

SEPTEMBER 2019



**WIM #48
CSAH 5,
MP 15.05
STORDEN, MN**

**MONTHLY
REPORT**



Your Destination...Our Priority



WIM Site Location

WIM #48 is located on CSAH 5 near Storden in Cottonwood county.

System Operation

WIM #48 was operational for the entire month of September 2019. Volume was computed using all monthly data.

System Calibration

WIM #48 was most recently calibrated on 2019-05-15. 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: 12208 | Passenger Vehicles: 10433 | Heavy Commercial Vehicles: 1775

Monthly Average Daily Traffic (MADT): 412 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 59

See Table 2 for vehicle class breakdown

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

Volume trends. NB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Sundays. SB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Wednesdays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), NB PVs generally reached peak volume levels between 07 AM and 05 PM. Similarly, SB PVs peaked in volume between 03 PM and 06 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 07 AM and 05 PM, while volume going SB peaked between 03 PM and 06 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 1775 HCVs, 392 of them were overweight ³. These overweight HCVs contributed to 3.4% of total monthly volume, and 23.1% of total monthly HCV

volume. NB overweight vehicles typically reached highest numbers on Tuesdays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Tuesdays, with lowest volumes reported on Sundays. See Figure 3 .

The top two overweight violators by class were the class 9 and class 13 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 67.5% of all overweight vehicles traveling SB 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 October.

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 ,31 NB vehicles exceeded 88,000 pounds (29 vehicles were Class 13's; 1 vehicles were Class 10's). Of vehicles traveling SB,

206 NB vehicles exceeded 88,000 pounds (114 vehicles were Class 9's; 50 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from September 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in September 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling NB, while there were more empty Class 9's than fully_loaded traveling SB. Data also suggests that there were more empty Class 10's than fully_loaded traveling in the NB direction. In the SB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 17065 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (62.2%) than NB (37.8%). See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 97506 (a precast box culvert) is approximately 1.3 miles north of WIM #48. Bridge No. 97666 (a precast box culvert) is approximately .45 miles south of WIM #48. WIM #48 recorded a total of 12208 vehicles with a combined GVW of 134216 kips (1 kip = 1,000 pounds = 0.5 tons) in September 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 1968 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 70.7% of all ESALs were recorded SB while 29.3% was observed NB. In particular, 52% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 29% 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:

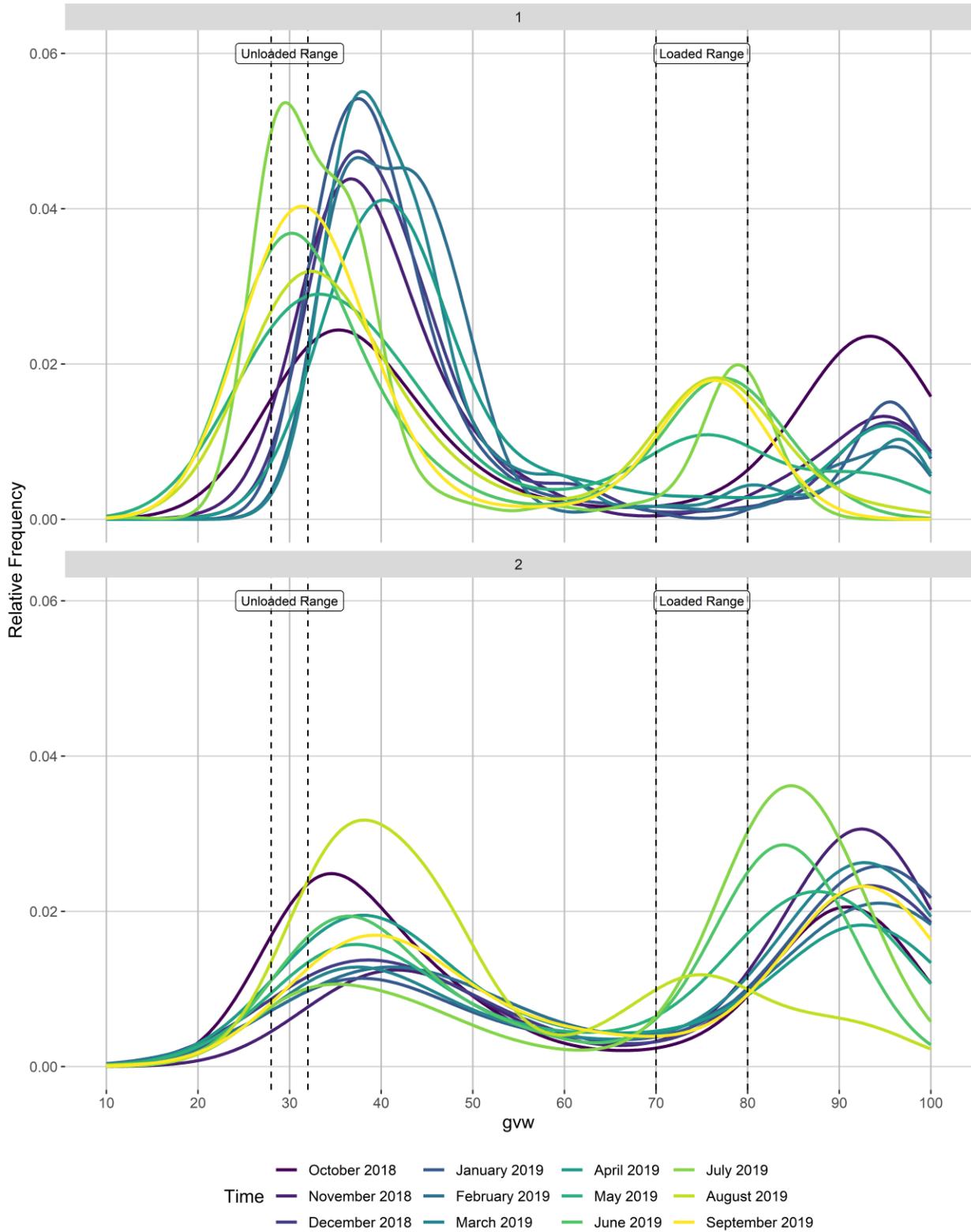
<http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html> MnDOT's vehicle

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.

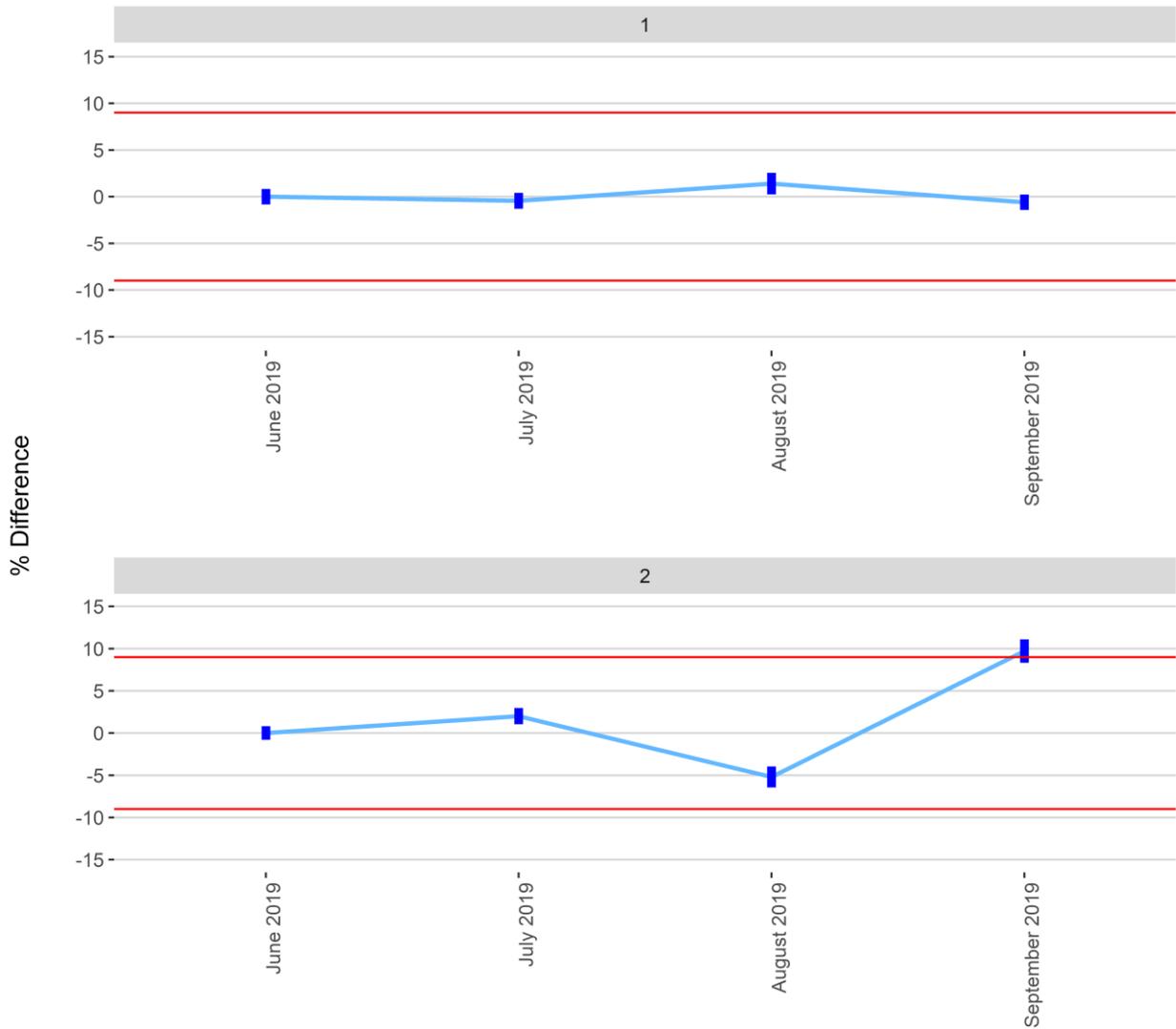
To request this document in an alternative format, please call 651-366-4718 or 1-800-657-3774, or email your request to ADArequest.dot@state.mn.us. Please request at least one week in advance.

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

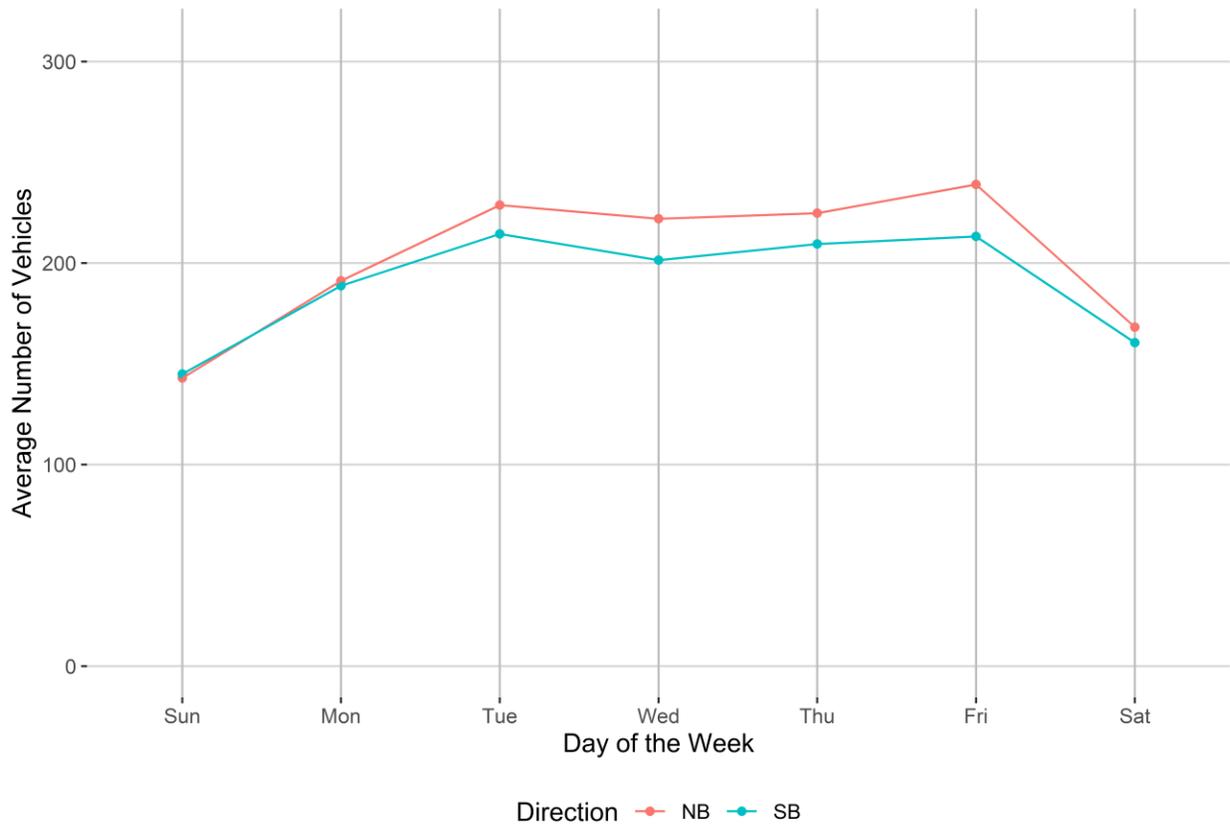


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

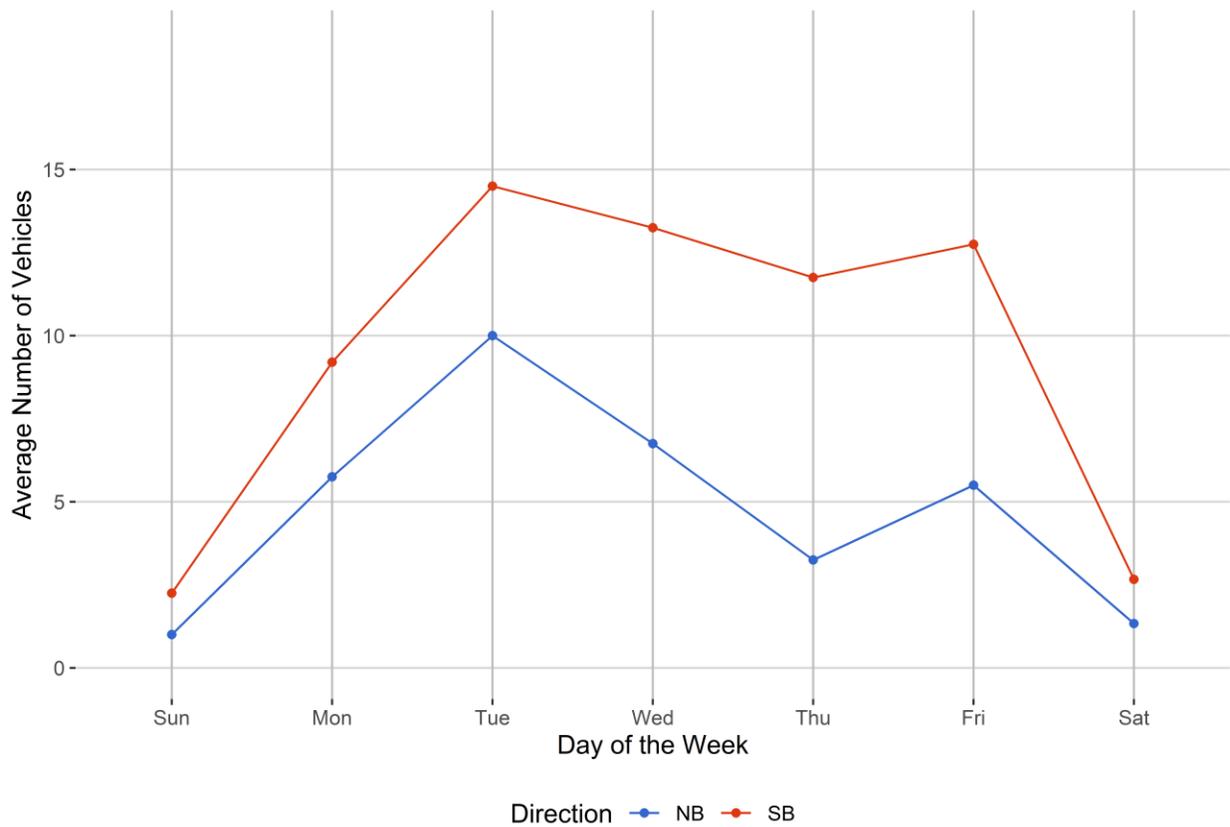


Figure 4 - Passenger Vehicles vs. Hour of the Day

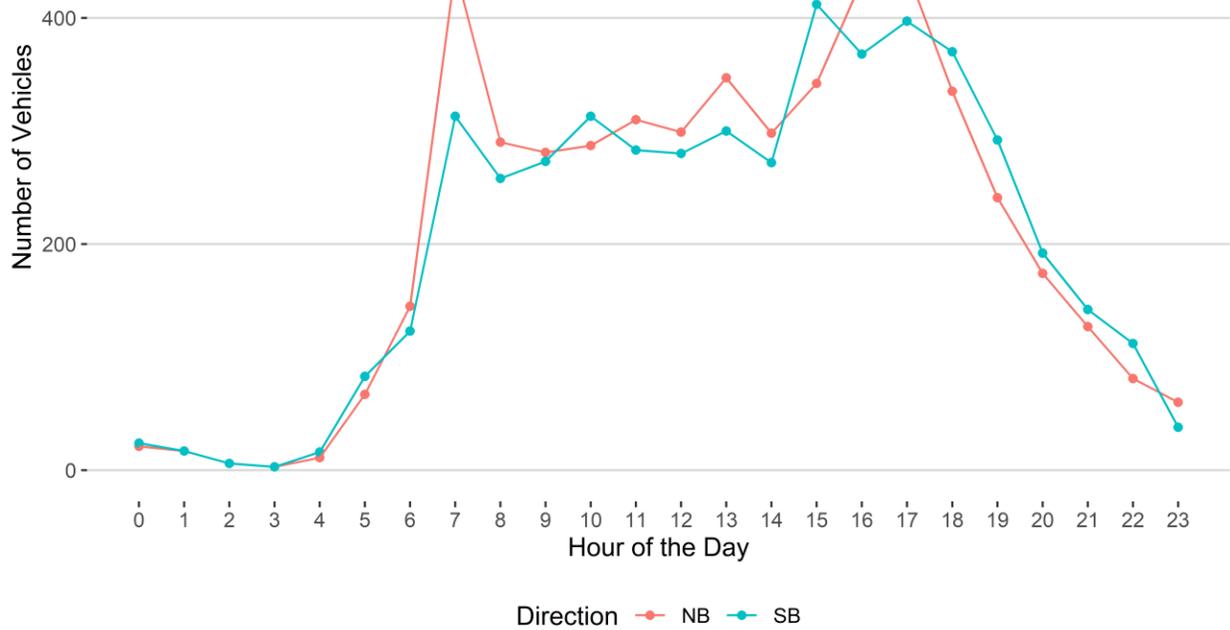


Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day

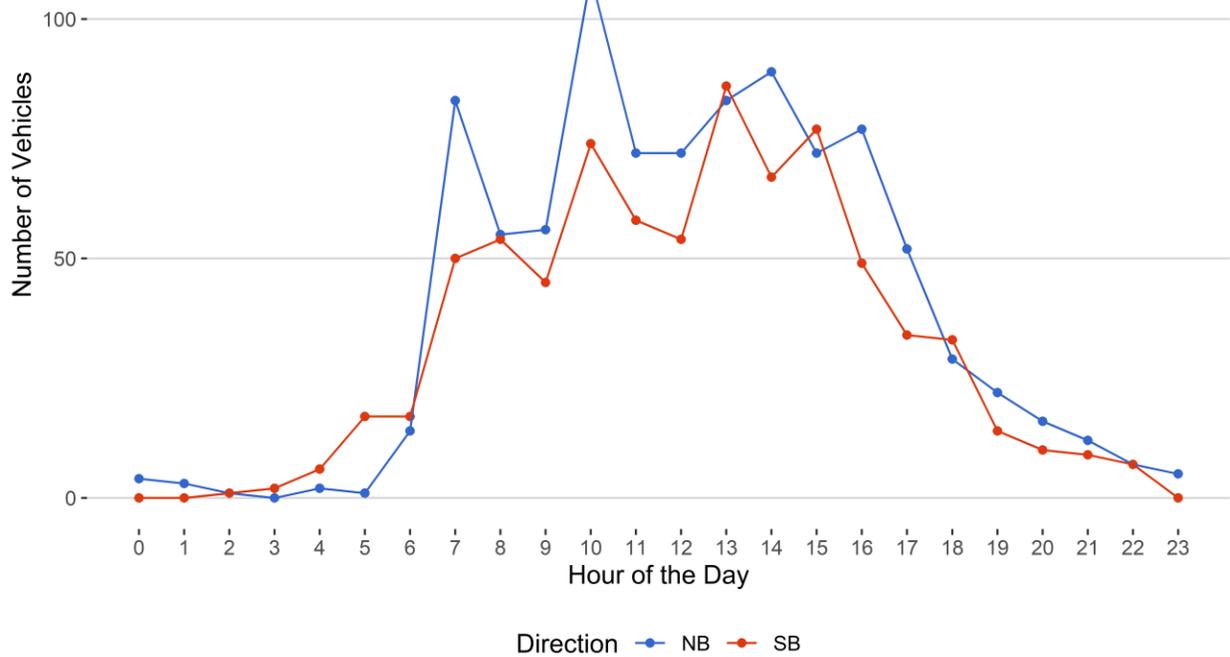


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

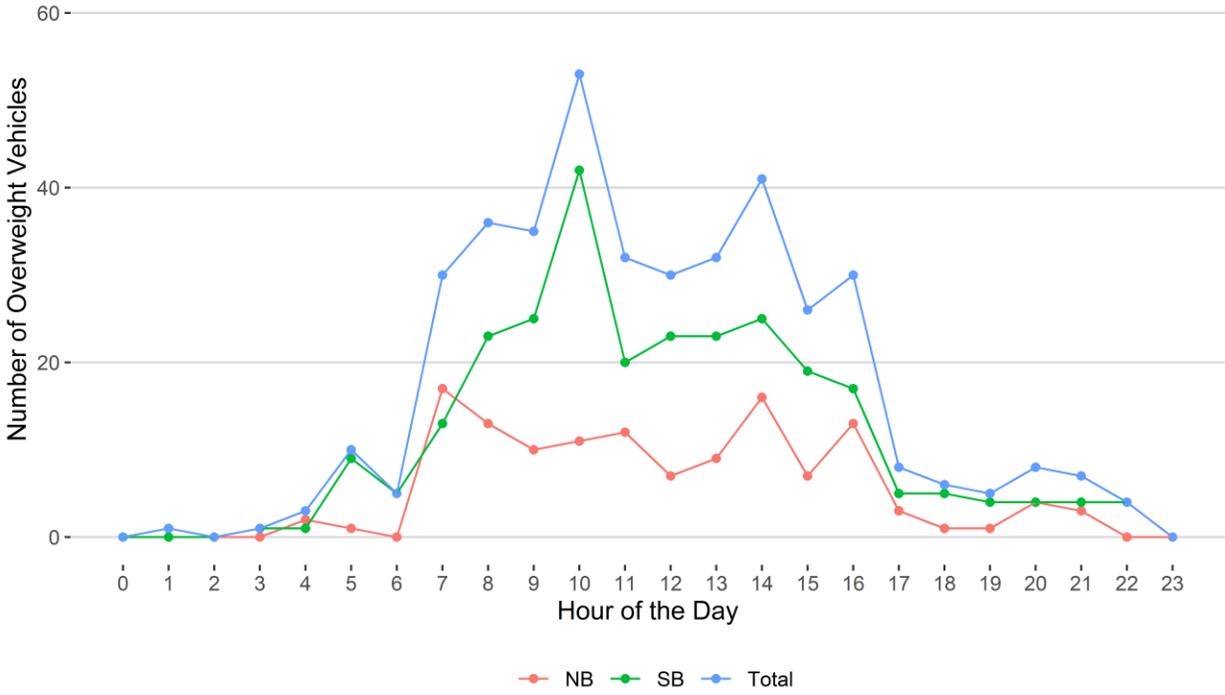
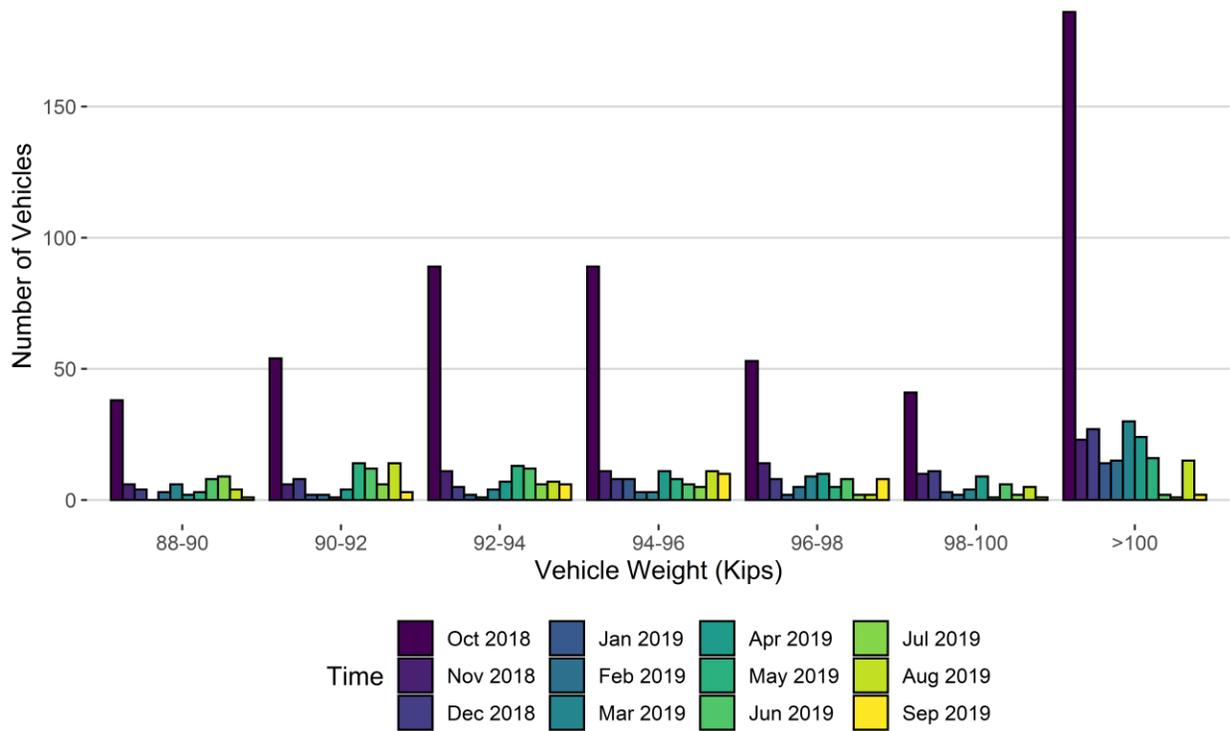


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019
88-90	38	6	4	0	3	6	2	3	8	9	4	1
90-92	54	6	8	2	2	1	4	14	12	6	14	3
92-94	89	11	5	2	1	4	7	13	12	6	7	6
94-96	89	11	8	8	3	3	11	8	6	5	11	10
96-98	53	14	8	2	5	9	10	5	8	2	2	8
98-100	41	10	11	3	2	4	9	1	6	2	5	1
>100	186	23	27	14	15	30	24	16	2	1	15	2
Total	550	81	71	31	31	57	67	60	54	31	58	31

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



Vehicle Weights (Kips)	Oct 2018	Nov 2018	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019
88-90	56	15	6	4	3	15	12	29	56	59	11	16
90-92	49	38	13	9	6	17	13	17	22	43	10	25
92-94	57	20	22	15	7	21	18	14	14	28	11	23
94-96	40	23	15	18	9	19	13	14	4	28	15	21
96-98	41	19	11	12	10	14	10	10	18	18	5	17
98-100	32	13	15	15	11	19	13	19	10	20	6	18
>100	81	64	62	49	79	78	48	35	26	34	20	85
Total	356	192	144	122	125	183	127	138	150	230	78	205

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

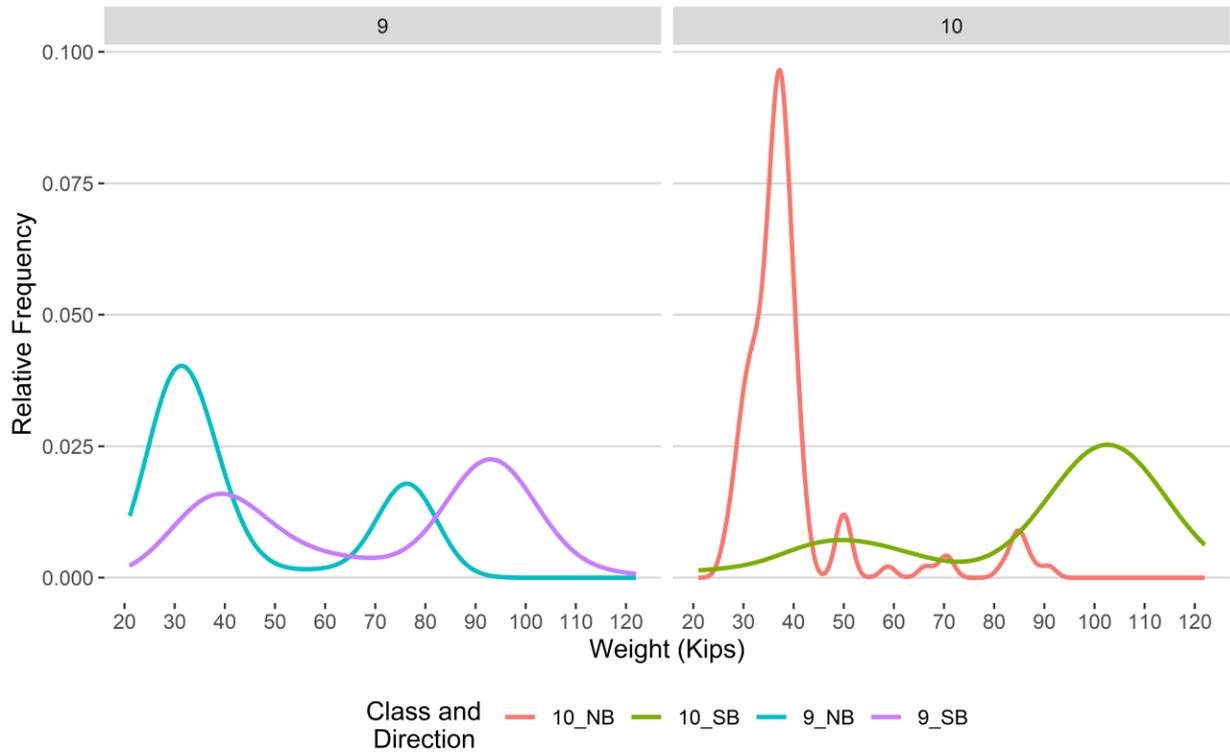


Figure 9 - Freight Percentage by Direction and Class

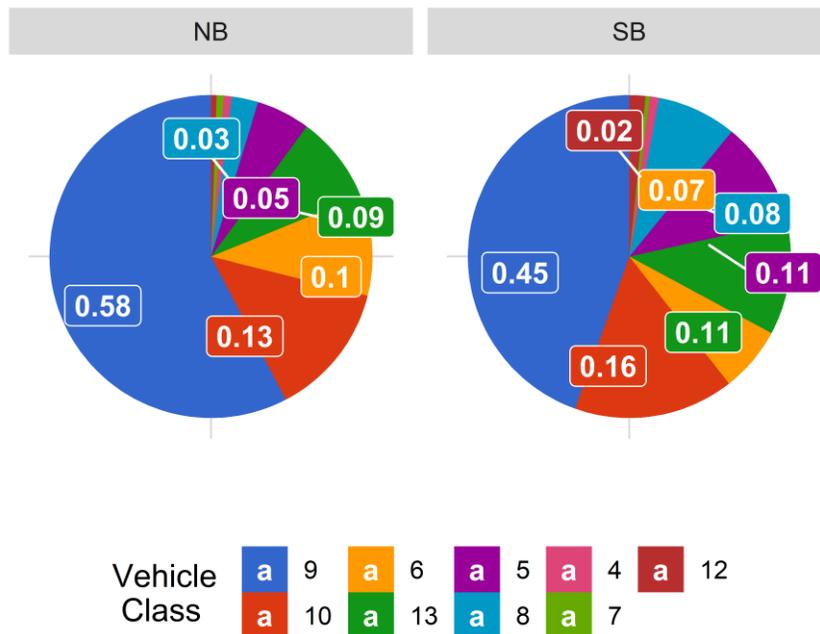


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

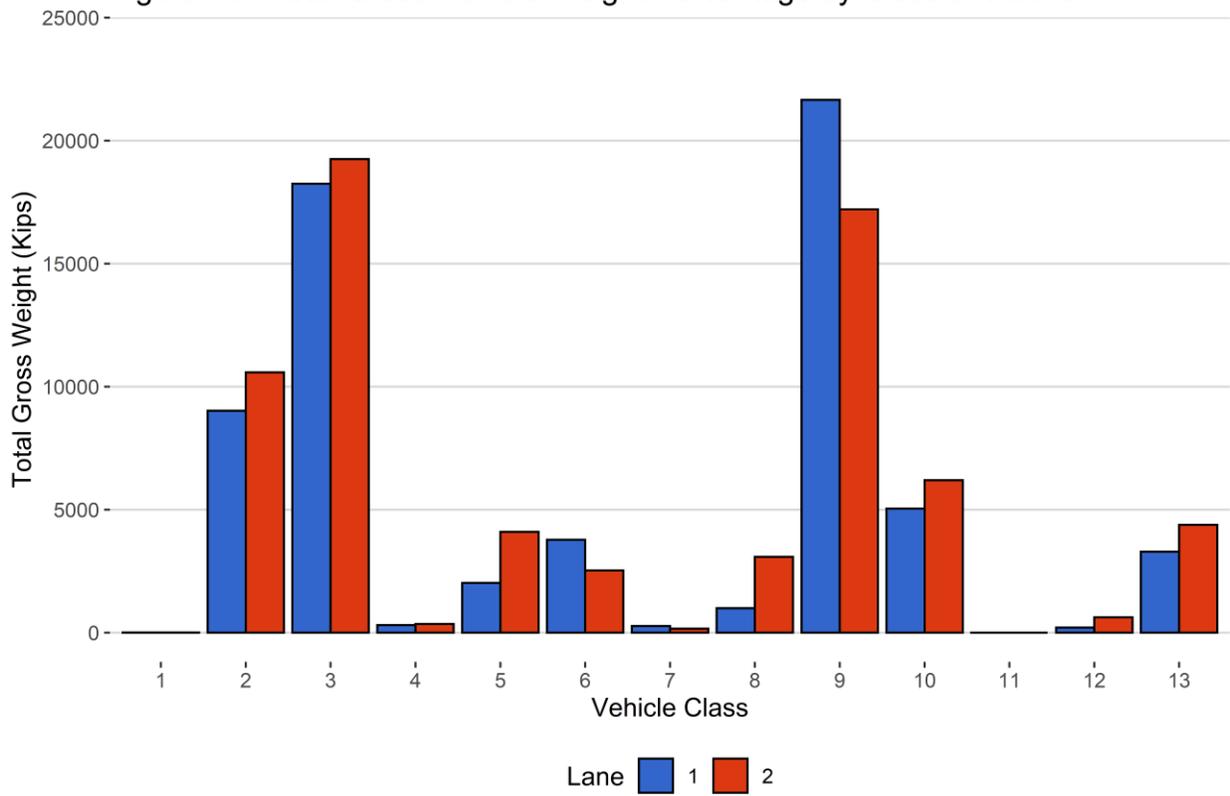


Figure 11 - Total Gross Vehicle Weight t

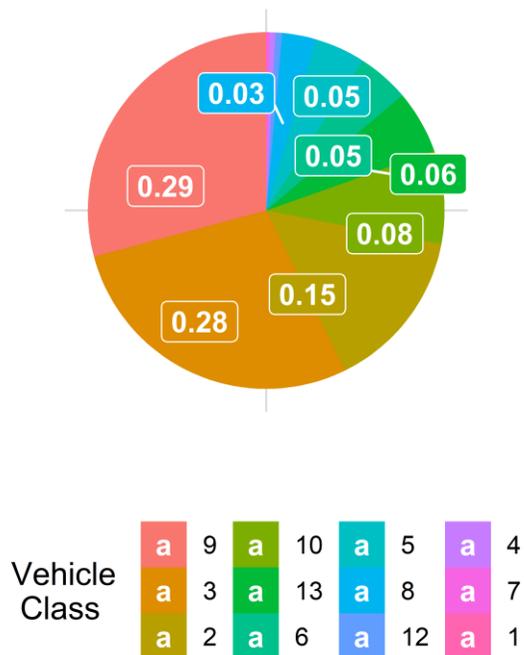


Figure 12 - Total ESALs by Class and Lane

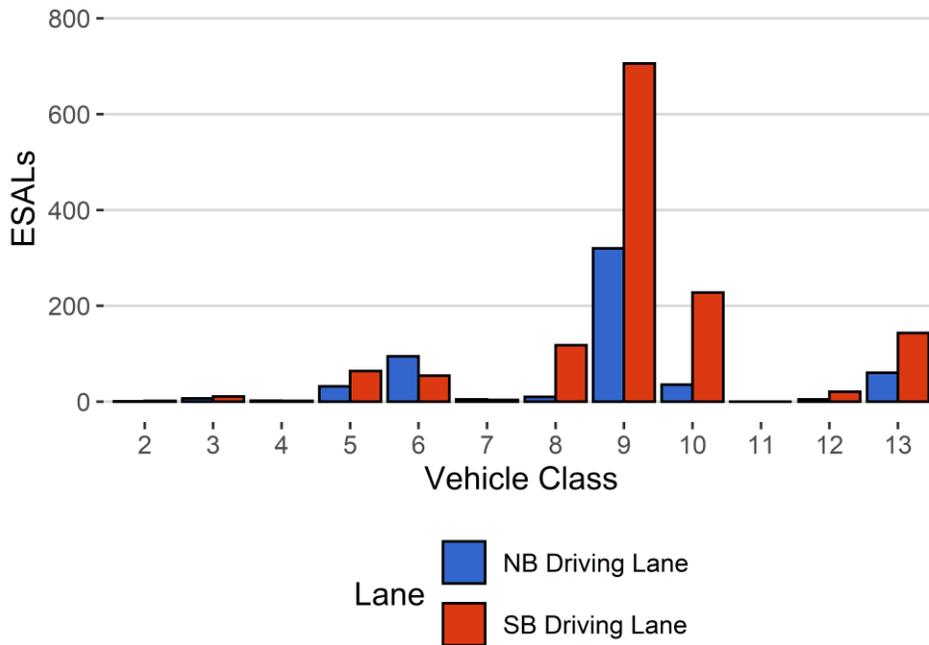


Figure 13 - ESALs by Class

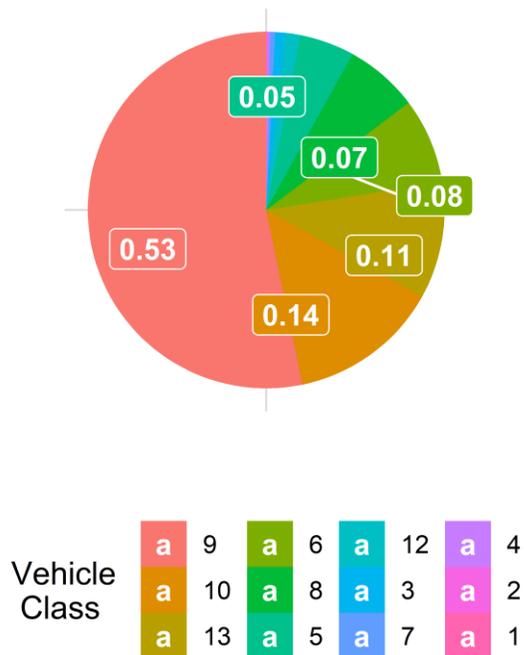


Table 1 Class 9 Front Axle Weight by Lane

<i>Month</i>	<i>Lane 1 (Kips)</i>	<i>Front Axle +/- 9%</i>	<i>Lane 2 (Kips)</i>	<i>Front Axle +/- 9%</i>
June 2019	10.37	0.00	11.18	0.00
July 2019	10.32	-0.45	11.41	2.00
August 2019	10.51	1.39	10.60	-5.20
September 2019	10.31	-0.60	12.27	9.71

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	6	0.1	0	0
2	157	4720	38.7	0	0
3	190	5707	46.7	0	0
4	1	34	0.3	1	0.3
5	13	391	3.2	5	1.3
6	6	182	1.5	43	11
7	0	8	0.1	0	0
8	4	107	0.9	23	5.9
9	25	761	6.2	178	45.4
10	7	205	1.7	60	15.3
11	0	0	0	0	0
12	0	10	0.1	9	2.3
13	3	77	0.6	73	18.6
TOTAL	407	12208	100	392	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>
2019-09-08	Sunday	16:44:07	9	SB	2	121.98
2019-09-02	Monday	16:51:42	10	SB	2	118.34
2019-09-29	Sunday	15:54:33	9	SB	2	117.72
2019-09-15	Sunday	16:19:19	10	SB	2	114.8
2019-09-06	Friday	22:36:58	10	SB	2	114.49
2019-09-10	Tuesday	15:53:06	10	SB	2	113.86
2019-09-06	Friday	21:07:58	10	SB	2	112.88
2019-09-08	Sunday	16:43:55	9	SB	2	112.11
2019-09-10	Tuesday	11:13:36	10	SB	2	111.46
2019-09-06	Friday	21:07:27	10	SB	2	111.17

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	NB	15	16	6	37.5	223	82	36
5	NB	8	130	24	18.5	1850	174	501
6	NB	19	101	6	5.9	3671	104	933
7	NB	11.5	4	0	0	267	0	111
8	NB	31	36	27	75	357	634	39
9	NB	33	485	208	42.9	15621	6036	3240
10	NB	33.5	126	29	23	4158	884	454
12	NB	36.5	3	1	33.3	175	32	51
13	NB	31.5	35	0	0	3286	0	1092
TOTAL	****	****	936	301	****	29608	****	6457
<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	SB	15	17	4	23.5	298	55	51
5	SB	8	244	4	1.6	4067	30	1074
6	SB	19	73	2	2.7	2488	37	570
7	SB	11.5	4	0	0	164	0	59
8	SB	31	66	9	13.6	2919	163	576
9	SB	33	244	6	2.5	17021	187	4583
10	SB	33.5	70	2	2.9	6152	45	1937
12	SB	36.5	7	0	0	621	0	183
13	SB	31.5	39	0	0	4379	0	1575
TOTAL	****	****	764	27	****	38109	****	10608
GRAND TOTAL	****	****	1700	328	283	67717	8464	17065

Table 5 Gross Vehicle Weight by Class and Lane

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>
1	5	1	6	0
2	9020	10580	19601	14.7
3	18245	19249	37494	28.1
4	305	353	658	0.5
5	2024	4097	6121	4.6
6	3775	2526	6301	4.7
7	267	164	431	0.3
8	991	3082	4073	3.1
9	21657	17207	38864	29.2
10	5043	6197	11240	8.4
12	206	621	827	0.6
13	3286	4379	7666	5.8
TOTAL	64824	68457	133281	100
GVW/LANE	48.64	51.36	100	0.08

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

<i>Vehicle Class</i>	<i>NB</i>	<i>SB</i>	<i>Total</i>	<i>Percentage</i>	<i>Flexible ESAL Factor</i>
1	0	0	0	0	0.1429
2	1	2	3	0.2	0.0018
3	7	11	18	0.9	0.0072
4	2	2	4	0.2	0.32
5	32	64	96	5	0.53
6	95	55	150	7.8	1.74
7	5	4	9	0.4	1.67
8	10	118	128	6.7	2.47
9	320	706	1026	53.2	2.86
10	36	228	263	13.7	2.67
12	5	21	26	1.3	2.95
13	60	143	204	10.6	4.96
TOTAL	573	1352	1926	100	20
ESALS/LANE	29.8	70.2	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>
Oct 2018	14892	480	112	11407	76.6	3485.3	23.4
Nov 2018	11107	370	47	9686	87.2	1421.5	12.8
Dec 2018	9594	310	39	8393	87.5	1201.4	12.5
Jan 2019	7052	282	28	6187	87.7	864.7	12.3
Feb 2019	7600	271	38	6535	86	1065.2	14
Mar 2019	9909	320	46	8474	85.5	1435.2	14.5
Apr 2019	10547	352	44	9227	87.5	1320.3	12.5
May 2019	12728	404	53	11098	87.2	1629.9	12.8
Jun 2019	12277	409	53	10701	87.2	1576.4	12.8
Jul 2019	13187	390	94	10276	77.9	2911.1	22.1
Aug 2019	12345	394	64	10346	83.8	1998.6	16.2
Sep 2019	12208	412	59	10433	85.5	1775.5	14.5
TOTAL	133446	-	-	112763	-	20685	-
AVERAGE	11120	366	56	9397	85	1724	15

###ESALs

<i>Month</i>	<i>ESALS NB Driving Lane</i>	<i>ESALS SB Driving Lane</i>	<i>Total ESALS</i>	<i>Pavement Life Decrease Months</i>
Oct 2018	3327	2736	6063	97
Nov 2018	707	1320	2027	88.4
Dec 2018	581	1022	1603	97.2
Jan 2019	315	859	1173	100.9
Feb 2019	426	1097	1523	116.2
Mar 2019	617	1276	1894	103.2
Apr 2019	589	898	1486	78.3
May 2019	606	1263	1869	61.4
Jun 2019	955	2099	3054	30.8
Jul 2019	868	1894	2762	37.4
Aug 2019	734	856	1590	41.3
Sep 2019	576	1392	1968	88.5
TOTAL	10300	-	-	-
AVERAGE	858	1392	2251	78

###Gross Vehicle Weight

<i>Month</i>	<i>GVW NB Driving Lane</i>	<i>GVW SB Driving Lane</i>	<i>Total GVW Kips</i>
Oct 18	120755	111263	232018
Nov 18	53687	60504	114190

Dec 18	46511	49899	96410
Jan 19	27108	36968	64076
Feb 19	32684	39784	72467
Mar 19	47910	55089	102999
Apr 19	51115	53745	104860
May 19	60319	69785	130104
Jun 19	107647	132267	239913
Jul 19	88299	95336	183635
Aug 19	65508	67768	133277
Sep 19	64897	69318	134216
TOTAL	766439	841726	1608165
AVERAGE	63870	70144	134014

###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>
Oct 2018	1250	9.4	39.9	907	341
Nov 2018	401	3.9	30.1	274	110
Dec 2018	286	3.2	25.2	216	116
Jan 2019	216	3.6	29.4	154	82
Feb 2019	237	3.8	26.4	156	107
Mar 2019	339	3.9	26.3	240	131
Apr 2019	261	2.7	21.2	194	94
May 2019	389	3.3	25.3	200	71
Jun 2019	716	3.2	24.7	204	44
Jul 2019	795	6.9	30.9	261	57
Aug 2019	347	3.2	19	137	47
Sep 2019	403	3.5	23.4	237	107
TOTAL	5640	-	-	3180	1307
AVERAGE	470	4.2	26.8	265	108.9

###Freight

<i>Month</i>	<i>NB Freight Tons</i>	<i>SB Freight Tons</i>	<i>Total Freight</i>	<i>NB Freight %</i>	<i>SB Freight %</i>
Oct 2018	23691	19714	43405	54.6	45.4
Nov 2018	5662	9780	15442	36.7	63.3
Dec 2018	4620	7430	12050	38.3	61.7
Jan 2019	2455	5954	8409	29.2	70.8
Feb 2019	3307	6523	9830	33.6	66.4
Mar 2019	4989	9102	14091	35.4	64.6
Apr 2019	5153	7228	12381	41.6	58.4

May 2019	6527	9850	16377	39.9	60.1
Jun 2019	10389	17912	28301	36.7	63.3
Jul 2019	10842	19097	29939	36.2	63.8
Aug 2019	8529	8525	17054	50	50
Sep 2019	6457	10608	17065	37.8	62.2
TOTAL	92621	131722	224343	-	-
AVERAGE	7718.4	10976.8	18695.2	39.2	60.8
