Appendix A
Value Pricing in the United States

The concept of varying highway charges by time of day had its antecedents in the New York Region, and can be traced back to the theories of a Columbia University professor, William S. Vickrey, a 1996 Nobel Prize winner in Economics. In 1959 Professor Vickrey conceived of the idea of using wayside electronic transponders to record vehicles passing a point, which would enable the road operator to bill the user in proportion to the levels of congestion at the time of use. The proposal to use this technology to relieve traffic was presented to a congressional committee dealing with traffic problems in Washington, D.C, but got nowhere at the time[1].

Throughout the 1970s and into the 1980s the idea of adjusting the price to manage demand on highways in the United States was not considered[2]. The idea was examined briefly by the Port Authority of New York and New Jersey in the late 1970s, when they were considering a toll increase[3], but rejected on two grounds: a) toll processing time would increase because the manually collected commuter discount coupons used at the time would be eliminated, adding to process time and delays, and b) variable pricing would create safety problems and confusion at the toll plazas as drivers either held back or rushed forward to benefit from a lower toll. At that time electronic toll collection devices were not available to address either of these problems.

In 1991, in response to the increasing levels of exasperation about traffic congestion, the Intermodal Surface Transportation Efficiency Act (ISTEA) established funding within the Federal Highway Administration (FHWA) for a limited number of local demonstration programs for "congestion pricing." In 1995 a 10-mile stretch of State Road 91 in Orange County, California was widened, representing a milestone, for two reasons. First, it introduced pricing that varied by time of day, and second because it permitted single-occupant vehicles to buy their way into the added free-flowing lanes. This privately owned highway road expansion used transponders purchased in advance with the price varying by time of day. The results were highly favorable, with congestion in the general-purpose lanes eased. Those willing to pay the toll gained substantial time advantages. The Interstate 5 toll lanes in San Diego came next. New lanes could be "bought into" by single occupant vehicles (SOVs), with pricing varying dynamically, changing as often as every five minutes according to the measured congestion levels. Throughout the country and in our Region pricing programs are now being implemented and have succeeded in shifting traffic and lowering peak demand[4].

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[1] William Vickrey, Statement on the Pricing of Urban Street Use, U.S. Congress, Joint Committee on Washington Metropolitan Problems, Hearings on the Transportation Plan for the Capital Region, November 1959.

[2] Variable pricing had long been a feature of commuter rail fares in the New York Region, with higher fares charged for the occasional user in the peak period than in the off-peak

[3] The requirement arose because it was raised in an *amicus curiae* brief by the Environmental Defense Fund, which supported the increase over the objections of motorists' groups

[4] For a review of these and other congestion pricing projects at the time see the FHWA website under Value Pricing. <http://www.fhwa.dot.gov/ >

The advent of electronic toll collection in the New York area, first seen as means to reduce collection costs and to increase vehicle throughput, also made variable time-of-day pricing easier to implement. Electronic toll lanes could process up to six times as many vehicles as staffed lanes. As time passed it became clearer that the strong penetration rates of E-ZPass was a technological "foot in the door" for variable pricing at toll facilities, overcoming the objections at the Port Authority in the late 1970s.

In 1996, in response to local concerns of rising truck traffic through Rockland County, the New York State Thruway Authority doubled truck tolls at the Tappan Zee Bridge in the peak period, dropping peak truck use significantly[5]. The Thruway Authority, at the urging of RPA and other transportation advocates, also studied a broader version of "congestion pricing" for the Tappan Zee Bridge involving all vehicles. The idea is now on hold pending the outcome of the current study regarding the repair or replacement of the bridge.

In the 1996 publication of its third plan[6], RPA laid out criteria for consideration of road pricing that can serve as useful guidelines for considering the situations that may be appropriate for congestion pricing. They include situations where:

- there is a serious and well known congestion problem;
- there are no expectations of significant additions to highway capacity;
- success of road pricing could reduce or eliminate the need for expensive highway construction projects;
- alternatives to single-occupant auto use exist or can be created;
- the new pricing system will either break even or generate funds for improvements in both highways and parallel transit facilities; or
- tolls are already in place.

At about the same time, another impetus appeared to be the awarding of the Nobel Prize for Economics to William Vickrey in October 1996, in part for his congestion pricing theories. It gave him an instant pulpit to promote road pricing. Unfortunately, he died just three days after being notified of the prize. The following April a colloquium co-sponsored by Columbia University and RPA honored his work by promoting congestion pricing in the New York Region.

In the late 1990s, the MTA considered studying congestion pricing on two occasions, but stopped short both times, as its Board balked. Although the reasons for the MTA's timidity were not certain, it can be surmised that discussion of variable tolls would raise the difficult political question of toll increases in general. Moreover, there was concern that MTA would lose substantial revenue if MTA tolls went up in the peak period in the absence of tolls on the free bridges. In 1999, Robert Kiley, former MTA Chairman, and then President and Chief Executive Officer of the New York City Partnership, frustrated by the inability of the MTA and other transportation providers to simultaneously raise enough funds for both needed infrastructure repair and transit expansion projects, began to promote pricing on un-tolled facilities in the Region.

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[5] Jeffrey M. Zupan, Truck Tolls in the New York Region, August 1999

[6] Robert D. Yaro and Tony Hiss, A Region at Risk, A Third Regional Plan for the New York-New Jersey-Connecticut Metropolitan Area, Island University Press, 1996

In 2000, with little fanfare and less public reaction, the New Jersey Turnpike Authority, eschewing studies (at least none acknowledged publicly) announced that it was raising its tolls simultaneously with the introduction of E-ZPass on its entire system, and that it would vary the increase by time of day and by use of E-ZPass[7]. Though the differentials were modest – E-ZPass peak tolls went up 8 percent and E-ZPass off-peak tolls did not increase – this was the first time in the New York Region that the tolls for automobiles were varied by time of day. To encourage E-ZPass, cash-payers would pay a 20 percent premium.

In December 2000, the Port Authority of New York and New Jersey, perhaps encouraged by the ease with which the Turnpike installed variable pricing, proposed a nuanced toll increase. Cash tolls were to be set much higher than E-ZPass tolls and peak E-ZPass tolls set higher than those off-peak. The commuter discount would be eliminated. E-ZPass tolls would be lower for those crossings where transit options were less available. The Port Authority explained that the increase was needed to contribute to the $15 billion of capital investments throughout the region, for both transportation facilities it owned and operated and those in the control of others. For political reasons, the proposed cash toll of $7.00 was reduced to $6.00, despite the fact that 60 percent of the motorists already used E-ZPass. Most importantly it reduced the gap between peak and off-peak for E-ZPass users from $2.00 to $1.00 at the Lincoln and Holland tunnels and from $1.50 to $1.00 at the George Washington Bridge and the three Staten Island bridges. This substantially compromised the congestion pricing aspects of the plan[8]. However, for trucks road pricing was strengthened. Despite the watering down of the variable pricing aspects of the toll changes, they represented a breakthrough for the toll agency that collects the second most toll revenue in the nation.

[7] In August 1998 the New Jersey Turnpike Authority had installed a 15 percent discount for trucks in off-peak hours in response to concerns in many communities around the state that had become corridors for trucks avoiding the substantial toll increase. This was done prior to the introduction of E-ZPass on the Turnpike. The effect of the discount was minor.

[8] This also had the effect of weakening the impact of experimentation with pricing changes that could dampen the peak demand at the Goethals Bridge, affecting the debate over a “twin” to it.

Appendix B
Four Scenario Toll Schedules

Tolls by Scenario, Crossing, Time of Day and Vehicle Class	**Holland and Lincoln Tunnels (Port Authority)**				**Brooklyn Battery and Queens Midtown Tunnels (MTA)**				**East River Bridges (NYC)**				**Southbound Avenues Crossing 60th Street**			
Status Quo*	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight
Cars	$5	$4	$4	$4	$7	$7	$7	$7	$0	$0	$0	$0	$0	$0	$0	$0
Taxis	$5	$4	$4	$4	$7	$7	$7	$7	$0	$0	$0	$0	$0	$0	$0	$0
2 axle Trucks	$12	$10	$10	$7	$13	$13	$13	$13	$0	$0	$0	$0	$0	$0	$0	$0
3 axle Trucks	$18	$15	$15	$11	$21	$21	$21	$21	$0	$0	$0	$0	$0	$0	$0	$0
4 axle Trucks	$24	$20	$20	$14	$27	$27	$27	$27	$0	$0	$0	$0	$0	$0	$0	$0
5 axle Trucks	$30	$25	$25	$18	$35	$35	$35	$35	$0	$0	$0	$0	$0	$0	$0	$0
Buses	$3	$3	$3	$3	$5	$5	$5	$5	$0	$0	$0	$0	$0	$0	$0	$0
Scenario 1 "Toll East River Like MTA"	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight
Cars	$5	$4	$4	$4	$7	$7	$7	$7	$7	$7	$7	$7	$0	$0	$0	$0
Taxis	$5	$4	$4	$4	$7	$7	$7	$7	$7	$7	$7	$7	$0	$0	$0	$0
2 axle Trucks	$12	$10	$10	$7	$13	$13	$13	$13	$13	$13	$13	$13	$0	$0	$0	$0
3 axle Trucks	$18	$15	$15	$11	$21	$21	$21	$21	$21	$21	$21	$21	$0	$0	$0	$0
4 axle Trucks	$24	$20	$20	$14	$27	$27	$27	$27	$27	$27	$27	$27	$0	$0	$0	$0
5 axle Trucks	$30	$25	$25	$18	$35	$35	$35	$35	$35	$35	$35	$35	$0	$0	$0	$0
Buses	$3	$3	$3	$3	$5	$5	$5	$5	$5	$5	$5	$5	$0	$0	$0	$0
Scenario 2 "Variable ER tolls, MTA to Match"	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight
Cars	$5	$4	$4	$4	$10	$7	$4	$4	$10	$7	$4	$4	$0	$0	$0	$0
Taxis	$5	$4	$4	$4	$5	$4	$2	$2	$5	$4	$2	$2	$0	$0	$0	$0
2 axle Trucks	$12	$10	$10	$7	$20	$20	$16	$8	$20	$20	$16	$8	$0	$0	$0	$0
3 axle Trucks	$18	$15	$15	$11	$30	$30	$24	$12	$30	$30	$24	$12	$0	$0	$0	$0
4 axle Trucks	$24	$20	$20	$14	$50	$50	$40	$20	$50	$50	$40	$20	$0	$0	$0	$0
5 axle Trucks	$30	$25	$25	$18	$80	$80	$64	$32	$80	$80	$64	$32	$0	$0	$0	$0
Buses	$3	$3	$3	$3	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Scenario 3 "Like London"	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight
Cars	$5	$4	$4	$4	$7	$7	$7	$7	$7	$7	$0	$0	$7	$7	$0	$0
Taxis	$5	$4	$4	$4	$7	$7	$7	$7	$7	$7	$0	$0	$7	$7	$0	$0
2 axle Trucks	$12	$10	$10	$7	$13	$13	$13	$13	$13	$13	$0	$0	$13	$13	$0	$0
3 axle Trucks	$18	$15	$15	$11	$21	$21	$21	$21	$21	$21	$0	$0	$21	$21	$0	$0
4 axle Trucks	$24	$20	$20	$14	$27	$27	$27	$27	$27	$27	$0	$0	$27	$27	$0	$0
5 axle Trucks	$30	$25	$25	$18	$35	$35	$35	$35	$35	$35	$0	$0	$35	$35	$0	$0
Buses	$3	$3	$3	$3	$5	$5	$5	$5	$0	$0	$0	$0	$0	$0	$0	$0
Scenario 4 "Full Variable Pricing"	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight	Peak Hours	Daytime	Evening	Overnight
Cars	$10	$7	$4	$4	$10	$7	$4	$4	$10	$7	$4	$4	$10	$7	$4	$4
Taxis	$5	$4	$2	$2	$5	$4	$2	$2	$5	$4	$2	$2	$5	$4	$2	$2
2 axle Trucks	$20	$20	$16	$8	$20	$20	$16	$8	$20	$20	$16	$8	$20	$20	$16	$8
3 axle Trucks	$30	$30	$24	$12	$30	$30	$24	$12	$30	$30	$24	$12	$30	$30	$24	$12
4 axle Trucks	$50	$50	$40	$20	$50	$50	$40	$20	$50	$50	$40	$20	$50	$50	$40	$20
5 axle Trucks	$80	$80	$64	$32	$80	$80	$64	$32	$80	$80	$64	$32	$80	$80	$64	$32
Buses	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

*Status Quo shows only E-ZPass discounted tolls
Peak Hours are 6 AM to 10 AM and 4 PM to 7 PM, Daytime is 10 AM to 4 PM, Evening is 7 PM to 11 PM, Overnight is 11 PM to 6 AM

Appendix C
Comparison Chart: Scenario Tolls and Current Toll Schedules

Passenger Cars	AM Peak	Daytime	PM Peak	Evening	Overnight
Current Round Trip Tolls					
East River Bridges	$0	$0	$0	$0	$0
MTA: Brooklyn Battery and Queens Midtown Tunnels	$7	$7	$7	$7	$7
Port Authority: Holland and Lincoln Tunnels	$5	$4	$5	$4	$4
South Bound Avenues Crossing 60th Street	$0	$0	$0	$0	$0
Scenario 2 Tolls					
East River Bridges	$10	$7	$10	$4	$4
MTA: Brooklyn Battery and Queens Midtown Tunnels	$10	$7	$10	$4	$4
Port Authority: Holland and Lincoln Tunnels	$5	$4	$5	$4	$4
South Bound Avenues Crossing 60th Street	$0	$0	$0	$0	$0
Scenario 4 Tolls					
East River Bridges	$10	$7	$10	$4	$4
MTA: Brooklyn Battery and Queens Midtown Tunnels	$10	$7	$10	$4	$4
Port Authority: Holland and Lincoln Tunnels	$10	$7	$10	$4	$4
South Bound Avenues Crossing 60th Street	$10	$7	$10	$4	$4

Note: Current round trip tolls reflect EZ-Pass prices. Scenario tolls are charged inbound only. AM Peak is from 6 to 10 am, Daytime is from 10 am to 4 pm, PM Peak is from 4 to 7 pm, Evening is from 7 to 11 pm, Overnight is from 11 pm to 6 am.

Three-Axle Trucks	AM Peak	Daytime	PM Peak	Evening	Overnight
Current Round Trip Tolls					
East River Bridges	$0	$0	$0	$0	$0
MTA: Brooklyn Battery and Queens Midtown Tunnels	$21	$21	$21	$21	$21
Port Authority: Holland and Lincoln Tunnels	$18	$15	$18	$15	$11
South Bound Avenues Crossing 60th Street	$0	$0	$0	$0	$0
Scenario 2 Tolls					
East River Bridges	$30	$30	$30	$24	$12
MTA: Brooklyn Battery and Queens Midtown Tunnels	$30	$30	$30	$24	$12
Port Authority: Holland and Lincoln Tunnels	$18	$15	$18	$15	$11
South Bound Avenues Crossing 60th Street	$0	$0	$0	$0	$0
Scenario 4 Tolls					
East River Bridges	$30	$30	$30	$24	$12
MTA: Brooklyn Battery and Queens Midtown Tunnels	$30	$30	$30	$24	$12
Port Authority: Holland and Lincoln Tunnels	$30	$30	$30	$24	$12
South Bound Avenues Crossing 60th Street	$30	$30	$30	$24	$12

Note: Truck tolls vary by number of axles; 3-axle trucks are used here as an example. Current round trip tolls reflect EZ-Pass prices. Scenario tolls are charged inbound only. AM Peak is from 6 to 10 am, Daytime is from 10 am to 4 pm, PM Peak is from 4 to 7 pm, Evening is from 7 to 11 pm, Overnight is from 11 pm to 6 am.

Appendix D
Methodologies to Estimate Impacts of Scenarios

To estimate traffic and revenue results from the four scenarios, hourly traffic volumes by vehicle class (cars, taxis, buses and four classes of truck) for each of nineteen crossings into Manhattan (including the eleven southbound crossings of 60th Street[1]) were used as a base. Each scenario is based on changes to how various entries to the central business district are tolled. In effect, each scenario represents a change to the whole system of tolls. The impacts of these changes on travelers are complex. Travelers entering the central business district do so for a wide variety of purposes – work, recreation, services. Each motor vehicle trip-maker may consciously or subconsciously make a change in their travel habits if changes in the cost of driving occur. They may decide to a) forego the trip, b) fulfill their trip purpose by traveling to a different destination other than the Manhattan CBD, c) respond by changing their driving route, or d) shift to transit. In the cases where variable time-of-day pricing is installed, they may shift their time of travel. Some broad assumptions can be made based on time of day and vehicle type – for example, most passenger cars in the am peak are traveling for work-related purposes.

In general, these sensitivities to pricing hold to the following principles:

(1) *Trip shift*: Some vehicles would travel outside the CBD or choose not to travel at all. This was only assumed for cars; it was assumed that trucks and taxis would not cease to do business in the CBD due to new charges. Trip shift is assumed to be weaker than a shift in the route or mode as the great majority of trips to the CBD are for work; they do not have a flexible destination and cannot be eliminated.

(2) *Route shift*: Some vehicles would move to more efficient routes due to toll schedule changes. For example, if tolls are equal across the East River some drivers are likely to travel via the Queens Midtown Tunnel instead of the formerly free Queensboro Bridge. Route shift was assumed to be much higher for trucks than cars. In fact, one of the chief reasons for raising the tolls on East River bridges is to disperse truck traffic instead of giving trucks an incentive to clog certain crossings (and therefore certain neighborhoods). For example, 38 percent of trucks crossing the East River use the free Manhattan Bridge while only 17 percent use the tolled Queens Midtown and Brooklyn Battery tunnels. In practice, changes in the system-wide toll schedule could also shift some vehicles to the Verrazano-Narrows Bridge; those shifts were not estimated here.

(3) *Mode shift*: Some cars would not cross into Manhattan because their drivers and passengers would choose transit. Mode shift was separated from trip shift to estimate impacts on transit. It is assumed that drivers are more likely to switch to transit than they are to change their driving route around the CBD, change their

[1] Data is primarily from the NYC Department of Transportation Bridge Toll Volumes Report, 2000. Street traffic reports were obtained from DOT as well, however vehicle class data was often estimated. A complete list of sources and assumptions used to compile pre-scenario data can be found in Appendix G.

destination or decide not to come in altogether. This is based on studies in London showing that many driving commuters will switch to transit when the cost of driving increases[2].

Time Shift. A fifth set of assumptions was employed regarding driver sensitivity to account for changes in behavior based on tolls varying by time of day, as they do in scenarios 2 and 4. The differences between tolls at various times of day were assumed to influence when drivers choose to enter the CBD. The same basic underlying assumptions about trip purpose were used to estimate drivers' sensitivity toward variable pricing. Some vehicles would migrate to earlier or later times of the day, depending on how tolls varied among the time slots; these numbers were informed by the Port Authority experiences at the Hudson River crossings.

Weekends. Insufficient data prohibits making estimates for Saturdays, Sundays and holidays. Research is needed to support sensitivity assumptions to account for weekends. Since the Port Authority varies tolls on weekends, its data could be a source for estimates in future scenario development.

Fines. Under each scenario there is a system of fines for late-payers as shown in Appendix E. Generally, if a driver crosses a tolled entry without paying, he is charged $10 if paid within two weeks, $45 within one month, and $100 thereafter (in London, the schedule is $65, $130 and $195). Fines are higher if the fee is skipped during peak hours. The scenarios assume that payments can be made using the same facilities as those for pre-paying the on board unit (transponder). Fines vary by vehicle type. High compliance rates are assumed. Since no enforcement is perfect, all scenarios assume that 1 percent of cars and .01 percent of trucks will escape tolls and fines altogether.

The actual numbers behind the sensitivities were derived to be consistent with the above stated principles, and with findings from London which show that mode shift is the most significant reason traffic shifts off the road. Sensitivities are shown on Table D-1.

[2] *Central London Congestion Charging Scheme Three Months On* Transport for London, June 2003

Table D-1
Sensitivity Assumptions by Crossing, Time Slot and Vehicle Class

Holland, Lincoln, Brooklyn Battery & Queens Midtown Tunnels				
	AM and PM Peak	10am to 4pm	7pm to 11pm	11pm to 6am
Trip Shift				
Cars	-0.05	-0.05	-0.03	-0.03
Taxis	0	-0.006	0	0
Trucks	0	0	0	0
Route Shift				
Cars	-0.05	-0.05	-0.05	-0.05
Taxis	0	0	0	0
Trucks	-0.025	-0.025	-0.025	-0.025
Mode Shift				
Cars	-0.175	-0.175	-0.175	-0.075
Taxis	0	-0.015	0	0
Trucks	0	0	0	0

East River Bridges				
	AM and PM Peak	10am to 4pm	7pm to 11pm	11pm to 6am
Trip Shift				
Cars	-0.05	-0.05	-0.04	-0.05
Taxis	0	0	0	0
Trucks	0	0	0	0
Route Shift				
Cars	-0.015	-0.015	-0.015	-0.015
Taxis	0	0	0	0
Trucks	-0.025	-0.025	-0.025	-0.025
Mode Shift				
Cars	-0.175	-0.175	-0.175	-0.175
Taxis	0	-0.015	-0.015	-0.015
Trucks	0	0	0	0

Southbound Avenues Crossing 60th Street				
	AM and PM Peak	10am to 4pm	7pm to 11pm	11pm to 6am
Trip Shift				
Cars	-0.05	-0.07	-0.04	-0.07
Taxis	0	-0.005	-0.005	-0.005
Trucks	0	0	0	0
Route Shift				
Cars	0	0	0	0
Taxis	0	0	0	0
Trucks	0	0	0	0
Mode Shift				
Cars	-0.175	-0.175	-0.175	-0.075
Taxis	-0.015	-0.05	-0.05	-0.05
Trucks	0	0	0	0

George Washington and Triborough Bridges				
	AM and PM Peak	10am to 4pm	7pm to 11pm	11pm to 6am
Trip Shift				
Cars	-0.03	-0.03	-0.03	-0.03
Taxis	0	0	-0.006	0
Trucks	0	0	0	0
Route Shift				
Cars	-0.01	-0.01	-0.01	-0.01
Taxis	0	0	0	0
Trucks	-0.025	-0.025	-0.025	-0.025
Mode Shift				
Cars	-0.125	-0.125	-0.125	-0.075
Taxis	0	-0.015	0	0
Trucks	0	0	0	0

Time shift entails vehicles moving out of the four AM and three PM peak hours and into the eight ‘shoulder’ hours. Sensitivities for Time Shift are shown in Table D-2.

Table D-2
Time Shift Sensitivities

All crossings: Holland, Lincoln, Queens Midtown, Brooklyn Battery tunnels, East River Bridges, Southbound Avenues Crossing 60th Street, George Washington Bridge, and Triborough Bridge				
Time Shift from Peak	shift to earlier AM hour	shift to later AM hour	shift to earlier PM hour	shift to later PM hour
Cars	-0.125	-0.100	-0.100	-0.075
Taxis	-0.075	-0.050	-0.050	-0.025
Trucks	-0.250	-0.200	-0.200	-0.150

Sensitivities were used as follows:

<u>Trip Shift and Mode Shift</u>

- These are calculated like elasticities.
- Number of vehicles that leaves the crossing = initial number of vehicles × sensitivity × percent change from former tolls to scenario tolls.
- If there was no toll initially (as on the East River bridges and at 60th Street), and the scenario toll is greater than 0, then the percent change in tolls is replaced by 1.

<u>Route Shift</u>

- Route shift only applies to vehicles leaving the East River bridges and moving on to the Brooklyn Battery and Queens Midtown tunnels. It is based on the dollar difference in the choice the driver has to make between the two crossings under the new scenario and the choice she had to make prior to the scenario.
- Number of vehicles that moves due to route shift = initial number of vehicles × sensitivity × ((difference between the scenario MTA toll and scenario East River Bridge tolls) – (difference between the former MTA toll and the former East River Bridge toll))
- If (difference between the scenario MTA toll and scenario East River Bridge tolls) + (difference between the former MTA toll and the former East River Bridge toll) = 0, then route shift = 0.

Time Shift

- Time shift is calculated after trip shift, mode shift and route shift are accounted for. It is based on the percent difference in tolls among the time slots the driver chooses between. Time shift applies to the 14 time slots in and around the peak hours:

Hour Ending	Time Slot Category
5 am	Shoulder (Overnight)
6 am	Shoulder (Overnight)
7 am	Peak
8 am	Peak
9 am	Peak
10 am	Peak
11 am	Shoulder (Daytime)
12 pm	Shoulder (Daytime)
4 pm	Shoulder (Daytime)
5 pm	Peak
6 pm	Peak
7 pm	Peak
8 pm	Shoulder (Evening)
9 pm	Shoulder (Evening)

- Number of vehicles that leave peak time slots = Number of vehicles after trip, mode and route shift are accounted for × percent difference among time slots × time shift sensitivity
- Shoulder time slots simply add back those leaving from peak time slots.

Revenue

- Revenue estimates do not include the George Washington Bridge to Triborough Bridge. Revenue estimates include revenue collected under each scenario from fines; to ease the comparison between revenue collected prior to and after the scenario, it is assumed that everyone pays and there are effectively no fines collected on the Holland, Lincoln, Brooklyn Battery and Queens Midtown Tunnels.
- Daily estimates are multiplied by 250 to get a yearly estimate for weekdays, and weekends are estimated as follows:
    - All crossings in Scenario 1 = weekdays × 1.46
    - All crossings in Scenario 2 and 4 = weekdays × 1.4
    - PA and MTA in Scenario 3 = weekdays × 1.4
    - City Streets and ER bridges in Scenario 3 = weekdays × 1

- These account for no weekend charges in the "Like London" Scenario 3, and assumes that variable time of day charges will in some way be extended to the weekends (as they are on Port Authority crossings now).

Comparison with Other Studies

The estimates produced for Scenario 1 "East River Bridge Tolls Only" with the above assumptions are compared to the three other recent studies on East River Bridge tolls in Table D-3.

Table D-3
Comparison of East River Bridge Toll Studies

East River Bridge Toll Studies	Revenue Gain	Total East River Traffic Impact
Schaller (T.A./Straphangers)	$580 million	-11%
Komanoff (Bridge Tolls Advocacy Project)	$750 million	-6%
Treffeisen (NYC Independent Budget Office)	$608 million	-5%
Perrotta and Zupan (Regional Plan Association)	$706 million	-5%

Note: All examples assume a flat $7 toll on East River bridges. Revenue and traffic impacts include the four city bridges plus the Brooklyn Battery and Queens Midtown Tunnels; Schaller's MTA estimates also include the Triborough Bridge.

Studies:

Bruce Schaller, Transportation Alternatives and NYPIRG Straphangers Campaign, <u>East River Bridge Tolls: Revenue, Traffic, Mobility and Equity Impacts</u>, September 2003.

Charles Komanoff, Bridge Tolls Advocacy Project, <u>East River Bridge Tolls: Who Will Really Pay?</u>, March 2003.

Alan Treffeisen, New York City Independent Budget Office, <u>Bridge Tolls: Who Would Pay? And How Much?,</u> October 2003.

Appendix E
Fine Schedules

Fines for all Scenarios	**East River Bridges (NYC) & Southbound Avenues Crossing 60th Street**		
		Peak Hours	Off Peak
Fine Level 1	*How Many Vehicles Pay*		
	Cars	2.00%	5.00%
	Trucks	0.05%	0.05%
	Fine Amount		
	Cars	$20	$10
	Trucks*	$20	$20
Fine Level 2	*How Many Vehicles Pay*		
	Cars	1.50%	2.50%
	Trucks	0.01%	0.01%
	Fine Amount		
	Cars	$60	$45
	Trucks*	$60	$50
Fine Level 3	*How Many Vehicles Pay*		
	Cars	0.05%	0.08%
	Trucks	0.00%	0.00%
	Fine Amount		
	Cars	$100	$100
	Trucks	n/a	n/a
Non Payers	*How Many Vehicles Evade All Charges*		
	Cars	1.00%	1.00%
	Trucks	0.01%	0.01%

*Truck fines increase $10 per axle. Amounts shown are for 2-axle trucks.

Peak Hours are 6 to 10 am and 4 to 7pm.
Fines only apply where scenario tolls differ from status quo.
For the sake of revenue comparisons, it was assumed that Brooklyn Battery, Queens Midtown, Holland and Lincoln Tunnels will not pay fines.
All scenarios assume all buses and taxis will always pay on time.

Appendix F
Pricing Technology

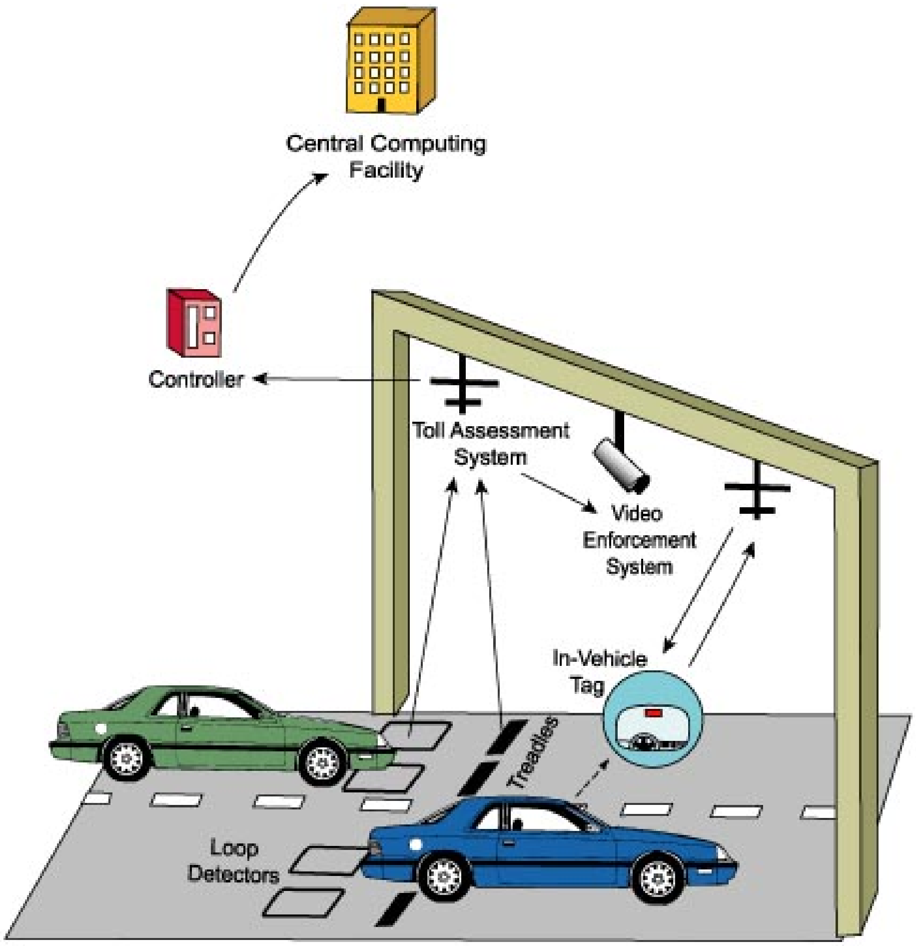
There are two main types of electronic toll collection. The first is dedicated short-range communication or DSRC, the system used by E-ZPass in the Northeast United States. It requires roadside and on board equipment, and uses radio, microwave or infrared frequencies. Each frequency type has its drawbacks: radio is relatively weak and cannot be read through metal, microwave presents potential health risks and is vulnerable to weather, infrared requires a clear line of sight between the on board unit and roadside equipment. Of these types, infrared has the capacity to communicate the greatest amount of data the fastest. For DSRC, there are two types of on board units, or tags, used for automatic vehicle identification: active tags and passive tags. Active tags are commonly known as transponders, and are the on board units used by E-ZPass. They are powered by batteries lasting up to 6 years, have relatively long read ranges of around 25 feet and can transmit information at around 60 miles per hour. Transponders cost $20 to $30 per tag. Passive tags are less expensive ($10 to $15 per tag), have shorter read ranges (15 feet) and require vehicles to move at slower speeds. Passive tags are powered by the reader, not batteries. These are commonly used for gated entrances and underground parking garages. DSRC is already in use all over the United States. When it was introduced in the 1990s there were major interoperability issues as different systems were using the same frequency carriers. Those issues have largely been overcome, however interoperability continues to be a priority issue in regions adopting this technology.

The second method of collection uses vehicle positioning systems, such as Global Positioning Systems (GPS). Tolling using GPS will soon be piloted by truckers in Germany and drivers in Seattle, Washington, and is under consideration for nationwide application in England. It uses virtual gantries to allow on board units to be tracked and charged with GPS. The vehicle and offsite databases communicate via cellular networks. In most respects this system is superior to DSRC: more data is communicated faster, vehicles can travel faster, on board units can be updated immediately. The cost of roadside equipment is removed completely, however on board tags must include "smartcards" capable of interfacing with GPS using cellular networks; these are much more expensive than the active tags used for DSRC. Using GPS it is easy and inexpensive to redefine charging areas and collect traffic data, making both ongoing traffic monitoring and experimentation cost effective.

Regardless of the type of pricing, the major costs of implementing a new pricing scheme are, broadly:

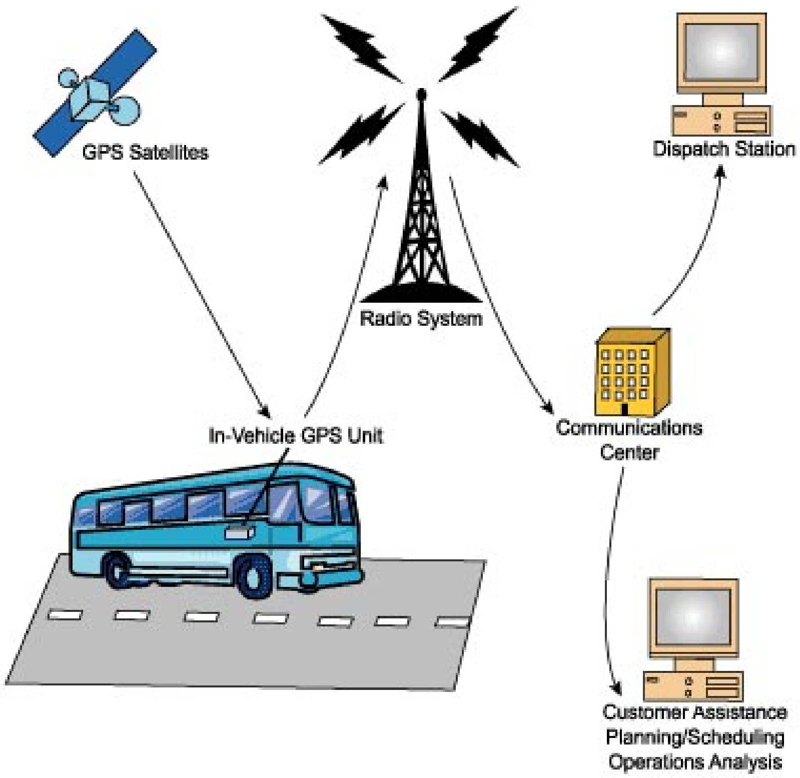
- Hardware on the ground
- Tags / on board units
- Data management / "back office"
- Enforcement

The diagrams below show the equipment needed for each system. London reportedly spent $320 million to implement congestion charging, but it is unclear how this breaks out. While much of the hardware was already in place and on board units are unnecessary, back office and enforcement costs have reportedly been more expensive than anticipated. Transport for London and Capita, the congestion charging contractor, are now planning to increase expenditures by $52 million over the next four years.[1] Costs of implementation are completely dependent on technology used and existing infrastructure.



Electronic Toll Collection diagram. This is a DSRC system.
Source: Intelligent Transportation Systems
http://www.path.berkeley.edu/itsdecision.

[1] "Increasing Capita's Capital ."Traffic Technology International. Aug/Sept 2003.



Global Positioning System-based vehicle location system
Source: Intelligent Transportation Systems
http://www.path.berkeley.edu/itsdecision.

Appendix G
Data Sources and Current Traffic Estimates

Estimates were made of Manhattan-bound traffic by vehicle class, by hour, for each of the 19 crossings plus the Triborough and George Washington Bridges. The eight vehicle classes used are:

- Passenger Cars,
- Commercial Vans,
- Taxis,
- Trucks: 2-Axle, 3-Axle, 4-Axle, and 5-Axle, and
- Buses.

Table G-1 shows total vehicles in each major class at each crossing (not stratified by truck classes). Figure G-1 shows total vehicles at each crossing by hour.

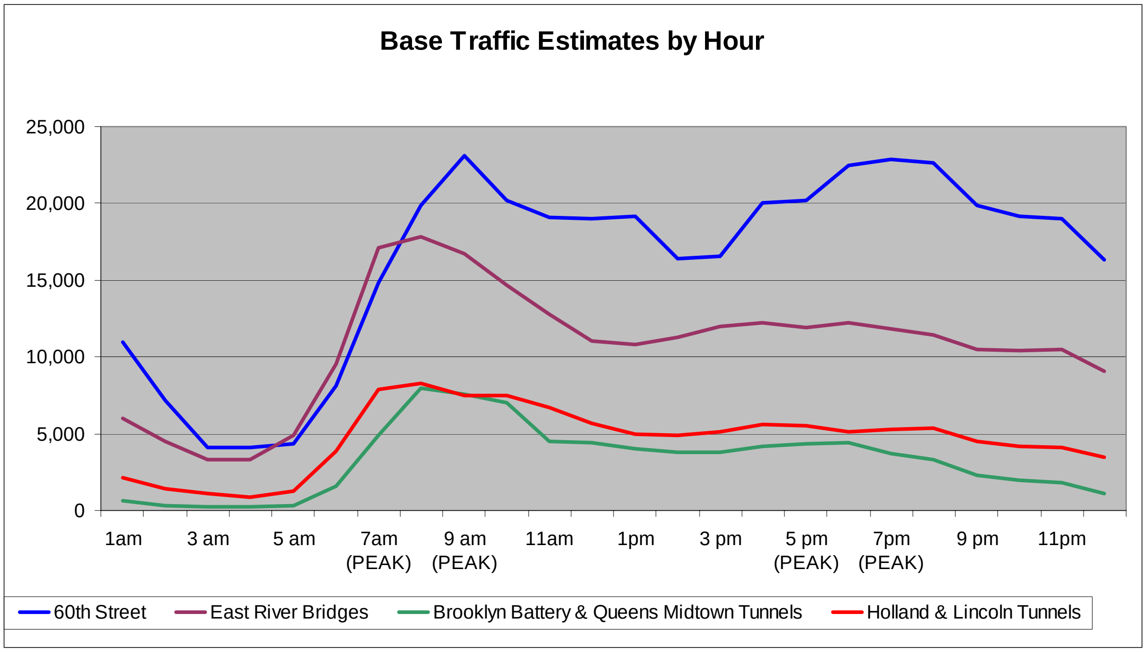
For the all of the bridges and tunnels, total daily and hourly daytime data are from New York City Department of Transportation <u>Bridge Traffic Volumes 2000</u> report, released in 2001. Various data sources were used for the avenues and highways. FDR, Broadway, Columbus Avenue, West End Avenue and Henry Hudson Parkway data are from the NYMTC 1998 Hub-Bound survey. Seventh, Fifth, Park, Lexington, Second, and York Avenue data are from total vehicle counts on those avenues at blocks near 60th Street in 2002, obtained from the New York City Department of Transportation.

None of these data sources provided complete information by vehicle class and hour. Estimates were made to fill in the gaps. NYMTC data in the Major Vehicular Crossings report (1999) provided daily percentages of autos, trucks and buses, along with classes of trucks, for each bridge and tunnel. There is very little data available on taxi counts by crossing or avenue; assumptions were made on the share of autos using each crossing which are taxis, ranging from 2% of autos on the Hudson River crossings to 60% of autos on Park Avenue. For streets, these assumptions were confined to current road use restrictions (no trucks on FDR Drive or Park Avenue), partly informed by two environmental analyses from the MTA (Manhattan East Side Transit Alternatives and Second Avenue Subway), and partly based on knowledge of the area road network.

Table G-1
Average Weekday Inbound Base Traffic Estimates by Vehicle Class

BaseTraffic Estimates by Vehicle Class	Passenger Cars	Taxis	Commerical Vans	Trucks	Buses
East River Bridges	151,070	59,004	26,078	17,020	2,714
Brooklyn Battery and Queens Midtown Tunnels	66,125	3,674	3,674	3,399	1,428
Holland and Lincoln Tunnels	93,650	2,014	5,035	5,667	6,134
FDR Drive	45,925	29,225	8,350	0	0
Henry Hudson Parkway	24,013	21,611	2,401	8,475	0
York Avenue	9,447	6,012	1,718	3,060	163
Second Avenue	16,031	16,031	3,563	9,975	1,900
Lexington Avenue	9,112	11,390	2,278	2,680	1,340
Park Aevnue	7,910	13,560	1,130	0	0
Fifth Avenue	10,162	12,702	2,540	2,920	876
Seventh Avenue	12,188	10,969	1,219	1,662	1,662
Broadway	11,792	10,613	1,179	2,680	536
Columbus Avenue	13,545	12,191	1,355	2,649	361
West End Avenue	8,742	7,868	874	930	186

Figure G-1
Average Weekday Inbound Base Traffic Estimates by Hour



Appendix H
Assumptions Behind Route Shift

The only route shift considered in the scenarios is from East River Bridges to the Brooklyn Battery and Queens Midtown tunnels. This is an oversimplification of the shifts which would likely occur if new tolls were added to East River crossings and/or on southbound avenues crossing 60th Street. Among other shifts, trucks now traveling for free from east to west across Manhattan would likely shift to the Verrazano-Narrows Bridge if its tolls were placed on the now free bridges over the East River. The scenarios do not account for this possibility, or any other complex route shifts resulting from system-wide tolls schedule changes, as it is beyond the modeling resources available at this time. The report calls for a more comprehensive look at system-wide impacts of traffic flow involving route shift analyses and the bounce-back effect among the East River bridges.

Route shift is based on the dollar difference in the choice the driver has to make between the two crossings under the new scenario and the choice available now.

> Number of vehicles that moves due to route shift = initial number of vehicles × sensitivity × ((difference between the scenario MTA toll and scenario East River Bridge tolls) – (difference between the former MTA toll and the former East River Bridge toll))

Because the scenarios are set up to match East River Bridge and MTA tolls, this dollar difference is the same across the scenarios, differing only during evenings and overnight in Scenario 3 “Like London”. In scenarios 1, 2 and 4, for cars, the number of vehicles that moves due to route shift = initial number of vehicles × -.005 × 7. In a further simplification, vehicles shifting from the East River Bridges to the MTA tunnels are assumed to split evenly between the two tunnels.

Appendix I
Results of Four Scenarios

Scenario 1 "Toll East River Bridges Like MTA"

Traffic Volumes	Total Daily Inbound Traffic	Change in Total Daily Inbound Traffic	Percent Change in Daily Inbound Traffic	Change in Total Daily Inbound Trucks	Percent Change in Daily Inbound Trucks
All Crossings	796,293	-40,092	-5%	0	0%
East River Bridges	186,650	-69,236	-27%	-10,543	-62%
MTA: Brooklyn Battery & Queens Midtown Tunnels	107,443	29,143	37%	10,543	310%
Port Authority: Holland & Lincoln Tunnels	112,500	0	0%	0	0%
Southbound Avenues Crossing 60th Street	389,700	0	0%	0	0%

Morning Peak	Change in Number of Vehicles at AM Peak	Percent Change AM Peak	Change in Trucks at AM Peak	Percent Change in Trucks at AM Peak
All Crossings	-10,257	-5%	0	0%
East River Bridges	-18,037	-27%	-2,994	-62%
MTA: Brooklyn Battery & Queens Midtown Tunnels	7,780	28%	2,994	256%
Port Authority: Holland & Lincoln Tunnels	0	0%	0	0%
Southbound Avenues Crossing 60th Street	0	0%	0	0%

Where the Traffic Goes	Loss of Trip Making to the Core (Trip Shift)	Route Shift	Additional Daily Transit Trips	Trip Shift as Percent of Total Diversions	Route Shift as Percent of Total Diversions	Mode Shift as Percent of Total Diversions
All Crossings	-8,559	0	94,599	21%	0%	79%
East River Bridges	-8,559	-29,143	94,599	12%	42%	46%
MTA: Brooklyn Battery & Queens Midtown Tunnels	0	29,143	0	0%	100%	0%
Port Authority: Holland & Lincoln Tunnels	0	0	0	n/a	n/a	n/a
Southbound Avenues Crossing 60th Street	0	0	0	n/a	n/a	n/a

Note: Route shift only considers vehicles moving from the East River Bridges to the Brooklyn Battery and Queens Midtown tunnels. Not shown is the potential shift from East River bridges to other crossings, such as the Verrazano-Narrows Bridge. Additional Daily Transit Trips estimates the number of people in the vehicles which leave the crossings due to mode shift (1.5 people per vehicle) and doubles this figure to account for round-trip transit journeys: Additional Daily Transit Trips = Mode Shift × 3.

Scenario 2 "Variable Pricing on East River Bridges; MTA to Match"

Traffic Volumes	Total Daily Inbound Traffic	Change in Total Daily Inbound Traffic	Percent Change in Daily Inbound Traffic	Change in Total Daily Inbound Trucks	Percent Change in Daily Inbound Trucks
All Crossings	793,781	-42,604	-5%	0	0%
East River Bridges	186,650	-69,236	-27%	-10,543	-62%
MTA: Brooklyn Battery & Queens Midtown Tunnels	104,932	26,632	34%	10,543	310%
Port Authority: Holland & Lincoln Tunnels	112,500	0	0%	0	0%
Southbound Avenues Crossing 60th Street	389,700	0	0%	0	0%

Morning Peak	Change in Number of Vehicles at AM Peak	Percent Change AM Peak	Change in Trucks at AM Peak	Percent Change in Trucks at AM Peak
All Crossings	-15,613	-8%	-466	-3%
East River Bridges	-20,254	-31%	-3,140	-65%
MTA: Brooklyn Battery & Queens Midtown Tunnels	4,641	17%	2,674	229%
Port Authority: Holland & Lincoln Tunnels	0	0%	0	0%
Southbound Avenues Crossing 60th Street	0	0%	0	0%

Where the Traffic Goes	Loss of Trip Making to the Core (Trip Shift)	Route Shift	Additional Daily Transit Trips	Trip Shift as Percent of Total Diversions	Route Shift as Percent of Total Diversions	Mode Shift as Percent of Total Diversions
All Crossings	-9,083	0	100,473	21%	0%	79%
East River Bridges	-8,559	-29,143	94,599	12%	42%	46%
MTA: Brooklyn Battery & Queens Midtown Tunnels	-523	29,143	5,874	2%	92%	6%
Port Authority: Holland & Lincoln Tunnels	0	0	0	n/a	n/a	n/a
Southbound Avenues Crossing 60th Street	0	0	0	n/a	n/a	n/a

Note: Route shift only considers vehicles moving from the East River Bridges to the Brooklyn Battery and Queens Midtown tunnels. Not shown is the potential shift from East River bridges to other crossings, such as the Verrazano-Narrows Bridge. Additional Daily Transit Trips estimates the number of people in the vehicles which leave the crossings due to mode shift (1.5 people per vehicle) and doubles this figure to account for round-trip transit journeys: Additional Daily Transit Trips = Mode Shift × 3.

Scenario 3 "Like London"

Traffic Volumes	Total Daily Inbound Traffic	Change in Total Daily Inbound Traffic	Percent Change in Daily Inbound Traffic	Change in Total Daily Inbound Trucks	Percent Change in Daily Inbound Trucks
All Crossings	763,317	-73,069	-9%	0	0%
East River Bridges	196,143	-59,742	-23%	-7,122	-42%
MTA: Brooklyn Battery & Queens Midtown Tunnels	97,950	19,650	25%	7,122	210%
Port Authority: Holland & Lincoln Tunnels	112,500	0	0%	0	0%
Southbound Avenues Crossing 60th Street	356,724	-32,976	-8%	0	0%

Morning Peak	Change in Number of Vehicles at AM Peak	Percent Change AM Peak	Change in Trucks at AM Peak	Percent Change in Trucks at AM Peak
All Crossings	-25,827	-13%	-1,023	-7%
East River Bridges	-20,887	-31%	-3,236	-67%
MTA: Brooklyn Battery & Queens Midtown Tunnels	7,778	28%	2,992	256%
Port Authority: Holland & Lincoln Tunnels	0	0%	0	0%
Southbound Avenues Crossing 60th Street	-12,718	-16%	-779	-12%

Where the Traffic Goes	Loss of Trip Making to the Core (Trip Shift)	Route Shift	Additional Daily Transit Trips	Trip Shift as Percent of Total Diversions	Route Shift as Percent of Total Diversions	Mode Shift as Percent of Total Diversions
All Crossings	-16,249	0	170,458	22%	0%	78%
East River Bridges	-8,559	-19,650	94,599	14%	33%	53%
MTA: Brooklyn Battery & Queens Midtown Tunnels	0	19,650	0	0%	100%	0%
Port Authority: Holland & Lincoln Tunnels	0	0	0	n/a	n/a	n/a
Southbound Avenues Crossing 60th Street	-7,690	0	75,859	23%	n/a	n/a

Note: Route shift only considers vehicles moving from the East River Bridges to the Brooklyn Battery and Queens Midtown tunnels. Not shown is the potential shift from East River bridges to other crossings, such as the Verrazano-Narrows Bridge. Additional Daily Transit Trips estimates the number of people in the vehicles which leave the crossings due to mode shift (1.5 people per vehicle) and doubles this figure to account for round-trip transit journeys: Additional Daily Transit Trips = Mode Shift × 3.

Scenario 4 "Full Variable Pricing"

Traffic Volumes	Total Daily Inbound Traffic	Change in Total Daily Inbound Traffic	Percent Change in Daily Inbound Traffic	Change in Total Daily Inbound Trucks	Percent Change in Daily Inbound Trucks
All Crossings	731,044	-105,341	-13%	0	0%
East River Bridges	186,650	-69,236	-27%	-10,543	-62%
MTA: Brooklyn Battery & Queens Midtown Tunnels	104,932	26,632	34%	10,543	310%
Port Authority: Holland & Lincoln Tunnels	98,344	-14,156	-13%	0	0%
Southbound Avenues Crossing 60th Street	341,119	-48,581	-12%	0	0%

Morning Peak	Change in Number of Vehicles at AM Peak	Percent Change AM Peak	Change in Trucks at AM Peak	Percent Change in Trucks at AM Peak
All Crossings	-35,000	-17%	-1,052	-7%
East River Bridges	-20,254	-31%	-3,140	-65%
MTA: Brooklyn Battery & Queens Midtown Tunnels	4,641	17%	2,674	229%
Port Authority: Holland & Lincoln Tunnels	-7,381	-24%	-119	-8%
Southbound Avenues Crossing 60th Street	-12,006	-15%	-467	-7%

Where the Traffic Goes	Loss of Trip Making to the Core (Trip Shift)	Route Shift	Additional Daily Transit Trips	Trip Shift as Percent of Total Diversions	Route Shift as Percent of Total Diversions	Mode Shift as Percent of Total Diversions
All Crossings	-25,810	0	270,839	22%	0%	78%
East River Bridges	-8,559	-29,143	94,599	12%	42%	46%
MTA: Brooklyn Battery & Queens Midtown Tunnels	-523	29,143	5,874	2%	92%	6%
Port Authority: Holland & Lincoln Tunnels	-5,220	0	59,144	21%	0%	79%
Southbound Avenues Crossing 60th Street	-11,507	0	111,222	24%	n/a	n/a

Note: Route shift only considers vehicles moving from the East River Bridges to the Brooklyn Battery and Queens Midtown tunnels. Not shown is the potential shift from East River bridges to other crossings, such as the Verrazano-Narrows Bridge. Additional Daily Transit Trips estimates the number of people in the vehicles which leave the crossings due to mode shift (1.5 people per vehicle) and doubles this figure to account for round-trip transit journeys: Additional Daily Transit Trips = Mode Shift × 3.