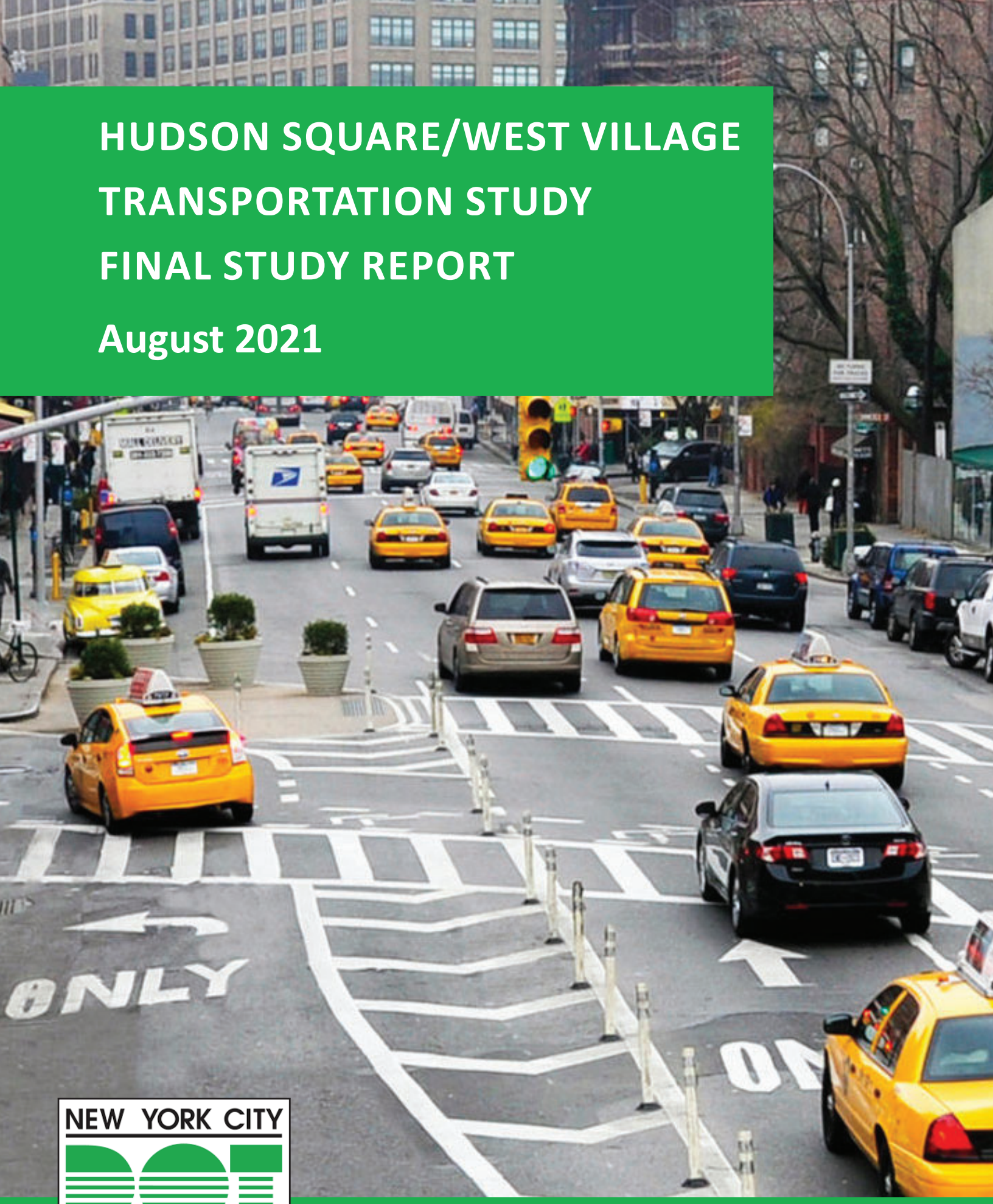
HUDSON SQUARE/WEST VILLAGE TRANSPORTATION STUDY

FINAL STUDY REPORT

August 2021



NEW YORK CITY DOT

Our Mission

DOT provides for the safe, efficient, and environmentally responsible movement of people and goods in the City of New York and maintains and enhances the transportation infrastructure crucial to the economic vitality and quality of life of our primary customers, City residents.

Contents

List of Figures

List of Tables

List of Appendices *(provided electronically, not as part of this document)*

Appendix 1A Technical Advisory Committee Meeting Summaries
Appendix 2A Data Collection Plan
Appendix 2B Automatic Traffic Recorder Data
Appendix 2C Turning Movement Counts
Appendix 2D Full Pedestrian Counts
Appendix 2E Physical Inventory
Appendix 2F On Street Parking Surveys
Appendix 2G Origin-Destination Data
Appendix 2H Crash Data
Appendix 3A 2017 Traffic Volume Flow Maps
Appendix 3B VISSIM Model Calibration Criteria and Results
Appendix 3C 2017 Travel Time Calibration Summary
Appendix 3D Methodology for Projecting Future 2027 Volumes Without Improvements
Appendix 3E 2027 Traffic Volume Flow Maps
Appendix 4A Early Action Concept Drawings
Appendix 4B Improvement Concept Drawings

EXECUTIVE SUMMARY

Executive Summary

The New York City Department of Transportation (NYC DOT) initiated the Hudson Square/ West Village Transportation Study (the "Study") at the request of Council Speaker Corey Johnson and Manhattan Community Board 2 (CB2). The Study provides recommendations for improving walking, bicycling, and vehicular safety and mobility in the Hudson Square/West Village neighborhoods. The Study identifies and addresses existing and longstanding transportation challenges, as well as shorter term challenges.

The study area is located in the Hudson Square and West Village neighborhoods in the borough of Manhattan. It is comprised of both a primary and a secondary study area. The primary study area is bounded by Christopher Street to the north; 6th Avenue (Avenue of the Americas) and Greene Street/Church Street to the east; Canal Street to the south; and West Street to the west. Since the Holland Tunnel entrance and exit ramps are located north and south of Canal Street, respectively, a secondary study area was extended further south to Watts Street and Leonard Street to capture the traffic conditions caused by vehicles exiting the Holland Tunnel. The project study area is shown in **Figure E-1**.

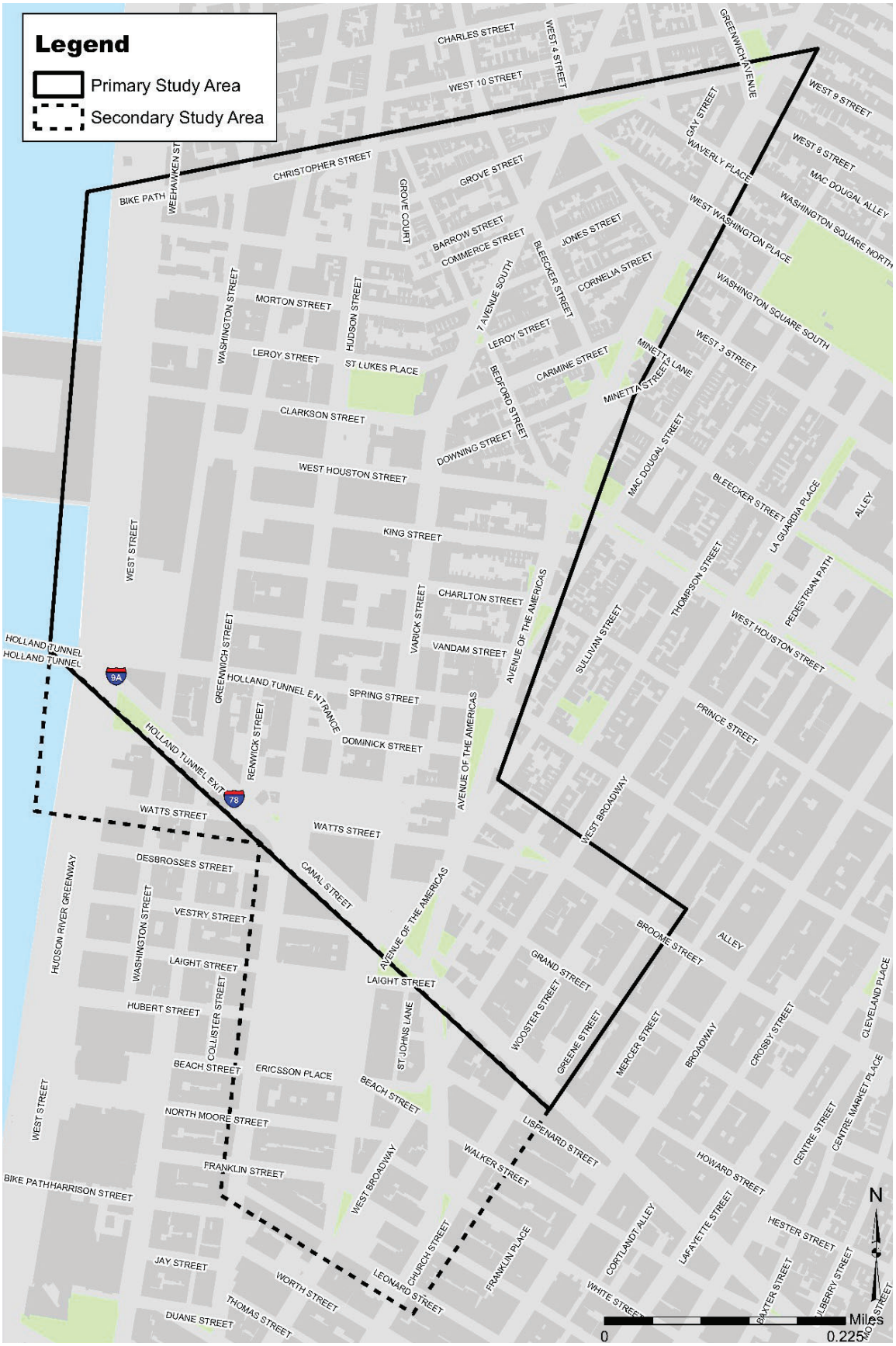


Figure E-1 Study Area

A key Study priority was to establish a robust stakeholder and agency coordination program that would incorporate community and agency knowledge and feedback into the identification of issues and assessment of potential improvements. The stakeholder program informed issue identification, concept development, and increased the understanding of planned development and other future transportation improvements in the study area. From the onset, NYC DOT focused the efforts on community concerns and potential improvements suggested by the stakeholders and the study team to enhance access, circulation, and safety for all street users. All stakeholders recognized the efforts would be focused on improving conditions for walking, bicycling, and local vehicle use, with reduction of traffic congestion into the Holland Tunnel considered secondary.

The project goals and objectives reflected the multi-modal nature of the study area and included the following:

- Balance the needs of all street users, including for people walking and bicycling
- Reduce conflicts and improve safety for all street users
- Reduce off-peak vehicle speeds to be consistent with traffic regulations
- Improve walking and bicycling environment
- Address emergency vehicle access needs
- Improve bus access to the Holland Tunnel and alleviate issues caused by current bus routing
- Develop options to improve safety and mobility for all street users

The Study comprised the following tasks, allowing for a flexible approach to identify issues and gather relevant data, as well to develop short and long-term solutions:

1. Agency Coordination
2. Existing Conditions and Issue Identification
3. Qualitative Assessment and Concept Design (Early Actions)
4. Data Collection
5. Quantitative Assessment and Concept Design (Other Improvements)

The development of recommended early actions and other future improvements was based on community concerns and potential improvements suggested by the stakeholders and the study team to enhance access and safety for all street users. A range of improvement options was developed, including early actions expected to be implemented by the end of 2021 and future improvements that, if selected for implementation, would be completed after 2021.

A number of early actions that were implemented before the Study was completed are described below and shown in **Figure E-2**:

- Adjustment of signal timing at 15 intersections along 7th Avenue South and Varick Street
- Construction of protected bicycle lane on 7th Avenue/7th Avenue South from West 30th Street to Clarkson Street
- Extension of protected bicycle lane on Varick Street from Clarkson Street to West Houston Street and provision of pedestrian islands and curb extension
- Installation of All-Way-Stop Control signs at Washington Street / Morton Street
- Provision of Leading Pedestrian Interval (LPI) for north crosswalk at 6th Avenue/West 4th Street/ Cornelia Street
- Installation of wayfinding signage to direct pedestrians to cross West Street at Clarkson Street or at Morton Street, rather than at Leroy Street
- Extension of the conventional bicycle lane on West 4th Street between 6th Avenue and Macdougal Street / Washington Square West
- Installation of new traffic signal at 7th Avenue South/Leroy Street

- Installation of curb extension on northwest corner of 7th Avenue South/Leroy Street

The early actions that are progressing to implementation are described below and shown in **Figure E-3**.

Identified early actions included the provision of curb extensions and the revision of traffic control devices. Curb extensions were recommended at the following intersections:

- 6th Avenue/Broome Street
- 6th Avenue/West 4th Street/Cornelia Street
- Charlton and Vandam Streets along Hudson Street (two intersections)
- Hudson Street/Canal Street
- King Street between Hudson and Varick Streets (two intersections)
- 7th Avenue South/Commerce Street
- Varick Street/Canal Street

Revised pavement markings, roadway signage, and/or traffic signal timing changes were recommended as early actions at the following locations:

- West 4th Street between 6th Avenue and Washington Square West (Macdougal Street)
- King Street from Hudson Street to Varick Street
- Hudson Street/Canal Street
- Broome Street/Watts Street/West Broadway
- 7th Avenue South/Grove Street
- West Street/West Houston Street

Improvement options that could have traffic impacts were evaluated to determine whether they should be progressed, modified, or rejected. A series of traffic simulation models were used to test future improvement options and understand their operational effects. These improvements, located along four of the key corridors in the study area, are expected to be implemented after 2021. Future improvements are shown in **Figure E-4**. No capital funding has been identified for these projects. These improvements may be pursued at such time as funding sources are identified.

Figure E-2 Completed Early Action Locations

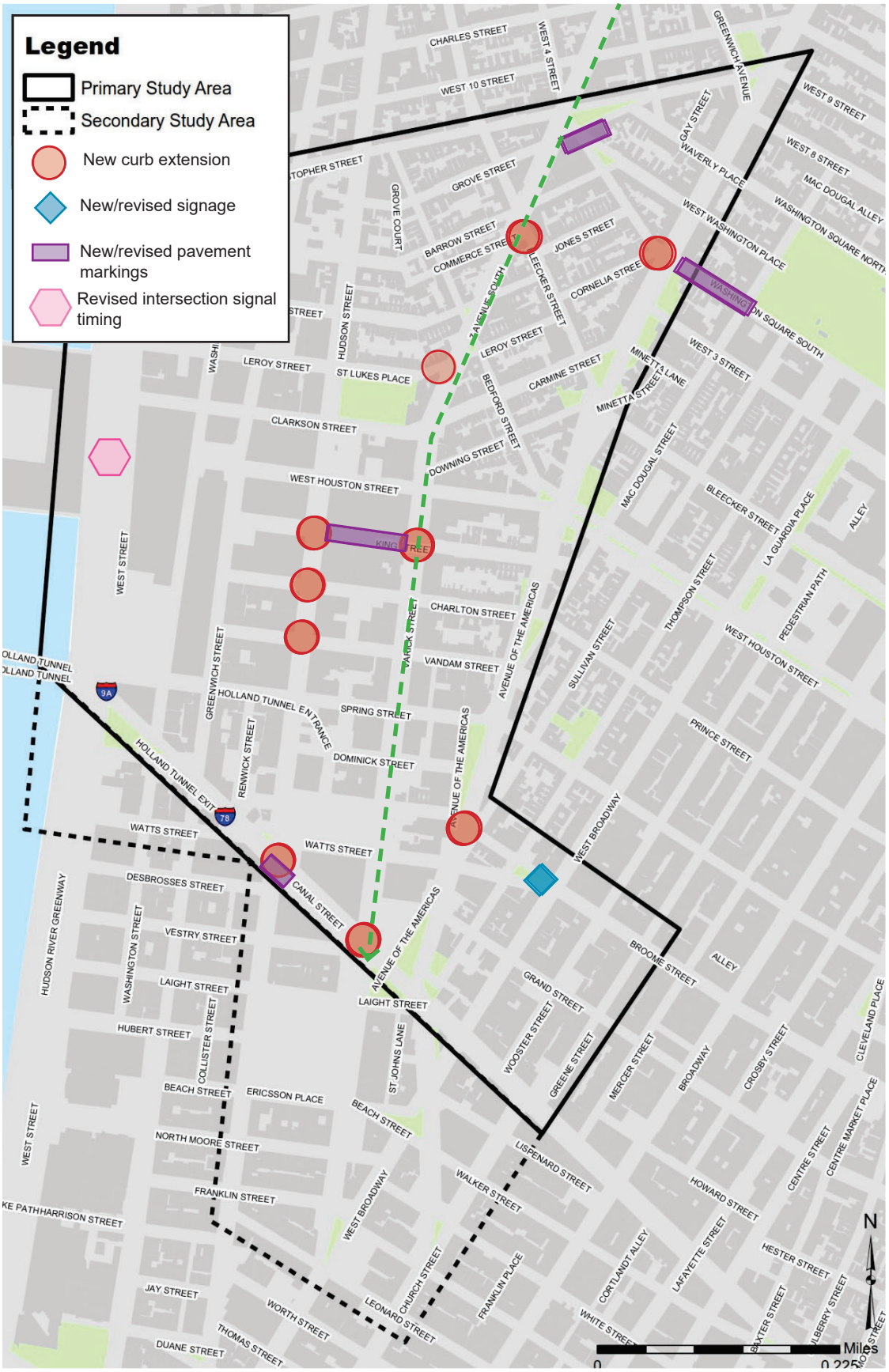


Figure E-3 Early Action Locations

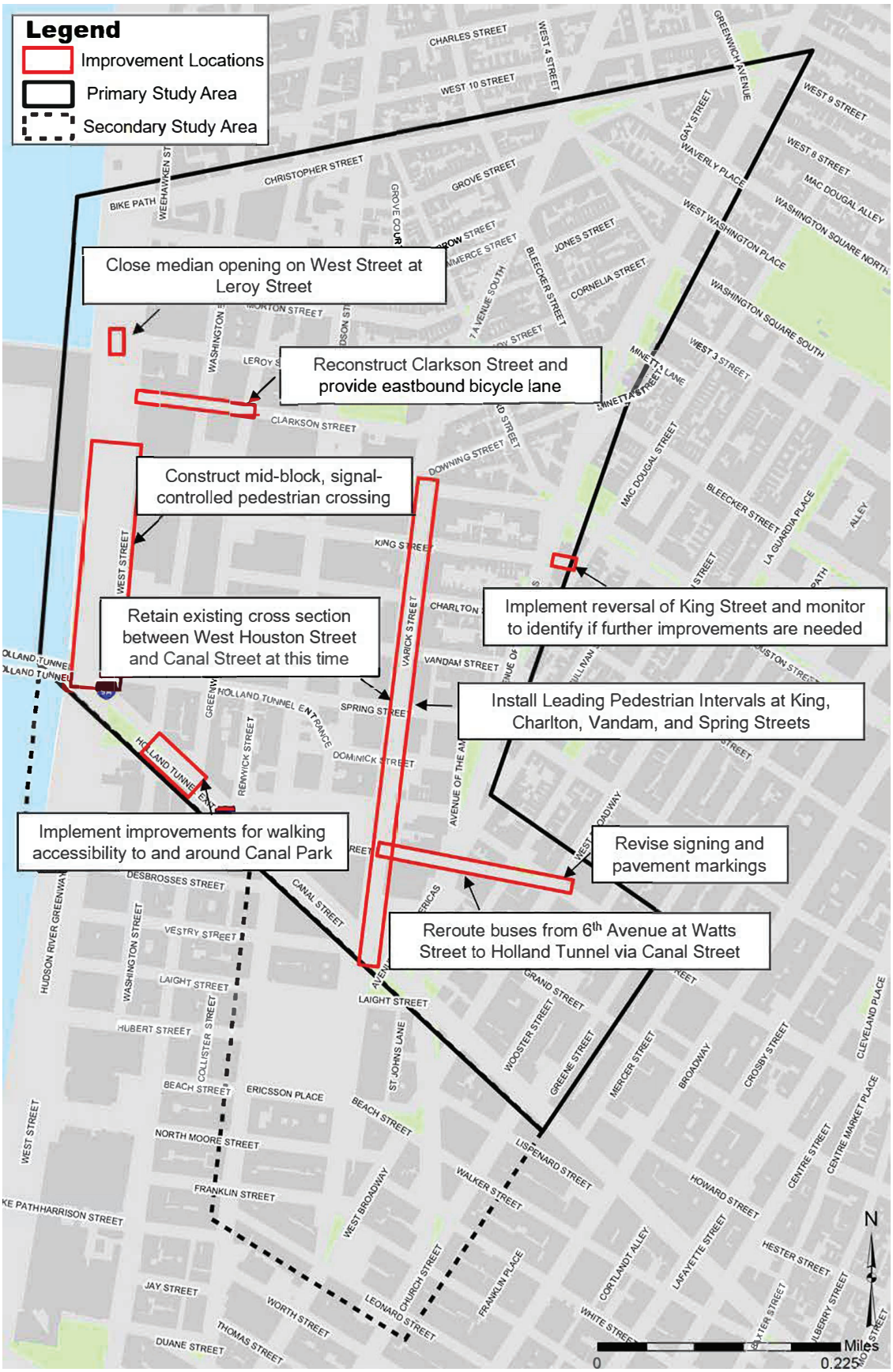


Figure E-4 Future Improvement Locations

6th Avenue Corridor

- 6th Avenue between West Houston Street and King Street – implement King Street reversal and evaluate its effectiveness to identify if signal timing changes are needed
- 6th Avenue from Watts Street to Canal Street – implement bus rerouting from Watts Street to Canal Street during the weekday PM peak period and monitor its effectiveness to identify if modifications are needed

West Street Corridor

- West Street/Leroy Street – close median opening
- Canal Street between Canal Park and Greenwich Street – implement improvements for walking accessibility to and around Canal Park
- Clarkson Street between West Street and Greenwich Street – reconstruct street and provide bicycle lane
- West Street between West Houston Street and Canal Street – construct new mid-block signal controlled pedestrian crossing

Watts Street Corridor

- Broome/Watts Streets approach to the Holland Tunnel – two improvement options were considered for this location to revise signing and pavement markings to achieve better lane balance, reduce merging conflicts, and better organize traffic flow using temporary materials. It is suggested that Option 1 be implemented and monitored to identify the effectiveness of these changes and whether modifications are needed.

Varick Street Corridor

- Varick Street between King Street and Spring Street – install Leading Pedestrian Intervals
- Varick Street between West Houston Street and Canal Street — retain existing cross section at this time

The issues identified and recommendations put forth in this report were guided and shaped by the insights provided by the stakeholders and agencies that participated throughout the study process. The stakeholder and agency coordination enabled the study team to build local and institutional support for the project, identify and verify concerns, and incorporate knowledge and feedback at key decision points throughout the process.

INTRODUCTION

1

1.1 Background

In February 2017, the New York City Department of Transportation (NYC DOT) initiated the Hudson Square/ West Village Transportation Study (the "Study") at the request of Council Speaker Corey Johnson and Manhattan Community Board 2 (CB2). The Study provides recommendations for improving walking, bicycling, and vehicular safety and mobility in the Hudson Square/West Village neighborhoods. The Study identifies and addresses existing and longstanding transportation challenges, as well as shorter term challenges.

The Study comprised the following tasks, allowing for a flexible approach to identify issues and gather relevant data, as well to develop short and long-term solutions:

1. Agency Coordination
2. Existing Conditions and Issue Identification
3. Qualitative Assessment and Concept Design (Early Actions)
4. Data Collection
5. Quantitative Assessment and Concept Design (Other Improvements)

A key Study priority was to establish a robust stakeholder and agency coordination program that would incorporate community/agency knowledge and feedback into the identification of issues and assessment of potential improvements. The stakeholder program informed issue identification and concept development as well as increased the understanding of planned development and other future transportation improvements in the study area. From the onset, NYC DOT focused the efforts on community concerns and potential improvements suggested by the stakeholders and the study team to enhance access, circulation, and safety for all street users. The issues raised by stakeholders are described in Chapter 2, Existing Conditions and the potential improvements are described in Chapter 4 for early action (i.e. short-term) and other future (i.e. long-term) improvements.

Stakeholder and agency coordination was critical to the success of the Study. The stakeholder and agency coordination enabled the study team to build local and institutional support for the project, identify and confirm concerns, and incorporate knowledge and feedback at key decision points throughout the process. The issues identified and recommendations put forth in this report were guided and shaped by the insights provided by the stakeholders and agencies that participated throughout the study process.

1.2 Project Goals and Objectives

The project goals and objectives reflected the multi-modal nature of the study area and included the following:

- Balance the needs of all street users, including for people walking and bicycling
- Reduce conflicts and improve safety for all street users
- Reduce off-peak vehicle speeds to be consistent with traffic regulations
- Improve walking and bicycling environment
- Address emergency vehicle access needs
- Improve bus access to the Holland Tunnel and alleviate issues caused by current bus routing
- Develop options to improve safety and mobility for all street users

From the start of the Study, all stakeholders recognized the efforts would be focused on improving conditions for walking, bicycling, and local vehicle use as its primary objective - with reduction of traffic congestion into the Holland Tunnel considered secondarily. The improvements presented in Chapter 4 reflect this focus.

1.3 Technical Advisory Committee

As part of the stakeholder and agency coordination program, NYC DOT organized a Technical Advisory Committee (TAC) consisting of key stakeholders and public agencies to provide insight and support. The community groups and agencies participating on the TAC included:

Agency Partners

- Fire Department of the City of New York (FDNY)
- New York City Department of City Planning (NYCDCP)
- New York City Police Department (NYPD)
- New York City Transit (NYCT)
- New York State Department of Transportation (NYS DOT)
- Office of the Deputy Mayor for Housing and Economic Development
- Port Authority of New York and New Jersey (PANYNJ)

Community Partners

- Community Board (CB) 2
- Hudson River Park Trust (HRPT)
- Hudson Square Connection
- Office of the Manhattan Borough President (MBPO)
- Office of New York City Council Speaker Corey Johnson
- Office of New York State Senator Brad Hoylman

TAC meetings were held over the course of the Study at critical junctures. The dates and purposes of the TAC meetings are summarized in the table below. The detailed TAC meeting summaries can be found in Appendix 1A, TAC Meeting Summaries:

Technical Advisory Committee Meetings		
Name	**Date**	**Purpose**
Kick-Off Meeting	February 14, 2017	Informed the various agencies, community organizations, and other stakeholders about the initiation of the transportation Study of the Hudson Square/West Village area and its purpose: to develop implementable recommendations for improving safety and mobility for walking, bicycling, and vehicles. Provided an early opportunity for sharing transportation concerns in the area and ideas for possible improvements.
TAC Meeting #1	March 13, 2017	Identified locations and corridors within the study area where community organizations and stakeholders have specific concerns regarding current safety and mobility for walking, bicycling, and vehicles. Provided an early opportunity for sharing transportation concerns in the area and ideas for possible improvements.
TAC Meeting #2	January 16, 2018	Summarized the results of the data collection. Reviewed potential early action improvements based on the issues identified in prior meetings, field observations, data review, and conversations with key stakeholders.
TAC Meeting #3	October 17, 2018	Presented an overview of the status of the early action improvements identified at the prior TAC meeting. Provided an opportunity for TAC review and comment on future improvement options that were based on traffic and safety data, field observations, data review, and stakeholder input.
TAC Meeting #4	June 25, 2019	Presented an overview of the findings from the assessment of future improvement options for review and discussion with the TAC.

1.4 Additional Stakeholder Coordination

In addition to the TAC meetings, NYC DOT held a stakeholder engagement meeting with CB 1. The main purpose of this meeting was to provide an update regarding the status of the Study and to review potential early action improvements that were developed to address issues identified from stakeholder input.

Additionally, NYC DOT conducted individual agency meetings with NYPD and FDNY, as well as the PANYNJ. The purpose of these meetings was to discuss specific issues and concerns with respect to these agencies and gather information regarding operational traffic plans and programmed changes in the study area, such as potential strategies for better managing traffic flow on Holland Tunnel approaches.

The study team also attended CB 2 Traffic and Transportation Committee and CB 2 Pier 40 task force meetings for informational purposes. These meetings provided additional background information on key issues, development plans, and insights in the study area.

EXISTING CONDITIONS

2

2.1 Introduction

A critical component of the Study was the evaluation of the existing conditions. To understand the underlying issues and formulate improvements that would mitigate traffic safety and operations in the study area, the study team performed field observations, collected a range of traffic data, and received input from stakeholders through an extensive issue identification process with the TAC (See Section 1.3).

2.2 Study Area

This section describes the project study area, critical roadways and defining characteristics of the study area.

The study area is located in the Hudson Square and West Village neighborhoods in the borough of Manhattan. One of the major contributors to poor traffic operations in the study area is the Holland Tunnel, which connects Lower Manhattan to New Jersey. Since the Holland Tunnel entrance and exit ramps are located north and south of Canal Street, respectively, a secondary study area was extended further south to Watts Street and Leonard Street to capture the traffic conditions caused by vehicles exiting the Holland Tunnel.

Figure 2-1 depicts the primary and secondary study areas, as defined by the boundaries described above. The focus of the Study was to assess transportation safety and operations for all street users in the study area, including major roadways leading to the Holland Tunnel, 7th Avenue South/Varick Street, Canal Street, Hudson Street, West Street, Broome/Watts Street, and 6th Avenue, which experience extensive traffic congestion and adversely effect street users.

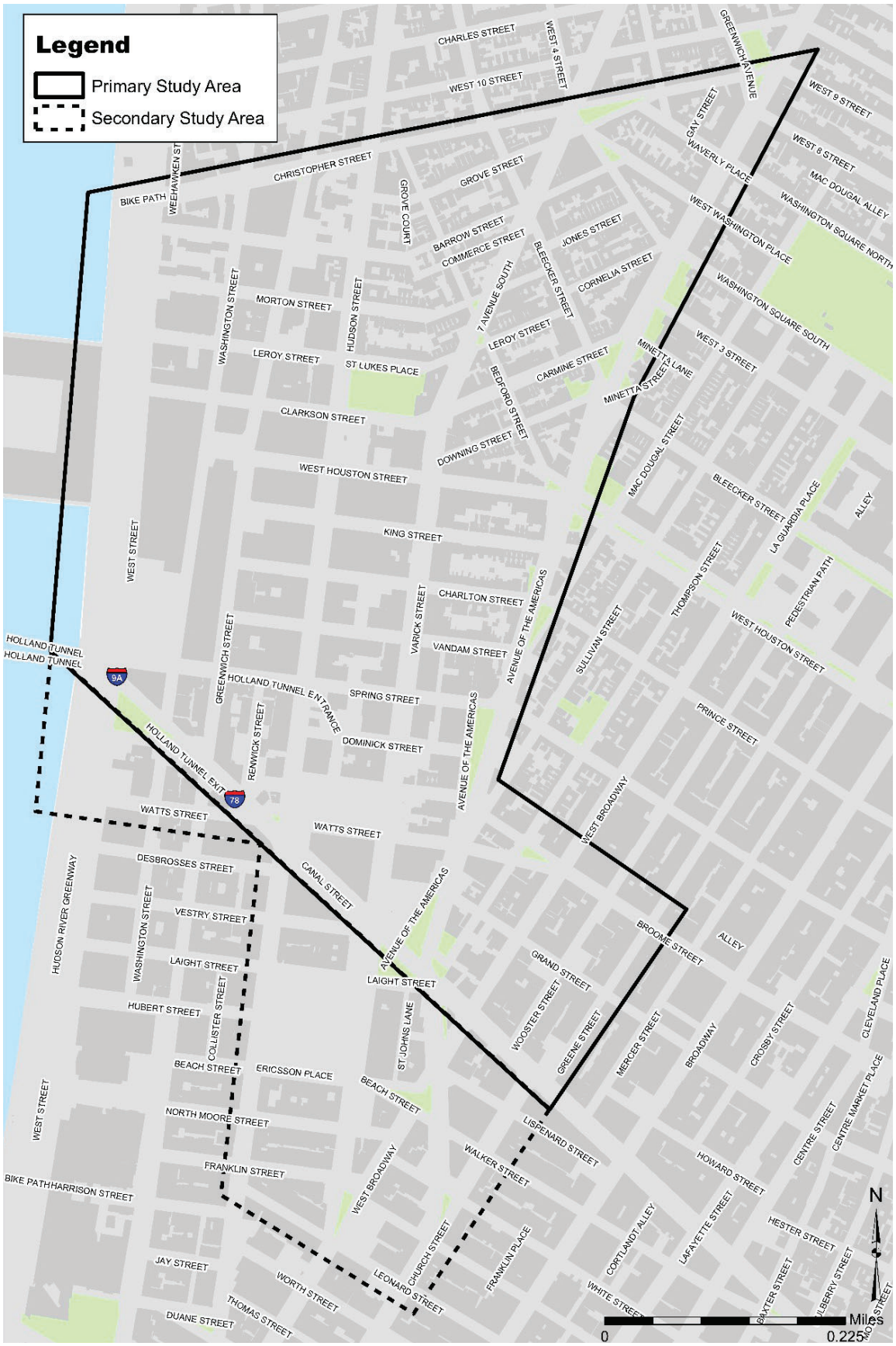


Figure 2-1 Study Area

2.2.1 Major Roadway Descriptions

2.2.1.1 Northbound/Southbound Roadways

There are four key northbound/southbound arterials in the study area that provide access to and from the Holland Tunnel including West Street, Hudson Street, 7th Avenue South/Varick Street, and 6th Avenue.

West Street: West Street (New York State Route 9A) is a multi-modal, six- to eight-lane urban arterial highway with a continuous protected walkway and bikeway along the Hudson River known as the Hudson River Park Greenway. West Street vehicular traffic includes cars, trucks, and buses and stretches from Battery Park in the Financial District up to Gansevoort Street in the Meatpacking District. The south end of West Street is a major access route to the Hugh L. Carey Tunnel, which connects Battery Park in the Financial District to Red Hook in Brooklyn. Route 9A extends to the north and becomes the Henry Hudson Parkway which provides access to the George Washington Bridge and areas to the north of New York City.

Hudson Street: Hudson Street is a major corridor in Lower Manhattan that has two distinct segments. Hudson Street is a one-way northbound roadway between Chambers Street and Bleeker Street/8th Avenue with two travel lanes and a protected bicycle lane along the west curb. North of Bleecker Street/8th Avenue to West 14th Street, Hudson Street runs southbound with two travel lanes and a protected bicycle lane. Within the study area, Hudson Street is a major northbound access route that facilitates vehicular traffic destined to the New Jersey-bound Holland Tunnel and northbound vehicular traffic exiting the Holland Tunnel from New Jersey.

7th Avenue/Varick Street: 7th Avenue South/Varick Street is a major southbound thoroughfare in Manhattan. 7th Avenue South transitions to Varick Street south of the Clarkson Street/Carmine Street intersections and terminates at Leonard Street. 7th Avenue South between Christopher Street and West Houston Street typically has three southbound travel lanes with varying left and right turn bays and a protected bicycle lane along the east curb. Varick Street south of Charlton Street to Watts Street provides travel lanes for through traffic and for Tunnel-bound traffic. These movements are separated by flexible delineators south of Vandam Street to Broome Street. During the weekday PM peak period there are three Tunnel-bound travel lanes and three through traffic lanes. South of the Varick Street entrance to the Tunnel at Broome Street, the number of lanes decreases to four. A shared bicycle lane exists in the east travel lane between Watts Street and Canal Street that becomes a conventional bicycle lane on the Varick Street block south of Canal Street to Laight Street, then transitions to a shared lane until Beach Street/West Broadway and continues as a conventional bicycle lane to Leonard Street. Within the study area, Varick Street is a major southbound access route to and from the Holland Tunnel, facilitating traffic entering and exiting the Tunnel. Varick Street/7th Avenue South is also a major transit corridor served by the 1, 2, and 3 New York City Transit subway lines and the M20 bus route, which is forced to skip two stops between Charlton Street and Canal Street during the weekday PM peak period due to congestion in the Tunnel-bound lanes on the west side of the street.

6th Avenue/Church Street: 6th Avenue is a major northbound thoroughfare in Manhattan, which becomes Church Street south of Franklin Street. The roadway provides a maximum of four travel lanes with a conventional bicycle lane along the east parking lane between Leonard Street and Walker Street that changes to a shared bike lane from Walker Street to West Broadway. During the weekday PM peak period, the west curb parking lane is designated a bus-only lane from White Street to Watts Street. 6th Avenue/Church Street runs from the Financial District to Central Park South in Midtown. Within the study area, 6th Avenue is a key access route to the Holland Tunnel from Lower Manhattan, especially for commuter buses bound for New Jersey. 6th Avenue is also a major transit corridor served by the A, C, E, B, D, F, and M New York City Transit subway lines.

2.2.1.2 Eastbound/Westbound Roadways

There are three major eastbound/westbound roadways in the study area, including Canal Street, Broome/Watts Street, and West Houston Street. The Canal Street and Broome/Watts Street corridors provide direct access to the Holland Tunnel.

Canal Street: Canal Street runs two-ways from West Street in Hudson Square to the Manhattan Bridge/Bowery on the Lower East Side. Canal Street is a major eastbound/westbound arterial in the study area, as it provides for east/west access between West Street and the Holland Tunnel to the west and the Manhattan Bridge to the east. Typically, there are three eastbound and three westbound travel lanes with the following exceptions: westbound between the approach to the Holland Tunnel and Hudson Street where there is one travel lane, eastbound between the approach to the Holland Tunnel and Hudson Street where there is one travel lane, and eastbound between Hudson Street and Varick Street where there are two travel lanes.

Broome/Watts Street: Broome/Watts Street is a major westbound access route leading to the Holland Tunnel. Broome Street provides access from the Lower East Side to Watts Street and terminates at Varick Street. In the study area, Broome Street provides four westbound travel lanes in the PM peak period and contains a mixture of shared/conventional bicycle lanes between West Broadway and Varick Street. Watts Street originates at West Broadway where it diverges from Broome Street and continues to Varick Street where it connects to the westbound Tunnel entrance ramp. The block of Watts Street between Varick Street and Hudson Street is discontinuous due to the entrances to the Holland Tunnel. There is also a segment of Watts Street to the west between West Street and Canal Street.

West Houston Street: West Houston Street is a major eastbound/westbound arterial that stretches from West Street in Hudson Square to the FDR Drive on the Lower East Side. The section east of Broadway is known as East Houston Street. West of 6th Avenue, West Houston Street narrows and becomes one-way westbound with two travel lanes. It terminates at the intersection with West Street and Pier 40 on the Hudson River. Portions of West Houston Street are served by the 1, B, D, F, and M New York City Transit subway lines. Between Hudson Street and Washington Street there is a shared bicycle lane and from Washington Street to West Street there is a conventional bicycle lane.

2.3 Existing Conditions

To better understand the underlying issues related to safety and operations in the study area, traffic data was collected during May and June of 2017 for the weekday AM, weekday PM and Sunday afternoon peak periods. The data collection plan and analysis are presented in this section.

Data collection was performed to determine typical peak period conditions during the school year. Data collection was not performed during inclement weather. The following three peak periods were used for all data collected:

- Weekday AM – 7:00 a.m. to 10:00 a.m.
- Weekday PM – 4:00 p.m. to 7:00 p.m.
- Sunday afternoon – 2:00 p.m. to 5:00 p.m.

The data that was collected and/or compiled for this study is included in Appendix 2. The detailed Data Collection Plan is included in Appendix 2A.

2.3.1 Automatic Traffic Recorder Counts

Automatic Traffic Recorder (ATR) counts were performed at 40 roadway locations. ATR counts were calibrated via 15-minute calibration counts for each ATR for each of the three peak periods, including the weekday AM, weekday PM, and Sunday afternoon. All ATRs were collected utilizing NYC DOT's Traffic Information Management System (TIMS) format. Locations where ATR counts were conducted are depicted in **Figure 2-2**. ATR counts were used to identify daily traffic fluctuations, inform the traffic analyses, and help in the development of improvement recommendations. The ATR count data is presented in Appendix 2B.

2.3.2 Turning Movement Counts

Turning Movement Counts (TMCs) were performed at 89 study intersections concurrently with the ATR counts based on their locations along the study corridors. Video technology was used to collect the majority of TMCs. The TMCs were used to obtain Turning Movement and Vehicle Classification (TM/VC) data that served as the basis for balanced flow vehicle diagrams as well as pedestrian and bicycle volumes. In addition, TMCs were used as inputs to the traffic analyses and to help develop improvement recommendations. The weekday counts were collected for 3-hour periods during the morning peak starting at 7:00 a.m. and ending at 10:00 a.m. and during the afternoon peak starting at 4:00 p.m. and ending at 7:00 p.m. The weekend counts were conducted on a Sunday afternoon for a 3-hour period from 2:00 p.m. to 5:00 p.m. Locations where TMCs were conducted are depicted in **Figure 2-2**. The TMC data is presented in Appendix 2C.

All TMCs were conducted and recorded on a 15-minute basis. For each turning movement, vehicles were classified into four vehicle groups at all intersections:

- Automobiles (includes SUVs, passenger vans, pickup trucks, taxis, for-hire vehicles and motorcycles)
- Trucks (includes single-unit trucks and tractor trailers)
- Buses (includes school buses, public transit buses, and express/coach buses)
- Bicyclists

In addition to the turning movement counts, conflicting pedestrian counts along the crosswalks were collected at each of the 89 study intersections where TMCs were performed.

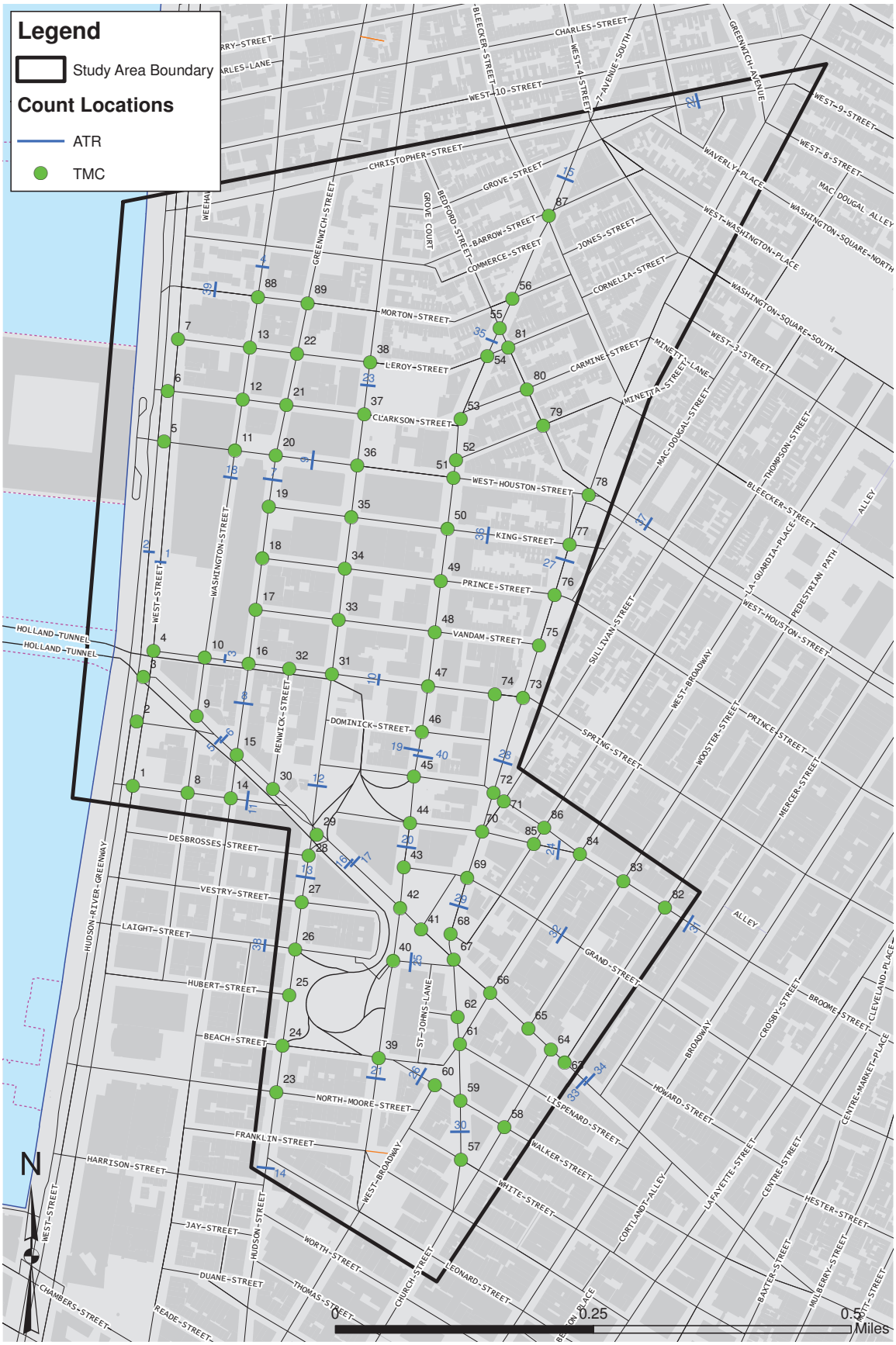


Figure 2-2 Location of ATRs and TMCs

2.3.3 Full Pedestrian Movement Counts

Full pedestrian movement counts were performed at 10 intersections and were conducted during weekday AM, weekday PM, and Sunday afternoon peak periods. The counts included official and unofficial crossings, intersection corner counts, and sidewalk counts. Official and unofficial crossings refer to crossings at striped crosswalks and illegal crossings at uncontrolled locations, respectively. The counts also included bi-directional pedestrian movements around all corners and along sidewalks. Full pedestrian movement counts were used to inform traffic analyses and to help develop improvement recommendations.

Counts were performed during good weather conditions and recorded in 15-minute intervals, by direction, and tabulated in accordance with NYC DOT's alphanumeric convention. These 10 intersections were selected based on several factors including the locations of proposed developments (i.e. 550 Washington Street), adjacent land uses, and the location of bus and subway stops, since pedestrian volume/activities are higher at these critical intersections where transit stops are located nearby.

Full pedestrian counts were conducted at locations depicted in **Figure 2-3** and are listed below. The count data is presented in Appendix 2D.

1. Barrow Street/Bleecker Street/7th Avenue South
2. West Street/West Houston Street
3. Varick Street/West Houston Street
4. Varick Street/Watts Street
5. Varick Street/Canal Street
6. West Street/Canal Street
7. 6th Avenue/Spring Street
8. 6th Avenue/Canal Street
9. West Street/Leroy Street
10. West Broadway/Canal Street

Figure 2-3 Full Pedestrian Movement Count Locations

2.3.4 Geometric Roadway Inventory

Physical inventories were performed at TMC locations, documenting relevant geometric elements of the roadway and network including lane configurations, lane widths, crosswalk lengths and widths, traffic control devices, and traffic signal timings/phasing sequences as recorded in the field. Roadway signs including parking regulations, lane usage, turning movement restrictions, and bus stop locations were also detailed. Locations of fire hydrants, street furniture, and other elements that may impact traffic and walking flows were also documented. These physical inventories were used as inputs to the traffic analyses and to help develop improvement recommendations. The physical inventory data is presented in Appendix 2E.

2.3.5 Queuing Observations and Field Observations

Field observations were used to inform traffic analyses and to help calibrate the traffic simulation models. Queuing observations were conducted on each major approach route to the Holland Tunnel at each signalized study intersection, performed concurrently with the TMCs. For each location, a 10-minute sample count of vehicles in queue on each approach during each hour of the weekday AM, weekday PM, and the Sunday afternoon periods was performed. The queue length recorded was based on the number of vehicles waiting on the approach at the start of its green time.

The queuing conditions for the weekday AM, weekday PM, and Sunday afternoon peak periods on the primary approaches to the Holland Tunnel are described and depicted below.

Weekday AM Queue: Figure 2-4 depicts the observation results for the maximum weekday AM queues destined to the Holland Tunnel. Limited westbound queuing was observed on the approach to the Holland Tunnel via Watts Street. However, the queue observed was not continuous and represented sporadic queuing that occurred. There was noticeable queuing observed on westbound Canal Street approaching the Holland Tunnel. However, the westbound Canal Street queue was actually caused by the westbound through traffic exceeding the single lane capacity at Hudson Street and was not due to traffic destined to the Holland Tunnel.

Weekday PM Queue: Figure 2-5 presents the observation results for the maximum weekday PM queues. Weekday PM queues on the approach to the Holland Tunnel were observed along Varick Street, Broome/Watts Street, Canal Street, 6th Avenue, and Hudson Street. On Canal Street and Broome/Watts Street, maximum queues extended beyond the eastern study area boundary at Greene Street. On Varick Street, the queue extended more than 8 blocks north of the entrance at Broome Street. On 6th Avenue, the observed queue extended approximately 7 blocks south of Watts Street. On Hudson Street, the queue extended more than 4 blocks south of the Tunnel entrance at Canal Street.

Sunday Afternoon Queue: Figure 2-6 depicts the observation results for Sunday afternoon queues. The maximum Sunday afternoon queues on approaches to the Holland Tunnel were generally comparable to the patterns observed for the maximum weekday PM queues. Substantial queues were observed on approaches to the Holland Tunnel from Varick Street, Broome/Watts Street, Canal Street, 6th Avenue, and Hudson Street. On Canal Street and Broome/Watts Street, maximum queues extended beyond the eastern study area boundary at Greene Street. On Varick Street, the observed queue extended about 6 blocks north of the entrance at Broome Street. On 6th Avenue, the observed queue extended more than 6 blocks south of Watts Street. On Hudson Street, the observed queue extended more than 4 blocks south of the entrance at Canal Street.

Field observations also identified the nature of freight and loading activity within the study area, including the type and number of delivery vehicles and where they stop to unload. Field observations were performed on each approach within 250 feet of the intersection for a 10-minute sample during each hour for which TMCs were collected.

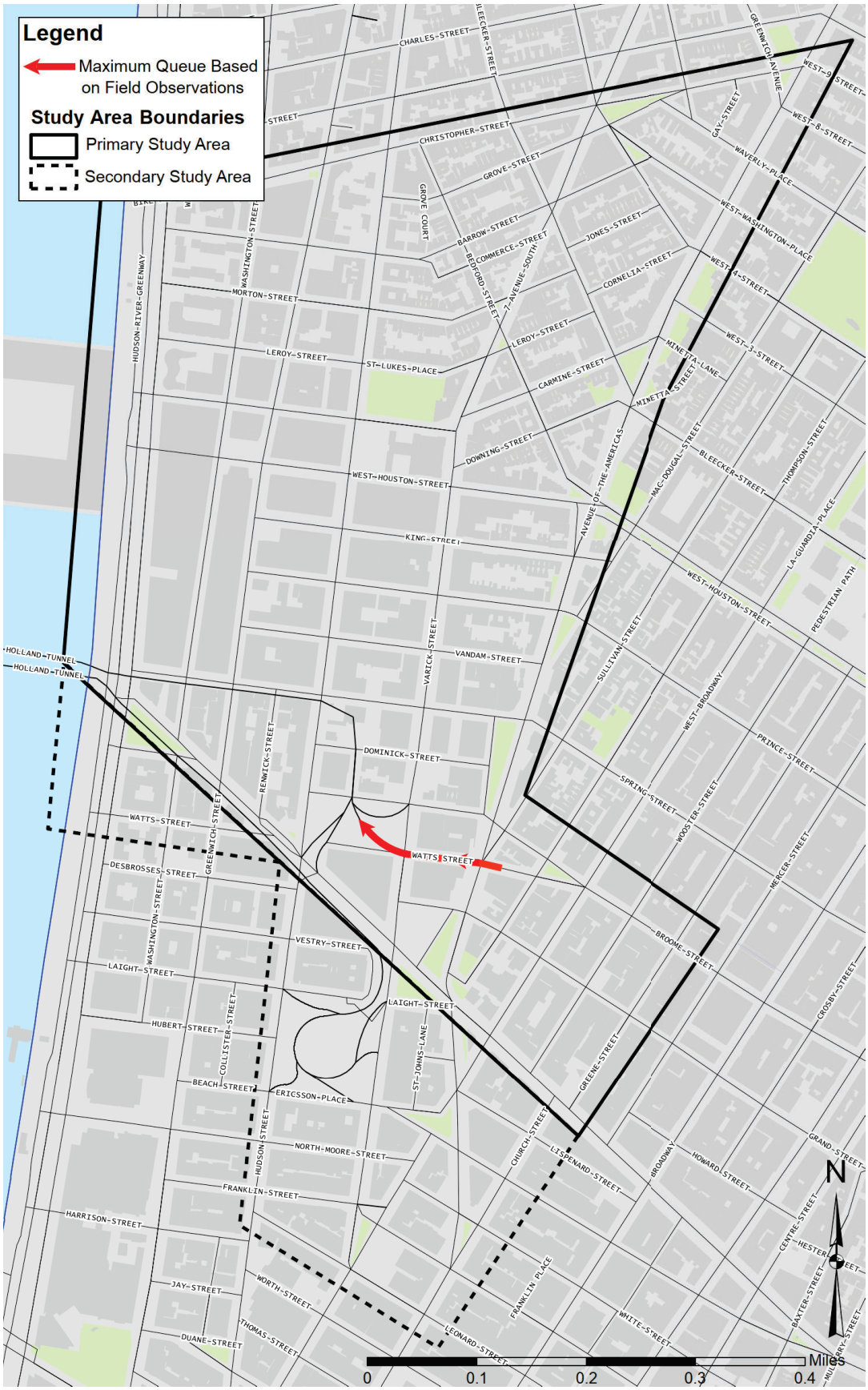


Figure 2-4 Holland Tunnel-Bound Queues: Weekday AM Peak

Figure 2-5 Holland Tunnel-Bound Queues: Weekday PM Peak

Figure 2-6 Holland Tunnel-Bound Queues: Sunday Afternoon Peak

2.3.6 On-Street Parking Utilization Surveys

On-street parking utilization surveys were targeted on the blockfaces approaching the Holland Tunnel, as stakeholders expressed concern regarding these areas (see Section 2.4, Issues Identification for more information on the Issues Log). The on-street parking utilization surveys were used to inform traffic analyses and to develop improvement recommendations.

An initial on-street parking survey was performed in January 2018 for 13 blockfaces that were identified following a review of the Issues Log. These initial parking utilization surveys were used to estimate the number of legally- and illegally-parked private cars, commercial vehicles, and buses on each of the surveyed blockfaces. The total number of legal on-street parking spaces was determined beforehand using existing roadway plans. The surveys were done between 7:00 a.m. to 10:00 a.m. and 4:00 p.m. to 7:00 p.m. on a weekday and between 2:00 p.m. to 5:00 p.m. on a Sunday. These times were selected to help assess traffic operating conditions during the peak periods for which the TMC data was collected. The January 2018 surveyed blockfaces were located on Varick Street, Broome Street, Watts Street, and Canal Street. This survey provided an indication of parking usage for selected blockfaces on the approaches to the Holland Tunnel.

A second more-detailed survey was conducted in September 2018 to obtain a better understanding of curbside usage/parking patterns and behavior on six blockfaces along Varick Street between King Street and Watts Street. The need for this survey was identified after the data collection was completed and improvement options were identified that would change the current cross section and reduce parking availability. The survey was performed to help assess the parking impact of Varick Street options. These on-street parking utilization surveys were conducted during one typical weekday, between 9:00 a.m. and 7:00 p.m., and on one Sunday, between 12:00 p.m. and 7:00 p.m. The survey collected data along the selected blockfaces related to parking duration, distribution, and utilization.

- Parking duration is the amount of time a vehicle is parked at a space.

- Parking distribution classifies the different vehicle types, parking status, legal status, and driver destination. The observed vehicles were categorized into five vehicle types: cars, commercial vans, trucks, fire/police/ambulance, and other. A vehicle's parking status was observed as being parked, standing, or loading. For each of the vehicles, the vehicle's legal status identified whether the vehicle was legally parked, violating regulations, double parked, or parked at a hydrant. Finally, destination identified whether the driver of the parked vehicle's destination was on the same block, different block, or not confirmed.

- Parking utilization is calculated as the number of parked vehicles divided by the total parking capacity along the surveyed area. Total parking capacity is determined by the posted parking regulations. Parking utilization was analyzed by vehicle type, parking status, and legal status, as defined above.

The September 2018 on-street parking surveys provided detailed information on the east curbside activity of Varick Street. The surveys showed that between 9:00 a.m. and 7:00 p.m. many vehicles, including a significant percentage of commercial vehicles, park and/or dwell in the east curb lane. Along Varick Street between King Street and Watts Street, there were 184 vehicles observed using the east curb lane for parking, standing, or loading. Along Varick Street between Charlton Street and Watts Street, there were 134 vehicles counted using the east curb lane for parking, standing, or loading. About 70 percent of the parked vehicles on Varick Street had a driver's destination on the same blockface they were parked. On-street parking utilization data is available in Appendix 2F.

2.3.7 INRIX and StreetLight Origin-Destination Data

INRIX and StreetLight collect and analyze real time anonymous GPS data from connected vehicles and devices. This data was utilized to provide traffic data for the study area. Origin-Destination (O-D) data was based on post processing of the INRIX data by StreetLight. The primary purpose of the data was to obtain O-D information for vehicles (including trucks) destined to the Holland Tunnel for a larger sample size than could be collected in the field. The data helped identify percentages of vehicles, particularly trucks, using the Holland Tunnel. The data also was used to identify vehicle routes to each of the Holland Tunnel ramps, as well as travel time data for a much larger sample size to help calibrate/validate the VISSIM traffic simulation models for the existing conditions. Further, the data was used to assess future turn bans.

The INRIX data was used at various levels of analysis:

- Estimating regional origin-destination patterns of the traffic using the Holland Tunnel, by NYC boroughs/tri-state metropolitan counties.
- Identifying patterns of traffic crossing the study area network boundaries. This analysis determined the percentage of vehicles entering the study area destined for: 1) the Holland Tunnel 2) through movement, or 3) neighborhood destinations in the study area.
- For vehicles accessing the Tunnel, identifying alternative routes and the percentage of traffic traveling between specific boundary points and the Holland Tunnel ramps (e.g. the primary alternative routes between southbound Varick Street at Christopher Street to New Jersey-bound Holland Tunnel Varick Street entrance).
- Providing travel times for each of the study area routes identified.

The INRIX data was broken down by car and truck traffic, by day of week and by hour of the day. Summaries of the INRIX origin-destination data is provided in Appendix 2G. Additional information regarding how the INRIX data was used to help develop the traffic simulation models is presented in Section 3.3.

2.3.8 Transportation Safety Review

The Transportation Safety Review consisted of analyzing Vision Zero priority corridors and intersections as well as high crash locations in the study area. Vision Zero is a New York City initiative that strives to reduce traffic fatalities and serious injuries to zero based on the belief that death and serious injuries in traffic are not inevitable "accidents," but preventable crashes that can be ended through engineering, enforcement, and education. A key part of Vision Zero is to identify priority corridors, intersections, and areas in each borough with the highest rates of walking related fatalities and severe injuries. NYC DOT data sources were utilized to assess Vision Zero priority intersections and corridors. Using NYC DOT's Vision Zero data accessed in February 2020, three priority corridors and three priority intersections were identified in the study area and are shown in **Figure 2-7**. An additional priority intersection was identified at Lafayette Street/Canal Street which is just outside of the study area.

The three priority Vision Zero corridors are:

- 6th Avenue
- Canal Street
- West Houston Street

The three priority Vision Zero intersections are:

- Varick Street/West Houston Street
- Varick Street/Canal Street
- 6th Avenue/Watts Street

High crash locations were identified utilizing NYC DOT crash data for the 3 years including 2015, 2016, and 2017 in the study area by mode including pedestrian involved, bicyclist-involved, and vehicle-only crashes. A high crash location is one where there were 48 or more total crashes (reportable or non-reportable) or five or more pedestrian/bicycle injury crashes in any consecutive 12 months of the most recent 3-year period for which data is available. The number of pedestrian and bicyclist-involved crashes and total crashes at each high crash location are listed below. In addition, Vision Zero priority corridors and intersections are noted.

High Crash Locations

High Crash Location	2015-2017 Pedestrian and Bicycle Crashes	2015-2017 Total Crashes	Vision Zero Priority Corridor*	Vision Zero Priority Intersection*
Varick Street/Canal Street	11	38	✓	✓
Varick Street/West Houston Street	11	29	✓	✓
6th Avenue/Canal Street/Laight Street	9	24	✓	
6th Avenue/West Houston Street	6	27	✓	
West Broadway/Canal Street	7	20	✓	

*Vision Zero data from NYC Vision Zero website accessed in February 2020.

The three Vision Zero priority corridors, three Vision Zero priority intersections, and the high crash locations are shown in **Figure 2-7**. Appendix 2H contains the crash data.

The Transportation Safety Review also assessed data that reflected the severity of crashes in the study area based on the KABCO scale that defines levels of injury severity. The scale[1] includes:
"K" Fatal injuries include deaths which occur within thirty days following injury in a motor vehicle crash.
"A" Severe injuries include skull fractures, internal injuries, broken or distorted limbs, unconsciousness, severe lacerations, severe burns, and unable to leave the scene without assistance.
"B" Moderate injuries include visible injuries such as a "lump" on the head, abrasions, and minor lacerations.
"C" Minor injuries include hysteria, nausea, momentary unconsciousness, and complaint of pain without visible signs of injury.
"O" No fatality or injury; property damage only.
"Unk Severity" Severity of injury unknown.

1 Source of these definitions used in the scale: https://www.itsmr.org/tssr-glossary/kabco-scale/

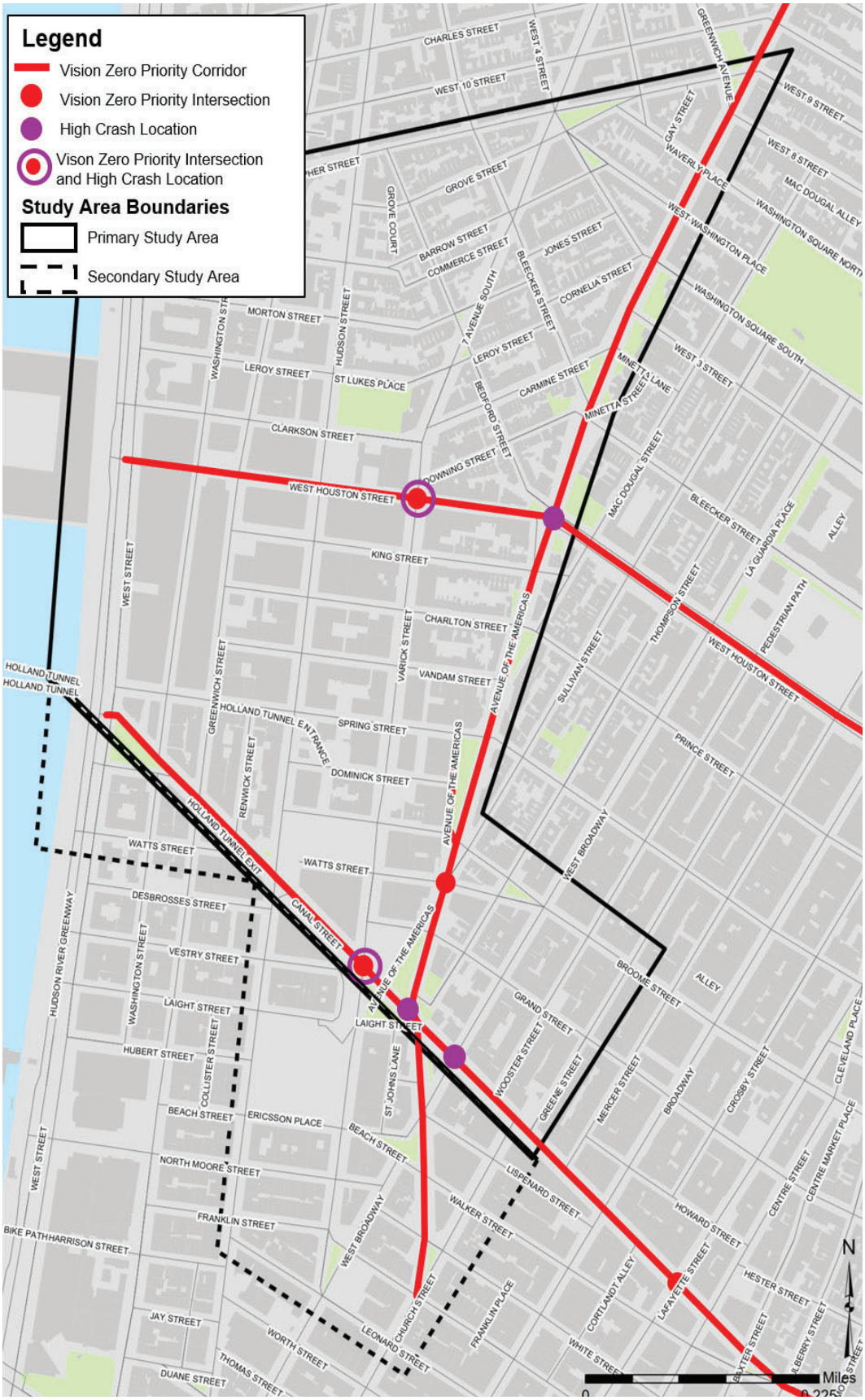


Figure 2-7 Vision Zero Priority Corridors and Intersections and High Crash Locations

Killed and Severely Injured (KSI) is the number of fatalities and severe injuries using the KABCO scale. There were a total of 11 locations in the study area that had 3 or more KSI during the 5-year period from 2014 to 2018. These locations are listed below. Nine of the locations are on Vision Zero corridors and two of these nine are Vision Zero intersections. This report (in Chapter 4) identifies improvements for the two locations with 5 KSI and for more than half of the locations with 3 or 4 KSI.

Locations with Greater Severity Crashes (2014-2018)

Location	KSI	Pedestrian Injuries	Bicycle Injuries	Motor Vehicle Injuries
Varick Street/West Houston Street	5	20	3	13
West Street/West Houston Street	5	5	4	13
West Street/Christopher Street	4	2	1	21
Varick Street/Canal Street	3	15	7	41
Hudson Street/Canal Street	3	3	3	46
6th Avenue/West 8th Street	3	9	7	20
West Street/Canal Street	3	0	0	26
West 4th Street/Grove Street	3	10	1	8
6th Avenue/West 4th Street	3	11	3	3
6th Avenue/Waverly Place	3	4	3	5
6th Avenue/White Street	3	2	2	3

2.3.9 Bicycle Routes

NYC DOT's 2019 New York City Bike Map was used to identify bicycle routes in the study area. There are more than 1,000 miles of bicycle routes in New York City with various types of lanes, including protected bicycle lanes, conventional bicycle lanes, shared lanes, and signed routes:

- Protected bicycle lanes are lanes where the bicycle lane is physically separated from vehicular traffic. An example of a protected bicycle lane in the study area is along Hudson Street, between West Houston and Christopher Streets, where the bicycle lane is separated from vehicular traffic by a buffer space and a parking lane.
- Conventional bicycle lanes provide bicyclists a lane alongside vehicular traffic and are commonly found throughout the study area.
- Shared lanes also exist in the study area and are streets that have pavement markings indicating that the street is shared by those bicycling or using motor vehicles.
- Signed routes are unmarked streets designated by "Bike Route" signage or a greenway medallion.

In the study area there are protected, conventional, and shared bicycle lanes, as depicted in **Figure 2-8**.

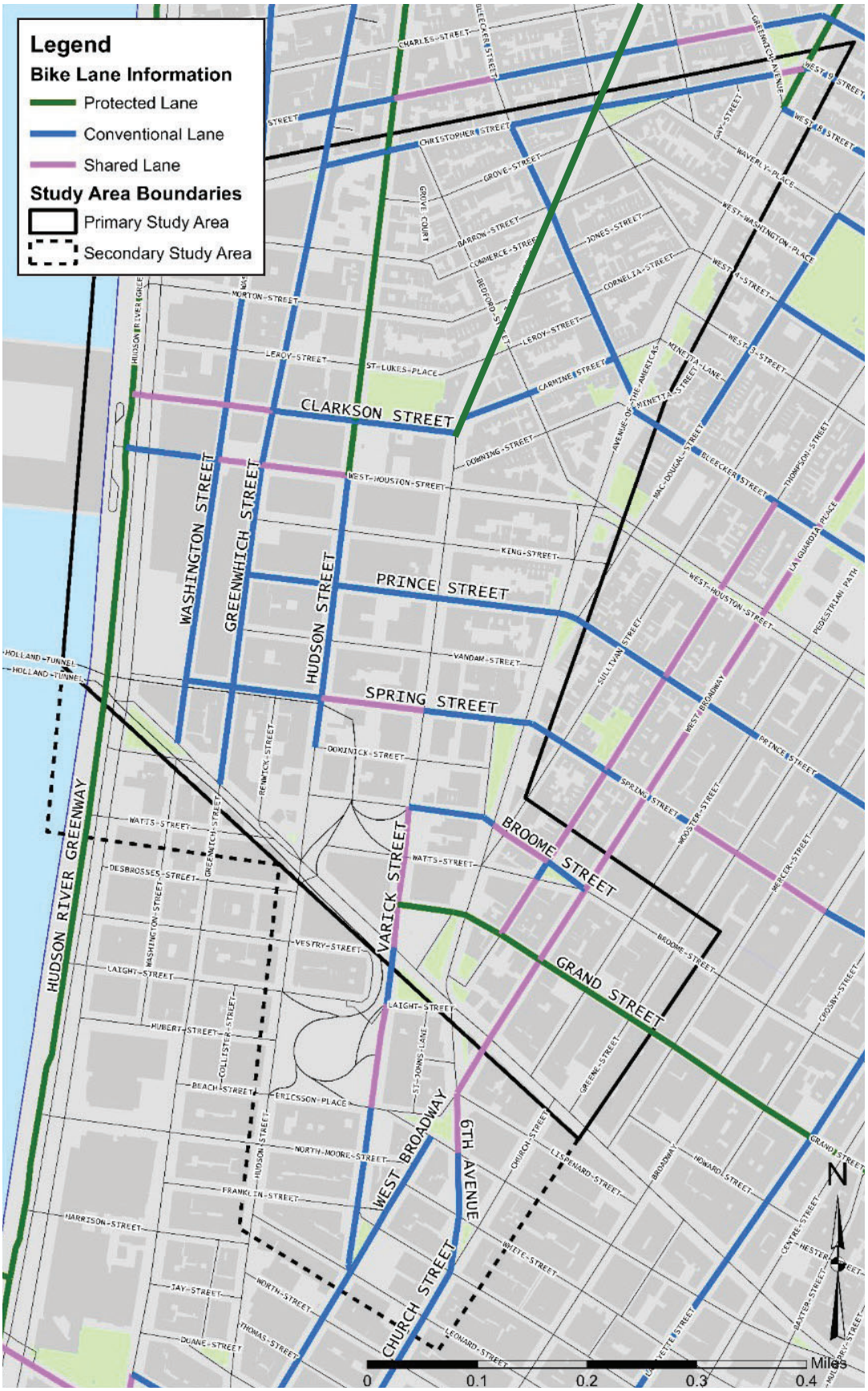


Figure 2-8 Bicycle Routes

2.3.10 Through and Local Truck Routes

NYC DOT's 2015 Truck Route Map was used to identify truck routes in the study area. New York City's truck routes are designated roadways that commercial vehicles and trucks must use when not making a delivery, loading, or servicing a particular street. These roads are divided into two different classes: through truck routes and local truck routes, as defined in Section 4-13 of the New York City Traffic Rules[1]. Through truck routes are primarily composed of major urban arterials and highways and must be used by trucks that have neither an origin or destination within a borough. Local truck routes are designated for trucks with an origin and destination within a borough. This includes trucks that are traveling to make a delivery, or for loading or servicing. Trucks should only use non-designated routes at the beginning or end of a trip, when traveling between their origin/destination and a truck route. According to the 2015 New York City Truck Route Map, there are both through and local truck routes in the study area. Of the various Holland Tunnel approaches, only Hudson Street and Canal Street are through truck routes. For traffic entering Manhattan from the Holland Tunnel, trucks may use all but Exit 1 on the rotary that connects to West Street via Laight Street. Through and local truck routes in the study area are depicted in **Figure 2-9**.

2 New York City Department of Transportation. Traffic Rules. February 15, 2019. https://www1.nyc.gov/html/dot/downloads/pdf/trafrule.pdf#section4-13a.

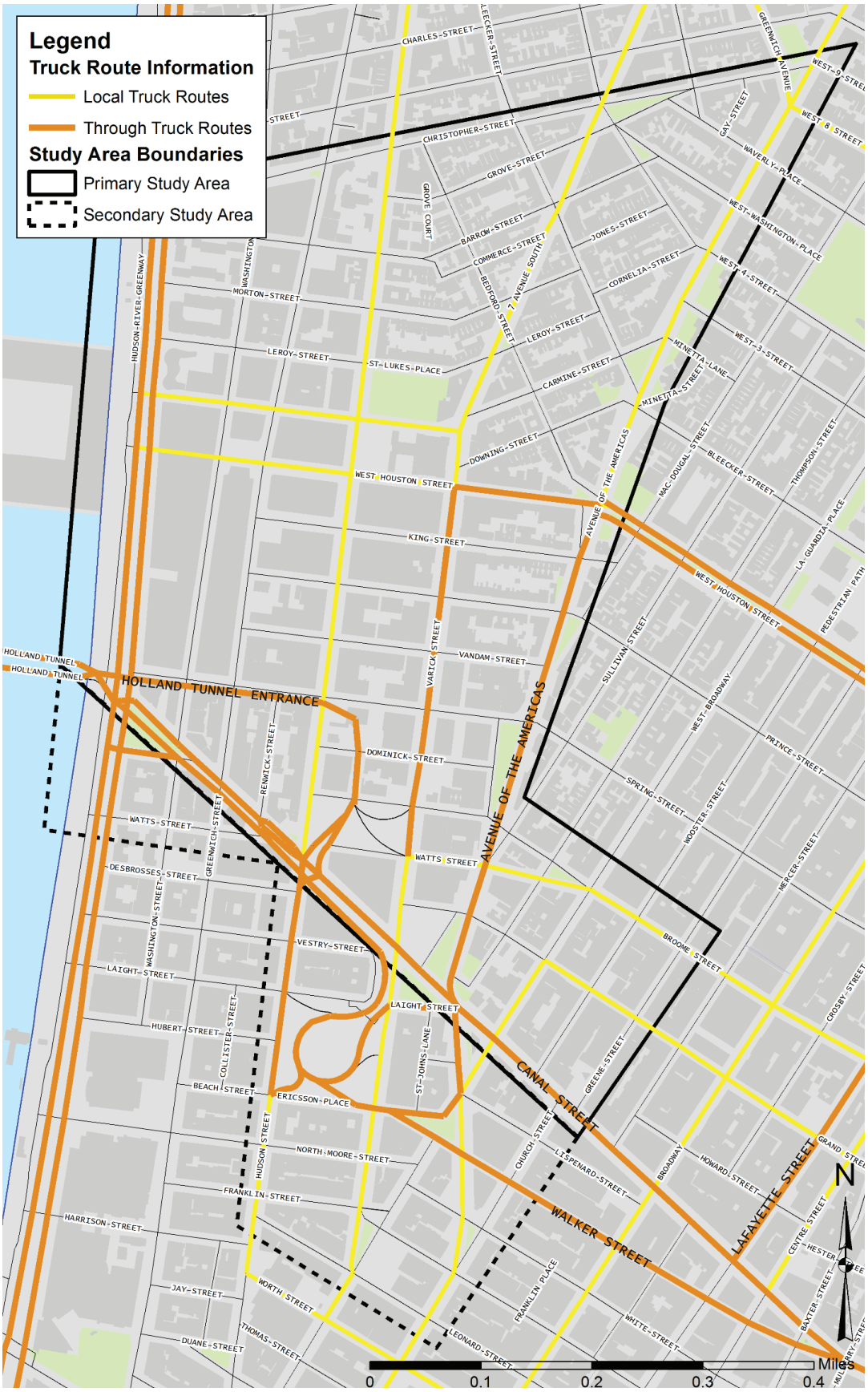


Figure 2-9 Through and Local Truck Routes

2.3.11 MTA NYCT Bus Routes

The Metropolitan Transportation Authority (MTA) New York City Transit (NYCT) operates both local buses and express buses within the study area. The local bus routes, depicted in **Figure 2-10**, include the M20, M21, M55, and M8 buses. A section of the M1 route, located outside of the study area, is also shown in the figure. The express bus routes, depicted in **Figure 2-11**, include the BxM18, X27, X8, SIM7, SIM9, SIM33, SIM1c, SIM1, SIM33c, SIM34, SIM3c, and SIM4c. The BxM18 express bus route serves Manhattan and the Bronx. The X27 and X28 bus routes connect Brooklyn to Manhattan. The express bus routes connecting Manhattan and Staten Island were redesigned in 2018. The Staten Island express bus routes in Manhattan include the SIM7, SIM33, SIM9, SIM1c, SIM1, SIM33c, SIM34, SIM3c, and SIM4c.

M20: The M20 bus connects the Upper West Side and Lower Manhattan, operating between Broadway/West 63rd Street and South Ferry. In the study area, the northbound and southbound M20 routes run along Hudson Street and Varick Street/7th Avenue South, respectively. The M20 bus is forced to skip two stops between Charlton Street and Canal Street during the weekday PM peak period due to congestion in the Tunnel-bound lanes on the west side of the street.

M21: The M21 bus connects the Lower East Side and Hudson Square/West Village neighborhoods, operating between FDR Drive South/Grand Street and Greenwich Street/Spring Street. In the study area, westbound M21 buses run along West Houston Street and Washington Street, while the eastbound M21 buses run east along Spring Street, north onto 6th Avenue, and eastbound to the Lower East Side on Houston Street.

M55: The M55 bus connects Midtown and Lower Manhattan, operating between 6th Avenue/West 44th Street and South Ferry. In the study area, the northbound M55 runs along 6th Avenue.

M8: The M8 bus connects the East Village and Hudson Square/West Village neighborhoods, operating between Avenue D/East 10th Street and West Street/Christopher Street. In the study area, westbound M8 buses run along Christopher Street (also referred to as West 9th Street east of 6th Avenue).

BxM18: The BxM18 express bus connects Riverdale in the Bronx to Midtown and Lower Manhattan, operating between Riverdale Avenue/261st Street to South Ferry. In the study area, northbound BxM18 buses run along 6th Avenue.

X27, X28: The X27 and X28 express bus routes connect Brooklyn to Manhattan. The X27 express bus runs from Bay Ridge in Brooklyn to Midtown Manhattan through Lower Manhattan and the X28 express bus runs from the Seagate and Bensonhurst neighborhoods in Brooklyn to Midtown Manhattan. In the study area, the Manhattan-bound X27 and X28 express buses run along 6th Avenue.

SIM7, SIM9, SIM33: The SIM7, SIM9, and SIM33 express bus routes connect Staten Island to Manhattan via Verrazano-Narrows Bridge and the Hugh L. Carey Tunnel. The SIM7 and SIM9 originate in Eltingville and the SIM33 originates in Mariners Harbor. All three express bus routes run through lower Manhattan and terminate in Greenwich Village at 6th Avenue/14th Street. In the study area, the Manhattan-bound SIM7, SIM9, and SIM33 travel on West Street. The Manhattan-bound routes use Spring Street to connect to 6th Avenue and the Staten Island-bound routes use West Houston Street to connect to West Street.

SIM1c, SIM1, SIM3c, SIM4c, SIM33c, SIM34: The SIM1c SIM1, SIM3c, SIM4c, SIM33c, SIM34, connect Staten Island to Manhattan via the Verrazano-Narrows Bridge and the Hugh L. Carey Tunnel. The SIM1 and SIM1c originate in Eltingville, the SIM3c originates in Port Richmond, the SIM4c originates in Annadale, and the SIM33c and SIM34c originate in Mariners Harbor. The SIM1 and SIM34c express bus routes terminate in the study area at 6th Avenue/West Houston Street. In the study area, the Manhattan-bound express buses travel on Church Street and 6th Avenue. The Staten Island-bound routes use Broadway, which is east of the study area.

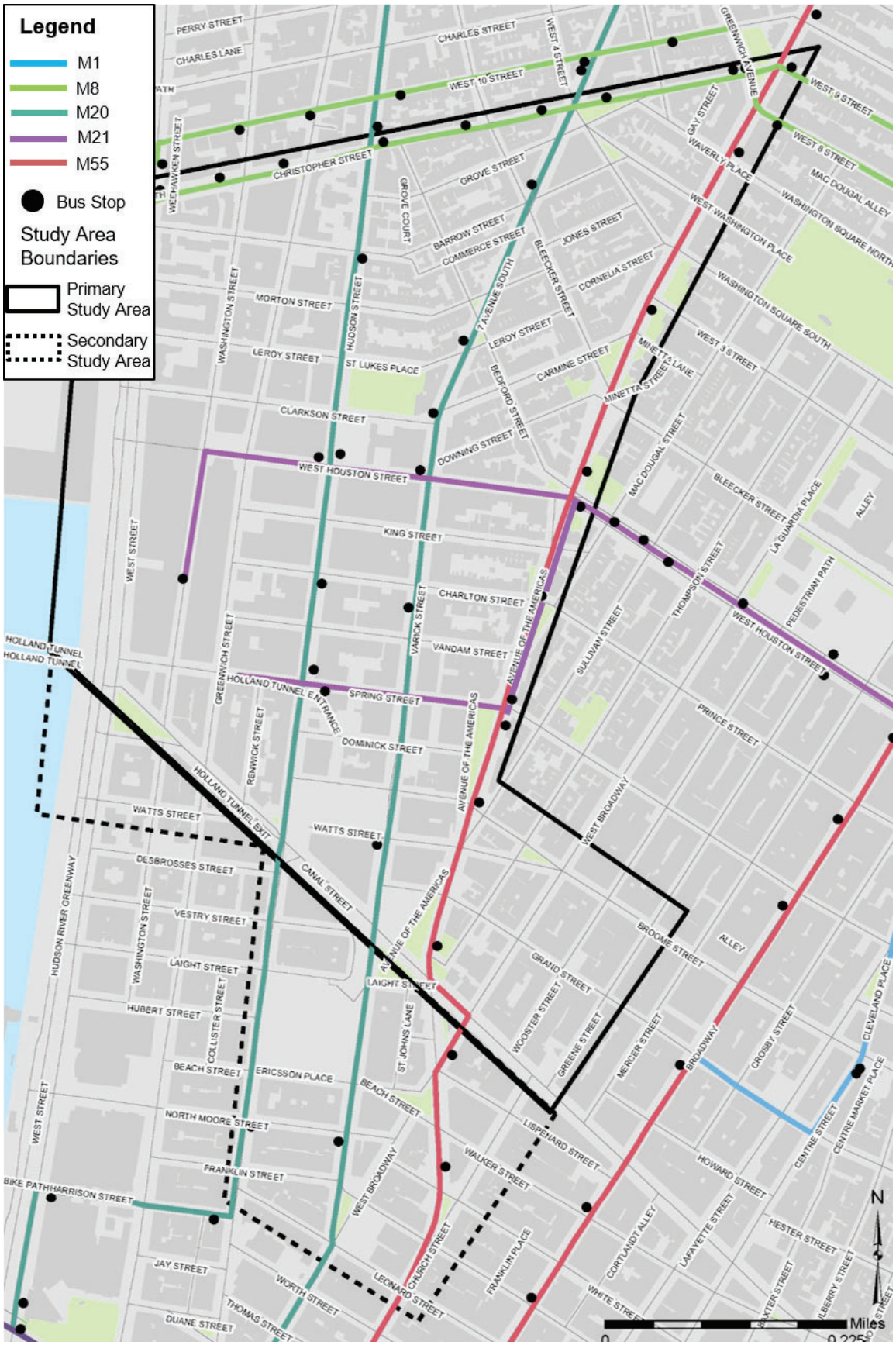


Figure 2-10 MTA Local Bus Routes

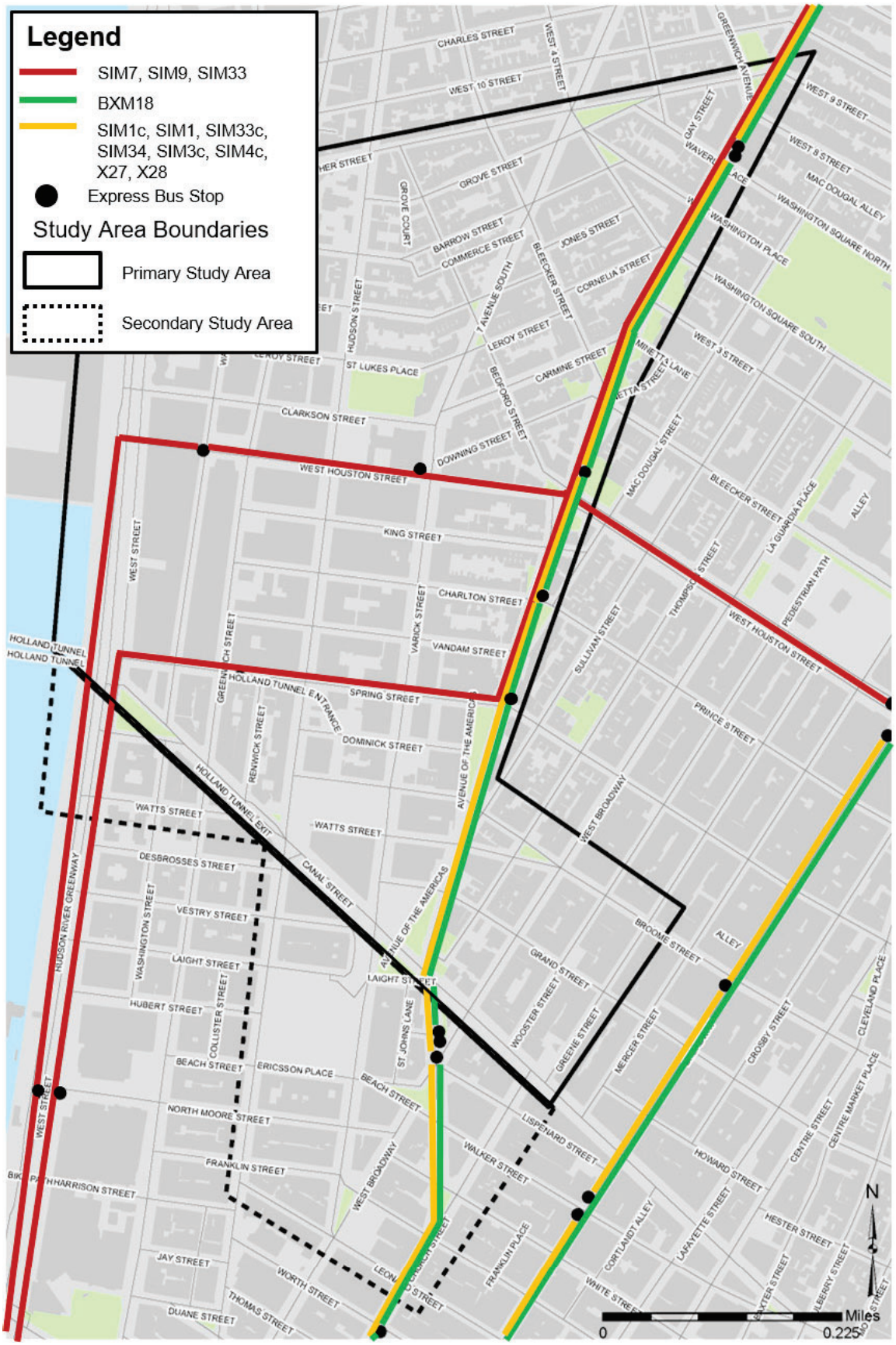


Figure 2-11 MTA Express Bus Routes

2.3.12 Commuter Bus Routes

In addition to MTA-operated buses, additional commuter bus routes run through the study area. These are operated by private companies and provide access from nearby states, including New Jersey and Pennsylvania. As depicted in **Figure 2-12**, these commuter buses run along West Street; 7th Avenue South and Varick Street; West Broadway; Franklin Street; 6th Avenue and Church Street; and Canal Street in the study area. Inbound commuter routes that enter Manhattan in the morning are shown by solid lines and outbound commuter bus routes that leave Manhattan in the afternoon are shown by dashed lines. During the weekday morning peak period, Canal Street, Varick Street, and Franklin Street are key bus routes from the Holland Tunnel. One of the operators, Lakeland, has stops in both the primary study area at Varick Street and Clarkson Street and in the secondary study area during the weekday AM peak period. Other operators have a stop in the secondary study area during the AM peak, with one operator having a stop during the weekday PM peak period.

During the weekday afternoon peak period, commuter buses leaving Manhattan approach the Holland Tunnel via Church Street and 6th Avenue. The route to the Tunnel usually involves traveling northbound on 6th Avenue and turning left onto westbound Watts Street to access the Tunnel at Varick Street. The concentration of the commuter buses at 6th Avenue/Watts Street and the difficult left turn maneuver for buses contribute to the congestion at the intersection, conflicts with people walking in the west crosswalk of Watts Street/6th Avenue, and queuing on the Watts Street and 6th Avenue approaches.

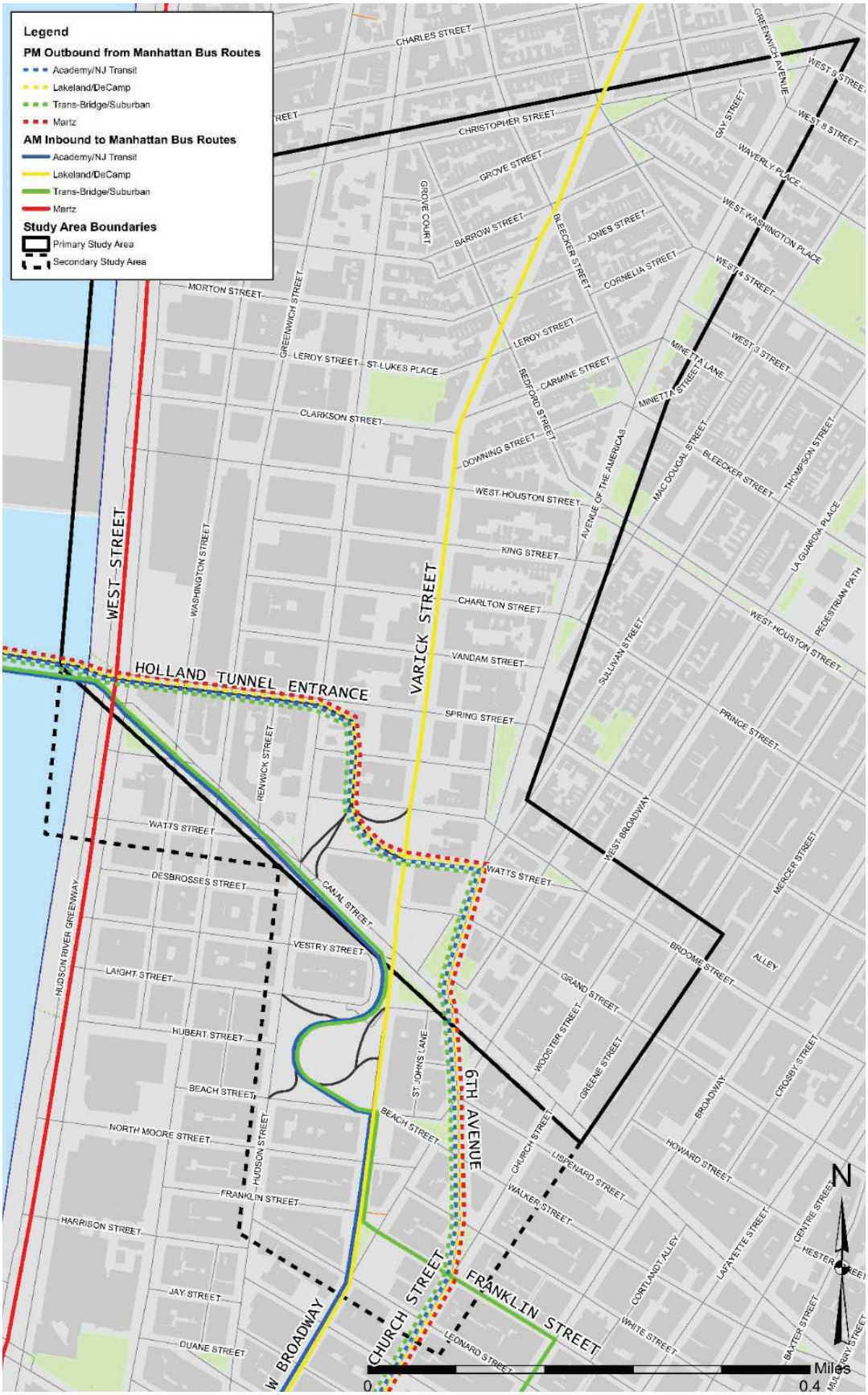


Figure 2-12 Commuter Bus Routes

2.4 Issue Identification

The identification of stakeholder issues was a key priority for the Study. Issue identification was conducted at the onset of the Study and provided a foundation for the development of early action items and other future improvements. A comprehensive log of operational and safety issues identified by stakeholders within the study area, along with a map depicting the location of each issue, is presented below.

2.4.1 Methodology

A list of key issues provided by Council Speaker Corey Johnson and CB 2 in the beginning of the Study was used as a starting point for the issues identification log. To incorporate broader community insight into the issues log, additional stakeholder meetings were conducted between the months of February 2017 and May 2017. The first of these meetings was the project kick-off meeting for the Study held on February 14, 2017, which informed the various agencies, community organizations, and stakeholders about the initiation of the Study. These forums provided early opportunities for stakeholders to share concerns about the conditions in the area and suggest ideas for possible improvements. The issues and suggestions raised in the meetings were incorporated into the issues log.

Additionally, a technical advisory committee (TAC) was formed to engage key stakeholders in the planning process throughout the duration of the Study. The TAC is comprised of community board members, the Hudson Square Connection Business Improvement District (BID), elected officials, and various public agencies that are connected to the study area. The first TAC meeting was held on March 13, 2017 to identify and discuss existing issues within the study area. These issues and potential suggestions are shown in the issues log.

After the first TAC meeting, two more stakeholder engagement meetings were held to obtain community input. On April 6, 2017, NYC DOT held a CB 2 Transportation Committee Meeting to discuss the purpose of the Study and obtain additional knowledge about issues in the study area. On May 4, 2017, NYC DOT met with the CB 2 Transportation Committee to brief stakeholders on NYC DOT's 7th Avenue Protected Bicycle Lane and Safety Improvements Project. Although this project was not part of the Hudson Square/West Village Transportation Study, some of the issued raised in the Study were related to the improvements associated with the 7th Avenue Protected Bicycle Lane and Safety Improvements Project. Therefore, the stakeholder coordination and issues identified for the 7th Avenue Bicycle Lane and Safety Improvements Project were relevant to the Study.

In addition to gathering input from stakeholder meetings, the project team reviewed CB 2 resolutions from the years 2011-2017 to gain a greater understanding of the history of the issues present within the study area. The majority of the concerns raised in the CB 2 resolutions were the same, or very similar, to issues that were raised in the stakeholder meetings held in 2017. The CB 2 resolutions provided additional context or background information about various issues.

2.4.2 Issues Log

The issues log identifies the location, location number, and associated issue. The log is accompanied by a corresponding map of the study area (**Figure 2-13**) that displays the physical location and location number of each issue.

Figure 2-13 Locations of Identified Issues

Issues Log		
Location	**Location Number**	**Issue**
South side of Watts Street between Thompson Street and 6th Avenue	1	Inconsistent and/or unclear parking regulations lead to blockages and lane imbalances heading to the Holland Tunnel, with weaving between lanes. There are blocks in the study area that currently have parking regulations that are confusing and there is no "predictability" to the rules.
Watts Street/Varick Street and 6th Avenue/Watts Street	2,3	Signals are not responsive to fluctuating traffic patterns.
Left turn from 6th Avenue to Watts Street	3	Buses turning left from 6th Avenue to Watts Street make a difficult turn that obstructs vehicular and walking movements, while adding bus traffic to an already overly-congested street.
Primary Study Area	N/A	Traffic enforcement agents (TEAs) are reassigned constantly with minimal time for them to learn about existing conditions, resulting in uninformed actions such as moving vehicles forward without any storage space causing queues to extend into intersections ("blocking the box").
Varick Street to the Watts Street Holland Tunnel Entrance	2	On weekday afternoons (between 4:00 p.m. and 5:00 p.m.) TEAs allow commuting public agency employees to illegally turn right from Varick Street to the Watts Street Holland Tunnel entrance, adding to the congestion.
Intersection of West Houston Street/ Varick Street	4	Previously implemented treatments, such as the curb extension at Houston and Varick Streets need to be adjusted.
Varick Street	5	Walking and bicycle access and local deliveries along the Varick Street corridor are of concern.
Varick Street Planted Median (between Vandam Street and Watts Street)	6	There is a desire to beautify Varick Street by building a landscaped median that would separate the Holland Tunnel lanes from the through lanes. The median would not allow for a bicycle lane or retention of on-street parking on the east side of Varick Street.
Intersection of Varick Street/7th Avenue South/Clarkson Street/Carmine Street	7	There are problems related to the angle of the intersection approaches, irregular geometry, large roadway width, restricted visibility of pedestrian traffic signals, and conflicting vehicle turning movements.

Issues Log		
Location	**Location Number**	**Issue**
Intersection of West Houston Street/ West Street	8	Intersection of West Houston Street/West Street has people and bicyclists crossing West Street that conflict with heavy westbound West Houston Street right turning vehicles. This intersection is of particular concern because of the high number of families, children, and recreational users seeking to access the sporting fields at Pier 40.
Intersection of 6th Avenue/West Houston Street	9	Traffic and safety issues at the intersection of 6th Avenue/West Houston Street, particularly on the northbound 6th Avenue approach.
Intersections of Spring Street/West Street and Canal Street/West Street	10, 11	People crossing West Street near the intersection of Spring Street is a concern. There are no crosswalks at West Street/ Spring Street. At Canal Street/West Street, there are “inadequate crossing times” for people walking and the median is too narrow to accommodate “stranded” pedestrians.
Clarkson Street between West Street and Greenwich Street	12	There are bicycle network connectivity issues due to the cobblestones on Clarkson Street between West Street and Greenwich Street.
Pier 40	13	Poor traffic distribution around Pier 40.
Varick Street	5	Vehicles speed on Varick Street during off-peak periods to the Holland Tunnel.
"Little 6th Avenue" between Broome and Spring Streets	14	Parking issues along Little 6th Avenue.
Intersection of King Street/West Street	15	Concern that a new crosswalk at King Street would serve 550 Washington Street development but would not address needs of the larger community to the south.
Canal Park	16	Walking environment on the west end of Canal Street is poor.
Hudson Street, where it intersects with Canal Street and goes into Tribeca	17	Improvements needed to "pedestrian continuity" along Hudson Street into Tribeca.

Issues Log		
Location	**Location Number**	**Issue**
West Street/Spring Street and West Street/Canal Street	18	At times, TEAs divert traffic from West Street destined to the Holland Tunnel via Canal Street onto Spring Street. It is problematic because these vehicles exacerbate long queues on Varick Street and vehicles turning right onto Spring Street conflict with the crosswalk.
Spring Street	19	Frequently For-Hire Vehicles (FHVs) idle on Spring Street east of Varick Street, which impacts through traffic and contributes to crashes as southbound left turning vehicles from Varick Street conflict with double-parked FHV's on Spring Street.
Canal Street/6th Avenue	20	The proposed Duarte Square School may attract more people walking and cause additional safety concerns in the area.
Varick Street/Dominick Street	21	The parking lot on the southeast corner of Varick Street/ Dominick Street has been planned for a new development.
Study Area	N/A	Need for the installation of additional curb extensions in study area.
Southeast corner of the intersection of King Street/Hudson Street and Southwest corner of the intersection of King Street/ Varick Street	22, 23	Vehicles often travel in the path of loading docks and trucks on the south side of King Street.
East side of 7th Avenue South between West 4th and Grove Street.	24	The curb extension on the east side of 7th Ave South between West 4th and Grove St extends too far into the travel lanes, making vehicle turns difficult.
Christopher Street between 6th and 7th Avenues	25	Recent designation of the Stonewall National Monument and increased tourism in the area may lead to curbside usage and pedestrian crossing safety issues on Christopher Street between 6th and 7th Avenues.
Bedford Street near Downing Street	26	Speeding occurs on Bedford Street near Downing Street.
Intersection of 6th Avenue /West 4th Street and intersection of W 4th Street/ Cornelia Street	27, 28	Intersection of 6th Avenue/West 4th Street poses safety issues for vehicles and people walking. The nearby stop-controlled intersection of West 4th Street /Cornelia Street creates operational and safety issues as vehicles approach the signalized 6th Avenue intersection.

Issues Log		
Location	**Location Number**	**Issue**
West 4th Street	29	Speeding occurs on West 4th Street and there is a lack of striping and organization along the roadway.
2 stops on M20 bus route on Varick Street	5	Holland Tunnel-bound lanes congestion results in NYCT buses on the M20 route skipping two stops on Varick Street during weekday PM periods.
Broome Street between Varick Street and Hudson Street	30	Parking along Broome Street between Varick Street and Hudson Street interferes with walking on a closed street.
Greenwich Street between Spring and Canal Streets	31	There is a facility for individuals with vision impairment on Greenwich Street between Spring Street and Canal Street where traffic signal enhancements to improve accessibility would be useful.
King Street/6th Avenue and 6th Avenue/ West Houston Street	32	There is a short and difficult weaving maneuver required for vehicles making an eastbound left-turn from King Street onto 6th Avenue, to then make a northbound right-turn onto Houston Street.
New pedestrian crossing of West Street (between Canal Street and West Houston Street)	33	A new pedestrian crossing of West Street is needed, especially as new development in the area occurs (e.g. 550 Washington Street)
Leroy Street/St Lukes Place between 7th Avenue South and Hudson Street	34	Vehicles speed on the block between 7th Avenue South & Hudson Street. Southbound right turning vehicles from 7th Ave South to St Lukes Place speed due to the lack of intersection control and obtuse angle. There is a need for a signalized pedestrian crossing.
Study Area	N/A	Provide LPI, increase length of LPI, or replace LPIs with All-Pedestrian Phase/Barnes Dance.
Greene Street	35	Holland Tunnel traffic causes congestion along Greene Street.
Intersection of Morton Street/ Washington Street	36	New school is open at 75 Morton Street and a new pedestrian crossing was added on Washington Street at Morton Street, but there is no STOP control at the crossing.
Intersection of West Street/Leroy Street	37	There is a pedestrian desire to cross West Street at Leroy Street.

Issues Log		
Location	**Location Number**	**Issue**
Southeast corner of the intersection of Hudson Street/Vandam Street and southeast and northeast corners of the intersection of Hudson Street/Charlton Street	44, 45	Curb extensions would reduce crosswalk distance and exposure to vehicular traffic.
Northeast and southwest corners of 6th Avenue/Broome Street	46	Curb extensions would reduce crosswalk distance and exposure to vehicular traffic.

EXISTING AND FUTURE CONDITIONS WITHOUT IMPROVEMENTS

3

3.1 Development of Traffic Methodology

Traffic analysis was conducted to evaluate the operations of the existing (2017) and future 2027 conditions with and without improvements. Balanced traffic flow networks were developed for existing conditions for three peak periods: weekday AM, weekday PM, and Sunday afternoon using the Automatic Traffic Recorder (ATR) and Turning Movement Count (TMC) data collected during June 2017. Balanced traffic flow networks were also developed for future conditions. To arrive at the future conditions traffic volumes, the balanced existing traffic volumes were increased to account for background growth and peak hour trips generated from future development, including the Hudson Square Rezoning and the 550 Washington Street Redevelopment.

The existing conditions traffic microsimulation models were developed and calibrated to serve as a base for the development of the future year microsimulation models using VISSIM. The results from the traffic simulation models were compared for future conditions with and without improvements to help assess the effectiveness of proposed future improvements.

3.2 Balanced Traffic Flow Networks

The traffic volumes from the ATR and TMC counts were balanced to develop traffic volume flows on the street network that could be used in the operational analysis. The objective was to identify traffic demand volumes throughout the network for analysis purposes. However, due to bottlenecks and queues, full demand volumes could not reach their destinations near the Holland Tunnel during peak periods. The raw TMC data and ATR data collected at congested locations represented the actual processed volume, but not the vehicular demand. The raw TMC data and ATR data collected at uncongested locations, upstream of bottlenecks, were more representative of the actual vehicular demand. The unconstrained volumes, used as control points for balancing the traffic flows, were chosen at key entrances to the study area, such as southbound Varick Street north of Barrow Street, northbound Hudson Street south of Franklin Street, and northbound 6th Avenue south of Walker Street. Recognizing that the Holland Tunnel entrance ramps are the primary bottlenecks due to the merging of multiple lanes into two Holland Tunnel entrance lanes, the following steps were applied to approximate demand for the congested entrance routes to the study area:

1. The processed volumes from the TMC and ATR data at the congested entrances on westbound Broome Street and westbound Canal Street were used as a basis for increasing the volumes to estimate demand.

2. The extent of congestion and estimated queue lengths along westbound Broome Street and westbound Canal Street were identified. The queue lengths were based on field observations and cross-referenced with Google Maps Typical Traffic, which indicate the historical average traffic conditions at various times of day. For the other key entrance routes to the study area, count data upstream of the congestion locations were used as-is.

3. The unmet demand was calculated based on the queuing identified and estimated in Step 2. The total congested segment length (from the study area entrances to the end of the queue) was divided by the average standstill space per vehicle (which was assumed to be 20 feet per vehicle for congested Manhattan traffic operations), and then multiplied by the effective number of travel lanes.

4. The processed volumes were aggregated and the unmet demand calculated to obtain the approximate demand at the congested entrances to the study area on westbound Broome Street and westbound Canal Street.

To develop the balanced traffic flow networks, key Origin-Destination (O-D) patterns were extracted from INRIX data for seven (7) key entrances (origins) to the study area and destined for: 1) Holland Tunnel entrances; 2) study area boundary exits; or 3) all other destinations within the study area. Additional O-D information was provided by NYC DOT using INRIX for five (5) alternative route options to the Holland Tunnel. The seven key entrances to the study area and five Holland Tunnel-bound route origins are listed as follows:

Seven Key Entrances to Study Area:

1. Northbound West Street, south of Laight Street
2. Southbound West Street, north of Barrow Street
3. Northbound Sixth Avenue, south of Walker Street
4. Southbound Varick Street, north of Barrow Street
5. Westbound Broome Street, east of Greene Street
6. Northbound Hudson Street, south of Franklin Street
7. Westbound Canal Street, east of Greene Street

Five Holland Tunnel-Bound Routes:

1. Northbound West Street, south of Laight Street to Holland Tunnel
2. Southbound West Street, north of Barrow Street to Holland Tunnel
3. Northbound Sixth Avenue, south of Walker Street to Holland Tunnel
4. Southbound Varick Street, north of Barrow Street to Holland Tunnel
5. Westbound Broome Street, east of Greene Street to Holland Tunnel

Traffic demand volumes originating at the entrances to the study area and destined to the Holland Tunnel or through to the opposite end of the network were estimated. The estimates were based on the traffic demand that was either counted at uncongested network entrances or estimated at congested entrances. Traffic demand estimates were also based on INRIX O-D pattern data for routes that start at the seven key entrances and for the five Holland-Tunnel bound alternative routes. With the traffic demand estimated at the entrances to the study area, these volumes were balanced through the network to the Holland Tunnel. The initial balanced volume diagrams based on the raw TMC and ATR counts were adjusted to account for the estimated traffic demand. The existing balanced traffic flow networks for three peak periods are included in Appendix 3A.

3.3 Development and Calibration of Simulation Models

The PTV VISSIM Version 9 software was used to develop and calibrate the existing condition traffic microsimulation models. The roadway networks for the existing conditions VISSIM models were initially developed according to the aerial map of the 2017 base year and the geometric inventories. The TMC videos from the June 2017 data collection effort were then used to verify and adjust the roadway geometry to replicate actual field operations in the models. Video reviews were particularly important at the locations with traffic cones and TEAs managing traffic flows at congested intersections. The balanced traffic flows fed the model's vehicle inputs and routing decisions to guide vehicles traveling through the roadway network. Traffic signal timing plans were provided by NYC DOT and were incorporated into the microsimulation models at the 80 signalized intersections in the network. In addition, conflict areas and priority rules were configured in the model to represent vehicle right-of-way that was consistent with field operations.

The existing conditions VISSIM models were then calibrated in accordance with the Federal Highway Administration's (FHWA) *Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modelling Software* (FHWA, July 2004). Appendix 3B includes calibration target values from these guidelines utilized for the Study's model validation.

Calibration is the adjustment of model parameters to improve the model's ability to reflect existing conditions. Calibration is necessary because the default model parameter settings typically do not represent actual traffic conditions, especially in heavily congested conditions experienced in NYC. Tremendous efforts were undertaken during the calibration process due to the large simulation network modeled, the congested multimodal complexities of the study area, and the dynamic day-to-day operations. An iterative process was used to adjust the models to reach calibration targets by modifying and adjusting model parameters to better reflect local driver behavior and traffic performance characteristics. For example, adjustments were related to safety distance reduction factor, headway distance, cooperative lane change percentage, look-back lane change distance, and priority rules to account for the cooperative lane change operation at Holland Tunnel entrances and the "DON'T BLOCK THE BOX" effect. Traffic volumes and queue lengths were the primary calibration metrics, with travel times reported to approximate existing congestion along the major routes to the Holland Tunnel.

The following were the peak hours selected for calibrating the model based on the review of the traffic data for each of the peak periods:

Weekday AM: 7:45 a.m. – 8:45 a.m.
Weekday PM: 4:00 p.m. – 5:00 p.m. and 5:00 p.m. – 6:00 p.m. (due to the sustained congestion experienced, two hours were calibrated and analyzed)
Sunday afternoon: 3:15 p.m. – 4:15 p.m.

Since the volumes used as input to the VISSIM models were based on balanced demand volumes to create the field-observed congestion and queuing, the model was not able to process all of the demand at the congested locations surrounding the Holland Tunnel entrances. Therefore, for the majority of the study locations, the balanced volumes were used to compare to the model- processed volumes. In addition, the Port Authority of New York and New Jersey provided Holland Tunnel counts by ramp and individual tunnel lane. The traffic volumes were calibrated if the difference between the traffic models and the field-processed volume was within the calibration criteria.

Appendix 3B includes the traffic volume and queue length calibration summaries for the existing weekday AM peak hour, weekday PM peak hours (4:00 p.m. – 5:00 p.m. and 5:00 p.m. – 6:00 p.m.), and Sunday afternoon peak hour. Additionally, travel times reported for the models' thirteen travel time segments are summarized in Appendix 3C. The processed volume calibration metrics met their established targets for each of the peak hours.

3.4 Projection of Future Traffic Volumes Without Improvements

The future year traffic volumes without improvements were projected for the study area for the weekday AM, weekday PM, and Sunday afternoon peak hours. Based on a 10-year planning horizon, the traffic volumes were forecasted to 2027. The 2027 projections were used to assess the effects of future improvement options by comparing them with projections for the future conditions without improvements.

Background development projects unaffiliated with this Study were identified to help forecast future traffic volumes in the study area. The first step in the future volume projection process was to compile a list of background developments. The focus was on projects that have the potential to influence traffic patterns in the study area. As a basis for this effort, environmental impact statements (EIS) and environmental assessment statements (EAS) for which the New York City Department of City Planning (NYC DCP) was the lead agency were used.

The identified background projects are shown in **Figure 3-1** and include:

- *550 Washington Street/Special Hudson River Park District, Environmental Impact Statement*, October 2016
- *Hudson Square Rezoning, Environmental Impact Statement*, January 2013
- *New York University CORE, Environmental Impact Statement*, May 2012
- Selected EASs in or near the study area on New York City Department of City Planning's Website since July 2012, as of November 10, 2017

Each of the above referenced EIS reports included a comprehensive list of background developments that those studies identified and a detailed description of the proposed developments' person-trip generation and traffic mitigation measures. Additionally, background development projects in or near the study area that were reviewed through the EAS process are presented in Appendix 3D. Please note that some projects are listed under multiple lists, given the overlapping geographic scope of the EISs and EASs. This was accounted for in the process that was applied to project the future volumes without improvements.

The square footage for each of the projects presented was summed to indicate total background growth projected for the entire study area. Since some of the projects were up to 5 years old, projects that were already built were not included in this total background growth calculation. Background developments appearing in multiple EISs and EASs were only accounted for once. For those projects that appear on multiple lists, the square footage provided in the most recently published information was used to develop the project list, with the

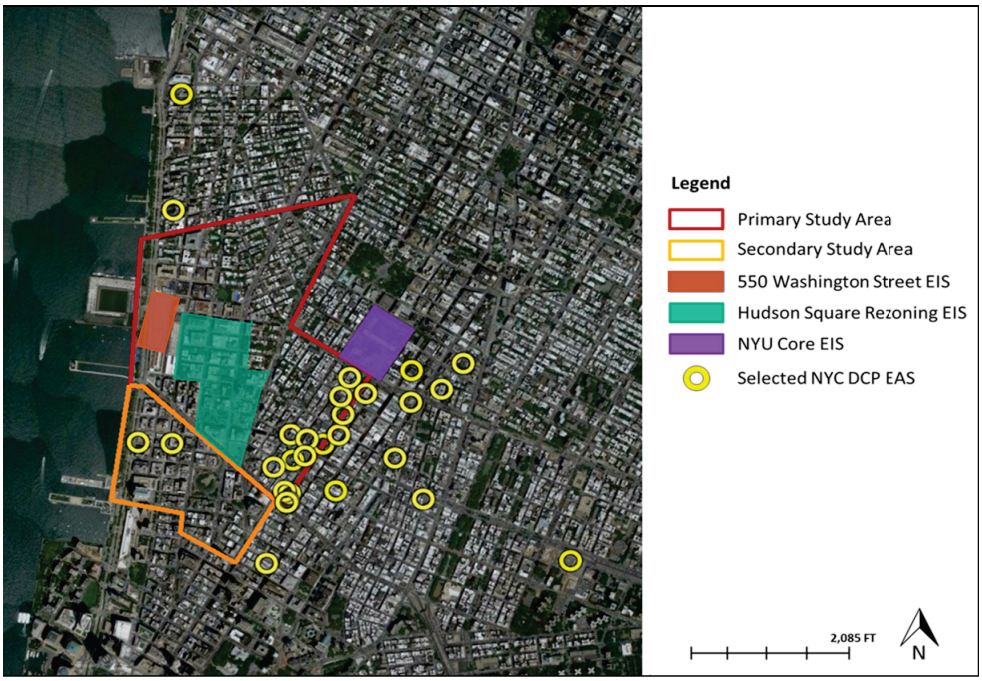


Figure 3-1 Background Development Projects

exception of Hudson Square Rezoning and NYU Core, where square footage was based on the respective EISs. Due to the magnitude of the 550 Washington and Hudson Square Rezoning developments, separate layers of incremental absolute volumes were created for each of these two projects to reflect the associated traffic projections. The layer for 550 Washington Street was subsequently modified to account for a substantial change to the development plan that replaced much of the residential square footage with office space.

The NYU Core development is not located in the Hudson Square/West Village study area, and thus traffic generated from the development was expected to have minimal effects on traffic in this project's study area. The minimal overlap of the study areas included only one intersection – West 4th Street/West Houston Street. Therefore, the NYU Core development was not added as separate layer.

To reflect additional background development and projected future traffic volumes in the study area, an overall three percent growth factor was applied to the balanced base volumes for the 10 year period between the existing and future analysis year. The background growth factor reflects the compiled list of development projects that could potentially affect future traffic volumes in the study area (not including 550 Washington Street and Hudson Square Rezoning which were treated as separate layers).

In summary, as indicated above, the future traffic volumes for the year 2027 were forecasted by adding the following traffic volume increments to the exiting conditions balanced traffic flow networks for the weekday AM, weekday PM, and Sunday afternoon peak periods:

- Incremental traffic volumes associated with the application of an annual growth factor of 0.3 percent/year for 10 years (three percent total growth) between 2017 and 2027 to reflect other developments within the study area.
- Project-generated traffic volumes for two major programmed developments within the study area:
  - 550 Washington Street
  - Hudson Square Rezoning

Further details regarding the process that was applied and the information that was compiled for purposes of projecting the future traffic volumes are presented in Appendix 3D. This consists of the March 1, 2018 memo that identifies the methodology for projecting 2027 future background traffic volumes and the January 22, 2019 memo that presents an updated methodology based on a significant change that was made to the development plan for the 550 Washington Street EIS. The future year balanced traffic flow networks are included in Appendix 3E.

In addition to the volume increase between years 2017 and 2027, the following elements were updated for the microsimulation models to represent planned network changes forecast to occur by the year 2027:

- Updated traffic signal timings for the intersections along northbound Sixth Avenue and southbound Varick Street/7th Avenue South.
- Extended the protected bicycle lane along southbound 7th Avenue South/Varick Street to Clarkson Street/Carmine Street.
- Changed southbound approach signal timings at West Street/West Houston Street to split phase. The split phase eliminates the conflict between southbound right-turning vehicles and people walking in the west crosswalk.
- Converted Washington Street/Morton Street to All-Way-Stop-Control.

3.5 Operational Analysis of Future Traffic Conditions Without Improvements

Traffic operational analysis were conducted for the weekday AM peak period, PM peak period, and Sunday afternoon peak period to establish future traffic operations in 2027 with increased traffic volumes and the network changes. Since the existing conditions are already over-saturated and the overall network experiences extensive congestion, the future network is expected to become more congested. Additional traffic delays are due to the increased volumes generated by the projected background growth and anticipated new developments.

Due to the lack of available capacity in the existing network, the increased future volumes were found to result in longer queue lengths along the major congested corridors such as southbound Varick Street/7th Avenue South, westbound Canal Street, westbound Broome/Watts Street, and northbound Hudson Street.

IDENTIFICATION OF IMPROVEMENTS

4

4.1 Introduction

The objective of this Study is to identify transportation issues in consultation with stakeholders, develop and analyze design options, and recommend a range of improvements that can be implemented as early action or future improvements to address these issues. Early actions are improvements that are expected to be implemented by the end of 2021. Future improvements are those that, if selected for implementation, would be completed after 2021. Early actions and future improvements are presented in this chapter.

A number of early actions that were implemented before the Study was completed are described below and shown in **Figure 4-1**:

- Adjustment of signal timing at 15 intersections along 7th Avenue South and Varick Street
- Construction of protected bicycle lane on 7th Avenue/7th Avenue South from West 30th Street to Clarkson Street
- Extension of protected bicycle lane on Varick Street from Clarkson Street to West Houston Street and provision of pedestrian islands and curb extension
- Installation of All-Way-Stop Control signs at Washington Street / Morton Street
- Provision of Leading Pedestrian Interval (LPI) for north crosswalk at 6th Avenue/West 4th Street/ Cornelia Street
- Installation of wayfinding signage to direct pedestrians to cross West Street at Clarkson Street or at Morton Street, rather than at Leroy Street
- Extension of the conventional bicycle lane on West 4th Street between 6th Avenue and Macdougal Street / Washington Square West
- Installation of new traffic signal at 7th Avenue South/Leroy Street
- Installation of curb extension on northwest corner of 7th Avenue South/Leroy Street

Figure 4-1 Completed Early Action Locations

4.2 Early Actions

A key component of this study was to recommend early actions (i.e. short-term improvements) that would enhance the safety and mobility for all street users in the area. As noted earlier, early action improvements are expected to be implemented by the end of 2021. The toolbox of early action improvements included curb extensions, pavement markings, vertical delineators, and signs. As part of the study, the team identified and progressed a set of early actions for implementation. This section presents the issues and the early actions, in response to issues identified by key stakeholders.

The study team reviewed each of the issues identified in Chapter 2, Existing Conditions and potential improvements suggested by members of the technical advisory committee (TAC), members of the study team, and other stakeholders through a series of meetings. Based on these discussions and a qualitative assessment of the entire study area, a list of potential early actions was presented to the TAC and feedback was solicited to further refine the improvements.

Each issue and potential improvement was reviewed to determine if the improvement would be suitable for early implementation using the following criteria:

- Traffic operations evaluation could be based on a qualitative assessment (i.e. did not involve detailed quantitative analysis)
- Implementation would not involve capital construction
- The improvement would not impede access by emergency vehicles or trucks (FDNY-95 Fire Truck or the WB-50 truck on through truck routes, WB-40 truck on local truck routes, or a single unit truck on non truck routes)

These improvements include painted curb extensions, signal timing adjustments, revised pavement markings and signage, multi-modal improvements, etc. The temporary curb extensions would be made permanent in the long term. The various types of early action improvements are described below and are shown in **Figure 4-2**.

Curb Extension: A curb extension is the expansion of a sidewalk into the roadway. Curb extensions can be accomplished with temporary materials (pylons, planters, granite blocks, and epoxy gravel or paint) or permanent materials, have a width two feet less than the lane width, and may be installed at the corner or in the middle of the block. Curb extensions enhance pedestrian safety by reducing crossing distances, relieving sidewalk crowding, and providing space for functional elements such as seating, plantings, and street furniture. A maintenance partner is needed for curb extensions that are less than 11-feet wide since narrower curb extensions cannot accommodate street sweepers. Curb extensions were identified for implementation at seven locations (nine intersections) listed below:

1. 6th Avenue/Broome Street
2. 6th Avenue/West 4th Street/Cornelia Street
3. Charlton and Vandam Streets along Hudson Street (two intersections)
4. Hudson Street/Canal Street
5. King Street between Hudson and Varick Streets (two intersections)
6. 7th Avenue South/Commerce Street
7. Varick Street/Canal Street

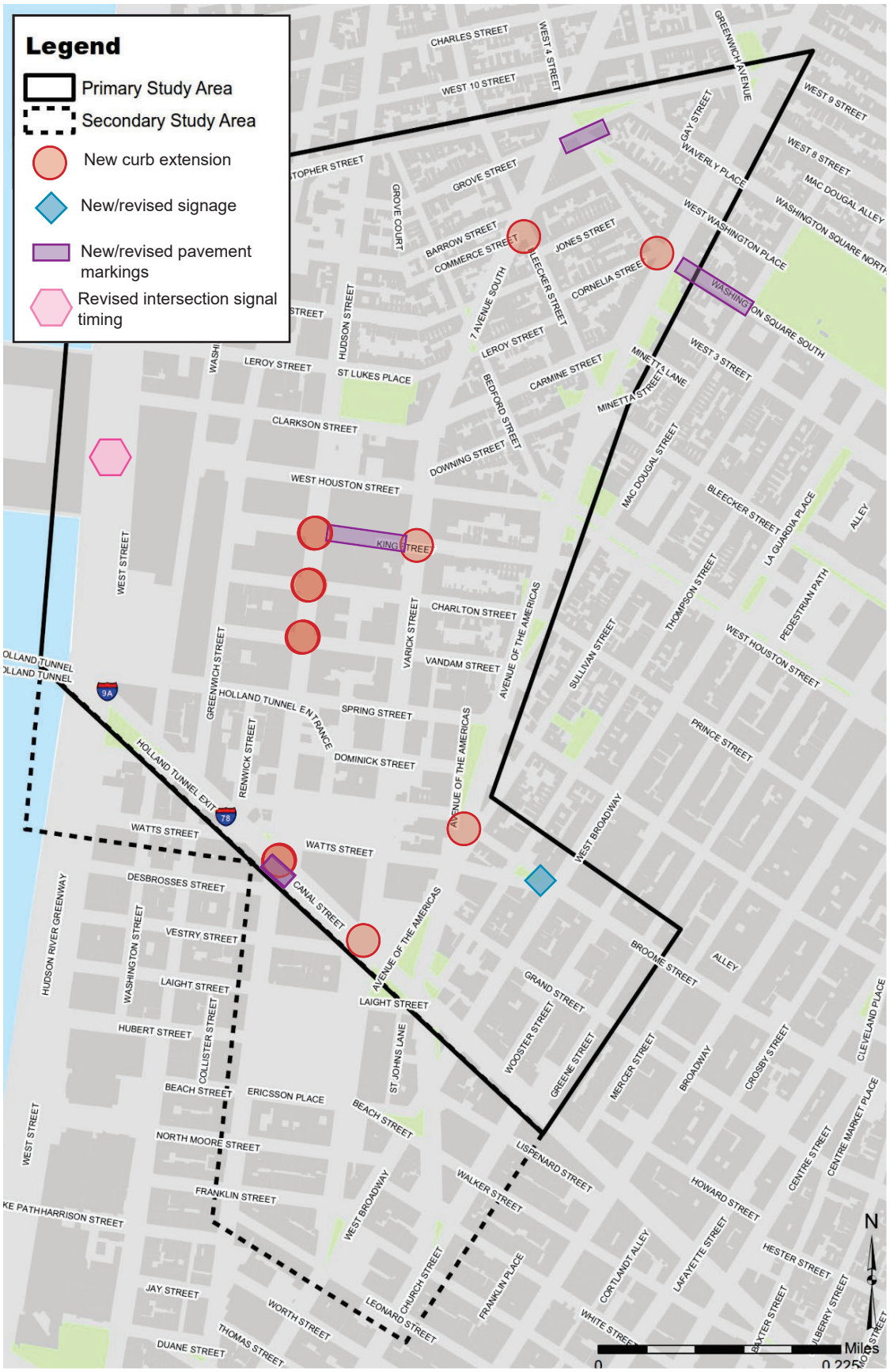


Figure 4-2 Early Action Locations

Signal Timing: At signalized intersections, conflicting traffic movements are assigned green times during different phases to allow for safe and efficient traffic flow. Signal timing refers to the amount of time allocated to the display of a traffic signal interval. Signal timing adjustments were implemented along 7th Avenue South/ Varick Street at 15 intersections in the study area by NYC DOT in 2018. In addition, a Leading Pedestrian Interval (LPI) was provided to give pedestrians a head-start, without any vehicle conflicts, when entering the north crosswalk at the 6th Avenue/West 4th Street/Cornelia Street intersection. Signal timing improvements were identified for implementation to provide a new pedestrian-only phase for the west crosswalk of West Street/Pier 40 driveway/West Houston Street.

Pavement Markings/Roadway Signage: Pavement markings are stripes, arrows, and other symbols installed on the roadway that provide guidance to drivers and bicyclists. Pavement markings provide street users clear direction by indicating permitted lane configurations and lane usage, alerting drivers and cyclists. Roadway signage utilizes symbols and words to provide regulatory, warning, and guidance to street users and is a critical element for wayfinding. As recommended in the study, additional pedestrian signage had been installed at West Street/Leroy Street and at West Street/Clarkson Street to discourage pedestrian crossings at the median opening on West Street at Leroy Street. In addition, the All-Way-Stop Control at Washington Street/Morton Street has been implemented.

Revised pavement markings and roadway signage were identified for implementation at the following locations throughout the study area:

1. West 4th Street between 6th Avenue and Washington Square West (Macdougal Street)
2. King Street from Hudson Street to Varick Street
3. Hudson Street/Canal Street
4. Broome Street/Watts Street/West Broadway
5. 7th Avenue South/Grove Street

In addition to new painted curb extensions, signal timing adjustments, revised pavement markings and new signage, multimodal improvements were identified for implementation at two locations to improve safety and connectivity. A protected bicycle lane was implemented in 2018 as part of NYC DOT's 7th Avenue Protected Bicycle Lane Safety Improvement project, from West 30th Street to Clarkson Street/Carmine Street along 7th Avenue/7th Avenue South. One of the recently completed improvements was to extend this bicycle lane from Clarkson Street / Carmine Street to West Houston Street.

Each of the issues and early action improvements expected for implementation by the end of 2021 are described in greater detail below for the following four corridors:

6th Avenue Corridor

- 6th Avenue/Broome Street
- West 4th Street between 6th Avenue and Washington Square West (Macdougal Street)
- 6th Avenue/West 4th Street/Cornelia Street

Hudson Street Corridor

- Hudson Street/Canal Street
- Charlton and Vandam Streets along Hudson Street
- King Street between Hudson and Varick Streets

Watts Street Corridor

- Broome Street/Watts Street/West Broadway

West Street Corridor

- West Street/West Houston Street

Varick Street Corridor

- 7th Avenue South/Grove Street
- 7th Avenue South/Commerce Street
- Varick Street/Canal Street

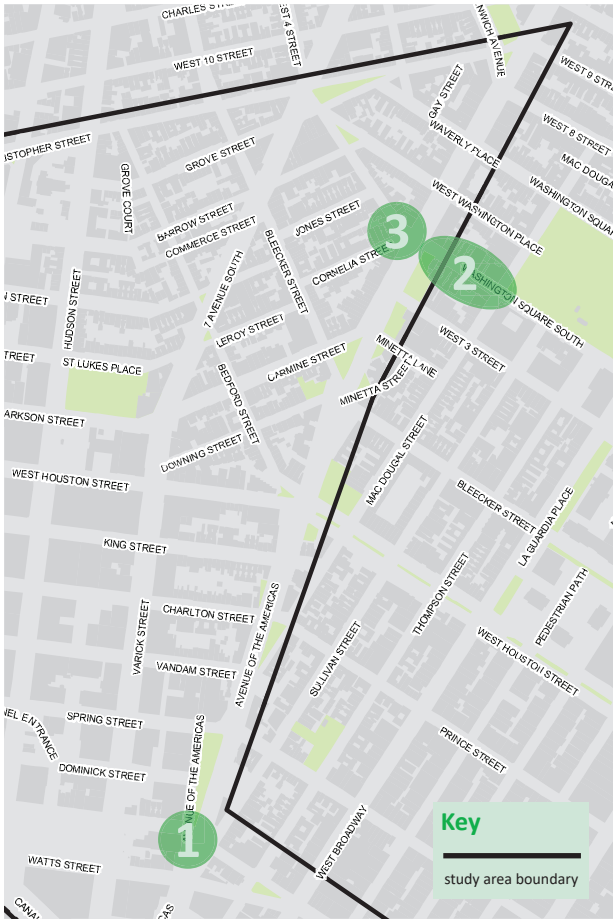
Photographs are provided for each issue and the affected transportation mode(s) are noted through icons on the top right corner of the page. Appendix 4A contains the conceptual drawings for these improvements.

6TH AVENUE CORRIDOR

1 6th Avenue /Broome Street

2 West 4th Street between 6th Avenue and Washington Square West

3 6th Avenue at West Fourth Street /Cornelia Street



6th Avenue/Broome Street

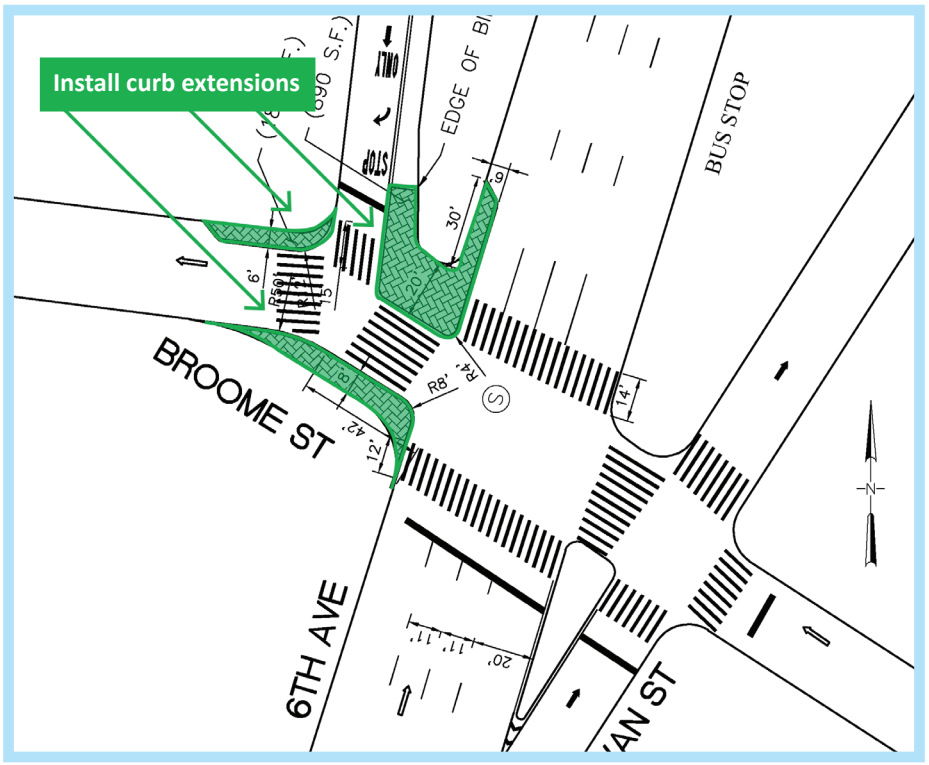
Issue

The intersection of 6th Avenue/Broome Street is part of a Vision Zero 2018 priority corridor. The 70 feet wide pedestrian crossing distance of 6th Avenue at Broome Street exposes crosswalk users to long crossing times and multiple conflict points with vehicles. There is also a high volume of school children crossing the intersection due to the Chelsea Vocational High School located at the northwest corner.

Looking north on 6th Avenue from the south side of Broome Street

Improvement

This interim improvement will provide three curb extensions at this intersection located along a Vision Zero Corridor. The curb extensions on the southwest corner of Broome Street/6th Avenue and the northwest corner of Broome Street/Little 6th Avenue will reduce the crossing distance across Broome Street. Extension of the channelization north of Broome Street between 6th Avenue and Little 6th Avenue will enable curb extensions for additional crossings. The temporary materials will be made permanent as part of a future improvement. A maintenance partner is needed for these extensions.



West 4th Street between 6th Avenue and Washington Square West

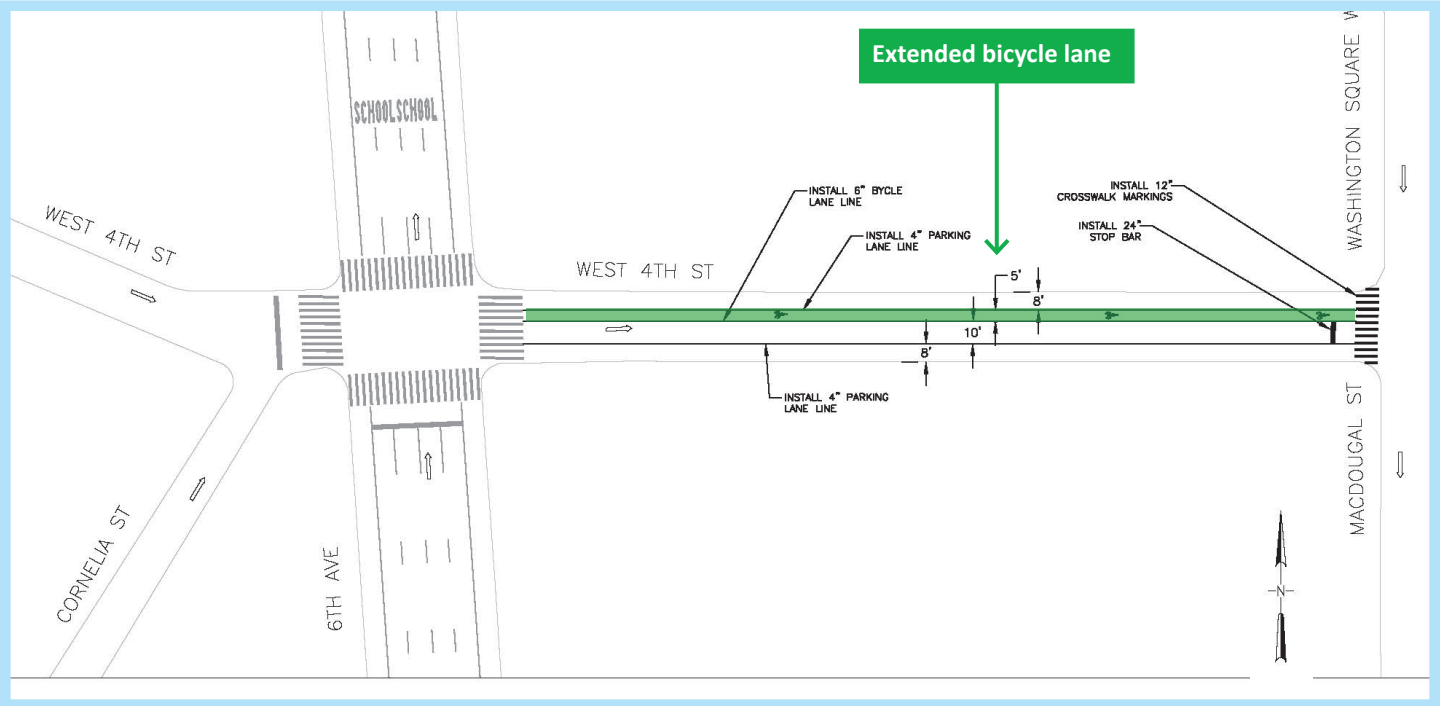
Issue

Drivers speed on West 4th Street between 6th Avenue and Washington Square West. There is a lack of pavement striping to distinguish parking and through traffic lanes along the roadway, which exacerbates this issue.

Looking east on West 4th Street from 6th Avenue

Improvement

The improvement will designate parking lanes with striping along both sides of West 4th Street. As part of the striping changes, an opportunity was identified to extend the conventional bicycle lane along West 4th Street from its current terminus at Macdougal Street / Washington Square West. This bicycle lane extension has already been installed and reduces the width of the travel lane to 10 feet to discourage speeding.



6th Avenue at West 4th Street/Cornelia Street

Issue

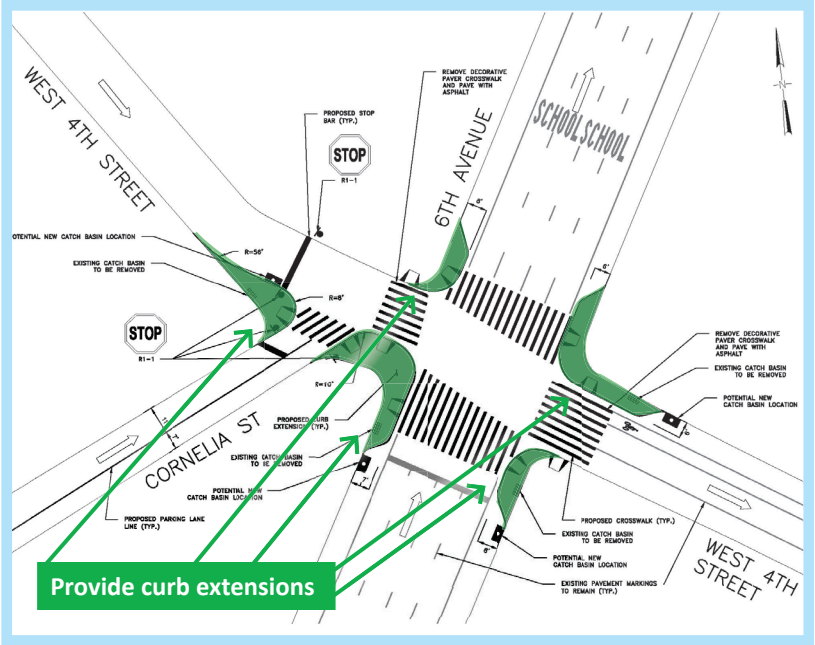
The convergence of Cornelia Street and West 4th Street is located immediately to the west of the intersection with 6th Avenue. Existing traffic control includes STOP signs on the West 4th Street and Cornelia Street approaches and signalization of the West 4th Street intersection with 6th Avenue. This mixed-control can cause confusion to drivers and people walking. In addition, there are many vehicle conflicts with people walking in the north crosswalk of 6th Avenue (60 feet wide).

Aerial view of 6th Avenue/West 4th Street/Cornelia Street

Improvement

The Study investigated the installation of curb extensions and the signalization of Cornelia Street and West 4th Street. These improvements were aimed at exploring ways to improve safety for all users of the intersection. There is an opportunity to reduce the pedestrian crossing distances by providing curb extensions at all four corners of the intersection of 6th Avenue/West 4th Street and on the southwest corner of West 4th Street/ Cornelia Street. Providing curb extensions is recommended, as the design would not impede emergency vehicle access including fire truck turns to and from 6th Avenue. The curb extensions would decrease pedestrian exposure to vehicle conflicts, provide additional walking circulation on the corners, as well as slow turning vehicles. A maintenance partner is needed for these curb extensions.

The signal modification option that was explored would replace the existing STOP control on the eastbound West 4th Street approach and at the northbound Cornelia Street approach with traffic signal control that would be connected with the existing 6th Avenue signal. This would provide separate signal phases for the West 4th Street and Cornelia Street approaches.
However, signalizing the Cornelia Street and West 4th Street intersection is not recommended due to the potential for conflicting signal indications being presented to drivers approaching 6th Avenue from West 4th Street and due to potential conflicts between drivers on Cornelia Street and people walking in the north crosswalk.

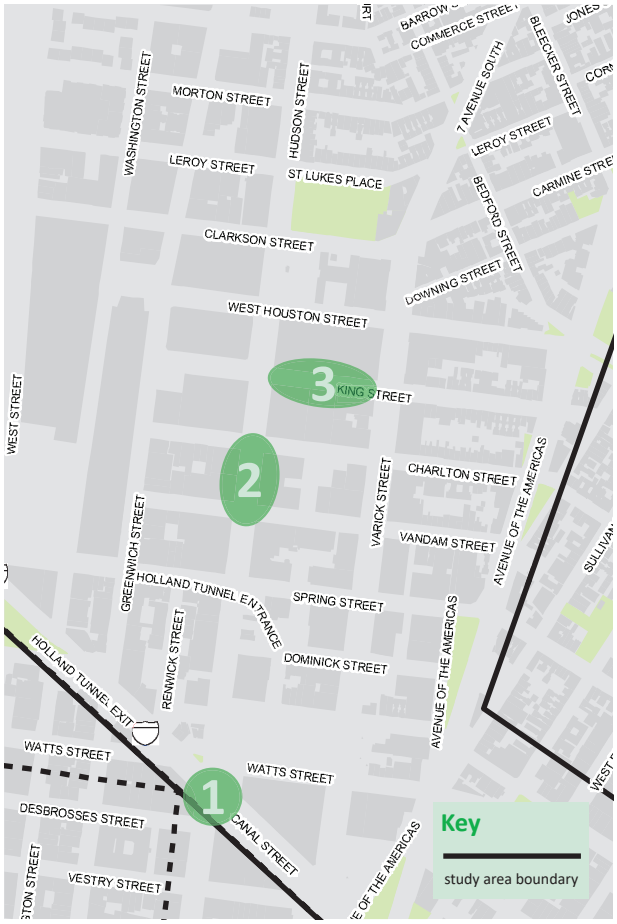


HUDSON STREET CORRIDOR

1 Hudson Street/Canal Street

2 Charlton and Vandam Streets along Hudson Street

3 King Street between Hudson Street and Varick Street

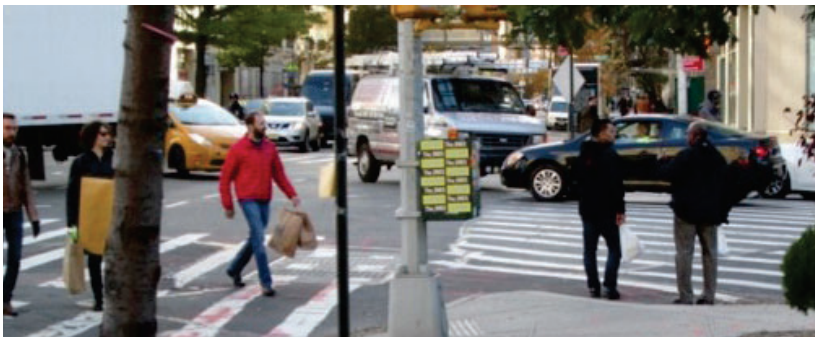


Hudson Street/Canal Street

Issue

Walking access and connectivity across Canal Street at Hudson Street are limited by long crossing distances and multiple lanes of turning vehicles. In addition, turning lane alignment markings on Hudson Street for motorists approaching the Holland Tunnel require updating.

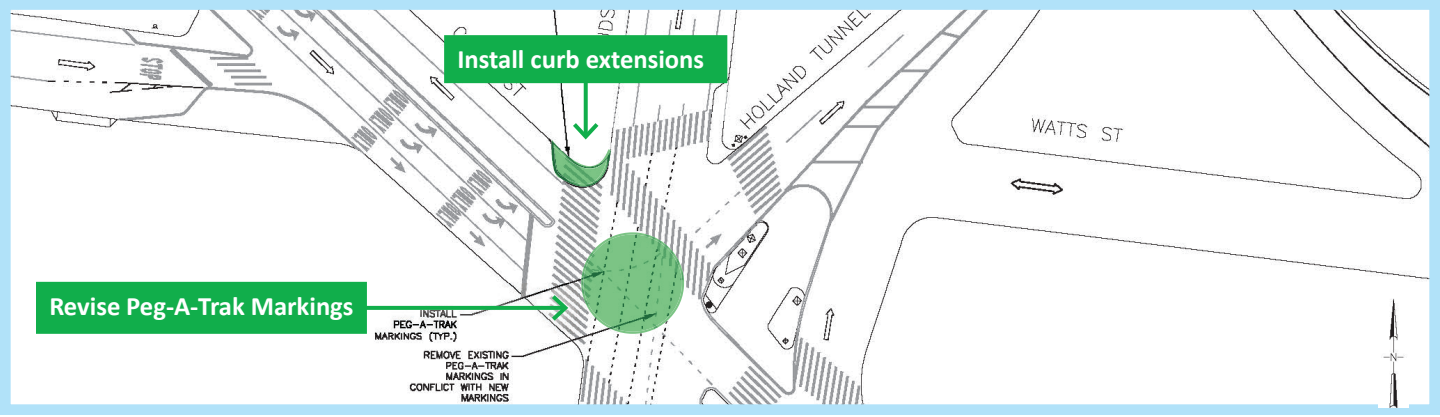
Looking north on Hudson Street at Canal Street to Holland Tunnel entrance



Looking south on Hudson Street from north of Canal Street

Improvement

The early action improvements will provide an interim curb extension on the northwest corner of Canal Street and Hudson Street and will revise Peg-A-Trak pavement markings on the northbound Hudson Street lanes. The curb extension will reduce the 80 feet long pedestrian crossing distance of Canal Street and improve connectivity for people walking along Hudson Street. A maintenance partner is needed for this curb extension. The updated Peg-A-Trak markings will more appropriately guide motorists into the Holland Tunnel from Hudson Street. The temporary curb extension will be made permanent as part of a future improvement program along Hudson Street.



Charlton and Vandam Streets along Hudson Street

Issue

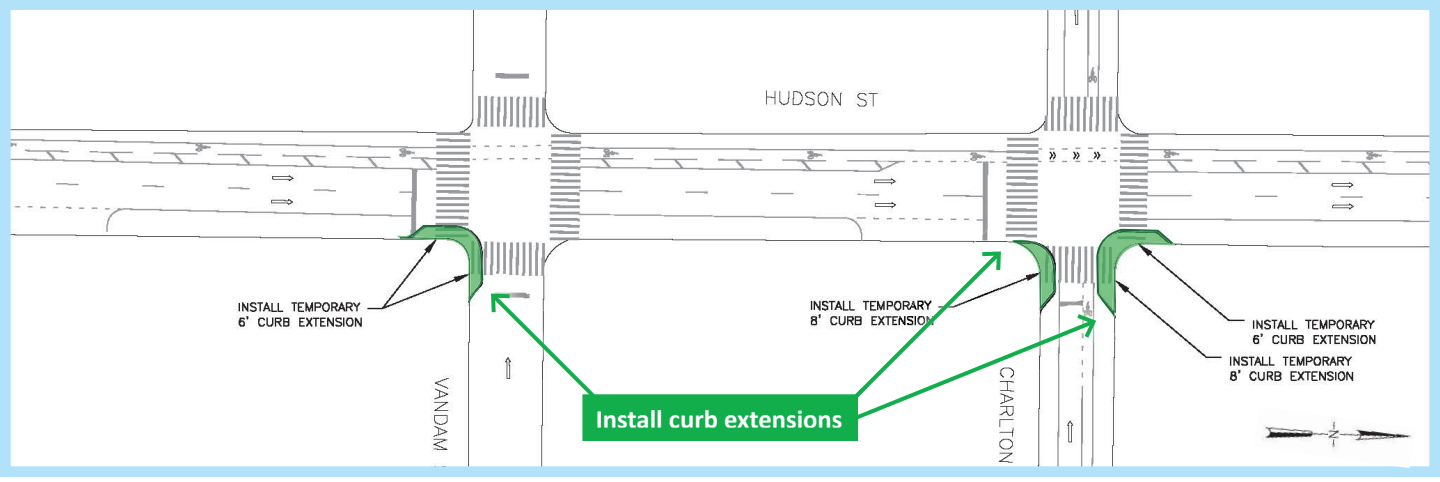
Hudson Street is a major northbound corridor in Manhattan. There are longer pedestrian crossings distances than necessary at Charlton and Vandam Streets along Hudson Street. There is an opportunity to reduce crossing distances using the parking lanes along both curbs.

Looking north at Hudson Street on Charlton Street

Looking north at Hudson Street on Vandam Street

Improvement

This early action improvement will provide temporary curb extensions along Hudson Street on the northeast and southeast corners of Charlton Street and on the southeast corner of Vandam Street. The curb extensions will reduce the crossing distance of Hudson Street and the two cross streets at a total of five crosswalks. The shortened crosswalks will reduce the exposure of pedestrians to conflicts with vehicular traffic. A maintenance partner is needed for these curb extensions. The temporary curb extensions will be made permanent as part of a future improvement. Implementation will be coordinated with the Hudson Street improvement project.



King Street between Hudson and Varick Streets

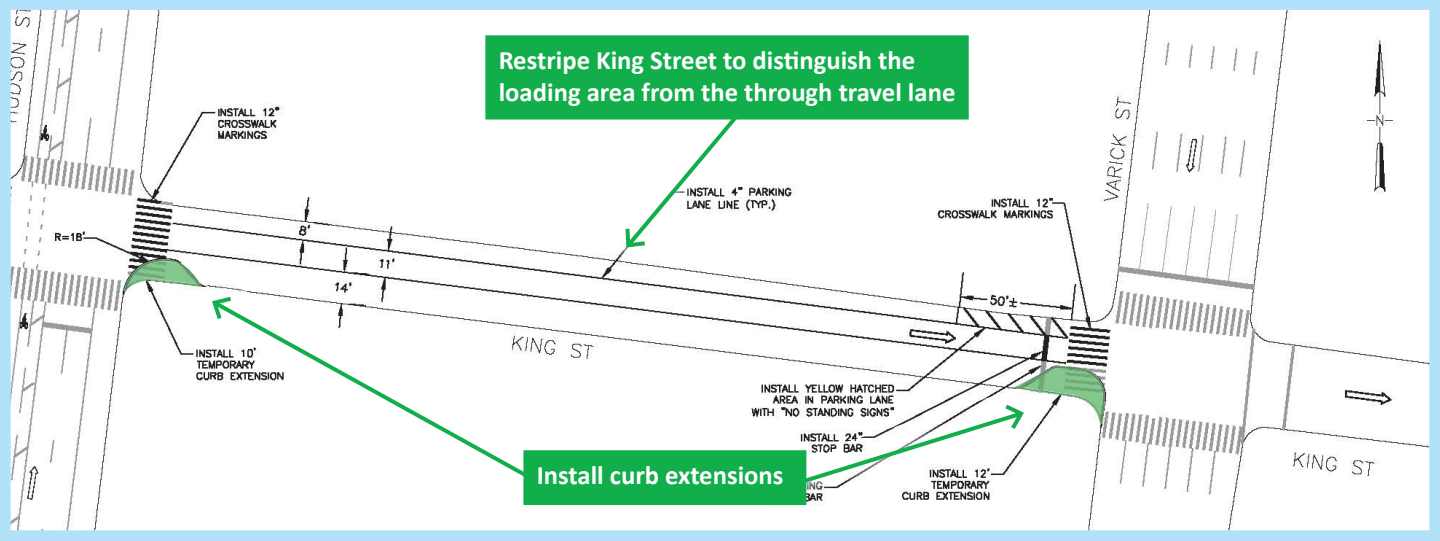
Issue

There are numerous loading docks and significant curbside loading along this block of King Street between Hudson Street and Varick Street. These activities result in conflicts between through vehicles and trucks in or near the loading docks.

Looking east on King Street

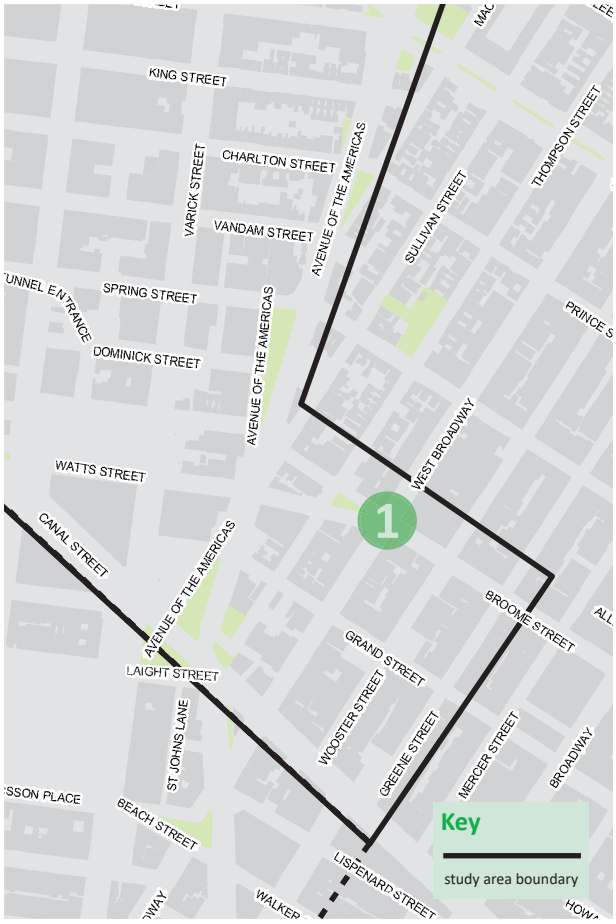
Improvement

The early action improvement will restripe King Street to distinguish the loading area from the through travel lane and reduce conflicts on this block. As part of this improvement, interim curb extensions will be provided along King Street on the southeast corner at Hudson Street and the southwest corner at Varick Street to physically align vehicles in the travel lane and away from stopped vehicles in the loading areas in the south curb lane. These curb extensions will also reduce the exposure of people crossing King Street to conflicts with vehicular traffic. A maintenance partner is needed for the curb extension on the southeast corner at Hudson Street. The temporary curb extensions will be made permanent as part of a future improvement. Implementation of the King Street/Hudson Street curb extension will be conducted with the Hudson Street improvement project.



WATTS STREET CORRIDOR

1 Broome Street/Watts Street/ West Broadway



Broome Street/Watts Street/West Broadway

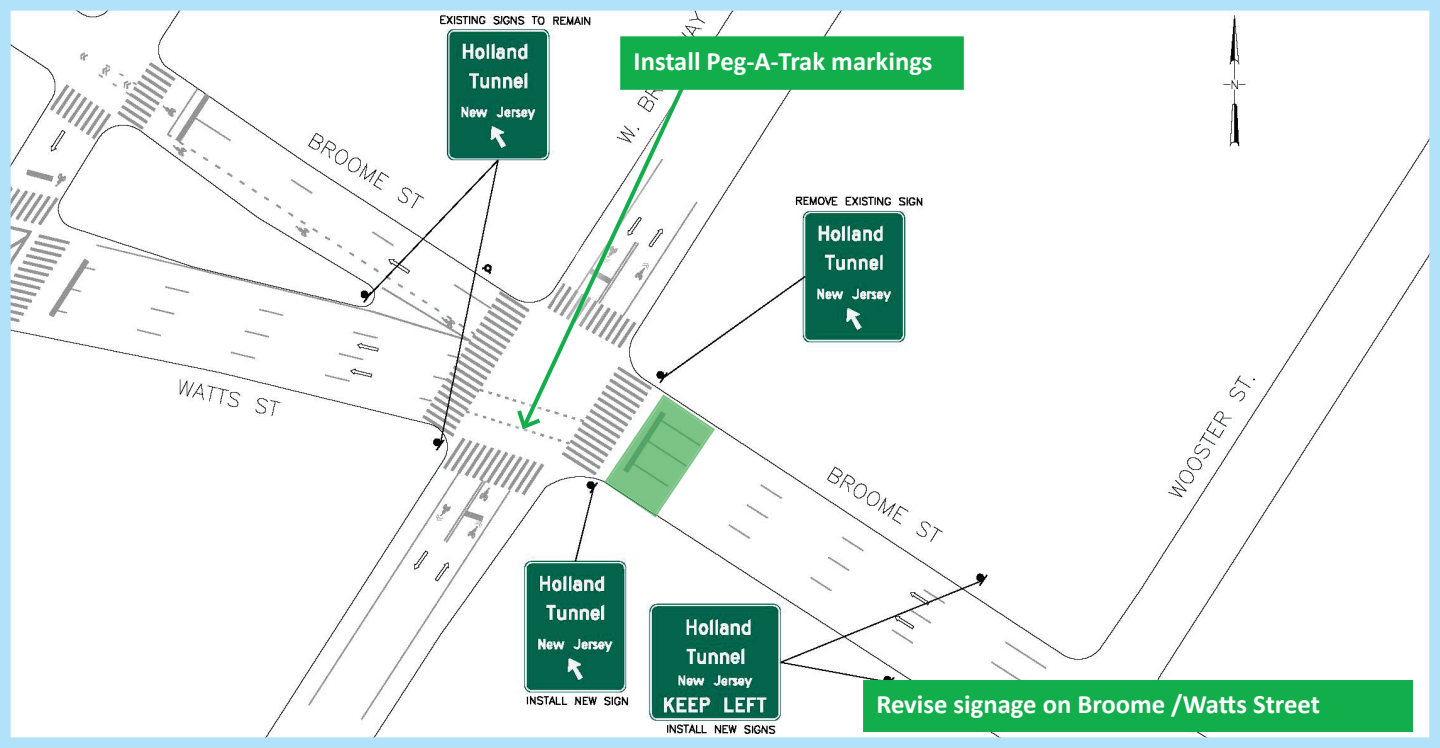
Issue

There is congestion and driver confusion at the diverge between westbound Watts Street and Broome Street at West Broadway. There is an opportunity to help address geometric and signage issues at this intersection.

Looking west at the intersection of Broome Street/Watts Street/West Broadway

Improvement

This early-action improvement will revise signage on Broome Street approaching the diverge between Watts Street and Broome Street to alleviate confusion. In addition Peg-A-Trak markings will be installed at this intersection to better guide motorists as they approach the Holland Tunnel.



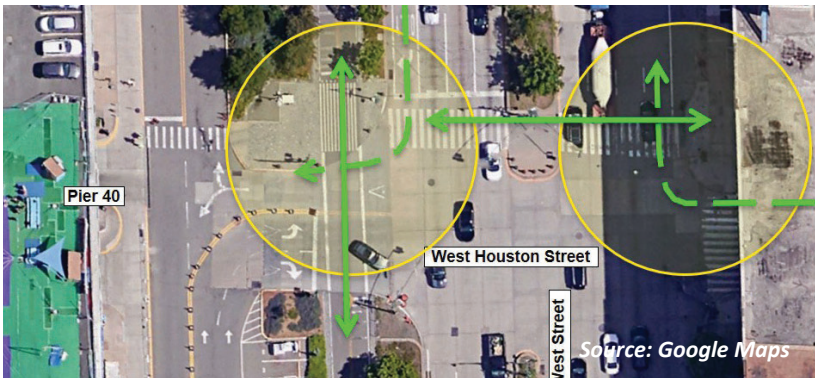
WEST STREET CORRIDOR

1 West Street/West Houston Street

West Street/West Houston Street

Issue

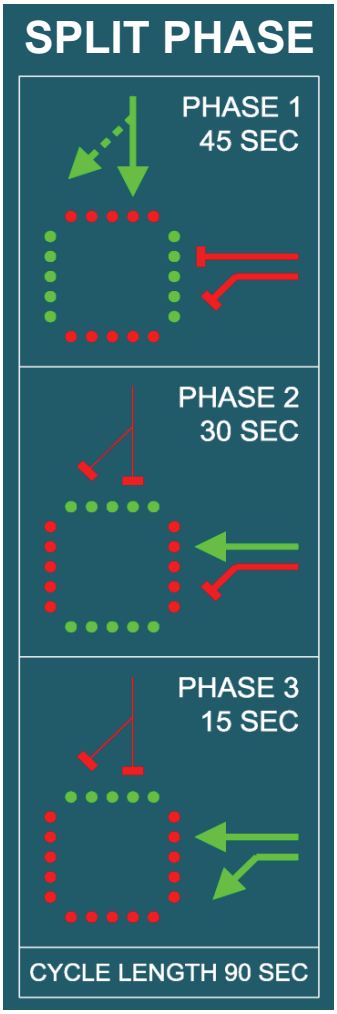
Stakeholders raised concerns about the high volume of turning vehicles conflicting with people walking in the west crosswalk by Hudson River Park.



Aerial view of West Houston Street and West Street intersection

Improvement

NYC DOT has developed signal timing changes to provide a new pedestrian-only phase for the west crosswalk of Pier 40 driveway/West Houston Street. This would reduce conflicts between the southbound West Street right turn to Pier 40 and people walking in the west crosswalk. Coordination with NYS DOT is on-going for the implementation of this improvement.



Key

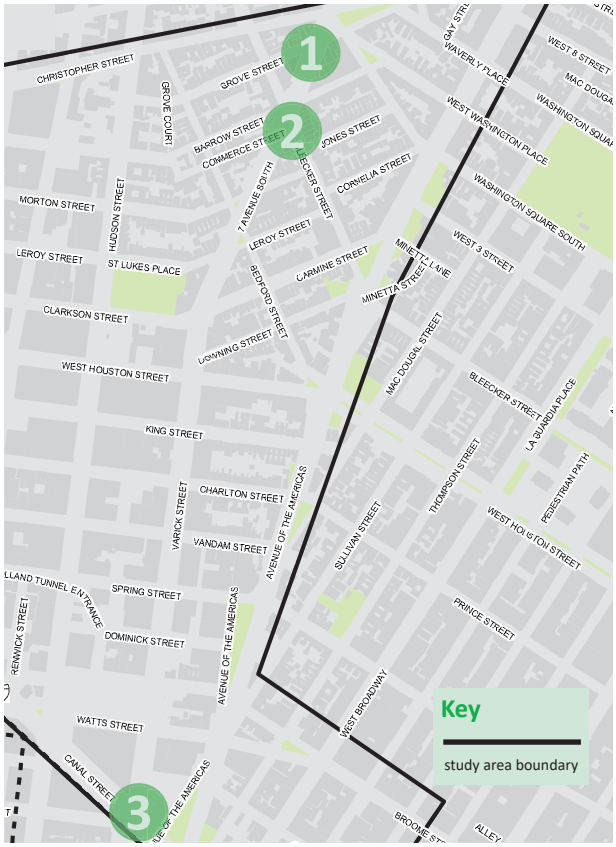
- permitted pedestrian crossing
- stopped pedestrian crossing
- permitted vehicle movement
- stopped vehicle movement

7TH AVENUE SOUTH / VARICK STREET CORRIDOR

1 7th Avenue South/Grove Street

2 7th Avenue South/Commerce Street

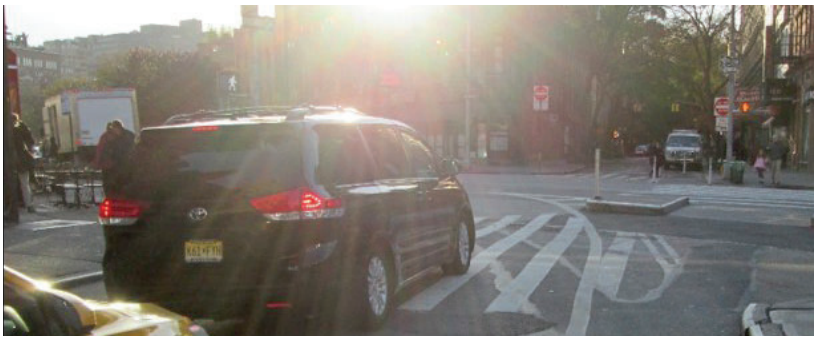
3 Varick Street/Canal Street



7th Avenue South/Grove Street

Issue

The median on the east side of 7th Ave South between West 4th Street and Grove Street extends into the travel lanes, making vehicle turns difficult and potentially guiding vehicles towards the pedestrian cut-through.

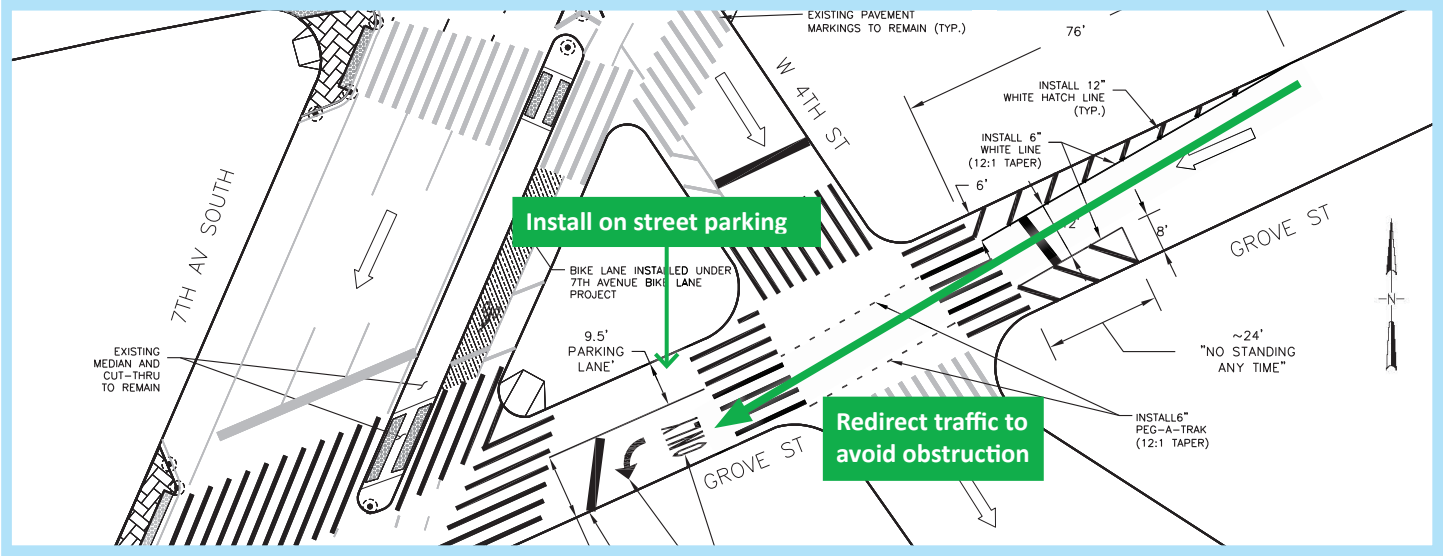


Vehicles turning onto 7th Avenue South from Grove Street

Looking west on Grove Street at 7th Avenue South

Improvement

This early action improvement consists of restriping the westbound Grove Street approach to 7th Avenue South to direct traffic away from the pedestrian facilities on 7th Avenue South. The improvement will also provide on-street parking on the north side of Grove Street between West 4th Street and 7th Avenue South.



7th Avenue South/Commerce Street

Issue

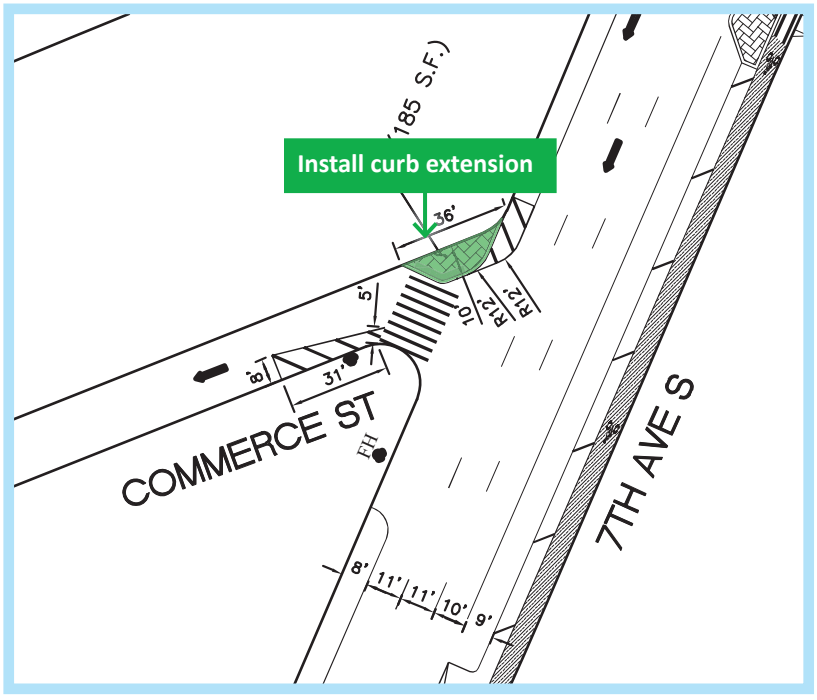
7th Avenue South is a major southbound arterial leading to the Holland Tunnel.

Southbound 7th Avenue right-turning vehicles to Commerce Street have been observed turning at unsafe speeds due to the lack of intersection control and obtuse angle, creating a potentially dangerous conflict with people crossing in the west crosswalk.

Looking south on 7th Avenue South at Commerce Street

Improvement

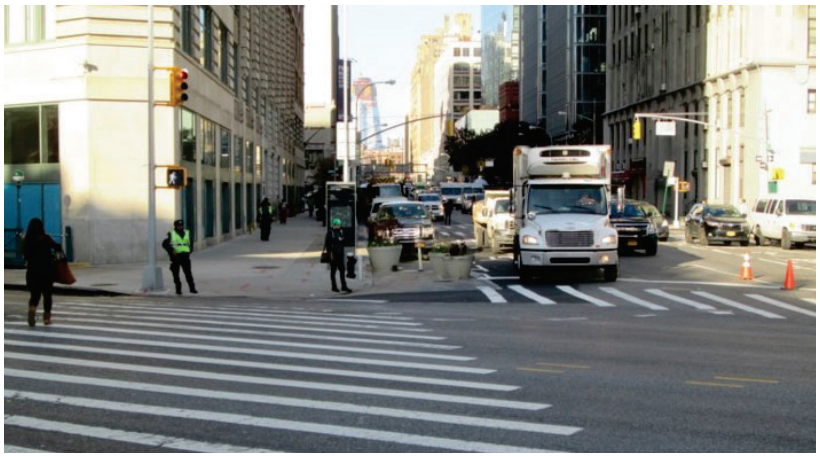
This early action improvement will install a temporary curb extension on the northwest corner of 7th Avenue South and Commerce Street to reduce the crossing distance for people crossing in the west crosswalk and slow traffic that is turning right onto Commerce Street. A maintenance partner is needed for this curb extension. The temporary curb extension will be made permanent as part of a future improvement.



Varick Street/Canal Street

Issue

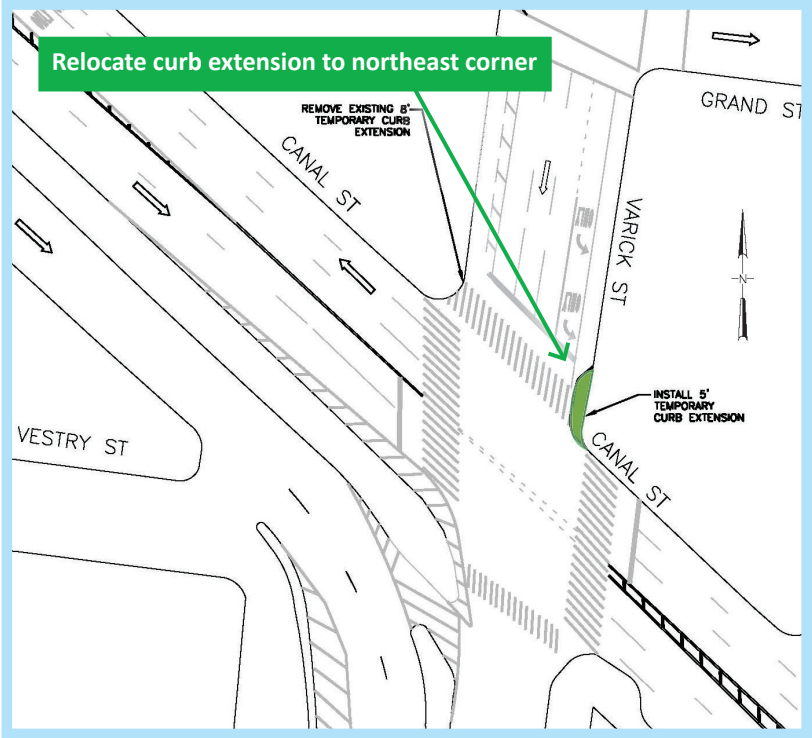
The curb extension on the northwest corner of Varick Street and Canal Street creates a challenging turning movement for southbound trucks turning right onto westbound Canal Street. Due to the existing geometry, trucks must turn into the left lane of westbound Canal Street, which may block the crosswalk and two lanes of traffic.



Looking North on Varick Street at Canal Street

Improvement

The improvement will replace the existing curb extension on the northwest corner with a curb extension on the northeast corner to alleviate the irregular turning geometry for southbound trucks turning right onto westbound Canal Street. Relocating the curb extension to the northeast corner will help retain the reduced pedestrian crossing distance currently provided by the curb extension on the northwest corner. A maintenance partner is needed for this curb extension. The temporary curb extensions will be made permanent as part of a future improvement.



4.3 Future Improvement Options

Based on the issues identified in Chapter 2, Existing Conditions, potential improvements were identified that could not be implemented as early actions. Based on a series of discussions held with the TAC and other stakeholders, a comprehensive list of locations needing longer-term improvements was identified. The improvements addressed in this section include those which required a quantitative analysis as part of the assessment and/or those that would involve design and funding through the capital construction program. As noted earlier, improvements identified in this section that are selected for implementation could be expected to be implemented after 2021. No capital funding has been identified for these projects. These improvements may be pursued at such time as funding sources are identified.

This section presents the issues identified by stakeholders, considerations and improvements that were evaluated as part of this study, the results of the assessments that were prepared using traffic simulation tools, and a recommendation as to whether an option should be progressed further. Appendix 4B contains the conceptual drawings for these improvements. Improvements at the following locations along four key corridors were assessed and are depicted in **Figure 4-3**:

6th Avenue Corridor

- 6th Avenue between West Houston Street and King Street
- Bus Rerouting on 6th Avenue from Watts Street to Canal Street
    - Phase I (weekday PM-period only)
    - Phase II (permanent dedicated bus lane)

West Street Corridor

- West Street/Leroy Street
- Canal Street between Canal Park and Greenwich Street
- Clarkson Street between West Street and Greenwich Street
- West Street between West Houston Street and Canal Street

Broome/Watts Street Corridor

- Broome/Watts Streets between West Broadway and Varick Street

7th Avenue South/Varick Street Corridor

- Varick Street between King Street and Spring Street
- Varick Street between West Houston Street and Canal Street

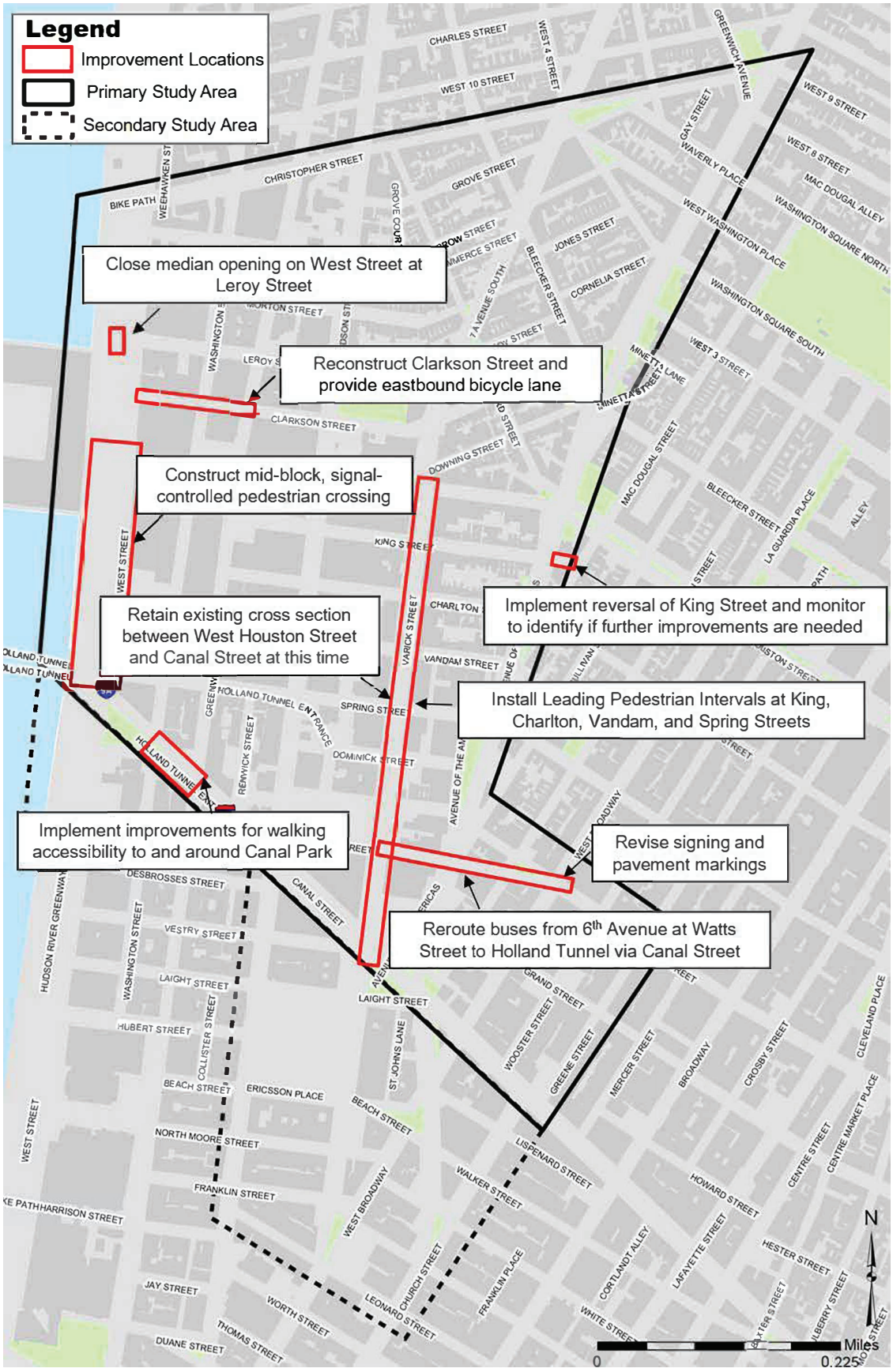


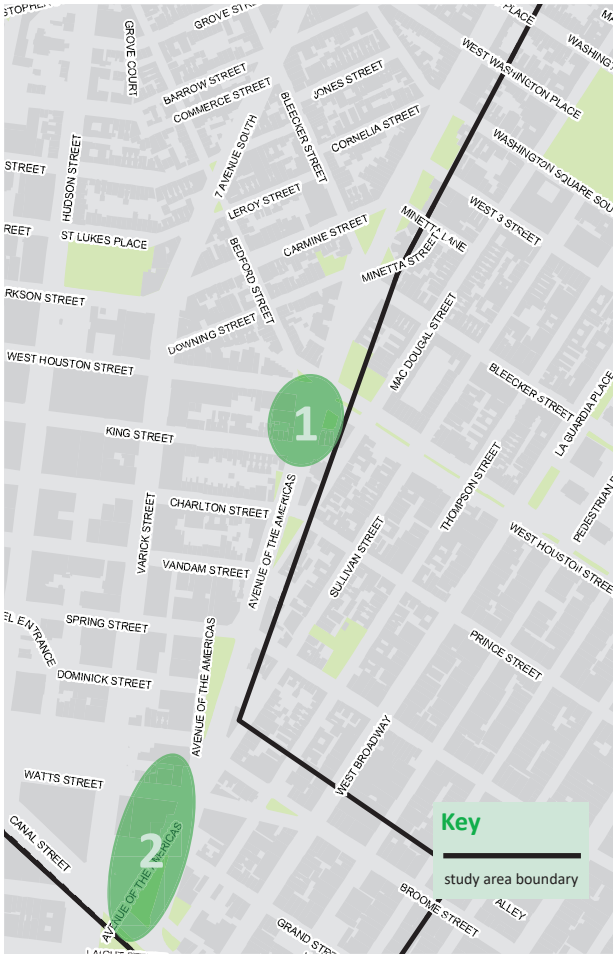
Figure 4-3 Future Improvement Locations

6TH AVENUE CORRIDOR

1 6th Avenue between West Houston Street and King Street

2 Bus Rerouting from 6th Avenue at Watts Street

- Phase I (weekday PM-period only)
- Phase II (permanent dedicated bus lane)

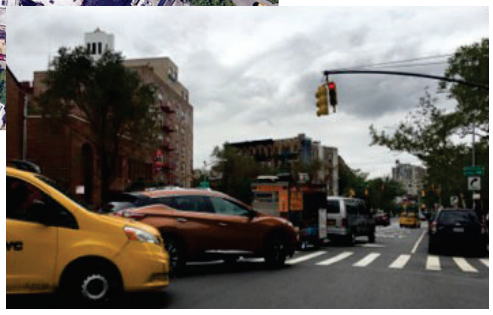


6th Avenue between West Houston Street and King Street

Issue

Due to West Houston Street's one-way westbound configuration between 6th Avenue and West Street, vehicles desiring to travel eastbound on West Houston Street tend to access the corridor via eastbound King Street. The vehicle movement from eastbound King Street to eastbound West Houston Street via 6th Avenue is difficult during peak periods and contributes to blocking-the-box and long delays at this location. Particularly on northbound 6th Avenue, queues extend south from the right turn lane at West Houston Street and reach the intersection at King Street, causing vehicles to block crosswalks and congestion. King Street, west of 6th Avenue, is one-way eastbound while King Street, east of 6th Avenue, is one-way westbound. This "head-on" condition of opposing westbound and eastbound traffic flows creates conflicts between vehicles turning from eastbound King Street that are predominantly destined for eastbound West Houston Street and vehicles from westbound King Street that generally travel north on 6th Avenue.

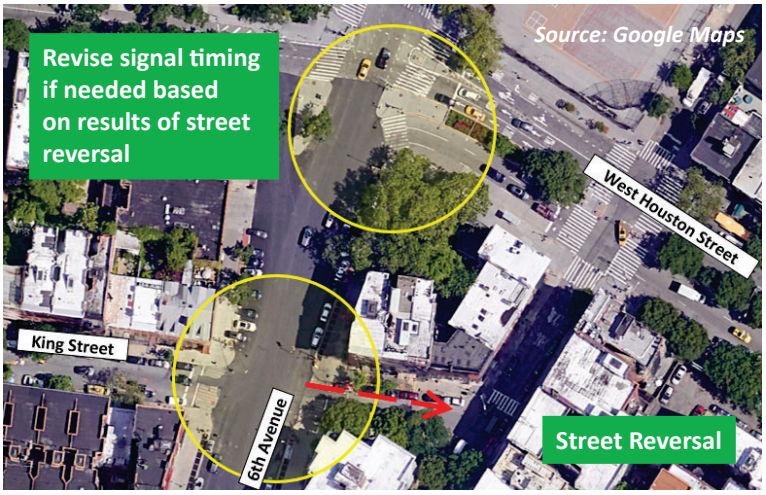
LEFT Difficulty accessing eastbound West Houston Street from eastbound King Street along 6th Avenue



RIGHT Cars from King Street merging into the right-turn lane on 6th Avenue towards West Houston Street

Improvement

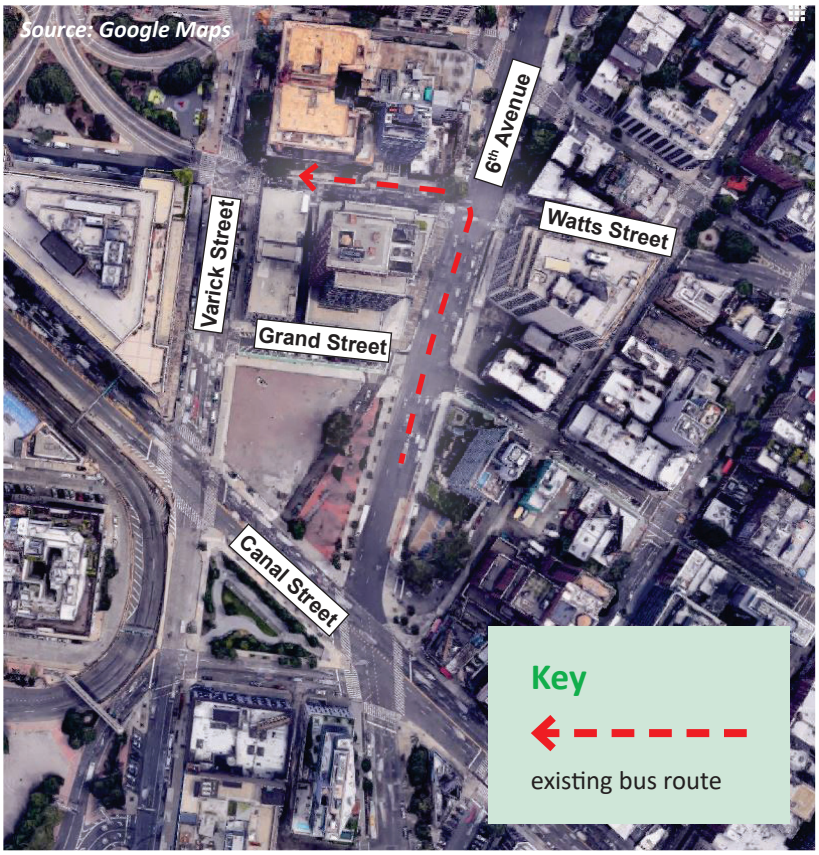
Three options were investigated to improve accessibility from eastbound King Street to eastbound West Houston Street via 6th Avenue. The first option, to provide separate King Street traffic signal phases for the eastbound and westbound approaches, did not yield the desired results and is not recommended for advancement. A second option, to reverse the direction of the westbound King Street approach, should be progressed and implemented as a first step in improving the conditions at this location. This option would involve installing new STOP control signs on the reconfigured, eastbound King Street approach to Macdougal Street. A third option, increasing the green time for the northbound right-turn vehicular movement, would reduce the pedestrian crossing time for the crosswalk that spans from the southeast corner to the pedestrian refuge island on West Houston Street. The pedestrian crossing time would still exceed the minimum time needed to cross the street. This incremental improvement can only be progressed if the King Street reversal does not yield the desired results.



Bus rerouting on 6th Avenue from Watts Street to Canal Street

Issue

During the weekday PM peak period, the existing bus route to the New Jersey-bound Holland Tunnel requires buses to turn left from 6th Avenue to Watts Street and access the Tunnel via the Watts Street entrance at Varick Street. Due to the size of these buses and their larger turning radii, this movement obstructs pedestrian and vehicular traffic through the intersection of 6th Avenue/Watts Street and contributes to extensive queues that extend east on Broome/Watts Street from the Holland Tunnel's Watts Street entrance at Varick Street. The bus lane on the north side of Watts Street is currently closed due to construction between 6th Avenue and Varick Street and exacerbates the intersection blockage issue.



Aerial view of existing bus route to Holland Tunnel

Looking north on 6th Avenue approaching the Holland Tunnel entrance via Watts Street

Facing northeast from Watts Street at 6th Avenue

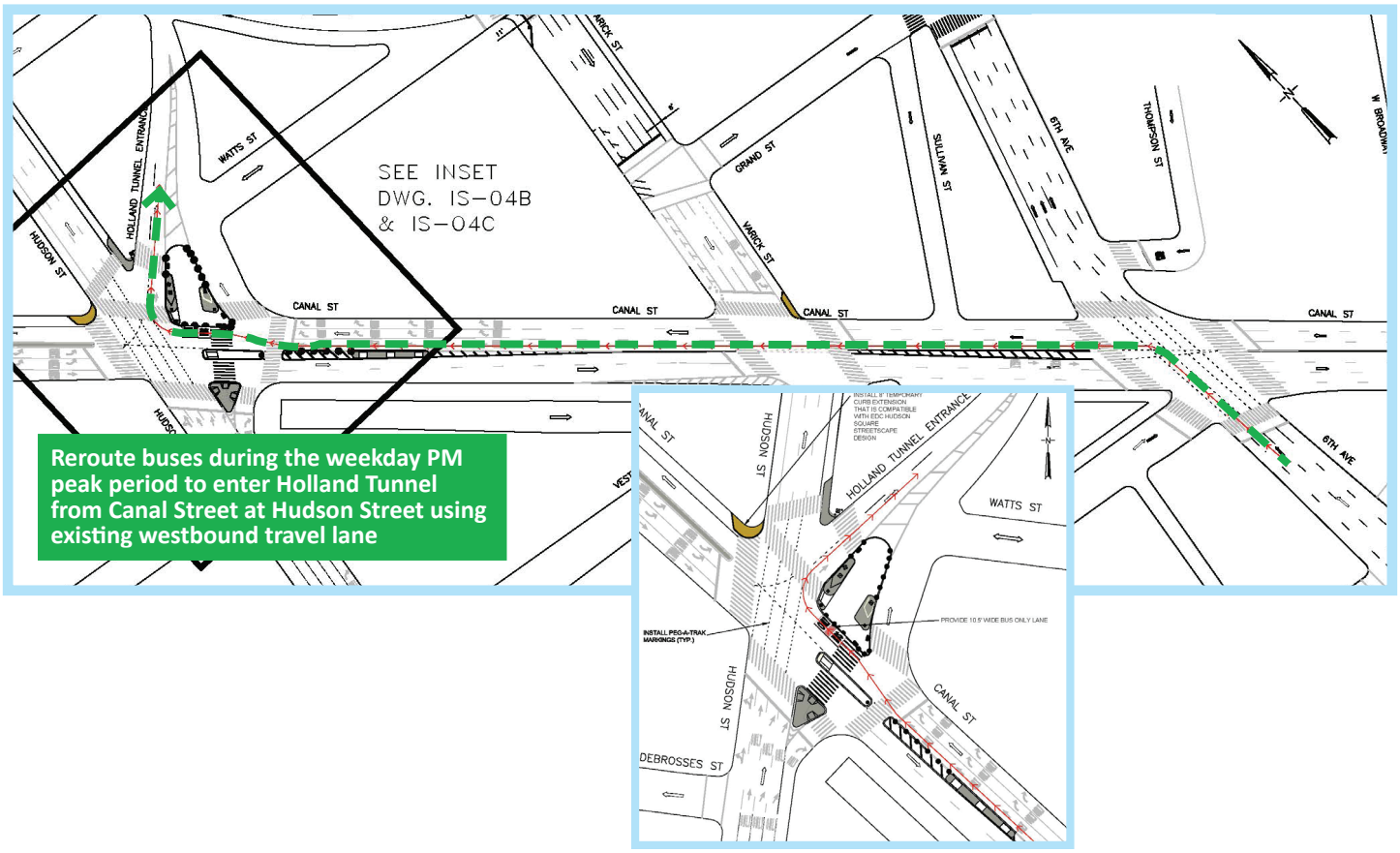
Bus rerouting on 6th Avenue from Watts Street to Canal Street (cont'd)

Improvements

There are two potential phases for rerouting Tunnel-bound buses on 6th Avenue from the Watts Street entrance on Varick Street to the Hudson Street entrance by turning left onto Canal Street and using westbound Canal Street instead of Watts Street. Phase I would route buses into the existing westbound through lane on Canal Street and be applied during the weekday PM peak only. Phase II would provide a permanent, dedicated westbound bus-only lane on Canal Street between 6th Avenue and Hudson Street that could be used throughout the day. This would reconfigure Canal Street between 6th Avenue and the Tunnel entrance to convert one eastbound lane into a permanent westbound bus-only lane.

Phase I (Weekday PM-period only)

Phase I, using the existing westbound through lane on Canal Street to access the Tunnel's Hudson Street entrance, is recommended for implementation during the weekday PM peak period. During this time period, buses would be rerouted to turn left from northbound 6th Avenue onto Canal Street instead of continuing north and traversing the intersection of 6th Avenue and Watts Street. It would enable buses to enter the Tunnel at Hudson Street and bypass the right-turn queue in the two Tunnel-bound lanes along Canal Street. This improvement will be accomplished with lane markings and signing modifications and will be closely coordinated with the private bus carriers. It will also be monitored by NYC DOT to determine if further operational or design refinements are needed.



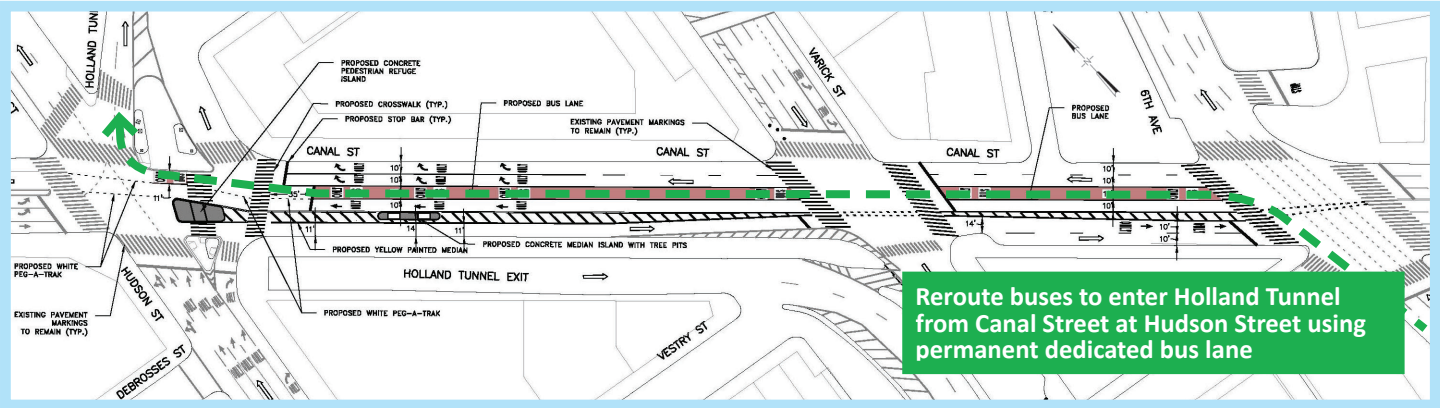
Reroute buses during the weekday PM peak period to enter Holland Tunnel from Canal Street at Hudson Street using existing westbound travel lane

Bus rerouting on 6th Avenue from Watts Street to Canal Street (cont'd.)

Improvements

Phase II (Permanent dedicated bus lane)

The potential Phase II for rerouting buses would reconfigure Canal Street between 6th Avenue and the Holland Tunnel entrance by converting one of two eastbound lanes to a westbound bus-only lane to facilitate bus access to the Tunnel. Phase II would create a permanent, dedicated bus lane, compared to the PM-peak only, Phase I operation. The reconfiguration of Canal Street as shown in the concept plan was deemed infeasible due to the heavy westbound Canal Street through volumes, which could not be accommodated in a single lane between 6th Avenue and Hudson Street.



Recommendations

It is recommended to evaluate the Phase I action using temporary materials during the PM peak to (1) identify the impact of rerouting buses to use the westbound through lane on Canal Street, (2) monitor impacts to identify how this change affects the larger street network and what modifications may be needed, and (3) determine whether major changes to the Phase II concept should be further investigated.

An additional Traffic Enforcement Agent (TEA) could be assigned at the Hudson Street entrance to the Holland Tunnel to help manage traffic flow and control bus turning conflicts with people walking in the north crosswalk on Hudson Street. Due to the rerouting of buses and improved traffic operations, it may be possible to reassign a TEA from the intersection of 6th Avenue/Watts Street to the Hudson Street Tunnel entrance.

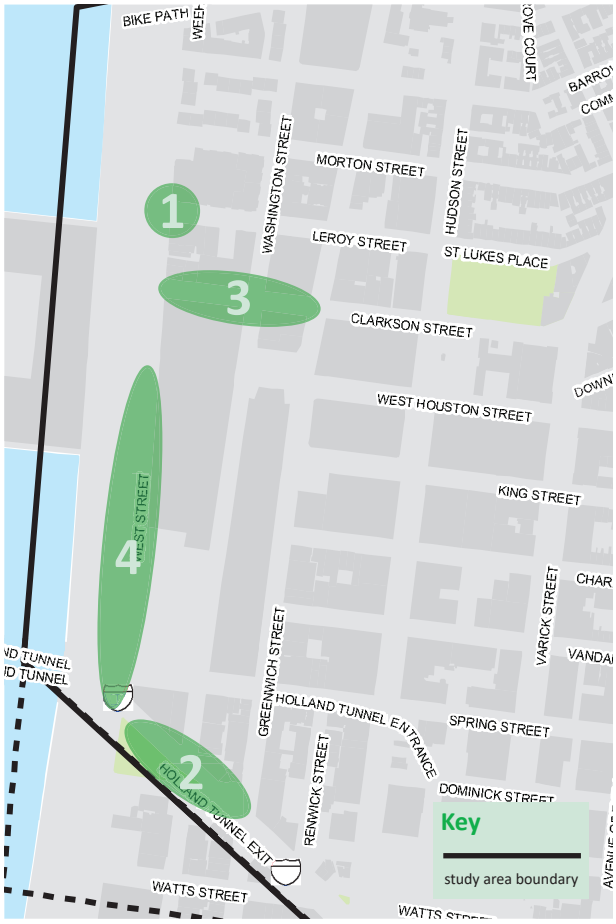
WEST STREET CORRIDOR

1 West Street/Leroy Street

2 Canal Street between Canal Park and Greenwich Street

3 Clarkson Street between West Street and Greenwich Street

4 West Street between West Houston Street and Canal Street

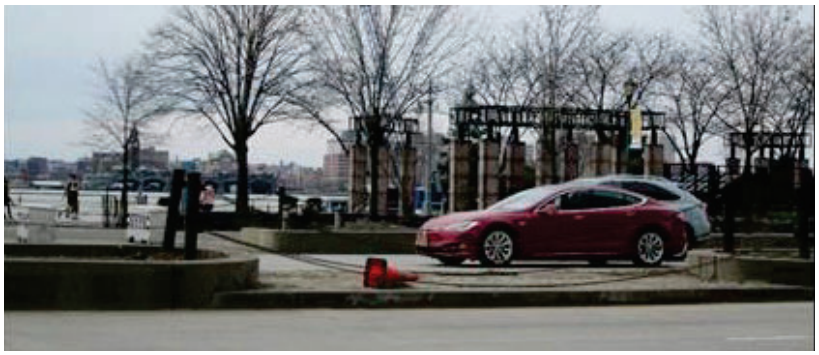


West Street/Leroy Street

Issue

West Street is part of New York State Route 9A and is a major arterial that facilitates car, bus, and truck traffic to and from the Hugh Carey Tunnel, the Holland Tunnel, and Lower Manhattan. While there are signalized crosswalks along West Street at Morton and Clarkson Streets, there is no crosswalk or traffic signal at Leroy Street. However, the opening in the median at Leroy Street allows for unauthorized and unsafe pedestrian crossings across this eight-lane wide section of West Street.

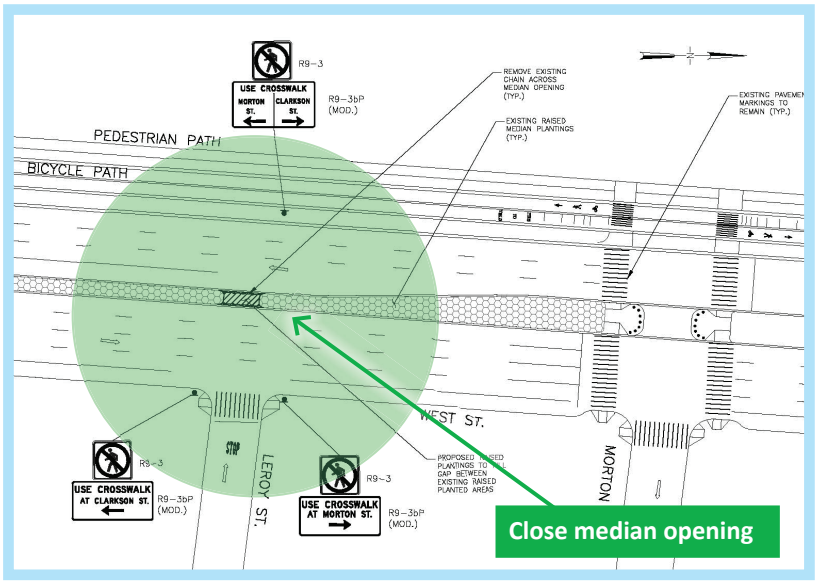
Aerial view of West Street/Leroy Street intersection



Looking west onto West Street at Leroy Street, where unauthorized pedestrian crossings occur

Improvement

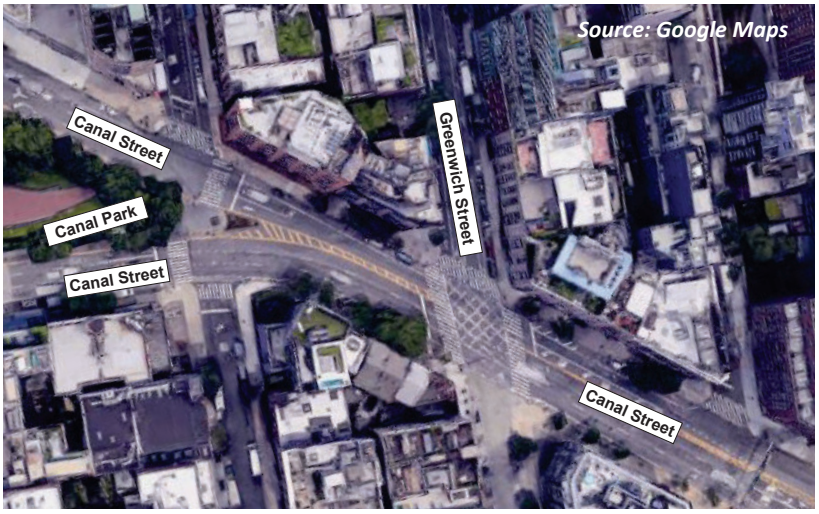
To prevent unsafe pedestrian crossings at Leroy Street, it is recommended that the median opening be closed and people walking be encouraged to use the nearby signalized crosswalks at Morton Street and Clarkson Street. The NYPD, FDNY, and NYS DOT expressed support for closing this median opening. Coordination with the Hudson River Park Trust will be required for the implementation of this improvement. As an early action, signing has been enhanced to guide people walking to use the nearest crosswalks at the intersection of West Street/Morton Street to the north and the south crosswalk at the intersection of West Street/Clarkson Street to the south.



Canal Street between Canal Park and Greenwich Street

Issue

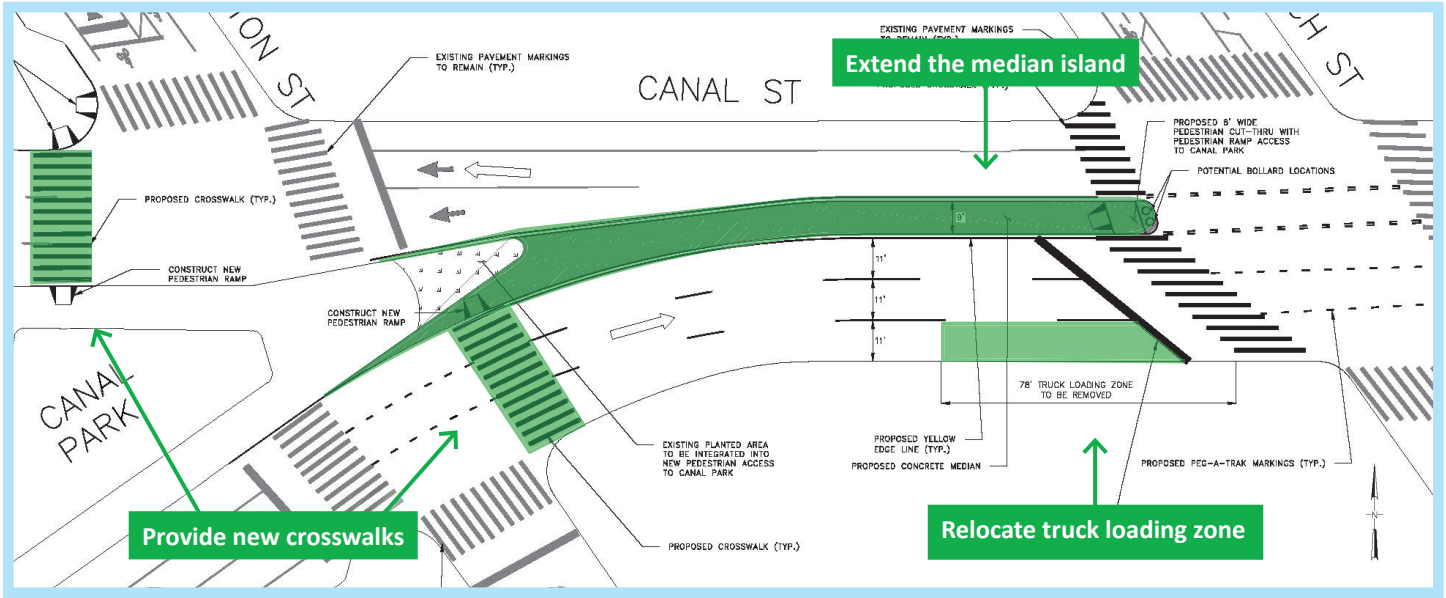
Stakeholders identified the need to improve walking accessibility at the west end of Canal Street near Canal Park to enhance the walking environment and park accessibility. Canal Park is a neighborhood park located in the middle of the eastbound and westbound Canal Street lanes, between West Street and Washington Street. Currently, there is limited pedestrian access to the park, which discourages its use by area residents.



Aerial view of Canal Street between Canal Park and Greenwich Street

Improvement

To improve walking accessibility to Canal Park, it is recommended that the east tip of the median be extended to Greenwich Street. This improvement would involve the relocation of a 78-foot truck loading zone on the south curb of Canal Street, west of Greenwich Street. The median extension would improve accessibility to the park by providing a conflict-free passage from Greenwich Street to West Street. Other recommended walking improvements in the area include new crosswalks and pedestrian ramps on eastbound Canal Street east of Washington Street and on westbound Canal Street west of Washington Street, both of which will be conflict-free due to the existing signal phase for pedestrian crossings only. These improvements enhance the walking environment and provide for better accessibility to Canal Park.



Clarkson Street between West Street and Greenwich Street

Issue

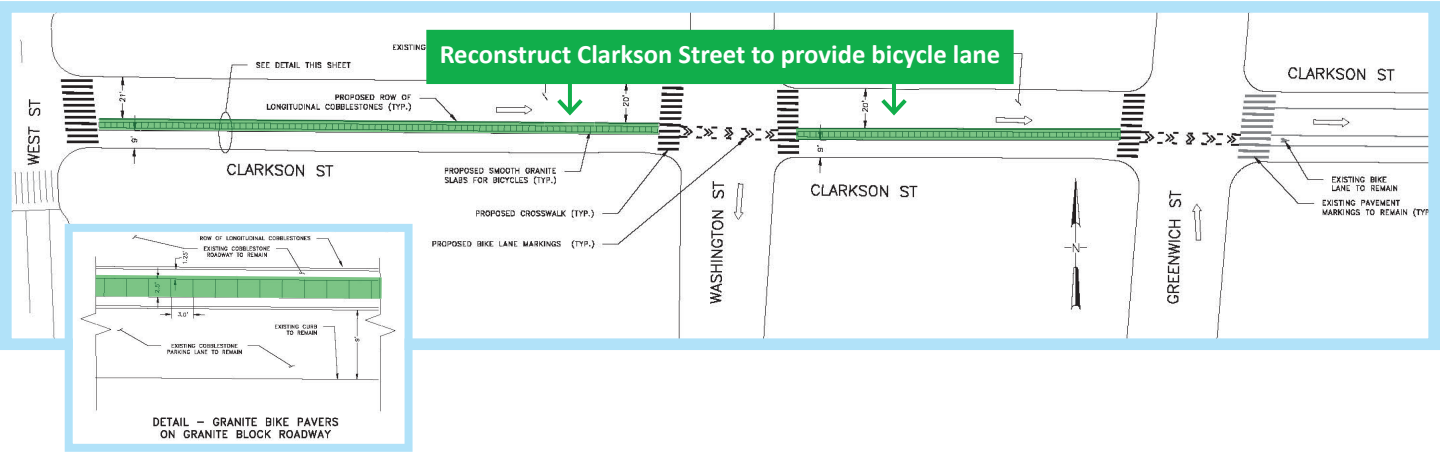
There is a conventional bicycle lane along Clarkson Street, east of Greenwich Street, which connects bicyclists to both uptown and downtown bicycle lanes. However, due to the cobblestone surface there is a gap in the bicycle network on Clarkson Street, between West Street and Greenwich Street. Along this segment, bicyclists riding eastbound from West Street and the Hudson River Greenway must ride on cobblestones or dismount and walk their bicycles.

Aerial view of Clarkson Street between West Street and Greenwich Street

Facing east on Clarkson Street (note the bicyclist using sidewalk)

Improvement

To improve bicycle network connectivity between West Street and Greenwich Street, it is recommended that the existing bicycle lane be extended by reconstructing this section of Clarkson Street and installing a granite slab that is wide enough to accommodate an eastbound bicyclist. The granite slabs for this two-block segment would both provide a ridable surface for bicyclists and help retain the historic character of Clarkson Street.



West Street between West Houston Street and Canal Street

Issue

Currently there are no official traffic signal-controlled pedestrian crossings on West Street for over 1,500 feet between eastbound Canal Street (south crosswalk) and West Houston Street (north crosswalk). Stakeholders requested the investigation of new crosswalks along this segment of West Street to improve accessibility to Hudson River Park and to accommodate pedestrian growth generated from new development in the area.

Facing north from Spring Street along West Street

Improvement

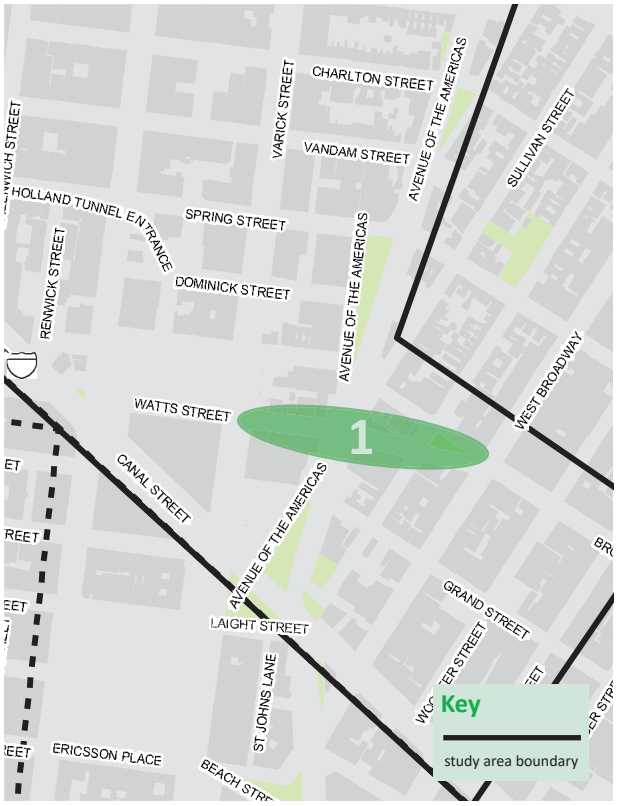
Three new potential signalized crosswalk locations were identified. The first location on West Street, 390 feet south of West Houston Street, was deemed feasible since (1) the median width is consistent with the existing pedestrian refuge widths on West Street; (2) the location is largely outside of the typical left-turn queue areas that extend to the south and north, therefore people walking are less likely to confront vehicles blocking the crosswalk; and (3) there would be no turning vehicles to conflict with people walking in the crosswalk. Coordination with NYS DOT, Hudson River Park Trust, and the developers of 550 Washington will be needed for the installation of the new crosswalk across West Street.

Aerial view of crosswalk options along West Street

The other two crosswalk options north and south of westbound Canal Street were deemed infeasible since (1) the median width would be substantially less than the typical pedestrian refuge width used along West Street, (2) vehicle queues would likely block the crosswalk, and (3) traffic operations would require multi-lane turning movements that would conflict with people walking at several points along the crosswalks at Canal Street, a practice that NYC DOT discourages.

BROOME/WATTS STREET CORRIDOR

1 Broome/Watts Street between West Broadway and Varick Street

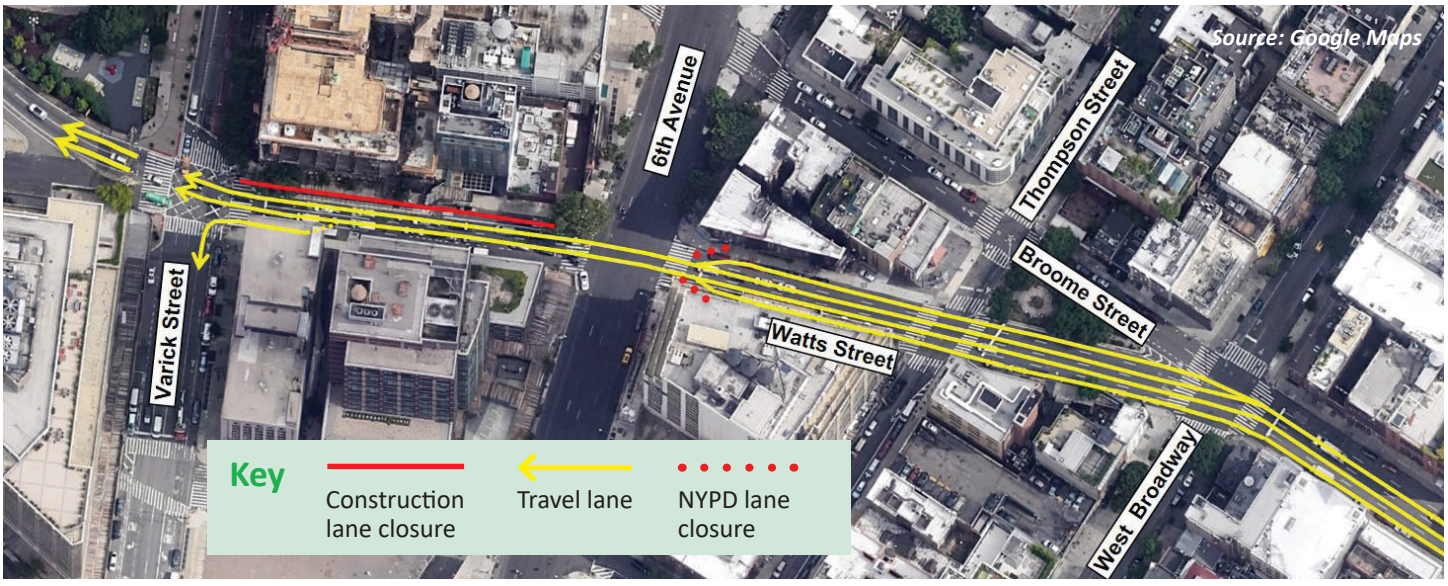


Broome/Watts Street between West Broadway and Varick Street

Issue

There is a travel lane imbalance along several blocks of Watts Street from West Broadway to the Holland Tunnel entrance on Varick Street. This lane imbalance exacerbates the congestion, conflicts, and confusion at the intersections along Broome/Watts Street approaching the Holland Tunnel. Conditions that contribute to the lane imbalance include: (1) the Watts Street entrance to the Holland Tunnel has only two lanes west of Varick Street, (2) construction on the north side of Watts Street between 6th Avenue and Varick Street has resulted in the closure of the north curbside bus lane, (3) northbound 6th Avenue left-turning buses destined for the Holland Tunnel block the intersection at Watts Street, and (4) due to the operational constraints along Watts Street, as noted above, the NYPD frequently closes the north and south curbside lanes on the westbound Watts Street approach to 6th Avenue. Depending on the actual operating conditions along this section of Watts Street during the weekday PM peak period, the number of lanes can vary from 3 lanes to 4 lanes and then to 2 lanes (see diagram below).

Facing west on Watts Street, approaching Sixth Avenue



Existing Condition Lane Configuration: Weekday PM Period

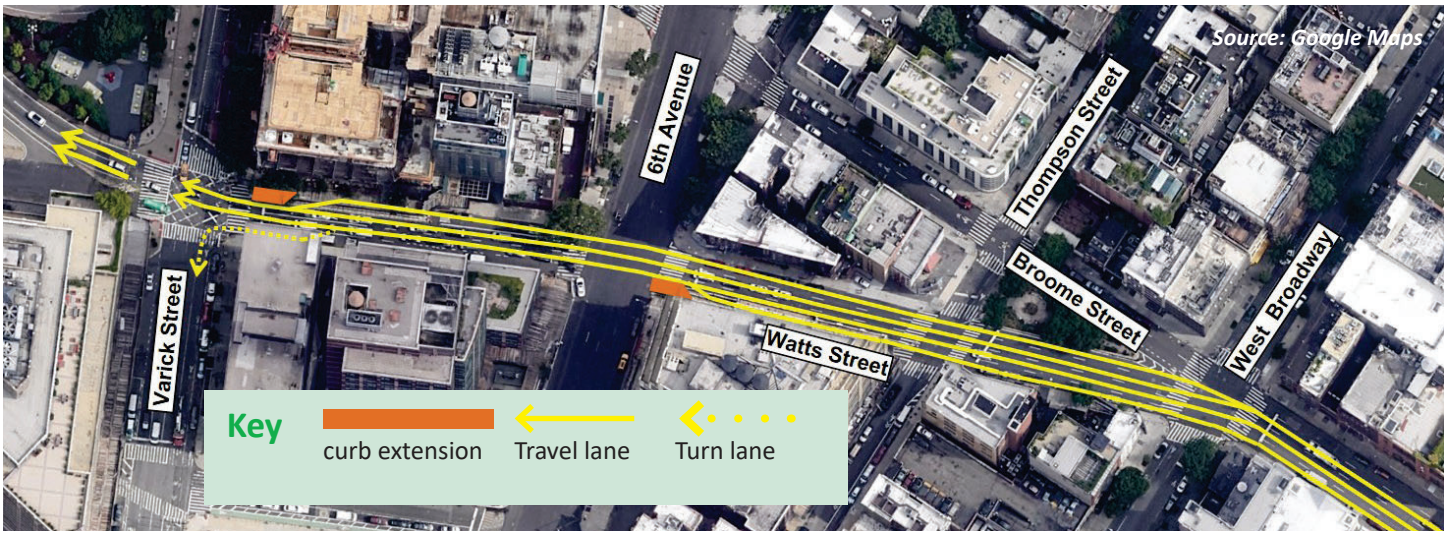
Broome/Watts Street between West Broadway and Varick Street (cont'd.)

Improvements

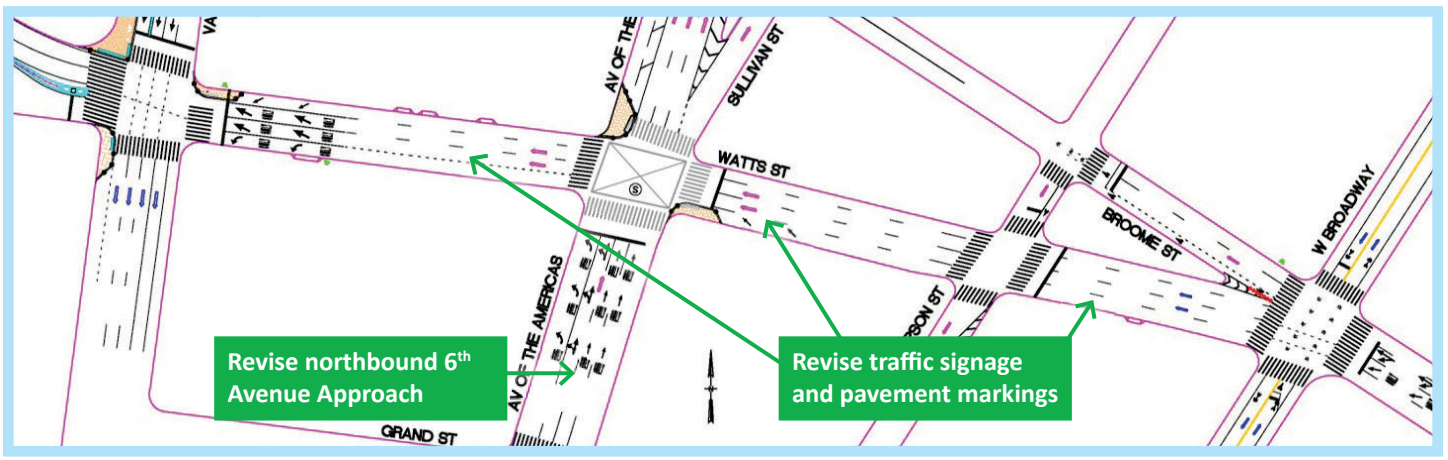
There were two improvement options identified to reduce vehicle merging operations. Both revise signage and pavement markings along the Broome/Watts Street corridor to achieve better lane balance, reduce merging conflicts, and better organize traffic flow on the approach to the Holland Tunnel.

Option 1

Improvement Option 1 starts with three westbound lanes from Broome Street that then expand to four westbound Watts Street lanes during the PM peak period on the west side of West Broadway. The south curb lane would be dropped approaching 6th Avenue with a curb extension. Three westbound lanes continue west of 6th Avenue until the north curb lane would be dropped approaching Varick Street with another curb extension. The existing left-turn lane onto Varick Street would continue to occupy the south curb lane resulting in two through lanes to match the number of receiving lanes at the Holland Tunnel entrance. This is the preferred option as it offers the largest amount of vehicle queue storage along Watts Street.



OPTION 1 Proposed Condition Weekday PM Peak Traffic Flow



OPTION 1 Proposed Condition Weekday PM Peak Traffic Flow - Curb extensions under 11 ft wide require maintenance partner

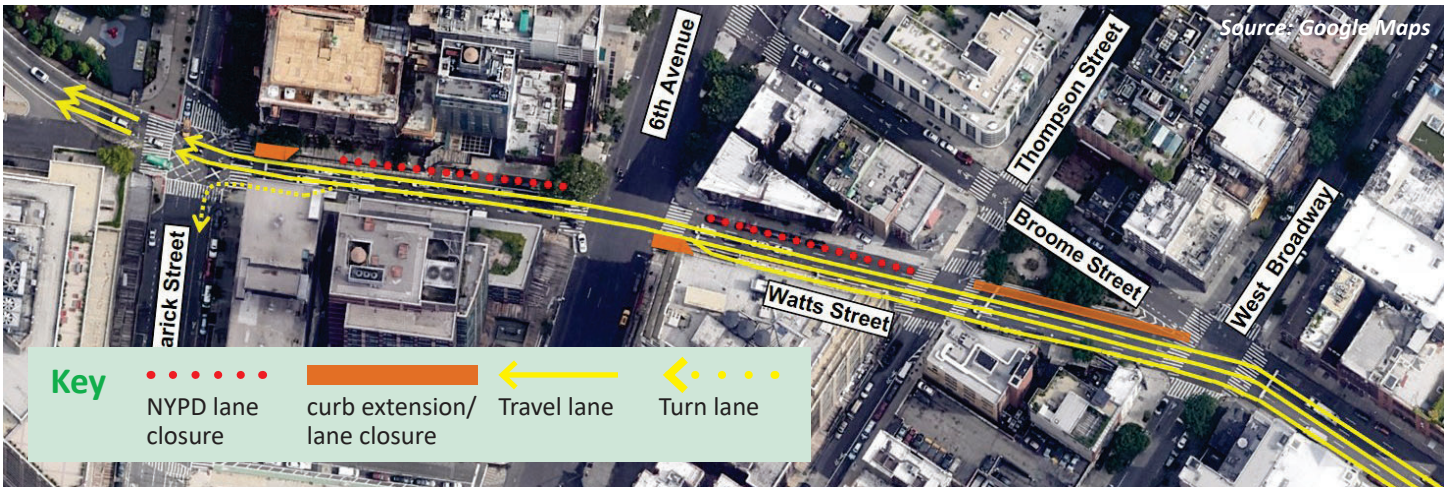
Broome/Watts Street between West Broadway and Varick Street (cont'd.)

Improvements

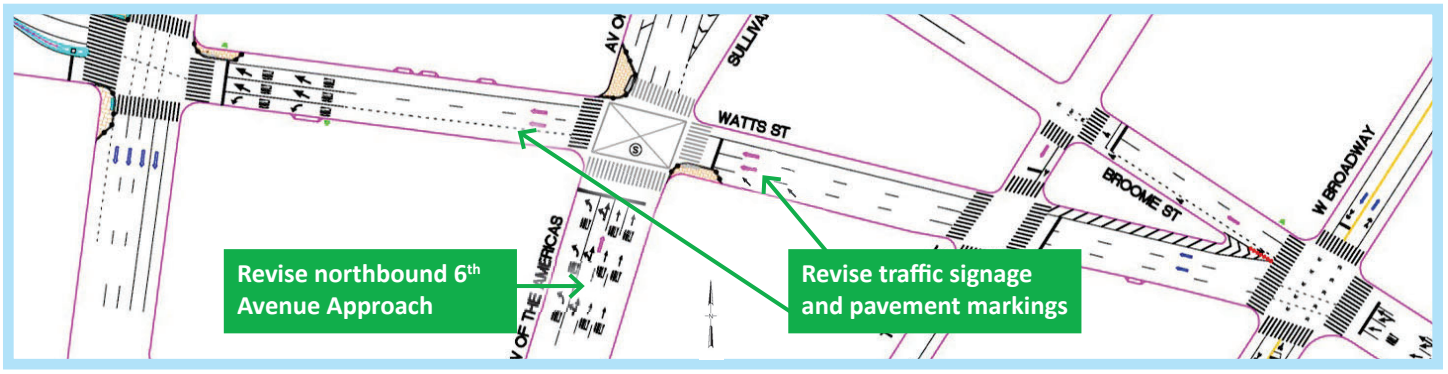
Option 2

Improvement Option 2 would also start with three westbound Broome Street lanes that are continued to 6th Avenue. The south curb lane would be dropped approaching 6th Avenue with a curb extension. Two westbound lanes continue west of 6th Avenue and would be used to access the Holland Tunnel. The existing left-turn lane onto Varick Street would occupy the south curb lane resulting in two through lanes to match the number of receiving lanes at the Holland Tunnel entrance.

This option would allow for the potential expansion of the pedestrian plaza into the existing north curb lane between West Broadway and Thompson Street and would provide two additional blockfaces of parking on the north side of Watts Street between Thompson Street and Varick Street. During the PM peak period, the north curb parking lane would be closed by NYPD with movable traffic barriers (such as barrels or cones) between Thompson Street and Varick Street to prevent the lane's usage by through traffic and to minimize traffic impacts from parking maneuvers. As noted earlier, it is recommended that Option 1 be progressed, since it would allow for greater queue storage and would eliminate the need for daily manual installation of movable traffic barriers by NYPD.



OPTION 2 Proposed Condition Weekday PM Peak Traffic Flow



OPTION 2 Proposed Condition Weekday PM Peak Traffic Flow - Curb extensions under 11 ft wide require maintenance partner

Broome/Watts Street between West Broadway and Varick Street (cont'd.)

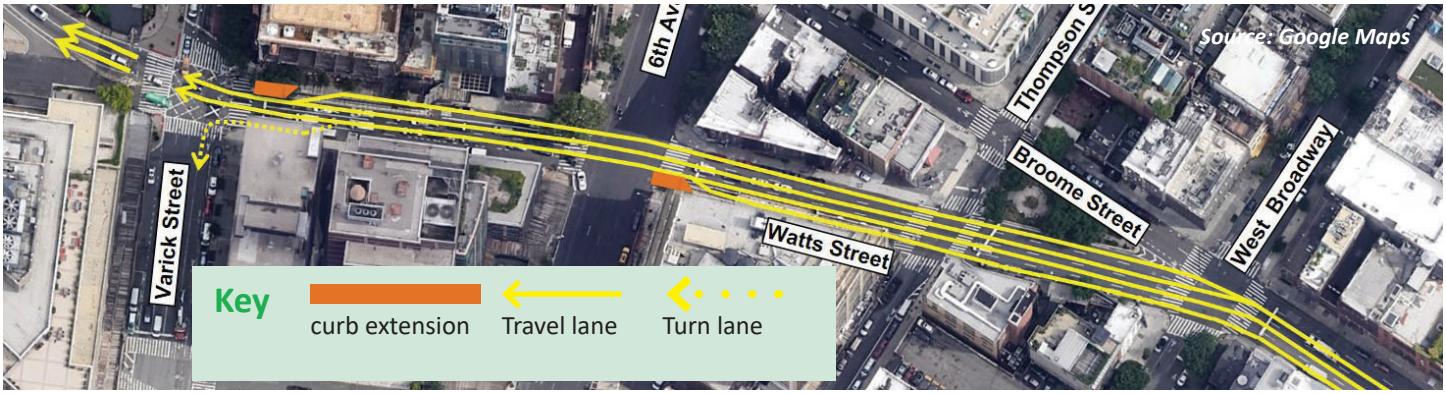
Improvements

Comparison of Improvement Options 1 and 2

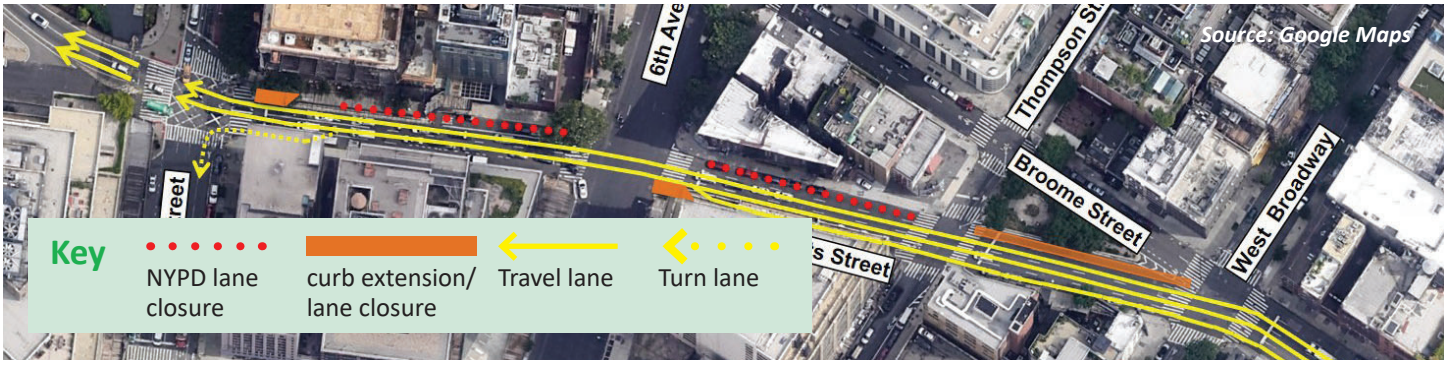
The first option would provide for more vehicle storage along the Broome/Watts Street corridor thereby shortening the length of the westbound queue approaching the Holland Tunnel, but would result in one additional downstream merge point east of Varick Street. It would also require less daily intervention from the NYPD (e.g., setting out traffic barriers to channelize traffic, as is done today). Although it would result in two merge points—one east of 6th Avenue on the south side, and one east of Varick Street on the north side—this would likely achieve a more consistent traffic flow and less lane changing among all four lanes since both sides of the roadway experience a merge — one from the left at 6th Avenue and one from the right at Varick Street.

It is recommended that the first option be implemented with temporary materials and evaluated to (1) identify the effect of these changes on the Broome/Watts Street approach to the Holland Tunnel, (2) refine the geometry/signal timing of this option based on field operations, and (3) determine if the option should be retained with permanent materials.

In addition, it is recommended that parking regulations on Broome/Watts Street be made consistent. Currently, there are different parking restriction times on Broome/Watts Street east and west of West Broadway. Parking regulations on Broome Street east of West Broadway should be changed to "No Parking" between 7 a.m. and 7 p.m. on Mondays through Fridays.



OPTION 1 Proposed Condition Weekday PM Peak Traffic Flow

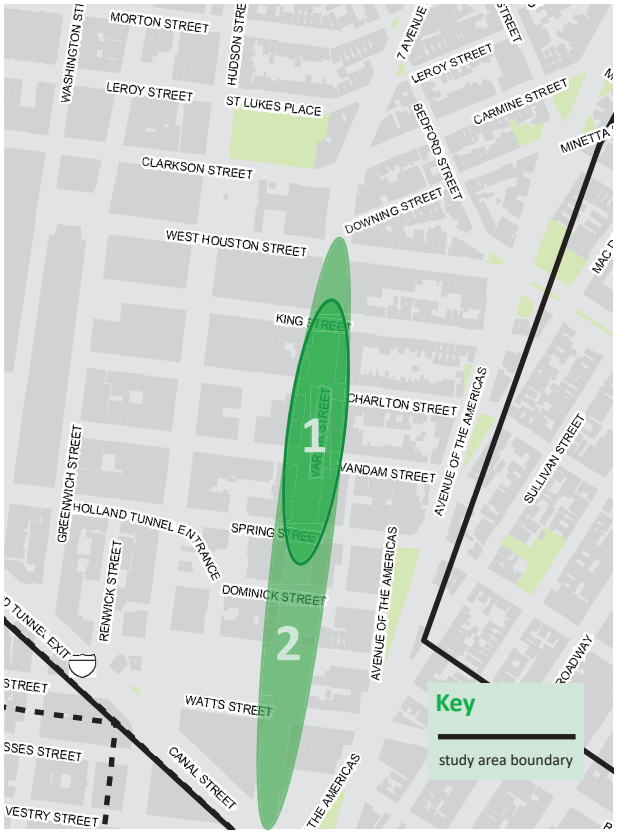


OPTION 2 Proposed Condition Weekday PM Peak Traffic Flow

7TH AVENUE SOUTH / VARICK STREET CORRIDOR

1 Varick Street between King Street and Spring Street

2 Varick Street between West Houston Street and Canal Street



Varick Street between King Street and Spring Street

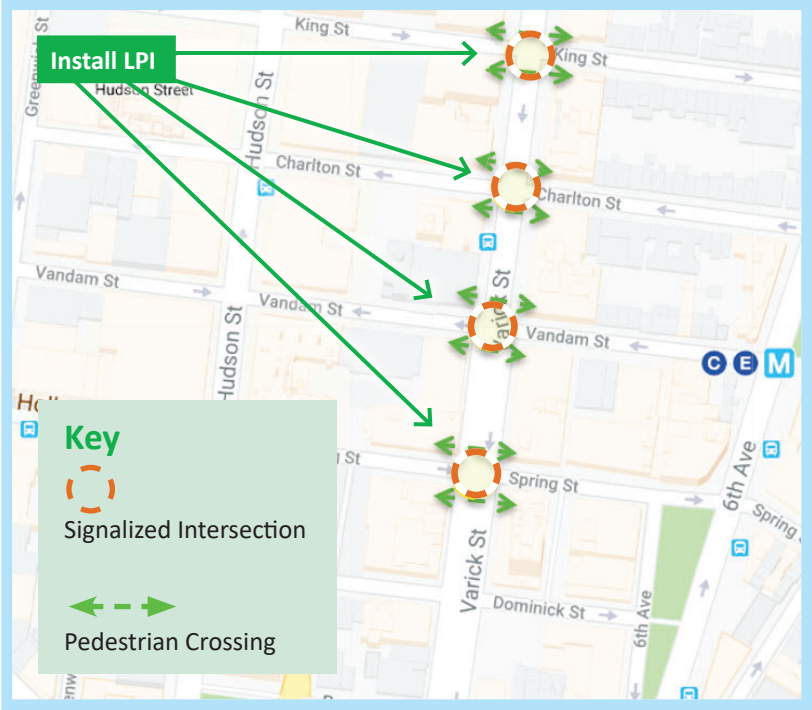
Issue

The Varick Street corridor accommodates a large volume of traffic and is often congested with vehicles destined to the Holland Tunnel. These conditions, particularly for the segment from King Street to Dominick Street, often make it difficult for people to cross Varick Street.

Facing south along Varick Street from Charlton Street

Improvement

To provide for improved pedestrian crossings at these intersections, it is recommended that Leading Pedestrian Intervals (LPIs) at the following locations along Varick Street be implemented: King, Charlton, Vandam, and Spring Streets. The primary benefit of the LPIs would be expected during the off-peak periods when traffic approaching the Holland Tunnel is less likely to block the crosswalks. (Note: An LPI is not needed at the Dominick Street intersection since there is already an all-pedestrian traffic signal phase.)

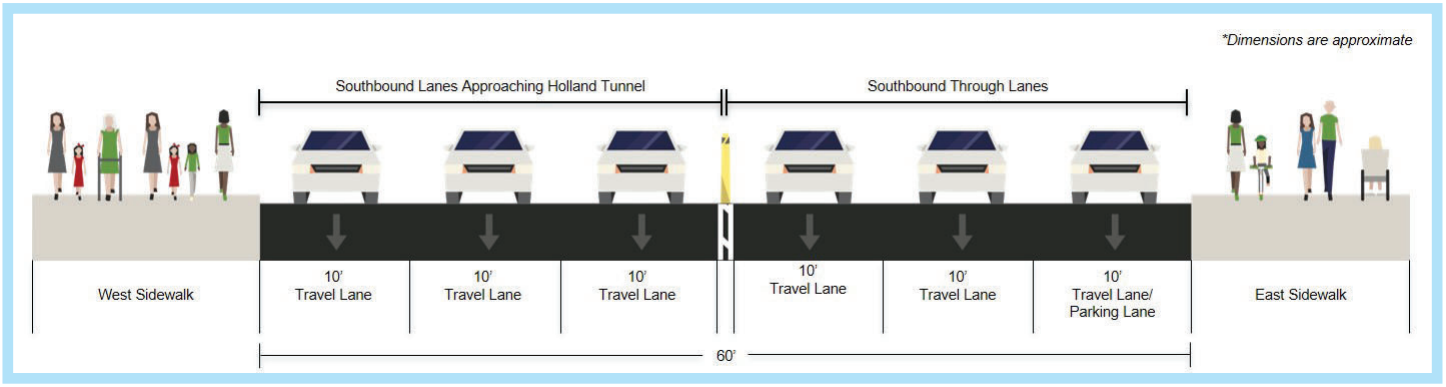


Varick Street between West Houston Street and Canal Street

Issue

The Study identified three potential street configuration options for Varick Street between West Houston Street and Canal Street. Potential options include: (1) retaining on-street parking along the east curb, (2) installing a pedestrian median separating through and Tunnel-bound lanes, and (3) installing a protected bicycle lane along the east curb. It should be noted that these options are mutually exclusive due to the limited width of Varick Street and the need to maintain a minimum of two through and two Tunnel-bound travel lanes at all times along this critical link for general mobility and emergency access purposes.

Facing south along Varick Street from Vandam Street



Existing cross-section on Varick Street approaching Holland Tunnel (looking north)

Varick Street between West Houston Street and Canal Street (cont'd.)

Improvement

One option retains the existing Varick Street geometry and roadway operations that provides for three Tunnel-bound lanes and three through lanes in the weekday PM peak period through the use of "No Standing/"No Stopping" parking regulations. During the off-peak periods, parking is allowed on the west and east curb lanes to serve as loading/unloading zones for the various businesses along the corridor. This is the recommended cross section at this time based on the evaluation of conditions during the Study. Further evaluation may be done by NYC DOT if conditions substantially change in the future.

A second option would replace the right-most through lane with a median approximately 8 to 9 feet wide that could be used as a pedestrian refuge for crossing Varick Street and/or landscaping. The median option would maintain three Tunnel-bound lanes in the PM peak period, but would permanently reduce the number of through lanes to two while necessitating the removal of the time-of-day parking on the east curb. This option is not recommended at this time for the reasons noted below.

Similarly, a third option, to provide a bicycle lane on Varick Street, would permanently remove the east curbside travel/parking lane and replace it with a protected bicycle lane with buffer space. Three Tunnel-bound travel lanes would remain in the PM peak period, however, only two travel lanes would be available for Varick Street through traffic. This option is not recommended at this time for the reasons noted below.

With either the Varick Street median or bicycle lane options, parking along the east curb lane would be removed. This curb lane is a through travel lane during the PM peak and is a parking/loading lane at other times. Therefore, the median or bicycle lane would require the implementation of "No Stopping Anytime" regulations for the east curb of Varick Street and/or a single through travel lane south of West Houston Street. This removal of parking/loading would disrupt commercial activities along Varick Street, since all access to the east curb would be prohibited. With no alternative access possible, trucks and other delivery vehicles would still be expected to operate at the curb, albeit illegally, which would reduce Varick Street to only a single through lane.

A parking survey was conducted that showed approximately 200 vehicles, including a significant percentage of commercial vehicles, use the five east blockfaces along this segment on a weekday. These vehicles would be displaced under either the Varick Street median or bicycle lane option. Evaluation of the options also considered that the queue storage approaching the Holland Tunnel would be reduced in the median or bicycle lane option, resulting in longer queues on Varick Street that already extend beyond West Houston Street. The median option also would present challenges for emergency vehicle access (NYPD, FDNY, etc.) to the west side of Varick Street during the PM peak period in the event of an emergency.

OPERATIONAL ANALYSIS RESULTS FOR IMPROVEMENT OPTIONS

5

5.1 Introduction

Traffic operational analyses were performed for future 2027 Build Conditions using the microsimulation models to assess the improvement options. The major improvements were categorized into four (4) corridor specific alternatives, Alternatives 1 through 4, based on the location and estimated implementation timeframe of each improvement. The improvements included in each of the four alternatives were:

Alternative 1 (Alt1) included early action improvements that are expected to be implemented by the end of 2021: 1) bicycle lane extension along 7th Avenue South/Leroy Street/St. Lukes Place from Clarkson/Carmine Street to West Houston Street; 2) new signal installation at Varick Street/7th Avenue South at Leroy Street; 3) bus rerouting on 6th Avenue from Watts Street to Canal Street during the weekday PM peak period (bus rerouting is not applicable to the Sunday PM peak period); 4) redesign of the Broome/Watts Street approach to the Holland Tunnel (i.e. between West Broadway and Varick Street), including the reconfiguration of the northbound 6th Avenue approach to the intersection at Watts Street.

Alternative 2 (Alt2) included the options in Alternative 1 plus an LPI for the cross streets at four (4) intersections along Varick Street. The four locations are King Street, Charlton Street, Vandam Street, and Spring Street.

Alternative 3 (Alt3) included the options in Alternative 1 and 2 plus the improvements along 6th Avenue. These improvements included: 1) conversion of King Street between 6th Avenue and Macdougal Street from one-way westbound to one-way eastbound; 2) traffic signal timing optimization to increase the phase length for the northbound right turn from 6th Avenue to eastbound West Houston Street; and 3) 6th Avenue/West 4th Street/Cornelia Street intersection modifications and associated traffic signal timing optimization.

Alternative 4 (Alt4) included the improvements in the prior three alternatives plus a new signalized cross-walk on West Street, located south of West Houston Street.

5.2 Analysis Results

Measures of effectiveness (MOEs), such as the maximum queue lengths and travel times along major corridors, were reported for projected future 2027 Build Alternatives and compared to the 2027 No-Build Conditions results to assist in the assessment of improvements. The Build scenarios were analyzed for the critical weekday PM peak period and the Sunday afternoon peak period, which were the periods when Tunnel traffic is the highest and the congestion is the greatest. During the AM peak period, the volumes are lower and the area is less congested. The detailed analysis results are presented in **Table 5-1** through **Table 5-5**.

Table 5-1 Queue Length Comparison: 2027 No-Build vs. Build – Weekday PM Peak Period

Queue Comparison No-Build vs. Build Alternatives - PM Peak Period						
	Access Corridor to Holland Tunnel	Projected Maximum Queue Length (ft)				
		No-Build	Build Alt1	Build Alt2	Build Alt3	Build Alt4
1	Varick Street SB	4900	4900	4950	4900	4900
2	Broome/Watts Street WB	2400	650	650	650	650
3	Canal Street WB	4650	4600	4800	4800	4850
4	Canal Street EB	2600	3150	3250	3100	3200
5	Hudson Street NB	1500	2500	2500	2550	2550
6	6th Avenue NB	3500	3100	3250	3250	3150

Note:

Build Alt1: early action improvements (bicycle lane extension along Varick Street from Clarkson/Carmine Street to West Houston Street; new signal installation at Varick Street/Leroy Street; bus reroute to Canal Street from Watts Street; Broome/Watts Street reconfiguration, including northbound 6th Avenue approach modification at intersection with Watts Street).

Build Alt2: Varick Street LPI in addition to Build Alt1.

Build Alt3: 6th Avenue improvements (6th Avenue/King Street, 6th Avenue/West Houston Street, 6th Avenue/Cornelia Street/West 4th Street) in addition to Build Alt2.

Build Alt4: new crosswalk along West Street in addition to Build Alt3.

Table 5-2 Travel Time Comparison: 2027 No-Build vs. Build - PM Peak Hour 4:00 p.m. - 5:00 p.m.

Travel Time Comparison No-Build vs. Build Alternatives - PM Peak Hour 4:00 p.m. - 5:00 p.m.								
	Travel Time Section			Projected Travel Time (min)				
	Sections	From	To	No-Build	Build Alt1	Build Alt2	Build Alt3	Build Alt4
1	West Street NB	South of Laight Street	North of Leroy Street	2.6	2.6	2.6	2.7	3.0
2	West Street SB	North of Leroy Street	South of Laight Street	2.4	2.4	2.4	2.4	3.4
3	Varick Street SB	North of Morton Street	South of Beach Street	7.8	8.6	7.6	8.1	7.5
4	6th Avenue NB	South of White Street	North of W Houston Street	5.5	6.7	6.7	6.8	6.7
5	Canal Street WB	East of Greene Street	East of West Street	10.4	10.6	10.3	10.4	10.6
6	Canal Street EB	East of West Street	East of Greene Street	3.6	3.8	3.7	3.8	3.5
7	West Houston Street WB	East of Thompson Street	East of West Street	4.5	4.5	4.5	4.5	4.6
8	Hudson Street NB	South of N Moore Street	North of Leroy Street	3.7	7.5	7.4	7.6	7.1
9	Canal Street EB to Holland Tunnel	East of West Street	Holland Tunnel entrance	9.4	10.8	10.7	11.6	9.6
10	Canal Street WB to Holland Tunnel	East of Greene Street	Holland Tunnel entrance	21.2	21.1	21.0	21.0	21.0
11	Hudson Street to Holland Tunnel	South of N Moore Street	Holland Tunnel entrance	8.0	19.5	19.5	19.7	18.9
12	Varick Street to Holland Tunnel	North of Morton Street	Holland Tunnel entrance	22.3	21.0	20.9	20.0	20.0
13	Broome Street to Holland Tunnel	East of Greene Street	Holland Tunnel entrance	27.3	6.5	6.5	6.5	6.5
14	6th Avenue to Holland Tunnel via Watts Street (Bus)	South of White Street	Holland Tunnel entrance	14.9	NA	NA	NA	NA
15	6th Avenue to Holland Tunnel via Canal Street (Bus)	South of White Street	Holland Tunnel entrance	NA	7.6	7.6	7.8	7.6

Note:

Build Alt1: early action improvements (bicycle lane extension along Varick Street from Clarkson/Carmine Street to West Houston Street; new signal installation at Varick Street/Leroy Street; bus reroute to Canal Street from Watts Street; Broome/Watts Street reconfiguration, including 6th Avenue northbound approach modification at intersection with Watts Street).

Build Alt2: Varick Street LPI in addition to Build Alt1.

Build Alt3: 6th Avenue improvements (6th Avenue/King Street, 6th Avenue/West Houston Street, 6th Avenue/Cornelia Street/West 4th Street) in addition to Build Alt2.

Build Alt4: new crosswalk along West Street in addition to Build Alt3.

Table 5-3 Travel Time Comparison: 2027 No-Build vs. Build - PM Peak Hour 5:00 p.m. - 6:00 p.m.

Travel Time Comparison No-Build vs. Build Alternatives - PM Peak Hour 5:00-6:00 PM								
	Travel Time Section			Projected Travel Time (min)				
	Sections	From	To	No-Build	Build Alt1	Build Alt2	Build Alt3	Build Alt4
1	West Street NB	South of Laight Street	North of Leroy Street	2.6	2.8	2.7	2.7	2.9
2	West Street SB	North of Leroy Street	South of Laight Street	2.5	2.6	2.6	2.6	3.3
3	Varick Street SB	North of Morton Street	South of Beach Street	12.3	11.5	12.0	12.2	12.8
4	6th Avenue NB	South of White Street	North of W Houston Street	6.6	7.7	7.9	7.5	7.5
5	Canal Street WB	East of Greene Street	East of West Street	9.4	9.3	9.1	9.1	9.4
6	Canal Street EB	East of West Street	East of Greene Street	4.3	4.6	4.7	4.6	4.1
7	West Houston Street WB	East of Thompson Street	East of West Street	4.6	4.6	4.4	4.5	4.7
8	Hudson Street NB	South of N Moore Street	North of Leroy Street	5.9	12.9	12.9	13.4	12.7
9	Canal Street EB to Holland Tunnel	East of West Street	Holland Tunnel entrance	14.5	15.9	16.3	16.2	14.5
10	Canal Street WB to Holland Tunnel	East of Greene Street	Holland Tunnel entrance	21.0	21.0	21.0	21.1	20.9
11	Hudson Street to Holland Tunnel	South of N Moore Street	Holland Tunnel entrance	16.2	31.0	31.7	32.9	31.9
12	Varick Street to Holland Tunnel	North of Morton Street	Holland Tunnel entrance	32.7	29.4	29.4	29.5	29.6
13	Broome Street to Holland Tunnel	East of Greene Street	Holland Tunnel entrance	42.6	8.2	7.9	8.2	8.0
14	6th Avenue to Holland Tunnel via Watts Street (Bus)	South of White Street	Holland Tunnel entrance	20.2	NA	NA	NA	NA
15	6th Avenue to Holland Tunnel via Canal Street (Bus)	South of White Street	Holland Tunnel entrance	NA	9.5	9.9	9.2	9.2

Note:

Build Alt1: early action improvements (bicycle lane extension along Varick Street from Clarkson/Carmine Street to West Houston Street; new signal installation at Varick Street/Leroy Street; bus reroute to Canal Street from Watts Street; Broome/Watts Street reconfiguration, including 6th Avenue northbound approach modification at intersection with Watts Street).

Build Alt2: Varick Street LPI in addition to Build Alt1.

Build Alt3: 6th Avenue improvements (6th Avenue/King Street, 6th Avenue/West Houston Street, 6th Avenue/Cornelia Street/West 4th Street) in addition to Build Alt2.

Build Alt4: new crosswalk along West Street in addition to Build Alt3.

The projected maximum queue lengths were compared for the 2027 weekday PM peak period (4:00 to 6:00 PM) between No-Build Conditions and the four Build Improvement Alternatives. As shown in **Table 5-1**, queue lengths along Broome/Watts Street were projected to decrease substantially in all Build Alternatives. The Build Alternatives' maximum queue lengths decreased along 6th Avenue while the maximum queue lengths increased along Hudson Street. The bus rerouting on 6th Avenue from Watts Street to Canal Street and the Broome/Watts Street reconfiguration were the main reasons for these changes. With the bus rerouting from Watts Street to Canal Street, the space that was originally occupied by buses is available to store additional cars along 6th Avenue, resulting in shorter queue lengths. The queue length decrease along Broome/Watts Street is also due to the bus rerouting, which allows additional space on Watts Street between Varick Street and 6th Avenue for vehicles destined to the Holland Tunnel. Hudson Street is expected to be affected by the bus rerouting with a queue length increase, related to the increased competition to enter the Holland Tunnel from Canal Street. The minimal queue length changes along other corridors are due to the dynamics of traffic operations and the ripple effects in the network caused by location-specific changes.

The average travel times were also compared between the projected 2027 No-Build Conditions and the four Build Improvement Alternatives. As shown in **Table 5-2** and **Table 5-3**, travel times for the rerouted buses were projected to decrease along Broome/Watts Street and northbound 6th Avenue. However, an increase in travel time was projected for Hudson Street due to the added bus volumes at Canal Street.

Table 5-4 Queue Length Comparison: 2027 No-Build vs. Build - Sunday Peak Hour 3:15 p.m. - 4:15 p.m.

Queue Comparison No-Build vs. Build Alternatives - Sunday Peak Hour						
	Access Corridor to Holland Tunnel	Projected Maximum Queue Length (ft)				
		No-Build	Build Alt1	Build Alt2	Build Alt3	Build Alt4
1	Varick Street SB	4500	4500	4500	4500	4350
2	Broome/Watts Street WB	2050	450	450	450	450
3	Canal Street WB	3000	2750	2800	2750	2750
4	Canal Street EB	750	800	850	800	850
5	Hudson Street NB	1500	1450	1450	1450	1450
6	6th Avenue NB	2350	3050	3300	3100	3150

Note:

Build Alt1: early action improvements (bicycle lane extension along Varick Street from Clarkson/Carmine Street to West Houston Street; new signal installation at Varick Street/Leroy Street; bus reroute to Canal Street from Watts Street; Broome/Watts Street reconfiguration, including northbound 6th Avenue approach modification at intersection with Watts Street).

Build Alt2: Varick Street LPI in addition to Build Alt1.

Build Alt3: 6th Avenue improvements (6th Avenue/King Street, 6th Avenue/West Houston Street, 6th Avenue/Cornelia Street/West 4th Street) in addition to Build Alt2.

Build Alt4: new crosswalk along West Street in addition to Build Alt3.

Table 5-5 Travel Time Comparison: 2027 No-Build vs. Build - Sunday Peak Hour 3:15 p.m. - 4:15 p.m.

Travel Time Comparison No-Build vs. Build Alternatives - Sunday Peak Hour 3:15 p.m. - 4:15 p.m.								
	Travel Time Section			Projected Travel Time (min)				
	Sections	From	To	No-Build	Build Alt1	Build Alt2	Build Alt3	Build Alt4
1	West Street NB	South of Laight Street	North of Leroy Street	2.4	2.3	2.4	2.4	2.4
2	West Street SB	North of Leroy Street	South of Laight Street	3.0	3.0	3.0	3.0	3.5
3	Varick Street SB	North of Morton Street	South of Beach Street	6.5	6.1	6.2	6.2	6.0
4	6th Avenue NB	South of White Street	North of W Houston Street	5.2	9.6	9.6	9.5	9.6
5	Canal Street WB	East of Greene Street	East of West Street	6.6	5.9	5.8	6.0	5.8
6	Canal Street EB	East of West Street	East of Greene Street	4.0	4.0	4.0	4.0	4.0
7	West Houston Street WB	East of Thompson Street	East of West Street	4.8	3.9	3.8	4.2	4.2
8	Hudson Street NB	South of N Moore Street	North of Leroy Street	6.1	6.2	6.2	6.2	6.1
9	Canal Street EB to Holland Tunnel	East of West Street	Holland Tunnel entrance	11.7	11.7	12.2	12.0	12.1
10	Canal Street WB to Holland Tunnel	East of Greene Street	Holland Tunnel entrance	15.9	14.5	14.5	14.5	14.5
11	Hudson Street to Holland Tunnel	South of N Moore Street	Holland Tunnel entrance	16.0	15.8	15.8	15.9	15.7
12	Varick Street to Holland Tunnel	North of Morton Street	Holland Tunnel entrance	21.0	20.1	20.2	20.3	20.1
13	Broome Street to Holland Tunnel	East of Greene Street	Holland Tunnel entrance	18.6	6.3	6.4	6.3	6.3

Note:

Build Alt1: early-action improvements (bicycle lane extension along Varick Street from Clarkson/Carmine Street to West Houston Street; new signal installation at Varick Street/Leroy Street; bus reroute to Canal Street from Watts Street; Broome/Watts Street reconfiguration, including 6th Avenue northbound approach modification at intersection with Watts Street).

Build Alt2: Varick Street LPI in addition to Build Alt1.

Build Alt3: 6th Avenue improvements (6th Avenue/King Street, 6th Avenue/West Houston Street, 6th Avenue/Cornelia Street/West 4th Street) in addition to Build Alt2.

Build Alt4: new crosswalk along West Street in addition to Build Alt3.

The projected 2027 maximum queue lengths were compared for the Sunday afternoon peak hour between No-Build Conditions and the four Build Improvement Alternatives. As shown in **Table 5-4**, queue lengths along Broome/ Watts Street decreased under all four Build Alternatives. The Build Alternatives' queue lengths along 6th Avenue increased, while the queue lengths along Varick Street, Canal Street, and Hudson Street experienced negligible changes. The queue length reduction along Broome/Watts Street and the increase

along 6th Avenue result from the street realignment and lane reconfiguration on northbound 6th Avenue approaching Watts Street. Based on actual field operations to be monitored after temporary implementation, the reconfiguration of Watts Street would be reassessed to determine if modifications may be needed.

The projected 2027 travel times for the Sunday afternoon peak hour were compared between No-Build Conditions and the four Build Improvement Alternatives. As shown in **Table 5-5**, travel time decreased along Broome/Watts Street and increased along northbound 6th Avenue for all Build Alternatives.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

6

6.1 Introduction

The Study developed and recommended improvements to address longstanding transportation challenges in the Hudson Square and West Village neighborhoods, as well as incorporate measures to facilitate multimodal usage.

The stakeholder and agency coordination enabled NYC DOT to build community and institutional support for the project, identify and confirm concerns, and incorporate knowledge at decision points throughout the process. The issues identified and recommendations put forth in this report were guided and shaped by the insights provided by this coordination. The development of recommended early actions and other improvements were based on community concerns and potential improvements suggested by the stakeholders and the study team to enhance access and safety for all street users.

A range of improvement options was developed for assessment. From these options, early actions were identified that could be implemented by the end of 2021. In addition, improvement options that could have traffic impacts were evaluated to determine whether they should be progressed, modified, or rejected. Some of these early actions were implemented before the study was completed. A series of traffic simulation models were used to test improvement options and understand their operational effects.

Recommended improvements include making permanent the curb extensions being implemented with temporary materials as early actions. In addition, improvements at the following locations are recommended to be progressed:

6th Avenue Corridor

- 6th Avenue between King Street and West Houston Street – implement King Street reversal and evaluate its effectiveness to identify if signal timing changes are needed
- 6th Avenue from Watts Street to Canal Street – implement bus rerouting from Watts Street to Canal Street (Phase I) during the weekday PM peak period and monitor its effectiveness to identify if modifications are needed

West Street Corridor

- West Street/Leroy Street – close median opening to discourage unsafe pedestrian crossings of West Street
- Canal Street between Canal Park and Greenwich Street – implement improvements for pedestrian accessibility to and around Canal Park
- Clarkson Street between West Street and Greenwich Street – reconstruct street and provide bicycle lane
- West Street between West Houston Street and Canal Street – construct new mid-block signal-controlled pedestrian crossing

Watts Street Corridor

- Broome/Watts Streets approach to the Holland Tunnel – implement Option 1 to better organize traffic flow using temporary materials and monitor the effectiveness of these changes to identify if modifications are needed

Varick Street Corridor

- Varick Street between King Street and Spring Street– install Leading Pedestrian Intervals
- Varick Street between West Houston Street and Canal Street —retain existing cross section at this time

6.2 Assessment Results

The following tables for the four study corridors summarize the improvement options that were assessed and provide additional information on the results of the assessments.

Findings and Recommendations: 6th Avenue Corridor

Location, Issue & Improvement	Options	Recommendation	Notes
6th Avenue between King Street and West Houston Street **Issue** Difficulty accessing eastbound West Houston Street from eastbound King Street along 6th Avenue results in traffic and safety issues, particularly on the northbound 6th Avenue approach. **Improvement** Streamline traffic movement from eastbound King Street to eastbound West Houston Street via 6th Avenue.	Provide separate signal phases for King Street eastbound and westbound approaches.	Do not progress	Providing separate signal phases for King Street approaches did not yield the desired results.
	Reverse direction of King Street between 6th Avenue and Macdougal Street to eliminate head-on condition at 6th Avenue.	Progress	New STOP control will be needed for eastbound King Street approach to intersection with Macdougal Street. Reversing the direction of the westbound King Street approach would not increase the traffic volume by the school located on Macdougal Street, north of King Street.
	Increase green time for the northbound 6th Avenue right turn onto West Houston Street.	Monitor effects of street reversal and determine whether signal timing change is needed.	This option would reduce the pedestrian crossing time for the south section of the east crosswalk that spans from the southeast corner to the pedestrian refuge island on West Houston Street. It would only be implemented if the King Street reversal did not yield the desired results. An additional option to provide a second right-turn lane from northbound 6th Avenue onto eastbound West Houston Street was determined to be infeasible and rejected as an option. Both 6th Avenue and West Houston Street are through truck routes and the right-turn lane would need to be designed for WB-40 trucks. As a result, the existing median and pedestrian refuge island, separating eastbound and westbound traffic, would have to be significantly reduced to accommodate the additional right-turn lane.

Findings and Recommendations: 6th Avenue Corridor

Location, Issue & Improvement	Options	Recommendation	Notes
Bus Rerouting on 6th Avenue from Watts Street to Canal Street **Issue** Bus movements to the Holland Tunnel during the weekday PM peak period generally involve: • Buses turning left from 6th Avenue onto Watts Street; and • Buses accessing the tunnel via the Watts Street entrance on Varick Street Lane closure due to construction on north side of Watts Street between 6th Avenue and Varick Street exacerbates this issue. **Improvement** Reroute buses to use Canal Street to access the Holland Tunnel via the Hudson Street entrance (instead of using Watts Street to access the Tunnel via the Varick Street entrance). Buses would access the Holland Tunnel by making a right-turn around the far side of the pedestrian island at the Hudson Street entrance.	Phase I (Test): Reroute buses to use the westbound through lane on Canal Street to access the Tunnel at Hudson Street during the weekday PM peak and bypass the queue in the two right-turn lanes accessing the Tunnel at Canal Street.	Progress the Phase I test and monitor travel times and other MOEs for buses and for Holland Tunnel approaches to evaluate benefits/ impacts and any refinements that may be needed.	Phase I bus rerouting during the weekday PM peak would reduce the estimated travel time for commuter buses from 6th Avenue to Holland Tunnel by approximately 12 minutes. Another TEA may need to be assigned at the Hudson Street entrance to the Holland Tunnel to help manage additional traffic flow. (With bus rerouting, a TEA may be reassigned from 6th Avenue at Watts Street.) The additional TEA would manage potential conflicts in the north crosswalk between buses and people crossing. In addition, a TEA could enforce the restriction that only buses on westbound Canal Street use the Hudson Street access to the Tunnel. Bus lane camera enforcement could also be applied.
	Potential Phase II: Reconfigure Canal Street between 6th Avenue and Tunnel entrance at Hudson Street to convert one eastbound lane into a permanent dedicated westbound bus lane.	Do not progress. Based on assessment of the Phase I test, identify whether major changes to the Phase II concept should be further investigated.	Traffic operations during the AM peak appear to be incompatible with the concept developed for a permanent westbound bus lane on Canal Street. Major changes would be needed to the Phase II concept that was developed initially.

Findings and Recommendations: West Street Corridor

Location, Issue & Improvement	Options	Recommendation	Notes
West Street/Leroy Street **Issue** Unauthorized and unsafe pedestrian crossings of West Street at the median opening on Leroy Street where there are no crosswalks or traffic signals. **Improvement** Close median opening to reinforce the signing that was an early action improvement to guide people crossing West Street at Morton Street to north or Clarkson Street to south.	N/A	Progress	NYS DOT, NYPD and FDNY supported this improvement. Requires continuing coordination with NYS DOT.

Findings and Recommendations: West Street Corridor

Location, Issue & Improvement	Options	Recommendation	Notes
Canal Street between Canal Park and Greenwich Street **Issue** Need to improve the walking environment near the west end of Canal Street in the vicinity of Canal Park. **Improvement** Improve walking accessibility in the vicinity of Canal Park.	Extend the median island on Canal Street by Canal Park to Greenwich Street and provide new crosswalk on eastbound Canal Street east of Washington Street.	Progress	The median island could be used as a pedestrian walkway, connecting Greenwich Street to Canal Park. This improvement would involve the relocation of a 78-foot truck loading zone on the south side of Canal Street west of Greenwich Street.
	Provide new crosswalk on westbound Canal Street west of Washington Street.	Progress	An all-pedestrian phase already exists at the eastbound and westbound Canal Street intersections with Washington Street. As a result, there are no conflicts between people walking in the proposed crosswalks and the traffic turning from Washington Street.
Clarkson Street between West Street and Greenwich Street **Issue** Bicycle network connectivity issues due to the lack of a bicycle lane and existing cobblestones on Clarkson Street between West and Greenwich Streets. **Improvement** Extend the existing eastbound bicycle lane on Clarkson Street from Greenwich Street to West Street by reconstructing this section and installing granite slabs while retaining a cobblestone surface.	N/A	Progress	This improvement would need to be part of a project that would require multi-agency coordination and full-depth reconstruction of Clarkson Street.

Findings and Recommendations: West Street Corridor

Location, Issue & Improvement	Options	Recommendation	Notes
West Street/West Houston Street (southbound approach) **Issue** Conflicts between southbound right-turning vehicles and people in the west crosswalk. **Improvement** Provide split phase for the southbound right turn from West Street to Pier 40 and people in the west crosswalk.	N/A	Progress	NYC DOT is planning to modify the signal phasing for these movements in coordination with NYS DOT and anticipates implementation of a full southbound right-turn split-phase. Coordination with NYS DOT is on-going for the implementation of this improvement.
West Street/West Houston Street (westbound approach) **Issue** Conflicts between westbound right-turning vehicles and people in the north crosswalk. **Improvement** Provide a split phase for the westbound right turn from West Houston Street and people in the north crosswalk.	Revise the traffic signal phasing while retaining the existing westbound approach configuration.	Do not progress	Options were explored but were found to be infeasible since they would result in longer queues than currently exist and create additional conflicts. Retaining the 15-second LPI for people in the north crosswalk is the most feasible option.
	Reconfigure the westbound approach to allow signal phasing changes.	Do not progress	

Findings and Recommendations: West Street Corridor

Location, Issue & Improvement	Options	Recommendation	Notes
West Street between West Houston Street and Canal Street **Issue** Desire for additional pedestrian crossing of West Street. Additional walking access to the Hudson River Greenway is needed between Canal Street and West Houston Street/Pier 40. **Improvement** Provide additional signalized pedestrian crossing of West Street.	Approximately 390 feet south of West Houston Street	Progress	New signalized crosswalk at this location was deemed feasible, since (1) the median width is consistent with existing pedestrian refuge widths for West Street; (2) the location is outside of the typical left-turn queue areas that exist to the south at the southbound West Street left turn to eastbound Canal Street, therefore people walking are less likely to confront vehicles in the crosswalk; (3) there would be no turning vehicles to conflict with people in the crosswalk; and (4) would provide alternate crossing location of West Street, relieving demand at West Houston Street crosswalk. This crosswalk is expected to meet a signal warrant based on vehicle and pedestrian volumes associated with future development, particularly 550 Washington Street. Requires coordination with NYS DOT, Hudson River Park Trust, and 550 Washingston Street developers.
	North of westbound Canal Street	Do not progress	The crosswalk options north and south of westbound Canal Street were deemed infeasible, since (1) the median width would be substantially less than the desired pedestrian refuge width used for West Street, (2) vehicle queues would block the crosswalk, and/or (3) traffic operations would require multilane permitted turning movements that would conflict with people at several points along the crosswalks at Canal Street.
	South of westbound Canal Street (at Canal Park)	Do not progress	

Findings and Recommendations: Watts Street Corridor

Location, Issue & Improvement	Options	Recommendation	Notes
Broome and Watts Streets Approach to Holland Tunnel **Issue** Congestion and confusion at the intersections along Broome/Watts Street approaching the Holland Tunnel. **Improvement** Revise traffic signage and pavement markings in the Broome/Watts Street corridor to achieve a better lane balance, reduce merging conflicts, and better organize traffic flow on the approach to the Holland Tunnel.	During weekday PM peak, four westbound lanes would be provided from the split at West Broadway. The south curb lane would be dropped approaching 6th Avenue. Three westbound lanes would continue west of 6th Avenue until the north curb lane would be dropped approaching Varick Street. The exclusive left-turn lane onto Varick Street would be maintained in the south curb lane.	Progress	Would provide for more vehicle storage along the Broome/ Watts Street corridor (shortening the length of the westbound queue approaching the Holland Tunnel), but would result in one additional downstream merge point, east of Varick Street. It would also require less daily intervention from NYPD (e.g., setting out traffic cones to channelize traffic, as is done today). Although it would result in two merge points—one east of 6th Avenue on the south side, and one east of Varick Street on the north side—this would likely achieve a better lane balance among all four lanes since all lanes experience one merge.
	During the weekday PM peak, three westbound lanes would be provided from the split at West Broadway. The north lane, adjacent to the south side of the park between Thompson Street and West Broadway, would be eliminated to maintain three westbound lanes (this lane could be dedicated to pedestrian space). The south curb lane would be dropped approaching 6th Avenue. Two westbound lanes would continue west of 6th Avenue and would be used to access the Holland Tunnel. The exclusive left-turn lane onto Varick Street would be maintained in the south curb lane. In this option, the north curb lane would be coned off by NYPD from west of Thompson Street to east of Varick Street to prevent this lane's usage by through traffic.	Do not progress	A variation of this proposal would allow parking in the north curb lane during all times except the PM peak to prevent its usage by through traffic and minimize parking maneuvers. As there is a concern that if parking was allowed in this lane, the added parking maneuvers would introduce additional friction and congestion to the Tunnel- bound traffic. Relative to Option 1 (described above), Option 2 would provide for less vehicle storage along the Broome/ Watts Street corridor (increasing the length of the westbound queue approaching the Holland Tunnel) and would require more daily intervention by NYPD to set up movable traffic barriers (i.e. cones) for traffic channelization purposes. Although it would result in only one merge point—east of 6th Avenue, between the left and center lanes—it may also create a lane imbalance and introduce friction by increasing the propensity for drivers to merge into the right lane (which has no merge points and continues straight to the Tunnel).

Findings and Recommendations: Varick Street Corridor

Location, Issue & Improvement	Options	Recommendation	Notes
Varick Street at Selected Intersections **Issue** Improve pedestrian crossings along Varick Street. **Improvement** Provide Leading Pedestrian Intervals (LPIs) at the following locations along Varick Street: King, Charlton, Vandam, and Spring Streets.	N/A	Progress	No LPI needed at the Dominick Street intersection, since there is already an all-pedestrian signal phase. Primary benefit could be expected during the off-peak periods. LPIs provide people crossing a head start when entering an intersection and increase the percentage of drivers who yield to people crossing.

Findings and Recommendations: Varick Street Corridor

Location, Issue & Improvement	Options	Recommendation	Notes
Varick Street between West Houston Street and Canal Street **Issue** Various potential street configurations have been identified for this section of Varick Street. **Improvement** Retain existing cross section.	Retain the existing Varick Street geometry, including the on-street parking along east curb.	Retain existing cross section at this time based on the evaluation of conditions during this Study	It should be noted that these options are mutually exclusive due to the limited cross-section on Varick Street and the need to maintain two travel lanes at all times along this critical section for general mobility and emergency access purposes. Notes for median and bike lane options: (1) Would remove through travel lane and eliminate parking, leaving two full time travel lanes. As a result, "No Stopping Anytime" regulations for the east curb on Varick Street would be needed. A parking survey was conducted that showed approximately 200 vehicles use the east curb, including many commercial vehicles. These vehicles would be displaced under either the median or bike lane option. (2) As a result, commercial activities along Varick Street would be disrupted, since all access to the east curb would be prohibited. However, trucks and other delivery vehicles could still be expected to stop (illegally) at the curb which would reduce Varick Street to only a single through lane. (3) NYPD and FDNY concerns regarding the elimination of a through lane along this section of Varick Street. (4) Would reduce queue storage south of West Houston Street approaching the Holland Tunnel. (5) Would affect traffic operations, including emergency vehicles and M20 bus route. Additional notes for the median option: (1) NYPD and FDNY concerns regarding inaccessibility to buildings on the west side of Varick Street when there is traffic backed up from the Holland Tunnel entrance on Varick Street (2) Would require further subsurface investigation, due to the subway line that is located under this section of Varick Street.
	Install median separating through and Tunnel-bound lanes by removing east curb lane from use as travel or parking lane.		
	Install protected bike lane extending along east curb by removing east curb lane from use as travel or parking lane.		

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