STUDY SESSION ITEM ERRATA SHEET

MEETING DATE: May 31, 2016

TO: City Council

FROM: Transportation Division/Public Works

DATE: May 23, 2016

ITEM: Study Session regarding Transportation Master Plan Progress Update – Attachment C

Please find the amended Attachment C for the Transportation Master Plan Progress memo – Living Lab Program Summary Report. The following change is provided:

1) Attachment C: The term "Draft" is removed from footer of Summary Report. The Summary Report presented to City Council is the final version.

Living Lab Phase II Folsom Street Pilot Project

Summary Report

May 20, 2016

Project Purpose and Background

The vision of the city's Transportation Master Plan (TMP) is to create and maintain a safe and efficient multimodal transportation system that meets the sustainability goals of the community. A focus area of the TMP is to provide "Complete Streets," that offer safe and comfortable access for all users, including pedestrians, bicyclists, motorists and transit riders of all ages and abilities. This approach emphasizes the value of a balanced and complete multimodal transportation system to enhance safety and increase access, while shifting trips away from single-occupant vehicles. The TMP Complete Streets vision includes developing streets that encourage walk and bike trips for women, older adults and families.

The Living Lab program is a Complete Streets action item that installs pilot projects to test new street designs and community engagement processes. The projects are experimental and allow city staff to gather technical, observational and community feedback as part of an ongoing evaluation process that assesses whether a pilot project treatment achieves the intended benefits of complete streets and is a good fit for Boulder. The results inform the development of a network of low-stress bicycle routes, enhance transit access and create a more pedestrian-friendly community.

The purpose of the Folsom Street pilot project is to demonstrate a corridor approach to testing new street designs with the intent to increase safety and access for people using all modes of transportation. The Folsom Street pilot project included converting portions of the corridor from Valmont to Canyon from four vehicle travel lanes to three, adding center left turn lanes, and protected bike lanes. South of Canyon, the Folsom Street pilot project included intersection restriping and other treatments, including buffered bike lanes to connect with the CU campus at Colorado.

Feedback from the Boulder community is an important part of the Living Lab program and to address traffic congestion impacts experienced by the community after installing the pilot project, the center segment of the Folsom Street pilot project was modified in the fall 2015. These modifications included restoring the four vehicle travel lanes and removing a segment of protected bike lanes from Spruce Street to Canyon Boulevard in order to improve the flow of traffic.

The following graphic is a map of the Folsom Street corridor illustrating the extent of the original installation in July 2015 and modifications that were performed in October 2015. The Folsom Street pilot project limits extend from Valmont Road to Colorado Avenue.


Valmont Rd
Valmont Rd - Spruce St
Protected Bike Lane
Spruce St
Pearl St
Spruce St - Canyon Blvd
4-Lanes Restored
Canyon Blvd
Canyon Blvd - Arapahoe Ave
Unchanged
Arapahoe Ave
Arapahoe Ave - Taft Dr
Buffered Bike Lane
Taft Dr
Taft Dr - Colorado Ave
Future Buffered Bike Lane
Colorado Ave

Project Evaluation Overview

The City of Boulder and the Fox Tuttle Hernandez Transportation Group have completed an evaluation of the primary and secondary performance measures for the Folsom Street pilot project. Using the results of the evaluation and community feedback from the public, the City's Transportation Staff has developed recommendations for the pilot project. This report discusses the key findings of the evaluation and outlines the recommendations for the pilot project by roadway segment.

Staff has been collecting multimodal data along the corridor before and after the initial project installment in July 2015. The evaluation criteria consist of both primary and secondary performance measures in order to understand the operational characteristics of the corridor. The primary performance measure data was collected on a weekly basis from July through October 2015 and then switched to a monthly data collection schedule in November 2015 through March 2016.

The primary data consists of the following criteria:

- weekday vehicle volume
- weekday bicycle volume
- vehicle travel time during the PM peak hour
- weekday vehicle speed
- traffic collisions
- number of male, female, and families (children and adults with children) riding bicycles during the AM, noon, and PM peak hours

In addition, more detailed technical transportation operations analysis was conducted along Folsom Street corridor, and at key intersections, and on side streets, as well as review of maintenance experience along the corridor during winter conditions.

Secondary performance measures include:

- peak hour vehicle turning movement counts
- level of service (LOS) and delay calculations
- side street daily vehicle volumes
- right-turn treatment evaluations
- mid-block pedestrian crossing information
- side street delays observed
- left-turn vehicle queue observations
- vehicle saturation flow rate calculations
- "cycle failure" observations
- maintenance practices

This report builds on the "3 Month Update" memorandum (dated January 7, 2016) with additional performance measure data collected through March 2016. Throughout the duration of project,

staff has reported the results of the data collection beginning with a weekly reporting schedule from July through October 2015 and later switching to a monthly reporting schedule from November through March 2016. In order to convey the results of the evaluation process for the primary performance measures, staff created an infographic to illustrate the changing conditions along the Folsom corridor. Staff has refined the infographic based on the Transportation Advisory Board's input and can be found on the Living Lab Folsom Street pilot project website.

Based on a review of the primary and secondary performance measure evaluations to date, the following comprise key findings for the Folsom Street Pilot Project:

Primary Measures Key Findings

- The initial conversion from four vehicle lanes to two lanes plus center turn lanes from Valmont Road to Canyon Boulevard resulted in considerable peak hour travel time delays and travel time variability along Folsom Street during the initial weeks of implementation, particularly in the section from Spruce Street to Canyon Boulevard. Average travel times during the evening peak hour measured between Valmont Road and Arapahoe Road were approximately 3.5 minutes before the project. During the first several months of the project the northbound average travel times increased to between 4 and 5 minutes and the southbound average travel times peaked at over 5 minutes. Since the four vehicle lanes were reinstalled between Spruce Street and Canyon Boulevard in the fall 2015, the travel times between Valmont and Arapahoe Road have returned to pre-project levels.

- Traffic counts along Folsom Street throughout the project indicated that volumes were reduced by up to 15% during the implementation of the full project, indicating that is likely that traffic diverted off Folsom Street. The traffic volume decrease on Folsom has been reduced to approximately 4% after the segment of Folsom between Spruce Street and Canyon Boulevard was returned to the four lane condition.

- Counts of bicycle volumes along Folsom Street showed an increase during the first three months (July through October) after initial installation, and have since decreased below initial levels. Based on cycling data from other sites, this is typical seasonal variation in bicycle travel. More data over a longer period of time is needed to determine if any changes in volume of bicycles is statistically significant.

- Evaluation of motor vehicle travel speeds (as measured with the 85th-percentile speed at Bluff Street) have decreased by roughly 2-3 miles per hour (mph) during the course of the project, but these speeds are still approximately seven miles per hour above the posted speed limit of 30 mph.

- The frequency of collisions in the corridor each month after installation is following a similar monthly pattern to a three-year collision history (2012 – 2014) from before the project was implemented. The monthly number of collisions is at or below this historic pattern.

- There were no pedestrians involved in collisions during the first eight months of the project; however, on April 21, 2016, a pedestrian died from injuries sustained in a collision at the intersection of Folsom Street and Canyon Boulevard. The pedestrian was crossing Canyon Boulevard in the east crosswalk and was struck by a truck turning left from southbound Folsom Street onto eastbound Canyon Boulevard.

- The number of male, female, and families riding bicycles in the corridor during the AM, noon, and PM peak hours varied throughout the implementation of the project with no clear trend. There's a high ratio of males to females currently bicycling the corridor, although the ratio was lower at the time of project installation. This ratio fluctuation may be seasonally related.

Secondary Measures Key Findings

- Analysis of side-street and parallel corridor traffic volumes, intersection peak hour turning movement volumes, intersection peak hour Levels of Service, and delay indicate that the reduction of traffic volumes on Folsom Street did not result in an identifiable pattern of diversion to any particular corridor. The analysis suggests that any diverted traffic that did occur was redistributed across the city roadway grid without identifiable impacts to any one corridor.

- Travel time data collected and public input all suggest that vehicular traffic operations on Folsom Street, particularly between Spruce Street and Canyon Boulevard, were impacted with the full implementation of the project as measured with travel times, queue lengths, signalized intersection Levels of Service, and side street delays. These impacts have been mitigated with the return to original lane geometry between Spruce Street and Canyon Boulevard.

- Staff observed that the pedestrian crossings on Folsom Street at Spruce Street and Walnut Street caused congestion, delay, and increased travel time when this section of the project was reduced to a single through lane in each direction.

- The project included two different treatments on intersection approaches along Folsom Street for vehicular right-turn interaction with bike lanes during the full implementation of the protected bike lanes. Field observations of the "transition" treatments at Pearl Street and Canyon Boulevard in September 2015 indicated that most right-turning motor vehicles complied with yielding requirements to bicyclists in the protected bike lane. Based on evaluations of the "Skip Green Dash" treatment at Pine Street in September 2015 and March 2016, most vehicles observed turning right across bicycle lanes at these locations are not complying with the City ordinance requiring vehicles to move as close to the curb as possible (into the bicycle space) before turning right.

- Field observations in September 2015 indicate that was a reduction in traffic saturation flow rate (which is an indicator of how much traffic a travel lane can accommodate during

peak conditions) in the section between Spruce Street and Canyon Boulevard. Possible factors that influenced the saturation rate in September 2015 are increased friction (from vertical bollards), visual elements (markings, signs, additional bicyclists), and the close proximity of signalized mid-block crossings (Spruce and Walnut Street). Field observations in March 2016 indicate that the saturation flow rate has increased by approximately 10% compared with September 2015, and are now consistent with estimated pre-project levels.

- Maintenance practices along the Folsom Street corridor, particularly in the segment between Valmont Road and Spruce Streets have increased due to the protected bike lane configuration. Snow removal and street sweeping practices have been modified to address the maintenance needs of the corridor. Additionally, staff has identified increased maintenance costs pertaining to the cleaning and replacement of the flexible bollards, as needed.

Community Feedback

An important component of the ongoing evaluation of Folsom Street pilot project is community and user feedback. Since installation, the city has hosted a number of opportunities for community input including bike audits (guided community bike rides), online surveys, in-person feedback at public events, and social media and Inspire Boulder posts.

In April 2016, staff hosted a public open house to present key findings of the ongoing evaluation and to gather additional community input. The Folsom Street Corridor was organized into four segments in order to best articulate specific facilities and modifications that have occurred since the installation of the project in July 2015. Community members were asked to provide comments under three topic headings: keep it, refine it, or remove it. Additionally, the city administered a survey to seek additional public input on the Folsom Street pilot project and to supplement the public feedback from the open house event. The survey was open to the public from April 29 through May 9, 2016. Preliminary results of the survey will be presented to the Transportation Advisory Board at the May meeting. The results of the survey will be added to the Summary Report prior to the May 31 City Council Study Session.

Below is a brief summary of the public input from the public open house event. A complete summary of public feedback from the public open house can be found in Section 1.0 of this report.

Most of the community feedback received at the Complete Streets Open House focused on the comments regarding the bicycle facility treatments along the corridor. Several people shared their desire for improved, physically separated north-south bicycle corridors. Overall, the bicycle treatments along the corridor were well received. There was support for keeping the protected bike lane treatment between Valmont and Spruce Street citing improved safety, comfort, directness and separation between users. However, some bicyclists have expressed difficulty with executing left turns from the protected bike lanes. Some people also preferred the segment between Valmont Road and Spruce Street be returned back to the four-travel lane condition citing concerns with delay when executing turns from side streets and aesthetic concerns presented by

the bollards. Several comments expressed concern for the width of the conventional bike lanes between Spruce and Arapahoe. There also was support for keeping the buffered bike lane treatment between Arapahoe and Colorado; though some comments expressed support for making them protected bike lanes, including planters to improve separation from the adjacent travel lane.

Preliminary Recommendations

Based on the technical key findings and community feedback to date, staff recommends continuing the Folsom Street pilot project in its current condition from Valmont Road to Colorado Avenue. Analysis of the corridor has been organized into four segments in order to best articulate specific facilities and modifications that have occurred since the installation of the project in July 2015.

Valmont Road to Spruce Street

This segment of the corridor currently consists of two travel lanes (one in each direction), a center left turn lane, and protected bike lanes using bollards. Other than thinning the number of bollards in the fall 2015, this segment has stayed intact since the initial project installation in July 2015. The protected bike lanes provide more perceived safety and comfort for bicyclists of different levels of confidence, particularly in this section of Folsom that includes a hill and curves in the roadway, which can cause some drivers to swerve into the bike lane without the bollards.

The technical evaluation indicates a minor drop in the 85th % of vehicle speed from 39 (mph) to 37 (mph). No significant operational impacts have been observed during the evaluation process concerning travel times, side-street delay, or visibility. The center left turn lane provides an opportunity for left turning vehicles to more safely execute left turns along the corridor without blocking through traffic. As with the other segments of the corridor, bicycle volume, demographics, and collision data will need to be analyzed over a longer period of time to gauge any significant trends.

Spruce Street to Canyon Boulevard

Today, this segment of the corridor consists of four travel lanes and conventional bike lanes. During the initial project installation, two of the four travel lanes were repurposed to provide two travel lanes, center left turn lanes, and protected bike lanes. Due to community feedback, and impacts to traffic congestion and other operational issues, this segment was reverted back to the original condition, the same condition that exists today. Staff recommendation is to continue the existing configuration, without any further changes. Corridor travel times have returned to the before condition, side-street delay has subsided, long left turn lane queues have shortened, and traffic impacts at signalized intersections at Pearl Street and Canyon Boulevard no longer exist.

Canyon Boulevard to Arapahoe Avenue

No vehicle travel lane repurposing modifications were performed along this segment of the corridor during the initial project installation. Today, the corridor consists of four travel lanes and conventional, striped bike lanes. Staff recommends continuing the current striping configuration along this segment of the corridor.

Arapahoe Avenue to Colorado Avenue

This segment of the Folsom corridor consists of two travel lanes and buffered bike lanes from Arapahoe Avenue to Taft Drive. During the initial project installation, the conventional bike lanes were converted to buffered bike lanes by utilizing excess space from adjacent travel lanes. This striping configuration was recently continued to Colorado Avenue following the completion of the CU stadium project.

Living Lab Program Next Steps

Staff recommends keeping the Folsom Street pilot project in the current configuration with on-going monitoring through fall 2016, along with the remaining Phase I projects. Staff will return to City Council in December 2016 with overall next steps for the Living Lab program. Staff does not intend to add additional projects to the Living Lab program. Since 2012, the program has helped the City of Boulder better understand and improve planning and public outreach processes, project implementation practices, and effective evaluation processes. Staff has adopted new street design techniques and has a better understanding of how innovative types of facilities operate in the real world context. With this information, staff is able to apply this knowledge toward existing and future corridor planning efforts while maintaining the spirit of innovation in order to create safe and comfortable travel conditions for all road users.

Detailed Summary of the Folsom Street Pilot Project Performance Measures

Contents

1.0 Complete Streets Open House Community Feedback (4/21/16)

Folsom - Valmont to Spruce

The current configuration consists of two travel lanes, a center turn lane, protected bike lanes and the green dash right turn treatment.

- Improve/extend. Bikers, like drivers, have jobs/deadlines/places to be. We need complete, safe, direct routes.
- When it snows, this is the best bike lane in town to the point that pedestrians use it.
- Extend protection separation. Build north-south bike path.
- Build dedicated bike paths. Do not try to mix cars and bikes.
- Protected bike lanes offer more protection area for pedestrians crossing the road.
- With delineators cars aren’t drifting into the bike lane.
- Buffered/Protected bike lanes north of spruce have seriously reduced my near collisions with vehicles. Especially at the n-bound intersection with Valmont where right-turning cars cross bike lane.

Keep it	Refine it	Remove it
√		√

Folsom - Spruce to Canyon

The current configuration consists of four travel lanes, conventional bike lanes and concrete / landscape medians with left turn lanes at intersections and some driveways.

- Buffered bike lanes please.
- Improve. Add planters. Extend protected bike lanes.
- Go back to the protected bike lanes. This is a dangerous stretch. Cars can use alternates. Cares have plenty of N-S roads; bikes have no safe north-south corridor.
- Worst stretch of Folsom bike commute especially with bus stops and potholes. Please refine.
- Variable. Too narrow and potholed. Will not ride it with my kids. Proper lane width needed. Buffered or protected.
- Enforce the 3' rule.
- Conventional bike lanes from Arapahoe to Spruce are seriously inadequate. Too narrow and ill repaired. In this region I am often (1-3 times a week) nearly hit/cut-off by vehicles turning onto Folsom across the bike lane.

Keep it	Refine it	Remove it
√	√	

Folsom - Canyon to Arapahoe

The current configuration consists of four travel lanes, conventional bike lanes and concrete/landscape medians with left turn lanes at intersections and some driveways, and a bike box at southbound Folsom and Arapahoe.

- Love the bike box.
- Got hooked and ended up on sidewalk.

Keep it	Refine it	Remove it
√		

Folsom - Arapahoe to Colorado

The current configuration includes two travel lanes, a center turn lane, and buffered bike lanes.

- These are fine. Protected would be nice, or a rumble strip. But they feel safe enough
- Can we add planters to make more safe separation

Keep it	Refine it	Remove it
√		

General comments

- We should study projects sufficiently so we do not put bike protection in then take them out i.e. Folsom & Baseline Rd.
- Great work. We need safer n-bound and s-bound bike routes… keep this strong and growing.
- I like protected bike lanes. The conventional bike lanes on Folsom are *narrow*. I ride Harvard Road a lot and I am not sure what best solution is. Keep working on TMP, would LOVE city eco-pass (I do not have one) would love "4 bike, walk transit cars." (confusing script)
- For Folsom to be truly accessible to all levels of bicycle there have to be protected, physically separated lanes. We do not currently have any complete streets. We need to do one (or more) REALLY WELL so the community sees what is possible.
- It is not enough. Have some vision in Boulder. We need a complete, direct N/S route from Iris to CU. Buffered or protected. Cars have 30th/28th/Foothills. Let us make Folsom different. People do not go to Pearl St. because it is full of cars. They go because it is 'pedestrianized,' different & beautiful. I cannot see business owners complaining if we make Folsom a somewhat new, but more functional version of Pearl, with reduced car traffic and lots of bikers and pedestrians. Honestly depressed right now. Tired of dragging kids and myself to meetings, repeating the same obvious arguments and seeing nothing change. Soon I will run out of steam but I guess that is what the car-driving mob in Boulder wants... This is not an optional extra for this city. As Boulder gridlocks and the air quality approaches that of Beijing we will realize we have made a mistake and it will be too late.
- During big snowstorms, the posts were not comfortable for driving. First choice is to remove, but if stays, please remove the posts. Please remove posts from Baseline. Bollards are visually distracting.

2.0 Vehicle Travel Time

The average travel time it takes to drive the Folsom corridor end-to-end from Valmont to Arapahoe in the northbound and southbound directions during the PM peak hour on a weekday was measured by driving the corridor before the installation and the first ten weeks after the installation of the protected bike lanes. During this time the average variability, including the shortest and longest travel times were also recorded. Beginning in mid-October 2015 through March 2016, the average travel time was measured using Acyclica Wi-Fi sensors in the corridor. The project team used the before travel time measurements to help calibrate the VISSIM modeling software, and then to forecast the expected travel time after the installation. The tables below report the travel time and variability for the PM peak hour during the project.

Table 1: Average PM Peak Hour Travel Times (in minutes: seconds)

Evaluation Period	PM Northbound	PM Southbound
Before (Nov. 2014)	3:32	3:20
Modeled	4:47	4:30
July 27 – Aug. 9, 2015	4:15	5:36
Aug. 10 – 16, 2015	4:02	4:41
Aug. 24 – 30, 2015	4:37	4:52
Aug. 31 – Sept. 6, 2015	4:13	5:19
Sept. 7 – 13, 2015	4:13	4:52
Sept. 14 – 20, 2015	3:05	4:36
Sept. 21 – 27, 2015	4:00	3:55
Sept. 28 – Oct. 4, 2015	3:24	4:21
Oct. 5 – 11, 2015	3:48	4:18
Oct. 12 – 25, 2015	N/A	
Oct. 26 – Nov. 1, 2015	3:38	3:35
November, 2015	3:36	3:34
December, 2015	3:33	3:45
January, 2016	3:27	3:37
February, 2016	3:28	3:46
March, 2016	3:24	3:32

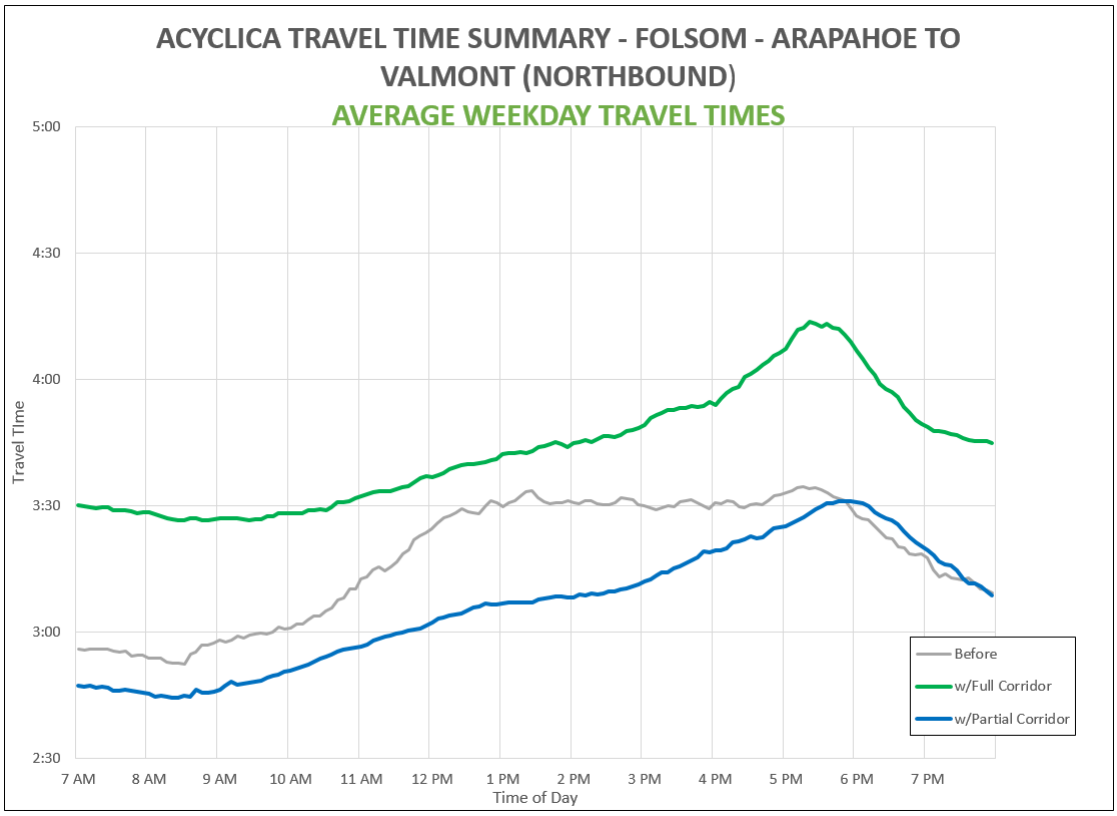
Table 2: Northbound PM Peak Hour Travel Time Variability (in minutes: seconds)

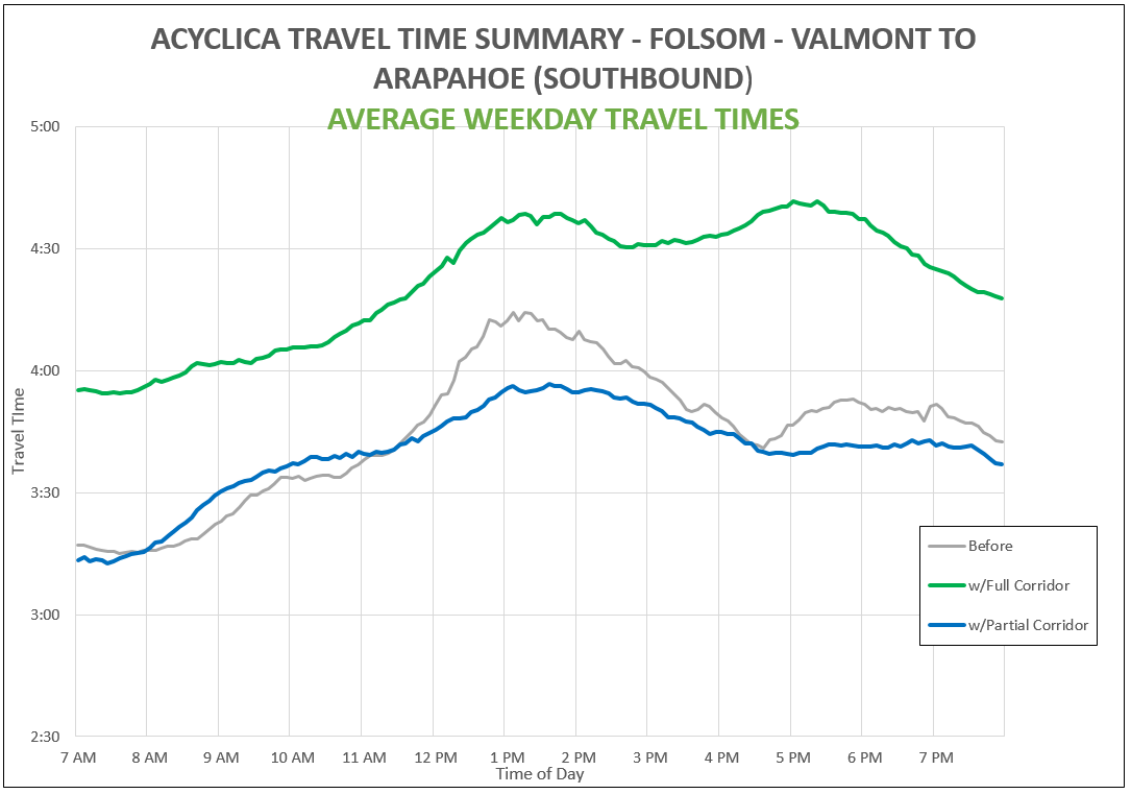
Evaluation Period	Average	High	Low	Variability
Before	3:32	4:52	2:46	2:06
July 27 – Aug. 9, 2015	4:15	6:48	2:40	4:08
Aug. 10 – 16, 2015	4:02	5:15	2:49	2:26
Aug. 24 – 30, 2015	4:37	6:33	2:57	3:36
Aug. 31 – Sept. 6, 2015	4:13	6:47	2:38	4:07
Sept. 7 – 13, 2015	4:13	5:25	3:03	2:22
Sept. 14 – 20, 2015	3:05	5:01	2:40	2:39
Sept. 21 – 27, 2015	4:00	4:57	2:39	2:36
Sept. 28 – Oct. 4, 2015	3:24	4:41	2:37	2:04
Oct. 5 – 11, 2015	3:48	N/A		
Oct. 12 – 25, 2015	N/A			
Oct. 26 – Nov. 1, 2015	3:38	N/A		
November, 2015	3:36	N/A		
December, 2015	3:33	N/A		
January, 2016	3:27	N/A		
February, 2016	3:28	N/A		
March, 2016	3:24	N/A		

Table 3: Southbound PM Peak Hour Travel Time Variability (in minutes: seconds)

Evaluation Period	Average	High	Low	Variability
Before	3:20	3:44	2:13	1:31
July 27 – Aug. 9, 2015	5:36	8:14	3:53	4:21
Aug. 10 – 16, 2015	4:41	5:58	3:35	2:23
Aug. 24 – 30, 2015	4:52	6:15	3:53	2:22
Aug. 31 – Sept. 6, 2015	5:19	7:50	3:52	3:58
Sept. 7 – 13, 2015	4:52	7:31	3:43	4:12
Sept. 14 – 20, 2015	4:36	7:28	3:33	3:55
Sept. 21 – 27, 2015	3:55	5:29	2:08	3:21
Sept. 28 – Oct. 4, 2015	4:21	5:47	3:12	2:35
Oct. 5 – 11, 2015	4:18	N/A		
Oct. 12 – 25, 2015	N/A			
Oct. 26 – Nov. 1, 2015	3:35	N/A		
November, 2015	3:34	N/A		
December, 2015	3:45	N/A		
January, 2016	3:37	N/A		
February, 2016	3:46	N/A		
March, 2016	3:32	N/A		

Acyclica readers record travel times through the day. The figures below illustrate the travel time variability before the project was installed (June through late July), from installation through October 18, 2015 when the full corridor was installed, and after the modifications from October 26, 2015 through April 8, 2016. The graphs of daily average travel time illustrate the variance during the day and the longer travel times experienced during the PM peak while the project was installed between Spruce and Canyon. The graphs also show that the travel times today are consistent, and sometimes lower, than the travel times before the project was installed.


ACYCLICA TRAVEL TIME SUMMARY - FOLSOM - ARAPAHOE TO VALMONT (NORTHBOUND)
AVERAGE WEEKDAY TRAVEL TIMES
5:00
4:30
4:00
3:30
3:00
2:30
Travel Time
7 AM
8 AM
9 AM
10 AM
11 AM
12 PM
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
Time of Day
Before
w/Full Corridor
w/Partial Corridor


ACYCLICA TRAVEL TIME SUMMARY - FOLSOM - VALMONT TO ARAPAHOE (SOUTHBOUND)
AVERAGE WEEKDAY TRAVEL TIMES
5:00
4:30
4:00
3:30
3:00
2:30
Travel TIme
7 AM
8 AM
9 AM
10 AM
11 AM
12 PM
1 PM
2 PM
3 PM
4 PM
5 PM
6 PM
7 PM
Time of Day
Before
w/Full Corridor
w/Partial Corridor

3.0 Motor Vehicle Volume and Speed

The city has been collecting average weekday traffic volume and speed at two locations along Folsom Street, north of Bluff Street and north of Canyon Boulevard. The data is recorded for a three-day period, and reported as the average of the three days, or average daily traffic (ADT). Note that Boulder Valley School District (BVSD), University of Colorado –Boulder (CU) and Naropa schools have been in session during some, but not all, of the before and after data collection periods (noted in the tables below). Week 11 after data may not be typical as work to return Folsom to a four-lane cross section between Spruce and Canyon began on October 8, 2015. **Table 4** summarizes the volume and speed during the project collected north of Bluff Street and **Table 5** summarizes the volume and speed collected north of Canyon Boulevard.

Table 4: Folsom Street north of Bluff Street – Posted Speed Limit = 30 mph

Evaluation Period	Date Collected	ADT-Weekday (vpd)	Average Speed (mph)	85th Percentile Speed (mph)	School In Session
Before	4/27-5/1/15	15,780	35	39	Yes
After-Week 2	8/5-8/7/15	13,790	33	37	No
After-Week 3	8/12-8/14/15	13,930	33	37	No
After-Week 5	8/26-8/28/15	14,310	32	36	Yes
After-Week 6	9/2/15-9/4/15	14,100	32	36	Yes
After-Week 7	9/8/15-9/11/15	14,210	32	36	Yes
After-Week 8	9/15/15-9/17/15	13,570	33	36	Yes
After-Week 9	9/22/15-9/24/15	13,750	33	36	Yes
After-Week 10	9/29-15-10/1/15	14,170	33	36	Yes
After-Week 11	10/6/15-10/8/15	13,960	33	36	Yes
After-Week 12	N/A				
After-Week 13	N/A				
After-Week 14	10/27/15-10/29/15	14,350	33	37	Yes
After-Month 4	11/17/15-11/19/15	14,140	33	37	Yes
After-Month 5	12/8/15-12/10/15	14,650	33	36	Yes
After-Month 6	1/12-16-1/14/16	14,060	33	37	Yes
After-Month 7	2/9/16 -2/11/16	14,120	33	37	Yes
After-Month 8	3/8/16-3/10/16	14,470	33	37	Yes

Table 5: Folsom Street north of Canyon Blvd. – Posted Speed Limit = 30 mph

Evaluation Period	Date Collected	ADT-Weekday (vpd)	Average Speed (mph)	85th Percentile Speed (mph)	School in Session
Before	6/30-7/2/15	18,970	29	34	No
After-Week 2	8/3-8/5/15	15,790	25	30	No
After-Week 3	8/10-8/12/15	16,480	24	29	No
After-Week 5	8/25-8/26/15	16,500	24	29	Yes
After-Week 6	9/2/15-9/4/15	15,960	24	29	Yes
After-Week 7	9/9/15-9/11/15	16,590	26	30	Yes
After-Week 8	9/16/15-9/17/15	16,200	26	30	Yes
After-Week 9	9/22/15-9/24/15	15,760	26	30	Yes
After-Week 10	9/29-15-10/1/15	16,520	25	30	Yes
After-Week 11	10/6/15-10/8/15	15,920	27	32	Yes
After-Week 12	N/A				
After-Week 13	N/A				
After-Week 14	10/27/15-10/29/15	17,780	30	35	Yes
After-Month 4	11/17/15-11/19/15	17,580	31	35	Yes
After-Month 5	12/8/15-12/10/15	18,200	30	35	Yes
After-Month 6	1/12/16-1/14/16	17,450	30	35	Yes
After-Month 7	2/9/16 -2/11/16	17,620	30	35	Yes
After-Month 8	3/8/16-3/10/16	18, 160	31	35	Yes

- ADT = Average Daily Traffic
- VPD = Vehicles per Day
- MPH = Miles per Hour

4.0 Bicycle Volume

Daily bicycle volumes are being collected at three locations along Folsom using permanent 24-hour counters: Boulder Creek, South Street, and Pine Street. Boulder Valley School District (BVSD), Colorado University (CU), and Naropa were not in session during the before data collection period. "Before" and "after" volumes at Boulder Creek were collected by a permanent 24-hour counter. The "before" volumes are an average of weekday volumes from the last week of July and first two weeks of August from 2012 to 2014. The before volumes at South and Pine Streets were collected from 6 a.m. to 9 p.m. on June 30, 2015, and after volumes are being collected by permanent 24-hour counters installed in late July 2015. The after volumes are an average of daily volumes on Tuesday, Wednesday, and Thursday during the corresponding week. The after data includes bicycle volumes while BVSD, CU and Naropa were both in and out of session. Note that the validation of the counters is currently in progress, and volumes may later be adjusted to account for potential variances.

Bicycle volumes at all three locations increased during Weeks 4 and 5 from before conditions and Week 3 volumes. BVSD classes started during Week 4 and CU and Naropa classes started during Week 5. The increase in bike volume from Week 4 to Week 5 is attributed to school in session. The increases in this volume along this corridor so far are consistent with the increases the city

typically sees when school is back in session. Bicycle volumes have since decreased below initial levels. It is unknown yet if this decrease is simply due to seasonal variation in bicycle travel.

Table 6: Daily Weekday Average Bicycle Volumes Along Folsom Street at Pine Street

Evaluation Period	Northbound	Southbound	Total	School in Session	Inclement weather
Before	437	440	877	No	
July 27 – Aug. 2, 2015	620	655	1,275	No	
Aug. 3 – 9, 2015	551	625	1,176	No	
Aug. 10 – 16, 2015	554	616	1,170	No	
Aug. 17 – 23, 2015	603	651	1,254	No	
Aug. 24 – 30, 2015	705	766	1,471	Yes	
Aug. 31 – Sept. 6, 2015	684	748	1,432	Yes	
Sept. 7 – 13, 2015	754	766	1,520	Yes	
Sept. 14 – 20, 2015	681	713	1,393	Yes	
Sept. 21 – 27, 2015	676	713	1,389	Yes	
Sept. 28 – Oct. 4, 2015	643	681	1,324	Yes	
Oct. 5 – 11, 2015	546	568	1,113	Yes	
Oct. 12 – 18, 2015	581	639	1,220	Yes	
Oct. 19 – 25, 2015	279	292	571	Yes	X
Oct. 26 – Nov. 1, 2015	440	477	917	Yes	
November, 2015	290	284	574	Yes	
December, 2015	176	169	346	Yes	
January, 2016	254	268	522	Yes	
February, 2016	260	250	510	Yes	
March, 2016	253	264	516	Yes	

Table 7: Daily Weekday Average Bicycle Volumes Along Folsom Street at South Street

Evaluation Period	Northbound	Southbound	Total	School in Session	Inclement weather
Before	388	389	777	No	
July 27 – Aug. 2, 2015	497	578	1,075	No	
Aug. 3 – 9, 2015	512	556	1,068	No	
Aug. 10 – 16, 2015	406	500	906	No	
Aug. 17 – 23, 2015	570	600	1,169	No	
Aug. 24 – 30, 2015	706	791	1,497	Yes	
Aug. 31 – Sept. 6, 2015	725	799	1,524	Yes	
Sept. 7 – 13, 2015	730	813	1,543	Yes	
Sept. 14 – 20, 2015	692	769	1,461	Yes	
Sept. 21 – 27, 2015	695	761	1,456	Yes	
Sept. 28 – Oct. 4, 2015	653	729	1,382	Yes	
Oct. 5 – 11, 2015	552	618	1,170	Yes	
Oct. 12 – 18, 2015	N/A				
Oct. 19 – 25, 2015	N/A				X
Oct. 26 – Nov. 1, 2015	N/A				
November, 2015	277	306	583	Yes	
December, 2015	161	202	363	Yes	
January, 2016	259	272	530	Yes	
February, 2016	251	268	519	Yes	
March, 2016	247	273	521	Yes	

Table 8: Daily Weekday Average Bicycle Volumes Along Folsom Street at Boulder Creek

Evaluation Period	Northbound - Adjusted	Southbound – Adjusted	Total - Adjusted	School in Session	Inclement weather
Before	592	483	1,076	No	
July 27 – Aug. 2, 2015	683	521	1,204	No	
Aug. 3 – 9, 2015	607	497	1,104	No	
Aug. 10 – 16, 2015	603	478	1,081	No	
Aug. 17 – 23, 2015	782	602	1,384	No	
Aug. 24 – 30, 2015	1,060	880	1,940	Yes	
Aug. 31 – Sept. 6, 2015	1,226	855	2,081	Yes	
Sept. 7 – 13, 2015	1,212	945	2,157	Yes	
Sept. 14 – 20, 2015	1,248	926	2,174	Yes	
Sept. 21 – 27, 2015	1,096	904	2,000	Yes	
Sept. 28 – Oct. 4, 2015	1,055	856	1,911	Yes	
Oct. 5 – 11, 2015	967	769	1,736	Yes	
Oct. 12 – 18, 2015	1002	816	1,819	Yes	
Oct. 19 – 25, 2015	547	429	976	Yes	X
Oct. 26 – Nov. 1, 2015	879	695	1573	Yes	
November, 2015	444	370	814	Yes	
December, 2015	263	203	466	Yes	
January, 2016	412	322	733	Yes	
February, 2016	402	324	725	Yes	
March, 2016	419	338	757	Yes	

5.0 Collisions

Collision data for the Folsom corridor from Valmont to Colorado is being compiled from police reports. The totals include all crashes at the intersections and in segments along the corridor. The following tables summarize the before collision frequency from 2012 to 2014 and weekly collision totals since installation for vehicle-vehicle, vehicle-bicycle, and vehicle-pedestrian collisions.

Table 9: Before Collisions Along Folsom Street from Valmont to Colorado from 2012-2014

Before Time Period	Vehicle-Vehicle	Vehicle-Bike	Vehicle-Pedestrian	Total
2012-2014	212	34	7	253
Average per Year	70.6	11.3	2.3	84.3
Average per Month	5.9	0.9	0.2	7.0

The frequency of collisions in the corridor is following a similar monthly pattern to the three-year collision history from before the project was implemented. It should be noted that the collision frequency shown in **Table 10** below is based on a small sample and additional data/time is needed to determine if the project will have a measurable long-term impact on collisions.

Table 10: Before Collisions Along Folsom Street from Valmont to Colorado from 2012-2014

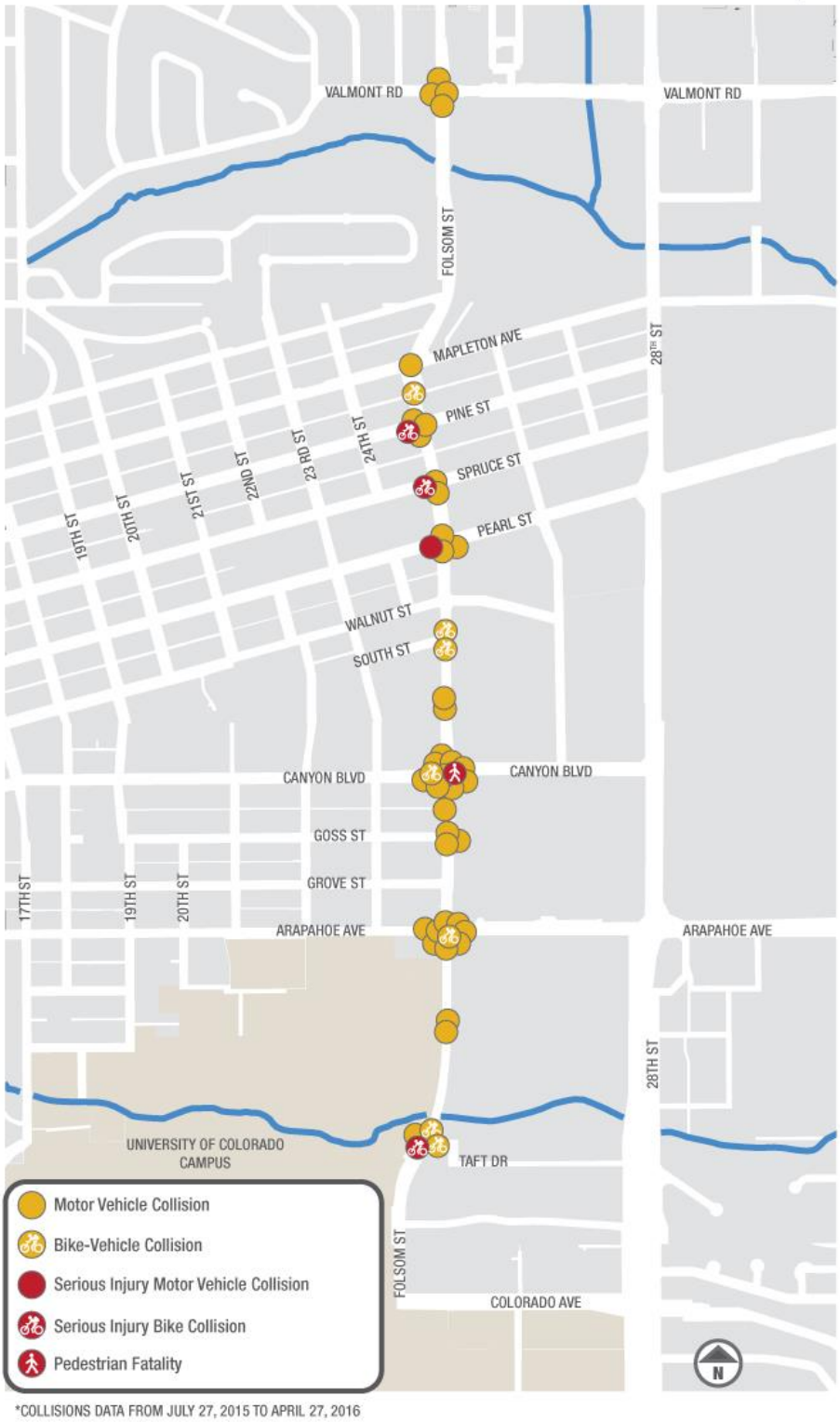
After Time Period	Vehicle-Vehicle	Vehicle-Bike	Vehicle-Pedestrian	Total
7/27/15 – 4/3/16	39	11	0	51
Average per Month	4.8	1.25	0	6.4

Table 11: After Collisions Along Folsom Street from Valmont to Colorado

After Evaluation Period	Vehicle-Vehicle	Vehicle-Bike	Vehicle-Pedestrian	Total
July 27 – Aug. 9, 2015	1	1	0	2
Aug. 10 – 16, 2015	1	0	0	1
Aug. 17 – 23, 2015	1	1	0	2
Aug. 24 – 30, 2015	0	0	0	0
Aug. 31 – Sept. 6, 2015	0	0	0	0
Sept. 7 – 13, 2015	1	0	0	1
Sept. 14 – 20, 2015	1	1	0	2
Sept. 21 – 27, 2015	3	0	0	3
Sept. 28 – Oct. 4, 2015	2	0	0	2
Oct. 5 – 11, 2015	2	1	0	3
Oct. 12 – 18, 2015	1	1	0	2
Oct. 19 – 25, 2015	1	0	0	1
Oct. 26 – Nov. 1, 2015	1	1	0	2
Nov. 2 – 8, 2015	1	0	0	1
Nov. 9 – 15, 2015	1	1	0	2
Nov. 16 – 22, 2015	1	0	0	1
Nov. 23 – 29, 2015	0	0	0	0
Nov. 30 – Dec. 6, 2015	1	0	0	1
Dec. 7 – 13, 2015	1	0	0	1
Dec. 14 – 20, 2015	3	0	0	3
Dec. 21 – 27, 2015	1	0	0	1
Dec. 28, 2015 – Jan. 3, 2016	0	0	0	0
Jan. 4 – 10, 2016	2	0	0	2
Jan. 11 – 17, 2016	1	0	0	1
Jan. 18 – 24, 2016	3	1	0	4
Jan. 25 – 31, 2016	1	1	0	2
Feb. 1 – 7, 2016	1	0	0	1
Feb. 8 – 14, 2016	1	0	0	1
Feb. 15 – 21, 2016	1	0	0	1
Feb. 22 – 28, 2016	1	0	0	1
Feb. 29 – Mar. 6, 2016	1	1	0	2
Mar. 7 – 13, 2016	2	0	0	2
Mar. 14 – 20, 2016	1	1	0	2
Mar. 21 – 27, 2016	0	0	0	0
Mar. 28 – Apr. 3, 2016	1	0	0	6
Total	**40**	**11**	**0**	**51**

The location, type, and severity of collisions along the corridor during the pilot project are illustrated in the following map. The majority of collisions, including all collisions that have resulted in serious injuries or fatalities, have occurred at intersections.

Folsom Street Collisions Overview Map



*COLLISIONS DATA FROM JULY 27, 2015 TO APRIL 27, 2016

6.0 Bicyclist Demographics

Bicycle demographic data has been observed and recorded along the Folsom corridor before and after the installation of pilot project. The before data was collected on April 28, 2015, for two hours. Observations have been taken during weekday AM, noon, and PM rush hours. Observers record the total number of male and female bicycle riders on the roadways. In addition, the number of children and adults riding with children is recorded and comprises the "family" category (see table below).

Table 12: Bicycle Weekday Demographic Along Folsom Street

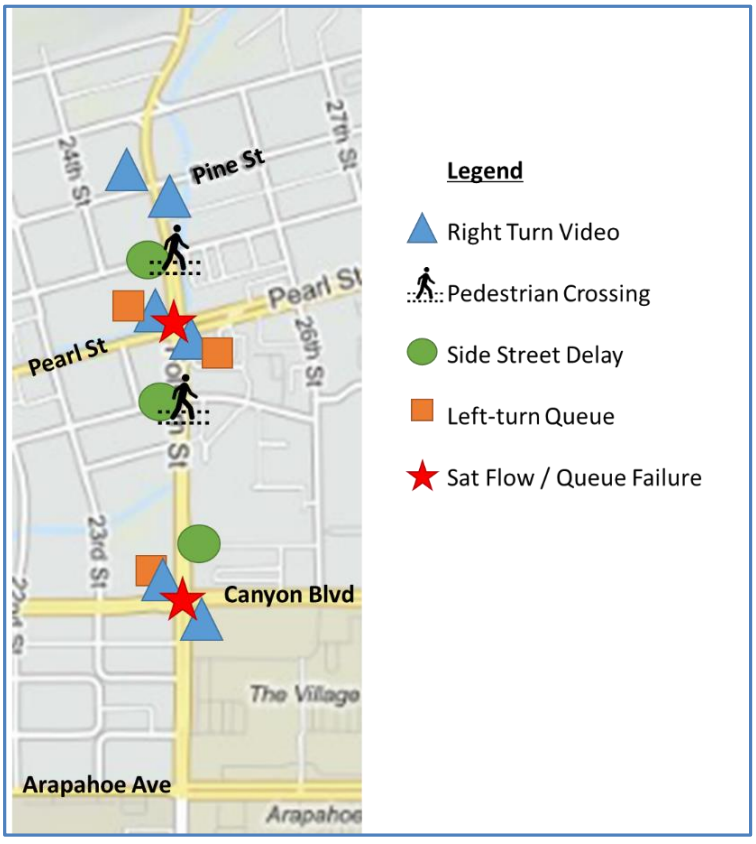
Evaluation Period	Male	Female	Family
Before	72%	28%	4%
July 27 – Aug. 9, 2015	78%	22%	6%
Aug. 10 – 16, 2015	67%	33%	5%
Aug. 24 – 30, 2015	66%	34%	4%
Aug. 31 – Sept. 6, 2015	66%	34%	4%
Sept. 7 – 13, 2015	67%	33%	2%
Sept. 14 – 20, 2015	70%	30%	1%
Sept. 21 – 27, 2015	69%	31%	2%
Sept. 28 – Oct. 4, 2015	70%	30%	2%
Oct. 5 – 11, 2015	73%	27%	1%
Oct. 12 – 18, 2015	66%	34%	0%
Oct. 19 – 25, 2015	72%	28%	1%
Oct. 26 – Nov. 1, 2015	65%	35%	0%
November, 2015	66%	34%	1%
December, 2015	89%	11%	0%
January, 2016	70%	30%	1%
February, 2016	76%	24%	1%
March, 2016	84%	16%	0%

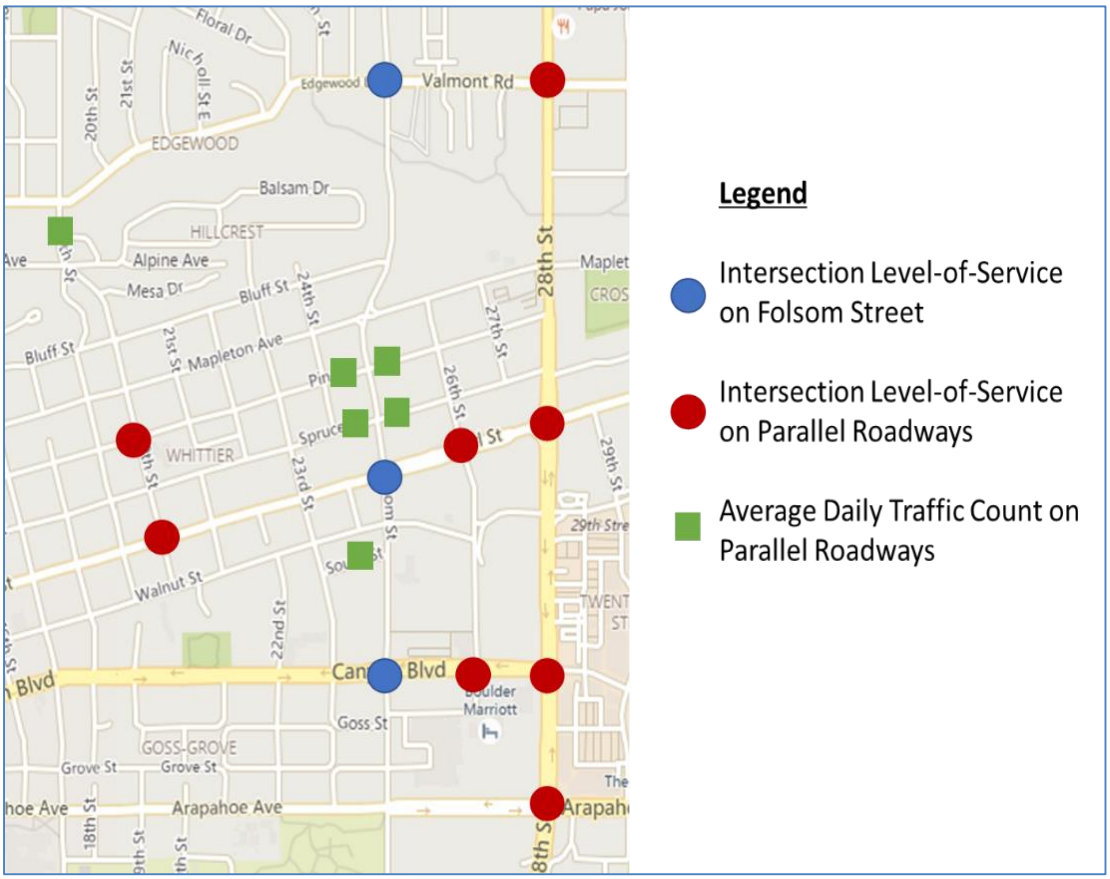
7.0 Overview of Secondary Performance Measures

The secondary performance measures evaluated in this report include:

- Peak hour turning movement counts (TMCs) at select signalized locations, with comparison to pre-project TMC data
- Level of Service (LOS) and delay calculations at select signalized locations, with comparison to pre-project LOS data. This includes intersections with potential diverted traffic from the Folsom Street corridor.
- Daily traffic data on select side streets, with comparison to available pre-project data
- Right-turn treatment evaluations and turning movement conflicts
- Mid-Block pedestrian crossing volumes and compliance at the Walnut Street/Folsom Street and Spruce Street/Folsom Street crossings, with comparison to pre-project data
- Peak hour side-street delay observations at Spruce Street (EB), Walnut Street (EB), and the commercial alley (WB) just north of Canyon Boulevard
- Left-turn queue observations (PM peak) on Folsom Street approaching Pearl Street (SB and NB) and on Folsom (SB) approaching Canyon Boulevard
- Saturation flow rate calculations (PM peak) on Folsom Street approaching Pearl Street (SB and NB) and on Folsom (SB) approaching Canyon Boulevard
- "Cycle failure" observations at the Folsom Street/Pearl Street and Folsom Street/Canyon Boulevard intersections during the PM peak hour

The map to the right and on the following page depict locations where secondary performance measure data collection was performed.



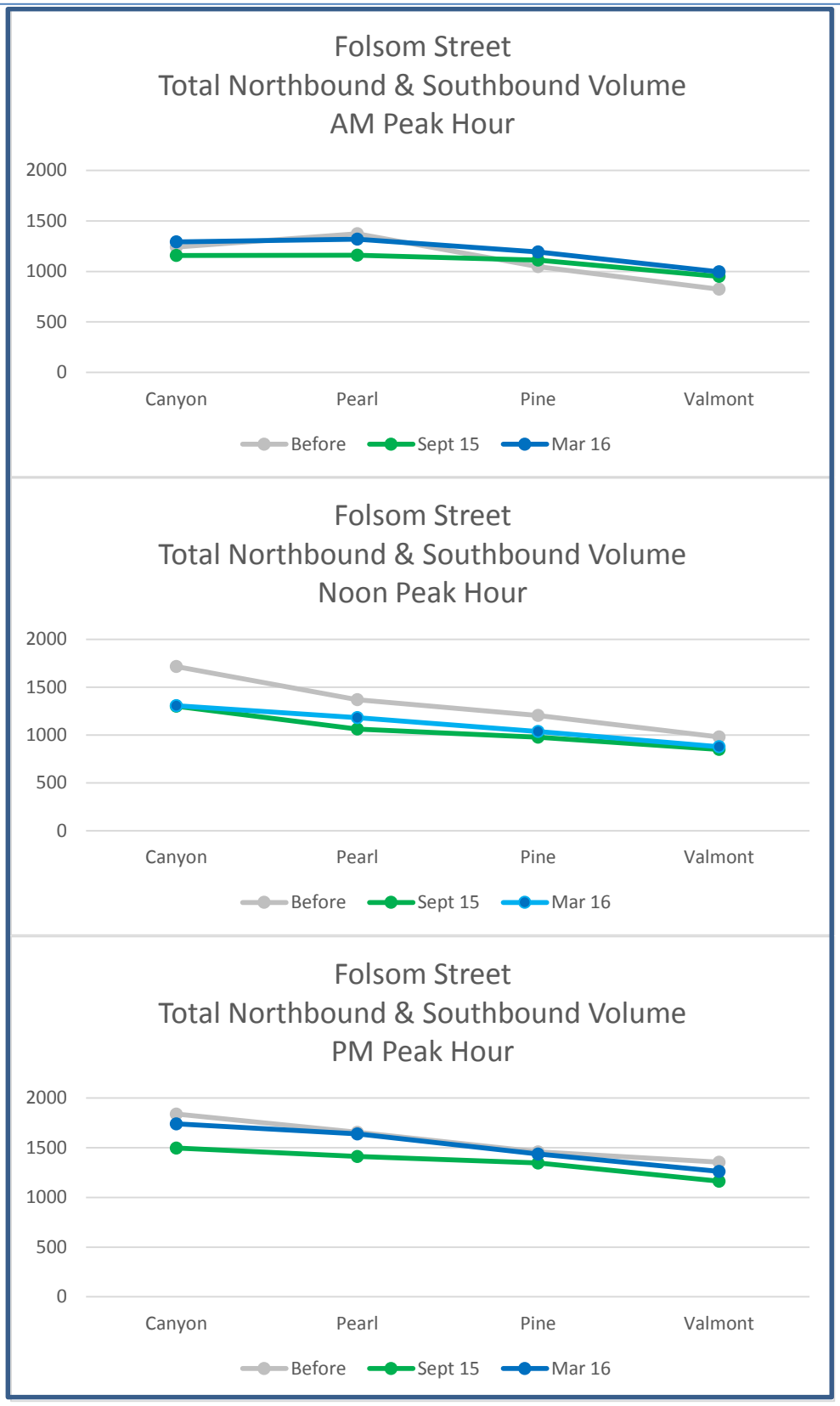


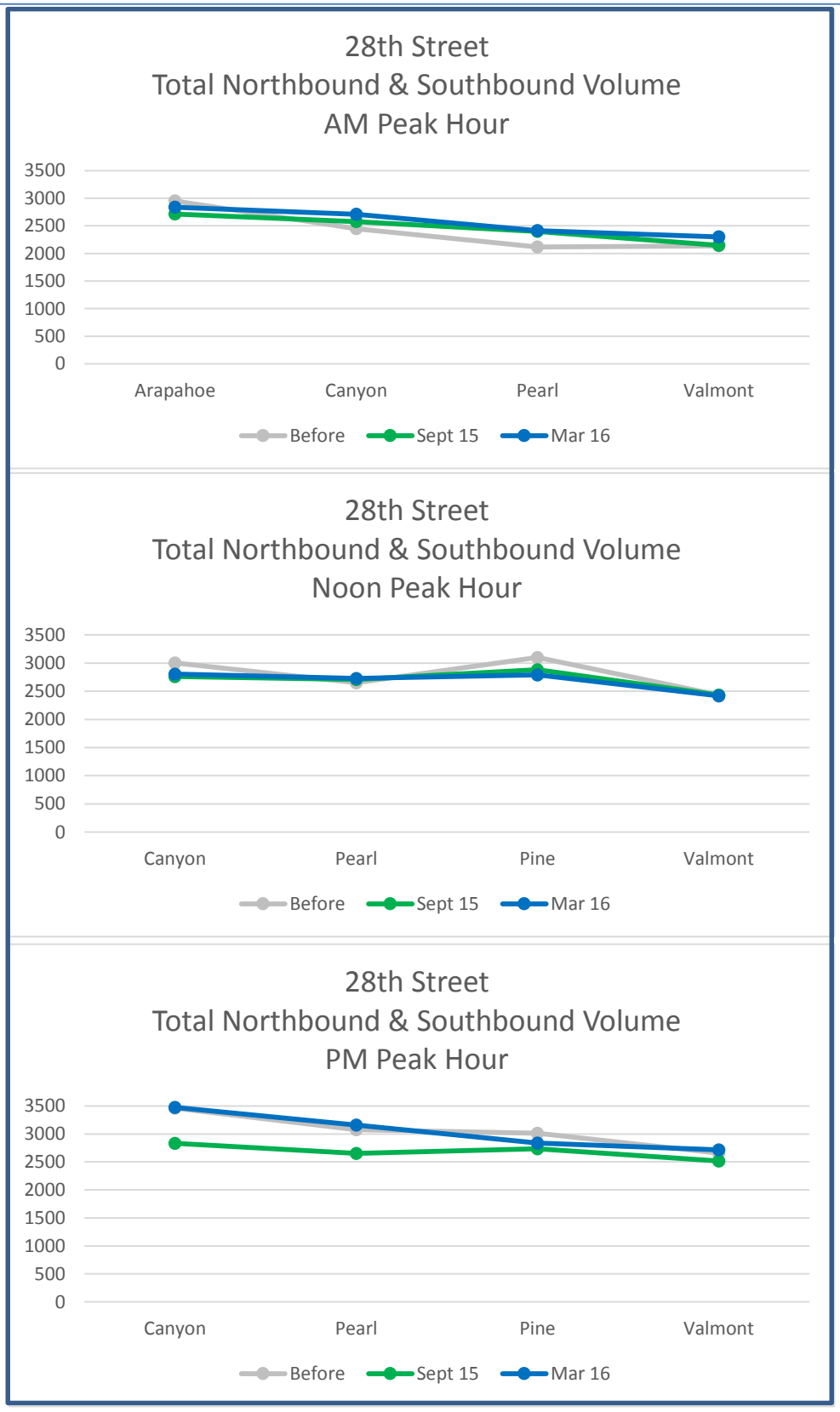
The following text, tables, and figures summarize the analysis for each of these secondary performance measures.

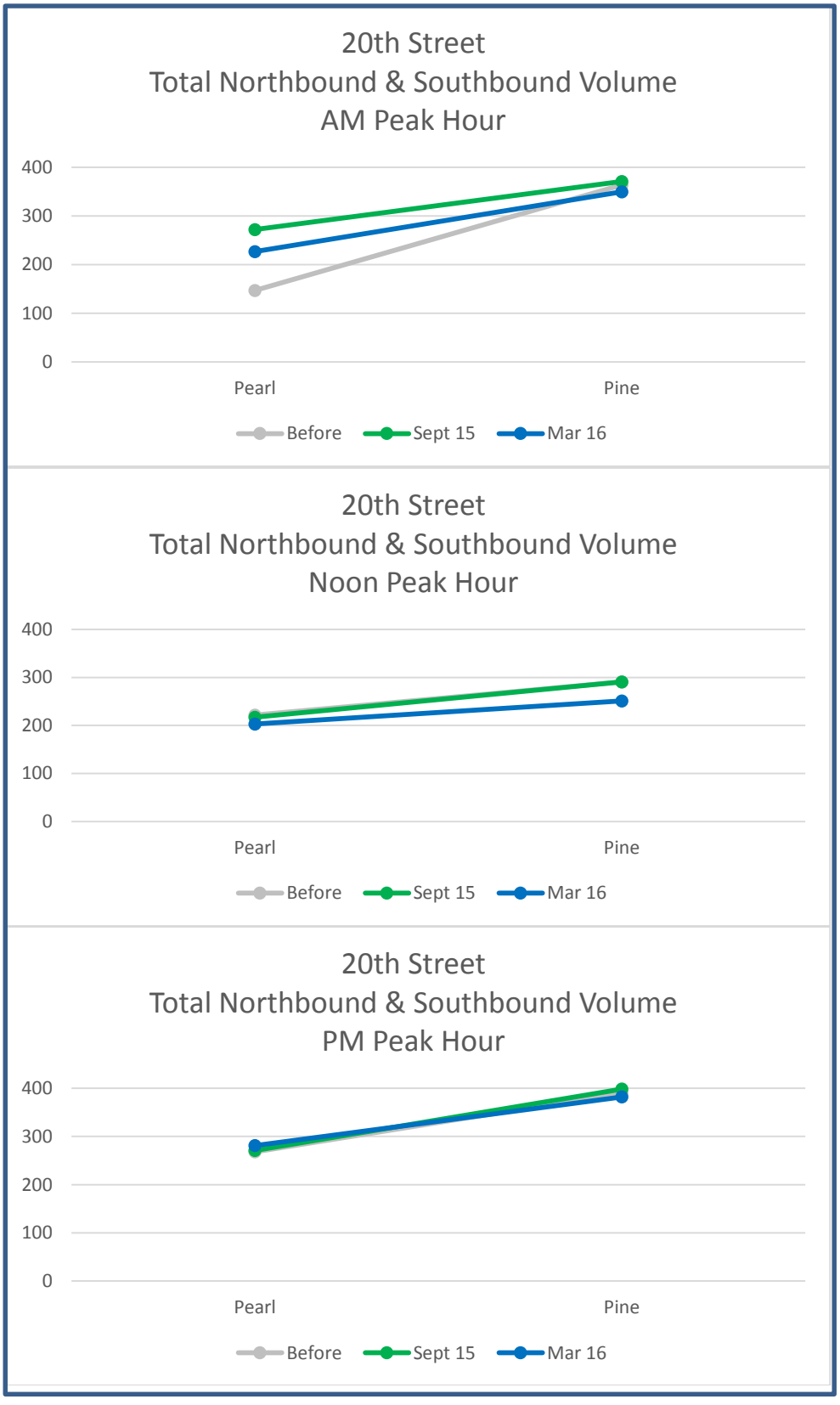
9.0 Peak Hour Turning Movement Counts

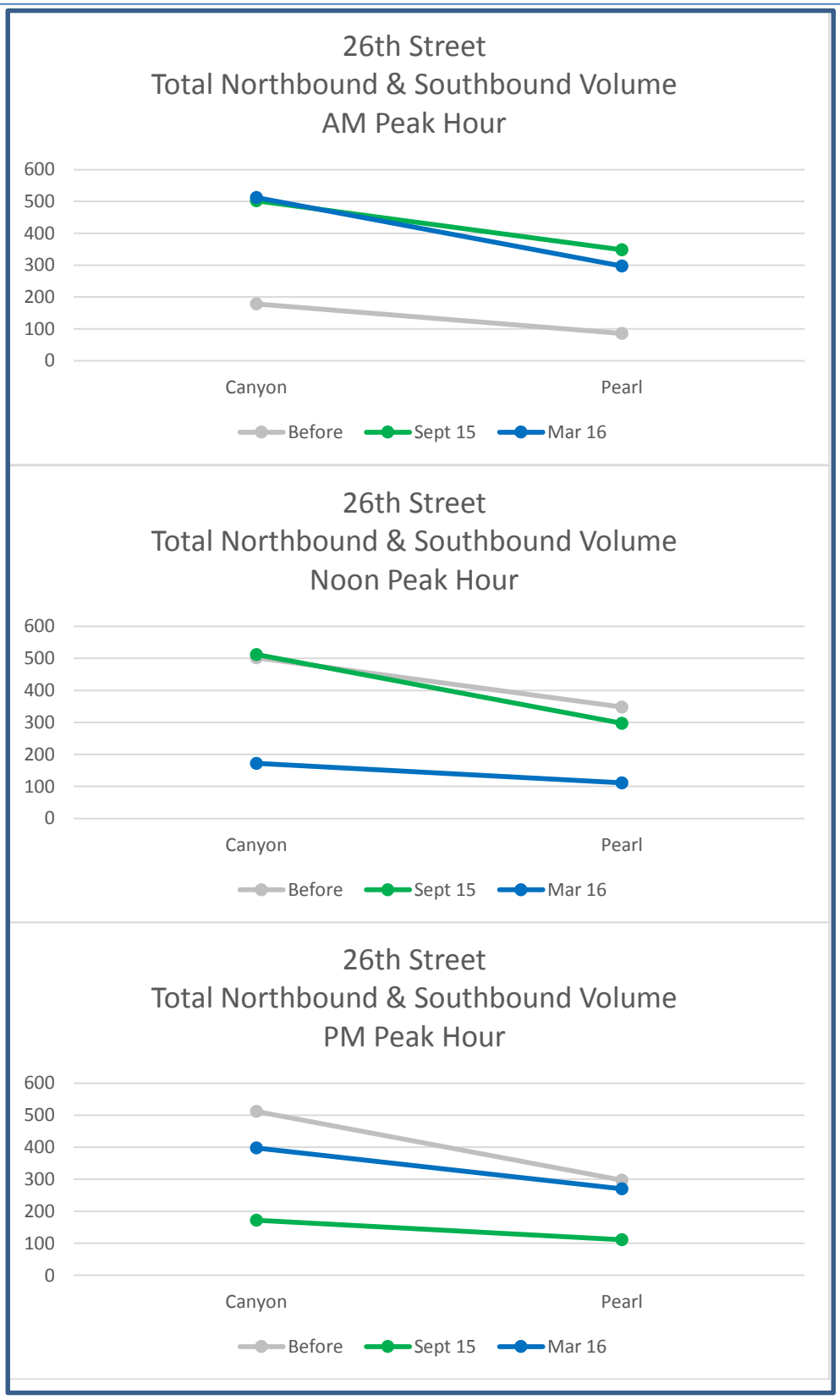
Vehicular turning movement counts were collected on September 15, 2015 and March 8, 2016 at four (4) signalized intersections along the Folsom Street and at eight (8) signalized intersections along adjacent corridors at locations that could experience potential diverted traffic as a result of the pilot project. Volumes were collected during the weekday AM (7:45-8:45am), noon (12-1pm) and PM (4:45-5:45pm) peak hours. The September 15, 2015 volumes were collected prior to the conversion of a section of the project back to two through lanes in each direction between Canyon Boulevard and Spruce Street.

The volumes are summarized in the Appendix for each intersection, along with a comparison to the most recent pre-project counts collected by the City as part of their regular count program. A summary of the pre-project, September 2015, and March 2016 northbound and southbound *combined* turning movement volumes are provided on the following charts for each peak hour for the Folsom Street, 28th Street, 20th Street, and 26th Street corridors within the project study area.


Folsom Street
Total Northbound & Southbound Volume
AM Peak Hour
2000
1500
1000
500
0
Canyon
Pearl
Pine
Valmont
Before
Sept 15
Mar 16
Folsom Street
Total Northbound & Southbound Volume
Noon Peak Hour
2000
1500
1000
500
0
Canyon
Pearl
Pine
Valmont
Before
Sept 15
Mar 16
Folsom Street
Total Northbound & Southbound Volume
PM Peak Hour
2000
1500
1000
500
0
Canyon
Pearl
Pine
Valmont
Before
Sept 15
Mar 16


28th Street
Total Northbound & Southbound Volume
AM Peak Hour
3500
3000
2500
2000
1500
1000
500
0
Arapahoe
Canyon
Pearl
Valmont
Before
Sept 15
Mar 16
28th Street
Total Northbound & Southbound Volume
Noon Peak Hour
3500
3000
2500
2000
1500
1000
500
0
Canyon
Pearl
Pine
Valmont
Before
Sept 15
Mar 16
28th Street
Total Northbound & Southbound Volume
PM Peak Hour
3500
3000
2500
2000
1500
1000
500
0
Canyon
Pearl
Pine
Valmont
Before
Sept 15
Mar 16


20th Street
Total Northbound & Southbound Volume
AM Peak Hour
400
300
200
100
0
Pearl
Pine
Before
Sept 15
Mar 16
20th Street
Total Northbound & Southbound Volume
Noon Peak Hour
400
300
200
100
0
Pearl
Pine
Before
Sept 15
Mar 16
20th Street
Total Northbound & Southbound Volume
PM Peak Hour
400
300
200
100
0
Pearl
Pine
Before
Sept 15
Mar 16


26th Street
Total Northbound & Southbound Volume
AM Peak Hour
600
500
400
300
200
100
0
Canyon
Pearl
Before
Sept 15
Mar 16
26th Street
Total Northbound & Southbound Volume
Noon Peak Hour
600
500
400
300
200
100
0
Canyon
Pearl
Before
Sept 15
Mar 16
26th Street
Total Northbound & Southbound Volume
PM Peak Hour
600
500
400
300
200
100
0
Canyon
Pearl
Before
Sept 15
Mar 16

The tabular summary in the Appendix and charts on the preceding pages illustrate that there is some variability between pre-project and post-project counts at many locations, likely due to a combination of factors, including: daily variation, seasonal variation, construction and maintenance projects, and events. Given this context, the following general observations were made:

- Northbound and southbound peak hour volumes on Folsom Street experienced roughly 0%-20% reductions with initial installation of the project, depending upon the peak hour time and location. This is consistent with the daily roadway counts performed as part of the Primary Performance measures evaluation. With the conversion of the segment from Spruce to Canyon back to pre-project lane geometry, volumes have increased to near pre-project volumes in most instances.

- The 20th Street and 26th Street northbound + southbound combined volumes show an increase in AM volumes but do not indicate diversion to this corridor during the noon or PM peak hours when potential traffic congestion along Folsom Street would be highest.

- 28h Street northbound + southbound combined volumes show post-project counts similar to or less than pre-project conditions. This indicates that any potential diversion of traffic from Folsom Street to 28th Street was not observed and that any variations were due to the other, non-project factors listed above.

10.0 Level of Service Calculations

Using the pre-project and post-project turning movement counts, peak hour intersection Levels of Service were performed for the four (4) signalized intersections along the Folsom Street and at eight (8) signalized intersections along adjacent corridors at locations that could experience potential diverted traffic as a result of the pilot project.

In determining the operational characteristics of an intersection, "Levels of Service" (LOS) A through F are applied, with LOS A indicating very good operations and LOS F indicating congested operations. The intersection LOS is represented as a delay in seconds per vehicle for the intersection as a whole and for each turning movement. A more detailed discussion of LOS methodology is contained in the Appendix for reference. Criteria contained in the Highway Capacity Manual (HCM) was applied for these analyses in order to determine pre-project and post-project levels of service during peak hour periods.

The pre-project and post-project LOS results are provided in a table in the Appendix. The results are summarized as follows:

Folsom Street Corridor Intersections: The LOS results do not indicate any new capacity issues associated with the project, though observations at the Canyon Boulevard, Pearl Street, and Pine Street intersections had indicated greater congestion during the peak

times of the noon and PM peak hours with the initial full project installation from Valmont Road to Canyon Boulevard. The City signalized intersection Synchro analysis does not factor in unsignalized side street and access traffic, mid-block pedestrian impacts, and compounding/cycle failures (spillback), all of which are believed to have an impact on delays during peak times in this area.

Parallel and Adjacent Corridors: The LOS results for 28th Street, 20th Street, and 26th Street intersections analyzed do not indicate any increased delays versus pre-project LOS calculations that would be outside of the typically expected daily and seasonal variation or due to non-project factors.

11.0 Side street Volumes

Daily traffic volumes and traffic speeds were collected along select side streets intersecting Folsom Street and along 20th Street parallel to Folsom Street, in order to evaluate potential diversion impacts. This data was compared to pre-project data, where available. This data is provided in the following **Table 13** and **Table 14** for the September 2015 and March 2016 data, respectively. Available historic data is also provided, for comparison and context.

Table 13: Side street Volume and Speed Comparison (Sept. 2015)

	"Before"(1) Data			"After"(2) Data - September 2015						
	Daily Roadway Volume			Daily Roadway Volume			Vehicular Speeds			
							NB or EB		SB or WB	
Roadway Count Location	NB or EB	SB or WB	Total	NB or EB	SB or WB	Total	Avg	85th%	Avg	85th%
Spruce Street west of Folsom	1,466	2,066	3,532	1,406	1,795	3,201	25 mph	29 mph	24 mph	28 mph
Spruce Street east of Folsom	*no data*			893	741	1,634	20 mph	27 mph	21 mph	28 mph
Pine Street west of Folsom	*no data*			3,148	2,916	6,064	24 mph	29 mph	26 mph	29 mph
Pine Street east of Folsom	1,595	2,218	3,813	1,512	1,549	3,061	27 mph	32 mph	27 mph	31 mph
South Street west of Folsom	*no data*			334	386	720	21 mph	25 mph	23 mph	28 mph
19th Street south of Edgewood	2,212	2,371	4,583	2,193	2,712	4,905	21 mph	25 mph	23 mph	28 mph

(1) October 28-30, 2014 Average
(2) September 15-17, 2015 Average

Table 14: Side street Volume and Speed Comparison (March 2016)

Roadway Count Location	"Before"[1] Data			"After"[3] Data - March 2016						
	Daily Roadway Volume			Daily Roadway Volume			Vehicular Speeds			
							NB or EB		SB or WB	
	NB or EB	SB or WB	Total	NB or EB	SB or WB	Total	Avg	85th%	Avg	85th%
Spruce Street west of Folsom	1,466	2,066	3,532	1,492	1,952	3,445	22 mph	28 mph	27 mph	33 mph
Spruce Street east of Folsom	*no data*			775	655	1,430	18 mph	24 mph	20 mph	26 mph
Pine Street west of Folsom	*no data*			3,506	3,015	6,521	22 mph	27 mph	28 mph	33 mph
Pine Street east of Folsom	1,595	2,218	3,813	1,421	1,576	2,997	31 mph	37 mph	22 mph	24 mph
South Street west of Folsom	*no data*			228	345	573	18 mph	23 mph	18 mph	23 mph
19th Street south of Edgewood	2,212	2,371	4,583	2,243	2,474	4,717	21 mph	28 mph	19 mph	24 mph

(1) October 28-30, 2014 Average
(2) September 15-17, 2015 Average
(3) March 8-10, 2016 Average

Historic Data for Comparison (from 2005 Spruce Street Improvements Project):

	Daily Roadway Volume			Vehicular Speeds			
				NB or EB		SB or WB	
	NB or EB	SB or WB	Total	Avg	85th%	Avg	85th%
Spruce Street west of Folsom	1,170	1,555	2,725	29 mph	32 mph	30 mph	33 mph
Spruce Street east of Folsom	1,080	1,505	2,585	19 mph	25 mph	25 mph	28 mph
Pine Street west of Folsom	3,742	3,203	6,945	26 mph	29 mph	28 mph	31 mph
Pine Street east of Folsom	1,417	1,660	3,077	29 mph	32 mph	28 mph	31 mph
19th Street south of Pine	2,372	2,942	5,314	18 mph	24 mph	20 mph	24 mph

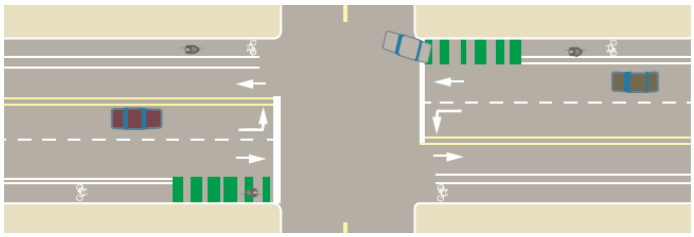
The data in **Table 13** and **Table 14** indicate some variation in volumes and speeds between the existing and two after studies. In many cases, volumes on these corridors decreased with the project or remained relatively steady through the project.

Along Pine Street west of Folsom Street, volumes have increased by almost 500 vpd (+8%) between counts taken in September 2015 and March of 2016. Roughly, 400 vpd of this growth is on Pine Street in the eastbound direction (towards the project area) with a roughly even split of traffic turning north (into the existing project) and south along Folsom Street based on peak hour counts. As half of this traffic is turning into the project, at least half of the growth along Pine Street eastbound towards Folsom Street cannot be attributed to diversion.
Volumes along 19th Street south of Edgewood indicated 7% growth with the full installation of the project in September 2015 and a 3% increase for the March 2016 data. This indicates that there may have been some diversion to 19th Street (up to approximately 300 vpd) occurring during the initial installation but that any diversion has since subsided.

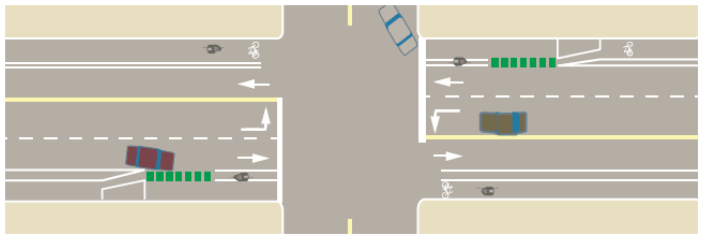
12.0 Right-Turn Treatment Evaluations

Two new right-turn treatments, the Skip Dashed Green and Transition, were installed along Folsom Street in July 2015. The Transition right-turn treatments were removed in October when the section of Folsom Street from Spruce Street to Canyon Boulevard was changed back to the original five-lane cross-section. Skip Dashed Green treatments remained installed in the section from Valmont Street to Spruce Street.

- In the Skip Dashed Green treatment, dashed green lines signify the area where right-turning motor vehicles and bicyclists share the right lane. This treatment advises motorists and bicyclists of proper lane positioning. It maintains bicyclist safety in the absence of a dedicated bicycle through lane. This treatment is used when there is a relatively low volume of right-turning vehicles.



- In the Transitions treatment, upon approaching an intersection, the bike lane transitions from next to the curb into the street while maintaining a designated lane between the vehicle travel lane and right turn lane. A green skip marking indicates the area where motor vehicles pass across the bike lane into the right turn lane. This type of intersection increases the visibility of bicyclists and motorists in advance of the intersection and mitigates the risk of "right-hook" crashes with turning motorists. This treatment is used when there is a high volume of right-turning vehicles.



Video data was collected on September 24th, 29th, and 30th, 2015 during the AM and PM peak hour for six locations that had the new right-turn designs. Note that the Transition design installed at southbound Folsom and Canyon Boulevard includes buffers between the bicycle lane and travel lane at the intersection. This treatment is referred to as "Buffered Transition" in the tables and text below.

1. Northbound right-turn at Pine Street (Skip Dashed Green)
2. Southbound right-turn at Pine Street (Skip Dashed Green)
3. Northbound right-turn at Pearl Street (Transition)
4. Southbound right-turn at Pearl Street (Skip Dashed Green)

5. Southbound right-turn at Canyon Boulevard (Buffered Transition)
6. Northbound right-turn at Canyon Boulevard (Transition)

Below are examples of the various field installations for right-turn treatments along Folsom Street:

Video data was also collected on March 17, 2016 during the AM and PM peak hour at the two Pine Street locations.

The videos were reviewed and interactions between bicyclists, pedestrians, and vehicles approaching and within the right-turn treatment were documented. The yield compliance of motorists to bicyclists within the bike lane or pedestrians within the crosswalk were recorded. In addition, the right-turning motorists' compliance with the signing and roadway markings was documented. **Table 15** summarizes the data collected in September 2015 for the pedestrians/bicyclists within the crosswalks per intersection and peak period at all six locations.

Table 15: Right-Turn Yield Compliance for Pedestrians/Bicyclists in Crosswalks (Sept. 2015)

Intersection	Approach	Right-Turn Treatment	Peak Period	Volume			Required Yield (NBR/SBR)	Yield Compliance	
				Total	Bicyclist	Pedestrian		Yes	No
Folsom Street at Pine Street	NB	Skip Dashed Green	AM	26	7	19	0	0	0
					27%	*73%*	*0%*	*N/A*	*N/A*
			PM	25	8	17	0	0	0
					32%	*68%*	*0%*	*N/A*	*N/A*
	SB	Skip Dashed Green	AM	10	5	5	0	0	0
					50%	*50%*	*0%*	*N/A*	*N/A*
			PM	31	13	18	5	5	0
					42%	*58%*	*16%*	*100%*	*0%*
Folsom Street at Pearl Street	NB	Transition	AM	21	7	14	2	2	0
					33%	*67%*	*10%*	*100%*	*0%*
			PM	61	16	45	9	9	0
					26%	*74%*	*15%*	*100%*	*0%*
	SB	Skip Dashed Green	AM	28	9	19	1	0	1
					32%	*68%*	*4%*	*0%*	*100%*
			PM	64	19	45	2	2	0
					30%	*70%*	*3%*	*100%*	*0%*
Folsom Street at Canyon Blvd	NB	Transition	AM	46	5	41	8	8	0
					11%	*89%*	*17%*	*100%*	*0%*
			PM	67	20	47	18	17	1
					30%	*70%*	*27%*	*94%*	*6%*
	SB	Buffered Transition	AM	57	6	51	25	25	0
					11%	*89%*	*44%*	*100%*	*0%*
			PM	131	69	62	25	24	1
					53%	*47%*	*19%*	*96%*	*4%*

Table 16 summarizes the data collected in March 2016 for the pedestrians/bicyclists within the crosswalks per intersection and peak period at Pine Street.

Table 16: Right-Turn Yield Compliance for Pedestrians/Bicyclists in Crosswalks (March 2016)

Intersection	Approach	Right-Turn Treatment	Peak Period	Volume			Required Yield (NBR/SBR)	Yield Compliance	
				Total	Bicyclist	Pedestrian		Yes	No
Folsom Street at Pine Street	NB	Skip Dashed Green	AM	10	2	8	0	0	0
					20%	*80%*	*0%*	*N/A*	*N/A*
			PM	17	3	14	1	1	0
					18%	*82%*	*6%*	*100%*	*0%*
	SB	Skip Dashed Green	AM	7	0	7	2	2	0
					0%	*100%*	*29%*	*100%*	*0%*
			PM	24	2	22	3	3	0
					8%	*92%*	*13%*	*100%*	*0%*

Table 17 summarizes the data collected September 2015 for the bicyclists within the protected bike lane per intersection and peak period.

Table 17: Right-Turn Yield Compliance for Bicyclists in Protected Bike Lane (September 2015)

Intersection	Approach	Right-Turn Treatment	Peak Period	Bicyclist Volume	Direction		Traveled in…			Required Yield (SBR)	Yield Compliance	
					Through	Right	Bike Lane	Buffer	Travel Lane		Yes	No
Folsom Street at Pine Street	NB	Skip Dashed Green	AM	19	18	1	19	0	0	0	0	0
					95%	*5%*	*100%*	*0%*	*0%*	*0%*	*0%*	*0%*
			PM	82	78	4	82	0	0	4	2	2
					95%	*5%*	*100%*	*0%*	*0%*	*5%*	*50%*	*50%*
	SB	Skip Dashed Green	AM	106	80	26	105	1	0	3	2	1
					75%	*25%*	*99%*	*1%*	*0%*	*3%*	*67%*	*33%*
			PM	53	44	9	53	0	0	4	3	1
					83%	*17%*	*100%*	*0%*	*0%*	*8%*	*75%*	*25%*
Folsom Street at Pearl Street	NB	Transition	AM	15	14	1	14	0	1	2	1	1
					93%	*7%*	*93%*	*0%*	*7%*	*13%*	*50%*	*50%*
			PM	118	118	0	118	0	0	8	7	1
					100%	*0%*	*100%*	*0%*	*0%*	*7%*	*88%*	*13%*
	SB	Skip Dashed Green	AM	100	100	0	91	9	0	6	6	0
					100%	*0%*	*91%*	*9%*	*0%*	*6%*	*100%*	*0%*
			PM	35	30	5	33	2	0	1	1	0
					86%	*14%*	*94%*	*6%*	*0%*	*3%*	*100%*	*0%*
Folsom Street at Canyon Blvd	NB	Transition	AM	16	15	1	15	1	0	1	1	0
					94%	*6%*	*94%*	*6%*	*0%*	*6%*	*100%*	*0%*
			PM	90	84	6	83	6	0	5	5	0
					93%	*7%*	*92%*	*7%*	*0%*	*6%*	*100%*	*0%*
	SB	Buffered Transition	AM	96	95	1	94	2	0	25	25	0
					99%	*1%*	*98%*	*2%*	*0%*	*26%*	*100%*	*0%*
			PM	33	30	3	31	2	0	7	5	2
					91%	*9%*	*94%*	*6%*	*0%*	*21%*	*71%*	*29%*

Table 18 summarizes the data collected March 2016 for the bicyclists within the protected bike lane per intersection and peak period.

Table 18: Right-Turn Yield Compliance for Bicyclists in Protected Bike Lane (March 2016)

Intersection	Approach	Right-Turn Treatment	Peak Period	Bicyclist Volume	Traveled in…			Required Yield (NBR/SBR)	Yield Compliance	
					Bike Lane	Buffer	Travel Lane		Yes	No
Folsom Street at Pine Street	NB	Skip Dashed Green	AM	6	6	0	0	0	0	0
					100%	*0%*	*0%*	*0%*	*0%*	*0%*
			PM	32	32	0	0	0	0	0
					100%	*0%*	*0%*	*0%*	*0%*	*0%*
	SB	Skip Dashed Green	AM	30	28	0	0	5	3	2
					93%	*0%*	*0%*	*17%*	*60%*	*40%*
			PM	15	2	0	0	1	1	0
					13%	*0%*	*0%*	*7%*	*100%*	*0%*

Table 19 summarizes the September 2015 data for the compliance of the pavement markings by right-turning motorists.

Table 19: Right-Turning Vehicle Compliance with Pavement Markings (September 2015)

Intersection	Approach	Right-Turn Treatment	Peak Period	Right-Turn Volume	Turned from…			Entered Right-Turn Lane…		
					Through Lane	Right-Turn Lane	Both	Before Dash	Within Dash	After Dash
Folsom Street at Pine Street	NB	Skip Dashed Green	AM	8	5 *63%*	3 *37%*	0 *0%*	0 *0%*	3 *100%*	0 *0%*
			PM	13	11 *85%*	2 *15%*	0 *0%*	2 *100%*	0 *0%*	0 *0%*
	SB	Skip Dashed Green	AM	63	49 *78%*	6 *10%*	8 *13%*	2 *33%*	4 *67%*	0 *0%*
			PM	74	52 *70%*	16 *22%*	6 *8%*	4 *25%*	12 *75%*	0 *0%*
Folsom Street at Pearl Street	NB	Transition	AM	55	1 *2%*	48 *87%*	6 *11%*	36 *75%*	11 *23%*	1 *2%*
			PM	108	2 *2%*	106 *98%*	0 *0%*	69 *65%*	30 *28%*	7 *7%*
	SB	Skip Dashed Green	AM	42	25 *60%*	8 *19%*	9 *21%*	2 *25%*	6 *75%*	0 *0%*
			PM	31	25 *81%*	5 *16%*	1 *3%*	1 *20%*	4 *80%*	0 *0%*
Folsom Street at Canyon Blvd	NB	Transition	AM	32	0 *0%*	29 *91%*	3 *9%*	22 *76%*	5 *17%*	2 *7%*
			PM	48	0 *0%*	48 *100%*	0 *0%*	24 *50%*	15 *31%*	9 *19%*
	SB	Buffered Transition	AM	225	0 *0%*	221 *98%*	4 *2%*	110 *50%*	103 *46%*	8 *4%*
			PM	145	2 *1%*	142 *98%*	1 *1%*	65 *46%*	73 *51%*	4 *3%*

Table 20 summarizes the March 2016 data for the compliance of the pavement markings by right-turning motorists.

Table 20: Right-Turning Vehicle Compliance with Pavement Markings (March 2016)

Intersection	Approach	Right-Turn Treatment	Peak Period	Right-Turn Volume	Turned from…			Entered Right-Turn Lane…		
					Through Lane	Right-Turn Lane	Both	Before Dash	Within Dash	After Dash
Folsom Street at Pine Street	NB	Skip Dashed Green	AM	3	0 *0%*	3 *100%*	0 *0%*	3 *100%*	0 *0%*	0 *0%*
			PM	6	2 *33%*	2 *33%*	2 *33%*	2 *100%*	0 *0%*	0 *0%*
	SB	Skip Dashed Green	AM	61	26 *43%*	24 *39%*	11 *18%*	2 *8%*	22 *92%*	0 *0%*
			PM	42	25 *60%*	13 *31%*	4 *10%*	6 *46%*	7 *54%*	0 *0%*

Based on the secondary performance measure evaluations of the Skip Dashed Green treatment at Pine St. in September 2015 and March 2016, almost 75% vehicles observed turning right across bicycle lanes at these locations are not complying with the City ordinance requiring vehicles to move into the bicycle space toward the curb before turning right. As such, this treatment, independent of the Folsom protected bicycle lane project, does not adequately address the mitigation of potential "right hook" collisions. In the Transition treatments, motor vehicles transition from the through to a right turn lane and bicyclists transition to a bike lane between the through and right turn vehicle lanes. The potential for "right hook" collisions is mitigated. In the Transition treatment, 85% of motor vehicles were observed yielding to bicyclists in the protected bike lane.

Additional observations are as follows:

- Pedestrians/Bicyclists within Crosswalks
    - 70% of those in the crosswalk were pedestrians and 30% were bicyclists
    - 87% of the pedestrians crossed during the Walk phase, 10% during the Flashing Don't Walk phase, and 3% during the Don't Walk phase
- Right-Turn Vehicles
    - Skip Dashed Green Treatments:
        - 64% turned from the through lane, 24% turned from the right-turn green dashed pocket, and 12% straddled the through and right-turn lanes.
        - Of those that utilized the right-turn pocket, 27% entered before the green dash began and 73% entered within the green dash.
    - Transition Treatments:
        - 1% turned from the through lane, 96% turned from the right-turn green dashed area, and 3% turned from the bike lane.
        - Of those that utilized the right-turn pocket, 60% entered before the green dash began, 33% entered within the green dash, and 7% entered after the green dash.
- Motorist Yield Compliance
    - Crosswalk
        - All Right-Turn Treatments: 88% yielded to pedestrians/bicyclists within a crosswalk that required yielding
        - Skip Dashed Green Treatments: 96% yielded to pedestrians/bicyclists within a crosswalk that required yielding

- Transition Treatments: 98% yielded to pedestrians/bicyclists within a crosswalk that required yielding

- Protected Bike Lane
  - All Right-Turn Treatments: 75% yielded to bicyclists in the protected bike lane that required yielding
  - Skip Dashed Green Treatments: 69% yielded to bicyclists in the protected bike lane that required yielding
  - Transition Treatments: 85% yielded to bicyclists in the protected bike lane that required yielding

13.0 Mid-Block Pedestrian Crossings

Observations were conducted during the AM, noon and PM peak hours on September 22, 2015 and March 15, 2016 at the Walnut Street and Spruce Street mid-block pedestrian crossings at Folsom Street. These observations documented pedestrian and bicycle crossing volumes and driver compliance with the state law yielding requirements when a vehicle approached with a pedestrian or bicycle present. The results are summarized in the following tables.

Table 21: Mid-Block Crossing on Folsom Street at Spruce Street –September 2015

Study Period	Tuesday, September 22, 2015							
	Driver Yields	Driver Fails to Yield	% Compliance	Total Pedestrians Observed	# Peds that Required Yield	% Peds that Required Yield	# Peds that Crossed while Flashing	% Peds that Crossed While Flashing
7:30AM - 8:30AM	21	10	68%	29	22	76%	24	83%
12:00PM - 1:00PM	40	16	71%	45	38	84%	38	84%
4:30PM - 5:30PM	51	24	68%	58	53	91%	50	86%
Overall (All Periods)	**112**	**50**	**69%**	**132**	**113**	**86%**	**112**	**86%**

- AM = 7 peds, 22 bikes
- Midday = 14 peds, 31 bikes
- PM = 12 peds, 46 bikes

Table 22: Mid-Block Crossing on Folsom Street at Spruce Street – March 2016

Study Period	Tuesday, March 15, 2016							
	Driver Yields	Driver Fails to Yield	% Compliance	Total Pedestrians Observed	# Peds that Required Yield	% Peds that Required Yield	# Peds that Crossed while Flashing	% Peds that Crossed While Flashing
7:30AM - 8:30AM	21	3	88%	21	18	86%	19	90%
12:00PM - 1:00PM	20	6	77%	23	18	78%	18	78%
4:30PM - 5:30PM	76	14	84%	54	46	85%	48	89%
Overall (All Periods)	**117**	**23**	**84%**	**98**	**82**	**84%**	**85**	**84%**

- AM = 13 peds, 8 bikes
- Midday = 10 peds, 13 bikes
- PM = 30 peds, 24 bikes

Table 23: Mid-Block Crossing on Folsom Street at Walnut Street – September 2015

Study Period	Tuesday, September 22, 2015							
	Driver Yields	Driver Fails to Yield	% Compliance	Total Pedestrians Observed	# Peds that Required Yield	% Peds that Required Yield	# Peds that Crossed while Flashing	% Peds that Crossed While Flashing
7:30AM - 8:30AM	35	12	74%	42	37	88%	40	95%
12:00PM - 1:00PM	61	6	91%	64	57	89%	60	94%
4:30PM - 5:30PM	62	6	91%	62	60	97%	54	87%
Overall (All Periods)	**158**	**24**	**87%**	**168**	**154**	**92%**	**154**	**92%**
July 2009 Data	***139***	***53***	***72%***	***152***	---	---	---	---

- AM = 16 peds, 26 bikes
- Midday = 24 peds, 40 bikes
- PM = 27 peds, 35 bikes

Table 24: Mid-Block Crossing on Folsom Street at Walnut Street – March 2016

Study Period	Tuesday, September 22, 2015							
	Driver Yields	Driver Fails to Yield	% Compliance	Total Pedestrians Observed	# Peds that Required Yield	% Peds that Required Yield	# Peds that Crossed while Flashing	% Peds that Crossed While Flashing
7:30AM - 8:30AM	34	6	85%	34	25	74%	33	97%
12:00PM - 1:00PM	62	14	82%	51	42	82%	46	90%
4:30PM - 5:30PM	107	16	87%	80	71	89%	78	98%
Overall (All Periods)	**203**	**36**	**85%**	**165**	**138**	**84%**	**157**	**84%**
July 2009 Data	***139***	***53***	***72%***	***152***	---	---	---	---

- AM = 17 peds, 17 bikes
- Midday = 36 peds, 15 bikes
- PM = 48 peds, 32 bikes

At the Spruce Street midblock crossing, crosswalk compliance was higher (84%) during the March 2016 study than during the September 2015 study. Bikes and pedestrian volumes were lower in March (98) vs. September (132).

July 2009 volume and compliance data at the Walnut Street mid-block crossing was also reviewed. At that time, 28, 46, and 78 total pedestrians/bikes were observed crossing in the AM, noon, and PM peak periods, with 72% overall driver compliance. The 2015 data shows an increase in both crossing volume (158 vs. 152 total) and in driver compliance (87% vs. 72%). The March 2016 data indicates that compliance at Walnut Street is roughly the same (85%) as in September 2015, with the same total crossing volumes (152 bikes and pedestrians).

Based on the compliance and crossing volume data to date, there are no identifiable impacts of the project on the performance of the midblock crossings at these locations.

14.0 Side-Street Delays

Video observations were collected on September 22nd and 23rd, 2015 and March 9th, 2016 during the AM and PM peak hours to document the delay for vehicles turning from three side streets onto Folsom Street. The locations included were:

1. Eastbound Spruce Street
2. Eastbound Walnut Street
3. Westbound REMAX Alley (just north of Canyon)

The delay was recorded for each side street vehicle to determine the average and maximum delay on each side street. On average, the side streets operate at LOS C or better in both peak periods. The maximum delays ranged from 10 seconds (LOS A) to 120 seconds (LOS F). **Table 24** summarizes the side street average and maximum delays per intersection and peak period observed in September 2015.

Table 25: Average and Maximum Side Street Delay (September 2015)

Intersection	Peak Period	Volume	Average		Maximum	
			Delay (sec)	LOS	Delay (sec)	LOS
Folsom Street at Walnut Street	AM	53	10	A	54	F
	PM	187	24	C	120	F
Folsom Street at Remax Alley	AM	10	4	A	10	A
	PM	21	19	C	85	F
Folsom Street at Spruce Street	AM	63	12	B	40	E
	PM	123	12	B	60	F

Table 25 summarizes the side street average and maximum delays per intersection and peak period observed in March 2016.

Table 25: Average and Maximum Side Street Delay (March 2016)

Intersection	Peak Period	Volume	Average		Maximum	
			Delay (sec)	LOS	Delay (sec)	LOS
Folsom Street at Walnut Street	AM	67	9	A	39	E
	PM	185	12	B	55	F
Folsom Street at Remax Alley	AM	2	2	A	2	A
	PM	24	11	B	47	E
Folsom Street at Spruce Street	AM	67	10	B	46	E
	PM	161	10	B	83	F

Based on the video observations and LOS calculations, average side street delays at these locations were at LOS C or better in September 2015, indicating good operation during most of the peak hours. These locations experienced LOS F at the highest periods of traffic, but within typical ranges for unsignalized approaches to arterial roadways (two minutes or less). The average side street delays at the locations on March 2016 were at LOS B or better. For context, the typical traffic signal in Boulder operates on a two-minute cycle length in the PM peak hour.

15.0 Left-Turn Queue Observations

Video observations were collected on September 23, 2015 during the PM peak hour for three locations:

1. Southbound Folsom Street at Pearl Street
2. Northbound Folsom Street at Pearl Street
3. Southbound Folsom at Canyon Boulevard

The data was reviewed to determine the average and maximum left-turn queue length as well as the number of times the queue blocks the through lane. **Table 26** summarizes the left-turn queue observations in September 2015 and **Table 27** summarizes the left-turn queue observations in March 2016. **Table 28** provides a comparison to pre-project data, collected in April 2015.

Table 26: Average and Maximum Left-Turn Queue (September 2015)

Intersection	Direction	Left-Turn Lane					Through Lane
		Average Queue (veh)	Maximum Queue (veh)	Blocked Thru Lane (% of cycle)	Cleared in Prot. Phase (% of veh)	Cleared in Cycle (% of veh)	Blocked Left-Turn Lane (% of cycle)
Folsom Street at Pearl Street	NB	1.60	5	0%	96%	94%	88%
Folsom Street at Pearl Street	SB	5.50	10	27%	70%	80%	21%
Folsom Street at Canyon Blvd	SB	2.70	8	3%	47%	84%	72%

The data in **Table 26** shows that the southbound left-turn storage and/or protected left-turn phase green time on Folsom Street at Pearl Street was insufficient to service all demand during the full project implementation. This resulted in the southbound through lane being blocked for some period during 27% of the signal cycles during the PM peak hour. The data also shows that 20% of these southbound left-turning vehicles would not be serviced during the first cycle. This would be expected to contribute to observed increases in travel time southbound on Folsom Street at Pearl Street.

Table 27: Average and Maximum Left-Turn Queue (March 2016)

Intersection	Direction	Left-Turn Lane					Through Lane
		Average Queue (veh)	Maximum Queue (veh)	Blocked Thru Lane (% of cycle)	Cleared in Prot. Phase (% of veh)	Cleared in Cycle (% of veh)	Blocked Left-Turn Lane (% of cycle)
Folsom Street at Pearl Street	NB	2.50	7	0%	85%	94%	39%
Folsom Street at Pearl Street	SB	5.10	10	31%	52%	77%	0%
Folsom Street at Canyon Blvd	SB	3.30	7	3%	57%	82%	9%

The field observations in March 2016 summarized in **Table 27** show that left-turn queues have returned to the pre-project conditions, as shown in **Table 28**.

Table 28: Left-Turn Queue (Before Data, April 2015)

Intersection	Direction	Left-Turn Lane				
		Average Queue (veh)	Maximum Queue (veh)	Blocked Thru Lane (% of cycle)	Cleared in Prot. Phase (% of veh)	Cleared in Cycle (% of veh)
Folsom Street at Pearl Street	NB	2.29	8	3%	94%	100%
Folsom Street at Pearl Street	SB	4.57	9	17%	87%	50%
Folsom Street at Canyon Blvd	SB	3.73	9	17%	63%	83%

16.0 Saturation Flow Rate Calculations

Field observations were performed on September 22nd and 29th, 2015 and March 9th and 28th, 2016 at three locations during the PM peak period to measure the saturation flow rate with the installation of the protected bike lane on Folsom Street:

1. Southbound Folsom Street at Pearl Street
2. Northbound Folsom Street at Pearl Street
3. Southbound Folsom at Canyon Boulevard

The methodology set forth by the *Highway Capacity Manual (HCM)* to calculate the saturation flow rate was utilized for the through lane at each location. The methodology is as follows:

1. Note these items before the green signal:
    a. The last vehicle in the stopped queue when the signal turns green
    b. Heavy vehicles
    c. Vehicles turning left or right
2. Record:
    a. Start time at beginning of green.
    b. When front axle crossing the stop bar for the 4th, 10th, and last vehicle in the stopped queue (the last vehicle may be a vehicle that joined the queue during green).
        i. If queued vehicles do not get through the intersection, record the last vehicle # and time.
    c. For a minimum of 15 signal cycles (each with more than 8 vehicles in the initial queue).

The average saturation flow rate along Folsom Street in September 2015 was measured at 1,582 vehicles per hour of green (vphg). **Table 29** summarizes the left-turn queue observations.

Table 29: Average Saturation Flow Rate (September 2015)

Intersection	Direction	Average Saturation Flow Rate
Canyon	SB	1647
Pearl	NB	1548
	SB	1552
Overall Average		**1582**

The observed average 1,582 vphg saturation flow-rate in September 2015 is lower than the standard HCM 1,900 vphg and what has been previously calculated for previous projects in Boulder (as high as 2,100 vphg on average). This would indicate that driver's behavior is more cautious in this corridor with longer headways and distances between vehicles than typical conditions. This might be indicative of the unfamiliarity of many drivers with the project (striping, signage, and delineators), but may also be related to congestion that appeared to be related to motorists yielding to pedestrians and bikes crossing Folsom at Spruce and Walnut Streets. For context, the difference between 1,582 vphg and 1,900 vphg saturation flows results in roughly one letter grade worse in Level of Service (LOS C to LOS D at Pearl Street & Folsom Street in the PM peak hour, for example).

Table 30: Average Saturation Flow Rate (March 2016)

Intersection	Direction	Average Saturation Flow Rate
Canyon	SB	N/A
Pearl	NB	1,719
	SB	N/A

In March 2016, only northbound Folsom at Pearl had more than 15 signal cycles with more than eight vehicles in the initial queue during the PM peak period. The observed average saturation flow rate was 1,719 vphg. The March 2016 vs. September 2015 saturation flow rate calculations indicated that the impact of the protected bike lanes and modified geometry prior to conversion of Folsom Street for this approach back to pre-project conditions resulted in a reduction of approximately 10% in saturation flow rate and lane capacity.

Southbound Folsom at Canyon was observed to have 13 cycles with greater than eight vehicles in the initial queue, and southbound Folsom at Pearl was observed to have 3 cycles with greater than eight vehicles in the initial queue. These observations were not sufficient to calculate saturation flow, and as such indicate a reduction in congestion at these intersections when comparing March 2016 to September 2015.

17.0 "Cycle-Failure" Observations

Field observations were performed on September 22nd and 29th, 2015 and March 9th and 28th, 2016 at two intersections to determine if there is cycle failure due to congestion on Folsom Street:

1. Folsom Street at Pearl Street
2. Folsom Street at Canyon Boulevard

During the PM peak hour in September 2015, the number of cycles that experienced queue failure during the green signal for Folsom Street were documented. There were approximately 30 cycles per peak hour. The following information was recorded:

- When the northbound and/or southbound through is stopped and the queue fails to make it through on the next green
- When the northbound and/or southbound vehicles have the green signal, but there is no receiving room for them to proceed beyond the intersection
- When the eastbound and/or westbound left-turning vehicles have a green signal, but there is no receiving room for them to proceed through the intersection onto Folsom Street

- When the eastbound and/or westbound right-turning vehicles has a green signal, but there is no receiving room for them to proceed through the intersection onto Folsom Street

Field observations were performed again in March 2016 during the PM peak hour. No cycle failures were observed at any the intersections.

Table 31 summarizes the observations of the cycle failure in September 2015.

Table 31: Cycle Failure Summary (September 2015)

Intersection	Variable	Northbound		Southbound		Eastbound		Westbound	
		Green / No Receiving Room	Queue Did Not Clear	Green / No Receiving Room	Queue Did Not Clear	Left-Turn Could not Turn	Right-Turn Could not Turn	Left-Turn Could not Turn	Right-Turn Could not Turn
Folsom Street at Canyon Boulevard	Number of Cycles	0	0	0	12	2	0	0	0
	Percent of Cycles	0%	0%	0%	40%	7%	0%	0%	0%
Folsom Street at Pearl Street	Number of Cycles	0	17	0	4	0	1	0	0
	Percent of Cycles	0%	57%	0%	13%	0%	3%	0%	0%

Appendix

Peak Hour Turning Movement Count (TMC) Summaries
Level of Service Definitions
Signalized Intersection Level of Service Summary