

MARCH 2019



**WIM #49
I-90,
MP 42.6
WORTHINGTON,
MN**

**MONTHLY
REPORT**



Your Destination... Our Priority



WIM Site Location

WIM #49 is located on I-90 near Worthington in Nobles county.

System Operation

WIM #49 was operational for the entire month of March 2019. Volume was computed using all monthly data.

System Calibration

WIM #49 was most recently calibrated on 2019-01-24. 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: 275186 | Passenger Vehicles: 222175 | Heavy Commercial Vehicles: 53011

Monthly Average Daily Traffic (MADT): 8877 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 1710

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. EB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Tuesdays. WB vehicles typically reached highest volume levels on Fridays, 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), EB PVs generally reached peak volume levels between 02 PM and 04 PM. Similarly, WB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 02 PM and 04 PM, while volume going WB 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 53011 HCVs, 1382 of them were overweight ³. These overweight HCVs contributed to 0.5% of total monthly volume, and 2.7% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Mondays, with lowest volumes reported on Saturdays. WB overweight vehicles tended to reach highest volumes on Fridays, 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 62.4% of all overweight vehicles traveling EB 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 November.

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 ,385 EB vehicles exceeded 88,000 pounds (319 vehicles were Class 9's; 34 vehicles were Class 10's). Of vehicles traveling WB,

62 EB vehicles exceeded 88,000 pounds (24 vehicles were Class 13's; 23 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from March 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in March 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling EB, while there were more empty Class 9's than fully_loaded traveling WB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the EB direction. In the WB direction, there were more empty class 10 vehicles.

Freight Totals. A total of 440342 tons of freight was recorded to have crossed the WIM. More freight was shipped WB (52.2%) than EB (47.8%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations

Bridge. Bridge No. 53815 and 53816 (Prestressed Beam Span) are approximately .18 miles east of WIM #49. Bridge No. 53813 and 53814 (Prestressed Beam Span) are approximately .43 miles west of WIM #49. WIM #49 recorded a total of 275186 vehicles with a combined GVW of 3310885 kips (1 kip = 1,000 pounds = 0.5 tons) in March 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 33118 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 51.4% of all ESALs were recorded EB while 48.6% was observed WB. In particular, 88% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 62% 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).

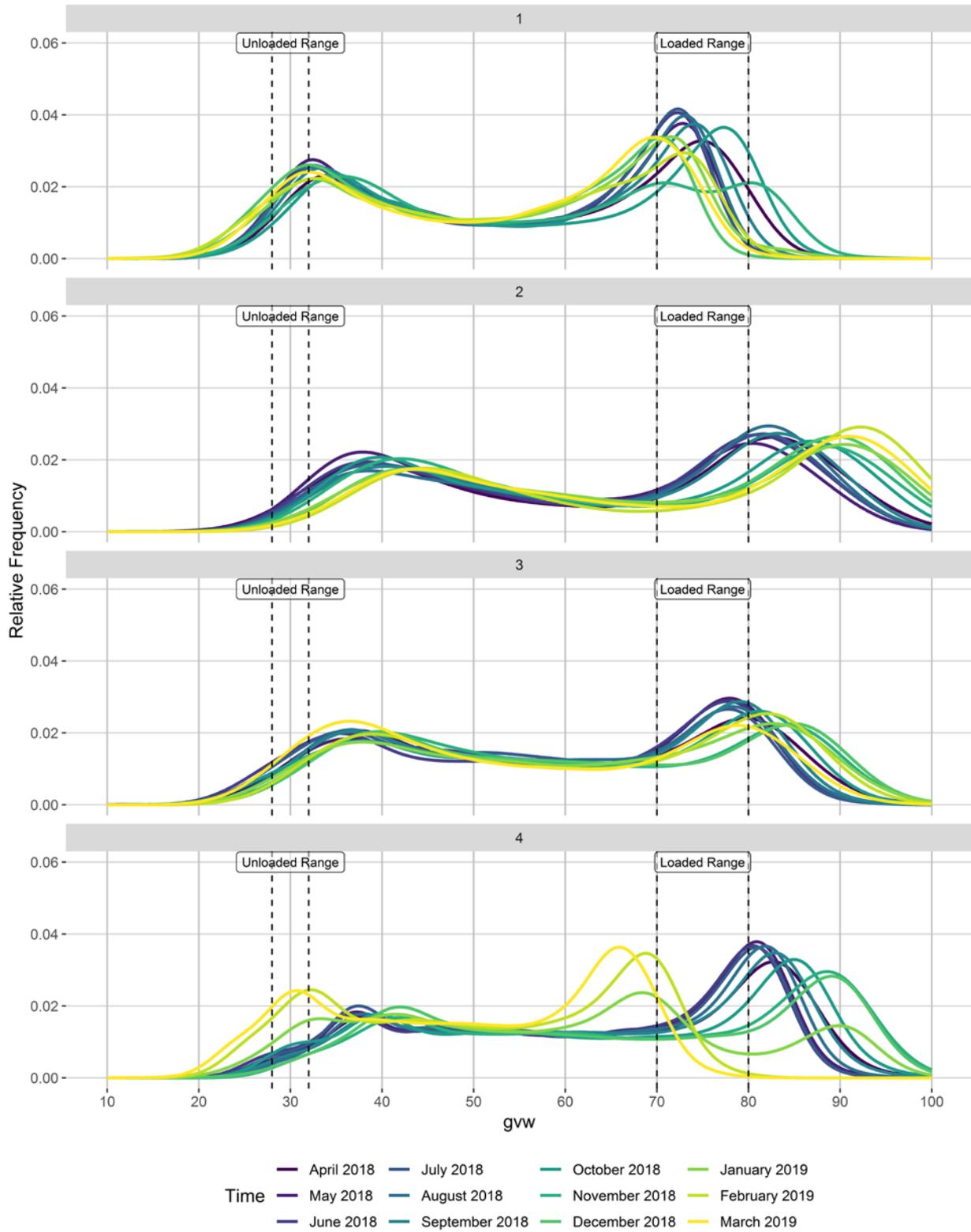
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

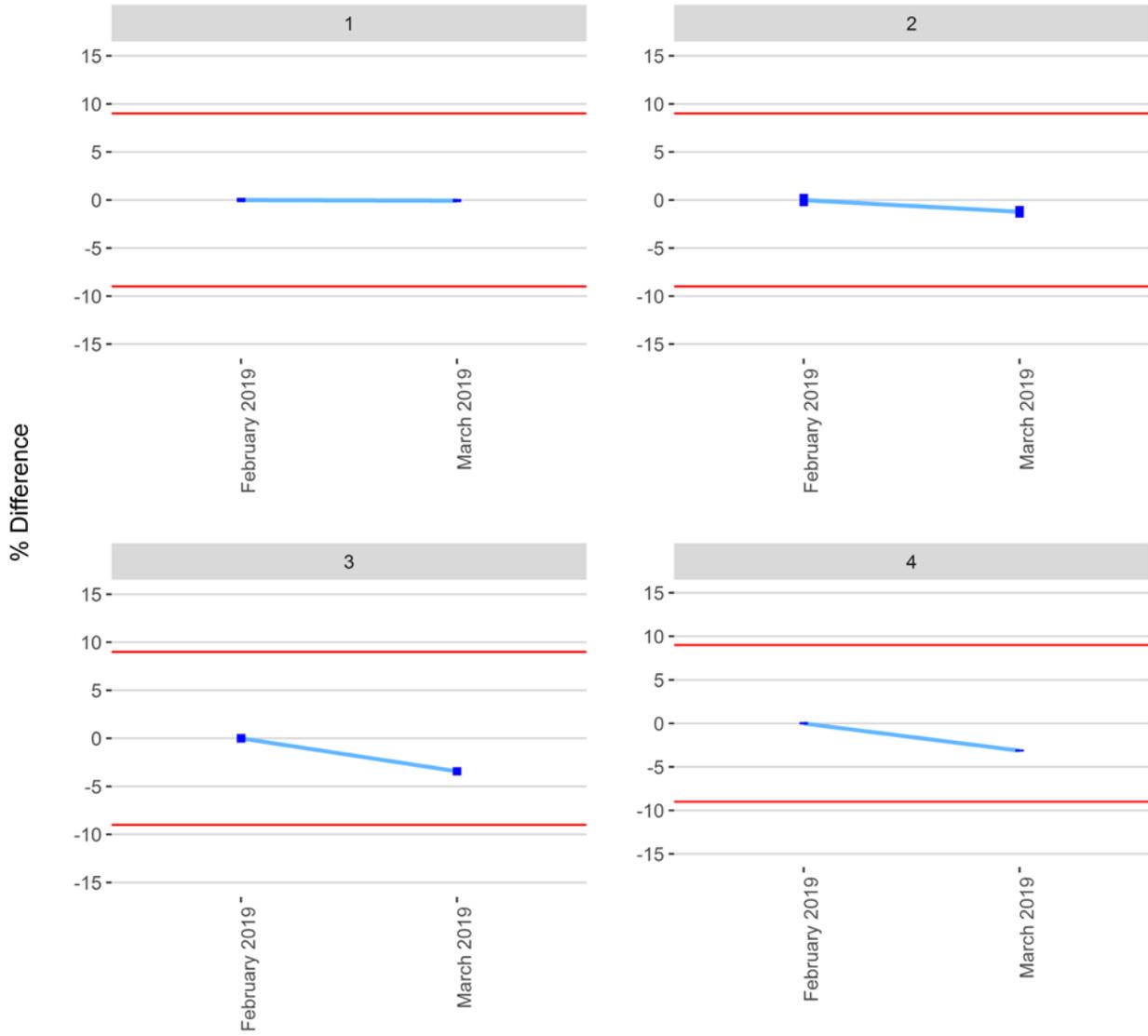
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

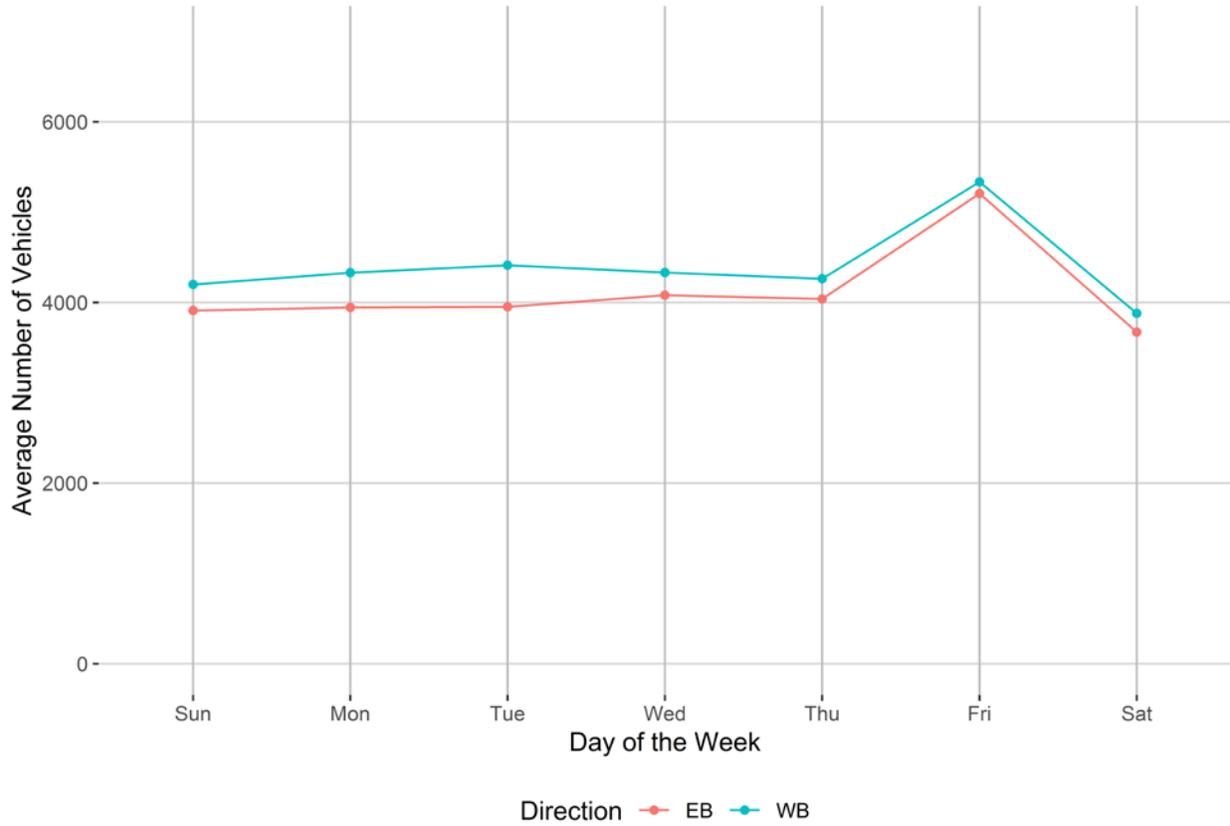


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

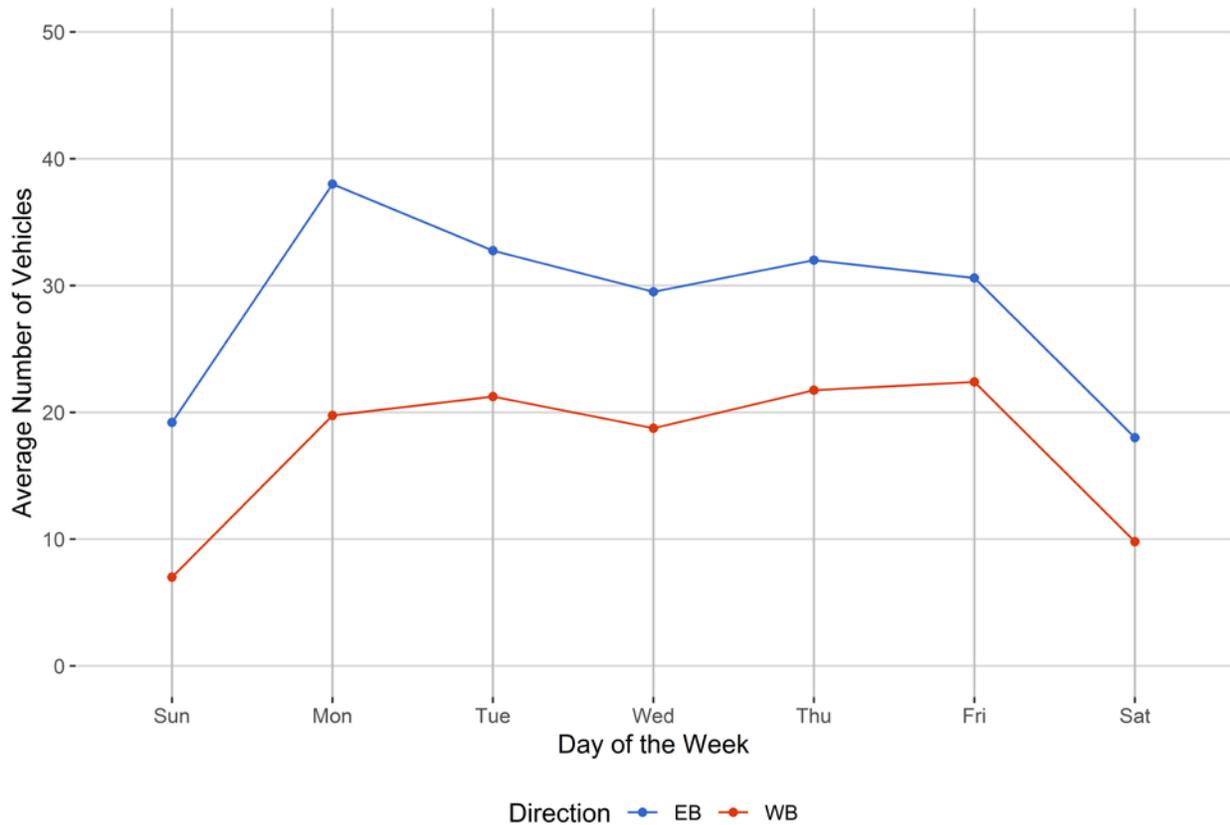


Figure 4 - Passenger Vehicles vs. Hour of the Day

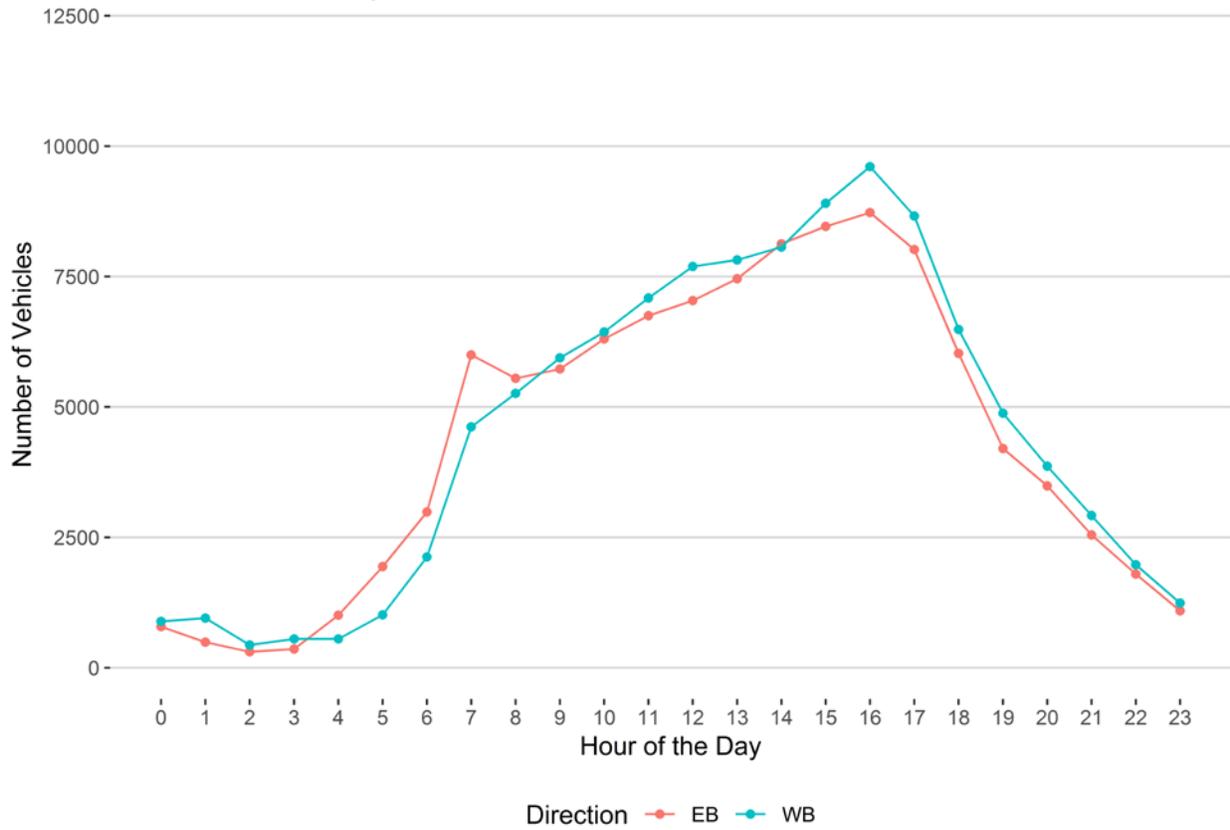


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

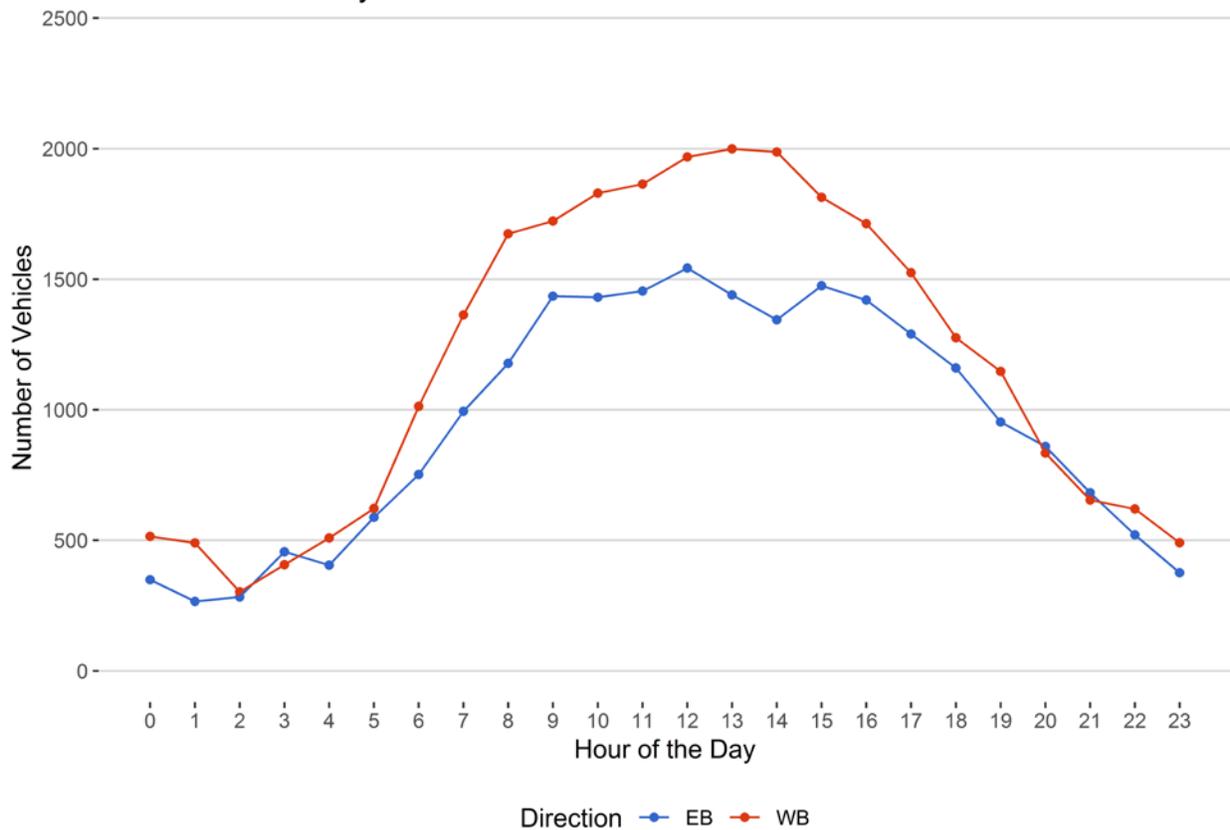


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

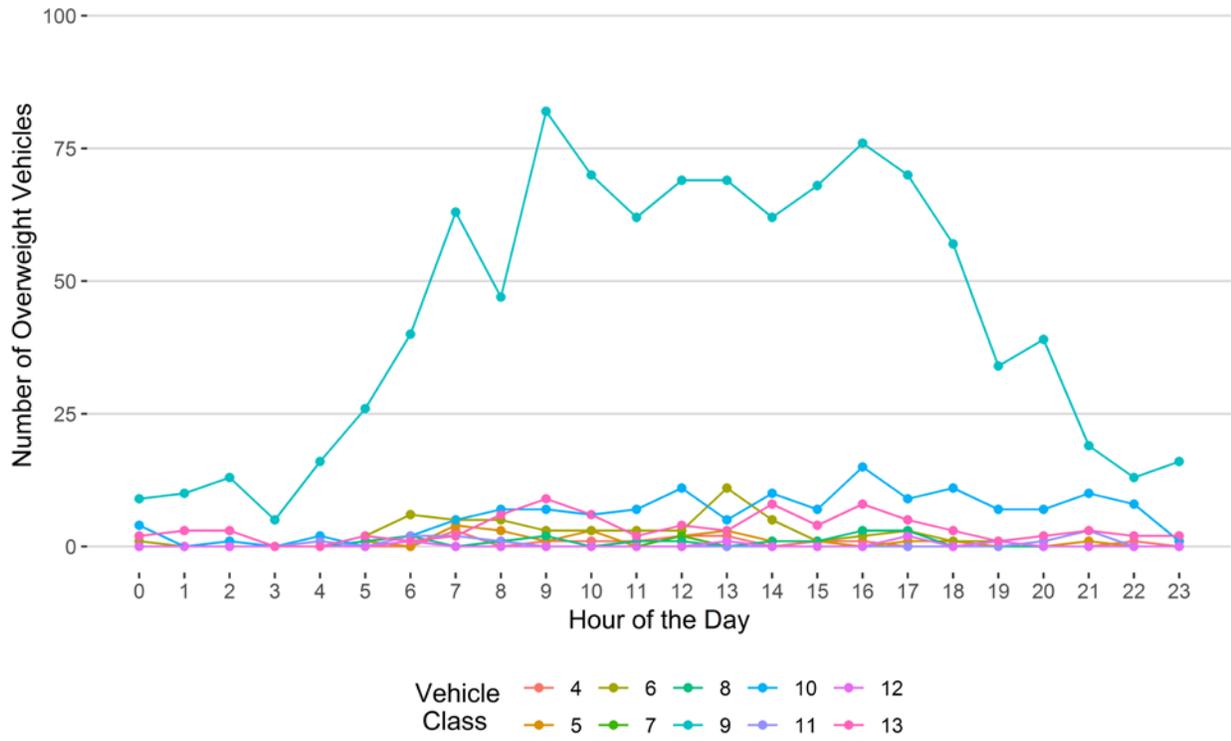


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

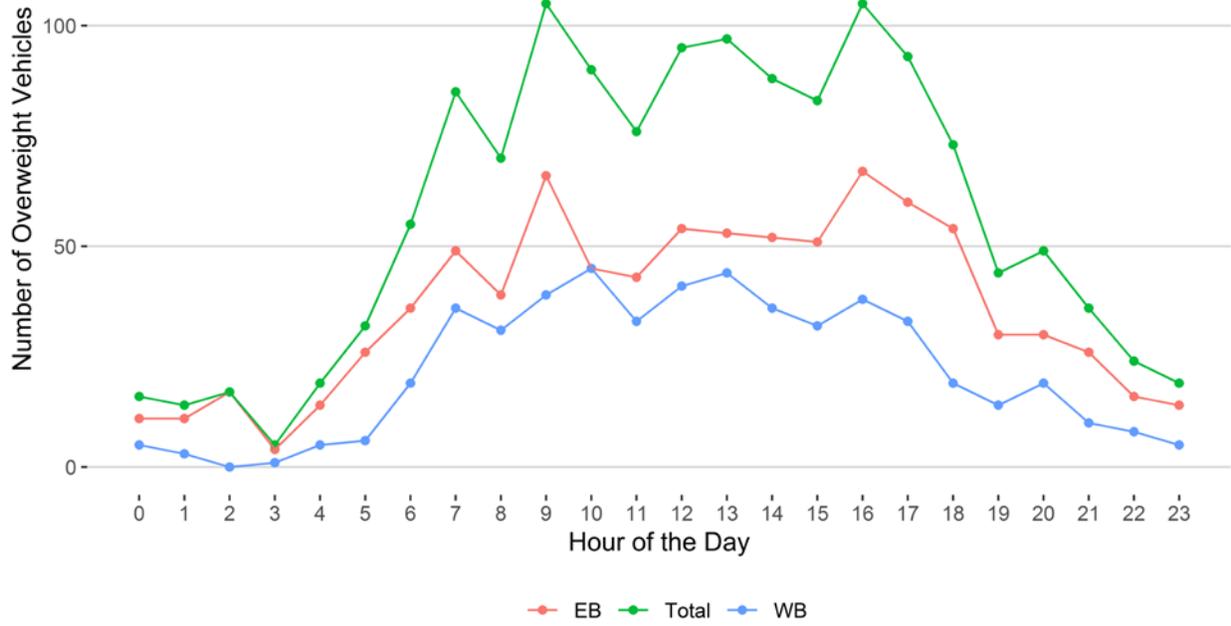
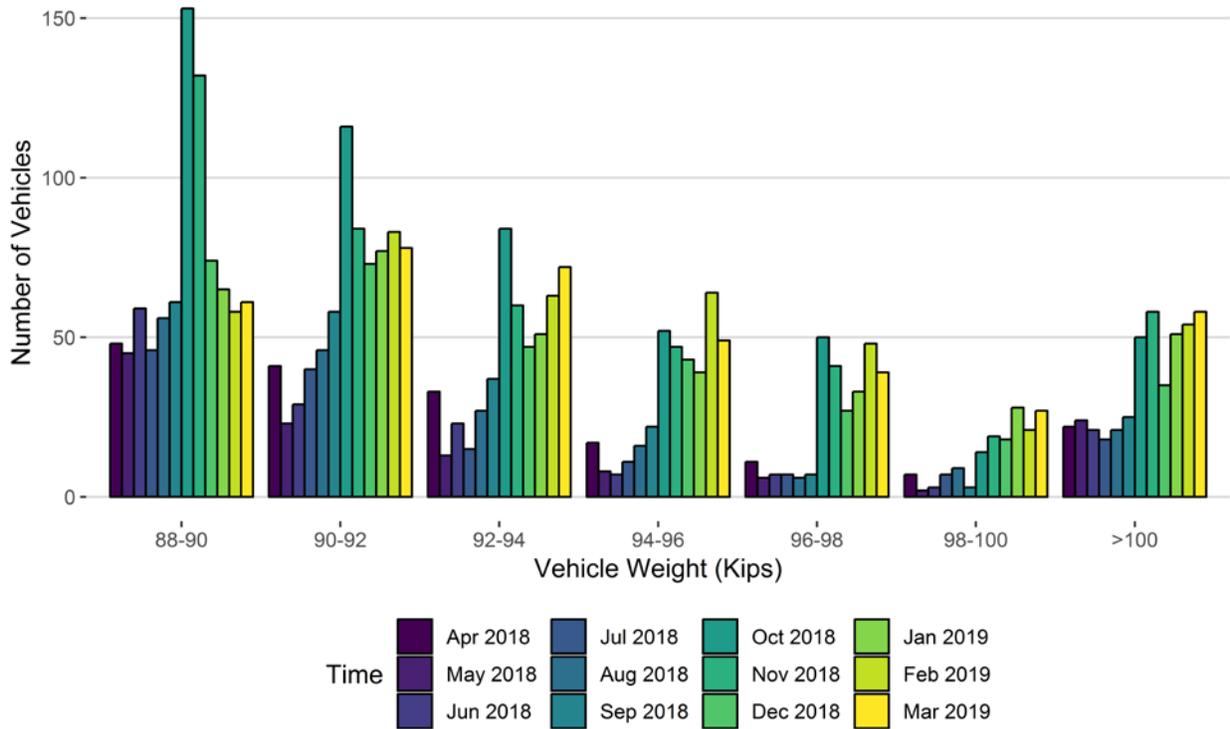
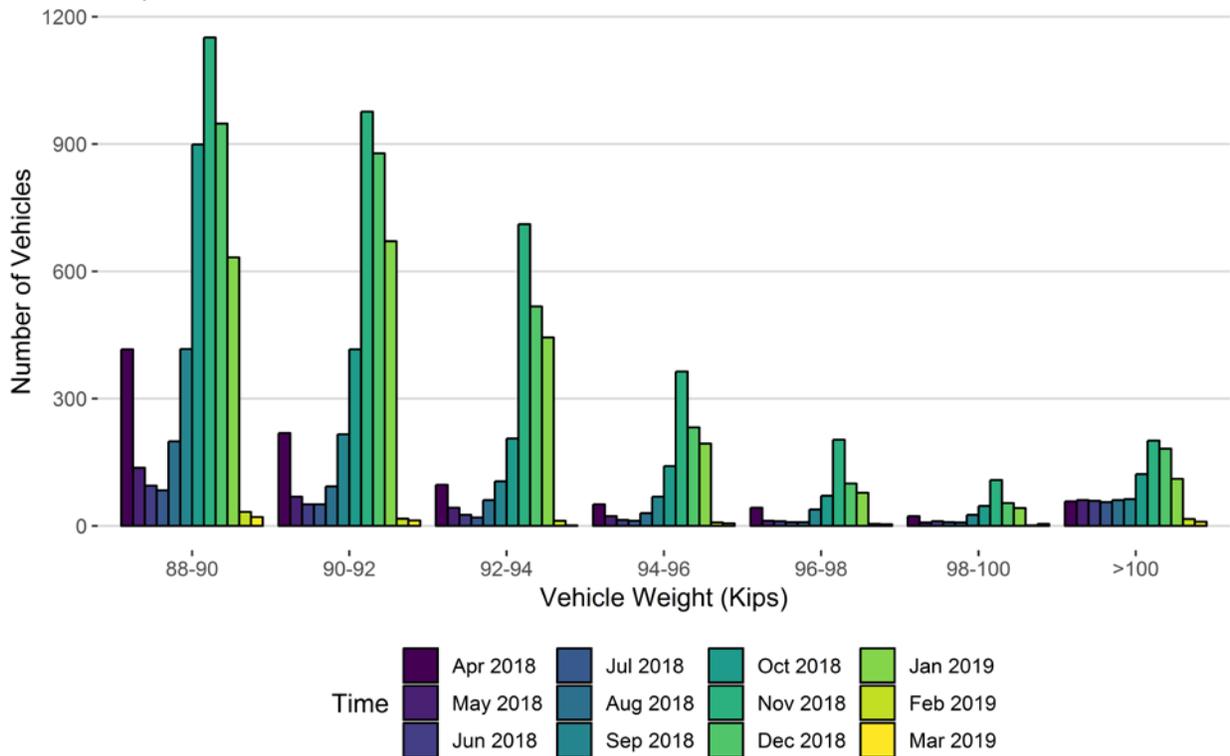


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019
88-90	48	45	59	46	56	61	153	132	74	65	58	61
90-92	41	23	29	40	46	58	116	84	73	77	83	78
92-94	33	13	23	15	27	37	84	60	47	51	63	72
94-96	17	8	7	11	16	22	52	47	43	39	64	49
96-98	11	6	7	7	6	7	50	41	27	33	48	39
98-100	7	2	3	7	9	3	14	19	18	28	21	27
>100	22	24	21	18	21	25	50	58	35	51	54	58
Total	179	121	149	144	181	213	519	441	317	344	391	384

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



Vehicle Weights (Kips)	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018	Sep 2018	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019
88-90	416	137	95	84	199	417	899	1151	948	633	33	21
90-92	219	69	51	51	93	216	416	976	878	671	17	13
92-94	97	43	26	20	61	105	206	711	517	444	12	1
94-96	51	23	14	12	30	69	141	364	232	194	8	6
96-98	43	12	11	9	9	39	71	203	100	78	5	4
98-100	23	8	11	9	8	26	47	108	54	42	1	5
>100	58	61	59	56	61	63	122	201	182	111	16	10
Total	907	353	267	241	461	935	1902	3714	2911	2173	92	60

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

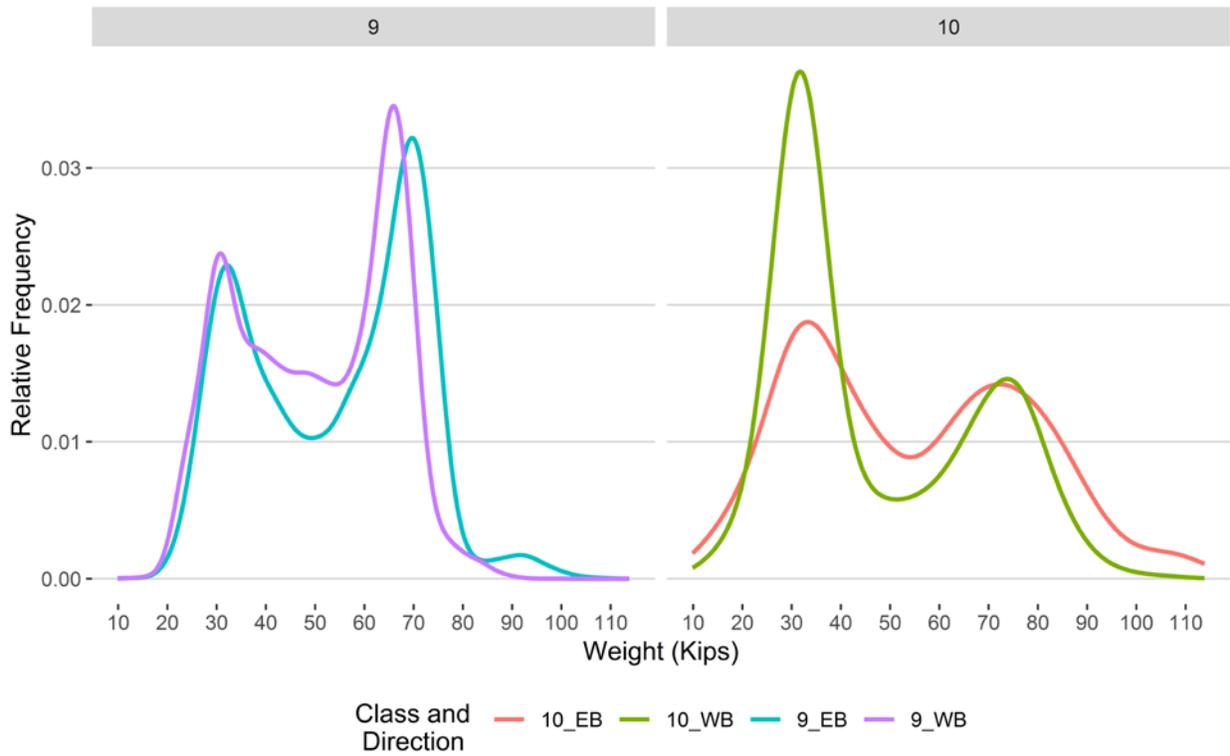


Figure 9 - Freight Percentage by Direction and Class

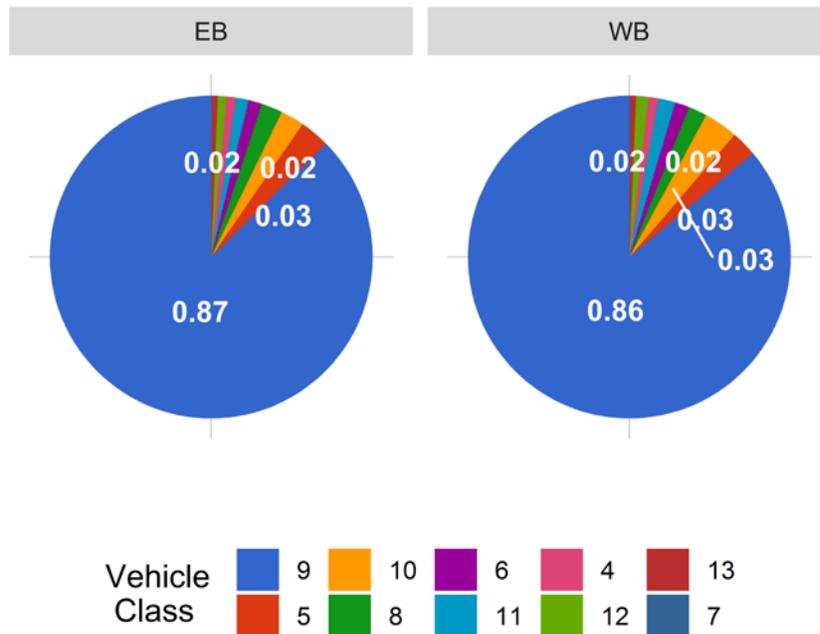


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

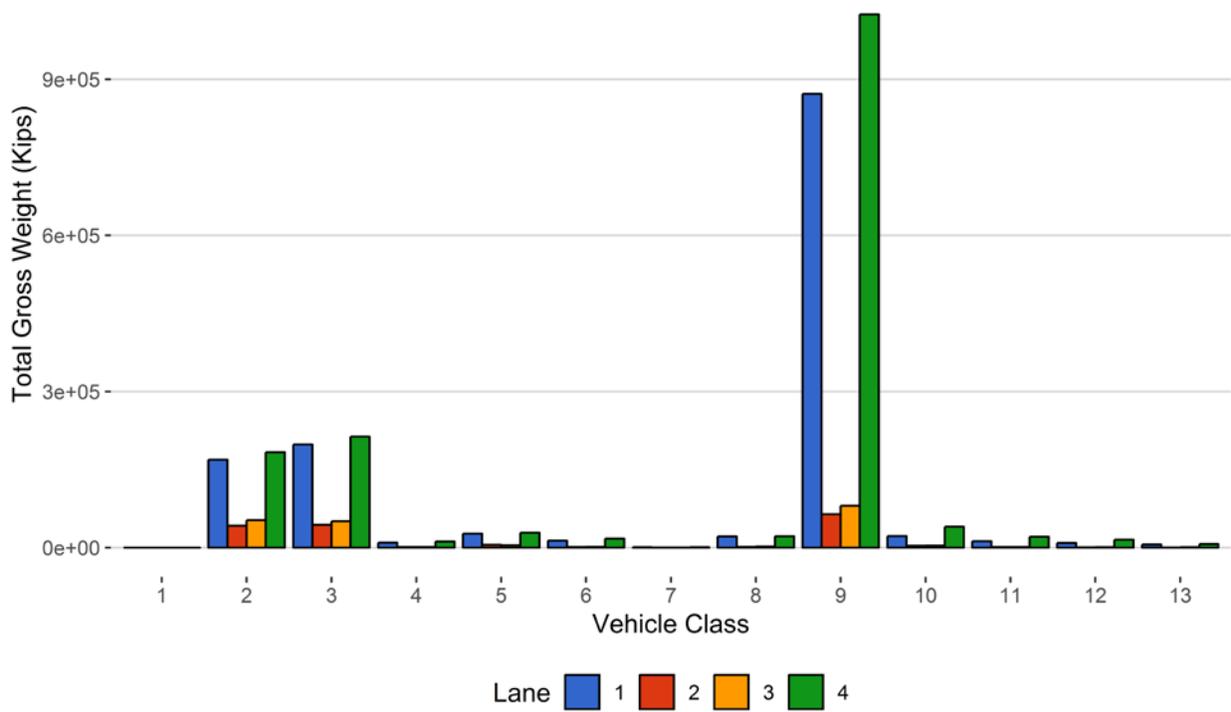


Figure 11 - Total Gross Vehicle Weight t

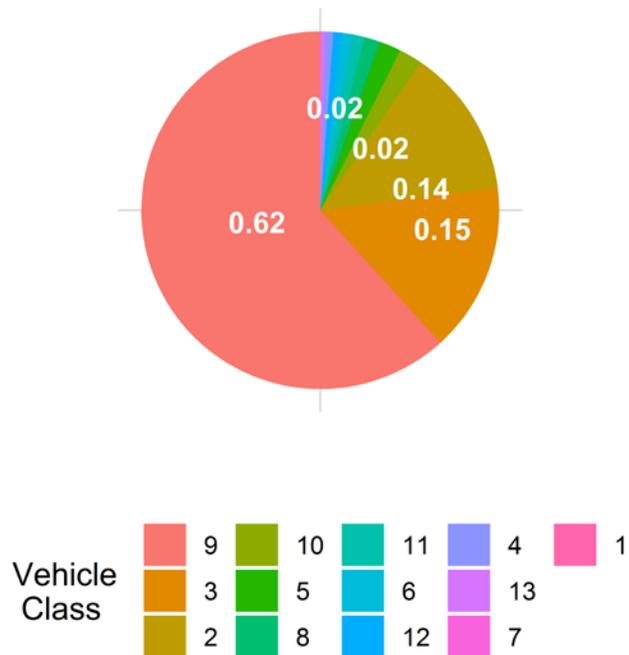


Figure 12 - Total ESALs by Class and Lane

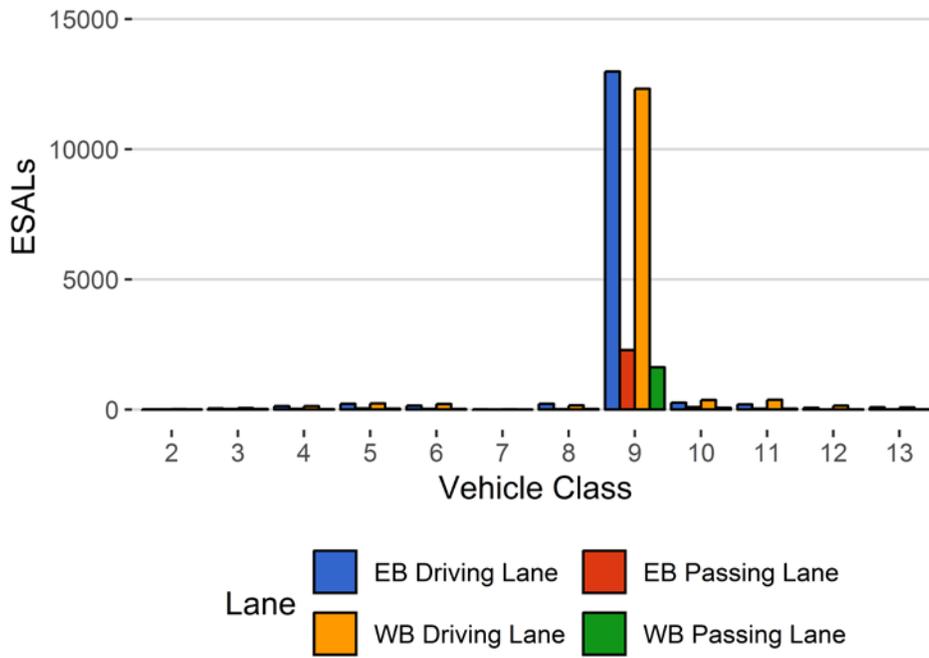


Figure 13 - ESALs by Class

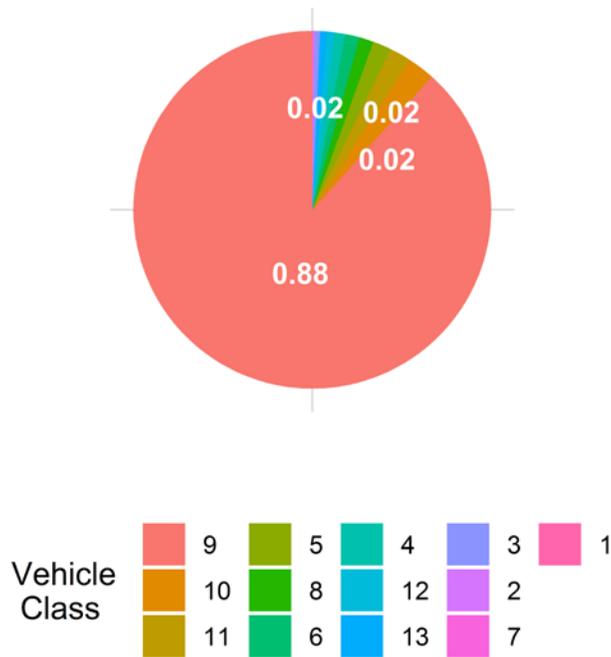


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 3 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 4 (kips)</i>	<i>Front Axle +/- 9%</i>
February 2019	9.78	0.00	13.14	0.00	12.28	0.00	9.93	0.00
March 2019	9.78	-0.06	12.98	-1.23	11.86	-3.43	9.62	-3.12

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	3	0	0	0
2	4156	128833	46.8	0	0
3	3011	93339	33.9	0	0
4	30	930	0.3	13	0.9
5	173	5372	2	22	1.6
6	44	1370	0.5	55	4
7	1	44	0	3	0.2
8	52	1622	0.6	16	1.2
9	1319	40882	14.9	1035	74.9
10	47	1452	0.5	142	10.3
11	22	678	0.2	10	0.7
12	16	483	0.2	5	0.4
13	6	178	0.1	81	5.9
TOTAL	8877	275186	100	1382	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>
2019-03-13	Wednesday	21:05:49	10	EB	2	120.82
2019-03-19	Tuesday	11:17:55	10	EB	2	113.84
2019-03-14	Thursday	19:57:15	9	EB	2	113.42
2019-03-03	Sunday	18:05:09	9	EB	2	112.4
2019-03-06	Wednesday	20:37:10	9	EB	2	111.4
2019-03-06	Wednesday	14:17:51	9	WB	3	111.1
2019-03-15	Friday	19:55:29	10	WB	4	110.13
2019-03-07	Thursday	17:40:39	9	EB	2	109.98
2019-03-07	Thursday	12:41:41	9	EB	2	109.97
2019-03-22	Friday	22:13:45	10	EB	2	109.89

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	EB	15	385	73	19	9461	903	2390
5	EB	8	2584	703	27.2	27325	4847	6139
6	EB	19	588	233	39.6	10880	3736	2067
7	EB	11.5	18	0	0	844	0	318
8	EB	31	737	387	52.5	13189	9463	1169
9	EB	33	17353	3043	17.5	848165	87954	187968
10	EB	33.5	466	121	26	22133	3300	5288
11	EB	36.5	266	56	21.1	11468	1793	1902
12	EB	36.5	188	16	8.5	8860	543	1291
13	EB	31.5	72	1	1.4	6024	31	1894
TOTAL	****	****	22657	4633	****	958348	****	210425
<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	WB	15	510	146	28.6	10656	1840	2598
5	WB	8	2584	668	25.9	28083	4708	6378
6	WB	19	730	318	43.6	13231	5298	2702
7	WB	11.5	24	1	4.2	1010	11	373
8	WB	31	823	507	61.6	11692	12199	948
9	WB	33	21977	4499	20.5	978051	127276	200639
10	WB	33.5	931	398	42.7	32225	11679	7185
11	WB	36.5	386	5	1.3	21688	143	3891
12	WB	36.5	277	2	0.7	16016	47	2989
13	WB	31.5	99	3	3	7454	85	2215
TOTAL	****	****	28341	6547	****	1120108	****	229917
GRAND TOTAL	****	****	50998	11180	445	2078456	275855	440342

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>EB Driving Lane</i>	<i>EB Passing Lane</i>	<i>WB Passing Lane</i>	<i>WB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>
1	2	0	0	2	4	0
2	168968	42112	52627	183061	446767	13.5
3	198180	43768	50650	213387	505984	15.3
4	9341	1023	986	11510	22860	0.7
5	26827	5345	4321	28470	64963	2
6	13415	1200	1379	17151	33146	1
7	695	149	171	850	1866	0.1
8	21257	1394	2092	21798	46542	1.4
9	872102	64016	80401	1024926	2041446	61.7
10	22005	3427	3875	40030	69336	2.1
11	12245	1015	1018	20813	35091	1.1
12	8951	452	817	15246	25466	0.8
13	5808	246	650	6889	13594	0.4
TOTAL	1359798	164148	198988	1584132	3307066	100
GVW/LANE	41.12	4.96	6.02	47.9	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>EB Driving Lane</i>	<i>EB Passing Lane</i>	<i>WB Passing Lane</i>	<i>WB Driving Lane</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0	0	0.25
2	12	8	8	18	46	0.14	8e-04
3	47	25	22	62	155	0.47	0.0035
4	136	30	15	133	314	0.95	0.7
5	220	50	40	240	550	1.66	0.21
6	148	34	24	214	420	1.27	0.64
7	11	5	4	11	31	0.09	1.39
8	221	19	26	168	434	1.31	0.56
9	12983	2286	1626	12324	29219	88.36	1.49
10	266	102	71	374	813	2.46	1.17
11	198	38	39	374	650	1.97	1.98
12	70	6	14	150	241	0.73	1.04
13	94	9	12	81	197	0.59	2.21
TOTAL	14407	2612	1901	14150	33069	100	12
ESALS/LANE	43.6	7.9	5.7	42.8	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>
Apr 2018	267156	8905	1586	219578	82.2	47578.5	17.8	92.6	7.4
May 2018	358888	11577	1879	300637	83.8	58251.1	16.2	92.1	7.9
Jun 2018	403413	13447	1991	343676	85.2	59737.3	14.8	91.1	8.9
Jul 2018	433111	13971	2018	370548	85.6	62563	14.4	91.2	8.8
Aug 2018	437569	14115	2112	372092	85	65476.8	15	90.9	9.1
Sep 2018	366152	12205	1991	306435	83.7	59717.1	16.3	91.6	8.4
Oct 2018	343352	11076	1957	282691	82.3	60660.8	17.7	90.5	9.5
Nov 2018	304874	10162	1707	253655	83.2	51219.4	16.8	92	8
Dec 2018	249836	8615	1330	208619	83.5	41216.7	16.5	91.7	8.3
Jan 2019	237632	7666	1585	188493	79.3	49138.8	20.7	93.6	6.4
Feb 2019	203760	7277	1529	160956	79	42803.6	21	92.4	7.6
Mar 2019	275186	8877	1710	222175	80.7	53010.7	19.3	93.1	6.9
TOTAL	3880929	-	-	3229555	-	651374	-	-	-
AVERAGE	323411	10658	1783	269130	83	54281	17	92	8

ESALS

<i>Month</i>	<i>ESALS EB Passing Lane</i>	<i>ESALS EB Driving Lane</i>	<i>ESALS WB Driving Lane</i>	<i>ESALS WB Passing Lane</i>	<i>Total ESALS</i>	<i>Driving Lane ESALS %</i>	<i>Passing Lane ESALS %</i>	<i>Pavement Life Decrease Months</i>
Apr 2018	17863	1980	1824	29657	51324	93	7	12.1
May 2018	18187	2207	2067	32166	54627	92	8	4.4
Jun 2018	18041	2590	2413	31030	54075	91	9	3.1
Jul 2018	18401	3035	2196	32322	55954	91	9	2.8
Aug 2018	20552	3197	2709	34960	61418	90	10	4.9
Sep 2018	19972	2728	2340	36203	61243	92	8	10.4
Oct 2018	23230	4308	2613	40888	71039	90	10	19.1
Nov 2018	20520	2451	2346	36773	62090	92	8	45.4
Dec 2018	12572	2548	2315	27559	44994	89	11	44.8
Jan 2019	15427	2515	2039	26307	46288	90	10	35.2
Feb 2019	11829	3709	2133	13009	30680	81	19	0.4
Mar 2019	14419	2617	1904	14178	33118	86	14	0.5
TOTAL	211014	33884	26900	355053	626850	-	-	-
AVERAGE	17584	2824	2242	29588	52238	90	10	15

Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Passing Lane</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Apr 18	1378927	161549	190965	1679683	3411124
May 18	1667286	222811	267585	2071628	4229309
Jun 18	1730907	271875	339657	2137868	4480307
Jul 18	1788923	325935	348429	2277404	4740692
Aug 18	1915875	339615	366948	2302915	4925352
Sep 18	1720129	252992	288908	2083638	4345667
Oct 18	1717957	290836	276910	2210236	4495940
Nov 18	1554196	195512	237763	1815173	3802644
Dec 18	1297542	166610	203153	1450218	3117523
Jan 19	1318897	132672	166003	1612384	3229956
Feb 19	1052899	129123	157838	1259469	2599329
Mar 19	1361595	164259	199086	1585945	3310885
TOTAL	18505132	2653789	3043245	22486561	46688727
AVERAGE	1542094	221149	253604	1873880	3890727

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>
Apr 2018	8708	3.4	19.2	1087	111
May 2018	7621	2.2	13.4	479	99
Jun 2018	7233	1.8	12.4	417	95
Jul 2018	7532	1.8	12.3	389	93
Aug 2018	8919	2.1	14	647	103
Sep 2018	9527	2.7	16.7	1171	119
Oct 2018	13380	4.1	22.9	2426	234
Nov 2018	11759	4.1	24.3	4157	387
Dec 2018	6713	2.7	16.2	3230	289
Jan 2019	5490	2.4	11.7	2523	234
Feb 2019	1777	0.9	4.4	487	93
Mar 2019	1390	0.5	2.7	447	100
TOTAL	90049	-	-	17460	1957
AVERAGE	7504.1	2.4	14.2	1455	163.1

Freight

<i>Month</i>	<i>EB Freight Tons</i>	<i>WB Freight Tons</i>	<i>Total Freight</i>	<i>EB Freight %</i>	<i>WB Freight %</i>
Apr 2018	223199	309322	532521	41.9	58.1
May 2018	246347	360108	606455	40.6	59.4
Jun 2018	249273	351320	600593	41.5	58.5
Jul 2018	258038	359867	617905	41.8	58.2
Aug 2018	280790	385307	666097	42.2	57.8
Sep 2018	263585	371797	635381	41.5	58.5
Oct 2018	295906	409353	705259	42	58
Nov 2018	249601	342900	592501	42.1	57.9
Dec 2018	189465	263947	453412	41.8	58.2
Jan 2019	214358	285394	499753	42.9	57.1
Feb 2019	169293	197643	366936	46.1	53.9
Mar 2019	210425	229917	440342	47.8	52.2
TOTAL	2850280	3866874	6717154	-	-
AVERAGE	237523.3	322239.5	559762.9	42.7	57.3