North-South Rail Link Feasibility Reassessment

What is the North-South Rail Link?

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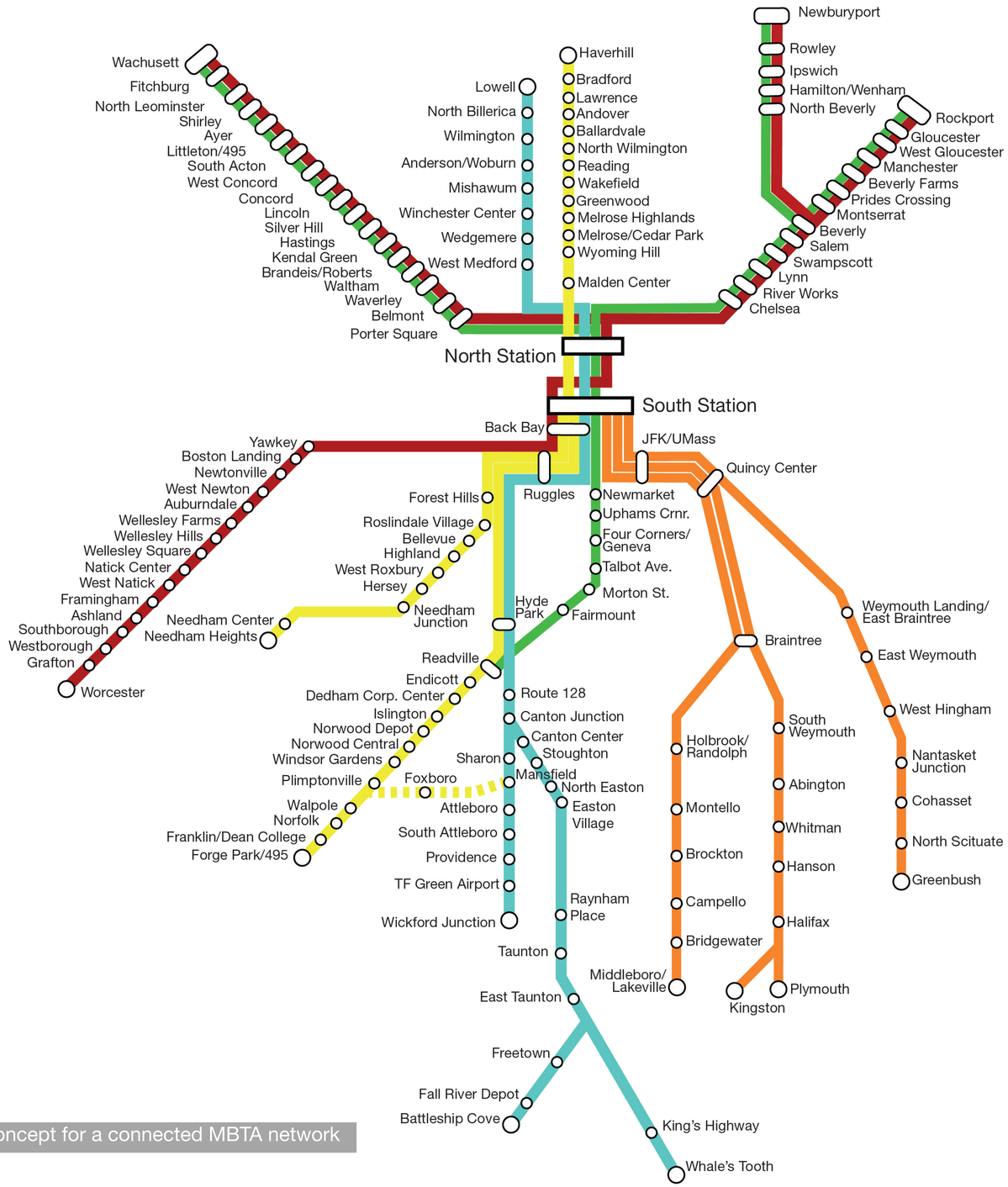

A potential concept for a connected MBTA network

Project Overview

The North South Rail Link is a concept to connect the north and south MBTA commuter rail network through the construction of a rail tunnel under downtown Boston.

Multiple benefits from the improved network connection could arise, including:

- Increase commuter rail capacity
- Improve access to employment
- Relieve rapid transit crowding
- Improve maintenance flexibility through easier access to facilities,
- Reduce highway congestion and emissions
- Create redevelopment opportunities by repurposing property no longer needed for rail layover

North-South Rail Link Feasibility Reassessment

Alignments – Central Artery

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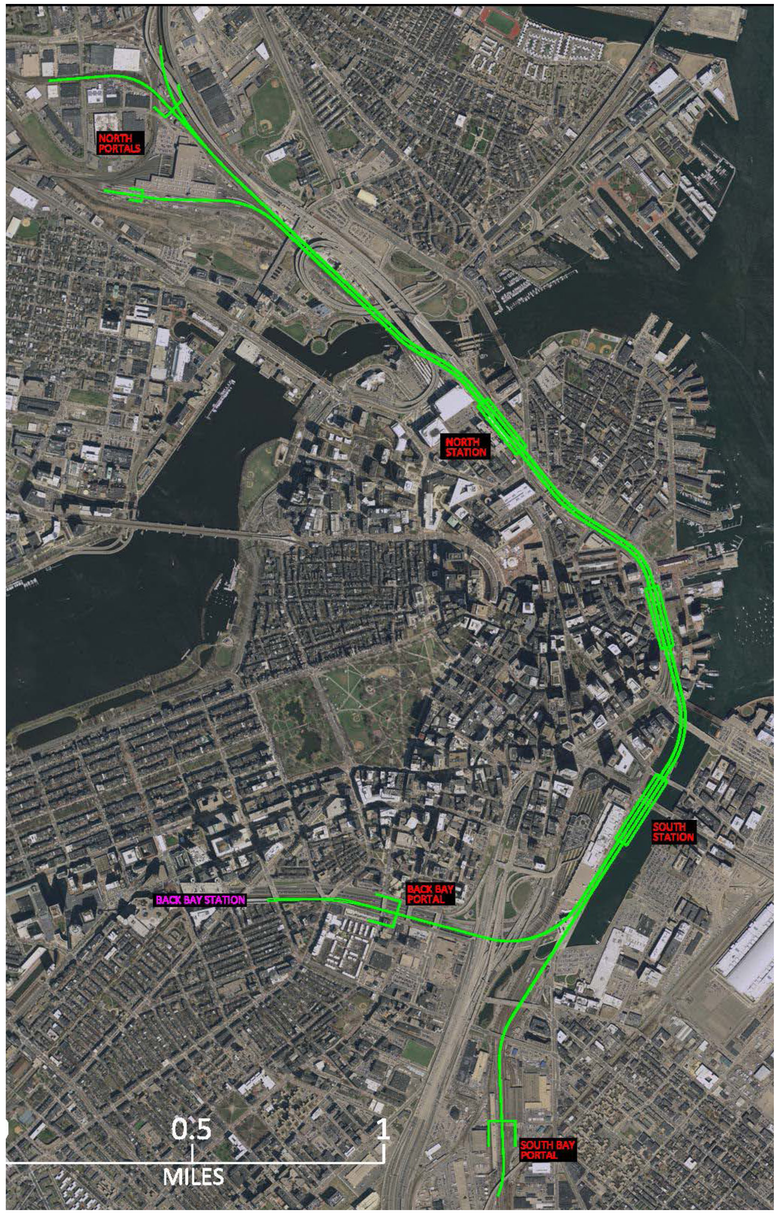
Option 1: Central Artery Four-Track

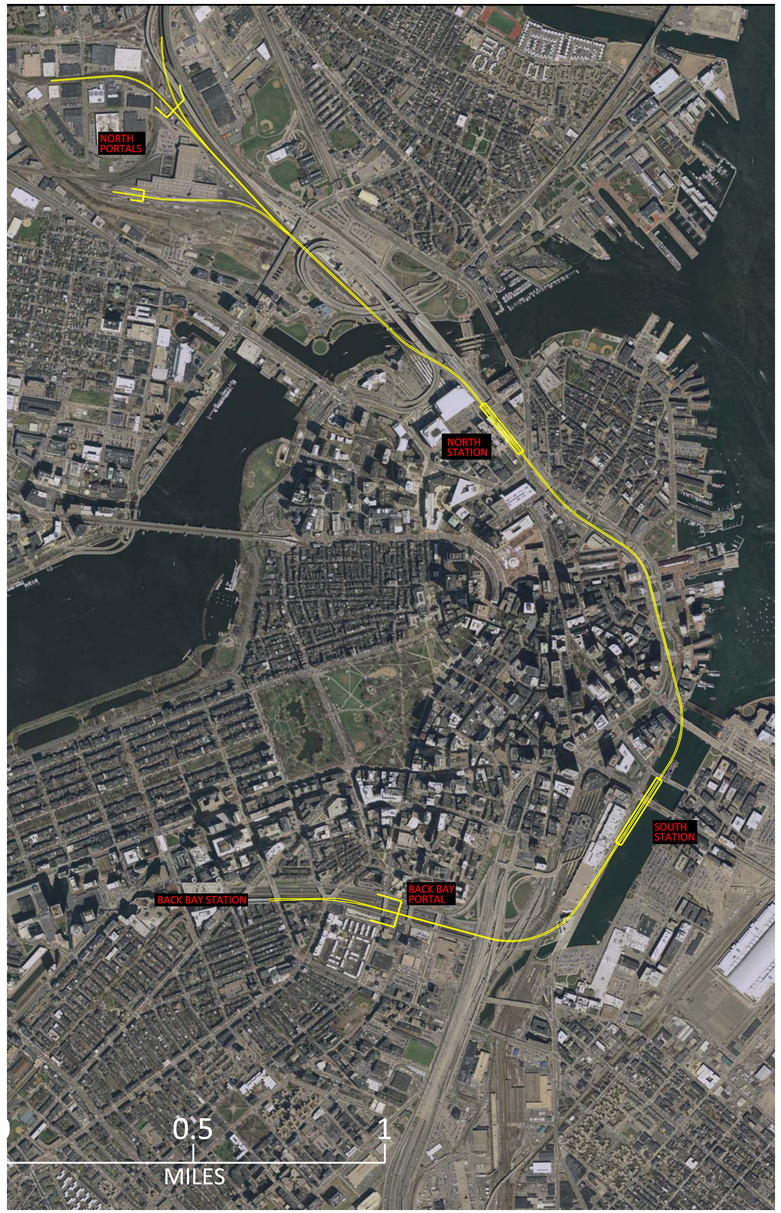


Key Features:

- Three stations; includes Central Station
- Cut-and-cover construction in Fort Point Channel, mining around South Bay interchange ramps
- Uses two 41-foot TBMs to form two 38-foot internal dimension tunnels
- Tunnels under the Orange Line, I-90 Ramps, the Red, Silver and Blue Lines
- Fairmount Line uses the tunnel
- Old Colony Lines continue to terminate at South Station at grade

Tracks	Tunnel Diameter	Stations	Alignment Depth
4	2 x 41ft	3	120-160ft

Option 2: Central Artery Two-Track



Key Features:

- Two stations
- Cut-and-cover construction in Fort Point Channel, mining around South Bay interchange ramps
- Alignment accommodated in a 38-foot internal diameter tunnel built using a 41-foot-diamter TBM
- Tunnels under the Orange Line, I-90 Ramps, the Red, Silver, and Blue Lines
- Fairmount and Old Colony Lines continue to terminate at South Station at grade

Tracks	Tunnel Diameter	Stations	Alignment Depth
2	1 x 41ft	2	120-160ft

North-South Rail Link Feasibility Reassessment

Back Bay Portal

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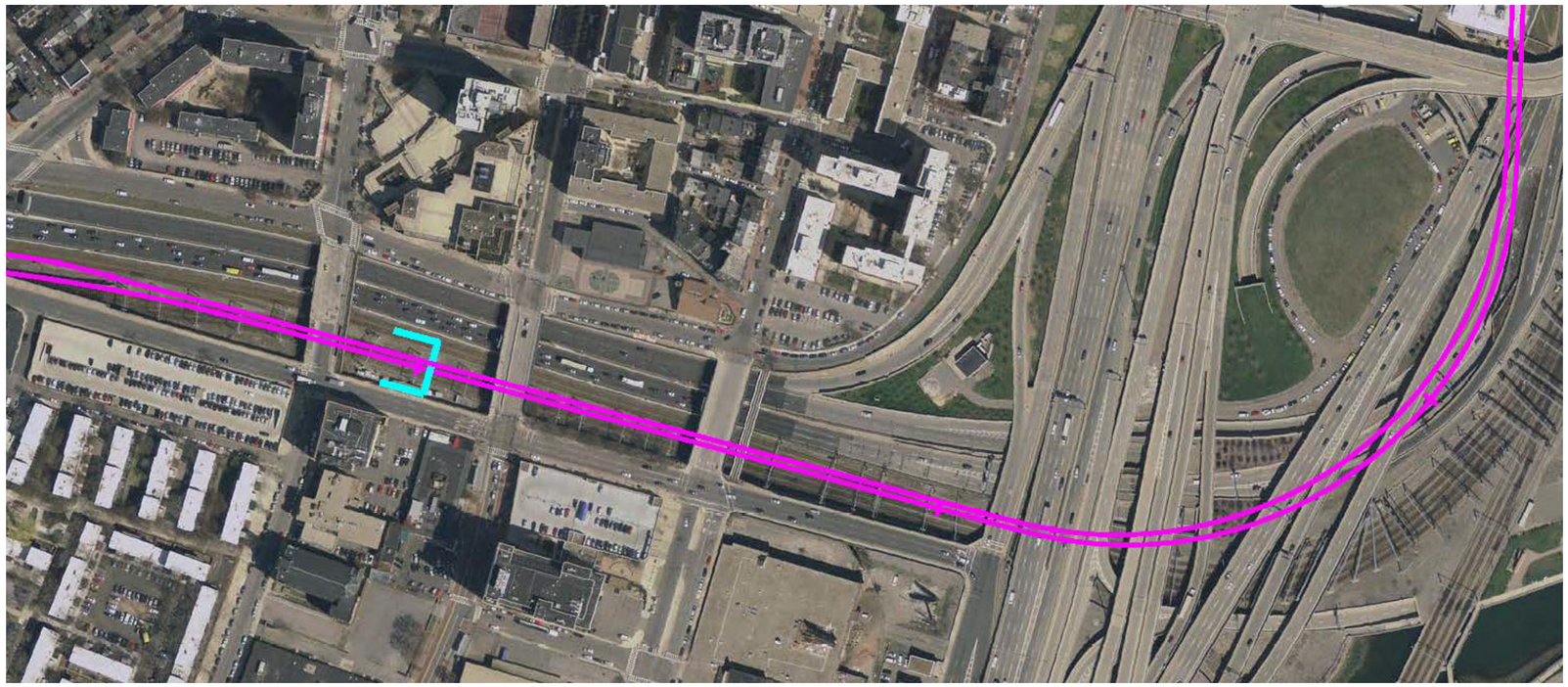
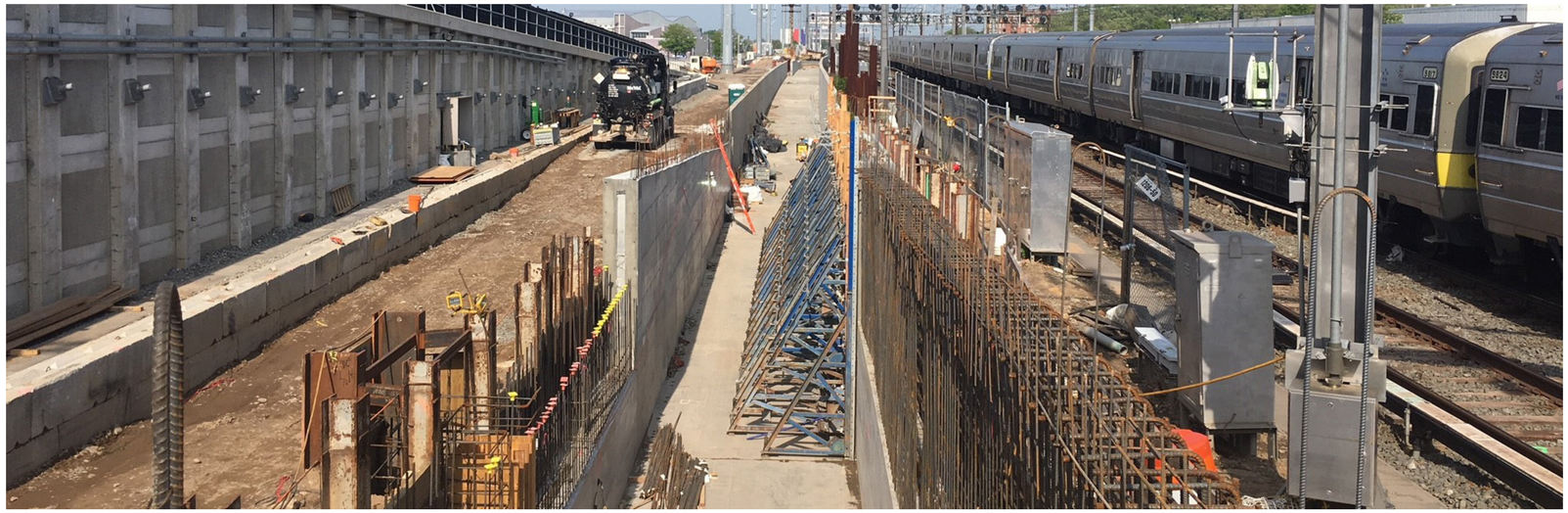
Back Bay Portal between Shawmut Avenue and Washington Street



Example Tunnel Portal (under construction)



Back Bay Portal is utilized in all alternatives.

Location:

- 2.75% grade means approach to portal must begin immediately east of Back Bay station, with portal located between Shawmut Avenue and Washington Street.

Method of Construction:

- Constructed using boat sections and cut-and-cover.

Construction Impacts:

- Limited single-tracking from Back Bay into South Station.
- Temporary rerouting of some or all Amtrak, Providence, Stoughton, and Franklin Line service via the Fairmount Line into South Station (this requires electrification of the Fairmount line to allow electric Amtrak service into South Station during construction).
- Termination of the Worcester Line and Amtrak Lakeshore Limited service west of Back Bay unless a viable rerouting (i.e. via the Grand Junction Line into North Station) is identified.

North-South Rail Link Feasibility Reassessment

Alignments – Congress Street

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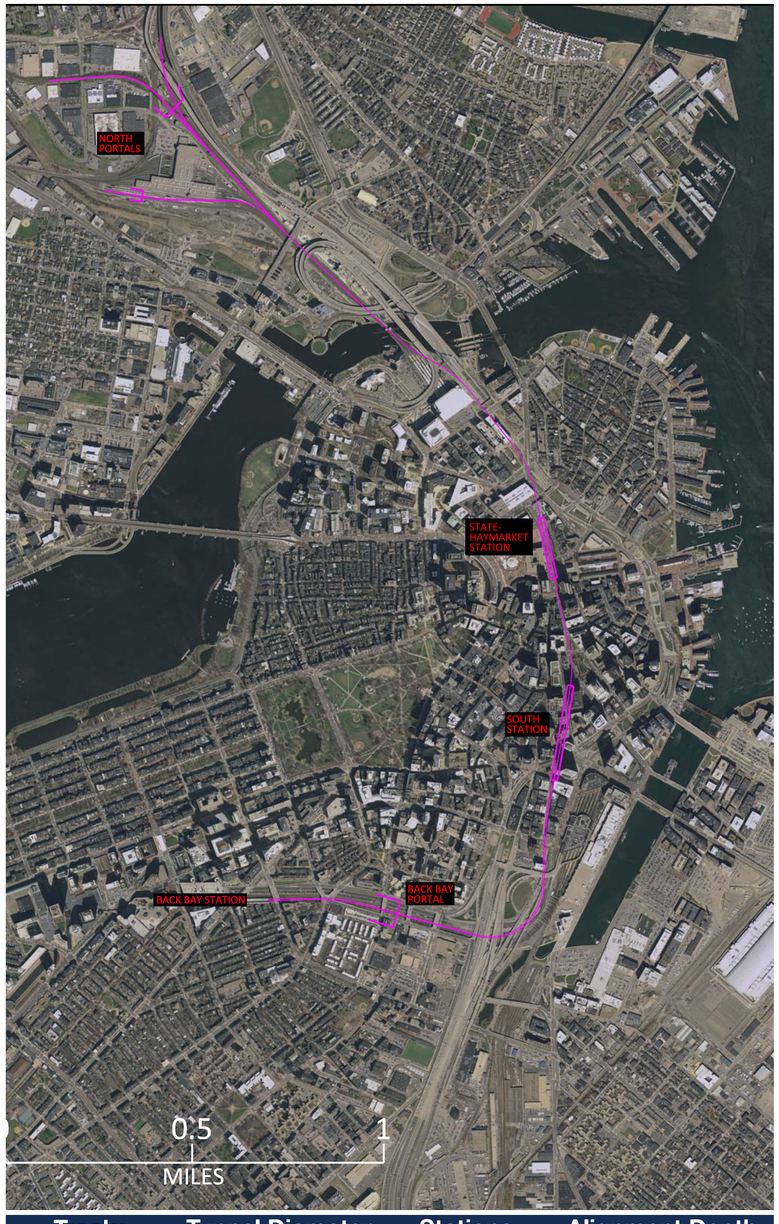
Option 3: South / Congress Alignment

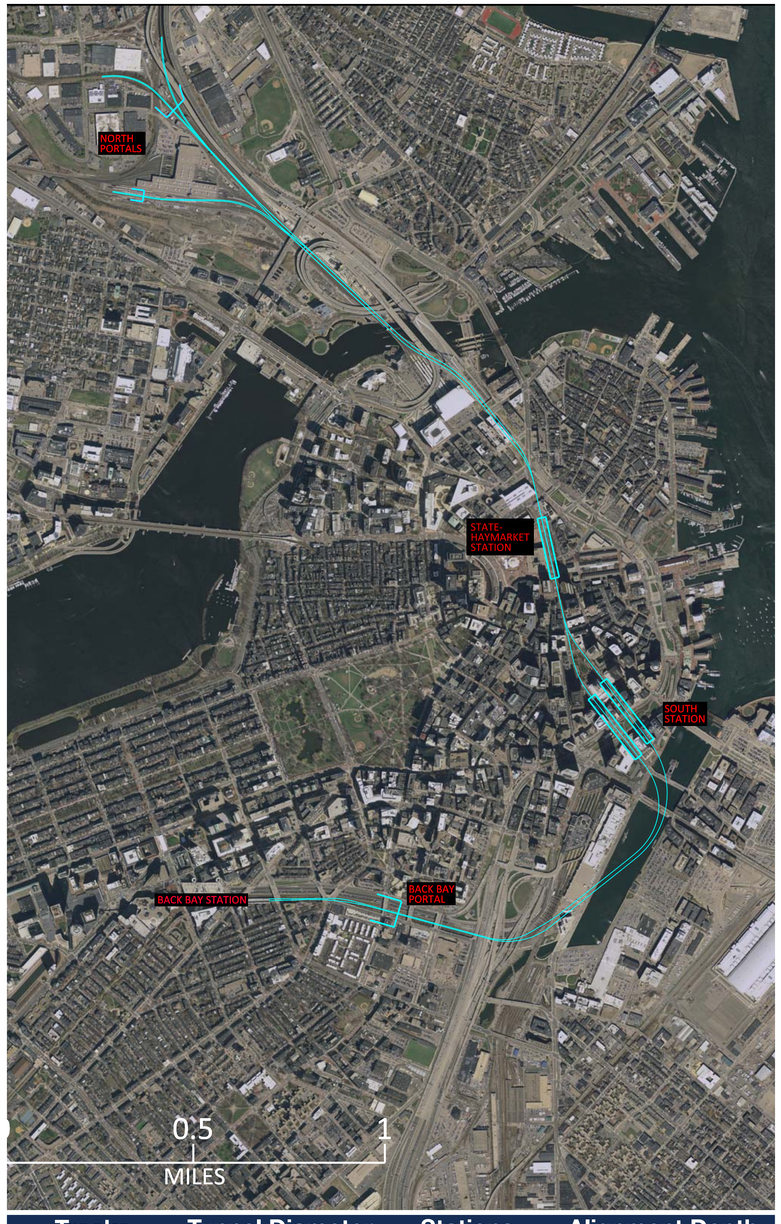


Key Features:

- Two stations
- Single 51-foot TBM bored tunnel with stacked tracks and platforms within the tunnel bore
- Tunnels under Red, Blue, Orange and Green Lines and the southbound lanes of I-93
- Fairmount and Old Colony Lines continue to terminate at South Station at grade

Tracks	Tunnel Diameter	Stations	Alignment Depth
2	1 x 51ft	2	110-160ft

Option 4: Pearl / Congress Alignment



Key Features:

- Two stations
- Mining around South Bay interchange ramps
- Uses two 29-foot-diameter TBM bored tunnels
- Tunnels under Orange Line, I-90 Ramps, the Red and Silver Lines, I-93 northbound lanes, I-93, the Blue and Green Lines
- Fairmount and Old Colony Lines continue to terminate at South Station at grade

Tracks	Tunnel Diameter	Stations	Alignment Depth
2	2 x 29ft	2	120-195ft

North-South Rail Link Feasibility Reassessment

Station Platforms

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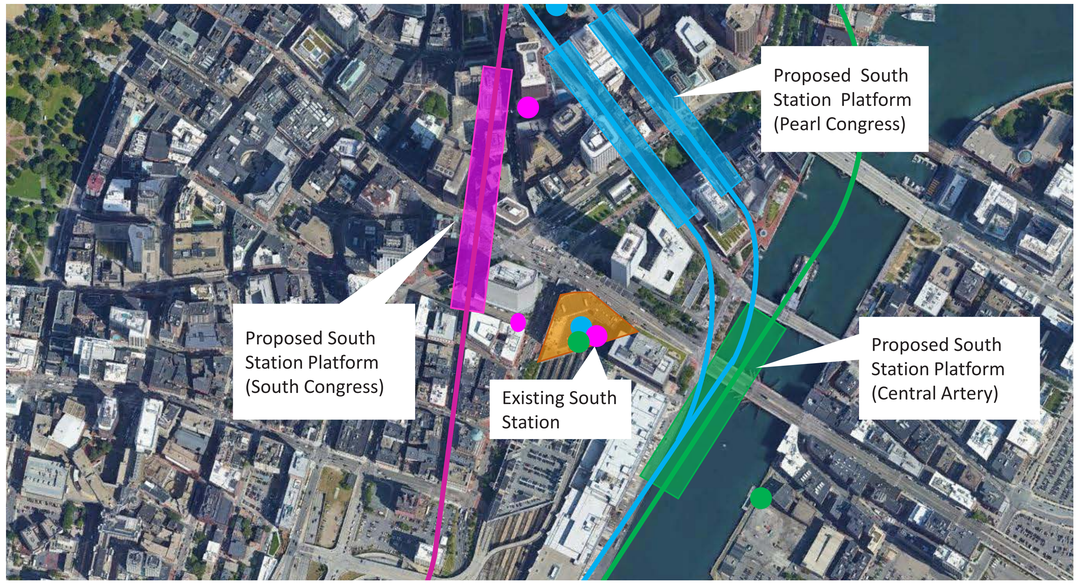
The following maps show potential locations for the North Station and South Station platforms, and how each option affects pedestrian connectivity and access.

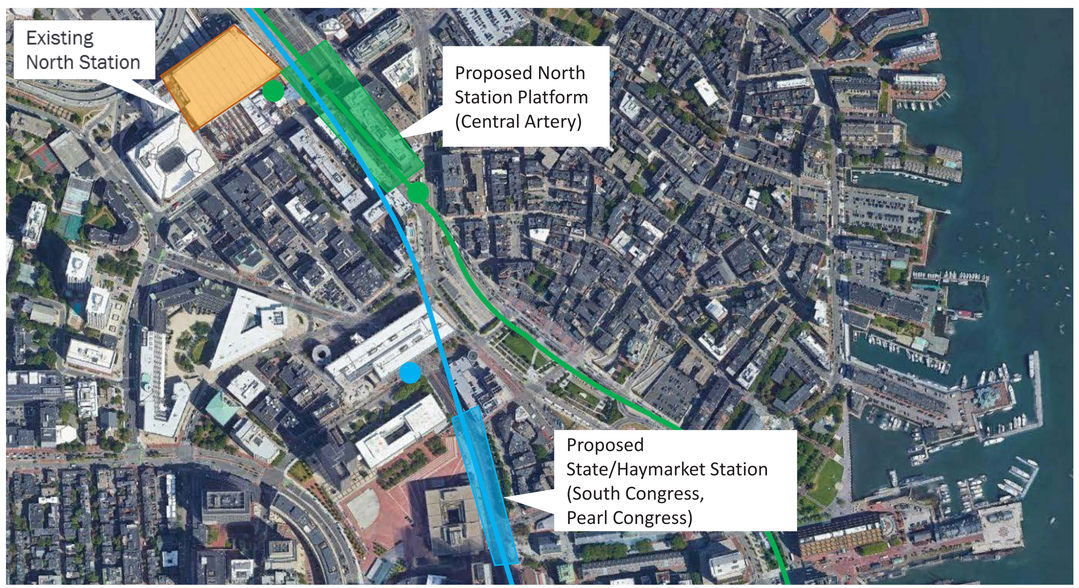
The accompanying tables estimate the change in walk times from the platforms to typical waking destinations from the existing stations.

South Station Platform: Location Alternatives and Passenger Walk Times



Alignment Option	Station Depth (ft)	Approximate change in walking distance* (min)	
		Seaport	Post Office Square
Central Artery	135 ft	+1	+4
South Congress	130 ft	+6	-1
Pearl Congress *(southbound)*	130 ft	+6	-1
Pearl Congress *(northbound)*	185 ft	+7	-1

North Station Platform: Location Alternatives and Passenger Walk Times



Alignment Option	Station Depth (ft)	Approximate change in walking distance* (min)
		State Street
Central Artery	140 ft	+1
South Congress	140 ft	-8
Pearl Congress *(southbound)*	135 ft	-8
Pearl Congress *(northbound)*	195 ft	-7

* Walking distance measurement taken from the center of the platform.

North-South Rail Link Feasibility Reassessment

Service Plans

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MBTA Service Plan

These alternative MBTA Service Plans are used to test the overall operations of the rail network, and measure the impacts of changes in train frequency along each rail corridor. Each Service Plan has been calibrated to provide a high level of service for MBTA passengers while maintaining operational effectiveness.

Service Plan alternatives use a combination of peak and off-peak strategies to deliver performance, and can be operated through any of the alignment alternatives, except as noted.

	Service Plan Alternatives			
	No Build	**South Station Expansion All-Day Peak Service (No NSRL)**	**NSRL Regular Service (2-Track)**	**NSRL All-Day Peak Service (2-Track and 4-Track)**
Peak Level Service	Current service schedule	Maximum achievable service levels*	Maximum achievable service levels*	Maximum achievable service levels*
Off-Peak Level Service	Current service schedule	Maximum achievable service levels*	Hourly Service	Maximum achievable service levels*
South Coast Rail	South Coast line via Middleborough	South Coast line via Stoughton (fully electrified)	South Coast line via Stoughton (fully electrified)	South Coast line via Stoughton (fully electrified)

*A potential frequency of trains every 10-30 minutes depending on the line

Service Plan Assumptions

- NSRL Tunnel can support 17 trains per hour (per track, per direction).
- NSRL process held 2-3 slots per hour in each direction for each tunnel options for Amtrak service. This allows flexibility for Amtrak to use tunnel capacity to serve intercity needs. Significant infrastructure and rolling stock improvements (as part of the NEC Future process) may be required.
- Service Plans assume no constraints on station parking.
- Quick passenger boarding and alighting using all train doors, similar to rapid transit operations.
- Based on trains following precise schedule operations that maintain a 17 trains/hour frequency.
- All trains operating through the tunnel are interlined with another line on the other side of the system.
- All trains serve North Station at new subsurface platforms
- Significant infrastructure investments beyond the tunnel may be needed to meet the above assumptions:
  - Resignaling of 30 track miles supports increased service.
  - Double Tracking at Worcester, Fitchburg, and Newburyport / Rockport (between McNall & Northey Point Junctions - between Swampscott and Salem stations).
  - Additional Platforms at Fitchburg, Lowell, and Worcester.
  - Turnback Crossovers at Fitchburg, Franklin, and Fairmount.
  - Crossing and Passing Loops at Needham, Old Colony (passing loop between Abington and Whitman Stations), and Haverhill.

North-South Rail Link Feasibility Reassessment

Service Assumptions

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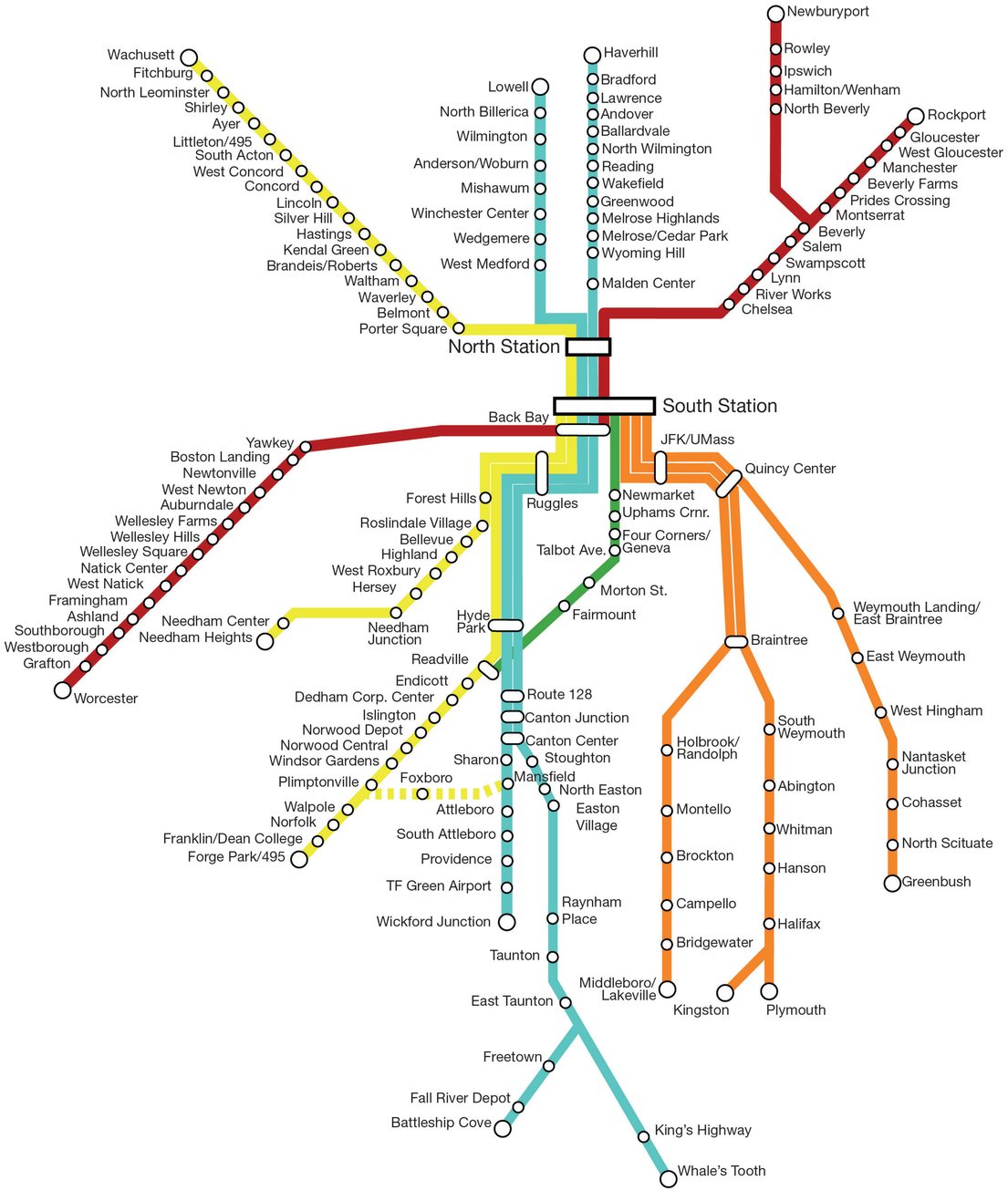
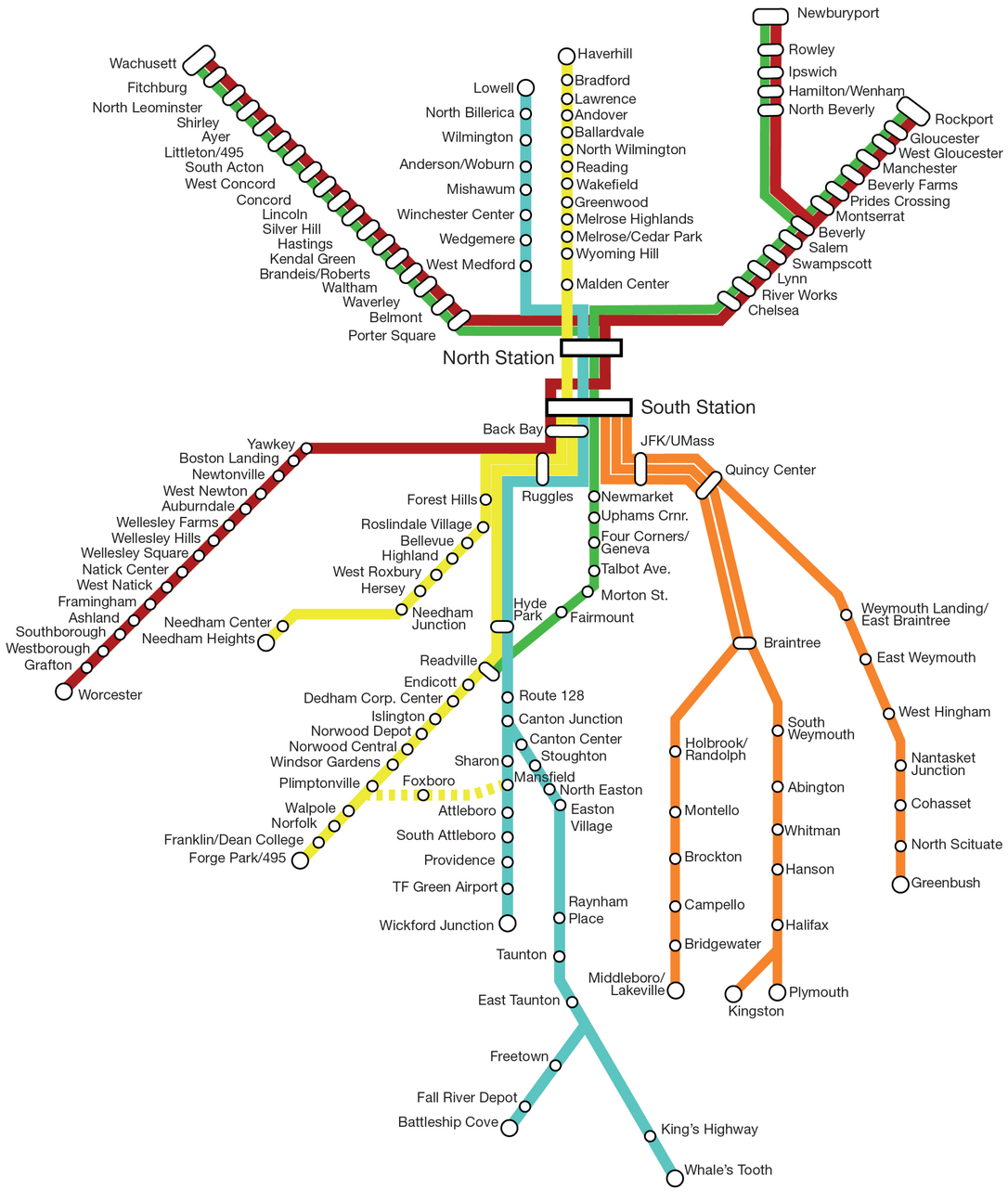
NSRL Regular Service and NSRL All-Day Peak Service (2-track)



NSRL All-Day Peak Service (4-track)



North-South Rail Link Feasibility Reassessment

Capital Cost Estimates

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Cost Estimate Overview

	South Station Expansion All-Day Peak Service	Central Artery (2 - Track)	South Congress	Pearl / Congress	Central Artery (4 - Track)
Tunneling	N/A	$8,629,000,000	$9,493,000,000	$10,701,000,000	$17,730,000,000
Vehicles	$1,397,000,000	$2,380,000,000	$2,380,000,000	$2,380,000,000	$2,439,000,000
Upstream Investments to Support Increased Service	$833,000,000	$1,307,000,100	$1,307,000,100	$1,307,000,100	$1,321,000,000
SSX*	$2,466,000,000	N/A	N/A	N/A	N/A
Total	**$4,696,000,000**	**$12,317,000,000**	**$13,181,000,000**	**$14,388,000,000**	**$21,491,000,000**

* Includes only project elements from MassDOT's South Station Expansion Federal Environmental Filing

Cost Estimate Assumptions:

- Each alternative has 2 stations except for the Central Artery 4-track which has 3 stations
- 2028 Midpoint of Construction USD
- Additional Vehicles costs are part of increased service in all alternatives

Cost Estimate Methodology

- Escalation to midpoint of construction (2028): Standard practice for construction costs. Aims at simplifying the cost-loading strategy of a project by assuming that 50% of the project cost will be incurred in 50% of the project's duration.
- Every cost estimate is escalated by 3.5% for escalation per year.
- Costs include: Alignment Lengths, tunnel types, station areas, trackwork, portals, and allowances
- Allowances: underpinning works, roadway reconstruction, and utility relocations.
- Total Design Build Costs = Direct Costs + Indirects + Contractor's Overhead / Profit + Design Engineering
- Total Project Costs = Total Design Build Costs + Owner's Soft Costs + Project Risk Contingency + Escalation to Midpoint of Construction

North-South Rail Link Feasibility Reassessment

Operating Cost Estimates

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Operating Cost Estimates

Operating costs have been estimated for the No Build, South Station Expansion All-Day Peak Service, and NSRL Regular Service options.

	No Build	South Station Expansion All-Day Peak Service	NSRL Regular Service
Vehicle Revenue Miles / Day	16,420	41,550	51,470
Operating Expenses / Year	$400M	$775M	$929M

*2018 dollars

Operating Cost Methodology

- Train miles and hours provide the basis for the estimation of operating costs, including maintenance
- Distances are derived from the current MBTA Commuter Rail track network
- Journey times are based on current schedule timings
- Non-revenue mileage and train hours are based on assumed trainyard locations. (A high-level assessment of yard capacity has been undertaken)
- The calculations do not allow for non-revenue moves between lines during operating hours or any additional movements required for rolling stock maintenance or refueling.
- Mileage and hours are based on the whole consist rather than per coach.

Operating Cost Inputs

The chart below shows train miles and hours per Service Plan alternatives.

Weekday Daily Totals				
Service Alternative	Revenue Miles	Revenue Hours	Non-revenue Miles	Non-revenue Hours
No Build	16,420	530	800	30
South Station Expansion All-Day Peak Service	41,550	1,370	1,630	60
NSRL Regular Service (2-Track)	28,290	950	2,300	60
NSRL All-Day Peak Service (2-Track)	51,470	1,690	2,800	80
NSRL All-Day Peak Service (4-Track)	55,230	1,780	2,800	90

North-South Rail Link Feasibility Reassessment

Other Factors Affecting Cost

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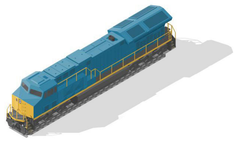
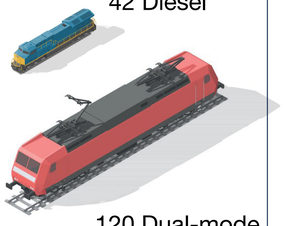
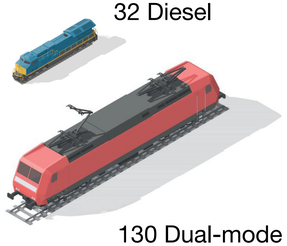
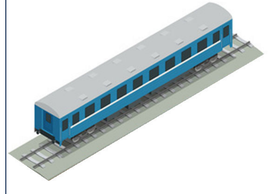
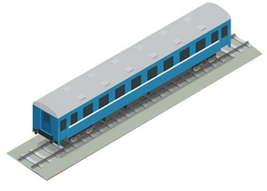
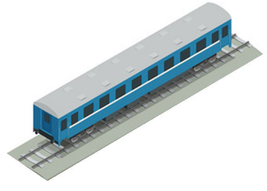
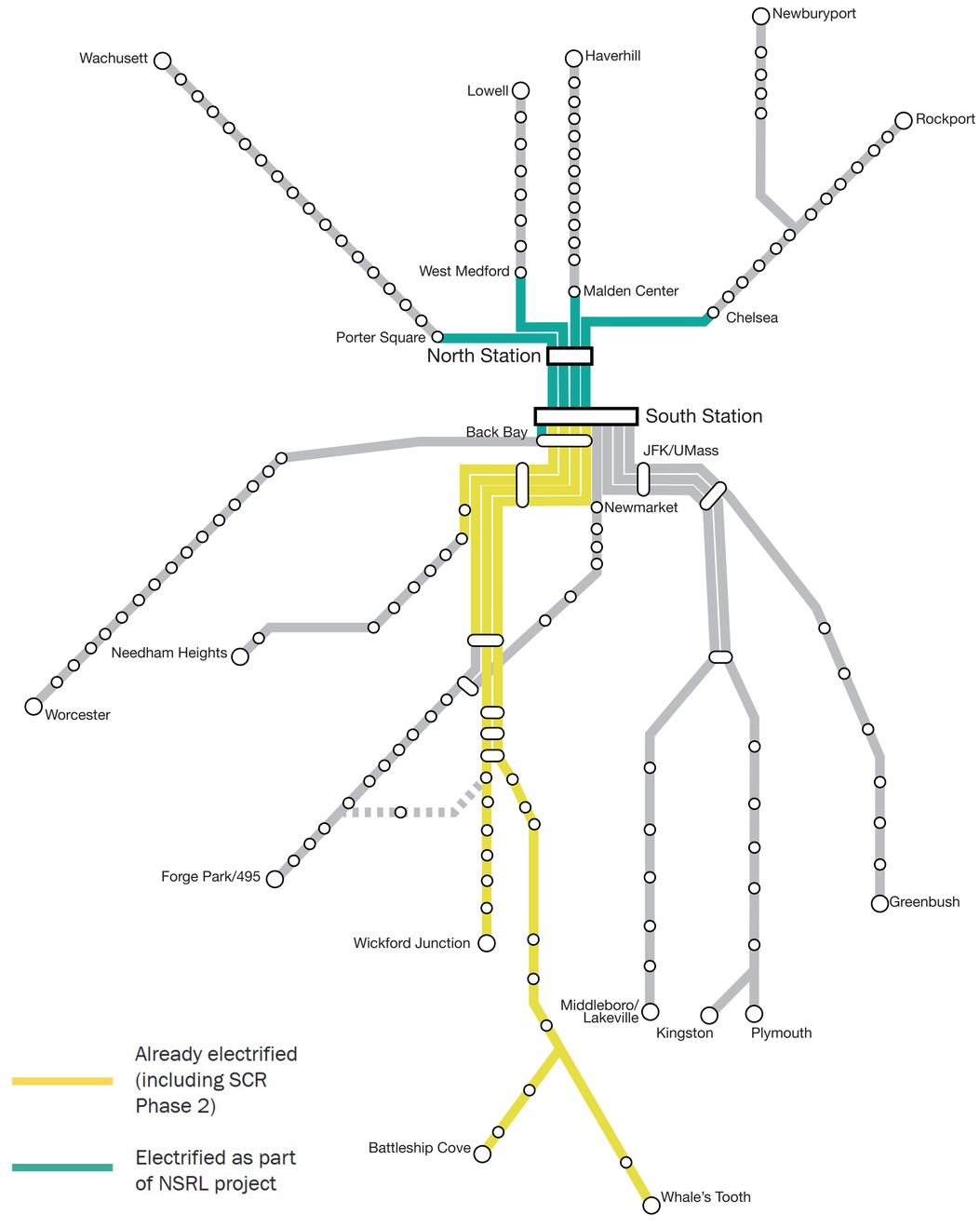
Dual Mode Locomotives and Coaches

Dual-mode locomotives are proposed for the NSRL tunnel alternatives as they are able to travel on both the electrified and non-electrified portions of the commuter rail system, switching between diesel and electric operations as appropriate. The chart below shows how the MBTA's fleet would change under each alternative to provide significant capacity across the network.

Rail Fleet Breakdown

	No Build	SSX All-Day Peak (No NSRL)	NSRL 2-Track Tunnel	NSRL 4-Track Tunnel
Locomotive Type	 90 Diesel	 145 Diesel	 42 Diesel 120 Dual-mode	 32 Diesel 130 Dual-mode
Total	**90**	**145**	**162**	**162**
Coaches				
Total	**397**	**583**	**600**	**600**

Electrification Proposal



North-South Rail Link Feasibility Reassessment

Ridership and Capacity

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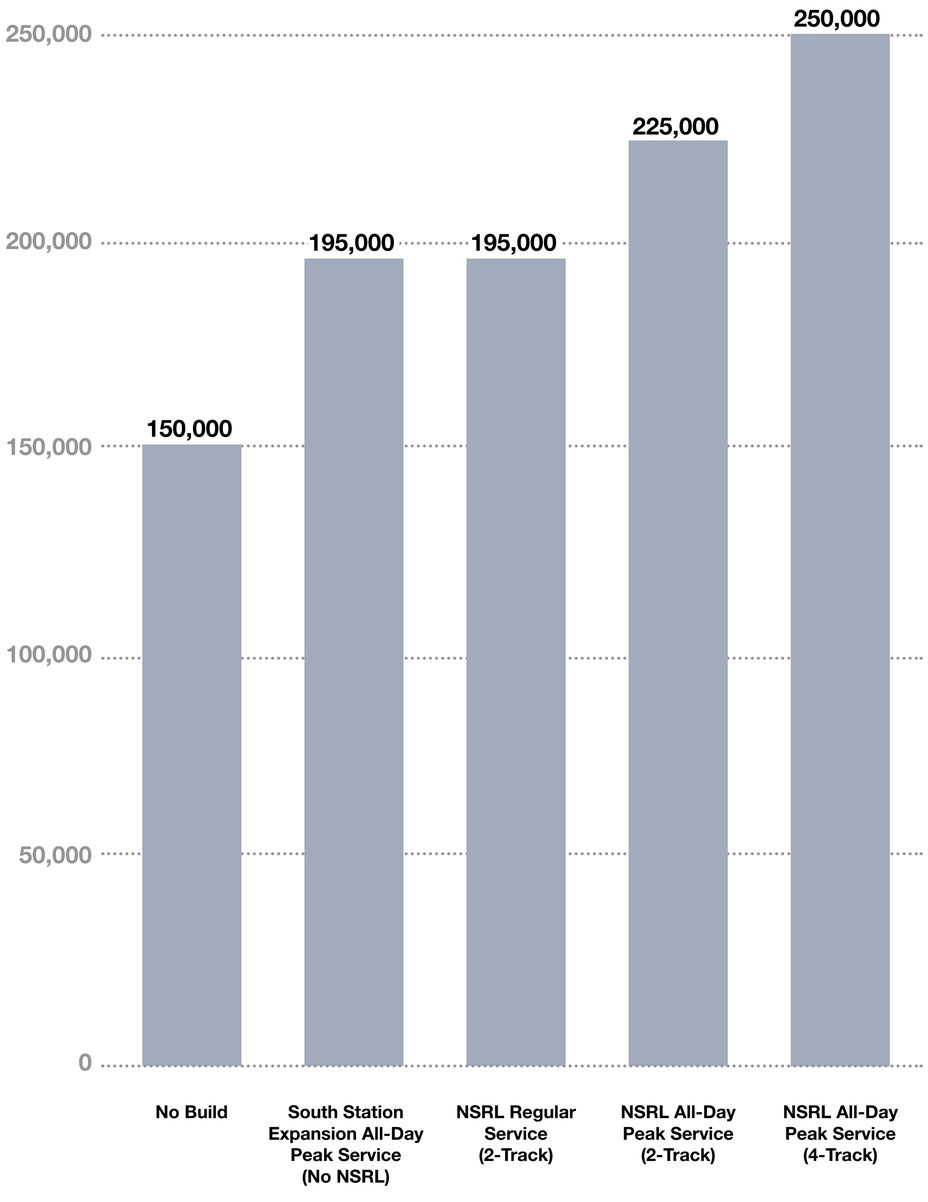
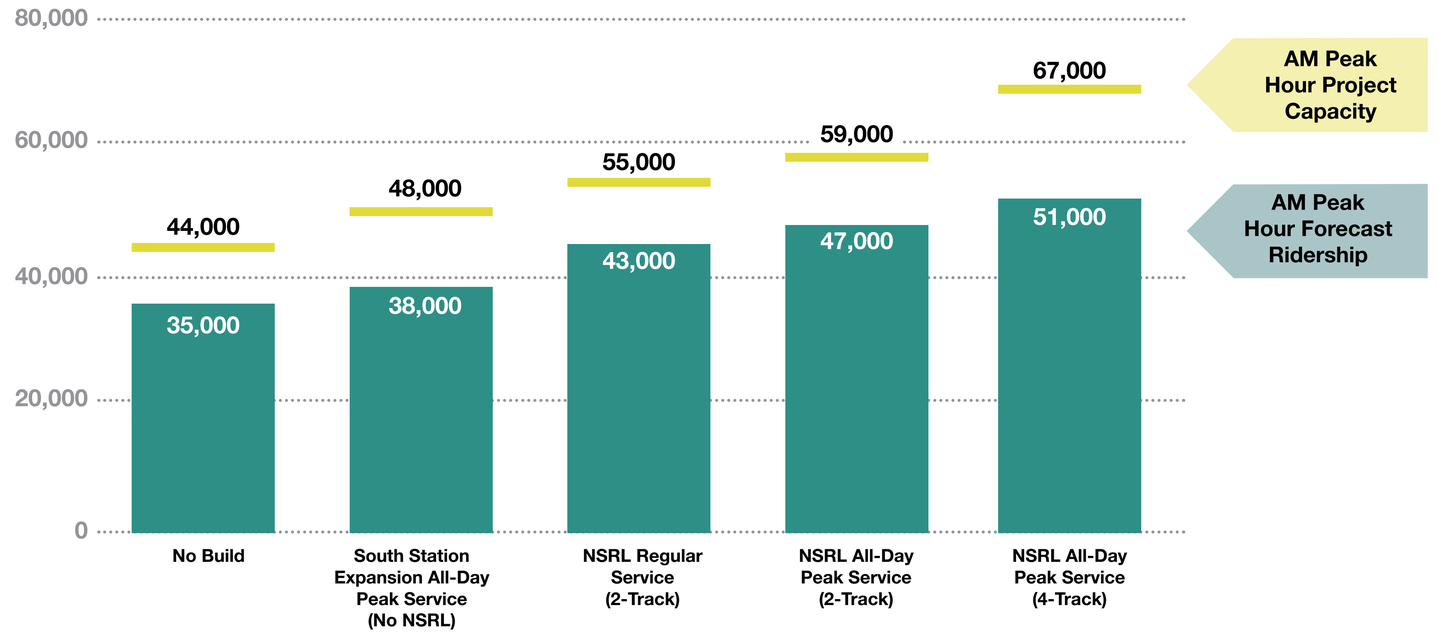
All-Day Boardings

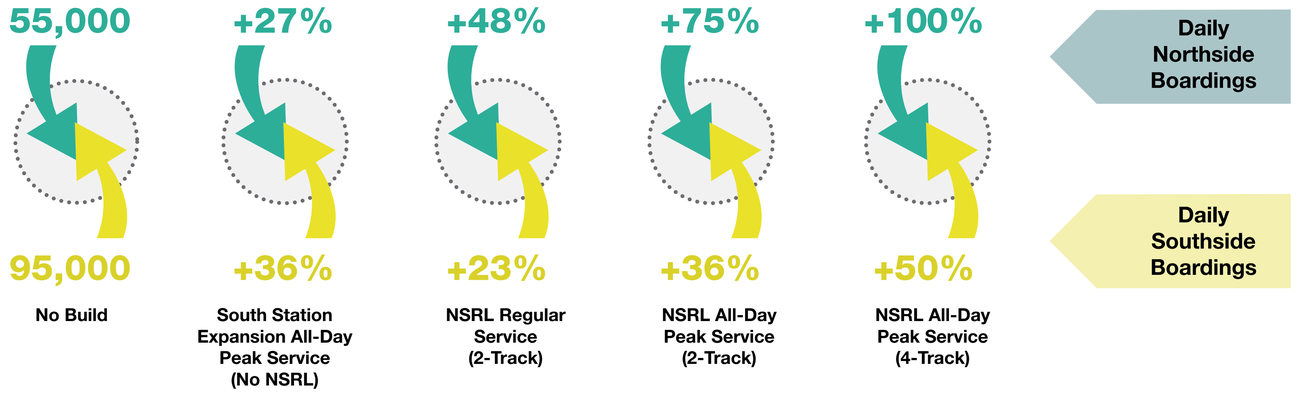


Peak Hour Project Capacity



*NSRL All-Day Peak Service capacity is slightly above NSRL Regular Service capacity due to slight differences in the proposed timetables for these two Service Plan alternatives.

Daily Ridership Forecast



Service Alternative	Lines/Line Pairings			Frequencies (peak direction)				
				AM Peak (6:00-9:00)	Midday (9:00-16:00)	PM Peak (16:00-19:00)	Evening (19:00-21:00)	Late Night (21:00-1:00)
No Build 2040	Newburyport/Rockport	to	North Station	15	60	20	30	60
	Haverhill	to	North Station	30	60	30	60	120
	Lowell	to	North Station	20	60	30	60	120
	Fitchburg	to	North Station	30	60	30	60	120
	Worcester	to	South Station	15	120	20	60	60
	Needham	to	South Station	30	60	30	60	120
	Franklin	to	South Station	30	60	30	60	60
	Providence/Stoughton	to	South Station	15	60	20	60	60
	Fairmount	to	South Station	30	60	60	60	120
	Middleborough/SCR	to	South Station	30	120	60	120	240
	Kingston/Plymouth	to	South Station	30	120	60	120	120
	Greenbush	to	South Station	30	120	30	120	240
South Station Expansion All Day Peak (No NSRL)	Newburyport/Rockport	to	North Station	15	15	15	15	30
	Haverhill	to	North Station	20	20	20	20	30
	Lowell	to	North Station	20	20	20	20	30
	Fitchburg	to	North Station	20	20	20	20	30
	Worcester	to	South Station	10	10	10	10	20
	Needham	to	South Station	30	30	30	30	60
	Franklin	to	South Station	30	30	30	30	60
	Providence/Stoughton	to	South Station	15	15	15	15	30
	Fairmount	to	South Station	15	15	15	15	30
	Middleborough/SCR	to	South Station	30	60	30	60	120
	Kingston/Plymouth	to	South Station	30	60	30	60	120
	Greenbush	to	South Station	30	60	30	60	120
NSRL Regular Service	Fairmount	to	South Station	15	60	15	60	60
	Middleborough	to	South Station	30	120	30	120	180
	Kingston/Plymouth	to	South Station	30	120	30	120	180
	Greenbush	to	South Station	30	120	30	120	180
	Worcester	to	Newburyport/Rockport	15	60	15	60	60
	Needham	to	Fitchburg	30	90	30	60	120
	Franklin	to	Fitchburg	25	90	25	90	120
	Providence/SCR	to	Lowell	20	60	20	60	60
	Providence/SCR	to	Haverhill	20	60	20	60	60
NSRL All-Day Peak Service (2-track)	Fairmount	to	South Station	15	15	15	15	30
	Middleborough	to	South Station	30	60	30	60	120
	Kingston/Plymouth	to	South Station	30	60	30	60	120
	Greenbush	to	South Station	30	60	30	60	120
	Worcester	to	Newburyport/Rockport	15	15	15	15	30
	Needham	to	Fitchburg	30	30	30	30	60
	Franklin	to	Fitchburg	15	15	15	15	30
	Providence/SCR	to	Lowell	15	15	15	15	30
	Providence/SCR	to	Haverhill	20	20	20	20	30
NSRL All-Day Peak Service (4-track)	Dedham	to	South Station	30	30	30	30	60
	Middleborough	to	South Station	30	60	30	60	60
	Kingston/Plymouth	to	South Station	30	60	30	60	60
	Greenbush	to	South Station	30	60	30	60	60
	Worcester	to	Newburyport/Rockport	30	30	30	30	60
	Worcester	to	Fitchburg	15	15	15	15	30
	Needham	to	Haverhill	30	30	30	30	60
	Franklin	to	Haverhill	30	30	30	30	60
	Providence/SCR	to	Lowell	10	10	10	10	30
	Fairmount	to	Newburyport/Rockport	30	30	30	30	60
	Fairmount	to	Fitchburg	30	30	30	30	60