

City of South Pasadena

THROUGH-LANE BIKE BOX EXPERIMENT EVALUATION

DECEMBER 2019

CTCTC Experiment 16-25

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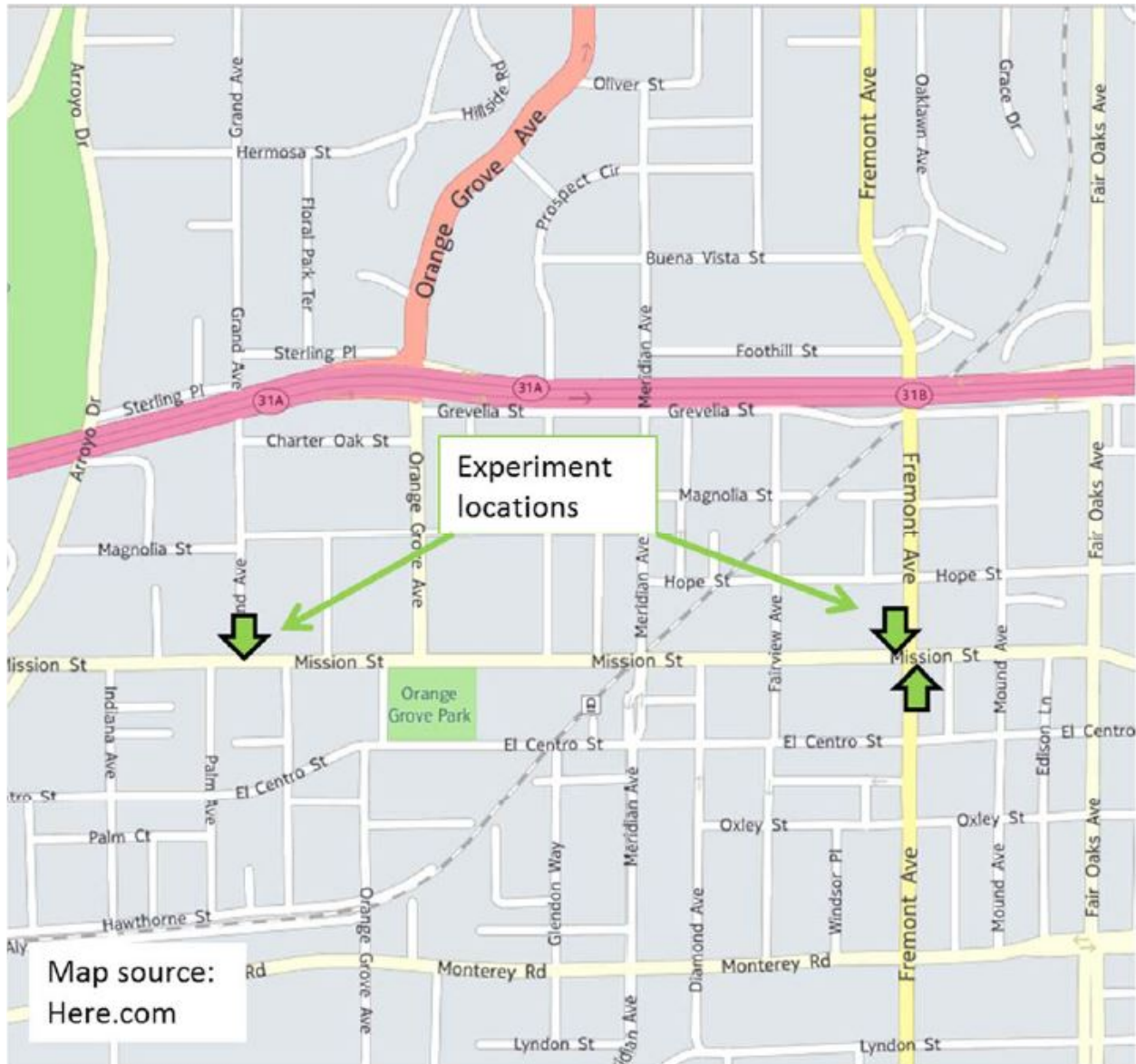
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1.0 INTRODUCTION

The California Traffic Control Devices Committee approved installation of three through-lane bicycle boxes, Experiment 16-25, in September 2016. Two were installed at the intersection of Fremont Avenue & Mission Street, one in the northbound direction and the other in the southbound direction. One was installed on Grand Avenue & Mission Street in the southbound direction. Bike boxes on Fremont Avenue were installed in July 2018 while bike boxes on Grand Avenue were installed in May 2019. See figure below.



Location of intersections where through-lane bicycle boxes were installed in the City of South Pasadena

Grand Avenue has moderate levels of bicycle travel, while Fremont Avenue has less bicycle travel but provides the most direct north-south route across the City of South Pasadena. These roadways have insufficient right-of-way to install a Class II bicycle lane between the through and right lane. The through-lane bicycle box is being evaluated for applicability to roadways that have an exclusive right-turn lane but insufficient lateral space to provide a Class II bicycle lane on the approach.

The intended purpose of the through-lane bicycle boxes is to provide an exclusive area for cyclists to wait at a red light in a traffic lane dedicated to straight through travel or a left-and-through movement. This would theoretically encourage cyclists who are travelling through or turning left to do so from the appropriate lane and not to do so from the right-turn lane, as this could both create potential conflicts with other vehicles, such as “right hook” collisions, and inhibit the throughput of vehicles in the dedicated right turn lane if a bicycle is blocking the path of travel. A bicycle box painted prominently in green at the front of the queue on a busy collector roadway also is intended to emphasize to motorists and bicyclists alike that bicycles belong on these roadways.

The through-lane bicycle boxes that were installed in South Pasadena have the following features, which are common with typical bike boxes:

- Advance stop bar
- Bicycle symbol pavement marking(s)
- Setback from adjacent crosswalk
- Green colored pavement

However, due to the lack of lateral roadway space, a bike lane was not provided upstream to feed into the bike box.



Concept design showing location of through-lane bike boxes at each intersection.

Bicyclists were expected to use the bicycle box in either of the following two ways:

1. Cyclists in the right-most lane would merge into the through lane when the right-most lane changes into a right-turn only lane. Cyclists then travel in the center of the through lane in mixed flow with motor vehicles, by “taking the lane.” Bicyclists who happen to be at the front of the queue when the traffic signal turns red would occupy the bicycle box.
2. Cyclists in the right-most lane would, upon reaching the exclusive right turn lane, travel between the through lane and right-turn lane (also known as “lane splitting”) to occupy the bike box.

Through-lane bicycle boxes would offer the following potential improvements over traditional bike boxes:

1. Bicyclists wishing to travel straight through the intersection would not block or be at the risk of a collision with a motorist making a right turn on red movement or proceeding on a right turn overlap signal
2. No prohibition of right turn on red is required. Throughput by motorists would not be significantly impeded.
3. The lack of a Class II bicycle lane feeding into a broader bike box removes the implication that bicyclists can make a sharp L-shaped turn at the limit line.



A bicyclist who stops on a through-lane bike box allows cars in the right-turn lane to turn right on red, as shown here at Grand Avenue & Mission Street after bike box installation.

2.0 EVALUATION METHODOLOGY

The following data was collected as part of the experiment:

1. Crash data
2. Conflicts and avoidance maneuvers between motor vehicles and bicycles
3. Bicyclist and motorist position and behavior approaching the intersection and positioning during a red light and resulting delay to motorists.

Crash data was collected from the Transportation Injury Mapping System (TIMS). TIMS displays data from the Statewide Integrated Records System (SWITRS), a comprehensive and frequently updated database that collects collision data across the state of California. Experimenters looked at 10 years of collision data from 2009 to 2018 to determine collision trends over the past decade at the locations of bike box installations.

Maneuvers, positioning, and behavior were collected through 24-hour video surveillance, once before and once after installation of the through-lane bike boxes. Data prior to installation was collected in 2017 on August 25 (a Friday) and August 31 (a Thursday). Data after installation was collected on September 6, 2019 (a Friday) for both the bike boxes on Grand Avenue and on Fremont Avenue. Experimenters watched the videos to determine bicyclist position at the limit line. They determined at what position each bike arrived at the intersection to stop. The following were options to document:

- Sidewalk
- Against curb (right side of right turn lane)
- Center of right turn lane
- Straddling between right lane and through lane
- Center of through lane
- Straddling between through and left lane
- Center of left lane
- Straddling yellow centerline

Because of the increasing presence of e-scooters within cities in California, experimenters were also encouraged to count and observe the behavior of e-scooters during the video count taking place after bike box installation. However, no e-scooters were observed at this intersection in the 24-hour video period.

Vehicle position, specifically compliance with stopping at the line prior to entering a through-lane bike box, was also observed. Video observations were made during vehicle peak hours of 7-9 AM and 4-6 PM for all three bike box locations, as this was expected to provide a snapshot of motorist behavior during the busiest roadway period.

Finally, experimenters reviewed the entire 24-hour video period to determine when conflicts and avoidance maneuvers occurred between motorists and bicyclists. Specifically, an avoidance maneuver means that either the motorist or the bicyclist had to visibly change their path of travel, such as by suddenly braking or turning, to avoid an anticipated collision.

3.0 EXPERIMENTATION RESULTS

COLLISIONS

Only three bicycle-vehicle collisions occurred in the last decade at or near the intersection of Fremont Avenue and Mission Street. The first collision, which happened in 2012, occurred in the middle of the intersection with a left-turning car headed north hitting a bicyclist proceeding straight (direction not specified). The motorist was at fault for violating bike right of way. The second collision, which occurred in 2013, happened 120 feet south of the intersection, from a right-turning car (into a driveway) hitting a bicyclist heading south, likely due to failure to observe the bicyclist to the right of the vehicle. The final collision also occurred in 2013 and involved a bicyclist heading east passing and hitting a vehicle- the bicyclist was listed at fault. It is difficult to determine whether installation of the through-lane bike boxes could be expected to reduce the likelihood of any of the above collisions.

The only collision at Grand Avenue & Mission Street in the last decade occurred in 2012. This was a driver hitting a bicyclist proceeding east while making a left turn (also heading east). The path of travel does not correspond with the location of the installed bike box, which was placed on the north approach.

BICYCLE POSITION

Bicycle position was observed at the approach to each intersection, broken down by what movement the bicyclist ultimately made at the intersection (turning right, turning left, or traveling through). Particular attention was paid to bicyclists making a through movement in both the northbound and southbound direction at Fremont Avenue & Mission Street or bicyclists making a through or left turn movement in the southbound direction at Grand Avenue & Mission Street, as these movements are intended to be served by the installation of the through-lane bike boxes (Fremont Street) or through- and left-lane bike box (Grand Avenue) respectively. Bicycle position was further broken down into whether bicyclists had to stop at a red light before proceeding through the intersection, as this potentially affects the behavior of bicyclists, and approaching on a red light is the only condition where bicyclists would be expected to stop on the installed through-lane bike boxes.

Before Bike Box Installation

The tables below shows the number of bicycles by arrival movement and position per intersection for the 24-hour observation period conducted prior to installation for each of the three approaches where bike boxes would be installed.

TABLE 3.1A- NUMBER OF BICYCLES BY MOVEMENT AND ARRIVAL POSITION, SB FREMONT AVENUE & MISSION STREET, BEFORE INSTALLATION

Movement	Stoplight on Approach	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Line between Through Lane & Left Lane	Center of Left Lane	Straddling Yellow Centerline	ALL ARRIVAL POSITIONS
SBL	Red			1						1
	Green							1		1
	TOTAL			1				1		2
SBT	Red	2								2
	Green			1	1					2
	TOTAL	2		1	1					4
SBR	Red			2		1				3
	Green			3						3
	TOTAL			5		1				6

Table 3.1A above shows the number of bicyclists by movement and arrival position traveling southbound at Fremont Avenue & Mission Street during the observation period prior to bike box installation. See Table A1 in Appendix A for a complete list of bicyclist movements by timestamp. Of the four bicyclists traveling through in the southbound direction on Fremont Avenue & Mission Street over the 24-hour period, three (75%) did so from some part of the right turn lane and one (25%) did so from the sidewalk. This means no bicyclist “correctly” travelled through the intersection from the through lane; the through-lane bike box was proposed in part to change this behavior. However, the one bicyclist who turned left did so “correctly” from the left-turn lane. The bicyclist turning right from the through lane and the bicyclist turning left from the right lane both did so late at night in a period with little street traffic.

TABLE 3.1B- NUMBER OF BICYCLES BY MOVEMENT AND ARRIVAL POSITION, NB FREMONT AVENUE & MISSION STREET, BEFORE INSTALLATION

Movement	Stoplight on Approach	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Line between Through Lane & Left Lane	Center of Left Lane	Straddling Yellow Centerline	ALL ARRIVAL POSITIONS
NBL	Red									
	Green									
	TOTAL									0
NBT	Red	2	1	2	1					6
	Green			1	1					2
	TOTAL	2	1	3	2					8
NBR	Red			1				1		2
	Green	1		2						3
	TOTAL	1		3				1		5

Table 3.1B above shows the number of bicyclists by movement and arrival position traveling northbound at Fremont Avenue & Mission Street during the observation period prior to bike box installation. See Table A2 in Appendix A for complete list of bicyclist movements by timestamp. Of the eight bicyclists traveling through in the northbound direction at Fremont Avenue & Mission Street over the 24-hour period, six (75%) did so from some part of the right turn lane and two (25%) did so from the sidewalk. This means no bicyclist “correctly” travelled through the intersection from the through lane; the through-lane bike box was installed to in part change this behavior. However, two of six bicyclists did straddle the right lane and through lane while doing this, which allowed cars in the right lane to pass by them. In no case did any bicyclists going straight through the right lane actually block cars on this particular date. Bicyclists traveling straight through in the right lane typically headed somewhat over to the crosswalk while crossing and then merged back to the right side of the through lane after passing through the intersection.

TABLE 3.1C- NUMBER OF BICYCLES BY MOVEMENT AND ARRIVAL POSITION, SB GRAND AVENUE & MISSION STREET, BEFORE INSTALLATION

Movement	Stoplight on Approach	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Yellow Centerline	ALL ARRIVAL POSITIONS
SBL	Red		2	4	2	9	2	19
	Green					4		4
	TOTAL		2	4	2	13	2	23
SBT	Red							
	Green							
	TOTAL							0
SBR	Red		1	19		2		22
	Green			5		2		7
	TOTAL		1	24		5		29

Table 3.1C above shows the number of bicyclists by movement and arrival position traveling southbound at Grand Avenue & Mission Street during the observation period prior to bike box installation. See Table A3 in Appendix A for a complete list of bicyclist movements by timestamp. Of the 23 bicyclists who made a left-turn movement heading south from Grand Avenue, 15 did so “correctly” from the left-turn lane, while 8 did so from the right-turn lane. This means about 65% of bicyclists were turning from the lane where the through/left bike box would be installed. Of the 35% of bicyclists turning left from the right lane, some simply straddled the lane line to the right of motorists in the through-left lane. This approach created a potential conflict with motorists heading through southbound to the driveway on the south leg of the intersection. Others did a “jughandle” turn, proceeding straight along the crosswalk to the front of motorists heading through on the west leg, and then proceeding straight through on the green light for east/west movements. On this particular date no right-turning motorists were blocked from making a right turn due to bicycles turning left from the right lane.

After Bike Box Installation

The tables below show the number of bicycles by arrival movement and position per intersection for the 24-hour observation period conducted after installation for each of the three approaches where bike boxes were installed.

TABLE 3.2A- NUMBER OF BICYCLES BY MOVEMENT AND ARRIVAL POSITION, SB FREMONT AVENUE & MISSION STREET, AFTER INSTALLATION

Movement	Stoplight on Approach	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Line between Through Lane & Left Lane	Center of Left Lane	Straddling Yellow Centerline	ALL ARRIVAL POSITIONS
SBL	Red	3								3
	Green									
	TOTAL	3								3
SBT	Red	1		3						4
	Green	2		3	2					7
	TOTAL	3		6	2					11
SBR	Red			2						2
	Green									
	TOTAL			2						2

Table 3.2A above shows the number of bicyclists by movement and arrival position traveling southbound at Fremont Avenue & Mission Street during the observation period after bike box installation. See Table A4 in Appendix A for a complete list of bicyclist movements by timestamp. As can be seen in the table above, of bicyclists heading south on Fremont Avenue, none of the 11 bicyclists making a through movement at this intersection used the through lane where the through-lane bike box was placed. Three of 11 used the sidewalk (27%) while the remainder used the right lane; overall, virtually no change occurred due to bike box installation. Of these 11 bicyclists, 7 traveled through on a green light, typically staying to the right of vehicles in the through lane or hugging the crosswalk then merging back into traffic. Four bicyclists had to stop at the red light, and in three of four of these cases a car was covering the bike box before the bike approached the intersection, preventing each bike from relocating to the bike box.

TABLE 3.2B- NUMBER OF BICYCLES BY MOVEMENT AND ARRIVAL POSITION, NB FREMONT AVENUE & MISSION STREET, AFTER INSTALLATION

Movement	Stoplight on Approach	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Line between Through Lane & Left Lane	Center of Left Lane	Straddling Yellow Centerline	ALL ARRIVAL POSITIONS
SBL	Red	2		1						3
	Green	1		1				1		3
	TOTAL	3		2				1		6
SBT	Red	2								2
	Green	1		5						6
	TOTAL	3		5						8
SBR	Red			1						1
	Green	2	1							3
	TOTAL	2	1	1						4

Table 3.2B above shows the number of bicyclists by movement and arrival position traveling northbound at Fremont Avenue & Mission Street during the observation period after bike box installation. See Table A5 in Appendix A for a complete list of bicyclist movements by timestamp. As can be seen in the table above, none of the 8 bicyclists making a through movement while traveling north on Fremont Avenue used the through lane where the through-lane bike box was placed. Three of eight used the sidewalk (37%) while the remainder used the right lane; overall, virtually no change occurred due to bike box installation. Of these 8 bicyclists, 6 traveled through on a green light, typically staying to the right of vehicles in the through lane or hugging the crosswalk then merging back into traffic. The 2 bicycles travelling through on a red light crossed at the sidewalk.

TABLE 3.2C- NUMBER OF BICYCLES BY MOVEMENT AND ARRIVAL POSITION, SB GRAND AVENUE & MISSION STREET, AFTER INSTALLATION

Movement	Stoplight on Approach	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Yellow Centerline	ALL ARRIVAL POSITIONS
SBL	Red	1		1	5	17		24
	Green					9		9
	TOTAL	1		1	5	26		33
SBT	Red	2		2				4
	Green			1				1
	TOTAL	2		3				5
SBR	Red		2	15	3	1		21
	Green			4		2		6
	TOTAL		2	19	3	3		27

Table 3.2C above shows the number of bicyclists by movement and arrival position traveling southbound at Grand Avenue & Mission Street during the observation period after bike box installation. See Table A6 in Appendix A for a complete list of bicyclist movements by timestamp. Of 38 bicyclists making a through or left movement at this intersection, 25 (66%) used the left lane, while 10 (26%) used the right lane and three (8%) used the sidewalk. Between the before installation condition and the after installation condition, the percentage of bicyclists using the through-left lane to make a through or left turn movement is virtually unchanged (65% to 66%). Of the 38 bicyclists making a through or left turn movement, 28 had to stop at a red light; of these, in 17 cases the bicyclist stopped in the bike box in the through/left lane, in 5 cases a car was covering the bicycle box, preventing the bicyclist from using it, and in 6 cases the car was not covering the bike box but the bicyclist was in the right lane, sidewalk, or behind other vehicles in the through/left lane, and thus did not use it.



A pair of bicyclists stops on the bicycle box at Grand Avenue & Mission Street

VEHICLE POSITION

TABLE 3.3 – ARRIVAL POSITION OF VEHICLES DURING PEAK HOURS, 7-9 AM AND 4-6 PM

Location & Recorded Period	Covers Bike Box	Stops Before Bike Box	Percent of Events Covered
SB Fremont Avenue & Mission Street 7-9 AM	29	34	46.0%
SB Fremont Avenue & Mission Street 4-6 PM	24	49	32.9%
NB Fremont Avenue & Mission Street 7-9 AM	32	46	41.0%
NB Fremont Avenue & Mission Street 4-6 PM	36	40	47.4%
SB Grand Avenue & Mission Street 7-9 AM	49	43	53.3%
SB Grand Avenue & Mission Street 4-6 PM	49	50	49.5%
TOTAL	219	262	45.5%

Vehicle position was observed during peak hours to determine whether vehicles obstructed the use of the through-lane bike boxes by covering them while stopped at the intersection. If a vehicle covers the bike box, it renders the box unable to be accessed by a bicyclist traveling in the right lane or straddling the right and through lane to jump the vehicle queue and enter the bike box to perform the through or left-

turn movement. For the purpose of this study, partially stopping on top of the bike box counted as “covering” the bike box, however, part of the vehicle’s wheels must actually cover the bike box to count. If the vehicle’s wheels did not enter the bike box, but part of the vehicle’s hood was overhanging the bike box, then the vehicle was not considered to be “covering” the box.

As can be seen in Table 3.3 above, over all periods observed, vehicles covered the through-lane bike boxes approximately 45% of the time, and stopped before it, leaving it accessible, 55% of the time. Some motorists appeared willing to comply with the regulation, while others simply ignored the box or did not understand the provision to stop prior to it. Video observations revealed that some motorists chose to stop before the bike box, and then, after waiting for some time, pull closer to the intersection; these motorists were counted as stopping before the bike box. A small number of motorists covered the bike box as a result of excessive traffic; vehicles would wait for the vehicle queue across the intersection to clear prior to crossing, pulling right up to the intersection (in the bike box). Most vehicles covering the bike box, however, did so without influence from a traffic queue. It appeared that motorists were more likely not to cover the bike box when pedestrians were present in the crosswalk.



When a car covers the bike box, bicyclists sometimes choose to wait on the right side of the vehicle.

AVOIDANCE MANEUVERS

TABLE 3.4A – LIST OF AVOIDANCE MANEUVERS OBSERVED BEFORE INSTALLATION

Location	Bike No.*	Arrival Time	Description	Potentially correctable by bike box?
SB Fremont Ave & Mission St	6	9:06:40 AM	Car proceeding straight southbound on Fremont has to brake to avoid hitting bicyclist, pulling out of the driveway north of the intersection and heading to the right turn lane (to make a right turn).	No
NB Fremont Ave & Mission St	2	10:47:17 AM	Bike has to brake while turning right to avoid hitting a bus.	No
SB Grand Ave. & Mission St	3	5:57:56 AM	Car has to brake behind bicycle making right turn from through/left lane.	No
SB Grand Ave. & Mission St	22	11:13:40 AM	Car trying to pass left-turning bicyclist while (properly) turning has to brake to avoid colliding with the bicyclist.	No
SB Grand Ave. & Mission St	30	12:40:09 PM	Bike intends to turn right on green light, but a northbound left-turning car (from driveway on south leg of intersection) is heading into the same path at the same time. The bike switches to the through/left lane, causing a few cars to brake, to increase the radius of their turn and arrive after the northbound left-turning car.	No
SB Grand Ave. & Mission St	36	4:52:34 PM	Bike makes a wide southbound left movement and as a result car doing a northbound left from the driveway must brake to avoid colliding with bicycle.	Yes

*See list by intersection in Appendix A

See Table 3.4A above for a list of avoidance maneuvers observed before installation at all three bike boxes. Across all approaches, six total avoidance maneuvers were observed from reviewing the video recordings made prior to bike box installation at each intersection. Only one avoidance maneuver was of the type that could be anticipated as being resolved through installation of a through-lane bike box. The bike on Grand Avenue and Mission Street at 4:52 PM turned from the left lane but had to stop behind a car that was stopped where the through-lane bike box would have been placed. If a through-lane bike box had been present, the biker may have been able to navigate around the motorist and wait in the bike box (if the motorist had properly stopped before the bike box), thus making themselves more visible to other motorists around the rest of the intersection.

The bike at the same location at 11:13 AM was positioned exactly where the bike box would be located and was noticed by the vehicle behind it, but the avoidance maneuver occurred when the car tried to pass the bicyclist during the left turn; it is unlikely that a through-lane bike box would have changed the motorist's behavior.

TABLE 3.4B – LIST OF AVOIDANCE MANEUVERS OBSERVED AFTER INSTALLATION

Location	Bike No.*	Arrival Time	Description	Correctable by bike box?
SB Fremont Ave & Mission St	7	9:32:02 AM	Bike approaching in right lane that wants to go through blocks a right-turning car behind it. Cannot move to bike box as being covered by a car.	No
SB Fremont Ave & Mission St	16	7:20:25 PM	Bike blocks right turning car in right-lane during red light. Proceeds straight on green light. Car in through lane on top of bike box.	No
NB Fremont Ave & Mission St.	12	15:22:56 PM	Bike heading straight through intersection from right lane (on green light) has to drift towards through-lane to dodge vehicle poking nose to turn right (WBR). Gets close to through-traffic cars as a result.	No
NB Fremont Ave & Mission St.	16	20:36:53 PM	Right-turning car must brake behind bike going through in right lane.	No
SB Grand Ave. & Mission St.	10	8:42:24 AM	Car turning right does not see bicyclist crossing in the crosswalk from sidewalk and must quickly brake.	N/A
SB Grand Ave. & Mission St.	20	10:14:05 AM	Bike pulls ahead of car from right lane to the bike box, requiring car to brake. Northbound traffic from the driveway has to yield due to a wide turn.	No
SB Grand Ave. & Mission St.	21	10:20:16 AM	Bike straddling right/through lane during red light causes right-turning car to have to carefully pass prior to making right turn on red.	No
SB Grand Ave. & Mission St.	24	10:25:18 AM	On bike's left turn, northbound left-turning motorists from driveway brake to avoid hitting southbound left-turning bicyclist.	No

**See list by intersection in Appendix A*

See Table 3.4B for a list of avoidance maneuvers observed after bike box installation at all three bike boxes. Eight avoidance maneuvers were observed from reviewing the video recordings made prior to bike box installation at each intersection. Of these, four were related to a bicycle traveling through the right turn lane blocking a car trying to make a right on red from this lane. The through-lane bicycle box was intended to solve this problem, yet it was still occurring even after the bike box installation. Additionally, there were some avoidance maneuvers related to supposed “correct” use of the bike box, including a braking maneuver from a motorist because a bicyclist drifted into the bike box from the right lane, and motorists turning left from the opposing driveway at Grand Avenue braking because of perceived worries of hitting a bicyclist making a left turn from the left turn lane, both in a case when the bicyclist did not follow a proper left turn path and a case when the bicyclist did follow a proper left turn path.



Bicycles traveling on the right side of through traffic may encounter conflicts from other movements in the intersection.

4.0 FINDINGS

Installation of the bike boxes did not increase use of through/left turn lane by bicyclists as compared to using the right lane to travel through the intersection. At Fremont Avenue & Mission Street, no bicyclists during either the before or after installation period used the through lane to travel through the intersection. At Grand Avenue & Mission Street, while more bicyclists used the left/through lane to make a left or through movement than not, the percentage of bicyclists choosing to do so did not change after the installation. This suggests that the bike box does not encourage bicyclists to travel with vehicle traffic in the through lane as compared to staying to the right of vehicles or using the sidewalk.

Motorists frequently do not comply with the requirement to stop at the intersection before the bike box. In the observation period after the installation of the bike boxes, motorists appeared to cover the bike box nearly half of the time.



Even bicyclists who turn left from the bike box may encounter challenging conditions while making a left turn.

Finally, there was no significant difference between the before condition and after condition in terms of avoidance maneuvers. It is difficult to make a judgment about this for Fremont Avenue & Mission Street as no bicyclists used the bike box. It does not appear that the installation of the bike box at Grand Avenue & Mission Street reduced the risk encountered by bicyclists turning left from the left lane; in both the before installation and after installation scenarios no cars failed to notice the bicyclist stopped in the front of the queue. However, both before and after installation, vehicles, especially those turning left from the opposite direction, had to be careful not to collide with the bicycle due to their different speed and/or path of travel from typical motorists. Because only 6 avoidance maneuvers of any kind were found in the before installation period of observation and only 7 avoidance maneuvers were found in the after installation period, there is no evidence of a significant change in the number of conflicts due to the installation of the bike box. Additionally, no bicycle versus vehicle collisions have occurred recently before or immediately after the installation of the bike boxes, so few insights can be gained from this data source.

Appendix A – Arrival Positions of Bicycles by Time Stamp

TABLE A1-ARRIVAL POSITION OF BICYCLISTS, SB FREMONT AVENUE & MISSION STREET,
BEFORE INSTALLATION

Bike No.	Stop Light	Arrival Time	Movement				Arrival Approach							
			SL	ST	SR	UT	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Line between Through Lane & Left Lane	Center of Left Lane	Straddling Yellow Centerline
1	Red	2:11:01 AM			X						X			
2	Red	5:45:45 AM				X			X					
3	Green	6:09:59 AM		X						X				
4	Green	7:47:34 AM		X					X					
5	Red	7:50:30 AM		X			X							
6	Green	9:06:40 AM			X				X					
7	Green	9:24:00 AM			X				X					
8	Green	1:59:39 PM	X										X	
9	Red	4:15:30 PM		X			X							
10	Red	5:26:24 PM			X				X					
11	Red	5:26:25 PM			X				X					
12	Green	11:58:27 PM			X				X					

TABLE A2-ARRIVAL POSITION OF BICYCLISTS, NB FREMONT AVENUE & MISSION STREET,
BEFORE INSTALLATION

Bike No.	Stop Light	Arrival Time	Movement			Arrival Approach							
			NL	NT	NR	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Line between Through Lane & Left Lane	Center of Left Lane	Straddling Yellow Centerline
1	Green	10:07:47 AM			X	X							
2	Red	10:47:17 AM			X			X					
3	Red	11:04:04 AM			X							X	
4	Red	12:05:30 PM		X					X				
5	Red	2:15:31 PM		X				X					
6	Green	2:17:05 PM			X			X					
7	Green	2:17:07 PM			X			X					
8	Red	3:17:37 PM		X		X							
9	Red	3:17:38 PM		X		X							
10	Green	5:28:08 PM		X				X					
11	Red	5:56:32 PM		X				X					
12	Red	7:03:33 PM		X			X						
13	Green	7:58:44 PM		X					X				

**TABLE A3-ARRIVAL POSITION OF BICYCLISTS, SB GRAND AVENUE & MISSION STREET,
BEFORE INSTALLATION**

Bike No.	Stop Light	Arrival Time	Movement			Arrival Approach					
			SL	ST	SR	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through/Left Lane	Center of Through/Left Lane	Straddling Yellow Centerline
1	Red	6:33:12 AM			X			X			
2	Red	6:57:20 AM	X							X	
3	Red	6:57:56 AM			X					X	
4	Red	7:15:13 AM			X			X			
5	Red	7:26:32 AM			X			X			
6	Red	7:35:20 AM	X				X				
7	Red	7:38:46 AM			X			X			
8	Red	7:45:25 AM			X			X			
9	Green	7:50:38 AM	X							X	
10	Red	7:58:21 AM			X			X			
11	Green	8:20:53 AM	X							X	
12	Green	8:36:42 AM	X							X	
13	Red	8:57:11 AM			X			X			
14	Green	8:58:17 AM			X			X			
15	Red	9:00:00 AM	X						X		
16	Red	9:00:00 AM	X							X	
17	Red	9:15:44 AM			X			X		X	
18	Red	9:26:33 AM			X					X	

Bike No.	Stop Light	Arrival Time	Movement			Arrival Approach					
			SL	ST	SR	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through/Left Lane	Center of Through/Left Lane	Straddling Yellow Centerline
19	Red	9:36:28 AM	X						X		
20	Red	9:48:24 AM			X			X			
21	Red	10:08:35 AM			X			X			
22	Red	11:13:40 AM	X							X	
23	Red	11:20:10 AM			X			X			
24	Green	11:46:35 AM			X			X			
25	Red	12:01:05 PM	X							X	
26	Red	12:26:23 PM			X			X			
27	Red	12:26:24 PM			X			X			
28	Red	12:26:24 PM			X			X			
29	Red	12:36:44 PM			X			X			
30	Green	12:40:09 PM			X					X	
31	Red	1:14:52 PM	X							X	
32	Green	1:45:27 PM			X					X	
33	Red	2:50:17 PM	X							X	
34	Green	2:59:18 PM	X							X	
35	Red	4:16:48 PM	X								X
36	Red	4:52:34 PM	X							X	
37	Red	4:56:22 PM	X					X			

Bike No.	Stop Light	Arrival Time	Movement			Arrival Approach					
			SL	ST	SR	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through/Left Lane	Center of Through/Left Lane	Straddling Yellow Centerline
38	Green	5:03:29 PM			X			X			
39	Green	5:21:40 PM			X			X			
40	Red	5:24:04 PM			X		X				
41	Red	6:03:24 PM			X			X			
42	Green	6:08:37 PM			X			X			
43	Red	6:16:09 PM	X				X				
44	Red	6:16:10 PM	X					X			
45	Red	6:33:24 PM	X							X	
46	Red	6:51:29 PM	X								X
47	Red	7:01:42 PM	X					X			
48	Red	7:13:31 PM	X							X	
49	Red	7:20:48 PM			X			X			
50	Red	7:39:20 PM			X			X			
51	Red	8:10:33 PM			X			X			
52	Red	9:14:15 PM	X					X			

TABLE A4-ARRIVAL POSITION OF BICYCLISTS, SB FREMONT AVENUE & MISSION STREET,
AFTER INSTALLATION

Bike No.	Stop Light	Arrival Time	Movement			Arrival Approach							
			SL	ST	SR	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Line between Through Lane & Left Lane	Center of Left Lane	Straddling Yellow Centerline
1	Green	5:02:49		X				X					
2	Red	5:33:40			X			X					
3	Red	7:37:14	X			X							
4	Red	7:37:15	X			X							
5	Green	8:52:08		X		X							
6	Green	8:52:09		X		X							
7	Red	9:32:02		X				X					
8	Red	10:37:01			X			X					
9	Green	13:24:20		X				X					
10	Red	14:15:25		X		X							
11	Red	17:10:37	X			X							
12	Green	17:39:33		X				X					
13	Green	17:52:42		X					X				
14	Green	18:41:14		X					X				
15	Red	19:10:23		X				X					
16	Red	19:20:25		X				X					

Table A5-ARRIVAL POSITION OF BICYCLISTS, NB FREMONT AVENUE & MISSION STREET,
AFTER INSTALLATION

Bike No.	Stop Light	Arrival Time	Movement			Arrival Approach							
			NL	NT	NR	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through Lane	Center of Through Lane	Straddling Line between Through Lane & Left Lane	Center of Left Lane	Straddling Yellow Centerline
1	Green	2:20:00		X		X							
2	Green	6:05:06			X		X						
3	Green	7:51:02			X	X							
4	Red	12:03:00	X			X							
5	Red	12:14:21			X			X					
6	Green	13:25:26	X									X	
7	Green	13:46:42	X					X					
8	N/A	14:12:25			X	X							
9	Green	14:32:47		X				X					
10	Red	15:03:20	X			X							
11	Red	15:11:18	X					X					
12	Green	15:22:56		X				X					
13	Green	16:55:22		X				X					
14	Red	18:49:14		X		X							
15	Red	18:49:17		X		X							
16	Green	20:36:53		X				X					
17	Green	21:52:24		X				X					
18	Green	21:58:01	X			X							

TABLE A6-ARRIVAL POSITION OF BICYCLISTS, SB FREMONT AVENUE & MISSION STREET,
AFTER INSTALLATION

Bike No.	Stop Light	Arrival Time	Movement			Arrival Approach					
			SL	ST	SR	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through/Left Lane	Center of Through/Left Lane	Straddling Yellow Centerline
1	Red	2:06:48			X				X		
2	Red	5:59:19	X							X	
3	Red	6:51:51	X							X	
4	Red	7:01:48			X			X			
5	Red	7:04:46			X			X			
6	Red	7:09:38			X			X			
7	Red	8:22:51			X			X			
8	Red	8:33:51	X						X		
9	Red	8:35:30			X			X			
10	Red	8:42:24	X			X					
11	Green	8:43:54			X			X			
12	Red	9:01:42			X			X			
13	Red	9:05:32	X							X	
14	Red	9:05:33		X				X			
15	Red	9:31:02	X					X			
16	Red	9:31:03	X							X	
17	Red	9:33:06	X							X	
18	Red	9:47:48	X							X	
19	Red	10:02:28	X							X	
20	Red	10:14:05	X						X		
21	Red	10:20:16	X						X		
22	Green	10:20:55	X							X	
23	Green	10:20:55	X							X	
24	Red	10:25:18	X							X	
25	Red	10:32:34	X							X	
26	Red	10:32:34	X							X	
27	Red	10:55:56			X			X			
28	Red	10:56:05			X			X			
29	Red	11:02:31		X				X			
30	Red	11:33:53			X			X			
31	Red	11:52:16			X			X			
32	Red	12:10:51			X					X	
33	Green	12:12:11			X					X	
34	Green	12:15:21	X							X	

Bike No.	Stop Light	Arrival Time	Movement			Arrival Approach					
			SL	ST	SR	Sidewalk	Against Curb	Center of Right Lane	Straddling Line between Right Lane & Through/Left Lane	Center of Through/Left Lane	Straddling Yellow Centerline
35	Red	12:18:27			X			X			
36	Red	14:15:21			X				X		
37	Red	15:11:39	X							X	
38	Red	15:11:42	X							X	
39	Red	15:18:30	X							X	
40	Red	15:46:19			X			X			
41	Red	15:47:43			X			X			
42	Red	15:48:40			X		X				
43	Red	16:01:06	X							X	
44	Green	16:32:29			X			X			
45	Red	16:37:17	X							X	
46	Green	16:59:53		X				X			
47	Red	17:01:39			X			X			
48	Red	17:07:07	X							X	
49	Green	17:14:09	X							X	
50	Green	17:17:45			X			X			
51	Green	17:27:34	X							X	
52	Red	17:29:09	X						X		
53	Red	17:32:25			X			X			
54	Green	17:39:52	X							X	
55	Red	17:50:01	X							X	
56	Red	18:09:35	X						X		
57	Red	18:35:00			X				X		
58	Green	18:57:58			X			X			
59	Red	19:37:05			X		X				
60	Red	19:40:14		X		X					
61	Red	19:40:14		X		X					
62	Green	20:13:21	X							X	
63	Green	20:13:23	X							X	
64	Green	20:45:36	X							X	
65	Green	21:13:33			X					X	