SOUTH STATION
EXPANSION

Appendix D - Track Configuration Alternatives Analysis - Tier 2 Screening Technical Report

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massDOT
Massachusetts Department of Transportation

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1. Introduction

The purpose of this technical report is to summarize the terminal track alternatives analysis for the South Station Expansion (SSX) project including a summary of the work previously conducted as part of the Tier 1 analysis; a description of the alternatives progressed to the Tier 2 analysis; and a discussion of the methodology, criteria, and results of the Tier 2 analysis.

MassDOT advanced two of four terminal track alternatives from the Tier 1 screening into the Tier 2 analysis. Alternative 3 performed better than Alternative 2 in five out of seven rating categories, including stakeholder preference, and will be advanced into preliminary design. The stakeholders that provided their preference were the FRA, Amtrak, and the MBTA.

In fall 2014, a Tier 1 screening analysis of the potential rail alternatives for the SSX project was conducted and provided in the Draft Environmental Impact Report (DEIR) Appendix 2 – *Track Configuration Alternatives Analysis – Tier 1 Screening Technical Report*. The Tier 1 analysis described the existing conditions of the terminal tracks at South Station and detailed the numerous configuration concepts Massachusetts Department of Transportation (MassDOT) considered for the terminal track expansion. A number of unconstrained alternatives were considered that included concepts with unrestricted design standards and few limitations. While these concepts solved many of the functional and operational limitations of South Station, those benefits were eclipsed by the significant construction impacts to major adjacent infrastructure.[1] MassDOT used these findings to develop and analyze a number of alternatives that reflected the constraints of the area and minimized the impacts to the surrounding infrastructure.

Four of these alternatives, referred to as the Constrained Rail Alternatives, were identified and evaluated as part of the DEIR. Each alternative was developed to address particular concerns while attempting to meet the overall project goals. The following briefly describes these alternatives:

- Constrained Rail Alternative 1 was developed with the focus on prioritizing operational flexibility within the terminal and providing a complete redesign of the existing South Station terminal area and existing bus terminal;
- Constrained Rail Alternative 2 was developed with the focus on streamlining operations and completely reconfiguring the existing Tower 1 Interlocking. This alternative adds the new station tracks and platforms to the terminal and provides operational improvements such as parallel moves as a separate mini-terminal in an effort to reduce conflicting movements;
- Constrained Rail Alternative 3 was developed with the focus on minimizing disruptions to existing operations and minimizing the amount of existing infrastructure within the terminal to be rebuilt. This alternative maintains, to the greatest extent possible, the existing platform configuration while adding new tracks and platforms parallel to the existing and allows for maximum platform accessibility; and
- Constrained Rail Alternative 4 was developed with the focus on maximizing the overbuild potential. This alternative consists of a complete redesign of the South Station terminal area without impacting the existing bus terminal while enhancing the opportunity for future overbuild development by prioritizing the location of the overbuild support columns.

Each of these four alternatives was analyzed as part of the DEIR Tier 1 Screening process using five rating criteria. The rating criteria utilized were:

[1] The major infrastructure considered includes: existing South Station headhouse; I-90 Mass Turnpike tunnels and ramps; I-93 and ramps; Central Artery/Tunnel vent buildings; and MBTA Red Line.

- Platform accessibility from each service line;
- Platform berthing lengths;
- Infrastructure maintenance requirements;
- Constructability;[2] and
- Capital cost.

Table 1 presents the findings of the Tier 1 screening of Constrained Rail Alternatives 1 through 4. Due to the major impacts to existing infrastructure and challenges that would be encountered throughout the construction period, including significant service shutdowns, Constrained Rail Alternatives 1 and 4 were deemed "not feasible" and were not advanced beyond the Tier 1 screening.

Table 1 — Summary Tier 1 Screening, Constrained Rail Alternatives 1 through 4

Alternative	Platform Rating		Infrastructure Maintenance Rating	Constructability Rating	Capital Cost Rating
	Accessibility	Berthing			
1	1	1*	3	4	4
2	2*	1*	2*	2	2
3	2*	3	1	1	1
4	4	4	2*	3	3

A rating of 1 indicates the most favorable alternative in comparison to other alternatives for the specific criterion.
A rating of 4 indicates the least favorable alternative in comparison to other alternatives for the specific criterion.
* indicates that the alternatives have equal ratings in this criterion.

Based on the five rating criteria, Constrained Rail Alternatives 2 and 3 were recommended to be advanced into next level of screening.

2. Tier 2 Screening Performance Objectives

The Tier 2 screening considered the following elements as part of the evaluation process: platform accessibility and berthing, ability to meet operations, constructability, and cost. The evaluations of these elements are described in Section 4.

Constrained Rail Alternatives 2 and 3 were both evaluated for their ability to meet future South Station performance objectives, including the need to accommodate future service plans and to meet on-time performance goals:

- **Accommodate future service plans**. By the year 2035, the National Railroad Passenger Corporation (Amtrak) projects 80 weekday revenue trips and 58 weekday non-revenue trips, representing a 100% revenue service increase above current levels. Future 2035 Amtrak operations are based on the Northeast Corridor Intercity Service Alternative: "B-Low 2020-2040" operating plan provided by Amtrak.[3] By 2035, the Massachusetts Bay Transportation Authority (MBTA) projects up to 315 weekday revenue trips and 101 weekday non-revenue trips, representing a 13% revenue service increase above current levels. Projections of train movements in and out of South Station are

[2] Constructability refers to the complexity of design and the impacts on the efforts required for construction, including timelines, costs, and service interruptions.
[3] Northeast Corridor Intercity Service Alternative: "B-Low 2020 – 2040" operating plan provided by Amtrak on November 11, 2013.

estimated to be a total of 554 daily trains by the year 2035, representing an overall increase of 23% above current revenue service levels.[4]

- **Meet On-Time Performance (OTP) Goals.** OTP goals have been established for the South Station complex, which includes the South Station platforms, Tower 1 Interlocking, and the key approach interlockings at Cove on the Northeast Corridor (NEC) and Broad in the Widett Circle/Southampton Street area.

3. Track Configuration Alternatives

The Tier 2 analysis included coordination with MassDOT and with other project stakeholders regarding rail engineering design criteria, including design modifications. In addition, Constrained Rail Alternatives 2 and 3 were evaluated with respect to other SSX project elements, including station layout and design of layover facility sites.

Prior to the Tier 2 Screening, MassDOT advanced certain elements of the designs for Constrained Rail Alternatives 2 and 3 to improve functionality and better address the project goals. These conceptual design advancements included: shifting existing track alignments, adjusting track-to-platform clearances and platform configurations, refining accommodation of the South Station Air Rights (SSAR) project,[5] as well as further refinement of track curvature and special trackwork. These advancements and refinements in the design occur within the existing right-of-way and would not affect the environmental impacts of either alternative.

Both Constrained Rail Alternatives 2 and 3 maintain the existing platform configuration at South Station and expand the terminal track configuration to the east with seven new tracks and four new platforms parallel to the existing tracks. The existing platforms would remain at their current width of 17 feet 6 inches and the new platforms would be 26 feet wide to meet current National Fire Protection Association (NFPA) and Americans with Disabilities Act (ADA) standards.

The following provides a summary description of the alternatives. For further information on Constrained Rail Alternatives 2 and 3, including detailed descriptions, opportunities, and impacts/challenges, please refer to DEIR Appendix 2, *Track Configuration Alternatives Analysis - Tier 1 Screening Technical Report*.

3.1 Constrained Rail Alternative 2 – Streamline Operations

Constrained Rail Alternative 2 was developed with the goal of streamlining daily operations at South Station and includes a complete redesign of Tower 1 Interlocking. The redesign of Tower 1 Interlocking provides for two separate mini-terminals, reducing conflicting movements into the terminal. This alternative layout is illustrated in Figure 1.

In order to accommodate the new configuration of the realigned tracks through Tower 1 Interlocking and to lengthen the platforms as much as possible, all of the existing platforms would require extensions at their ends. In particular, Platform G would require extensive modifications to accommodate future Amtrak trainset lengths. The complete reconfiguration of the existing Tower 1 Interlocking would impact all the mainline tracks, special trackwork, and terminal tracks and would significantly impact existing

[4] 2035 revenue service level weekday train movements are based on Massachusetts Department of Transportation. *Basis of Operations Analysis and Assumptions Verification Report*, Version 3. June 2014.

[5] The South Station Air Rights (SSAR) project is a possible future project (EEA No. 9131) for a development above the South Station headhouse and terminal area. The SSX project alternatives evaluation is independent of the SSAR project, however has taken into account any impacts the project would have on the site if constructed.

service during construction. It would also require the implementation of a new operations plan by the dispatcher for future operations of the terminal.

3.2 Constrained Rail Alternative 3 – Minimize Disruption to Operations

Constrained Rail Alternative 3 was developed with the goal of minimizing the disruption to existing operations of the terminal. The additional terminal tracks are accommodated by adding special trackwork to the existing Tower 1 Interlocking, including an additional ladder configuration on the Dorchester Branch. The Dorchester Branch Second Ladder configuration included in this alternative provides added flexibility in cases of disabled trains or other unexpected activities in the Tower 1 Interlocking area. This added flexiblity provides redundancy that is preferred in larger stations to avoid a case where one disabled train can shut down access to numerous platforms and tracks. This alternative layout is illustrated in Figure 2.

Similar to Constrained Rail Alternative 2, existing Platform G would require extensive lengthening modifications, however, there would be no modifications to the other existing platforms.

By retaining the existing Tower 1 Interlocking with minor modifications, this alternative minimizes the construction staging impacts and allows the current operation plan to remain in place.

3.3 Approach (Setup) Interlockings

This section presents the proposed configuration of the interlockings[6] approaching Tower 1 Interlocking, Cove Interlocking from the east and Broad Interlocking from the south. This concept would apply to both Constrained Rail Alternatives 2 and 3. The proposed future 20-track South Station layout envisions infrastructure that can support multiple trains moving simultaneously through the Tower 1 Interlocking area. This proposed layout would be paired with an operating philosophy that reduces the amount of conflicting movements through the terminal area by making it possible for most trains to use the approach interlockings at Cove and Broad, thereby allowing faster and more efficient crossover moves in preparation of berthing at station platforms. The Cove Interlocking on the NEC allows crossovers to occur at 20-30 mph, versus the speed of 10 mph in the Tower 1 Interlocking area, making the necessary crossover movements more efficient. The proposed universal interlocking at Broad Interlocking would deploy the same philosophy of pushing the conflicting movements to an area of higher-speed crossovers and away from the Tower 1 Interlocking area. This proposed layout would continue to provide the operational flexibility needed in the event of an equipment failure or emergency.

[6] An interlocking is a segment of railroad infrastructure comprised of track, turnouts, and signals linked (interlocked) in a way that allows trains to move from one track to another, or across tracks, safely preventing conflicting train movements. The interlockings enable train dispatchers to route incoming trains over a variety of tracks to/from available station tracks. An approach interlocking is an interlocking leading up to a terminal interlocking and station. Typically, approach interlockings are only a short distance from the terminal and allow trains to switch tracks leading into the terminal to prepare to berth at specific platform tracks. Making these movements at the approach interlocking instead of at the terminal also allows for more efficient operations as the crossing movements can be made at higher speeds while avoiding conflicting movements.

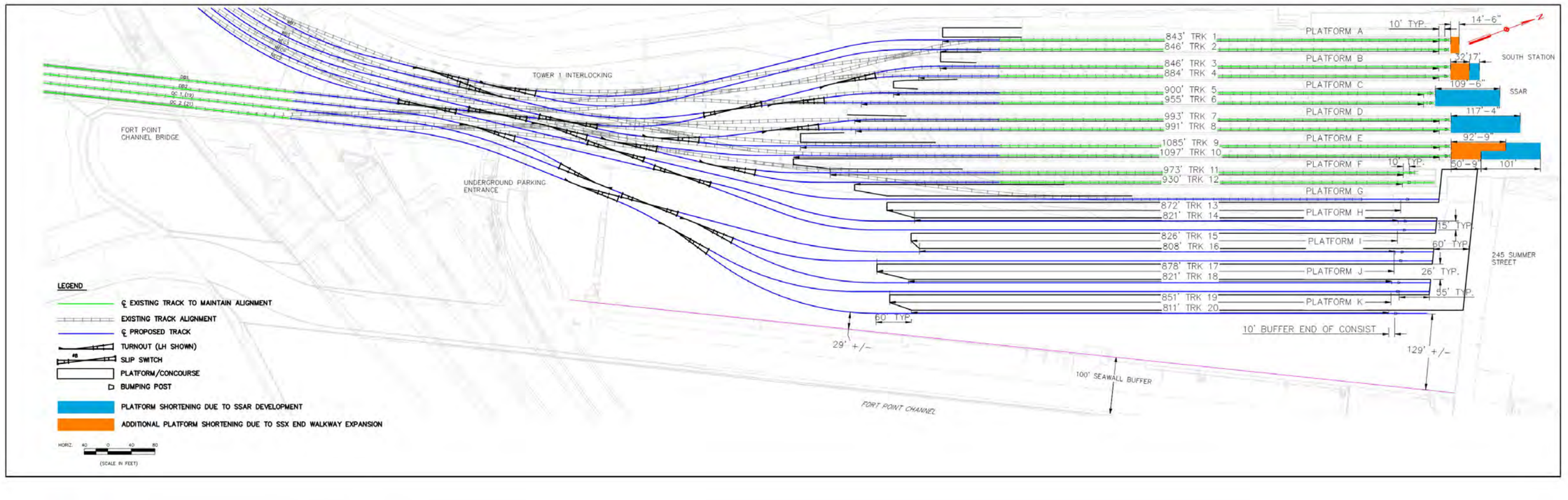

Figure 1 — Constrained Rail Alternative 2 — Streamline Operations

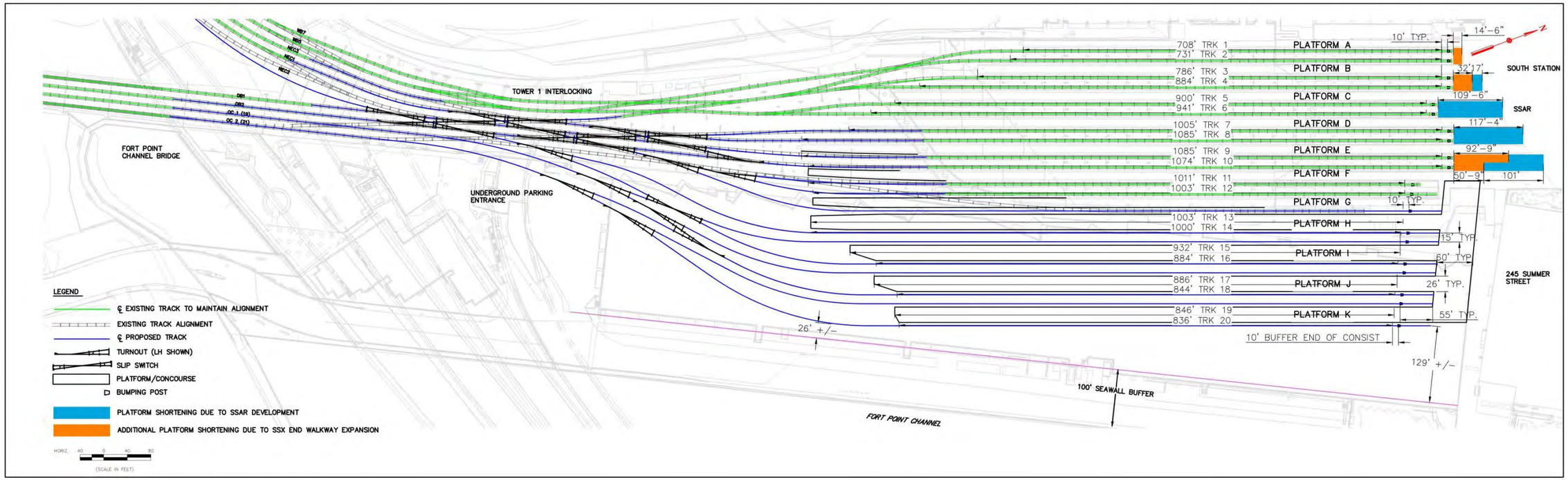

Figure 2 — Constrained Rail Alternative 3 — Minimize Disruptions to Operations

Figure 3 — Broad Interlocking — Proposed Layout

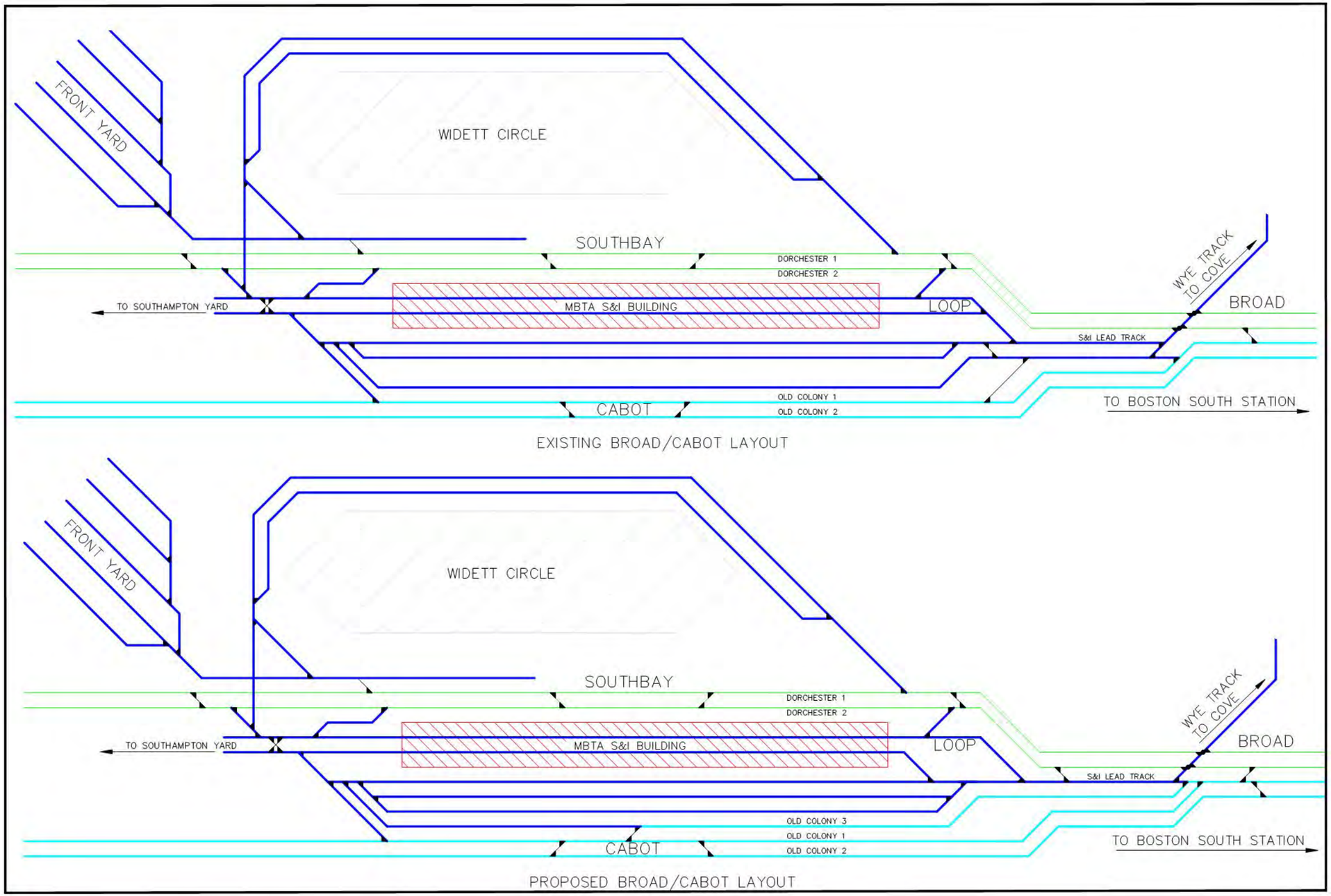

Figure 4 — Broad Interlocking — Proposed Schematic

Broad Interlocking

Broad Interlocking, as illustrated in Figures 3 and 4, would be substantially modified to include the introduction of a third running track (designated OCRR3). This running track would contain an 850-foot minimum section between Cabot and Broad Interlockings that would provide sufficient space to hold one trainset outside of Tower 1 Interlocking. This would help with maintaining speed and maximizing efficient train movements through Tower 1 Interlocking.

Other improvements at Broad Interlocking would include the installation of new universal crossovers, on the north end of the interlocking, in the vicinity of the existing Wye track, to allow moves between DB2 and OC19 and maintain moves to the Wye track and Service and Inspection (S&I) Facility. A new yard lead would be established and the MBTA's S&I Facility yard tracks would be realigned. The proposed track realignment of the Fairmount Line/Dorchester Branch Track 1 and Track 2 may require a small partial acquisition of the Boston Department of Public Works (DPW) Lot and could impact the garage access ramp.

4. Alternatives Screening

4.1 Rating Criteria

This section discusses the rating criteria that were used to screen Constrained Rail Alternatives 2 and 3 in the Tier 2 analysis. Each alternative was graded using a numerical rating of 1 or 2 to evaluate the ability of the alternative to meet the criteria, with 1 being the more favorable alternative to meet system requirements and 2 being the less favorable alternative to meet system requirements. The rating criteria included: platform accessibility and platform berthing, operations, constructability, capital cost, maintenance cost, and stakeholder preference. The criteria listed herein are related to operational and physical characteristics of the rail alternatives.

As stakeholders in the SSX project, the Federal Railroad Administration (FRA), Amtrak, and MBTA were provided opportunities to review and comment on the Constrained Rail Alternatives 2 and 3. Their comments and preferences were important to consider as part of each rating criteria.

4.1.1 Platform Rating

The platform designs of the Constrained Rail Alternatives were rated for their accessibility by each service line and their ability to berth future Amtrak and MBTA trainsets. The goals are to:

- **Provide maximum platform accessibility**. In the case of an emergency or a stopped vehicle, flexibility in platform accessibility is critical. Platform accessibility is measured by the number of station tracks that each service track can access whether the crossover move occurs at the approach interlocking or at Tower 1 Interlocking.
- **Accommodate Amtrak and MBTA platform berthing standards**. In order for a trainset to use any platform, adequate berthing length is required. To accommodate future Amtrak trainsets, platform berthing lengths are desired to be 1,050 feet. To accommodate future MBTA trainsets, platform berthing lengths are desired to be 850 feet. In instances where site restrictions limit the ability to meet the above described length, design modifications may be incorporated into platform design to "extend" platform capabilities to accommodate berthing of Amtrak and MBTA trainsets. These design modifications are depicted in Figure 5.

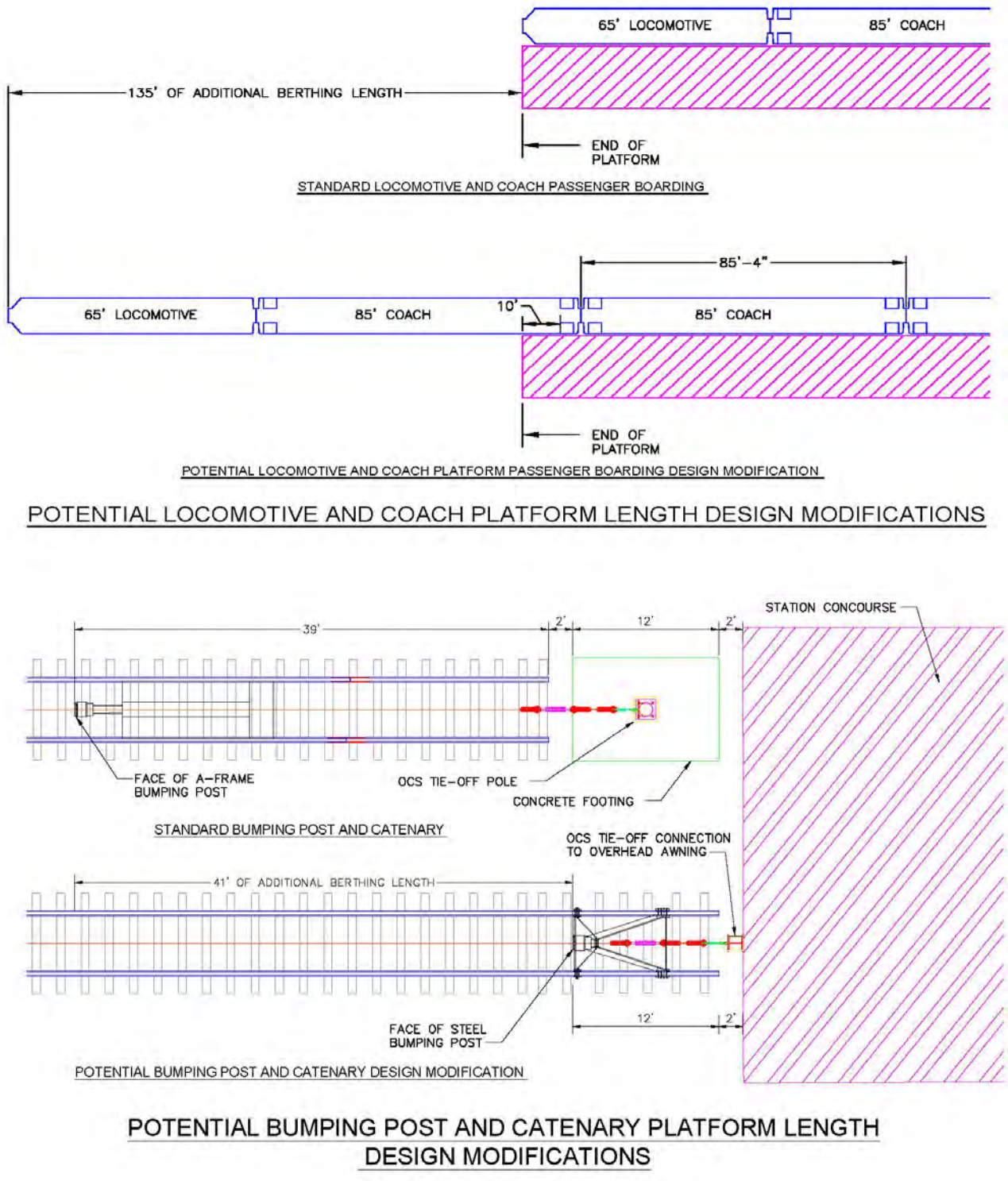

Figure 5 — Potential Berthing Accommodation Design Modifications

4.1.2 Operations Rating

Operations simulation models were developed for each alternative and were evaluated for how each would support future 2035 service levels, as well as on their OTP and delay performance. Additionally, operational efficiencies and limitations of each alternative were identified. FEIR Appendix E, *Rail Operations Analysis Technical Report* details the operations simulation models and the operational efficiencies and limitations.

4.1.3 Constructability Rating

The Constrained Rail Alternatives 2 and 3 were evaluated for their constructability, measured by the degree to which they would minimize impacts to existing infrastructure and minimize disruption to passenger service. The goals are to:

- **Minimize impacts to existing infrastructure**. Existing infrastructure at South Station includes the station tracks and platforms, bus terminal, and foundations for future development (SSAR project).
- **Minimize disruption to passenger service**. South Station is one of the busiest terminals in the Northeast, thus, keeping the trains running during construction with the least impact to their schedules becomes a challenge. It is critical that construction phasing minimize disruption to operations and maximize safety.

4.1.4 Capital Cost Rating

The Constrained Rail Alternatives 2 and 3 were rated according to their anticipated capital costs. The goal is to:

- **Minimize capital costs**. Order-of-magnitude costs are used to evaluate the constrained rail alternatives. Capital costs include station area track and platforms, Tower 1 Interlocking, approach interlockings, signal, communication system, and overhead contact system (OCS).

As discussed earlier in the Track Configuration Alternatives section, the engineering of Constrained Alternative 2 and 3 has been advanced since the conclusion of the Tier 1 study. From a capital cost perspective, the advancements and refinements in the design are not considered an impact to the order-of-magnitude costs to any significant degree.

4.1.5 Maintenance Cost Rating

The Constrained Rail Alternatives 2 and 3 were rated according to their anticipated maintenance costs. The goal is to:

- **Minimize maintenance costs**. It was not possible at this time to determine actual maintenance costs; therefore a comparison of the quantity of maintenance expected for each of the constrained rail alternatives was utilized.

4.2 Tier 2 Alternatives Screening

4.2.1 Platform Rating

This section describes the screening results for platform rating for the station track accessibility and berthing standards criteria.

Station Track Accessibility

Table 2 and Table 3 present the proposed station track accessibility at South Station in both alternatives. The tables compare the station tracks that would be accessible for each rail service line track approaching the station in two scenarios: 1) with the crossover move(s) occurring at the approach interlocking; or 2) with the crossover move(s) occurring at Tower 1 Interlocking.

Table 2 — Proposed Station Track Accessibility, Constrained Rail Alternative 2

Trains Entering South Station			Accessible Station Tracks																			
Service Line	Track	Crossover Move at Proposed Interlocking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Framingham/ Worcester	7	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1	✓	✓	✓	✓	✓	✓														
	5	Cove			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓														
Northeast Corridor	3	Cove			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓	✓	✓	✓											
	1	Cove			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
	2	Cove			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
		Tower 1			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Fairmount/ Dorchester Branch	1	Broad			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
	2	Broad			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1														✓	✓	✓	✓	✓		
Old Colony	19	Broad														✓	✓	✓	✓	✓	✓	✓
		Tower 1																✓	✓	✓		
	21	Broad														✓	✓	✓	✓	✓	✓	✓
		Tower 1																✓	✓	✓	✓	✓

✓ Indicates that the station track would be accessible if the crossover move were to occur at specified interlocking.

Constrained Rail Alternative 2 Track Accessibility

- The NEC service lines and Framingham/Worcester Track 5, for crossover moves made at Cove Interlocking, would have 13 of 20 station tracks available for all trains (65% accessibility).

- The Fairmount Line/Dorchester Branch service lines track accessibility, with crossover moves at Broad Interlocking, would be high, with 18 of 20 station tracks available (90% accessibility).

- Dorchester Branch Track 2 would have limited accessibility for crossover moves at Tower 1 Interlocking with access to only five of 20 station tracks (25% accessibility).

- Station track accessibility for the Old Colony Lines would be limited, with accessibility for seven of 20 station tracks (35% accessibility) for crossover moves at Broad Interlocking. Track 19 would be most limited for crossover moves at Tower 1 Interlocking, with access to only three of 20 station tracks (15% accessibility).

Table 3 — Proposed Station Track Accessibility, Constrained Rail Alternative 3

Trains Entering South Station			Accessible Station Tracks																			
Service Line	Track	Crossover Move at Proposed Interlocking	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Framingham/ Worcester	7	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
		Tower 1	✓	✓	✓	✓																
	5	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
		Tower 1	✓	✓	✓	✓	✓	✓														
North East Corridor	3	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
		Tower 1	✓	✓	✓	✓	✓	✓														
	1	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							
	2	Cove	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
Fairmount/ Dorchester Branch	1	Broad	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
	2	Broad	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
Old Colony	19	Broad	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1															✓	✓	✓	✓		
	21	Broad	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tower 1																		✓	✓	✓

✓ Indicates that the station track would be accessible if the crossover move were to occur at the specified interlocking.

Constrained Rail Alternative 3 Track Accessibility

- Trains approaching South Station via the Fairmount Line/Dorchester Branch would have nearly universal platform accessibility if the crossover move was to occur at Tower 1 Interlocking and fully universal platform accessibility for crossover moves at Broad Interlocking.

- Platform accessibility for the NEC and Framingham/Worcester service lines for crossover moves made at Cove Interlocking would be provided by 16 out of 20 station tracks (80% accessibility).

- Framingham/Worcester Track 7 would have limited track accessibility for crossover moves at Tower 1 Interlocking with access to four of 20 station tracks (20% accessibility).

- Station track accessibility for crossover moves at Tower 1 Interlocking would be most limited for the Old Colony (OC) Lines, with OC Track 21 limited to only three of 20 tracks (15% accessibility) and OC Track 19 limited to four of 20 tracks (20% accessibility).

Amtrak commented that Constrained Rail Alternative 3 is more consistent with their current dispatching than Constrained Rail Alternative 2, and expressed concerns with the differences between Constrained Rail Alternative 2 and their current dispatching. The MBTA commented that they would prefer the versatility of Constrained Rail Alternative 3.

Constrained Rail Alternative 3 receives the higher rating for this criterion because of the greater station track accessibility and stakeholder preference.

Berthing Standards

As discussed in Appendix 2 of the DEIR, the South Station terminal area presents many physical constraints to platform berthing. The SSAR project would add to these constraints by shortening some platform lengths. The platform length modifications due to SSAR are detailed in Section 3.2.4 of DEIR Appendix 2. Because of these constraints, MassDOT was required to develop design modifications to enhance platform capabilities and accommodate Amtrak and MBTA berthing length standards. These modifications are design and operational solutions that vary from standard practice; however, they have been implemented successfully in other projects with similar constraints.

The first modification is an operational solution that reduces the required platform length by locating the locomotive and a portion of the first coach beyond the end of the platform. This would restrict boarding on the first coach as it could only occur using the station end door, as shown in Figure 5. This approach would effectively increase the available berthing length of the platform by 135 feet (65 feet for locomotive and 70 feet for the first coach). As a result, the effective platform length to accommodate Amtrak trainsets would be 915 feet (as opposed to 1,050 feet), and the effective platform length to accommodate MBTA trainsets would be 715 feet (as opposed to 850 feet). In order to consider this design modification, adjustments would need to be made to the signal position and height. The signal would need to be positioned far enough away from the locomotive and at a height that can be seen by the Train Engineer, as shown in Figure 6.

The second modification is a design solution that includes using a fixed type bumping post to replace some of the longer hydraulic bumping posts which require additional space to slide along the track and are currently proposed for South Station. This solution also includes terminating OCS within the station area and using existing station structures (such as canopies, beams, columns, etc.) to support the OCS instead of using OCS tie-off poles, as shown on Figure 5. By removing the standard OCS foundation and

pole and replacing the standard movable bumping post with a fixed bumping post, this approach would effectively increase the available berthing length of the platform by 41 feet. In combination with the first design modification, the minimum effective platform length to accommodate Amtrak trainsets would be 874 feet (as opposed to 1,050 feet), and the minimum effective platform length to accommodate MBTA trainsets would be 674 feet (as opposed to 850 feet). In order to consider these design modifications, standard criteria and practices would need to be modified with a design exception and each individual exception approved by the project stakeholders.

For the purposes of this Tier 2 analysis, Constrained Rail Alternatives 2 and 3 included the use of platform boarding and alighting modifications and bumping post and OCS design modifications to accommodate Amtrak and MBTA berthing standards. Also included for this analysis was the assumption of a minimum 10-foot buffer between the end of the trainset and the face of the bumping post, as in practice today at South Station. A more thorough analysis of the space required and the space available for the platform boarding modifications will need to be conducted and MassDOT will work with project stakeholders to review potential design exceptions required to maintain acceptable platform/berthing lengths.

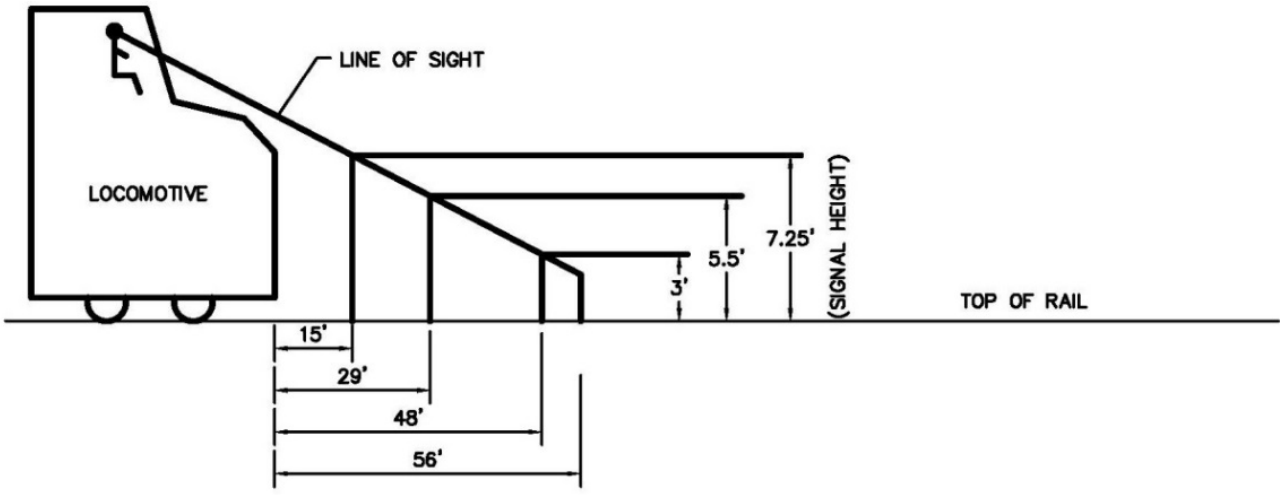

Figure 6 — Signal Sight Line

Table 4 summarizes the ability of the proposed platforms in Constrained Rail Alternatives 2 and 3 to accommodate Amtrak and MBTA berthing standards. Both Constrained Rail Alternatives 2 and 3 would meet platform berthing standards for MBTA trainsets at all station tracks, providing design modifications can be applied at all platforms. However, Constrained Rail Alternative 3 would accommodate MBTA trainsets at more station tracks than Constrained Rail Alternative 2 if platform design modifications are not permitted at some or all platforms. Constrained Rail Alternative 3 would meet platform berthing standards for Amtrak trainsets at 14 out of 20 station tracks. Constrained Rail Alternative 2 would meet platform berthing standards for Amtrak trainsets at only 10 out of 20 station tracks.

The FRA and Amtrak both commented that Constrained Rail Alternative 3 was their preferred alternative because the alternative had longer platforms. Therefore, Constrained Rail Alternative 3 receives the higher rating for this criterion.

Table 4 — Proposed Berthing Standard Accommodations, Constrained Rail Alternatives 2 and 3

Track	Platform	Alternative 2				Alternative 3			
		Design Length		With Modifications		Design Length		With Modifications	
		MBTA	Amtrak	MBTA	Amtrak	MBTA	Amtrak	MBTA	Amtrak
1	A			✓				✓	
2	B			✓				✓	
3	B			✓				✓	
4	C	✓		+	✓	✓		+	✓
5	C	✓		+	✓	✓		+	✓
6	D	✓		+	✓	✓		+	✓
7	D	✓		+	✓	✓		+	✓
8	E	✓		+	✓	✓	✓	+	+
9	E	✓	✓	+	+	✓	✓	+	+
10	F	✓	✓	+	+	✓	✓	+	+
11	F	✓		+	✓	✓		+	✓
12	G	✓		+	✓	✓		+	✓
13	H	✓		+		✓		+	✓
14	H			✓		✓		+	✓
15	I			✓		✓		+	✓
16	I			✓		✓		+	✓
17	J	✓		+	✓	✓		+	✓
18	J			✓				✓	
19	K	✓		+				✓	
20	K			✓				✓	

✓ indicates that the station platform would be able to accommodate Amtrak and/or MBTA berthing standards
\+ indicates that innovations are not necessary to accommodate Amtrak and/or MBTA berthing standards

4.2.2 Operations Rating

Operations simulation models were developed for each alternative and were evaluated for how each would support future 2035 service levels, as well as on their OTP and delay performance. Additionally, operational efficiencies and limitations of each alternative were identified.

- **Ability to Meet Future Service Goals.** Both Alternative 2 and Alternative 3 would meet the 2035 future service plans for the MBTA and Amtrak.

- **Ability to Meet OTP and delay goals.** Under randomized conditions, the average OTP was simulated to be 96% for Alternative 2 and 94% for Alternative 3 during the PM peak period, the most heavily congested portion of the day. This indicates that OTP results for a full day of operations would likely meet or exceed the OTP goal of 95% in both alternatives. Average delay in the randomized simulation was found to be 7% for Alternative 2 and 13% for Alternative 3. While the randomized results show that trains in Alternative 2 experience less delay and greater OTP than in Alternative 3, these PM peak period results indicate that both alternatives are robust and flexible enough to provide reliable service given the large increase in future 2035 trip volumes. The results prove that both alternatives can meet the goals of this project, but the minor variance between the two does not offset more significant differences in other rating criteria.

- **Operational Efficiencies/Limitations.** Operational efficiencies related to parallel moves through the Tower 1 Interlocking and access to tracks and platforms were evaluated for each alternative and are summarized below. Detailed descriptions of these operational efficiencies and limitations for each alternative are included in FEIR Appendix E, *Rail Operations Analysis Technical Report.*

The Alternative 2 layout was developed to streamline terminal operations and sectionalize the operations into "mini terminals" to reduce the amount of conflicting movements at the critical junction. Alternative 2 has significantly less special trackwork through the Tower 1 Interlocking, providing for more efficient access between the approach tracks and the platform tracks. The Alternative 2 Tower 1 Interlocking layout can support up to eight parallel train movements simultaneously between the nine approach tracks and 20 platform tracks, including five parallel movements to or from the five approach tracks from the NEC and MBTA Framingham/Worcester Line. For comparison, the existing Tower 1 Interlocking layout can currently support a total of six parallel movements, with the possibility of four parallel movements to or from the NEC and Framingham/Worcester Line approach tracks. Alternative 2 includes an operational challenge for non-revenue movements. The single connection between Dorchester Branch Track 1 to platform Tracks 3-13, forces all non-revenue operations moving between the South Side facilities and those platform tracks to use the same single piece of track into the South Station Terminal.

The Alternative 3 layout considers the addition of Tracks 14-20 by adding special trackwork to the existing Tower 1 layout in order to maximize access to platform tracks from each approach track while also maintaining as much of the existing infrastructure as possible. The Alternative 3 Tower 1 Interlocking layout can support up to seven parallel moves simultaneously between the nine approach tracks and 20 platform tracks, including four parallel movements to or from the five approach tracks from the NEC and Framingham/Worcester Line. However, if any trains from the NEC tracks are routed to a platform track higher than Track 10, the number of possible simultaneous parallel moves is reduced to six.

Alternative 3 does not provide the same level of operational efficiency or number of parallel moves as Alternative 2; but it does provide increased flexibility for non-revenue moves between the station platform tracks and the south side layover facilities with two ladders to access the Dorchester Branch tracks. This second Fairmount Line/Dorchester Branch ladder track provides less of an opportunity for delays if a disabled train or other unexpected activity blocked trackwork within the Tower 1 Interlocking. The significant amount of special trackwork throughout the Alternative 3 Tower 1 Interlocking layout may pose challenges for operations in the terminal.

Both Amtrak and the MBTA commented that the lack of a second ladder connection for the Fairmount Line/Dorchester Branch in Constrained Rail Alternative 2 was a significant concern and differs from what occurs today at South Station. It was stated that Constrained Rail Alternative 3 would be preferred as it provide the second ladder connection within the terminal area. During stakeholder meetings, Amtrak and the MBTA both reflected on recent events where the second ladder connection was necessary for access to the terminal. Amtrak also commented that Constrained Rail Alternative 3 looked more favorable because of the operational benefits. Constrained Rail Alternative 3 is therefore rated higher for this criterion.

4.2.3 Constructability Rating

Constrained Rail Alternative 2 would require a complete reconfiguration of the existing Tower 1 Interlocking and would require a new operations plan to be implemented by the dispatcher, while retaining existing station Track 1-13 alignments and platform widths. Several switches and crossovers would be removed from the Tower 1 Interlocking, requiring reconfiguration of the existing tracks within the interlocking. This complete reconfiguration of the existing interlocking is challenging to constructability because it will require significant disruptions to current service to the terminal during construction.

Constrained Rail Alternative 3 would maintain the existing configuration of Tower 1 Interlocking with modifications and replacements to a much lesser degree than Constrained Rail Alternative 2. It would not require the extensive special trackwork and realignment required in Constrained Rail Alternative 2. The additional track expansion would tie into the eastern side of Tower 1 Interlocking, limiting the required track outages and impacts to rail service, especially for the tracks entering the terminal from the west. Additional special trackwork within Tower 1 Interlocking would limit required track outages because it is anticipated that the work would not require much of the interlocking to be taken out of service at the same time or for an extended period of time. However, the additional special trackwork required within Tower 1 Interlocking could pose challenges to constructability because of the complexity of the special trackwork required to fit within the existing tracks and special trackwork.

The FRA, Amtrak, and MBTA were all presented with the Constrained Rail Alternative 2 and 3 constructability analysis and asked for comments and preference. All parties agreed that constructability is a major issue and that Constrained Rail Alternative 3 is the preferred alternative because it can be built up to a certain point without impacting operations whereas Constrained Rail Alternative 2 would require the complete replacement of Tower 1 Interlocking, which represents a significant additional risk to construction phasing and operations.

Since it is anticipated to require the least amount of track outages and is the preferred alternative amongst the stakeholders, Constrained Rail Alternative 3 receives the higher rating for this criterion.

4.2.4 Order-of-Magnitude Capital Cost Rating

Table 5 presents order-of-magnitude capital costs for constructing the Constrained Rail Alternatives 2 and 3. Capital costs were calculated for all tracks, signal system, OCS, communication system, and associated civil work within terminal and station areas including work at Tower 1, and the approach interlockings. These cost estimates were based on the initial conceptual designs and are used as to compare Constrained Rail Alternatives 2 and 3. The capital costs here do not represent present project costs.

The FRA, Amtrak, and MBTA were all presented with Constrained Rail Alternatives 2 and 3 and asked for comments and preference. All identified Constrained Rail Alternative 3 as the preferred alternative because it is the less expensive option.

Constrained Rail Alternative 3 receives the higher rating for this criterion.

Table 5 — Capital Costs, Constrained Rail Alternatives 2 and 3

Alternative	Order-of-Magnitude Capital Costs
2	$175 million
3	$111 million

4.2.5 Maintenance Cost Rating

Although specific costs associated with maintenance have not been calculated, the quantity of maintenance for the two alternatives can be compared. It is anticipated that Constrained Rail Alternative 3 would require the highest overall maintenance requirements because it would require a greater amount of special trackwork at Tower 1 Interlocking. Constrained Rail Alternative 2 would require a lesser amount of special trackwork at Tower 1 Interlocking and is therefore anticipated to require the least amount of overall maintenance and lower maintenance costs. Table 6 presents a comparison of the amount of special trackwork at Tower 1 Interlocking for the existing conditions, Constrained Rail

Alternative 2, and Constrained Rail Alternative 3. Constrained Rail Alternative 2 receives the higher rating for this criterion.

Table 6 — Amount of Special Trackwork, Existing and Constrained Rail Alternatives 2 and 3

Alternative	Turnouts	Double Split Switches	Diamond Crossings
Existing	24	13	2
2	15	7	0
3	21	13	4

4.2.6 Summary of Findings

Table 7 summarizes the findings of the Tier 2 screening of Constrained Rail Alternatives 2 and 3. Constrained Alternative 3 ranked higher in four of the performance criteria:

- Platform accessibility;
- Platform berthing lengths;
- Constructability; and
- Capital cost.

In addition, all project stakeholders were in agreement that Constrained Rail Alternative 3 is their preferred alternative. Based on this and the results of all rating criteria, Constrained Rail Alternative 3 is recommended as the alternative that will advance to preliminary design.

Table 7 — Summary Tier 2 Screening Table, Constrained Rail Alternatives 2 and 3

Alternative	Platform Rating		Operations Rating	Constructability Rating	Capital Cost Rating	Maintenance Cost Rating	Stakeholder Preference
	Accessibility	Berthing					
2	2	2	1	2	2	1	2
3	1	1	2	1	1	2	1

Note: A rating of 1 indicates the more favorable alternative in comparison to the other alternative for the specific criterion. A rating of 2 indicates the less favorable alternative in comparison to the other alternative for the specific criterion.

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