APPENDIX C

Bus Stop Field Audit Reports

The following provides stand-alone Bus Stop Field Audit reports at the seven bus stop intersections listed below. These locations represent a subset of high crash pedestrian injury and or fatality bus stops within the NJTPA region. The site improvements identified include both feasible short-term, low-cost measures, as well as longer-term, "ideal" conditions for each of the seven bus stop intersections.

1. Blackwell & Bergen Streets, Town of Dover, Morris County
2. Fairmount & Newark Avenues, City of Elizabeth, Union County
3. U.S. Route 9 & Adelphia Road, Freehold Township, Monmouth County
4. Essex & Huyler/State Streets, City of Hackensack, Bergen County
5. 18th Street & Irvine Turner Boulevard, City of Newark, Essex County
6. U.S. Route 9 & Fairway Lane, Township of Old Bridge, Middlesex County
7. Main & Day Streets, City of Orange, Essex County

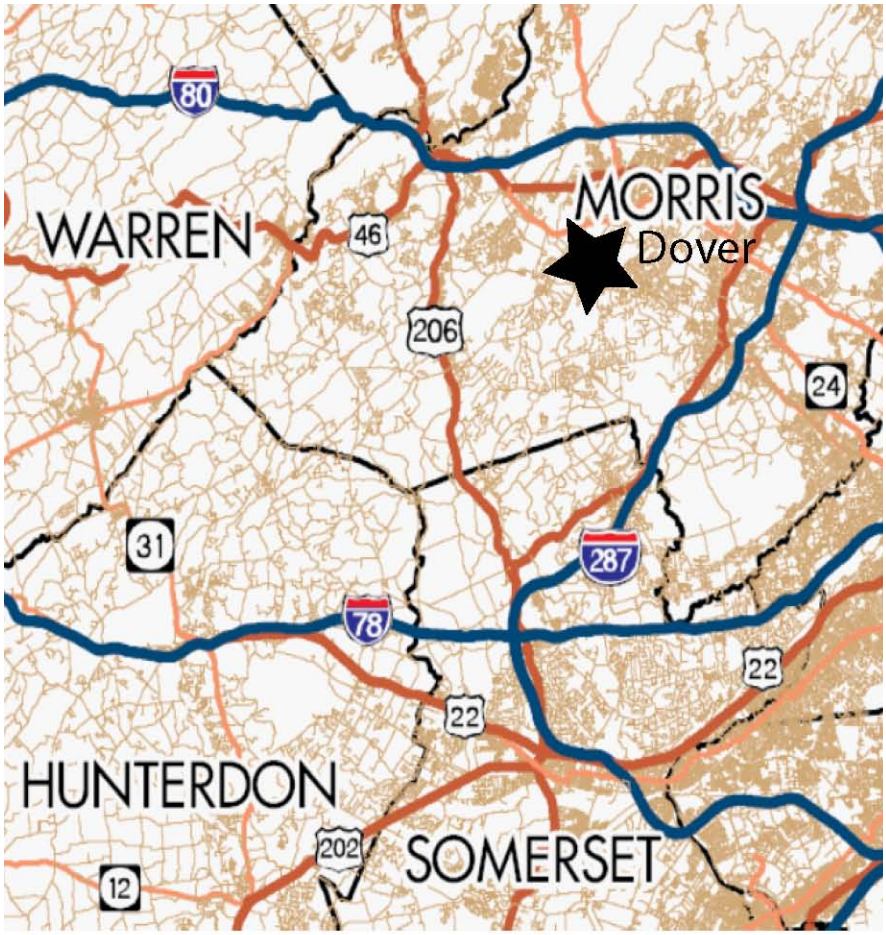
NJTPA
NORTH JERSEY TRANSPORTATION PLANNING AUTHORITY

Pedestrian Safety at and Near Bus Stops Study

Bus Stop Field Audit

Blackwell & Bergen Street

Town of Dover, Morris County



NELSON NYGAARD

This report is published by the North Jersey Transportation Planning Authority, Inc. with funding from the Federal Transit Administration and the Federal Highway Administration. The NJTPA is solely responsible for its contents.

June 2011

Pedestrian Safety at and Near Bus Stops Study
North Jersey Transportation Planning Authority
Blackwell Street (County Route 513) and Bergen Street Bus Stops, Town of Dover, Morris County

Table of Contents

Introduction

New Jersey experiences a disproportionately high number of pedestrian injury crashes and fatalities compared to the nation as a whole. Many factors contribute to this, such as the state's density, traffic congestion, and high level of transit ridership, particularly bus ridership. Bus ridership accounts for two-thirds of all transit riders, with approximately 600,000 trips per day boarding at over 20,000 marked bus stops in New Jersey. Many bus passengers board and alight from buses along busy highways and often must cross these roadways after dark or during inclement weather. Many crashes at and near bus stops occur on congested urban street systems and along highway corridors.

The Pedestrian Safety At and Near Bus Stops Study seeks to identify approaches to reduce the severity and frequency of crashes involving pedestrians at and near bus stops in the 13-county NJTPA region and to improve safe pedestrian access to transit facilities. Successful approaches to improving travel safety often involve a combination of engineering, enforcement, and educational strategies, as well as strategies to improve emergency response time.

The study has three components:

1. An Education Campaign Plan to encourage bus riders and motorists to be conscious of safety at and around bus stops was developed. The campaign involved extensive input from focus groups, one-on-one interviews, stakeholders, and bus passenger surveys. Methods to evaluate the campaign's success were developed as well.
2. A broad-based review of a sampling of bus stops representing various geographies, high usage and/or high pedestrian crash rates was analyzed. Field audits were conducted at these locations to look at bus stop design and access to and from the bus stop.
3. Physical improvement recommendations were developed for a subset of high crash bus stop locations, and a “toolbox” of bus stop design and policy recommendations to encourage bus stop improvements. This included an informational guide designed to help municipalities navigate the process of establishing well-designed bus stops.

The following is one of the seven reports developed for the study’s physical improvement recommendations, and was developed based on observations of pedestrian and motorist circulation at each individual bus stop location to understand roadway usage and opportunities for change. Each report provides a background and pedestrian crash history at the bus stop, short- and long-term improvement recommendations, and a summary of the suggested improvements’ safety benefits and cost range.

Pedestrian Safety at and Near Bus Stops Study

North Jersey Transportation Planning Authority

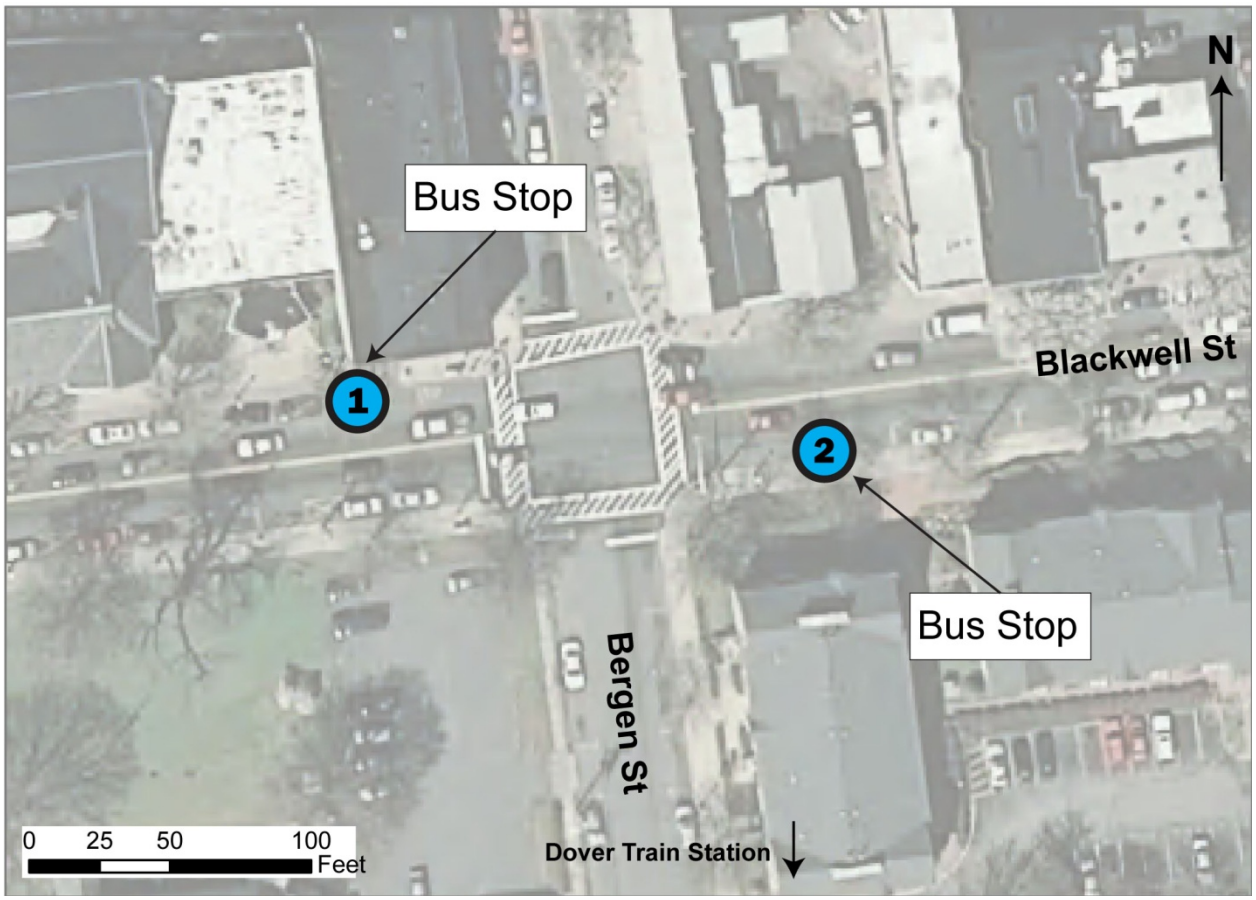
Blackwell Street (County Route 513) and Bergen Street Bus Stops, Town of Dover, Morris County

Background

Blackwell Street is the main retail corridor in the Town of Dover. Both Bergen and Blackwell Streets are two-way streets with one lane in each direction and on-street parking on both sides. There is a traffic signal at this intersection with pedestrian heads. Bergen Street south of Blackwell Street provides access to the commuter parking lot for the Dover train station. The train station generates a lot of drop-off traffic, which loops around on Blackwell, Essex, and Bergen Streets. Bergen Street north of Blackwell is mostly residential.

Blackwell Street, County Route 513, is owned and maintained by Morris County while Bergen Street is a local street under the jurisdiction of the Town of Dover. This site had eight injuries from January 2006 – August 2010. There are numerous pedestrians at this bus stop intersection. The Route 872, Route 875, and Route 880 bus stops are located at 1) Blackwell Street westbound and 2) Blackwell Street eastbound. Both stops are far-side stops. The Dover NJ TRANSIT train station on the Morris and Essex and Montclair-Boonton Lines is one block south of the intersection.

Figure 1: Aerial of Blackwell and Bergen Streets



Crash Data

From January 2006 to August 2010, eight pedestrian crashes occurred within 100 feet of the bus stops. All occurred during the week and at the intersection. Six of the pedestrians were hit while crossing at the marked crosswalk. Five of the crashes involved drivers who failed to yield the right of way to a vehicle or pedestrians. Half the crashes occurred at night, and half involved a cargo van. No pedestrian fatalities occurred at this location.

Four of the crashes occurred when eastbound traffic on Blackwell Street turned left onto Bergen Street to travel north. These left-turn crashes are likely a result of the long distance between Bergen Street and the next intersection to the east at Union and Blackwell Streets. As shown below, west of Bergen Street the street grid takes on a typical urban pattern, with blocks spaced approximately 200 feet apart. To the east of Bergen Street, the next intersection is more than 750 feet away, and it is not signalized. The nearest signal is 0.4 miles away. This results in a steady stream of traffic heading toward the Bergen Street intersection without any signals to control traffic progression. Thus, drivers making a left-turn from Blackwell Street, to north on Bergen Street, likely become impatient waiting for a gap, and when they see one, they make the left turn quickly, without checking the crosswalk on the north leg of the intersection. In addition, right-turning traffic was observed to pull far into the crosswalk to look for an opening in traffic.

Figure 2: View of Blackwell and Bergen Street

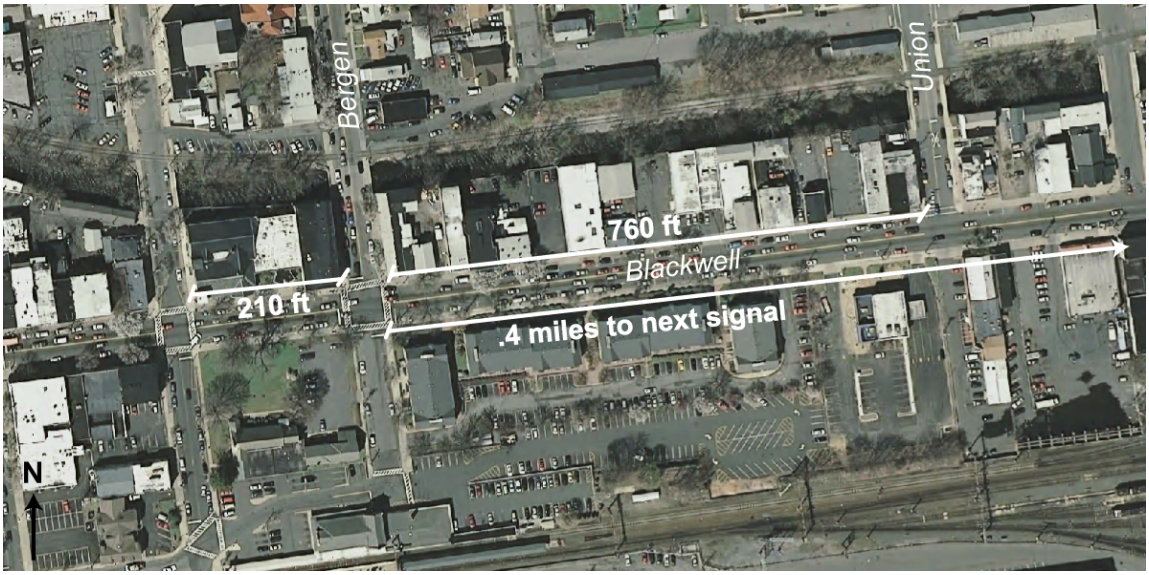


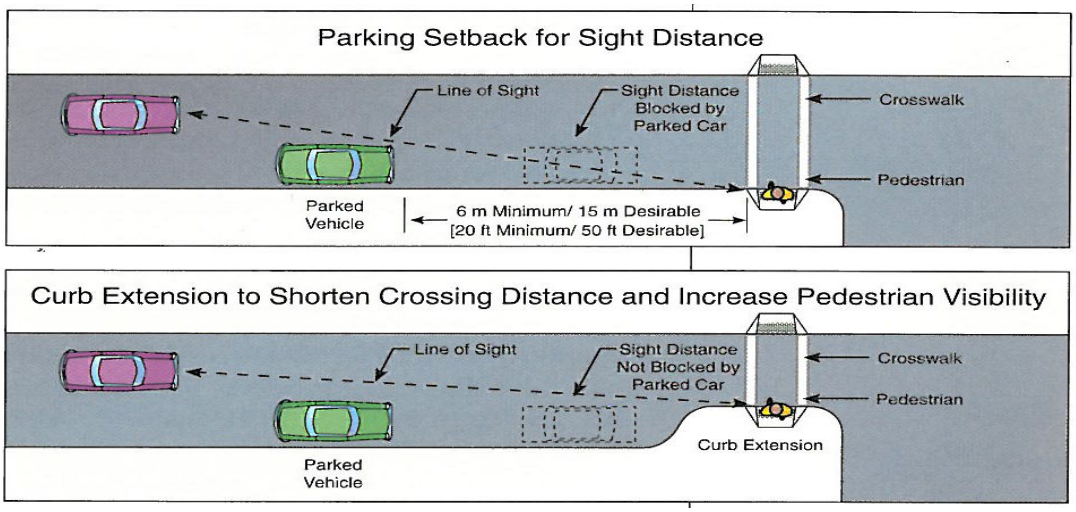
***Figure 3*: Bergen Street northbound, right turning driver blocks southeast corner**

***Figure 4*: Bergen Street, right turning driver in north leg of intersection crosswalk looking for a gap**

***Figure 5*: Blackwell & Bergen Streets: Pedestrian signals are not fixed to vehicle green cycles**

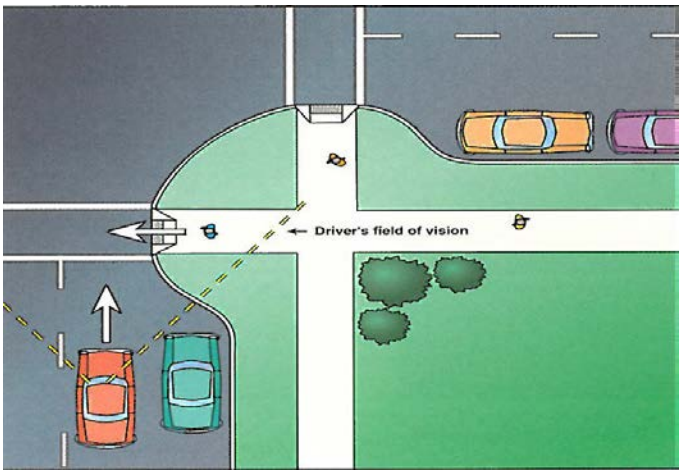
On-street parking should be provided on both sides of the street on all intersection legs. For a downtown district, on-street parking is important to patrons and business owners. It can, however, impede sight distances of drivers, as shown below. Curb extensions make pedestrians more visible by placing them past the view corridor of the parking lane. Curb extensions also shorten the crossing distance, which helps all users, especially older people or children who walk at slower speeds. The following diagram provides a visual demonstration of sight distance when attempting to cross the street and how curb extensions enhance sight distance to help the pedestrian see and be seen.

Sight Distance



Source: AASHTO. Guide for the Planning, Design, and Operation of Pedestrian Facilities. 2004.

Curb Extension Improves Visibility



Source: AASHTO. Guide for the Planning, Design, and Operation of Pedestrian Facilities. 2004.

The recommended curb extensions should have a curb radius of 10 feet, meaning passenger vehicles will take the turn at a low to crawling speed.[1] This is crucial as the severity of injury in a crash increases dramatically when a pedestrian is struck by a driver traveling over 20 mph. At corners where buses must make right turns, such as the northwest corner of the intersection, curb radii should be 20 feet. This additional length allows a bus to complete the turn without having to cross over the double yellow line into the other lane of traffic. Since the intersection's west leg is 43 feet, the bus stop

[1] *Flexibility in Highway Design*. Federal Highway Administration. Chapter 8. http://www.fhwa.dot.gov/environment/flex/ch08.htm

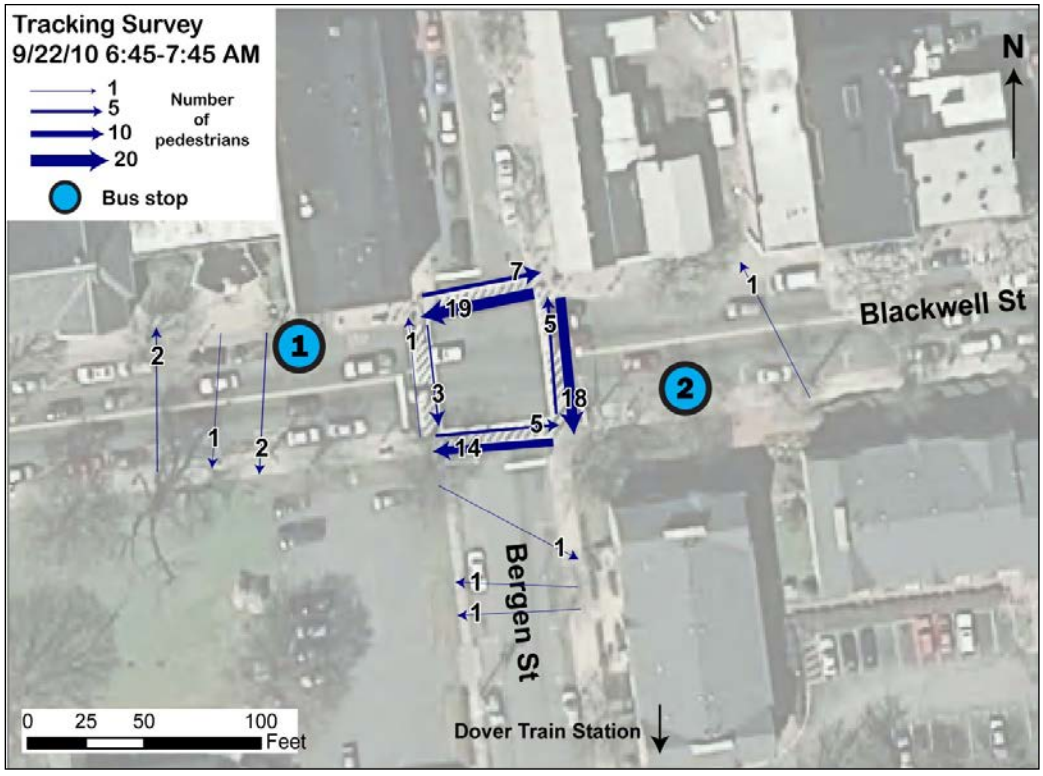
needs to be moved further west from the intersection to accommodate the curb extension and allow through traffic to go around the bus.

Method of Assessing Pedestrian Safety at and Near Bus Stops

The initial part of this analysis began with the use of Plan4Safety. This database contains a wealth of data about pedestrian, bicyclist and motor vehicle crashes, including the movement of the vehicle before and at the time of the crash, contributing factors to the crash caused by the pedestrian and the driver, some information on gender of the pedestrian, and age and gender of the motorist. This crash information was analyzed to understand potential trends, the interaction between pedestrians and motorists at specific locations at and near the intersection bus stops, and the type of vehicles involved in the crashes. Vehicle type was included to determine if any crashes involved buses at and near bus stops. At this specific bus stop location, crashes did not involve a bus.

This analysis was followed by a field audit, led by the consultant team, on September 22, 2010 from 6:45-7:45 AM to track pedestrian usage of the crosswalks and sidewalks that provide access to and from bus stops, and a bus passenger surveying effort, where team members interviewed bus stop passengers waiting at the bus stop.

Figure 6: Pedestrian Tracking Survey of Bus Stop Intersection



The intersection is well-used by pedestrians, as it is a link to the downtown and the train station. Many people were observed walking westbound on Blackwell Street into town, then returning a short time later. Vehicles were observed as traveling at fairly low speeds. This, in combination with the fact that destinations are often across the street from each other, means that pedestrians feel safe crossing midblock. In addition, a high number of vehicular turning movements occur at the intersection that may make pedestrians feel safer crossing midblock for sight distance reasons.

During the field audit, a stakeholder observed that, although a low number of people were seen taking the bus at that hour, it is likely that the commuting patterns in the area are on a later schedule, such as 10 AM to 7 PM. One potential explanation could be that many people taking transit to work are employed at local restaurants or malls that have later opening hours; however, this would need substantiation from surveys or further outreach.

The crossing of Blackwell Street is actuated for pedestrians; however, two push buttons (on the northeast and northwest corners) were not working during the one-hour field audit. Pedestrian signals are not coordinated with vehicle signals, meaning that the WALK sign does not appear with every green vehicle signal automatically; the pedestrian must push the button to trigger the WALK sign. In addition to pedestrians, bicyclists were observed on both Blackwell and Bergen Streets.

***Figure 7:* Push button at northwest corner of Blackwell & Bergen Street intersection is broken**

The bus passenger surveys asked people to rate sidewalk conditions, crosswalk safety, and motorist behavior. The results were used to gain site-specific information about access to the two public bus stops to help inform the location's improvement needs. It is important to note that the rate of response for the bus passenger surveys was low and a major contributing factor for the bus stop intersection and bus stop improvement recommendations are based on the consultants' field audit observation, which informed the following suggested improvements.

Improvement Recommendations

Downtown Dover is a walkable main street, lined with shops, restaurants, and parks. The intersection of Blackwell and Bergen Streets represents the gateway into the downtown, and should be given treatments that signal to drivers that they are entering

a pedestrian-oriented area. The intersection also provides pedestrian access from the bus stop intersection to the train station, making walking to transit more attractive. A combination of left turn pockets and an additional signal are recommended in addressing this intersection's issues of left turning vehicles injuring pedestrians.

The following section describes recommendations for improvement at Blackwell and Bergen Street intersection to facilitate safer pedestrian access to and from the bus stop. The suggested improvements are divided into short- and long-term actions. Short-term improvements are those that can be done quickly in one-year, at low cost, with no additional traffic analysis. Long-term improvements may require additional traffic analysis, and can, but do not always, require more significant capital expenditures. Often, short-term improvements are considered "pilot projects" using inexpensive and easily removable materials to test how a change to the intersection impacts safety and operations (typically done during the spring over a three-month period of time). Deemed acceptable, these improvements are then moved to the long-term category for final design and implementation using materials to create more permanent safety improvements.

Short-term Improvements

1. Make pedestrian signals fixed-time rather than actuated. As observed during fieldwork, two of the actuated signals on the northeast and northwest corner of the intersection were not working. Fixed-time signals provide optimal service for consistent opportunities to cross the street and signals to the driver to be alert for pedestrian crossings.[2] Recommend using countdown signals.
2. Add a Leading Pedestrian Interval (LPI) of 5 seconds during all signal phases. Since six out of eight pedestrian injuries occurred when drivers were turning left, an LPI allows pedestrians to establish their presence in the crosswalk before vehicles begin turning.
3. Install STOP FOR PEDESTRIANS IN CROSSWALK signs approaching the intersection from all directions.

Long-term Improvements

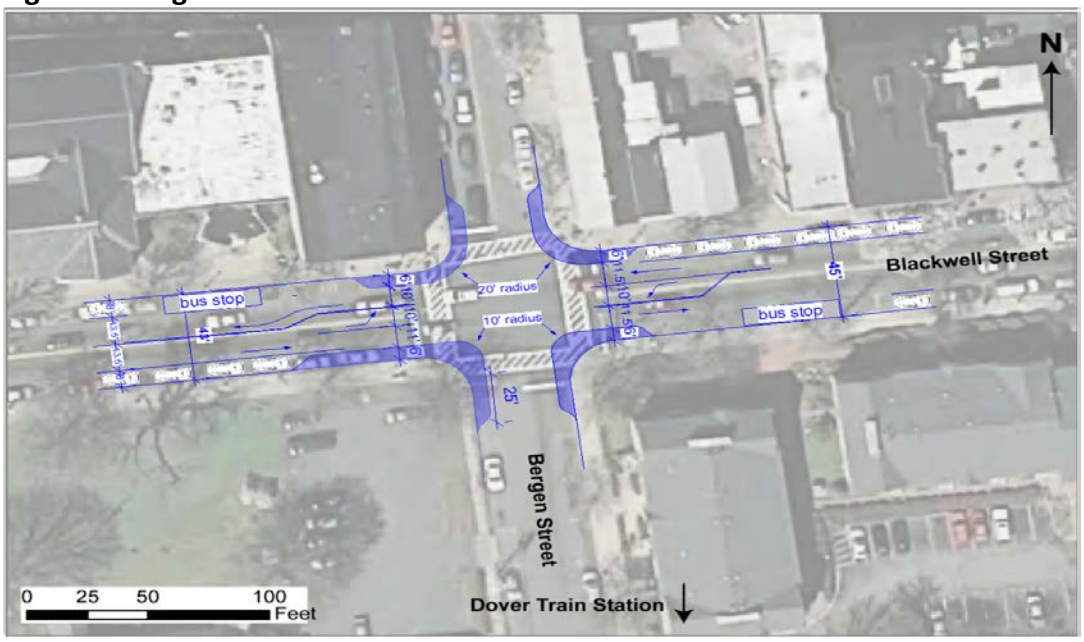
1. Upgrade to ADA Compliance at bus stop and bus stop intersection:
    a. All curbs flush with the street.
    b. All curbs have tactile treatments at the edges.
    c. A tactile surface at the edge of the sidewalk at bus stops should be considered to keep pedestrians away from the edge of the road and to reduce the chance of pedestrians slipping and falling under a bus at the bus stop.
2. Install curb extensions at all corners. (See Figure 8)

[2] http://www.walkinginfo.org/engineering/crossings-signals.cfm#pedestrian-signal-timing

3. Add left turn lanes on Blackwell Street. The roadway width for Blackwell Street is 45 feet east of Bergen Street and 40 feet west of Bergen Street and can accommodate left turn lanes for turning vehicles to queue, reducing congestion for through vehicles, and still provide a 10 to 11 foot driving lane, 10 foot left-turn lane, and 8 foot parking lane.
4. Consider exploring the addition of a signal at Blackwell and Union Streets. As shown earlier, the closest signal east of Blackwell and Bergen Streets is 0.4 miles away. This might be appropriate for suburban settings, but Blackwell Street east of Bergen has a downtown streetscape, including street-fronting retail, on-street parking, and street trees. A signal at Union Street, 750 feet east of the intersection under study, can actually ease traffic congestion and decrease speeds. The signals could be coordinated so that traffic on Blackwell westbound is better controlled and vehicles heading eastbound on Blackwell do not have to wait for occasional gaps in westbound traffic to make left turns.

Figure 8 below shows the potential long-term build-out of the intersection, and includes potential improvement concepts. Further study would be required at the town and county level should they choose to adopt these improvements. New Jersey law states that vehicles cannot be parked within 25 feet of an intersection or crosswalk, thus the curb extensions would be constructed so that this no parking zone is enforced. Since drivers may not be aware of this law, the curb extensions may also serve to improve compliance.

Figure 8: Long-Term Intersection Build Out*



**Suggested roadway lane and curb extension widths may need to be adjusted. Further study would be needed to assess appropriate dimensions.*

On the west leg of the intersection, the design shows:

- A 10-foot-wide westbound travel lane and an 11-foot-wide eastbound travel lane
- An 8-foot parking lane,
- A 40-foot by 10-foot left turn lane,
- A 6-foot curb extension so that drivers can get past a bus at the bus stop.

This would require vehicles to park at least 40 feet from the intersection to accommodate room for the westbound and eastbound left turn lanes. The bus stops are 100 feet long per NJ TRANSIT guidelines for far-side bus stops.

On the eastbound leg, which is 2 feet wider than the west leg, the design shows:

- Two 11.5-foot-wide through lanes,
- A 40-foot by 10-foot left turn lane,
- A 100-foot-long bus stop.

Traffic calming measures such as those suggested at Dover have raised concerns in many communities about the effect of such design on emergency vehicle response time. Much research has been conducted on this topic, for maintaining swift response time is, of course, a priority for all. Significant research has examined the influence of traffic calming measures such as narrowing travel lanes, tightening curb radii, traffic circles and speed humps/tables on EMS response time.[3,4] Much of this work has shown that the minor delays on EMS response times due to traffic calming are less significant than the overall daily, street safety goals achieved through traffic calming measures.[5,6] In many cases, concerns associated with EMS response time related to traffic calming measures are alleviated once these projects are test driven by EMS drivers.[7] Some communities have mapped primary and secondary EMS routes and categorized traffic calming measures appropriate to each route type.[8]

[3] Burden D, Zykofsky P. Emergency Response: traffic calming and traditional neighborhood streets. Sacramento, CA: Local Government Commission Center for Livable Communities. 2000.
[4] Ewing R. Traffic calming: state of the practice. Washington, D.C. Institute of Traffic Engineers. 1999.
[5] Burden D, Zykofsky P. Walkable Streets and Fire Departments. Sacramento, CA: Local Government Commission Center for Livable Commuities. 2000.
[6] Ewing R, Stevens T, Brown S. Skinny streets and fire trucks. Urban Land Institute, Urban Land, Washington D.C. August, 2007, 121-123.
[7] Coleman, MA, The influence of traffic calming devices upon fire vehicle travel times, City of Portland DOT, 1996.
[8] Development of "Emergency Response Friendly" Traffic Calming Policies in the Tualatin Valley Service Area. http://www.dksassociates.com/admin/paperfile/8Cmccourt_district62005paper.pdf

Implementation

The following table indicates approximate range of costs for each of the suggested improvements, and which agency might be responsible for moving an improvement project through the implementation phase. As Blackwell Street is a county road and Bergen Street is a local road, these agencies are recommended to coordinate short- and long-term improvements.

Summary of Short-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
Pedestrian Countdowns & Fixed-Time Signals	Fixed-time pedestrian signals, rather than actuated, provide a continual visual cue to drivers that pedestrians have the right of way during their phase. This also allows traffic engineers to time the complete intersection for all modes of travel, rather than specific corners for specific users. Making the signals countdown provides excellent information to pedestrians on how much time they have to cross the street. Countdowns also provide information that is understandable by all users.	Low: The cost of adding a countdown timer to an existing pedestrian signal head is $300 to $800.[9]	County/Town
Signal Cycle/Pedestrian Signal Timing	Leading Pedestrian Intervals or "pedestrian head starts" allow the most vulnerable pedestrians time to ascend and descend the curb before vehicles can begin turning movements. This provides better eye contact between pedestrians and motor vehicles as it establishes the pedestrian further into the crosswalk.	Low/Medium: Staff and consultant time	County/Town
Stop for Pedestrian Signage	Draws attention of drivers to pedestrians in the crosswalk and promotes new law.	Low: $50-$150 per sign plus installation costs	County/Town

[9] http://www.mtc.ca.gov/planning/bicyclespedestrians/tools/countdownSignal/index.htm

Summary of Long-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
ADA Compliance	Assists pedestrians of all ages with visual and mobility impairments in tracking the edge of curbs and timing to cross so they can use the intersection and bus stops without assistance.	Medium: Concrete curbs and sidewalks are approximately $49/linear meter ($15/linear foot) for curbing and $118/square meter ($11/square foot) for walkways	County/Town
Curb Extensions	Shorten the crossing distance for pedestrians and decrease the turning radii at corners to reduce quick turns. Extensions also provide pedestrians and motorists better view of each other at an intersection.	Medium: Approximately $2,000 to $20,000 per corner	County/Town
Left Turn Lanes	Six of the eight crashes occurred when drivers were making left turns. During fieldwork, left turning vehicles were observed as causing intersection congestion, as through vehicles tried to get around people waiting to turn. Left turn lanes will improve operation of the intersection.	Low: Installation requires restriping	County/Town

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
New signal at Blackwell and Union Streets	Traffic signals are used to improve safety and vehicle flows. In downtown areas, signals may be spaced as closely as every block.	Medium/High: Approx. $40,000 to $200,000 for new signals.[10]	County/Town

**Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System, September 2004, unless otherwise noted.*

Exhibits

A. Pedestrian Crash Data

CRASH YEAR	# OF PED INJURY CRASHES
2006	4
2007	3
2008	1
2009	0
2010*	0
Total Crashes	8

2010 Crashes only from January to August of that year

CRASH TYPE	# OF CRASHES
Weekday	8
Night-Time	4
At Intersection	8
Alcohol Use	1
Involved Cargo or Passenger Van	4

CHARACTERISTICS OF PEDESTRIAN & MOTORIST	
Driver Age & Gender	F(56), F(48), F(29), M(60), M(27), M(32), F(38), F(73)
Pedestrian Gender	2(F), 6(M)

[10] http://www.walkinginfo.org/engineering/crossings-signals.cfm

CONTRIBUTING VEHICLE CIRCUMSTANCE	# OF CRASHES
Failed to Yield Right of Way to Vehicle/Pedestrian	4
Driver Inattention	1
None (Driver/Pedcycle)	3

PRE-CRASH VEHICLE ACTION	# OF CRASHES
Left Turn	6
Going Straight	0
Right Turn on Red	1
Unknown or NULL	1

B. Bus Passenger Survey

Two people responded to the passenger survey. Responses are detailed below.

1. Gender
   - Male: 1 Female: 1
2. Age
   - Under 18: 1 19-35: 1
3. How often do you take the bus?
   - Daily: 1 1-2 x/week: 1
4. How did you get here?
   - Walk: 1 Transfer: 1 – from Train
5. Did you use the sidewalk? Both said yes.
6. Regarding the sidewalk conditions at this site?
   - Good: 2
7. Is the sidewalk comfortable for walking?
   - Yes: 1
8. Do you use the crosswalk?
   - Yes: 2
9. Did motorists stop for you in the crosswalk?
   - Yes: 1 No: 1
10. Did motorists frequently block the crosswalk?
    - Yes: 2
11. Did they experience aggressive driving from motorists while crossing:
    - Yes: 1 No: 1
12. Have you ever been left by a bus driver?
    - Never: 1
13. Both respondents spoke English.

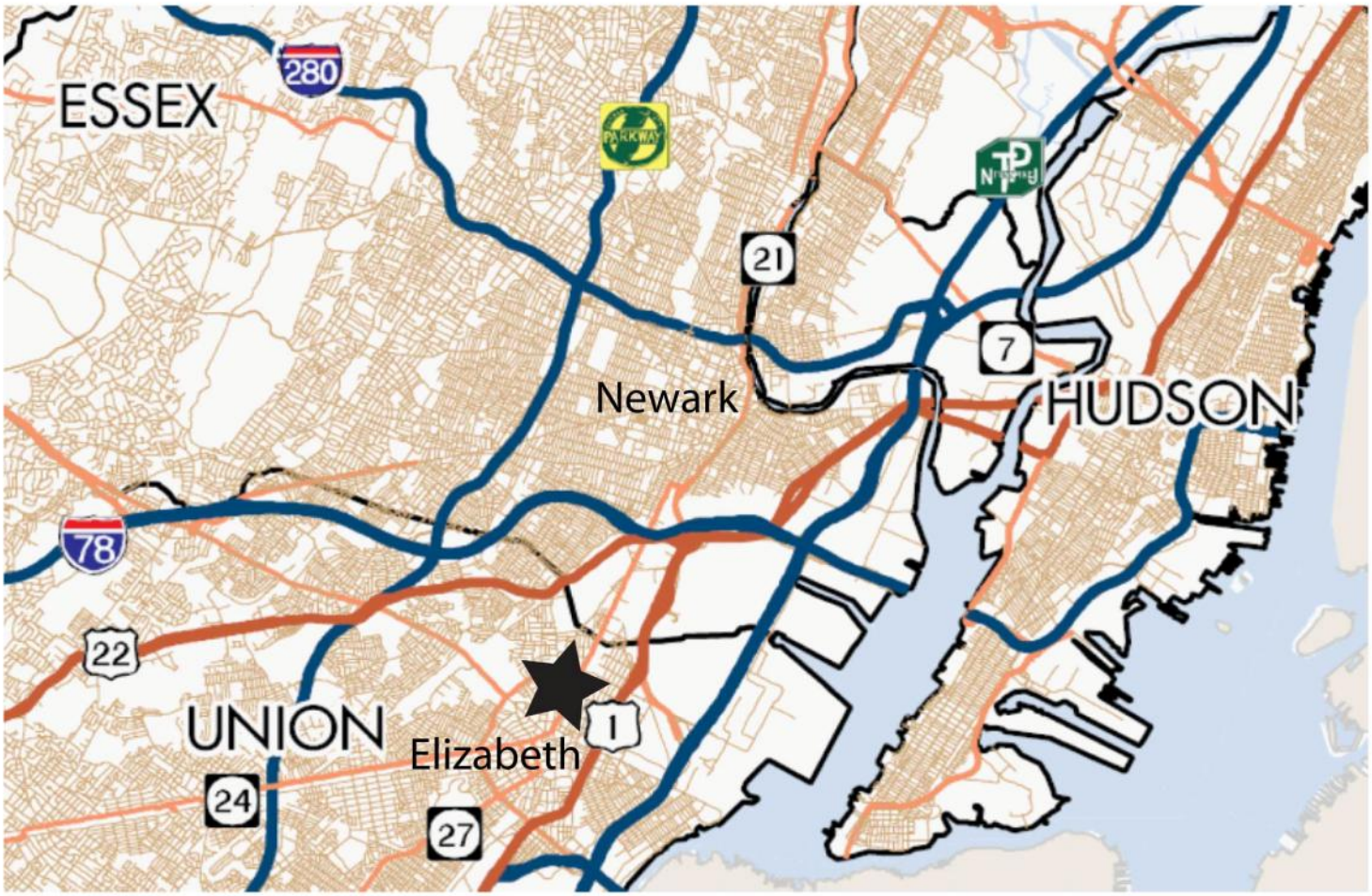
NJTPA

NORTH JERSEY TRANSPORTATION PLANNING AUTHORITY

Pedestrian Safety at and Near Bus Stops Study

Bus Stop Field Audit

Fairmount & Newark Avenue
City of Elizabeth, Union County



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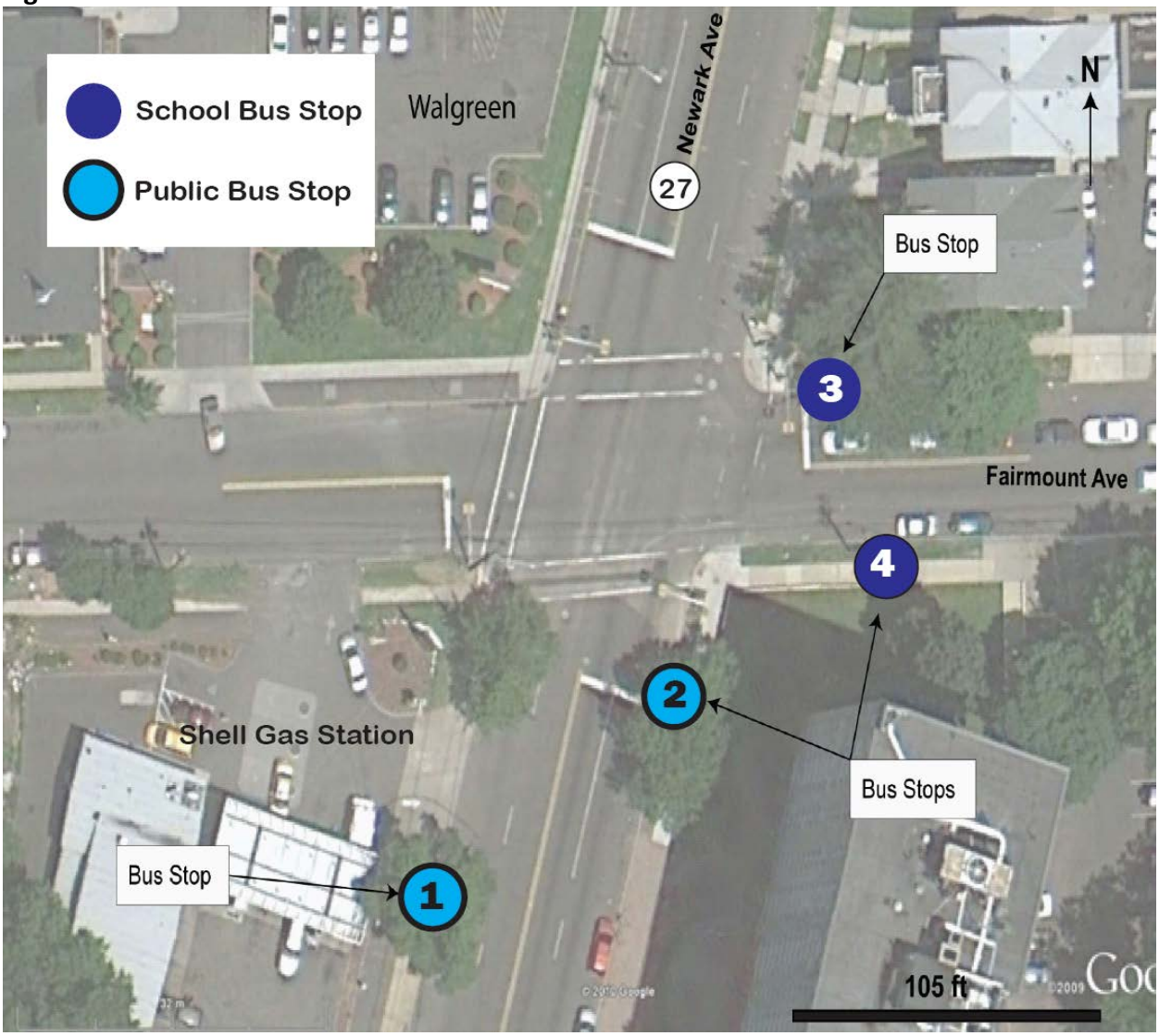
Bus Stop Site Background

Newark Avenue, or State Route 27, is a north-south, two-way, four-lane street, with parking on both sides in the City of Elizabeth, Union County. Newark Avenue intersects Fairmount Avenue, a local two-way, two-lane street, with on-street parking. The Newark and Fairmount Avenue intersection is slightly skewed, meaning two corners have obtuse angles and two have acute angles. New Jersey Transit, Coach USA and school buses use this intersection. New Jersey Transit and Coach USA stop at (1) Newark Avenue southbound on the southwest corner and (2) Newark Avenue northbound on the southeast corner. School buses stop on (3) Fairmount Avenue westbound at the northeast corner of the intersection, and (4) Fairmount Avenue eastbound at the southeast corner. The intersection and bus stop locations are shown here:

Figure 1: Aerial of Fairmount and Newark Avenues



The Newark and Fairmount Avenue intersection consists of commercial and residential uses that encourage pedestrian activity. A Shell gas station and shopping center anchored by a Walgreens are located along the southwest and northwest side of the intersection. Fairmount Avenue is more residential in nature than Newark Avenue, with high-rise buildings to the west and single-family homes to the east. Numerous school buses were observed moving through the area. Children wait for school buses on Fairmount Avenue's east leg, as shown in the diagram above.

During a one-hour observation period on September 14, 2010 from 6:30-7:30 AM, a large number of students were seen waiting for school buses on Fairmount Avenue and at the public bus stop at Newark Avenue southbound heading toward New York City. The bus serving this stop, New Jersey Transit route 112, runs every 15 minutes during the morning peak, with up to a dozen passengers waiting for bus arrival at one time. The other route serving the intersection, Coach USA route 24, runs more frequently but appeared to pick up fewer riders than the 112. As passengers waited for the oncoming bus, they typically stepped out into the street to scan traffic. The presence of on-street parking beyond the bus stop likely engenders a feeling of safety for passengers to do this. However, it makes the bus stop prone to safety issues, especially since it is a few feet from the Shell gas station driveway and bus riders tend to wait in the middle of the driveway as seen in the image below.

Photo A: ***Bus riders waiting for Newark Ave south-bound NJTRANSIT Rt. 112 or Coach USA Rt. 24 at southwest corner of Fairmount & Newark Ave***

Other issues observed at the site were the lack of pedestrian signal heads at all corners of the intersection, no bus shelters, and faded crosswalk striping. While drivers generally exhibited good yielding behavior to pedestrians in the crosswalk, providing pedestrian signal heads, bus shelters, and upgrading the crosswalk striping would provide more comfort and safety for bus riders and reinforce the presence of pedestrian activity to motorists at the intersection.

***Photo B:** Northeast corner of Fairmount & Newark Ave intersection*

Crash Data

From 2006 to August 2010, eight crashes resulting in nine pedestrian injuries occurred within 100 feet of the public bus stops. All pedestrian crashes occurred between 4:30 and 10:30 in the evening suggesting there are higher pedestrian crash rates when people are commuting home from work or school at this bus stop location. Two of the eight crashes occurred at night and all occurred during the weekday. A majority of crashes had no information on the pre-crash pedestrian characteristics. In terms of the vehicle action, seven of the eight crashes occurred when the driver was turning left. Four of the crashes occurred in one year – 2008. No pedestrian fatalities occurred at this location.

Method of Assessing Pedestrian Safety at and Near Bus Stops

The initial part of this analysis began with the use of Plan4Safety, an on-line crash analysis tool developed by Rutgers' Center for Advanced Infrastructure and Transportation. Plan4Safety contains a wealth of data about each crash, including the movement of the vehicle before and at the time of the crash, contributing pedestrian and driver crash factors, information on gender of the pedestrian, and age and gender of the motorist. This crash information was analyzed to understand potential trends, the interaction between pedestrians and motorists at and near the Fairmount and Newark Avenue bus stops, and the type of vehicles involved in the crashes. Vehicle type was included to determine if any crashes involved buses. No buses were involved in the pedestrian crashes.

This analysis was followed by a field audit to track pedestrian usage of the crosswalks and sidewalks that provide bus stop access. The results of the pedestrian tracking survey, provided on page 6, *Figure 3*, shows that there are pedestrians who cross mid-block and do not use the crosswalks to access the Walgreens and Shell Station on the western side of Newark Avenue. The level nature of Newark Avenue and its long sight distances creates an environment where people may feel they have good visibility and can safely cross midblock.

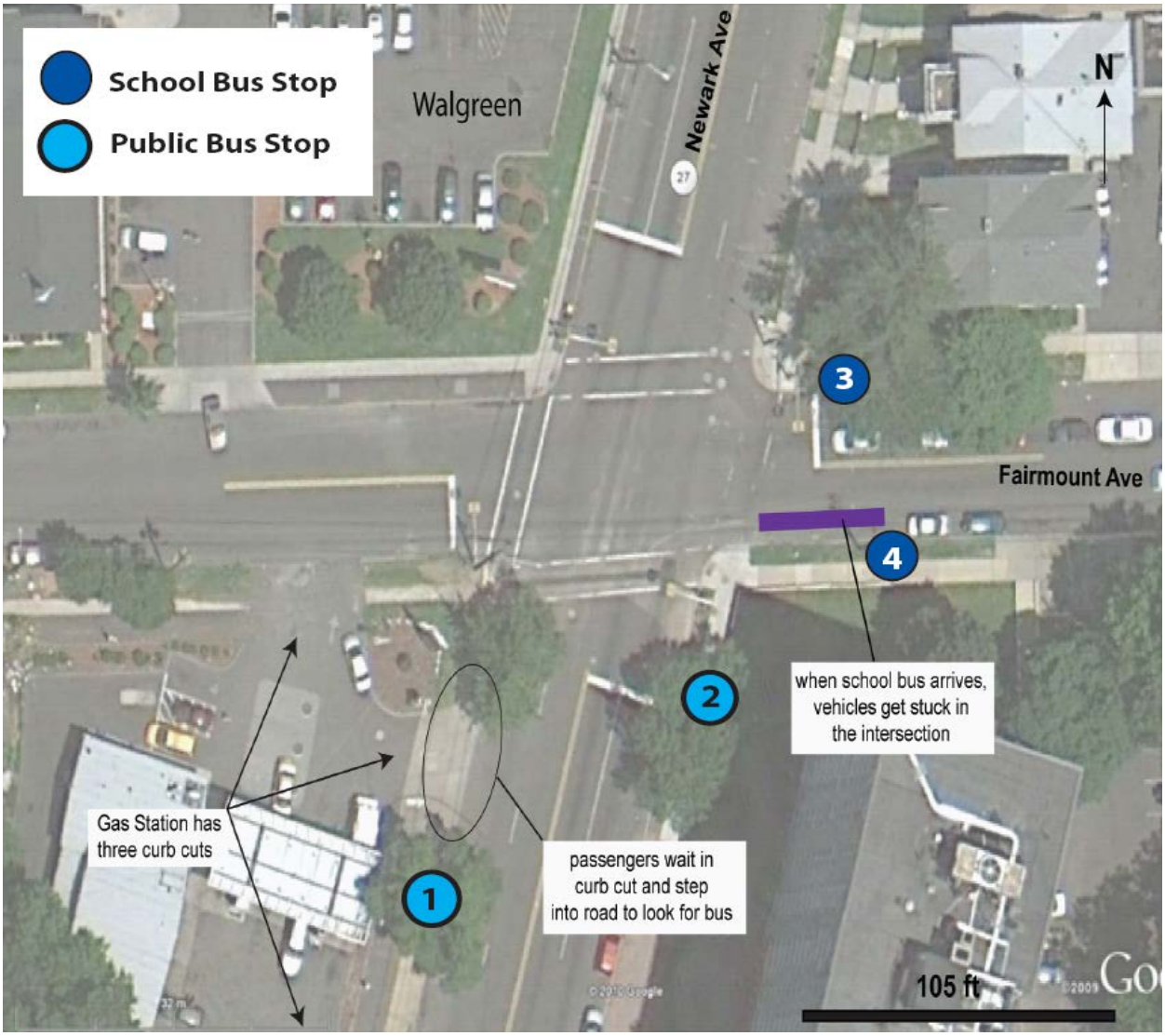
***Photo C:** Bus passengers waiting for southbound bus in front of Shell Gas Station*

In addition to the pedestrian tracking surveys, bus passengers were surveyed while waiting at the bus stop. The surveys asked people to rate sidewalk conditions, crossing safety, and motorist behavior. The results were used to gain site-specific insight about access to the bus stops. Nineteen of the 22 bus passengers that responded to the survey use the bus stops daily. All 22 of those surveyed reach the bus stop on foot and use existing sidewalks. The results of the survey questions are listed in Exhibit C.

Figure 2: Pedestrian Tracking Survey of Bus Stop Intersection

The field audit also included an assessment of the physical aspects of the bus stop intersection and bus stops to formulate the suggested improvements. The major site issues observed are shown in the following image:

Figure 3: Pedestrian Safety Issues at and Near Fairmount and Newark Avenues Bus Stops



Improvement Recommendations

The following section describes recommendations for improvement at Fairmount and Newark Avenue intersection and bus stops to facilitate safer pedestrian access to and from the transit stop. The suggested improvements are divided into short- and long-term actions. Short-term improvements are those that can be done quickly in one-year, at low cost, with no additional traffic analysis. Long-term improvements may require additional traffic analysis, and can, but do not always, require more significant capital expenditures. Often, short-term improvements are considered "pilot projects" using inexpensive and easily removable materials to test how a change to the intersection impacts safety and operations (typically done during the spring over a three-month period of time). Deemed acceptable, these improvements are then moved to the long-term category for final design and implementation using materials to create more permanent safety improvements.

The short- and long-term improvements to provide better roadway safety for all users at and near the Fairmount and Newark Avenue bus stops include:

Short-term Improvements

4. Install Pedestrian Countdown Signal Heads at all four corners.

5. Add a Leading Pedestrian Interval (LPI) of 5 seconds during all signal phases. Since 7 out of the 8 pedestrian injuries occurred after drivers were turning left, an LPI would allow a safer pedestrian crossing that establishes their presence in the crosswalk before vehicles begin turning.

6. Repaint faded crosswalks as "ladder" type.

7. Install STOP FOR PEDESTRIANS IN CROSSWALK signs approaching the intersection from the north, south, and east – these legs were used the most by students during the field audit observation.

Long-term Improvements

5. Upgrade to ADA Compliance at bus stop and bus stop intersection:
    a. All curbs flush with the street.
    b. All curbs have tactile treatments at the edges.
    c. A tactile surface at the edge of the sidewalk at bus stops should be considered to keep pedestrians away from the edge of the road and to reduce the chance of pedestrians slipping and falling under a bus at the bus stop.

6. Provide bus shelters southbound and northbound along Newark Avenue. Bus shelters are a basic amenity that encourage bus ridership and provides comfort when traveling by transit. Further analysis will be needed to look at sidewalk space for a bus shelter.

Due to limited sidewalk space, it may need to be included in the bus bulb installation discussed on page 9 as a long-term improvement.

7. Close the curb cut at the Shell station adjacent to the bus stop. The gas station already has three curb cuts. By closing this curb cut, passengers will be safe from vehicles turning in and out of the gas station. The closure of this curb cut also falls in line with access management strategies. Access management consists of ways to ensure the safe flow of traffic while encouraging street connectivity. Driveway consolidation, medians, and corner clearance, or the minimum distance a driveway can be located from an intersection, are some of the tools of access management. The basic idea behind corner clearance is that intersections operate most efficiently and safest by themselves. If a driveway is located within a queue of drivers stopped at a signal, or if a driver from a minor street interferes with another focusing on the upcoming intersection, then efficiency and safety is compromised. The dimensions of proper corner clearance are a function of queue length, sight distance, vehicle speed and other traffic related data; there is no set standard.[11] The New Jersey Department of Transportation recommends driveways at a minimum of 100 feet from the curb cut in the vicinity of signalized intersections such as the 35 mph speed limit Fairmount and Newark Avenue intersection.[12] The Shell Gas Station curb cut is just 45 feet from the intersection. This creates an unsafe situation both for pedestrians and motorists.

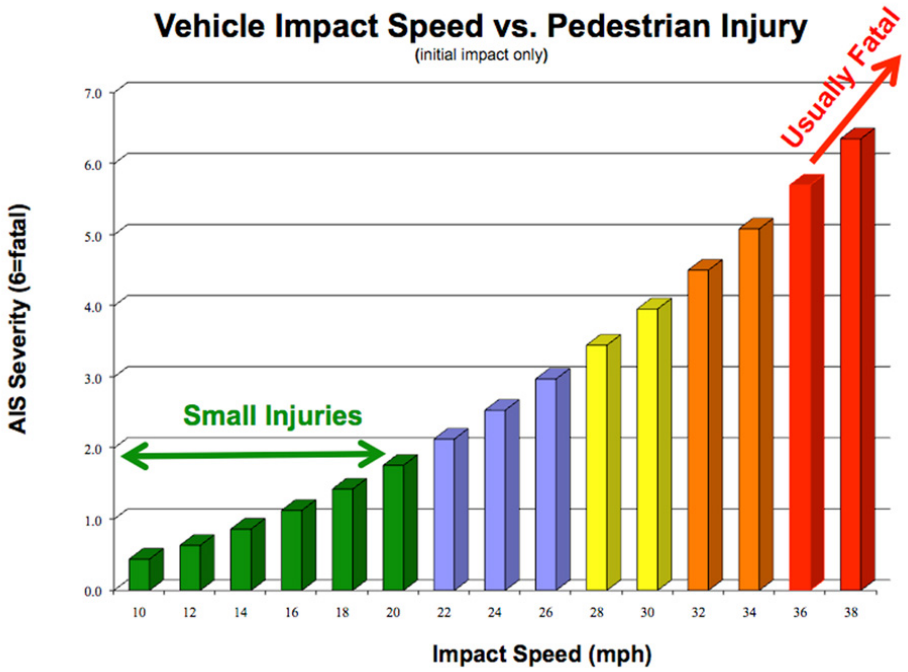
8. Create bus bulbs along Newark Avenue at both public bus stops. Bus bulbs are basically curb extensions that run the length of the bus stop. On Newark Avenue, which is fairly wide, bus bulbs will help decrease motorist speeds by narrowing the line of vision and will give passengers more waiting room. Since no parking is allowed at the bus stops, bulbs will not decrease on-street parking.

***Photo D:** Cross Section of Newark Avenue facing north*

[11] Committee on Access Management (2003). *Access Management Manual*. Washington, DC: Transportation Research Board, 2003, Figure 9-10.
[12] NJ State Highway Access Management Code. Title 16, Chapter 47, Page 26,

Ensure that the bus bulbs have an actual vehicle turning radius of 15 feet, meaning passenger vehicles will take the turn at a low to crawl speed[13]. This is crucial, as the severity of injury in a crash increases dramatically when a pedestrian is struck by a driver traveling over 20 mph, as illustrated in the chart below. The near-side bus stop on Newark Avenue northbound is recommended to remain near-side. One reason for this is that residents from the apartment buildings along the southeast corner of the intersection were observed as using the bus stop, meaning that moving the stop far-side would force them to cross the street. For convenience, the stop seems well-used where it is. The second reason is that buses heading westbound on Fairmount Avenue must make a right turn onto Newark Avenue northbound. A far-side bus bulb on Newark Avenue might make the turn difficult for bus drivers.

Figure 4: Impact of Speed on Pedestrian Injury



9. Add a curb extension on the acute northwest corner of the intersection. This does not have an effect on parking since no parking is currently allowed at this corner. A curb extension will help decrease the crossing distance and increase pedestrian visibility. As noted above, ensure that the curb extension is built with a 15 foot turning radius.

[13] *Flexibility in Highway Design*. Federal Highway Administration. Chapter 8. http://www.fhwa.dot.gov/environment/flex/ch08.htm

Implementation

The following table indicates approximate range of costs for each of the suggested improvements, and which agency might be responsible for moving an improvement project through the implementation phase. As Newark Avenue is a state road, and Fairmount Avenue is a city road, these agencies will have to coordinate short- and long-term improvements.

Summary of Short-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
Pedestrian Signal Heads and Countdowns	Vehicle signals control the flow of vehicle traffic; thus it follows that pedestrian signals are needed to control the flow of pedestrian travel. The intersection, however, does not have any pedestrian signal heads today. Adding pedestrian signals provides information for pedestrians as to when to cross. Fixed-time pedestrian signals, rather than actuated, also provides a continual visual cue to drivers that pedestrians have the right of way as well. This also allows traffic engineers to time the complete intersection for all modes of travel, rather than specific corners for specific users. Countdown signal heads improve comfort and safety by providing information to pedestrians on how much longer they have to cross the street.	Medium/High: An estimate for installation ranges from $40,000 to $200,000 per signal; however, as NJDOT can install them themselves, the cost would likely be on the lower end. Installing countdowns would incur minimal cost as the signals will be new.	State/City
Signal Cycle/Pedestrian Signal Timing	Leading Pedestrian Intervals or “pedestrian head starts” allow the most vulnerable pedestrians time to ascend and descend the curb before vehicles can begin turning movements. This provides better eye contact between pedestrians and motorists as it establishes the pedestrian further into the crosswalk.	Low: Few hours of staff time	State/City

Improvement Type	Safety Benefits	Cost Range*	Responsible Agency
Repaint Crosswalks	Show pedestrians and motorists the desired path of crossing at each leg of the intersection.	Low: Approximately $400 for regular striped, $600 for ladder, and $6,500 for patterned concrete crosswalk	State/City
Stop for Pedestrian Signage	Draws attention of drivers to pedestrians in the crosswalk and promotes new law.	Low: $50-$150 per sign plus installation costs	State/City

**Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System, September 2004, and consultant feedback.*

Summary of Long-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
ADA Compliance	Assists pedestrians of all ages and abilities to track the edge of curbs and crosswalk timing.	Medium: Approx. for concrete curbs and sidewalks is $49/linear meter ($15/linear foot) for curbing and $118/square meter ($11/square foot) for walkways ADA Detectable Warning Surface: $300 / UNIT	State/City

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
Provide Bus Shelters	Bus shelters provide comfort and safety for transit riders from inclement weather. All shelters should be wheelchair accessible.	$1,000-$10,000. Cost varies widely depending on type of improvements **	State/City
Bus Bulbs	Bus bulbs assist both transit riders and all pedestrians. Bulbs give more space for passengers to queue and also for potentially installing amenities like shelters or benches in the future. Bus bulbs also act as curb extensions for all pedestrians – they shorten the crossing distance, increase visibility to drivers, and reduce exposure time. By installing bus bulbs with 15' turning radii, they reduce the turning geometry for motor vehicles, forcing slower turns and better eye contact with people in the crosswalk.	Medium/High: Costs range from $15,000 to $55,000 depending on drainage needs and construction materials	State/City
Curb Extensions	Shorten the crossing distance for pedestrians and decrease the turning radius at corners to reduce quick turns. Extensions also provide pedestrians and motorists better view of each other at an intersection.	Medium: Approx. $2,000 to $20,000 per corner	State/City

**Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System, September 2004.*
***Accessing Transit: Design Guidelines for Florida Bus Passenger Facilities, March 2004.*

Exhibits

C. Pedestrian Crash Data

CRASH YEAR	# OF PED INJURY CRASHES
2006	0
2007	1
2008	4
2009	1
2010*	2
Total Crashes	8

2010 Crashes only from January to August of that year

CRASH TYPE	# OF CRASHES
Weekday	8
Night-Time	2
At Intersection	8
Cell phone Use	0
Involved Cargo or Passenger Van	0

CHARACTERISTICS OF PEDESTRIAN & MOTORIST	
Driver Age & Gender	25(F), 40(M), 19(M), 22(F), 48(M), 53(M), 58(M), 62(F)
Pedestrian Gender	M(56), M(40), F(23), F, F, F, M

CONTRIBUTING VEHICLE CIRCUMSTANCE	# OF CRASHES
Failed to Yield Right of Way to Vehicle/Pedestrian	0
Driver Inattention	1
Other (Driver/Pedcycle) or Unknown	7

PRE-CRASH VEHICLE ACTION	# OF CRASHES
Left Turn	7
Going Straight	1
Right Turn	0
Unknown	0

D. Bus Passenger Survey

Twenty-two people responded to the passenger survey. Responses are detailed below. Numbers do not always add to 22 due to people who did not respond.

4. Gender
    a. Male: 12 Female: 10
5. Age
    a. Under 18: 9 19-35: 6 36-55: 5 55+: 2
6. How often do you take the bus?
    a. Daily: 19 1-2 x/week: 3
7. How did you get here? All respondents walked.
8. What route did you transfer from? No Transfers
9. Did you use the sidewalk? 100% said yes.
10. Regarding the sidewalk conditions at this site?
    a. Good: 7 Satisfactory: 12 Poor: 1
11. Is the sidewalk comfortable for walking?
    a. Yes: 9 Sometimes: 4
12. Do you use the crosswalk?
    a. Yes: 17 No: 1
13. Did motorists stop for you in the crosswalk?
    a. Yes: 13 Sometimes: 1 No: 1
14. Did motorists frequently block the crosswalk?
    a. Yes: 3 Sometimes: 2 No: 5
15. Did they experience aggressive driving from motorists while crossing:
    a. Yes: 9 Sometimes: 4 No: 7
16. Have you ever been left by a bus driver?
    a. Frequently: 4 Sometimes: 13 Never: 4
17. If you were left by a bus, did you run after the bus?
    a. Yes: 9 No: 5
18. Were you left when you were trying to transfer? Two people said no.
19. All respondents spoke English.

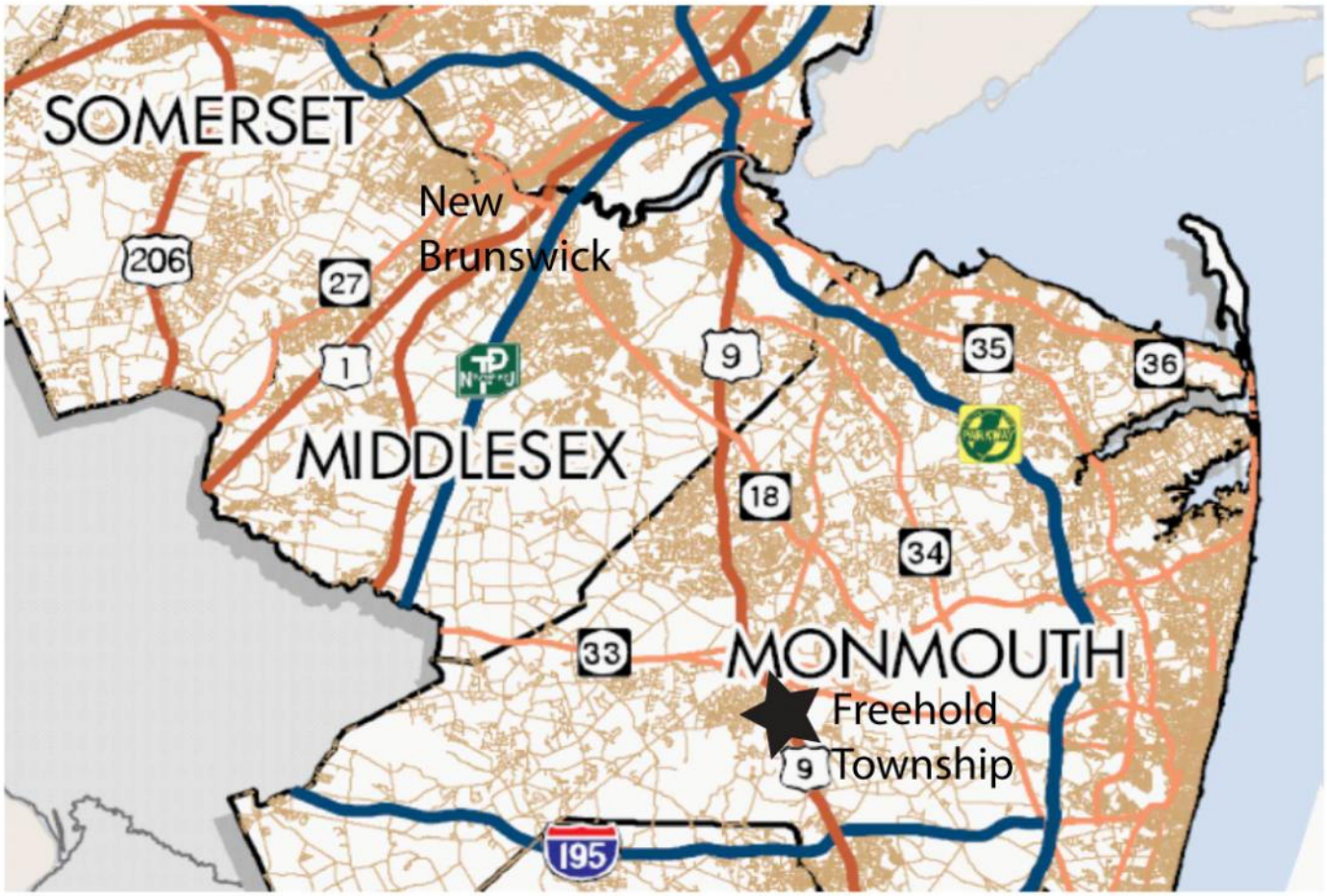
NJTPA

NORTH JERSEY TRANSPORTATION PLANNING AUTHORITY

Pedestrian Safety at and Near Bus Stops Study

Bus Stop Field Audit

U.S. Route 9 & Elton-Adelphia Road (CR524)
Freehold Township, Monmouth County



NELSON NYGAARD

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June 2011

Table of Contents

Introduction

New Jersey experiences a disproportionately high number of pedestrian injury crashes and fatalities compared to the nation as a whole. Many factors contribute to this, such as the state's density, traffic congestion, and high level of transit ridership, particularly bus ridership. Bus ridership accounts for two-thirds of all transit riders, with approximately 600,000 trips per day boarding at over 20,000 marked bus stops in New Jersey. Many bus passengers board and alight from buses along busy highways and often must cross these roadways after dark or during inclement weather. Many crashes at and near bus stops occur on congested urban street systems and along highway corridors.

The Pedestrian Safety At and Near Bus Stops Study seeks to identify approaches to reduce the severity and frequency of crashes involving pedestrians at and near bus stops in the 13-county NJTPA region and to improve safe pedestrian access to transit facilities. Successful approaches to improving travel safety often involve a combination of engineering, enforcement, and educational strategies, as well as strategies to improve emergency response time.

The study has three components:

1. An Education Campaign Plan to encourage bus riders and motorists to be conscious of safety at and around bus stops was developed. The campaign involved extensive input from focus groups, one-on-one interviews, stakeholders, and bus passenger surveys. Methods to evaluate the campaign's success were developed as well.
2. A broad-based review of a sampling of bus stops representing various geographies, high usage and/or high pedestrian crash rates was analyzed. Field audits were conducted at these locations to look at bus stop design and access to and from the bus stop.
3. Physical improvement recommendations were developed for a subset of high crash bus stop locations, and a “toolbox” of bus stop design and policy recommendations to encourage bus stop improvements. This included an informational guide designed to help municipalities navigate the process of establishing well-designed bus stops.

The following is one of the seven reports developed for the study’s physical improvement recommendations, and was developed based on observations of pedestrian and motorist circulation at each individual bus stop location to understand roadway usage and opportunities for change. Each report provides a background and pedestrian crash history at the bus stop, short- and long-term improvement recommendations, and a summary of the suggested improvements’ safety benefits and cost range.

Background

U.S. Route 9 is a major north-south corridor within the NJTPA region. It carries approximately 50,000 vehicles per day in both directions and serves as a major commuter corridor, including considerable bus ridership. NJ TRANSIT route 139 and two private bus carriers (Academy and Coach USA) provide transit services for daily commuters at the U.S. Route 9 and Elton Adelphia Road bus stops. Pedestrians accessing destinations along this corridor, including bus stops, must often interface (or avoid) motorists traveling well over 50 mph (the speed limit is 50-55 mph but, anecdotally, people drive much faster).

Elton Adelphia Road (hereafter Adelphia Road) is a county road. Just north and south of the intersection with Adelphia Road, U.S. Route 9 is two lanes each way. At the intersection, U.S. Route 9 widens for the southbound and northbound travel to four lanes each; following the intersection, the roadway reverts back to three lanes with shoulders. Bus stops are located at U.S. Route 9 southbound and U.S. Route 9 northbound. In this area of U.S. Route 9, buses stop on the shoulder and then merge back into the travel lanes, differing from the U.S. Route 9 corridor in Middlesex County where bus-only lanes are provided.

***Photo A:** Northwest corner of U.S. Route 9 & Adelphia intersection (Southbound bus stop is without continuous sidewalk.)*

NJDOT collected volume data on U.S. Route 9 0.7 miles south of Adelphia Road above Strickland Road in early September 2008. Data on Adelphia Road 0.7 miles west of the intersection with U.S. Route 9 was collected in November 2009. Over a 24-hour weekday period U.S. Route 9 carried 49,161 vehicles. During a 24-hour period in November 2009, Adelphia Road carried 10,161 vehicles.

Figure 1: Vehicle Volumes Per Lane at Intersection

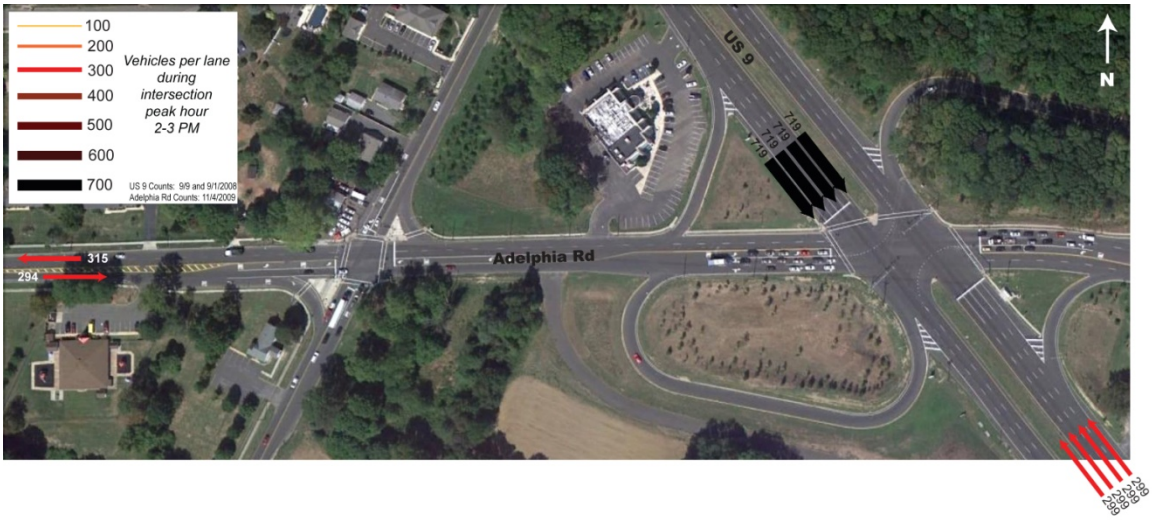
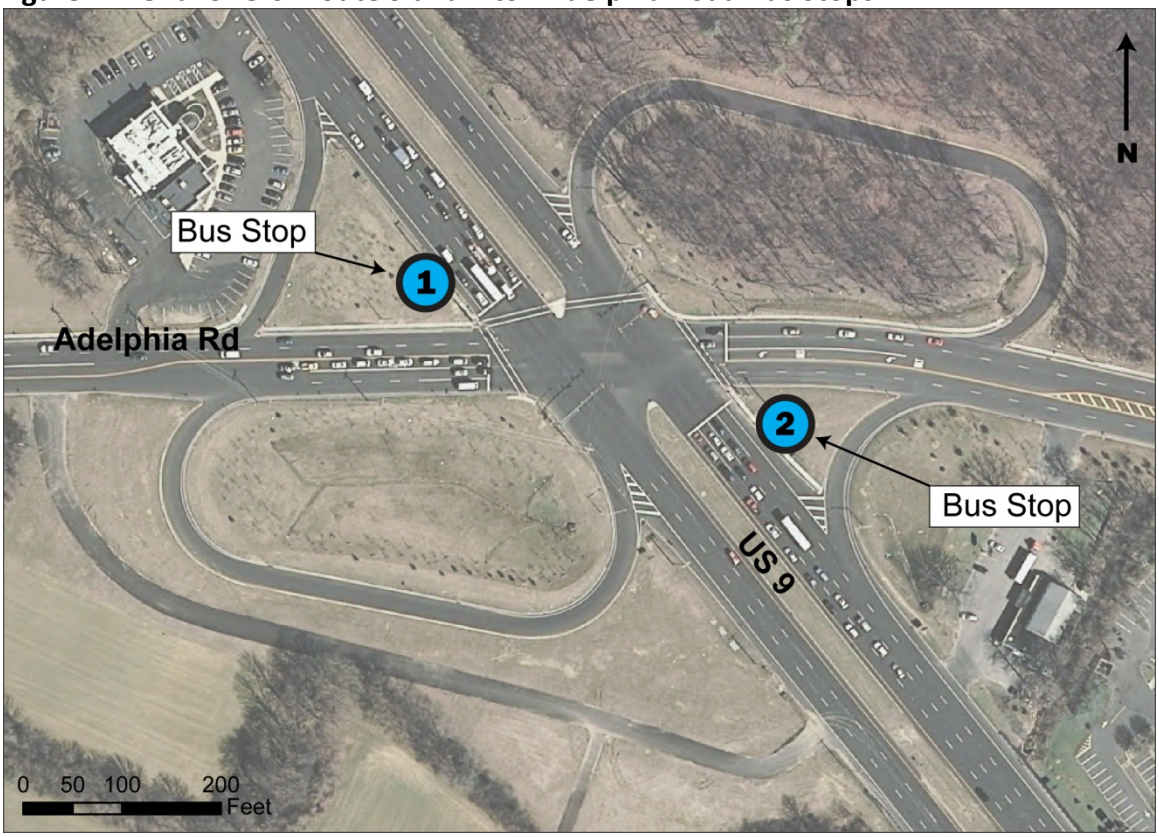


Figure 2: Aerial of U.S. Route 9 and Elton Adelphia Road Bus Stops



The intersection is surrounded by low-density, auto-oriented land uses. A diner sits on the northwest corner, however, because of the free right turn and jughandle configuration, it is not accessible through the actual intersection. Approximately 350 feet south of the northbound bus stop there is some small-scale retail, which then

opens up into a large parking lot for a Walgreen's and Acme. The northbound bus stop has a shelter; however, like many U.S. 9 bus stops, the southbound bus stop does not. Since the direction of travel is heavily skewed toward northbound passengers boarding in the morning and southbound passengers alighting in the afternoon, few passengers are waiting for southbound buses, lessening demand for shelters.

***Photo B:** Heavy turning volumes conflict with pedestrians in the north leg of the crosswalk*

A two-line crosswalk exists along the north, west, and east legs, along with pedestrian signal heads. During fieldwork conducted on two separate mornings, monitors observed very high turning volumes on Adelphia Road eastbound turning onto U.S. 9 northbound. Two left turn lanes exist to handle these vehicles. During both fieldwork visits, drivers did not yield to pedestrians crossing with the WALK signal in the crosswalk, which made it difficult for the pedestrian to cross safely. The U.S. Route 9 and Adelphia Road intersection did not have high ridership at both bus stops on the day of field observation; as such, coupled with low density land uses, motorists are less likely to expect pedestrians crossing in the intersection as they make turning movements towards the crosswalk with the WALK signal.

Lighting

The bus stops at U.S. Route 9 and Adelphia Road can be dark early in the morning and in the evening during winter months. Bus commuters of U.S. Route 9 take the bus in the early morning and evening hours; these commuters may be practically invisible to drivers. In addition to safety, the lack of lighting is also a security issue at bus shelters.

Lighting for pedestrians at the U.S. Route 9 and Adelphia Road is minimal with cobra head lamps. Traditionally, jurisdictions have installed street lighting using High-Pressure Sodium (HPS) lamps in cobra head fixtures. Three other technologies, metal halide, induction, and Light-Emitting Diode (LED) are also available. Communities often rely upon HPS lamps because they are low cost and last a long time, but consideration should also be given over to the quality of the space that is created. HPS lamps give off a yellowish glare, whereas newer technologies like LED have high-quality color rendering. Although LED lamps are more expensive up front, they also last much longer than HPS bulbs.

Figure 3: Comparison of a street lit by HPS (left) versus LED (right)

Source: KS Lights

The height of lamps is also important. Light posts for drivers are typically installed at 20-30 feet high, and in the cobra head design the lamps are placed to illuminate the road, not the sidewalk. Pedestrian-scale lighting consists of lamps placed at 10-15 feet high.

Figure 4: Post Height for Drivers Vs. Pedestrians

Source: "University City Lighting Master Plan." University City District. March 2007.

Crash Data

Two pedestrians were killed at this location between 2006 to October of 2010, both within 100 feet of the bus stops. Both fatalities occurred in the evening (in dark conditions with the street lights on) and involved alcohol. Unfortunately, Plan4Safety does not clarify whether the alcohol use was on the part of the driver or the pedestrian. The pedestrians killed were both men; the drivers were both women. The crash occurring on Monday, November 26, 2007, involved a male in dark clothing, crossing where prohibited and struck by a female driver, age 18. The crash on Monday, January 26, 2009, involved a male running across the street and struck by a female driver, age 58. Both motorists were heading southbound.

According to newspaper reports, at least two more pedestrians were killed along U.S. Route 9 in October and February during the study's development.[14] The February pedestrian was killed while trying to cross the street after alighting from a southbound bus along the U.S. Route 9 corridor.

Method of Assessing Pedestrian Safety at and Near Bus Stops

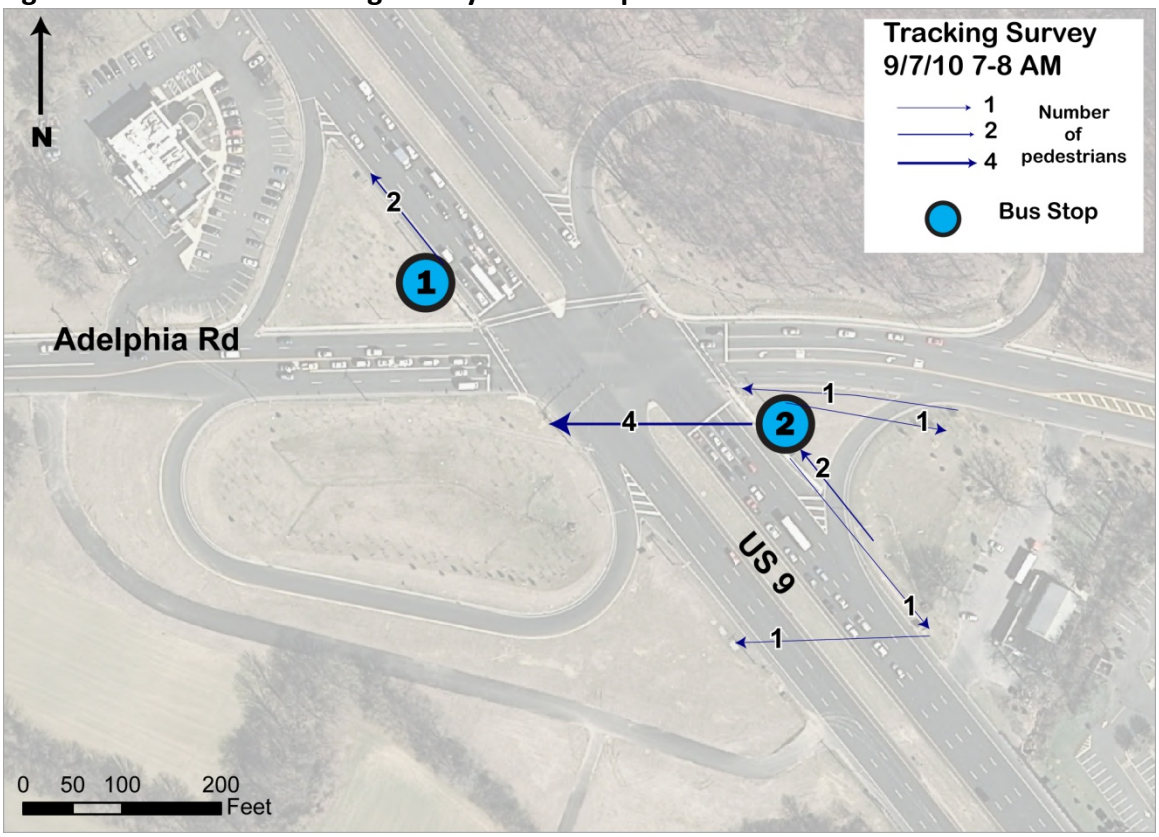
The initial part of this analysis began with the use of Plan4Safety, an on-line crash analysis tool developed by Rutgers' Center for Advanced Infrastructure and Transportation. Plan4Safety contains a wealth of data about each crash, including the movement of the vehicle before and at the time of the crash, contributing pedestrian and driver crash factors, information on gender of the pedestrian, and age and gender of the motorist. This crash information was analyzed to understand potential trends, the interaction between pedestrians and motorists at specific places at and near the U.S. Route 9 and Adelphia Road bus stops, and the type of vehicles involved in the crashes.

[14] http://www.nj.com/news/local/index.ssf/2010/10/old_bridge_man_killed_trying_t.html, http://www.nj.com/news/index.ssf/2011/02/accident_closes_lanes_on_us_ro.html

Vehicle type was included to determine if any crashes involved buses at and near bus stops. No buses were involved in the pedestrian crashes.

This analysis was followed by a field audit to track pedestrian usage of the crosswalks that provide bus stop access. The results of the tracking survey, shown in *Figure 5*, showed that one person crossed midblock and a group of 4 bus riders jaywalked along the south leg of the intersection after alighting from the bus on the northbound side. A fence has been installed in many areas of U.S. Route 9's median to prohibit midblock crossing. Since U.S. Route 9 is designed with highway standards, there is a long sight distance in each direction, and pedestrians may incorrectly believe they can accurately judge the speed of approaching cars.

Figure 5: Pedestrian Tracking Survey of Bus Stop Intersection



During the one-hour field audit from 7-8 AM on September 7, 2010, only a few pedestrians were observed using the intersection. While there are sidewalks present in certain areas around the bus stops, sidewalks end north and south of the bus stops. Pedestrians were observed walking, as shown in *Photo C*, in the grass along the side of U.S. Route 9 to get to and from the bus stops.

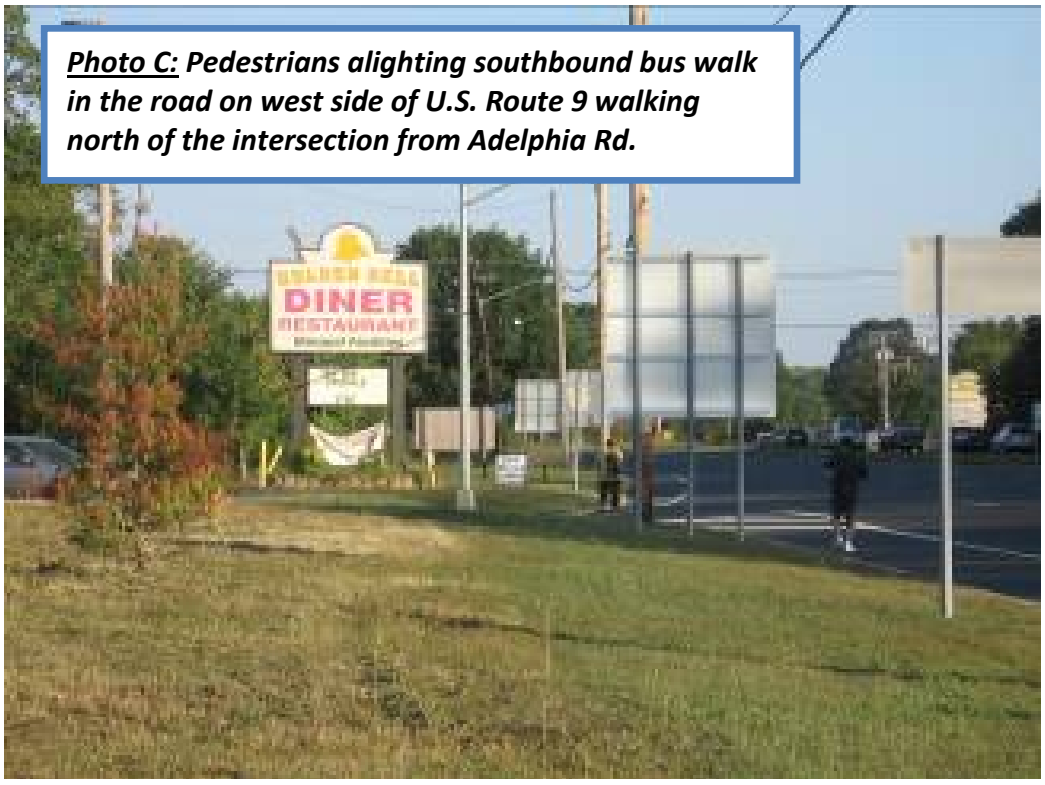


***Photo C:** Pedestrians alighting southbound bus walk in the road on west side of U.S. Route 9 walking north of the intersection from Adelphia Rd.*

In addition, bus passengers were surveyed while waiting at the bus stop. The surveys asked people to rate sidewalk conditions, crossing safety, and motorist behavior. The results were used to gain site-specific insight about access to the two bus stops. Since there were very few pedestrians observed during fieldwork, only two surveys were completed. One person noted that he has to "race across" U.S. Route 9.

The field audit also included an assessment of the physical aspects of the bus stop intersection and bus stops to formulate the suggested improvements that are highlighted below. In addition, sidewalks and non-existing sidewalks in the immediate vicinity of the bus stops were examined to determine if there were any pedestrian safety issues up or downstream from the intersection.

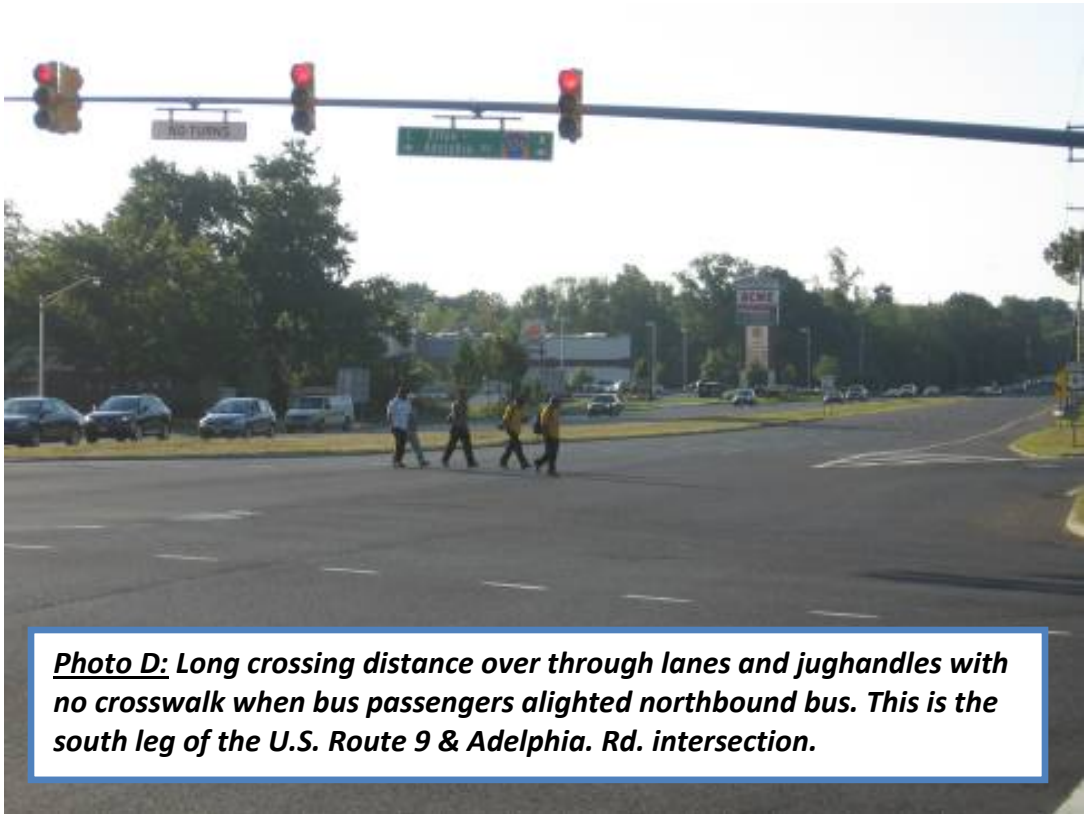


***Photo D:** Long crossing distance over through lanes and jughandles with no crosswalk when bus passengers alighted northbound bus. This is the south leg of the U.S. Route 9 & Adelphia. Rd. intersection.*

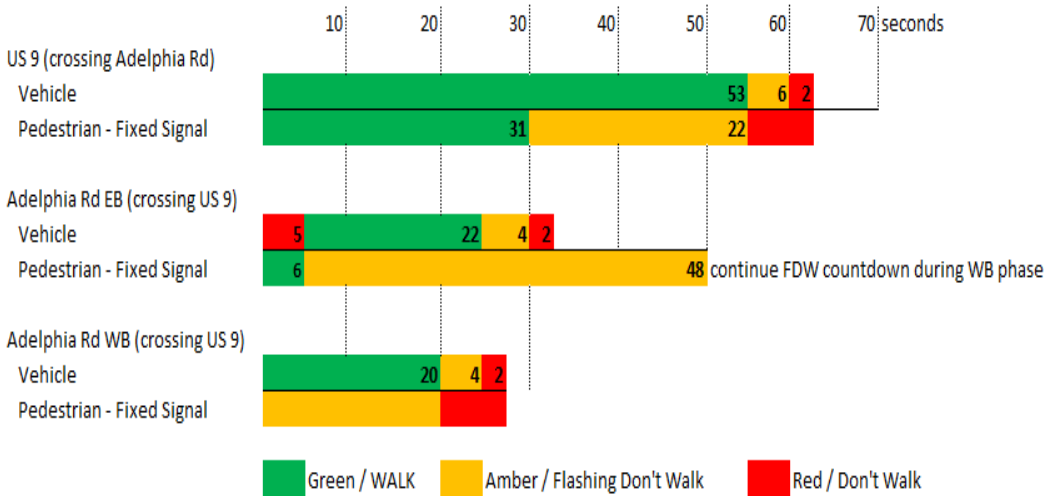
Improvement Recommendations

The following section describes recommendations for improvement at the U.S. Route 9 and Adelphia intersection to facilitate safer pedestrian access to and from the bus stop. The suggested improvements are divided into short- and long-term actions. Short-term improvements are those that can be done quickly in one-year, at low cost, with no additional traffic analysis. Long-term improvements may require additional traffic analysis, and can, but do not always, require more significant capital expenditures. Often, short-term improvements are considered "pilot projects" using inexpensive and easily removable materials to test how a change to the intersection impacts safety and operations (typically done during the spring over a three-month period of time). Deemed acceptable, these improvements are then moved to the long-term category for final design and implementation using materials to create more permanent safety improvements.

Short-term

1. Stripe a ladder crosswalk along the south leg of the intersection and the jughandle at the southeast corner of U.S. Route 9, where pedestrians were observed walking south from the bus stop to retail areas. As existing crosswalks fade and require restriping, repaint with "ladder" type.

Figure 6: Pedestrian Clearance Times for U.S. Route 9 & Adelphia Rd. Intersection



2. Consider adjusting pedestrian clearance times at the intersection to comply with the Manual on Uniform Traffic Control Devices' 3.5 feet per second recommendation. Currently, if a pedestrian pushes the button to cross U.S. Route 9, the person is given a WALK time of 25 seconds and Flashing Don't Walk of 13 seconds, for a total of 38 seconds[15] for 4.6 feet per second. Since the intersection is slightly skewed, the crossing of U.S. Route 9 measures 175 feet, requiring a crossing time of 50 seconds per MUTCD. Currently, pedestrians only have the opportunity to cross U.S. Route 9 during the Adelphia Road eastbound phase. To provide more crossing opportunities, and given the recommendation to stripe a new crosswalk on the south leg of the intersection, the pedestrian WALK signal should be extended to both eastbound and westbound phases on Adelphia Road. An example of how the signal timing might work on the current 120-second cycle (which is in effect from 6:30 am to 10 pm) is shown above. The signal timing would require further study by NJDOT; however, this is a starting point to consider.
3. Add a Leading Pedestrian Interval (LPI) of five seconds during the east-west signal phases. As discovered during fieldwork, the heavy left turn volumes eastbound and westbound pose a serious safety threat to pedestrians trying to access the bus stop. Any lead time pedestrians can be given to get a head start on turning vehicles will help them establish presence in the crosswalk. The LPI phase in the signal diagram above would take place during the first five seconds of the WALK during Adelphia Road EB.
4. Install STOP FOR PEDESTRIAN signs approaching the intersection from the east and west, as well as in the medians on U.S. Route 9.
5. Upgrade current pedestrian signal heads to countdown at each of the four corners with pedestrian signal heads (as opposed to actuated). Two new

[15] Signal timing data was provided by NJDOT

pedestrian countdown signal heads are recommended at the south leg of the intersection.

Long-term Improvements

1. Upgrade to ADA Compliance at bus stop and bus stop intersection:
    a. All curbs flush with the street.
    b. All curbs have tactile treatments at the edges.
    c. A tactile surface at the edge of the sidewalk at bus stops should be considered to keep pedestrians away from the edge of the road and to reduce the chance of pedestrians slipping and falling under a bus at the bus stop.
2. Extension of sidewalk is recommended north of the southbound bus stop to accommodate current pedestrian activity from alighting bus passengers. See *Figure 7* for location of proposed sidewalk.
3. At U.S. Route 9 and Adelphia Road, where the crosswalk measures 175 feet, it is suggeted to install LED pedestrian-scale lighting at each end of the crosswalks and in the medians. U.S. Route 9's current lighting consists of cobra-head High-Pressure Sodium style lighting.
4. Protect crosswalks with median tips. The current medians are angled on one side, which allows drivers to turn quickly. By building out the median (as shown in the Sight Improvements image on Page 13), drivers are forced to turn slower.
5. Decrease jughandle radii (see *Figure 7*). The current intersection configuration with jughandles allows for fairly high-speed vehicle turns. By tightening up the turning radii at the jughandles, the crossing distances can be decreased and drivers slowed.
6. Designate fourth lane as a bus and right-turn only lane (see *Figure 7*).
7. One of the major problems at this intersection is the angle. If Adelphia Road were aligned at a 90-degree angle to U.S. 9, the crossing distance across the highway would be decreased from 175 to 155 feet. The crossing time, using 3.5 feet per second, would drop from 50 to 44 seconds. This decreases the pedestrian exposure to vehicle traffic and reduces the amount of time a pedestrian is at risk of being hit by a driver. Since re-angling the entire intersection would be very expensive, measures such as bus bulbs, decreased turning radii, and median tips help reduce this crossing distance without undergoing major reconstruction.

Implementation

The following table indicates approximate range of costs and safety benefits for each of the suggested improvements, and which agency might be responsible for moving an improvement project through the implementation phase.

Summary of Short-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
Paint/Repaint & Re-align Crosswalks	Show pedestrians and motorists the desired path of crossing at each leg of the intersection. Re-aligning crosswalks to be closer to 90 degrees shortens the crossing distance and reduces the pedestrian risk of exposure to motor vehicle traffic.	Low: Approximately $100 for regular striped, $300 for ladder, and $3,000 for patterned concrete crosswalk	State
Revise Pedestrian Clearance Times and add LPI	Reduces confusion about how much time is left in a pedestrian signal for crossings. This also allows for a "complete" intersection for all modes of travel. Leading Pedestrian Intervals allow the most vulnerable pedestrians time to ascend and descend the curb before vehicles can begin turning movements. This provides better eye contact between pedestrians and motor vehicles as it establishes the pedestrian further into the crosswalk.	Low: Few hours of staff time	State
Stop for Pedestrian Signage	Draws attention of drivers to pedestrians in the crosswalk.	Low: $50-$150 per sign plus installation costs	State

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
Pedestrian Countdown Signal Heads	Provide pedestrians with information on how much time they have to cross the street.	Low for existing heads: Retrofitting costs $300-$800[16] Medium: Need four new heads, cost $40,000-$200,000 each	State

*Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System September 2004

Summary of Long-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
ADA Compliant Curb Ramps	Assists pedestrians of all ages with visual and mobility impairments in tracking the edge of intersection curbs, edge of sidewalk at the bus stop, and amount of time needed to cross so they can use the intersection and bus stops without assistance.	Medium: Approx. for concrete curbs and sidewalks is $49/linear meter ($15/linear foot) for curbing and $118/square meter ($11/square foot) for walkways	State
Extension of Sidewalk from bus stop	Provides for a safe and comfortable walkway to access destinations such as employment, residence, and or shopping.	$15/linear for curbing and $11 square foot for walkways	State

[16] http://www.mtc.ca.gov/planning/bicyclespedestrians/tools/countdownSignal/index.htm

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
Pedestrian-scale lighting	Lighting provides pedestrian visibility to the motorist during the early morning and evening commuting in the winter months. In addition to safety, lighting can be a security issue.	Medium: Costs for lighting range based upon the light type and style	State
Median Tips	Protects the crosswalk from turning vehicles and also slows turning movements.	Medium: Approx. $15,000 to $30,000 per 30 m or 100 ft depending on design, site conditions, and whether the median can be added as part of a utility improvement or other construction project	State
Decrease Jughandle Turning Radii	Enforces lower turning speeds for vehicles.	Medium: See cost for "Median Tips"	State
Bus Stop Lane	The right-most lanes on U.S. 9 at this location are already designated bus lanes. Traffic utilizing the jughandle can share the bus-only lane to facilitate intersection operations.	Low - requires painting "RIGHT TURN" in lanes.	State
Bus-Bulbs	Decreases crossing distance.	Medium: See cost for "Median Tips"	State

*Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System September 2004

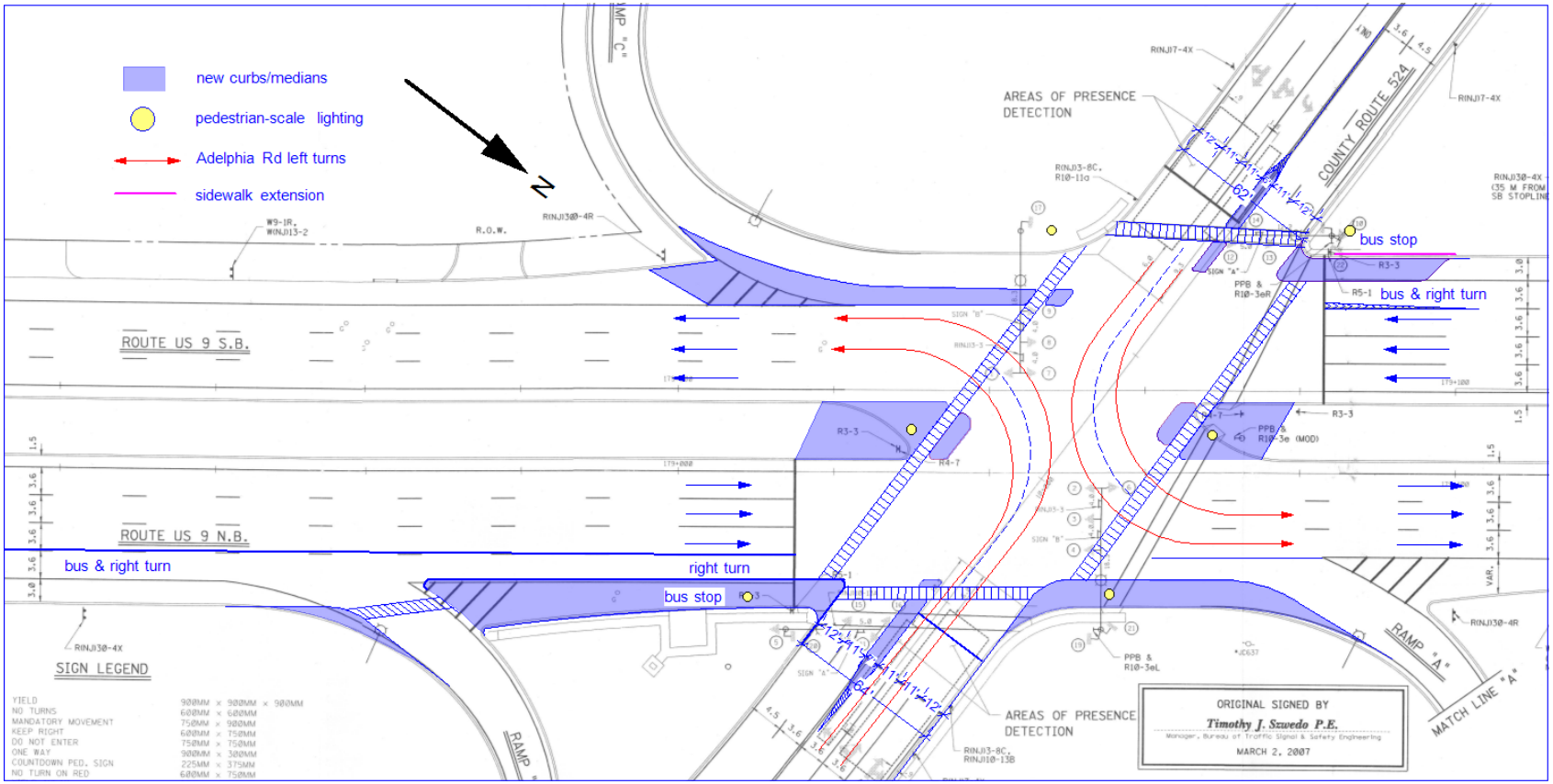
Figure 7: Site Improvements on the following page shows the short and long-term potential improvement concepts. Further study would be required at the state and county level should they choose to implement these improvements. The design maintains the same number of lanes and uses lane widths of 11 feet for inner lanes and 12 feet for outer lanes.

Pedestrian Safety at and Near Bus Stops Study

North Jersey Transportation Planning Authority

U.S. Route 9 and Elton Adelphia Road (CR 524) Bus Stops, Freehold Township, Monmouth County

Figure 7: Site Improvements



Exhibits

E. Bus Passenger Survey

Two people responded to the passenger survey; the responses to the survey are as follows:

1. Gender
    - Male: 2 Female: 0
2. Age:
    - 19-35: 1 55+: 1
3. How often do you take the bus? Both daily.
4. How did you get here?
    - Walked: 1 Dropped off: 1
5. Did you use the sidewalk? Both said yes.
6. Regarding the sidewalk conditions at this site? Both satisfactory.
7. Is the sidewalk comfortable for walking? Both said sometimes.
8. Do you use the crosswalk?
    - Yes: 1 No Response: 1
9. Did motorists stop for you in the crosswalk?
    - Yes: 1 No Response: 1
10. Did they experience aggressive driving from motorists while crossing:
    - Yes: 2 No: 0
11. Have you ever been left by a bus driver? Both said sometimes.
12. If you were left by a bus, did you run after the bus?
    - Yes: 1 No Response: 1
13. All respondents spoke English.

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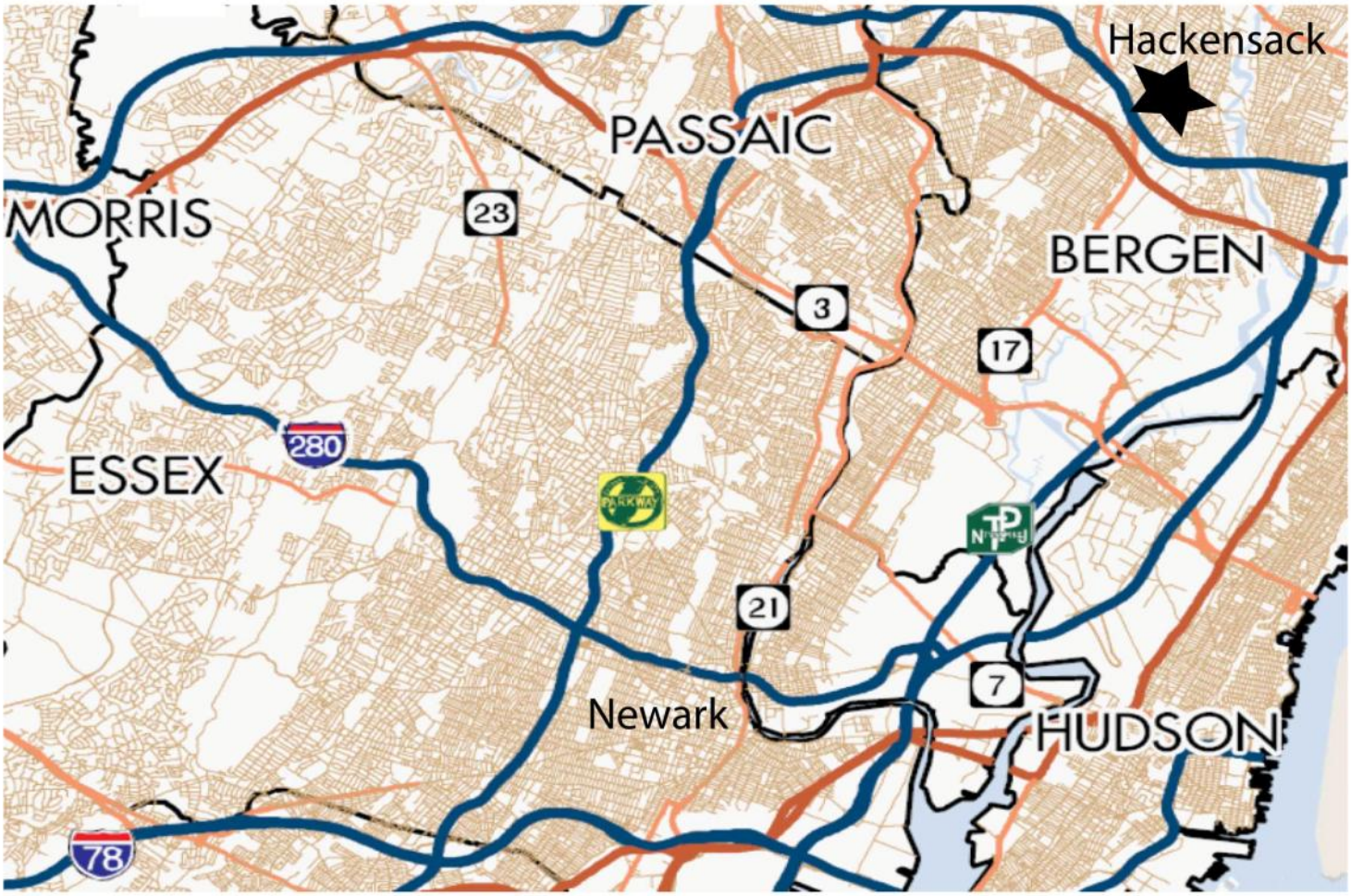
Pedestrian Safety at and Near Bus Stops Study

Bus Stop Field Audit

Essex & State/Huyler Street
City of Hackensack, Bergen County



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June 2011

Pedestrian Safety at and Near Bus Stops Study
North Jersey Transportation Planning Authority
Essex and State Street Bus Stops, City of Hackensack, Bergen County

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Pedestrian Safety at and Near Bus Stops Study
North Jersey Transportation Planning Authority
Essex and State Street Bus Stops, City of Hackensack, Bergen County

Introduction

New Jersey experiences a disproportionately high number of pedestrian injury crashes and fatalities compared to the nation as a whole. Many factors contribute to this, such as the state's density, traffic congestion, and high level of transit ridership, particularly bus ridership. Bus ridership accounts for two-thirds of all transit riders, with approximately 600,000 trips per day boarding at over 20,000 marked bus stops in New Jersey. Many bus passengers board and alight from buses along busy highways and often must cross these roadways after dark or during inclement weather. Many crashes at and near bus stops occur on congested urban street systems and along highway corridors.

The Pedestrian Safety At and Near Bus Stops Study seeks to identify approaches to reduce the severity and frequency of crashes involving pedestrians at and near bus stops in the 13-county NJTPA region and to improve safe pedestrian access to transit facilities. Successful approaches to improving travel safety often involve a combination of engineering, enforcement, and educational strategies, as well as strategies to improve emergency response time.

The study has three components:

1. An Education Campaign Plan to encourage bus riders and motorists to be conscious of safety at and around bus stops was developed. The campaign involved extensive input from focus groups, one-on-one interviews, stakeholders, and bus passenger surveys. Methods to evaluate the campaign's success were developed as well.
2. A broad-based review of a sampling of bus stops representing various geographies, high usage and/or high pedestrian crash rates was analyzed. Field audits were conducted at these locations to look at bus stop design and access to and from the bus stop.
3. Physical improvement recommendations were developed for a subset of high crash bus stop locations, and a “toolbox” of bus stop design and policy recommendations to encourage bus stop improvements. This included an informational guide designed to help municipalities navigate the process of establishing well-designed bus stops.

The following is one of the seven reports developed for the study’s physical improvement recommendations, and was developed based on observations of pedestrian and motorist circulation at each individual bus stop location to understand roadway usage and opportunities for change. Each report provides a background and pedestrian crash history at the bus stop, short- and long-term improvement recommendations, and a summary of the suggested improvements’ safety benefits and cost range.

Bus Stop Site Background

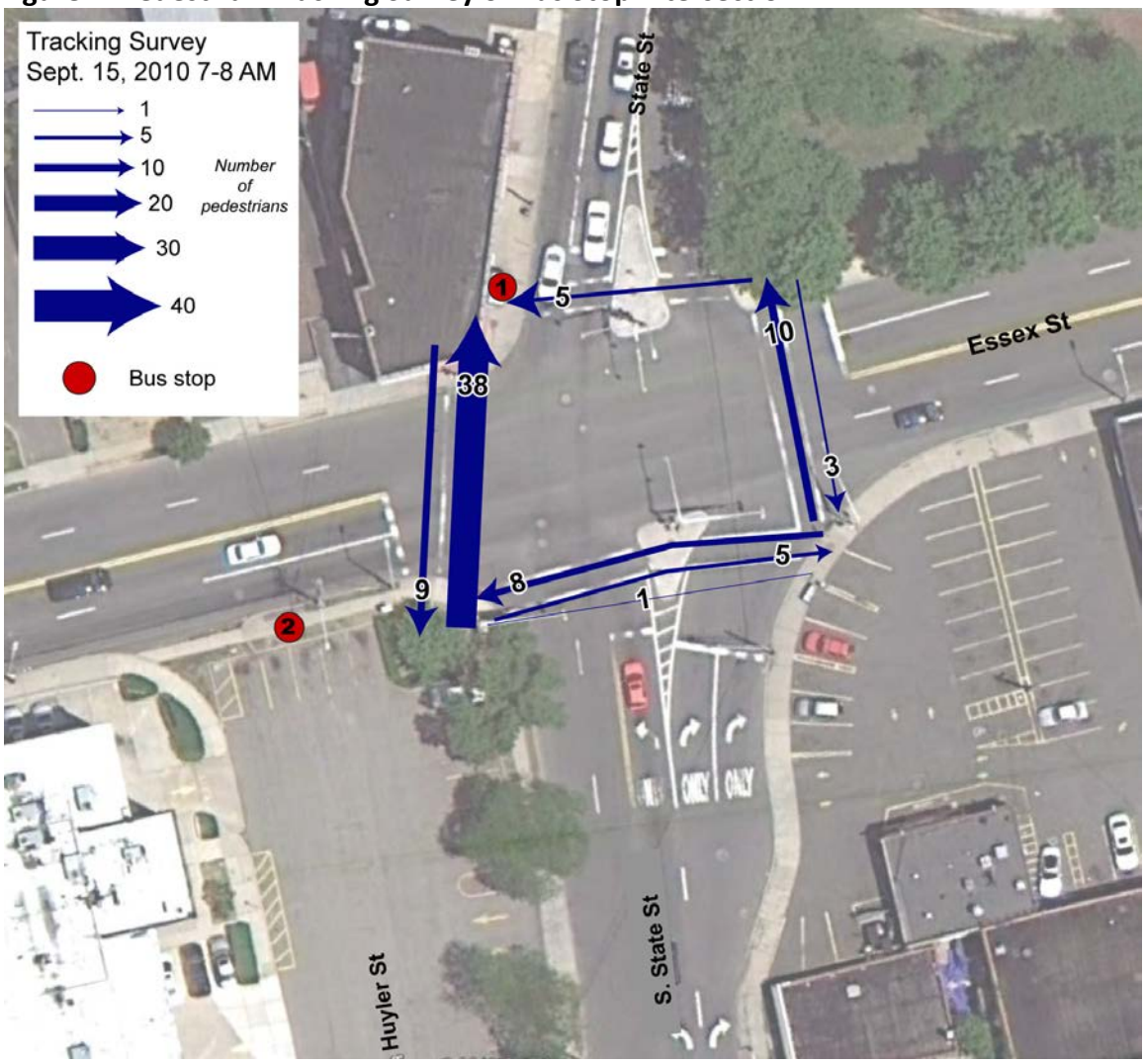
Essex Street (County Route 56) is an east-west, four-lane, two-way street in Hackensack, Bergen County. This street is intersected by State Street; which is three lanes one-way from the north, and three lanes of bidirectional traffic that expands to five lanes at Essex Street from the south, providing a unique circulation pattern. The current bus stops and bus travel pattern are (1) State Street at Essex Street traveling south along State Street, and (2) Essex at State Street traveling east along Essex Street.

Figure 1: Aerial of Essex and State Street Bus Stops:

The surrounding bus stop area has commercial and residential land uses, with sidewalks that provide for an active walking community and residents who use the NJ TRANSIT bus service daily. Some of the bus riders at the bus stop are Spanish speakers (as noted during the field audit).

In addition, there are several schools within walking distance from the two bus stops, and school children are seen using the intersection crosswalks daily. While the roadway access to the bus stop has pedestrian signal heads, pedestrian islands at two legs of the intersection, and crosswalk visibility, there are several needed upgrades. The current bus stop at (1) State Street has a bus shelter in generally good condition, but the (2) Essex Street bus stop has a bus stop sign with no shelter. During observation of the two bus stops from 7:00-8:00 AM, the (1) State Street bus stop has more bus rider traffic than the (2) Essex Street bus stop.

Figure 2: Pedestrian Tracking Survey of Bus Stop Intersection



During the morning 7:00-8:00 AM peak period, about 80 pedestrians utilized the bus stops' intersection. A large number of the pedestrian crossings were at the west leg of the intersection heading towards the (1) State Street bus stop. It is assumed that residents living south of Essex Street walk to the bus stop for their daily transit commute based on field audit observation and the bus passenger surveys.

Crash Data

From 2006 to 2010, seven pedestrian crashes occurred within 100 feet of the Essex and State Street bus stops. Four of the seven crashes occurred while the pedestrian was crossing in the marked crosswalk of the intersection, and all crashes happened during the weekday daylight time. Three of the crashes were left turn crashes, four involved male pedestrians. No pedestrian fatalities occurred at this location.

Method of Assessing Pedestrian Safety at and Near Bus Stops

The initial part of this analysis began with the use of Plan4Safety, an on-line crash analysis tool developed by Rutgers' Center for Advanced Infrastructure and Transportation. Plan4Safety contains a wealth of data about each crash, including the movement of the vehicle before and at the time of the crash, contributing pedestrian and driver crash factors, information on gender of the pedestrian, and age and gender of the motorist. This crash information was analyzed to understand potential trends, the interaction between pedestrians and motorists at and near the Essex and State Street bus stops, and the type of vehicles involved in the crashes. Vehicle type was included to determine if any crashes involved buses at and near bus stops. No buses were involved in the pedestrian crashes.

This analysis was followed by a field audit to track pedestrian usage of the intersection crosswalks near the bus stops (shown in *Figure 2*). In addition, bus passengers were surveyed while waiting at the bus stops. The surveys asked people to rate sidewalk conditions, crossing safety, and motorist behavior. The results were used to gain site-specific insight about access to and from the two bus stops. Fourteen bus passengers responded to the survey. Almost all reached the bus stop on foot and ride daily. Four of the 14 bus passengers transferred at the Essex and State Street intersection**.** The results of the survey questions are listed in Exhibit E.

The field audit also included an assessment of the physical aspects of the bus stop intersection and bus stops to formulate the suggested improvements that are highlighted below. In addition, sidewalks in the immediate vicinity of the bus stops were examined to determine if there were any pedestrian safety issues up or downstream from the intersection. These issues generally include pedestrians jaywalking to catch the bus, although this did not appear to be an issue at this location. A majority of the pedestrians used the crosswalk to reach the bus stops.

Improvement Recommendations

The following section describes recommendations for improvement at Essex and State Street intersection and bus stops to facilitate safer pedestrian access to and from the transit stop. The suggested improvements are divided into short- and long-term actions. Short-term improvements are those that can be done quickly in one-year, at low cost, with no additional traffic analysis. Long-term improvements may require additional traffic analysis, and can, but do not always, require more significant capital expenditures. Often, short-term improvements are within a year and considered "pilot projects" using inexpensive and easily removable materials to test how a change to the intersection impacts safety and operations (typically done during the spring over a three-month period of time). Deemed acceptable, these improvements are then moved to the long-term category for final design and implementation using materials to create more permanent safety improvements.

The short- and long-term pedestrian improvements at the Essex and State Street bus stop intersection include:

Short-term Improvements

1. Upgrade and install pedestrian countdown signal heads at each of the four corners with fixed time pedestrian signal heads (as opposed to actuated). Fixed-time signals are recommended to provide additional, pre-programmed walking time for pedestrians. Fixed-time signals are also much less expensive than actuated signals.
2. Consider adjusting pedestrian clearance times at the intersection to comply with the Manual on Uniform Traffic Control Devices' 3.5 feet per second recommendation. See Exhibit B for details on current pedestrian clearance time at the bus stop intersection.
3. Add a Leading Pedestrian Interval (LPI) of 5 seconds during the north-south and east-west signal phases as a response to adjusting pedestrian clearance times.
4. Repaint all crosswalks with "ladder" type and align with curbs at 90 degree angles as much as possible.
5. Repaint all stop bars.
6. Install STOP FOR PEDESTRIANS signs approaching the intersection from the north, south, and east. The motorist approach from west of the intersection is the only section that has a STOP FOR PEDESTRIANS sign. This is especially important since students use this intersection to access nearby schools on foot.

Long-term Improvements

1. Upgrade to ADA Compliance at bus stop and bus stop intersection:
    a. All curb ramps flush with the street.
    b. All curbs have tactile treatments at the edges.
    c. All medians are a minimum of eight feet wide to accommodate passing wheelchairs and to serve as refuges.

   d. A tactile surface at the edge of the sidewalk at bus stops should be considered to keep pedestrians away from the edge of the road and to reduce the chance of pedestrians slipping and falling under a bus at the bus stop.
2. Add medians on Essex Street to reduce crossing distance and potential conflicts with bus riders and turning motor vehicles.
3. Extend the curb out at the southeast and southwest corners of the intersection. This will decrease the speed of right-turning motorists and help the pedestrian to see and be seen. It also shortens the crosswalk so the pedestrian spends less time in the street, with less exposure to being hit by a motorist.
4. Change bus stop locations on Essex and State Street from near side to far side bus stops. While this would require moving the bus shelter on State Street, NJ TRANSIT has acknowledged the safety benefit of far-side over near side bus stops (Further explanation of the advantages and disadvantages of bus stop locations are described in Exhibit D).
5. Provide a wheelchair accessible bus shelter for the (1) State Street bus stop.

Implementation

The following table indicates approximate range of costs and safety benefits for each of the suggested improvements, and which agency might be responsible for moving an improvement project through the implementation phase.

Summary of Short-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency**
Pedestrian Countdown Signal Heads	Provide pedestrians with information on how much time they have to cross the street.	Medium: Approx. $20,000 to $40,000	County/City
Signal Cycle/ Pedestrian Signal Timing	Leading Pedestrian Intervals allow the most vulnerable pedestrians time to ascend and descend the curb before vehicles can begin turning movements. This provides better eye contact between pedestrians and motor vehicles as it establishes the pedestrian further into the crosswalk.	Low/medium: County electrical subcontractor time	County/City
Revise Pedestrian Clearance Times (see	Reduces confusion about how much time is left in a pedestrian signal for crossings. This also allows traffic engineers to time	Low: Few hours of staff time	County/City

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency**
Exhibit B)	the complete intersection for all modes of travel, rather than specific corners for specific users.		
Repaint/ Re-align Crosswalks	Show pedestrians and motorists the desired path of crossing at each leg of the intersection. Re-aligning crosswalks to be closer to 90 degrees shortens the crossing distance and reduces the pedestrian risk of exposure to motor vehicle traffic.	Medium: About $400 for regular striped, $600 for ladder, and $6,500 for patterned concrete crosswalk	County/City
Repaint Stopbars	Directs motorists where to stop prior to the crosswalk. This reduces encroachment into the crosswalk as pedestrians are crossing.	Low	County/City
Stop for Pedestrian Signage	Draws attention of drivers to pedestrians in the crosswalk.	Low: $50-$150 per sign plus installation costs	County/City

**Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System September 2004*

Summary of Long-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency**
ADA Compliant Curb Ramps	Assists pedestrians of all ages with visual and mobility impairments in tracking the edge of intersection curbs, edge of sidewalk at the bus stop, and amount of time needed to cross so they can use the intersection and bus stops without assistance.	Medium: Approx. for concrete curbs and sidewalks is $49/linear meter ($15/linear foot) for curbing and $118/square meter ($11/square foot) for walkways ADA Detectable Warning Surface: $300 / UNIT	County/City
Medians	Shorten the crossing distance for pedestrians allowing them less time in the crosswalk with exposure to motor vehicles. Medians provide refuge for those that can't safely make it across the street in one signal progression. These installations also reduce the turning geometry for motor vehicles, forcing slower turns and better eye-contact with people in the crosswalk.	Medium: Approx. $15,000 to $30,000 per 30 m or 100 ft depending on design, site conditions, and whether the median can be added as part of a utility improvement or other construction project	County/City
Curb Extensions	Shorten the crossing distance for pedestrians and increase the turning radius at all corners to reduce quick turns. Extensions also provide pedestrians to see and be seen by the motorist.	Medium: Approx. $2,000 to $20,000 per corner	County/City

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency**
Change the (1) State at Essex Street Bus Stop Location	As this is a location of transfers, create a far-side bus stop on (1) State Street and keep the near-side bus stop on Essex Street to reduce potential conflicts between bus passengers and motor vehicles.	Medium	NJ TRANSIT

**Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System September 2004*

Exhibits

A. Pedestrian Crash Data

CRASH YEAR	# OF PED INJURY CRASHES
2006	1
2007	3
2008	2
2009	0
2010	1
Total Crashes	7

CRASH TYPE	# OF CRASHES
Weekday	7
Night-Time	0
At Intersection	6
Cell phone Use	1
Involved Cargo or Passenger Van	2

CHARACTERISTICS OF PEDESTRIAN & MOTORIST	
Driver Age & Gender	26(F), 41(F), 42, (F), 62(F), 68(F)
Pedestrian Gender	4(M), 3(F)

PRE CRASH PEDESTRIAN CIRCUMSTANCE	# OF CRASHES
Crossing at Marked Crosswalk (At Intersection)	4
Going Straight Ahead	2
Other Pedestrian Action	1

CONTRIBUTING VEHICLE CIRCUMSTANCE	# OF CRASHES
Failed to Yield Right of Way to Vehicle/Pedestrian	1
Driver Inattention	3
Other (Driver/Pedcycle) or Unknown	3

PRE-CRASH VEHICLE ACTION	# OF CRASHES
Left Turn	3
Going Straight	2
Right Turn	1
Unknown	1

B. Pedestrian Clearance Times Accessing Bus Stops

Intersection	crossing...	Leg	Signal cycle (sec)	Crosswalk distance (ft)	Required Clearance interval (sec)	Current clearance interval (sec)	Is Clearance OK? (-no, +yes)
Essex & State	Essex	East	90	70	20	14	-6
	Essex	West		56	16	14	-2
	State	North		58	17	12	-5
	South State	South		98	28	12	-16

The pedestrian crossing time is too short along the east and west crossing legs of the bus stop intersection. The south and north crossing legs are too short if a pedestrian is making a full crossing. The crossing time for the south and north crossing legs are only acceptable if the pedestrian utilizes the pedestrian islands and crosses in two signal phases. The preferred crossing times were calculated by the 3.5 feet per second recommendation by the Manual on Uniform Traffic Control Devices.

The WALK cycle for those crossing the west leg of Essex Street occurs in Phase II when vehicles are heading southbound on State Street. There is no pedestrian cycle during Phase III for northbound traffic on State Street. The turning movements during Phase II and III have equal chance to conflict with pedestrian movements, thus a possibility exists to extend the pedestrian signal through both Phase II and III. This would greatly ease pedestrian access, as the crossing of Essex Street has the heaviest volumes as shown in the pedestrian tracking survey.

C. Advantages and Disadvantages of Bus Stop Locations

Near-Side Stop: Bus stop is located immediately before the intersection
Far-Side Stop: Bus stop is located immediately after the intersection[17]

	Advantages	Disadvantages
Far-Side Stop	• Minimizes conflicts between right-turning vehicles and buses • Provides additional right turn capacity by making curb lane available for traffic • Minimizes sight distance problems on approaches to intersection • Encourages pedestrians to cross behind the bus • Creates shorter deceleration distances for buses since the bus can use the intersection to decelerate • Results in bus drivers being able to take advantage of the gaps in traffic flow that are created at signalized intersections	• May result in the intersections being blocked during peak periods by stopping buses • May obscure sight distance for crossing vehicles • May increase sight distance problems for crossing pedestrians • Can cause a bus to stop far side after stopping for a red light, which interferes with both bus operations and all other traffic • May increase number of rear-end accidents since drivers do not expect buses to stop again after stopping at a red light • Could result in traffic queued into intersection when a bus is stopped in travel lane
Near-Side Stop	• Minimizes interferences when traffic is heavy on the far side of the intersection • Allows passengers to access buses closest to crosswalk • Results in the width of the intersection being available for the driver to pull away from curb • Eliminates the potential of double stopping • Allows passengers to board and alight while the bus is stopped at a red light • Provides driver with the opportunity to look for oncoming traffic, including other buses with potential passengers	• Increases conflicts with right-turning • May result in stopped buses obscuring curbside traffic control devices and crossing pedestrians • May cause sight distance to be obscured for cross vehicles stopped to the right of the bus • May block the through lane during peak period with queuing buses • Increases sight distance problems for crossing pedestrians
Mid-block Stop	• Minimizes sight distance problems for vehicles and pedestrians • May result in passenger waiting areas experiencing less pedestrian congestion	• Requires additional distance for no-parking restrictions • Encourages patrons to cross street at mid-block (jaywalking) • Increases walking distance for patrons crossing at intersections

17 "Guidelines for the Location and Design of Bus Stops", Transportation Research Board, TCRP, 1996

D. Photos

Photo A: ***Pedestrians cross the west leg of the Essex & State St. intersection during a break in traffic since the WALK signal is actuated***

Photo B: ***Double right turn lanes at south leg of Essex & State St. intersection make for a wide pedestrian crossing***

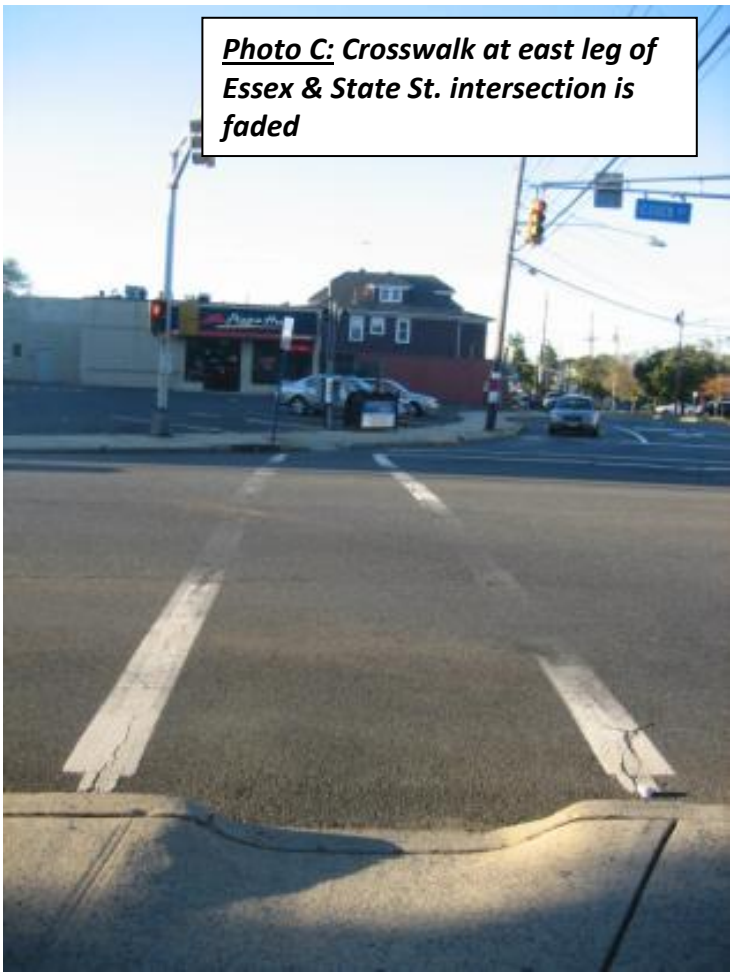


***Photo C:** Crosswalk at east leg of Essex & State St. intersection is faded*

E. Bus Passenger Survey

Fourteen people responded to the passenger survey; the responses to the survey are as follows:

1. Gender:
    - Male: 12 Female: 2
2. Age:
    - Males: 4 = 19-35, 6 = 36-55, 2 = Over 55
    - Females: 19-35
3. How often do you take the bus?
    - Male: 1 over age 55 once or twice a week
    - All others daily
4. How did you get here?
    - Walked: 9 Transferred: 4 Drove: 1
5. What route did you transfer from?
    - 165, 703, 76, and 76L
6. Did you use the sidewalk?
    - 100% Yes
7. Regarding the sidewalk conditions at this site?
    - Good Condition: 5 Satisfactory: 9
8. Is the sidewalk comfortable for walking?
    - 12 Responded; Yes: 10 Sometimes: 2
9. Do you use the crosswalk?
    - 12 Responded; Yes: 11 No: 1
10. Did motorists stop for you in the crosswalk?
    - 11 Responded; Yes: 9 No: 2
11. Did motorists frequently block the crosswalk?
    - 10 Responded; Yes: 2 No: 7 Sometimes: 1
12. Did they experience aggressive driving from motorists while crossing?
    - 12 Responded; Yes: 4 No: 8
13. Have you ever been left by a bus driver?
    - 12 Responded; Sometimes: 2 No: 10
14. If you were left by a bus, did you run after the bus?
    - 2 Responded, Both Yes
15. Were you left when you were trying to transfer?
    - 1 Responded: No
16. All respondents spoke English.

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NORTH JERSEY
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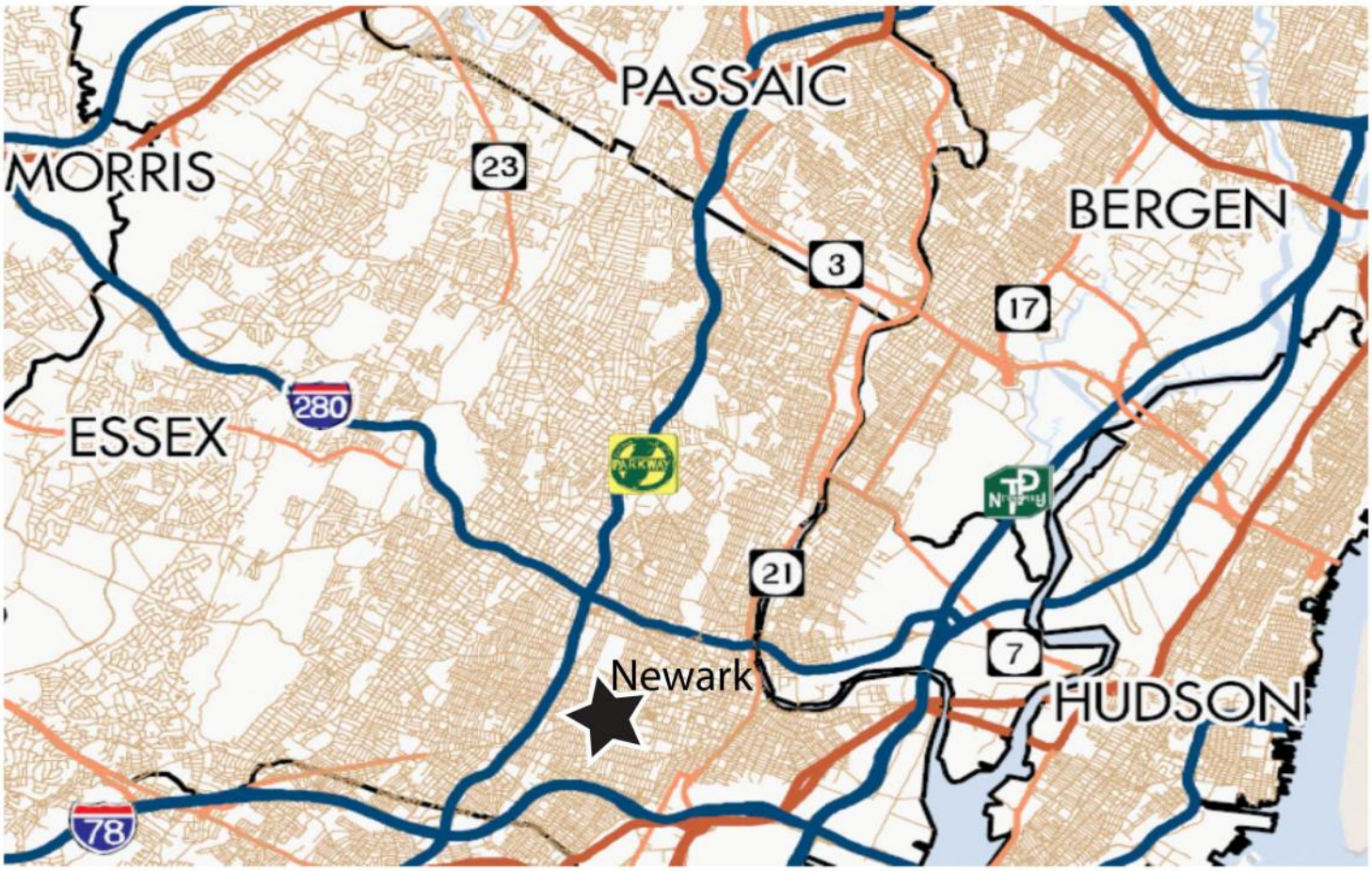
Pedestrian Safety at and Near Bus Stops Study

Bus Stop Field Audit

18th Avenue & Irvine Turner Boulevard
City of Newark, Essex County



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The following is one of the seven reports developed for the study’s physical improvement recommendations, and was developed based on observations of pedestrian and motorist circulation at each individual bus stop location to understand roadway usage and opportunities for change. Each report provides a background and pedestrian crash history at the bus stop, short- and long-term improvement recommendations, and a summary of the suggested improvements’ safety benefits and cost range.

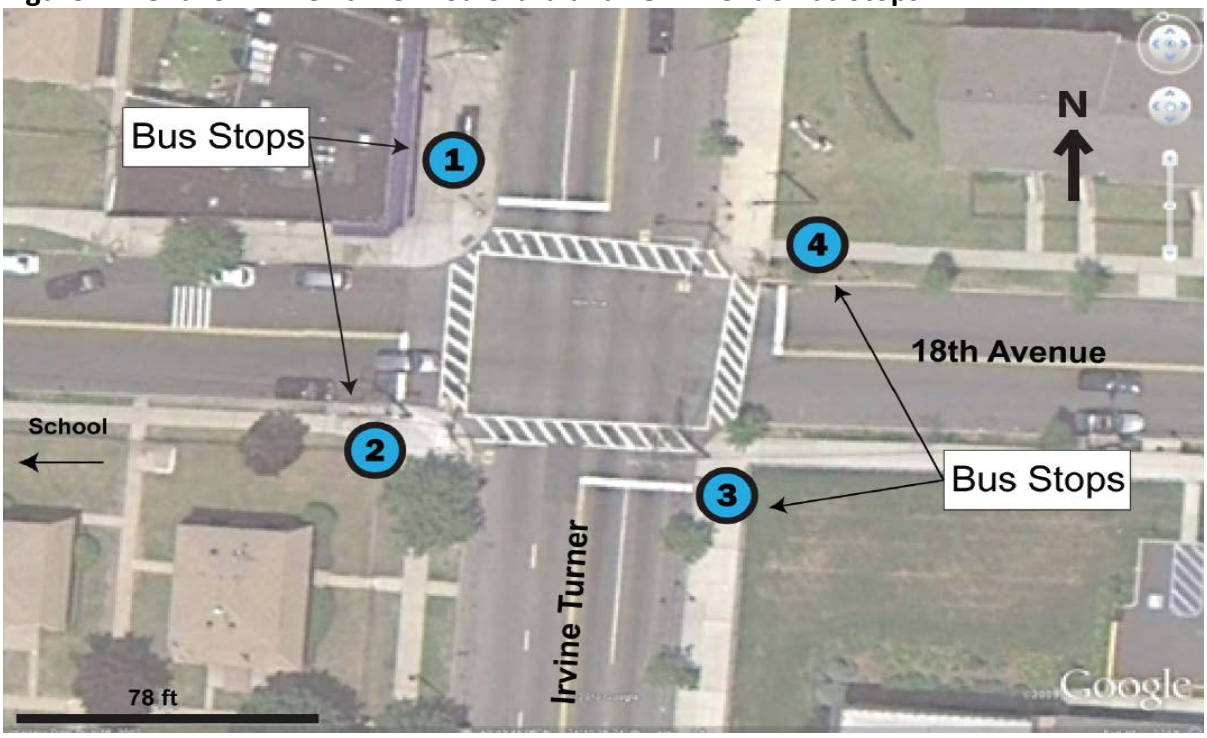
Background

Irvine Turner Boulevard is a north-south, four-lane, two-way local street with on-street parking in the city of Newark. This street is intersected by 18th Avenue, a local street, with one lane in each direction and on-street parking on both sides of the street. The Irvine Turner Boulevard and 18th Avenue intersection had 3 pedestrian injuries and 1 pedestrian fatality from 2006 to September 2010. The fatality occurred as a result of a bus colliding with a pedestrian as the bus made a left turn.

NJ TRANSIT serves four stops at this intersection: 1) Irvine Turner Boulevard southbound at the northwest corner of the intersection serving bus routes 5 and 99, 2) 18th Avenue eastbound, serving bus routes 5 and 42. The route 5 bus operator must make a left turn onto Irvine Turner Boulevard after serving this stop. Bus route 42 continues east along 18th Avenue. Bus stop 3) Irvine Turner northbound serves bus route 99, and 4) 18th Avenue westbound serves bus route 42.

Irvine Turner Boulevard has the feel of a high-speed street, due to its width, even though the speed limit is 25 mph. 18th Avenue has traffic calming measures in the form of rumble strips approaching three schools located west of the intersection. Despite the high number of children crossing the intersection, there are no pedestrian signal heads present on any corner of the intersection. All crosswalks are high-visibility zebra crossings.

Figure 1: Aerial of Irvine Turner Boulevard and 18th Avenue Bus Stops



Potential immediate destinations from the bus stops include a community center on the southeast corner, new residential attached homes on the northeast corner, residential apartments on the southwest corner, and a bodega on the northwest corner.

During fieldwork conducted September 15, 2010, from 7-8 AM, the majority of intersection users were adults walking children to school and students walking alone to school. Central High School, 18th Avenue Elementary School, and Link Community School are all located within two blocks west of the intersection, following 18th Avenue. The bodega (convenience store) on the northwest corner was observed as a major draw, with students and others stopping in for snacks and drinks. The bus stop in front of the convenience store has a shelter. A number of students were observed walking to the intersection from the east, and alighting at the bus stops.

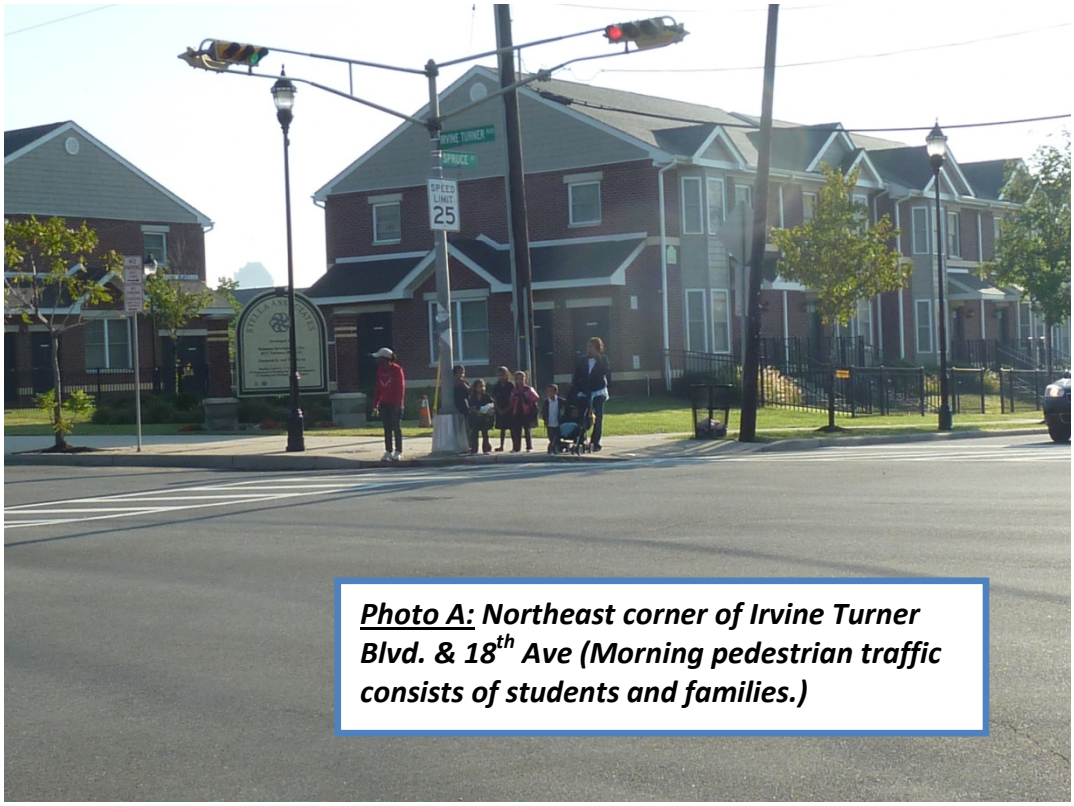


***Photo A:** Northeast corner of Irvine Turner Blvd. & 18th Ave (Morning pedestrian traffic consists of students and families.)*

***Photo B:** Northwest corner of Irvine Turner Blvd. & 18th Ave (No pedestrian signals at intersection)*

Crash Data

From 2006 to September 2010, there were three pedestrian injuries and one pedestrian fatality within 50 feet of the bus stops at the intersection. The pedestrian fatality is a NJ TRANSIT recorded crash. Two of the three pedestrian injury crashes involved male drivers, dark conditions with active street lighting, a pedestrian crossing at the intersection, and a cargo or passenger van. All three pedestrian injury crashes occurred after 5PM and on a Monday or Friday. Exhibit A on page 11 provides further information.

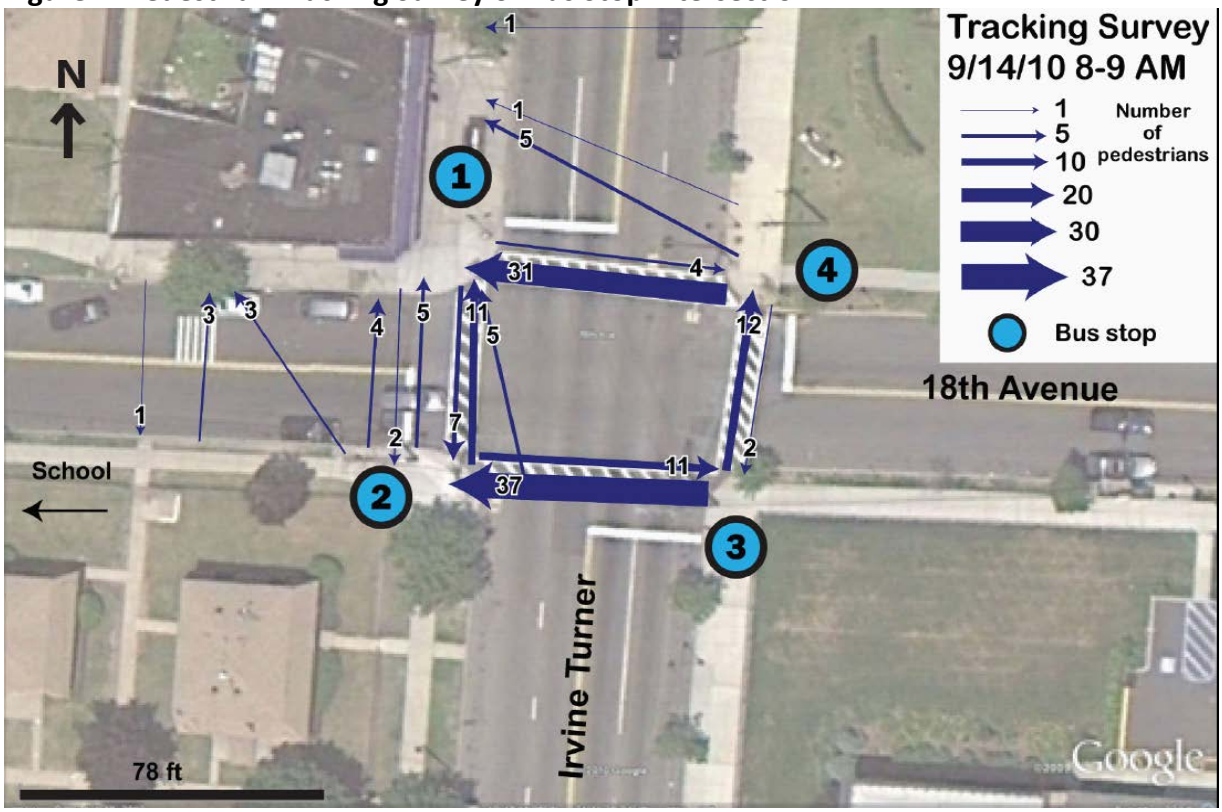
Method of Assessing Pedestrian Safety at and Near Bus Stops

The initial part of this analysis began with the use of Plan4Safety, an on-line crash analysis tool developed by Rutgers' Center for Advanced Infrastructure and Transportation. Plan4Safety contains a wealth of data about each crash, including the movement of the vehicle before and at the time of the crash, contributing pedestrian and driver crash factors, information on gender of the pedestrian, and age and gender of the motorist. This crash information was analyzed to understand potential trends, the interaction between pedestrians and motorists at specific places at and near the bus stops, and the type of vehicles involved in the crashes. Vehicle type was included to determine if any crashes involved buses at and near bus stops. The fatality occurred in 2010, caused when a bus operator making a left turn struck a pedestrian. Given that circumstance, this location became a priority for further analysis.

This analysis was followed by a field audit on September 14, 2010 to track pedestrian usage of the crosswalks that provide for bus stop access. The pedestrian tracking survey, shown in *Figure 2*, explains that more then 100 people used the intersection during the study team's one hour weekday field audit. A majority of the pedestrian activity travels west in the morning.

In addition, bus passengers were surveyed while waiting at the bus stops. The surveys asked people to rate sidewalk conditions, crossing safety, and motorist behavior. The results were used to gain site-specific insight about access to the four bus stops and can be found in Exhibit B of this report. Seventeen bus riders responded to the survey during the one-hour field audit. A majority of the respondents were female, and 14 of the 17 respondents use the bus stop daily to access destinations by transit.

Figure 2: Pedestrian Tracking Survey of Bus Stop Intersection



The field audit also included an assessment of the physical aspects of the bus stop intersection and bus stops to formulate the suggested improvements that are highlighted below on page 7 in Long-Term Improvements. In addition, sidewalks in the immediate vicinity of the bus stops were examined to determine if there were any pedestrian safety issues up or downstream from the intersection. The tracking survey below showed evidence that pedestrians were crossing the street to catch the bus outside of the intersection crosswalks. The tracking survey also shows that pedestrian traffic largely moves westward along 18th Avenue to access the three schools to the west of the intersection during the weekday morning period. This is prevalent in

the north leg of the intersection, where the route 5 bus encounters pedestrians as it makes a left turn from the west leg of the intersection to the north leg and proceeds north on Irvine Turner Boulevard.

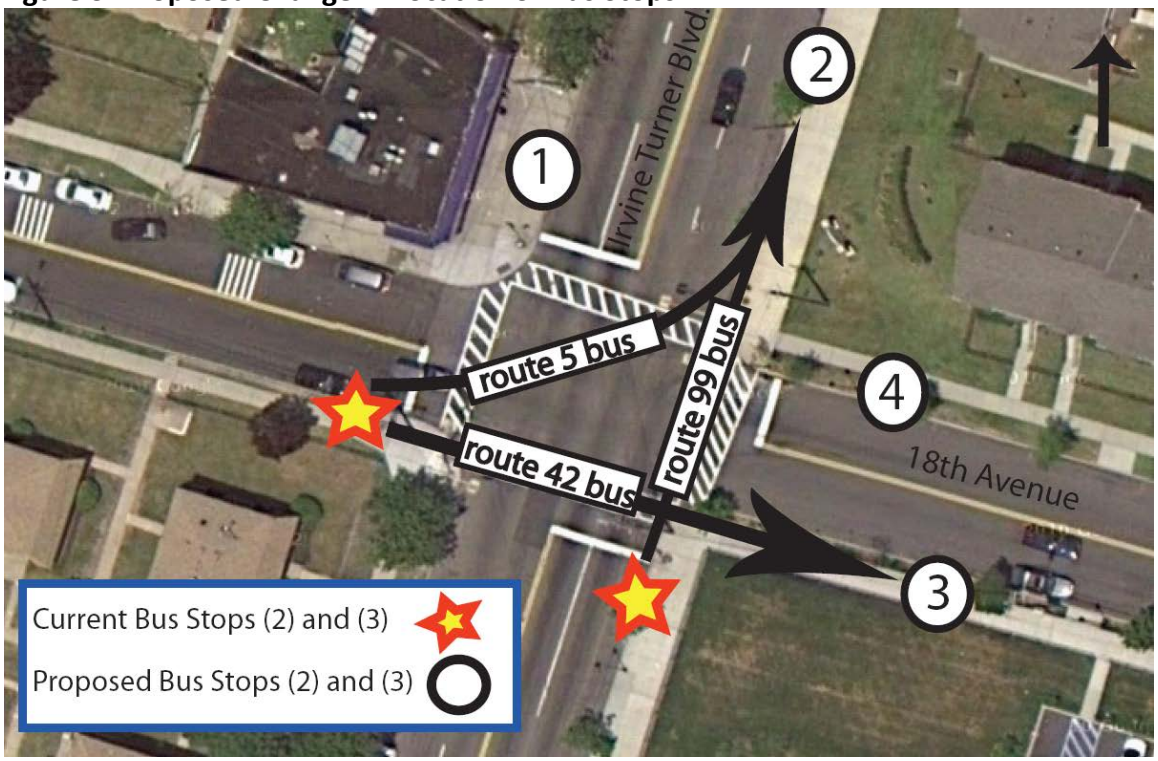
Improvement Recommendations

The following section describes recommendations for improvement at Irvine Turner Boulevard and 18th Avenue intersection and bus stops to facilitate safer pedestrian access to and from the transit stop. The suggested improvements are divided into short- and long-term actions. Short-term improvements are those that can be done quickly in one-year, at low cost, with no additional traffic analysis. Long-term improvements may require additional traffic analysis, and can, but do not always, require more significant capital expenditures. Often, short-term improvements are considered "pilot projects" using inexpensive and easily removable materials to test how a change to the intersection impacts safety and operations (typically done during the spring over a three-month period of time). Deemed acceptable, these improvements are then moved to the long-term category for final design and implementation using materials to create more permanent safety improvements.

Short-Term Improvements

1. Install pedestrian signal heads at all four corners. Use countdown signals.
2. Add a Leading Pedestrian Interval (LPI) of 5 seconds during all signal phases. During fieldwork, a high number of vehicles making left turns were observed. LPIs allow the most vulnerable pedestrians time to ascend and descend the curb before vehicles can begin turning movements.
3. Install STOP FOR PEDESTRIANS IN CROSSWALK signs approaching the intersection from all legs. Given the high number of children using the intersection, this is an important safety measure.
4. Consider moving the route 5, 42, and 99 bus stops from near-side to far-side. See *Figure 3* for guidance on change in bus stop locations. Currently, the route 5 bus operator must turn immediately left after stopping at the route 5 northbound bus stop at the southwest corner of the intersection. A pedestrian fatality occurred during this left turn bus maneuver while the pedestrian was attempting to cross on the north leg of the intersection.

Figure 3: Proposed Change in Location of Bus Stops

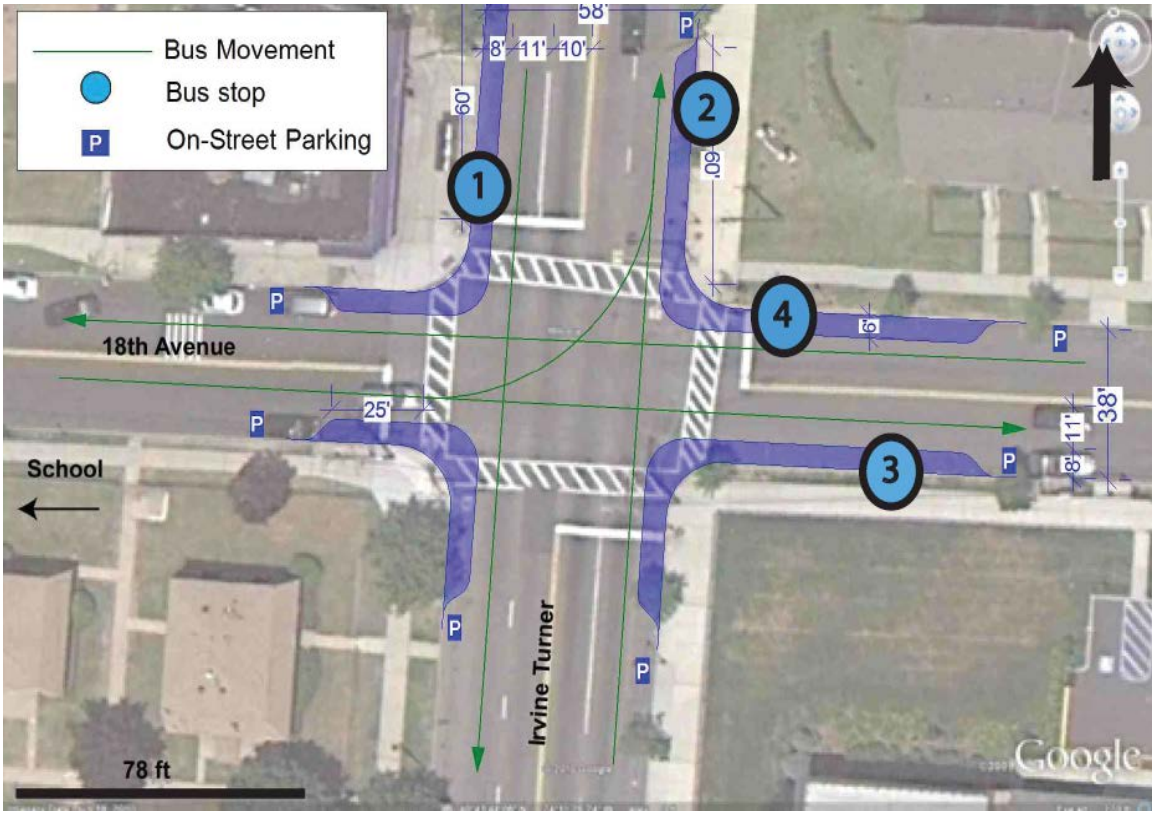


Long-Term Improvements

1. Upgrade to ADA Compliance at bus stop and bus stop intersection:
    a. All curbs flush with the street.
    b. All curbs have tactile treatments at the edges.
    c. A tactile surface at the edge of the sidewalk at bus stops should be considered to keep pedestrians away from the edge of the road and to reduce the chance of pedestrians slipping and falling under a bus at the bus stop.
2. Create curb extensions on all four corners of the intersection. This shortens the pedestrian crossing distance and improves visibility to drivers. At bus stops, extend the curb the length of the bus stop (60 feet for a regular-sized bus – this allows 45 feet for the bus to stop plus 15 feet to pull into traffic). Along Irvine Turner Boulevard, there are two lanes each way, thus having the bus stop in traffic will not pose a serious conflict. 18th Avenue is one lane each way, thus the 42 bus will need to stop in the travel lane. Route 42 only runs hourly, thus does not pose a major inconvenience to drivers. The curb extensions should have a radius of 10 feet, meaning a passenger vehicle can take the turn at a low to crawl speed. The speed a vehicle is traveling when it hits a pedestrian directly relates to the severity of injury. A pedestrian is more likely to survive a collision with a vehicle if the driver is going 20 mph or less.
3. Provide bus shelters at the 2), 3), and 4) bus stops depicted in *Figure 3*. Bus shelters are a basic amenity that encourage bus ridership and provide comfort when traveling by transit. The three new shelters could be placed in the curb extensions/bus bulbs.

Figure 3 shows the potential long-term build-out of the intersection, and includes potential improvement concepts, including relocated bus stops and curb extensions. Further study would be required at the municipal level should they choose to adopt the improvements.

Figure 4: Proposed Bus Stop Locations & Movement



Implementation

The following table indicates approximate range of costs and safety benefits for each of the suggested improvements, and which agency might be responsible for moving an improvement project through the implementation phase. Both roadways are owned by the City of Newark.

Summary of Short-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
Pedestrian Countdown Signal Heads	Provide pedestrians with information on how much time they have to cross the street.	Medium: Approx. $20,000 to $40,000	City
Leading Pedestrian Interval	Leading Pedestrian Intervals allow the most vulnerable pedestrians time to ascend and descend the curb before vehicles can begin turning movements. This provides better eye contact between pedestrians and motor vehicles as it establishes the pedestrian further into the crosswalk.	Low: Few hours of staff time	City
Stop for Pedestrians Signage	Draws attention of drivers to pedestrians in the crosswalk.	Low: $50-$150 per sign plus installation costs	City
Move bus stops	The bus stop at the southwest corner of the intersection poses a safety concern since the operator must turn left after passengers board.	Medium: Requires moving sign pole	NJ TRANSIT

*Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System September 2004, and consultant feedback

Summary of Long-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
ADA Compliant Curb Ramps	Assists pedestrians of all ages with visual and mobility impairments in tracking the edge of intersection curbs, edge of sidewalk at the bus stop, and amount of time needed to cross so they can use the intersection and bus stops without assistance.	Medium: Approx. for concrete curbs and sidewalks is $49/linear meter ($15/linear foot) for curbing and $118/square meter ($11/square foot) for walkways	City
Curb Extensions	Shorten the crossing distance for pedestrians and increase the turning radius at all corners to reduce quick turns. Extensions also provide pedestrians and motorists better view of each other at an intersection.	Medium: Approx. $2,000 to $20,000 per corner	City
Install bus shelters	Bus shelters provide comfort and safety for transit riders from inclement weather. All shelters should be wheelchair accessible.	Medium: $1,000 to $10,000. Cost varies widely depending on the type of improvements**	Installation: NJ TRANSIT Maintenance: City

*Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System September 2004, and consultant feedback

** *Accessing Transit: Design Guidelines for Florida Bus Passenger Facilities, March 2004*

Exhibits

A. Bus Passenger Survey

Seventeen people responded to the passenger survey; the responses to the survey are as follows:

1. Gender:
    - Male: 2 Female: 15
2. Age:
    - Males: 1 = 36-55, 1 = Over 55
    - Females: 4 = Under 18, 5 = 19-35, 4 = 36-55, 2 = Over 55
3. How often do you take the bus?
    - Males: Both daily
    - Females: 3 One-to-two times per week, 12 Daily
4. How did you get here?
    - All 17 Walked
5. What route did you transfer from?
    - None Transferred
6. Did you use the sidewalk?
    - 100% Yes
7. Regarding the sidewalk conditions at this site?
    - Good condition: 12 Satisfactory: 5
8. Is the sidewalk comfortable for walking?
    - 9 Responded; All Yes, Always
9. Do you use the crosswalk?
    - 14 Responded; All Yes
10. Did motorists stop for you in the crosswalk?
    - 13 Responded; Yes: 9 No: 4
11. Did motorists frequently block the crosswalk?
    - 6 Responded; Yes: 1 No: 5
12. Did they experience aggressive driving from motorists while crossing?
    - 7 Responded; Yes: 5 No: 2,
13. Have you ever been left by a bus driver?
    - Frequently: 3 Sometimes: 10 Never: 4
14. If you were left by a bus, did you run after the bus?
    - 12 Responded; Yes: 6 No: 6
15. Were you left when you were trying to transfer?
    - 4 Responded; Yes: 4
16. All respondents spoke English.

NJTPA

NORTH JERSEY
TRANSPORTATION
PLANNING AUTHORITY

Pedestrian Safety at and Near Bus Stops Study

Bus Stop Field Audit

U.S. Route 9 & Fairway Lane

Township of Old Bridge, Middlesex County

NELSON
NYGAARD

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June 2011

Pedestrian Safety at and Near Bus Stops Study
North Jersey Transportation Planning Authority
U.S. 9 and Fairway Lane, Township of Old Bridge, Middlesex County

Table of Contents

Introduction

New Jersey experiences a disproportionately high number of pedestrian injury crashes and fatalities compared to the nation as a whole. Many factors contribute to this, such as the state's density, traffic congestion, and high level of transit ridership, particularly bus ridership. Bus ridership accounts for two-thirds of all transit riders, with approximately 600,000 trips per day boarding at over 20,000 marked bus stops in New Jersey. Many bus passengers board and alight from buses along busy highways and often must cross these roadways after dark or during inclement weather. Many crashes at and near bus stops occur on congested urban street systems and along highway corridors.

The Pedestrian Safety At and Near Bus Stops Study seeks to identify approaches to reduce the severity and frequency of crashes involving pedestrians at and near bus stops in the 13-county NJTPA region and to improve safe pedestrian access to transit facilities. Successful approaches to improving travel safety often involve a combination of engineering, enforcement, and educational strategies, as well as strategies to improve emergency response time.

The study has three components:

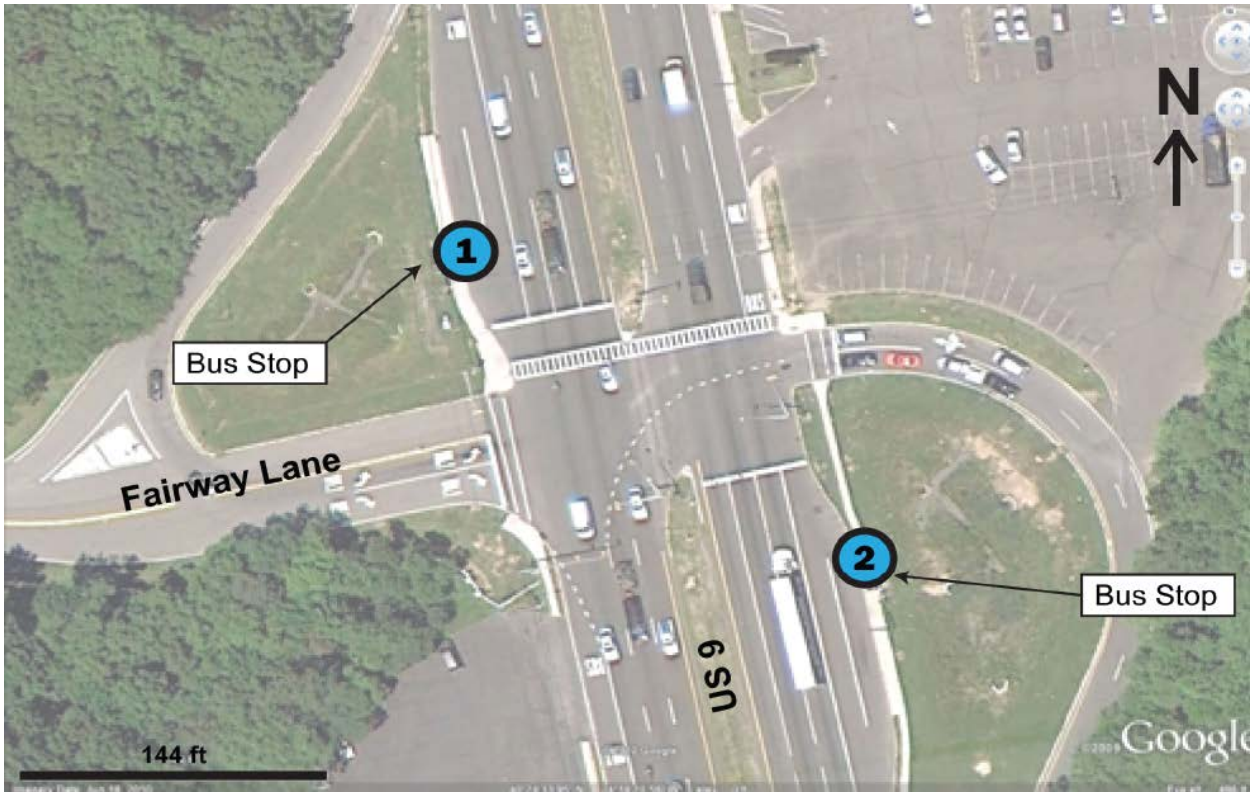
1. An Education Campaign Plan to encourage bus riders and motorists to be conscious of safety at and around bus stops was developed. The campaign involved extensive input from focus groups, one-on-one interviews, stakeholders, and bus passenger surveys. Methods to evaluate the campaign's success were developed as well.
2. A broad-based review of a sampling of bus stops representing various geographies, high usage and/or high pedestrian crash rates was analyzed. Field audits were conducted at these locations to look at bus stop design and access to and from the bus stop.
3. Physical improvement recommendations were developed for a subset of high crash bus stop locations, and a “toolbox” of bus stop design and policy recommendations to encourage bus stop improvements. This included an informational guide designed to help municipalities navigate the process of establishing well-designed bus stops.

The following is one of the seven reports developed for the study’s physical improvement recommendations, and was developed based on observations of pedestrian and motorist circulation at each individual bus stop location to understand roadway usage and opportunities for change. Each report provides a background and pedestrian crash history at the bus stop, short- and long-term improvement recommendations, and a summary of the suggested improvements’ safety benefits and cost range.

Bus Stop Site Background

The intersection of U.S. Route 9 and Fairway Lane provides access between the local road and Route 9, which is a divided, limited-access state highway. U.S. Route 9 is a divided highway running north-south through the state. It is an artery both for vehicle traffic and bus traffic, as the roadway provides a linkage to roadways that feed into the Holland and Lincoln Tunnels for Manhattan access. This dual use as both highway and bus route means that there are a lot of pedestrians walking along and crossing a high-speed roadway with long signal spacing. The speed limit on U.S. Route 9 is 50 and 55 mph in Middlesex County, depending on mile segment. Four bus routes (67, 139, 818, and 64) serve the intersection of U.S. Route 9 with Fairway Lane, which is a local road. Bus route 139, connecting Lakewood to New York City, is a very well-used route, with buses running at two-minute headways during the morning peak. The intersection is configured as a "jug handle", with the traffic signals timed in three phases. The bus stops are located (1) at U.S. Route 9 southbound and (2) at U.S. Route 9 northbound. Both stops are near side bus bays. The bus has a dedicated lane along this portion of U.S. Route 9. Both northbound and southbound bus stops have a shelter.

Figure 1: Aerial of Fairway Lane and U.S. Route 9 Bus Stops



A shopping center, including a Shop Rite Supermarket and several eateries, is located at the northeast corner of the intersection. High-rise apartment buildings are located behind the shopping center, and some bus patrons were observed walking to and from these buildings. A convenience store is located at the southwest corner. The crosswalks for the bus stop intersection are on three of the intersection legs. The WALK signal to cross both sides of Fairway Lane is fixed and the pedestrian signal head has a countdown.

***Photo A:** Bus Stop "(2)" southbound, Intersection of Route 9 & Fairway Lane*

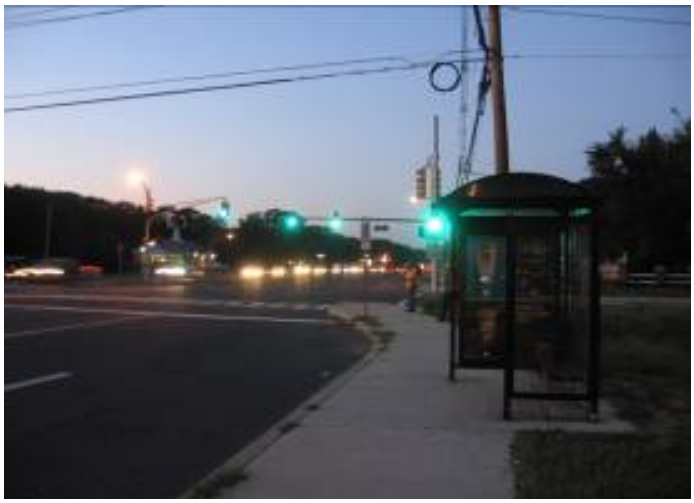


***Photo B:** Bus Stop "(1)" at Route 9 northbound, Intersection of Route 9 & Fairway Lane*

Crash Data

From 2006 to August 2010, four pedestrian crashes occurred within 100 feet of the bus stops, of which two were fatalities. The fatalities that occurred in 2007 and 2009 involved male pedestrians. All crashes occurred after dark. More detailed analysis of the crashes can be found at Exhibit A.

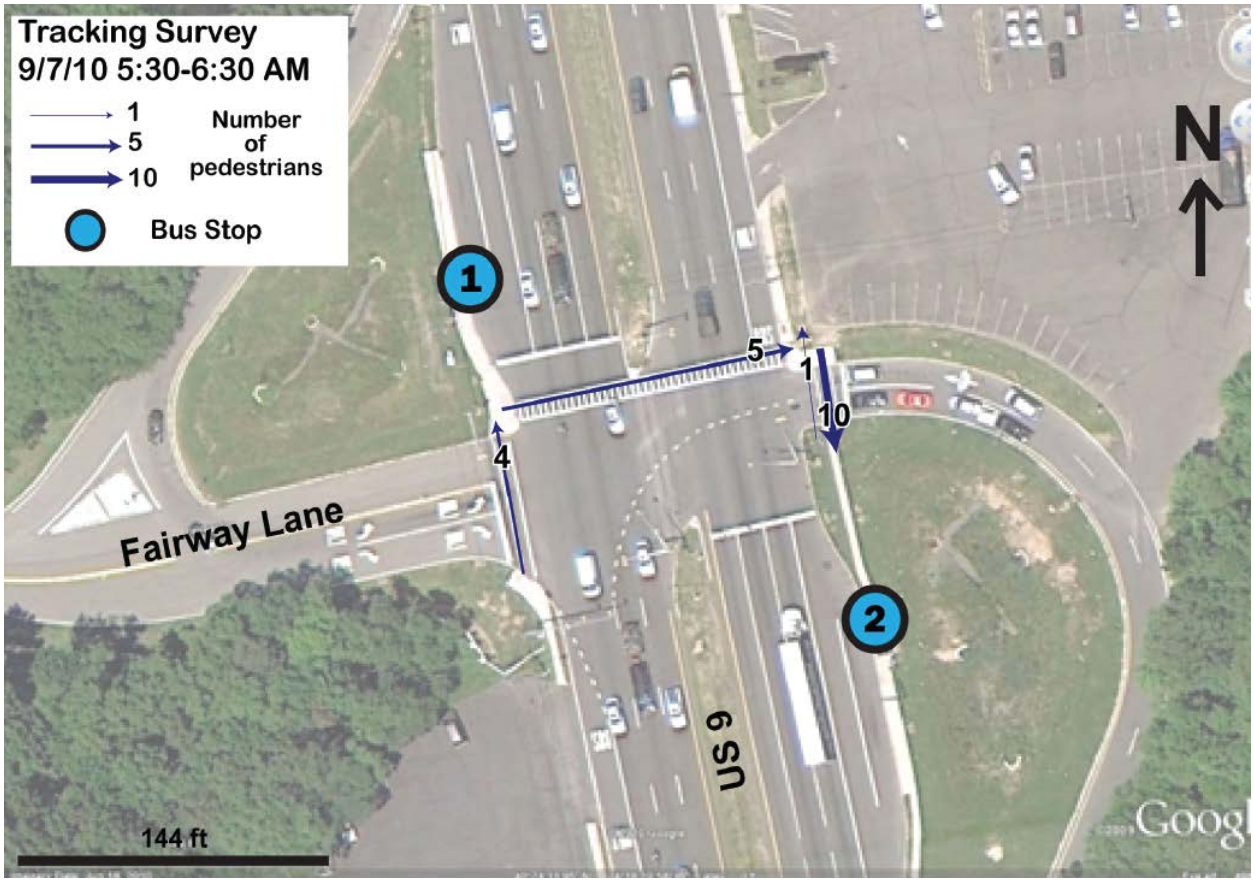
Method of Assessing Pedestrian Access to Bus Stops and Bus Stop Design

The initial part of this analysis began with the use of Plan4Safety, an on-line crash analysis tool developed by Rutgers' Center for Advanced Infrastructure and Transportation. Plan4Safety contains a wealth of data about pedestrian, bicyclist and motor vehicle crashes, including the movement of the vehicle before and at the time of the crash, contributing factors to the crash caused by the pedestrian and the driver, some information on gender of the pedestrian, and age and gender of the motorist. This crash information was analyzed to understand potential trends, the interaction between pedestrians and motorists at specific places at and near the intersection bus stops, and the type of vehicles involved in the crashes. Vehicle type was included to determine if any crashes involved buses at and near bus stops.

This analysis was followed by a field audit to track pedestrian usage of the crosswalks and sidewalks that provide access to and from bus stops. The pedestrian tracking survey, shown in *Figure 2*, was conducted on a Tuesday morning in September of 2010 from 5:30 AM to 6:30 AM to capture commuters traveling north to employment hubs in Jersey City and Manhattan. During this time, the northbound bus stop was used significantly more than the southbound bus stop.

None of the pedestrians observed during the one-hour fieldwork observation period crossed along the south leg, which has no crosswalk. Commuters in this area start their day early, as evidenced by the bus schedules. Buses start running every two minutes by 5:14 AM. During the day that the fieldwork occurred, the bus stop and intersection were in complete darkness at 5:30 AM. A few passengers surveyed noted the problem with the lack of lighting. This is an issue also from a security standpoint, as it makes the bus stop feel unsafe. In addition, four pedestrians were observed walking north on the sidewalk along U.S. Route 9 southbound; those passengers then had to cross at three crosswalks to get to the bus stop. The pedestrian signal timing to cross U.S. Route 9 is quite short, with most people needed to jog to cross. A majority of the pedestrians were seen crossing the east leg of the U.S. Route 9 and Fairway Lane intersection during the pedestrian tracking survey as noted below:

Figure 2: Pedestrian Tracking Survey of Bus Stop Intersection



In addition to the pedestrian tracking surveys, bus passengers were surveyed while waiting at the bus stop. The bus passenger surveys administered at the northbound and southbound bus stops asked people to rate sidewalk conditions, crossing safety, and motorist behavior. The results were used to gain site-specific information about access to the two public bus stops to help inform the location's improvement needs. Answers to the bus passenger survey can be found in the Exhibit B. Ten bus riders responded to the bus passenger survey. Only four of the bus riders surveyed walked to the bus stop, while the other bus passengers were dropped by car, parked, or transferred from another bus. Four survey respondents brought up inadequate snow removal as a barrier to transit access. The stops are bus bays; when plows go through, they plow the bus lane and push all the snow into the bus bay. Passengers must then climb over a snow bank to board the bus because the bus has to stop in the travel lane.

Improvement Recommendations

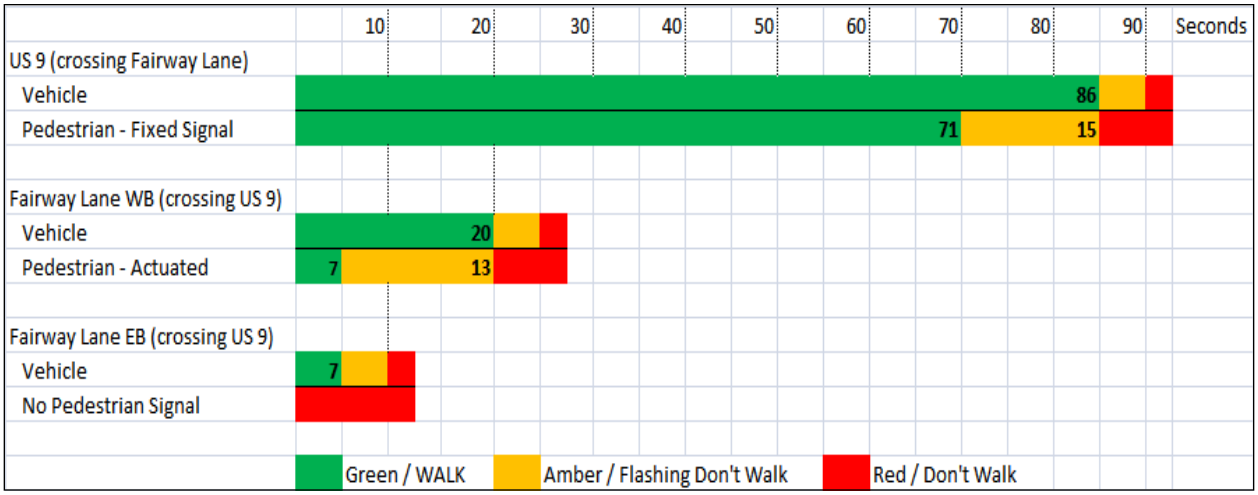
The following section describes recommendations for improvement at U.S. 9 and Fairway Lane intersection and bus stops to facilitate safer pedestrian access to and from the transit stop. The suggested improvements are divided into short- and long-term actions. Short-term improvements are those that can be done quickly in one-year, at low cost, with no additional traffic analysis. Long-term improvements may require additional traffic analysis, and can, but do not always, require more significant capital expenditures. Often, short-term improvements are considered "pilot projects" using inexpensive and easily removable materials to test how a change to the intersection impacts safety and operations (typically done during the spring over a three-month period of time). Deemed acceptable, these improvements are then moved to the long-term category for final design and implementation using materials to create more permanent safety improvements.

Short-term Improvements:

1. Crosswalks – Install a "ladder" type crosswalk along the south leg of the intersection.
2. Crosswalks – As existing crosswalks on Fairway Lane become faded, restripe as "ladder" type.
3. Pedestrian Signal Heads – Install on each side of the new crosswalk crossing U.S. Route 9. Use countdown signals on all signal heads.
4. Install STOP FOR PEDESTRIANS IN CROSSWALK sign on U.S. Route 9 northbound and southbound.
5. Signal Timing – Revise the pedestrian time allotted to cross U.S. Route 9. Current crossing time is very short with a long crossing distance. The Manual on Uniform Traffic Control Devices (MUTCD), produced by the Federal Highway Administration, is the standard for signage and signals on all public roads. MUTCD states that the pedestrian WALK signal should be at least 7 seconds, although 4 seconds may be used in some cases. The "clearance time," or the Flashing Don't Walk phase, should be timed such that a person who has already entered the crosswalk can complete the crossing at a

walking speed of 3.5 feet per second.[18] The signal phasing as provided by NJDOT shows that the intersection operates in three phases – A) U.S. Route 9, B) Fairway Lane westbound, and C) Fairway Lane eastbound. The total cycle length varies throughout the day, from 70 to 140 seconds. The timing also varies slightly depending on whether a pedestrian actuates the U.S. Route 9 crossing. Based upon the Plan 1 signal cycle (presumably the most common) of 135 seconds, and assuming pedestrian actuation, the following diagram shows the current signal phasing.

Figure 3: Signal Phasing for Fairway Lane and U.S. Route 9



During the green time for U.S. Route 9 motorists, the diagram shows that pedestrians have adequate walk time to complete the crossing of Fairway Lane during the 15-second clearance interval. The east leg of the intersection is 25 feet wide and the west leg is 55 feet. Assuming a walk speed of 3.5 feet per second, a pedestrian needs 15.7 seconds to cross. The crossing of U.S. Route 9, however, measures 120 feet, which requires 34 seconds of clearance. Pedestrians are only given a total of 13 seconds during the flashing don't walk. Even when taking into account the walk time of 7 seconds, the time to cross U.S. Route 9 is still only 20 seconds, meaning the pedestrian has to rush across. During the intercept interviews, one pedestrian commented that he has to "run" to complete the crossing.

6. Lead Pedestrian Interval (LPI) – Consider providing an (actuated or phased) LPI of 8-seconds for exclusive "WALK" time. The interval would be for crossing U.S. Route 9 and provides pedestrians with exclusive use of the crosswalk for a few seconds at the beginning of the pedestrian phase while all conflicting vehicle movements have a red light. When an LPI is added, pedestrians receive the WALK signal before the vehicles in the adjacent lane receive a green light. This head start has been reported to increase

[18] Manual on Uniform Traffic Control Devices. Federal Highway Administration. 2009. Chapter 4E page 498. http://mutcd.fhwa.dot.gov/pdfs/2009/pdf_index.htm

pedestrian visibility and alert motorists to the presence of pedestrians and enhances safety.

Long-term Improvements:

1. Upgrade to ADA Compliance at bus stop and bus stop intersection:
    a. All curbs flush with the street.
    b. All curbs have tactile treatments at the edges.
    c. A tactile surface at the edge of the sidewalk at bus stops should be considered to keep pedestrians away from the edge of the road and to reduce the chance of pedestrians slipping and falling under a bus at the bus stop.
    d. All medians should be a minimum of six feet wide to accommodate passing wheelchairs and to serve as refuges.
2. Narrow the curb cut for the convenience store on the southwest corner. The curb cut on U.S. Route 9 is 60 feet wide, which is much more space than is necessary for a driveway. Narrow the curb cut to 20 feet.
3. On a road as wide as U.S. Route 9, lighting in the median illuminates the crosswalk and those using it. Pedestrian-scaled lighting should be installed in the median, at the corners, and at the bus stop for bus stop and street crossing illumination. Given how early people catch the bus, lighting is important both for safety and security. During fieldwork in September, the bus stop is completely dark at 5:30 AM. The pedestrian in the photos below is barely visible.

Photo C: North crosswalk of intersection

Photo D: Northeast corner of intersection

An important distinction should be drawn between roadway lighting, which is meant to illuminate roads for drivers, and pedestrian-scaled lighting over sidewalks. Road lighting alone does not spread light onto the sidewalks. Good lighting at sidewalk level improves the perception of safety. In Seattle, the Department of Neighborhoods and Seattle City Light are installing pedestrian-scaled lighting, at a height of 12 to 15 feet, in business

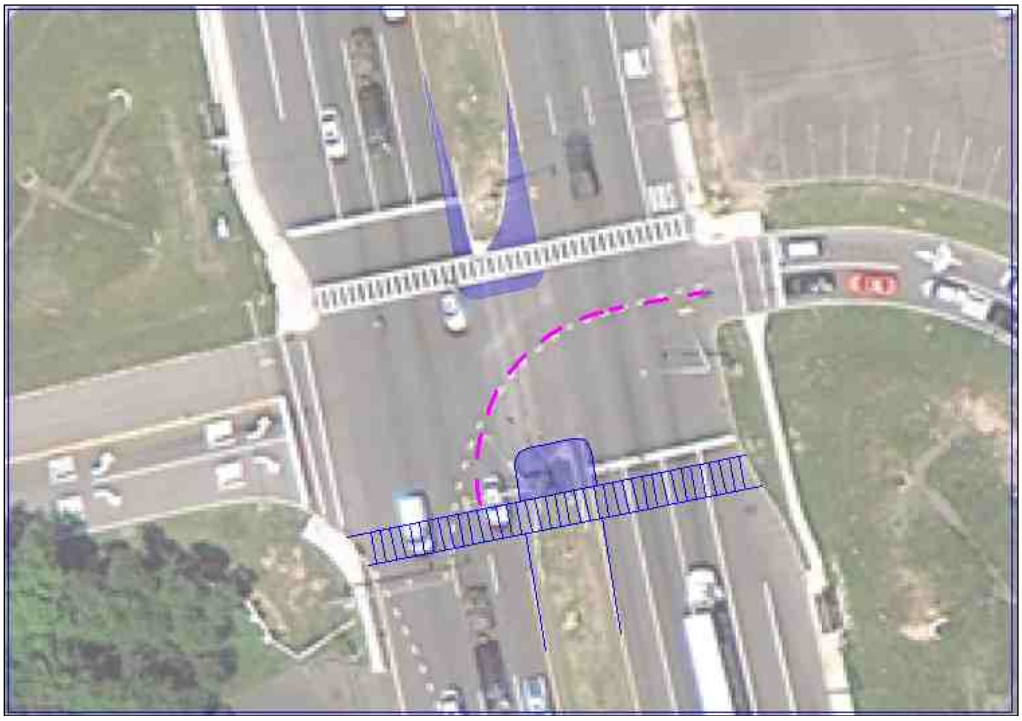
districts. These lights are placed on the sidewalk rather than in the road, and will improve safety and business exposure.[19]

Another issue to consider when choosing street lights is the quality of the light. The Dalles, a city in Wasco County, Oregon, hired the Lighting Design Lab in 1996 to remove 28 High Pressure Sodium cobra head street lights standing 23 feet tall and replace them with 46 14-foot poles that use Philip QL Induction lamps. The reaction from businesses and pedestrians was very positive, for the quality of light given off by the Induction lamps has a much higher color rendering quality than the HPS lamps, giving off a warmer and brighter light.[20] Communities often rely upon HPS lamps because they are low cost and last a long time, but consideration should also be given over to the quality of the space that is created with lights that produce better color rendering. Recent advances in LED technology have proven that a balance can be struck between high-quality lighting that minimizes environmental impacts. A recent study at the University of Pittsburgh found that LEDs are expensive, but in comparison to HPS and metal halide lamps consume half the electricity, last up to five times longer, and produce more light.[21]

4. Build out the medians, forcing drivers to make slower turns. Data consistently show that crashes with pedestrians occur far more often with turning vehicles than with through traffic. Left-turning vehicles are more often involved in pedestrian collisions than right-turning vehicles, partly because drivers are not clearly able to see pedestrians on the left. This is supported by the November 2009 FHWA *Pedestrian Safety at Intersections* Issue Brief. The medians on U.S. Route 9 are shaped in a way that encourages high-speed turns. The below image is an "ideal" condition, for further consideration (if funds are available). The image below shows how the median extends past the crosswalks.

[19] http://www.cityofseattle.net/economicDevelopment/biz_district_guide/Pedestrian_Lighting.htm
[20] http://www.lightingdesignlab.com/commercial/articles/Exterior.htm
[21] http://www.sciencedaily.com/releases/2010/03/100308132136.htm

Figure 4: Median Improvements at Bus Stop Intersection



Implementation

The following table indicates approximate range of costs for each of the suggested improvements, and which agency might be responsible for moving an improvement project through the implementation phase.

Summary of Short-Term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
Paint New Crosswalks	Show pedestrians and motorists the desired path of crossing at each leg of the intersection.	Low: Approximately $400 for regular striped, $600 for ladder, and $6,500 for patterned concrete crosswalk	Township/ State
Repaint Crosswalks as Ladder Type on east and west intersection legs	Show pedestrians and motorists the desired path of crossing at each leg of the intersection. Ladder crosswalks make the pedestrian path more visible than the two-line style.	Low: Approximately $600 for ladder crosswalk	Township/ State
Pedestrian Signal Heads and Countdown indicator at the proposed new crosswalk on the southbound leg of intersection	Vehicle signals control the flow of vehicle traffic; thus it follows that pedestrian signals are needed to control the flow of pedestrian travel and provides information on when to cross. Fixed-time pedestrian signals, rather than actuated, provides a continual visual cue to drivers that pedestrians have the right of way. This also allows traffic engineers to time the complete intersection for all modes of travel. Making the signals countdown provides excellent information to pedestrians on the amount of time they have to cross the street. Countdown signals are particularly beneficial to pedestrians at wide intersections where judging the crossing distance is more difficult.	Medium: An estimate for installation ranges from $40,000 to $200,000 per signal; however, this may vary if NJDOT does the installation. Only two heads need to be installed (south side of U.S. Route 9) and the poles already exist.	State

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
Stop for Pedestrian Signage	Draws attention of drivers to pedestrians in the crosswalk and promotes new law.	Low: $50-$150 per sign plus installation costs	Township/ State
Signal Retiming	Provides more "Walk" time for pedestrian crossing. Decreases chances the pedestrian will be caught in the crosswalk with oncoming traffic.	Medium: Staff hours to retime signal	Township/ State
Lead Pedestrian Interval	Increase pedestrian visibility and alert motorists to the presence of pedestrians.	Medium: Staff hours to retime signal for LPI	Township/ State

**Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System, September 2004, and consultant feedback.*

Summary of Long-Term Improvements

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
ADA Compliance	Assist pedestrians of all ages with visual and mobility impairments in tracking the edge of curbs and timing to cross so they can use the intersection and bus stops without assistance.	Medium: Approx. for concrete curbs and sidewalks is $49/linear meter ($15/linear foot) for curbing and $118/square meter ($11/square foot) for walkways. ADA Detectable Warning Surface: $300 / UNIT	Township/ State
Curb Cut Closure	Overly wide curb cuts, especially those close to intersections, present a safety hazard to both pedestrians and motorists. A driveway should be 20 feet to handle turning vehicles in a two-way driveway.	Medium: Approx. for concrete curbs and sidewalks is $49/linear meter ($15/linear foot) for curbing and $118/square meter ($11/square foot) for walkways	Township/ State
Pedestrian-scaled lighting	Lighting at crosswalks and at bus stops is key to making pedestrians visible and	Medium/High: Depends on the	Township/ State

Improvement Type	Safety Benefit	Cost Range*	Responsible Agency
	safe. Light source should be 12-15 feet above the ground, installed in the center median.	type of lamp purchased. Pursue LED technology if possible.	

**Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System, September 2004, unless otherwise noted.*

Exhibits

A. Pedestrian Crash Data

CRASH YEAR	# OF PEDESTRIAN CRASHES	DAY OF WEEK	TIME OF DAY	LIGHTING CONDITION	AT INTERSECTION	ALCOHOL USE	PEDESTRIAN GENDER	DRIVER AGE & GENDER
2006	0							
2007	1 Fatality	Mon	10:30PM	Dark (Street lights on/continuous)	At Intersection	YES	26 Male	26 Male
2008	0							
2009	1 Injury	Sun	3:51PM	Dark (Street lights on/continuous)	Not at Intersection	NO	67 Male	48 Female
2009	1 Injury	Tues	6:41PM	Dark (Street lights on/continuous)	At Intersection	NO	47 Male	NULL
2009	1 Fatality	Sat	11:00PM	Dark (Street lights on/continuous)	Not at Intersection	NO	26 Male	18 Female
2010	0							
Total	4							

The crashes in 2007 and 2009 resulted in pedestrian fatalities; with two additional pedestrian injury crashes in 2009. The crash in 2007 occurred on a Monday during the evening, with a male jaywalking and struck by a 26-year-old male, heading northbound. Alcohol was a contributing factor to the crash, but it was not clear from the available data if this could be attributed to the driver or pedestrian. The pedestrian was in the intersection, with the pre-crash action as the pedestrian failed to obey the traffic device.

The pedestrian fatality in 2009 occurred on a Saturday night, with a jaywalking male struck by an 18-year-old female driver, heading southbound. Alcohol and cell phone use were not factors

in this crash. This fatality occurred outside of the intersection, with the pre-crash condition of the pedestrian running across the roadway.

The two pedestrian injuries in 2009 occurred on a Sunday afternoon and Tuesday evening. The Tuesday crash involved a male pedestrian crossing east in the crosswalk. The driver was heading north and the crash is attributed to driver inattention. The age of the driver is not listed.

B. Bus Passenger Survey

Ten people responded to the passenger survey. Responses are detailed below. Numbers do not always add to 10 due to people who did not respond.

1. Gender
   - Male: 6 Female: 4
2. Age
   - Under 18:1 19-35: 3 36-55: 4 55+: 2
3. How often do you take the bus?
   - Daily: 9 1-2 x/week: 1
4. How did you get here?
   - Walked: 4 Dropped Off: 4 Parked: 1 Transferred: 1 (from 139)
5. Where did you park or get dropped off?
   - Shop Rite: 2 Road: 1 Church: 1 (1 man parks at a church up the road)
6. Did you use the sidewalk?
   - Yes: 8 No: 1
7. Regarding the sidewalk conditions at this site?
   - Good: 4 Satisfactory: 4
8. Is the sidewalk comfortable for walking?
   - Yes: 4 Sometimes: 2
9. Do you use the crosswalk?
   - Yes: 8 No: 1
10. Did motorists stop for you in the crosswalk?
    - Yes: 7 No: 1
11. Did motorists frequently block the crosswalk?
    - No: 5
12. Did they experience aggressive driving from motorists while crossing:
    - Yes: 1 Sometimes: 1 No: 5
13. Have you ever been left by a bus driver?
    - Frequently: 1 Sometimes: 7 Never: 2
14. If you were left by a bus, did you run after the bus?
    - Yes: 3 No: 4
15. Were you left when you were trying to transfer? Two people said no.
16. All respondents spoke English.
17. Four respondents commented that snow removal is an issue.

NJTPA

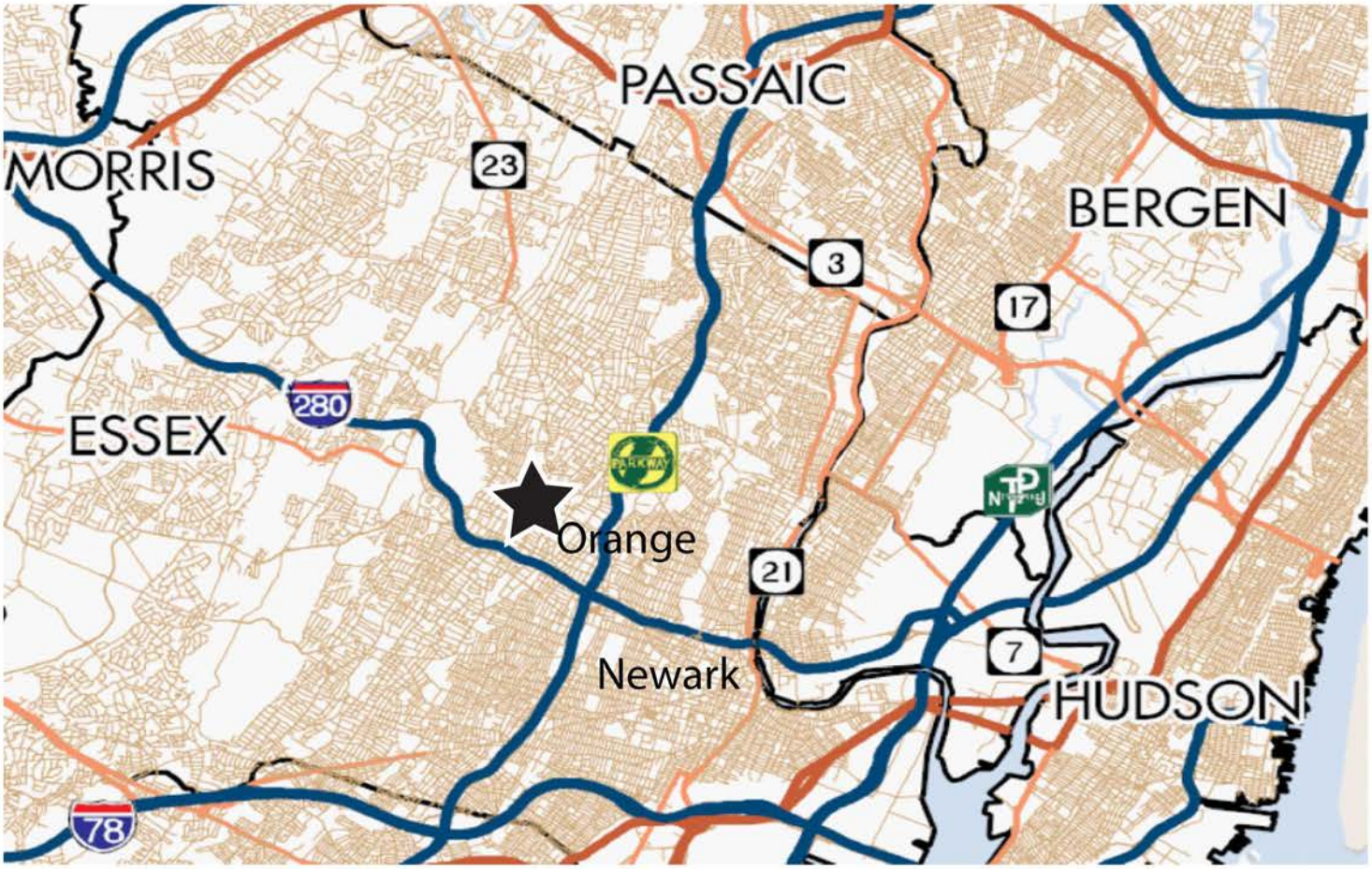
NORTH JERSEY TRANSPORTATION PLANNING AUTHORITY

Pedestrian Safety at and Near Bus Stops Study

Bus Stop Field Audit

Main & Day Streets

City of Orange Township, Essex County



NELSON NYGAARD

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June 2011

Pedestrian Safety at and Near Bus Stops Study
North Jersey Transportation Planning Authority
Main Street & Day Street Bus Stops, City of Orange Township, Essex County

Table of Contents

Introduction

New Jersey experiences a disproportionately high number of pedestrian injury crashes and fatalities compared to the nation as a whole. Many factors contribute to this, such as the state's density, traffic congestion, and high level of transit ridership, particularly bus ridership. Bus ridership accounts for two-thirds of all transit riders, with approximately 600,000 trips per day boarding at over 20,000 marked bus stops in New Jersey. Many bus passengers board and alight from buses along busy highways and often must cross these roadways after dark or during inclement weather. Many crashes at and near bus stops occur on congested urban street systems and along highway corridors.

The Pedestrian Safety At and Near Bus Stops Study seeks to identify approaches to reduce the severity and frequency of crashes involving pedestrians at and near bus stops in the 13-county NJTPA region and to improve safe pedestrian access to transit facilities. Successful approaches to improving travel safety often involve a combination of engineering, enforcement, and educational strategies, as well as strategies to improve emergency response time.

The study has three components:

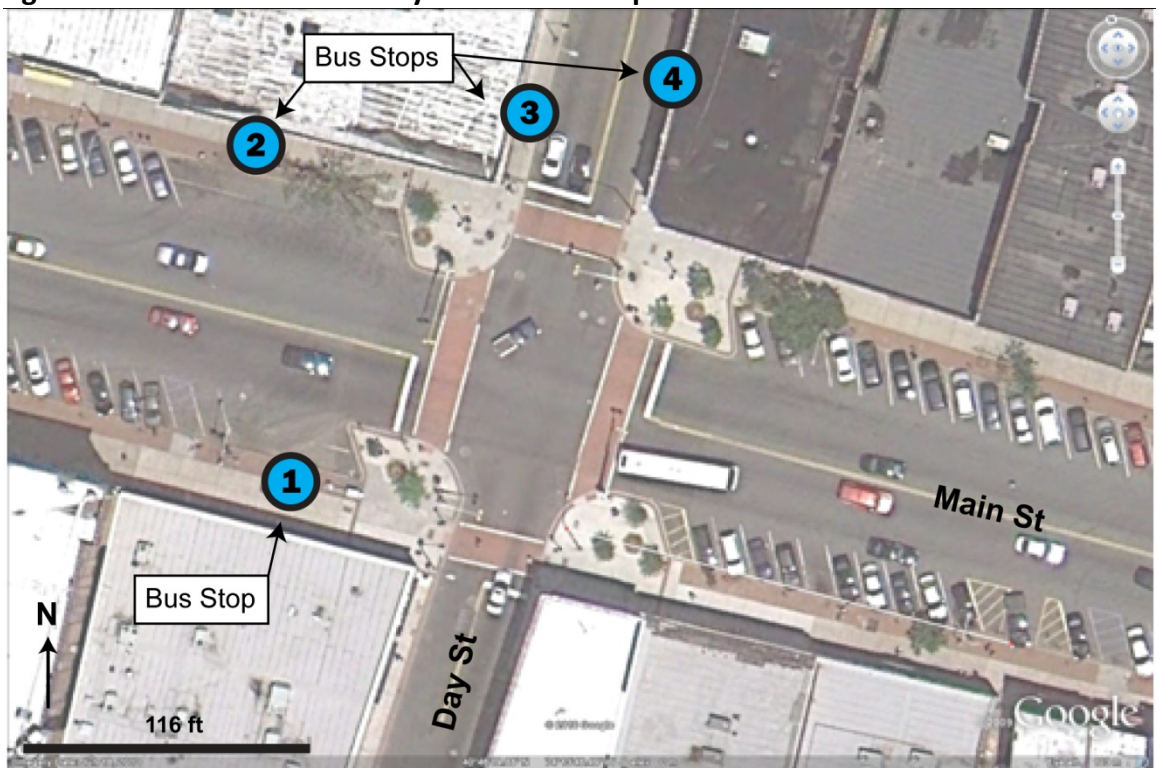
1. An Education Campaign Plan to encourage bus riders and motorists to be conscious of safety at and around bus stops was developed. The campaign involved extensive input from focus groups, one-on-one interviews, stakeholders, and bus passenger surveys. Methods to evaluate the campaign's success were developed as well.
2. A broad-based review of a sampling of bus stops representing various geographies, high usage and/or high pedestrian crash rates was analyzed. Field audits were conducted at these locations to look at bus stop design and access to and from the bus stop.
3. Physical improvement recommendations were developed for a subset of high crash bus stop locations, and a “toolbox” of bus stop design and policy recommendations to encourage bus stop improvements. This included an informational guide designed to help municipalities navigate the process of establishing well-designed bus stops.

The following is one of the seven reports developed for the study’s physical improvement recommendations, and was developed based on observations of pedestrian and motorist circulation at each individual bus stop location to understand roadway usage and opportunities for change. Each report provides a background and pedestrian crash history at the bus stop, short- and long-term improvement recommendations, and a summary of the suggested improvements’ safety benefits and cost range.

Background

Main Street and Day Street are both local roads in the downtown area of the City of Orange. The intersection is near the train station, City Hall, and retail destinations, and is designated as one of the state's Transit Villages. . Main Street is a major retail corridor and has a high level of pedestrian activity. Day Street contains commercial development at the intersection, and becomes residential north of the intersection. The intersection is well-served by bus, with six bus routes (21, 41, 71, 73, 79, 92) stopping at Main and Day Streets. NJ TRANSIT has four bus stops at the intersection as shown below: 1) Main Street eastbound and 2) Main Street westbound. Similarly, bus stops 3) Day Street southbound and stop 4) Day Street northbound are a near-side/far-side pair. Bus stops on Main Street have benches but no shelters.

Figure 1: Aerial of Main and Day Streets Bus Stops



Main Street is wide (90 feet midblock), and is one lane each way. Brick crosswalks in good condition exist on all four legs of the intersection. This is the only site at which pedestrian crashes occurred on the weekend; thus fieldwork was conducted on a Saturday in September. According to stakeholders, this area is bustling with pedestrians at all times; during the Saturday visit, this was the case. Sidewalks range from 15-20 feet in width.

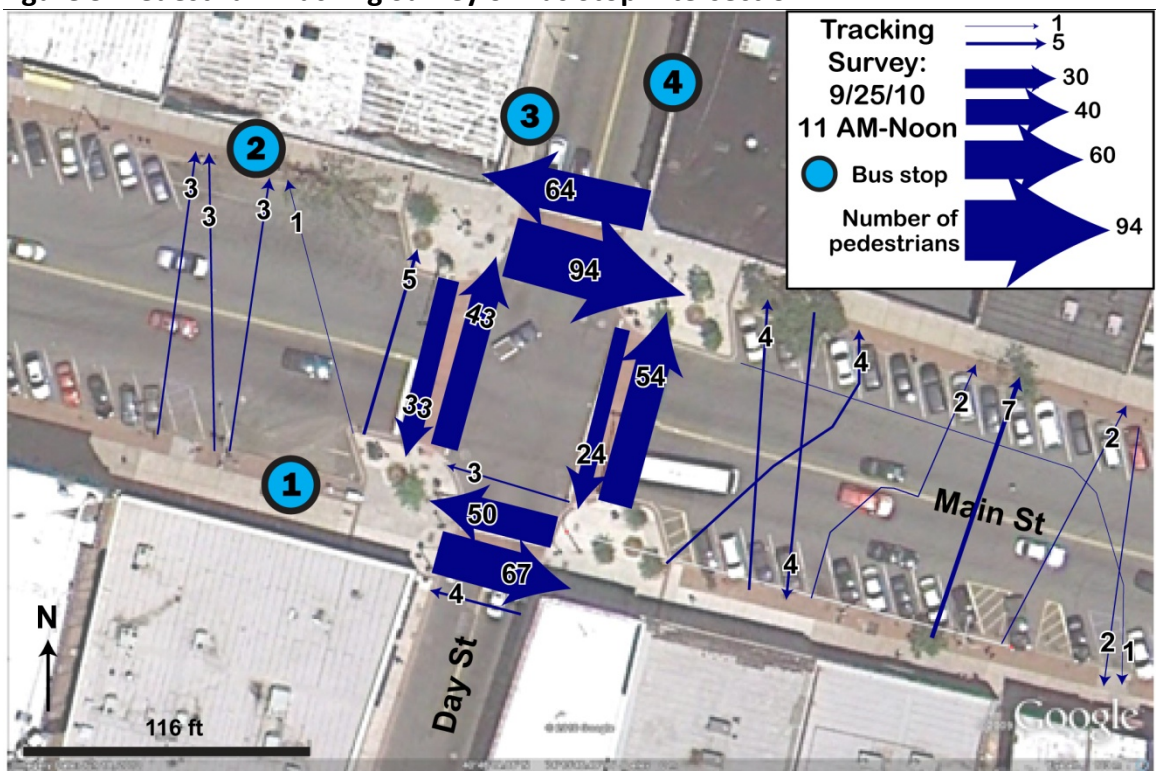
During a one-hour field survey from 11 AM-Noon on September 25, 2010, more than 450 pedestrians were observed crossing at crosswalks and midblock. While Main Street is very wide, with approximately 56 feet available for two lanes of travel, speeding was not observed as an issue. The presence of so many pedestrians, many of whom cross midblock most likely puts drivers on alert to proceed with caution. The pedestrian signal to cross Day Street is fixed with the vehicle green cycles. In order to cross Main Street, pedestrians must use a push button. During fieldwork, 159 people crossed Main Street. Given this high level of pedestrian activity, the WALK sign to cross Main Street should also be fixed with vehicle green cycles. Photos and the tracking survey are shown below.

***Figure 2:* Actuated Pedestrian Crossing at Southwest corner of Main & Day Street Intersection Looking North**

Figure 3: ***Generous Main Street width west of Main & Day Street intersection***

Figure 4: ***Main Street west of Main & Day Street intersection has benches but no bus shelter***

Figure 5: Pedestrian Tracking Survey of Bus Stop Intersection



Crash Data

Eight pedestrians were injured at this location from 2006 to September 2010; three crashes occurred during the weekend and five during a weekday on either Wednesday or Thursday. Half of the crashes occurred at the intersection when a pedestrian was crossing at the marked crosswalk. Given the high number of pedestrians crossing midblock, it makes sense that half the crashes occurred away from the intersection. One occurred when the driver was backing up, likely from a parking space. Five of the drivers were male; five of the injured pedestrians were female. During fieldwork, people were observed walking in the road behind the parked cars.

Method of Assessing Pedestrian Safety at and Near Bus Stops

The initial part of this analysis began with the use of Plan4Safety, an on-line crash analysis tool developed by Rutgers' Center for Advanced Infrastructure and Transportation. Plan4Safety contains a wealth of data about each crash, including the movement of the vehicle before and at the time of the crash, contributing pedestrian and driver crash factors, information on gender of the pedestrian, and age and gender of the motorist. This crash information was analyzed to understand potential trends, the interaction between pedestrians and motorists at specific places at and near the Main and Day Streets bus stops, and the type of vehicles involved in the crashes. Vehicle type

was included to determine if any crashes involved buses at and near bus stops. No buses were involved in the pedestrian crashes.

This analysis was followed by a field audit to track pedestrian usage of the crosswalks that provide for bus stop access. The results of the tracking survey, shown above, illustrate that this intersection is heavily used by pedestrians. It also shows that pedestrians cross midblock to connect with retail across the street as shown in ***Figure 6***. There were more than 36 jaywalkers within the one-hour time period field audit. This observation, coupled with the crash data showing half of the pedestrian injuries were not at the intersection, informed the decision to list a midblock crosswalk with medians as a **Long-term Improvement** in this report's **Improvement Recommendations** section. A midblock crosswalk with medians can be accommodated due to the streets generous width.

Figure 6: ***Main Street east of the Main & Day Street intersection***

In addition, bus passengers were surveyed while waiting at the bus stop. The surveys asked people to rate sidewalk conditions, crossing safety, and motorist behavior. The results were used to gain site-specific insight about access to the four bus stops. Since the bus stops had crashes on the weekend, the bus passenger surveys were conducted on a Saturday, yielding a high response rate of 42 surveys with 33 of the respondents female. Results of the survey can be found in Exhibit C of this report.

The field audit also included an assessment of the physical aspects of the bus stop intersection and bus stops to formulate the suggested improvements that are highlighted below. In addition, sidewalks in the immediate vicinity of the bus stops were examined to determine if there were any pedestrian safety issues up or downstream from the intersection.

Improvement Recommendations

The following section describes recommendations for improvement at Main and Day Street intersection and bus stops to facilitate safer pedestrian access to and from the transit stop. The suggested improvements are divided into short- and long-term actions. Short-term improvements are those that can be done quickly in one-year, at low cost, with no additional traffic analysis. Long-term improvements may require additional traffic analysis, and can, but do not always, require more significant capital expenditures. Often, short-term improvements are considered "pilot projects" using

inexpensive and easily removable materials to test how a change to the intersection impacts safety and operations (typically done during the spring over a three-month period of time). Deemed acceptable, these improvements are then moved to the long-term category for final design and implementation using materials to create more permanent safety improvements.

Short-term Improvements

1. Add a Leading Pedestrian Interval (LPI) of 5 seconds during all phases. LPIs allow pedestrians to get a head start on turning vehicles, helping them establish their presence in the crosswalk.
2. Install STOP FOR PEDESTRIAN signs approaching the intersection.
3. Upgrade and install pedestrian countdown signal heads at each of the four corners with fixed time pedestrian signal heads (as opposed to actuated).

Long-term Improvements

1. Upgrade to ADA Compliance at bus stop and bus stop intersection:
    a. All curbs flush with the street.
    b. All curbs have tactile treatments at the edges.
    c. A tactile surface at the edge of the sidewalk at bus stops should be considered to keep pedestrians away from the edge of the road and to reduce the chance of pedestrians slipping and falling under a bus at the bus stop.
    d. All medians should be a minimum of six feet wide to accommodate passing wheelchairs and to serve as refuges (see recommendation #4).

2. Given the high ridership levels at this location, all bus stops should have shelters to protect passengers from the weather. At the stops on Main Street, two shelters per stop are needed to accommodate passengers.

3. Add midblock crossings protected by median islands with curb extensions for pedestrian sight beyond the on-street parking east and west of the intersection on Main Street (see ***Figure 8***).
    a. Install left-turn stripping on eastbound side of Main Street approaching recommended median island located west of Day Street. This left-turn designation allows for access to a parking lot.
    b. Provide two protected medians for the striped midblock crosswalk on the east leg of Main Street since no driveways are present.
    c. Recommend street trees at the curb extensions connecting with the midblock crosswalk. Trees are visually beneficial to a downtown, as well as a traffic calming enhancement. Some researchers state that street trees have an effect on driver behavior. Driver perceptions are

manipulated by the edge of the environment, and street trees create a diverse edge. This keeps drivers on alert and results in them driving more carefully than if there were no trees.[22] One study by Texas A&M University recorded speed differentials of 3 to 15 mph in segments with trees versus those without.[23]

4. The intersection of Main & Day Streets has curb extensions, which decrease the crossing distance and improve visibility. However, Main Street's curb extensions do not extend through bus stops 1 and 2 pictured in Figure 1. While parking is restricted at the bus stops, this zone is not long enough for the bus to pull over to the curb and pull out again into traffic. NJ TRANSIT operators were therefore observed stopping in the travel lane to pick up and drop off passengers, as shown in Figure 7. The bus routes serving Main Street operate at short headways. This means that often times two buses stop at bus stops 1 and 2 at the same time. Since the parking restriction at the bus stop only accommodates one vehicle, riders boarding and alighting the second bus must thread their way through parked cars. A bus bulb 85 feet in length will accommodate two buses loading and unloading simultaneously and will facilitate boarding and alighting activity.

***Figure 7:* Proposed location for bus bulbs on southwest corner of Main and Day Street intersection**

5. Redesign on-street parking as “back-in head-out angle” parking. A pedestrian was injured due to a vehicle backing up, which was likely a conflict that occurred when the driver was backing out of a parking space. Many pedestrians cross midblock, or simply walk in the street behind the parked cars, waiting for a gap to cross. See Exhibit B for additional information on “back-in-head-out-angle” parking.

[22] Jody Rosenblatt Naderi, Byoung Suk Kweon, and Praveen Maghelal, “The Street Tree Effect and Driver Safety”, *ITE Journal on the Web,* (February 2008), 69-73.
[23] Dan Burden, “Benefits of Urban Street Trees”, Urban Forests Ecosystem Institute web site, http://www.ufei.org/files/pubs/22BenefitsofUrbanStreetTrees.pdf, (accessed January 20, 2011).

Implementation

The following table indicates approximate range of costs and safety benefits for each of the suggested improvements, and which agency might be responsible for moving an improvement project through the implementation phase.

Summary of Short-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Suggested Responsible Agency
Leading Pedestrian Interval	Leading Pedestrian Intervals allow the most vulnerable pedestrians time to ascend and descend the curb before vehicles can begin turning movements. This provides better eye contact between pedestrians and motor vehicles as it establishes the pedestrian further into the crosswalk.	Low: Few hours of staff time	City
Stop for Pedestrian Signage	Draws attention of drivers to pedestrians in the crosswalk.	Low: $50-$150 per sign plus installation costs	City
Pedestrian Countdown Signal Heads & Fixed Signals	Provide pedestrians with information on how much time they have to cross the street. Fixed WALK signals visually cue drivers to yield the right-of-way to pedestrians.	Low for existing heads: Retrofitting costs $300-$800[24]; Main & Day Streets intersection already has 8 signals, no new signal heads needed.	City

*Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System September 2004
****The responsible agency is suggested only.*

[24] http://www.mtc.ca.gov/planning/bicyclespedestrians/tools/countdownSignal/index.htm

Summary of Long-term Improvements

Improvement Type	Safety Benefit	Cost Range*	Suggested Responsible Agency
ADA Compliant Curb Ramps	Assists pedestrians of all ages with visual and mobility impairments in tracking the edge of intersection curbs, edge of sidewalk at the bus stop, and amount of time needed to cross so they can use the intersection and bus stops without assistance.	Medium: Approximate cost for concrete curbs and sidewalks is $49/linear meter ($15/linear foot) for curbing and $118/square meter ($11/square foot) for walkways	City
Install bus shelters	Bus shelters provide comfort and safety for transit riders from inclement weather. All shelters should be wheelchair accessible.	Low-Medium: $1,000-$10,000. Cost varies widely depending on type of improvements**	NJ TRANSIT
Midblock crossings with curb extensions	Curb extensions shorten the crossing distance for pedestrians and improve visibility to drivers, as there is angled parking extending out 17 feet from the current curb line on either side of the proposed midblock crossing.	Medium: Curb Extensions approx. $15,000 to $30,000 per 30 m or 100 ft depending on design, site conditions, and whether the median can be added as part of a utility improvement or construction project. Ladder crosswalk $600.	City

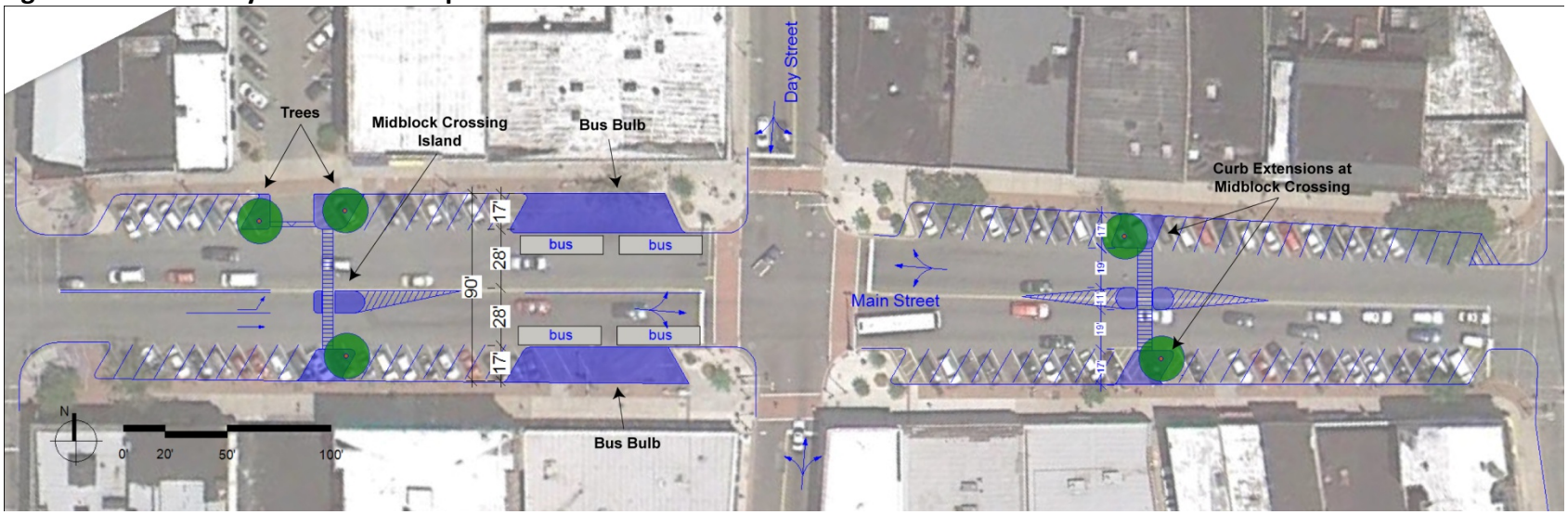
Improvement Type	Safety Benefit	Cost Range*	Suggested Responsible Agency
Bus Bulbs	Bus bulbs assist both transit riders and all pedestrians. Bulbs give more space for passengers to queue and also for potentially installing amenities like shelters or benches in the future. Bus bulbs also act as curb extensions for all pedestrians – they shorten the crossing distance, increase visibility to drivers, and reduce exposure time. By installing bus bulbs with 15 foot turning radii, they reduce the turning geometry for motor vehicles, forcing slower turns and better eye contact with pedestrians in the crosswalk.	Medium/High: Costs range from $15,000 to $55,000 depending on drainage needs and construction materials[25]	City
Back-in angle parking	Improves safety by allowing motorists to see oncoming traffic and pedestrians when pulling out of parking space	Low-Medium: Requires restriping parking and installing signage to instruct motorists.	City

*Cost estimates provided by the FHWA's Pedestrian Safety Guide and Countermeasure Selection System September 2004
***Accessing Transit: Design Guidelines for Florida Bus Passenger Facilities, March 2004,*

[25] *Evaluation of Bus Bulbs*. TCRP Report 65. 2001.

The graphic below shows the potential long-term build-out of the intersection, and includes potential improvement concepts. Further study would be required at the city level should they choose to implement these improvements.

Figure 8: Main & Day Streets Site Improvements



Exhibits

A. Pedestrian Crash Data

CRASH YEAR	# OF PEDESTRIAN INJURIES
2006	0
2007	3
2008	4
2009	1
2010*	0

2010 Crashes only from January to September of that year

CRASH TYPE	# OF CRASHES
Weekday	5
Weekend	3
Night-Time	3
At Intersection	4
Cell phone Use	0
Involved Cargo or Passenger Van	0

CHARACTERISTICS OF PEDESTRIAN & MOTORIST	
Driver Age & Gender	24(F), 28(M), 30(F), 31(M), 33(M), 51(M), 54(F), 59(M)
Pedestrian Gender	5(F), 2(M), 1(NULL)

CONTRIBUTING VEHICLE CIRCUMSTANCE	# OF CRASHES
Failed to Yield Right of Way to Vehicle/Pedestrian	1
Driver Inattention	4
None (Driver/Pedcycle)	3

PRE CRASH PEDESTRIAN CIRCUMSTANCE	# OF CRASHES
Crossing at Marked Crosswalk (At Intersection)	4
Crossing/Jaywalking	2
Coming from Behind Parked Car	1
Walking/Jogging Against Traffic	1

PRE-CRASH VEHICLE ACTION	# OF CRASHES
Left Turn	4
Going Straight	3
Right Turn on Red	0
Unknown or NULL	1

B. Back-In-Head-Out-Angle-Parking

Many cities have successfully installed back-in head-out angle parking, which has several benefits:

1. Improved visibility and increased field of vision. Motorists are able to see oncoming traffic as they enter the travel lane from their parking spot.

Source: T. Boulanger, Transportation Services, City of Vancouver, WA.

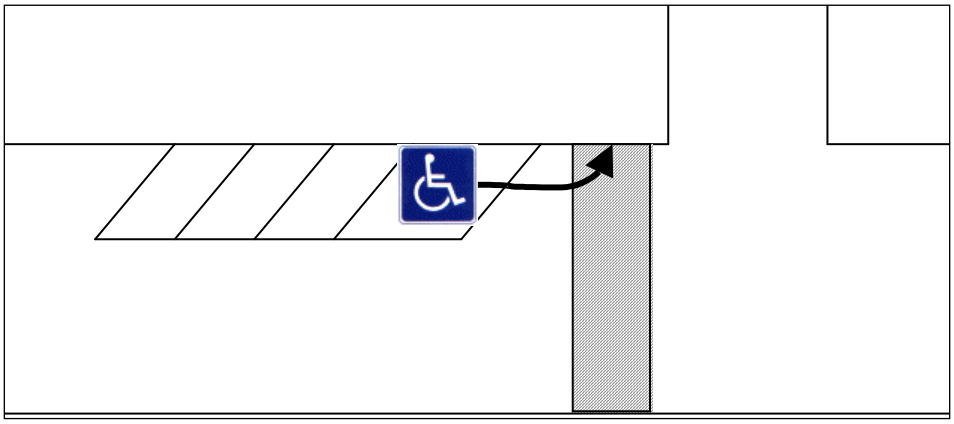
2. Reduces crashes because the motorist no longer has to back up blindly.
3. Improved safety for children (car doors open in a manner that ushers children to the sidewalk rather than the street) and cyclists.
4. Improves loading and unloading because trunks are adjacent to the sidewalk.

Loading a car on the curb rather than in the street

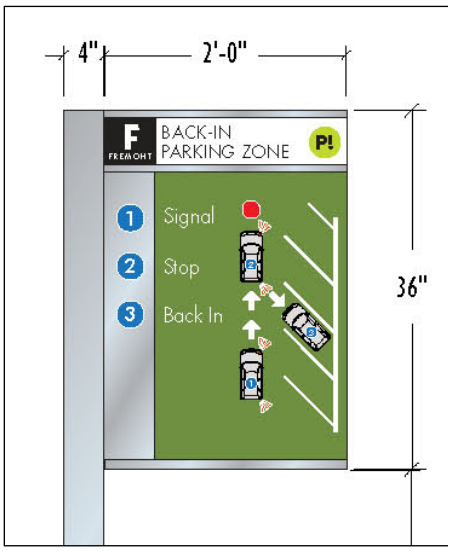
Source: T. Boulanger, Transportation Services, City of Vancouver, WA.

5. Improves handicap parking. Handicap spaces can be placed adjacent to curb ramps. Typically with angle parking, persons with disabilities must exit out a door adjacent to another parked car, and there may be little room to maneuver. In the example shown

below, with back-in angle parking the handicapped space can be placed at the end of the row such that the person has ample room to get out of the vehicle and use the curb ramp to access the sidewalk.



Below are a couple examples of signage to illustrate back-in angle parking to drivers.



One potential drawback of back-in angle parking is that idling vehicles emit exhaust onto the sidewalk. Some communities, such as Burlington, VT, enforce a "no idling" law for parked vehicles.[26] This would also be important for idling taxis in a back-in angle parking spot.

[26] "What is Reverse Angle Parking?" City of Burlington, VT. http://www.dpw.ci.burlington.vt.us/docs/brochure_v2.pdf Viewed 3/17/2011.

C. Bus Passenger Survey

A total of 42 people responded to the passenger survey. Responses were as follows (note that responses do not always add up to 42 due to incomplete answers.)

1. Gender
   Male: 7 Female: 33
2. Age
   Under 18: 3 19-35: 13 36-55:13 55+: 11
3. How often do you take the bus?
   Daily: 35 1-2 x/week: 7
4. How did you get here?
   Walked: 25 Transferred: 16 Dropped Off: 1
5. What route did you transfer from?
   Primarily route 92 (5 respondents)
6. Where were you dropped off?
   At the intersection (1 respondent)
7. Did you use the sidewalk?
   Yes: 41 No: 1
8. Regarding the sidewalk conditions at this site?
   Good: 12 Satisfactory: 23 Poor: 6
9. Is the sidewalk comfortable for walking?
   Always: 28 Sometimes: 9 Never: 4
10. Do you use the crosswalk?
    Yes: 41 No: 1
11. Did motorists stop for you in the crosswalk?
    Yes: 34 Sometimes: 1 No: 7
12. Did motorists frequently block the crosswalk?
    Yes: 14 Sometimes: 6 No: 14
13. Did they experience aggressive driving from motorists while crossing:
    Yes: 19 Sometimes: 7 No: 14
14. Have you ever been left by a bus driver?
    Frequently: 10 Sometimes: 16 Never: 15
15. If you were left by a bus, did you run after the bus?
    Yes: 11 No: 15
16. Were you left when you were trying to transfer?
    Yes: 9 No: 11
17. Language:
    English: 39 Spanish: 3