South Station Expansion Project

Appendix 9 (Part 2) – Pedestrian Circulation Analysis Technical Report

October 2014

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1. Introduction

The Massachusetts Department of Transportation (MassDOT), the Massachusetts Bay Transportation Authority (MBTA), and the National Railroad Passenger Corporation (Amtrak) have for decades identified the expansion of rail capacity at Boston South Station as a crucial transportation need, one that has been articulated in multiple local, regional, state, and Northeast Corridor (NEC)-wide planning documents.[1] In cooperation with the Federal Railroad Administration (FRA), Amtrak, and the MBTA, MassDOT is now pursuing the expansion of South Station to support existing NEC and commuter rail services and to provide for future Amtrak and MBTA service expansions. The current track capacity, layout, and operations of South Station limit the ability to accommodate projected future expanded services. In addition to expanding South Station terminal facilities, the South Station Expansion (SSX) project will also identify a solution to address existing and future intercity and commuter rail service layover needs. The SSX project includes planning, environmental reviews, and preliminary engineering for the five primary elements of the project:

1. **Expand the South Station terminal facilities**, including the addition of up to seven tracks and four platforms and construction of a new passenger concourse and other amenities.
2. **Acquire and demolish the U.S. Postal Service (USPS) General Mail Facility** located on Dorchester Avenue adjacent to South Station, which will provide an approximate 14-acre site on which to expand South Station. (Note that the relocation of the USPS facility will be the subject of a separate environmental review process by others.) Dorchester Avenue will be restored for public and station access.
3. **Create an extension of the Harborwalk along reopened Dorchester Avenue.**
4. **Provide for the possibility of future joint public/private development** adjacent to and over an expanded South Station.
5. **Provide adequate rail vehicle layover space** to address existing and future intercity and commuter rail service needs.

This Pedestrian Circulation Analysis Technical Report has been prepared in support of the Draft Environmental Impact Report (Draft EIR) and Environmental Assessment (EA) for the SSX project, in accordance with the Certificate of the Secretary of the Office of Energy and Environmental Affairs (EEA) on the Environmental Notification Form (ENF) for the SSX project (April 19, 2013), the Massachusetts Environmental Policy Act (MEPA) regulations, 301 CMR 11.00 (revised, May 10, 2013), and FRA's Procedures for Considering Environmental Impacts, 64 Federal Register (FR) 101 (26 May 1999), pp. 28545-28556.

1.1. Purpose

The purpose of this report is to document how the predicted increase in ridership at South Station, due to the proposed Build Alternatives, would impact the pedestrian level-of-service (LOS) on the MBTA's commuter rail and rapid transit facilities at the station, including platforms, waiting areas, and vertical circulation elements (VCEs). The analysis focuses on the Existing Condition, No Build Alternative condition, and Alternative 3 – Joint/ Private Development Maximum Build condition. Alternative 3 was selected since it reflects the maximum potential developmental square footage and passenger volumes,

[1] Documents citing the need for an expanded South Station include: *The Northeast Corridor Infrastructure Master Plan* (2010); Amtrak's *A Vision for High-Speed Rail in the Northeast Corridor* (2010), *The Amtrak Vision for the Northeast Corridor – 2012 Update* (2012), the *Massachusetts State Rail Plan* (2010), the *Massachusetts Freight Plan* (2010), and the two most recent long range transportation plans of the Boston Region Metropolitan Planning Organization (2007, 2011).

both of which are likely to translate to the highest possible pedestrian flows within South Station. Refer to Appendix 9 - *Transit Capacity Analysis Technical Report* for detailed descriptions of each alternative.

2. Summary of Findings

This report illustrates the methodology and assumptions used to determine the pedestrian LOS for the different elements of public circulation at South Station. The analysis uses a spreadsheet model to estimate the pedestrian LOS on the platforms, concourses and vertical circulation within the station. The approach used is based on the methodology described in the *Transit Capacity and Quality of Service Manual (TCRP Report 100)* (refer to Section 3 for more detail).

Throughout the preliminary engineering stage of the project, the station design should be developed to mitigate the areas of congestion, while responding to constraints of existing conditions, constructability assumptions and other parameters.

The findings of this report can be summarized as follows:

- Existing Conditions:
    - Platforms:
        - <u>Commuter Rail and Amtrak:</u> The southern end of the platforms experience the best LOS (LOS A/B). However, as the cumulative volume of passengers traverse the northern end of Platform A, the LOS can reach LOS F.
        - <u>Red Line:</u> An average LOS is maintained throughout the AM peak (LOS C). During the PM peak, the LOS deteriorates to LOS D.
        - <u>Silver Line:</u> A good LOS is maintained throughout the AM and PM peaks (LOS A/B).
    - Concourses:
        - During the PM peak, a large volume of pedestrians wait within the rail head concourse for their train to be announced. This results in significant congestion at the rail head concourse (LOS E or better) and minor congestion beneath the train announcement board within the headhouse (LOS C).
    - Vertical Circulation:
        - An acceptable LOS is experienced on all VCEs during the Existing Conditions AM and PM peak (LOS D or better).
- No Build Alternative:
    - Platforms:
        - <u>Commuter Rail and Amtrak:</u> The southern end of the platforms would experience the best LOS (LOS A/B-C). However, as the cumulative volume of passengers traverse the northern end of the platforms, the LOS would continue to reach LOS F for platform A and, in addition, would reach LOS E for platform G.
        - <u>Red Line:</u> An average LOS would be maintained throughout the AM peak (LOS C). During the PM peak, the LOS would deteriorate to LOS D. The increase in ridership associated with the No Build Alternative would result in a slightly reduced LOS when compared to the Existing Condition.
        - <u>Silver Line:</u> A good LOS would be maintained throughout the AM and PM peaks (LOS C or better, with most platform areas experiencing LOS A/B).

- Concourses:
    - During the PM peak, a large volume of pedestrians wait within the rail head concourse for their train to be announced. As a result of the significantly expanded rail head concourse as part of the SSAR project, the LOS experienced by waiting passengers in the No Build Alternative would be improved when compared to the Existing Conditions (LOS D or better versus LOS E or better, respectively). This is still greater than the typical target LOS C assumed for a facility of this type.
- Vertical Circulation:
    - The LOS would be slightly worse during the No Build Alternative AM peak when compared with the Existing Conditions. Despite this reduction, an acceptable LOS (LOS D or better) would be maintained throughout the AM and PM peaks.

- Alternative 3:
    - Platforms:
        - Commuter Rail and Amtrak: The existing commuter rail and Amtrak platforms would experience a very poor LOS (LOS E/F). This is the same as the worst case Existing Conditions and No Build Alternative platform LOS but it would occur more frequently due to the increased number of trains and ridership.
        - Red Line: The increase in ridership associated with Alternative 3 would result in a slightly reduced LOS when compared to the No Build Alternative (LOS D or better during both the AM and PM peaks versus LOS C or better during the AM peak and LOS D or better during the PM peak, respectively).
        - Silver Line: An average LOS (LOS C) or better is maintained throughout the AM and PM peaks.
    - Concourses:
        - Despite the significantly expanded rail head concourse, passengers waiting within the rail head concourse adjacent to the existing platforms would experience a poor LOS (LOS E/F). Passengers waiting adjacent to the new platforms would experience an acceptable LOS (LOS D or better).
    - Vertical Circulation:
        - The VCE LOS in Alternative 3 would be slightly worse as compared to the No Build Alternative. Despite this reduction, an acceptable LOS (LOS D or better) would be maintained throughout the AM and PM peaks.
    - The Alternative 3 design includes emergency egress only staircases and passageways. These elements could potentially be expanded to provide connectivity to an elevated concourse that facilitates mid-platform boarding and alighting during normal operations, thereby reducing the overall congestion level on the platforms and concourses.

2.1. Comparative Analysis

The following tables provide a summary comparison between the Existing Condition, No Build Alternative and Alternative 3. Detailed analysis and diagrams for each alternative are provided in the succeeding sections.

Table 1 compares the maximum density experienced on the commuter rail and Amtrak platforms for the representative passenger loads for the Existing Condition (723 passengers), No Build Alternative (829 passengers) and Alternative 3 (1092 passengers). The No Build Alternative would have the best LOS because it has the fewest impediments to pedestrian circulation (existing canopy columns have been removed and the requisite egress elements have been omitted) and a moderate increase of passenger volumes. Worsening LOS for Alternative 3 reflects higher passenger volumes coupled with the introduction of the egress only stairs that occupy the platform circulation area.

Table 1—Maximum Commuter Rail and Amtrak Platforms Levels-of-Service Comparison

Platform	Existing Condition	No Build Alternative	Alternative 3
A	F	F	F
B	D	C	E
C	D	C	E
D	D	C	E
E	D	C	E
F	C	C	E
G	D	E	F
H	D	-	C
I	-	-	C
J	-	-	C
K	-	-	C

Table 2 compares the LOS experienced on the Red Line Platforms. The analysis indicates that there would be a slight deterioration in LOS associated with Alternative 3 when compared with the No Build Alternative. However, the LOS would still be within a typically acceptable range for a facility of this type during peak conditions.

Table 2—Red Line Platforms Levels-of-Service Comparison

AM and PM Peak Levels-of- Service	Existing Condition		No Build Alternative		Alternative 3	
Platform	AM Peak (LOS)	PM Peak (LOS)	AM Peak (LOS)	PM Peak (LOS)	AM Peak (LOS)	PM Peak (LOS)
Inbound (Northbound)	C	B	C	C	D	C
Outbound (Southbound)	C	D	C	D	D	D

Table 3 compares the LOS experienced on the Silver Line Platforms. The analysis indicates that there would only be a minor change in LOS between the alternatives and that a typically acceptable range would be maintained during peak conditions.

Table 3—Silver Line Platforms Levels-of-Service Comparison

AM and PM Peak Levels-of- Service	Existing Condition		No Build Alternative		Alternative 3	
Platform	AM Peak (LOS)	PM Peak (LOS)	AM Peak (LOS)	PM Peak (LOS)	AM Peak (LOS)	PM Peak (LOS)
Inbound (Northbound)- Zone 1	A	A	A	A	A	A
Inbound (Northbound)- Zone 2	A	A	A	A	A	A
Outbound (Southbound)- Zone 3	B	A	B	A	B	A
Outbound (Southbound)- Zone 4	B	A	C	A	C	A
Outbound (Southbound)- Zone 5	A	A	B	A	B	A
Outbound (Southbound)- Zone 6	A	A	B	A	C	A

Table 4 compares the LOS experienced throughout the passenger concourses. The analysis indicates that the zones within the existing rail head concourse (Z3 and Z4) would be the most congested due to the high volume of passengers circulating or waiting within the space. Alternative 3 would experience the worst LOS in this area despite the significantly expanded rail head concourse. This occurs due to the large increase in passengers compared to the No Build Alternative. Passengers waiting adjacent to the new platforms would experience an acceptable LOS (LOS D or better).

As previously mentioned, Alternative 3 incorporates in its design emergency egress only staircases and passageways. These elements could potentially be expanded to provide connectivity to an elevated concourse that facilitates mid-platform boarding and alighting during normal operations, thereby reducing the overall congestion level on the platforms and concourse.

Table 4—LOS Zone Analysis Comparison

AM and PM Peak Levels-of- Service	Existing Condition		No Build Alternative		Alternative 3	
Zones	AM Peak (LOS)	PM Peak (LOS)	AM Peak (LOS)	PM Peak (LOS)	AM Peak (LOS)	PM Peak (LOS)
Z1	A	B	A	C	A	D
Z2	A	C	A	D	A	D
Z3	A	E	A	D	A	F
Z4	A	D	A	D	A	F
Z5	A	C	A	B	A	B
Z6	A	A	A	A	A	A
Z7	A	C	A	B	A	C
Z8	A	A	A	A	A	A
Z9	A	A	A	A	A	A
Z10	A	A	A	A	A	A
Z11	A	A	A	A	A	A
Z12	A	A	A	A	A	A
Z13	A	A	A	A	A	A
Z14	A	A	A	A	A	A
Z15	A	A	A	A	A	A
Z16	A	A	A	A	A	A
Z17	-	-	A	A	A	A
Z18	-	-	A	A	A	A
Z19	-	-	-	-	A	C
Z20	-	-	-	-	A	C
Z21	-	-	-	-	A	C
Z22	-	-	-	-	A	C
Z23	-	-	-	-	A	D
Z24	-	-	-	-	A	A

Table 5 compares the LOS experienced on the VCEs that provide connections to/from the Subway Mezzanine, Red Line Platforms, and Silver Line Platforms. The analysis indicates that an acceptable LOS would be maintained on all VCEs throughout the AM and PM peaks. VCE 1, that connects the Subway Mezzanine and the South Station Headhouse, would experience a slight deterioration in LOS associated with Alternative 3 when compared with the No Build Alternative. However, the LOS would still be within a typically acceptable range for a facility of this type during peak conditions.

Table 5—Vertical Circulation Analysis Comparison

AM and PM Peak Levels-of-Service	Existing Condition				No Build Alternative				Alternative 3			
Zones	AM Peak (LOS)		PM Peak (LOS)		AM Peak (LOS)		PM Peak (LOS)		AM Peak (LOS)		PM Peak (LOS)	
Direction	DOWN	UP	DOWN	UP	DOWN	UP	DOWN	UP	DOWN	UP	DOWN	UP
VCE 1	B	A	A	B	B	A	A	C	C	A	A	D
VCE 2	A	A	A	A	A	A	A	A	A	A	A	A
VCE 3	A	A	A	A	A	B	A	A	A	B	A	A
VCE 4	A	D	D	A	A	D	D	A	A	D	D	A
VCE 5	A	B	B	A	A	C	B	A	A	C	B	A
VCE 6	B	A	C	A	C	A	C	A	C	A	C	A
VCE 7	A	-	A	-	A	-	A	-	A	-	A	-
VCE 8	A	-	A	-	A	-	A	-	A	-	A	-
VCE 9	-	A	-	A	-	A	-	A	-	A	-	A
VCE 10	-	A	-	A	-	A	-	A	-	A	-	A

3. Ridership Data Assumptions and Methodology

This section describes data assumptions and methodology used to determine the pedestrian volumes within South Station used throughout this analysis.

3.1. Overview

Ridership data for the SSX project were based on existing conditions and the development of 2035 travel demand forecasts provided by the Central Transportation Planning Staff (CTPS) as well as existing conditions and 2035 forecasts for intercity passenger rail provided by Amtrak. The SSX ridership results, detailed in Appendix 9 - *Ridership Forecasting Technical Report,* include existing and projected South Station boardings, alightings, and transfers by mode for four time periods of a typical weekday: AM Peak (6:00 a.m. – 8:59 a.m.), Midday (9:00 a.m. – 2:59 p.m.), PM Peak (3:00 p.m. – 5:59 p.m.), and Night (6:00 p.m. – 5:59 a.m.).

In order to analyze both the morning and evening peak passenger demands at South Station against current and future proposed available capacity, peak hour ridership (broken down into 15-minute increments) was estimated from the peak period ridership results for Existing Conditions, the 2035 No Build Alternative, and 2035 Alternative 3. For commuter rail and Amtrak intercity trains, ridership by train was estimated for those trains scheduled to arrive at or depart from South Station within the peak hour.[2]

To the greatest extent possible, assumptions were based on existing conditions ridership data and counts as well as projections from the CTPS travel demand model. In cases where mode-specific or time-specific data were unavailable, best engineering practices and conservative assumptions were used.

[2] Assumes SSX project Existing Conditions Weekday Schedule, 2035 No Build Alternative Weekday Schedule (Existing Conditions plus additional Fairmount Line service), and 2035 Future Conditions Weekday Schedule developed as a basis for the SSX project DEIR.

The methodology used to develop the morning and evening peak hour ridership data for Existing Conditions, the 2035 No Build Alternative, and 2035 Alternative 3 consisted of the following major steps:

- The peak period ridership results were expanded to account for ridership splits between the various Red Line branches and Silver Line routes that serve South Station, as well as the geographic distribution of arriving/departing pedestrians.
- The station-wide morning and evening peak hour and peak 15-minutes, in terms of ridership, were determined.
- The peak hour boardings, alightings and transfers at South Station were estimated.
- The peak hour ridership estimates were further broken down into estimated boardings, alightings and transfers in 15-minute increments.

3.2. Expansion of Peak Period Ridership Results

3.2.1. Red Line Ridership

A detailed breakdown of peak period Red Line boardings was prepared in order to account for the potential that some passengers might board the next train that arrives at the station platform, whereas others might wait for the arrival of a branch-specific Red Line train (Ashmont or Braintree). Red Line ridership was split into Northbound versus Southbound ridership, as well as boardings destined for the Red Line trunk (Alewife to JFK/UMass), Red Line Ashmont branch, or Red Line Braintree branch, based on existing conditions data provided by the MBTA.

3.2.2. Silver Line Ridership

A detailed breakdown of peak period Silver Line boardings was prepared in order to account for the potential that some passengers might board the next bus that arrives at the station platform, whereas others might wait for the arrival of a route-specific Silver Line bus (Silver Line 1, Silver Line 2, or the permitted Silver Line Gateway). Silver Line boardings at South Station were broken down into Silver Line 1, Silver Line 2, Silver Line Waterfront Shuttle, and Silver Line Gateway boardings based on the results of the CTPS travel demand model. The CTPS travel demand model was also used to estimate the percent of passengers boarding the Silver Line at South Station destined for stations along the Silver Line trunk (South Station to Silver Line Way), the Silver Line 1 route beyond Silver Line Way, the Silver Line 2 route beyond Silver Line Way, or the Silver Line Gateway route beyond Silver Line Way.

3.2.3. Geographic Distribution of Arriving/Departing Pedestrians

Pedestrian access/egress was broken down to account for the geographic distribution of pedestrians arriving from/going to surrounding neighborhoods immediately to the north, south, east or west of South Station. The geographic distribution assumed an average daily geographic split of passengers arriving from/going to the neighborhoods immediately surrounding South Station from the CTPS travel demand model. Modeled data for the Silver Line were used to develop the geographic distribution of Silver Line passengers arriving from/going to the neighborhoods surrounding South Station. An average geographic distribution based on modeled data for the Red Line and commuter rail was used to estimate the geographic distribution for all other modes.

3.3. Determination of the Peak Hour and Peak 15 Minutes

Passenger counts of the Red Line, Silver Line and commuter rail conducted by CTPS at South Station between 2012 and 2013 were used to determine the existing station-wide morning and evening peak hour and peak 15 minute periods. The Existing Conditions AM peak hour was identified as 8:00-8:59 a.m., with the peak 15 minutes occurring between 8:15 – 8:29 a.m. The Existing Conditions PM peak hour was identified as 5:00-5:59 p.m., with the peak 15 minutes occurring between 5:00-5:14 p.m.

3.4. Estimation of Peak Hour Ridership

It was assumed that 40% of the three hour peak period ridership would occur within the peak hour for all modes, except for commuter rail and Amtrak intercity rail peak hour ridership, which was estimated according to the following methodology.[3]

3.4.1. Existing Conditions Peak Hour Commuter Rail and Amtrak Ridership

Existing commuter rail and Amtrak intercity ridership by train was calculated for the station-wide peak hour definitions (8:00 – 8:59 a.m. and 5:00 – 5:59 p.m.) based on data from the 2012 MBTA Commuter Rail Passenger Counts and FY 2012 data provided by Amtrak, respectively.

3.4.2. 2035 No Build Alternative Peak Hour Commuter Rail and Amtrak Ridership

For the 2035 No Build Alternative, MBTA Fairmount Line ridership was estimated based on the percent increase in daily Fairmount Line system ridership between 2012 Existing Conditions and the 2035 No Build Alternative, established from the CTPS travel demand model. For inbound and outbound trains, total estimated peak hour Fairmount Line ridership was divided evenly amongst the Fairmont Line trains operating in the peak hour. In order to estimate the 2035 No Build Alternative commuter rail ridership by train for all other lines, the existing commuter rail counts were adjusted based on the percent increase in peak period commuter rail ridership between 2012 Existing Conditions and the 2035 No Build Alternative from the results in Appendix 9 - *Ridership Forecasting Technical Report*.[4]

Amtrak ridership by train from 2012 to the 2035 No Build Alternative was assumed to grow at an annual rate of approximately 1.2%, reflecting Amtrak's inability to provide substantial additional seating until new rail service is implemented and the fact that the NEC has many existing infrastructure constraints that threaten to constrain the 2.7% average annual intercity growth rate experienced across the NEC over the past fifteen years.

3.4.3. 2035 Alternative 3 Peak Hour Commuter Rail and Amtrak Ridership

The commuter rail service plan for 2035 Alternative 3 consists of increased frequencies on the Fairmount Line; South Coast Rail service; and additional peak period, peak direction trains on the Needham, Franklin, Providence, and Worcester/Framingham Lines. In the AM peak hour, total peak direction commuter rail ridership was assumed to equal approximately 60% of the total AM peak period, peak direction ridership, as provided in Appendix 9 - *Ridership Forecasting Technical Report.* In the PM peak hour, total peak direction commuter rail ridership was assumed to equal approximately 70% of the total PM peak period, peak direction ridership, as provided in Appendix 9 - *Ridership Forecasting Technical Report.* Peak direction South Coast Rail ridership by train was estimated based on results from the South

[3] A peak hour/peak period ratio of 0.40 is consistent with the standard system-wide benchmark established by CTPS from an historical examination of Boston area rapid transit lines.
[4] Calculated less estimated peak hour Fairmount Line ridership.

Coast Rail Study for the 2035 Stoughton Electric alternative. The estimated AM peak hour and PM peak hour South Coast Rail ridership was divided evenly amongst the South Coast Rail trains operating in the AM peak and PM peak hours, respectively. Peak direction commuter rail ridership for all other lines was estimated based on the ridership demand distributions from the Existing Conditions data and the 2035 No Build Alternative estimates. Ridership for new peak direction trains was assumed to equal the average of ridership from the preceding and following route-specific trains.

In the non-peak direction, all peak hour commuter rail ridership growth between the 2035 No Build Alternative and 2035 Alternative 3 was assumed to be attributable to the new South Coast Rail trains. To establish the growth in peak hour commuter rail ridership, the peak period percentage growth in ridership between the 2035 No Build Alternative and 2035 Alternative 3 was applied.

Amtrak ridership by train was based on the 2035 future year projections provided by Amtrak and included in Appendix 9 - *Ridership Forecasting Technical Report*.

3.5. Breakdown of Peak Hour Ridership into 15-Minute Increments

Using data from the South Station pedestrian and passenger counts conducted by CTPS between November 2012 and January 2013, mode-to-mode factors were first developed for the Existing Conditions AM peak 15-minutes (8:15 – 8:29 a.m.) and PM peak 15-minutes (5:00 – 5:14 p.m.) in order to convert the peak hour mode-to-mode transfer data into peak 15-minute ridership data. The peak 15-minute factors developed from the Existing Conditions data were also used to convert peak hour ridership data for the 2035 future year scenarios into peak 15-minute estimates. The difference between the peak hour and peak 15-minute ridership data was split evenly amongst the three non-peak 15 minute periods within the peak hour.

Next, commuter rail and Amtrak intercity rail ridership by train for each 15-minute increment was incorporated into the mode-to-mode ridership data. Transfers to/from the commuter rail and Amtrak intercity rail modes were distributed according to peak period mode-to-mode distributions calculated from the ridership results provided in Appendix 9 - *Ridership Forecasting Technical Report.* Lastly, a balancing process was applied to the transfers to/from the commuter rail and Amtrak intercity rail modes for each of the 15-minute increment ridership estimates.

4. Analysis Methodology

Several metrics were established to estimate station effectiveness in accommodating ridership, and to provide a basis of comparison among existing conditions and future conditions. The analysis focused on three main areas: platforms, concourses, and vertical circulation.

For the purposes of this analysis, Fruin Levels of Service (LOS)[5] have been used to benchmark the practical capacity of the station elements. LOS C is typically considered an average design standard for the peak 15-minute period in train stations, with small periods of LOS D being acceptable.

[5] Fruin, John J. *Pedestrian Planning and Design.* 1987.

Table 6—Fruin Level of Service Definition

Level-of-Service		Description
Excellent	A	Walking speeds freely selected; conflicts with other pedestrians unlikely.
Good	B	Walking speeds freely selected; pedestrians respond to presence of others.
Average	C	Walking speeds freely selected; passing is possible in unidirectional streams; minor conflicts for reverse or cross movement.
Acceptable	D	Freedom to select walking speed and pass others is restricted; high probability of conflicts for reverse or cross movements.
Poor	E	Walking speeds and passing ability are restricted for all pedestrians; forward movement is possible only by shuffling; reverse or cross movements are possible only with extreme difficulty; volumes approach limit of walking capacity.
Very Poor	F	Walking speeds are severely restricted; frequent, unavoidable contact with others; reverse or cross movements are virtually impossible; flow is sporadic and unstable.

Source: *Transit Capacity and Quality of Service Manual (TCRP Report 100)*

To be consistent with the South Station Air Rights (SSAR) Final EIR analysis, the following LOS ranges have been adopted for calculation of LOS of multi-activity passenger circulation areas which involve both walking and standing pedestrians.

Table 7—Ratio of Level-of-Service Demand to Design Capacity (Concourses)

Level-of-Service	Ratio
LOS A	0.0 - 0.3
LOS B	0.3 - 0.6
LOS C	0.6 - 1.0
LOS D	1.0 - 1.3
LOS E	1.3 – 1.6
LOS F	1.6+

4.1. Platforms

The pedestrian circulation analysis for the LOS on the platforms was undertaken using the methodology that would be applied to any standard walkway analysis. For the AM peak period volumes, it was assumed that it would take passengers approximately two minutes to empty out the coaches and proceed along the platform.

To calculate the effective width of the platform, a standard 1.5 feet was deducted from either side thereby reducing the total platform width by three feet.[6] Where platform impediments were present, the width of the same were also deducted and an additional one foot on either side of the impediment was deemed not to be conducive for walking and hence a total of another two feet was deducted to calculate the effective width.

Passenger loads have been assigned to zones along the platform to coincide with the length of each coach/locomotive and the cumulative loads at each of the zones was used to calculate the total pedestrian volumes. It was assumed that walking speed would be an average of 4.4 feet per second.[7] Using the above mentioned information, the pedestrian LOS was calculated at each of the platform zones starting at the

[6] The methodology used to determine the effective width available is described in the *Transit Capacity and Quality of Service Manual (TCRP Report 100)*. Studies have shown that pedestrians keep as much as an 18 inch buffer between themselves and adjacent walls, street curbs, platform edges, and other obstructions, such as trash receptacles, sign posts, and so forth. In practice, the width of the unused buffer depends on the character of the wall or obstruction, the overall width of the available walkway, and on the level of pedestrian congestion. In general, 18 inches has been deducted next to walls and platform edges and 12 inches has been deducted next to other obstructions, including walls up to three feet tall.

[7] Average walking speeds assumed for the calculations are based on observations cited in *Pedestrian, Planning and Design* by John Fruin. Pedestrian speeds of 270, 254 and 265 feet per minute (4.50, 4.23, 4.42 feet per second) were observed for 1000 non-baggage carrying male, female and combined passengers respectively at the Port Authority Bus Terminal and Pennsylvania Station in New York.

south and moving towards the north to account for the general direction of the passenger flow and to take into account the increasing volume of pedestrians on the platform as passengers alight and head to their destinations.

For the PM peak period calculation, passenger activity was analyzed in 15 minute increments. However, surge volumes are anticipated within each 15 minute increment due to specific train schedules. It is assumed that approximately 60% of the total passengers for each train would board the train within the first five minutes of its availability. This has been done to take into account the initial surge that is generally observed of the passenger flows at terminal stations. It was assumed that 60% of the passengers would be equally divided amongst the different coaches assigned to each of the trains.

To account for the pedestrian flow, the LOS is calculated from the north to the south thereby taking into account the passengers that leave the platform and board the train.

Passenger flow rates were calculated at each of the platforms zones and expressed as a number of pedestrians per minute per feet of effective width. The results were compared to the standardized LOS benchmarks as illustrated in *Transit Capacity and Quality of Service Manual (TCRP Report 100)* Exhibit 7-3 to obtain the LOS.

4.2. Concourses

The methodology used to determine the LOS for the concourse spaces is based on the methodology described in the *Transit Capacity and Quality of Service Manual (TCRP Report 100).* For the purposes of this analysis, the concourses include the waiting/circulation area within the existing headhouse, the rail head concourse, and the subway mezzanine.

The space required for a particular activity is represented by the formula:

$$TS_{req} = \Sigma\, P_i \times S_i \times T_i$$

where:

TS_{req} = time-space required (ft^2-s);

P_i = number of people involved in activity i;

S_i = space required for activity i (ft^2); and

T_i = time required for activity i (s).

The total time space requirements of all of the activities are then compared with the time-space available, represented by the formula:

$$TS_{avail} = S_{avail} \times T_{avail}$$

where:

TS_{avail} = time-space available (ft^2-s);

S_{avail} = space available within the area analyzed (ft^2); and

T_{avail} = time available as defined for the analysis period (s).

The approach of applying the time-space analysis involved the following steps:

1. Establish pedestrian origins and destinations within and at the edges of the space analyzed.
2. Assign pedestrian routes through the pedestrian network for each origin-destination pair.
3. Sum the volumes of persons passing through each analysis zone.
4. Identify the walking time within each zone for pedestrians. This may vary depending on their route through each zone.
5. Determine the percentage of people passing through each zone who stop and dwell in that zone to wait for a train.
6. Determine the time spent dwelling in each zone waiting for a train.
7. Calculate the time-space demand by multiplying the number of persons passing through and waiting for a train by the respective space needed for them.
8. Calculate the time-space available by multiplying the usable floor area by the duration of the analysis period.
9. Calculate the demand-supply ratio by dividing time-space demand by time-space available.
10. Apply an LOS based on ranges of demand-supply ratios.

During the PM peak period pedestrian circulation analysis, 30% of pedestrian volumes within the waiting area analysis zones (Z1, Z2, Z3, Z4, Z5 and Z7) have been assigned a dwell time of approximately five minutes to account for passenger waiting prior to a train announcement. The remainder proceed directly to their train's assigned platform.

4.3. Vertical Circulation

The LOS for vertical circulation (stairs and escalators) was calculated based on the Volume/SVCD (service volume between LOS C and D) design capacity ratio. The threshold between LOS C and LOS D at a volume to capacity (v/c) ratio of 1.00 has been assumed to be the minimum acceptable standard for pedestrian conditions on stairways. Where adjacent stairs and escalators form a system, the capacity of the escalator has been added to the stair capacity.

Table 8—Ratio of Level-of-Service Demand to Design Capacity (Vertical Circulation)

Level-of-Service	LOS Volume/SVCD Ratio
LOS A	< 0.45
LOS B	> 0.45 to > 0.70
LOS C	> 0.70 to > 1.00
LOS D	> 1.00 to > 1.33
LOS E	> 1.33 to > 1.67
LOS F	> 1.67

Source: Metropolitan Transportation Authority/New York City Transit. *South Ferry Terminal Project: 5.9 Transportation & Pedestrian Circulation*. May 2004, page 5-40.

5. Findings

5.1. Existing Conditions

The existing South Station site includes the following: South Station rail, South Station rapid transit (subway), South Station Bus Terminal, and the USPS General Mail Facility/South Postal Annex, including that portion of Dorchester Avenue fronting the site and running parallel to the Fort Point Channel.

Figure 1 illustrates the South Station terminal area, which currently consists of the historic headhouse/concourse, 13 tracks, and eight platforms. Figure 2 illustrates the subway, which consists of a mezzanine level leading to two side platforms serving the Red Line and two side platforms serving the Silver Line. The bus terminal concourse located above the existing commuter rail platforms is not included in this analysis.

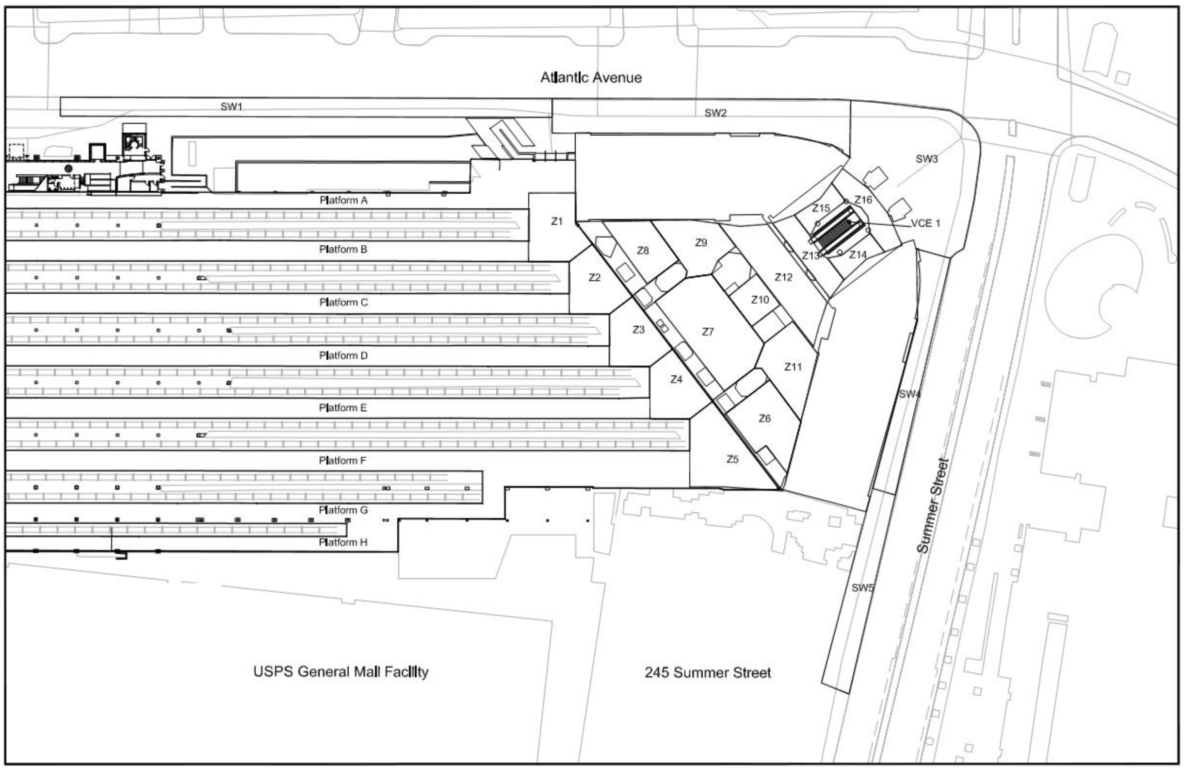

Figure 1—Existing Conditions - Commuter Rail and Amtrak Analysis Zones and Vertical Circulation

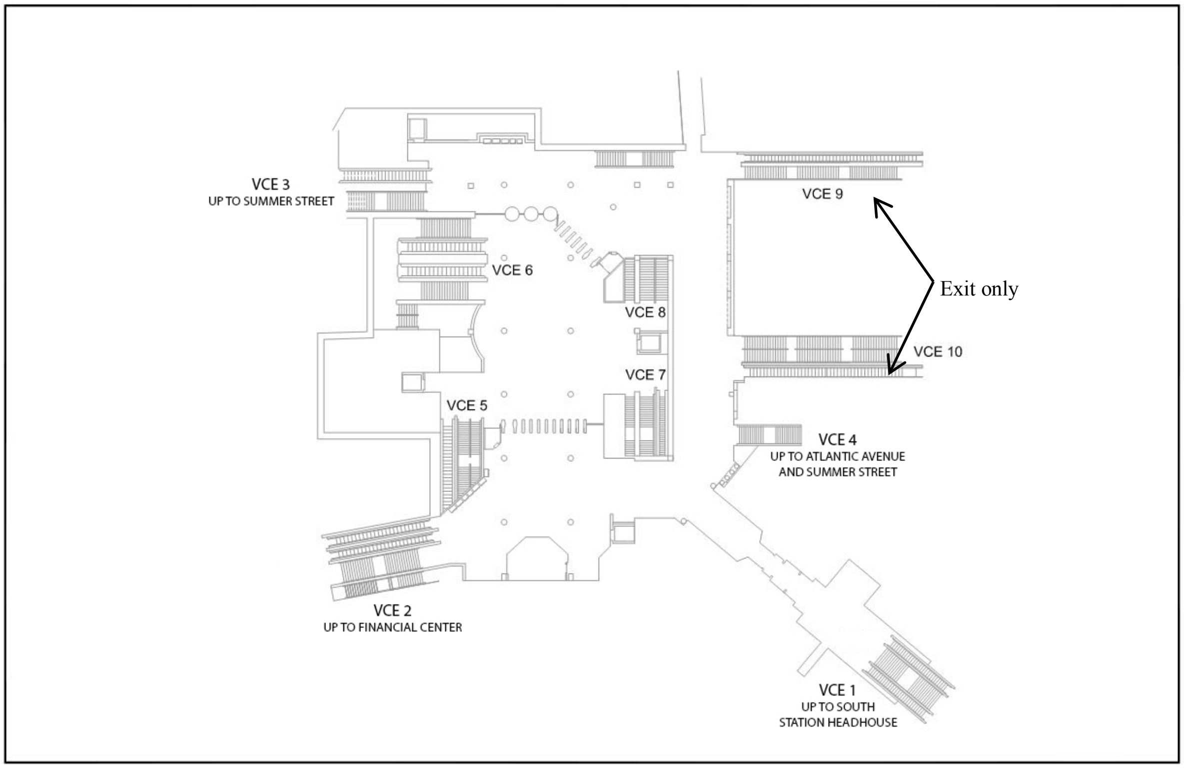

Figure 2—Existing Conditions – Subway Mezzanine Level Vertical Circulation

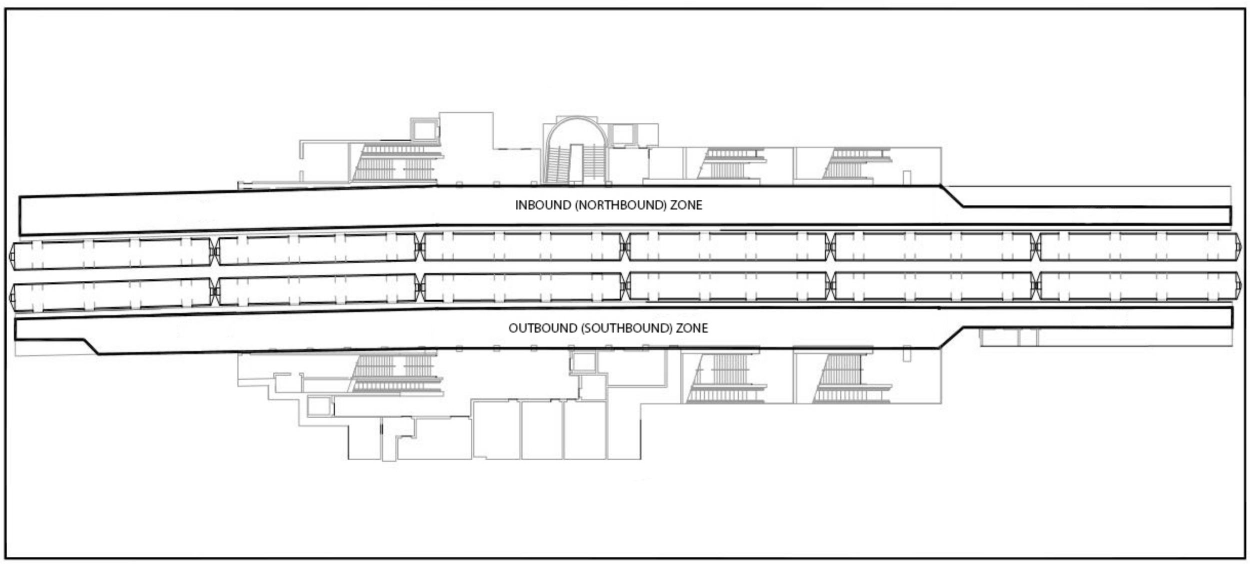

Figure 3—Existing Conditions – Red Line Platforms Analysis Zones

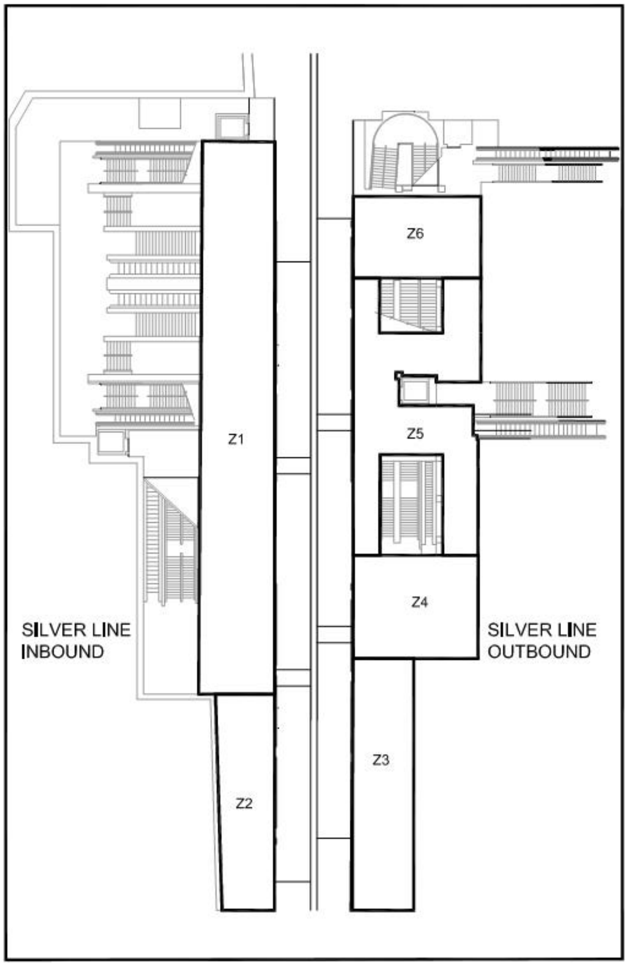

Figure 4—Existing Conditions – Silver Line Platform Analysis Zones

5.1.1. Platforms

Table 9 summarizes the LOS ranges for the commuter rail and Amtrak platforms based on the maximum occupancy (723 passengers) of a single peak train derived from the Existing Conditions ridership and train schedules.

The analysis for Platform A assumed a worst case condition whereby all passengers exited via the northern end of the platform. No passengers were siphoned off to use the exit directly onto Atlantic Avenue adjacent to the edge of the bus terminal.

The analysis indicates that the southern end of the platforms would experience the best LOS (LOS A/B). However, as the cumulative volume of passengers traverse the northern end of Platform A, the LOS can reach LOS F.

The northern end of Platform F is wider than the rest of the platform and this localized zone has trains berthing along its western edge only. The eastern edge coincides with the periphery of the South Station building. This difference in geometry and train service leads to an improved LOS at the northern zones of Platform F as compared to the zones located at the middle of Platform F.

Table 9—Existing Conditions Commuter Rail and Amtrak Platforms Levels-of-Service: Peak Single Train Load (723 Passengers)

Platform	Platform Analysis Zone Adjacent to Coach Number (North End to South End)								
	1	2	3	4	5	6	7	8	Maximum
A	F	F	D	C	B	A			F
B	D	C	C	B	A	A			D
C	D	C	C	B	A	A			D
D	D	C	C	B	A	A			D
E	D	C	C	B	A	A			D
F	B	B	C	C	B	A			C
G	D	D	C	C	B	A			D
H	D	D	C	C	B	A			D

Table 10 summarizes the LOS ranges for the Red Line platforms based on the Existing Conditions ridership and train frequencies. The analysis indicates that an average LOS is maintained throughout the AM peak. During the PM peak, the LOS deteriorates to LOS D.

Table 10—AM and PM Peak Existing Conditions: Red Line Platforms Levels-of-Service

Platform	AM Peak (LOS)	PM Peak (LOS)
Inbound (Northbound)	C	B
Outbound (Southbound)	C	D

Table 11 summarizes the LOS ranges for the Silver Line platforms based on the Existing Conditions ridership and bus frequencies. The analysis indicates that a good LOS is maintained throughout the AM and PM peaks (LOS A/B). Since no passengers get on the Silver Line service at the inbound platform, the LOS on this platform is calculated solely based on the space requirements associated with the time taken for the passengers to exit from the platform. For the outbound platform, it is assumed that the wait period would be an average of 2.5 minutes for this alternative.

Table 11—AM and PM Peak Existing Conditions: Silver Line Platforms Levels-of-Service

Platform	AM Peak (LOS)	PM Peak (LOS)
Inbound (Northbound)- Zone 1	A	A
Inbound (Northbound)- Zone 2	A	A
Outbound (Southbound)- Zone 3	B	A
Outbound (Southbound)- Zone 4	B	A
Outbound (Southbound)- Zone 5	A	A
Outbound (Southbound)- Zone 6	A	A

5.1.2. Concourses

Table 12 summarizes the LOS ranges for the Existing Conditions analysis zones within the headhouse and rail head concourse during the AM peak as the majority of pedestrians are exiting the station to street or interchanging with another mode. During the PM peak, a large volume of pedestrians wait within Z1, Z2, Z3, Z4, Z5 and Z7 for their train to be announced. This results in significant congestion at the rail head concourse (LOS E maximum) and minor congestion beneath the train announcement board with the headhouse (LOS C).

Table 12—AM and PM Peak Existing Conditions: LOS Zone Analysis

Zone	AM Peak (LOS)	PM Peak (LOS)
Z1	A	B
Z2	A	C
Z3	A	E
Z4	A	D
Z5	A	C
Z6	A	A
Z7	A	C
Z8	A	A
Z9	A	A
Z10	A	A
Z11	A	A
Z12	A	A
Z13	A	A
Z14	A	A
Z15	A	A
Z16	A	A

5.1.3. Vertical Circulation

Table 13 summarizes the LOS ranges for the VCEs associated with the subway. The analysis indicates that an acceptable LOS would be experienced on all VCEs during the Existing Conditions AM and PM peak (LOS D maximum).

Table 13—AM and PM Peak Existing Conditions: Vertical Circulation Analysis

Vertical Circulation Element (VCE)	AM Peak (LOS) Down	AM Peak (LOS) Up	PM Peak (LOS) Down	PM Peak (LOS) Up
VCE 1	B	A	A	B
VCE 2	A	A	A	A
VCE 3	A	A	A	A
VCE 4	A	D	D	A
VCE 5	A	B	B	A
VCE 6	B	A	C	A
VCE 7	A	-	A	-
VCE 8	A	-	A	-
VCE 9	-	A	-	A
VCE 10	-	A	-	A

5.2. No Build Alternative

The No Build Alternative represents a future baseline condition against which the Build Alternatives are compared. As Figure 5 illustrates, with the No Build Alternative, South Station, including the headhouse and track operations, and the USPS General Mail Facility, would remain as they currently exist. The majority of Dorchester Avenue at the site would remain in private use by the USPS in support of USPS operations. Extending from the southern line of Summer Street, the MBTA would continue to maintain a permanent easement along Dorchester Avenue for pedestrians and vehicles of over approximately 200 feet. Generally unrestricted public access would continue to be provided along Dorchester Avenue of over approximately 400 feet for customer use of USPS facilities.

With the No Build Alternative, there would be no private development associated with South Station beyond the development previously approved by the Massachusetts EEA: the South Station Air Rights

(SSAR) project. The SSAR project was approved by the Secretary of EEA in 2006 (EEA Number 3205/9131) as an approximate 1.8 million sf mixed-use development to be located directly above the railroad tracks at the South Station headhouse. The SSAR project also includes a horizontally expanded bus terminal of approximately 70,000 square feet, pedestrian connections from the train station concourse and platforms to the expanded bus terminal, and a 3-level parking garage with 775 spaces located above the bus terminal.

With the No Build Alternative, the Widett Circle site would remain in private development. The Beacon Park Yard site would remain largely the same as today, with the exception of highway reconfiguration of the Massachusetts Turnpike to the north of the site and MBTA Worcester Line track improvements to the south of the site. The MBTA would continue to use Readville – Yard 2 to provide layover space for 10 trainsets.

The No Build Alternative would maintain a similar level of rail service as exists today, but would also provide increased frequencies on the Fairmount Line.

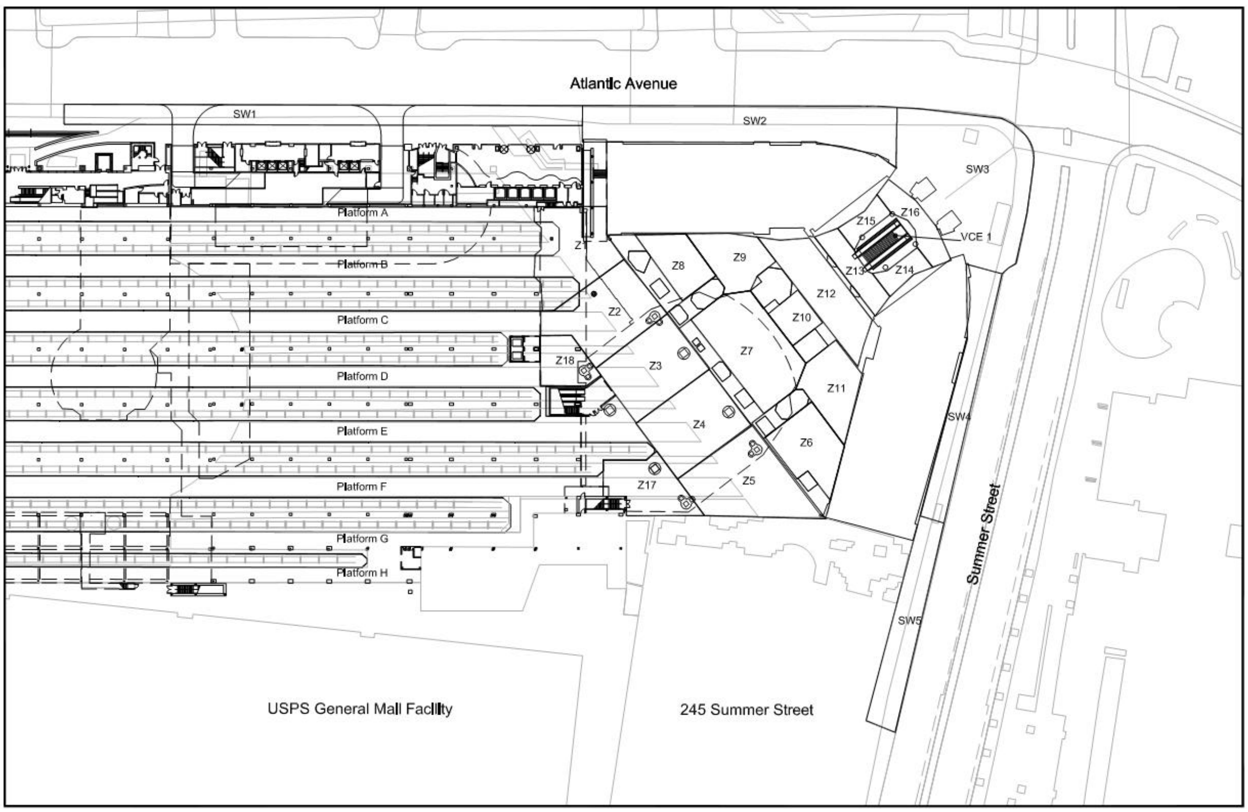

Figure 5—No Build Alternative - Commuter Rail and Amtrak Analysis Zones and Vertical Circulation

5.2.1. Platforms

Table 14 summarizes the LOS ranges for the commuter rail and Amtrak platforms based on the maximum occupancy (839 passengers) of a single peak train derived from the No Build Alternative ridership and train schedules. The analysis indicates that the southern end of the platforms would experience the best LOS (LOS A/B-C). However, as the cumulative volume of passengers traverse the northern end of the platforms, the LOS would reach F and E for platform A and G, respectively. The other platforms would experience a LOS of C, a condition which can be expected to be reasonable for a commuter train station.

The reduced LOS on platform A and G can be explained by their reduced width and the multiple impediments which further reduce the effective width of the platforms.

Table 14—No Build Alternative Commuter Rail and Amtrak Platforms Levels-of-Service: Peak Single Train Load (839 Passengers)

Platform	Platform Analysis Zone Adjacent to Coach Number (North End to South End)								
	1	2	3	4	5	6	7	8	Maximum
A	F	E	D	C	C	A			F
B	C	C	C	B	B	A			C
C	C	C	C	B	B	A			C
D	C	C	C	B	B	A			C
E	C	C	C	B	B	A			C
F	C	C	C	B	B	A			C
G	E	D	D	C	C	A			E
H	**								

** Platform H requires coordination with the SSAR project's egress plans. It is expected that Platform H will perform in a similar fashion as the adjacent Platform G.

Table 15 summarizes the LOS ranges for the Red Line platforms based on the No Build Alternative ridership and train frequencies. The analysis indicates that an average LOS would be maintained throughout the AM peak. During the PM peak, the LOS would deteriorate to LOS D. The increase in ridership associated with the No Build Alternative would result in a slightly reduced LOS when compared to the Existing Condition (LOS C or worse versus LOS B or worse, respectively).

Table 15—AM and PM Peak No Build Alternative: Red Line Platforms Levels-of-Service

Platform	AM Peak (LOS)	PM Peak (LOS)
Inbound (Northbound)	C	C
Outbound (Southbound)	C	D

The configurations of the No Build Alternative Red Line platforms are the same as the Existing Conditions. Refer to Figure 3 for analysis zone locations.

Table 16 summarizes the LOS ranges for the Silver Line platforms based on the No Build Alternative ridership and bus frequencies. The analysis indicates that a good LOS would be maintained throughout the AM and PM peaks (LOS C or better, with most platform areas experiencing LOS A/B). Since no passengers get on the Silver Line service at the inbound platform, the LOS on this platform is calculated solely based on the space requirements associated with the time taken for the passengers to exit from the platforms. For the outbound platforms it is assumed that the wait period would be an average of 2.5 minutes for this alternative.

Table 16—AM and PM No Build Alternative: Silver Line Platforms Levels-of-Service

Platform	AM Peak (LOS)	PM Peak (LOS)
Inbound (Northbound)- Zone 1	A	A
Inbound (Northbound)- Zone 2	A	A
Outbound (Southbound)- Zone 3	B	A
Outbound (Southbound)- Zone 4	C	A
Outbound (Southbound)- Zone 5	B	A
Outbound (Southbound)- Zone 6	B	A

The configurations of the No Build Alternative Silver Line platforms are the same as the Existing Conditions. Refer to Figure 4 for analysis zone locations.

5.2.2. Concourses

Table 17 summarizes the LOS ranges for the No Build Alternative analysis zones within the headhouse and expanded rail head concourse beneath the SSAR project. The analysis indicates that a good level LOS (LOS A) is experienced during the AM peak as the majority of pedestrians are exiting the station to street or interchanging with another mode. During the PM peak, a large volume of pedestrians wait within Z1, Z2, Z3, Z4, Z5 and Z7 for their train to be announced. As a result of the significantly expanded rail head concourse, the LOS experienced by waiting passengers in the No Build Alternative would improve when compared to the Existing Conditions (LOS D or better versus LOS E or better, respectively). This is still greater than the typical target LOS C assumed for a facility of this type.

Table 17—AM and PM Peak No Build Alternative: LOS Zone Analysis

Zone	AM Peak (LOS)	PM Peak (LOS)
Z1	A	C
Z2	A	D
Z3	A	D
Z4	A	D
Z5	A	B
Z6	A	A
Z7	A	B
Z8	A	A
Z9	A	A
Z10	A	A
Z11	A	A
Z12	A	A
Z13	A	A
Z14	A	A
Z15	A	A
Z16	A	A
Z17	A	A
Z18	A	A

5.2.3. Vertical Circulation

Table 18 summarizes the LOS ranges for the VCEs associated with the subway. The analysis indicates that the VCE LOS would be slightly worse during the No Build Alternative AM peak when compared with the Existing Conditions. Despite this reduction, an acceptable LOS is maintained throughout the AM and PM peaks.

Table 18—AM and PM Peak No Build Alternative: Vertical Circulation Analysis

Vertical Circulation Element (VCE)	AM Peak (LOS) Down	AM Peak (LOS) Up	PM Peak (LOS) Down	PM Peak (LOS) Up
VCE 1	B	A	A	C
VCE 2	A	A	A	A
VCE 3	A	B	A	A
VCE 4	A	D	D	A
VCE 5	A	C	B	A
VCE 6	C	A	C	A
VCE 7	A	-	A	-
VCE 8	A	-	A	-
VCE 9	-	A	-	A
VCE 10	-	A	-	A

5.3. Alternative 3 – Joint/ Private Development Maximum Build

Alternative 3 would include the previously-approved SSAR project described in the No Build Alternative. In addition, South Station would be expanded onto the adjacent 16-acre USPS property. MassDOT would acquire and demolish the USPS General Mail Facility/South Postal Annex. The existing South Station Terminal would be expanded, consisting of an expanded passenger concourse and passenger support services. Capacity improvements would include construction of up to seven tracks and four platforms (including widening of one existing platform), for a total of 20 tracks and 11 platforms, as shown in Figure 6.

In Alternative 3, the potential for future private development at the South Station site could include approximately 2.1 million square feet of mixed-use development along Dorchester Avenue, consisting of residential, office, and commercial uses, including retail and hotel uses, with building heights up to approximately 26 stories. Development could include approximately 507 parking spaces.

The future commuter rail service plan for Alternative 3 would include South Coast Rail commuter rail service; additional peak period, peak direction trains on the Needham, Franklin, Providence, and Worcester/Framingham Lines; and increased frequencies on the Fairmount Line.

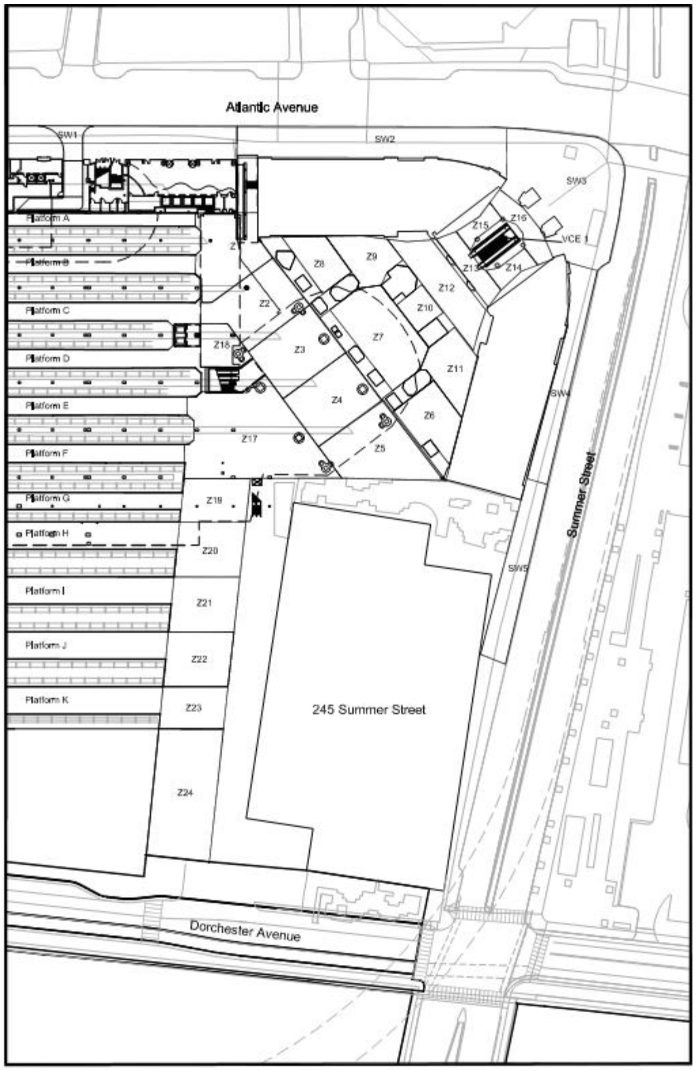

Figure 6—Alternative 3 - Commuter Rail and Amtrak Analysis Zones and Vertical Circulation

Alternative 3 incorporates in its design emergency egress only staircases and passageways located above the southern half of the existing and proposed platforms. These elements could potentially be expanded to provide connectivity to an elevated concourse that facilitates mid-platform boarding and alighting during normal operations, thereby reducing the overall congestion level on the platforms and concourse. However, that connection is not assumed in this analysis.

5.3.1. Platforms

Table 19 summarizes the LOS ranges for the commuter rail and Amtrak platforms based on the maximum occupancy (1,092 passengers) of a single peak train derived from the Alternative 3 ridership and train schedules. The analysis indicates that the southern end of the platforms would experience the best LOS (LOS A) across all the platforms. The presence of staircases on the existing platforms leads to rapid deterioration of the LOS due to the reduced circulation space left on either side of the staircase for walking. Platform areas beyond (north) the staircase show improvement in the LOS due to the absence of such an impediment (staircase), but at the northern end the LOS starts a downward dip again as all alighting passengers try to exit the platform at its north end resulting in a congested condition. The condition for the new platforms would be better primarily because of the extra platform width. For three of the four new platforms, the train passengers would encounter only one staircase. The combined factor of the extra platform width along with staircases being located at the southern ends of the platforms (such that few passengers would be passing them) helps maintain LOS B.

Table 19—Alternative 3 Commuter Rail and Amtrak Platforms Levels-of-Service: Peak Single Train Load (1092 Passengers)

Platform	Platform Analysis Zone Adjacent to Coach Number (North End to South End)								
	1	2	3	4	5	6	7	8	Maximum
A	F	E	E	D	D	C	C	A	F
B	D	D	C	C	C	E	D	A	E
C	D	D	C	C	C	E	D	A	E
D	D	D	C	C	C	E	D	A	E
E	D	D	C	C	C	E	D	A	E
F	D	D	C	C	C	E	D	A	E
G	E	E	E	D	D	F	E	A	F
H	C	C	C	C	B	B	A	A	C
I	C	C	C	C	B	B	A	A	C
J	C	C	C	C	B	B	A	A	C
K	C	C	C	C	B	B	A	A	C

Table 20 summarizes the LOS ranges for the Red Line platforms based on the Alternative 3 ridership and train frequencies. The analysis indicates that the increase in ridership associated with Alternative 3 would result in a reduced LOS when compared to the No Build Alternative (LOS D or better for the AM and PM peaks versus LOS C or better during the AM peak and LOS D or better during the PM peak, respectively).

Table 20—AM and PM Peak Alternative 3: Red Line Platforms Levels-of-Service

Platform	AM Peak (LOS)	PM Peak (LOS)
Inbound (Northbound)	D	C
Outbound (Southbound)	D	D

The configurations of the Alternative 3 Red Line platforms are the same as the Existing Conditions. Refer to Figure 3 for analysis zone locations.

Table 21 summarizes the LOS ranges for the Silver Line platforms based on the Alternative 3 ridership and bus frequencies. The analysis indicates that the Alternative 3 LOS would be reduced on Zone 6 of the Outbound Platform when compared to the No Build Alternative (LOS C or better versus LOS B or better, respectively). Despite the LOS reduction, the platforms still would achieve uninterrupted flow of passengers.

Since no passengers get on the Silver Line service at the inbound platform, the LOS on this platform is calculated solely based on the space requirements associated with the time taken for the passengers to exit from the platform. For the outbound platform it is assumed that the wait period would be an average of 2.5 minutes for this alternative.

Table 21—AM and PM Alternative 3: Silver Line Platforms Levels-of-Service

Platform	AM Peak (LOS)	PM Peak (LOS)
Inbound (Northbound)- Zone 1	A	A
Inbound (Northbound)- Zone 2	A	A
Outbound (Southbound)- Zone 3	B	A
Outbound (Southbound)- Zone 4	C	A
Outbound (Southbound)- Zone 5	B	A
Outbound (Southbound)- Zone 6	C	A

The configurations of the Alternative 3 Silver Line platforms are the same as the Existing Conditions. Refer to Figure 4 for analysis zone locations.

5.3.2. Concourses

Table 22 summarizes the LOS ranges for the Alternative 3 analysis zones within the headhouse, expanded rail head concourse beneath the SSAR project, and new rail head concourse adjacent to the northern end of the new platforms. It has been assumed that the new rail head concourse would act in a similar way to the existing rail head concourse, whereby pedestrians both wait and circulate within the space. To be realistic, the analysis assumes that approximately 30% of the pedestrians passing through the rail head concourse would ultimately wait/pause in one of the zones. The average time assigned to this wait period is three minutes for the new rail head concourse and five minutes for the existing rail head concourse. The assigned wait period times reflect the level of weather protection and proximity to retail.

The analysis indicates that a good level LOS (LOS A) would be experienced during the AM peak as the majority of pedestrians are exiting the station to street or interchanging with another mode. During the PM peak, a large volume of pedestrians wait within the expanded rail head concourse for their train to be announced. Despite the significantly expanded rail head concourse, passengers waiting within zones Z3 and Z4 would experience a very poor LOS. Passengers within zones Z19, Z20, Z21, Z22 and Z23 adjacent to the new platforms would experience an acceptable LOS (LOS D or better). This reflects the realistic condition where a certain number of passengers would wait in this area.

Table 22—AM and PM Alternative 3: LOS Zone Analysis

Zone	AM Peak (LOS)	PM Peak (LOS)
Z1	A	D
Z2	A	D
Z3	A	F
Z4	A	F
Z5	A	B
Z6	A	A
Z7	A	C
Z8	A	A
Z9	A	A
Z10	A	A
Z11	A	A
Z12	A	A
Z13	A	A
Z14	A	A
Z15	A	A
Z16	A	A
Z17	A	A
Z18	A	A
Z19	A	C
Z20	A	C
Z21	A	C
Z22	A	C
Z23	A	D
Z24	A	A

5.3.3. Vertical Circulation

Table 23 summarizes the LOS ranges for the VCEs associated with the subway. The analysis indicates that the VCE LOS for Alternative 3 would be slightly worse as compared to the No Build Alternative. Despite this reduction, an acceptable LOS would be maintained throughout the AM and PM peaks.

Table 23—AM and PM Peak Alternative 3: Vertical Circulation Analysis

Vertical Circulation Element (VCE)	AM Peak (LOS) Down	AM Peak (LOS) Up	PM Peak (LOS) Down	PM Peak (LOS) Up
VCE 1	C	A	A	D
VCE 2	A	A	A	A
VCE 3	A	B	A	A
VCE 4	A	D	D	A
VCE 5	A	C	B	A
VCE 6	C	A	C	A
VCE 7	A	-	A	-
VCE 8	A	-	A	-
VCE 9	-	A	-	A
VCE 10	-	A	-	A

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