U.S. Department of Transportation
Federal Railroad Administration

# New York Penn Station Service Optimization Study

Phase I Report | June 2026

## Acronyms and Definitions

| Acronym | Definition |
|---|---|
| **ADA** | Americans with Disabilities Act |
| **CBD** | Central Business District |
| **ERT** | East River Tunnels |
| **FRA** | Federal Railroad Administration |
| **FTA** | Federal Transit Administration |
| **HRT** | Hudson River Tunnel |
| **LIRR** | Long Island Rail Road |
| **Metro-North** | Metro-North Railroad |
| **Moynihan** | Moynihan Train Hall |
| **MSG** | Madison Square Garden |
| **MTA** | Metropolitan Transportation Authority |
| **NEC** | Northeast Corridor |
| **NJ Transit** | New Jersey Transit |
| **NRT** | North River Tunnels |
| **NYMTC** | New York Metropolitan Transportation Council |
| **OTP** | On-Time Performance |
| **PATH** | Port Authority Trans-Hudson |
| **Penn Expansion** | Penn Station Expansion Design |
| **Penn Station** | New York Pennsylvania Station |
| **Penn Transformation** | Penn Station Transformation Project |
| **PSCC** | Penn Station Central Control |
| **PTV** | PTV Group Vissim/Viswalk Pedestrian Modeling Software |
| **RTC** | Rail Traffic Controller Simulation Software |
| **Study** | Penn Station Service Optimization Study |
| **TPHPD** | Trains per Hour per Direction |
| **USDOT** | U.S. Department of Transportation |
| **VCE** | Vertical Circulation Element |

# Table of Contents

# Executive Summary

## Penn Station Today: A Station Under Stress

New York Pennsylvania Station (Penn Station) is the busiest passenger rail hub in the United States, serving more than 350,000 riders every day across more than 1,000 daily train movements. But despite its scale and importance, the station has both physical and operating issues that make it challenging for both passengers and the railroads that use it.

Riders today navigate platforms that are too narrow for the crowds that use them, with too few stairs, elevators and escalators to move people on and off trains efficiently. Platform clutter, such as equipment, signage, trash receptacles, and other obstructions, further reduces usable space. Signage is inconsistent, making the station confusing for anyone who does not use it regularly. These conditions make the passenger experience unnecessarily difficult and slow down the boarding and alighting process for every train.

The reliability of operations at the station also leaves room for improvement. Only 76 percent of Amtrak trains arrived on time on the Northeast Corridor (NEC) in 2025. New Jersey Transit (NJ Transit) reports an 81 percent on-time performance (OTP) on its NEC Line for January 2026, its busiest service. When trains do not arrive or depart on schedule, delays often cascade such that a late train on one track can delay movements across the entire station. During the peak hour, Penn Station runs at or near full capacity, leaving almost no buffer to absorb disruption.

## Why This Will Matter More in the Future

The problems facing Penn Station today are serious and will only become more severe as train service and ridership grow in the future.

Several previously planned and ongoing capital programs centered on and around Penn Station aim to address anticipated passenger growth, expand concourse capacity, enable more efficient operations, and allow for new services including adding the Metropolitan Transportation Authority's (MTA) Metro-North Railroad (Metro-North) service via the Penn Station Access project. Chief among these is the Gateway Program, which includes a suite of critical rail infrastructure projects on the NEC between Newark, NJ and Penn Station. Upon completion, the Gateway Program is expected to expand trans-Hudson rail capacity, potentially doubling throughput from 24 to up to 48 trains per hour per direction (TPHPD). The Gateway Program includes the new Hudson River Tunnel (HRT), which is currently under construction and will take approximately nine years to build (estimated completion 2035), and rehabilitation of the North River Tunnels (NRT) (estimated completion 2038).[1]

Once these Gateway Program investments are complete, Penn Station itself—its tracks, platforms, stairs, and operations—becomes the binding constraint on how much passenger rail service the system can accommodate. If the station cannot process passengers quickly, safely, and more reliably, the benefits of these adjacent rail infrastructure investments will not reach riders.

## The Penn Station Service Optimization Study and the Penn Station Transformation Project

There is no status quo at Penn Station; change is coming. Under the direction of Secretary Sean Duffy, the United States Department of Transportation (USDOT) and the Federal Railroad Administration (FRA) intend to make a one-time investment with the **Penn Transformation Project** (Penn Transformation) that modernizes and improves not only the Penn Station passenger concourses, but the tracks, platforms, and service operations as well. This **New York Penn Station Service Optimization Study** (the Study) seeks to determine how much additional service capacity could reasonably be unlocked from the existing Penn Station complex through targeted, minimal infrastructure improvements, without substantially expanding the existing footprint or rebuilding the station. Phase I of the Study, covered in this report, focuses only on the existing footprint of the Penn Station complex.

The infrastructure improvements identified in this report are either intended to be implemented by Amtrak and relevant partners as part of, or in conjunction with, Penn Transformation — or critically, must not be precluded by it. FRA, Amtrak, and the selected Master Developer will work collaboratively to advance the improvements that USDOT expects to see as part of Penn Transformation or delivered by Amtrak in conjunction with Penn Transformation.

Two primary factors currently constrain service at the station: (1) conflicting train flows resulting from the mixing of terminal and through operations; and (2) long platform dwell times (the total amount of time a train remains stationary at a station, primarily for the purpose of boarding/alighting passengers). The capacity of the new HRT and related investments will be underutilized if these two constraints are not addressed. To increase capacity within the existing station footprint, this report explores both physical and operational options to separate train flows and reduce dwell times by improving platform efficiency for both through-running and terminating trains.

[1] Hudson Tunnel Project Overview - Gateway Development Commission, December 2025. In addition to the new HRT and NRT rehabilitation, the Gateway Program includes four currently unfunded projects: Newark-Harrison Systems Modernization, Sawtooth Bridges Replacement, Portal South Bridge, and Secaucus Junction Capacity Expansion.

## How the Study Was Structured

The Study is being conducted in two phases. Phase I, summarized in this report, is limited to Penn Station's track, platform, and vertical circulation elements (VCEs) within the existing station complex, between West 31st and West 33rd Streets and 6th to 10th Avenues (see **Figure ES-1**). Phase I evaluates potential improvements limited to these elements of Penn Station.

Phase I examines track, platform, and vertical circulation elements (VCEs) within Penn Station's existing complex.

Phase II will evaluate broader regional infrastructure and operational strategies that may further enable long-term service growth, including infrastructure beyond Penn Station, train fleets, and other important topics such as governance and labor.

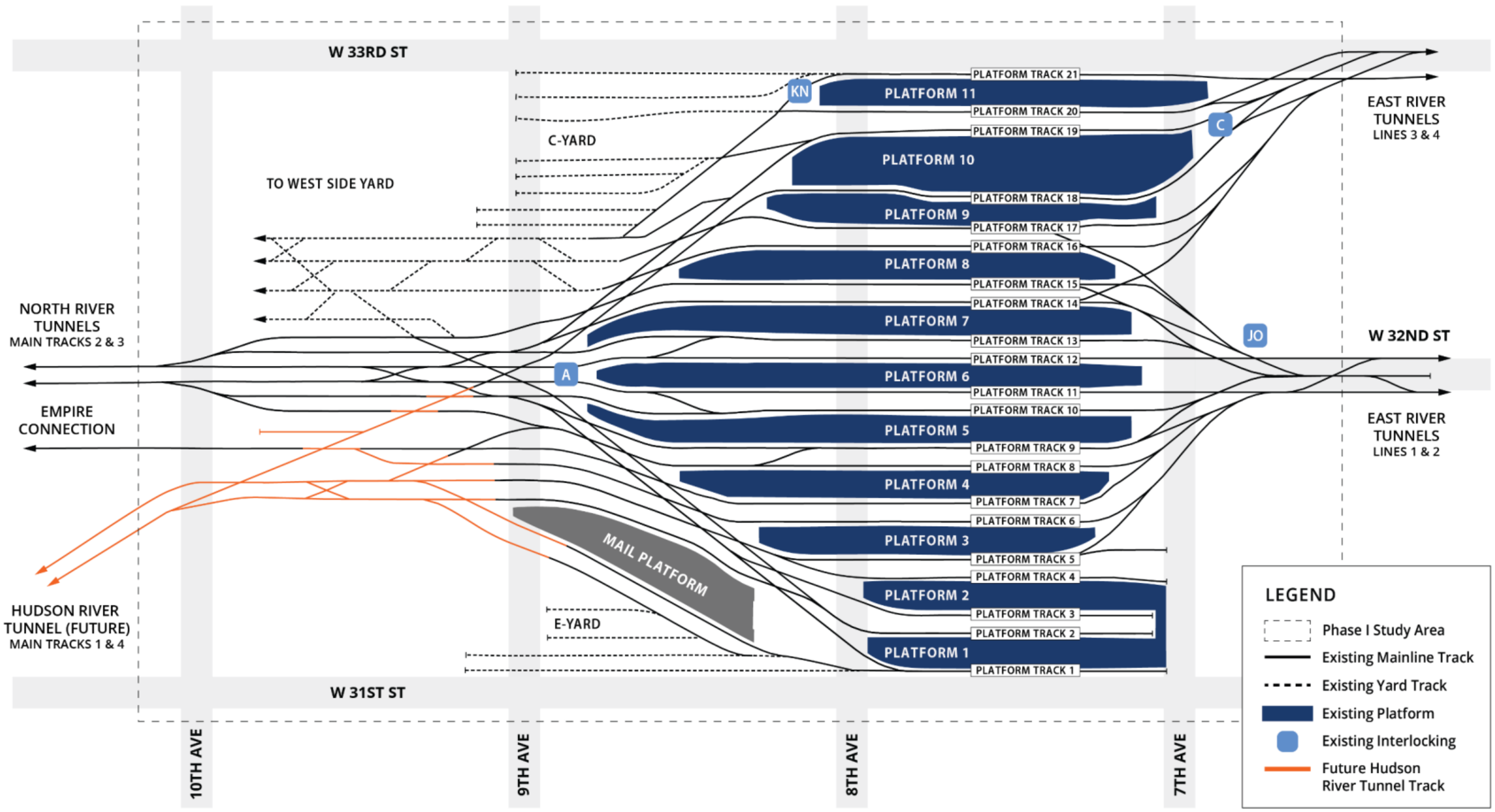
Phase II will evaluate broader regional infrastructure and operational strategies that may further enable long-term service growth, including infrastructure beyond Penn Station, train fleets, and other important topics such as governance and labor. These improvements aim to increase future service levels at Penn Station, while also improving customer experience and safety at the platform level.

Phase I did not include a review of railroad expansion plans outside of Penn Station; therefore, alignment or divergence with those plans has not been assessed and will be evaluated in Phase II.

The FRA Study Team's (Study Team) Phase I analysis is based on four principles that have been proven to maximize capacity at major rail stations around the world:

- **Interlocking Deconfliction** — Reducing conflicting train movements by realigning track usage to increase reliable throughput.
- **Platform Clearance** — Improving vertical access and boarding processes so passengers can clear platforms faster, shortening train dwell times.
- **Through-Running Operations** — Reducing dwell times by running trains through the station rather than terminating them at the station and turning them on the platform.
- **Operational Discipline** — Building a terminal operating plan that uses performance management to drive continuous improvement.

## Figure ES-1: Service Optimization Study Phase I Study Area




Source: FRA Study Team

The Study Team drew from dozens of existing reports from government agencies, planning groups, and advocacy organizations, as well as direct input from Amtrak, NJ Transit, Long Island Rail Road (LIRR), and Metro-North staff with deep operational knowledge of the station.

The Study Team developed and tested concepts based on different ways of organizing train traffic through the station, ranging from keeping each railroad's operations largely separate to rebuilding the station and fully integrating all services across every track. Across these concepts, the Study Team tested a total of 86 scenarios spanning numerous combinations of operating parameters, including dwell times and train flows.

The analysis explored options that included varying degrees of through-running commuter rail service between New York and New Jersey, beyond the existing through movements between Penn Station and Sunnyside Yard, to understand both potential capacity gains and real-world implementation constraints.

## What Phase I Found

The analysis found that organizing the station into three distinct operating zones offers the most promising balance of capacity, reliability, flexibility, and feasibility. This approach builds on how Penn Station works today, adding targeted infrastructure changes to account for the new HRT and improvements to platform clearance, dwell times, and train flow.

The improvements identified through the refined operating concepts are grouped in two infrastructure packages: **Penn Transformation Improvements** (pedestrian flow, track and platform improvements) and **Penn Station Future** (additional platform and track reconfiguration). Each infrastructure package includes investments to be incorporated into, or not precluded by, Penn Transformation, as well as additional improvements earmarked for further analysis in Phase II.

### Penn Transformation Improvements

**Penn Transformation Improvements** include both pedestrian circulation and track and platform upgrades designed to improve both the passenger experience and railroad operations. These improvements include extending Platforms 1, 2, and 3 to the west, adding up to 23 new VCEs (stairs and escalators) with at least one added to every platform, decluttering platforms to restore usable space, and improving signage throughout the station. Phase I results identified VCE limitations as the primary constraint to platform clearance and found adding VCEs is an effective strategy to reduce dwell times at Penn Station.

Together, these physical changes support a new operating concept that reduces dwell times, improves train flows, and introduces limited through-running commuter service, meaning some commuter trains will have the ability to continue revenue service past Penn Station rather than terminating and turning around at the station. The platform and circulation elements allow platforms on average to be cleared and boarded an estimated 2.4 minutes faster than currently, an improvement of 28 percent over existing conditions (specific improvements by service type vary widely, see full results in **Section 4.2.1**). The concept calls for up to four regional commuter trains per hour in each direction to run through the station, in addition to the four Amtrak through-running trains per hour that currently operate or are already planned. The concept also maintains existing LIRR train volumes while expanding service for Amtrak and NJ Transit.

> The Penn Transformation Improvements, combined with reduced dwell times and accounting for current levels of operational variability, can increase cross-Hudson rail capacity from 24 TPHPD to up to 32 TPHPD.

Using railroad operations and pedestrian simulation models, the Study Team determined that these improvements, combined with reduced dwell times and accounting for current levels of operational variability, can increase cross-Hudson rail capacity from 24 TPHPD to up to 32 TPHPD in the AM peak and 30 TPHPD in the PM peak. This operating concept works within the existing station footprint and supports either current commuter rail service concepts (with revenue trains terminating at Penn Station) or a gradual shift toward a more integrated regional rail system (with through-running trains), phased in over time.

Importantly, these improvements will deliver real benefits to passengers and railroad operations before the broader Gateway Program infrastructure investments in New Jersey come online. Better vertical circulation between the concourse and track connections, decluttered platforms, and clearer signage will improve passenger flow and reduce friction in daily operations regardless of when regional operational and infrastructure upgrades are implemented.

## Penn Station Future

**Penn Station Future** would build on Penn Transformation Improvements to enable a fundamentally different way of operating the station, albeit with the same train capacity as Penn Transformation. By combining Platforms 5 and 6 into a single, wider platform, and adding stairs and escalators to serve it, the station could support up to eight regional commuter through-running trains per hour in each direction, in addition to the planned Amtrak service of four through-running trains per hour in the peak period. The Penn Transformation design will keep this Penn Station Future option open by preserving space for future stairs and escalators and avoiding new structural columns where tracks are removed and platforms are widened. Penn Station Future needs further analysis in Phase II due to a lack of regional reliability and high variability in train arrivals into Penn Station.

**Table ES-1** provides an overview of the primary benefits and outputs of the infrastructure packages. Full details on train counts, platform clearance, and other outputs are included in **Sections 4 and 5** of this report.

**Table ES-1: Infrastructure Package and Operating Concept Overview**

| Infrastructure Package | Operating Concept | Trans-Hudson Capacity | | Benefits |
|---|---|---|---|---|
| | | TPHPD (Morning Peak) | TPHPD (Evening Peak) | |
| **Penn Base** (Existing Conditions) | Existing operations | **24** | **24** | N/A |
| **Penn Transformation Improvements**<br>• Adds VCEs, declutters platforms, and improves signage<br>• Extends Platforms 1, 2, 3 with associated track work (and additional VCEs on platforms) | **Concept 1** See full description in Section 4.2 | **Up to 32** (including 4 intercity, 4 through-running commuter) | **Up to 30** (including 4 intercity, 4 through-running commuter) | • Improves safety and customer experience<br>• Increases station throughput<br>• Increases reliability<br>• Allows NJ Transit to increase train length/capacity |
| **Penn Future**<br>• Creates a super-wide platform with additional VCEs | **Concept 2** See full description in Section 4.2 | **Up to 32** (including 4 intercity, 8 through-running commuter) | **Up to 30** (including 4 intercity, 8 through-running commuter) | • Allows for reduced dwell times<br>• Improves safety and customer experience<br>• Enables a shift to regional rail |

These targeted improvements within the existing Penn Station complex, combined with operations changes, could increase total cross-Hudson rail capacity from 24 TPHPD to up to 32 TPHPD in the AM peak (up to 30 TPHPD in the PM peak). These improvements could provide up to a third of the additional capacity envisioned under the previous Penn Station Expansion project at a fraction of its estimated $16.7 billion cost. These throughput gains are dependent on key assumptions regarding dwell-time reductions and operational changes. Broader improvements across the region that target schedule adherence of trains arriving at the station could further improve throughput and will be identified in detail during Phase II of the Study.

Additional station capacity is feasible; however, exceeding a potential maximum of 32 TPHPD requires broader, regionwide improvements that address the reliability and consistency of trains arriving at the station. These opportunities will be identified and evaluated in Phase II of the Study.

## Next Steps

Phase II will expand the Study's analysis beyond the existing footprint of the Penn Station complex to cover the service areas of Metro-North, LIRR, and NJ Transit, focusing on additional capital projects and operational changes throughout the region that are necessary to provide the additional service filling the added capacity at the future Penn Station. Phase II also will include an evaluation of the governance, fleet, operational costs, funding strategies, and agreements necessary to implement these changes over the long term. As in Phase I, the FRA will continue to engage and collaborate with Amtrak, NJ Transit, MTA, the Federal Transit Administration (FTA), and other key stakeholders to inform the Phase II Study. In addition, FRA will collaborate with the selected Master Developer and Amtrak on Penn Transformation.

# 1 Introduction

The USDOT, FRA, and Amtrak are advancing a multi-pronged strategy to reimagine and modernize Penn Station. Amtrak is leading the redevelopment of the station itself, Penn Transformation, supported by funding from the FRA. Amtrak selected a Master Developer to lead the station redevelopment as it prepares to break ground by the end of 2027.

In parallel, FRA initiated the **Penn Station Service Optimization Study** in October 2025. The Study includes two phases, aiming to develop an optimal approach to advancing passenger rail service at Penn Station that delivers maximum service improvements while minimizing costs and impacts.

- **Phase I** aims to expand train capacity at Penn Station to accommodate future increases in service by identifying service options and proposed infrastructure improvements within the existing track and platform configuration, which would require additional, currently unfunded, capital investments.
- **Phase II** will establish a vision for Penn Station service that identifies capital projects and operational changes in the broader New York Metropolitan area to achieve future service growth.

Phase I results, documented in this report, are infrastructure improvements either intended to be implemented by Amtrak and relevant partners as part of, or in conjunction with, Penn Transformation — or critically, must not be precluded by it.

Key outputs from Phase I include:

- Approximate locations of new VCEs within the existing station complex
- Changes to track and platform configurations
- Not-to-preclude elements that may be constructed in the future

The Phase I Study's outputs are consistent with Penn Transformation's project goals[2], which include:

- Renovating and modernizing the station
- Increasing concourse capacity and access
- Enabling safer and more efficient operations
- Accommodating passenger service growth
- Delivering a world-class experience for users

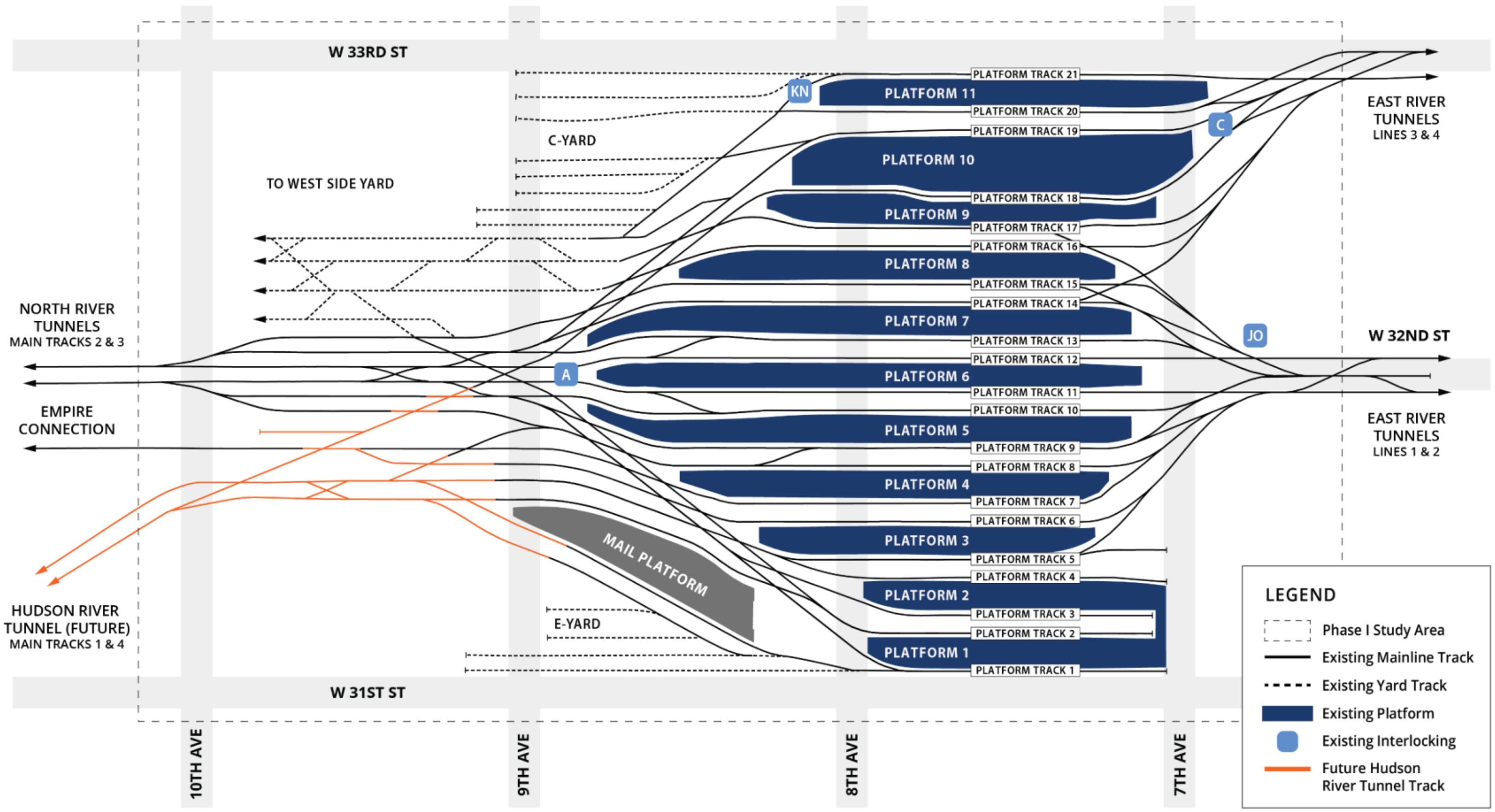
Together, this Study and Penn Transformation support a modern, safe, and efficient passenger rail future for the greater New York Metropolitan region and the broader NEC.

[2] New York Penn Station Transformation: Modernizing the Complex into a World-Class Facility & Landmark

## 1.1 Phase I Study Area

The Phase I study area is the track and platform level of the existing Penn Station complex between West 31st Street and West 33rd Street, and between 6th Avenue and 10th Avenue, as shown in **Figure 1**. The Study does not address any improvements at the concourse or street level, as those improvements will be addressed by Penn Transformation. However, the Study Team analyzed VCEs from the track and platform level to the envisioned Penn Transformation single-level concourse, as these VCEs address critical access needs that shape train operations, train loading locations, and access to trains.

## Figure 1: Service Optimization Study Phase I Study Area




Source: FRA Study Team

## 1.2 Scope of Work

Phase I of the Study included an assessment of the current service and operating parameters within the existing underground footprint of the Penn Station complex to document existing conditions and establish a baseline for analysis. After the assessment of existing conditions, the Study Team developed a series of operating concepts to evaluate the potential for capacity increases, operational feasibility, pedestrian flow, constructability, and cost-effectiveness.

Using several analytical tools, including modular timetabling software (Viriato), rail operations simulation software (Rail Traffic Controller (RTC)), and pedestrian flow modeling software (PTV Vissim), the Study Team iteratively developed, tested and refined dozens of concepts and scenarios to identify pedestrian flow improvements, capital infrastructure improvements, and operational plans to optimize routing and service options through Penn Station.

The operational concepts from Phase I will be refined in Phase II through further analysis, including additional modeling and simulation. **Section 3** of this report includes full details on the Phase I workflow and methodology. Phase I results will be provided to Amtrak and the Master Developer for inclusion in Penn Transformation. Phase I did not develop an implementation strategy; FRA, Amtrak, and the selected Master Developer will work collaboratively to advance infrastructure improvements that USDOT expects to see as part of Penn Transformation or delivered by Amtrak in conjunction with Penn Transformation.

**Phase I identifies infrastructure improvements while the full operating concepts are further refined in Phase II**. The infrastructure improvements include elements to improve the tracks and platforms for better passenger and train flows, which may be further refined with Amtrak and the Master Developer as part of Penn Transformation. As part of the Phase I results, the infrastructure improvements provide benefits which can be maximized with further operational changes. The corresponding operating concepts will be further assessed, iterated, and refined in Phase II. The operating concepts identified in Phase I are not intended to be implemented systemwide without investments in improving capacity and reliability.

**Phase II will iterate and build on Phase I results**. Improvements beyond Penn Station's complex will be evaluated in Phase II and may modify initial Phase I results. Some improvements included in the Phase I results require infrastructure and rail fleet to be defined in Phase II, limiting the level of detail included in the Phase I results. Phase II will establish an overall vision for Penn Station that maximizes the use of preserved capacity for potential future service increases as identified in the Phase I concepts. These concepts include a combination of operational, pedestrian flow and infrastructure changes to Penn Station, including additional VCEs, platform extensions, and platform widening. Long-term capital, operational, and institutional improvements throughout the New York Metropolitan area will also be identified. Phase II will investigate and make recommendations on how to advance the future vision for Penn Station given complex governance, labor, and financial realities in the region's multi-operator environment.

**Impacts on the traveling public during construction and the implementation approach must be considered**. Every day, Penn Station plays a critical role in the region's transportation system and economy. Construction activities have the potential to significantly disrupt passenger flows and station operations; even taking a single platform or track out of service can constrain capacity, reduce resilience, and impact riders who rely on rail service for work and other essential travel.

While assessing in detail the potential construction impacts of the Phase I concepts was outside the scope of this Study, the Study Team did take into consideration the potential effects on passengers during its analysis and the need to potentially phase the construction of improvements. The Phase I results align with Penn Transformation efforts, creating an opportunity to coordinate improvements and minimize the scale and duration of future disruptions.

# 2 Existing Conditions

This section reviews the current conditions of Penn Station, including how its history and governance affect station operations and challenges for passengers and train operators. Penn Station in Midtown Manhattan connects rail services offered by Amtrak, NJ Transit, and MTA's LIRR. Penn Station also provides connections to MTA's Seventh and Eighth Avenue Lines at two different New York City Subway stations.

## 2.1 Station History and Governance

Penn Station was constructed between 1904 and 1910, initially as the northern terminus of the Pennsylvania Railroad's main line between New York, Philadelphia, Washington, St. Louis, and Chicago. The station was developed to consolidate the operations of the Pennsylvania Railroad and its commuter subsidiary, LIRR, into a large, single terminal.

Since its opening in 1910, Penn Station has served as New York City's primary intercity and commuter rail hub, providing the first direct rail access into Manhattan from the west and south. The station entered a period of decline after World War II as private railroads faced financial losses from growing competition with automobile and air travel. This culminated in the sale and demolition of the original Penn Station headhouse in the 1960s and the construction of Madison Square Garden (MSG) above a rebuilt, primarily underground Penn Station with reduced passenger space. During this period, the railroad industry underwent major restructuring, including a failed merger that created the Penn Central Transportation Company and its subsequent bankruptcy, as well as the formation of Amtrak in 1971 to take over intercity passenger rail service in the United States.

By the mid-1970s, federal intervention had reshaped Penn Station's ownership and operations, with Amtrak acquiring the station in 1976 and assuming control of much of the NEC. Commuter services were gradually transferred to public agencies, including the MTA (which took over the LIRR in 1965) and NJ Transit, which began direct service to Penn Station in the 1980s. Subsequent decades focused on expanding capacity, connectivity, and service integration through projects such as the Empire Connection, Midtown Direct service, and Secaucus Junction, alongside the introduction of high-speed Acela service on the NEC between Boston, MA and Washington, DC. More recent investments have emphasized passenger experience and station modernization, including expanded concourses and the opening of Moynihan Train Hall (Moynihan) in 2021.

Penn Station itself—its tracks, platforms, and much of the below-grade structure—is owned by Amtrak. However, several other related entities and connected properties play a role in Penn Station and its service governance, as described in this section.

### 2.1.1 Amtrak and USDOT Organizational Governance

The Rail Passenger Service Act of 1970 established Amtrak to relieve private railroads of their passenger rail service obligations. Amtrak, officially "The National Railroad Passenger Corporation," is operated and managed as a for-profit corporation and is not a department or agency of the United States government.

Amtrak receives funds to operate and manage its services from a variety of sources, including passenger ticket revenue, cost-sharing agreements with state partners, and the federal government. The Amtrak Board of Directors is appointed by the President of the United States and confirmed by the U.S. Senate (49 U.S.C. 24302). The federal government owns Amtrak's preferred stock and holds a lien on the mortgage on the NEC, as well as most Amtrak-owned property and infrastructure (49 U.S.C. 24907), including Amtrak's Penn Station assets. The USDOT is a member of the Amtrak Board of Directors and has a role in several congressionally established organizations that provide additional oversight of and direction to Amtrak, including the Northeast Corridor Commission (49 U.S.C. 24905) and the State-Amtrak Intercity Passenger Rail Committee (49 U.S.C. 24712).

### 2.1.2 Capital Investment

Capital investment and state-of-good repair programs are similarly shaped by Penn Station's governance framework. Although Amtrak owns much of the infrastructure, major rehabilitation and expansion projects along the NEC may be jointly led and supported by the various railroad entities and often depends on cost sharing strategies that include federal, state and local funding sources. The FRA oversees federal funding provided to Amtrak, as well as safety and regulatory compliance for passenger rail systems that operate on the general railroad network, including commuter rail, while the FTA oversees federal funding for commuter rail (as well as safety and funding for transit-based passenger rail systems such as subway, light rail, and streetcar systems). Both agencies administer federal funding that supports and expands passenger rail development at the station.

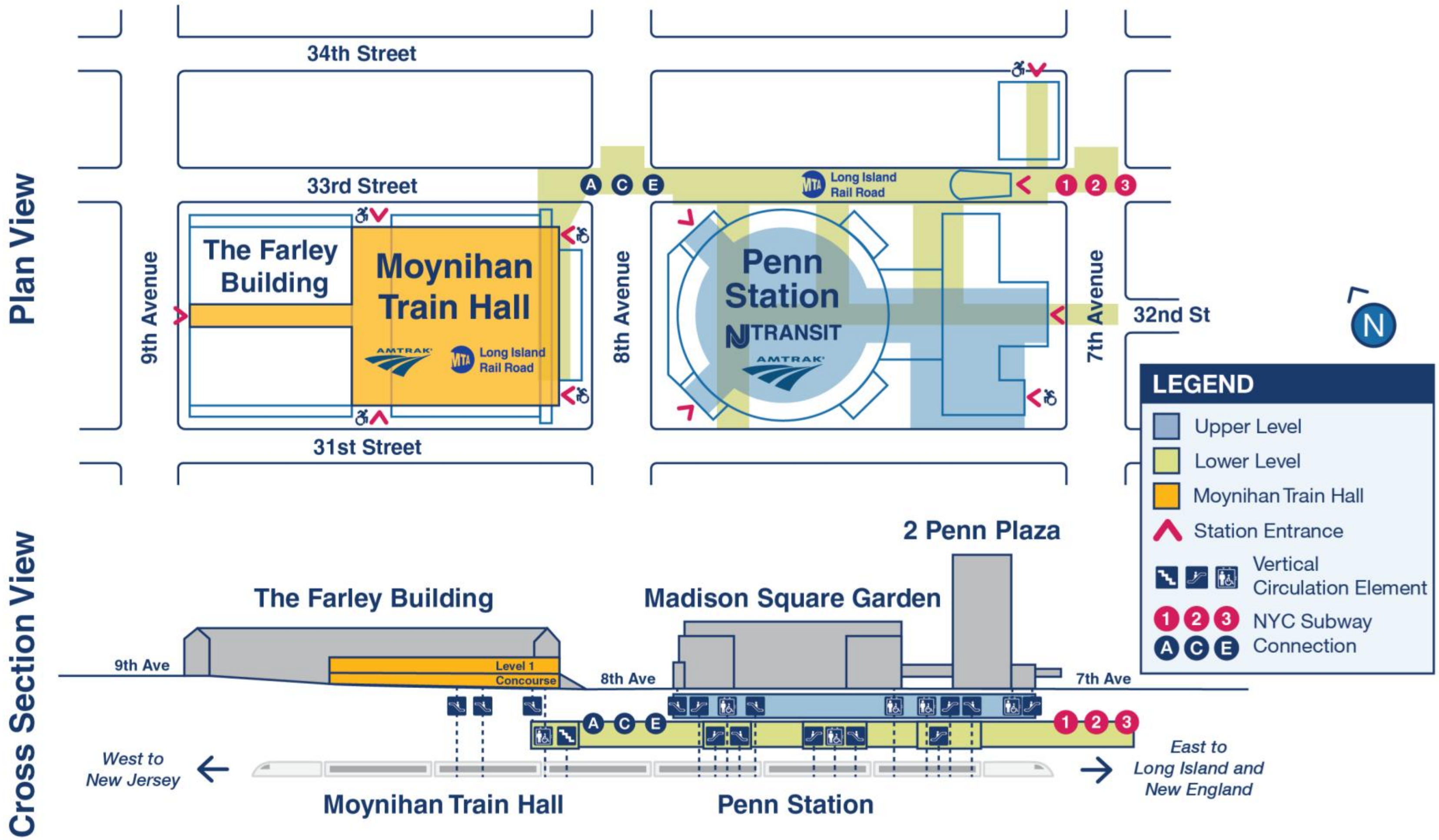
### 2.1.3 Penn Station and Related Properties Governance and Ownership

Today, the governance of Penn Station is defined by a fragmented, interdependent ownership and operating structure that directly shapes how the station functions day-to-day. Penn Station, including its tracks, platforms, and much of the below-grade structure, is owned by Amtrak, which serves both as landlord and as one of the primary operators. Moynihan, to the west of the original station headhouse, provides access to most platforms at Penn Station including all Amtrak and LIRR service, and is owned and governed by the State of New York through the Empire State Development Corporation. Penn Station sits directly beneath MSG and partially beneath 2 Penn Plaza, adding a private real estate dimension that constrains certain structural modifications and ties long-term redevelopment to broader property negotiations.

Passenger experience and station management also reflect this layered governance. Several agreements between Amtrak and LIRR or NJ Transit delegate primary responsibility for certain sections to the commuter railroads. This results in different concourses and customer-facing areas being managed by different entities, leading to variations in branding, signage, and service standards. For example, there is no unified information on all departures and arrivals anywhere in the station. Public safety also involves coordination between multiple police forces, including Amtrak Police and agency-specific transit police departments.

The Penn Station complex, shown in **Figure 2**, includes Moynihan and four concourses on two levels that serve the station's underground tracks and platforms.

## Figure 2: Penn Station Complex




Source: FRA Study Team

### 2.1.4 Tracks and Platforms

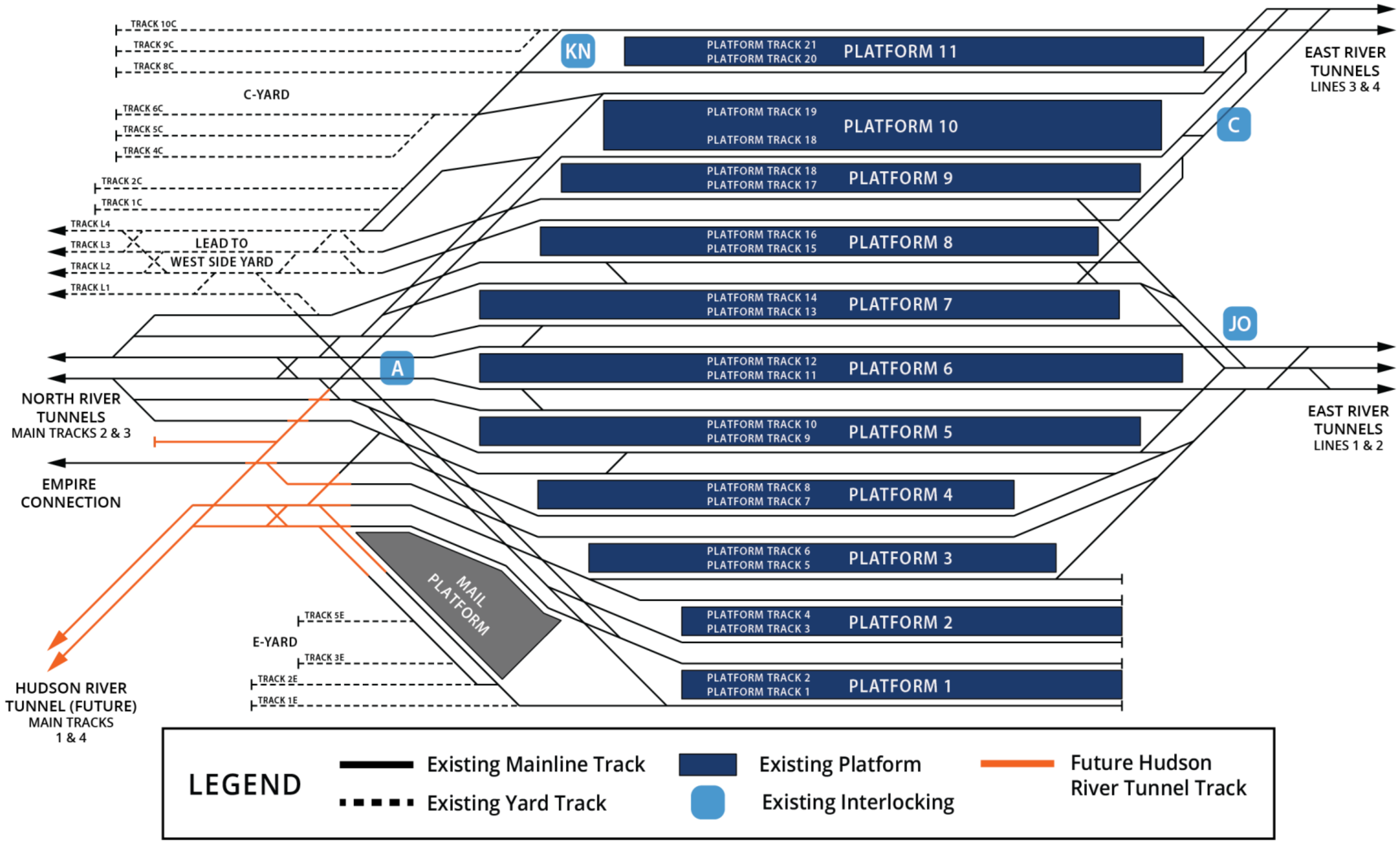
Since its inception, operations at Penn Station have been confined to 21 platform tracks (shown in **Figure 3**) numbered south to north, and 11 mostly narrow-width platforms. Construction of the original station required subgrade steel columns to support the station building, which over time has grown to more than 1,000 columns constructed within Penn Station's boundaries to support added structures above such as MSG, PENN 2, Moynihan, subway lines, and other buildings. The resulting dense structural grid effectively fixes the underlying track and platform configuration in place, making any substantial reconfiguration infeasible without major impact to multiple structures above the tracks.

All train operations within Penn Station utilize electricity to power trains. All platform tracks feature Alternating Current (AC) overhead catenary systems. Additionally, Tracks 5–21 also feature a Direct Current (DC) third rail. LIRR, and the Albany-bound Amtrak trains on the Empire Connection, operate on DC third rail. NJ Transit services and all other Amtrak services operate with the overhead AC system.

Penn Station is served by seven tunnels, with two additional tunnel tracks under construction, as shown in **Figure 3**:

- The **North River Tunnels** (NRT) include two tunnels that are used by NJ Transit and Amtrak for regular passenger operations and provide access under the Hudson River between Penn Station and New Jersey, shown as Main Tracks 2 and 3. They provide access to Platform Tracks 1–19 through A Interlocking.
- The **East River Tunnels** (ERT) include four tunnels that provide access east of Penn Station under the East River, shown as Lines 1–4. Platform Tracks 14–21 access ERT Line 3 and Line 4 through C Interlocking. Platform Tracks 5–17 access ERT Line 1 and Line 2 through JO Interlocking. Amtrak uses these tunnels for both running through trains north of New York into New England and accessing Sunnyside Yard in Queens for train servicing. NJ Transit also uses these tunnels to access Sunnyside Yard for train servicing and layovers, and LIRR uses the tunnels for regular passenger operations into Long Island.
- The **Empire Connection** includes a single tunnel that provides access for Amtrak's Empire Service (between New York City and Albany, with some trains continuing to Buffalo and Niagara Falls) and Lake Shore Limited (between New York City and Chicago) services to/from the north (via the west side of Manhattan) to Platform Tracks 1–8.
- The **Hudson River Tunnel** (HRT) and associated track improvements are currently under construction and will add two additional tracks between Penn Station and New Jersey, shown as Main Tracks 1 and 4. Additional detail on the HRT and other planned and under construction infrastructure can be found in **Section 2.2 Future Infrastructure**.

## Figure 3: Existing Penn Station Track and Platform Layout and Future Hudson River Tunnel Connections




Source: FRA Study Team

Platform lengths vary from approximately 680 to 1,530 feet long, which accommodate eight to 18-car trains, and widths are between 17 and 23 feet wide, except Platform 10 (used exclusively by LIRR) which is 44-feet wide. Most platforms do not have consistent widths as they taper inwards (narrow) towards the ends to accommodate track switches.

Each platform has several VCEs that provide access to the various concourses of Penn Station and Moynihan. VCEs include staircases, escalators, and elevators. Due to the width of the platforms, each escalator is relatively narrow and can only accommodate the width of one person per step.

All Penn Station tracks have access to LIRR's West Side Yard, which is located west of 10th Avenue between 30th and 33rd Streets. Platform Tracks 20 and 21 can only access West Side Yard via KN Interlocking. West Side Yard features 30 tracks where LIRR trains are stored and maintained.

## 2.2 Future Infrastructure

A series of major capital investments, ranging from projects currently under construction to longer-term planned initiatives, will reshape the infrastructure serving Penn Station. Although these investments will be completed in the future, they are important to understanding the base case of this Study, since the analyses conducted assumes that the projects described below will add track capacity, improve resilience and/or potentially increase train and passenger counts into the station when completed. These projects are intended to restore assets to a state of good repair, address capacity and reliability constraints, and expand the station's ability to accommodate additional rail service.

### 2.2.1 Projects Under Construction

#### *East River Tunnel Rehabilitation Project (Sponsor: Amtrak)*

The ERT Rehabilitation Project will restore two tubes that were damaged by Superstorm Sandy in 2012. The project will modernize the tunnel infrastructure—improving safety, reliability, and security—and bring the systems to a state of good repair. The project involves demolishing the existing tunnel systems down to the concrete liners, followed by reconstructing and modernizing all tunnel systems. Construction began in 2025 with the removal of ERT Line 2 from service. In 2026, ERT Line 2 will be placed back into service and ERT Line 1 will come out of service for restoration. The project is expected to be completed in early 2028.

#### *Penn Station Access (Sponsor: MTA)*

The Penn Station Access project includes track, bridge, and signal improvements to the Amtrak-owned Hell Gate route that connects Amtrak NEC trains between New England and Penn Station via The Bronx and Queens. Additionally, four new stations that will be Americans with Disabilities Act (ADA) accessible will be constructed in The Bronx. This project will enable MTA's Metro-North New Haven Line trains to serve Penn Station in addition to current service to Grand Central Terminal. Construction began in 2022. The project is expected to be completed in 2030.

#### *Portal North Bridge (Sponsor: NJ Transit/Amtrak)*

The new two-track Portal North Bridge was completed in 2026 after construction began in 2022. The first track went into service on March 16, 2026, and the second track is planned to go into service in the Fall of 2026. The bridge rises 50 feet above the Hackensack River in New Jersey, high enough for boat traffic to pass beneath it and eliminating the need for openings. This replaces the need for the existing two-track swing bridge that was required to open for boat traffic, creating delays for Amtrak and NJ Transit trains.

#### *Hudson Tunnel Project (Sponsor: Gateway Development Commission)*

The Hudson Tunnel Project will build nine miles of new two-track rail corridor between Penn Station and Bergen, New Jersey and rehabilitate the existing NRT. Once complete, four tracks will be available from Bergen to Penn Station. Construction of the new tunnels began in 2022 and is expected to be completed by 2035. North River Tunnel rehabilitation is expected to be completed in 2038.

### 2.2.2 Planned Projects

#### *Gateway Program*

The Gateway Program is a group of infrastructure projects between Newark, New Jersey and Penn Station that will significantly increase the capacity of the rail routes along the NEC and into Penn Station. The Hudson Tunnel and Portal North projects listed above are currently under construction and are a part of the larger Gateway Program. Gateway Program projects relevant to improving Hudson Tunnel capacity listed below are in various stages of development and implementation:

- **Dock Bridge Rehabilitation (Sponsor: Amtrak)**: The Dock Bridge is a moveable bridge located east of Newark Penn Station and is used by Amtrak, NJ Transit, and Port Authority Trans Hudson (PATH) trains. This project will rehabilitate the bridge and convert it to a fixed bridge. Amtrak has received funding for construction.
- **Sawtooth Bridges Replacement (Sponsor: Amtrak)**: This project will replace an existing bridge in Kearny, New Jersey. Amtrak has received funding for early enabling works for a two-track bridge replacement. Subsequent unfunded phases would include construction of the two-track bridge replacement and design and construction of a second bridge to carry two additional tracks.
- **Portal South Bridge (Sponsor: TBD)**: This proposed project will build an additional two-track bridge over the Hackensack River—south of the new Portal North Bridge—to allow for two additional tracks to be built along the NEC.
- **Secaucus Junction Capacity Expansion (Sponsor: NJ Transit):** This project will expand and reconfigure tracks at Secaucus Junction to support increased service levels.

## 2.3 Train Operations

Penn Station sees more than 1,000 daily train movements. Even though Amtrak is the owner of the station, most train movements are by LIRR and NJ Transit commuter trains, with more than 800 combined commuter train movements per day. LIRR and NJ Transit collectively account for the highest peak period demand and passenger volumes at Penn Station. Amtrak schedules approximately 130 Acela, Northeast Regional, Keystone, Empire, and long-distance trains to and through Penn Station per day.

Penn Station's train movements are controlled by a complex network of contiguous interlockings controlled from a centralized dispatching facility. Together these interlockings form one of the largest and most complex terminal signal systems in the United States, incorporating more than 90 turnouts (track switches), numerous diamonds (crossings), and specialized track configurations.

The governance modeled on the concourse levels extends to Penn Station train operations. Multiple arrangements, many dating back decades, intend to represent major stakeholders in decision-making, but require significant coordination and complex funding structures. This includes, for example, both the Joint Facility Agreement and the Penn Station Control Center (PSCC) Joint Venture Agreement between Amtrak and LIRR. The Joint Facility Agreement covers train movement priorities and responsibilities for certain sections of the station and the tracks leading to it. The PSCC Joint Venture Agreement created the PSCC train control facility, which is jointly staffed by Amtrak and LIRR to enable centralized operator-neutral control of train operations. Within the facility, Amtrak and LIRR employees direct movements on all tracks in the area roughly between North Bergen, New Jersey and Harold Interlocking in Queens, New York. Operational decision-making is further supported by terminal coordination centers operated by Amtrak and NJ Transit and by the LIRR's Station Master's Office, which manages its own crew and service coordination.

Unique to PSCC, Amtrak and LIRR employees take turns every few months leading and operating the train control system regardless of the owner of the underlying track infrastructure. This differs from more traditional operating approaches of each railroad being responsible for dispatching trains on tracks they own. In this model, control changes between railroads when track ownership changes.

A benefit of the PSCC structure is that employees who are directly responsible for directing train movements for Amtrak and LIRR work together in close physical proximity. Prior to PSCC communication between Amtrak and LIRR, dispatching between the two operators would be conducted via telephone or radio. This introduced opportunities for delays or errors in an already demanding operating environment. The PSCC co-location structure enables rapid communication between Amtrak and LIRR staff in the same room, allowing for decision-making and execution to be achieved faster with reduced errors.

There are two major categories of limitations to operational efficiency within Penn Station: physical infrastructure limitations, which are largely fixed, and policy or operational practices, which are largely adaptable. The needs of operations also change throughout the day with peak service and passenger volumes, which uncover limitations of the station's infrastructure that may not exist at times of day with lower service levels or passenger volumes.

### 2.3.1 Dwell Times

Dwell time ("dwells") refers to the total duration a train remains stationary at a station, primarily to facilitate passenger boarding and alighting. This period is a critical determinant of station capacity, as longer dwells limit the number of trains that can enter and exit the station within a given hour. The importance of dwell time lies in its direct impact on throughput—shorter dwells enable higher frequencies and more efficient use of platform tracks.

While dwell times are often presented as a single value, they are composed of several discrete activities that occur sequentially, or occasionally in parallel, resulting in a total time measured in seconds or minutes. Each component activity contributes to the overall dwell period and must be considered when analyzing station operations.

The fundamental elements of a dwell include three key activities: door opening, passenger boarding and alighting, and door closing. The process begins with train wheel stop, followed by the operator opening the doors. Boarding and alighting then occur, allowing passengers to enter and exit the train. Finally, doors are closed, the operator confirms all doors are secured, and the train prepares to depart. While passenger boarding and alighting are the main drivers of an elongated dwell, there are other operational procedures that impact dwell such as crew changes, crew sweeps, and commissary activities.

**Penn Station Tri-Venture Council**

The Tri-Venture Council was established by Amtrak, LIRR, and NJ Transit to provide guidance and collaboratively advance operational improvements within the defined territory serving Penn Station. The Council produced a document that enumerates platform dwell times for studies and initiatives.

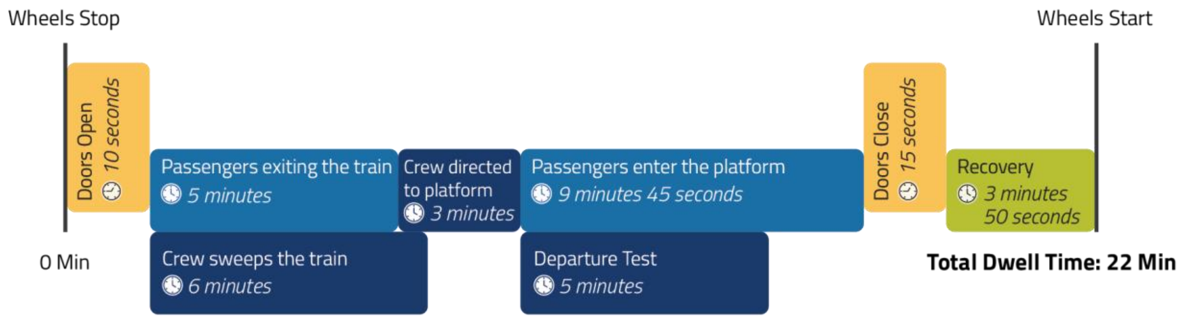
The document, last revised December 6, 2013, lists *shortest scheduled dwell* and *minimum required dwell* for several train operating scenarios in Penn Station for Amtrak, NJ Transit, LIRR, and future Metro-North operations. The *shortest scheduled dwell* is the minimum time a train in a particular scenario will be scheduled to dwell at Penn Station. The *minimum required dwell* is the shortest period of time the activities of a dwell can take place. The difference between the two numbers represents a pad or schedule margin to help absorb inbound accrued lateness.

**Example Penn Station Dwell**

**Figure 4**: Activities for a NJ Transit Turn Dwell in Penn Station below shows the progression of activities in a dwell for a NJ Transit turn in Penn Station. There are several sequential and

concurrent activities as part of this 22-minute overall dwell time, currently NJ Transit's shortest scheduled turning dwell. After doors open, almost 4 minutes are allocated to recovery time that is built into the turn. Five minutes is allocated to passengers exiting the train. As passengers exit the train, the train operating crew walks through the train ensuring all passengers have left. After alighting is complete, a new operating crew boards the train and needs 3 minutes to prepare. Then passengers are released from the concourse to board the train. While passengers board the train, the crew does its required safety checks, or departure test.

**Figure 4: Activities for a NJ Transit Turn Dwell in Penn Station**




Source: FRA Study Team

### 2.3.2 Amtrak Commissary

Amtrak operates a commissary within Penn Station that provides food and beverages for Acela and Northeast Regional trains that travel to or through Penn Station. Penn Station commissary activities provide additional supplies or "top-off" Acela or Northeast Regional trains that operate through Penn Station. The facility in Penn Station is augmented by an additional commissary facility located at Sunnyside Yard in Queens. The commissary supplies all Long Distance, Empire, and Northeast Regional trains that originate from Sunnyside Yard. All Acela trains that originate in New York receive a full supply from the Penn Station commissary, even if the train comes from Sunnyside Yard, due to a lack of high-level platforms to deliver supplies to Acela trainsets at Sunnyside Yard. Phase I does not include recommendations on changes to commissary operations; however, concepts may be explored in Phase II.

### 2.3.3 Departure Readiness Inefficiency

During peak periods, the NRT and ERT tunnels feeding Penn Station operate at, or close to, their maximum capacity. The time-defined nature of railroad capacity means that opportunities to utilize that capacity, especially on constrained assets such as the tunnels, are on a "use it or lose it" basis. Therefore, each train that operates through the tunnels does so with as little delay or deviation from schedule as possible. Any wasted seconds per train over the maximum 24 movements-per-hour through the NRT can lead to delays for following trains.

An example of delays introduced into the system is when a train scheduled to depart Penn Station does not initiate movement within 15 to 30 seconds after the PSCC train dispatcher provides a signal for the train to depart the station. Penn Station, through the PSCC, uses several informal systems for verifying that trains are ready for departure. In some instances, train dispatchers assume a train will be ready to depart at the scheduled departure time and route track switches and signals for the movement. In other instances, the train dispatchers talk with operating supervisors who communicate departure readiness. A third method includes the train dispatcher communicating directly with the train crew. Each method introduces risks or communication burdens into the departure process—the assumption method can lead to delays when a train does not depart as assumed, while the other methods introduce time-consuming manual communications.

An additional element that complicates these processes is a lack of common understanding of “ready to depart.” Feedback received from one railroad indicated that some train crews do not close their doors until after the train receives a signal to depart. This adds time between receiving authorization to move and initiating movement while the train crew ensures all doors are closed properly. In other stations, such as Chicago Union Station, a “Train Start System” is used to standardize the train departure process, eliminating the manual or third-party communication, and reinforcing a common understanding of ready to depart. This type of Train Start System does not exist at Penn Station.

### 2.3.4 Absence of Centralized Terminal Operating Plan

The centralized PSCC structure allows for improved collaboration and communication between Amtrak and LIRR dispatching staff. However, there is divided responsibility amongst the three operators for the planning of daily train operations. This is most acutely observed through the lack of a centralized Terminal Operating Plan. A centralized Terminal Operating Plan is a singular document that would exhibit all of Penn Station’s planned operation for a calendar day. Elements of the document would include all trains arriving at Penn Station, their scheduled arrival time, planned arrival track, planned train length, and that train’s subsequent scheduled departure time and destination. A Terminal Operating Plan accounts for known track outages for maintenance and any changes in platform assignments derived from the outages. A key benefit of the plan is that it removes the need for tactical minute-to-minute decision making by train dispatchers. The planning to ensure optimal use of station infrastructure would be done in advance. This enables train dispatchers to focus on consistent, reliable, execution of the plan and management of minute-to-minute deviations in operating conditions.

It is important to note that a Terminal Operating Plan is not a rigid structure that must be adhered to at all costs—daily variability in operations will inevitably lead to instances where the plan must be changed to protect or restore reliable train service. The Terminal Operating Plan in these instances provides a path back to on-time service delivery.

LIRR, the only Penn Station operator with a Terminal Operating Plan, has the highest OTP of the station's three operators, at 97 percent as of February 2026, and primarily operates on platform tracks dedicated to LIRR and NJ Transit services. LIRR publishes a base-track utilization Terminal Operating Plan for their services based on days of the week. The LIRR plan shows which trains will arrive or depart from a specific track within Penn Station.

## 2.4 Base Case Operating Plan

The Study developed a base case operating plan to reflect both the current infrastructure configuration within the existing Penn Station footprint and the current operating plans for Amtrak, NJ Transit, and LIRR. For NJ Transit and LIRR service, the Study Team developed representative schedules for both railroads with hourly train volumes that matched those shown in the NJ Transit 2024 timetable and the LIRR 2023 timetable.[3] The Study Team determined NJ Transit peak service hours and direction from hourly train counts in the 2024 timetable; LIRR peak service hours and direction were determined from hourly train counts in the 2023 timetable.

The existing Amtrak schedule was incorporated as a direct one-to-one replication of the Amtrak timetable as provided within the 2024 NJ Transit timetable. This base case does not include future planned increases in Amtrak service or future Metro-North service into Penn Station.

Peak period commuter service at Penn Station varies slightly by operator; however, Penn Station experiences the highest overall peak usage during morning and evening commute times, generally between 6:00 and 10:00 AM and between 4:00 and 8:00 PM. During these windows, and accounting for trains on the east and west side of Penn Station, there is an average of 52 trains per hour. A maximum of 62 trains per hour occurs in the morning between 8:00 and 9:00 AM, and an evening maximum of 62 trains per hour occurs between 5:00 and 6:00 PM.

## 2.5 Market Review

The Manhattan Central Business District (CBD), defined as Manhattan south of 60th Street, represents the largest employment center in the United States and the focal point of regional commuting in the New York Metropolitan area. In 2024, approximately 3.2 million people entered the Manhattan CBD on a typical business day.[4] Approximately 72 percent of these trips were made by public transportation, reflecting the CBD's density, limited

[3] Note that the specified timetables were used to reflect normal service levels prior to current frequency reductions required for the reconstruction of the East River Tunnels

[4] 2024 Hub Bound Report, New York Metropolitan Transportation Council

roadway capacity, high parking costs, tolls, an extensive mass transit network, and commuter preferences for choosing transit over daily commuting by automobile.

Within the broader transit market, commuter rail plays a critical role by serving suburban markets outside of the more central service areas of subway service (including both the New York City Subway and PATH). The regional commuter rail market served by Penn Station is geographically divided into two major markets served by LIRR and NJ Transit, while Amtrak covers regional, intercity, and long-distance travel to and through the station.

### 2.5.1 Long Island Rail Road Services Overview

LIRR connects Manhattan with suburban markets in Nassau and Suffolk Counties as well as central and eastern Queens. These areas represent a large residential population whose commuting patterns are closely tied to Midtown Manhattan employment centers. With the completion of the East Side Access project in 2023, LIRR began running some trains to its new Grand Central Madison terminal instead of Penn Station; however, Penn Station still supports the majority of LIRR service into Manhattan. Per LIRR's 2023 operating schedule, LIRR runs 751 trains into and out of Manhattan during the week, with approximately 58 percent of those serving Penn Station.

### 2.5.2 NJ Transit Services Overview

NJ Transit operates rail service from northern and central New Jersey to Penn Station along its NEC, Morristown, Gladstone, Montclair-Boonton, Raritan Valley, and North Jersey Coast Lines. NJ Transit's Main, Bergen, Pascack Valley, and Metro-North's Port Jervis Line do not have a direct connection to Midtown Manhattan, but passengers on these lines can transfer at Secaucus Junction to reach Penn Station.

### 2.5.3 Regional and Long-Distance (Amtrak) Services Overview

Amtrak operates regional and long-distance intercity services on two corridors into, out of, and through Penn Station. The first, Amtrak's NEC, connects Washington, DC to Boston, MA through Penn Station with connecting corridors to Harrisburg, PA and Springfield, MA and into Virginia. The second, Amtrak's Empire Corridor, connects New York City to Albany and Buffalo, NY. Penn Station is Amtrak's busiest station, serving more than double the number of riders at the next busiest Amtrak station, Washington, DC's Union Station.[5]

### 2.5.4 Central Business District-Bound Travel

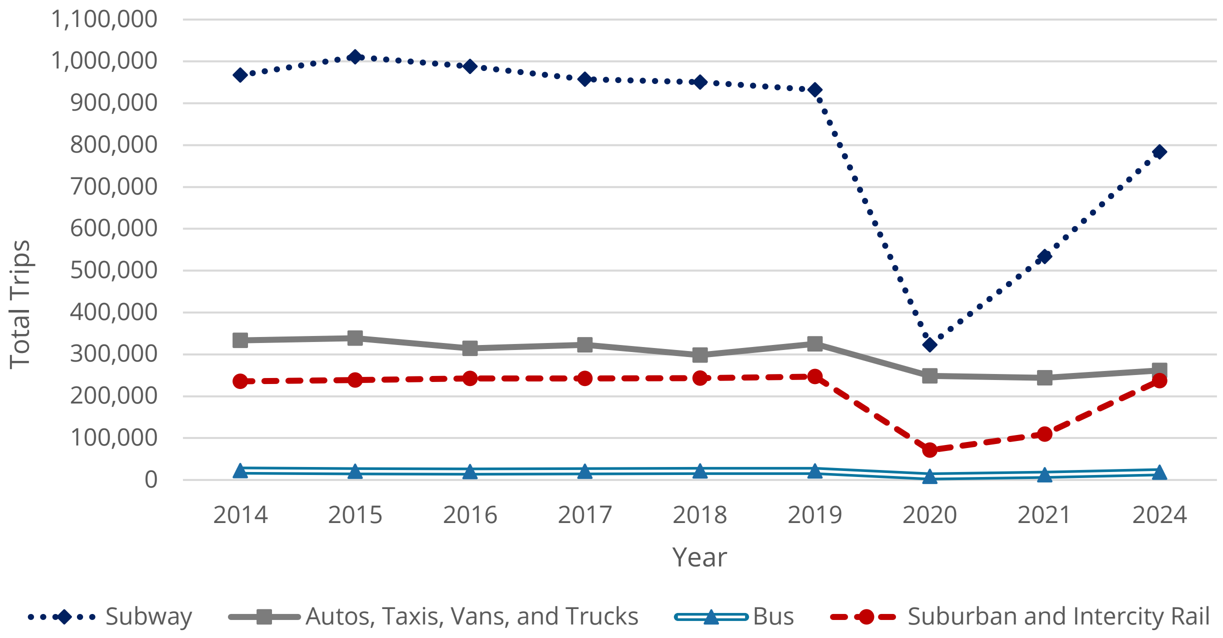
The New York Metropolitan Transportation Council (NYMTC) identifies five sectors of entry into the Manhattan CBD, which include New Jersey, Staten Island, Brooklyn, Queens, and 60th Street. The Queens (which includes Long Island) and New Jersey markets are the two markets with direct rail access to Penn Station. Of these two travel markets, Queens is the largest, generating 664,000 total daily trips into the Manhattan CBD compared to New

[5] U.S. Bureau of Transportation Statistics, "Amtrak Ridership", Fiscal Year 2025; Amtrak, "Fact Sheet: Amtrak in New York," Fiscal Year 2024

Jersey's 512,000 daily trips. Daily trips from Queens via LIRR[6] accounts for 118,000 daily trips. Travel from New Jersey, on the other hand, has accounted for the majority of growth in commuters into the Manhattan CBD over the past several decades. While travel from Queens has remained relatively flat, growing only slightly from 654,000 daily trips into the Manhattan CBD in 1981 to roughly 664,000 in 2024, travel from New Jersey has surged by approximately 50 percent, increasing from 342,000 to more than 512,000 daily trips into the Manhattan CBD during the same period.[7]

**Figure 5** shows daily trips to and from the Manhattan CBD through Queens by mode of transportation. While the subway and driving markets have not fully recovered to 2019 (pre-COVID-19 pandemic) levels, regional rail volumes entering from Queens have rebounded strongly. According to NYMTC Hub Bound Report data, the combined "suburban and intercity rail" category for this sector, which is driven predominantly by the LIRR, but also includes Amtrak NEC traffic via the Hell Gate Line, has reached 96 percent of its 2019 travel levels.

**Figure 5: Travel to and from Manhattan Central Business District, 2024 Fall Weekday, by Mode, Entering through Queens**




Source: NYMTC Hub Bound Report

Note: Suburban and intercity rail includes Amtrak. Amtrak passengers are 5 percent of the total. This analysis removed travel by ferry, tramway, and bicycle because they were a trivial amount of the overall travel total. Additional details can be found in the source data.

[6] 2024 Hub Bound Report, New York Metropolitan Transportation Council

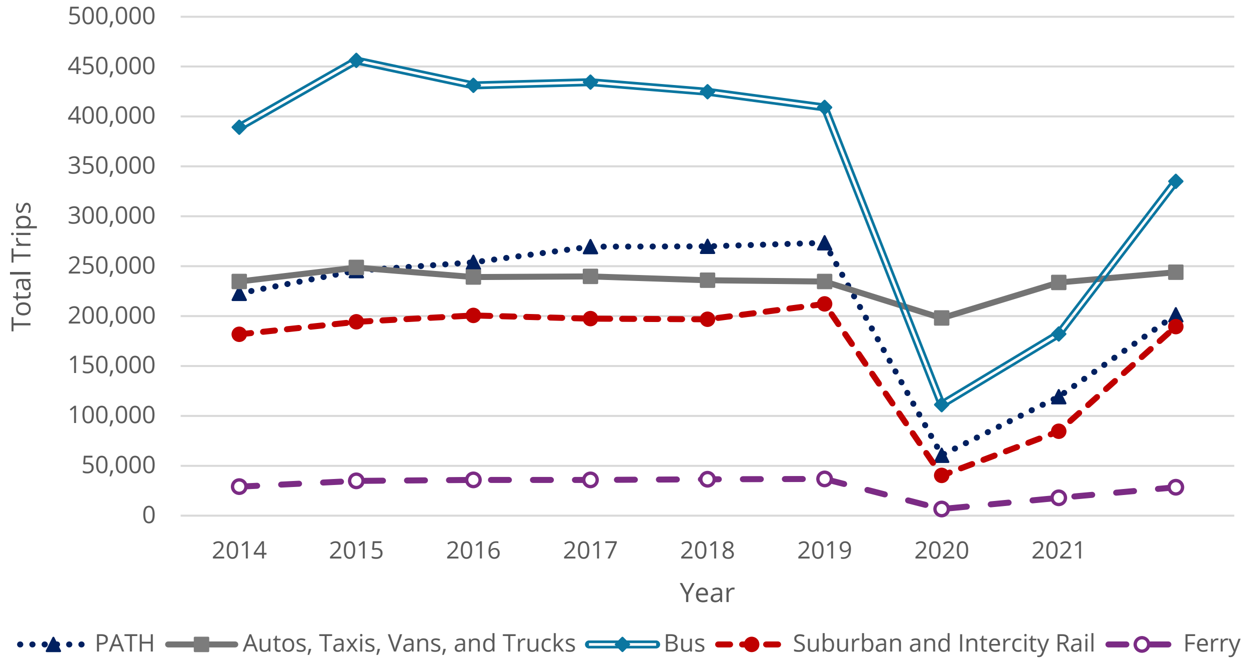
[7] "Gateway and the Post-COVID Economy," Regional Plan Association, June 2022

For Long Island commuters, Penn Station historically served as Manhattan's only rail terminal until the completion of the East Side Access project and subsequent opening of Grand Central Madison in 2023. Even with this new, second Manhattan terminal, Penn Station remains the destination for a majority of LIRR commuters due to its direct access to Midtown West employment centers, entertainment attractions (Theater District, MSG), faster connections to the subway, and higher levels of LIRR service. Operating patterns since the start of Grand Central Madison service indicate that roughly 60 percent of Manhattan-bound LIRR passengers travel to Penn Station, while the remainder travel to Grand Central Madison.[8]

Travel to and from New Jersey is served by a wide variety of mass transit options, including NJ Transit (both commuter rail and buses), Amtrak, PATH, and the NY Waterway Ferry system. **Figure 6** shows the daily trips to and from the Manhattan CBD through New Jersey by mode of transportation. Buses represent the largest mode share of trips from New Jersey by far, driven by the morning peak period exclusive bus lane approaching the Lincoln Tunnel. The NJ Transit commuter rail and PATH systems make up roughly equal mode shares. According to NYMTC data, the combined "suburban and intercity rail" category for the New Jersey sector (encompassing both NJ Transit and Amtrak) has recovered to 89 percent of 2019 levels. Rail travel under the Hudson River into Manhattan is one of the largest commuter corridors in North America and is constrained by limited capacity between New Jersey and Manhattan.

[8] 2024 Hub Bound Report, New York Metropolitan Transportation Council

**Figure 6: Travel to and from Manhattan Central Business District, 2024 Fall Weekday, by Mode, Entering through New Jersey**




Source: NYMTC Hub Bound Report

Note: Suburban and intercity rail include Amtrak. Amtrak passengers are 14 percent of the total.

While **Figure 6** shows what appears to be slow growth on NJ Transit's rail services, it experienced significant growth over the previous decades, attributing to congestion today. Between 1990 and 2019, commuting from New Jersey to Manhattan via rail increased substantially, accounting for roughly 71 percent of the total increase in all commuters traveling to Manhattan from outside New York City during this period.[9] Weekday ridership on NJ Transit rail services operating through the NRT increased more than threefold, rising from about 52,000 daily trips in 1990 to more than 170,000 by 2018.[10]

Reviewing inbound peak-period travel into the Manhattan CBD demonstrates that LIRR and NJ Transit together carried 65 percent of all travelers entering Manhattan during peak periods in 2024, according to NYMTC.

The market for travel into Manhattan also is characterized by strong morning and evening peak periods. Morning peak travel continues to be dominated by inbound commuting to Manhattan, with more than 450,000 people entering the Manhattan CBD in the 8:00 AM hour; the largest flows of any point during a typical weekday.[11] During this period, most

[9] "Gateway and the Post-COVID Economy," Regional Plan Association, June 2022

[10] Ibid

[11] 2024 Hub Bound Report, New York Metropolitan Transportation Council

travelers entering the Manhattan CBD use public transportation, including commuter rail. The afternoon peak period is less concentrated, with about 400,000 people commuting outbound from Manhattan during the 5:00 PM hour and continuing to be more spread out through the evening. Additionally, during the afternoon, a second inbound peak of nearly 200,000 people arrives in the Manhattan CBD during the same hour.[12]

The 2024 Hub Bound Report data also indicates that peak travel patterns are somewhat less concentrated than in the past, reflecting continued hybrid and remote work arrangements across the region, as average weekday office attendance dropped from 78 percent in 2019 to 56 percent in 2024.[13] Compared with the same data from 2019, commuter flows are spread more broadly across the morning and evening periods, with a greater share of travel occurring outside the traditional peak hour. Despite this shift, the core directional pattern of commuting remains intact: large inbound passenger volumes in the morning and large outbound passenger volumes in the evening.[14]

Less studied and understood is the market for "through travel"—travel between New Jersey and The Bronx, Queens, and beyond (not bound for Manhattan). Traffic congestion makes driving challenging and the lack of direct mass transit options between these Manhattan-adjacent areas limited today. While through-running commuter services could attract potential ridership, in Phase I of this study through-running is used as an operational option to increase capacity.

Although not the focus, Phase II will further evaluate whether through-running services may enable increased train capacity at Penn Station due to shorter dwell times associated with through-running services.

Through-running might attract latent demand or build new demand for through, non-Manhattan-bound travel. Phase II will include detailed ridership demand forecasting using these identified geographic concentrations and travel time constraints to evaluate operational scenarios, calculate potential volumes, and understand the potential costs of serving them.

[12] 2024 Hub Bound Report, New York Metropolitan Transportation Council

[13] Partnership for New York City, "Return to Office Survey Results," May 2024

[14] 2024 Hub Bound Report, New York Metropolitan Transportation Council; 2019 Hub Bound Report, New York Metropolitan Transportation Council

# 3 Study Methodology

Despite its importance in the region, the existing conditions of Penn Station reveal significant physical and operational deficiencies that degrade both the passenger experience and railroad performance. During peak periods, the station operates at or near its practical limit, leaving little margin to absorb disruptions. Several previously planned and ongoing capital investments in capacity leading into Penn Station make addressing these challenges even more urgent. There is no status quo at Penn Station; change is coming. Without improvements to Penn Station itself, its tracks, platforms, and operations will become the primary constraint on system performance, limiting the ability to realize the full benefits of these investments.

Therefore, the Study Team developed a methodology to examine targeted physical improvements, intended to be implemented as part of, or in conjunction with, Penn Transformation, to separate train flows, reduce dwell times, and unlock additional service capacity within the existing station complex.

Phase I of the Study applied a data-driven, iterative methodology to identify and refine service and supporting infrastructure concepts for future improvements while preserving the operational capacity needed for their later implementation. Three elements define the Study's overall Phase I methodology:

1. **Iterative approach and tools**. This approach combines high-level engineering and timetabling, dynamic simulation, and pedestrian modeling approaches, working concurrently, to quickly analyze different ideas and refine and advance the most promising concepts.
2. **Capacity evaluation framework**. Major train stations around the world face regular challenges with capacity. While Penn Station is in many ways unique, the comparison to international peers and the use of a standard capacity framework helps identify successful approaches to addressing constraints.
3. **Existing work and expertise**. The Study incorporated background data and considered findings from prior relevant studies and projects, including the Penn Station Access project, Penn Expansion, and the Gateway Program, as well as studies from regional planning groups and advocacy organizations. The Study Team also engaged Penn Station experts and working groups with members from the railroads to gather input and feedback on the Study's approach, analytical findings, and results.

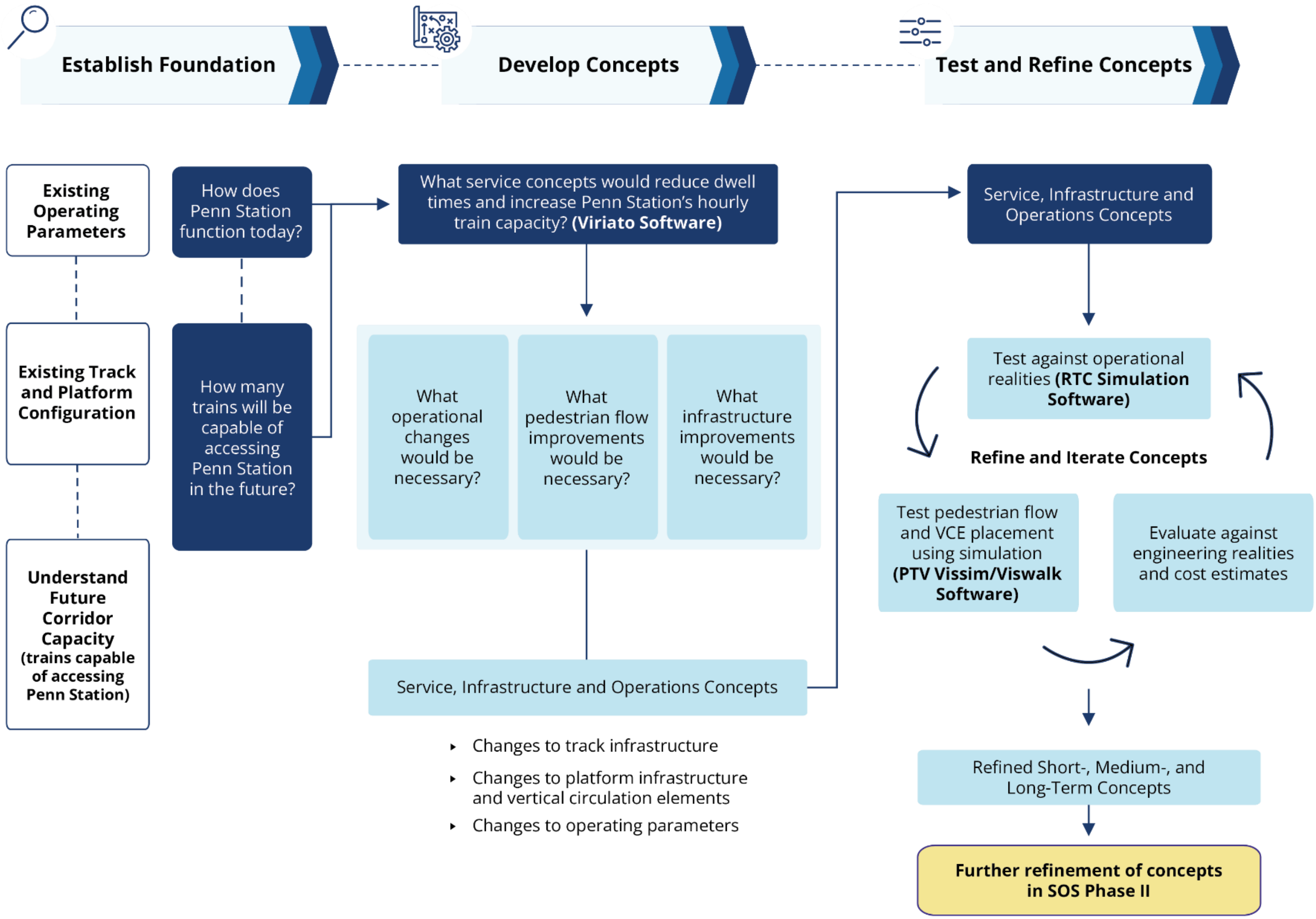
While Phase I focused on the existing Penn Station complex, the Study is structured to allow concepts with implications to the broader region to be evaluated further in Phase II.

This section describes a review of international standards and best practices that informed the range of potential strategies the Study Team considered in Phase I. It then details the methodology used to develop and iteratively refine concepts for increased passenger service at Penn Station.

## 3.1 Methodology Detail

In Phase I of the Study, the Study Team used a structured approach that integrates service plan development, infrastructure assessment, pedestrian flow improvement, and operational feasibility. **Figure 7**: Service Optimization Study Phase I Methodology and Workflow illustrates the methodology and workflow used in Phase I to develop and evaluate potential capacity improvements further described below.

## Figure 7: Service Optimization Study Phase I Methodology and Workflow




Source: FRA Study Team

### 3.1.1 Establishing a Foundation

The Study Team began by reviewing railroad data, previous studies, and facilities and operations documents to develop a detailed understanding of Penn Station's existing physical layout, electrification, dispatching practices, interlocking control, and operational practices. These background materials highlighted how pedestrian and train flows constrain capacity and flexibility. The Study Team also made several site visits to Penn Station and PSCC to better understand existing operations, document challenges, and gather data. Additionally, the Study Team conducted structured workshops with the railroads at key milestones to review assumptions, present preliminary findings, and refine concepts. Railroad feedback helped identify additional constraints or opportunities that initial work did not uncover.

### 3.1.2 Developing Concepts for Increased Future Capacity

The Study Team then developed a range of service and operating concepts for evaluation. These concepts tested variations in dwell times, interlocking configurations, and train routing, with generalized assumptions on rail fleet and signaling systems that largely use the existing conditions as a baseline.

These concepts identified operational strategies and capital improvements under which higher hourly train throughput can be achieved. The Study Team advanced concepts that demonstrated meaningful throughput improvements and operational plausibility for further evaluation.

### 3.1.3 Testing and Refining Concepts

The Study Team further tested and refined concepts through an iterative process to evaluate operational constraints and engineering realities.

- **Operational Feasibility**: Using dynamic rail simulation modeling, the Study Team tested concepts to understand whether the operating plans and infrastructure configurations could support robust and reliable performance under real-world variability. This analysis tested concepts using a service plan with a theoretical 24-hour weekday timetable.
- **Pedestrian Flow**: The Study Team assessed pedestrian flow using both static capacity calculations and industry standard dynamic microsimulation tools to understand the physical and temporal dimensions of passenger flow.
- **Engineering**: The Study Team evaluated infrastructure improvements from an engineering feasibility perspective to evaluate constructability.

### 3.1.4 Analytical Tools

To model timetables and test operational performance, the Study Team employed three primary analytical software tools:

- **Viriato Software**: Used as the primary service-planning platform to develop the platform-occupancy plan, defining capacity, slot allocation, and schedule development.
- **Rail Traffic Controller (RTC) Software**: During concept development, RTC was used to develop precise run times between platforms and main lead tracks to seed the Viriato analysis. RTC software was also used to dynamically test the concepts developed in Viriato under real world conditions using existing variability parameters.
- **PTV Vissim/Viswalk Software**: Used to analyze pedestrian flow under various concepts and operational scenarios. Vissim software simulates overall system dynamics, while Viswalk software represents individual pedestrians with realistic reproduction of pedestrian behaviors.

## 3.2 Data Inputs

The Study Team used a variety of data inputs, including data from past studies and related projects, existing station documents from operators and other sources, on-site visits, and ridership data from federal agencies, railroads, and third-party sources.

- **Railroad stakeholder engagement and subject matter experts**: Regular consultation with Amtrak, NJ Transit, MTA, LIRR, Metro-North, and experts with on-the-ground operating experience at Penn Station informed the data inputs, goals, parameters and results in this Study. This included subject matter experts with service planning, operations analysis and engineering expertise.
- **Past project documents and studies**: A review of past studies focused on Penn Station, including those developed as part of projects related to train flows to Penn Station. During the past five years, Amtrak and the commuter railroad operators initiated several project and planning studies relevant to Penn Station. Prior relevant studies include those completed for Penn Expansion, Penn Station Reconstruction Project, and the Gateway Program. The Study Team reviewed these sources and collected relevant information from them to support the Study.
- **Existing documentation**: Documentation provided by the railroads on operating practices, track conditions, train volumes, signal systems, timetables, architectural drawings, and other key factors helped establish a baseline for service and operations.
- **On-site data collection**: Additional data was collected on-site at Penn Station over multiple site visits by the Study Team to verify critical pedestrian infrastructure elements including platform obstructions, platform and VCE widths, and clearance distances.

### 3.2.1 International Standards Framework

The Study Team reviewed Penn Station and 14 international rail stations that serve as major hubs to see where Penn Station stands out and where it is challenged when compared to other stations around the world. **Figure 8**: Comparing New York Penn Station to International Peer Rail Stations in Selected Cities demonstrates Penn Station's standing on some of the most relevant elements that help put into context some of its challenges with current and future capacity.

The volume of trains per hour at Penn Station is in the middle of the range compared with the largest stations in peer cities across the world, while the dwell times at Penn Station are the longest amongst its global peers. Dwell time ("dwells") is the total amount of time a train remains stationary at a station, primarily to facilitate passenger boarding and alighting. Dwell time is the primary limiting factor in station capacity, as longer dwells mean fewer available platform tracks for additional trains to enter and exit the station per hour.

Commuter rail dwells for through trains at Penn Station today are scheduled for between 6 and 15 minutes depending on the type of service, while Amtrak dwells are generally scheduled for 15 minutes. Both commuter and intercity dwells at Penn Station are more than three times higher than its closest international peer.

One of the important factors in determining dwell times is the amount of time it takes to clear passengers from a platform. Penn Station's platform widths average less than 20 feet, representing the narrowest width in the Study Team's international comparison dataset. Peer stations with similar or higher train volumes utilize wider platforms to help clear platforms quickly, such as Utrecht Centraal Station (about 39 feet) located in Utrecht, Netherlands or Waterloo Station (about 33 feet) located in London, England.

In addition, Penn Station is the only hub among its peers that operates as the sole through-running station within the urban core, and the only hub where intercity trains through-run while commuter trains terminate. International peer markets often distribute passenger and train volumes across multiple stations in their cores, such as in Tokyo, Japan (15 stations), Berlin, Germany (11 stations), and Paris, France (eight stations).[15] No other station in the dataset attempts to sustain this level of throughput within a single core hub while also utilizing narrow platforms. Without building other stations in Manhattan on through-running lines or conducting extensive work to reconstruct some of the more than 1,000 columns supporting buildings above Penn Station to widen platforms, it would not be possible to achieve comparable dwell times to the international peers.

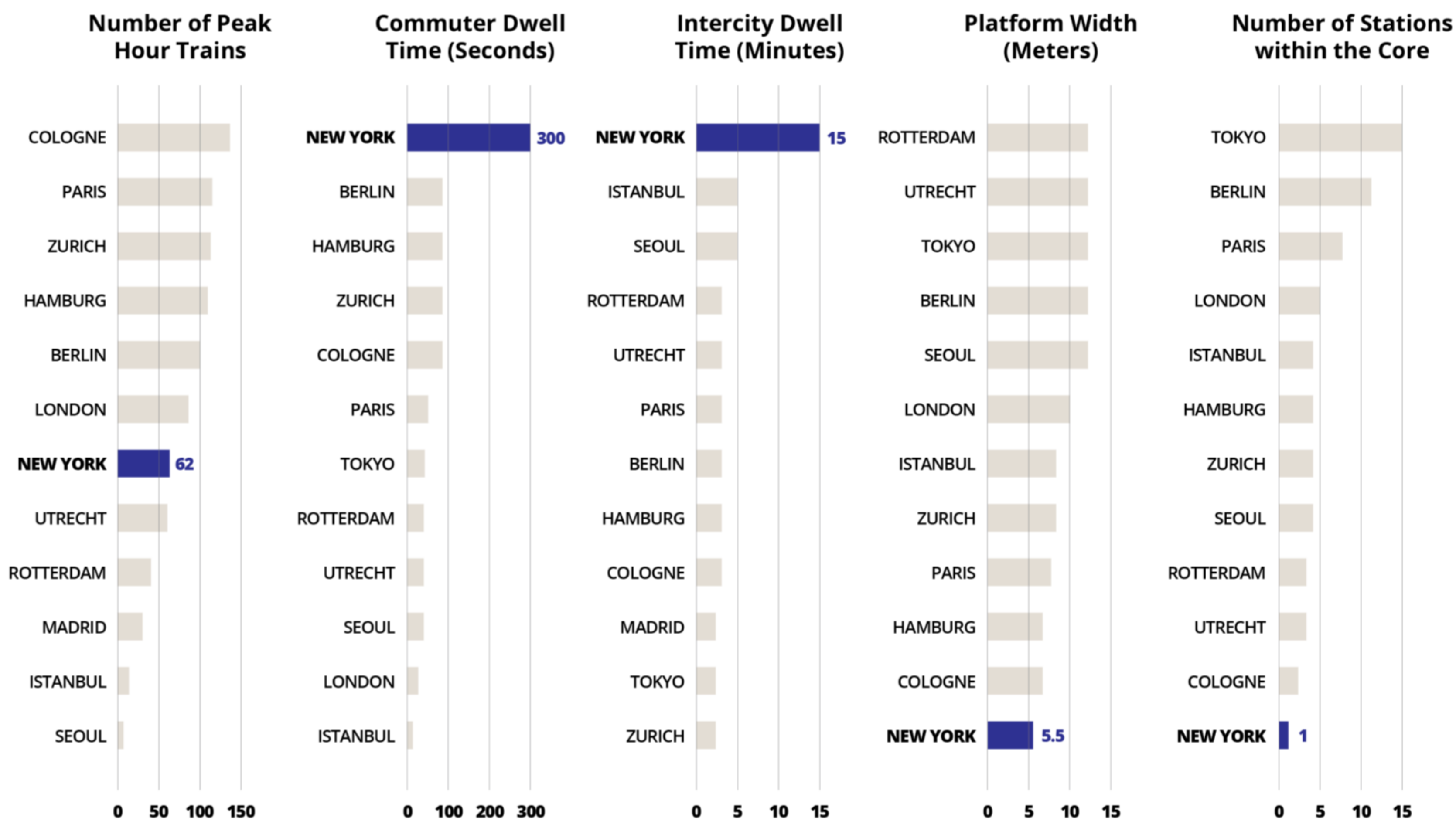
These distinctions are important when making international comparisons to ensure they are understood in an appropriate context. While compiling international performance data is useful to establish a foundational benchmark, drawing direct comparisons in a comparative analysis is limited by differences in data reporting and operational metrics between systems. National operators use different standards to define, capture, and report schedule adherence. For example, a 90 percent adherence rate in one jurisdiction may

[15] Stations within the "Core" by city: **Tokyo:** Tokyo St., Shinjuku, Ueno, Shinagawa, Ikebukuro, Shibuya, Shimbashi, Kanda, Akihabara, Osaki, Ebisu, Nippori, Takadanobaba, Ochanomizu, Yotsuya; **Berlin:** Hauptbahnhof, Friedrichstraße, Alexanderplatz, Ostbahnhof, Zoologischer Garten, Charlottenburg, Gesundbrunnen, Potsdamer Platz, Südkreuz, Ostkreuz, Jungfernheide; **Paris:** Nation, Gare de Lyon, Châtelet - Les Halles, Auber, Charles de Gaulle - Étoile, Gare du Nord, Gare de l'Est, Gare Saint-Lazare; **London:** St Pancras Int., Farringdon, City Thameslink, Blackfriars, London Bridge; **Istanbul:** Halkalı, Söğütlüçeşme, Yenikapı, Pendik; **Hamburg:** Hauptbahnhof, Dammtor, Altona, Harburg; **Zurich:** Altstetten, Central Station, Oerlikon, Stadelhofen; **Seoul:** Yeonsinnae, Seoul Station, Samseong, Suseo; **Rotterdam:** Centraal, Blaak, Alexander; **Utrecht:** Centraal, Vaartsche Rijn, Overvecht; **Cologne:** Hbf, Messe/Deutz; **New York:** Penn Station.

reflect a different level of operational discipline than an identical figure in another jurisdiction, due to differences in standards and measurements. For instance, a 3-minute measurement standard for on-time performance, such as that applied to Swiss Intercity services, demands a significantly higher degree of operational precision than a 15-minute tolerance buffer, which is frequently utilized in other European long-distance networks to absorb late-stage operational variability.

Furthermore, Japanese rail operations present a unique challenge regarding analytical transparency. While the Japanese network, specifically the Shinkansen and major private commuter lines, is globally recognized for its exacting precision, its public reporting framework complicates direct comparison. Instead of publishing success rates measured against fixed minute-thresholds, Japanese operators predominantly report the "average delay per train". By expressing performance as a fractional average (often less than a single minute), the metric demonstrates systemic excellence but flattens the statistical distribution of delays. This methodology effectively obscures the frequency and severity of individual disruption events, making it difficult to compare against threshold-based punctuality data utilized by Western European operators. Ultimately, these distinctions regarding on-time performance measurement reinforce why international schedule adherence must be interpreted within its appropriate operational context.

**Figure 8: Comparing New York Penn Station to International Peer Rail Stations in Selected Cities**




Source: Respective Station Plans and Timetables

The Study Team used internationally observed practices from large stations and systems to help identify strategies for Penn Station that could expand service capacity within its current footprint. While it is important to recognize that Penn Station is unique, it is still valuable to consider how the approaches and operating philosophies of highly efficient systems, such as Tokyo's (which has served as a model for other systems), can provide operating improvement strategies within the Penn Station context. The following four strategies were used as a basis for developing future concepts for Penn Station, serving as proven ways to maximize existing and future station assets and having been used in station planning around the world:

- **Platform Access and Clearance**: Improving access to platforms including vertical circulation, rail fleet configuration, and boarding/alighting processes. A clear platform allows shorter dwell times by removing passenger-load bottlenecks.
- **Through-Run Operations**: Reducing dwell times by running trains through a station instead of turning them from one direction to another on platforms, for both revenue-to-revenue (e.g., trains serving passengers in each direction) and revenue-to-non-revenue (e.g., trains offloading passengers and then proceeding to a train yard for service or storage) movements.
- **Junction Deconfliction**: Reducing conflicting train movements by re-aligning track usage to minimize operating conflicts can increase reliable throughput.
- **Operational Discipline**: Developing a terminal operating plan that uses performance management processes to drive continuous improvement.

## 3.3 Methodology for Penn Station Analysis

The review of international peers shows that Penn Station is an outlier with its narrow platforms and its role as a single station in the region's core. Despite these challenges, applying these global lessons to Penn Station means focusing capacity improvements on variables that most directly govern how many trains the station can process, especially during peak demand for travel. The Study targets the four strategies through which additional capacity can be realized: more efficient platform clearance, interlocking deconfliction, through-running operations, and operational discipline.

Every minute a train occupies a platform is a minute that the platform cannot serve the next train. When dwells are long and unpredictable, schedulers must build in longer buffers between movements, compressing the number of trains that can be reliably operated per hour. Reducing dwells, and reducing the variability around them, is therefore not merely a passenger experience improvement, it is the necessary precondition for any meaningful increase in service capacity.

Understanding where time is lost and how that can be reduced is the foundation of this analysis. Passengers moving off and onto trains are slowed by crowded, cluttered platforms that reduce pedestrian throughput and by queues that form at VCEs. Trains entering or leaving Penn Station are further delayed by conflicts at the interlocking where terminating and through train movements interact. Each of these friction points extends the time a train must remain at the platform and introduces unpredictability into the operating pattern. The interventions explored in this Study—platform decluttering, additional or improved VCEs, and the operational and physical separation of train flows—address each of these sources of lost time directly. Together, they define a set of reduced dwell parameters that can serve as the basis for a more efficient train plan. This approach is explicitly aligned with the Study's core objective of maximizing service capacity within Penn Station's existing footprint while minimizing capital cost.

The Study organizes the specific interventions required to reduce dwell times and throughput around the following operational challenges.

### 3.3.1 Decreasing Time to Clear Platforms on Arrival

The time required to clear a platform after a train arrives is governed primarily by two physical factors: 1) the capacity of the VCEs connecting the platform to the concourse above, and 2) the effective usable width of the platform itself. When VCE capacity is insufficient relative to the volume of alighting passengers, queues form at the base of stairs and escalators, holding passengers on the platform even after they have left the train. This queueing extends the dwell well beyond the time needed for the train to discharge its passengers, as the platform cannot be considered clear and the next train cannot arrive onto the platform until passengers have moved off. Global practices show that the most important objective to reduce dwells is to get passengers off the platform and into a concourse as quickly as possible, where signage can then direct them toward their next destination.

Relatedly, platform clutter in the form of pillars, equipment, signage, mechanical infrastructure, and other obstructions reduces the effective width available for passenger circulation, slowing crowd dispersal and compounding the bottleneck at VCEs. The relationship between platform clearance time and minimum feasible dwell is direct. Improvements that accelerate platform clearance translate immediately into shorter dwells and, in turn, into greater scheduling flexibility and higher achievable throughput.

Railcar fleet is also an important factor in determining platform clearance times. The number of doors on a train car can be a constraining factor for passenger flows; however, this is more commonly the case when passengers are exiting onto wide platforms. Also, where trains stop on the platform can impact platform clearance time. Trains parked near the greatest concentration of VCEs have better pedestrian performance and platform clearance times. Similarly, passenger analysis should account for aspects of train usage, such as familiarity with the station (for regular commuters) and for those carrying luggage (more prevalent on regional and long-distance trains). Reviewing ways to get different types of passengers quickly off platforms is a key component of the analysis.

### 3.3.2 Decreasing Time to Board Trains Prior to Departure

Boarding efficiency is shaped by how passengers are distributed along the platform prior to train arrival and by the policies that govern when and how they are permitted to board. When passengers concentrate at a small number of access points, boarding loads are unevenly distributed, slowing the process and extending the pre-departure portion of the dwell. Distributed boarding practices, supported by clear and accurate wayfinding, allow passengers to position themselves along the platform in a pattern that mirrors the train's car arrangement, reducing crowding at individual doors and accelerating the boarding process overall.

In the context of Penn Station, Amtrak boarding from Moynihan and commuter railroads from their respective concourses can leave some VCEs underutilized and others overutilized, lengthening the boarding time. The extent to which boarding policy changes, signage improvements, and physical layout adjustments can collectively reduce the boarding component of dwell is a central question this analysis addresses.

### 3.3.3 Deconflicting Interlockings

Beyond the platform itself, the movement of trains through Penn Station's interlocking introduces a further source of delay and variability. The station currently handles both terminal operations (trains that arrive, reverse directions, and depart from the same platform) and through-running operations (trains pass through the station without reversing). When these two types of train movements share the same interlocking pathways, they create conflicts that force departing trains to wait for clearance, extending dwells and introducing variability into the departure pattern.

The current layout of Penn Station naturally creates these conflicts, but the new HRT enables a future where train flows can have greater separation prior to entering the Penn Station complex. Separating train flows by operation type reduces the frequency and severity of these conflicts and allows each operation type to proceed more predictably. The concept of flow separation is introduced here as an operational necessity rather than a design preference. Without it, the variability inherent in mixed terminal and through operations will continue to constrain how reliably the station can be scheduled and how many trains per hour can be consistently achieved. The specific mechanisms by which flow separation can be implemented within Penn Station's existing track and platform configuration are explored in detail in the analysis.

More predictable arrivals and departures will be addressed in greater detail in Phase II of this Study to reinforce the opportunity for capacity gains by allowing schedules to be written to tighter, more reliable parameters.

### 3.3.4 Through Running Operations

Through-running train operations, both revenue and non-revenue, at Penn Station can materially increase overall throughput by eliminating the time and operational complexity associated with turning trains within the station. Today, many trains terminate at Penn Station and must dwell for extended periods to unload passengers, undergo crew changes, perform inspections, and prepare for departure in the opposite direction. These turnback processes can add 15 to 25 minutes or more under constrained conditions to a train's occupation of a platform and its use of critical interlocking capacity.

By contrast, a through-running train can complete passenger alighting and boarding in a much shorter dwell. This reduction in platform occupancy time directly increases the number of trains that can be processed per track per hour. Through-running also is related to interlocking deconfliction, where turning trains must cross over more tracks, leading to more conflicts within interlockings.

### 3.3.5 Operational Discipline

Operational discipline at Penn Station is fundamentally tied to two related but distinct concepts: schedule adherence and variability. Schedule adherence, or reliability, refers to how closely trains meet their planned arrival and departure times. Variability captures the degree to which actual operations deviate from expected performance, particularly in dwell times and train movements. Even if average dwell times are reduced, high variability and poor schedule adherence can erode capacity by forcing operators to build in additional buffer time and limiting the ability to run trains at tighter, repeatable intervals. Strong operational discipline through consistent dispatching practices, standardized boarding procedures, and predictable platform management primarily acts to reduce this variability, creating a more stable operating environment.

While operational discipline is critical to long-term capacity gains, it is not the primary focus of Phase I of this study. The current phase emphasizes identifying infrastructure and physical interventions that can reduce baseline dwell times and enable more efficient operations within the existing footprint. In many cases, the potential future capacity gains depend on improvements to schedule adherence and variability. Improvements related to schedule adherence, reliability, and the reduction of variability—many of which depend on changes to operating practices, governance, and real-time management—will be addressed more fully in Phase II.

# 4 Pedestrian and Train Flow Analysis

## 4.1 Initial Concept Development

The Study Team began the technical analysis by examining service concepts and infrastructure improvements that could reduce train dwell times and deconflict train movements to increase Penn Station's hourly capacity during peak periods. Rather than producing definitive outcomes, the analysis used comparable dwell times and rail fleet, largely based on existing practices, across concepts to compare their relative capacity. These results were then weighed against high-level construction effort estimates to identify the most promising concepts for further analysis.

For platform clearance, the Study Team reviewed platforms, passenger loading, and rail fleet to identify the greatest constraints on train loading and unloading. Platform clearance depends on many factors, including total passenger volume, number of train cars, door width, doors per car, platform space and width, boarding process, and the number and location of VCEs. The analysis found that on Penn Station's existing narrow platforms, the primary constraint for both loading and clearing was the number of VCEs and available platform space — not the existing rail fleet used by the railroads or the door widths of their respective equipment. As a result, reducing dwell times by improving passenger flow is primarily addressed by adding VCEs.

The Study Team developed nine operating concepts based on three broad station concepts, **three side-by-side stations**, **two side-by-side stations**, and **one fully integrated station**, described below. The Study Team evaluated the nine operating concepts with numerous combinations of operating parameters resulting in a total of 86 operating scenarios that were tested and evaluated. This section contains a high-level overview of the operating concepts and rationales for either advancing and refining or eliminating each concept for further consideration.

Each station concept used a different track and platform configuration to explore how different track layouts and train routings affect total throughput capacity. The station and operating concepts explored increasing levels of alterations, including configurations that are possible within the current column structure to reshape how trains can move through the station.

Across the different station and operating concepts, the Study Team examined how varying the number of platform tracks assigned to through-services versus turn-services affects overall station capacity compared to other approaches. The Study Team also considered platform extensions or platform widening. While widenings could reduce the total number of platform tracks, it could allow for improved operating parameters that yield higher throughput capacities, even across fewer platform tracks.

### 4.1.1 Three Side-by-Side Stations Concept

The "Three Side-By-Side Stations" concept creates three "stations" within Penn Station that each operate using their own dedicated tunnel approaches. This concept is most like how Penn Station operates today, with modest changes to infrastructure to account for track connections to the new HRT and other improvements needed to improve platform clearance, dwell times, and organization of train flows. In these cases, NJ Transit operates turning trains on Platform Tracks 1–4, NJ Transit and Amtrak operate through and turning trains on Platform Tracks 5–16, and LIRR uses Platform Tracks 16–21.

From the "Three Side-By-Side Stations" concept, the Study Team developed the three primary operating concepts to test how a combination of operational changes and increased through-running service in the middle of the station through targeted station reconfiguration could increase capacity compared to current operations. This included reviewing "super-wide" platforms, which are created by eliminating two through-running tracks and filling the former track space by combining two existing platforms. While a super-wide platform reduces the tracks available, it can enable faster boarding and alighting of trains.

The analysis found benefits to adding one super-wide platform, and diminishing returns associated with a second super-wide platform. Removing two more platform tracks for a second super-wide resulted in lower maximum capacity compared to having just one. These concepts were advanced and further refined as described in **Section 4.2**.

### 4.1.2 Two Side-by-Side Stations Concept

The "Two Side-By-Side Stations" concept connects Platform Tracks 1–4 to ERT Line 1 to allow through-running service. The operation is considered two adjacent "stations" because Platform Tracks 16–21 flow between C Interlocking and West Side Yard (upper section), and Platform Tracks 1–15 share the NRT and the HRT (lower section).

Each of the operating concepts for the "Two Side-By-Side Stations" concept resulted in an initial train count similar to the three side-by-side stations. The "Two Side-By-Side Stations" concept did not increase throughput because the four tracks approaching Penn Station on the west side (via the NRT and HRT) ultimately feed into only two tracks on the east side of the station (ERT Lines 3 and 4). This creates a bottleneck, requiring trains from the west to turn before reaching the east side, since a two-track tunnel cannot accommodate the volume from four approach tracks. Given that a significant number of trains would need to turn regardless, the added cost and complexity of connecting Platform Tracks 1–4 was not justified. Ultimately, the Study Team eliminated these operational concepts because they did not deliver additional capacity beyond what could be achieved through less costly improvements when compared to the "Three Side-By-Side Stations" concept.

### 4.1.3 One Fully Integrated Station

The "One Fully Integrated Station" concept investigated how a fully integrated through-running station with platforms and tracks redesigned beyond the constraints of the existing column structure could maximize capacity. These operating concepts assumed a fully integrated, regionally coordinated through-running service plan, which could enable much shorter dwell times. This has potential capacity much higher than any other approach reviewed in this Study.

Achieving the uniform platform widths required to support this level of operation would necessitate removal of structural columns and major reconstruction affecting MSG, Moynihan, 2 Penn Plaza, the Farley Office Building, and the 7th and 8th Avenue subway lines, making the concepts too disruptive and costly compared to possible benefits. As a result, the Study Team eliminated all operating concepts for the "One Fully Integrated Station" concept.

## 4.2 Overview of Operating Concepts 1 and 2

The Study Team determined that two operating concepts, herein referred to as **Operating Concept 1** and **Operating Concept 2**, based on the "Three Side-by-Side Stations" concept, best meet the Study's objective of maximizing service capacity within the existing Penn Station footprint while minimizing costs and impacts.

- **Operating Concept 1** uses the current Penn Station configuration and includes platform extensions, VCE additions, and platform decluttering to improve pedestrian flow.
- **Operating Concept 2**, in addition to the improvements in Concept 1, modifies the current station configuration by creating one super-wide platform in the center of the middle section and includes additional VCEs to help clear the super-wide platform.

By separating train flows and reducing conflicts within A Interlocking, these concepts contribute to improved operational reliability while enabling more flexible platform use by NJ Transit trains (see **Figure 9**). Operating Concepts 1 and 2 function similarly, but use different platform track assignments for the middle and lower sections depending on the operating concept (see **Figure 9** and **Figure 10**).

Importantly, these operating concepts can be implemented within the existing station footprint and phased in over time, supporting either continuation of the current commuter hub concept or gradual transition to a more integrated regional rail concept with more through-running service. These operating concepts indicate simplified operational plans and do not change the configuration of C, JO, or KN Interlockings. Platform Tracks 1–6 would only access the new HRT and Empire Connection. All other A Interlocking functionality would remain.

### 4.2.1 Improving VCE and Platform Clearance Performance

Increasing capacity at Penn Station within the existing footprint requires more efficient use of the station's platforms. This efficiency is achieved by reducing the time required to clear a platform following a train's arrival and to load passengers prior to departure. Two elements are critical in this process: 1) the VCEs that help passengers move between the concourse and platform levels, and 2) the platforms themselves, which must provide sufficient usable space for passengers to access and board trains. Limitations in either element—whether insufficient vertical capacity or constrained effective platform width—directly increase clearance and boarding times and, in turn, extend dwell durations.

The following sections describe how incremental capacity gains can be achieved by improving performance on these two critical elements within the constraints of the existing station. Platform decluttering increases effective platform carrying capacity by removing physical obstacles that impede passenger flow, while the addition of VCEs increases the rate at which passengers can clear and access platforms. These capacity gains drive down minimum required dwell parameters through improved platform and vertical circulation efficiency. Future operating conditions can support scheduled dwells comparable to today's minimums, while maintaining similar levels of schedule margin to ensure reliable, day-to-day operations. Together, these interventions reduce the minimum time required to service trains.

#### Platform Decluttering

The Study Team identified that items placed or stored on platforms, such as trash receptacles, equipment, signage, boxes, technical equipment, and other fixtures, reduce effective pedestrian circulation space. Removing as many of these items as possible increases usable platform area and reduces localized congestion, as shown in **Table 1**.

**Table 1: Results of Platform Decluttering Analysis**

| Platform | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Current Circulation Area** (Square feet) | 13,700 | 13,100 | 12,900 | 17,900 | 20,700 | 20,900 | 22,500 | 19,000 | 16,500 | 27,500 | 17,600 |
| **Additional Circulation Area** (Square feet) | 880 | 660 | 360 | 580 | 870 | 650 | 950 | 830 | 290 | 3,980 | 350 |
| **Increase in Circulation Area** (Percent) | 6% | 5% | 3% | 3% | 4% | 3% | 4% | 4% | 2% | 14% | 2% |

Physical clutter and fixed obstructions discourage passengers from distributing themselves along the full platform length. This behavior further concentrates demand at stairways and escalators, increasing congestion, and reducing effective boarding and alighting rates. Platform decluttering addresses this constraint by increasing the passenger flow area and enabling passengers to disperse more evenly, while improved signage and distributed boarding practices can encourage use of the full platform. The platform decluttering program can therefore provide near-term benefits even prior to adding VCEs.

**Additional VCEs and Distributed Boarding**

The Study Team applied a combined static and dynamic analysis approach to assess pedestrian circulation, platform clearance performance, and the impact of proposed improvements. The dynamic simulation assessed how these additional VCEs impact passenger service time. Passenger service time is defined as the total duration required for passengers to alight from the train, move through the platform, and access VCEs, as well as for boarding passengers to reach and enter the train from the concourse level. The Study Team conducted multiple simulations to replicate passenger alighting and boarding conditions under the most constrained schedules and operating parameters. The scenarios represent worst-case stress-test conditions, including double train operations where a train is alighting and boarding from both tracks served by the same platform with a 2.5-minute overlap between arrivals and assuming a maximum of 1,600 passengers per commuter train. Amtrak services were simulated with 520 passengers. Testing performance under these conditions confirmed that passenger service times can be achieved under high-demand operations. The analysis was intentionally based on stress-test conditions representing highly constrained peak-demand scenarios. These results reflect the conservative upper-bound performance, rather than typical day-to-day peak service times, which are likely lower. **Table 2** compares a Baseline Scenario (current vertical circulation configuration) with a Circulation Optimization Scenario reflecting the addition of VCEs.

The analysis identified VCEs as the primary constraint to platform performance, followed by available platform space as a secondary factor. Passenger distribution along the platform also influences performance, with improved conditions observed where flows are more evenly distributed across available VCEs. Rail fleet and door placement were not controlling factors in platform clearance and loading times.

The rate at which passengers can move between the concourse and platform level directly governs both platform clearance and boarding durations. Under existing conditions, limited vertical circulation capacity concentrates passenger movements at a small number of access points, creating localized congestion. As platform clearance times increase, additional schedule margin is required between successive trains serving the same track, and adjacent tracks sharing the same platform, since introducing a new trainload of passengers before the previous load has cleared increases the risk of unsafe crowding conditions.

Platform decluttering and additional VCEs measurably reduced the minimum time required during both boarding and alighting. These quantified reductions provide the basis for revised minimum dwell assumptions used in subsequent capacity testing and operating concept evaluation. The table below summarizes estimated time savings by operational process. These time savings are the result of both static and dynamic modeling that incorporate the platform decluttering and the addition of up to 23 VCEs (shown in **Section 5.2**, **Figure 11**) on the platforms.

**Service and Dwell Types**

The following service types were modeled as part of the pedestrian flow analysis. They reflect the various combinations of operators and tactical movements that occur within Penn Station.

- **Amtrak NEC and Empire Service** represent existing or future Amtrak trains including *Acela, Northeast Regional, Keystone,* and *Empire* trains that either originate, terminate or run-through Penn Station.
- **NJ Transit (Drop and Go)** are NJ Transit services that arrive at Penn Station with customers, alight all passengers (drop), and then the train equipment proceeds to Sunnyside Yard in non-revenue "deadhead" service without passengers (go).
- **NJ Transit (Load and Go)** is the opposite of the drop and go. A non-revenue train arrives from Sunnyside Yard, boards passengers (load) and then departs westward towards New Jersey (go).
- **NJ Transit (Turn)** is a NJ Transit service that arrives Penn Station with customers, alights all passengers, boards new passengers and returns to New Jersey. While this process is called a turn, the train is not physically turned around. It changes directions due to the availability of operator controls at either end of the train (sometimes called "push-pull"). For pedestrian model purposes the trains carry passengers in both directions. However, it is possible for either the inbound or outbound movement to be non-revenue.
- **Commuter Revenue Through Service** are trains with commuter-style equipment catering to regional travel that operate through Penn Station from New York to New Jersey or return with passengers being able to board, alight, or ride through Penn Station. These services are modeled with no presumed service operator.
- **LIRR (Drop and Go)** trains are similar to NJ Transit Drop and Go with the non-revenue portion being to LIRR's West Side Yard located on the west side of Manhattan.
- **LIRR (Load and Go)** trains are similar to NJ Transit Load and Go with the non-revenue portion starting at LIRR's West Side Yard.
- **Commuter Revenue Super-Wide Platform** trains are commuter-style equipment catering to regional travel on a future super-wide platform within Penn Station as covered in Operating Concept 2.

**Table 2: Summary of Passenger Service Time Improvements Across Platforms (Baseline vs. Circulation Optimization Scenario)**

| Operator and Service Type | Service Time Across Platforms | | Improvement | |
|---|---|---|---|---|
| | Baseline Scenario (Maximum passenger service time in minutes) | Circulation Optimization Scenario (Maximum passenger service time in minutes) | Maximum Service Time Reduction | Average Across Platforms (in minutes) |
| **Amtrak NEC and Empire Service** | 19.3 | 10.2 | 45% | 7.0 |
| **NJ Transit (Drop and Go)**[16] | 7.9 | 5.7 | 31% | 1.5 |
| **NJ Transit (Load and Go)**[17] | 11.2 | 6.0 | 43% | 3.6 |
| **NJ Transit (Turn)** | 11.4 | 9.0 | 15% | 1.3 |
| **Commuter Revenue Through Service**[18] | 13.1 | 10.0 | 20% | 2.0 |
| **LIRR (Drop and Go)**[16] | 7.3 | 5.3 | 25% | 0.8 |
| **LIRR (Load and Go)**[17] | 7.6 | 6.3 | 10% | 0.7 |
| **Commuter Revenue Super-Wide Platform**[19] | 9.0 | 2.4[20] | 71% | 6.0 |

The results in **Table 2** list the maximum passenger service times for each operator and service type. Maximum Passenger Service Time represents the highest observed passenger service time across all simulated variations of a given scenario. For each operator and service type, multiple simulation runs were conducted to reflect variability in operational conditions; the reported value (or presented value) corresponds to the maximum result observed across these runs. Average across platforms is an average of the passenger service time across every track and platform modeled for the specific operator and service

[16] The shown values reflect stress case in AM peak period

[17] The shown values reflect stress case in PM peak period

[18] Commuter Revenue Through Service is limited to results from Platforms 4-8

[19] Baseline Scenario for Super-wide platform is based on the circulation optimized configuration of Platforms 5 and 6

[20] Circulation optimization scenario considers only boarding and alighting times. Passengers will wait on platform before arrival and clear platform after departure of trains.

type. Variability in passenger service time exists across platforms, reflecting differences in platform geometry and access configuration.

### Platform Extensions and Associated VCEs

The analysis includes extending Platforms 1-3 to the west to allow at least 10-car trains (not including the locomotive) to open all doors at any platform, except on Platform Track 5 where the limit will be nine cars, excluding the locomotive; currently only the 8 eastern cars can open all doors at those platforms. Each platform will include a new VCE to serve the far west end of the platform. Consistent platform length and new VCEs allow for shorter dwells, and more flexibility when designing service timetables.

The platform extensions reduce platform-to-platform variability and make overall performance less dependent on the specific platform assignment, decreasing the risk that an individual platform disproportionately drives passenger service time assumptions for operations planning. This confirms that adding VCE capacity and reconfiguring passenger distribution throughout the platforms are important for the effectiveness of infrastructure improvements. As a result, passenger service time becomes more consistent across the station complex, which improves operational reliability and reduces the likelihood of cascading delays.

### Boarding Activity

For Amtrak services, overall passenger service time remains constrained where boarding activity is concentrated at Moynihan via a single access point. While VCEs improve alighting and clearance conditions, their impact on total passenger service time is limited if trains are boarded primarily from Moynihan. The Circulation Optimization Scenario shown in **Table 2** reflects boarding for Amtrak trains from multiple locations throughout the complex (Moynihan and Penn Station), which reduces boarding times for Amtrak trains. Additional iterative tests included the distribution of boarding activity across multiple concourse access points. The results demonstrate that infrastructure improvements and boarding practices must be aligned to achieve full performance benefits, with VCEs enabling efficient discharge and distributed access to reduce boarding-related constraints.

The precise locations of future boarding and alighting points may evolve, as they must be coordinated with the redevelopment of the concourse above the platforms. However, the analysis demonstrates that overall performance is driven less by the exact placement of access points than by the number of access points, their general distribution along the platform, and the boarding process. Coordination with Amtrak and the Master Developer will be needed to ensure the benefits identified in this analysis are preserved as final placement and configuration decisions for access points are made as part of Penn Transformation or delivered by Amtrak in conjunction with Penn Transformation.

### Platform Dwell Reductions

The Study Team created three dwell parameter sets based on the Tri-Venture Council *shortest scheduled* and *minimum required* dwells, as well as modest reductions in dwell time associated with the proposed physical improvements. These are shown in **Table 3**.

Dwell Parameter Set 1 is the Tri-Venture shortest scheduled dwells, with Empire dwells reduced to match other Amtrak trains. Currently some Empire trains run-through to Sunnyside Yard and others change direction within Penn Station and return. A baseline service plan was developed and analyzed using Dwell Parameter Set 1, representing a regularized version of the existing timetable. This baseline matches current hourly train volumes but does not replicate the exact scheduled train times. This baseline was used in the simulation to provide a consistent point of comparison against future build scenarios.

Dwell Parameter Set 2 was used in Operating Concept 1. Dwell Parameter Set 2 is generally similar to the Tri-Venture minimum required dwells. The set's **Amtrak NEC, Metro-North/NJ Transit through-running,** and **NJ Transit drop and go** dwells can be achieved through the passenger service time improvements coming from circulation optimization, as demonstrated in **Table 2**.

**NJ Transit and LIRR load and go** dwells in Dwell Parameter Set 2, like the other dwell types, were demonstrated to be achievable during the pedestrian modeling. Implementing these times, however, will require an operational process change by NJ Transit. Currently, NJ Transit does not announce the departure track information until the train is on the platform at Penn Station. Providing advanced information on the departure track to customers, even two to three minutes prior to arrival, enables a shorter boarding time. Positioning passengers on the platform in advance of train arrival allows the passengers to start boarding as soon as possible after wheel stop and doors open. The current practice does not advance passengers from the concourse to the platform until after the train arrives.

**NJ Transit Turn** dwells are trains that arrive from New Jersey to Penn Station, change operational directions, and return to New Jersey. Dwell Parameter Set 2 allocates 18 minutes for this operation. Currently, NJ Transit allocates 22 minutes for these movements. NJ Transit indicated that of these 22 minutes, 15 are for alighting and boarding of passengers. The pedestrian simulation revealed a need for 11.4 minutes in the baseline and 9 minutes in the circulation optimization scenario. The six-minute improvement between the 15 minutes currently planned by NJ Transit and the nine minutes in the circulation optimization scenario would allow for the four-minute reduction required.

Dwell Parameter Set 3 was used in Operating Concept 2. It incorporates and expands upon the improvements to the Tri-Venture dwells utilized in Dwell Parameter Set 2. The improvements required to meet Dwell Parameter Set 3 were achieved through the passenger service time improvements from the circulation optimization demonstrated in **Table 3**.

The analysis used adjustments to **NJ Transit drop and go/load and go** times. These adjustments standardize the NJ Transit through moves (revenue-to-non-revenue and non-revenue-to-revenue) to 7.5 minutes to allow for more effective slot allocations in the HRT and NRT that correspond to the 2.5-minute planned headway in the tunnel.

Dwell Parameter Set 3 also introduces a new minimum dwell of five minutes for through-running commuter service on the super-wide platform. Under the assumed operating concept, passengers have unrestricted access to the platform and are prepositioned on the platform prior to train arrival. The combination of ample platform width and substantially increased vertical circulation capacity enables faster passenger exchange. Modeling results indicate that anticipated passenger loads can be fully alighted and boarded within 2.5 minutes under these conditions, less than the five-minute scheduled dwell.

**Table 3: Dwell Time Parameter Sets by Operator and Service Type**

| Operator and Service Type | S (Shortest Scheduled Tri-Venture) | M (Minimum Required Tri-Venture) | Dwell Parameter Sets (Minutes) | | |
|---|---|---|---|---|---|
| | | | 1 | 2 | 3 |
| **Amtrak NEC (Through-Running)** | 15 | 12 | **15** | **12** | **10** |
| **NJ Transit (Through-Running)** | 12 | 10 | **12** | **10** | **10** |
| **NJ Transit (Drop and Go)** | 7 | 6 | **7** | **6** | **7.5** |
| **NJ Transit (Load and Go)** | 15 | 10 | **15** | **8** | **7.5** |
| **NJ Transit (Turn)** | 22 | 18 | **22** | **18** | **18** |
| **Metro-North (Through-Running)** | 12 | 10 | **12** | **10** | **10** |
| **LIRR (Drop and Go to West Side Yard)** | 6 | 5 | **6** | **6** | **6** |
| **LIRR (Load and Go from West Side Yard)** | 15 | 10 | **15** | **7** | **7** |
| **Commuter (Through-Running at Super-Wide Platform)** | / | / | **/** | **/** | **5** |
| **Amtrak Empire Service (Turn)** | 55 | 30 | **/** | **/** | **/** |
| **Amtrak Empire Service (Through to Sunnyside Yard)** | / | / | **15** | **12** | **12** |

### Train Flow Separation

Reorienting Penn Station operations around a clear geographic and functional division of tunnel and platform assignments creates a more comprehensible and resilient operating plan. Under the Operating Concept 1 and 2 track configurations, the new HRT would feed a stub-end station on the south side of the Penn Complex, dedicated to terminating and originating NJ Transit services.

Platforms 1, 2, and (partially) 3 would no longer function as part of a mixed-use station but instead would become the exclusive interface between the HRT and the NJ Transit system. Because of this change, these platforms must be extended to accommodate at least 10-car NJ Transit trainsets. Without these extensions, the platform lengths at Penn Station would effectively cap train length for entire segments of the NJ Transit network, forcing operational compromises beyond the station. Extending Platforms 1–3 ensures the new train flow separation enabled by the HRT can be fully utilized without constraining fleet deployment or future service growth.

In parallel, the existing NRT would be aligned with the station's middle tracks and configured as a continuous east–west run-through to Lines 1 and 2 of the ERT. Finally, ERT Lines 3 and 4 would be paired with the station's northernmost tracks and operate through to West Side Yard. This arrangement establishes three distinct operating "zones" within the station, each with a clear purpose and a limited set of movements, rather than today's highly interwoven pattern.

Functionally, this organization separates train flows by service type and movement intent—NJ Transit turning services on the south stub-ended tracks, through-running Amtrak and commuter service to New England and Sunnyside Yard through the middle, and LIRR service running through to/from the West Side Yard—sharply reducing the number of conflicting routes that must be set simultaneously. Stub-end operations on the south side are largely self-contained, with arrivals and departures turning back without crossing the core east–west flows. Through trains using the middle tracks follow a straight, bidirectional path between the NRT and ERT, minimizing crossing moves and enabling more consistent and predictable dispatching. Similarly, dedicating the northern tracks to ERT Lines 3 and 4 and West Side Yard access removes yard-bound moves from the center of the station. The net effect is a simplification of movements within the station throat.

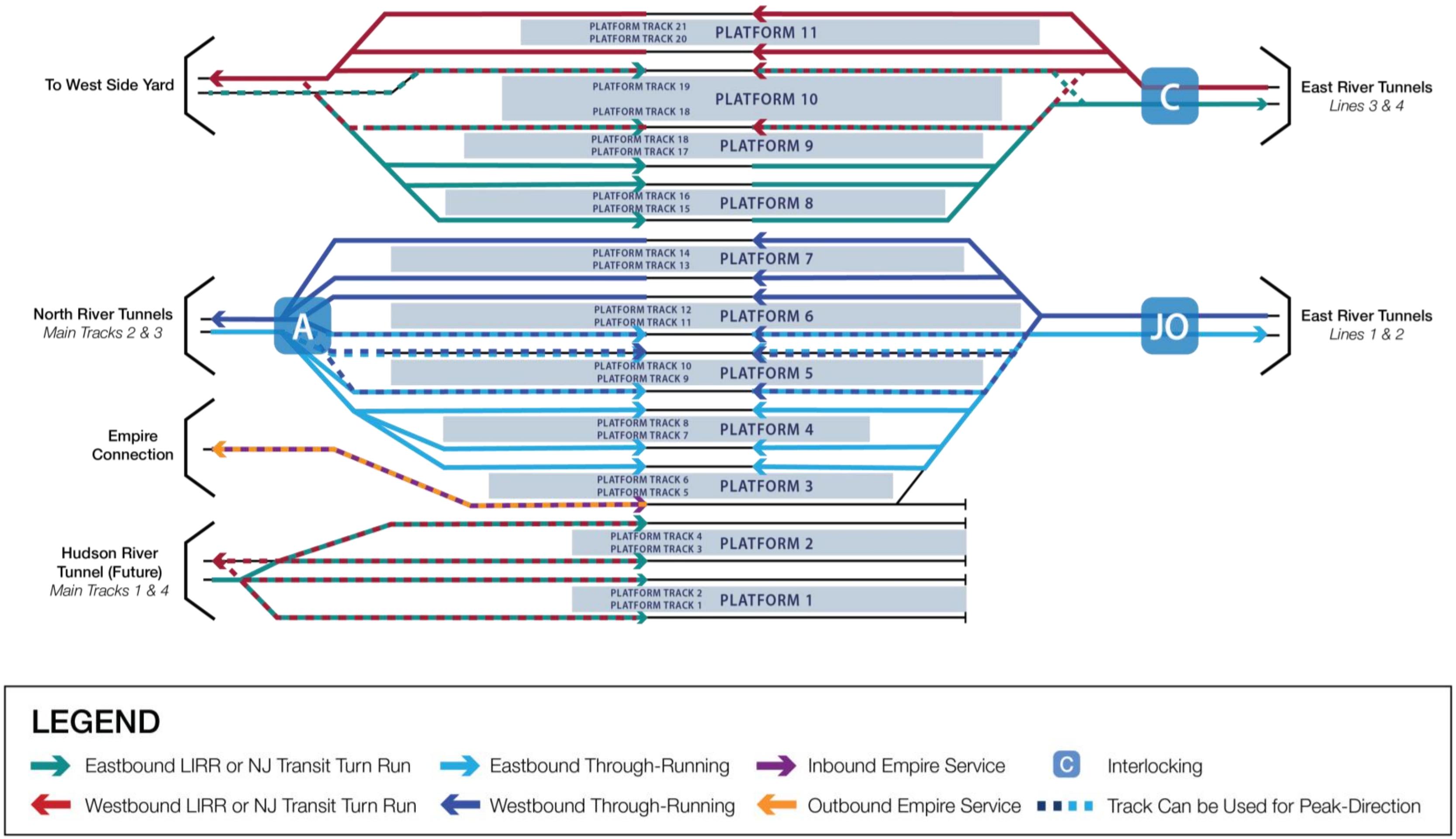
These benefits are most pronounced at A Interlocking, where today a dense concentration of flat junctions forces incompatible movements to compete for the same switches and signal blocks. By assigning each tunnel pair to a defined track group and downstream destination, the number of route conflicts through A Interlocking is reduced dramatically, and many remaining conflicts become predictable rather than randomly distributed.

The Study Team evaluated potential conflicting movements within A Interlocking during the 08:00 to 09:00 AM period and found that they were reduced from 113 conflicts to 51, representing a 55 percent reduction in conflicts that directly contribute to unpredictable service impacts within the station complex. Fewer crossing moves translate directly into shorter route-setting times, less signal delay, and reduced sensitivity to minor delays propagating across services. The station will be able to achieve higher throughput and improved reliability. As a result, delays are more likely to remain localized within a single operating zone instead of cascading across the entire Penn Station complex.

For **Operating Concept 1**, the existing station is altered with westward extensions to Platforms 1-3 (see **Figure 9**: Operating Concept 1 Platform Track Access Diagram), where most NJ Transit trains that are not running through to Sunnyside Yard terminate in the station. Dwell Parameter Set 2 was used in the development of Operating Concept 1.

The morning peak period emphasizes “drop-and-go” trains. These trains run through the station continuing in the same direction, entering the station as a revenue train, offloading passengers, and deadheading out of the station as a non-revenue train (without passengers). The evening peak period emphasizes “load-and-go” trains. These trains run through the station continuing in the same direction, entering the station as a non-revenue train, loading passengers, and exiting the station in revenue service. Initial capacities vary from the morning to evening peak due to longer dwell times required for load-and-go trains compared to drop-and-go trains, because platforms are not currently pre-loaded, which increases boarding times.

## Figure 9: Operating Concept 1 Platform Track Access Diagram

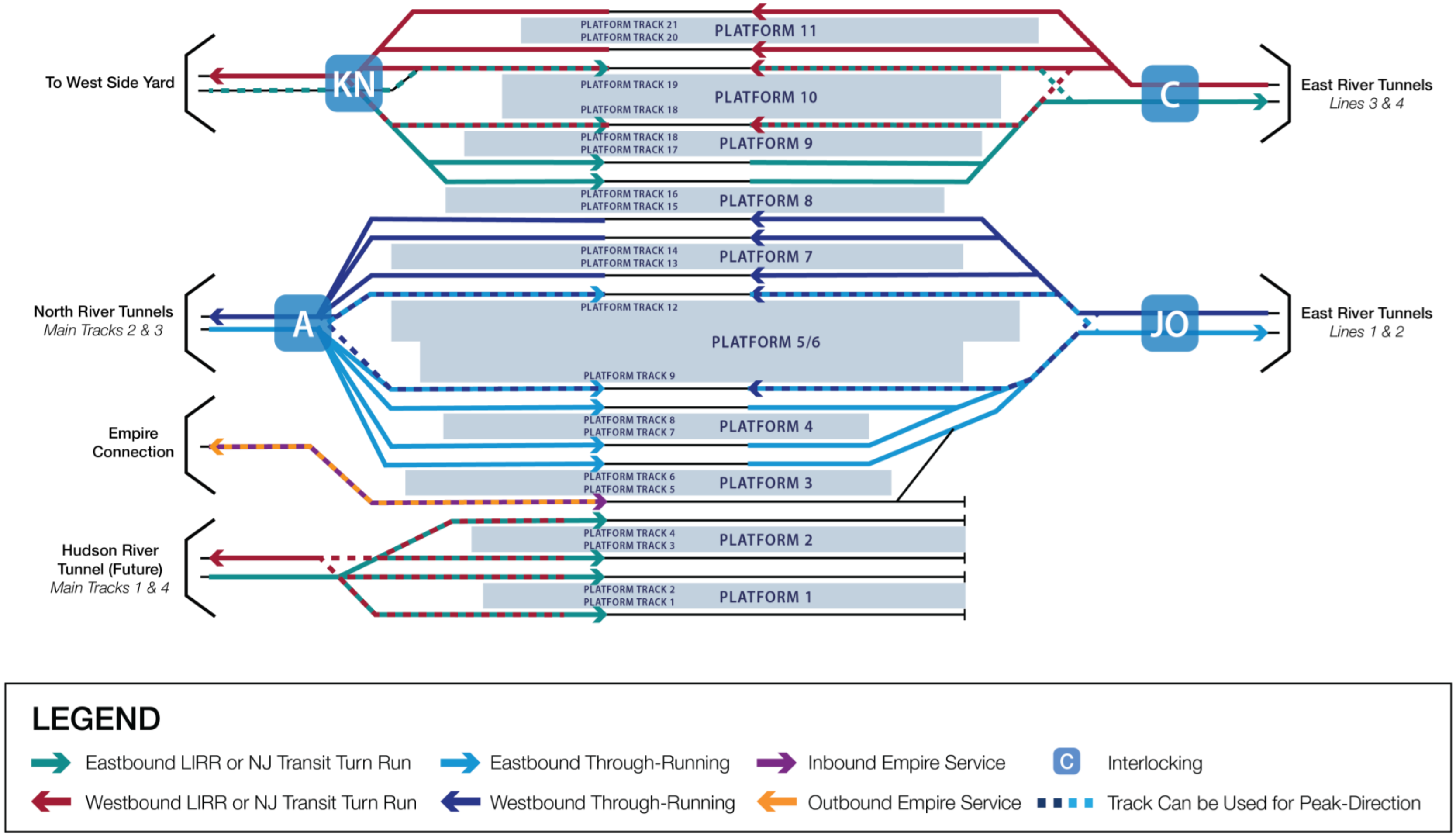



Source: FRA Study Team

Note: Platform Track Access Diagrams show operational routings for regular service and do not show all possible routings and track connections.

For **Operating Concept 2**, Platforms 5 and 6 are combined into a super-wide platform, with additional VCEs, operating adjustments, and modest through-running service that boards and alights on the super-wide platform. By reducing dwell times and creating the opportunity for more through-running service, Operating Concept 2 enables a shift toward a regional rail concept with a more balanced peak and reverse-peak flows if desired in a future operating state (see **Figure 10**: Operating Concept 2 Platform Track Access Diagram). Dwell Parameter Set 2 was used in the development of Operating Concept 2.

## Figure 10: Operating Concept 2 Platform Track Access Diagram




Source: FRA Study Team

Note: Platform Track Access Diagrams show operational routings for regular service and do not show all possible routings and track connections.

## 4.3 Validating Operational and Infrastructure Concepts

The Study Team used Berkley Simulation's RTC software simulation to determine the feasibility of the refined concepts when considering real-world uncertainty. Each simulation run evaluated a 24-hour weekday timetable, including both morning and evening peak periods, as well as ramp-up and ramp-down periods before and after each peak period. The Study Team evaluated the results relative to the existing baseline (no capital improvements assumed) to determine whether the increased theoretical throughput of the refined operating concepts was feasible.

Initial operating analysis for both Operating Concept 1 and Operating Concept 2 demonstrated a potential throughput capacity up to 32 TPHPD in the morning peak period and up to 30 TPHPD in the evening peak period under the Hudson River (see **Table 4** and **Table 5**). These results assumed current levels of operational variability. Additional throughput may be achievable by addressing broader improvements across the region that target the reliability and variability of trains arriving at the station. Potential regional improvements will be further explored and identified in detail during Phase II. Consistent with the pedestrian flow analysis that supported the reduction in platform dwell times, the RTC simulation results show that it is possible to run a higher level of service within the existing Penn Station complex through operational improvements rather than major infrastructure expansion.

The modeling effort used existing variability parameters provided by NJ Transit, recorded Amtrak station dwells, and railroad stakeholder input, into the model by having trains show up at the tunnels delayed (up to 60 minutes for Amtrak, up to 30 minutes for commuter rail) and extending minimum dwell times at the station (up to 18 minutes for Amtrak, up to five minutes for commuter rail) to seed the simulations and found that, under current operating conditions, Amtrak services enter the system with higher levels of variability than commuter rail services. Consequently, on a per train basis, each additional Amtrak train has a disproportionately greater impact on overall capacity and reliability.

The simulation introduced entry and dwell delay parameters based on the variability conditions experienced in current operations. The goal of the simulation is to understand the delay experienced on a "typical" weekday rather than resolving degraded or emergency operations, such as when a disabled train is blocking a tunnel or interlocking, because the specific cause of the degraded or emergency operation was not relevant to the study of the variability for Phase I.[21] The recommended operating concepts in this report deal with many of the same constraints that Penn Station has today, and problems with rail fleet or switch failures will create cascading issues for the system.

[21] The analysis conducted in Phase I centered on the capacity increases and network stability from changes in dwell times in Penn Station. While simulation is appropriate for evaluating degraded and emergency conditions, the overall modest amount of infrastructure changes made this effort unnecessary. The tactics used to handle degraded operations today would be used in Operating Concept 1 or 2.

With the Phase I study area being constrained to the existing tracks, platforms, and overall Penn Station complex, the Study Team made certain simplifications in train operations based on how trains move through the station complex (e.g., for Amtrak through-running trains and NJ Transit or LIRR turn trains). As a result, trains of individual operators are indifferent to origin, destination, and other types of tactical train operations. Train lengths were simplified and standardized for Phase I, as there was no detailed service and equipment plan beyond the study area.

In the future configuration with extended platforms as part of Penn Transformation Improvements, trains are more likely to have universal platform access. As a result, differences in train lengths will not be a limiting factor. In Phase II, more detailed service plans will incorporate these constraints and other details.

An additional implication of this simplified approach is that all LIRR services will operate as through movements that begin or end in West Side Yard, meaning no LIRR services "turn" or change directions within Penn Station. For modeling purposes, this reduces conflicts at C Interlocking while new conflicts are created within West Side Yard as westbound trains change to an eastbound direction. West Side Yard is a facility primarily designed for the storage and maintenance of rolling stock. The repositioning of train consists to change operating directions is likely to be slower and exposed to greater variability than for the same activity within Penn Station.

This provides a general structure for LIRR services from a planning perspective, even if it is an unlikely tactical operating plan. As service plans continue to be developed for a larger service area in Phase II, the Study Team will investigate adjustments to the LIRR service plan (such as adjusting assumed turn service and through-running service) to address congestion to and from West Side Yard.

By using Dwell Parameter Set 2 (as described in Overview of Operating Concepts 1 and 2) along with existing variability parameters, the Study Team found that under Operating Concept 1, an increase in service up to 32 TPHPD in the AM peak under the Hudson River is feasible. Under Phase I assumptions, running up to 32 TPHPD under the Hudson River results in slightly higher delay results than the baseline case while running a service plan with up to 30 TPHPD leads to a slight improvement to delays. The performance of these service plans may change as service plans and assumptions are developed as part of Phase II of this Study.

Earlier versions of the service plans developed for Operating Concept 1 included six Amtrak trains per hour in each direction during the peak periods. While these plans were feasible under the assumed dwell times and separation parameters, they did not perform reliably once variability and dynamic interactions between trains were introduced in simulation. As a result, all final service plans include four Amtrak trains per hour in each direction during peak hours.

Removing two Amtrak trains from the service plans yielded a larger improvement in modeled reliability than would have resulted from removing two commuter trains. This reflects Amtrak's higher capacity consumption due to longer dwell times and greater variability assumptions taken from historical data.

Achieving higher Amtrak service levels may be possible through reductions in entry delay and dwell time variability. Potential improvements to these variability parameters—particularly entry delay variability—will be evaluated further as part of the Phase II analysis of regional system performance on both commuter and intercity trains.

Under Phase I assumptions, **Operating Concept 2** produced a working timetable of up to 32 TPHPD under the Hudson River in the AM peak using Dwell Parameter Set 3. However, initial analysis using RTC simulations failed with train arrival variability and the aforementioned congestion associated with LIRR West Side Yard movements. This congestion could be avoided by developing a service plan with LIRR trains turning on the platform or a higher percentage of through-running commuter trains (NJ Transit, Metro-North, and/or LIRR). This service plan configuration will be tested and refined in Phase II. The Study Team will also examine the delay variables and routing options in Phase II and will identify the necessary reduction in delays and associated investments necessary to make Operating Concept 2 function in simulation.

### Table 4: Practical Train Throughput for Recommended Operational and Infrastructure Concepts (Morning Peak)

| Concept | Morning Peak Period | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Under the Hudson River** (to/from New Jersey) | | | | | | | | | | **Under the East River** (to/from Long Island and New England) | | | | | | | | | |
| | Amtrak | | NJ Transit | | LIRR | | Commuter Run-Through | | Total | | Amtrak | | NJ Transit | | LIRR | | Commuter Run-Through | | Total | |
| | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB |
| **Baseline** | 3 | 2 | 20 | 11 | 0 | 0 | 0 | 0 | **23** | **13** | 3 | 2 | 9 | 0 | 10 | 19 | 0 | 0 | **22** | **21** |
| **Concept 1** *Peak of up to 32 cross-Hudson TPHPD* | 4 | 4 | 24 | 12 | 0 | 0 | 4 | 4 | **32** | **20** | 4 | 4 | 12 | 0 | 10 | 24 | 4 | 4 | **30** | **32** |
| **Concept 1** *Peak of up to 30 cross-Hudson TPHPD* | 6 | 6 | 20 | 12 | 0 | 0 | 4 | 4 | **30** | **22** | 6 | 6 | 8 | 0 | 10 | 24 | 4 | 4 | **28** | **34** |
| **Concept 2** | 4 | 4 | 20 | 12 | 0 | 0 | 8 | 8 | **32** | **24** | 4 | 4 | 8 | 0 | 10 | 24 | 8 | 8 | **30** | **36** |

### Table 5: Practical Train Throughput for Recommended Operational and Infrastructure Concepts (Evening Peak)

| Concept | Evening Peak Period | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Under the Hudson River** (to/from New Jersey) | | | | | | | | | | **Under the East River** (to/from Long Island and New England) | | | | | | | | | |
| | Amtrak | | NJ Transit | | LIRR | | Commuter Run-Through | | Total | | Amtrak | | NJ Transit | | LIRR | | Commuter Run-Through | | Total | |
| | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB | EB | WB |
| **Baseline** | 2 | 3 | 10 | 17 | 0 | 0 | 0 | 0 | **12** | **20** | 2 | 3 | 0 | 7 | 19 | 11 | 0 | 0 | **21** | **21** |
| **Concept 1** *Peak of up to 32 cross-Hudson TPHPD* | 4 | 4 | 12 | 24 | 0 | 0 | 4 | 4 | **20** | **32** | 4 | 4 | 0 | 12 | 24 | 12 | 4 | 4 | **32** | **32** |
| **Concept 1** *Peak of up to 30 cross-Hudson TPHPD* | 6 | 6 | 12 | 20 | 0 | 0 | 4 | 4 | **22** | **30** | 6 | 6 | 0 | 8 | 24 | 12 | 4 | 4 | **34** | **30** |
| **Concept 2** | 4 | 4 | 12 | 20 | 0 | 0 | 8 | 8 | **24** | **32** | 4 | 4 | 0 | 8 | 24 | 12 | 8 | 8 | **36** | **32** |

# 5 Infrastructure Improvements

## 5.1 Overview

The Phase I analysis found that organizing the station into three distinct operating zones offers the most promising balance of capacity, reliability, flexibility, and feasibility. This approach builds on how Penn Station works today, adding targeted infrastructure changes to account for the new HRT and improvements to platform clearance, dwell times, and train flow.

Phase I identified two infrastructure packages through the refined operating concepts: **Penn Transformation Improvements** (pedestrian flow and track and platform improvements) and **Penn Station Future** (additional platform and track reconfiguration). Each package includes investments to be incorporated into, or not precluded by, Penn Transformation, as well as additional improvements earmarked for further analysis in Phase II.

Both infrastructure packages can accommodate Operating Concept 1 and Operating Concept 2, respectively, each with up to 32 TPHPD under the Hudson River in the morning peak period. These operational concepts have comparable evening peak performance of up to 30 TPHPD. Together, this provides an increase in capacity of 25 to 33 percent over current operations under the Hudson River within the Penn Station complex's existing footprint. Further analysis and refinement of the operational concepts will be conducted in Phase II of the Study.

**Table 6** highlights the infrastructure package, operating concept, and key benefits associated with these results.

**Table 6: Infrastructure Package and Operating Concepts**

| Infrastructure Package | Operating Concept | TPHPD (Morning) | TPHPD (Evening) | Benefits |
|---|---|---|---|---|
| **Penn Base**<br>Existing Conditions | Existing operations | 24 | 24 | N/A |
| **Penn Transformation**<br>• Adds VCEs, declutters platforms, improves signage<br>• Extends Platforms 1, 2, 3 with associated track work (and additional VCE on those platforms) | **Concept 1**<br>See full description in Section 5.2 | Up to 32 | Up to 30 | • Improves safety and customer experience<br>• Increases station throughput<br>• Increases reliability<br>• Increases NJ Transit train length/ capacity |
| **Penn Future**<br>• Creates a super-wide platform with additional VCEs | **Concept 2**<br>See full description in Section 5.3 | Up to 32 | Up to 30 | • Allows for reduced dwell times<br>• Improves safety and customer experience<br>• Enables a shift to regional rail |

Note: Further analysis and refinement of the operational concepts will be conducted in Phase II of the Study.

The Study Team will further explore additional system improvements in Phase II. The achievable capacity range is sensitive to dwell time reductions relative to existing Amtrak, NJ Transit, and LIRR schedules, with shorter dwell times yielding higher throughput as well as supporting track and bridge infrastructure in the Gateway Program. Additionally, accommodating more than a potential maximum of 32 TPHPD requires broader system improvements in OTP and variability of trains arriving at the station.

These results are structured to future-proof Penn Station by incorporating future capacity needs into station redevelopment as part of Penn Transformation. None of the infrastructure packages under this Study preclude future station expansion.

Construction of these elements and other Penn Transformation improvements will temporarily constrain capacity in Penn Station. Amtrak and the selected Master Developer will need to develop in coordination with the rail operators a construction implementation plan that reduces construction impacts to station operations as much as possible.

## 5.2 Penn Transformation Improvements

**Penn Transformation Improvements** includes a targeted package of both pedestrian circulation and track and platform upgrades designed to improve the passenger experience and railroad operations. These improvements include extending Platforms 1, 2, and 3 to the west, adding up to 23 new VCEs with at least one added to every platform, decluttering platforms to restore usable space, and improving signage throughout the station. These improvements assume any concourse reconstruction will include both the existing VCEs and additional VCEs identified in this Study.

The pedestrian analysis results found that additional VCEs and platform decluttering can lead to reduction in passenger service times on the platform to support reduced dwell times for both commuter and intercity services. The platform and circulation elements, including distributed boarding across concourses, allow platforms on average to be cleared and boarded, depending on the service, by an average of 2.4 minutes faster, an improvement of 28 percent.

Together, these physical changes support a new operating concept that maintains existing LIRR service levels and increases Amtrak and NJ Transit service. The operating concept introduces limited commuter rail through-running service, with up to four commuter trains per hour in both directions running through, rather than terminating at Penn Station, not including existing and planned Amtrak service.

Using RTC software and pedestrian simulation models, the Study Team tested the operational validity of train operations and pedestrian flows of up to 32 TPHPD in the morning peak. With current operational performance variability and a reduction in dwell times, Penn Station can potentially accommodate up to 32 TPHPD. Further analysis and refinement of the operational concepts will be conducted in Phase II of the Study.

Specific elements of the Penn Transformation Improvements infrastructure package include:

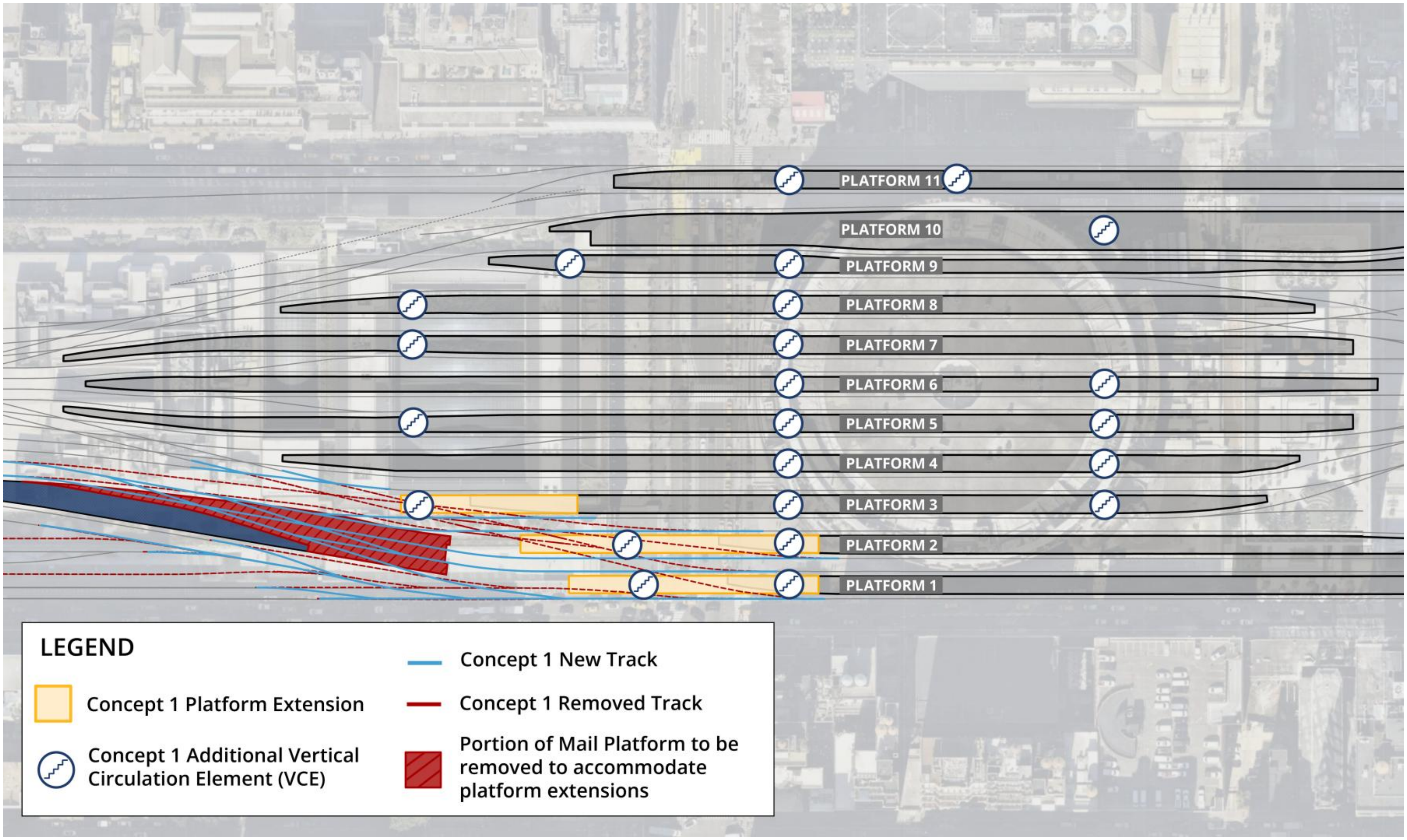
- **New VCEs**. The infrastructure plan proposes the addition of up to 23 new VCEs as follows, with generalized locations displayed in **Figure 11**:
    - Five VCEs in Moynihan
    - Two VCEs up to the west side of 8th Avenue
    - 16 VCEs in Penn Station

Some VCEs are included because they enhance the passenger experience and distribute passengers more evenly across the waiting areas. These also enable passengers to access all platforms from a designated waiting area. If they are not included, it would likely lead to uneven usage of the VCE spaces in that section of the concourse. Amtrak or the Penn Transformation Master Developer may choose to add more VCEs for consistency across concourse areas, further improving platform clearance times.

- **Platform extensions and trackwork**. The infrastructure plan includes extending Platforms 1, 2, and 3 to the west to allow at least 10-car trains (not including the locomotive) to open all doors at any platform (except Platform Track 5, which will be capped at nine passenger cars), over the current limit of only eight of the eastern cars being able to open all doors at those platforms. The work involves moving columns, demolishing approximately 60 percent of the Mail Platform (currently used for storage and workspace), and reworking track connections to the HRT and A Interlocking. Each platform will include a new VCE to serve the far west end of the platform. Consistent platform length and new VCEs allow for shorter dwells and more flexibility when designing service timetables.

- **Platform decluttering**. The infrastructure plan uses platform decluttering to improve pedestrian flow. Decluttering involves removing or relocating items such as mobile equipment to non-passenger areas, creating more space for passenger movement. Proposed VCE additions are displayed in **Figure 11**.

## Figure 11: Penn Transformation Improvements – Proposed VCE Additions




Source: FRA Study Team

**Table 7: Penn Transformation Improvements - Capital Infrastructure Components**

| Capital Infrastructure Components |
|---|
| **Install up to 23 new VCEs: 19 stairs, 4 escalators** |
| **Relocate signage, mobile equipment, and utility cabinets to declutter platforms** |
| **Extend Platforms 1, 2, and 3 by approximately 200 to 350 feet west to accommodate 10-car NJ Transit trains** |
| **Disconnect Platform Tracks 1–5 from the existing "U" and "M" ladders and create a new double-ladder to deconflict access to the new HRT** |
| **Remove 60 percent of the existing Mail Platform** |
| **Remove and replace approximately 115 columns** |

The Penn Transformation Improvements are designed to provide immediate benefits to railroad operations once Penn Transformation is complete, but track capacity remains constrained between the HRT and Newark, New Jersey. The additional VCEs, platform decluttering, and new signage will improve passenger flow and operational performance. Station operations will gain the benefits of these investments as they are delivered, when Penn Transformation is complete.

## 5.3 Penn Station Future

Penn Station Future involves infrastructure improvements in addition to the proposed Penn Transformation Improvements. Infrastructure improvements include combining Platforms 5 and 6 into a super-wide platform and additional VCEs for the super-wide platform. Like Platform 10, the new super-wide platform would allow passengers to wait on the platform and be able to fully alight and board passengers under 2.5 minutes, which is less than the scheduled five-minute dwell. This would enable Operating Concept 2 with eight through-running commuter trains per hour, not including existing and planned through-running Amtrak service, supporting a shift toward a balanced regional rail concept if desirable in the future. The concourse design of Penn Transformation would not preclude future VCEs to this platform. It also would require that new support columns not be placed where the tracks are removed in case a decision is made in the future to restore the tracks.

The Penn Transformation Improvements and Penn Future concepts maintain the existing configurations of track interlockings, with Platform Tracks 1–6 only accessing the new HRT and Empire Connection. Penn Station Future's operating concept may expand train counts in a similar way to Penn Transformation Improvements, but it introduces eight, rather than four, through-running trains per hour.

Dynamic simulation of the station operations found that using current delay parameters, the performance of this concept is problematic, so if this operating concept is desirable in the future, additional investments are required in infrastructure, equipment, and operational adherence to deliver trains from the network to Penn Station more reliably. The Study Team will examine the delay variables and routing options in Phase II and will identify the necessary reduction in delays and associated investments necessary to make Operating Concept 2 function in simulation. None of the retained concepts foreclose potential future station expansion beyond the existing footprint, although the operating railroads would need to modify existing expansion plans to account for the capacity improvements planned in this Study.

Assuming completion of the HRT and future investments in bridges and capacity improvements, Penn Future allows for up to 32 TPHPD between Penn Station and New Jersey (further analysis and refinement of the operational concepts will be conducted in Phase II of the Study). Platforms 1, 2, and 3 are extended, and the extension isolates Platform Tracks 1–4 from connections to the higher-numbered platform tracks. Under this configuration, Platform Tracks 1–4 will operate with a dedicated double-track lead providing a direct connection to the new HRT approach.

Specific elements of the Penn Station Future infrastructure package include the following:

- **Super-Wide Platform**. Platforms 5 and 6 are combined to create a super-wide platform by leaving the existing platforms in place, removing Platform Tracks 10 and 11 and filling in the track space between the platforms. The infrastructure package also includes additional VCEs to better clear the super-wide platform. FRA will work with Amtrak and the Master Developer for Penn Transformation to identify the most appropriate place for these VCEs so their future installation can be incorporated in the Penn Transformation design. The super-wide platform allows for a reduction in dwell times by allowing more space for passengers to circulate and access the concourses.

**Table 8: Penn Station Future - Capital Infrastructure Components**

| Capital Infrastructure Components |
|---|
| **Combine Platforms 5 and 6 into a super-wide platform (approximately 64 feet wide) and provide additional VCEs** |
| **Remove Platform Tracks 10 and 11** |

# 6 Next Steps

In Phase I, the Study Team identified an approach for implementing improvements to Penn Station, accomplishing two primary objectives:

- Providing Amtrak and the Master Developer for Penn Transformation with station- and platform-level improvements to include (and not to preclude) in station redevelopment conceptual design plans that will reduce dwell times and preserve the ability to increase service levels in the future. These conceptual infrastructure improvements will be further refined as part of, or in coordination with, Penn Transformation prior to construction, with consideration given to further engineering and constructability reviews.
- Identifying the Phase II analytical focus to further develop and iterate on Phase I concepts, including refinement of infrastructure needs, operational benefits, implementation considerations, and tradeoffs.

In Phase II, the Study Team will further examine the most promising operating concepts to understand how they affect the broader passenger rail network in the New York Metropolitan region and identify other infrastructure improvements across the region that are needed in combination with improvements to the Penn Station complex, including necessary Gateway Program investments and changes that improve schedule adherence.

Phase II will include additional, more precise simulation and modeling that considers additional improvements to the operating concepts in conjunction with the Phase I infrastructure improvements. Areas for additional analysis include:

- **Regional service, routing, and infrastructure needs**: Analysis of regional needs beyond the footprint of the Penn Station complex to increase OTP, reliability, and capacity within the service areas of LIRR, NJ Transit, and Metro-North railroads. This includes a review of the back of house functions and needs at Penn Station and whether some functions could be housed elsewhere.
- **Routing, service, and operations analysis**: In-depth exploration of additional factors that impact the feasibility of operational changes, including interoperability considerations for infrastructure, signal systems, electrical systems, fleet, and the associated future operating costs.
- **Preliminary engineering and cost estimation**: Advancing a more detailed level of engineering for proposed improvements and updating capital cost estimates.
- **Travel demand and ridership forecasting**: Generating reasonable and empirically supported ridership estimations for potential rail service plans to evaluate tradeoffs between different service options.

In Phase II, the Study Team also will focus on governance structures, funding strategies, and agreements between operators and other key stakeholders, as well as conducting public engagement and regional stakeholder outreach. This will culminate in a future vision for Penn Station, identifying capital projects and operational changes throughout the region to maximize the use of preserved train capacity identified in Phase I.