Research, Development & Technology Transfer Program

Evaluation of Different Curb Extension Treatments for Pedestrian Comfort and Safety at Intersections

Research Report

University of North Carolina (UNC), Highway Safety Research Center (HSRC)

Wesley Kumfer, Ph.D.

Sarah Worth O'Brien

Mike Vann

Portland State University (PSU), Transportation Research and Education Center (TREC)

Nathan McNeil

Sirisha Kothuri, Ph.D.

Minju Kim Song, Ph.D.

January 2026

Research Project
Final Report
2026-02

Technical Report Documentation Page

1. Report No. DDOT-RDT-26-02	2.	3. Recipient's Catalog No.	
4. Title and Subtitle Evaluation of Different Curb Extension Treatments for Pedestrian Comfort and Safety at Intersections		5. Report Date January 2026 6. Performing Organization Code	
7. Author(s) Wesley Kumfer, Sarah Worth O'Brien, Mike Vann, Nathan McNeil, Sirisha Kothuri, Minju Kim Song		8. Performing Organization Report No.	
9. Performing Organization Name and Address Highway Safety Research Center, University of North Carolina, Campus Box 3430, Chapel Hill, NC 27599-3430 Transportation Research and Education Center, Portland State University, PO Box 751, Portland, OR 97201		10. 11. Contract or Grant No. Contract and Task Order #	
12. Sponsoring Organization Name and Address District of Columbia Department of Transportation (SPR) 250 M Street, SE, Washington, DC 20003		13. Type of Report and Period Covered Final Report 2/1/2024-1/31/26 14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract The purpose of this study was to examine the effect of different kinds of curb extensions in Washington, D.C. on both driver yielding behavior and on pedestrian crossing satisfaction. To explore these questions, we used a mixed methods approach of surveying pedestrians crossing the roads from 47 curb extensions and video data recording of driver yielding behavior at 15 study intersections and 10 control intersections. Both sets of data were analyzed by examining descriptive statistics and logistic regression of pedestrian crossing satisfaction (for the survey data) and driver failure to yield (for the video data). We examined 180 survey responses and found that while pedestrians were more likely to wait in permanent curb extensions than in tactical curb extensions or tactical curb extensions with mural art, pedestrians crossing from tactical curb extensions with mural art reported the greatest crossing satisfaction. After analyzing 223 hours of video data and coding 1,396 events where drivers should have yielded to pedestrians, we found that tactical curb extensions with mural had a statistically significant effect on decreasing the log odds of a driver's failure to yield. The combined results indicate that tactical curb extensions, including those with mural art, likely meet the needs of pedestrians crossing the roadway compared to permanent or normal crossing locations.			
17. Key Words Curb extension, survey, pedestrian		18. Distribution Statement No restrictions. This document is available from the Research Program upon request.	
19. Security Classification (of this report) Unclassified.	20. Security Classification (of this page) Unclassified.	21. No. of Pages 121	22. Price N/A

Disclaimer

This research was performed in cooperation with the District Department of Transportation (DDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or DDOT. This report does not constitute a standard, specification, or regulation.

Acknowledgements

Author Acknowledgements

Thanks to Sarah Bayldon (UNC HSRC) and Jad Salloum (DDOT) for assistance with intercept survey data collection. Thanks to Joe Kortenhoff, James Shelstad and Aidan McClinton (PSU) for their help with reviewing and coding video data. We would also like to thank all the agencies who responded to our agency scan.

Contents

Figures

Tables

1 Executive Summary

Curb extensions, also referred to as bulb outs or sidewalk extensions, are geometric safety treatments that seek to improve pedestrian safety, by extending the sidewalk out at corners, thus increasing the visibility of pedestrians and motorists to one another and shortening crossing distance and time for pedestrians. Due to high cost and limited resources, agencies are increasingly using tactical curb extensions with flexible posts and paint. The addition of mural art as an aesthetic treatment within tactical curb extensions is an emerging trend that provides color and art into the streetscape. The DC Department of Transportation (DDOT) has deployed tactical curb extensions at a number of locations in Washington, D.C., including locations with mural art.

This study sought to assess pedestrian user safety and comfort at intersections in Washington, D.C., at permanent versus tactical (both with and without mural art) curb extensions, as well as at a set of control locations with no curb extensions. The project team used a mixed methods approach to understand pedestrian safety and comfort at intersections with different types of curb extensions. An intercept survey of pedestrians focused on perceptions of safety and comfort. Video observation was conducted to document pedestrian use of the curb extension space, including factors that could influence crossing distance and visibility, along with motorist yielding behavior.

The intercept survey was conducted at 10 intersections, including three with permanent curb extensions, three with tactical curb extensions, and four with tactical curb extensions with mural art. One hundred and eighty pedestrians who had just completed a crossing completed the intercept surveys. The video observation was based on data from 25 intersections in Washington, D.C., including five with permanent curb extensions, five with tactical curb extensions, five with tactical curb extensions with mural art, and ten control locations. A total of 223 hours of video were reviewed, from which 10,573 pedestrians were coded for crossing behavior, and a total of 45,668 motorists were counted from which 1,396 yielding event opportunities were coded.

Each of the curb extension types succeeded in placing pedestrians closer to the street, and into a place of higher mutual visibility for pedestrians and motorists, than they would have been if no curb extension were present. Permanent curb extensions clearly resulted in pedestrians being more likely to wait further out, with 84% waiting in the curb extension area and 43% waiting at the edge of the curb extension. Tactical curb extensions and tactical curb extensions with mural art performed similarly, with 42% and 45%, respectively, waiting in the curb extension area. However, pedestrians were less likely to report feeling safe when waiting in tactical curb extensions than in permanent curb extensions.

Each of the curb extension types were associated with higher yielding rates than control locations. We observed some variance in the type of yielding, with mural art locations having the highest yielding for

near side through and turning vehicles, and permanent curb extensions having the highest yielding rate for far side lane through vehicle yielding.

While each of the curb extension types were associated with relatively high pedestrian self-reported crossing satisfaction, those crossing at locations with mural art reported the highest satisfaction (93%) compared to 84% at other tactical curb extension locations and 71% at permanent curb extension locations.

These findings suggest that tactical curb extensions with or without mural art offer a feasible alternative to improve pedestrian satisfaction and safety compared to control locations.

2 Introduction

Curb extensions, also referred to as bulb outs or sidewalk extensions, are geometric safety treatments that offer the promise of improving pedestrian safety and comfort through increasing visibility, decreasing crossing distances, and calming traffic by reducing the turning speed of vehicles. Curb extensions are a prevalent safety treatment used by transportation agencies. Due to their high cost and limited resources, agencies are increasingly using tactical curb extensions, including those with mural art. Tactical curb extensions are created with pavement markings such as lines and paint and often paired with flexible plastic posts or other vertical barriers, such as planters. They are often considered temporary, trial, or pilot projects. Some tactical curb extensions are painted with an aesthetic treatment, which can help them stand out from the unpainted roadway surface. Some agencies are coloring the curb extension areas with single colors, but the addition of mural art is an increasing trend which provides an opportunity to provide color and art into the streetscape.

The objective of this study is to identify and document factors associated with road user safety and comfort at intersections with permanent versus tactical (both with and without mural art) curb extensions, as well as a set of control locations with no curb extensions. The project team used a mixed methods approach to understand pedestrian safety and comfort at intersections with different types of curb extensions. An intercept survey of pedestrians focused on perceptions of safety and comfort. Video observation was conducted to document pedestrian use of the curb extension space, including factors that could influence crossing distance and visibility, along with motorist yielding behavior.

The remainder of the report is laid out as follows. Chapter 3 describes the findings from a state of practice review, Chapter 4 outlines the methodology used in this research, Chapter 5 presents the findings, and Chapter 6 wraps up with conclusions and ideas for future research.

3 State of Practice Summary

A scan of agencies in the United States (U.S.) and a literature review were conducted to understand the reasons behind installing the various types of curb extensions, typical locations for installation, and the resulting impacts. A summary of the findings from the agency scan and literature review are presented below. See Appendix A for the full state of practice review, including more details on the review methodology and findings.

3.1 State of Practice Overview

Of the 35 U.S. agencies who responded to the agency scan, 89% of them reported having permanent curb extensions, 83% reported the presence of tactical curb extensions (with flex posts and paint) and 54% reported having tactical curb extensions with mural art in their jurisdictions. Consistently, the reasons stated for installing curb extensions (generally) were to reduce motorist speeds, improve safety, reduce pedestrian crossing lengths, and increase visibility. For tactical curb extensions, specifically, low costs and the ability to quick-build and test installations were commonly cited. For tactical curb extensions with mural art, improving aesthetics and community livability through the addition of art were frequently mentioned as reasons to install them.

A literature review was conducted to assess the current state of knowledge around curb extensions, including permanent, tactical and tactical with mural art. For tactical curb extensions (including those with mural art), existing research is quite limited and often derives from agency reports and similar non-peer-reviewed sources. While the existing agency reports generally find positive results, for example increased vehicle yielding, reduced speeds, and reductions in pedestrian crossing distance and time, there are still very few rigorous studies of safety and curb extensions, particularly across multiple contexts or jurisdictions. Even for the permanent curb extension application, few studies were found.

There is a need for more rigorous evaluations to better understand the safety implications of these installations. Very few tactical curb extension studies (with or without mural art) isolated the impact of the tactical curb extensions from broader corridor changes, or the impact of mural art from the tactical curb extension generally, and many studies were based on very limited samples, or lacked methodological information.

3.2 Permanent Curb Extensions

Figure 3-1 A Permanent Curb Extension at 12 St NE and Quincy St NE

Among the stated reasons from the agency scan for installing permanent curb extensions, 68% of respondents indicated installing curb extensions to reduce speeds, 65% for reducing crossing length, 39% installed them to improve safety, 32% for improved visibility, 13% for reduction in curb radii, and 10% for improving pedestrian comfort.

Studies looking at the efficacy of curb extensions have primarily focused on crashes, driver yielding, and pedestrian delay. A recent broad safety evaluation from New York City Department of Transportation (NYC DOT) found a reduction of 16.5% in average annual pedestrian injuries for sites with curb extensions, along with a 44.7% reduction in fatalities and severe pedestrian injuries (NYC DOT, 2022). Other studies looking at more detailed evaluations of specific sites or sets of sites were more limited, and at least ten years old. In general, studies have reported positive findings from curb extensions, ranging from reductions in the number of pedestrian crashes (Thompson and Heydon, 1991; King, 1999) and severity of pedestrian crashes (King, 1999). Two of three studies looking at yielding found improved driver yielding (Johnson, 2005; van Hengel, 2013), while one reported mixed results, with some sites showing decreased driver yielding possibly due to fluctuations in traffic conditions (Huang and Cynecki, 2000).

3.3 Tactical Curb Extensions

Figure 3-2 A Tactical Curb Extension at 44th St NW and Ellicott St NW

A majority of the agency scan respondents indicated that tactical curb extensions were installed to reduce speed (48%), improve safety (45%), decrease pedestrian crossing length (38%), increase visibility (21%), and reduce curb radii (7%). A large proportion of respondents (72%) stated other reasons for installing tactical curb extensions, including low cost and the ability to test solutions before installing more permanent installations. Respondents also stated that these quick-build and temporary installations allowed them to engage the community to determine their response to curb extensions. Other reasons for installation include reduced crowding by providing more storage or waiting space for pedestrians.

The bulk of the research found that relates to tactical curb extensions is derived from agency or agency-affiliated evaluations and reports. Two studies found changes in the number of reported crashes, with one finding crashes reduced along a corridor by 67% and injury crashes declined by 83% (City of Columbus, 2022), and another finding a 16% reduction on all crashes (pedestrians are not reported

separately in the report) (FHWA, 2020). Five studies reported on motorists yielding to pedestrians. All four agency studies reported positive yielding results, with three of them reporting 25% to 42% increases in motorist yielding (FHWA, 2020; SMFTA, 2021; SFMTA, 2022), and one reporting a 100% yielding rate to pedestrians (SFMTA, 2018). Four studies reported on vehicle speeds. Two studies looked at speeds along a corridor, with one finding that vehicles traveling above 30 mph decreased by 43% (FHWA, 2020), while another reported mixed speed results (Green et al., 2019). Two studies explored vehicle turning speeds, with one finding a 55% decrease in vehicle turning speeds at locations with tactical curb extensions (SFMTA, 2021); and another reported 98% of turning vehicles traveling at or below the speed limit on approach to the intersection (SFMTA, 2018).

3.4 Tactical Curb Extensions with Mural Art

Figure 3-3 A Tactical Curb Extension with Mural Art at 56th St NE and Eads St NE

Respondents indicated that tactical curb extensions with roadway mural art were installed to reduce speed (37%), improve safety (37%), decrease pedestrian crossing length (26%), increase visibility (26%), and reduce curb radii (5%). A large proportion of respondents (74%) stated other reasons for installing tactical curb extensions with mural art, including improving aesthetics, improving walkability, ability to

fill blank pavement space with paint, comparing how well they work with respect to permanent curb extensions, supporting local restaurants and dining, based on community requests, improving walking access and community cohesion, to designate a pedestrian priority area, to aid community building, adding public art, improving safety at school zones, improving neighborhood compatibility and quality of life. Respondents also stated that these are low cost, quick-build installations and as such are conducive for quick removal if the agency does not see immediate benefits.

The available research pertaining to tactical curb extensions with mural art is quite limited. No peer-reviewed academic studies were found, and there are fewer agency-produced evaluations than for tactical curb extensions. Much of the available information comes from one or two-page summary briefs produced by community, education or advocacy type organizations based on pilot installations, along with a few similar brief overviews produced by transportation agencies. Almost none of the evaluations that were found isolated the addition of mural art. The identified studies are shown in Table 3-1.

Nine of the eleven identified studies had some assessment of safety or behavioral findings based on observation. Safety and behavioral findings from the various site evaluations cover a variety of topics, from pedestrian-motor vehicle conflicts, vehicle yielding and speeds, pedestrian crossing distances, and pedestrian compliance with crossing in marked zones. Four of the eleven studies collected some type of survey data, although sample sizes were generally quite limited. One study sought to assess conflicts between pedestrians and turning motor vehicles, and found that, of the three mural art curb extension sites, two experienced significant drops in conflicts, while one experienced a slight increase (Bloomberg and Sam Schwartz, 2022). It should be noted that the before conditions did not include any curb extension, so it is unclear if these results are related to the mural art. Two of the Bloomberg sites were unsignalized (locations in Pittsburgh, PA and Lancaster, PA), and yielding rates were mostly unchanged from prior to the addition of the curb extensions (Bloomberg and Sam Schwartz, 2022). At three sites in Baltimore, rates of vehicles yielding to pedestrians increased significantly, going from 29% to 74% at one site (MICA et al., 2021), and increasing from 40% to 68% and 35% to 85% at two locations on Valley Street (MICA et al., 2022). Three of the studies provided data on changes in vehicle speed, although none specifically looked at turning vehicle speeds, with all three finding reductions in speeds (Barker-Winkworth, 2023; Ulupono Initiative, 2021a; City of Fort Lauderdale, 2022).

Table 3-1 Studies of curb extensions with mural art

Study	Site information	Key findings
Bloomberg Philanthropies & Sam Schwartz (2022)	3 locations: Richmond, VA: W. Marshal St. & Brook Rd. - signalized; Pittsburgh, PA; Roup Ave., S. Fairmont St. & Harriet St. - unsignalized; Lancaster, PA: Strawberry & Vine St. - unsignalized	**Behavioral / safety findings:** **Richmond VA site**: Conflicts dropped from 14 to 6 (56%), including 5 to 1 deemed "high crash potential" and 9 to 5 deemed "low crash potential"; Decrease in peds crossing outside crosswalks (21% to 11%). Decrease in crossing against the signal (from 1.5% to 0.3%) **Pittsburgh, PA site**: Conflicts dropped from 12 to 6 (all "low crash potential"); Roughly similar driver yielding (92-93%) before and after; Decrease in peds crossing outside crosswalks (10% to 6%) **Lancaster, PA site**: Conflicts increased from 4 to 6 (all "low crash potential"); Slight increase in driver yielding, from 69% before to 76% after. Increase in peds crossing outside crosswalks (17% to 21%)
Barker-Winkworth (2023)	1 location in Tucson, AZ: South 6th Ave. Approach to intersection included a painted (art) median and midblock crossing.	**Survey findings:** Intercept survey (n=32 before and n=50 after): Percentage reporting feeling safe decreased after installation. Frequent users were more likely to notice drivers speeding and find it difficult to cross the street (both before and after) **Behavioral / safety findings:** 85th percentile speed dropped from 27 to 22 mph, and 6 mph drop in average speed (midblock)
MICA Center (2022)	3 locations in Baltimore, MD: E. Chase St. & Wilcox St.; E. Chase St. & Valley St.; E. Biddle St. & Valley St..	**Survey findings:** Informal interviews with community members found an increased stated sense of safety (n of 5-6 per location). **Behavioral / safety findings:** Crossing distance reduced from 40-44 ft to 20-22 ft. **E. Chase at Valley**: Decrease in peds crossing outside crosswalks (35% to 10%); Increase in driver yielding (40% to 68%) **E. Biddle at Valley:** Decrease in peds crossing outside crosswalks (28% to 17%); Increase in driver yielding (35% to 85%)
MICA Center (2021) Graham Projects (2022)	1 location in Baltimore, MD: Whitelock St. & Brookfield Ave. Also includes crosswalk with mural art.	**Behavioral / safety findings:** Decrease in peds crossing outside crosswalks (63% to 25%); Increase in driver yielding (29% to 74%)
MICA Center (2020)	1 location in Baltimore, MD: Greenmount Ave. & Oliver St.	**Survey findings:** Community survey sent via email, newsletters, and Nextdoor. (n=30) 93% said cars drive slower. 85% said they now feel safer as pedestrians and cyclists.
City of Honolulu (n.d.)	1 location in Honolulu, HI: King St. & Haka St.	**Behavioral / safety findings:** Reported 15-40% decrease in crossing distance and 15-20% reduction in crossing time after installation

Study	Site information	Key findings
Ulupono Initiative (2023)	1 location in Honolulu, HI: Prospect St. & Prospect Pl.	**Behavioral / safety findings:** Crossing distance dropped by 20-40% depending on crossing direction. Exposed cross time decreased 55%.
Ulupono Initiative (2021a)	1 location in Kahului, HI: S. Papa Ave. & Ma'alo St.	**Behavioral / safety findings:** Vehicle speeds decreased by 7% at peak hours after install
Ulupono Initiative (2021b)	1 location in Ewa Beach, HI: Hailipo St. & Papipi Rd.	**Behavioral / safety findings:** Crossing distance dropped by 60-66%.; Crossing time decreased by 47-60%.
Mobility Beverly Hills (2021)	1 location in Beverly Hills, CA: Camden Dr. & Brighton Way. Intersection includes a scramble signal and marked diagonal crosswalks.	**Survey findings:** General survey respondents (n=240) were split on liking the project (54% said it's more pleasant for people of all ages and ability, compared to 37% disagreeing; 51% said the city should spend the money on other services). In a survey of businesses (n=32), 59% of respondents agreed that this type of treatment near their business would make it more appealing for their customers (30% disagreed), while 56% agreed it would create a stronger sense of community (33% disagree) **Behavioral / safety findings:** Percentage of pedestrians using the scramble increased from 71% to 80%.
City of Fort Lauderdale (2022)	NE 15th Ave. at NE 11th St., Fort Lauderdale. Location with tactical mural buffer (bike lane) and median island which provides some elements of tactical curb extension	**Behavioral / safety findings:** 85th percentile speeds dropped ~10% to 15% (from 40 mph to 35 mph for NB vehicles and from 34 mph to 31 mph for SB vehicles). Average speed dropped from 27 to 22 mph (NB) and 21 to 19 mph (SB).

4 Methodology

The project team used a mixed methods approach to understand pedestrian safety and comfort at intersections with different types of curb extensions. An intercept survey of pedestrians focused on perceptions of safety and comfort. Video observation was conducted to document pedestrian use of the curb extension space, including factors that could influence crossing distance and visibility, along with motorist yielding behavior.

4.1 Site Selection

The project team selected both treatment sites and control sites in close coordination with DDOT staff. First, DDOT personnel provided the team with an inventory of treated intersections with at least one type of curb extension. The inventory contained 309 potential intersections with tactical curb

extensions, 31 intersections with tactical curb extensions with painted mural art, and 41 intersections with permanent curb extensions. The team examined each list and eliminated potential sites based on traffic control; signalized intersections and all-way stop-controlled intersections were eliminated because of the inability to properly record yielding behavior at the treated crossings. The team then examined potential sites using Google Street View to determine if the curb extensions were located to allow crossing of an uncontrolled approach. Finally, the team eliminated any sites where there was evidence of a change in treatment type visible in Google Street View.

The team compiled a list of 15 intersections (five per treatment type) where at least one viable crossing from a curb extension was present and submitted this list to DDOT personnel for examination. Several sites were initially rejected because they were actually signalized, the curb extension type had been changed, or the crossings would be on controlled approaches. Across the 15 study intersections, the team identified 11 crosswalks with permanent, 18 tactical, and 18 mural art sites. More detail on these specific crossings, including speed limits, crossing distances, directionality of traffic, and road user volumes can be seen in Table C-1 in Appendix C. The 15 treatment intersections include:

- Permanent curb extensions
    - 12th St NE & Quincy St NE
    - 18th St NW & Wyoming Ave NW
    - Minnesota Ave NE & Nash St NE
    - 14th St NW & Riggs St NW
    - M St SE & 2nd Pl SE
- Tactical curb extensions
    - Ellicott St NW & 44th St NW
    - 14th St NW & Perry Pl NW
    - 15th St NW & N St NW
    - Minnesota Ave SE & 27th St SE
    - 12th St NE & Shepherd St NE
- Tactical curb extensions with mural art
    - 56th St NE & Eads St NE
    - 53rd St SE & C St SE
    - 57th St NE & Eads St NE
    - Texas Ave SE & B St SE
    - 15th St NW & Church St NW

After selecting the 15 treatment intersections, the team requested an inventory of potential control sites from DDOT personnel. Specifically, sites with uncontrolled crossings, similar speed limits, and similar traffic volumes were requested. The team then selected 10 intersections from this inventory and further examined them to ensure their appropriateness. The 10 intersections, also detailed in Table C-1 in the Appendix C, include:

- 12th Pl NE & Upshur St NE
- Texas Ave SE & Dubois Pl SE
- 45th St NW & Ellicott St NW
- Alabama Ave SE & F St SE
- 13th Ave NW & Corcoran St NW
- 58th St NE & Eads St NE
- K St SE & 3rd Pl SE
- 53rd St SE & Call Pl SE
- 18th St NW & Riggs Pl NW
- 53rd St SE & Drake Pl SE

4.2 Intercept Survey

An intercept survey was deployed at several intersections for which video data were also collected to ask people about their stated comfort crossing at those locations. Sites were selected to include a range of curb extension types. The survey tool was used to understand pedestrian comfort, convenience, and security at the crossing and to understand where people wait to cross the street and why they choose to wait there. Additional information was gathered about the pedestrian's trip purpose, frequency in using the crossing where they were intercepted, and basic demographic information.

4.2.1 Survey Design

The surveys targeted people crossing streets with curb extensions of various types and asked them a few quick questions about their particular trip, their satisfaction with the crossing, and level of agreement with a set of statements designed to elicit their perceived safety and other perceptions of crossing at that location.

Initially, the survey asked respondents "How would you rate your experience crossing the street at this location?" Response options included *very dissatisfied*, *somewhat dissatisfied*, *somewhat satisfied*, and *very satisfied*.

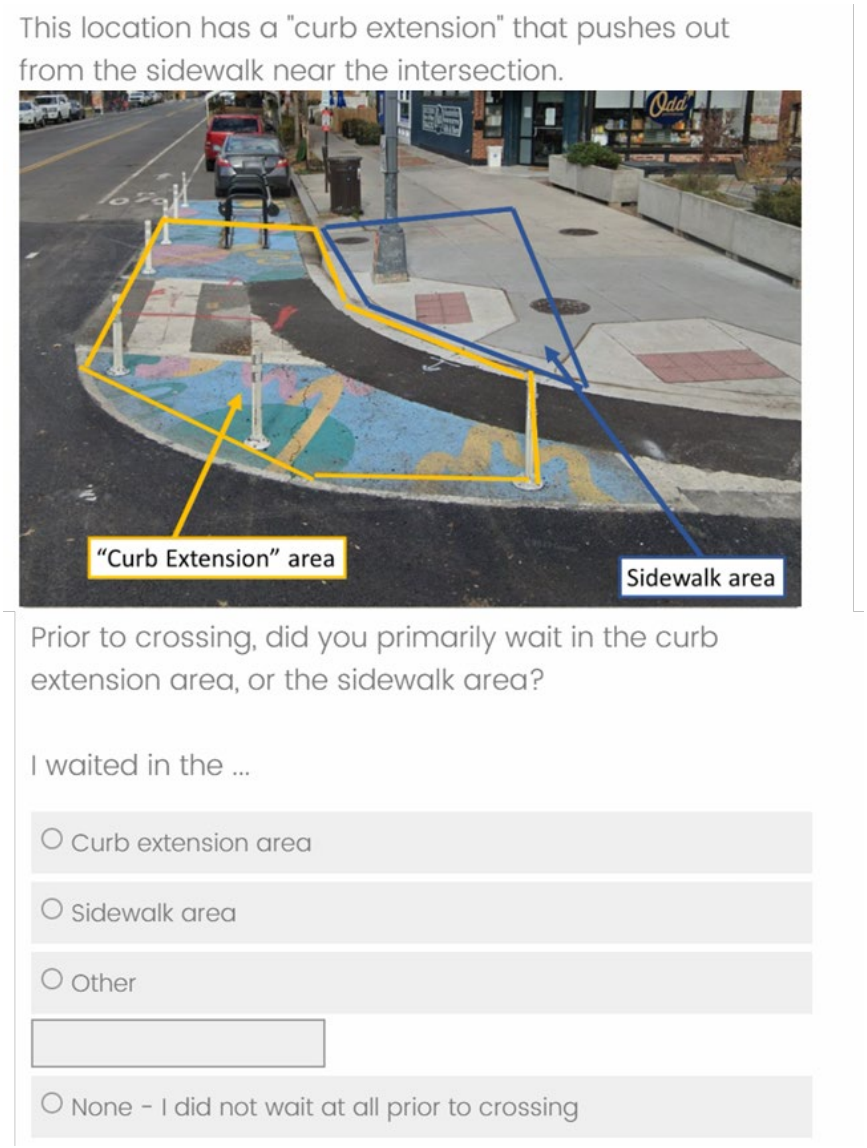
To obtain more nuanced perceptions, respondents were asked to indicate their agreement with a series of statements. The statements each fell into one of five topic areas, including perceptions of safety, driver behavior, crossing time, willingness to deviate from the shortest route, and visual appeal of the intersection. For each topic area, one positive and one negative statement were presented, for a total of 10 statements. The statements were randomly presented, with response options of *strongly disagree*, *somewhat disagree*, *somewhat agree*, and *strongly agree*. The statements are presented in Table 4-1.

Table 4-1 Intercept survey perception statements

Topic area	Statements
Perceived safety	I felt like I might get hit by a car when crossing here I felt safe crossing here
Driver behavior	People drive too fast through this intersection Drivers see and acknowledge me when I need to cross here
Crossing time	I had enough time to cross this street I felt rushed trying to cross this street
Willingness to deviate from shortest route	I went out of my way to cross here Crossing here was the most direct route to get where I was going
Visual appeal	This is a visually appealing intersection to walk through I don't like how this intersection looks

We also asked where in the curb extension area they wait prior to crossing (a graphic was provided showing the "curb extension area", the "sidewalk area", and participants could also choose to enter "other" and provide their own description, or select "none - I did not wait at all prior to crossing", and how safe they feel waiting in the curb extension area (See Figure).

Figure 4-1 Survey screenshot asking about pedestrian waiting position



Other questions included in the survey asked about the purpose of the trip, if respondents were travelling alone or with any other people on their trip, and how often they cross at that particular location where they were intercepted. Several sociodemographic questions were included about race, age, and gender.

Once the survey questions were finalized, they were uploaded to Qualtrics. Members of the research team tested the survey prior to implementation, checking for discrepancies and flow. Based on testing, the questions were further refined and finalized for implementation.

4.2.2 Survey Implementation

Ten locations were identified as intercept intersections to deploy the survey as shown in Table 4-2; however, one site (53rd St. SE and C St. SE.) resulted in no response data due to its low pedestrian volume which consisted of only children crossing to/from the adjacent elementary school and who were ineligible to participate. Two data collectors, one standing on each corner of the specified crossing, targeted pedestrians exiting the crosswalk to recruit them to take the survey. For individuals who were interested, the data collector then proceeded to confirm that the respondent was an adult and consented to participate and then administered the survey. Responses were recorded on tablets preloaded with the Qualtrics survey. The 2-person data collection team conducted intercepts for approximately 2 hours at each site with the goal of collecting at least 20 fully completed responses per intersection. Additional hours were collected at intersections where 20 responses were not obtained within the initial 2-hour window.

The intercept surveys were initially conducted over a period of five days, completing two intersections per day. Data at the morning site were typically collected between 9:00 AM and 11:00 AM while the afternoon site data were collected between 2:00 PM and 4:00 PM. Where schools or other nearby destinations influenced pedestrian travel patterns or volumes at a given site, these data collection times were adjusted accordingly. Between each collection period, the tablets were connected to the Internet to upload the locally stored data from each tablet. Some sites were revisited later in the month to attempt to get up to 20 completions per intersection.

Several survey items were filled out by the survey staff prior to engaging the pedestrian, including the intersection, crosswalk used by the pedestrian, and treatment type (e.g., permanent curb extension, tactical curb extension, or tactical curb extension with mural art). If the pedestrian declined to take the survey, the survey staff marked that individual as “does not agree to take the survey”, which allowed for tracking response rates.

The data collectors intercepted 480 respondents across nine locations. Of these, 293 respondents opted to not take the survey, while 187 respondents participated in the survey yielding a 39% response rate. The 187 responses were examined, and mostly incomplete responses were removed from the dataset. The final data set consisted of 180 responses which were either fully or mostly complete.

Table 4-2 Survey Site Locations

Location	Crosswalk(s)	Survey Date	Number of Completed Surveys		
			Permanent CE	Tactical CE	Tactical CE with Mural Art
18th Street NW & Wyoming Avenue NW	N, S, W	6/2/25 10:40am-12:40 pm; 1:20-2:05 pm	3	16	n/a
14th Street NW & Riggs Street NW	N, E	6/3/25 9-11 am, 12:05-1:05 pm	25	4	n/a
15th Street NW & Church Street NW	N, S, E	6/3/25 3:10-5:10 pm	n/a	n/a	33
44th Street NW & Ellicott Street NW	all	6/2/25 9-9:30 am, 3-4:30 pm	n/a	13	n/a
14th Street NW & Perry Place NW	all	6/4/25 9-11 am	n/a	20	n/a
12th Street NE & Shepherd Street NE	all	6/5/25 9-1140 am	n/a	22	n/a
12th Street NE & Quincy Street NE	N, S	6/5/25 2-440 pm	21	n/a	n/a
Eads Street NE & 56th Street NE	all	6/6/25 8-11 am	n/a	n/a	11
Eads Street NE & 57th Street NE	all	6/6/25 2:08-5 pm	n/a	n/a	12
53 St. SE @ C St SE	all	6/4/25 3-4 pm	n/a	n/a	0
Total			49	75	56

4.2.3 Survey Data Modeling Overview

In addition to the general assessment of the survey results, the research team sought to answer a specific question about the efficacy of curb extensions: Is there a kind of curb extension treatment that increases pedestrian crossing satisfaction compared to other types?

To answer this, the team used a binary variable for crossing satisfaction (1 = very satisfied or somewhat satisfied; 0 = somewhat dissatisfied or very dissatisfied). Given that the dependent variable is binary, logistic regression is appropriate. Using SAS 9.4, the team calculated the log odds of the outcome variable (1 = satisfied) versus the alternative (0 = unsatisfied). The logistic regression equation can be seen below:

$$log\frac{Pr(Y=satisfied)}{Pr(Y=unsatisfied)} = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n$$ Where:

Pr(Y=satisfied) = the probability of a satisfactory crossing
Pr(Y=unsatisfied) = the probability of an unsatisfactory crossing
β_0 = the intercept of the model
β_n = the coefficient of variable n
x_n = The value of variable n

Logistic regression results can be interpreted considering the sign of the coefficient (β_n). A positive sign indicates that the variable increases the log odds of a satisfactory crossing, whereas a negative sign indicates a decrease in the log odds of a satisfactory crossing. Considering this, the model results will focus on the signs of the coefficients and can be interpreted as which type of curb extensions increase or decrease the log odds of a satisfactory crossing.

Additionally, the research team developed the survey questions in such a way as to explore five latent constructs of crossing satisfaction. The variables that we expected to load onto each latent variable are provided below. Note that the "LA" nomenclature is derived from the questions asking survey respondents their level of approval with a particular statement:

- Safety
  - LAcross = "I felt like I might get hit by a car when crossing here."
  - LAsafe = "I felt safe crossing here."
- Acknowledgment
  - LAfast = "People drive too fast through this intersection."
  - LAacknow = "Drivers see and acknowledge me when I need to cross here."
- Time
  - LAtime = "I had enough to cross this street."
  - LArush = "I felt rushed trying to cross the street."
- Convenience
  - LAway = "I went out of my way to cross here."
  - LAdirect = "Crossing here was the most direct route to get where I was going."
- Aesthetics
  - LAappeal = "This is a visually appealing intersection to walk through."
  - LAugly = "I don't like how this intersection looks."

To determine if these five latent constructs exist within the survey responses, we used a factor analysis to uncover how the different survey responses might load onto (i.e., correlate to) the latent factors. Factor analysis typically begins with the specification of the suspected number (i.e., 5, initially) of latent constructs, and then this number is reassessed after investigating the results.

After identifying the appropriate number of latent factors to investigate, the team developed these latent factor variables as the average of the Likert scores per loaded factor. Numerical values were assigned to each question's Likert score based on agreement (i.e., Strongly agree = 4, Somewhat agree =

3, Somewhat disagree = 2, Strongly disagree = 1). That is to say, if a latent factor for safety existed and both LAcross and LAsafe loaded onto that factor, the safety factor would be the average of the Likert scores for both questions per respondent. In the case of negatively worded questions (i.e., LAcross, LAfast, LArush, and LAugly), the Likert scores were reversed (e.g., a "Strongly agree" would be reverse coded as 1).

The latent factors identified were examined alongside treatment type.

4.3 Video Observation

Video observation was conducted to document pedestrian and motorist behaviors at locations with curb extensions and control locations, including pedestrian use of the curb extension space, factors that could influence crossing distance and visibility, and motorist yielding behavior.

4.3.1 Video Data Collection

Video data were collected by a vendor at 25 intersection sites on April 22, 2025. As discussed in the site selection discussion, the sample included 5 permanent curb extensions, 5 tactical curb extensions, 5 tactical curb extensions with mural art, and 10 control locations without curb extensions (see Table C-1 in the Appendix). The camera locations and angles were determined to capture pedestrian crossings and vehicles as they approached the crossing locations, including adequate stopping sight distance for uncontrolled crossings. For turning vehicles, the primary concern was whether drivers yielded appropriately to pedestrians in the targeted crosswalk. One to two cameras were used for each intersection depending on the location geometry and data needs.

All intersections were reviewed and pedestrian and motor vehicle behavior coded by trained students under the supervision of project staff. Each intersection was initially reviewed during the periods of 12:00-2:00 pm and 4:00-6:00 pm. Additional hours were added for locations with fewer pedestrian-motorist interactions (i.e., yielding opportunities) to maximize the usable sample of interactions for analysis across a range of sites. Depending on the observed number of interactions in the initial four hours, sites were marked as either needing three, six, or nine additional hours of review. For several intersections with fewer pedestrian activities, review hours were extended up to 7:00 am-8:00 pm. Table 4-3 summarizes each site's location, recording date, crossing type, review hours, and total hours reviewed. A total of 223 hours of video were reviewed across the 25 intersections.

Table 4-3 Summary of video observation hours reviewed

Location	Crossing type	Hours coded	Total hours reviewed
12th St NE & Quincy St NE	Permanent	12-2pm, 4-6pm	4
18th St NW & Wyoming Ave NW	Permanent	12-2pm, 4-6pm	4
Minnesota Ave NE & Nash St NE	Permanent	7am-8pm	13

Location	Crossing type	Hours coded	Total hours reviewed
14th St NW & Riggs St NW	Permanent	12-2pm, 4-6pm	4
M St SE & 2nd Pl SE	Permanent	12-2pm, 4-6pm	4
Ellicott St NW & 44th St NW	Tactical	11am-2pm, 4-8pm	7
14th St NW & Perry Pl NW	Tactical	12-2pm, 4-6pm	4
15th St NW & N St NW	Tactical	12-2pm, 4-6pm	4
Minnesota Ave SE & 27th St SE	Tactical	7am-8pm	13
12th St NE & Shepherd St NE	Tactical	11am-2pm, 4-8pm	7
56th St NE & Eads St NE	Mural	7am-8pm	13
53rd St SE & C St SE	Mural	7am-8pm	13
57th St NE & Eads St NE	Mural	8am-2pm, 4-8pm	10
Texas Ave SE & B St SE	Mural	8am-2pm, 4-8pm	10
15th St NW & Church St NW	Mural	11am-2pm, 4-8pm	7
12th Pl NE & Upshur St NE	Control	7am-8pm	13
Texas Ave SE & Dubois Pl SE	Control	7am-8pm	13
45th St NW & Ellicott St NW	Control	8am-2pm, 4-8pm	10
Alabama Ave SE & F St SE	Control	8am-2pm, 4-8pm	13
13th Ave NW & Corcoran St NW	Control	11am-2pm, 4-8pm	7
58th St NE & Eads St NE	Control	8am-2pm, 4-8pm	10
K St SE & 3rd Pl SE	Control	8am-2pm, 4-8pm	10
53rd St SE & Call Pl SE	Control	8am-2pm, 4-8pm	10
18th St NW & Riggs Pl NW	Control	11am-2pm, 4-8pm	7
53rd St SE & Drake Pl SE	Control	7am-8pm	13

Before beginning the review, trained reviewers examined available video angles for each intersection to identify the primary video that provided the clearest and most comprehensive view of pedestrian and vehicle activity within the crosswalk(s) of interest. Secondary video angle was also reviewed when necessary to confirm upstream vehicle information or to check whether a vehicle was within the stopping sight distance when a pedestrian started crossing. Before starting coding, reviewers oriented themselves to the intersection's cardinal directions (N, S, E, W) by cross-checking the video with Google Maps to identify the direction of pedestrian crossings and vehicle activities.

4.3.2 Video Coding and Variables

The variables collected from the video observations included pedestrian waiting location, vehicle yielding, and interaction between pedestrian and vehicle, among other variables (Table 4-4). Reviewers recorded one entry for each pedestrian who crossed from one sidewalk to another using one of the crosswalks identified for data collection. People on or pushing bicycles, scooters or other micromobility devices were counted if they crossed in the crosswalk area, but not if they were traveling in the street. Adults carrying a baby or pushing a stroller were entered as a single observation, while kids walking

independently were coded as separate records. Each pedestrian received a unique Individual ID, while people walking together were assigned a Group ID.

In some cases, intersections had different curb designs for different corners (for example, the NE corner might have a tactical curb extension, while the NW corner has a standard corner, with no curb extension). The pedestrian departing corner type was also recorded for each crossing. This variable was determined based on the point of departure. For example, if the pedestrian was traveling westbound across the North crosswalk, moving from the NE corner to the NW corner, the corresponding departing corner type was classified as the NE corner.

Vehicle yielding was recorded for both near side and far side motor vehicles approaching the crosswalk when the pedestrian reached the curb in an attempt to cross. The vehicle position when approaching the crosswalk was coded based on whether or not they passed the point at which they would be able to see and react to the pedestrian in order to stop - this is called the “stopping sight distance” or “yielding point”, and was determined on a location by location basis using AASHTO suggested distances of 115 feet for 20 mph streets and 155 feet for 25 mph streets.[1] Diagrams were developed to help visualize the location of the stopping sight distance (marked as the green shaded area in the site plans) (Figure). A vehicle was classified as “approaching yielding point” if it had not yet passed the yielding point (i.e., outside of the green area of the site plans - for example on Figure) and far enough back to yield. “Past yielding point” indicated a vehicle had already passed the yielding point when the pedestrian reached the curb, indicating that they might be too close to see, react, and stop in time to yield. “At stop sign” indicated a vehicle either approaching or stopped at a stop sign when the pedestrian begins crossing, while “No” indicated that there was no approaching vehicle in that lane. Additionally, the far side approaching vehicle variable was coded as not applicable for one-way streets where no opposing traffic was present. Instances in which a motorist or pedestrians made an avoidance maneuver to prevent a collision were marked as “interactions”; reviewers were instructed to mark interactions as either precautionary or emergency avoidance maneuvers, or as collisions if that were to be observed.

[1] https://highways.dot.gov/safety/speed-management/speed-concepts-informational-guide/chapter-4-engineering-and-technical

Figure 4-2 Example of stopping sight distance at the intersection

The same reviewer revisited each video to count the total number of motor vehicles entering the intersection during the observation period, which were collected in five-minute and hourly bins. The motor vehicle count represented the total number of vehicles observed within the reviewed hours.

Appendix E includes the video review protocol and video collection form.

Table 4-4 Description of variables from video observation

Variable	Description
Intersection	Intersection that is being reviewed.
Date	Date the video was collected.
Time ped arrived at curb	Time at which the pedestrian arrives at the edge of the curb (if they do not pause), or time that they initially pause/stop prior to crossing. HH:MM:SS format, using 24HR.
IndividualID	Unique Identifier for each pedestrian.
GroupID	Group that is obviously together.
Group size	Number of people crossing together.
Crossing	Crosswalk the pedestrian used to cross street - cardinal directions to indicate if the crosswalk is on the North side of the intersection (N), South side (S), East (E) or West (W).
Direction	Direction the pedestrian was travelling during the crossing. Indication direction with Eastbound (EB), Westbound (WB), Southbound (SB), or Northbound (NB).
Corner type	Corner type from which the crossing departs (e.g., permanent, tactical, mural, control).
User Type	Basic descriptive of how the pedestrian/user is traveling (e.g., pedestrian vs someone using a bicyclist, scooter, wheelchair/mobility scooter, other mobility device, stroller, or other).
Gender	Observed perceived gender if possible to determine.

Variable	Description
Age	Observed perceived age category (under 16, 17 to 60, 61 plus, or unable to determine).
KidsPresent	Is the person travelling with kids, and if so, are the kids walking on their own, being pushed (i.e., in a stroller), or carried?
PedWait	Did the pedestrian stop at the curb/sidewalk before crossing the street?
PedWaitPosition	If they stopped, where did the pedestrian primarily wait? (middle of sidewalk area, edge of sidewalk area, middle of curb extension area, edge of curb extension area, in street)
CrossingLocation	What is the pedestrian's position in relation to the crosswalk? (full within, in on one end of their crossing, not in crosswalk, diagonal crossing, or other)
Near side - approaching vehicle?	Is there an approaching vehicle in the first lane the pedestrian will cross? Were they approaching or past the yielding point when the pedestrian reached the curb?
Near side - 1st vehicle yield	Does the vehicle yield? If so, where do they stop? (yes, outside crosswalk area; yes, inside crosswalk area; no, (fail to yield); or other such as the pedestrian intentionally crosses behind the vehicle, or no interaction occurs).
Near side - other vehicles	If the 1st vehicle does not yield, how many pass without yielding?
Far side - approaching vehicle?	Is there an approaching vehicle in the far lane the pedestrian crosses? Were they approaching or past the yielding point when the pedestrian reached the curb?
Far side - 1st vehicle yield	Does the vehicle yield? If so, where do they stop? (yes, outside crosswalk area; yes, inside crosswalk area; no, (fail to yield); or other such as the pedestrian intentionally crosses behind the vehicle, or no interaction occurs).
Far side - other vehicles	If the 1st vehicle does not yield, how many pass without yielding?
Turning vehicle?	Is there a vehicle turning into the crosswalk that a pedestrian is crossing that could conflict with their crossing action?
Turning vehicle - 1st vehicle yield	Does the vehicle yield? If so, where do they stop? (yes, outside crosswalk area; yes, inside crosswalk area; no, (fail to yield); or other such as the pedestrian intentionally crosses behind the vehicle, or no interaction occurs).
Turning vehicle - other vehicles	If the 1st vehicle does not yield, how many pass without yielding?
Intrusion-type	Do any vehicles pass through any part of the curb extension area while the pedestrian is at this location?
Intrusion-vehicle	If any of above, which vehicle? (in near side lane, far side lane, turning vehicle, etc.)
Pedestrian - Vehicle interaction	Note any time a pedestrian or interacting MV makes an avoidance maneuver.

Variable	Description
Pedestrian - Vehicle interaction - description	Open text field to describe a pedestrian-vehicle interaction if observed.
Motor vehicle counts	Count of motor vehicles entering the intersection during the video observation period.
Peak hour MV count	The highest hourly count of motor vehicles entering the intersection during the video observation period.

4.3.3 Data Validation

Before conducting data analysis, validation checks were performed to ensure coding was as consistent and accurate as possible. The validation included logical checks, missing value detection, and correction of incorrect entries.

Logical checks were performed to confirm that directional information aligned with the corresponding crosswalk location. For example, pedestrians coded as walking NB or SB on the north crosswalk were flagged as logically inconsistent. The dataset was also examined for missing values in key variables, such as vehicle yielding. Any identified issues were reviewed and corrected through comparison with the original video data to ensure the validity of all observations.

4.3.4 Data Preparation

Each spreadsheet contained pedestrian and vehicle observations for one intersection. After validation, the data were prepared to create a unified dataset suitable for statistical analysis. Individual spreadsheets from 25 intersections were combined into a single master spreadsheet.

To maintain consistency across sites, *Near side lanes* and *Far side lanes* were aggregated at 14th St NW & Riggs St NW, which has a four-lane configuration (two near side and two far side lanes). For this intersection, if either lane on a given side included a yielding event, that side was coded as *yielding*; if either lane failed to yield, it was coded as *fail to yield*. The total number of vehicles that passed without yielding was summed across both lanes on each side.

In addition, the categorical variables such as *Kids present, Near side approaching vehicle* and *Far side approaching vehicle* were reviewed for inconsistencies. This step ensured that variables followed the same naming and category, which allowed the dataset to be consistent and ready for further analysis.

4.3.5 Video Data Modeling Overview

In addition to presenting descriptive findings from the video review (for example, the percentage of motorists that yielded for crossing pedestrians at each of the different types of intersections), we also

statistically modeled the video data to better understand factors associated with yielding at these locations.

The primary questions the team sought to answer in the modeling analysis of video data were:

1. Compared to the corners of traditional (i.e., control) intersections, do curb extensions have a statistically significant benefit on driver yielding behavior?
2. Is there a difference in driver yielding behavior when comparing the different kinds of curb extension treatments?

As with the survey analysis, the team answered these questions by using a binary variable to account for a driver failing to yield (i.e., no observed yielding to the crossing pedestrian) when it would be appropriate to do so (i.e., when there was an observed interaction between driver and pedestrian and it would be appropriate for the driver to give the right of way to the pedestrian). The team considered this binary variable for near-side yielding behavior, far-side yielding behavior, and total yielding behavior.

Given that the dependent variable is binary, logistic regression is appropriate. Using SAS 9.4, the team calculated the log odds of the outcome variable (1 = failure to yield) versus the alternative (0 = proper yield). The logistic regression equation can be seen below:

$$log\frac{Pr(Y = non - yield)}{Pr(Y = yield)} = \beta_0 + \beta_1 x_1 + \cdots + \beta_n x_n$$

Where:

Pr(Y=non-yield) = the probability of a failure to yield
Pr(Y=yield) = the probability of a proper yield
β_0 = the intercept of the model
β_n = the coefficient of variable n
x_n = The value of variable n

As mentioned, logistic regression results can be interpreted considering the sign of the coefficient. A positive sign indicates that the variable increases the log odds of a failure to yield, whereas a negative sign indicates a decrease in the log odds of a failure to yield. Considering this, the model results will focus on the signs of the coefficients and can be interpreted as which type of curb extensions increase or decrease the log odds of a driver appropriately yielding compared to other kinds of treatments. For these analyses, the team examined just the treatment type in isolation and the treatment type along with other data points extracted from the video.

5 Findings

This chapter presents findings from the survey, video observation (broken into descriptive statistics and modeling analysis), and then followed by a discussion of how the findings interact.

5.1 Survey Findings

5.1.1 Survey Respondent Characteristics

After data cleaning, 180 survey responses were retained for analysis. These included fully completed and partially completed responses, with 49 at permanent curb extension locations, 75 at tactical curb extension locations and 56 at tactical curb extension locations with mural art. Table 5-1 shows demographic statistics of the survey respondents. The highest proportion of respondents were between 26-39 years of age (39%), male (52%), and white (43%).

Table 5-1 Survey Respondents Demographics

	Category	n	%
Age	18-25	24	13%
	26-39	71	39%
	40-65	57	32%
	66-75	22	12%
	76+	3	2%
	Did not answer	3	2%
	Total	180	100%
Gender	Male	93	52%
	Female	81	45%
	Non binary	1	1%
	Other	1	1%
	Did not answer	4	2%
	Total	180	100%
Race	White	78	43%
	Black or African American	54	30%
	Hispanic, Latino/a, or Spanish origin	16	9%
	Asian	13	7%
	American Indian or Alaska Native	1	1%
	Mixed	11	6%
	Other	1	1%
	Prefer not to say/Did not respond	6	4%
	Total	180	100%

Respondents were asked if they were taking the trip alone or with others. A majority of respondents (83%) responded that they were taking the trip alone, followed by those in a group consisting of all

adults (11%). Only a small percentage of respondents (6%) responded that they were crossing in a group with kids.

When asked about the purpose of the trip that they were currently undertaking (Table 5-2), a majority of respondents at the permanent curb extension and tactical curb extension locations reported running errands, while those at the tactical curb extension with mural art locations (35%) reported going to work. The trip purpose is likely related to the time these surveys were administered at the various locations.

Table 5-2 Stated trip purpose

	Permanent curb extension		Tactical curb extension		Tactical curb extension with mural art	
	n	%	n	%	n	%
Exercising	7	14%	22	29%	10	19%
Going home	2	4%	4	5%	7	13%
Going to work/school	9	18%	12	16%	19	35%
Running errands	22	45%	24	32%	15	28%
Visiting friends	5	10%	7	9%	0	0%
Other	4	8%	6	8%	3	6%
Total	49	100%	75	100%	54	100%

When asked about frequency of crossing (Table 5-3), the majority of respondents at all three types of locations crossed at those locations frequently (4 or more days a week), which indicates that they were familiar with these crossings.

Table 5-3 Stated frequency of crossing

	Permanent curb extension		Tactical curb extension		Tactical curb extension with mural art	
How often do you use this crossing location?	n	%	n	%	n	%
First time	4	8%	2	3%	0	0%
Less than 1 day a month	3	6%	4	5%	0	0%
1-3 days a month	7	15%	11	15%	2	4%
1-3 days a week	12	25%	15	20%	13	24%
4 or more days a week	22	46%	42	57%	39	72%
Total	48	100%	74	100%	54	100%

5.1.2 Satisfaction with Crossing Experience:

Overall, 83% of the respondents expressed satisfaction with their crossing experience (Table 5-4). The highest proportion of respondents at the tactical curb extension locations with mural art installations (93%) expressed satisfaction with their crossing experience at the location that they were crossing, followed by tactical curb extension locations (84%) and permanent curb extension locations (71%).

Table 5-4 Pedestrian Crossing Satisfaction

Type	Satisfied	Dissatisfied
Permanent curb extension	71%	29%
Tactical curb extension	84%	16%
Tactical curb extension with mural art	93%	7%
All locations	83%	17%

5.1.3 Waiting Location

Respondents crossing at the permanent curb extension locations primarily reported waiting in the curb extension area (67%), followed by the sidewalk area (24%) – see Table 5-5. However, a higher proportion of respondents at both tactical (61% vs 13%) and tactical curb extensions locations with mural art (54% vs 37%) reported waiting in the sidewalk area as compared to the curb extension area.

Table 5-5 Pedestrian waiting location

	Permanent	Tactical	Tactical with mural art
	%	%	%
Curb extension area	67%	13%	37%
Sidewalk area	24%	61%	54%
None - I did not wait at all prior to crossing	8%	21%	9%
Other	0%	4%	0%
n	49	54	78

Respondents were also asked how they felt waiting in the curb extension to cross the street. The highest proportion of respondents at the permanent curb extension locations (83%) responded that they felt either somewhat or very safe, followed by 69% and 35% at the tactical curb extensions with and without mural art respectively.

5.1.4 Perceptions

A series of Likert style agreement questions were presented to respondents to elicit their perceptions of crossing as a pedestrian at the intercepted location. Respondents were asked to state their level of agreement with each statement. Results are shown in Table 5-6.

Three of the statements were oriented toward safety, perceptions of driver behavior and crossing times. With respect to perceived safety, the highest proportion of respondents at the tactical curb extension locations with mural art felt safe while crossing at those locations, disagreeing with the statement that they might get hit by a car while crossing at the location (85%) and agreeing with the statement that they felt safe crossing at the location (94%). When asked about driver behavior, respondents again felt that the tactical curb extension locations with mural art felt safe with a higher proportion of respondents disagreeing with the statement that people drove too fast through the intersection (55%) and agreeing that drivers saw and acknowledged them when they crossed at the location (92%). With

respect to crossing time, a higher proportion of respondents at the tactical curb extension locations agreed with the statement that they had enough time to cross the street (96%) and disagreed with the statement that they felt rushed crossing at that location (82%).

Two statements pertained more to the attractiveness of crossing at the location, including if they would go out of their way to cross there, and the visual appeal of the location. When asked about willingness to deviate, most respondents at all three location types stated that they did not do so with 97-98% of the respondents agreeing that crossing at that location was the most direct route to get to where they were going, while a higher proportion of respondents at the tactical curb extension locations disagreed that they went out of their way to cross there (97%). Finally, when asked about the visual appeal of the intersection, a higher proportion of respondents crossing at the tactical curb extension with mural art locations agreed with the statement that the intersection was visually appealing to walk through (94%) and disagreed with the statement that they don't like how the intersection looks (90%).

Table 5-6 Pedestrian perceptions

		Permanent		Tactical		Tactical with mural art	
Topic area	**Statement**	**Agree**	**Disagree**	**Agree**	**Disagree**	**Agree**	**Disagree**
Perceived safety	I feel like I might get hit by a car when crossing here	50%	50%	28%	72%	15%	**85%**
	I felt safe crossing here	67%	33%	82%	18%	**94%**	6%
Driver behavior	People drive too fast through this intersection	69%	31%	65%	35%	45%	**55%**
	Drivers see and acknowledge me when I need to cross here	71%	29%	79%	21%	**92%**	8%
Crossing time	I had enough time to cross this street	84%	16%	**96%**	4%	89%	11%
	I felt rushed trying to cross this street	55%	45%	18%	**82%**	19%	81%
Willingness to deviate	I went out of my way to cross here	19%	81%	3%	**97%**	17%	83%
	Crossing here was the most direct route to get to where I was going	**98%**	2%	97%	3%	**98%**	2%
Visual appeal	This is a visually appealing intersection to walk through	86%	14%	86%	14%	**94%**	6%
	I don't like how this intersection looks	32%	68%	29%	71%	10%	**90%**

5.1.5 Statistical Analysis

Using a threshold of 0.3 as the cutoff for factor loading, we identified two latent factors in the survey data, seemingly corresponding to a mix of safety and convenience (LAcross, LAsafe, LAacknow, LAtime, and LArush) and to aesthetics (LAappeal and LAugly). The two survey questions corresponding to convenience (LAway and LAdirect) did not load onto either factor. The factor loadings are shown below in Table 5-7.

Table 5-7 Loadings of Different Variables onto Two Latent Factors

Survey Variable	Factor 1 (x1)	Factor 2 (x2)
LAcross	0.84749	-0.05404
LAsafe	0.72918	0.16975
Lafast	0.57722	-0.09351
LAacknow	0.67978	-0.00272
LAtime	0.65936	0.17884
LArush	0.82191	-0.02072
LAway	-0.18539	-0.03927
LAdirect	0.06436	0.05231
LAappeal	-0.02781	0.77760
LAugly	0.02111	0.50905

As mentioned previously, the research team analyzed the survey data using logistic regression. First, only the treatment type was tested as an independent variable to see if there was a statistically significant difference between the three types of curb extensions in pedestrian crossing satisfaction. The model results are shown in Table 5-8. This model used 179 observations, and the overall model fit was statistically significant (p=0.0137). For this model, the permanent curb extension was used as the base category. Compared to permanent curb extensions, tactical curb extensions with mural art increase the log odds of a satisfactory crossing experience. There is no statistically significant difference between the tactical curb extensions and permanent curb extensions.

Table 5-8 Logistic Regression Results for Pedestrian Satisfaction Considering Only Treatment Type

Variable	Category	Coefficient	Odds Ratio	Standard Error	P-value
Treatment Type	Tactical	0.7419	2.100	0.4663	0.0964
	Tactical, mural	**1.6289**	**5.098**	**0.6079**	**0.0074**
	Permanent	Base category	-	-	-
Intercept	**-**	**0.9163**	**-**	**0.3162**	**0.0038**

Note: bolded cells indicate statistical significance at the p=0.05 level.

We also tested a logistic regression model for satisfaction consisting of the treatment variable, the two latent factors (hereafter referred to as LFComfort for the latent factor that seems to capture feelings of safety and LFAesthetic for the latent factor that captures the aesthetic appeal of curb extension sites), the two unloaded survey responses (LAway and LAdirect), and other variables (e.g., age, gender, where

the pedestrian waited, and whether the pedestrian was in a group). Only LFComfort was statistically significant in predicting satisfaction. The model used 178 observations and was statistically significant ($p<0.0001$). The results are shown in Table 5-9. As can be seen in this table, the model seems to indicate that the various survey questions that make up the safety/acknowledgment/time construct all support pedestrian satisfaction. The factor relating to aesthetics was not statistically significant.

Table 5-9 Logistic Regression Results for Pedestrian Satisfaction with only LFComfort Retained

Variable	Coefficient	Odds Ratio	Standard Error	P-value
LFComfort	**2.1633**	**8.700**	**0.3727**	**<0.0001**
Intercept	**-4.3330**	**-**	**0.9699**	**<0.0001**

Note: bolded cells indicate statistical significance at the p=0.05 level.

A final analysis of the survey results included two linear regression models to see if different curb extension types increased or decreased the average value of the two latent factors related to comfort and aesthetic appeal, which would indicate greater agreement with safety/acknowledgment/time and aesthetics, respectively. The results for these models are shown in Table 5-10 and Table 5-11. For latent factor LFComfort, the permanent curb extensions decreased the latent factor score compared to tactical curb extensions, while there was no statistical difference between tactical curb extensions and those with mural art. This result may indicate that while permanent curb extensions provide greater satisfaction for waiting, they do not provide as pleasant of an experience for crossing maneuvers. For latent factor LFAesthetic, the tactical curb extensions with mural art increased the factor score, while there was no statistically significant difference between permanent curb extensions and tactical curb extensions. This finding makes intuitive sense given the presence of mural art at some curb extensions.

Table 5-10 Linear Regression Model for LFComfort and Treatment Type

Variable	Category	Coefficient	Standard Error	T Value	P-value
Treatment Type	**Permanent**	**-0.44431**	**0.12822**	**-3.47**	**0.0007**
	Tactical, mural	0.22830	0.12458	1.83	0.0686
	Tactical	Base category	-		-
Intercept	**-**	**3.15689**	**0.08060**	**39.17**	**<0.0001**

Note: bolded cells indicate statistical significance at the p=0.05 level.

Table 5-11 Linear Regression Model for LFAesthetic and Treatment Type

Variable	Category	Coefficient	Standard Error	T Value	P-value
Treatment Type	Permanent	-0.10380	0.14056	-0.74	0.4613
	Tactical, mural	**0.27438**	**0.13481**	**2.04**	**0.0434**
	Tactical	Base category	-		-
Intercept	**-**	**3.16901**	**0.088137**	**35.96**	**<0.0001**

Note: bolded cells indicate statistical significance at the p=0.05 level.

5.2 Video Observation Descriptive Statistics

5.2.1 Pedestrian Characteristics

Table 5-12 summarizes the basic characteristics of pedestrians observed across the four intersection types, based on the departing corner of pedestrians. In total, 10,573 pedestrians were observed. Most observations were recorded at the control sites (n=4,585), followed by permanent (n=2,045), tactical (n=2,514), and mural (n=1,429) locations.

Across all intersections, pedestrians were the majority of users, with only a small percentage using bicycles, scooters, or strollers. In terms of gender, a greater proportion of men was observed at the permanent and tactical locations compared to the mural and control locations.

Age patterns also differed across locations. Kids were more common at the mural intersections (21%), whereas most users at the other intersections were adults aged 17 to 60. Similarly, mural intersections had more kids and family groups, while permanent, tactical, and control intersections were used mainly by adults traveling without kids.

Table 5-12 Summary of user characteristics by intersection type

	Permanent		Tactical		Mural		Control		Total	
	n	%	n	%	n	%	n	%	n	%
User Type										
Pedestrian	1975	97%	2331	93%	1353	95%	4398	96%	10057	95%
Bicyclist	27	1%	94	4%	40	3%	43	0.9%	204	2%
Scooter	11	0.5%	27	1%	10	0.7%	23	0.5%	71	0.7%
Wheelchair/ mobility scooter	10	0.5%	1	0.0%	3	0.2%	6	0.1%	20	0.2%
Person with mobility device	4	0.2%	3	0.1%	5	0.3%	7	0.2%	19	0.2%
Person with stroller	18	0.9%	53	2%	16	1%	106	2%	193	2%
Other	0	0.0%	5	0.2%	2	0.1%	2	0.0%	9	0.1%
Total	2045	100%	2514	100%	1429	100%	4585	100%	10573	100%
Gender										
Male	1108	54%	1352	54%	670	47%	2146	47%	5276	50%
Female	770	38%	921	37%	584	41%	2103	46%	4378	41%
Unable to determine	167	8%	241	97%	175	12%	336	7%	919	9%
Total	2045	100%	2514	100%	1429	100%	4585	100%	10573	100%
Age										
Under 16	98	5%	105	4%	297	21%	329	7%	829	8%
Between 17 and 60	1836	90%	2311	92%	1089	76%	4088	89%	9324	88%
Over 61	63	3%	91	4%	32	2%	163	4%	349	3%
Unable to determine	48	2%	7	0.3%	11	0.8%	5	0.1%	71	0.7%

	Permanent		Tactical		Mural		Control		Total	
Total	2045	100%	2514	100%	1429	100%	4585	100%	10573	100%
Presence of Kids										
No	1812	89%	2289	91%	982	69%	3930	86%	9013	85%
Yes - walking	111	5%	60	2%	121	8.5%	184	4%	476	4.5%
Yes - not walking	24	1%	60	2%	29	2%	142	3%	255	2%
IS a kid	98	4.8%	105	4%	297	21%	329	7%	829	8%
Total	2045	100%	2514	100%	1429	100%	4585	100%	10573	100%

Totals may not equal 100% due to rounding

Table 5-13 presents the pedestrian crossing behavior and waiting patterns by intersection type. Overall, pedestrians at tactical (92%) and permanent (89%) locations were slightly more likely to remain fully within the crosswalk throughout their crossing compared to those at mural (84%) and control (83%) intersections. Diagonal crossings were relatively uncommon at all sites but occurred more often at mural intersections (5%).

Pedestrian waiting behavior also varied by intersection type. Only 3.5% of pedestrians at the control intersections stopped and waited before crossing, compared with over 9% at permanent and mural sites.

Table 5-13 Summary of pedestrian crosswalk use and waiting behavior by intersection type

	Permanent		Tactical		Mural		Control		Total	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Crossing location										
Fully within crosswalk	1816	89%	2316	92%	1199	84%	3797	83%	9128	86%
In crosswalk on one end	188	9%	169	7%	151	17%	584	13%	1092	10%
Not in crosswalk	14	0.7%	7	0.3%	11	0.8%	90	2%	122	1%
Diagonal	22	1%	21	0.8%	68	5%	108	2%	219	2%
Other	5	0.2%	1	0.0%	0	0.0%	6	0.1%	12	0.1%
Total	2045	100%	2514	100%	1429	100%	4585	100%	10573	100%
Pedestrian waiting										
Yes	195	9.5%	178	7%	128	9%	159	3.5%	660	6%
No	1772	87%	2234	89%	1232	86%	4364	95%	9602	91%
Slow, but not stopped	78	4%	101	4%	55	4%	59	1%	293	3%
Unable to determine	0	0%	1	0%	14	1%	3	0.1%	18	0.2%
Total	2045	100%	2514	100%	1429	100%	4585	100%	10573	100%

Totals may not equal 100% due to rounding

5.2.2 Use of Curb Extension Area by Pedestrians

One of the purported benefits of curb extensions is that they place pedestrians further out, increasing visibility between pedestrians and motorists and reducing crossing distances. To get at how the intersection type influences pedestrian waiting location (for those that stopped or slowed) we coded whether the pedestrian waited in the middle of the sidewalk area, at the edge of the sidewalk area (but not yet in the curb extension), in the middle of the curb extension area, at the edge of the curb extension area, or in the street.

Among those who fully stopped and waited before crossing, waiting position also differed by intersection type (Table 5-14). At permanent curb extension locations, 84% of pedestrians stood within the curb extension area, either middle (41%) or at the edge (43%). In contrast, fewer people waited in the curb extension area at tactical and mural locations (42% and 35% respectively); at these tactical locations people more often waited in the sidewalk area (56% at tactical locations and 64% at tactical locations with mural art). At control sites without curb extensions, pedestrians commonly waited either at the edge of the sidewalk (47%) or middle of the sidewalk (37%), while 16% waited in the street.

In cases where the pedestrians slowed prior to crossing, we noted the location where they slowed (similar to if they had stopped). When considering those that either stopped or slowed (lower half of Table 5-14), the proportion of pedestrians using the curb extension area increased slightly for mural art locations, up to 45% when considering either the middle or edge of the curb extension area. The rates for permanent curb extensions (86%) and tactical curb extensions (42%) are roughly consistent when including those who slow or stop.

Table 5-14 Summary of pedestrian waiting position by intersection type

	Permanent		Tactical		Mural		Control		Total	
	n	%	n	%	n	%	n	%	n	%
Only those pedestrians that fully stopped										
Middle of sidewalk area	1	0.5%	15	8%	13	10%	59	37%	88	13%
Edge of sidewalk area	7	4%	85	48%	69	54%	74	47%	235	36%
Middle of curb extension area	79	41%	46	26%	31	24%	0	0%	156	24%
Edge of curb extension area	84	43%	29	16%	14	11%	0	0%	127	19%
In street	24	12%	3	2%	1	0.8%	26	16%	54	8%
Total	195	100%	178	100%	128	100%	159	100%	660	100%
Including those that slow or fully stopped										
Middle of sidewalk area	1	0%	23	9%	13	8%	64	36%	101	12%
Edge of sidewalk area	8	3%	120	47%	74	47%	83	47%	285	34%
Middle of curb extension area	109	43%	64	25%	48	30%	0	0%	221	26%

	Permanent		Tactical		Mural		Control		Total	
Edge of curb extension area	111	43%	44	17%	23	14%	0	0%	178	21%
In street	27	11%	6	2%	1	1%	30	17%	64	8%
Total	256	100%	257	100%	159	100%	177	100%	849	100%

Totals may not equal 100% due to rounding

5.2.3 Vehicle Yielding

Tables Table 5-15 to Table 5-20 summarize approaching vehicle location and vehicle yielding behavior. First we present data for through vehicles in the near side lane (the first lane the pedestrian crossed), followed by through vehicles in the far side lane, and then turning vehicles (that turn across the pedestrian's path).

Yielding - Through Vehicles in Near Side Lane

On the near side lane, most observations showed no approaching vehicle within the immediate yielding area (Table 5-15). The share of "no vehicle" was particularly high at the control intersections (92.5%), followed by permanent (87%), mural (86%), and tactical (79%) locations.

When vehicles were observed, only about 2 to 3 percent were approaching the yielding point, which reflects cases where drivers still had enough distance to slow or stop for pedestrians. A slightly large percentage of vehicles was already past the yielding point, particularly at permanent (7%) and tactical (4%) intersections. Vehicles stopped at stop signs appeared more common at tactical (13%) and mural (8%) intersections.

Table 5-15 Summary of approaching vehicle location by intersection type (Near side)

	Permanent		Tactical		Mural		Control		Total	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Approaching yielding point	56	3%	60	2%	38	3%	45	1%	199	2%
Past yielding point	145	7%	109	4%	48	3%	55	1%	357	3%
Unable to determine yielding point	23	1%	13	0.5%	6	0.4%	39	0.9%	81	0.8%
At stop sign	41	2%	337	13%	111	8%	204	4%	693	7%
None	1780	87%	1995	79%	1226	86%	4242	92.5 %	9243	87%
Total	2045	100%	2514	100%	1429	100%	4585	100%	1057 3	100%

Totals may not equal 100% due to rounding

Table 5-16 summarizes yielding location when vehicles approached the near side. When considering all through vehicles, including those already past the yielding point, yielding patterns varied across

intersection types. Mural intersections showed the highest yielding rates with 70% of drivers stopped outside the crosswalk and 30% failing to yield. In contrast, permanent and tactical locations had more than half of drivers failing to yield (51% and 55%, respectively). Control intersections showed a mixed pattern, with similar shares of drivers yielding outside the crosswalk (51%) and failing to yield (47%).

When focusing only on vehicles that were still approaching the yield point, yielding rates increased at all intersection types except control. Mural art locations showed the strongest yielding behavior, with 84% and drivers yielding. This was significantly higher than yielding at other location types, including the 62% at tactical intersections, 50% at permanent intersections and 49% at control intersections.

Table 5-16 Summary of yielding location by intersection type (Near side)

	Permanent		Tactical		Mural		Control		Total	
	n	%	n	%	n	%	n	%	n	%
Yielding (all through vehicles, including approaching yield point, past yield point, and UTD yield point)										
Vehicle yielded, outside crosswalk area	91	48%	59	42%	56	**70%***	47	51%	253	51%
Vehicle yielded, inside crosswalk area	1	0.5%	4	3%	0	0%	2	2%	7	1%
Fail to yield	97	51%	77	55%	24	30%	43	47%	241	48%
Total	189	100%	140	100%	80	100%	92	100%	501	100%
Yielding (vehicles approaching yield point or UTD)										
Vehicle yielded, outside crosswalk area	27	50%	28	62%	27	**84%***	22	49%	104	59%
Fail to yield	27	50%	17	38%	5	16%	23	51%	72	41%
Total	54	100%	45	100%	32	100%	45	100%	176	100%

Cases in which the pedestrian and motorist did not interact are excluded. Totals may not equal 100% due to rounding. *Significant different compared to other intersection types

Yielding - Through Vehicles in Far Side Lane

For the far side, all percentages exclude observations coded as “not applicable”, which corresponded to one-way approaches with no opposing traffic. As shown in Table 5-17, vehicles approaching from the far side were relatively uncommon across all intersections when pedestrians were crossing. The share of “no vehicle” was highest at the control intersections (93%), followed by mural (85%), permanent (83%), and tactical (70%).

Among observations with a vehicle, a small proportion was approaching the yielding point - between 3 – 5% at permanent and mural intersections, while higher at tactical intersections (8.5%). A similar pattern was observed for vehicles past the yielding point, where tactical intersections showed the highest proportion (12%). Vehicles recorded at stop signs were relatively consistent across intersections, ranging from about 3 - 4%.

Table 5-17 Summary of approaching vehicle location by intersection type (Far side)

	Permanent		Tactical		Mural		Control		Total	
	n	%	n	%	n	%	n	%	n	%
Approaching yielding point	77	4%	59	8.5%	50	5%	41	1%	227	3%
Past yielding point	156	8%	86	12%	60	6%	47	2%	349	5%
Unable to determine yielding point	36	2%	35	5%	5	0.5%	40	1%	116	2%
At stop sign	75	4%	29	4%	36	4%	80	3%	220	3%
None	1701	83%	482	70%	862	85%	2787	93%	5832	87%
Total	2045	100%	691	100%	1013	100%	5832	100%	6744	100%

Totals may not equal 100% due to rounding

When considering all through vehicles on the far side, including those already past the yielding point (Table 5-18), yielding patterns were relatively similar across intersection types. About half of drivers yielded outside the crosswalk, with rates ranging from 48% at tactical to 55% at mural intersections.

Yielding became more common when looking at vehicles that were still approaching the yielding point with enough distance to stop. Drivers at permanent intersections yielded most often (68%), while tactical and mural intersections showed moderate yielding rates (56% and 55%, respectively). At control intersections, yielding remained comparatively low, with a 51% yield rate.

Table 5-18 Summary of yielding location by intersection type (Far side)

	Permanent		Tactical		Mural		Control		Total	
	n	%	n	%	n	%	n	%	n	%
Yielding (all through vehicles, including approaching yield point, past yield point, and UTD yield point)										
Vehicle yielded, outside crosswalk area	122	54%	70	48%	56	55%	44	49%	292	52%
Vehicle yielded, inside crosswalk area	1	0.4%	4	3%	0	0%	0	0%	5	0.9%
Fail to yield	102	45%	73	50%	46	45%	46	51%	267	47%
Total	225	100%	147	100%	102	100%	90	100%	564	100%
Yielding (all through vehicles, only approaching yield point, and UTD yield point)										
Vehicle yielded, outside crosswalk area	53	**68%***	40	56%	23	55%	25	51%	141	59%
Fail to yield	25	32%	31	44%	19	45%	24	49%	99	41%
Total	78	100%	71	100%	42	100%	49	100%	240	100%

*Significant different compared to control intersections only

Cases in which the pedestrian and motorist did not interact are excluded. Totals may not equal 100% due to rounding.

Yielding - Turning Vehicles

Turning vehicles across pedestrian crossings were relatively rare, as most observations were no turning vehicles during pedestrian crossings (Table 5-19). Overall, 2% observed pedestrians experienced a right-turning vehicle, and 0.9% experienced a left-turning vehicle. Turning vehicles were most common at the permanent locations, and least common at the control locations.

The yielding results shown in Table 5-20 are based on cases when there was a turning vehicle, excluding no interaction or no turning observations. Among turning vehicles, yielding rates were highest at mural intersections, where nearly all drivers (98%) yielded. Permanent intersections also had compliance, with 91% yielding. In contrast, failures to yield occurred more often at tactical (14%) and control (17%).

Table 5-19 Summary of approaching vehicle location by intersection type (Turning vehicle)

	Permanent		Tactical		Mural		Control		Total	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Location of approaching vehicle (Turning vehicle)										
No	1898	93%	2415	96%	1382	97%	4525	99%	10220	97%
Left-turning	25	1%	24	1%	10	0.7%	37	0.8%	96	0.9%
Right-turning	122	6%	75	3%	37	3%	23	0.5%	257	2%
Total	2045	100%	2514	100%	1429	100%	4585	100%	10573	100%

Totals may not equal 100% due to rounding

Table 5-20 Summary of yielding location by intersection type (Turning vehicle)

	Permanent		Tactical		Mural		Control		Total	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Yielding (all turning vehicles)										
Vehicle yielded, outside crosswalk area	118	**91%***	76	84%	40	**98%****	36	78%	270	88%
Vehicle yielded, inside crosswalk area	0	0%	2	2%	0	0%	2	4%	4	1%
Fail to yield	11	9%	13	14%	1	2%	8	17%	33	11%
Total	129	100%	91	100%	41	100%	46	100%	307	100%

Cases in which the pedestrian and motorist did not interact are excluded. Totals may not equal 100% due to rounding.
*Significant difference compared to control intersections only;
**Significant difference compared to tactical and control intersections

5.2.4 Motorist Intrusion into Curb Extension

Motorist behavior related to curb extension areas and pedestrian activity was also collected across intersection types (Table 5-21). Intrusions into the curb extension area were rarely observed. Intrusion rates at permanent and mural intersections were very low (less than 0.5%). However, tactical locations had a slightly higher intrusion rate (2%), mostly driven by vehicles entering the extra area (2%). When intrusions occurred at tactical locations, they were most often in the right turn areas (1%).

Table 5-21 Summary of motorist intrusion into curb extension by intersection type

	Permanent		Tactical		Mural		Control		Total	
	n	%	n	%	n	%	n	%	n	%
Type of intrusion										
None	2040	100%	2457	98%	1422	99.5 %	4585	100%	10504	99%
Glancing touch	5	0.2%	7	0.3%	0	0%	0	0%	12	0.1%
Drives in extra area	0	0%	50	2%	6	0.4%	0	0%	56	0.5%
Hits post	0	0%	0	0%	1	0.1%	0	0%	1	0%
Total	2045	100%	2514	100%	1429	100%	4585	100%	10573	100%
Location of intruding vehicle										
NA	2040	100%	2459	98%	1423	100%	4585	100%	10507	99%
Near side	0	0%	8	0.3%	0	0%	0	0%	8	0.1%
Far side	0	0%	1	0%	0	0%	0	0%	1	0%
Right turn	5	0.2%	24	1%	0	0%	0	0%	29	0.3%
Micromobility	0	0%	3	0.1%	6	0.4%	0	0%	9	0.1%
Other	0	0%	19 *	0.8%	0	0%	0	0%	19	0.2%
Total	2045	100%	2514	100%	1429	100%	4585	100%	10573	100%

*most of the "other" intruding vehicles were parked school buses.
Totals may not equal 100% due to rounding.

5.2.5 Motorist - Pedestrian Interactions

Pedestrian and vehicle interactions were rarely observed across all intersection types (Table 5-22), with only 24 instances observed (0.2%). These interactions were coded when either the pedestrian or the driver made a precautionary adjustment. Control intersections recorded the highest number of interactions (n=9), followed by permanent (n=8) and tactical (n=7). No interactions between pedestrian and vehicle were observed at mural intersections. No emergency interactions or collisions were observed.

Table 5-22 Motorist - Pedestrian Interactions

	Permanent		Tactical		Mural		Control		Total	
	n	%	n	%	n	%	n	%	n	%
None	2,037	100%	2,507	100%	1,429	100%	4,576	100%	10,549	100%
Precautionary	8	0.4%	7	0.3%	0	0%	9	0.2%	24	0.2%
Total	2,045	100%	2,514	100%	1,429	100%	4,585	100%	10,573	100%

5.3 Modeling from Video Observation

As discussed, the primary focus of this analysis was to determine the effect that treatment type has on driver yielding behavior. First, the team analyzed all yielding events (N=1244) and used the standard curb as the base category (i.e., curbs at control intersections). The model results can be seen in Table 5-23. This model included treatment type and several other roadway and operational variables. One-way operations, number of lanes, peak hour volume, presence of children, and gender of crossing pedestrians all were statistically significant in the model. When all of these variables were included, two curb extension types (tactical and tactical with mural art) decreased the log odds of a driver failing to yield in comparison to typical curbs.

Table 5-23 Logistic Regression Results for All Yielding Events when Roadway and Operational Variables Are Included

Variable	Category	Coefficient	Odds Ratio	Standard Error	P-value
Peak hourly volume	-	**0.00632**	**1.006**	**0.000651**	**<0.0001**
Number of Lanes	-	**-1.7813**	**0.168**	**0.2564**	**<0.0001**
One-way	**Two-way**	**1.1533**	**3.169**	**0.3025**	**<0.0001**
	One-way	Base category	-	-	-
Curb extension at corner	Permanent	-0.2597	0.771	0.1862	0.1631
	Tactical	**-0.4568**	**0.633**	**0.2101**	**0.0297**
	Tactical, mural	**-1.2920**	**0.275**	**0.3042**	**<0.0001**
	Standard	Base category	-	-	-
Children present	Yes, walking	-0.0977	0.907	0.3034	0.7475
	Yes, not walking	**-1.8048**	**0.165**	**0.5175**	**0.0005**
	Is a kid	0.0347	1.035	0.0347	0.8823
	No	Base category	-	-	-
Gender	**Female**	**0.3938**	**1.483**	**0.1407**	**0.0051**
	Undetermined	**0.5525**	**1.738**	**0.1962**	**0.0049**
	Male	Base category	-	-	-
Intercept	-	0.3365	-	0.4552	0.4598

Note: Statistically significant variables (p=0.05) are shown in bold.

However, as can be seen in Table 5-24, when only the curb extension type is compared to control sites, there are no statistically significant differences in driver yielding. This model used 1366 events and had good fit (p=0.0088).

Table 5-24 Logistic Regression Results for All Yielding Events Considering only Curb Extension Type (Control Type as Base)

Variable	Category	Coefficient	Odds Ratio	Standard Error	P-value
Curb extension at corner	Permanent	0.2684	1.308	0.1563	0.0859
	Tactical	0.1263	1.135	0.1675	0.4507
	Tactical, mural	-0.3256	0.722	0.2028	0.1083
	Standard	-	-	-	-
Intercept	**-**	**-0.7665**	**-**	**0.1262**	**<0.0001**

Note: Statistically significant variables (p=0.05) are shown in bold.

By changing only the base category, the team further examined the differences between curb extension types for driver yielding behavior. When permanent curb extensions were used as the base category (Table 5-25), only the tactical curb extension with mural art decreased the log odds of a driver failing to yield. The other two curb extension types (tactical and control) were not statistically significantly different from permanent curb extensions. Similarly, when the base category is changed to tactical curb extensions (Table 5-26), only tactical curb extensions with mural art decrease the log odds of a driver failing to yield. The other two curb extension types (tactical and control) are not statistically different from tactical curb extensions. When tactical curb extensions with mural art (Table 5-27) are used as the base category, the results indicate that permanent curb extensions and tactical curb extensions both increase the log odds of a driver failing to yield. There is no statistically significant difference between standard curbs and tactical curb extensions with mural art.

Table 5-25 Logistic Regression Results for All Yielding Events Considering only Curb Extension Type (Permanent Curb Extensions as Base)

Variable	Category	Coefficient	Odds Ratio	Standard Error	P-value
Curb extension at corner	Standard	-0.2684	0.765	0.1563	0.0859
	Tactical	-0.1421	0.868	0.1436	0.3223
	Tactical, mural	**-0.5940**	**0.552**	**0.1836**	**0.0012**
	Permanent	Base category	-	-	-
Intercept	**-**	**-0.4980**	**-**	**0.0922**	**<0.0001**

Note: Statistically significant variables (p=0.05) are shown in bold.

Table 5-26 Logistic Regression Results for All Yielding Events Considering only Curb Extension Type (Tactical Curb Extensions as Base)

Variable	Category	Coefficient	Odds Ratio	Standard Error	P-value
Curb extension at corner	Permanent	0.1421	1.153	0.1436	0.3223
	Standard	-0.1263	0.881	0.1675	0.4507
	Tactical, mural	**-0.4519**	**0.636**	**0.1932**	**0.01903**
	Tactical	Base category	-	-	-
Intercept	**-**	**-0.6402**	**-**	**0.1101**	**<0.0001**

Note: Statistically significant variables (p=0.05) are shown in bold.

Table 5-27 Logistic Regression Results for All Yielding Events Considering only Curb Extension Type (Tactical Curb Extensions with Mural Art as Base)

Variable	Category	Coefficient	Odds Ratio	Standard Error	P-value
Curb extension at corner	**Permanent**	**0.5940**	**1.811**	**0.1836**	**0.0012**
	Standard	0.3256	1.385	0.2028	0.1083
	Tactical	**0.4519**	**1.571**	**0.1932**	**0.0193**
	Tactical, mural	Base category	-	-	-
Intercept	**-**	**-1.0921**	**-**	**0.1587**	**<0.0001**

Note: Statistically significant variables (p=0.05) are shown in bold.

The research team also examined the type of intersection itself (i.e., treated with a curb extension or a control intersection) to see if there was a difference in observed yielding behavior. The model (N=1366, p=0.252) is shown in Table 5-28. As can be seen in this table, there was no statistically significant difference in driver yielding between intersections with curb extensions and control intersections.

Table 5-28 Logistic Regression Results of Intersection Type

Variable	Category	Coefficient	Odds Ratio	Standard Error	P-value
Treatment Intersection	Tactical, mural	-0.3471	0.707	0.1986	0.0805
	Permanent	0.1983	1.219	0.1545	0.1992
	Tactical	0.0349	1.036	0.1640	0.8314
	Control	-	-	-	-
Intercept	**-**	**-0.7080**	**-**	**0.1222**	**<0.0001**

Note: Statistically significant variables (p=0.05) are shown in bold.

When near-side yielding specifically is examined, the results provide more nuance to the previous findings. Table 5-29 (N=1330, p<0.0001) shows the results of this model. Taking standard curbs (i.e., control locations) as the base category, only permanent curb extensions increase the log odds of a failure to yield. There are no statistically significant differences between tactical curb extensions, tactical curb extensions with mural art, and standard curbs.

Table 5-29 Logistic Regression Results of Near-Side Yielding Behavior

Variable	Category	Coefficient	Odds Ratio	Standard Error	P-value
Curb extension at corner	**Permanent**	**1.2910**	**3.636**	**0.2023**	**<0.0001**
	Tactical	0.3699	1.448	0.1932	0.0556
	Tactical, mural	-0.0344	0.966	0.2596	0.8945
	Standard	Base category	-	-	-
Intercept	**-**	**-1.8402**	**-**	**0.1570**	**<0.0001**

Note: Statistically significant variables (p=0.05) are shown in bold.

However, the far-side yielding results differ. Table 5-30 (N=912, p=0.484) shows the results for this model. As can be seen in the table, only tactical curb extensions increased the log odds of a failure to yield on the far-side. There are no statistically significant differences between permanent curb extensions, tactical curb extensions with mural art, and standard curbs.

Table 5-30 Logistic Regression Results of Far-Side Yielding Behavior

Variable	Category	Coefficient	Odds Ratio	Standard Error	P-value
Curb extension at corner	Permanent	0.3398	1.405	0.2025	0.0933
	Tactical	**0.6026**	**1.827**	**0.2191**	**0.0060**
	Tactical, mural	0.4096	1.506	0.2408	0.0889
	Standard	Base category	-	-	-
Intercept	**-**	**-1.2038**	**-**	**0.1646**	**<0.0001**

Note: Statistically significant variables (p=0.05) are shown in bold.

5.4 Discussion of Findings

Video observation was utilized to explore several surrogate measures of safety. Pedestrian use of the curb extension – for example waiting out in the curb extension area before crossing – has several potential safety benefits, including improving visibility between pedestrians and motorists, and reducing pedestrian crossing distances and times (and therefore, exposure). Motorist yielding to pedestrians is an important safety metric and is another key measure from the video observation. Pedestrian perceptions of safety and comfort are assessed using survey data.

5.4.1 Pedestrian use of curb extension

One of the primary purported benefits of a curb extension is to improve the visibility of pedestrians and motorists to one another, and to reduce pedestrian crossing distance. Both of these benefits are partially based on the assumption that a pedestrian waiting further out (i.e., into the curb extension area) is more likely to be within the sightlines of motorists and vice versa. Our findings from both the video observation and survey results suggest that permanent curb extensions perform best in this area, with most pedestrians waiting in the curb extension area (86% in our video observation, and 66% of our intercepted pedestrians). For tactical locations (including those with mural art), some pedestrians wait in the curb extension area - 42% and 45%, respectively, for the tactical locations and tactical with mural art locations in the video observation, while the rates for intercepted pedestrians were 13% and 39%, respectively.

5.4.2 Motorist yielding

From descriptive statistics, we observed that each of the curb extension locations performed as well or better than control locations in terms of motorist yielding:

- In the near side lane, permanent and tactical locations performed similar to control locations (with yielding rates of 50%, 62% and 49%, respectively), while tactical locations with mural art had a significantly higher yielding rate at 84%.
- For far side lane yielding, permanent locations exhibited a higher yielding rate than control locations (68% compared to 51%), while the tactical locations were in the middle at 55-56%.

- For turning vehicles, tactical mural art locations and permanent curb extension locations had the highest yielding rates (98% and 91%), followed by tactical (84%) and control locations (78%). The higher yielding rates for turning vehicles at mural art and permanent locations may suggest that intersections with more visually distinctive curb designs may increase driver awareness and encourage yielding when turning across intersections.

Through statistical analysis, we found that when a variety of roadway, operational, and pedestrian characteristics are considered, only tactical curb extensions and tactical curb extensions with mural art decreased the log odds of a failure to yield compared to permanent curb extensions ($p=0.0297$ and $p<0.0001$, respectively). When only curb extension type was considered, there was no statistically significant difference in driver yielding behavior between curb extensions and control locations. Permanent curb extensions did seem to increase the log odds of a driver on the near side failing to yield ($p<0.0001$), while tactical curb extensions did seem to increase log odds of a far-side failure to yield ($p=0.0060$).

These results, taken altogether, seem to indicate a few important results:

- When considering other variables beyond just the curb extension at the departing corner, all types of curb extensions decreased the log odds of a failure to yield compared to a standard corner design.
- When only considering curb extension type, there was no statistically significant difference in failure to yield between curb extension types and standard corners.
- Near-side and far-side yielding show greater variability.
- Tactical curb extensions with mural art seem to be most associated with a decrease in failure to yield.

5.4.3 Pedestrian perceptions of safety and comfort

Several questions asked in the survey indicated that pedestrians experience differing levels of comfort when using different types of curb extensions. When asked if they felt like they might get hit by a car when crossing, 85% of respondents at tactical curb extensions with mural art disagreed, compared to 72% at tactical curb extensions and 50% at permanent curb extensions. When asked if they felt safe crossing here, more pedestrians agreed than disagreed, but agreement was highest at tactical curb extensions with mural art (94%) than at tactical curb extensions (82%) and permanent curb extensions (67%). Tactical curb extensions with mural art were also the only curb extension types where pedestrians felt that people did not drive too fast through the intersection (55%). At all curb extension types, survey respondents felt that drivers saw and acknowledged them, but this was highest at tactical curb extensions with mural art (92%) compared to tactical curb extensions (79%) and permanent curb extensions (71%).

However, for intercepted pedestrians who stated that they waited in the curb extension area, those at the permanent curb extension sites were more likely to state that they felt safe waiting in the curb extension (83%, compared to 69% at mural art locations and 35% at tactical locations).

Through the surveys, pedestrians indicated that they were most satisfied with tactical curb extension sites (p=0.0074). There was no statistically significant difference between permanent curb extensions and tactical curb extensions when it came to pedestrian satisfaction. Interestingly, one latent factor in the survey results seemed to capture an important construct related to satisfaction as a combination of feelings of safety, a lack of being rushed, and drivers acknowledging pedestrians. When this factor was analyzed, there was no statistically significant difference between tactical curb extensions and tactical curb extensions with mural art, although permanent curb extensions did seem to decrease the survey response scores slightly (p=0.0007). Tactical curb extensions with mural art seemed to provide aesthetic enjoyment compared to the other two types of curb extensions (p=0.0434).

6 Conclusions

Through an analysis that covered 15 treatment intersections and 10 control intersections, video observation and survey data were used to assess the impacts of different types of curb extensions on pedestrians and motorist behavior and perceptions.

Each of the curb extension types succeeded in placing pedestrians closer to the street, and into a place of higher mutual visibility for pedestrians and motorists, than they would have been if no curb extension were present. Permanent curb extensions clearly result in pedestrians being more likely to wait further out, with 84% waiting in the curb extension area and 43% waiting at the edge of the curb extension. Tactical curb extensions and tactical curb extensions with mural art performed similarly, with 42% and 45%, respectively, waiting in the curb extension area. This behavior is likely affected by perceptions of safety - pedestrians were less likely to report feeling safe when waiting in tactical curb extensions than in permanent curb extensions.

Each of the curb extension types were associated with higher yielding rates than control locations. We observed some variance in the type of yielding, with mural art locations having the highest yielding for near side through and turning vehicles, and permanent curb extensions having the highest yielding rate for far side lane through vehicle yielding.

While each of the curb extension types were associated with relatively high pedestrian self-reported crossing satisfaction, those crossing at locations with mural art reported the highest satisfaction (93%) compared to 84% at other tactical curb extension locations and 71% at permanent curb extension locations. There seems to be a difference between pedestrian perceptions of safety when waiting in the curb extension area (for which pedestrians felt safer with the permanent curb extension) and when crossing the street (for which pedestrians felt safer with the tactical curb extension locations –

particularly mural art locations). This finding may be a result of the degree of protection offered by a permanent curb extension versus tactical flex posts, but more research may be needed to better understand this difference in comfort in waiting versus crossing.

Combining all of the analyses performed for this study, the research team found that there was no statistically significant difference between curb extension types and standardized curbs when it came to a generalized failure to yield. The analyses showed that specific curb extension types may be more associated with specific kinds of yielding problems (e.g., near-side, far-side, or turning vehicles), so more data may be needed to better interpret the nuanced effects on specific maneuvers. The survey data showed respondents were most satisfied at crossings with tactical curb extensions with mural art, but respondents were generally satisfied with crossings across all variations of curb extension types. Unfortunately, the research team did not collect survey data at control sites to allow direct comparison between curb extensions and regular intersections for pedestrian crossing satisfaction. Combining all of these results, the research team concludes that different types of curb extensions do not seem to cause any pronounced problems with yielding behaviors and generally provide satisfactory crossing experiences, with tactical curb extensions with mural art performing as well or better than other curb extension types in some regards.

Table 6-1 Summary of key findings from video observation and survey data by intersection type

Design Type	Video observation	Survey
Permanent Curb Extension	84% of pedestrians waiting out in the curb extension area, including 43% at the edge of the curb extension; Highest yielding rate for far side through vehicles (68%)	71% satisfaction among pedestrians; Lowest perceived safety when **crossing** and having enough time to cross; however highest perceived safety when **waiting** in the curb extension area
Tactical Curb Extension	42% of pedestrians waiting out in the curb extension area, including 17% at the edge of the curb extension area;	84% satisfaction among pedestrians; Highest pedestrian perceptions on having enough crossing time; Slightly higher rate of pedestrians reporting going out of their way to cross at these locations
Tactical with Mural Art Curb Extension	45% of pedestrians waiting out in the curb extension area, including 14% at the edge of the curb extension area; Highest yielding rate for near side through vehicles (84%) and turning vehicles (98%).	93% satisfaction among pedestrians (significant compared to permanent locations); Highest perceived safety when crossing, best perceived driver behavior, and best perceived visual appeal

6.1 Limitations

There are a few limitations to the current work. First, although we observed over 10,000 pedestrians crossing at locations of interest, over 90% of these pedestrians never stopped prior to making their crossings or interacted with any motorists. This resulted in limited sample sizes for understanding pedestrian waiting locations and motorist yielding, which limited our ability to make solid distinctions in expected safety outcomes between curb extension types.

We observed some differences between types of pedestrians at the different intersection types. For example, 21% of pedestrians observed at mural art locations were coded at under 16 years of age, while men were more likely to cross at the permanent and tactical locations, and less likely at the mural art locations and control locations. While our modeling efforts take the presence of children and gender into consideration, it's possible there are underlying characteristics not captured by our models.

6.2 Future Research

There is limited existing research on tactical curb extensions, including those with mural art. While this study expands the knowledge base of these facilities, it also clarifies where there are still gaps in the research.

Tactical curb extensions lack some of the design features that help visually impaired pedestrians navigate roadways crossings, including the placement of the yellow detectable warning survey at the edge of the curb, indicating the start of a cross. While there have been some efforts to consider how to make tactical curb extensions work better for visually impaired pedestrians (Scott et al 2025), this issue was out of the scope of the current research. Future research could involve working with agencies to more broadly test applications of solutions to this challenge.

Quick-build pedestrian projects are inherently limited when it comes to crash data analysis because crashes are (thankfully) relatively rare, and it may take several years or more before there is enough data to conduct an analysis. Future researchers should assess the feasibility of a safety analysis with crash data to see what the longer-term safety impact once facilities have been in place for several years.

As noted in the discussion section on turning vehicle yielding, we saw some evidence that visually distinct designs appear to designate space as not for cars. More and longer-term research is needed to further assess this potential impact.

A concern mentioned in the scan of current practice, but not included in this assessment includes better documentation of how long mural art lasts and what upkeep is necessary.

Finally, while this study asked pedestrians their perceptions of different curb extensions, future studies should ask drivers about their perceptions and comprehension of different types of designs.

7 References

Barker-Winkworth, L. (2023). *Enhancing Pedestrian Safety with Tactical Urbanism* [Capstone, University of Arizona College of Architecture, Planning & Landscape Architecture]. https://repository.arizona.edu/bitstream/handle/10150/668175/SBE_2023_Capstone_Thesis_Barker-Winkworth.pdf

Bloomberg Philanthropies & Sam Schwartz. (2022). *Asphalt Art Safety Study: Historical Crash Analysis and Observational Behavior Assessment at Asphalt Art Sites*. Bloomberg Philanthropies. https://trid.trb.org/View/1946734

City of Columbus, Department of Public Service. (2022). *Tactical Urbanism Results*. https://bronzevillemoves.com/wp-content/uploads/2023/06/Mt-Vernon-Ave-Tactical-Urbanism-Results-29Nov2022.pdf

Federal Highway Administration. (2020). *Milwaukee Avenue Rapid Delivery Approach — Chicago, Illinois*. FHWA-SA-20-007. https://safety.fhwa.dot.gov/zerodeaths/docs/Chicago_RapidDelivery_Final_508.pdf

City of Fort Lauderdale. (2022). *NE 15th Avenue, Fort Lauderdale Tactical Case Study Story of completing a street* StoryMap: https://storymaps.arcgis.com/stories/c3fd2a2efe924a3783c9af0244cb92be

Gan, A., Shen, J., & Rodriguez, A. (2005). *Update of Florida Crash Reduction Factors and Countermeasures to Improve the Development of District Safety Improvement Projects* (FDOT 99700-3596-119). FDOT. https://trid.trb.org/view/758027

Graham Projects. (2022). *Whitelock: Seasonal Turn. A Graham Projects Case Study*. https://grahamprojects.com/wp-content/uploads/2022/02/220118-Graham-Projects-Case-Study-Whitelock-Seasonal-Turn.pdf

Green, G., Gase, L. N., Singh, C., & Kuo, T. (2019). Evaluating streetscape modifications in Los Angeles, California with a health lens. *Californian journal of health promotion*, *17*(1), 10-23. https://journals.calstate.edu/cjhp/article/view/2220

Harwood, D.W., Bauer, K.M., Richard, K.R., Gilmore, D.K., Graham, J.L., Potts, I.B., Torbic, D.J. and Hauer, E., 2008. *Pedestrian safety prediction methodology* (No. NCHRP Project 17-26).

City of Honolulu. (n.d.) *Kalihi Quick Build Complete Streets Project*. https://www.honolulu.gov/rep/site/dts/tpd/tpd_docs/Kalihi_Quick_Build_One_Pager.pdf

Huang, H. F., & Cynecki, M. J. (2000). Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior. *Transportation Research Record*, *1705*(1), 26–31. https://doi.org/10.3141/1705-05

Johnson, R. S. (2005). *Pedestrian safety impacts of curb extensions: A case study: final report.* (FHWA-0R-DF-06-01). https://rosap.ntl.bts.gov/view/dot/22856

King, M. R. (1999). Calming New York City Intersections. *Transportation Research Board Circular E-CO19: Urban Street Symposium*. https://onlinepubs.trb.org/onlinepubs/circulars/ec019/ec019.pdf

MICA's Center for Social Design; Maryland Department of Transportation's Highway Safety Office; the Neighborhood Design Center. (2020). *Greenmount West Bright Lane Evaluation*. https://static1.squarespace.com/static/6216756c173a54045bda9b2f/t/62a78e650c4ee74de1985133/1655148133437/Greenmount+West+Bright+Lane+Evaluation.pdf

MICA's Center for Social Design; Maryland Department of Transportation's Highway Safety Office; the Neighborhood Design Center. (2022). *Johnston Square "Bee Safe" Art Crosswalk Evaluation Report*. https://static1.squarespace.com/static/6216756c173a54045bda9b2f/t/62a7826258c9cb53c2fc35f4/1655145082442/Johnston+Square+Bee+Safe+Evaluations.pdf

MICA's Center for Social Design; Maryland Department of Transportation's Highway Safety Office; the Neighborhood Design Center. (2021). *Reservoir Hill Art in the Right of Way Evaluation*. https://static1.squarespace.com/static/6216756c173a54045bda9b2f/t/62a78e2c3cf4f444887ba38d/1655148079071/Reservoir+Hill+Bright+Lane+Evaluation.pdf

Mobility Beverly Hills. (2021). *Beverly Hills Pedestrian & Bicycle Awareness Campaign* (2021).

New York City Department of Transportation. (2022*). Safety Treatment Evaluation (2005-2018).* https://www.nyc.gov/html/dot/downloads/pdf/safety-treatment-evaluation-2005-2018.pdf

Scott, A. C., Myers, L., Schroeder, B., Worth O'Brien, S., Kent, M., Mello, M., & Bentzen, B. L. (Beezy). (2024). Making Quick-Build Sidewalk Extensions Accessible to Pedestrians with Vision Disabilities. *Transportation Research Record: Journal of the Transportation Research Board*, *2679*(3), 175-188. https://doi.org/10.1177/03611981241275539

SFMTA. (2021). *Painted Safety Zones Three Ways Painted Safety Zones Make People Safer*. https://www.sfmta.com/reports/painted-safety-zones-initial-evaluation

SFMTA. (2022) *Jones Street Quick-Build project*. https://www.sfmta.com/sites/default/files/reports-and-documents/2023/09/jones_street_quick-build_project_evaluation_factsheet.pdf

SFMTA. (2018). *9th and Division Street Protected Intersection Project Evaluation Fact Sheet*. https://www.sfmta.com/reports/9th-and-division-street-protected-intersection-project-evaluation-fact-sheet

Thompson, S.J. and Heydon, S. (1991). Improving Pedestrian Conspicuity by Use of a Promontory, *Traffic Engineering + Control.* 1991/08, pp 472-478

Ulupono Initiative. (2021a). *Papa Avenue Quick Build Kahului*. https://ulupono.com/media/xkkavvde/papa-ave-quick-build-project-09-23-21.pdf

Ulupono Initiative. (2021b). *Papipi Road Quick Build Ewa Beach*. https://ulupono.com/media/xcpp5sr4/papipi-quick-build-project-case-study.pdf

Ulupono Initiative. (2023). *RL Stevenson Middle School Quick Build*. https://ulupono.com/media/5koodgy2/stevenson-ms-quick-build-summary-report-d3-2.pdf

van Hengel, D. (2013). Build It and They Will Yield: Effects of Median and Curb Extension Installations on Motorist Yield Compliance (13–3084). Article 13–3084. *Transportation Research Board 92nd Annual Meeting Transportation Research Board*. https://trid.trb.org/view/1241821

Appendix A State of Practice Review

Curb extensions, also referred to as bulb outs or sidewalk extensions, are geometric safety treatments that offer the promise of improving pedestrian safety and comfort through increasing visibility, decreasing crossing distances, and calming traffic by reducing the turning speed of vehicles. Curb extensions are a prevalent safety treatment used by transportation agencies. A 2022 Federal Highway Administration (FHWA) study on curb radius found that 88% (57 of 65) of surveyed transportation practitioners had installed curb extensions in the past 10 years (Fitzpatrick et al 2022). Despite this, no crash modification factor currently exists for curb extensions, although limited research does show positive findings related to improved driver yielding (Sanders et al 2020).

A typical curb extension is created with physical infrastructure (e.g., concrete curb). The *Manual on Uniform Traffic Control Devices* (MUTCD), 11th Edition, uses the term "sidewalk extension" to describe curb extensions, and defines the facility as "a pedestrian facility at an intersection or midblock crosswalk which extends the sidewalk by physically and visually narrowing the roadway" (3). Due to their high cost and limited resources, agencies are increasingly using tactical curb extensions, including those with mural art. Tactical curb extensions are created with pavement markings such as lines and paint and often paired with flexible plastic posts or other vertical barriers, such as planters. They are often considered temporary, trial or pilot projects. Some tactical curb extensions are painted, which can help them stand out from the unpainted roadway surface. Some agencies are coloring the curb extension areas with single colors, but the addition of mural art is an increasing trend which provides an opportunity to provide color and art into the streetscape.

An agency scan and literature review were conducted to inform the "Evaluation of Different Curb Extension Treatments for Pedestrian Comfort and Safety at Intersections" study, and specifically to understand the reasons behind installing the various types of curb extensions, typical locations for installation and the resulting impacts. These methods are further described below.

Approach

Agency Scan

An online survey was designed and administered in Qualtrics to practitioners at various agencies. The purpose of this survey was to determine the types of curb extensions that were being installed by agencies across the U.S. and the rationale for installing them. The survey was designed to be short and could be completed in 5-10 minutes. The initial draft of the survey questions was developed and shared with the project funders (District Department of Transportation). The feedback received was incorporated by the research team and a final draft was produced. The final draft of the online survey was shared with various professional organization listservs such as National Association of City

Transportation Officials (NACTO), Association of Pedestrian and Bicycle Professionals (APBP) and Institute of Transportation Engineers (ITE).

At the beginning of the survey, the respondents were asked to indicate the types of curb extensions (permanent, tactical, or tactical with mural art) present in their jurisdictions. Respondents were shown example images of the different types of curb extensions as shown below in Figures A1-A3.

Figure A1 Permanent curb extensions (e.g., with concrete curb and gutter) (Image Source: Map Data ©2023 Google)

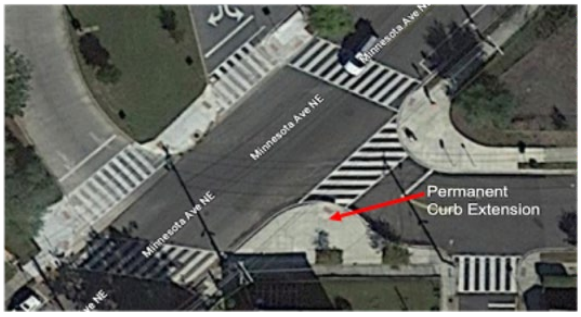


Figure A2 Tactical curb extensions (e.g., a quick-build / demonstration with flex posts and paint) (Image Source: Map Data ©2023 Google)

Figure A3 Tactical curb extensions with roadway / mural art (Image Source: Map Data ©2023 Google)

For each type of extension chosen, respondents were asked common questions about the primary reasons why these types of curb extensions were installed, and to provide details on any reports they

were aware of any reports or evaluations conducted on these types of curb extensions. They were also asked about the number and type of each curb extension present in their jurisdiction and asked to share the inventory or weblink for the locations if available. Specifically for the tactical curb extensions with mural art installations, additional questions on the decisions behind where to install these types of curb extensions and who typically installed them were also posed to the respondents.

A total of 67 responses were received. Partially incomplete responses were filtered out. When duplicate responses were received from the same agency, these were combined to form one response. Ultimately, 35 unique agency responses were obtained and considered for further analysis.

Literature Review

The literature review sought to identify existing research / evaluations that shed light on the impacts of tactical curb extensions with mural art. As a relatively new treatment, it should be noted that there is very limited academic research on this application. There is slightly more evidence of tactical curb extensions more broadly (i.e., without the mural art component) and even more when looking just at general curb extensions. However, even when considering all three treatment types there is limited data on the safety impacts of these treatments.

The literature review involved searching the Transport Research International Documentation (TRID) database (https://trid.trb.org/) and Google Scholar (https://scholar.google.com/) for research containing keywords of curb extension variants ("curb extension", "bulb out", "sidewalk extension", "tactical urbanism"). Once any reports or research articles were identified, any related articles cited within those documents to identify other curb extension research were also reviewed. Additionally, a scan was undertaken for agency reports and briefs focused on tactical curb extensions (with and without mural art), incorporating evaluations identified through Google searches and through our survey of agencies.

Findings are broken out into research that looks at curb extensions generally, research that focuses on tactical curb extensions more narrowly, and then most specifically curb extensions with mural art. Also included are some findings on other safety and traffic calming measures that are generally part of a curb extension project - at least in practical application. These include measures such as curb radius reductions, improved visibility or daylighting at intersections, and reduced crossing distances for pedestrians.

Findings from Scan of Agencies

TABLE A1 shows the types of curb extensions that were noted as being available across the respondents' jurisdictions, along with stated reasons for installing them. Eighty-nine percent of respondents reported having permanent curb extensions, 83% reported the presence of tactical curb extensions (with flex posts and paint) and 54% reported having tactical curb extensions with mural art in their jurisdictions.

The findings by type of curb extension are described below, including stated reasons for implementing the facilities, and if they catalog or inventory their curb extensions. Information about any evaluations conducted and the findings from those evaluations have been included in the findings from the literature review section.

TABLE A1 Agency Scan Findings

Installations	Number of Agencies	Percent
Permanent curb extensions (e.g., with concrete curb and gutter)	31	89%
Tactical curb extensions (e.g., a quick build / demonstration, with flex posts and paint)	29	83%
Tactical curb extensions with roadway / mural art	19	54%
Total (n)	**35**	**100%**
Reasons for installing permanent curb extensions		
Reduce speed	21	68%
Decrease pedestrian crossing length	20	65%
Improve safety	12	39%
Increase visibility	10	32%
Reduce curb radii	4	13%
Pedestrian comfort	3	10%
Other	10	32%
Reasons for installing tactical curb extensions		
Reduce speed	14	48%
Improve safety	13	45%
Decrease pedestrian crossing length	11	38%
Increase visibility	6	21%
Reduce curb radii	2	7%
Pedestrian comfort	0	0%
Other	21	72%
Reasons for installing tactical curb extensions with mural art		
Reduce speed	7	37%
Improve safety	7	37%
Decrease pedestrian crossing length	5	26%
Increase visibility	5	26%
Reduce curb radii	1	5%
Pedestrian comfort	0	0%
Other	14	74%

Permanent Curb Extensions

Overall, 68% of respondents indicated installing curb extensions to reduce speeds, 65% for reducing crossing length, 39% installed them to improve safety, 32% for improved visibility, 13% for reduction in

curb radii, and 10% for improving pedestrian comfort. Thirty-two percent of respondents gave other reasons for installing permanent curb extensions, including beautification, to provide placemaking opportunities, to focus on school zones, improve pedestrian access, and as part of Complete Streets reconfigurations.

Of the agencies who reported installing permanent curb extensions, 17% reported having an inventory. The responses from the respondents indicated that the number and location of installations varied widely from a handful in some jurisdictions to hundreds of locations in other jurisdictions. Typical locations where permanent curb extensions are installed include downtown, near schools, on commercial corridors, at high volume pedestrian areas, and at priority vision zero intersections. One agency stated that they installed curb extensions as a part of all road work.

Tactical Curb Extensions (e.g., with flex posts and paint)

A majority of the respondents indicated that tactical curb extensions were installed to reduce speed (48%), improve safety (45%), decrease pedestrian crossing length (38%), increase visibility (21%), and reduce curb radii (7%). A large proportion of respondents (72%) stated other reasons for installing tactical curb extensions, including low cost and the ability to test solutions before installing more permanent installations. Respondents also stated that these quick-build and temporary installations allowed them to engage the community to determine their response to curb extensions. Other reasons for installation include reduced crowding by providing more storage or waiting space for pedestrians.

Of the agencies who reported having installations of tactical curb extensions, 7 (24%) reported having an inventory. The number and location of these installations varied widely among the respondents' jurisdictions but generally these installations were fewer than the permanent installations. Respondents reported that the tactical installations were installed in downtowns, commercial corridors, at priority Vision Zero intersections and at midblock locations in conjunction with rectangular rapid flashing beacons (RRFBs).

Tactical Curb Extensions with Roadway Mural Art

Respondents indicated that tactical curb extensions with roadway mural art were installed to reduce speed (37%), improve safety (37%), decrease pedestrian crossing length (26%), increase visibility (26%), and reduce curb radii (5%). A large proportion of respondents (74%) stated other reasons for installing tactical curb extensions with mural art, including improving aesthetics, improving walkability, ability to fill blank pavement space with paint, comparing how well they work with respect to permanent curb extensions, supporting local restaurants and dining, based on community requests, improving walking access and community cohesion, to designate a pedestrian priority area, to aid community building, adding public art, improving safety at school zones, improving neighborhood compatibility and quality of life. Respondents also stated that these are low cost, quick-build installations and as such are conducive for quick removal if the agency does not see immediate benefits.

Responses regarding the location of curb extensions with mural art were mixed. Several respondents indicated community interest and support as a significant factor in choosing locations for installation. Other factors include future locations of permanent projects, downtown business district, proximity to schools, and locations with high volumes of pedestrians.

Respondents of the survey were also asked about who typically installs the tactical curb extensions with mural art. Most respondents (72%) stated that the city or community installed them in collaboration with the community, while 22% stated that only the city or county installed them, while 6% were unsure. Thirty-two percent of responding agencies also reported having an inventory of installed tactical curb extensions with mural art.

Other Findings

Respondents were also asked if there was anything else that they would like to share with the research team. One agency noted that their tactical curb extension with mural art was universally liked but the temporary nature of the materials made it challenging to maintain. Their public works team did not have the resources to touch up the artwork, while trying to keep up with other responsibilities, so their Traffic and Parking Commission recommended removal. They plan to install a tactical curb extension in the future without the mural art.

Another agency also noted the challenges with temporary installations in their jurisdiction due to lack of resources both in terms of staff and operating budget. One respondent stated that mural art is resisted by city, county and state roadway/traffic engineers due to fears of distraction. They noted that art was not allowed in crosswalk or in wheel paths of vehicles but is allowed on shoulders, curb extensions or traffic circles. They also noted that murals have been used in limited instances but often the tactical curb extensions are painted with a red earth tone and are installed by local agencies on locally owned roadways (i.e., city or county owned) without consultation with the State DOT, as they are allowed to do so. Another respondent felt that State DOTs present the largest barrier to installing tactical curb extensions with mural art as they were not previously allowed in the MUTCD. However, the most recent edition allows a narrow set of designs. The respondent stated that they are waiting for local agencies to adopt them, and the State DOTs would follow suit.

One agency noted that treatments with just paint and/or delineators have not been effective in keeping vehicles out of pedestrian spaces. Another respondent noted that anecdotal information from residents was generally positive, and residents felt that the curb extensions improved safety by reducing the crossing distance and improved driver compliance due to improved pedestrian visibility. A couple of agencies noted that they plan to replace the tactical curb extensions with permanent curb extensions in the future. Some agencies are also experimenting with different surface materials for tactical curb extensions (e.g., gore markings, epoxy paint, barrier type) and suggested that there are advantages and disadvantages to each method, but having many different options is difficult to balance.

One agency noted that they had received feedback from the blind and low vision community, who noted it was important to be able to detect the difference between white paint of the crosswalk markings and unpainted pavement to safely navigate crossings. Recent research further raises concerns that people with vision disabilities may not recognize that a tactical curb extension even exists given that the placement of push buttons, curb ramps and detectable warning surfaces remain in place, and that often there are no other cues to aid them in finding where the new crossing location begins (Scott et al., 2025).

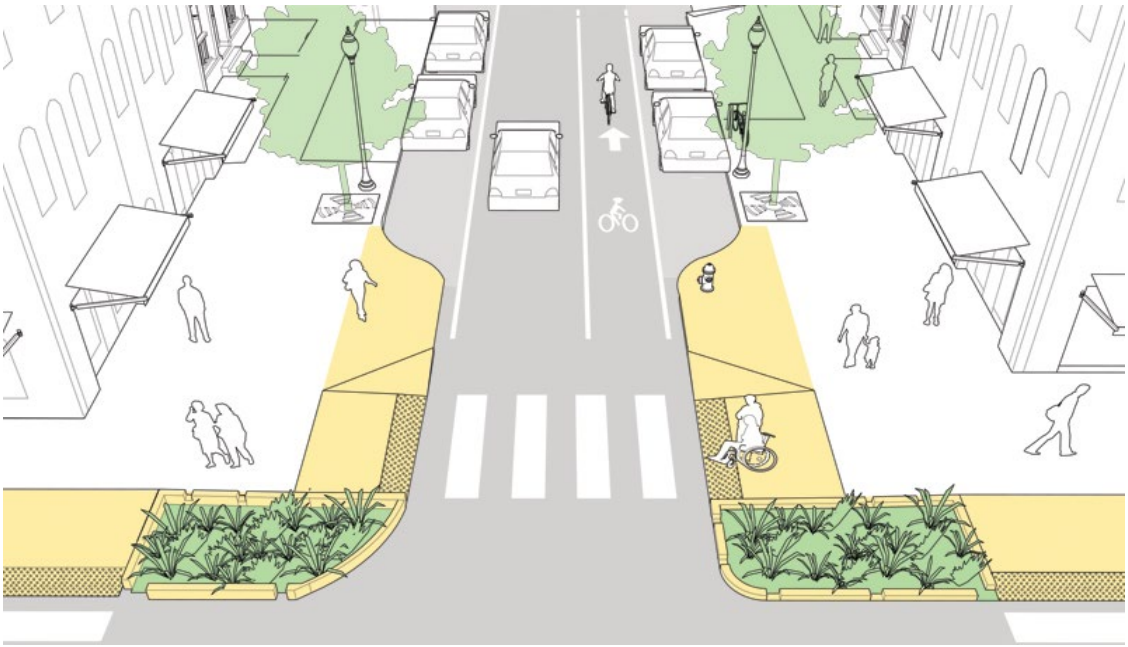
Several agencies directed us to publicly available reports or briefs. The findings from these documents are discussed in the following literature review section. One agency conducted an evaluation that has not yet been released and found an overall reduction in pedestrian injury crashes; however, they noted that an increase in pedestrian fatal and serious injury crashes.

Findings from Literature Review

Permanent Curb Extensions

A graphic of a curb extension from the National Association of City Transportation Officials (NACTO) *Urban Street Design Guide* is shown in Figure A4.

Figure A4 NACTO graphic of curb extension used as gateway treatment (Image: NACTO 2013)



As part of NCHRP 926 *(Guidance to Improve Pedestrian and Bicyclist Safety at Intersections)*, a scan was conducted of existing research on various intersection countermeasures - the report notes that no crash modification factor (CMF) exists for curb extensions, although limited research does show positive findings related to improved driver yielding (NCHRP Report 926, 2020). A 2016 survey of states

(primarily state pedestrian coordinators) conducted as part of the NCHRP Synthesis 498 (*Application of Pedestrian Crossing Treatments for Streets and Highways)* found that 94% use curb extensions in certain situations (*NCHRP Synthesis 498 2016*). Jurisdictions most often mentioned using this treatment in downtown and urban settings, or along main roads/trunk lines through towns and cities (6). Other criteria mentioned were high-pedestrian locations, and the need to shorten crossing distances/reduce pedestrian exposure. Several jurisdictions mentioned on-street parking as a requirement, which is consistent with the current recommended practice guides. One jurisdiction mentioned the need to consider drainage issues (*NCHRP Synthesis 498, 2016*). The 2022 survey found that 71% of transportation practitioners surveyed felt that a CMF was needed for curb extensions (Fitzpatrick et al, 2022). Studies looking at the efficacy of curb extensions have primarily focused on crashes, driver yielding, and pedestrian delay. Studies with findings on these outcomes are summarized in TABLE A2.

A recent broad safety evaluation from the New York City Department of Transportation (NYC DOT) compared three years of crash data before and two to three years of crash data after the installation of curb or sidewalk extensions for 266 locations in the city (*NYC DOT 2022*). Notably, the study included both permanent and tactical curb extensions because that they found similar results between the two types in preliminary analysis. That study found a reduction of 16.5% in average annual pedestrian injuries and 44.7% reduction in fatalities and severe pedestrian injuries. They also found a reduction in motor vehicle injuries of 10.1% for all and 24.1% for severe or fatal injuries. These reductions well exceed the citywide reductions of 0.4% for all injuries and 2.4% for severe and fatal injuries during this time period (*NYC DOT 2022*).

Other studies looking at more detailed evaluations of specific sites or sets of sites were more limited. It is worth noting that none of these studies is less than 10 years old. In general, studies have reported positive findings from curb extensions, ranging from reductions in the number of pedestrian crashes (Thompson and Heydon 1991 and King 1999) and severity of pedestrian crashes (King 1999). Two of three studies looking at yielding found improved driver yielding (Johnson 2005; van Hengel 2013), while one reported mixed results, with some sites showing decreased driver yielding possibly due to fluctuations in traffic conditions (Huang and Cynecki 2000).

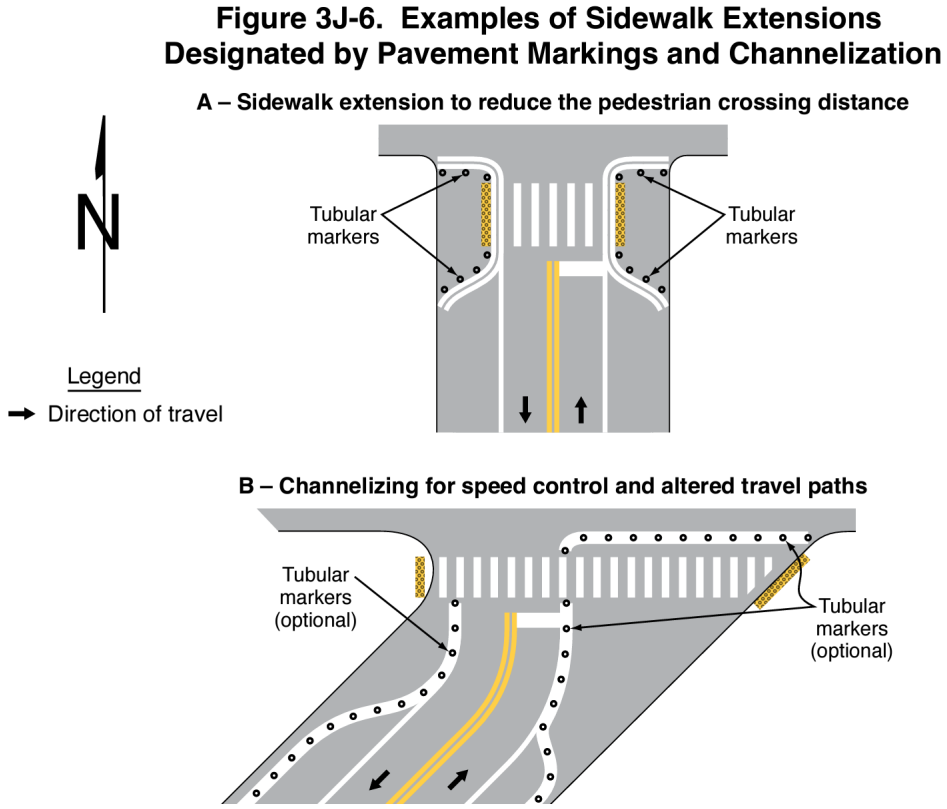
TABLE A2 Summary of findings from curb extension studies

Study	Site information	Key findings
NYC DOT (2022)	266 sites in New York, NY. Data from 2005-2018	17% fewer pedestrian (ped) injuries 45% reduction in fatalities and severe injuries. Reduction in motor vehicle occupant injuries (10% reduction for all injuries; 24% reduction for severe or fatal injuries)
Thompson and Heyden, 1991 (related by Davies (1999)	Nottingham, England. Number of locations not specified. Bulbout of 2.5 meters with guard rail at locations with prior poor visibility due to parked vehicles.	Ped crashes fell from 4.7 per year to 1 per year
King (1999)	6 sites in New York, NY	Overall crashes: 4 of 6 sites saw reductions in crashes; 4 of 6 saw reductions when factored for severity. Ped / vehicle crashes: 2 of 3 saw reduction in severity, and 1 saw an increase in severity.
Huang and Cynecki (2000)	2 sites in Cambridge, MA, and 2 sites in Seattle, WA.	Average ped. wait time decreased in Cambridge (not sig.); increased at Seattle locations. Percentage of peds using crosswalk – did not change at Cambridge locations (67% to 67% after), but decreased at Seattle locations (94% to 74%). Motorist yielding increased in Cambridge (not sig.) and decreased in Seattle (58% to 52%; not sig.). Seattle locations results likely affected by changes in traffic conditions.
Johnson (2005)	4 sites in Albany, OR. Crossings were of one-way, 2 lane roads	Peds had to wait for fewer vehicles to pass before a yield (1.81 in near lane with curb extension compared to 2.58 without). Percentage of peds crossing with a yield - insignificant improvement in (66.7% compared to 64.9% in near lane). Percentage of vehicles yielding at stop bar was higher with curb extension. (53.8% compared to 42.6%; not sig.)
van Hengel (2013)	1 site in Santa Barbara, CA (curb extension along with a pedestrian refuge island and stop bars)	Decrease in average ped delay (8 seconds to 4.9 seconds). Driver yielding - no change in near lane (10% to 13.5% of vehicles failed to yield); increase in far-lane driver yielding rates (38.5% before but 18% of vehicles failed to yield). Vehicles in both lanes yielded further back on average.

Tactical Curb Extensions

The MUTCD notes that the typical curb extension is created with physical infrastructure (e.g., concrete curb), but also recognizes those designated by pavement markings, consistent with tactical curb extensions. The MUTCD states that when adjoining curb and raised sidewalk are present, it can result in a multi-level sidewalk due to the difference in elevation between the adjoining pedestrian surfaces (FHWA 2023). The pavement markings used for tactical curb extensions differ from other paved areas designated by pavement markings that are used by motor vehicles (FHWA 2023). Figure A5 shows several example sidewalk extensions included in the MUTCD.

Figure A5 Examples of tactical type curb extensions in MUTCD, 11th Edition (Figure 3J-6)



The bulk of the research identified relating to tactical curb extensions is derived from agency or agency-affiliated evaluations and reports (See TABLE A3). Of the studies identified, four covered multiple sites/intersections, including studies in Portland, OR (10 locations), Columbus, OH (3 locations along one corridor), Chicago, IL (multiple locations long one corridor), and San Francisco, CA (8 locations), while several focused on a single intersection. The Portland study was premised on the objective of creating additional physical distancing space during the COVID-19 pandemic and asked survey respondents about maintaining social distancing - 64% said it was easier with the expanded corner (PBOT 2021).

Six studies were identified with behavioral, or safety findings related to tactical curb extensions, although most were brief (1-2 page) overviews of agency findings with limited methodology or other study process details. It should also be noted that the NYC DOT study described above included tactical style curb extensions but did not break them out separately from permanent curb extensions.

Two studies found changes in the number of reported crashes. The Columbus study reported on overall crashes (including motor vehicle-only crashes). Using one year of before and one year of after data, the study found that crashes in the corridor section with tactical curb extensions went from 27 total crashes before to 4 crashes after, while crashes on adjacent sections of the corridor remained relatively constant (dropping from 9 to 8). When considering the entire corridor, crashes were reduced 67% and injury crashes declined 83%. Analysis of before and after speeds showed 0-2 mph reduction in average speeds and 2-4 mph reduction in 85th percentile speeds. In addition to the tactical curb extensions at three locations, this Columbus project involved converting several 2-way stops to 4-way stops and adding new continental crosswalks (City of Columbus 2022). The assessment of the Chicago corridor reported on crash rates in 2016 (before changes including tactical curb extensions) and 2018 (after); they report a 16% reduction on all crashes (pedestrians are not reported separately in the report) (FHWA 2020).

Five studies reported on motorists yielding to pedestrians. Four agency studies all reported positive yielding results, including 25% to 42% increases in motorist yielding (FWHA 2020; SFMTA 2021; SFMTA 2022), and one reported a 100% yielding rate to pedestrians (*SFMTA 2019*). Green et al. (2019) report more details on their study process, which included before and after data over multiple days for at least one location - they used “difference-in-difference” analysis, an econometrics-based approach that looks at longitudinal difference in treatment and control locations and found no significant change in yielding with the addition of the tactical curb extension.

Four studies reported on vehicle speeds. Two studies looked at speeds along a corridor, rather than turning speeds; in Chicago, vehicles traveling above 30 mph decreased by 43% (FHWA 2020); while Green et al. (*2019)* report mixed findings on César Chávez Ave. in Los Angeles, with incidence of speeding increasing in one direction (westbound traffic) and decreasing in the other (eastbound). Two studies explored vehicle turning speeds: in SFMTA’s study of 8 locations in San Francisco, they found a 55% decrease in vehicle turning speeds at locations with tactical curb extensions (*SFMTA 2021)*; a brief focused on another San Francisco location (9th and Division St.) reported 98% of turning vehicles traveling at or below the speed limit (SFMTA 2018).

Other metrics described in the identified studies include a reduction in the number of turning motor vehicles coming within six feet of the curb, noted in the SFMTA study of eight tactical curb extension locations (2021), and a 50% reduction in vehicle-pedestrian interactions noted at one location in San Francisco (2022).

TABLE A3 Findings from tactical curb extension studies

Study	Site information	Key findings
Portland Bureau of Transportation (2021)	Expanded 10 corners using paint, flexposts and other markings as part of a COVID physical distancing initiative.	**Survey findings:** Conducted survey (137 responses) and 64% said it was easier to maintain social distancing with the expanded corner.
City of Columbus, Department of Public Service (2022)	Tactical curb extensions included in a set of safety improvements (included converting 2-way stops to 4-way stops) at 3 intersections on one corridor (Mt Vernon Ave.)	**Behavioral / safety findings:** All crashes reduced from 27 to 4 in the treatment area, compared to 9 to 8 in the rest of the area. Average speeds reduced 0-2 mph; 85th percentile speeds reduced 2-4 mph.
Chicago DOT / FHWA (2020)	Tactical curb extensions included in a set of safety improvements along a 1.5 mile stretch of Milwaukee Avenue in Chicago, IL	**Behavioral / safety findings:** 42% fewer people failing to stop for pedestrians in uncontrolled crosswalks; 60% more people crossing at two new crosswalks during the afternoon rush hour. 43% fewer people driving at > 30 mph; 16% more people driving at < 20 mph. 23% reduction in crashes involving people biking; 16% reduction in crashes for all modes.
SFMTA (2021)	Collected safety data before and after install of tactical curb extensions with khaki colored paint infill at 8 locations in SF	**Behavioral / safety findings:** Turning speeds reduced 55% (based on 100 vehicles' speeds collected via radar) Yielding increased 25% # vehicles turning w/in 6 feet of curb decreased 35%
SFMTA (2018)	1 location in SF (9th and Division St.) Protected Intersection.	**Survey findings:** 55% of peds reported increase comfort and feeling of safety (85% of bicyclists reported increases) **Behavioral / safety findings:** 100% of vehicles yielded to peds (96% approaching bicyclists yielded) 98% of turning vehicles at or below speed limit
SFMTA (2022)	1 location in SF (Jones Street)	**Behavioral / safety findings:** Before and after data collection - 50% decrease in vehicle / ped interactions. Yielding increased by 30% points
Green, Gase, Singh and Kuo 2019	Two intersections with a painted (red) curb extension and plastic bollard (St. Louis and César Chávez Ave.; and Mott and César Chávez Ave. in Los Angeles, CA).	**Behavioral / safety findings:** Study looking at pedestrian volumes and crossing behavior, motorist failure to yield and encroachment in crosswalks, and motorist speeds. 3.4% of pedestrians waited to cross in the curb extension area (post condition). No sig. difference in failure to yield or encroachment by motorists. Mixed speed results, with speeding increasing for westbound and decreasing for eastbound traffic.

Tactical Curb Extensions with Mural Art

An example of a location with a curb extension with mural art is shown in Figure A6.

Figure A6 Curb extensions with mural art in Washington, D.C.

The MUTCD notes that aesthetic surface treatments are sometimes used between the transverse lines within a crosswalk, in islands, medians, shoulders and within sidewalk extensions designated by pavement markings or in other areas outside of the traveled way (MUTCD 2023). Examples of materials used for the aesthetic surface treatments include brick, paving bricks, paving stones, or other materials designed to simulate such paving (MUTCD 2023). Some examples of geometries for aesthetic surface treatments include honeycomb, lattice, mesh, grid, and regular polygon patterns (MUTCD 2023). Commonly used colors for the aesthetic surface treatments include brick red, rust, brown, burgundy, clay, tan, or similar earth-tone equivalents (MUTCD 2023).

The MUTCD also lays down certain standards for aesthetic surface treatments including that they shall not interfere with traffic control devices; they shall not include a surface that can confuse pedestrians with vision disabilities that rely on tactile treatments or cues for navigation; colors used for aesthetic surface treatments shall be outside the chromaticity coordinates that define the ranges of acceptable colors for traffic control devices; patterns used for surface treatment shall not include advertising and contain elements of retroreflectivity; and patterns used for the aesthetic surface treatment shall not be designed to encourage users to remain in the crosswalk, engage or interact with the pattern or inhibit the users from crossing the street (MUTCD 2023).

The available research pertaining to curb extensions with mural art is quite limited. No academic studies were identified, and there are fewer agency-produced evaluations than for tactical curb extensions. Much of the available information comes from one or two-page summary briefs produced by community, education or advocacy type organizations based on pilot installations, along with a few similar brief overviews produced by transportation agencies. The identified studies are shown in TABLE A4.

Among the more rigorous of the studies identified is the Bloomberg Philanthropies & Sam Schwartz "Asphalt Art Safety Study" (2022). That study includes some before and after observational data (conflicts between pedestrian and turning vehicles, yielding rates, and pedestrian crossing locations), including three locations with mural art curb extensions. However, in each case, the before condition did not involve any curb extension at all, so the study does not isolate the impact of the mural art. Other confounding variables make understanding the mural art impact difficult: an intersection in Richmond, VA also included a painted intersection and curb extensions only on one corner; another in Pittsburgh, PA involved the addition of two new crosswalks (where none had been marked before) and the upgrade of two other crosswalks from parallel bars to continental crosswalks. It should also be noted that almost none of the other evaluations we found isolated the addition of mural art. Only one location (MICA Greenmount location) appeared to have a tactical curb extension in the pre period, however the extension in that location is not connected to a crosswalk.

Nine of the eleven identified studies / evaluations had some element of safety or behavioral findings based on observation. Safety and behavioral findings from the various site evaluations cover a variety of topics, from pedestrian-motor vehicle conflicts, vehicle yielding and speeds, pedestrian crossing distances and compliance with crossing in marked zones. Four of the eleven studies collected some type of survey data, although sample sizes were generally quite limited. Behavioral and safety findings are listed below.

Only the Bloomberg study (2022) sought to assess conflicts between pedestrians and turning motor vehicles. Of the three mural art curb extension sites, two experienced significant drops in conflicts, while one experienced a slight increase. As noted above, the before conditions did not include any curb extension, so it is unclear if these results are related to the mural art. No other evaluations examined conflicts.

Two of the Bloomberg sites were unsignalized (locations in Pittsburgh, PA and Lancaster, PA), and yielding rates were mostly unchanged from prior to the addition of the curb extensions (2022). At three sites in Baltimore, rates of vehicles yielding to pedestrians increased significantly, going from 29% to 74% at one site (MICA 2021), and increasing from 40% to 68% and 35% to 85% at two locations on Valley Street (MICA 2022). The sample sizes of these observations were quite low, with all being below 40 vehicles per site per condition (i.e., before or after), except for the Lancaster, PA site, which had 93 observations in the after condition.

Three of the studies provided data on changes in vehicle speed, although none specifically looked at turning vehicle speeds. At a location in Tucson, AZ, which included a long, painted median along with mural art curb extensions, midblock 85th percentile speed dropped from 27 to 22 mph and the average speed dropped from 24 mph to 18 mph. (Barker-Winkworth 2023). A location in Kahului, HI, had a 7% decrease in average vehicle speed during peak hours (Ulupono Initiative 2021a). In Fort Lauderdale, FL, 85th percentile speeds dropped from 40 mph to 35 mph for vehicles traveling northbound and from 34 mph to 31 mph for southbound vehicles, and average speeds dropped from 27 to 22 mph northbound and 21 to 19 mph southbound (City of Fort Lauderdale 2022).

Crossing distance and pedestrian crossing/exposure times were reported in four evaluations and were essentially a direct result of the reduction in crossing length due to the extensions. One report from Baltimore noted that crossing distance was reduced from between 40 and 44 feet to between 20-22 feet (MICA 2022). Several studies of single locations reporting on percentage decrease in crossing distance or crossing times, with reductions in crossing distance of between 15% up to 66%, and reductions in crossing time of between 15% to 60% (MICA 2022; Ulupono Initiative 2023; Ulupono Initiative 2021b).

Several studies looked at the compliance of pedestrians relating to crossing in marked crosswalks. In the Bloomberg study (2022), two sites had minor improvements in compliance of pedestrians using the marked crossings (from already high compliance rates), while a third site saw a small reduction in compliance. Three locations in Baltimore, MD, reported considerable reductions in the percentage of pedestrians crossing outside marked crosswalks, dropping from 35% to 10% at the intersection of E. Chase at Valley, from 28% to 17% at the intersection of E. Biddle at Valley, and from 63% to 25% at the intersection of Whitelock St. at Brookfield Ave. (MICA 2021; MICA 2022). An intersection in Beverly Hills, CA, with a scramble phase for pedestrians noted that the percentage of pedestrians using the scramble increased from 71% to 80% after installing curb extensions with mural art (Mobility Beverly Hills 2021).

Some of the studies employed surveys to assess pedestrians' sense of safety and general views toward tactical curb extensions with mural art. The results provide some mixed results, though with some data limitations. One study surveyed 32 people before and 50 after an intersection received tactical curb extensions and a median with mural art (Barker-Winkworth 2023). Results indicated that the proportion of who felt safe had decreased in the after condition, however the author noted that sampling differences may play a confounding role - the after sample had more people to walk on the street frequently (compared to occasional users) and were more likely to have observed drivers speeding. Two site

evaluations in Baltimore found an increased perception of safety for pedestrians (MICA 2022; Mobility Beverly Hills 2021); however, both had very limited samples - one was based on an informal sampling of intercepted community members, and another based on a community survey with 30 respondents. Finally, a survey at the Beverly Hills site (Mobility Beverly Hills 2021) noted mixed findings on a general survey of people walking, driving by, or visiting the intersection (n=240), with 54% saying the changes made the intersection more pleasant, but a similar percentage (51%) saying the city should spend the money on other services. A more limited sample of businesses (n=32) was more positive, with 59% of respondents agreeing that this type of treatment near their business would make it more appealing for their customers (30% disagreed), and 56% agreeing it would create a stronger sense of community (33% disagreed).

TABLE A4 Curb extension with mural art studies

Study	Site information	Key findings
Bloomberg Philanthropies & Sam Schwartz (2022)	3 locations with mural art and curb extensions included in behavioral study: Richmond, VA W. Marshal St. and Brook Rd. - signalized; Pittsburgh, PA Roup Ave., S. Fairmont St. & Harriet St. - unsignalized; Lancaster, PA Strawberry and Vine St. - unsignalized	**Behavioral / safety findings:** **Richmond VA site**: Conflicts dropped from 14 to 6 (56%), including 5 to 1 deemed "high crash potential" and 9 to 5 deemed "low crash potential"; Decrease in peds crossing outside marked crossings (21% to 11%). Decrease in crossing against the signal (from 1.5% to 0.3%) **Pittsburgh, PA site**: Conflicts dropped from 12 to 6 (all "low crash potential"); Roughly similar driver yielding (92-93%) before and after; Decrease in peds crossing outside marked crossings (10% to 6%) **Lancaster, PA site**: Conflicts increased from 4 to 6 (all "low crash potential"); Slight increase in driver yielding, going from 69% before to 76% after. Increase in peds crossing outside marked crossings (17% to 21%)
Barker-Winkworth (2023)	South 6th Ave, in Tucson, AZ. Curb extension with mural art, along with painted (art) median and midblock crossing.	**Survey findings:** In an intercept survey, the percentage reporting feeling safe actually decreased after installation. More frequent users were more likely to have noticed drivers speeding and find it difficult to cross the street (both before and after) **Behavioral / safety findings:** 85th percentile speed dropped from 27 to 22 mph, and 6 mph drop in average speed (midblock)
MICA Center (2022)	3 locations in Baltimore, MD near Johnston Square Park: E. Chase St.	**Survey findings:** Informal interviews with community members found an increased stated sense of safety.

Study	Site information	Key findings
	at Wilcox Street; E. Chase St. at Valley Street; E. Biddle St. at Valley Street.	**Behavioral / safety findings:** Crossing distance reduced from 40-44 feet to 20-22 feet. **E. Chase at Valley**: Decrease in peds crossing outside marked crossings (35% to 10%); Increase in cars yielding (40% to 68%) **E. Biddle at Valley:** Decrease in peds crossing outside marked crossings (28% to 17%); Increase in cars yielding (35% to 85%)
MICA Center (2021) Graham Projects (2022)	1 location in Baltimore, MD: Whitelock St. at Brookfield Ave. Curb extension area AND crosswalk had mural art.	**Behavioral / safety findings:** Decrease in peds crossing outside marked crossings (63% to 25%) Increase in cars yielding (29% to 74%)
MICA Center (2020)	1 location in Baltimore, Greenmount Ave. and Oliver St.	**Survey findings:** Community survey sent via email, newsletters and Nextdoor. (n=30) 93% said cars drive slower. 85% said they now feel safer as pedestrians and cyclists.
City of Honolulu (n.d.)	King St. at Haka St. in Honolulu, HI.	**Behavioral / safety findings:** Reported 15-40% decrease in crossing distance and 15-20% reduction in crossing time after curb extension with mural art installed
Ulupono Initiative (2023)	Prospect St. at Prospect Pl., Honolulu, HI. By R.L. Stevenson Middle School.	**Behavioral / safety findings:** Crossing distance dropped by 20-40% depending on crossing direction. Exposed cross time decreased 55%.
Ulupono Initiative (2021a)	S. Papa Ave. and Ma'alo St., Kahului, HI. By Lihikai Elementary School	**Behavioral / safety findings:** Vehicle speeds decreased by 7% at peak hours after install
Ulupono Initiative (2021b)	Hailipo St. at Papipi Rd., Ewa Beach, HI.	**Behavioral / safety findings:** Crossing distance dropped by 60-66%.; Crossing time decreased by 47-60%.
Mobility Beverly Hills (2021)	Camden Drive at Brighton Way in Beverly Hills, CA. Intersection includes a scramble signal and marked diagonal crosswalks.	**Survey findings:** General survey respondents (n=240) were split on liking the project (54% said it's more pleasant for people of all ages and ability, compared to 37% disagreeing; 51% said the city should spend the money on other services). In a survey of businesses (n=32), 59% of respondents agreed that this type of treatment near their business would make it more appealing for their customers (30% disagreed), while 56% agreed it

Study	Site information	Key findings
		would create a stronger sense of community (33% disagree) **Behavioral / safety findings:** Location with scramble crossing, saw the percentage of pedestrians using scramble increase from 71% to 80%.
City of Fort Lauderdale (2022)	NE 15th Ave. at NE 11th St., Fort Lauderdale. Location with tactical mural buffer (bike lane) and median island which provides some elements of tactical curb extension	**Behavioral / safety findings:** 85th percentile speeds dropped ~10% to 15% (from 40 mph to 35 mph for NB vehicles and from 34 mph to 31 mph for SB vehicles). Average speed dropped from 27 to 22 mph (NB) and 21 to 19 mph (SB).

Curb Extension Components or Adjacent Elements

Tactical curb extensions with mural art contain some components of other design elements that are associated with positive pedestrian safety findings. For example, tactical curb extensions tend to reduce the curb radius for turning vehicles. Fitzpatrick et al. (2022) found that large curb radii were associated with increased speeds and increased pedestrian crash risk, suggesting a 59% increase in crash risk when a curb radius goes from 10 ft to 70 ft. Thomas et al. (2016) found that 64% of states and 78% of local jurisdictions use curb radius reductions as a safety measure. Curb extensions also generally provide more open space for vehicle drivers and pedestrians to see and be seen by one another. This improved visibility, sometimes referred to as daylighting, is associated with a 30% reduction in vehicle-pedestrian crash risk (0). Finally, curb extensions effectively reduce the crossing distance for pedestrians. Harwood et al. (2008) found that the crossing distance, and specifically the number of lanes crossed, is positively associated with increased pedestrian crash risk.

Key Findings from State of Practice Review

In our scan we found that most agencies have installed permanent (89%) and tactical (83%) curb extensions, while about half (54%) have installed curb extensions with mural art. Consistently, the reasons stated for installing curb extensions related to reducing motorist speeds, improving safety, reducing pedestrian crossing lengths, and increasing visibility. For tactical curb extensions, low costs and the ability to quick-build and test installations were commonly cited. For tactical curb extensions with mural art, improving aesthetics and community livability through the addition of art were frequently mentioned.

While the existing agency reports generally find positive results, for example increased vehicle yielding, reduced speeds, and reductions in pedestrian crossing distance and time, there are still very few

rigorous studies of safety and curb extensions, particularly across multiple contexts or jurisdictions. Even for the permanent curb extension application, there are few studies.

For curb extensions with mural art, existing guidance (e.g., from MUTCD) suggests that aesthetic treatments should conform to a limited set of repetitive patterns and generally use earth-tone colors. However, these limiting conditions, implicitly encouraging designs that do not "stand out", run counter to some of the primary stated objectives of agencies that are installing curb extensions with mural art – namely to create a sense of place and community (while addressing community safety). Existing research through this review and scan suggests that mural art curb extensions can be effective from a safety standpoint; however more rigorous study is needed.

Very few tactical curb extension studies (with or without mural art) contained any type of control or specific measures to isolate the impact of specific elements of the designs, such as isolating the impact of the tactical curb extensions from broader corridor changes, or the impact of mural art from the tactical curb extension generally. Much of the available research, particularly for tactical curb extensions and those with mural art are based on very limited samples, for example only one or a few locations. Agency reports often lack detailed methodological information, such as the days, times, and hours, or method of any observations, as well as limited information on how survey respondents were recruited or presented with questions.

Many of the agency reports referencing reductions in crossing distance appear to be basing the findings on the distance from the edge of the curb extension to the far side of the street (or corresponding curb extension on the receiving end); although as noted, with the limited methodology descriptions it is not always clear how these findings are determined. However, the location of the pedestrian waiting to cross, and in particular if they wait within the curb extension area, was rarely reported.

There is clearly a need for more rigorous evaluations to better understand the safety implications of these installations.

The scan of agencies also uncovered some logistical and other challenges. For example, agencies may lack the staff capacity to maintain mural artwork. Roadways engineers may resist installing mural art in curb extensions due to fears that it could distract drivers, which is likely at least in part related to the limitations in place from engineering guidance documents such as the MUTCD. Another concern relates to the impact of tactical curb extensions on the ability of people with vision or mobility impairments to safely navigate the crossings.

References for State of Practice Review

Barker-Winkworth, L. (2023). *Enhancing Pedestrian Safety with Tactical Urbanism* [Capstone, University of Arizona College of Architecture, Planning & Landscape Architecture]. https://repository.arizona.edu/bitstream/handle/10150/668175/SBE_2023_Capstone_Thesis_Barker-Winkworth.pdf

Bloomberg Philanthropies & Sam Schwartz. (2022). *Asphalt Art Safety Study: Historical Crash Analysis and Observational Behavior Assessment at Asphalt Art Sites*. Bloomberg Philanthropies. https://trid.trb.org/View/1946734

City of Columbus, Department of Public Service. (2022). *Tactical Urbanism Results*. https://bronzevillemoves.com/wp-content/uploads/2023/06/Mt-Vernon-Ave-Tactical-Urbanism-Results-29Nov2022.pdf

Davies, D. G. (1999). *Research, development, and implementation of pedestrian safety facilities in the United Kingdom* (FHWA-RD-99-089, Synthesis report). https://rosap.ntl.bts.gov/view/dot/14266

Federal Highway Administration. *Manual of Uniform Traffic Control Devices*, 2023. https://mutcd.fhwa.dot.gov/pdfs/11th_Edition/mutcd11thedition.pdf

Federal Highway Administration. (2020). *Milwaukee Avenue Rapid Delivery Approach — Chicago, Illinois*. FHWA-SA-20-007. https://safety.fhwa.dot.gov/zerodeaths/docs/Chicago_RapidDelivery_Final_508.pdf

Fitzpatrick, K., Avelar, R., Pratt, M. P., Das, S., Lord, D., & Texas A&M Transportation Institute. (2022). *Crash Modification Factor for Corner Radius, Right-Turn Speed, and Prediction of Pedestrian Crashes at Signalized Intersections* (FHWA-HRT-21-105). https://rosap.ntl.bts.gov/view/dot/59936

City of Fort Lauderdale. (2022). *NE 15th Avenue, Fort Lauderdale Tactical Case Study Story of completing a street* StoryMap: https://storymaps.arcgis.com/stories/c3fd2a2efe924a3783c9af0244cb92be

Gan, A., Shen, J., & Rodriguez, A. (2005). *Update of Florida Crash Reduction Factors and Countermeasures to Improve the Development of District Safety Improvement Projects* (FDOT 99700-3596-119). FDOT. https://trid.trb.org/view/758027

Graham Projects. (2022). *Whitelock: Seasonal Turn. A Graham Projects Case Study*. https://grahamprojects.com/wp-content/uploads/2022/02/220118-Graham-Projects-Case-Study-Whitelock-Seasonal-Turn.pdf

Green, G., Gase, L. N., Singh, C., & Kuo, T. (2019). Evaluating streetscape modifications in Los Angeles, California with a health lens. *Californian journal of health promotion*, *17*(1), 10-23. https://journals.calstate.edu/cjhp/article/view/2220

Harwood, D.W., Bauer, K.M., Richard, K.R., Gilmore, D.K., Graham, J.L., Potts, I.B., Torbic, D.J. and Hauer, E., 2008. *Pedestrian safety prediction methodology* (No. NCHRP Project 17-26).

City of Honolulu. (n.d.) *Kalihi Quick Build Complete Streets Project*. https://www.honolulu.gov/rep/site/dts/tpd/tpd_docs/Kalihi_Quick_Build_One_Pager.pdf

Huang, H. F., & Cynecki, M. J. (2000). Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior. *Transportation Research Record*, *1705*(1), 26–31. https://doi.org/10.3141/1705-05

Johnson, R. S. (2005). *Pedestrian safety impacts of curb extensions: A case study: final report.* (FHWA-0R-DF-06-01). https://rosap.ntl.bts.gov/view/dot/22856

King, M. R. (1999). Calming New York City Intersections. *Transportation Research Board Circular E-CO19: Urban Street Symposium*. https://onlinepubs.trb.org/onlinepubs/circulars/ec019/ec019.pdf

MICA's Center for Social Design; Maryland Department of Transportation's Highway Safety Office; the Neighborhood Design Center. (2020). *Greenmount West Bright Lane Evaluation*. https://static1.squarespace.com/static/6216756c173a54045bda9b2f/t/62a78e650c4ee74de1985133/1655148133437/Greenmount+West+Bright+Lane+Evaluation.pdf

MICA's Center for Social Design; Maryland Department of Transportation's Highway Safety Office; the Neighborhood Design Center. (2022). *Johnston Square "Bee Safe" Art Crosswalk Evaluation Report*. https://static1.squarespace.com/static/6216756c173a54045bda9b2f/t/62a7826258c9cb53c2fc35f4/1655145082442/Johnston+Square+Bee+Safe+Evaluations.pdf

MICA's Center for Social Design; Maryland Department of Transportation's Highway Safety Office; the Neighborhood Design Center. (2021). *Reservoir Hill Art in the Right of Way Evaluation*. https://static1.squarespace.com/static/6216756c173a54045bda9b2f/t/62a78e2c3cf4f444887ba38d/1655148079071/Reservoir+Hill+Bright+Lane+Evaluation.pdf

Mobility Beverly Hills. (2021). *Beverly Hills Pedestrian & Bicycle Awareness Campaign* (2021).

National Association of City Transportation Officials. *Urban Street Design Guide*, 2013.

New York City Department of Transportation. (2022*). Safety Treatment Evaluation (2005-2018).* https://www.nyc.gov/html/dot/downloads/pdf/safety-treatment-evaluation-2005-2018.pdf

Portland Bureau of Transportation. (2021). *Safe Streets Initiative: Evaluation Report*. https://www.portland.gov/transportation/safestreetspdx/documents/safe-streets-initiative-evaluation-report-public-review/download

Sanders, R. L., Schultheiss, B., Judelman, B., Burchfield, R., Nordback, K., Gelinne, D., Thomas, L., Carter, D., Zegeer, C., Semler, C., Sanders, M., Steyn, H., Ryus, P., Hunter, W. W., & Koonce, P. (2020). *Guidance to Improve Pedestrian and Bicyclist Safety at Intersections* (926; NCHRP Research Report). Transportation Research Board. http://www.trb.org/Main/Blurbs/180624.aspx

Scott, A. C., Myers, L., Schroeder, B., Worth O'Brien, S., Kent, M., Mello, M., & Bentzen, B. L. (Beezy). (2024). Making Quick-Build Sidewalk Extensions Accessible to Pedestrians with Vision Disabilities. *Transportation Research Record: Journal of the Transportation Research Board*, *2679*(3), 175-188. https://doi.org/10.1177/03611981241275539

SFMTA. (2018). *9th and Division Street Protected Intersection Project Evaluation Fact Sheet*. https://www.sfmta.com/reports/9th-and-division-street-protected-intersection-project-evaluation-fact-sheet

SFMTA. (2022) *Jones Street Quick-Build project*. https://www.sfmta.com/sites/default/files/reports-and-documents/2023/09/jones_street_quick-build_project_evaluation_factsheet.pdf

SFMTA. (2021). *Painted Safety Zones Three Ways Painted Safety Zones Make People Safer*. https://www.sfmta.com/reports/painted-safety-zones-initial-evaluation

Thomas, L., Thirsk, N. J., & Zegeer, C. V. (2016). *NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways*. Transportation Research Board. https://doi.org/10.17226/24634

Thompson, S.J. and Heydon, S. (1991) Improving Pedestrian Conspicuity by Use of a Promontory, *Traffic Engineering + Control.* 1991/08, pp 472-478

Ulupono Initiative. (2021a). *Papa Avenue Quick Build Kahului*. https://ulupono.com/media/xkkavvde/papa-ave-quick-build-project-09-23-21.pdf

Ulupono Initiative. (2021b). *Papipi Road Quick Build Ewa Beach*. https://ulupono.com/media/xcpp5sr4/papipi-quick-build-project-case-study.pdf

Ulupono Initiative. (2023) *RL Stevenson Middle School Quick Build*. https://ulupono.com/media/5koodgy2/stevenson-ms-quick-build-summary-report-d3-2.pdf

van Hengel, D. (2013). Build It and They Will Yield: Effects of Median and Curb Extension Installations on Motorist Yield Compliance (13–3084). Article 13–3084. *Transportation Research Board 92nd Annual Meeting Transportation Research Board*. https://trid.trb.org/view/1241821

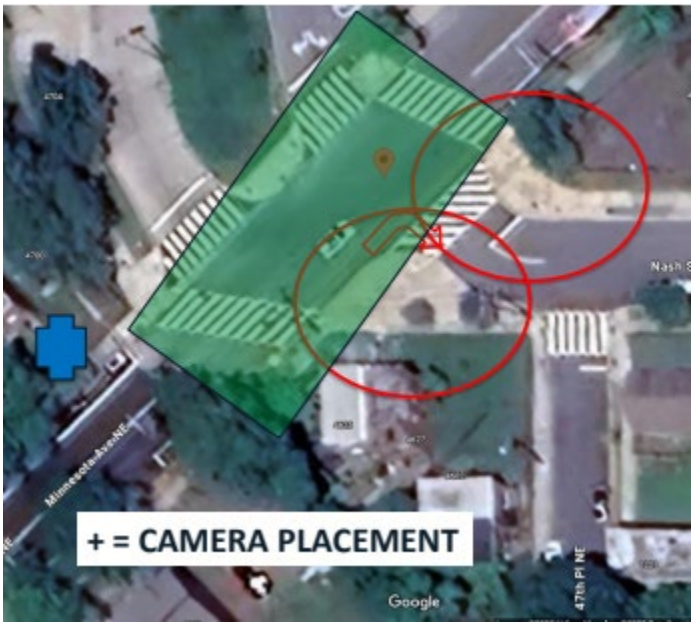
Appendix B Site Diagrams and Video Screenshots

Appendix B.1 Permanent Curb Extension Intersections

12th St NE & Quincy St NE

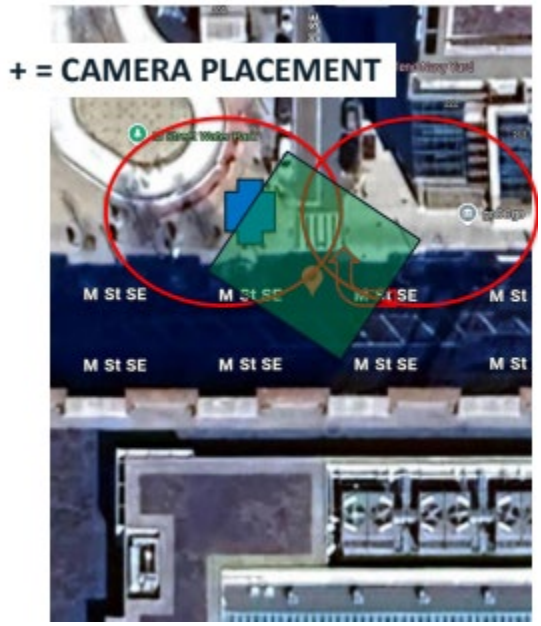
18th St NW & Wyoming AVE NW

Minnesota Ave NE & Nash St NE



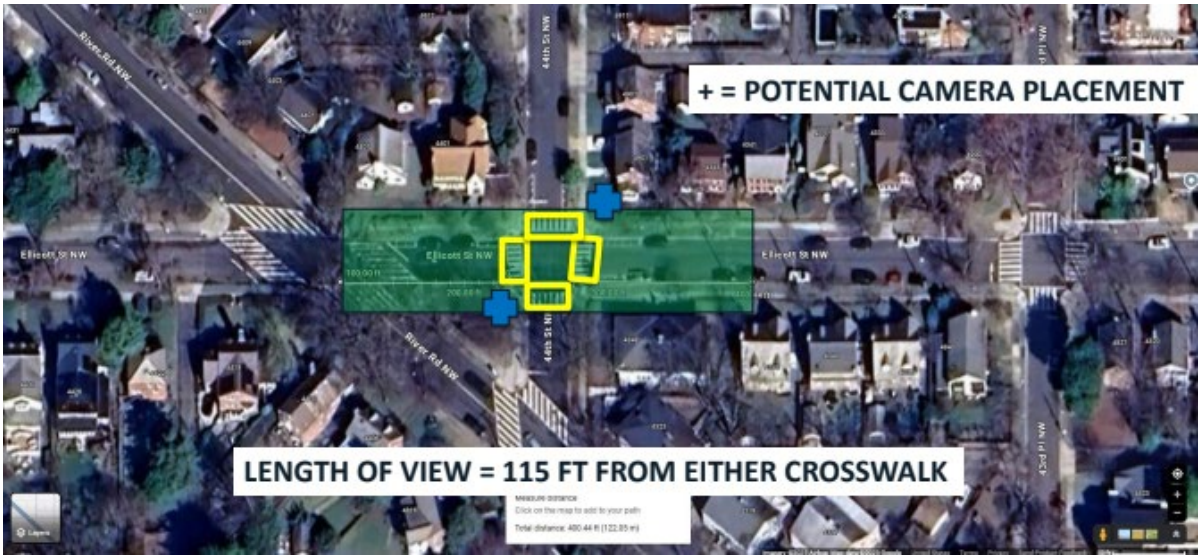
14th St NW & Riggs St NW

M St SE & 2nd Pl SE

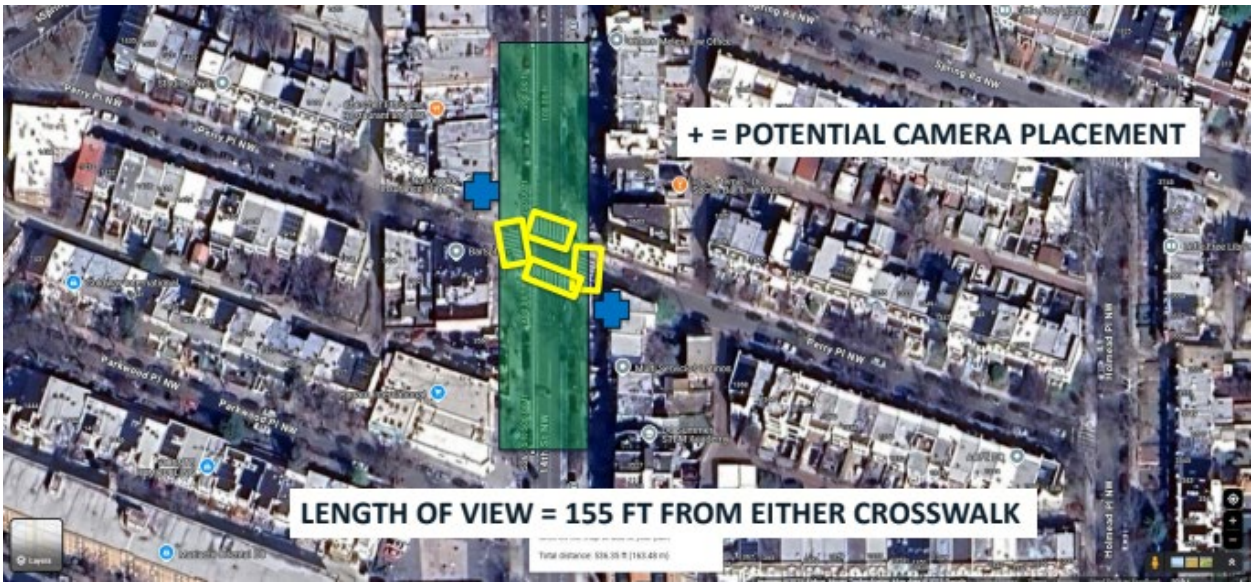


Appendix B.2 Tactical Curb Extension Intersections

Ellicott St NW & 44th St NW



14th St NW & Perry Pl NW



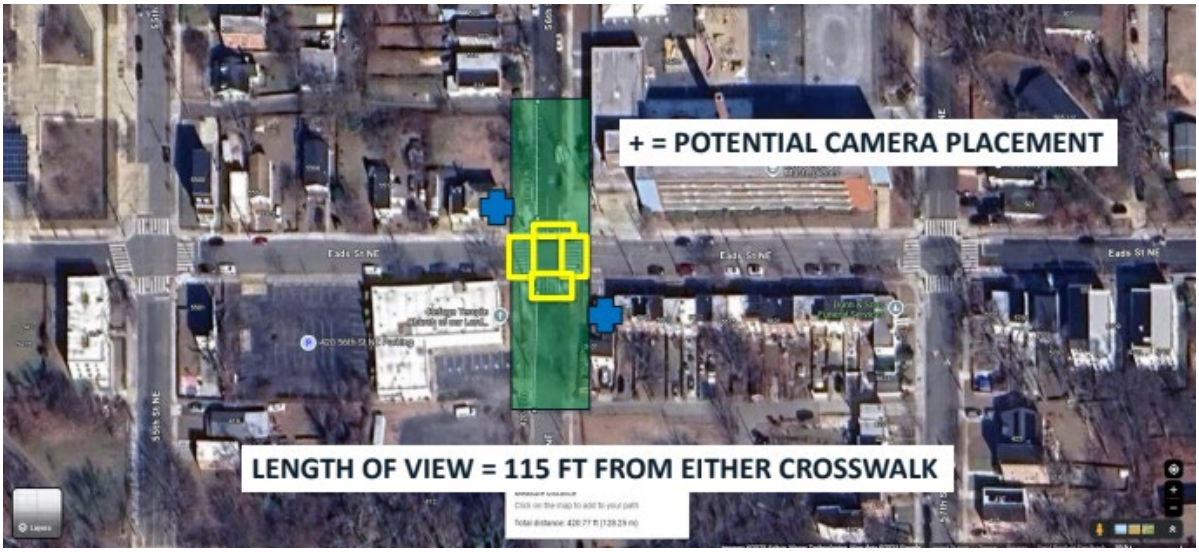
15th St NW & N St NW

Minnesota Ave SE & 27th St SE

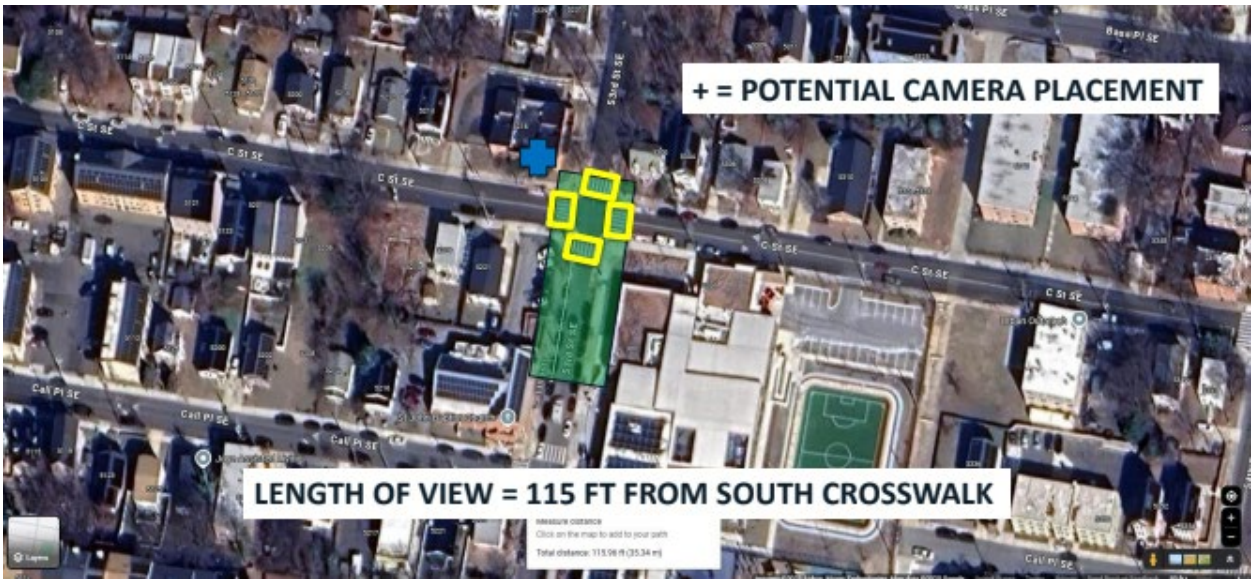
12th St NE & Shepherd St NE

Appendix B.3 Mural Art Curb Extension Intersections

56th St NE & Eads St NE



53rd St SE & C St SE



57th St NE & Eads St NE

Texas Ave SE & B St SE

15th St NW & Church St NW

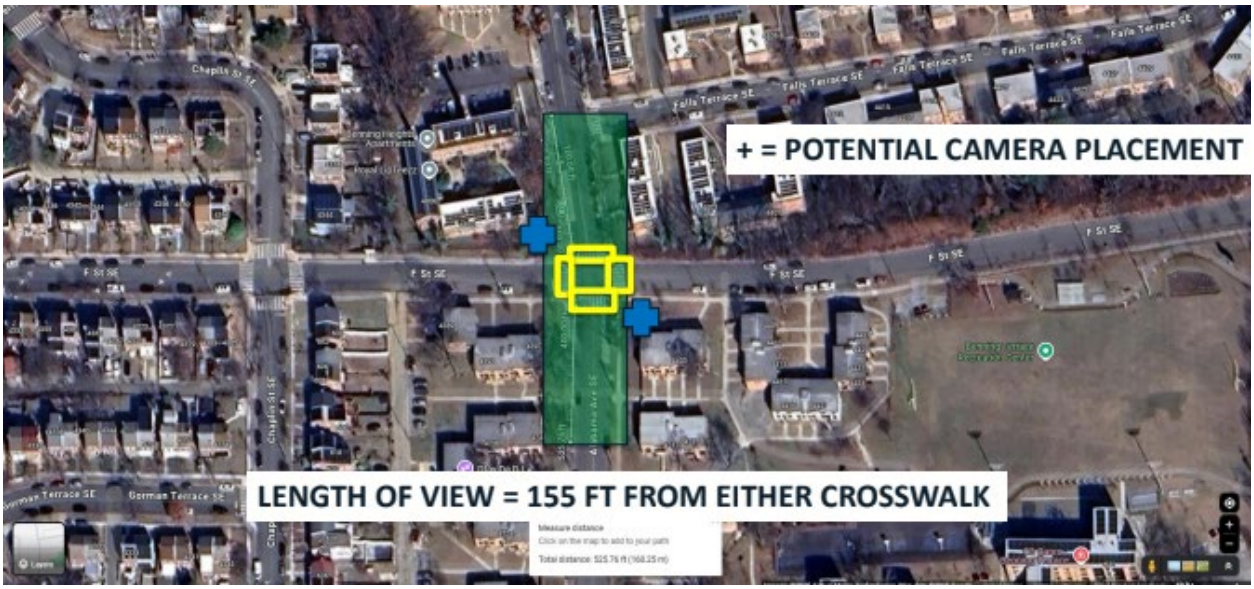
Appendix B.4 Control Intersections

12th Pl NE & Upshur St NE

Texas Ave SE & Dubois Pl SE

45th St NW & Ellicott St NW

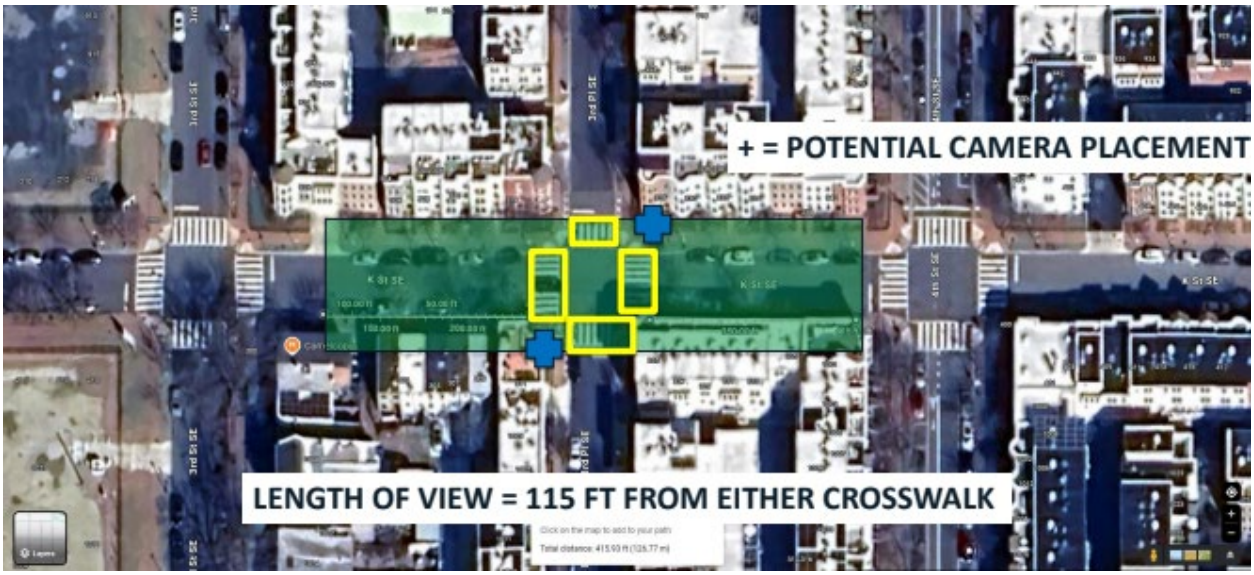
Alabama Ave SE & F St SE



13th Ave NW & Corcoran St NW

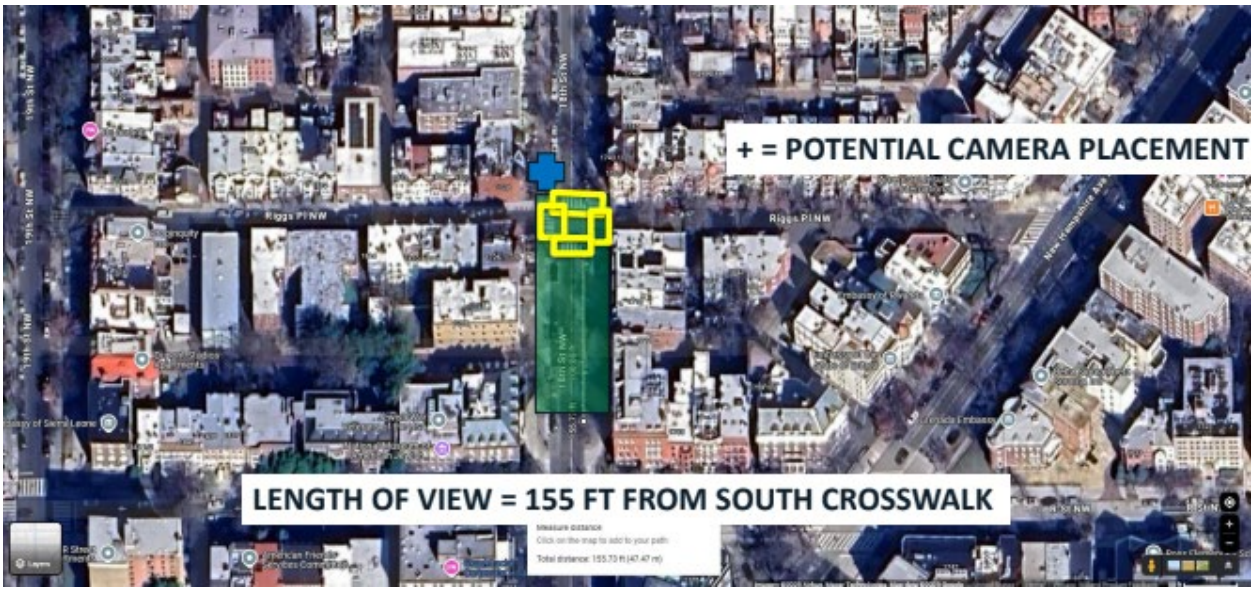
58th St NE & Eads St NE

K St SE & 3rd Pl SE



53rd St SE & Call Pl SE

18th St NW & Riggs Pl NW



53rd St SE & Drake Pl SE

Appendix C Crossing Details

TABLE C1 Summary of crossing details

Intersection type	Location	Crossing	Crossing distance	Directionality of traffic	Number of lanes	Curb Ext.	Control	Speed Limit (mph)	Total Ped. count	Ave. hourly MV count
Permanent	12th St NE & Quincy St NE	N	38 ft	two-way	2	Permanent	Uncontrolled	25	62	238
		S	42 ft	two-way	2	Permanent	Uncontrolled	25	63	218
		E	35 ft	two-way	2	None	Stop	20	100	66
		W	39 ft	two-way	2	None	Stop	20	94	69
	18th St NW & Wyoming Ave NW	N	34 ft	two-way	2	Permanent	Uncontrolled	25	122	234
		S	35 ft	two-way	2	Permanent	Uncontrolled	25	150	234
		W	31 ft	one-way	1	Tactical	Stop	20	535	99
	Minnesota Ave NE & Nash St NE	SE	37 ft	two-way	2	Permanent	Stop	20	73	6
	14th St NW & Riggs St NW	N	54 ft	two-way	4	Permanent	Uncontrolled	20	155	854
		E	28 ft	one-way	1	None	Stop	20	na*	17
	M St SE & 2nd Pl SE	N	21 ft	two-way	2	Permanent	Stop	20	1317	16
Tactical	Ellicott St NW & 44th St NW	N	20 ft	two-way	2	Tactical	Stop	20	28	26
		S	21 ft	two-way	2	Tactical	Stop	20	22	22
		E	20 ft	two-way	2	Tactical	Uncontrolled	20	94	39
		W	25 ft	two-way	2	Tactical	Uncontrolled	20	43	32
	14th St NW & Perry Pl NW	N	37 ft	two-way	2	Tactical	Uncontrolled	25	80	267
		S	39 ft	two-way	2	Tactical	Uncontrolled	25	87	322
		E	14 ft	one-way	1	Tactical	NA	20	261	0
		W	12 ft	one-way	1	Tactical	Stop	20	459	45

Intersection type	Location	Crossing	Crossing distance	Directionality of traffic	Number of lanes	Curb Ext.	Control	Speed Limit (mph)	Total Ped. count	Ave. hourly MV count
	15th St NW & N St NW	N	58 ft	one-way	3	Tactical	Uncontrolled	20	148	0
		S	56 ft	one-way	3	Tactical	Uncontrolled	20	173	637
		E	19 ft	two-way (bikes), one-way (motor vehicles)	1	Tactical	NA (MVs); Stop (bikes)	20	719	1
		W	34 ft	two-way	2	None	Stop	20	na*	22
	Minnesota Ave SE & 27th St SE	NE	31 ft	two-way	3	Tactical	Uncontrolled	25	30	555
		S	20 ft	one-way	1	Tactical	Stop	20	161	69
	12th St NE & Shepherd St NE	N	24 ft	two-way	2	Tactical	Uncontrolled	25	23	321
		S	24 ft	two-way	2	Tactical	Uncontrolled	25	19	180
		E	20 ft	two-way	2	Tactical	Stop	20	80	44
		W	22 ft	two-way	2	Tactical	Stop	20	128	35
Mural	56th St NE & Eads St NE	N	20 ft	two-way	2	Tactical/ Mural	Uncontrolled	20	130	13
		S	20 ft	two-way	2	Tactical/ Mural	Uncontrolled	20	54	3
		E	24 ft	two-way	2	Tactical/ Mural	Stop	20	49	32
		W	24 ft	two-way	2	Tactical/ Mural	Stop	20	26	21
	53rd St SE & C St SE	N	16 ft	one-way	1	Tactical/ Mural	Uncontrolled	20	23	0
		S	15 ft	one-way	1	Tactical/ Mural	Uncontrolled	20	39	90
		E	20 ft	two-way	2	Tactical/ Mural	Stop	20	122	11
		W	20 ft	two-way	2	Tactical/ Mural	Stop	20	54	12

Intersection type	Location	Crossing	Crossing distance	Directionality of traffic	Number of lanes	Curb Ext.	Control	Speed Limit (mph)	Total Ped. count	Ave. hourly MV count
	57th St NE & Eads St NE	N	24 ft	two-way	2	Tactical/ Mural	Uncontrolled	20	83	9
		S	24 ft	two-way	2	Tactical/ Mural	Uncontrolled	20	42	15
		E	22 ft	two-way	2	Tactical/ Mural	Stop	20	20	26
		W	22 ft	two-way	2	Tactical/ Mural	Stop	20	54	21
	Texas Ave SE & B St SE	S	23 ft	two-way	2	Tactical/ Mural	Uncontrolled	25	43	209
		E	18 ft	two-way	2	Tactical/ Mural	Stop	20	165	12
	15th St NW & Church St NW	N	54 ft	one-way	3	Tactical	NA	20	na*	0
		S	46 ft	one-way	3	Tactical/ Mural	Uncontrolled	20	314	600
		E	16 ft	one-way	1	Tactical/ Mural	Stop	20	640	51
		W	19 ft	one-way	1	None	NA	20	na*	0
Control	12th Pl NE & Upshur St NE	N	22 ft	two-way	2	None	Stop	20	72	12
		S	22 ft	two-way	2	None	Stop	20	36	8
		E	28 ft	two-way	2	None	Uncontrolled	20	19	30
		W	28 ft	two-way	2	None	Uncontrolled	20	24	48
	Texas Ave SE & Dubois Pl SE	S	39 ft	two-way	2	None	Uncontrolled	25	18	210
		W	35 ft	two-way	2	None	Stop	20	86	6
	45th St NW & Ellicott St NW	N	33 ft	two-way	2	None	Uncontrolled	20	15	22
		S	33 ft	two-way	2	None	Uncontrolled	20	89	13
		E	33 ft	two-way	2	None	Stop	20	66	35
		W	29 ft	two-way	2	None	Stop	20	52	35

Intersection type	Location	Crossing	Crossing distance	Directionality of traffic	Number of lanes	Curb Ext.	Control	Speed Limit (mph)	Total Ped. count	Ave. hourly MV count
	Alabama Ave SE & F St SE	N	38 ft	two-way	2	None	Uncontrolled	25	38	37
		S	38 ft	two-way	2	None	Uncontrolled	25	13	50
		E	33 ft	two-way	2	None	Stop	20	73	14
		W	33 ft	two-way	2	None	Stop	20	35	18
	13th Ave NW & Corcoran St NW	N	45 ft	two-way	2	None	Uncontrolled	20	64	169
		S	30 ft	two-way	2	None	Uncontrolled	20	59	309
		W	41 ft	one-way	1	None	Stop	20	634	36
	58th St NE & Eads St NE	N	40 ft	two-way	2	None	Uncontrolled	20	33	122
		S	39 ft	two-way	2	None	Uncontrolled	20	41	90
		E	33 ft	two-way	2	None	Stop	20	39	14
		W	32 ft	two-way	2	None	Stop	20	37	21
	K St SE & 3rd Pl SE	N	26 ft	two-way	2	None	Stop	20	216	6
		S	26 ft	two-way	2	None	Stop	20	276	9
		E	33 ft	two-way	2	None	Uncontrolled	20	53	69
		W	33 ft	two-way	2	None	Uncontrolled	20	53	37
	53rd St SE & Call Pl SE	N	28 ft	one-way	1	None	Uncontrolled	20	44	0
		S	28 ft	one-way	1	None	Uncontrolled	20	23	83
		W	26 ft	two-way	2	None	Stop	20	58	7
	18th St NW & Riggs Pl NW	N	28 ft	two-way	2	Permanent	Uncontrolled	25	119	147
		S	26 ft	two-way	2	Permanent	Uncontrolled	25	81	135
		E	29 ft	two-way	2	None	Stop	20	913	8
		W	24 ft	one-way	1	None	Stop	20	911	10
	53rd St SE & Drake Pl SE	N	29 ft	one-way	1	None	NA	20	19	0
		S	29 ft	one-way	1	None	Stop	20	17	85
		E	27 ft	two-way	2	None	Uncontrolled	20	153	10
		W	27 ft	two-way	2	None	Uncontrolled	20	47	12

* pedestrians not coded at crossings marked with asterisk

Appendix D Survey Instrument and Protocol

Intercept survey protocol

Overview:

- The survey is preloaded into Qualtrics and will be accessed on iPads using the Qualtrics app, which allows for offline responses and then syncing once an internet connection is available.
- Survey staff went to locations in pairs.
- We will be surveying 10 locations (Map of all sites provided)
- Weekdays are preferred; non-rainy days are preferred
- Survey at least 2 hours per location with the goal of collecting at least 20 fully completed responses at each. At sites where less than 20 surveys are completed in the initial 2 hours, complete a total of 3 hours of data collection or until 20 surveys have been completed.
- Typical data collection day:
    - 9am-11am at 1st site (remain until 12 pm if needed)
    - Break in between sites
        - Lunch
        - Recharge iPad (if needed)s
        - Sync iPad to upload completed survey data (requires internet access)
    - 2pm-4 pm at 2nd site (remain until 5 pm if needed)

Before the survey date:

- iPads:
    - Make sure the most up-to-date survey is downloaded
        - Test the app and survey to make sure they are working offline.
    - Make sure to sync any previous survey data
    - Charge iPads
- Map survey location and identify travel plans to and from the site.

On survey date

- Bring survey equipment:
    - 2 x iPads
- Make sure you have accompanying materials:
    - Your ID and/or business card, if you have one
    - Organization (i.e., University) shirt and/or traffic safety vest
    - Printed copies of Information 1 pager (e.g., consent statement) to distribute if people want more information
    - Sunscreen if needed.

    - Water, snack.
    - Paper copies of the survey (in case of issues with iPads)
- Double check survey location (see PPT and map links above - print directions if necessary) and travel plans.

At survey site

- Identify the type of location - Permanent curb extension, tactical curb extension, tactical with mural art.
- Confirm crosswalk(s) to target and pedestrian directions of travel to target. (Use PPT diagrams to verify crosswalks to target).
    - Position each surveyor at a corner so that the ped to target is traveling from a curb extension of interest across a crosswalk toward them.
    - Typically, each surveyor will be at opposite corners of a crosswalk rather than both being at the same corner, but it may depend on the crosswalks to target and the flow of ped traffic.

Begin Surveys

Before asking the respondent to take the survey:

- Select the intersection you are surveying
- Select the crosswalk the potential respondent is crossing
- Select the treatment type for which you are surveying.

After person completes crossing the street, ask if they will take the survey

- Examples of approaches:
    - "Hi there! Do you have a minute to take a survey on crossing the street here?"
    - "Hey there! Do you have some time to answer questions about this crosswalk?"
- If they accept, and they appear young, also ask "Are you at least 18 years old?", then proceed below for any who are 18 years old or more.
    - If they are not 18, thank them for their willingness to participate.
- If the respondent declines to take the survey, select "I do not agree to take the survey" on the intro page and submit the response (this will track refusals.)
- Proceed in administering the survey:
    - Briefly review the consent information:
        - Key points: "It will take about 5 minutes to complete. You can choose to not respond to any question or stop participating at any time. It is anonymous and none of your responses will be personally tied to you."
        - Benefits: "You'll help contribute to the body of knowledge about how to design and locate intersection features for pedestrians."
        - Let them know you have printed copies available if they would like to review it that way, or to take with them.

    - Read the questions and response options and record their answers.
        - At the "This location has a 'curb extension' that pushes out" question - show them the image example so that they understand what this means.
        - If you observed where the pedestrian waited, record this answer without asking the question.
- If administering the survey seems inefficient or ineffective, or the participant would like to do it themselves, you can also hand over the iPad at the consent page for respondent to self-administer.

Quick List of Survey Questions

- How would you rate your experience crossing the street at this location?
- What is the purpose of your trip?
- How often do you use this crossing location?
- Please indicate your level of agreement with the following statements:
    - Read scale and then list of statements one by one, waiting for a response in between
- Prior to crossing, did you primarily wait in the curb extension area, or the sidewalk area?
    - Interviewer can answer this if observed.
- How did you feel about waiting in the curb extension to cross the street?
- Can you briefly explain why you chose to wait where you did?
- Personal characteristics (race, age, gender)
- Are you taking this trip alone or with other people?
    - Interviewer can answer this if observed.
- Is there anything else that you want to share with us about crossing at this location?

After each data collection period

- Sync iPads on Qualtrics; at least daily is preferred.
- Recharge iPad

Intercept survey instrument

Intersection (to be filled out by project staff member)

- 44th Street Northwest & Ellicott Street Northwest
- 18th Street Northwest & Wyoming Avenue Northwest
- 15th Street Northwest & Church Street Northwest
- 14th Street Northwest & Riggs Street Northwest
- 14th Street Northwest & Perry Place Northwest
- 12th Street Northeast & Quincy Street Northeast
- 12th Street Northeast & Shepherd Street Northeast
- Eads Street Northeast & 56th Street Northeast
- Eads Street Northeast & 57th Street Northeast

- 53rd Street Southeast & C Street Southeast

Crosswalk (to be filled out by project staff member)

- North
- South
- East
- West

Location type (to be filled out by project staff member)

- Permanent curb extension
- Tactical curb extension
- Tactical curb extension with mural art
- Control

Researchers from the University of North Carolina (UNC) and Portland State University (PSU) are conducting a study about the experience of walking in Washington, D.C., especially as it relates to crossing through or standing and waiting at intersections. Being in a research study is completely voluntary. You can choose not to be in this research study. You can also say yes now and change your mind later.

If you agree to take part in this research, you will be asked to complete an approximately 5-minute survey about your experience crossing at this intersection. We expect that approximately 200 people will take part in this research study.

The possible risks for you in taking part in this research are:

- Feeling uncomfortable being asked about your perceptions.
- Having someone else find out that you were in a research study.

The possible benefits to you for taking part in this research are:

- Gaining insight into how you felt while crossing the street.
- Contributing to DDOT knowledge about how to design and locate intersection features for pedestrians.

To protect your identity as a research subject, the research team will store your survey responses in a password-protected server housed at UNC. If you have any questions about this research, please contact the Principal Investigator, Wesley Kumfer, at kumfer@hsrc.unc.edu. If you have questions or concerns about your rights as a research subject, you may contact the UNC Institutional Review Board at 919-966-3113 or by email to IRB_subjects@unc.edu.

- o **I AGREE** to take the survey
- o **I DO NOT AGREE** to take the survey

How would you rate your experience crossing the street at this location?

- o Very dissatisfied
- o Somewhat dissatisfied
- o Somewhat satisfied
- o Very satisfied

What is the purpose of your trip?

- o Going to work / school / university
- o Going home
- o Visiting friends / family
- o Exercising
- o Running errands
- o Other

How often do you use this crossing location?

- o First time
- o Less than 1 day a month
- o 1-3 days a month
- o 1-3 days a week
- o 4 or more days a week

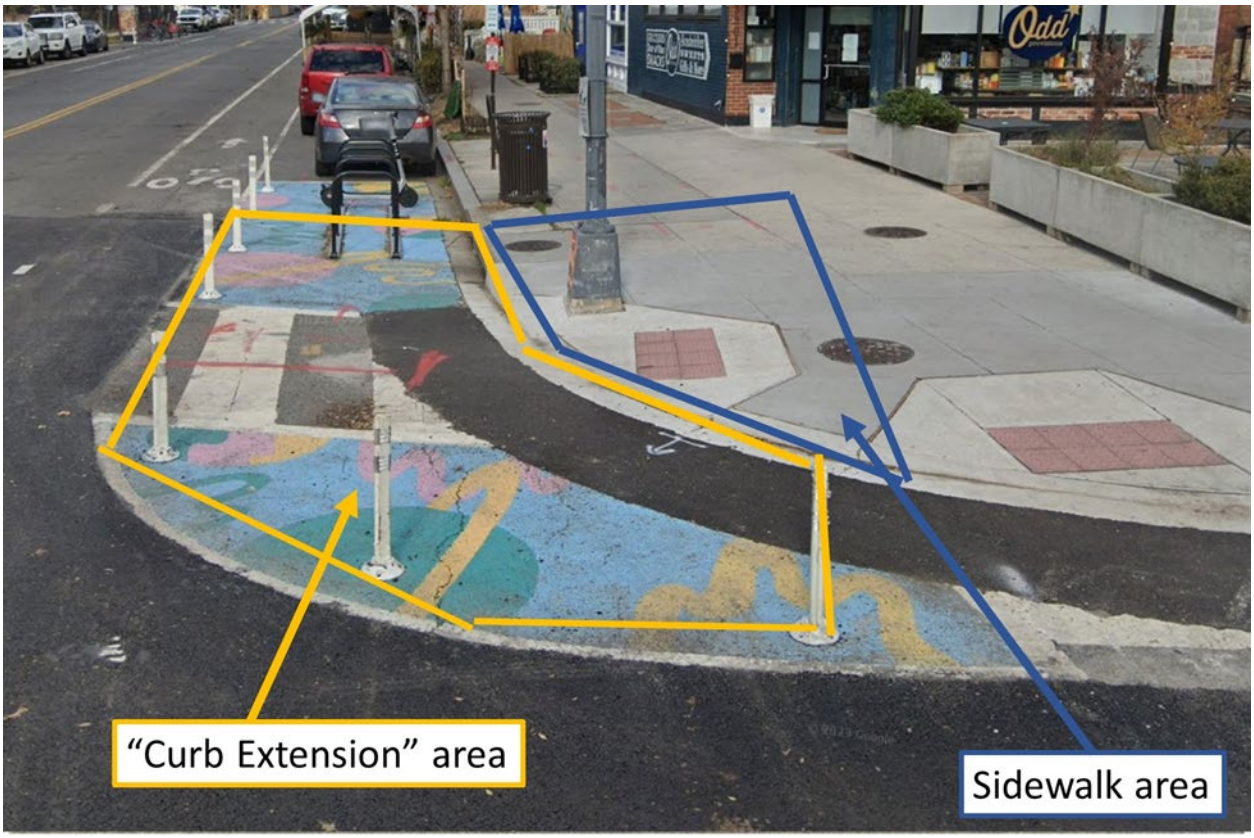
Please indicate your level of agreement with the following statements: (Note: statements' order was randomized)

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
I felt like I might get hit by a car when crossing here	o	o	o	o
I felt safe crossing here	o	o	o	o
People drive too fast through this intersection	o	o	o	o
Drivers see and acknowledge me when I need to cross here	o	o	o	o
I had enough time to cross this street	o	o	o	o

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
I felt rushed trying to cross this street	o	o	o	o
I went out of my way to cross here	o	o	o	o
Crossing here was the most direct route to get to where I was going	o	o	o	o
This is a visually appealing intersection to walk through	o	o	o	o
I don't like how this intersection looks	o	o	o	o

(Note: depending on the location, the graphic presented was either a permanent curb extension, tactical curb extension, or tactical curb extension with mural art – the latter option is shown in the example below)

This location has a "curb extension" that pushes out from the sidewalk near the intersection.



Prior to crossing, did you primarily wait in the curb extension area, or the sidewalk area? I waited in the ...

- Curb extension area
- Sidewalk area
- Other _____
- None - I did not wait at all prior to crossing

How did you feel about waiting in the curb extension to cross the street?

- Very unsafe
- Somewhat unsafe
- Somewhat safe
- Very safe

Can you briefly explain why you chose to wait where you did?

_____
_____
_____

Do you consider yourself?

- ☐ Hispanic, Latino/a, or Spanish origin
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Black or African American
- ☐ White
- ☐ Prefer not to say
- ☐ Other _____

What is your age?

- o 18-25
- o 26-39
- o 40-65
- o 66-75
- o 76+

Are you ... ?

- o Male
- o Female
- o Non binary
- o Other

Are you taking this trip alone or with other people?

- o Alone
- o Group - All adults
- o Group - Adults with kids

Is there anything else that you want to share with us about crossing at this location?

_____

_____

_____

Appendix E Video Review Protocol

The protocol used for coding video for pedestrian and motorist behavior at curb extension (and control) locations is shared below. The form used for collecting data is available here: DDOTVideoCodingSheetTEMPLATE_Share.xlsx

Prior to starting review:

- Download VLC media player
    - Make sure you have “advanced controls” and “status bar” visible (found under “view”). Note the VLC shortcuts at the bottom of this page.
- For each video that you are reviewing, you will want to download the video and open it in VLC to enable addition viewing capabilities (see shortcuts below)
- During the review, you can record clips of any interesting behavior or interactions. Make sure the save the clip.

To start

- Open the ReviewLog.
    - Identify an uncoded intersection and place your Name and the current date on the in the “DateStarted” column.
    - Check the “Hours to review” column - at some locations, we may review all daylight hours, while others may be just a selection of hours.
- Consult the “Curb extension sites” diagram for the location for pedestrian crossing of interest, vehicle yielding of interest, and stopping sight distance (SSD) for motorists (green shaded area). Motorists *OUTSIDE* the shaded area would be expected to yield to pedestrians, while those inside the shaded area may not have time to see and react to pedestrians in time to yield.
- Check the video files for the intersection.
    - Most intersections have multiple angles - check which angle allows you to see the best view of activity at the intersection. This will be your primary video.
        - Check if the timestamps match or are off at all.
    - Open the primary video in VLC (this provides the best ability to slow, fast forward, pause, etc.).
    - Orient yourself to cardinal directions (N,S,E,W in the video - check the Google Maps link (in ReviewLog) and compare against the site diagram. It will be important to note the cardinal direction of the crosswalks when coding pedestrian activity
    - Secondary angles may need to be consulted to check upstream information - for example if a vehicle was within the stopping sight distance when a pedestrian started crossing an intersection.
- IF NOT ALREADY DONE, save a screenshot (“take Snapshot” under the “video” tab on VLC player) of the video for each angle. Using paint or similar software, mark up the yield point or

stopping sight distance (SSD), that would approximately match the "Curb extension sites" diagram for that site. Draw two yield lines for both camera angles (if there are two), one line for the near crosswalk and one line for the far crosswalk.
    - Also code the crossing characteristics
- Open the review template file and save a copy with "YourInitialsReview_" and the intersection name (from the video file name).
- Fill out the "Peds" tab in the review form following the instructions below.

Review basics

- Each row in the review spreadsheet will represent one pedestrian
    - Anyone walking or rolling will be in their own row. Adults carrying a baby or pushing a stroller can be on one row (i.e., the kids do not need their own row in these cases.
    - People on or pushing bicycles, scooters or other micromobility devices will be counted if they cross from one sidewalk to another in the crosswalk area of interest (but not if they are traveling in the street)
    - Each pedestrian will receive a unique, sequential ID
- Groups who are clearly together will be coded as such in the "GroupID" field
- Vehicle yielding will be considered for any vehicle that is behind the stopping sight distance

    Note: Consult the "Curb extension sites" diagrams for the stopping site distance (green shared area) for each location

    WES: do we have a table of the stopping sight distance for each location?

Filling out the sheet for each intersection:

- Intersection
    - Which intersection is being reviewed?
    - *(this can be copy and pasted for all rows at an intersection)*
- Reviewer
    - Reviewer initials
    - *(this can be copy and pasted for all rows at an intersection for a reviewer)*
- Date
    - What is the date the video was collected?
    - *(this can be copy and pasted for all rows at an intersection)*
- Time ped arrived at curb
    - Time at which the pedestrian arrives at the edge of the curb (if they do not pause), or time that they initially pause / stop prior to crossing
    - Use format HH:MM:SS, using 24HR
- IndividualID
    - Unique Identifier for each pedestrian
    - This sequential number will start at 1 for each intersection, and go up by 1 for each arriving pedestrian

- GroupID
    - Group that is obviously together
    - This sequential number will start at 1 for each intersection, and go up by 1 for each arriving group.
    - Multiple peds may share a groupID if they are obviously travelling together
    - "NA" if pedestrian is not in a group
- Group size
    - Number of people crossing together
    - Count of the number of people in a group that is obviously together.
    - "NA" if pedestrian is not in a group
- Crossing
    - Which crosswalk - use cardinal directions to indicate if the crosswalk is on the North side of the intersection (N), South side (S), East (E) or West (W). If needed, use NW, NE, SW, SE.
    - If a diagonal crossing maneuver is made, enter the first crossing that would have been crossed if they have made a full crossing, and then under "crossinglocation" below - enter "diagonal".
- Direction
    - Which direction was the pedestrian travelling during the crossing?
    - Indication direction with eastbound (EB) westbound (WB) Southbound (SB) Or Northbound (NB)
- User Type
    - Basic descriptive of how the pedestrian / user in traveling
    - *Select from Pedestrian; Bicyclist; Scooter; Wheelchair/Mobility scooter; Person with mobility device; Person with Stroller; Other.* If "other" include brief text to describe
    - Notes
        - Person walking bike - code as pedestrian
        - Person with mobility device - could be a cane, walker, guide dog, etc.
- Gender
    - Observed perceived gender if possible to determine
    - *Select from Male; Female; UTD*
- Age
    - Observed perceived age. Best guess is okay.
    - *Select from U16 (16 and under); 17-60; 61+; UTD*
- KidsPresent
    - Is the person travelling with kids, and if so, are the kids walking on their own, being pushed (i.e., in a stroller), or carried?
    - *Select from No; Yes-walking; Yes-not walking; IS a kid*
    - NOTE,

        - kids who are Walking, would be included in their own row - in this case select "IS a kid"
        - Kids who are being pushed or carried - select "Yes-not walking". These do not need to have their own row.
- PedWait
    - Did the pedestrian stop at the curb / sidewalk before crossing the street?
    - *Select from Yes; No; Slow, but not stopped*
- PedWaitPosition
    - Where did the ped primarily wait? Was the pedestrian's waiting position in the curb extension area
    - *Select from Middle of sidewalk area; Edge of sidewalk area; middle of curb extension area; edge of curb extension area; In street; NA*
    - *Enter NA if they did not wait*
- CrossingLocation
    - What is the pedestrian's position in relation to the crossing during the crossing?
    - *Select from Fully within; In on one end; Not in crosswalk; Diagonal; Other*
- Near side - approaching vehicle?
    - Is there an approaching vehicle in the first lane the pedestrian will cross? Were they approaching or past the yielding point (also known as the stopping site distance point) when the ped reached the curb?
    - *Select from Yes - approaching yielding point; Yes - past yielding point; Yes - at stop sign; No*
    - (Reference the "Curb extension sites" diagram -
        - "Yes - *approaching yielding point*" would be outside of the green area, and indicate that they were far enough back to yield
        - "Yes - *past yielding point*" would be within the green area, indicating that they might be too close to see, react and stop in time to yield.
        - "Yes- *at stop sign"* would indicate a vehicle either approaching or stopped at a stop sign when the pedestrian begins crossing.
        - "No" would indicate that there was no approach vehicle in the near side (first) lane
- Near side - 1st vehicle yield
    - Does the vehicle yield? If so, where do they stop in relation to the crosswalk?
    - *Select from Yes, outside crosswalk area; Yes, inside crosswalk area; No (fail to yield); Ped steps out behind; No interaction; NA*
    - *Enter NA if*
        - *no vehicles present*
        - *Vehicle is at a stop sign*
- Near side - other vehicles
    - If 1st vehicle does not yield, how many pass without yielding?

    - *Count of vehicles that do not yield (including the first vehicle)*
    - *Enter NA if not applicable (e.g., the 1st vehicle yielded, or no vehicles)*
- Far side - approaching vehicle?
    - Is there an approaching vehicle in the 2nd lane the pedestrian will cross? Were they approaching or past the yielding point (also known as the stopping site distance point) when the ped reached the curb?
    - *Select from Yes - approaching yielding point; Yes - past yielding point; Yes - at stop sign; No*
    - (Reference the "Curb extension sites" diagram -
        - "Yes - *approaching yielding point*" would be outside of the green area, and indicate that they were far enough back to yield
        - "Yes - *past yielding point*" would be within the green area, indicating that they might be too close to see, react and stop in time to yield.
        - "Yes- *at stop sign"* would indicate a vehicle either approaching or stopped at a stop sign when the pedestrian begins crossing.
        - "No" would indicate that there was no approach vehicle in the far side (second) lane
- Far side - 1st vehicle yield
    - Does the vehicle yield? If so, where do they stop in relation to the crosswalk?
    - *Select from Yes, outside crosswalk area; Yes, inside crosswalk area; No (fail to yield); Ped steps out behind; No interaction; NA*
    - *Enter NA if*
        - *no vehicles present*
        - *Vehicle is at a stop sign*
- Far side - other vehicles
    - If 1st vehicle does not yield, how many pass without yielding?
    - *Count of vehicles that do not yield (including the first vehicle)*
    - *Enter NA if not applicable (e.g., the 1st vehicle yielded, or no vehicles)*
- Turning vehicle?
    - Is there a vehicle turning into the crosswalk that a pedestrian is crossing that could conflict with their crossing action?
    - *Select from No; Left-turning; Right-turning*
- Turning vehicle - 1st veh. yield
    - Does the vehicle yield? If so, where do they stop in relation to the crosswalk?
    - *Select from Yes, outside crosswalk area; Yes, inside crosswalk area; No (fail to yield); Ped steps out behind; No interaction; NA*
    - *Enter NA if*
        - *no vehicles present*
        - *Vehicle is at a stop sign*
- Turning vehicle - other vehicles

    - If 1st vehicle does not yield, how many pass without yielding?
    - *Count of vehicles that do not yield (including the first vehicle)*
    - *Enter NA if not applicable (e.g., the 1st vehicle yielded, or no vehicles)*
- Micromobility device
    - Count of bikes or other micromobility devices that travel past the crosswalk in the 2 seconds before or during the crossing
- Intrusion-type
    - Do any vehicles pass through any part of the curb extension area?
    - Select from No; Glancing touch; Drives in ext. Area; hits post
- Intrusion-vehicle
    - If any of above, which vehicle?
    - Select from NA; Near side; far side; right turn; left turn; micromobility; other
- Pedestrian - Vehicle interaction
    - Note any time a pedestrian or interacting MV makes an avoidance maneuver
    - Select from None; precautionary; Emergency;
- Pedestrian - Vehicle interaction - description
    - Open text field to describe a pedestrian-vehicle interaction if observed