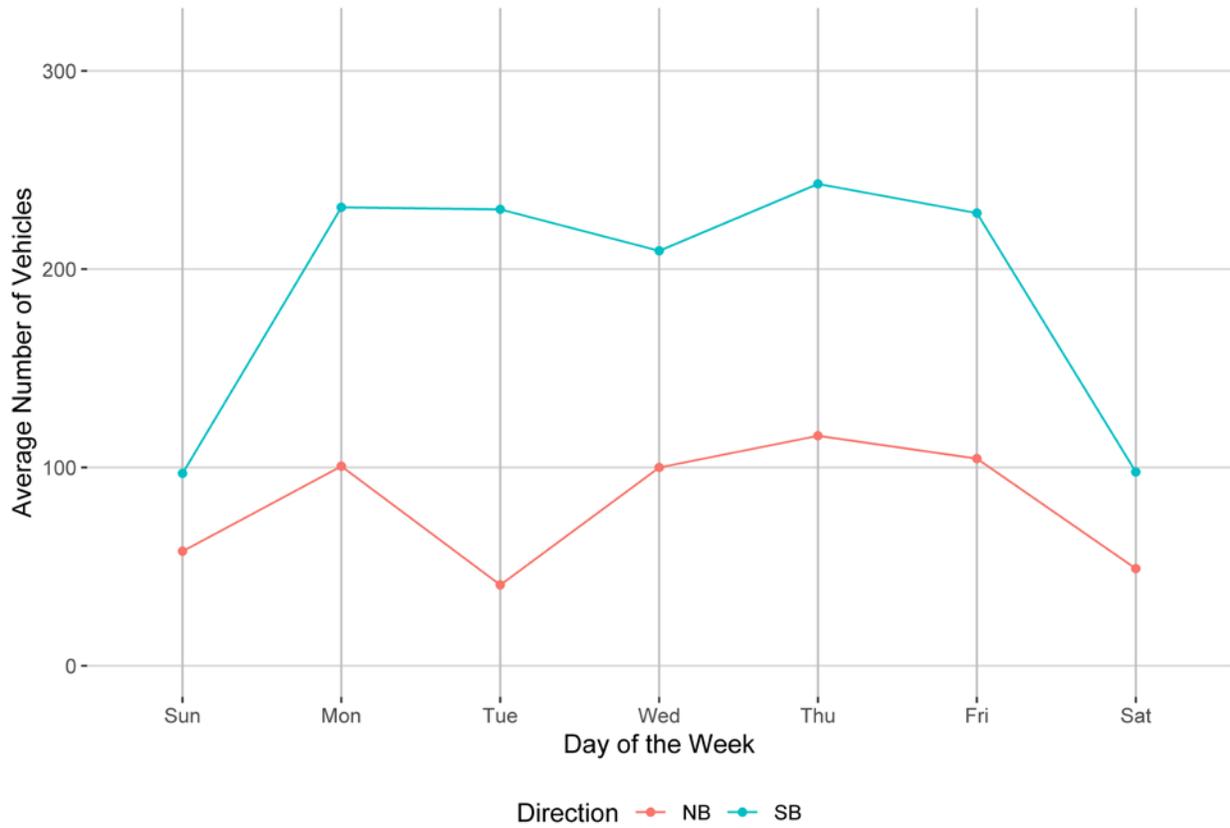


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

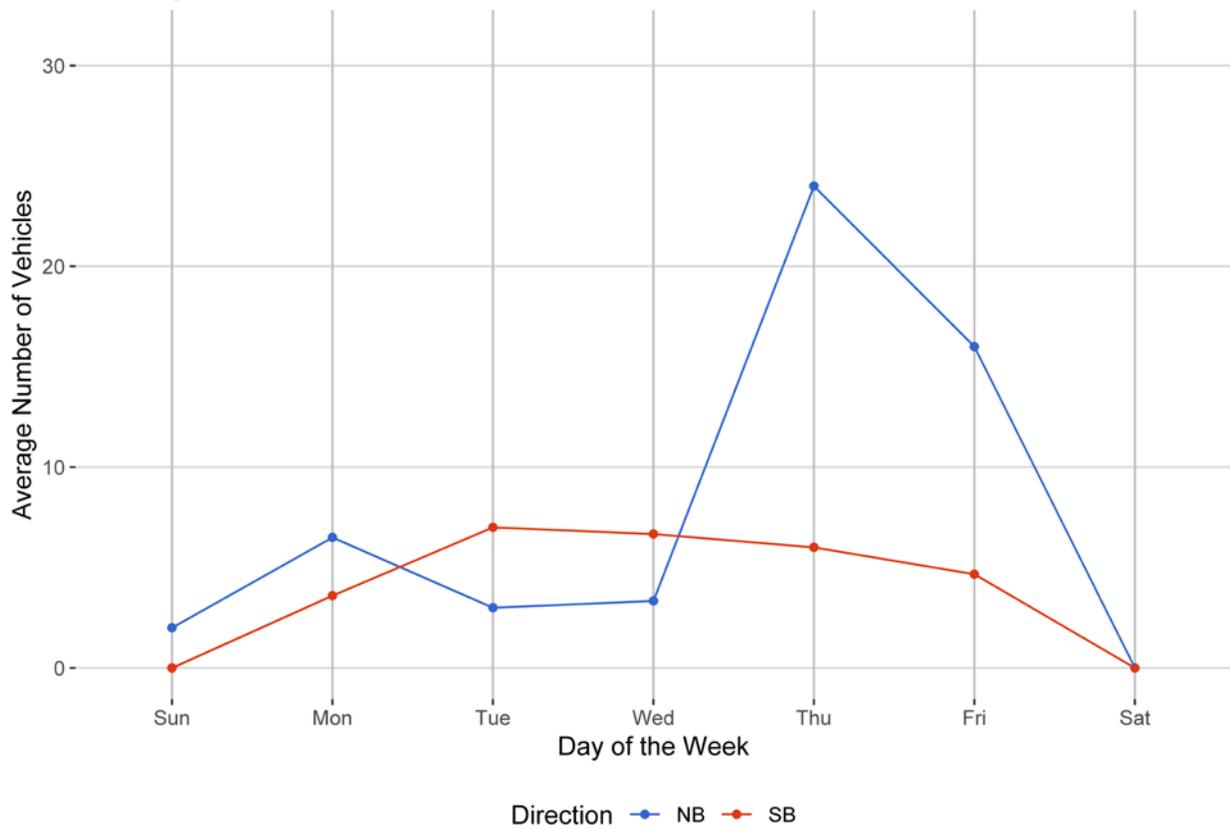


Figure 4 - Passenger Vehicles vs. Hour of the Day

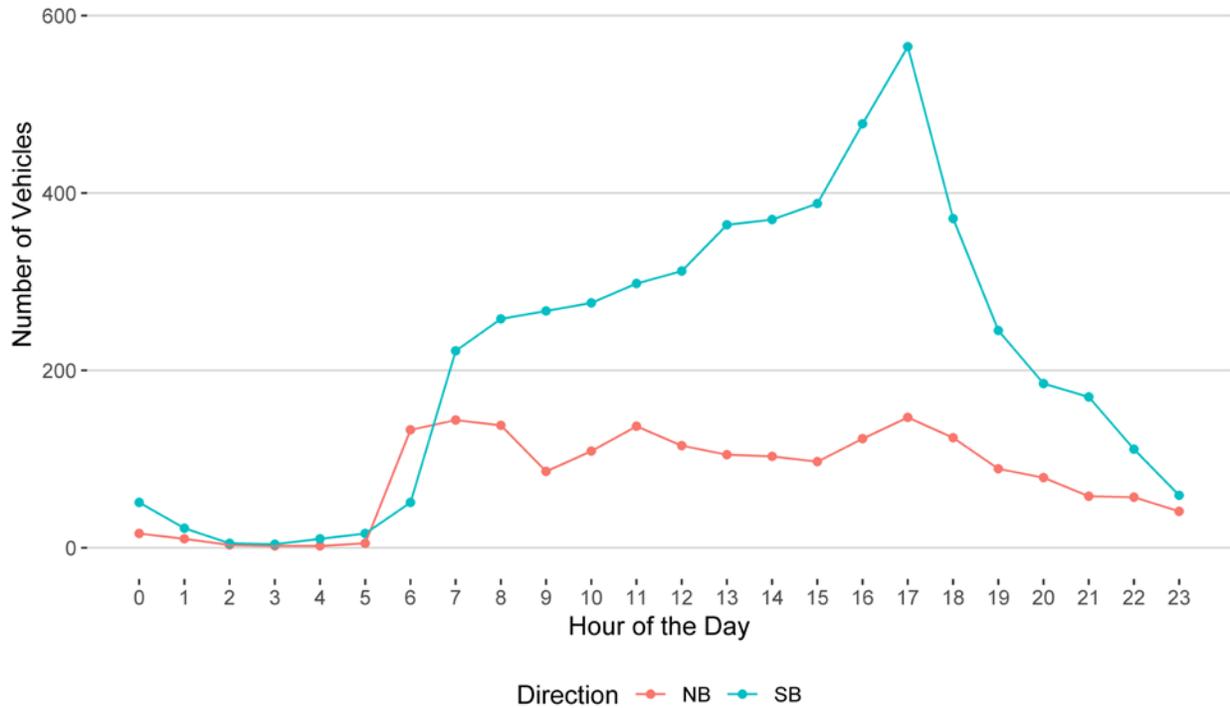


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

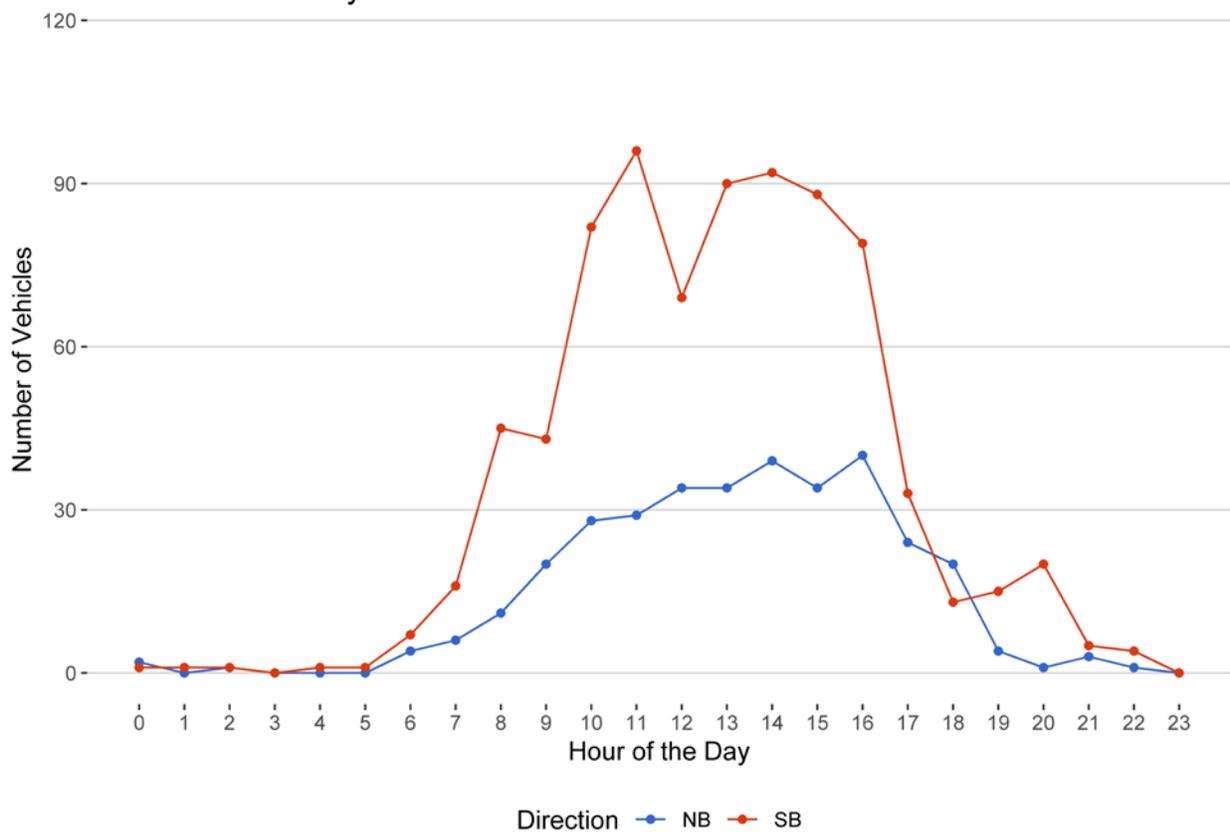


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

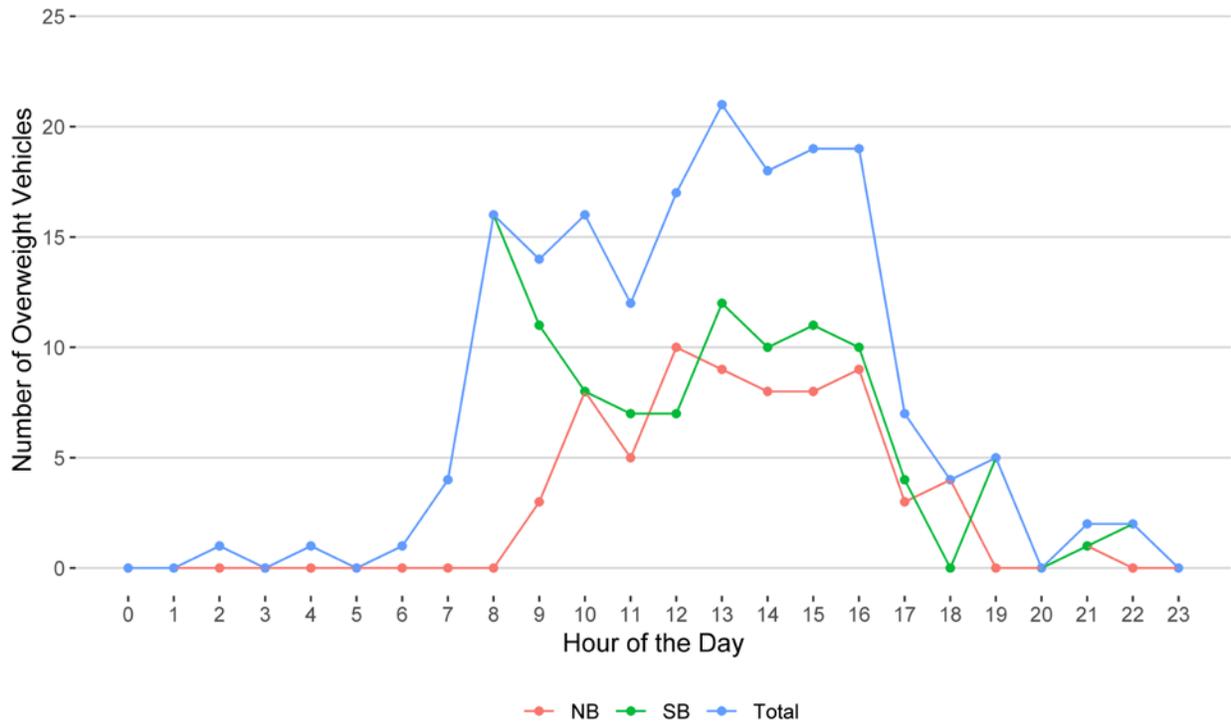
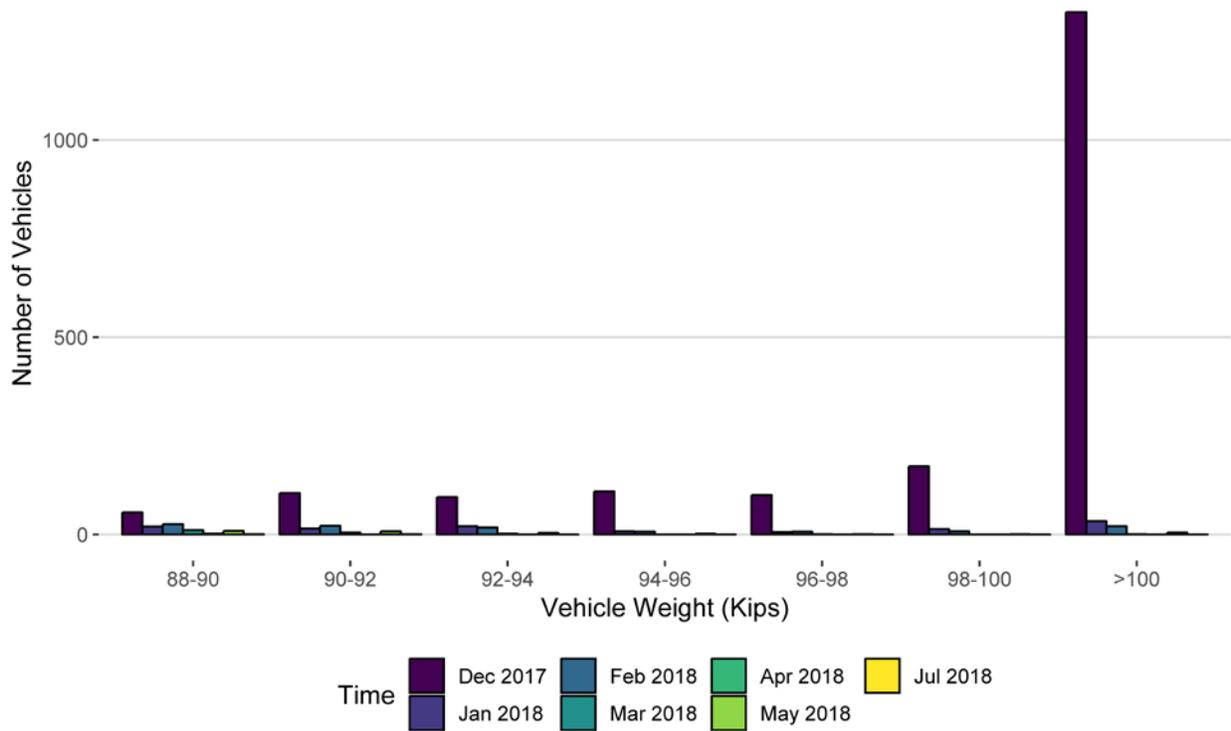
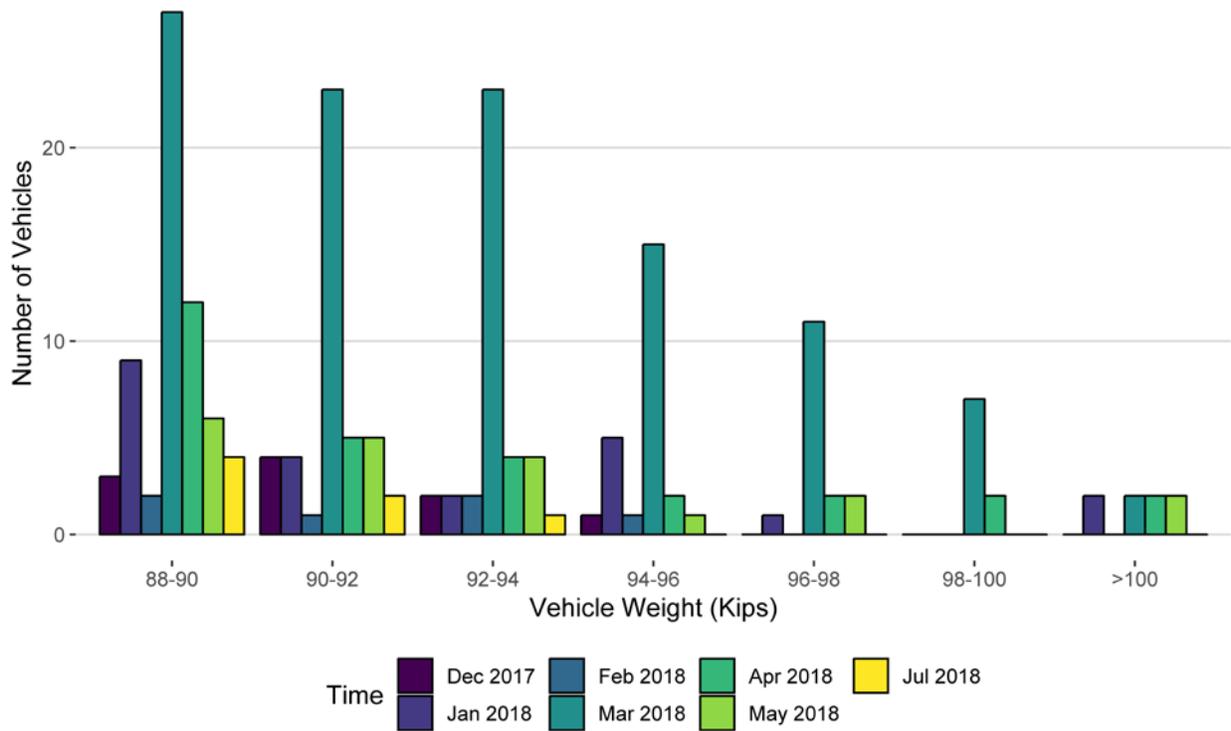


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jul 2018
88-90	56	20	26	11	2	9	1
90-92	105	15	22	5	0	8	1
92-94	95	21	18	2	0	4	0
94-96	109	8	7	0	0	2	0
96-98	100	6	7	1	0	1	0
98-100	173	14	8	0	0	1	0
>100	1324	34	21	1	0	5	0
Total	1962	118	109	20	2	30	2

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



Vehicle Weights (Kips)	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jul 2018
88-90	3	9	2	27	12	6	4
90-92	4	4	1	23	5	5	2
92-94	2	2	2	23	4	4	1
94-96	1	5	1	15	2	1	0
96-98	0	1	0	11	2	2	0
98-100	0	0	0	7	2	0	0
>100	0	2	0	2	2	2	0
Total	10	23	6	108	29	20	7

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

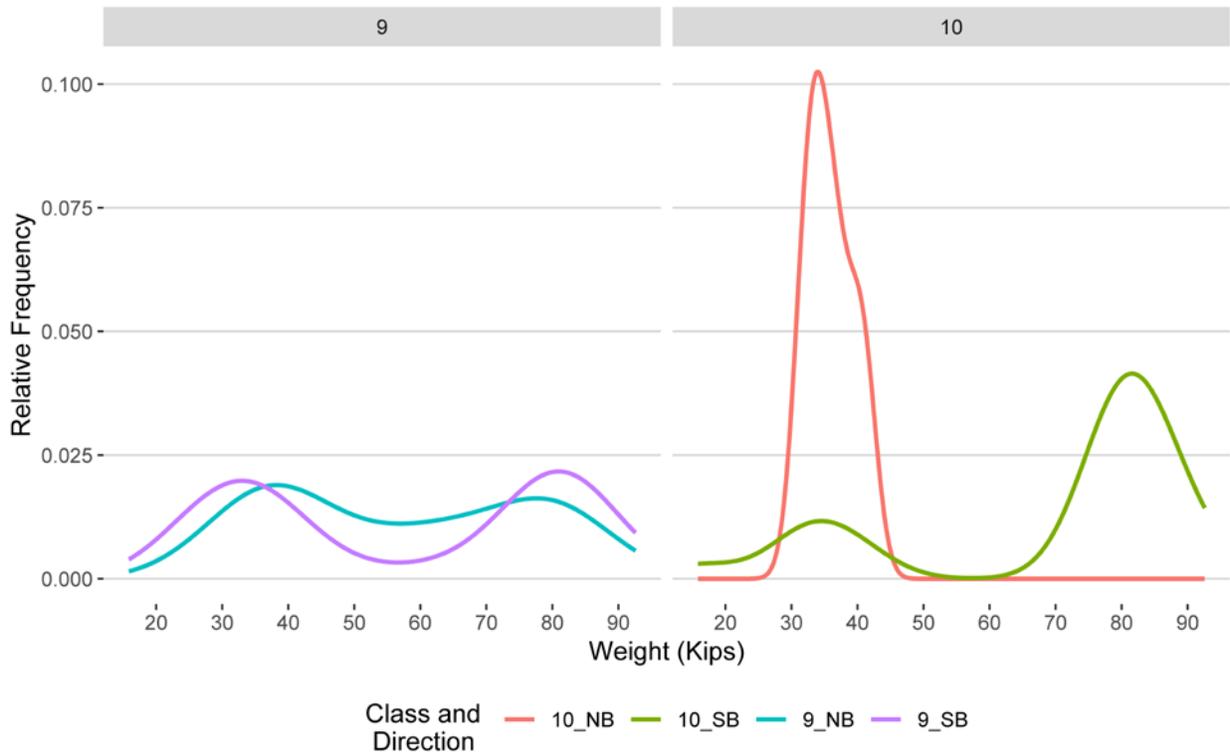


Figure 9 - Freight Percentage by Direction and Class

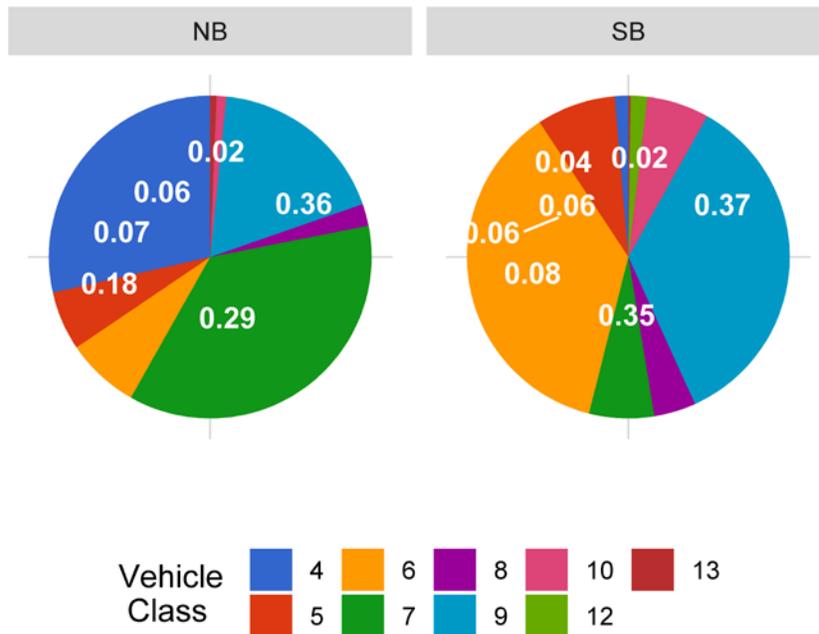


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

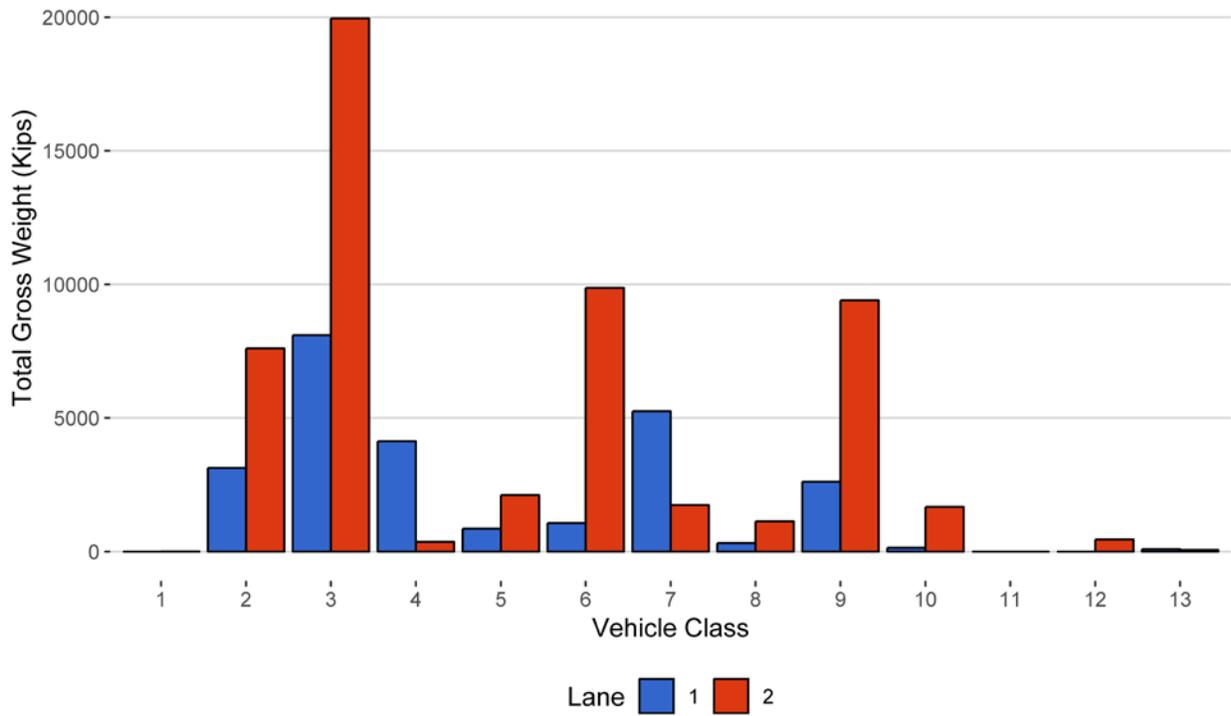


Figure 11 - Total Gross Vehicle Weight t

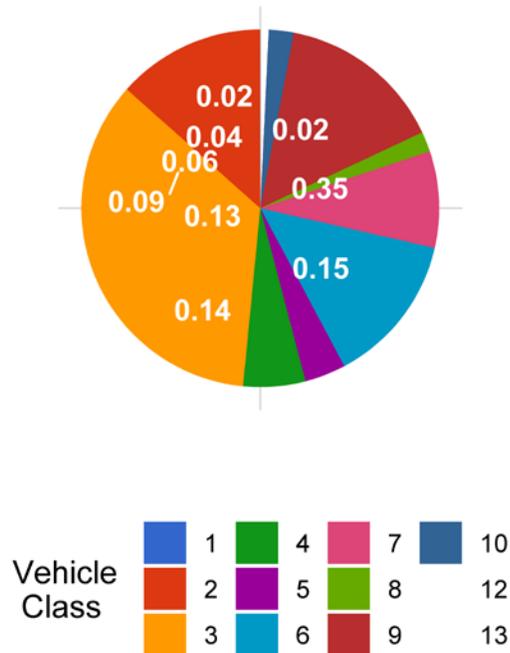


Figure 12 - Total ESALs by Class and Lane

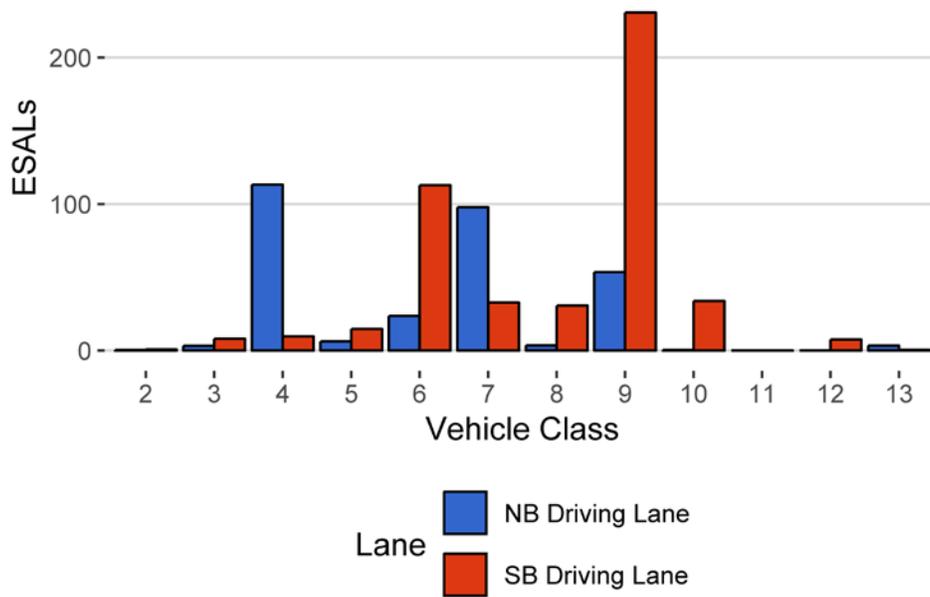


Figure 13 - ESALs by Class

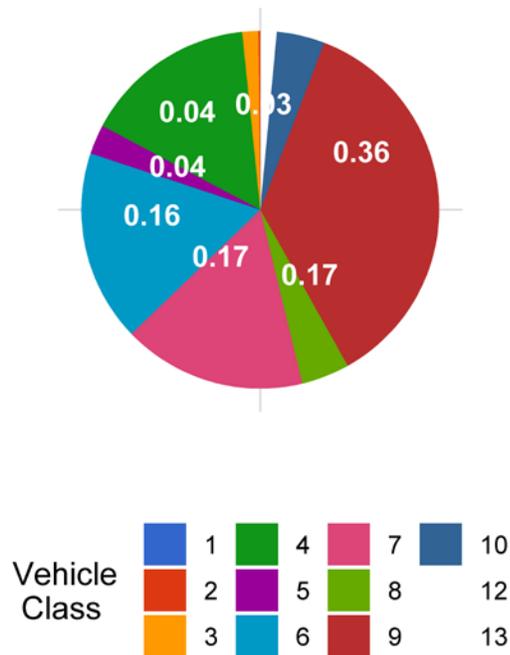


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
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
May 2018	11.18	-6.83	11.28	-1.46
July 2018	10.82	-9.84	11.12	-2.91

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	5	0	0	0
2	138	4265	33.3	0	0
3	217	6741	52.7	0	0
4	4	133	1	6	3.4
5	13	398	3.1	0	0
6	20	615	4.8	12	6.9
7	6	182	1.4	57	32.6
8	2	67	0.5	9	5.1
9	11	329	2.6	78	44.6
10	1	44	0.3	11	6.3
11	0	0	0	0	0
12	0	9	0.1	1	0.6
13	0	3	0	1	0.6
TOTAL	413	12791	100	175	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>
2018-07-30	Monday	09:45:37	10	SB	2	92.6
2018-07-27	Friday	08:04:24	9	SB	2	91.57
2018-07-27	Friday	10:19:05	9	SB	2	90.44
2018-07-30	Monday	11:41:18	9	SB	2	88.89
2018-07-09	Monday	21:58:38	9	NB	1	88.67
2018-07-31	Tuesday	09:28:33	10	SB	2	88.65
2018-07-30	Monday	15:02:43	10	SB	2	88.52
2018-07-27	Friday	11:24:44	9	SB	2	87.95
2018-07-25	Wednesday	17:27:48	9	SB	2	87.8
2018-07-10	Tuesday	16:39:19	9	SB	2	87.73

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	77	0	0	4132	0	1488
5	NB	8	71	4	5.6	830	30	147
6	NB	19	36	9	25	906	159	196
7	NB	11.5	88	0	0	5254	0	2121
8	NB	31	12	7	58.3	214	106	30
9	NB	33	46	3	6.5	2528	88	555
10	NB	33.5	4	1	25	111	32	5
13	NB	31.5	1	0	0	90	0	29
TOTAL	****	****	335	24	****	14065	****	4572
<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	8	0	0	364	0	122
5	SB	8	183	10	5.5	2042	74	329
6	SB	19	357	12	3.4	9657	210	1551
7	SB	11.5	28	0	0	1741	0	709
8	SB	31	31	16	51.6	828	300	182
9	SB	33	164	34	20.7	8452	948	2081
10	SB	33.5	24	3	12.5	1592	79	444
12	SB	36.5	6	0	0	449	0	115
13	SB	31.5	1	0	0	59	0	14
TOTAL	****	****	802	75	****	25183	****	5546
GRAND TOTAL	****	****	1137	99	214	39248	2027	10118

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	0	4	4	0
2	3130	7607	10736	13.4
3	8103	19959	28063	35
4	4132	364	4496	5.6
5	860	2116	2976	3.7
6	1065	9867	10932	13.7
7	5254	1741	6995	8.7
8	320	1128	1448	1.8
9	2616	9400	12016	15
10	144	1671	1814	2.3
12	0	449	449	0.6
13	90	59	149	0.2
TOTAL	25714	54363	80077	100
GVW/LANE	32.11	67.89	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>
1	0	0	0	0	0.25
2	0	1	1	0.2	0.0017
3	3	8	12	1.5	0.0064
4	113	10	123	15.6	2.99
5	6	15	21	2.7	0.19
6	24	113	137	17.3	0.74
7	98	33	131	16.6	2.32
8	4	31	34	4.3	1.59
9	54	231	284	36	2.8
10	0	34	34	4.3	2.19
12	0	8	8	1	1.57
13	4	0	4	0.5	1.43
TOTAL	306	483	789	100	16
ESALS/LANE	38.8	61.2	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 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
May 2018	13681	441	68	11572	84.6	2109.3	15.4
Jul 2018	12791	413	57	11011	86.1	1780.1	13.9
TOTAL	78913	-	-	65407	-	13507	-
AVERAGE	11273	370	63	9344	84	1930	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>
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
May 2018	604	715	1318	14.3
Jul 2018	308	492	800	6
TOTAL	8665	-	-	-
AVERAGE	1238	550	1787	24

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Dec 2017	53516	26950	80466
Jan 2018	46043	18588	64631
Feb 2018	42984	48768	91752
Mar 2018	56222	66743	122966
Apr 2018	56968	62127	119095
May 2018	25746	54565	80312
Jul 2018	254680	79312	333992
TOTAL	536159	357055	893213
AVERAGE	76594	51008	127602

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 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
May 2018	309	2.8	18.1	50	8
Jul 2018	179	2.2	15.7	9	0
TOTAL	3757	-	-	2446	1598
AVERAGE	536.7	5.1	27	349.4	228.3

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>
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
May 2018	6365	7033	13398	47.5	52.5
Jul 2018	4572	5546	10118	45.2	54.8
TOTAL	107798	35490	143288	-	-
AVERAGE	15399.8	5070	20469.7	59	41