

APRIL 2019



**WIM #48
CSAH 5,
MP 15.05
STORDEN, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #48 is located on CSAH 5 near Storden in Cottonwood county.

System Operation

WIM #48 was operational for the entire month of April 2019. Volume was computed using all monthly data.

System Calibration

WIM #48 was most recently calibrated on 2018-06-12. 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: 10547 | Passenger Vehicles: 9227 | Heavy Commercial Vehicles: 1320

Monthly Average Daily Traffic (MADT): 352 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 44

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 Sundays, with lowest volumes reported on Thursdays. SB vehicles typically reached highest volume levels on Sundays, with lowest volumes reported on Thursdays (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 9's and Class 5's.

Overweight HCVs

Volume trends. Of a total of 1320 HCVs, 260 of them were overweight ³. These overweight HCVs contributed to 2.7% of total monthly volume, and 21.4% 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 Mondays, with lowest volumes reported on Saturdays. 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 63.2% 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 September.

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 ,67 NB vehicles exceeded 88,000 pounds (47 vehicles were Class 9's; 12 vehicles were Class 13's). Of vehicles traveling SB,

127 NB vehicles exceeded 88,000 pounds (77 vehicles were Class 9's; 23 vehicles were Class 13's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from April 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in April 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 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 12381 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (58.4%) than NB (41.6%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 97506 (a precast box culvert) is approximately 1.3 miles north of WIM #48. Bridge No. 97666 (a precast box culvert) is approximately .45 miles south of WIM #48. WIM #48 recorded a total of 10547 vehicles with a combined GVW of 104860 kips (1 kip = 1,000 pounds = 0.5 tons) in April 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 1486 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 60.4% of all ESALs were recorded SB while 39.6% was observed NB. In particular, 55% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 25% 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).

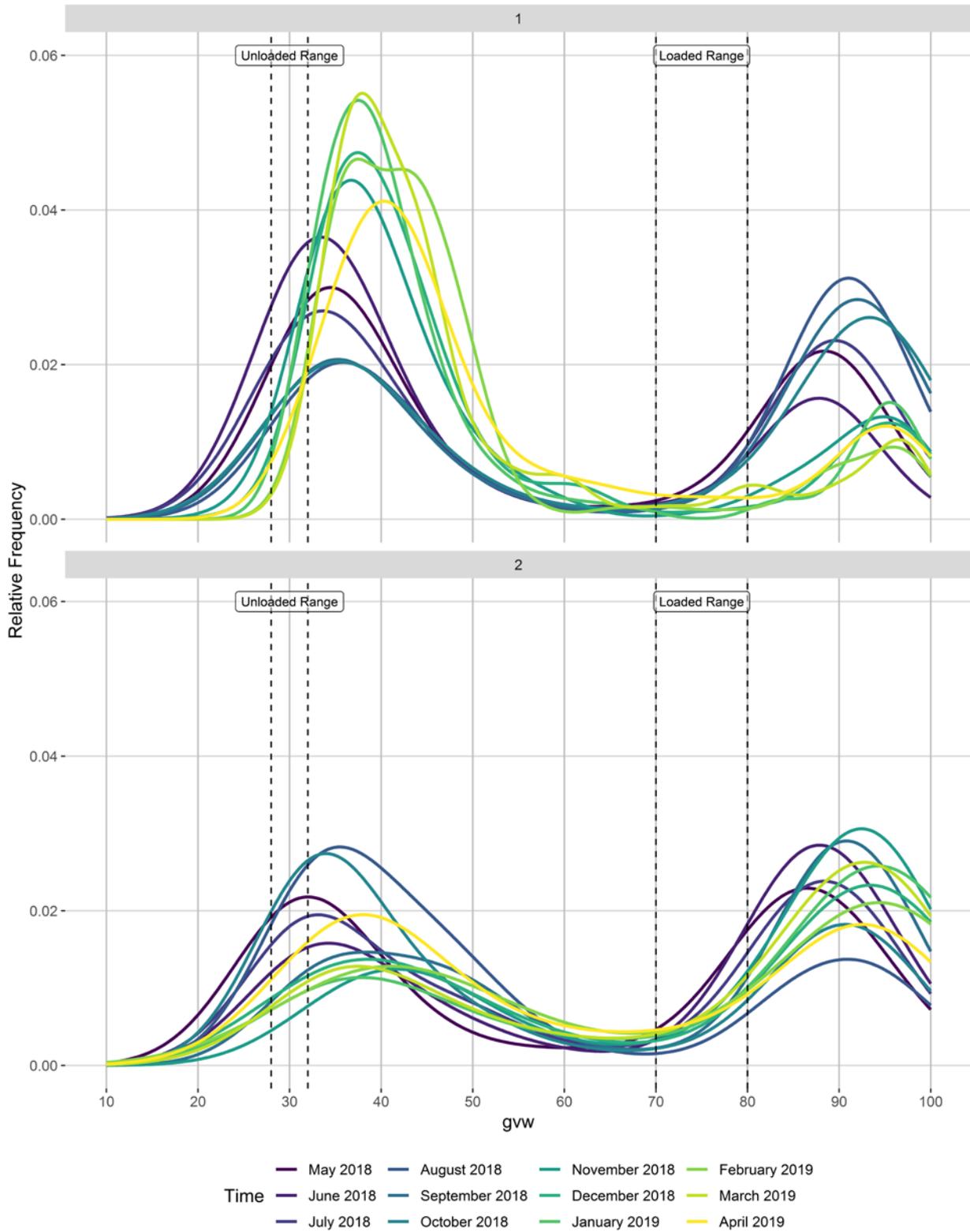
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

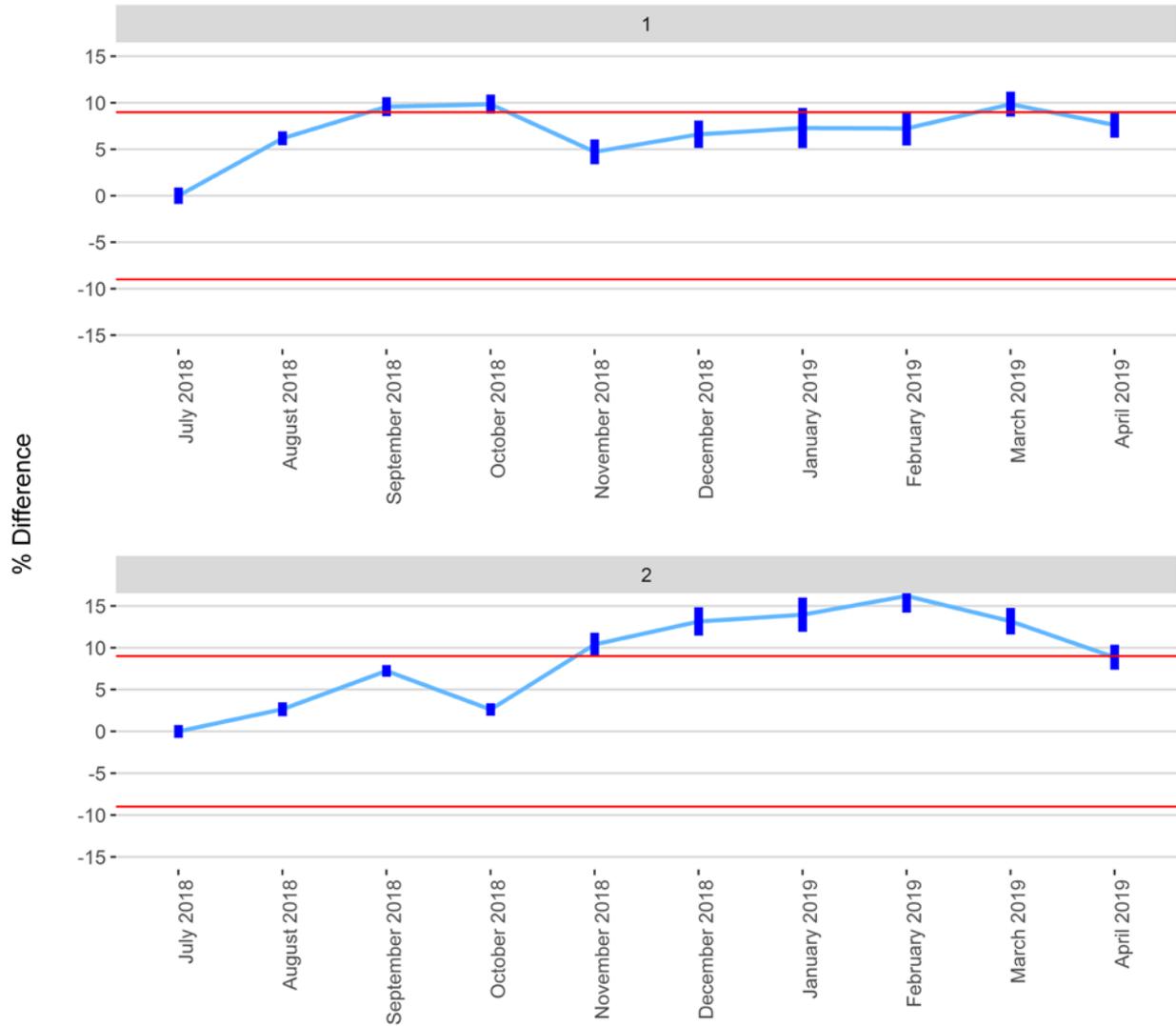
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

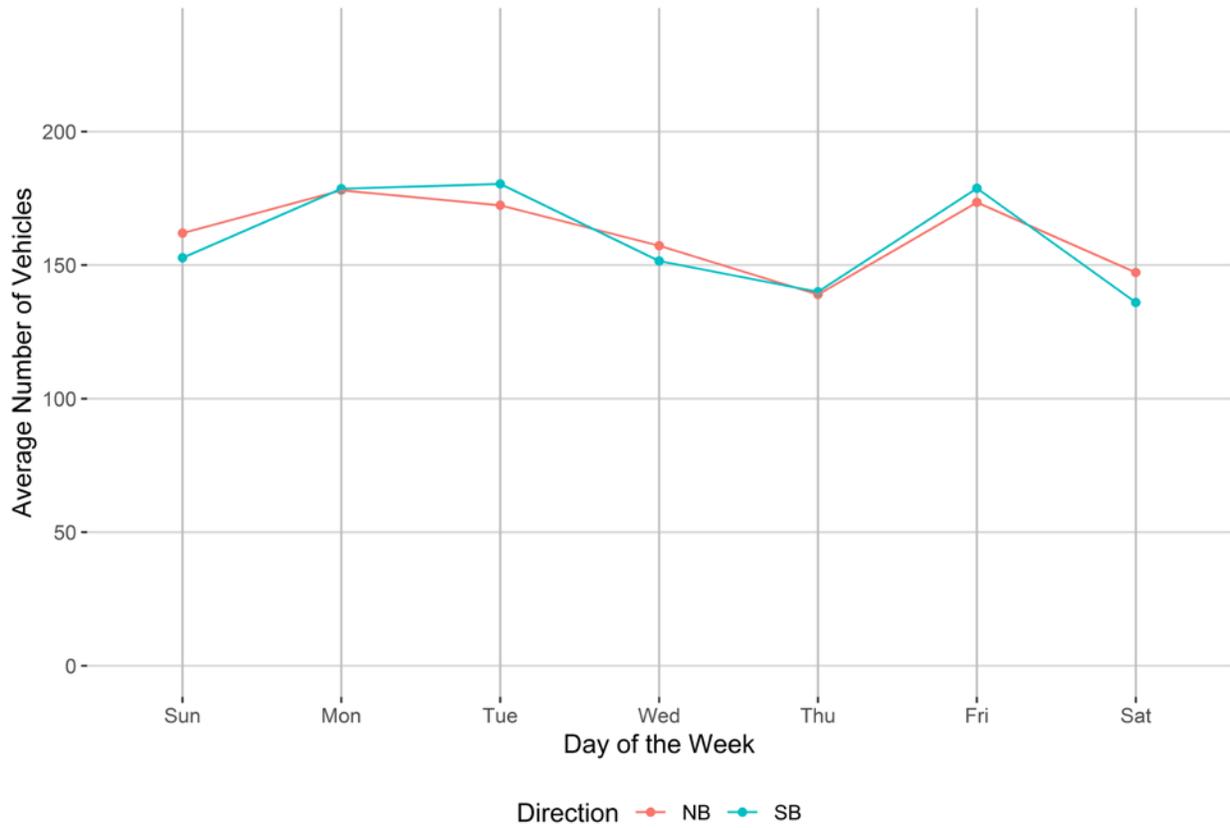


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

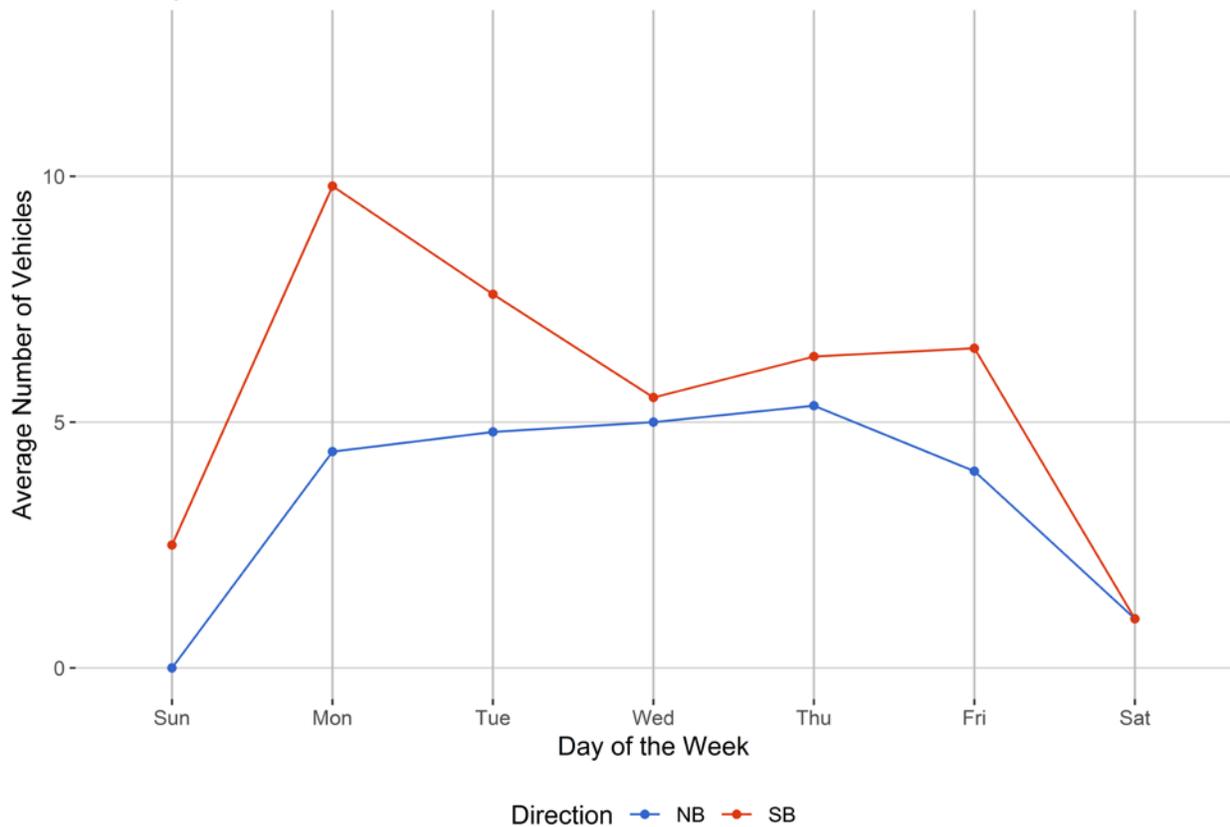


Figure 4 - Passenger Vehicles vs. Hour of the Day

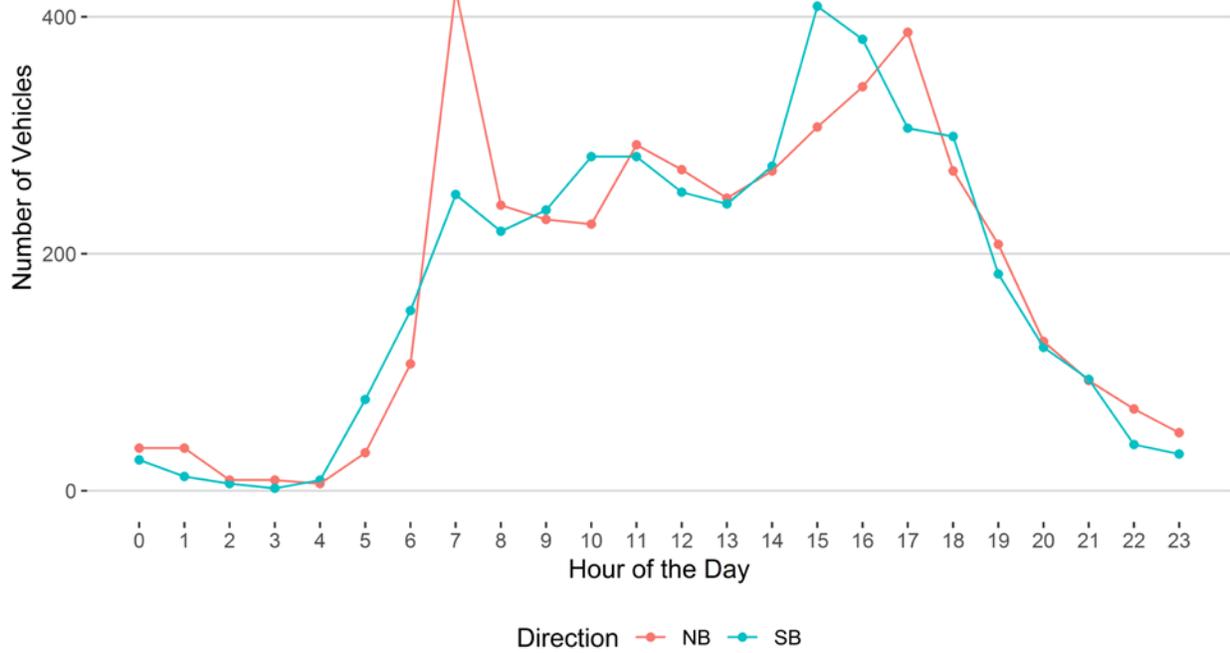


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

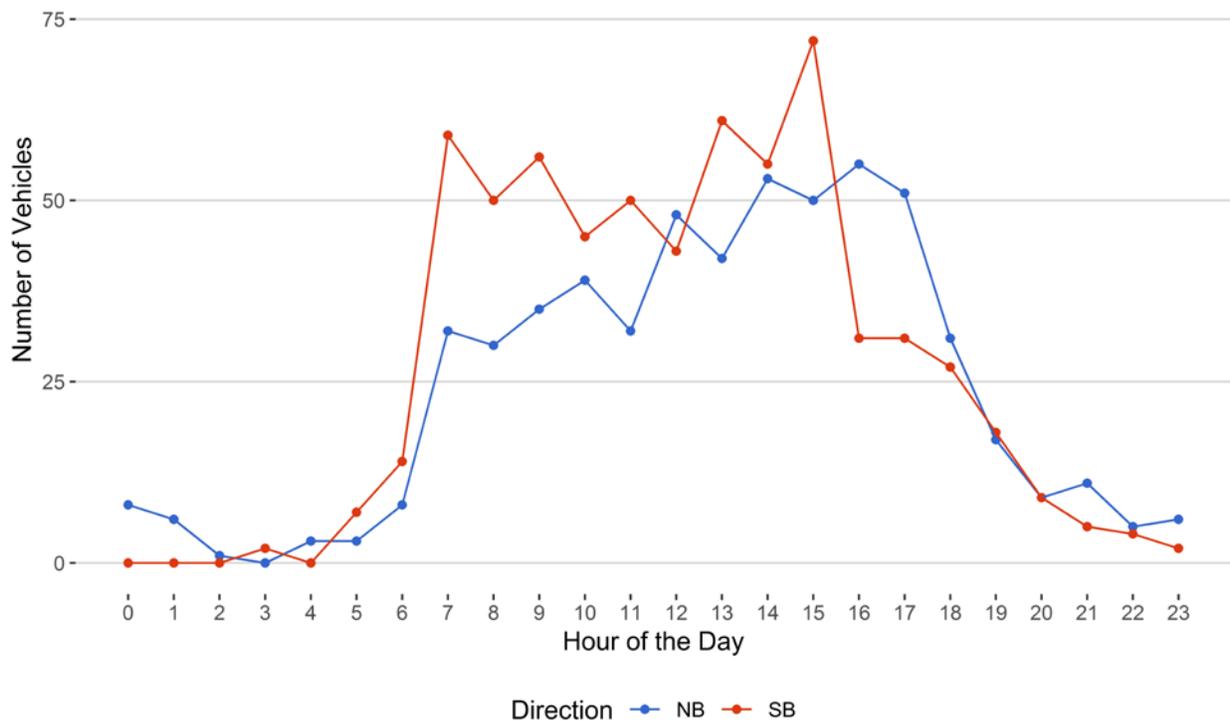


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

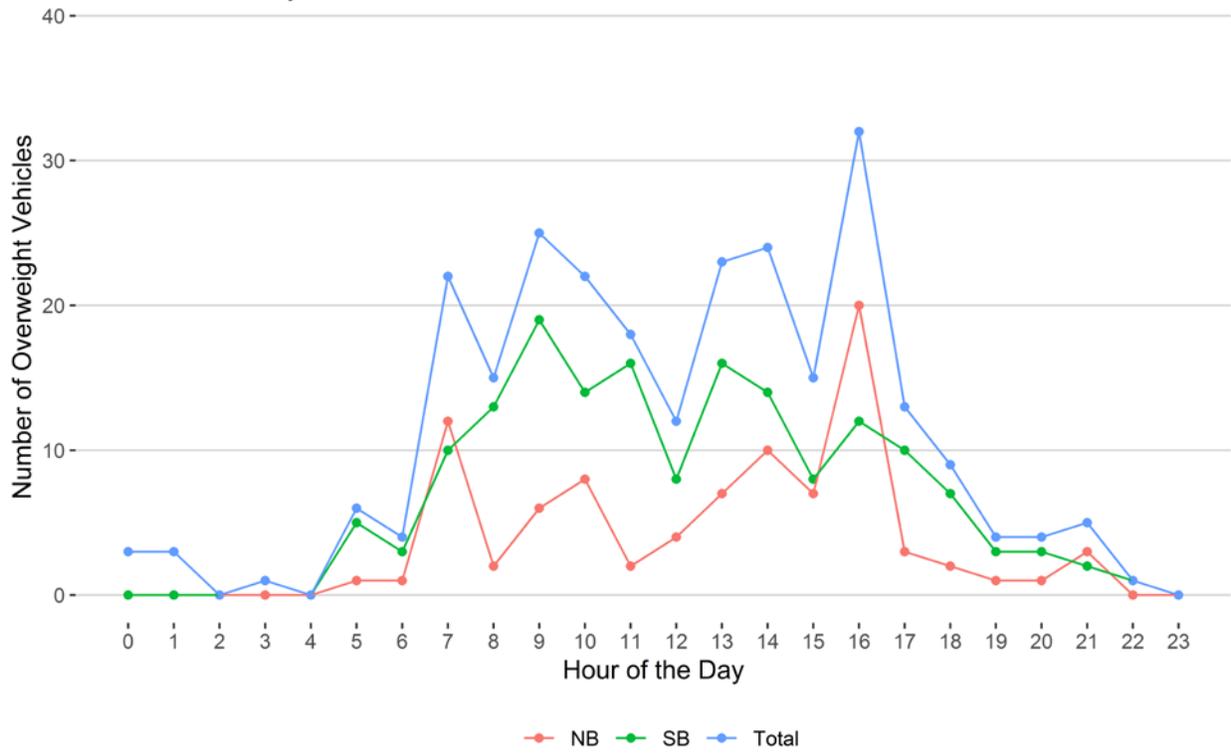
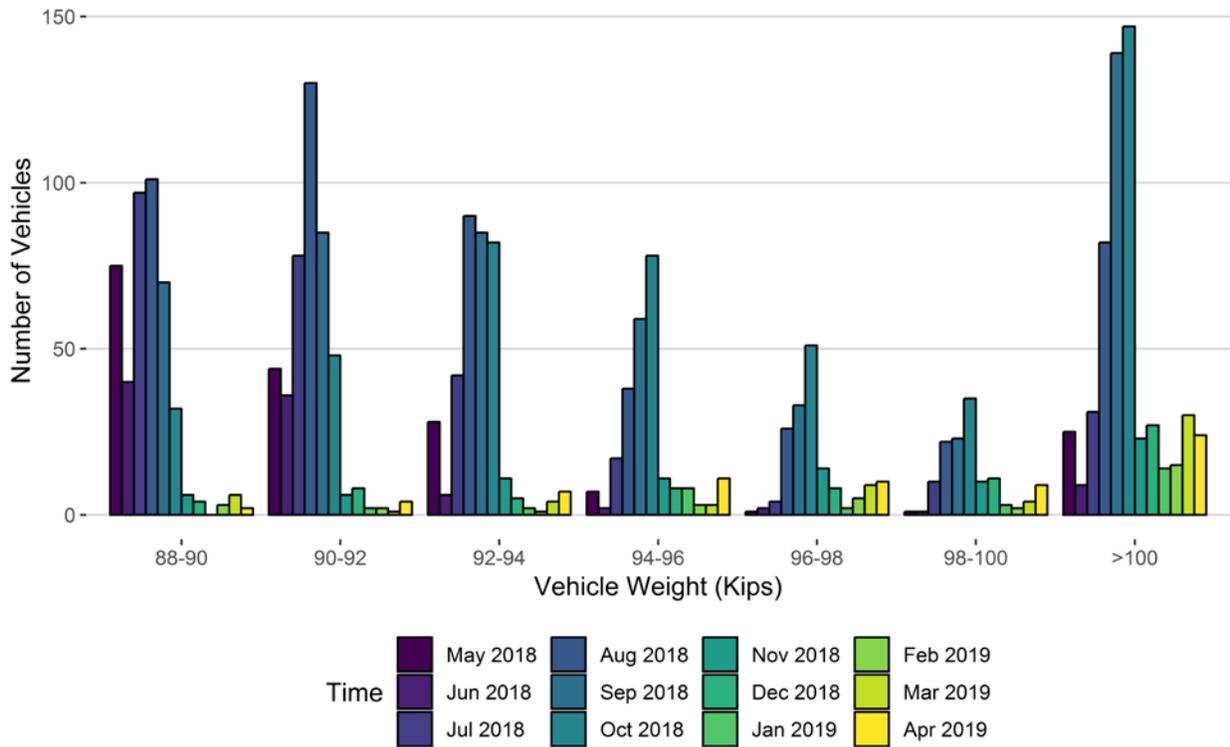
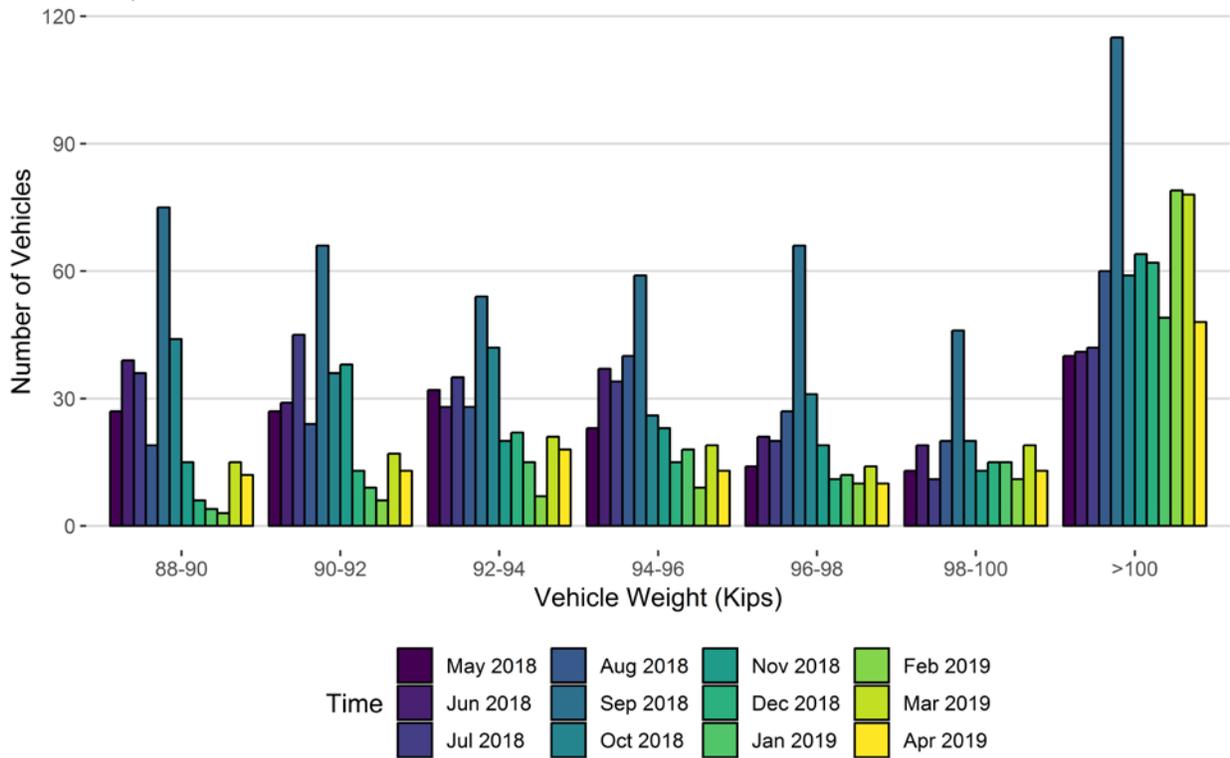


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019
88-90	75	40	97	101	70	32	6	4	0	3	6	2
90-92	44	36	78	130	85	48	6	8	2	2	1	4
92-94	28	6	42	90	85	82	11	5	2	1	4	7
94-96	7	2	17	38	59	78	11	8	8	3	3	11
96-98	1	2	4	26	33	51	14	8	2	5	9	10
98-100	1	1	10	22	23	35	10	11	3	2	4	9
>100	25	9	31	82	139	147	23	27	14	15	30	24
Total	181	96	279	489	494	473	81	71	31	31	57	67

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



Vehicle Weights (Kips)	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019
88-90	27	39	36	19	75	44	15	6	4	3	15	12
90-92	27	29	45	24	66	36	38	13	9	6	17	13
92-94	32	28	35	28	54	42	20	22	15	7	21	18
94-96	23	37	34	40	59	26	23	15	18	9	19	13
96-98	14	21	20	27	66	31	19	11	12	10	14	10
98-100	13	19	11	20	46	20	13	15	15	11	19	13
>100	40	41	42	60	115	59	64	62	49	79	78	48
Total	176	214	223	218	481	258	192	144	122	125	183	127

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

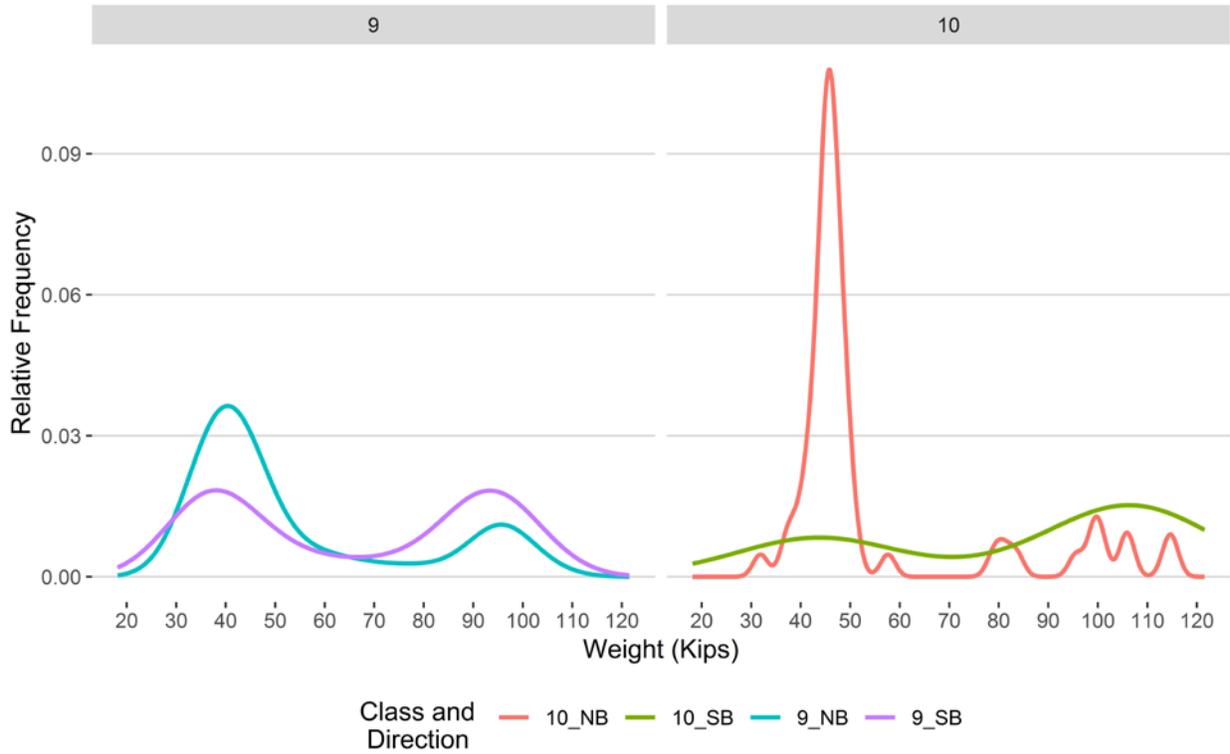


Figure 9 - Freight Percentage by Direction and Class

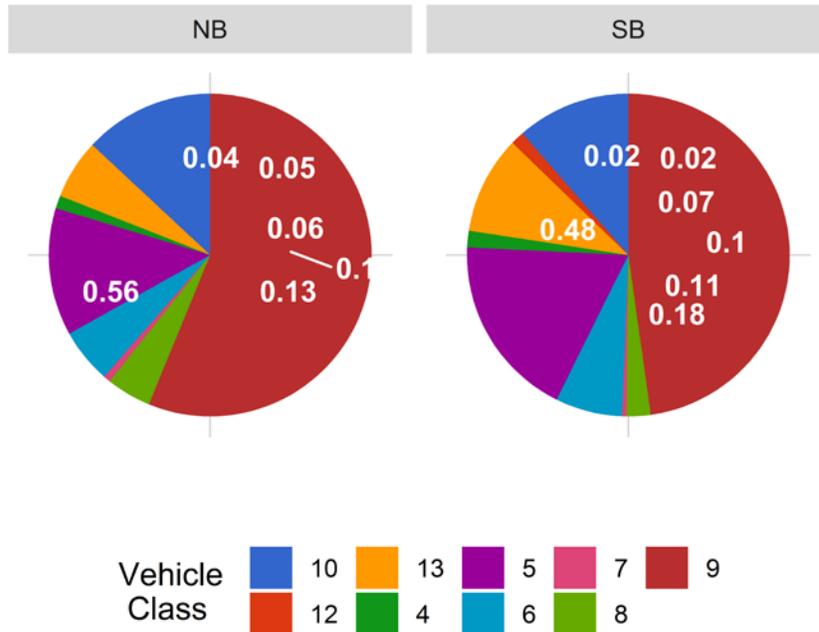


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

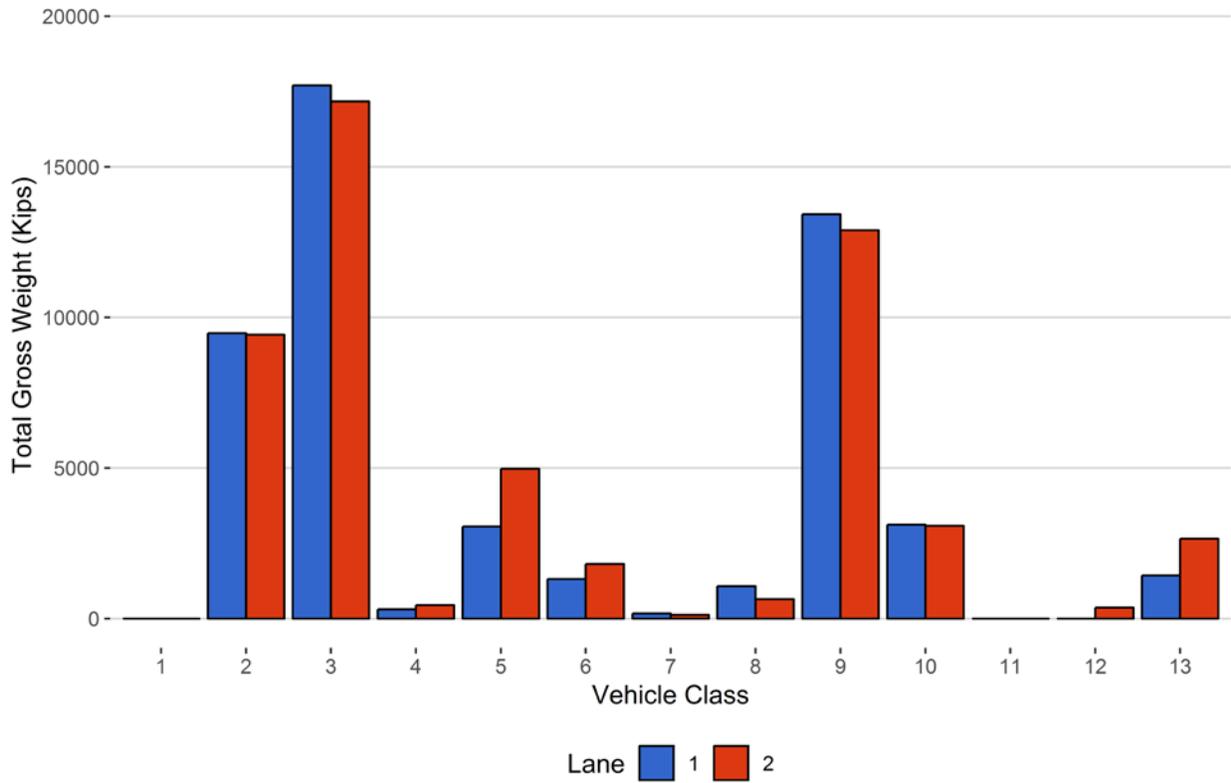


Figure 11 - Total Gross Vehicle Weight t

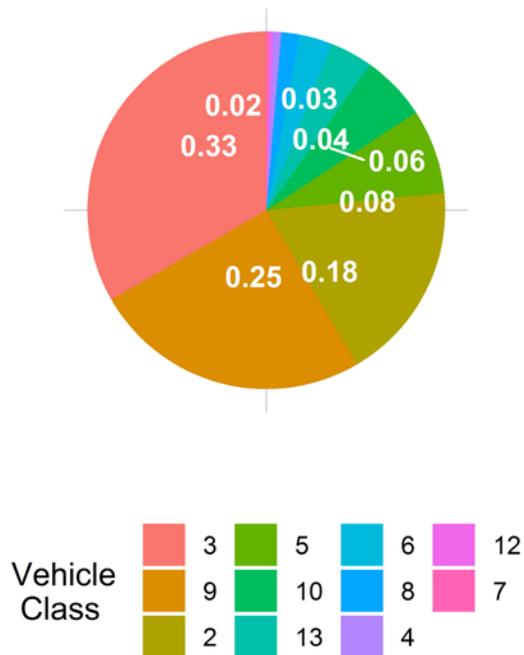


Figure 12 - Total ESALs by Class and Lane

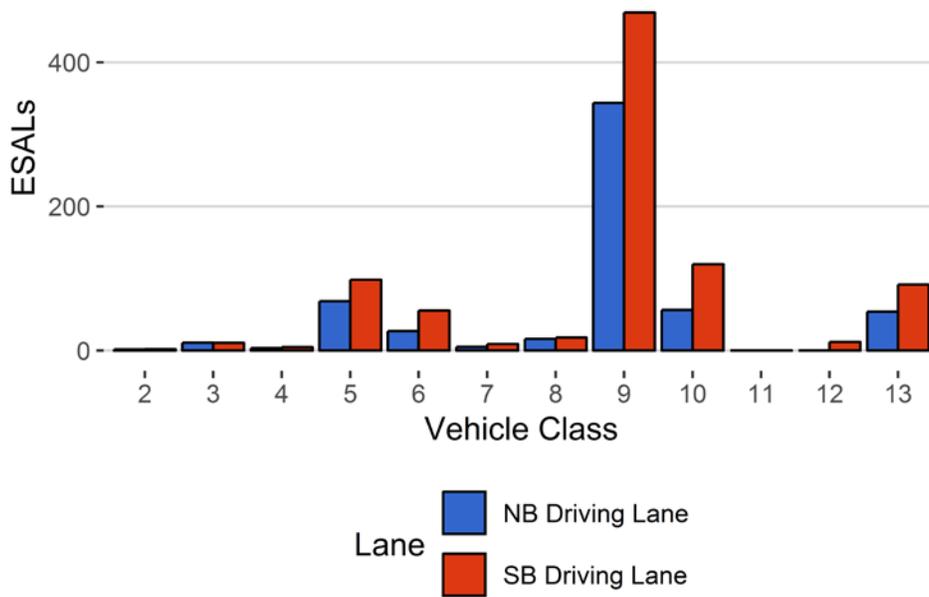


Figure 13 - ESALs by Class

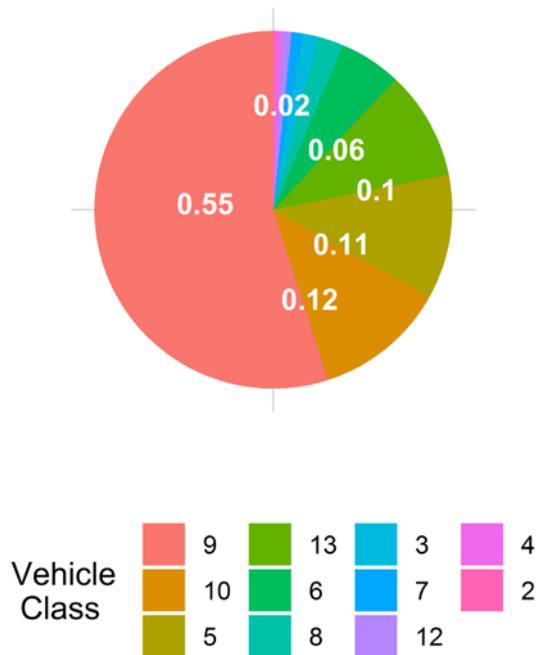


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
July 2018	11.77	0.00	11.70	0.00
August 2018	12.50	6.18	12.01	2.65
September 2018	12.90	9.58	12.54	7.23
October 2018	12.93	9.86	12.00	2.62
November 2018	12.33	4.72	12.91	10.39
December 2018	12.55	6.61	13.23	13.13
January 2019	12.63	7.29	13.33	13.95
February 2019	12.62	7.24	13.59	16.20
March 2019	12.93	9.85	13.24	13.18
April 2019	12.67	7.62	12.73	8.86

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	140	4199	39.8	0	0
3	168	5028	47.7	0	0
4	1	33	0.3	2	0.8
5	17	520	4.9	18	6.9
6	3	89	0.8	15	5.8
7	0	4	0	3	1.2
8	2	51	0.5	2	0.8
9	16	480	4.6	146	56.2
10	3	101	1	35	13.5
11	0	0	0	0	0
12	0	4	0	4	1.5
13	1	38	0.4	35	13.5
TOTAL	352	10547	100	260	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>
2019-04-22	Monday	16:39:12	10	SB	2	121.55
2019-04-20	Saturday	17:12:09	10	SB	2	119.75
2019-04-22	Monday	17:15:14	10	SB	2	117.65
2019-04-30	Tuesday	05:32:36	10	SB	2	116.06
2019-04-29	Monday	05:33:08	10	SB	2	115.35
2019-04-15	Monday	01:34:00	10	NB	1	115.1
2019-04-26	Friday	15:05:59	10	NB	1	114.17
2019-04-28	Sunday	13:55:32	10	SB	2	111.56
2019-04-04	Thursday	08:29:26	10	SB	2	111.15
2019-04-28	Sunday	15:57:13	10	SB	2	110.33

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	12	0	0	305	0	63
5	NB	8	178	1	0.6	3048	8	816
6	NB	19	37	0	0	1312	0	304
7	NB	11.5	2	0	0	169	0	73
8	NB	31	31	8	25.8	927	147	107
9	NB	33	247	9	3.6	13139	287	2643
10	NB	33.5	56	1	1.8	3085	32	621
13	NB	31.5	12	0	0	1430	0	526
TOTAL	****	****	575	19	****	23415	****	5153
<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	18	2	11.1	418	30	89
5	SB	8	301	3	1	4952	21	1284
6	SB	19	45	0	0	1814	0	479
7	SB	11.5	2	0	0	120	0	49
8	SB	31	16	3	18.8	582	62	90
9	SB	33	195	12	6.2	12512	383	3237
10	SB	33.5	37	1	2.7	3062	18	928
12	SB	36.5	4	0	0	364	0	109
13	SB	31.5	23	0	0	2653	0	964
TOTAL	****	****	641	21	****	26477	****	7228
GRAND TOTAL	****	****	1216	40	72	49892	988	12381

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	9477	9427	18904	18.1
3	17707	17168	34876	33.3
4	305	447	752	0.7
5	3056	4973	8029	7.7
6	1312	1814	3125	3
7	169	120	289	0.3
8	1074	645	1718	1.6
9	13426	12896	26322	25.2
10	3117	3080	6196	5.9
12	0	364	364	0.3
13	1430	2653	4082	3.9
TOTAL	51073	53586	104659	100
GVW/LANE	48.8	51.2	100	0.1

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	2	2	4	0.2	0.0025
3	11	11	22	1.5	0.0103
4	4	5	8	0.6	0.64
5	69	98	167	11.3	0.72
6	27	56	83	5.6	2.01
7	5	9	14	1	3.31
8	16	18	34	2.3	1.44
9	344	469	813	55	3.75
10	56	120	176	11.9	3.63
12	0	12	12	0.8	2.3
13	54	92	146	9.8	6.55
TOTAL	588	891	1479	100	24
ESALS/LANE	39.8	60.2	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>
May 2018	14674	473	73	12414	84.6	2259.8	15.4
Jun 2018	13021	434	67	11020	84.6	2001.1	15.4
Jul 2018	13682	441	78	11271	82.4	2410.8	17.6
Aug 2018	13562	438	85	10928	80.6	2634	19.4
Sep 2018	14017	467	98	11073	79	2944.3	21
Oct 2018	14892	480	116	11303	75.9	3589.5	24.1
Nov 2018	11107	370	47	9686	87.2	1421.5	12.8
Dec 2018	9594	310	39	8393	87.5	1201.4	12.5
Jan 2019	7052	282	28	6187	87.7	864.7	12.3
Feb 2019	7600	271	38	6535	86	1065.2	14
Mar 2019	9909	320	46	8474	85.5	1435.2	14.5
Apr 2019	10547	352	44	9227	87.5	1320.3	12.5
TOTAL	139657	-	-	116511	-	23148	-
AVERAGE	11638	387	63	9709	84	1929	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>
May 2018	1396	1406	2801	50.4
Jun 2018	916	1578	2494	67.8
Jul 2018	1730	1722	3452	58.4
Aug 2018	2494	1632	4127	86.4
Sep 2018	2756	3014	5769	85
Oct 2018	2883	1950	4833	100
Nov 2018	707	1320	2027	88.4
Dec 2018	581	1022	1603	97.2
Jan 2019	315	859	1173	100.9
Feb 2019	426	1097	1523	116.2
Mar 2019	617	1276	1894	103.2
Apr 2019	589	898	1486	78.3
TOTAL	15410	-	-	-
AVERAGE	1284	1481	2765	86

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
May 18	86626	80895	167521
Jun 18	72965	78450	151415
Jul 18	91632	86499	178130
Aug 18	104470	87394	191864
Sep 18	101402	112503	213905
Oct 18	95547	82834	178381
Nov 18	53687	60504	114190
Dec 18	46511	49899	96410
Jan 19	27108	36968	64076
Feb 19	32684	39784	72467
Mar 19	47910	55089	102999
Apr 19	51115	53745	104860
TOTAL	811654	824564	1636218
AVERAGE	67638	68714	136352

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>
May 2018	669	4.9	31.6	360	82
Jun 2018	607	4.9	31.7	313	73
Jul 2018	828	6.6	36.7	502	94
Aug 2018	907	7.4	37.3	708	185
Sep 2018	1229	10.1	47.7	976	324
Oct 2018	993	10.1	41.6	732	262
Nov 2018	401	3.9	30.1	274	110
Dec 2018	286	3.2	25.2	216	116
Jan 2019	216	3.6	29.4	154	82
Feb 2019	237	3.8	26.4	156	107
Mar 2019	339	3.9	26.3	240	131
Apr 2019	261	2.7	21.2	194	94
TOTAL	6973	-	-	4825	1660
AVERAGE	581.1	5.4	32.1	402.1	138.3

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>
May 2018	11363	11901	23264	48.8	51.2
Jun 2018	8008	12671	20678	38.7	61.3
Jul 2018	14113	13882	27995	50.4	49.6
Aug 2018	19506	13260	32765	59.5	40.5
Sep 2018	19864	22935	42800	46.4	53.6
Oct 2018	19870	14175	34045	58.4	41.6
Nov 2018	5662	9780	15442	36.7	63.3
Dec 2018	4620	7430	12050	38.3	61.7
Jan 2019	2455	5954	8409	29.2	70.8
Feb 2019	3307	6523	9830	33.6	66.4
Mar 2019	4989	9102	14091	35.4	64.6
Apr 2019	5153	7228	12381	41.6	58.4
TOTAL	118909	134841	253750	-	-
AVERAGE	9909	11236.8	21145.8	43.1	56.9