CAMBRIDGE SYSTEMATICS

Data Summary Report

C-470 Traffic Modeling

Draft

report

prepared for

Douglas County

prepared by

Cambridge Systematics, Inc.

March 4, 2014

www.camsys.com

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1.0 Introduction

The purpose of this document is to summarize the traffic data that is being used for the C-470 traffic analysis, which involves two models, as described in the Methods and Assumptions document: 1) the Focus Model, which is the Denver Regional Council of Governments (DRCOG) Regional Demand Model (Focus), and 2) a VISSIM microsimulation model of the Segment 1 corridor. The Focus model is being used to assess regional behavior and to provide travel demand information that will be fed into the VISSIM model. The VISSIM model will be used to model detailed traffic operations and to assign traffic to the tolled express lanes.

The models will supply information to make decisions on the design of ingress/egress locations and the revenue potential of tolled lanes. To ensure stakeholders have faith in the models and to confirm the model is functioning properly, they must match field conditions. Accurate and timely traffic data is critical to understanding the field conditions throughout the corridor so the model development process is successful. The models will be calibrated to meet a minimum set of calibration and validation criteria, in accordance with the guidelines set forth by the Federal Highway Administration (FHWA). This document summarizes the data that will be used for calibration and validation.

2.0 Available Data Sources

Various types of data are critical to this study, including roadway geometry, speeds, volumes and signal operations. This document focuses on traffic operating conditions. Existing available data were reviewed and new data was collected specifically for this project. Table 2.1 summarizes the existing data items that were provided for this study along with the year of collection and the source. The right-most column labeled "Comment" contains a brief description of the relevancy of the data to this study. Nearly all of these data are valuable, but some data sets are more relevant than others. Old data (2010 or previous) can be used to compare against new data to identify and examine unusual findings. New data is summarized in subsequent sections.

Table 2.1 Available Traffic Data Sources

Data Items	Source	Year	Comment
Turning Movement Counts	Atkins	2008-2009	Limited locations
	DRCOG	2011-2012	Limited locations
	CDOT	2010	Limited locations, AM only
	Douglas County	2007-2009	Limited locations
	ATD	2003	Dated
Mainline and Ramp Volumes	CDOT	2012-2013	Current and relevant
	ATD	2002	Dated
Ramp Volumes	DRCOG	2007	Dated, Peak hours only
Arterial Volumes	Douglas County	2009-2011	Hourly
	Jefferson County	2011-2012	Hourly
Signal Timing Plans	Douglas County	2013	Limited locations
	Douglas County		Synchro format
	City of Centennial	2011-2013	
	CDOT	2008-2010	
Ramp Meter Controller Parameters	CDOT	2013	
Mainline Speeds	ATD	2013	Radar
	DRCOG	2012	Free flow speeds
Speed Study Review	DRCOG	2011	GPS survey
Satellite	Douglas County		
C-470 Plan Drawings and Aerials	Wilson & Co.		
U.S. 36 Stated Preference Survey	CDOT	2011	
C-470 Market Demand Study	CDOT	2004	
C-470 Express Lanes Feasibility Study	Wilson & Co.	2005	Dated

3.0 Data Collection

After careful review of all the readily available data, it was determined that many items are out of date, not complete enough to conduct a basic traffic study, and not robust enough to build two reliable 7-hour traffic simulation models (AM and PM). For the development of any microsimulation model, a critical step in this project, a data set containing speeds and volumes collected simultaneously provides the ideal context to match actual field conditions. Therefore, it was recommended by the Traffic Subcommittee to perform a new data collection effort.

This following data collection was performed in May 2013:

- **Automatic Traffic Collection on Mainline Freeways –** continuous traffic volume, spot speeds, and vehicle classification by direction on I-25 immediately north of the County line Road interchange and on C-470 immediately west of I-25.
- **Automatic Traffic Collection on Ramp Roadways –** continuous traffic volume and vehicle classification at 39 ramp roadway locations.
- **Automatic Traffic Collection on Arterial Roadways –** continuous two-way traffic volumes and vehicle classification for 20 arterial roadway locations.
- **Turning Movement Counts –** manual turning movement counts at 26 intersection locations within the study area collected on one day for 8 hours (6-10 a.m. and 2-6 p.m.).
- **Speeds –** travel times along C-470 collected over two days (6-10 a.m. and 2-7 p.m.) using the floating car method and GPS collection.

In addition, traffic data was obtained from the Colorado Department of Transportation's (CDOT) Intelligent Transportation Systems (ITS) detectors.

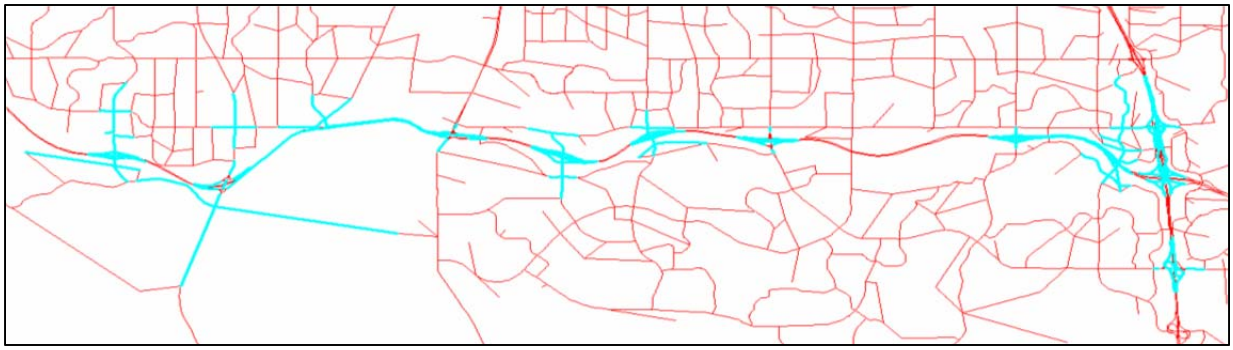
All of the data used to present the existing conditions in this report were collected in May 2013, supplemented by some field checks in November 2013. Table 3.1 presents a summary.

Table 3.1 New Data Collected in May 2013

Data Type	Location	Period	Data Collected	Vehicle Class
Ramp Meter Detectors	26 on-ramps and adjacent mainlines	May 5-11, 2013	5-min. speed and volume by lane	No
Ramp Counts	39 on- and off-ramps	May 14-16, 2013	15-min. volume	13 vehicle types
Arterial Counts	Arterials just outside 20 interchanges	May 14-16, 2013	15-min. volume	13 vehicle types
Automatic Traffic Recorders	2 mainline sites	January 3, 2012 - May 28, 2013	Hourly volumes	No
Mainline Counts	2 mainline sites	May 14-16, 2013	15-min. volume and speed	3 vehicle types
Turning Movement Counts	26 intersections	25 intersections on May 14, 2013 and 1 intersection on May 16, 2013	15-min. volume	No
Travel Time Runs	C-470 both directions	9 to 13 runs in each direction on May 14 and May 16, 2013	Segment average travel time and speed	No

The new data underwent a quality control review and data processing procedures before it was compiled into a geo referenced database for use in this study. The electronic database is included under separate cover. Each of the count sites was assigned a unique station name and ID. Stations are grouped into directional routes, C-470 EB, C-470 WB, I-25 NB, and I-25 SB, and 40 arterial links. Each station was also assigned a sequence number based on its position on its route. All the stations are geocoded in a GIS map. Figure 3.1 shows all the count sites geocoded as blue roadway links in the study area.

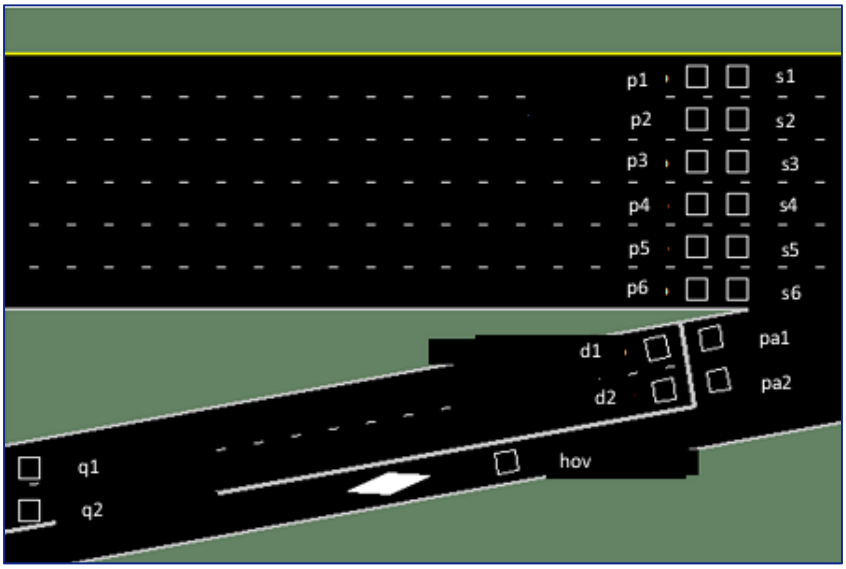
Figure 3.1 Traffic Volume Count Sites



The ramp meter data was reviewed to examine and address data collected during any communication or equipment failures that could skew data processing results. The other purpose of the review is to make sure the speeds are reasonable in comparison to the volumes.

The ITS detectors include Primary detectors and Secondary detectors on the mainline, and Queue detectors, Demand detectors, and Passage detectors on the on-ramps (see Figure 3.2). Continuous speed and volume data are collected at each lane at 5-minute intervals. Volumes at Primary detectors are selected as mainline volumes, and volumes at Demand detectors are selected as ramp volumes in this study.

Figure 3.2 Ramp Metering Detectors



Source: CDOT

The ramp meter data was quality reviewed and aggregated to insure only reliable and relevant data is used in the analysis. Unusually high volumes (i.e., any 5-minute observation with a volume greater than 250 vehicles) were reset to a null value as it most likely was a result of an equipment malfunction.

Lane level volumes were added up to a directional station level, and station volume was reset to null if one or more lane volumes were missing at the station during the same 5-minute interval. The 5-minute station volumes were then summed up into 15-minute intervals. If one or more 5-minute station volume was missing, the entire 15-minute volume was reset to null.

Ramp counts were conducted at 39 ramp locations. Because ramp meter data was not available during the week of the manual counts, data from one week before the manual counts were used in this study. A route volume test was performed as follows to examine the difference between the data sets.

The total volumes on C-470 were calculated from 6:00 a.m. to 8:00 p.m. at each count location, and checkpoints were set up at the mainline locations where mainline count data were available. The estimated mainline volumes from on- and off-ramp counts were compared with the counted volumes at the checkpoints. The results in Table 3.2 show that the mainline counts estimated from on- and off-ramp counts are lower than the mainline volumes from ramp metering mainline detectors or the mainline volumes from ATR counts. The difference is within 7% in the eastbound direction and within 16% in the westbound direction. The mainline radar counts are extremely low in comparison to the other counts.

Table 3.2 Route Volume Test Results

Route	Location	Data Type	Date	Volume	Estimated Mainline Volume	% Volume Difference at Checkpoint
C470EB	470EB-Kipling Mainline	Ramp Meter	20130508	19894	19894	
	C-470 EB ON RAMP E-O KIPLING	Ramp Count	20130515	8465	28359	
	C-470 EB OFF RAMP W-O WADSWORTH	Ramp Count	20130515	4532	23827	
	C-470 EB ON RAMP E-O WADSWORTH	Ramp Count	20130515	8594	32421	
	000003EB Mainline	ATR	20130515	33366	32421	-3%
	C-470 EB OFF RAMP W-O SANTE FE	Ramp Count	20130515	8049	24372	
	C-470 EB ON RAMP E-O SANTE FE	Ramp Count	20130515	14496	38868	
	C-470 EB OFF RAMP W-O LUCENT	Ramp Count	20130515	9449	29419	
	470EB-Lucent Mainline	Ramp Meter	20130508	30983	29419	-5%
	470EB-Lucent On Ramp	Ramp Meter	20130508	6063	35482	
	C-470 EB OFF RAMP W-O BROADWAY	Ramp Count	20130515	4071	31411	
	470EB-Broadway Mainline	Ramp Meter	20130508	33348	31411	-6%
	470EB-Broadway On Ramp	Ramp Meter	20130508	10474	41885	
	C-470 EB OFF RAMP W-O University	Ramp Count	20130515	7895	33990	
	470EB-University Mainline	Ramp Meter	20130508	35337	33990	-4%
	470EB-University On	Ramp Meter	20130508	7672	41662	

	Ramp					
	C-470 EB OFF RAMP W-O QUEBEC	Ramp Count	20130515	6827	34835	
	470EB-Quebec Mainline	Ramp Meter	20130508	37520	34835	-7%
	470EB-Quebec On Ramp	Ramp Meter	20130508	13928	48763	
	105548EB Mainline	ATR	20130515	52909	48763	-8%
	C-470 EB OFF RAMP W-O YOSEMITE	Ramp Count	20130515	8075	40688	
	C-470EB Mainline	Mainlane Count	20130515	23575	40688	73%
C470WB	470WB-Yosemite Mainline	Ramp Meter	20130508	38943	38943	
	470WB-Yosemite On Ramp	Ramp Meter	20130508	6929	45872	
	105548WB Mainline	ATR	20130515	48155	45872	-5%
	C-470 WB OFF RAMP E-O QUEBEC	Ramp Count	20130515	12957	32915	
	470WB-Quebec Mainline	Ramp Meter	20130508	33510	32915	-2%
	470WB-Quebec On Ramp	Ramp Meter	20130508	7810	40725	
	C-470 WB OFF RAMP E-O UNIVERSITY	Ramp Count	20130515	9003	31722	
	470WB-University Mainline	Ramp Meter	20130508	33334	31722	-5%
	470WB-University On Ramp	Ramp Meter	20130508	7284	39006	
	C-470 WB OFF RAMP E-O BROADWAY	Ramp Count	20130515	9555	29451	
	470WB-Broadway Mainline	Ramp Meter	20130508	32442	29451	-9%
	470WB-Broadway On Ramp	Ramp Meter	20130508	3898	33349	
	C-470 WB OFF RAMP E-O LUCENT	Ramp Count	20130515	6949	26400	
	470WB-Lucent Mainline	Ramp Meter	20130508	30175	26400	-13%
	470WB-Lucent On Ramp	Ramp Meter	20130508	6353	32753	
	C-470 WB OFF RAMP E-O SANTE FE	Ramp Count	20130515	8890	23863	
	470WB-Santa-Fe Mainline	Ramp Meter	20130508	28275	23863	-16%
	470WB-Santa-Fe On Ramp	Ramp Meter	20130508	8592	32455	
	000003WB Mainline	ATR	20130515	38242	32455	-15%

4.0 Existing Traffic Volumes

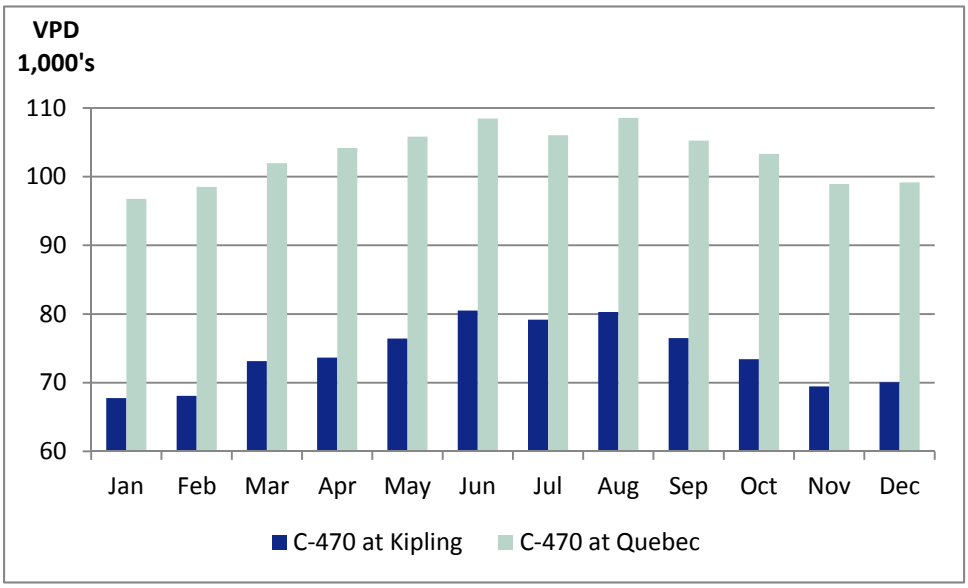
4.1 DAILY TRAFFIC

The long-term traffic patterns were determined by a full year of data (2012) from the two automatic traffic recorder (ATR) count stations on C-470. The American Association of State Highway and Transportation Officials (AASHTO) method[1] was used to calculate Annual Average Daily Traffic (AADT), monthly factor, and day-of-week (DOW) factor. A similar "average of averages" approach was conducted for the hourly factor.

Monthly Variation

The AADT is 35,442 vehicles. There are five months in 2012 that have monthly factors within five percent of the AADT in all four directional count locations: March, April, May, September and October. Figure 4.2 illustrates that the month of May is well suited for model validation/calibration as it represents average travel patterns.

Figure 4.1 2013 C-470 Average Daily Traffic by Month

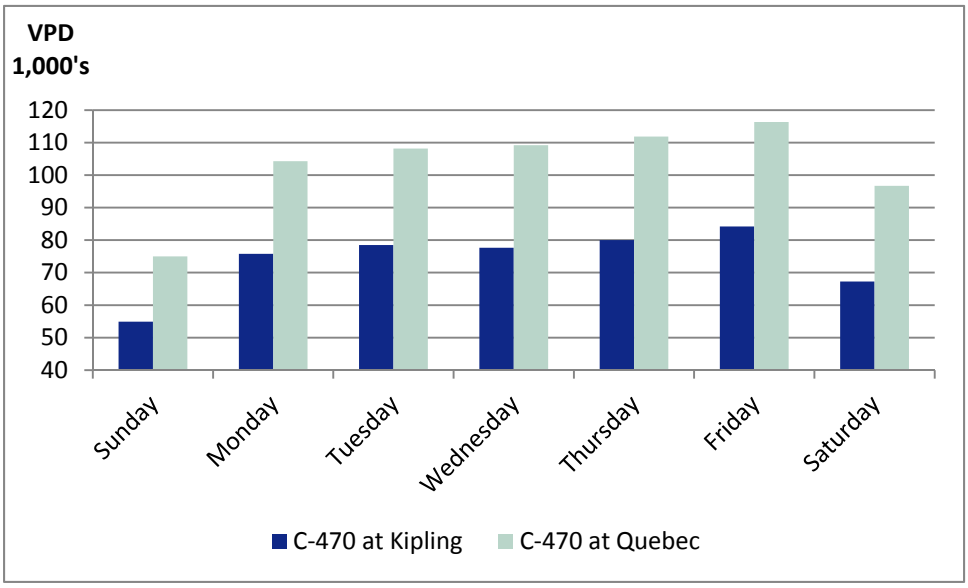


[1] AASHTO Guidelines for Traffic Data Programs, 1992.

Day of Week Variation

For all four directional count locations on C-470, only the Monday average count is within five percent of AADT. Tuesday, Wednesday, and Thursday are within five to ten percent of AADT. Most of the new data collection was recorded on May 14 through 16, a Tuesday, Wednesday and Thursday. Figure 4.2 illustrates that these days of the week are well suited for this study.

Figure 4.2 Daily Traffic by Day of Week



Peak Hour Volumes

The peak hours were identified by reviewing the hourly volumes at four ATR sites on C-470 and 26 turning movement counts that were collected in May 2013. The ATR counts included hourly volumes from the top of the hour. As shown in Table 4.1, the highest peak hour volume was 7:00-8:00 AM and the PM peak hour was 5:00-6:00 PM.

Table 4.1 2013 Average Weekday Hourly Volumes

Hour Start	C-470 at Kipling[2]			C-470 at Quebec[3]		
	Eastbound	Westbound	two-way	Eastbound	Westbound	two-way
0:00	176	191	367	281	317	598
1:00	110	109	219	164	186	349
2:00	82	82	164	127	131	258
3:00	95	87	182	173	120	293
4:00	219	172	391	372	225	598
5:00	783	657	1,440	1,245	743	1,988
6:00	2,136	1,675	3,810	3,164	1,929	5,093
7:00	**2,659**	**2,597**	**5,256**	**4,003**	**2,925**	**6,928**
8:00	2,390	2,319	4,709	3,880	2,874	6,754
9:00	1,966	1,987	3,953	3,231	2,598	5,829
10:00	1,893	1,995	3,888	3,104	2,691	5,795
11:00	1,960	2,129	4,089	3,303	2,937	6,240
12:00	2,017	2,239	4,256	3,392	3,072	6,464
13:00	2,030	2,302	4,333	3,303	3,175	6,478
14:00	2,267	2,590	4,857	3,370	3,537	6,907
15:00	2,715	3,195	5,910	3,770	4,014	7,783
16:00	3,033	3,538	6,571	3,852	3,973	7,824
17:00	**2,944**	**3,382**	**6,326**	**3,707**	**3,614**	**7,321**
18:00	2,075	2,549	4,624	3,051	3,103	6,154
19:00	1,282	1,599	2,881	2,107	2,196	4,302
20:00	996	1,248	2,244	1,662	1,786	3,448
21:00	778	998	1,776	1,325	1,497	2,821
22:00	509	617	1,126	855	950	1,804
23:00	330	340	669	508	540	1,048
total	35,442	38,598	74,040	53,948	49,130	103,078

The ATR counts were at limited locations along the corridor and only available at hourly intervals. Turning movement counts also collected in May 2013 were used for comparison purposes and to identify the peak hour using smaller time increments. Total hourly volumes at the 26 sites were summed every 15 minutes during the AM and PM peak periods. In the AM period, the hour with the largest volume was 7:30-8:30 AM. The PM peak hour was very close between 4:45-5:45 PM and 5:00-6:00 PM. Therefore the 5:00-6:00 PM time was selected.

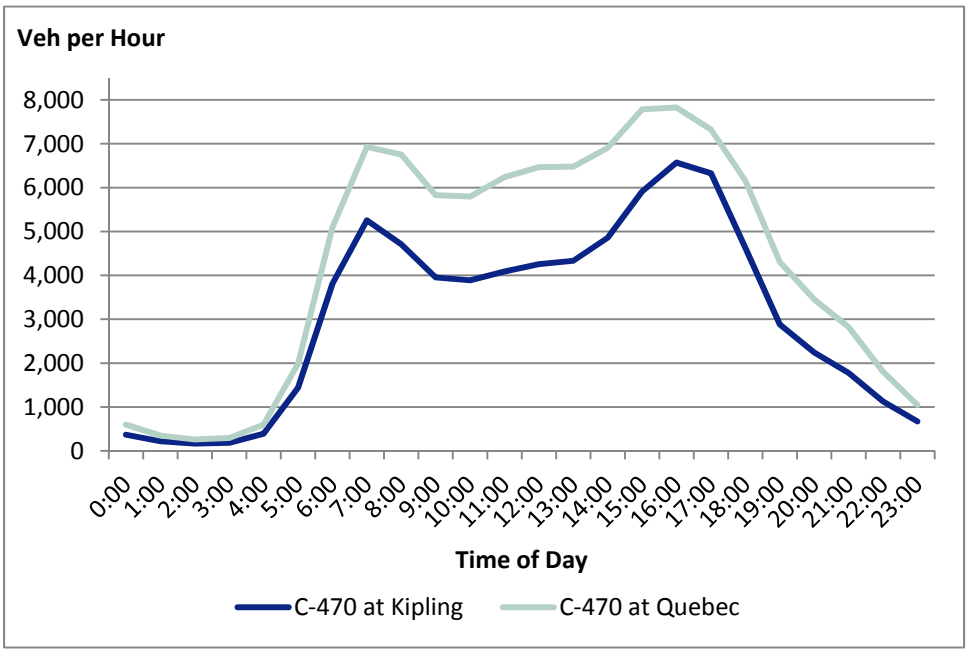
[2] Automatic Recorder Station #000003

[3] Automatic Recorder Station #105548

Hourly Variation

Figure 4.4 shows the calculated hourly factors, where the AM peak period is from 6:00 to 10:00 a.m., and PM peak period is from 3:00 to 8:00 p.m.

Figure 4.3 C-470 Hourly Variation



Typical Day Volumes

Volumes from ramp meters, ramp counts, ATR counts, mainline counts, and arterial counts during six days (Tuesday May 7, 2013 to Thursday May 9, 2013, and Tuesday, May 14 to Thursday May 16, 2013) were chosen, and each volume observation was compared with the mean volume at the same observation time slot by each count type. If the volume observation was within one standard deviation away from the mean, that observation interval is flagged as a typical. Then the numbers of observations with the typical flags were summarized from 6:00 a.m. to 8:00 p.m., and the days with the most typical numbers were chosen to represent a "Typical Day".

The overall results are shown in Table 4.3. More than 60% of observations can be considered as typical. The results also show that Wednesday May 15 and Wednesday May 8 are the typical days.

Table 4.2 Typical Day Analysis

Date	Number of Observations	Number of Typical Flags	Percent
20130507	1484	965	65%
20130508	1484	1003	68%
20130509	1512	964	64%
20130514	4704	3107	66%
20130515	4704	3163	67%
20130516	4704	3009	64%

Mainline and Ramp Volumes

Mainline and Ramp volumes were balanced for both east and westbound C-470 for the Data collected on May 15, 2013

Table x is a summary of eastbound C-470 AM, PM peak and Daily Traffic and Table x is a summary of Westbound.

Arterial Volumes

A balanced network of turning movement counts was developed for the arterial study area using the May 2013 traffic counts and existing available counts from other sources (see Section 2.0). The balanced arterial flow map is divided into two separate figures for clarity: Figure 4.5 shows the western portion of the study area (Kipling to Broadway) and Figure 4.6 shows the eastern portion of the study area (Broadway to I-25).

Table 4.3 Eastbound C-470 Mainline and Ramp Volumes May 15, 2013

Location Description	Location Type	AM	PM	Daily
C-470 EB	mainline	3,178	3,489	31,051
Kipling off-ramp	off-ramp	191	265	2,934
C-470 EB	mainline	2,987	3,224	28,117
Kipling on-ramp	on-ramp	690	759	8,590
C-470 EB	mainline	3,677	3,983	36,707
Wadsworth off-ramp	off-ramp	424	477	5,146
C-470 EB	mainline	3,253	3,506	31,561
Wadsworth on-ramp	on-ramp	668	583	9,996
C-470 EB	mainline	3,921	4,089	41,557
Santa Fe off-ramp	off-ramp	731	870	8,929
C-470 EB	mainline	3,190	3,219	32,628
Santa Fe on-ramp	on-ramp	1,248	1,257	16,495
C-470 EB	mainline	4,438	4,476	49,123
Lucent off-ramp	off-ramp	1,295	1,000	10,329
C-470 EB	mainline	3,143	3,476	38,794
Lucent on-ramp	on-ramp	390	389	6,699
C-470 EB	mainline	3,533	3,865	45,493
Broadway off-ramp	off-ramp	248	383	4,677
C-470 EB	mainline	3,285	3,482	40,816
Broadway on-ramp	on-ramp	541	594	11,991
C-470 EB	mainline	3,826	4,076	52,807
University off-ramp	off-ramp	366	799	9,062
C-470 EB	mainline	3,460	3,277	43,745
University on-ramp	on-ramp	735	387	8,637
C-470 EB	mainline	4,195	3,664	52,382
Quebec off-ramp	off-ramp	597	526	7,678
C-470 EB	mainline	3,598	3,138	44,704
Quebec on-ramp	on-ramp	1,916	833	15,751
C-470 EB	mainline	5,514	3,971	60,455
Yosemite off ramp	off-ramp	604	620	8,795
C-470 EB	mainline	4,910	3,351	51,660
I-25 nb off ramp	off-ramp	3,271	1,227	27,785
I-25 sb off ramp		1,026	1,198	14,844
I-25 off ramp		4,297	2,425	42,629
C-470 EB	mainline	613	926	9,031
I-25 on-ramp (from NB)	on-ramp	281	1,198	7,014
I-25 on-ramp (from SB)		402	541	5,322
I-25 on-ramp		683	1,739	12,336
C-470 EB	mainline	1,296	2,665	21,367

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Table 4.4 Westbound C-470 Mainline Volumes May 15, 2013

Location Description	Location Type	AM	PM	Daily
C-470 WB	mainline	2,906	2,365	23,109
I-25 NB off ramp	off-ramp	1,243	351	7,461
I-25 SB off ramp		437	622	5,577
I-25 Off ramp		1,680	973	13,038
C-470 WB	mainline	1,226	1,392	10,071
I-25 NB on ramp	on-ramp	1,336	1,530	23,276
I-25 SB on ramp		1,069	795	13,667
I-25 on ramp		2,405	2,325	36,943
C-470 WB	mainline	3,631	3,717	47,014
Yosemite on-ramp	on-ramp	315	420	8,247
C-470 WB	mainline	3,946	4,137	55,261
Quebec off-ramp	off-ramp	826	1,346	15,018
C-470 WB	mainline	3,120	2,791	40,243
Quebec on-ramp	on-ramp	621	629	8,683
C-470 WB	mainline	3,741	3,420	48,926
University off-ramp	off-ramp	697	626	10,378
C-470 WB	mainline	3,044	2,794	38,548
University on-ramp	on-ramp	755	431	8,219
C-470 WB	mainline	3,799	3,225	46,767
Broadway off-ramp	off-ramp	931	493	11,074
C-470 WB	mainline	2,868	2,732	35,693
Broadway on-ramp	on-ramp	327	200	4,555
C-470 WB	mainline	3,195	2,932	40,248
Lucent off ramp	off-ramp	702	427	8,081
C-470 WB	mainline	2,493	2,505	32,167
Lucent on ramp	on-ramp	792	495	6,964
C-470 WB	mainline	3,285	3,000	39,131
Santa Fe off ramp	off-ramp	823	350	10,180
C-470 WB	mainline	2,462	2,650	28,951
Santa Fe on ramp	on-ramp	836	933	9,382
C-470 WB	mainline	3,298	3,583	38,333
Chatfield off ramp	off-ramp	342	410	5,081
C-470 WB	mainline	2,956	3,173	33,252
Chatfield on ramp	on-ramp	137	114	1,308
C-470 WB	mainline	3,093	3,287	34,560
Wadsworth off ramp	off-ramp	1,005	772	11,022
C-470 WB	mainline	2,088	2,515	23,538
Wadsworth on ramp	on-ramp	467	441	4,744
C-470 WB	mainline	2,555	2,956	28,282
Kipling off ramp	off-ramp	726	868	9,423
C-470 WB	mainline	1,829	2,088	18,859
Kipling on ramp	on-ramp	270	302	3,209
C-470 WB	mainline	2,099	2,390	22,068

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Figure 4.4 Balanced Turning Movement Counts (Kipling to Broadway)

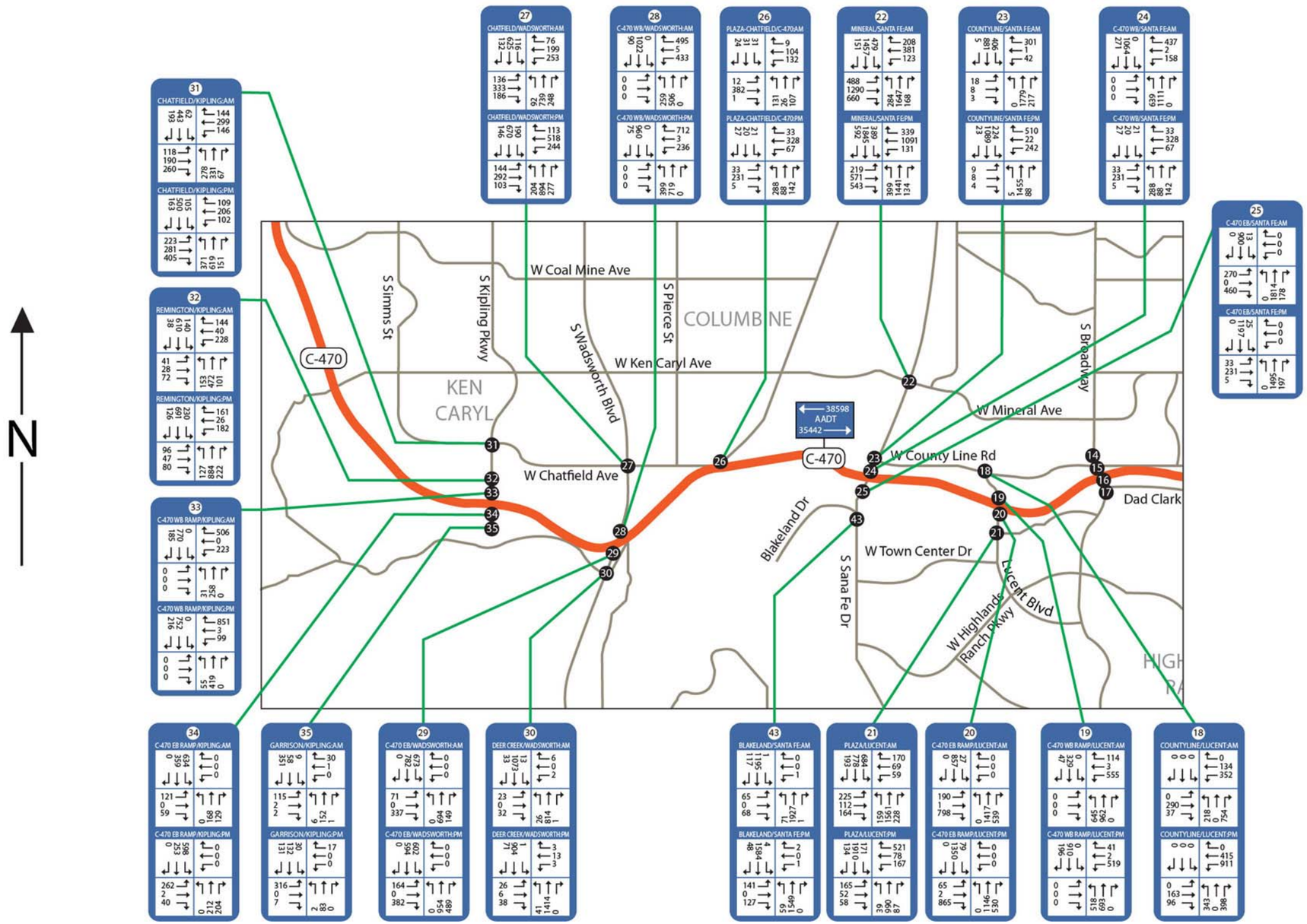
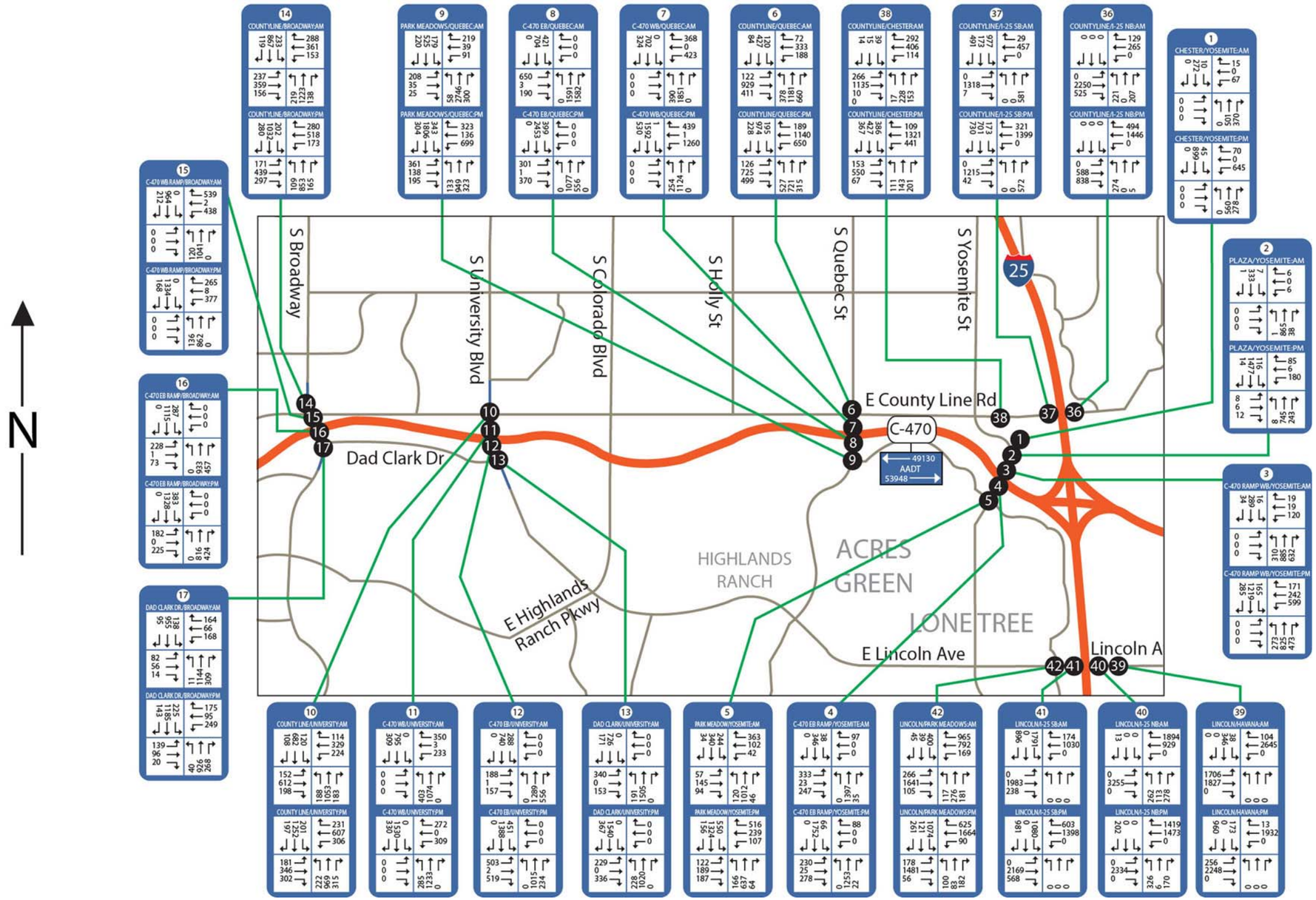


Figure 4.5 Balanced Turning Movement Counts (Broadway to I-25)



4.2 VEHICLE COMPOSITION

Vehicle classification information was obtained from available sources and was collected in the field the week of May 15, 2013. The historical data from CDOT is contained on the OTIS webpage (http://dtdapps.coloradodot.info/Otis/TrafficData). The Classification count Data is very limited along the corridor. There is one permanent count station at Kipling (Station #000003) that counts both vehicles and classification on a continual basis. The other permanent count station in the corridor around Quebec (Station #105548) does **not** collect vehicle classification. The truck % information is only an estimate and does not represent counted vehicles. The Truck percentage from Station #000003 (at Kipling) was 2.2%, this same percentage was estimated at Station #105548 (at Quebec).

The vehicle Composition is summarized by the C-470 on and off ramps counted the week of May 15, 2013, and crossing arterials immediately adjacent to C-470 and I-25 in the study area counted the week of May 15, 2013.

Table 4.5 Freeway Ramp Trucks %'s week of May 15, 2013

Location				Daily Volume	Daily Trucks	Truck %
C-470	WB	I-25	Off Ramp TO I-25nb	7,420	352	4.7%
			Off Ramp To I-25 Sb	5,660	532	9.4%
			On Ramp From Nb I-25	23,503	1,079	4.6%
			On Ramp From Sb I-25	14,175	618	4.4%
		Quebec	Off Ramp To Quebec	15,050	470	3.1%
		University	Off Ramp To University	10,334	777	7.5%
		Broadway	Off Ramp To Broadway	11,222	167	1.5%
		Lucent	Off Ramp To Lucent	8,162	801	9.8%
		Sant Fe	Off Ramp To Sante Fe	10,456	734	7.0%
		Platte River	Off Ramp To Platte River	5,092	373	7.3%
			On Ramp From Platte River	1,354	40	3.0%
		Wadsworth	Off Ramp To Wadsworth	11,160	450	4.0%
			On Ramp From Wadsworth	4,830	323	6.7%
		Kipling	Off Ramp To Kipling	9,458	272	2.9%
			On Ramp From Kipling	3,288	86	2.6%
	EB	Kipling	Off Ramp To Kipling	2,996	204	6.8%
			On Ramp From Kipling	9,393	505	5.4%
		Wadsworth	Off Ramp To Wadsworth	5,534	227	4.1%
			On Ramp From Wadsworth	10,049	172	1.7%
		Sante Fe	Off Ramp To Sante Fe	8,793	491	5.6%
			On Ramp From Sante Fe	16,687	905	5.4%
		Lucent	Off Ramp To Lucent	10,206	484	4.7%
		Broadway	Off Ramp To Broadway	4,674	175	3.7%
		University	Off Ramp To University	9,216	268	2.9%
		Quebec	Off Ramp To Quebec	7,528	132	1.7%
		Yosemite	Off Ramp To Yosemite	8,847	98	1.1%
		I-25	Off Ramp To Nb I-25	27,068	837	3.1%
			Off Ramp To Sb I-25	14,908	448	3.0%
			On Ramp From Nb I-25	6,966	359	5.1%
			On Ramp From Sb I-25	5,422	496	9.1%
I-25	NB	Lincoln	Off Ramp From Lincoln Rd	6,905	468	6.8%
			On Ramp(Loop Ramp)	9,832	236	2.4%
			On Ramp To Lincoln Rd	16,836	358	2.1%
		County Line	Off Ramp To Countyline Rd	6,073	75	1.2%
	SB	County Line	Off Ramp To Countyline Rd	21,819	688	3.2%
			On Ramp From Countyline Rd	7,615	99	1.3%
		Lincoln	Off Ramp To Lincoln Rd	26,285	1,141	4.3%
			On Ramp From Wb Loop Ramp)	3,107	251	8.1%
			On Ramp From Eb Lincoln Rd	4,702	79	1.7%

Table 4.6 Arterial Truck %'s Week of May 15, 2013

Arterial	Location	Daily Traffic		
		Cars	Trucks	% Trucks
BROADWAY	North of C-470	30,576	1,327	4.2%
	South of C-470	28,332	2,352	7.7%
KIPLING PKWY	North of C-470	21,660	906	4.0%
	South of C-470	7,442	320	4.1%
LUCENT BLVD	North of C-470	14,122	587	4.0%
	South of C-470	32,557	1,196	3.5%
QUEBEC ST	North of C-470	38,583	3,529	8.4%
	South of C-470	36,959	3,070	7.7%
UNIVERSITY BLVD	North of C-470	30,275	2,936	8.8%
	South of C-470	34,217	1,488	4.2%
Santa Fe/US 85	North of C-470	26,100	1,653	6.0%
	South of C-470	30,424	3,278	9.7%
WADSWORTH BLVD	North of C-470	24,544	1,000	3.9%
	South of C-470	22,624	1,062	4.5%
YOSEMITE ST	North of C-470	22,608	1,402	5.8%
	South of C-470	28,234	1,592	5.3%
COUNTYLINE RD	East of I-25	25,422	1,086	4.1%
	West of I-25	29,306	1,695	5.5%
LINCOLN AVE	East of I-25	52,040	2,773	5.1%
	West of I-25	46,805	3,077	6.2%

5.0 Existing Traffic Operations

Traffic operations that were observed and collected were centered around speed data. Speed data was gathered from two sources. The first source was spot speeds from mainline detection used for the ramp metering system

5.1 TRAVEL TIME STUDIES

During the week of May 15, 2013 while traffic counts were being conducted a number of travel time runs were

Figure 5.1 Travel Time Profile C-470 Westbound PM Peak Period

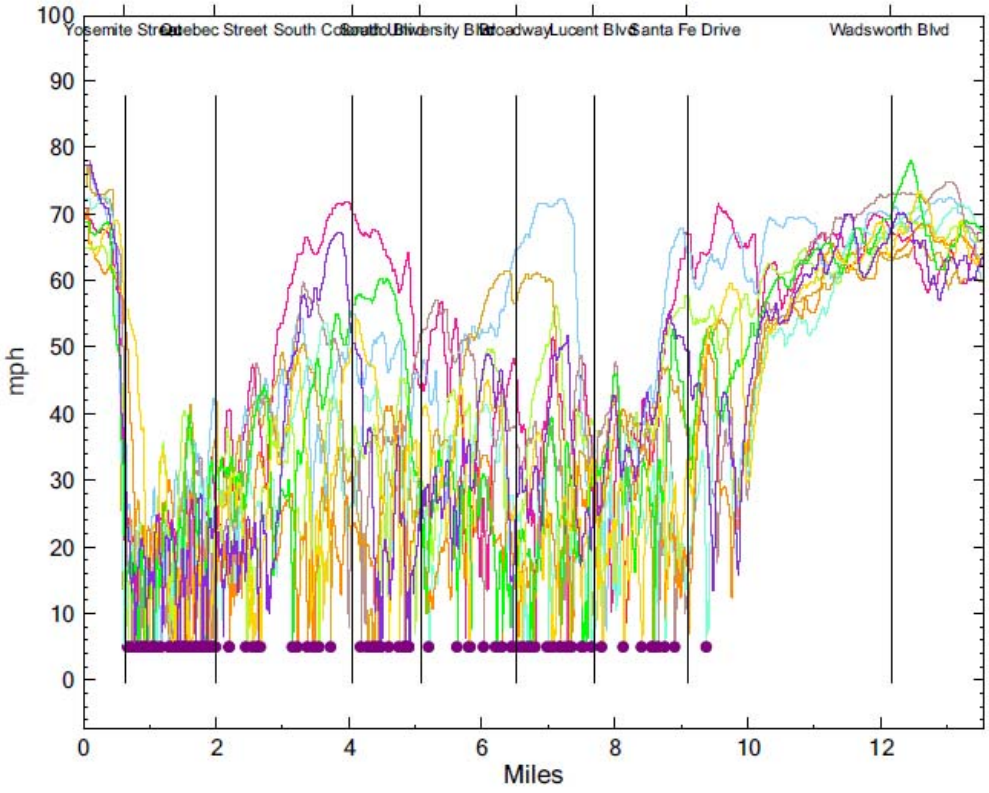


Figure 5.2 Travel Time Profile Eastbound C-470 AM Peak

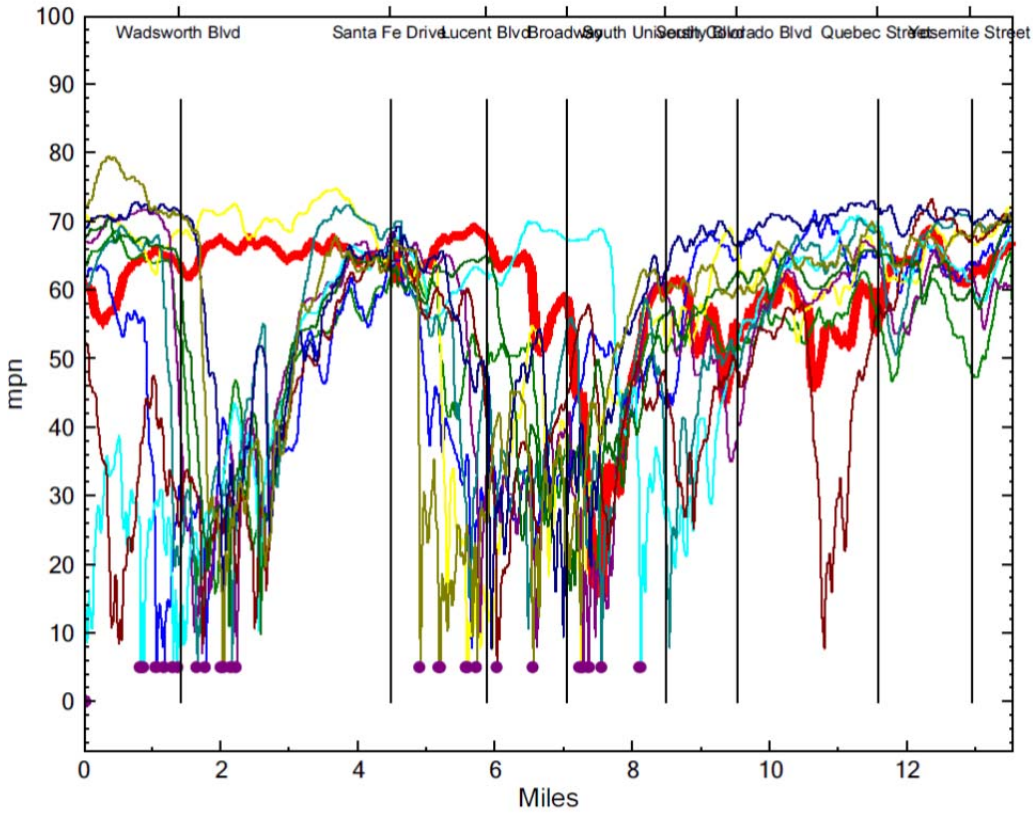


Figure 5.3 Segmentation of Travel Runs

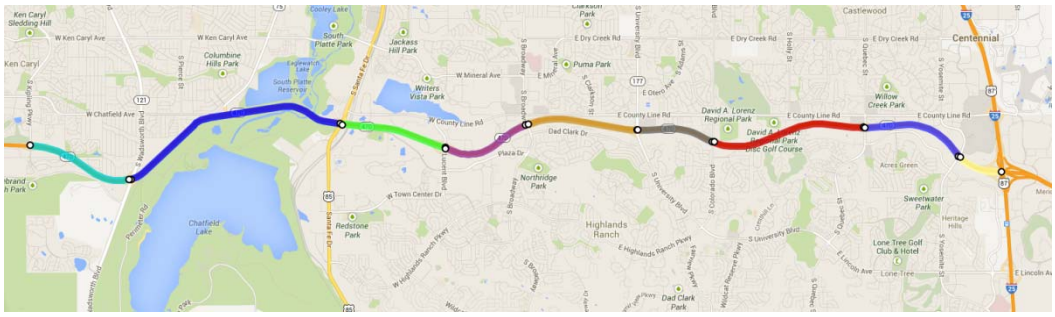
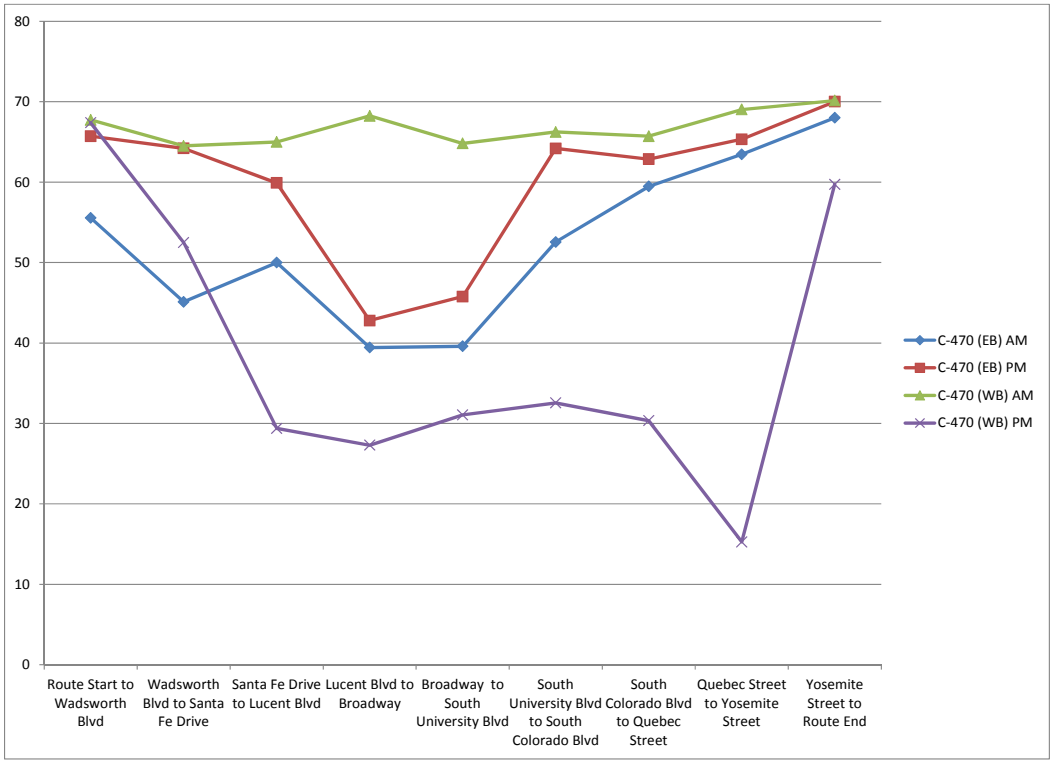


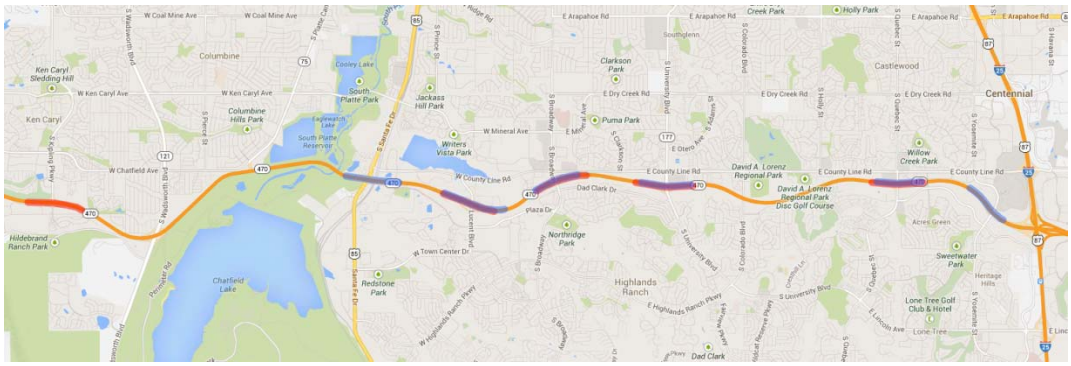
Figure 5.4 Average Sub Segment Speeds from GPS Travel Time Runs



5.2 SPOT SPEEDS

The speed data from the ramp metering system was provided at five eastbound locations (shown as red links in Figure 4.5) and six westbound locations (shown as blue links in Figure 4.5). Not all interchanges are covered and the data is not continuous. Therefore, speed contours along C-470 are not presented. The analysis focuses on the location speeds recorded on Wednesday, May 8, 2013. Figures 4.6 and 4.7 illustrate the travel speeds at the ramp meter locations in the eastbound and westbound directions, respectively.

Figure 5.5 C-470 Speed Data Locations used for Ramp metering



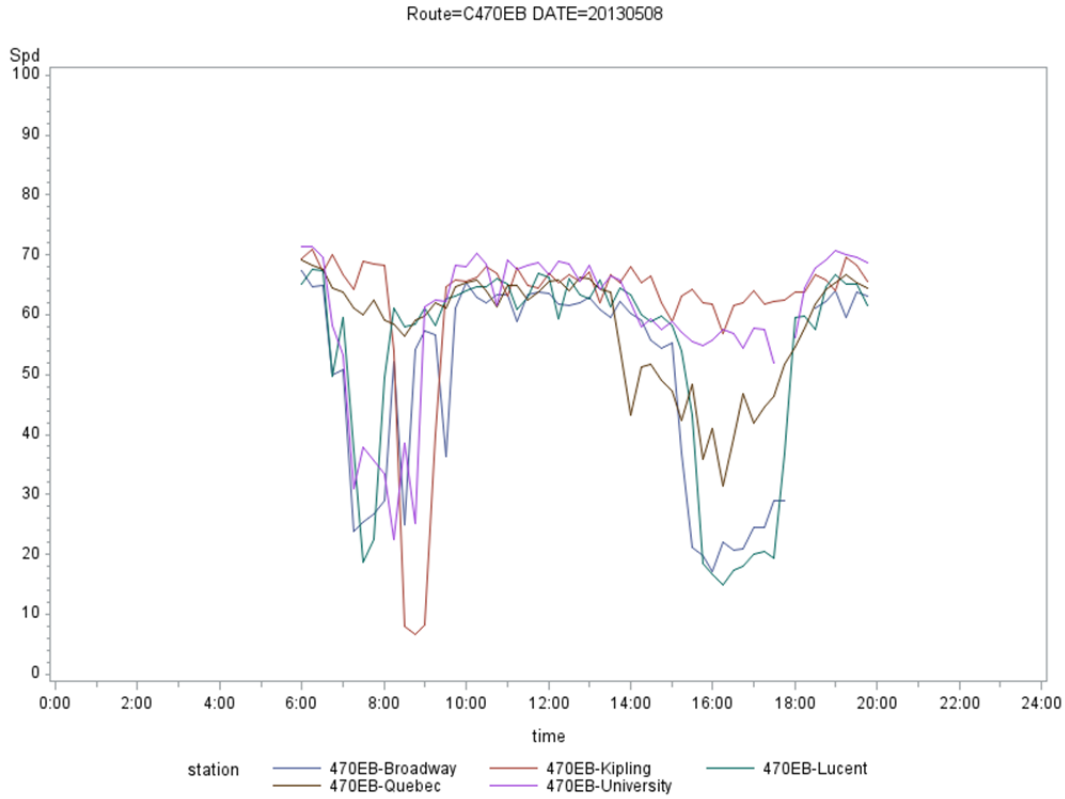
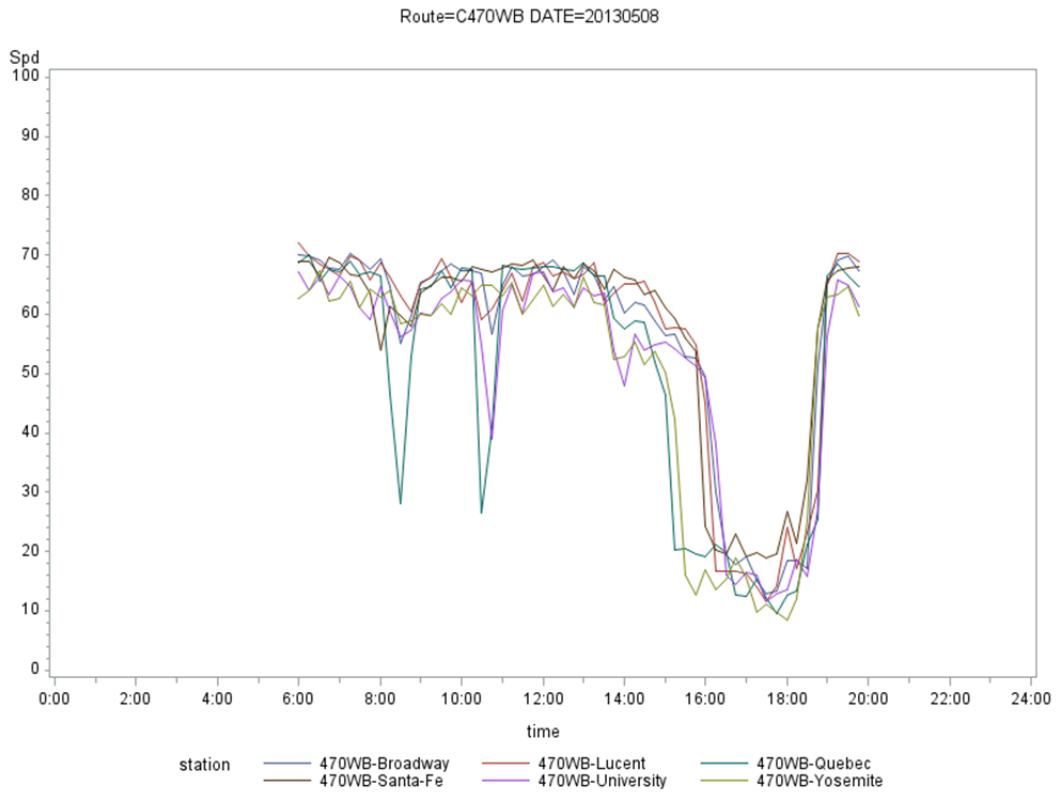


Figure 5.6 Observed Speeds on C-470 Westbound



The data presented in Figures 4.6 and 4.7 demonstrate that there is a wide period of congestion from 3:00 to 7:00 p.m. in both directions at all of the stations. The major congestion in the PM period is in the westbound direction, with the most severe congestion located on the eastern part of the study area. The major congestion in the AM period is in the eastbound direction, with the most severe congestion located on the western part of the study area.

In addition to the ramp meter speeds, mainline traffic speeds were collected using GPS probe runs on C-470 in both directions during the AM and PM periods over two days. The corridor was divided into nine segments, as illustrated in Figure 4.8. The average segment speeds for the AM and PM periods in both directions are shown in Figure 4.9. For some segments, the difference between the two days is significant.

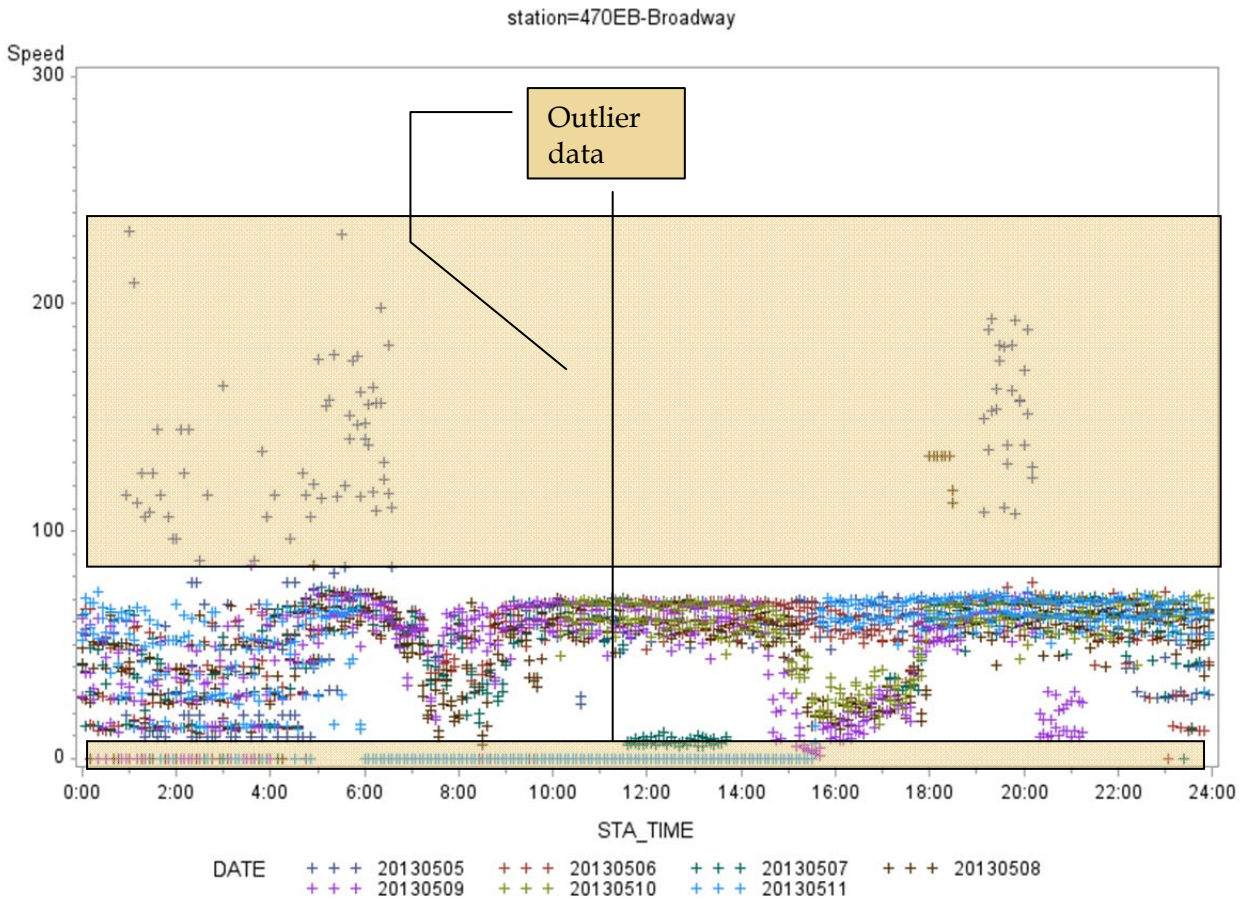
The same data also is used to create probe vehicle trajectory plots, which trace each vehicle's cumulative distance traveled as time elapses. Figures 4.10 and 4.11 reflect the traffic conditions as each probe vehicle went through its run, in the AM and PM periods, respectively.

The mainline and ramp meter speed data are found to be consistent.

Mainline and Ramp Speeds

Speed data were also affected by the equipment failures, which resulted in some extremely high or low speed values, as shown in Figure 4.14. As the result, any speed greater than 80 mph or less than 5 mph was reset to a null value. Further review found that the speed value was "0" when there is no vehicle present in the volume data. These 0 speed values were reset to a null value. Speed data during nighttime were also found to be problematic, so any speed data before 6:00 a.m. and after 8:00 p.m. was reset to a null value. (Note that the microsimulation models cover 6:00 a.m. to 1:00 p.m. and 1:00 p.m. to 8:00 p.m.)

Figure 5.7 Sample Raw Speed Data



The 5-minute station speed is calculated as the average 5-minute lane speed weighted by 5-minute lane volume. The 15-minute station speed is the average of 5-minute station speed weighted by 5-minute station volume.

Figure 4.15 shows a sample of the processed speed data, which depicts typical PM congestion and some isolated delays.