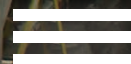


Building Rail Transit Projects Better for Less

A Report on the Costs of
Delivering MTA Megaprojects

A Report of The Fourth Regional Plan and
the Milstein Forums on New York's Future
February 2018



Acknowledgments

This report highlights key recommendations from RPA's Fourth Regional Plan for the New York-New Jersey-Connecticut metropolitan area. View the full plan at fourthplan.org

The Fourth Regional Plan
has been made possible by

Major support from

The Ford Foundation

The JPB Foundation

The Robert Wood Johnson Foundation

The Rockefeller Foundation

Grants and donations from

Albert W. & Katharine E. Merck Charitable Fund

Anonymous

Fairfield County Community Foundation

Fund for the Environment and Urban Life/Oram
Foundation

Howard and Abby Milstein Foundation

JM Kaplan Fund

Lincoln Institute of Land Policy

New York Community Trust

Rauch Foundation

Siemens

And additional support from

Rohit Aggarwala

Peter Bienstock

Brooklyn Greenway Initiative

Doris Duke Charitable
Foundation

Emigrant Bank

Friends of Hudson River Park

Fund for New Jersey

Garfield Foundation

Greater Jamaica

Development Corporation

Town of Hackettstown

Laurance S. Rockefeller Fund

Leen Foundation

Lily Auchincloss Foundation

National Park Service

New Jersey Board of Public
Utilities

New Jersey Highlands
Council

New Jersey Institute of
Technology

New York State Energy

Research and Development
Authority (NYSERDA)

Open Space Institute

PlaceWorks

Ralph E. Ogden Foundation

Robert Sterling Clark

Foundation

Rutgers University

Shawangunk Valley

Conservancy

Stavros Niarchos Foundation

Suffolk County

Two Trees Foundation

Upper Manhattan

Empowerment Zone

Volvo Research and
Education Foundations
World Bank

Regional Plan Association is especially
grateful to the Howard and Abby Milstein
Foundation for their generous support.

Authored by

Richard Barone, Vice President for Transportation

Julia Vitullo-Martin, Senior Fellow

Alyssa Pichardo, Senior Planner, Transportation

Additional content and support was provided by Christopher Jones, Senior Vice-President and Chief Planner, Moses Gates, Director of Community Planning and Design, Dani Simons, Vice President for Strategic Communications, and Allison Henry, Research Analyst, Transportation. Graphics and layout by Ben Oldenburg, Senior Graphic Designer, and David Young Shin, Graphic Design Intern.

RPA thanks the over 100 professionals whose interviews informed the findings of this study. We would also like to thank the following transportation agencies for the data and technical assistance they provided

The New York Metropolitan Transportation Authority
Transport for London and Crossrail Ltd
Consorcio Regional de Transportes de Madrid
Metro de Santiago
Tokyo Metro
Los Angeles Metro
Toronto Transit Commission
Société du Grand Paris

The Milstein forums on New York's future

We are grateful for the intellectual input provided via the Milstein Forums on New York's Future.

Rohit Aggarwala
David Armour
Richard Bagger
Larry Belinsky
Anthony Borelli
Tonio Burgos
Armando
Carbonell
Anthony Coscia
Andrew Farkas
Michael Fascitelli
Patrick Foye
Jerry Gottesman
Gary Hack
Leo Hindery

David Klinges
Jay Kriegel
Tom Madison
Marvin Markus
Howard Milstein
Angela Pinsky
Seth Pinsky
John Porcari
Richard Ravitch
Scott Rechler
Ed Rendell
Lucius Riccio
Denise Richardson
Marc Ricks
Stephen Ross

Lynne Sagalyn
Elliot Sander
Rob Schiffer
Samuel Schwartz
Jim Simpson
Jeffrey Stewart
Marilyn Jordan
Taylor
Bill Thompson
Julia Vitullo-
Martin
Thomas Wright
Bob Yaro

We thank all our donors for their
generous support of our work.

Contents

Executive Summary / 2

The Challenges of Expanding New York's Public Transportation / 7

Three Case Studies: Second Avenue Subway, East Side Access, and #7 Line Extension / 11

Second Avenue Subway, Phase One: 63rd Street to 96th Street / 12

East Side Access: LIRR to Grand Central Terminal / 18

#7 Line Subway Extension to the Far West Side / 26

Lessons: What Was Learned from the Case Studies / 32

Lessons from Other Cities: National and International Comparatives / 49

Crossrail (Tunneled Portion) – London, UK / 53

Purple Line Phase I Expansion: Western Avenue to La Cienega - Los Angeles, California, USA / 60

Line 14 Southern Expansion: Olympiades to Orly Airport - Paris, France / 62

Line 9 Extension: Herrera Oria to Paco de Lucia - Madrid, Spain / 66

Northern Line Extension Kennington to Battersea - London, United Kingdom / 69

Construction Standards and Best Practices From Other Places / 71

Capital Construction Recommendations: Reforms and Strategies / 73

Executive Summary

The extraordinarily high costs associated with building transit projects in New York are due to many factors, at every stage, from decisions made by political leaders at the inception of the projects to the final stages of lengthy planning, design, and construction processes. Long tolerated as an accepted natural consequence of New York's size and dominance, these costs threaten to strangle the region's future economic growth. Other global cities have outpaced New York in building modern infrastructure and attracting new business and residents as New York struggles to simply keep up with basic maintenance.

Nowhere is the impact of high costs felt more keenly than in transportation — the subways, commuter trains, tunnels, bridges, airports, ports, and roads that helped transform an island city into an economic powerhouse. Of these, the city's extensive subway system has been uniquely important not only as an efficient mover of people and goods, but as a channel of upward mobility, linking far-flung neighborhoods to centrally located jobs and businesses via a service used by New Yorkers of every ethnicity and socioeconomic level.

Despite its fundamental importance to the region's welfare, the subway system has barely expanded since its peak in 1937. In fact, the commuter rail system's reach has actually declined, as many lines were consolidated or decommissioned when private companies were merged into the MTA and New Jersey Transit. New York needs to reverse this trend and set itself back on the path of building wealth-creating infrastructure.

The twin challenges the region faces are high costs and the slow pace of project delivery. Public confidence in the ability of the MTA and public agencies to deliver capital improvements erodes as budgets swell and deadlines are repeatedly missed. Yet the public's understanding of the problems in building large capital projects is limited, because the process is complex and opaque.

This report examines the MTA's three recent megaprojects (#7 Line Extension, Second Avenue Subway, and East Side Access), articulates the major causes of high costs and serious delays, and proposes a series of strategies to address these issues. RPA conducted extensive interviews with

experts locally and abroad, undertook a comprehensive literature review, and researched the best practices of other world cities.¹

Each MTA megaproject has been so expensive, when compared with peer cities, that some transportation advocates now argue against any further expansion — urging the MTA to put all resources into maintenance and repair. But extending rail service into underserved neighborhoods is central to ensuring New York remains a region of upward mobility. As things stand, trains have become increasingly crowded and roads more congested as riders choose cars over trains. The New York region risks losing businesses and jobs to other world cities that are building far more transit capacity and upgrading services much faster.

While this report focuses on MTA megaprojects, many of its findings and recommendations are relevant to others agencies and types of infrastructure.

New York is the world's most expensive city in which to build.

With a \$43 billion construction boom combined with a 3.5 percent cost increase over the previous year, New York overtook Zurich in 2016 as the most expensive city in the world in which to build private or public buildings, according to a survey by Turner and Townsend.² This "New York premium" has long been understood to be the price of building in the region, partly but not exclusively because of its high density and older infrastructure. This cost premium holds true for new infrastructure as well, as other similarly dense and far older regions build for far less. The Second Avenue Subway (SAS), for example, has the distinction of being the world's most expensive subway extension at a cost of \$807 million per track mile for construction costs alone. This is over 650% more per mile than London's Northern Line extension to Battersea — estimated at \$124 million per track mile. Some observers argue SAS's

¹ Milstein Forums on New York's Future

² Turner & Townsend. "International Construction Market Survey 2017: Building Momentum." 2017. <http://www.turnerandtowntsend.com/media/2389/icms-survey-2017.pdf> (accessed January 15, 2017).

high cost is due to the complexity of its Upper East Side neighborhood, the densest residential neighborhood in the United States. Yet the East Side Access (ESA) budget ballooned from \$6.3 billion to more than \$10.2 billion over the past decade while having little surface impact on the crowded commercial district above. The #7 line subway extension is a \$2.1 billion, 1.5-mile addition of rail service from Times Square to a new Hudson Yards Station at 11th Avenue and 34th Street on Manhattan's Far West Side. The line was originally planned with two stops — one at Hudson Yards and a second at 11th Avenue and 41st Street. As costs soared, the MTA eliminated the second stop, failing to build even a cavern for a future station, thereby decreasing the project's overall cost efficiency and significantly increasing the projected costs of constructing the station in the future.

High costs and delays are embedded in every aspect of public-project delivery.

Politics and Public Process

Inaccurate project budgets and time lines lead to avoidable cost overruns.

Project budgets and time lines are developed by professional MTA staff within constraints established by governors, mayors, and legislators reacting to a range of stakeholders. Under-budgeted projects are often put on unrealistic time lines and segmented into phases that interrupt construction. The results are avoidable project delays, an excessive number of change orders, and cost overruns.

Lengthy environmental reviews undervalue the economic and environmental costs of project delays.

Environmental reviews, which can follow federal, state, or city regulations — depending on the project — take far longer to complete here than in other parts of the world. In addition, the MTA goes to great lengths to avoid interrupting existing service or disturbing neighborhoods, even when doing so seriously inflates project time and costs. Minimizing environmental damage and neighborhood disruption are critical objectives, but need to be fully weighed against the environmental and economic benefits that are deferred or reduced by project delays.

Local communities are engaged too late in public review, regularly resulting in poor project design and litigation.

Agencies tend to rely on limited, tightly controlled hearings and outreach that are part of environmental review's public input. In many cases, opposition and lawsuits could be avoided, and project outcomes improved, if communities were engaged earlier in planning and design, and kept engaged throughout the process.

New York's insurance costs are the highest in the country, in part because of the 19th century scaffold law, which imposes absolute liability on a property owner or construction employer in any case of a work-related fall.

New York is the only state with such a law, which has the effect of increasing construction costs by about 7 percent, according to a 2013 Rockefeller Institute report.

Institutional Processes and Decision-Making

Flawed project design results in frequent change orders and project delays.

Limited assessments of constructability (a pre-construction look at how easily and efficiently a project can be built), excessive customization, and insufficient time and resources to incorporate innovative practices lead to projects with unneeded features and construction problems that require midstream alterations.

Inconsistent project management produces inefficiencies.

The lack of vertical integration within the MTA, with six different agencies operating subways, commuter rails, buses, bridges, and tunnels — each with multitudes of subdivisions that have to coordinate planning, approvals and operations during construction projects — adds to the complexity of construction management and fosters a fractured process for project design and implementation.

Overly complex or detailed procurement creates unnecessary layers of bureaucracy and inefficient bidding.

High costs can also be attributed to piecemeal procurement, in which each project phase is often awarded to a separate consultant and contractor — despite the MTA not being required by law to break projects apart or follow the Wicks Law division of contracts. This practice can add to project-management and other costs that could be avoided by awarding projects to a single contractor. In addition, the MTA's practice of selecting the lowest qualified bidder, even though they are permitted to issue Requests-for-Pro-

posals, has resulted in excessive rebidding and the selection of teams that cannot deliver, resulting in millions of dollars in emergency repairs.

Lack of post-project reviews impedes continuous improvement.

Other transit agencies, including Los Angeles, Denver, Madrid, and London, have used postmortem reviews to evaluate the costs of their megaprojects. These documents are publicly available and serve to guide future projects moving forward with lessons and best practices learned.

Labor Practices and Work Rules

Requirements to use agency workforces on construction projects lead to delays and inefficiencies.

Megaprojects are required to use workers from the MTA's operating workforce for a range of jobs. This can result in worker shortages and delays at the construction site, and blur the distinction between operating tasks and capital programming.

Out-of-date work rules lead to excessive staffing and unproductive work time.

Union work rules, which were designed to prevent employer abuses and protect union jurisdictions, have failed to keep up with technological advances. Far fewer workers are employed in European world cities on different phases of construction, such as tunneling. Narrow definitions of work rules have undermined efficiency, impeded the use of new technology, and inflated costs.

Workforce specialization, limited training capacity, and unpredictable project pipelines contribute to an inconsistent labor supply.

Highly specialized occupational roles constrict management's ability to assign workers where needed, while worker training programs need more capacity to keep pace with demand. And because funding and project time lines are uncertain, the lack of a predictable pipeline for infrastructure projects creates little incentive to maintain a skilled workforce large enough to meet peak demands.

Reforming MTA's Capital Project Delivery

The entire process of designing, bidding, and building megaprojects needs to be rethought and reformed top-down and bottom-up. The strategies recommended here are a starting point for comprehensive reform.

All recommendations point to the urgent need for governance reforms — be they the processes controlled by the government directly or the public and private institutions that are influenced by political actors. Structural changes in transportation governing bodies, which are addressed in RPA's Fourth Regional Plan, are not covered here.

Because of limitations in the available data, assigning specific cost savings to RPA's recommendations is difficult. Comparable major cities, however, are building similar projects for less than half New York's costs. Some of this cost differential is beyond the control of the MTA or New York State. Health and pension benefits, for example, are largely nationalized in Europe, but here fall on employers, including contractors and the MTA. Further, projects receiving federal support must follow federal regulations, including environmental review, which is often more onerous than abroad. Even with these constraints, a comprehensive set of reforms should allow the MTA to reduce its costs of building new subways and commuter rails by at least 25-33%.

Politics and the Public Process

Federal and State Government Actions

Make the cost of construction a top priority of environmental review.

This could be institutionalized in federal, state, and local environmental reviews by including an independent analysis that weighs the potential costs and disruption to surrounding communities against the costs, both financial and environmental, of the most cost-effective construction plan. Construction costs should be given equal weight to other costs, thus institutionalizing iterative and updated constructability assessments.

Rationalize the environmental review time line.

Few of New York's international peers are burdened with lengthy environmental review processes, which average seven years in the U.S. Federal and state agencies should examine and consider European practices, which can

complete reviews in 18 to 24 months, in part by separating public outreach and preliminary engineering from the environmental review.

MTA Actions

Engage the public early in sustained, substantive discussion.

Although far from being merely a public-engagement strategy, environmental review is limited to public hearings on technical documents conducted well after projects have been largely selected and designed. The MTA could get broader acceptance of system improvements by engaging the public with greater frequency, clarity, and transparency. The MTA's early and sustained outreach to stakeholders as part of the 15-month L train outage is the type of approach the MTA should replicate in future projects. Another best practice the MTA has started to implement is the early opening of local community outreach and education centers, like the SAS Community Information Center on 125th Street and Park Avenue.

State and MTA Actions

Move to a ten-year pipeline for megaprojects.

The current five-year outlook is insufficient for planning and funding large-scale capital projects. A ten-year plan would not only require sufficient dedicated revenue for both annual operating and long-term capital budgets, it would reassure contractors and the public of a project's feasibility.

Institutional Processes and Decision-Making

MTA Actions

Adopt London's project-delivery model.

For each megaproject, an independent Special Purpose Delivery Vehicle (SPDV) modeled after London's Elizabeth Line should be created. The temporary organization would have a singular purpose: to construct the megaproject. While operating independently, the MTA would have a hand in the SPDV's creation and oversight, while the city and state would have equal representation on the SPDV board, enhancing coordination and cooperation with government agencies. The SPDV would give construction managers the ability to require supplemental funding from any agency proposing costly changes. This cost accountability would introduce a level of budget discipline that is missing today.

Land use and utility work would also benefit from this new structure. With its control over land use, zoning, and streets, city government is in the best position to lead com-

munity outreach efforts and negotiate with major utilities. The city can, for example, order utilities with city franchises to cooperate, at little or no charge to the MTA. The MTA also has the resources of its own technical expertise, diverse funding sources, and a downstate political constituency. Combined and coordinated, these stakeholders would give the SPDV staff tremendous leverage to drive megaprojects forward.

Adopt new project insurance and liability models.

London and Australia have incorporated new models that remove the adversarial culture between project teams to create a no fault-no blame culture. London used Integrated Project Insurance Programs for Heathrow Terminal 5 and Crossrail, while Australia employs alliance contracting — both of which have shown to reduce costs and delay.

State Actions

Use design-build for all new rail lines and extensions.

The increasingly accepted practice of design-build, in which there is a single contract for designing and building a project, would allow the MTA to plan carefully, leaving traditional design-bid-build for smaller projects, such as station renovations.

State and City Actions

Maximize the land-use development potential of transportation investments.

Future megaprojects should incorporate land-use and zoning changes to capture the value created through redevelopment, as was done successfully in the case of the #7 extension and rezoning of Manhattan's West Side. And the process must be collaborative and cooperative, with each side recognizing the assets the other is bringing to the table, in order to catalyze growth.

Labor Practices and Work Rules

MTA and Labor Actions

Rethink labor practices and work rules, borrowing procedures from competing world cities, such as London and Madrid.

Other world cities have demonstrated that employment and wages can be maintained while delivering projects faster and at lower costs. Borrowing from some of those cities' best practices, there are two specific reforms that could result in significant costs savings, and indicate wider savings that could be achieved by a comprehensive examination of the rules embedded in collective bargaining agreements:

- ▶ Start overtime pay once a minimum 40-hour workweek has been met. Most MTA capital work is done on atypical schedules (other than M–F 9–5), when overtime premiums are highest. Rather than paying overtime when less than 40 hours have been worked, reasonable premiums for late-night and weekend shifts should be negotiated.
- ▶ Substantially reduce the number of workers staffing TBMs, following the international practice of 9–15 workers rather than New York’s 20–25. The modern precast segment TBM’s have automated and streamlined many tunnel-construction tasks, combining the tunnel-boring, waterproofing and concrete-lining steps into a single effort — resulting in substantial time savings and a reduction in costs.

Create a public institute to supply a well-trained pool of labor for the next generation of megaprojects.

An institute whose primary mission will be to train the next generation of construction workers would help add capacity to existing public and private programs. A data-oriented organization such as the UK’s Infrastructure Skills Programme could furnish labor-supply data to help megaproject planners expand capacity to better meet demand.

End requirement to use operations workforce on capital construction.

Capital construction projects should be free to use third-party trade labor for all jobs in and around active facilities in coordination with the relevant operating agencies.

Achieving these reforms will be difficult, requiring strong political leadership, cooperative partners in labor and management, and a willingness to reexamine customary practices that have outlived their original value.

The Challenges of Expanding New York's Public Transportation

New Yorkers have long understood that their city endures higher construction costs — both private and public — than other jurisdictions, here and abroad. With a \$43 billion construction boom combined with costs increasing 3.5% last year, New York took the title of the world's most expensive city in which to build, pushing Zurich from its former top spot, concluded a report by Turner & Townsend. Although the study focused on buildings rather than infrastructure, its findings were consistent with the region's reputation for having high construction costs — for both public and private development — which were the result of high construction bids from outmoded labor practices, expensive materials, complicated site logistics, excessive government regulations, complex codes, institutional and owner inefficiencies, and bonding requirements. Habitually tolerated as an accepted natural consequence of New York's size and dominance, the premium is increasingly understood as a serious impediment to New York's economic competitiveness. While New York struggles to keep up with basic maintenance, other global cities have pressed their economic advantages to attract new businesses and residents, and build important, economically driven infrastructure.

Nowhere is this more clearly seen than in transportation — the subways, tunnels, bridges, harbor, airports, and roads that helped transform an island city into an economic powerhouse. Of these, the city's extraordinary subway system has been uniquely important not only as an efficient mover of people and goods, but as a channel of upward mobility, linking far-flung neighborhoods to centrally located jobs and businesses. Yet even as today's subway faces historic demand for service, its physical dilapidation — constant delays, noise, dirt, and deplorable communications — drives users to other forms of transportation, including private cars. Deteriorating maintenance accurately reflects a system in decline — indeed, a system that peaked in 1937. New York has only recently begun to increase its system capacity for the — first time since the 1930s. Progress has been far too slow, even as London, Paris, Madrid, and other cities have surged ahead, building whole new lines and enhancing their economies and neighborhoods.

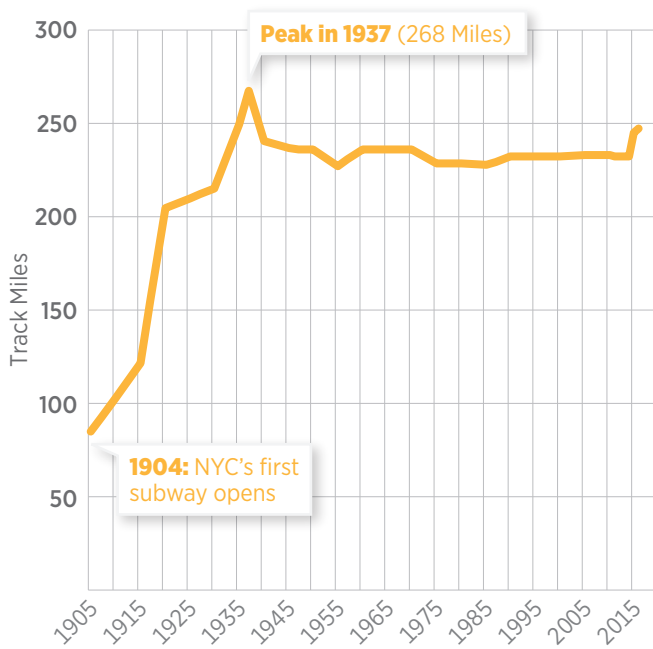
New York needs to reverse this decline and set itself back on the path of building wealth-creating infrastructure.

The twin challenges the region faces in expanding public transportation are high costs and the slow pace of project delivery. They are interrelated — costs rise, for example, as project schedules are continually stretched. Public confidence in the government's ability to deliver capital improvements erodes as budgets balloon and deadlines are repeatedly missed. Yet public understanding of the problems associated with building large capital projects is limited because the process is complex and opaque. At the same time, the agencies responsible for delivering projects are struggling. Whether the root cause is political interference, time-consuming environmental reviews, labor issues, or internal management procedures that add years and waste hundreds of millions of dollars, it is abundantly clear that reforms are needed.

Regional Plan Association (RPA) has forecast that **the region could add an additional two million jobs and four million people by 2040**, with most of this growth concentrated in urban areas — growth that cannot be accommodated without improving all aspects of public transportation, including rail systems. This will not happen unless costs are brought down and project delivery is rationalized.

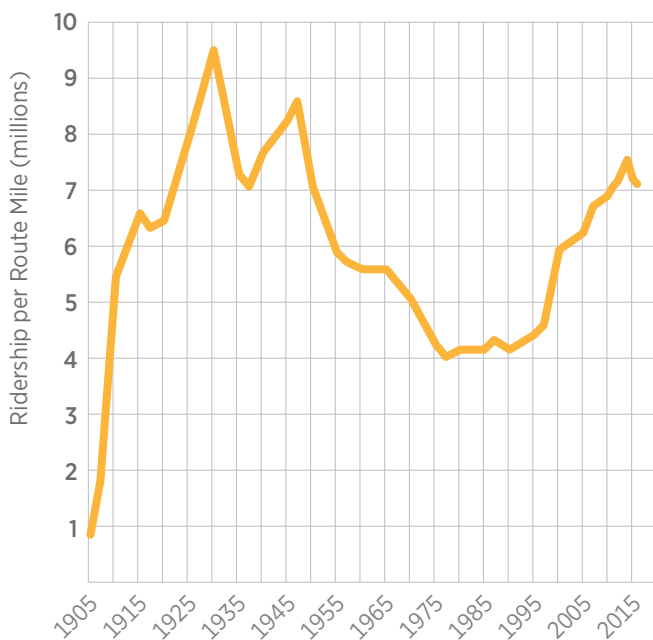
This report is an essential part of RPA's fourth regional plan — a strategic blueprint that assumes an expanded public transportation system is crucial to supporting a growing economy, expanded opportunity, and the efficient use of energy, land, and other resources. Using the Metropolitan Transportation Authority as a proxy for the region, RPA has evaluated the three megaprojects — the #7 Line Extension, Second Avenue Subway (SAS), and East Side Access (ESA) — and has undertaken, through interviews with experts here and abroad, an extensive literature review, and a compilation of best practices in other world cities, thereby articulating the major causes of high costs and serious delays, and formulating a series of strategies to address both. The Milstein Forums on New York's Future provided critical information for this report.

Figure 1: Subway Track Miles in New York City (MTA) 1904 - 2016



Source: MTA

Figure 2: Subway Crowding: Riders per Route Mile, 1904-2016



Source: MTA

On-Time Project Delivery: the Pace of Building Projects

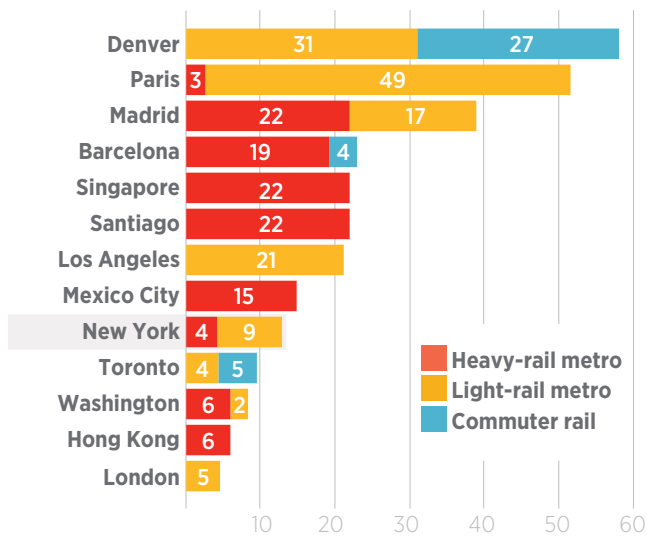
With the exception of a few modest projects, there has been no substantial increase in New York City's system capacity since the 1930s. The subway has 15 fewer miles of track than at its peak in 1937. The same is true for the commuter rail network, even though the story of its devolution is even more complex.

As public transportation struggles to handle the explosive population growth over the last decade, subway and commuter rails face levels of congestion that rival the region's infamous highways and parkways. Slow to respond to this crisis, government has floundered along the way. In the 1990s, the Metropolitan Transportation Authority (MTA), Port Authority, and NJ Transit collaborated on the Access to the Region's Core (ARC) study to build new tunnels under the Hudson River. From the start, the intention was to connect Penn Station and Grand Central Terminal (GCT) as part of ARC (Alternative G) to provide direct east-side access for trans-Hudson commuters. When Alternative G was later dropped, the MTA proceeded with a separate project at GCT called East Side Access, building a new terminal below the existing complex for the Long Island Rail Road (LIRR), to be completed by 2022. ARC continued independently with a plan for new Hudson River tunnels and a terminal below 34th Street between Eighth Avenue and Herald Square, until it was eliminated in 2008. Around the same time, the MTA began construction of the first phase of the Second Avenue Subway from 63rd Street to 96th Street. The City of New York also kicked off the redevelopment of the Far West Side by funding an extension of the #7 Line subway from Eighth Avenue and 41st Street to 11th Avenue and 34th Street.

Since then, both the extension of the #7 Line and the first phase of the Second Avenue Subway have opened. Yet over the last 30 years, the region has planned and built only those two limited heavy-rail extensions, a mere 6.6 track-miles of right-of-way, and 4.5 stations. Meanwhile, 50 track-miles and 23 stations were built in London, and closer to home, 48 track-miles and 22 stations were developed in Los Angeles.³ New York is clearly falling behind, while Denver, Paris, Madrid, and many other cities built far more miles of rail (light rail, metrorail, and commuter) in the last decade (Figure 3). And more projects are underway as these cities plan for substantial population growth.

³ London's Jubilee Line extension is a mix of new stations (6) and expanded or rebuilt stations (5). The renovation of the expanded stations, however, was far more extensive than the building of the Second Avenue Subway's 63rd Street and Lexington station, which outfitted an already existing station's shell. This includes the existing Red and Purple Lines, the regional connector tunnels and underground stations, and phase one of the Purple Line Extension that began construction in 2014. However, this is a fraction of the track miles and stations that LA has built over this period. Much of the LA region's new transit consists of light rail – to date, including 68 stations and 136 track miles of LRT, with more under construction.

Figure 3: Rail Miles Built from 2006 to 2016 in Major Cities



Source: RPA Analysis

It is abundantly clear that, however measured, New York is not keeping pace with other global cities.

New York City and its surrounding urban counties will have to accommodate most of the **region's future growth** over the next 25 years — projected to be as many as **3.7 million additional people** — many of whom will rely on rail transit. But even as more people and jobs generate increased demand for travel and public transportation, the pace of construction remains far too slow to deliver the projects required by 2040.

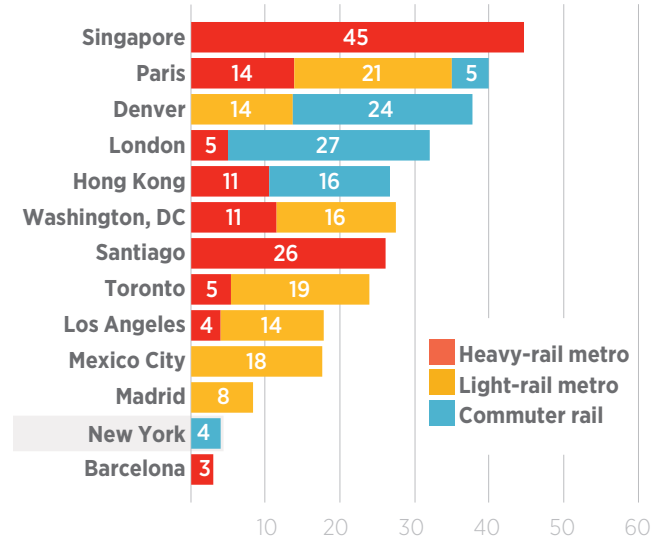
High Costs: the Price of Projects

The MTA has spent over \$115 billion to restore New York's public transit system since the first five-year capital plan in 1982.⁴ Since abandoning its Grand Design in the late 1970s due to the fiscal crisis, the MTA did little to expand until the 1990s.⁵ RPA, along with other stakeholders, began a campaign for MTA expansion, advocating for building the Second Avenue Subway and bringing the Long Island Rail Road to the East Side of Manhattan. Despite the advocacy's success, budgets for the projects strained credibility from the start — with cost projections that were far lower than those of both the federal government and expert advocates. The Second Avenue Subway (SAS) has the dubious distinc-

⁴ MTA. "MTA Capital Program 2015-2019." *MTA.Info*. May 23, 2016. http://web.mta.info/capital/pdf/MTA_15-19_Capital_Plan_Board_WEB_Approved_v2.pdf (accessed May 30, 2016).

⁵ The "Grand Design" was a vision to guide the system's expansion. Developed by the MTA shortly after it was formed in 1968 the Grand Design included proposals such as the two-level 63rd Street tunnel, a plan for a LIRR station at 3rd Avenue and 42nd Street, the Queens Bypass and Second Avenue Subway, among others. Source: Danielson, Michael N., and Jameson W. Doig. New York: The Politics of Urban Regional Development. Los Angeles: University of California Press, 1981.

Figure 4: Rail Miles Under Construction In Major Cities



Note: Project starts before March 2017; Source: RPA Analysis

tion of being the most expensive subway extension in the world at a cost of \$807 million per track mile for construction costs alone.⁶ This is over 650% more per mile than Transport for London's (TfL) Northern Line extension to Battersea in London — estimated at \$124 million per track mile. Compared to U.S.-based projects, SAS per-track-mile costs are over 350% more than Los Angeles's Purple Line — estimated at \$226 million per track mile. Why? Some say it is because the SAS is being built in the nation's densest residential neighborhood. But this cannot explain why the Long Island Rail Road's ESA budget ballooned from \$6.3 billion to more than \$10 billion (not including contingency and finance charges) over the past decade.⁷ Construction of ESA was planned to have little surface impact on the dense commercial district that lies above it, further adding to the project's costs. Indeed, as the General Contractors Association (GCA) noted, "The removal of mined rock through the tunnel and out through Queens in order to limit disruption above ground was a major factor in terms of cost and delay." New York's exorbitant costs have raised serious concerns about its ability to afford heavy rail, and has eroded the public's confidence in the MTA.

The MTA: Background on Capital Planning and Construction

As the nation's single largest transit agency, the MTA owns, operates, and finances the commuter rail system in Long Island, Connecticut, and the Hudson Valley, in addition to

⁶ These track-mile costs exclude unallocated contingencies, financing charges, and administrative costs such as design and engineering.

⁷ Including unallocated contingencies and finance charges.

the entire bus and subway system in New York City. The MTA faces two related challenges: (1) delivering major projects and improvements on time and on budget, and (2) identifying funding for a system that carries over 2.5 billion riders yearly. Transit systems rely on a multitude of funding sources — many of which are imperfect and cobbled together from compromises. Illustrative of this is the recent struggle to fund the MTA’s 2015–2019 capital plan, which took over a year to secure, with both the city and state fighting over how much each would contribute. This delayed work and procurements, pushed out projects, and ultimately increased their costs.⁸ The MTA’s five-year capital planning process is far too short to properly analyze and secure long-term funding for major investments —even shorter than the time it typically takes to build rail-line extensions, in the United States or abroad. This short capital time line has led to the piecemeal phasing of projects.

The MTA has one of the largest capital programs in the nation, with \$32 billion to be invested from 2015 to 2019. Yet over 65% of the funding is dedicated to bringing the system into a state of good repair and maintaining a normal replacement schedule for agency assets.⁹ Since 1982, the agency has spent almost \$100 billion on repairs to address decades of deferred maintenance, with some of these earlier investments now reaching the end of their useful life. This spending does little to enhance the growing region’s transit capacity. To date, only two major system expansion projects have been funded by the MTA’s five-year capital plans: Second Avenue Subway and East Side Access. The #7 Line Extension was funded by the City of New York.¹⁰ Without additional transit, the region’s residents will turn to less efficient travel options, like auto travel (autonomous or otherwise), that will increase roadway congestion, carbon emissions, and traffic fatalities, while harming air quality and the region’s overall attractiveness.

Pervading the MTA’s challenges in building major capital improvements is the consistent lack of secure funds. **Taxes** and fees are being replaced by debt-based financing at an alarming rate. Even as far back as 1937, RPA highlighted in a *Municipal Planning Procedure*, “We praise our officials for the improvements they make, and at the same time condemn them for increasing taxes. The effect has been for the municipality to issue bonds for physical improvements. Under these conditions, the legal debt limit is about the only restraint on public officials.”¹¹ Little has changed

in the past 80 years. Every transportation agency and state transportation fund in the region has incurred high levels of debt to finance system maintenance and repairs.¹² Within the MTA’s budget, debt service payments are 17% of the plan, with outstanding debt exceeding \$36 billion. And the system’s state of good repair, normal replacement, and system-improvement needs have comprised over 75% of capital budgets since 2005.¹³

Table 1: Debt Service by Agency

	Debt Outstanding (\$ billions)	Debt Service Payment (\$ millions)	Debt Service (percent)
MTA	30.8	2,500	17
PANYNJ	19.5	1,400	27
NJ TTF	14.9	1,080	96
NY DHBTF	3.2	242	17
CT STF	3.8	465	35

Note: New Jersey Transportation Trust Fund (NJ TTF); New York Dedicated Highway and Bridge Trust Fund (NY DHBTF); Connecticut Special Transportation Fund (CT STF)

In 2003, the MTA board created the MTA Capital Construction Company (MTACC), a subsidiary with the specific mission to plan, design, and construct major MTA system expansion and security projects for the three operating agencies: Long Island Rail Road (LIRR), Metro-North Railroad (MNR), and New York City Transit (NYCT). The MTA’s intent was to “consolidate existing construction and improvement initiatives with critical system expansion projects. The Capital Construction Company will be the single clearinghouse for all major capital funded projects, thereby enhancing the MTA’s competitive position to the benefit of its customers.”¹⁴

The focus of this report will be the three projects managed by MTACC: Second Avenue Subway, East Side Access, and #7 Subway Extension. The research team interviewed all program executives, including the president and his staff at MTACC. These interviews were supplemented by sessions with public officials and experts from various fields who worked on the projects, including through the Milstein Forums on New York’s Future. RPA also combed through public documents and requested additional documentation from the MTA on component costs and pertinent construction contract details.

⁸ Capital plan amendments have also held up project starts and delayed federal approvals. For example, the delay in approving the MTA’s 2005-09 plan (proposed in April 2004, but not approved by the CPRB until April 2005,) caused uncertainty about the local match for FTA new-starts funding. This held up the award of the first ESA tunneling contract until December of 2016, which ultimately needed to be rebid because the contractor was unable to hold the price for the duration of the delay (market forces/inflation).

⁹ MTA. Capital Program Dashboard. March 31, 2017. <http://web.mta.info/capitaldashboard/CPDHome.html?AGY=a&PLN=5&RPT=c> (accessed June 30, 2017).

¹⁰ The Northern Blvd extension to the 63rd Street tunnels only added system capacity; the two new stations for the project pre-date the MTA’s capital plans. The Archer Avenue subway, started as part of the Grand Design, also predates the MTA Capital Plans.

¹¹ RPA. *Municipal Planning Procedure: Useful Information for Newly Appointed Municipal Planning Boards and Newly Elected Municipal Officials*.

RPA Archived Report, New York: Regional Plan Association, 1937.

¹² RPA Analysis of MTA Budget and Financial Statements, PANYNJ Budget and Financial Statements, New Jersey Transportation Trust Fund (NJ TTF); New York Dedicated Highway and Bridge Trust Fund (NY DHBTF); Connecticut Special Transportation Fund (CT STF)

¹³ MTA. Capital Program Dashboard. March 31, 2017. <http://web.mta.info/capitaldashboard/CPDHome.html?AGY=a&PLN=5&RPT=c> (accessed June 30, 2017); and RPA. “Charting a New Course: A Vision for A Successful Region.” *Regional Plan Association Library*. May 2016. <http://library.rpa.org/pdf/RPA-Charting-a-New-Course.pdf> (accessed May 30, 2016).

¹⁴ MTA. MTA Press Release: MTA Board Creates Capital Construction Company. July 30, 2003. <http://www.mta.info/press-release/mta-headquarters/mta-board-creates-capital-construction-company> (accessed February 16, 2016).

Three Case Studies: Second Avenue Subway, East Side Access, and #7 Line Extension

As system expansion projects, the SAS, ESA, and #7 Line involve distinct funding, financing, and project-management strategies as well as a range of physical environments and project scales.



Case Study

Second Avenue Subway, Phase One: 63rd Street to 96th Street



SAS's first phase was a short extension to the Upper East Side of the Broadway Line, which had long terminated at 57th Street and 7th Avenue. The SAS runs north and then east underneath Central Park to the 63rd Street and Lexington station, which was built in the 1960s, at the same time as the 63rd Street tunnel under the East River and connections to the Sixth Avenue subway. In 2007, the MTA began building a two-track northern extension from 63rd Street to 105th Street, incorporating an old cut-and-cover segment from 99th Street to 105th Street. Completed in 2016, phase one started revenue service on January 1, 2017.

This modest expansion was the first of four segments that would make up the full-length SAS — running from 125th Street in Harlem to Lower Manhattan.¹⁵ It took the MTA eight years and \$5.57 billion (with contingency costs) to build phase one's three-mile segment. Although phase one opened years after its original deadline,¹⁶ it essentially stayed on schedule and on budget after being rebaselined in 2009. The MTA is planning the next phase, which will extend the subway another 1.5 miles north to 125th Street, with a projected cost of \$6 billion — a 30% increase over phase one.

¹⁵ The Second Avenue Subway had been planned since the 1920s, with the first major, practical step occurring in the 1950s, when the city issued bonds for the new subway. This debt, however, was instead used for several major system modernization projects, and it was not until the 1970s that construction on the line actually commenced. Three short cut-and-cover segments were built -- two nearly ten-block tunnel segments on the Upper East Side and one very short segment on the Lower East Side. Construction terminated in 1975 during the city's fiscal crisis, leaving the project dormant until the 1990s when planning for the SAS was again kicked-off.

¹⁶ While the original schedule estimated that construction of the SAS's first phase would last 4-5 years, in the end it took 8-9 years.

Phasing of phases

SAS's first phase offers many lessons for phase two, starting with how best to manage the overlap of a project with multiple phases. To date, the MTA has not completed engineering and design for phase two, which is only just getting started. This has made it impossible for the agency to coordinate the winding down of phase one with the ramping up of construction for phase two, which would have allowed the experienced crews working on phase one to move directly onto the next segment. Instead, the MTA ended major construction in January 2017 and left the neighborhood, with plans to return in roughly three years. The loss of experienced labor, current staging docks, and remote office spaces means the MTA will have to start the process all over again — adding to the time and costs of phase two as well as the disgruntlement of the neighborhood. And without institutionalizing the lessons learned from phase one, the MTA risks the loss of institutional knowledge that agency staff and project managers have developed on the job over the course of building SAS.

A City Project without the City

Since the SAS was first proposed, the project has been plagued with several starts and stops due to the Great Depression of the 1930s, shifting political priorities, and New York City's economic downturn and fiscal crisis in the 70s. Decades in the making, the SAS has had its governance and planning shift from the city to the state. Throughout SAS's early history, the city had played the lead role advocating for a new subway on the Upper East Side. The concept for the SAS was originated in 1919 by the New York Public Service Commission, and later taken up by the New York City Board of Transportation, which approved expansion plans in 1929. The city attempted to build the subway

line several times, even issuing bonds in 1951, which were later used for modernization of the existing system, including signal replacements and platform extensions. The city also worked to secure federal funds in the 1960s. In 1965, however, the State of New York created the MTA to operate transit downstate, including subways and eventually the buses. The MTA then took on building the SAS, which finally commenced in 1972, but was abruptly halted just three years later. The city, only recently divorced from its subway, proposed a series of zoning changes for the Upper East Side to encourage greater density and create a special transit district in which new buildings would be required to provide off-sidewalk easements for station entrances, whether inside the building or in set-back plazas.

Yet when construction finally restarted on the SAS three decades later, the MTA found itself very much on its own and without robust support from the Bloomberg administration. No additional zoning or land-use changes, city-sponsored community outreach, or formal construction partnership with the city had taken place as part of the preparation. The SAS's champions were the governor, the head of the state assembly, and a congresswoman — not the mayor. The MTA, with only a minority of its board recommended by the mayor, was left to build a project in one of New York City's densest residential corridors and work through a complex series of utility relocations and reconstruction without the benefit of City Hall's influence and local land-use powers.

Greater city involvement might have reduced the utility relocation and reconstruction costs that consumed hundreds of millions of dollars from the SAS budget. These higher costs and concerns about surface impacts pushed the MTA to tunnel even deeper, resulting in some of the deepest stations in the system — almost 100 feet from the surface to the platform. Concerns over surface disruptions and costs also led to shrinking the 72nd Street cavern, cutting the number of tracks from three to two, and island platforms from two to one. This shrinkage was performed to save the MTA from the full costs and risks associated with underpinning the foundations of buildings because the wider station would have required an easement below existing structures. The MTA also maintains that geological information reviewed during final engineering discovered an unacceptable level of risk with a three-track cavern excavation. This station configuration change has the potential to significantly undermine phases three and four by eliminating the Q's ability to turn at 72nd Street while retaining a cross-platform transfer with the future full-length SAS service.¹⁷ Without this capability, the MTA will likely be forced to run Q service to 125th Street, limiting the number of full-length SAS T service trains it will be able to run on the southern two phases (three and four).

¹⁷ Forthcoming RPA Fourth Regional Plan technical report: *Trans-Regional Express: Evaluation of the New York Region's Commuter Rail System*

Figure 5: Elements of the Second Avenue Subway Project

Source: Regional Plan Association

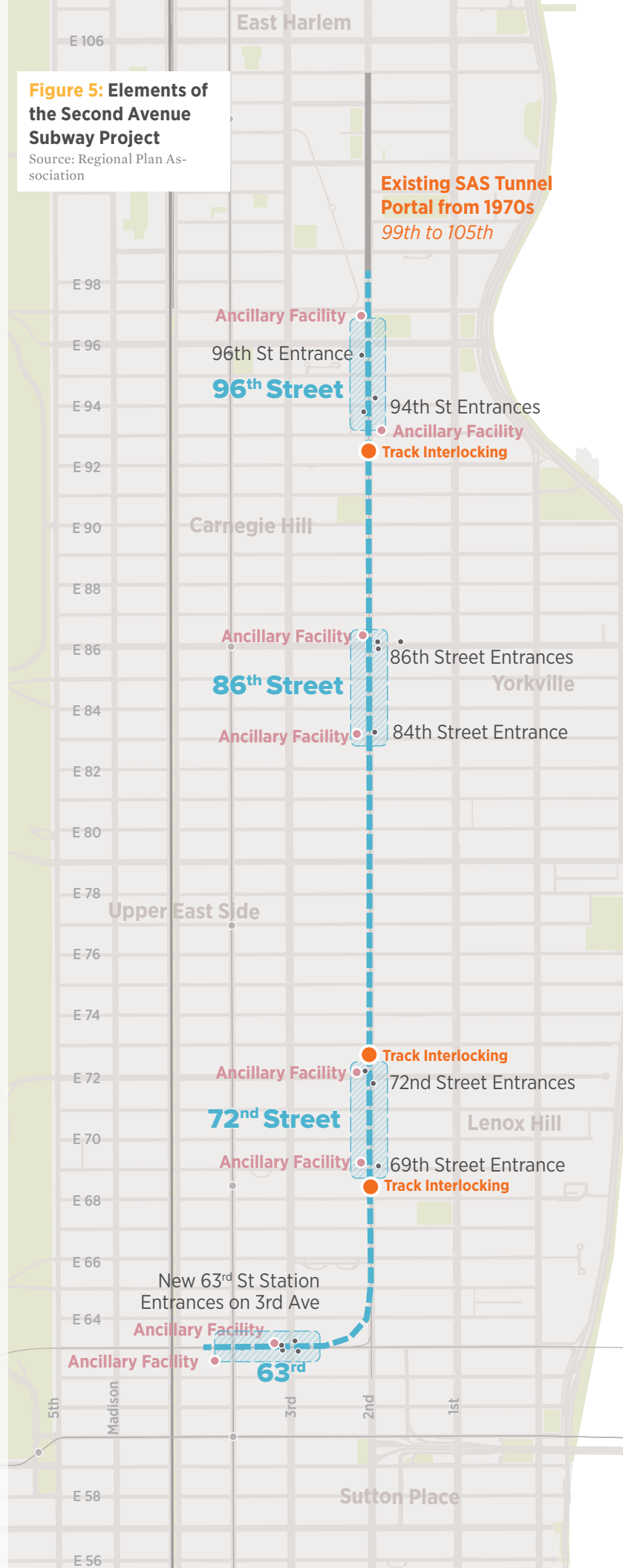




Figure 6: Typical Second Avenue Subway Ancillary Building with no overbuild

The Untapped Potential of SAS Lots

The MTA chose to forego development on six corner lots, building only vents and entrances instead of a larger building that could have combined residential and commercial uses with transit. While three of the lots are small and difficult to develop in conjunction with subway vents and entrances, they do hold transferable air rights. Some 225 feet of valuable commercial street frontage could have been developed had the three lots been assembled into an adjacent, larger development site.

The other three lots are each large enough to be stand-alone development parcels and are much less likely to transfer air rights. Because ventilation facilities should be able to be built in conjunction with new mixed-use development on lots of 4,000 square feet or larger, all three sites gave up significant potential in the form of apartments, affordable housing, commercial frontage, and community facilities.

Two lots, one on 69th Street and the other on 72nd Street, are zoned for the maximum residential zoning possible, allowing a Floor Area Ratio (FAR) of 10, meaning residential development up to ten times the lot size is allowed as-of-right. Under existing zoning, the 69th Street and 72nd Street sites could be developed as the high-density mixed-use developments typical of the Upper East Side, with ground-floor commercial uses topped by residential development. The 97th Street lot could be developed as a health care facility because of its proximity to hospitals and the additional FAR-allowed community facilities. Other community facilities, such as schools, libraries, museums, and community centers, could also have been sited. The 97th Street lot has a

very high potential to be rezoned for greater density, being adjacent to an R10A district that allows 10 FAR (12 FAR with bonus) development.

Combined, the 69th Street and 72nd Street lots had the potential for 116,000 square feet of development, which would have yielded approximately 112 apartments, 28 of them affordable, assuming the developments utilized both the 421-a tax abatement and R10 Inclusionary Zoning. The two sites could also have yielded approximately 10,000 square feet of commercial space (to be shared with ground-floor MTA uses), and approximately 230 feet of commercial frontage.

Under current zoning, the 97th Street lot would have yielded approximately 50,000 square feet of community facility use, in addition to the existing MTA uses. Had the 97th Street lot been rezoned for high-density mixed-use development similar to nearby districts, it would have yielded approximately 5,100 square feet of commercial space in addition to existing MTA uses, and 140 feet of commercial frontage, topped by a 106-unit apartment building with 27 affordable housing units.

Assuming this rezoning of the 97th Street site, the market value of the three development sites would have been about \$125 million in 2015.¹ Even accounting for land value being depressed by the square footage, easements, and added development costs needed for the MTA uses on-site, the market value would likely still have been over \$100 million for the three sites.

¹ The Newmark Grubb Knight Frank New York City Development Update capital report estimated a market price of \$526 per buildable square foot (BSF) on the Upper East Side of Manhattan. <http://docplayer.net/43726113-New-york-city-development-update-manchattan-brooklyn-queens.html>

Lost Development Opportunities

Another outcome of the lack of city-state partnership can be seen in the MTA's land-use decisions along the Second Avenue corridor, specifically, the seven short new structures sprinkled along the avenue from 69th Street to 97th Street. These cookie-cutter-looking two- to four-story buildings are ventilation plants, entrances, or a combination of both, mostly located on Second Avenue corners, consuming valuable commercial real estate. None of the structures were designed to support additional height, although current zoning allows for high-rise residential development as tall as 30 stories. Except for two entrances, the structures display only blank walls with no street-level frontage — thus deactivating the sidewalk experience for pedestrians. Combined, the seven parcels represent thousands of square feet of undeveloped space and countless millions of dollars in lost revenue for the MTA (see callout — The Untapped Potential of SAS Lots).

Tunneling the Old Way

“A well-executed tunneling project is a work of art, and the client should be prepared to spend the necessary time in choosing the artist.” Metro de Madrid CEO Manuel Melis Maynar.¹⁸

Although, as a new project, the SAS could have benefited from state-of-the-art technology, it has instead relied on older techniques for construction, a strategy the MTA left to contractors. While it used a tunnel-boring machine (TBM) to drill the two new tunnels, it did not follow the modern practice of installing precast segments to finish the tunnels. Instead, the SAS relied on a traditional, more labor-intensive approach called “form-in-place,” a two-part process that requires the installation of waterproof lining followed by temporary forms to create the finished tunnel structure for the concrete pour. Needing at least two passes through the tunnels, waterproofing, and concrete pour, form-in-place is prone to greater human error. In contrast, precast segments, an internationally accepted technique that leverages an automated robotic system incorporated into the TBM's structure to place interlocking precast segments, typically only requires five laborers. The precast segments include a waterproofing system, thus eliminating a step in the process. The MTA and contractors raise several issues with precast construction, such as having sufficient laydown room to both store the tunnel segments and remove or disassemble the TBM. This space is needed because the TBM is unable to reverse course due to the smaller diameter of the tunnel after the precast segments have been installed. However, while RPA agrees that these can be technical challenges, this method would likely have been preferred if its manning costs had been substantially lower than the more conventional options.

¹⁸ Maynar, Manuel Melis. “Madrid Metro and Railway Infrastructure 1995 - 2003.” Tunnel Builder. April 2003. <http://tunnelbuilder.com/metrosur/edition-2pdf/page2.pdf> (accessed January 20, 2016).

Internal Politics of Change Orders

Throughout the construction of any megaproject, some elements or components need to be changed or added, whether adapting the design to new safety standards, altering space for a new technology, or encountering an unexpected geotechnical condition. Change is normal, and even anticipated in the budget. The SAS has a remaining unallocated contingency budget of \$554 million (10% of total costs) as of the second quarter 2016. Only change orders of \$250,000 or more require board approval, (if a single element of the plan changes by 10% an amendment to the five-year capital plan is also required), making it difficult to get a full accounting.

While change orders do typically occur, the SAS seems to have been inundated by them. The stations have had hundreds of change orders — 271 for 96th Street alone. Interviews with MTACC staff and project workers indicated that the operating agency, NYCT, has been driving the change orders.¹⁹ In some cases it has been NYCT's desire to update system specifications that are six to seven years old. In others, it has been new management making its mark. The extended duration of the project alone has allowed for more change orders because, as time passes, technologies and standards tend to evolve. There are, however, a number of basic issues (such as placement of conduits or fit and finishes) that should have been settled in the original design. According to several professionals, this was due to the operating agency not paying close attention to the details of the initial designs or ensuring there was consensus up the chain. NYCT's primary job is to operate service for over six million riders a day. Maintaining the existing system is its second priority, with expansion a distant third. Others have argued that because NYCT was not bearing the costs of change orders it had no incentive to focus on the details or minimize the number of changes it ordered.

According to the GCA, the SAS had thousands of change orders, with 96th Street issuing 200 orders during the acceleration phase alone (a claim the MTA disputes). Change orders modified more than 30% of the contract plans. An extreme example occurred with the electrical contractor at 96th Street having over 70% of its bid scope of work modified by change orders, which were issued serially as items were discovered. “This required the general contractor to perform other work out of sequence,” noted GCA, “and in many instances, remove and replace (at its expense) work that had already been completed and installed.”

The MTA's Office of the Inspector General (OIG) has found similar issues with change-order requests, concluding that their frequency has cost millions of dollars. The most common reasons for change orders can be attributed to design errors or omissions, which should be charged back to the design firm. Other change orders are apparently initiated to accommodate user requests. Both categories (design errors/omissions and user requests) are often controllable

¹⁹ Ibid.

or avoidable.²⁰ Additionally, the OIG found that the MTACC and NYCT apply a 21% overhead and profit rate to every material and supply change order submitted by contractors, which is two to four times higher than the profit and overhead rates on materials used by most transit and commuter railroads. The 21% overhead rate was also applied by MTACC and NYCT to contractor equipment, though neither the LIRR nor MNR apply an overhead equipment rate, partially because the contractors often own the equipment they supply.²¹ Contractors argue that the overhead rate is necessary to cover significant costs that are prohibited by the contract. While not all change orders are equal, nor do all have a large impact on the budget, at a minimum, change orders take time, erode schedules, and ultimately increase costs.

Project Budget

MTACC staff provided RPA with the Full-Funding Grant Agreement (FFGA) categorical cost budget for SAS in March 2016. Since that time, the agency has raised concerns about the validity of this reporting for making comparisons across projects, even though that was the intent behind the creation of the FTA's standard cost categories (see page 31 for further details). In addition, RPA evaluated the project costs, construction costs by task, and project delays using the publicly available SAS quarterly reports from MTACC and quarterly meeting reports provided by the MTA board's transit and bus subcommittee.

The SAS has been budgeted at \$5.57 billion, including contingency and finance charges, and \$4.2 billion without contingency and finance charges — a 25% difference. A little less than half of SAS's \$5.57 billion budget was used for nonconstruction tasks, with 52% allocated to construction, followed by \$817 million (15%) for finance charges, and a contingency of \$544 million (10%), which was unspent as of March 2016

(Figure 7). Design and engineering are 9% of project costs at \$534 million, while administrative-regulatory costs (\$273 million) and real estate relocation (\$282 million) are each roughly 5% of SAS's overall costs. No rolling stock was purchased for the SAS.

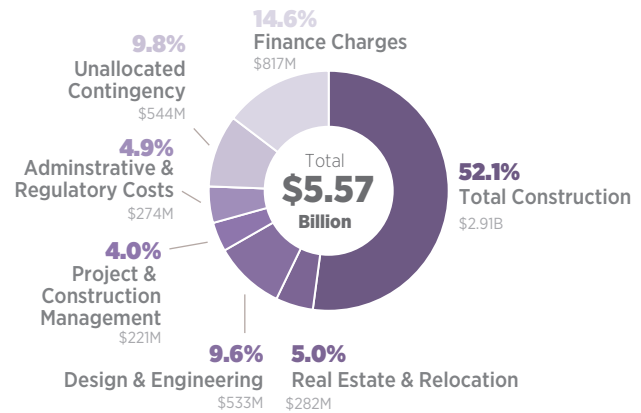
SAS tunneling costs were \$45 million per track mile and only 7 percent of the construction costs, even though the project used the more traditional form-in-place practice, which can be more labor intensive (Figure 8). Overwhelmingly, SAS construction costs are dominated by the cost of stations and intermodal facilities: \$1.74 billion at 60% of construction costs (Figure 8). In rank order, the SAS station costs as of December 2016 are:

1. 96th Street = \$386 million
2. 72nd Street = \$322 million

²⁰ Office of the Inspector General, MTA. "2010 Annual Report." State of New York MTA Office of Inspector General. 2010. <http://mtaig.state.ny.us/assets/pdf/annual/10-annua.pdf> (accessed 06/01, 2016).

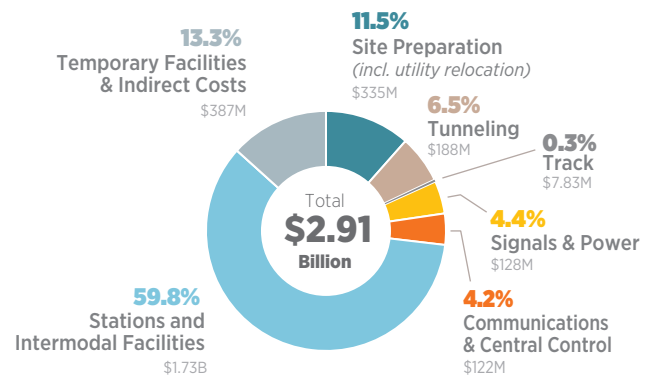
²¹ Ibid.

Figure 7: Second Avenue Subway Project Cost Breakdown (March 2016)



Source: FTA New Starts Reporting

Figure 8: Second Avenue Subway Construction Costs (March 2016)



Source: FTA New Starts Reporting

3. 86th Street = \$244 million

4) 63rd Street = \$209 million

- 63rd Street station is a retrofit of the existing 63rd – Lexington F Line station. Station costs are for fit and finishes only (no station box, of course).

Construction costs for temporary facilities and indirect costs for power and facilities exceed \$387 million (13% of construction costs). Temporary facilities and indirect costs include staging and project start-up, barriers for storm water pollution prevention, and other interim mitigation measures during the course of construction. Site preparation, including utility relocation, is an additional \$335 million or 12% of construction costs for a two-mile length of Second Avenue. The MTA carries the at-cost burden of relocating all Con Edison gas and electric utilities, the telecommunications lines of Verizon, Time Warner, and AT&T, all water and sewer lines owned by the NYC Department Environmental Protection, and any other utility owner with infrastructure beneath Second Avenue.

Table 2: SAS Key Project Phase Delay and costs (December 2016 \$ in Million)

Summary of Construction Phases	Current Contract millions?	Expenditures to Date millions? (Dec 2016)	Procurement / Design Delay (months)	Construction Delay (months)
63rd St Station	\$209	\$205	6	32
72nd St Station	\$322	\$301	3	14
86th St Station	\$244	\$226	-4	8
96th St Station	\$386	\$368	15	13
Track, Signals, Power and Communications	\$290	\$273	10	5

Source: MTA Capital Construction Committee Reports

Given the available data, the cost of SAS's delays cannot be evaluated, although subway service did begin three years behind schedule. Change orders initiated by the owner-operator (NYCT) contributed to this delay, as did lags in design and procurement, and the failure of some contractors to deliver project milestones in line with the schedule.²²

The 63rd Street station procurement and design lagged six months behind, while construction delays added nearly three years to the schedule (Table 2). The 72nd Street station fared slightly better with three months of procurement and design delays, and just over a year of construction delays. Both 63rd Street and 72nd Street stations were built by a contractor repeatedly cited by private and public construction and project managers for failing to purchase materials in a timely fashion and source labor to complete the station finishes.²³ The 63rd Street station is a retrofit of the existing F line station, requiring no tunneling, yet construction delays exceeded the other SAS stations. The contractor's failure to deliver the 72nd Street station on time led MTA board member Mitchell Pally to comment, "So let me get this straight. The station contractor did not do his job and we are making the systems contractor do it? I just want to make sure we're keeping a financial track of who did what to whom."²⁴ The other two stations on the line, 86th Street and 96th Street, were built by joint ventures. The procurement and design for 86th Street was completed earlier than anticipated and experienced a relatively short construction delay of only eight months. The 96th Street station was more complex to build, given that half the site was cut-and-cover rather than excavated by TBM, contributing to the significant design and procurement delays of over a year.²⁵ Construction delays then added another year to the final delivery. A joint venture of Comstock and Skanska, 96th Street was set back only five months during construction, even though it

faced nearly a year of delays due to procurement problems, largely the fallout from extensive delay in delivering the civil works and systems at the stations.²⁶

The high costs of the 96th Street station can be partly explained by the inclusion of 65,000 square feet for the MTA workforce in underground facilities and office space, requiring expensive blasting. The station has hundreds of non-public-access employee spaces. This equates to three to four times as many employee spaces as any other station along the line. The MTA's justification was that 96th is a terminus, which is only temporary because the line will actually terminate at 125th Street when phase two is completed. Instead of spending the extra millions of dollars to build these temporary facilities, the MTA should have explored the cost-effectiveness of providing employee spaces at the surface by renting commercial space.²⁷ There are also redundant employee facilities at 86th Street and 72nd Street.

Of course, another reason SAS's stations were extraordinarily expensive lies with the materials. The archway entrances, for example, are built of granite that is six to eight inches thick. As one MTA project manager noted, part of the problem is nothing is off the shelf, with all of the granite being custom-produced.²⁸ Granite, by nature, is nonstandard; each piece is unique due to its geologic formation. Under Buy America procurement rules, the MTA was required to buy American materials. Yet the United States has only a few suppliers that could provide granite of this size, custom-cut to curve at around eight inches thick to support the weight of the archways. This was a deliberate material design decision that almost surely should not be repeated in the future if the MTA hopes to contain costs. As former Metro de Madrid CEO Manuel Melis Maynar said about his legendary efficiency in building new transit systems: "Design should be focused on the needs of the users, rather than on architectural beauty or exotic materials."²⁹

²² MTA Board, Transit and Bus Committee Meeting Report January 2017. Board Meeting Report, New York: MTA, 2017.

²³ Expert Interviews

²⁴ Weaver, Shaye, and Danielle Tcholakian. *Disappointing Delay in June Puts 2nd Ave. Subway Behind: MTA Consultant*. July 25, 2016. <https://www.dnainfo.com/new-york/20160725/upper-east-side/disappointing-delay-june-puts-2nd-ave-subway-behind-mta-consultant> (accessed September 20, 2016).

²⁵ An example noted by several interviewees: it took the MTA almost two years to settle on new light fixtures after rejecting the ones delivered by the contractors per the original procurement specifications, delaying work throughout 96th Street and the other stations.

²⁶ The General Contractors Association noted that one major issue involved the light fixtures and the related decision to change conduit and wiring, all of which were supplied, and approved, as specified in the contract but later rejected by NYCT. It took the MTA almost two years to settle on new light fixtures, delaying work throughout 96th Street and the other stations.

²⁷ Interview with General Contractors Association

²⁸ Expert Interviews

²⁹ Williamson, Kevin D. "Toward the Separation of Celebrity and State." *National Review*, October 28, 2015.

Case Study

East Side Access: LIRR to Grand Central Terminal



Photo: MTA / Rehema Trimiew

An expansion of Grand Central Terminal (GCT), ESA connects the LIRR to a new facility, 100 feet below the existing tracks and platform. ESA will offer riders huge benefits when revenue service is estimated to begin in 2022, by alleviating the circuitous commute of Long Island commuters who work on Manhattan's East Side but arrive today at Penn Station on Midtown Manhattan's West Side. The MTA estimates ESA will save 150,000 LIRR riders up to 40 minutes of commuting time each day by eliminating the need to transfer to a bus, subway, or taxi to reach the East Side.³⁰ RPA's 2013 study, *Rail Rewards*, projected ESA would shorten travel times by an average of 18 minutes a day for commuters headed to East Midtown, and modestly increase home values for 587,000 households in Queens, Nassau, and Suffolk counties.³¹ Cumulatively, ESA has the potential to raise home values in Queens and Long Island by \$4.7 billion.³² The project will also substantially increase capacity across the East River to Manhattan, adding another 22–24 trains per hour, or almost 50% more tunnel capacity. It will allow, for the first time, transfers between MTA's LIRR and Metro-North services, albeit after a rather lengthy walk of five to eight minutes. ESA will free up capacity at Penn Station, allowing some Metro-North trains to enter Penn Station as well as Grand Central Terminal.

Once estimated at \$4.3 billion (earliest estimates were half this amount), ESA's costs have more than doubled to \$10.2 billion (without finance charges and contingency

costs, which increase the budget to \$12.2 billion). Initially projected to be completed in 2009 after five years of construction,³³ revenue service is now anticipated by 2022, with construction to finish in 2023. Civil construction began in earnest in 2007 with an estimated 16 years to completion — a 200% increase in the construction schedule. While just four route miles, the tunnels, and junctions that serve the expansive new terminal and the leading tunnels in Sunnyside Yards equate to 12.8 track miles, another 27 miles of track were laid in Harold and for the East Yards, Highbridge Yards, Arch Street Yards, and Sunnyside Mid-Day Storage Yard to support ESA.

ESA has been fraught with delays and unanticipated costs since its start in 2000, when the MTA allocated \$1.5 billion in capital funds and the FTA provided \$1 billion in New Starts funding.³⁴ ESA's project scope and scale have since expanded. On three separate occasions (2009, 2012, and 2014),³⁵ ESA's costs have been rebaselined. The project received an infusion of \$2.6 billion in 2006 through New Starts, and \$195 million through the American Recovery and Reinvestment Act in 2010.³⁶ In 2014, the MTA placed their most experienced program manager (formerly in

³⁰ MTA. *MTA News: MTA Approves Final Major Contract on East Side Access*. January 1, 2016. <http://www.mta.info/news-east-side-access-lirr-grand-central-terminal/2016/01/27/mta-approves-final-major-contract-east> (accessed September 20, 2016).

³¹ RPA "Rail Rewards." Regional Plan Association Library. January 2013. <http://www.rpa.org/library/pdf/RPA-Rail-Rewards.pdf> (accessed November 15, 2015).

³² Ibid.

³³ Donohue, Pete. "East Side Access Work Won't Conclude Until 2023." *New York Daily News*, January 27, 2014: <http://www.nydailynews.com/new-york/east-side-access-work-won-conclude-2023-article-1.1593233>.

³⁴ United States Congress. "Volume 150 Part 18." *Congressional Records Archive*. November 18, 2006. https://books.google.com/books/about/Congressional_Record_V.150_Pt.18_Novembe.html?id=dANTZWDDq5wC (accessed July 15, 2016).

³⁵ U.S. Federal Transit Agency. "ESA Monthly Project Management Oversight Committee Report June 2015." FTA. June 20, 2015. <https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/ESA%20Monthly%20PMOC%20Report%20-%20June%202015.pdf> (accessed July 15, 2016).

³⁶ U.S. Department of Transportation, Office of Inspector General. "East Side Access Project ARRA Funds." Office of the Inspector General DOT. June 12, 2013. <https://www.oig.dot.gov/sites/default/files/FTA's%20Oversight%20of%20NYC%20East%20Side%20Access%20Project%20ARRA%20Funds%5E6-12-13.pdf> (accessed July 15, 2016).

Table 3: East Side Access Time line and Budget (1992-2023)

Year	Progress	Budget (\$ in millions)
1992	East Side Transportation Alternatives and Feasibility Study begins	
1998	LIRR service to Grand Central Terminal selected as preferred East Side transportation alternative	
1998	Environmental and planning work begins and Federal Transit Administration (FTA) approves ESA to enter into preliminary engineering	
2001	FTA approves ESA Final Environmental Impact Statement and Record of Decision	
2001	Advance work begins on Metro-North Highbridge Yard	
2002	ESA final design approved	
2002	Advance work begins in Queens on LIRR Arch Street Yard and shop facility	
2002	Work begins in Queens on open-cut and bellmouth excavation and other site prep	
2006	Amtrak agreement signed by LIRR, MTACC, Amtrak	
2006	Major construction begins in Queens and Manhattan	
2006	Manhattan tunneling contract awarded	
2006	FTA and MTA sign full-funding agreement. Federal contribution is \$2.6 billion.	\$ 4,300
2007	Tunnel boring work begins in Manhattan	
2007	Manhattan structures contract awarded	
2009	IEC determines insufficient budget for commissioning and testing. MTACC adds \$50 million to budget to cover full testing and commissioning of systems as part of 2014 Q4 rebaseline	
2009	44th Street ventilation facility contract awarded	
2009	Queens tunnel boring contract awarded	
2009	Contract for the 50th Street ventilation facility awarded	
2009	ESA budget rebaselined	\$7,328
2010	Northern Boulevard Crossing contract awarded	
2010	Tunnel boring work in Manhattan completed	
2011	Tunnel boring work begins in Queens	
2011	Queens Structures contract awarded	
2012	Tunnel boring work in Queens completed	
2012	Manhattan and Queens tunnels connected; 55th Street ventilation facility contract awarded	
2012	ESA budget rebaselined	
2013	First contract for penitent lining, interior structures, and fill-out of caverns and tunnels awarded	
2013	Entrance at 245 Park Avenue opens to public	
2014	Systems contract awarded	
2014	ESA Budget rebaselined	\$ 10,200
2014	50th Street Commons opens to the public; second contract for the permanent lining, interior structures and fit-out of the caverns and tunnels is awarded	
2015	Contract for the fit-out and completion of the LIRR Concourse is awarded	
2022	Forecasted Completion	
2023	FTA's Project Management Oversight Committee Forecasted Completion	

Source: MTA

charge of the SAS and responsible for the rebaselining in 2009) in charge of ESA to introduce much-needed schedule and budget discipline. To date, ESA appears to be making steady progress (Table 3). The MTA, however, is still struggling to meet critical deadlines, most notably work involving the Harold Interlocking (Figure 9), the country's busiest rail junction, connecting LIRR trains from Manhattan to Long Island and Amtrak services on the Northeast Corridor. The Harold serves as the primary interchange between the ESA tunnels, Penn Station tunnels, and commuter and intercity rail services to the east and northeast of Manhattan. Additionally, the Harold routes rail cars from NJ Transit, Metro-North, LIRR, and Amtrak into the Sunnyside rail yards.

The key components that led to delays and increasing costs include:

1. Initial decisions, driven by political pressures, led to under-budgeting and unrealistic scope.
2. Institutional decision-making within the MTA does not foster operating synergies between divisions. For example, the LIRR and MNR lack common power and systems equipment on their respective rolling stocks and are unwilling to share platforms and operating space in GCT.
3. The staging of all spoils and debris removal was inefficient, with limited site access from Long Island City, forced by opposition from Manhattan's Upper East Side and East Midtown residential and business communities during environmental review.³⁷
4. Progress on Harold Interlocking — a crucial interchange for the LIRR, NJ Transit, and Amtrak — has been slow, and securing extensive outages to complete construction work has been difficult.
5. A complex and flawed procurement process, with multiple contracts and project phases, has delayed the project for years.

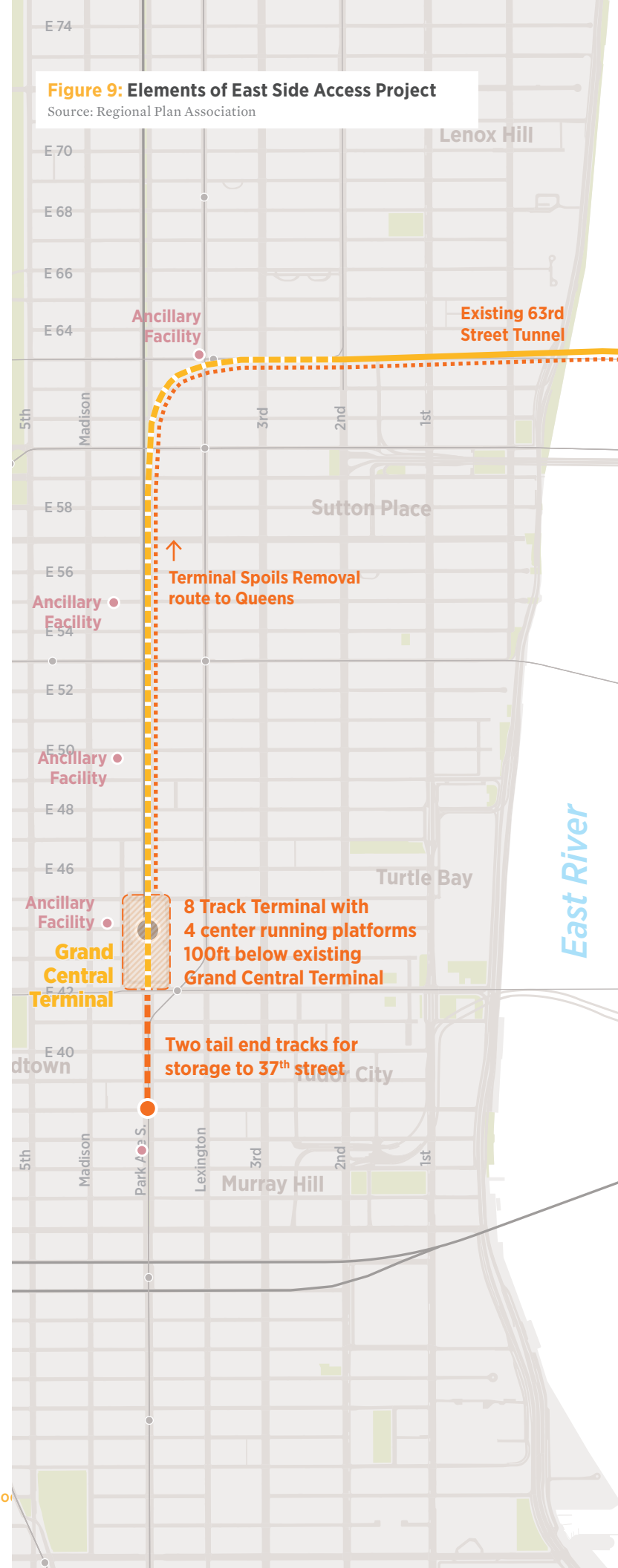
Design of Project, Impact on Spoils Removal

Two options were fleshed out in ESA's environmental review. One was to bring the LIRR into Grand Central's existing lower level, the other to excavate a new terminal 100 feet below the lower level. The deeper station was preferable because of the high risks inherent to excavating the shallow connecting tunnels to the foundations of buildings along Park Avenue. The greater capacity afforded by a new terminal rather than sharing an existing one was also cited. Not noted but known to be a consideration was the institutional dispute between MNR and LIRR, neither wanting the other to "invade its turf."

³⁷ MTA. "East Side Access Final Environmental Impact Statement." *MTA Capital Program*. n.d. http://web.mta.info/capital/esa_docs/feis.htm (accessed July 15, 2016).

Figure 9: Elements of East Side Access Project

Source: Regional Plan Association





While not as complicated as construction at the Harold Interlocking, the deep cavern site has proven to be a significant challenge. The Environmental Impact Statement (EIS) required construction activities in Manhattan to take place in the subterranean realm, with almost all equipment and spoils transitioning through the 63rd Street tunnels to staging sites in Sunnyside Yards. This was far more costly than SAS, which had several vertical access shafts along the axis of the site (corridor) and an automated spoils sorting and removal system combined with enclosed muck houses (which hold debris from blasting) located at the surface to take spoils directly to awaiting trucks. This process limited the number of human touches, thereby saving labor hours. ESA's process was much more intensive, typically with laborers filling burlap bags with spoils that were then loaded onto trains to Queens (or in some cases, the Bronx) and then unloaded and sorted by laborers (including force-account labor³⁸) and loaded again onto trucks. This equated to four steps for ESA versus one for SAS. The MTACC estimated that it could have saved at least \$75 million in schedule-related costs had it deployed an SAS-like system on ESA's Manhattan portion.³⁹

Additionally, workers traveling with equipment between Long Island City and Manhattan through the East River tunnels routinely spent at least an hour on both ends of their eight-hour shift in transit, leaving only three to five hours of time for productive work at the construction site. All work also had to be finished by 10 p.m. to mollify Long Island City's residential neighborhoods, further restricting work hours.

Making matters worse, after work on ESA began, the MTA changed the contract terms to refuse to allow blasting under GCT for cavern construction, requiring the contractors to mechanically mine instead. This represented a substantial change to the contract that affected the project's schedule and cost.⁴⁰

Harold Interlocking

Harold is the busiest passenger rail interlocking in North America and is critical to service on Amtrak's Northeast Corridor and LIRR, whose 783 commuter trains pass through Harold's complex series of switches and junctions every day. ESA must be weaved into this existing complex — a herculean task — squeezing in new portals to its new Manhattan terminal and a new daytime storage yard complex in Sunnyside, Queens. To maintain safe passage of Amtrak and LIRR trains,⁴¹ MTACC must work within a narrow window, setting up and breaking down the work site every day so that rail service can be restored — or get

out of the way so that rail service may continue. This erodes the productivity of an eight-hour work shift, resulting in just four to five hours of actual work, or up to a 50% reduction in productivity.

The Final Environmental Impact Statement (FEIS) plan for Harold to segregate Amtrak's North East Corridor from LIRR requires the upgrading of over 24 switches, eight central signal and equipment stations, and demolition and construction of new east and west bypass structures for both Amtrak and LIRR.⁴² The Environmental Impact Statement (EIS) stipulated these changes would be completed with "no adverse impact on either Amtrak's or NJ Transit's nonrevenue use of Sunnyside Yard[s] (i.e., for train storage) or East River Tunnels."⁴³ This was an unrealistic requirement that increased costs and exacerbated overall project delays. The total cost of redesigning Harold is nearly 11% of ESA's overall costs, and preserving revenue service and nonrevenue track uses while constructing ESA has proved to be complex and expensive. The costs of protecting Amtrak's right-of-way exceeded \$20 million between 2005 and 2014. Additionally, the force-account labor for track flaggers, and Amtrak and LIRR personnel working on Harold exceeds \$240 million, 2.4 % of ESA's overall project budget.⁴⁴ The anticipated total cost of Harold's demolition, rerouting, construction, and design has grown to \$966 million, with an additional \$114 million anticipated for the final phase of the eastbound rerouting.⁴⁵ Due to Harold's complexities, MTACC has decoupled its contracts from ESA, meaning the GCT access of LIRR through ESA will open as early as 2022, before all investments in Harold will be realized (these are not critical for revenue service). According to MTACC, work on Harold has been repackaged in the 2015-2019 capital plan based on a 2014 risk assessment.⁴⁶ As such, all third-party construction and associated force-account budgets have been adjusted. Schedule delays, associated impact costs, and updated estimates on existing contracts have expanded the project scope and increased budget estimates by \$183 million. This budget increase was the result of additional costs associated with the utility pole (Woodside) work, though some budget reduction resulted from underruns of contracts winding down as well as a recent favorable bid.⁴⁷ MTACC

⁴² MTA. "East Side Access Q3 2016 Progress Report." *MTA Capital Construction*. 2016. http://web.mta.info/capital/esa_docs/East%20Side%20Access-%20Quarterly%20Report%202016%20Q3.pdf (accessed January 20, 2017)

⁴³ MTA. "East Side Access Final Environmental Impact Statement." *MTA Capital Program*. n.d. http://web.mta.info/capital/esa_docs/feis.htm (accessed July 15, 2016)

⁴⁴ Force account labor is a public agency's union workforce. Under inter-agency agreements force account labor must be used for track safety, such as train operation and track flagging, and other system tasks, such as engineering design specifications. It is required for all contracted work within the rail right-of-way by the public agency. In the case of Harold this workforce includes flaggers from Amtrak and LIRR workers. RPA analysis of ESA Quarterly Reports from 2009-2016

⁴⁵ MTA. *Capital Program Dashboard*. March 31, 2017. <http://web.mta.info/capitaldashboard/CPDHome.html?AGY=a&PLN=5&RPT=c> (accessed June 30, 2017).

⁴⁶ U.S. Federal Transit Agency. "ESA Monthly Project Management Oversight Committee Report June 2015." FTA. June 20, 2015. <https://www.transit.dot.gov/sites/fta.dot/files/docs/ESA%20Monthly%20PMOC%20Report%20-%20June%202015.pdf> (accessed July 15, 2016).

⁴⁷ MTA. *Capital Program Dashboard*. March 31, 2017. <http://web.mta.info/capitaldashboard/CPDHome.html?AGY=a&PLN=5&RPT=c> (accessed June 30,

³⁸ Force account labor, which is an operating agency's public union workforce required for track safety, is required by NYCT, LIRR, and Amtrak for all contracted work within their specific rail rights-of-way.

³⁹ Expert Interviews

⁴⁰ Expert Interviews

⁴¹ McGeehan, Patrick. "Guiding Hundreds of Trains, a Junction Named Harold." *New York Times City Room*. May 22, 2012. <http://cityroom.blogs.nytimes.com/2012/05/22/guiding-hundreds-of-trains-a-junction-named-harold/> (accessed November 10, 2016).

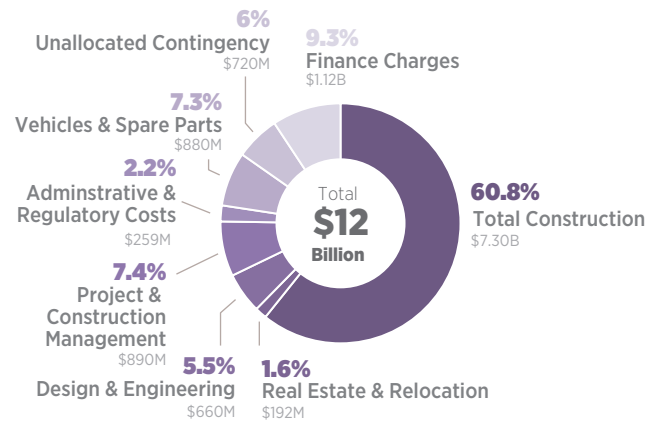
currently projects it will finish work on Harold (additional Amtrak and LIRR projects separate from ESA) in 2023, 12 months after ESA commences revenue service. The MTA claims delays at Harold during the summer of 2017, which were due to the emergency repairs at Penn Station, will not affect their critical schedule of cutting over the signals at the interlocking in May of 2018.

Procurement

Procurement can be a daunting, complex dance that requires the MTA to line up funding with the letting of major contracts. The contractual history of ESA is replete with examples of practices and decisions that led to unnecessary delays, defaults, and costs. Over the course of ESA, three contracts were canceled and one was defaulted. The contract to excavate the Queens cut to access the 63rd Street tunnels and launch the tunnel boring machine (TBM) was awarded to Pile Foundation Construction Company, which defaulted in 2009 (\$129 million) when its bond proved insufficient to cover the costs of the delays or the completion of the job.⁴⁸ The initial bid for the Queens cut had come in significantly lower (\$95 million) years earlier from a more experienced contractor, Kiewit, but this first-round contract was canceled due to delays in securing state and federal funds (pre-FFGA).⁴⁹

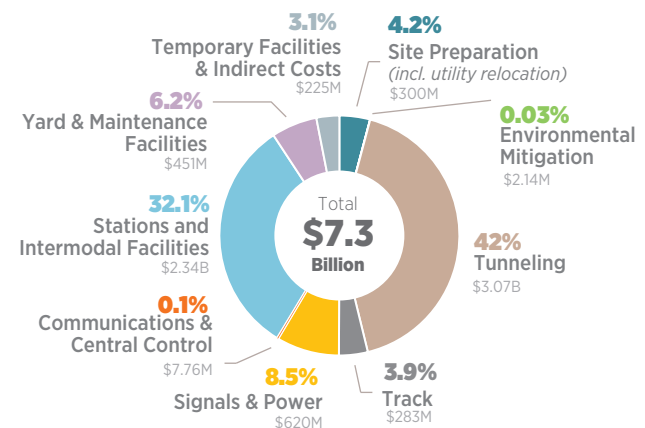
The same thing occurred with the Manhattan tunnels bid, which initially came in \$29 million below the engineers' estimate, but was canceled due to budget uncertainty. But the most significant contractual impact on ESA took place in the fall of 2012 when the MTA decided all bids on Contract Modification 12 (CM12) were too high, upward of \$950 million, and canceled them. They broke CM12 into three smaller contracts: CM005, -006, and -007. This reprocurement caused a two-year delay, while little progress was made on the Manhattan caverns.⁵⁰ The three contracts also came in at a cumulative cost greater than the single, larger contract. This, combined with the idle work site, ended up costing the MTA at least \$373 million in additional contract costs, with modifications in excess of \$56 million — and saving no time.⁵¹ The adherence to accepting only the lowest qualified bid has led to less-experienced contractors defaulting on contracts. Insufficient federal funding of the megaproject, due to the project budget escalation after the FFGA was awarded,⁵² resulted in contract

Figure 10: East Side Access Project Task Costs (as of March 2016)



Source: FTA New Starts Reporting

Figure 11: East Side Access construction Costs (as of March 2016)



Source: FTA New Starts Reporting

2017).ma

⁴⁸ Expert Interviews

⁴⁹ Ibid.

⁵⁰ Expert Interviews and U.S. Federal Transit Agency. "ESA Monthly Project Management Oversight Committee Report July 2013." FTA. June 20, 2015. https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/ESA_Monthly_PMO_Report_-_July_2013_Redacted.pdf (accessed July 15, 2016).

⁵¹ MTA. "East Side Access Q4 2015 Progress Report." *MTA Capital Construction*. 2015. http://web.mta.info/capital/esa_docs/East%20Side%20Access-%20Quarterly%20Report%202015%20Q4.pdf (accessed January 20, 2017); and MTA. "East Side Access Q3 2016 Progress Report." *MTA Capital Construction*. 2016. http://web.mta.info/capital/esa_docs/East%20Side%20Access-%20Quarterly%20Report%202016%20Q3.pdf (accessed January 20, 2017).

⁵² The MTA originally asked for 50% of \$5.4 billion budget when it applied for the FFGA, the federal government complied allotting \$2.7 billion in 2006.



Photo: MTA / Rehema Trimiew

repackaging and rebidding and, coupled with lowest-bid process, directly contributed to increasing costs and delays for ESA.

Project Budget

MTACC staff provided RPA with the FFGA categorical cost budget for ESA in March 2016. As noted earlier, the agency has raised concerns about the validity of this reporting as a means of making comparisons across projects even though that was the intent behind the creation of the FTA's standard cost categories (see page 31 for further details). In addition to these materials, RPA has evaluated the project costs, construction costs by task, and project delays using the publicly available ESA quarterly reports from MTACC, quarterly meeting reports provided by the MTA Board's LIRR subcommittee, monthly FTA Project Management Oversight contractor reports, and oversight reports produced by the New York State Comptroller. ESA has been budgeted at \$12 billion including contingency and finance charges, and \$10.2 billion without contingency and finance charges. At \$12 billion, ESA is one of the most expensive civil works projects in the U.S. (Figure 10). Some \$2.3 billion went to ESA's concourse terminal facility. Nearly one-tenth of the budget covers debt financing on bonds and federal New Starts funding (\$1.1 billion or 9%). Design and engineering costs are \$660 million (6%) and \$890 million (7%) of ESA costs, including management costs. Another \$720 million (7%) is for new rolling stock on LIRR to provide a higher frequency of 24 trains an hour at GCT and 37 trains an hour at Penn Station.⁵³

Of ESA's \$12 billion in costs, \$7.3 billion (61%) went to construction. The most expensive item is the terminal station beneath MNR's existing terminal at Grand Central Terminal, totaling \$2.3 billion (32% of construction costs) with tunneling at \$3.0 billion (42%) (Figure 11). At less than 1% of construction costs, direct environmental mitigation costs seem small, but they do not include impacts on project budget and schedule. As noted, the decision made during environmental review requiring all spoils from Manhattan caverns to be hauled back to Queens through the new tunnels severely undermined the project's productivity. This choice inflated tunneling and station construction costs by as much as \$75 million, partly by increasing the project time line by roughly six months.⁵⁴ These costs are reflected in the sheer number of man-hours required during tunneling: nearly 12 million as of November 2016.⁵⁵

Labor costs are not listed separately from materials. Component costs, which include both labor and materials, are reported in the summary due to contractual constraints. Data on labor and materials costs, which are wholly unavailable to public scrutiny, are bundled within private construction contracts that cannot be analyzed due to non-disclosure bid agreements the MTA signs with its contractors. According to one MTA project manager, there are no standard hourly performance reporting procedures at the task, trade, or administrative levels. Tracking task hours is at the discretion of each MTA project manager.⁵⁶

⁵³ MTA. "East Side Access Facts and Figures." *MTA.Info*. November 2, 2015. http://web.mta.info/capital/esa_docs/ESA%20Press%20Kit%20-%20FACTS%20&%20FIGURES_11.2015.pdf (accessed February 15, 2016).

⁵⁴ Expert Interviews

⁵⁵ MTA CC Project Controls

⁵⁶ Expert Interviews

Table 4: ESA Estimated Labor Hours and Costs (April 1999 - November 2016)

Trade (Level)	Estimated Man Hours (millions)	Minimum Wage Costs (millions)	Minimum Benefit Costs (millions)	Wage Costs at Premium Sunday Rate (millions)	Benefit Costs at Premium Sunday Rate (millions)	Minimum Labor Costs (millions)	Labor Costs at Higher Premium Rates (millions)	Rate Source for Estimate
Cable Installation/ Electrical Wiring (Electrician A)	1	\$65	\$62	\$97	\$93	\$127	\$191	Prevailing Wage NYC Schedule 220
Non-pneumatic Tunneling/ Blasting/ Rock Excavation/ Excavation (Tunnel Worker in Free Air Conditions)	12	\$668	\$559	\$1,337	\$1,119	\$1,228	\$2,455	Prevailing Wage NYC Schedule 220
Concrete Construction & Cement Work (Cement and Concrete Worker)	4	\$149	\$81	\$297	\$100	\$229	\$397	Prevailing Wage NYC Schedule 220
Non-manual laborE**	13	\$755	\$567	-	-	\$1,322	-	Average of Labor Costs in MTA CC Operating Budget for 140 employees
Total	30	\$1,636	\$1,270	-	-	\$2,906	\$4,365	

*Benefit costs include health care, retirement benefits, fringe benefits, and training for trade labor.

**Nonmanual includes program management, construction management, engineering, and contractor's management and engineering.

Note: Average hourly wage and supplemental benefit rates are based on 2080 annual hours (40-hour workweek at 52 weeks/year) for 140 full-time employee equivalents in FY 2016. Publicly released MTACC labor data is reported because data on private labor costs — design/engineering consultants and contractor construction and management workforce — are not publicly available.

Source: RPA Analysis

Because labor costs are not reported separately, the following costs are estimates based on the total man-hours of the three primary civil and systems tasks on ESA: tunneling and excavation, concrete and cement work, and electrical and wiring. Based on man-hour data provided by MTACC from April 1999 to November 2016, and using publicly available prevailing wage data, the cost of trade labor is estimated at \$1.6–\$3.0 billion (22–45% of construction costs) for ESA (Table 4).⁵⁷ The lower-end estimate is based on standard non-premium rates for the three primary trades. Because non-premium prevailing wage rates do not account for overtime or night and weekend rates, RPA provided a high-end estimate based on premium Sunday wage rates,⁵⁸ which included health, pension, and fringe benefits. Based on the prevailing wage schedules that are the minimum rates to be paid to trade labor, these rates can be negotiated upward during the pre-bid phase between contractors and union representatives. The large difference illustrates how difficult it is to estimate the impact of labor on the costs of these projects. It also highlights the need for greater transparency and reporting.

An estimated \$1.3 billion for 13.3 million hours of nonmanual labor in the form of MTACC, consultant and contractor project management, construction management, design, engineering, and administrative labor have been totaled

as of November 2016.⁵⁹ The estimated cost of nonmanual labor, which is a minimum, does not accurately represent private consultant and contract labor costs. Wages and benefits for private labor – such as engineering, design and management consultants or contractors' administrative, management, and engineering labor — are not publicly available. The wages and supplemental-benefit hourly rates estimated for nonmanual labor are based on MTACC labor wage and benefit budgets for FY 2016 for 140 employees on a standard 40-hour workweek.

ESA is years behind schedule, contributing to escalating costs for the primary construction sites of the terminal station, Harold, caverns and structures in Manhattan and Queens Plaza, and the systems contracts for signals, communications, and track power.⁶⁰ The construction delay on each of these key elements is three to six years. With construction delays of 52 months, the delivery performance of joint-venture contracts fares little better than that of single prime contractors at 57 months. Procurement and design delays on the most recent round of construction contracts have added between two and nine months of delay on average. But these delays do not include the repackaging and rebidding process described above under *Procurement*.

⁵⁷ Labor hour data provided by MTA CC Project Controls

⁵⁸ Office of the Comptroller, City of New York. "Labor Law §220 Prevailing Wage Schedule." Office of the Comptroller, NYC. January 9, 2017. <https://comptroller.nyc.gov/wp-content/uploads/documents/220-schedule2016-2017.pdf> (accessed March 10, 2017).

⁵⁹ Labor hour data provided by MTA CC Project Controls

⁶⁰ MTA Board. Long Island Rail Road Committee Meeting Report January 2017. Board Meeting Report, New York: MTA, 2017.

Case Study

#7 Line Subway Extension to the Far West Side



Photo: RPA

The #7 Line is a 1.5-mile extension of rail service from Times Square to a new Hudson Yards station at 11th Avenue and 34th Street on Manhattan's Far West Side. A second station at 11th Avenue and 41st Street, planned as part of the original project, was dropped due to rising costs.

Opened in September 2015, the #7 immediately became an important catalyst for redevelopment of the Far West Side, which will ultimately contain more than 50 million square feet of new office, retail, and residential space. This was the first substantial addition to Manhattan's subway system in over 30 years, and the first to be entirely financed by the City of New York, at a cost of \$2.4 billion (\$2.1 billion for subway construction costs alone).

The #7 extension demonstrates the value resulting from coordinating transit investments with economic development plans and land use. The city's significant investment will be paid off many times over by the resulting increase in economic activity, more employment, and larger tax base. The major innovations include:

1. The city's reliance on local funding saved time and money (but did not lower actual construction costs) by eliminating the complexities that characterize state- and federally funded projects. This model also included land-value recapture, a first for a New York City transit project.
2. The partnership between the MTA, City Hall, and the developers, fostered by City Hall (and its political champion, Mayor Bloomberg) and its Hudson Yards Development Corporation (HYDC), produced synergies that kept the project closer to schedule and perhaps contained costs.

3. Integration of land use, economic development, and transit made this project feasible, and initiated far better outcomes on the ground.

Local Innovative Finance, no Federal Funding

The #7 is being financed locally through the city's Hudson Yards Infrastructure Corporation, which issued \$3 billion in bonds to cover the extension's \$2.3 billion cost, new open spaces, and other supportive infrastructure for redevelopment. The value capture funding was not through a typical tax increment financing district. Rather, three separate sources of revenue will pay back the bonds as part of a tax increment financing scheme: (1) development impact bond purchases, (2) air rights sales, and (3) parcel-by-parcel payments in lieu of taxes (PILOT).⁶¹ The value of air rights under post-Hudson Yards rezoning was used to leverage private bank investment for the #7 Line and additional infrastructure investments to prepare the area for redevelopment. The PILOT provides a maximum of 40% reduction in property taxes on the first 500 million square feet of commercial development within the district, with an increase of 3% annually for 15 years. The assumption is that value capture will reimburse the city for most, or all, of these costs via the PILOT and commercial development fees. Over time, the district's increasing property-tax base should eventually service the bond's interest payments, which are now paid from the city's general operating funds.⁶²

⁶¹ Expert Interviews

⁶² Ibid.

Table 5: #7 Line Project Time line and Budget

Month	Year	Progress Note	Budget (millions)
December	2001	DCP releases planning framework to spur Hudson Yards redevelopment planning process	
November	2002	DCP and its consultants present master plan for Hudson Yards redevelopment	
June	2002	City requests market study of Hudson Yards redevelopment potential	
September	2003	Borough president review of ULURP for Hudson Yards rezoning	
February	2003	Joint CEQR application submitted for rezoning proposal and 7 line extension by DCP and MTA	
	2003	Rezoning proposal for Hudson Yards redevelopment & 7 line extension	
November	2004	DCP approves ULURP for Hudson Yards redevelopment plan rezoning	
June	2004	Draft EIS for SEQRA and CEQR complete	
July	2004	Financing options for 7 line extension presented to city council	
July	2004	Community board review of ULURP for Hudson Yards rezoning	
October	2004	Final EIS for SEQRA and CEQR complete	
October	2005	Eminent domain filings complete	
June	2005	Notice of eminent domain sent for property acquisition for 7 line extension	
January	2005	New York City Council approves Hudson Yard rezoning and 7 line extension	
April	2006	Property acquisition for 7 line extension begins	
December	2007	Ceremonial event marking the launch of the 7 line extension.	
November	2007	First construction contract awarded	
December	2009	First TBM finishes southbound tunnel and breaks through into 34th Street station cavern.	
June	2009	Excavation of cavern and support box beneath the Port Authority Bus Terminal is complete. TBM mining continues at 26th Street and 11th Avenue.	
February	2009	First TBM is lowered into the shaft on the corner of 26th Street and 11th Avenue.	
July	2010	TBM tunneling is complete.	
July	2011	HYDC added additional scope of \$266 million for non-subway construction work	\$ 2,366
May	2012	65% complete and installation of first set of rails.	
December	2013	Ceremonial ride from Times Square to the new station at 34th Street & 11th Avenue.	
August	2013	Project 90% complete	
September	2015	34th Street - Hudson Yards Station opens for revenue service.	\$ 2,420

Source: MTA

Table 6: #7 Line Estimated Labor Hours and costs Millions \$ (Lifetime of Project)

Trade (Level)	Man Hours (est)	Minimum Wage	Minimum Benefit Costs*	Wage at Premium Sunday Rate	Benefit Costs at Premium Sunday Rate	Minimum Labor Costs	Labor at Higher Premium Rates	Rate Source for Estimate
Cable Installation, Electrical Wiring & Signals (Electrician A)	1,375,000	\$74	\$71	\$111	\$107	\$146	\$218	Prevailing Wage NYC Schedule 220
Not Pneumatic Tunneling, Blasting, Rock Excavation, General Excavation Track work (Tunnel Worker in Free Air Conditions)	4,800,000	\$267	\$224	\$535	\$447	\$491	\$982	Prevailing Wage NYC Schedule 220
Concrete Construction & Cement Work (Cement and Concrete Worker)	1,500,000	\$64	\$35	\$127	\$43	\$98	\$170	Prevailing Wage NYC Schedule 220
Plumbing & Mechanical (Plumber Mechanical)	425,000	\$17	\$6	\$25	\$9	\$23	\$34	Prevailing Wage NYC Schedule 220
Non-manual labor	Data not provided	-	-	-	-	-	-	
Total	8,100,000	\$422	\$336	\$799	\$606	\$758	\$1,405	

*health care, retirement benefits, fringe benefits, training

Source: MTA

Streamlined Permitting and Construction

The cost and time savings allowed by the #7's innovative finance, permitting, and approval processes cut years and perhaps several hundred million dollars from the construction costs and schedule. The #7's 15-month delayed completion was partially the result of poor vendor decisions⁶³ made by the MTACC and by the NYCT's operational certification process, both of which should be reviewed for lessons learned. The MTA also states that the delayed completion was the result of the city's asking the MTACC to undertake \$266 million in non-subway work activities,⁶⁴ which included building-foundation and structural work for new development sites adjacent to the subway station. These were aligned with the station construction time line.⁶⁵ While the subway extension's budget never technically increased, the high cost of the initial construction contract (running tunnels and underground structures) instigated elimination of the second station at 41st Street and Tenth Avenue, which was myopic, given the demand for service in Hudson Yards and the likelihood an opportunity like this will never recur.

Although the MTACC was responsible for designing and building the project, the city opted not to pursue state or federal funding in order to reduce construction costs and limit environmental reviews, with the hope of delivering the extension in time for the 2012 Olympics (which were ultimately held in London). This approach eliminated the need for approvals from the governor and state legislature, potentially shaving years off the state funding and approval processes by streamlining environmental assessment and project development (Table 5). While the #7 did not require a federal environmental impact statement (FEIS), cutting two or more years from

⁶³ The inclined elevators were a debacle that added time and cost to the project. Making matters worse, the performance of these elevators is subpar and not in line with conventional lifts (even though they could be) and escalators.

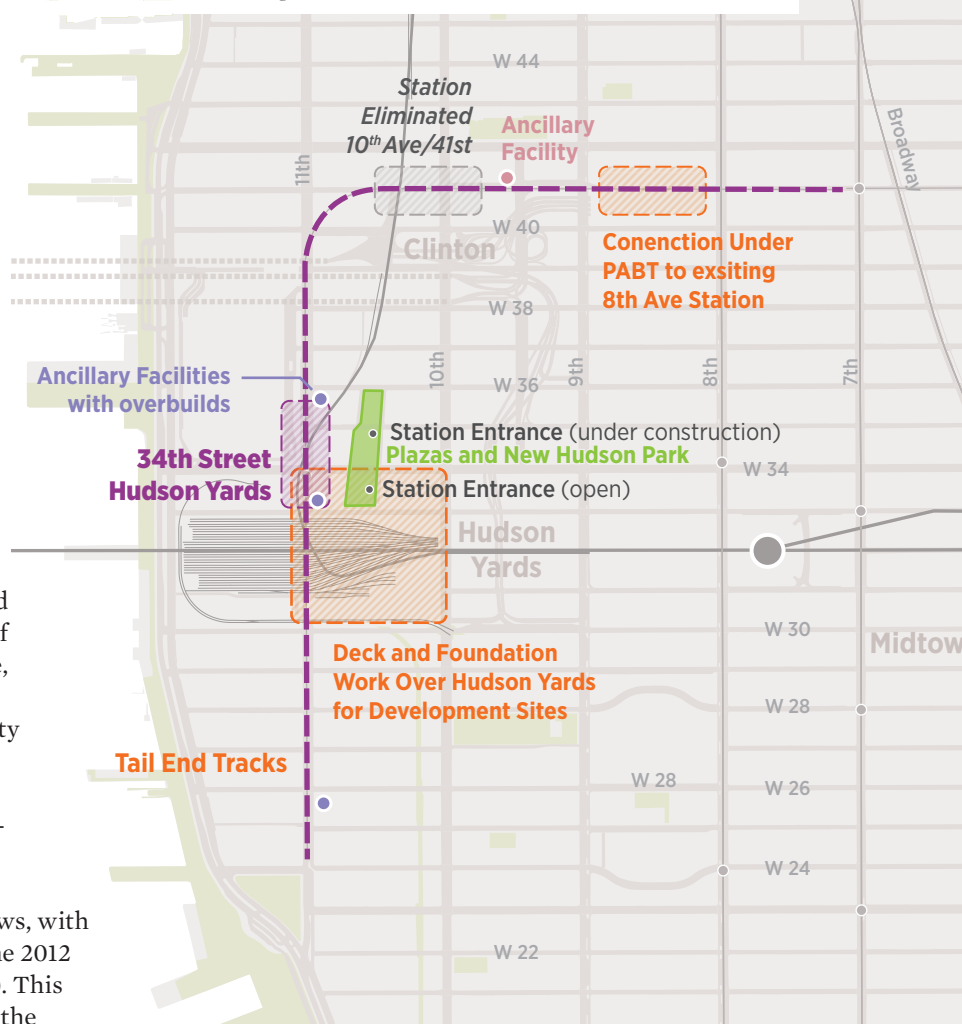
⁶⁴ The non-subway work included:

- Site K Ventilation Building: This additional non-subway work included reconstruction of portions of NYCDOT's 11th Avenue and West 36th Street viaducts, and construction of an exhaust air plenum for the Jacob Javits Convention Center.
- Elimination of Tenth Avenue Station: This elimination added more work such as shafts, adits, cross passage #6, and a duct bench through what would have been the Tenth Avenue Station area.
- Site A – This added a parking ramp to the systems building for the developer's future underground garage, and “beefed up” structural columns and beams to support an overbuild structure.
- Site J (Main Entrance) – Significant caissons and other foundation work, bolstered structural columns, beams, other structural elements, and shear walls were added, all to support the future overbuild high-rise.
- Site P (Secondary Entrance) – All structural, mechanical/electrical/communications systems and architectural systems work from the station's upper mezzanine and to street level were added as this portion of the Secondary Entrance had been specifically omitted from the original concept plan. Instead, the city, HYDC, HYIC, and MTA envisioned this portion of the Secondary Entrance as being part of a developer's over-build structure.

⁶⁵ Expert Interviews

Figure 12: Elements of the #7 Extension Project

Source: Regional Plan Association



permitting, it remained subject to the city's land-use and environmental reviews, the seven-month ULURP, and the concurrent 19-month CERQ, which supersedes the New York State Environmental Quality Review process.⁶⁶ The #7 was not subject to additional federal reviews and restrictive construction standards, such as “Buy America” requirements, again shaving significant costs and avoiding delays.

Coordinated Economic and Infrastructure Development

Although it is common in other world cities to closely coordinate planning, economic development, and housing with infrastructure development, this does not often happen in New York, in part because the city's land-use and economic development functions are separate from and independent of the transit system — controlled by the State of New York. The #7 extension was New York's first coordinated economic development and transit construction project in decades. All of the #7's auxiliary subway structures (vent

⁶⁶ New York City Department of City Planning. “Hudson Yards.” NYC.gov. N.d. <http://www1.nyc.gov/assets/planning/download/pdf/plans/hudson-yards/hyards.pdf> (accessed September 2, 2016).

shafts), for example, are designed for overbuilds and integrated into the site plan. By comparison, the seven auxiliary structures constructed along Second Avenue for that long-awaited subway are two to four stories in a corridor dominated by 20- to 30-story residential towers.

Although proposed by many advocates and officials over the decades, the #7 extension was finally brought to life by Mayor Michael Bloomberg and Deputy Mayor Daniel Doctoroff, who urged that it be built to provide access to the new Jets Football Stadium anticipated as part of the city's 2012 Olympic bid. While the stadium was not ultimately approved, and the Olympics went to London, the #7 proceeded as part of the city's rezoning, and in support of the Hudson Yards mixed-use development being built on air rights over LIRR's West Side Yard, located between Tenth Avenue and 12th Avenue, and 30th Street and 33rd Street.⁶⁷

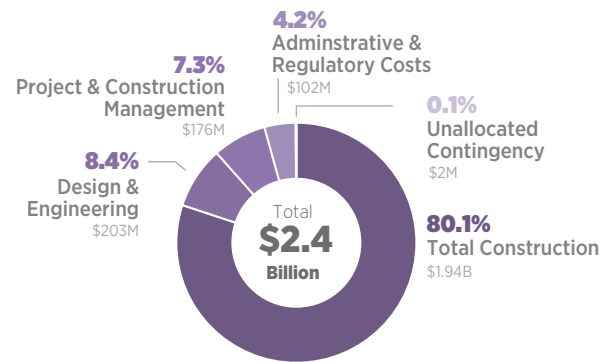
The HYDC model⁶⁸ was created by the city as a marshaling and coordinating body. The partnership between the MTA, the city, and developers produced synergies that moved the project along, giving parties leverage in negotiating within their own bureaucracies. During construction, all sides benefited from regular communications and the ability to exert pressure collectively to work through tough problems.

Project Budget

The MTACC provided RPA with #7 costs as close to the FFGA categories as possible in July 2016. In response to RPA questions about the categorical assignments, the agency provided substantially different figures. Several months later, the MTA provided a third set of revised figures and raised concerns about the validity of the FTA's standard cost categories to represent the true costs of the project elements for comparative purposes (see page 31 for further details). This analysis uses the original numbers provided as they are closest to the FTA categories used for the call-out analysis.

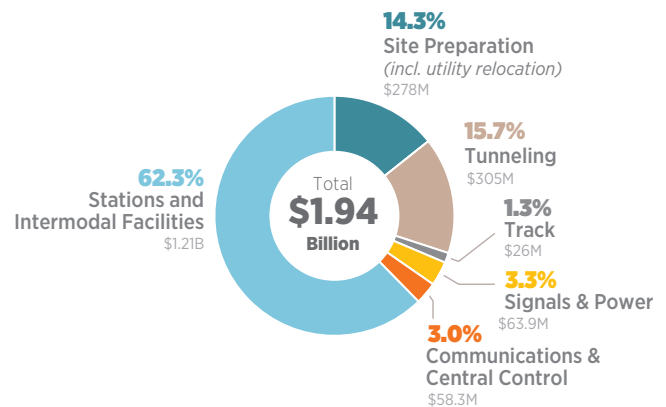
Because the project received no federal funding, it was not required to submit federal reports. The #7 is unique among megaprojects in the MTACC's portfolio because costs are overwhelmingly for construction, partially because the city covered some nonconstruction costs and #7 was able to avoid federal environmental and procurement regulations. Of the #7's \$2.4 billion budget (\$2.1 billion for subway and over \$266 million for non-subway works), 75% was for construction, with \$176 million (7%) spent on project and construction management and \$134 million (6%) on design and engineering. An estimated \$105 million, 5% of the initial \$2.1 billion budget, was allocated for contingency,

Figure 13: #7 Project Costs by Task (July 2016)



Source: MTA Generated New Starts Reporting

Figure 14: #7 Line Construction Costs (July 2016)



Source: MTA Generated New Starts Reporting

but was not reported separately in the categorical cost data provided.⁶⁹ These contingency costs are embedded within the categories above.

Additional oversight, plus administrative, permitting, and project management costs were paid by the city government through HYDC and EDC, with modest costs for non-subway work covered by developers in Hudson Yards. This data was not provided as part of the #7 project costs.

A large portion of the project's budget went to the large new terminal at 34th Street and 11th Avenue, which cost \$746 million. That, plus the retrofit of the Eighth Avenue station brings the total to \$845 million, or 47% of construction costs. (Figure 15). Tunneling consumed 17% of construction costs, or \$305 million (the MTA has stated this is even higher, at one point suggesting it could be as high as 63% of construction costs). At \$110 million per track mile, the #7's precast tunneling costs are far less than ESA's \$261 million. Still, #7 tunneling costs were nearly twice as high as SAS's at \$54 million per track mile.

⁶⁹ Project contingency of 5% based on expert interviews.

⁶⁷ New York City Department of City Planning. *Projects and Proposals, Manhattan: Hudson Yards*. 2015. <http://www.nyc.gov/html/dcp/html/hyards/proposal.shtml> (accessed January 10, 2016).

⁶⁸ Hudson Yards Development Corporation. *About HYDC*. 2015. <http://www.hydc.org/html/about/about.shtml> (accessed January 10, 2016).

Unlike SAS and ESA — which reported costs on site preparation, utility relocation, and other indirect construction costs — the #7 figures do not enumerate these areas. Based on interviews, RPA concluded that utility relocation and site mitigation costs were lower than for other megaprojects. In general, utility costs associated with the subway were included in the lump-sum costs for each of the six construction contracts. As most work took place deep underground rather than at street level, relocations of existing utilities were relatively minor (totaling approximately \$1 million) in comparison to the overall \$2.4 billion program. Property needed for the station entrances and four ventilation buildings was acquired by the city via easements from the property owners. Such easements included terms pertaining to demolition of existing structures and site preparation, including utility relocations. One unusual feature was that the project was designed to prevent groundwater from entering the station cavern and then “raining down,” and instead was designed to allow groundwater to “bubble up” below track level, to be collected and then conveyed out to LIRR-yard drains. This added indirect construction costs that were not reported separately. This was not an environmental issue that needed to be remediated for negative impacts. And while the utility relocation costs were negotiated by the city, the extent is unclear. The city has the right to order out utilities, and they [utility companies] have franchise agreements with the city,

which means the city has negotiating power to eliminate or greatly reduce the cost of utility relocation rather than pay at cost, as MTA does on other megaprojects.⁷⁰

The MTA does not itemize labor costs separately within component costs. The following estimates are based on the total man-hours of the primary civil and systems tasks on the #7 Line (Table 6). Publicly available prevailing wage data suggests the cost of trade labor is between \$757 million and \$1.4 billion (45–83% of construction costs). The lower-end estimate is based on standard non-premium rates for the four primary trades, which do not account for overtime or night and weekend rates. RPA thus provided a high-end estimate based on premium Sunday wage rates. These estimates included health, pension, and fringe benefits. While prevailing wage schedules are the minimum rates to be paid to trade labor, rates can be negotiated upward between contractors and union representatives during pre-bidding. These rate variables illustrate how difficult it is to estimate the impact of labor on the costs of projects. It also highlights the need for greater transparency and reporting.

The estimated labor-cost data below do not include non-manual labor hours, overhead, or supervision costs because they were not provided by MTACC. Nor are the costs of TBM equipment or precast liners. Labor for rebar work is excluded from the figures for concrete and cement.

70 Expert Interviews



Photo: RPA

Tunneling and Station Cost Comparisons Using the MTA's Preferred Methodology

Photo: MTA / Rehema Trimiew

Table 7: MTA Comparative Tunneling Costs Estimate for ESA, #7 and SAS

Project	New Tunnel Construction Costs by TBM (Millions)	TBM Tunnel Distance (Linear Feet)	TBM Tunnel Distance (Miles)	Average Cost per Mile (Millions)
East Side Access	\$1,730.2	47,098	8.92	\$194.0
#7 Subway Line Extension	\$494.8	12,400	2.35	\$210.6
Second Avenue Subway, Phase One	\$466.1	12,779	2.42	\$192.6

Source: MTA Analysis

As noted earlier, the MTA has several concerns with project costs developed using FTA New Starts guidelines for comparing the costs of different projects for tunneling, stations, and other project components. The MTA had provided RPA with the cost breakdowns for SAS and ESA using FTA directives on how to categorize different tasks. Because the #7 was not federally funded the MTA did not generate reporting in FTA format. Over the duration of this two-year study, however, the MTA did provide RPA with two iterations of possible New Starts reporting for the #7. Towards the end of the study the MTA informed RPA that neither set of numbers represent an accurate comparison and that they had concerns about the FTA's "Standard Cost Categories" (also used by RPA when asking international peers for comparative unit cost data). Instead, the MTA began developing alternative comparisons with their preferred methodology.

While the MTA was unable to provide a full comparative accounting of all project elements due to the limited time-frame, it did create a table (below) comparing tunneling costs for ESA, SAS, and #7 using their preferred method. The MTA states that this is an "apples-to-apples" comparison of the projects, and recommended against using the costs for the three megaprojects using FTA guidelines. RPA questions some of the revised costs, specifically construction management and bonding costs that could logically be compiled separately. A complete list of elements included in the MTA tunneling estimate can be found in the appendix.

Comparing the tunneling costs using FTA guidelines, this analysis shows far lower tunneling costs for ESA and higher costs for SAS and #7. While the \$1.1 billion reduction in ESA tunneling costs over the FTA reported figures shaves approximately \$70 million off the prior track-mile estimate, the project remains twice as expensive as Cross-rail. The estimate for SAS increases its per track-mile tunneling costs by 256%, making it three times more expensive than LA's Purple line. The MTA's analysis also further confirms that the organizational structure of #7 line project did not necessarily lower construction costs. In fact, their analysis shows that – for tunneling – it was the most expensive of all three.

For the purpose of international comparisons, RPA continued to use the initial analysis provided by the MTA using FTA guidelines. This is a federally sanctioned methodology and the only one that provides a complete and consistent set of cost comparisons. Clearly, different assumptions on how costs should be categorized can result in large differences in calculations of unit costs for different project components. Even with these differences, each methodology supports the finding that New York's costs are substantially higher than costs in other regions.

Although the alternative analyses do not affect RPA's overall conclusions, it is still important for the MTA to develop and report cost analyses that can be reliably compared across MTA projects and with similar projects in other regions. This diagnostic is central to evaluating how processes can be improved.

Lessons: What Was Learned from the Case Studies

The three megaprojects provide a window into the players and major challenges faced by capital construction in the region. Various patterns began to emerge as RPA assembled its research, conducted its interviews and discussed with a range of experts through the Milstein Forums on New York's Future. The three major actors shaping these projects participated in flawed decision-making and construction management processes that produced higher costs and longer delays. The following sections delve into the roles of the actors, the decision-making process, and the major cost drivers highlighted through our research and through the Milstein Forums.

Actors

Three sets of actors are responsible for shaping the MTA's capital projects: political, institutional, and labor. The decisions they each make — through an iterative and nonlinear process — profoundly affect costs. There are two types of political actors: elected officials and the public. "Institutional" refers to transportation agencies — the MTA being the dominant institution that must also interact with other agencies, contractors, and organizations. Labor, which includes trade associations and unions, functions as a third and crucial participant. All of these actors have a role in capital construction — especially the determination of project costs. Their priorities can shift project planning, design, feasibility, and, ultimately, success.

Political

Public officials are elected by a citizenry that includes constituencies and advocates who articulate their views of transportation problems to political leaders, identify issues, and propose solutions. In many cases, they also influence the early conceptual planning, cost estimates, and construction time lines for capital projects.

Given that the region's transportation infrastructure is built in a dense urban environment, other external actors, such as real estate developers and owners, indirectly influence capital construction — expressing their interests through lobbying and the political discourse on land use. In tunneling beneath neighborhoods for the Second Avenue Subway, for example, the MTA worked with owners to

underpin their buildings (determined by the agency's own engineering analysis). Nonetheless, owners then protested to local officials about the construction. Though they are not the primary drivers of costs, these actors influence decisions by political leaders.

Institutional

Other actors driving capital construction costs are within the MTA and other government institutions. The MTA Board of Directors, appointed by the governor, sets the agency's strategic priorities (Figure 15). The professional staff, including civil servants, plans for, assesses, and operates transportation services. MTA capital construction is managed by the MTACC division, which was formed to oversee all capital expansion megaprojects for the operating entities. MTACC-managed megaprojects include:

- ▶ New York City Transit Assets
 - Fulton Center
 - South Ferry Terminal
 - Second Avenue Subway
 - #7 Line Extension
- ▶ Long Island Rail Road Assets
 - East Side Access

Outside the MTA's official staff are external technical consultants for design and engineering, and construction contractors retained through MTA procurement. Additionally, as many MTA capital projects require subterranean work, the NYC Department of Environmental Protection, which manages sewer and water lines, and major utilities companies, including Con Edison, Verizon, Time Warner, and National Grid that relocate water, sewer, gas, telephone, cable and electrical utilities for major infrastructure projects, are involved as well.

Labor

The trades typically involved in the construction of MTA's infrastructure include:

- ▶ Blasters
- ▶ Sandhogs (tunnel miners/excavators)
- ▶ Carters and movers
- ▶ Iron workers
- ▶ Lathers
- ▶ Riggers
- ▶ Operating engineers
- ▶ Concrete workers, plasterers, cement masons
- ▶ Painters, glaziers, tapers
- ▶ Laborers
- ▶ Teamsters
- ▶ Electricians
- ▶ Plumbers
- ▶ Sheet-metal workers
- ▶ Mechanical contractors
- ▶ Steamfitters

Construction contractors hire and manage workers for each project according to requirements stipulated in union contracts, and ensure they have the necessary safety training for working on the MTA's tracks and within the rail right-of-way. Many construction contractors are represented by the General Contractors Association (GCA),⁷¹ which works with its members to negotiate with the unions on the pool of labor required to bid on capital infrastructure contracts. GCA's membership includes the contractors hired by the MTA to oversee and manage the union workers building the tunnels and stations for the megaprojects.

Additionally, the MTA itself directly employs members of public labor unions, including the Transport Workers Union, the United Transportation Union and Metro-North Railroad Union, the International Brotherhood of Teamsters, the Association of Commuter Rail Employees, the American Railway and Airway Supervisors Association, Transportation Communications Union, the Superior Officers Benevolent Association, and the District Council 37 public-employee union.⁷² These unions influence labor practices within the MTA and its capital projects, including requirements for force-account labor (the MTA's and Amtrak's public union workforce required for track safety, such as train operation and track flagging, and other system tasks, such as engineering design specifications). Force-account labor is required for all contracted work within the rail right-of-way. And in the case of shared rail rights-of-way with Amtrak, which both LIRR and MNR operate along portions of their lines, Amtrak's force-account workforce is required for capital projects like ESA or repair work.

⁷¹ GCA negotiates agreements with the blasters, sandhogs, lathers, operating engineers, laborers, teamsters, carpenters, and dock-builders. All other trades listed are represented by other association agreements.

⁷² MTA. "Independent Auditors' Review Report Three-Month Period Ending March 31, 2015." *MTA.info*. June 22, 2015. http://web.mta.info/mta/news/books/docs/DRAFT_%20MTAFinancialStatement_062215.pdf (accessed May 20, 2016).

Figure 15: MTA Leadership Organizational Chart

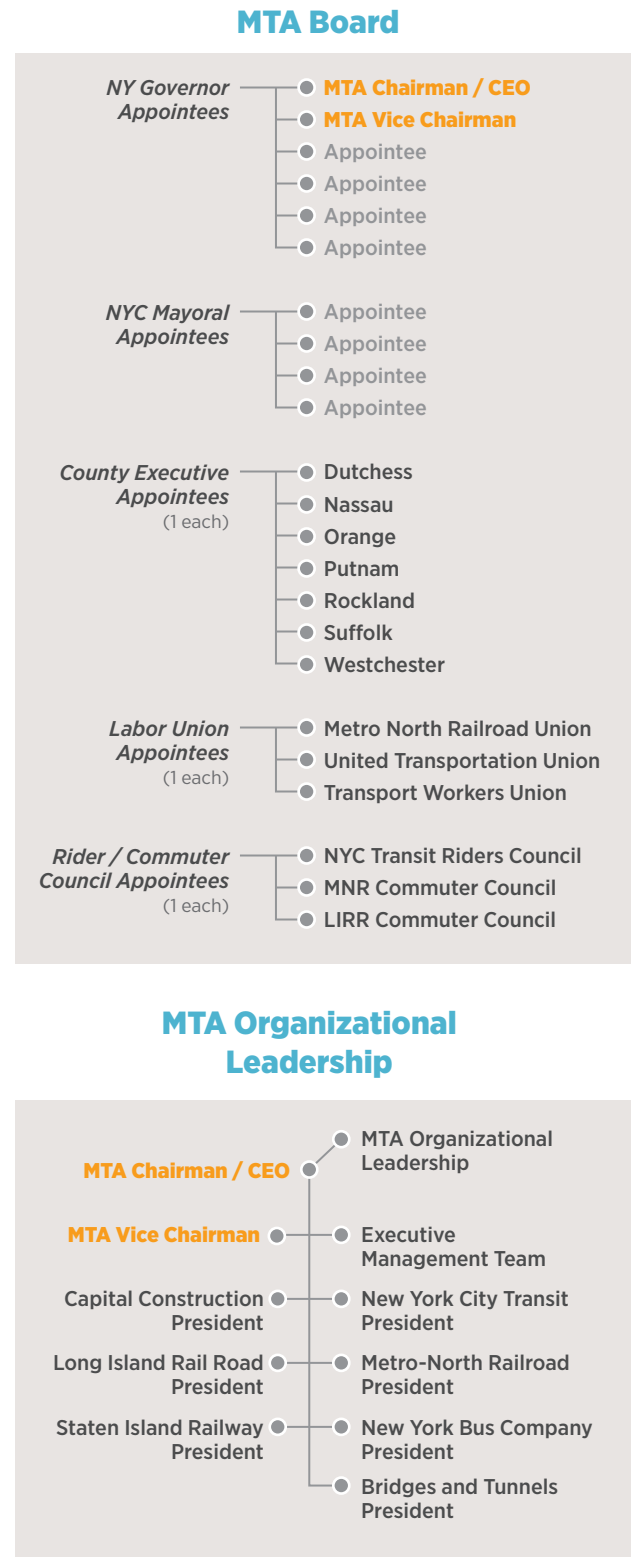
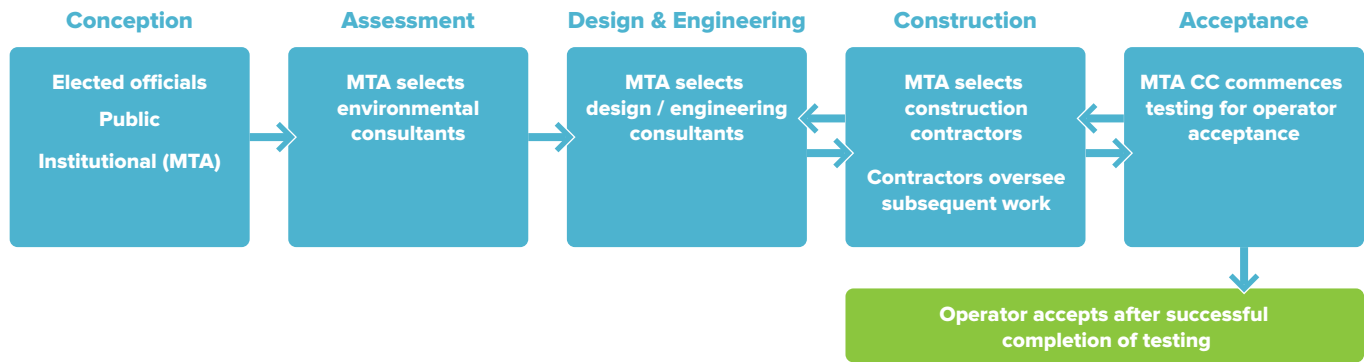


Figure 16: Capital Construction Project Decision-Making Process

Source: Regional Plan Association



The Decision-Making Process: Conception to Acceptance

The dense decision-making process for capital construction projects is made even more complex by the differing priorities of political, institutional, and labor actors. The decision-making process has five parts – conception, assessment, design, construction and acceptance – and distinct roles for each (Figure 16).

In consultation with transit professionals, political and public actors define transportation solutions that city, state, or federal officials then announce as a project concept, providing a time line and preliminary budget for each megaproject. Politicians champion these major infrastructure projects, presenting the general public with estimated costs and end dates.

Solutions presented by political leadership then typically go through a government-mandated environmental impact assessment, and are vetted against other options for alignments, modes, and location, and analyzed for specific local, environmental, and economic impacts. Project assessments are completed by technical consultants hired by the MTA, which has historically held an inherent bias toward the mode, alignment, and location first presented by political leaders as the preferred alternative.⁷³

The chosen option next enters design and engineering, which is completed by technical consultants contracted through an MTA-controlled procurement process. Design and engineering proposals are developed by consultants through subcontracts. The final design proposal undergoes a constructability audit for issues at the project site(s) by yet another set of consultants. The MTA then publishes the final design as the scope of work to be bid on by contractors,

⁷³ Agencies typically conduct their own internal studies to work out technical details of a project first before the NEPA/public process commences. This analysis is typically used to feed the NEPA process and is further refined over the course of the study.

a phase that former MTA CEO Thomas Prendergast sees as one of the most flawed. As he discussed at RPA's 2017 Regional Assembly plenary panel, "So much of the path of outcome is set in the first 15% of the project, when we basically have no people and no money. The elements are cast in stone then, and we spend [the] rest of [the] project dealing with the constraints we've been dealt early on."⁷⁴

The project construction request for services is typically divided into five major components: general/civil, electrical, heating ventilation and air conditioning (HVAC), and plumbing. Each is a separate primary bid by one or multiple construction contractors through subcontract agreements. The (union signatory) contractors hire union labor for the duration of the awarded project, adhering to specific contractual requirements for working conditions and labor costs. These costs are outlined in the budgets submitted with each bid.

The final phase of the project is *acceptance*, or the hand-off from capital construction to the operating agency. First the project must successfully undergo full testing certifying it for safety, quality, and performance. Only after it has passed all tests does the operating assume ownership. Acceptance can be a major source of delay, as it was for the #7, which repeatedly failed acceptance testing.

Major Project Cost Drivers

RPA interviewed over 50 experts in labor and the construction industry, including project managers, consultants, and engineers within and outside of the MTA regarding the construction of megaprojects. Through many of these discussions, the MTA's high cost for project delivery was attributed to:

- Politics and the Public Process
 - Inaccurate setting of project budgets and time lines

⁷⁴ "Building Big for Less," Plenary Session, Regional Assembly, April 21, 2017

- Protracted environmental review processes
- Local communities engaging too late and with insufficient information
- ▶ Institutional Processes and Decision-Making
 - Flawed project design affecting site access, constructability assessments, costs for utility relocation, frequent change orders, and project phasing
 - Inconsistent construction management roles (public and private sector)
 - Overly complex or detailed procurement
- ▶ Labor Practices and Work Rules
 - Lack of distinction between capital-construction and operating workforces
 - Work rules and regulations out of date with modern best practices and technologies
 - Workforce specialization, limited training capacity, and inadequate project pipelines contributing to inconsistent labor supply

In concert, these factors drive up the costs of the New York region's megaprojects to a greater extent than those faced by other national and international regions. There are overlapping concerns among all actors that extend beyond the MTA, including city agencies, real estate interests, construction contractors, labor and trade unions, local and state politicians, and the general public.

Politics and Public Process

Political and public processes primarily influence the project conception phase, budget development, and time line of capital projects — and throughout the environmental review projects are assessed according to public priorities that can shape a project's scope and cost.

Inaccurate Budgeting and Time Line

Local, state, and federal political leaders determine the amount of public funding that gets dedicated to capital projects through budgetary processes. The MTA's budgets, which are approved by the legislature and governor, are based on funding that is determined within political cycles. The federal government often provides additional funding for specific projects through grants or loans. All funding sources, and therefore budget limitations, stipulate how and when money is to be spent — outlining a project time line in advance of the full environmental and constructability reviews. Typically, projects are funded for less than what is requested even after completion of the environmental review and design. Funding is very tightly restricted by the five-year MTA capital planning process. Cost-overrun requests greater than \$250,000 require a stringent review within the agency, at the federal level by Federal Transit Administration, and by the MTA board. Sometimes cost overruns are warranted to address changes in project scope, design, and constructability. Yet consistent under-

budgeting and excessive restrictions on how funds can be spent lead to greater costs. Together, these procedural hurdles and time spent addressing them result in higher costs.

Protracted Environmental Review

The environmental review and resulting EIS are used to outline high-level site constructability overviews for the preferred modal and alignment option. The environmental review of MTA megaprojects must be completed for national and state compliance in order to receive federal and state funds.

Additionally, a large part of the environmental assessment is dedicated to defining the mitigating measures that must be taken to minimize impacts on the communities and ecology surrounding the construction site. The actual costs of environmental mitigation are often only a small part of project costs, but decisions made during the review process can add significantly to cost and project delays. It is impossible in a dense urban environment to build major infrastructure without affecting surrounding residents and businesses. Mitigating the noise, movement of equipment and excavated materials, and environmental and community impacts of construction have delayed every MTA megaproject undertaken in recent decades. Mitigation is a legitimate and important part of construction planning, but decisions and project budgets are often made without fully accounting for costs. A study of the Gateway Rail Tunnel Project by Common Good found that procedural delays for infrastructure, including but not limited to environmental review, more than doubled the cost estimate of the project.⁷⁵ Verifying these claims is beyond the scope of this study, but prior research by RPA indicates a number of ways in which the environmental review process could be improved.

RPA's study, *Getting Infrastructure Going*, found the primary drivers of delay in the federal NEPA review process are due to:

- ▶ A lack of stakeholder consensus over fundamental aspects of a project, which are not efficiently resolved during the environmental review process
- ▶ Differing and conflicting interpretations of NEPA requirements
- ▶ Inconsistent implementing policies and procedures among the multitude of government agencies
- ▶ Administrative bottlenecks and outdated procedures within agencies that have insufficient staff capacity and training to efficiently complete environmental studies or reviews

⁷⁵ Howard, Philip K. "Billions for Red Tape: Focusing on the Approval Process for the Gateway Rail Tunnel Project." *CommonGood.org* May 2016. http://commongood.3cdn.net/e68919da002c4300cd_bzm6bxnb9.pdf (accessed December 5, 2015).

⁷⁶ The preliminary ESA project budget was informed by just 1% of completed design.

- Misdirected response to the threat of environmental litigation, which leads to overly complex and technical environmental analysis and rigorous documentation efforts⁷⁷

Analysis of the MTA's megaprojects indicates costs related to constructability are not sufficiently considered in the review process. For example, siting a single construction access point in Long Island City for ESA was a choice made to avoid inconveniencing residents and businesses on Manhattan's East Side with the truck traffic required to move equipment and spoils from tunneling. Decisions made to minimize impacts on the surrounding community created an array of issues that drove up costs by limiting productivity, complicating muck removal, and restricting the hours of construction operations.

The cost of mitigating environmental and community impacts for ESA staging was not fully assessed by the MTA and its consultants, contributing to the billions of dollars in overruns that have plagued the project. And the public discourse of the costs of mitigation efforts has been limited, with the agency going to great lengths to avoid interrupting existing service or disturbing neighborhoods. There is hope, however, that the MTA's approach to mitigation can be improved. In 2016, MTA NYCT began a public discussion of the time and cost impacts of project phasing and service projected for the upcoming, much-needed repair of the Canarsie Tubes. Both in public meetings and in the press, the MTA outlined the additional delays and costs of limiting work to weekends and evenings to minimize impacts on L train service, successfully persuading New Yorkers to accept an L train shutdown in exchange for speed.⁷⁸ NYCT has embraced an aggressive project schedule with full line closures to get the job done fast and efficiently.

Local Communities Engaged Too Late in Planning Process

The MTA and other public authorities have a poor record of proactively engaging the public. Typically, the agencies tend to rely on the superficial hearings and outreach that are part of environmental review. The public's perception is that their input has little impact, the process is fixed, and outcomes are preordained. The agencies in turn enter the process with a predetermined outcome after years of internal studies. It should not come as a surprise then that the public's preferred recourse to affect change is often to file a lawsuit. Legal action can hold up a project for years, regardless of whether it is representative of the public's position, as only those with means can afford a lawsuit.

SAS has been plagued by significant community opposition, negative press, and lawsuits over its ventilation structures and entrances, even years after work on the project commenced.⁷⁹ It was clear the MTA did not have a robust mitigation plan in place beforehand and was making it up on the go. The impact on local businesses and the economy of disruptions from prolonged subway construction in the Upper East Side was ill-considered by the MTA and the city — a serious shortcoming due to the city's lack of involvement. As the project progressed, the MTA engaged the public more directly, opening a community information center on 84th Street and Second Avenue in 2013, and providing public tours of stations and tunnels. These tours informed the public of the huge project underway below their neighborhood, and the exhibits educated them on its benefits. While this development should be lauded, it came very late — six years after construction started.⁸⁰ Incurring the public's anger, the MTA was forced to compromise certain aspects of the SAS to gain acceptance, such as the placement of entrances at 72nd Street and 86th Street. Had the public been engaged earlier, it might have been more receptive to the disruption, perhaps even seeing the MTA as more of a community partner providing a crucial service than a nuisance.

A model for the future can be found in the MTA's recent efforts to rebuild the L train's East River tunnels. In planning for a rare extended shutdown of one of the city's busiest subway lines in 2019, the MTA started community outreach three years early. For 15 months, six stations and more than three miles of track will be idle. The MTA has also been working with the city to develop a series of options — a mix of new bus, ferry, and subway services — to move the 200,000 daily commuters who rely on the L. RPA was one of the earliest voices calling for an extended shutdown to complete the work faster and save money by having unimpeded access to tracks and stations. Advocacy for this effort is ongoing, and the MTA is still evaluating additional capital construction actions. RPA believes the MTA should take advantage of this outage to rebuild all five Manhattan L stations to modern standards, unlocking the L's capacity and maximizing its earlier investment in modern Communications-Based Train Control (CBTC). This means addressing major system bottlenecks, including the Eighth Avenue terminal, and dealing with crowding issues by resizing the busiest stations to meet current and projected ridership. More details on these improvements can be found in RPA's report, *Fixing the L Train and Managing the Shutdown: A Community Consensus Proposal*.

These capital investments should be combined with surface improvements to mitigate the service outage that will be required to rebuild the East River tunnels. Most and prob-

⁷⁷ RPA. "Getting Infrastructure Going: Expediting the Environmental Review Process." *Regional Plan Association Library*. June 2012. <http://library.rpa.org/pdf/RPA-Getting-Infrastructure-Going.pdf> (accessed January 20, 2017).

⁷⁸ MTA. *MTA Press Release: MTA Announces Plan to Engage with Community on L Train Tunnel Reconstruction Work*. February 6, 2016. <http://www.mta.info/press-release/nyc-transit/mta-announces-plan-engage-community-l-train-tunnel-reconstruction-work> (accessed February 10, 2016).

⁷⁹ Brown, Steven Rex. "Upper East Side residents sue MTA over placement of entrance to Second Avenue Subway." *New York Daily News*, March 25, 2013: <http://www.nydailynews.com/new-york/ues-residents-sue-mta-ave-subway-entrance-article-1.1298619>

⁸⁰ Some of this delay is attributed to public safety issues, with the site having to reach a certain level of completion before the tours could commence.

ably all of these improvements could remain in place once the tunnel is rebuilt, enabling the MTA to incrementally add service to meet demand for decades to come.

Institutional Processes and Decision-Making

Decision-making processes within transportation agencies affect project design, procurement, and management. Inefficiencies at different stages can cause delays and drive up costs.

Flawed Project Design

Project design is often disconnected from the project's other phases, leading to cost overruns. Because ESA and SAS are system-expansion megaprojects that have been in the MTA budget for several decades, designs have undergone numerous iterations. Access to the construction site is a key variable to efficient design, as are labor and environmental regulatory constraints, which are rarely accounted for accurately at the start of a project. This results in change orders — limited initial constructability assessments or design choices made through subsequent specification changes on the part of the MTA or its operating agencies.

Limited Site Access

Site access and staging areas analyzed during environmental review are influenced by both what is least inconvenient for surrounding residents, businesses, and building owners, and the operating agencies involved (NYCT, MNR, LIRR, and Amtrak), rather than on what makes the most sense for the project's scale and equipment. New York's subway is a 24/7 operating railroad, and the MTA's commuter rail systems also run nearly 24 hours a day while sharing track and rail facilities with Amtrak. Accessing the tracks and stations for capital maintenance for an extended period is difficult, and the length of the closures necessary to make regular progress on major expansion is nearly impossible. This lack of access has necessitated the further partitioning of projects into piecemeal tasks on which only a few hours of productive work can be completed each day — extending the duration and costs of the projects.

Access to construction sites is limited by: (1) staging area setup, (2) system shutdown — third rail, clearing stations of passengers and trains, (3) arrival time of force-account labor — flaggers, operating staff, etc., and (4) handoff of construction site from force-account labor to contractor labor, or between contractors and their unionized workforce. Construction contractors have no ability to control track and site access, which is solely controlled by the MTA or Amtrak. Both operating agencies require force-account labor be used to shut down track and power systems before allowing contractors to access the site, and for flagging. Project managers and former MTACC staff noted the inability of Amtrak to provide timely force-account flaggers for work on ESA at the Harold Interlocking during the project's narrow work windows, particularly for the electrical

and catenary works.⁸¹ Site access can be delayed either because agencies do not provide access in time to allow proper staging at their current properties, or properties must be acquired by the MTA or the city in advance of an expansion project. Contractors are compelled to bear this risk, and price their services accordingly.

Overlooked Costs in Constructability Assessments

Site conditions not being properly assessed during constructability reviews exacerbates project time lines and increases costs. Relocating water, sewer, gas, electric, broadband, cable, and telephone lines requires city permits and the participation of the utility owner or operator (DEP, Con Edison, National Grid, Verizon, Time Warner, etc.). The cost of relocation has typically been covered by the MTA's capital budget. A notable exception was the city absorbing these costs⁸² through the HYDC, and using its leverage with the utilities (franchise agreements) to negotiate better terms, for the #7 Line extension. Proposed stipulations in the most recent capital plan budget included requirements for utility owners to bear relocation costs, based on the MTA's *Reinvention Commission* recommendations.⁸³ The MTA completed a constructability review of utility site conditions for SAS, relocating most of the utilities before civil construction commenced, with the exception of the TBM launch box and a portion of 96th Street station.⁸⁴ Utility relocation adds substantial costs for transportation authorities in other U.S. cities as well. In Los Angeles, for example, the Metro Accountability Office found that understaffing at utility companies and city oversight agencies had added to project delays, and projected that advanced utility relocation — identifying the utility location early in capital planning — could be reduced by \$4.62 for every dollar spent on it.⁸⁵

Excessive Customization

Excessive customization can come into play in two ways during design and construction. Extended project planning carries a risk of overdesign, as engineering consultants seek to avoid the liability of inadequate design. With changing technology and construction techniques, preliminary engineering can easily become outdated before construction begins should planning exceed a few years. During construction, excessive customization and change orders may also add delays as operating agencies lag in meeting basic

⁸¹ Expert Interviews

⁸² It should be noted that the volume of utility work on #7 was far less than required for ESA and SAS

⁸³ New York State Government. "2016-17 NEW YORK STATE EXECUTIVE BUDGET TRANSPORTATION ECONOMIC DEVELOPMENT AND ENVIRONMENTAL CONSERVATION ARTICLE VII LEGISLATION MEMORANDUM IN SUPPORT." NY.gov. 2016. p 5: https://www.budget.ny.gov/pubs/archive/fy17archive/eBudget1617/fy1617artVIIbills/TED_ArticleVII_MS.pdf (accessed April 30, 2016).

⁸⁴ Contract C-26002, (TBM Launch box, Tunnels & 96th Station) included advance utility relocation at the north and south shafts to be used by a future contract to mine the 72nd street station. Contract C-26013, (Open-cut & Utility Relocation) relocated utilities at the north and south shaft location to be used by a future contract to mine the 86th street station.

⁸⁵ Los Angeles County Metropolitan Transportation Authority Office of the Inspector General. "Capital Project Construction Management Best Practices Study." LA Metro. February 29, 2016. http://media.metro.net/about_us/oig/images/16aud01_final_report_LACMTA_best_practices_study_02.29.16.pdf (accessed March 5, 2016).

industry standards. Much of the MTA's existing equipment — particularly signal systems — are over 100 years old and are being replaced in kind as good repair projects move forward, thus ensuring compatibility between new and old technologies will continue to be a struggle for project engineers. Striking a balance between preliminary engineering that is not overdesigned and developing maintainable systems for operating agencies — to reduce the number of change-order requests while allowing for quick resolutions thereof — can limit delays.

Also, custom equipment is often built by small manufacturers that lack the inventory to supply replacement equipment for a system as large as the MTA, or have since gone out of business altogether, thus backlogging repairs and replacement. The capital costs required for customized systems and equipment as part of state-of-good-repair investments eats into funds that could be dedicated to new system expansion.

Specialized Design and Construction Techniques

Implementing highly customized construction design and equipment in expansion projects has led to unanticipated delays. In East Side Access, for example, the portions of the tunnels adjacent to GCT were blasted from bedrock, and feature precast walls made to add finishes. The shipment of precast pieces from the staging site in Long Island City led to many pieces being damaged. Even after arrival and repair, the slight slope of the tunnel meant precast pieces did not fit together seamlessly, and the method was abandoned. Ultimately, the decision was made to finish the tunnel walls by hand. Simplifying the project design by not adding finishes to blasted tunnels, and instead leaving exposed bedrock, as was done in Stockholm, would have been simpler, cheaper, and, in the views of many users, far more beautiful.⁸⁶

Frequent Change Orders

The highly customized nature of the specifications requested by MTA's operating agencies led to an excessive number of change orders, with poor interagency coordination and staffing creating slow approvals and project delays. MTACC's project managers are not empowered to stem the flow of frequent change orders from the operating agencies: NYCT and LIRR. Within the MTA, poor intra- and inter-agency coordination on clearly defined project outcomes and lack of project controls has produced a proliferation of change orders by operators. In interviews with parties both within and outside the MTA, change orders were cited repeatedly for adding to project delays and costs. One interviewee from an international consulting firm summed the issue up, "There is no client or owner that doesn't struggle with executing timely change orders. Any change order in general is hard for clients to scope. The construction manager and contractors will complain that they turn around a

change order in 15 to 20 days, and then it sits in the operating agency for two to three months for approval."⁸⁷ In many instances, contractors are authorized to continue work on the project based on the changed scope before the change orders are approved and end up financing the added project work as they await payment from the MTA.

Specification requests or change orders are often given after the start of the project, requiring construction to proceed according to new engineering or equipment specifications. Change orders do have a place, as projects may be underdesigned during preliminary engineering. After all, "there is no 100% design" on a tunnel project, as one construction manager noted.⁸⁸ The placement of equipment that must undergo regular maintenance and inspection may be determined without concern for accessibility by operating staff. For example, fire and other emergency-management systems must be readily accessible at all times. An MTA project manager explained that the type and number of specification changes add to the costs of base materials and increase delays: "The goal should always be off-the-shelf, and not a custom design or equipment procurement. Sometimes it has to be unique, but off-the-shelf should be the goal."⁸⁹ The number of change orders on megaprojects can quickly balloon if operating agencies cannot maintain new equipment as designed by engineers. On SAS, for example, a single station (96th Street) underwent over 50 change orders in the "acceleration" phase from February to May 2016 (there were many before this phase as well) to meet the December 2016 opening deadline.⁹⁰ One MTA official noted that the high frequency of change orders matters less than their scale because they impact contractor costs, project schedule, and labor productivity. Yet this high level of change orders on a single station calls into question the necessity of special equipment to maintain cross-compatibility with older systems, and casts doubt on whether the operating agencies are sufficiently staffed to thoroughly review the preliminary engineering before construction begins. Additionally, according to the GCA, 30% of the entire SAS electrical package was modified with change orders after construction had already commenced. This affected the entire project and created years of delay.

Additionally, once projects are underway, operating agencies may not be properly staffed to process change orders. Processing time for change orders by NYCT staff can average nine months, adding to costs associated with delays, with longer time lines for more complex change orders.⁹¹ Smaller change orders up to \$10,000 can be processed by NYCT field project managers. Recognizing that the MTA is not the only agency with change-order issues, the New York Building Congress has recommended a tiered

⁸⁶ RPA. "Transit Leadership Summit – Capital Investment Priorities White Paper." *TransitLeadership.org*. 2014. <http://transitleadership.org/docs/TLS-WP-Capital-Investment-Priority.pdf> (accessed November 10, 2015).

⁸⁷ Expert Interviews

⁸⁸ Expert Interviews

⁸⁹ Expert Interviews

⁹⁰ Ibid.

⁹¹ Ibid.

approach to mitigate the long 16-month average delays by city agencies, particularly the Department of Environmental Protection.⁹²

Slow Adoption of Best Practices

Adopting innovative best practices carries substantial risk to both the contractors and the MTA. Without sufficient time and budget to test new technologies, or contingencies in place to pilot new strategies and technologies, project time lines can quickly become derailed. The unfortunate side effect is that customers, local constituents, and partners see a lack of progress on the project or poorly tested new systems prone to breakdown, making the MTA and the local industry hesitant to try another new technique that may have been successful elsewhere. The sluggish adoption of CBTC is a key example of industry standards and technological best practices being poorly funded and deprioritized in New York. Most major systems worldwide have CBTC. The world's oldest subway systems, London and Paris, are rapidly converting to CBTC, with full implementation anticipated by the 2030s. And San Francisco's MUNI has fully converted to CBTC in the past decade. The MTA has implemented CBTC technology on under 3% of the system, with the L Train (Canarsie Line) CBTC-operational and the #7 (Flushing Line) currently undergoing testing.⁹³ Due to underfunding, there is no clear timetable for fully implementing CBTC system-wide — while both London and Paris have plans to completely upgrade their systems to CBTC over the next 20 years.

The lack of sufficient budget and time to pilot best practices hinders the development of the construction practice within the MTA, though MTACC has made strides employing risk assessment to identify the uncertainties associated with technological change to qualify for FTA funding. Yet the current method of project planning and design as part of the five-year capital plan does not allow for a range of values to be used in the MTA's budgeting.⁹⁴

Construction Management

Good construction managers can reduce costs by minimizing delays from change orders, effectively marshaling resources to address physical site issues revealed during construction, and focusing on discrete goal-oriented outcomes. Contractors prefer responsive and efficient agency construction managers who are effective at motivating and managing resources within the MTA, to deliver specifications on time and within scope. The ideal construction

manager provides timely decision-making, thoroughly addressing issues that arise over the course of construction and mitigating before the next phase of tasks.⁹⁵

Overall construction management needs to focus on goal-oriented outcomes, minimizing the hyper-customization and overdesign of systems⁹⁶ that are based on specific and sometimes outdated needs of agency operators and their subdivisions. The lack of vertical integration within the MTA, with six different service operators — each with multitudes of subdivisions — adds to the complexity of construction management and fosters a fractured process for project design and implementation. The refusal of different operators to share assets, rights-of-way, and resources, for example, creates a scarcity of labor for specific tasks, and does not promote cross-fertilization of ideas to develop best practices in design and engineering. The lack of internal MTA coordination across operating divisions bleeds into capital project management and is complicated further as project managers must coordinate multiple parties within and outside the MTA. A GCA representative summarized the problem: “There is a tremendous lack of internal coordination among the various divisions within the agencies and between an individual agency and MTA HQ. The contractor thinks that it is dealing with the project manager decision-maker, but the reality is that the project manager is regularly overruled and contradicted by the station's department, maintenance-of-way personnel, signal personnel, and others. In fact, as the contractors are trying to wrap up Second Avenue, a frequent response from the MTA has been that the project manager did not have the authority to make the decision the contractor had relied on. However, the contract provisions designate the project manager as the party to whom the contractor is responsible. If the MTA is serious about getting its costs under control, it will implement organizational reform to eliminate the ability of multiple departments being able to opine on and overrule decisions made by others.”

Complex Procurement Processes

The MTA's procurement process is overly complex and time-intensive. The agency disaggregates its contracts instead of bundling them, a vestige of bygone statutory requirements and the desire to attract a more diverse group of contractors to bid for the work (minority and/or women-owned business enterprises or MWBE requirements), and still relies predominantly on design-bid-build for its capital projects — adding a year or more to procurement. It also imposes some of the construction risks on the contractor, which results in higher bids. Yet, the MTA continues to employ one of its most outmoded procurement practices: typically selecting contractors based on lowest qualified bid rather than best value.

⁹² New York Building Congress. “Improving the Change Order Process.” *New York Building Congress*. N.d. <https://www.buildingcongress.com/eupdate/pdf/Change-Order-Process-Improvements.pdf> (accessed November 5, 2017).

⁹³ RPA. “Moving Forward: Accelerating the Transition to Communications-Based Train Control for New York City's Subways.” *Regional Plan Association Library*. 2014. <http://library.rpa.org/pdf/RPA-Moving-Forward.pdf> (accessed November 10, 2015).

⁹⁴ MTA. “MTA Blue Ribbon Panel for Construction Excellence Final Report” *MTA Info*. March 2008. http://web.mta.info/mta/pdf/BluRibPanel-Const_Excellence.pdf (accessed May 30, 2016).

⁹⁵ Ibid.

⁹⁶ Ibid.

MTA Owner Controlled Insurance Program (OCIP)

The MTA is limited to using the Owner Controlled Insurance Program (OCIP), which only provides risk-sharing between the owner and the contractor (including its subcontractors of every tier). It may also provide limited coverage to construction management consultants acting on behalf of the owner. The current risk-sharing is only used for worker injuries (workers compensation), bodily injury and property damage to third parties (general liability), and damage to or loss of property under construction (builders' risk). Auto coverage is excluded. Liability for errors and omissions (professional liability) is not available in U.S. market as an OCIP product. **There is no OCIP coverage for construction delays, penalties, or fines.**

The use of OCIP at the MTA is not universal and is only applied to selected projects. For MTACC, OCIP covers East Side Access and phase one of the Second Avenue Subway. For the MTA Capital Program, the list of OCIP projects is negotiated with each agency (NYCT, LIRR, MNR) at the onset of the project. MTA Bus and MTA Bridges and Tunnels are not eligible for OCIP.

The OCIP has been successful in the difficult New York construction liability market. Part of this success stems from fighting claims instead each other. It is much easier to defend a claim when only one party is at the table with the plaintiff. So long as the owner agrees to accept the liability, the MTA's experience to date has been the contractor and their subcontractors no longer taking great interest in defending the claims. The MTA and OCIP insurance carrier will seek contributions from responsible parties not included on the OCIP, such as design engineers, fabricators, and suppliers.

Low Bid versus Best Value Procurement

MTA's preference to select the lowest bidder has resulted in excessive rebidding and/or teams that cannot deliver the bid being selected, ultimately costing millions of dollars in emergency repairs. ESA is the most extreme example of this, with the MTA losing time and money on contractors that failed to deliver because they underbid or were unqualified. This indicates that in practice the MTA does a poor job of evaluating risk and selecting the best procurement method for projects. The MTA is too easily swayed by bid price and does not use the tools at its disposal to disqualify low bidders. In fact, while the MTA is authorized by the NYS Public Authorities Law to use best-value procurement, it still *chooses* to predominately use lowest-bid procurement. The MTA could change its practices without legislative action.⁹⁷ The MTA has also broken up contracts when bids were viewed as too high, resulting in no savings plus significant delays and costs. Other agencies around the globe evaluate bids on best value, prequalifying contractors on their competency and performance, including on-time delivery. Bids are then scored based on the criteria and their creativity, cost being just one of several factors evaluated.

Risk is Not Shared by Public Sector

"Risk is money," commented a major contractor, pretty much speaking for his profession.⁹⁸ The MTA's current contracting procedures put much of the responsibility for delays on contractors, requiring them to pay for overages for "authority-provided services," including flaggers, site access, and permits for train movements. The MTA responded to this criticism by providing RPA with the terms and conditions of the East Side Access contract. It is important to note RPA only received this level of detail for ESA; the risk might have been handled differently in the MTA's other contracts. The ESA contract's terms and conditions section outlines a series of criteria for *Excusable and Compensable Delays*, stipulating that the MTA only compensates the contractor if the delays qualify and specified conditions are met. Closer examination of the document, however, confirms much of what RPA learned from various contractors, which is that most risk falls on contractors, with MTA only sharing risk in narrow circumstances.

⁹⁷ Section 1265-a Contracts, Subdivision 4 states that the authority may, by resolution approved by a two-thirds vote of its members then in office, or by a majority vote of its members with respect to contracts proposed to be let pursuant to paragraph (a) of this subdivision declare that competitive bidding is impractical or inappropriate because of the existence of any of the circumstances hereinafter set forth and thereafter the authority may proceed to award contracts without complying with the requirements of subdivision two or three of this section. In these cases, paragraph (f) states that when the authority determines that it is in the public interest to award contracts pursuant to a process for competitive requests for proposals as hereinafter set forth. For purposes of this section, a process for competitive requests for proposals shall mean a method of soliciting proposals and awarding a contract on the basis of a formal evaluation of the characteristics, such as quality, cost, delivery schedule and financing of such proposals against stated selection criteria. This is the best-value selection method that is used by MTA when appropriate.

⁹⁸ RPA. *The High Cost of Construction in New York City*. May 1, 2011. Internal Report.

While the MTA will excuse some forms of delay, meaning they will not penalize the contractor for missing a deadline, it will not compensate force-account delays, such as Amtrak's inability to provide a sufficient workforce at Harold. This also applies to delays caused by authority-provided services, which again are excusable but not compensable delays. The MTA will compensate contractors for site-access constraints and stop-work orders, but only when the contractor can demonstrate that it will affect the "contract substantial completion date." Unlike its international peers, the MTA does not seem to play an active role in controlling risk comprehensively, nor does it undertake complete extensive project risk-management analyses. Crossrail Ltd. and Transport for London staff, for example, described extensive premortem processes for megaprojects, such as reducing scope to deliver projects on budget and on time.⁹⁹ Within MTA's current system, contractors are exposed to risk for project elements that are beyond their power to affect. Based on interviews with a former MTA director, contractors will claim over 20% of their costs are due to risk related to an operating agency's failure to deliver site access and/or general orders for project work, while operating agencies counter that number is less than 10%.¹⁰⁰ How contractors price construction work is directly related to the notoriety of operating agencies that delay delivering change orders, general work orders, and/or site access. Contractors maintain that the additional costs these changes and delays create are borne solely by them and that they are not compensated by the MTA for these losses (the MTA disputes this, stating contractors could petition for an *Excusable and Compensable Delay* in certain instances).¹⁰² Other interviewees, however, said contractors are finessing their bids to account for costs associated with the higher risk burden, or, alternatively, are using the change-order or dispute-resolution process to recoup costs due to failed risk-management strategy.¹⁰³ All of these actions are legal, and the lack of proactive risk management and inadequate risk-sharing further exacerbate delays and incidental costs.

Additionally, land for ancillary facilities is acquired by the city, state, or MTA, and delays in delivering sites further expose contractors to risk. Contractors either respond by building these anticipated delays into their labor costs estimates or face additional delays and cost overruns by requesting change orders.¹⁰⁴ Contractors may be able to recoup some expenses as impact costs, which are "costs for specified types of excusable delays." These include broader provisions for failure to provide access to the work site, or issuance of stop-work orders or change orders. Impact costs are liquidated at a flat fee for negotiated procurement contracts.¹⁰⁵ Flagging "authority-provided services" over-

ages and permit-swapping for train diversions and work trains can enable special conditions to negotiate the risk, but this depends on the operating authority. NYCT signal contracts, for example, have considerable risk mitigation to accommodate the contractor's need for constant access to the right-of-way, but Metro-North imposes an outright "No Damage for Delay" policy.

Two competing perspectives to pricing project costs and associated risks are at odds with current procurement. Design and engineering consultants typically price projects either at a low cost before site constructability is fully assessed, or they recommend construction methods that may be costly and in excess of what is needed, either because they are unaware of more recent techniques or to minimize their risk exposure and liability. Construction contractors, on the other hand, may submit higher estimates because they anticipate project delays driven by limited site access, multiple change orders, and little control over tasks delegated to MTA's force-account labor. Given the constraints of the project design process, the misalignment of design and constructability estimates, and improperly apportioned risk, contractors may be submitting higher bids across the board, given their share of risk is disproportionate.

Piecemeal Procurement

Project delays can also be attributed to piecemeal procurement, affecting overall project design and construction. MTA capital construction projects are planned, designed, and contracted in phases, and awarded across multiple consultants and contractors. The MTA's procurement bundles multiple components together as prime contracts based on industry classifications defined by New York State Law, with construction contractors bidding on each prime contract. Though the MTA is not required to bid projects based on the Wicks Law, its procurement process appears to function in a similar way. A state law passed in 1924, Wicks requires every publicly funded project over \$50,000 be broken into four separate contractual bids for the building trades, one each for civil construction, electrical, HVAC, and plumbing. Under MTA procedures, systems for electrical, HVAC, and communications are individual bids separate from civil construction tasks such as tunneling and station construction.¹⁰⁶ Each bid is also assessed by the MTA and submitted by the agency to an independent cost assessor. This contracting environment functions as if Wicks applied to the MTA.

In 2008, the NYS legislature amended Wicks, fully exempting public agencies using Project Labor Agreements (PLAs) from bidding contracts separately, though there are still bid-shopping protections preventing prime contrac-

⁹⁹ Expert Interviews

¹⁰⁰ Ibid

¹⁰¹ The MTA has informed proposers for the recent LIRR third track project that they should assume 15% for risk of cancelled/delayed track access.

¹⁰² Ibid

¹⁰³ Expert Interviews

¹⁰⁴ MTA. "MTA Blue Ribbon Panel for Construction Excellence Final Report" *MTA.Info*. March 2008. http://web.mta.info/mta/pdf/BluRibPanel-Const_Exc-excellence.pdf (accessed May 30, 2016).

¹⁰⁵ Ibid.

¹⁰⁶ MTA. "Eye on the Future." *MTA.Info*. September 23, 2016. http://web.mta.info/mta/capital/pdf/eotf_0916_0817.pdf (accessed September 30, 2016).

tors from disclosing a trade contractor's price for project tasks.¹⁰⁷ The MTA, however, has not employed PLAs in its capital construction projects.

The industry pretty much agrees the design-bid-build system of bringing the general contractor to the team post-design provides little or no opportunity for the contractor to offer practical construction advice on the options being presented. This is one of several reasons some projects have undergone multiple bid cycles.

A new bid cycle for the same project may be initiated for a specific trade contract or consultant task, or for subtasks, because:

- ▶ Financing was insufficient for the final project scope.
- ▶ Tasks were not delivered on time or the project scope was incomplete.
- ▶ Bids came in higher than expected.
- ▶ Technical consultants and construction contractors may submit over-budget bids because of a high demand for their services, the burden of potential risks imposed by the built environment, customization requests originating with operating agencies, or a project manager's apparent lack of technical ability.¹⁰⁸

Currently, some cost overruns on MTA megaprojects are to be covered by the contractor, which include costs incurred due to delays on the MTA's behalf. The contract for ESA, however, provides for excusable and compensable delays if the contractor meets a handful of prerequisites.

Labor Practices and Work Rules

Labor practices in New York City are not standard. The one-off process used to build infrastructure has been borrowed from the private sector, where a building goes up, the project is over, and the team disbands. This is distinctly different from transportation infrastructure in which capital projects are linked into existing systems. Transit megaprojects require streamlined labor and project processes to limit impacts on the operating system as a whole. New York does not have a process for long-term infrastructure development, nor does it have a pipeline of capital projects to sustain labor.

New York's unionized construction industry is fractionalized, with the MTA akin to a building owner/developer. At the same time, the MTA is also the construction manager that can tap into its own unionized workforce to build capital projects, particularly for state of good repair (SOGR).

The core issues with the existing labor environment are:

- ▶ Lack of distinction between operating and force-account labor
- ▶ Work rules that complicate work scheduling, increase costs for nights and weekends, impede introduction of new technology, and are out of sync with worldwide industry standards
- ▶ Workforce specialization (lack of job flexibility), lack of training capacity, and inadequate project pipelines lead to labor shortages, particularly during accelerated phases of megaprojects
- ▶ Disproportionate burden on infrastructure project costs from the U.S. health care system.

All of these factors drive up costs, resulting in an inefficient use of labor.

MTA Capital Maintenance Workforce on Megaprojects Increases Delays and Costs

The MTA's own unions also have narrowly defined roles governed by specific work rules on staffing. Megaprojects mandate force-account labor, which is recruited from the operating agencies' labor pool, such as LIRR track flaggers working on ESA, or NYCT engineers designing specification orders for the SAS or the #7. This labor is primarily drawn from the Transport Workers Union and agency unions that include operating engineers, track flaggers, and much of the planning and operations staff of NYCT, LIRR, and MNR. All worksites require force-account laborers, including track flaggers, to arrive before a task can begin. Additionally, operating agency staff submit specification design orders and undertake inspections of system components for capital projects, billing their time to MTACC's budgets. Labor recruited from the operating, engineering, and design staffs can blur the distinction between operating tasks and capital programming.

Work Rules Not Keeping Pace with New Techniques and Technologies

With labor constituting a large proportion of construction costs,¹⁰⁹ (in the case of ESA and #7 line between 22% and 83% of construction costs, depending on overtime rules), efficient deployment is a key consideration. While the private construction sector has moved increasingly to an open-shop mix of union and nonunion labor, the MTA uses only unionized labor for its megaprojects, despite not being legally required to do so. While not completely comparable to public works on large infrastructure projects, open-shop contractors in the private sector are known to come in at rates 20-30% below union shops.¹¹⁰ The difference, say some contractors, is not due to lower wages and benefits, but to the absence of rigid work rules that impede project delivery and drag down productivity.

¹⁰⁷ NY State Department of Labor. "WICKS Reform 2008." 2008. <https://labor.ny.gov/workerprotection/publicwork/PDFs/WICKS%20Reform%202008.pdf> (accessed May 10, 2016).

¹⁰⁸ Expert Interviews

¹⁰⁹ RPA. "Transit Leadership Summit – Capital Investment Priorities White Paper." *TransitLeadership.org*. 2014. <http://transitleadership.org/docs/TLS-WP-Capital-Investment-Priority.pdf> (accessed November 10, 2015).

¹¹⁰ Cohen, Hope. "The high price of union construction: Fix work rules or jobs will vanish." *The New York Daily News*, April 29, 2011: <http://www.nydailynews.com/opinion/high-price-union-construction-fix-work-rules-jobs-vanish-article-1.109244>

Table 8: Conditions When Overtime Wage and Benefit Rates Apply

Trade	Weekday Shift		Weekday Shifts beginning		Saturday Shifts	Sunday Shifts	Shifts worked on Holidays
	greater than 7 hours	greater than 8 hours	after 4:30pm	after 5 pm			
Cement and Concrete Worker	Xa			X	X	X	Not mentioned in 220 Schedules
Latherers - Metallic Lather	Xb	X		X			Not mentioned in 220 Schedules
Operating Engineer (Road and Heavy Construction XVI)		X		X			X
Carpenter - Heavy Construction Workc		X	X		Xd	X	Not mentioned in 220 Schedules
Electrician	X		X				Not mentioned in 220 Schedules
Sandhog Tunnel Worker (TBM)	X				X	X	X
Sandhog Blasters/Muck Machine Operators (TBM)	X				X	X	X
Sandhog Tunnel Worker (non-TBM)	X				X	X	X
Sandhog Blasters/Muck Machine Operators (non-TBM)	X				X	X	X
Ironworker – Structural		X	X		X	X	Not mentioned in 220 Schedules

a. On shift work extending over a twenty-four hour period, all shifts are paid at straight time.

b. Overtime rates are based on workday shift agreement prior to the start of a job. "Overtime would be time and one half the regular rate after a seven (7) or eight (8) hours workday, which would be set at the start of the job."

c. The 220 Schedules are not explicit that overtime shift scheduling or time periods also increase the benefits paid hourly to Carpenters (Heavy Construction Work).

d. Saturday may be worked at straight time to make up for weekday shift cancelled due to inclement weather.

Source: Office of the Comptroller, City of New York

Trade unions working in capital construction include everything from the sandhogs, who excavate the tunnels, to electricians, plumbers, and engineers. Union work-rule restrictions typically include:

1. The number of hours per shift (typically eight), including travel to the job site from the surface head house
2. Specific tasks to be completed by each trade
3. Number of laborers needed for construction tasks

New York work rules have evolved over the course of the 20th century to address the abuses of excessive work weeks that were substantially longer than today's standard 40 hours, unsafe and unhealthy conditions with no occupational safety standards, and high risks of injury. As unions formed to protect worker safety, compensation, and professional development, they further defined roles within the construction trades — a practice tracing back to the medieval guilds. While distinctions in tasks allowed for specialization, the narrow definitions of work rules for each trade union has undermined efficiency, impeded the use of new technology, and increased costs.

The history of construction in New York, whether public or private, is a history of conflict for many reasons: The amount of capital invested is stupendous and the returns potentially huge, the logistics are daunting, labor is highly paid but also dirty and dangerous, government's regulatory agencies are involved every step of the way, and, increasingly, neighborhoods effectively oppose change.

Union contracts can assert authority over areas once considered management's, such as hiring decisions, production schedules, deliveries of construction materials, and work rules. Any dispute between management and a union, or between two or more unions, can halt a project, costing time and money.

Disputes between unions happen because construction workers represent many different trades, including carpenters, electricians, masonry workers, HVAC technicians, and plumbers. Who does what job is determined by collective bargaining agreements. These agreements can also mandate jobs, such as Local 14's master mechanics, who must be present at any construction site that has five or more pieces of heavy equipment, or Teamsters Local 282 foremen, who patrol construction sites to ensure only union drivers enter.

Expensive changes can also come from government-imposed reclassifications, such as the 2015 ruling by the Department of Labor that pedestrian traffic managers, commonly called flaggers, at a lower Manhattan worksite were construction laborers, not traffic-control agents. In threatening New York City with a civil-rights action, given that many pedestrian traffic managers were females and minorities, the administration also imposed the ruling on East Side Access workers. The salary jump at the time was roughly \$30,000 annually per pedestrian traffic manager.¹¹¹

¹¹¹ Gelinas, Nicole. "DC's threats to New York work." The New York Post, April 12, 2015: <http://nypost.com/2015/04/12/building-block-dcs-threats-to-ny-work/>

The essential document of management-labor relations is the collective bargaining agreement (CBA) between contractor and union. RPA recently obtained an electrical union CBA containing 29 sets of rules, many with subsections.¹¹² These rules included:

- ▶ There must be a supervisory union foreman, who gets paid by the employer.
- ▶ All emergency overtime must be approved by the business manager's office of the union.
- ▶ When a day shift is worked, the second or third shift must employ at least 25% of the number of electricians as the day shift.
- ▶ Work performed Saturdays, Sundays, and holidays is paid at overtime rates regardless of the number of hours previously worked.
- ▶ There is a mandatory ratio of apprentices to journeymen regardless of the employer's assessment of need.
- ▶ On live electrical work of 440 volts or over, two journeymen must be employed.
- ▶ All temporary light and power is under jurisdiction of the union.
- ▶ Off-loading and handling of deliveries of electrical materials and tools at a job site are under the jurisdiction of the union.
- ▶ Journeymen electricians are to stay on-site to supply power to tunnel boring machines or other equipment.
- ▶ All workers must start and end the work day at the shanty.
- ▶ A mandatory union superintendent is to be employed on jobs over \$500,000.

In addition to the variability in work rules, the application of standard pay rates is also highly mutable among trades, with overtime and premium wages being activated at different points (Table 7). Premium wage and benefit rates, roughly 50 to 100% higher based on NYC 220 Prevailing Wage Schedules, apply frequently to projects adjacent to active rail rights-of-way. Most service disruptions are planned for evenings and weekends when premium rates apply to nearly every trade, regardless of whether a 40-hour workweek has been met.

A GCA spokesperson argued overtime reform would be impractical: "The construction industry, like many others, does not have flexible schedules that allow a worker to work 12 hours one day, to have a day off later in the week, to work a total of 40 hours over a limited number of days. For construction, that requires a consistent level of staffing commensurate with the tasks being performed. Flexible schedules are not workable. Academically, floating sched-

ules may appear to save money. Realistically, a construction crew needs to have all of its members working on the same hours and the same schedule."

Each trade union typically covers only specific tasks unique to their trade. These jurisdictions go back to the New York Plan — first established in 1903 but often amended, with an updated arbitration agreement in 2012.¹¹³ While central electrical wiring, for example, is installed by electricians, wiring into the primary electrical systems for HVAC and communications is subsequently done by two different trades. Each task is covered under multiple contracts to reflect the jurisdictional divisions among the trade unions. There are exceptions. Electrical wiring in the tunnels, for example, is handled by sandhogs rather than electricians.¹¹⁴

Technological advancement has increased mechanization and reduced the need for heavy manual labor, thus allowing for greater workforce flexibility. While today's highly skilled workers are capable of assuming multiple roles, few advances have been reflected in work rule changes.

In the case of tunneling, the older compressed air shield and cut-and-cover practices, which require far larger crews, have mainly been supplanted by tunnel boring machines (TBMs). The TBM drills, feeds muck and spoils to the back of the machine, and lays precast interlocking concrete forms for the tunnel — processes managed by trained operators inside the TBM. Because the workers are inside the TBM, compressed air isn't needed, thus lessening exposure to hazards when transitioning between compressed and free-air environments.

Yet New York crew sizes retain the same high numbers as this bygone era, unlike other global cities. OHL Construction project managers (and their subsidiary Judlau) said in an interview that they must use 20 person crews on TBMs in New York due to union work rules, while in Poland and Spain they use crews less than half that size.¹¹⁵ In equally dense London, with softer soils and centuries-old subterranean utilities, Crossrail's TBM crews are 15 people.¹¹⁶ Nearly a dozen interviewees confirmed the large New York crews affecting all tunneling jobs — even those using modern precast equipment, such as the #7. This is one example where technology has improved the construction environment and safety for the workforce, without the benefit of lowering a megaproject's costs or enhancing the schedule. Given its inflated TBM crews, particularly when the additional workforce could be shifted to other tasks, the MTA has realized few gains in tunneling efficiency.

¹¹² Source: AGREEMENT by and between NEW YORK ELECTRICAL CONTRACTORS ASSOCIATION, INC. and the ASSOCIATION OF ELECTRICAL CONTRACTORS, INC.

¹¹³ New York City Building Trades Council. "The New York Plan for the Settlement of Jurisdictional Disputes." 2012. [http://www.nycbuildingtrades.org/newspdf/ny_plan_2012%20\(1\).pdf](http://www.nycbuildingtrades.org/newspdf/ny_plan_2012%20(1).pdf) (accessed May 20, 2016).

¹¹⁴ Expert Interviews

¹¹⁵ Ibid.

¹¹⁶ Ibid.

Task Specialization, Limited Training Capacity, and Inadequate Project Pipelines Contribute to Inconsistent Labor Supply

The combination of jurisdictional divisions of labor into highly specialized tasks by occupational role and workforce requirements that are based on older technologies has exacerbated a scarcity of labor at times of high demand. A 2008 report by Carter & Burgess for the MTA, *Blue Ribbon Panel for Construction Excellence*, correctly forecast that by 2011, at the peak of MTA's capital construction programs, there would be a deficit of skilled lathers and sandhogs, and perhaps other trades as well. One MTA representative noted the difficulties of filling second and third shifts for work to keep subterranean construction going around the clock for the megaprojects, a shortage that was particularly acute during the acceleration phase of SAS.¹¹⁷

Heated national debates about labor shortages in construction, manufacturing, and health care in 2017 had been preceded years before in New York by forceful discussions of labor shortages in construction. Beginning in 2009, as developers and contractors started looking forward to a revival in construction, they noted a disturbing trend: Older skilled workers had been leaving construction.¹¹⁸ And because union construction jobs come with high pay and good benefits, this carried serious ramifications for New York's future. A shortage of skilled construction workers could slow both the private economy and the government's productive construction of infrastructure.

And while no publicly released study has ever been done on the interrelationships of the private and public construction labor markets in New York, both private and public officials say off the record that the markets move in tandem, with wage and benefit pressures in one market affecting the other. This was born out by a national survey of its members by the Associated General Contractors of America, which concluded that nearly 80% of construction contractors, both private and public, have been facing difficulties finding skilled labor.¹¹⁹

Similarly, in a new commercial construction index developed by Dodge Data & Analytics for the U.S. Chamber of Commerce, 66% of contractors said they expected to employ more workers in the second six months of 2017, but 61% reported difficulty hiring skilled workers.¹²⁰ The largest shortages were in concrete, masonry, electrical and plumbing trades, and millwork.

A 2016 study by the Conference Board attributed the tightening of the national labor market to, first, the retirement of large numbers of baby boomers and, second, a slowdown in labor productivity to just 0.5% annually, rather than the 2 to 3% annual growth before the 2008 recession.¹²¹ The Conference Board believes shortages will worsen over the next 15 years as highly skilled older workers leave the market and are replaced by unskilled younger workers, or not at all. The one hopeful note is the Conference Board's belief that there has been a "significant recovery" among 25-to-34-year-olds. Generation Z, however, is smaller than the Millennial generation, which suggests there will be little or no growth over the next 15 years in the country's working-age population.

Contractors in New York have recruited workers from around the country to fill skilled workforce vacancies. Both the General Contractors Association (GCA) and the Building Trades Employers Association (BTEA) have begun implementing workforce-training programs in partnership with unions and community colleges to address the shortage.¹²² Yet New York has a more restricted training program than cities like London. In large part because of state-imposed restrictions, the only significant construction-skills program is the Edward J. Malloy Initiative for Construction Skills, created by unions and union contractors in 2001. A report by Columbia University's School of International and Public Affairs, "Expanding Opportunity for Middle Class Jobs in New York City: Minority Youth Employment in the Building and Construction Trades," calls it "the most successful construction industry pre-apprenticeship program in the country, based on a review of placement data of pre-apprenticeship programs in other cities." Yet the numbers are modest. In the 13 years covered by the study (2001–2014) the program placed 1,442 graduates into union apprenticeship programs. Of these graduates, 80% have continued as union apprentices or journeyman workers. No figures are given for how many go onto full-fledged union construction jobs, although the report projects the construction industry will add some 14,200 new jobs over the next few years at an average annual wage in New York of \$67,110.

Other training programs are ad hoc and based on per project design and engineering.¹²³ Making matters worse, the lack of a steady project pipeline for infrastructure provides little incentive to maintain a sufficient labor force for large infrastructure projects whose time lines are driven by inconsistent political and funding cycles.

In reviewing RPA's draft report, the MTA remarked that shortages of skilled labor drive up their costs, noting "New York has been experiencing an overheated construction

¹¹⁷ Expert Interviews

¹¹⁸ Julia Vitullo-Martin and Hope Cohen, *Construction Labor Costs in New York City: A Moment of Opportunity* (New York: Regional Plan Association) May 2011.

¹¹⁹ Associated General Contractors of America. "2015 Workforce Survey Results: National Results." 2015. https://public-gazfnvk.netdna-ssl.com/wp-content/uploads/2015/11/2015_Workforce_Survey_National.pdf?x64028 (accessed July 20, 2017).

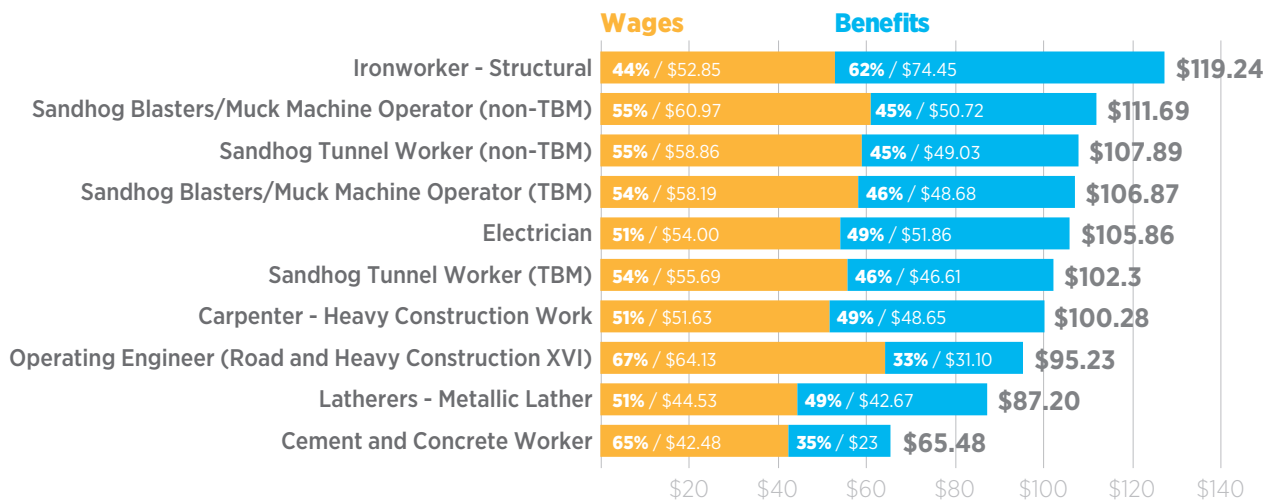
¹²⁰ Commercial Construction Index (New York: USG + U.S. Chamber of Commerce) 2017.

¹²¹ *Labor Shortages are Coming: The When and Where* (New York: The Conference Board) 2016.

¹²² MTA. "MTA Blue Ribbon Panel for Construction Excellence Final Report" MTA.Info. March 2008. http://web.mta.info/mta/pdf/BluRibPanel-Const_Excellence.pdf (accessed May 30, 2016).

¹²³ Expert Interviews

Figure 18: NYC Prevailing Wage Rates for Applicable Subway/Rail Construction Trades (July 2016 – June 2017)



Source: NYC and NY State Department of Labor Prevailing Wage Rates

market for quite some time, with new record highs for construction spending every year. This causes a loss of market competition and shortages of skilled construction labor, and project management personnel that are overstretched.”

Health Care and Pension Costs Higher than International Peers

Project labor rates also include benefits, with union health care, pensions, dues, and training bundled within labor rates by trade. This increases the complexity of comparing project costs to international peers whose benefit programs are typically funded through national health and pension plans.

The variability in benefit rates (health care and pensions) for trade unions can range from 35 to 62% of prevailing wage rates (Figure 18). Benefit rates for consultant labor are completely opaque, without any public records reported. For the MTA’s own workforce, an analysis by Moody’s found that operational costs are twice Paris’s RATP and 40% more than TfL’s. Much, but not all, of this delta is directly due to the MTA’s health care and pension burdens, which are 32% of labor costs, while the French government bears these liabilities and TfL has defined-benefit pensions and government-provided health care. Moody’s concluded that TfL’s pension liabilities are 5% of operating expenses while the MTA’s are more than double at 11%. The Moody’s research team stated outright, “Given the systemic nature of the factors driving these differences, the cost differentials between the three will remain.”¹²⁴ The MTA’s workforce on capital projects will reflect these higher health care and pension costs compared with international peer projects.

The high cost of health care in the United State and the direct burden of these costs on the budgets of infrastructure projects increases costs overall. Countries without a highly privatized system for health care and retirement like the U.S. have lower infrastructure costs. The cost of health care and retirement benefits are largely disassociated from infrastructure budgets, and predominately financed through higher income taxes with lower employer contributions.

¹²⁴ Bergman, Elizabeth, Nicholas Fintzel, and Baye B. Larsen. “Moody’s: New York’s MTA debt profile, governmental support distinguish it from London, Paris counterparts.” Moody’s. March 10, 2016. https://www.moody.com/research/Moodys-New-Yorks-MTA-debt-profile-governmental-support-distinguish-it-PR_345455 (accessed April 10, 2016).



Project Labor Agreements

Photo: MTA / Rehema Trimiew

A series of project labor agreements (PLAs) initiated in New York in 2009 as developers were reeling under the global economic crisis sought to offer contractors savings, efficiencies, and higher productivity in return for guaranteeing the use of unionized labor. PLAs, which incorporate by referencing existing collective bargaining agreements (CBAs) of all signatory unions, establish the rules and conditions of employment for individual construction projects or classes of projects within a stated period.¹ The City of New York (2008) and the State of New York (beginning in 1997) negotiate PLAs with labor unions for major infrastructure projects — setting wages, hours, and work rules before a project is bid on by contractors. Since 1992, the use of PLAs for federally funded projects, including MTA capital projects, has shifted between being banned or encouraged by presidential executive orders, depending on the sitting president.² As such, the MTA has not employed PLAs in their contracting. The potential to reduce the time and expense for multi-contract procurement is under review by the MTA's staff, and the savings from removing the additional steps to procuring a cost assessment consultant for each prime contract could be substantial. The research on cost reductions with PLAs is mixed, however.

The core objectives of a PLA are to ensure the hiring of local union workers, avoid strikes through clear dispute-resolution arrangements, define wage/benefit rates over the course of the project, and set specific work hours, schedules, and overtime rules. The end goal of these objectives is to save time and money with a PLA.

Studies on the effectiveness of PLAs in bringing down costs and delays have reached opposite conclusions, with both opponents and proponents of PLAs weighing in. While no research has been done on the cost savings attributable to PLAs for transit projects in New York State or the region, some research has been carried out on building costs in other fields. Boston's Beacon Hill Institute, for example, found PLAs did not produce cost savings for school construction, concluding that school capital projects with PLAs in New York City cost \$17.08 more per square foot.³ The Cornell School of Industrial and Labor Relations, on the other hand, estimated cost savings due to work-rule changes at \$2 million over the life span of a package of government building contracts in Orange County, New York.⁴

Evaluations of the realized benefits of PLAs after a project's completion are rare. Rarer still are comparisons of early estimates of PLA costs savings versus actual performance. Sound Transit in Seattle evaluated the effectiveness of its PLA after its Sound Move capital projects for light rail and commuter rail were complete. Due to substantial changes in scope and time lines (nine versus seven years for the Central Link LRT), only half of the \$2 billion project portfolio had data that could be evaluated within the PLA. Thus, analyzing the PLA's actual savings in cost and time was not possible.

While wages and benefits change twice yearly under most states' prevailing wage laws to account for inflation and cost-of-living increases, Sound Transit's consultant found these costs inaccessible, concluding that jurisdictionally based cost savings were not quantifiable.⁵ Additionally, the study found that acquiring data on cost savings related

¹ Vitullo-Martin, Julia, and Hope Cohen. "Construction Labor Costs in New York City: A Moment of Opportunity." Regional Plan Association Library. 2011. <http://library.rpa.org/pdf/RPA-CUI-Construction-Costs.pdf> (accessed February 1, 2016).

² Use of PLAs was not permitted for federal projects beginning in 2001 by Executive Order 13202, first signed by President George W. Bush. In 2009, restrictions set by Executive Order 13202 were repealed by Executive Order 13502 signed by President Barack Obama, which strongly recommended the use of PLAs in all federally funded infrastructure projects.

³ Bachman, Paul, and David G. Tuerck. "Project Labor Agreements and Public Construction." *The Beacon Hill Institute*. April 2006. <http://www.beaconhill.org/BHStudies/PLA2006/NYPLAReport0605.pdf> (accessed June 30, 2016).

⁴ Kotler, Fred B. "Project Labor Agreements in New York State: In the Public Interest." *Cornell University Industrial Labor Relations School*. March 2009. <http://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=1021&context=reports> (accessed June 30, 2016).

⁵ Agreement Dynamics. "Sound Transit Project Labor Agreement Study." *Sound Transit*. 2011. <http://www.soundtransit.org/sites/default/files/documents/pdf/about/plareport12111.pdf> (accessed June 20, 2016).

Table 9: Estimated Cost Savings with Sound Transit’s PLA

Cost Savings Measure	Description	Estimated Cost Savings (millions)
No organized breaks		\$1,496
Higher utilization of apprenticeships	Estimate based on apprenticeship utilization rates split between 80% union and 20% nonunion. Averaged \$8 per hour worked	\$941
No crew size restrictions	Resulting in 4–8 fewer foremen required for contracts	\$126 to \$252
No strike/no lockout	Fewer and less impactful strikes; four strikes during project period, lasting only 74 days	Not quantified
Jurisdictional dispute resolution		Not quantified
Cost Increases		Estimated Additional Costs
Shift differentials/shift premium wage and benefit requirements	Union shift premiums applied to nonunion workforce’ estimate based on 5–20% of total work hours on 2nd shift	(\$112) to (\$449)
Show-up/Reporting Pay Requirements	Show-up pay was applied to nonunion workforce Estimate based on 1–5% lost work days rate	(\$89) to (\$447)
Sound Transit reimbursement of dual benefits	Reimbursement of dual benefits for benefit packages paid out to nonunion workers to be on par with union workers	(\$256)
Prevailing wage escalation	Wage escalation over 9-year time line of projects	Not quantified
Estimated Net Savings		\$1,411 to \$2,232

Source: RPA Summary of [Sound Transit Project Labor Agreement Study \(2011\)](#)

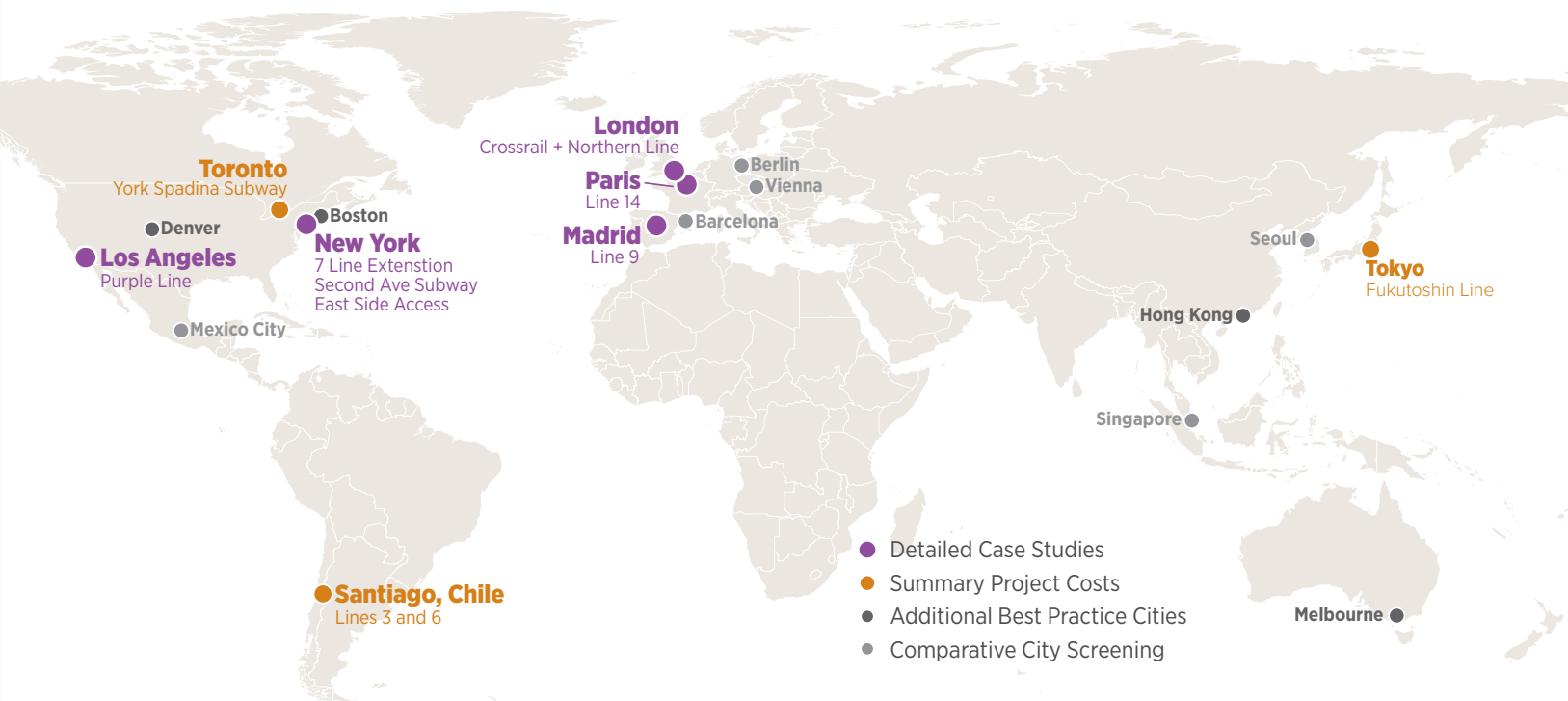
to workweek length, overtime, and premiums for certain times of work was either too difficult to source or too insignificant in its impact on costs. PLA overtime costs may have been higher — Sound Transit agreed to two times the hourly rate of pay for days when a worker had completed a full day of overtime (eight to ten hours, depending on the trade) — but “inaccessible” data made scrutiny impossible.⁶ Project and task detail on labor hours by trade, overtime hours by trade, and associated wage and benefit rates are not publicly available for most capital projects, and particularly not for transit megaprojects. Table 8 summarizes the cost savings and increases with the Sound Transit PLA.

Total cost savings could have been as high as \$2.6 million based on the savings that were quantifiable, but those savings total less than 0.3% of project costs under the PLA. And increased costs due to the PLA could be as high as \$1.1 million, which is less than one-tenth of a percent of total project costs. All in all, changes brought about by the PLA are \$1.4–\$2.2 million, low-hanging fruit perhaps, but very little savings — less than 1% — on a multibillion-dollar project.

⁶ Agreement Dynamics. “Sound Transit Project Labor Agreement Study.” Sound Transit. 2011. <http://www.soundtransit.org/sites/default/files/documents/pdf/about/plareport12111.pdf> (accessed June 20, 2016).

Lessons from Other Cities: National and International Comparatives

Figure 19: Map of Cities assessed as Part of comparative Analysis



It would be best to analyze the costs of MTA megaprojects in relation to similar large-scale capital projects in peer cities. Yet RPA found no accurate, comprehensive, publicly available comparisons of public transit capital costs. Publications such as *Engineering News-Record* publish quarterly databases of construction costs in U.S. metropolitan regions. However, these costs are across all construction sectors and are not solely reflective of public transit megaprojects. RPA screened dozens of possible comparative cities, focusing on transit systems in similar urban and operational contexts, including high population densities, ridership per capita, and a mix of regional and metropolitan rail. RPA reviewed existing literature on capital construction processes and costs as well as data and input from U.S. and foreign transit agencies that are building new heavy rail connections and extensions (Figure 20). RPA also reached out to over 20 agencies to source capital construction component costs for heavy rail transit projects. RPA then selected projects comparable to New York City's megaprojects, summarizing the differences between projects, lessons learned and discussed them with the Milstein Forums on New York's Future.

Based on RPA's research, transit agencies and construction authorities around the world have used many strategies to reduce the cost of building megaprojects:

1. Reformed finance models by creating diversified funding streams that include new tax revenue, public-private partnerships, private concessions, joint development, and direct contributions by localities
2. Employed new project delivery models (special-purpose delivery vehicles) and moved beyond the traditional design-bid-build procurement process
3. Focused on performance-based outcomes rather than physical design specifications as part of the project design process
4. Frontloaded projects with more rigorous site assessments, physical-conditions testing, and utility relocation
5. Empowered project managers, consolidated engineering renderings, and reformed the change-order process
6. Developed new project insurance, contingency, and risk-management policies that reduce costs

Table 10: Categorical Breakdown of Project Costs (Highest Cost Projects to Lowest Cost Projects)

Project	City	Status	Route Length (miles)	Civil Construction Works	Engineering Design & CM Costs	Indirect and Administrative Costs***	Rolling Stock	Total Project Costs (million USD)
Crossrail*	London, UK	In Progress	13.7	53%	4%	15%	Not Reported Separately	\$18,851
East Side Access	New York City, USA	In Progress	4	56%	13%	19%	7%	\$12,038
Second Avenue Subway	New York City, USA	Complete	1.8	48%	13%	35%	-	\$5,575
Line 14 Southern Extension**	Paris, France	In Progress	8.5	74%	Not Reported Separately	10%	16%	\$4,390
Fukutoshin Line**	Tokyo, Japan	Complete	5.5	65%	Not Reported Separately	28%	7%	\$3,578
Lines 3 and 6	Santiago, Chile	In Progress	23	71%	9%	8%	11%	\$3,064
Purple Line Phase One	Los Angeles, USA	In Progress	4	55%	12%	29%	5%	\$3,041
#7 Line Extension	New York City, USA	Complete	1.5	85%	17%	-	-	\$2,424
Toronto-York Spadina	Toronto, Canada	In Progress	5	87%****	4%	6%	3%	\$1,961
Northern Line	London, UK	In Progress	2	36%	34%	10%	10%	\$1,065
Line 9 to Paco de Lucia	Madrid, Spain	Complete	5	85%	5%	1%	-	\$140

Costs reported do not total 100% and include the cost of delivery under Crossrail Ltd., which is £12.3 billion of £14.8 billion. Costs are adjusted based on exchange rates of June 2017, when Crossrail Ltd. provided data on construction component costs.

**Inflation-adjusted projects costs reported prior to 2015.

***Real estate purchases, surveys, insurance, modifications of services, finance charges, unallocated contingencies, and indirect/temporary facilities costs related to construction

****TTC does not report tasks for completed works — the civil works cost figure includes \$1.2 billion of completed works

- Promoted and funded workforce skills-development programs and robust project pipelines that support a consistent labor supply
- Disassociated the cost of health care and pensions from project budgets
- Used project post-mortem review process to find areas of high costs, reform project processes, and develop institutional best practices — sharing these lessons learned publicly

Comparative Projects, Review of Project Costs and Elements

The comparatives selected are projects of similar scale, site conditions, and construction to the MTA's megaprojects. RPA found no controlled analyses with variables that would make direct comparisons possible. Earlier comparative research by Flyvbjerg, Bruzelius, and van Wee demonstrated that, "The main reasons for the high variation in the route-kilometre costs are differences between projects as regards the ratio of underground to above-ground con-

struction, ground conditions, station spacing, type of rolling stock, environmental and safety constraints, and labour costs."¹²⁵ Unlike those prior studies, RPA's comparative analysis not only focuses on track-mile versus route-mile cost differences, but also considers project components. Additionally, the analysis includes a discussion of the differences in governance, site conditions, project-delivery models, and financing for each of the comparatives. Agencies were provided with a standardized cost worksheet and a survey by RPA asking them to evaluate project component costs and articulate the differences in physical, regulatory, and labor environments. A number of interviewees also took part in follow-up discussions. As noted earlier, the MTA has since raised concerns over their original comparative figures. RPA collected data from international and national peers months before using the FTA-defined standard cost categories, making it impossible to redo this analysis at the final hour. RPA used the FTA reported figures for ESA and SAS and the most reasonable breakdown of the #7 costs the MTA had provided earlier in the New Starts reporting format.

¹²⁵ Flyvbjerg, Bent, Bruzelius, Nils, and van Wee, Bert. (2008). Comparison of Capital Costs per Route-Kilometre in Urban Rail. *European Journal of Transport and Infrastructure Research*. 8. 17-30.

There are substantial differences in scale and scope of the comparatives, which fall into roughly three categories: commuter rail expansion, metrorail expansion, and metro-rail line short extensions. For example, ESA is a commuter line extension similar to London's Crossrail in scope and scale — albeit a terminal instead of a through-running system. Second Avenue Subway mirrors the metrorail expansion projects of the Purple Line in Los Angeles and Line 14 in Paris, as both are longer line extensions with four or more stations. The #7 line is a shorter line extension with a single station similar in scope to the shorter extensions of London's Northern Line and Madrid's Line 9, both of which are extended by two stations.

Commuter Rail Expansion Comparatives – Crossrail vs. ESA

Crossrail will run on a 78-mile, two-track transit line from Heathrow Airport to the Docklands, connecting existing regional rail and national rail networks (Figure 20). The heart of the system is a new 13.7 route-mile (27 track miles) tunnel running under central London, the Elizabeth Line, which will bridge London's gap — connecting the Paddington and Liverpool Street national rail stations with through-running service — and parallel the Central tube line, relieving London's most congested corridors. When it opens in 2018, Crossrail will increase the total capacity of London's transit system by 10%, and significantly cut travel times and congestion across the region. It will be operated by Hong Kong's MTR transit company under a concession from TfL, and will accommodate special-purpose trains,

The Hidden Costs of Health Care and Retirement Benefits in U.S. Megaprojects

Construction costs in New York City are difficult to compare to costs abroad for many reasons, not least of which is health care and pensions are funded by project budgets here, unlike in non-U.S. world cities. With trade labor estimated at 22–69% of construction costs on ESA and the #7 Line, in addition to 13 million man-hours for project management on ESA alone, high health care and retirement benefit costs are embedded in these labor costs.¹ The disassociation of these costs from project budgets of international peers dramatically affects construction cost comparisons.

Madrid, Paris, and London are in countries with universal health care provided by the national government. In Madrid and Paris, national health care funding is provided through general taxation.² In Spain, health-care taxes are local or regionally based and can include consumption and sales taxes.³ In London, the National Health System (NHS)

is primarily funded through national income taxation, constituting 18% of an employee's personal income tax.⁴ In these cities, health care costs for the workforce on infrastructure projects are not directly funded by the project. Rebuttals could be made that additional taxation for single payer systems inflates wages to compensate for the difference, however overall health care costs are far lower in the UK, France, and Spain. In 2015, health care expenditure in the UK was \$4,015 per person, \$4,415 in France, and \$3,153 in Spain, while in the U.S. averages \$9,450 per person.⁵ American health care costs are double to triple that of these countries, and contribute directly to higher overall construction costs in New York when compared to international peer cities. Additionally, pension plans in Spain and Paris are funded by their national governments. In the UK, employers contribute a minimum defined rate to social security for pensions, unemployment compensation, and some NHS coverage — typically 2–3% of wages.⁶ Employees contribute 6% of their salaries as part of an opt-out system, producing much less variability in minimum benefit rates between trades or workforces as there are in New York City.⁷ More recent programs by private employers include pension contribution rates of 10–15%, in addition to the minimums.⁸

¹ U.S. employers also contribute approximately 12% of the hourly wage cost to FICA, Medicare and SUTA. These costs are bundled into the overhead rate that the MTA pays.

² World Health Organization. "Tax-Based Financing for Health Systems: Options and Experiences." *WHO.int*. 2004. http://www.who.int/health_financing/taxed_based_financing_dp_04_4.pdf (accessed January 4, 2017).

³ Costa-Font, Joan, and Joan Gil. "Exploring the pathways of inequality in health, health care access and financing in decentralized Spain." *Journal*

of European Social Policy, 2009: 446–458. <http://journals.sagepub.com/doi/abs/10.1177/0958928709344289> (accessed January 4, 2017).

⁴ Chang, Josh, et al. "The UK Health Care System." *Columbia.edu*. 2008. <http://assets.ce.columbia.edu/pdf/actu/actu-uk.pdf> (accessed May 4, 2017).

⁵ UK National Health Service. *Key statistics on the NHS*. July 14, 2017. <http://www.nhsconfed.org/resources/key-statistics-on-the-nhs> (accessed April 2, 2017).

⁶ Expert Interviews.

⁷ Ibid.

⁸ Expert Interviews

while operating in a mixed environment with traditional commuter rail trains outside central London, which is served by several private operators. Crossrail Ltd.'s cost of delivery is \$15.7 billion, with an additional \$3.2 billion for upgrades to National Rail yards and facilities. The construction costs of Crossrail's core section is estimated at \$6.6 billion.

Overall, East Side Access is a significantly more expensive construction project than Crossrail, with construction costs at \$7.3 billion for a single terminal station consisting of two large three-story caverns located 100 feet below the existing Grand Central Terminal, and just over 12.8 miles of tunnel and track (which includes several junction caverns), compared to Crossrail's \$7.3 billion for seven stations and twice as much tunneled track (Table 11). At a unit-cost rate, the differentials are much starker. Tunnels and track average \$261 million per mile for ESA compared to \$105 million per mile for Crossrail. The costs of signals and systems components are also much lower for Crossrail than ESA.

These large cost differentials appear to be partially attributed to labor costs in New York City compared to London. On a per-track-mile basis, the manual labor hours on ESA are roughly half of Crossrail — 2.7 million man-hours/track mile for ESA versus 4.4 million estimated man-hours/track mile for Crossrail. Yet at \$571 million per track mile, ESA construction costs are more than two times greater than Crossrail's \$195 million per track mile. These numbers exclude administrative and nonmanual labor costs such as design, engineering, and construction management. The start-and-stop nature of ESA's site access and the complexity of the Harold Interlocking work contribute to this cost differential by reducing productive work hours. Crossrail's management noted that they do all they can to maintain productivity and project schedules. Crossrail must strictly adhere to work windows for extended station or track closures or risk waiting over a year (60 weeks) to access the track again due to scheduling work windows with National Rail and London Underground services.

ESA's signals and systems cost more than three times Crossrail's: \$628 million versus \$196 million. On a per-track-mile basis, the cost difference is more extreme, with ESA's over 12 miles of track average of \$50 million for signals and systems compared to the \$7 million per track mile for signals and systems on Crossrail (Table 10). The extremely high costs for signals and systems on ESA are correlated to the redesign and streamlining of the Harold Interlocking.

Crossrail and ESA have similar costs for design and engineering, site preparation, and vertical circulation, though ESA's costs are often higher on a unit basis given the scale of Crossrail compared to ESA. Both projects are complex given their dense urban environments, and each needs to support structures above both the tunnels and stations. Design and engineering costs on Crossrail,

with its intricate tunnel works that must thread through multiple underground tube lines within inches, are \$686 million. For ESA's deep-bored station over 100 feet underground, and structures underneath highways and bridges in Queens as well as the Harold redesign, the total design and engineering costs are \$660 million. Site preparation for construction works is similar in total amounts spent, yet London appears to be getting more for its money. Over \$301 million in site preparation has been spent for ESA and \$248 million for Crossrail. But Crossrail's costs are for site preparation along the entire 13-mile route and seven stations, all with transfers to London Underground services and the Docklands LRT.

Crossrail and TfL's joint procurement program for elevators and escalators is reducing the overall costs of vertical circulation. For seven stations, the cost of vertical circulation is \$75 million compared to ESA's \$87 million for the terminal station at Grand Central. ESA's escalators and elevators were a part of a design-bid-build procurement that may have reduced the overall costs, but it does not appear to be performing on par with London's joint procurement programs across TfL divisions and Crossrail.

Table 11: Summary Component Costs for Commuter rail Expansion Project Comparative Analysis (millions \$)

	East Side Access	Crossrail (tunnel portion)
Real Estate	\$192	Not reported
Site Preparation	\$301	\$248
Indirect Costs and Temporary Facilities	\$225	Not reported
Tunneling and Track	\$3,353	\$3,637
Per track mile	\$261	\$107
Stations	\$2,344	\$3,307
Per station	\$2,344	\$473
Vertical Circulation (Elevators & Escalators)	\$87	\$75
Systems: Signals, Power, Communications	\$628	\$196
Per track mile	\$100	\$6
Design & Engineering	\$660	\$686
Remaining Contingency	\$720	Not Reported

Project Profile

Crossrail (Tunneled Portion) – London, UK

Under Construction

Tunneled Length: 13.67 miles

Total Tunneled Track Mileage: 26.1 miles

New Stations: 10

- ▶ Paddington
- ▶ Bond Street
- ▶ Tottenham Court Road
- ▶ Farringdon, Liverpool Street
- ▶ Whitechapel
- ▶ Canary Wharf
- ▶ Custom House
- ▶ Woolwich
- ▶ Abbey Wood

Construction Time Line:

Nine years (2009–anticipated opening 2018)

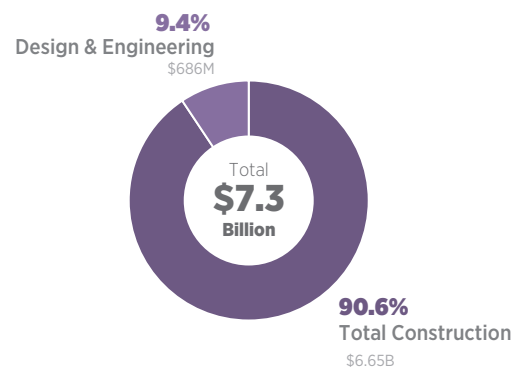
Tunneling Method(s)

Twin Tunnel Boring Machines

Environmental Assessment Time Line
not provided

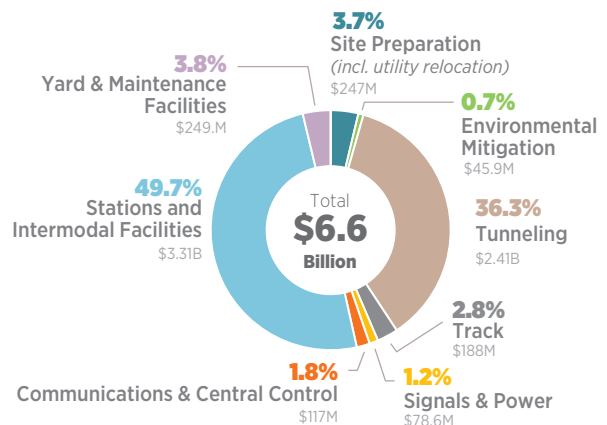
Design/Engineering Time Line
not provided

Figure 21: London's Crossrail Project Costs (U.S. \$ 2017)



Source: Transport for London

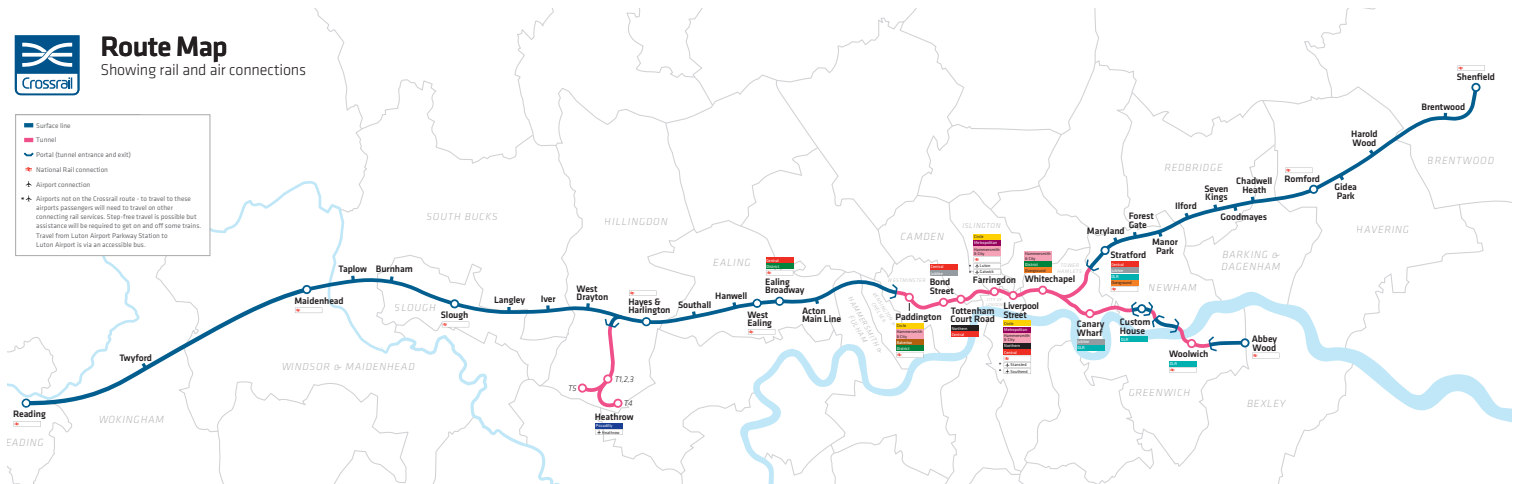
Figure 22: Crossrail Construction Costs (U.S. \$ 2017)



Source: Transport for London

Figure 20: Map of Crossrail (Elizabeth Line) Route

Source: Transport for London



Special Project Delivery Corporation: Crossrail, Ltd.

Crossrail is being built by Crossrail Ltd, a special-purpose public authority with the sole responsibility of financing, designing, procuring, and delivering the project. Initially a 50/50 joint venture between TfL and the Department for Transport, Crossrail became a wholly owned subsidiary of TfL in 2008.¹²⁶ Free of the many bureaucratic procedures that handcuff long-established public agencies, this model has been used to deliver several large, complex public infrastructure projects in the UK, including the HS1 and HS2 High Speed Rail lines, the 2012 Olympics, and others. Crossrail Ltd. will be dissolved following the completion of the railroad.

Region-Wide Value Capture: Greater London's Community Infrastructure Levy

Rather than employing tax-increment financing as value capture, London has used a metropolitan region-wide tax assessment. In 2010, London's mayor established a Community Infrastructure Levy (CIL), a broad-based mechanism to "capture" the incremental value produced by the planned investment.¹²⁷ Approximately one-third of Crossrail's \$19 billion budget is funded by special tax assessments on commercial properties across the region and the CIL, which is designed to capture the increase in property values in districts surrounding the stations. The national government provides the remainder of the budget. To avoid the complexity of determining the transit and community benefits of such a large project in a specific area, the CIL applies to new development, both commercial and residential, in all of Greater London. Exemptions are given to affordable housing, charitable organizations, and public schools. Different rates are applied across city districts,

with portions of the CIL contributing to Crossrail, local surface transportation infrastructure improvements, new rail extensions, and school construction. The CIL assessment district covers over 30,000 acres of dense urban area in 32 boroughs and the City of London.¹²⁸ The government (along with residents and businesses) acknowledges that the benefits of transit investments not only accrue to the properties immediately adjacent to the new train stations, but also infill development throughout the metropolitan area. The CIL primarily funds Crossrail, though exemptions are made for other transportation and local quality-of-life infrastructure improvements like parkland and community facilities. The Nine Elms Battersea District, for example, which covers areas adjacent to the Northern Line Extension, contributes CIL funds to the Northern Line Extension rather than to Crossrail (see Northern Line Extension project profile).

Integrated Project Insurance

Integrated Project Insurance (IPI), London's innovative model for insurance on capital construction, consists of a single insurance policy taken out by the client to cover risks associated with delivering the full program instead of each individual consultant, contractor, or subcontractor firm purchasing separate insurance policies.¹²⁹ First used on Heathrow's Terminal 5 expansion, IPI is being employed on Crossrail Phase 1. The UK National Government has supported the adoption of integrated project insurance for capital projects to consolidate policies held by the client, the TfL subsidiary Crossrail Ltd, and its consultants, contractors, and supply-chain providers. In addition to a single

¹²⁸ Transport for London. *Community Infrastructure Levy*. N.d. <https://tfl.gov.uk/info-for/urban-planning-and-construction/planning-applications/community-infrastructure-levy> (accessed April 2, 2017).

¹²⁹ Bourke, Mark. "Taking an Integrated Approach to Insurance." *Chartered Institute of Building*. 2017. <http://www.constructionmanagemagazine.com/features/taking-integrated-approach-insurance/> (accessed April 2, 2017); and UK Government. "The Integrated Project Insurance (IPI) Model: Project Procurement and Delivery Guidance." *Gov.uk*. July 2, 2014. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/326716/20140702_IPI_Guidance_3_July_2014.pdf (accessed April 2, 2017).

insurance policy, there are technical and cost assessors to help manage project risks. The UK National Government has estimated that IPI policies can potentially save 10–40% of project costs over a more traditional insurance policy structure by removing the adversarial culture within project teams, creating something akin to the no-fault-no-blame culture of alliance contracting, and encouraging integration and early involvement of supply chain partners.¹³⁰

Risk Management in Place of Cost Contingencies

TfL does not have contingency funding on capital projects, which in much of the world accounts for up to 20% of a project's budget. Nor does TfL often use schedule contingency allowances. This is similar to the #7 Line extension in which no schedule contingency was provided, although a 5% cost contingency, or \$105 million of the overall project budget, was permitted for subway work. Rather than schedule or fund contingencies, TfL does ongoing risk management of the construction time line, highlighting strategic risks and defining mitigating action items.¹³¹ When warranted, TfL derives a risk allowance, allocating schedule, or cost allowance to complete action items as necessary.¹³² Any additional funding is at the discretion of the funding entities. For the Northern Line, TfL and the Greater London Authority are the funding entities. For Crossrail, it's the UK National Government, TfL, and the Greater London Authority. In 2010, Crossrail Ltd and the UK National Auditors Office established aggressive cost-savings measures, including resequencing tasks, reducing project scope, and making inflation adjustments due to the global recession to save Crossrail from overruns that were estimated at £1.6 billion¹³³ (\$2.5 billion).¹³⁴ Proactive risk management by Crossrail to address concerns from the public and the UK government was key to mitigating the impact of these cost overruns and finding savings to stay within the project's original budget. Since that time, the project has held its budget and the first station to reach practical completion is Canary Wharf, by far the most complicated construction works on the project, meeting this benchmark four months early in the fall of 2015.¹³⁵

¹³⁰ Stone, Jonathan, and Walsh, Marcus. "Integrated Project Insurance." *Mayer Brown*. N.d. https://www.mayerbrown.com/Files/News/b51a819a-d629-414d-84b6-b030d281794d/Presentation/NewsAttachment/56333efc-5311-4d2d-a4ea-b05c52a258cf/art_walsh-stone.pdf (accessed November 2, 2016).

¹³¹ Transport for London. "Audit and Assurance Committee: Strategic Risk Management Update." *TfL.gov*. October 8, 2014. <http://content.tfl.gov.uk/aac-20141008-part-1-item15-strategic-risk-management-update-q-1.pdf> (accessed November 2, 2016).

¹³² Los Angeles County Metropolitan Transportation Authority Office of the Inspector General. "Capital Project Construction Management Best Practices Study." *LA Metro*. February 29, 2016. http://media.metro.net/about_us/oig/images/16aud01_final_report_LACMTA_best_practices_study_02.29.16.pdf (accessed March 5, 2016).

¹³³ UK National Audit Office Comptroller and Auditor General. "Crossrail." January 24, 2014. <https://www.nao.org.uk/wp-content/uploads/2014/01/Crossrail.pdf> (accessed November 2, 2016).

¹³⁴ Conversion based on exchange rate of 1.561 USD to GBP as of December 31, 2010.

¹³⁵ UK Government. *Annual Update on Crossrail 2016*. June 30, 2016. <https://www.gov.uk/government/speeches/annual-update-on-crossrail-2016> (accessed November 2, 2016).

National Investment in Infrastructure Skills & Technology Advancement: The Tunneling and Underground Construction Academy (TUCA)

The New York trade unions, including those that work on MTA capital projects, are fragmented, adhering to diverse work rules, wages, and on-site practices. The UK has faced similar challenges as it has aggressively pursued large-scale infrastructure programs. Unlike the United States, the UK has implemented a *national* program for labor supply and skills improvements. Its National Improvement Program for Skills acknowledges the "fragmented approaches to skills planning and high levels of bespoke training limit the effectiveness and efficiency of labour market mobility. This makes it harder for skilled workers to move easily between sectors and projects, exacerbating key skills shortages for key projects and programmes."¹³⁶ The same is true of the New York trades, which lack an integrated approach to skills development, limiting the ability of workers to move between projects and sectors. Additionally, newer construction and engineering techniques require a greater focus on education in the science, technology, engineering, and math (STEM) fields to handle computer-aided equipment and on-site challenges. This means the construction industry is competing to attract young entrants within the growing global tech sector.¹³⁷ To address these issues, the UK National Government has established targets to improve the technical skills of the construction trades through education programs funded by the national government.¹³⁸ Her Majesty's Treasury monitors the success of programs to advance workforce skills and maintains targets and benchmarking for the National Infrastructure Plan for Skills.

The core action items in HM Treasury's National Infrastructure Plan for Skills (2015) over the next decade include:¹³⁹

- ▶ Increasing the apprenticeship enrollment to three million within the parliamentary term, including rolling out degree apprenticeships recognized as pathways to higher education
- ▶ Recruitment and training of 100,000 additional workers
- ▶ Retraining and up-skill development of 250,000 existing workers

¹³⁶ Transport for London. "TfL Skills and Employment Strategy: Progress Report and Future Strategy." *TfL*. April 2014. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/464354/NIP_for_skills_final_web.pdf <http://content.tfl.gov.uk/skills-and-employment-strategy.pdf> (accessed November 2, 2016).

¹³⁷ Transport for London. "TfL Skills and Employment Strategy: Progress Report and Future Strategy." *TfL*. April 2014. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/464354/NIP_for_skills_final_web.pdf <http://content.tfl.gov.uk/skills-and-employment-strategy.pdf> (accessed November 2, 2016).

¹³⁸ Her Majesty's Treasury. "National Infrastructure Plan for Skills." *Gov.UK*. September 2015. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/464354/NIP_for_skills_final_web.pdf (accessed November 2, 2016).

¹³⁹ Her Majesty's Treasury. "National Infrastructure Plan for Skills." *Gov.UK*. September 2015. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/464354/NIP_for_skills_final_web.pdf (accessed November 2, 2016).

- Establishment of Institutes of Technology, sponsored by employers that are registered with professional bodies (universities) and aligned with trade apprenticeship standards

While HM Treasury reports progress on the National Infrastructure Plan, the UK Department for Transport maintains an accreditation program for workforce development establishing Centres of Excellence.

With Crossrail and several other large-scale public works underway, TfL and the Prospects College of Advanced Technology developed a training and education program, the Tunneling and Underground Construction Academy (TUCA). In 2011, Crossrail and Prospects College established a Memorandum of Understanding that incorporates the TUCA into the Centres of Excellence program formed by the UK's Department for Transport. The TUCA has been funded by £13 million from Crossrail Ltd., with a £5 million contribution provided by the UK government's Skills Funding Agency. Opened in 2012, the TUCA includes spaces for training apprentices with hands-on practice for tunnel excavation and spraying concrete lining in a tunnel opening as well as a laboratory to study and develop tunneling materials. In addition to construction-practice training, the TUCA includes a Crossrail line maintenance and station training center that employs a station mock-up to train staff in customer service. As of June 2016, the TUCA has achieved over 12,000 course enrollments.¹⁴⁰ In 2017, 20 new rail maintenance apprentices and over 130 railway-engineering apprentices began training.¹⁴¹

Labor Policy

The UK's labor policies and practices differ from those in the United States. On Crossrail, the following programmatic changes differ from practices employed on megaprojects in New York:

1. The use of daily or weekly rates rather than hourly for some trades. For example, between £1500–£1800 (\$1,982–\$2,379) per week for TBM crews and approximately £200 (\$264) per day for concrete workers
2. Overtime pay rates only kick in after 50 or 60 hours worked during a five-day workweek rather than being based on time of day and/or day of week
3. Voluntary overtime to meet project goals is paid at regular overtime rates without premiums for weekend rates
4. Bonuses to workers for construction milestones achieved on time — for tunnelers these are referred to as “ring bonuses”

5. Consolidation of worker breaks into a single mid-shift break for all trades on the project (civil, tunnelers, electricians)
6. With a transparent negotiation process for wages between Crossrail Ltd., contractors, and labor, no contractor can offer trades a better agreement without all contractors agreeing to the wage and benefit changes.¹⁴²

As noted above, the manual labor hours on Crossrail are estimated at 4.4 million man-hours per track mile for construction, totaling over 148 million hours over the lifetime of the project, at a cost of \$3.7 billion for the 13-mile tunneled route through central London. The nonmanual labor for design and engineering is estimated at 20 million man-hours. Overall the project averages close to five million man-hours on a per-track-mile basis. Yet Crossrail has achieved significant efficiencies in labor compared to New York City — driven by a need to maintain project schedules, ensuring track closures are utilized to the maximum.

¹⁴⁰ UK Government. *Annual Update on Crossrail 2016*. June 30, 2016. <https://www.gov.uk/government/speeches/annual-update-on-crossrail-2016> (accessed November 2, 2016).

¹⁴¹ Crossrail Ltd. *TUNNELLING AND UNDERGROUND CONSTRUCTION ACADEMY TO SUPPORT VITAL INFRASTRUCTURE PROJECTS*. March 10, 2017. <http://www.crossrail.co.uk/news/articles/tunnelling-and-underground-construction-academy-to-support-vital-infrastructure-projects> (accessed May 2, 2017).

¹⁴² Expert Interviews

Metrorail Expansion Comparatives – Purple Line and Line 14 vs. SAS

The cities of Los Angeles and Paris have line extensions underway that are very similar to New York's SAS phase one. Los Angeles's Purple Line Phase 1 is being constructed along Wilshire Boulevard and involves significant reconstruction of that avenue. This phase of the Purple Line will run from the mixed-use district of Wilshire Central, through Central Los Angeles and Miracle Mile, and will pass through the difficult subsurface topography of the La Brea Tar Pits. Though the surrounding neighborhoods are less dense than Manhattan's Upper East Side, Wilshire Boulevard is a high-traffic thoroughfare that runs from Downtown through Central Los Angeles, Beverly Hills, and Westwood to Santa Monica.

Paris's Line 14 multiphase extension is part of a larger plan to address the transportation needs of its metropolitan region's core over the next decade. The phase of Line 14 that was evaluated is the southern extension to Orly Airport that will pass through the 13th administrative district, a growing high-rise residential part of Paris, and into medium- to low-density municipalities just south of Paris's city limits.

Route length is the most substantial difference between SAS and these two metrorail expansion projects. SAS was a three-mile metrorail project, while Los Angeles's Purple Line will be nearly four miles and Paris's Line 14 southern extension over eight miles. Also, the age of portal stations and number of new stations vary between these projects. SAS included three new stations with a retrofit of an existing station, Lexington Ave to 63rd Street, which opened in 1987. Los Angeles's first phase of the Purple Line will be similar, building three new stations plus a retrofit to the existing Wilshire/Western station from 1996. The southern extension of Paris's Line 14 will include six new stations and a connection into the existing Olympiades station (the current Line 14 terminal) that opened in 1991, and the Maison Blanche station (Line 7) that was incorporated into the Métro system in 1931.¹⁴³ The age of the portal stations, where the line extensions originate, are within a ten-year timespan. Line 14's connection into Maison Blanche and the intermodal connection to RER C at Orly Airport, however, contain additional complexities, contributing to station construction costs.

The cost of tunneling and track work for SAS is less than 8% of the overall project costs, adding up to just under \$195 million for 3.9 track miles, or roughly \$54 million per mile. LA's Purple Line is being excavated at \$49 million per mile

for just shy of eight miles of track in twin tunnels, which is 22% of the project's construction cost — tunneling constituting most of those costs at \$349 million. On the high end of tunneling costs is Paris, where 17.4 miles of track and tunnels total \$1.2 billion (38% of Line 14's construction costs) at approximately \$71 million per mile. It is important to keep in mind the construction phasing, methods, design, and physical environment will drive differences in costs between projects. Line 14, for example, has three segments for a single large tunnel (with two parallel tracks) to be excavated simultaneously by three TBMs. The SAS and Purple Line used two TBMs to excavate twin parallel tunnels. Paris Métro also operates with rubber-tired train cars, making the track design substantially different from the steel-wheel trains used by the MTA and LA Metro. The main reason for SAS's lower tunneling costs as a percentage of the overall project costs is the use of the deep-bored TBMs, which reduced utility relocation costs. Line 14 is being excavated to 55 feet from the surface, roughly half the depth of SAS tunnels and stations.¹⁴⁴ LA's Purple Line tunnels will be 50–70 feet deep and stations will be 50 feet below the surface.¹⁴⁵ Despite its depth contributing to a higher share of project costs for tunneling, the Purple Line still costs less on a per-track-mile basis than the Second Avenue Subway.

Although SAS's depth was an intentional design decision made to save money, it ended up creating the most significant cost difference between SAS and the Purple Line and Line 14. Station costs dominate SAS's construction budget, with the three new stations and the station connection at 63rd Street to Lexington Avenue constituting 60% of construction costs, totaling over \$1.7 billion, or an average of \$425 million per station. Paris's Line 14 will have lower station costs, anticipated to be just shy of \$1.2 billion, averaging \$147 million per station, or just 36% of the budget. Line 14 will have twice as many stations as SAS's phase one, with larger intermodal connections to existing lines (7, 15, RER C, and 18). This also includes a retrofit of the much older Maison Blanche station with a connection to Line 7. Built in a similar fashion to SAS's single cut-and-cover station at 96th Street, the Purple Line stations are expected to cost \$482 million, or 20% of budget, the lowest of the metrorail expansion projects evaluated. LA Metro is building the stations under Wilshire Boulevard by excavating half of the street for the station box, then placing a deck over the partially completed station box. This deck is to allow auto traffic to access the corridor during the second phase of excavation in which the other half of the station box will be excavated.¹⁴⁶

¹⁴³ Wikipedia. *Maison Blanche Station*. March 17, 2017. [https://en.wikipedia.org/wiki/Maison_Blanche_\(Paris_M%C3%A9tro\)](https://en.wikipedia.org/wiki/Maison_Blanche_(Paris_M%C3%A9tro)) (accessed March 20, 2017).

¹⁴⁴ Railway Technology. *Grand Paris Express, France*. 2017. <http://www.railway-technology.com/projects/grand-paris-express/> (accessed March 20, 2017).

¹⁴⁵ LA Metro. "Metro Purple Line Extension Project: Construction." *LA Metro*. 2014. http://media.metro.net/projects_studies/westside/images/mpl-construction_factsheet_2014.pdf (accessed March 20, 2017).

¹⁴⁶ LA Metro. *Construction Fact Sheet*. 2017. <https://www.metro.net/projects/westside/westside-construction-fact-sheet/> (accessed March 20, 2017).

To provide passenger access to the platform, SAS's elevators and escalators in its deep stations cost over \$60 million (3% of station costs), compared to the \$28 million LA Metro will spend for the same number of stations. The costs for Line 14's escalators and elevators are a portion of the \$333 million to be spent on station equipment and finishes, which also includes platform screen doors for passenger safety.¹⁴⁷ Like SAS, all of these stations will also be ADA-compliant. In addition to the station costs, some costs for excavation and utility relocation are part of the site preparation and temporary facility/indirect construction budget, which are 23% of SAS costs and 45% of the Purple Line's costs.

While the Purple Line includes more site work, utility relocation, and other indirect construction costs, the project is likely to perform better than SAS's phase one. Purple Line's anticipated utility relocation, site preparation, and indirect costs are \$1.3 billion for a longer rail expansion project (3.9 miles) compared to \$1.1 billion for shorter-length SAS (1.8 miles). Los Angeles will spend \$94 million for advanced utility relocation compared to SAS site utilities and relocation costs of \$214 million. By the end of 2016, most of the advanced utility relocation and site preparation work was completed for the Purple Line along Wilshire Boulevard.

SAS site preparation and utility costs are so high compared to those of Los Angeles due to the age of New York's utility infrastructure, but also because utility costs are borne by megaprojects based on governance structures. LA Metro's board includes elected officials, the mayor of Los Angeles, the five Los Angeles county supervisors, and city council members from Los Angeles and surrounding cities. Both the City of Los Angeles and the County of Los Angeles have direct franchise agreements with utility providers. It is in the best interest of utility providers to maintain good working relationships with local politicians, who in turn can negotiate favorable expenditures of public funds spent by LA Metro for utility relocation and replacement. Far more isolated politically, the MTA lacks a similar working relationship with utility providers, frequently having to accept nonnegotiable unit rates established by the utility providers.¹⁴⁸ So while less of the overall SAS budget was dedicated to tunneling to avoid subsurface utility relocation impacts, these cost savings were not realized for the project as a whole. SAS deep-station construction was more expensive than the other two projects due to higher excavation costs and the need for more extensive mechanical vertical circulation elements.

Station costs were the primary driver of the overall cost differential between the SAS and the two comparatives: Paris and Los Angeles. The decision to go deep, building deep-bored tunnels and two stations 100 feet below the street's surface to avoid costly utility relocation along the

entire length of Second Avenue (minimizing subsurface disturbances to older buildings along the corridor) does not appear to have had its intended effect. The success or failure of this potential cost-saving measure, however, cannot be fully evaluated with the data currently available to RPA.

In addition to cost savings realized from advanced utility relocation, site preparation, and shallower station and tunnel depths, the Purple Line stations will also be integrated into the surrounding land use through joint-development projects at the surface. SAS was not coordinated with the surrounding land use nor did it leverage New York's zoning code to fully utilize the required station easements and their potential on adjacent property redevelopment. Although MTA's real estate and relocation costs are on par with LA Metro's at 5% of the overall project budget, the MTA paid \$79 million more than LA Metro has for the Purple Line, even though the outcome at the surface is subpar by comparison, and the agency will not generate any revenue from development. Unlike the #7 Line extension, neither the MTA nor New York City tried to collaborate on an integrated land-use and transportation plan and investment strategy for the Second Avenue corridor. This was both a barrier to cost reduction and a missed opportunity for SAS. By comparison, LA Metro has worked in partnership with the City of Los Angeles since the Purple Line won funding under local tax Measure R in 2008. LA's Department of City Planning has developed the Purple Line's station plans in collaboration with LA Metro, including LA Metro's leasing and easement of properties for station construction.¹⁴⁹ The Los Angeles Department of City Planning also upzoned parcels along the Wilshire Boulevard corridor.¹⁵⁰ These investments will result in an indirect value-capture mechanism for the City of Los Angeles and by extension LA Metro, as higher property tax rates are assessed for redevelopment of the upzoned parcels. Also, LA Metro has a robust joint-development program on the Purple Line corridor. Three joint-development projects, including the current portal station at Wilshire/Western Ave, are transit-oriented developments with affordable and market-rate housing as well as a middle school and an integrated bus station.¹⁵¹ LA Metro is planning for more joint development along the Purple Line Extension,¹⁵² though the locations and specifics of those projects are still being evaluated for Phase 2.¹⁵³

¹⁴⁹ LA Metro. *Westside Property Acquisition Fact Sheet*. 2017. <https://www.metro.net/projects/westside/Westside-property-acquisition-fact-sheet/> (accessed March 20, 2017).

¹⁵⁰ <http://www.citywatchla.com/index.php/the-la-beat/11346-metro-s-purple-line-meets-a-fork-in-the-road>

¹⁵¹ LA Metro. *Interactive Project Map*. 2017. https://www.metro.net/interactives/gmaps/joint_project/ (accessed March 20, 2017).

¹⁵² LA Metro. "Metro's Joint Development Program." *Smart Growth America*. N.d. <http://smartgrowthamerica.us/documents/hornstock-locus.pdf> (accessed March 20, 2017).

¹⁵³ Federal Transit Administration. "Westside Purple Line Extension Section 2." *FTA*. November 2014. https://www.transit.dot.gov/sites/fta.dot.gov/files/CA_Los_Angeles_Westside_Purple_Line_Extension_Section_2_Profile_FY16.pdf (accessed March 20, 2017).

¹⁴⁷ Société de Grand Paris did not provide subtotals for elevators and escalators. Rather data was reported under station equipment and finishes.

¹⁴⁸ Expert Interviews

In addition to tunneling and station construction, there is also a delta in system costs, including signals, power, and communications that vary substantially among projects. For SAS, signals, power, and communications were 8% of construction costs, or \$250 million. In Los Angeles, the Purple Line's signal, power, and communications systems are anticipated to be less than half that, at \$101 million, or 6% of the construction budget. These figures are much lower than Paris's Line 14, for which systems are over \$500 million, or 16% of the total construction budget (Table 12). Paris will spend five times as much as the Purple Line and twice as much as SAS for signal and power systems, but it will be generations ahead of the technology for either SAS or the Purple Line. Paris's existing Line 14 is fully automated and runs on CBTC.¹⁵⁴ All extensions, including the first phase to Orly Airport, will also be fully automated with CBTC equipment. Line 14 is anticipated to have peak headways of less than 1.5 minutes. On a per-track-mile basis, Paris's costs will be \$33 million less than what was spent on Second Avenue Subway for a more advanced train control system.

Above and beyond the cost of construction are administrative, regulatory, engineering, and financing costs associated with each project that drive overall budgets. Each metrorail expansion project includes substantial contingency costs and finance charges. Even though SAS's construction budget has been reported as \$4.2 billion, there is another half a billion dollars for unallocated contingencies available as of the second quarter of 2016, at the start of the construction escalation period. These contingencies equal 10% of the SAS budget. Likewise, LA's Purple Line, only three years into site preparation and early construction, has 8%, or \$243 million, of the budget set aside for contingencies. In the very early stages of construction, Paris's Line 14 extension to Orly Airport has over \$54 million, or 1%, of the total project budget allotted in concessionaire contract contingencies.

Table 12: Summary of Component Costs for Metrorail Expansion Project Comparative Analysis (million \$)

Project	Second Avenue Subway	Purple Line Extension	Line 14 to Orly Airport
Real Estate	\$282	\$203	Not reported separately
Site Preparation*	\$724	\$721	\$167
Indirect Costs and Temporary Facilities	\$387	\$589	\$16
Tunneling and Track	\$195	\$388	\$1,223
Per track mile	\$54	\$49	\$71
Stations	\$1,737	\$482	\$1,178
Per station	\$425	\$120	\$147
Vertical Circulation (Elevators/ Escalators)	\$60	\$28	Not reported separately
Systems: Signals, Power, Communications	\$250	\$101	\$509
Per track mile	\$70	\$13	\$30
Remaining Contingency	\$554	\$243	\$54

*Includes utility relocation costs

¹⁵⁴ For an in-depth look at CBTC systems around the world and MTA's slow roll out see RPA's "Moving Forward: Accelerating the Transition to Communications-Based Train Control for New York City's Subways." *Regional Plan Association Library*. 2014. <http://library.rpa.org/pdf/RPA-Moving-Forward.pdf>

Project Profile

Purple Line Phase I Expansion: Western Avenue to La Cienega - Los Angeles, California, USA

Under Construction

Extension Length: 3.92 miles

Track Mileage: 7.84 miles

New Stations: 3

- ▶ Wilshire/La Brea
- ▶ Wilshire/Fairfax
- ▶ Wilshire/La Cienega

Construction Phases: Single

Construction Time Line

Nine years (2014–anticipated opening 2023)

Includes an additional year of site exploration and advanced utility relocation work along Wilshire Boulevard.

Tunneling Method(s): Cut and Cover (1% of tunneling costs), Tunnel Boring Machine (99% of tunneling costs)

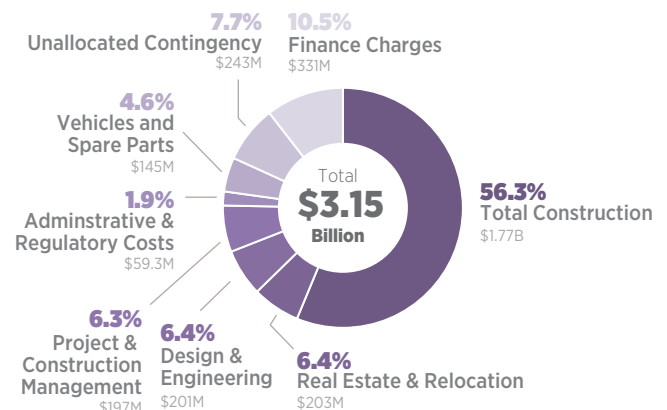
Environmental Assessment Time

Line: Four years (2008–2012)

Design/Engineering Time Line: Two years after EIS process

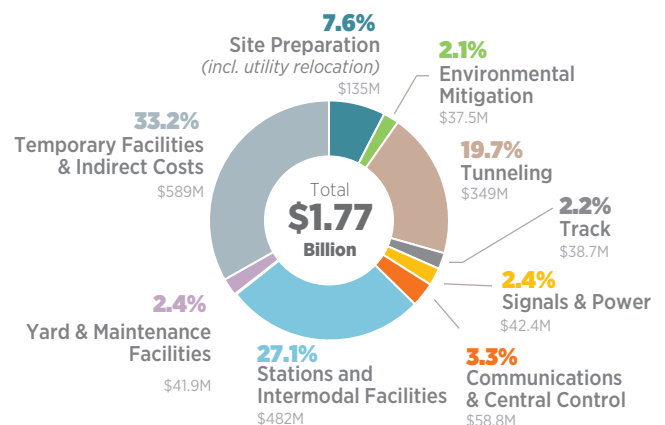
Anticipated long-term benefits include 49,300 new daily riders on the Purple Line after the second phase extension to Westwood/VA Hospital is complete. The Purple Line expansion is also anticipated to draw 78,000 new daily riders to the Metro Rail System as a whole. Peak headways will be every four minutes.

Figure 23: Purple Line Project Costs (U.S. 2016)



Source: Los Angeles Metro New Starts Reporting

Figure 24: Purple Line Construction Costs Breakdown by Key Components (U.S. 2016)



Source: Los Angeles Metro New Starts Reporting

LA Metro's Public Labor Agreement

In recent years, Public Labor Agreements have been used for tunnels and transit infrastructure in Los Angeles, Seattle, and Boston, albeit with mixed results. In 2012, LA Metro, which owns, operates, and builds metro rail transit for LA County, approved the Project Labor Agreement and Construction Careers Policy. LA Metro's PLA is an agreement between LA Metro and the Los Angeles/Orange County Building Trades Council. As part of the agreement, the Buildings Trades Council will be the primary source of all craft labor employed on LA Metro construction contracts. According to LA Metro, "in the event the unions are unable to fulfill the labor requirements of the contract within 48 hours, excluding weekends and holidays, employers may hire qualified applicants from any other available source."¹⁵⁵ Additionally, the PLA sets the terms and conditions of employment on projects, including expedited resolution of disputes to avoid strikes and lockouts. The PLA and the Construction Careers Policy component define procedures for hiring targeted workers, requiring "40% participation of construction workers residing in economically disadvantaged areas,¹⁵⁶ 10% participation of disadvantaged workers, and 20% participation of apprentices."¹⁵⁷ While the Los Angeles PLA does not require all LA Metro projects to be bid on by union contractors, nonunion contractors must agree to the worker utilization and other conditions specified in the PLA.¹⁵⁸ To date, research has not been done on specific savings attributable to LA Metro's PLA. One important issue is how narrowly or broadly to apply local hiring requirements. For skilled trades in particular, a small geographic area can make it difficult to find a sufficient number of qualified workers.

The first phase of the Purple Line is being built with a unionized workforce under the PLA terms established in 2012. At this point, no lockouts or strikes have occurred, though hiring targets are low for the apprentice and disadvantaged workforces, with a workforce gap of 6.5% and 4 percent respectively.¹⁵⁹

Investing in Utility Relocation Upfront to Save Time and Money Later

In 2015, the LA Metro's Office of Inspector General completed a thorough review of capital construction cost drivers and institutional best practices. A key driver of higher costs was found to be the cost of inadequate upfront utility relocation — for every \$1 spent to complete early and exten-

sive subsurface utility identification there were \$4.62 of avoided costs later in the project.¹⁶⁰ Project costs that were avoided include scope changes, additional excavation during construction, redesign delays, and change orders. Based on these findings, LA Metro has mandated a longer time line for pre-tunneling construction on the Purple Line. They've invested significant time and upfront expense over the past two years relocating utilities along Wilshire at an estimated cost of \$94 million, an expense deemed worthwhile to avoid schedule and cost slippage later in the project.

In addition, LA Metro's review of best practices for capital construction found the largest bottleneck and potential driver for costs of utility relocation was the significant understaffing of city agencies and utility companies tasked with approving utility relocation. LA Metro and the City of Los Angeles are negotiating ways to reduce delays due to high workloads of city staff. One option being explored is LA Metro providing paid consultants working under the city's direction to process utility relocation needs and requests,¹⁶¹ though this offer has stalled likely due to concerns about liability.

Local Funding through Voter Approved Tax Increases: Measure R

In 2008, LA county voters passed ballot Measure R, a half-cent sales tax increase to create a dedicated funding stream for transportation infrastructure. The Purple Line Sections 1 and 2 are funded through Measure R, which reduces the federal and state investment. Measure R will contribute 55% of the Purple Line Section 1 budget — 28% as direct contributions and an additional 27% to repay a federal Transportation Infrastructure Finance and Innovation Act (TIFIA) loan. Other funding sources are a New Starts grant of \$1.25 billion (39% of project budget), state funds of \$85 million (3%), and contributions from the City of Los Angeles of \$75 million (2.4%). As of September 2016, Measure R has provided funds to cover over \$480 million in project costs.¹⁶²

¹⁵⁵ LA Metro. *Metro Board approves Project Labor Agreement for Metro Construction Projects*. January 26, 2012. https://www.metro.net/news/simple_pr/Metro-Board-approves-PLA-for-Metro-Construction-Pr/ (accessed March 5, 2016).

¹⁵⁶ LA Metro lobbied nationally for a regulatory change in the federal rules allowing federal dollars to be used for "local hire" requirements. This pilot program was recently ended.

¹⁵⁷ LA Metro. *Project Labor Agreement & Construction Career Policy*. 2017. <https://www.metro.net/about/pla/> (accessed February 20, 2017).

¹⁵⁸ LA Metro. "Project Labor Agreement." 2016. http://media.metro.net/about_us/pla/images/agreement_projectlabor_2016.pdf (accessed March 5, 2016).

¹⁵⁹ LA Metro. "Westside Purple Line Extension Section 1 Project: Monthly Project Status Report." January 2016. https://media.metro.net/projects_studies/pm/images/report_pmo_purpleline_2016-01.pdf (accessed March 5, 2016).

¹⁶⁰ Los Angeles County Metropolitan Transportation Authority Office of the Inspector General. "Capital Project Construction Management Best Practices Study." *LA Metro*. February 29, 2016. http://media.metro.net/about_us/oig/images/16aud01_final_report_LACMTA_best_practices_study_02.29.16.pdf (accessed March 5, 2016).

¹⁶¹ Los Angeles County Metropolitan Transportation Authority Office of the Inspector General. "Capital Project Construction Management Best Practices Study." *LA Metro*. February 29, 2016. http://media.metro.net/about_us/oig/images/16aud01_final_report_LACMTA_best_practices_study_02.29.16.pdf (accessed March 5, 2016).

¹⁶² Westside Purple Line Extension Section 1 Project Quarterly Project Status Report (September 2016). Provided by LA Metro staff.

Project Profile

Line 14 Southern Expansion: Olympiades to Orly Airport - Paris, France

Under Construction

Extension Length: 8.6 miles

Track Mileage: 17.4 miles

New Stations: 6

- ▶ Kremlin - Bicêtre
- ▶ Villejuif Institut Gustave Roussy
- ▶ Chevilly "Trois communes"
- ▶ Parte de Thiais
- ▶ Pont de Rungis
- ▶ Orly Airport

Three intermodal connections to existing metro and commuter rail lines at Maison Blanche, Villejuif Institut Gustave Roussy, and Orly Airport

Construction phases: Single with three simultaneous TBMs excavating the following sections:

- ▶ Section A: Orly Airport to Pont de Rungis
- ▶ Section B: Pont de Rungis to just north of Chevilly "Trois Communes"
- ▶ Section C: Just north of Chevilly to Maison Blanche

Construction Time Line:

Seven years (anticipated time line 2017 –2024)

Tunneling Method(s):

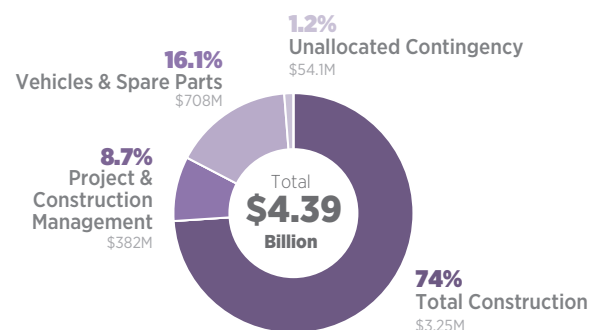
Tunnel Boring Machine

Project Feasibility and Development (Planning and Approval Phases) Time Line:
2010–2014

Environmental Assessment Process Time Line:
Not specified

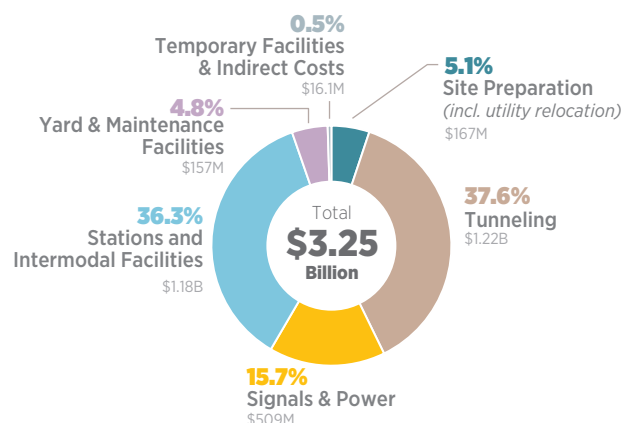
Estimated daily ridership after commissioning in 2024 is 1 million annual passengers with peak headways of 85 seconds.

Figure 25: Line 14 Extension to Orly Airport Project Costs (U.S. 2016)



Source: Société du Grand Paris & RATP

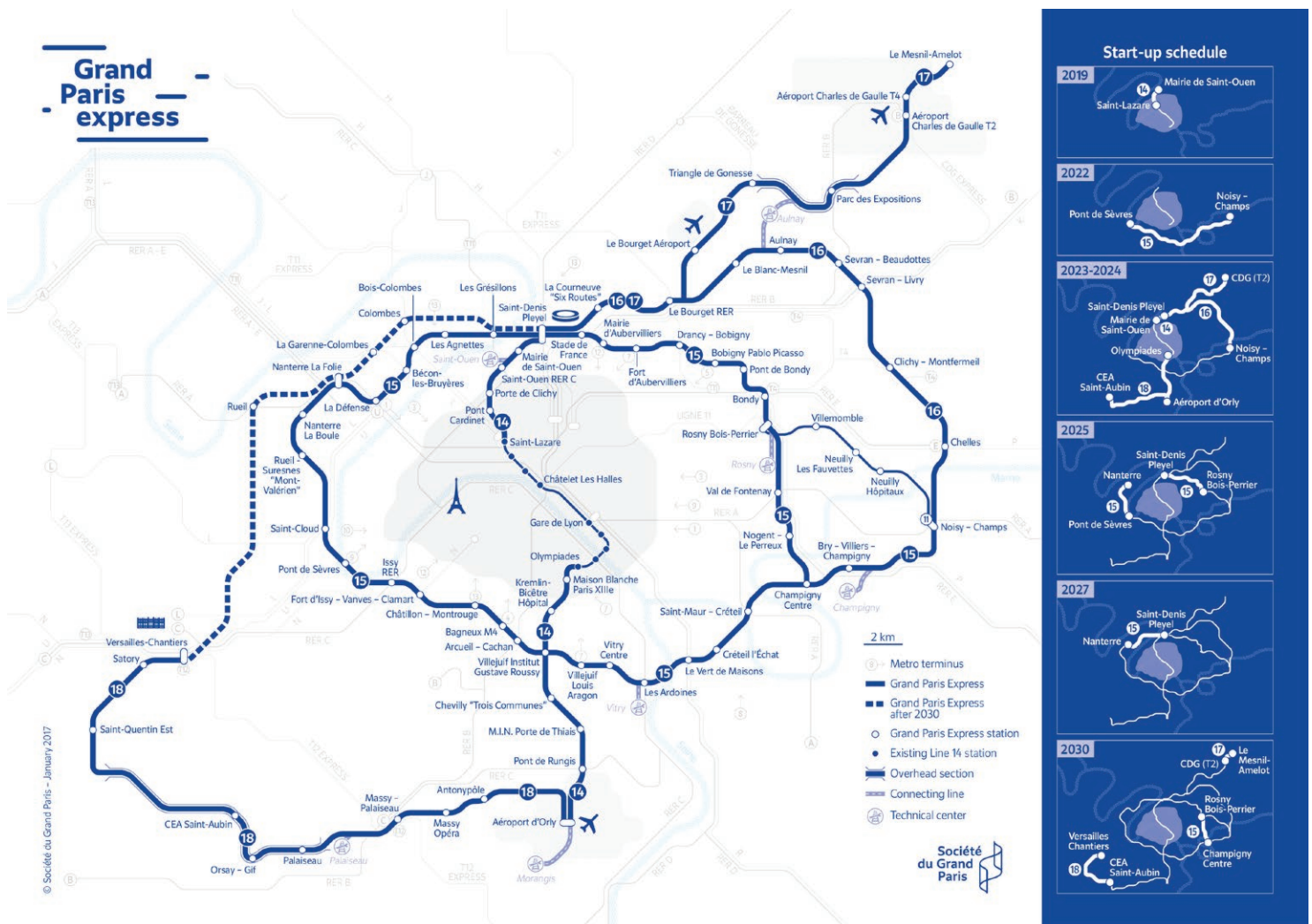
Figure 26: Line 14 Extension to Orly Airport Construction Costs (U.S. 2016)



Source: Société du Grand Paris & RATP

Figure 27: Map of Grand Paris Express

Source: Société du Grand Paris



Grand Paris Society and the Grand Paris Express

In 2010, France created the Société du Grand Paris (SGP) to serve as a regional planning body for the Paris metropolitan region. The SGP facilitates a regional governance by which the national government of France, the municipal government of Paris, and surrounding municipal governments can develop, finance, and execute transportation, urban development, and economic initiatives that further the region's sustainability, social cohesion, and economic growth. It has been tasked with coordinating and developing a regional transportation improvement program, the Grand Paris Express. The program proposes a series of metrorail investments that will connect existing lines, create new line capacity, and improve access to rapid transit for millions of Parisians (Figure 27).¹⁶³ The full Grand Paris Express is expected to be operational by 2030, with nearly 125 miles of new automated metro lines and 68 new sta-

tions with connections to three airports and the national rail stations. A key link in the Grand Paris Express is Line 14's southern extension to Orly Airport, which will serve the southern districts of Paris and suburbs to the south of the city. The extension will be completely financed by the Société du Grand Paris.

¹⁶³ Société du Grand Paris. *Nouveau Metro Grand Paris*. April 9, 2014 <https://www.societedugrandparis.fr/projet/le-grand-paris/nouveau-metro-grand-paris> (accessed March 5, 2016).

Metrorail Short Line Extension Comparatives

Madrid and London have both extended their subway lines in recent years. Madrid, renowned for its low costs as an efficient urban builder of subways, has completed several line extensions since the 1990s.¹⁶⁴ The most recent line extension is Line 9, a three-mile extension from the La Paz neighborhood to the Mirasierra neighborhood in the north-west district (borough) of Fuencarral-El Prado. The Line 9 extension built two new stations, including an intermodal facility connecting to Renfe's regional commuter lines at Pitis Station.

London's TfL is currently extending the Charing Cross branch of the Northern Line two miles from Kensington through a growing commercial and residential district of Nine Elms on the south bank into the former industrial district of Battersea. The Northern Line extension (NLE) includes the construction of two new stations at Nine Elms and Battersea, as well as a redevelopment of the Battersea Power Station.

Beyond construction costs, there are differences with New York that derive from planning and environmental impact assessment. Both the Line 9 extension and NLE design and engineering took one to two years. Environmental reviews were shorter than typical transportation projects in New York — less than two years in Madrid and only 18 months for the NLE. In Madrid, public outreach and its costs are separate from the environmental review, which is handled by an independent body, with costs excluded from the project budget. Public outreach on the NLE was mandated as part of the environmental review, but outreach began much earlier, spanning two and a half years during conceptual planning and design, and incorporating the feedback of “local authorities, local communities, developers, businesses and statutory authorities” into the design.¹⁶⁵

Additionally, in London, the elements of project review that are typically part of the U.S.'s environmental impact assessment (business case, alternatives evaluation, public outreach, cost estimates and possible funding solutions, planning and preliminary design, and systems design) are separated into different phases:

- Project Feasibility - option (alternatives) evaluation and business case
- Project Development - scheme design (planning), refinement of the business case, planning approval, funding solution development, public consultation (outreach), environmental assessment

► Detailed Design

These planning stages happen simultaneously, with some sequential phasing (i.e., business case and its refinement), and for the NLE these stages combined spanned four years. Similar stages of planning, environmental review, and design for the #7 Line spanned four to five years, from filing the generic review forms in 2003 to the public review through 2007.¹⁶⁶ Compared with New York's other transportation megaprojects, this process was considered an expedited review because only the City Environmental Quality Review (CEQR) was required. There was no federal funding for the #7 Line, which exempted it from the more onerous federal National Environmental Policy Act (NEPA).

Delving into the component costs of these metrorail line extensions, RPA found that New York City pays dearly for its stations, but receives less access and fewer amenities than peer projects in London and Madrid. Both the Line 9 and NLE include two new stations, while the #7 Line extension has just one. NLE station costs include connection into the existing terminal station. At a per-station analysis, including joint-development and intermodal facility costs, Madrid's Line 9's two stations cost the least among the three projects at \$14 million, which is significantly lower than both the NLE at \$211 million and #7 Line at \$746 million for the single new station, and \$114 million to retrofit the existing station (Table 13). For Line 9, a station averages \$13.5 million, and the NLE stations are anticipated to be \$106 million per station on average. Madrid builds stations exclusively using cut-and-cover. The #7 Line's single station at 34th Street – Hudson Yards, as mentioned earlier, cost a whopping \$746 million, consuming 33% of the project's overall costs. It is a deeper station at 125 feet below grade compared with the roughly 55 feet for Line 9 and NLE, both of which use cut-and-cover construction. The #7's deeper station was necessitated by the construction of tail-end tracks that extend beyond the terminal below the adjacent, depressed rail yards and other deep infrastructure under 11th Avenue to 25th Street.

Escalator and elevator construction consumes a higher percentage of station construction costs in Madrid (13%) and London (19%), than for the #7 Line (just 1 percent). The percentage is lower despite the #7 Line's escalators being longer by over 55% than any other in New York's subway system.¹⁶⁷ Additionally, over \$2.3 million was spent on biking, walking, and commuter rail access for Line 9, including parkland above the new station at Paco de Lucia and a mural that spans the entire mezzanine level of the station. And an anticipated \$2.6 million will provide bike-share, bike parking, bus and taxi drop-offs, and artwork at the NLE stations. The costs of Hudson Yards station amenities — open space, landscaping at entrances, and a small park at

¹⁶⁴ Flyvbjerg, Bent, Bruzelius, Nils, and van Wee, Bert. (2008). Comparison of Capital Costs per Route-Kilometre in Urban Rail. *European Journal of Transport and Infrastructure Research*. 8. 17-30.

¹⁶⁵ London Underground Staff

¹⁶⁶ MTA. #7 Line Project Documents. Updated March 20, 2017. http://web.mta.info/capital/docs_no7_alt.html (accessed November 2, 2016).

¹⁶⁷ Expert Interviews

34th Street — are partially borne by the project, as well as the City of New York and its real estate development partners. And some amenities, like the park, will come online years after the station’s opening.

Another key difference among the three metrorail projects is the variability in the costs associated with project and construction management. The highest management costs are those projected for the NLE at \$286 million (27% of total), likely due to the complexity of the redevelopment of the old Battersea Power Station adjacent to the terminal station. The management costs for the #7 Line are similar to the NLE’s share of the project costs, \$286 million or 27% of total project costs. By far the lowest costs for project and construction management are Madrid’s Line 9 at \$4.2 million (3% of overall costs). But when considering outcomes — greater track mileage for both Line 9 and the NLE, more than one station on both projects, and greater station amenities — the #7 Line’s management costs are excessively high.

The variability in construction and project management costs is likely due to the variability in the site environments. The #7 Line was built at brownfield sites with former warehouse and industrial uses. A portion of the NLE is being built underneath similar sites, but with significantly more residential areas adjacent to these industrial sites. Line 9 is built underneath established mid-rise residential neighborhoods.

There was no cost contingency provided for the projects abroad. The #7 Line had a much lower 5% cost contingency than most MTA megaprojects, and indeed most U.S. projects, which can have contingencies of 20%.¹⁶⁸ This contingency was not reported separately in the data provided. TfL stated that it specifically does not employ contingencies, rather it uses a proactive risk management process described above under the Crossrail profile. Consorcio Regional de Transportes de Madrid (CRTM), the regional authority coordinating transportation operations, provided no cost contingencies in their Line 9 report. Based on literature and interviews with Madrid Metro’s former president and CEO, Manuel Melis Maynar, contingencies may be low because contract disputes are resolved expeditiously. Schedule slippage is minimal as local politicians are very responsive to requests from Madrid Metro. Madrid Metro did not employ external project managers or engineers during the expansion of their metro system from 1995–2005: “Civil engineering and architectural elements [were] carried out by just three chief engineers, and six further engineers, all of whom were direct employees of the Madrid Regional Government [CRTM].”¹⁶⁹ Also, Melis noted instances in which the president of CRTM and the Regional Ministry of Public Works responded within 24

hours to requests for project approvals.¹⁷⁰ Given his prior tunneling experience, Melis does, however, recommend a 30% budget allocation to account for cost overruns on large public works.¹⁷¹

Unlike New York and London, Spain imposes profit restrictions on all public works projects. Overhead rates are limited to no more than 13% of material execution costs, and profit is limited to 6%. Profit rates are not explicitly outlined for projects in New York but, as noted above, MTACC and NYCT employ up to 21% overhead rates for contractor equipment on change orders.¹⁷² We could not determine how often similar overhead rates or profit limits are applied by MTA agencies on other capital construction line items.

Table 13: Summary Component Costs for Metrorail Expansion Project Comparative Analysis (\$ in millions)

	#7 Line Extension	Northern Line Extension	Line 9 Extension
Site Preparation*	Not reported separately	\$27 million	\$26 million
Tunneling & Track	\$331	\$146	\$37
Per track mile	\$110	\$37	\$9
Station Costs	\$746 new station	\$211	\$28
Per Station	\$114 retrofit	\$70	\$14
Vertical Circulation	\$13	\$40	\$3.60
Station Amenities	***	\$2.60	\$2.30
Systems: Signals, Power, Communications	\$122	\$106	\$9.70
Per track mile	\$40	\$27	\$2.50
Construction & Project Management	\$176	\$286	\$4.20
Contingency**	***\$105	NA	NA

*Includes utility relocation costs

**Estimated at \$105 million, 5% of the \$2.1 billion in costs for subway construction, excluding ancillary works (roadway construction, foundational work for adjacent development projects, etc.)

***Not reported separately from other project components

¹⁷⁰ Ibid.

¹⁷¹ Houses of the Oireachtas. “Visit by Spanish Delegation: Interview with Manuel Maynar Melis, director general of transportation in Madrid, Ildefonso de Matías Jiménez, Ricardo Gil of Metro Madrid, José Andres Gallegos of the Spanish Embassy.” Dublin: Houses of the Oireachtas, 2003. <http://oireachtas-debates.oireachtas.ie/Debates%20Authoring/DebatesWebPack.nsf/committeesetakes/TRJ2003061900003>

¹⁷² Office of the Inspector General MTA. “2015 Annual Report.” State of New York MTA Office of Inspector General. 2015. <http://mtaig.state.ny.us/assets/pdf/annual/2015.pdf> (accessed June 30, 2016).

¹⁶⁸ Project contingency of 5% based on expert interviews

¹⁶⁹ Maynar, Manuel Melis. “Madrid Metro and Railway Infrastructure 1995 - 2003.” Tunnel Builder. April 2003. <http://tunnelbuilder.com/metrosur/edition-2pdf/page2.pdf> (accessed January 20, 2016).

Project Profile

Line 9 Extension: Herrera Oria to Paco de Lucia - Madrid, Spain

Construction Complete

Extension Length: 2.7 miles

Track Mileage: 5.3 miles

New Stations: 2

- ▶ Mirasierra Station
- ▶ Paco de Lucia Station

Construction phases: 2

- ▶ Phase I to Mirasierra: 2009–2011
- ▶ Phase II to Paco de Lucia: 2011–2015

Construction Time Line

Six years

Tunneling Method(s):

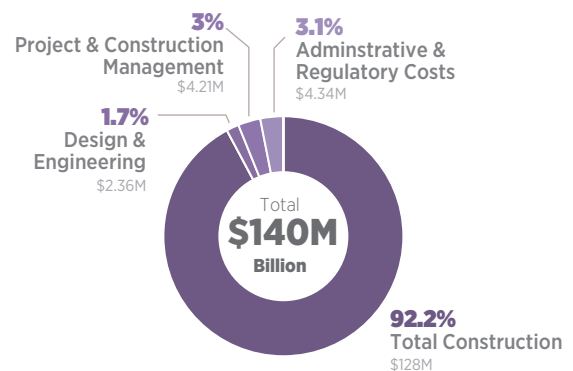
Cut-and-Cover (16% of tunneling costs), Tunnel Boring Machine (84% of tunneling costs)

Project Feasibility and Development (Planning and Design/Engineering Phases) Time Line:
Not specified

Environmental Assessment Process Time Line
Not applicable - separate from project process and costs

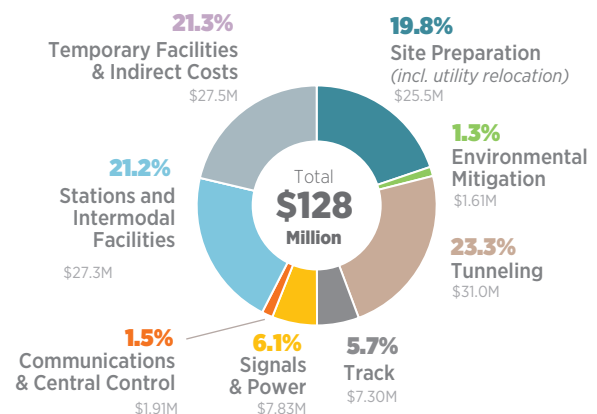
Est. Population Served at Mirasierra and Paco de Lucia Stations:
100,000

Figure 28: Line 9 Project Costs (U.S. 2016)



Source: CRTM

Figure 29: Line 9 Construction Costs Breakdown by Key Components (U.S. 2016)



Source: CRTM

The Key to Madrid's Success in Building Rail

Despite Spain's having a robust labor and safety environment, Madrid has led the world in effective and low-cost rail construction. Consulting firm BB&J analyzed Madrid's efficiency in capital construction in 2000 and concluded the city's success was due to several factors:¹⁷³

1. Full commitment at the regional political level (president of Regional Authority, minister of Public Works), that included ensuring project financing, on-time payments, and the contractor's full confidence in making a profit
2. A small and highly experienced project management team with full control over both technical and financial on-the-spot decisions
3. Contract procurement based not on the cheapest bid, but on sound technical and experience analysis, with the construction method specified by the administration
4. Fair prices that allow construction and supplier companies to have a reasonable profit
5. Strong involvement and direct regular presence in the field of top management officials

The active support by Spain's secretary of Transport and Infrastructure and the mayor of Madrid helped marshal resources and financing while addressing issues quickly for CRTM and Madrid Metro in line extensions like Line 9. Former CEO of Madrid Metro, Manuel Melis Maynar, has pointed out that on the MetroSur extensions, "All decisions by the top politicians with responsibility for the project, President Alberto Ruiz-Gallardón of the Regional Government of Madrid, and Sr Luis Eduardo Cortes, his regional minister for Public Works, were taken within 24 hours."¹⁷⁴ Such a timetable is unheard of in New York. That level of proactive involvement by political leadership to bolster public support and ensure prompt and decisive turnaround on project financing and road and system closures for construction works moves megaprojects forward.

Simpler Station Construction

Both the Mirasierra and Paco de Lucia stations are constructed with center running tracks and side platforms, unlike the #7 Line, which has an island platform. Like most Madrid stations, Mirasierra and Paco de Lucia were built using cut-and-cover, at a depth of 55 feet.¹⁷⁵ The stations have a split-level design for pedestrian circulation on both the mezzanine and platform levels. Escalators lead down

to the boarding platforms from the mezzanine. Both stations have a large main entrance. Mirasierra has a separate elevator at street level. Paco de Lucia includes a single station entrance plus an intermodal connection to RENFE, Spain's rail network, from the main entry to the elevated commuter rail station. Station architecture is uniform, with an open view from the mezzanine level down to the boarding platforms. The Paco de Lucia's open view displays a 3000-square-foot mural wrapping the station that's visible from both the mezzanine and platform levels. The station name and mural are a tribute to Spanish musician Paco de Lucia, who passed away the year before the station's opening. Also, a park and children's playground were built on the surface, running the length of the station.

Melis Maynar often points out that the simplicity of the metro station design, with wide platforms and basic materials having been one of Metro's key cost-saving tools. He also states that using cut-and-cover construction will add disruption, intensifying the importance of getting public support, which is crucial to the success of the Metro's rapid expansion: "In Madrid everyone understood we had to move the water lines, sewers, and electric lines. They understood that there would be disruption on the streets for three or four months, but it was for their benefit in that they would have a beautiful metro system. Everyone was supportive and understood that we had to divert traffic and close streets. It should not be a problem as it has been done everywhere a metro system has been built."¹⁷⁶



Photo: Sacyr

Labor Health and Safety Regulation

Madrid employs an integrated management program with regard to labor health and safety. Funds are set aside for technical assistance to ensure worker safety on Metro installations and rolling stock work. The allocation and

¹⁷³ BB&J Consult, S.A., The World Bank Group Urban Transport Strategy. "Review: Implementation of Rapid Transit. Final Report." World Bank, Washington D.C., December 2000. http://siteresources.worldbank.org/INTURBANTRANSPORT/Resources/rapid_transit_bb&j.pdf

¹⁷⁴ Maynar, Manuel Melis. "Madrid Metro and Railway Infrastructure 1995 - 2003." Tunnel Builder. April 2003. <http://tunnelbuilder.com/metrosur/edition-2pdf/page2.pdf> (accessed January 20, 2016).

¹⁷⁵ Houses of the Oireachtas. "Visit by Spanish Delegation: Interview with Manuel Maynar Melis, director general of transportation in Madrid, Ildefonso de Matías Jiménez, Ricardo Gil of Metro Madrid, José Andres Gallegos of the Spanish Embassy." Dublin: Houses of the Oireachtas, 2003. <http://oireachtas-debates.oireachtas.ie/Debates%20Authoring/DebatesWebPack.nsf/commit-teetakes/TRJ2003061900003>

¹⁷⁶ Houses of the Oireachtas. "Visit by Spanish Delegation: Interview with Manuel Maynar Melis, director general of transportation in Madrid, Ildefonso de Matías Jiménez, Ricardo Gil of Metro Madrid, José Andres Gallegos of the Spanish Embassy." Dublin: Houses of the Oireachtas, 2003. <http://oireachtas-debates.oireachtas.ie/Debates%20Authoring/DebatesWebPack.nsf/commit-teetakes/TRJ2003061900003>

regulation of these funds are directed by national safety laws and standards.¹⁷⁷ CRTM states that the Labor Health and Safety Program “is an important part of our construction project[s],” with the program striving to maintain worker health and safety, and proper training oversight with funds contributed on a per-project basis.

¹⁷⁷ Metro Madrid. “Directors’ Report and Corporate Social Responsibility (CSR) Report.” *Metro Madrid*. 2014. <https://www.metromadrid.es/export/sites/metro/comun/documentos/memoria/2014/Directorreport2014.pdf> (accessed February 20, 2016); and Villanti, Benjamin. “Subway Lessons from Madrid.” *City Journal*. Spring 2010 <http://www.city-journal.org/html/subway-lessons-madrid-13289.html> (accessed February 25, 2016).

Project Profile

Northern Line Extension Kennington to Battersea - London, United Kingdom

Under Construction

Extension Length: 2 miles

Track Mileage: 4 miles

New Stations: 2

- Nine Elms Station
- Battersea Station

Construction phases: Single

Construction Time Line:

Less than 5 years (anticipated opening 2020)

Tunneling Method(s)

Cut-and-Cover (34% of tunneling costs), Tunnel Boring Machine (64% of tunneling costs)

Project Feasibility and Development (Planning and Design/Engineering Phases) Time Line:
4 years

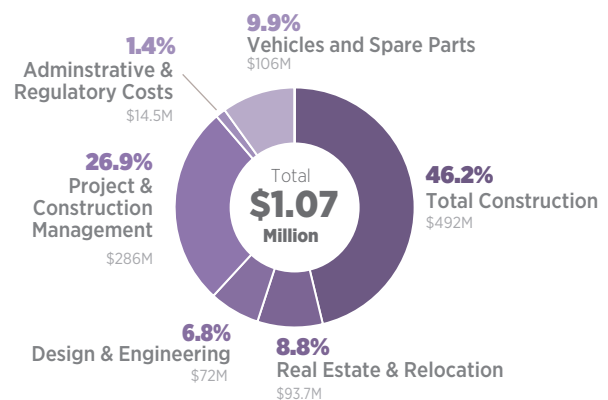
Including two and a half years of public consultation on project planning, detailed design and engineering, and refinement of the business case

Environmental Assessment Process Time Line
18 months

Anticipated long-term benefits include the creation of 25,000 new jobs and more than 20,000 new homes with redevelopment of Battersea Power Station.¹⁷⁸

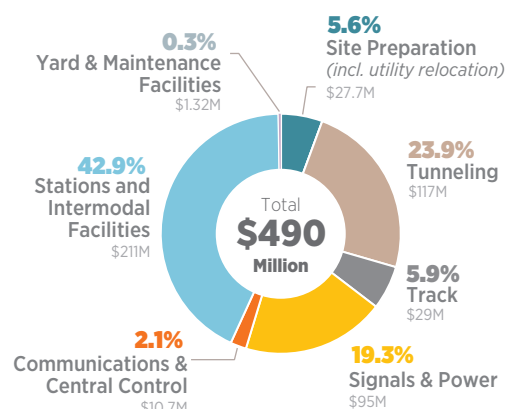
¹⁷⁸ Transport for London. *Northern Line Extension*. N.d. <https://tfl.gov.uk/travel-information/improvements-and-projects/northern-line-extension> (accessed November 2, 2016).

Figure 30: Northern Line Project Costs (U.S. 2016)



Source: Transport for London

Figure 31: Northern Line Construction Costs Breakdown by Key Components (U.S. 2016)



Source: Transport for London

Funding for the NLE includes a £1 billion (\$1.32 billion) infrastructure loan, of which 50% was sourced from local authority bonds, and the rest from the European Investment Bank. This loan will be repaid over the next 20 years through development contributions from the CIL and business tax rate contributions generated by businesses in the new commercial development surrounding the NLE.

Special Tax Assessment: London's Community Infrastructure Levy & Business Rates

Development in the Wandsworth Borough of London is the primary contributor of Community Infrastructure Levy (CIL) funds to the NLE. Due to its immediate adjacency to the NLE, the Nine Elms residential area has higher rates for CIL contributions for commercial and retail developments (\$13 per square foot) and residential (between \$35 and \$74 per square foot) than the rest of the Wandsworth Borough (\$0 for commercial and retail and \$33 per square foot for residential).¹⁷⁹ The broader Wandsworth Borough commercial and retail rates for the CIL are low to minimize impacts on and encourage the development of local businesses further from the Nine Elms district. Sixty-two% of the CIL collected from the borough is expected to go to the NLE; these contributions were formerly called Section 106 funds based on a community development agreement clause in the UK's Town and Country Planning Act of 1990. Over \$615 million in developer contributions have been agreed to and will primarily contribute to the NLE (Table 14).¹⁸⁰ The largest development contributors to the Nine Elms CIL are listed in Table 14 and include the U.S. State Department's \$10.3 million contribution from the New London Embassy.¹⁸¹

Joint Development – Battersea Power Station & Nine Elms Station

Similar to New York's joint development projects for the #7 Line extension and the more recent One Vanderbilt investments in GCT, the NLE stations incorporate joint-development projects with local real estate developers. TfL is working closely with Battersea Power Station Development Company (backed by several Malaysian developers: S P Setia Berhad, Sime Darby Property, and the Employees Provident Fund).¹⁸² The Battersea Station itself will contain retail space, a 2,000-person event complex, and residential apartments on the upper floors.¹⁸³ The surrounding site will

¹⁷⁹ Rates are based on a 1.32 USD to GBP 2016 exchange rate conversion sourced from *Nine Elms Community Infrastructure Levy (CIL) Charging Schedule*. July 11, 2012 https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjFrDTCgP_SAhUUwGMKHYPDgIQFggdMAA&url=http%3A%2F%2Fwww.wandsworth.gov.uk%2Fdownloads%2Fdownloads%2Fid%2F6315%2Fcommunity_infrastructure_levy_cil_charging_schedule.pdf&usq=AFQjCNF050h2hHDxqJ8UziTtTxTrGqXsIwg&sig2=0-BDywx4M8nRGtOtX79-Iw&bvm=bv.151325232,bs.1.d.eWE

¹⁸⁰ Nine Elms on the South Bank. "Section 106 & CIL." August 2012. <http://nineelmslondon.com/wp-content/uploads/2012/08/chapter-10-Section-106-and-CIL.pdf> (accessed March 10, 2017).

¹⁸¹ U.S. Embassy and Consulates in the United Kingdom. *New London Embassy*. N.d. <https://uk.usembassy.gov/our-relationship/new-embassy/> (accessed March 10, 2017).

¹⁸² Battersea Project Land Company Limited. *About Us*. 2015. <https://batterseapowerstation.co.uk/#1/go/view/app/aboutUs?view=aboutUs> (accessed March 10, 2017).

¹⁸³ Battersea Project Land Company Limited. *Battersea Power Station*. 2015. <https://batterseapowerstation.co.uk/#1/> (accessed March 10, 2017).

Table 14: Contributions to the Community Infrastructure Levy (Section 106 Agreements pre-2012)

Development Plan	CIL Contributions
U.S. Embassy	\$10,300,077
Lambeth (Various sites)	\$8,617,270
Battersea Power Station	\$346,722,706
Tideway	\$56,927,718
Marco Polo House	\$19,642,905
Embassy Gardens	up to \$90,653,684
Nine Elms Parkside	up to \$82,758,310
Total up to	\$615,622,670

Source:

include several thousand apartments, a hotel, additional office space, and a riverfront promenade. The developer is directly contributing funds to the station's design and construction costs in addition to the existing development projects at the power plant's adjacent sites. TfL will work with private developers to build Nine Elms Station.¹⁸⁴ The focus of these joint projects is to create transit-oriented development, recapturing land value increases from the new NLE stations. Eight development projects have been completed along the NLE corridor, with another 22 under construction and 23 under review or in predevelopment.¹⁸⁵ All development will contribute to the CIL based on square footage.

Streamlining Supply Chain and Procurement

In London, TfL began to standardize their equipment and supply chains across user departments and divisions through joint-procurement programs. Escalator and elevator designs had been tailored by project — sometimes virtually bespoke — to specific agencies. In 2010, a joint procurement for Crossrail and London Underground created a standard escalator contract agreement for all capital construction, followed by a similar joint procurement for elevators in 2012. TfL, which estimates a potential savings of 30% over the lifetime of the assets, saved 43% in capital costs after the first installation of escalators at Charing Cross.¹⁸⁶

¹⁸⁴ Nine Elms on the South Bank. *Construction Contracts*. 2017. <http://nineelmslondon.com/transformation/construction-contacts> (accessed March 10, 2017).

¹⁸⁵ Ibid.

¹⁸⁶ Her Majesty's Treasury. "Infrastructure Cost Review: annual report 2011-12." April 2012. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/205191/iuk_cost_review_report2012_230412.pdf (accessed March 10, 2016).

Construction Standards and Best Practices From Other Places

Denver

Denver is particularly noted in the literature and by experts for the procurement and financing innovations of its FasTracks program.

Diversified Funding

New models to pay for projects have prioritized capital improvements, diversifying funding pools and significantly increasing early funding, which in turn can buffer megaprojects against the pitfalls of insufficient budgets at the outset. Denver's Regional Transportation District (RTD) has been expanding commuter and light rail substantially in the past decade through FasTracks.¹⁸⁷ One of the key RTD reforms was the increase in local contributions solely dedicated to transit. In 2004, the region's voters approved by referendum a \$4.7 billion sales tax for FasTracks. Increases in the cost of construction during the housing boom of the mid-2000s produced a potential shortfall of at least \$1.5 billion for the full network build-out within a decade.¹⁸⁸ RTD employed a diverse array of public-private partnerships within its Eagle P3 program to fill the gap, including a concession to build the East Rail Line to Denver International Airport and direct local municipal contributions with private matching investments.¹⁸⁹ The full 122-mile build-out of Denver's LRT and commuter rail system is projected to finish in 2018.

Performance-Based Procurement

The procurement process and design practices of the traditional design-bid-build delivery model can add delays and costs. Even without undertaking new delivery models, changes to the project design that affect procurement can have an impact. As part of FasTracks, RTD simplified design specifications for its project bidders, emphasizing performance rather than the detailed design-level drawings. RTD's 30% design documents were provided as reference,

not as contractual standards — flexibility that allowed teams to underbid internal costs estimates by \$300 million.¹⁹⁰

Construction Manager/General Contractor Delivery Model

While much has been written about design-build in recent years, especially with regard to road and bridge projects, design-build has infrequently been employed for transit megaprojects. Denver is implementing new delivery models for heavy-rail megaprojects (not design-build, but similar) by effectively introducing innovative construction techniques and minimizing risk.

Denver RTD used the Construction Manager/General Contractor (CM/GC) delivery model for the West Rail Line project's civil and systems contracts. A CM/GC contract approach can vary from project to project, but the intent is to bring the contractor on early in the design phase rather than having a contractor bid to build after the project design is complete. RTD found that the CM/GC approach was more effective than traditional design-bid-build but that it could have been improved in the core area of reducing conflicts between the designer and CM/GC. Of particular issue was the later involvement of the CM/GC at the 65% design phase, when the design team was unwilling to make changes based on CM/GC's input. As one of the core lessons learned, RTD will bring CM/GCs on board at the 30% design level through a pre-construction services contract. Additionally, on future CM/GC contracts, RTD will create selection criteria for the designer contract that includes provisions for interfacing with a CM/GC. And they will colocate the design team, CM/GC, and agency project managers to maximize communication and promote teamwork, reducing conflicts in the design and construction stages.¹⁹¹

¹⁸⁷ Regional Transportation District of Denver. *FasTracks*. 2016 http://www.rtd-fastracks.com/main_91 (accessed November 10, 2016).

¹⁸⁸ Johnson, Fawn. "How Denver Leaders Pulled Off a Public Transit Miracle." *The Atlantic*. October 1, 2014. <http://www.theatlantic.com/business/archive/2014/10/how-denver-leaders-pulled-off-a-public-transit-miracle/425583/>

¹⁸⁹ Regional Transportation District of Denver. "Eagle P3 Project Procurement Lessons Learned." RTD. N.d. http://www.rtd-fastracks.com/media/uploads/main/Eagle_P3_Procurement_Lessons_Learned_final_with_cover_letter.pdf (accessed November 10, 2016).

¹⁹⁰ Regional Transportation District of Denver. "Eagle P3 Project Procurement Lessons Learned." RTD. N.d. http://www.rtd-fastracks.com/media/uploads/main/Eagle_P3_Procurement_Lessons_Learned_final_with_cover_letter.pdf (accessed November 10, 2016).

¹⁹¹ Regional Transportation District of Denver. "Program Management Lessons Learned West Rail Line Project." RTD. December 2014 <http://www.rtd-fastracks.com/media/uploads/wc/WRL-LL-Final.pdf> (accessed November 10, 2016).

Hong Kong

Joint Development and Value Capture

Hong Kong's MTR relies on three different finance models. The agency first determines the project's costs and potential revenues based on ridership demand, including initial capital expenses, replacement capex (lifecycle costs, which is not done in New York), operating expenses, revenues, and funding support. The identified funding gap will be filled using one of the following funding models:

- ▶ Rail+Property, which is essentially MTR-funded using the value recaptured by development. MTR could pay pre-rail premium for land to the government, but this can be rebated as well at the government's discretion.
- ▶ Cash Grant from government when there is little to no development potential but the government wants to improve access or add capacity to an existing corridor. Once built, however, the line is owned and operated by MTR.
- ▶ Service Concession, in which the construction is entirely funded by government. The infrastructure is also owned by government, and MRT plays annual lease payments for the assets under operations.

MTR will typically partner with a developer to build out the site, paying all or part of the land premium. The agency believes in owning brick and mortar assets — something tangible. While MTR's review process is short, its construction and development can take a decade or more. The development of the one-million-square-meter Kowloon station, for example, started in 1995, and was completed 16 years later in 2010, with the new Airport Express station opening in 1997. Commercial office development will complete the project.

Melbourne, Australia

Alliance Contracting Delivery Model

Local governments in Australia have adopted alliance contracting throughout many transportation capital projects. The core elements of alliance contracting are: "the collective assumption of risks by the alliance participants; best-for-project decision-making processes; a no fault—no blame culture; and a joint management structure."¹⁹² Alliance contracts have been increasingly employed in Australia for smaller capital projects, such as bridge replacements and roadway repair, and have been used recently for rail projects. In 2013, Trackstar Alliance completed an 8.5-mile rail line from Richland to Springfield, south of Brisbane. A single project team, Trackstar Alliance made up of staff

¹⁹² Australian Department of Infrastructure and Regional Development. "National Alliance Contracting Guidelines Guide to Alliance Contracting." Australian Government. September 2015. https://infrastructure.gov.au/infrastructure/ngpd/files/National_Guide_to_Alliance_Contracting.pdf (accessed November 10, 2016).

from Queensland Rail, engineering and design consultants, and construction firms, completing the project three weeks earlier than the original time line. Overall cost savings were \$221 million, with \$171 million in savings from the alliance contract bid coming in below the Queensland government's budget and an additional \$50 million saved during construction and design.¹⁹³ The project's full design was completed in less than a year¹⁹⁴ and construction spanned two years.¹⁹⁵ The combination of sharing project risks equally and the no fault-no blame culture among the alliance partners has resulted in few post-project damage claims or litigation.

Boston

In-Depth Subsurface Surveying

Boston's MBTA recently completed a review of prior capital projects' best practices and concluded that unforeseen site conditions and undocumented or poorly documented utilities increase costs and delays. Moving forward with construction on new capital projects such as the Green Line, the MBTA will need upfront conditions assessments, including test pits, utility surveys, and subsurface geotechnical examinations.¹⁹⁶

¹⁹³ Lawson, Chris, "Trackstar – Richlands to Springfield Practical Procurement Case Study." Griffith University. September 4, 2015 https://www.griffith.edu.au/_data/assets/pdf_file/0008/747647/C-Lawson-Presentation-EPPM2015.pdf (accessed November 10, 2016).

¹⁹⁴ Ibid.

¹⁹⁵ Thiess. DARRA TO SPRINGFIELD TRANSPORT CORRIDOR, STAGE 2 RICHLANDS TO SPRINGFIELD. 2016. <https://www.thiess.com/projects/darra-to-springfield-transport-corridor-stage-2-richlands-to-springfield/de-tail> (accessed November 10, 2016).

¹⁹⁶ Massachusetts Department of Transportation Rail and Transit Division. "The MBTA Station Modernization Program." MassDOT. September 28, 2010. https://www.massdot.state.ma.us/portals/0/docs/infoCenter/boards_committees/finance_committee/DCC_Lessons092810.pdf (accessed November 15, 2016).

Capital Construction Recommendations: Reforms and Strategies

The reforms and strategies recommended here target the major cost drivers identified from the case studies of the three MTA megaprojects and domestic and international comparatives of best practices in heavy-rail capital construction.

All recommendations point to the urgent need for governance reforms — be they the processes controlled by the government directly or the public and private institutions that are influenced by political actors. Structural changes in transportation governing bodies, which are addressed in RPA's Fourth Regional Plan, are not covered here. The following recommendations are organized by the same three categories used to identify the main project cost drivers earlier: politics and public process, institutions, and labor.

Politics and the Public Process

The current public process to debate transportation capital projects has become closed off, opaque, undemocratic, and litigious. Often the most effective tactic for shaping a project is to file a lawsuit, which can set a project back years.

Make constructability a top priority of environmental review.

Federal, state, and local environmental reviews should commission an independent analysis to weigh the potential costs and disruption to surrounding communities against the costs, both financial and environmental, of the most cost-effective construction plan. Construction costs should be given equal weight to other costs. Constructability assessments should be iterative and updated over the project's duration.

Environmental review should be rationalized.

The review time line should be substantially reduced from the current national average of 84 months. RPA suggested a series of reforms to the federal review process in *Getting Infrastructure Going: Expediting the Environmental Review Process*, released in 2012.¹⁹⁷ Some of these changes were

incorporated into President Obama's efforts to fast-track reviews, such as the "Permitting Dashboard" to foster collaboration between agencies, enhancing transparency.¹⁹⁸ Few of New York's international peers are burdened with long environmental review processes. New York should examine and adopt practices used by these cities, which can complete reviews in 18 to 24 months in part by separating public outreach, a business case for the project, and preliminary engineering from the environmental review process. Opportunities to streamline these processes must be identified and efforts taken to prevent them from being caught in the same bureaucratic malaise that encumbers reviews today. Performing these functions outside of, and often parallel to, the environmental review could slash months or years from the process.

Engage the public early in sustained, substantive discussion.

Far from being a public engagement strategy, environmental review is limited to public hearings on technical documents conducted well after projects have been largely selected and designed. To get broad acceptance of system improvements, the MTA must engage the public with greater frequency, clarity, and transparency. The MTA's sustained outreach to stakeholders as part of the 15-month L-train outage is taking place years before the start of construction. The MTA should replicate this approach on future projects. Another best practice the MTA has started to implement is the early opening of local community outreach and education centers, like the SAS Community Information Center recently opened on 125th Street and Park Avenue. These efforts must be supported and expanded.

Move to a ten-year pipeline for larger capital projects with regular maintenance and operating budgets.

The current five-year outlook is insufficient to plan and fund large-scale capital projects. In fact, much of the current capital budget includes relatively short-term maintenance tasks such as track replacement and signal/interlocking repairs. Such state-of-good-repair and normal replacement works should be combined with the operating

[org/pdf/RPA-Getting-Infrastructure-Going.pdf](http://pdf/RPA-Getting-Infrastructure-Going.pdf) (accessed January 20, 2017).

¹⁹⁸ Winkler, Andy. *Accelerate the Permitting Process*. Bipartisan Policy Center. February 2, 2017. <https://bipartisanpolicy.org/blog/accelerate-the-permitting-process/> (accessed January 20, 2017).

¹⁹⁷ RPA. "Getting Infrastructure Going: Expediting the Environmental Review Process." *Regional Plan Association Library*. June 2012. <http://library.rpa.org/>

budget and funded annually — a practice already adopted by most of New York’s peers. The MTA should prepare a ten-year capital plan for larger generational capital investments, and develop a dedicated funding/financing plan for each project, separate from its annual budget. To be effective, this reform would require sufficient dedicated revenue for both annual operating and long-term capital budgets.

Institutional Processes and Decision-Making:

Rather than being a single vertically integrated agency, the MTA is more a collection of discrete, independent, and loosely affiliated organizations, each with its own culture and priorities. Vertical integration was never completed, and political intervention has led to ever-shifting priorities as new agency heads have been appointed frequently. In the midst of all of this, MTACC was created in 2003 to provide expertise and oversight of the megaprojects in one centralized unit, and to remove the burden from the responsible operating agencies. Its effectiveness, however, has been widely criticized, and its creation added yet another layer of isolated bureaucracy within the MTA.¹⁹⁹

Adopt London’s project delivery model.

For each megaproject, create an independent Special Purpose Delivery Vehicle (SPDV), modeled on London’s Elizabeth Line. The temporary organization would have a single purpose: to construct the megaproject. While operating independently, the MTA would have a hand in the SPDV’s creation and oversight. The city and state would have equal representation on the SPDV board, enhancing coordination and cooperation with government agencies. This would address a fundamental shortcoming of the MTACC, which is that it has no authority over the operating agencies. This results in a tug-of-war between MTACC and the more powerful operating agencies, with construction professionals unable to meet deadlines due to constant changes made to the plans by their client agency. The SPDV would enable construction professionals to do their jobs, giving them the ability to push back and require supplemental funding from any agency proposing costly changes. This cost accountability would introduce a level of budget discipline that is missing today.

¹⁹⁹ See Hawkins, Andrew, and O’Kane S. “Inside New York City’s East Side Access, the biggest transportation project in America.” *The Verge*, November 5, 2015: <https://www.theverge.com/2015/11/5/9677300/manhattan-train-tunnel-project-grand-central-lirr-access>; Kabak, Benjamin. “On the MTA’s Capital Construction accountability problem.” 2nd Ave. Sagas, January 27, 2014: <http://secondavenuesagas.com/2014/01/27/on-the-mtas-capital-construction-accountability-problem/>; Office of the Inspector General MTA. “Governance Assessment of MTA Capital Program Mega Projects.” State of New York MTA Office of Inspector General. 2010. <http://mtaig.state.ny.us/assets/pdf/10-04.pdf> (accessed June 06, 2016); and, Rashbaum, William K. “Use of Mob-Linked Firm Shows M.T.A. Problem Vetting Subcontractors.” *New York Times*, May 19, 2010: <http://www.nytimes.com/2010/05/20/nyregion/20dirt.html>

Land use and utility work would also benefit from this new structure. With its control over land use, zoning, and streets, city government is in the best position to lead community outreach efforts and to negotiate with the major utilities. The city can, for example, order the utilities with city franchises to cooperate at little or no charge to the MTA. The MTA also has the resources of its own technical expertise, diverse funding sources, and the political constituency of the downstate region. Combined and coordinated, these two stakeholders would give the SPDV staff tremendous leverage and the ability to drive megaprojects forward with greater priority that would result in better outcomes.

Share the cost of holistic infrastructure investments, facilitated through equal stakeholder representation and engagement in the project.

Through the SPDV structure, future megaprojects would benefit from the city’s participation, which was evident in the #7 Line extension project. Unlike SAS and ESA, the MTA was not solely responsible for coordinating the utility work for the #7 Line, as property easements for subway purposes (station entrances and ventilation buildings) were acquired by the city from the property owners. Such agreements included terms pertaining to demolition of existing structures and site preparation, including utility relocations. The MTA also did not pay for these costs as part of the project budget. New York City covered them through its reciprocal relationships with the utilities or out of the general budget, or property owners paid for them. This collaboration could also serve as a catalyst for thinking more holistically about corridors and their infrastructure. Future subway projects could be used as opportunities to replace and upgrade aging utilities along the entire length of the corridor, making cut-and-cover construction feasible and lowering the lifecycle costs of new stations.

Maximize the land-use development potential of transportation investments, and leverage value-capture mechanisms to recover a portion of the project’s costs.

Future megaprojects must incorporate land-use and zoning changes to take full advantage and capture a portion of the value created through redevelopment opportunities. New York has only done this once, as part of the #7 Line extension, in which the city prepared a former industrial area for redevelopment to a mixed-use commercial center. ESA and SAS, whose economic impacts are more diffuse, could have leveraged redevelopment opportunities at new or existing stations that could have defrayed project costs and helped address the region’s housing and employment needs.

Expand project insurance and liability models.

Both London and Australia have adopted extensive insurance and liability models that ease the adversarial culture, creating a no fault-no blame culture. London has used Integrated Project Insurance (IPI) for both Heathrow Terminal

5 and Crossrail, while Australia employs alliance contracting. Both have been shown to reduce costs and delays. Under IPI, all parties on a project — consultants, contractors, and supply-chain providers — are insured under a single policy. The UK National Government has found that IPI schemes have the potential to reduce costs by 10 to 40% by early involvement of chain partners and reducing the adversarial relationship between project consultants and contractors. The MTA's OICP program should be expanded to cover all parties and provide additional protections for professional liability and the risks associated with delay.

Use design-build for all new major rail lines and extensions.

The MTA should replace its traditional design-bid-build procurement, which is primarily useful for targeted improvements on existing infrastructure, with design-build for major rail projects. Conventional procurement has added years to megaproject schedules. Design-build opens the door for greater creativity that can also produce budget savings by mixing design and contractor teams, allowing for better and closer collaboration from the outset, and eliminating the need to reconcile designs later. Contractors are able to evaluate the constructability of designs as drawings are produced, offering suggestions on cost savings based on their experience in the field.

Develop lessons learned and best-practice guidance as part of a post-project review.

Currently, costs are reported to the FTA for projects that receive federal funding, but there is no publicly released post-project review. A full post-mortem on each megaproject can help mitigate high costs on future projects by developing best practices to be employed during the project or act as lessons learned on the job. Other transit agencies, including Los Angeles, Denver, Madrid, and London, have used post-mortem reviews to evaluate the costs of construction for megaprojects. These documents are publicly available and build a knowledge base of lessons learned and best practices within and outside of these institutions. Denver's lessons learned on the Eagle P3 projects is shaping future public-private partnerships in its region, and Los Angeles Metro's review of construction practices is providing a framework for construction best practices on the Purple Line Extension. MTA and other transit agencies should institutionalize the practice of post-project construction cost reviews, sharing these lessons learned with the public and developing guidance to integrate cost-reduction strategies for future megaprojects.

Labor Practices and Work Rules:

Union labor costs account for a high proportion of total costs of megaprojects, meaning wages, benefits, and productivity. Construction labor costs in New York are the highest in the world, concluded Turner & Townsend, "Edging close to \$100 per hour."²⁰⁰ The rules governing workplace practices are a major cause. "If the union shops want to stick to the 100% building model, then 100% of them have to change and be competitive," said Louis Coletti, president and CEO of the Building Trades Employers Association (BTEA), the alliance of general contractors, subcontractors, and union construction managers.²⁰¹ Under the current system, productivity is impeded by a series of antiquated work rules negotiated between labor, contractors, and their representatives, and sometimes directly with the MTA, that have New York playing catch-up to other regions when it comes to leveraging the latest construction technologies and techniques. These rules resist reform in part because a series of baseline rules in collective bargaining agreements that were altered to meet the site conditions of each job in an opaque and inconsistent process. Nor does New York, like most global cities, have a central public clearinghouse for benchmarking and best practices.

Clearly distinguish capital and operating workforces.

Capital construction projects should be free to use third-party labor (trades) on jobs in and around active facilities in coordination with the relevant operating agencies. Today, MTACC must rely on the operating agencies' unionized labor force (force-account) for mandatory work involving safety, such as track flaggers. This constraint has delayed progress on the Harold Interlocking, where Amtrak has been unable or unwilling to provide its own labor, forcing the MTACC to add years to the ESA time line.

Reform outmoded, inefficient work rules.

It is imperative that the MTA, organized labor, and contractors work together to create a baseline series of work-rule reforms. Many project managers and contractors cite work rules as the major factor driving inefficiency and higher costs. Said one megaproject manager: "Our biggest cost issue is unionized labor, not because we pay too much on wages and benefits, but because of the work rules." Although none of the MTA managers, independent contractors, or contractor association would provide written work rules, which are in the collective bargaining agreements between contractors and unions, MTA managers provided many anecdotal examples of rules that impede flexibility,

²⁰⁰ Turner & Townsend, "International Construction Market Survey 2017: Building Momentum." Turner & Townsend. 2017. <http://www.turnerandtowntsend.com/media/2389/icms-survey-2017.pdf> (accessed January 15, 2017).

²⁰¹ Louis Coletti Interview with Cathy Cunningham, *Commercial Observer*, June 15, 2016 <https://commercialobserver.com/2016/06/we-want-coletti-btea-stalwart-lou-coletti-on-how-he-rose-through-the-ranks-and-what-lies-ahead-for-unions/>

ignore the physical realities of the job site, and require several levels of unnecessary backup personnel who remain mostly idle. Two reforms in overtime pay and staffing of tunnel boring machines (TBM's) could result in significant cost savings in and of themselves and indicate wider savings that could be achieved by examining the rules embedded in collective bargaining agreements.

- ▶ Institute an eight-hour day/40-hour week schedule for workers, with staggered start times or days of the week, ensuring shifts are filled when needed.
- ▶ Start overtime pay once a minimum 40-hour workweek has been met. Most MTA capital work is done on atypical schedules (other than M–F 9–5), when overtime premiums are highest. Rather than paying overtime pay when less than 40 hours has been worked, reasonable premiums for late-night and weekend shifts should be negotiated.
- ▶ Substantially reduce the number of workers staffing TBMs, follow the international practice of 9 to 15 workers rather than New York's 20 to 25. Through modern precast segments, TBMs have automated and streamlined many tunnel construction tasks, combining the tunnel boring, waterproofing, and concrete-lining steps into a single effort — resulting in substantial time savings and reductions in costs. However, higher staffing levels have negated many of these benefits and have contributed to the MTA's decision to use outdated manual and labor-intensive methods to construct tunnels.

Create a public institute to supply a well-trained pool of labor for the next generation of megaprojects.

New York has a more limited training program than cities like London. In large part because of state-imposed restrictions, the only significant construction-skills program is the Edward J. Malloy Initiative for Construction Skills. While the program is highly regarded, only a modest number of laborers were trained there over the past 13 years, just 1,442 graduates to fill the surging demand for construction jobs. It is estimated that 14,200 new positions will be added over the next few years. The institute could be hosted by New York State or a new not-for-profit entity supported by the state, industry, and unions to train the next generation of construction workers.



Regional Plan Association

Regional Plan Association is an independent, not-for-profit civic organization that develops and promotes ideas to improve the economic health, environmental resiliency and quality of life of the New York metropolitan area. We conduct research on transportation, land use, housing, good governance and the environment. We advise cities, communities and public agencies. And we advocate for change that will contribute to the prosperity of all residents of the region. Since the 1920s, RPA has produced four landmark plans for the region, the most recent was released in November 2017. For more information, please visit www.rpa.org or fourthplan.org.

New York

One Whitehall St, 16th Floor
New York, NY 10004
212.253.2727

New Jersey

179 Nassau St, 3rd Floor
Princeton, NJ 08542
609.228.7080

Connecticut

Two Landmark Sq, Suite 108
Stamford, CT 06901
203.356.0390

Board of Directors

Chairman

Scott Rechler*

President & CEO

Thomas K. Wright*

Chair, Advancement Committee

Marcia Bateson*

Co-Chair, New York Committee

Robert L. Billingsley*

Co-Chair, Connecticut Committee

Michael J. Cacace

Co-Chair, Connecticut Committee

Michael J. Critelli

Vice Chair

Douglas Durst

Co-Chair, New Jersey Committee

Hon. James J. Florio

Counsel

David Huntington*

Co-Chair, New Jersey Committee

Paul Josephson*

Treasurer & Co-Chair, Long Island Committee

Matthew S. Kissner*

Co-Chair, Communications Committee

Marc Ricks

Co-Chair, Communications Committee

Janette Sadik-Khan

Co-Chair, New York Committee

Lynne B. Sagalyn

Chair, Nominating Committee

Marilyn J. Taylor*

Secretary of the Corporation

Juliette Michaelson

Rohit Aggarwala*

David Armour*

Charles Avolio

Giacomo Barbieri

Stephen R. Beckwith

Eugenie Birch

Robert Blumenthal

Mark Blumkin

Anthony Borelli

Jo Ivey Boufford

James J. Brinkerhoff

Tonio Burgos

Vishaan Chakrabarti, AIA

Kevin Chavers

Jun Choi*

Frank Cohen

Hon. Anthony R. Coscia

Steve Denning

Thomas Patrick Dore, Jr.

Eva Lauren Durst

Winston Fisher

James F. Fitzgerald

Doreen Frasca

Timur F. Galen*

Jonathan Goldstick

Christopher Hahn

Rachel Haot

Richard Haray

Suzanne Heidelberger

Peter W. Herman

Dylan Hixon

Kerry Hughes

Kenneth T. Jackson

Sabrina Kanner

Anaita Kasad

Gregory A. Kelly

Thomas Klin

Hope Knight*

Mitchell A. Korbey

Ben Korman

Judith Lagano*

Christopher LaTuso

Jill Lerner*

Trent Lethco*

Mark Marcucci

Andrew Mathias

Douglas McCoach

Jan Nicholson

Richard L. Oram

Kevin J. Pearson

Seth Pinsky*

Clint Plummer

Jason Post

Thomas Prendergast

Milton Puryear

Hon. Richard Ravitch

Gregg Rechler

Michael J. Regan

Denise M. Richardson*

Todd Richman

Marc Ricks*

Gary D. Rose

Janette Sadik-Khan

Elliot G. Sander

John Santora

Samuel Schwartz

Peggy Shepard

Tokumbo Shobowale

H. Claude Shostal

Ryan Simonetti

Monica Slater Stokes

Susan L. Solomon

Robert K. Steel*

Robert Stromsted

Michael J. Sweeney

Kent Swig

Sharon C. Taylor

Richard T. Thigpen

Darryl Towns

Jane Veron

Kevin Willens

Robert D. Yaro

Directors Emeriti

Edward J. Blakely

Barbara J. Fife

Marc Joseph

Charles J. Maikish

Luther Tai

*Member of Executive Committee