

DECEMBER 2019



**WIM #37
I-94, MP 200.1
OTSEGO, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #37 is located on I-94 near Otsego in Wright county. The WIM is located only on the westbound (WB) side of I-94, meaning that all data mentioned in this report pertains to WB traffic only (Lanes 1 and 2).

System Operation

WIM #37 was operational for the entire month of December 2019. Volume was computed using all monthly data.

System Calibration

WIM #37 was most recently calibrated on 2016-08-01. Table 1 summarizes the front axle weights of class 9s by lane ¹. Figure 1 shows the distribution of gross vehicle weights (GVW) in the Class 9s at this site for the last 12 months 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: 887059 | Passenger Vehicles: 783144 | Heavy Commercial Vehicles: 103915

Monthly Average Daily Traffic (MADT): 28615 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 3352

See Table 2 for vehicle class breakdown

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

Volume trends. 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), WB PVs generally reached peak volume levels between 02 PM and 04 PM.

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling WB typically reached peak volume levels 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 103915 HCVs, 8176 of them were overweight ³. These overweight HCVs contributed to 1% of total monthly volume, and 8.3% of total monthly HCV volume. WB overweight vehicles typically reached highest numbers 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 (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 December.

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 ,3428 WB vehicles exceeded 88,000 pounds (2897 vehicles were Class 9's; 354 vehicles were Class 10'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 9's and 10's in December 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling WB Data also suggests that there were more NA Class 10's than NA traveling in the WB direction.

Freight Totals. A total of 829086 tons of freight was recorded to have crossed the WIM. See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 86817 is approximately 1.2 miles east of WIM #37 and Bridge No. 86813 is approximately 4.7 miles west of WIM #37. WIM #37 recorded a total of 887059 vehicles with a combined GVW of 8245999 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 115398 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 49% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 39% 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>

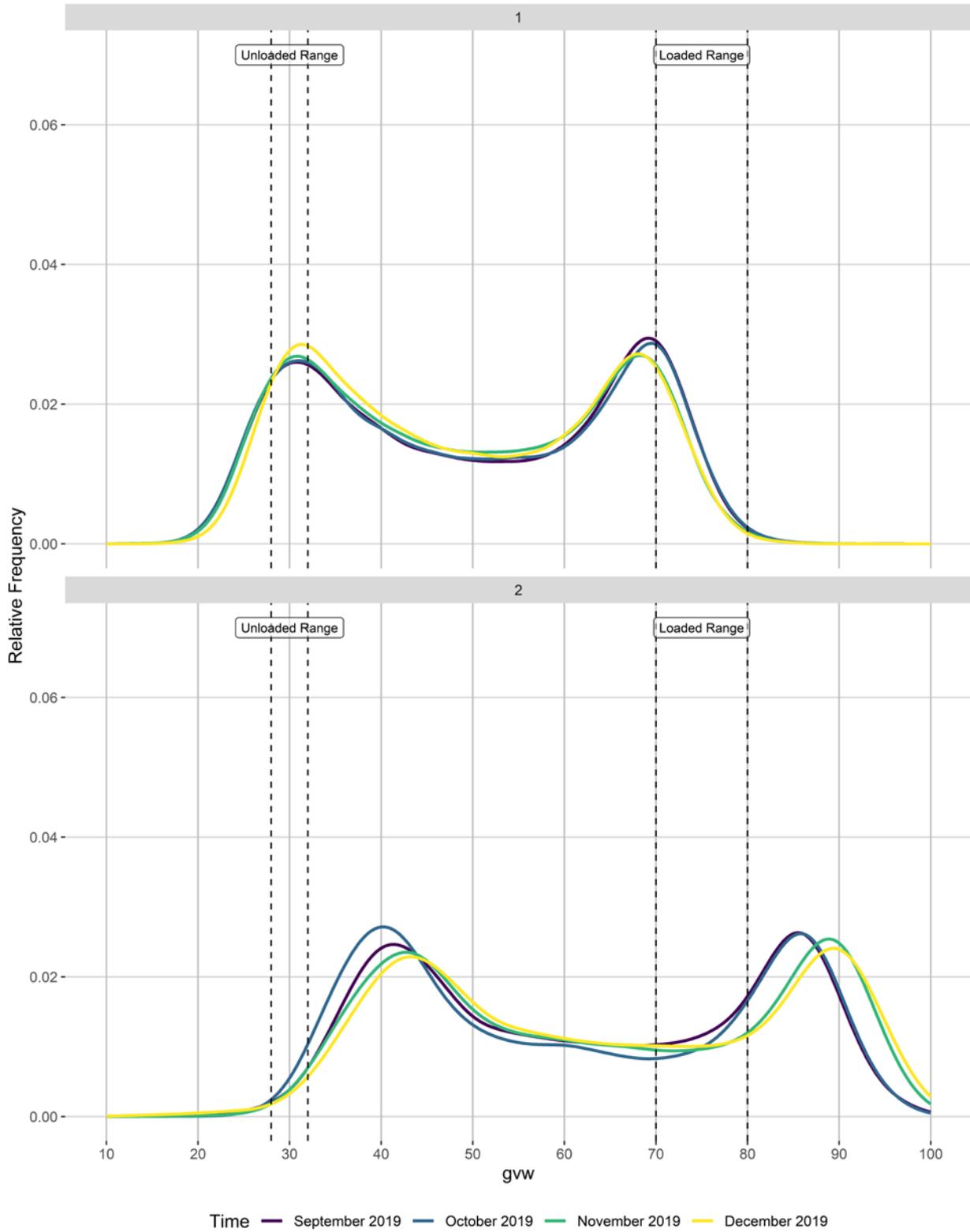
- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of +/-9% of baseline calibration values
- ² Previous WIM research indicates that unloaded 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.

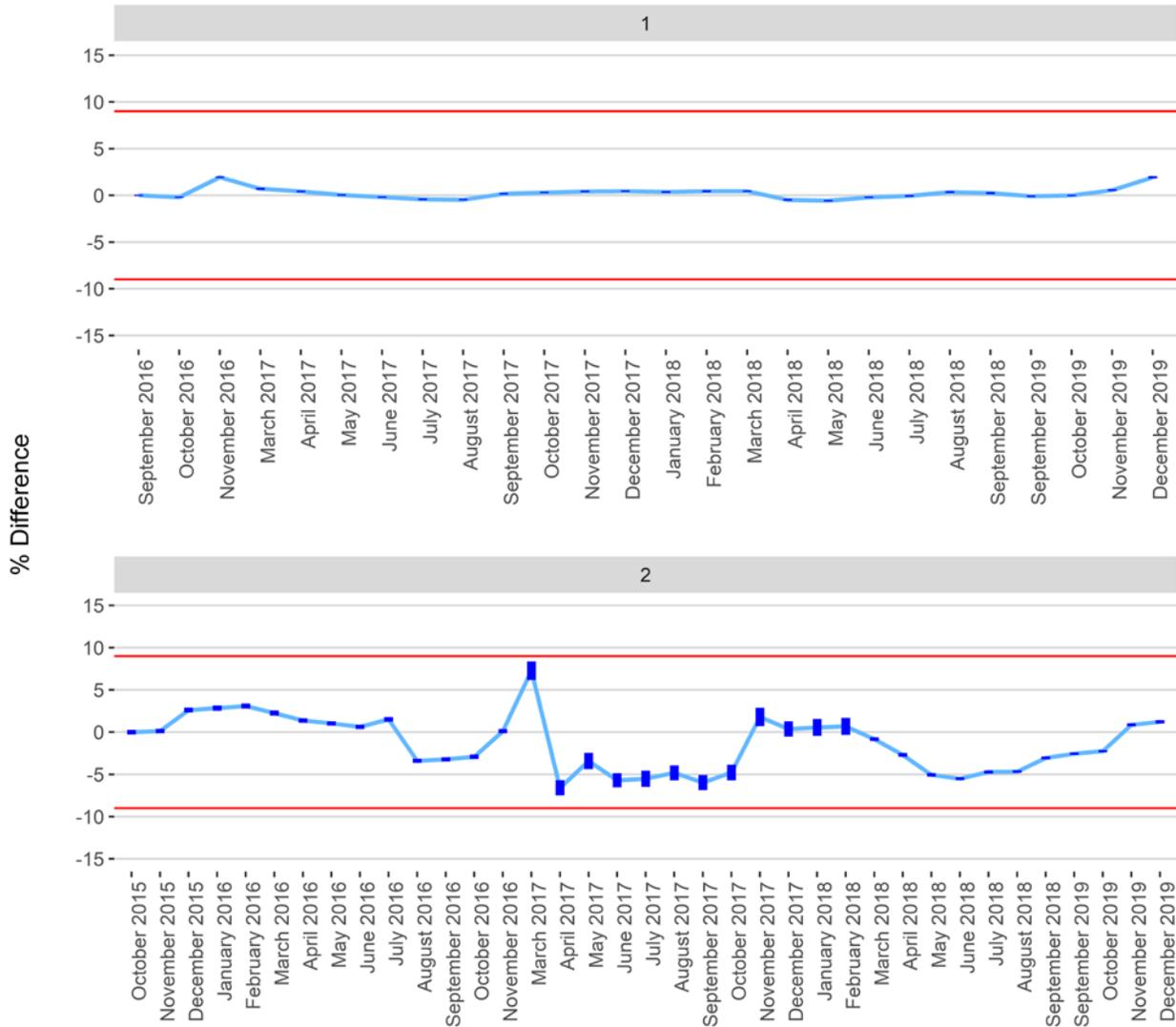
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Figure 1 - Monthly Class 9 GVW Histogram



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

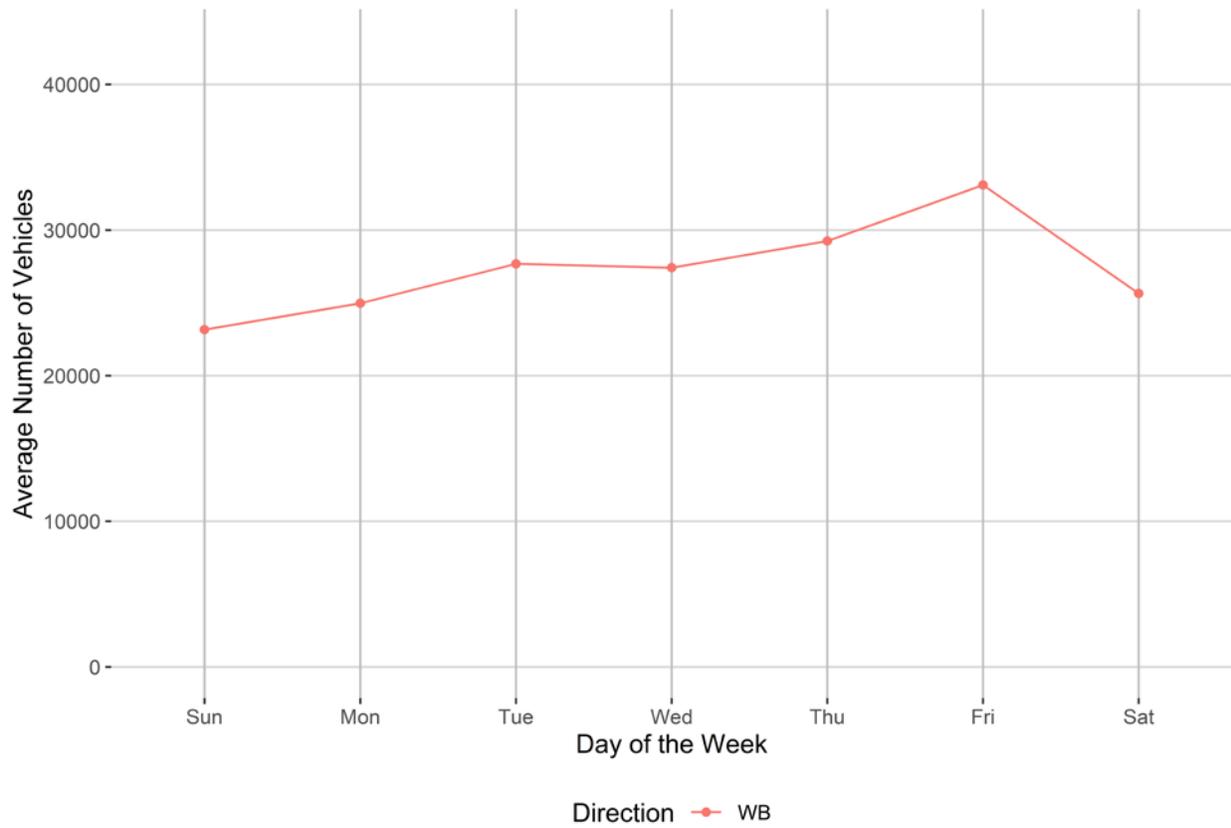


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

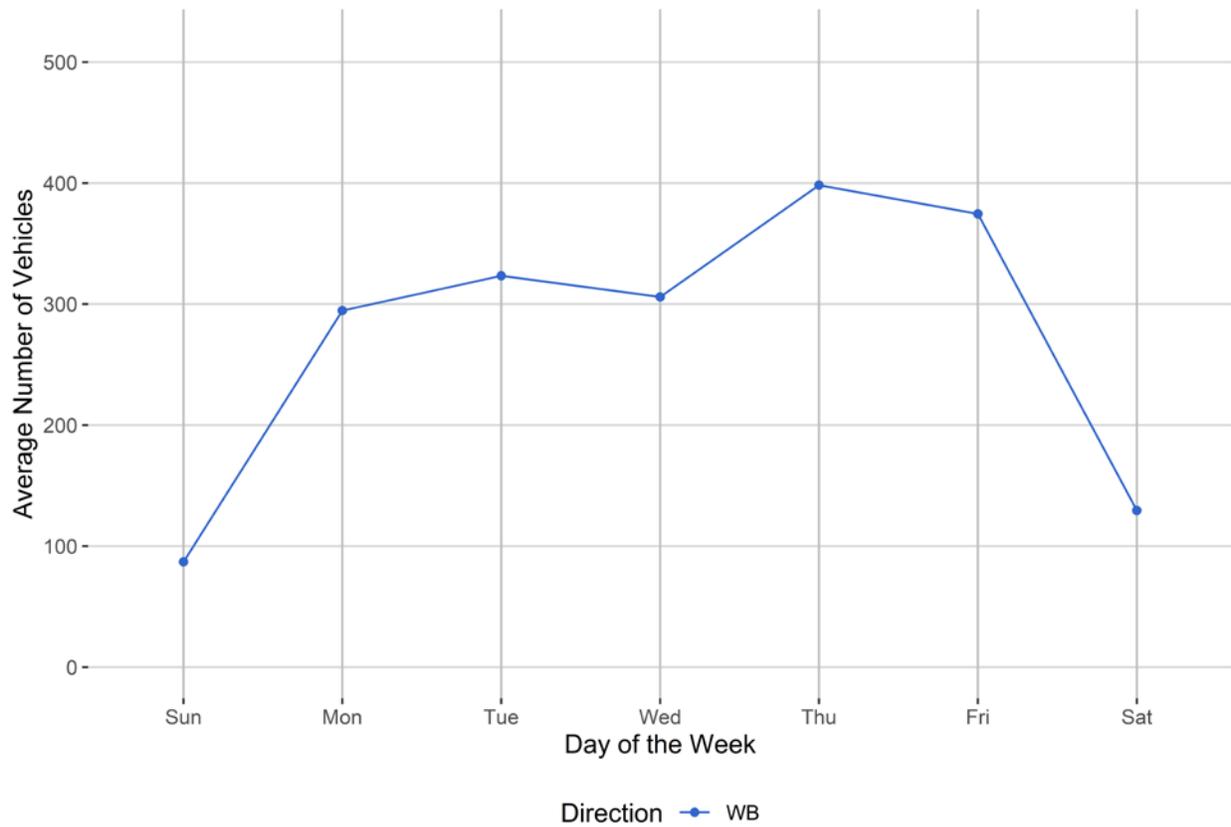


Figure 4 - Passenger Vehicles vs. Hour of the Day

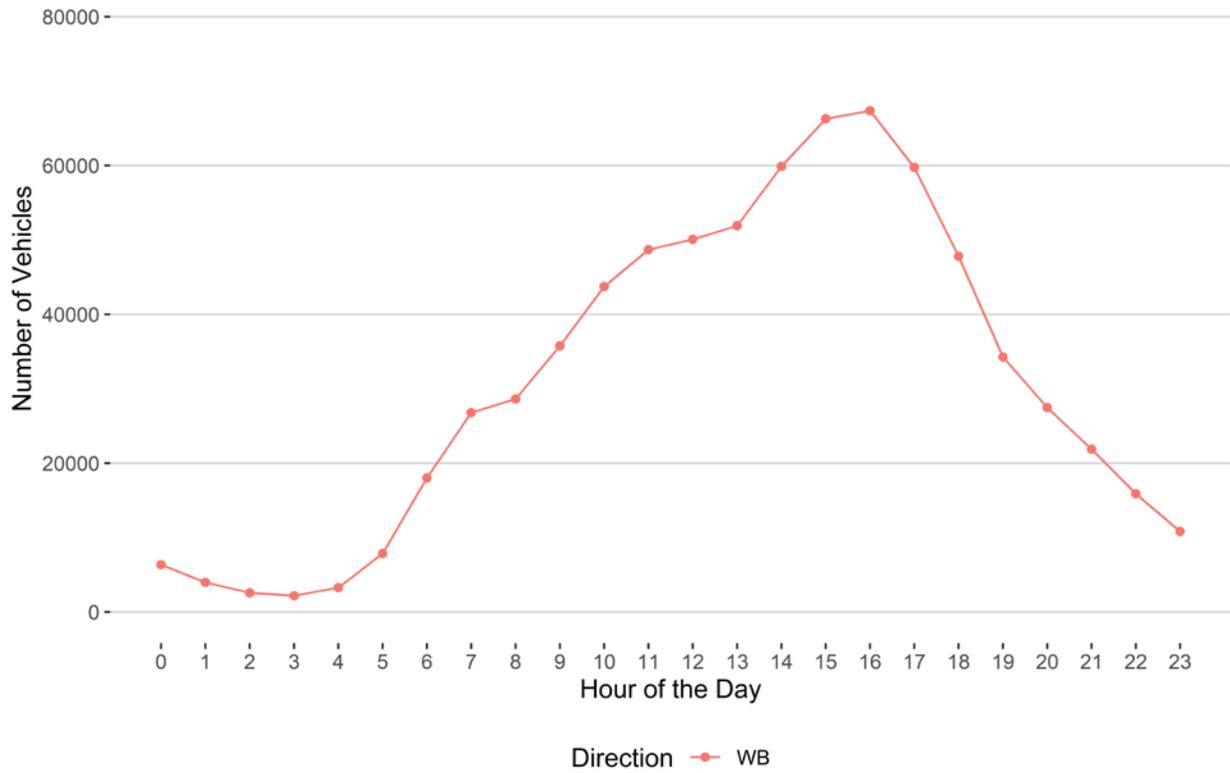


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

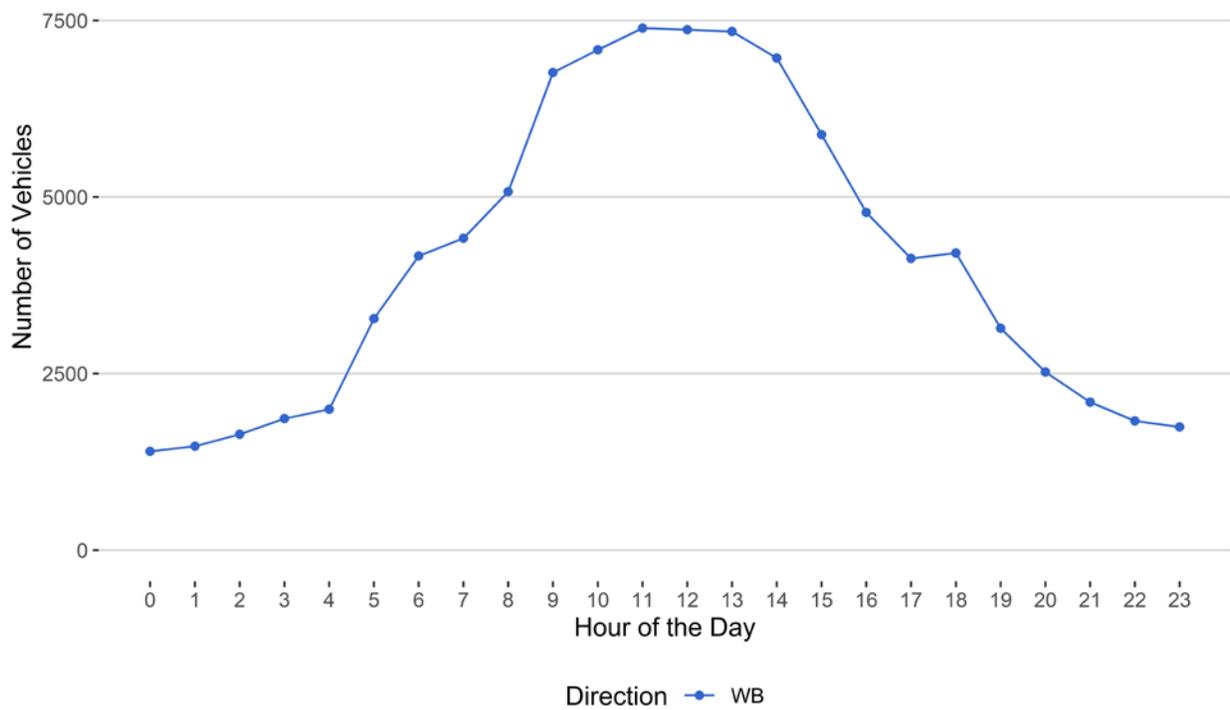


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

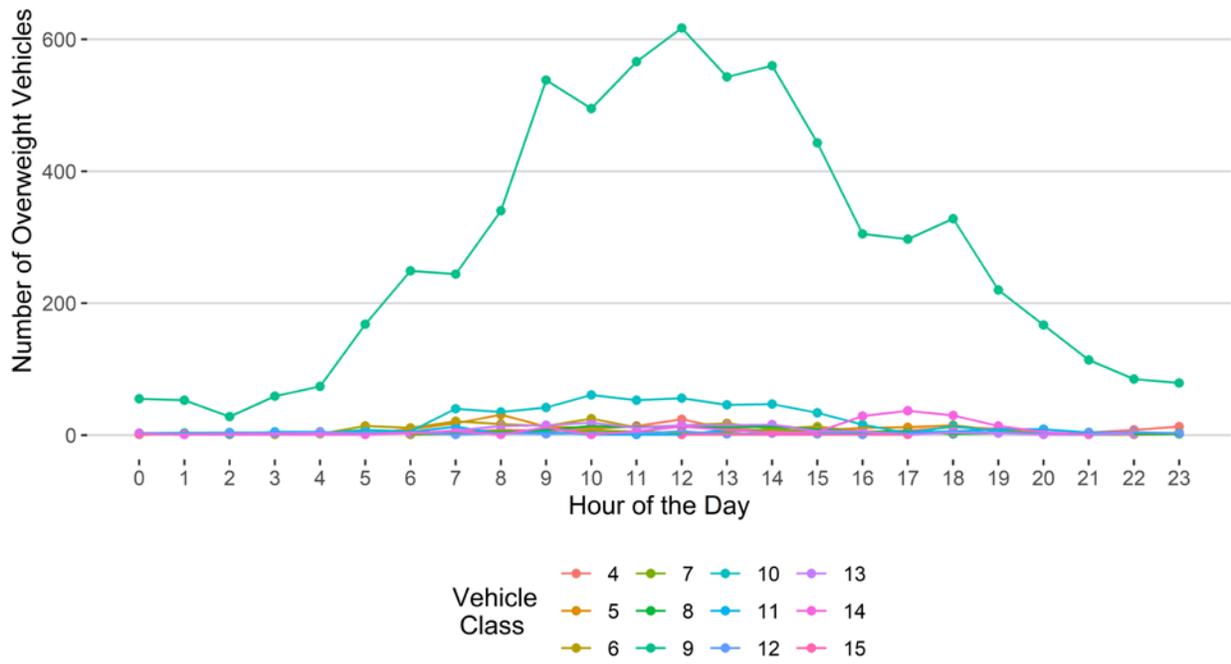


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

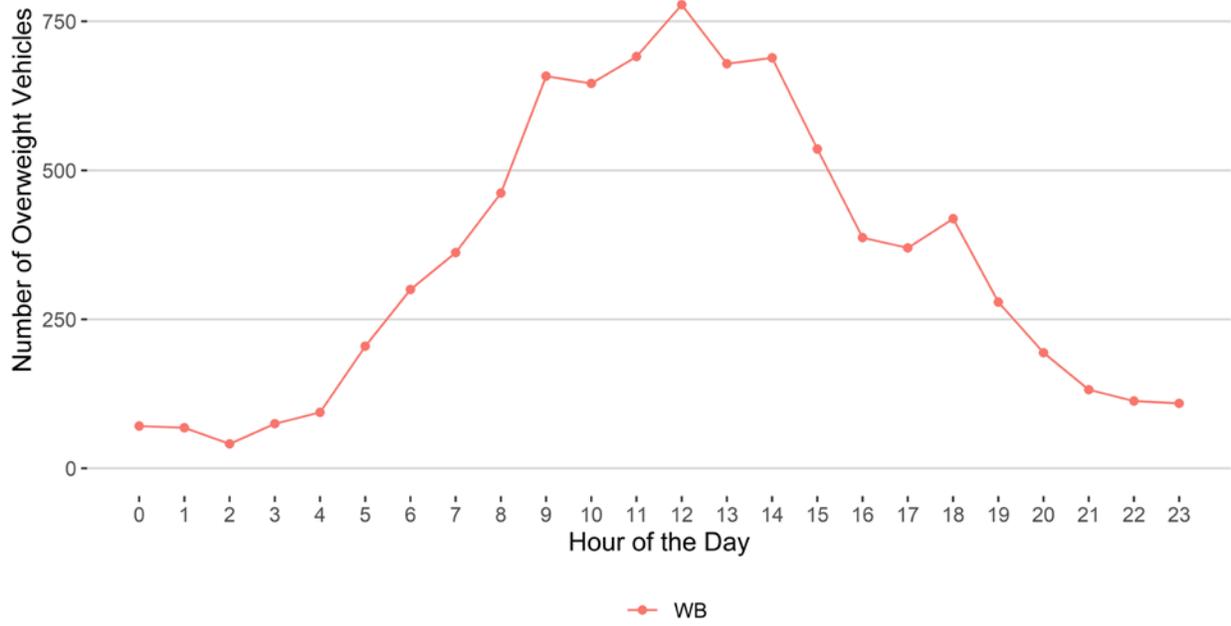
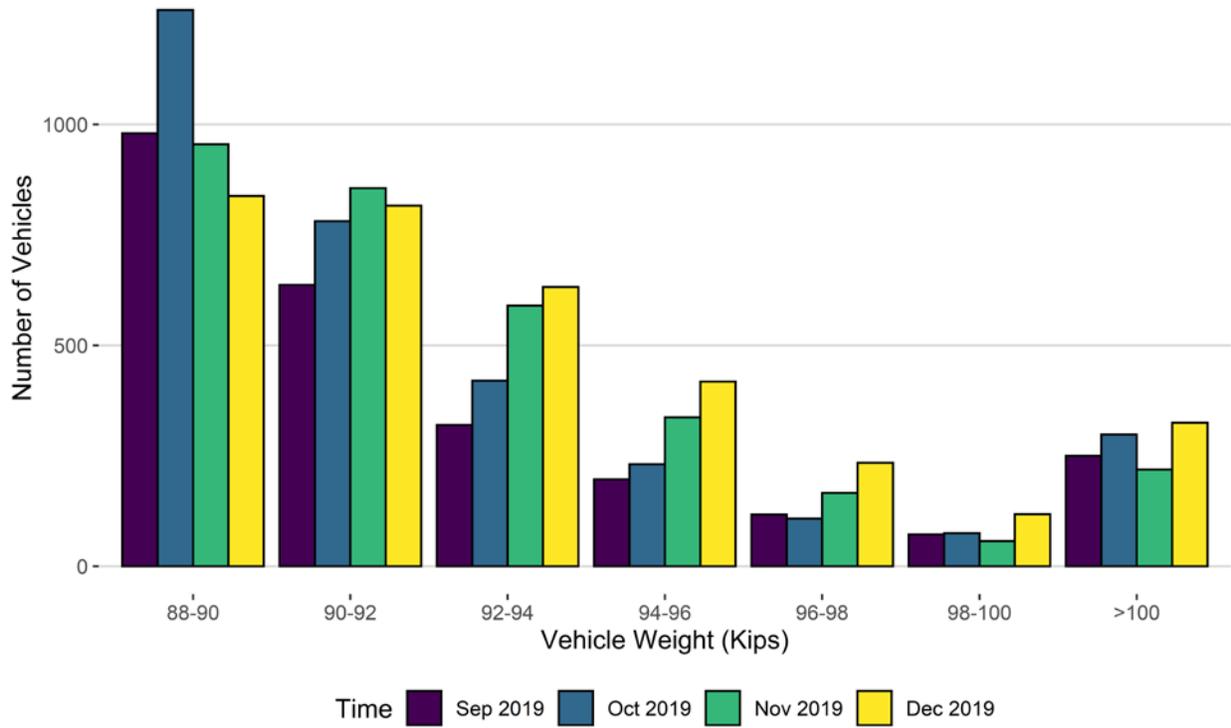


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Sep 2019</i>	<i>Oct 2019</i>	<i>Nov 2019</i>	<i>Dec 2019</i>
88-90	980	1259	955	838
90-92	637	781	856	816
92-94	320	420	590	632
94-96	197	231	337	418
96-98	117	108	166	234
98-100	72	75	57	118
>100	250	298	219	325
Total	2573	3172	3180	3381

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

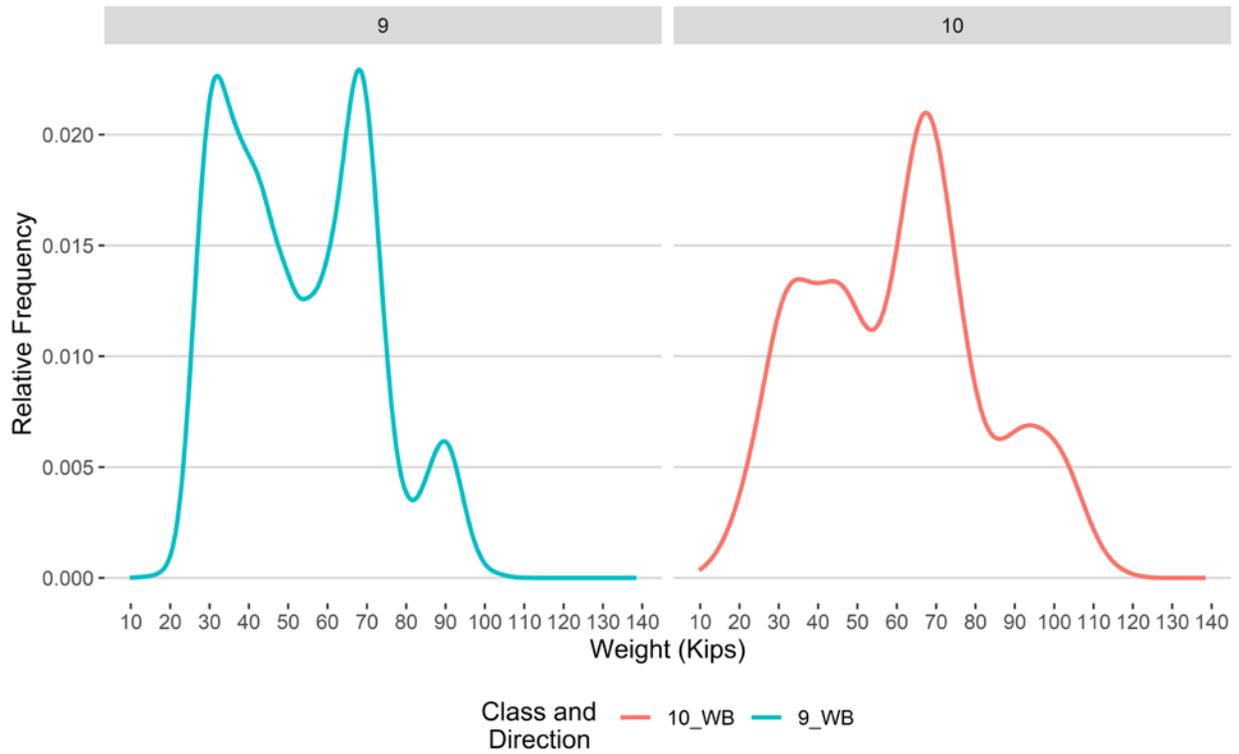


Figure 9 - Freight Percentage by Direction and Class

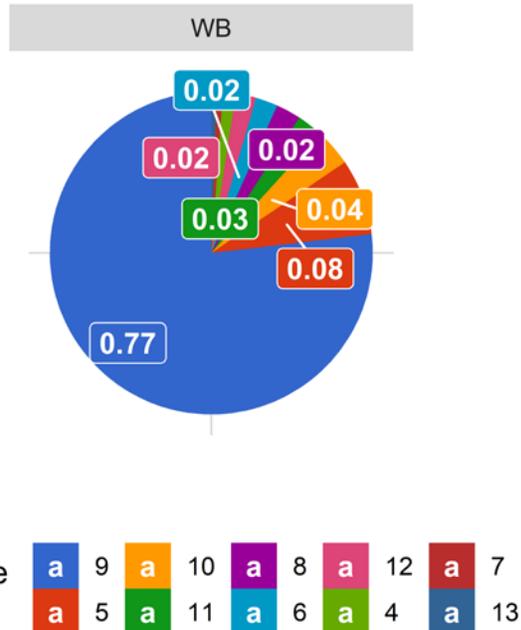


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

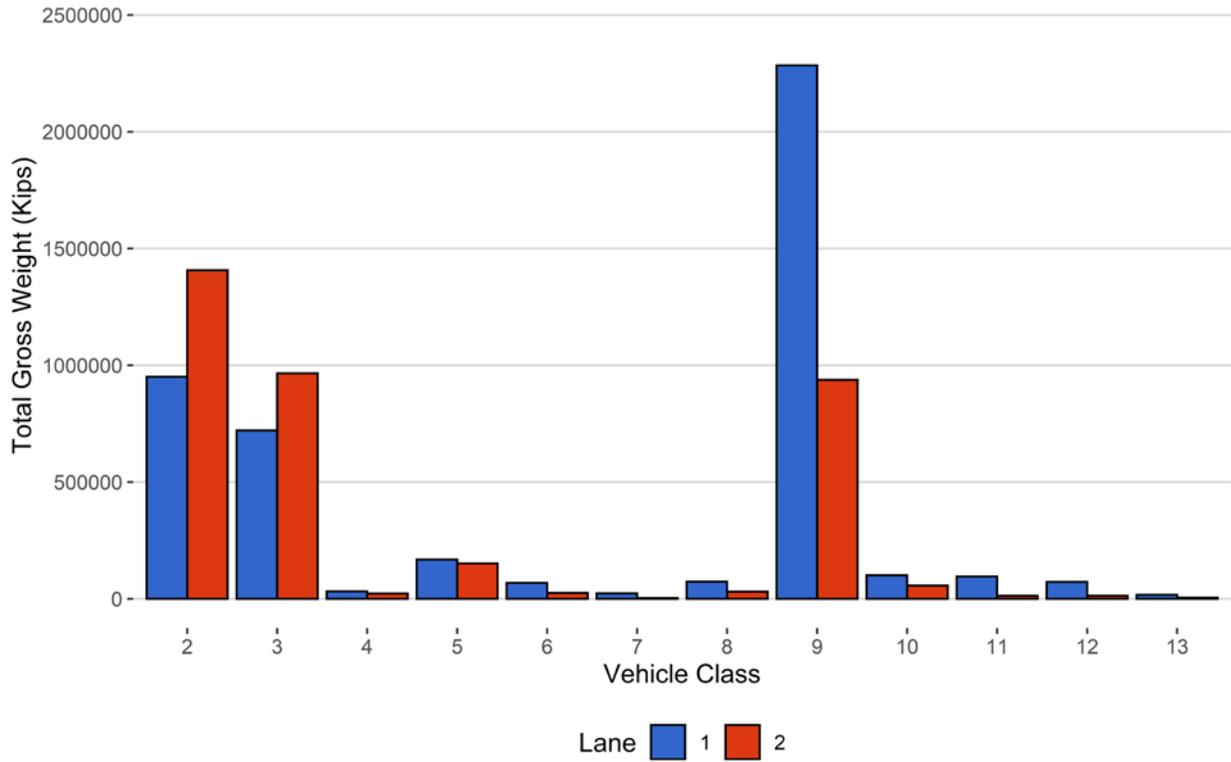


Figure 11 - Total Gross Vehicle Weight t

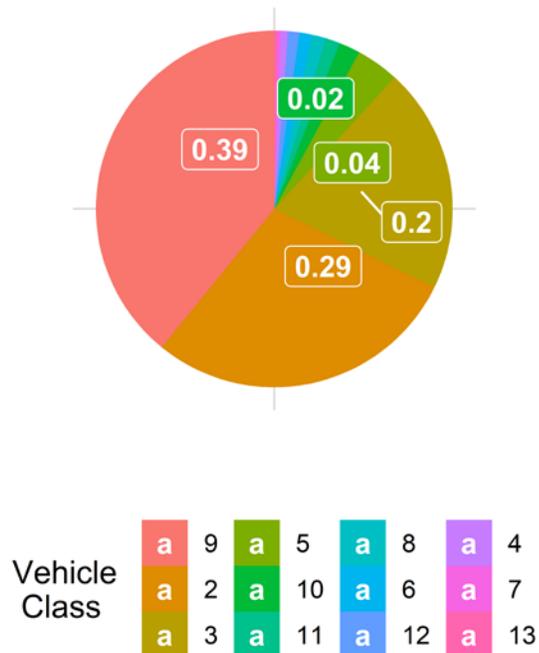


Figure 12 - Total ESALs by Class and Lane

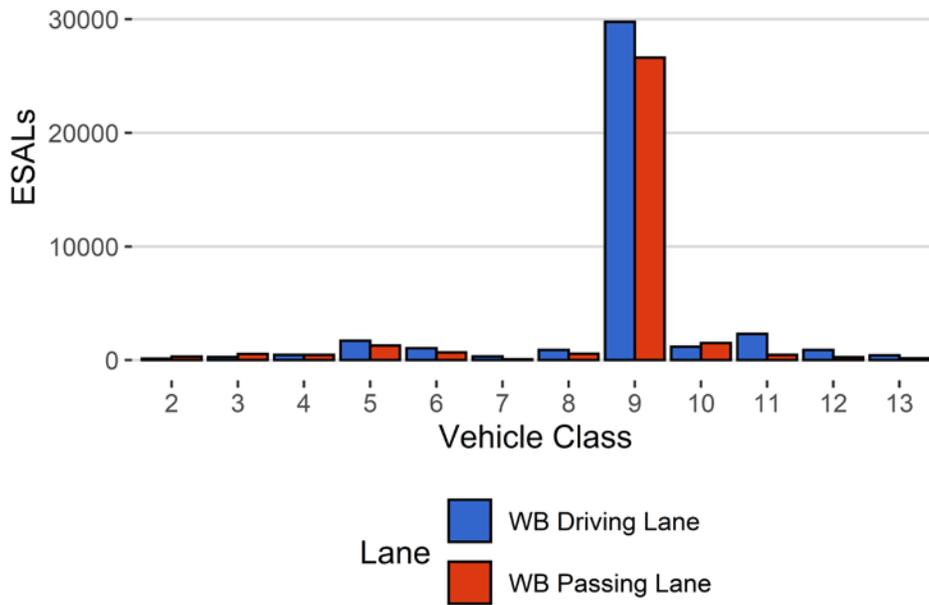


Figure 13 - ESALs by Class

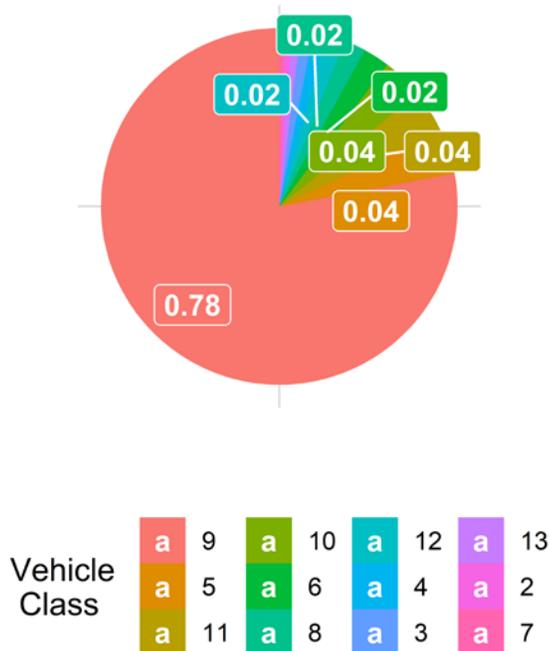


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
October 2015	NA	NA	12.62	0.00
November 2015	NA	NA	12.63	0.13
December 2015	NA	NA	12.95	2.61
January 2016	NA	NA	12.98	2.85
February 2016	NA	NA	13.01	3.09
March 2016	NA	NA	12.90	2.25
April 2016	NA	NA	12.79	1.38
May 2016	NA	NA	12.75	1.03
June 2016	NA	NA	12.70	0.61
July 2016	NA	NA	12.81	1.51
August 2016	NA	NA	12.19	-3.40
September 2016	10.50	0.00	12.21	-3.22
October 2016	10.48	-0.20	12.25	-2.92
November 2016	10.70	1.94	12.63	0.12
March 2017	10.57	0.70	13.54	7.27
April 2017	10.54	0.42	11.79	-6.60
May 2017	10.50	0.04	12.19	-3.41
June 2017	10.48	-0.19	11.90	-5.71
July 2017	10.45	-0.42	11.92	-5.51
August 2017	10.45	-0.47	12.01	-4.82
September 2017	10.52	0.16	11.86	-5.97
October 2017	10.53	0.30	12.02	-4.78
November 2017	10.54	0.42	12.84	1.79
December 2017	10.55	0.44	12.67	0.37
January 2018	10.54	0.36	12.69	0.55
February 2018	10.55	0.44	12.70	0.68
March 2018	10.55	0.45	12.51	-0.83
April 2018	10.45	-0.48	12.28	-2.69
May 2018	10.44	-0.57	11.98	-5.06
June 2018	10.48	-0.21	11.92	-5.52
July 2018	10.49	-0.06	12.02	-4.72
August 2018	10.54	0.35	12.03	-4.67
September 2018	10.52	0.24	12.23	-3.05
September 2019	10.49	-0.09	12.30	-2.55
October 2019	10.50	-0.01	12.33	-2.26
November 2019	10.56	0.56	12.73	0.86
December 2019	10.70	1.93	12.77	1.22

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>
2	17107	530330	59.8	0	0
3	8155	252814	28.5	0	0
4	68	2109	0.2	161	2
5	784	24314	2.7	211	2.6
6	101	3132	0.4	203	2.5
7	17	541	0.1	42	0.5
8	114	3531	0.4	123	1.5
9	2064	63999	7.2	6627	81.1
10	89	2746	0.3	494	6
11	59	1838	0.2	102	1.2
12	47	1454	0.2	70	0.9
13	8	251	0	143	1.7
TOTAL	28615	887059	100	8176	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>
2019-12-06	Friday	00:23:44	9	WB	2	138.53
2019-12-07	Saturday	18:26:52	9	WB	2	130.07
2019-12-28	Saturday	11:54:16	10	WB	1	128.95
2019-12-19	Thursday	14:50:29	10	WB	1	120.91
2019-12-30	Monday	16:24:43	9	WB	1	118.23
2019-12-23	Monday	11:30:18	10	WB	2	117.43
2019-12-20	Friday	07:04:31	9	WB	1	116.87
2019-12-01	Sunday	14:03:06	10	WB	2	116.76
2019-12-01	Sunday	13:30:03	9	WB	1	116.73
2019-12-12	Thursday	03:22:14	10	WB	2	116.29

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	WB	15	2000	268	13.4	50090	3555	12055
5	WB	8	23062	971	4.2	312552	6909	67912
6	WB	19	2971	199	6.7	90133	3463	18733
7	WB	11.5	513	0	0	26028	0	10064
8	WB	31	3349	1735	51.8	63620	40583	6793
9	WB	33	60703	10386	17.1	2921459	299833	630499
10	WB	33.5	2605	365	14	146911	10021	35935
11	WB	36.5	1743	28	1.6	107311	929	22357
12	WB	36.5	1379	13	0.9	84514	362	17328
13	WB	31.5	238	0	0	22319	0	7411
TOTAL	****	****	98563	13965	****	3824936	****	829086

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>WB Driving Lane</i>	<i>WB Passing Lane</i>	<i>Total</i>	<i>Percentage</i>
2	950581	1406548	2357129	28.6
3	720555	964952	1685507	20.5
4	31408	22237	53645	0.7
5	168178	151283	319462	3.9
6	68404	25193	93596	1.1
7	22860	3168	26028	0.3
8	73657	30546	104203	1.3
9	2283827	937464	3221291	39.1
10	100900	56032	156932	1.9
11	95517	12723	108240	1.3
12	71907	12970	84876	1
13	16995	5325	22319	0.3
TOTAL	4604789	3628439	8233228	100
GVW/LANE	55.93	44.07	100	0

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>WB Driving Lane</i>	<i>WB Passing Lane</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
2	124	302	425	0.6	0.0017
3	282	542	824	1.1	0.0069
4	470	453	923	1.3	0.92
5	1713	1283	2996	4.1	0.26
6	1053	673	1726	2.4	1.16
7	321	70	390	0.5	1.52
8	898	555	1453	2	0.87
9	29763	26610	56373	78	1.86
10	1187	1503	2690	3.7	2.06
11	2309	455	2764	3.8	3.16
12	906	260	1166	1.6	1.69
13	428	157	585	0.8	4.72
TOTAL	39454	32861	72316	100	18
ESALS/LANE	54.6	45.4	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	1008591	33620	4586	871021	86.4	137569.5	13.6
Oct 2019	1016074	32777	4867	865184	85.1	150890	14.9
Nov 2019	889379	29646	4002	769306	86.5	120072.5	13.5
Dec 2019	887059	28615	3352	783144	88.3	103914.9	11.7
TOTAL	3801103	-	-	3288655	-	512447	-
AVERAGE	950276	31164	4202	822164	87	128112	13

###ESALs

<i>Month</i>	<i>ESALS WB Driving Lane</i>	<i>ESALS WB Passing Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Sep 2019	57713	282452	340165	34.4
Oct 2019	93325	381848	475173	33.7
Nov 2019	52720	39396	92116	1.2
Dec 2019	74157	40214	114371	0.8
TOTAL	277916	-	-	-
AVERAGE	69479	185977	255456	18

###Gross Vehicle Weight

<i>Month</i>	<i>GVW WB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>Total GVW Kips</i>
Sep 2019	5780096	4752543	10532640
Oct 2019	8992436	5775843	14768279
Nov 2019	5504682	3625854	9130535
Dec 2019	4616178	3637654	8253831
TOTAL	24893392	17791893	42685285
AVERAGE	6223348	4447973	10671321

###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	15331	1.6	11.1	2659	388
Oct 2019	20027	1.5	9.9	3313	478
Nov 2019	9152	1.1	7.8	3189	279
Dec 2019	8356	1	8.4	3428	478
TOTAL	52866	-	-	12589	1623
AVERAGE	13216.5	1.3	9.3	3147.2	405.8

###Freight

<i>Month</i>	<i>WB Freight Tons</i>
Sep 2019	1169417
Oct 2019	1670063
Nov 2019	992830
Dec 2019	829086
TOTAL	4661396
AVERAGE	1165348.9