

**MILTON AVENUE BIKE BOX**  
**FHWA EXPERIMENTATION STUDY**

**Initial Evaluation**  
**September 1, 2010**  
**City of Columbus, Ohio**



Mayor Michael B. Coleman



A legacy of **experience**. A reputation for **excellence**.



A legacy of **experience**. A reputation for **excellence**.

## TABLE OF CONTENTS

<b>1.0 INTRODUCTION .....</b>	<b>1</b>
<b>2.0 DATA COLLECTION .....</b>	<b>4</b>
<b>3.0 ANALYSES .....</b>	<b>7</b>
<b>3.1 Phase 1 – No Bike Box .....</b>	<b>7</b>
<b>3.2 Phase 2 – Bike Box (Without Green Paint) .....</b>	<b>8</b>
<b>3.3 Phase 3 – Bike Box (With Green Paint) .....</b>	<b>9</b>
<b>4.0 CONCLUSION.....</b>	<b>10</b>

## TABLES

<b>TABLE 1: Volume and Speed Data Summary.....</b>	<b>10</b>
<b>TABLE 2: Cyclist Position Summary .....</b>	<b>10</b>
<b>TABLE 3: Vehicle Position Summary.....</b>	<b>11</b>

## FIGURES

<b>FIGURE 1: Site Location Map .....</b>	<b>2</b>
<b>FIGURE 2: Milton Avenue Bike Box .....</b>	<b>3</b>
<b>FIGURE 3: Cyclist Positioning .....</b>	<b>5</b>
<b>FIGURE 4: Vehicle Positioning .....</b>	<b>6</b>

## APPENDICES

APPENDIX A:	Phase 1 – No Bike Box Data Collected
APPENDIX B:	Phase 2 – Bike Box (Without Green Paint) Data Collected
APPENDIX C:	Phase 3 – Bike Box (With Green Paint) Data Collected
APPENDIX D:	Detailed Comparison Tables



A legacy of **experience**. A reputation for **excellence**.

## 1.0 INTRODUCTION

This study has been prepared in association with design improvements for the Milton Avenue/West North Broadway intersection located in the City of Columbus, Ohio, as shown on **Figure 1**. The Olentangy Trail is a very popular 14-mile multi-use trail that generally runs off-road, except for a 1-mile stretch where the designated route consists of neighborhood streets, including Milton Avenue. As a result, Milton Avenue was recently converted to a “bike boulevard” in which priority is given to bicyclists over motorists. Subsequently, a “bike box” is desired on Milton Avenue on the northbound and southbound approaches to the West North Broadway signalized intersection to further signify priority to cyclists.

A “bike box” is an intersection design treatment intended to provide vehicles with greater visibility and awareness of bicycles, particularly between drivers turning right and bicyclists going straight. It is a box between the stop bar and crosswalk with a short bike lane leading to the box on the right and at a red light, bicyclists pull in front of vehicles stopped behind the bike box. Right turns on red are prohibited and separate signal detection is provided for bicyclists, indicated by pavement markings and signage. A schematic illustration of the “bike box” is provided on **Figure 2**.

The “bike box” is currently not an approved device according to the Manual of Uniform Traffic Devices for Streets and Highways (MUTCD), (U.S. Department of Transportation Federal Highway Administration (FHWA), 2009 Edition). Therefore, a request for permission to experiment was submitted by the City of Columbus, Ohio to FHWA on June 26, 2009. Approval was obtained and experimentation requirements were issued including staged evaluation of the bike box, as follows:

### Phase 1 – No Bike Box

Preliminary data of existing conditions is collected to establish “before” conditions.

### Phase 2 – Bike Box (Without Green Paint)

Bike box is installed without solid green pavement marking in the box and lead-in lane and data is collected to establish the first stage of “after” conditions.

### Phase 3 – Bike Box (With Green Paint)

Bike box and lead-in lane are colored with green pavement marking and data is collected to establish the second stage of “after” conditions.

### Phase 4 – Proposed Conditions (With Green Paint) Six-Month Evaluation

6-months subsequent to Phase 3 installation, data is collected to establish the third stage of “after” conditions.

The purpose of this report is to document experimental procedures and results for Phase 1 through Phase 3.







A legacy of **experience**. A reputation for **excellence**.

## 2.0 DATA COLLECTION

Experimentation requirements indicate various evaluation criteria to be collected for each phase of the process, and the following data was collected:

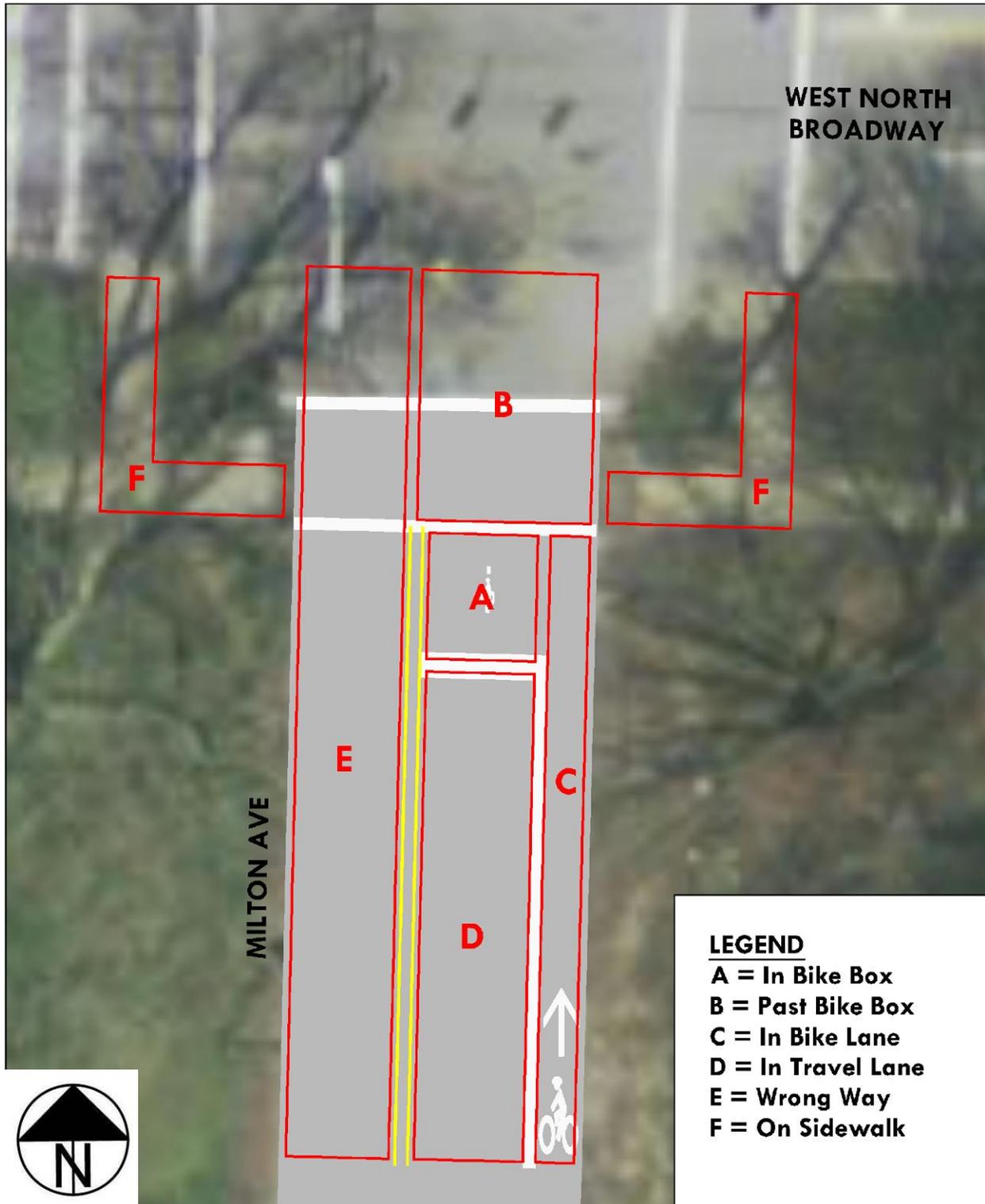
- Speed data on Milton Avenue
- Bicycle crash data at the Milton Avenue/West North Broadway intersection
- 48-hour video of the Milton Avenue/West North Broadway intersection, used to document:
  - Average daily traffic volumes (ADT) on Milton Avenue
  - Northbound/Southbound approach vehicular turning movements on Milton Avenue
  - Pedestrian movements, by crosswalk
  - Northbound/Southbound approach bicycle turning movements on Milton Avenue
  - Position of all stopped cyclists (See **Figure 3**)
  - Position of stopped vehicles (lead vehicle only) See **Figure 4**
  - Bicyclists riding the wrong way
  - “No Turn on Red” motorist compliance
  - Cyclist reaction to clearance interval
  - Conflicts and near-conflicts between bicyclists and motorists

The video data provided detailed insight into the operations of the bike box over the various phases. The camera was pointed north and positioned to view the start of the lead-in lane, as well as the traffic signal heads on the south leg of the intersection. While viewing video data, each element described above was recorded for each signal cycle. Cyclist and vehicle positioning was tabulated for the northbound approach to the intersection only. Details of data collected are further examined in **Section 3.0**.

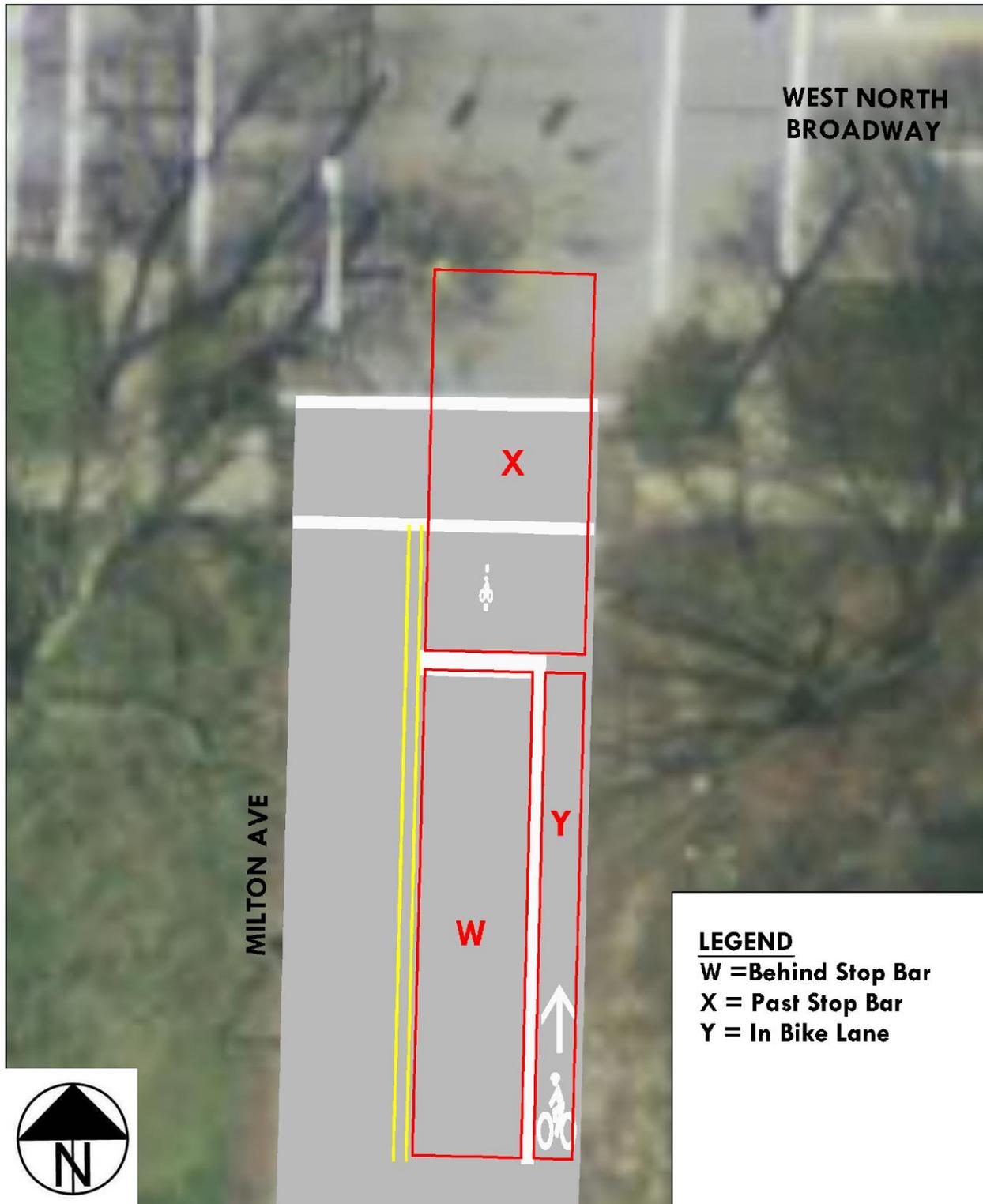
Crash history for the Milton Avenue/North Broadway intersection was examined to determine if any bicycle related crashes occurred before or after the implementation of the bike box. Crash data was reviewed for the period beginning September 27, 2008 through March 1, 2010. Video data and speed data was collected on the following dates:

- Phase 1 – No Bike Box
  - Video data – Friday, September 11, 2009 to Sunday, September 13, 2009
  - Speed data – Tuesday, September 29 to Wednesday, September 30, 2009 (Data received for southbound traffic was erroneous, so speed data previously obtained on August 18, 2008, was used in lieu of year 2009 data.)
- Phase 2 – Bike Box (Without Green Paint)
  - Video data – Saturday, October 10, 2009 to Tuesday, October 13, 2009
- Phase 3 – Bike Box (With Green Paint)
  - Video data – Friday, November 6, 2009 to Sunday, November 8, 2009
  - Speed data – Wednesday, November 11 to Thursday, November 12, 2009

**FIGURE 3**  
**Cyclist Positioning**



**FIGURE 4**  
**Vehicle Positioning**





A legacy of **experience**. A reputation for **excellence**.

### 3.0 ANALYSES

#### 3.1 Phase 1 – No Bike Box

The conditions prior to the installation of the bike box were similar to the layout illustrated on **Figure 2**, except there were no bike lane/bike detector symbols, green bike lane/bike box paint, or signage relating to bicycle positioning. Bicycle loop detectors were not yet installed, so existing push buttons just off the edge of the roadway near the crosswalks were available for bicyclists to change signal indications. “No Right Turn on Red” signage was posted and pedestrian countdown timers were already installed. The traffic signal operates with 2 phases and has a cycle length of approximately 80 seconds.

Results of the data collection procedures indicate an ADT of approximately 2,500 vehicles per day on Milton Avenue. The majority of vehicles made southbound right turn and northbound left turn movements, indicative of freeway access to the west on North Broadway. The 85<sup>th</sup> percentile vehicular speed on Milton Avenue was observed to be approximately 25 mph which corresponds with the posted speed limit.

Daily bicycle volumes on Milton Avenue were observed to be about 1,500 bicycles per day and daily pedestrian volumes at the intersection were observed to be over 700 pedestrians per day. Nearly all of the cyclists and pedestrians proceeded through the intersection in a north/south direction on Milton Avenue. This data exemplifies the multi-modal nature of the Milton Avenue corridor, resulting from its use as a leisure trail connection.

Qualitative analysis of the video data showed the majority (70-percent) of bicyclists stopped in front of the crosswalk (position B), generally to utilize the push button on the right side of the roadway. About 7-percent of the bicyclists positioned themselves in the area that would become the bike box in the future (Position A). Approximately 15-percent were located in Position C, which would become the lead-in bike lane in the next phase. Only 3-percent utilized sidewalk locations, identified as Position F.

Further analyses indicated nearly 90 bicyclists (3%) ran the north/south red light and over 170 vehicles turned right on red (3% of right turns), which is prohibited by signage on the span wire. A very small percentage (<1%) of vehicles encroached upon what is to become the lead-in bike lane (Position Y). 54-percent of stopped vehicles did so behind the painted stop bar (Position W), while 45-percent stopped beyond the stop bar (Position X).

During the viewing of the video data, there were no bicycle/vehicle conflicts or near conflicts observed. A near conflict was considered as a situation where a cyclist or motorist was required to alter its current course of motion in direct response to an unexpected action performed by the other user. Crash data collected for the entire year prior to implementation of phase two indicated there were no reported collisions between cyclists and motorists at the Milton Avenue/North Broadway intersection.

Detailed data collected for Phase 1 is provided in **Appendix A** and detailed calculation tables are presented in **Appendix D**.

### 3.2 Phase 2 – Bike Box (Without Green Paint)

The intersection configuration for the second phase of evaluation is illustrated in **Figure 2**, with the exception of the green paint which was added later for phase 3 evaluation. Bicycle loop detectors were installed in the center of the bike box, as well as on the right side of the bike box to ensure cyclists who stayed in the lead-in bike lane could trigger the signal. The push buttons on the right side of the roadway previously used by cyclists to change signal indication were removed. Signage was added indicating where cyclists must position themselves in order to receive the green indication and signage was also added requesting vehicles to stop behind the stop bar during a red light.

Results of the data collection procedures indicate an ADT of approximately 2,700 vehicles per day on Milton Avenue, which is similar to the ADT documented in Phase 1. Bicycle and pedestrian traffic declined during the second phase of evaluation, compared to the first phase, likely due to changes in temperature. While the weather was favorable, the average temperature during the second phase of video data collection was approximately 10 degrees cooler than the first phase. Daily bicycle volumes on Milton Avenue were observed to be approximately 600 bicycles per day and pedestrian volumes at the intersection were observed to be about 300 pedestrians per day.

Qualitative analysis indicated increased utilization of the bike box area. Over 16-percent of cyclists used the bike box as intended by stopping in Position A. An additional 28-percent were positioned on the right side of the bike box, as indicated by Position C. Therefore, approximately 45-percent of the cyclists were located in the bike box area. However, a large number (43-percent) of cyclists were still observed to be positioned in the crosswalk and beyond, as indicated by Position B.

One drawback to the implementation of the bike box is the number of cyclists utilizing the sidewalk increased. This number increased from 3% before the bike box to 11% after the installation of the bike box. This may have been the result of unfamiliarity with the situation and an assumption that it was necessary to utilize the pedestrian push button in order to receive the green indication to cross North Broadway.

Vehicle positioning and “right turn on red” habits did not change, as indicated by the fact that percentages were very similar to that observed in Phase 1. There were no reported accidents between cyclists and motorists within Phase 2 and Phase 3 implementation, but there was one situation observed during the video data analysis in which a cyclist ran into the rear bumper of a car stopped at a red light. This was a very minor incident as the driver was not even aware of the situation and there was no property damage or injuries. It can be stated with relative certainty that this situation was not a result of the bike box configuration.

Detailed data collected for Phase 2 is provided in **Appendix B** and detailed calculation tables are presented in **Appendix D**.



A legacy of **experience**. A reputation for **excellence**.

### **3.3 Phase 3 – Bike Box (With Green Paint)**

The intersection configuration for the third phase of evaluation is illustrated in **Figure 2**. The only difference between Phase 2 and Phase 3 conditions is the addition of green pavement marking in the bike box and bike lead-in lane.

Vehicular volumes on Milton Avenue declined in Phase 3 with approximately 1,900 vehicles per day. The 85<sup>th</sup> percentile speed on Milton Avenue was documented to be about 27 mph. Bicycle and pedestrian traffic remained relatively consistent between Phase 2 and Phase 3. Daily bicycle volumes on Milton Avenue were observed to be approximately 700 bicycles per day and pedestrian volumes at the intersection were observed to be about 270 pedestrians per day.

Qualitative analysis indicated increased utilization of the bike box area in Phase 3, relative to Phase 2. Nearly 19-percent used the bike box as intended by stopping in Position A. An additional 46-percent were positioned on the right side of the bike box, as indicated by Position C. Therefore, approximately 65-percent of the cyclists were located in the bike box area, as opposed to 45-percent in Phase 2. Also, a much smaller number (24-percent) of cyclists were observed to be positioned in the crosswalk and beyond, as indicated by Position B.

The number of cyclists utilizing the sidewalk remained higher than without the bike box in Phase 1, but slightly lower than Phase 2. This number increased from 3% before the bike box to 9% after the installation of the bike box. This may have been the result of unfamiliarity with the situation and an assumption that it was necessary to utilize the pedestrian push button in order to receive the green indication to cross North Broadway.

Vehicle positioning and “right turn on red” habits did not change, as indicated by the fact that percentages were very similar to that observed in Phase 1 and Phase 2. Analysis of video data further revealed no conflicts or near conflicts between cyclists and motorists during the 48 hours analyzed. In addition, there were no accidents reported between cyclists and motorists after Phase 3 implementation and prior to the compilation of this report.

Detailed data collected for Phase 3 is provided in **Appendix C** and detailed calculation tables are presented in **Appendix D**.



A legacy of **experience**. A reputation for **excellence**.

#### 4.0 CONCLUSION

**Table 1** provides a summary of volume and speed data collected for each phase while **Table 2** and **Table 3** provide a summary of cyclist positioning and vehicle positioning, respectively.

**TABLE 1**  
**Volume and Speed Data Summary**

	<b>Phase 1 No Bike Box</b>	<b>Phase 2 Bike Box (Without Green Paint)</b>	<b>Phase 3 Bike Box (With Green Paint)</b>
Vehicular Volume (Average/Day)	2,500	2,700	1,900
Bicycle Volume (Average/Day)	1,500	600	700
Pedestrian Volume (Average/Day)	700	300	270
Vehicular Speed (85 <sup>th</sup> Percentile)	25 mph	---	27 mph

**TABLE 2**  
**Cyclist Positioning Summary**

	<b>Phase 1 No Bike Box</b>	<b>Phase 2 Bike Box (Without Green Paint)</b>	<b>Phase 3 Bike Box (With Green Paint)</b>
In Bike Box (Position A)	6.9%	16.1%	18.8%
Past Bike Box (Position B)	70.1%	43.2%	24.2%
In Bike Lane (Position C)	15.5%	28.6%	46.2%
In Bike Box Area (Position A + C)	22.4%	44.7%	65.0%
In Travel Lane (Position D)	4.3%	1.3%	1.7%
Wrong Way (Position E)	0.1%	0.0%	0.0%
On Sidewalk (Position F)	3.1%	10.7%	9.1%



**TABLE 3**  
**Vehicle Positioning Summary**

	<b>Phase 1 No Bike Box</b>	<b>Phase 2 Bike Box (Without Green Paint)</b>	<b>Phase 3 Bike Box (With Green Paint)</b>
Behind Stop Bar (Position W)	53.8%	53.8%	53.9%
Past Stop Bar (Position X)	45.3%	45.9%	45.6%
In Bike Lane (Position Y)	0.9%	0.3%	0.5%

Results of the initial evaluation of the Milton Avenue bike box indicate progressively greater usage of the device throughout the process. Approximately 65-percent of the cyclists were located in the bike box area (positions A and C) in Phase 3 as opposed to 45-percent in Phase 2. However, the majority of these cyclists remained in the bike box lead-in lane (Position C) and did not maneuver into the center of the bike box (Position A).

Vehicle behavior remained unchanged throughout the process. In all three phases, 54-percent of the lead approach vehicles stopped behind the stop bar while 45-percent stopped beyond the stop bar. The remaining 1-percent encroached upon the bike box lead-in lane on the right. Adherence to the “right turn on red” signage also remained unchanged throughout the process.

Since there were no bicycle/vehicle conflicts or near conflicts related to the installation of the bike box and proper usage of the bike box by cyclists has increased with each phase, it is recommended the evaluation procedure move forward as planned.