

AUGUST 2018



**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 August 2018. 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. Table 1 indicates that the class 9 front axle weights were all within +/- 9% of baseline calibration values for all lanes. 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: 42679 | Passenger Vehicles: 32687 | Heavy Commercial Vehicles: 9992

Monthly Average Daily Traffic (MADT): 1377 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 322

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 Tuesdays. WB vehicles typically reached highest volume levels on Saturdays, 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 03 PM and 05 PM. Similarly, WB PVs peaked in volume between 10 AM and 04 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 10 AM and 04 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 9992 HCVs, 372 of them were overweight³. These overweight HCVs contributed to 0.9% of total monthly volume, and 3.9% of total monthly HCV volume. EB overweight vehicles typically reached highest numbers on Tuesdays, 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 10 and class 6 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 50% 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 report⁴.

Using normal load limits ,86 EB vehicles exceeded 88,000 pounds (84 vehicles were Class 10's; 2 vehicles were Class 12's). Of vehicles traveling WB,

67 EB vehicles exceeded 88,000 pounds (59 vehicles were Class 10's; 8 vehicles were Class 13's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from August 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in August 2018. 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 24100 tons of freight was recorded to have crossed the WIM. More freight was shipped EB (53.9%) than WB (46.1%). 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 42679 vehicles with a combined GVW of 318216 kips (1 kip = 1,000 pounds = 0.5 tons) in August 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 2096 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 52.5% of all ESALs were recorded WB while 47.5% was observed EB. In particular, 26% of all ESALs were generated by the Class 10's (Class 10's were also responsible for generating 7% 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).

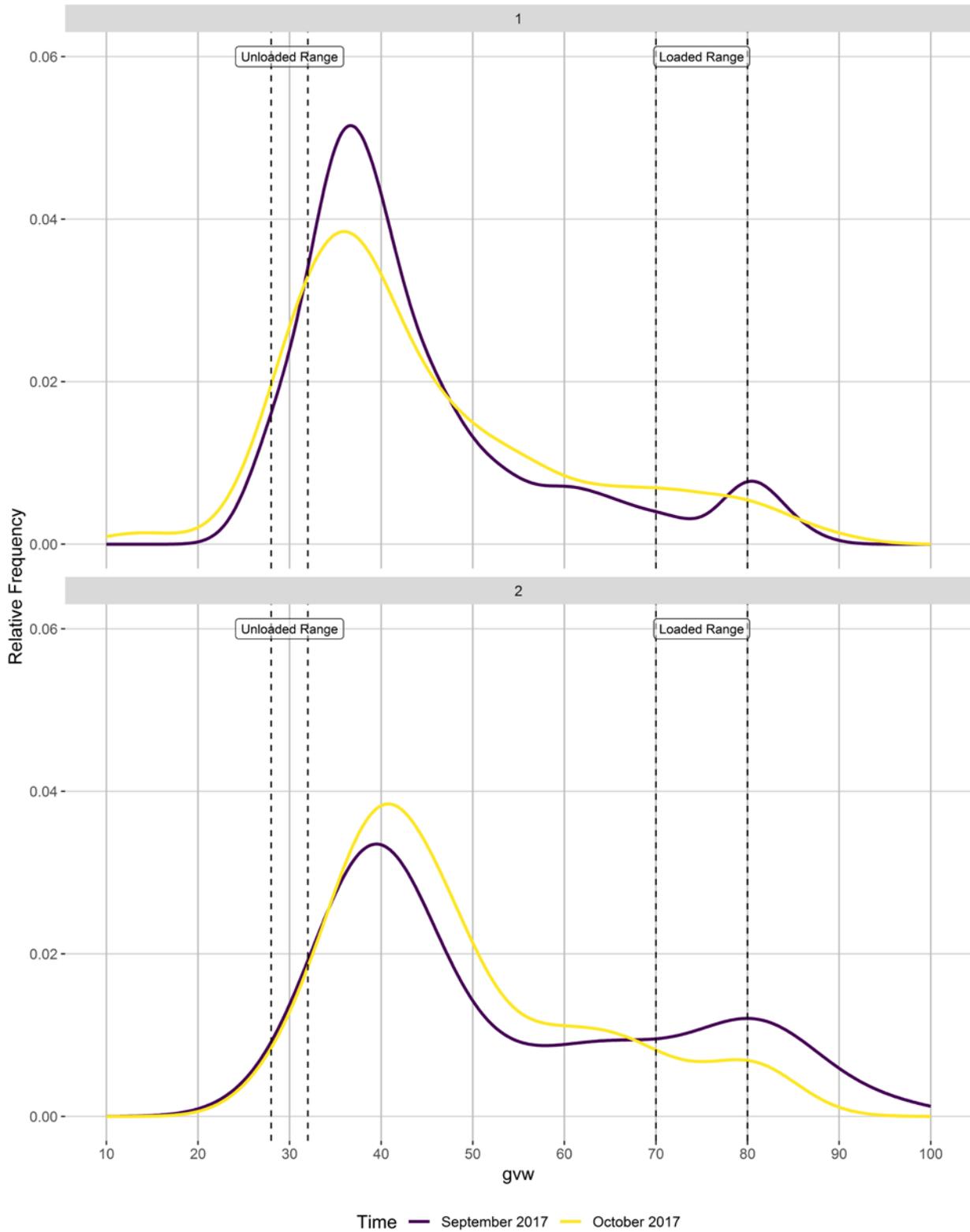
WIM monthly reports can be found at: <http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html>

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.

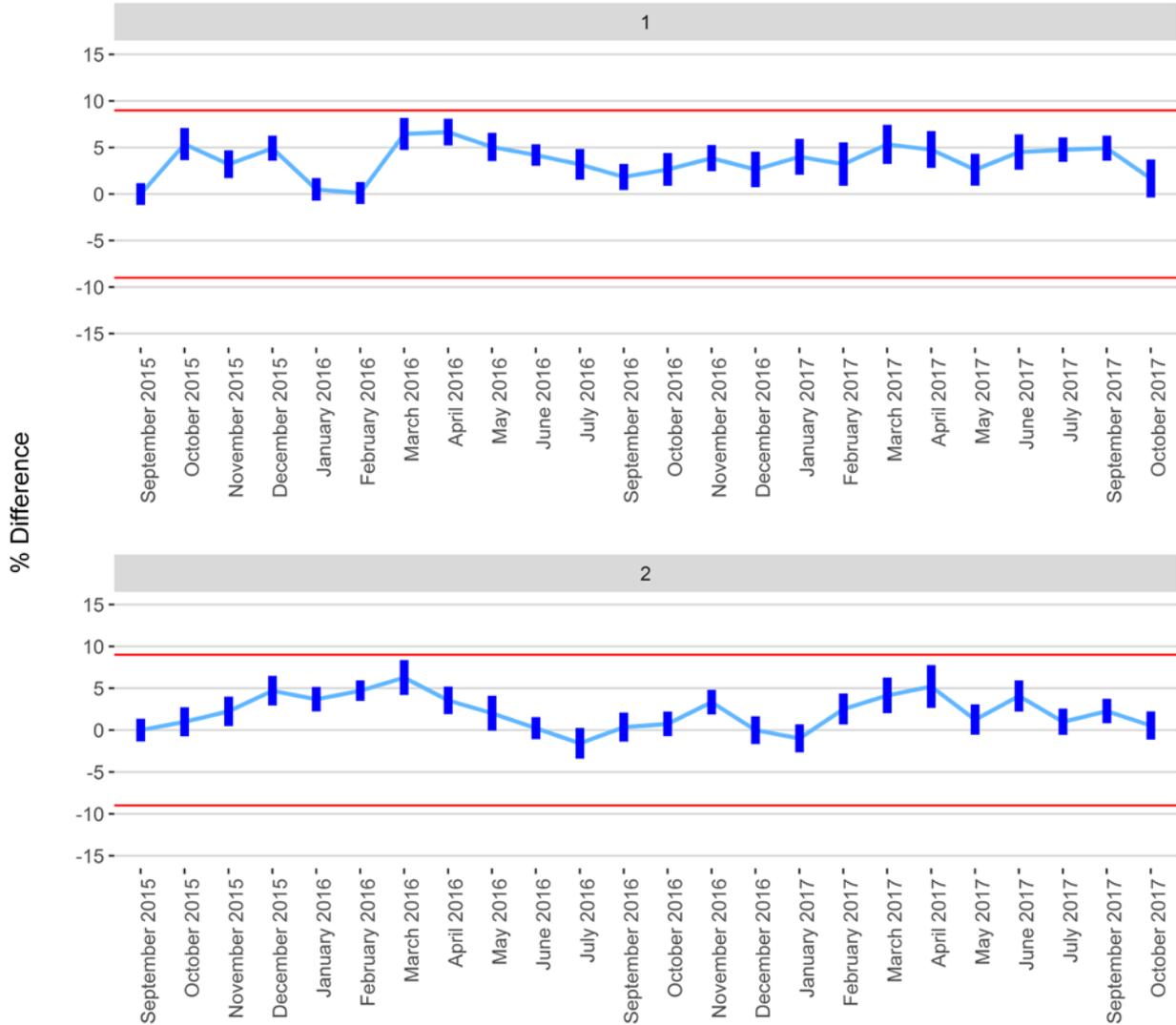
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

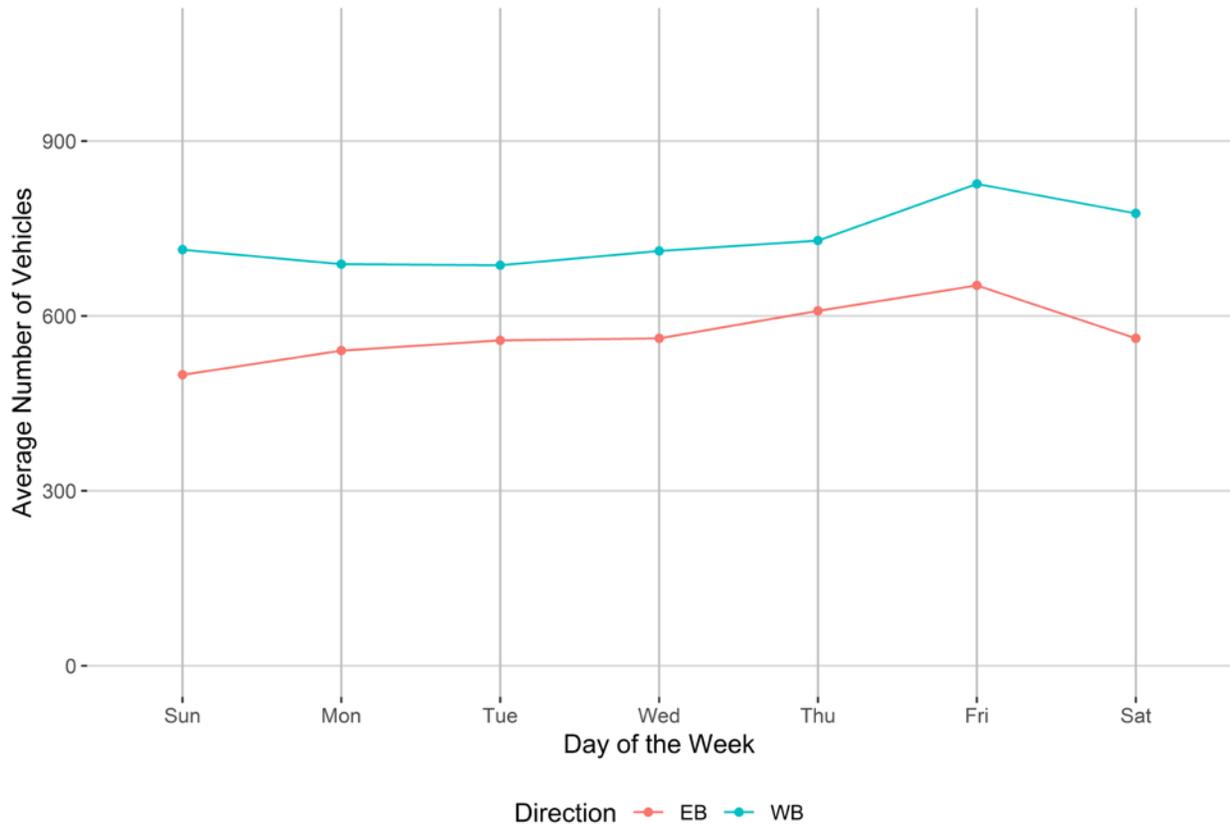


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

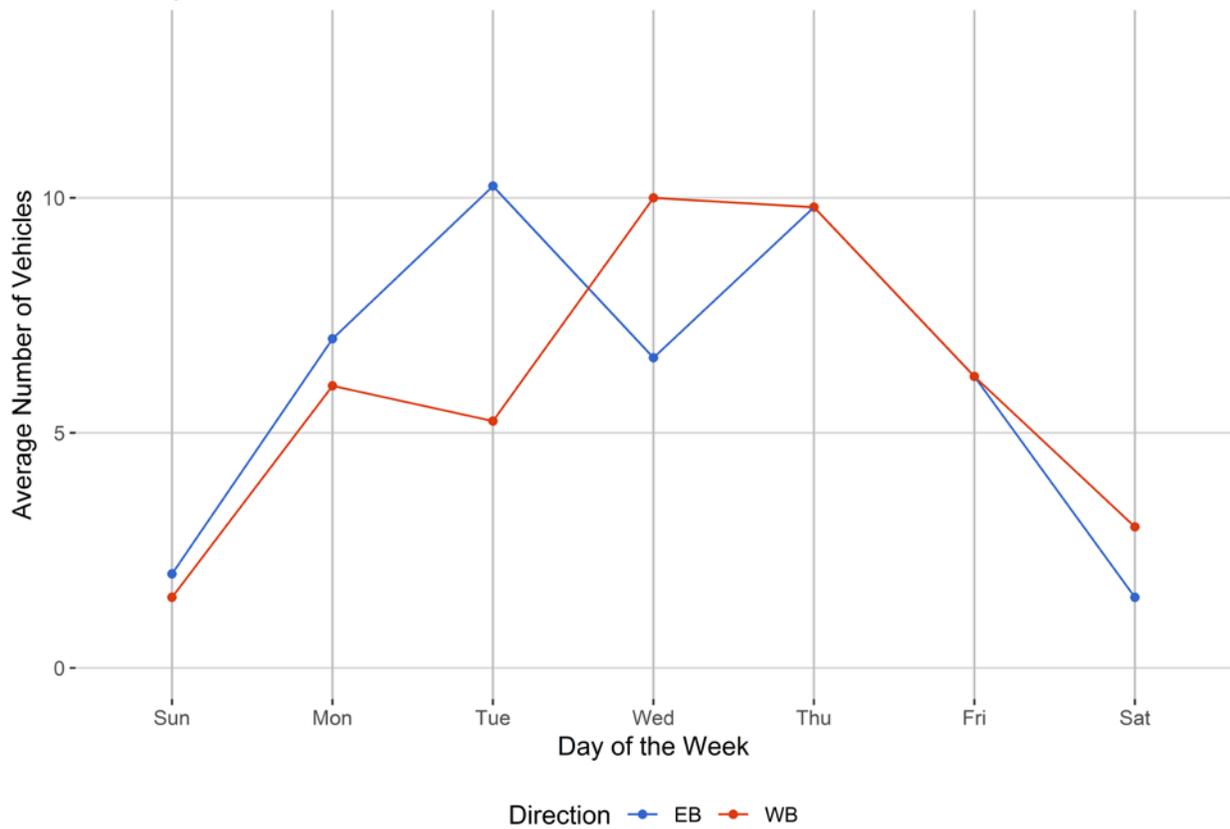


Figure 4 - Passenger Vehicles vs. Hour of the Day

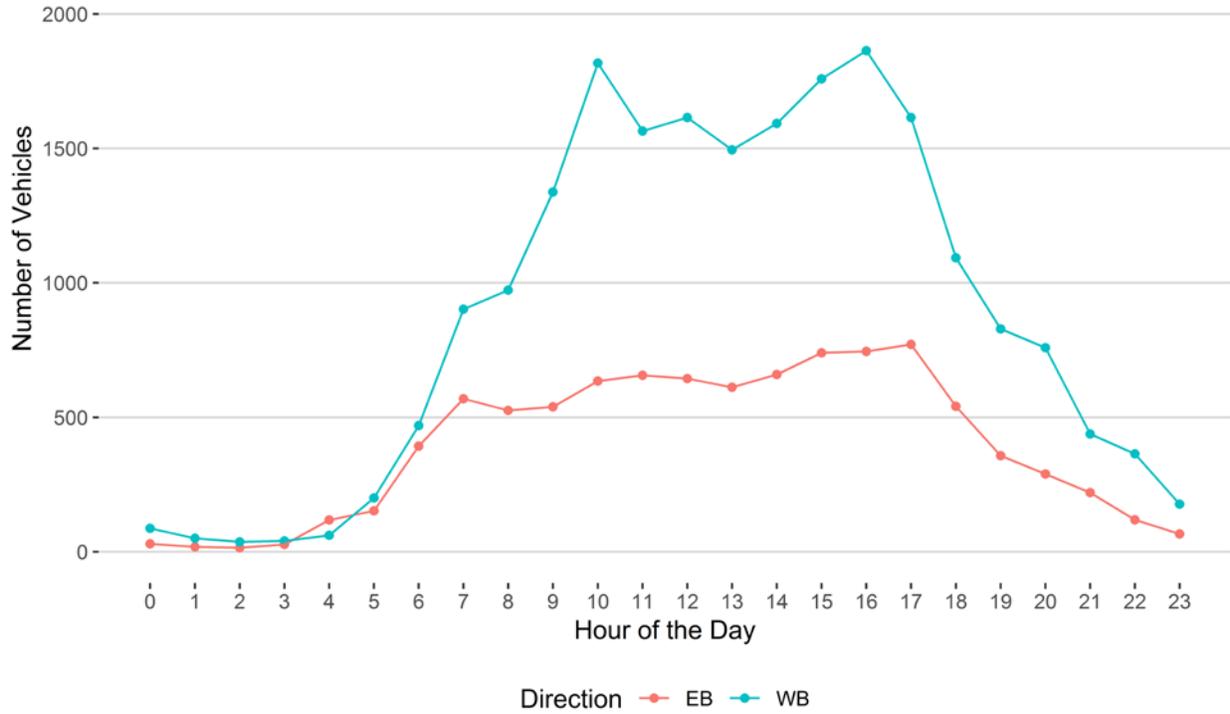


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

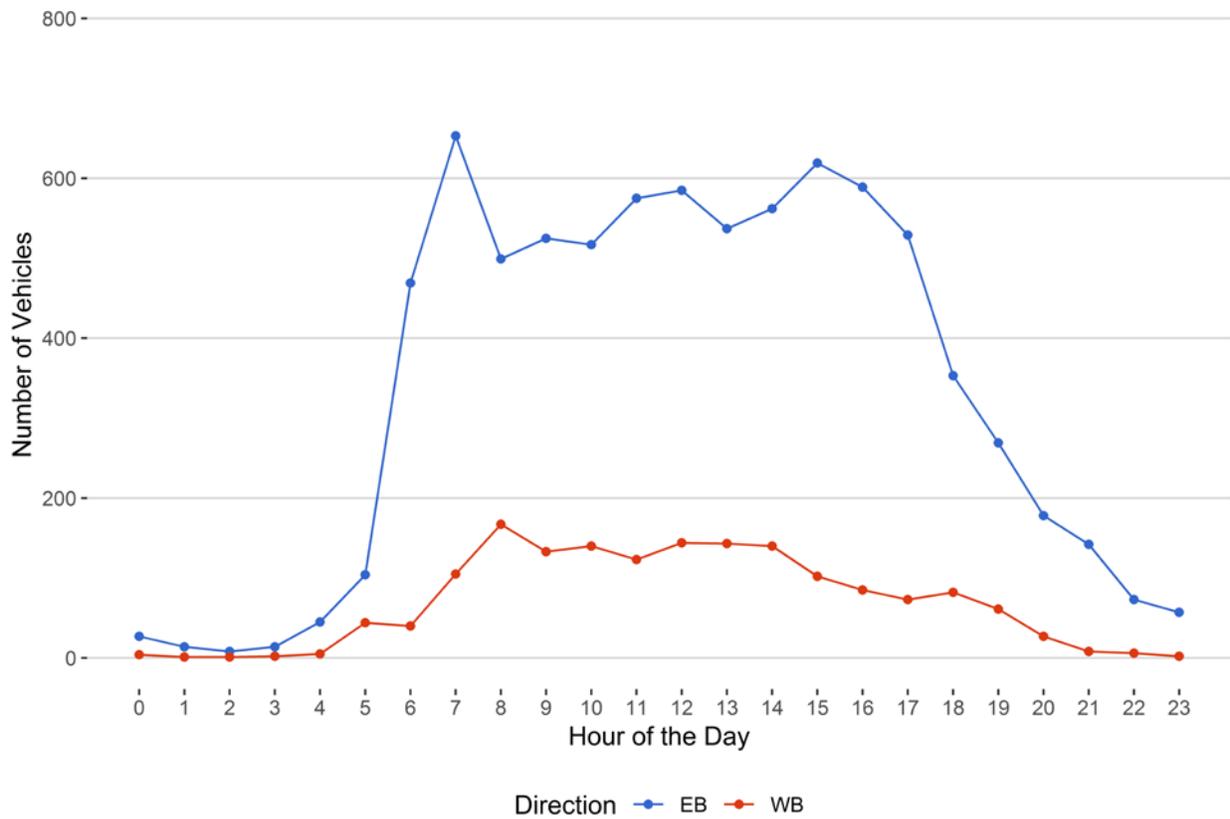


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

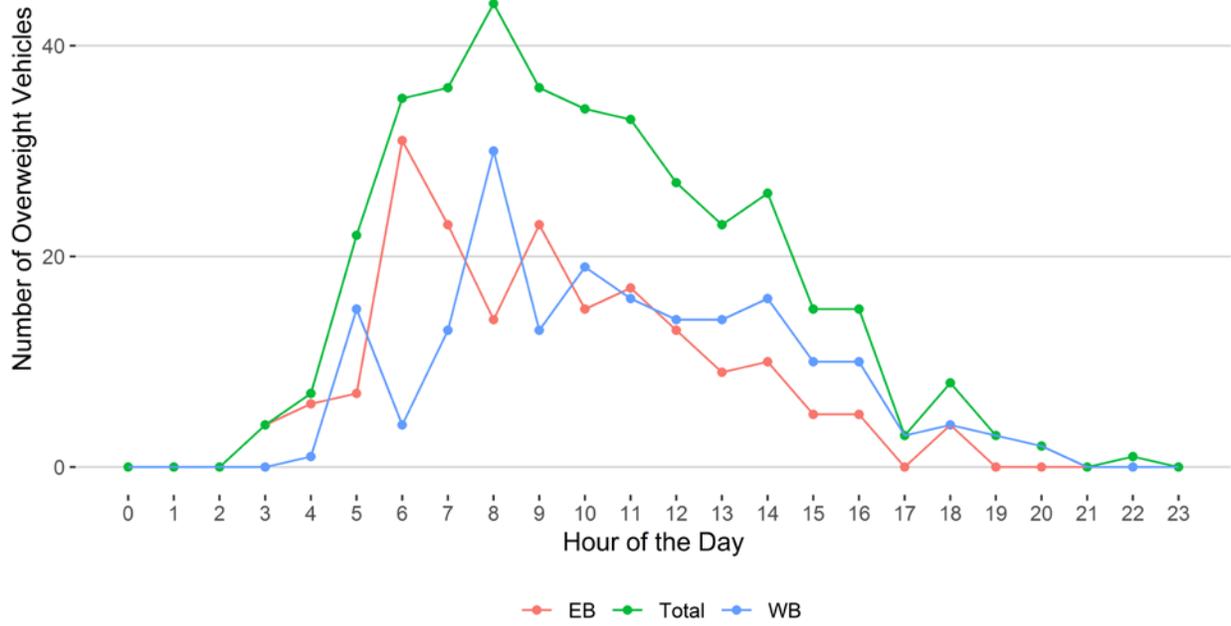
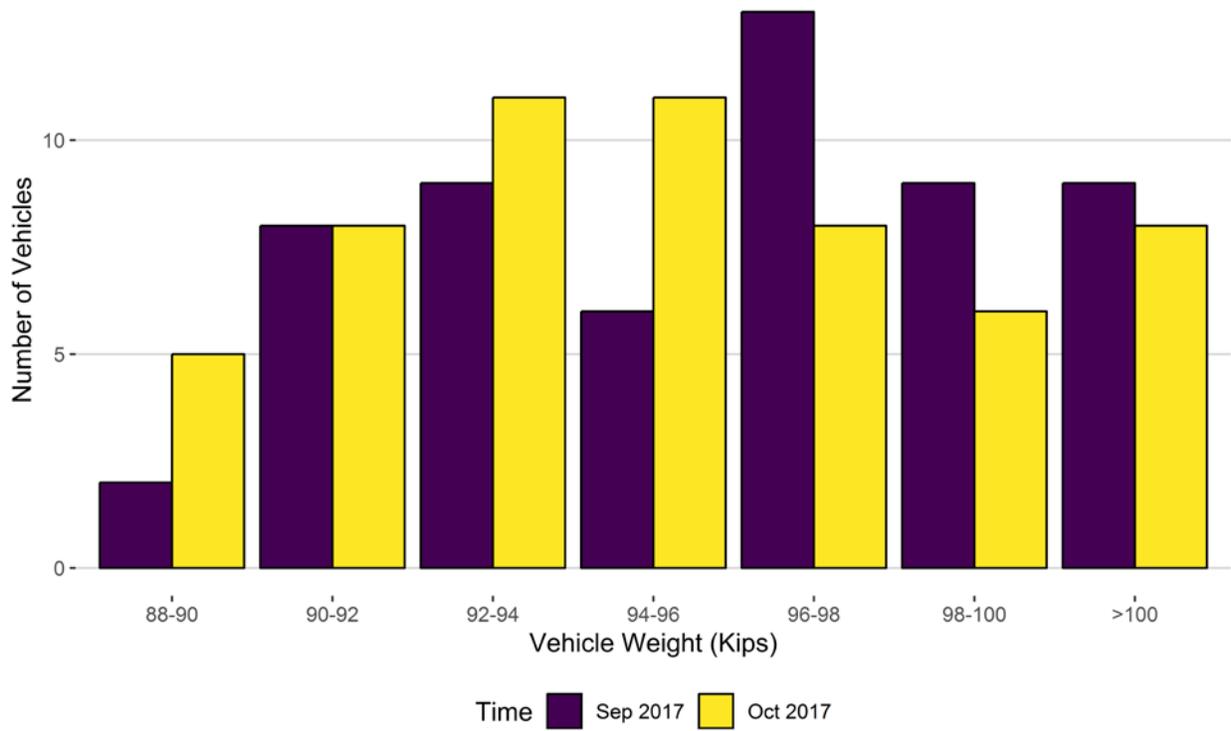
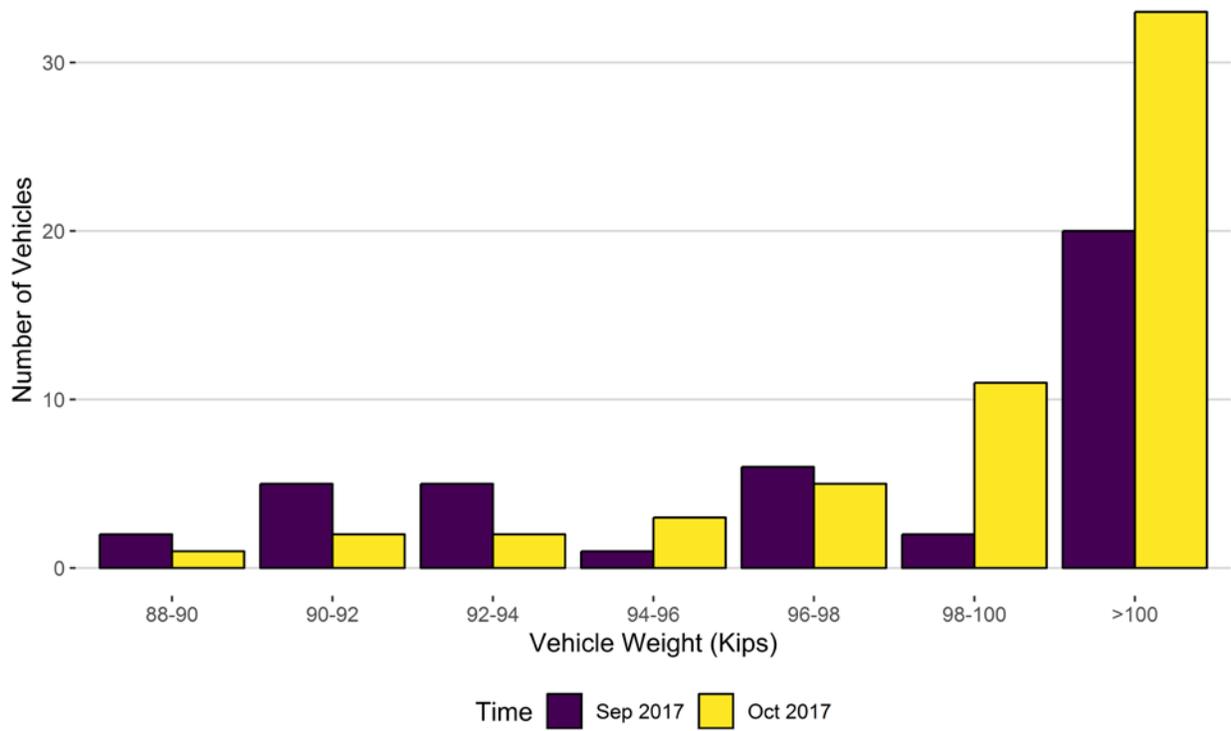


Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month



<i>Vehicle Weights (Kips)</i>	<i>Sep 2017</i>	<i>Oct 2017</i>
88-90	2	5
90-92	8	8
92-94	9	11
94-96	6	11
96-98	13	8
98-100	9	6
>100	9	8
Total	56	57

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



<i>Vehicle Weights (Kips)</i>	<i>Sep 2017</i>	<i>Oct 2017</i>
88-90	2	1
90-92	5	2
92-94	5	2
94-96	1	3
96-98	6	5
98-100	2	11
>100	20	33
Total	41	57

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

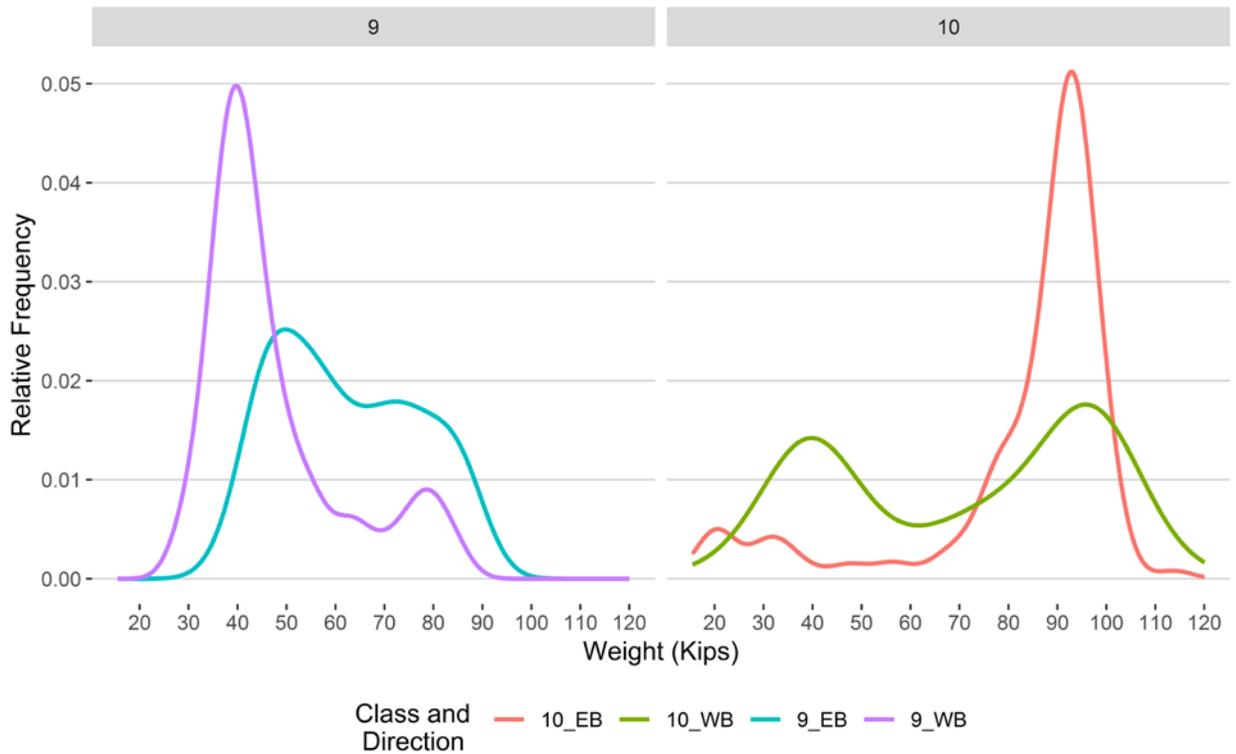


Figure 9 - Freight Percentage by Direction and Class

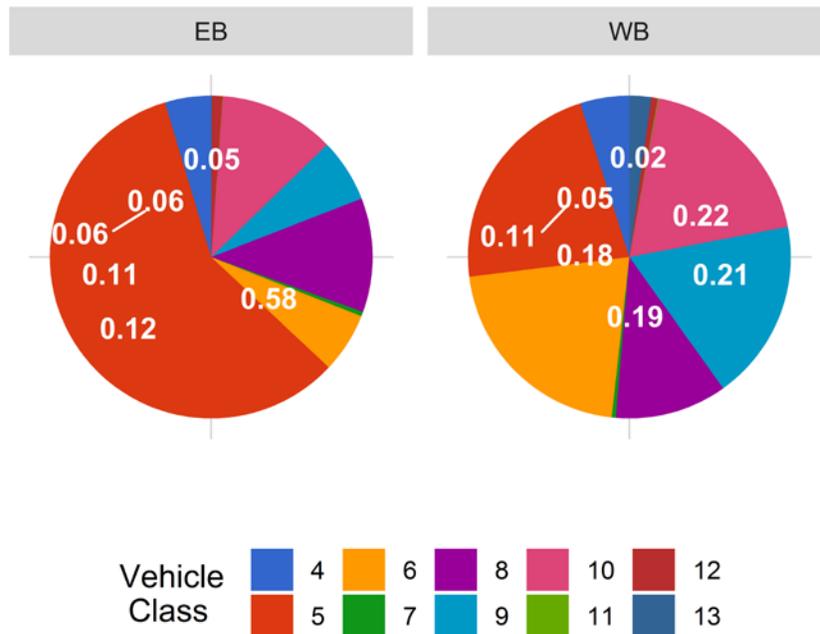


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

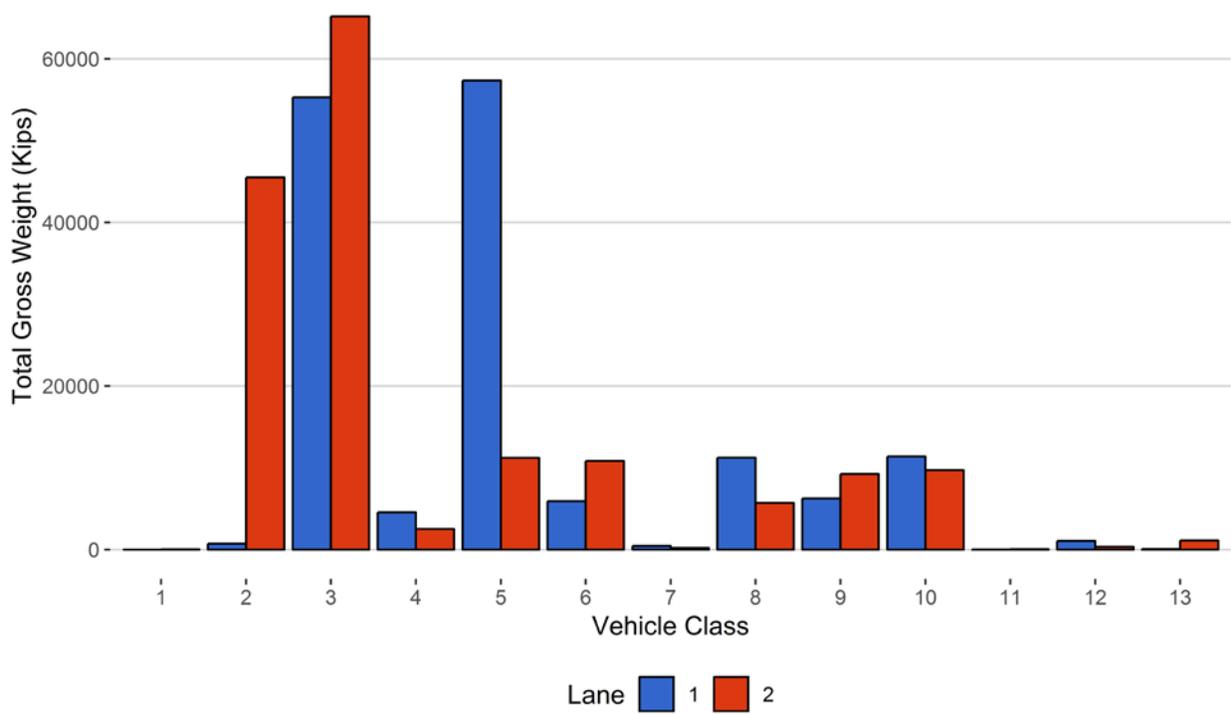


Figure 11 - Total Gross Vehicle Weight t

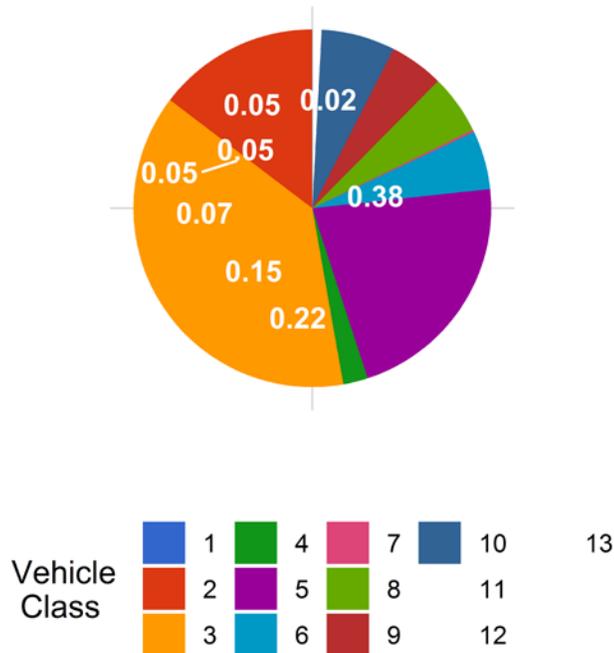


Figure 12 - Total ESALs by Class and Lane

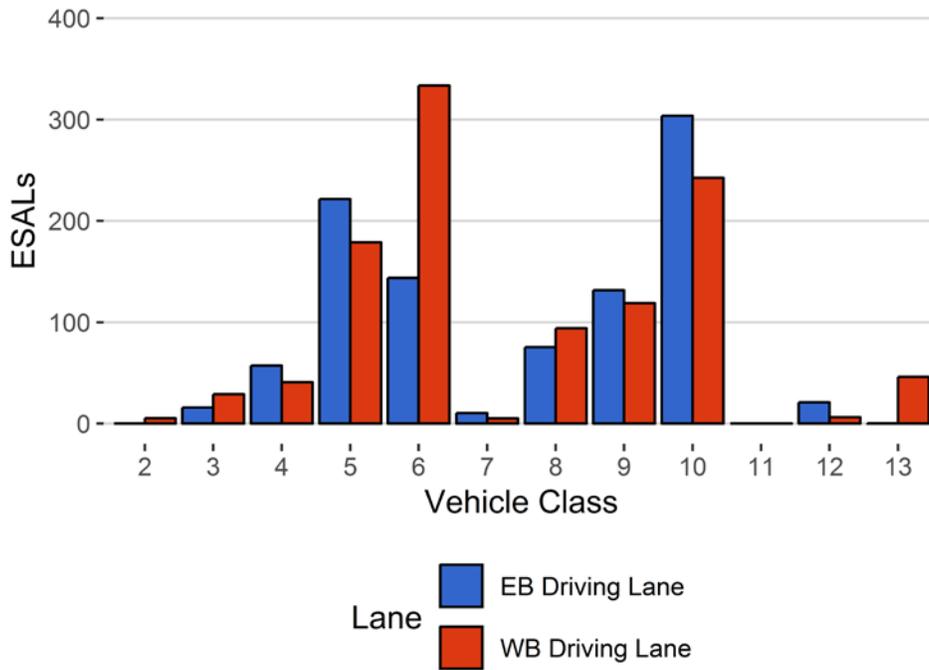


Figure 13 - ESALs by Class

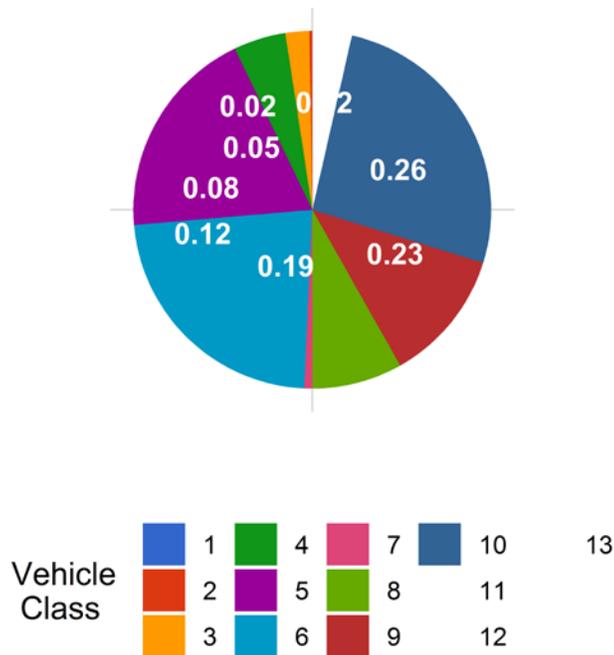


Table 1 Class 9 Front Axle Weight by Lane

<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

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	21	0	0	0
2	414	12834	30.1	0	0
3	640	19833	46.5	0	0
4	9	267	0.6	5	1.3
5	251	7791	18.3	27	7.3
6	14	436	1	84	22.6
7	0	11	0	6	1.6
8	28	857	2	19	5.1
9	10	308	0.7	39	10.5
10	9	287	0.7	171	46
11	0	3	0	0	0
12	1	20	0	12	3.2
13	0	11	0	9	2.4
TOTAL	1377	42679	100	372	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>
2018-08-17	Friday	19:19:15	10	WB	2	120.04
2018-08-10	Friday	06:18:17	10	EB	1	113.85
2018-08-16	Thursday	05:33:29	10	WB	2	107.1
2018-08-09	Thursday	05:26:15	10	WB	2	105.66
2018-08-03	Friday	05:31:49	10	WB	2	105.53
2018-08-02	Thursday	05:42:39	10	WB	2	105.43
2018-08-20	Monday	05:47:43	10	WB	2	104.57
2018-08-06	Monday	05:50:20	10	WB	2	103.78
2018-08-15	Wednesday	05:38:49	10	WB	2	103.54
2018-08-15	Wednesday	18:26:56	10	EB	1	103.09

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	169	12	7.1	4390	158	1017
5	EB	8	6711	4130	61.5	29869	27486	4610
6	EB	19	145	0	0	5913	0	1579
7	EB	11.5	8	0	0	440	0	174
8	EB	31	656	607	92.5	2338	8896	409
9	EB	33	100	0	0	6236	0	1468
10	EB	33.5	138	11	8	11124	263	3435
11	EB	36.5	1	1	100	0	20	0
12	EB	36.5	14	2	14.3	1001	51	282
13	EB	31.5	1	0	0	65	0	17
TOTAL	****	****	7943	4763	****	61375	****	12991
<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	87	12	13.8	2350	161	613
5	WB	8	760	93	12.2	10539	679	2601
6	WB	19	273	5	1.8	10754	88	2831
7	WB	11.5	3	0	0	210	0	88
8	WB	31	166	45	27.1	4757	959	503
9	WB	33	195	11	5.6	8898	334	1413
10	WB	33.5	137	5	3.6	9588	127	2583
11	WB	36.5	2	2	100	0	45	0
12	WB	36.5	5	1	20	303	26	79
13	WB	31.5	10	0	0	1113	0	399
TOTAL	****	****	1638	174	****	48512	****	11109
GRAND TOTAL	****	****	9581	4937	468	109887	39293	24100

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>
1	0	27	27	0
2	711	45513	46225	14.6
3	55282	65196	120478	38.1
4	4548	2511	7059	2.2
5	57355	11218	68573	21.7
6	5913	10842	16755	5.3
7	440	210	650	0.2
8	11234	5715	16950	5.4
9	6236	9231	15467	4.9
10	11387	9715	21102	6.7
11	20	45	65	0
12	1053	330	1382	0.4
13	65	1113	1178	0.4
TOTAL	154244	161666	315910	100
GVW/LANE	48.83	51.17	100	0.03

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>
1	0	0	0	0	0.0476
2	0	5	5	0.3	0.0011
3	16	29	45	2.2	0.005
4	57	41	98	4.7	0.79
5	222	179	401	19.2	0.11
6	144	334	477	22.9	2.32
7	11	5	16	0.8	2.17
8	75	94	170	8.2	0.43
9	132	119	250	12	1.72
10	304	243	546	26.2	3.96
11	0	0	0	0	0.79
12	21	6	28	1.3	2.2
13	0	46	46	2.2	4.51
TOTAL	982	1101	2083	100	19
ESALS/LANE	47.1	52.9	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 2017	35473	1182	92	32700	92.2	2773	7.8
Oct 2017	31525	1017	95	28567	90.6	2957.8	9.4
TOTAL	66998	-	-	61267	-	5731	-
AVERAGE	33499	1100	94	30634	91	2865	9

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 2017	877	1083	1959	22.1
Oct 2017	909	1075	1983	29.6
TOTAL	1785	-	-	-
AVERAGE	893	1079	1972	26

Gross Vehicle Weight

<i>Month</i>	<i>GVW EB Driving Lane</i>	<i>GVW WB Driving Lane</i>	<i>Total GVW Kips</i>
Sep 2017	121395	140110	261505
Oct 2017	116073	133692	249765
TOTAL	237468	273802	511270
AVERAGE	118734	136901	255635

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 2017	323	0.9	11.5	98	40
Oct 2017	344	1.1	10.3	115	58
TOTAL	667	-	-	213	98
AVERAGE	333.5	1	10.9	106.5	49

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>
Sep 2017	9454	10945	20399	46.3	53.7
Oct 2017	10009	11716	21725	46.1	53.9
TOTAL	19462	22661	42124	-	-
AVERAGE	9731.2	11330.6	21061.9	46.2	53.8