Connecticut Electronic Tolling and Congestion Pricing Study

draft **final report**

Volume 1: Summary of Findings

prepared for

Connecticut Transportation Strategy Board
Connecticut Office of Policy and Management

prepared by

Cambridge Systematics, Inc.

with

Urbitran, a division of DMJM Harris/AECOM
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Preface

The final documentation for the Connecticut Electronic Tolling and Congestion Pricing Study has three components:

- **Volume 1: Summary of Findings**, which presents key material on tolling and congestion pricing and summarizes the findings of the analysis of electronic tolling and congestion pricing options in Connecticut.

- **Volume 2: Background Report,** which provides details relating to implementation considerations of electronic tolling and road pricing in general on a variety of topics, as well as detailed technical analysis of options in Connecticut.

- **Volume 3: Technical Appendices,** which provides further detail on methodology and results.

This is Volume 1: Summary of Findings

1.0 Background and Concepts

Connecticut is at a crossroads when it comes to looking into the future of transportation finance and congestion relief. The Department of Transportation (ConnDOT) Reform Commission recently explored alternative delivery mechanisms. Connecticut now has an opportunity to rethink how it funds transportation and how it addresses congestion issues. When Connecticut removed its last toll booth in the mid-1980s, the collective impression of I-95 was of long lines of cars and trucks every 10 miles or so waiting for what seemed like forever to use a token worth 17.5 cents. Although no one was excited about having to pay, what really annoyed people was the unsatisfactory experience of stopping so often and the travel-time delays incurred. The deadly crash at the Stratford tolls in 1983 that took seven lives also had a role in tolls being eliminated in Connecticut, as did an agreement with the Federal government to use Federal dollars to maintain and rehabilitate I-95.

Tolling has changed a lot since then. All-electronic tolling is a reality in Toronto, Australia, Chile, Israel, Texas, and California. E-ZPass is in use from Virginia to Maine, and the Port Authority of New York and New Jersey (PANYNJ) is seriously looking at the idea of making their bridges and tunnels entirely cashless. Tolls are no longer about just raising revenue to pay for a new highway, bridge or tunnel – tolls are being used to modify traveler behavior to relieve congestion and fund viable transit alternatives. Implementation of congestion pricing in London is a particularly strong example of how congestion pricing and better transit work hand in glove. In the Northeast United States, the only states without highway tolls are Connecticut and Vermont.

The goal of this study was to prepare a document that lays out as many options as possible with respect to electronic tolling and congestion pricing, sets the context for informed decision-making, and provides a knowledge base with respect to tolls and congestion pricing in Connecticut. In doing so, we cast a wide net for potential electronic tolling and congestion pricing applications in Connecticut, from tolling single lanes to pricing all roads. In evaluating these potential applications, we considered the effects on the transportation system, anticipated toll revenues, implementation costs, financial viability, and a variety of other factors: environmental, economic, equity, safety, and implementation considerations.

From the outset, this study assumed that any future tolls in Connecticut would be done without traditional toll booths at full highway speeds with no stopping or slowing down. This is sometimes called all-electronic tolling (AET) or cashless tolling.

Modern Tolling Technology

Advances in electronic toll collection (ETC) during the last 10 to 15 years have made all electronic tolling (AET) a practical way to collect tolls or implement road pricing strategies. AET requires no manual toll collection booths and instead uses gantries or other technologies to identify vehicles using the toll facility. Once the vehicle is electronically identified, the driver/owner's account can be charged or payment collected in some other way. Tolls are collected without vehicles stopping or slowing at toll booths.

There are three established approaches for all-electronic tolling based upon how vehicles are identified:

License Plate. This approach uses gantry-mounted Automatic License Plate Recognition (ALPR) cameras to identify the vehicle's license plate. No in-vehicle equipment is required.

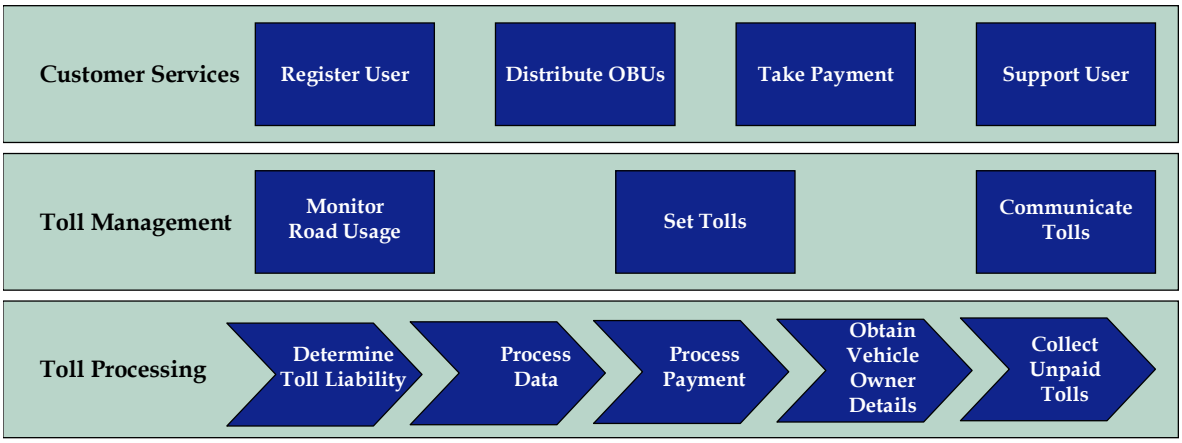
Radio Frequency ID (RFID). This approach uses an in-vehicle transponder (such as E-ZPass) which communicates with a road-side antenna to identify the vehicle. Video recording of license plates (as in ALPR) is used for collection from vehicles that are not equipped with transponders.

Global Positioning System (GPS). Vehicles under this approach are fitted with an on-board unit (OBU) which communicates with GPS satellites to determine its position. No roadside vehicle identification equipment is needed except for sample validation purposes.

All electronic tolling requires three high-level functions: customer service, toll management, and toll processing.

Connecticut is in good company when it comes to thinking about reinstituting tolling. Washington State recently opened the second span of the Tacoma Narrows Bridge – reinstituting tolls in a state that has not had them since 1979, and the State is developing policies relating to whether, when, and how to apply tolling for both revenue and traffic management purposes. Oregon has been experimenting with global positioning system (GPS) technology to allow charging by the mile on all its roads to ultimately replace the motor fuel tax, and also is looking at the policy basis for tolling and congestion pricing. Texas and Florida have made the policy decision that all new capacity will at least be considered for tolling, and the Federal government has been promoting congestion pricing as part of its Urban Partnership initiative. New York City made a serious attempt at instituting a cordon toll around midtown and lower Manhattan, and may return to a modified version of this approach to fund the Metropolitan Transportation Authority's (MTA) huge transit deficit. Minnesota has converted a traditional HOV lane (I-394) in the Twin Cities to a HOT lane (High-Occupancy Toll). At the same time, public-private partnerships involving toll finance have waxed and waned in popularity over the last several years.

Toll Management Functions



Tolling and congestion pricing are in the spotlight, but they are not a silver bullet, and the issues are clearly complex and felt not only at the state level but also locally within a state. Any attempt to change the rules – to change the status quo – must demonstrate substantial improvements, and that there are no significant "losers" to the change. For example, are there alternative roadways that can be used without significantly impacting them and their surrounding uses? Will congestion pricing really reduce overall congestion? Are there transit options available to shift drivers to another mode? Who will benefit most? Who cannot afford to pay, or to shift driving habits? Impacts of pricing on the roads of the 169 cities and towns in Connecticut are of particular importance.

Tolling or Pricing?
What Are We Talking About?

The words "tolling," "pricing," "value pricing," "congestion pricing" and others are sometimes used interchangeably, but they have taken on subtly different meanings in the transportation community. Tolling is a broad term that refers to any kind of direct user fee on highway transportation. Pricing, on the other hand, refers specifically to using the amount of the toll price to achieve some other objective, usually congestion relief or reliable traffic flow.

Although the community of transportation analysts is coming to understand this distinction, this subtlety is usually lost on the general public, who often react negatively to the idea of "pricing" to do anything other than generate revenue.

The first difficulty in talking about tolling and pricing is that not everyone knows what we are talking about. A second difficulty is that people immediately assume they will have to either pay more or find an alternative travel mode, and often have negative feelings to the real or perceived problems with public transportation services. Therefore, any consideration of congestion pricing must recognize the need to study and possibly enhance the public transit network.

1.1 Brief History of Tolling in the United States

Tolling has been used for centuries to finance highways. For example, early road building in the United States relied heavily on private, profit-seeking entities, and the historical remnants of these early turnpikes can be seen in the numerous roads with the "turnpike" moniker. The earliest turnpike in the United States was the Philadelphia and Lancaster Turnpike Road, built in 1795. The State of Connecticut shares in this history and had over 100 private turnpikes from 1790 to 1850.

It was not until the popularization of automobiles in the early to mid-20th century that toll-backed financing gained renewed popularity. Starting with the Pennsylvania Turnpike in the 1930s, state after state embarked on building intercity highways using toll revenue bonds. For the most part, these new highways were developed by special purpose authorities and were financed with bonds backed by the anticipated toll collections. This era of turnpike building extended into the 1950s and early 1960s, but was mostly ended by the advent of the Interstate Highway System begun in 1956 which substituted the motor fuel tax for tolling as the primary means of highway funding. Though some of these early turnpikes paid off their debt and removed their tolls, most still operate as tolled facilities, since the need to upgrade, expand, and extend could be funded through continuing toll collection on the original facilities. The late 1970s and 1980s saw another revival of the toll

financing concept, this time focusing on urban expressways in a few fast-growing areas, where traditional revenue sources were inadequate to meet growing traffic demands.

In the 1990s and continuing into the early part of the 21st century, toll facility development continued, this time enhanced by the promise of electronic toll collection to reduce or eliminate the delays commonly associated with traditional toll roads. Electronic toll collection also opened the opportunity for new concepts in tolling, such as high-occupancy toll (HOT) lanes, express toll lanes, truck-only lanes, cordon tolling, and mileage-based pricing. Innovations are proceeding at a pace, whereby, it soon may be technically feasible to toll a broad spectrum of roads, using global positioning satellites (GPS) or roadside short-range radio methods. Though the more recent activity has been more widespread than that in the 1970s and 1980s, tolling continues to be a solution primarily being done by a few states with intense traffic needs.

The advent of electronic toll collection has broadened the potential policy rationale for tolling. Whereas, the historical use of tolling has been to fund high-cost projects, it can now be used to manage congestion on a network with limited capacity. Economists have long argued that using flat user charges (the gas tax) does not reflect the true value of highway travel under congested conditions. Using price to manage demand is used in the airline, hotel, and telecommunications industries, to name a few. With electronic tolling, managing demand through pricing can now be used in the highway industry, and many regions are starting to move in that direction.

1.2 Potential Policy Drivers for Electronic Tolling and Congestion Pricing

Traditionally, tolling was seen purely as a means to get new bridges, tunnels, and roads built by leveraging the revenue stream from tolls over many years. That historic policy driver remains today. Tolls also are increasingly being seen as a means to supplement tax funding to rehabilitate, maintain, or operate *existing* transportation infrastructure. For example, in the New York City region, both the Port Authority of New York and New Jersey and the Metropolitan Transportation Authority (MTA) use toll revenue to subsidize transit operations. In addition, the Federal government has a demonstration program that would allow putting tolls on Interstate highways for the purpose of reconstructing those highways – although no state has actually done this yet.

Beyond the motivation for funding, there also is a motivation to use congestion pricing as a means of managing demand to reduce congestion. Today, electronic toll collection technology allows tolls to be collected without stopping vehicles and with variable prices to manage demand.

With so many opportunities to use tolling and pricing, it is easy to become confused about what we are trying to accomplish. It is essential that transportation providers begin with a fundamental discussion of what policy drivers will determine what types of toll projects they institute. The two primary policy drivers are funding and system efficiency. Various tolling concepts perform differently in relation to these two policy drivers. Some tolling

concepts are purely driven by the need to generate funding and have no impact on system efficiency. Others perform well at managing transportation system efficiency but generate little net revenue. However, most tolling concepts can support both policies and their relative influence on each depends on the policy decisions made by transportation decision-makers. The various funding motivations and the kinds of projects or concepts that support them are described below.

1.3 Funding Motivation

New Toll Roads, Bridges, and Tunnels

The main motivation for tolling remains to raise funds to build new roads, bridges, and tunnels. These project types are particularly popular in high-growth states like Texas and Florida. These projects require future land use development over time (new urban and suburban growth) with limited existing transportation options. When focused on these types of projects, transportation providers need to determine what type of funding mix will be required to get them built and what they will do with the toll revenues once the project debt has been retired.

There is an active movement to explore a greater use of private equity in funding transportation infrastructure through the use of Public-Private Partnerships (PPP or P3). These arrangements have been widely used in Europe, Latin America, and Australia for some time and are now being adapted in a few cases in the United States.

A private concessionaire paid $1.8 billion in 2006 for the right to collect tolls for 99 years. In exchange, they are responsible for operations, maintenance, and rehabilitation.

P3 typically fall into two categories – brownfields and greenfields. Brownfields[1] are defined by the leasing or sale of an existing tolled asset in return for an upfront payment and are motivated by a desire to monetize an asset. Two recent examples are the Chicago Skyway Bridge and Indiana Tollway. Greenfield projects are defined by the construction of new transportation

[1] The term "brownfield" also is used in the context of land development, referring to the expansion, redevelopment, or reuse of property which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. When used in the context of highway public-private partnerships, brownfields are simply preexisting toll highways that will have a higher than usual private sector component, often involving a long-term concession. There are no implied environmental issues.

infrastructure with private equity and then charging tolls to recoup the private investment. The Dulles Greenway in Virginia and SR 91 in California are widely cited examples of this type of P3.

Transportation System Efficiency Motivation

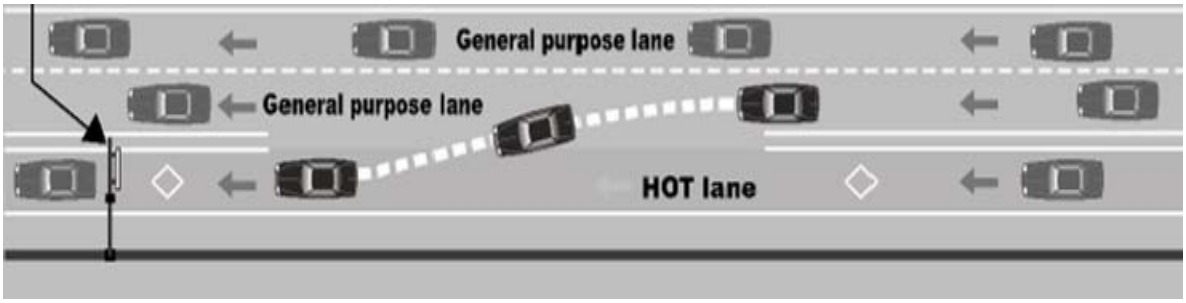
In simple terms, congestion pricing aims to improve transportation system efficiency by charging different rates during different times of day (or based on different real congestion levels) to encourage shifting demand from peak (or rush) hours to off-peak hours, less congested routes, other modes, or to reduced overall travel. The reality can be much more complicated, since pricing one facility can have effects on other facilities and the benefits of pricing may accrue to one population while additional burdens are borne by others.

Congestion pricing typically involves differential tolls, and today there are two ways this is carried out: static and dynamic:

- **Static pricing** works by prepublishing toll rates to let drivers know how much tolls will be at certain times. Toll rates might vary by time of day and/or day of week, but people will know in advance what the tolls will be at any particular time, and can make their travel plans accordingly. Static pricing is technically simple and can manage congestion levels to a predetermined goal based on historical traffic patterns. To maintain their effectiveness the toll rates need to be modified periodically (e.g., monthly, quarterly) to reflect changing travel conditions. Static pricing is particularly suited to bridge or tunnel applications or to applications with no viable alternative route, because they would not have time to respond to dynamic price signals.

- **Dynamic pricing** works by using traffic sensors in the roadway to constantly monitor the traffic flow and adjust toll rates to maintain a particular level of service. This pricing technique is more complex, requires more sophisticated technology, is more expensive to operate, and requires robust communication with the motorist. To be effective, dynamic pricing requires a viable toll-free (or lower toll) alternative so that drivers can make split-second decisions as to whether to pay a toll or not.

When motivated by the system efficiency goal, the simplest toll project to implement is the conversion of high-occupancy vehicle (HOV) lanes to high-occupancy toll (HOT) lanes as was recently done in Minnesota. HOT lanes are just one kind of "managed lane" that involves tolling. Others are "express toll lanes" and "truck only toll lanes." As a group, these might all be called tolled managed lanes. Regardless of the specifics, all toll managed lanes depend for their success on significant congestion in the adjacent nontolled lanes, because toll-paying customers are paying for time savings and reliability. If there is no congestion in the "free" lanes, there is not much reason to pay a toll to use the managed lanes, even at a low price. The revenue-producing potential of most HOT lanes, therefore, is limited to peak periods in the peak direction.



HOT lanes are a type of managed lane where drivers that are not usually eligible for carpool lanes (e.g., people driving alone) can use the lanes for a price.

An additional benefit of express toll lanes is the ability to allow for buses, or bus rapid transit (BRT) vehicles, to operate inside these lanes. There also is the potential for excess toll revenues to be used to subsidize the operation of the BRT.

Multiple Motivations – Funding Plus System Efficiency

The majority of toll and pricing concepts have motivations that satisfy both the need for additional funding and achieve system efficiencies. How well they respond to the two goals depends on how toll rates are set and what provisions there are for free travel by HOVs and transit service. Examples of projects with multiple motivations include the following:

- Construct New HOT Lanes;
- Construct New Express Toll Lanes;
- Pricing Existing Highways;
- Cordon or Area Tolling; and
- Mileage-Based Pricing.

2.0 Concepts and Criteria

2.1 Electronic Tolling and Congestion Pricing Concepts Studied

The Cambridge Systematics team presented a comprehensive menu of potential opportunities for electronic tolling and congestion pricing in Connecticut to staff of the Office of Policy and Management (OPM) and Transportation Strategy Board (TSB). Since Connecticut's planned transportation improvements do not include substantial new highways, bridges, or tunnels that could be tolled and Connecticut's urban areas do not have (and are not forecast to have) the level of intense urban congestion that would warrant congestion pricing, certain tolling concepts were dropped from further consideration: **constructing new toll roads, bridges, or tunnels** and instituting **cordon pricing** in urban areas. By urban congestion and cordon pricing we mean pricing entry into a specific urbanized area such as is done in London and was proposed for Manhattan. Connecticut does have specific congested highways in urbanized areas and several of the tested concepts evaluate tolling these roadways.

A wide variety of tolling concepts for evaluation still remained, however, to provide a solid basis on which future discussion and decisions could be made. The following concepts were selected for analysis:

Funding Motivation

- **Concept A: New Toll Express Lanes.** These would involve building new lanes and tolling just the new lanes as express lanes:
  - **A-1: Interstate 95 –** Branford to Rhode Island State Line; and
  - **A-2: Interstate 84 –** Waterbury to New York State Line.
- **Concept B: Border Tolling:** Toll All Limited Access Entry Points into Connecticut.
- **Concept C: Truck-Only Tolling**. Toll trucks on All Limited Access Facilities (Interstates 95, 84, 91, 395, 691, 291 and State Routes 2, 8, and 9).

Transportation System Efficiency Motivation

- **Concept D: HOV to HOT Lane Conversion:**

- **D-1: Interstate 84 –** East of Hartford; and
- **D-2: Interstate 91 –** North of Hartford.

Multiple Motivations – Funding plus System Efficiency

- **Concept E: HOT Lane Conversion of Existing Shoulders on Limited Access Facilities.**
- **Concept F: Toll Individual Highways Needing New Capacity:**
  - **F-1: I-95 –** Branford to Rhode Island State Line; and
  - **F-2: I-84 –** Waterbury to New York State Line.
- **Concept G: Statewide Tolling:**
  - **G-1: Toll All Limited Access Facilities** (same facilities as Concept C plus Route 15)**;** and
  - **G-2: Tax All Vehicle Miles Traveled in the State.**
- **Concept H: Congested Corridor Pricing –** I-95 and Route 15 between the New York border and the Bridgeport area.

2.2 Evaluation Criteria

All of the evaluation was done using sketch-level techniques using broad assumptions, readily available data, and spreadsheet tools. The intent is to provide a sense of the likely revenue, financial implications, traffic effects, and other factors so that Connecticut's elected officials can make informed decisions as to whether any of these concepts deserves more detailed project-level analysis. To aid in the evaluation, the study considered these evaluation criteria:

Transportation Impacts and Revenue

This considered the overall impact on congestion in the corridor (both on the tolled route and on parallel alternative routes) as measured by average vehicle hours and miles of travel (VMT/VHT) and speed, and included the impact of diversion from tolled to non-tolled routes; the resulting volume on the tolled routes and the revenue which would be generated from tolling. The study also considered any potential diversion to transit, the adequacy of transit services in the corridor for handling diversion, and any impacts on these services. All costs and revenue (including toll rates) were assumed to increase with inflation at the rate of three percent annually.

Implementation Schedule and Costs

The team considered the timeframe for implementing the concept and the costs, including installation of the tolling system, any new roadway construction required, and costs of operating, maintaining, and rehabilitating the tolling system.

Financial

The preliminary financial analysis combines the revenue and cost numbers to look at the overall financial performance of the concept over a 30-year period from 2015 to 2044. Since there are so many ways that a particular project might be financed, the analysis was kept simple, comparing the present value of the revenue stream minus the present value of operating, maintenance, and rehabilitation costs. This represents the revenue available for project delivery – either on the highway being tolled itself, or somewhere else. This provided a baseline from which to make other observations for projects that might be financed through revenue bonds or public private partnerships relating to the additional costs of financing. More detailed financial forecasts in five-year increments are provided in Volume 2.

Environmental, Economic, and Equity Impacts

Our team analyzed the likely impacts of each concept on several of the standard environmental factors used to assess major infrastructure investments under Federal and state environmental laws such as air quality, noise, water quality, energy use, environmental justice, community disruption, cultural/historic resources, and bicycle/pedestrian travel. The team also considered economic impacts to individual toll payers and the broader economy of the region where the tolls are implemented and/or the State as a whole. Any concerns about equity – the degree to which the economic impacts are distributed fairly across different categories of payers and/or regions of the State, and in particular the impact on low- to moderate-income residents – also were considered.

Safety Impacts

We considered the potential impact on roadway safety, and in particular, the impact of traffic diversion away from tolled highways onto nontolled local routes.

Implementation Issues

Four types of implementation issues were considered in the evaluation of each concept. These are described below:

- **Legal/Institutional –** The underlying legal and institutional framework for implementing the concept are presented, including Federal and state laws, regulations and policies.

- **Public/Private Partnerships –** The potential for the alternative to be implemented to one degree or another through a public/private partnership is assessed. This consideration is analyzed separately from the underlying fundamental considerations of who should pay and which projects should go forward.

- **Privacy –** Privacy issues are typically raised regarding the means of collecting, retaining, and sharing of the personal information collected in the implementation of electronic tolling. These issues can typically be mitigated to the extent that travelers have viable choices as to whether to use tolled roads or alternative routes or modes, and that data confidentiality is protected. It also should be noted that many Connecticut drivers already use the E-ZPass electronic tolling system to drive in neighboring states.

- **Public Acceptance –** There are many factors which go into assessing whether the public will accept tolling, including the extent to which the tolls are linked to specific transportation improvements and can or cannot be used for other purposes; perceptions of equity and simplicity; the extent and impact of traffic diversion from the tolled routes; and availability of alternative routes and modes.

3.0 Major Findings

There was a time in the 18th and 19th century when virtually all major roads in Connecticut were toll roads. In modern times, the Connecticut Turnpike, Merrit and Wilbur Cross Parkways, and several bridges were built and financed through tolls. Since these roads and bridges were opened initially with tolls, people factored in the cost of the toll as they made home and work location choices, and when they decided to go shopping or visit friends. Sometimes, it made sense to pay a toll, and sometimes it did not, but either way, everyone knew the rules, and could plan accordingly.

Connecticut has been without tolls for two decades. Like all states, Connecticut is short of money and struggles with congestion on some of its highways. The advent of electronic tolling has caused people to reconsider whether tolling might have a place in Connecticut again, either as a way to fund needed improvements or through a new idea called congestion pricing. This study was commissioned in order to determine whether there are tolling or congestion pricing options that make sense for Connecticut.

A complicating aspect of this study is that Connecticut is not building much in the way of new highways or bridges, nor is likely to do so in the future. With only a few exceptions (such as HOT lanes or express toll lanes) this means that any new tolling or congestion pricing would entail putting tolls on roads that had previously been toll free. This makes matters complicated, because this changes the rules. Housing and work location decisions that had been made with one set of rules now would have a different set of rules. Although the net result of a tolling or congestion project may be positive, there are likely to be perceived winners and losers particularly in the short term before the benefits of the toll revenue can be realized through improvements to the transportation system. And the rules might change for some people (in one corridor, for example) and not for others. In some cases, the question of how toll revenue is spent (for example, on highway and/or transit improvements on a specific facility or region) can compensate the losers, but current laws may hinder the State's ability to broadly redistribute toll revenue. Short-term impacts caused by diversion from tolled to untolled routes may reach a new equilibrium over time as people adjust their lives to the new rules, but the short-term impacts will be seen as real enough.

Volume 2: Background Report contains a detailed treatment of each of the tolling concepts that the consultant team studied across each of the evaluation criteria described above. We have condensed the Volume 2 details into two-page summaries of each concept in Section 4.0 of this *Volume 1: Final Report.* The following summarizes the major findings of the study across the concepts, particularly in regard to the extent in which they meet the two primary drivers of tolling policy – funding and transportation system efficiency.

A Few Concepts Have Little to Recommend Them

A few of the concepts we studied just do not work financially even under the least stringent measures, have little policy rationale, or would be very difficult to build.

New Toll Express Lanes on I-95 and I-84 (Concept A) would be a way to implement projects that have been in planning for years but with no money to do so. Some places have considered adding new lanes and tolling just the new lanes to help defray the costs of construction and/or provide an uncongested alternative to people who really need to be somewhere on time. In the case of I-95 and I-84, however, there would not be enough congestion to convince enough drivers to pay a toll to make this concept worthwhile. Our analysis found that this concept would not generate enough revenue to pay for toll collection costs, much less contributing to the capital cost of constructing the new lanes. It also would have minimal congestion relief benefits.

Tolls on All Trucks on Limited Access Highways (Concept C) is based on the belief that trucks cause much more damage to highways than they pay in taxes, and this would be one way to recoup the costs. Germany successfully rolled out a truck-only toll concept on its Autobahn system a few years ago in order to address the issue of Eastern European trucks passing through without paying taxes. This concept could raise a considerable amount of money, albeit at a relatively high cost of collection (compared to the motor fuel tax). Although Connecticut has a lot of through truck traffic, truckers do pay their share of motor fuel taxes through the International Fuel Tax Agreement system. Also, despite the expectation that few trucks would divert from the limited access highways to local roads (since the local roads are so much slower, and truckers values of time are considerably higher than automobile drivers), the small number of trucks that do divert would create negative impacts on the communities through which they travel. Also, state and national trucking associations have vigorously opposed truck-exclusive tolling.

Conversion of Highway Shoulders to HOT Lanes (Concept E) is aimed at increasing the capacity of highways by converting shoulders to regular lanes and instituting active traffic management to close lanes when necessary due to incidents. This idea is being considered in more and more places. We considered this option in the I-95 corridor in southwest Connecticut, but found that it had severe constructability issues and, therefore, did not do more extensive analysis in this report.

HOV to HOT Lane Conversions Would Be Relatively Easy to Implement, but The Finances Are Tenuous

In trying to implement **HOV to HOT lane conversions (Concept D),** the existing HOV lanes in the Hartford area already are well laid out for HOT lanes. The HOV lanes are physically separate from the general purpose lanes and there are dedicated transition zones between the lanes. However, for HOT lanes to be successful, traffic in the general purpose lanes needs to be severe for long enough each day for some people to be willing to pay a premium to use them. While most HOT lanes do not recover the cost of

constructing the toll equipment, they are typically expected to at least cover the operating and maintenance costs of toll collection. Our analysis found that neither I-91 nor I-84 would generate enough revenue to cover collection costs, although I-91 came closest. If costs could be lower than we estimated, or revenues higher, the I-91 conversion could potentially be viable. The analysis does show meaningful improvements in delay reduction, and there would be no significant negative impacts. Since no one has to use the lanes if they do not want to, and there is no reduction in existing capacity, there would typically be little public opposition to a HOT lane, although if it requires significant public funds to construct, reasonable questions about whether HOT lanes are the best use of public money could be raised, and should be evaluated if a HOT lane is to move forward.

Tolling Existing Highways Without Making Specific Improvements Can Raise a Lot of Money, but Will Entail Considerable Impacts and Opposition

Border tolling on all limited access highways (Concept B) would raise significant revenue, but would do little to improve congestion in the corridor unless the revenues were invested in projects that provided such benefits. Although the percentage of vehicles that would choose to avoid the tolls would be relatively small, these small amounts would have considerable impacts on local traffic conditions at many of the border locations. This concept would raise the cost of traveling, and there could be economic impacts in the vicinity of the borders, as well as geographic equity impacts related to people near the borders bearing the burden for revenue while those in the center of the State are less affected. There also are current legal restrictions on how the money would be used (Federal law dictates that toll revenue on existing Interstates must be spent on that highway), and there could be U.S. constitutional challenges through the Commerce Clause that might or might not have merit, depending on the specifics of implementation. Both Massachusetts and New Hampshire are actively considering additional border tolls.

Tolling All Limited Access Highways (Concept G-1) also would raise quite a bit of money at moderate toll rates, but Federal law currently would limit the use of that revenue to the highway on which it was collected. This concept did not anticipate specific construction projects on the highways. Because the toll rates are lower and spread out over the entire highway system, the diversion amounts at the toll rates evaluated are not likely to be large enough to cause significant traffic impacts. There could be economic and equity impacts related to the increasing cost of travel, but these might be mitigated by the spending of the revenue appropriately. The revenue from this concept could be used to reconstruct or improve the specific tolled roadways.

Tax All Vehicle Miles Traveled (VMT) (Concept G-2) is a radical change in the way transportation would be financed and is likely to become part of a spirited national debate in the next couple of years focused around the reauthorization of Federal transportation legislation. This concept is basically a charge on all vehicle miles traveled (VMT) in the State. It has not been implemented anywhere but a small demonstration project has been conducted in Oregon.

Tolling Existing Highways to Pay for Highway Widening Can Pay for or at Least Offset the Cost of Improvements, but The Toll Itself Could Cause a Reduction in Demand that Reduces the Need for The Improvement

Toll Individual Highways Needing New Capacity (Concept F) is similar to Concept G-1, except the tolls are tied explicitly to a major improvement. We looked at the same corridors as in Concept A: I-95 from Branford to Rhode Island and I-84 from Waterbury to New York. With relatively low toll rates, the diversion to parallel roads can be kept to a minimum, but revenues also are lower. These lower rates might not be enough to fully fund the improvement project. Although the higher rates would raise more money, diversion impacts would be greater, and may be enough to reduce the need for the improvement itself. Unlike some of the other tolling concepts on existing highways, existing Federal rules would allow use of toll revenue for reconstruction and rehabilitation, as long as Federal permission was achieved. However, there would be some restrictions on retolling the portion of I-95 that had been the Connecticut Turnpike from the New York border to New London.

Corridor Congestion Pricing is a Difficult Challenge

We selected the most congested corridor in the State (I-95 and Route 15 between the New York border and Bridgeport area) and tried to devise a congestion pricing concept that would mitigate the congestion problems without expansion **(Concept H).** Ideally, congestion pricing would apply pricing in such a way to eliminate congestion. In our evaluation of this corridor, however, we found that achieving this objective would be virtually impossible during many time periods. Therefore, we set toll rates that could achieve a 10 percentage-point reduction in the volume/capacity ratio on the tolled highways, and evaluated the revenues and impacts that this concept would produce. This concept would raise $32 billion in revenue in excess of the cost of tolling (there are no construction costs). Significant roadway diversion would occur to roads that are unable to accommodate them, and there would be some diversion to transit, with the primary concern being the ability of park-and-ride lots to handle the additional demand. These diversion levels would raise economic, environmental, equity and safety concerns in the impacted communities.

4.0 Summary of Electronic Tolling and Congestion Pricing Concept Evaluations

Short summaries of the implications of each of the concepts studied by the project team are provided on individual sheets on the pages that follow.

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Concept A: New Toll Express Lanes

Toll express lanes are new tolled lanes that are operated adjacent to existing untolled lanes. They are tolled based on congestion levels. Express toll lanes are physically identical to High-Occupancy Toll lanes (Concept D) with a simple policy difference. With express toll lanes – all users pay. There is no reduced toll rate or free ride for certain classes of vehicles or occupancy levels. Two possible project locations were identified under this concept for study:

1. A-1: I-95 between Branford and the Rhode Island line; and
2. A-2: I-84 between Waterbury and the New York line.

These corridors were selected because they are the subject of current studies considering widening. Neither has the sustained high levels of congestion needed for the financial success of tolled express lanes operating in parallel with free general purpose lanes. **These lanes would not be expected to generate sufficient revenue to pay for the operating cost of toll collection**, much less the construction costs of the toll collection system or the lanes themselves. Although financial performance should not be the only measure of whether a project should move forward, in this case, the financials are so poor that further consideration would need a compelling public benefit – a benefit that we do not find.

Transportation Impacts (Highway and Transit)

Neither corridor has substantial traffic congestion beyond the usual commute peaks, and during tourist-oriented weekend travel, at certain bottleneck points. We would expect the I-95 project to result in a 6.2 percent reduction in vehicle hours of delay over the course of a year in the corridor over a condition without the new lanes at all. On I-84, a 13.8 percent reduction could be expected. We have not done a comparison to building the new lanes as general-purpose lanes without tolls. Since both projects involve additional capacity on the highway, we would not expect to see any negative impacts due to diversion to other parallel routes, nor to transit services. The express toll lanes would provide a congestion-free route for express bus service in the corridor.

Implementation Schedule

These projects require significant roadway work and would not be expected to be **open to traffic until 2020**.

Financial Summary

Neither project is expected to produce net revenues that exceed even the annual cost of toll collection over the course of a 30-year period.

Financial Summary (Millions of 2008 Dollars) Concept A: Express Toll Lanes	A-1: I-95	A-2: I-84
Present Value of Net Toll Revenue	(98.0)	(37.0)
Initial Capital Cost of Toll Collection System	91.6	60.5
Total Highway Construction Costs	1,366.1	371.0
Life-Cycle Surplus/(Shortfall)	**(1,555.7)**	**(468.5)**

Environmental, Economic, Equity, and Safety Impacts

There are minimal economic, equity or safety concerns with these projects because motorists will still have the choice to drive in the adjacent general purpose lanes for free and the new tolled express lanes would be constructed to current design standards. A marginal environmental benefit may be realized associated with improved air quality resulting from the small decreases in congestion at peak travel times of the day.

Legal and Institutional, Public Private Partnerships, and Privacy Issues

Express toll lanes are mainstream Federal policy today, so the legal and institutional issues are minimal. Privacy is of limited concern because there are toll-free options that are no worse than they are today, and people are not forced to use electronic toll collection. A public private partnership involving financing would be unlikely to be viable because of the negative cash flow. A public private partnership involving life-cycle project delivery, such as design-build-operate-maintain, could be viable if the project were to advance, as a way to mitigate construction risk. This approach would be independent of the financing of the project.

Concept B: Border Tolling at Major Highways

This concept involves putting tolls on all limited access highway border crossings for the purpose of raising revenue. We tested automobile toll rates of $1, $3, and $5, with proportionately higher tolls for trucks to gauge the amount of revenue that could be collected and the transportation impacts that would result. If this concept were to move forward, the toll level could be customized to achieve the revenue target desired while considering the potential adverse impacts of diversion. **This project would raise significant toll revenue but do little to improve overall congestion in the corridors. However, if the toll revenue were used effectively, there could be other transportation system benefits achieved that were not evaluated in this study.**

Transportation Impacts (Highway and Transit)

While overall levels of traffic diversion to alternate routes would be small relative to total volumes on the limited access highways, **the impacts will be significant on certain local traffic conditions**. The highest percentage of vehicles will divert at the more rural crossings at the Massachusetts and Rhode Island borders, but the greatest number of vehicles will divert at the more congested crossings on the New York border in southwestern Connecticut. Higher toll levels significantly increase diversion volumes. No large amount of transit diversion is forecast

We estimated the impact of traffic that would be expected to divert off the main highway on the alternative routes. The diversion numbers reported below uses the potential impacts to Toll Level 2 car ($3) and truck tolls in 2015 as an illustrative example of likely impacts under this tolling concept. All daily and hourly figures are for total diverted vehicles in both directions combined.

Location	Diversion, Vehicles Per Day
I-95 at New York Border	About 14,000 vehicles per day
Route 15 at New York Border	About 5,200 vehicles per day
I-84 at New York Border	About 13,800 vehicles per day
I-91 at Massachusetts Border	About 1,000 vehicles per day
I-84 at Massachusetts Border	About 8,100 vehicles daily vehicles
I-395 at Massachusetts Border	About 6,900 vehicles would be diverted
Route 6 at Rhode Island Border	Less than 630 vehicles would be diverted
I-95 at Rhode Island Border	About 10,500 vehicles would be diverted

Implementation Schedule

Putting tolls on existing highways has never been done before, and as a result, the pre-implementation tasks associated with gaining consensus, legal, and regulatory authority to move forward are likely to be considerable. The technical requirements are reasonably simple, being related simply to toll collection, thereby reducing the design, build and testing tasks (compared to some of the other, more extensive concepts).

Financial Summary

Since this concept involves tolling existing highways with no specific road improvements, revenues are well in excess of all costs under all toll levels.

Financial Summary (Millions of 2008 Dollars) Concept B: Border Tolling	Automobile Toll $1.00	$3.00	$5.00
Present Value of Net Toll Revenue	4,048.0	12,495.5	19,738.1
Initial Capital Cost of Toll Collection System	264.7	248.3	226.7
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	**3,783.3**	**12,247.2**	**19,511.4**

Environmental, Economic, Equity and Safety Impacts

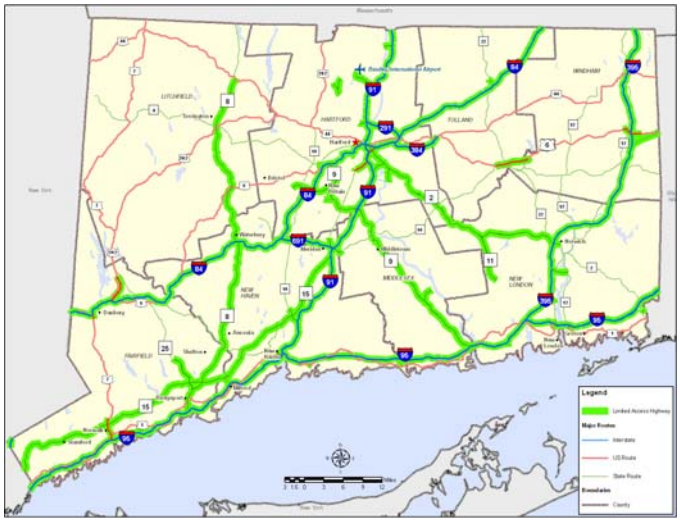
These impacts are potentially considerable. Traffic diversion to local routes could have negative impacts on water and air quality, community ambiance, bicycle and pedestrian safety and quality, noise, energy consumption and cultural/historic resources. From an economic and equity perspective, travelers in the border regions would incur most of the costs and impacts, but few of the benefits. This could significantly disadvantage these regions of the State. Safety issues might arise on the diversion routes given the increases in volume, particularly among trucks.

Legal and Institutional, Public Private Partnerships, and Privacy Issues

The primary legal/institutional issue is that current Federal law requires that revenue from tolls on existing Interstate highways be used to improve the highway on which it is collected. Therefore, using border tolls as a mechanism for general transportation improvements would not be allowed, at least on the Interstate border crossings. However, these roadways traverse long distances through the State and the revenue could presumably be used anywhere along the route. The project also could violate the Commerce Clause of the U.S. Constitution, although a final determination on this would depend on how it was implemented, and only come after a court challenge. It should be noted that both Massachusetts and New Hampshire also are actively considering border tolling strategies.

This project has significant positive cash flow with little initial capital costs, which would make it a tempting opportunity for a long-term concession type PPP. With demonstrated traffic streams, the future toll revenue potential is significant, and not at high risk. Private companies would be willing to give Connecticut quite a bit of upfront money for the right to collect future tolls and operate/ maintain the toll system. However, the public perception of "selling our existing roads" to private companies would be significant, and the State would be trading a one-time upfront payment for a long-term revenue stream that it could use itself, without paying the private sector profit. A stronger argument could be made if the private sector also were obligated to maintain and rehabilitate some or all of the highway on which the tolls were collected. However, long-term maintenance and preservation agreements could be done even without toll revenue. Privacy concerns are likely to be moderate because motorists would have to disclose personal information unless choosing to divert to an alternate route but would only have to disclose that information at one single point of entry.

Concept C: Toll Trucks On Limited Access Highways



Truck only tolling is simply the charging of tolls on heavy commercial trucks and can be done to generate revenue and also provide for system efficiency. The thought is that trucks cause much more damage to infrastructure and that current taxes and fees (e.g., fuel tax and others) do not reflect their true cost on infrastructure. By tolling heavy trucks in particular, the full cost of their impacts could be recouped. In this concept, trucks would be subject to mileage-based tolls on Interstates 95, 84, 395, 91, 691, and 291 throughout their length in Connecticut, and on the limited access sections of Routes 2, 8, and 9. Route 15 was not included in this concept because trucks are prohibited. All trucks would be tolled all of the time at variable rates depending on truck size.

This concept raises significant revenue in excess of cost since it involves no new highway construction, between $3.9 and 11.2 billion at toll rates of 30, 45 and 60 cents per mile. However, the diversion of heavy trucks onto local roads (even if not in sufficient quantity to measurably increase congestion) raise significant economic, environmental, safety and equity issues. **Tolls aimed exclusively at trucks are likely to be strongly opposed by the state and national trucking industry.**

Transportation Impacts (Highway and Transit)

Overall diversion rates to local routes are forecast to be small even at the higher toll rates. Increasing tolls from 30 cents per mile to 60 cents per mile increases diversion rates by less than one percent, but this is not expected to increase vehicle miles of travel (VMT) because the diversion routes are typically more direct than the limited access highways (albeit slower). As a result, vehicle hours of travel is forecast to increase from three to six percent due to truck travel on more congested local routes. **These diversion rates do not result in quantifiable changes in traffic conditions.** Transit should not be affected by this concept.

Implementation Schedule

This project requires little highway construction but extensive construction of tolling systems and could be **fully operational by 2020.**

Financial Summary

This concept would result in significant new revenue, but also would entail significant startup costs for the toll system and ongoing collection costs. The initial cost of the toll collection system would consume from 10 to 26 percent of the present value of net revenues depending on the toll rate (with net revenues already accounting for annual operating and capital cost of collection).

Financial Summary (Millions of 2008 Dollars) Concept C Toll Trucks on Limited Access Highways	Average Per Mile Toll Rate		
	$0.30	$0.45	$0.60
Present Value of Net Toll Revenue	5,061.2	8,468.5	12,256.8
Initial Capital Cost of Toll Collection System	1,349.6	1,349.1	1,348.7
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	**3,711.6**	**7,118.9**	**10,908.1**

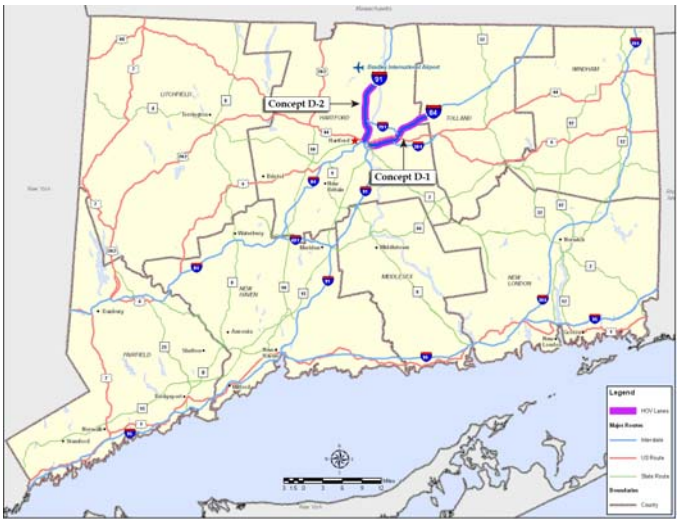
Environmental, Economic, Equity and Safety Impacts

Diversion of trucks to local routes would result in environmental impacts to community ambiance, air quality, bicycle/pedestrians, and noise. While the number of diverted trucks is not large in terms of increasing congestion on local routes, there is a significant perception and reality of large trucks traveling down small local routes which often serve as the "Main Street" of quaint rural New England town centers and of busy suburbs. Truck tolls are likely to raise economic and equity issues in terms of the impacts to trucking companies and to Connecticut businesses and consumers to the extent these costs are passed down the delivery chain. The diversion of trucks to local routes is likely to raise greater safety issues than the diversion of autos.

Legal and Institutional, Public Private Partnerships, and Privacy Issues

Legal challenges will certainly arise and the ability to institute this program on facilities built with Federal dollars may be limited. While a public private partnership could be used to bring capital forward to construct and install the necessary toll collection equipment, public acceptance could be made more difficult if the public thought large streams of revenue were going to a private consortium. Privacy concerns are small because truckers and trucking companies already are required to submit substantial information. However, the trucking industry is adamantly opposed to special truck tolls and can be expected to vociferously oppose this concept.

Concept D: HOV to HOT Lane Conversion



This concept involves converting the HOV lanes on I-84 (Concept D-1) and/or I-91 (Concept D-2) in the Hartford area to HOT lane operation, allowing single-occupant vehicle drivers to pay to use the lanes along with HOVs which would continue to travel for free. The two HOV lanes have significant excess capacity to "sell" at most times of the day. However, congestion levels on the parallel free general purpose lanes are not high at most times of the day. The success of this concept is dependent on the degree of congestion in the parallel general purpose lanes which would make drivers willing to pay for an uncongested trip. Currently, the I-91 HOV lane carries 6.7 percent of total corridor traffic, and the I-84 lane carries 5.4 percent.

This is a relatively easy and noncontroversial project to implement, but has **limited congestion reduction potential, and the preliminary financial evaluation shows that it would be unlikely to cover operating expenses**. There would be few, if any, negative impacts since free flow speeds will be maintained in the HOV/HOT lanes, and no diversion from the general purpose lanes is expected.

Transportation Impacts (Highway and Transit)

In 2015, the I-84 HOT lane is forecast to attract about 3,000 vehicles during peak hours in the peak travel direction compared to about 12,000 vehicles in the GP lanes, of which 1,400 (47 percent) would pay a toll and the rest would be free HOVs. A typical toll rate would be $1, although that rate would vary dynamically based on actual traffic conditions. The I-91 HOT lane would have similar peak-period performance – 2,700 HOT lane trips of which 1,100 would pay a toll (41 percent) averaging 85 cents, versus 8,600 GP lane trips.

On I-84, average speed across all lanes would increase by 4.4 mph during the peaks and by 2 mph when averaged over the entire day, with savings in vehicle hours of travel of 8.1 percent in the peaks and 3.4 percent daily. On I-91, speeds would improve by 7 mph in the peak and 4 mph on a daily basis, resulting in overall vehicle hours of travel in the corridor reduced by 13.4 percent in the peak and 7.4 percent daily. We would not expect to see diversion of traffic away from the Interstate to other routes, since this concept simply gives general purpose lane drivers an opportunity to move into the HOV lane – it does not toll the existing general purpose lane. There should be no change to transit in the corridor, since buses already can use the HOV lane, but the traffic would be monitored to ensure free-flowing conditions in the HOT lane. Over time, it is possible that some people may choose to shift from buses to driving alone if the HOT lane option were there, although this has not been observed on other HOT lane implementations around the country.

Implementation Schedule

These projects require little capital construction and could be **open to traffic by 2014.**

Financial Summary

Our preliminary analysis suggests that on I-84 there would not be sufficient congestion to result in toll revenue adequate to pay for the ongoing operations costs of toll collection, much less any of the initial capital expenses of toll collection. It is not unusual for HOT lane projects to have low net income inadequate to pay back the initial capital costs, but for a project sponsor to move forward with a toll project that cannot cover operational expenses would suggest a project of extraordinary value to the public, which is probably not present in this case. In the case of Concept D-2, the I-91 HOT lane, we found net toll revenue to exceed annual costs by just under a half million dollars over a 30-year period, which may be close enough to warrant a second look in a more detailed study.

Financial Summary (Millions of 2008 Dollars) Concept D: HOV to HOT Lane Conversion	D-1: I-84	D-2: I-91
Present Value of Net Toll Revenue	(40.0)	0.4
Initial Capital Cost of Toll Collection System	13.6	28.4
Total Highway Construction Costs	0	0
Life-Cycle Surplus/(Shortfall)	**(53.6)**	**(28.0)**

Environmental, Economic, Equity and Safety Impacts

Air quality and energy consumption should be improved due to reduced congestion. No other significant environmental, economic, equity impacts are anticipated. There should be no significant safety impacts although the higher traffic volumes in the HOT lanes relative to today's HOV lanes will require greater monitoring.

Legal and Institutional, Public Private Partnerships, and Privacy Issues

HOV to HOT lane conversion had previously been allowed only as part of the Value Pricing Pilot Program, but since SAFETEA-LU, it has been mainstreamed, and can be done in any state. This means that all that is required is a toll agreement among the FHWA, ConnDOT, and the operating agency in Connecticut. Regarding Public Private Partnerships, Connecticut could consider an operations and maintenance contract (including toll collection) funded from toll revenues, sharing revenues beyond certain estimates with the private provider, and using the public portion of shared revenues to offset the capital costs of conversion. There are no significant privacy issues associated with this concept. HOT lanes have been instituted nationally.

Concept E: Convert Highway Shoulders to HOT Lanes

The motivation for converting shoulders to HOT lanes would be identical to converting HOV lanes to HOT lanes. By opening up the shoulder to traffic there is the potential to carry more people through the corridor and possibly generate some amount of revenue. The typical issues with these types of projects is the amount of engineering and reconstruction that would be necessary to make the shoulder a safe travel lane. Typically these costs are higher than anticipated and these projects do not move beyond the study phase. **There are no projects like this in the United States**, although Minnesota DOT is advancing something like this through the Federal Urban Partnership Program.

Based on past studies by ConnDOT and similar operations around the country, we felt that I-95 and Route 15 between the New York line and the Bridgeport area, and on sections of I-91 and I-84 in the Hartford area, might have the highest potential for this concept. However, the minimum clearances for HOT lane operation generally do not exist, making it very difficult to create the type of continuous HOT lane needed for effective operation without major bridge reconstruction; and creating the necessary roadway width would be prohibitively expensive – effectively the same in many areas of adding a new highway lane in one or both directions.

This finding is consistent with the results of earlier studies by ConnDOT which concluded that while limited use of shoulders at various exit ramps to increase capacity at certain locations might be possible, the full use of continuous shoulders for additional highway capacity (such as a shoulder HOT lane) is not a viable concept. **Therefore, this concept was not further analyzed.**

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Concept F: Toll Individual Highways Needing New Capacity

This concept was applied to the same two roadway segments tested in Concept A – I-95 from New Haven to the Rhode Island line (Concept F-1), and I-84 from Waterbury to the New York line (Concept F-2). Instead of adding a tolled express lane to otherwise free general purpose lanes as in Concept A, in Concept F each highway would be widened by one lane in each direction and the entire segment would be tolled. The motivation for this concept would be to raise revenue to pay for the highway widening, while also potentially providing a tool for traffic management. We evaluated three levels of tolls to provide an illustration of the revenue potential and impacts: $0.10, $0.20, and $0.30 per mile, rates that are generally in line with toll roads elsewhere.

Tolling existing highways has never been done, and there is likely to be significant opposition, even if the toll revenue is used to fund the highway improvement.

Interestingly, as the per-mile toll rate is increased, the reduction in I-95 traffic may result in traffic levels that do not require an extra lane, but can be accommodated on the existing two lanes. This is essentially congestion pricing. A per-mile toll rate of $0.20 resulting in an estimated 14 percent reduction in traffic on I-95 would essentially be correcting for approximately 15 years of growth. A relatively low per-mile toll rate that can still generate enough revenue for the improvements, while minimizing and/or mitigating the potential diversion to U.S. 1, would seem to be the optimal solution.

Transportation Impacts (Highway and Transit)

This concept would significantly improve traffic operations on the existing highways, but would divert considerable traffic to free parallel alternate routes – Route 1 along I-95 and a series of routes in the I-84 corridor. As a result, overall traffic operations in the corridor would be about a wash at the lowest tested toll level (10 cents), and would significantly degrade at the two higher levels due to the greater diversion to local routes. There also would likely be some diversion of trips to transit, which is relatively more robust in the I-84 corridor than in the I-95 corridor.

Implementation Schedule

These projects require significant roadway work and would not be **open to traffic until 2016**.

Financial Summary

Tolling existing highways will raise a significant amount of revenue, even at the lowest toll rates, resulting in more than enough revenue to cover the cost of toll collection and construction. It is important to note that the financial analysis below does not account for the costs of bonding or

financing through other mechanisms, such as public private partnerships. If, for example, the projects were to be financed through traditional nonrecourse revenue bonds, the effects of debt service coverage ratios (perhaps as high as 1.75), funding debt service reserve accounts, capitalized interest during the construction period, and issuing costs could cut the value for financing to 45 percent of the values shown below. This means that the lowest toll rate might not be sufficient to fully fund construction and additional public funding would be required.

Financial Summary (Millions of 2008 Dollars)	Per Mile Toll Rate		
Concept F-1: I-95	**$0.10**	**$0.20**	**$0.30**
Present Value of Net Toll Revenue	2,959.5	6,181.8	8,509.5
Initial Capital Cost of Toll Collection System	436.9	407.8	373.5
Total Highway Construction Costs	1,468.5	1,468.5	1,468.5
Life-Cycle Surplus/(Shortfall)	**1,054.1**	**4,305.5**	**6,667.6**
Concept F-2: I-84			
Present Value of Net Toll Revenue	1,716.0	3,623.0	5,002.8
Initial Capital Cost of Toll Collection System	267.4	250.8	230.3
Total Highway Construction Costs	404.7	404.7	404.7
Life-Cycle Surplus/(Shortfall)	**1,043.9**	**2,967.6**	**4,367.9**

Environmental, Economic, Equity and Safety Impacts

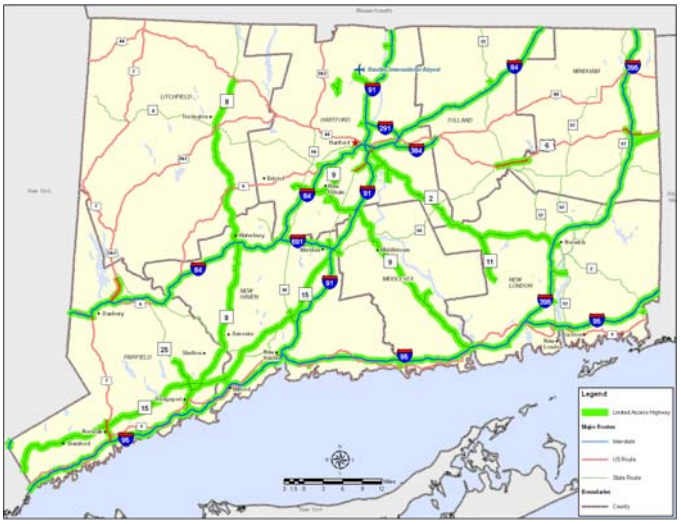
Most environmental measures would be negatively impacted to at least a small degree due to the overall degradation in corridor traffic operations resulting from the diversion of traffic to local routes. Significant community ambiance and bicycle/pedestrian impacts would be experienced in the I-95 corridor due to the diversion of traffic to Route 1 which serves as the "Main Street" of a series of rural town centers. Unlike in Concept A, all users who stay on the highway will have to pay a toll. Those who are willing to do so will experience some improvement in level of service, but this is relatively minor particularly on I-95 where congestion tends to be limited to summer Friday afternoons. In equity terms, there are limited alternate routes and transit options for those choosing not pay. There are likely to be safety impacts due to the increased volume on local roads.

Legal and Institutional, Public Private Partnerships, and Privacy Issues

Federal approval to toll the Interstates could be sought under the Interstate System Reconstruction and Rehabilitation Toll Pilot Program. Revenue generated under this program, however, may only be used for debt service, reasonable return on investment to any private person financing the project, and necessary costs for the improvement and proper operation and maintenance of the toll facility. Toll revenue may not be used for operation and maintenance of any other facility or for any other transportation project.

This revenue stream may attract private sector interest in a long-term concession, however, such a PPP would appear to be giving a public highway – currently toll free – to the private sector with the private sector profiting from the deal at the expense of the public. It is possible to build in revenue sharing provisions. The privacy concerns would be great because all lanes would be tolled meaning the mandatory disclosure of personal information is hard to avoid for some drivers unless they take a different road completely – which is not an equivalent option.

Concept G-1: Toll All Limited Access Highways



This concept would toll all of the limited access highways in the State (Interstates 95, 84, 395, 91, 691, and 291 and the limited access sections of Routes 2, 8, 9, and 15) in order to raise revenue for transportation improvement projects. We assumed that tolls would be constant over the course of the day and we tested three illustrative toll levels for autos: $0.030, $0.045, and $0.060 per mile, with truck tolls proportionately higher by class. Over the course of 30 years, this concept would **raise between $9 and $22 billion in revenue** in excess of the cost of tolling, depending on the toll rate. There could be some economic, environmental, equity and safety impacts along the diversion routes many of which serve as "main streets" of rural town centers, and bustling dense suburbs along Connecticut's Southwest coast. It could be possible, however, to mitigate these negative impacts through appropriate improvements paid for with the toll revenue. Current Federal law, however, prohibits spending of revenue from Interstate tolling for any other purpose than operating, maintaining, rehabilitating or expanding the highway on which it is collected, which could reduce the potential for this to be a general-purpose transportation funding instrument.

Transportation Impacts (Highway and Transit)

This concept would result in some vehicle diversion from all of the tolled routes to parallel local routes. The greatest diversion would occur on I-91 between Hartford and New Haven, with roughly 2,600 vehicles diverting daily in 2015 and 3,000 in 2030. This equals about 260 to 300 vehicles per hour assuming no diversion during nighttime hours. **Diversion rates never exceed 3 percent of the limited-access highway volume in any corridor.** This diversion is not large enough to cause major traffic problems on the diversion routes. No significant diversion to transit is forecast. At toll level 2, ($0.045 per mile), VHT is forecast to increase by 2.2 percent in 2015 and by 3.4 percent in 2030.

Implementation Schedule

These projects would have significant implementation challenges and would not **open to traffic until 2020**.

Financial Summary

This concept could raise considerable revenue, but the use of that revenue, at least on the Interstate portion of the system, would be limited to improvements to the highway on which it was collected.

Financial Summary (Millions of 2008 Dollars) Concept G-1: Toll All Limited Access	Per Mile Toll Rate (Autos) $0.03	 $0.045	 $0.06
Present Value of Net Toll Revenue	11,437.9	18,489.1	25,708.8
Initial Capital Cost of Toll Collection System	1,678.3	1,677.4	1,675.3
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	**9,759.6**	**16,811.7**	**24,033.5**

Environmental, Economic, Equity and Safety Impacts

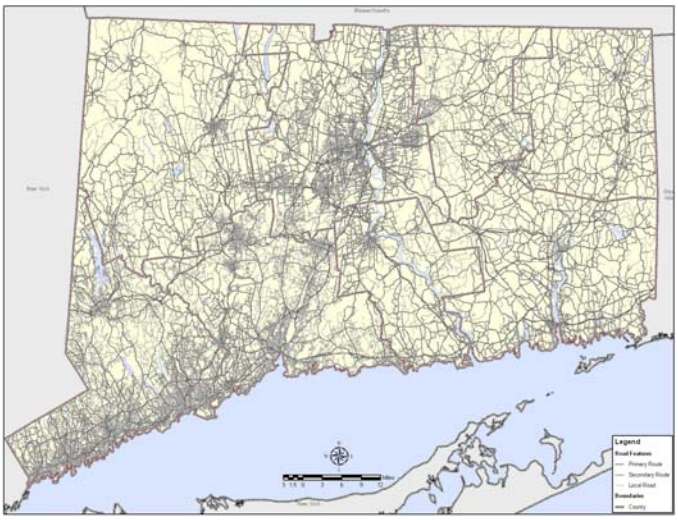
Environmental impacts resulting from the diversion would be minor to water quality, energy consumption and environmental justice, and potentially more significant to air quality, community ambiance, bicycle/pedestrian conditions, noise, and cultural/historic resources. Economic impacts would be felt by all users of these roadways across the State. Those drivers who chose to remain on the tolled highways and pay the toll would experience some improvement in congestion, while those who diverted would experience increased congestion but no toll. Truck operations would be similarly impacted. These impacts would be mitigated by the extent to which toll revenue is used to improve the State's transportation systems.

In regard to equity, low- and moderate-income residents live all over the State and use these roadways. In many of the more rural parts of the State, alternative transit service is limited. These **impacts could be mitigated to the extent that revenue from the tolls is used to improve the highways and/or transit services**, and/or rebates are provided to low-income residents via other means of taxation. Safety impacts would be similar to other alternatives where traffic is diverted onto local roadways.

Legal and Institutional, Public Private Partnerships, and Privacy Issues

A statewide program for tolling on all limited access facilities in the State would likely require a patchwork of programs to obtain Federal permission to toll on highways constructed with Federal funding. Tolling on highways not constructed with Federal funding would require only approval of the state legislature. This concept may be more feasible under the reauthorization of SAFETEA-LU if the new bill allows for more tolling opportunities than currently exist. Statewide tolling would be primarily a new form of transportation funding mechanism and, therefore, a PPP project for implementation could be awarded based on the lowest cost of administration as a percentage of revenues collected. If all limited-access facilities are tolled, privacy concerns would be very high because no other equivalent alternatives exist for the drivers (other than much slower roads that are not limited-access).

Concept G-2: Tax All Vehicle Miles Traveled



Concept G2 is significantly different from all other concepts analyzed. Rather than tolling-specific roadways, it proposes to toll all vehicle movements in the State. This concept is typically referred to as a vehicle miles of travel (VMT) fee, and is frequently proposed to either replace or supplement the traditional motor fuel tax. Therefore, two scenarios have been analyzed – one in which the VMT fee is in addition to the existing motor fuel tax, and the other in which it replaces the tax. In each case, three per-mile toll levels were tested – $0.02, $0.04, and $0.06 for autos, with proportionately higher rates for the three truck classes. As the motor fuel tax loses productivity over time due to increasing fuel economy, this concept has the potential to replace the motor fuel tax as the primary revenue source for highways. In addition to the funding component, mileage-based pricing also might allow for congestion pricing by time of day and type of vehicle.

Moving to this type of pricing system would be controversial and take some time to implement. It would require next generation Global Positioning System (GPS) technology to collect the toll and most likely a Federal policy to establish standards across the country. While it faces institutional and implementation challenges, and is probably not ripe for full deployment in the near future, over the long term, it has the highest potential for achieving both goals of tolling for revenue generation and system efficiency. This has never been attempted but Oregon has implemented a pilot project to test this concept.

Transportation Impacts (Highway and Transit)

The lowest of the tested toll rates would essentially equal the taxation rate of the current state motor fuel tax. Therefore, no traffic impacts would be expected from this case. When applied on top of the existing motor fuel tax, **this concept results in a reduction of VMT of 2.3 to 6.8 percent** depending on the toll level tested. When applied as a replacement for the motor fuel tax, VMT is forecast to go down from zero (in the case of Toll Level 1 at two cents) to 4.5 percent. By reducing VMT, some reduction in congestion also should be expected although more detailed analysis would be required to assess the impact on travel speeds and VHT. **No route diversion is expected because all vehicular travel would be tolled**. If VMT tolling were implemented, it would be possible to vary tolls by time of day or historical congestion levels to achieve an aggressive congestion pricing concept, affecting all travel in the State.

Implementation Schedule

This concept has not been fully implemented anywhere in the world, therefore, it would be too speculative based on this limited analysis to estimate an implementation schedule.

Financial Summary

It was not possible to precisely estimate the overall financial performance of this concept. It is unknown today what the toll collection costs would be for a future GPS-based toll collection system. Also, the concept could be implemented either to augment or replace entirely the State's existing motor fuel tax. However, it was possible to generate order of magnitude estimates based on forecast future traffic volumes for both the scenarios of replacing the motor fuel tax and leaving it in place.

Financial Summary (Millions of 2008 Dollars)	Per Mile Rates (Autos)		
Concept G-2: Toll All VMT and Gas Tax Stays	**$0.02**	**$0.04**	**$0.06**
Present Value of Net Toll Revenue	15,774.9	30,873.6	45,296.3
Initial Capital Cost of Toll Collection System	Unknown	Unknown	Unknown
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	Unknown	Unknown	Unknown
Concept G-2: Toll All VMT and No Gas Tax			
Present Value of Net Toll Revenue	16,113.0	31,549.8	46,310.5
Initial Capital Cost of Toll Collection System	Unknown	Unknown	Unknown
Total Highway Construction Costs	0	0	0
Life-Cycle Surplus/(Shortfall)	Unknown	Unknown	Unknown

Environmental, Economic, Equity and Safety Impacts

The only anticipated environmental impacts from this concept would be improvements in air quality and reductions in energy consumption due to reductions in VMT/VHT. There are several potential economic and equity impacts if Connecticut was to implement this concept on its own. The State is part of a small, densely populated and developed region consisting of the five other New England states, the New York City metropolitan region (which includes parts of New Jersey), and the rest of New York State. It is possible that some through traffic might be diverted around the State. While this diversion might reduce congestion in parts of Connecticut, it also could reduce economic activity related to pass through traffic. Trucking costs could impact businesses and consumers to the extent higher costs are passed on down the delivery chain. All of these impacts could be mitigated over time if the revenue is used to improve transportation systems in the State. Low- and moderate-income residents of the State could be negatively impacted particularly given the limited transit options in many parts of the State. These impacts could be mitigated by investing some of the new revenue in improved transit services, and/or providing rebates through other tax instruments. Travel safety is likely to be improved through reductions in VMT.

Legal and Institutional, Public Private Partnerships, and Privacy Issues

It currently is not possible to toll all existing Federally funded highway capacity without a patchwork of Federal programs. Tolling of all mileage would involve pricing Federal, state, and locally operated roadway facilities which would require strong coordination among all parties. Statewide tolling would be primarily a new form of transportation funding mechanism and, therefore, a PPP for project delivery, maintenance and operations could be awarded based on the lowest cost of administration as a percentage of revenues collected. The option of tolling all mileage driven in Connecticut would involve recording mileage of all trips within the State, and issues with collection from out-of-state travelers would be significant unless this were rolled out nationwide. This system would be the most intrusive of all concepts in terms of privacy concerns regarding roadway usage, because no alternatives (e.g., nontolled routes) exist.

Concept H: Congested Corridor Tolling

The objective of this type of congestion pricing is two-pronged. First, congestion pricing aims to change people's travel behavior so that less valuable trips are diverted to uncongested routes, modes, or time periods. The result would be less congestion and delay. Second, the revenue generated from a congestion pricing plan could support highway improvements, transit services or other socially beneficial projects.

The state highways shown by ConnDOT and others to have the most serious and recurring congestion problems are the western portions of I-95 and I-84, portions of I-91 and I-84 in the Hartford area, and much of CT Route 15. For this study, we have chosen the highways in southwestern Connecticut as an illustrative example of congested corridor tolling: I-95 between the New York border and the Bridgeport/Stratford town line, and Route 15 between the New York border and the Milford/Stratford town line. We also considered including the only other through route in this corridor – Route 1 – in the congestion pricing concept, but found that there were too many signalized intersections and curb cuts for this to be technically viable.

Ideally, congestion pricing would apply pricing in such a way to eliminate congestion. In our evaluation of this corridor, however, we found that achieving this objective would be virtually impossible during many time periods. Therefore, we set toll rates that could achieve a 10 percentage-point reduction in the volume/capacity ratio on the tolled highways, and evaluated the revenues and impacts that this concept would produce.

This concept would raise $32 billion in revenue in excess of the cost of tolling (there are no construction costs). **Significant roadway diversion would occur** and there would be some diversion to transit. These diversion levels would raise economic, environmental, equity and safety concerns in the impacted communities.

Transportation Impacts (Highway and Transit)

The largest diversion would occur from I-95 southbound in the AM peak period. Approximately 2,000 vehicles would divert in 2015, increasing to almost 3,900 in 2030. There would be lower diversion levels on Route 15, and during the PM peak period on both roadways. Most of the diverted traffic would go onto the parallel Route 1. This road already experiences high levels of congestion throughout the day due to its extensive commercial activity. **Route 1 would not be able to efficiently handle these diversion rates**. There would be no need to toll either road during the nighttime hours because of relatively low congestion levels, and Route 15 would not be tolled during the midday period. Most diversion would be by autos, but between 250 and 500 tractor trailers would divert from I-95. There is likely to be a small amount of diversion to transit which the robust transit services in this corridor is capable of handling, with the main constraint being the supply of park-and-ride spaces at some Metro North Railroad stations.

Implementation Schedule

Due to the speculative nature of this concept an implementation schedule has not been prepared.

Financial Summary

This concept could be expected to generate over $35 billion in toll revenue over and above the cost of collection.

Financial Summary (Millions of 2008 Dollars) Concept H: Toll Congested Highways	
Present Value of Net Toll Revenue	38,823.8
Initial Capital Cost of Toll Collection System	355.0
Total Highway Construction Costs	0
Life-Cycle Surplus/(Shortfall)	**38,468.8**

Environmental, Economic, Equity and Safety Impacts

Most of the diverted traffic would go onto the parallel Route 1. This diversion would result in minor environmental impacts to water and air quality, noise and energy consumption, and major impacts to community ambiance, bicycle/pedestrian operations, and cultural/historic facilities. Route 1 in this part of the State serves as the "Main Street" for a series of vibrant and densely developed suburban communities. Significant traffic diversion, in particular large trucks, would have a major impact on the quality of life in these communities, economic activity, and on vehicular safety. While considerable traffic on I-95 represents local trips traveling a couple of exits which ideally is better served on local roadways, the lack of roadway capacity today makes this diversion problematic. These environmental and economic impacts could be mitigated to the extent that the revenue from this concept is used to improve transportation systems in this part of the State.

In terms of economics and equity, the imposition of these tolls in just the southwestern part of the State could disadvantage this part of the State relative to the rest of the State, and relative to the rest of the New York City metropolitan region of which it is a part. Of course, most highways, bridges and tunnels in the rest of the NYC region already are tolled. In general, this region has one of the highest per capita income levels in the nation. However, there are notable exceptions such as the city of Bridgeport which has large concentrations of low- and moderate-income residents. Ultimately, the determination of economic and equity impacts would depend heavily on how the significant toll revenue was spent. Traffic diversions, including tractor trailers, to Route 1 would be a significant safety concern.

Legal and Institutional, Public Private Partnerships, and Privacy Issues

Tolling on I-95 and Route 15 would require Federal and state permission. A PPP project for implementation could be awarded based on the lowest cost of administration as a percentage of revenues collected. Privacy concerns would be moderate because motorists would have the option to divert to the slower alternative of Route 1.