

APRIL 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 April 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: 290206 | Passenger Vehicles: 237070 | Heavy Commercial Vehicles: 53136

Monthly Average Daily Traffic (MADT): 9674 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 1771

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 Sundays, with lowest volumes reported on Wednesdays. WB vehicles typically reached highest volume levels on Sundays, with lowest volumes reported on Wednesdays (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 53136 HCVs, 953 of them were overweight ³. These overweight HCVs contributed to 0.3% of total monthly volume, and 1.9% 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 13 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 65.6% 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 ,279 EB vehicles exceeded 88,000 pounds (238 vehicles were Class 9's; 22 vehicles were Class 10's). Of vehicles traveling WB,

27 EB vehicles exceeded 88,000 pounds (20 vehicles were Class 13's; 5 vehicles were Class 9'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 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 407776 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 290206 vehicles with a combined GVW of 3274517 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 30096 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 53.2% of all ESALs were recorded EB while 46.8% was observed WB. In particular, 85% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 60% 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).

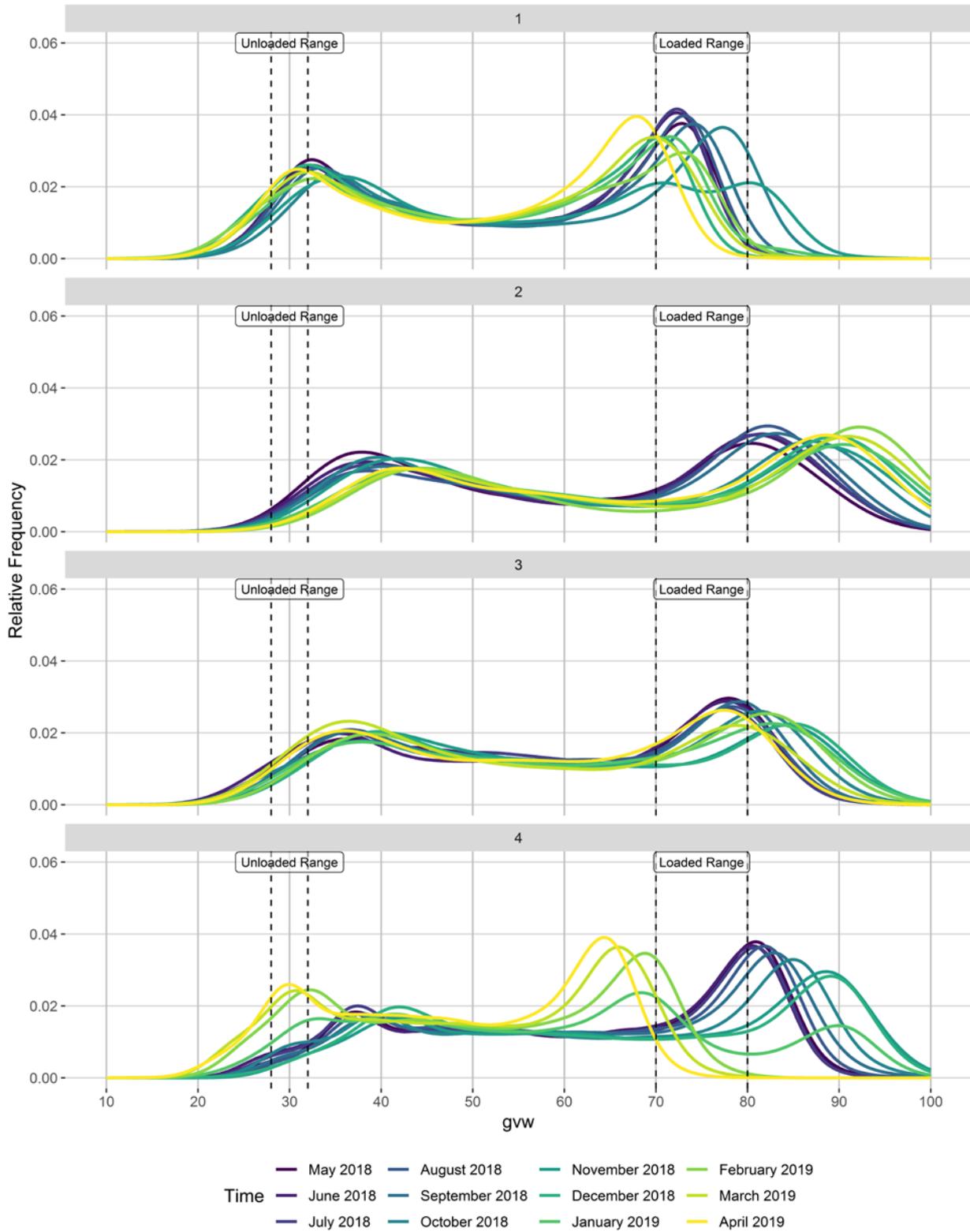
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

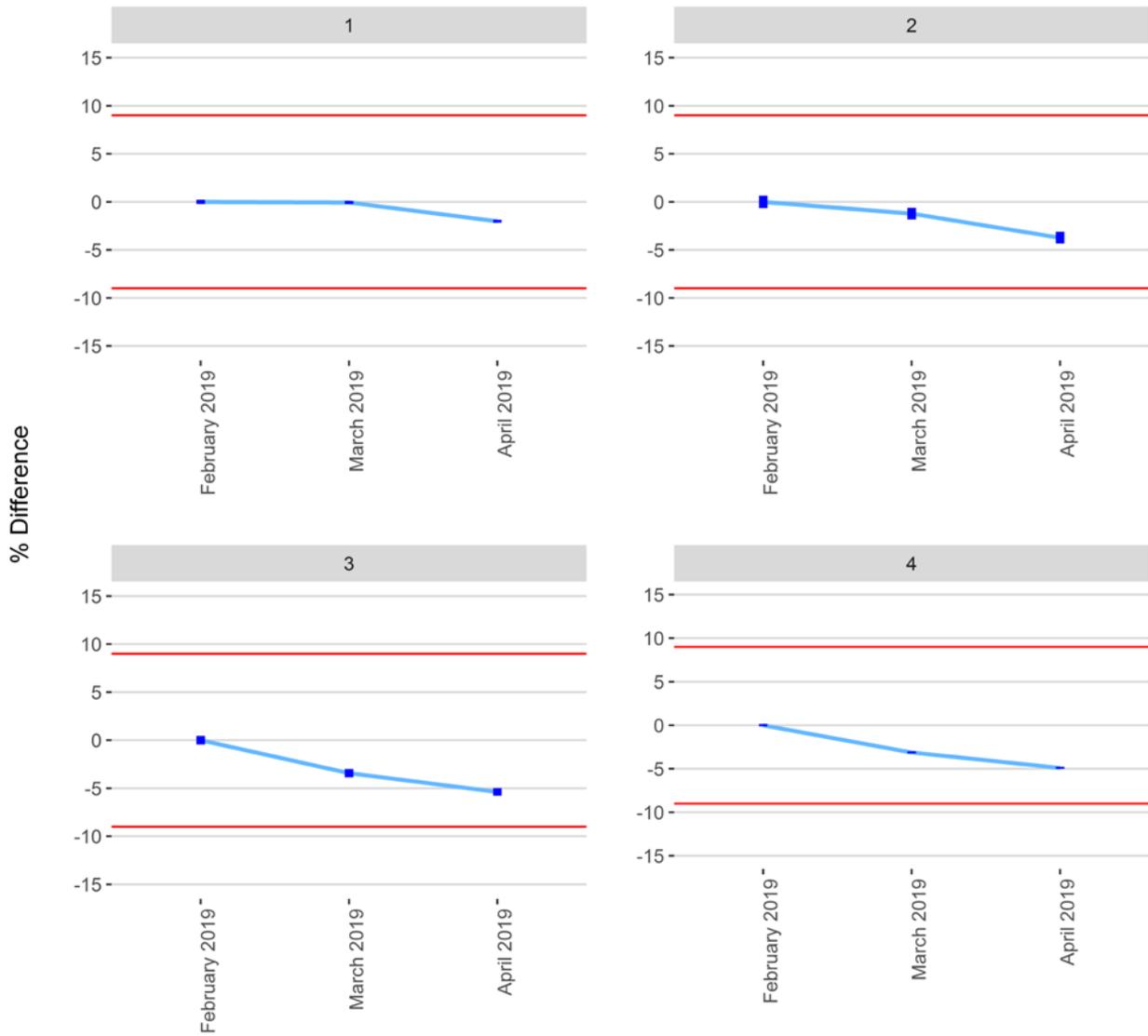
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

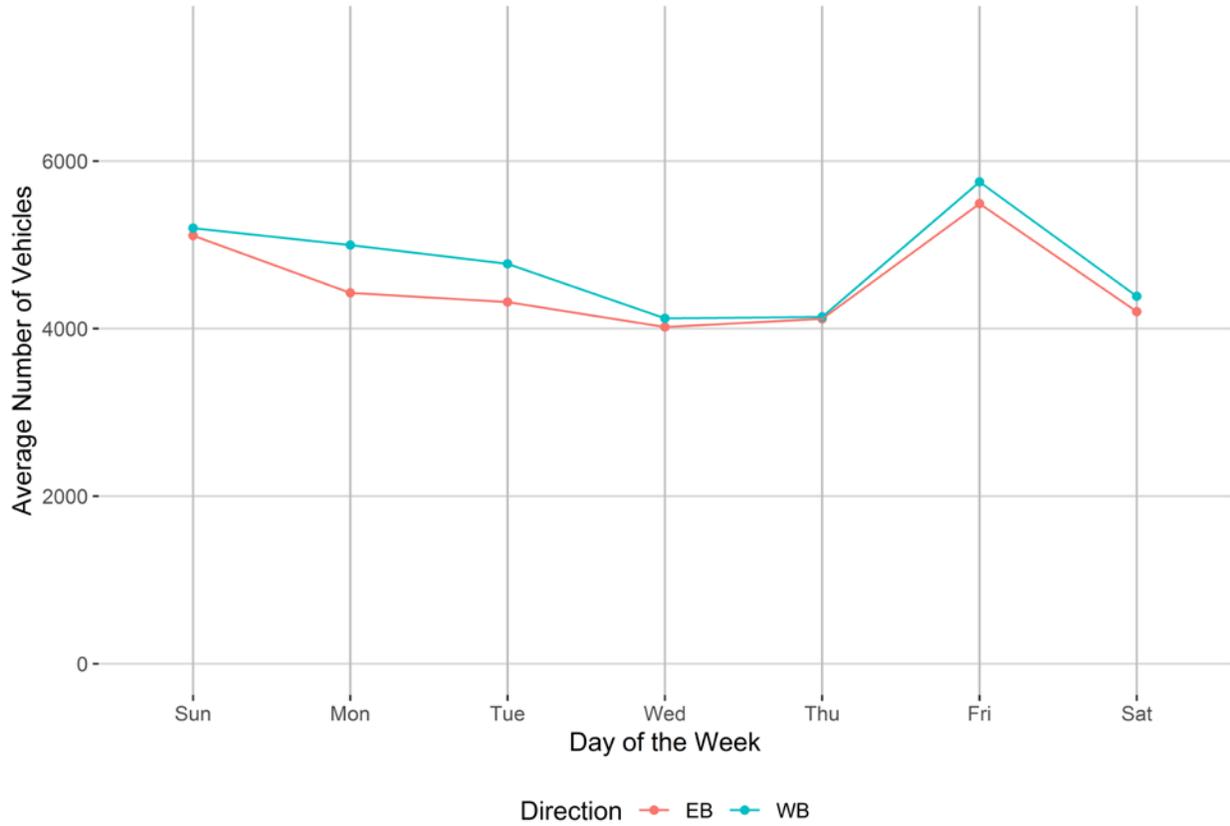


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

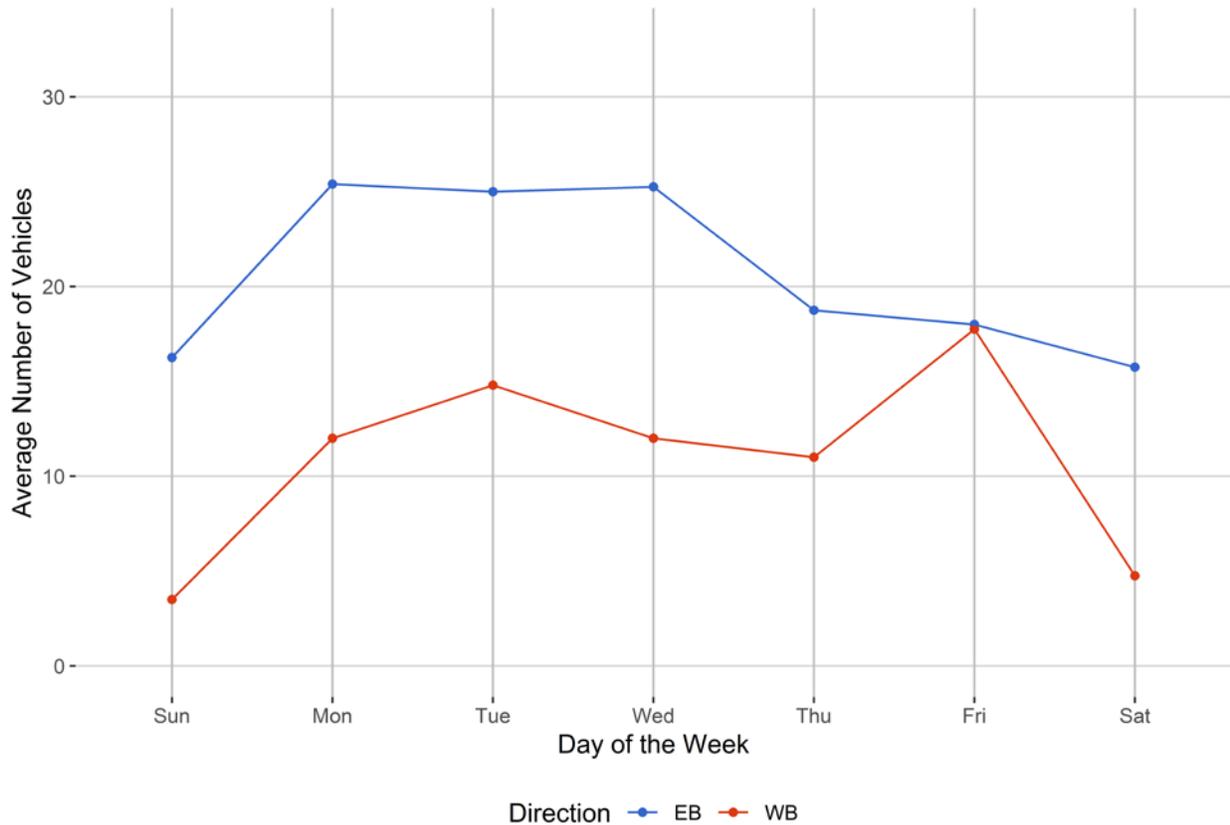


Figure 4 - Passenger Vehicles vs. Hour of the Day

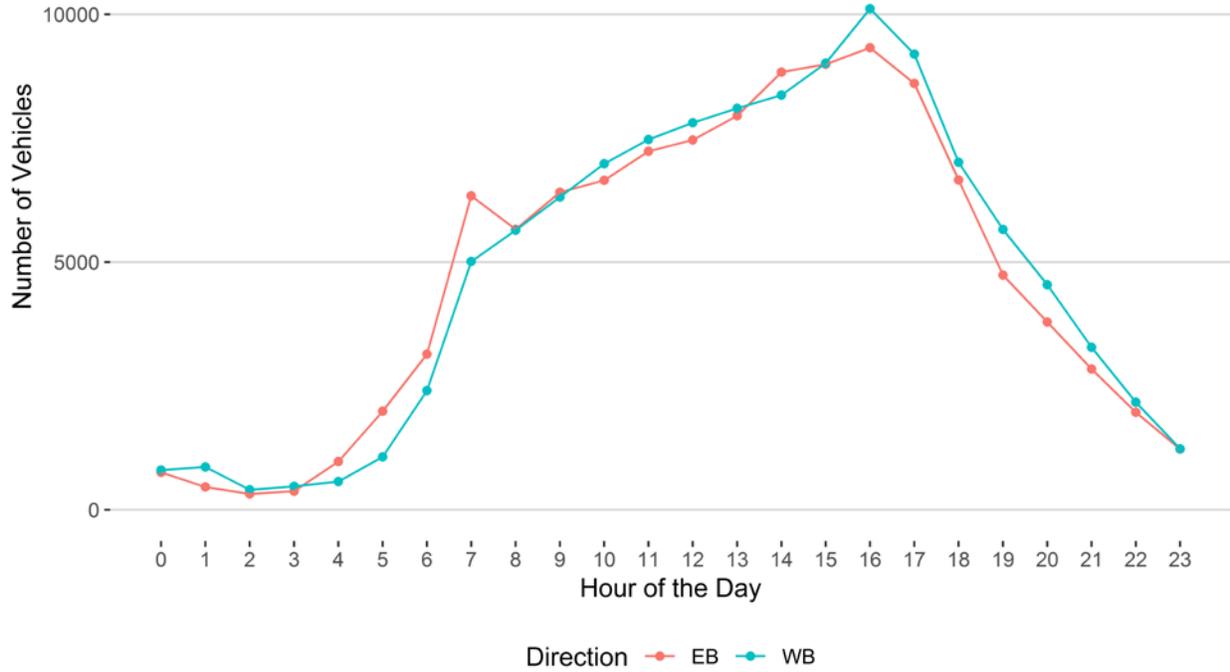


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

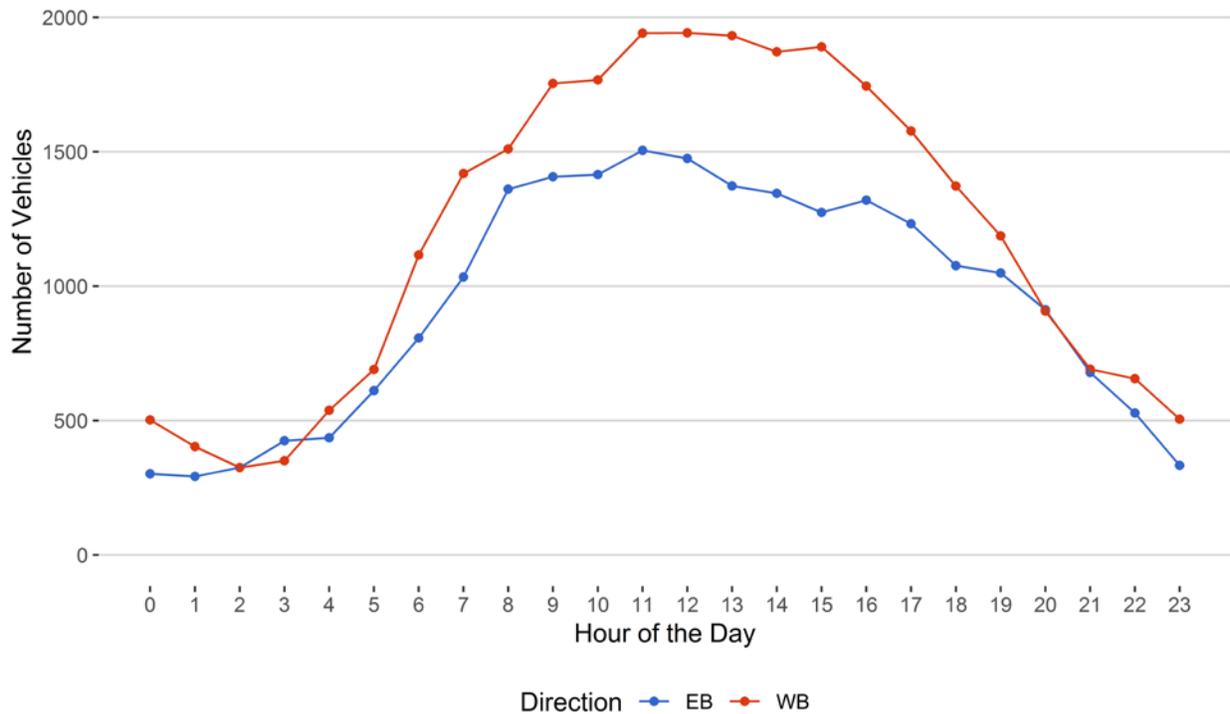


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

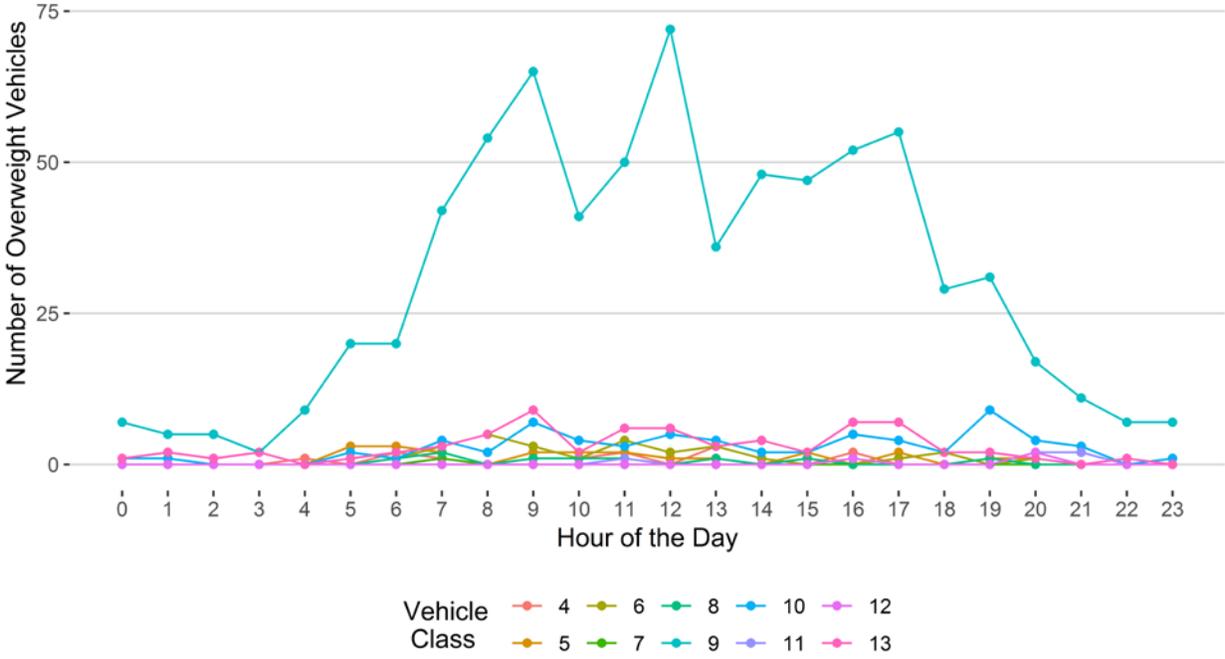


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

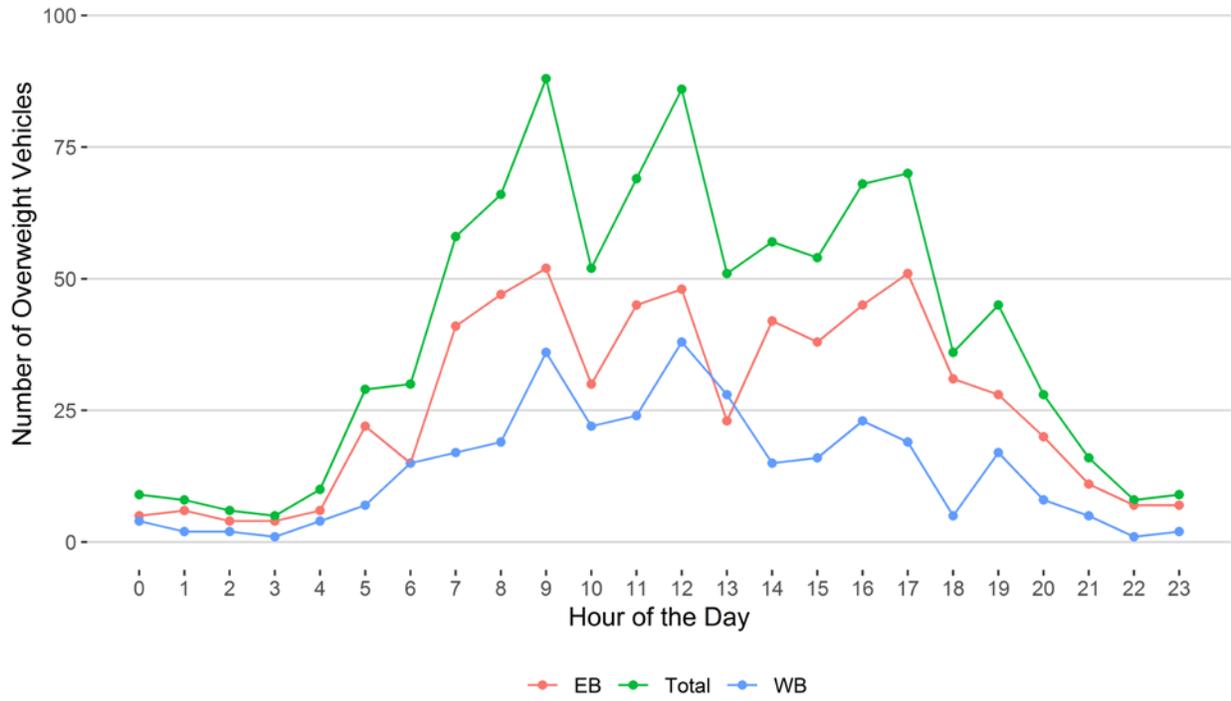
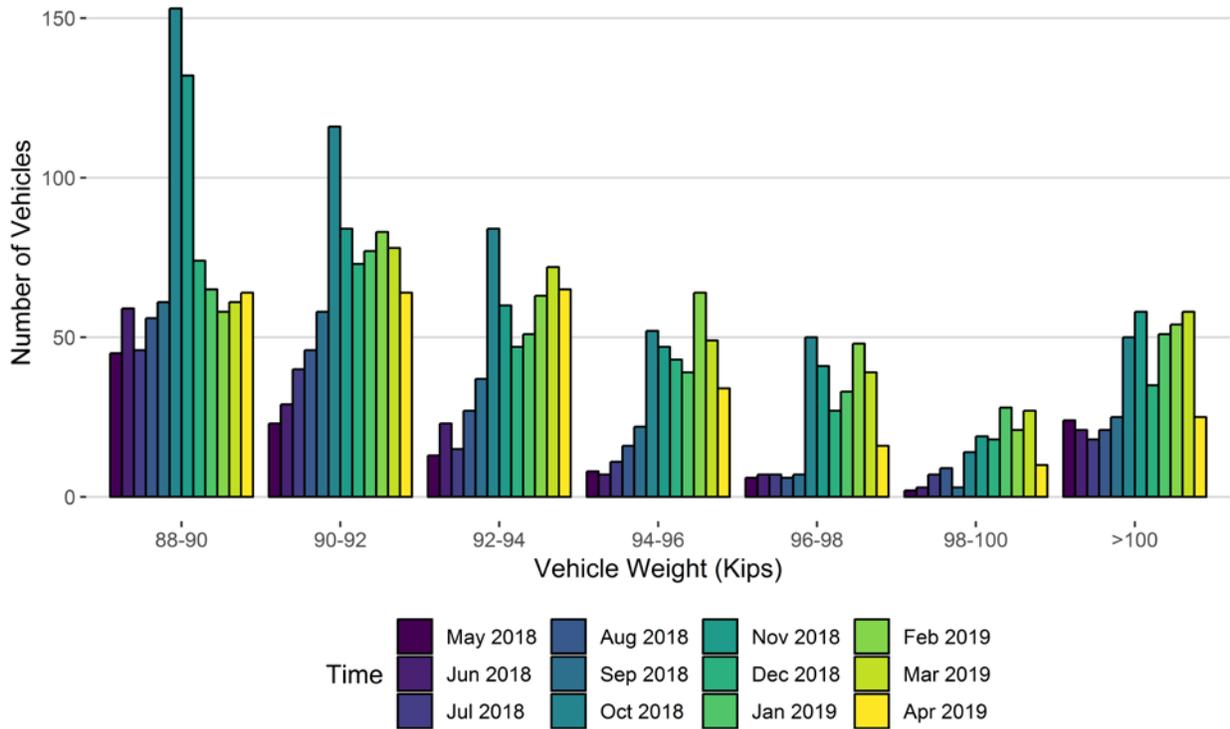
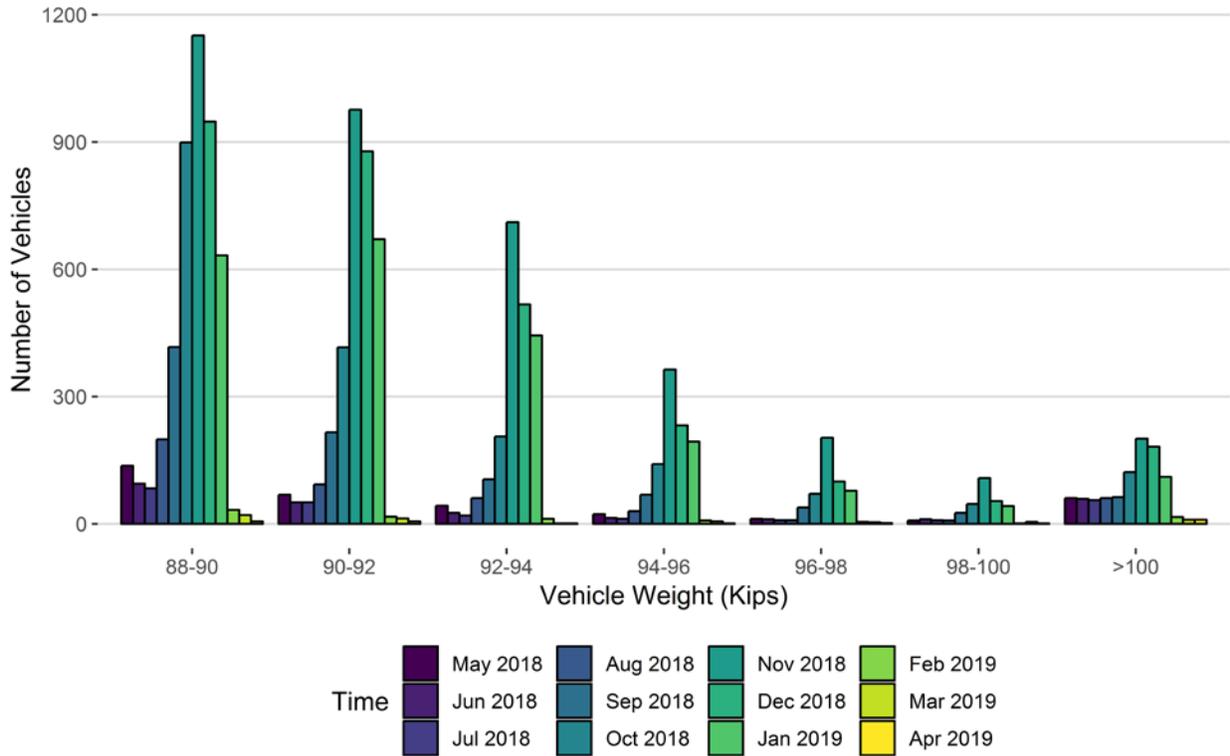


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	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	45	59	46	56	61	153	132	74	65	58	61	64
90-92	23	29	40	46	58	116	84	73	77	83	78	64
92-94	13	23	15	27	37	84	60	47	51	63	72	65
94-96	8	7	11	16	22	52	47	43	39	64	49	34
96-98	6	7	7	6	7	50	41	27	33	48	39	16
98-100	2	3	7	9	3	14	19	18	28	21	27	10
>100	24	21	18	21	25	50	58	35	51	54	58	25
Total	121	149	144	181	213	519	441	317	344	391	384	278

Figure 8 - Histogram of WB 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	137	95	84	199	417	899	1151	948	633	33	21	6
90-92	69	51	51	93	216	416	976	878	671	17	13	6
92-94	43	26	20	61	105	206	711	517	444	12	1	1
94-96	23	14	12	30	69	141	364	232	194	8	6	1
96-98	12	11	9	9	39	71	203	100	78	5	4	2
98-100	8	11	9	8	26	47	108	54	42	1	5	1
>100	61	59	56	61	63	122	201	182	111	16	10	10
Total	353	267	241	461	935	1902	3714	2911	2173	92	60	27

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

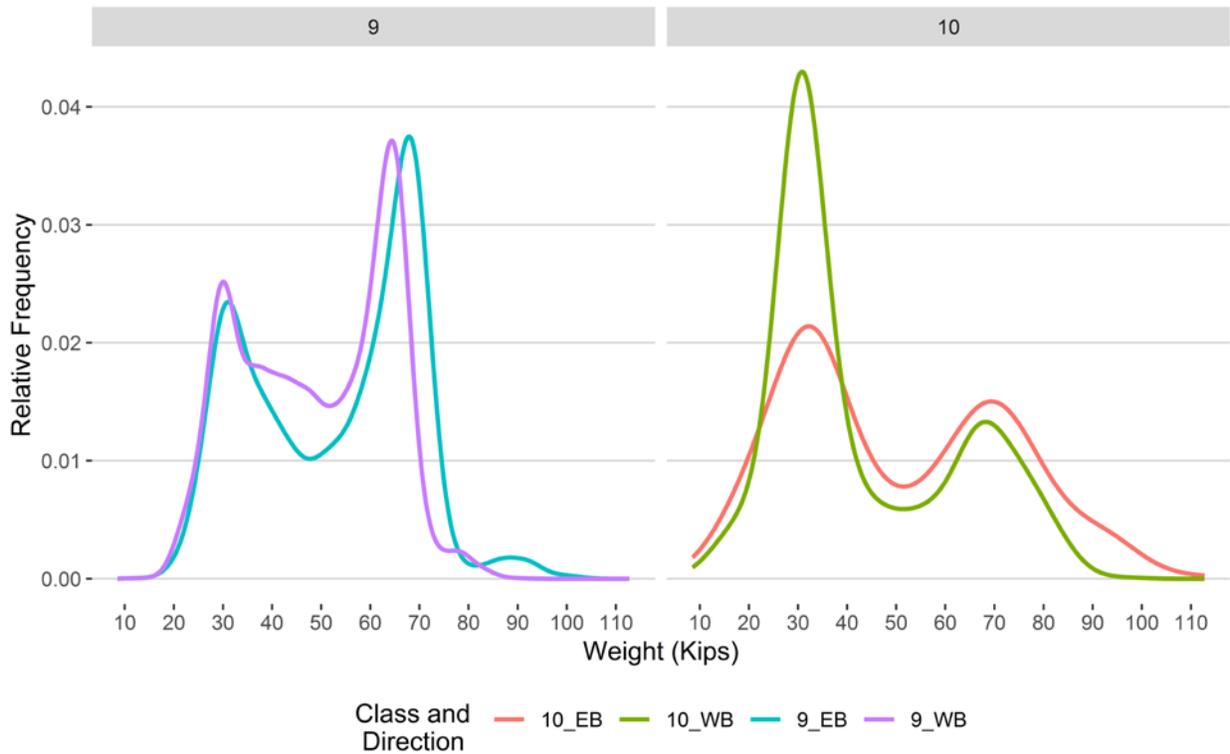


Figure 9 - Freight Percentage by Direction and Class

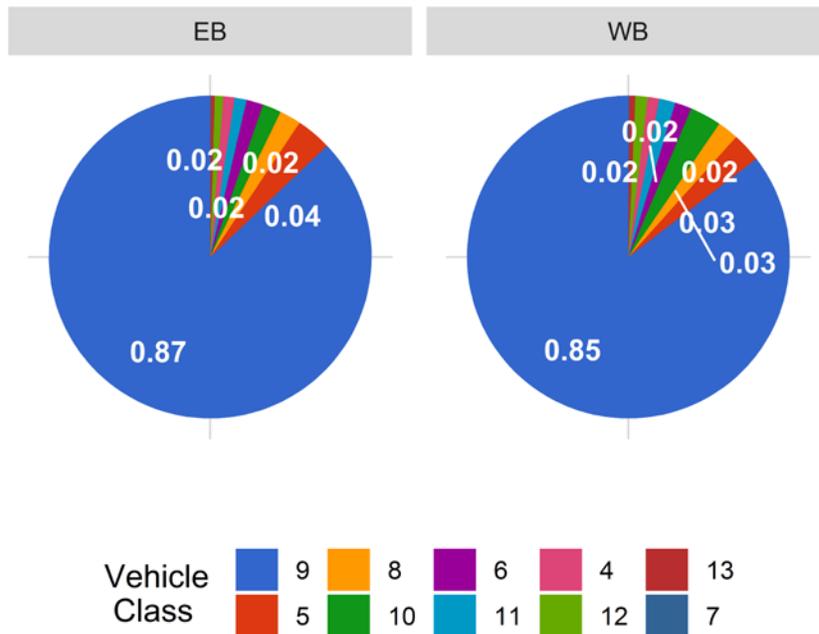


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

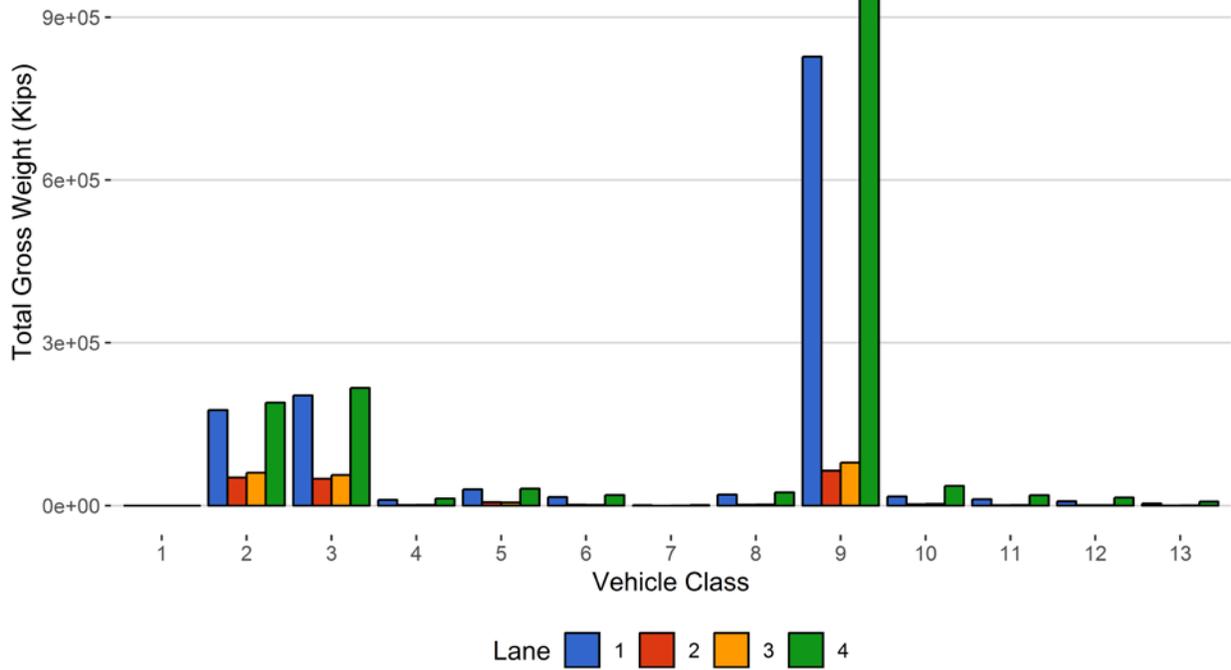


Figure 11 - Total Gross Vehicle Weight t

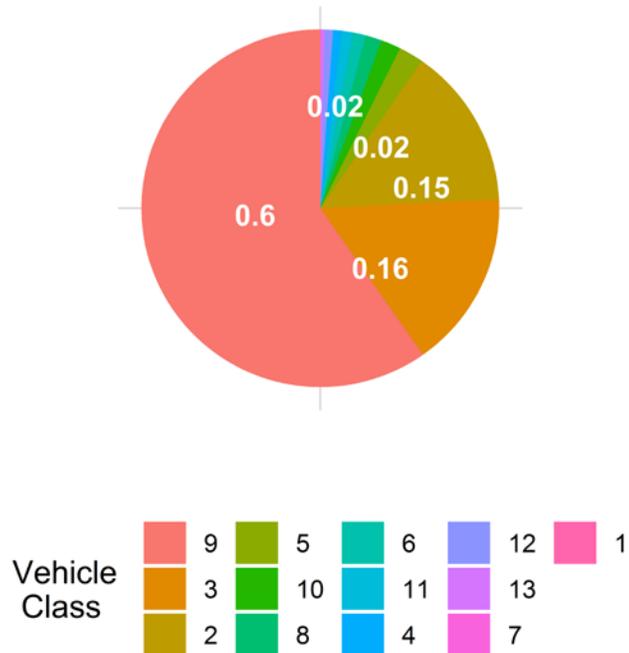


Figure 12 - Total ESALs by Class and Lane

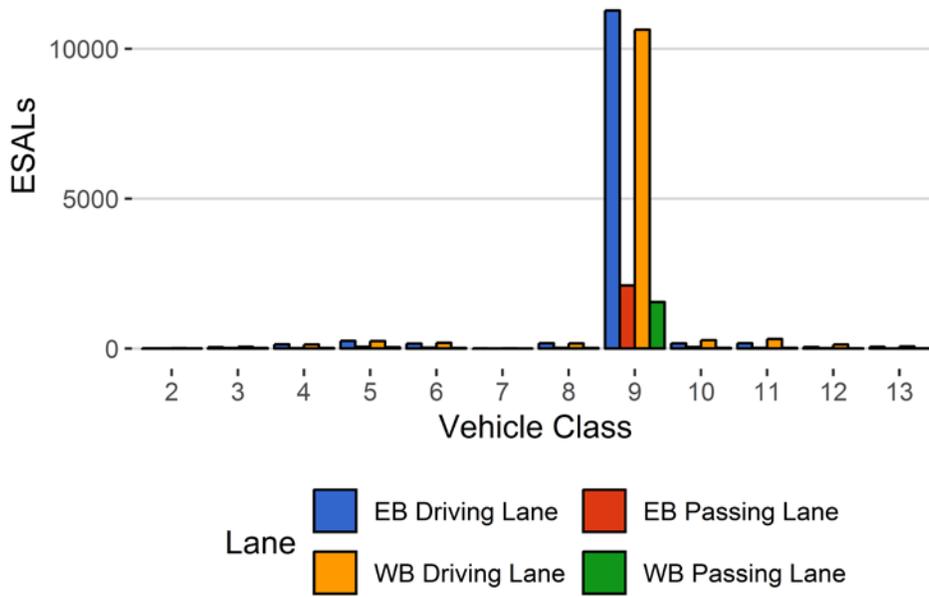


Figure 13 - ESALs by Class

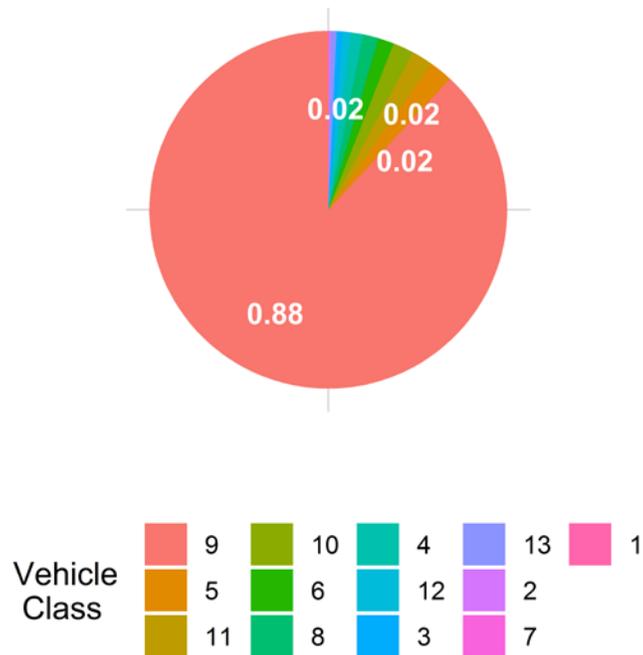


Table 1 Class 9 Front Axle Weight by Lane

<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
April 2019	9.58	-2.02	12.65	-3.73	11.62	-5.38	9.44	-4.90

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	1	25	0	0	0
2	4667	139997	48.2	0	0
3	3235	97048	33.4	0	0
4	37	1115	0.4	15	1.6
5	200	6003	2.1	22	2.3
6	53	1598	0.6	30	3.1
7	1	44	0	1	0.1
8	59	1765	0.6	9	0.9
9	1334	40007	13.8	732	76.8
10	45	1344	0.5	66	6.9
11	21	636	0.2	6	0.6
12	16	472	0.2	3	0.3
13	5	151	0.1	69	7.2
TOTAL	9674	290206	100	953	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>
2019-04-04	Thursday	18:48:51	9	EB	2	118.51
2019-04-02	Tuesday	06:55:12	9	EB	2	113.96
2019-04-24	Wednesday	05:33:15	10	EB	2	112.77
2019-04-05	Friday	08:14:03	9	EB	2	112.46
2019-04-04	Thursday	07:09:10	9	EB	2	111.34
2019-04-01	Monday	08:44:43	9	EB	2	109.8
2019-04-06	Saturday	00:20:18	9	EB	2	109.02
2019-04-19	Friday	05:26:34	9	EB	2	108.58
2019-04-10	Wednesday	14:54:41	9	EB	2	108.13
2019-04-05	Friday	10:54:41	9	EB	2	108.04

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	463	104	22.5	10240	1275	2427
5	EB	8	2848	727	25.5	31253	4986	7143
6	EB	19	694	296	42.7	12397	4824	2418
7	EB	11.5	19	2	10.5	670	19	237
8	EB	31	767	474	61.8	10826	11232	871
9	EB	33	16866	3178	18.8	800199	91274	174248
10	EB	33.5	381	128	33.6	15749	3448	3637
11	EB	36.5	248	58	23.4	10388	1872	1727
12	EB	36.5	185	38	20.5	7547	1235	1091
13	EB	31.5	45	0	0	3912	0	1247
TOTAL	****	****	22516	5005	****	903181	****	195045
<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	609	167	27.4	12127	2108	2749
5	WB	8	2926	762	26	31229	5363	6958
6	WB	19	843	352	41.8	15109	5705	2890
7	WB	11.5	23	0	0	1017	0	376
8	WB	31	931	639	68.6	10767	15361	857
9	WB	33	21613	4524	20.9	933712	127985	184888
10	WB	33.5	912	471	51.6	25792	13522	5509
11	WB	36.5	364	5	1.4	19986	144	3441
12	WB	36.5	269	2	0.7	15381	34	2818
13	WB	31.5	100	0	0	7640	0	2245
TOTAL	****	****	28590	6922	****	1072759	****	212731
GRAND TOTAL	****	****	51106	11927	498	1975939	290385	407776

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	12	0	3	11	27	0
2	175798	51821	60676	189572	477867	14.6
3	203112	49314	56211	216932	525570	16.1
4	10529	986	1289	12946	25749	0.8
5	29995	6244	5489	31103	72831	2.2
6	15627	1594	1388	19426	38034	1.2
7	689	0	61	955	1706	0.1
8	20340	1718	1882	24246	48186	1.5
9	827185	64288	79056	982641	1953170	59.7
10	16774	2422	3108	36205	58510	1.8
11	11484	777	936	19193	32390	1
12	8017	765	760	14654	24197	0.7
13	3823	89	375	7265	11551	0.4
TOTAL	1323385	180018	211235	1555150	3269788	100
GVW/LANE	40.47	5.51	6.46	47.56	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	0.04
2	12	9	10	18	48	0.17	7e-04
3	50	25	24	62	162	0.56	0.0035
4	142	15	19	135	312	1.07	0.58
5	256	62	46	251	615	2.12	0.21
6	166	35	19	197	417	1.44	0.55
7	10	0	1	10	21	0.07	1
8	184	28	20	175	407	1.4	0.48
9	11280	2111	1555	10640	25586	88.09	1.33
10	178	56	31	281	546	1.88	0.85
11	184	31	28	322	566	1.95	1.84
12	52	13	12	140	217	0.75	0.96
13	61	3	8	76	147	0.51	1.94
TOTAL	12577	2388	1774	12307	29045	100	10
ESALS/LANE	43.3	8.2	6.1	42.4	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>
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
Apr 2019	290206	9674	1771	237070	81.7	53135.6	18.3	92.9	7.1
TOTAL	3903979	-	-	3247047	-	656931	-	-	-
AVERAGE	325332	10722	1798	270587	83	54744	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>
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
Apr 2019	12589	3407	1777	12322	30096	83	17	0.3
TOTAL	205740	35311	26853	337718	605622	-	-	-
AVERAGE	17145	2943	2238	28143	50468	89	11	14

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>
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
Apr 19	1325756	180407	211379	1556974	3274517
TOTAL	18451961	2672647	3063659	22363852	46552119
AVERAGE	1537663	222721	255305	1863654	3879343

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	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
Apr 2019	958	0.3	1.9	306	47
TOTAL	82299	-	-	16679	1893
AVERAGE	6858.2	2.1	12.7	1389.9	157.8

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>
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
Apr 2019	195045	212731	407776	47.8	52.2
TOTAL	2822126	3770283	6592409	-	-
AVERAGE	235177.2	314190.3	549367.5	43.2	56.8