

APRIL 2018



**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 April 2018. Volume was computed using all monthly data.

System Calibration

WIM #37 was most recently calibrated on 2017-03-23. 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 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: 865392 | Passenger Vehicles: 756114 | Heavy Commercial Vehicles: 109278

Monthly Average Daily Traffic (MADT): 28846 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 3643

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 Tuesdays (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 03 PM and 05 PM.

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling WB typically reached peak volume levels 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 109278 HCVs, 7439 of them were overweight ³. These overweight HCVs contributed to 0.9% of total monthly volume, and 7.2% 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 March.

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 ,872 WB vehicles exceeded 88,000 pounds (526 vehicles were Class 9's; 186 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from April 2018.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9's and 10's in April 2018. 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 950237 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 865392 vehicles with a combined GVW of 8182910 kips (1 kip = 1,000 pounds = 0.5 tons) in April 2018. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 87305 equivalent single axle loads (ESALs) passed over the pavement at this site. In particular, 72% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 46% 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>

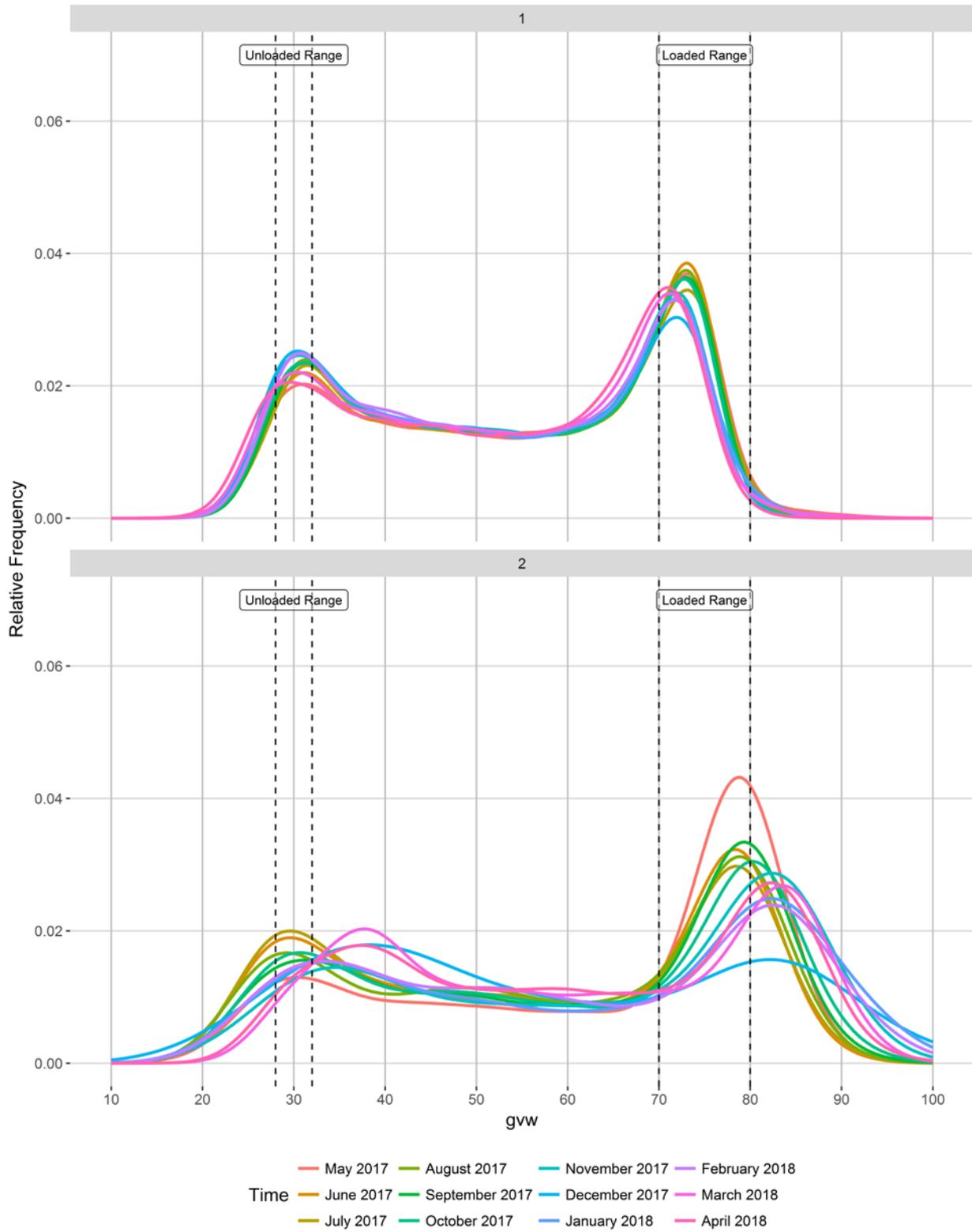
- ¹ Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to

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.

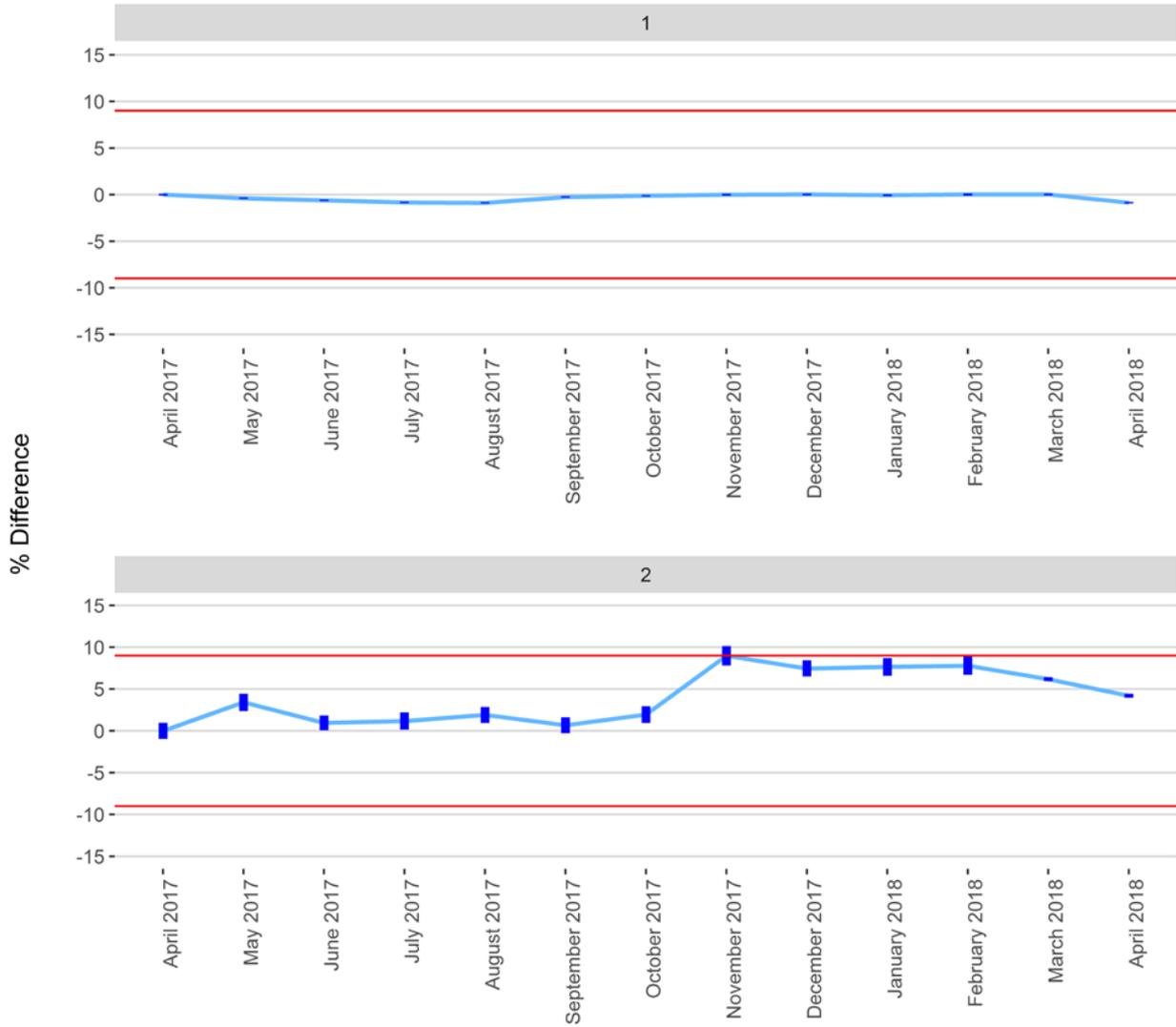
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Figure 1 - Monthly Class 9 GVW Histogram



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

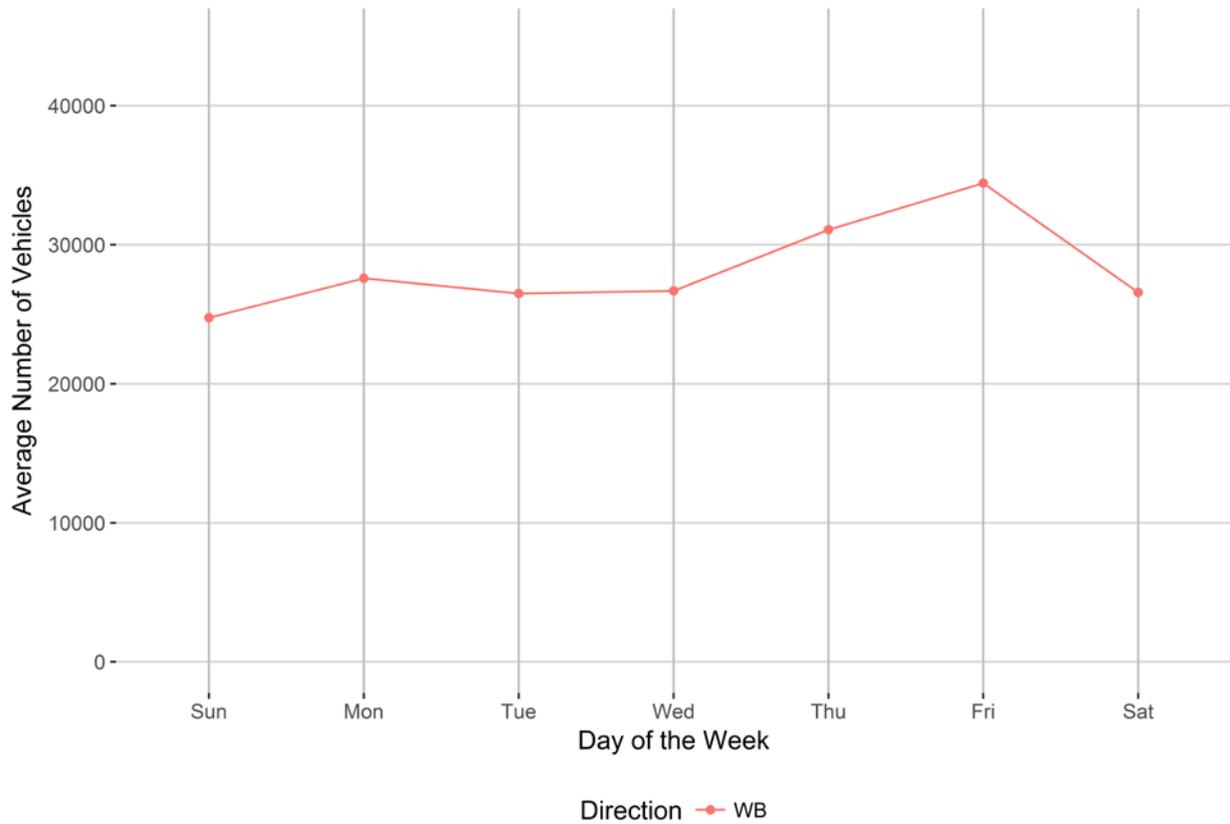


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

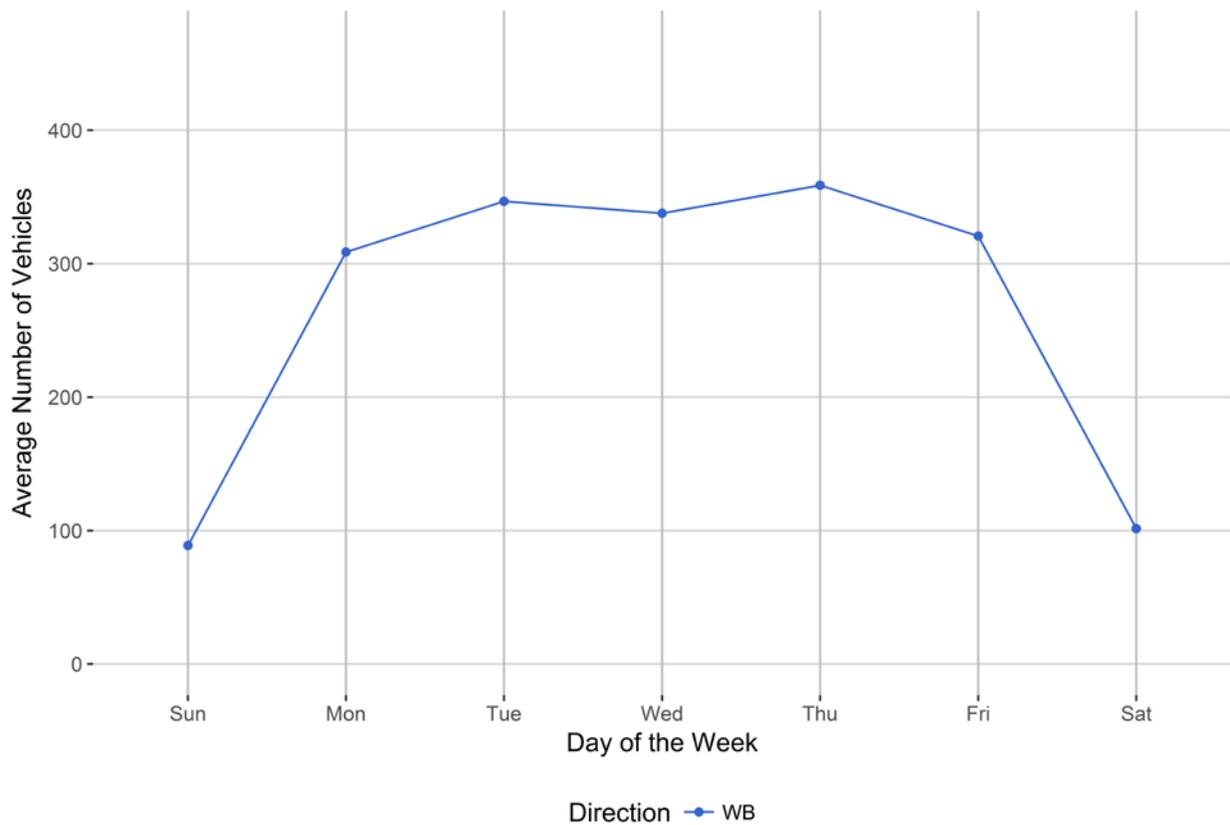


Figure 4 - Passenger Vehicles vs. Hour of the Day

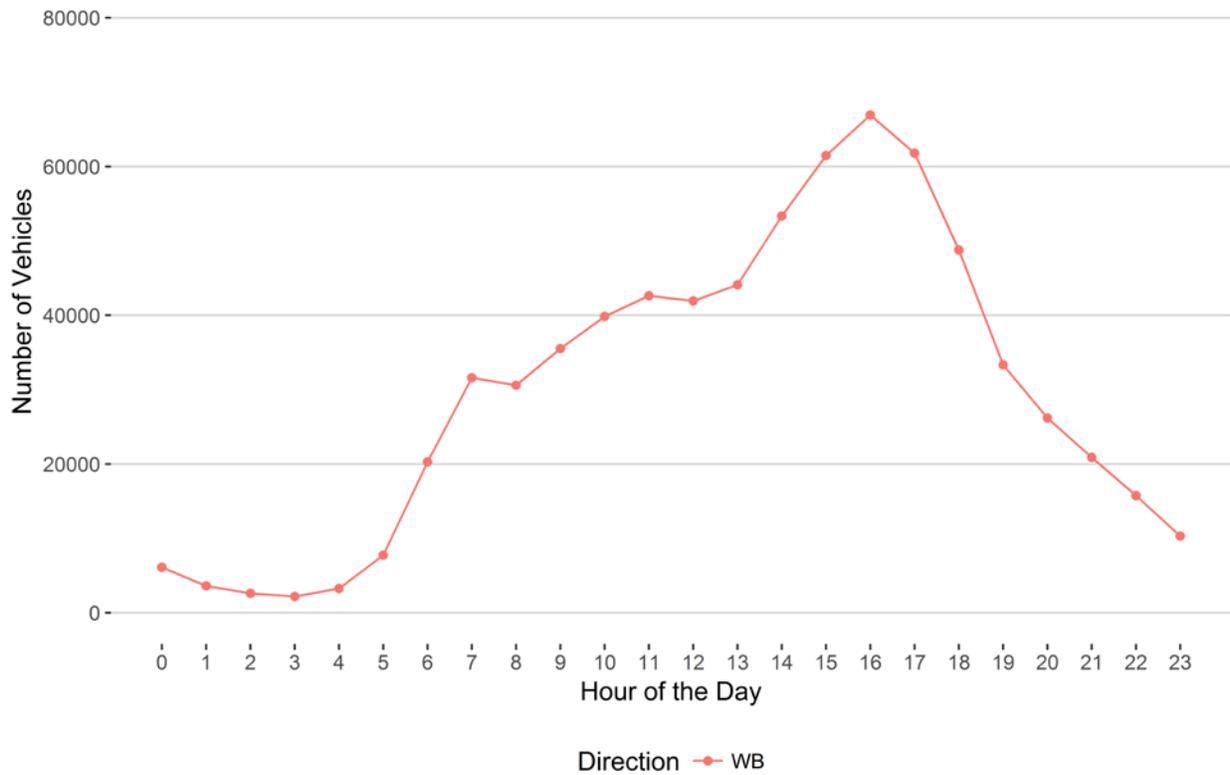


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

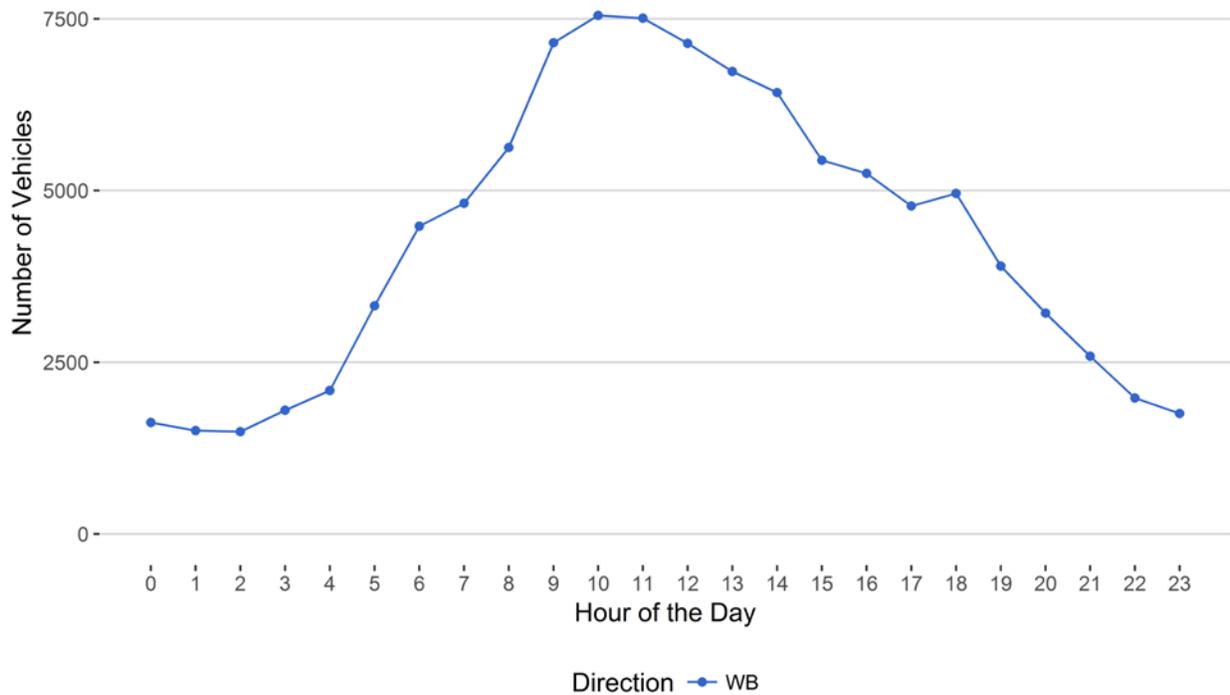


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

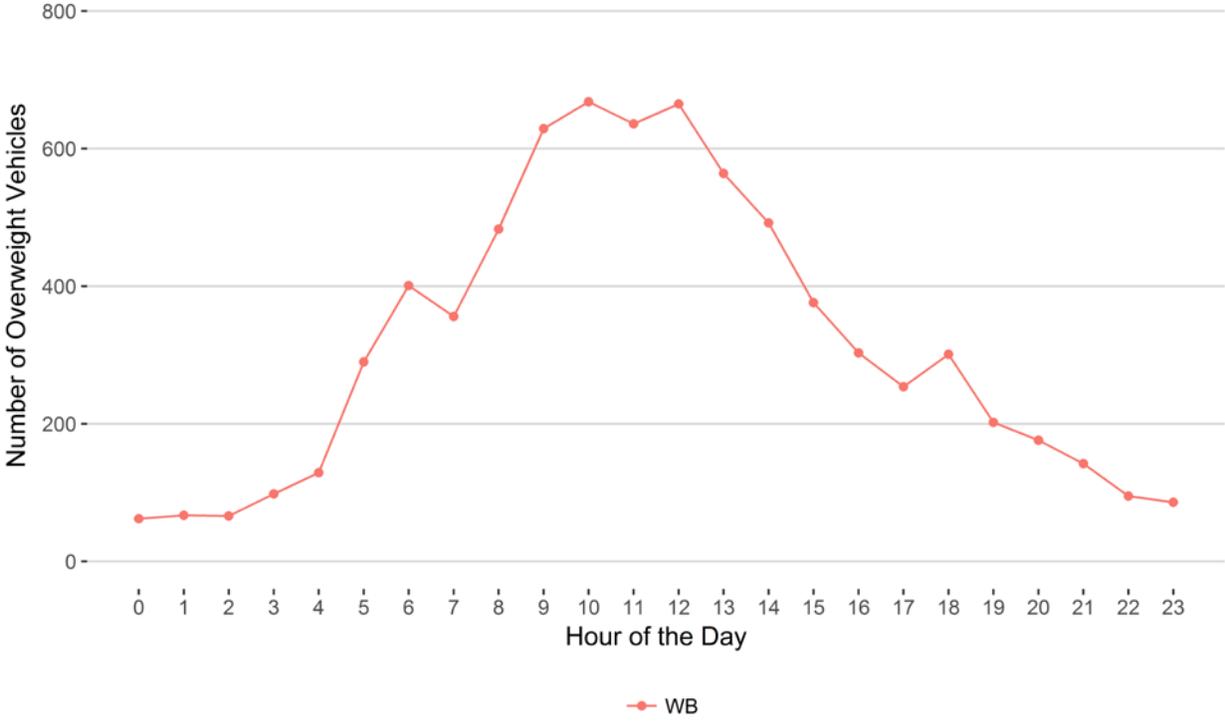
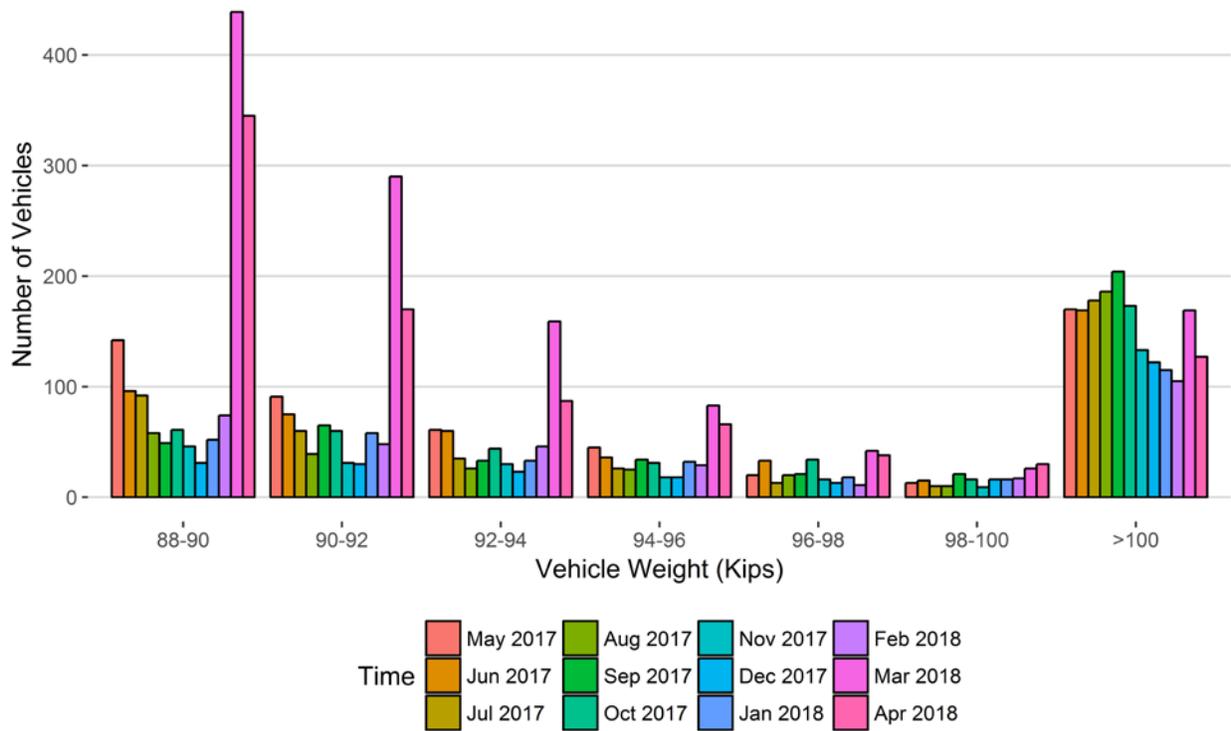


Figure 8 - Histogram of Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	May 2017	Jun 2017	Jul 2017	Aug 2017	Sep 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018
88-90	142	96	92	58	49	61	46	31	52	74	439	345
90-92	91	75	60	39	65	60	31	30	58	48	290	170
92-94	61	60	35	26	33	44	30	23	33	46	159	87
94-96	45	36	26	25	34	31	18	18	32	29	83	66
96-98	20	33	13	20	21	34	16	13	18	11	42	38
98-100	13	15	10	10	21	16	9	16	16	17	26	30
>100	170	169	178	186	204	173	133	122	115	105	169	127
Total	542	484	414	364	427	419	283	253	324	330	1208	863

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

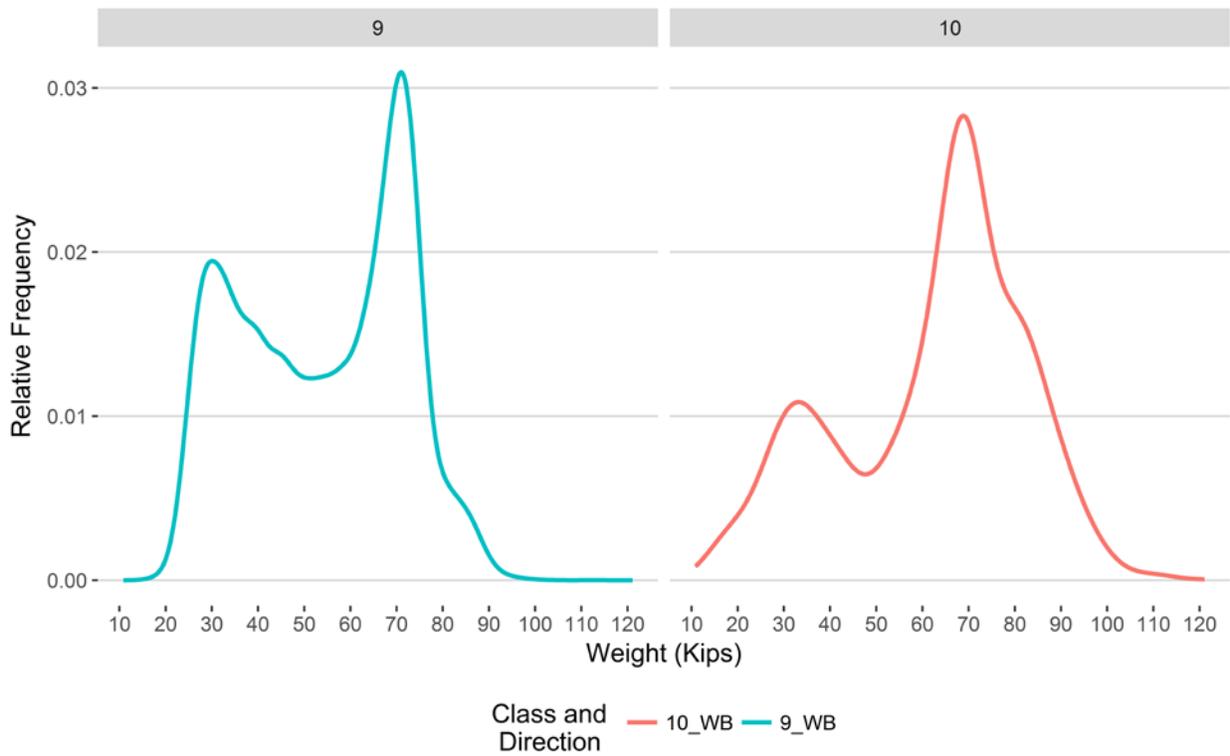


Figure 9 - Freight Percentage by Direction and Class

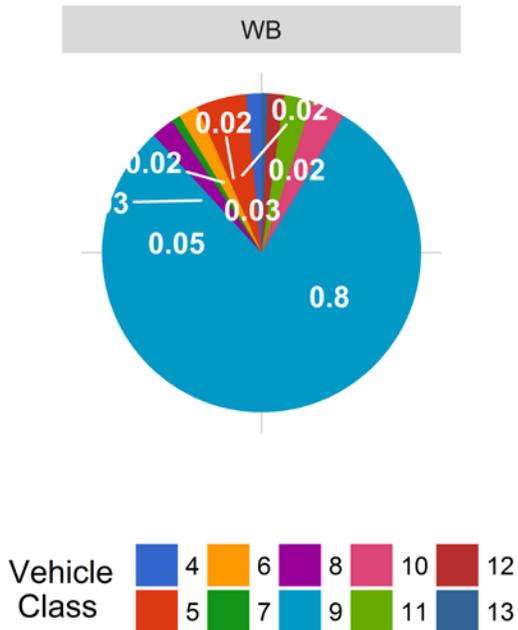


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

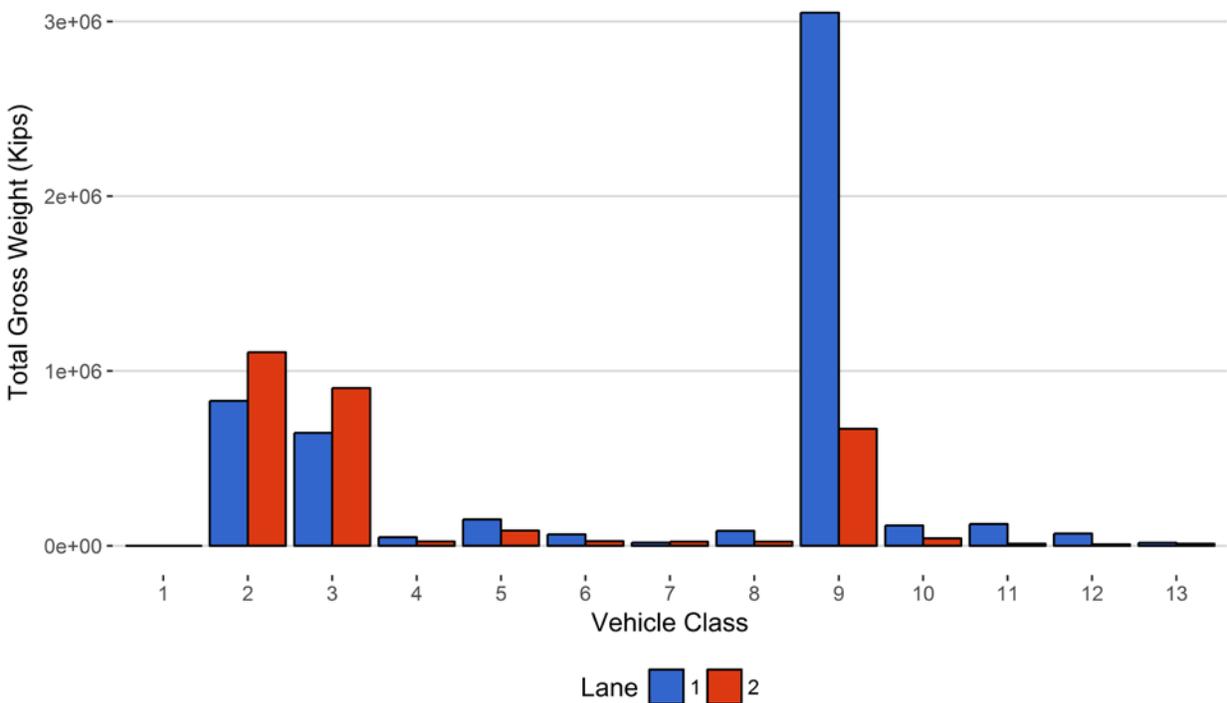


Figure 11 - Total Gross Vehicle Weight I

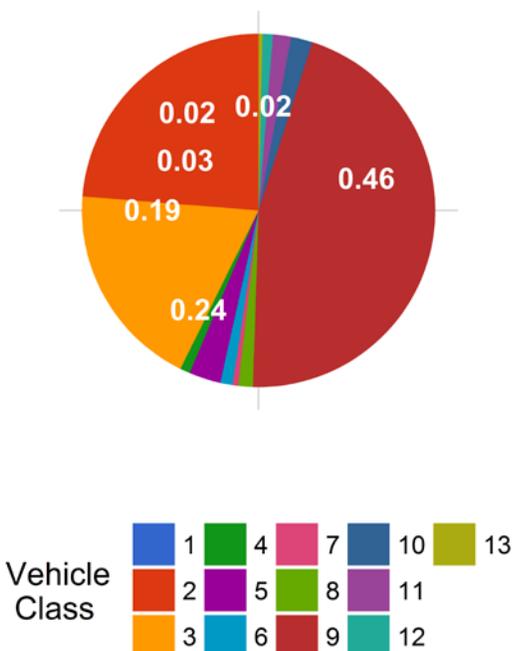


Figure 12 - Total ESALs by Class and Lane

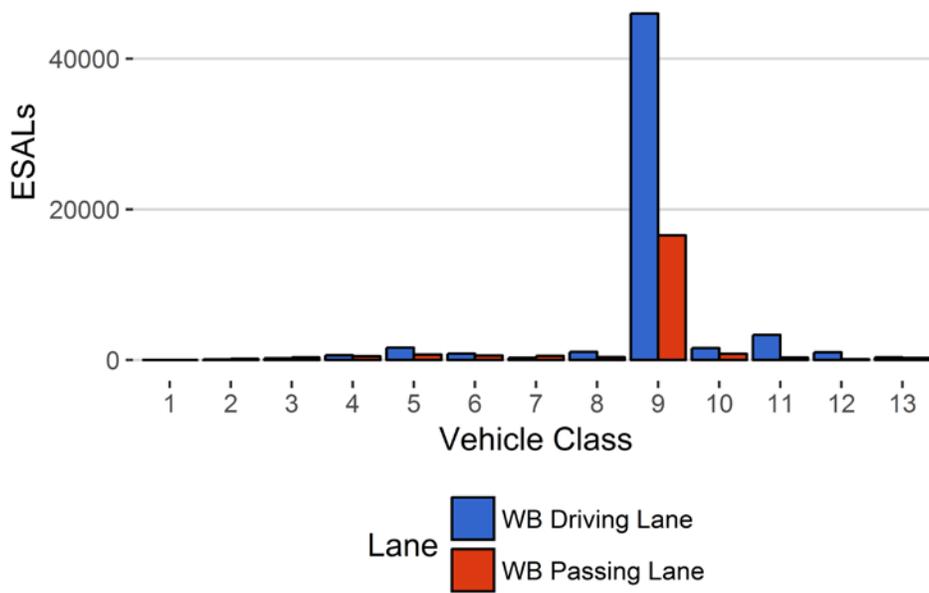


Figure 13 - ESALs by Class

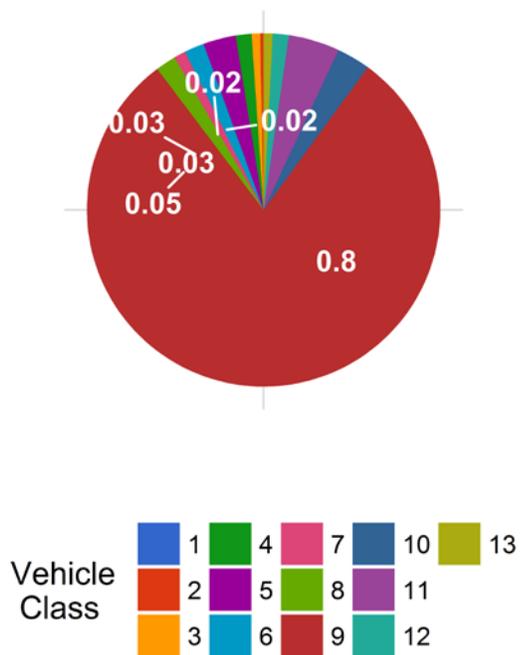


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
April 2017	10.54	0.00	11.79	0.00
May 2017	10.50	-0.39	12.19	3.41
June 2017	10.48	-0.62	11.90	0.95
July 2017	10.45	-0.84	11.92	1.16
August 2017	10.45	-0.89	12.01	1.90
September 2017	10.52	-0.26	11.86	0.67
October 2017	10.53	-0.12	12.02	1.94
November 2017	10.54	0.00	12.84	8.98
December 2017	10.55	0.02	12.67	7.46
January 2018	10.54	-0.06	12.69	7.65
February 2018	10.55	0.02	12.70	7.79
March 2018	10.55	0.02	12.51	6.17
April 2018	10.45	-0.87	12.28	4.20

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	16770	503099	58.1	0	0
3	8433	252994	29.2	0	0
4	102	3054	0.4	143	1.9
5	617	18516	2.1	115	1.5
6	113	3375	0.4	164	2.2
7	37	1103	0.1	115	1.5
8	129	3869	0.4	114	1.5
9	2425	72755	8.4	5958	80.1
10	90	2709	0.3	509	6.8
11	75	2239	0.3	98	1.3
12	43	1295	0.1	26	0.3
13	12	361	0	197	2.6
TOTAL	28846	865392	100	7439	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>
2018-04-25	Wednesday	11:12:47	9	WB	2	144.96
2018-04-27	Friday	09:21:38	9	WB	2	143.53
2018-04-12	Thursday	13:43:48	9	WB	2	142.56
2018-04-13	Friday	09:00:03	9	WB	2	141.79
2018-04-19	Thursday	07:17:02	9	WB	2	141.02
2018-04-10	Tuesday	15:45:28	9	WB	2	136.38
2018-04-26	Thursday	08:40:12	9	WB	2	134.91
2018-04-15	Sunday	10:59:25	9	WB	2	126.64
2018-04-23	Monday	08:26:09	9	WB	2	121.14
2018-04-15	Sunday	12:53:53	10	WB	1	121.1

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	2882	531	18.4	66474	6879	15604
5	WB	8	17472	1742	10	224500	12543	49330
6	WB	19	3185	516	16.2	83106	8936	16197
7	WB	11.5	1041	10	1	41445	111	14794
8	WB	31	3651	1998	54.7	65034	43548	6896
9	WB	33	68652	11823	17.2	3384827	335011	754735
10	WB	33.5	2556	332	13	150375	8747	37936
11	WB	36.5	2113	15	0.7	134705	451	29064
12	WB	36.5	1222	14	1.1	77231	418	16570
13	WB	31.5	341	1	0.3	28934	21	9112
TOTAL	****	****	103115	16982	****	4256630	****	950237

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>
1	19	4	22	0
2	828935	1107258	1936193	23.7
3	645649	902646	1548295	19
4	48289	25063	73352	0.9
5	150499	86545	237044	2.9
6	65239	26802	92041	1.1
7	18187	23369	41556	0.5
8	84698	23885	108583	1.3
9	3050529	669309	3719837	45.6
10	116326	42797	159123	2
11	124120	11035	135156	1.7
12	69816	7833	77649	1
13	17442	11513	28955	0.4
TOTAL	5219749	2938057	8157806	100
GVW/LANE	63.98	36.02	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>
1	0	0	0	0	0.0476
2	93	150	243	0.3	0.001
3	244	371	615	0.8	0.0052
4	633	496	1128	1.4	0.78
5	1638	710	2348	3	0.27
6	836	589	1425	1.8	0.9
7	304	542	846	1.1	1.62
8	1081	385	1466	1.9	0.8
9	45972	16550	62522	79.7	1.82
10	1593	815	2408	3.1	1.88
11	3346	329	3675	4.7	3.47
12	1029	120	1149	1.5	1.87
13	361	290	651	0.8	3.71
TOTAL	57130	21346	78476	100	17
ESALS/LANE	72.8	27.2	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>
May 2017	980832	31640	3814	862596	87.9	118235.9	12.1
Jun 2017	1035311	34510	4042	914057	88.3	121254	11.7
Jul 2017	1042528	33630	3684	928333	89	114195.2	11
Aug 2017	1085741	35024	3979	962396	88.6	123345.5	11.4
Sep 2017	971749	32392	3802	857703	88.3	114045.8	11.7
Oct 2017	964314	31107	3898	843483	87.5	120831.4	12.5
Nov 2017	870827	29028	2971	781684	89.8	89143	10.2
Dec 2017	861735	27798	2856	773186	89.7	88548.6	10.3
Jan 2018	786355	25366	2885	696926	88.6	89429.4	11.4
Feb 2018	731714	26133	3001	647696	88.5	84018.2	11.5
Mar 2018	891514	28758	3685	777288	87.2	114225.9	12.8
Apr 2018	865392	28846	3643	756114	87.4	109278.3	12.6
TOTAL	11088012	--	--	9801462	--	1286551	--
AVERAGE	924001	30353	3522	816788	88	107213	12

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>
May 2017	79233	11675	90908	2.4
Jun 2017	78317	11346	89663	2.1
Jul 2017	72545	11473	84018	1.6
Aug 2017	78120	17210	95329	1.2
Sep 2017	71448	17904	89353	1.1
Oct 2017	74092	13806	87898	1
Nov 2017	52468	12005	64473	1.7
Dec 2017	56619	5356	61975	1.9
Jan 2018	68067	10039	78106	1.2
Feb 2018	53421	7393	60815	1.6
Mar 2018	68692	22307	90998	2.7
Apr 2018	65405	21901	87305	1.3
TOTAL	818427	--	--	--
AVERAGE	68202	13534	81737	2

Gross Vehicle Weight

<i>Month</i>	<i>GVW WB Driving Lane</i>	<i>GVW WB Passing Lane</i>	<i>Total GVW Kips</i>
May 2017	5022577	2017371	7039948
Jun 2017	4627274	1899924	6527198
Jul 2017	5819299	3102304	8921603
Aug 2017	5225627	2958231	8183858
Sep 2017	6519459	2682815	9202274
Oct 2017	6656768	2984914	9641682
Nov 2017	6419065	2950979	9370045
Dec 2017	6869439	3007734	9877174
Jan 2018	6264517	2813582	9078098
Feb 2018	6472379	2845191	9317570
Mar 2018	5031471	2309308	7340779
Apr 2018	5296388	2102076	7398464
TOTAL	70224264	31674429	101898693
AVERAGE	5852022	2639536	8491558

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 2017	7310	0.8	6.2	553	188
Jun 2017	6542	0.7	5.3	491	186
Jul 2017	6484	0.6	5.6	420	190
Aug 2017	6125	0.6	4.9	366	198
Sep 2017	6376	0.7	5.5	435	229
Oct 2017	6672	0.7	5.4	423	189
Nov 2017	4048	0.5	4.6	286	142
Dec 2017	3927	0.5	4.5	254	139
Jan 2018	4659	0.6	5.3	344	141
Feb 2018	3808	0.5	4.6	334	125
Mar 2018	8752	1	7.8	1213	198
Apr 2018	7541	0.9	7.2	872	164
TOTAL	72244	--	--	5991	2089
AVERAGE	6020.3	0.7	5.6	499.2	174.1

Freight

<i>Month</i>	<i>WB Freight Tons</i>
May 2017	1081072
Jun 2017	1087451
Jul 2017	1008664
Aug 2017	1076902
Sep 2017	1013502
Oct 2017	1063947
Nov 2017	728121
Dec 2017	735210
Jan 2018	745526
Feb 2018	694995
Mar 2018	1048394
Apr 2018	950237
TOTAL	11234023
AVERAGE	936168.6