

Connecticut Tolling Options Evaluation Study



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**CDM
Smith**

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Executive Summary

Connecticut Tolling Options and Evaluation Study

Connecticut's highways and bridges are aging, in need of repair, and congested. Current transportation revenues are insufficient to maintain the existing infrastructure or make the types of improvements needed to reduce congestion. Gasoline tax revenues have been flat for ten years and are expected to begin declining as cars become more efficient, and as the sales of electric vehicles increase. A new source of revenue is needed that reduces the burden on the Special Transportation Fund. The fund needs to be sustainable and sufficient to improve the condition of Connecticut's existing infrastructure and finance highway improvements that will reduce congestion that clogs our major highways. Tolling is one potential source of revenue that could raise sufficient funding and meet the goals of being sustainable and directly related to one's use of the system.

For the last few years, Connecticut (CT) has been considering tolling as a potential new source of revenue to support its transportation programs. The CT Department of Transportation (CTDOT) conducted several studies to gain insight into how much revenue tolls might raise, and how tolling can help manage congestion on our busiest highways. More recently, CTDOT retained the consulting firm of CDM Smith to prepare this *Connecticut Tolling Options and Evaluation Study* to conduct additional analysis that provides more detailed answers to questions raised during recent tolling discussions among the Governor, the State Legislature, other policy-makers, and the public. Commonly-heard questions during these discussions include: *"Where would tolls be located?"* and, *"What are reasonable and responsible toll rates?"*.

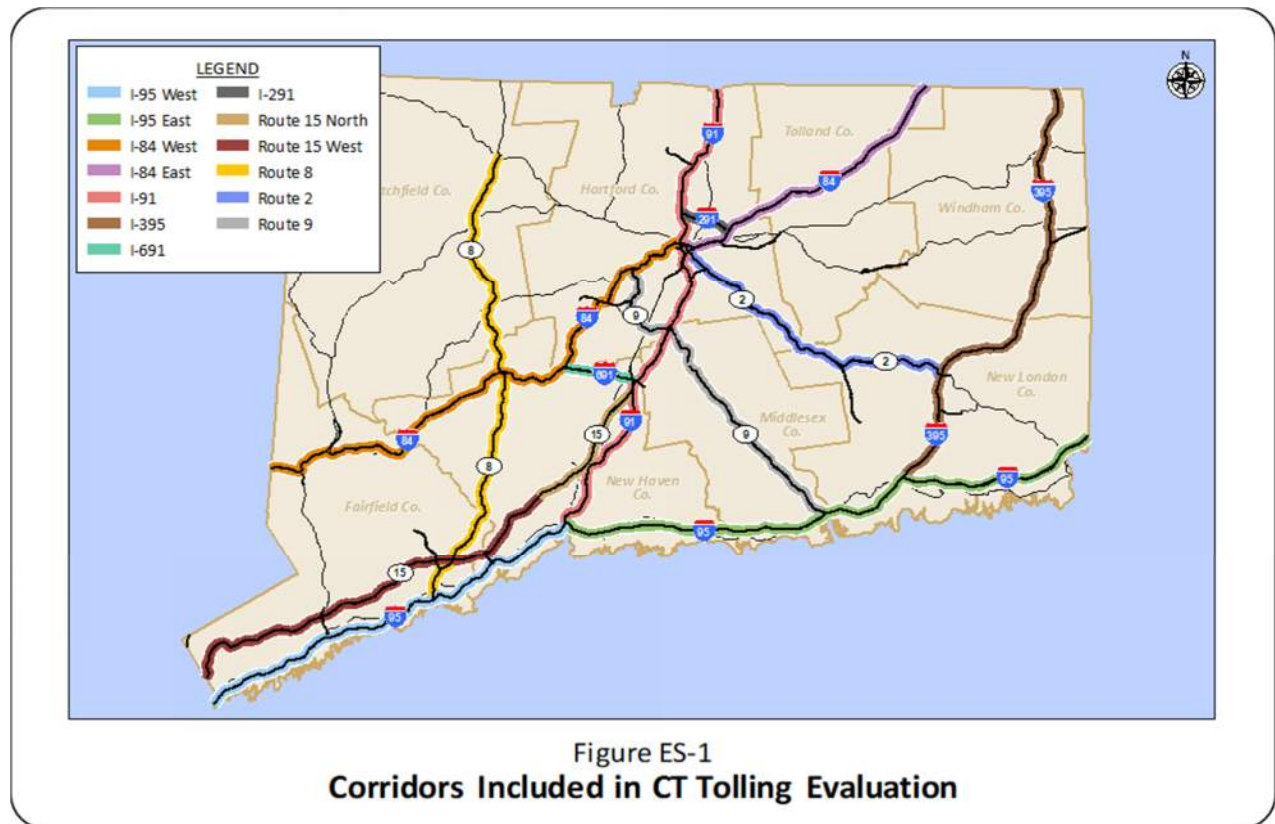
This study not only answers those questions, but also provides estimates of revenue, cost, and congestion reduction benefits that could result from tolling. It assumes a statewide system and includes specific routes, toll locations, toll rates, discounts, costs, and revenue estimates. While the toll system presented herein is based on a realistic set of assumptions, it should **not** be considered a 'recommended toll system' since its intent is to inform the on-going discussion on tolling.

Basis of Toll Scenario. The statewide system presented in this report would yield **\$950 million** in annual net revenue in 2023 and is **based on some of the lowest toll rates in the country**. The toll rate structure developed and tested for this study is comparable to or lower than toll rates established in Connecticut's neighboring states. This study evaluated many toll scenarios, but the scenario presented in this report was selected for discussion because it met four criteria:

- **Fairness** – tolls should be set to ensure collection of revenues from CT as well as out-of-state auto and truck trips.
- **Equity** - tolls should be set to ensure per mile rates are the same on all toll roads in the state.
- **Flexibility** – the toll system should allow the flexibility to set and adjust discount rates for CT car and truck drivers – including discounts for commuters and frequent users.
- **Revenue efficiency** – the toll system should seek to minimize the cost of collection and administration while also addressing key congestion relief objectives.

Scope of the Potential Statewide Tolling System

The tolling system selected for this report is a statewide, all-electronic tolling system inclusive of all interstate highways and four other major expressways and parkways. This statewide extent spreads toll collection equitably across the state. It also captures most of the out-of-state traffic that passes through Connecticut, minimizes traffic diversions to un-tolled major highways, and can yield higher toll revenues at a lower per mile toll rate. The potential toll network is shown in **Figure ES-1**. It should be noted that the current HOV lanes that traverse portions of I-84 east of Hartford and I-91 north of Hartford were assumed to remain toll free.



All-Electronic Toll Collection

Unlike CT tolling systems of the past, modern tolling systems use cashless, All-Electronic Tolling (AET), like those recently implemented on the Massachusetts Turnpike and several New York area toll bridges and tunnels. There would be no toll plazas or toll booths installed on existing highways, and no requirement for vehicles to stop and pay with cash.

AET systems use electronic toll readers and cameras mounted overhead to read E-ZPass transponders and license plates of vehicles at normal highway speeds. The photo in **Figure ES-2** shows a mainline toll gantry from the new Massachusetts Turnpike AET system.



Figure ES-2
Typical AET Toll Gantry

The large majority (70-90%) of tolls would be collected using electronic transponders like E-ZPass. Vehicles not equipped with E-ZPass would still be able to use the tolled roads. Tolls would be collected by video imaging of license plates, with billing and payment by mail or internet. Cash would not be accepted.

Payment Options. As shown in **Figure ES-3**, there would generally be four possible payment options for motorists using the state’s highways:

E-ZPass Transponders: E-ZPass is a prepaid electronic toll payment and collection method. Connecticut would join the existing E-ZPass system that is in use from Maine to Virginia and as far west as Illinois. There would be two categories of E-ZPass users:

1. **CT Issued E-ZPass.** Vehicles with E-ZPass transponder accounts issued and maintained by Connecticut. Drivers using this method would receive a **30% discount** compared to out-of-state E-ZPass users.
2. **Out-of-State E-ZPass.** E-ZPass accounts issued and maintained by agencies in other states;

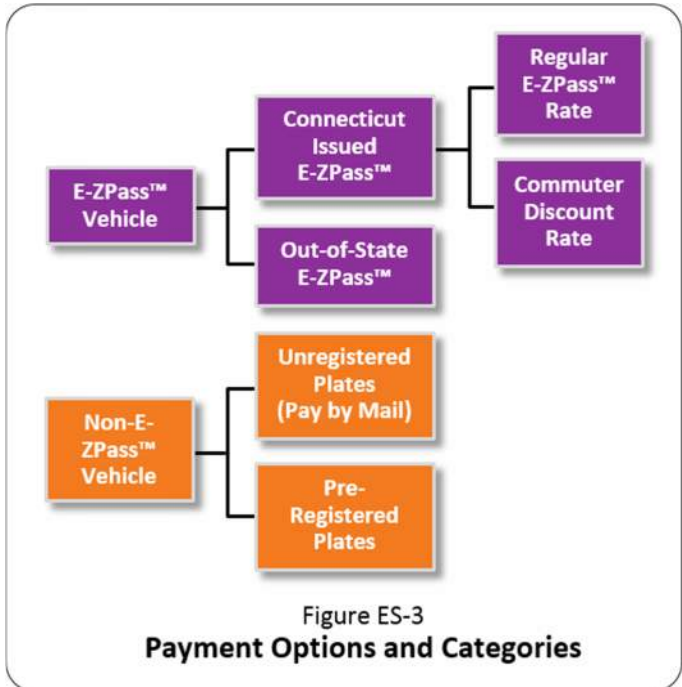


Figure ES-3
Payment Options and Categories

Vehicles without E-ZPass. Vehicles without an E-ZPass would pay through a video tolling system that records images of license plates. Bills are then sent to the owner of the registered vehicle. There would be two payment categories for video tolling:

3. **Unregistered Plates.** Unregistered plates would require a Department of Motor Vehicle (DMV) lookup (both within the CT DMV’s database of vehicles and within databases of other state DMVs), to enable invoicing and collection. Bills would be mailed to these vehicle owners. Due the high administrative cost associated with this method, these users would be charged a higher toll rate to cover the cost of the DMV look-up, invoicing and collection; and
4. **Pre-registered Plates.** For motorists who choose to complete a one-time registration of their license plate with the CT toll system and authorize payment directly to a connected credit card or bank account. The toll for these users was assumed to be set at the midpoint of unregistered plate users and out-of-state E-ZPass users.

Potential Toll Rates

A wide range of potential toll rates and discounts were tested as part of the study. The toll rate structure presented in **Table ES-1** was selected for this report because it met the four criteria discussed previously – fairness, equity, flexibility and revenue efficiency. The same per mile toll rates were used on all potential toll corridors included in this study. These rates are hypothetical, intended to inform future toll discussions.

Table ES-1
Potential Toll Rates: Cents per Mile

Payment Type	Class 1		Class 2		Class 3	
	Passenger Vehicles		Medium trucks, buses		Heavy Trucks	
	Off-Peak Hours	Peak Periods	Off-Peak Hours	Peak Periods	Off-Peak Hours	Peak Periods
E-ZPass						
CT E-ZPass (30% discount off base rate)	4.4	5.5	8.8	11.0	17.6	22.0
CT E-ZPass (with 20% commuter discount)	3.5	4.4	----	----	----	----
Out-of-state E-ZPass (base rate)	6.3	7.9	12.6	15.8	25.2	31.6
VIDEO						
Pre-registered plate (25% higher than base)	7.9	9.9	15.8	19.8	31.6	39.6
Unregistered plate (50% higher than base)	9.4	11.8	18.8	23.6	37.6	47.2

CT E-ZPass Discount. Drivers with a CT-issued E-ZPass would receive a **30 percent discount** off the out-of-state E-ZPass toll rate. They would pay **4.4 cents** per mile in the off-peak and **5.5 cents** per mile during the peak traffic periods.

Commuter Discount. Under a possible commuter discount program, commuters and other frequent users would qualify for an additional **20 percent discount** if they use a CT E-ZPass and make 40 or more one-way trips (20 round trips) per month. This would bring the rate for CT drivers down to **3.5 cents** per mile for off-peak hours and **4.4 cents** during peak periods.

Video Toll Rates. Vehicles without an E-ZPass would be charged rates that are 25 percent higher than the out-of-state rates if they have pre-registered their license plate with the Connecticut toll system. The higher rate covers the higher processing costs of video tolling. Vehicles without an E-

ZPass or pre-registered plate would be charged rates that are 50 percent higher than an out-of-state E-ZPass due to the higher processing cost and the cost of paying the Department of Motor Vehicles (CT or any other state) to look up the plate owner and address.

Truck Toll Rates. Larger vehicles such as trucks and buses would be charged higher rates to reflect the greater wear and tear these vehicles exert on roads and bridges. Medium trucks and buses would be charged twice the rate of passenger cars and pick-up trucks. **However, Connecticut transit buses would be exempt from any toll.** Tractor trailers (heavy trucks) would be charged four times the rate of passenger cars. Trucks with a CT E-ZPass would receive the 30% CT discount.

Higher Peak Period Tolls: Congestion Pricing. The addition of new tolling systems on existing toll-free interstate highways is generally prohibited by federal law. However, the reinstatement of tolls in Connecticut, if ultimately approved by the State Legislature, would be enabled by the state’s current designation as one of 13 states in the Federal Highway Administration’s (FHWA) Value Pricing Pilot Program (VPPP). This program requires the use of variable tolls by time of day. Variable tolling is a means by which higher toll rates are charged during both the morning and afternoon peak hours of travel (i.e. ‘rush hours’) to effectuate ‘congestion pricing’ benefits. Variable tolling or congestion pricing is a proven and effective way to mitigate traffic congestion because it:

- Encourages drivers who do not need to travel during rush hours to shift to off-peak periods;
- Encourages commuters to shift to alternate modes of travel such as car pools, or transit;
- Encourages drivers to combine or consolidate trips, which reduces traffic; and
- Encourages drivers to choose alternative routes or alternate destinations.

Costs of Typical Trips. To illustrate how the toll rates in Table ES-1 would affect drivers’ pocketbooks, some typical trips along I-95, I-91, and I-84 were selected and their total toll costs were calculated. The examples listed in **Table ES-2** are for passenger vehicles with CT E-ZPass transponders.

Route	From	To	Miles	Off Peak Toll		Peak Period Toll	
				CT E-ZPass	Commuter Discount	CT E-ZPass	Commuter Discount
I-91	Wallingford	New Haven	12	\$0.53	\$0.42	\$0.66	\$0.53
I-84	Southington	Hartford	22	\$0.97	\$0.77	\$1.21	\$0.97
I-84	Waterbury	Danbury	27	\$1.19	\$0.95	\$1.49	\$1.19
I-91	New Haven	Hartford	38	\$1.67	\$1.33	\$2.09	\$1.67
I-95	New York	New Haven	48	\$2.11	\$1.68	\$2.64	\$2.11
I-84	New York	Hartford	63	\$2.77	\$2.21	\$3.47	\$2.77
I-95	New York	Rhode Island	112	\$4.93	\$3.92	\$6.16	\$4.93

Comparison with Other States

The toll rate structure presented in this report compares favorably with toll rates in neighboring states. In the northeast region, the average electronic toll for passenger cars is approximately 6.3 cents per mile, while the CT E-ZPass rate tested in this scenario would be 4.4 cents per mile (off-peak). For frequent travelers, the rate is even lower at 3.5 cents per mile (off-peak). Five-axle trucks (the most common heavy truck category) pay an average per mile rate of 29.3 cents in neighboring states, compared to a possible CT E-ZPass truck rate of 17.6 cents per mile or out-of-state E-ZPass rate of 25.2 cents per mile (off-peak). At a national level, the overall average toll rate is 9.7 cents per mile for passenger cars, and 40.2 cents per mile for trucks. As shown in **Figure ES-4**, on a per-mile basis, tolls charged in Connecticut would be among the lowest in the United States.

Figure ES-4

Comparison of Possible Connecticut E-ZPass Toll Rates Relative to Toll Rates in Other States

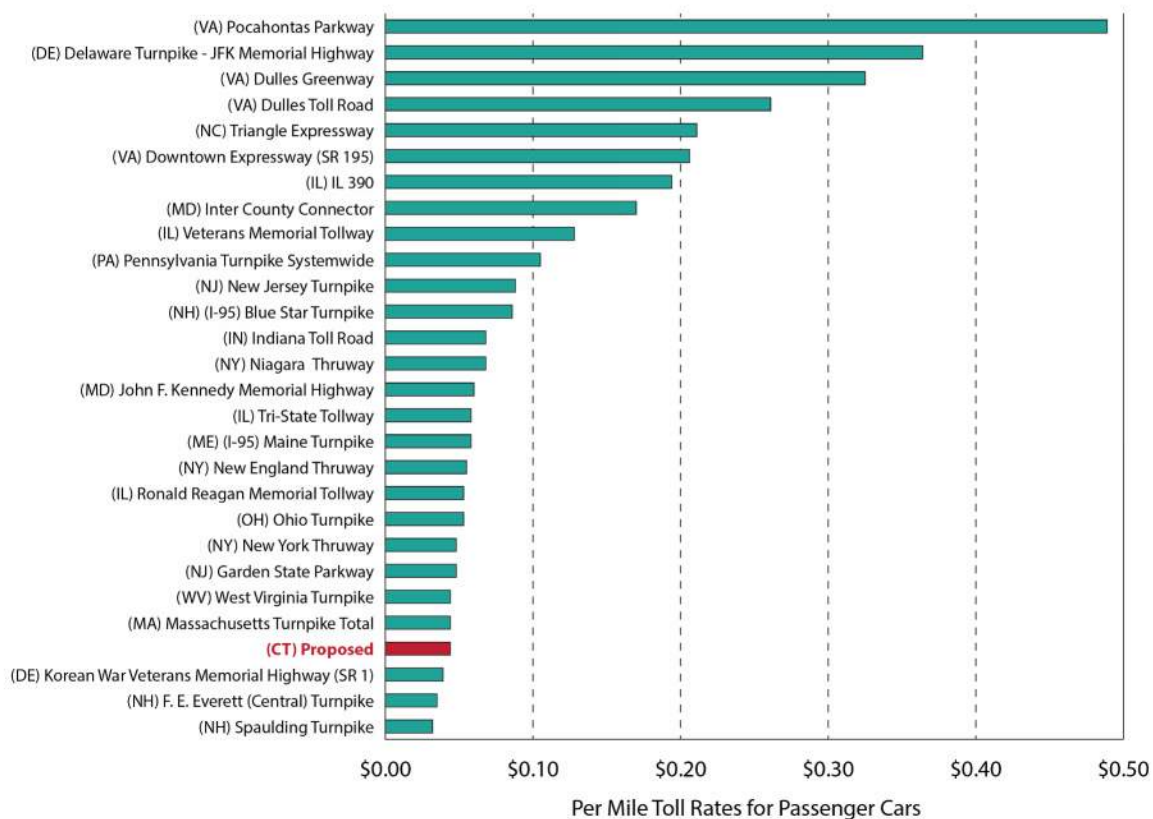


Table ES-3 provides a comparison of a 50-mile trip on sample toll facilities in the region. The calculated toll rate for the other facilities was constructed based on someone leaving Connecticut and entering the other facility at its nearest entrance and traveling 50 miles. For example, trips on the Garden State Parkway and the New Jersey Turnpike enter from the northernmost point and exit

50 miles south of there. The conceptual toll rate for CT is based on the commuter toll rate of 3.5 cents per mile. Connecticut would be by far the lowest trip cost among any of the facilities shown.

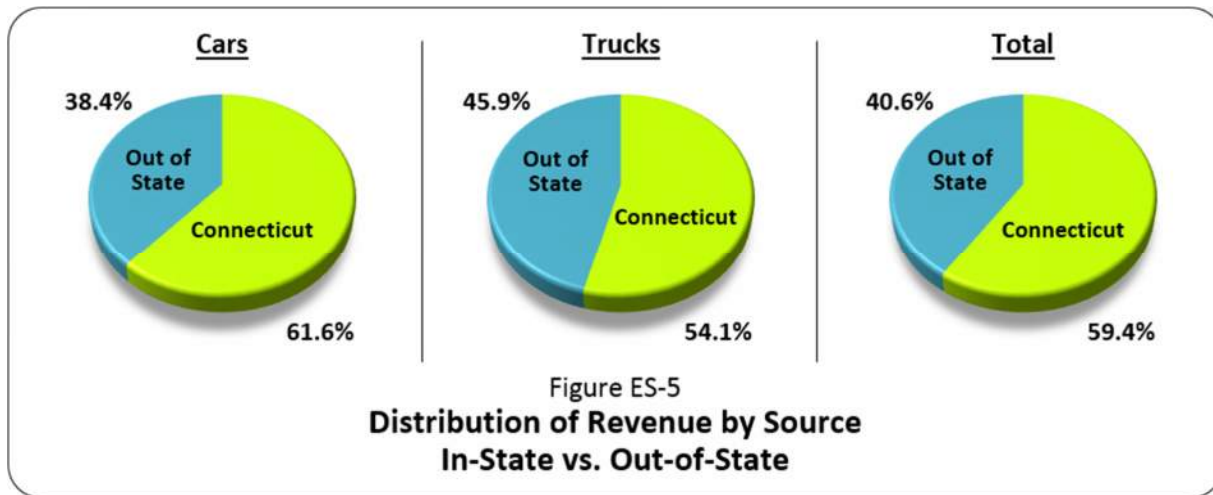
Table ES-3
Comparison of Proposed CT Toll Rates to Neighboring States

Toll Facility	50-mile Trip Cost (E-Zpass)
Pennsylvania Turnpike	\$7.06
New Jersey Turnpike	\$6.02
Garden State Parkway	\$4.34
New York Thruway	\$2.12
Connecticut (Studied)	\$1.75

Gross Revenue

The statewide toll system described in this report would yield an estimated \$3.2 million in weekday revenue in 2023. This would result in more than **\$1.086 billion** in gross annual toll revenue. A similar amount of annual revenue was estimated for 2040, even though a higher number of transactions or vehicle trips are expected. This is because the proportion of vehicles assumed to be equipped with an E-ZPass increases over time; hence, the average toll per transaction tends to be reduced over time (as would the operating costs as more drivers use E-ZPass).

Out-of-State Revenue. As shown in **Figure ES-5**, with the pricing strategies assumed, slightly more than **40 percent** of toll revenue would come from out-of-state motorists.



Trucks. Class 2 & 3 vehicles would contribute **29 percent** of the total revenue (not shown in pie chart). **46 percent** of the truck revenue would be from out-of-state trucks.

Passenger vehicles. Class 1 vehicles would yield **71 percent** of revenue (not shown in pie chart), and **38 percent** of that would come from out-of-state.

Net Revenue

The net annual revenue in the first year of operation (2023) is projected to be **\$950 million**. This is the amount remaining after annual operating costs and annualized capital costs are deducted from the estimated gross revenues of \$1.086 billion.

The net revenues would be used pay for maintenance, repair, and improvement of Connecticut's transportation network. The new revenue would enable an expanded transportation infrastructure program, including improvements to the condition of roads and bridges across the State, as well highway widening and operational improvements to reduce congestion.

Capital & Operating Costs

The toll system assumed in this study is composed of two subsystems: (1) the roadside electronic toll collection or gantry system; and, (2) the central service center that processes the toll data, manages the billing systems, and provides customer service.

Electronic Toll Collection System. The electronic toll collection system would consist of 82 gantries and associated electronic sensors, plus a statewide fiber optic network to connect the gantries to one another and to the central processing center. While more than 500 miles of total fiber communications would be required, a portion of this already exists along some of the proposed tolled corridors. Overall, an estimated additional 360 miles of fiber optic communication network would need to be established.

Central Processing & Customer Service. All the gantry locations would transmit data to a central processing and customer service center. The center would handle all customer inquiries and register new E-ZPass users. It would also process data transmitted from the gantries, administer all the electronic billing, prepare and mail bills to drivers without an E-ZPass, and manage the process for collecting payments from toll violators. "Walk-in" customer service centers would be located at the central service center and at a limited number of satellite locations for the convenience of customers.

Capital Cost. The capital cost of the entire toll collection system, including all toll gantries and equipment is estimated at \$210 million, in 2016 dollars. In addition, the expanded and upgraded statewide fiber optic network is estimated at \$162 million, bringing the total capital cost associated with the entire new toll collection and communication system to an estimated **\$372 million**. For purposes of this study, the cost was annualized and estimated to be **\$38 million per year**.

Operating Cost. Annual toll collection related operating costs are estimated at about **\$100 million** per year, at 2023 levels (but in 2016 dollars). This is projected to decrease over time, dropping to about \$82 million (in 2016 dollars) by 2040. The projected decrease in operating costs is due to the assumption that the proportion of vehicles equipped with electronic toll collection would increase over time; which means the costlier video image processing transactions would decrease over time. The **\$100 million** annual operating cost in 2023 represents just under 10 percent of gross annual toll revenue.

Traffic Benefits

In addition to estimated traffic and revenue, the study also modeled potential traffic diversions and other impacts associated with tolling. A comparative analysis was performed between tolled and toll-free conditions at both 2023 and 2040 levels. In the case of 2040, two different tolling scenarios were run:

- 1. Tolling-Only Scenario.** A scenario with tolling and congestion pricing, but no highway widening or operational improvements, and
- 2. Tolling Plus Highway Improvements Scenario (Build Scenario).** A scenario with congestion pricing plus highway improvements intended to help reduce congestion.

Many of the major capital improvements included in the “Tolling Plus Highway Improvements Scenario” could be financed with the toll revenues generated by the toll system. Some of the major highway improvements included in the 2040 “build” scenario include:

- Widening of I-95 West between the New York State line and Bridgeport. This includes a shorter-term targeted widening program as well as a much longer-term and more extensive widening program.
- Widening of I-95 East between Exit 55 in Branford and Exit 85 in New London, including the full reconstruction of the I-95/I-395 interchange. Some of the more extensive widening elements would be longer-term projects.
- Widening of portions of I-84 in the Danbury area, a full reconstruction and realignment of the I-84/Route 8 Mixmaster in the Waterbury area, and reconstruction of the Hartford Viaduct.
- Widening and other improvements on I-91 near the junction of I-91/I-691/Route 15.
- Removal of the traffic signals on Route 9 in Middletown to eliminate the bottleneck caused by the only two signals on this limited access highway.

Congestion Reduction

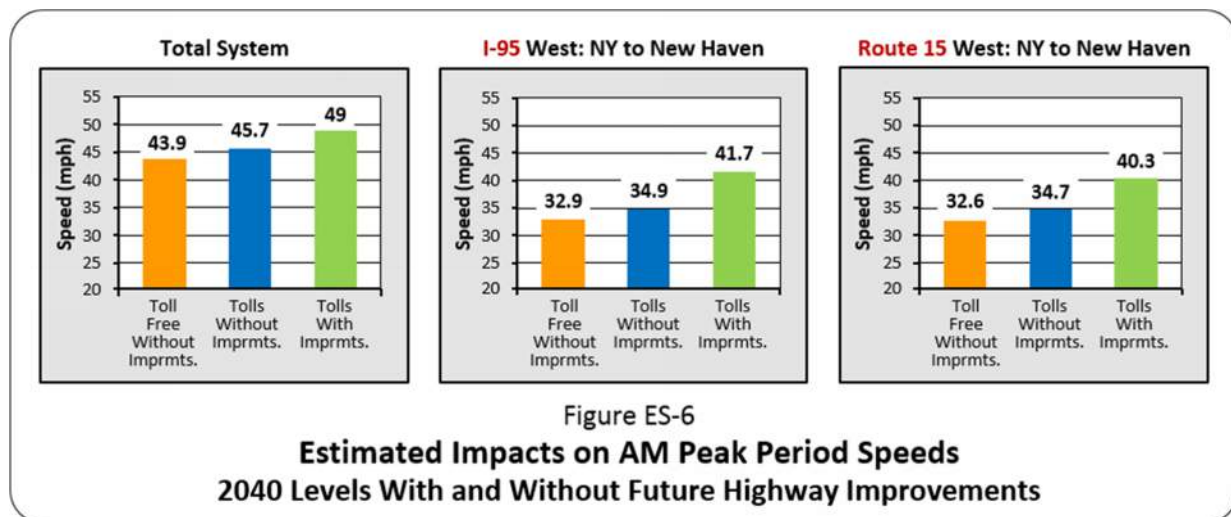
A primary objective of tolling/congestion pricing and the highway improvements is the reduction of congestion on Connecticut’s major highways. Significant savings in travel time can be expected on some of the most congested routes even at the relatively low toll rates examined in the study. For example:

- On I-95 West, the average commuter would save about 18 hours per year at 2040 levels simply because of tolling; this would increase to almost 29 hours per year of annual time savings with both tolling and the widening of this route enabled by tolling. The cumulative time savings of all drivers using I-95 West during am and pm peak hours would reach 3.0 million hours per year, valued at about \$75 million; with tolling alone. If the benefits of the widening financially enabled by tolling are included, a total peak period travel time savings

of about 4.9 million hours would accrue for this segment of expressway, with an equivalent value of more than \$120 million per year.

- On I-84 West, the average commuter would save 9 hours per year, worth about \$230 per year. This equates to total time savings for all peak hour users of I-84 West of about 1.8 million hours per year with tolling alone, with an equivalent value of more than \$44 million per year. When the benefit of several major improvements is also included, cumulative travel savings increase to about 3.4 million hours per year for this segment of expressway, nominally worth about \$86 million per year.
- Over the entire tolled system, the average commuter would save 10 hours per year in travel due to tolling, with that value increasing to 15 hours per year, systemwide, considering the impact of both tolling and the major highway improvements enabled by it. The cumulative peak period time savings systemwide from tolling only in 2040 is estimated at about 12 million hours, with an economic value of almost \$300 million. With the added benefit of widening and other major improvements, peak period time savings systemwide would reach almost 20 million hours; worth almost \$500 million in economic benefit.

Figure ES-6 shows these benefits graphically for the total system and for Connecticut’s two most congested routes: I-95 West (NY to New Haven) and Route 15 West (NY to New Haven). The three colored bars present average speeds and average trip times under three alternative toll scenarios: 1) toll-free; 2) tolled without improvements; and, 3) tolling with the major highway improvements.



Total System. For the total system, average morning peak hour speeds in 2040 would increase from 44 mph to 46 mph with tolling only. When tolling is combined with highway improvements, average speed increases from 44 mph to 49 mph.

I-95 West of New Haven. The average speed on I-95 in 2040 in the morning peak-hour is projected to be 33 mph. Average speeds would increase to over 35 mph with tolling alone. If tolling is combined with widening, average speeds would increase from 33 mph to 42 mph. This would have the effect of reducing trip travel times by at least 25 percent during morning peak hours.

Route 15 West of New Haven. Merritt Parkway speeds would increase even though there is no widening proposed for the Parkway. The average morning peak-hour speeds are estimated at 33 mph without tolls but increase to 35 mph with tolls. While no widening would be done to the Parkway, the widening of I-95 would encourage some traffic to shift to I-95. This would reduce traffic and congestion on the Parkway, and increase average speeds to 40 mph.

Summary

In summary, this tolling study evaluated several options to test the viability of All Electronic Tolling in Connecticut. The principal findings of this study include:

- The extent of electronic tolling in Connecticut should be statewide - on all major expressways and parkways. This option would spread toll collection equitably across the state and would minimize potential traffic diversions to non-tolled expressways.
- Tolls would be collected using an All Electronic Tolling system comprised of 82 overhead gantries constructed throughout the State. This cashless system would not require vehicles to stop or even slow down.
- A pricing strategy should be based on a hierarchy of rates, with higher charges for heavier vehicles, and possibly with commuter discounts for high frequency travel and other programs available to low-income populations to mitigate equity concerns.
- Toll prices would also vary by time of day. This variable tolling or value pricing approach, where higher toll rates are charged during 'rush hours,' is a proven and effective way to mitigate traffic congestion.
- The toll rate structure presented in this report which would result in a base rate of 4.4 cents per mile (off-peak) for passenger cars equipped with a CT issued E-ZPass. This rate would be among the lowest in the United States. Frequent users would see a lower toll rate at 3.5 cents per mile (off-peak). Higher rates would apply to trucks and other heavier vehicles as well as to vehicles that are not equipped with a Connecticut issued transponder.
- This statewide toll system and toll rate structure would result in about \$950 million in net annual toll revenue in the assumed opening year of 2023. Slightly more than 40 percent of this potential revenue would be from out-of-state vehicles.
- Revenue from tolling would be dedicated to the maintenance, repair and improvement of Connecticut's transportation network. This infusion of revenue would enable CTDOT to implement many major capital improvements which would result in significant reduction of congestion on Connecticut's major highways.

Chapter 1

Introduction and Study Overview

The State of Connecticut has identified the need for significant transportation capital investments over the next three decades. Like most states, due to funding shortages and declining revenue from the motor fuel tax, many transportation improvement projects have been deferred in the past. The State believes it needs to aggressively embark on a program of reconstruction and expansion to deal with its aging infrastructure and growing problems with traffic congestion.

In 2017, the Connecticut Department of Transportation (CTDOT) retained the consulting firm of CDM Smith to evaluate the potential for electronic tolling on the State's limited access facilities, both as a possible strategy to increase transportation-related revenue and to deal with traffic congestion. This report summarizes the results of this evaluation, which looked at a wide range of issues and potential deployment alternatives associated with potential highway tolls in Connecticut.

Why Tolls?

For more than 100 years, the gas tax has been the primary source of highway transportation funding. While the fuel tax has served our country well, it is becoming increasingly unsustainable in the future, due primarily to increases in fuel efficiency and an accelerating shift toward plug-in electric vehicles. Most states agree that new sources of funding will be needed, and user fees, such as electronic tolls, are among the top contenders.

Electronic tolls can be applied to all users regardless of whether the vehicle is gasoline or electric powered. As travel increases in the future, revenue from these user fees will increase; the same can no longer be said about the gas tax. We can anticipate continual declines in motor fuel tax revenue, even in the face of increasing vehicle miles of travel, as vehicles become more efficient and the automobile industry moves away from internal combustion engines.

The transportation funding problem is particularly acute in Connecticut, where the solvency of the State Transportation Fund (STF) was recently avoided by adding new revenues from the general sales tax, the sales tax on new cars, and a \$3 fee on new tires sold. This fix keeps the STF solvent for 5 years, but after that the Fund is again at risk of insolvency. A more permanent fix is required that is not dependent on the gasoline and diesel fuel taxes, especially in view of the need to increase annual transportation expenditures to meet the capital needs which have been identified.

In addition, several of the state's limited access highways and parkways have become heavily congested, particularly I-95 and the Merritt Parkway between New York and New Haven. Based on congestion pricing studies conducted in 2015, stop and go traffic on I-95 can often extend 20-30 miles or more in the afternoon peak periods. In some cases, this can make a 48-mile trip between the New York state line and New Haven take 90 minutes to two hours. Even with relatively modest levels of annual traffic growth, this delay has been projected to increase by as much as another 30-45 minutes by 2040.

Similar congestion routinely occurs on Route 15, as traffic attempts to use the Parkway to avoid extreme congestion on I-95. The Merritt Parkway, constructed in the late 1930's, was built to a design standard which is largely obsolete today. While the state takes pride in preserving the historic nature of this roadway, its design limitations further compound problems with recurring congestion.

Congestion is also routinely experienced in the Hartford area on both I-84 and I-91. I-84 is also heavily congested in the Danbury and Waterbury areas. In short, congestion is a serious issue in the state. Using tolling to manage peak demand along with targeted widening projects can be an effective strategy for reducing congestion.

Background

Connecticut has extensive prior experience with tolling. The Connecticut Turnpike, which encompassed most of I-95 and portions of I-395, was originally constructed as a toll facility, using an open cash barrier toll system. Eight toll plazas were located along the 129-mile route. The toll plazas often experienced extensive backups and delays during peak periods. A major fatal accident occurred in 1985 at the Stratford Toll Plaza which ultimately resulted in policy decisions to remove all tolls in the state.

Tolls were also used in the financing and construction of both the Merritt and Wilbur Cross Parkways. Three toll plazas were located on that route. Finally, tolls were also used on four bridges in the state, three of which were in the Hartford area and one in southeastern Connecticut. All tolls were removed by 1986.

While the State accumulated more than four decades of experience with traditional tolling, it has not had toll facilities in more than 30 years. Due to technological advances in tolling systems including vehicle detection, tolling in 2018 is quite different than tolling in 1985. It is extremely important for motorists to recognize that all electronic tolling, if implemented in Connecticut, would not bring the return of toll plazas and associated traffic backups. All toll collection would be made at full travel speeds without the need for vehicles to stop or slow down.

CTDOT recently conducted two major congestion pricing studies with funding from the Federal Highway Administration (FHWA), one on I-95 between New York and New Haven and another on I-84 in the greater Hartford area. These Value Pricing Pilot (VPP) program studies, showed considerable potential for congestion reduction through tolling particularly the one conducted for I-95. Importantly, the combined effect of using variable electronic toll pricing, coupled with the benefit of roadway widening (which could be financially enabled by toll revenue), could be expected to provide huge benefits to travelers in that corridor.

While the VPP studies were conducted for limited sections of I-95 and I-84, they resulted in development of new statewide traffic models and tolling analysis tools that enable the study of tolling beyond the areas covered by the original VPPP studies. Governor Malloy appointed a special panel in 2015 to evaluate alternative options for new transportation funding in the state. That panel issued its report in January 2016. Among other suggestions, electronic tolling on the State's congested expressways was among the top suggestions for dealing with both congestion and raising badly needed additional revenue for transportation investment.

Partially because of the Finance Panel’s recommendations, general discussions began in the Connecticut Legislature about the potential of electronic tolling. In support of this, CTDOT retained CDM Smith to perform this preliminary evaluation of tolling options for the state. This report recognizes that no final decisions on tolling have been made and the ultimate deployment of tolls in Connecticut is subject to approval by the Legislation, and the Federal Highway Administration (FHWA). This report is intended to provide a summary of the options, costs, revenue potential and impacts associated with a possible statewide tolling program.

Study Objectives

The primary objectives of the study were to help the state answer seven critical questions:

- Should tolling be used in the State of Connecticut to help manage congestion and raise additional revenue for transportation?
- What roads should be tolled and how should tolls be collected?
- Where should toll gantries be placed?
- What would the cost be to implement and operate tolling?
- What toll rates should be used and what discounts could be available to Connecticut residents?
- What is the annual revenue potential from tolling in Connecticut and what portion of that revenue would come from Connecticut versus out-of-state traffic?
- What traffic and other travel impacts could be expected?
- How should tolling be operated in the State and how should it be administered/managed within CTDOT?

The approach for this study was designed to answer each of these questions, providing CTDOT within a range of options from which preferred alternatives could be selected. While dozens of variations were tested, both in terms of “where and how” to toll, at the study conclusion a single alternative was selected to use as a basis for discussion with the Legislature. Those discussions would provide guidance on how to modify the alternatives to best suit Connecticut’s needs.

An early task in the study related to defining the geographic scope of a potential tolling program. Initially, the study considered almost 20 potential routes, route segments and/or bridges/tunnels within the state as potential candidates. Ultimately, after reviewing revenue potential and preliminary estimates of capital and operating costs, the study team decided that a fairly uniform program of electronic tolling should be implemented on almost all limited access expressways and parkways in the state, but not on isolated bridges or tunnel facilities or HOV lanes.

The rationale behind this selection came back to the four criteria of fairness, equity, flexibility, and revenue efficiency. It also allowed for the use of a uniform lower toll rate spread out among a network, rather than isolated to a limited number of locations or bridges where higher tolls would be needed to generate the same revenue. The statewide system provides geographic equity

while also fitting within the FHWA Value Pricing Pilot Program structure with which such a program would be enabled,

All-Electronic Tolling - This study looked at various alternative methods of tolling, and quickly settled on the use of cashless, all electronic tolling. This concept would be similar to methods now used on the Massachusetts Turnpike and other toll facilities in the U.S., which have eliminated cash collection (and all associated delays at toll plazas) in favor of overhead toll gantries which collect tolls through electronic toll transponders (such as E-ZPass) or a “Pay by Plate” approach. This was further reinforced by the fact that FHWA has indicated that the construction of toll booths for cash collection and its inherent traffic disruption and delays, would not be permitted on currently toll-free interstate routes.

Toll Gantry Locations - This study included a preliminary determination of tolling locations throughout the network and an initial desktop survey to identify any physical constraints for the selected locations. While it would be infeasible to place a gantry between every interchange given the frequency of interchanges in Connecticut, a fairly uniform spacing of gantry locations was chosen with an average spacing of 6.6 miles to be consistent with the four criteria of fairness, equity, flexibility, and revenue efficiency. Other criteria included minimizing diversion possibilities to the extent possible and limiting the number of tolling gantries to not more than one location per town, per tolled route. In addition, tolling locations were not located within cities or on major bridges that would become an impediment between communities on either side of a major waterway.

Toll Technology - This study included an evaluation of the development of electronic toll technology for the entire state. This technology included roadside system architecture, central system requirements, back office accounting procedures, customer service centers throughout the state, and more. As part of that task, estimates of the capital costs and annual operating costs were developed for various tolling scenarios.

Toll Rate Sensitivity Analysis - This study also included a toll rate sensitivity analysis, testing alternative levels of toll charges, alternative spacing of electronic toll points, alternative price differentials between several different payment options, alternative levels of peak-hour surcharges for congestion management, and alternative volume discount program options. A single preferred rate structure was then selected for use in developing traffic and revenue estimates for the preferred toll concept.

Traffic Impact Analysis - The study team also conducted a travel demand modeling process, which enabled the team to estimate potential traffic diversions, time of day travel shifts from peak to off-peak hours, potential shifts to transit, and overall trip reductions. The modeling process also resulted in the estimation of congestion reduction benefits from tolling.

Procurement of Toll Systems - Finally, institutional options were identified for the procurement and operation of the toll system as well as CTDOT organizational and management structure needs for providing oversight.

Chapter 2

Tolling Program Overview

As noted in Chapter 1, this tolling options and evaluation study considered a wide range of alternative tolling applications, both in terms of geographic coverage, tolling methods and pricing strategies. Early in the study, a “sketch level” assessment was made on a variety of options; these were presented to the CTDOT leadership in early Fall 2017. After review and consideration of these assessments, CTDOT established a series of key assumptions that would help define scenarios for consideration in the analyses which are presented in this report. These assumptions included:

- The tolling program should nominally be considered on a “statewide” basis to:
 1. Ensure geographic equity.
 2. Provide a large base of tolled miles so toll rates can be set as low as possible.
 3. Collect revenue from out of state trucks and cars, while offering discounts to CT E-ZPass users and frequent commuters.
 4. Minimize traffic diversion.
 5. Allow for efficient use of toll revenue.
- Tolling of bridges, tunnels, or other isolated locations was not to be included;
- Tolling should only employ “All Electronic Tolling” (AET), without requiring the construction of toll booths, toll plazas, or any other impediments to traffic flow;
- Tolling would be subject to review and approval by the Connecticut Legislature and FHWA before implementation;
- Based on current federal restrictions, tolling on existing toll-free interstate routes within Connecticut would be enabled through Connecticut’s designation as one of 13 states within the federal Value Pricing Pilot Program (VPPP); this tolling authority would not be limited to the facilities studied in previous congestion pricing studies, but *would* require the use of variable, time of day pricing (higher tolls during peak traffic periods, also known as congestion pricing) to encourage shifts of traffic from peak to off-peak conditions; and,
- This study should address the specific tolling locations, costs, toll prices, discount options, diversion, congestion reduction benefits, and institutional and oversight considerations.

Geographic Scope

After the preliminary assessments were completed, it was determined that all major expressways and parkways within Connecticut would be included in the Statewide Tolling Program, whether bearing an interstate route designation or a Connecticut State Route designation.

Figure 1 shows the potential routes that may be included in the system; final decisions about which routes are tolled would be subject to further study and approval of the Legislature. Major routes such as I-95, I-84 and State Route 15 were subdivided into two corridor sections, recognizing significant differences in traffic and congestion levels within each portion of the overall route. In total, 13 different routes, or route segments, were considered in the analysis.

I-95 was broken into two corridors, generally west and east of New Haven. Similarly, I-84 was subdivided into I-84 West, between New York State and Hartford, and I-84 East between Hartford and the Massachusetts line. The Parkways were also broken into two segments; Route 15 West, between New York State and New Haven, and Route 15 North, a more northerly segment between New Haven and Meriden. I-91 and I-395 were evaluated as one full-length project.

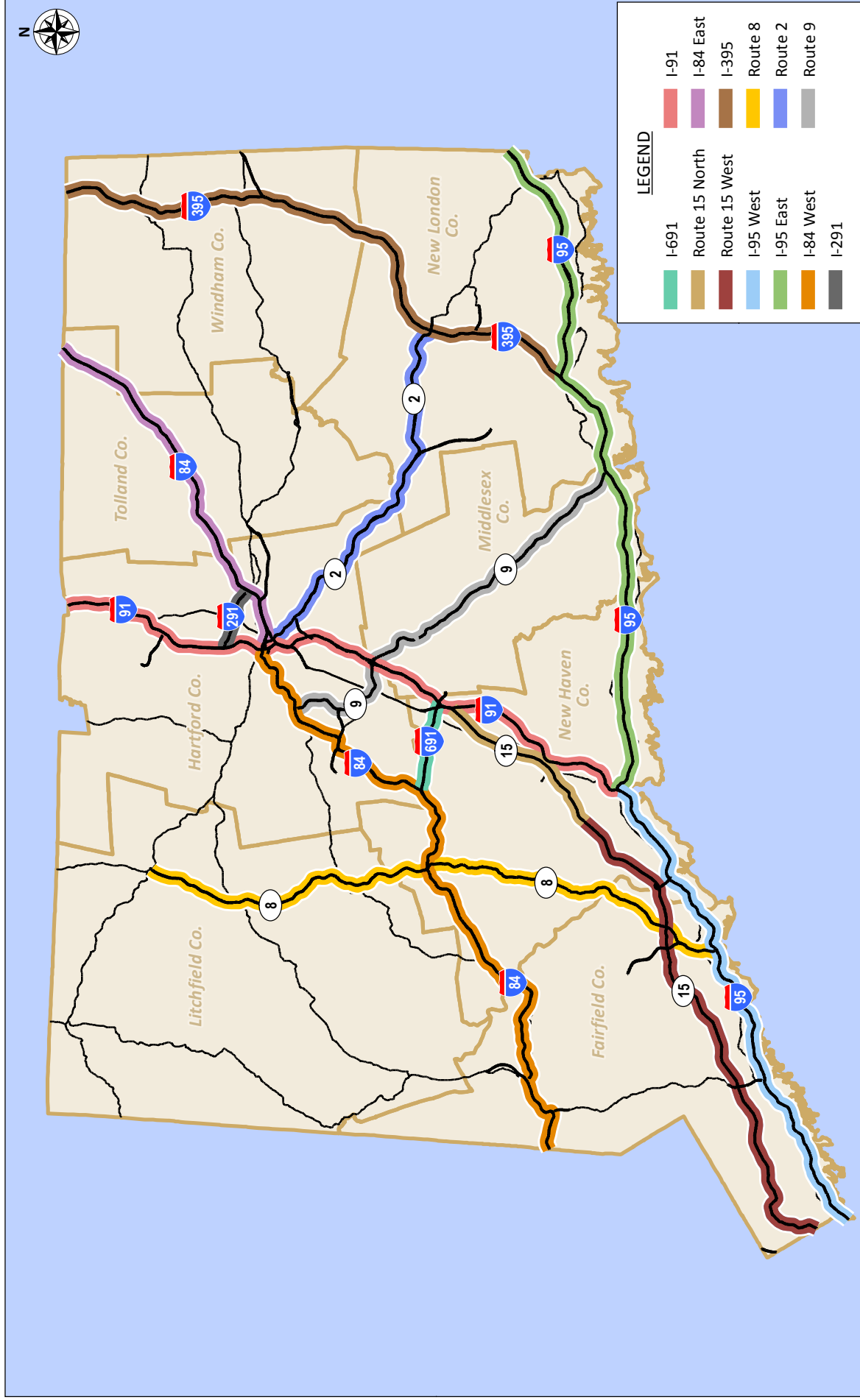
In addition to these major routes, five other expressways were included in the system. These are Route 2 between Hartford and Norwich, Route 8 between Bridgeport and Winsted, and Route 9 between Old Saybrook and New Britain. Two short interstate spur segments, I-691 between Waterbury and Meriden, and I-291 northeast of Hartford were also included.

Table 1 provides an overview of each of these corridors, which cover 539 miles of roadway or 2.5 percent of the total roadway miles in Connecticut. The table shows the limits of each corridor segment, the total length, and the number of interchanges within each segment. Over the 13 route segments, there are a total of 414 interchanges, resulting in an average interchange spacing of just 1.3 miles. This is an important point of distinction from other major toll roads in the Northeast, which tend to have more widely spaced interchanges.

The proximity of interchanges in Connecticut contributes to congestion in some locations. I-95, most of which was originally constructed as the Connecticut Turnpike, has an overall average interchange spacing of between 1.0 and 1.4 miles. This results in virtually the entire length between New York and New Haven functioning as a typical urban expressway; making it very difficult to establish a fully “closed” toll system in which every vehicle would be subjected to a toll.

The longest interchange spacing is found along I-395; where a total of 27 interchanges have been constructed along a 56-mile corridor length. Even here, however, the interchange spacing is just 2.1 miles, considerably below the national average for toll roads.

Table 1 also shows estimated average traffic levels and truck proportions from modeling data projected to 2023 levels, without tolls. A regional travel demand model was developed for use in this study, based initially on the latest versions of the Connecticut Statewide Model, expanded to include some routes and regions in nearby states. After calibration, future year travel estimates were developed at 2023 and 2040 levels for purposes of this tolling evaluation. The volumes shown reflect the average overall traffic level over the entire length of each corridor.



CORRIDORS INCLUDED IN CONNECTICUT TOLLING EVALUATION

FIGURE 1

Table 1
Summary of Corridors Evaluated for Tolling in Connecticut
 Traffic and Trip Data estimated for 2023 levels without Tolls

Corridor	Corridor Limits	Corridor Length (Miles)	Number of Interchanges	Average Interchange Spacing (mi)	Average Daily Traffic (2)	Daily Vehicle Miles Traveled	Share of Vehicle Miles Traveled	Approximate Percent Trucks	Average Trip Length (mi.) (3)		
									Cars	Trucks	All Vehicles
I-95 West	New York to New Haven	48	48	1.0	152,599	7,324,754	16.5%	16.8%	8.7	13.9	9.3
I-95 East	New Haven to Rhode Island	64	46	1.4	84,200	5,388,831	12.2%	13.4%	11.2	16.1	11.6
I-84 West	New York to Hartford	63	51	1.2	103,031	6,490,936	14.6%	12.4%	7.4	11.0	7.7
I-84 East	Hartford to Massachusetts	35	22	1.6	94,946	3,323,124	7.5%	15.6%	8.5	15.1	9.2
I-395	Full Length	56	27	2.1	44,037	2,466,087	5.6%	10.1%	9.3	11.2	9.5
I-91	Full Length	58	50	1.2	127,762	7,410,206	16.7%	11.5%	9.0	12.0	9.2
I-691	Full Length	9	9	1.0	61,228	551,050	1.2%	9.2%	4.1	4.1	4.1
I-291	Full Length	6	5	1.2	62,732	376,390	0.8%	6.7%	4.1	3.9	4.0
Route 15 (West)	New York to New Haven	47	29	1.6	69,529	3,267,886	7.4%		9.3		9.3
Route 15 North	New Haven to Meriden	18	9	2.0	52,218	939,927	2.1%		6.0		6.0
Route 2	Full Length	37	43	0.9	46,125	1,706,633	3.8%	6.6%	7.8	6.5	7.7
Route 8	Full Length	58	43	1.3	53,280	3,090,232	7.0%	6.9%	6.5	5.8	6.4
Route 9	Full Length	40	32	1.3	50,037	2,001,475	4.5%	6.5%	7.6	6.8	7.5
Total System (1)		539	414	1.3	82,259	44,337,530	100%	11.1%	10.4	14.8	10.7

(1) Note: On a systemwide basis average trip lengths tend to be longer than the trip length on each individual corridor. This is because many trip use more than one of these interconnected corridors, while the trip lengths shown for each corridor include only the portions of each trip made within that corridor itself.

(2) Weighted average daily traffic volumes on the overall corridor. Volumes at each individual mainline segment may be higher or lower than the averages indicated in this table.

(3) Average trip lengths for Total System include travel on more than one corridor; hence these are slightly longer than values shown on individual corridors.

By far, the heaviest traffic levels are projected for I-95 West, between New York and New Haven. This segment is expected to have an overall average daily traffic of almost 153,000 vehicles per day in 2023. Some locations will approach or exceed 200,000. Of this, almost 17 percent of the traffic is trucks, further explaining why this segment is the most congested of all routes on the Connecticut expressway system. Furthermore, about three-quarters of the trucks on I-95 are trailers. Heavy traffic levels are also shown on I-84 West and East and on I-91. Route 15 West will carry an average of just under 70,000 vehicles per day between New York and New Haven, without tolls. While this volume is considerably lower than the parallel I-95 West, the roadway capacity is also significantly less in that it has only four travel lanes (two in each direction), and predominantly substandard interchange geometry, lane widths and only limited shoulders. Traffic on Route 15 is also restricted to non-commercial vehicles.

Overall, the entire system is expected to carry an average of more than 82,000 vehicles per day per corridor with an overall average of about 11.1 percent commercial vehicles. In general, the proportion of trucks is higher on the major interstate routes and somewhat lower on the state designated highways such as Routes 2, 8 and 9.

Finally, the right portion of Table 1 shows approximate average trip lengths of cars versus trucks on each of the corridor segments. For example, while the I-95 West corridor extends about 48 miles, and carries more than 150,000 vehicles per day, on average, the overall average trip length is only 9.3 miles. The typical passenger car trip is 8.7 miles; the truck average trip length is estimated at 13.9 miles. These trip lengths were estimated based on a comparison of corridor-wide vehicles miles of travel with the total number of trips in each corridor.

On a total system basis, the overall average trip length, in the absence of tolling, was found to be 10.7 miles. Broken down by vehicle type, the overall average trip length for passenger cars is estimated at 10.4 miles, while truck trip lengths are almost 15 miles on average.

Federal Tolling Restrictions and Implications

Federal Law has long had prohibitions on the implementation of tolling, electronic or otherwise, on currently untolled portions of the interstate highway system. At one time, this prohibition was very broad and had few exceptions. While these prohibitions date back to early portions of USC Title 23, renewed emphasis was added to tolling restrictions with the establishment of the Interstate Highway System in 1956.

What is now I-95 in Connecticut was under construction as part of the Connecticut Turnpike at the time of the establishment of the Interstate Highway System. The facility had been financed as a toll facility and, like other legacy toll roads such as the Massachusetts Turnpike, New York Thruway and New Jersey Turnpike, tolling was allowed to continue, and the toll roads were simply incorporated into the interstate system.

When tolls were removed from the Connecticut Turnpike and other toll facilities in the state in the mid-1980's, CTDOT received additional federal funding for maintenance and rehabilitation activities along I-95 and other tolled facilities. This was because up until that point in time, portions of the Interstate system which had been tolled were not included in mileage computations used for calculating allocation of federal funding to the states. As such, federal

funds were not available for ongoing maintenance and rehabilitation for much of I-95 and portions of I-395 when these operated as tolled facilities.

However, it is important to recognize that federal restrictions on tolling have been eased significantly in the years since tolls were removed from Connecticut's toll facilities. A number of pilot toll programs were introduced on a federal level, some of which remain in effect today. In addition, under a new federal tolling program (Section 129 of Title 23) tolls can be used on interstate routes as follows:

- On any **new capacity**, be that new interstate routes or new lanes on existing interstate routes, provided the equivalent number of toll-free lanes remain available;
- The significant **reconstruction of a bridge or tunnel** located on the interstate system (the State of Rhode Island is using this provision to implement truck tolling at 14 locations, including many on interstate highways); and,
- The **conversion of HOV lanes to high occupancy toll (HOT) or managed lanes**, provided toll-free travel or reduced rates is maintained for high occupant vehicles and certain minimum speed thresholds are also maintained (covered under Section 166).

In addition to Section 129, there are two major federal pilot programs associated with interstate route tolling which continue to be available:

- The Interstate System Reconstruction and Rehabilitation Pilot Program (ISRRPP); and,
- The Value Pricing Pilot Program (VPPP).

Both of these programs have been in existence for many years, although nationally there is limited experience with implementing tolling on free interstate routes under either program. The ISRRPP provides for up to three "slots" (including one interstate route in each of up to three different states - Missouri, North Carolina and Virginia). These slots have been filled for many years, although none of the states have yet to implement tolling. The most recent transportation bill (FAST Act) established a "use it or lose it" provision within the ISRRPP, and all three slots have now again become available for other states to apply for.

There are several reasons why CT has not applied for the ISRRPP. First, it is restricted to one facility in a given state; this has proven to be a concern in most state legislatures where one corridor within an overall population is singled out for tolling. Finally, the ISRRPP has significant limitations on the use of toll revenue and it is the only interstate tolling program which still exists which *does* require a loss of federal funding if tolls are established.

Value Pricing Pilot Program (VPPP)

As noted previously, Connecticut is one of 13 states designated as part of the Value Pricing Pilot Program (there can be a maximum of 15 states in this program). Connecticut was added to the list of VPPP states, and between 2014 and 2016 CTDOT conducted two congestion pricing studies under the program. Being designated as a VPPP state permits Connecticut to implement tolling on interstate highways, with the concurrence of FHWA and the State Legislature. However, the program requires the use of variable tolls (time of day pricing or congestion pricing) to encourage some peak-hour traffic to travel in off-peak hours. It also requires the use of all electronic toll

collection. The VPPP is the tolling exemption program under which interstate route tolling in Connecticut has been evaluated.

Tolling Impact on Current Federal Revenues

As noted above, when tolls were removed in Connecticut in the mid-1980's, the State received an increase in federal funding as lane miles on the Connecticut Turnpike were added into the calculation of Connecticut's share of annual federal funding. Connecticut executed a Secretarial Agreement on August 30, 1983 for the Connecticut Turnpike. It agreed to remove all of the tolls when the remaining bonds for the road were retired and the costs of removing the toll facilities were covered by toll revenue. In exchange, the mileage of the Connecticut Turnpike was added to Connecticut's eligible 4R mileage, resulting in an initial increase of \$11-12 million annually¹. It also made I-95 eligible for use of federal funds in roadway maintenance and reconstruction activities.

FHWA has confirmed that reintroduction of all electronic tolling on I-95 or any other state highway in Connecticut would not result in a reduction of federal funding for transportation.

Other States Considering Tolling

Connecticut is not alone in its consideration of adding tolls to its interstates and other expressways. However, Connecticut's program would be unique in that this would be virtually the only statewide system.

Several states are actively considering tolling, some with enacted or pending legislation. Nearby Rhode Island, for example, achieved legislation enabling the implementation of electronic tolls for heavy trucks on about 14 bridges in urgent need of reconstruction. Rhode Island Department of Transportation (RIDOT) has used the bridge reconstruction provisions in Section 129, with full concurrence of FHWA, to deploy all electronic tolling. Tolling was initiated in June 2018 at two of the 14 planned locations

Rhode Island elected to impose tolls only on heavy trucks; generally multi-unit trailer trucks. Past research has shown that a disproportionately high proportion of bridge damage and pavement wear and tear is a result of heavy trucks; some research claims a single, fully loaded, 5-axle truck can have the same damaging effect as more than 9,000 passenger cars. While tolling is moving ahead as planned in Rhode Island, representatives of the trucking industry have filed legal action, largely because only trucks are being assessed a toll.

In Indiana, legislation has been passed mandating a study of tolling at least three long interstate corridors in that state. Preliminary traffic and revenue studies have been performed and a consultant team has now been selected to develop a strategic implementation plan and undertake necessary NEPA impact assessments. The state of Indiana intends to use the same bridge tolling exemption used by Rhode Island, however all vehicles would be charged. Section 129 provides no limits on what the toll rates can be charged at each bridge location. Further, it permits the use of "excess revenue", after assurance that the bridges would be properly maintained, for any legitimate transportation purpose. Hence, Indiana plans to finance a significant portion of overall

¹ https://www.cga.ct.gov/2009/rpt/2009-R-0122.htm#P129_9848

interstate route expansion and reconstruction by simply placing electronic tolling points at or adjacent to bridges being reconstructed as part of the process.

Utilizing Section 129 for Connecticut as Rhode Island is doing would be permissible, but may not be consistent with the four criteria set out for the tolling program in Connecticut or with portions of the selection criteria for gantry locations. Connecticut's highway network is unique as well, with closely spaced interchanges where concentrated tolls on bridges may lead to unacceptable levels of diversion to achieve equivalent levels of revenue from a uniform statewide system. Ideal bridge locations may also cause unintended travel impedances between communities on either side of the bridge.

Other states continue to actively discuss adding tolls to free interstate routes. The State of Oregon is evaluating implementing congestion pricing on I-5 and I-205 in the greater Portland area under the same VPPP provisions being contemplated by Connecticut. Wisconsin has had major studies performed and the issue of adding tolls is still being debated within that state's legislature. Proposals have been made within Illinois for the state's current toll agency to take over responsibility for I-80 and to fund badly needed reconstruction and bridge replacement programs on that route.

How Tolls Would be Collected in Connecticut

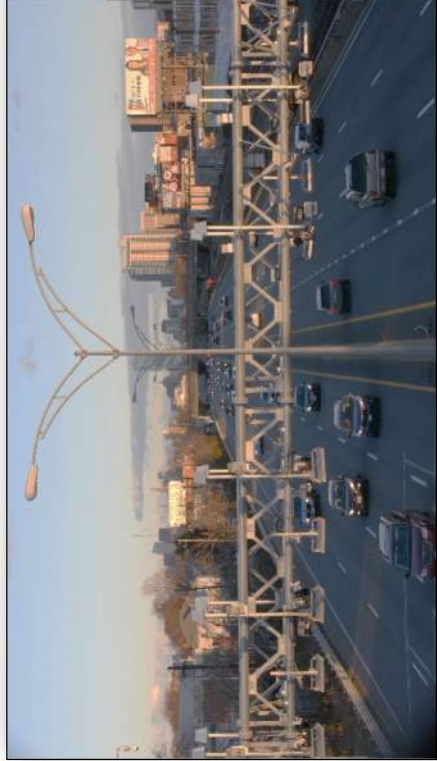
If tolls are implemented in the state, the use of all electronic tolling (AET) has been assured. No new toll plazas, toll booths or other restrictions would need to be constructed that would impede traffic or require traffic to even stop and pay with cash, as part of the user fee collection process.

Figure 2 shows examples of existing all electronic toll gantries in use throughout the United States, including some that recently have been placed into use on the Massachusetts Turnpike which eliminated cash collection in 2016.

Equipment required for toll collection would include toll gantries constructed across expressways. The gantries would be outfitted with electronic toll readers, high-technology cameras for license plate imaging, laser devices, and other specialty tools for automatic vehicle classification. "No cash" collection option is provided, and implementation of the presence of the toll gantries would be fairly unnoticeable to motorists and to the communities nearby. Minimal, if any, right-of-way is required to implement the field systems and, as a result, environmental impacts are generally limited to potential traffic diversions and equity considerations.

The majority of tolls collected in the system would be by means of E-ZPass transponders. E-ZPass is a multi-state integrated, interoperable electronic toll transponder network. There are more than 25 million vehicles equipped with E-ZPass transponders in the program, which extends from Maine to Virginia and as far west as Illinois. It is not the only network of electronic toll systems in the US, but it is by far the largest. Connecticut could be part of the Interagency Group (IAG), a consortium of about 28 toll agencies throughout the region who use E-ZPass.

Toll systems operating within the IAG agree to exchange revenue and to accept each other's transponders for bill payment. Most of the individual agencies offer reduced rate or some form of discount for transponders issued by the "home" agency, but transponders from all other E-Z-Pass agencies are accepted for payment as well. As described later in Chapter 4, a similar pricing strategy is possible in Connecticut.



Both of these would be valid transactions, however the nominal cost per passage beneath a gantry toll point would be different between these two categories of transponders. This practice is quite common throughout the existing toll industry.

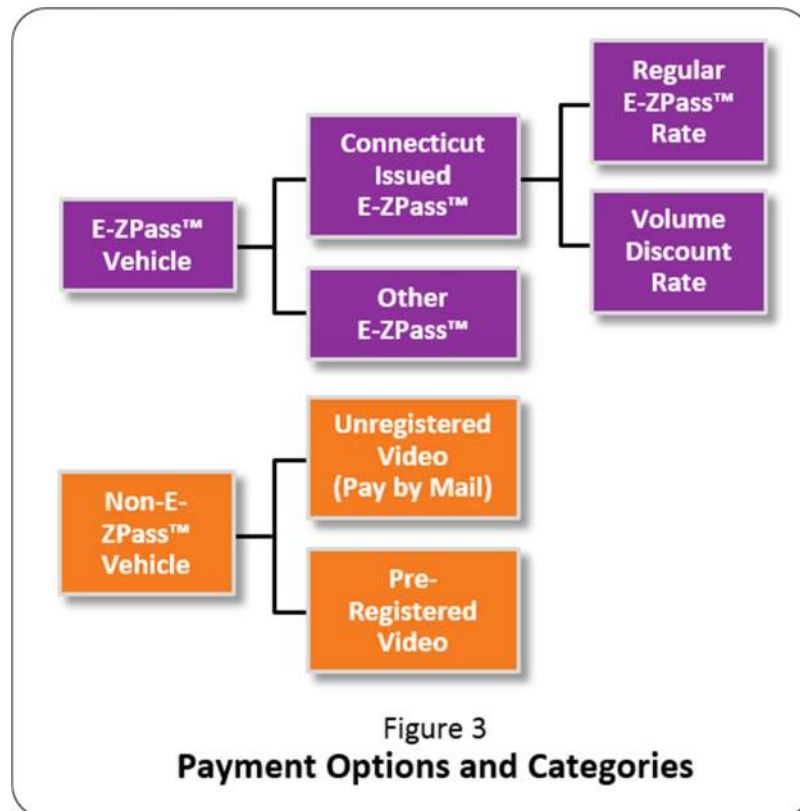
Detection of vehicles without transponders would occur through video transactions, they are further subdivided into two categories:

- Vehicles with pre-registered license plates; and,
- Unregistered plates in which direct billing would be required.

It would be in the State's interest to encourage motorists who choose not to have transponders to at least pre-register their license plates. In this manner, motorists could register a plate on a one-time basis, potentially link an account to a credit card, and then each time that license plate image was obtained in the tolling system, the appropriate toll charge would simply be assessed to that credit card account. For motorists with unregistered plates, the system would need to obtain name and address information on the vehicle owner, from the appropriate state Department of Motor Vehicles (DMV). Periodically, the owner of the vehicle would then be mailed an invoice for toll charges, and the tolls would be paid by return mail or via internet.

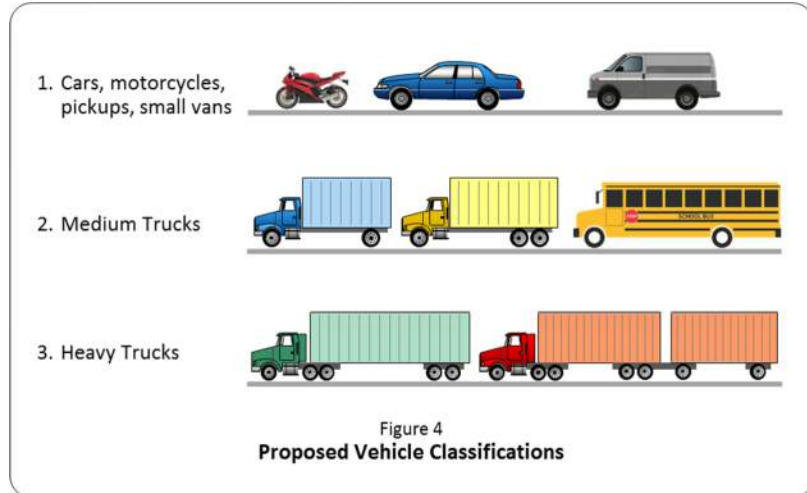
By far, the highest collection difficulty, and collection cost, is associated with unregistered plates. Hence, a pricing structure is recommended to incentivize motorists without transponders to make a one-time pre-registration of the plate. This eliminates the need for DMV lookup, billing, and collections risk, and minimizes additional costs associated these administrative tasks.

Finally, as shown in **Figure 3**, passenger car motorists with a Connecticut issued transponder would also be eligible for a further volume discount program. This would reduce the rate per transaction even further, based on a retroactively applied threshold of frequency of use. This is discussed in more detail in Chapter 4.



Vehicles would also need to be classified. Historically, toll systems have established vehicle classes based on the number of vehicle axles, often with as many as 7-10 different vehicle classifications. With AET collection, in a multi-lane high-speed environment, it is easier to work with a more simplified classification structure. Based on the results of the study, it was suggested that a three-class structure be used, as shown in **Figure 4**.

Class 1 would refer to cars and other light duty 2-axle vehicles (including motorcycles and pick-up trucks). Class 2 would generally be single unit trucks (e.g. box trucks) and buses, while Class 3 would be multi-unit trucks and other similar heavy vehicles. **CT public transit buses would not be tolled.**



Potential Toll Collection Locations

After considerable analysis of various alternatives and recognizing a set of criteria established by CTDOT, a preliminary set of potential toll locations was established along each of the 13 route/corridor segments considered in this analysis. The approximate locations of the gantries are shown, in general terms, in **Figure 5**. A total of 82 locations have been identified, if all 13 route segments (see Table 1) are included in the final system. For example, on the 48-mile I-95 West corridor, seven toll gantry locations would be established. The average overall spacing systemwide is about 6.6 miles. Slightly longer average spacing has been proposed for the more rural routes with less congestion; in a few more congested corridors closer spacing is recommended.

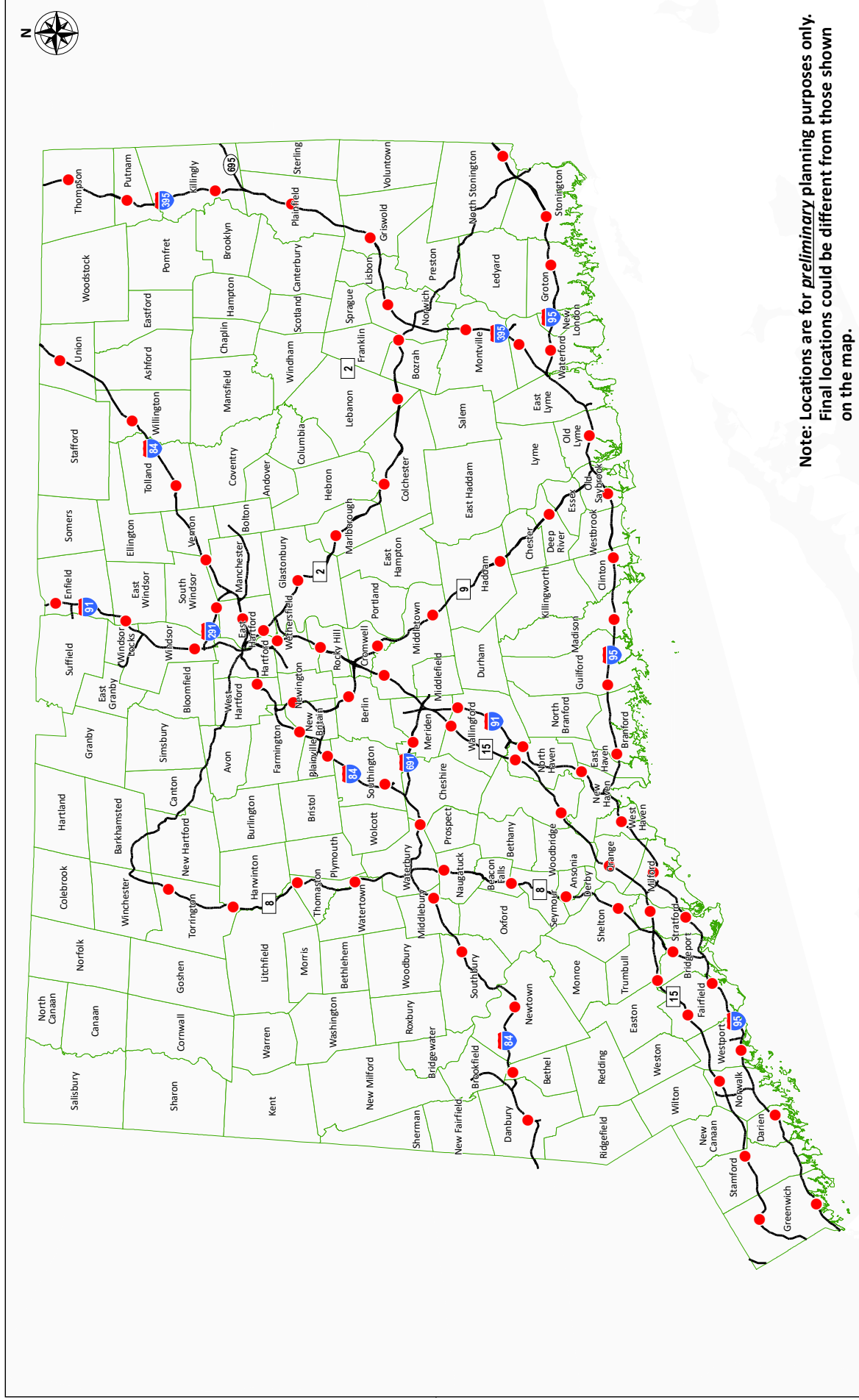
This arrangement would allow for some measure of toll-free travel on the existing routes. As noted previously, the average spacing of interchanges on the overall system is only 1.3 miles. As compared with the average toll zone spacing of 6.6 miles, several interchange-to-interchange travel movements would be possible without encountering a tolling point. All toll gantries would be located across all mainline lanes, in each travel direction. No tolls would be established on interchange ramps.

In selecting these preliminary locations for purposes of the analysis, criteria established jointly with CTDOT was taken into consideration. Some of this criterion included:

- No more than one toll location on a given route within a given city or town boundary in the state (there may be more than one toll location if there is more than one tolled route in a given municipality);
- Where possible, avoid major cities to minimize traffic diversions and income equity considerations;

- Generally, follow an overall average toll gantry spacing of six or more miles, with a minimum spacing of not less than five miles;
- When considering spacing, consider gantry locations on interconnecting tolled routes; and
- Implement tolling at generally parallel locations on competing routes to minimize inter-corridor traffic diversions, such as I-91 and Route 15 South of Meriden.

Overall, the selected (but very preliminary) locations used in this analysis resulted from a balancing of revenue needs, capital and operating costs, and toll rates while minimizing diversion potential. While there would be a significant number of tolling locations, the tolled charges at each location would be relatively low. In general, reducing the number of tolling locations would require higher tolls at each location to achieve the same level of toll revenue. This, in turn, would lead to higher levels of traffic diversion to local roads at the more limited number of locations. Reducing the number of tolling locations (i.e. increase distances between toll points or gantries) would also reduce the number of toll payers (because it would increase the number of motorists that can travel between interchanges without encountering a tolling point), thereby making the toll system less fair and equitable.



Note: Locations are for preliminary planning purposes only. Final locations could be different from those shown on the map.

Chapter 3

Toll Technology System Concept and Estimated Cost

As stated in Chapter 1, a principal objective of this conceptual study is to explore and evaluate the development of a statewide, all-electronic toll network for Connecticut. The concept of tolling in Connecticut is subject to continuing refinement and development, but the tentative tolling system developed and assessed under this study provided a reasonable basis for estimating the approximate capital and operating costs; important considerations as the state considers toll deployment.

Importantly, as required under the federal Value Pricing Pilot Program (VPPP) under which tolling would be authorized in Connecticut by the Federal Highway Administration (FHWA), the pricing of trips on tolled corridors would vary by time of day so that trips that occur during more congested peak travel periods would cost more than trips taken during off-peak travel periods. Variably priced tolling (also known as ‘congestion pricing’) is a means by which higher toll rates are charged during both the morning and afternoon peak hours of travel (i.e. ‘rush hours’) to effectuate ‘congestion pricing’ benefits. Variable tolling or congestion pricing is a proven and effective way to mitigate traffic congestion because it:

- Encourages motorists that do not need to travel during rush hours to shift their travel to off-peak periods;
- Encourages commuters to shift to alternate modes of travel such as car pools, or transit;
- Encourages motorists to combine or consolidate trips which reduces overall trip frequency and to choose alternative routes.

This toll concept was developed in parallel with traffic, revenue and institutional aspects of a potential tolling program. The system would need to process vehicles under various payment categories, as well as automatically classify vehicles in a high speed, multi-lane environment. The development of approximate capital and operating costs required a determination of system sizing, system configuration and other operating parameters.

The traffic and revenue analysis estimated toll transactions by payment mode, which further contributed to the understanding of operating costs. The study team also assessed the potential for outsourcing tolling operations to third party providers, and potential alternative approaches for system procurement.

Chapter 3 provides a summary of all efforts related to the toll system configuration, system operating assumptions, and capital and operating cost estimates.

Toll Technology System Overview

Technology advancements have allowed tolling agencies across the U.S. and abroad to utilize an effective and efficient all-electronic tolling system for toll collection. CTDOT has determined that

All-Electronic Tolling (AET) would be the most suitable alternative for Connecticut, should tolling be implemented.

To implement All-Electronic Tolling, tolling gantries would be installed at predetermined sites, and toll equipment, such as AET antennas and readers, license plate image capture cameras, and vehicle classification equipment, would be placed on the gantries to identify and classify vehicles as they drive through each tolling zone. As discussed previously, it would not be practical to place tolling gantries on each expressway segment (i.e. between all interchanges) to ensure a “closed” (i.e. no toll-free movements) tolling system. Therefore, not every motorist trip along the toll corridors would be captured.

The All-Electronic Tolling solution is a cashless system whereby customers join an electronic toll collection service, such as E-ZPass. Motorists would be requested to join the CTDOT E-ZPass program, by establishing an account and obtaining a transponder to mount on the dashboard of their vehicle, to use the toll facility.

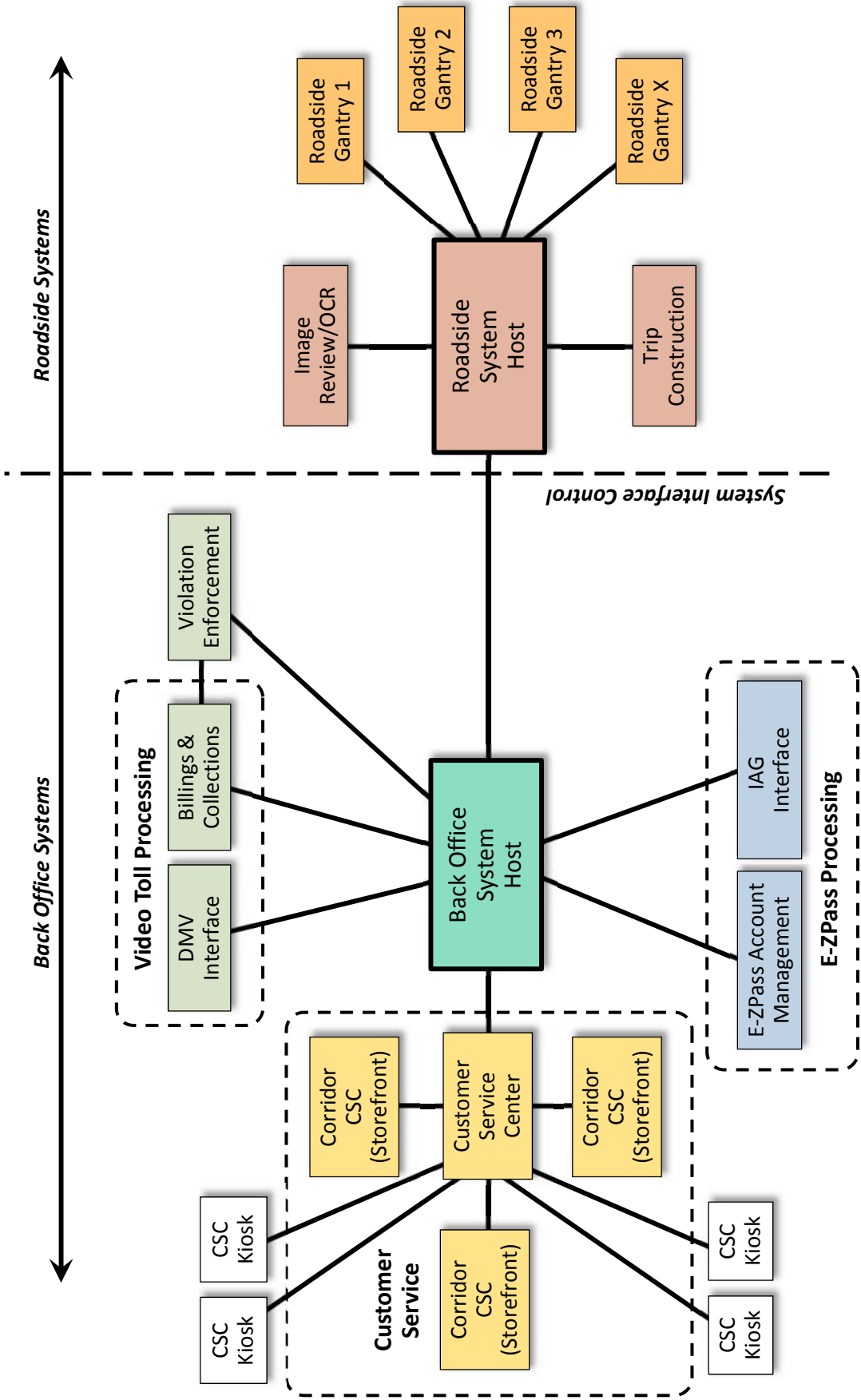
Vehicles without an E-Z Pass account or transponder would still be permitted to use the toll roads; tolls for these motorists would be processed via license plate image capture technology and a billing system. When a vehicle without an E-ZPass drives through a tolling zone, the electronic toll system would glean vehicle owner information from the Connecticut Department of Motor Vehicles (DMV) and send a toll payment invoice, plus an administrative fee, to the vehicle owner.

The electronic toll system would also allow motorists that do not join the E-ZPass program to “pre-register” for the video tolling program. These pre-registered video customers would register their license plate with a one-time registration and link their vehicle to a “License Plate account.” This account could then be linked to a credit card or bank account for automated direct payment. When these pre-registered vehicles traverse tolling zones, their license plate data would be captured through video tolling; the vehicle owner would then be sent a toll notice that would request payment for the tolls, plus an administrative fee. A listing of “registered plates” would be continually updated; when plate images are recorded, the list of pre-registered plates would first be checked; thereby eliminating the need for DMV “look-ups” or costly mailed-out billings and collection.

Overall System Configuration

A conceptual configuration of the overall toll system is shown in **Figure 6**. The right side of Figure 6 represents the “Roadside System”, which would include up to 82 toll gantries on expressways throughout the State. In addition, it would include a central system which would communicate with each gantry site to conduct an automated image review of all license plate toll transactions.

The left side of the diagram delineates “Back Office” system components and functions. After initial data checks, trip and transaction data would be transferred to the back office system for further processing, including transaction posting into E-ZPass accounts and a range of other accounting functions. The back office would also be connected to a network of staffed customer service centers throughout the state, as well as several automated kiosks which can be used for account opening, payments and balance replenishments.



The vertical dashed line in Figure 6 depicts the critical transition point between the two major subsystems. Since the roadside and back office systems may be provided and operated by different vendors, it is critical that the system have a well-defined interface control document(s) by specifying data formats and standardizing data structures.

Roadside System

As stated previously, it is not feasible or practical to place tolling gantries on each expressway segment (i.e. between all interchanges). Tolling point locations were therefore chosen based on results of the traffic and revenue analysis, toll technology system design, operational considerations, and a geometric review of potential gantry sites. The locations tentatively identified for the 82 potential gantry tolling locations are shown in Figure 5. The toll gantries are spaced 6.6 miles apart, on average.

Figure 7 provides a simplified view of a typical toll gantry point. The upper portion of the graphic provides an overhead view showing how a typical single gantry structure covers both directions of travel. In some cases, where there are a larger number of travel lanes or a wider median, it is necessary to use two separate gantry structures; one for each direction. The actual gantries are similar in design to “sign bridges,” used to mount overhead signs on expressways. They are designed for maximum stability to reduce vibration and movement due to wind conditions.

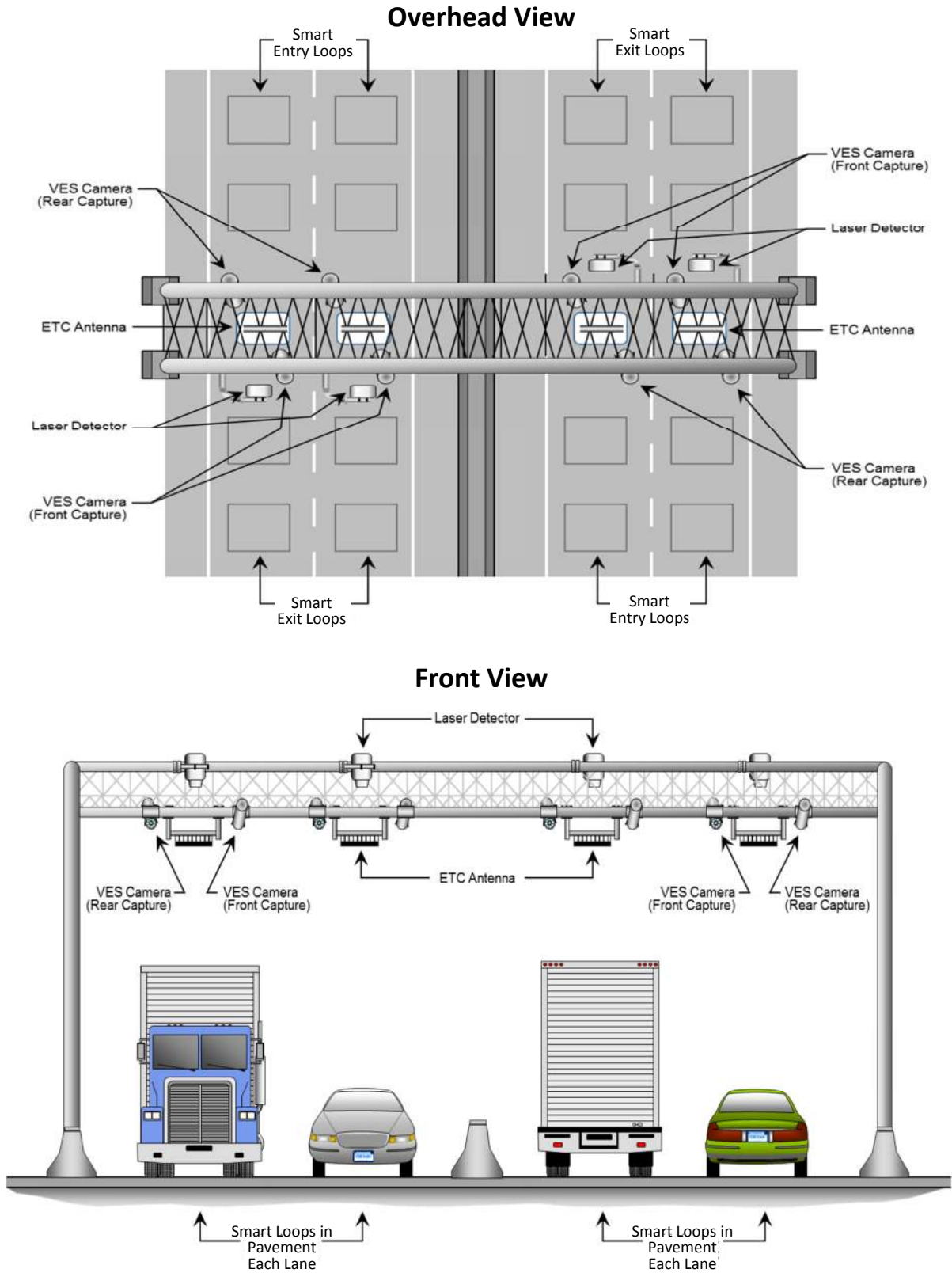
The overhead view in Figure 7 also shows “smart loops” in the pavement, which can be used in automatic vehicle classification (AVC) and in the tracking of vehicles through the toll zone. In some newer systems, AVC is done via stereoscopic cameras without the need for *in pavement* systems.

The lower portion of Figure 7 shows a cross-section of travel lanes at the gantry or toll point, and how gantries would be equipped with E-ZPass antennas, ETC readers and high-resolution cameras. For Connecticut, this would likely include both front and rear plate reading cameras.

While not shown in Figure 7, toll zone computers and lane controllers would be located in a small building or roadside cabinets adjacent to each gantry. In most cases these can be deployed within the existing right-of-way at each toll point.

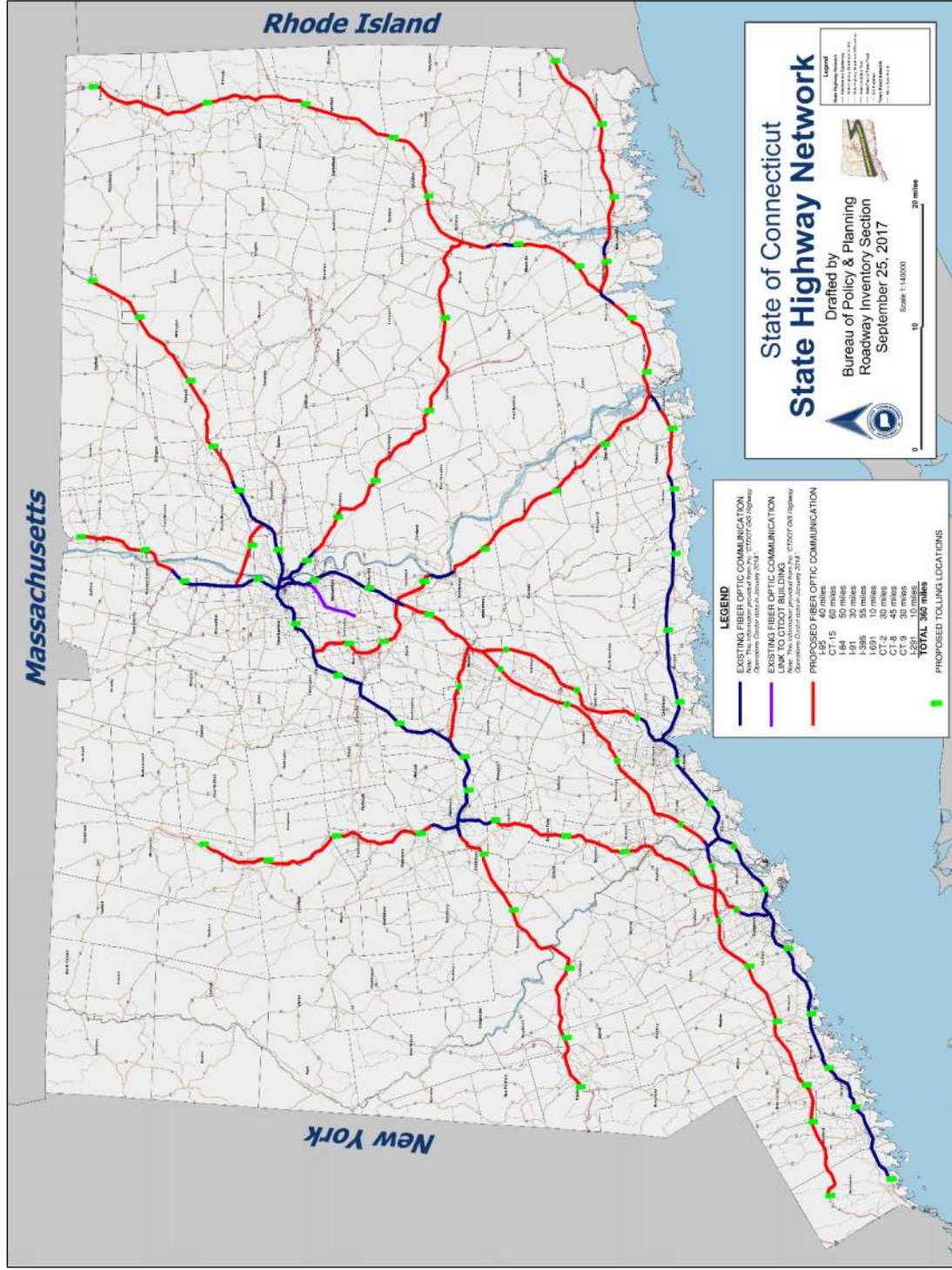
Telecommunications Requirements

An ETC system in Connecticut would need near continuous, high speed, electronic data communication. While the majority of transactions would be made with E-ZPass, with relatively small record sizes, the video imaging needed for license plate video tolling demands a high amount of bandwidth that would require the installation of a fiber optic communication network.



As shown in blue in **Figure 8**, fiber optic cables have already been installed by CTDOT along some expressway segments. Based on a preliminary review, most of this communication system has available capacity for use in the tolling system; basically about 175 miles or so. This would require the installation of about 360 miles of new, single-mode fiber optic cable along other portions of the system, as shown in orange in Figure 8.

The tolling system fiber optic network has other potential uses and benefits for CTDOT. The fiber system could be used to interconnect roadside traffic management equipment for data and video transmission to the Traffic Management Center (TMC) server. Along with the additional mounting points for CCTV on the toll gantries, this robust communications network could also provide CTDOT with the opportunity to monitor its roadways in greater detail and improve notification of roadway conditions and incidents to expressway travelers. Other tolling agencies have also leased the unused fiber optic strands in the roadside fiber ducts to third parties. This practice could leverage the newly-constructed statewide fiber optic system for additional revenue for the CTDOT.



Back Office Systems (Toll Processing and Customer Service)

As shown in **Figure 9**, the back office system would be comprised of E-ZPass record processing, video toll processing and customer service center subsystems. The system envisioned for Connecticut is based on the Massachusetts model put in place for their all electronic toll system.

E-ZPass Toll Processing -

The E-ZPass subsystem would automatically process the E-ZPass-based toll trips by debiting toll payments from each motorist's pre-paid E-ZPass account.

Video Toll Processing -

The video tolling subsystem, would video detect and process toll payments to unregistered and pre-registered program vehicles. The video tolling subsystem would also interface to the Connecticut DMV to secure license plate ownership and address information and a violation processing subsystem for those

motorists that fail to pay their toll notices within the pre-determined period of time.

Customer Service - The customer service subsystem would include 5-10 small satellite facilities or service counters located in Service Plaza rest areas or other convenient locations. They would be staffed by 1-2 employees of the Service Center operator.

The Back Office System Host would operate the E-ZPass account management system and would contain all transponder, billing and vehicle processing information for CTDOT's customers. The Host also receives, on a routine basis, valid transponder numbers from all other Interagency Group (IAG) customers (such as out-of-state motorists) so that their transponders can be accepted and processed when they traverse any of the CTDOT tolling points.

- **Customer payments and interface** - Customers have a variety of ways to interface and communicate with the Customer Service Centers, including in-person, via regular mail, e-mail, online chat, website (regular and mobile), and kiosk. All forms of payments would be accepted at the centers. To support anonymous accounts, cash payments can be made at the center or via a kiosk. Checks can be presented in-person or mailed to the CSC. Credit/debit cards can be used to make payment on the phone, at the CSC, at a kiosk or via the CSC's website (regular and mobile).

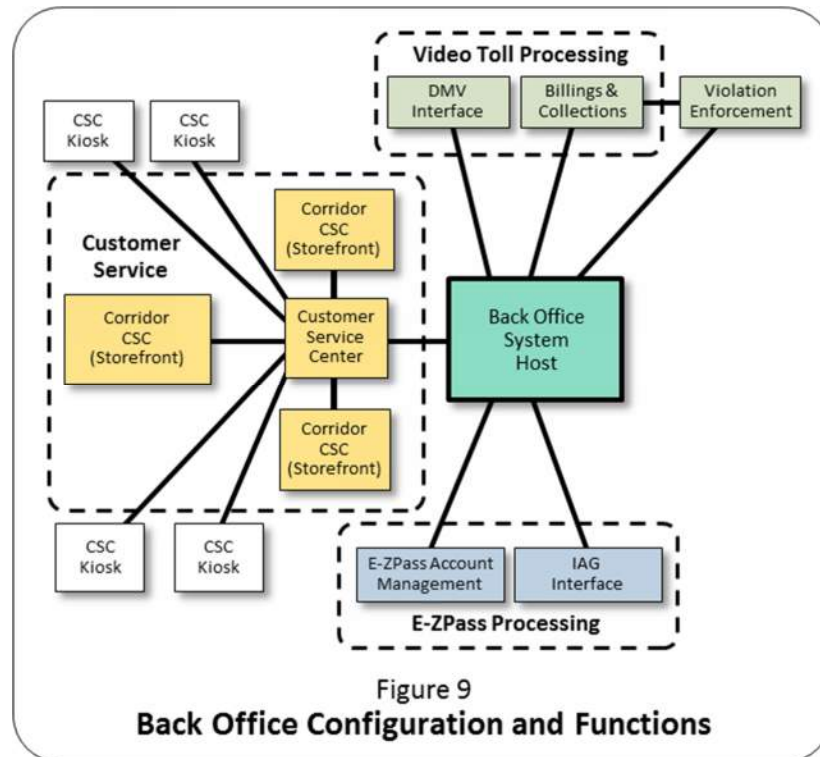


Figure 9
Back Office Configuration and Functions

- **CTDOT E-ZPass interface with other states** - CTDOT has the option to become a full member of the E-ZPass consortium known as the Interagency Group or IAG. The IAG is comprised of nearly 30 toll agencies that have agreed to accept each other's E-ZPass transponders for toll payments. The IAG interoperability systems extend from Maine to Virginia, and as far west as Illinois. It is the largest interoperable electronic toll network in the U.S. with about 25 million vehicles equipped with its transponders. Based on prior studies, it was determined that a fairly large number of Connecticut motorists already have E-ZPass transponders issued by other states, especially motorists in the southwest parts of the state.

Being a member of the E-ZPass Interagency Group would allow drivers with CTDOT transponders to be tolled electronically by all other toll facilities in other states that use E-ZPass. E-ZPass transponders from other E-ZPass agencies that are detected at any of the CTDOT toll zones would be processed as ETC transactions by the CTDOT back office and sent to those IAG agencies on a nightly basis for payment. Each member agency would make E-ZPass transaction payment debits to the appropriate sister agency via the customer's account and send the appropriate toll payments to the CTDOT back office subsystem. This exchange of data and payment between other IAG agencies is known as reciprocity.

- **Billing and payment video transactions** - Video transactions would occur at CTDOT's tolling locations if no valid E-ZPass transponder is detected on the passing vehicle or if the automatic vehicle classification differs from the registered class linked to the E-ZPass transponder that was detected. Video transactions would include images of the license plate of the vehicle and, using optical character recognition (OCR) software, would automatically determine the image information, including the state where the license plate was issued. The roadside Host would then attempt to associate the license plate data with an E-ZPass or pre-registered video tolling account in its database. If a match is found, it is processed either as a regular E-ZPass or a video tolling transaction. If no match is found and the plate registered to an in-state motorist, the data and image are sent to the Connecticut DMV to determine the vehicle registration owner and address. This address would be used to mail an invoice to the driver for each trip that is taken on any Connecticut tolled expressway. Out-of-state video transactions would be handled in a similar manner except the DMV interface would need to be established with the DMV of the state where the vehicle is registered.
- **Customer Service Program** - A walk-in Customer Service Center would be located at the central back office location. This would allow customers in-person access to a variety of services including E-ZPass account setup, transponder acquisition, cash payments, check and credit card payments, questions regarding the CTDOT E-ZPass program, etc. A single, centralized call center would also be implemented at this prime service center. To provide a more localized approach to customer service, it is envisioned that 5-10 small satellite service centers could be located in existing facilities such as highway service plazas, rest areas, DMV offices, or retail stores. The 'office' might consist of only a service counter and computer link to the central office to register drivers for an E-ZPass, add funds to a customer's account, allow drivers to pay toll bills, and answer questions.

By locating these at key locations throughout the state, it would make it more convenient for drivers. The small offices would require only 1-2 service center employees to staff a satellite office during normal business hours. To supplement service center activities, up to 100 remote kiosk payment machines would be located strategically throughout the state. These kiosks would accept credit and debit cards as well as cash for “unbanked” account members. The kiosks would be located at highway rest areas, truck stops, other large service stations, etc. An example of a staffed satellite service center, which is on the MassPike, is shown in the photos below.



**Typical E-ZPass Customer Service Center:
Mass. Turnpike**

Estimated Capital and Operating Costs

As part of the technology task, estimates were prepared of both capital and operating costs for a possible statewide ETC system in Connecticut. The cost estimates were done by corridor and for the total system, assuming all corridors shown in Figure 1 would be tolled. All costs, both capital and operating, were developed in nominal 2016 dollars, and would be subject to inflation adjustments in the future.

Estimated Toll System Capital Costs

This section includes the estimated tolling system capital costs for a possible CTDOT statewide toll system. As noted previously, there would be no toll booths and no cash payment option. All tolls would be collected electronically. For those motorists that choose not to join the E-ZPass program, their tolls would be collected through a video tolling system (either pre-registered or unregistered) that would include license plate image capture cameras that would capture license plate data from vehicles that traverse the tolling zones. The estimated tolling related capital costs

are based on toll industry trends and the experience of toll agencies that have deployed electronic tolling systems elsewhere in the U.S.

The following assumptions have been made during the toll capital cost estimation process:

- Cost estimates are in 2016 dollars;
- Electronic toll system costs include all equipment, hardware and software related to the collection and reporting of toll revenue;
- Procurement and installation costs of the toll gantry structures and CCTV camera poles are included;
- Vehicle front and rear license plate image capture would be deployed at each tolling zone site;
- Roadway shoulders at each tolling zone site would be covered with toll equipment;
- Spare equipment costs are assumed to be 5% for each total number of toll equipment and devices;
- E-ZPass transponders have not been included in the cost estimate;
- The back office platform, which includes the required hardware and software to operate all of the back office functions (E-ZPass account management, customer service functions and the video tolling/violation enforcement system) is included in these estimated capital costs; and,
- Toll infrastructure civil engineering design costs are included.

Presented below in **Table 2** are the estimated toll facility capital costs. The costs are presented by toll corridor for roadside, fiber network, and roadside Host elements and include civil engineering design. The total roadside capital costs are estimated to be \$187,700,000. This includes all required toll equipment and devices that would be installed at each of the 82 toll zone or gantry sites to support a fully operational, all-electronic toll system. It also includes a reasonable “contingency” amount appropriate for this preliminary level of analysis. The fiber optic network estimated cost is \$162,000,000, systemwide. This cost includes the procurement of and installation of a fully functional fiber optic network along each potential toll facility. Where possible, existing CTDOT fiber lines would be utilized in support of the toll system as indicated previously. The estimated roadside host and civil design cost is \$22,410,000. This cost, which is evenly distributed for each toll zone, includes the required roadside Host hardware and software as well as civil engineering design. The total estimated systemwide toll capital cost is \$372,110,000.

Table 2
Estimated Toll Facility Capital Costs
 (All Costs in 2016 Dollars)

<u>Tolled Corridor</u>	<u>Roadside Capital Costs</u>	<u>Fiber Network Capital Costs</u>	<u>Roadside Host and Civil Design Costs</u>	<u>Total Capital Costs</u>
I-95 West	\$19,523,000	\$0	\$1,724,000	\$21,247,000
I-95 East	\$22,355,000	\$18,000,000	\$1,724,000	\$42,079,000
Rte. 15 West	\$7,075,000	\$13,500,000	\$1,724,000	\$22,299,000
Rte. 15 North	\$4,073,000	\$13,480,000	\$1,724,000	\$19,277,000
I-84 West	\$26,387,000	\$11,250,000	\$1,724,000	\$39,361,000
I-84 East	\$15,581,000	\$11,250,000	\$1,724,000	\$28,555,000
I-91	\$25,230,000	\$13,480,000	\$1,724,000	\$40,434,000
I-395	\$15,746,000	\$24,750,000	\$1,724,000	\$42,220,000
I-691	\$1,542,000	\$4,540,000	\$1,724,000	\$7,806,000
Route 2	\$8,903,000	\$13,500,000	\$1,724,000	\$24,127,000
Route 8	\$21,619,000	\$20,250,000	\$1,724,000	\$43,593,000
Route 9	\$17,830,000	\$13,500,000	\$1,724,000	\$33,054,000
I-291	\$1,835,000	\$4,500,000	\$1,724,000	\$8,059,000
System Total	\$187,700,000	\$162,000,000	\$22,410,000	\$372,110,000

Note: The capital costs for the roadside host hardware and software and the civil design costs are evenly distributed for each toll facility for purposes of this Table. The total \$22.4 million cost is actually a systemwide cost.

Other Start-Up Costs

There would be other one-time costs associated with the start-up of a tolling program that are not included in either the capital or operations and maintenance costs. These costs include the development of environmental documentation required by the FHWA NEPA process, the toll system planning and development process, and the 'process' of procuring the toll system that includes preparing final system designs and preparing the Request for Proposals. Presented below is a concise description of these additional cost components.

- **Environmental Assessments** - The deployment of variable priced, all-electronic tolling on Connecticut's expressways and parkways would require final approval by FHWA, and that approval would, among other things, be contingent on successful completion of an Environmental Assessment (EA) of the impacts of tolling. The EA would be conducted in accordance with the requirements of the National Environmental Policy Act (NEPA). Since the deployment of all-electronic tolling could be done with minimal physical environmental impacts or right of way procurement, the NEPA environmental documentation for tolling would likely focus on the assessment of potential travel impacts and environmental justice considerations and other equity considerations.

- **Toll System Planning and Development-** Prior to procurement of a toll collection system and the toll operational services, a toll system planning and design process would be required. This process would include the preliminary engineering of the toll system equipment, including software design and the design of operational and administrative systems. The final location of each of the 82 tolling zone locations would also need to be finalized. The locations of CSC storefronts and remote kiosks would also need to be determined. All of this information, plus the CTDOT contractual terms and conditions, would need to be developed before CTDOT can procure a tolling system operator and integrator.
- **Toll System and Operational Services Procurement-** It is likely that a Design-Build-Operate-Maintain (DBOM) approach would be used to procure and operate the system. This same approach has been used recently by both MassDOT and RIDOT in electronic tolling systems in the respective states. It is also likely that the CTDOT toll system procurement would be split into two separate contracts; one for the roadside system and the second for the back office systems and long-term back office operations. This would allow CTDOT to have the technical and cost flexibility to select the best value solution for each toll system category.

The toll system procurement would include the design, development and provision of the roadside toll equipment and software, and the roadside Host hardware and software. This contract would also include all services pertaining to the systems integrator contract, including program management, design and testing documentation development, factory and field testing, civil engineering design, toll equipment and infrastructure installation, commissioning of the new toll system, warranty period and toll system related maintenance. A request for proposals (RFP) document would be developed and released to prospective toll system integrators that, at a minimum, details the following:

- Quantities of each type of tolling equipment to be designed, supplied and installed;
- Exact location of each tolling point;
- System, equipment and software design and performance specifications;
- Factory acceptance testing requirements;
- Delivery, installation and field testing requirements;
- Final acceptance testing requirements;
- Toll system maintenance requirements;
- Project milestones;
- Back office hardware and software design specifications;
- Back office (electronic tolling account management, customer service center, video program processing, and the violation processing system) operational requirements;

- The staffing plan to properly operate the back office electronic tolling account management system;
- The staffing plan for the customer service centers and call centers;
- The remote customer service center kiosks requirements; and,
- Preventive and corrective maintenance of the back office system.

Estimated Operating Costs

Presented in **Table 3** are the estimated annual toll collection costs, which are estimated at \$100,490,000 in the assumed opening year (2023). The back office costs related to the processing of the E-ZPass transactions are estimated at \$22,650,000 and the cost to process the video tolling records is \$53,190,000 at the opening year. The noted video tolling transactions item is a combination of the pre-registered and unregistered video records that would need to be processed. Also presented in this table are the toll collection costs associated with other service center related services (\$15,150,000) and the annual roadside toll system maintenance and operations costs (\$9,500,000).

The costs associated with operating and maintaining the CTDOT statewide tolling system would be coming from two (2) separate vendors (the backoffice system service provider) and the toll systems integrator (maintaining the toll system). The E-ZPass processing costs are generally for the various E-ZPass account management activities that involve the cost of labor to open, close and manage E-ZPass accounts, process electronic transactions from the roadside equipment lanes, developing and issuing E-ZPass account notices, tracking payments from customers, monitoring escalated penalties and charges, review of toll financial, toll audit and reconciliation of transactions from other E-ZPass agencies, etc. These costs would also include a portion of the E-ZPass IAG membership costs that would be shared with the video image program costs. It should be noted that the E-ZPass and video tolling operational related costs are highly dependent on the volume of transactions that are generated systemwide. High transaction volumes combined with efficient operations typically result in lower E-ZPass, video tolling and violation processing costs.

The video image tolling operating costs include staff to manage all of the video tolling accounts to identify and confirm license plate data that is reported by the Optical Character Recognition software, coordinate and monitor the CTDOT and out-of-state DMV interfaces, issue video payment toll notices, track payments, review of video tolling audit and transaction reconciliation reports. Additional activities include monitoring third party staff performance, analysis of video revenue and expenses, recording and quickly resolving inquiries and complaints.

The customer service operational costs include staff to manage and operate the storefront and back office centers, including the customer service representatives, some of the video image review clerks (the bulk of the license plate image review would be conducted under the systems integrator contract), notice and payment processing clerks, and customer service center administrative staff. These costs would also include staff to manage and direct the overall operation and functional areas such as a general manager, center manager, image processing supervisor, accounting and toll audit director and back office system maintenance manager.

The toll system maintenance and operational costs include staff and equipment to maintain the roadside toll equipment, the back office computer system, the communications network equipment, and all of the toll system software (roadside and back office). This staff would include the toll system maintenance manager, field technicians, off-site software programmers and other technical support staff from the system integrator's development center. These costs also include the video image review group, which includes management staff and clerks that would review those images that have not met the pre-determined Optical Character Recognition confidence level. The costs in this category are typically included in the toll systems integrator contract.

Table 3
Estimated Annual Toll Collection Operating Costs
Systemwide in Thousands
(In 2016 Dollars)

Year	Backoffice Processing Cost		Other Service Center Costs (000)	Roadside System Maint. & Operations (000)	Total Annual Toll Collection Maint. & Operating Cost (000)
	E-Zpass (000)	Video (000)			
2023	\$22,650	\$53,190	\$15,150	\$9,500	\$100,490
2024	\$22,940	\$51,110	\$15,150	\$9,500	\$98,700
2025	\$23,230	\$49,120	\$15,150	\$9,500	\$97,000
2026	\$23,520	\$47,240	\$15,150	\$9,500	\$95,410
2027	\$23,820	\$45,460	\$15,150	\$9,500	\$93,930
2028	\$24,120	\$43,760	\$15,150	\$9,500	\$92,530
2029	\$24,420	\$42,160	\$15,150	\$9,500	\$91,230
2030	\$24,730	\$40,620	\$15,150	\$9,500	\$90,000
2031	\$25,040	\$39,180	\$15,150	\$9,500	\$88,870
2032	\$25,350	\$37,790	\$15,150	\$9,500	\$87,790
2033	\$25,670	\$36,490	\$15,150	\$9,500	\$86,810
2034	\$26,000	\$35,250	\$15,150	\$9,500	\$85,900
2035	\$26,320	\$34,080	\$15,150	\$9,500	\$85,050
2036	\$26,650	\$32,980	\$15,150	\$9,500	\$84,280
2037	\$26,990	\$31,920	\$15,150	\$9,500	\$83,560
2038	\$27,330	\$30,930	\$15,150	\$9,500	\$82,910
2039	\$27,670	\$29,990	\$15,150	\$9,500	\$82,310
2040	\$28,020	\$29,100	\$15,150	\$9,500	\$81,770
2041	\$28,380	\$28,270	\$15,150	\$9,500	\$81,300
2042	\$28,730	\$27,470	\$15,150	\$9,500	\$80,850
2043	\$29,090	\$26,720	\$15,150	\$9,500	\$80,460
2044	\$29,460	\$26,020	\$15,150	\$9,500	\$80,130
2045	\$29,830	\$25,360	\$15,150	\$9,500	\$79,840
2046	\$30,210	\$24,730	\$15,150	\$9,500	\$79,590
2047	\$30,590	\$24,150	\$15,150	\$9,500	\$79,390

Potential Annualized Capital Cost Recovery

For purposes of this study, the estimated capital cost was assumed to be recovered over the life of the projection period, using an annual cost of financing of 5.0 percent. This may or may not be

how the cost is funded, but this approach enabled a progressive deduction of capital recovery cost from toll revenue to provide a more realistic estimate of true “net revenue” yielded by tolling.

In general, the typical life expectancy of toll technology is roughly 10 years. That is, on average, roadside and central system hardware and software would likely be replaced every ten years. This is in part due to wear and tear, but also, increasing, driven by continual changes and improvement in tolling technology. As such, toll system capital costs were assumed to be “amortized” over a nominal ten-year period and assumed to continue each year through the entire 25-year projection period.

However, about 40 percent of the total capital cost associated with tolling would relate to the new fiber optics communications system. This would have a much longer life and is assumed to remain functional over the full 25-year forecast period. Hence, annualized capital recovery for this cost was assumed over the full 25 years, also at a financial cost of 5 percent per annum.

The total equivalent annual capital recovery cost, therefore, was estimated as follows:

<u>Cost Element</u>	<u>Estimated Cost (000)</u>	<u>Assumed Amort. Years</u>	<u>Annual Capital Recovery Cost (000)</u>
Toll Collection System	\$210,100	10	\$26,742
Communications System	<u>\$162,000</u>	25	<u>\$11,364</u>
Total System	\$372,100		\$38,106

Chapter 4

Toll Pricing Objectives and Strategies

Tolling is being considered in Connecticut to achieve two important, statewide objectives:

- Assist in reducing congestion on many of the State's major expressways; and
- Generate new, sustainable sources of annual revenue to help fund badly needed, long-range transportation improvements in the state, in the face of declining revenue from the motor fuel tax.

With these objectives in mind, the study looked at a wide range of pricing strategies, pricing levels and various forms of local discounting.

- If tolls are introduced, motorists currently using the toll-free routes are anticipated to respond in a variety of ways: They could choose to pay the toll and continue driving on the expressway routes they now use, at the travel times they now use them (this would likely be the preferred choice by most travelers);
- They could choose to divert to alternative routes to avoid the tolling points for the entire length of their trip;
- They can alter where they enter or exit a freeway to avoid a particular local tolling point;
- They could shift their time of travel to off-peak hours while continuing to drive on the expressway routes they now use, thus incurring lower toll charges and, incidentally, helping to reduce traffic congestion;
- They could choose to shift to transit; particularly where good transit options are available such as along the I-95 corridor and along portions of the I-84 and I-91 corridors; and/or,
- They could elect to reduce the frequency of their trips (e.g. forego some trips entirely, combine trips, or carpool with others), this is also referred to as trip suppression or consolidation.

The second response – diverting travel to an alternate, non-tolled route - would add traffic to these roads and could have some negative local impacts. The last three of these responses – shifting time of travel, shifting mode of travel and reducing overall vehicle miles travelled - would be favorable to the objective of reducing traffic congestion during peak periods without negatively impacting alternative routes.

Strategic Pricing Objectives and Rationale

These potential motorist responses to expressway tolling were taken into consideration in developing alternative pricing strategies and price differentials. It was also determined that toll charges should be based on a hierarchy of rates, with higher charges for heavier vehicles in

recognition of the disproportionately high impact that trucks and other heavy vehicles have on the State's highway infrastructure. In addition, it was important to consider discounts to frequent and local travelers, and other programs that could be available to low-income populations to mitigate equity concerns, as compared to the relatively high proportion of infrequent, "through" trips generally made by out-of-state motorists and truckers.

There are four basic principles that were established to develop a toll framework for consideration in Connecticut:

1. **Fairness** – tolls should be set to ensure collection of revenues from CT as well as out-of-state auto and truck trips.
2. **Equity** - tolls should be set to ensure that per mile toll rates are the same on all toll roads in the state.
3. **Flexibility** – the toll system should allow the flexibility to set and adjust discount rates for CT car and truck drivers – including discounts for commuters and frequent users.
4. **Revenue efficiency** – the toll system should seek to minimize the cost of collection and administration while also addressing key congestion relief objectives.

Peak Period Surcharges

Because Connecticut's tolling program would likely be authorized under the FHWA Value Pricing Pilot Program (VPPP), it would be necessary to comply with certain provisions of VPPP, including utilizing "time of day," variable tolling (also known as value pricing or congestion pricing). This variable tolling approach, where higher toll rates are charged during 'rush hours,' is a proven and effective way to mitigate traffic congestion. However, FHWA regulations do not stipulate the specific magnitude of the price differentials, nor whether the same differentials need to be used on all segments of the tolled system. At all locations, it would be necessary, however, to use higher tolls during peak hours and lower tolls during off-peak hours, for all vehicle categories.

As part of this study, a range of peak versus off-peak surcharge proportions were tested, ranging from toll rates that would be 25 percent higher to as much as 100 percent higher during peak hours. After review of traffic and revenue study results, the CTDOT study team selected a "time of day" price differential of 25 percent for the entire tolled network. The 25% higher peak toll rate resulted in a significant reduction in peak period travel in this preliminary analysis. The degree of this price differential, and the potential to have varying differentials for different expressway segments, could be revised upon future, more refined analysis.

For purposes of this study, peak hours of travel were assigned to 6:00-9:00 AM and 3:00-7:00 PM. Accordingly, travel between 9:00 AM and 3:00 PM, and between 7:00 PM and 6:00 AM were assigned as "off-peak" travel hours that would be tolled at reduced toll levels.

The travel modeling in this study was performed to represent an average weekday. However, in adjusting estimated weekday revenue to annual transactions and revenue, it was assumed that the off-peak rates would be charged all day on Saturdays, Sundays and holidays. Connecticut's expressways often experience significant congestion on weekends and holidays, especially during

the summer months; the study team therefore recommends that the application of peak hour travel rates be evaluated in future studies.

In-State Versus Out-of-State Price Differentials

Another strategic price variant evaluated in the study was an E-ZPass price differential. This would establish lower toll rates for vehicles with Connecticut issued E-ZPass transponders and higher rates for all other E-ZPass transponders. This is a common practice used by many existing toll agencies, including throughout the Northeast. It would be particularly appropriate in Connecticut considering the relatively small size of the state. This is because there is a significant proportion of traffic which passes through the state without stopping to purchase fuel. These “through” vehicles thereby impact Connecticut’s expressways but do not contribute to the state’s motor fuel tax revenue.

This study tested a range of toll rate differentials between in-state versus out-of-state E-ZPass users. This ranged from an in-state discount of 20 percent to as much as 50 percent. After review of the revenue results, and various other factors raised in this study, the CTDOT study team selected a nominal 30 percent price differential between in-state E-ZPass and all other E-ZPass vehicles. This differential is close to the typical in-state/out-of-state price differentials used on other toll facilities in the Northeast.

E-ZPass Versus Video Tolling

Video tolling of vehicles without E-ZPass transponders is much costlier than E-ZPass toll processing; in some cases, 5-10 times as much depending on whether invoices are required to be sent to video customers. In addition, “Pay by Mail” tolling has a relatively high potential for “leakage”; basically, uncollected revenue. Leakage can occur due to a variety of factors, such as unreadable license plates, outdated owner address information on DMV registration records, and non-payment by the customer. Collection risk is particularly significant for vehicles registered outside the state of the toll operation; since interstate collection enforcement reciprocity agreements are rare (notably, New Hampshire, Maine, and Massachusetts are among the few states with interstate collection enforcement agreements).

As such, pricing strategies are usually developed to encourage the use of E-ZPass. In the case where motorists choose not to obtain E-ZPass (for whatever reason) pricing should be set to encourage at least the pre-registration of plates. With pre-registered plates, payment would be automatic, and it would not be necessary to obtain owners names and addresses, send out bills, and pursue collections.

Typically, toll pricing strategies would have a higher charge for unregistered video transactions and a lower charge for pre-registered plate transactions. Both would typically be higher than E-ZPass rates. For the purpose of this study, it was determined that unregistered video transactions would be priced 1.5 times the out-of-state E-ZPass rate. Pre-registered plate toll rates were set half-way between the non-Connecticut E-ZPass and the unregistered video rates, for all vehicle categories.

Trucks Versus Cars

As noted previously, a simplified 3-class classification structure was established for this study. The baseline toll rates would be set for Class 1, passenger cars and other two-axle vehicles, such as pick-up trucks and vans. Class 2, single unit trucks were nominally assumed to be two times the passenger car rate. Heavy trucks, typically multi-unit or tandem trucks, would be charged four times the passenger car rate.

Several factors were considered when establishing a toll rate structure for trucks – and especially heavy trucks. These included:

- 1. Truck toll rates in neighboring states.** Truck toll rates in CT should be comparable to rates in neighboring states
- 2. Revenues collected from trucks through diesel fuel taxes & toll revenues combined.** States collect revenues from trucks in many ways including tolls, motor fuel taxes, registration fees, ties taxes, and more. The two largest sources are motor fuel taxes (primarily diesel fuel) and highway tolls. Connecticut's diesel fuel tax is high relative to neighboring states, so any decision about what toll rate to set for trucks in CT must consider the combined impact of diesel taxes plus toll rates.
- 3. Cost of damages caused by trucks on CT highways and bridges.** A single heavy truck causes much more wear and physical damage to roads and bridges than a car, SUV, pick-up truck, or similar small vehicle. These disproportionate impacts must be considered in setting toll rates to ensure trucks pay their fair of CT's cost to maintain and repair our highway infrastructure.

Most of the toll industry uses even higher differentials for truck toll rates relative to passenger car rates than what was assumed for this study. The most common category of commercial vehicles on Connecticut's expressways is the multi-unit, heavy truck (Class 3). Within that category, the 5-axle truck is by far the most common vehicle size. Typical pricing differentials established by tolling agencies in other states result in charges for a 5-axle truck that are four times the rate charged for a passenger car. Hence, the 4.0 truck rate multiplier tentatively established for Connecticut would be consistent with national averages.

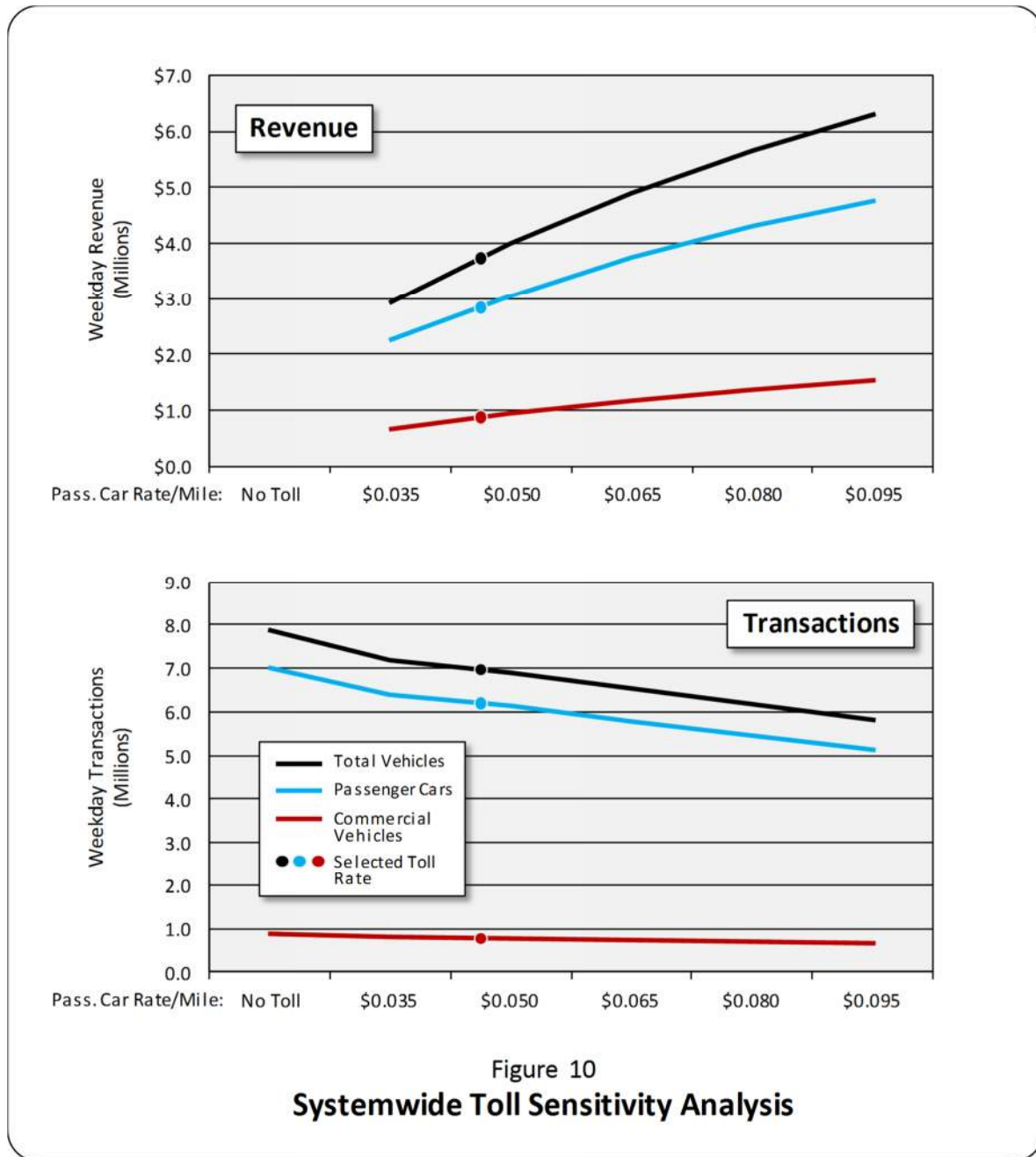
Toll Sensitivity Assessment

Computer model runs were used to perform a toll rate sensitivity assessment on a systemwide basis and on each individual corridor. The results of this are graphically depicted in **Figure 10**. Five rate levels were tested, based initially on an equivalent passenger car per-mile rate ranging from \$0.035 per mile to \$0.095 per mile.

Revenue potential at each of the alternative rates is shown in the upper portion of Figure 10, while toll transactions are depicted in the lower portion. Passenger car values are shown in blue, commercial vehicles (Classes 2 and 3) are depicted in red and total vehicle information is depicted in black. The analysis was performed on a weekday average basis, at 2023 levels.

Total weekday revenue potential was estimated just under \$3 million per day from all vehicles at the lowest toll rate tested, assuming tolling on all 13 of the route and corridor sections discussed

previously in Chapter 2. At \$0.05 per mile, revenue would increase to about \$4 million per weekday and continue to rise over the full range of rates tested. The revenue curves did not reach a maximum peak within the range of rates tested. However, it is important to recognize that for the most part the rates tested in this study were well below rates in actual use on most other toll facilities. The average toll rate for passenger cars in the Northeast is about \$0.068 per mile. Nationally, the average per mile toll rate for passenger cars is about \$0.097 per mile (excluding premium priced bridges, tunnels and managed lanes). This is similar to the highest rate tested in this study.



Higher rates would be charged for commercial vehicles. A \$1.0-\$1.5 billion in gross revenue target range would be equivalent to a weekday revenue range of about \$3.0-\$4.5 million per day. Based on the toll sensitivity analysis, this could be achieved in a range of rates between \$0.035 and \$0.055 per mile. As more information regarding operating and capital costs became available during the study, CTDOT selected a preferred rate in between these two levels at about \$0.044 per mile which is directly equivalent to the average per-mile toll rate today on the Massachusetts Turnpike. The selected rate location is shown by dots on each curve in both the revenue and transaction levels.

While revenue increases, traffic is reduced as toll rates get progressively higher. It is important to recognize, however, that not all the net difference from toll-free conditions can be attributed to traffic diversions to non-tolled routes. A portion of the reduced volume of expressway traffic is attributable to trip consolidation and shifts to transit.

Potential Toll Rates

A wide range of potential toll rates, discounts and peak period surcharges were tested as part of the study. Based on this extensive analysis, the CTDOT study team tentatively selected a **baseline toll rate of 4.4 cents per mile (off-peak)** for passenger cars equipped with a CT E-ZPass. This rate was found to be sufficient to generate revenue levels needed for the major transportation capital improvement program; it was also comparable or lower than rates charged on toll roads in New England and elsewhere in the northeast. In fact, this rate would be among the lowest per-mile toll rates in the United States. For motorists reaching the threshold for volume discounts, the per-mile rate would be effectively reduced to **3.5 cents per mile (off-peak)**.

Table 4 shows suggested toll rates for passenger vehicles. Tentative rates are shown for the five payment categories for passenger vehicles, for both peak and off-peak hours. Single unit trucks and larger multi-unit trucks would be charged two and four times the passenger vehicle rates shown, respectively. The out-of-state E-ZPass rate is considered the base rate and discounts or surcharges are applied to the base rate. Drivers who purchase a CT-issued E-ZPass would receive a 30% discount plus an extra 20% if they are frequent users (more than 40 1-way trips/month). Vehicles without an E-ZPass are charged an extra 25% or 50% depending on whether they register their license plate with the CT toll system. All drivers would be charged 25% more in the peak traffic period, assumed to be 6 a.m. to 9 a.m. and 4 p.m. to 7 p.m.

Payment Category	Discount	Off Peak (rate/mile)	Peak Period (rate/mile)
CT E-Zpass	30%	4.4 cents	5.5 cents
CT E-Zpass - Frequent User Rate	20%	3.5 cents	4.4 cents
Out-of-state E-Zpass	base rate	6.3 cents	7.9 cents
Video Toll (registered)	25% higher	7.9 cents	9.9 cents
Video Toll (not registered)	50% higher	9.4 cents	11.8 cents

Table 5 presents a summary of “through” trip toll rates for each of the 13 corridors tested in the study (for purposes of this study, a “through” trip is defined as a vehicle who uses the entire corridor). For example, on I-95 West, between New York State and New Haven, the 48-mile corridor would include seven tolling points. At full price at off-peak hours, a Connecticut issued E-ZPass passenger car would be charged a total of \$2.11 for the entire 48-mile trip, or an average per-mile toll of \$0.044. In peak periods, the cumulative toll would be increased to \$2.64 for a through trip, a per-mile peak period rate of \$0.055.

Tolled Corridor	Miles	Number Toll Pts.	Through Trip Tolls (Class 1 - Passenger Cars)			
			CT Issued E-ZPass -- Off-Peak		CT Issued E-ZPass-- Peak Hours	
			Full Price Toll	With Vol. Discount Toll	Full Price Toll	With Vol. Discount Toll
I-95 West	48	7	\$2.11	\$1.68	\$2.64	\$2.11
I-95 East	64	10	\$2.82	\$2.24	\$3.52	\$2.82
Route 15 West	47	7	\$2.07	\$1.65	\$2.59	\$2.07
Route 15 North	18	3	\$0.79	\$0.63	\$0.99	\$0.79
I-84 West	63	10	\$2.77	\$2.21	\$3.47	\$2.77
I-84 East	36	5	\$1.58	\$1.26	\$1.98	\$1.58
I-91	58	9	\$2.55	\$2.03	\$3.19	\$2.55
I-291	6	1	\$0.26	\$0.21	\$0.33	\$0.26
I-691	8	1	\$0.35	\$0.28	\$0.44	\$0.35
I-395	56	8	\$2.46	\$1.96	\$3.08	\$2.46
Route 2	37	6	\$1.63	\$1.30	\$2.04	\$1.63
Route 8	58	9	\$2.55	\$2.03	\$3.19	\$2.55
Route 9	40	6	\$1.76	\$1.40	\$2.20	\$1.76
Total	539	82				

As assumed under this study, passenger car motorists with Connecticut issued E-ZPass would also be eligible for retroactively applied volume discounts. Various alternative strategies were

tested for this volume discount program, all of which were targeted to provide a discount of approximately 20 percent for frequent users where the number of trips exceeds a certain established minimum threshold per month. This volume discount would be in addition to the lower price charged to Connecticut E-ZPass regardless of frequency of use. For purposes of this study, it has been assumed that frequent users would wind up with an effective retroactive discount of about 20 percent versus the full price charge. This would have the effect of bringing the off-peak, per-mile rate to \$0.035 per mile. Systemwide peak-hour rates for frequent commuters with a Connecticut E-ZPass would be \$0.044 per mile, which is effectively the same as the off-peak Connecticut E-ZPass rate.

Comparison with Other Regional Toll Rates

Table 6 provides a useful comparison of the nominal toll rates tested in the Connecticut study with rates on other toll roads in the Northeast. Eight different facilities are shown, excluding bridges, tunnels and managed lane projects. The average regional per-mile rate for through trips is \$0.063. The New Hampshire Turnpike and the Massachusetts Turnpike currently have in-state E-ZPass per-mile toll rates that are essentially equivalent to the nominal \$0.044 being tested in Connecticut.

Table 6
Comparison of Northeast Regional Per Mile Toll Rates

(Excludes Bridges, Tunnels and Managed Lanes)

<u>Toll Road</u>	<u>2018 ETC Per Mile Toll Rates</u>		<u>Truck / Car</u> <u>Toll Multiple</u>	<u>Car In-State</u> <u>E-ZPass Toll</u> <u>Discount?</u>	<u>Car</u> <u>Volume</u> <u>Discounts</u>
	<u>Cars</u>	<u>5 Ax. Trucks</u>			
New Hampshire Turnpike	\$0.043	\$0.187	4.35	Yes	No
New Jersey Turnpike	\$0.117	\$0.385	3.29	No	No
New York Thruway	\$0.049	\$0.258	5.27	Yes	Yes
Maine Turnpike	\$0.058	\$0.233	4.02	Yes	Yes
Garden State Parkway	\$0.048	N/A	N/A	No	No
Massachusetts Turnpike	\$0.044	\$0.167	3.80	Yes	No
Kennedy Hwy (Md)	\$0.060	\$0.480	8.00	Yes	Yes
Atlantic City Expressway	\$0.085	\$0.341	4.01	No	Yes
Regional Average	\$0.063	\$0.293	4.65		
National Average	\$0.097	\$0.402	4.14		
CT E-ZPass Rate (Off-Peak)	\$0.044	\$0.176	4.00		
CT E-ZPass Rate (Peak)	\$0.055	\$0.220	4.00		
CT Peak Rate with Vol. Disc.	\$0.044	N/A			
Non-CT E-Zpass OP Rate	\$0.063	\$0.252	4.00		

Note: The E-Zpass rate shown for each respective state is the lowest rate provided to a driver with an E-Zpass issued by that particular state.

Nationally, the overall average of all toll roads is \$0.097 per mile; about double the rates selected in this study for Connecticut E-ZPass users. **Table 6** also shows current per mile rates for 5-axle trucks, the most common type of commercial vehicle encountered in the toll industry. On a regional basis, the average 5-axle truck pays \$0.293 per mile, or 4.65 times the passenger car rate. Nationally, the truck/car toll multiple is about 4.14. For the purpose of projecting toll revenue for this study, it is assumed that the heaviest trucks be charged the rate multiple of 4.00 times that of passenger car rates.

Finally, Table 6 provides general information about whether toll facilities in other states in the Northeast assess lower rates for in-state E-ZPass users. Most of the facilities in the immediate region do, and some provide additional volume discounts, similar to those being considered in Connecticut.

Volume Discount Programs

In addition to in-state discounts and other strategic pricing differentials, this study considered volume discounts for passenger cars with Connecticut E-ZPass transponders. This would be targeted at frequent users, such as everyday commuters. There are basically three methods used for volume discount programs by other tolling agencies in the US:

- Pre-enrollment programs, which enable lower toll rates but require a minimum number of transactions per month to achieve the benefit. If the customer makes less transactions than the minimum required for the discount, any balance in prepaid tolls is lost or the uncompleted trips are simply added to the toll account per advance agreement;
- Some agencies retroactively apply discounts, without requiring pre-enrollment by the customer. In this case, once a predetermined threshold of transactions has been reached within a given month, subsequent transactions are charged at a discounted rate. Based on typical usage patterns, the combination of discounted and undiscounted transactions may yield an effective discount of as much as 20 percent for everyday commuters; and,
- In a variation on retroactive discounting, some agencies simply use a stepped retroactive discounting program in which when certain levels of toll charges (or toll transactions) are achieved, the entire toll balance for the month is reduced by a certain proportion. Maine Turnpike uses this type of approach.

For the purpose of this study, and after extensive analysis, it was determined by the CTDOT study team that no pre-enrollment would be required. Rather, toll discounts could be applied retroactively, as a proportional adjustment for trips made above a certain minimum threshold per month.

The toll discount was assumed to be structured to provide an effective 20 percent discount for the typical commuter making 40 or more trips per month with a Connecticut issued E-ZPass. Since some participants would make more than 40 trips per month, but many other Connecticut drivers would not qualify for any discount; for the purpose of projecting impacts to toll revenue it was determined that the overall revenue impact of this program would be a reduction of about 17.5 percent of revenue collected from passenger cars with Connecticut issued E-ZPass transponders.

For the purpose of this study, it is assumed that volume discounts would only apply to passenger cars with Connecticut issued E-ZPass transponders. No volume discounts would be available for trucks, nor for motorists using E-ZPass transponders from other states or vehicles without transponders. These assumptions would be subject to further study and refinement if the Connecticut Legislature determines that tolls should be implemented.

Chapter 5

Estimated Traffic and Revenue Potential

This chapter provides an overview of the development of the travel demand model and of the approach used to evaluate Connecticut's potential toll corridors using the toll rate structure discussed in Chapter 4. In addition, key information is provided about average trip distance of toll payers, and average tolls by payment type. Estimates of weekday transactions, toll revenue by corridor, the amount of transactions and toll revenue attributed to in-state versus out-of-state traffic, and annual gross and net toll revenue are also provided.

Overview of Methodology

CTDOT maintains a traditional daily, four-step travel demand model that helps CTDOT and other agencies study current and projected vehicle trip generation, trip distribution, mode choice, and route choice on Connecticut's roadways. The latest available version of this Connecticut Statewide Model Network and trip tables was obtained at the start of the study. A thorough review of the statewide model network was completed, including travel speeds, number of lanes, and link capacities. The model network was expanded into New York, Rhode Island, and Massachusetts to allow for improved representation of regional traffic patterns and potential diversion alternatives for cars and trucks. In addition, trip tables were also disaggregated into the larger network area.

At the outset of the study, traffic counts were assembled to produce an hourly, balanced traffic profile of each study corridor representing 2016 traffic conditions. In addition, data on traffic speeds and truck flows were obtained through INRIX and Streetlight Data to improve the accuracy of model output speeds and truck volumes and flows in the region. Using this data, an extensive model calibration effort was undertaken to produce model traffic volumes, truck percentages, and travel speeds that align with current data for four-time periods of the day; 6-9AM, 9AM-3PM, 3PM-7PM, and 7PM-6AM. Following completion of model calibration to 2016 conditions, future year networks and trip tables were developed to represent an assumed tolling commencement in 2023 and a horizon year of 2040. Two versions of the 2040 network were created. One that contained currently known funded improvements and one that contained a much more robust set of expressway widenings and improvements that would likely be funded through potential toll revenue.

To perform the traffic and revenue analysis at 2023 and 2040 conditions, the model was further updated with parameters and toll diversion procedures specifically developed to predict motorist's behavior or travel choices under tolling. These parameters were refined to reflect data and information specific to Connecticut drivers. Utilizing the toll diversion modeling procedures, an extensive traffic and toll revenue analysis was completed for 2023 and 2040 levels to estimate transactions and toll revenue for the selected toll rates. Following are the key findings of this traffic and revenue analysis.

Estimated 2023 Traffic and Revenue

To estimate tolling revenue for this study, the start of tolling operations for expressways in Connecticut was assumed to begin in the year 2023. **Table 7** details the estimated toll transactions and revenue for 2023 by corridor and by payment type. Each of the 13 expressway corridors included in this study are shown in detail, including the split corridors of I-95, Route 15, and I-84. The time of day is shown across the top, reflecting peak hours (6-9am and 3-7pm) and off-peak hours (9am-3pm and 7pm-6am). It should be noted that a transaction is defined as a vehicle passing through a single tolling point or gantry. A trip, on the other hand, may travel through multiple tolling points or gantries; therefore, a trip can have multiple transactions attributed to it. On a system-wide basis, there would be 82 tolling locations or gantries on approximately 539 miles of tolled corridors (within the 13 expressway corridors) resulting in an average spacing of about 6.6 miles per gantry.

The I-95 West corridor which would have 7 tolling locations spanning from the New York state line to the city of New Haven. This corridor, which is among the most congested in the state, is estimated to produce over 1.0 million transactions per day, with 44 percent of these coming in the peak hours of travel. These expected transactions would produce \$670,000 in gross toll revenue per weekday. Route 15 West, the parkway that parallels I-95 and spans from the New York border to New Haven, is roughly 47 miles in length and would contain 7 tolling locations. It is estimated that this corridor would produce about 500,000 daily transactions and toll revenue of \$217,000.

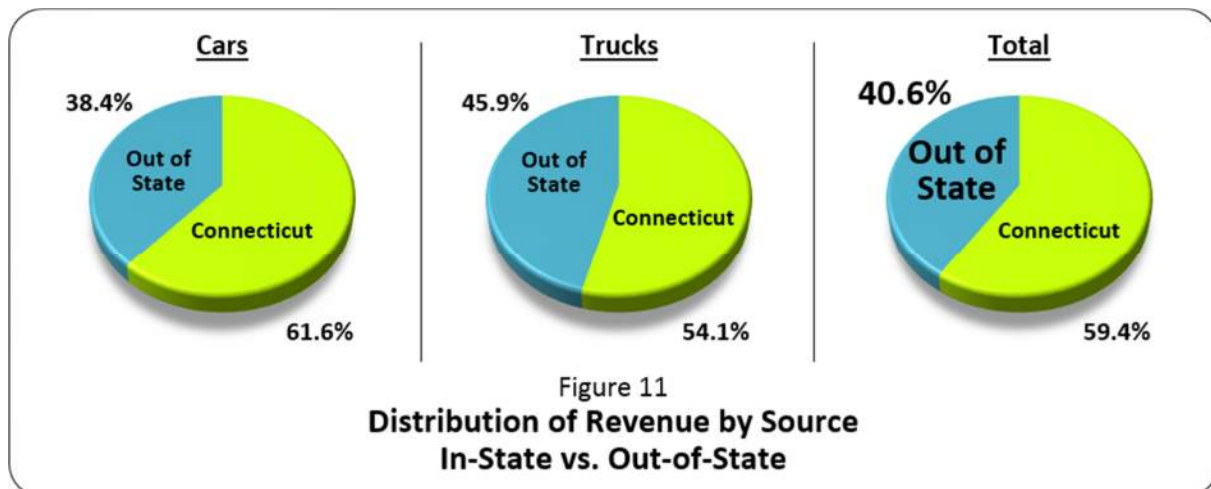
Another highly congested corridor in the state is the I-84 West expressway which travels between the New York line and Hartford. This stretch of road covers 63 miles and would contain 10 tolling locations. The I-84 West corridor is estimated to produce nearly 1 million transactions that would generate about \$531,000 per weekday. Of these transactions, 78% are estimated to be completed by E-ZPass users, compared to just 22% using video tolling. In addition, almost 30% of these transactions are made by out-of-state users, resulting in more than 37% of revenue coming from out-of-state users.

Interstate 91, the major north-south thoroughfare connecting the city of New Haven to Hartford and Springfield MA, covers 58 miles and would contain 9 tolling locations. I-91 would produce 1.1 million transactions and generate \$586,000 per weekday, including 37% of the revenue coming from out-of-state users.

Statewide, 6.7 million weekday transactions are estimated, which would result in \$3.6 million in gross toll revenue. It is important to note this number is prior to any adjustments related to possible discounts such as frequent traveler discount programs, and to leakage and tolling operations and maintenance costs. Once the passenger car frequency discount is accounted for, the daily estimated gross toll revenue would be reduced to about \$3.4 million, with 40.6 percent coming from out-of-state users.

In-State Versus Out-of-State Traffic and Revenue Share

An important factor to consider when looking at projected revenue results is the proportion of toll revenue that is expected to be generated from out-of-state traffic. One of the key reasons for instituting tolling in Connecticut is to collect revenue from out-of-state vehicles that are putting strain on state infrastructure, but currently are paying little or nothing in the form of fuel taxes. **Figure 11** shows a breakdown of estimated transactions and revenue by vehicle class for in-state and out-of-state traffic at 2023 levels. For passenger cars, 29.7% of the transactions would be made by out-of-state vehicles, producing 38.4% of the revenue. The difference in the percentages stems from out-of-state vehicles paying higher toll rates. For trucks, out-of-state vehicles are estimated to produce 40.5% of transactions and 45.9% of the revenue. Combining cars and trucks, **out-of-state vehicles are estimated to produce 30.8% of all transactions and contribute 40.6% of toll revenue for the system.**



Estimated 2040 Traffic and Revenue

In addition to model assignments performed at 2023, traffic assignments were also completed at 2040 levels. The 2040 network included additional roadway projects assumed to be implemented and financially supported by toll revenue. **Table 8** details the estimated toll transactions and revenue by corridor and by payment class and type for year 2040.

Following a similar pattern to 2023, I-95 West is estimated to generate almost \$700,000 during an average weekday. Nearly 33% of the transactions were made from out-of-state vehicles, while 45% of the revenue comes from out-of-state. When coupled with Route 15 West, the combined parallel expressway corridors in southwestern Connecticut would produce 1.7 million transactions and just over \$900,000 per day in revenue.

2040 modeling of the I-91 corridor projects over 1.2 million transactions per day in 2040. These transactions would result in a gross revenue of \$578,000 per day. Of this revenue, 71% of it comes from passenger cars and 29% coming from trucks. In addition, nearly 82% of the revenue comes from vehicles equipped with E-ZPass, while just 18% are using video as their payment method.

All the lesser used corridors, which include I-691, Route 2, Route 8, Route 9, and I-291 are expected to generate a total of 1.3 million daily transactions in 2040. These transactions would result in gross daily toll revenues of \$573,000. In addition, these corridors are more typically used by in-state residents. Of these corridors, the highest out-of-state percentage for transactions and revenue is on I-291, which, among the lesser used corridors, is expected to produce about 17.0% of the transactions and 24.0% of the revenue. On a systemwide basis in 2040, 7.5 million weekday transactions are estimated, which would result in \$3.7 million in gross toll revenue. Once the passenger car frequent user discount is accounted for, the revenue drops to over \$3.4 million, with 41.0% of the revenue being paid by out-of-state users.

Table 8
Estimated Year 2040 (Build Scenario) Toll Transactions and Revenue
By Tolled Corridor

Tolled Corridor	Miles	Number Toll Pts.	Item	Peak Hours (6-9am and 3-7pm)										Off Peak Hours (9am-3pm and 7pm to 6 am)										Weekday Totals			Approximate Out of State		
				Class 1 (Passenger Cars and Other Light Vehicles)					Classes 2 & 3 (All Truck Classes Combined)					Class 1 (Passenger Cars and Other Light Vehicles)					Classes 2 & 3 (All Truck Classes Combined)					E-Zpass	Video	Total	Amount	% of Total	
				CT E-Zpass	Non-CT E-Z	Reg. Video	Unreg. Vid.	Total Cl. 1	CT E-Zpass	Non-CT E-Z	Reg. Video	Unreg. Vid.	Total Cl. 2&3	CT E-Zpass	Non-CT E-Z	Reg. Video	Unreg. Vid.	Total Cl. 1	CT E-Zpass	Non-CT E-Z	Reg. Video	Unreg. Vid.	Total Cl. 2&3						
Assumed Percent out of state				0%	95%	60%	60%	0%	90%	60%	60%	0%	95%	60%	60%	0%	90%	60%	60%										
I-95 West	48	7	Transactions Revenue	307,474 \$116,597	95,713 \$55,111	34,052 \$23,291	30,435 \$24,989	467,673 \$219,988	33,922 \$41,823	21,401 \$39,198	1,369 \$3,062	1,319 \$3,547	58,011 \$87,629	310,427 \$93,656	126,136 \$57,518	37,039 \$20,279	35,406 \$23,313	509,007 \$194,766	67,412 \$67,733	78,372 \$114,486	3,687 \$6,688	3,587 \$7,804	153,057 \$196,711	1,040,856 \$586,121	146,893 \$112,974	1,187,749 \$699,095	388,687 \$313,097	32.7% 44.8%	
I-95 East	64	10	Transactions Revenue	238,395 \$84,965	99,246 \$50,160	28,510 \$18,096	26,191 \$19,894	392,342 \$173,116	19,883 \$23,040	19,702 \$32,686	989 \$2,051	956 \$2,378	41,531 \$60,155	245,725 \$69,671	124,772 \$50,403	31,401 \$15,887	30,230 \$18,389	432,128 \$154,351	38,526 \$35,894	45,717 \$60,808	2,125 \$3,530	2,065 \$4,117	88,434 \$104,349	831,967 \$407,628	122,468 \$84,343	954,435 \$491,971	345,176 \$230,286	36.2% 46.8%	
Route 15 West	47	7	Transactions Revenue	156,676 \$55,270	44,037 \$23,314	17,120 \$10,893	15,558 \$11,865	233,390 \$101,343	0 \$0	0 \$0	0 \$0	0 \$0	0 \$0	173,785 \$48,668	74,511 \$30,787	21,368 \$10,769	20,921 \$12,703	290,585 \$102,926	0 \$0	0 \$0	0 \$0	0 \$0	0 \$0	449,009 \$158,039	74,967 \$46,230	523,975 \$204,269	157,601 \$79,134	30.1% 38.7%	
Route 15 North	18	3	Transactions Revenue	80,120 \$29,117	8,336 \$4,300	7,416 \$4,818	6,681 \$5,184	102,553 \$43,419	0 \$0	0 \$0	0 \$0	0 \$0	0 \$0	83,405 \$24,179	23,186 \$9,579	9,052 \$4,674	8,857 \$5,487	124,501 \$43,919	0 \$0	0 \$0	0 \$0	0 \$0	0 \$0	195,047 \$67,175	32,007 \$20,163	227,054 \$87,338	49,150 \$25,283	21.6% 28.9%	
I-84 West	63	10	Transactions Revenue	354,643 \$124,033	73,142 \$36,526	35,777 \$23,342	32,653 \$24,411	496,215 \$207,311	30,604 \$35,306	15,761 \$26,000	1,145 \$2,359	1,104 \$2,728	48,615 \$66,393	343,094 \$95,988	104,161 \$41,629	37,433 \$18,697	36,007 \$21,562	520,695 \$177,876	52,465 \$48,350	40,514 \$53,401	2,334 \$3,845	2,266 \$4,479	97,579 \$110,075	1,014,384 \$461,233	148,720 \$100,422	1,163,104 \$561,655	308,318 \$205,961	26.5% 36.7%	
I-84 East	35	5	Transactions Revenue	131,664 \$48,705	45,774 \$24,894	14,867 \$9,882	13,738 \$10,913	206,042 \$94,395	10,240 \$12,606	9,271 \$16,646	485 \$1,075	467 \$1,244	20,463 \$31,572	138,130 \$40,773	81,186 \$35,217	18,512 \$9,887	17,965 \$11,466	255,793 \$97,343	21,267 \$21,117	34,431 \$49,407	1,405 \$2,513	1,363 \$2,923	58,467 \$75,961	471,964 \$249,366	68,802 \$49,904	540,765 \$299,270	201,225 \$146,496	37.2% 49.0%	
I-91	58	9	Transactions Revenue	370,222 \$131,459	71,494 \$35,435	36,680 \$23,105	32,980 \$24,907	511,376 \$214,905	31,325 \$36,291	11,182 \$18,215	1,030 \$2,121	983 \$2,429	44,521 \$59,056	361,468 \$103,361	117,744 \$46,788	39,987 \$20,284	38,248 \$23,288	557,446 \$193,721	54,256 \$50,406	39,284 \$51,704	2,309 \$3,812	2,221 \$4,398	98,070 \$110,319	1,056,974 \$473,658	154,438 \$104,343	1,211,412 \$578,001	317,858 \$203,644	26.2% 35.2%	
I-395	56	8	Transactions Revenue	104,926 \$40,757	33,466 \$18,649	11,377 \$7,880	10,515 \$8,725	160,283 \$76,012	7,490 \$9,584	4,959 \$9,123	304 \$695	290 \$796	13,042 \$20,198	106,498 \$32,935	41,206 \$18,390	12,286 \$6,788	11,797 \$7,834	171,786 \$65,947	12,764 \$12,983	10,223 \$14,961	572 \$1,043	553 \$1,208	24,112 \$30,195	321,530 \$157,382	47,693 \$34,971	369,223 \$192,352	113,217 \$77,844	30.7% 40.5%	
I-691	9	1	Transactions Revenue	32,791 \$16,395	2,329 \$1,654	2,840 \$2,528	2,493 \$2,668	40,454 \$23,245	2,643 \$4,361	283 \$668	69 \$203	65 \$230	3,059 \$5,461	28,872 \$11,549	2,595 \$1,479	2,556 \$1,814	2,433 \$2,092	36,455 \$16,935	3,938 \$5,199	752 \$1,422	113 \$268	108 \$307	4,912 \$7,195	74,204 \$42,726	10,677 \$10,109	84,881 \$52,835	12,017 \$10,923	14.2% 20.7%	
Route 2	37	6	Transactions Revenue	110,560 \$37,680	10,815 \$5,296	10,055 \$6,145	8,975 \$6,581	140,404 \$55,702	6,465 \$7,333	1,045 \$1,669	179 \$362	170 \$412	7,858 \$9,776	101,493 \$27,729	12,505 \$4,881	9,457 \$4,626	9,168 \$5,376	132,623 \$42,612	9,687 \$8,777	2,417 \$3,076	292 \$470	279 \$538	12,675 \$12,861	254,986 \$96,442	38,574 \$24,509	293,560 \$120,951	48,414 \$28,645	16.5% 23.7%	
Route 8	58	9	Transactions Revenue	199,977 \$71,080	19,510 \$9,930	18,233 \$11,519	16,449 \$12,478	254,169 \$105,007	13,153 \$15,445	1,706 \$2,908	355 \$746	338 \$850	15,552 \$19,948	198,628 \$55,866	21,600 \$8,668	18,387 \$9,207	17,706 \$10,645	256,321 \$84,386	22,092 \$20,563	2,492 \$3,344	599 \$995	575 \$1,146	25,758 \$26,047	479,158 \$187,802	72,642 \$47,585	551,801 \$235,387	86,418 \$51,845	15.7% 22.0%	
Route 9	40	6	Transactions Revenue	128,549 \$44,593	9,958 \$5,131	11,520 \$7,119	10,302 \$7,633	160,329 \$64,476	7,838 \$8,823	762 \$1,329	206 \$416	196 \$475	9,002 \$11,042	118,382 \$32,615	10,890 \$4,560	10,748 \$5,317	10,364 \$6,145	150,384 \$48,637	11,569 \$10,594	1,673 \$2,477	322 \$533	308 \$612	13,872 \$14,217	289,622 \$110,121	43,966 \$28,251	333,588 \$138,372	48,377 \$29,581	14.5% 21.4%	
I-291	6	1	Transactions Revenue	23,481 \$7,749	2,219 \$1,021	2,143 \$1,243	1,910 \$1,337	29,753 \$11,349	1,574 \$1,685	277 \$424	45 \$86	43 \$99	1,940 \$2,295	22,075 \$5,739	3,100 \$1,147	2,081 \$957	2,001 \$1,120	29,256 \$8,964	1,862 \$1,601	490 \$602	58 \$88	56 \$102	2,465 \$2,394	55,077 \$19,968	8,336 \$5,034	63,413 \$25,002	10,745 \$6,004	16.9% 24.0%	
Total System	539	82	Transactions Revenue	2,239,476 \$808,402	516,039 \$271,420	230,590 \$148,861	208,880 \$161,585	3,194,984 \$1,390,268	165,137 \$196,295	86,350 \$148,866	6,176 \$13,175	5,932 \$15,187	263,595 \$373,524	2,231,981 \$642,729	743,591 \$311,047	250,306 \$129,187	241,103 \$149,421	3,466,981 \$1,232,383	295,838 \$283,217	256,365 \$355,686	13,817 \$23,785	13,381 \$27,636	579,401 \$690,323	6,534,778 \$3,017,662	970,183 \$668,837	7,504,961 \$3,686,499	2,087,202 \$1,408,743	27.8% 38.2%	
Volume Discount Application (17.5% of Class 1 CT E-Zpass)				(\$141,470)										(\$112,478)															
Estimated Revenue After Volume Discount				\$666,931	\$271,420	\$148,861	\$161,585	\$1,248,798	\$196,295	\$148,866	\$13,175	\$15,187	\$373,524	\$530,252	\$311,047	\$129,187	\$149,421	\$1,119,906	\$283,217	\$355,686	\$23,785	\$27,636	\$690,323	\$2,763,714	\$668,837	\$3,432,551	\$1,408,743	41.0%	

Estimated Annual Transactions and Revenue

Table 9 presents estimated annual traffic and revenue on a systemwide basis. Included in this table are the estimated annual transactions and toll revenue, revenue adjustments, and estimated annual adjusted revenue. Adjusted revenue accounts for two deductions, the volume discount associated with frequency and revenue leakage. The volume discount program is designed for frequent users of the system to receive a discount based on their total usage. Leakage is an adjustment that accounts for the loss of revenue due to uncollectable tolls. There are a variety of reasons for tolls being uncollected, including video images with unreadable license plates, video users that cannot be located by the DMV of the state where the vehicle registration was issued, and failure of users to pay bills that are mailed to them.

In the opening year of 2023, there would be an estimated 1.8 billion E-ZPass transactions and 500 million video transactions, for a total of nearly 2.3 billion transactions. These transactions would produce \$850 million in E-ZPass revenue and \$380 million in video revenue for a total of \$1.23 billion in potential annual revenue. Accounting for the volume discount of approximately \$61 million and leakage adjustments of approximately \$81 million, the State of Connecticut can expect an estimated annual adjusted toll revenue of \$1.086 billion. This number is projected to grow to \$1.162 billion in 2047. All revenue is presented in 2016 dollars.

Over the 25-year forecast period, over 52 billion E-ZPass transactions would be made along with nearly 9.5 billion video transactions for a total of nearly 62 billion transactions. These projected transactions would result in a cumulative adjusted toll revenue for Connecticut of \$27.9 billion over 25 years, or about \$1.114 billion per year over the 25 years.

Estimated Net Toll Revenue

Estimated net toll revenue was calculated by taking the adjusted annual revenue and deducting annual costs associated with tolling maintenance and operations, and annualized system capital and replacement recovery costs. **Table 10** shows the breakdown for estimated annual net revenue by year, between 2023 and 2047, on a systemwide basis. As mentioned previously in Table 10, the estimated adjusted annual toll revenue in 2023 is estimated to be \$1.086 billion. The toll collection, maintenance, and operating costs are estimated at \$100.5 million, while the system capital and replacement recovery costs are estimated at \$38.1 million. This would result in an annual net revenue from tolling of \$947.4 million in 2023.

The system capital and replacement recovery costs remain constant for all years, as the costs are amortized over the lifetime of the project. Operating cost estimates are expected to decrease over time as the proportion of video transactions to total transactions would decrease throughout the forecasted period. Video transactions cost more to collect and as those transactions decrease, the operations costs would decrease. In 2047, the toll collection costs would be expected to reduce to about \$79.4 million. As a result, the annual net revenue in 2047 is estimated at \$1.044 billion. The 25-year cumulative total would be \$24.7 billion in net revenue, or an average of 989 million per year.

Table 9
Estimated Annual Traffic and Revenue
(All revenue and Adjustments in 2016 dollars)
(In Thousands)

Year	Estimated Annual Transactions			Estimated Annual Potential Revenue (1)			Revenue Adjustments		Estimated Annual Adjusted Revenue
	E-Z-Pass	Video	Total	E-Z-Pass	Video	Total	Volume Disc.	Leakage (2)	
2023	1,787,821	499,962	2,287,783	\$849,191	\$378,806	\$1,227,998	(61,286)	(80,684)	\$1,086,028
2024	1,810,824	487,880	2,298,704	\$858,692	\$367,605	\$1,226,297	(62,534)	(76,868)	\$1,086,895
2025	1,834,122	476,090	2,310,213	\$868,300	\$356,734	\$1,225,034	(63,808)	(73,363)	\$1,087,863
2026	1,857,720	464,586	2,322,306	\$878,014	\$346,185	\$1,224,199	(65,107)	(70,060)	\$1,089,032
2027	1,881,622	453,359	2,334,981	\$887,838	\$335,948	\$1,223,786	(66,434)	(66,946)	\$1,090,406
2028	1,905,832	442,403	2,348,235	\$897,771	\$326,013	\$1,223,784	(67,787)	(64,011)	\$1,091,987
2029	1,930,353	431,712	2,362,065	\$907,815	\$316,373	\$1,224,188	(69,167)	(61,245)	\$1,093,776
2030	1,955,189	421,280	2,376,469	\$917,972	\$307,017	\$1,224,989	(70,576)	(58,640)	\$1,095,774
2031	1,980,345	411,099	2,391,444	\$928,243	\$297,938	\$1,226,181	(72,014)	(56,185)	\$1,097,983
2032	2,005,825	401,165	2,406,990	\$938,628	\$289,128	\$1,227,756	(73,480)	(53,873)	\$1,100,403
2033	2,031,632	391,471	2,423,103	\$949,130	\$280,578	\$1,229,708	(74,977)	(51,696)	\$1,103,034
2034	2,057,772	382,011	2,439,782	\$959,749	\$272,281	\$1,232,030	(76,504)	(49,648)	\$1,105,878
2035	2,084,247	372,779	2,457,027	\$970,486	\$264,229	\$1,234,716	(78,062)	(47,721)	\$1,108,933
2036	2,111,064	363,771	2,474,835	\$981,344	\$256,416	\$1,237,760	(79,652)	(45,909)	\$1,112,199
2037	2,138,225	354,980	2,493,205	\$992,324	\$248,833	\$1,241,157	(81,274)	(44,207)	\$1,115,676
2038	2,165,736	346,402	2,512,138	\$1,003,426	\$241,475	\$1,244,901	(82,930)	(42,609)	\$1,119,362
2039	2,193,601	338,031	2,531,632	\$1,014,653	\$234,334	\$1,248,987	(84,619)	(41,110)	\$1,123,258
2040	2,221,825	329,862	2,551,687	\$1,026,005	\$227,405	\$1,253,410	(86,342)	(39,706)	\$1,127,361
2041	2,250,411	321,891	2,572,302	\$1,037,484	\$220,680	\$1,258,164	(88,101)	(38,392)	\$1,131,671
2042	2,279,365	314,112	2,593,478	\$1,049,092	\$214,154	\$1,263,246	(89,895)	(37,165)	\$1,136,186
2043	2,308,692	306,522	2,615,214	\$1,060,829	\$207,821	\$1,268,650	(91,726)	(36,021)	\$1,140,904
2044	2,338,396	299,115	2,637,511	\$1,072,698	\$201,676	\$1,274,374	(93,594)	(34,957)	\$1,145,823
2045	2,368,483	291,886	2,660,369	\$1,084,699	\$195,712	\$1,280,411	(95,501)	(33,970)	\$1,150,941
2046	2,398,956	284,833	2,683,789	\$1,096,835	\$189,925	\$1,286,760	(97,446)	(33,059)	\$1,156,256
2047	2,429,822	277,950	2,707,772	\$1,109,107	\$184,308	\$1,293,415	(99,431)	(32,212)	\$1,161,773
25-Year Total	52,327,882	9,465,153	61,793,034	\$24,340,326	\$6,761,575	\$31,101,901	(1,972,247)	(1,270,255)	\$27,859,399
Annual Average	2,093,115	378,606	2,471,721	\$973,613	\$270,463	\$1,244,076	(78,890)	(50,810)	\$1,114,376

(1) Potential Revenue before adjustments for volume discounts and uncollectible revenue (leakage)

(2) Leakage relates to uncollectible tolls, primarily related to non-E-Zpass video transactions, including unreadable plates, incorrect owner address and unpaid billings. The effect of leakage is generally offset by the toll differentials established between E-Zpass and pay by plate transactions. However, since these higher toll rates are included in the potential revenues shown in this table, revenue adjustments are made to avoiding an overestimate of actual collections

Table 10
Estimated Annual Net Revenue
(All Revenue and Cost Estimates in 2016 Dollars)
(in Thousands)

Year	Estimated Adjusted Annual Toll Revenue	Estimated Annual Toll Collection Maintenance and Operating Cost (1)	Annualized System Capital & Replacement Recovery Cost (2)	Estimated Annual Net Revenue
2023	\$1,086,028	\$100,490	\$38,106	\$947,432
2024	\$1,086,895	\$98,700	\$38,106	\$950,089
2025	\$1,087,863	\$97,000	\$38,106	\$952,757
2026	\$1,089,032	\$95,410	\$38,106	\$955,516
2027	\$1,090,406	\$93,930	\$38,106	\$958,370
2028	\$1,091,987	\$92,530	\$38,106	\$961,351
2029	\$1,093,776	\$91,230	\$38,106	\$964,440
2030	\$1,095,774	\$90,000	\$38,106	\$967,668
2031	\$1,097,983	\$88,870	\$38,106	\$971,007
2032	\$1,100,403	\$87,790	\$38,106	\$974,507
2033	\$1,103,034	\$86,810	\$38,106	\$978,118
2034	\$1,105,878	\$85,900	\$38,106	\$981,872
2035	\$1,108,933	\$85,050	\$38,106	\$985,777
2036	\$1,112,199	\$84,280	\$38,106	\$989,813
2037	\$1,115,676	\$83,560	\$38,106	\$994,010
2038	\$1,119,362	\$82,910	\$38,106	\$998,346
2039	\$1,123,258	\$82,310	\$38,106	\$1,002,842
2040	\$1,127,361	\$81,770	\$38,106	\$1,007,485
2041	\$1,131,671	\$81,300	\$38,106	\$1,012,265
2042	\$1,136,186	\$80,850	\$38,106	\$1,017,230
2043	\$1,140,904	\$80,460	\$38,106	\$1,022,338
2044	\$1,145,823	\$80,130	\$38,106	\$1,027,587
2045	\$1,150,941	\$79,840	\$38,106	\$1,032,995
2046	\$1,156,256	\$79,590	\$38,106	\$1,038,560
2047	\$1,161,773	\$79,390	\$38,106	\$1,044,277
25- Year Total	\$27,859,399	\$2,170,100	\$952,650	\$24,736,649
Average Annual	\$1,114,376	\$86,804	\$38,106	\$989,466

(1) Includes all roadside, backoffice and customer service operating costs. Excludes postage for billing of unregistered plate transactions. Assumes small billing fee will be added to charges to cover mailing costs. This fee is not included in the toll charge or the revenue estimates above.

(2) The toll collection system is assumed to need replacement every ten years; hence the annualized recovery cost for the toll system capital cost assumes a 10 year recovery period at a nominal 5% financing cost per year. The Fiber optics communication system is assumed to be amortized over 25 years.

Chapter 6

Tolls Organizational and Administrative Overview

This Chapter discusses the options to provide a toll organization and administrative structure that would be required if the State of Connecticut decides to move forward with a statewide tolling program of its expressways. It would be essential that the State of Connecticut establishes a solid organizational/administrative structure to develop, implement, and manage the toll program to ensure efficiency of the program and to ensure that the State achieves the objectives established for a toll program.

For any tolling program that could be establish in Connecticut, the DOT would contract out the civil, back office and tolling operations and maintenance efforts which is now common practice in the industry, However, the DOT would still need an internal organization comprised of management and staff to oversee these outsourced services and ensure the contractors and system are in compliance with set performance measures. This would also include continued on-going activities once the system is in operation.

Tolling Organization Placement in Connecticut Department of Transportation

Research on how other states administer tolling programs reveals flexibility in how this could be structured in Connecticut. The toll organization should receive appropriate resources and staffing levels to develop and implement the program, manage the toll operations and collection systems, anticipate and address possible challenges, and resolve issues in a timely manner.

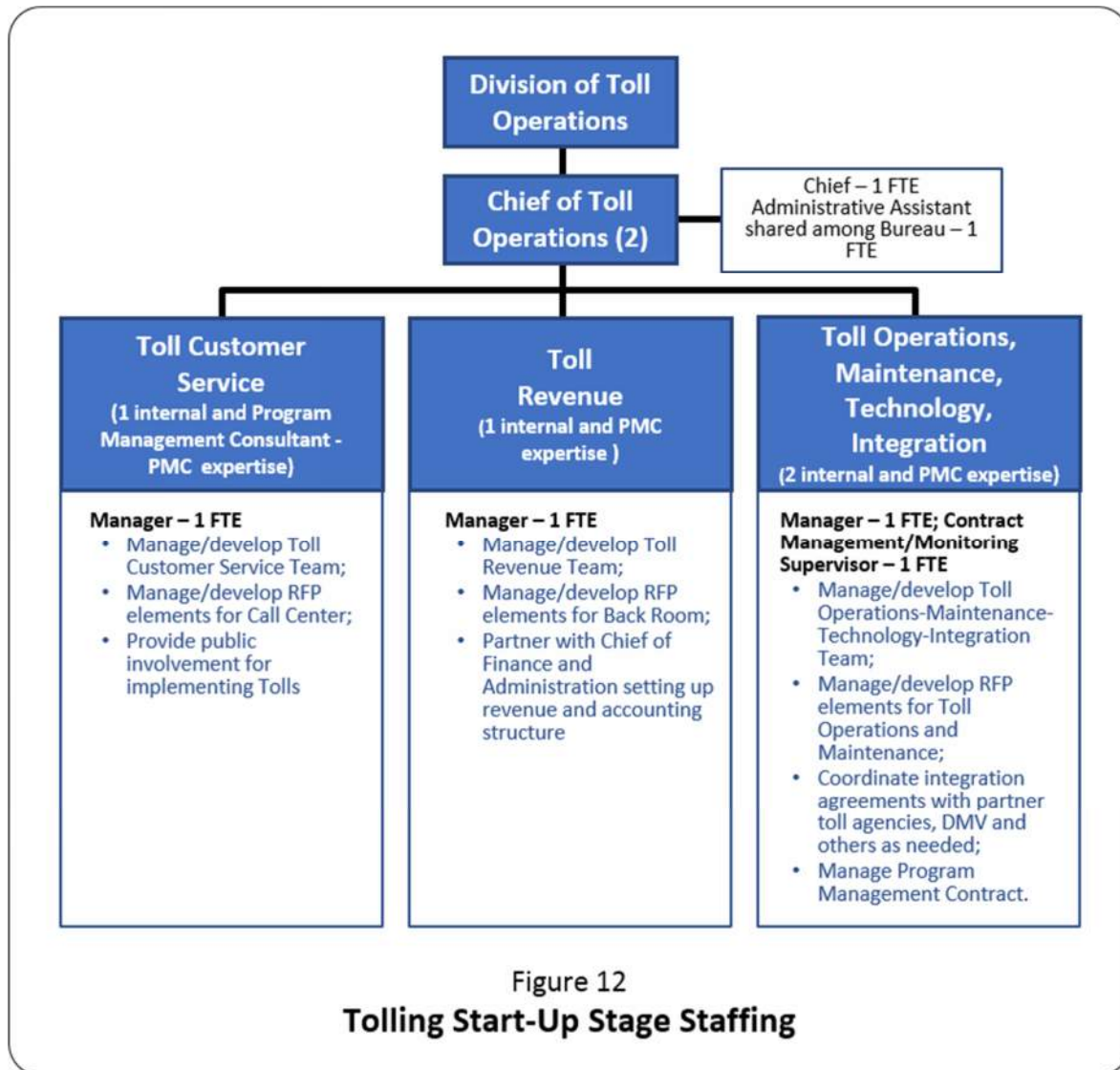
The most common structure at other state DOTs that have established a toll organization with similar functions is a new Division that reports to either an existing Bureau Chief or the Commissioner. There is no right or wrong answer to this decision, but more of a “best fit” for the State of Connecticut. Whatever the structure, the new toll organization would need to interact with all areas of CTDOT management and operations at some point during the life cycle of toll operations.

Start Up Organization and Costs

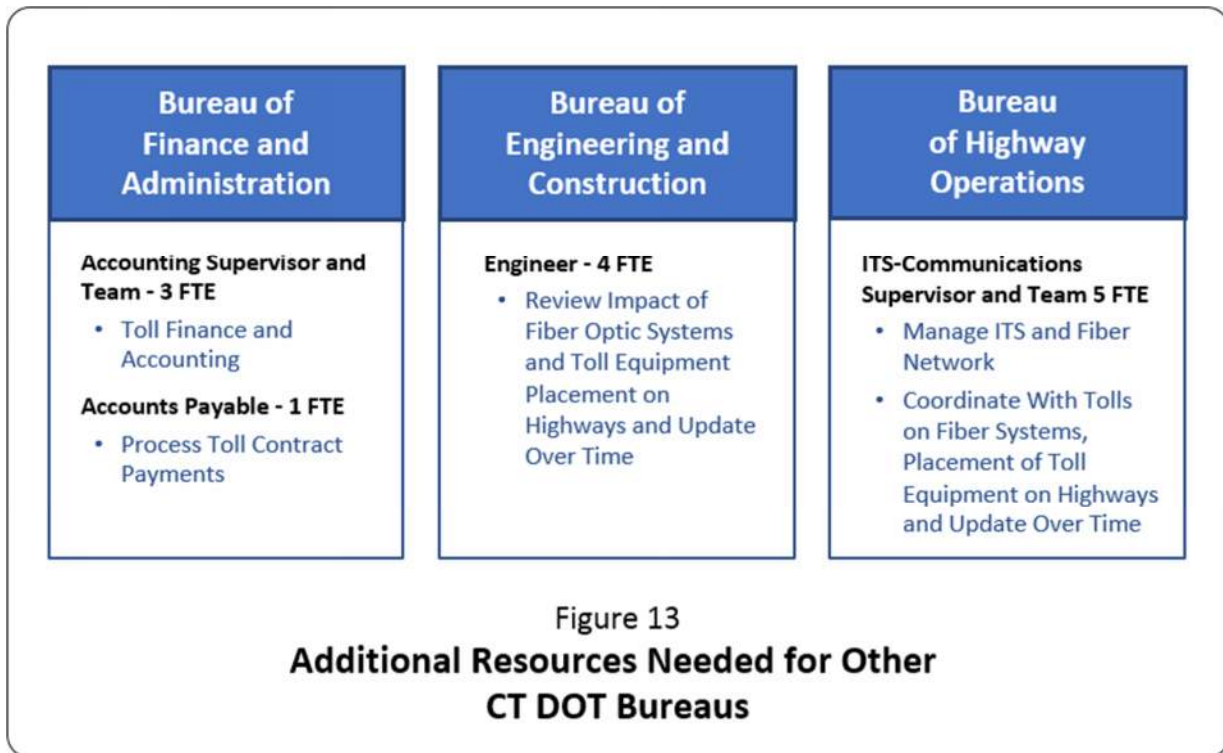
Toll Organization In-House Resources

The early phase in the establishment of a toll program is termed the “Start-Up Stage.” It is during this Start-Up Stage where key decisions would need to be made about the program; however, less overall resources would be required during this initial stage than when the program becomes fully operational. The full annual organization/administrative costs for a toll program outlined in the next section would not start until about six months before the toll program becomes operational. **Figure 12** shows minimum organizational needs of six full-time positions for the Start-Up Stage of the toll program, including a director, an administrative assistant, and four other discipline managers – all to oversee the development and advancement of the major

functions of tolling customer service, toll revenue, and toll operations and maintenance. These annual internal start-up costs are estimated to be roughly \$1.2 million.



Other, existing divisions of CTDOT - such the Bureau of Finance and Administration, the Bureau of Engineering and Construction, and the Bureau of Highway Operations - would also need to staff-up as the toll program is developed and implemented. **Figure 13** shows the number of full time equivalents that would be needed in these other bureaus to support the tolling program. The annual cost to other bureaus is estimated at \$2.0 million.



Start-Up Outsourced Resources

It is critical that the State budget, procure, and contract specialized, third party expertise in toll operations and collections in parallel to building the internal start-up staff. There are firms that specialize in implementing tolling programs that can assist the State of Connecticut in the start-up phase. This support helps to ensure the most efficient, technologically advanced, and cost-effective toll program is developed and seamlessly implemented. This outsourced team can provide expertise when needed to help move the toll program forward at this critical phase. The initial contract would likely last five years, with a total cost of \$15 to \$20 million. The major functions of the outsourced team during the start-up phase would include.

- Develop specifications for the toll operations call center
- Develop specifications for toll operations, maintenance, technology, and integration
- Procurement support to procure the toll operations team
- System testing of the toll operations system provided by the toll operations team.
- Develop standard operating procedures
- Marketing and communications

Ongoing Toll Operations Organization

To be effective there would need to be some level of outsourced resources to provide specialized expertise to the program. The outsourced resources would consist of a major tolling program management consultant (PMC) contract. A decision would need to be made to hire more in-house

staff and less outsourced resources or less in-house staff and more outsourced resources. The study has evaluated both options and provides a graphic summary (**Figure 14**) of the resources that would be needed should the State of Connecticut choose to create a statewide tolling system. The resources shown in Figure 14 assumed more outsourced service and less in-house staff. It might be best for Connecticut to start with this model and if desired build up the in-house expertise over time.

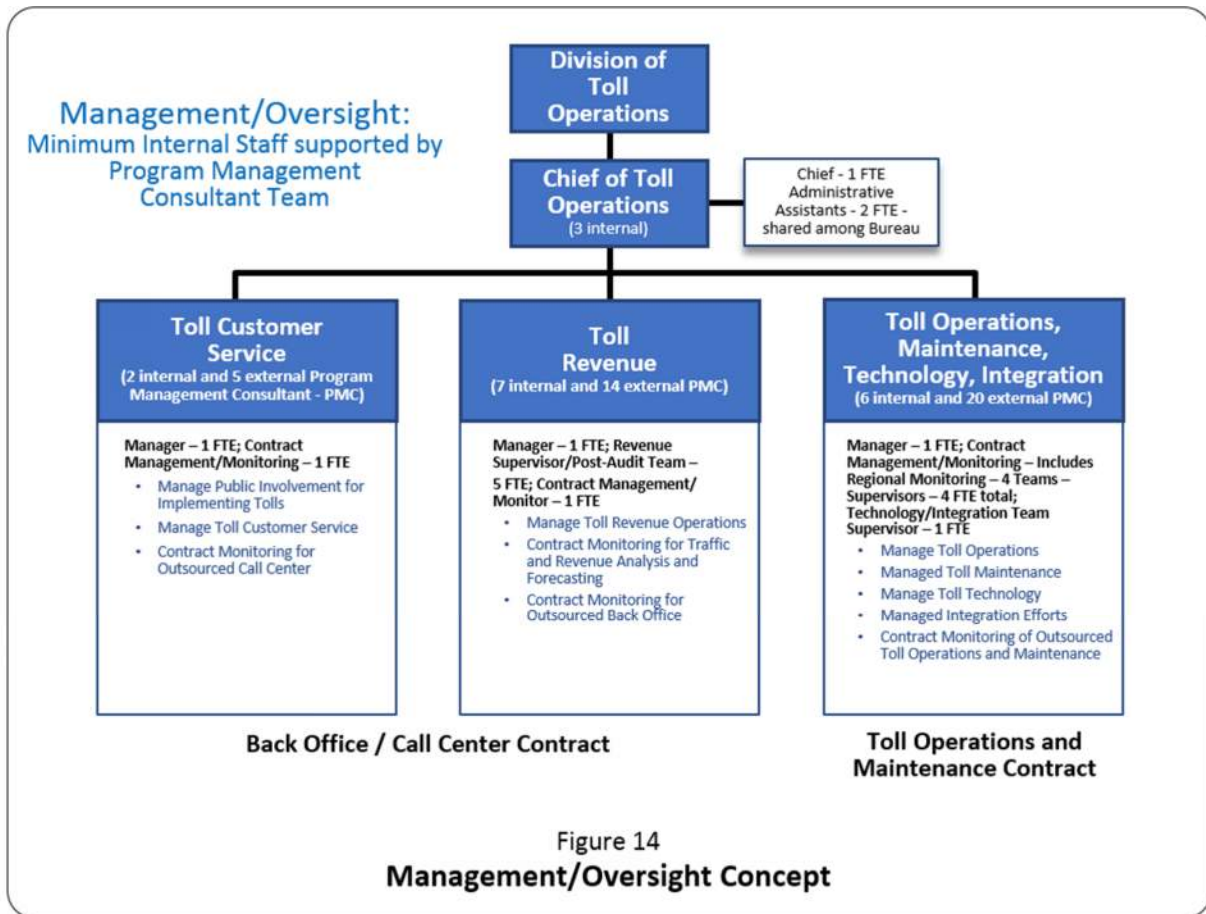
More In-House and Less Outsourced

This option assumes more in-house resources provided by CTDOT and less outsourced resources or private contractor. The major challenge with this approach is it may take an extended time to establish, recruit and hire an in-house staff of public employees with the expertise and compensation required to support a major tolling program. This challenge may lead to a decision against this option initially and then the State of Connecticut could adjust the mix of in-house to outsourced resources in the future as the State learns and grows into a tolling program.

The annual cost for the option of more in-house and less outsourced resources is likely to be higher than the reciprocal setup, primarily because outsourced resources are more flexible and can be scaled up or down quickly depending on needs. In contrast, in-house resources may be harder to scale up and down quickly as needs change. This requires keeping more in-house resources to ensure the toll program operates effectively.

Streamlined In-House and Augmented by Outsourced (Assumed in Figure 14)

This option assumes a streamlined in-house staff at CTDOT augmented by specialized outsourced resources. The major advantage of this option is the outsourced staff levels of the toll organization can be easily and quickly scaled up and down as needed. This is very similar to how CTDOT contracts or outsources professional engineering and construction services for its road and transit capital programs. The average annual cost for CTDOT to manage, operate, and maintain its toll program while relying heavily on outsourced resources would likely be lower than the previous option that relies more heavily on in-house resources. The total full-time staff that CTDOT would need to employ for this option would be 18, costing an estimated \$3.3 million annually. The PMC contract would cost an estimated \$7.5 million annually, resulting in an estimated total cost of \$10.8 million annually for this option.



Toll System Procurement Approach

Public toll agencies typically use the Design-Build-Operate-Maintain (DBOM) procurement process when they do not have the appropriate internal engineering resources or if they desire to cost-effectively contract private parties to manage, operate, and maintain the toll system. This procurement process, which was recently used for the MassDOT AETS and Rhode Island DOT Truck Tolling Programs, allows public agencies to effectively secure long-term warranty support for the toll systems work. When this DBOM procurement approach is used for toll system procurement, toll agencies often secure their toll system and associated operational services for a prolonged term, typically for a 10-year period after system commissioning. Toll agencies typically split the toll system and services into 2 primary contracts:

- The roadside system; and
- The back office system.

A recent trend among public toll agencies is for the toll Design-Build-Operate-Maintain (DBOM) contracts to be led by the toll systems integrator for the roadside contract and the back office system provider for the services contract. Splitting the procurements into these two components provides very little risk to the agency since new toll systems are typically structured with a very

strong demarcation point between the roadside and back office systems. This demarcation point is clearly identified in the toll systems interface control document that dictates the transaction data and file formats to ensure that both systems interface to one another properly.

The roadside system contract would include all the toll equipment and software that would be required from travel lane equipment to a roadside Host system. The roadside DBOM contract would also include required toll systems integrator services such as program management, business rule development, toll system design, software development and integration, factory and field testing, equipment and toll infrastructure installation, maintenance staff training, and commissioning support. This contract would also include civil engineering design of toll gantries and other roadside infrastructure, and oversight of roadway construction activities. A major advantage of this approach is assurance that the civil engineering work is closely coordinated with toll technology and that potential conflicts between the roadway contractor and systems provider are avoided. Under this DBOM contract the roadside contractor is also responsible for ongoing toll equipment and software maintenance as well as operational support of the roadside portion of the system for 10 years.

The second DBOM contract is for the back office system, which includes the electronic toll collection account management, customer service and the video tolling programs. The level of toll operations a public agency can provide is project specific and depends on the organization's ability to ramp operations staff up and/or down quickly as different portions of the tolling project are commissioned. For example, if an agency is planning to open new toll facilities they would need to increase the required staff needed to fulfill new transponder orders and provide additional customer service representatives to answer questions about opening accounts. Based on the complexity of operating toll facilities and customer service centers, most public agencies that operate electronic toll systems elect to outsource the operations to either a back office service provider or a third party system operator who have demonstrated experience in this niche field.

In summary, the Design-Build-Operate-Maintain (DBOM) approach that relies on two, private, specialty services firms provide assurance that the toll system is efficiently designed, developed, tested, operated and maintained since the same contractor is obligated to provide long-term maintenance or operational services. Another benefit of the DBOM approach is the fact that long-term system delivery and operation is under competition at the same time. This approach also enhances competition during the procurement process since some of the toll system integrators do not provide back office systems and/or operational services and some back office providers do not provide the roadside toll systems.

Chapter 7

Travel Benefits, Impacts and Equity Considerations

The potential implementation of all electronic tolling on Connecticut's expressways and parkways is expected to have some level of impact on travel behavior and overall network performance. Some of these impacts would be positive, especially as related to congestion reduction on the heavily used expressways in the state. Other impacts could be perceived as being negative, such as traffic diversions to alternative routes, especially by commercial vehicles.

Experience in other states that have used congestion pricing or value pricing in the form of variable tolling is quite positive. These states report notable shifts in vehicle traffic – shifts of time of travel and shifts of mode of travel from private automobile to public transit or to carpools, for example - would be a particular benefit; but might ultimately require investment in increased parking along commuter rail lines and BRT-type bus facilities.

Equity considerations are also important when considering the deployment of electronic tolling. To some extent, new tolls in Connecticut would result in additional travel costs; some of the economic impact of this would be mitigated by expected, travel time savings and related reduced fuel consumption. However, the impact of new user fees on travel may be more difficult to absorb by lower income individuals and families. This is a particularly important consideration for implementation of tolling under the FHWA Value Pricing Pilot Program (VPPP).

Chapter 7 addresses, in a broad sense, impacts of tolling on the transportation system, with a focus on congestion reduction and time savings for typical commuter trips. In addition, the chapter addresses some potential equity and income considerations, and discusses mitigation strategies which have been used in other tolling applications.

Overview of Potential Impacts

While there is a range of potential impacts of tolling, the study focused on the following:

- Traffic diversions to alternative routes;
- Reductions in congestion on the more heavily used portions of Connecticut's expressway system;
- Overall impacts on state highways, including changes in vehicle miles of travel (VMT) on both tolled routes and untolled routes;
- Changes in overall total travel time on Connecticut's highways, usually referred to as vehicle hours of travel (VHT), including both tolled routes and untolled routes; and
- Environmental justice and equity considerations.

A summary of statewide impacts for each of these categories is provided below. The impact assessments were generally made at 2023 and, in some cases, 2040 levels.

Toll Revenues Could Fund Future Highway Capacity Improvements

The implementation of tolling, and the significant additional revenue generated for transportation investment purposes, would *financially enable* implementation of major, long-range transportation improvements such as facility reconstruction and expressway widening. In addition to the impacts of tolling itself, comparative information is provided at 2040 levels that includes major improvements that would be made possible, in part, by additional revenue generated from tolling.

The timing of these improvements is uncertain. Hence, the potential impact of the improvements was tested only at 2040 levels. In general, the traffic impact analysis was performed under two assumptions at 2040:

- One assuming only the implementation of tolls, as compared with the toll-free condition; and,
- The second assumed implementation of both tolling as well as the most critical major improvements.

Some of these improvements included possible widening on extremely congested roadway segments. As noted below, this would multiply the benefits that would arise from implementation of tolling by providing additional capacity as a further mechanism to achieve congestion relief.

For purposes of this analysis, a limited number of “major” improvements were assumed for the “build” condition at 2040 levels. This is not necessarily all future improvements that would be implemented, and the specific details of these improvements are yet to be defined through more detailed evaluation in years to come. Some of the major improvements assumed to be implemented in the “build” condition include:

- On I-95 West, the most congested route in the state, widening would be done in phases which would start with short targeted widening projects in the short to mid-term. In the long term, this could involve adding a fourth lane from the New York state line to Bridgeport;
- On I-95 East, a third lane would be added in each direction between Exit 55 and Exit 69 in Old Saybrook;
- On I-95 East, the interchange with I-395 would be fully reconstructed and a third lane will be added in each direction from the Connecticut River (Exit 70) through Exit 85 in New London;
- On I-84 West, a fourth lane would be added in each direction between Exits 3 and 8 in Danbury;
- On I-84 West, a major project referred to as the “Waterbury Mix Master” would be implemented, providing three through lanes in each direction on I-84 through the major

interchange with Route 8, as well as relocation of a portion of Route 8 and reconstruction of the entire interchange, a major current bottleneck location;

- Replacement and reconstruction of a portion of I-84 in Hartford, referred to as the Hartford Viaduct, which will improve operating conditions and capacity;
- Improvements to Route 9 in Middletown to remove signalized intersection;
- On I-91, at least one additional lane in each direction in the greater Middletown/Meriden/Wallingford area, near the I-91/Route 15/I-691 interchange; and,
- Replacement of the Putnam Bridge (Route 3) with a new structure that will carry three lanes in each direction.

Congestion Reduction

A primary objective of the potential deployment of variable rate tolls on the Connecticut expressway system is the reduction of congestion. This is particularly true on western sections of both I-95 and the Merritt and Wilbur Cross Parkways (Route 15). Major congestion also typically exists on I-84 in the Hartford area, and in the Danbury and Waterbury areas. Congestion is routinely experienced on some portions of I-91, particularly in the Hartford and New Haven areas and in the Meriden vicinity near the junction with I-691 and Route 15. Finally, congestion is also experienced on I-95 in southeastern Connecticut, although it tends to be related to weekend and summer recreational travel.

Figure 15 presents a graphic depiction of potential peak period speed improvements on the more heavily used and congested portions of the proposed tolled highway network. Five heavily used segments of the system are shown, including I-95 West and I-95 East, Route 15 West, I-84 West, and I-91.

In each case, the graphs provide a comparison of average morning peak-period (6am-9am) speeds, under a toll-free condition, as compared with a tolled condition and finally as compared with a “toll plus improvement” condition; otherwise known as the “full build” scenario. All comparisons shown in Figure 15 are at 2040 levels, with and without the future highway improvements.

In each case, the orange bars depict the anticipated 2040 conditions without tolling or the potential widenings. The speeds reflect the average over the full length of the entire corridor in the morning peak period.

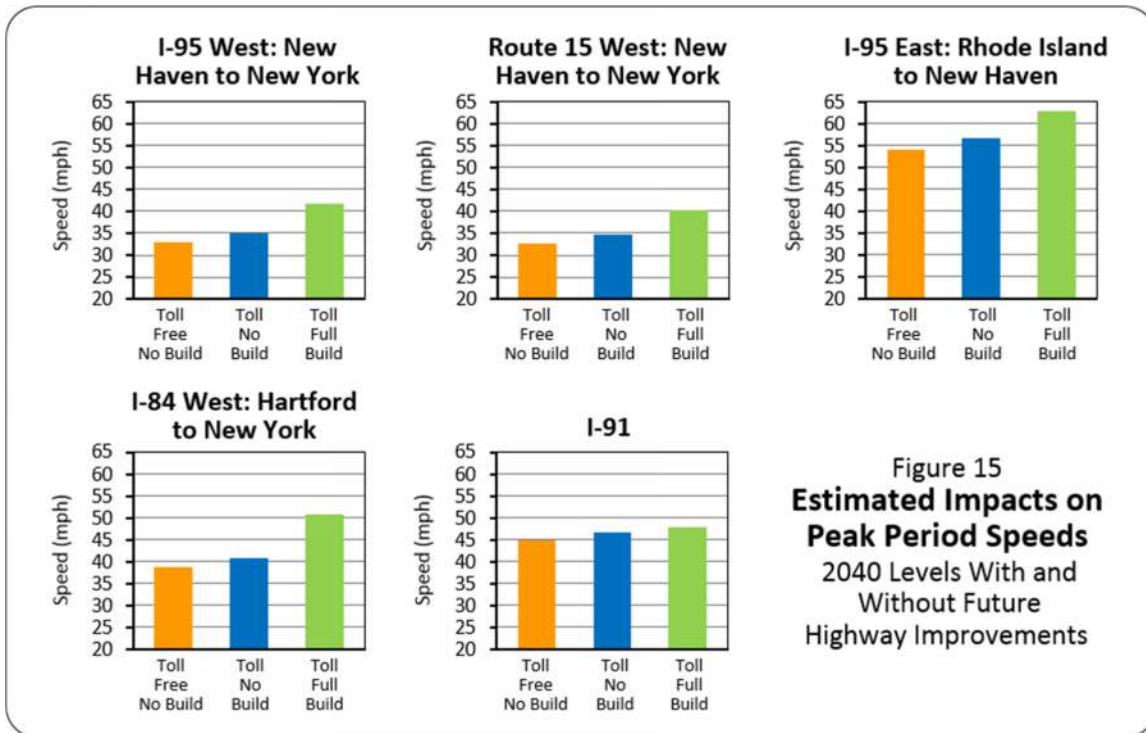


Figure 15
Estimated Impacts on Peak Period Speeds
 2040 Levels With and Without Future Highway Improvements

On both I-95 and Route 15 between New Haven and New York, the average morning peak period speed in 2040 is estimated at about 33 mph. Low average speeds are also shown on I-84, the overall segment between Hartford and New York at about 39 mph, while I-91, over its full length would expect to see an overall average speed in morning peak hours of about 45 mph.

The blue bars depict estimated average conditions in the morning peak hour in 2040 if tolls are implemented. Not all the improvements demonstrated result from traffic diversions to alternative routes. The variable pricing strategy would be designed to encourage some shifts to transit, some trip reductions particularly for discretionary trips, and some changes in when people decide to travel; basically, moving some traffic from the morning peak, for example, to pre- or post-peak conditions where congestion is low.

Significant benefits are shown on the more congested sections of the system. I-95 West, for example, would have average speeds increased from 33 mph under toll-free to about 35 mph with tolls to almost 42 mph with tolls plus widening. The tolls plus widening provides more than a 25 percent increase in speeds as compared to toll free no-build. This improvement in speeds is realized even when considering toll rates are on the very low end when compared with other toll facilities.

Interestingly, Route 15 West (the Merritt Parkway) shows significant speed increases under the full build condition even though there are no major improvements or widenings assumed on Route 15. There is a very significant difference in congestion between the build and no-build condition. This is due to the impact of widening of the parallel I-95, which will not only benefit I-95, but also greatly benefit commuters using the Parkway, primarily between New York and Bridgeport as some traffic would shift from Route 15 to the widened I-95.

Similar patterns are shown for I-95 East, between Rhode Island and New Haven. However, in the absence of expansion, conditions are not expected to be as severe (It is noted that congestion is experienced on eastern portions of I-95 on weekends, which were not modeled in the study), However, the improvements which arise from both tolling and widening are still significant. Similar results are shown for I-84 West, and for I-91. In reviewing I-91 results, most of the congestion reduction results directly from the tolling itself. Capacity expansions under the “build” scenario on I-91 are generally limited to the Middletown/Meriden/Wallingford areas.

Table 11 displays similar information for these five major route sections, and the entire tolled system, in terms of annual hours saved per commuter. On I-95 West, the typical commuter, nominally making about 40 one-way trips per month, will save about 18 hours per year with tolls, and almost 29 hours per year with tolls plus widening. Commuters on Route 15 would save more than 12 hours with tolls per year, and more than 33 hours per year when factoring in the benefits of widening on I-95. That would have an economic value of more than \$800 per year, even assuming a relatively low economic value of \$25.00 per hour.

Most Heavily Congested Corridors	Unit	Annual Hours Saved Per Commuter		Total Annual Peak Hours Saved	
		Tolls Without Improvements	Tolls Plus Improvements	Tolls Without Improvements	Tolls Plus Improvements
I-95 West (1)	Hours	18.2	28.7	2,992,000	4,899,000
	\$ Value	\$455	\$718	\$74,800,000	\$122,475,000
Route 15 West (1)	Hours	12.5	33.2	1,058,000	2,767,000
	\$ Value	\$313	\$830	\$26,450,000	\$69,175,000
I-95 East (2)	Hours	10.9	18.6	1,144,000	2,112,000
	\$ Value	\$273	\$465	\$28,600,000	\$52,800,000
I-84 West (3)	Hours	9.2	18.5	1,759,000	3,421,000
	\$ Value	\$230	\$463	\$43,975,000	\$85,525,000
I-91 (Full length)	Hours	8.8	10.9	1,525,000	1,902,000
	\$ Value	\$220	\$273	\$38,125,000	\$47,550,000
Entire Tolled System	Hours	9.3	14.9	11,929,000	19,240,000
	\$ Value	\$233	\$373	\$298,225,000	\$481,000,000

(1) Between New York line and New Haven
 (2) Between New Haven and Rhode Island line
 (3) Between New York Line and Hartford

On the entire toll system, the average peak-hour commuter would save about 9.3 hours per year of travel time, worth more than \$200. When adding in the effect of improvements to the system, the overall average travel time savings would be about 15 hours per year, valued at about \$373.

The right side of Table 11 shows the total annual peak hours saved by all motorists traveling in peak hours on each of the routes indicated. In total, peak hour drivers on I-95 West would save 3.0 million hours per year, with an estimated value of about \$75 million per year. When adding in the effect of widening of I-95, the 2040 benefit is estimated annually at about 4.9 million hours, valued at more than \$122 million per year. Since the improvements on I-95 benefit both users on that facility as well as the adjacent Route 15 West corridor, total annual peak period time savings for the western corridor are estimated at more than 7.6 million hours, with an economic value (in 2016 dollars) of \$192 million.

Systemwide, the peak period travel time savings due to reduced congestion on all tolled routes combined is estimated at about 12 million hours, with an economic value of \$300 million. When benefits of the improvements are added in, 19 million hours of travel time savings would be realized in 2040, with a value of \$480 million. It is noted that figures in Table 11 only relate to average travel time savings during peak hours. The total net impact in terms of vehicle hours of travel on the entire system for all hours of the day would be somewhat higher than values shown in Table 11.

Overall Network Impacts

While significant reductions in congestion and travel time benefits will accrue to motorists paying tolls on the expressway system, some of the reduction in traffic will result from diversion to alternative routes. Hence, it is important to consider the total impact on a statewide tolling network, on both the tolled routes and on alternative facilities. Systemwide network impacts were estimated at 2023 and 2040 levels for both vehicle miles of travel and vehicle hours of travel.

Importance of Vehicle Hours of Travel (VHT). Vehicle hours of travel is the more important factor since travel time is a measure of traffic congestion. The more congested a section of highway is, the more time it takes to drive through that section.

Estimated Impacts on Vehicle Miles of Travel

Table 12 provides an overall summary of the network-wide impacts on vehicle miles traveled at both 2023 and 2040 levels. All VMT figures are shown in thousands, and reflect a typical weekday condition, except for the right-hand column which provides estimates of annual VMT impacts.

At 2023 levels, the upper portion of the table, a comparison is made between systemwide estimates of VMT under a toll free and a tolled condition. Network VMT estimates are broken out for Connecticut's system of expressways, and parkways (most of which would become part of the tolled system) and all other Connecticut routes. Hence, one would expect a decrease in VMT of the tolled facilities but some increase on non-tolled on the other Connecticut routes, which is confirmed in the information provided in Table 12. VMT on the tolled facilities would be reduced by about 2.5 million miles of travel per day, or 5.4 percent. A portion of this additional mileage, 1.3 million, would transfer to alternative routes, but this would represent just a 2.1 percent increase versus the base case toll-free condition. In total, implementation of tolls in 2023 would reduce total vehicle miles of passenger car travel by about 1.0 percent, or 387 million miles of travel per year.

Table 12
Estimated Impact on Vehicle Miles of Travel (VMT)
(2023 and 2040 levels)

Analysis Year	Vehicle Class	Scenario	Connecticut Freeways, Expressways and Parkways			All Other Connecticut Routes			All Connecticut Network Routes			Annual Net Total VMT Impacts (000)
			Vehicle Miles Of Travel (000)	Net Change From Toll Free VMT (000)	Percent	Vehicle Miles Of Travel (000)	Net Change From Toll Free VMT (000)	Percent	Vehicle Miles Of Travel (000)	Net Change From Toll Free VMT (000)	Percent	
2023	All Vehicles	Toll Free	45,111			63,792			108,902			
		Tolled	42,655	(2,456)	-5.4%	65,109	1,318	2.1%	107,764	(1,138)	-1.0%	(386,950)
2040	All Vehicles	Toll Free	48,767			71,587			120,354			
		Tolled	46,673	(2,094)	-4.3%	72,585	998	1.4%	119,258	(1,096)	-0.9%	(372,497)
		Toll + Improvements	47,174	(1,593)	-3.3%	71,956	369	0.5%	119,130	(1,224)	-1.0%	(416,051)

The lower portion of the table provides similar information at 2040 levels. In this case, however, there are two alternative cases compared with the base “toll-free” scenario. Statewide, VMT on the tolled facilities would be reduced by about 4.3 percent without the planned future improvements. However, if those improvements are also taken into consideration, the net reduction is reduced to just 3.3 percent. There would be some increase in VMT on alternative routes under either case, but the net total reduction in travel is estimated at 372-416 million miles per year.

Estimated Congestion Reduction Impacts (Reduced Vehicle Hours of Travel)

Table 13 provides similar information regarding the statewide impacts on congestion as measured by reductions in vehicle hours of travel (VHT). VHT impacts reflect both the effect of VMT shifts as well as the benefit of improved operating speeds on the tolled facilities. In some cases, traffic diversions to alternative routes may slightly reduce average speeds on those facilities; this is also included in the impacts shown in Table 13. Again, VHT impacts are presented in thousands.

For example, in 2023, total congestion as measured by travel time on the State’s tolled expressways would be reduced by about 74,000 hours per day, or about 8.4 percent. However, VHT on alternative routes would be increased by 34,000 hours, resulting in a net reduction of 40,000 hours per day. This is equivalent to a savings of more than 13.6 million annual hours of travel.

As shown in the lower portion of the table, hourly time savings in 2040 are similar, but higher than in 2023. This reflects changing levels of congestion in both the base case and the alternative toll and toll plus improvements scenarios. The total reduction in vehicle hours of travel are estimated at 17.7 million hours per year, statewide, on all routes combined, under the tolling only condition.

Congestion pricing (peak period tolls) in combination with highway improvements yields nearly twice the congestion reduction benefit of tolls alone. The net congestion reduction for the combination is a travel time saving of about 27.9 million hours of travel time per year. Since most of this reduction would occur during peak traffic periods, it will provide substantial relief to Connecticut commuters.

Table 13
Estimated Impact on Vehicle Hours of Travel (VHT)
(2023 and 2040 levels)

Analysis Year	Vehicle Class	Scenario	Connecticut Freeways, Expressways and Parkways			All Other Connecticut Routes			All Connecticut Network Routes			Annual Net Total VHT Impacts (000)
			Vehicle Hours Of Travel (000)	Net Change From Toll Free VHT (000)	Percent	Vehicle Hours Of Travel (000)	Net Change From Toll Free VHT (000)	Percent	Vehicle Hours Of Travel (000)	Net Change From Toll Free VHT (000)	Percent	
2023	All Vehicles	Toll Free	885			2,205			3,090			
		Tolled	811	(74)	-8.3%	2,239	34	1.5%	3,050	(40)	-1.3%	(13,621)
2040	All Vehicles	Toll Free	1,020			2,550			3,570			
		Tolled	948	(73)	-7.1%	2,571	20	0.8%	3,518	(52)	-1.5%	(17,701)
		Toll + Improvements	905	(115)	-11.3%	2,531	(19)	-0.7%	3,436	(82)	-2.3%	(27,851)

Environmental Justice and Equity Considerations

Equity and environmental justice considerations are always an important factor in evaluating the potential implementation of tolling on existing toll-free facilities. The addition of user fees will increase the cost of travel for some motorists; and this increase may have more significant negative impacts on lower income communities. This is a particularly important factor given that Connecticut is contemplating use of its status as a designated value pricing state to get federal approval to implement tolling. The FHWA VPPP program requires special consideration of environmental justice and income equity implications.

This study does not include an environmental assessment or other formal evaluations of environmental justice considerations, but the report does discuss how some other agencies have attempted to deal with environmental justice and income equity considerations.

The toll approval process also requires some level of environmental assessment. The National Environmental Policy Act (NEPA), and its State of Connecticut counterpart, the Connecticut Environmental Policy Act (CEPA), require federal and state agencies to assess the environmental effects of their proposed actions prior to making decisions on major construction projects and other publicly-owned facilities. Under NEPA and CEPA, CTDOT must evaluate the environmental and related social and economic effects of implementing tolling. CTDOT must also provide opportunities for public review and comment on its evaluations. CTDOT will need to conduct a systematic, interdisciplinary review of the toll proposal as well as reasonable and practical alternative actions, and prepare detailed statements assessing the potential environmental impacts, both positive and negative impacts. Potential factors or impacts to be studied under the NEPA/CEPA assessment of tolling could include:

- **Equity**. Tolls frequently raise concerns about issues related to the fairness (equity) of the distribution of the benefits and burdens of toll costs particularly to the impact of tolls on minority and low-income groups. The impact assessment on this topic will therefore consider Environmental Justice issues related to tolling including the types of effects on minority and low-income populations to determine if the proposed action will cause disproportionately high and adverse effects on minority and low-income populations. CTDOT and the FHWA must ensure that the project includes all “practicable” measures to avoid or reduce potential disproportionately high and adverse effects.
- **Economic impacts of tolling** Examples: costs of toll payments, increased vehicle operating costs, increased costs resulting from using longer or slower routes to avoid tolls.
- **Economic benefits of tolling** Examples: increased revenue to build additional capacity and/or maintain existing transportation systems including transit; reduced congestion and increased capacity of new or existing systems, reduced congestion by spreading out demand and reducing congestion at peak hours; improved reliability of transportation network; improved air quality and reduced greenhouse gas emissions; increased access to job opportunities and increased economic and worker productivity as a result of traffic reductions and easier/faster commutes to work; overall increase in economic development.

- Community impacts, such as traffic diversions and other factors.

Potential Mitigation Strategies for Low Income Users

The CT DOT has not yet developed any recommendations regarding policies aimed at reducing the burden on lower income drivers. This section is just intended to describe some of the ways in which impacts on lower income users could be mitigated.

Some agencies have attempted to introduce programs aimed at mitigating impacts of tolling on low income families. The most common strategy is to eliminate monthly fees, and in some cases up front deposits required for electronic toll collection accounts, such as E-ZPass. This may include waiving the purchase price for a transponder, monthly billing charges and similar strategies to lighten the impact of tolling on lower income families.

In the case of a congestion pricing program such as that envisioned in Connecticut, it may also be possible to establish a “toll credits” program, partially or fully funded from revenues collected from the total vehicle population. In such a case, families below certain pre-established income thresholds might be eligible for the deposit of monthly “toll credits”, such as nominal prepaid toll amounts into electronic toll accounts. This would have the effect of providing a low-income discount for certain drivers.

A variation on this concept would be enabling the purchase of pre-paid tolls at a reduced rate. All E-ZPass accounts would typically be prepaid; often linked to credit cards or other automatic balance replenishment systems. When opening an account, a certain amount of prepaid tolls are loaded into the account, say \$25.00 or \$50.00 in tolls. As the account balance reaches a pre-determined level, tolls are automatically replenished by adding another say \$50.00 into the account. In essence, electronic toll collection typically works on a pre-payment basis.

It might be possible to allow low-income families to procure toll value at a reduced rate. For example, certain low-income participants might be able to purchase \$50.00 in toll value for, say, \$25.00 in actual cost.

A number of strategies like this would be possible. In addition, in establishing the parameters of the E-ZPass system it would be important, to develop procedures for the “unbanked” community. This might include placement of automated kiosks at locations throughout the state allowing cash replenishment for accounts not automatically linked to credit card or bank accounts.

Other Potential Considerations

While not evaluated in this study, there are other potential ideas that could be given consideration if a potential tolling program in Connecticut is further studied. These other considerations may include but are not limited to the following:

- CT resident income tax credits for tolls paid in CT;
- Fuel tax refund for mileage driven on toll roads;
- Truck only tolling;

- Conversion of the High Occupancy Vehicle lanes to High Occupancy Toll lanes; and
- Consideration of other federal tolling programs beyond the current Value Pricing Pilot Program that was assumed for this study.

Chapter 8

Summary and Next Steps

Summary

Connecticut's highways and bridges are aging, in need of repair, and congested. Current transportation revenues are insufficient to maintain the existing infrastructure or make the types of improvements needed to reduce congestion. Gasoline tax revenues have been flat for ten years and are expected to begin declining as cars become more efficient, and as the sales of electric vehicles increase. A new source of revenue is needed that is sufficient to improve the condition of the existing infrastructure and also finance highway improvements that would reduce congestion that clogs our major highways. Tolling is one potential source that could raise sufficient funding.

For the last few years, Connecticut has been considering tolling as a potential new source of revenue to support its transportation programs. The Connecticut Department of Transportation (CTDOT), has conducted several preliminary studies to gain greater insight into how much revenue tolls might raise, and how tolling might also be used to help manage congestion on our busiest highways.

This tolling study evaluated several options to test the viability of All Electronic Tolling in Connecticut. The principal findings of this study include:

- The extent of electronic tolling in Connecticut should be statewide - on all major expressways and parkways. This option would spread the impact of tolling most equitably across the state and would minimize potential traffic diversions to non-tolled expressways.
- Tolls would be collected using an All Electronic Tolling system comprised of 82 overhead gantries constructed throughout the State. This cashless system would not require vehicles to stop or even slow down.
- A pricing strategy should be based on a hierarchy of rates, with higher charges for heavier vehicles, and possibly with commuter discounts for high frequency travel and other discounts available to low-income populations to mitigate equity concerns.
- Toll prices would also vary by time of day. This variable tolling or value pricing approach, where higher toll rates are charged during 'rush hours,' is a proven and effective way to mitigate traffic congestion.
- The toll rate structure presented in this report which would result in a base rate of 4.4 cents per mile (off-peak) for passenger cars, which would be among the lowest in the United States. Higher rates would apply to trucks and other heavier vehicles as well as to vehicles that are not equipped with a Connecticut issued transponder.
- This statewide toll system and toll rate structure would result in almost \$1.0 billion in net annual toll revenue. Slightly more than 40 percent of this potential revenue would be from vehicles from outside Connecticut.

- Revenue from tolling would be dedicated to the maintenance, repair and improvement of Connecticut's transportation network. This infusion of revenue would enable CTDOT to implement many major capital improvements which would result in significant reduction of congestion on Connecticut's major highways.

Next Steps

This report provided findings from recent toll investigations performed by CTDOT. These preliminary studies provide a good overall assessment of the potential of tolling. The reality is, there remains a substantial amount of additional information that would be required to support a future decision by the Legislature on whether to authorize tolls in Connecticut and to obtain the required approval by the Federal Highway Administration to implement tolls. The work that was recently funded by the Bond Commission to fully develop a detailed toll proposal would include the following activities:

Strategic Financial Plan. Develop a 10 to 20-year strategic financial plan with specific programs and projects as well as alternatives for how to fund and finance the operating budget and capital program beyond the current 5-year Special Transportation Fund revenues.

Public Engagement. Conduct extensive public and stakeholder engagement to seek input regarding the electronic toll system and options like toll rates and discounts, gantry locations, and traffic impacts.

Environmental Assessment (EA). Prepare an EA as required by the Federal Highway Administration (FHWA). For tolling projects, FHWA places special emphasis on ensuring that tolls do not create disproportionate impacts on any individual socioeconomic groups, communities, or regions of the state. The EA must fully evaluate these socioeconomic and geographic equity concerns. More generally, it must address the location of tolls, diversion of traffic, congestion relief, and the economic impact of tolls on residents, businesses, and low-income and minority neighborhoods.

Preliminary Design Documents. Prepare the preliminary (30%) design documents needed to support the EA, capital and operating cost estimates, and provide the basis for final design plans should tolling be authorized.

Revenue & Cost Estimates. Develop detailed estimates of toll revenues and toll system capital and operating costs.

Traffic Forecasts. Develop detailed traffic forecasts, congestion reduction estimates, and traffic diversion estimates. Analyze their impacts on residents and businesses.

Concept of Operations. Develop a concept of operations for operating and maintaining the toll system, processing electronic toll transactions, managing toll revenues, and providing customer service.