Low-Cost Improvements to Express-Highway Bottleneck Locations

Low-Cost Improvements to Express-Highway Bottleneck Locations

Project Manager
Chen-Yuan Wang

Project Principal
Mark Abbott

Data Analysts
Julie Dombroski
Kathy Jacob

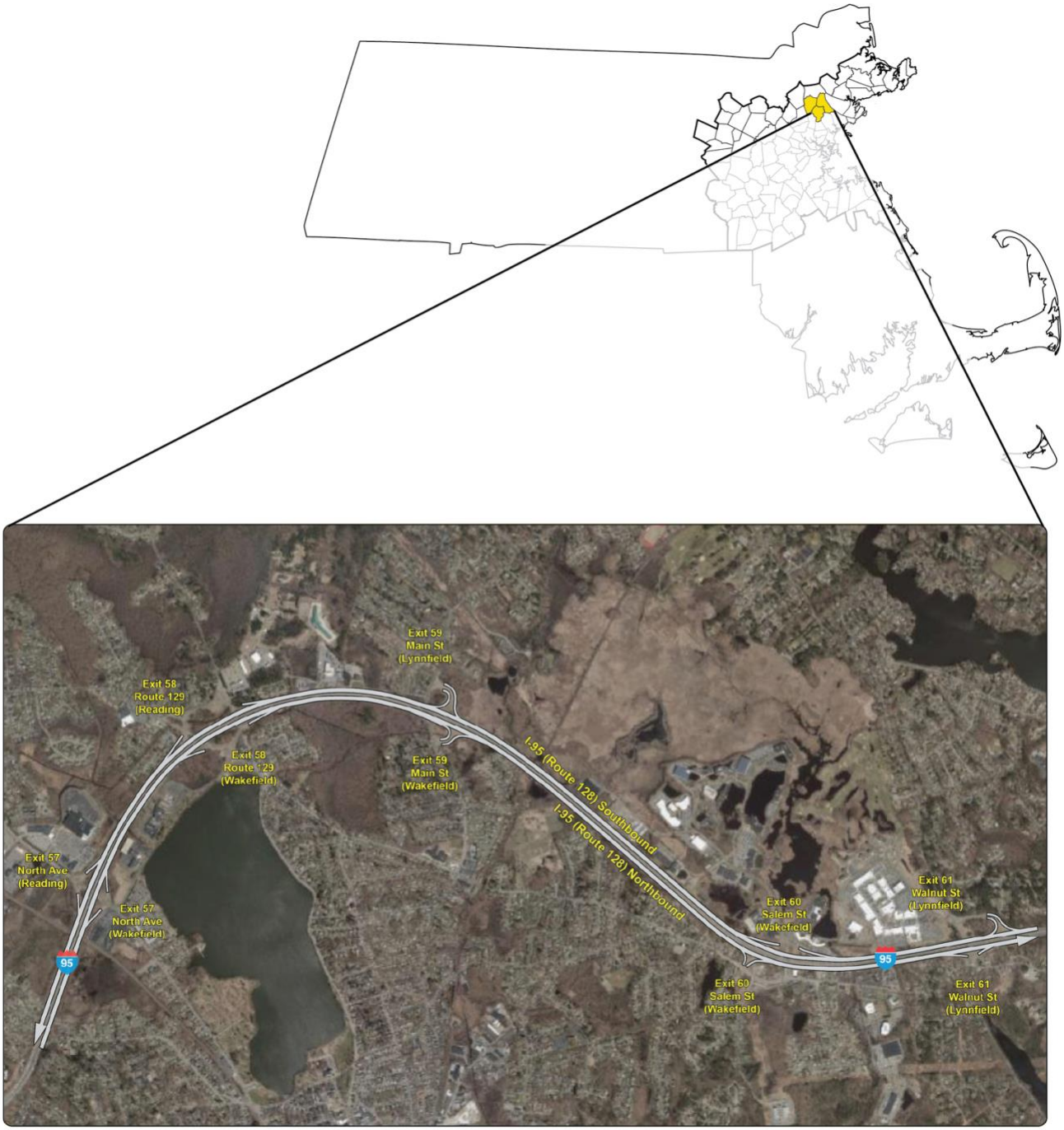
Graphics
Kim DeLauri

Cover Design
Kim DeLauri

The preparation of this document was supported by the Federal Highway Administration through MPO Planning Contract #112310.

Central Transportation Planning Staff is directed by the Boston Region Metropolitan Planning Organization (MPO). The MPO is composed of state and regional agencies and authorities, and local governments.

May 2022



For general inquiries, contact

Central Transportation Planning Staff
State Transportation Building
Ten Park Plaza, Suite 2150
Boston, Massachusetts 02116

857.702.3700
ctps@ctps.org
ctps.org

The Boston Region Metropolitan Planning Organization (MPO) operates its programs, services, and activities in compliance with federal nondiscrimination laws including Title VI of the Civil Rights Act of 1964 (Title VI), the Civil Rights Restoration Act of 1987, and related statutes and regulations. Title VI prohibits discrimination in federally assisted programs and requires that no person in the United States of America shall, on the grounds of race, color, or national origin (including limited English proficiency), be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination under any program or activity that receives federal assistance. Related federal nondiscrimination laws administered by the Federal Highway Administration, Federal Transit Administration, or both, prohibit discrimination on the basis of age, sex, and disability. The Boston Region MPO considers these protected populations in its Title VI Programs, consistent with federal interpretation and administration. In addition, the Boston Region MPO provides meaningful access to its programs, services, and activities to individuals with limited English proficiency, in compliance with U.S. Department of Transportation policy and guidance on federal Executive Order 13166.

The Boston Region MPO also complies with the Massachusetts Public Accommodation Law, M.G.L. c 272 sections 92a, 98, 98a, which prohibits making any distinction, discrimination, or restriction in admission to, or treatment in a place of public accommodation based on race, color, religious creed, national origin, sex, sexual orientation, disability, or ancestry. Likewise, the Boston Region MPO complies with the Governor's Executive Order 526, section 4, which requires that all programs, activities, and services provided, performed, licensed, chartered, funded, regulated, or contracted for by the state shall be conducted without unlawful discrimination based on race, color, age, gender, ethnicity, sexual orientation, gender identity or expression, religion, creed, ancestry, national origin, disability, veteran's status (including Vietnam-era veterans), or background.

A complaint form and additional information can be obtained by contacting the MPO or at http://www.bostonmpo.org/mpo_non_discrimination.

To request this information in a different language or in an accessible format, please contact

Title VI Specialist
Boston Region MPO
10 Park Plaza, Suite 2150
Boston, MA 02116
civilrights@ctps.org

By Telephone:
857.702.3702 (voice)
For people with hearing or speaking difficulties, connect through the state MassRelay service:

- **Relay Using TTY or Hearing Carry-over:** 800.439.2370
- **Relay Using Voice Carry-over:** 866.887.6619
- **Relay Using Text to Speech:** 866.645.9870

For more information, including numbers for Spanish speakers, visit
https://www.mass.gov/massrelay.

Abstract

The section of Interstate 95 (I-95) between Exits 57 and 61 that runs through Reading, Wakefield, and Lynnfield, is one of the most frequently traveled corridors in the state. Motorists on this section of I-95 regularly experience delays resulting from highway bottlenecks, particularly during peak travel periods in the morning and afternoon. The federal fiscal year 2021 *Low-Cost Improvements to Express-Highway Bottleneck Locations* study examined these conditions to identify the cause of the traffic delays and develop low-cost solutions to improve traffic operations and safety in this area. Recommendations are given for reconfiguring acceleration and deceleration lanes and adding an auxiliary lane to alleviate congestion. The results of this study provide the MassDOT Highway Division with information for beginning to design and engineer improvements to these bottleneck locations.

TABLE OF CONTENTS **PAGE**

TABLES

FIGURES

APPENDICES

Executive Summary

The purpose of the *Low-Cost Improvements to Express-Highway Bottleneck Locations* study was to identify low-cost improvements that will help reduce congestion at freeway bottleneck locations in the Boston Metropolitan Planning Organization (MPO) region. The study was accomplished through cooperation with the Massachusetts Department of Transportation (MassDOT) Highway Division.

Bottlenecks on the freeway network can occur where geometric elements, such as ramps or lane drops, restrict traffic flow and become a major contributor to recurring congestion. Candidate locations in this study were identified based on input from the MassDOT Highway Division and review of the MPO's Congestion Management Process data. The screening process yielded two locations on Interstate 95 (I-95) that had the potential for low-cost improvements: 1) I-95 southbound between Exit 58 (Route 129) and Exit 57 (North Avenue) in Wakefield and Reading, and 2) I-95 northbound at Exit 61 (Walnut Street) in Lynnfield.

After further review of the areas adjacent to the two locations and discussions with MassDOT Highway Division District 4 staff, MPO staff selected the northbound and southbound sections of I-95 between Exit 57 and Exit 61 for a comprehensive and systematic analysis to identify bottleneck locations for low-cost improvements. Travelers on this section of I-95 regularly experience poor levels of service and endure additional delays while entering or exiting the freeway during the weekday AM and PM peak travel periods.

MPO staff performed a series of operational and safety analyses, including traffic-volume estimations and projections, and analyses of highway capacity, travel speeds, and crash data. Staff then developed low-cost improvement proposals for the identified bottleneck locations.

The locations and proposed improvements are as follows:

- *I-95 northbound between Exit 57 and Exit 58:* Expand the existing paved shoulder and add an auxiliary lane between the exit ramp and the entrance ramp.
- *I-95 northbound merge segment at Exit 58:* Extend the acceleration length.
- *I-95 northbound diverge segment at Exit 60:* Extend the deceleration length.

- *I-95 southbound between Exit 58 and Exit 57:* Expand the existing paved shoulder and add an auxiliary lane between the exit ramp and the entrance ramp.
- *I-95 southbound merge segments at Exit 59 and Exit 61:* Extend the acceleration length.
- *I-95 southbound diverge segments at Exit 58 and Exit 59:* Extend the deceleration length.

The study aligns with the MPO's goals of managing capacity, improving mobility, and improving safety on the region's highway system. The proposed low-cost improvements would improve the freeway facilities, make traffic operations more efficient, and reduce congestion at the identified bottleneck locations. The improvements also would reduce crashes and improve safety for the freeway users.

Chapter 1—Introduction

1.1 BACKGROUND

According to the Federal Highway Administration (FHWA), "Much of recurring congestion is due to physical bottlenecks—potentially correctible points on the highway system where traffic flow is restricted. While many of the nation's bottlenecks can only be addressed through costly major construction projects, there is a significant opportunity for the application of operational and low-cost infrastructure solutions to bring about relief at these chokepoints." [1]

The cause and duration of highway bottlenecks are various. In general, recurring bottlenecks, the subject of this study, are influenced by the design or operation present at the point where the bottleneck begins. These points may be where the highway design is less than optimal; where traffic merges, diverges, or weaves; where there are abrupt changes in highway alignment, lane drops, or narrowing of lanes; at low-clearance structures; or where traffic is disrupted intentionally for management purposes.

Since 2011, MPO staff analyzed several express-highway bottleneck locations in five previous studies; these studies were well received by the Massachusetts Department of Transportation (MassDOT) and the FHWA.[2] Previous study locations included sections of Interstate 95 (I-95) in Burlington, Lexington, and Weston; sections of Interstate 93 (I-93) in Woburn; sections of Route 3 in Braintree; sections of Route 24 in Canton and Randolph; sections of I-93 northbound in Wilmington; and sections of I-93 southbound in Quincy and Braintree.

[1] Federal Highway Administration, *Recurring Traffic Bottlenecks: A Primer: Focus on Low-Cost Operations Improvements* (US Department of Transportation, June 2009) p. 1.

[2] Seth Asante, MPO staff, memorandum to the Transportation Planning and Programming Committee of the Boston Region Metropolitan Planning Organization, "Low-Cost Improvements to Bottleneck Locations," June 2, 2011; Chen-Yuan Wang, MPO staff, memorandum to the Transportation Planning and Programming Committee of the Boston Region Metropolitan Planning Organization, "Low-Cost Improvements to Bottleneck Locations, Phase II," March 12, 2012; Seth Asante, MPO staff, memorandum to the Boston Region Metropolitan Planning Organization, "Low-Cost Improvements to Bottleneck Locations," December 3, 2015; Seth Asante, MPO staff, "Low-Cost Improvements to Bottleneck Locations," Boston Region Metropolitan Planning Organization, January 2018; and Seth Asante and Chen-Yuan Wang, MPO staff, "Low-Cost Improvements to Bottleneck Locations," Boston Region Metropolitan Planning Organization, February 2020.

The MassDOT Highway Division has implemented many of the recommendations from those studies, and the FHWA has interviewed MPO staff about these successful implementations, including

- restriping lanes to serve traffic demand better on I-95 northbound at Interchange 24 in Weston;
- restriping lanes to serve traffic demand better on I-95 southbound at Interchange 24 in Weston;
- providing two-lane exits for traffic exiting I-95 northbound to Route 3 northbound and the Middlesex Turnpike at Interchange 32 in Lexington and Burlington; and
- providing two-lane exits for traffic exiting I-95 southbound to Route 3 northbound and the Middlesex Turnpike at Interchange 32 in Burlington.

Cost estimates for low-cost bottleneck improvements that have been implemented by the MassDOT Highway Division, or currently are in design status, range between $10,000 and $1 million.

1.2 PURPOSE OF STUDY

The purpose of this study was twofold. First, the study aimed to identify bottleneck locations where low-cost mitigation improvements are potentially applicable. Second, the study aimed to recommend low-cost mitigation improvements based on analysis of geometric design, traffic volumes and other data, and projected service performance associated with the improvements at each location.

MPO staff conducted a series of highway operations and crash data analyses to identify low-cost methods to reduce congestion, increase safety, and improve traffic operations. Technical expertise was provided by MassDOT Highway Division staff, who are familiar with the region’s express-highway system operations, to develop and evaluate a comprehensive list of potential improvements at the bottleneck locations.

1.3 REPORT ORGANIZATION

The following chapters of this report describe the selection of study locations, an assessment of the safety and operational problems, and potential improvement strategies. The final section presents the proposed low-cost improvements for several locations and recommendations. This report also includes a series of technical appendices, which cite the study methods, highway capacity analysis reports, and intersection capacity analysis reports for the signalized interchanges in the study area.

Chapter 2—Selection of Study Locations

2.1 INVENTORY OF CANDIDATE LOCATIONS

MPO staff developed an initial list of candidate locations in the Boston region based on the following:

- Consultations with MassDOT Highway Division
- Staff knowledge of bottleneck locations in the Boston region
- Review of Congestion Management Process (CMP) monitoring data, recent MPO studies, and other planning studies

The inventory process also included a review of the locations collected in the previous studies that have potential for low-cost improvements. The process yielded over 20 bottleneck locations in the Boston region for further screening.

2.2 SCREENING CANDIDATE LOCATIONS

MPO staff used the following three criteria to screen the bottleneck locations:

1. Does the location qualify as a bottleneck?

   A repetitive, long traffic queue upstream trailing free-flowing traffic downstream usually characterizes the location as a bottleneck. In other words, the location experiences routine and predictable congestion because traffic volume exceeds the available capacity at that location.

2. Is a physical design constraint or operational conflict inherent in the location the cause of the bottleneck?

   Examples of these constraints or conflicts include the following:

   - *Lane drop:* One or more travel lanes end, requiring traffic to merge
   - *Weaving area:* Drivers must merge across one or more lanes to access an entry or exit ramp
   - *Merge area:* On-ramp traffic merges with mainline traffic to enter the freeway
   - *Major interchanges:* High-volume traffic is directed from one freeway to another

3. Can low-cost operational and geometric improvements fix the bottleneck?

   These improvements exclude costly long-term solutions such as expansion or widening of the roadway. Examples of low-cost operational and geometric improvements include the following:

- Using a short section of shoulder as an additional travel lane or for lengthening an acceleration or deceleration lane
- Restriping merge and diverge areas to better serve traffic demand
- Providing all-purpose reversible lanes
- Changing or adding signs and striping

Based on the suggestions from MassDOT Highway Division officials and the screening criteria, MPO staff identified nine express-highway bottleneck locations that have the potential to be corrected with low-cost mitigation strategies (see Table 1). Among them, Locations 1 and 2 are considered as having high potential because there is sufficient highway layout and few constraints in the adjacent areas. The other locations were not selected in this round because of funding resources. Those locations can be considered in future bottleneck studies.

Table 1
Express-Highway Locations with Potential for Low-Cost Improvements

Location Number	City/Town	MassDOT District	Express-Highway Section	Problem
1	Wakefield	4	I-95 southbound between Exit 58 (Route 129) and Exit 57 (North Avenue)	Merge and diverge
2	Lynnfield	4	I-95 northbound at Exit 61 (Walnut Street)	Merge and diverge during the PM commute
3	Woburn	4	I-95 northbound between Exit 53 (Route 38) and Exit 54 (Washington Street)	Merge and diverge
4	Medford	4	I-93 southbound between Route 16 on-ramp and Exit 22 (Route 16 off-ramp)	Merge and diverge
5	Saugus	4	Route 1 southbound between Essex Street and Broadway (Route 99)	Merge and diverge
6	Foxborough	5	I-95 southbound at I-495 northbound and southbound	Merge and diverge during the PM commute
7	Boston	6	I-93 northbound at the end of the HOV zipper lane in Savin Hill	Merge and weave during the AM commute
8	Canton and Randolph	6	I-93 northbound between Exit 1 (I-95) and Exit 4 (Route 24)	Merge, diverge, and weave
9	Canton and Randolph	6	I-93 southbound between Exit 1 (I-95) and Exit 4 (Route 24)	Merge, diverge, and weave

Notes: 1) Shading indicates locations identified as having high potential for low-cost improvements in this study.
2) All the exit numbers are based on the recently (2020–21) updated mile-based numbers.

HOV = High occupancy vehicle. MassDOT = Massachusetts Department of Transportation.

Source: Central Transportation Planning Staff.

2.3 SELECTED BOTTLENECK LOCATIONS FOR STUDY: I-95 NORTHBOUND AND SOUTHBOUND BETWEEN EXIT 57 (NORTH AVENUE, WAKEFIELD) AND EXIT 61 (WALNUT STREET, LYNNFIELD)

After the screening process, staff further reviewed the two locations with high potential for low-cost improvements and the adjacent highway segments and found that both the northbound and southbound sections of I-95 between Exit 57 and Exit 61 were suitable for study.

Figure 1 shows the selected sections of I-95 in the study area. These sections contain five interchanges:

- Exit 57: North Avenue in Wakefield
- Exit 58: Route 129 in Wakefield and Reading
- Exit 59: Vernon Street in Wakefield and Main Street in Lynnfield
- Exit 60: Salem Street and Pleasure Island Road in Wakefield
- Exit 61: Walnut Street in Lynnfield

The distances for traffic to merge and diverge on I-95 northbound and southbound at these interchanges are generally short, some less than 500 feet. However, most of these segments appear to have sufficient highway layout with no significant terrestrial constraints. Therefore, there is space to extend the distances where traffic may merge and diverge.

Both directions of I-95 between Exit 57 and Exit 61 are usually congested in the peak periods. In general, the traffic in the peak direction (southbound in the AM peak period and northbound in the PM peak period) is much more congested than the off-peak direction. In addition to the mainline congestion, localized bottlenecks develop at the areas where traffic merges and diverges when high entry and exit volumes are present in the peak hours.

Review of the crash data also indicated that there were significant numbers of crashes on I-95 at the locations of merging and diverging traffic. This study provided a systematic review of this frequently congested section of I-95 to identify short-term improvement strategies and support long-term improvement planning.

Chapter 3—Data Collection and Analysis Methods

3.1 TRAFFIC VOLUME DATA

The MassDOT Transportation Data Management System provides traffic volume data on major express highways, arterials, and major collectors throughout the state.[3] The database contains four permanent count stations in the study area:

- I-95 between Exit 57 and Exit 58 (Location ID: 4137)
- I-95 between Exit 58 and Exit 59 (Location ID: 4423)
- I-95 between Exit 59 and Exit 60 (Location ID: 4121)
- I-95 between Exit 60 and Exit 61 (Location ID: 5099)

In addition, it contains ramp counts collected in October 2020 at all the interchanges in the study area. MPO staff used these counts and available historical data to estimate traffic volumes on the I-95 northbound and southbound mainline and ramps. Staff also adjusted some of the counts collected during the COVID-19 pandemic period.[4]

3.2 CRASH DATA

MPO staff used crash data from January 2015 to December 2017 from the MassDOT Registry of Motor Vehicles database to analyze crash severity, collision type, and roadway conditions and to evaluate safety for motorists.

3.3 SPEED DATA

The CMP maintains average speed data on express-highway systems in the Boston region, incorporating the INRIX historical traffic speed data.[5] MPO staff used the current speed data from the CMP (spring 2019 and fall 2019) to determine the average weekday travel speeds through the bottlenecks.

3.4 LEVEL OF SERVICE CRITERIA

Level of service (LOS) is a quality measure of effectiveness describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions,

[3] The data are available from Massachusetts government webpage: https://www.mass.gov/traffic-volume-and-classification.

[4] See Section 4.2.1 of this report for further description of the estimation process.

[5] INRIX is a private company that collects roadway travel times and origin-destination data for most roadways that are collectors, arterials, limited-access roadways, or freeways.

and comfort and convenience. Factors influencing LOS are volumes, lane width, lateral obstructions, traffic composition, grade, and speed. The *Highway Capacity Manual* (HCM) methodology demonstrates driving conditions on freeways in terms of LOS ratings from A through F.[6]

The LOS criteria have been developed for each freeway component—basic freeway, ramp merge/diverge, and weaving segments. The locations and traffic flow characteristics at each of the components are described below.

- *Basic freeway segments* are outside of the influence area of ramps or weaving areas of the freeway. The flow in such segments occurs more smoothly than segments with merging, diverging, or weaving. The exact point at which basic freeway segments begin or end depends on local conditions, particularly the LOS operating at the time. If traffic flow is light, the influence may be negligible, whereas under congested conditions, queues may be extensive.
- *Freeway merge segments* are ramp junction areas where two separate traffic streams (mainline and on-ramp) join to form one stream on the mainline. The influence areas of merging segments depend on local traffic conditions.
- *Freeway diverge segments* are ramp junction areas where one traffic stream diverges to form two separate streams (mainline and off-ramp). The influence areas of merge segments depend on local traffic conditions.
- *Weaving segments* are areas of the freeway where two or more vehicle flows must cross paths along a length of the freeway in order to continue. They are usually formed when merge areas are closely followed by diverge areas.
- A *major merge* occurs when two multilane freeway segments combine to form a single freeway segment with three or more lanes. Likewise, a *major diverge* occurs when a freeway segment with three or more lanes splits into two multilane basic freeway segments. While these locations can create turbulence in the traffic flow, they are less restrictive than freeway ramps because speed differences are smaller and lane changes are often unnecessary.

Table 2 shows the LOS criteria for basic freeway, merge/diverge, and weaving segments. LOS A represents the best operating conditions (unrestricted operations) while LOS F represents the worst operating conditions. LOS A

[6] Transportation Research Board of the National Academies, *Highway Capacity Manual Sixth Edition: A Guide for Multimodal Mobility Analysis*, or HCM 2016, or HCM6, (Washington, DC, October 2016).

through LOS D represent acceptable operating conditions. LOS E represents operating conditions at capacity. LOS F represents failing conditions (demand exceeds capacity). The LOS criteria characterize freeway performance measures in terms of density (passenger cars per lane mile).

Table 2
LOS Criteria for Basic Freeway, Merging/Diverging, and Weaving Segments

	Basic Freeway Segment	Ramp Merge/Diverge and Weaving Segments
LOS	**Density (pc/lane mile)**	**Density (pc/lane mile)**
A	0–11	0–10
B	11–18	10–20
C	18–26	20–28
D	26–35	28–35
E	35–45	>35
F	>45	Demand exceeds capacity (V/C>1)

LOS = level of service. pc/lane mile = passenger cars per lane mile. V/C = volume-to-capacity ratio.
Source: Highway Capacity Manual 2010.

The traffic operations analyses conducted by MPO staff were consistent with HCM methodologies. Using the data collected, MPO staff then built traffic analysis networks for the AM and PM peak hours and applied the Highway Capacity Software (HCS) to assess the capacity and quality of traffic flow at the potential bottleneck locations.[7]

[7] Highway Capacity Software 7(HCS7), Version 7.9, McTrans Center, University of Florida, July 15, 2020. HCS7 implements the methodologies of HCM6.

Chapter 4—Operations and Safety Analysis

4.1 EXISTING FREEWAY CHARACTERISTICS

As explained in Section 3.4, in general, three types of segments are found on express highways (freeways):

- *Freeway merge and diverge segments:* Segments in which two or more traffic streams combine to form a single traffic stream (merge) or a single traffic stream divides to form two or more separate traffic streams (diverge).
- *Freeway weaving segments:* Segments in which two or more traffic streams traveling in the same direction cross paths along a significant length of freeway without traffic control devices. In most cases, weaving segments are formed when a diverge segment is closely followed by a merge segment.
- *Basic freeway segments:* All segments that are not merge, diverge, or weaving segments.

The study locations in the I-95 northbound and southbound sections between Exit 57 and Exit 61 are associated with the freeway merge segment, freeway diverge segment, and basic freeway segment operations. Figure 2 shows the three freeway segment types at the locations analyzed in this study. The operational components of the three types of freeway segments are further discussed in the next section.

In addition, freeway operations could be affected by operations at interchanges where the freeway entrance and exit ramps meet the arterial and major roadways, especially when the interchange traffic is busy and causes traffic queues extending into the freeway. Three of the five interchanges (Exits 57, 60, and 61) are under traffic signal controls and their operations in the peak hours could potentially interfere with I-95 traffic operations. To examine their potential impacts to I-95 operations, this study reviewed traffic operations at the three interchanges based on peak-hour turning movement counts collected in the summer of 2021.[8]

Another major factor that affects I-95 operations in the study area is the traffic conditions at the interchange of I-93 and I-95 (Exit 28 on I-93 and Exit 55 on I-95). The interchange carries significant traffic volumes from both interstate

[8] The counts were taken during a period when the COVID-19 pandemic was less severe but still prevailing. As no historical data at the count locations were available for comparisons and adjustments, these current data were used directly for analysis.

highways and is one of the most congested locations in the state. During peak periods, the congestion has a significant impact on I-95 and causes significant delays for users of both highways. In the study area, the interchange congestion mainly affects the traffic operations on I-95 between Exit 57 and Exit 58, especially in the southbound direction during the AM peak period and in the northbound direction during the PM peak period.

The interchange of I-93 and I-95 is a major bottleneck in the region and its congestion is a much larger issue that can only be addressed through long-term transportation planning. However, the low-cost improvements proposed in this study would meaningfully improve the freeway merge and diverge operations and enhance the safety for users in the freeway sections north of the major interchange.

4.2 TRAFFIC CONDITIONS AND OPERATIONS

A number of factors potentially contributed to traffic congestion at various locations in the I-95 northbound and southbound study sections:

- High volume of traffic during the peak hours
- Short deceleration lanes affecting freeway diverging operation
- Short acceleration lanes affecting freeway merging operation
- Basic freeway segments operating at capacity during the peak hours
- Congestion at the interchange of I-93 and I-95 affecting the freeway traffic flow in the study sections
- Potential traffic queues from the interchange traffic operations

These factors are further analyzed in the following sections.

4.2.1 Traffic Volumes

The section of I-95 between Exits 57 and 61 is one of the most frequently traveled corridors in the state. This section of highway carried approximately 140,000 to 150,000 vehicles per average weekday in recent years, from 2015 to 2019, before the COVID-19 pandemic.[9] Daily traffic on I-95 in the study area reduced significantly during this pandemic period, varying from approximately 10 to 25 percent in general to more than 50 percent in the peak pandemic period (spring 2020).[10]

[9] Massachusetts Governor's COVID-19 Order #5, which prohibited gatherings of more than 25 people, was issued on March 15, 2020.

[10] The review was based on two resources: 1) available traffic counts on I-95 in the study area from MassDOT Transportation Data Management System, and 2) the MassDOT Mobility Dashboard (https://mobility-massdot.hub.arcgis.com) that provides information to monitor the impacts of COVID-19 on the state's transportation network, including roadways and transit

MPO staff therefore chose 2019 as the base year for the analysis of the existing traffic conditions and used the available traffic data from 2015 to 2019 to estimate the traffic volumes on an average weekday during active traveling months in the spring and fall. Figure 3 shows the estimated daily traffic volumes on the freeway and entrance and exit ramps in both the northbound and southbound directions.

From the collected data, staff found that weekday peak periods in this stretch of I-95 had been expanding to at least four hours: 6:00–10:00 AM and 2:30–6:30 PM. To perform a highway capacity analysis for assessing the existing traffic conditions, staff further identified AM and PM peak hours and estimated peak-hour traffic volumes. Figures 4 and 5 show the traffic flows in the AM peak hour (6:00–7:00 AM in the southbound direction and 7:00–8:00 AM in the northbound direction) and PM peak hour (5:00–6:00 PM in both directions) separately.

During the peak hours, the I-95 mainline and the entrance and exit ramps generally carry high traffic volumes, especially at Exits 57 and 58. In general, all the study locations carry high traffic volumes on the I-95 mainline in the peak direction (northbound in the AM and southbound in the PM peak hour). Field observations indicated that the merging and diverging activities are frequently impeded by the high mainline traffic volumes during the peak hours.

4.2.2 Diverging Operations

There are a number of variables that influence the freeway diverging and merging operations at the ramp-freeway junctions. Attributes influencing the merging and diverging operations include the length and type (taper or parallel) of acceleration or deceleration lanes, sight distances, speed, the distribution of vehicles across lanes, and free flow speeds of upstream freeway traffic.

Tables 3 and 4 show key attributes observed in the diverge areas on I-95 northbound and southbound by the study interchange locations and the freeway-interchange ramp types. Appendix A contains the classification of the interchange ramp types based on *A Policy on Geometric Design of Highways and Streets* (as known as the Green Book) by the American Association of State Highway and Transportation Officials (AASHTO).

The length of the deceleration lane is one of the key attributes of particular importance to the diverging operations. Based on the design guidance for

---

services, and published weekly traffic volumes at permanent count stations in the state with comparison of the volumes in the same period in 2019.

minimum deceleration lengths in MassDOT's *Project Development and Design Guide*, deceleration lanes at the study locations generally require a minimal length of 440 or 470 feet.[11] Appendix B exhibits the design standards and the applicable minimal deceleration lengths for this study.

Table 3
Diverging Operation Attributes: I-95 Northbound Locations

Location	Exit 57	Exit 58	Exit 59	Exit 60	Exit 61
Interchange Ramp Type[a]	Diagonal	Diagonal	One Quadrant	Diagonal	Diagonal
Exit Ramp Form	Slip	Slip	Loop	Compound Curve	Slip
Ramp Advisory Speed	30 mph	30 mph	25 mph	25 mph	30 mph
Estimated Deceleration Length[c]	600 feet	350 feet	750 feet	200 feet	450 feet

[a] See Appendix A.
[b] The length of the deceleration lane is measured from the starting point of the taper to the tip of the painted gore, as defined by the Highway Capacity Manual for capacity analysis purposes. This length may differ from the length defined by AASHTO, which is for geometric design purposes. In this study, these deceleration lengths were estimated approximately from the digital orthophotos of US Geological Survey Massachusetts 2019 and Google Earth 2021.
AASHTO = American Association of State Highway and Transportation Officials. mph = miles per hour.
Source: Central Transportation Planning Staff.

Table 4
Diverging Operation Attributes: I-95 Southbound Locations

Location	Exit 57	Exit 58	Exit 59	Exit 60	Exit 61
Interchange Ramp Type[a]	Diagonal	Diagonal	One Quadrant	Diagonal	One Quadrant
Exit Ramp Form	Slip	Slip	Slip	Slip	Slip
Ramp Advisory Speed	30 mph	30 mph	30 mph	30 mph	30 mph
Estimated Deceleration Length[c]	550 feet	500 feet	275 feet	575 feet	450 feet

[a] See Appendix A.
[b] The length of the deceleration lane is measured from the starting point of the taper to the tip of the painted gore, as defined by the Highway Capacity Manual for capacity analysis purposes. This length may differ from the length defined by AASHTO, which is for geometric design purposes. In this study, these deceleration lengths were estimated approximately from the digital orthophotos of US Geological Survey Massachusetts 2019 and Google Earth 2021.
AASHTO = American Association of State Highway and Transportation Officials. mph = miles per hour.
Source: Central Transportation Planning Staff.

[11] Massachusetts Highway Department, *Project Development and Design Guide*, January 2006. The guidebook describes the project development procedures and design guidelines applicable to projects with MassDOT Highway Division involvement. It provides guidance to municipalities, authorities, and other entities involved in the design and development of highways and streets, and other transportation facilities. The lengths of acceleration and deceleration lanes are measured from the point where the lane reaches 12 feet wide to the first controlling curve, according to *A Policy on Geometric Design of Highways and Streets* by AASHTO.

Among the I-95 northbound study locations, the deceleration lane at Exit 60 has a deceleration length of approximately 200 feet, which is much shorter than the minimal design standards of 470 feet. This location (under an advisory speed of 25 miles per hour) is of particular concern as the exit ramp is short in length with a sharp compound curvature and ends at a traffic signal. During peak hours, vehicles on the ramp were observed to queue back onto the freeway section from time to time, especially in the PM peak period.

Among the I-95 southbound study locations, the deceleration lane at Exit 59 has a deceleration length of approximately 275 feet, which is shorter than the minimal design standards. A quick review of the area's digital orthophotos indicates that there is potential to extend the deceleration lane in the diverge area.

4.2.3 Merge Operations

In order to allow vehicles on ramps to accelerate for merging, acceleration lanes generally require a longer distance than deceleration lanes. Based on the design guidance in MassDOT's *Project Development and Design Guide* for minimum acceleration lengths, the assumptions for initial on-ramp speed before merging is 30 miles per hour (mph) for slip ramps and 25 mph for loop ramps. The acceleration lanes in at the study locations generally require a minimal acceleration length of 1,000 and 1,120 feet to meet design standards. Appendix C exhibits the design standards and the applicable minimal deceleration lengths for this study.

Tables 5 and 6 show key operation attributes in the merge areas on I-95 northbound and southbound at the study interchange locations. The study locations generally do not meet the minimum acceleration length design standards. Among them, the merge operations at Exits 59 and 61 on I-95 southbound are of particular concern. The acceleration lengths at both locations are much shorter than the minimal design standards. Meanwhile, drivers at both on-ramps have a limited sight distance when merging due to the loop ramp geometrics.

It is challenging to meet the minimal acceleration length standards for express highways in urban areas where the adjacent areas are densely developed. Highway capacity analyses for the merge segments in the study area indicated that opportunities exist at some of the merging locations that could improve the merging capacity and operations, although design standards still would not be met.

Table 5
Merging Operation Attributes: I-95 Northbound Locations

Location	Exit 57	Exit 58	Exit 59	Exit 60	Exit 61
Interchange Ramp Type[a]	Diagonal	Diagonal	One Quadrant	Diagonal	Diagonal
Entrance Ramp Form	Slip	Slip	Slip	Compound Curve	Slip
Assumed Initial Speed[b]	30 mph	30 mph	25 mph	25 mph	30 mph
Estimated Acceleration Length[c]	600 feet	350 feet	750 feet	200 feet	450 feet

[a] See Appendix A.
[b] The initial merging speed is assumed to be comparable to the advisory speed of the exit ramp at the interchange.
[c] The length of the acceleration lane is measured from the tip of the painted gore to the end point of the taper, as defined by the Highway Capacity Manual for capacity analysis purposes. This length may differ from the length defined by AASHTO, which is for geometric design purposes. In this study, these acceleration lengths were estimated approximately from the digital orthophotos of US Geological Survey Massachusetts 2019 and Google Earth 2021.
AASHTO = American Association of State Highway and Transportation Officials. mph = miles per hour.
Source: Central Transportation Planning Staff.

Table 6
Merging Operation Attributes: I-95 Southbound Locations

Location	Exit 57	Exit 58	Exit 59	Exit 60	Exit 61
Interchange Ramp Type[a]	Diagonal	Diagonal	One Quadrant	Diagonal	One Quadrant
Entrance Ramp Form	Slip	Slip	Loop	Slip	Loop
Assumed Initial Speed[b]	30 mph	30 mph	25 mph	30 mph	25 mph
Estimated Acceleration Length[c]	550 feet	500 feet	400 feet	500 feet	350 feet

[a] See Appendix A.
[b] The initial merging speed is assumed to be comparable to the advisory speed of the exit ramp at the interchange.
[c] The length of the acceleration lane is measured from the tip of the painted gore to the end point of the taper, as defined by the Highway Capacity Manual for capacity analysis purposes. This length may differ from the length defined by AASHTO, which is for geometric design purposes. In this study, these acceleration lengths were estimated approximately from the digital orthophotos of US Geological Survey Massachusetts 2019 and Google Earth 2021.
AASHTO = American Association of State Highway and Transportation Officials. mph = miles per hour.
Source: Central Transportation Planning Staff.

4.2.4 Basic Freeway Segment Operations

As shown in Figure 2, in the operational analysis the sections between the exit ramps and the entrance ramps at the interchanges were assumed to be operating as basic freeway segments. The only other locations identified for such analysis were the northbound and southbound sections of I-95 between Exit 59 and Exit 60. According to the *Highway Capacity Manual*, the merge segments have an influence area 1,500 feet downstream of the merge point and the diverge segments have the same influence upstream of the diverge point. In this study, therefore, the basic-freeway-segment analysis was applied only to the sections where the merge and diverge segments' influence areas do not overlap.

Attributes influencing basic-freeway-segment operation include the number of lanes, lane widths, lateral clearances, terrain and grades, degree of curvature, and total ramp density.[12] The basic freeway segments on I-95 northbound and southbound in the study area generally contain three 12-foot travel lanes, a 10-foot or more right shoulder, and a six-foot left shoulder. The terrain where the segments are located is level, with a grade generally less than two percent.

4.2.5 Highway Capacity Analyses

Based on the freeway attributes and the estimated base-year (2019) peak-hour traffic volumes, staff conducted highway capacity analyses for the merge, diverge, and freeway basic segments in the study area. Figures 6 and 7 summarize the AM and PM analyses by the segment locations on I-95 northbound and southbound. Appendices D and E contain full HCS reports of the AM and PM peak-hour capacity analyses for the various study locations.

The analyses indicated that most of the diverge segments operated at acceptable LOS D, except the diverge segment on I-95 southbound at Exit 57. The segment is estimated to operate at LOS E and near its capacity.

For the merge segments, several locations were assessed to operate at LOS E and near their capacities. These include the segment at Exit 57 on I-95 northbound during both the AM and PM peak hours, Exit 58 on I-95 southbound during both the AM and PM peak hours, Exit 59 on I-95 southbound during the AM peak hour, and Exit 61 on I-95 southbound during the AM peak hour.

[12] The total ramp density is the average number of on-ramp, off-ramp, major merge, and major diverge junctions per mile. It applies to a six-mile segment of a freeway facility, three miles upstream and three miles downstream of the midpoint of the study segment.

All the basic freeway segments were assessed to operate at acceptable LOS D, with the segments at Exits 57, 58, and 59 generally having a high volume to capacity ratio near 0.90.

Note that HCS is not a traffic simulation software and the above capacity analyses do not include the congestion effects from the major bottleneck at the interchange of I-93 and I-95. The analyses, however, provide a baseline of the exiting traffic conditions for analyzing and assessing the future year no-build and proposed scenarios.

4.2.6 Freeway Travel Speeds

Figures 8 and 9 depict congestion scans that cover I-95 in the study area in the northbound and southbound direction separately. They show the average travel speeds on I-95 northbound from Exit 57 to Exit 61 and the average speeds on I-95 southbound from Exit 61 to Exit 57. The 2019 spring and fall midweek (Tuesday to Thursday) travel-time data (provided by INRIX) were used for this analysis.

As shown in Figure 8, travel speeds at the study locations on I-95 northbound generally slow to less than 55 mph from 2:30 PM to 6:30 PM, with the impact to travel speeds and the length of the congested period gradually decreasing from Exit 57 to Exit 61. The congestion scan clearly indicates the significance of the congestion effect from the major bottleneck upstream at the interchange of I-93 and I-95. The severe congestion at the interchange often causes stop-and-go traffic conditions on I-95 northbound during the PM peak hours when travel demand is high. Meanwhile, the exit and entrance ramps on I-95 northbound also carry high traffic volumes during the PM peak hours and the diverging and merging operations further impede the recovery of normal freeway travel speeds.

As shown in Figure 9, travel speeds at the study locations on I-95 southbound generally slow to less than 55 mph from 6:00 AM to 10:00 AM, with the impact to travel speeds and the length of congested period gradually increasing from Exit 61 to Exit 57. The congestion scan indicated the severe congestion at the major bottleneck downstream significantly reduces the travel speeds on I-95 southbound, especially between Exist 57 and Exit 59. Meanwhile, the exit and entrance ramps on I-95 southbound also carry high traffic volumes during the AM peak hours and the diverging and merging operations further reduce travel speeds in the mainline sections.

4.2.7 Interchange Traffic Operations

The study area contains five interchanges of different types, including diamond interchanges, a traffic rotary, a combined diamond, and one quadrant. Table 7

summarizes the configurations of these interchanges, the functional classification of the surrounding minor roadways, and the types of traffic controls present.

Table 7
Interchange Configurations and Traffic Operations

Location	Exit 57	Exit 58	Exit 59	Exit 60	Exit 61
Interchange Type	Diamond	Traffic Rotary	Two Quadrants Adjacent	Diamond	Diamond (NB)/ One Quadrant (SB)
Minor Roadway Functional Class	Minor Arterial	Principal Arterial/ Minor Arterial	Minor Arterial	Minor Arterial	Minor Arterial
Traffic Control	Traffic Signal	Yield to enter traffic circulation	Stop/Yield	Traffic Signal	Traffic Signal

NB = northbound. SB = southbound.
Source: Central Transportation Planning Staff.

Based on field observations, staff considered that the three signalized interchanges (Exits 57, 60, and 61) were more likely to cause traffic queues backing up onto the freeway. To examine the potential impacts of the traffic operations, staff requested MassDOT's assistance in collecting AM and PM peak-period turning movement counts at the three interchanges (collected on August 4, 2021) and conducted intersection capacity analyses for the three interchanges by using the Synchro traffic analysis and simulation program.[13]

Appendix F contains the capacity analyses at the signalized locations in both the AM and PM peak hours for the three interchanges. In general, all the signalized locations were assessed to operate at an acceptable LOS, except the Exit 60 ramp of I-95 northbound at Salem Street in Wakefield. The signalized location was assessed to operate at LOS F, with an average delay of nearly two minutes per vehicle and a queue length of approximately 300 feet during peak traffic periods.

Note that the analyses were based on the counts collected during the period that traffic increased significantly from the spring in 2020 when the COVID-19 pandemic was prevalent. However, the traffic had not reached the pre-pandemic level, according to MassDOT's COVID-19 traffic monitoring reports. The traffic operations at these interchanges should be reassessed when the traffic returns to the normal conditions.

[13] Synchro Version 11.1 was used for the analyses. This software is developed and distributed by Trafficware Ltd. It can perform capacity analysis and traffic simulation (when combined with SimTraffic) for an individual intersection or a series of intersections in a roadway network.

4.3 CRASH DATA ANALYSIS

MPO staff collected the recent three-year (2015–17) crash reports from the MassDOT Crash Data Portal for the selected I-95 northbound and southbound sections and conducted crash data analysis.[14] In total, 463 crashes were reported in the three-year period at different locations in the study area, consisting of 206 crashes on I-95 northbound and 257 crashes on I-95 southbound. Tables 8 and 9 summarize key attributes of the total crashes in the I-95 northbound and southbound study sections separately.

Nearly 30 percent of the total crashes on the northbound side and approximately 25 percent on the southbound side caused personal injuries, including a fatal crash on the northbound side in 2015. Nearly 60 percent of the total crashes on the northbound side and nearly 70 percent on the southbound side were reported as rear-end collisions. Single vehicle (out-of-control) and sideswipe collisions (same direction) were also prevailing on the express highway in both directions.

The data indicate that 45 percent or more of the total crashes occurred during the peak traffic periods when I-95 is congested. Meanwhile, the data show that there were more crashes on the southbound side than the northbound, which may be attributed to the congestion on I-95 as the southbound is generally more congested than the northbound during the peak times of the day (see Figures 8 and 9).

[14] The MassDOT Crash Data Portal is located at https://apps.impact.dot.state.ma.us/cdp/home.

Table 8
Summary of Crash Data 2015–17:
I-95 Northbound from Exit 57 to Exit 61

Statistics Period		2015	2016	2017	3-Year Total	Annual Average	Percentage
Total number of crashes		83	47	76	206	68.7	100%
Severity	Property damage only	52	37	57	146	48.7	71%
Severity	Non-fatal injury	30	10	19	59	19.7	29%
Severity	Fatality	1	0	0	1	0.3	0%
Severity	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	18	15	13	46	15.3	22%
Collision type	Rear-end	47	22	50	119	39.7	58%
Collision type	Angle	6	2	3	11	3.7	5%
Collision type	Sideswipe, same direction	10	7	5	22	7.3	11%
Collision type	Sideswipe, opposite direction	0	0	2	2	0.7	1%
Collision type	Head-on	0	0	0	0	0.0	0%
Collision type	Rear-to-rear	1	0	0	1	0.3	0%
Collision type	Not reported/unknown	1	1	3	5	1.7	2%
Occurred during weekday peak periods*		38	19	35	92	30.7	45%
Wet or icy pavement conditions		13	9	9	31	10.3	15%
Dark conditions (lit or unlit)		30	19	19	68	22.7	33%

* Peak periods are defined as 6:00–10:00 AM and 2:30–6:30 PM.
Source: Massachusetts Department of Transportation Crash Data Portal.

Table 9
Summary of Crash Data 2015–17:
I-95 Southbound from Exit 61 to Exit 57

Statistics Period		2015	2016	2017	3-Year Total	Annual Average	Percentage
Total number of crashes		85	78	94	257	85.7	100%
Severity	Property damage only	68	54	75	197	65.7	77%
Severity	Non-fatal injury	17	24	19	60	20.0	23%
Severity	Fatality	0	0	0	0	0.0	0%
Severity	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	11	15	14	40	13.3	16%
Collision type	Rear-end	62	52	60	174	58.0	68%
Collision type	Angle	8	2	4	14	4.7	5%
Collision type	Sideswipe, same direction	3	9	14	26	8.7	10%
Collision type	Sideswipe, opposite direction	0	0	0	0	0.0	0%
Collision type	Head-on	1	0	0	1	0.3	0%
Collision type	Rear-to-rear	0	0	1	1	0.3	0%
Collision type	Not reported/unknown	0	0	1	1	0.3	0%
Occurred during weekday peak periods*		39	39	41	119	39.7	46%
Wet or icy pavement conditions		13	6	19	38	12.7	15%
Dark conditions (lit or unlit)		27	17	19	63	21.0	25%

* Peak periods are defined as 6:00–10:00 AM and 2:30–6:30 PM.
Source: Massachusetts Department of Transportation Crash Data Portal.

Staff further examined the crashes by their locations in the freeway corridor. Figures 10 and 11 show the approximate crash cluster sizes and locations of the crashes in the merge, diverge, and the in-between areas at Exits 57 to 61 on I-95 northbound and southbound separately.[15] Appendices G and H summarize key attributes of the crashes at each of the interchanges on I-95 northbound and southbound separately.

On the northbound side (Figure 10), Exits 57 and 58 had a number of crashes and an injury crash rate higher than the other locations. Meanwhile, Exit 60 had a relatively high number of crashes and a high injury crash rate. In general, most of the crashes occurred in the merge and diverge areas and only a few or none occurred in the in-between areas.

On the southbound side (Figure 11), all the interchanges generally had a high number of crashes but with injury crash rates somewhat lower than those on the northbound side. This may be attributed to the slower travel speeds and more congested conditions on the southbound side. Meanwhile, none or only a few crashes occurred in the in-between areas at all the interchanges and the basic freeway segment between Exit 60 and Exit 59.

Note that the data indicated that more crashes occurred in the diverge areas than the merge areas at most of the interchanges in the study area; this finding could be the result of geocoding defaults due to insufficient information of the exact crash locations.[16] However, even with a smaller sample size, the data indicate that crashes in the merge areas generally had a higher injury crash rate than those in the diverge areas at almost all the interchanges.

4.4 FUTURE-YEAR HIGHWAY CAPACITY ANALYSES

Staff chose 2030 as the future year and projected traffic volumes for the various freeway analysis segments by using growth factors estimated from the Boston

[15] To distinguish the crash locations, staff applied a similar method to the method for defining freeway segments. The in-between area refers to the basic freeway segment between a diverge segment and a merge segment.

[16] Most crash records indicate the location only at the freeway exit number with no indications of the on-ramp or off-ramp, or the location of the crash on the freeway. Staff plotted the crash data and found that the majority of the crashes were geocoded at the diverge point of the freeway at all the study interchanges. After further reviewing the police narratives and collision diagrams, staff identified the exact locations of approximately 40 to 50 percent of the total crashes at the study interchanges. These findings, however, were considered not sufficient to represent the exact number of crashes in the merge, diverge, and in-between areas at the study interchanges. As such, Figures 8 and 9 show the total number of crashes in the vicinity of each interchange with the approximate crash clusters in the merge, diverge, and in-between areas based on the proportions of the crashes whose locations were identified.

Region MPO's regional transportation planning model. The models projected that traffic in the study area would increase by seven percent (about 0.6 percent annually) on the northbound side and six percent (about 0.55 percent annually) on the southbound side in the AM peak hour, and by six percent on the northbound and seven percent on the southbound in the PM peak hour from 2019 to 2030. Figures 12 and 13 show the projected AM and PM peak hour traffic volumes at the different locations in the study area on an average weekday in 2030.

Staff then conducted highway capacity analyses based on the projected volumes and the identified freeway segment types at each study location. Figures 14 and 15 summarize the AM and PM peak hour highway capacity analyses by segment locations in the I-95 northbound and southbound directions. Appendices I and J contain full HCS reports of the 2030 AM and PM peak-hour capacity analyses for the various study locations.

The AM peak hour analyses (Figure 14) indicate that several locations on I-95 southbound would deteriorate from LOS D to LOS E with their adjacent freeway sections near capacity under the projected 2030 traffic conditions. Noticeably, the diverge segment at Exit 57 (Segment 3), the diverge segment at Exit 58 (Segment 6), and the merge segment at Exit 59 (Segment 7) would operate at LOS E with the adjacent freeway sections at capacity. Moreover, the merge segments at Exit 57 (Segment 1) and at Exit 58 (Segment 4) would fail at LOS F with the volume-to-capacity ratio of the adjacent freeway sections equal to 1.01.

The PM peak hour analyses (Figure 15) indicate that many merge and diverge segments on both I-95 northbound and southbound would deteriorate from LOS D to LOS E. Noticeably, in the peak direction (northbound) the merge segment at Exit 57 (Segment 3) and the diverge and merge segments at Exit 58 (Segments 4 and 6) would operate at LOS E with the adjacent freeway sections reaching capacity limits.

Chapter 5—Proposed Low-Cost Improvements

The analyses described in the previous chapter identified locations in the study area with operational and safety concerns. Most of them are in the merge and diverge segments where the lengths of the acceleration and deceleration areas are insufficient. Localized bottlenecks can develop at these locations when the freeway mainline sections are congested during the peak hours.

For these locations, extending the acceleration or deceleration length is one effective low-cost strategy if the adjacent terrain is suitable and the right-of-way of the freeway is sufficient. Meanwhile, for locations where the entrance and exit ramps at interchanges are closely spaced, operational efficiency may be improved by creating a continuous auxiliary lane between the entrance and exit ramps.[17]

The sections of I-95 studied are generally located in level terrain with sufficient right-of-way, especially on the southbound side. Based on the projected 2030 traffic volumes, MPO staff conducted a series of highway capacity analyses to assess the potential application of these improvement strategies at the various study locations. Staff identified five locations on I-95 southbound and three on I-95 northbound that have potential for such low-cost improvements.

5.1 PROPOSED IMPROVEMENTS ON I-95 SOUTHBOUND

The locations and proposed low-cost improvements at the five locations on I-95 southbound are as follows:

1. *Exit 58 entrance ramp to Exit 57 exit ramp:* Expand the existing paved shoulder and add an auxiliary lane between the two ramps.
2. *Exit 58 diverge segment:* Extend the deceleration length to approximately 750 feet long.
3. *Exit 59 merge segment:* Extend the acceleration length to approximately 800 feet long.
4. *Exit 59 diverge segment:* Extend the deceleration length to approximately 450 feet long.
5. *Exit 61 merge segment:* Extend the acceleration length to approximately 800 feet long.

[17] Federal Highway Administration, *Freeway Management and Operations Handbook*, Chapter 5 (US Department of Transportation, September 2003, updated January 2011).

Figures 16 and 17 summarize the AM and PM peak hour highway capacity analyses at the locations proposed for improvements on I-95 southbound and northbound. For reference, they also include the capacity analyses under the 2030 no-build scenario at locations with no proposed improvements. Appendices K and L contain full HCS reports of 2030 AM and PM peak hour capacity analyses for the locations proposed for improvements. Figures 18 and 19 show the approximate locations and conceptual diagrams of the proposed low-cost improvements in the study area.

At Location 1, the section between the Exit 58 entrance ramp and Exit 57 exit ramp (Figure 18), the two ramps are located in close proximity (approximately 1,600 feet apart).[18] Further extending the acceleration or deceleration length and reducing the space in between would potentially increase the risk of crashes.[19] HCS tests of different deceleration and acceleration lengths also indicated that extensive lengths would require improvements to the diverging operation at Exit 58 and the merging operation at Exit 57, which are not possible in this relatively short section.

Thus, the proposed recommendation from this study is to expand the existing paved shoulder and create a 12-foot auxiliary lane with a 10-foot shoulder between the two ramps. A review of the digital orthophotos and highway layouts of the area indicated that there should be sufficient space for expansion. At the design stage of an improvement project, when there is more precise geometry information, a 12-foot shoulder should be considered if the available space can accommodate it.[20]

With the proposed auxiliary lane, the section between the two ramps would become a highway weaving segment that could facilitate the merging operation for drivers entering from Exit 58 and the positioning and diverging operation for drivers moving toward Exit 57. The capacity analyses for the proposed weaving segment (Location 1 on I-95 southbound in Figures 16 and 17) indicated that traffic operations during both the AM and PM peak hours at this location would significantly improve to the desirable LOS D from the undesirable LOS F or at-capacity LOS E under the merging and diverging operations in the no-build scenario (Segments 3 and 4 on I-95 northbound in Figures 14 and 15).

[18] Ramp spacing is defined as the distance between the painted tips of successive ramps. As in this case, both the entrance and exit ramps are the parallel type; the spacing is estimated at the end of the solid white line extending from the painted tip of the two ramps.

[19] Transportation Research Board, *Guidelines for Ramp and Interchange Spacing*, National Cooperative Highway Research Program (NCHRP) Report 687 (Washington DC, 2011).

[20] According to the *Freeway Management and Operations Handbook*, 8- to 12-foot shoulders are desirable for auxiliary lanes, with a minimal required width of six feet.

In addition, the proposed improvement would reduce the number of crashes and improve safety for freeway users at this location. A crash modification factor (CMF) is an estimate of the change in the number crashes expected after the implementation of a countermeasure. Applying CMFs from the *Highway Safety Manual* (HSM) and the CMF Clearinghouse show that adding continuous auxiliary lanes for weaving between the entrance ramp and the exit ramp would generally reduce crashes by 20 to 25 percent.[21]

For other locations on I-95 southbound (Locations 2, 3, 4, and 5), the recommendations from this study are to extend the deceleration or acceleration lengths for the respective diverging and merge segments. The recommended lengths would depend on the adjacent terrain and development conditions.

The highway capacity analyses with the proposed improvements (Figures 16 and 17) indicated that traffic operations at these locations would improve to the desirable LOS D from the near- or at-capacity LOS E under the 2030 no-build scenario.

More importantly, the proposed improvements would reduce the number of crashes and improve safety for freeway users at these locations, especially at Location 3 (Exit 59) and Location 5 (Exit 61) where drivers enter the freeway via a loop on-ramp with a limited sight distance and a relatively short acceleration lane. Applying CMFs for lengthening an acceleration lane showed that the proposed acceleration lane extensions would reduce crashes at the merge areas by 10 to 20 percent.

Implementing the proposed improvement at Location 1 (Exit 58–Exit 57) would require widening, resurfacing, and restriping the shoulder and its adjacent areas between the entrance ramp at Exit 58 and the exit ramp at Exit 57. No right-of-way acquisition or major alignment modifications would be required other than realignment of the adjacent travel lane, adding pavement markings, and relocating existing guide signs or installing new guide signs. The proposed improvement is estimated to cost between $500,000 and $750,000 to construct.[22]

[21] American Association of State Highway and Transportation Officials (AASHTO), *Highway Safety Manual* (Washington, DC, 2010).; The Crash Modification Factors Clearinghouse provides a searchable online database of CMFs along with guidance and resources on using CMFs in road safety practice (www.cmfclearinghouse.org/index.cfm).

[22] The cost was approximated from the general expenses of similar projects. The estimation is only for design and construction; it does not include right-of-way, utility relocation, or contingency costs.

Implementing the proposed improvements at Locations 2, 3, 4, and 5 would require mainly restriping the areas near the exit and/or entrance ramps at Exits 58, 59 and 61, with minor widening of the adjacent shoulders if necessary. No right-of-way acquisition or alignment modifications would be required other than adding pavement markings and relocating existing guide signs or installing new guide signs. The proposed improvements are estimated to cost between $50,000 and $100,000 per location to construct, depending on the length of the acceleration or deceleration lane extensions and the conditions of the adjacent areas.

5.2 PROPOSED IMPROVEMENTS ON I-95 NORTHBOUND

Unlike the southbound side, the areas adjacent to I-95 northbound generally have more constraints. These constraints include slopes and wooded areas, adjacent residential and commercial developments, and a series of sound barriers running along the shoulder area between Exit 59 and Exit 60. As such, only three locations were identified as suitable for low-cost improvements. The locations and proposed low-cost improvements are as follows:

1. *Exit 57 entrance ramp to Exit 58 exit ramp:* Expand the existing paved shoulder and add an auxiliary lane between the two ramps.
2. *Exit 58 merge segment:* Extend acceleration length to approximately 1,050 feet long.
3. *Exit 60 diverge segment:* Extend deceleration length to approximately 450 feet long.

The conditions at Location 1 are similar to its counterpart on the southbound side. The Exit 57 entrance ramp and Exit 58 exit ramp are located in close proximity (approximately 1,750 feet apart). Further extending the acceleration and deceleration lengths at the entrance and exit ramps is not adequate and would potentially increase the risk of crashes.

Thus, the proposed recommendation of this study is to expand the existing paved shoulder and create a 12-foot auxiliary lane with a six-foot shoulder between the two ramps (see Figure 18). The capacity analyses for the proposed weaving segment (Location 1 on I-95 northbound in Figures 16 and 17) indicated that traffic operations at this location would significantly improve during both the AM and PM peak hours to the desirable LOS D from the undesirable, near- or at-capacity LOS E under the merging and diverging operations in the no-build scenario (Segments 3 and 4 on I-95 northbound in Figures 14 and 15).

In addition, the proposed improvement would reduce the number of crashes and improve safety for freeway users at this location. Applying CMFs from the HSM

and the CMF Clearinghouse show that adding continuous auxiliary lanes for weaving between the entrance ramp and the exit ramp would generally reduce crashes by 20 to 25 percent.

A review the digital orthophotos indicated that the areas next to the shoulder are slightly sloping toward the south. To widen the shoulder area for adding the auxiliary lane, minor widening of the adjacent areas may be required. At minimum, a six-foot wide shoulder is currently recommended. When more information is available at the project design stage, a 10-to-12-foot shoulder should be considered.

For Location 2 (Exit 58) and Location 3 (Exit 60) on I-95 northbound, the recommendation from this study is to extend the acceleration length for the merge terminal at Exit 58 and the deceleration length in for the diverge terminal at Exit 60.

The highway capacity analyses with the proposed improvements (Figures 16 and 17) indicated that traffic operations at the two locations would improve to the desirable LOS D from the near- or at-capacity LOS E under the 2030 no-build scenario. In addition, the proposed improvement would reduce the number of crashes and improve safety for freeway users at these locations. Applying CMFs for lengthening an acceleration lane showed that the proposed acceleration lane extensions would reduce crashes at each of the two locations by 10 to 20 percent.

Implementing the proposed improvement at Location 1 would require widening, resurfacing, and restriping the shoulder and its adjacent areas between the entrance ramp at Exit 57 and the exit ramp at Exit 58. No right-of-way acquisition or major alignment modifications would be required other than realignment of the adjacent travel lane, addition of pavement markings, relocation of existing guide signs or installation of new guide signs, and potential minor modifications of the slope areas next to the shoulder. The proposed improvement is estimated to cost between $750,000 and $1,000,000 to construct.

Implementing the proposed improvements at Locations 2 and 3 would require mainly restriping the areas near the entrance ramp at Exit 58 and the exit ramp at Exit 60, with minor widening of the adjacent shoulders if necessary. No right-of-way acquisition or major alignment modifications would be required other than adding pavement markings and relocating existing guide signs or installing new guide signs. The proposed improvement at Location 2 is estimated to cost between $75,000 and $125,000 to construct. The proposed improvement at

Location 3 is estimated to cost between $50,000 and $100,000 to construct due to minor modifications of the adjacent slope area may be necessary.

Chapter 6—Conclusion and Next Steps

In this study, the MPO staff performed a series of operational and safety analyses for the bottleneck locations on the northbound and southbound sections of I-95 between Exit 57 and Exit 61. Low-cost improvements were then recommended for several locations on I-95 northbound and southbound:

- *I-95 northbound between Exit 57 and Exit 58:* Expand the existing paved shoulder and add an auxiliary lane between the exit ramp and the entrance ramp.
- *I-95 northbound merge segment at Exit 58:* Extend the acceleration length.
- *I-95 northbound diverge segment at Exit 60:* Extend the deceleration length.
- *I-95 southbound between Exit 58 and Exit 57:* Expand the existing paved shoulder and add an auxiliary lane between the exit ramp and the entrance ramp.
- *I-95 southbound merge segments at Exit 59 and Exit 61:* Extend the acceleration length.
- *I-95 southbound diverge segments at Exit 58 and Exit 59:* Extend the deceleration length.

This study provides the MassDOT Highway Division with an opportunity to assess the most critical needs in the study area and to start planning design and engineering efforts. The sections between Exits 57 and 58, particularly on I-95 southbound, were considered priority locations. The implementation of improvements to priority locations would depend on available resources and further evaluations at the project design stage.

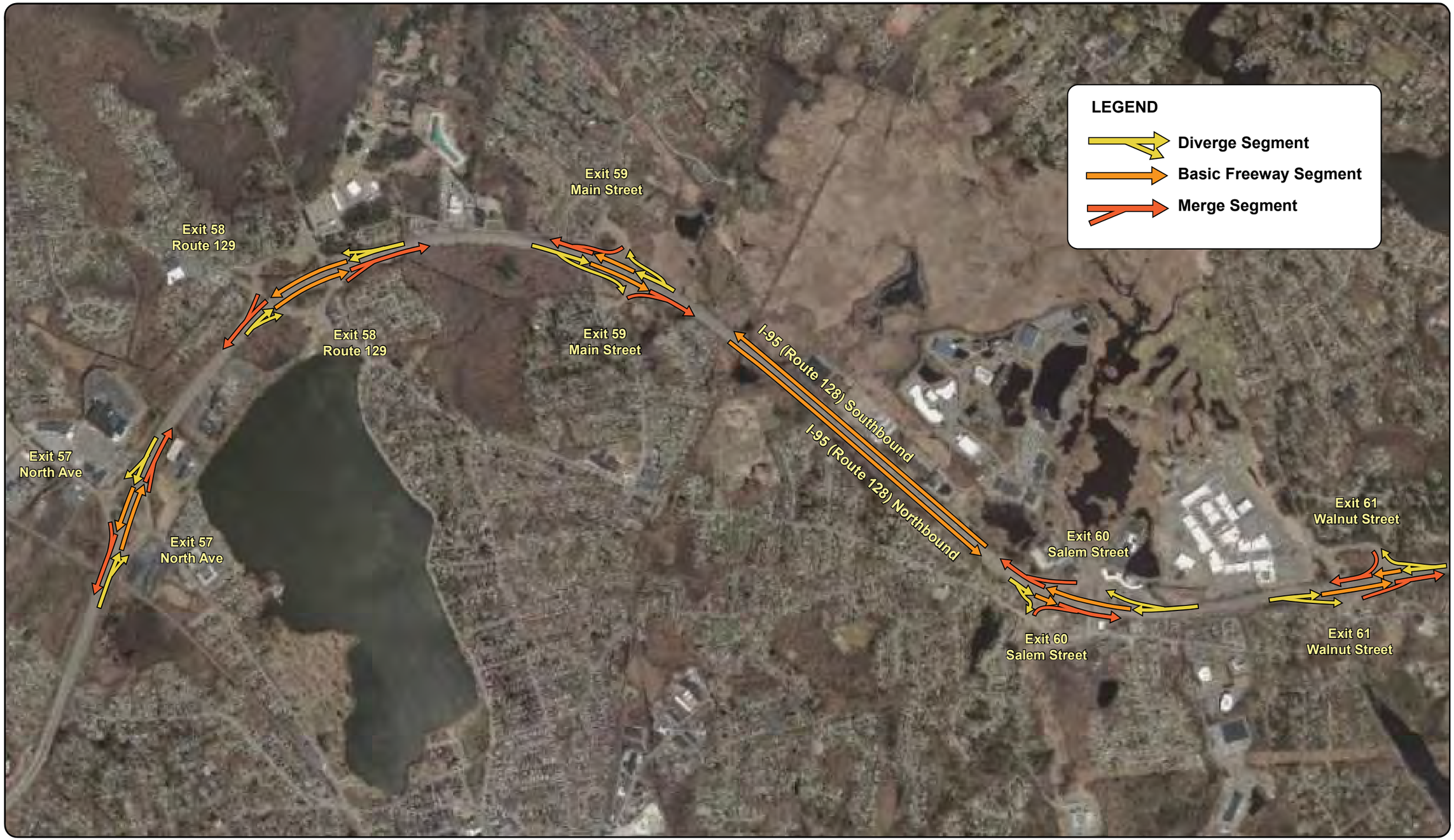
The MPO staff conducted this study in conjunction with MassDOT staff as part of the ongoing work to identify, develop, and evaluate improvements to bottleneck locations in the Boston region. The study aligns with the MPO's goals of managing capacity and improving mobility and safety on the region's highway system. If implemented, these low-cost improvements would improve the freeway facilities, make traffic operations more efficient, reduce congestion at the identified bottleneck locations, reduce crashes, and improve safety for the freeway users.

BOSTON
REGION
MPO

N

Figure 1
Study Area Map
I-95 between Exit 57 and Exit 61

Low-Cost Improvements
to Express-Highway
Bottleneck Locations

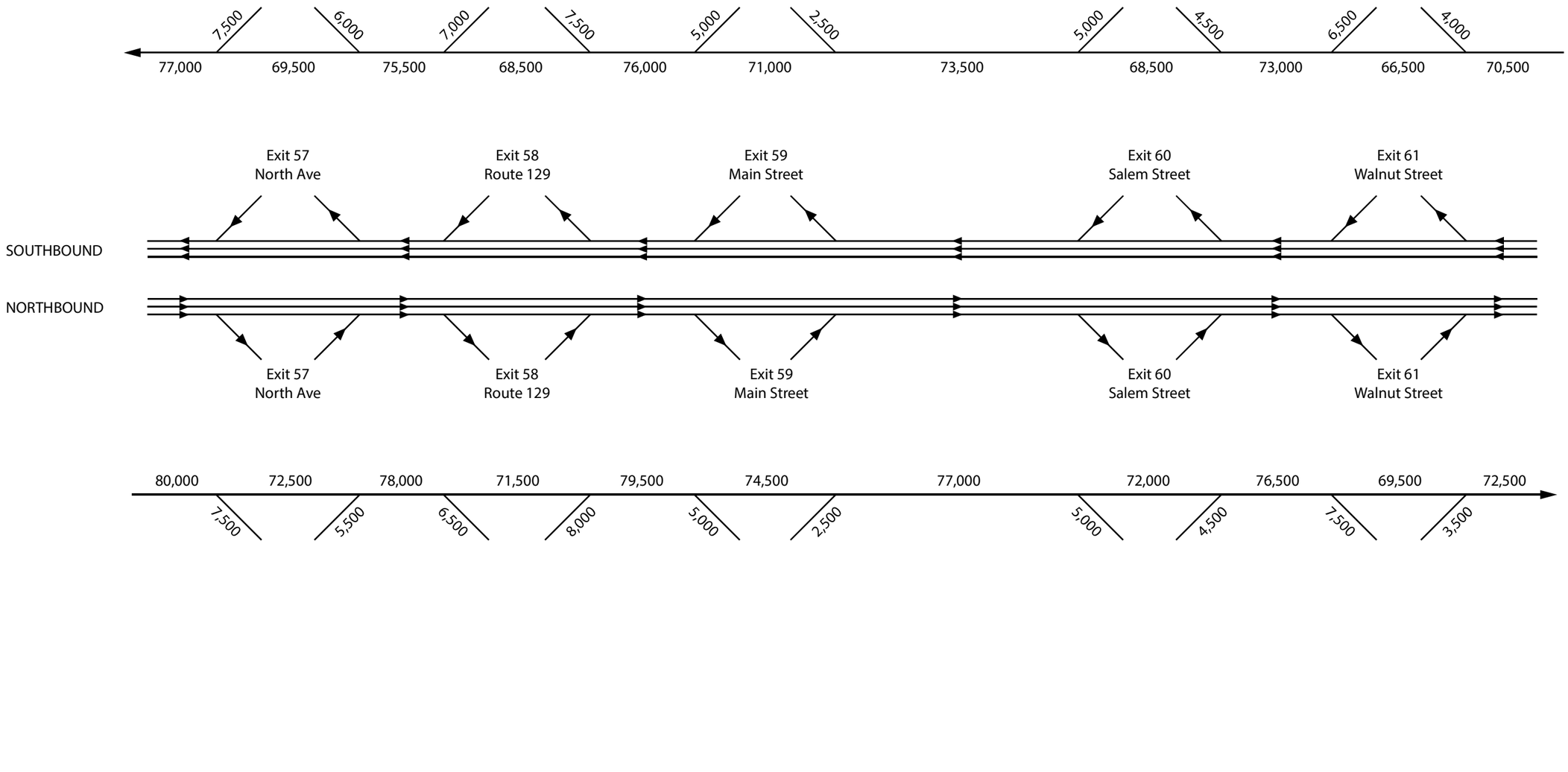


BOSTON
REGION
MPO

N

Figure 2
Freeway Segments under Analysis
I-95 between Exit 57 and Exit 61

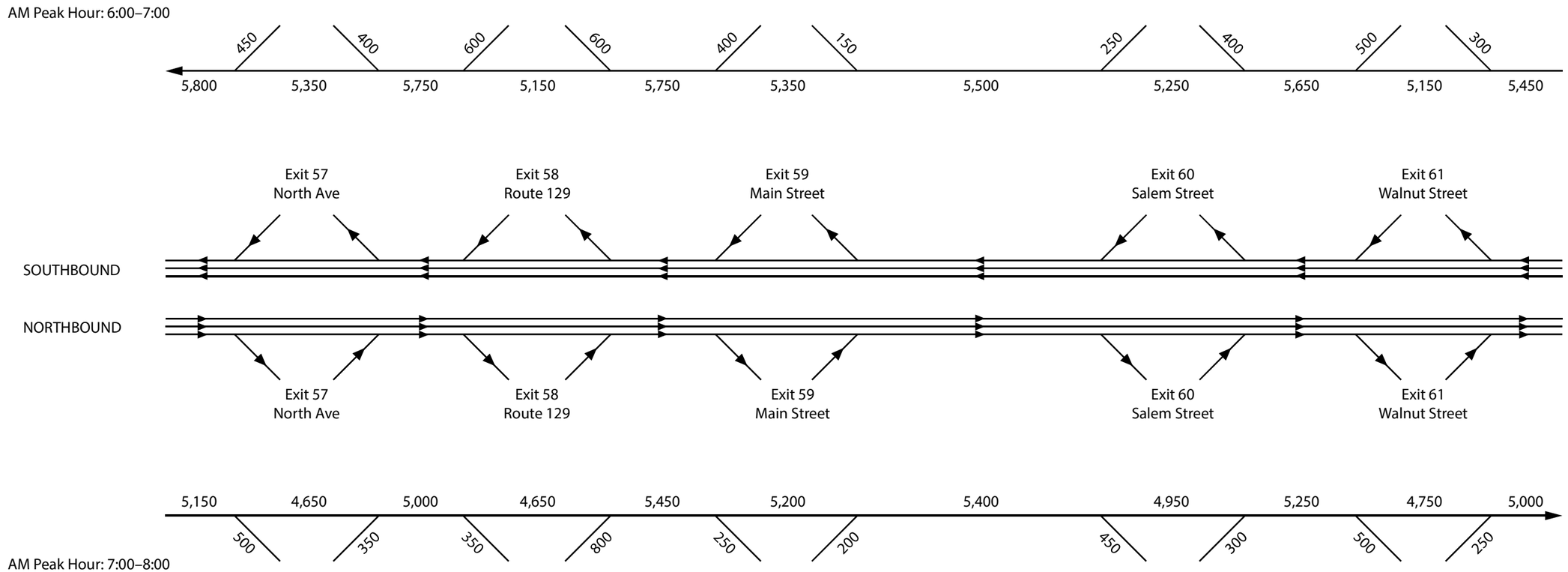
Low-Cost Improvements
to Express-Highway
Bottleneck Locations

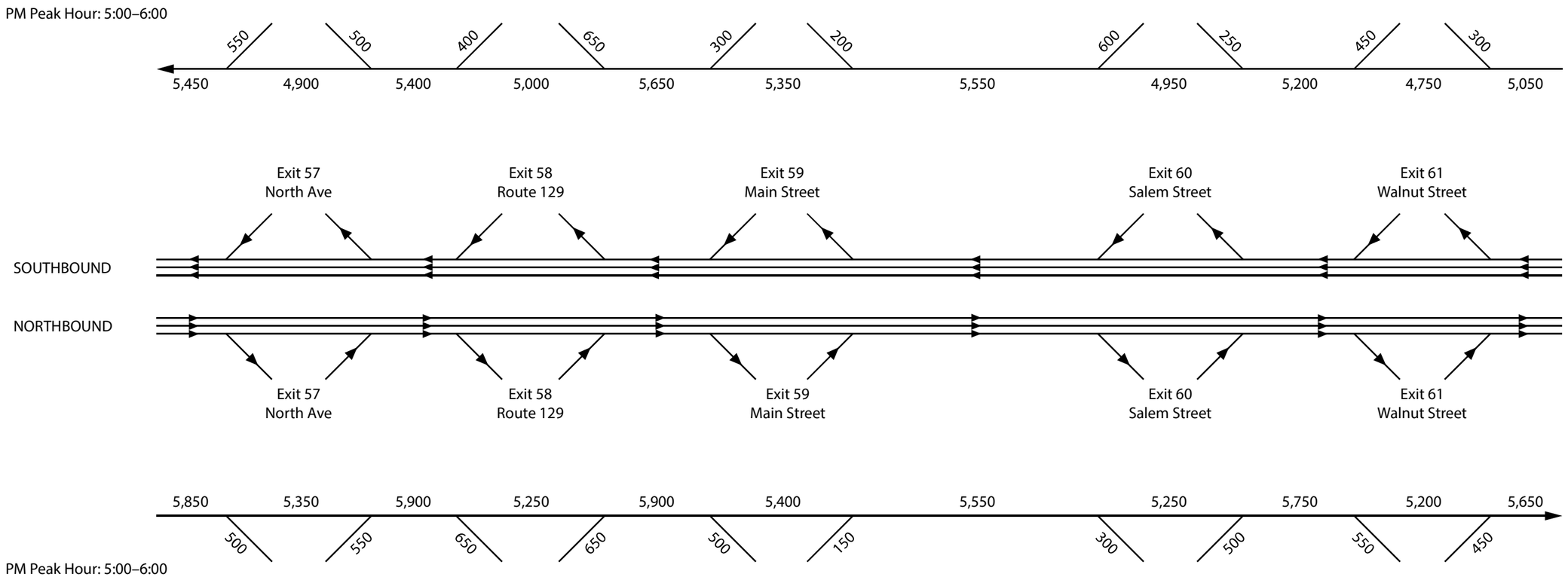


BOSTON
REGION
MPO

Figure 3
Estimated Daily Traffic Volumes
2019 Average Weekday

Low-Cost Improvements
to Express-Highway
Bottleneck Locations


AM Peak Hour: 6:00–7:00
450
400
600
600
400
150
250
400
500
300
5,800
5,350
5,750
5,150
5,750
5,350
5,500
5,250
5,650
5,150
5,450
Exit 57
North Ave
Exit 58
Route 129
Exit 59
Main Street
Exit 60
Salem Street
Exit 61
Walnut Street
SOUTHBOUND
NORTHBOUND
Exit 57
North Ave
Exit 58
Route 129
Exit 59
Main Street
Exit 60
Salem Street
Exit 61
Walnut Street
5,150
4,650
5,000
4,650
5,450
5,200
5,400
4,950
5,250
4,750
5,000
500
350
350
800
250
200
450
300
500
250
AM Peak Hour: 7:00–8:00

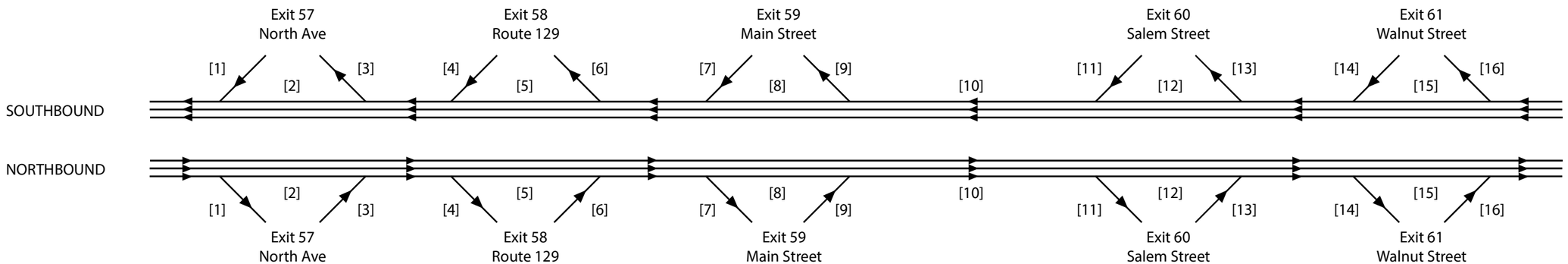


BOSTON
REGION
MPO

Figure 5
Estimated PM Peak-Hour Traffic Volumes
2019 Average Weekday

Low-Cost Improvements
to Express-Highway
Bottleneck Locations

Highway Segment:	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Anaylsis Type:	Merge	Basic	Diverge	Merge	Basic	Diverge	Merge	Basic	Diverge	Basic	Merge	Basic	Diverge	Merge	Basic	Diverge
Level of Service:	D	D	E	E	D	D	E	D	D	D	D	D	D	E	D	D
Density (pc/mi/ln):	33.1	34.2	36.6	37.8	32.1	33.6	35.6	34.2	34.0	34.7	31.5	32.0	32.3	35.4	31.0	32.4
V/C Ratio:	0.95	0.87	0.94	0.94	0.84	0.94	0.94	0.87	0.90	0.88	0.88	0.84	0.91	0.90	0.83	0.87
Average Speed (mph):	54.8	58.2	54.4	49.7	59.7	53.9	53.3	58.3	56.1	59.1	57.3	61.2	56.6	54.6	61.9	56.9



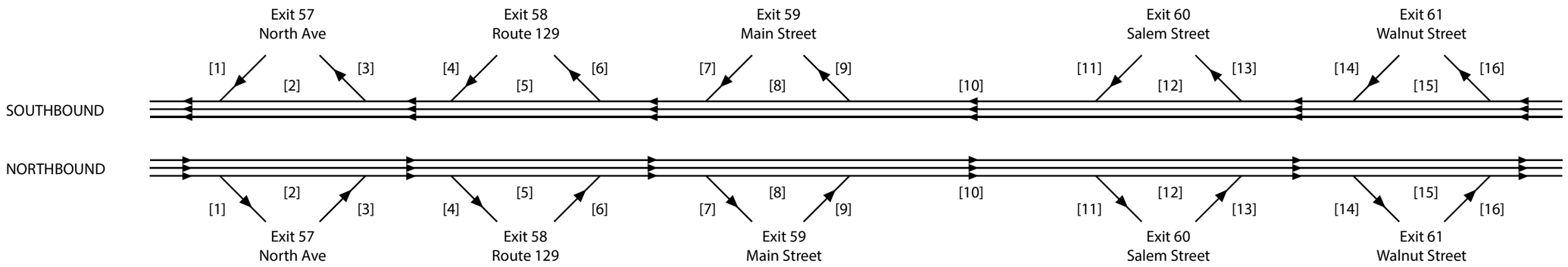
Highway Segment:	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Anaylsis Type:	Diverge	Basic	Merge	Diverge	Basic	Merge	Diverge	Basic	Merge	Basic	Diverge	Basic	Merge	Diverge	Basic	Merge
Level of Service:	D	D	E	D	D	D	D	D	D	D	D	D	D	D	D	D
Density (pc/mi/ln):	30.1	27.7	35.5	31.5	27.7	31.6	29.5	31.8	30.2	33.8	34.8	29.3	33.6	31.9	27.5	29.0
V/C Ratio:	0.85	0.76	0.82	0.82	0.76	0.89	0.90	0.84	0.89	0.87	0.87	0.80	0.89	0.85	0.76	0.80
Average Speed (mph):	54.2	62.7	51.8	54.5	62.7	55.3	54.2	61.2	57.6	59.7	54.7	63.2	55.5	56.3	64.6	58.6

Notes:

1) Level of service (LOS) A through D represents acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity).
2) Density (pc/mi/ln) refers to the ramp influence area (merge/diverge analysis), the weaving influence area (weaving analysis), or the freeway section (basic freeway segment analysis).
3) V/C ratio refers to the freeway section's volume-to-capacity ratio.
4) Speed (mph) refers to the ramp influence area average speed (merge/diverge analysis), the weaving and non-weaving average speed (weaving analysis), or the average of all vehicles (basic freeway segment analysis). These speeds are directly cited from Highway Capacity Software for comparison purposes only (between scenarios). A traffic simulation model, with a modeling area including the I-93/I-95 interchange, would estimate and predict the average speeds more accurately.

pc/mi/ln = passenger cars per mile per lane. V/C= volume-to-capacity. mph = miles per hour.

Highway Segment:	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Anaylsis Type:	Merge	Basic	Diverge	Merge	Basic	Diverge	Merge	Basic	Diverge	Basic	Merge	Basic	Diverge	Merge	Basic	Diverge
Level of Service:	D	D	D	E	D	D	D	D	D	D	D	D	D	D	D	D
Density (pc/mi/ln):	30.9	32.8	33.9	36.0	29.5	32.7	34.3	32.8	33.7	33.7	32.1	28.0	29.5	31.0	26.4	30.0
V/C Ratio:	0.87	0.85	0.86	0.86	0.80	0.90	0.90	0.85	0.89	0.87	0.87	0.77	0.81	0.81	0.74	0.79
Average Speed (mph):	56.2	59.2	54.2	51.7	61.5	53.8	64.4	59.3	56.0	59.8	56.9	64.2	57.0	57.6	65.4	56.9

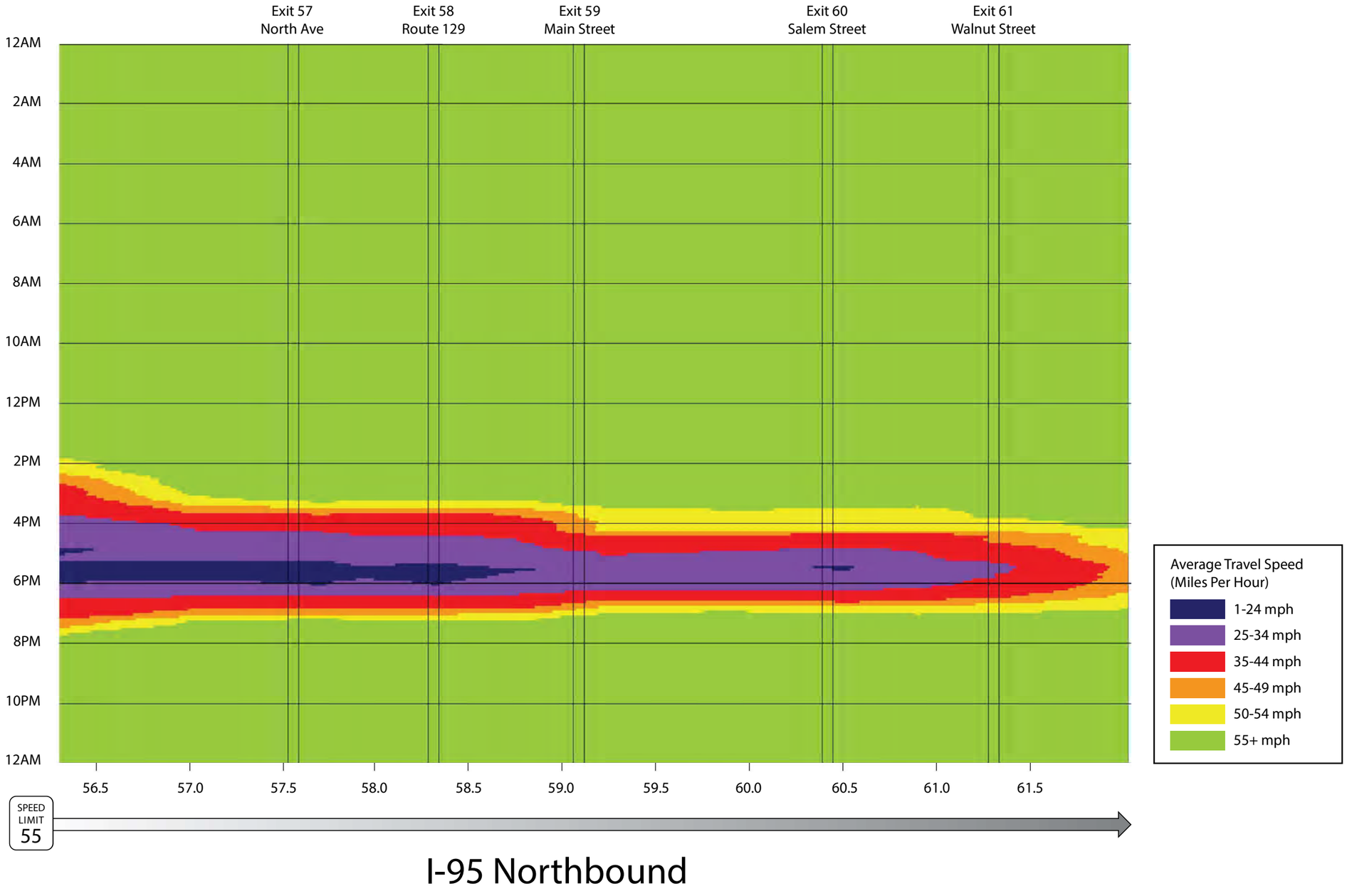


Highway Segment:	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Anaylsis Type:	Diverge	Basic	Merge	Diverge	Basic	Merge	Diverge	Basic	Merge	Basic	Diverge	Basic	Merge	Diverge	Basic	Merge
Level of Service:	D	D	E	D	D	D	D	D	D	D	D	D	D	D	D	D
Density (pc/mi/ln):	32.4	32.8	40.7	34.9	31.8	34.7	31.0	32.3	30.0	33.7	34.5	30.7	34.7	33.4	30.2	32.1
V/C Ratio:	0.93	0.85	0.94	0.94	0.84	0.94	0.94	0.85	0.89	0.87	0.87	0.82	0.90	0.90	0.81	0.88
Average Speed (mph):	54.2	59.2	44.6	54.1	59.9	52.8	53.6	60.8	57.7	59.8	55.1	62.2	54.3	56.2	62.5	56.9

Notes:

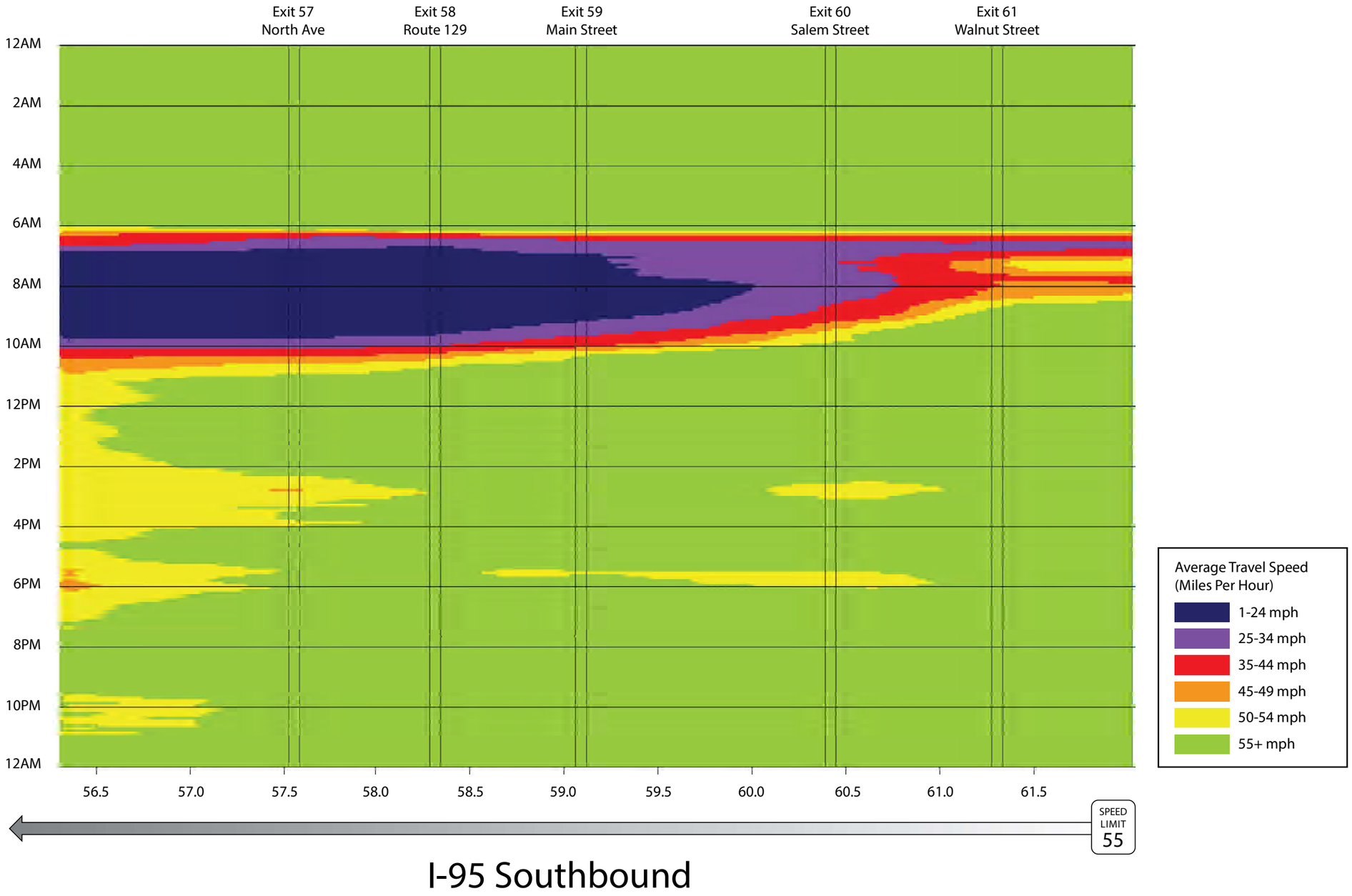
1) Level of service (LOS) A through D represents acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity).
2) Density (pc/mi/ln) refers to the ramp influence area (merge/diverge analysis), the weaving influence area (weaving analysis), or the freeway section (basic freeway segment analysis).
3) V/C ratio refers to the freeway section's volume-to-capacity ratio.
4) Speed (mph) refers to the ramp influence area average speed (merge/diverge analysis), the weaving and non-weaving average speed (weaving analysis), or the average of all vehicles (basic freeway segment analysis). These speeds are directly cited from Highway Capacity Software for comparison purposes only (between scenarios). A traffic simulation model, with a modeling area including the I-93/I-95 interchange, would estimate and predict the average speeds more accurately.

pc/mi/ln = passenger cars per mile per lane. V/C= volume-to-capacity. mph = miles per hour.



BOSTON
REGION
MPO

Figure 8
Freeway Congestion Scan
I-95 Northbound



BOSTON
REGION
MPO

Figure 9
Freeway Congestion Scan
I-95 Southbound

BOSTON REGION MPO

N

Figure 10
Crashes on I-95 Northbound from Exit 57 to Exit 61
MassDOT Crash Data 2015–17

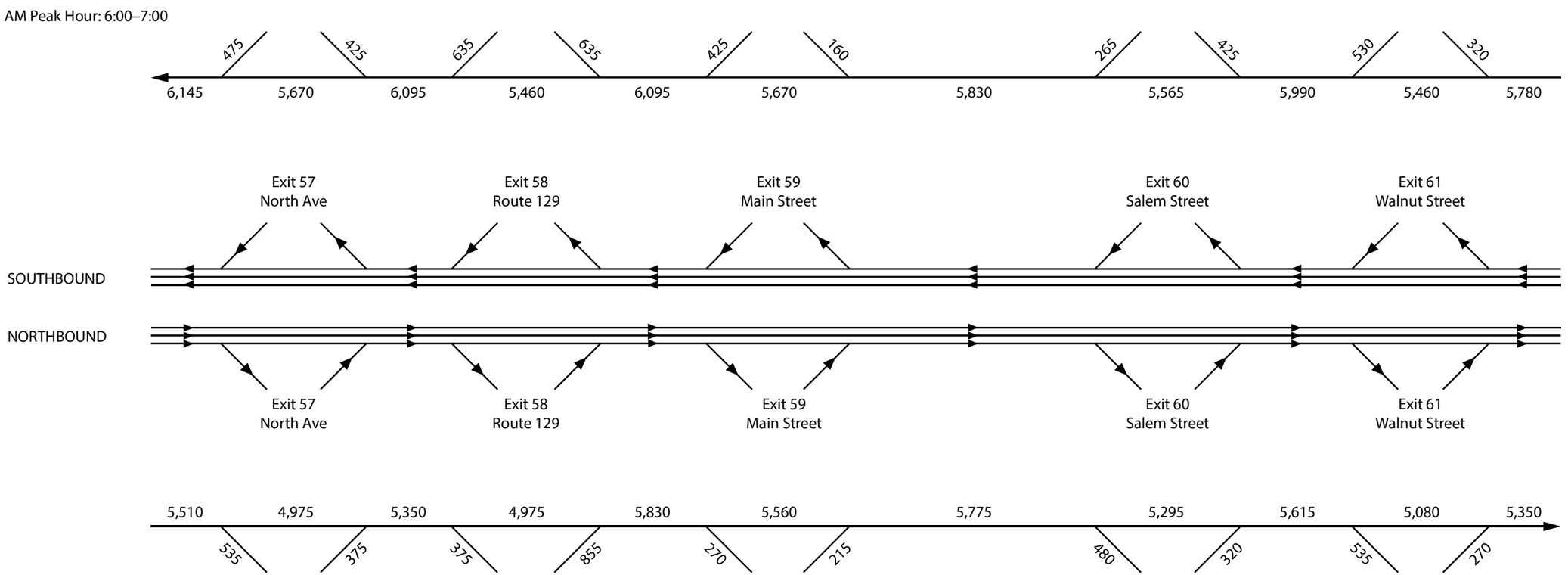
Low-Cost Improvements to Express-Highway Bottleneck Locations

BOSTON REGION MPO

N

Figure 11
Crashes on I-95 Southbound from Exit 61 to Exit 57
MassDOT Crash Data 2015–17

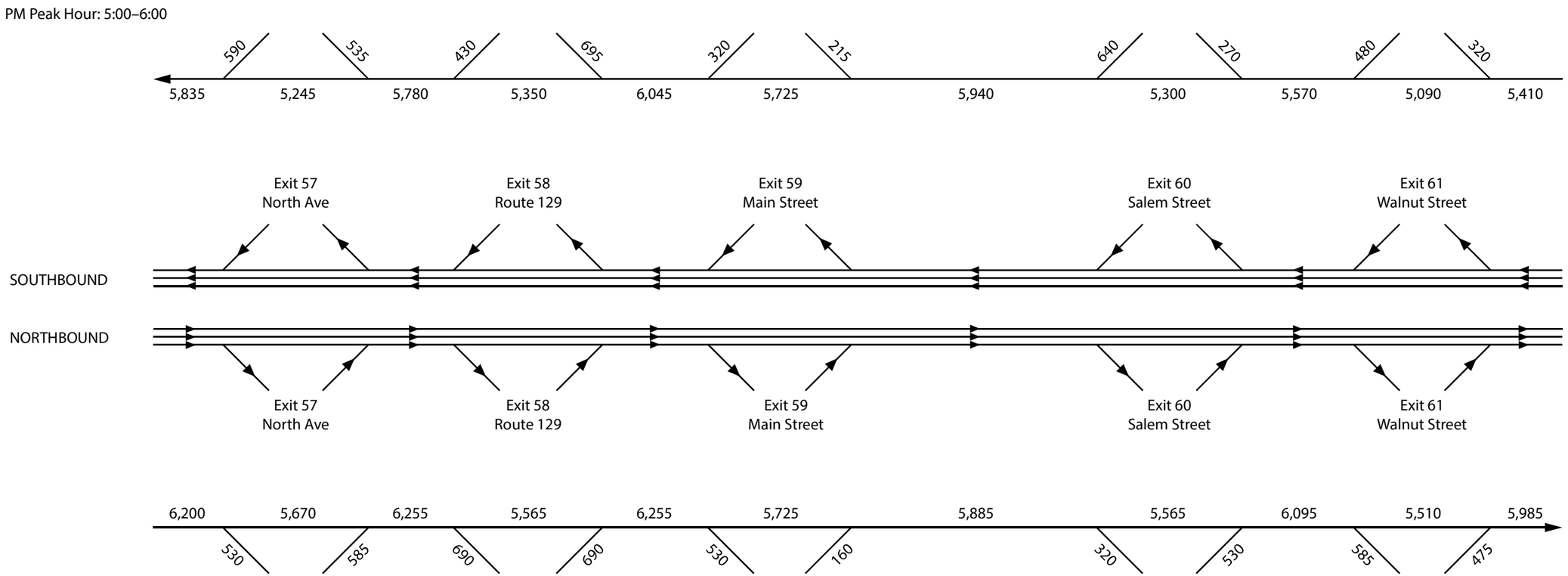
Low-Cost Improvements to Express-Highway Bottleneck Locations



BOSTON
REGION
MPO

Figure 12
Projected AM Peak-Hour Traffic Volumes
2030 Average Weekday

Low-Cost Improvements
to Express-Highway
Bottleneck Locations

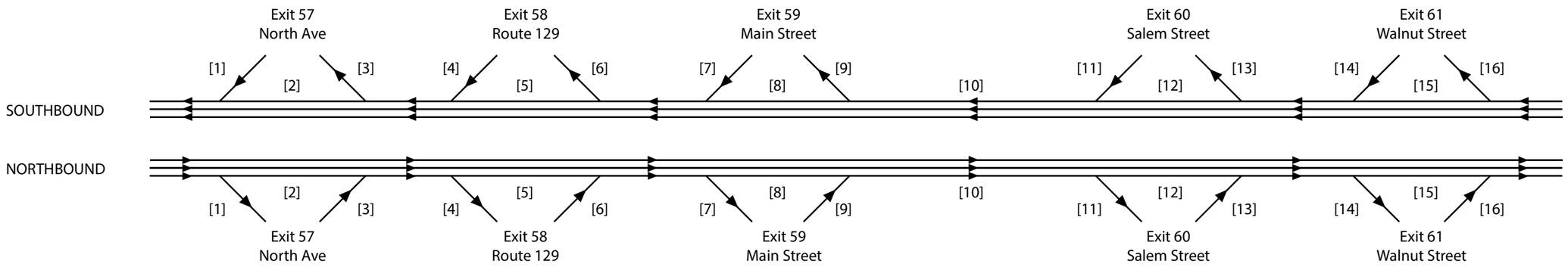


BOSTON
REGION
MPO

Figure 13
Projected PM Peak-Hour Traffic Volume
2030 Average Weekday

Low-Cost Improvements
to Express-Highway
Bottleneck Locations

Highway Segment:	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Anaylsis Type:	Merge	Basic	Diverge	Merge	Basic	Diverge	Merge	Basic	Diverge	Basic	Merge	Basic	Diverge	Merge	Basic	Diverge
Level of Service:	F	E	E	F	E	E	E	E	E	E	D	E	D	E	D	D
Density (pc/mi/ln):	–	38.1	37.6	–	35.5	35.1	37.5	38.5	35.4	38.9	33.3	35.4	33.7	37.4	34.2	33.8
V/C Ratio:	1.01	0.93	1.00	1.01	0.89	1.00	1.00	0.92	0.95	0.94	0.94	0.89	0.96	0.96	0.88	0.93
Average Speed (mph):	–	55.4	54.3	–	57.3	53.9	51.5	55.5	56.1	55.8	56.2	58.5	56.5	52.8	59.4	56.8



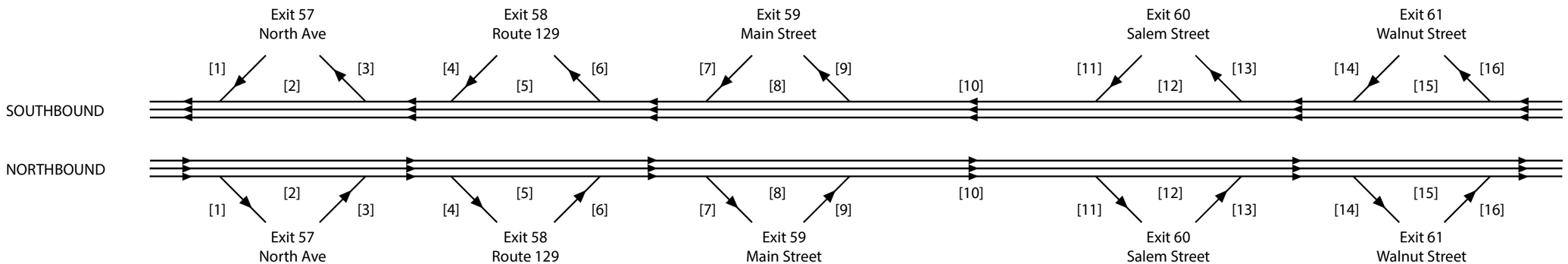
Highway Segment:	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Anaylsis Type:	Diverge	Basic	Merge	Diverge	Basic	Merge	Diverge	Basic	Merge	Basic	Diverge	Basic	Merge	Diverge	Basic	Merge
Level of Service:	D	D	E	D	D	D	D	E	D	E	E	D	E	D	D	D
Density (pc/mi/ln):	31.7	30.6	37.9	33.1	30.6	33.8	31.2	35.8	32.2	38.4	36.4	32.7	35.8	33.6	30.5	30.9
V/C Ratio:	0.91	0.82	0.88	0.88	0.82	0.96	0.96	0.90	0.95	0.93	0.93	0.85	0.96	0.90	0.82	0.86
Average Speed (mph):	54.1	60.8	49.1	54.4	60.8	53.6	54.1	58.1	56.3	56.3	54.6	60.6	53.3	56.2	62.3	57.7

Notes:

1) Level of service (LOS) A through D represents acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity).
2) Density (pc/mi/ln) refers to the ramp influence area (merge/diverge analysis), the weaving influence area (weaving analysis), or the freeway section (basic freeway segment analysis).
3) V/C ratio refers to the freeway section's volume-to-capacity ratio.
4) Speed (mph) refers to the ramp influence area average speed (merge/diverge analysis), the weaving and non-weaving average speed (weaving analysis), or the average of all vehicles (basic freeway segment analysis). These speeds are directly cited from Highway Capacity Software for comparison purposes only (between scenarios). A traffic simulation model, with a modeling area including the I-93/I-95 interchange, would estimate and predict the average speeds more accurately.

pc/mi/ln = passenger cars per mile per lane. V/C= volume-to-capacity. mph = miles per hour.

Highway Segment:	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Anaylsis Type:	Merge	Basic	Diverge	Merge	Basic	Diverge	Merge	Basic	Diverge	Basic	Merge	Basic	Diverge	Merge	Basic	Diverge
Level of Service:	D	E	E	E	D	D	E	E	E	E	D	D	D	D	D	D
Density (pc/mi/ln):	32.9	37.0	35.5	38.4	32.8	34.3	36.5	36.9	35.3	38.2	34.2	31.1	31.1	32.9	29.2	31.7
V/C Ratio:	0.93	0.91	0.92	0.92	0.85	0.97	0.97	0.91	0.95	0.93	0.93	0.83	0.87	0.87	0.79	0.85
Average Speed (mph):	54.9	56.2	54.1	49.1	59.2	53.7	52.5	56.3	55.9	56.4	55.3	61.8	57.0	56.5	63.3	56.8



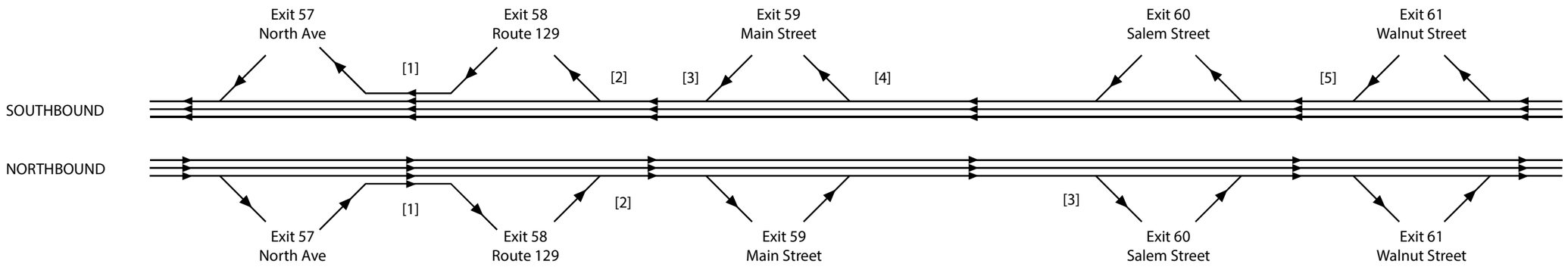
Highway Segment:	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]
Anaylsis Type:	Diverge	Basic	Merge	Diverge	Basic	Merge	Diverge	Basic	Merge	Basic	Diverge	Basic	Merge	Diverge	Basic	Merge
Level of Service:	D	E	E	E	E	E	D	E	D	E	E	D	E	D	D	D
Density (pc/mi/ln):	33.8	36.3	43.0	36.5	35.1	36.7	32.7	35.8	31.7	37.6	35.9	33.9	36.7	34.8	33.3	33.9
V/C Ratio:	0.99	0.90	1.00	1.00	0.89	1.00	1.00	0.90	0.94	0.94	0.92	0.87	0.95	0.95	0.86	0.94
Average Speed (mph):	54.1	56.7	39.4	54.0	57.6	50.4	53.5	58.1	56.7	56.9	55.0	59.7	52.1	56.1	60.1	55.6

Notes:

1) Level of service (LOS) A through D represents acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity).
2) Density (pc/mi/ln) refers to the ramp influence area (merge/diverge analysis), the weaving influence area (weaving analysis), or the freeway section (basic freeway segment analysis).
3) V/C ratio refers to the freeway section's volume-to-capacity ratio.
4) Speed (mph) refers to the ramp influence area average speed (merge/diverge analysis), the weaving and non-weaving average speed (weaving analysis), or the average of all vehicles (basic freeway segment analysis). These speeds are directly cited from Highway Capacity Software for comparison purposes only (between scenarios). A traffic simulation model, with a modeling area including the I-93/I-95 interchange, would estimate and predict the average speeds more accurately.

pc/mi/ln = passenger cars per mile per lane. V/C= volume-to-capacity. mph = miles per hour.

Proposed Location:			[1]		[2]	[3]		[4]					[5]		
Anaylsis Type:	Merge	Basic	Weaving	Basic	Diverge	Merge	Basic	Diverge	Basic	Merge	Basic	Diverge	Merge	Basic	Diverge
Level of Service:	F	E	D	E	D	D	E	D	E	D	E	D	D	D	D
Density (pc/mi/ln):	–	38.1	34.2	35.5	32.9	35.0	38.5	33.8	38.9	33.3	35.4	33.7	34.5	34.2	33.8
V/C Ratio:	1.01	0.93	0.83	0.89	1.00	1.00	0.92	0.95	0.94	0.94	0.89	0.96	0.96	0.88	0.93
Average Speed (mph):	–	55.4	50.5	57.3	53.9	52.1	55.5	56.1	55.8	56.2	58.5	56.5	53.5	59.4	56.8



Proposed Location:			[1]		[2]				[3]						
Anaylsis Type:	Diverge	Basic	Weaving	Basic	Merge	Diverge	Basic	Merge	Basic	Diverge	Basic	Merge	Diverge	Basic	Merge
Level of Service:	D	D	D	D	D	D	E	D	E	D	D	E	D	D	D
Density (pc/mi/ln):	31.7	30.6	30.1	30.6	32.3	31.2	35.8	32.2	38.4	33.4	32.7	35.8	33.6	30.5	30.9
V/C Ratio:	0.91	0.82	0.76	0.82	0.96	0.96	0.90	0.95	0.93	0.92	0.85	0.96	0.90	0.82	0.86
Average Speed (mph):	54.1	60.8	52.8	60.8	53.7	54.1	58.1	56.3	56.3	54.6	60.6	53.3	56.2	62.3	57.7

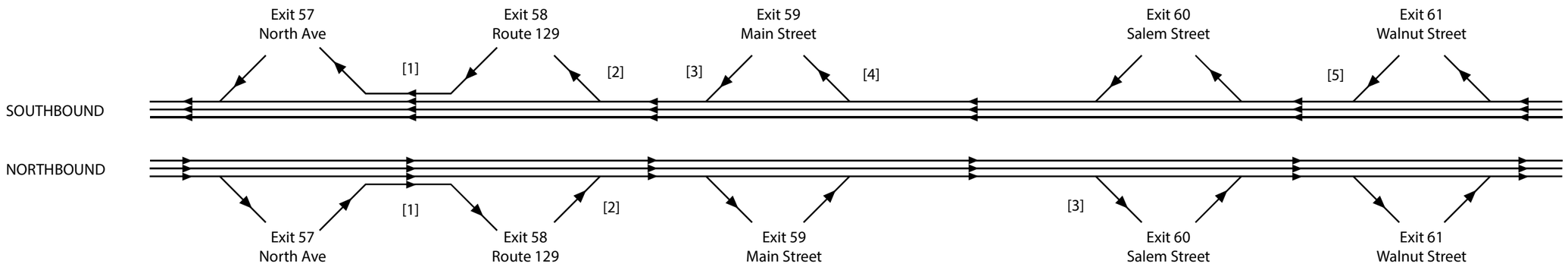
Notes:

1) Level of service (LOS) A through D represents acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity).
2) Density (pc/mi/ln) refers to the ramp influence area (merge/diverge analysis), the weaving influence area (weaving analysis), or the freeway section (basic freeway segment analysis).
3) V/C ratio refers to the freeway section's volume-to-capacity ratio.
4) Speed (mph) refers to the ramp influence area average speed (merge/diverge analysis), the weaving and non-weaving average speed (weaving analysis), or the average of all vehicles (basic freeway segment analysis). These speeds are directly cited from Highway Capacity Software for comparison purposes only (between scenarios). A traffic simulation model, with a modeling area including the I-93/I-95 interchange, would estimate and predict the average speeds more accurately.

pc/mi/ln = passenger cars per mile per lane. V/C= volume-to-capacity. mph = miles per hour.

Figure 16
AM Peak-Hour Highway Capacity Analyses
2030 Proposed Improvements Scenario

Proposed Location:			[1]		[2]	[3]		[4]					[5]		
Anaylsis Type:	Merge	Basic	Weaving	Basic	Diverge	Merge	Basic	Diverge	Basic	Merge	Basic	Diverge	Merge	Basic	Diverge
Level of Service:	D	E	D	D	D	D	E	D	E	D	D	D	D	D	D
Density (pc/mi/ln):	32.9	37.0	30.5	32.8	32.1	34.0	36.9	33.7	38.2	34.2	31.1	31.1	30.6	29.2	31.7
V/C Ratio:	0.93	0.91	0.60	0.85	0.97	0.97	0.91	0.95	0.93	0.93	0.83	0.87	0.87	0.79	0.85
Average Speed (mph):	54.9	56.2	51.4	59.2	53.7	53.2	56.3	55.9	56.4	55.3	61.8	57.0	57.0	63.3	56.8



Proposed Location:			[1]		[2]				[3]						
Anaylsis Type:	Diverge	Basic	Weaving	Basic	Merge	Diverge	Basic	Merge	Basic	Diverge	Basic	Merge	Diverge	Basic	Merge
Level of Service:	D	E	D	E	D	D	E	D	E	D	D	E	D	D	D
Density (pc/mi/ln):	33.8	36.3	34.9	35.1	34.8	32.7	35.8	31.7	37.6	33.2	33.9	36.7	34.8	33.3	33.9
V/C Ratio:	0.99	0.90	0.83	0.89	1.00	1.00	0.90	0.94	0.94	0.92	0.87	0.95	0.95	0.86	0.94
Average Speed (mph):	54.1	56.7	48.7	57.6	50.9	53.5	58.1	56.7	56.9	55.0	59.7	52.1	56.1	60.1	55.6

Notes:

1) Level of service (LOS) A through D represents acceptable operating conditions; LOS E represents operating conditions at capacity; and LOS F represents failing conditions (demand exceeds capacity).
2) Density (pc/mi/ln) refers to the ramp influence area (merge/diverge analysis), the weaving influence area (weaving analysis), or the freeway section (basic freeway segment analysis).
3) V/C ratio refers to the freeway section's volume-to-capacity ratio.
4) Speed (mph) refers to the ramp influence area average speed (merge/diverge analysis), the weaving and non-weaving average speed (weaving analysis), or the average of all vehicles (basic freeway segment analysis). These speeds are directly cited from Highway Capacity Software for comparison purposes only (between scenarios). A traffic simulation model, with a modeling area including the I-93/I-95 interchange, would estimate and predict the average speeds more accurately.

pc/mi/ln = passenger cars per mile per lane. V/C= volume-to-capacity. mph = miles per hour.

Figure 17
PM Peak-Hour Highway Capacity Analyses
2030 Proposed Improvements Scenario

BOSTON
REGION
MPO

Figure 18
Approximate Locations and Conceptual Diagrams
Proposed Improvements at Exits 57, 58, and 59

Low-Cost Improvements
to Express-Highway
Bottleneck Locations

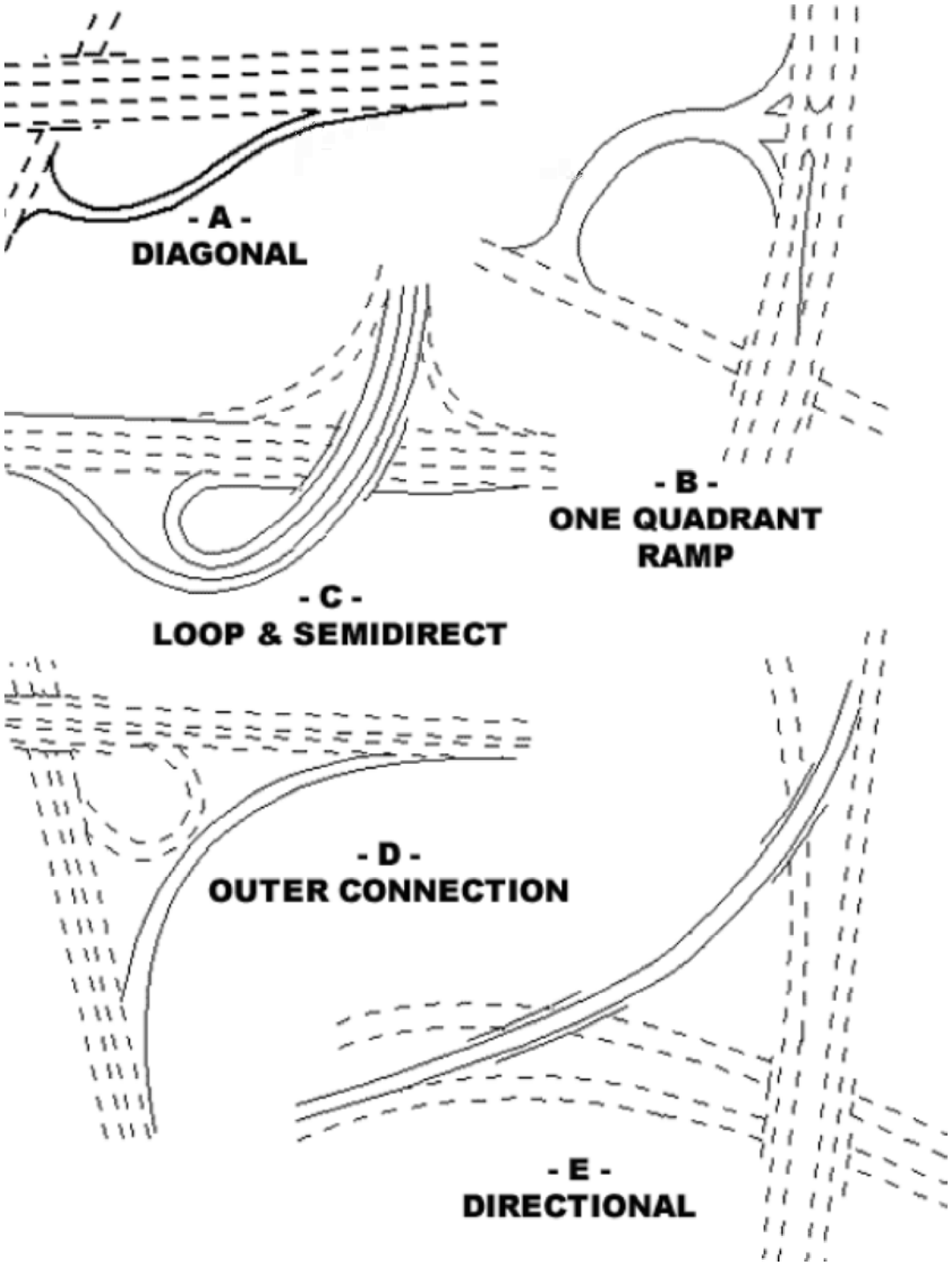
BOSTON
REGION
MPO

Figure 19
Approximate Locations and Conceptual Diagrams
Proposed Improvements at Exits 60 and 61

Low-Cost Improvements
to Express-Highway
Bottleneck Locations

APPENDIX A

General Types of Freeway Ramps
American Association of State Highway and Transportation Officials


- A -
DIAGONAL
- B -
ONE QUADRANT
RAMP
- C -
LOOP & SEMIDIRECT
- D -
OUTER CONNECTION
- E -
DIRECTIONAL

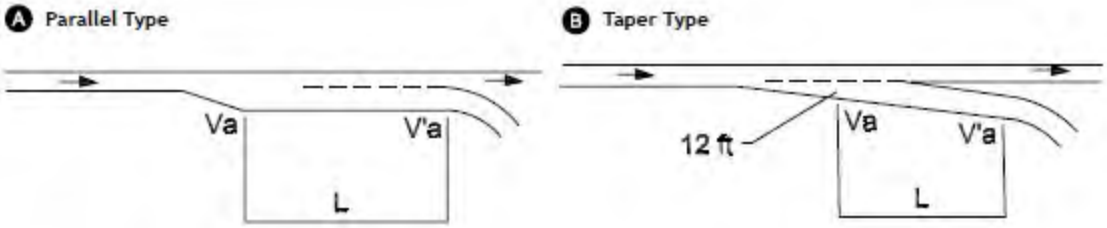
APPENDIX B

Deceleration Length Design Guidelines
MassDOT Project Development and Design Guide

Exhibit 7-13
Minimum Deceleration Lengths for Exit Terminals with Flat Grades of 2% or Less

		Deceleration Length L (ft) for Design Speed of Exit Curve V_N (mph)								
		Stop Condition	15	20	25	30	35	40	45	50
Highway Design Speed V (mph)	Highway Speed Reached, V_a (mph)	For Average Running Speed on Exit Curve V'_a (mph)								
		0	14	18	22	26	30	36	40	44
30	28	235	200	170	140	—	—	—	—	—
35	32	280	250	210	185	150	—	—	—	—
40	36	320	295	265	235	185	155	—	—	—
45	40	385	350	325	295	250	220	—	—	—
50	44	435	405	385	355	315	285	225	175	—
55	48	480	455	440	410	380	350	285	235	—
60	52	530	500	480	460	430	405	350	300	240
65	55	570	540	520	500	470	440	390	340	280
70	58	615	590	570	550	520	490	440	390	340
75	61	660	635	620	600	575	535	490	440	390

V = Design Speed of Highway (mph)
V_a = Average Running Speed of Highway (mph)
V_N = Design Speed of Exit Curve (mph)
V'_a = Average Running Speed of Exit Curve (mph)



Source: *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2004. Chapter 10 Grade Separations and Interchanges

Notes for This Stdy:

Applicable to diverge locations at Exits 59 and 60 on I-95 northbound

Applicable to other diverge locations in the study area

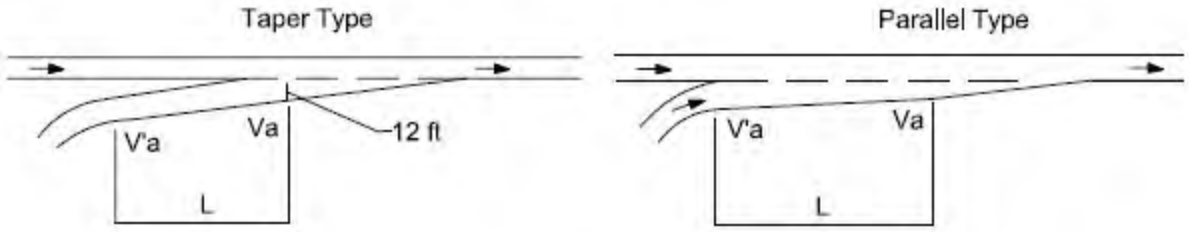
APPENDIX C

Acceleration Length Design Guidelines
MassDOT Project Development and Design Guide

Exhibit 7-14
Minimum Acceleration Lengths for Entrance Terminals with Flat Grades of 2% or Less

		Acceleration Length L (ft) for Entrance Curve Design Speed (mph)								
		Stop Condition	15	20	25	30	35	40	45	50
Highway Design Speed	Highway Speed Reached,	and Initial Speed V'a (mph)								
V (mph)	Va (mph)	0	14	18	22	26	30	36	40	44
30	28	180	140	—	—	—	—	—	—	—
35	32	280	220	160	—	—	—	—	—	—
40	36	360	300	270	210	120	—	—	—	—
45	40	560	490	440	380	280	160	—	—	—
50	44	720	660	610	550	450	350	130	—	—
55	48	960	900	810	780	670	550	320	150	—
60	52	1200	1140	1100	1020	910	800	550	420	180
65	55	1410	1350	1310	1220	1120	1000	770	600	370
70	58	1620	1560	1520	1420	1350	1230	1000	820	580
75	61	1790	1730	1630	1580	1510	1420	1160	1040	780

Note: Uniform 50:1 to 70:1 tapers are recommended where lengths of acceleration lanes exceed 1,300 feet.



Source: *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2004. Chapter 10 Grade Separations and Interchanges

Notes for This Study:

Applicable to merge locations at Exits 59 and 61 on I-95 southbound

Applicable to other merge locations in the study area

APPENDIX D

Highway Capacity Analyses
2019 Weekday AM Peak Hour

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex57 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5150	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5779	551
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.85	0.28

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1999.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	3600	Speed Index (DS)	0.489
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2143
Distance to Downstream Ramp (LDOWN), ft	1750	Off-Ramp Influence Area Speed (SR), mi/h	54.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.590	Outer Lanes Freeway Speed (SO), mi/h	67.7
Flow in Lanes 1 and 2 (v12), pc/h	3636	Ramp Junction Speed (S), mi/h	58.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	32.9
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	30.1

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex57 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	4650	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1739
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.76
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	62.7
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	27.7
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex57 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	650
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	4650	350
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5218	385
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.82	0.20

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	868.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1750	Speed Index (MS)	0.589
Downstream Equilibrium Distance (LEQ), ft	3917.7	Flow Outer Lanes (vOA), pc/h/ln	1221
Distance to Downstream Ramp (LDOWN), ft	850	On-Ramp Influence Area Speed (SR), mi/h	51.8
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.766	Outer Lanes Freeway Speed (SO), mi/h	63.2
Flow in Lanes 1 and 2 (v12), pc/h	3997	Ramp Junction Speed (S), mi/h	53.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	4382	Average Density (D), pc/mi/ln	34.7
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	35.5

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex58 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	350
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5000	350
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5611	385
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.82	0.20

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2212.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	850	Speed Index (DS)	0.474
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2080
Distance to Downstream Ramp (LDOWN), ft	2300	Off-Ramp Influence Area Speed (SR), mi/h	54.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.602	Outer Lanes Freeway Speed (SO), mi/h	68.0
Flow in Lanes 1 and 2 (v12), pc/h	3531	Ramp Junction Speed (S), mi/h	58.8
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	31.8
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.5

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex58 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	4650	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1739
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.76
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	62.7
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	27.7
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex58 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	750
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	4650	800
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5218	881
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.89	0.46

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1019.3	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2300	Speed Index (MS)	0.483
Downstream Equilibrium Distance (LEQ), ft	1421.9	Flow Outer Lanes (vOA), pc/h/ln	2098
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	55.3
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.598	Outer Lanes Freeway Speed (SO), mi/h	62.0
Flow in Lanes 1 and 2 (v12), pc/h	3120	Ramp Junction Speed (S), mi/h	57.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	4001	Average Density (D), pc/mi/ln	35.4
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.6

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex59 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	775
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5450	250
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	6116	275
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	0.90	0.15

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	4528.2	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.528
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2371
Distance to Downstream Ramp (LDOWN), ft	1125	Off-Ramp Influence Area Speed (SR), mi/h	54.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.594	Outer Lanes Freeway Speed (SO), mi/h	69.0
Flow in Lanes 1 and 2 (v12), pc/h	3745	Ramp Junction Speed (S), mi/h	59.1
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	34.5
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	29.5

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex59 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.16
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.4
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5200	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1945
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2396
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2319
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.84
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	61.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	31.8
Total Ramp Density Adjustment	3.6	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	69.6		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex59 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	650
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5200	200
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5835	220
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.89	0.11

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	965.5	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.434
Downstream Equilibrium Distance (LEQ), ft	2712.3	Flow Outer Lanes (vOA), pc/h/ln	2357
Distance to Downstream Ramp (LDOWN), ft	4900	On-Ramp Influence Area Speed (SR), mi/h	57.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.596	Outer Lanes Freeway Speed (SO), mi/h	62.7
Flow in Lanes 1 and 2 (v12), pc/h	3478	Ramp Junction Speed (S), mi/h	59.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	3698	Average Density (D), pc/mi/ln	33.9
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	30.2

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex59-60 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5400	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2020
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.87
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.7
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	33.8
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex60 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	200
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5400	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	6060	496
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.87	0.27

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1250.6	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	4900	Speed Index (DS)	0.548
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2303
Distance to Downstream Ramp (LDOWN), ft	1200	Off-Ramp Influence Area Speed (SR), mi/h	54.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.586	Outer Lanes Freeway Speed (SO), mi/h	71.7
Flow in Lanes 1 and 2 (v12), pc/h	3757	Ramp Junction Speed (S), mi/h	60.1
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	33.6
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.8

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex60 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	4950	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1852
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.80
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	63.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	29.3
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex60 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	625
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5250	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5891	330
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.89	0.17

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	989.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1200	Speed Index (MS)	0.518
Downstream Equilibrium Distance (LEQ), ft	3059.3	Flow Outer Lanes (vOA), pc/h/ln	2103
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	55.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.643	Outer Lanes Freeway Speed (SO), mi/h	64.2
Flow in Lanes 1 and 2 (v12), pc/h	3788	Ramp Junction Speed (S), mi/h	58.2
Flow Entering Ramp-Infl. Area (vR12), pc/h	4118	Average Density (D), pc/mi/ln	35.6
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.6

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex61 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5250	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	2.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.976
Flow Rate (vi),pc/h	5891	545
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.85	0.28

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1962.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.489
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2203
Distance to Downstream Ramp (LDOWN), ft	1800	Off-Ramp Influence Area Speed (SR), mi/h	56.3
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.588	Outer Lanes Freeway Speed (SO), mi/h	72.1
Flow in Lanes 1 and 2 (v12), pc/h	3688	Ramp Junction Speed (S), mi/h	61.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	32.0
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.9

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex61 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	4750	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1777
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.76
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	64.6
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	27.5
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex61 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	4750	250
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5330	275
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.80	0.14

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	802.6	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1800	Speed Index (MS)	0.407
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2175
Distance to Downstream Ramp (LDOWN), ft	-	On-Ramp Influence Area Speed (SR), mi/h	58.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.592	Outer Lanes Freeway Speed (SO), mi/h	64.0
Flow in Lanes 1 and 2 (v12), pc/h	3155	Ramp Junction Speed (S), mi/h	60.6
Flow Entering Ramp-Infl. Area (vR12), pc/h	3430	Average Density (D), pc/mi/ln	30.8
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	29.0

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex57 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5350	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	5978	493
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.95	0.25

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1032.3	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1700	Speed Index (MS)	0.503
Downstream Equilibrium Distance (LEQ), ft	945.7	Flow Outer Lanes (vOA), pc/h/ln	2427
Distance to Downstream Ramp (LDOWN), ft	3600	On-Ramp Influence Area Speed (SR), mi/h	54.8
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.594	Outer Lanes Freeway Speed (SO), mi/h	60.5
Flow in Lanes 1 and 2 (v12), pc/h	3551	Ramp Junction Speed (S), mi/h	56.8
Flow Entering Ramp-Infl. Area (vR12), pc/h	4044	Average Density (D), pc/mi/ln	38.0
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.1

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex57 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1993
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.87
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	58.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	34.2
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Diverge Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex57 Diverge - 2019 AM	Unit	United States Customary

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors

	Freeway	Ramp
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

	Freeway	Ramp
Demand Volume (Vi)	5150	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5779	551
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.85	0.28

Speed and Density

Upstream Equilibrium Distance (LEQ), ft	1999.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	3600	Speed Index (DS)	0.489
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2143
Distance to Downstream Ramp (LDOWN), ft	1750	Off-Ramp Influence Area Speed (SR), mi/h	54.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.590	Outer Lanes Freeway Speed (SO), mi/h	67.7
Flow in Lanes 1 and 2 (v12), pc/h	3636	Ramp Junction Speed (S), mi/h	58.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	32.9
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	30.1

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex58 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	550
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5150	600
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	5755	657
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.94	0.34

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	997.5	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2600	Speed Index (MS)	0.678
Downstream Equilibrium Distance (LEQ), ft	2602.0	Flow Outer Lanes (vOA), pc/h/ln	1796
Distance to Downstream Ramp (LDOWN), ft	825	On-Ramp Influence Area Speed (SR), mi/h	49.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.688	Outer Lanes Freeway Speed (SO), mi/h	61.1
Flow in Lanes 1 and 2 (v12), pc/h	3959	Ramp Junction Speed (S), mi/h	52.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	4616	Average Density (D), pc/mi/ln	40.8
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	37.8

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex58 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	4650	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1739
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.76
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	62.7
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	27.7
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex58 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	550
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5150	600
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	5755	657
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.94	0.34

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	997.5	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2600	Speed Index (MS)	0.678
Downstream Equilibrium Distance (LEQ), ft	2602.0	Flow Outer Lanes (vOA), pc/h/ln	1796
Distance to Downstream Ramp (LDOWN), ft	825	On-Ramp Influence Area Speed (SR), mi/h	49.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.688	Outer Lanes Freeway Speed (SO), mi/h	61.1
Flow in Lanes 1 and 2 (v12), pc/h	3959	Ramp Junction Speed (S), mi/h	52.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	4616	Average Density (D), pc/mi/ln	40.8
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	37.8

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex59 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	275
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5500	150
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6146	164
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.90	0.08

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1370.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	5600	Speed Index (DS)	0.454
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2399
Distance to Downstream Ramp (LDOWN), ft	1250	Off-Ramp Influence Area Speed (SR), mi/h	56.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.599	Outer Lanes Freeway Speed (SO), mi/h	68.9
Flow in Lanes 1 and 2 (v12), pc/h	3747	Ramp Junction Speed (S), mi/h	60.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	33.9
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.0

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex59 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.16
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.4
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1993
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2360
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2284
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.87
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	58.3
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	34.2
Total Ramp Density Adjustment	3.6	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	66.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex59 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	275
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5500	150
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6146	164
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.90	0.08

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1370.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	5600	Speed Index (DS)	0.454
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2399
Distance to Downstream Ramp (LDOWN), ft	1250	Off-Ramp Influence Area Speed (SR), mi/h	56.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.599	Outer Lanes Freeway Speed (SO), mi/h	68.9
Flow in Lanes 1 and 2 (v12), pc/h	3747	Ramp Junction Speed (S), mi/h	60.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	33.9
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.0

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex59-60 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5500	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2049
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.88
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.1
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	34.7
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex60 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	625
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5250	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5891	330
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.89	0.17

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	989.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1200	Speed Index (MS)	0.518
Downstream Equilibrium Distance (LEQ), ft	3059.3	Flow Outer Lanes (vOA), pc/h/ln	2103
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	55.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.643	Outer Lanes Freeway Speed (SO), mi/h	64.2
Flow in Lanes 1 and 2 (v12), pc/h	3788	Ramp Junction Speed (S), mi/h	58.2
Flow Entering Ramp-Infl. Area (vR12), pc/h	4118	Average Density (D), pc/mi/ln	35.6
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.6

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex60 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5250	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1956
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.84
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	61.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	32.0
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex60 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	575
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5650	400
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6314	438
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.91	0.23

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2994.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.479
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2456
Distance to Downstream Ramp (LDOWN), ft	1925	Off-Ramp Influence Area Speed (SR), mi/h	56.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.582	Outer Lanes Freeway Speed (SO), mi/h	71.1
Flow in Lanes 1 and 2 (v12), pc/h	3858	Ramp Junction Speed (S), mi/h	61.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	34.2
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.3

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex61 Merge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	25.0
Segment Length (L) / Acceleration Length (LA),ft	1500	350
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5150	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	5755	548
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.90	0.30

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	377.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.550
Downstream Equilibrium Distance (LEQ), ft	2980.6	Flow Outer Lanes (vOA), pc/h/ln	2158
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	54.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.625	Outer Lanes Freeway Speed (SO), mi/h	64.0
Flow in Lanes 1 and 2 (v12), pc/h	3597	Ramp Junction Speed (S), mi/h	57.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	4145	Average Density (D), pc/mi/ln	36.5
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	35.4

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex61 Basic Fwy - 2019 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5150	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1918
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.83
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	61.9
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	31.0
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex61 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5450	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6090	329
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.87	0.17

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	-	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	-	Speed Index (DS)	0.469
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2345
Distance to Downstream Ramp (LDOWN), ft	1125	Off-Ramp Influence Area Speed (SR), mi/h	56.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.593	Outer Lanes Freeway Speed (SO), mi/h	71.5
Flow in Lanes 1 and 2 (v12), pc/h	3745	Ramp Junction Speed (S), mi/h	61.8
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	32.8
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.4

APPENDIX E

Highway Capacity Analyses
2019 Weekday PM Peak Hour

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex57 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5850	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6376	540
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.93	0.28

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2445.6	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	3600	Speed Index (DS)	0.488
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2474
Distance to Downstream Ramp (LDOWN), ft	1750	Off-Ramp Influence Area Speed (SR), mi/h	54.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.576	Outer Lanes Freeway Speed (SO), mi/h	66.4
Flow in Lanes 1 and 2 (v12), pc/h	3902	Ramp Junction Speed (S), mi/h	58.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	36.4
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.4

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex57 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1944
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.85
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	32.8
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex57 Merge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	650
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5350	550
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	5831	594
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.94	0.31

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1044.7	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1750	Speed Index (MS)	0.892
Downstream Equilibrium Distance (LEQ), ft	3917.7	Flow Outer Lanes (vOA), pc/h/ln	1364
Distance to Downstream Ramp (LDOWN), ft	850	On-Ramp Influence Area Speed (SR), mi/h	44.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.766	Outer Lanes Freeway Speed (SO), mi/h	62.7
Flow in Lanes 1 and 2 (v12), pc/h	4467	Ramp Junction Speed (S), mi/h	47.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	5061	Average Density (D), pc/mi/ln	45.1
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	40.7

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex58 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	350
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5900	550
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6431	594
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.94	0.31

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	3417.7	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	850	Speed Index (DS)	0.493
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2498
Distance to Downstream Ramp (LDOWN), ft	2300	Off-Ramp Influence Area Speed (SR), mi/h	54.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.572	Outer Lanes Freeway Speed (SO), mi/h	66.3
Flow in Lanes 1 and 2 (v12), pc/h	3933	Ramp Junction Speed (S), mi/h	58.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	36.8
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.9

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex58 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5250	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1907
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.84
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.9
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	31.8
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex58 Merge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	750
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5250	650
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	5722	702
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.94	0.36

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1088.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2300	Speed Index (MS)	0.582
Downstream Equilibrium Distance (LEQ), ft	2843.8	Flow Outer Lanes (vOA), pc/h/ln	2043
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	52.8
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.643	Outer Lanes Freeway Speed (SO), mi/h	62.2
Flow in Lanes 1 and 2 (v12), pc/h	3679	Ramp Junction Speed (S), mi/h	55.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	4381	Average Density (D), pc/mi/ln	38.6
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.7

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex59 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	775
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5900	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6431	540
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	0.94	0.29

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	3945.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.552
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2510
Distance to Downstream Ramp (LDOWN), ft	1125	Off-Ramp Influence Area Speed (SR), mi/h	53.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.574	Outer Lanes Freeway Speed (SO), mi/h	68.5
Flow in Lanes 1 and 2 (v12), pc/h	3921	Ramp Junction Speed (S), mi/h	58.6
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	36.6
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.0

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex59 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.16
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.4
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5400	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1962
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2396
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2319
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.85
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	60.8
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	32.3
Total Ramp Density Adjustment	3.6	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	69.6		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex59 Merge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	650
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5400	150
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	5886	162
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.89	0.08

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	964.0	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.430
Downstream Equilibrium Distance (LEQ), ft	1808.2	Flow Outer Lanes (vOA), pc/h/ln	2378
Distance to Downstream Ramp (LDOWN), ft	4900	On-Ramp Influence Area Speed (SR), mi/h	57.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.596	Outer Lanes Freeway Speed (SO), mi/h	62.6
Flow in Lanes 1 and 2 (v12), pc/h	3508	Ramp Junction Speed (S), mi/h	59.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	3670	Average Density (D), pc/mi/ln	33.9
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	30.0

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex59-60 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5550	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2016
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.87
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.8
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	33.7
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex60 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	200
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5550	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6049	324
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.87	0.18

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	873.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	4900	Speed Index (DS)	0.533
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2324
Distance to Downstream Ramp (LDOWN), ft	1200	Off-Ramp Influence Area Speed (SR), mi/h	55.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.594	Outer Lanes Freeway Speed (SO), mi/h	71.6
Flow in Lanes 1 and 2 (v12), pc/h	3725	Ramp Junction Speed (S), mi/h	60.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	33.3
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.5

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex60 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5250	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1907
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.82
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	62.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	30.7
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex60 Merge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	625
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5250	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	5722	540
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.90	0.28

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	998.7	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1200	Speed Index (MS)	0.559
Downstream Equilibrium Distance (LEQ), ft	3365.3	Flow Outer Lanes (vOA), pc/h/ln	1986
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	54.3
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.653	Outer Lanes Freeway Speed (SO), mi/h	64.7
Flow in Lanes 1 and 2 (v12), pc/h	3736	Ramp Junction Speed (S), mi/h	57.2
Flow Entering Ramp-Infl. Area (vR12), pc/h	4276	Average Density (D), pc/mi/ln	36.5
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.7

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex61 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5750	550
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6267	594
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.90	0.31

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	3175.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.493
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2405
Distance to Downstream Ramp (LDOWN), ft	1800	Off-Ramp Influence Area Speed (SR), mi/h	56.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.576	Outer Lanes Freeway Speed (SO), mi/h	71.3
Flow in Lanes 1 and 2 (v12), pc/h	3862	Ramp Junction Speed (S), mi/h	61.2
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	34.1
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.4

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex61 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5200	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1889
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.81
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	62.5
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	30.2
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex61 Merge - 2019 PM	Unit	United States Customary

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity

Demand Volume (Vi)	5200	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	5668	486
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.88	0.25

Speed and Density

Upstream Equilibrium Distance (LEQ), ft	920.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1800	Speed Index (MS)	0.469
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2313
Distance to Downstream Ramp (LDOWN), ft	-	On-Ramp Influence Area Speed (SR), mi/h	56.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.592	Outer Lanes Freeway Speed (SO), mi/h	63.4
Flow in Lanes 1 and 2 (v12), pc/h	3355	Ramp Junction Speed (S), mi/h	59.2
Flow Entering Ramp-Infl. Area (vR12), pc/h	3841	Average Density (D), pc/mi/ln	34.7
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.1

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex57 Merge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	4900	550
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5341	597
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.87	0.31

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	918.2	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1700	Speed Index (MS)	0.449
Downstream Equilibrium Distance (LEQ), ft	936.5	Flow Outer Lanes (vOA), pc/h/ln	2168
Distance to Downstream Ramp (LDOWN), ft	3600	On-Ramp Influence Area Speed (SR), mi/h	56.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.594	Outer Lanes Freeway Speed (SO), mi/h	61.8
Flow in Lanes 1 and 2 (v12), pc/h	3173	Ramp Junction Speed (S), mi/h	58.1
Flow Entering Ramp-Infl. Area (vR12), pc/h	3770	Average Density (D), pc/mi/ln	34.1
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	30.9

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex57 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1944
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.85
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	32.8
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex57 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	225
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5400	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5886	543
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.86	0.28

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2628.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	825	Speed Index (DS)	0.489
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2201
Distance to Downstream Ramp (LDOWN), ft	1700	Off-Ramp Influence Area Speed (SR), mi/h	54.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.588	Outer Lanes Freeway Speed (SO), mi/h	67.5
Flow in Lanes 1 and 2 (v12), pc/h	3685	Ramp Junction Speed (S), mi/h	58.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	33.5
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.9

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex58 Merge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	550
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5000	400
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5450	434
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.86	0.22

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	884.5	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2600	Speed Index (MS)	0.591
Downstream Equilibrium Distance (LEQ), ft	3220.9	Flow Outer Lanes (vOA), pc/h/ln	1515
Distance to Downstream Ramp (LDOWN), ft	825	On-Ramp Influence Area Speed (SR), mi/h	51.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.722	Outer Lanes Freeway Speed (SO), mi/h	62.1
Flow in Lanes 1 and 2 (v12), pc/h	3935	Ramp Junction Speed (S), mi/h	54.0
Flow Entering Ramp-Infl. Area (vR12), pc/h	4369	Average Density (D), pc/mi/ln	36.3
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	36.0

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex58 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5000	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1817
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.80
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	61.5
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	29.5
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex58 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5650	650
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	6158	706
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.90	0.36

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	293.5	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2150	Speed Index (DS)	0.503
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2323
Distance to Downstream Ramp (LDOWN), ft	2600	Off-Ramp Influence Area Speed (SR), mi/h	53.8
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.574	Outer Lanes Freeway Speed (SO), mi/h	67.0
Flow in Lanes 1 and 2 (v12), pc/h	3835	Ramp Junction Speed (S), mi/h	58.1
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	35.3
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.7

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59 Merge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	25.0
Segment Length (L) / Acceleration Length (LA),ft	1500	400
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5350	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5831	326
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	0.90	0.18

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	368.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1250	Speed Index (MS)	0.521
Downstream Equilibrium Distance (LEQ), ft	4628.1	Flow Outer Lanes (vOA), pc/h/ln	2128
Distance to Downstream Ramp (LDOWN), ft	2150	On-Ramp Influence Area Speed (SR), mi/h	54.4
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.635	Outer Lanes Freeway Speed (SO), mi/h	61.9
Flow in Lanes 1 and 2 (v12), pc/h	3703	Ramp Junction Speed (S), mi/h	56.8
Flow Entering Ramp-Infl. Area (vR12), pc/h	4029	Average Density (D), pc/mi/ln	36.1
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.3

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.16
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.4
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1944
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2360
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2284
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.85
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.3
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	32.8
Total Ramp Density Adjustment	3.6	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	66.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	275
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5550	200
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	6049	217
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.89	0.11

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	3642.5	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	5600	Speed Index (DS)	0.459
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2339
Distance to Downstream Ramp (LDOWN), ft	1250	Off-Ramp Influence Area Speed (SR), mi/h	56.0
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.599	Outer Lanes Freeway Speed (SO), mi/h	69.2
Flow in Lanes 1 and 2 (v12), pc/h	3710	Ramp Junction Speed (S), mi/h	60.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	33.3
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.7

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59-60 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	5550	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2016
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.87
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.8
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	33.7
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex60 Merge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	4950	600
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5395	651
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.87	0.34

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	897.0	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1925	Speed Index (MS)	0.469
Downstream Equilibrium Distance (LEQ), ft	1330.6	Flow Outer Lanes (vOA), pc/h/ln	2201
Distance to Downstream Ramp (LDOWN), ft	5600	On-Ramp Influence Area Speed (SR), mi/h	56.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.592	Outer Lanes Freeway Speed (SO), mi/h	63.9
Flow in Lanes 1 and 2 (v12), pc/h	3194	Ramp Junction Speed (S), mi/h	59.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	3845	Average Density (D), pc/mi/ln	34.0
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.1

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex60 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	4950	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1798
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.77
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	64.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	28.0
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex60 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	575
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5200	250
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5668	271
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.81	0.14

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2701.2	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.464
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2126
Distance to Downstream Ramp (LDOWN), ft	1925	Off-Ramp Influence Area Speed (SR), mi/h	57.0
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.606	Outer Lanes Freeway Speed (SO), mi/h	72.4
Flow in Lanes 1 and 2 (v12), pc/h	3542	Ramp Junction Speed (S), mi/h	61.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	30.5
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	29.5

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex61 Merge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	25.0
Segment Length (L) / Acceleration Length (LA),ft	1500	350
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	4750	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5177	488
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.81	0.27

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	241.3	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.443
Downstream Equilibrium Distance (LEQ), ft	1844.8	Flow Outer Lanes (vOA), pc/h/ln	2092
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	57.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.596	Outer Lanes Freeway Speed (SO), mi/h	64.3
Flow in Lanes 1 and 2 (v12), pc/h	3085	Ramp Junction Speed (S), mi/h	59.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	3573	Average Density (D), pc/mi/ln	31.5
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.0

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex61 Basic Fwy - 2019 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.000

Demand and Capacity

Demand Volume veh/h	4750	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1726
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.74
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	65.4
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	26.4
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2019
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex61 Diverge - 2019 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.000	1.000

Demand and Capacity		
Demand Volume (Vi)	5050	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5504	326
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.79	0.17

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	-	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	-	Speed Index (DS)	0.469
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2035
Distance to Downstream Ramp (LDOWN), ft	1125	Off-Ramp Influence Area Speed (SR), mi/h	56.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.607	Outer Lanes Freeway Speed (SO), mi/h	72.8
Flow in Lanes 1 and 2 (v12), pc/h	3469	Ramp Junction Speed (S), mi/h	61.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	29.6
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	30.0

APPENDIX F

Intersection Capacity Analyses
Signalized Interchanges at I-95 Exits 57, 60, and 61
2021 Summer Weekday AM/PM Peak Hour

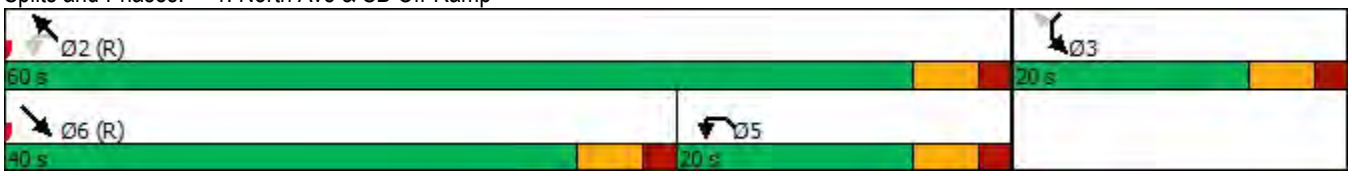
Intersection Capacity Analysis: I-95 Exit 57
1: North Ave & SB Off-Ramp

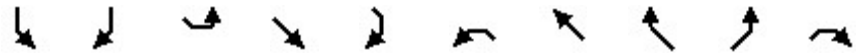
02/10/2022

Lane Group	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR	SWL2	SWL	SWR
Lane Configurations											
Traffic Volume (vph)	0	0	0	739	275	245	554	0	93	0	322
Future Volume (vph)	0	0	0	739	275	245	554	0	93	0	322
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Right Turn on Red					Yes			Yes			Yes
Link Speed (mph)	30			30			30			30	
Link Distance (ft)	822			402			673			375	
Travel Time (s)	18.7			9.1			15.3			8.5	
Confl. Peds. (#/hr)					6	6					
Peak Hour Factor	0.92	0.92	0.92	0.94	0.94	0.90	0.90	0.92	0.93	0.92	0.93
Heavy Vehicles (%)	2%	2%	0%	2%	2%	2%	2%	0%	1%	2%	1%
Shared Lane Traffic (%)											
Turn Type				NA		pm+pt	NA		Prot		Perm
Protected Phases				6		5	2		3		
Permitted Phases						2					3
Detector Phase				6		5	2		3		3
Switch Phase											
Minimum Initial (s)				10.0		6.0	10.0		6.0		6.0
Minimum Split (s)				16.0		12.0	16.0		12.0		12.0
Total Split (s)				40.0		20.0	60.0		20.0		20.0
Total Split (%)				50.0%		25.0%	75.0%		25.0%		25.0%
Yellow Time (s)				4.0		4.0	4.0		4.0		4.0
All-Red Time (s)				2.0		2.0	2.0		2.0		2.0
Lost Time Adjust (s)				0.0			0.0		0.0		0.0
Total Lost Time (s)				6.0			6.0		6.0		6.0
Lead/Lag				Lead		Lag					
Lead-Lag Optimize?				Yes		Yes					
Recall Mode				C-Max		Max	C-Min		None		None
Act Effct Green (s)				38.1			58.1		9.9		9.9
Actuated g/C Ratio				0.48			0.73		0.12		0.12
v/c Ratio				0.65			0.55		0.45		0.69
Control Delay				17.5			6.7		38.3		11.5
Queue Delay				0.0			0.0		0.0		0.0
Total Delay				17.5			6.7		38.3		11.5
LOS				B			A		D		B
Approach Delay				17.5			6.7			17.5	
Approach LOS				B			A			B	

Intersection Summary			
Area Type:	Other		
Cycle Length: 80			
Actuated Cycle Length: 80			
Offset: 42 (53%), Referenced to phase 2:NWTL and 6:SET, Start of Green			
Natural Cycle: 55			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.69			
Intersection Signal Delay: 13.5		Intersection LOS: B	
Intersection Capacity Utilization 70.3%		ICU Level of Service C	
Analysis Period (min) 15			

Splits and Phases: 1: North Ave & SB Off-Ramp





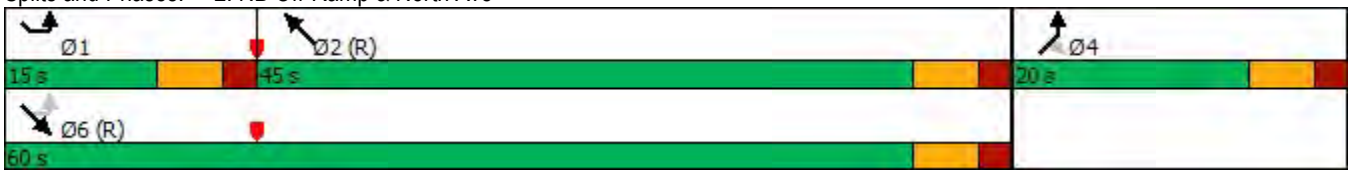
Lane Group	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR	NEL	NER
Lane Configurations										
Traffic Volume (vph)	0	0	362	494	0	0	611	157	181	253
Future Volume (vph)	0	0	362	494	0	0	611	157	181	253
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0		0	0		0	0	200
Storage Lanes	0	0	0		0	0		0	2	1
Taper Length (ft)	25		25			25			25	
Right Turn on Red					Yes			Yes		Yes
Link Speed (mph)	30			30			30		30	
Link Distance (ft)	322			673			260		405	
Travel Time (s)	7.3			15.3			5.9		9.2	
Confl. Peds. (#/hr)									4	4
Peak Hour Factor	0.92	0.92	0.93	0.93	0.92	0.92	0.85	0.85	0.84	0.84
Parking (#/hr)				0						
Shared Lane Traffic (%)										
Turn Type			pm+pt	NA			NA		Prot	Perm
Protected Phases			1	6			2		4	
Permitted Phases			6							4
Detector Phase			1	6			2		4	4
Switch Phase										
Minimum Initial (s)			6.0	10.0			10.0		6.0	6.0
Minimum Split (s)			12.0	16.0			16.0		12.0	12.0
Total Split (s)			15.0	60.0			45.0		20.0	20.0
Total Split (%)			18.8%	75.0%			56.3%		25.0%	25.0%
Yellow Time (s)			4.0	4.0			4.0		4.0	4.0
All-Red Time (s)			2.0	2.0			2.0		2.0	2.0
Lost Time Adjust (s)				0.0			0.0		0.0	0.0
Total Lost Time (s)				6.0			6.0		6.0	6.0
Lead/Lag			Lead				Lag			
Lead-Lag Optimize?			Yes				Yes			
Recall Mode			None	C-Min			C-Min		Max	Max
Act Effct Green (s)				49.9			49.9		18.1	18.1
Actuated g/C Ratio				0.62			0.62		0.23	0.23
v/c Ratio				1.31dl			0.42		0.28	0.51
Control Delay				24.2			10.8		28.6	7.4
Queue Delay				0.0			0.9		0.0	0.0
Total Delay				24.2			11.7		28.6	7.4
LOS				C			B		C	A
Approach Delay				24.2			11.7		16.3	
Approach LOS				C			B		B	

Intersection Summary	
Area Type:	Other
Cycle Length: 80	
Actuated Cycle Length: 80	
Offset: 0 (0%), Referenced to phase 2:NWT and 6:SETL, Start of Green, Master Intersection	
Natural Cycle: 60	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.81	

Intersection Signal Delay: 17.6	Intersection LOS: B
Intersection Capacity Utilization 66.2%	ICU Level of Service C
Analysis Period (min) 15	

dl Defacto Left Lane. Recode with 1 though lane as a left lane.

Splits and Phases: 2: NB Off-Ramp & North Ave

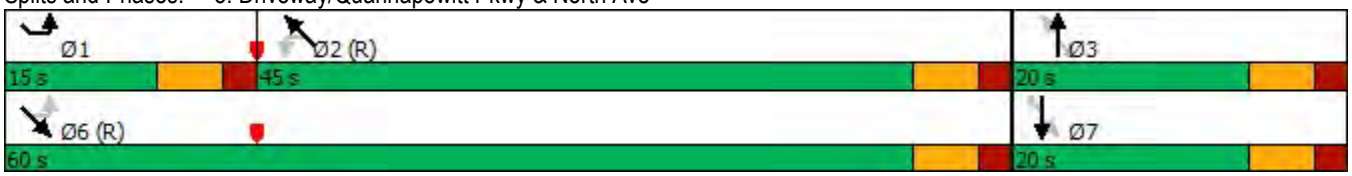


Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	42	4	12	20	1	34	25	697	19	15	695	46
Future Volume (vph)	42	4	12	20	1	34	25	697	19	15	695	46
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		150	0		0	0		0	0		0
Storage Lanes	0		1	0		1	0		0	0		0
Taper Length (ft)	25			25			25			25		
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		242			308			260			333	
Travel Time (s)		5.5			7.0			5.9			7.6	
Confl. Peds. (#/hr)	3					3	6		1	1		6
Peak Hour Factor	0.81	0.81	0.81	0.71	0.71	0.71	0.93	0.93	0.93	0.85	0.85	0.85
Heavy Vehicles (%)	0%	0%	0%	2%	2%	2%	2%	2%	2%	3%	3%	3%
Shared Lane Traffic (%)												
Turn Type	Perm	NA	Perm	Perm	NA	Perm	pm+pt	NA		Perm	NA	
Protected Phases		3			7		1	6			2	
Permitted Phases	3		3	7		7	6			2		
Detector Phase	3	3	3	7	7	7	1	6		2	2	
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	10.0		10.0	10.0	
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	16.0		16.0	16.0	
Total Split (s)	20.0	20.0	20.0	20.0	20.0	20.0	15.0	60.0		45.0	45.0	
Total Split (%)	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	18.8%	75.0%		56.3%	56.3%	
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0	0.0		0.0	0.0		0.0			0.0	
Total Lost Time (s)		6.0	6.0		6.0	6.0		6.0			6.0	
Lead/Lag							Lead			Lag	Lag	
Lead-Lag Optimize?							Yes			Yes	Yes	
Recall Mode	None	None	None	None	None	None	None	C-Min		C-Min	C-Min	
Act Effct Green (s)		8.1	8.1		8.1	8.1		63.5			63.5	
Actuated g/C Ratio		0.10	0.10		0.10	0.10		0.79			0.79	
v/c Ratio		0.41	0.05		0.22	0.18		0.31			0.35	
Control Delay		42.0	0.4		36.1	1.5		4.7			3.7	
Queue Delay		0.0	0.0		0.0	0.0		0.4			0.0	
Total Delay		42.0	0.4		36.1	1.5		5.1			3.7	
LOS		D	A		D	A		A			A	
Approach Delay		33.3			14.5			5.1			3.7	
Approach LOS		C			B			A			A	

Intersection Summary	
Area Type:	Other
Cycle Length: 80	
Actuated Cycle Length: 80	
Offset: 0 (0%), Referenced to phase 2:NWTL and 6:SETL, Start of Green	
Natural Cycle: 45	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.41	

Intersection Signal Delay: 5.9	Intersection LOS: A
Intersection Capacity Utilization 57.3%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 3: Driveway/Quannapowitt Pkwy & North Ave



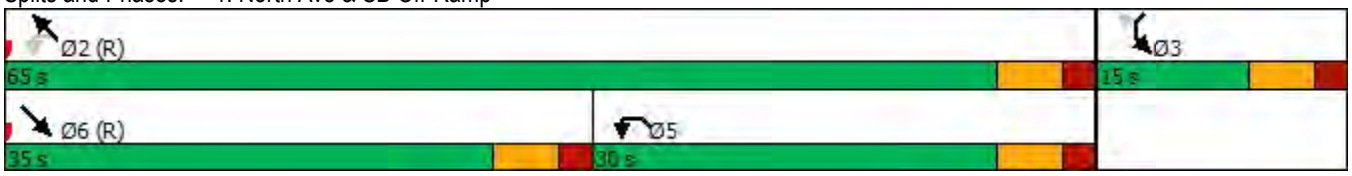
Intersection Capacity Analysis: I-95 Exit 57
1: North Ave & SB Off-Ramp

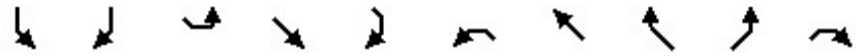
02/10/2022

Lane Group	NBL	NBR	SEL	SET	SER	NWL	NWT	NWR	SWL2	SWL	SWR
Lane Configurations											
Traffic Volume (vph)	0	0	0	426	226	229	489	0	135	0	396
Future Volume (vph)	0	0	0	426	226	229	489	0	135	0	396
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Right Turn on Red					Yes			Yes			Yes
Link Speed (mph)	30			30			30			30	
Link Distance (ft)	822			402			673			375	
Travel Time (s)	18.7			9.1			15.3			8.5	
Confl. Peds. (#/hr)					6	6					
Peak Hour Factor	0.92	0.92	0.92	0.93	0.93	0.94	0.94	0.92	0.86	0.92	0.86
Heavy Vehicles (%)	2%	2%	0%	5%	5%	4%	4%	0%	2%	2%	2%
Shared Lane Traffic (%)											
Turn Type				NA		pm+pt	NA		Prot		Perm
Protected Phases				6		5	2		3		
Permitted Phases						2					3
Detector Phase				6		5	2		3		3
Switch Phase											
Minimum Initial (s)				10.0		6.0	10.0		6.0		6.0
Minimum Split (s)				16.0		12.0	16.0		12.0		12.0
Total Split (s)				35.0		30.0	65.0		15.0		15.0
Total Split (%)				43.8%		37.5%	81.3%		18.8%		18.8%
Yellow Time (s)				4.0		4.0	4.0		4.0		4.0
All-Red Time (s)				2.0		2.0	2.0		2.0		2.0
Lost Time Adjust (s)				0.0			0.0		0.0		0.0
Total Lost Time (s)				6.0			6.0		6.0		6.0
Lead/Lag				Lead		Lag					
Lead-Lag Optimize?				Yes		Yes					
Recall Mode				C-Max		Max	C-Min		None		None
Act Effct Green (s)				29.1			59.1		8.9		8.9
Actuated g/C Ratio				0.36			0.74		0.11		0.11
v/c Ratio				0.56			0.40		0.80		0.81
Control Delay				18.1			5.2		64.4		17.2
Queue Delay				0.0			0.0		0.0		0.0
Total Delay				18.1			5.2		64.4		17.2
LOS				B			A		E		B
Approach Delay				18.1			5.2			29.2	
Approach LOS				B			A			C	

Intersection Summary			
Area Type:	Other		
Cycle Length: 80			
Actuated Cycle Length: 80			
Offset: 42 (53%), Referenced to phase 2:NWTL and 6:SET, Start of Green			
Natural Cycle: 60			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.81			
Intersection Signal Delay: 16.7		Intersection LOS: B	
Intersection Capacity Utilization 60.2%		ICU Level of Service B	
Analysis Period (min) 15			

Splits and Phases: 1: North Ave & SB Off-Ramp



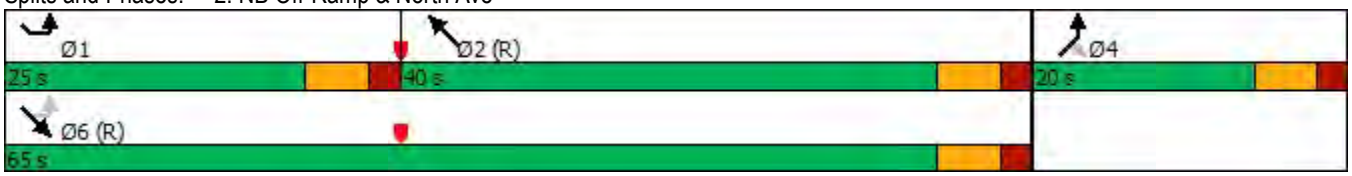


Lane Group	SBL	SBR	SEL	SET	SER	NWL	NWT	NWR	NEL	NER
Lane Configurations										
Traffic Volume (vph)	0	0	172	392	0	0	526	111	198	328
Future Volume (vph)	0	0	172	392	0	0	526	111	198	328
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0	0	0		0	0		0	0	200
Storage Lanes	0	0	0		0	0		0	2	1
Taper Length (ft)	25		25			25			25	
Right Turn on Red					Yes			Yes		Yes
Link Speed (mph)	30			30			30		30	
Link Distance (ft)	322			673			260		405	
Travel Time (s)	7.3			15.3			5.9		9.2	
Confl. Peds. (#/hr)									4	4
Peak Hour Factor	0.92	0.92	0.86	0.86	0.92	0.92	0.96	0.96	0.92	0.90
Heavy Vehicles (%)	2%	2%	3%	3%	2%	2%	3%	3%	2%	6%
Shared Lane Traffic (%)										
Turn Type			pm+pt	NA			NA		Prot	Perm
Protected Phases			1	6			2		4	
Permitted Phases			6							4
Detector Phase			1	6			2		4	4
Switch Phase										
Minimum Initial (s)			6.0	10.0			10.0		6.0	6.0
Minimum Split (s)			12.0	16.0			16.0		12.0	12.0
Total Split (s)			25.0	65.0			40.0		20.0	20.0
Total Split (%)			29.4%	76.5%			47.1%		23.5%	23.5%
Yellow Time (s)			4.0	4.0			4.0		4.0	4.0
All-Red Time (s)			2.0	2.0			2.0		2.0	2.0
Lost Time Adjust (s)				0.0			0.0		0.0	0.0
Total Lost Time (s)				6.0			6.0		6.0	6.0
Lead/Lag			Lead				Lag			
Lead-Lag Optimize?			Yes				Yes			
Recall Mode			None	C-Min			C-Min		Max	Max
Act Effct Green (s)				41.7			41.7		31.3	31.3
Actuated g/C Ratio				0.49			0.49		0.37	0.37
v/c Ratio				0.62			0.39		0.17	0.47
Control Delay				18.5			12.0		19.4	4.7
Queue Delay				0.0			0.6		0.0	0.0
Total Delay				18.5			12.5		19.4	4.7
LOS				B			B		B	A
Approach Delay				18.5			12.5		10.1	
Approach LOS				B			B		B	

Intersection Summary	
Area Type:	Other
Cycle Length: 85	
Actuated Cycle Length: 85	
Offset: 0 (0%), Referenced to phase 2:NWT and 6:SETL, Start of Green, Master Intersection	
Natural Cycle: 45	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.62	

Intersection Signal Delay: 13.9	Intersection LOS: B
Intersection Capacity Utilization 54.6%	ICU Level of Service A
Analysis Period (min) 15	

Splits and Phases: 2: NB Off-Ramp & North Ave

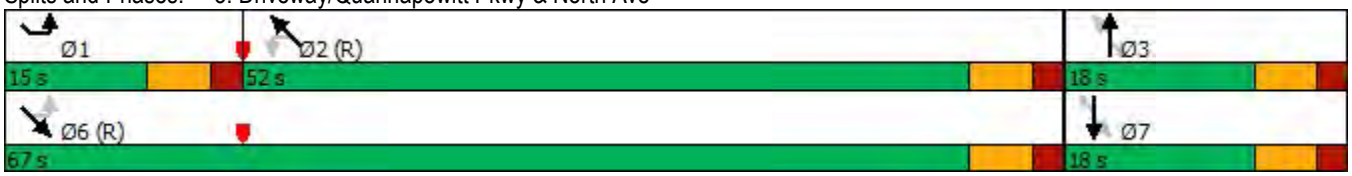


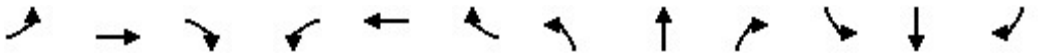
Lane Group	NBL	NBT	NBR	SBL	SBT	SBR	SEL	SET	SER	NWL	NWT	NWR
Lane Configurations												
Traffic Volume (vph)	23	0	9	25	2	26	58	641	45	18	571	37
Future Volume (vph)	23	0	9	25	2	26	58	641	45	18	571	37
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		150	0		0	0		0	0		0
Storage Lanes	0		1	0		1	0		0	0		0
Taper Length (ft)	25			25			25			25		
Right Turn on Red			Yes			Yes			Yes			Yes
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		242			308			260			333	
Travel Time (s)		5.5			7.0			5.9			7.6	
Confl. Peds. (#/hr)	3					3	7					7
Peak Hour Factor	0.84	0.92	0.84	0.70	0.70	0.70	0.88	0.88	0.88	0.94	0.94	0.94
Heavy Vehicles (%)	5%	2%	5%	0%	0%	0%	4%	4%	4%	3%	3%	3%
Shared Lane Traffic (%)												
Turn Type	Perm	NA	Perm	Perm	NA	Perm	pm+pt	NA		Perm	NA	
Protected Phases		3			7		1	6			2	
Permitted Phases	3		3	7		7	6			2		
Detector Phase	3	3	3	7	7	7	1	6		2	2	
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	10.0		10.0	10.0	
Minimum Split (s)	12.0	12.0	12.0	12.0	12.0	12.0	12.0	16.0		16.0	16.0	
Total Split (s)	18.0	18.0	18.0	18.0	18.0	18.0	15.0	67.0		52.0	52.0	
Total Split (%)	21.2%	21.2%	21.2%	21.2%	21.2%	21.2%	17.6%	78.8%		61.2%	61.2%	
Yellow Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)		0.0	0.0		0.0	0.0		0.0			0.0	
Total Lost Time (s)		6.0	6.0		6.0	6.0		6.0			6.0	
Lead/Lag							Lead			Lag	Lag	
Lead-Lag Optimize?							Yes			Yes	Yes	
Recall Mode	None	None	None	None	None	None	None	C-Min		C-Min	C-Min	
Act Effct Green (s)		7.4	7.4		7.4	7.4		69.2			69.2	
Actuated g/C Ratio		0.09	0.09		0.09	0.09		0.81			0.81	
v/c Ratio		0.24	0.05		0.33	0.15		0.36			0.26	
Control Delay		40.6	0.3		43.4	1.3		2.7			2.8	
Queue Delay		0.0	0.0		0.0	0.0		0.2			0.0	
Total Delay		40.6	0.3		43.4	1.3		2.9			2.8	
LOS		D	A		D	A		A			A	
Approach Delay		28.9			22.9			2.9			2.8	
Approach LOS		C			C			A			A	

Intersection Summary	
Area Type:	Other
Cycle Length: 85	
Actuated Cycle Length: 85	
Offset: 0 (0%), Referenced to phase 2:NWTL and 6:SETL, Start of Green	
Natural Cycle: 40	
Control Type: Actuated-Coordinated	
Maximum v/c Ratio: 0.36	

Intersection Signal Delay: 4.4	Intersection LOS: A
Intersection Capacity Utilization 61.5%	ICU Level of Service B
Analysis Period (min) 15	

Splits and Phases: 3: Driveway/Quannapowitt Pkwy & North Ave



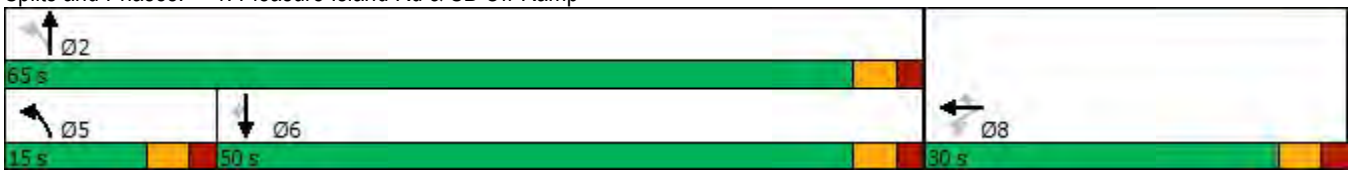


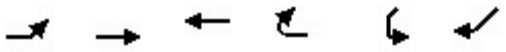
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	208	0	182	133	561	0	0	189	101
Future Volume (vph)	0	0	0	208	0	182	133	561	0	0	189	101
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		200	200		0	0		175
Storage Lanes	0		0	0		1	1		0	0		1
Taper Length (ft)	25			25			50			25		
Satd. Flow (prot)	0	0	0	0	1736	1583	1752	3505	0	0	3505	1568
Flt Permitted					0.950		0.412					
Satd. Flow (perm)	0	0	0	0	1736	1583	760	3505	0	0	3505	1568
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						188						126
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		795			527			668			287	
Travel Time (s)		18.1			12.0			15.2			6.5	
Peak Hour Factor	0.92	0.92	0.92	0.97	0.97	0.97	0.95	0.95	0.92	0.92	0.80	0.80
Heavy Vehicles (%)	2%	2%	2%	4%	4%	2%	3%	3%	2%	2%	3%	3%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	214	188	140	591	0	0	236	126
Turn Type				Perm	NA	Perm	pm+pt	NA			NA	Perm
Protected Phases					8		5	2			6	
Permitted Phases				8		8	2					6
Detector Phase				8	8	8	5	2			6	6
Switch Phase												
Minimum Initial (s)				10.0	10.0	10.0	6.0	10.0			10.0	10.0
Minimum Split (s)				15.0	15.0	15.0	11.0	15.0			18.0	18.0
Total Split (s)				30.0	30.0	30.0	15.0	65.0			50.0	50.0
Total Split (%)				31.6%	31.6%	31.6%	15.8%	68.4%			52.6%	52.6%
Yellow Time (s)				3.0	3.0	3.0	3.0	3.0			3.0	3.0
All-Red Time (s)				2.0	2.0	2.0	2.0	2.0			2.0	2.0
Lost Time Adjust (s)					0.0	0.0	0.0	0.0			0.0	0.0
Total Lost Time (s)					5.0	5.0	5.0	5.0			5.0	5.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Recall Mode				None	None	None	None	Min			Min	Min
Act Effct Green (s)					12.0	12.0	21.2	21.2			10.7	10.7
Actuated g/C Ratio					0.28	0.28	0.49	0.49			0.25	0.25
v/c Ratio					0.45	0.33	0.25	0.35			0.27	0.26
Control Delay					18.1	4.7	7.3	7.4			16.3	5.9
Queue Delay					0.0	0.0	0.0	0.0			0.0	0.0
Total Delay					18.1	4.7	7.3	7.4			16.3	5.9
LOS					B	A	A	A			B	A
Approach Delay					11.8			7.4			12.7	
Approach LOS					B			A			B	
Queue Length 50th (ft)					47	0	15	37			26	0
Queue Length 95th (ft)					102	36	44	78			50	25
Internal Link Dist (ft)		715			447			588			207	
Turn Bay Length (ft)						200	200					175
Base Capacity (vph)					1092	1066	606	3505			3358	1507

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn					0	0	0	0			0	0
Spillback Cap Reductn					0	0	0	0			0	0
Storage Cap Reductn					0	0	0	0			0	0
Reduced v/c Ratio					0.20	0.18	0.23	0.17			0.07	0.08

Intersection Summary			
Area Type:	Other		
Cycle Length: 95			
Actuated Cycle Length: 43.5			
Natural Cycle: 45			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 0.45			
Intersection Signal Delay: 9.9		Intersection LOS: A	
Intersection Capacity Utilization 39.7%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 1: Pleasure Island Rd & SB Off-Ramp





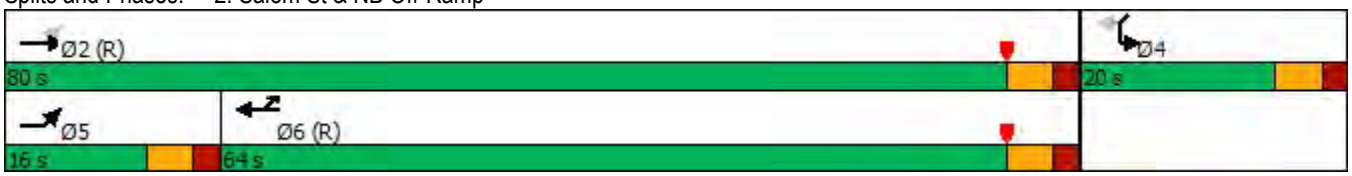
Lane Group	EBL	EBT	WBT	WBR	SWL	SWR
Lane Configurations						
Traffic Volume (vph)	115	236	294	204	482	27
Future Volume (vph)	115	236	294	204	482	27
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0			150	0	250
Storage Lanes	0			1	2	1
Taper Length (ft)	25				25	
Satd. Flow (prot)	0	3320	3252	1455	3400	1568
Flt Permitted		0.717			0.950	
Satd. Flow (perm)	0	2419	3252	1455	3400	1568
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				246		32
Link Speed (mph)		30	30		30	
Link Distance (ft)		346	296		281	
Travel Time (s)		7.9	6.7		6.4	
Peak Hour Factor	0.79	0.79	0.83	0.83	0.84	0.84
Heavy Vehicles (%)	7%	7%	11%	11%	3%	3%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	445	354	246	574	32
Turn Type	pm+pt	NA	NA	Prot	Prot	Perm
Protected Phases	5	2	6	6	4	
Permitted Phases	2					4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	7.0	7.0
Minimum Split (s)	10.5	15.5	15.5	15.5	12.5	12.5
Total Split (s)	16.0	80.0	64.0	64.0	20.0	20.0
Total Split (%)	16.0%	80.0%	64.0%	64.0%	20.0%	20.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)		0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)		5.5	5.5	5.5	5.5	5.5
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	C-Max	C-Max	C-Max	None	None
Act Effct Green (s)		74.5	74.5	74.5	14.5	14.5
Actuated g/C Ratio		0.74	0.74	0.74	0.14	0.14
v/c Ratio		0.25	0.15	0.21	1.16	0.13
Control Delay		4.4	4.4	2.4	133.4	14.5
Queue Delay		0.0	0.0	0.6	0.8	0.0
Total Delay		4.4	4.4	2.9	134.2	14.5
LOS		A	A	A	F	B
Approach Delay		4.4	3.8		127.9	
Approach LOS		A	A		F	
Queue Length 50th (ft)		38	40	15	~225	0
Queue Length 95th (ft)		46	m47	m28	#297	24
Internal Link Dist (ft)		266	216		201	
Turn Bay Length (ft)				150		250
Base Capacity (vph)		1802	2422	1146	493	254

Lane Group	EBL	EBT	WBT	WBR	SWL	SWR
Starvation Cap Reductn		0	0	570	0	0
Spillback Cap Reductn		96	0	0	45	0
Storage Cap Reductn		0	0	0	0	0
Reduced v/c Ratio		0.26	0.15	0.43	1.28	0.13

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBT, Start of Yellow, Master Intersection			
Natural Cycle: 45			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.16			
Intersection Signal Delay: 49.5		Intersection LOS: D	
Intersection Capacity Utilization 45.7%		ICU Level of Service A	
Analysis Period (min) 15			

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.
95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 2: Salem St & NB Off-Ramp



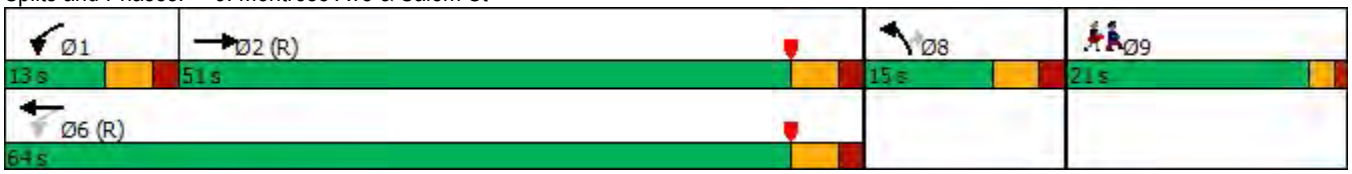
Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	Ø9
Lane Configurations							
Traffic Volume (vph)	645	81	168	362	135	160	
Future Volume (vph)	645	81	168	362	135	160	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	
Satd. Flow (prot)	3437	0	0	3229	1736	1553	
Flt Permitted				0.577	0.950		
Satd. Flow (perm)	3437	0	0	1893	1736	1553	
Right Turn on Red		Yes				Yes	
Satd. Flow (RTOR)	18					184	
Link Speed (mph)	30			30	30		
Link Distance (ft)	296			620	304		
Travel Time (s)	6.7			14.1	6.9		
Confl. Peds. (#/hr)		2	2				
Peak Hour Factor	0.84	0.84	0.90	0.90	0.87	0.87	
Heavy Vehicles (%)	3%	3%	10%	10%	4%	4%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	864	0	0	589	155	184	
Turn Type	NA		pm+pt	NA	Prot	Perm	
Protected Phases	2		1	6	8		9
Permitted Phases			6			8	
Detector Phase	2		1	6	8	8	
Switch Phase							
Minimum Initial (s)	10.0		5.0	10.0	7.0	7.0	5.0
Minimum Split (s)	15.5		10.5	15.5	12.5	12.5	21.0
Total Split (s)	51.0		13.0	64.0	15.0	15.0	21.0
Total Split (%)	51.0%		13.0%	64.0%	15.0%	15.0%	21%
Yellow Time (s)	3.5		3.5	3.5	3.5	3.5	2.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0			0.0	0.0	0.0	
Total Lost Time (s)	5.5			5.5	5.5	5.5	
Lead/Lag	Lag		Lead				
Lead-Lag Optimize?	Yes		Yes				
Recall Mode	C-Max		None	C-Max	None	None	None
Act Effct Green (s)	79.5			79.5	9.5	9.5	
Actuated g/C Ratio	0.80			0.80	0.10	0.10	
v/c Ratio	0.32			0.39	0.95	0.59	
Control Delay	7.1			5.7	104.0	14.8	
Queue Delay	2.0			0.0	0.0	0.0	
Total Delay	9.1			5.7	104.0	14.8	
LOS	A			A	F	B	
Approach Delay	9.1			5.7	55.6		
Approach LOS	A			A	E		
Queue Length 50th (ft)	214			52	100	0	
Queue Length 95th (ft)	m203			113	#213	58	
Internal Link Dist (ft)	216			540	224		
Turn Bay Length (ft)							
Base Capacity (vph)	2736			1504	164	314	
Starvation Cap Reductn	1669			0	0	0	
Spillback Cap Reductn	0			0	0	0	

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	Ø9
Storage Cap Reductn	0			0	0	0	
Reduced v/c Ratio	0.81			0.39	0.95	0.59	

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 99 (99%), Referenced to phase 2:EBT and 6:WBTL, Start of Yellow			
Natural Cycle: 70			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.95			
Intersection Signal Delay: 16.8		Intersection LOS: B	
Intersection Capacity Utilization 56.6%		ICU Level of Service B	
Analysis Period (min) 15			

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 3: Montrose Ave & Salem St



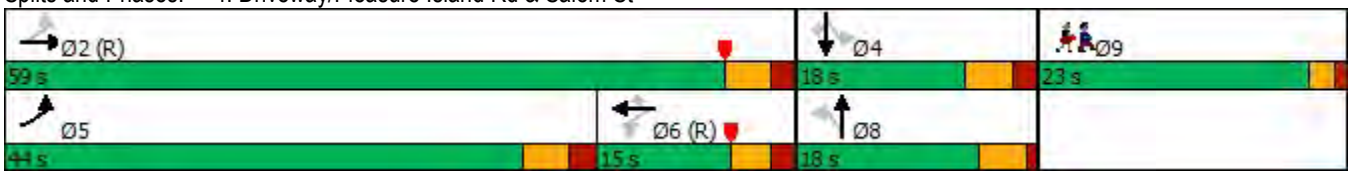
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	550	240	85	28	166	27	61	52	37	47	44	305
Future Volume (vph)	550	240	85	28	166	27	61	52	37	47	44	305
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	150		175	0		0	0		0
Storage Lanes	1		0	1		1	1		0	0		1
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1752	1762	0	1687	3374	1509	1805	1762	0	0	1764	1538
Flt Permitted	0.579			0.548			0.667				0.766	
Satd. Flow (perm)	1066	1762	0	961	3374	1473	1267	1762	0	0	1381	1538
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		27				120		30				372
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		620			336			119			668	
Travel Time (s)		14.1			7.6			2.7			15.2	
Confl. Peds. (#/hr)	4		4	4		4			2	2		
Peak Hour Factor	0.91	0.91	0.91	0.92	0.92	0.92	0.94	0.94	0.94	0.82	0.82	0.82
Heavy Vehicles (%)	3%	3%	3%	7%	7%	7%	0%	0%	0%	5%	5%	5%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	604	357	0	30	180	29	65	94	0	0	111	372
Turn Type	pm+pt	NA		Perm	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2			6			8			4	
Permitted Phases	2			6		6	8			4		4
Detector Phase	5	2		6	6	6	8	8		4	4	4
Switch Phase												
Minimum Initial (s)	8.0	10.0		10.0	10.0	10.0	8.0	8.0		8.0	8.0	8.0
Minimum Split (s)	13.5	15.5		15.0	15.0	15.0	12.5	12.5		13.5	13.5	13.5
Total Split (s)	44.0	59.0		15.0	15.0	15.0	18.0	18.0		18.0	18.0	18.0
Total Split (%)	44.0%	59.0%		15.0%	15.0%	15.0%	18.0%	18.0%		18.0%	18.0%	18.0%
Yellow Time (s)	3.5	3.5		3.0	3.0	3.0	3.5	3.5		3.5	3.5	3.5
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	1.0	1.0		2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0			0.0	0.0
Total Lost Time (s)	5.5	5.5		5.0	5.0	5.0	4.5	4.5			5.5	5.5
Lead/Lag	Lead			Lag	Lag	Lag						
Lead-Lag Optimize?	Yes			Yes	Yes	Yes						
Recall Mode	None	C-Max		C-Max	C-Max	C-Max	None	None		None	None	None
Act Effct Green (s)	77.7	77.7		53.9	53.9	53.9	12.3	12.3			11.3	11.3
Actuated g/C Ratio	0.78	0.78		0.54	0.54	0.54	0.12	0.12			0.11	0.11
v/c Ratio	0.63	0.26		0.06	0.10	0.03	0.42	0.39			0.71	0.74
Control Delay	11.7	1.5		14.5	13.1	0.1	48.5	32.7			67.3	14.2
Queue Delay	0.0	0.0		0.0	0.0	0.0	0.0	0.0			0.0	0.0
Total Delay	11.7	1.5		14.5	13.1	0.1	48.5	32.7			67.3	14.2
LOS	B	A		B	B	A	D	C			E	B
Approach Delay		7.9			11.7			39.2			26.4	
Approach LOS		A			B			D			C	
Queue Length 50th (ft)	147	19		9	28	0	38	37			68	0
Queue Length 95th (ft)	56	23		29	57	0	82	86			#117	54
Internal Link Dist (ft)		540			256			39			588	
Turn Bay Length (ft)				150		175						

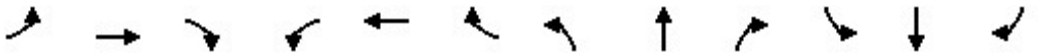
Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	23.0
Total Split (s)	23.0
Total Split (%)	23%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	1091	1374		518	1819	849	171	263			172	517
Starvation Cap Reductn	0	0		0	0	0	0	0			0	0
Spillback Cap Reductn	0	0		0	0	0	0	0			0	0
Storage Cap Reductn	0	0		0	0	0	0	0			0	0
Reduced v/c Ratio	0.55	0.26		0.06	0.10	0.03	0.38	0.36			0.65	0.72

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 86 (86%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow			
Natural Cycle: 90			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.74			
Intersection Signal Delay: 16.0		Intersection LOS: B	
Intersection Capacity Utilization 63.7%		ICU Level of Service B	
Analysis Period (min) 15			
# 95th percentile volume exceeds capacity, queue may be longer.			
Queue shown is maximum after two cycles.			

Splits and Phases: 4: Driveway/Pleasure Island Rd & Salem St



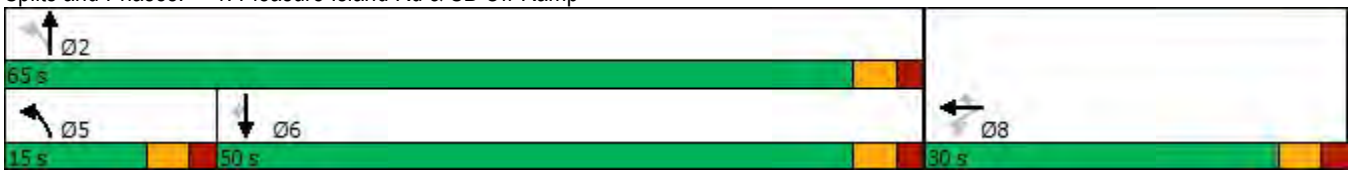


Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	260	1	64	191	330	0	0	392	292
Future Volume (vph)	0	0	0	260	1	64	191	330	0	0	392	292
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		200	200		0	0		175
Storage Lanes	0		0	0		1	1		0	0		1
Taper Length (ft)	25			25			50			25		
Satd. Flow (prot)	0	0	0	0	1646	1468	1770	3539	0	0	3574	1599
Flt Permitted					0.953		0.328					
Satd. Flow (perm)	0	0	0	0	1646	1468	611	3539	0	0	3574	1599
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)						80						360
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		795			527			668			287	
Travel Time (s)		18.1			12.0			15.2			6.5	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.85	0.85	0.85	0.81	0.81	0.81
Heavy Vehicles (%)	2%	2%	2%	10%	10%	10%	2%	2%	2%	1%	1%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	0	0	0	0	284	70	225	388	0	0	484	360
Turn Type				Perm	NA	Perm	pm+pt	NA			NA	Perm
Protected Phases					8		5	2			6	
Permitted Phases				8		8	2					6
Detector Phase				8	8	8	5	2			6	6
Switch Phase												
Minimum Initial (s)				10.0	10.0	10.0	6.0	10.0			10.0	10.0
Minimum Split (s)				15.0	15.0	15.0	11.0	15.0			18.0	18.0
Total Split (s)				30.0	30.0	30.0	15.0	65.0			50.0	50.0
Total Split (%)				31.6%	31.6%	31.6%	15.8%	68.4%			52.6%	52.6%
Yellow Time (s)				3.0	3.0	3.0	3.0	3.0			3.0	3.0
All-Red Time (s)				2.0	2.0	2.0	2.0	2.0			2.0	2.0
Lost Time Adjust (s)					0.0	0.0	0.0	0.0			0.0	0.0
Total Lost Time (s)					5.0	5.0	5.0	5.0			5.0	5.0
Lead/Lag							Lead				Lag	Lag
Lead-Lag Optimize?							Yes				Yes	Yes
Recall Mode				None	None	None	None	Min			Min	Min
Act Effct Green (s)					15.3	15.3	30.9	30.9			16.0	16.0
Actuated g/C Ratio					0.27	0.27	0.55	0.55			0.28	0.28
v/c Ratio					0.64	0.15	0.42	0.20			0.48	0.51
Control Delay					26.2	5.0	10.0	7.3			18.9	5.1
Queue Delay					0.0	0.0	0.0	0.0			0.0	0.0
Total Delay					26.2	5.0	10.0	7.3			18.9	5.1
LOS					C	A	A	A			B	A
Approach Delay					22.0			8.3			13.1	
Approach LOS					C			A			B	
Queue Length 50th (ft)					84	0	34	30			68	0
Queue Length 95th (ft)					172	22	81	62			112	35
Internal Link Dist (ft)		715			447			588			207	
Turn Bay Length (ft)						200	200					175
Base Capacity (vph)					751	713	545	3404			2901	1365

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn					0	0	0	0			0	0
Spillback Cap Reductn					0	0	0	0			0	0
Storage Cap Reductn					0	0	0	0			0	0
Reduced v/c Ratio					0.38	0.10	0.41	0.11			0.17	0.26

Intersection Summary			
Area Type:	Other		
Cycle Length: 95			
Actuated Cycle Length: 56.5			
Natural Cycle: 45			
Control Type: Actuated-Uncoordinated			
Maximum v/c Ratio: 0.64			
Intersection Signal Delay: 13.2		Intersection LOS: B	
Intersection Capacity Utilization 55.6%		ICU Level of Service B	
Analysis Period (min) 15			

Splits and Phases: 1: Pleasure Island Rd & SB Off-Ramp



Lane Group	EBL	EBT	WBT	WBR	SWL	SWR
Lane Configurations						
Traffic Volume (vph)	236	365	396	274	245	39
Future Volume (vph)	236	365	396	274	245	39
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0			150	0	250
Storage Lanes	0			1	2	1
Taper Length (ft)	25				25	
Satd. Flow (prot)	0	3472	3539	1583	3400	1568
Flt Permitted		0.654			0.950	
Satd. Flow (perm)	0	2315	3539	1583	3400	1568
Right Turn on Red				Yes		Yes
Satd. Flow (RTOR)				297		45
Link Speed (mph)		30	30		30	
Link Distance (ft)		346	296		281	
Travel Time (s)		7.9	6.7		6.4	
Peak Hour Factor	0.95	0.95	0.88	0.88	0.87	0.87
Heavy Vehicles (%)	2%	2%	2%	2%	3%	3%
Shared Lane Traffic (%)						
Lane Group Flow (vph)	0	632	450	311	282	45
Turn Type	pm+pt	NA	NA	Prot	Prot	Perm
Protected Phases	5	2	6	6	4	
Permitted Phases	2					4
Detector Phase	5	2	6	6	4	4
Switch Phase						
Minimum Initial (s)	5.0	10.0	10.0	10.0	7.0	7.0
Minimum Split (s)	10.5	15.5	15.5	15.5	12.5	12.5
Total Split (s)	25.5	106.0	80.5	80.5	80.5	80.5
Total Split (%)	13.7%	56.8%	43.2%	43.2%	43.2%	43.2%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)		0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)		5.5	5.5	5.5	5.5	5.5
Lead/Lag	Lead		Lag	Lag		
Lead-Lag Optimize?	Yes		Yes	Yes		
Recall Mode	None	C-Max	C-Max	C-Max	None	None
Act Effct Green (s)		154.4	154.4	154.4	21.1	21.1
Actuated g/C Ratio		0.83	0.83	0.83	0.11	0.11
v/c Ratio		0.33	0.15	0.23	0.73	0.21
Control Delay		4.6	3.5	0.8	91.2	18.8
Queue Delay		0.0	1.3	2.1	0.0	0.0
Total Delay		4.6	4.8	3.0	91.2	18.8
LOS		A	A	A	F	B
Approach Delay		4.6	4.1		81.2	
Approach LOS		A	A		F	
Queue Length 50th (ft)		83	49	3	175	0
Queue Length 95th (ft)		123	72	20	215	39
Internal Link Dist (ft)		266	216		201	
Turn Bay Length (ft)				150		250
Base Capacity (vph)		1915	2929	1361	1367	657

Lane Group	EBL	EBT	WBT	WBR	SWL	SWR
Starvation Cap Reductn		0	2228	893	0	0
Spillback Cap Reductn		0	0	0	0	0
Storage Cap Reductn		0	0	0	0	0
Reduced v/c Ratio		0.33	0.64	0.66	0.21	0.07

Intersection Summary			
Area Type:	Other		
Cycle Length: 186.5			
Actuated Cycle Length: 186.5			
Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBT, Start of Yellow, Master Intersection			
Natural Cycle: 40			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.73			
Intersection Signal Delay: 18.9		Intersection LOS: B	
Intersection Capacity Utilization 48.6%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 2: Salem St & NB Off-Ramp

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	Ø9
Lane Configurations							
Traffic Volume (vph)	534	107	218	490	175	173	
Future Volume (vph)	534	107	218	490	175	173	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	
Satd. Flow (prot)	3401	0	0	3486	1787	1599	
Flt Permitted				0.615	0.950		
Satd. Flow (perm)	3401	0	0	2175	1787	1599	
Right Turn on Red		Yes				Yes	
Satd. Flow (RTOR)	22					228	
Link Speed (mph)	30			30	30		
Link Distance (ft)	296			620	304		
Travel Time (s)	6.7			14.1	6.9		
Confl. Peds. (#/hr)		8	8				
Peak Hour Factor	0.94	0.94	0.89	0.89	0.76	0.76	
Heavy Vehicles (%)	3%	3%	2%	2%	1%	1%	
Shared Lane Traffic (%)							
Lane Group Flow (vph)	682	0	0	796	230	228	
Turn Type	NA		pm+pt	NA	Prot	Perm	
Protected Phases	2		1	6	8		9
Permitted Phases			6			8	
Detector Phase	2		1	6	8	8	
Switch Phase							
Minimum Initial (s)	10.0		5.0	10.0	7.0	7.0	5.0
Minimum Split (s)	15.5		10.5	15.5	12.5	12.5	21.0
Total Split (s)	85.5		25.5	112.0	25.5	25.5	21.0
Total Split (%)	53.9%		16.1%	70.7%	16.1%	16.1%	13%
Yellow Time (s)	3.5		3.5	3.5	3.5	3.5	2.0
All-Red Time (s)	2.0		2.0	2.0	2.0	2.0	1.0
Lost Time Adjust (s)	0.0			0.0	0.0	0.0	
Total Lost Time (s)	5.5			5.5	5.5	5.5	
Lead/Lag	Lag		Lead				
Lead-Lag Optimize?	Yes		Yes				
Recall Mode	C-Max		None	C-Max	None	None	None
Act Effct Green (s)	127.5			127.5	20.0	20.0	
Actuated g/C Ratio	0.80			0.80	0.13	0.13	
v/c Ratio	0.25			0.46	1.02	0.57	
Control Delay	3.9			5.7	131.8	13.1	
Queue Delay	2.0			0.5	0.0	0.0	
Total Delay	5.9			6.2	131.8	13.1	
LOS	A			A	F	B	
Approach Delay	5.9			6.2	72.7		
Approach LOS	A			A	E		
Queue Length 50th (ft)	74			114	~252	0	
Queue Length 95th (ft)	92			141	#327	33	
Internal Link Dist (ft)	216			540	224		
Turn Bay Length (ft)							
Base Capacity (vph)	2740			1749	225	400	
Starvation Cap Reductn	1860			483	0	0	
Spillback Cap Reductn	0			0	0	0	

Lane Group	EBT	EBR	WBL	WBT	NBL	NBR	Ø9
Storage Cap Reductn	0			0	0	0	
Reduced v/c Ratio	0.78			0.63	1.02	0.57	

Intersection Summary			
Area Type:	Other		
Cycle Length: 158.5			
Actuated Cycle Length: 158.5			
Offset: 99 (62%), Referenced to phase 2:EBT and 6:WBTL, Start of Yellow			
Natural Cycle: 80			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.02			
Intersection Signal Delay: 21.8		Intersection LOS: C	
Intersection Capacity Utilization 61.6%		ICU Level of Service B	
Analysis Period (min) 15			

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 3: Montrose Ave & Salem St

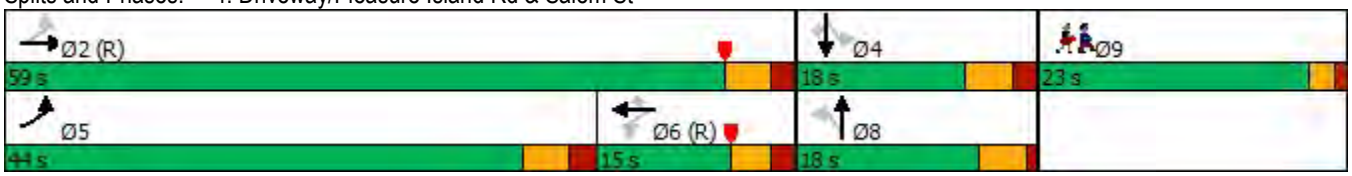
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	367	318	29	12	210	133	21	12	23	126	9	525
Future Volume (vph)	367	318	29	12	210	133	21	12	23	126	9	525
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	150		175	0		0	0		0
Storage Lanes	1		0	1		1	1		0	0		1
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1752	1818	0	1736	3471	1553	1770	1632	0	0	1712	1524
Flt Permitted	0.546			0.527			0.525				0.706	
Satd. Flow (perm)	1007	1818	0	932	3471	1553	978	1632	0	0	1239	1524
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		7				156		31				603
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		620			336			119			668	
Travel Time (s)		14.1			7.6			2.7			15.2	
Confl. Peds. (#/hr)			11	11					6	6		
Peak Hour Factor	0.87	0.87	0.87	0.85	0.85	0.85	0.74	0.74	0.74	0.87	0.87	0.87
Heavy Vehicles (%)	3%	3%	3%	4%	4%	4%	2%	2%	2%	6%	6%	6%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	422	399	0	14	247	156	28	47	0	0	155	603
Turn Type	pm+pt	NA		Perm	NA	Perm	Perm	NA		Perm	NA	Perm
Protected Phases	5	2			6			8			4	
Permitted Phases	2			6		6	8			4		4
Detector Phase	5	2		6	6	6	8	8		4	4	4
Switch Phase												
Minimum Initial (s)	8.0	10.0		10.0	10.0	10.0	8.0	8.0		8.0	8.0	8.0
Minimum Split (s)	13.5	15.5		15.0	15.0	15.0	12.5	12.5		13.5	13.5	13.5
Total Split (s)	44.0	59.0		15.0	15.0	15.0	18.0	18.0		18.0	18.0	18.0
Total Split (%)	44.0%	59.0%		15.0%	15.0%	15.0%	18.0%	18.0%		18.0%	18.0%	18.0%
Yellow Time (s)	3.5	3.5		3.0	3.0	3.0	3.5	3.5		3.5	3.5	3.5
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	1.0	1.0		2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0	0.0	0.0			0.0	0.0
Total Lost Time (s)	5.5	5.5		5.0	5.0	5.0	4.5	4.5			5.5	5.5
Lead/Lag	Lead			Lag	Lag	Lag						
Lead-Lag Optimize?	Yes			Yes	Yes	Yes						
Recall Mode	None	C-Max		C-Max	C-Max	C-Max	None	None		None	None	None
Act Effct Green (s)	76.5	76.5		58.1	58.1	58.1	13.5	13.5			12.5	12.5
Actuated g/C Ratio	0.76	0.76		0.58	0.58	0.58	0.14	0.14			0.12	0.12
v/c Ratio	0.49	0.29		0.03	0.12	0.16	0.21	0.19			1.01	0.84
Control Delay	5.7	4.1		10.5	10.2	2.3	43.0	21.4			120.1	15.6
Queue Delay	0.0	0.0		0.0	0.0	0.0	0.0	0.0			0.0	0.0
Total Delay	5.7	4.1		10.5	10.2	2.3	43.0	21.4			120.1	15.6
LOS	A	A		B	B	A	D	C			F	B
Approach Delay		4.9			7.2			29.5			36.9	
Approach LOS		A			A			C			D	
Queue Length 50th (ft)	68	61		4	34	0	16	9			~100	0
Queue Length 95th (ft)	96	87		13	56	24	35	31			#220	#136
Internal Link Dist (ft)		540			256			39			588	
Turn Bay Length (ft)				150		175						

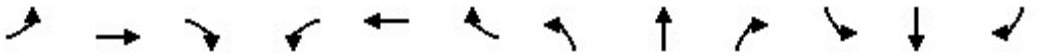
Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	23.0
Total Split (s)	23.0
Total Split (%)	23%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	1057	1392		541	2016	967	132	247			154	718
Starvation Cap Reductn	0	0		0	0	0	0	0			0	0
Spillback Cap Reductn	0	0		0	0	0	0	0			0	0
Storage Cap Reductn	0	0		0	0	0	0	0			0	0
Reduced v/c Ratio	0.40	0.29		0.03	0.12	0.16	0.21	0.19			1.01	0.84

Intersection Summary			
Area Type:	Other		
Cycle Length: 100			
Actuated Cycle Length: 100			
Offset: 86 (86%), Referenced to phase 2:EBTL and 6:WBTL, Start of Yellow			
Natural Cycle: 80			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 1.01			
Intersection Signal Delay: 18.0		Intersection LOS: B	
Intersection Capacity Utilization 60.0%		ICU Level of Service B	
Analysis Period (min) 15			
~ Volume exceeds capacity, queue is theoretically infinite.			
Queue shown is maximum after two cycles.			
# 95th percentile volume exceeds capacity, queue may be longer.			
Queue shown is maximum after two cycles.			

Splits and Phases: 4: Driveway/Pleasure Island Rd & Salem St





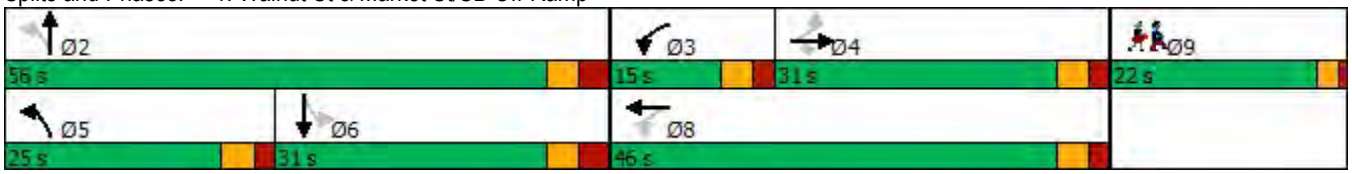
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	66	51	134	131	139	33	212	90	354	29	127	87
Future Volume (vph)	66	51	134	131	139	33	212	90	354	29	127	87
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		150	300		250	0		0
Storage Lanes	1		1	1		0	1		1	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1752	1845	1568	1770	1801	0	1752	1845	1568	1787	1766	0
Flt Permitted	0.621			0.490			0.405			0.696		
Satd. Flow (perm)	1142	1845	1568	913	1801	0	747	1845	1568	1309	1766	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			147		10				369		25	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		347			512			708			266	
Travel Time (s)		7.9			11.6			16.1			6.0	
Confl. Peds. (#/hr)	2					2						
Peak Hour Factor	0.91	0.91	0.91	0.78	0.78	0.78	0.96	0.96	0.96	0.98	0.98	0.98
Heavy Vehicles (%)	3%	3%	3%	2%	2%	2%	3%	3%	3%	1%	1%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	73	56	147	168	220	0	221	94	369	30	219	0
Turn Type	Perm	NA	Perm	pm+pt	NA		pm+pt	NA	Free	Perm	NA	
Protected Phases		4		3	8		5	2			6	
Permitted Phases	4		4	8			2		Free	6		
Detector Phase	4	4	4	3	8		5	2		6	6	
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0		6.0	10.0		10.0	10.0	
Minimum Split (s)	12.0	12.0	12.0	12.0	11.0		12.0	16.0		16.0	16.0	
Total Split (s)	31.0	31.0	31.0	15.0	46.0		25.0	56.0		31.0	31.0	
Total Split (%)	25.0%	25.0%	25.0%	12.1%	37.1%		20.2%	45.2%		25.0%	25.0%	
Yellow Time (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	3.0		3.0	3.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	6.0		6.0	6.0	
Lead/Lag	Lag	Lag	Lag	Lead			Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes			Yes			Yes	Yes	
Recall Mode	None	None	None	None	None		None	Min		Min	Min	
Act Effct Green (s)	10.4	10.4	10.4	24.8	24.8		34.5	33.5	69.6	13.9	13.9	
Actuated g/C Ratio	0.15	0.15	0.15	0.36	0.36		0.50	0.48	1.00	0.20	0.20	
v/c Ratio	0.43	0.20	0.41	0.38	0.34		0.38	0.11	0.24	0.11	0.59	
Control Delay	37.6	30.1	9.6	20.3	18.7		12.6	10.7	0.4	26.6	30.9	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	37.6	30.1	9.6	20.3	18.7		12.6	10.7	0.4	26.6	30.9	
LOS	D	C	A	C	B		B	B	A	C	C	
Approach Delay		21.2			19.4			5.7			30.4	
Approach LOS		C			B			A			C	
Queue Length 50th (ft)	29	21	0	49	63		51	21	0	11	75	
Queue Length 95th (ft)	77	59	49	96	118		104	50	0	36	165	
Internal Link Dist (ft)		267			432			628			186	
Turn Bay Length (ft)							300		250			

Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	18%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	440	711	694	452	1098		668	1367	1568	485	670	
Starvation Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Reduced v/c Ratio	0.17	0.08	0.21	0.37	0.20		0.33	0.07	0.24	0.06	0.33	

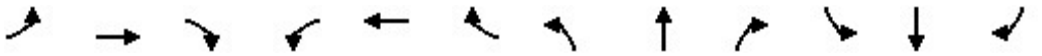
Intersection Summary			
Area Type:	Other		
Cycle Length: 124			
Actuated Cycle Length: 69.6			
Natural Cycle: 75			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.59			
Intersection Signal Delay: 15.6		Intersection LOS: B	
Intersection Capacity Utilization 55.6%		ICU Level of Service B	
Analysis Period (min) 15			

Splits and Phases: 1: Walnut St & Market St/SB Off-Ramp



Lane Group	Ø9
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary



Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	97	0	474	0	0	0	0	550	89	111	314	0
Future Volume (vph)	97	0	474	0	0	0	0	550	89	111	314	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		0	300		0
Storage Lanes	1		2	0		0	0		1	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1736	0	2733	0	0	0	0	1863	1583	1787	1881	0
Flt Permitted	0.950									0.343		
Satd. Flow (perm)	1736	0	2733	0	0	0	0	1863	1546	645	1881	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			494						124			
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		246			800			287			708	
Travel Time (s)		5.6			18.2			6.5			16.1	
Confl. Peds. (#/hr)									2	2		
Peak Hour Factor	0.96	0.96	0.96	0.92	0.92	0.92	0.96	0.96	0.96	0.96	0.96	0.96
Heavy Vehicles (%)	4%	4%	4%	2%	2%	2%	2%	2%	2%	1%	1%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	101	0	494	0	0	0	0	573	93	116	327	0
Turn Type	Prot		Prot					NA	Perm	pm+pt	NA	
Protected Phases	4		4					2		1	6	
Permitted Phases									2	6		
Detector Phase	4		4					2	2	1	6	
Switch Phase												
Minimum Initial (s)	6.0		6.0					10.0	10.0	6.0	10.0	
Minimum Split (s)	12.0		12.0					16.0	16.0	12.0	16.0	
Total Split (s)	31.0		31.0					35.0	35.0	15.0	50.0	
Total Split (%)	32.0%		32.0%					36.1%	36.1%	15.5%	51.5%	
Yellow Time (s)	3.0		3.0					3.0	3.0	3.0	3.0	
All-Red Time (s)	3.0		3.0					3.0	3.0	2.0	3.0	
Lost Time Adjust (s)	0.0		0.0					0.0	0.0	0.0	0.0	
Total Lost Time (s)	6.0		6.0					6.0	6.0	5.0	6.0	
Lead/Lag	Lag		Lag					Lag	Lag	Lead		
Lead-Lag Optimize?	Yes		Yes					Yes	Yes	Yes		
Recall Mode	None		None					C-Min	C-Min	None	C-Min	
Act Effct Green (s)	11.2		11.2					61.3	61.3	74.8	73.8	
Actuated g/C Ratio	0.12		0.12					0.63	0.63	0.77	0.76	
v/c Ratio	0.51		0.66					0.49	0.09	0.20	0.23	
Control Delay	48.4		8.1					12.2	1.1	4.0	4.2	
Queue Delay	0.0		0.0					7.9	0.0	0.0	0.0	
Total Delay	48.4		8.1					20.2	1.1	4.0	4.2	
LOS	D		A					C	A	A	A	
Approach Delay		15.0						17.5			4.1	
Approach LOS		B						B			A	
Queue Length 50th (ft)	60		0					167	0	14	47	
Queue Length 95th (ft)	106		47					315	13	34	93	
Internal Link Dist (ft)		166			720			207			628	
Turn Bay Length (ft)										300		

Lane Group	Ø3
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	3
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	16.0
Total Split (s)	16.0
Total Split (%)	16%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	Lead
Lead-Lag Optimize?	Yes
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	

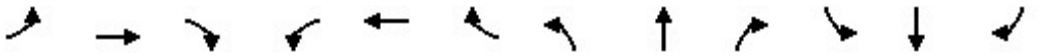
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	447		1071					1177	1022	616	1431	
Starvation Cap Reductn	0		0					556	0	0	0	
Spillback Cap Reductn	0		0					0	0	0	0	
Storage Cap Reductn	0		0					0	0	0	0	
Reduced v/c Ratio	0.23		0.46					0.92	0.09	0.19	0.23	

Intersection Summary			
Area Type:	Other		
Cycle Length: 97			
Actuated Cycle Length: 97			
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green, Master Intersection			
Natural Cycle: 70			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.66			
Intersection Signal Delay: 13.1		Intersection LOS: B	
Intersection Capacity Utilization 53.0%		ICU Level of Service A	
Analysis Period (min) 15			

Splits and Phases: 2: Walnut St & NB Off-Ramp

Lane Group	Ø3
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary



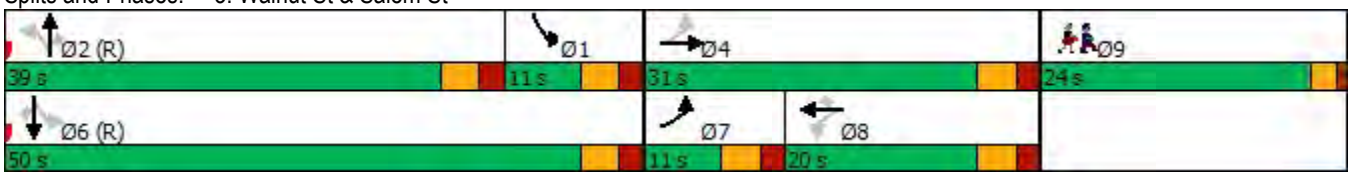
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	73	105	70	18	153	113	80	454	26	80	546	144
Future Volume (vph)	73	105	70	18	153	113	80	454	26	80	546	144
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		150	0		0
Storage Lanes	1		0	1		1	0		1	1		1
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1719	1701	0	1770	1863	1583	0	1868	1599	1752	3505	1568
Flt Permitted	0.315			0.638				0.832		0.343		
Satd. Flow (perm)	570	1701	0	1188	1863	1583	0	1565	1599	633	3505	1568
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		30				156			156			157
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		260			308			259			287	
Travel Time (s)		5.9			7.0			5.9			6.5	
Peak Hour Factor	0.92	0.92	0.92	0.90	0.90	0.90	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	5%	5%	5%	2%	2%	2%	1%	1%	1%	3%	3%	3%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	79	190	0	20	170	126	0	580	28	87	593	157
Turn Type	pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4			8			2		1	6	
Permitted Phases	4			8		8	2		2	6		6
Detector Phase	7	4		8	8	8	2	2	2	1	6	6
Switch Phase												
Minimum Initial (s)	6.0	10.0		10.0	10.0	10.0	10.0	10.0	10.0	6.0	10.0	10.0
Minimum Split (s)	11.0	15.0		15.0	15.0	15.0	15.0	15.0	15.0	11.0	15.0	15.0
Total Split (s)	11.0	31.0		20.0	20.0	20.0	39.0	39.0	39.0	11.0	50.0	50.0
Total Split (%)	10.5%	29.5%		19.0%	19.0%	19.0%	37.1%	37.1%	37.1%	10.5%	47.6%	47.6%
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead			Lag	Lag	Lag	Lead	Lead	Lead	Lag		
Lead-Lag Optimize?	Yes			Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Recall Mode	None	None		None	None	None	C-Max	C-Max	C-Max	None	C-Max	C-Max
Act Effct Green (s)	22.3	22.3		13.5	13.5	13.5		63.9	63.9	72.7	72.7	72.7
Actuated g/C Ratio	0.21	0.21		0.13	0.13	0.13		0.61	0.61	0.69	0.69	0.69
v/c Ratio	0.42	0.49		0.13	0.71	0.37		0.61	0.03	0.17	0.24	0.14
Control Delay	39.4	33.9		41.8	60.5	6.9		18.4	0.0	8.0	6.9	1.4
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	0.7	0.5
Total Delay	39.4	33.9		41.8	60.5	6.9		18.4	0.0	8.0	7.6	1.9
LOS	D	C		D	E	A		B	A	A	A	A
Approach Delay		35.5			37.9			17.6			6.6	
Approach LOS		D			D			B			A	
Queue Length 50th (ft)	42	90		12	109	0		261	0	19	77	0
Queue Length 95th (ft)	83	158		35	181	33		391	0	36	103	21
Internal Link Dist (ft)		180			228			179			207	
Turn Bay Length (ft)									150			
Base Capacity (vph)	186	443		169	266	359		952	1034	502	2427	1134

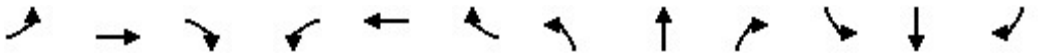
Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	24.0
Total Split (s)	24.0
Total Split (%)	23%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	
Base Capacity (vph)	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Starvation Cap Reductn	0	0		0	0	0		0	0	0	1431	667
Spillback Cap Reductn	0	0		0	0	0		0	0	0	0	0
Storage Cap Reductn	0	0		0	0	0		0	0	0	0	0
Reduced v/c Ratio	0.42	0.43		0.12	0.64	0.35		0.61	0.03	0.17	0.60	0.34

Intersection Summary			
Area Type:	Other		
Cycle Length: 105			
Actuated Cycle Length: 105			
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green			
Natural Cycle: 100			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.71			
Intersection Signal Delay: 18.6		Intersection LOS: B	
Intersection Capacity Utilization 78.2%		ICU Level of Service D	
Analysis Period (min) 15			

Splits and Phases: 3: Walnut St & Salem St





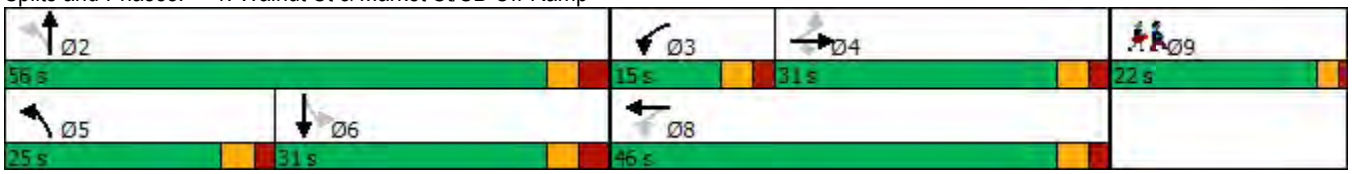
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	99	159	396	106	232	53	356	122	390	23	134	95
Future Volume (vph)	99	159	396	106	232	53	356	122	390	23	134	95
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		150	300		250	0		0
Storage Lanes	1		1	1		0	1		1	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1787	1881	1599	1770	1801	0	1787	1881	1599	1770	1747	0
Flt Permitted	0.583			0.438			0.295			0.677		
Satd. Flow (perm)	1088	1881	1599	816	1801	0	555	1881	1565	1256	1747	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			421		10				398		26	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		347			512			708			266	
Travel Time (s)		7.9			11.6			16.1			6.0	
Confl. Peds. (#/hr)	5					5			2	2		
Peak Hour Factor	0.94	0.94	0.94	0.99	0.99	0.99	0.98	0.98	0.98	0.76	0.76	0.76
Heavy Vehicles (%)	1%	1%	1%	2%	2%	2%	1%	1%	1%	2%	2%	2%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	105	169	421	107	288	0	363	124	398	30	301	0
Turn Type	Perm	NA	Perm	pm+pt	NA		pm+pt	NA	Free	Perm	NA	
Protected Phases		4		3	8		5	2			6	
Permitted Phases	4		4	8			2		Free	6		
Detector Phase	4	4	4	3	8		5	2		6	6	
Switch Phase												
Minimum Initial (s)	6.0	6.0	6.0	6.0	6.0		6.0	10.0		10.0	10.0	
Minimum Split (s)	12.0	12.0	12.0	12.0	11.0		12.0	16.0		16.0	16.0	
Total Split (s)	31.0	31.0	31.0	15.0	46.0		25.0	56.0		31.0	31.0	
Total Split (%)	25.0%	25.0%	25.0%	12.1%	37.1%		20.2%	45.2%		25.0%	25.0%	
Yellow Time (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
All-Red Time (s)	2.0	2.0	2.0	2.0	2.0		2.0	3.0		3.0	3.0	
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0		0.0	0.0		0.0	0.0	
Total Lost Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	6.0		6.0	6.0	
Lead/Lag	Lag	Lag	Lag	Lead			Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes	Yes	Yes			Yes			Yes	Yes	
Recall Mode	None	None	None	None	None		None	Min		Min	Min	
Act Effct Green (s)	16.5	16.5	16.5	27.1	27.1		46.0	44.9	83.5	19.4	19.4	
Actuated g/C Ratio	0.20	0.20	0.20	0.32	0.32		0.55	0.54	1.00	0.23	0.23	
v/c Ratio	0.49	0.46	0.64	0.29	0.49		0.60	0.12	0.25	0.10	0.71	
Control Delay	40.8	35.7	8.4	22.1	24.4		17.1	12.2	0.4	29.0	38.4	
Queue Delay	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	
Total Delay	40.8	35.7	8.4	22.1	24.4		17.1	12.2	0.4	29.0	38.4	
LOS	D	D	A	C	C		B	B	A	C	D	
Approach Delay		19.9			23.8			8.9			37.6	
Approach LOS		B			C			A			D	
Queue Length 50th (ft)	52	83	0	40	115		107	32	0	13	137	
Queue Length 95th (ft)	108	151	77	80	197		212	75	0	33	204	
Internal Link Dist (ft)		267			432			628			186	
Turn Bay Length (ft)							300		250			

Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	22.0
Total Split (s)	22.0
Total Split (%)	18%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	352	609	802	383	924		612	1171	1565	391	562	
Starvation Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0		0	0	0	0	0	
Reduced v/c Ratio	0.30	0.28	0.52	0.28	0.31		0.59	0.11	0.25	0.08	0.54	

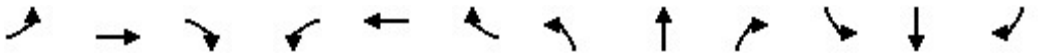
Intersection Summary			
Area Type:	Other		
Cycle Length: 124			
Actuated Cycle Length: 83.5			
Natural Cycle: 90			
Control Type: Semi Act-Uncoord			
Maximum v/c Ratio: 0.71			
Intersection Signal Delay: 18.9		Intersection LOS: B	
Intersection Capacity Utilization 71.1%		ICU Level of Service C	
Analysis Period (min) 15			

Splits and Phases: 1: Walnut St & Market St/SB Off-Ramp



Lane Group	Ø9
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary



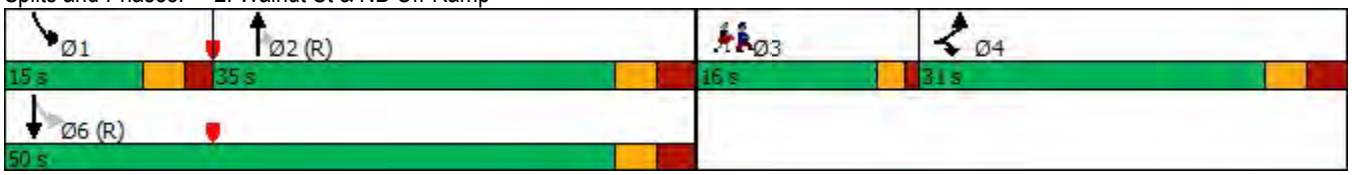
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	190	0	537	0	0	0	0	685	171	271	365	0
Future Volume (vph)	190	0	537	0	0	0	0	685	171	271	365	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		0	300		0
Storage Lanes	1		2	0		0	0		1	1		0
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1787	0	2814	0	0	0	0	1881	1599	1787	1881	0
Flt Permitted	0.950									0.117		
Satd. Flow (perm)	1787	0	2814	0	0	0	0	1881	1562	220	1881	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			548						146			
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		246			800			287			708	
Travel Time (s)		5.6			18.2			6.5			16.1	
Confl. Peds. (#/hr)									2	2		
Peak Hour Factor	0.98	0.98	0.98	0.92	0.92	0.92	0.99	0.99	0.99	0.90	0.90	0.90
Heavy Vehicles (%)	1%	1%	1%	2%	2%	2%	1%	1%	1%	1%	1%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	194	0	548	0	0	0	0	692	173	301	406	0
Turn Type	Prot		Prot					NA	Perm	pm+pt	NA	
Protected Phases	4		4					2		1	6	
Permitted Phases									2	6		
Detector Phase	4		4					2	2	1	6	
Switch Phase												
Minimum Initial (s)	6.0		6.0					10.0	10.0	6.0	10.0	
Minimum Split (s)	12.0		12.0					16.0	16.0	12.0	16.0	
Total Split (s)	31.0		31.0					35.0	35.0	15.0	50.0	
Total Split (%)	32.0%		32.0%					36.1%	36.1%	15.5%	51.5%	
Yellow Time (s)	3.0		3.0					3.0	3.0	3.0	3.0	
All-Red Time (s)	3.0		3.0					3.0	3.0	2.0	3.0	
Lost Time Adjust (s)	0.0		0.0					0.0	0.0	0.0	0.0	
Total Lost Time (s)	6.0		6.0					6.0	6.0	5.0	6.0	
Lead/Lag	Lag		Lag					Lag	Lag	Lead		
Lead-Lag Optimize?	Yes		Yes					Yes	Yes	Yes		
Recall Mode	None		None					C-Min	C-Min	None	C-Min	
Act Effct Green (s)	16.4		16.4					41.9	41.9	69.6	68.6	
Actuated g/C Ratio	0.17		0.17					0.43	0.43	0.72	0.71	
v/c Ratio	0.64		0.59					0.85	0.23	0.59	0.31	
Control Delay	46.6		5.6					38.0	5.9	19.5	6.7	
Queue Delay	0.0		0.0					50.8	0.5	0.0	0.0	
Total Delay	46.6		5.6					88.8	6.4	19.5	6.7	
LOS	D		A					F	A	B	A	
Approach Delay		16.4						72.3			12.2	
Approach LOS		B						E			B	
Queue Length 50th (ft)	112		0					363	9	88	82	
Queue Length 95th (ft)	171		44					#682	55	187	156	
Internal Link Dist (ft)		166			720			207			628	
Turn Bay Length (ft)										300		

Lane Group	Ø3
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	3
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	7.0
Minimum Split (s)	16.0
Total Split (s)	16.0
Total Split (%)	16%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	Lead
Lead-Lag Optimize?	Yes
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	460		1132					813	758	507	1329	
Starvation Cap Reductn	0		0					293	307	0	0	
Spillback Cap Reductn	0		0					0	0	0	0	
Storage Cap Reductn	0		0					0	0	0	0	
Reduced v/c Ratio	0.42		0.48					1.33	0.38	0.59	0.31	

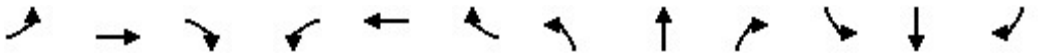
Intersection Summary			
Area Type:	Other		
Cycle Length: 97			
Actuated Cycle Length: 97			
Offset: 0 (0%), Referenced to phase 2:NBT and 6:SBTL, Start of Green, Master Intersection			
Natural Cycle: 90			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.85			
Intersection Signal Delay: 36.0		Intersection LOS: D	
Intersection Capacity Utilization 74.1%		ICU Level of Service D	
Analysis Period (min) 15			
# 95th percentile volume exceeds capacity, queue may be longer.			
Queue shown is maximum after two cycles.			

Splits and Phases: 2: Walnut St & NB Off-Ramp



Lane Group	Ø3
Base Capacity (vph)	
Starvation Cap Reductn	
Spillback Cap Reductn	
Storage Cap Reductn	
Reduced v/c Ratio	

Intersection Summary



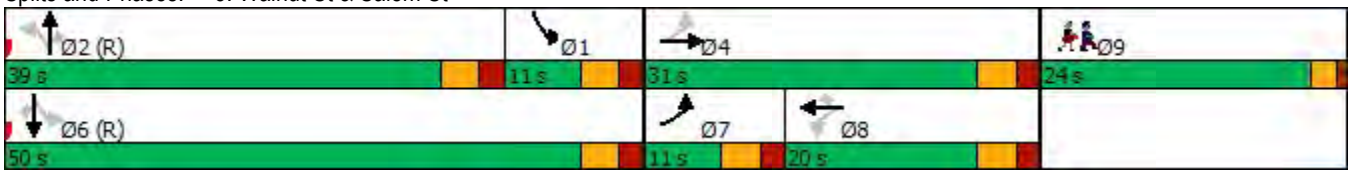
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	111	147	103	24	147	120	55	609	47	124	732	82
Future Volume (vph)	111	147	103	24	147	120	55	609	47	124	732	82
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		150	0		0
Storage Lanes	1		0	1		1	0		1	1		1
Taper Length (ft)	25			25			25			25		
Satd. Flow (prot)	1770	1737	0	1770	1863	1583	0	1855	1583	1787	3574	1599
Flt Permitted	0.349			0.586				0.871		0.254		
Satd. Flow (perm)	650	1737	0	1088	1863	1561	0	1622	1583	478	3574	1563
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)		32				156			156			104
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		260			308			259			287	
Travel Time (s)		5.9			7.0			5.9			6.5	
Confl. Peds. (#/hr)	1		2	2		1	2					2
Peak Hour Factor	0.88	0.88	0.88	0.96	0.96	0.96	0.95	0.95	0.95	0.86	0.86	0.86
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	1%	1%	1%
Shared Lane Traffic (%)												
Lane Group Flow (vph)	126	284	0	25	153	125	0	699	49	144	851	95
Turn Type	pm+pt	NA		Perm	NA	Perm	Perm	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4			8			2		1	6	
Permitted Phases	4			8		8	2		2	6		6
Detector Phase	7	4		8	8	8	2	2	2	1	6	6
Switch Phase												
Minimum Initial (s)	6.0	10.0		10.0	10.0	10.0	10.0	10.0	10.0	6.0	10.0	10.0
Minimum Split (s)	11.0	15.0		15.0	15.0	15.0	15.0	15.0	15.0	11.0	15.0	15.0
Total Split (s)	11.0	31.0		20.0	20.0	20.0	39.0	39.0	39.0	11.0	50.0	50.0
Total Split (%)	10.5%	29.5%		19.0%	19.0%	19.0%	37.1%	37.1%	37.1%	10.5%	47.6%	47.6%
Yellow Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Lost Time Adjust (s)	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Total Lost Time (s)	5.0	5.0		5.0	5.0	5.0		5.0	5.0	5.0	5.0	5.0
Lead/Lag	Lead			Lag	Lag	Lag	Lead	Lead	Lead	Lag		
Lead-Lag Optimize?	Yes			Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Recall Mode	None	None		None	None	None	C-Max	C-Max	C-Max	None	C-Max	C-Max
Act Effct Green (s)	24.1	24.1		13.1	13.1	13.1		59.9	59.9	70.9	70.9	70.9
Actuated g/C Ratio	0.23	0.23		0.12	0.12	0.12		0.57	0.57	0.68	0.68	0.68
v/c Ratio	0.59	0.67		0.19	0.66	0.38		0.76	0.05	0.36	0.35	0.09
Control Delay	45.7	40.8		43.6	57.4	6.8		24.2	0.1	12.0	8.0	1.3
Queue Delay	0.0	0.0		0.0	0.0	0.0		0.0	0.0	0.0	1.9	0.0
Total Delay	45.7	40.8		43.6	57.4	6.8		24.2	0.1	12.0	9.9	1.3
LOS	D	D		D	E	A		C	A	B	A	A
Approach Delay		42.3			35.4			22.6			9.4	
Approach LOS		D			D			C			A	
Queue Length 50th (ft)	70	154		15	99	0		340	0	31	117	0
Queue Length 95th (ft)	118	234		41	165	33		521	0	53	146	13
Internal Link Dist (ft)		180			228			179			207	
Turn Bay Length (ft)									150			

Lane Group	Ø9
Lane Configurations	
Traffic Volume (vph)	
Future Volume (vph)	
Ideal Flow (vphpl)	
Storage Length (ft)	
Storage Lanes	
Taper Length (ft)	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Right Turn on Red	
Satd. Flow (RTOR)	
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	
Confl. Peds. (#/hr)	
Peak Hour Factor	
Heavy Vehicles (%)	
Shared Lane Traffic (%)	
Lane Group Flow (vph)	
Turn Type	
Protected Phases	9
Permitted Phases	
Detector Phase	
Switch Phase	
Minimum Initial (s)	5.0
Minimum Split (s)	24.0
Total Split (s)	24.0
Total Split (%)	23%
Yellow Time (s)	2.0
All-Red Time (s)	1.0
Lost Time Adjust (s)	
Total Lost Time (s)	
Lead/Lag	
Lead-Lag Optimize?	
Recall Mode	None
Act Effct Green (s)	
Actuated g/C Ratio	
v/c Ratio	
Control Delay	
Queue Delay	
Total Delay	
LOS	
Approach Delay	
Approach LOS	
Queue Length 50th (ft)	
Queue Length 95th (ft)	
Internal Link Dist (ft)	
Turn Bay Length (ft)	

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Base Capacity (vph)	213	454		155	266	356		924	969	397	2412	1088
Starvation Cap Reductn	0	0		0	0	0		0	0	0	1355	0
Spillback Cap Reductn	0	0		0	0	0		0	0	0	0	0
Storage Cap Reductn	0	0		0	0	0		0	0	0	0	0
Reduced v/c Ratio	0.59	0.63		0.16	0.58	0.35		0.76	0.05	0.36	0.81	0.09

Intersection Summary			
Area Type:	Other		
Cycle Length: 105			
Actuated Cycle Length: 105			
Offset: 0 (0%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green			
Natural Cycle: 120			
Control Type: Actuated-Coordinated			
Maximum v/c Ratio: 0.76			
Intersection Signal Delay: 21.7		Intersection LOS: C	
Intersection Capacity Utilization 94.4%		ICU Level of Service F	
Analysis Period (min) 15			

Splits and Phases: 3: Walnut St & Salem St



APPENDIX G

Summary of Crash Data
I-95 Northbound at Exits 57 to 61

Table G-1
Summary of Crash Data 2015–17
I-95 Northbound at Exit 57

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percentage
Total number of crashes		29	8	21	58	19.3	100%
Severity	Property damage only	20	7	16	43	14.3	74%
	Non-fatal injury	9	1	5	15	5.0	26%
	Fatality	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	4	1	3	8	2.7	14%
	Rear-end	16	6	14	36	12.0	62%
	Angle	4	0	2	6	2.0	10%
	Sideswipe, same direction	4	1	0	5	1.7	9%
	Sideswipe, opposite direction	0	0	0	0	0.0	0%
	Head-on	0	0	0	0	0.0	0%
	Rear-to-rear	0	0	0	0	0.0	0%
	Not reported/unknown	1	0	2	3	1.0	5%
Involved pedestrian(s)		0	0	0	0	0.0	0%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		11	1	7	19	6.3	33%
Wet or icy pavement conditions		7	2	3	12	4.0	21%
Dark conditions (lit or unlit)		7	3	4	14	4.7	24%

* Peak periods are defined as 06:00–10:00 AM and 2:30–6:30 PM.

Table G-2
Summary of Crash Data 2015–17
I-95 Northbound at Exit 58

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percentage
Total number of crashes		17	19	16	52	17.3	100%
Severity	Property damage only	10	11	11	32	10.7	62%
	Non-fatal injury	7	8	5	20	6.7	38%
	Fatality	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	1	8	5	14	4.7	27%
	Rear-end	14	7	8	29	9.7	56%
	Angle	0	2	2	4	1.3	8%
	Sideswipe, same direction	2	2	0	4	1.3	8%
	Sideswipe, opposite direction	0	0	0	0	0.0	0%
	Head-on	0	0	0	0	0.0	0%
	Rear-to-rear	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	1	1	0.3	2%
Involved pedestrian(s)		0	0	0	0	0.0	0%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		8	8	5	21	7.0	40%
Wet or icy pavement conditions		1	3	2	6	2.0	12%
Dark conditions (lit or unlit)		4	6	6	16	5.3	31%

* Peak periods are defined as 06:00–10:00 AM and 2:30–6:30 PM.

Table G-3
Summary of Crash Data 2015–17
I-95 Northbound at Exit 59

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percentage
Total number of crashes		7	9	13	29	9.7	100%
Severity	Property damage only	3	9	10	22	7.3	76%
	Non-fatal injury	4	0	3	7	2.3	24%
	Fatality	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	4	2	3	9	3.0	31%
	Rear-end	2	5	7	14	4.7	48%
	Angle	0	0	0	0	0.0	0%
	Sideswipe, same direction	1	1	2	4	1.3	14%
	Sideswipe, opposite direction	0	0	1	1	0.3	3%
	Head-on	0	0	0	0	0.0	0%
	Rear-to-rear	0	0	0	0	0.0	0%
	Not reported/unknown	0	1	0	1	0.3	3%
Involved pedestrian(s)		0	0	0	0	0.0	0%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		2	5	7	14	4.7	48%
Wet or icy pavement conditions		2	2	2	6	2.0	21%
Dark conditions (lit or unlit)		5	5	2	12	4.0	41%

* Peak periods are defined as 06:00–10:00 AM and 2:30–6:30 PM.

Table G-4
Summary of Crash Data 2015–17
I-95 Northbound at Exit 60

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percentage
Total number of crashes		17	8	15	40	13.3	100%
Severity	Property damage only	8	7	11	26	8.7	65%
	Non-fatal injury	8	1	4	13	4.3	33%
	Fatality	1	0	0	1	0.3	3%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	5	4	1	10	3.3	25%
	Rear-end	9	1	11	21	7.0	53%
	Angle	1	0	0	1	0.3	3%
	Sideswipe, same direction	1	3	3	7	2.3	18%
	Sideswipe, opposite direction	0	0	0	0	0.0	0%
	Head-on	0	0	0	0	0.0	0%
	Rear-to-rear	1	0	0	1	0.3	3%
	Not reported/unknown	0	0	0	0	0.0	0%
Involved pedestrian(s)		0	0	0	0	0.0	0%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		9	4	9	22	7.3	55%
Wet or icy pavement conditions		2	2	3	7	2.3	18%
Dark conditions (lit or unlit)		8	5	6	19	6.3	48%

* Peak periods are defined as 06:00–10:00 AM and 2:30–6:30 PM.

Table G-5
Summary of Crash Data 2015–17
I-95 Northbound at Exit 61

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percentage
Total number of crashes		13	3	12	28	9.3	100%
Severity	Property damage only	11	3	9	23	7.7	82%
	Non-fatal injury	2	0	3	5	1.7	18%
	Fatality	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	4	0	1	5	1.7	18%
	Rear-end	6	3	10	19	6.3	68%
	Angle	1	0	0	1	0.3	4%
	Sideswipe, same direction	2	0	0	2	0.7	7%
	Sideswipe, opposite direction	0	0	1	1	0.3	4%
	Head-on	0	0	0	0	0.0	0%
	Rear-to-rear	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Involved pedestrian(s)		0	0	0	0	0.0	0%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		8	1	7	16	5.3	57%
Wet or icy pavement conditions		1	0	0	1	0.3	4%
Dark conditions (lit or unlit)		6	0	1	7	2.3	25%

* Peak periods are defined as 06:00–10:00 AM and 2:30–6:30 PM.

APPENDIX H

Summary of Crash Data
I-95 Southbound at Exits 57 to 61

Table H-1
Summary of Crash Data 2015–17
I-95 Southbound at Exit 57

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percetage
Total number of crashes		22	14	23	59	19.7	100%
Severity	Property damage only	14	10	17	41	13.7	69%
	Non-fatal injury	8	4	6	18	6.0	31%
	Fatality	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	2	3	3	8	2.7	14%
	Rear-end	14	8	16	38	12.7	64%
	Angle	4	0	0	4	1.3	7%
	Sideswipe, same direction	1	3	4	8	2.7	14%
	Sideswipe, opposite direction	0	0	0	0	0.0	0%
	Head-on	1	0	0	1	0.3	2%
	Rear-to-rear	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Involved pedestrian(s)		1	0	0	1	0.3	2%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		11	6	6	23	7.7	39%
Wet or icy pavement conditions		2	1	7	10	3.3	17%
Dark conditions (lit or unlit)		7	3	3	13	4.3	22%

* Peak periods are defined as 6:00–10:00 AM and 2:30–6:30 PM.

Table H-2
Summary of Crash Data 2015–17
I-95 Southbound at Exit 58

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percentage
Total number of crashes		9	15	15	39	13.0	100%
Severity	Property damage only	9	12	11	32	10.7	82%
	Non-fatal injury	0	3	4	7	2.3	18%
	Fatality	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	1	1	5	7	2.3	18%
	Rear-end	5	12	7	24	8.0	62%
	Angle	2	1	0	3	1.0	8%
	Sideswipe, same direction	1	1	3	5	1.7	13%
	Sideswipe, opposite direction	0	0	0	0	0.0	0%
	Head-on	0	0	0	0	0.0	0%
	Rear-to-rear	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Involved pedestrian(s)		0	0	0	0	0.0	0%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		3	8	8	19	6.3	49%
Wet or icy pavement conditions		2	1	1	4	1.3	10%
Dark conditions (lit or unlit)		3	3	4	10	3.3	26%

* Peak periods are defined as 06:00–10:00 AM and 2:30–6:30 PM.

Table H-3
Summary of Crash Data 2015–17
I-95 Southbound at Exit 59

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percentage
Total number of crashes		14	20	12	46	15.3	100%
Severity	Property damage only	12	11	9	32	10.7	70%
	Non-fatal injury	2	9	3	14	4.7	30%
	Fatality	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	2	2	0	4	1.3	9%
	Rear-end	12	17	8	37	12.3	80%
	Angle	0	0	1	1	0.3	2%
	Sideswipe, same direction	0	1	2	3	1.0	7%
	Sideswipe, opposite direction	0	0	0	0	0.0	0%
	Head-on	0	0	0	0	0.0	0%
	Rear-to-rear	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	1	1	0.3	2%
Involved pedestrian(s)		0	0	0	0	0.0	0%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		8	10	5	23	7.7	50%
Wet or icy pavement conditions		2	1	3	6	2.0	13%
Dark conditions (lit or unlit)		3	5	2	10	3.3	22%

* Peak periods are defined as 06:00–10:00 AM and 2:30–6:30 PM.

Table H-4
Summary of Crash Data 2015–17
I-95 Southbound at Exit 60

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percentage
Total number of crashes		17	15	19	51	17.0	100%
Severity	Property damage only	13	12	16	41	13.7	80%
	Non-fatal injury	4	3	3	10	3.3	20%
	Fatality	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	3	5	3	11	3.7	22%
	Rear-end	14	7	13	34	11.3	67%
	Angle	0	0	3	3	1.0	6%
	Sideswipe, same direction	0	3	0	3	1.0	6%
	Sideswipe, opposite direction	0	0	0	0	0.0	0%
	Head-on	0	0	0	0	0.0	0%
	Rear-to-rear	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Involved pedestrian(s)		0	0	0	0	0.0	0%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		7	11	10	28	9.3	55%
Wet or icy pavement conditions		3	2	2	7	2.3	14%
Dark conditions (lit or unlit)		5	2	5	12	4.0	24%

* Peak periods are defined as 06:00–10:00 AM and 2:30–6:30 PM.

Table H-5
Summary of Crash Data 2015–17
I-95 Southbound at Exit 61

Statistics Period		2015	2016	2017	3-Yr. Total	Annual Avg.	Percentage
Total number of crashes		23	14	25	62	20.7	100%
Severity	Property damage only	20	9	22	51	17.0	82%
	Non-fatal injury	3	5	3	11	3.7	18%
	Fatality	0	0	0	0	0.0	0%
	Not reported/unknown	0	0	0	0	0.0	0%
Collision type	Single vehicle	3	4	3	10	3.3	16%
	Rear-end	17	8	16	41	13.7	66%
	Angle	2	1	0	3	1.0	5%
	Sideswipe, same direction	1	1	5	7	2.3	11%
	Sideswipe, opposite direction	0	0	0	0	0.0	0%
	Head-on	0	0	0	0	0.0	0%
	Rear-to-rear	0	0	1	1	0.3	2%
	Not reported/unknown	0	0	0	0	0.0	0%
Involved pedestrian(s)		0	0	0	0	0.0	0%
Involved cyclist(s)		0	0	0	0	0.0	0%
Occurred during weekday peak periods*		10	4	12	26	8.7	42%
Wet or icy pavement conditions		4	1	6	11	3.7	18%
Dark conditions (lit or unlit)		9	4	5	18	6.0	29%

* Peak periods are defined as 06:00–10:00 AM and 2:30–6:30 PM.

APPENDIX I

Highway Capacity Analyses
AM Peak Hour: 2030 No-Build Scenario

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex57 Diverge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5150	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	6183	589
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.91	0.30

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1923.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	3600	Speed Index (DS)	0.493
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2361
Distance to Downstream Ramp (LDOWN), ft	1750	Off-Ramp Influence Area Speed (SR), mi/h	54.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.578	Outer Lanes Freeway Speed (SO), mi/h	66.9
Flow in Lanes 1 and 2 (v12), pc/h	3822	Ramp Junction Speed (S), mi/h	58.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	35.3
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.7

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex57 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	4650	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1861
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.82
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	60.8
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	30.6
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex57 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	650
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	4650	350
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5584	412
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.88	0.21

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	952.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1750	Speed Index (MS)	0.701
Downstream Equilibrium Distance (LEQ), ft	3917.7	Flow Outer Lanes (vOA), pc/h/ln	1307
Distance to Downstream Ramp (LDOWN), ft	850	On-Ramp Influence Area Speed (SR), mi/h	49.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.766	Outer Lanes Freeway Speed (SO), mi/h	62.9
Flow in Lanes 1 and 2 (v12), pc/h	4277	Ramp Junction Speed (S), mi/h	51.6
Flow Entering Ramp-Infl. Area (vR12), pc/h	4689	Average Density (D), pc/mi/ln	38.7
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	37.9

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex58 Diverge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	350
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5000	350
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	6004	412
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.88	0.21

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2125.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	850	Speed Index (DS)	0.477
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2287
Distance to Downstream Ramp (LDOWN), ft	2300	Off-Ramp Influence Area Speed (SR), mi/h	54.4
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.591	Outer Lanes Freeway Speed (SO), mi/h	67.2
Flow in Lanes 1 and 2 (v12), pc/h	3717	Ramp Junction Speed (S), mi/h	58.7
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	34.1
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.1

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex58 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	4650	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1861
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.82
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	60.8
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	30.6
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex58 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	750
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	4650	800
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5584	943
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.96	0.49

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1110.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2300	Speed Index (MS)	0.552
Downstream Equilibrium Distance (LEQ), ft	1449.9	Flow Outer Lanes (vOA), pc/h/ln	2245
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	53.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.598	Outer Lanes Freeway Speed (SO), mi/h	61.5
Flow in Lanes 1 and 2 (v12), pc/h	3339	Ramp Junction Speed (S), mi/h	56.1
Flow Entering Ramp-Infl. Area (vR12), pc/h	4282	Average Density (D), pc/mi/ln	38.8
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.8

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex59 Diverge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	775
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5450	250
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	6545	295
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	0.96	0.16

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	4338.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.530
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2606
Distance to Downstream Ramp (LDOWN), ft	1125	Off-Ramp Influence Area Speed (SR), mi/h	54.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.583	Outer Lanes Freeway Speed (SO), mi/h	68.1
Flow in Lanes 1 and 2 (v12), pc/h	3939	Ramp Junction Speed (S), mi/h	58.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	37.0
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.2

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex59 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.16
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.4
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	5200	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2081
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2396
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2319
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.90
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	58.1
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	35.8
Total Ramp Density Adjustment	3.6	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	69.6		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex59 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	650
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5200	200
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	6244	236
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.95	0.12

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1056.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.481
Downstream Equilibrium Distance (LEQ), ft	2712.3	Flow Outer Lanes (vOA), pc/h/ln	2523
Distance to Downstream Ramp (LDOWN), ft	4900	On-Ramp Influence Area Speed (SR), mi/h	56.3
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.596	Outer Lanes Freeway Speed (SO), mi/h	61.7
Flow in Lanes 1 and 2 (v12), pc/h	3721	Ramp Junction Speed (S), mi/h	58.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	3957	Average Density (D), pc/mi/ln	37.0
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.2

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex59-60 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	5400	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2161
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.93
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	56.3
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	38.4
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex60 Diverge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	200
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5400	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	6484	531
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.93	0.29

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1201.3	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	4900	Speed Index (DS)	0.551
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2542
Distance to Downstream Ramp (LDOWN), ft	1200	Off-Ramp Influence Area Speed (SR), mi/h	54.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.573	Outer Lanes Freeway Speed (SO), mi/h	70.8
Flow in Lanes 1 and 2 (v12), pc/h	3942	Ramp Junction Speed (S), mi/h	60.0
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	36.0
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	36.4

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex60 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	4950	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1981
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.85
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	60.6
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	32.7
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex60 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	625
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5250	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	6304	354
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.96	0.18

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1083.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1200	Speed Index (MS)	0.598
Downstream Equilibrium Distance (LEQ), ft	3059.3	Flow Outer Lanes (vOA), pc/h/ln	2251
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	53.3
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.643	Outer Lanes Freeway Speed (SO), mi/h	63.7
Flow in Lanes 1 and 2 (v12), pc/h	4053	Ramp Junction Speed (S), mi/h	56.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	4407	Average Density (D), pc/mi/ln	39.3
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	35.8

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex61 Diverge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5250	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	2.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.976
Flow Rate (vi),pc/h	6304	583
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.90	0.30

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1886.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.492
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2426
Distance to Downstream Ramp (LDOWN), ft	1800	Off-Ramp Influence Area Speed (SR), mi/h	56.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.576	Outer Lanes Freeway Speed (SO), mi/h	71.2
Flow in Lanes 1 and 2 (v12), pc/h	3878	Ramp Junction Speed (S), mi/h	61.2
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	34.3
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.6

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex61 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	4750	Heavy Vehicle Adjustment Factor (f_{HV})	0.948
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1901
Total Trucks, %	5.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.82
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	62.3
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	30.5
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex61 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	4750	250
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5703	295
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.86	0.15

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	886.7	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1800	Speed Index (MS)	0.440
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2327
Distance to Downstream Ramp (LDOWN), ft	-	On-Ramp Influence Area Speed (SR), mi/h	57.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.592	Outer Lanes Freeway Speed (SO), mi/h	63.3
Flow in Lanes 1 and 2 (v12), pc/h	3376	Ramp Junction Speed (S), mi/h	59.8
Flow Entering Ramp-Infl. Area (vR12), pc/h	3671	Average Density (D), pc/mi/ln	33.4
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	30.9

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex57 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5350	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6337	523
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	1.01	0.27

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	-	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1700	Speed Index (MS)	-
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2573
Distance to Downstream Ramp (LDOWN), ft	3600	On-Ramp Influence Area Speed (SR), mi/h	-
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.594	Outer Lanes Freeway Speed (SO), mi/h	-
Flow in Lanes 1 and 2 (v12), pc/h	3764	Ramp Junction Speed (S), mi/h	-
Flow Entering Ramp-Infl. Area (vR12), pc/h	4287	Average Density (D), pc/mi/ln	-
Level of Service (LOS)	F	Density in Ramp Influence Area (DR), pc/mi/ln	-

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex57 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2112
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.93
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	55.4
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	38.1
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex57 Diverge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	225
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5750	400
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6811	465
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	1.00	0.24

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	3418.6	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	825	Speed Index (DS)	0.482
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2700
Distance to Downstream Ramp (LDOWN), ft	1700	Off-Ramp Influence Area Speed (SR), mi/h	54.3
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.568	Outer Lanes Freeway Speed (SO), mi/h	65.6
Flow in Lanes 1 and 2 (v12), pc/h	4111	Ramp Junction Speed (S), mi/h	58.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	38.9
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	37.6

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex59 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	30.0
Segment Length (L) / Acceleration Length (LA),ft	1500	400
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5350	400
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6337	465
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	1.00	0.25

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	758.0	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	125	Speed Index (MS)	0.632
Downstream Equilibrium Distance (LEQ), ft	4314.0	Flow Outer Lanes (vOA), pc/h/ln	2351
Distance to Downstream Ramp (LDOWN), ft	2150	On-Ramp Influence Area Speed (SR), mi/h	51.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.629	Outer Lanes Freeway Speed (SO), mi/h	61.0
Flow in Lanes 1 and 2 (v12), pc/h	3986	Ramp Junction Speed (S), mi/h	54.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	4451	Average Density (D), pc/mi/ln	41.7
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	37.5

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex58 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5150	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2033
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.89
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	57.3
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	35.5
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex58 Diverge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5750	600
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6811	697
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	1.00	0.36

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2509.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2150	Speed Index (DS)	0.502
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2700
Distance to Downstream Ramp (LDOWN), ft	2600	Off-Ramp Influence Area Speed (SR), mi/h	53.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.558	Outer Lanes Freeway Speed (SO), mi/h	65.6
Flow in Lanes 1 and 2 (v12), pc/h	4111	Ramp Junction Speed (S), mi/h	58.0
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	39.1
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	35.1

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex59 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	30.0
Segment Length (L) / Acceleration Length (LA),ft	1500	400
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5350	400
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6337	465
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	1.00	0.25

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	758.0	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	125	Speed Index (MS)	0.632
Downstream Equilibrium Distance (LEQ), ft	4314.0	Flow Outer Lanes (vOA), pc/h/ln	2351
Distance to Downstream Ramp (LDOWN), ft	2150	On-Ramp Influence Area Speed (SR), mi/h	51.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.629	Outer Lanes Freeway Speed (SO), mi/h	61.0
Flow in Lanes 1 and 2 (v12), pc/h	3986	Ramp Junction Speed (S), mi/h	54.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	4451	Average Density (D), pc/mi/ln	41.7
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	37.5

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex59 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.16
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.4
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2112
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2360
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2284
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.92
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	55.5
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	38.1
Total Ramp Density Adjustment	3.6	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	66.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex59 Diverge - 2019 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	275
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5500	150
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6515	174
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.95	0.09

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1319.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	5600	Speed Index (DS)	0.455
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2606
Distance to Downstream Ramp (LDOWN), ft	1250	Off-Ramp Influence Area Speed (SR), mi/h	56.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.589	Outer Lanes Freeway Speed (SO), mi/h	68.1
Flow in Lanes 1 and 2 (v12), pc/h	3909	Ramp Junction Speed (S), mi/h	60.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	36.0
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	35.4

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex59-60 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.16
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.4
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5500	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2172
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2396
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2319
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.94
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	55.8
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	38.9
Total Ramp Density Adjustment	3.6	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	69.6		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex60 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5250	250
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6219	290
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.93	0.15

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	996.0	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1925	Speed Index (MS)	0.494
Downstream Equilibrium Distance (LEQ), ft	1007.7	Flow Outer Lanes (vOA), pc/h/ln	2537
Distance to Downstream Ramp (LDOWN), ft	5600	On-Ramp Influence Area Speed (SR), mi/h	56.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.592	Outer Lanes Freeway Speed (SO), mi/h	62.0
Flow in Lanes 1 and 2 (v12), pc/h	3682	Ramp Junction Speed (S), mi/h	58.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	3972	Average Density (D), pc/mi/ln	37.2
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.3

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex60 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5250	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2073
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.89
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	58.5
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	35.4
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex60 Diverge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	575
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5650	400
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6693	465
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.96	0.24

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2889.6	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.482
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2672
Distance to Downstream Ramp (LDOWN), ft	1925	Off-Ramp Influence Area Speed (SR), mi/h	56.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.571	Outer Lanes Freeway Speed (SO), mi/h	70.3
Flow in Lanes 1 and 2 (v12), pc/h	4021	Ramp Junction Speed (S), mi/h	61.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	36.4
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.7

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex61 Merge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	30.0
Segment Length (L) / Acceleration Length (LA),ft	1500	350
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5150	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6100	581
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.96	0.32

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	709.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.616
Downstream Equilibrium Distance (LEQ), ft	2980.6	Flow Outer Lanes (vOA), pc/h/ln	2288
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	52.8
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.625	Outer Lanes Freeway Speed (SO), mi/h	63.6
Flow in Lanes 1 and 2 (v12), pc/h	3812	Ramp Junction Speed (S), mi/h	56.1
Flow Entering Ramp-Infl. Area (vR12), pc/h	4393	Average Density (D), pc/mi/ln	39.7
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	37.4

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex61 Basic Fwy - 2030 AM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5150	Heavy Vehicle Adjustment Factor (f_{HV})	0.952
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2033
Total Trucks, %	5.00	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.88
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.4
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	34.2
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex61 Diverge - 2030 AM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5450	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6456	348
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.93	0.18

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	-	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	-	Speed Index (DS)	0.471
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2547
Distance to Downstream Ramp (LDOWN), ft	1125	Off-Ramp Influence Area Speed (SR), mi/h	56.8
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.583	Outer Lanes Freeway Speed (SO), mi/h	70.8
Flow in Lanes 1 and 2 (v12), pc/h	3909	Ramp Junction Speed (S), mi/h	61.6
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	34.9
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.8

APPENDIX J

Highway Capacity Analyses
PM Peak Hour: 2030 No-Build Scenario

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex57 Diverge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5850	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6759	572
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.99	0.30

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2360.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	3600	Speed Index (DS)	0.491
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2691
Distance to Downstream Ramp (LDOWN), ft	1750	Off-Ramp Influence Area Speed (SR), mi/h	54.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.565	Outer Lanes Freeway Speed (SO), mi/h	65.6
Flow in Lanes 1 and 2 (v12), pc/h	4068	Ramp Junction Speed (S), mi/h	58.2
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	38.7
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.8

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex57 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2060
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.90
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	56.7
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	36.3
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex57 Merge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	650
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5350	550
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6181	630
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	1.00	0.33

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1127.3	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1750	Speed Index (MS)	1.110
Downstream Equilibrium Distance (LEQ), ft	3917.7	Flow Outer Lanes (vOA), pc/h/ln	1446
Distance to Downstream Ramp (LDOWN), ft	850	On-Ramp Influence Area Speed (SR), mi/h	39.4
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.766	Outer Lanes Freeway Speed (SO), mi/h	62.4
Flow in Lanes 1 and 2 (v12), pc/h	4735	Ramp Junction Speed (S), mi/h	42.7
Flow Entering Ramp-Infl. Area (vR12), pc/h	5365	Average Density (D), pc/mi/ln	53.2
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	43.0

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Period 5:00-6:00
Project Description	I-95 NB Ex58 Diverge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	350
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5900	550
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6817	630
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	1.00	0.33

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	3301.0	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	850	Speed Index (DS)	0.496
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2700
Distance to Downstream Ramp (LDOWN), ft	2300	Off-Ramp Influence Area Speed (SR), mi/h	54.0
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.561	Outer Lanes Freeway Speed (SO), mi/h	65.6
Flow in Lanes 1 and 2 (v12), pc/h	4117	Ramp Junction Speed (S), mi/h	58.1
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	39.1
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	36.5

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex58 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5250	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2022
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.89
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	57.6
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	35.1
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex58 Merge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	750
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5250	650
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6066	744
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	1.00	0.38

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1171.5	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2300	Speed Index (MS)	0.675
Downstream Equilibrium Distance (LEQ), ft	2843.8	Flow Outer Lanes (vOA), pc/h/ln	2166
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	50.4
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.643	Outer Lanes Freeway Speed (SO), mi/h	61.8
Flow in Lanes 1 and 2 (v12), pc/h	3900	Ramp Junction Speed (S), mi/h	53.5
Flow Entering Ramp-Infl. Area (vR12), pc/h	4644	Average Density (D), pc/mi/ln	42.4
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	36.7

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex59 Diverge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	775
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5900	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6817	572
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	1.00	0.31

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	3807.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.555
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2700
Distance to Downstream Ramp (LDOWN), ft	1125	Off-Ramp Influence Area Speed (SR), mi/h	53.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.563	Outer Lanes Freeway Speed (SO), mi/h	67.7
Flow in Lanes 1 and 2 (v12), pc/h	4117	Ramp Junction Speed (S), mi/h	58.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	39.0
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.7

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex59 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.16
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.4
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5400	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2080
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2396
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2319
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.90
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	58.1
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	35.8
Total Ramp Density Adjustment	3.6	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	69.6		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex59 Merge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	650
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5400	150
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6239	172
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.94	0.09

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1041.7	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.467
Downstream Equilibrium Distance (LEQ), ft	1808.2	Flow Outer Lanes (vOA), pc/h/ln	2521
Distance to Downstream Ramp (LDOWN), ft	4900	On-Ramp Influence Area Speed (SR), mi/h	56.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.596	Outer Lanes Freeway Speed (SO), mi/h	61.7
Flow in Lanes 1 and 2 (v12), pc/h	3718	Ramp Junction Speed (S), mi/h	58.6
Flow Entering Ramp-Infl. Area (vR12), pc/h	3890	Average Density (D), pc/mi/ln	36.5
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.7

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex59-60 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5550	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2137
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.92
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	56.9
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	37.6
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex60 Diverge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	200
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5550	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6412	343
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.92	0.19

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	841.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	4900	Speed Index (DS)	0.534
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2525
Distance to Downstream Ramp (LDOWN), ft	1200	Off-Ramp Influence Area Speed (SR), mi/h	55.0
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.584	Outer Lanes Freeway Speed (SO), mi/h	70.8
Flow in Lanes 1 and 2 (v12), pc/h	3887	Ramp Junction Speed (S), mi/h	60.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	35.4
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	35.9

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex60 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5250	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2022
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.87
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.7
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	33.9
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex60 Merge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	625
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5250	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6066	572
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.95	0.30

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1079.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1200	Speed Index (MS)	0.641
Downstream Equilibrium Distance (LEQ), ft	3365.3	Flow Outer Lanes (vOA), pc/h/ln	2105
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	52.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.653	Outer Lanes Freeway Speed (SO), mi/h	64.2
Flow in Lanes 1 and 2 (v12), pc/h	3961	Ramp Junction Speed (S), mi/h	55.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	4533	Average Density (D), pc/mi/ln	39.9
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	36.7

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex61 Diverge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5750	550
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6643	630
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.95	0.33

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	3069.2	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.496
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2616
Distance to Downstream Ramp (LDOWN), ft	1800	Off-Ramp Influence Area Speed (SR), mi/h	56.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.565	Outer Lanes Freeway Speed (SO), mi/h	70.5
Flow in Lanes 1 and 2 (v12), pc/h	4027	Ramp Junction Speed (S), mi/h	61.0
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	36.3
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.8

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex61 Basic Fwy -2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

Demand Volume veh/h	5200	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2003
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.86
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	60.1
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	33.3
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex61 Merge - 2030 PM	Unit	United States Customary

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors

	Freeway	Ramp
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity

	Freeway	Ramp
Demand Volume (Vi)	5200	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6008	515
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.94	0.27

Speed and Density

Upstream Equilibrium Distance (LEQ), ft	999.0	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1800	Speed Index (MS)	0.516
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2451
Distance to Downstream Ramp (LDOWN), ft	-	On-Ramp Influence Area Speed (SR), mi/h	55.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.592	Outer Lanes Freeway Speed (SO), mi/h	62.6
Flow in Lanes 1 and 2 (v12), pc/h	3557	Ramp Junction Speed (S), mi/h	58.0
Flow Entering Ramp-Infl. Area (vR12), pc/h	4072	Average Density (D), pc/mi/ln	37.5
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.9

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex57 Merge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	600
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	4900	550
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5715	638
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.93	0.33

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1007.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1700	Speed Index (MS)	0.500
Downstream Equilibrium Distance (LEQ), ft	936.5	Flow Outer Lanes (vOA), pc/h/ln	2320
Distance to Downstream Ramp (LDOWN), ft	3600	On-Ramp Influence Area Speed (SR), mi/h	54.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.594	Outer Lanes Freeway Speed (SO), mi/h	61.2
Flow in Lanes 1 and 2 (v12), pc/h	3395	Ramp Junction Speed (S), mi/h	57.0
Flow Entering Ramp-Infl. Area (vR12), pc/h	4033	Average Density (D), pc/mi/ln	37.2
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.9

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex57 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2080
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.91
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	56.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	37.0
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex57 Diverge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	225
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5400	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	6298	581
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.92	0.30

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2527.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	825	Speed Index (DS)	0.492
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2424
Distance to Downstream Ramp (LDOWN), ft	1700	Off-Ramp Influence Area Speed (SR), mi/h	54.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.576	Outer Lanes Freeway Speed (SO), mi/h	66.6
Flow in Lanes 1 and 2 (v12), pc/h	3874	Ramp Junction Speed (S), mi/h	58.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	36.0
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	35.5

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex58 Merge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	550
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5000	400
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5831	465
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.92	0.24

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	972.7	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2600	Speed Index (MS)	0.702
Downstream Equilibrium Distance (LEQ), ft	3220.9	Flow Outer Lanes (vOA), pc/h/ln	1621
Distance to Downstream Ramp (LDOWN), ft	825	On-Ramp Influence Area Speed (SR), mi/h	49.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.722	Outer Lanes Freeway Speed (SO), mi/h	61.8
Flow in Lanes 1 and 2 (v12), pc/h	4210	Ramp Junction Speed (S), mi/h	51.8
Flow Entering Ramp-Infl. Area (vR12), pc/h	4675	Average Density (D), pc/mi/ln	40.5
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	38.4

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex58 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.25
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.1
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	5000	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1944
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2358
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2283
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.85
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	59.2
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	32.8
Total Ramp Density Adjustment	3.9	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	65.8		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex58 Diverge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5650	650
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	6590	756
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.97	0.39

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	282.6	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2150	Speed Index (DS)	0.508
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2567
Distance to Downstream Ramp (LDOWN), ft	2600	Off-Ramp Influence Area Speed (SR), mi/h	53.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.560	Outer Lanes Freeway Speed (SO), mi/h	66.1
Flow in Lanes 1 and 2 (v12), pc/h	4023	Ramp Junction Speed (S), mi/h	57.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	37.9
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.3

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59 Merge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	25.0
Segment Length (L) / Acceleration Length (LA),ft	1500	400
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5350	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	6239	348
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	0.97	0.19

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	460.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1250	Speed Index (MS)	0.592
Downstream Equilibrium Distance (LEQ), ft	4628.1	Flow Outer Lanes (vOA), pc/h/ln	2277
Distance to Downstream Ramp (LDOWN), ft	2150	On-Ramp Influence Area Speed (SR), mi/h	52.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.635	Outer Lanes Freeway Speed (SO), mi/h	61.4
Flow in Lanes 1 and 2 (v12), pc/h	3962	Ramp Junction Speed (S), mi/h	55.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	4310	Average Density (D), pc/mi/ln	39.7
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	36.5

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.16
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.4
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	5350	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2080
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2360
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2284
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.91
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	56.3
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	36.9
Total Ramp Density Adjustment	3.6	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	66.0		

HCS7 Freeway Diverge Report

Project Information

Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59 Diverge - 2030 PM	Unit	United States Customary

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	275
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors

Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity

Demand Volume (Vi)	5550	200
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	6472	232
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.95	0.12

Speed and Density

Upstream Equilibrium Distance (LEQ), ft	3487.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	5600	Speed Index (DS)	0.461
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2571
Distance to Downstream Ramp (LDOWN), ft	1250	Off-Ramp Influence Area Speed (SR), mi/h	55.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.588	Outer Lanes Freeway Speed (SO), mi/h	68.2
Flow in Lanes 1 and 2 (v12), pc/h	3901	Ramp Junction Speed (S), mi/h	60.2
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	35.8
Level of Service (LOS)	E	Density in Ramp Influence Area (DR), pc/mi/ln	35.3

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59-60 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	5550	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	2157
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.93
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	56.4
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	38.2
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	E
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex60 Merge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	4950	600
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5773	697
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.93	0.36

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	987.7	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1925	Speed Index (MS)	0.526
Downstream Equilibrium Distance (LEQ), ft	1330.6	Flow Outer Lanes (vOA), pc/h/ln	2355
Distance to Downstream Ramp (LDOWN), ft	5600	On-Ramp Influence Area Speed (SR), mi/h	55.3
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.592	Outer Lanes Freeway Speed (SO), mi/h	63.1
Flow in Lanes 1 and 2 (v12), pc/h	3418	Ramp Junction Speed (S), mi/h	57.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	4115	Average Density (D), pc/mi/ln	37.2
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.2

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex60 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	4950	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1924
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.83
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	61.8
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	31.1
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex60 Diverge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	575
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5200	250
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	6065	291
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.87	0.15

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2592.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1500	Speed Index (DS)	0.466
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2338
Distance to Downstream Ramp (LDOWN), ft	1925	Off-Ramp Influence Area Speed (SR), mi/h	57.0
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.595	Outer Lanes Freeway Speed (SO), mi/h	71.6
Flow in Lanes 1 and 2 (v12), pc/h	3727	Ramp Junction Speed (S), mi/h	61.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	32.7
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.1

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex61 Merge - 2030 PM	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	25.0
Segment Length (L) / Acceleration Length (LA),ft	1500	350
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	4750	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5539	523
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.87	0.28

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	326.3	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.482
Downstream Equilibrium Distance (LEQ), ft	1844.8	Flow Outer Lanes (vOA), pc/h/ln	2238
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	56.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.596	Outer Lanes Freeway Speed (SO), mi/h	63.7
Flow in Lanes 1 and 2 (v12), pc/h	3301	Ramp Junction Speed (S), mi/h	59.0
Flow Entering Ramp-Infl. Area (vR12), pc/h	3824	Average Density (D), pc/mi/ln	34.2
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.9

HCS7 Basic Freeway Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex61 Basic Fwy - 2030 PM	Unit	United States Customary

Geometric Data

Number of Lanes, ln	3	Terrain Type	Level
Segment Length (L), ft	-	Percent Grade, %	-
Measured or Base Free-Flow Speed	Base	Grade Length, mi	-
Base Free-Flow Speed (BFFS), mi/h	75.0	Total Ramp Density (TRD), ramps/mi	1.00
Lane Width, ft	12	Free-Flow Speed (FFS), mi/h	71.8
Right-Side Lateral Clearance, ft	10		

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.975
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

Demand Volume veh/h	4750	Heavy Vehicle Adjustment Factor (f_{HV})	0.976
Peak Hour Factor	0.94	Flow Rate (V_p), pc/h/ln	1846
Total Trucks, %	2.50	Capacity (c), pc/h/ln	2400
Single-Unit Trucks (SUT), %	-	Adjusted Capacity (c_{adj}), pc/h/ln	2323
Tractor-Trailers (TT), %	-	Volume-to-Capacity Ratio (v/c)	0.79
Passenger Car Equivalent (E_T)	2.000		

Speed and Density

Lane Width Adjustment (f_{LW})	0.0	Average Speed (S), mi/h	63.3
Right-Side Lateral Clearance Adj. (f_{RLC})	0.0	Density (D), pc/mi/ln	29.2
Total Ramp Density Adjustment	3.2	Level of Service (LOS)	D
Adjusted Free-Flow Speed (FFS_{adj}), mi/h	70.0		

HCS7 Freeway Diverge Report

Project Information

Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex61 Diverge - 2030 PM	Unit	United States Customary

Geometric Data

	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors

	Freeway	Ramp
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity

	Freeway	Ramp
Demand Volume (Vi)	5050	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5890	348
Capacity (c), pc/h	6970	1936
Volume-to-Capacity Ratio (v/c)	0.85	0.18

Speed and Density

Upstream Equilibrium Distance (LEQ), ft	-	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	-	Speed Index (DS)	0.471
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2233
Distance to Downstream Ramp (LDOWN), ft	1125	Off-Ramp Influence Area Speed (SR), mi/h	56.8
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.597	Outer Lanes Freeway Speed (SO), mi/h	72.0
Flow in Lanes 1 and 2 (v12), pc/h	3657	Ramp Junction Speed (S), mi/h	61.7
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	31.8
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	31.7

APPENDIX K

Highway Capacity Analyses
AM Peak Hour: 2030 Proposed Improvements Scenario

HCS7 Freeway Weaving Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/21/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex57-58 Weaving - 2030 AM Proposed Scenario	Unit	United States Customary

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	1250	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	1.25	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	4650	315	35	315
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	5.50	3.50	3.50	3.50
Heavy Vehicle Adjustment Factor (f_{HV})	0.948	0.966	0.966	0.966
Flow Rate (v_i), pc/h	5583	371	41	371
Weaving Flow Rate (v_w), pc/h	742	Freeway Max Capacity (c_{IFL}), pc/h/ln		2358
Non-Weaving Flow Rate (v_{NW}), pc/h	5624	Density-Based Capacity (c_{IWL}), pc/h/ln		2170
Total Flow Rate (v), pc/h	6366	Demand Flow-Based Capacity (c_{IW}), pc/h		20513
Volume Ratio (VR)	0.117	Weaving Segment Capacity (c_W), veh/h		8248
Minimum Lane Change Rate (LC_{MIN}), lc/h	742	Adjusted Weaving Area Capacity, pc/h		8402
Maximum Weaving Length (L_{MAX}), ft	3705	Volume-to-Capacity Ratio (v/c)		0.76

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	879	Average Weaving Speed (S_W), mi/h	52.6
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	1066	Average Non-Weaving Speed (S_{NW}), mi/h	52.8
Weaving Lane Change Rate (LC_W), lc/h	1110	Average Speed (S), mi/h	52.8
Weaving Lane Change Rate (LC_{All}), lc/h	2176	Density (D), pc/mi/ln	30.1
Weaving Intensity Factor (W)	0.350	Level of Service (LOS)	D

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex58 Merge - 2030 AM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	1050
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	4650	800
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	5584	943
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.96	0.49

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1244.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2300	Speed Index (MS)	0.546
Downstream Equilibrium Distance (LEQ), ft	1240.2	Flow Outer Lanes (vOA), pc/h/ln	2195
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	53.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.607	Outer Lanes Freeway Speed (SO), mi/h	61.7
Flow in Lanes 1 and 2 (v12), pc/h	3389	Ramp Junction Speed (S), mi/h	56.1
Flow Entering Ramp-Infl. Area (vR12), pc/h	4332	Average Density (D), pc/mi/ln	38.8
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.3

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/24/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 NB Ex60 Diverge - 2030 AM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5400	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.50	3.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.948	0.966
Flow Rate (vi),pc/h	6423	525
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.92	0.29

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1231.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	4900	Speed Index (DS)	0.551
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2507
Distance to Downstream Ramp (LDOWN), ft	1200	Off-Ramp Influence Area Speed (SR), mi/h	54.6
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.575	Outer Lanes Freeway Speed (SO), mi/h	70.9
Flow in Lanes 1 and 2 (v12), pc/h	3916	Ramp Junction Speed (S), mi/h	60.0
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	35.7
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.4

HCS7 Freeway Weaving Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex57-58 Weaving - 2030 AM Proposed Scenario	Unit	United States Customary

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	1250	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	1.25	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	4930	570	30	320
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	5.00	3.00	3.00	3.00
Heavy Vehicle Adjustment Factor (f_{HV})	0.952	0.971	0.971	0.971
Flow Rate (v_i), pc/h	5840	662	35	372
Weaving Flow Rate (v_W), pc/h	1034	Freeway Max Capacity (c_{IFL}), pc/h/ln		2358
Non-Weaving Flow Rate (v_{NW}), pc/h	5875	Density-Based Capacity (c_{IWL}), pc/h/ln		2145
Total Flow Rate (v), pc/h	6909	Demand Flow-Based Capacity (c_{IW}), pc/h		16000
Volume Ratio (VR)	0.150	Weaving Segment Capacity (c_W), veh/h		8193
Minimum Lane Change Rate (LC_{MIN}), lc/h	1034	Adjusted Weaving Area Capacity, pc/h		8305
Maximum Weaving Length (L_{MAX}), ft	4031	Volume-to-Capacity Ratio (v/c)		0.83

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	918	Average Weaving Speed (S_W), mi/h	51.5
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	1117	Average Non-Weaving Speed (S_{NW}), mi/h	50.1
Weaving Lane Change Rate (LC_W), lc/h	1402	Average Speed (S), mi/h	50.3
Weaving Lane Change Rate (LC_{All}), lc/h	2519	Density (D), pc/mi/ln	34.3
Weaving Intensity Factor (W)	0.393	Level of Service (LOS)	D

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex58 Diverge - 2030 AM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	750
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5750	600
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6811	697
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	1.00	0.36

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	2509.1	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2150	Speed Index (DS)	0.502
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2700
Distance to Downstream Ramp (LDOWN), ft	2600	Off-Ramp Influence Area Speed (SR), mi/h	53.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.558	Outer Lanes Freeway Speed (SO), mi/h	65.6
Flow in Lanes 1 and 2 (v12), pc/h	4111	Ramp Junction Speed (S), mi/h	58.0
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	39.1
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.9

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex59 Merge - 2030 AM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	30.0
Segment Length (L) / Acceleration Length (LA),ft	1500	800
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5350	400
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6337	465
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	1.00	0.25

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	935.6	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	125	Speed Index (MS)	0.609
Downstream Equilibrium Distance (LEQ), ft	3368.1	Flow Outer Lanes (vOA), pc/h/ln	2351
Distance to Downstream Ramp (LDOWN), ft	2150	On-Ramp Influence Area Speed (SR), mi/h	52.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.629	Outer Lanes Freeway Speed (SO), mi/h	61.0
Flow in Lanes 1 and 2 (v12), pc/h	3986	Ramp Junction Speed (S), mi/h	54.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	4451	Average Density (D), pc/mi/ln	41.3
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	35.0

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Period 6:00-7:00
Project Description	I-95 SB Ex59 Diverge - 2019 AM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5500	150
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6515	174
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.95	0.09

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1319.4	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	5600	Speed Index (DS)	0.455
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2606
Distance to Downstream Ramp (LDOWN), ft	1250	Off-Ramp Influence Area Speed (SR), mi/h	56.1
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.589	Outer Lanes Freeway Speed (SO), mi/h	68.1
Flow in Lanes 1 and 2 (v12), pc/h	3909	Ramp Junction Speed (S), mi/h	60.4
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	36.0
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.8

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/21/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	AM Peak Hour 6:00-7:00
Project Description	I-95 SB Ex61 Merge - 2030 AM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	30.0
Segment Length (L) / Acceleration Length (LA),ft	1500	800
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5150	500
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	5.00	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.952	0.971
Flow Rate (vi),pc/h	6100	581
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.96	0.32

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	909.7	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.590
Downstream Equilibrium Distance (LEQ), ft	2245.4	Flow Outer Lanes (vOA), pc/h/ln	2288
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	53.5
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.625	Outer Lanes Freeway Speed (SO), mi/h	63.6
Flow in Lanes 1 and 2 (v12), pc/h	3812	Ramp Junction Speed (S), mi/h	56.6
Flow Entering Ramp-Infl. Area (vR12), pc/h	4393	Average Density (D), pc/mi/ln	39.3
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.5

APPENDIX L

Highway Capacity Analyses
PM Peak Hour: 2030 Proposed Improvements Scenario

HCS7 Freeway Weaving Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/21/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex57-58 Weaving - 2030 PM Proposed Scenario	Unit	United States Customary

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	1250	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	1.25	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.060

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	4730	520	30	620
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	2.50	1.50	1.50	1.50
Heavy Vehicle Adjustment Factor (f_{HV})	0.976	0.985	0.985	0.985
Flow Rate (v_i), pc/h	5465	595	34	710
Weaving Flow Rate (v_w), pc/h	1305	Freeway Max Capacity (c_{IFL}), pc/h/ln		2358
Non-Weaving Flow Rate (v_{NW}), pc/h	5499	Density-Based Capacity (c_{IWL}), pc/h/ln		2113
Total Flow Rate (v), pc/h	6804	Demand Flow-Based Capacity (c_{IW}), pc/h		12500
Volume Ratio (VR)	0.192	Weaving Segment Capacity (c_W), veh/h		8264
Minimum Lane Change Rate (LC_{MIN}), lc/h	1305	Adjusted Weaving Area Capacity, pc/h		8182
Maximum Weaving Length (L_{MAX}), ft	4455	Volume-to-Capacity Ratio (v/c)		0.83

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	859	Average Weaving Speed (S_W), mi/h	50.9
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	1040	Average Non-Weaving Speed (S_{NW}), mi/h	48.2
Weaving Lane Change Rate (LC_W), lc/h	1673	Average Speed (S), mi/h	48.7
Weaving Lane Change Rate (LC_{All}), lc/h	2713	Density (D), pc/mi/ln	34.9
Weaving Intensity Factor (W)	0.417	Level of Service (LOS)	D

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex58 Merge - 2030 PM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Acceleration Length (LA),ft	1500	1050
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5250	650
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6066	744
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	1.00	0.38

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1304.7	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2300	Speed Index (MS)	0.655
Downstream Equilibrium Distance (LEQ), ft	2432.5	Flow Outer Lanes (vOA), pc/h/ln	2166
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	50.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.643	Outer Lanes Freeway Speed (SO), mi/h	61.8
Flow in Lanes 1 and 2 (v12), pc/h	3900	Ramp Junction Speed (S), mi/h	53.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	4644	Average Density (D), pc/mi/ln	42.1
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.8

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 NB Ex60 Diverge - 2030 PM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	30.0
Segment Length (L) / Deceleration Length (LA),ft	1500	500
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.060	1.060

Demand and Capacity		
Demand Volume (Vi)	5550	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	1.50
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.985
Flow Rate (vi),pc/h	6412	343
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.92	0.19

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	841.8	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	4900	Speed Index (DS)	0.534
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2525
Distance to Downstream Ramp (LDOWN), ft	1200	Off-Ramp Influence Area Speed (SR), mi/h	55.0
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.584	Outer Lanes Freeway Speed (SO), mi/h	70.8
Flow in Lanes 1 and 2 (v12), pc/h	3887	Ramp Junction Speed (S), mi/h	60.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	35.4
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.2

HCS7 Freeway Weaving Report

Project Information

Analyst	Chen-Yuan Wang	Date	1/24/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex57-58 Weaving - 2030 PM Proposed Scenario	Unit	United States Customary

Geometric Data

Number of Lanes (N), ln	4	Segment Type	Freeway
Segment Length (L_S), ft	1250	Number of Maneuver Lanes (N_{WL}), ln	2
Weaving Configuration	One-Sided	Ramp-to-Freeway Lane Changes (LC_{RF}), lc	1
Terrain Type	Level	Freeway-to-Ramp Lane Changes (LC_{FR}), lc	1
Percent Grade, %	-	Ramp-to-Ramp Lane Changes (LC_{RR}), lc	0
Interchange Density (ID), int/mi	1.25	Cross Weaving Managed Lane	No

Adjustment Factors

Driver Population	Mostly Familiar	Final Speed Adjustment Factor (SAF)	0.925
Weather Type	Non-Severe Weather	Final Capacity Adjustment Factor (CAF)	0.968
Incident Type	No Incident	Demand Adjustment Factor (DAF)	1.070

Demand and Capacity

	FF	RF	RR	FR
Demand Volume (V_i), veh/h	4530	360	40	460
Peak Hour Factor (PHF)	0.94	0.94	0.94	0.94
Total Trucks, %	2.50	2.50	2.00	2.00
Heavy Vehicle Adjustment Factor (f_{HV})	0.976	0.976	0.980	0.980
Flow Rate (v_i), pc/h	5283	420	46	534
Weaving Flow Rate (v_w), pc/h	954	Freeway Max Capacity (c_{IFL}), pc/h/ln		2358
Non-Weaving Flow Rate (v_{NW}), pc/h	5329	Density-Based Capacity (c_{IWL}), pc/h/ln		2144
Total Flow Rate (v), pc/h	6283	Demand Flow-Based Capacity (c_{IW}), pc/h		15789
Volume Ratio (VR)	0.152	Weaving Segment Capacity (c_W), veh/h		8373
Minimum Lane Change Rate (LC_{MIN}), lc/h	954	Adjusted Weaving Area Capacity, pc/h		8301
Maximum Weaving Length (L_{MAX}), ft	4051	Volume-to-Capacity Ratio (v/c)		0.76

Speed and Density

Non-Weaving Vehicle Index (I_{NW})	833	Average Weaving Speed (S_W), mi/h	52.1
Non-Weaving Lane Change Rate (LC_{NW}), lc/h	1005	Average Non-Weaving Speed (S_{NW}), mi/h	51.4
Weaving Lane Change Rate (LC_W), lc/h	1322	Average Speed (S), mi/h	51.5
Weaving Lane Change Rate (LC_{All}), lc/h	2327	Density (D), pc/mi/ln	30.5
Weaving Intensity Factor (W)	0.369	Level of Service (LOS)	D

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex58 Diverge - 2030 PM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.1	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	750
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.925	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5650	650
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	6590	756
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.97	0.39

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	1971.6	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	2150	Speed Index (DS)	0.508
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2567
Distance to Downstream Ramp (LDOWN), ft	2600	Off-Ramp Influence Area Speed (SR), mi/h	53.7
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.560	Outer Lanes Freeway Speed (SO), mi/h	66.1
Flow in Lanes 1 and 2 (v12), pc/h	4023	Ramp Junction Speed (S), mi/h	57.9
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	37.9
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	32.1

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/18/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59 Merge - 2030 PM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	30.0
Segment Length (L) / Acceleration Length (LA),ft	1500	800
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5350	300
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	6239	348
Capacity (c), pc/h	6824	1839
Volume-to-Capacity Ratio (v/c)	0.97	0.19

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	889.6	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	125	Speed Index (MS)	0.565
Downstream Equilibrium Distance (LEQ), ft	3613.3	Flow Outer Lanes (vOA), pc/h/ln	2277
Distance to Downstream Ramp (LDOWN), ft	2150	On-Ramp Influence Area Speed (SR), mi/h	53.2
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.635	Outer Lanes Freeway Speed (SO), mi/h	61.4
Flow in Lanes 1 and 2 (v12), pc/h	3962	Ramp Junction Speed (S), mi/h	55.8
Flow Entering Ramp-Infl. Area (vR12), pc/h	4310	Average Density (D), pc/mi/ln	39.3
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	34.0

HCS7 Freeway Diverge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	8/10/2021
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex59 Diverge - 2019 PM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.4	35.0
Segment Length (L) / Deceleration Length (LA),ft	1500	450
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.950	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	5550	200
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	3.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.971
Flow Rate (vi),pc/h	6472	234
Capacity (c), pc/h	6824	1936
Volume-to-Capacity Ratio (v/c)	0.95	0.12

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	3221.9	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	5600	Speed Index (DS)	0.461
Downstream Equilibrium Distance (LEQ), ft	-	Flow Outer Lanes (vOA), pc/h/ln	2576
Distance to Downstream Ramp (LDOWN), ft	1250	Off-Ramp Influence Area Speed (SR), mi/h	55.9
Prop. Freeway Vehicles in Lane 1 and 2 (PFD)	0.587	Outer Lanes Freeway Speed (SO), mi/h	68.2
Flow in Lanes 1 and 2 (v12), pc/h	3896	Ramp Junction Speed (S), mi/h	60.2
Flow Entering Ramp-Infl. Area (vR12), pc/h	-	Average Density (D), pc/mi/ln	35.8
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	33.7

HCS7 Freeway Merge Report

Project Information			
Analyst	Chen-Yuan Wang	Date	1/21/2022
Agency	CTPS	Analysis Year	2030
Jurisdiction	MassDOT District 4	Time Period Analyzed	PM Peak Hour 5:00-6:00
Project Description	I-95 SB Ex61 Merge - 2030 PM Proposed Scenario	Unit	United States Customary

Geometric Data		
	Freeway	Ramp
Number of Lanes (N), ln	3	1
Free-Flow Speed (FFS), mi/h	71.8	30.0
Segment Length (L) / Acceleration Length (LA),ft	1500	800
Terrain Type	Level	Level
Percent Grade, %	-	-
Segment Type / Ramp Type	Freeway	Right-Sided One-Lane

Adjustment Factors		
Driver Population	Mostly Familiar	Mostly Familiar
Weather Type	Non-Severe Weather	Non-Severe Weather
Incident Type	No Incident	-
Final Speed Adjustment Factor (SAF)	0.975	0.975
Final Capacity Adjustment Factor (CAF)	0.968	0.968
Demand Adjustment Factor (DAF)	1.070	1.070

Demand and Capacity		
Demand Volume (Vi)	4750	450
Peak Hour Factor (PHF)	0.94	0.94
Total Trucks, %	2.50	2.00
Single-Unit Trucks (SUT), %	-	-
Tractor-Trailers (TT), %	-	-
Heavy Vehicle Adjustment Factor (fHV)	0.976	0.980
Flow Rate (vi),pc/h	5539	523
Capacity (c), pc/h	6970	1839
Volume-to-Capacity Ratio (v/c)	0.87	0.28

Speed and Density			
Upstream Equilibrium Distance (LEQ), ft	777.2	Number of Outer Lanes on Freeway (NO)	1
Distance to Upstream Ramp (LUP), ft	1125	Speed Index (MS)	0.463
Downstream Equilibrium Distance (LEQ), ft	1667.7	Flow Outer Lanes (vOA), pc/h/ln	2182
Distance to Downstream Ramp (LDOWN), ft	1500	On-Ramp Influence Area Speed (SR), mi/h	57.0
Prop. Freeway Vehicles in Lane 1 and 2 (PFM)	0.606	Outer Lanes Freeway Speed (SO), mi/h	63.9
Flow in Lanes 1 and 2 (v12), pc/h	3357	Ramp Junction Speed (S), mi/h	59.3
Flow Entering Ramp-Infl. Area (vR12), pc/h	3880	Average Density (D), pc/mi/ln	34.1
Level of Service (LOS)	D	Density in Ramp Influence Area (DR), pc/mi/ln	30.6