

NOVEMBER 2019



**WIM #44
CSAH 1, MP 8.1
MANHATTAN
BEACH, MN**

**MONTHLY
REPORT**

Your Destination... Our Priority



WIM Site Location

WIM #44 is located on CSAH 1 near Manhattan Beach in Crow Wing county.

System Operation

WIM #44 was operational for the entire month of November 2019. Volume was computed using all monthly data.

System Calibration

WIM #44 was most recently calibrated on 2015-08-10. 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: 27290 | Passenger Vehicles: 19806 | Heavy Commercial Vehicles: 7484

Monthly Average Daily Traffic (MADT): 942 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 249

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 Mondays, with lowest volumes reported on Fridays. WB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Saturdays (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 03 PM and 05 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 03 PM and 05 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 5's and Class 8's.

Overweight HCVs

Volume trends. Of a total of 7484 HCVs, 315 of them were overweight ³. These overweight HCVs contributed to 1.2% of total monthly volume, and 4.4% of total monthly HCV volume.

EB overweight vehicles typically reached highest numbers on Thursdays, with lowest volumes reported on Sundays. 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 10 and class 5 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 53% 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 ,92 EB vehicles exceeded 88,000 pounds (91 vehicles were Class 10's; 1 vehicles were Class 13's). Of vehicles traveling WB,

70 EB vehicles exceeded 88,000 pounds (64 vehicles were Class 10's; 5 vehicles were Class 9's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from November 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in November 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 18878 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (54.3%) than WB (45.7%). See Table 4 and Figure 11 for more freight information.

####Infrastructure Considerations Bridge. Bridge No. 95425 (a precast pipe arch) is approximately 3.45 miles south west from WIM #44. Bridge No. 95426 (a precast pipe arch) is approximately .08 miles sw of WIM #44. WIM #44 recorded a total of 27290 vehicles with a combined GVW of 214609 kips (1 kip = 1,000 pounds = 0.5 tons) in November 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 1612 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 50.3% of all ESALs were recorded EB while 49.7% was observed WB. In particular, 37% of all ESALs were generated by the Class 10's (Class 10's were also responsible for generating 10% 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).

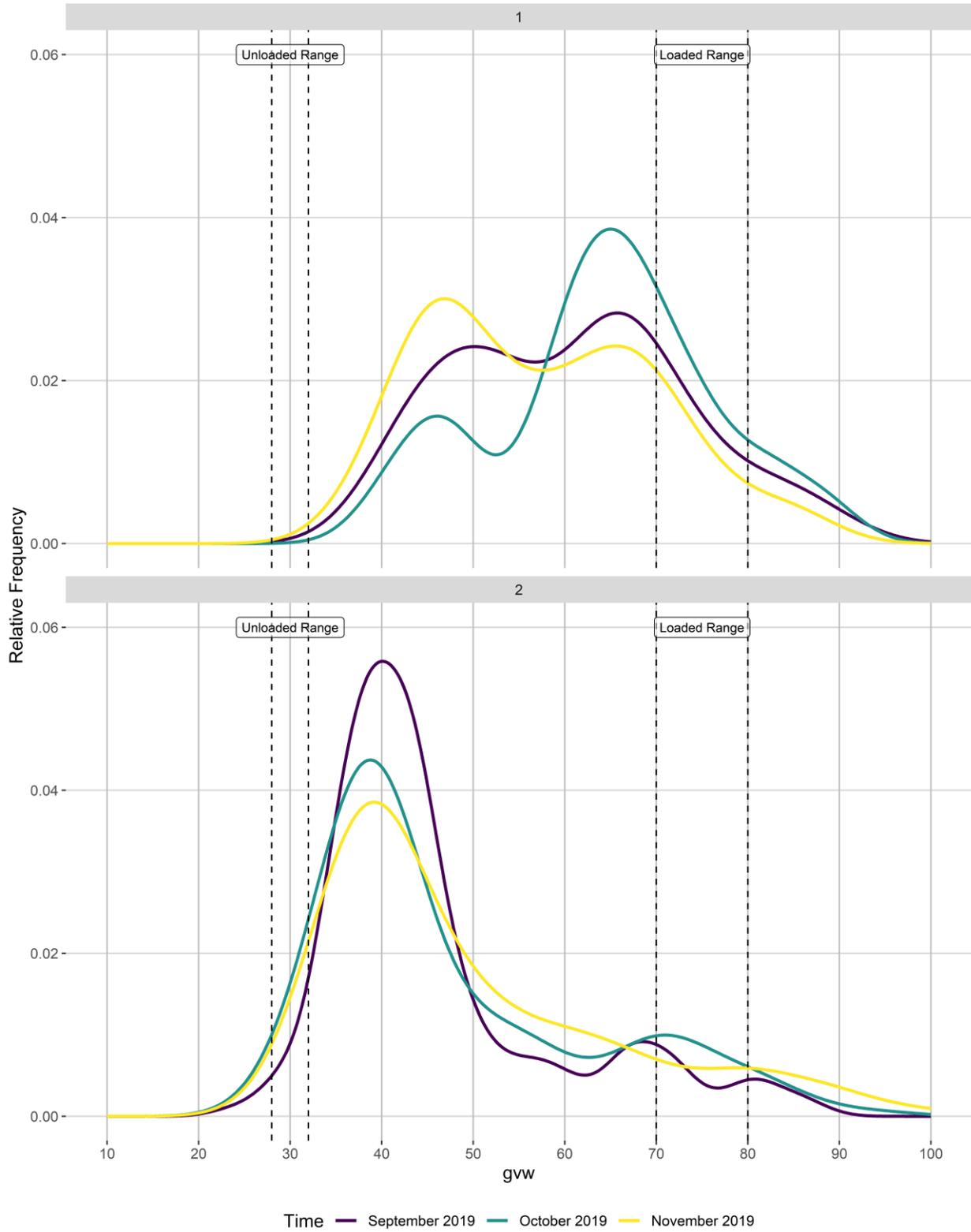
#####WIM monthly reports can be found at:

<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.

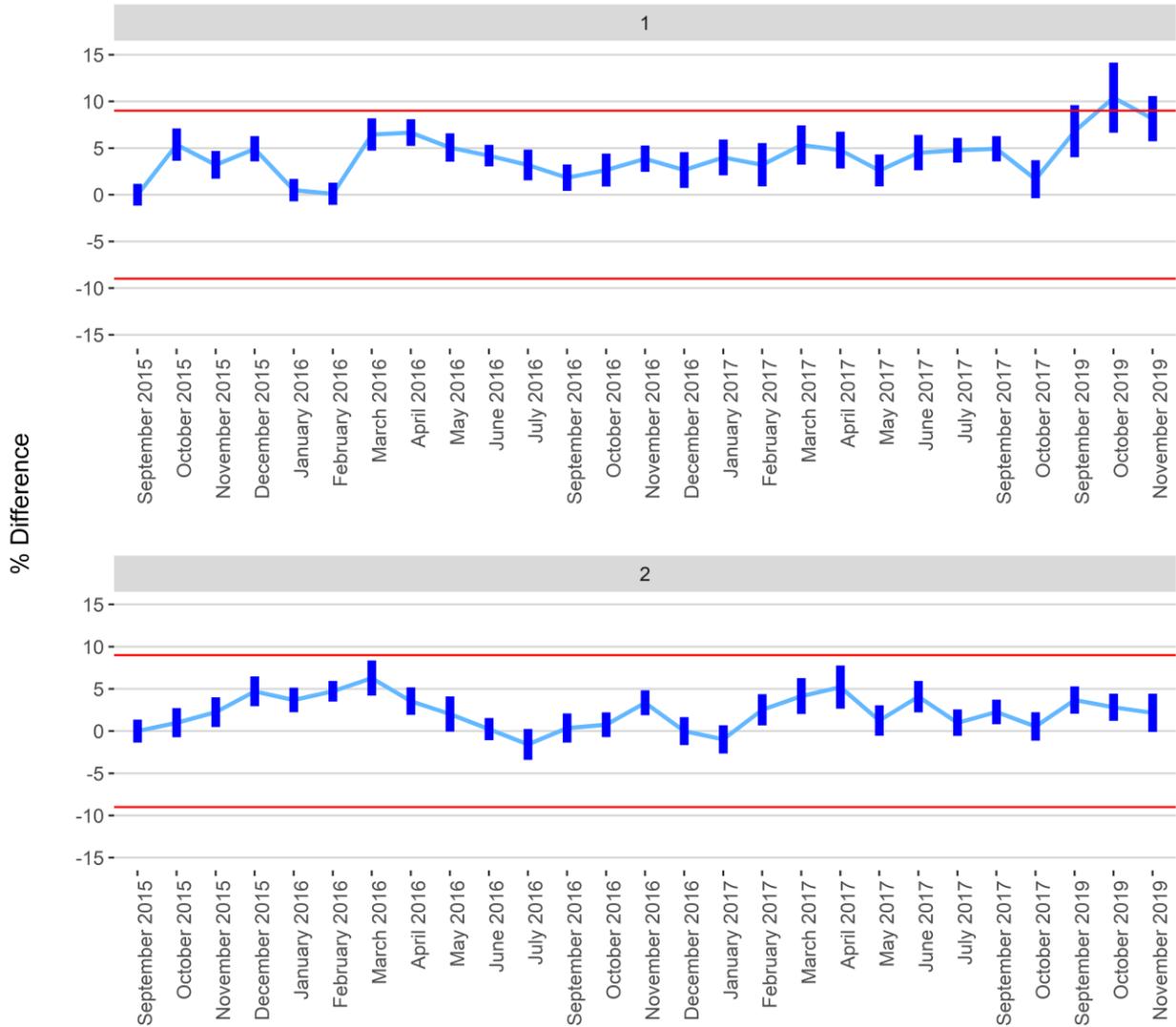
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

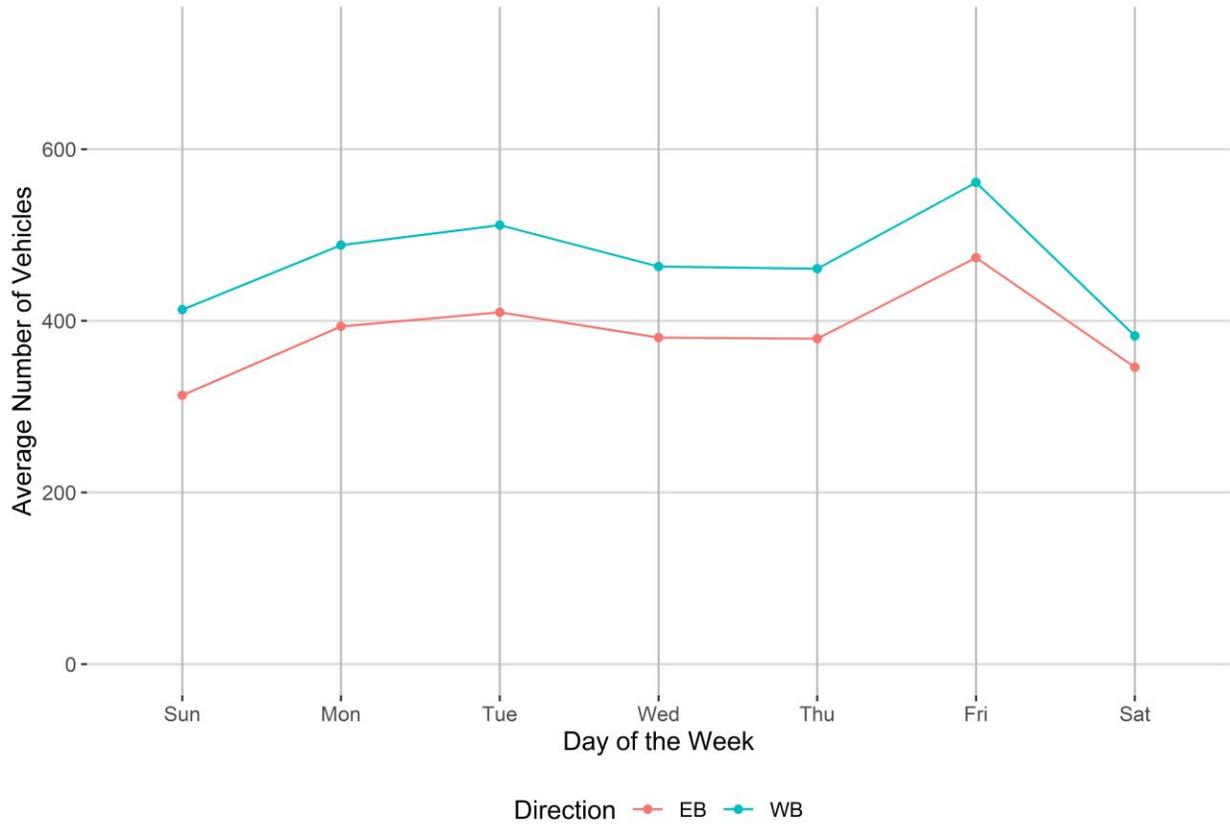


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

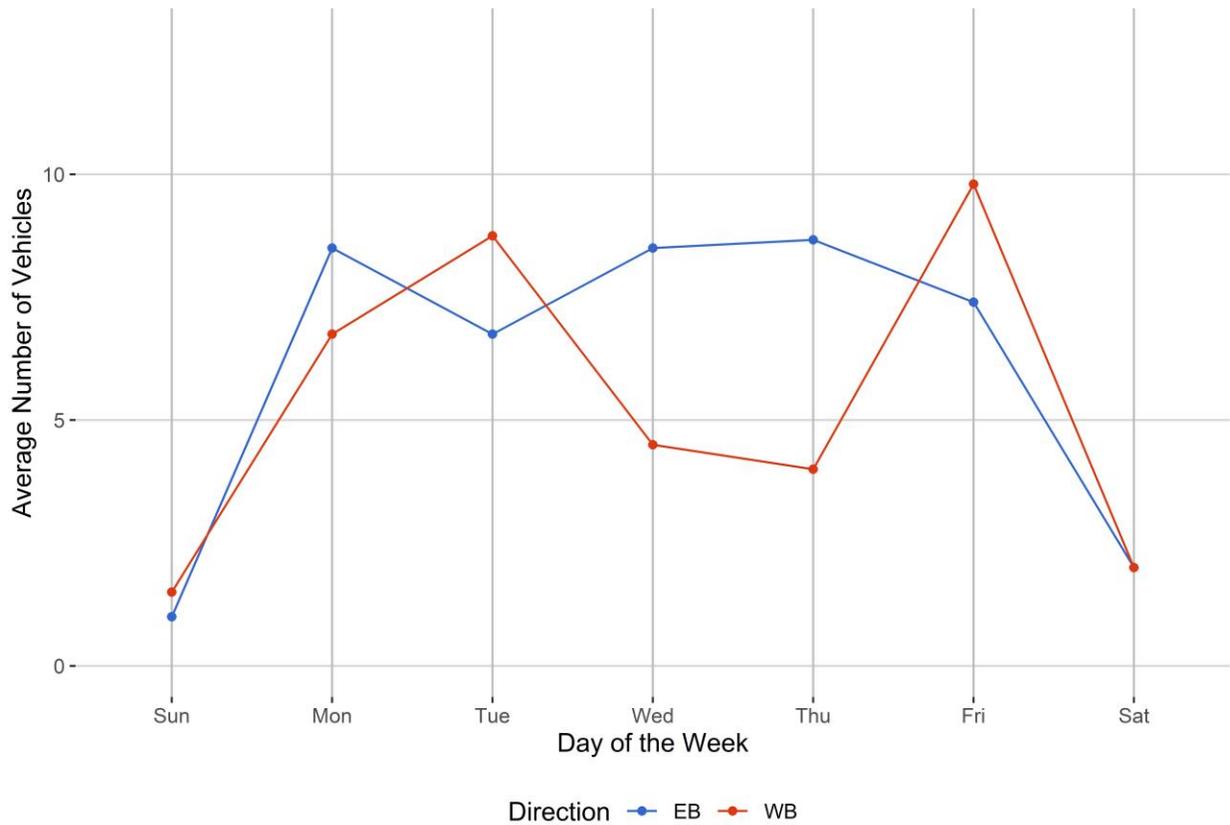


Figure 4 - Passenger Vehicles vs. Hour of the Day

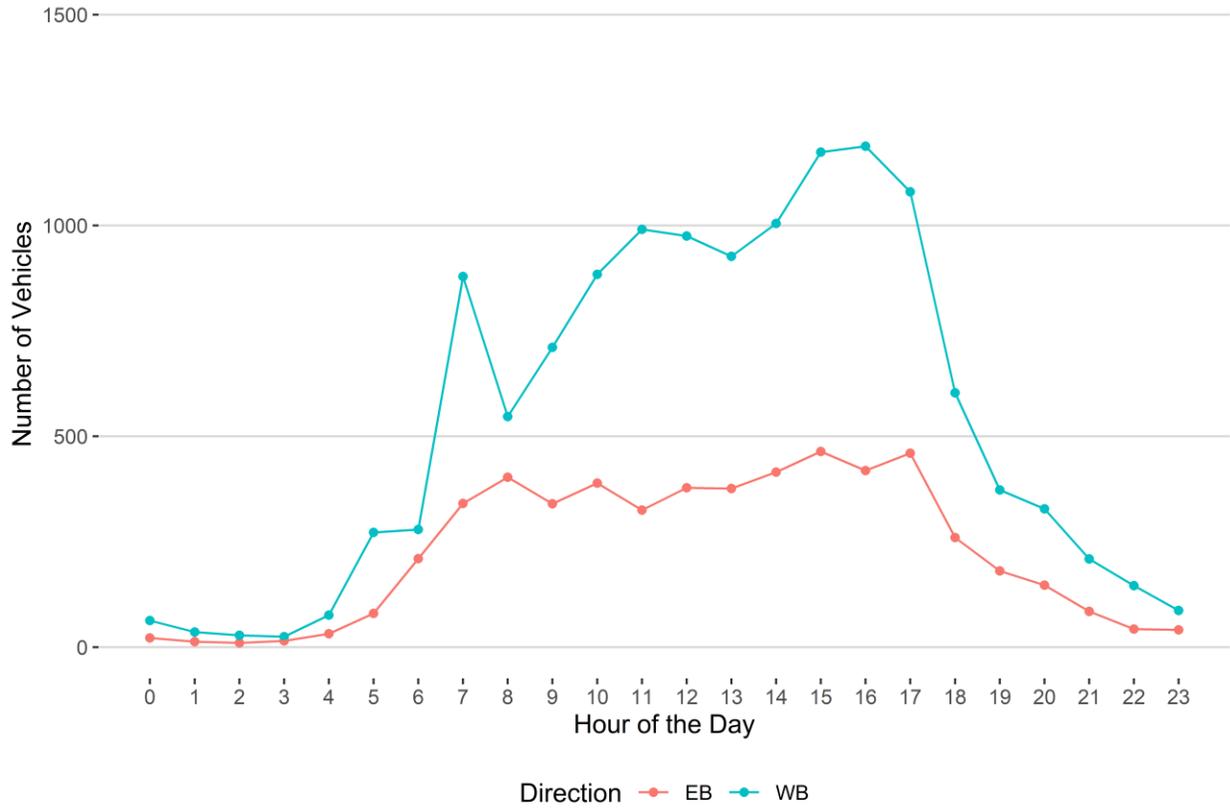


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

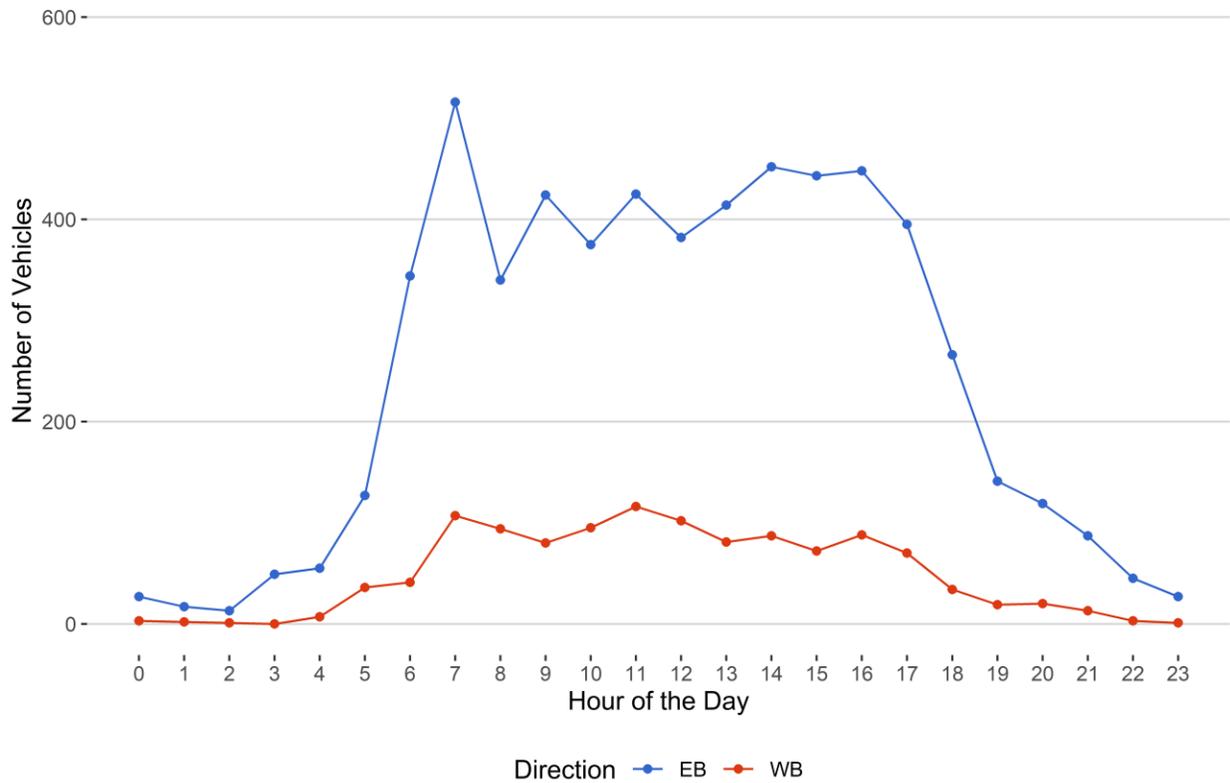


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

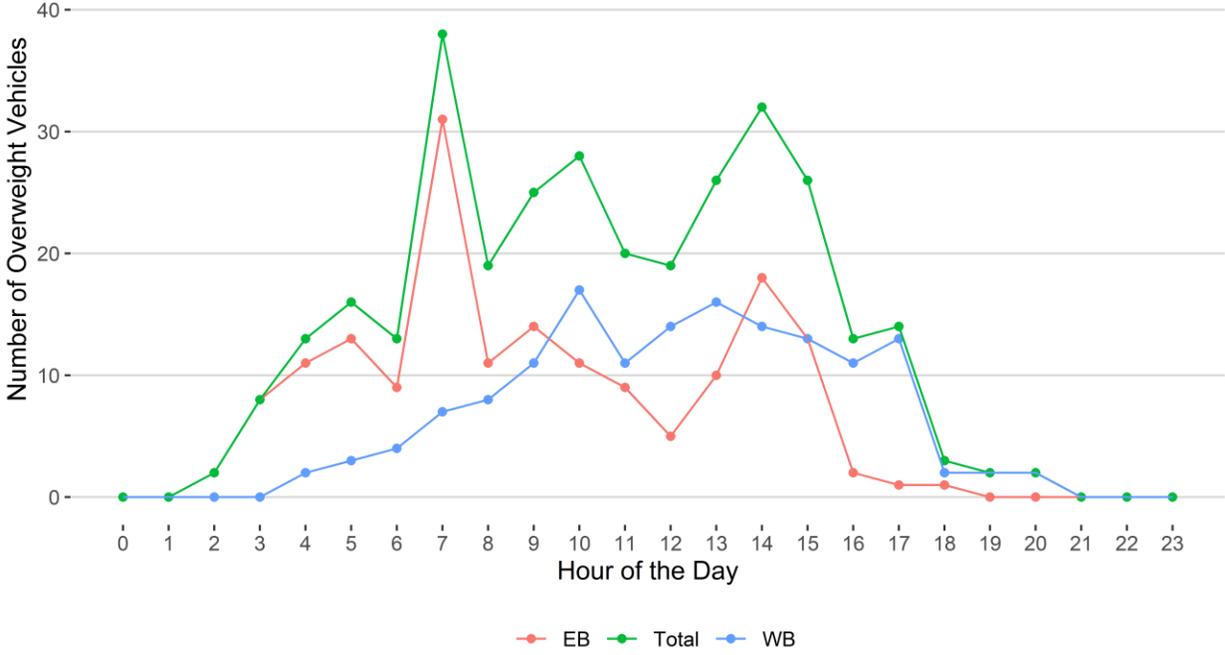
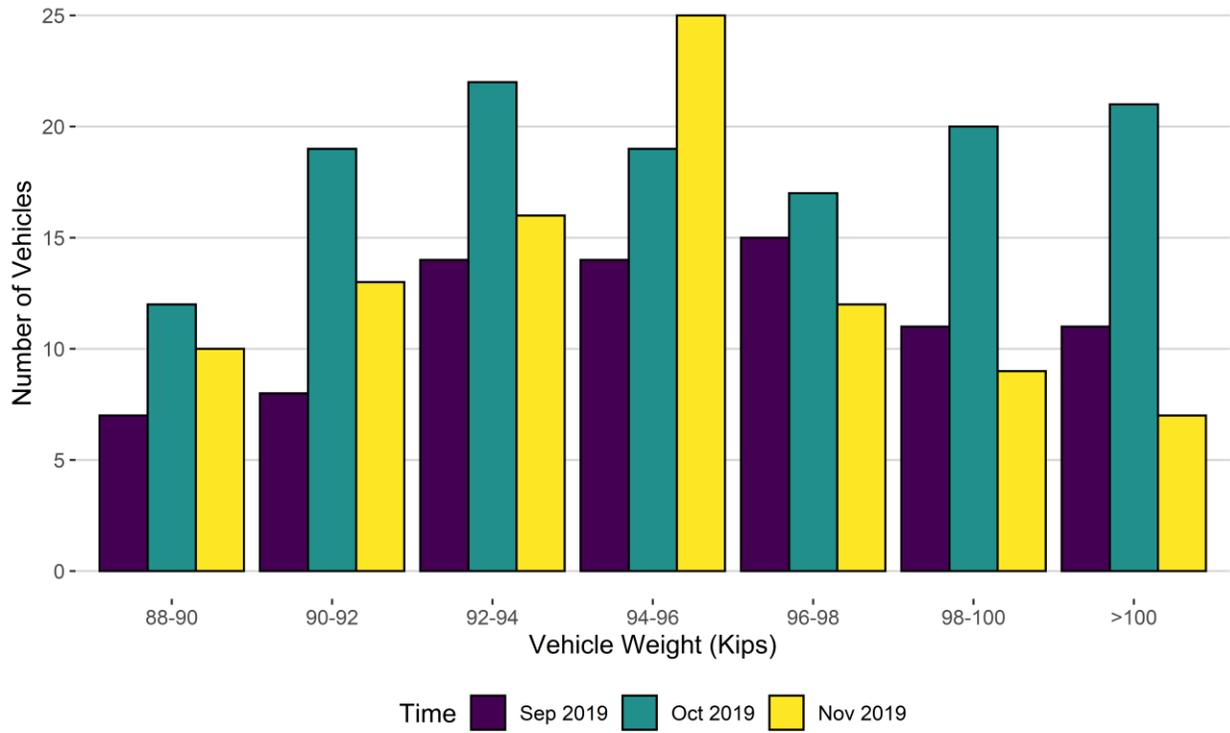
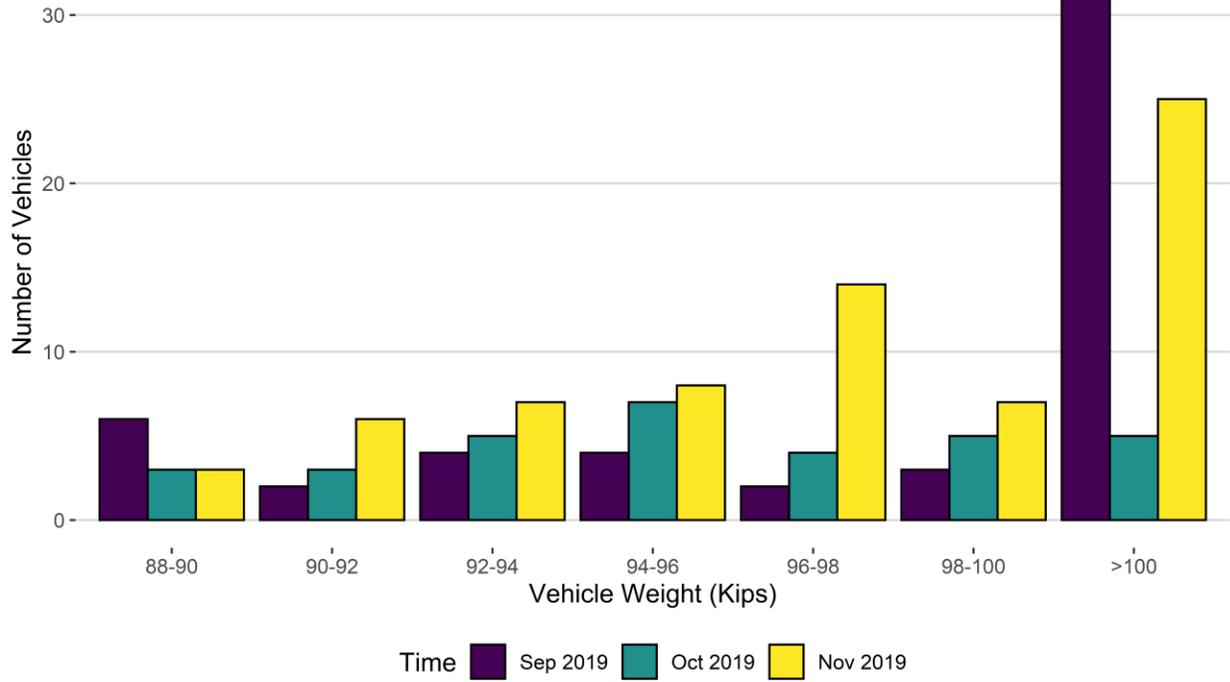


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Sep 2019</i>	<i>Oct 2019</i>	<i>Nov 2019</i>
88-90	7	12	10
90-92	8	19	13
92-94	14	22	16
94-96	14	19	25
96-98	15	17	12
98-100	11	20	9
>100	11	21	7
Total	80	130	92

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



<i>Vehicle Weights (Kips)</i>	<i>Sep 2019</i>	<i>Oct 2019</i>	<i>Nov 2019</i>
88-90	6	3	3
90-92	2	3	6
92-94	4	5	7
94-96	4	7	8
96-98	2	4	14
98-100	3	5	7
>100	33	5	25
Total	54	32	70

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

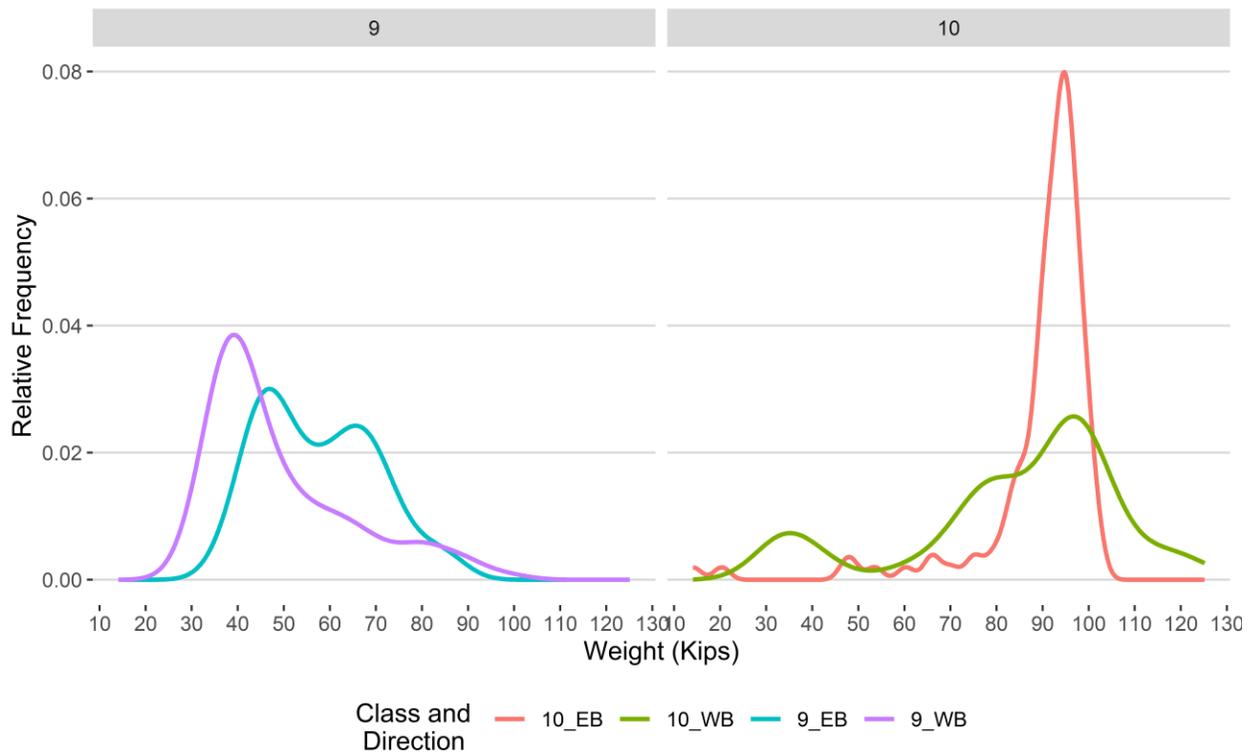


Figure 9 - Freight Percentage by Direction and Class

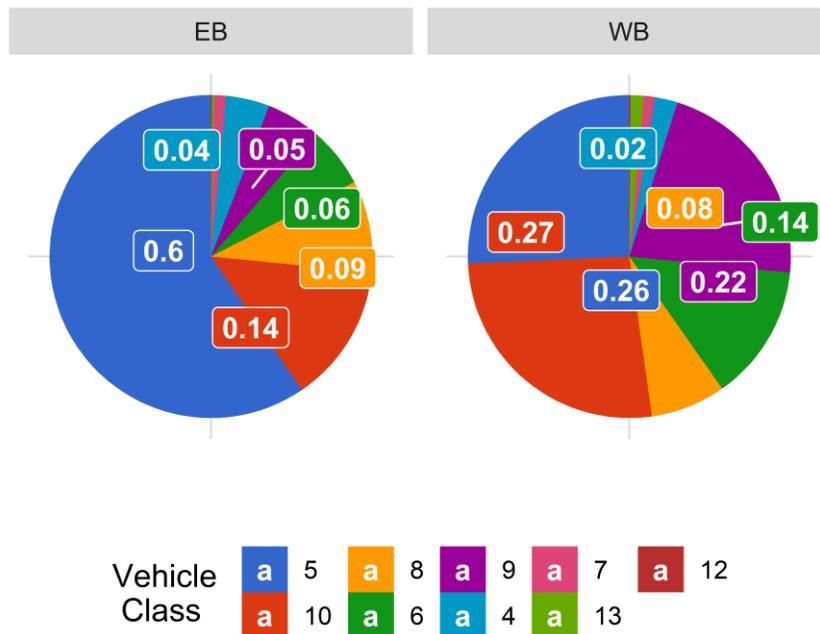


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

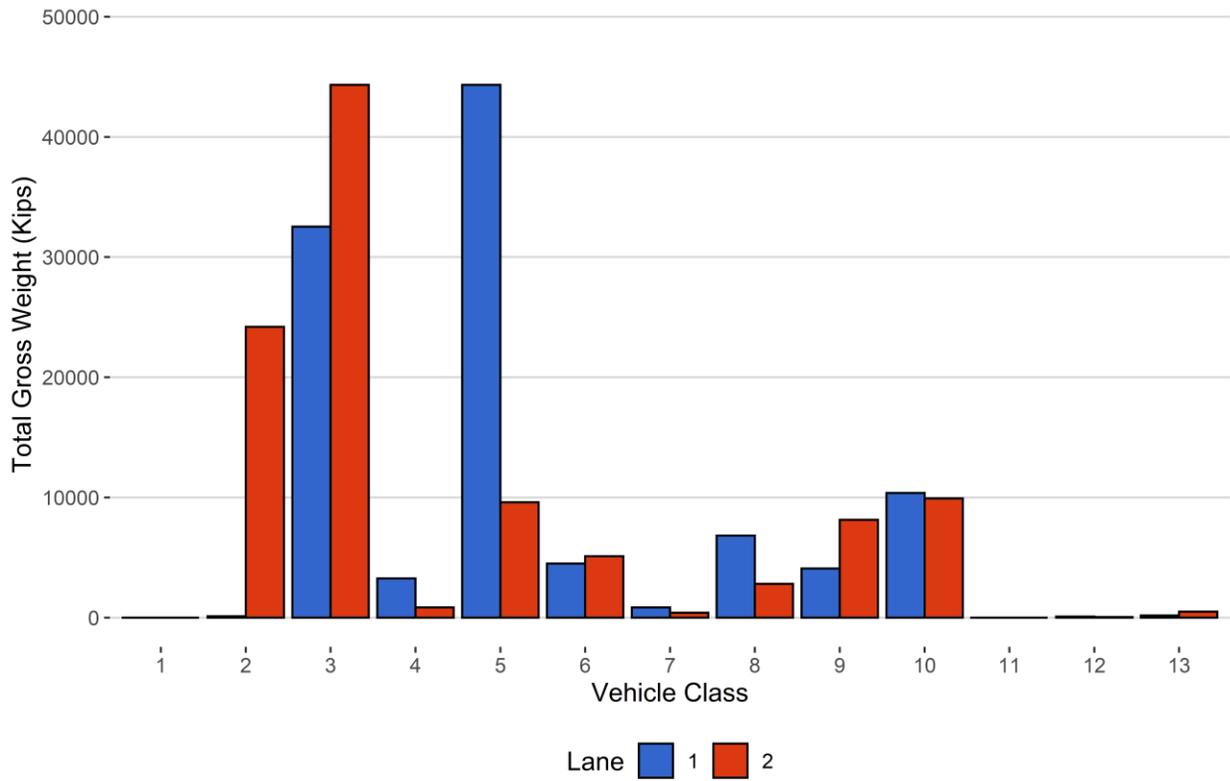


Figure 11 - Total Gross Vehicle Weight t

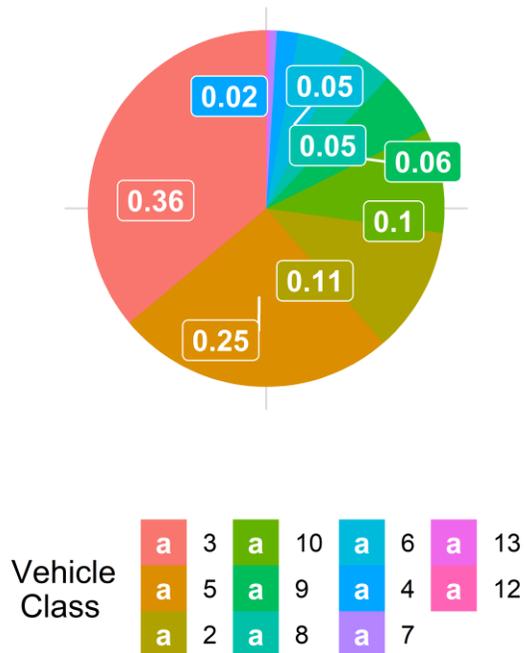


Figure 12 - Total ESALs by Class and Lane

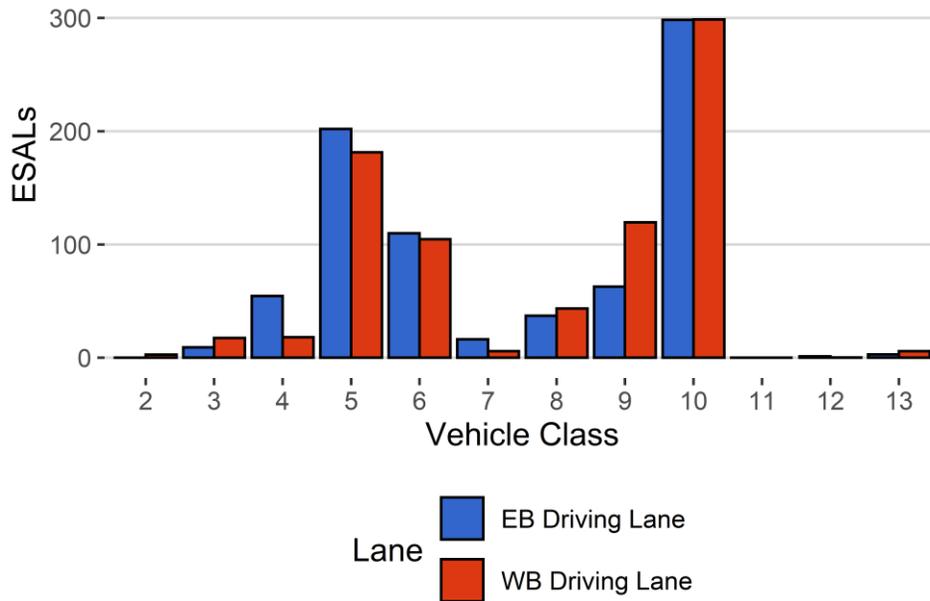


Figure 13 - ESALs by Class

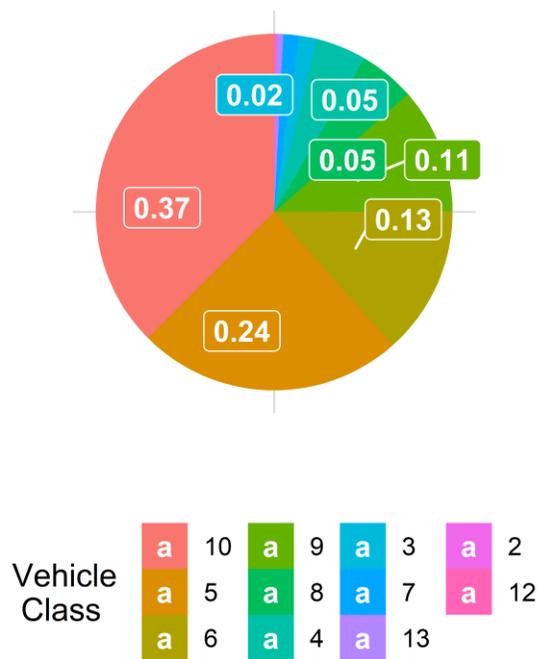


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
September 2015	10.51	0.00	10.69	0.00
October 2015	11.07	5.36	10.79	0.99
November 2015	10.85	3.20	10.93	2.24
December 2015	11.03	4.92	11.19	4.71
January 2016	10.56	0.50	11.08	3.69
February 2016	10.52	0.10	11.19	4.71
March 2016	11.19	6.46	11.36	6.28
April 2016	11.21	6.66	11.07	3.55
May 2016	11.04	5.06	10.90	2.02
June 2016	10.95	4.18	10.71	0.24
July 2016	10.84	3.19	10.52	-1.58
September 2016	10.70	1.83	10.72	0.36
October 2016	10.79	2.64	10.77	0.75
November 2016	10.92	3.86	11.04	3.35
December 2016	10.79	2.64	10.69	0.00
January 2017	10.93	4.00	10.58	-0.98
February 2017	10.85	3.21	10.96	2.52
March 2017	11.07	5.33	11.13	4.15
April 2017	11.01	4.78	11.24	5.21
May 2017	10.78	2.61	10.82	1.25
June 2017	10.98	4.51	11.12	4.08
July 2017	11.01	4.77	10.79	0.99
September 2017	11.03	4.93	10.93	2.27
October 2017	10.68	1.65	10.74	0.55
September 2019	11.22	6.81	11.08	3.68
October 2019	11.60	10.40	10.99	2.82
November 2019	11.37	8.15	10.92	2.16

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	229	6859	25.1	0	0
3	432	12948	47.4	0	0
4	6	169	0.6	2	0.6
5	200	5989	21.9	45	14.3
6	9	268	1	29	9.2
7	1	23	0.1	12	3.8
8	18	528	1.9	7	2.2
9	8	249	0.9	27	8.6
10	8	247	0.9	188	59.7
11	0	0	0	0	0
12	0	2	0	1	0.3
13	0	11	0	4	1.3
TOTAL	910	27290	100	315	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>
2019-11-25	Monday	15:37:38	10	WB	2	125.14
2019-11-23	Saturday	12:01:04	10	WB	2	122.88
2019-11-22	Friday	13:30:57	10	WB	2	120.4
2019-11-19	Tuesday	15:24:03	10	WB	2	119.21
2019-11-19	Tuesday	04:59:34	10	WB	2	118.99
2019-11-20	Wednesday	04:48:37	9	WB	2	118.59
2019-11-14	Thursday	17:32:43	10	WB	2	116.65
2019-11-15	Friday	04:55:18	10	WB	2	114.83
2019-11-22	Friday	10:50:46	10	WB	2	114.82
2019-11-18	Monday	12:11:12	10	WB	2	113.86

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	133	8	6	3161	101	643
5	EB	8	5076	2930	57.7	24443	19888	3638
6	EB	19	110	0	0	4502	0	1206
7	EB	11.5	14	0	0	852	0	345
8	EB	31	408	372	91.2	1535	5292	209
9	EB	33	71	0	0	4083	0	870
10	EB	33.5	116	2	1.7	10337	34	3259
12	EB	36.5	1	0	0	79	0	21
13	EB	31.5	2	0	0	177	0	57
TOTAL	****	****	5931	3312	****	49169	****	10249
<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	27	6	22.2	768	78	227
5	WB	8	608	94	15.5	8904	691	2396
6	WB	19	144	1	0.7	5087	18	1185
7	WB	11.5	8	0	0	412	0	160
8	WB	31	93	44	47.3	1909	899	195
9	WB	33	165	9	5.5	7851	283	1352
10	WB	33.5	118	5	4.2	9766	156	2990
12	WB	36.5	1	0	0	49	0	6
13	WB	31.5	8	0	0	491	0	120
TOTAL	****	****	1172	159	****	35237	****	8630
GRAND TOTAL	****	****	7103	3471	252	84405	27442	18878

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>EB</i>	<i>WB</i>	<i>Total</i>	<i>Percentage</i>
2	109	24195	24304	11.4
3	32534	44328	76862	36.1
4	3262	846	4108	1.9
5	44331	9595	53926	25.3
6	4502	5105	9607	4.5
7	852	412	1264	0.6
8	6827	2808	9635	4.5
9	4083	8134	12217	5.7
10	10372	9922	20294	9.5
12	79	49	127	0.1
13	177	491	668	0.3
TOTAL	107127	105886	213013	100
GVW/LANE	50.29	49.71	100	0.05

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>EB</i>	<i>WB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
2	0	3	3	0.2	0.0013
3	9	17	27	1.7	0.0047
4	54	18	73	4.6	0.94
5	202	182	384	24.1	0.14
6	110	105	214	13.5	1.72
7	16	6	22	1.4	1.82
8	37	44	81	5.1	0.34
9	63	120	182	11.4	1.57
10	298	299	597	37.5	5.09
12	1	0	1	0.1	1.07
13	3	6	9	0.6	1.34
TOTAL	794	798	1592	100	14
ESALS/LANE	49.9	50.1	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>
Sep 2019	36383	1221	298	27458	75.5	8925.3	24.5
Oct 2019	NA	NA	NA	NA	NA	NA	NA
Nov 2019	27290	942	249	19806	72.6	7483.6	27.4
TOTAL	NA	-	-	NA	-	NA	-
AVERAGE	NA	NA	NA	NA	NA	NA	NA

###ESALS

<i>Month</i>	<i>ESALS EB Driving Lane</i>	<i>ESALS WB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Sep 2019	811	946	1758	35.3
Oct 2019	1023	919	1941	60.8
Nov 2019	811	801	1612	51.1
TOTAL	2645	-	-	-
AVERAGE	882	888	1770	49

###Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Sep 19	134778	139600	274377
Oct 19	132790	128310	261100
Nov 19	108549	106060	214609
TOTAL	376117	373970	750087
AVERAGE	125372	124657	250029

###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>
Sep 2019	304	0.9	3.4	134	58
Oct 2019	365	1.2	4.3	162	51
Nov 2019	319	1.2	4.3	162	48
TOTAL	988	-	-	458	157
AVERAGE	329.3	1.1	4	152.7	52.3

###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>
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Sep 2019	10568	10398	20967	50.4	49.6
Oct 2019	12708	10131	22839	55.6	44.4
Nov 2019	10249	8630	18878	54.3	45.7
TOTAL	33525	29159	62684	-	-
AVERAGE	11175	9719.7	20894.7	53.4	46.6