Appendix A – Station Headhouse Alternatives Analysis

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SOUTH STATION
EXPANSION

South Station Expansion Project
Draft Environmental Assessment and
Draft Section 4(f) Determination

Appendix A – Station Headhouse Alternatives Analysis

March 2017

massDOT
Massachusetts Department of Transportation

U.S. Department of Transportation
Federal Railroad Administration

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1. Introduction

The purpose of this technical report is to discuss the alternatives considered for the expansion of the South Station headhouse facility. This report presents the option selected by MassDOT to advance for further evaluation.

A key objective of the South Station Expansion project (SSX) is blending the future station expansion with the existing station while creating an integrated facility that improves multimodal links and transfers for all users. MassDOT established a series of design principles for the South Station headhouse expansion, addressing planning and urban design, station architecture, access and connectivity, and historic preservation. Initial unconstrained concepts included expanding the South Station footprint to include the USPS facility site and 245 Summer Street, as well as relocating or significantly altering the South Station Air Rights (SSAR) project.[1] These concepts were rejected due to the substantial impact to existing infrastructure. MassDOT also considered various joint development scenarios for South Station. The station design selected as part of the Build Alternative, evaluated in the DEIR dated October 2014, includes an expanded headhouse located along Dorchester Avenue, comprised of a new trackhead concourse, a new elevated concourse, and emergency egress elements. Although MassDOT did not select a Build Alternative with joint development, the design of the expanded headhouse and terminal will not preclude, and to the extent practicable will support, private transit-oriented development in the future. As the SSAR project is considered an existing condition for the SSX project, the analysis also examined how the rail transportation expansion is integrated with the SSAR project to realize a coherent and functional multimodal integrated station for bus, rail, subway, and intercity patrons at South Station. The ultimate goal of the expanded headhouse is to build upon the landmark that is South Station to create a safer, comfortable, efficient, and attractive rail terminal.

2. The Site

The study area is bordered to the north by Summer Street, to the south by the I-90 Central Artery/Tunnel Vent Building and Tower 1 Interlocking in the rail yard, and spans west-to-east between Atlantic Avenue and the Fort Point Channel seawall, including Dorchester Avenue, as shown on Figure 1.

This Alternatives Analysis for the station expansion takes into consideration the existing and anticipated passenger circulation paths within and around the station; existing connections to the station headhouse and between MBTA rail, bus, and subway facilities; existing and anticipated passenger circulation paths between the rail station and bus facility and its proposed expansion; existing and anticipated passenger circulation paths between the rail station and the office building at 245 Summer Street; and integration with the urban context surrounding South Station with the station facilities. Also considered is the SSAR project, approved in 2006 by the Secretary of Energy and Environmental Affairs, but not yet constructed.

[1] The SSAR project was approved by the Secretary of Energy and Environmental Affairs in 2006. Commonwealth of Massachusetts, Executive Office of Environmental Affairs, Certificate of the Secretary of Environmental Affairs on the Final Environmental Impact Report. South Station Air Rights. April 14, 2006. A Certificate on a Notice of Project Change for the SSAR Project was issued by the Secretary on October 7, 2016.

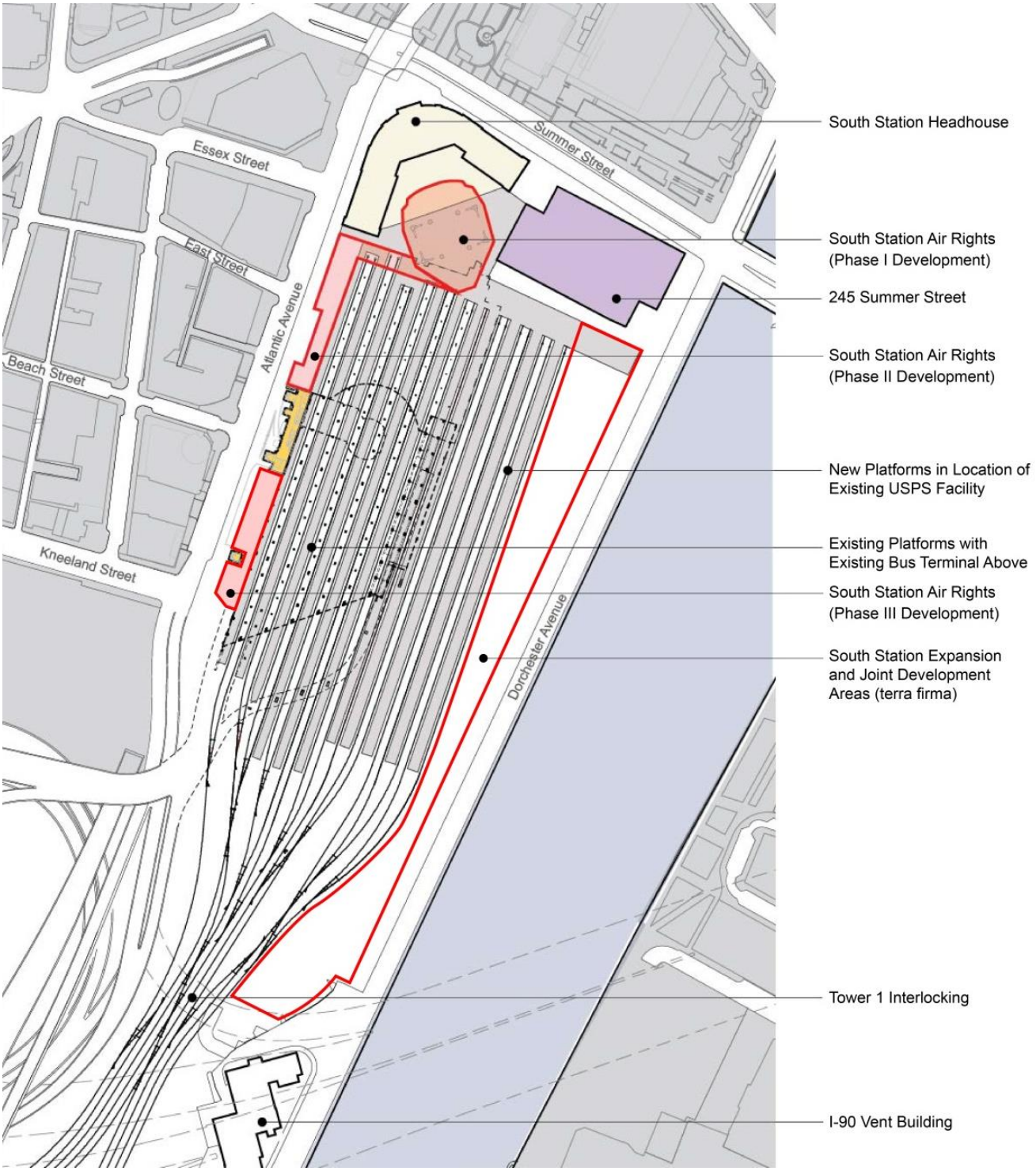


Figure 1 – Future Site Plan

3. Current Constraints and Needs

3.1. Inadequate Station Facilities

The passenger waiting area and circulation zone within the South Station headhouse is an area of approximately 15,000 net square feet. It is inadequately sized and configured to accommodate the daily demand of approximately 100,000 passengers and visitors to the station. The insufficient and awkward headhouse space results in a poor passenger experience, especially during peak-period train boarding and alighting when passengers and pedestrians are crowded together and their movements are obstructed. The current configuration of the concourse forces passenger queues to overlap and lacks easy and intuitive connections among the various intercity rail, commuter rail, bus service, and transit services available at the station. In addition, many of the current passenger amenities at South Station are obsolete and do not meet the standards for a modern passenger rail facility.

3.2. Platform Deficiencies

Last upgraded approximately 30 years ago, the South Station platforms are inadequate to handle existing service needs. The northern and southern portions of the station's platforms are exposed to the elements, forcing riders to walk through rain, snow, sleet and cold/hot temperatures to reach their trains, as shown on Figure 2. Existing platform lengths do not meet berthing requirements for either MBTA or Amtrak for its high speed rail train sets (to meet projected future demand). Additionally, upgrades are required to stay current with Americans with Disabilities Act (ADA) and life safety regulations, including National Fire Protection Association (NFPA) 130.

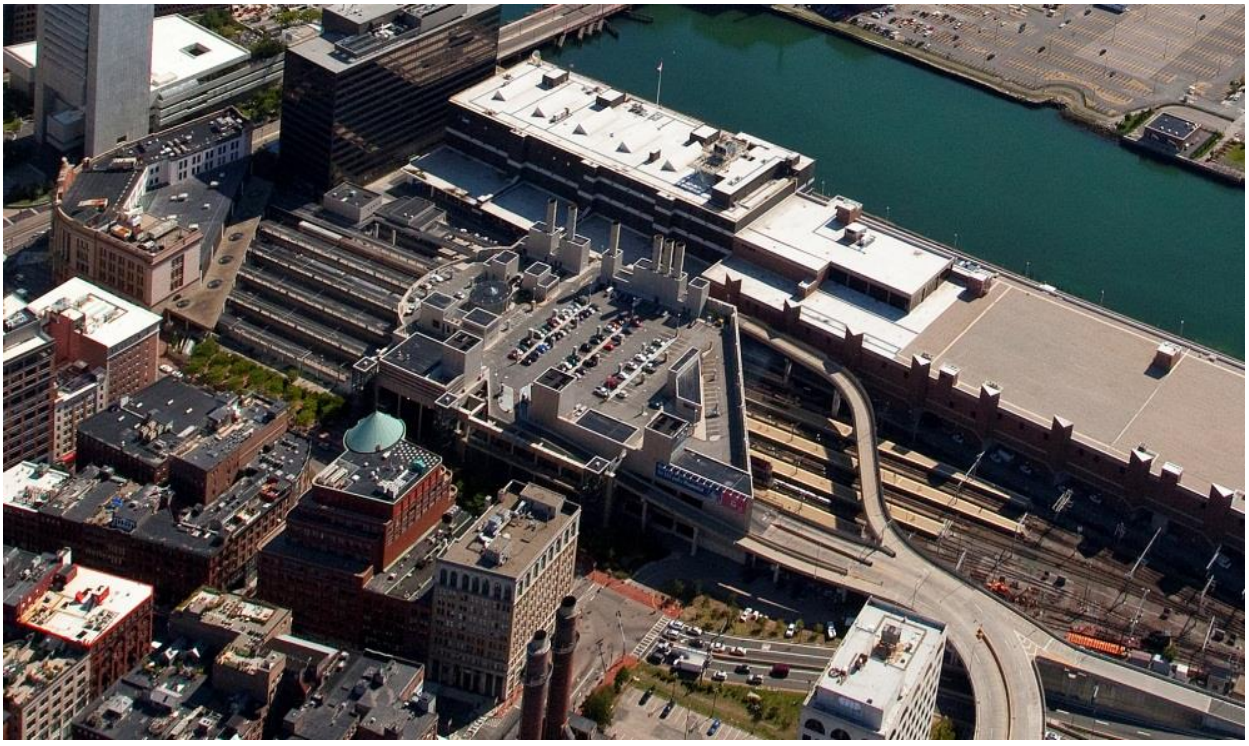


Figure 2 – Aerial Photograph of Open Platforms at South Station

3.3. Future Passenger Service Needs

For the Build Alternative in 2035, Amtrak's and the MBTA's future service increases will nearly double, resulting in a total of 198,000 passengers per day to an already congested South Station. To remedy the existing public space deficit and to accommodate the future increase in service, additional platform, public circulation, and waiting area space is required. These passenger-focused facilities would include comfortable seating and generous waiting space, vertical circulation with direct access to track level, numerous monitor screens providing up-to-the minute arrival and departure information, wireless internet, charging stations for personal devices, quality food and beverage options, as well as retail and entertainment offerings. Platform improvements will include wider and longer new platforms and resurfaced existing platforms, incorporating emergency egress requirements. The ability of South Station to meet passenger needs and comfort expectations associated with a modern intermodal and multimodal transportation center is important to ensuring that rail travel along the NEC remains a viable and attractive alternative to air, bus, and automobile travel.

3.4. South Station Air Rights Project

The Station Headhouse Alternatives Analysis incorporates the SSAR project as planned, with Phase I (Tower) to be located directly behind/above the existing South Station headhouse and its entrance to be located along Atlantic Avenue. The project also includes an expansion of the existing bus terminal and the existing parking garage towards the South Station headhouse. SSAR phases II and III will be developed above the bus terminal expansion and existing bus terminal, respectively. Integrating the SSX project with the SSAR project presents design challenges that are being addressed, but nevertheless compromise the optimal design for the SSX project. The first challenge lies in integrating the tower's columns located at the trackhead into the increased passenger circulation flow between the historic headhouse's Great Hall and the east-west trackhead concourse to be connected to the new island platforms. Ideally, the trackhead would be free of all circulation impediments and provide an area for free flowing passenger movement. While the SSAR project offers a wider platform, the location of the SSAR tower columns and vertical circulation elements (VCEs) to the bus terminal inhibits the SSX project from providing the optimal free-flowing passenger movement. The other significant challenge relates to the potential impact to light and air (platform ventilation) resulting from the overbuild construction above the northern end of existing open-air platforms, approximately 300-ft plus in length. As planned, the SSAR project's bus facility expansion essentially will create an overhead enclosure. Both of these issues are being discussed with the SSAR project team as the design of both projects advances.

4. The Vision

By expanding and improving South Station, MassDOT intends to create a safe, attractive, and comfortable transportation facility, one that fully integrates passenger rail, public transit, well-designed bike/pedestrian facilities, and curbside pick-up and drop-off.

This new vision for the station emphasizes convenient and comfortable passenger waiting areas with height, natural light, clear lines of sight and easy orientation, and view corridors to Fort Point Channel and the urban neighborhoods beyond. More broadly, MassDOT envisions an expanded South Station that is linked – physically and visually – to the waterfront via Dorchester Avenue (currently closed to the public) and an extension of the Harborwalk.

The vision for the future of South Station and the surrounding areas will be realized by:

- Creating an identifiable and compelling sense of place that celebrates Boston's unique character, culture, and history;

- Using design to capture the unique character of South Station as a waterfront intermodal station in the heart of the city;
- Maximizing South Station's strategic location with direct connections to Boston's Financial District and core transportation infrastructure;
- Creating a contemporary and innovative intermodal facility that meets future transportation goals for rail capacity and on-time performance;
- Incorporating sustainable design and technical innovation to develop South Station into a national model for customer service, convenience, safety, and security; and
- Providing pedestrian, bicycle, and vehicular facility improvements in and around South Station.

The key components of the plan for the expansion of South Station are:

- Opening of Dorchester Avenue to vehicular, bicycle, and pedestrian traffic with access to Fort Point Channel waterfront via a new segment of the Boston Harborwalk;
- Terminal expansion to improve the passenger experience at South Station;
- Updated infrastructure (track and signals) and layover capacity;
- Optimized rail capacity for Amtrak intercity passenger rail service;
- Addition of seven new tracks and four island platforms at the current USPS facility site;
- Improved pedestrian/passenger level-of-service (LOS), including additional accessibility and life safety upgrades;
- An elevated passenger concourse with direct track access to provide for more waiting areas, retail space, and passenger amenities, and to facilitate a more organized boarding process;
- Additional entrances and exits into South Station and enhanced connectivity to the surrounding communities;
- Mid-platform boarding opportunities for passenger convenience, circulation, and safety;
- Incorporation of the proposed SSAR project (pre-existing and separate from the SSX project) and bus facility expansion; and
- Enhanced connections to MBTA rapid transit services and intercity/regional bus services.

5. Station Alternatives

The station conceptual design alternatives for the expansion of South Station, as shown on Figure 3, were developed to evaluate the physical, contextual, and architectural impacts of different alternatives to existing or proposed facilities within the project area. Each scenario looks at the various opportunities in conjunction with accompanying constraints related to passenger amenities and experience, passenger flow, passenger level-of-service (LOS), existing structure and infrastructure, concourse expansion, and intermodal connections. The ventilation strategy involves a highly complex engineering analysis supported by computer modeling. For the alternatives analysis, best practice assumptions are being applied to these station concept scenarios so as not to preclude additional air shafts, openings through structures to reach open air while preserving zones of space for necessary mechanical ventilation fan plants. Ventilation will be a qualitative evaluation for the reasons mentioned.

In addition, each scenario looked at the concepts for manifesting a project vision in concert with the opportunities and impacts to potential future overbuild. The assessment provides a qualitative view to provide a strategic design framework for the future overbuild potential within an overall conceptual design for the station alternatives.

The alternatives evaluation began with these three station scenarios to illustrate the design opportunities and highlight the primary planning constraints.

- **Scenario 1: Base Condition – Single-Level Concourse**, consisting of single-level boarding/ alighting platforms utilizing the main headhouse/Dewey Square entrance with side entrances to Atlantic and Dorchester Avenues.
- **Scenario 2: Functional Concourses**, consisting of bridges located above platforms and connected to a station expansion with a Dorchester Avenue station entrance. Additional station entrances are provided along Atlantic Avenue from the concourse bridges.
- **Scenario 3: Diagonal Concourses**, consisting of bridges located above platforms and connected to a station expansion with a Dorchester Avenue station entrance. Additional station entrances are provided along Atlantic Avenue from the concourse bridges.

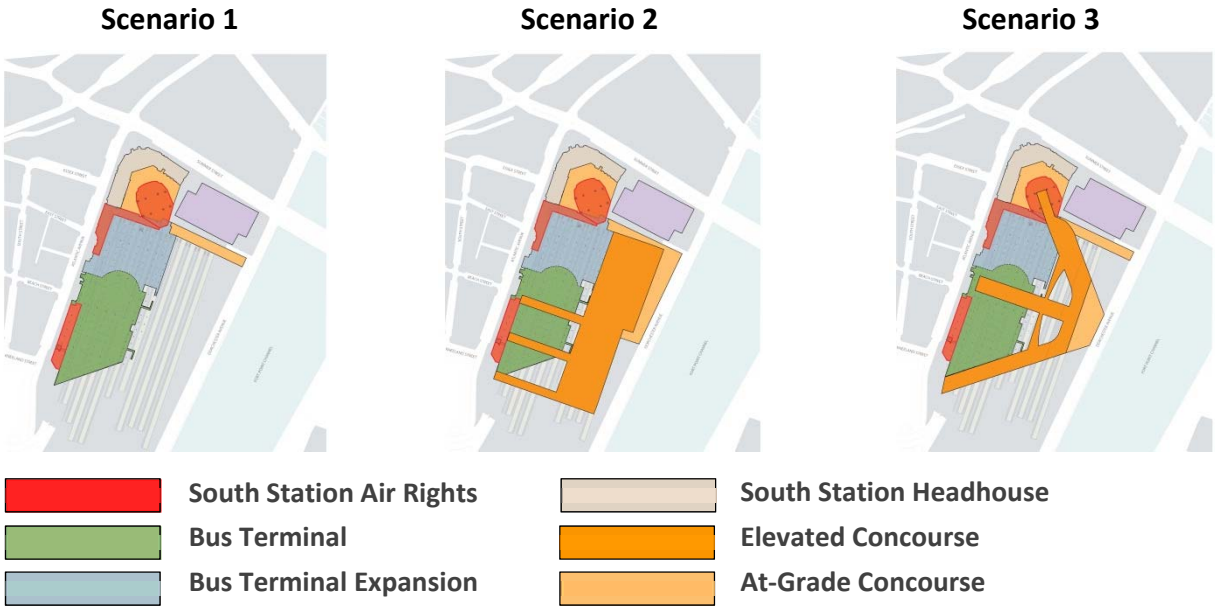


Figure 3 – Station Alternatives for South Station Expansion

5.1. Scenario 1 – Base Condition – Single-Level Concourse

Scenario 1 represents the base condition where the SSAR project proceeds as planned. As described in Section 3.4, the presence of the SSAR project presents some design challenges and potential adverse impacts in this scenario as well as in Scenarios 2 and 3.

In Scenario 1, the expanded South Station consists of an entirely single-level station for boarding and alighting from the trains through the trackhead – similar to the current day configuration. This aspect is unique to Scenario 1, however, it has its advantages and disadvantages. The circulation movements are familiar to current users. The South Station headhouse continues to support and house all the passenger amenities, retail, food and beverage concessions. Where the new 26 foot-wide island platforms and tracks

are added, a 20-foot wide trackhead concourse is provided perpendicular to the platforms to facilitate passenger circulation among headhouse, platforms, and station exits/entrances. Scenario 1 provides for the bus facility expansion and the SSAR project to proceed as planned, as shown on Figure 4. It should be noted that the SSAR Phase 1 development – the tower and bus facility expansion – was planned and designed prior to existence of the SSX project, thus there will be elements constraining the SSX project. This scenario assumes no impact or re-designs to the 2006 proposed construction for the SSAR project.

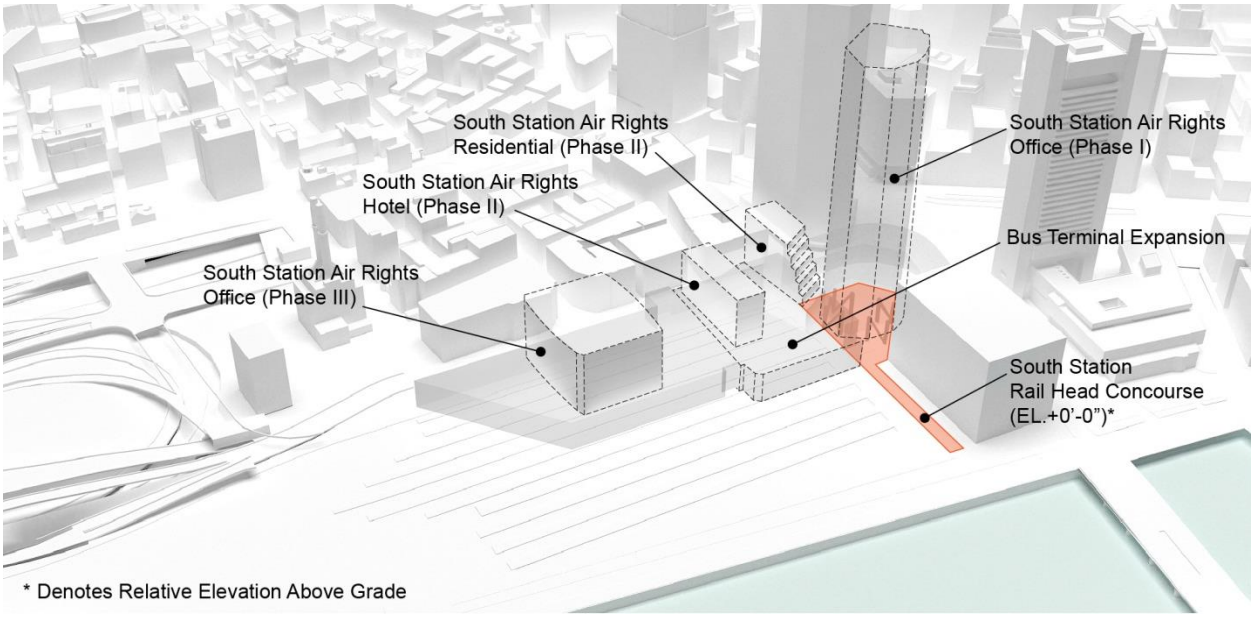


Figure 4 – Scenario 1 – Single-Level Concourse

The constraints in Scenario 1 are a direct result of the cause and effect from the vertical circulation elements (stairs, escalators, and elevator) at the trackhead, the proposed column structures with some located in the trackway requiring shortening of existing tracks, and the emergency egress stair shaft enclosure of the SSAR project Phase I (Tower) located in the concourse. These elements of the SSAR project negatively impact passenger flows and congestion for pedestrians who are moving between bus, rail, and subway services. Where the existing platforms and station meet with the station expansion, the circulation movement occurs at a physically narrow area – a pinch point between existing and new. MassDOT and the MBTA's desired transportation objectives in the expansion of South Station for improved integration of the intermodal connections among rail, bus, and subway services are thus constrained by these elements. In addition, the expansion of the bus facility to the north limits the ability of the South Station concourse to expand in this area. Lastly, in Scenario 1 with the single-level boarding and alighting configuration, it does not comply with NFPA 130 – Standard for Fixed Guideway Transit and Passenger Rail Systems (the reference standard adopted by Massachusetts Building Code for emergency egress compliance). Scenario 1 does not egress or clear the platform in the NFPA 130 required 4-minutes time period. In order to comply, additional exits, stairs and escalators or combination of these vertical circulation elements (VCEs) are required.

Opportunities and constraints are described in the following Sections 5.1.1 and 5.1.2, respectively.

5.1.1. Opportunities

- Provides the shortest passenger connection between the bus concourse and subway entrance at South Station, as shown in Figure 5.

- Provides single-level boarding and alighting from the existing and new platforms, as shown in Figure 6. This aspect is unique to Scenario 1.
- Provides potentially the maximum overbuild opportunities for joint development.

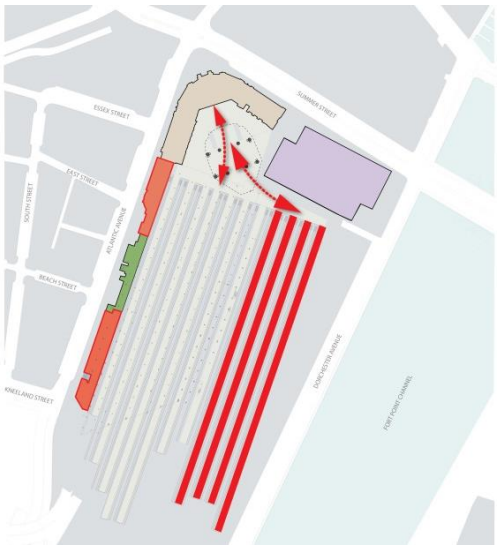


Figure 5 – Passenger Flows between Bus and Subway and from New Platforms

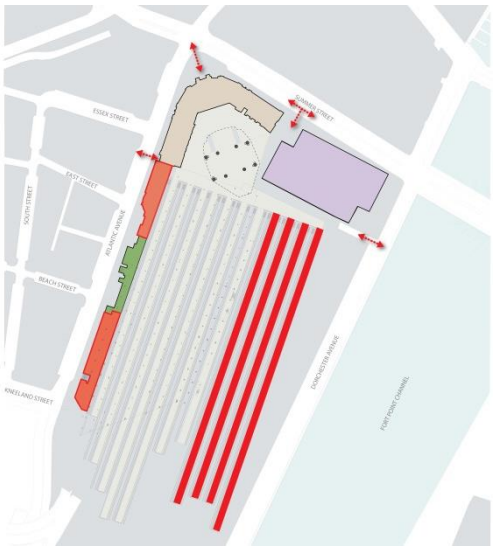


Figure 6 – New 26'-0" Wide Platforms

5.1.2. Constraints

- Locates the connection between bus concourse and subway at a constrained trackhead area of South Station, where the confluence of SSAR tower columns, tower VCEs, rail, bus and egress paths all converge, thus creating a "bottleneck" at rush hour periods, as shown on Figure 7.
- Does not provide for mid-platform boarding for existing platforms.
- Does not provide adequate egress capacity to comply with NFPA 130.
- Inhibits the development of a fully integrated multimodal center; the SSAR tower and bus facility expansion will split the rail station into two segments, as shown on Figure 7, with a passenger hall located adjacent to the South Station headhouse and a new trackhead concourse located behind 245 Summer Street serving the additional platforms in the station expansion.
- Has the minimum potential of the three alternatives in terms of place-making opportunity, which translates to least value on the scale of project vision from a passenger experience and memory, "sense of place" perspective.
- Requires confirmation by the SSAR project approvals and permits from the authority having jurisdiction (AHJ) with respect to fire and life safety issues that there will be no impacts to the SSX Project. SSAR approvals and permits include:
    - Separation and mixing of transit and non-transit spaces;
    - Egress separation;
    - Platform egress compliance;
    - Bus Terminal egress compliance; and
    - Capacity of egress elements.

Figure 7 – South Station Expansion as shown in accordance with the SSAR project

- Requires construction of the following structural systems concurrent with the SSX project to minimize the impact of the SSAR project on the new station and its operation:
    - Vertical support columns and egress stairs for the tower;
    - First parking level above bus expansion; and
    - Parking ramp helix and vehicular entrance on Atlantic Avenue.

5.1.3. Passenger Flow Constraints

- The tower columns and stairs from the SSAR project obstruct effective passenger flows to/from trains, worsening the current passenger congestion at the north end of platforms, as shown on Figure 8.
- Several narrow corridors are created at Platforms D, E, and F due to the egress stair, escalators, and elevators from the bus expansion and SSAR Tower columns. Figure 9 presents a layout of an improved condition with a widened concourse.
- Due to the lack of mid-platform boarding for existing tracks, the existing conflict of passenger boarding and alighting cannot be resolved.
- Due to the tower's egress stair shaft enclosure onto the concourse and its proximity between two of the tower's columns, narrow corridors are created that restrict the flow to/from the new platforms and South Station headhouse, as shown on Figure 9.
- The inadequate capacity and location of circulation between the bus concourse and subway worsen current passenger congestion.

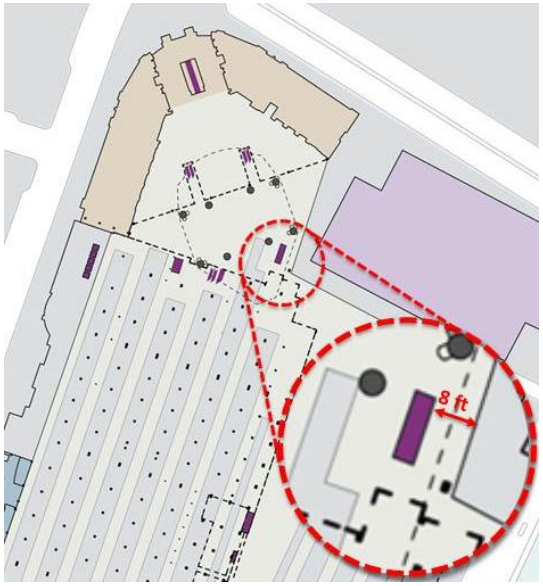


Figure 8 – Passenger Flow from Platform to Headhouse (before Concourse Widening)

Figure 9 – Passenger Flow from Platform to Headhouse (after Concourse Widening)

5.2. Scenario 2 – Functional Concourse

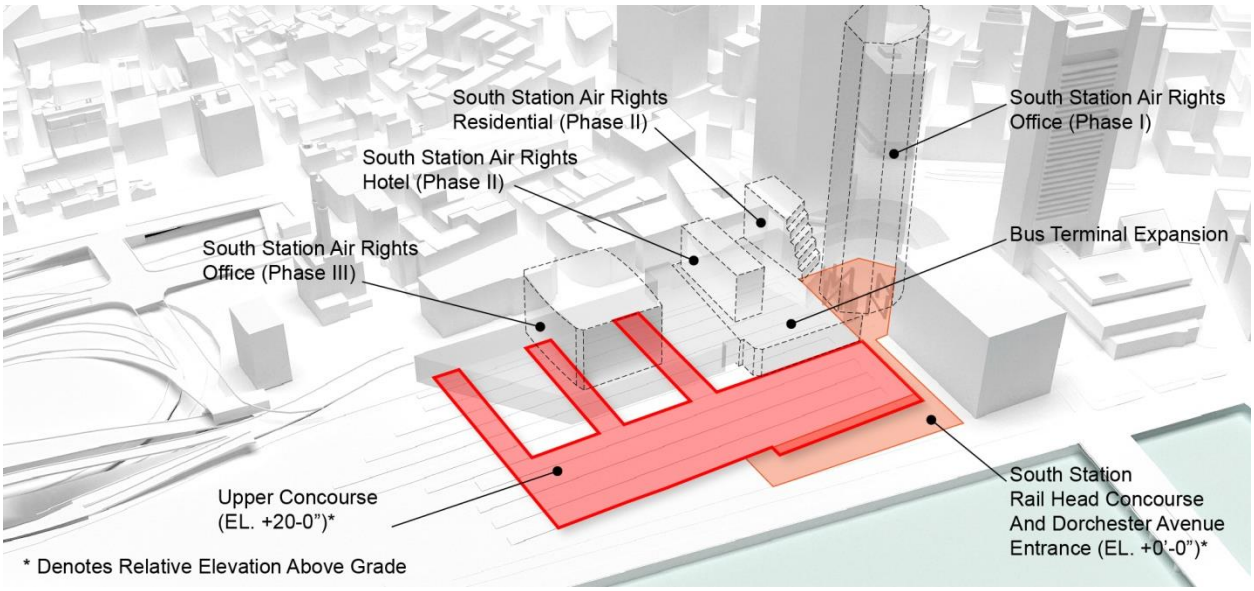


Figure 10 – Scenario 2 – Functional Concourse

This scenario requires no modification by the SSAR project, as the station expansion works around the SSAR project. Scenario 2 provides a new headhouse expansion located along Dorchester Avenue with a major station entrance, in addition to a functional concourse layout deploying three transverse elevated concourses that are arranged perpendicular to the platforms. The station at-grade concourse maintains the existing entry/exit points through South Station headhouse, in addition to providing an additional Dorchester Avenue entrance (adjacent and behind 245 Summer Street) which connects to the proposed trackhead concourse of the station expansion project. Scenario 2 includes connections to the South Station

headhouse and bus facility via the northernmost elevated concourse. The three elevated concourses link with a north-south concourse spine that all connect to the headhouse expansion and back down to the at-grade trackhead concourse. Scenario 2 also provides additional perimeter access with an at-grade connection from the station expansion to a passenger pick-up/drop off area on Dorchester Avenue; and provides at-grade station entrances to Atlantic Avenue from the elevated concourses.

The new elevated concourses would be constructed to bridge all existing and proposed tracks to facilitate separate boarding and alighting operations. Passenger boarding occurs from the concourse above, while alighting occurs at the platform level, thereby reducing passenger flow conflicts and relieving passenger congestion. Similar to Scenario 1, there are negative passenger flow impacts and transportation planning constraints as a result of the planned location and support columns of the SSAR tower. Opportunities and constraints are described in the following sections.

5.2.1. Opportunities

- Moves toward an intermodal connection between bus concourse, rail station, and subway, as the South Station concourse expansion occupies the area west of the bus terminal and the existing platforms and tracks, as shown on Figure 10. The station expansion is the connector in a north-to-south orientation.
- Allows for elevated concourses serving all platforms to relieve the current conflict of passenger flow by separating passengers boarding and alighting the trains, as shown on Figure 11.
- Dedicates passenger flows alighting rail platform directly to street exits, as shown on Figure 12.
- Allows for multiple exits off the platform via concourse bridges to comply with NFPA 130 in clearing the platforms in four minutes or less.
- Reserves a ventilation zone between the bus terminal and Dorchester Avenue side station expansion so as not to preclude mechanical equipment placement, air shafts, and structural penetrations.
- Requires no modification to the existing ventilation system in the existing track and platform areas. The SSAR project provides a ventilation system for the overbuild at the northern ends of the platforms.

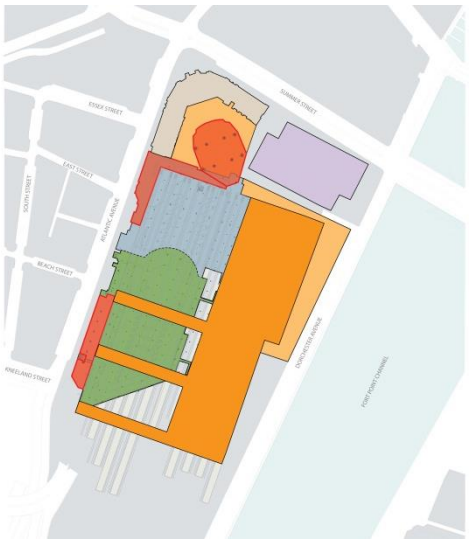


Figure 11 – South Station Expansion Upper Concourse at Level +20

Figure 12 – South Station Expansion Passenger Flow at Platform Level 0

5.2.2. Constraints

- Obstructs direct connection to the street at Atlantic Avenue from the Dorchester Avenue side due to the SSAR project.
- Creates a bifurcated station due to the SSAR project.
- Creates a narrow corridor between the existing and new platforms due to the SSAR tower columns and egress stair, thereby obstructing effective passenger flow at the concourse level and worsening the existing condition.
- Involves physically constrained and limited area for vertical circulation elements (e.g. stairs, escalators, and elevators to connect to the new upper concourse).
- Has minimum terra firma land value along Dorchester Avenue for optimal future joint development due to the elongated upper concourse and at-grade rail terminal facility. Future joint development could be built over portions of the Dorchester Avenue entrances, but with limited at-grade square footage.
- Creates a Dorchester Avenue presence for the SSX project that is important for urban connections, but not dynamic in bringing the desire lines in circulation paths to the entire station. The length of the upper concourse and the perpendicular concourse "arms" while functional in configuration are long in distance and lengthy for pedestrian travel.
- Lacks the place-making quotient of the project vision for an identifiable and compelling sense of place due to the elongated frontage on Dorchester Avenue.

5.3. Scenario 3 – Diagonal Concourses

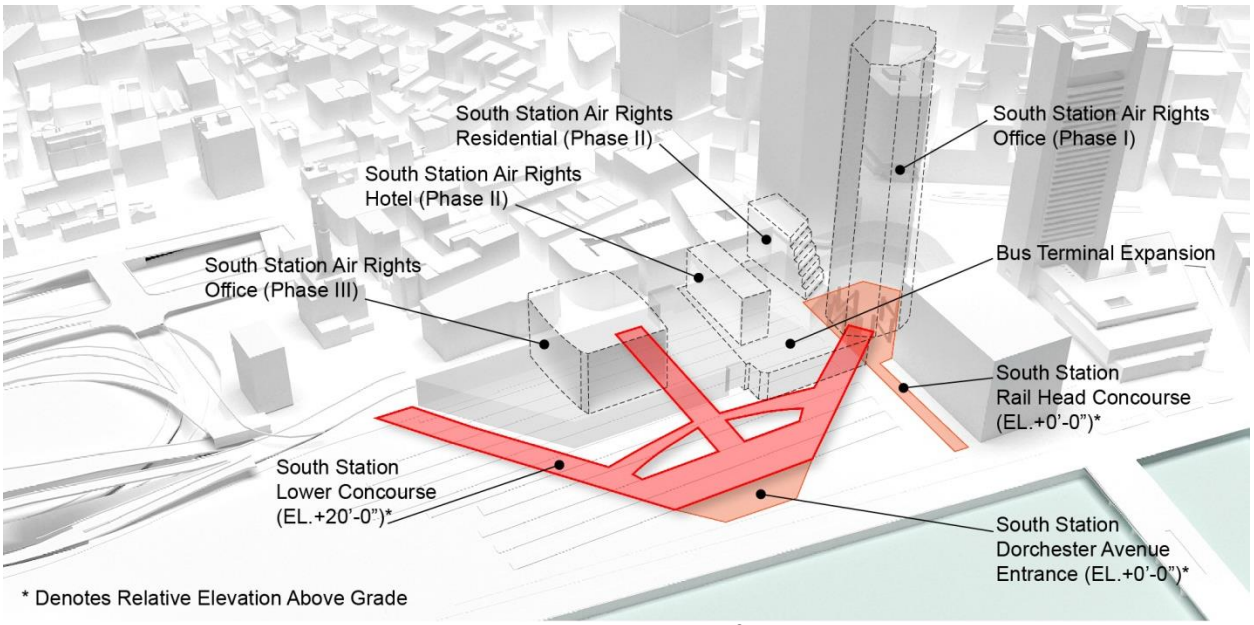


Figure 13 – Scenario 3 – Diagonal Concourse at Level +20[2]

[2] Level +20 and Level +30 is a reference to height above the platform; i.e. Level +20 is 20 feet above the platform.

Scenario 3 incorporates the SSAR project with minor design modifications for improved multimodal and intermodal connections at South Station. The functional concourse bridges are realigned to directly respond to the desire lines from Dewey Square/Downtown Financial District, Leather District, and Chinatown. In effect, the two outer concourses or "arms" are configured in a diagonal axis for direct connections for these neighborhoods to the train station node. The new station and the Dorchester Avenue entrance into the station are now shaped by the circulation paths and desire lines, creating a trapezoidal plan.

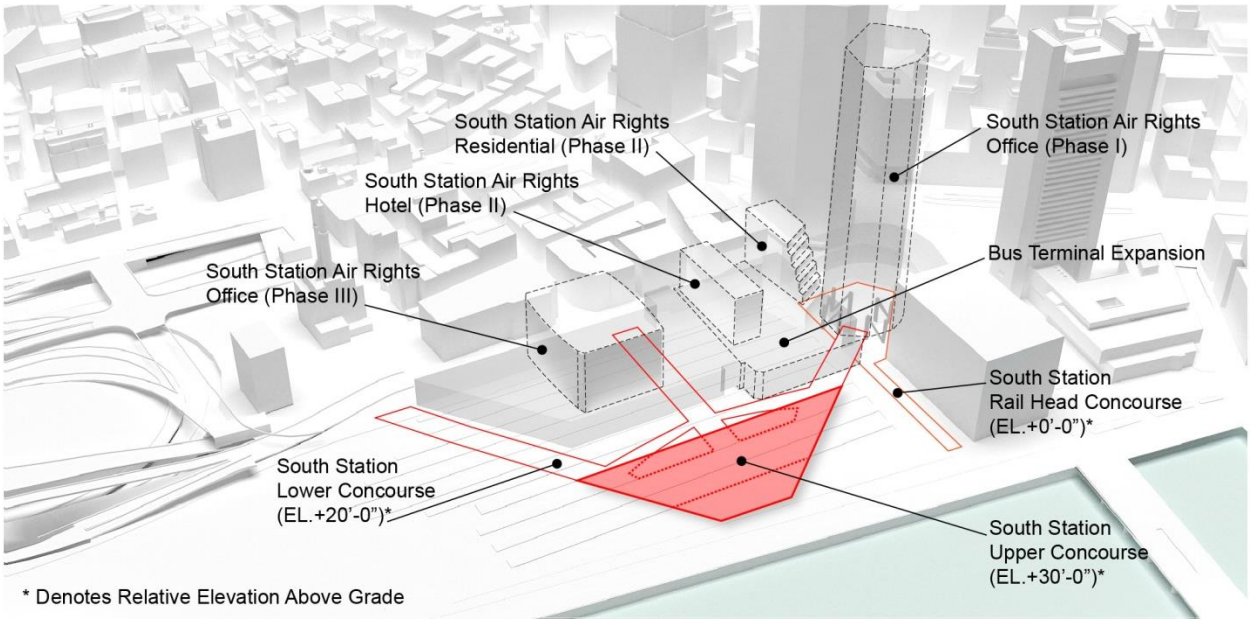


Figure 14 – Scenario 3 – Diagonal Concourse at Level +30

Passenger boarding would occur from a new elevated concourse at Level +20 that serves the existing and new platforms, as shown in Figure 13. Separated passenger alighting occurs via the trackhead at platform level, thereby reducing passenger flow conflicts and relieving passenger congestion. Scenario 3 is an organic outgrowth of Scenario 2 from the direct diagonal lines of concourse circulation. At Level +30, shown on Figure 14, passenger amenities, passenger services, station retail, and food and beverage concessions are programmed for the space in the headhouse expansion.

Opportunities and constraints are described in the following sections.

5.3.1. Opportunities

- Eliminates the need to shorten some of the existing tracks. This is possible by the following:
    - Relocation of the SSAR project elevators for the bus expansion at the head of Tracks 5 and 6, which would have required track shortening.
    - Relocation of the SSAR project stairs and escalators for the bus expansion at the head of Tracks 7 and 8, which would have required shortening of these tracks and adjacent Platforms D & E; and
    - Shortening of Track 8 due to the location of the SSAR column that supports the tower. Thus, Platforms E & F are shortened for this reason.
- Optimizes passenger flow between the headhouse and platforms by straightening and aligning the north ends of the platform to create a uniform trackhead concourse width to optimize circulation.

- Allows for an elevated concourse that relieves the current passenger flow conflicts by separating passenger boardings and alightings.
- Allows for multiple exits off the platform via concourse bridges to comply with NFPA 130's requirement to clear the platforms in four minutes or less.
- Provides an opportunity for significant daylighting and use of natural ventilation at the expanded station, through implementing a "no build" zone above the station expansion.
- Reserves a ventilation zone between the bus terminal and Dorchester Avenue side station so as not to preclude mechanical equipment placement, air shafts, and structural penetrations.
- Requires modification to the current ventilation system in the existing track and platform areas due to the presence of the elevated concourses or "bridges" over the platforms.
- Requires minimum modification to the station ventilation provided under the SSAR project due to the overbuild structures over the northern ends of the existing platforms – Platform A through Platform G.
- Creates a more integrated, intermodal connection among the rail station, bus concourse, and subway, as the headhouse expansion is the central node of the upper concourses, as shown on Figure 15.
- Creates multiple station entrances and exits as well as improves the pedestrian access to the existing entrances and exits, as shown on Figure 15.
- Passengers in Scenario 3 will have more access points and choices; and no longer have to walk to the outside of the terminal if their origin is south of the main entrance through the South Station headhouse. Pedestrians will have more direct station access from Beach Street to the center concourse and/or from Kneeland Street to the southernmost concourse. Likewise, on the Dorchester Avenue side of the station, pedestrians will have a major entrance supplemented by another entrance at the west end of the trackhead concourse (behind the 245 Summer Street building).
- Creates an opportunity for a significant station connection to Dorchester Avenue and Harborwalk, with visual corridors to the Innovation District across Fort Point Channel.
- Dedicates land with terra firma value along Dorchester Avenue north and south of the headhouse expansion entrance facing Fort Point Channel. In Scenario 3, the headhouse expansion is an infill site between potential joint development properties with urban design goals of maintaining a cognizant street plane along Dorchester Avenue. The diagonal footprint of the expansion provides more frontage for potential joint development than Scenario 2.
- Creates a dynamic Dorchester Avenue headhouse presence for the SSX project. The axiom "form follows function" concentrates and culminates the desire lines of the circulation paths into the Dorchester Avenue entrance. Circulation routes on the upper (+20 Level) concourses are direct requiring lower travel distances as a result of the diagonal concourse configuration.
- Scenario 3 has high value in the place-making quotient of the project vision for an identifiable and compelling sense of place. The ends of the upper concourses lead into a grand public hall in the headhouse expansion with strong, clear dominate views to Fort Point Channel and the Innovation District. The station expansion in Scenario 3 is the "town square" for public gathering, dwelling and waiting for train departures; and allows for natural daylight to penetrate into the platform levels of the rail platforms and concourses.

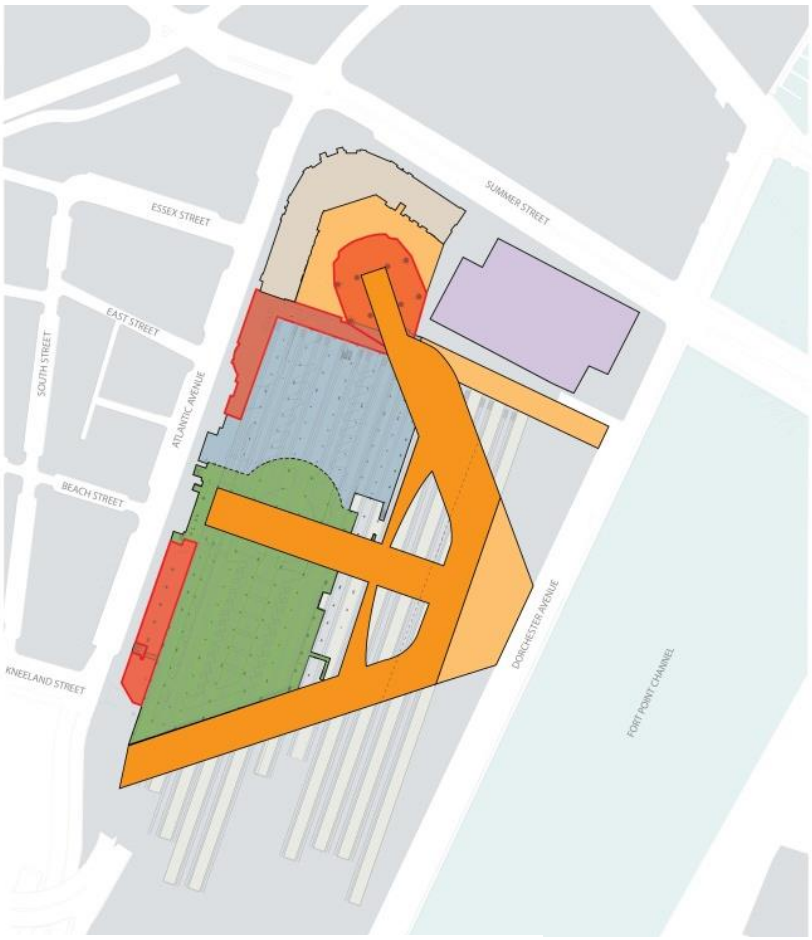


Figure 15 – Scenario 3 – Diagonal Concourse and Headhouse Expansion (Central Node)

5.3.2. Constraints

- Requires minor modification of SSAR project's plenum[3] and associated mechanical ventilation dampers (operable louvers) in the northeast corner of the station ventilation system located directly above the platforms and train tracks.
- Requires re-modeling and validating the SSAR project's computational fluid dynamic (CFD) analysis for the platform ventilation system, due to the modification of the plenum.
- Requires relocation of the vertical circulation elements (VCE), consisting of escalators, stairs and elevators, for the bus terminal expansion to the north end of the diagonal concourse.
- The above-mentioned VCEs relocated from the SSAR bus expansion project will largely benefit both the SSAR and SSX projects. The new location of the VCE will be co-located within the SSAR super columns and will be a joint use for bus terminal travelers as well as for the rail passengers in creating an integrated intermodal facility.
- Obstructs direct connection to the street from the northern half of the platform.

[3] Plenum is an air-filled space in a structure; one that receives air from a blower or set of fans for distribution (as in a ventilation system).

6. Transportation-Related Qualitative Screening

6.1. Transportation Criteria

The following transportation qualitative criteria were used to rate Scenarios 1, 2, and 3:

- **Multi-modal / Integrated Station.** How does the scenario integrate the multimodal functions, connections and transfers among bus-rail-subway as well as surface transportation modes and bicyclists?

- **Mid-platform Boarding.** Does the scenario address mid-platform boarding to segregate boarding from exiting passenger flows from the rail platform? Are platform bridges used solely for egress-only purposes?

- **Overall Passenger Circulation.** What is the scenario's rating with respect to circulation flows, as measured or estimated by LOS at congestion points ("bottlenecks") on the concourse, VCEs, and around fixed obstructions?

- **Passenger Experience and Amenities.** How does the scenario allocate station amenities and support functions, such as restrooms, ticketing, retail, and food and beverage concessions, with respect to passenger circulation and waiting areas?

- **NFPA 130 / Egress Paths.** How does the scenario comply with NFPA 130 for egress (clearing) of platforms? What is the scenario's adequacy of VCEs to clear the platforms and travel distances?

- **Ventilation.** How does the scenario accommodate ventilation shafts, ducts, openings, and (horizontal/vertical) fan plants at this conceptual level? How does the scenario acknowledge space-proofing measures still need to be performed?

- **Construction Cost.** Are there additional infrastructure requirements, such as ramps, structures including components for joint development, and ventilation, which would elevate the construction costs relative to other scenarios?

- **Phasing / Constructability.** What is the qualitative phasing and constructability ranking of the scenario?

- **Project Vision.** How does the alternative address the objectives emphasizing convenient and comfortable passenger waiting areas with height, natural light, clear lines of sight, easy, intuitive orientation and view corridors to Fort Point Channel, and connections with adjacent neighborhoods?

6.2. Rating System

A rating system of 1 through 5 was used to screen Scenarios 1, 2, and 3, as presented in Figure 16. The ratings for the evaluation are ranked from "1," rated as poor, to "5," rated as excellent. For this screening, the ratings are defined as follows:

- 1 Rating = Poor
- 2 Rating = Fair

- 3 Rating = Average
- 4 Rating = Good
- 5 Rating = Excellent

6.3. Screening Results

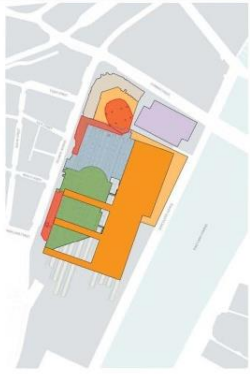
		Scenario 1		Scenario 2		Scenario 3	
South Station Air Rights		As Permitted by Hines		As Permitted by Hines		Hines with Minor Modification	
Rail Expansion		Single-Level Concourse		Functional Concourses - separate flows		Diagonal Concourses – separate flows	
Plan							
		South Station Headhouse South Station Concourse Bus Terminal Bus Terminal Expansion South Station Air Rights					
Transportation	Multi-modal /Integrated Station	Poor	1	Fair	2	Good	4
	Mid-platform Boarding	Poor (none provided)	1	Good	4	Good	4
	Overall Passenger Circulation	Poor (no improvement)	1	Average	3	Excellent	5
	Passenger Experience & Amenities	Poor (little improvement)	1	Average	3	Excellent	5
	NFPA 130/Egress Paths	Poor (no improvement)	1	Good	4	Good	4
	Ventilation	Fair (Hines provides at existing)	2	Good	4	Excellent	5
	Construction Cost	TBD	-	TBD	-	TBD	-
	Phasing/Constructability	Average	3	Average	3	Average	3
	Joint Development Opportunity	Good (Terra Firma)	4	Poor (minimal Terra Firma)	1	Average	3
	Funding & Financing Implication	TBD	-	TBD	-	TBD	-
	Project Vision	Poor	1	Fair	2	Excellent	5

Figure 16 – Screening Matrix: South Station Expansion Scenarios

- **Scenario 1: Base Condition – Single-Level Concourse**. Scenario 1 incorporates the SSAR project "as planned" by the developer, including the bus terminal and parking expansion in Phases 1, 2, and 3. It utilizes a single-level for both boarding and alighting trains, similar to present day conditions. Scenario 1 represents the base case scenario for comparison with the other two options. Scenario 1 scored 15 points.

- **Scenario 2: Functional Concourses**. Scenario 2 has similar existing conditions elements as Scenario 1 with respect to the SSAR project components, e.g. bus expansion, super columns, station ventilation system, VCEs, and others. Scenario 2 employs functional concourse bridges which comply with NFPA 130 for egress requirements, as well as provides boarding from the upper concourse from above the platforms. This scenario separates the passenger arriving and departing flows. Scenario 2 scored 26 points.

- **Scenario 3: Diagonal Concourses**. Scenario 3 builds off of Scenario 2, and realizes an organic circulation flow through the concourse layouts, corresponding to the diagonal desire lines from Dewey Square, Chinatown, and Leather Districts into the South Station train shed. The station expansion is the centroid of the desire lines conveyed through the concourse bridges. Scenario 3 scored 38 points.

7. Build Alternative

The screening resulted in the development of an alternative that incorporates elements from both headhouse Scenarios 2 and 3. As shown in Figure 17, the Build Alternative provides multiple access points along Dorchester Avenue; integrates with the existing headhouse underneath the SSAR tower; and provides a mid-platform elevated concourse that will access the new and existing platforms. The main access point for the station expansion will be at Dorchester Avenue just south of 245 Summer Street.

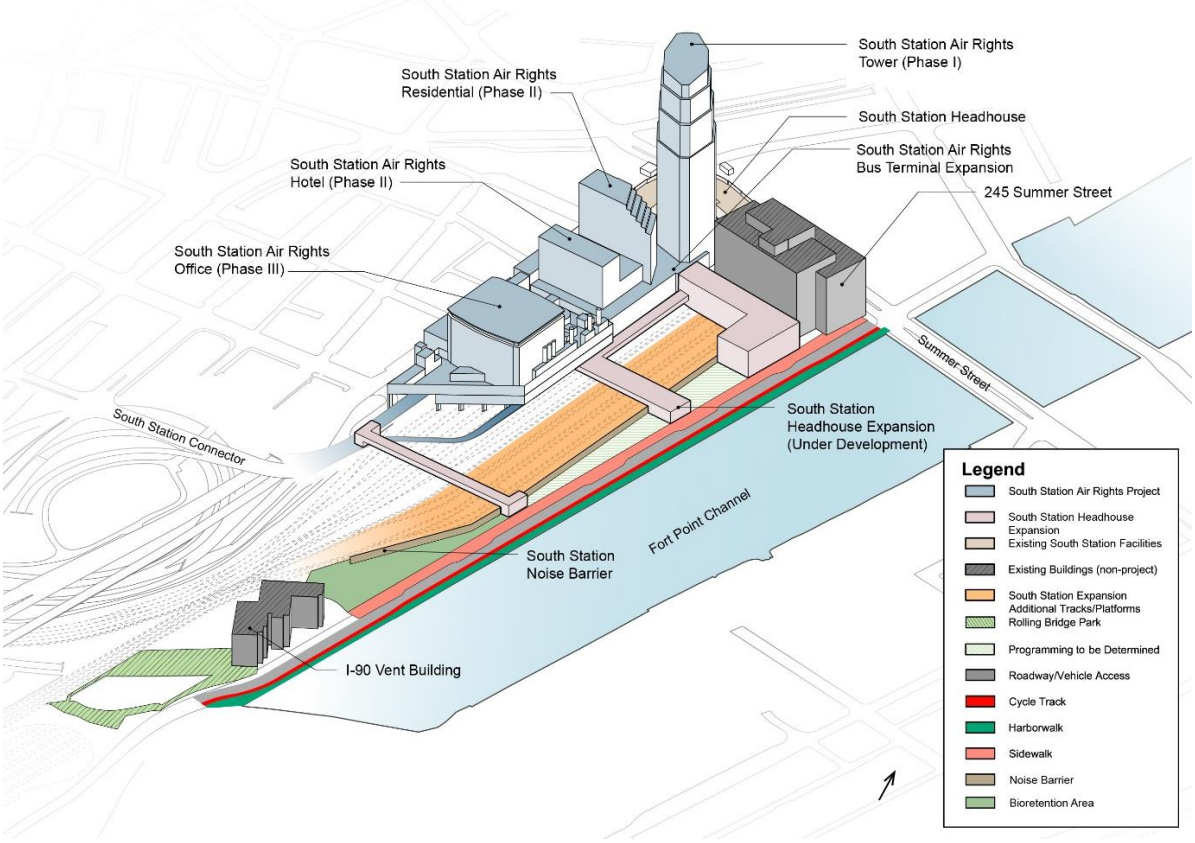


Figure 17 – Preferred SSX Headhouse Alternative

This northern access is more appropriately located to capture the pedestrian flow along Summer Street than the more southern location of the main entrance in Scenario 3. The elevated mid-platform concourse will have direct access to Dorchester Avenue and will also connect with Atlantic Avenue through the existing bus terminal rotunda providing a direct connection through the station to the waterfront. The southernmost access will be emergency egress only, as required for compliance with NFPA 130.

7.1.1. Opportunities

- Optimizes passenger flow between the headhouse and platforms by straightening and aligning the north ends of the platform to create a uniform trackhead concourse width to optimize circulation.

- Allows for an elevated concourse that relieves the current passenger flow conflicts by separating passenger boarding and alighting.
- Allows for multiple exits off the platform via concourse bridges to comply with NFPA 130's requirement to clear the platforms in four minutes or less.
- Provides an opportunity for significant daylighting and use of natural ventilation at the expanded station by minimizing structures above the platforms.
- Requires modification to the existing ventilation system in the existing track and platform areas due to the presence of the elevated concourses or "bridges" over the platforms.
- Requires minimum modification to the station ventilation provided under the SSAR project due to the overbuild structures over the northern ends of the existing platforms – Platform A through Platform G.
- Creates a more integrated, intermodal connection among the rail station, bus concourse, and subway.
- Creates multiple station entrances and exits as well as improves the pedestrian access to the existing entrances and exits.
- Similar to Scenario 3, passengers will have more access points and choices; and no longer have a need to walk on the outside of the terminal if their origin is south of the main entrance through the South Station headhouse. Pedestrians will have more direct station access from Atlantic Avenue to the center concourse. Likewise, on the Dorchester Avenue side of the station, pedestrians will have a major entrance at the trackhead supplemented by another entrance further south along Dorchester Avenue.
- Creates an opportunity for a significant station connection to Dorchester Avenue and the Harborwalk, with visual corridors to the Innovation District across Fort Point Channel.
- Maximizes land with terra firma value along Dorchester Avenue adjacent to the station entrances facing Fort Point Channel. The Build Alternative provides the most symmetrical parcels along Dorchester Avenue for the potential to accommodate future development.
- Minimizes the impacts associated with the SSAR project through improved integration of the elements of the two projects that interface with each other.

7.1.2. Constraints

- Although the Build Alternative minimizes the impacts associated with the SSAR project, it is imperative for continued coordination between the projects to ensure optimal integration.

8. Conclusion

This South Station Headhouse Alternatives Analysis Report provides a high level synopsis of the station design scenarios that have been evaluated from a transportation improvement and station integration perspective. This aspect of the SSX alternatives analysis has been developed in parallel with other on-going separate studies, such as urban design, traffic and transportation, financial, and structural feasibility.

Regulatory requirements, environmental review, and desired passenger and service improvements guide the design of the Build Alternative through preliminary engineering. MassDOT is committed to achieving the project goals outlined in the design principles, meeting and/or exceeding regulatory requirements, and

providing a multimodal station that will serve all passengers today and in the future. MassDOT will continue to coordinate with the SSAR project to ensure that the two projects will integrate seamlessly and combine to create an improved passenger experience at South Station. The Build Alternative accommodates increased rail service; enhances the passenger experience at the station; improves multimodal connections; and integrates the station with adjacent neighborhoods and open spaces. Additionally, the preferred headhouse alternative would be aligned so that it would not preclude any future air rights development.

While the station alternatives analysis has centered on development incorporating the SSAR project, the evaluations consistently identify the impact to passenger circulation flows resulting from the columns of the Phase I tower structure. MassDOT will continue coordination with the SSAR project team to minimize the passenger flow impacts, better integrate the two projects, and emphasize the multimodal functions of South Station.

There are many financial and urban design benefits that can be derived from successful future joint development. Concurrently, there is strong merit and desire to maintain well-lit, expansive, open unobstructed public atria in the proposed station expansion. Significant benefits that can be realized include:

- Strong intuitive circulation paths through an expansive room;
- Collateral value to the surrounding area associated with the historic South Station headhouse;
- An indelible “sense of arrival” and memorable “sense of place” at South Station;
- Destination-oriented place in downtown Boston; and
- A notable interior public space to connect and accommodate the intersecting circulation paths of bus, rail, and subway passengers.