

FEBRUARY 2018



WIM #30
MN 61, MP 16.3
TWO HARBORS,
MN

MONTHLY
REPORT



Your Destination...Our Priority



WIM Site Location

WIM #30 is located on MN 61 near Two Harbors in Lake county.

System Operation

WIM #30 was operational for the entire month of February 2018. Volume was computed using all monthly data.

System Calibration

WIM #30 was most recently calibrated on 2017-01-20. 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: 187768 | Passenger Vehicles: 175321 | Heavy Commercial Vehicles: 12447

Monthly Average Daily Traffic (MADT): 6706 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 445

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 Fridays, with lowest volumes reported on Sundays. SB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Tuesdays (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 11 AM and 04 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 11 AM and 04 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 5's and Class 9's.

Overweight HCVs

Volume trends. Of a total of 12447 HCVs, 2413 of them were overweight³. These overweight HCVs contributed to 1.3% of total monthly volume, and 19.7% of total monthly HCV volume. NB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Thursdays, 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 59.9% 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 February.

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 ,398 NB vehicles exceeded 88,000 pounds (259 vehicles were Class 9's; 116 vehicles were Class 10's). Of vehicles traveling SB,

896 NB vehicles exceeded 88,000 pounds (674 vehicles were Class 10's; 211 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from February 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in February 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 empty Class 10's than fully_loaded traveling in the NB direction. In the SB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 115732 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (57.7%) than NB (42.3%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridges No. 9341 and No. 9339, which are respectively on the NB and SB side of MN 61, are approximately 1.5 miles north of WIM #30. Bridge No. 9333 (a box culvert) is approximately 1.8 miles south of WIM #30. WIM #30 recorded a total of 187768 vehicles with a combined GVW of 1372339 kips (1 kip = 1,000 pounds = 0.5 tons) in February 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 13089 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 57.8% of all ESALs were recorded SB while 42.2% was observed NB. In particular, 50% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 18% 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).

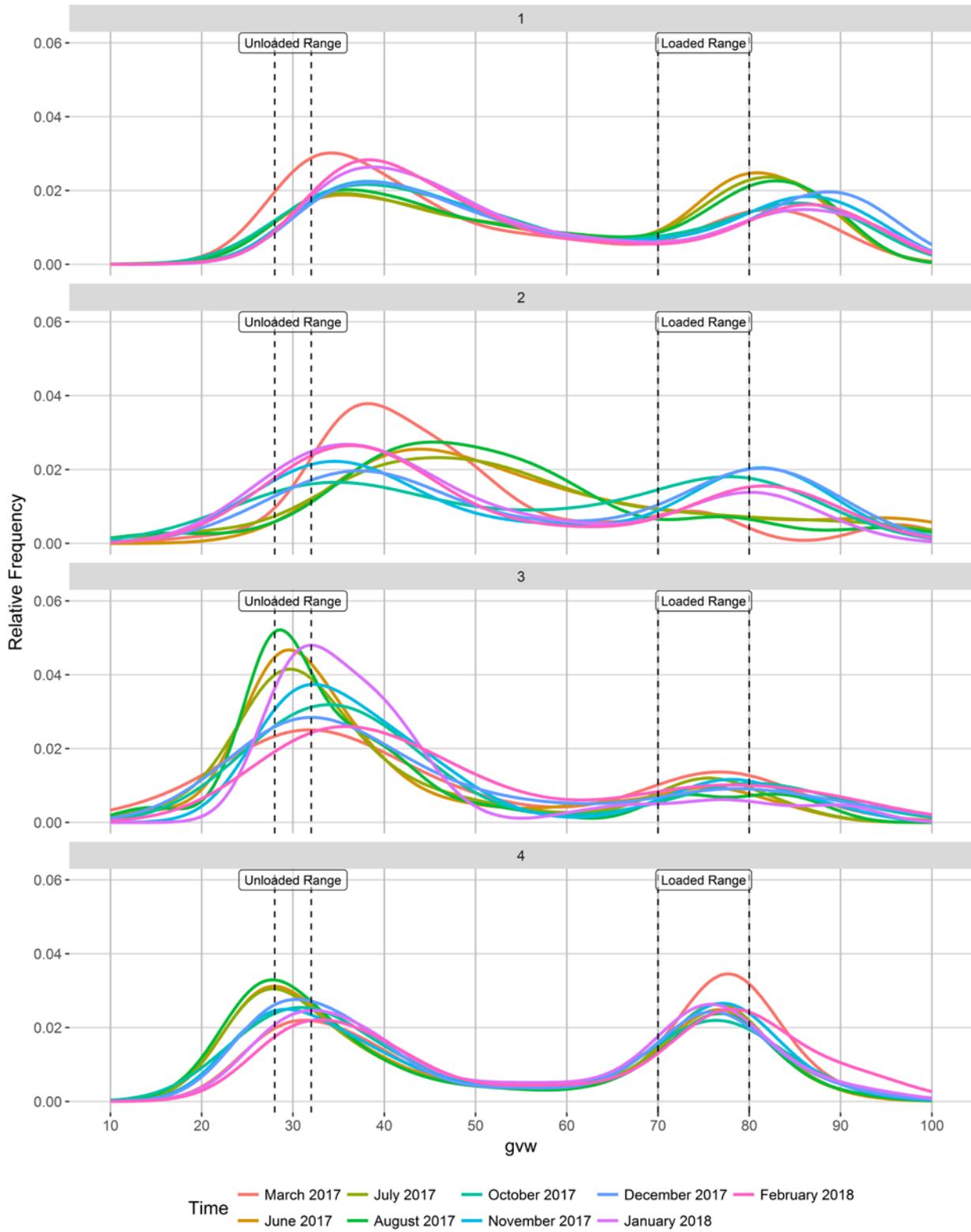
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

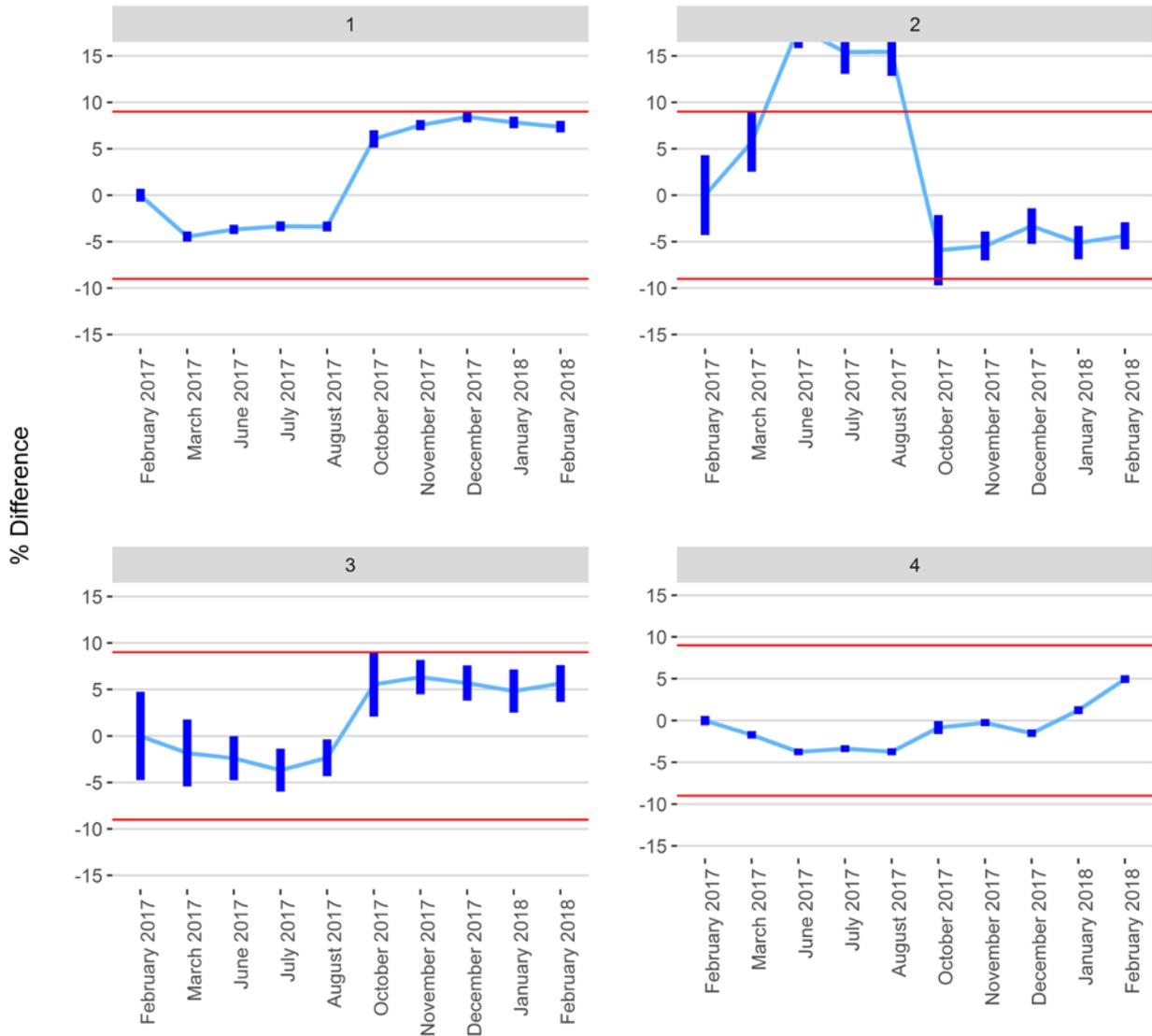
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

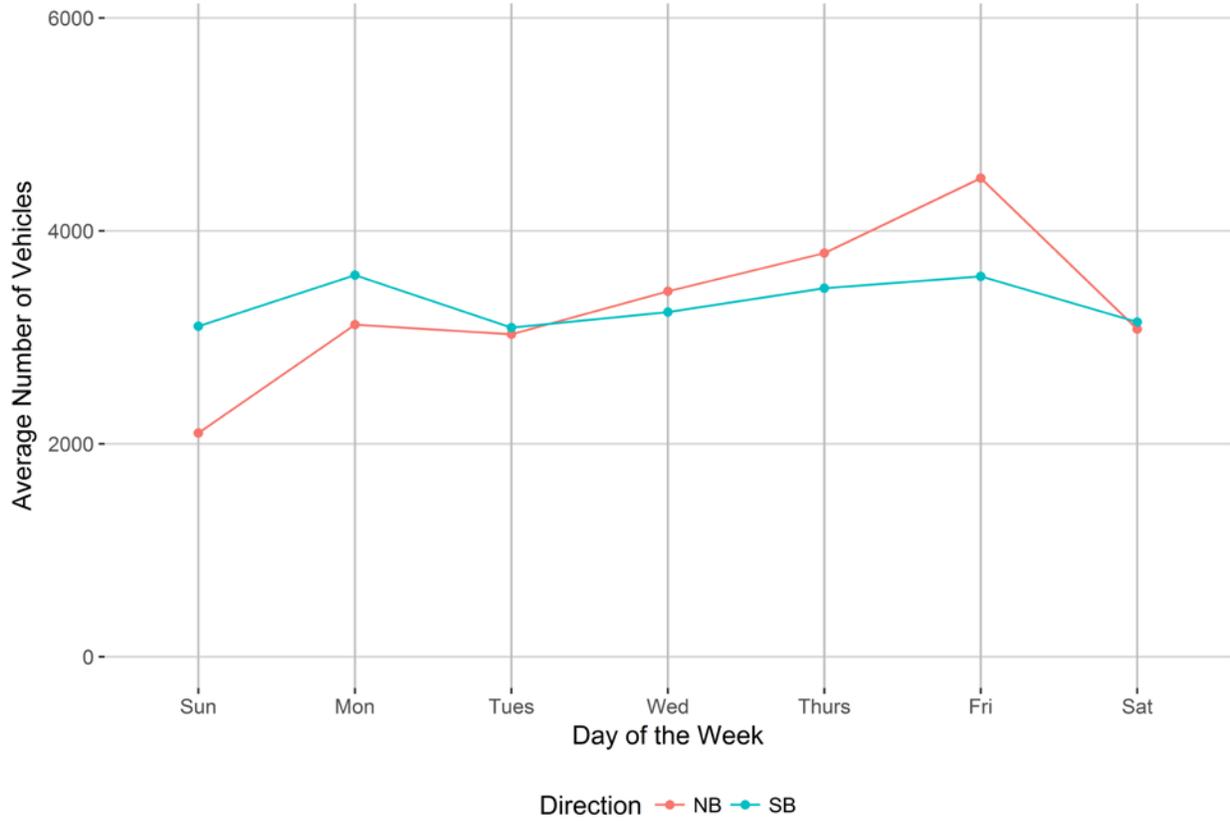


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

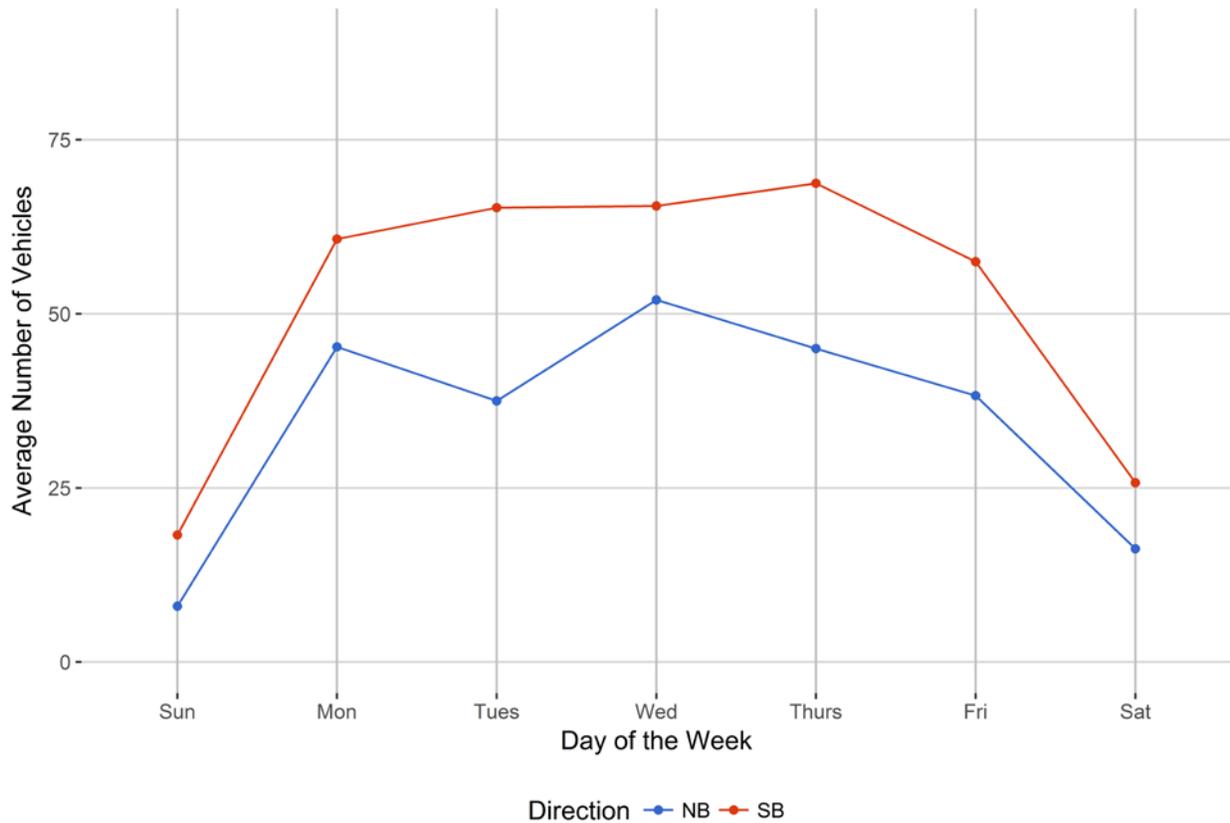


Figure 4 - Passenger Vehicles vs. Hour of the Day

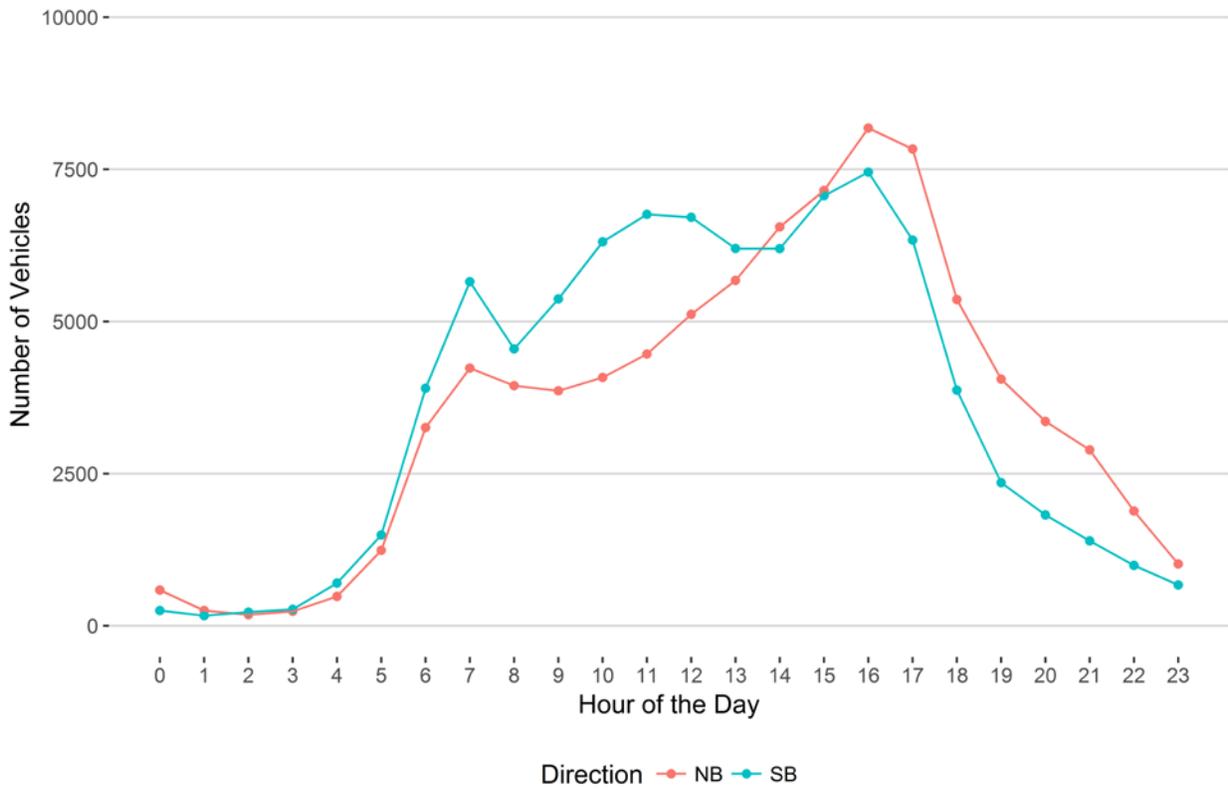


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

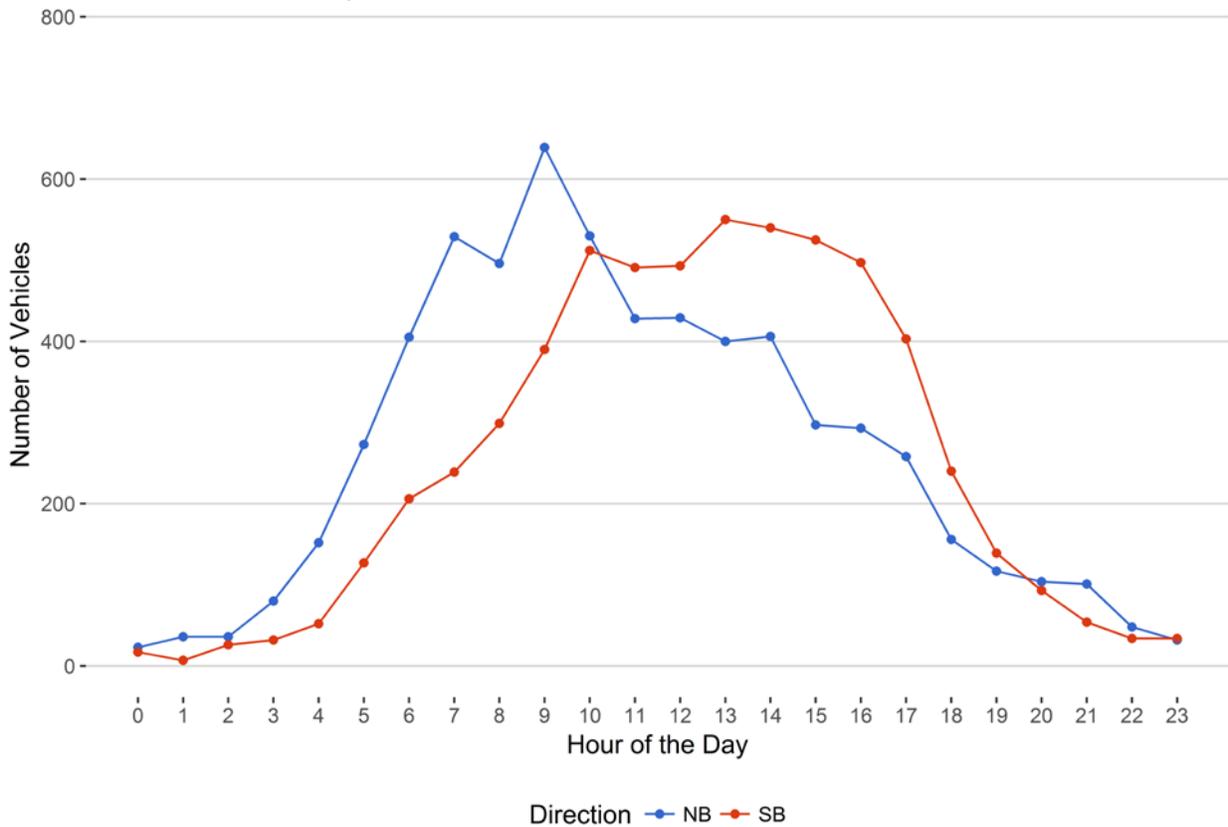


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

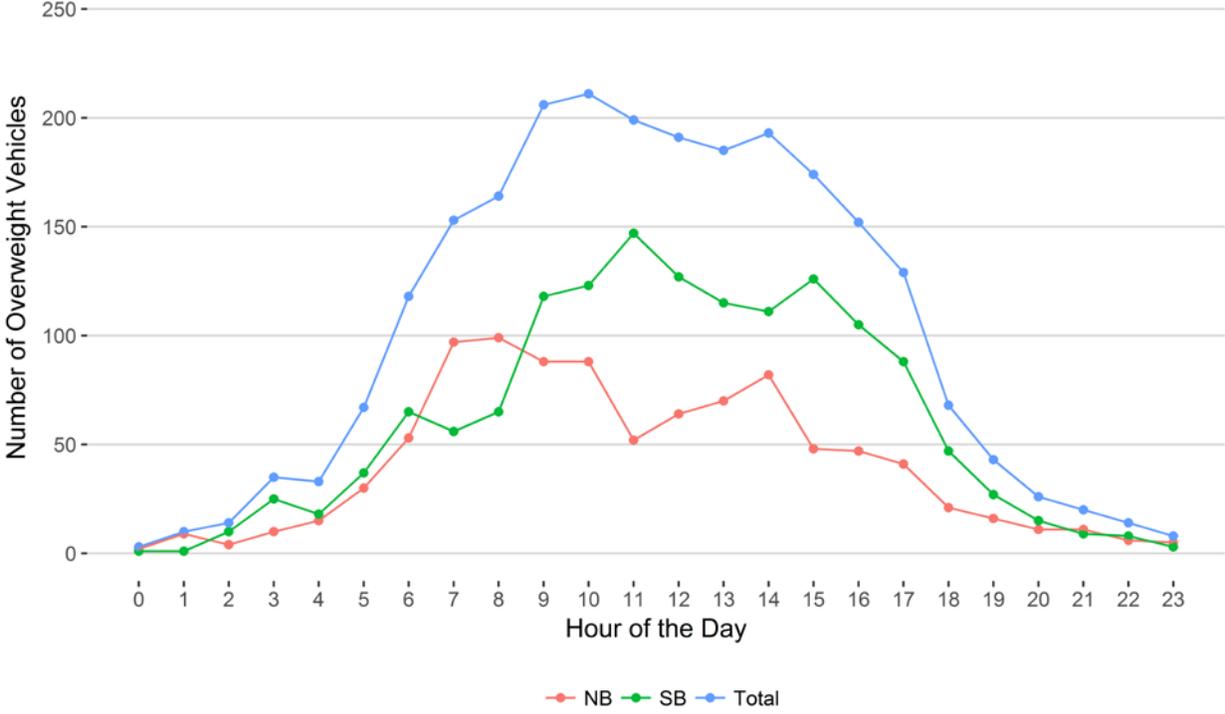
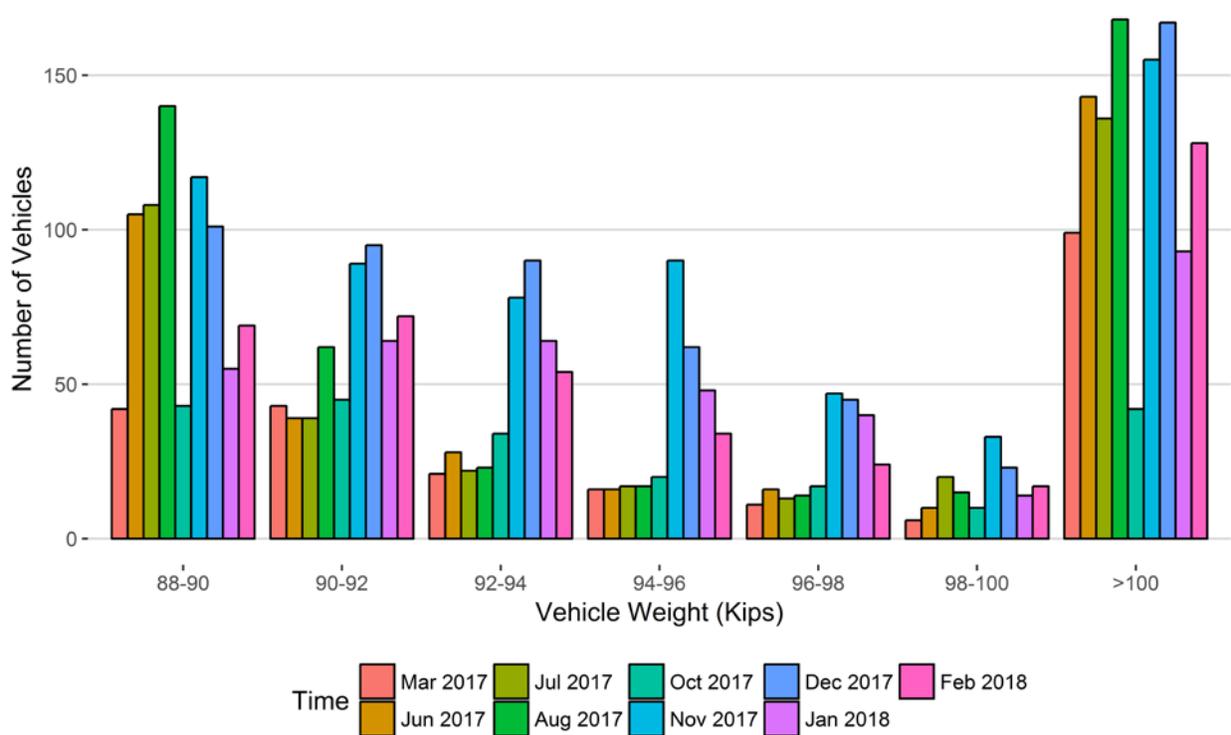
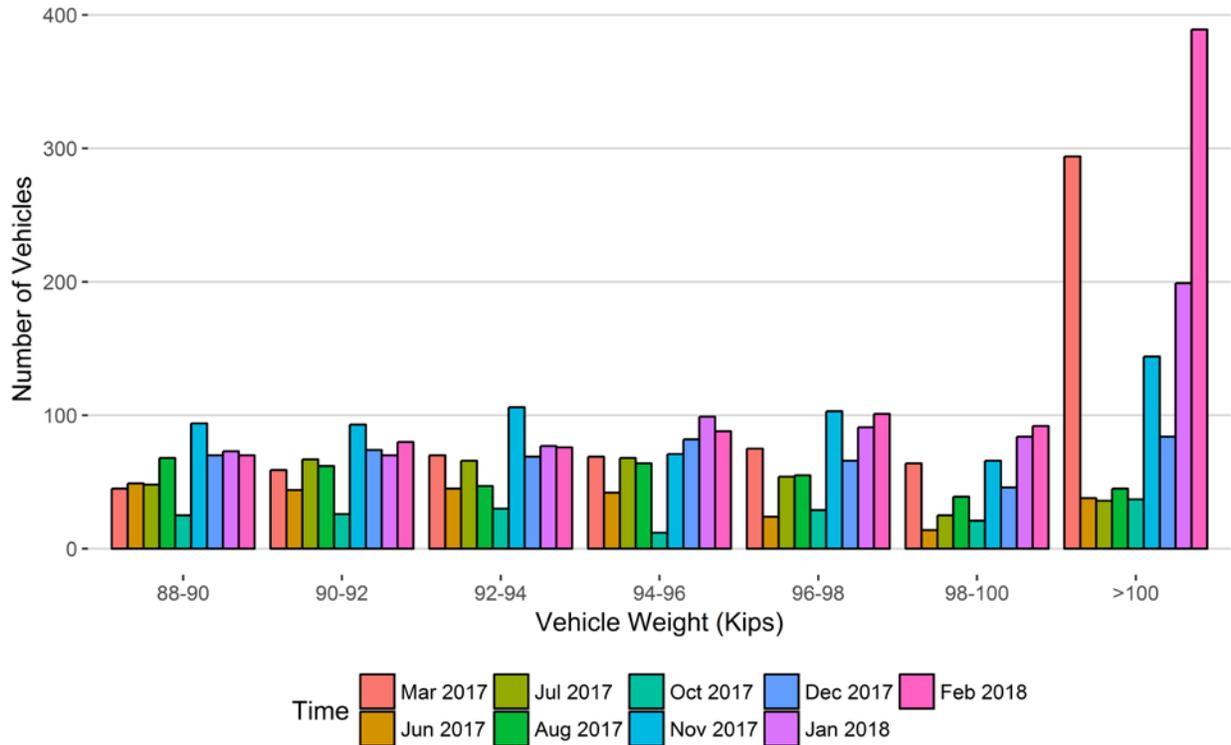


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Mar 2017	Jun 2017	Jul 2017	Aug 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018
88-90	42	105	108	140	43	117	101	55	69
90-92	43	39	39	62	45	89	95	64	72
92-94	21	28	22	23	34	78	90	64	54
94-96	16	16	17	17	20	90	62	48	34
96-98	11	16	13	14	17	47	45	40	24
98-100	6	10	20	15	10	33	23	14	17
>100	99	143	136	168	42	155	167	93	128
Total	238	357	355	439	211	609	583	378	398

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



Vehicle Weights (Kips)	Mar 2017	Jun 2017	Jul 2017	Aug 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018
88-90	45	49	48	68	25	94	70	73	70
90-92	59	44	67	62	26	93	74	70	80
92-94	70	45	66	47	30	106	69	77	76
94-96	69	42	68	64	12	71	82	99	88
96-98	75	24	54	55	29	103	66	91	101
98-100	64	14	25	39	21	66	46	84	92
>100	294	38	36	45	37	144	84	199	389
Total	676	256	364	380	180	677	491	693	896

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

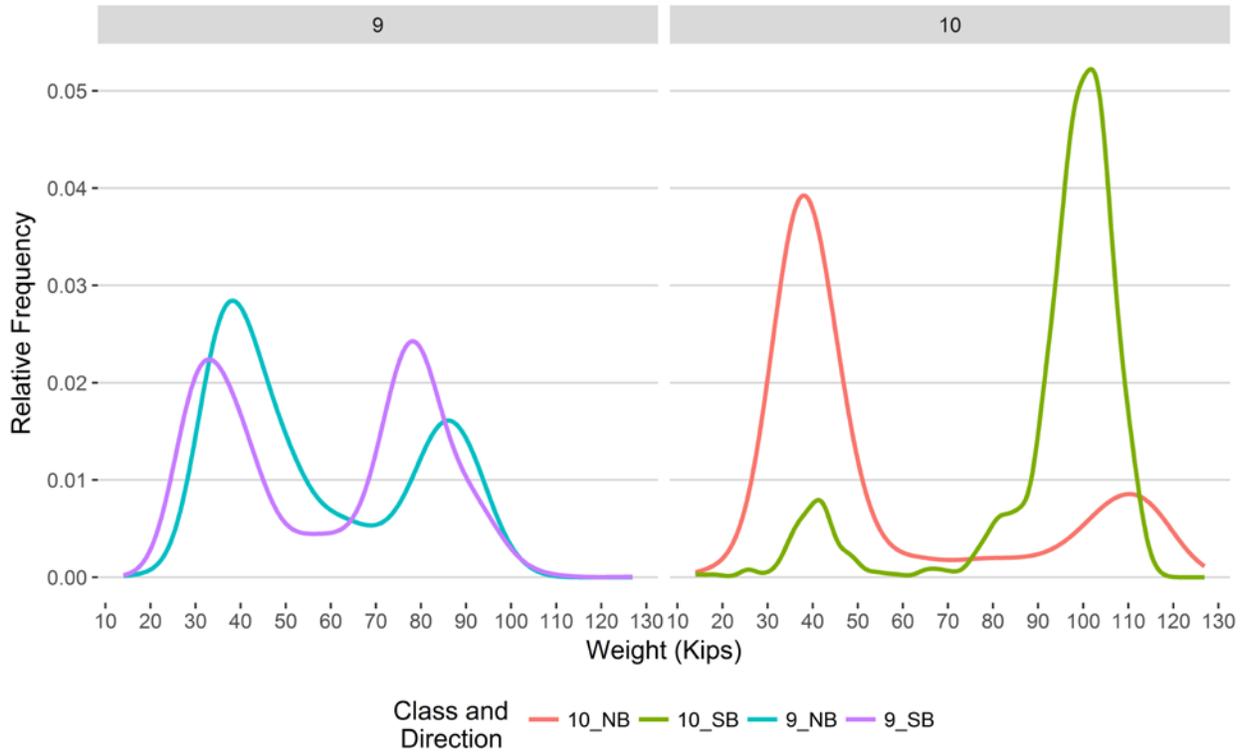


Figure 9 - Freight Percentage by Direction and Class

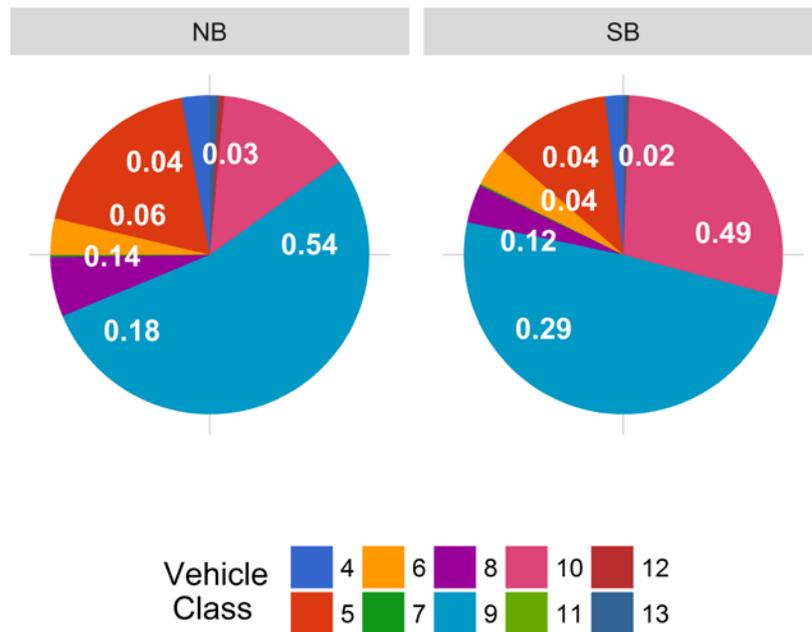


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

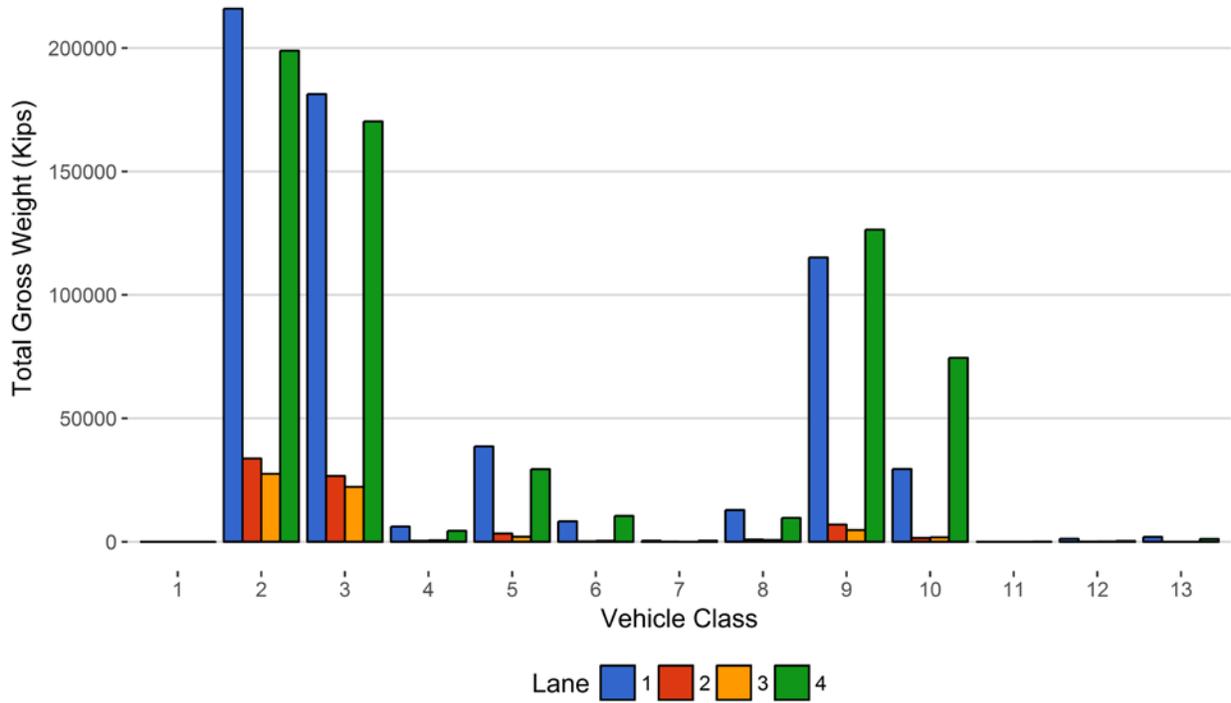


Figure 11 - Total Gross Vehicle Weight I

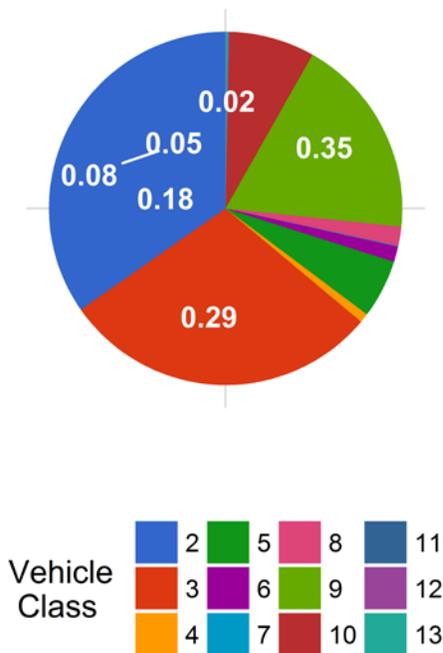


Figure 12 - Total ESALs by Class and Lane

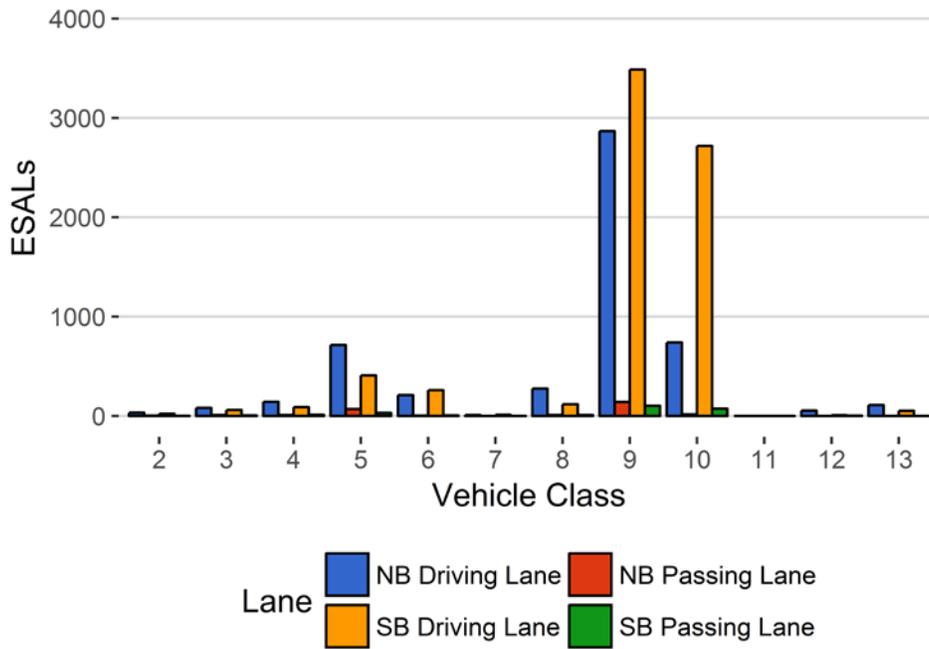


Figure 13 - ESALs by Class

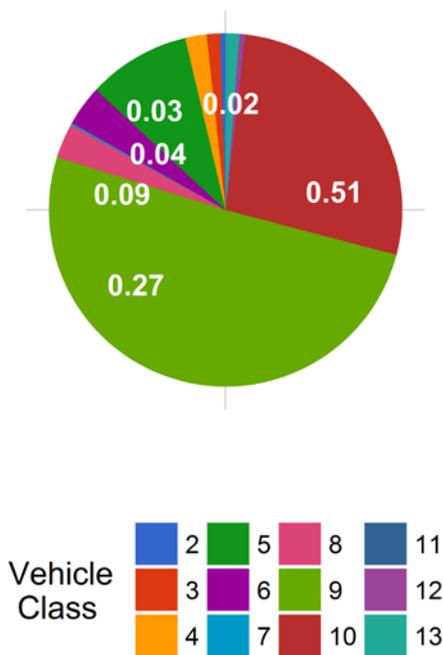


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 3 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 4 (kips)</i>	<i>Front Axle +/- 9%</i>
February 2017	11.62	0.00	12.12	0.00	10.33	0.00	11.31	0.00
March 2017	11.10	-4.45	12.82	5.74	10.14	-1.83	11.11	-1.71
June 2017	11.19	-3.68	14.31	18.03	10.08	-2.40	10.88	-3.75
July 2017	11.23	-3.35	13.99	15.41	9.95	-3.68	10.93	-3.36
August 2017	11.23	-3.36	13.99	15.43	10.09	-2.35	10.89	-3.73
October 2017	12.32	6.06	11.40	-5.91	10.91	5.55	11.21	-0.85
November 2017	12.49	7.54	11.46	-5.46	10.99	6.32	11.28	-0.25
December 2017	12.60	8.45	11.72	-3.32	10.92	5.69	11.14	-1.52
January 2018	12.53	7.84	11.50	-5.10	10.83	4.84	11.45	1.24
February 2018	12.47	7.38	11.59	-4.37	10.92	5.64	11.87	4.95

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	4073	114043	60.7	0	0
3	2188	61278	32.6	0	0
4	14	388	0.2	33	1.4
5	174	4866	2.6	173	7.2
6	19	528	0.3	97	4
7	1	16	0	8	0.3
8	28	771	0.4	37	1.5
9	158	4426	2.4	1181	48.9
10	50	1405	0.7	847	35.1
11	0	1	0	0	0
12	1	19	0	14	0.6
13	1	27	0	23	1
TOTAL	6706	187768	100	2413	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>
2018-02-18	Sunday	15:54:11	9	SB	4	126.95
2018-02-21	Wednesday	13:28:03	10	NB	1	123.05
2018-02-22	Thursday	08:51:20	10	NB	1	122.8
2018-02-13	Tuesday	10:05:02	10	NB	1	122.07
2018-02-13	Tuesday	12:39:46	10	NB	1	121.54
2018-02-13	Tuesday	16:41:19	10	NB	1	120.83
2018-02-22	Thursday	16:56:48	10	NB	1	120.61
2018-02-02	Friday	15:34:48	10	NB	1	120.35
2018-02-22	Thursday	11:46:35	10	NB	1	119.58
2018-02-28	Wednesday	05:25:35	10	NB	1	118.57

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	219	27	12.3	6185	364	1653
5	NB	8	2676	94	3.5	41286	698	10315
6	NB	19	226	7	3.1	8346	119	2093
7	NB	11.5	8	0	0	496	0	202
8	NB	31	400	131	32.8	11285	2425	1473
9	NB	33	2145	180	8.4	116654	5455	25905
10	NB	33.5	564	60	10.6	29215	1816	6166
12	NB	36.5	14	0	0	1312	0	401
13	NB	31.5	16	0	0	1986	0	741
TOTAL	****	****	6268	499	****	216765	****	48947
<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	163	30	18.4	4577	397	1291
5	SB	8	2120	199	9.4	29982	1433	7307
6	SB	19	294	5	1.7	10793	89	2651
7	SB	11.5	8	0	0	440	0	174
8	SB	31	360	192	53.3	6356	3995	574
9	SB	33	2217	427	19.3	118684	12501	29807
10	SB	33.5	821	8	1	76133	206	24449
11	SB	36.5	1	1	100	0	31	0
12	SB	36.5	5	0	0	398	0	108
13	SB	31.5	11	0	0	1196	0	425
TOTAL	****	****	6000	862	****	248559	****	66785
GRAND TOTAL	****	****	12268	1361	274	465324	29527	115732

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>NB Driving Lane</i>	<i>NB Passing Lane</i>	<i>SB Passing Lane</i>	<i>SB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>
2	215973	33713	27521	198941	476148	34.7
3	181353	26653	22210	170268	400485	29.2
4	6159	390	529	4444	11522	0.8
5	38641	3343	2046	29370	73399	5.4
6	8260	205	371	10512	19347	1.4
7	434	62	0	440	936	0.1
8	12849	861	695	9655	24061	1.8
9	115149	6961	4779	126405	253295	18.5
10	29485	1545	1840	74498	107369	7.8
11	0	0	0	31	31	0
12	1258	54	103	294	1710	0.1
13	1986	0	0	1196	3182	0.2
TOTAL	611546	73787	60095	626055	1371484	100
GVW/LANE	44.59	5.38	4.38	45.65	100	0.01

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>NB Driving Lane</i>	<i>NB Passing Lane</i>	<i>SB Passing Lane</i>	<i>SB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
2	33	4	3	24	65	0.5	0.0012
3	82	10	7	61	159	1.22	0.0053
4	143	10	12	90	254	1.96	1.33
5	715	69	32	410	1225	9.42	0.51
6	210	4	7	261	482	3.71	1.85
7	10	1	0	12	23	0.18	2.3
8	276	10	10	118	413	3.17	1.09
9	2867	142	102	3487	6598	50.75	3.03
10	741	16	73	2720	3550	27.3	5.12
11	0	0	0	0	0	0	0.94
12	55	0	4	9	69	0.53	4.85
13	110	0	0	54	164	1.26	8.54
TOTAL	5241	266	250	7245	13002	100	30
ESALS/LANE	40.3	2	1.9	55.7	100	--	--

Table 7 Site Summary: Volume and Vehicle Class

<i>Month</i>	<i>Total Volume</i>	<i>Monthly ADT</i>	<i>Monthly HCAD T</i>	<i>Passenger Vehicles</i>	<i>Passenger Vehicles %</i>	<i>Heavy Commercial Vehicles</i>	<i>Heavy Commercial Vehicles %</i>	<i>Heavy Commercial Vehicles in Driving Lane %</i>	<i>Heavy Commercial Vehicles in Passing Lane %</i>
Mar 2017	200186	6673	500	184674	92.3	15512.4	7.7	83.6	16.4
Jun 2017	303289	10110	767	280277	92.4	23012.5	7.6	76.9	23.1
Jul 2017	351544	11340	754	328181	93.4	23363.1	6.6	75.3	24.7
Aug 2017	350278	11299	800	325471	92.9	24806.8	7.1	75.2	24.8
Oct 2017	79225	7922	171	73909	93.3	5315.5	6.7	91.8	8.2
Nov 2017	214234	7141	488	199588	93.2	14646	6.8	92.7	7.3
Dec 2017	210731	6798	402	198277	94.1	12454.1	5.9	93.2	6.8
Jan 2018	203332	6559	416	190447	93.7	12885.2	6.3	94.4	5.6
Feb 2018	187768	6706	445	175321	93.4	12447.3	6.6	93.7	6.3
TOTAL	2100587	--	--	1956145	--	144443	--	--	--
AVERA GE	233399	8283	527	217349	93	16049	7	86	14

ESALS

<i>Month</i>	<i>ESALS NB Passing Lane</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>ESALS SB Passing Lane</i>	<i>Total ESALS</i>	<i>Driving Lane ESALS %</i>	<i>Passing Lane ESALS %</i>	<i>Pavement Life Decrease Months</i>
Mar 2017	3848	426	294	6820	11388	94	6	66.6
Jun 2017	5791	1165	571	5331	12860	86	14	18.6
Jul 2017	5657	1255	367	5539	12818	87	13	20.6
Aug 2017	6093	1231	310	5649	13284	88	12	24.6
Oct 2017	2404	157	213	1939	4714	92	8	40.8
Nov 2017	6711	379	332	6211	13634	95	5	53.5
Dec 2017	6031	297	262	4744	11333	95	5	62.1
Jan 2018	5226	297	153	5862	11538	96	4	70
Feb 2018	5255	266	317	7250	13089	96	4	91.1
TOTAL	47016	5474	2820	49347	104658	--	--	--
AVERAGE	5224	608	313	5483	11629	92	8	50

Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Passing Lane</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Passing Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Mar 2017	642847	77552	51867	631608	1403875
Jun 2017	612031	73787	60261	626261	1372339
Jul 2017	450117	64680	77822	609994	1202612
Aug 2017	668090	130691	158883	817641	1775306
Oct 2017	718725	157727	191477	889237	1957166
Nov 2017	735483	162845	184034	862884	1945246
Dec 2017	246018	34262	43177	241343	564799
Jan 2018	698717	96530	89621	663298	1548165
Feb 2018	675664	81599	69056	602852	1429172
TOTAL	5447691	879673	926199	5945118	13198680
AVERAGE	605299	97741	102911	660569	1466520

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	2106	1.2	15.8	914	463
Jun 2017	2304	0.9	11.6	613	205
Jul 2017	2347	0.8	11.7	723	221
Aug 2017	2449	0.8	11.7	820	268
Oct 2017	998	1.3	18.8	392	110
Nov 2017	2780	1.3	19	1289	398
Dec 2017	2132	1	17.2	1074	320
Jan 2018	2101	1.1	16.5	1071	390
Feb 2018	2416	1.3	19.6	1294	626
TOTAL	19633	--	--	8190	3001
AVERAGE	2181.4	1.1	15.8	910	333.4

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	39723	66250	105973	37.5	62.5
Jun 2017	64202	60259	124461	51.6	48.4
Jul 2017	63358	60634	123992	51.1	48.9
Aug 2017	67447	59958	127406	52.9	47.1
Oct 2017	25289	21734	47024	53.8	46.2
Nov 2017	65328	66591	131919	49.5	50.5
Dec 2017	55298	50890	106189	52.1	47.9
Jan 2018	49987	59879	109866	45.5	54.5
Feb 2018	48947	66785	115732	42.3	57.7
TOTAL	479579	512982	992561	--	--
AVERAGE	53286.6	56997.9	110284.5	48.5	51.5