Impacts of Deferred Investment on Capital and Operating Budgets

Case Studies for the
Metropolitan Transportation Authority

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December 13, 2004

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Contents

Overview of Case Studies

Case Study Name	Agency	Project Type	Award (Duration)	Scenario Tested
Railcar Lifecycle Maintenance Investments	LIRR	NR/SI	2005 (10 yrs.)	No Build
Jamaica Bus Depot Replacement	NYCT	SGR	2007 (3 yrs.)	5-Yr Delay
Cross Bay Bridge Deck Rehabilitation	B&T	NR	2005 (3 yrs.)	9-Yr Delay
Verrazano Bridge Deck Replacement	B&T	NR	2008 (3 yrs.)	2-Yr Delay
Commuter Rail Power Distribution	MNR	NR	1984 (7 yrs.)	5-Yr Delay
Commuter Rail Concrete Tie Installation	LIRR	NR	2005 (4 yrs.)	No Build

Conclusions

Project Name[1]	Useful Life (Years)	(Millions of Dollars) Capital Cost[4]	Net Budget Impact[5]	2005 Net Present Value	Budget Impact vs. Capital Cost
Railcar Lifecycle Maintenance Investments	25[2]	$167.6	$422.2	$35.6	252%
Jamaica Bus Depot Replacement	100	$130.0	$30.0	-$4.6	23%
Cross Bay Bridge Deck Rehabilitation	50	$48.8	$42.2	$34.1	547%
Verrazano Bridge Deck Replacement	50	$165.0	$93.9	$18.0	57%
Commuter Rail Power Distribution	35[3]	$207.9	$63.9	$10.8	31%
Commuter Rail Concrete Tie Installation	50	$116.2	$239.7	$10.2	214%

[1] These cases are not directly comparable, but illustrate that SGR and NR investments bring long-term savings across a variety of capital systems.

[2] Project has a useful life of 50+ years, but analysis was terminated at 25 years due to data constraints.

[3] Useful life of a substation is 35 yrs, and useful life of 3rd rail is 50 yrs; analysis assumed 35 years.

[4] In current (year of expenditure) dollars.

[5] Total lifecycle savings in current dollars.

Case Study 1

Railcar Lifecycle Maintenance

Project Name: Improvement to support facilities needed for LIRR Lifecycle Maintenance Program (LCM), including modifications of Heavy Equipment Repair and Overhaul (HERO) facility.

ID Number: n/a

Overview: This project would reduce rolling stock maintenance costs by facilitating more efficient operations, improving working conditions, and enabling the agency to transition to a scheduled maintenance regime.

Cost: Various improvements $62.1 million; HERO modifications $105.5 million.

Status: Master plan

Existing Condition: Most facilities are in good repair; however, existing conditions will not allow full implementation of the lifecycle maintenance program.

Schedule: HERO facility proposed 2006; other components 2005-2014.

Railcar Lifecycle Maintenance
Why make this investment?

Upgrades are needed to minimize long-term maintenance costs.

Facilities need to be modified to meet requirements necessary for LIRR's transition to a new "lifecycle maintenance" (LCM) strategy.

- Under current practice, most maintenance needs are identified by periodic inspections or by operating crews, or on regular but uncoordinated cycles.
- Under LCM, most maintenance is carried out on a pre-determined schedule to minimize duplication of major work tasks and minimize risk of equipment failures in the field.

Railcar Lifecycle Maintenance
Why make this investment?

The benefits of LCM include:

- Improved fleet reliability which improves on-time performance.
- Improved fleet availability which enables the same service to be operated with a smaller fleet.
- Reduced maintenance costs which results in efficiencies achieved through coordinating work in tandem.

Additional benefits of these investments include:

- Reduced worker safety risks; less difficult working conditions.
- Reduced costs of maintaining deteriorating facilities.
- Improved operational flexibility, due to the reduced dependence on storage tracks for rolling stock maintenance activities..

Railcar Lifecycle Maintenance
Why make this investment?

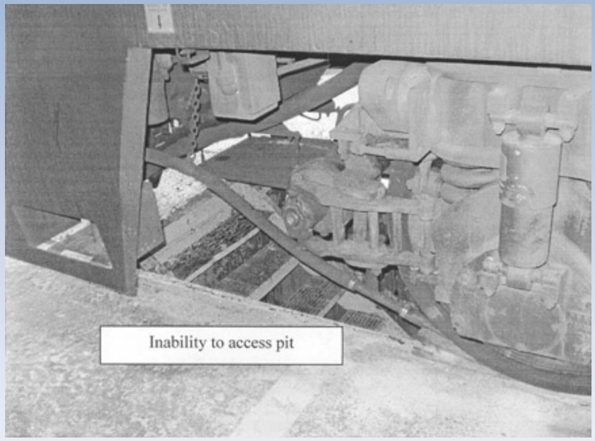
These investments would facilitate the implementation of LCM, and also solve numerous operations problems with current facilities:

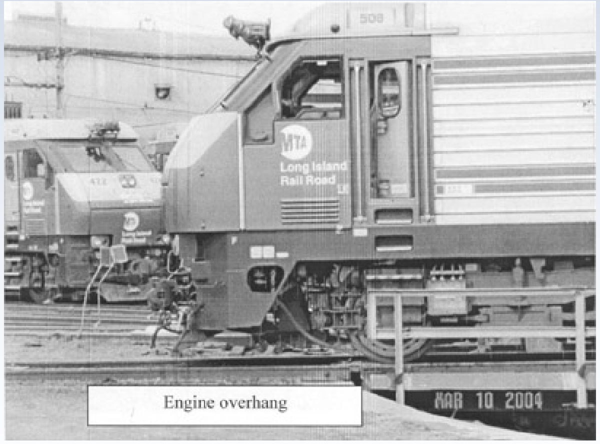
- Inadequate working space Space requirements for component maintenance such as trucks severely limits the number of simultaneous car repairs.
- Obsolete facilities While not a direct LCM investment, existing 100-year-old roundhouse and turntable are not designed to handle the weight and length of today's fleet.
- Potentially unsafe conditions Repair pits are smaller than the rail cars that they are used to maintain.
- Poor working environments Doors cannot be closed in winter because rail cars are too big; leaking roofs; etc.

Railcar Lifecycle Maintenance
Why make this investment?

Interim Locomotive Shop lacks space for engine overhauls required for LCM.

Pits at Morris Park Roundhouse are inaccessible when train is in position, hampering even routine maintenance.





If Morris Park Turntable were to break down due to the excessive loads, most heavy maintenance work would come to a halt.

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Railcar Lifecycle Maintenance
Key assumptions

Scenario Tested: Modify and outfit new and existing facilities to enable the transition to full a Lifecycle Maintenance Program vs. maintain existing practice

Key Assumptions:

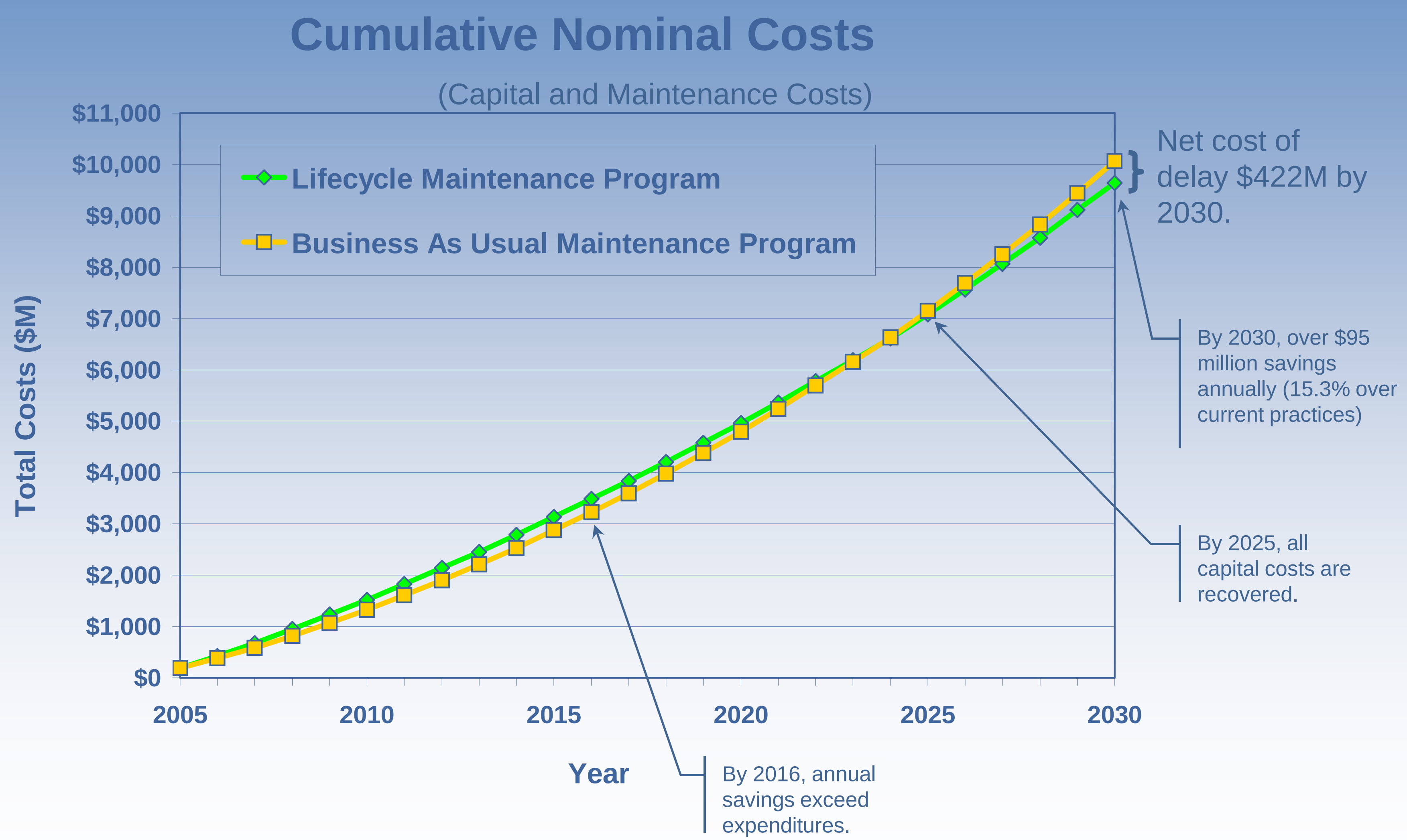
- Business-as-usual (BAU) assumes periodic inspection and maintenance costs are 80% of those under LCM; without LCM major costs increase 6% annually; other costs grow with inflation.
  - These BAU assumptions produce a net cost escalation of 3.9%. Historic LIRR cost escalation has been 5%, so these assumptions are conservative.
  - A sensitivity analysis was conducted on the assumed cost of major repairs.
- LCM scenario uses LIRR's detailed cost projections over 25 years.
- Worker availability and fringe benefits add 62% to the nominal cost of labor.
- LCM enables spare ratio to be reduced from 13.7% to 11.1%, resulting in a future fleet reduction of 32 cars for this study (a.k.a. the "redundancy tax").
- Not included: benefits from safer and better working conditions, more reliable service, and reduced need for train-moving crews.

Railcar Lifecycle Maintenance
Cost-benefit analysis results

Impact	Net Year-of-Expenditure Costs ($M)	Description
"Reliability Tax"	**$317.5**	Difference between higher unscheduled major repairs and lower scheduled maintenance.
"Efficiency Tax"	**$0.0**	
"Redundancy Tax"	**$249.0**	Capital and operating costs from larger fleet.
"Capital Tax"	**-$144.2**	Capital savings from not building new maintenance facility.
Cost Escalation	**$0.0**	
Net Budgetary Impact	**$422.2**	Net cost of business-as-usual scenario

- Although periodic inspection and maintenance costs are 20% higher, LCM saves on unscheduled major repairs and a lower spare ratio.
- The LCM capital investments yield savings of 252% of the capital cost.
- Including inflation and borrowing costs, investing now has a $35.6 million present value benefit (in 2005 dollars).

Railcar Lifecycle Maintenance
Cost-benefit analysis results



Railcar Lifecycle Maintenance
Sensitivity Analysis

Cautionary note:

The results are highly dependent on the assumptions about the growth in running repair costs in the base case scenario.

Growth Rate Assumed for BAU Running Repair Costs*	Aggregate BAU Maintenance Cost Growth Rate, Per Car**	Net Present Value of Switching to LCM
5%	3.5%	-$163.1 M
6%	3.9%	+$35.6 M
7%	4.3%	+$272.6 M
8%	4.8%	+$556.0 M

**This case study assumes a growth rate for BAU Running Repair Costs of 6%*

***Historic rate over past 10 years has been 5%.*

"BAU" = Business as Usual

Case Study 2

Jamaica Bus Depot

Project Name: Replacement of Jamaica Bus Depot

ID Number: Planning Number SF06-6024; ACEP T5120305

Overview: This project would reduce bus maintenance costs by facilitating more efficient operations.

Cost: $125M construction; $5M property acquisition

($5M in design and engineering costs committed in previous capital program and not included here).

Status: Master plan

Existing Condition: Not in state of good repair; overall condition level 4 (major capital improvement needed).

Schedule: Construction proposed for 2007-2010.

Jamaica Bus Depot
Why make this investment?

Need for project:

- The existing Jamaica Bus Depot is obsolete and is not in a state of good repair.
- The facility has not kept pace with the needs of an evolving fleet
  - Today's fleet has buses of varying lengths, some of which are too big for existing facilities.
  - Maintenance of rooftop air conditioning units is difficult in facilities that lack the proper work platforms.
  - Not all facilities can handle the maintenance and refueling needs of alternative fuel vehicles.
- The facility lacks the capacity and workspaces needed to maintain buses safely and efficiently.

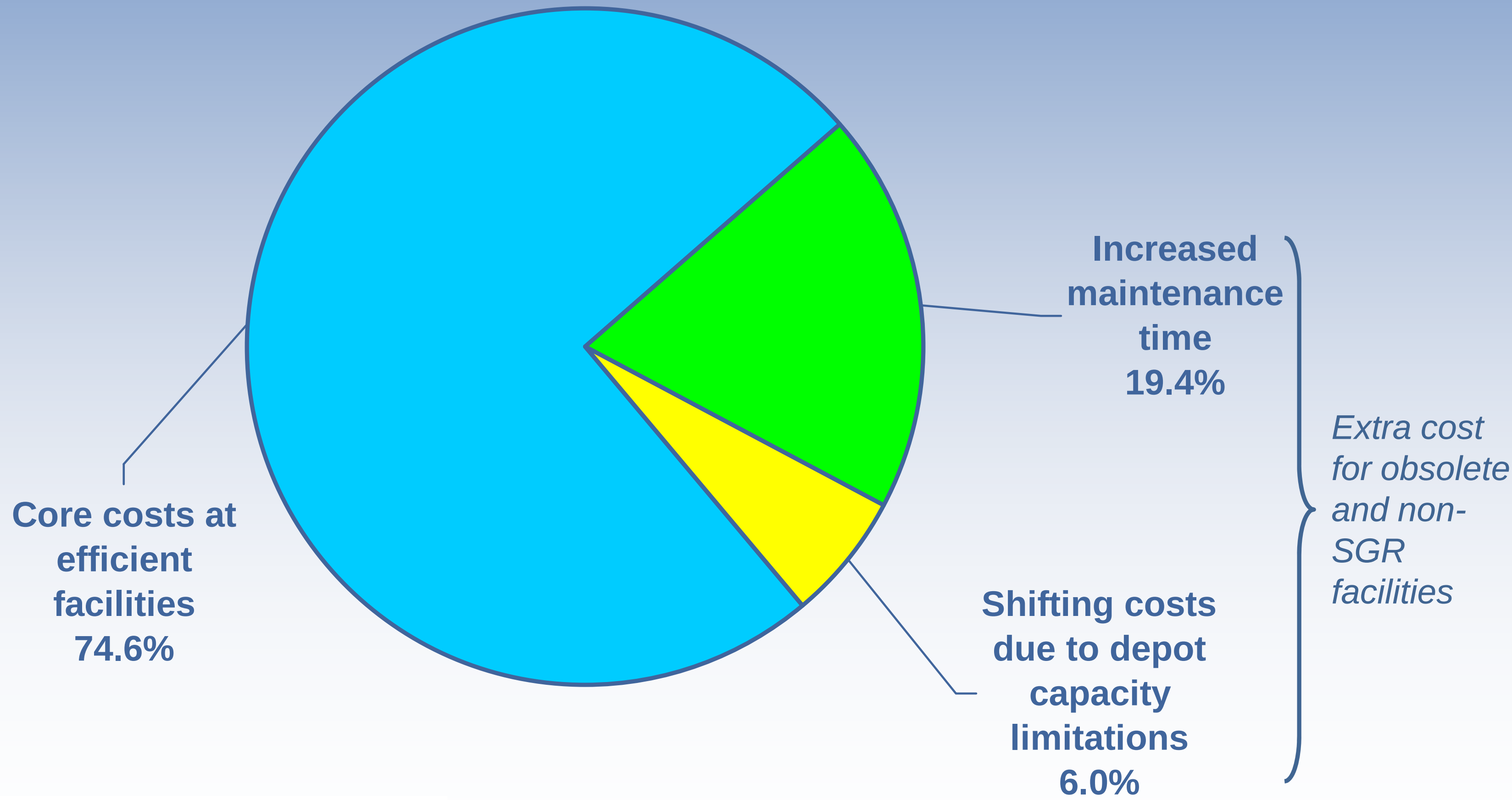
Jamaica Bus Depot
Why make this investment?

Bus depots that are overcrowded and not in a state of good repair have labor costs 34% higher for bus maintenance and bus shifting.

Type of costs	Cost per bus per year
Labor costs for maintenance and bus shifting at efficient facilities	**$26,958**
Additional cost per bus in facilities not meeting modern standards and in a state of good repair.	**$9,172**
Increased time per maintenance task due to inefficient workspace clearances and configurations.	$6,996
Additional bus shifting costs due to capacity and storage limitations.	$2,176
Total labor cost for maintenance and shifting in substandard depots	**$36,131**
"Efficiency Tax"	**34.0%**

Jamaica Bus Depot
Why make this investment?

Labor Costs for Bus Maintenance and Shifting at a Non-SGR Facility



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Jamaica Bus Depot
Key assumptions

Scenario Tested: Project is deferred 5 years to the next capital plan.

Key Assumptions:

- The new Jamaica Depot would match the system's highest-performing depots in terms of shifting costs and labor costs for bus maintenance.
- The new facility would serve 250 vehicles, drawing 191 from the existing Jamaica Depot, 29 from Queens Village, and 30 from Casey Stengel.
- In the absence of this investment, there would be no deterioration of existing conditions at Jamaica Depot
- Useful life of the facility is 100 years

Not included in this analysis:

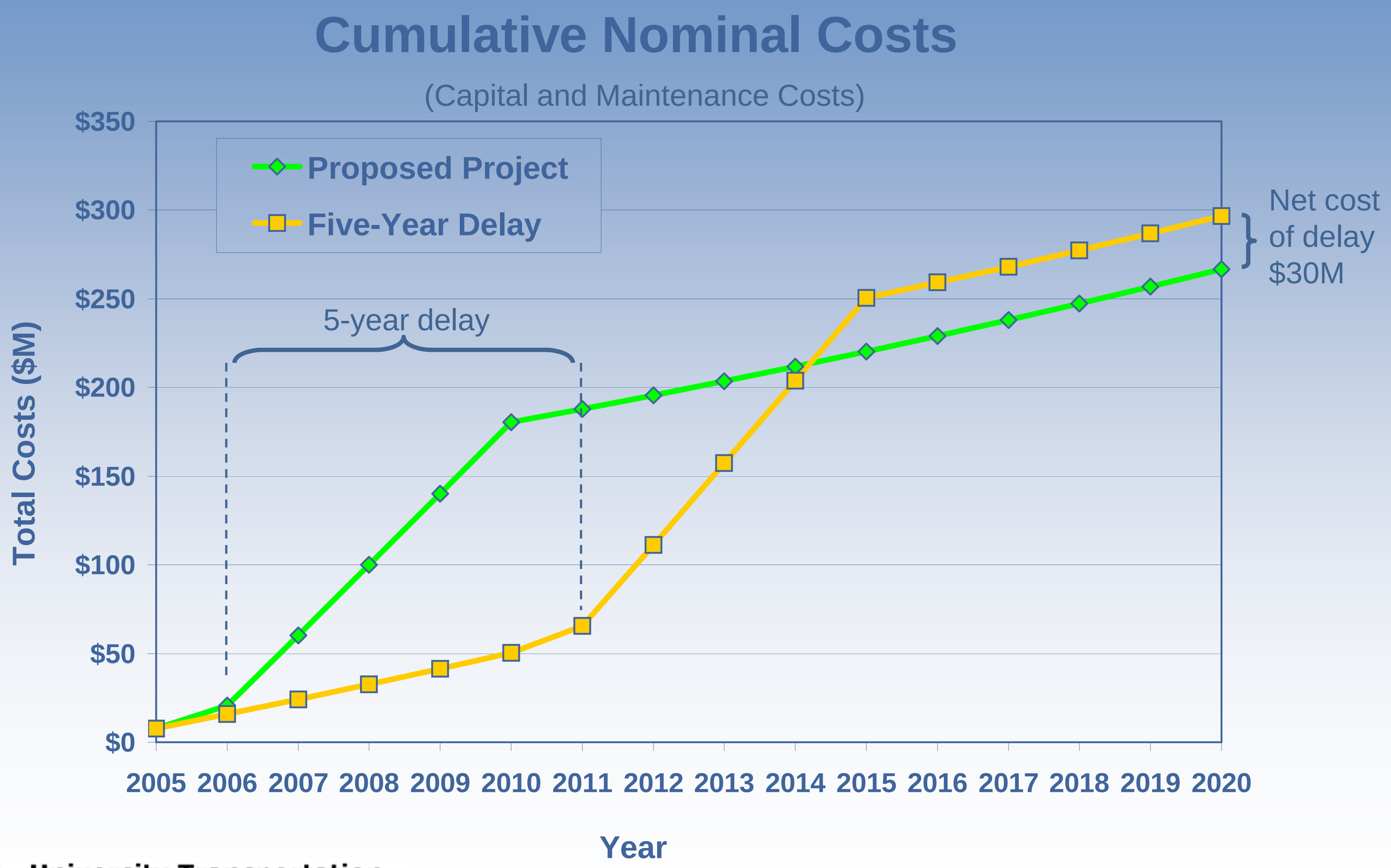
- Improved working conditions for MTA employees
- Reduced maintenance costs for deteriorating Jamaica facility
- Avoided costs of handling hybrid-engine vehicles.
- Potential that improved maintenance and vehicle storage will reduce lifecycle costs

Jamaica Bus Depot
Cost-benefit analysis results

Impact	Net Year-of-Expenditure Costs ($M)	Description
"Reliability Tax"	**$0.0**	
"Efficiency Tax"	**$9.3**	Reduced bus shifting needs, and reduced time per maintenance task.
"Redundancy Tax"	**$0.0**	
"Capital Tax"	**$0.0**	
Cost Escalation	**$20.7**	Five-year delay in construction and land acquisition.
Net Budgetary Impact	**$30.0**	Net cost of five-year delay

- Building the depot now saves $30 million (in current-year dollars) compared with delaying the investment for five years.
- A 5-year delay effectively adds 23% to the capital cost of pursuing the project now.

Jamaica Bus Depot
Cost-benefit analysis results



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Case Study 3

Cross Bay Bridge Deck Rehab

Project Name: Deck and Structural Rehabilitation at Cross Bay Bridge

ID Number: D501CB08.

Overview: Originally a $7.7M repaving project scheduled for 1997, but was repeatedly postponed due to budget constraints. After nine years of delay, this has grown to a major rehabilitation project.

Cost: $48.8M

Status: Final design.

Existing Condition: Major structural repairs required.

Schedule: Construction proposed for 2005-2008.

Cross Bay Bridge Deck Rehab
Why make this investment?

Need for project:

- The 9-year delay of this project has led to further deterioration of the structure and a sharp increase in the scope of the project.
- All closure pours, deck joints, asphalt wearing surfaces, and concrete barriers, and some navigation channel spans must be replaced.
- Most T Girders have cracks, spalls, and/or deteriorating anchorages, and require substantial, expensive repairs.
- Deterioration is accelerating now that salt water is able to reach the steel components of the structure.
- Small structural failures are already occurring on the bridge. In 2003, a concrete section collapsed, creating hazardous roadway conditions.
- There is a growing risk of structural failure. Further delays could cause navigation spans to approach failure, requiring costly emergency repairs to prevent progressive collapse.

Cross Bay Bridge Deck Rehab
Why make this investment?

Collapse of closure pour in 2003 created hazardous conditions for motorists and required $50,000 in emergency repairs.

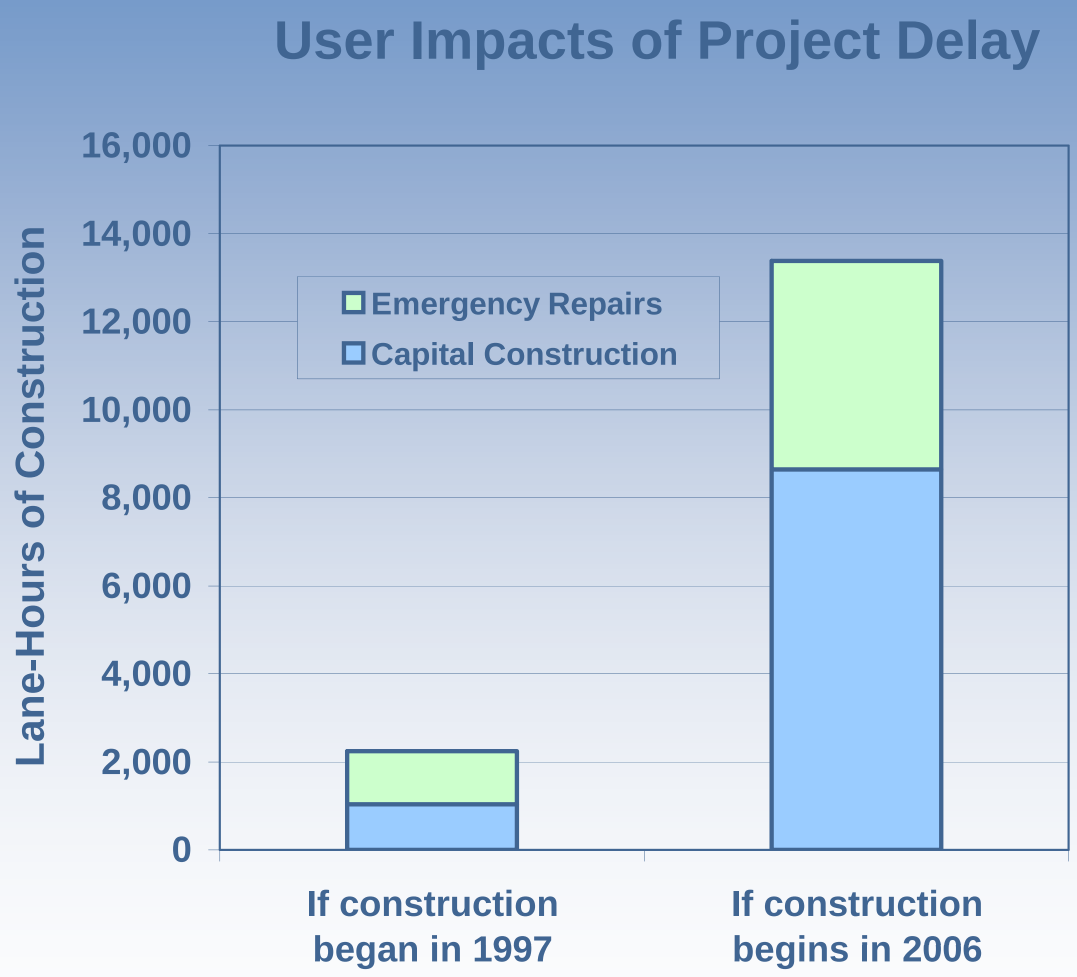
Rebar and tendons exposed and corroding due to deferred maintenance

Cross Bay Bridge Deck Rehab
Why make this investment?

User Costs of Delays:

- Expanded project scope added 7,600 hours of lane closures, a 730% increase.
- Delay also added 3,540 lane-hours of emergency repairs, a 295% increase.
- There will be 10.8 million additional vehicle trips during construction period, due to traffic growth and longer project duration.

Cross Bay Bridge Deck Rehab
Why make this investment?



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Cross Bay Bridge Deck Rehab
Key Assumptions

Scenario Tested: Current proposal vs. beginning project 9 years earlier (constructing project in 2006 as is currently being considered vs. in 1997 as originally proposed).

Key Assumptions:

- Timely completion of the original repaving and waterproofing project would have prevented the subsequent expansion in the scope of work needed.
- All maintenance costs in excess of the average maintenance costs for a bridge this size are due to the deferred maintenance.
- No social costs from the increased potholes and duration of construction are included in the cost-benefit analysis.

Cross Bay Bridge Deck Rehab
Cost-benefit analysis results

Impact	Net Year-of-Expenditure Costs ($M)	Description
"Reliability Tax"	**$1.1**	Increased maintenance and emergency repairs.
"Efficiency Tax"	**$0.0**	
"Redundancy Tax"	**$0.0**	
"Capital Tax"	**$38.7**	Increased project scope.
Cost Escalation	**$2.3**	Nine year delay in construction.
Net Budgetary Impact	**$42.2**	Net cost of nine-year delay.

- Accounting for inflation and borrowing costs, investing in this project in 1997 would have had a $34.1M present value benefit (in 2005 dollars).
- The 9-year delay effectively added 548% to the original capital cost of the project.

Cross Bay Bridge Deck Rehab
Cost-benefit analysis results

Case Study 4

Verrazano Deck Replacement

Project Name: Rehabilitation of the Upper Deck Suspended Spans of the Verrazano Narrows Bridge

ID Number: D501VN80.

Overview: Upper level deck is due for replacement. Delay will mean sprialing costs, as the deck quality degrades and other contingent construction projects are themselves delayed.

Cost: $165 million.

Status: Master plan.

Existing Condition: Facility is in SGR but requires normal replacement. Condition is deteriorating rapidly because of high levels of truck traffic.

Schedule: Construction proposed for 2008-2011, phased over two capital programs

Verrazano Deck Replacement
Why make this investment?

Need for Project:

- The deck is in a deteriorated state, and interim repairs have been unsuccessful at preventing further deterioration.
- Over 25% of the deck has already seen temporary repairs, leading to a patchy and uneven surface.
- Each year, an additional 8% of the deck surface becomes degraded, leading to potholes and emergency repairs.
- Sharp growth in truck traffic due to post-9/11 restrictions.
- Project must be completed in order to minimize emergency work on upper deck, so other capital projects can proceed efficiently.

Verrazano Deck Replacement
Why make this investment?

Delaying this project will:

- Postpone other capital projects on the bridge, because construction projects on the bridge must be carefully phased and coordinated.
- Increase the scope of other capital projects. At greatest risk is the lower deck rehabilitation project (VN-80B). If not completed soon, a full replacement will become necessary, sharply increasing its cost. But VN-80 must be completed for this project to proceed.
- Increase in potholes and emergency repair work in the interim years before the project begins, and extend the duration of construction, as a result of increased project scopes.
- Impose a number of social impacts, including damage to vehicles from poor pavement conditions, and increased congestion and air pollution due to more hours of construction-related lane closures.

Verrazano Deck Replacement
Why make this investment?

Delay will also bring significant user impacts:

- 177 million additional vehicle trips during construction period, due to 0.85% annual traffic growth and longer project duration.
- 9,480 more lane-hours of emergency repairs due to worsening deck conditions (an 8.3% increase), increasing congestion and pollution.

> *“Long term lane closures and unplanned emergency repairs will become customary if deck deterioration is not arrested.”*
>
> *—MTA Bridges & Tunnels staff*

- Significant impacts on express bus operations between Staten Island and Manhattan, as well as regional freight movement.
- 4-yr delay in the opening of new bus/HOV lane on the bridge, deferring key mobility and environmental benefits to 2017.

Verrazano Deck Replacement
Key assumptions

Scenario Tested: Project is deferred 2 years (begin construction in 2010 instead of 2008).

Key Assumptions:

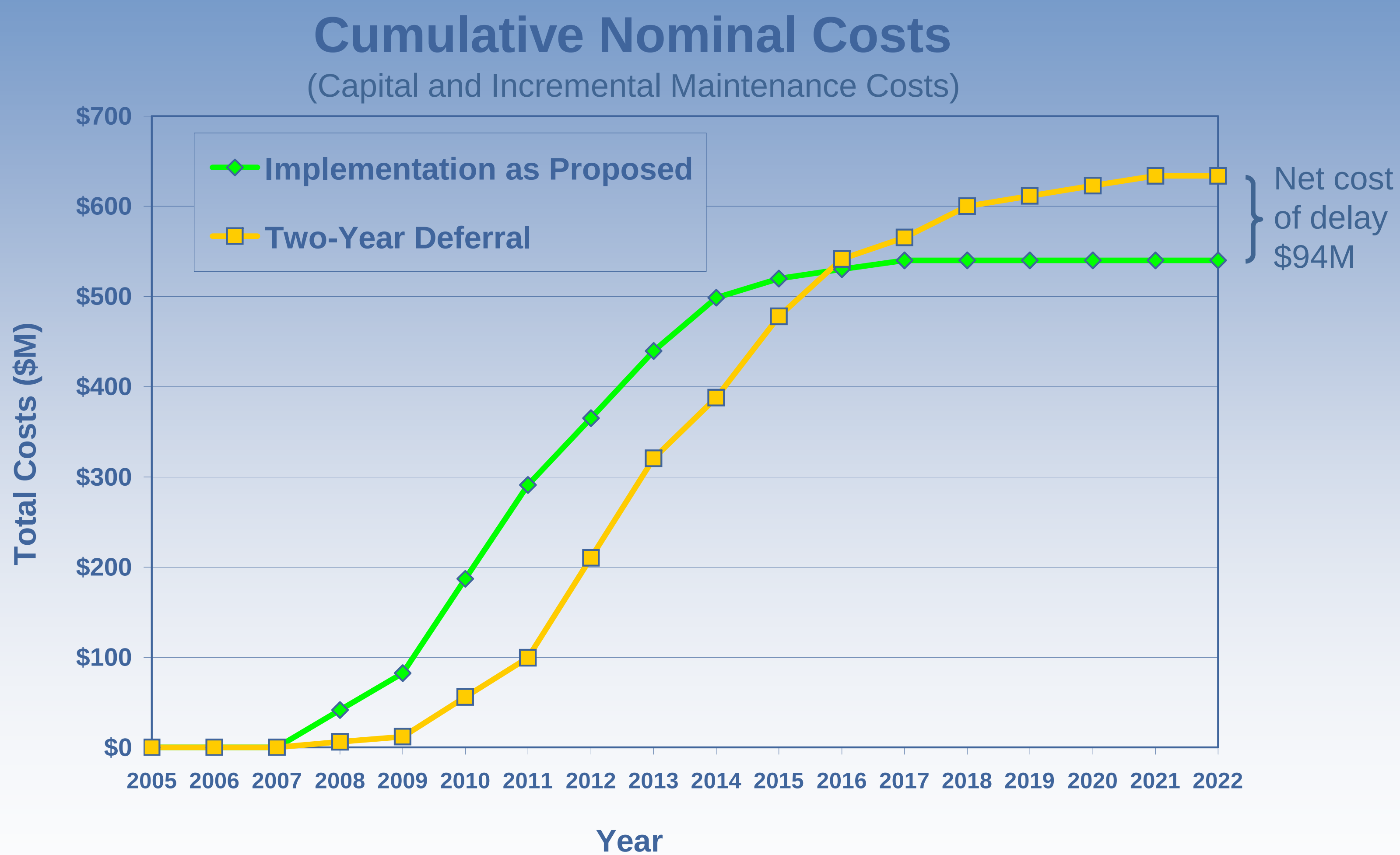
- Postponing this project will delay four other projects by 2-4 years.
- This delay will require the scope of another project – rehabilitation of the Lower Level deck (VN-80B) – to be expanded into a full deck replacement project. This will roughly double its cost.
- Annual maintenance costs for Upper Level deck are $6 million per year higher than they would be for a facility in a state of good repair.

Verrazano Deck Replacement
Cost-benefit analysis results

Impact	Net Year-of-Expenditure Costs ($M)	Description
"Reliability Tax"	**$12.0**	Additional maintenance and emergency repairs.
"Efficiency Tax"	**$0.0**	
"Redundancy Tax"	**$0.0**	
"Capital Tax"	**$45.0**	Increase in project scope for VN-80B.
Cost Escalation	**$36.9**	2-4 year delay in construction.
Net Budgetary Impact	**$93.9**	Net costs of two-year delay.

- Including inflation and borrowing costs, investing now has a $18 million present value benefit (in 2005 dollars).
- 2-year delay effectively adds 57% to the capital cost of the project.

Verrazano Deck Replacement
Cost-benefit analysis results



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Case Study 5

Commuter Rail Power Distribution

Project Name: Metro-North Harlem-Hudson Power Distribution Project.

ID Number: M05A0101

Overview: Capital investments included: (1) modernization or construction of 34 substations and four circuit breaker houses, and replacement of electric power feeder cables; and (2) replacement of 170 miles of third rail with thicker-gauge material.

Cost: $207.9M in current dollars.

Status: Completed in mid-1980s.

Commuter Rail Power Distribution
Why make this investment?

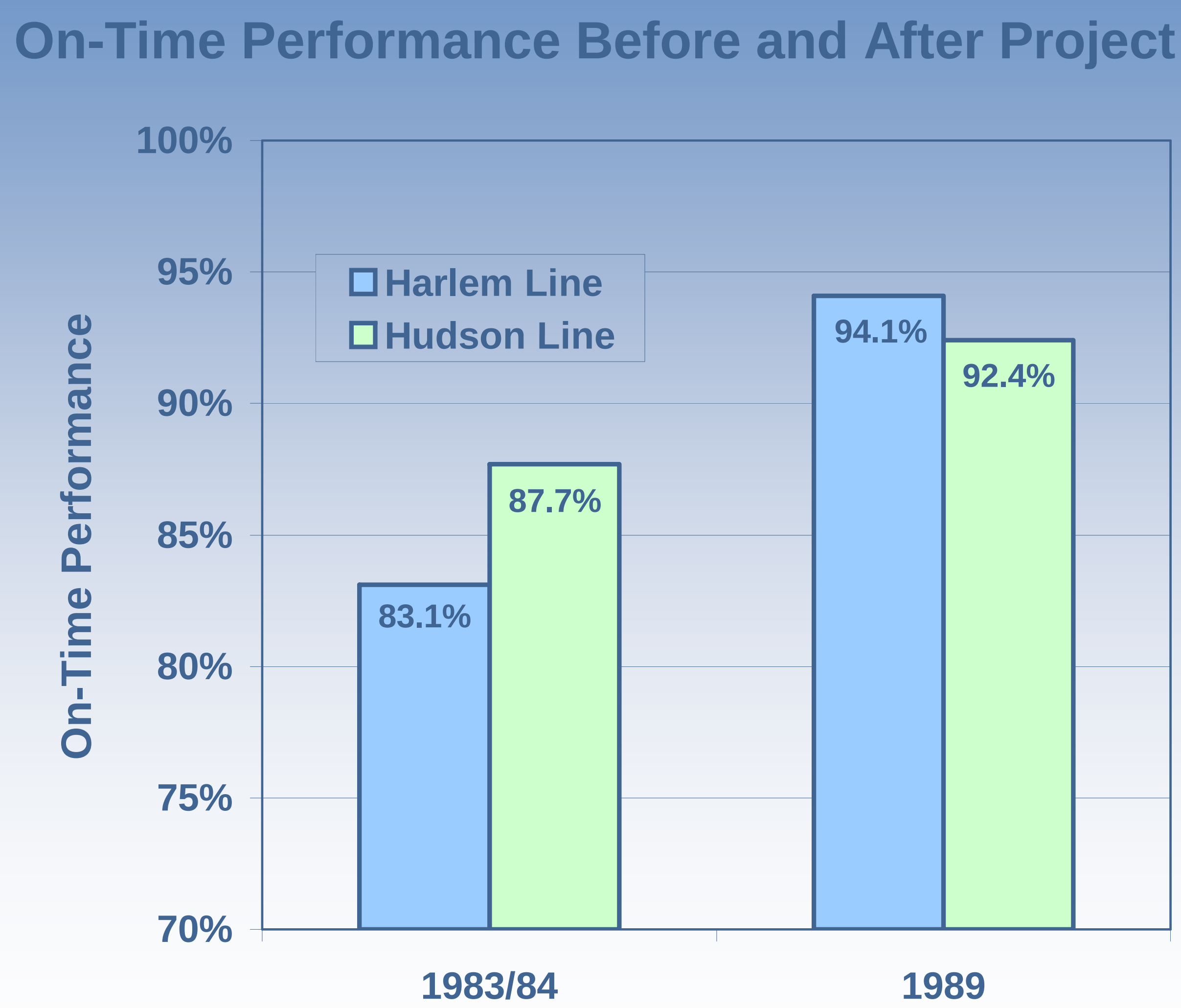
Agency benefits:

- Improved reliability (90% drop in power-related delays).
- Reduced personnel requirements due to the replacement of substations requiring full-time staff with new unstaffed facilities.
- Reduced energy loss, due to the installation of larger-gauge 3rd rail.

User benefits:

- Improved reliability (significant improvement in on-time performance).
- Operation of longer trains, providing more seating.
- 20% better acceleration, cutting travel times by 2 min./trip.
- Sufficient power to provide reliable air conditioning.
- Improved safety by reducing risk of power system failure.

Commuter Rail Power Distribution
Why make this investment?



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Commuter Rail Power Distribution
Key assumptions

Scenario Tested:.Project deferred by five years.

Key Assumptions:

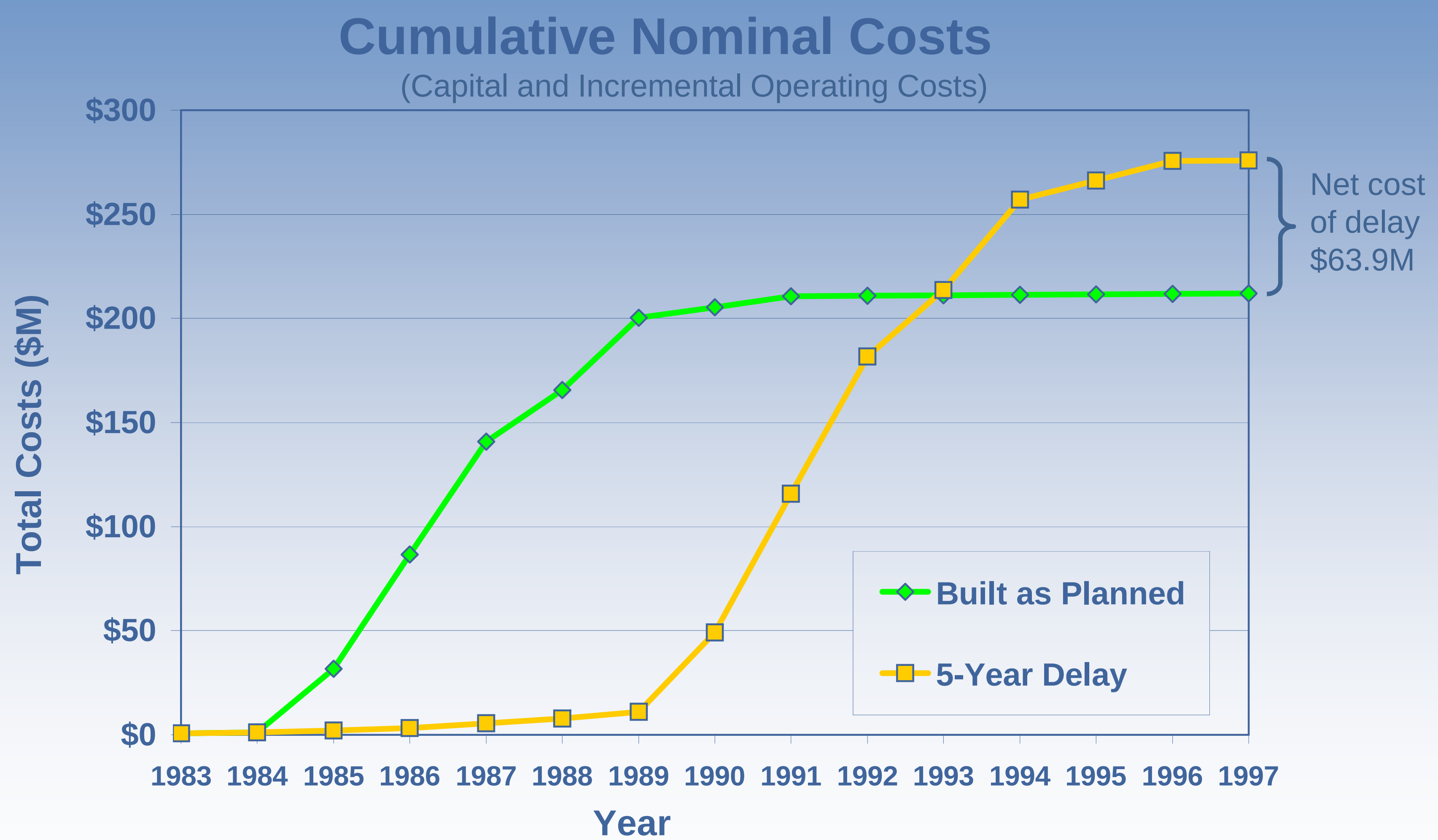
- Capital funds expended at constant rate, and benefits phased in proportionally to expenditure of funds.
- Modernization of substations allowed the elimination of 56 substation operator positions, saving $2.65 million per year.
- Energy savings assumptions:
  - Substations are spaced evenly over the 56 miles of the project
  - Third rail resistance dropped from 0.0125 to 0.0038 ohms/1000 ft
  - Power requirements per car range from 250 kW when idle to 640 kW at full speed.
  - Acceleration and deceleration each take 40 seconds; dwell time at stations is 45 seconds.
- Delay of project assumed not to affect quantity of service provided.

Commuter Rail Power Distribution
Cost-benefit analysis results

Impact	Net Year-of-Expenditure Costs ($M)	Description
"Reliability Tax"	**$0.0**	
"Efficiency Tax"	**$30.8**	Higher personnel and energy costs.
"Redundancy Tax"	**$0.0**	
"Capital Tax"	**$0.0**	
Cost Escalation	**$33.1**	5-year delay in construction.
Net Budgetary Impact	**$63.9**	Net costs of 5-year delay.

- Including inflation and borrowing costs, investing in the project when MTA did had a $10.8 million present value benefit (in 2005 dollars), compared with a 5-year delay.
- Five-year delay effectively adds 30.7% to the capital cost of the project.

Commuter Rail Power Distribution
Effects of Deferral



Case Study 6

Concrete Tie Installation

Project Name: LIRR Track Maintenance Strategy – Concrete Tie Installation Program.

ID Number: L50301T1-T5

Overview: LIRR is installing concrete crossties on sections of its network that have heavy traffic, heavy wear, or are difficult to shut down for track work.

Cost: $116M in 2005-2009 Capital Program for 56 miles of track.

Status: Ongoing Program

Existing Condition: Facilities already in SGR. This is a NR project.

Schedule: Ongoing investments planned for 2005-2009.

Concrete Tie Installation
Why make this investment?

Benefits of concrete crossties:

- Minimizes repetitive disruptions that presently occur due to cyclical replacement of wood ties. LIRR expects to increase service after completion of East Side Access, and track closures will become increasingly difficult to schedule.
- Track closures entail additional operational costs, such as busing and scheduling costs.
- Reduces future capital and maintenance costs.
- Longer useful life than wood.
- Better suited for the heavier loads associated with the new fleet.
- Even if concrete tie installation includes premature replacement of rails, these can often be reused elsewhere in the system.

Primary drawback:

- Higher initial capital cost.

Concrete Tie Installation
Why make this investment?

Long-term cost differences for wood vs. concrete crossties:

- A complete concrete tie installation occurs once every 50 years, and includes new rails and all required welds.
- For wood ties, each segment track is visited every six years, and individual ties are replaced as necessary. In the high-volume areas that are typically candidates for replacement with concrete ties, at least 25% of wood ties need to replaced on each 6-year cycle. This is equivalent to a 24-year useful life.
- Track quality is significantly better on concrete ties.
  - Reduced repairs from broken rails and track conditions
  - Improved passenger comfort
  - Uncertain impacts on rolling stock maintenance

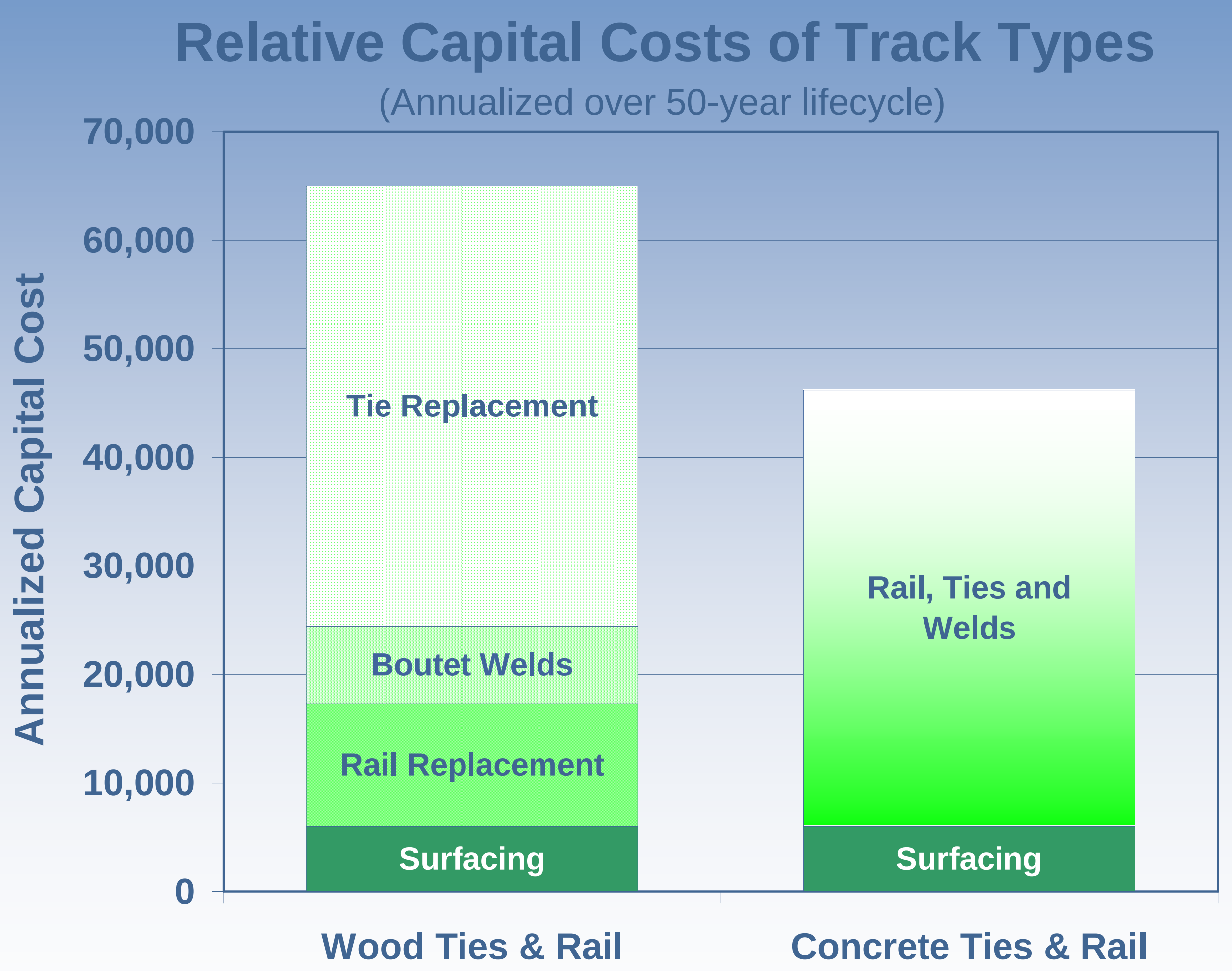
Concrete Tie Installation
Why make this investment?

Average costs for concrete ties are significantly lower:

If costs are spread evenly over the 50-year replacement cycle, and treated on an annualized basis—

- For one mile of track, concrete ties provide a capital cost savings of $2.1 million (28.9%) over 50 years.
- This has a net present value benefit of $591,000 per mile.

Concrete Tie Installation
Why make this investment?



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Concrete Tie Installation
Key assumptions

Scenario tested: Continue with wood tie replacement cycle vs. install concrete ties.

Key Assumptions:

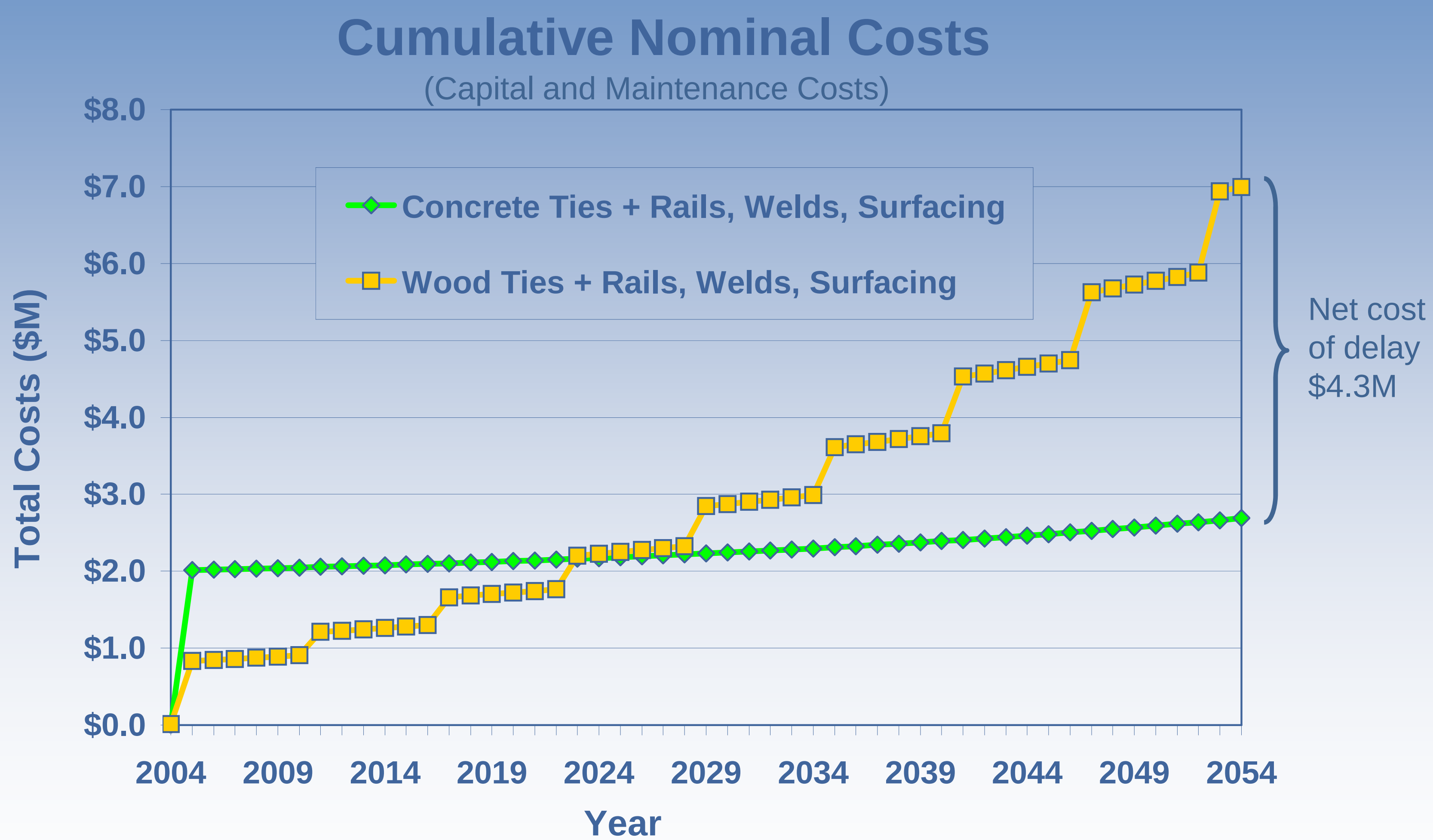
- Analyzed generic 1-mile project, based on average system-wide installation costs
- In wood tie replacement case, rails are replaced in Year 1. Concrete ties replacement has a positive NPV as long as the rails on wood ties need replacement by Year 20.
- Costs and benefits not included:
  - Replacing broken or flawed rails
  - Track outages due to maintenance work
  - Schedule changes and busing programs
  - Purchasing, maintaining, or leasing equipment
  - Improved track quality
  - Higher average costs of wood tie replacement in high-volume areas

Concrete Tie Installation
Cost-benefit analysis results

Impact	Net Year-of-Expenditure Costs ($M)	Description
"Reliability Tax"	**$0.0**	
"Efficiency Tax"	**$19.9**	Greater frequencies for unscheduled tasks (rail, weld, surfacing for wood ties; surfacing for concrete ties).
"Redundancy Tax"	**$0.0**	
"Capital Tax"	**$41.5**	Lower costs for scheduled tasks (just ties for wood ties; ties, rail, and welds for concrete ties).
Cost Escalation	**$178.2**	Rising costs over 50 years of ongoing capital and maintenance work.
Net Budgetary Impact	**$239.7**	Average cost of using wood ties instead of concrete

- Including inflation and borrowing costs, conversion of 56 miles to concrete ties has a net present benefit of $10.2 million.
- This savings represents 214% of the capital costs of the proposed investment.

Concrete Tie Installation
Cost-benefit analysis results



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