The Boston South Station HSIPR Expansion Project Cost-Benefit Analysis

High Speed Intercity Passenger Rail Technical Appendix

Prepared by HDR
August 5, 2010

The Boston South Station HSIPR Expansion Project

Benefit-Cost Analysis Summary

The proposed Boston South Station Expansion Project is expected to enhance service and provide other quantifiable benefits, such as improved on-time performance benefitting existing users and increased ridership due to the service improvements. Travelers induced to take rail, instead of driving or taking the bus, will mean fewer users on the roadways, resulting in a reduction in emissions, congestion, vehicle operating costs, accidents, and pavement wear and tear. Some diversion from air travel is also anticipated with the improved service offerings out of South Station.

In addition to the improvements associated specifically with South Station, this project includes the construction of a layover solution which will provide a layover facility within three miles of South Station. This will reduce the operating costs associated with the movement of non-revenue service trains between the station and the layover facility, as the nearest layover facility is currently 8 miles away and does not have the capacity to serve the expanded service expected in the future.

Project Benefits: There are three general categories of benefits associated with the South Station improvements: 1) Benefits to rail users; 2) Benefits to remaining highway users; 3) Environmental benefits.

Project Costs: Costs include the initial capital construction and rolling stock procurement costs as well as the operating and maintenance (O&M) costs associated with the enhanced service out of South Station and improved proximity of the layover facility to the station.

The following principles guided the estimation of benefits and costs:

- Only incremental benefits and costs are measured. Incremental costs of implementation of the project include initial and recurring costs. Initial costs refer to the capital costs incurred for design and construction of the station improvements and layover solution. Recurring costs include annual operating costs in addition to incremental maintenance expenses. Only additions in costs to the current operations and planned investments are considered in this analysis.
- Benefits and costs are valued at their opportunity costs. The benefits stemming from the implementation of the transportation improvement are those above and beyond the benefits that could be obtained from the best transportation alternative. Annual costs and benefits are computed over a long-run planning horizon and summarized through a lifecycle cost analysis.
- Analysis is based on the construction completion at the end of 2016 with the new South Station improvements opening for service in 2017.

The opportunity cost associated with the delayed consumption of benefits and the alternative uses of the capital for the implementation of the project is measured by the discount rate. All benefits and costs are discounted to reflect the opportunity costs of committing resources to the project. Calculated real discount rates are applied to all future costs and benefits as a representation of how the public sector evaluates investments. A 7% real discount rate is used in the analysis, with a sensitivity test at 3%.

Using a discount rate of 7%, investment in South Station improvements will result in:

- Total benefits of $2,265.9 million in present value terms
- Total costs of $1,674.9 million in present value terms
- Total net present value of $591.0 million, with a benefit-cost ratio of 1.35.

For comparison purposes, the BCR was also calculated at a 3% discount rate, resulting in a BCR of 1.89 versus the BCR of 1.35 using the 7% discount rate.

The following describes all of the benefits derived from the proposed South Station improvements and layover solution.

Benefits to Rail Users: Existing rail users receive a benefit from increased on-time performance leading to a reduction in unexpected delay at South Station. The number of existing riders is based on 2009 ridership data for the Acela, Northeast Regional, and MBTA services and is projected over time based on socioeconomic forecasts. Ridership growth forecasts under the improvement scenario were calculated by both Amtrak and MBTA as part of the Northeast Corridor Master Plan.

Benefits are quantified in relation to the average wage rate in the region of approximately $25 per hour depending on trip purpose and mode. It was assumed that 80 percent of Acela trips are business related and 20 percent are personal (e.g, college students, tourism), while 40 percent of Northeast Regional trips are business related, and 60 percent of MBTA Commuter Rail Trips are business related. The personal travelers receive a value of $18.64/hr. for their time, and business travelers receive a wage of $26.75/hr. Travel reliability benefits are not included in average speed calculations, and the transportation literature values reliability gains at between 50% and 200% of the value of travel time. This cumulative reliability benefit is estimated to be $20.0 million for existing Amtrak users and $345.9 million for existing MBTA Commuter Rail users, totaling $365.9 million.

In addition to the benefits to existing users, there are also benefits to new users who divert to rail because of the increase in reliability of the existing service and the expansion of service that will take place once station construction is completed. These service increases include 5 new daily round-trip Acela trains to Washington, DC via New York City, and 8 new daily round-trip Commuter Rail trips to various areas originating at South Station.

Ridership forecasts of induced rail trips lead to additional user benefits consistent with consumer surplus theory; new riders would only use rail if they are better off by doing so. This benefit is measured by the difference between the generalized cost of either highway or air and rail travel for each origin-destination pair, accounting for travel time, vehicle operating costs, rail fare, and an amenity/convenience factor. These riders are either diverting from air, auto, or bus for intercity travel, auto for commuter travel, or are induced by the additional service options to take a trip that they otherwise would not have taken.

Users who are diverted from auto experience cost savings because they no longer incur the costs of operating their vehicles or parking their car at their destination. Somewhat offsetting these costs are

those they pay as rail fare, for parking at the station, and to account for the time spent waiting to ride the train. These are deducted from their cost savings. In total, the benefits to those diverted from auto to rail amount to $1,524.5 million for Amtrak users and $1,107.1 million for MBTA users. Users can also be diverted from the bus or air, or induced to ride. The benefits to these users are calculated in terms of the cost differential from the previous mode to rail, including time spent waiting. For induced users, the value is calculated as the difference between the cost of the lowest-price alternative to rail and the rail service. The benefits of diversion from bus and air, as well as induced rider benefits, total $668.9 million. The total benefits to new riders of the service is $2,170.7 million for intercity users and $1,107.1 million for commuter, totaling $3,277.8 million when combined.

In our analysis, fare is counted in the cost to the user as well as in the operations cost of the system provider. In order to offset this, the fare revenue generated by the service is included as a benefit to the system operator. This avoids double-counting of the costs. Overall, this amounts to $4,386 million for Amtrak and $1,929 million for MBTA.

In total, the benefits to the rail users of the improvement are $6,576.4 million for intercity rail and $3,381.8 million for commuter rail. This results in a total benefit to rail users of $9,958.2 million.

Benefits to Remaining Highway Users: Improvements to South Station will enable better intercity passenger rail service, which will induce additional passenger ridership and move some travelers off the roadways and away from air travel. The users of the railway derive benefits, and the remaining highway users also experience benefits due to the removal of vehicles from the road when some travelers choose the train rather than driving their cars. These are accrued in the following categories:

- Highway maintenance cost savings: Reduced Vehicle Miles Traveled (VMT) leads to a reduction in pavement wear and lower future highway maintenance costs. This benefit is estimated on a cost per mile basis using data and guidance provided by the Federal Highway Administration (FHWA). The total value of this savings is $13.3 million due to intercity rail and $11.1 million due to commuter rail.
- Accident reduction benefits: Fewer cars, trucks and buses on the road mean fewer accidents on the roadways. This benefit is based on VMT and totals $121.7 million for intercity rail and $101.7 million for commuter rail.
- Highway congestion relief: Reduced VMT relieves congestion for those vehicles remaining on the highway, resulting in higher speeds and reduced travel time (VHT). A value of time based on average wages is used to compute this benefit. In total, the benefit of congestion reduction for intercity rail is $286.7 million, and the benefit to users related to commuter rail is $239.6 million.

The benefits to remaining highway users from highway maintenance cost savings, accident reduction benefits, and highway congestion relief total $421.7 million for intercity service and $352.4 million for commuter rail service, for a total of $774.1 million in benefits to remaining highway users.

Environmental Benefits: The removal of trucks, buses and autos diverted from the highway results in a reduction in total emissions. This benefit is based on VMT reductions due to the service improvements. There are also emissions reductions associated with the diversion of air travelers to the improved rail

service. This emissions reduction benefit is derived using an estimate of the likely passengers who will choose to take the train, rather than fly, take the bus or drive to their destination, once intercity passenger rail service is improved. While the modal shifts reduce emissions, the addition of train service for both intercity and commuter trains produces additional rail emissions. These must be netted out of the savings in emissions from diversion. There are also environmental benefits with reduced noise pollution. When these calculations are done, the total emission reduction related to intercity passenger rail is $82.4 million and the benefits related to commuter rail are $60.3 million for a total of $142.7 million in environmental benefits.

Capital/O&M Costs: The capital costs, including preliminary engineering, are estimated to be $603.6 million for the South Station improvements with expenditures from 2011 to the end of 2016. The layover solution (including PE/NEPA) is anticipated to cost $160.5 million with expenditures from 2014 to 2015. In addition, the procurement of new rolling stock is necessary to facilitate the increased Acela and Commuter Rail service. This will cost a total of $256 million from 2014 to 2022 for the Acela vehicles and $276.2 million from 2011 to 2015 for the new MBTA vehicles. Total capital costs for the project are estimated to be $1,296.2 million including new rolling stock procurement.

Operating costs in the analysis include both those additional costs associated with the South Station improvements and the estimated savings in operating costs associated with transferring trains from South Station to the new layover facility, which is closer than the current layover facilities. Total operating costs are estimated to be $3,134.5 million for Acela and $171.5 million for MBTA, with $88.4 million in operating cost savings attributable to the improved location of the layover solution.

Benefit-Cost Analysis Summary:

The present value of all benefits is $2,265.9 million, with costs at $1,674.9 million, a Net Present Value (NPV) of $591.0 million, and a benefit-cost ratio of 1.35. Benefits and costs are in millions of 2010 dollars and assume a 7 percent discount rate. The benefit-cost ration is 1.89 using a 3% discount rate.

BENEFITS	Millions of 2010$	
Benefits to Existing Riders	$	365.9
Benefits to New Riders	$	3,277.8
System Revenue	$	6,314.4
Pavement Maintenance	$	24.4
Accident Reduction	$	223.5
Congestion Cost Savings	$	526.2
Environmental Benefits	$	142.7
Total Benefits	$	10,874.9
PV of Total Benefits	$	2,265.9
COSTS		
Capital Costs	$	1,296.2
Operating & Maintenance Costs	$	3,376.6
Total Costs	$	4,672.8
PV of Total Costs	$	1,674.9
Net Present Value (NPV)	$	**591.0**
Benefit-Cost Ratio (BCR)		**1.35**

The table below provides a breakdown of the benefits to Amtrak (Intercity Passenger Rail) and MBTA (Commuter Rail). This indicates that 62 percent of the benefits associated with the Boston South Station Expansion Project are attributable to the intercity passenger rail, while 38 percent are attributable to the commuter rail service improvements.

BENEFITS (Millions of 2010$)	Amtrak	MBTA
Benefits to Existing Riders	**$ 20.0**	**$ 345.9**
Benefits to New Riders	**$ 2,170.7**	**$ 1,107.1**
System Revenue	**$ 4,385.6**	**$ 1,928.8**
Pavement Maintenance	**$ 13.3**	**$ 11.1**
Accident Reduction	**$ 121.7**	**$ 101.7**
Congestion Cost Savings	**$ 286.7**	**$ 239.6**
Environmental Benefits	**$ 82.4**	**$ 60.3**
Total Benefits	**$ 7,080.4**	**$ 3,794.5**
PV of Total Benefits	**$ 1,408.4**	**$ 857.5**