

DECEMBER 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 December 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: 285122 | Passenger Vehicles: 239087 | Heavy Commercial Vehicles: 46035

Monthly Average Daily Traffic (MADT): 9266 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 1485

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 Mondays. WB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Mondays (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 02 PM and 04 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 02 PM and 04 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 46035 HCVs, 2612 of them were overweight ³. These overweight HCVs contributed to 1% of total monthly volume, and 6.1% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Wednesdays, with lowest volumes reported on Saturdays. WB overweight vehicles tended to reach highest volumes on Wednesdays, 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 64.5% 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 January.

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, 474 EB vehicles exceeded 88,000 pounds (398 vehicles were Class 9's; 42 vehicles were Class 13's). Of vehicles traveling WB,

139 EB vehicles exceeded 88,000 pounds (62 vehicles were Class 9's; 37 vehicles were Class 13's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from December 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in December 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 fully_loaded Class 9's than empty 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 fully_loaded class 10 vehicles.

Freight Totals. A total of 404285 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (50.6%) than WB (49.4%). 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 285122 vehicles with a combined GVW of 3098330 kips (1 kip = 1,000 pounds = 0.5 tons) in December 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 36879 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 50.6% of all ESALs were recorded EB while 49.4% was observed WB. In particular, 81% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 56% 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:

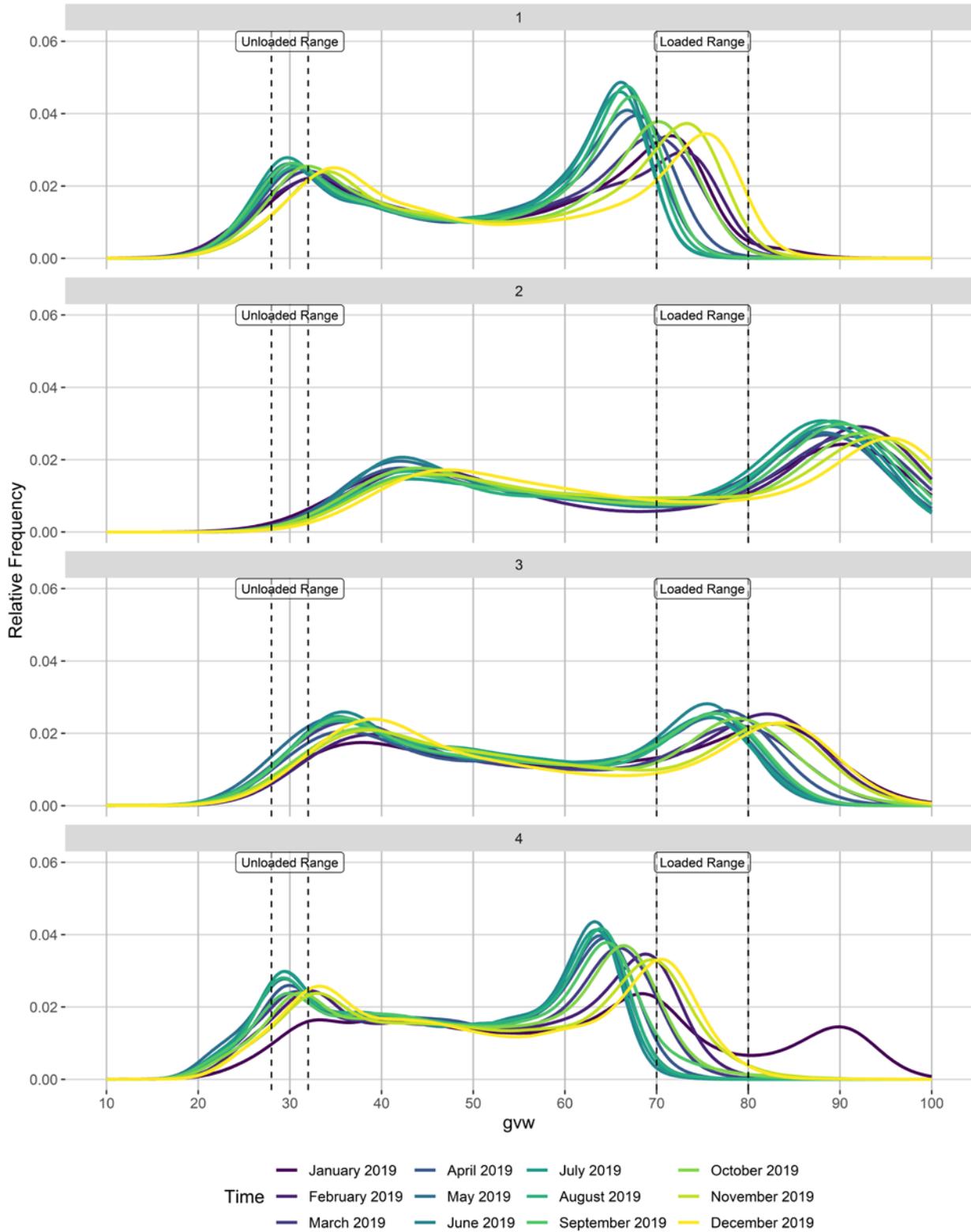
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at:

<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.

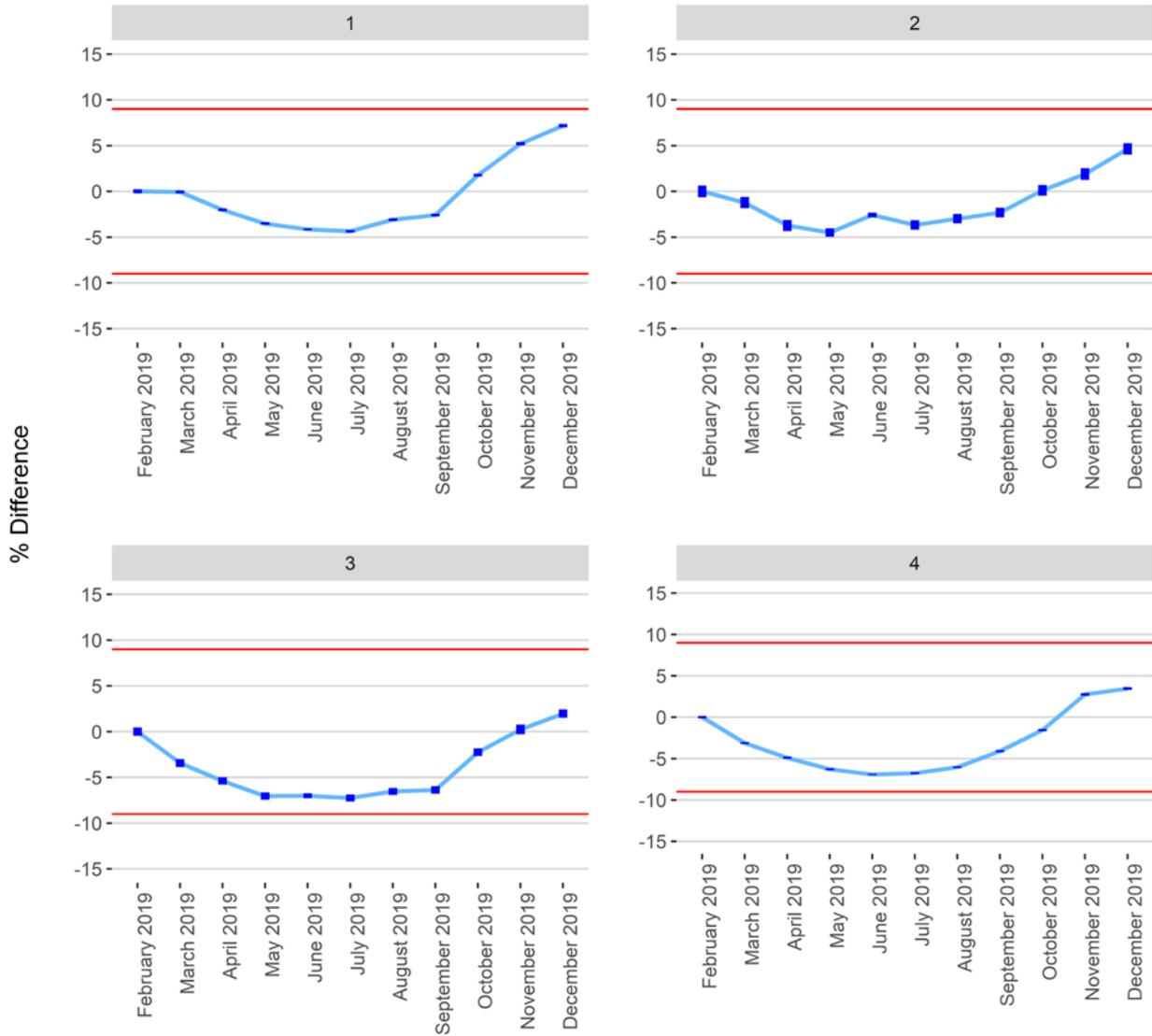
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

Figure 1 - Monthly Class 9 GWW 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

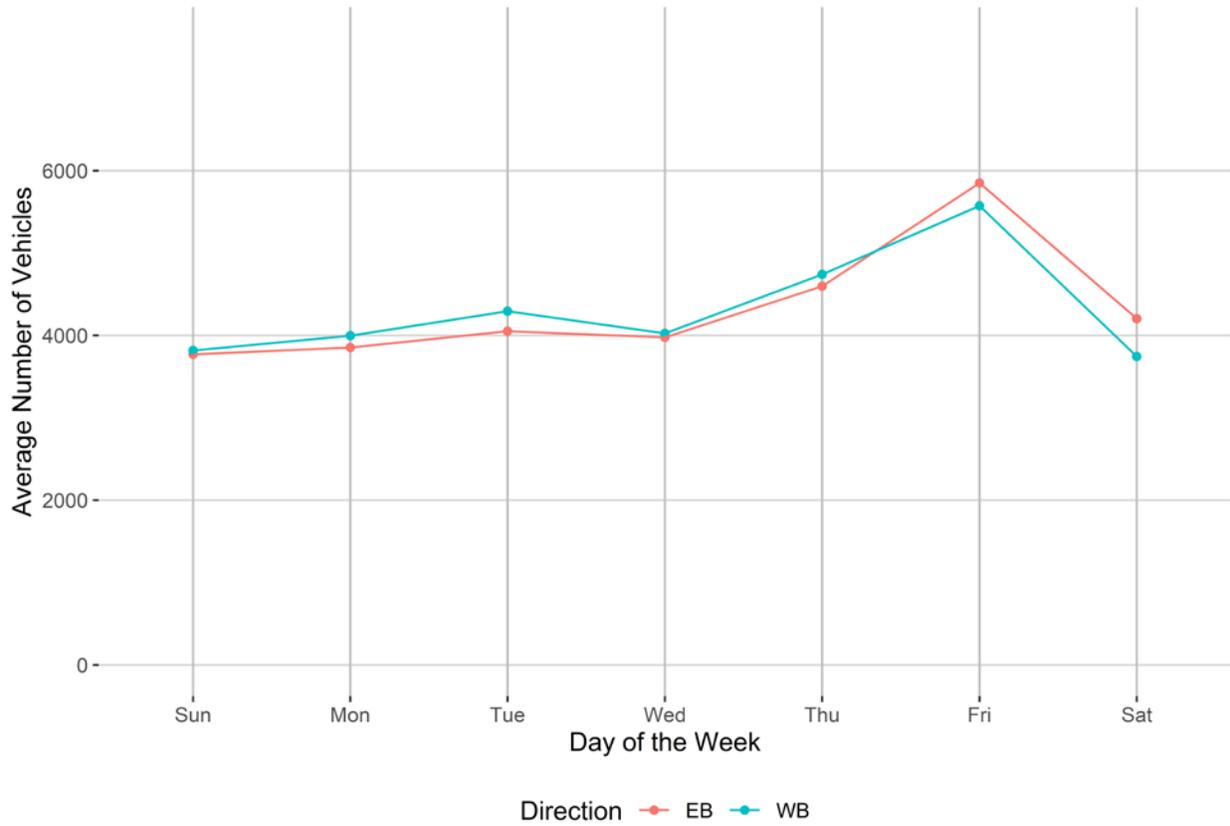


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

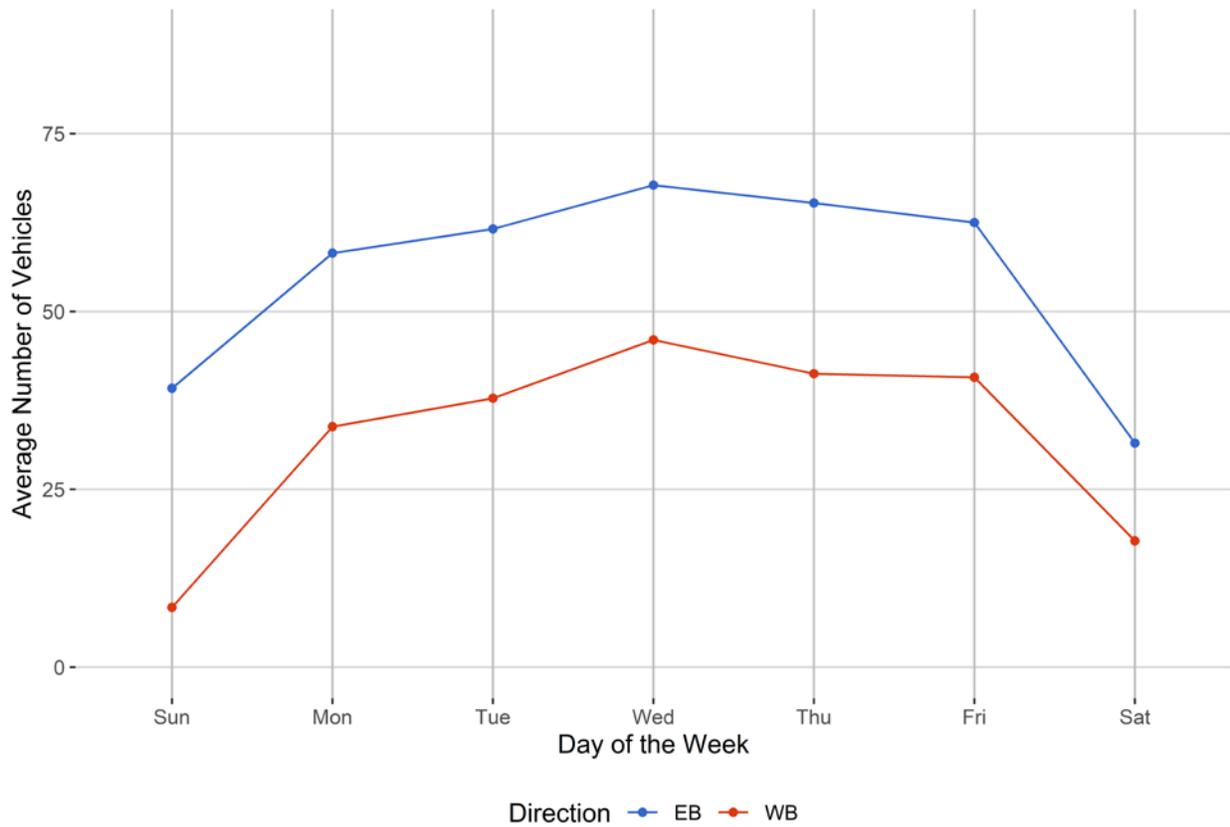


Figure 4 - Passenger Vehicles vs. Hour of the Day

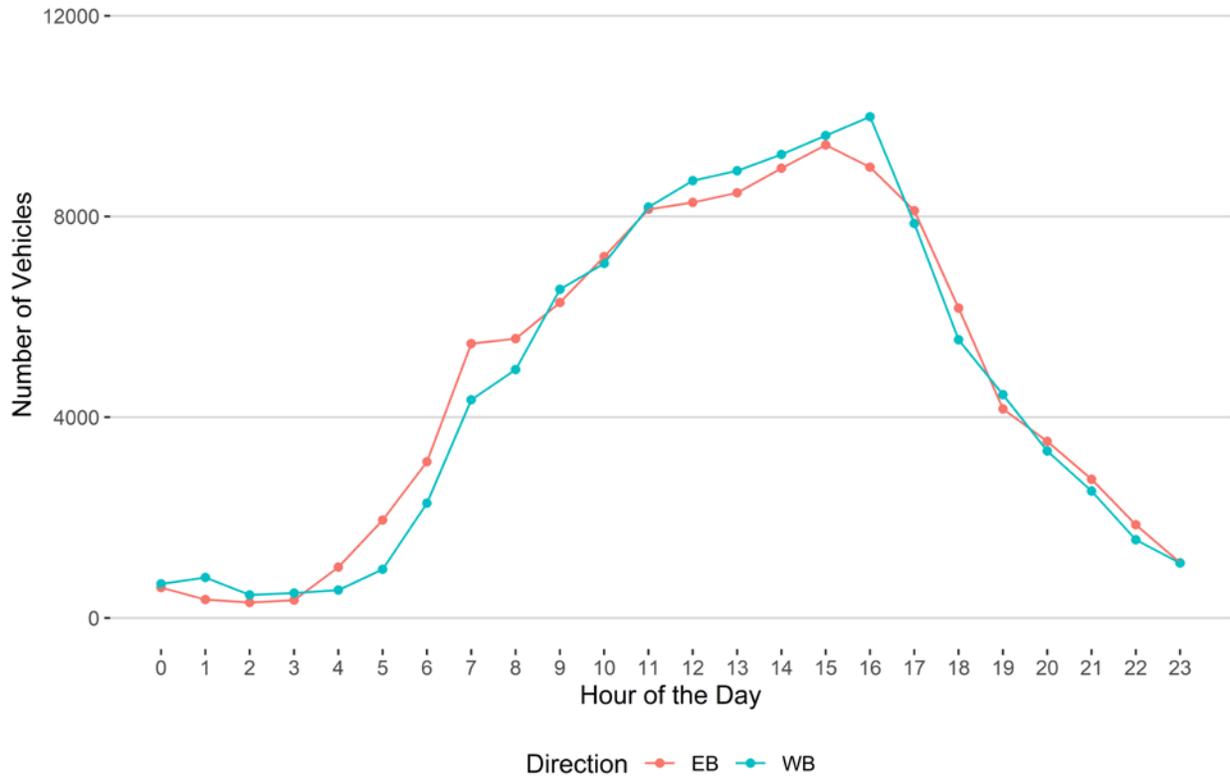


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

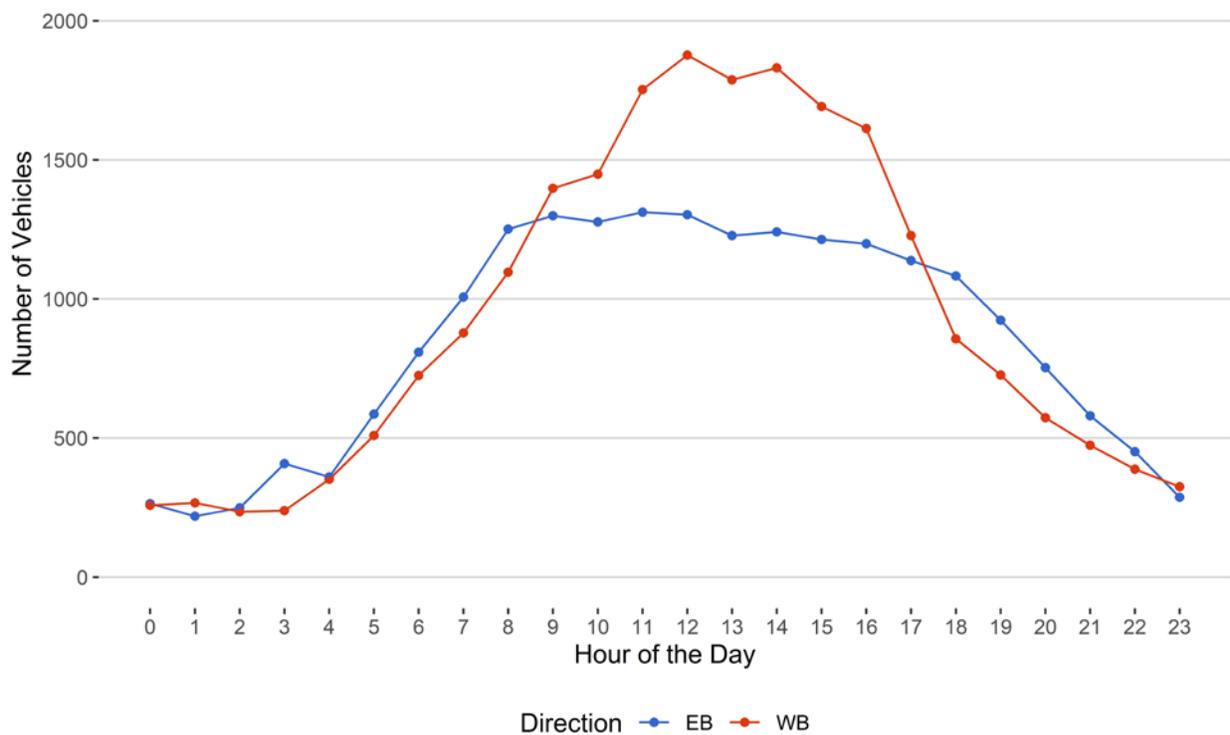


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

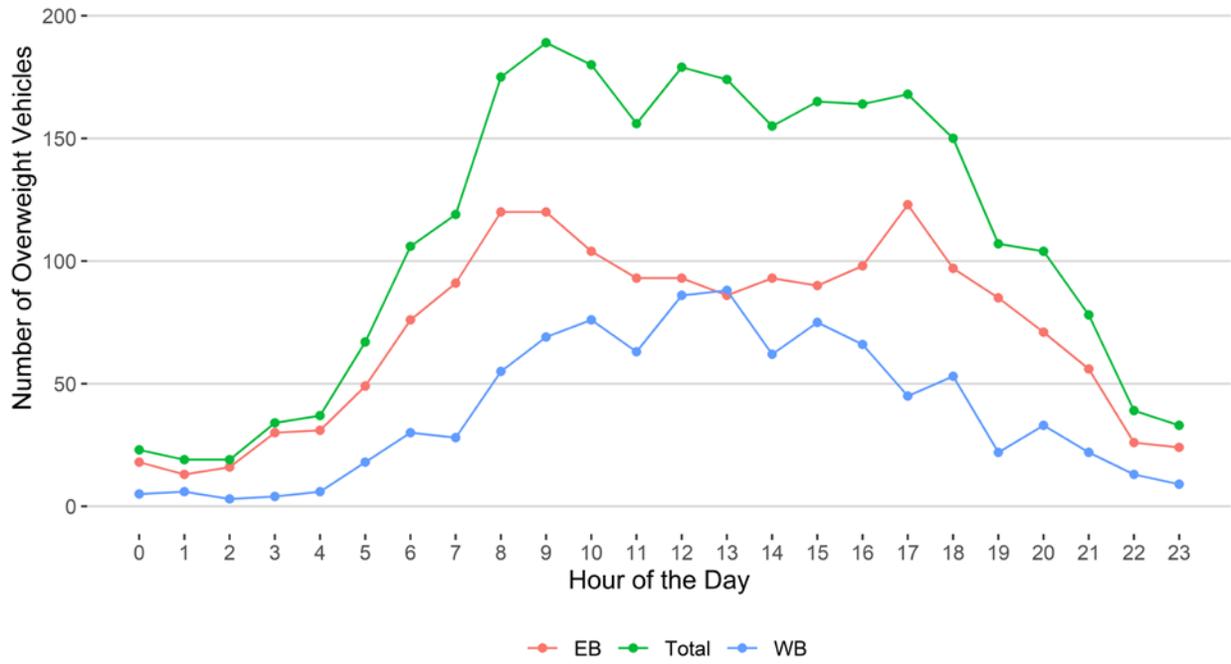
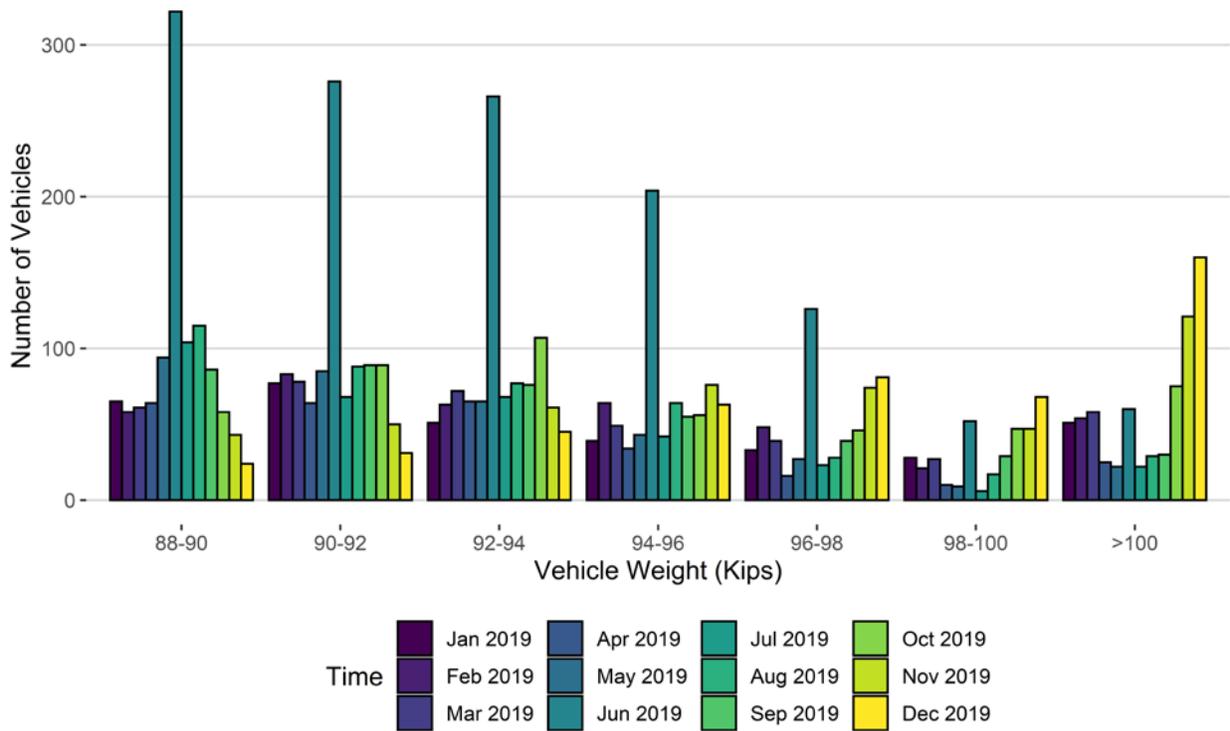
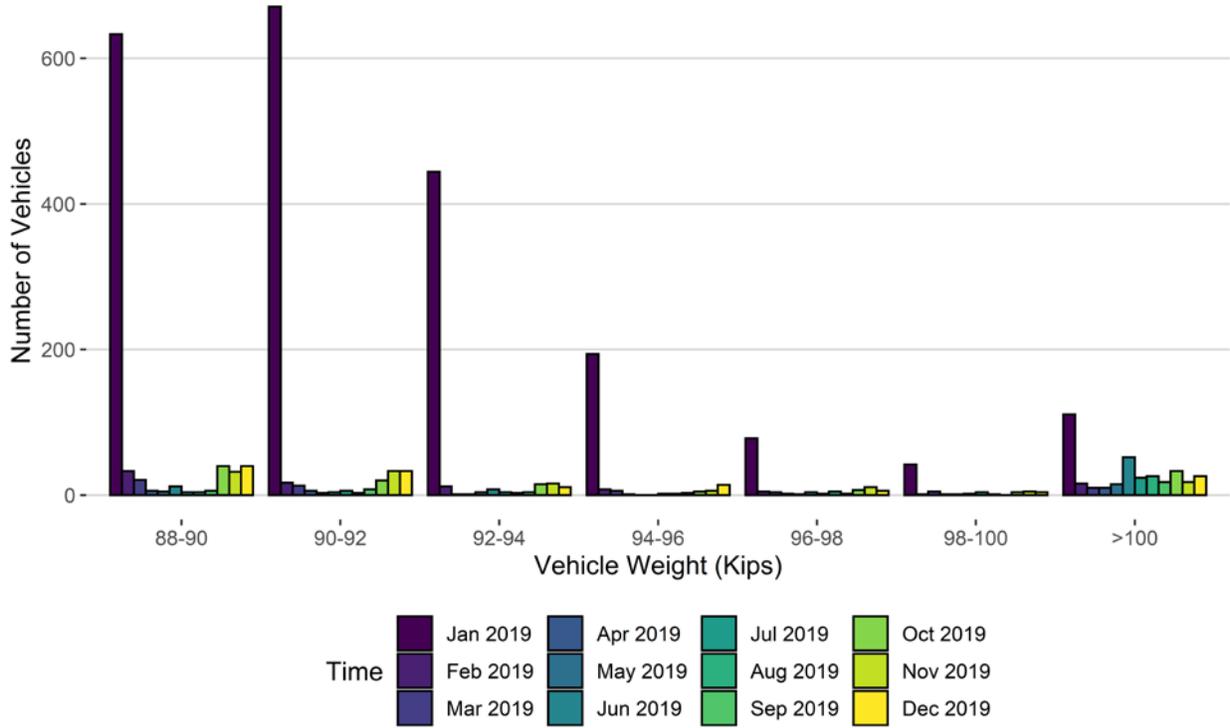


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	65	58	61	64	94	322	104	115	86	58	43	24
90-92	77	83	78	64	85	276	68	88	89	89	50	31
92-94	51	63	72	65	65	266	68	77	76	107	61	45
94-96	39	64	49	34	43	204	42	64	55	56	76	63
96-98	33	48	39	16	27	126	23	28	39	46	74	81
98-100	28	21	27	10	9	52	6	17	29	47	47	68
>100	51	54	58	25	22	60	22	29	30	75	121	160
Total	344	391	384	278	345	1306	333	418	404	478	472	472

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



Vehicle Weights (Kips)	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019	Dec 2019
88-90	633	33	21	6	5	12	4	4	6	40	32	40
90-92	671	17	13	6	3	4	6	3	8	20	33	33
92-94	444	12	1	1	4	8	4	3	4	15	16	11
94-96	194	8	6	1	0	0	2	2	3	5	6	14
96-98	78	5	4	2	1	4	2	5	2	7	11	6
98-100	42	1	5	1	1	2	4	1	0	4	5	4
>100	111	16	10	10	15	52	24	26	18	33	18	26
Total	2173	92	60	27	29	82	46	44	41	124	121	134

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

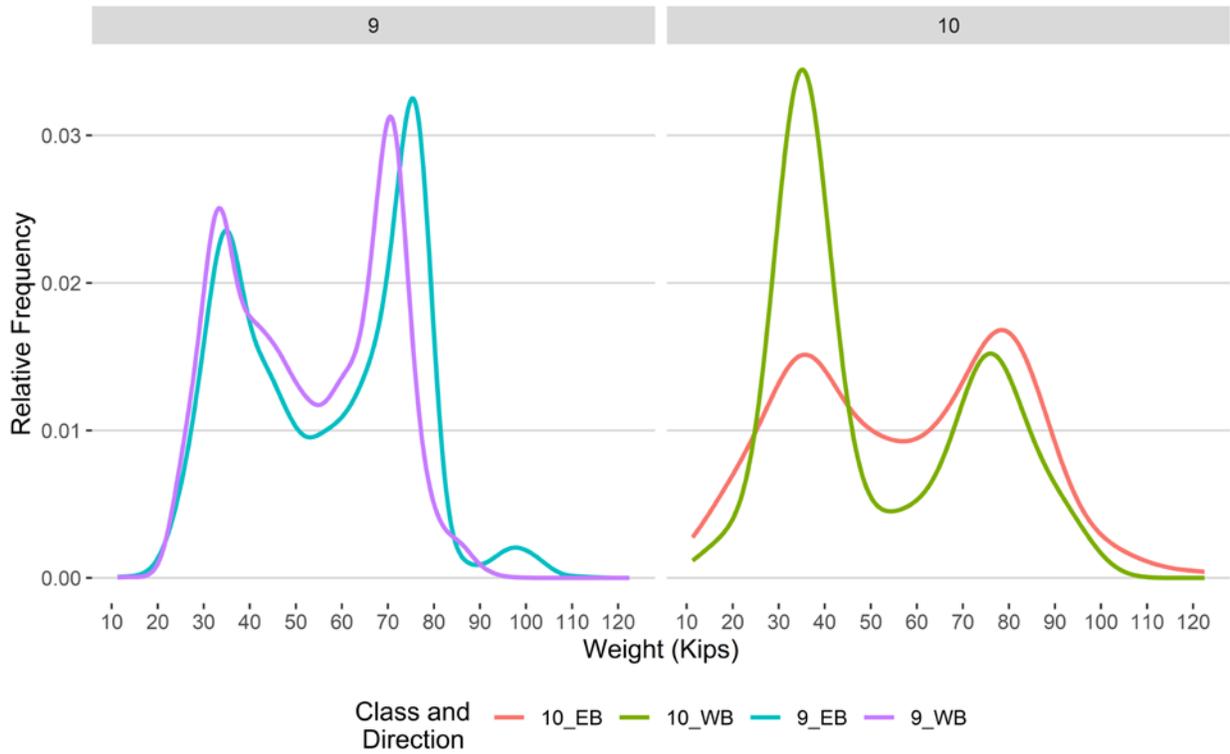


Figure 9 - Freight Percentage by Direction and Class

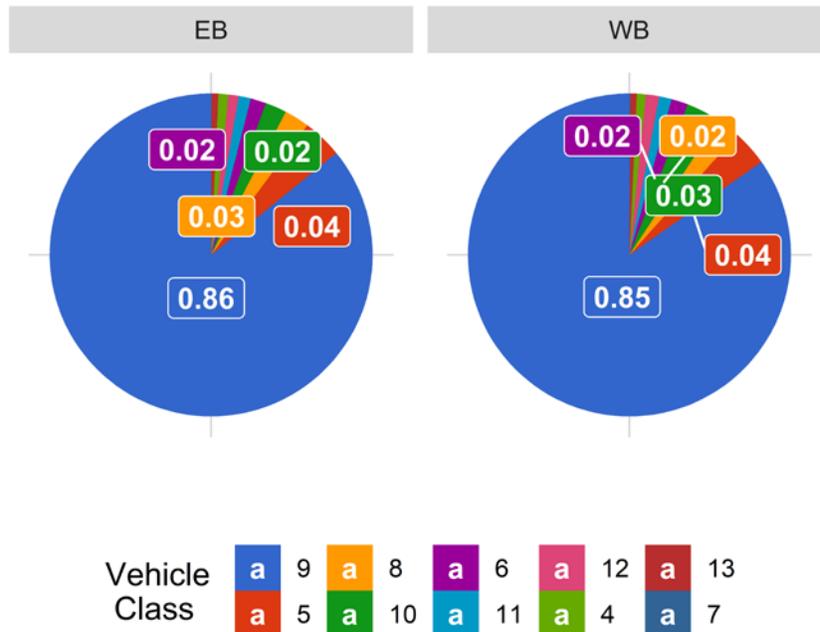


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

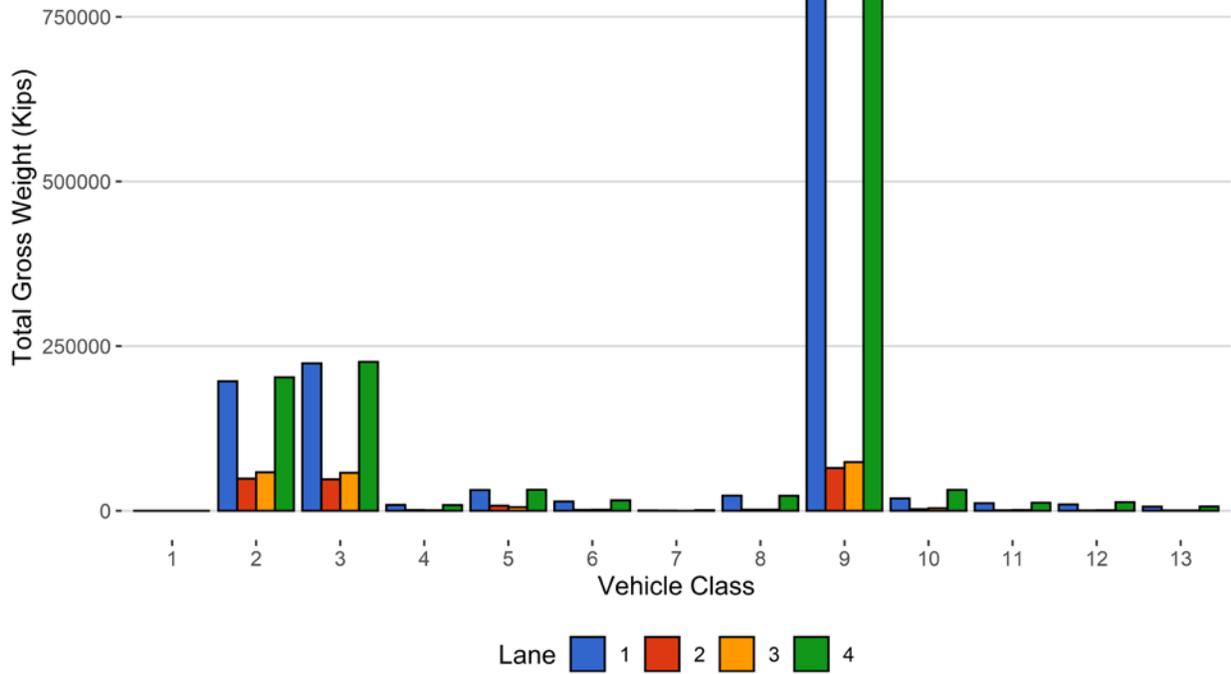


Figure 11 - Total Gross Vehicle Weight t

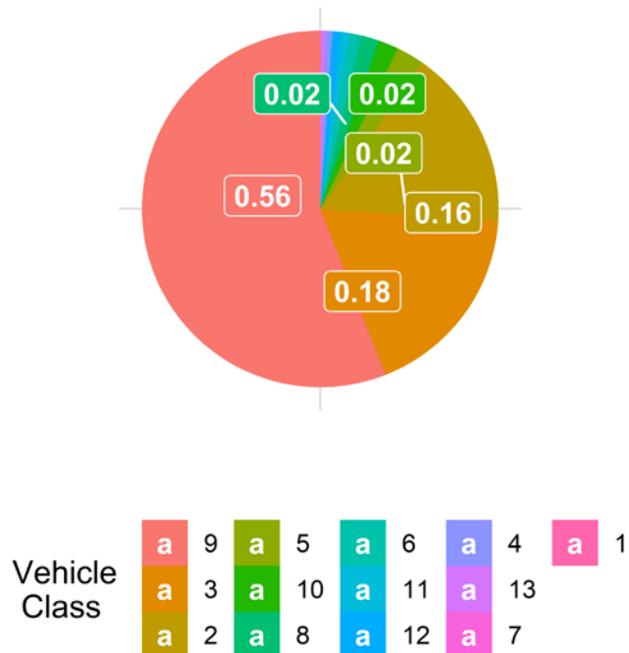


Figure 12 - Total ESALs by Class and Lane

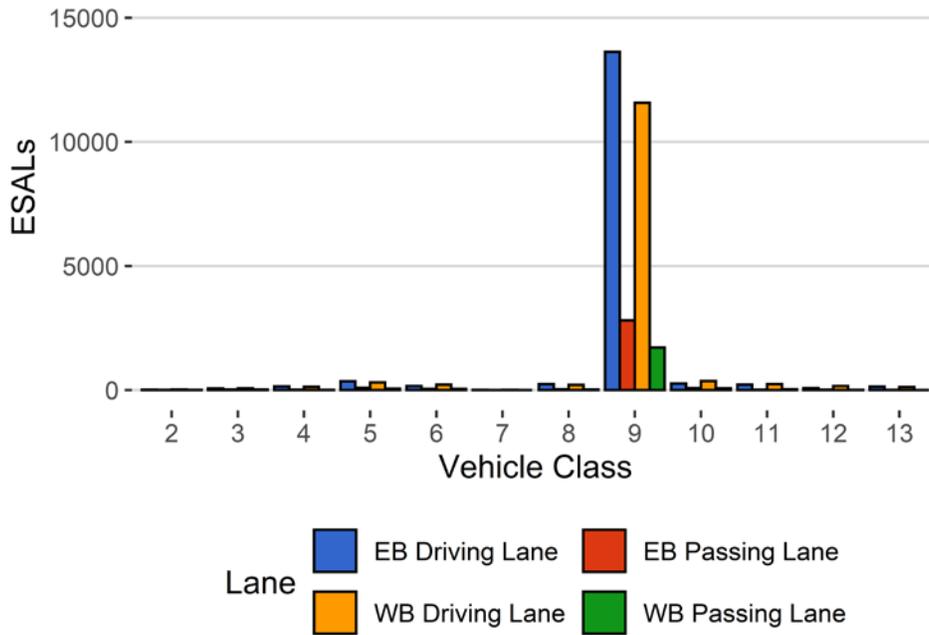


Figure 13 - ESALs by Class

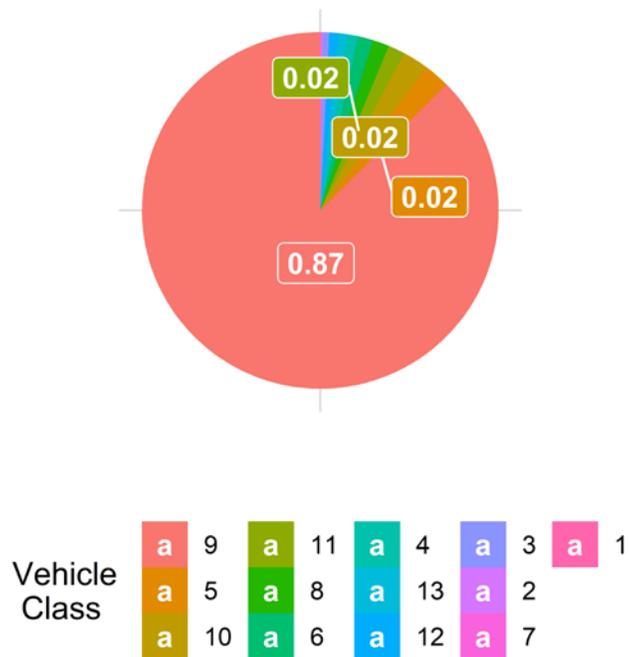


Table 1 Class 9 Front Axle Weight by Lane

<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
May 2019	9.44	-3.53	12.55	-4.49	11.42	-7.04	9.31	-6.28
June 2019	9.38	-4.15	12.80	-2.59	11.42	-7.00	9.24	-6.91
July 2019	9.35	-4.36	12.66	-3.67	11.39	-7.25	9.26	-6.76
August 2019	9.48	-3.09	12.75	-2.99	11.48	-6.53	9.33	-6.05
September 2019	9.53	-2.59	12.83	-2.32	11.50	-6.37	9.52	-4.10
October 2019	9.95	1.77	13.15	0.11	12.01	-2.25	9.78	-1.55
November 2019	10.29	5.21	13.39	1.89	12.31	0.24	10.20	2.75
December 2019	10.48	7.18	13.75	4.64	12.53	1.97	10.27	3.46

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	4490	139186	48.8	0	0
3	3222	99897	35	0	0
4	24	736	0.3	32	1.2
5	200	6196	2.2	51	2
6	42	1305	0.5	50	1.9
7	1	29	0	1	0
8	53	1650	0.6	13	0.5
9	1094	33906	11.9	2174	83.2
10	37	1134	0.4	169	6.5
11	15	477	0.2	5	0.2
12	14	445	0.2	19	0.7
13	5	157	0.1	98	3.8
TOTAL	9197	285122	100	2612	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>
2019-12-12	Thursday	12:23:54	10	EB	2	122.64
2019-12-11	Wednesday	11:47:24	10	EB	2	122.48
2019-12-14	Saturday	10:26:42	10	EB	2	121.68
2019-12-08	Sunday	18:06:12	9	EB	2	116.26
2019-12-09	Monday	14:49:44	9	EB	2	113.66
2019-12-18	Wednesday	20:31:19	9	EB	2	113.01
2019-12-21	Saturday	18:15:24	9	EB	2	112.26
2019-12-20	Friday	23:11:40	9	EB	2	111.63
2019-12-14	Saturday	13:12:43	9	EB	2	111
2019-12-08	Sunday	17:42:26	9	EB	2	110.97

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	347	48	13.8	9357	600	2436
5	EB	8	2935	576	19.6	35062	3949	8095
6	EB	19	578	166	28.7	12485	2799	2328
7	EB	11.5	10	1	10	484	10	190
8	EB	31	770	326	42.3	16848	7887	1542
9	EB	33	14946	1876	12.6	791053	54383	179871
10	EB	33.5	366	65	17.8	19528	1607	4722
11	EB	36.5	225	22	9.8	11163	730	1877
12	EB	36.5	193	13	6.7	9549	425	1490
13	EB	31.5	72	1	1.4	6574	29	2169
TOTAL	****	****	20442	3094	****	912102	****	204720
<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	340	68	20	8509	864	2215
5	WB	8	2849	466	16.4	34104	3371	7520
6	WB	19	640	206	32.2	13855	3580	2804
7	WB	11.5	17	0	0	872	0	338
8	WB	31	770	356	46.2	15580	8803	1373
9	WB	33	16706	2594	15.5	808208	75707	171256
10	WB	33.5	693	131	18.9	31766	3796	6470
11	WB	36.5	220	2	0.9	12967	56	2505
12	WB	36.5	222	2	0.9	13788	33	2879
13	WB	31.5	75	2	2.7	6709	34	2205
TOTAL	****	****	22532	3827	****	946358	****	199565
GRAND TOTAL	****	****	42974	6921	316	1858460	168664	404285

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	0	0	0	4	4	0
2	196658	48711	58423	202744	506536	16.4
3	223839	47741	57690	225964	555234	18
4	8828	1129	716	8657	19329	0.6
5	31384	7628	5579	31896	76487	2.5
6	14043	1241	1558	15876	32719	1.1
7	464	30	0	872	1366	0
8	22920	1815	1707	22676	49118	1.6
9	780547	64889	74046	809869	1729351	56
10	18725	2410	3817	31745	56697	1.8
11	11399	495	973	12050	24916	0.8
12	9495	479	695	13126	23795	0.8
13	6272	332	296	6448	13347	0.4
TOTAL	1324572	176899	205500	1381927	3088899	100
GVW/LANE	42.88	5.73	6.65	44.74	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	0.1667
2	17	10	11	24	62	0.18	0.001
3	63	27	28	73	190	0.56	0.0041
4	147	18	12	137	315	0.93	0.92
5	360	96	56	308	820	2.41	0.28
6	166	46	50	217	479	1.41	0.79
7	10	0	0	13	23	0.07	1.57
8	242	35	23	208	508	1.49	0.66
9	13626	2806	1716	11577	29725	87.49	1.88
10	269	77	72	368	786	2.31	1.48
11	218	20	32	242	511	1.5	2.27
12	81	17	11	162	271	0.8	1.3
13	143	9	6	127	285	0.84	3.65
TOTAL	15341	3161	2017	13455	33974	100	15
ESALS/LANE	45.2	9.3	5.9	39.6	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>
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
May 2019	360874	11568	1847	303630	84.1	57244.3	15.9	91.7	8.3
Jun 2019	400718	13357	2006	340534	85	60184.1	15	89	11
Jul 2019	427176	13874	1976	365919	85.7	61256.9	14.3	91.6	8.4
Aug 2019	435975	13961	2028	373117	85.6	62857.5	14.4	91.3	8.7
Sep 2019	359424	11974	1980	300014	83.5	59410.2	16.5	92	8
Oct 2019	342071	11093	1929	282268	82.5	59803.1	17.5	92.1	7.9
Nov 2019	288551	9627	1660	238750	82.7	49800.5	17.3	92.1	7.9
Dec 2019	285122	9266	1485	239087	83.9	46034.6	16.1	92	8
TOTAL	3906695	-	-	3252013	-	654680	-	-	-
AVERAGE	325558	10684	1792	271001	83	54557	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>
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
May 2019	11950	3256	1712	12107	29025	83	17	0.1

Jun 2019	23167	11821	3770	23583	62341	75	25	0.1
Jul 2019	12316	3275	1958	11890	29439	82	18	0.1
Aug 2019	12933	3646	2141	12756	31476	82	18	0.1
Sep 2019	12528	3209	1874	13878	31489	84	16	0.2
Oct 2019	14480	3195	2179	16922	36776	85	15	0.9
Nov 2019	14558	3226	1902	16472	36157	86	14	1.1
Dec 2019	15437	3210	2019	16214	36879	86	14	0.8
TOTAL	171634	47083	25409	189640	433766	-	-	-
AVERAGE	14303	3924	2117	15803	36147	84	16	3

###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>
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
May 19	1423938	260130	265009	1700873	3649951
Jun 19	2939660	809623	639308	3533060	7921650
Jul 19	1616775	307221	340173	1791764	4055932
Aug 19	1640953	322458	343031	1861861	4168303
Sep 19	1473408	243119	267034	1684716	3668276
Oct 19	1474233	225471	268145	1804192	3772042
Nov 19	1319010	192225	207923	1477704	3196861
Dec 19	1331098	177559	205573	1384100	3098330
TOTAL	18278221	3144267	3270502	21253041	45946031
AVERAGE	1523185	262022	272542	1771087	3828836

###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>
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
May 2019	1034	0.3	1.9	374	47
Jun 2019	3062	0.4	2.6	1390	166
Jul 2019	1028	0.2	1.7	380	56
Aug 2019	1195	0.3	1.9	462	73
Sep 2019	1311	0.4	2.3	446	77

Oct 2019	1756	0.5	3.1	602	159
Nov 2019	2254	0.9	4.9	595	193
Dec 2019	2640	1	6.1	613	262
TOTAL	23895	-	-	8625	1507
AVERAGE	1991.2	0.7	3.8	718.8	125.6

###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>
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
May 2019	198928	211636	410564	48.5	51.5
Jun 2019	440455	421133	861588	51.1	48.9
Jul 2019	208712	210195	418907	49.8	50.2
Aug 2019	214388	225896	440283	48.7	51.3
Sep 2019	203138	225059	428197	47.4	52.6
Oct 2019	213924	260048	473972	45.1	54.9
Nov 2019	204313	221327	425640	48	52
Dec 2019	204720	199565	404285	50.6	49.4
TOTAL	2677699	2900543	5578242	-	-
AVERAGE	223141.6	241711.9	464853.5	47.8	52.2